COURSE
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MODULES

D. 4.3

METVET

SYLLABUS

Aluminium & Metal Construction Technicians

Co-funded by the
Erasmus+ Programme
of the European Union

SYLLABUS

Aluminium & Metal Construction Technicians

METVET

JOINT HIGHER VET COURSE IN THE METAL SECTOR

Co-funded by the Erasmus+ Programme of the European Union

Erasmus + KA3 Joint Qualifications in VET
597806-EPP-1-2018-1-EL-EPPKA3-VET-JQ

About METVET
JOINT HIGHER VET COURSE IN THE METAL SECTOR

Metal, machinery and related trades workers are engaged in a range of skilled activities. Those workers need to understand work organization, and the specialist materials and tools to be used in their jobs, as well as of the nature and purpose the final product they are engaged in making.

According to Cedefop's European skills and jobs survey (ESJS), the 5 key skills for metal, machinery and related trades workers are job-specific skills, problem solving, teamwork, learning and communication. These skills will support employees in this occupation to also tackle anticipated future skill challenges.

METVET project aims at a competence-based professional generic profile served as a basis for designing competence-based training programs. The underlying idea is that vocational education should enable trainees to acquire the competences needed in their future professions. While working as professionals, they should continue to develop competences in order to be able to react to and anticipate future developments in their work.

The project specifically aims at one hand designing, for Aluminium & Metal Constructions technicians including:

- a professional (qualification) profile & a core curriculum (EQF 5)
- **a corresponding VET program**, including innovative teaching methods
- a qualification standard (according to ISO/IEC17024) for evaluation & certification.

To achieve those targets, experts from Greece, Italy, Germany and Belgium, following their involvement in projects and discussions with national and European stakeholders are joining forces to create a support for policy reform (METVET), creating a European offer of adapted and innovative initial training and certification. The training will concern skills' developments (fabrication and installation of aluminium frames), as much as international standards, regulations and certification awareness, based on common transnational curricula.

METVET

JOINT HIGHER VET COURSE IN THE METAL SECTOR

Sustainability will be the driving force changing the way we work and live in the 21st century.

The Metvet Team

Welcome

We have created this publication with the intention of providing a modular training material for Aluminium & Metal Constructions technicians' trainees and relevant trainers.

Our vision was to create a high-quality publication that will not only focus on job-related skills but also on transversal ones, such as entrepreneurship, ICT and interdisciplinary skills, always according to the previously defined curricula.

The Metvet Team

A Joint Venture Networking

SYLLABUS

Aluminium & Metal Construction Technicians

TRAINING
LEARNING
MODULES

Course Learning Modules

Designed with the weighting of the curricular elements in place and include content subsets with their own set of learning objectives

01 MODULE

Materials technology & applications in constructions

Understanding materials' properties, yields to efficient and better off constructions

02 MODULE

Production facilities and equipment

Selection of appropriate tooling & suitable production layout organization leads to increased productivity and cost minimization

03 MODULE

Production of aluminium constructions

Processes for the production of an aluminium construction industry, in order to meet the energy-related targets

04 MODULE

Production of metal constructions

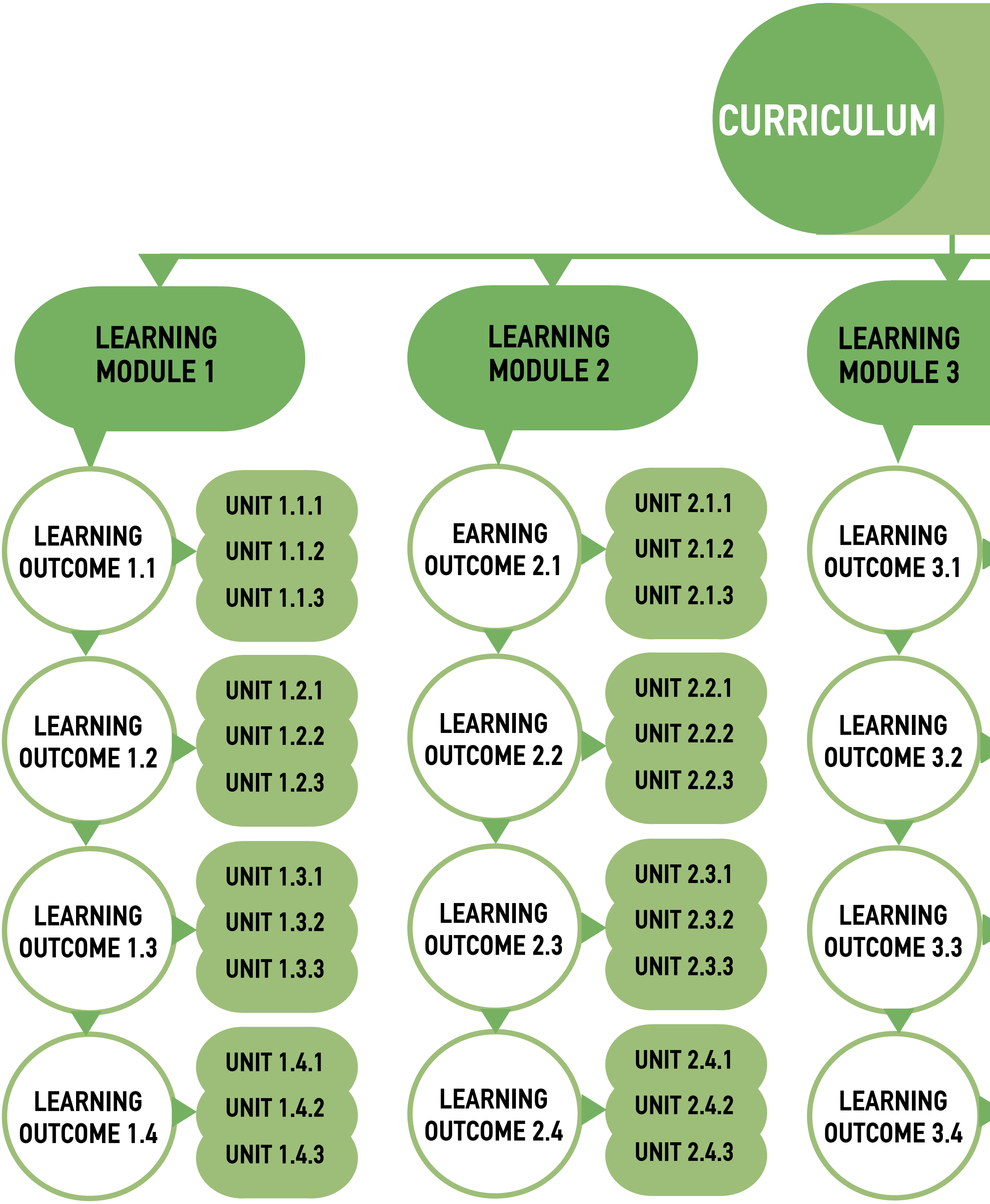
Administrative and steel production processes compliant with National and European Legislation

05 MODULE

Constructions Installation

Selection and application methods for installation pertinent to building elements, geographical area, residence's type etc.

DISCLAIMER


CURRICULUM
LEARNING MODULE 1
LEARNING OUTCOME 1.1
UNIT 1.1.1
UNIT 1.1.2
UNIT 1.1.3
LEARNING OUTCOME 1.2
UNIT 1.2.1
UNIT 1.2.2
UNIT 1.2.3
LEARNING OUTCOME 1.3
UNIT 1.3.1
UNIT 1.3.2
UNIT 1.3.3
LEARNING OUTCOME 1.4
UNIT 1.4.1
UNIT 1.4.2
UNIT 1.4.3
LEARNING MODULE 2
EARNING OUTCOME 2.1
UNIT 2.1.1
UNIT 2.1.2
UNIT 2.1.3
LEARNING OUTCOME 2.2
UNIT 2.2.1
UNIT 2.2.2
UNIT 2.2.3
LEARNING OUTCOME 2.3
UNIT 2.3.1
UNIT 2.3.2
UNIT 2.3.3
LEARNING OUTCOME 2.4
UNIT 2.4.1
UNIT 2.4.2
UNIT 2.4.3
LEARNING MODULE 3
LEARNING OUTCOME 3.1
LEARNING OUTCOME 3.2
LEARNING OUTCOME 3.3
LEARNING OUTCOME 3.4

ALUMINIUM & METAL CONSTRUCTION TECHNICIANS

JOINT HIGHER VET COURSE IN THE METAL SECTOR

METVET

UNIT 3.1.1
UNIT 3.1.2
UNIT 3.1.3

UNIT 3.2.1
UNIT 3.2.2
UNIT 3.2.3

UNIT 3.3.1
UNIT 3.3.2
UNIT 3.3.3

UNIT 3.4.1
UNIT 3.4.2
UNIT 3.4.3

LEARNING MODULE 4

LEARNING OUTCOME 4.1
- UNIT 4.1.1
- UNIT 4.1.2
- UNIT 4.1.3

LEARNING OUTCOME 4.2
- UNIT 4.2.1
- UNIT 4.2.2
- UNIT 4.2.3

LEARNING OUTCOME 4.3
- UNIT 4.3.1
- UNIT 4.3.2
- UNIT 4.3.3

LEARNING OUTCOME 4.4
- UNIT 4.4.1
- UNIT 4.4.2
- UNIT 4.4.3

LEARNING MODULE 5

LEARNING OUTCOME 5.1
- UNIT 5.1.1
- UNIT 5.1.2
- UNIT 5.1.3

LEARNING OUTCOME 5.2
- UNIT 5.2.1
- UNIT 5.2.2
- UNIT 5.2.3

LEARNING OUTCOME 5.3
- UNIT 5.3.1
- UNIT 5.3.2
- UNIT 5.3.3

LEARNING OUTCOME 5.4
- UNIT 5.4.1
- UNIT 5.4.2
- UNIT 5.4.3

Contents

01 MODULE

Materials technology & applications in constructions

Erasmus+

Contents

JOINT HIGHER VET COURSE IN THE METAL SECTOR

02 MODULE

Production facilities and equipment

Contents

03 MODULE

Production of aluminum constructions

Contents

JOINT HIGHER VET COURSE IN THE METAL SECTOR

MODULE 04

Production of metal constructions

Contents

05 MODULE

Constructions Installation

Erasmus+

MODULE

Materials technology & applications in constructions

Understanding materials' properties, yields to efficient and better off constructions

01

MODULE

Materials technology & applications in constructions

Understanding materials' properties, yields to efficient and better off constructions

Introduction - Learning Objectives
Special features of materials used in Aluminium and Metal Constructions

Aluminium and Metal constructions quality strongly depend on the properties of materials used, both during the production phase and as parts of the final product. The evolution of materials technology has delivered alloys with enhanced properties including mechanical, thermal, corrosion protection, fire resistant etc. In this module special features of materials used in Aluminium and Metal Constructions are presented and analysed, providing a wide range of technical solutions suitable for various applications.

This module deals with material technology and its applications in construction. You will become familiar with metal alloys and different profiles made through different production methods and for different uses.

You will also have knowledge of a wide range of fillers of different materials and technologies, most notably glass and you will be able to select and dimension the permissible thickness based on the technical characteristics.

Applications of materials for aluminium constructions are also a basic chapter concerning where and how materials are used, their types of fenestrations and other fields of aluminium use, emphasizing on glass as much as outside frames, such as railings etc.

Furthermore, we will examine the profiles applications of different alloys to steel structures and the interaction of metal with aluminium structures.

Knowledge Objectives to be achieved through this learning module are:

- Aluminium alloys
- Alloys for extrusion, profiles, casting, accessories
- Metal alloys, steels -Stainless steel
- Profile & bending shapes
- Technical features / configuration / closed profiles - welding options
- Technical characteristics & dimensioning of glazing for fenestrations
- Technical characteristics – dimensioning of synthetic panels coverings
- Typologies, casement, sliding etc. of fenestrations and their features
- Curtain walling systems and their features
- Outdoors systems, fences, pergolas, railing etc.
- Typologies of metal fenestration with different alloys
- Possibilities of fire-resistant constructions
- Metal-to-aluminium co-operation in metal pre-frame and other mixed- curtain walling, atrium-metal applications

For the Teacher

Learning Outcome 1.1
Familiarization with metal alloys & profiles

Learning Unit 1.1.1 - 4h
Aluminium alloys. Alloys for extrusion, architectural profiles, casting, hardware

Learning Unit 1.1.2 - 3h
Metal alloys, Steel, Stainless steel. Profile / bending shapes

Learning Unit 1.1.3 - 3h
Technical features / sheet bending / closed profiles - welding techniques

Learning Outcome 1.2
Technical specifications of filling materials

Learning Unit 1.2.1 - 6h
Technical characteristics & dimensioning of glazing for fenestrations

Learning Unit 1.2.2 - 2h
Technical characteristics & dimensioning coverings

Learning Unit 1.2.3 - 2h
Technical characteristics / dimensioning synthetic panels coverings

Learning Outcome 1.3
Applications for aluminium constructions

Learning Unit 1.3.1 - 6h
Fenestration, shutters, roller shutters typologies and their features

Learning Unit 1.3.2 - 2h
Curtain walling systems and their features

Learning Unit 1.3.3 - 2h
Outdoors systems, fences, pergolas, railing etc.

Learning Outcome 1.4
Metal constructions applications & interaction with aluminium structures

Learning Unit 1.4.1 - 6h
Metal construction products typologies with various alloys

Learning Unit 1.4.2 - 2h
Special constructions

Learning Unit 1.4.3 - 2h
Scope of metal-to-aluminium co-operation in metal pre-frame and other mixed- curtain walling, atrium-metal applications

1.1. Familiarization with metal alloys & profiles

Key Words

Alloy: an alloy is a substance made by melting two or more elements together, at least one of them metal

Extrusion: the process of producing profiles from billet.

Casting: a shaping process by forcing molten metal into a mold cavity.

Rolling: a process in which metal sheet is passed through one or more pairs of rolls to reduce the thickness and to make the thickness uniform.

Paint: the various painting pretreatment and painting stages

Architectural Systems: set of profiles and accessories that fit together, creating various combinations.

Hardware: mechanisms used to facilitate the movement of architectural systems various parts.

To be achieved upon learning outcome completion

- Aluminium alloys
- Alloys for extrusion, profiles, casting, accessories
- Metal alloys, steels -Stainless steel
- Profile & bending shapes
- Technical features / configuration / closed profiles - welding options

KNOWLEDGE

- Choose the appropriate alloys & equipment for processing according to technical specifications
- Select the appropriate materials
- Knowledge of mechanical-qualitative materials behaviour
- Continuous improvement mindset
- Apply raw materials good practices
- Sheet metal forming cutting and elaboration process for all categories of metal shapes
- Understand basic circular economy aspects
- Implement appropriate profile for elaboration based on technical needs
- Knowledge of mechanical-qualitative materials behaviour
- Apply different soldering techniques

SKILLS

- Understand the consequences of wrong choice
- Choose the ideal alloy in special climatic conditions & aesthetics
- Exploit the ideal cross section in relation to the use of construction

COMPETENCIES

1.1.1. Aluminium alloys, alloys for extrusion, architectural profiles, casting, hardware

The term "alumine" was first given by the chemist Louis Guyton de Morveau (1736-1816) to name some sulphates containing Aluminium. Alumine was derived from the Latin word alumen, which is said to have been used for the potassium aluminium, KAl(SO4)2*12H2O during the Roman period. Aluminium compounds were used in large quantities also in antique pottery, as dyestuff and as an astringent. However, it is not the term "alumine" which is to designate the aluminium ore, but the word "bauxite". This is because in 1821 Pierre Berthier (1792-1867), a mining engineer, discovered that the red soil of the village Les-Baux-de-Provence contained 40-50% alumina, the rest being comprise essentially of iron oxide (Fe3O4) and silica (SiO2)

The ore to produce aluminium is Bauxite. Even though it is widely distributed in the earth's crust, aluminium did not become an industrial metal before the end of the 19th century. **Alumina, the aluminium oxide is one of the most stable of all oxides, and therefore extremely difficult to be reduced to the respective metal.**

The discovery of metallic aluminium is attributed to Sir Humphrey Davy (1778-1829) and his first reference to it as aluminium was in 1809. By electrolysis of molten aluminium salts, he obtained an alloy of aluminium and iron, because he used iron as the cathode.

Alumina is produced from bauxite by complex chemical and electrochemical processes.

The first kilogram of Aluminium manufactured in 1856 was sold at a price slightly higher that Silver, due to the high production cost. After successive improvements in the manufacturing processes, Carl Josef Bayer (also Karl Bayer, 1847-1904) in 1887 Bayer filed a patent for a method to extract alumina from bauxite based on the attack of bauxite by caustic soda.

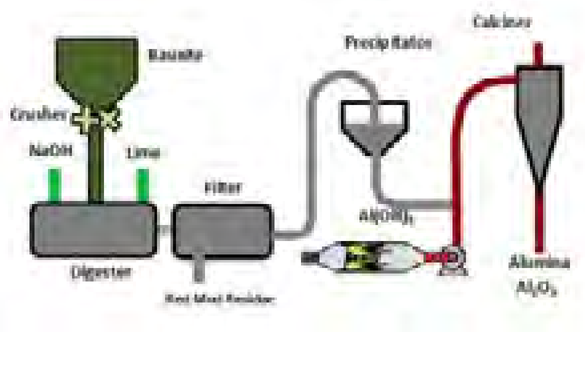


Figure 1.1. Bayer process

From the alumina by electrolysis, aluminium is produced the primary aluminium.

An overview of the process used to produce aluminium is presented in the next figure.

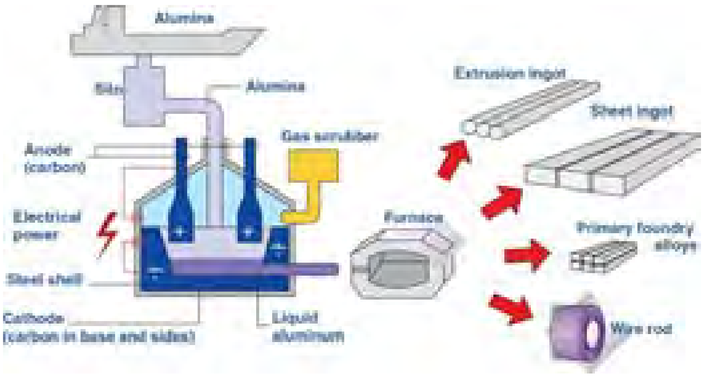


Figure 1.2. Production of aluminium

The physical properties of unalloyed aluminium are given in the next Table. Note that theses refer to the unalloyed Aluminium and not to the alloys that are typically being used in engineering applications.

Table 1.1. Properties of unalloyed aluminium.

Property	Value
Atomic Number	13
Atomic Weight (g/mol)	26.98
Valency	3
Crystal Structure	FCC
Melting Point (°C)	660.2
Boiling Point (°C)	2480
Mean Specific Heat (0-100°C) (cal/g.°C)	0.219
Thermal Conductivity (0-100°C) (cal/cms. °C)	0.57
Co-Efficient of Linear Expansion (0-100°C) (x10-6/°C)	23.5
Electrical Resistivity at 20°C (Ω.cm)	2.69
Density (g/cm3)	26.898
Modulus of Elasticity (GPa)	68.3
Poisons Ratio	0.34

Unalloyed aluminium has only few applications, mainly in the basic research sector. The metals that are typically being used in engineering applications are being fabricated, exploiting metallurgical processes. The art of metallurgy is to create alloys from a given base metal, e.g. aluminium, by adding controlled amount of other metals, in order to improve of modify certain properties such as mechanical properties, formability, weldability etc.

Pure aluminium has poor mechanical properties and for this reason various other elements must be added to produce certain alloys.

Aluminium products are commercially available as:
- castings
- wrought semi-products that are flat-rolled, extruded, or forged.

The main alloying elements are the following:
- copper
- manganese
- silicon
- magnesium
- zinc

Each element creates different properties in the final alloy.

Based on the main alloying element various types alloys are formed. These are called series.

Al alloys are characterized by 4 (XXXX) numbers:
- The **first** number characterizes the main alloy element, that is the elements added in addition to pure aluminium.
- The **second** and third numbers show the different alloy forms.
- The **last two** digits represent the purity of the metal

Series 1000: Pure aluminium with 99.00% minimum purity
Mechanical strengths are relatively low

Series 2000: Aluminium - Copper Alloys
Mechanical strengths higher than those of the middle steel

Series 3000: Aluminium - manganese alloys
Easy molding, good resistance to atmospheric corrosion

4000 Series: Aluminium - Silicon Alloys
The presence of silicon reduces the melting point of alloys of this category. They are used in welding of aluminum parts

5000 Series: Aluminum - Magnesium Alloys
Very good anti-corrosion behavior in the marine environment, average mechanical strength. It is widely used in shipbuilding, chemical industry, construction, transportation, etc. Characteristic alloys: 5005, 5052, 5754, 5083, 5086, 5182.

Series 6000: Aluminum - Silicon - Magnesium Alloys
They are the alloys that are basically used in extrusion to produce profiles. Characteristic alloys: 6005, 6061, 6082, 6060, 6063.

7000 series: Zinc alloy alloys
They are widely used in the aerospace and aerospace industries

In the next Figure a typical example of a datasheet is given. This is a datasheet from the Aluminium alloy 6063.

ALUMINIUM ALLOY **EN-AW 6063** (AlMg0.7Si)

Material data sheet

Scope

Aluminium alloy 6063 is a medium strength alloy commonly referred to as an architectural alloy
It has a good surface finish, high corrosion resistance, is readily suited to welding and can be easily anodised

Alloy	Forms	Characteristics - Properties	Applications
EN - AW 6063	• Extruded square, rectangular hexagonal rod/bar	• Very good corrosion resistance • Medium strength • Complex sections • Anodising quality	Architectural sections, frames, lightings, railing, ladders, furniture, fences, heat sink

Alloy	Tempers	Temper designation (EN 515)
EN - AW 6063	O	Annealed wrought alloys
	T4	Solution heat treated & natural aged
	T5	Cooled from an elevated temperature forming operation & artificially aged (precipitation hardened)
	T6	Solution heat treated & artificially aged (precipitation hardened) Press quenching required
	T64	Solution heat treated & artificially aged (precipitation hardened) Under aged to improve formability (bending temper)
	T66	Cooled from an elevated temperature forming operation & artificially aged (precipitation hardened) to a higher level of mechanical properties through special control of manufacturing processes. Press quenching required

Aluminium & aluminium alloys Extruded rod/bar, tubes and precision profiles

EN 755-1	Technical conditions for inspection & delivery
EN 755-2	Mechanical properties
EN 755-3	Round bars, tolerances on dimension & form
EN 755-4	Square bars, tolerances on dimension & form
EN 755-5	Rectangular bars, tolerances on dimension & form
EN 755-6	Hexagonal bars, tolerances on dimension & form
EN 755-7	Seamless tubes, tolerances on dimension & form
EN 755-9	Profiles, tolerances on dimension & form
EN 12020-1	Technical conditions for inspection & delivery precision profiles
EN 12020-2	Tolerances on dimension & form precision profiles

Physical properties	
Alloys EN - AW	6063
Metallic range °C	585-650
Density g/cm³	2.70
Electrical conductivity MS/m	
Thermal conductivity W/(m K)	
Specific Heat J/(Kg K)	
Thermal expansion values	
-50 to 20 °C (10^{-6} K)	23.4
20 to 100 °C (10^{-6} K)	
20 to 200 °C (10^{-6} K)	
20 to 300 °C (10^{-6} K)	
Youngs Modulus Mpa	69500
Shear Modulus Mpa	26100

Chemical composition according to EN573-3 (EN - AW %)

Alloy	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Others		Al
									Each	Total	
6063	0.20-0.60	0.35	0.10	0.10	0.45-0.90	0.10	0.10	0.10	0.05	0.15	Rest

Mechanical properties according to EN 755-2 extruded profiles

Alloy	Temper	Wall Thickness e mm*	Tensile strength Rm Mpa min	Proof stress Rp0,2 Mpa min	Elongation		Brinell Hardness HB**
					A50mm % min	A % min	
EN - AW 6063	T4	e ≤ 25	130	65	12	14	45
	T5	e ≤ 3	175	130	6	6	55
		3 < e ≤ 25	160	110	5	7	50
	T6	e ≤ 10	215	170	6	8	65
		10 < e ≤ 25	195	160	6	8	60
		e ≤ 10	245	200	6	8	75

Figure 1.3. Al 6063 material datasheet (Aluminco)

Aluminium alloys are produced in three basic forms: (i) sheet, (ii) Billet and (iii) Ingot. Each form requires a different production line and will be discussed further

Figure 1.4. Aluminum alloys (Alumil Academy)

Figure 1.5. [Billet production process]

The extrusion process for the fabrication of profiles is performed with a hydraulic press in which a piece of aluminium (billet) is pre-heated at 480 ° C before the die. The die is a metal with an engraved hole that has profile's shape to be produced. The piston presses and the billet, the aluminium alloy, passes through the die and turns/shapes into a profile.

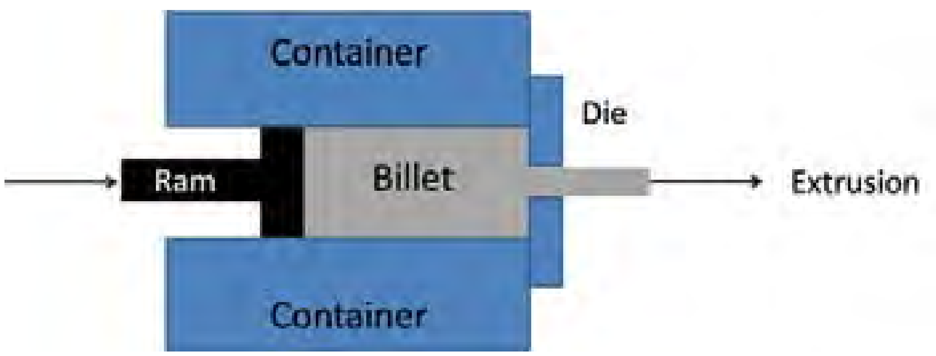


Figure 1.6. [The extrusion process]

The extrusion process produces aluminium profiles, the basic elements of fenestrations, fences, railing, pergolas, etc. Typical examples of aluminium profiles are demonstrated below.

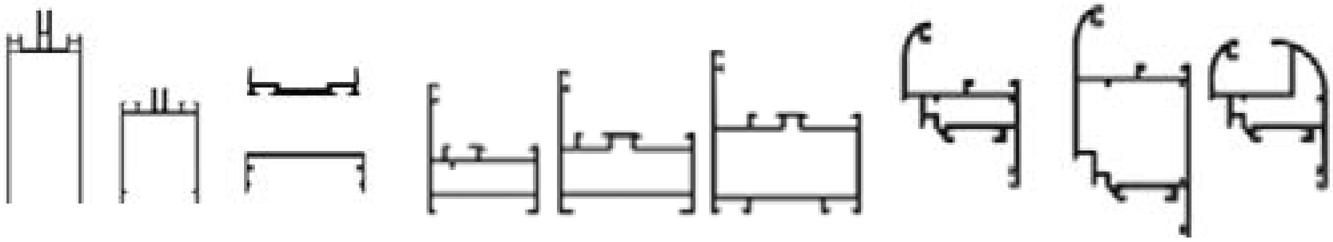


Figure 1.7. Various types of architectural aluminium profiles_(Alumil Academy)

Casting is one of the oldest process for metals shaping. In casting the molten metal is poured into a mold, which is usually made of sand or metal and has a cavity of a particular shape. The material is then cooled, the mold removed and thus the molded product is created. The industrial production of a kind of hardware and mechanisms is typically facilitated by press machine.

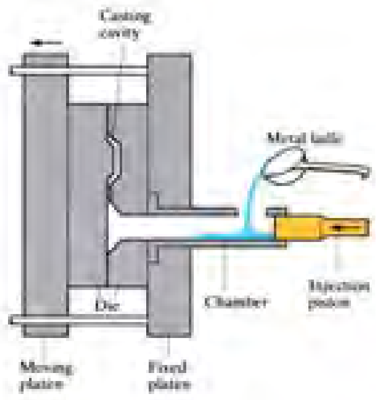


Figure 1.8. High pressure die casting process

In the rolling mill process the billet is placed between two pressing rollers and a foil is obtained at the desired thickness. Various foil thickness can be achieved, and typically this is achieved by means of successive rolling mill steps in a tandem configuration. The process is done without preheating the aluminium.

Figure 1.9. Rolling mill process

In typical architectural applications the aluminium products shall be painted to meet the aesthetic demands. In order to enhance the final/top coat adherence to the metal substrate and in order to prevent corrosion a chemical pretreatment, or surface preparation, is employed. This pretreatment entails surface cleaning/degreasing and application of a chemical conversion coating or an anodization.

Surface processing of aluminium alloys is required to improve the adhesion of the topcoat to the metal substrate and to protect from corrosion.

Anodizing is an electrochemical process, with which a thin layer of aluminium oxide is formed at the aluminium substrate surface. This layer has been evolved from the metal base and is fully integrated on the outer surface of the profiles, offering remarkable attributes to aluminium profiles such as aesthetics, colour stability and durability. It also allows for colouring/dyeing.

Two main approaches for surface preparation prior to painting: (i) Anodizing and (ii) Chemical Conversion coatings

Powder coating is a process in which a film of decorative powder is laid on the aluminium surface to colour it and protect it from external factors. This process takes part in two main steps:

a) Dying, in which coloured power is sprayed on the profiles with the use of electrostatic guns
b) Curing, during which the powder is polymerized and stabilized on the surface of the profile

Today the vast majority of the architectural profiles are being painted using the powder coating process.

Sublimation is a dying practice to combine the aesthetics of wood or other materials such as concrete or copper with the aluminium profiles.

The production process is the same as the one of powder coatings with one extra step, the addition of a coloured foil on top of the profiles after dying and before curing.

Figure 1.10. Aluminium powder coating process

The quality of the surface preparation and the powder coating has a tremendous effect on the durability of the final products.

The fenestration is a system of structural elements, frame, guide, sash, glass, shutters, galvanized stainless parts, rubbers and other connection and function hardware, harmoniously connected/fit to each other to make up the architectural aluminium system. The development of the frames, technologically and aesthetically, enables many different typologies that satisfy all the modern requirements.

For better thermal insulation and therefore for energy saving purposes, aluminium thermal break systems have been developed and are being widely used. Thermal break is the implementation of a material with low thermal conductivity between the inner and outer aluminium profiles of a fenestration. This material, used as a thermal barrier, is a polyamide section mounted between the inner and outer aluminium profiles (usually 18-40 mm depending on the profile type). During the last years further improvement has been achieved with the addition of a special foam insulation to attain even lower heat-permeability coefficients.

The aluminium´s fenestrations offers thermal and sound insulation. With the special design and use of suitable materials, aluminium systems attain high thermal insulation and sound insulation indices thus providing comfortable living conditions.

Moreover, aluminium fenestrations may offer increased security against burglary. With special locking mechanisms the aluminium frames can provide a high level of safety.

They, also, provide solutions to any architectural or construction idea with an endless variety of profiles in shapes and types due to the material's flexibility in formatting and design. They offer great durability over time while maintaining their original dimensions comparing to other materials.

Among the various technical advantages of aluminium alloys as material for the production of fenestrations, one relies on the recyclability of the aluminium alloys. 93% of the collected materials can be recycled after the end-of-life of the architectural product, and only 5% of the energy needed for its primary production is required for its re-production. While the electrolysis method (from bauxite to alumina) currently requires approximately 14 KWh per kilo of aluminium, recycling requires 0.7 KWh.

In aluminium fenestrations a variety of accessories -hardware are used such as:

- Connection corners,
- Rollers
- Brushes
- Gaskets
- Handles

Figure 1.11. Hardware & accessories for aluminium fenestrations (Alumil)

These accessories may be manufactured by the casting or extrusion process. There are 4 different types of connection corners for aluminium frames:

- Mechanical corner
- Crimping's corner
- Corner with screw or pin
- Connection 90^0

Figure 1.12. Connection corners (Europa)

The locking mechanisms are intended to lock the frame and are being placed on the sash. There are two categories of mechanisms for casement:

- Euro Groove
- Steel mechanism, perimetric or groove PVC or 16

The mechanism place in the sash's groove. The steel perimetric (groove PVC or 16) is different, much deeper than the European groove.

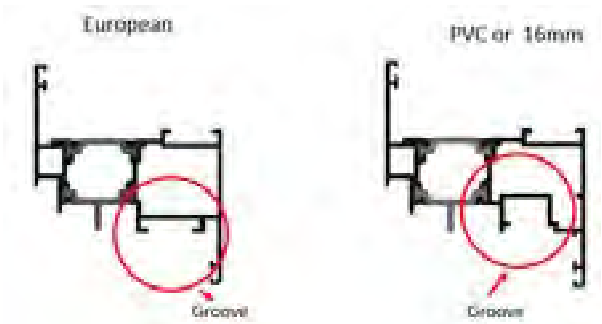


Figure 1.13. Groove (Alumil Academy)

The mechanisms for the entrance doors provide a set of locking points and are placed in the lock profile.

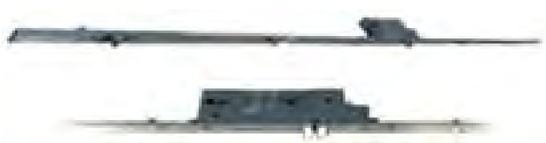


Figure 1.14. Locking mechanisms (Europa)

On the sliding fenestrations there are also two categories:

- Sliding mechanisms
- Mechanisms for lift-sliding

Figure 1.15. Locks for sliding and lift-sliding fenestrations (Alumil, Alumil-Gu)

1.1.2. Metal alloys, Steel, Stainless steel. Profile / bending shapes

Key Words

- **Iron oxides:** an ore, usually an iron oxide, such as magnetite or hematite.
- **Steel:** is an alloy mainly from iron and carbon
- **Stainless steel:** steel alloy, with a minimum of 11% chromium (Cr) content by mass and a maximum of 1.2% carbon (C) by mass
- **Ivar:** steel and nickel alloy containing 36% Ni
- **Galvanization:** a chemical process of applying a protective zinc coating to steel or iron, to prevent rusting
- **Trapezoidal profiles:** corrugated sheet
- **Mannesmann profiles:** Production method with extruded products seamless steel tubes
- **Bending:** forming/shaping of sheet metal by application of force, which exerts pressure on a certain length of material either at a certain point or linear as an evenly distributed weight

Metal profile sheets are metal structural members that due to the fact they can have different profiles, with different heights and different thickness, engineers and architects can use them for a huge variety of buildings, from a simple industrial building to a high demand design building.

Modern steelmaking processes can be divided into two categories: primary and secondary.

Primary steelmaking involves converting liquid iron from a blast furnace and steel scrap into steel via basic oxygen steelmaking or melting scrap steel or direct reduced iron (DRI) in an electric arc furnace.

Secondary steelmaking involves refining of the crude steel before casting and the various operations are normally carried out in ladles.

In secondary metallurgy, alloying agents are added, dissolved gases in the steel are lowered, and inclusions are removed or altered chemically to ensure that high-quality steel is produced after casting.

Iron, as iron oxide, is commonly found in the Earth's crust in the form of an ore, usually an iron oxide, such as magnetite or hematite. Iron is extracted from iron ore by removing the oxygen through its combination with a preferred chemical partner such as carbon which is then lost to the atmosphere as carbon dioxide. This process, a chemical reduction process, known as smelting, was first applied to metals with lower melting points.

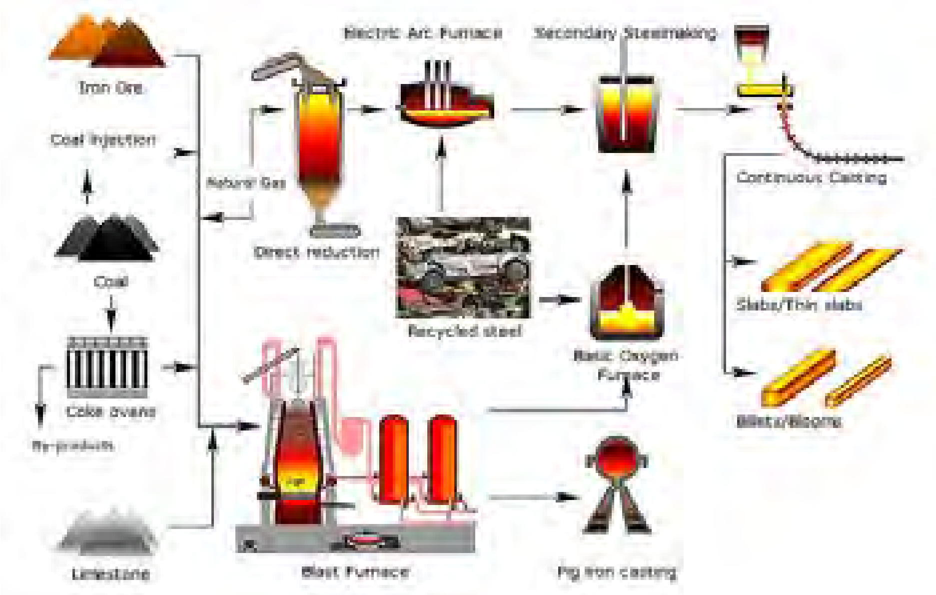


Figure 1.16. **The production of steel by two different routes**

Elemental iron, combined with non-metallic carbon or silicon, produces alloys called steel or silicon steel. The resulting mixture forms a substance with properties that often differ from those of the pure metals, such as increased strength or hardness. Due to its high tensile strength and low cost, it is a major component used in buildings, infrastructure, tools, ships, trains, automobiles, machines, appliances, and weapons. In some cases, a combination of metals may reduce the overall cost of the material while preserving important properties. In other cases, the combination of metals imparts synergistic properties to the constituent metal elements such as corrosion resistance or mechanical strength.

In pure iron, the crystal structure has relatively little resistance to the iron atoms slipping past one another, and so pure iron is quite ductile, or soft and easily formed. In steel, small amounts of carbon, other elements, and inclusions within the iron act as hardening agents that prevent the movement of dislocations.

The carbon in typical steel alloys may contribute up to 2.14% of its weight. Varying the amount of carbon and many other alloying elements, as well as controlling their chemical and physical makeup in the final steel (either as solute elements, or as precipitated phases), slows the movement of those dislocations that make pure iron ductile, and thus controls and enhances its qualities.

When iron is smelted from its ore, it contains more carbon than is desirable. To become steel, it must be reprocessed to reduce the carbon to the correct amount, at which point other elements can be added. In the past, steel facilities would cast the raw steel product into ingots which would be stored until use in further refinement processes that resulted in the finished product. In modern facilities, the initial product is close to the final composition and is continuously cast into long slabs, cut, and shaped into bars and extrusions and heat-treated to produce a final product. Today only a small fraction is cast into ingots. Approximately 96% of steel is continuously cast, while only 4% is produced as ingots.

Ingots are then heated in a soaking pit and hot rolled into slabs, billets, or blooms. Slabs are hot or cold rolled into sheet metal or plates. Billets are hot or cold rolled into bars, rods, and wire. Blooms are hot or cold rolled into structural steel, such as I-beams and rails. In modern steel mills these processes often occur in one assembly line, with ore coming in and finished steel products coming out. Sometimes after a steel's final rolling, it is heat treated for strength; however, this is relatively rare.

There are many types of heat-treating processes available to steel. The most common are annealing, quenching, and tempering.

Steel's most common heat treatment is the annealing the quenching and the tempering.

Annealing is the process of heating the steel to a sufficiently high temperature to relieve local internal stresses. It does not create a general softening of the product but only locally relieves strains and stresses locked up within the material.

Quenching involves heating the steel then quenching it in water or oil. This rapid cooling results in a hard but brittle martensitic structure. The steel is then tempered, which is just a specialized type of annealing, to reduce brittleness. In this application the annealing (tempering) hence it reduces the internal stresses and defects. The result is a more ductile and fracture-resistant steel.

In metallurgy, stainless steel, also known as inox steel or inox from French inoxydable (inoxidizable), is a steel alloy, with a minimum of 11% chromium content by mass and a maximum of 1.2% carbon by mass.

Stainless steels are most notable for their corrosion resistance, which increases with increasing chromium content. Additions of molybdenum increases corrosion resistance in reducing acids and against pitting attack in chloride solutions. Thus, there are numerous grades of stainless steel with varying chromium and molybdenum contents to suit the environment the alloy must endure. Resistance to corrosion and staining, low maintenance, and familiar luster make stainless steel an ideal material for many applications where both the strength of steel and corrosion resistance are required.

Stainless steel is rolled into sheets, plates, bars, wire, and tubing to be used in: cookware, cutlery, surgical instruments, major appliances; construction material in large buildings, such as the Chrysler Building; industrial equipment (for example, in paper mills, chemical plants, water treatment); and storage tanks and tankers for chemicals and food products (for example, chemical tankers and road tankers). Corrosion resistance, the ease with which it can be steam cleaned and sterilized, and lack of need for surface coatings has also influenced the use of stainless steel in commercial kitchens and food processing plants.

Invar is one of the main alloys. It is a steel and nickel alloy containing 36% Ni. This alloy has a minimum expansion coefficient, almost zero. Invented in 1896 by the Swiss Charles Eduard Guillaume, this alloy proved to be vital for the manufacture of high-precision scientific instruments. It is mainly used for the manufacture of precision instruments, wires and measuring rods etc.

In order to protect metal surfaces from corrosion surface processes and painting are being used. Typically, the metal surfaces has first to be prepared, i.e. to be degreased and de-oxidized and then to apply organic coatings. The most common approach includes a two-layer scheme: a primer and a top coat finish.

1. Epoxy Anti-Corrosion Primer as a substrate and the final color is made of epoxy resin.
2. Electrostatic paint with different surface's treatment than aluminium

Galvanization or galvanizing (also spelled galvanisation or galvanising) is another protection process, by applying a protective zinc coating to steel or iron in order to prevent them from rusting. The most common method is hot-dip galvanizing, in which the parts are submerged in a bath of molten hot zinc.

Galvanizing protects the underlying iron or steel in the following main ways:

- The zinc coating, when intact, prevents corrosive substances from reaching the underlying steel or iron.
- The zinc protects iron by corroding first. For better results, application of chromates over zinc is also seen as an industrial trend.

Galvanized construction steel is the most common application of galvanized metal, and hundreds of thousands of tons are galvanized annually worldwide. In developed countries most larger cities have several galvanizing factories, and many items of steel manufacture are galvanized for protection. Typically, these include street furniture, building frameworks, balconies, verandahs, staircases, ladders, walkways, and more.

Hot dip galvanized steel is also used for making steel frames as a basic construction material for steel frame buildings.

In the early 20th century, galvanized piping replaced previously used cast iron and lead in cold-water plumbing. Typically, galvanized piping rusts from the inside out, building up layers of plaque on the inside of the piping, causing both water pressure problems and eventual pipe failure. The life expectancy of galvanized piping is about 70 years.

Since World War II, copper and plastic piping have replaced galvanized piping for interior drinking water service, but galvanized steel pipes are still used in outdoor applications requiring steel's superior mechanical strength. The use of galvanized pipes lends some truth to the urban myth that water purity in outdoor water faucets is lower, but the actual impurities (iron, zinc, calcium) are harmless.

The presence of galvanized piping detracts from the appraised value of housing stock because piping can fail, increasing the risk of water damage. Galvanized piping will eventually need to be replaced if housing stock is to outlast a 50 to 70-year life.

As we described above, rolling is the technique of flat or cylindrical metal or aluminium forming by pushing through a series of rollers that compress to reduce its thickness or diameter. Produced metal sheets, cast iron (rails and beams of various cross sections), concrete reinforcing bars, etc. The rolling is done at high temperatures (hot) or at relatively low temperatures (cold).

Most steel mills have rolling mill divisions that convert the semi-finished casting products into finished products.

Trapezoidal profiles and cassettes have been known in Europe for around 100 years. Today's characteristic profile shape came to Europe from the USA in the 50 s and has gained relevance since about 1960. At present the proportion of load bearing, room sealing trapezoidal profiles used in the overall area of new and slightly sloping roofs amounts to 90%. Above all else the wide acceptance has resulted from the simple constructive training, fast assembly, and the low costs of the trapezoidal profile construction.

Trapezoidal profiles are large metal structural members, which, thanks to the profiling and its thickness, retain their high load bearing capability. They have been developed from the corrugated profile.

Figure 1.17. Trapezoidal profiles

By extraction, using lubricated molten glass, seamless steel tubes are also produced (Mannesmann profiles).

Figure 1.18. Typical Mannesmann profiles

1.1.3. Technical features / sheet bending / closed profiles - welding techniques

Key Words

- **Corrosion:** a natural process that converts a refined metal into a more chemically-stable form such as oxide, hydroxide, or sulfide and gradually degrades its properties
- **Bottoming:** a kind of bending, when the punch will press the material against the inner surfaces of the bottom die, so the angle of the bottom tool defines the bend angle
- **Slotting:** a kind of bending, when the punch will press the material before the inner surfaces of the bottom die
- **Closed sections:** circular Hollow Sections (CHS) are a type of metal profile with a hollow tubular cross section and excellent resistance to torsion

The basic aluminium physical properties are:

Aluminium Density: Aluminium has a density around one third that of steel or copper making it one of the lightest commercially available metals. The resultant high strength to weight ratio makes it an important structural material allowing increased payloads or fuel savings for transport industries.

Aluminium Strength: Pure aluminium have poor tensile strength. However, the addition of alloying elements like manganese, silicon, copper and magnesium can increase the strength properties of aluminium and produce an alloy with properties tailored to particular applications. Aluminium is well suited to cold environments. It has the advantage over steel in that its' tensile strength increases with decreasing temperature while retaining its toughness. Steel on the other hand becomes brittle at low temperatures.

Aluminium Corrosion Resistance: When exposed to air, a layer of aluminium oxide forms almost instantaneously on the surface of aluminium. This layer has excellent resistance to corrosion. It is fairly resistant to most acids but less resistant to alkalis.

Aluminium Thermal Conductivity: The thermal conductivity of aluminium is about three times greater than that of steel. This makes aluminium an important material for both cooling and heating applications such as heat-exchangers. Combined with it being non-toxic this property means aluminium is used extensively in cooking utensils and kitchenware.

Aluminium Electrical Conductivity: Along with copper, aluminium has an electrical conductivity high enough for use as an electrical conductor. Although the conductivity of the commonly used conducting alloy (1350) is only around 62% of annealed copper, it is only one third the weight and can therefore conduct twice as much electricity when compared with copper of the same weight.

Melting Point (°C)	660.2
Boiling Point (°C)	2480
Mean Specific Heat (0-100°C) (cal/g.°C)	0.219
Thermal Conductivity (0-100°C) (cal/cms. °C)	0,57
Co-Efficient of Linear Expansion (0-100°C) (x10-6/°C)	23,5
Electrical Resistivity at 20°C (Ω.cm)	2.69
Density (g/cm3)	2.6898
Modulus of Elasticity (GPa)	68.3

Table 1.2. Aluminium physical properties

Aluminium can be severely deformed without failure. This allows aluminium to be formed by rolling, extruding, drawing, machining and other mechanical processes. It can also be cast to a high tolerance. Alloying, cold working and heat-treating can all be utilized to tailor the properties of aluminium. The tensile strength of pure aluminium is around 90 MPa but this can be increased to over 690 MPa. **(Aalco - Ferrous and Non-Ferrous Metals Stockist.)**

The mechanical properties of iron are characterized by its ability to withstand a load or be hammered or molded without breaking. All of these constitute the “stamina”, a property that metals have, but to varying degrees each. Steel is one of the most durable metals.

One of iron’s basic characteristics is that it is strongly magnetic. When it is exposed to a strong magnetic field can be easily magnetized. Scientists believe that the Earth’s core is made up of about 90% iron and the produced magnetic force creates the magnetic north and south poles.

Density	7.874g/cm3
Melting point	1538°C
Boiling point	2862°C
Moh’s hardness	4

Table 1.3. Iron physical properties

Iron is commonly found in the Earth’s crust in the form of an ore, usually an iron oxide, such as magnetite or hematite. Iron is extracted from iron ore by removing the oxygen through its combination with a preferred chemical partner such as carbon which is then lost to the atmosphere as carbon dioxide.

This process, known as smelting, was first applied to metals with lower melting points, such as tin, which melts at about 250 °C, and copper, which melts at about 1.100 °C, and the combination, bronze, which has a melting point lower than 1.083 °C. In comparison, cast iron melts at about 1.375 °C.

Other materials are often added to the iron/carbon mixture to produce steel with desired properties. Nickel and manganese in steel, enchases its tensile strength and makes the austenite form of the iron-carbon solution more stable, while chromium increases hardness and melting temperature.

To inhibit corrosion, at least 11% chromium is added to steel so that a hard oxide is formed on the metal surface; which is known as stainless steel.

The density of steel varies, based on the alloying constituents, but usually ranges between 7,750 and 8,050 kg/m3, or 7.75 and 8.05 g/cm3. (wikipedia.org)

At ambient temperature stainless steel has excellent resistance to oxidation, even in the presence of strong acids, such as nitric acid. The material is extremely resistant to alkaline solutions, as well as to organic and inorganic salts. In general, the material provides excellent resistance to oxidation in the environment, while in a highly saline environment it exhibits virtual oxidation spots, that are avoided by cleaning.

Stainless steels do not suffer uniform corrosion like carbon steel, when exposed to wet environments. Unprotected carbon steel rusts readily when exposed to the combination of air and moisture.

The resulting iron oxide surface layer (the rust) is porous and fragile. Since iron oxide occupies a larger volume than the original steel, this layer expands and tends to flake and falls away, exposing the underlying steel to further attack. In comparison, stainless steels contain sufficient chromium to undergo passivation, spontaneously forming a microscopically thin inert surface film of chromium oxide, by reaction with air oxygen and even the small amount of dissolved oxygen in water. This passive film prevents further corrosion by blocking oxygen diffusion to the steel surface and thus prevents corrosion from spreading into the bulk of the metal.

This film is self-repairing if it is scratched or temporarily disturbed by an upset condition in the environment, that exceeds the inherent corrosion resistance of that grade. The resistance of this film to corrosion depends upon the chemical composition of the stainless steel, chiefly the chromium content.

Corrosion of stainless steels can occur when the grade is not suited for the working environment. It is customary to distinguish between four forms of corrosion: uniform, localized (pitting), galvanic and SCC (stress corrosion cracking)

Sheet metal forming is one of the most common metal manufacturing process, that can be used to produce complex parts with a high degree of dimensional accuracy and increased mechanical properties, along with a good surface finish. Bending is defined as the plastic deformation of sheet metal along a straight line. Bending is a commonly used sheet metal shaping process in various sheet metal industrial products.

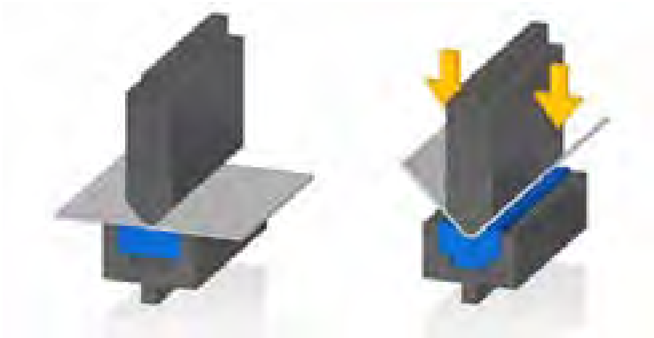


Figure 1.19. **Bending process**

A bending operation is employed to fabricate parts such as braces, brackets, supports, hinges, angles, frames, channel and other non- symmetrical sheet metal parts which are used in automobiles, aircrafts, ships and various consumer products.

During the bending process, a force is applied to a sheet metal blank, causing it to bend at an angle and form the desired shape. The workpiece is initially bent in an elastic region. As the process continues, the workpiece is deformed by plastic deformation, thereby changing its shape. The material is stressed beyond the yield strength but below the ultimate tensile strength of the material.

The bending action results in both tension and compression in the sheet metal. The outer surface of the sheet undergoes tension and stretches to a greater length while the inner surface experiences compression and shortens. The tensile stresses and compressive stresses decrease towards the centre of the sheet.

The most common bending methods, but surely not the only ones, are air bending and bottoming. They can be done on the same press brake and usually do not require more than 25 tons of pressure for general purpose workshop use.

Air Bending: Air Bending uses a punch tool and an often V-shaped bottom die. The profile of the punch defines the bend radius while the stroke depth defines the bend angle. Since the stroke depth is adjustable on the machine, air bending lets you bend sheet material to an arbitrary angle without replacing the die or punch tools.

Bottoming: Just like air bending, bottoming uses a punch and a V-shaped bottom die. However, the punch will press the material against the inner surfaces of the bottom die, so the angle of the bottom tool defines the bend angle. Therefore, the method requires separate bottom dies and retooling for every bending angle as well as significantly more pressure. However, it is more accurate and has less springback than air bending.

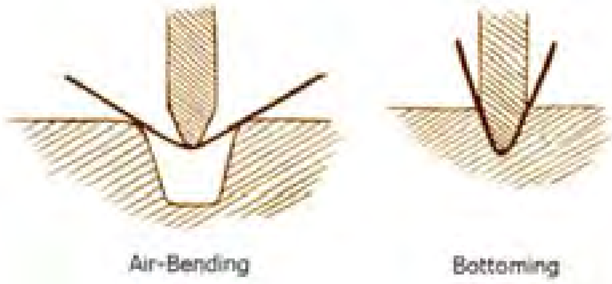


Figure 1.20. **Air Bending and Bottoming**

To define the bend region and reduce the force required to bend a part out of sheet metal down to something you can handle without a brake press, slots can be cut at the bending line to selectively weaken the material. Slotting is a great technique to get custom metal enclosures and frames for small robotic projects and even large unloaded structures.

However, since it obviously weakens the material, it's a no-no for heavy load-bearing parts that rely on the structural integrity of the bend region. **(https://hackaday.com/2016/05/18/the-art-and-science-of-bending-sheet-metal/)**

In the figure listed below, mechanical bending equipment is presented:

Figure 1.21. **Press bending** & **Roll bending**

With the method of bending and roll forming we can make large cross sections from sheet metal, which can be closed by special welding techniques as laser and HF welded closed sections, which allow the ends of the metal strips to be automatically assembled and welded. Of course, there is the punch (spot) welding machine also which costs less and is easier to use.

1.2. Technical specifications of filling materials

Key Words

- **Ug:** Ug-value is a measure of how quickly heat transfers through an insulated glass unit (IGU)
- **Energy glazing:** a regular transparent glass reinforced with one or more thin layers of metallic oxides
- **Category of glazing:** different qualities of glasses as treatment

To be achieved upon learning outcome completion

KNOWLEDGE

- Technical characteristics & dimensioning of glazing for fenestrations
- Technical characteristics & dimensioning of covering
- Technical characteristics – dimensioning of synthetic panels coverings
- Typologies, casement, sliding etc. of fenestrations and their features

SKILLS

- Implement the appropriate glazing in quality & thickness in relation to dimensional requirements
- Choose the right materials combinations (profiles, glass, etc.)
- Understand basic circular economy aspects
- Optimize different application techniques for each covering
- Select the best combination of materials, taking into consideration energy saving and efficiency
- Apply synthetic panel in all kinds of aluminium or steel constructions
- Recycle
- Apply typology to customer needs and available space
- Select the best combination of materials & typology type according to building specifications and energy saving and efficiency

COMPETENCIES

- Apply alternative quality & technical features for best results
- Understand the consequences of an incorrect application - location, use of materials or technical positioning
- Utilize and combine covering in masonry, frames or fences and generally in composite structures
- Apply an alternative category of frame for best results

1.2.1. Technical characteristics & dimensioning of glazing for fenestrations

Glass is made from sand. One can make glass by heating ordinary sand (which is mostly made of silicon dioxide-SiO2) until it melts and turns into a liquid. Of course, you will not see that happening on your local beach: sand melts at the incredibly high temperature of 1700°C.

Glazing is very important, as it usually covers is 70-80% of the total surface area in an aluminium structure, affecting the final thermo-sound and aesthetic effects.

Glass panels in fenestrations:

- Controls heat gains by reducing energy consumption in heating and air conditioning.
- Controls natural lighting by reducing energy consumption in artificial lighting.
- Affects the aesthetics

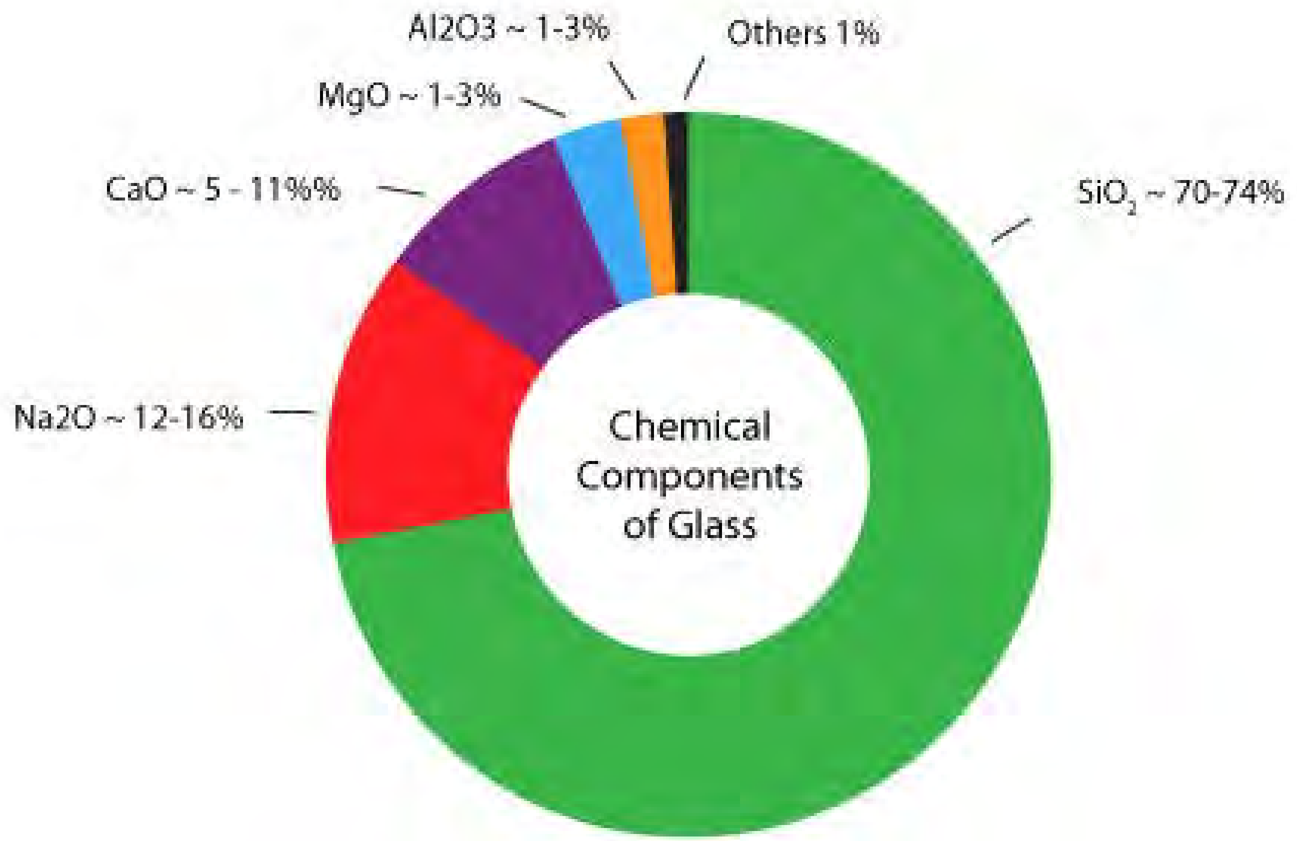


Figure 1.22. Oxides in glass

Erasmus+

The basic mechanical and physical properties of glazing are:

- **Density:** 2.500 kg/m^3
- **Coefficient of linear expansion:** 9 x 10-6 m / oC (Aluminium 24 x 10-6 m / oC, i.e. 2.5 times larger)
- **Thermal permeability (u-value):** 5,2 - 5,8 watt / m^2 * K (depending on thickness) is defined as the amount of heat passed each hour through 1 m^2 of thickness d (m) when the difference of the stationary air tangent to the two surfaces of the element shall be kept constant and equal to 1 degree Kelvin (or Celsius).
- **Solar factor or g value:** indicates the percentage of solar heat passing through the pane. The lower its value, the greater the solar protection.
- **Thermal conductivity (K-value):** 1.05 watt / m * K (Aluminium 220 watt / m * K) is the ability of materials to allow heat flow (heat passage) through their mass.
- **Temperature difference resistance:** at 6 mm an artificially heated glass will break from this thermal fracture if submerged in water with a temperature difference above 55 ° C
- **Light reflection (Light loss due to reflection):** Light passing through a 2-optic separating surface with different refractive indices (eg air-glass) is always reflected. The amount of light reflected depends on the refractive indices of the media and the angle of incidence of the light.
- **Light permeability:** about 85% for 6 mm white glazing.
- **Ultraviolet radiation permeability:** at wavelength 340 nm 41%, at 315 nm 1%.
- **Chemical Resistance:** Glass is extremely resistant to most acids except hydrofluoride and at high temperatures and phosphate. But it shows alkali sensitivity. Also, soluble sulphides from metal corrosion tend to adhere permanently to the free surface of the glass which must be removed as soon as possible.
- **Compressive strength:** 1000 MPa. It is extremely high and means that to crush a 1cm3 glass die, it must apply a weight of 10 tonnes (100kg /mm^2).
- **Tensile strength:** 180 MPa (this figure goes up to 200 MPa for reinforced glass panes) significantly lower than compressive strength.
- **Melting point:** about 730° C.
- **Elasticity measure (E - Young factor):** 70 GPa. This coefficient expresses the theoretical force (per unit area) that should be applied to a glass specimen to double its original length.
- **Hardness:** 6.5 Mosh scale (diamond has 10, sapphire 9 and gypsum 2) measure the material's resistance to locally limited plastic deformation
- **VT - Visual Transmittance:** shows us the percentage of light passing through the glass. We want this to be high (60-80%) so that the use of artificial lighting is not required, which leads to an increase in energy consumption.
- **Emissivity:** the ability of a surface to absorb or reflect heat (solar energy). The lower its value in a glass, the lower is its heat permeability factor K (value U).
- **Thermal Resistance (R-value):** This is the value used to give the effectiveness of various materials of various thickness. The heat resistance of a material of a particular thickness expresses the heat flow caused by the temperature difference between the surfaces of the material and is measured in m^2 * K / W. The higher the value of the thermal resistance, the better its insulating property.

There are five main types of glass used in buildings:

- Annealed glass
- Tempered glass (EN 12150 standard)
- Heat strengthen glass (EN 1863 standard)
- Laminated glass (EN 14449 standard)
- Insulating glass units (IGU) (EN 1279-5 standard)

Annealing of glass is a thermal process of slowly cooling hot glass objects after they have been formed, to relieve residual internal stresses introduced during manufacture. Especially for smaller, simpler objects, annealing may be incidental to the process of manufacture, but in larger or more complex products it commonly demands a special process of annealing in a temperature-controlled kiln known as a lehr.

Annealing of glass is critical to its durability. Glass that has not been properly annealed retains thermal stresses caused by quenching, which indefinitely decrease the strength and reliability of the product. Inadequately annealed glass is likely to crack or shatter when subjected to relatively small temperature changes or to mechanical shock or stress. It even may fail spontaneously.

For most kinds of glass, this annealing temperature is in the range of 454–482 °C and is the so-called stress-relief point or annealing point of the glass. At such a viscosity, the glass is still too hard for significant external deformation without breaking, but it is soft enough to relax internal strains by microscopic flow in response to the intense stresses they introduce internally.

The piece then heat-soaks until its temperature is even throughout and the stress relaxation is adequate. The time necessary for this step varies depending on the type of glass and its maximum thickness.

The glass then is permitted to cool at a predetermined rate until its temperature passes the strain point (n = 1014.5 Poise) below which even microscopic internal flow effectively stops and annealing stops with it.

It then is safe to cool the product to room temperature at a rate limited by the heat capacity, thickness, thermal conductivity, and thermal expansion coefficient of the glass.

After annealing is complete the material can be cut to size, drilled, or polished without risk of its internal stresses shattering it.

All glass is produced in the following thickness: 2, 3, 4, 5, 6, 8, 10, 12, 15, 19,25 mm. Wikipedia

Tempered glasses are thermally processed glasses with higher mechanical and thermal durability. The glass is heated reaching temperatures of up to 600° C and then is rapidly (full tempering) or slowly (thermal amplification) cooled.

In both cases, a strictly controlled cautious cooling speed is required. This processes submits the glass surface under a permanent compression force, providing the glass with special properties, as for example resistance to mechanical or thermal shocks, i.e. up to 5 times higher (thermally tempered) or up to 2 times (thermally amplified) compared to conventional glasses.

This process protects the glass from shattering due to high temperature differences taking place on its surface (e.g. because of ever-changing shading).

This is particularly important for glasses exposed to intense sun radiation with high energy absorption on an everyday basis. In addition, in case of breakage, tempered glasses break into small, round glass particles, eliminating the risk of dangerous sharp shards which otherwise would be a danger in the case of conventional glasses.

The differences between tempered glass are that in heat-strengthened glass, the cooling process is slower, which means the compression strength is lower. In the end, heat-strengthened glass is approximately twice as strong as annealed, or untreated, glass.

The industry standard specification requirements for heat-treated or tempered glasses are ASTM C1048. For heat-strengthened glass, the requirement is a surface compression of 3,500 to 7,500 psi with no requirement for edge compression. Fully tempered glass will have either a minimum surface compression of 69 MPa (10,000 psi), or an edge compression of not less than 67 MPa (9,700 psi).

Safety glazings are typically specified to provide security or to keep occupants safe wherever there is the potential for broken glass to hurt people if it becomes a projectile, such as in a fire, explosion, tornado or hurricane. Glass Education Center http://glassed.vitroglazings.com/topics/heat-strengthened-vs-tempered-glass

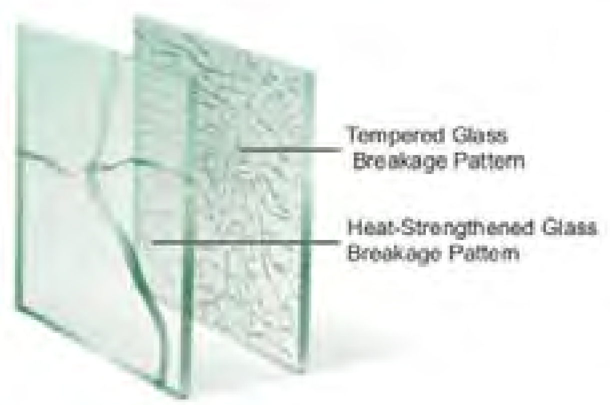


Figure 1.23. Breakage patterns in tempered and heat-strengthened glass

Laminated glass is made by pasting PVB (polyvinyl butyral) resin glue film between two or more pieces of glass sheet, then heating, pressing and bonding them together to create flat or curved compound glass product. The glass sheet for making laminated glass can be ordinary glass, float glass, tempered glass, coloured glass, heat-absorbing glass or heat-reflecting glass etc. The layer quantity is 2, 3, 5, 7, up to 9. For double-layer laminated glass, the common thickness of glass sheet is (mm) 2 + 3, 3 + 3 and 3 + 5 etc. Laminated glass has good transparency, and its impact resistance is several times higher than that of ordinary sheet glass. Bullet-proof glass is made by compounding multiple layers of ordinary glass or tempered glass.

Due to the adhesion of PVB glue film, even when the glass breaks, its fragments keep binding on the thin film and will not hurt people, and the surface of the fragmented glass remains clean and smooth, which effectively prevents fragments from penetrating or falling, thus ensures human safety. Laminated glass made of different sheet glass has different features such as durability, heat resistance and moisture resistance etc.

In Europe and America, laminated glass is applied to most buildings to avoid dangerous accidents because of its strong anti-shocking and anti-break-in abilities.

The glue film in the middle is able to resist the consecutive striking by lethal weapons such as hammers and wood-cutting blades, and to resist the penetration of bullets for a certain period of time, so it is of high security level.

Sound-insulation effect is one of the important factors to evaluate the quality of modern residential buildings. Glass with PVB interlayer films is able to block sound wave and retain calm and comfortable office ambient. Its special UV filtering function not only protects human skin, but also prevents important and precious furniture and exhibiting artworks from fading. It also reduces the transmission of light and saves refrigerating energy.

Due to so many advantages, laminated glass creates unimaginable unique effects in household decoration. For instance, now frosted glass is applied to home doors, including kitchen doors, and oily smoke is easy to stick to the surface; however, if laminated glass is taken instead of frosted glass, such trouble will disappear. Moreover, large surface partitions at home are always a hidden trouble to the safety of active kids; if laminated glass is applied, parents will feel released about the safety of the children.

Laminated glass is safe to people even it is broken. Hit by a heavy ball, it is likely to break into fragments, but the whole block of glass retains consistent, and its debris and small sharp fragments keep binding with the glue film in the middle.

Laminated glass is safer, so it is generally applied to doors, windows and skylights of high buildings, and showcases and partitions in stores, banks and jewellery shops etc. (ScienceDirect).

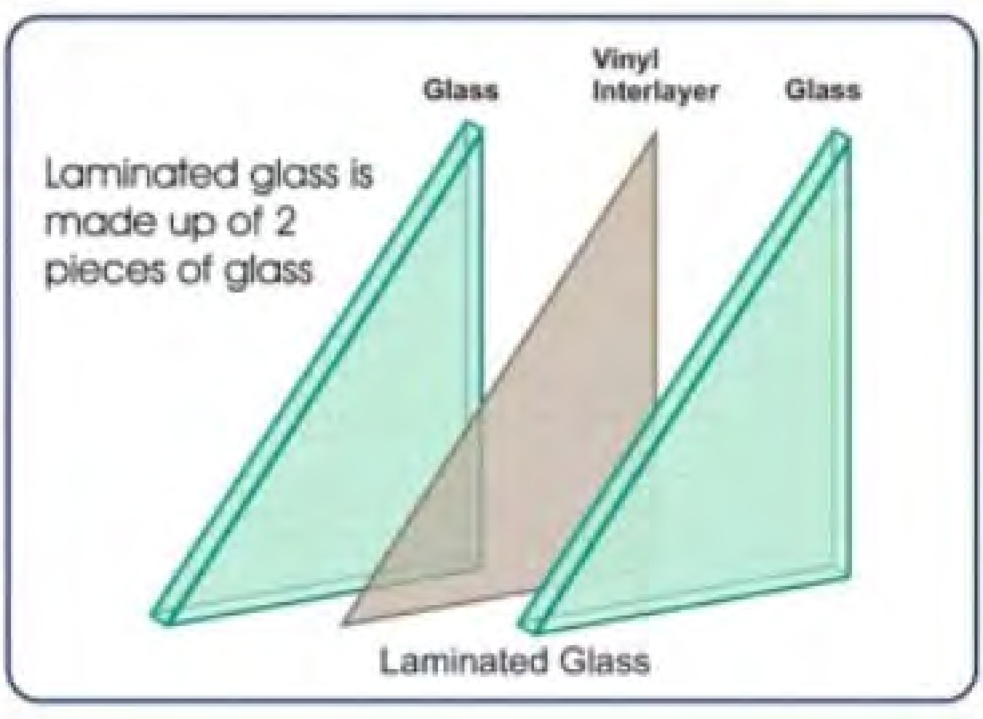


Figure 1.24. Laminated glazing

Insulating glass units or energy glazing as it has prevailed the last years, is a regular transparent glass coated with one or more thin layers of metallic oxides on one side. These coatings exhibit a high reflectivity in the infrared portion of the radiation and may be almost transparent or have different colour tones. The coating consists of metals (Ag) and in so thin (nm) that it is transparent. Low emissivity (Low-e) glass is mainly used in homes and offices where the cost of cooling and heating plays an important role and the use of this type of glass can bring about a significant reduction in the cost of cooling and heating.

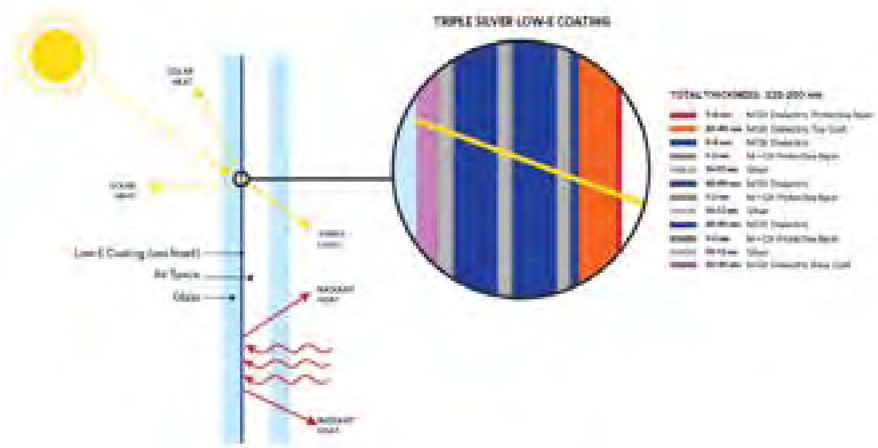


Figure 1.25. Low-e coating

With low-e coatings we deal with the thermal loss of a home (long IR) rather than solar radiation. Solar radiation (UV, visible light and short IR) is treated with solar control coatings.

Figure 1.26. Double/Triple IGU

Double glazing refers to using two (or more) sheets of glass, separated by a gap of approximately 10-18 mm. They are sealed so moisture cannot enter the gap and cause condensation.

The gap can be filled with argon rather than air to improve the insulating performance and the glass can be coated on the inside (low-E or tinted) to improve radiant heat performance.

Normally the gap contains crystals to absorb any moisture. Secondary glazing is the addition of a second layer of glass, again separated by an air gap.

The U-Factor for a 3 mm glass is 5.9 W/m^2*K. This means that one square meter will transmit 5.9 watts if there is a 1-degree temperature difference across the glass. If there is a 10-degree temperature difference from inside to outside the house, each square meter loses the same heat as a 60-watt light globe.

1.2.2. Technical characteristics & dimensioning coverings

Key Words

- **Coverings:** preformed metal wall panels, manufactured from a variety of metals, including steel, aluminium, covered by a durable paint or coating that is applied in order to maximize protection from environmental factors

Corrugated galvanized iron or steel (CGI) is a building material composed of sheets of hot-dip galvanized mild steel, cold-rolled to produce a linear corrugated pattern in them. Only the surviving vintage sheets may actually be made up of 100% iron.

The corrugations increase the bending strength of the sheet in the direction perpendicular to the corrugations, but not parallel to them, because the steel must be stretched to bend perpendicular to the corrugations. Normally each sheet is manufactured longer in its durable side.

CGI is lightweight and easily transported. It is widely used especially in rural and military buildings such as sheds and water tanks. Its unique properties were used in the development of countries like Australia from the 1840s, and it is still helping developing countries today.

Today the corrugation process is carried out using the process of roll forming. This modern process is highly automated to achieve high productivity and low costs associated with labour. In the corrugation process, sheet metal is pulled off huge rolls and through rolling dies that form the corrugation. After the sheet metal passes through the rollers it is automatically sheared off at a desired length. The traditional shape of corrugated material is the round wavy style, but different dies form a variety of shapes and sizes. Industrial buildings are often built with and covered by trapezoidal sheet metal. (Wikipedia)

The steel from which profiled cladding sheets are made is available pre-coated in a wide range of colours and textures, allowing architects to choose a finish that best suits the location and function of the building. Profile shape is also a characteristic that can be adapted to the demand of the architects.

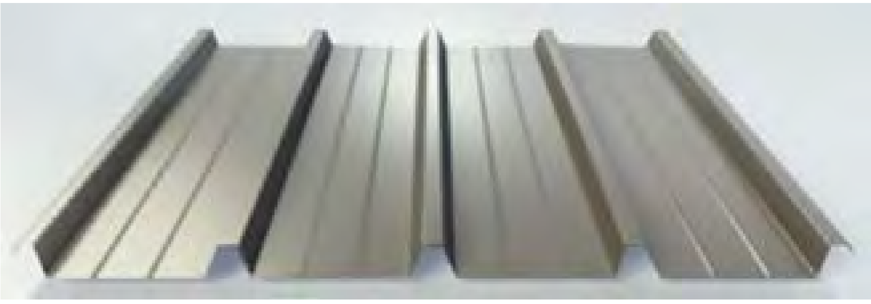


Figure 1.27. Corrugated sheet (isopan)

The primary function of the cladding system is to provide a weather-tight building envelope, suitable for the intended use of the building. Trapezoidal metal roof sheets with through fix fasteners are generally suitable for slopes of 4% or steeper. This limit is critical to the performance of the cladding. For shallower pitches, down to 1.5%, a fix system with no exposed through fasteners, special side laps and preferably no end laps should be used. For low pitch roof, ponding is a potential problem that must be considered at the design stage in order to avoid the deleterious effects of prolonged soaking and the increased loading, due to the weight of the water.

In order to ensure that the building envelope remains fully functional throughout its life cycle, it is important that it receives regular maintenance, including inspection, removal of debris, cleaning and repair of damage. Weather exposure, natural movement, installation error and manufacturing defects are examples. The need of maintenance may be greatly reduced using specific coating depending on the weather conditions, this coating guarantee the expected life cycle of the cladding. The commonly used stainless steel is resistant to acetic acid, acetone and boric acid, among others.

Metal profiles sheets have a high scrap steel content that is recyclable. Many steel components can be unbolted and even reused for future applications. The possibility of reusing building elements makes steel construction even more sustainable than the already significant contribution of today's simple material recycling. Steel can be repeatedly recycled because it does not lose any of its inherent physical properties as a result of the recycling process. Stainless steel fasteners is a sustainable material having excellent corrosion resistance and durability.

Metal cladding systems are required to carry externally applied loads, such as snow and wind loading without deflecting excessively or compromising the other performance requirements. The individual characteristic loads should be obtained from the relevant part of EN 1991, considering the building geometry and location as applicable. These individual loads should be combined by using the appropriate safety factors from EN 1990, in order to obtain the load cases used in design.

For most application of metal cladding technology, the only permanent load for roof cladding is its own self-weight. For wall cladding, it is not normally necessary to consider permanent loads since the self-weight acts in the cladding. In addition to its self-weight, the roof cladding must also be designed for the following variable loads as specified in the relevant parts of EN 1991: -Access for cleaning and maintenance. -A uniformly distributed load due to snow over the complete roof area. The value of this load will depend on the building's location. -Asymmetric snow load and loading due to snow drifts. -Wind loading due to pressure and suction.

Care must be taken on site to avoid excessive local deflection. Typical deflection limits imposed on the cladding are depend on the loading regime considered, the location of the structural component and whether a brittle material is present.

For the correct product installation, dimensions are given by the manufacturer based on the design of the construction and are mounted with special supports on metal or wooden profiles.

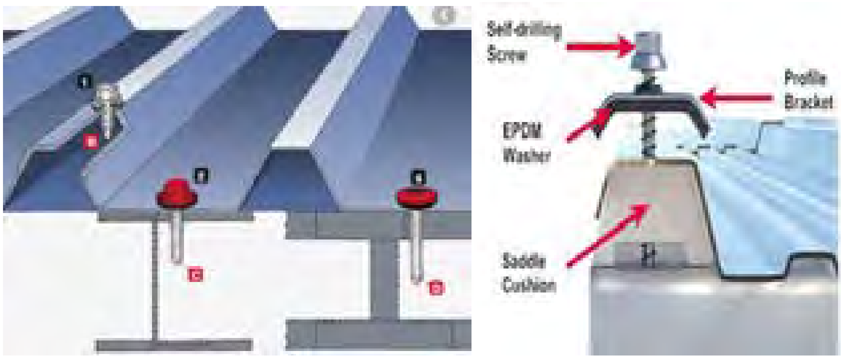


Figure 1.28. Fastening (GEIT Metal Roof Accessories)

1.2.3. Technical characteristics / dimensioning composite panels coverings

Key Words

- **Composite panels:** Panels consisting of two sheets (metal, aluminium or plastic) with insulation in the core.
- **Bond:** is a composite panel consisting of two aluminium cover sheets and a mineral-filled polymer core.
- **Honeycomb panel:** Aluminium Honeycomb Panel is sandwich panel that is consisted of two aluminium sheets bonded to an aluminium honeycomb core by using two components PU glue.

There are two categories of composite panels:

- Panels that are used for buildings covering or fenestrations filling.
- Profiles from aluminium or composite materials that are used for facades or fenestrations filling.

Figure 1.29. Roof Sheet Metal Panels, Side Sheet Metal Panels, Panel for Frames

The elemental U-value (thermal transmittance, W/m^2K) of a cladding panel, depends on the conductivity and thickness of the insulation, which is added, the profile shape and the presence of thermal bridges. So, metal profile sheets can fulfil thermal performance regulations demands, due to insulation and profile shape. It is especially important to analyse and avoid all possible thermal bridges during the roof and wall cladding assembly, in order to minimize local heat/cold losses.

Roofs constructed with trapezoidal profiles have excellent sound reduction characteristics that have been measured up to 53 dB. The measured sound reduction for wall constructions using cassettes has been assessed at an RW of 57 dB.

The acoustic performance of a particular cladding system depends on the insulation material, the cover sheet, the liner sheet profiles and the assembly method. To minimize reverberation architects may take advantage of the sound absorbing properties of the cladding insulation layer by replacing the standard liner sheet with a perforated liner.

The panels for frames are mostly made of polyurethane insulation and two metal sheets. There is a very wide range, in various colors, designs and dimensions. The manufacturer cuts them to the desired size and places them in the frame.

Figure 1.30. Panel for Frames

Bond is a product of polyethylene-filled composite foils used for exterior building covering. It is mounted on the sides with special aluminium or metal formed profiles.

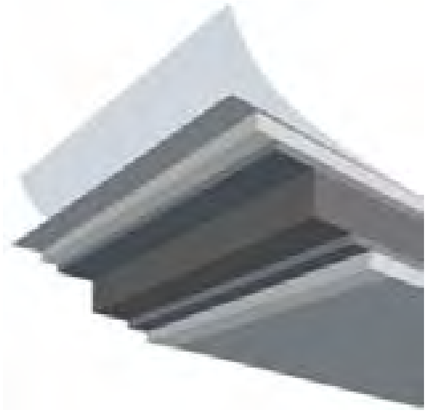


Figure 1.31. Etalbond

Bond panels have an impressive strength-to-weight ratio, while the insulation material thickness varies. By using it most of the energy-related building standards can be easily fulfilled. Moreover, it provides effective protection from rain, moisture and vandalism (graffiti, mechanical loading).

Rear-ventilated facade systems are not very prone to damage and have low service life costs, as very little maintenance and repair work is needed. Bond is easy disassembled and can be reused and recycled.

Bond provides a Huge variety of materials, surfaces, colors, shapes, joins. Furthermore, it influences the architectonic character of a building as the cladding is either attached in a visible or concealed manner.

Figure 1.32. Example of a building with Bond cladding (Alumil)

A new category of buildings covering materials are the honeycomb panels that were first invented in Ireland. The first piece in the world was made in 1973. In 1983, an American company succeeded in producing the same product.

A German company produced the super light stone wave composite which is quite like the super thin honeycomb panel in 1989. In 1990, two Italian companies have also started the production. The production of super thin honeycomb stone panels has passed a history of 30 years and now is a fully mature product. The application in many engineering projects has proved many superiorities of this product.

The surface of the aluminium honeycomb panels is made of aluminium alloy plates roller coated with PVDF while in the middle are the aluminium honeycombs which meets the international aeronautical standards. This product is specially made with the cold-glue and hot-press technology. The structural honeycomb core provides strength and consistent rigidity at an exceptionally low density, when bonded to similarly lightweight facings.

The honeycomb panel is an aluminium sandwich-type panel with high rigidity and extremely low weight. It is the ideal material for a most of applications in architecture, transport, display or industrial production.

Figure 1.33. Honeycomb panel

The advantages of honeycomb panels are:

- Large dimensional panels (Max 5000 mm x 1500 mm).
- High strength no reinforcement measure necessary.
- Light weight: Weight of 25 mm thickness honeycomb panel is 5.6 kg/m^2.
- Precise dimension and roller-pressing technology, ensuring products' high quality
- The absolute flatness of the surface makes installation easier and the fast "cut the garment according to the figure" productive way will ensure the quality of each piece of the products and minimize the wastage of raw materials.
- Perfect installation system, which eliminates the panel distortion caused by the temperature changes. Therefore, the sealing against the gas or water leakages will be ensured.
- Unique sealing installation system looks graceful in shape. Besides, it can effectively avoid the reduction of the lifetime of the sealing glues due to the direct radiation.
- No colour difference: Lot roller-coated aluminium sheets may be used for one project.
- Reasonable interior wall and ceiling installation will ensure each panel sheet to be easily and separately dismantled for maintenance service.

1.3. Applications for aluminium constructions

Key Words

- **Typologies:** different ways of operating the frames of the window and the locking mechanisms
- **Entrance door:** the main door in the house
- **Casement:** Opening, rotating on one shaft (hinges-pins)
- **Sliding:** slide, move on rollers (wheels)
- **Folding:** special category of sliding typology
- **Minimal:** special category of sliding typology in which the frames are boxed to the wall
- **Shutter:** product installed externally to provide additional covering and/or protection to an opening (e.g. Windows, doors)

To be achieved upon learning outcome completion

KNOWLEDGE	SKILLS	COMPETENCIES
• Knowledge of curtain walling systems and their features • Knowledge of outdoors systems, fences, pergolas, railing etc.	• Selection and implementation of the appropriate system • Understand basic circular economy aspects • Implementation of the ideal system for collaboration with neighbouring structures and landscape architecture	• Customize by selecting and executing on-the-spot alternatives to troubleshooting • Making the most of system combinations to technical specifications and adapting to the desired results

1.3.1. Fenestration, shutters, roller shutters typologies and their features

Windows are divided into two major categories according to the way that they open:

1. **Opening windows** that rotating on one shaft (hinges-pins),
2. **Sliding windows** that move on rollers (wheels).

The Basic Opening Typologies are: Single opening tilt/turn, Double opening tilt/turn, opening outside, Projected-Awning, pivoting vertical/horizontal, Hopper. In most cases the symbolism is done with a triangle in which the two corners are in the hinges and the third in the lock.

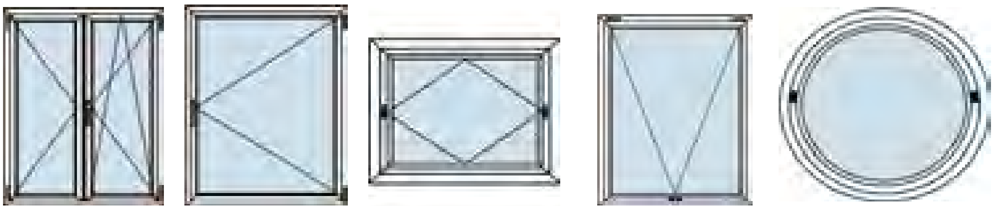


Figure 1.34. Basic Opening Typologies (Profilsmart Gold Software)

Complex typologies of opening windows may be produced using various combinations of the basic typologies. Some of them are presented in the figure below.

Figure 1.35. Complex Opening Typologies (Profilsmart Gold Software)

Casement fenestrations based on their use are separated except for windows and balcony doors in:

1. **Main entrance doors**
2. **Secondary entrance door**

The entrance door is a construction that is made with:

- larger profiles
- stronger components
- entrance lock
- handles

In entrance doors there is no profile at the bottom or there is a small one for waterproofing enhancement. Moreover, panels can be used instead of a glass pane.

Figure 1.36. Examples of Entrance doors (Profilsmart Gold Software)

The secondary entrance door is something between a balcony door and a main entrance door. Essentially it is a glazed patio door that is used many times and for an entrance door. It has a perimeter frame, and at the bottom it has a small profile for waterproofing. If a lock is needed to be used as a second entrance door, a larger profile on the leaf is used.

The second major category is sliding windows. In sliding windows Symbolism/Drawing is done with an arrow to the opening side. The typologies of the slides depend on the way the leaves are sealing on the side of the hook profile. Double horizontal sliding sash, when they overlay each other. One sash in the wall sliding window or outer sliding window when sealing with the wall.

Figure 1.37. Sliding (Profilsmart Gold Software)

The combination of basic typologies creates complex typologies. Some combinations are depicted below.

Figure 1.38. Complex typologies (Profilsmart Gold Software)

The Double horizontal sliding sash is made with a guide with two rails, on which the leaves move. There are guides with 3,4 etc. rails with whom we can make single-leaf, double-leaves, three-leaves etc.

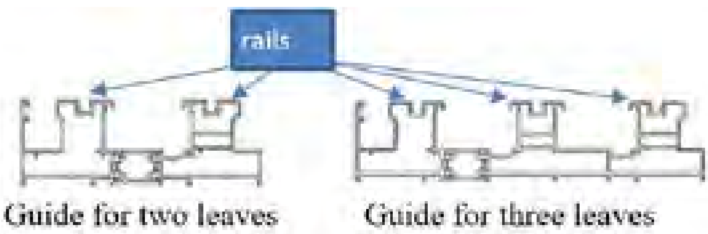


Figure 1.40. Guides for sliding windows (Europa)

In folding doors, the frame is different from the other sliding systems. It has special fittings for the easy adjustment of the double profile frame, with selection from solid or hollow inox guide rails. Optimal sealing is achieved around the roller-hinges, due to special rubber fitting.

There are two categories of folding doors, depending on with the load position on the upper or on the down guide.

Figure 1.41. Folding doors (Alumil)

A folding door may be constructed by multiple leaves, from 1 to 2, 3, 4, 5, 6, 7, 8, 9, etc.

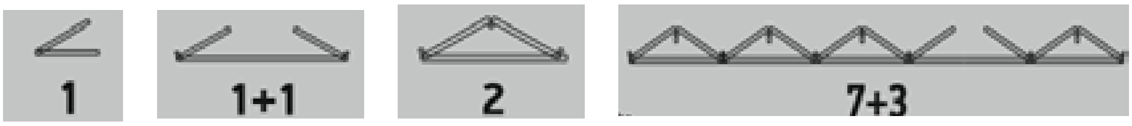


Figure 1.42. Folding doors typologies

A new trend is the minimal sliding windows, which are the ideal solution for projects requiring wide spans with minimal aluminium sight lines. Massive yet elegant glazing surfaces are achieved while maintaining high functionality, performances, and minimal architectural design. The frame is mounted inside the wall, and therefore there should be provision in the design in collaboration with the architect.

Figure 1.43. Minimal sliding (Alumil)

Pocket sliding windows is a subcategory, in which the sliding sash is moving inside the wall, as it is depicted in the Figure below.

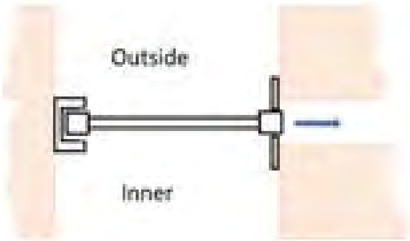


Figure 1.44. One sash pocket sliding

Some combinations of pocket sliding windows are depicted in the figure below.

Figure 1.45. Pocket sliding combinations (Profilsmart Gold Software)

All aluminium architectural systems provide profiles for shutters constructions. Shutters are installed externally to provide additional covering and/or protection to the opening. The shutter typology (opening or sliding) is the same with the architectural systems.

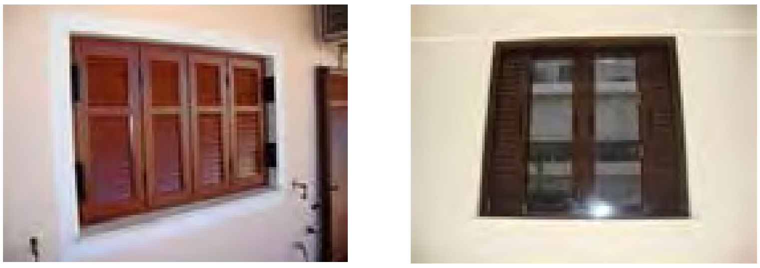


Figure 1.46. Typical examples of Shutters

Another product that may be installed externally to the opening is a roller shutter. It consists of a box (in a variety of dimensions), of guides and slats (in many shapes and dimensions). Boxes could be constructed with thermal break profiles.

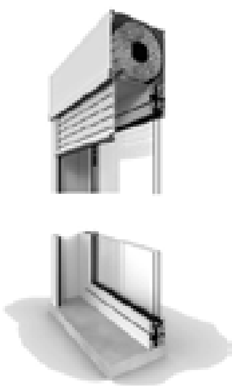


Figure 1.47. Roller shutter (Europa)

They are two types of roller shutters depending on the place of box installation. In the first type the box is installed on the fenestration, while in the second one outside the fenestration.

1.3.2. Curtain walling systems and their features

Key Words

- **Curtain walling:** non-structural cladding systems for the external walls of buildings
- **Stick curtain wall:** Stick are systems that are mounted on site from the outside of the building unit by unit
- **Unitized curtain wall:** systems where large units are prefabricated and placed on site with a crane

The term "curtain walling" was first used to describe the outer wall of medieval fortifications. Today the term Curtain Wall (CW) is defined in most literature to be any building wall of any material that is designed to resist lateral loads due to wind or earthquake and its own self weight. In other words, the curtain wall is a non-load-bearing wall.

According the American Architectural Manufacturers Association (AAMA) Curtain Wall is an exterior building covering which may consist entirely or principally of metal, or may be a combination of metal, glass and other surfacing materials supported by or within a metal framework. According to AAMA Window Wall is a type of metal curtain wall installed between floors or between floor and roof and typically composed of vertical and horizontal framing members, containing operable sash or ventilators, fixed lights or opaque panels or any combination of there.

Curtain walls are installed externally of the building shell and consists of columns, transoms and leaves - fixed or casement.

Figure 1.48. Photo of typical CW application

All loads shall be absorbed by the columns transmitted through the transoms. The columns carry the loads to the structure, where the glass or panel is applied, through the support base. The forces developed internally on materials, contraction / expansion, are related to the temperature difference season by season.

During installation differences in profiles lengths due to thermal expansion and glazing distances from the profiles should be taken into consideration. The coefficient of linear expansion of aluminium is twice from steel and should be kept in mind. When aluminium profiles are fastened to the metal structure should not block the water drainage.

Curtain walls are categorized by the way they are assembled and installed:

- **Sticks:** systems that are mounted on site unit by unit, from the outside of the building by using a scaffold or a drop front basket (Ladder subcategory).
- **Unitized:** systems where large units are prefabricated and placed on side by using a crane. The filling can be glass or panel (wall panel).

The Stick system could be categorized in:

- **Standard** – The glass is directly supported on the profiles by pressure plates.
- **Structural** – When there is no external profile (pressure plate).
- **Semi Structural** – When outward, a small profile from the glass sheet appears.

The main steps for the installation of a stick curtain walling are (i) install the columns on the building's frame and then (ii) fix the transoms on the columns and finally place the glass pane directly or with aluminium profiles (sheets). These systems can be placed in a building with a maximum height of 100 meters with a drop front basket and in buildings up to 50 meters high with scaffolding. They are mounted unit by unit on site and therefore have the option of special shapes as it is not standard.

On the other hand, Unitized CW is a special class of curtain wall prefabricated in pieces in the factory. The bases are installed from the inner side to each floor without scaffolding. These systems can be placed in buildings however high is, since the prefabricated units are placed with crane from outside.

Roofs constructed with trapezoidal profiles have excellent sound reduction characteristics that have been measured up to 53 dB. The measured sound reduction for wall constructions using cassettes has been assessed at an RW of 57 dB.

The acoustic performance of a particular cladding system depends on the insulation material, the cover sheet, the liner sheet profiles and the assembly method. To minimize reverberation architects may take advantage of the sound absorbing properties of the cladding insulation layer by replacing the standard liner sheet with a perforated liner.

Figure 1.49. Unitized CW installation (Harmon Curtain Wall)

Window Wall is a unitized system installed between two slopes and categorized by the kind of the materials that are assembled and installed. When a piece of Unitized CW is slab-based (not outside the building) it is called wall window. It is a type of metal curtain wall installed between floors or between floor and roof and typically composed of vertical and horizontal framing parts, containing operable sash or ventilators, fixed lights or opaque panels or any combination of there.

Figure 1.50. Window Wall

Spider glazing is a major concept for facade glazing and elevation glazing using spider glass hardware. Structural support for the spider glazing can be taken from structure of the building and for the larger elevations structural support should be created with mild steel or stainless steel.

Figure 1.51. Window Wall

Skylight / Patio is the most appropriate suggestion for swimming pools, gyms, shopping malls, daily home extensions creating a pleasant feeling and well-being for guests. It has a drainage system for the removal of water, which is created by condensation of water vapour, while guaranteeing excellent resistance to corrosion-free materials under the harshest climatic conditions.

System Technical Specifications:

- Column width (vertical and horizontal) 50-60 mm
- Large channel for water drainage and ventilation
- Separate water vapour drainage channel
- Possibility of making electrically ventilated windows
- Large variety of cross sections to support all structures, without static problems.
- Combined use with collapsible patio extensions.

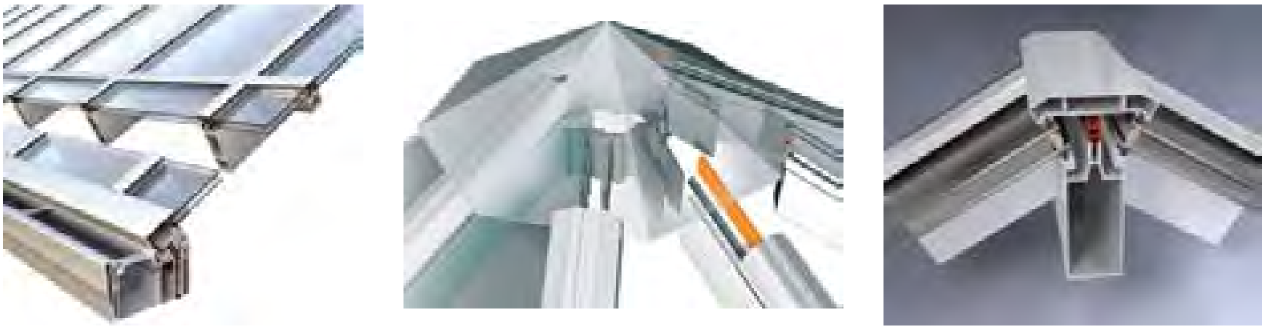


Figure 1.52. Sketches from a Skylight system (Alumil)

All kinds of constructions can be manufactured as one level, two levels, pyramids, cones etc.

Rainscreen cladding is part of a double-wall construction that can be used to form the exterior walls of buildings. Open joints between the panels allow a circulating air layer to be formed between the hung panels and the thermal insulation, which is mounted directly on to a building structure. In a glass rainscreen cladding system, the outer leaf panels can be made of laminated glass or tempered glass.

The primary difference between the two types of glass cladding is that curtain walling is usually the whole building envelope, which is the physical separator between the conditioned and unconditioned environment of a building. Rainscreen cladding is just the outer protective layer of the envelope. https://wakefieldequipment.com/glass-cladding-curtain-walling-vs-rainscreen/

Figure 1.53. Rainscreen cladding

1.3.3. Outdoors systems, fences, pergolas, railing etc.

Key Words

- **Outdoors systems:** all the architectural systems except the fenestrations
- **Pergola:** a form of shed
- **Railing (balustrade):** a balustrade is a railing (handrail) and the row of balusters (posts) that support it. They are installed at the side/edge of a staircase or balcony to prevent people from falling
- **Fences:** a high railing installed on the side of a field to define and guarding the property
- **Woopee :** a composite material for investment
- **Woodalux:** a composite material for investment
- **Canopies:** constructions for protecting the main entrances and professional spaces from rain and sun

Outdoors systems are all the other system except the doors and windows, as railing, pergolas, fencing, decking. In the figure below typical examples are provided.

Figure 1.54. Outdoors systems (Alumil)

The main advantages that outdoor systems shall offer are listed below:

- complete qualitative solutions to client
- complete solutions of high standards in a project (hotels, restaurants, villas, HoReCa)
- aluminium systems of high aesthetics and zero maintenance
- opportunities for combined sales, "cross-selling", first aluminium windows and then outdoors, or vice versa
- increased chances of success in a project (combo solutions and lower prices)
- solutions, characterized by ease, vast variety and broad application
- solutions, compatible and uniform with other aluminium systems

- "barriers" to competition to prevent from reaching their own customers
- increase of their product mix and the number of their customers
- increase of total turnover and profitability
- saving time and cost reduction (communication, administration, transport, etc.)
- differentiation and competitiveness

The forces developed internally on materials, contraction / expansion, are related to the temperature difference season by season.

Pergola is a light construction in different designs for protection from the sun and in some cases from the rain. There are many models with different designs such as classic and modern with fixed blinds or motorized. Each model has many components, and with different columns the corresponding dimension is width x width. Lightweight glass slides can be adjusted to the side, as well as lighting incorporated into the profiles.

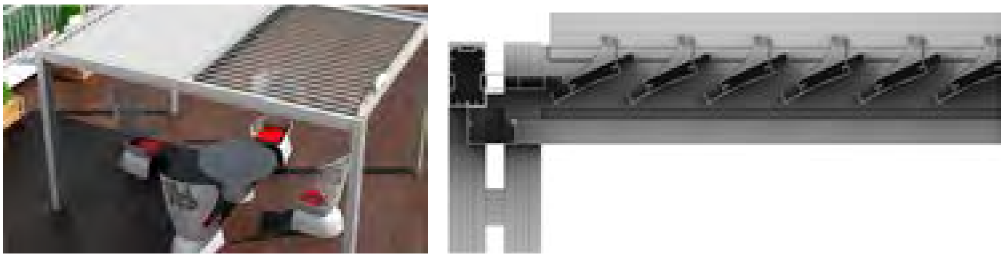


Figure 1.55. Pergola (Europa)

Railing is a type of fence made of one of more usually metal bars attached to posts. The basic railing categories are:

- Glazing railings
- Tubular railing
- Cast railing

The glass railings have modern aesthetics, which enable the visual field free and offer a sense of luxurious freedom. Many base profiles are provided to cover every technical need such as:

- on-floor plus
- one side-mounted
- one embedded
- one curved

They have Extreme sturdiness, to resist horizontal loads up to 4.0 KN/m and robustness, which is not met easily in the market and allows very long and high structures. There is an extensive variety of solutions in terms of:

- mounting, e.g.. side-mounted
- load resistance, up to 4.0 kN/m
- glass thickness, from 5+5 mm to 10+10 mm
- surface treatment
- handrails, round, oval, square plus flexibility & capability for new & customized solutions.
- LED possibility at the bottom of the glass

In glazing railings there are a wide range of glass panels, in various thickness and characteristics according to specifications. There are two main categories according to EN 12543 and EN 12600 specified by EU concerning the thermal treatment of the glass. More specifically, EN 12543 specifies the use of tempered and laminated glass with the insert of PVB membranes.

This type of glass panels has the following qualities: a) In case of breakage, they do not break in large and sharp pieces. b) Even in case of such breakage, the broken glass pieces remain attached on the PVB surface without putting in danger the safety of nearby persons. The fabrication of these tempered and laminated glass panels is being carried out by thermal treatment of ordinary glass which is afterwards sandwiched together with the PVB membranes to give the various grades and thickness of laminated glass panels.

Figure 1.56. Examples of Glazing Railing (Aluminco)

Tubular railing is a system of anodized or polyester powder coated aluminium with a wide range of profiles and accessories.

Figure 1.57. Examples of tubular railing systems (Aluminco)

Cast railing from aluminium is the resulting product created after molten aluminium is poured into a mold. They are made in many designs with many components and usually for mounting often require welding.

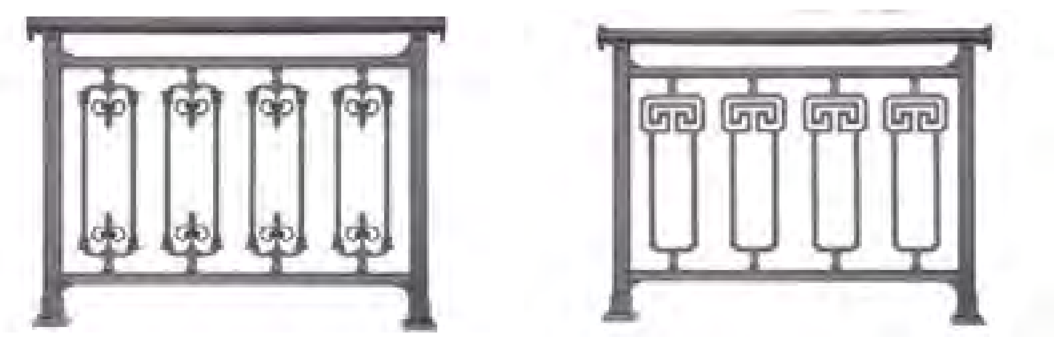


Figure 1.58. Cast railing systems (Aluminco)

In our days have entered the market fencing systems of minimal design with a wide variety of louvers, either attached or installed between the mullions.

Figure 1.59. Photo of Fencing project (Alumil)

Entrance **canopies** are an ideal solution for the protection of main entrances and professional spaces from rain and sun. They are made of pure aluminium, powder coated, in traditional and modern designs. They are available with solid polycarbonate sheets. They are easily installed without intervening in the building's architecture, available in four beautiful designs, providing an excellent aesthetic and functional result.

Figure 1.60. Canopies for Entrances doors (Aluminco)

1.4. Applications in metal constructions & interaction with aluminium structures

Key Words

- **Metal casements:** Casements from special metal profiles.
- **Photovoltaic base:** Stands for mounting photovoltaic cells.
- **Mezzanine:** Interior metal construction between two floors.

To be achieved upon learning outcome completion

KNOWLEDGE	SKILLS	COMPETENCIES
• Typologies of metal fenestration with different alloys • Possibilities of fire-resistant constructions • Metal-to-aluminium co-operation in metal pre-frame and other mixed- curtain walling, atrium-metal applications	• Selection and manufacture of typology according to the client's needs with the ideal metal alloy • Selection and construction of typology in relation to place and fire safety requirements • Apply good practices for raw materials and final products storage • Ideal metal profile cross sections for static reinforcement & support of aluminium cross sections	• Exploit an alternative alloy - typology class for the ideal construction • Use mixed typology to solve technical & aesthetic problems • Utilize the strength of the metal alloys to support the aluminium frames in the installation and the static strengthening of the large openings

1.4.1. Metal construction products typologies with various alloys

Metal fenestration constructions are most times steel frames – steel or stainless steel - made of galvanized 1,2-2 mm thick steel profile and glass depending on the application. Copper profiles are also used for fenestration constructions. There are many profiles even with thermal break, with which various typologies could be achieved. Opening typologies dominate, but rarely we can find sliding systems, especially double hang. Many classic/old-fashioned front door doors are also manufactured.

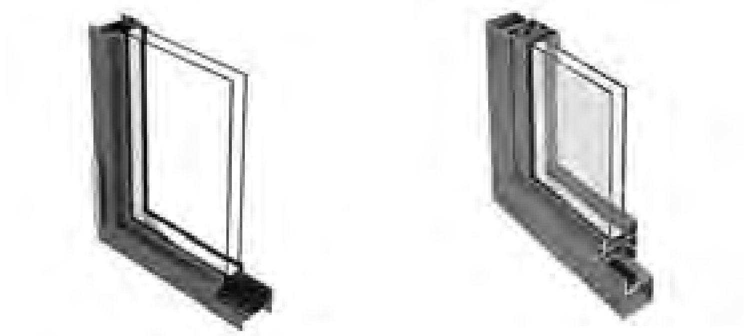


Figure 1.61. Metal fenestration systems (Jansen)

Metal systems have also developed thermal break profiles with special techniques, as well as many mounting fittings, so that in many cases they are painted with electrostatic paint and assembled without damaging the aesthetics.

Figure 1.62. Steel curtain walling (Jansen)

Apart from metal frames the iron is easy to process and therefore we can do all types of construction, such as, Fences, Shelter / Greenhouse, Staircase, Garage doors, Loft, photovoltaic base, etc.

Figure 1.63. Stainless steel canopies for main entrance

Figure 1.64. Steel made fence

Figure 1.65. Photos from typical Staircase (Can stock photo)

Figure 1.66. Photos from Garage doors (Kete)

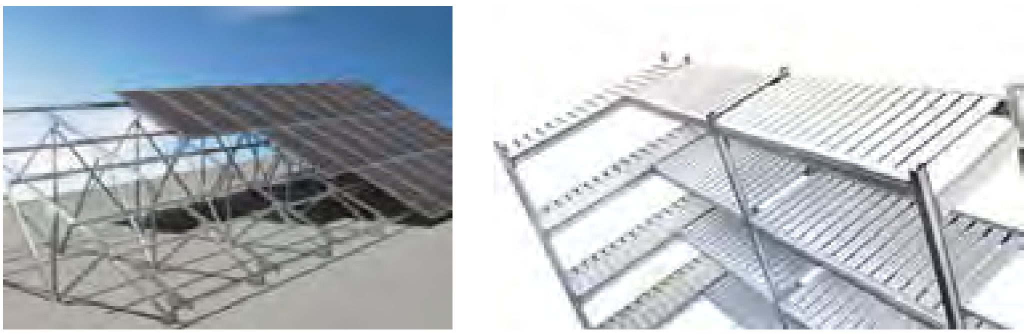


Figure 1.67. Sketches from photovoltaic base / Shelves (Alumil)

1.4.2. Special constructions, i.e. fire-resistant, anti-burglar, bullet proof etc.

Key Words

- **Fire resistance:** protection against fire
- **Security doors:** protection against thieves
- **Antivandal:** protection against a firearm
- **Universal door:** general purpose door

Fire protection is the study and practice of mitigating the unwanted effects of potentially destructive fires. It involves the study of the behaviour, compart mentalization, suppression and investigation of fire and its related emergencies, as well as the research and development, production, testing and application of mitigating systems.

Buildings must be constructed in accordance with the version of the building code that is in effect when an application for a building permit is made. Passive fire protection - the installation of firewalls and fire rated floor assemblies to form fire compartments intended to limit the spread of fire, high temperatures, and smoke. For the fire protection these are steel frames made of galvanized 1,2-2 mm thick steel profile and glass depending on the application.

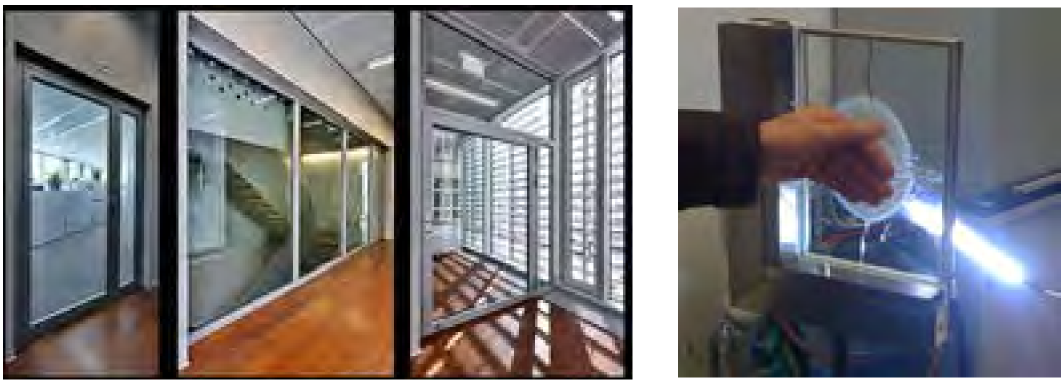


Figure 1.68. Fire-resistant fenestrations (Ili-Con)

A fire door is a door with a fire-resistance rating (sometimes referred to as a fire protection rating for closures) used as part of a passive fire protection system to reduce the spread of fire and smoke between separate compartments of a structure and to enable safe egress from a building or structure or ship.

In Europe national standards for fire doors have been harmonized with the introduction of the new standard EN 16034, which refers to fire doors as fire-resisting door sets. All fire doors must be installed with the appropriate fire-resistant fittings, such as the frame and door hardware, for it to fully comply with any fire regulations. Both the door leaf (the swinging panel of the door) and the door frame are required to meet the guidelines of the testing agency which provides the product listing.

The door frame includes the fire or smoke seals, door hardware, and the structure that holds the fire door assembly in place. Together, these components form an assembly, typically called a "doorset" which holds a numerical rating, quantified in hours of resistance to a test fire.

All of the components of the fire door assembly must bear a listing agencies label (with the exception of ball-bearing hinges which meet the basic build requirements) to ensure the components have been tested to meet the fire rating requirement.

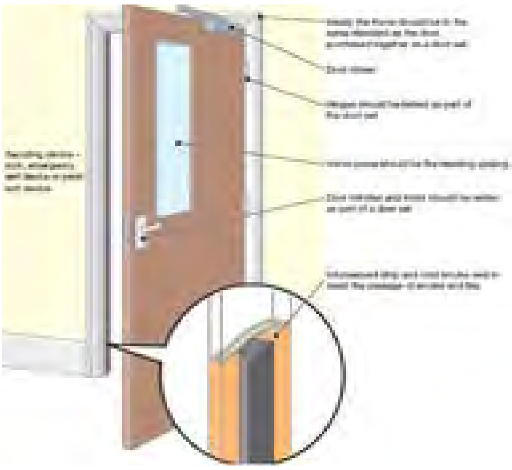


Figure 1.69. Fire-resistant door

Security doors / Expandable Security Doors is metal door with multi-point lock. Security doors can prevent or delay intrusions unless intruders put significant force into gaining entry, usually using tools. They're a deterrent, they're a physical barrier, and they're highly effective. Given sufficient time and using the right equipment, all security doors can be penetrated.

A good modern security door can also provide this screening function without compromising your home security.

A heavy-duty security door is a very demanding proposition for intruders, even if they do have the equipment required to penetrate it. Modern security doors are rated against force, including direct impacts and attempted leverage of the door frame fixtures. Forcing a security door takes time, and any good on-site security system will spot an attempted entry almost instantly.

Commercial security doors are even tougher. Generally, the stronger the security door, the less likely it is to be penetrated.

These very durable doors may include multiple folding doors, expanding doors, and commercial roller shutters. All these doors offer very high levels of anti-intruder protection.

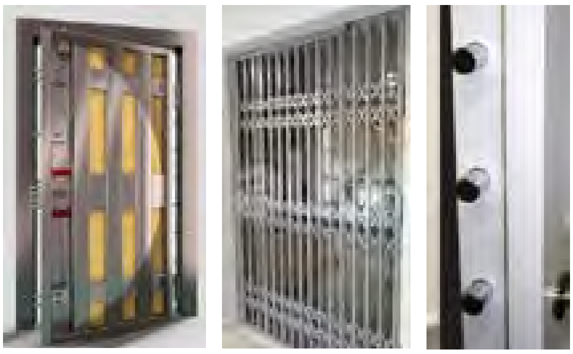


Figure 1.70. Examples of Security doors (Kete)

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Bullet resistance windows and doors are the ultimate in-home protection – complemented with walls secured by ballistic material they can provide a completely secure home. If these constructions use glass, it must be laminated according to EN 14449 (multi-membrane).

Figure 1.71. Examples of Bullet Proof doors

Finally, it must be referred that universal metal door is a simple construction with 0.9 mm thick sheet metal and is used for staircases, warehouses, etc.

Figure 1.72. Universal metal door

1.4.3. Scope of metal-to-aluminium co-operation in metal pre-frame and other mixed- curtain walling, atrium-metal applications

Key Words

- **Pre metal-frame:** galvanized tube 40x40 or 20x40 or 20x60 etc. and placed before the window in the masonry to facilitate installation
- **Spider curtain:** curtain walls that as a structural element has metal rods, and the glass panels are fastened with special accessories

Metal and aluminium combine together in many types of construction. In large-size curtain walling the static part is made of metal on which an aluminium profile is fastened with all the components required for good sealing and insulation.

Depending on the size of the structure, the corresponding metal profiles are also used. In the following drawings are aluminium profiles and the way they work with metal.

Figure 1.73. Examples of Combination steel with aluminium (Alumil)

It is important to take the necessary corrosion prevention actions when aluminium comes in contact with steel. That could be a neutral material which interferes between the two metals.

In some cases, a metal pre frame is placed and before in the masonry in order to the facilitate window's installation. The metal pre frame is made of galvanized steel tubes 20x40mm, 40x40mm etc.

Figure 1.74. Metal pre frame (IME GSEVEE, new techniques for aluminium and iron construction works Athens 2014, ISBN:978-618-5025-42-7)

01 MODULE
Conclusions

Knowledge of material technology and its applications in manufacturing is the basic knowledge, as far as metal alloys and different profiles, production methods and uses, are concerned.

The architectural aluminium systems offer a great number of advantages. Their increasing place in the market is due to the development of new materials with great technological potential, which ensure very good performance in the final product in factors important for the consumers, such as energy saving.

Aluminium architectural systems offer significant energy saving potential by permitting manufacturers to meet the energy requirements of the projects. This is due to the significant technological developments of recent years in aluminium architectural profiles, where the prevalence of profiles with thermal barriers could achieve low thermal transmittance factors.

A professional manufacturer should have the basic knowledge of thermal insulation and thermal transmission, as well as the most important properties that affect the energy behavior of the frames. He should be able to calculate the performance of the frames and take them into account, proposing to the building owners ways that will help to reduce thermal losses and increase energy saving.

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Self Assessment Questions

Improvement begins with assessment.
Self Assessment is the first step to all assessment.
Start by choosing the correct answers.

1. From what raw material is the aluminium produced?
    a. from Granite Rocks
    b. from limestone rocks
    c. from Bauxite
    d. from iron
2. How much are the alloys there?
    a. 1XXX, 2XXX, 3XXX, 4XXX, 5XXX, 6XXX, 7XXX & 8XXX Series
    b. 6XXX Series
    c. 6XXX, 7XXX & 8XXX Series
    d. 1XXX, 2XXX & 3XXX Series
3. What alloys do you use to produce fenestration´s profiles?
    a. all 6XXX series alloys
    b. specifically, 6060, 6063, 6005 & 6082
    c. specifically, 6060, 6063,6061, 6005 & 6082
    d. specifically, 6060, 6063,6061, 6101 & 6082
4. Why do we have so many alloys?
    a. because according to the use of each profile the specifications of each alloy change. For example, architectural uses 6060, while for industrial purposes such as ladders, scaffolding, strollers we use different alloys of higher strength
    b. because according to the use of each profile the specifications of each alloy change. For example, architectures use 6101 while for industrial purposes such as ladders, scaffolding, strollers we use different lower strength alloys
    c. because according to the use of each profile the specifications of each alloy change. But because the alloys are the same, we use the 6060
    d. we have so much because there are so many uses of aluminium

5. How many different shapes of primary aluminium are there?
   a. there are three shapes, sheets, billets and ingots
   b. there are four shapes, sheets, billets, profiles and ingots
   c. there are two shapes, billets and ingots
   d. there are various shapes, slabs, billets, industrial, architectural profiles and ingots

6. What is Extrusion?
   a. the process to produce sheets
   b. the process of processing the sheets
   c. the process of making ingot
   d. the process of producing profiles

7. Can we use profiles and components from different architectural systems?
   a. yes,we can
   b. no we can not
   c. it depends on the system
   d. we can use a small category

8. What are the differences between euro groove e groove 16?
   a they make no difference
   b. the European is a more powerful mechanism
   c. the shape and dimension of the channel being placed varies
   d. the mechanism 16 is the cheapest one

9. How do we distinguish the mechanism to be placed on a profile?
   a. we do not understand it from the profile
   b. from the groove in the leaves
   c. from the shape of the frame
   d. from the thickness

10. What is the difference in sliding mode between a simple sliding and a lift-sliding?
   a. the lift-sliding has a larger profile
   b. how the mechanism works
   c. it’s the same
   d. the lift-sliding can lift a lot of weight

11. Why do entrance doors need strong hinges?
    a. because it works more than the other frames
    b. to be safety
    c. to be beautiful
    d. to be able to lift a lot of weight

12. How many dye categories for aluminium are there?
    a. 6
    b. 2
    c. 3
    d. 7

13. Which paint category has the widest variety of colours?
    a. all categories have the same colours
    b. anodizing
    c. powder coating
    d. sublimations

14. What is the difference between iron and steel?
    a. steel is an alloy of iron and carbon
    b. there is no difference
    c. iron is heavier that steel
    d. the variety is in colour

15. What is the stainless steel?
    a. a steel alloy with 2% carbon
    b. a steel alloy, >11% and maximum of 1.2% carbon
    c. iron with 10% carbon
    d. steel alloy, >11% carbon

16. What is galvanization?
    a. the process of applying a protective zinc coating to steel or iron
    b. the process of applying a protective zinc coating to steel
    c. the process to anodize the steel
    d. the process to paint the steel

17. What is the roll forming?
    a. the process to produce sheets
    b. the process to produce ingots
    c. the process to produce billet
    d. the process to produce profiles

18. What is the bottoming process?
    a. when the punch presses the material against the inner surfaces of the bottom die
    b. when the punch presses the material against the inner surfaces until the middle stroke
    c. when the punch presses the material against the inner surfaces for 3 mm
    d. when the punch presses the material

19. What is a trapezoidal profile?
    a. a corrugated profile
    b. a large metal structural members
    c. a square profile
    d. a round profile

20. Why is quality window glazing essential in a frame?
    a. because it's nice
    b. because the law requires it
    c. because it's better the Uw
    d. because no air enters

21. What is energy glazing?
    a. decorative glass
    b. glass reinforced with one or more thin layers of metallic oxides
    c. glass reinforced with one or more thin layers of carbon
    d. glass reinforced with one or more thin layers of zinc

22. Are glazes produced in all thickness?
    a. yes
    b. no
    c. only at 4,6,8,10 mm
    d. in many thickness

23. What does the heat strengthen glass?
    a. during production when the cooling process is fast
    b. the cooling process does not matter
    c. the cooling process is slower
    d. there is no such process

24. What is tempered glass?

   a. the glass that in production process heated reaching temperatures of up to 1000° C
   b. the glass that in production process heated reaching temperatures of up to 200° C
   c. the glass that in production process heated reaching temperatures of up to 600° C
   e. there is no such thing

25. What is laminated glass?

   a. the glass that has two or more pieces
   b. the glass that has PVB (polyvinyl butyral) resin glue film between two or more pieces
   f. there is no such thing
   c. own glass with PVB (polyvinyl butyral) resin glue film

26. Why is laminated glass resistant to loads?

   a. because it is used in small dimensions
   b. because it's thick
   c. you cannot lift many loads
   d. because there are a lot of glazed together with a membrane

27. In a double-glazed window on which side it is better to have the energy coating?

   a. on the outside of the house
   b. on the inside of the house
   c. between the gap
   d. ıt doesn't matter which side it will be on

28. How much difference in performance has a double glazing from a single one?

   a. the same
   b. 10%
   c. 80%
   d. 50%

29. What type of glass panels are used in the patios/skylight?

   a. annealed glass
   b. tempered glass
   c. heat strengthen glass
   d. laminated glass

30. On what factor depends the thickness of the glass to be used in a window?
    a. on the height of the fenestration
    b. on the width
    c. it does not matter
    d. on the dimension

31. Where is the corrugated galvanized iron used?
    a. for overlapping side of metal buildings
    b. for overlapping roof of metal buildings
    c. for overlapping side & roof of metal buildings
    d. not for this use

32. What causes the stability and rigidity of sheet metal?
    a. the corrugated shape
    b. the thickness of the sheet
    c. the kind of material made
    d. the way of placement

33. What is the advantage of composite panels?
    a. the insulation
    b. the dimensions
    c. the safety
    d. the fire protection

34. Where is the bond used?
    a. for overlapping side of buildings
    b. for overlapping roof of buildings
    c. for overlapping side & roof of buildings
    d. not for this use

35. Where is the Woodee used?
    a. for overlapping side of buildings
    e. for overlapping roof of buildings
    f. for overlapping side & roof of buildings
    g. for overlapping side & floor of buildings

36. What is the difference between sliding and minimal in installation?

a. it's the same

b. minimal has only 2 sashes

c. the slides are positioned only in the middle of the wall

d. the frame of the minimals placed inside the wall

37. What is the main difference between sliding shutters and sliding systems?

a. there is no difference

b. the shutters have slats for filling

c. the shutters use thermal – break profiles

d. shutters are using only for windows

38. How many roller shutters do we have relative to the installing position?

a. 5

b. 7

c. 2

d. 3

39. What is the basic difference of a curtain wall from a fenestration?

a. they are not different

b. the curtain wall is placed outside the building

c. it's a matter of aesthetics

d. it's a matter of colour

40. What are the 2 major categories of curtain wall based on the way they are assembled and installed?

a. stick & wall window

b. unitized & spider

c. stick & unitized

d. rainscreen & wall window

41. What is the basic difference between Stick and Unitized?

a. there is no difference

b. stick installed piece by piece while unitized is prefabricated

c. stick can withstand more loads

d. unitized is nicer than stick

42. What is the basic difference between standard and structural?

a. there is no difference

b. standard holds the glass with a pressure plate & structural with glue

e. structural ones are for larger constructions than standard

f. structural is nicer than standard

43. How do we place the Unitized curtain wall on the building?

a. with a crane

b. with scaffolding

c. with crane and scaffolding

d. we don't need any of the above

44. Can we place Stick curtain walls in a skyscraper?

a. yes we can

b. no we can't

c. we can up to 200 floors

d. we can up to 100 floors

45. What is the basic difference between a window wall and a curtain wall?

a. curtain wall is installed out of the building, while window wall between slabs

b. they are unitized for high buildings

c. there is no difference

d. window wall is only for small windows

46. What is the basic difference between stick and spider?

a. at stick the glazing is supported by aluminium profiles, while at spider is fastened to a metal frame with screws

b. there is no difference

c. at stick the glazing is only tempered & laminated, while at spider no

d. at stick the glazing is only single

47. For what purpose is a pergola used?

a. as a greenhouse

b. as a storage space

c. as a bedroom

d. as an auxiliary recreation area

48. What types of railings are there?
    a. glazing/ tubular / cast
    b. sheeted railing
    c. sheet railing
    d. Pvc railing

49. Can we place glass railings on side-mounted?
    a. no
    b. yes
    c. it depends on the type of building
    d. it depends on the dimensions

50. What quality of glazing pane do we use on the glass railings?
    a. all types
    b. heat strengthen glass
    c. coloured
    d. laminated glass - tempered glass

51. In what part of a house are canopes used?
    a. in the swimming pool
    b. at the main entrance
    c. at the balcony
    d. in the parking lot

52. What typologies can we make with metal frames?
    a. sliding
    b. casement
    c. curtain wall
    d. all typologies

53. How are the aluminium's profiles for fenestrations produced?
    a. with a bending machine
    b. with a roller machine
    c. with mannesmann
    d. through extrusion

54. When are stainless steel profiles used?
    a. on mountain constructions
    b. near rivers
    c. near the sea
    d. in town

55. Where are metal Frames needed the most?
    a. in fire safety systems
    b. in casements systems
    c. in sliding systems
    d. in simple frames

56. Why do we place fire doors in buildings?
    a. it blocks the smoke during the fire
    b. they have good aesthetics
    c. they have a good price
    d. they are easier to install

57. What glasses are used on bullet doors?
    a. tempered glass
    b. heat strengthen glass
    c. laminated glass
    d. special category

58. What is the purpose of the pre-frame?
    a. easily fit the frame
    b. to give moor value to construction
    c. be stronger
    d. it is mandatory by law

59. When do aluminium curtain walls re combined with metal?
    a. when we want a cheaper construction
    b. to be more beautiful
    c. when we have large dimensions in construction
    d. we should always use for security

60. Where else can aluminium be combined with metal?
    a. it is mandatory by law
    b. for reinforcement inside aluminium profiles for curtain walls
    c. for cheaper construction
    d. for an elegant build

MODULE

Production facilities and equipment

Selection of appropriate tooling & suitable production layout organization leads to increased productivity and cost minimization

02 MODULE
Production facilities and equipment

Selection of appropriate tooling & suitable production layout organization leads to increased productivity and cost minimization.

Exploiting principles from production engineering is now more important than ever in reaching productivity optimization. To this end proper selection of tools, adaptive layout design of the production area, on-time logistics and smart investment in hardware, is of prime importance.

All the above should be combined with a healthy and safe working environment, which will protect the employee and at the same time motivate him to optimize his performance, in order to manufacture and install a quality product.

Introduction - Learning Objectives
Special features of appropriate tooling and production layout organization

This module covers the section of "Production facilities and equipment". It analyses the functionality and scope of the main types of equipment, in accordance to the European health and safety legislation. In this module organization-related issues are also presented towards minimization of dead times and production costs as well as optimization of process times.

Risks that threaten the safety of workers that may come from infrastructure, equipment and incorrect practices that workers follow at work, are also identified. Finally, good practices to be followed by the employee are presented, in order to reduce the possibility of an accident during work.

Knowledge Objectives to be achieved through this learning module are:

- Equipment for cutting, machining, assembling etc.
- Handling of equipment in line with health & safety regulations.
- CAD-produced technical drawings, descriptions, and work orders.
- IT systems, including digitized processes.
- Working practices (working field, equipment, etc.).
- Machine tools with optimized methods to load processing data and yield optimized results.
- Tools and consumables, suitable for the equipment with health & safety.
- Basic principles in cleanliness and maintenance processes for mechanical equipment.
- Machinery layout in the production site to minimize dead time.
- Production methods.
- Layout of machinery, with tools and consumables to meet production requirements.
- Human resources based on production needs.
- Line managers, using technical terminology.
- Data collection on production costing.
- Timetables for cost accounting.
- Time schedules.
- Mechanical equipment for saving time and protect aluminium from other metal constructions.
- Shop of other metals and processing shop of aluminium.
- Auxiliary structures, devices, templates, and flat patterns.
- Selection of personnel with basic knowledge in aluminium & metals.
- Good health and safety practices in the production area
- Adapt equipment handling to occupational health and safety rules
- Logistics and warehouse good practices.
- Secure loads, transport components and sub-assemblies and use lifting gear.
- Working practices in transportation such as suitable vehicle, appropriate means of support etc.

For the Teacher

Learning Outcome 2.1
Handling & maintenance of mechanical equipment

Learning Unit 2.1.1 - 4h
Handling equipment for cutting, machining, assembling etc
Learning Unit 2.1.2 - 3h
Tools and consumables
Learning Unit 2.1.3 - 3h
Basic maintenance principles

Learning Outcome 2.2
Acquaintance with production area, personnel - machines, for aluminium

Learning Unit 2.2.1 - 6h
Optimum layout of machinery in the production site
Learning Unit 2.2.2 - 2h
Organize human resources based on production requirements
Learning Unit 2.2.3 - 2h
Principles for cost estimation- Data collection, timesheets etc.

Learning Outcome 2.3
Acquaintance with production area, personnel - machines, for metal and mixed production

Learning Unit 2.3.1 - 6h
Optimum layout of machinery in the production site
Learning Unit 2.3.2 - 2h
Organize human resources based on production requirements
Learning Unit 2.3.3 - 2h
Principles for cost estimation- Data collection, timesheets etc.

Learning Outcome 2.4
Health and safety practices in production & packaging & storage

Learning Unit 2.4.1 - 6h
Health and safety practices in the production area
Learning Unit 2.4.2 - 2h
Health and safety practices in equipment handling
Learning Unit 2.4.3 - 2h
Health and safety practices after product manufacturing

2.1. Handling & maintenance of mechanical equipment

Key Words

Equipment: a set of tools that are used to achieve a specific objective. A tool can be non-mechanical as well

Assembling: the process of putting together, a final product from finished parts or partially assembled units

Manufacturing: the integrated process of producing a final product from unprocessed or semi-processed materials

To be achieved upon learning outcome completion

KNOWLEDGE

- Handling equipment for cutting, machining, assembling etc
- Tools and consumables, when, How and where they are used in relation to the needs of equipment
- Bsic cleanliness and maintenance periods of mechanical equipment

SKILLS

- Ensure operational readiness of machines and plants
- Handle equipment properly with health & safety
- Read, understand and apply CAD-produced and presented descriptions and work orders
- Apply regulations related to data protection and information security
- Plan and control work processes, check and evaluate work results
- Understand and use 3D-Equipment for production of tools, parts etc.
- Use IT systems, included in digitized processes
- Implement good working practices Handle the measuring equipment
- Use and apply tools and consumables with health & safety
- Implement manufacturer’s maintenance equipment instructions
- Carry out required maintenance work on systems, machines and tools

COMPETENCIES

- Choose the most suitable machine with the ideal way to load processing data and use it to get the expected results
- Select the appropriate mechanical equipment in relation to the size and type of production
- Select the most suitable tool and consumables for optimal and faster processing
- Maintain mechanical equipment for optimum operating condition and maintain a timely log of damage

2.1.1. Handling equipment for cutting, machining, assembling etc.

The tools that are used in the work of a craftsman are,

- **Hand tools**, tools that are powered manually and may include anything from axes to wrenches
- **Handheld electric**, such as screwdrivers, wheels, etc.
- **Larger tools** such as saw, blades, etc.
- **CNC machines**

A **senior craftsman** should have the following **skills** in order to operate machinery:

- read and understand production orders and select the suitable processing methods if these are not specified in the production order.
- select and transfer the raw material to the machine.
- select suitable tools and load them to the respective machine.
- handle the working piece on the machine tool.
- program machines tools with basic commands.
- verify the output of digital guidance programming.
- start and stop the machine following the operation guidelines.
- monitors the processing and adjust the operation if needed.
- troubleshoot problems on machines operating under digital guidance.
- performs dimensional checks during processing and at the end.
- perform finishing work on the working piece.
- fill in and archive production reports.
- deliver the processes working items to the next processing step.
- periodically check and provide maintenance of the tools.
- implement the waste management program of the production process.
- clean the machine and the surrounding area and perform clean-as-you-go procedures.
- perform primary maintenance on the machine.
- deal with minor machine malfunctions.
- apply procedures for health and safety.
- identify the risks that exist in the work environment or arise from the work that is performed.
- apply the predefined procedures in the event of an accident as well as dealing with emergencies, such as fire, leaks, etc.
- constantly improving his/her personal performance.
- participate in the training of his/her colleagues.
- be involved in corporate restructuring programs.

Hand tools are being used by craftsmen in manual operations, such as chopping, chiselling, sawing, filing, or forging. Complementary tools, often needed as auxiliaries to shaping tools, include the hammer for nailing and the vise for holding.

Basic principles of use are:

- Never push a tool against a part unless you hold the tool with your palm open.
- Point sharp tools (e.g., saws, chisels, knives) laying on benches away from aisles and handles should not extend over the edge of the bench top. Maintain tools carefully.
- Keep them clean and dry and store them properly after each use.

Figure 2.1. Typical hand tools

Handheld electric tools should always be used with the prescribed protection systems, and not with accessories other than those provided by the manufacturer. Tools shall be electrically grounded, and shall be used with appropriate gloves and special shoes to provide protection against electricity

Figure 2.2. Handheld electric tools

Larger equipment include double/single hand cutting machines, drilling machine, crimping machine, bending machine, fence systems etc., which we cut, machining and assemble the frames. Each machine has special tools and operational instructions by the manufacturer, which shall be followed by the operator.

Figure 2.3. Larger tools

CNC machines operation and applications may vary from one machine type to another, but all types of CNC machines have some common advantages. Some of the major benefits of CNC machines are the following:

- CNC machine tools improves process automation. Operator intervention in the production process can be reduced or even eliminated completely. Many CNC machines can perform the entire treatment cycle automatically without human supervision, thus allowing the operator to perform other tasks.
- The reduced need for operator involvement results in reduced human fatigue, fewer human errors, and consistent and predictable processing time for each workpiece.
- As the machine operates under program control, a lower level of competence is required by the CNC operator compared to a mechanic who performs machining with conventional machine tools.
- CNC technology improves the consistency and precision of each piece being machined. Modern CNC machines have huge accuracy and repeatability specifications. This means that once a program is tested, two, ten, or a thousand identical pieces can be processed very accurately and consistently.

- CNC machine tools are flexible. Since these machines operate based on programming, editing a different piece is usually as easy as loading a different program. Once a program has been checked and executed for a production process, it can very easily be recalled the next time it is desired to perform a same process. This leads to yet another benefit, the high production rates. Since these machines are quite easy to set up and operate and since programs can be very easy to load, the time required to prepare the machine is very short. This feature satisfies the urgent need of our time for last minute productions.

Figure 2.4. CNC Machines

CNC Machine operation & programming provides a wide range of capabilities in technical level. Programming a machine to perform a work instead of a worker results in numerous advantages, both technically and practically. CNC Machine Tool Operators - Developers in modern machine shops should have knowledge in programming as well as in data processing, in selection of suitable tools, in supervision and in basic machine maintenance.

They should be able to adapt and deliver in a real-time CNC working environment, be able to identify preventive risks that may arise during the upcoming CNC processing and to avoid any risks or errors that may occur, ensuring high quality of their work and end result without any unnecessary damage. Moreover, they should be able to know how to behave and function as conscientious professionals in a well-organized, modern, and extroverted corporate environment.

The operator should have the following knowledges:

- Mechanical drawing: types of drawings, basic aspects, sections. Numerical control: CNC machine tools, CNC machine tool organization.
- Metrology: measuring instruments and apparatus. Dimensioning.
- Machining: Industry standard templates, controllers, quality, applications - use.
- CNC machine tool components.
- Machining materials, Cutting tools materials.
- Programming: Utility commands, basic programming commands, coordinate system commands, compensation, processing cycles.
- Manufacture of piece cutter and soft clamps on lathe and milling machine.
- Processing cycles, G code (also called preparatory codes, are any word in a CNC program that begins with the letter G. Generally it is a code telling the machine tool what type of action to perform, such as: Rapid movement), final piece.
- Planning and construction of CNC lathe and milling machine.
- Presentation of the basic principles of CAD / CAM systems and their utility in machining planning.
- CAD system design and machining of CAM machining.

Figure 2.5. CNC Machines Operator

2.1.2. Tools and consumables

Key Words

Tools: an object used to extend the ability of an individual worker to modify working parts

Consumables: products that consumers use repeatedly, i.e. items that are "run out" or discarded. For example, for tools are wheels, drills, etc.

The list tools and consumables on electricals tools and large compatible tools that are being used in Aluminum and Metal Constructions shops is exceptionally large. They are stored in tool cabinets. For CNC machines there are different ways of storage and management.

Figure 2.6. Tools and consumable

Figure 2.7. Tools Cabinet

Tool management is needed in metalworking so that the information regarding the tools on hand can be uniformly organized and integrated. The information is stored in a database and is registered and applied using tool management. Tool data management consists of specific data fields, graphics and parameters that are essential in production, as opposed to managing general production equipment.

Unlike hand tools, a tool in numerically (digitally) controlled machines is composed of several parts, such as the cutting tool, which may be one piece or comprise a body plus indexable inserts, a collet, and a toolholder with a machine taper.

Putting the parts together accurately into an assembly is required to achieve error-free production. Processing a part with a CNC machining operation requires several tool assemblies that are documented in a list. Each component, each assembly and each list have an identifier under which the specifications are found.

Several functions are available to manage, process, print and combine with other applications. Logistics deals with demand planning, supplies and tool location. This includes, on one hand, the location in the warehouse and the purchasing of individual parts with the corresponding consumption report. It also allows for the planning and coordination of the movements of the assemblies within the shop floor **(https://en.wikipedia.org/wiki/Tool_management).**

Figure 2.9. Cnc Tools

The components are individual elements that can be combined into an assembly. Components are purchased as a unit and stored in a tool room. Cutting components (ex.: inserts) wear out during use and therefore must be purchased and replaced periodically.

Non-cutting components (ex.: collets) are practically unlimited. They are often acquired together with a new machine. (Clamping equipment is handled like non-cutting components.)

Header data is uniformly structured and contains information such as name, supplier product code and a unique item number.

Each component is assigned a specific tool type, which defines the number and description of the required data fields. Each component is also linked to a tool category that belongs to a user-specific tree structure, which serves to find the tools according to their technical criteria without indicating the number.

The tool assembly is built using several components. The component at the rear end must connect the machine tool, and the cutting component is found on the other end (ex.: drill or insert).

Varying components are used intermediately (ex.: extension, collets) to reach the desired geometry. The assembly documentation describes how the components are assembled, to ensure that the applied geometry in the CAM system matches that of the real tools in the CNC machine.

CAM systems generate the G-Code commands (NC program) for the CNC machine. Geometry, description and cutting conditions are selected and received directly from tool management. This ensures that all tools used are documented and consistent with the reality in the workshop. From the CAM system, all tools used in an NC program are automatically saved as tool lists in tool management.

This ensures the correct use of the tools during the preparation of the work process.

They are 3 categories of gases:

1. Flammable gases (e.g. acetylene)
2. Oxidizing gases (e.g. oxygen)
3. Inert gasses (e.g. nitrogen, helium, argon etc.)

Basic operation guidelines regarding gases management are:

- Use cylinders for the purpose they were manufactured and not as brackets or rollers etc.
- Storing and handling them should not reduce their mechanical strength (avoiding strokes, incisions, corrosion). Store in well-ventilated areas away from rain, snow, or fuel.
- Do not store cylinders without labelling their contents.
- Do not store more cylinders than necessary in workplaces.
- Preferably near doors and away from escape routes or inaccessible places.
- Close the valve when the cylinder is in storage
- Keep the connections clean.
- Regularly check their condition.
- Only connect equipment suitable for the given use.
- Return the cylinders to the supplier with the valve closed and the protective cap closed.
- Always keep a small amount of gas inside the cylinders to avoid air or moisture contamination.

Figure 2.10. Gas cylinders

2.1.3. Basic maintenance principles

Key Words

Maintenance: the process of preserving a good

Machinery maintenance include means by which mechanical assets in a facility are kept in operational order. Machinery maintenance involves regular servicing of equipment, routine checks, repair work, and replacement of worn or nonfunctional parts.

Preventive maintenance, also known as PM, main objectives are to:

1. Enhance capital equipment productive life.
2. Reduce critical equipment breakdown.
3. Minimize production loss due to equipment failures

Preventive maintenance has the following advantages:

- The care and servicing by personnel for the purpose of maintaining equipment in satisfactory operating condition by providing for systematic inspection, detection, and correction of incipient failures either before they occur or before they develop into major defects.
- The work carried out on equipment in order to avoid its breakdown or malfunction. It is a regular and routine action taken on equipment in order to prevent its breakdown.
- Maintenance, including tests, measurements, adjustments, parts replacement, and cleaning, performed specifically to prevent faults from occurring.

Scheduled maintenance, is a planned maintenance including scheduled downtime for equipment replacement. Planned preventive maintenance (PPM) is another name for PM breakdown maintenance (fixing things only when they break), also known as "a reactive maintenance strategy" involving "consequential damage".

Corrective maintenance happens when equipment is repaired or replaced after wear, malfunction or break down. It is a type of maintenance used for equipment after equipment break down or malfunction is often most expensive – not only worn equipment may damage other parts and cause multiple damage, but consequential repair and replacement costs and loss of revenues due to down time during overhaul can be significant. Rebuilding and resurfacing of equipment and infrastructure damaged by erosion and corrosion as part of corrective or preventive maintenance programmes involves conventional processes such as welding and metal flame spraying, as well as engineered solutions with thermoset polymeric materials.

Predictive maintenance, uses sensor data to monitor a system, then continuously evaluates it against historical trends to predict failure before it occurs. Predictive maintenance techniques are designed to help determine the condition of in-service equipment in order to estimate when maintenance should be performed. This approach promises cost savings over routine or time-based preventive maintenance, as tasks are performed only when warranted. The main promise of predictive maintenance is to allow convenient scheduling of corrective maintenance, and to prevent unexpected equipment failures. (wikipedia.org).

2.2. Acquaintance with production area, personnel - machines, for aluminium

Key Words

Line/types of production: a line of machines and workers in a factory that a product moves along while it is being produced.

Process layout: all machines performing similar type of operations are grouped at one location.

Dead time: time that does not add value on the product.

Flexible Assembly Line: products built on the same line while the assembly process may turn into a puzzle.

Flexible manufacturing systems: are most often used when small (relative to mass production), customized batches of products are required. A "small" single manufacturing cell can consist of varying kinds of production, material handling, and computer control modules.

Cell: all in a cell operations necessary to produce a product or service for a customer performed in close proximity, often times in a U-shaped layout, allowing quick feedback between operations when problems and other issues arise.

To be achieved upon learning outcome completion

- Layout of machinery in the production site to minimize dead time
- Organize human resources based on production skills and needs
- Data collection knowledge on production costing

- Arrange mechanical equipment for saving time
- Create auxiliary structures, devices, templates and flat patterns
- Practical and productive knowledge
- Knowledge of production methods
- Use employees skills in the appropriate production location
- Plan coordinate and agree work with line managers, colleagues and other working divisions using technical terminology
- Use data collection, timesheets etc
- Update timetables for cost accounting

- Exploit the ideal layout of machinery, tools and consumables in relation to production requirements
- Select alternatives, for own employee, for optimum results
- Create additional schedules or modify existing ones if needed

KNOWLEDGE | SKILLS | COMPETENCIES

2.2.1. Optimum layout of machinery in the production site

In order to understand what kind of layout is needed the various types of production shall first be analysed. There are 4 basic types of productions which are most used.

The type of production that will be selected by the company depends on the type of product being manufactured, the demand of the product as well as the supply of raw materials. Taking these factors into consideration, below are the **4 types of Production**.

1. **Unit or Job type of production:** This type of production is most commonly observed when you produce one single unit of a product. A typical example of the same will be tailored fenestrations are made just for a project.

2. **Batch type of Production:** It is one of the types of production most commonly used in consumer durables, or other such industries where there are large variety of products with variable demands. Batch production takes place in batches. The manufacturer already knows the number of units he needs to a manufacturer and they are manufactured in one batch.

3. **Mass Production or Flow production**: One of the best examples of mass production is the manufacturing process adopted by Ford. Mass production is also known as flow production or assembly line production. It is one of the most common types of products used in the automobile industry and is also used in industries where continuous production is required.

4. **Continuous production or Process production:** There is a lot of confusion between mass production and continuous production. It can be differentiated by a single element. The amount of mechanical work involved. In Mass production, both machines and humans work in tandem. However, in continuous production, most of the work is done by machines rather than humans. In continuous production, the production is continuous, 24x7 hours, all days in a year.

The ability to design and operate manufacturing facilities that can quickly and effectively adapt to changing technological and market requirements is becoming increasingly important to the success of any manufacturing organization.

In the face of shorter product life cycles, higher product variety, increasingly unpredictable demand, and shorter delivery times, manufacturing facilities dedicated to a single product line cannot be cost effective any longer.

Investment efficiency now requires that manufacturing facilities be able to shift quickly from one product line to another without major retooling, resource reconfiguration, or replacement of equipment.

Investment efficiency also requires that manufacturing facilities be able to simultaneously make several products so that smaller volume products can be combined in a single facility and that fluctuations in product mixes and volumes can be more easily accommodated.

Erasmus+

In short, manufacturing facilities must be able to exhibit high levels of flexibility and robustness despite significant changes in their operating requirements.

In industry sectors, it is important to manufacture the products which have good quality and meet customers' demand. This action could be conducted under existing resources such as employees, machines and other facilities.

However, plant layout improvement, could be one of the tools to response to increasing industrial productivity.

It is needed to appropriately plan, and position employees, materials, machines, equipment, and other manufacturing supports and facilities to create the most effective plant layout.

Three basic plans (Plant Layout) of the arrangement of manufacturing facilities are:

- Product layout or continuous production, linear arrangement of workstation to produce a specific product.
- Process layout or lot production, machines grouped by process they perform.
- Cellular layouts, group machines into machining cells.
- They are another three type of layout used for different production or product:
- Fixed position layout used in projects where the product cannot be moved.
- Flexible manufacturing systems, automated machining and material handling systems,
- Mixed-model assembly lines i.e. produce variety of models on one line.

The choice of the type of production line depends on the products that will be produced (Product Layout). There are three cases:

a. **Product layout or continuous production:** all machines are arranged in the sequence, as required to produce a specific product. This line is suitable in the following cases:
   - Where one or few standardized products are manufactured.
   - Where a large volume of production of each item must travel the production process, over a considerable period.
   - Where time and motion studies can be done to determine the rate of work.
   - Where a possibility of a good balance of labor and equipment exists.
   - Where minimum of inspection is required, during sequence of operations.
   - Where materials and products permit bulk or continuous handling by mechanical parts.
   - Where minimum of set-ups is required

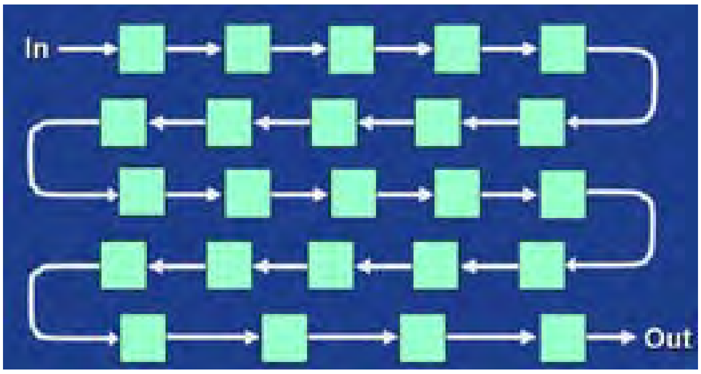


Figure 2.11. Product layout

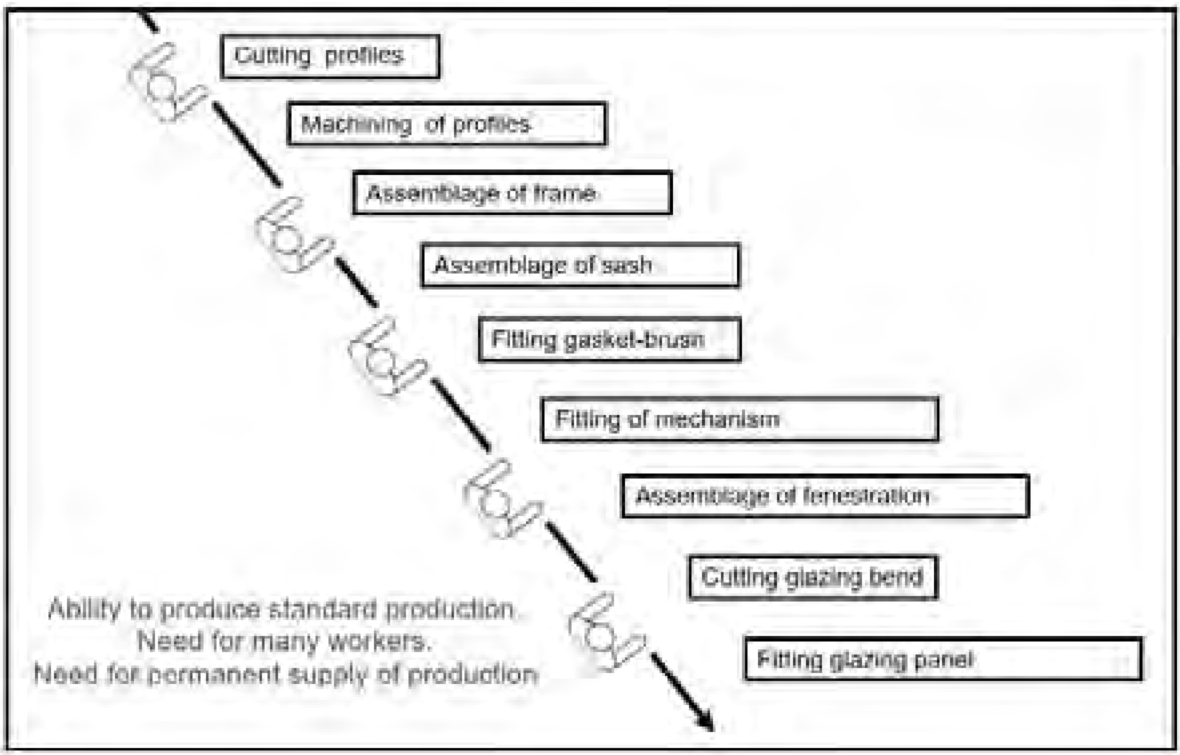


Figure 2.12. Product layout in steel production

b. Cellular layouts (cell of Toyota): Unit type of production is suitable in the following cases:

- For non-standard products
- For different qualities
- For different quantities
- Different typologies
- Different dimensions

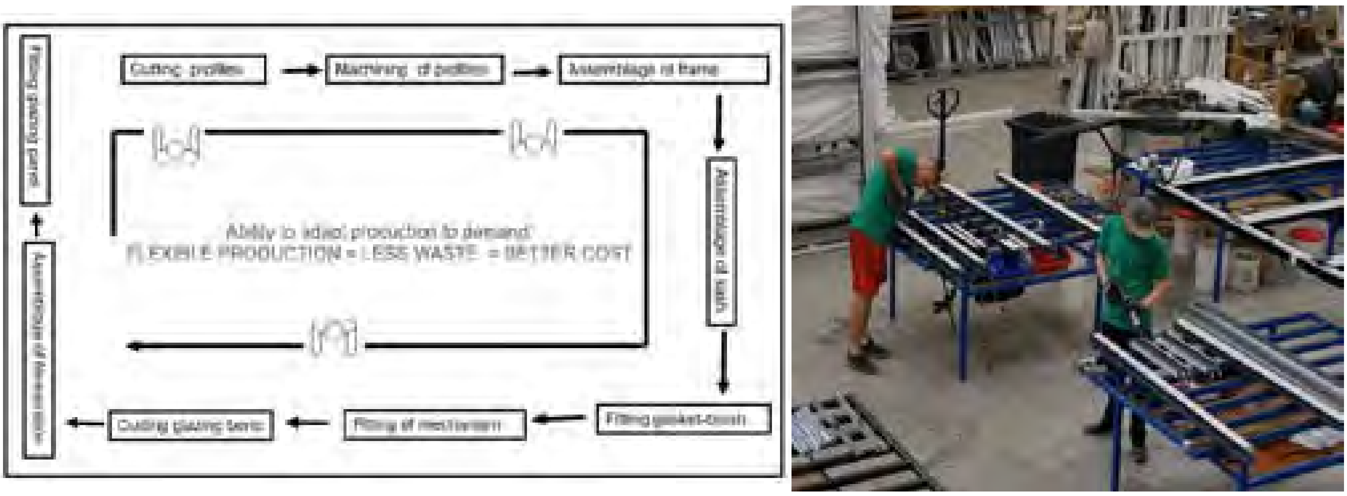


Figure 2.13. Unit or Job type of production (Cellular layout) - Cell type of production

c. **Process layout:** In this type of layout, all machines (i.e. all lathes, milling machines etc.) performing similar type of operations are grouped and clustered at one location. Process layout advantages are:

- Greater flexibility about work distribution to machinery and personnel. Adaptable to frequent changes in sequence of operations.
- Lower investment due to general purpose machines, which usually are less costly than special purpose machines.
- Higher utilization of production facilities, which can be adapted to a variety of products.
- Variety of jobs makes the work challenging and interesting.
- Breakdown of one machine does not result complete stoppage of work. If the machines that do the same processing are not in the same place, then we will have a dead time.

Figure 2.14. Process layout

In all cases of production organization, the layout of the mechanical equipment should be such that the product's production tray is not wasted dead time by staff distributing many distances from one machine to the other.

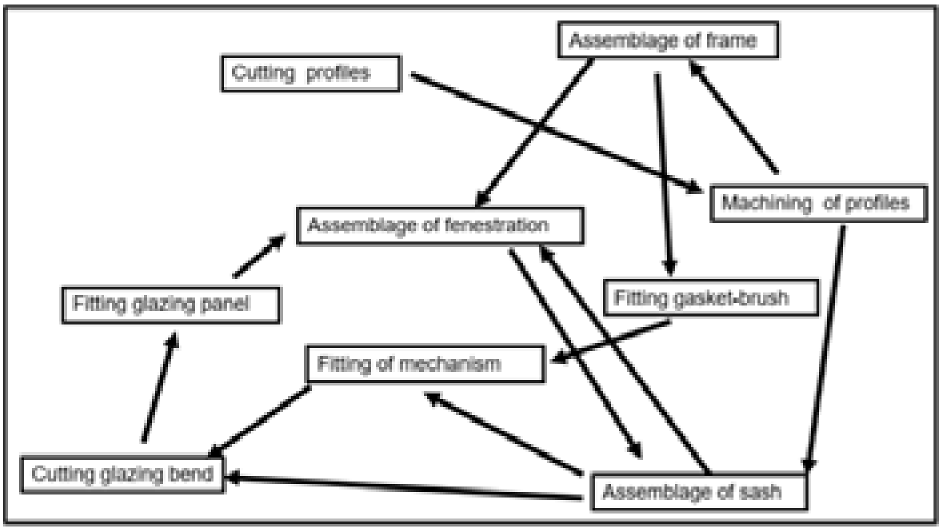


Figure 2.15. Wrong machines layout. The wasted dead time is large

From the piece value flow charts, that is, by recording the times of the successive phases of the construction, (processes) we can have the useful production time and the waste time. It is essential to know our production capabilities for each type of crate and understand at the same time what is wasted in the production process.

From the diagram a prediction of the "dead" times, transferring the profile from one job to another, etc. can be made. Such dead time are actually be incorporated in the final costing even if do not add added value to the product. It is therefore a matter of prime importance in minimizing the cost and improving the productivity of the shop. If the competition manages to minimize such cost it will have an advantageous position with regard to the cost.

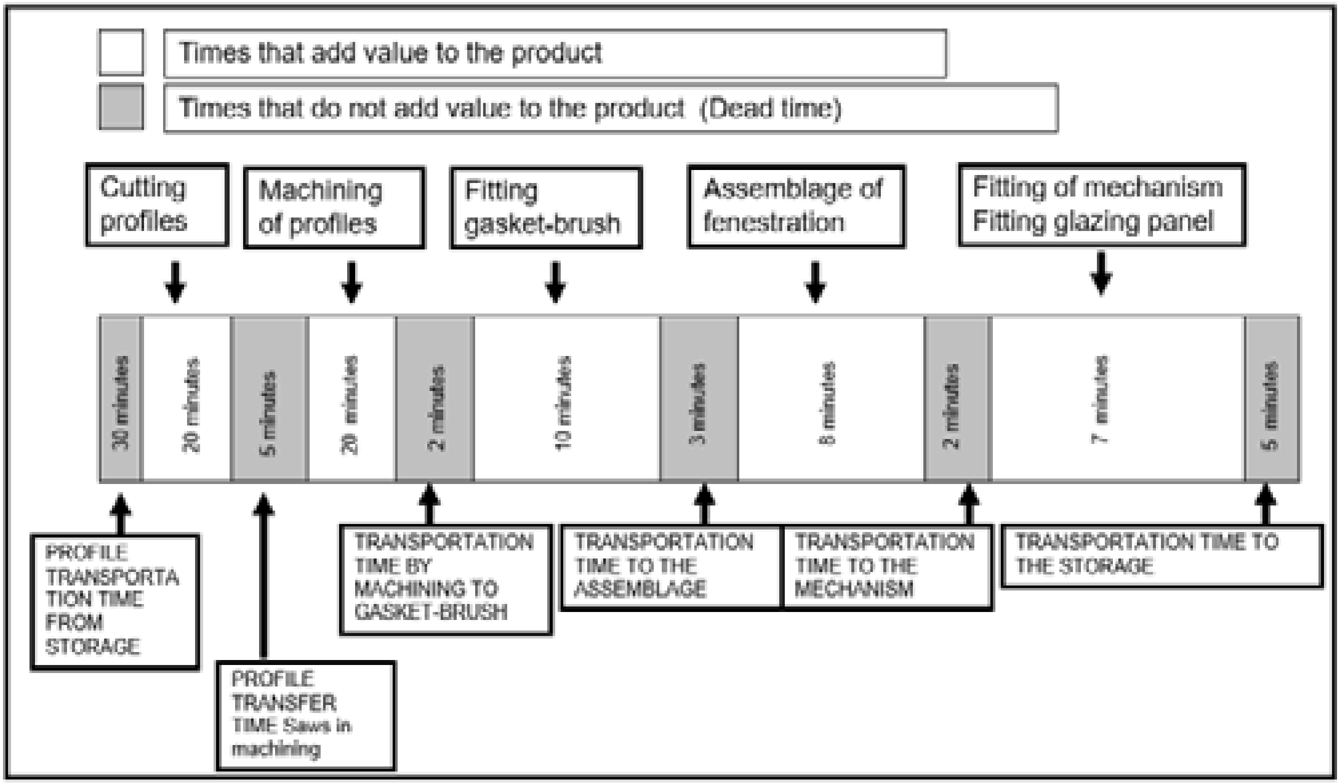


Figure 2.16. Identification of dead times in the process

Large product mix and time are the key parameters that increase or decrease the cost of manufacturing the product and depend largely on the layout of the product. Flexibility is needed to make different typologies in the same manufacturer with the same people and tools, without wasting time in as little space as possible. The production cell over industrial production gives the business the flexibility it needs today.

2.2.2. Organize human resources based on production requirements

Key Words

Human resources: people who work for a company or an organization

In today's economy it is a multifaceted and crucial aspect of almost all businesses, with the role of Human Resources (HR) in planning and driving strategic growth being just as important as technology or business leadership.

Alongside the increasing importance laid on work experience, workplace culture, the digitization of HRM - particularly the implementation of technologies such as analytics, digital labour, AI, and performance management - has played a fundamental role in its advancement.

The role of Chief Human Resource Officer has become one of the most important roles of a company, and these roles are no longer based on the management side of businesses, but are vital to the implementation of day-to-day changes that help transform traditional organizational structures into new ones flexible structures. Much of it responds to the changing needs of today's talent as they seek a greater fluctuation in employment arrangements, which, if fulfilled, can boost both motivation and production. One of the key functions of HR in recent years has been to introduce employee experience as a process that reflects the customer experience.

Employee engagement has become a strategic priority. (www.thebalancecareers.com)

Business generally choose to compete within one or two areas of strength. These areas of strength are often referred to as distinctive competencies, core competencies, or competitive priorities.

Among the options for competition are price (cost), quality, delivery, service, and flexibility. An ever-increasing number of firms are choosing to compete in the area of flexibility. Generally, this has meant that the firm's major strength is flexibility of product (able to easily make changes in the product) or flexibility of volume (able to easily absorb large shifts in demand).

Firms that can do this are said to have flexible capacity, the ability to operate manufacturing equipment at different production rates by varying staffing levels and operating hours or starting and stopping at will.

Specifically, manufacturing flexibility consists of three components:

- The flexibility to produce a variety of products using the same machines and to produce the same products on different machines.
- The flexibility to produce new products on existing machines; and
- The flexibility of the machines to accommodate changes in the design of products.

For the Aluminium and Metal Construction shops n particular and For the selection and placement of personnel in the appropriate workplaces must bear in mind that the manufacturer must produce a different and large product mix every day:

- Many typologies of frames
- Different difficulty / typology
- Lots of colour choices
- Different dimensions / frame
- Many related items (rolls, etc.)
- Wide range of accessories...

The manufacturer must handle multiple typologies on the same day, in variable quantities (large small), and therefore the appropriate method of producing the frames is to work per piece. They produced piece per piece, as opposed to lot production (batch) that produced many same pieces.

In order to make production flexible, workers must be able to change positions, and therefore be periodically trained in all production positions.

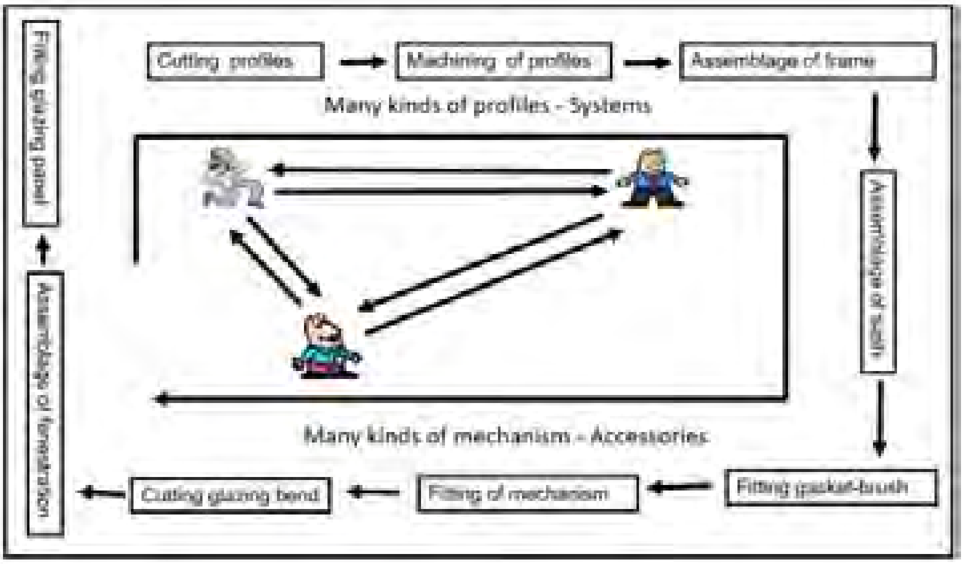


Figure 2.17. Flexibility in the usage of Human Resources

For this reason and for small and medium-sized craft, the ideal production line is the Unit or Job type of production (cell), so that people can change jobs and be educated. Potential benefits from the implementation and utilization of a flexible manufacturing system have much benefits:

- less waste,
- fewer workstations,
- quicker changes of tools, dies, and stamping machinery,
- reduced downtime,
- better control over quality,
- reduced labour,
- more efficient use of machinery,
- work-in-process inventory reduced,
- increased capacity,
- increased production flexibility.

2.2.3. Principles for cost estimation- Data collection, timesheets etc.

Key Words

Cost: necessary expenditures that must be made in order to run a business

Timesheets: activity data

Various costs: different ways of categorizing costs according to their relationship to output as well as the context they are used

Costs are the necessary expenditures that must be made in order to run a business. Every factor of production has an associated cost. The cost of labour, for example, used in the production of goods and services is measured in terms of wages and benefits. Businesses are vitally interested in measuring their costs. Many types of costs are observable and easily quantifiable. In such cases there is a direct relationship between cost of input and quantity of output.

Other types of costs must be estimated or allocated. That is, the relationship between costs of input and units of output may not be directly observable or quantifiable.

The cost of the final product or service is related to the way we design and organize production.

Consequently, there are different ways of categorizing costs according to their relationship to output as well as according to the context in which they are used.

The two basic types of costs incurred by businesses are:

- **Fixed costs:** they do not vary with output, while variable costs do. Fixed costs are sometimes called overhead costs. They are incurred whether a firm manufactures 100 frames or 1,000 frames. When preparing a budget, fixed costs may include rent, depreciation, and supervisors' salaries. Manufacturing overhead may include such items as property taxes and insurance. These fixed costs remain constant despite changes in output.
- **Variable costs**: they fluctuate in direct proportion to changes in output. In a production facility, labour and material costs are usually variable costs that increase as the volume of production increases. It takes more labour and material to produce more output, so the cost of labour and material varies in direct proportion to the volume of output. For many companies in the service sector, the traditional division of costs into fixed and variable does not work. Typically, variable costs have been defined primarily as "labour and materials.

In addition to variable and fixed costs, some costs are considered mixed. That is, they contain elements of fixed and variable costs. In some cases, the cost of supervision and inspection are considered **mixed costs**.

Furthermore, there are other ways to categorize costs in different business applications such as:

- **Direct costs:** similar to variable costs. They can be directly attributed to the production of output. The system of valuing inventories called direct costing is also known as variable costing.
- **Indirect costs:** similar to fixed costs. They are not directly related to the volume of output. Indirect costs in a manufacturing plant may include supervisors' salaries, indirect labour, factory supplies used, taxes, utilities, depreciation on building and equipment, factory rent, tools expense, and patent expense. These indirect costs are sometimes referred to as manufacturing overhead.
- **Product costs:** those that the firm's accounting system associates directly with output and that are used to value inventory.
- **Period costs:** those charged as expenses to the current period. Under direct costing, period costs are not viewed as costs of the products being manufactured, so they are not associated with valuing inventories. If the firm uses a full cost accounting system, however, then all manufacturing costs—including fixed manufacturing overhead costs and variable costs—become product costs. They are considered part of the cost of manufacturing and are charged against inventory.

Costing of the products in the aluminium-iron craft is based on the manufacturing process, where all stages from initial communication to delivery, is schematically described in the following figure.

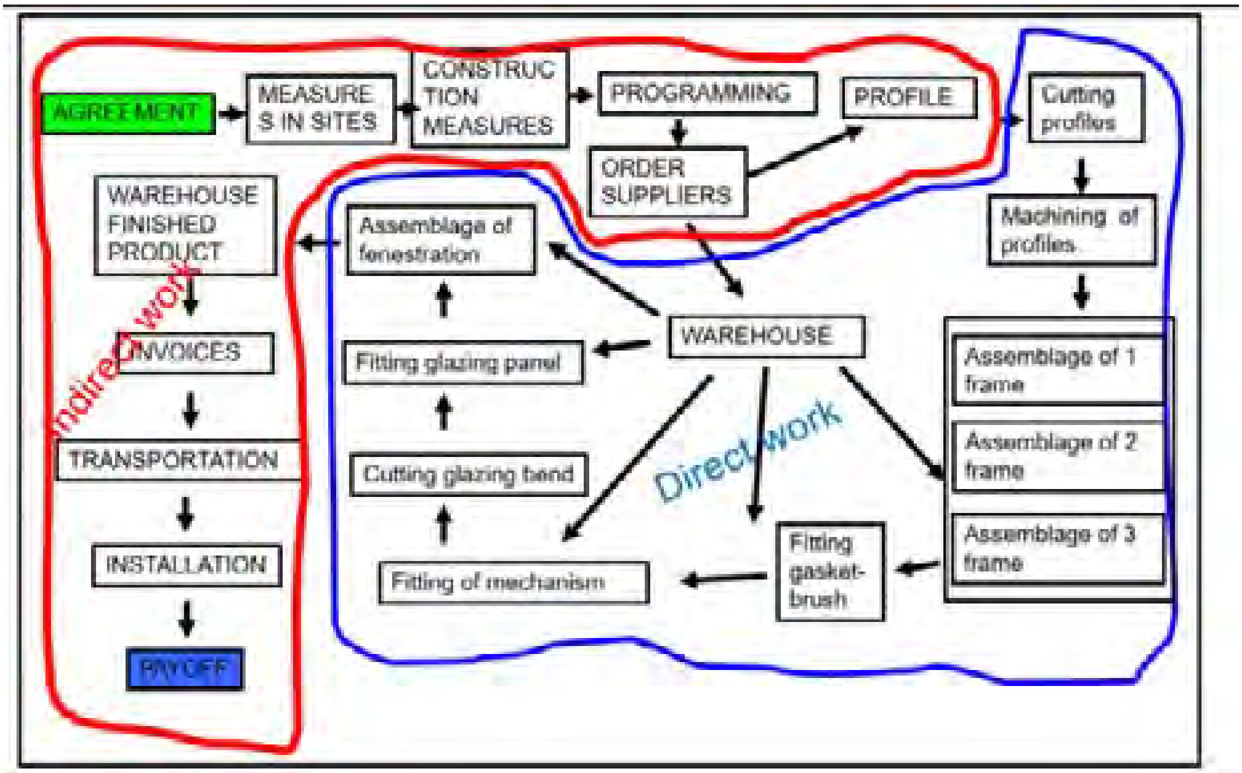


Figure 2.18. The manufacturing processes

It can be noticed that a craftsman starts the cycle by agreement, the measure, the production (cutting – machining, the assemblage, the installation and finally the payoff.

Regarding the data for the costing of the products in the aluminium-iron craft, we can group the fixed (direct) and variable (indirect) costs as in the following figure,

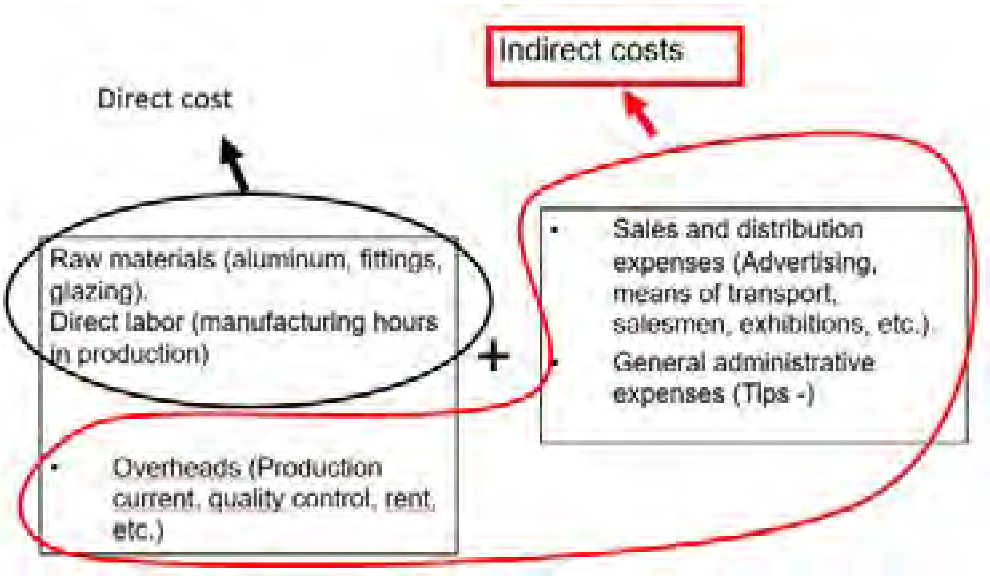


Figure 2.19. Direct and indirect costs

The materials need to make a window frame are easy to quantify and costing, with the related software. All data (typology, profiles, dimension, colour, price list) can be recorded and thus have the materials catalogue.

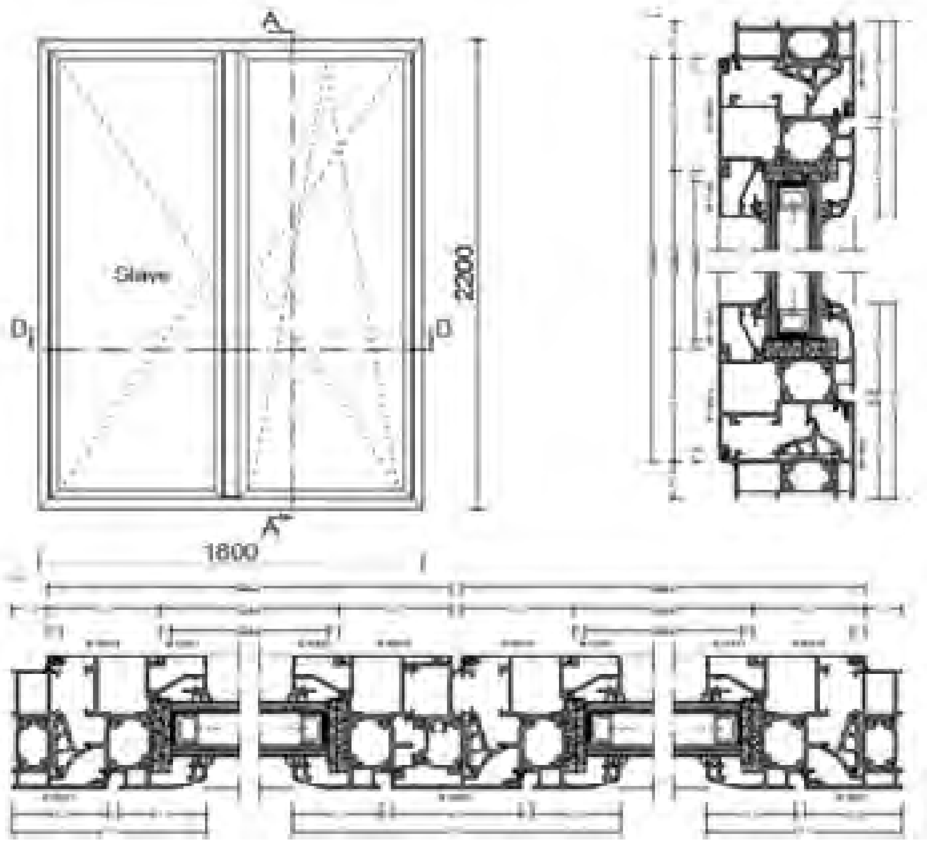


Figure 2.20. Materials needed to construct a window

gth	Required	Unit	Description	Colour	Weight [kg]	Weight [kg]	Bar Length [EU
6,0	11,2	m	GLAZING BEAD	WHITE	0,305	3,660	11,
6,0	8,0	m	HINGED FRAME	WHITE	0,953	11,436	34,
6,0	12,2	m	HINGED HIDDEN SASH EUROPEAN GROOVE PROFILE	WHITE	1,326	23,832	48,
6,0	2,1	m	HINGED ADAPTION MEETING EUROPEAN GROOVE PROFILE FOR WIN	WHITE	1,222	7,332	44,
6,0	3,0	m	BOLT ROD MECH. PROFILE	Mill Finish	0,135	0,810	4,
						47,070	

	Required	Unit	Description	Colour	Weight [kg]	Weight [kg]	PricePU [EU
	1	pc	EXTERIOR WINDOW FINGER PULL HANDLE	WHITE	0,300	0,300	2,
	1	pc	WINDOW STANDARD HANDLE SECUSTIC ALUMIL PIN25mm	WHITE	0,196	0,196	2,
	1	pc	STAY ARM FIXED FOR SIDE HUNG ADJUSTABLE AK-8		0,150	0,150	3,
	1	pc	CONCEALED MIDDLE HINGE AK-8 ZAMAK		0,053	0,053	2,
	2	pc	BASIC BAG TILT-TURN HINGE SIDE ALUJET 6	WHITE	0,420	0,840	7,
	2	pc	TRANSMITION FOR LATCH AK-8	BLACK	0,018	0,036	0,
	2	pc	LATCH DRIVE ROD D/F AK-8		0,014	0,028	0,
	3	pc	LOCKING PLATE NOT ADJUSTABLE ALU-JET 10 A1.5mm		0,008	0,024	0,
	1	pc	ALU-JET 06 connector with cam		0,033	0,033	0,
	1	pc	ALU-JET 06 T/T central locking with IG		0,379	0,379	6,
	1	pc	BASIC KIT FOR EXTRA LOCKING EURO JET		0,109	0,109	3,
	2	pc	LOCKING PLATE FOR INACTIVE SASH AK-8		0,019	0,038	0,
	1	pc	STAY ARM T/T ALU-JET 606 701-1000mm		0,410	0,410	6,
	1	pc	STRIKER ANTILIFT ALU-JET A1.5mm		0,018	0,018	0,
	1	pc	DOOR CATCH WITH ROLLER EURO GROOVE		0,069	0,069	1,
	1	pc	Alignment Wedge for frame AK8	BLACK	0,005	0,005	1,
	1	pc	ALIGNMENT WEDGE FOR SASH AK-8		0,002	0,002	0,
						2,652	

gth	Required	Unit	Description	Colour		Weight [kg]	PricePU [EU
0,0	8	pc	CRIMP CORNER CLEAT 9x7.4mm		0,017	1,066	14,
0,0	4	pc	CRIMP CORNER CLEAT 13.2x8.4mm		0,012	1,344	18,
0,0	4	pc	CRIMP CORNER CLEAT 13.2x19.8mm		0,038	2,736	20,
0,0	6	pc	CRIMP CORNER CLEAT 23x25.5mm		0,082	2,460	19,
0,0	8	pc	ALIGNMENT CORNER M11000	BLACK	0,003	0,300	5,
0,0	12	pc	ALIGNMENT CORNER MON2000	BLACK	0,016	0,800	12,
0,0	4	pc	VULCANIZED CORNER FOR M9880 CENTRAL GASKET EPDM	BLACK	0,017	0,680	17,
0,0	12	pc	SETTING BLOCK 4mm	RED	0,005	0,500	4,
0,0	12	pc	SETTING BLOCK 5mm	BLACK	0,006	0,600	4,
0,0	1	pc	ADJOINING PROFILE END CAP FOR M19682	BLACK	0,025	0,250	4,
1,0	11	m	UNDERGLAZING FOAM INSULATION 30X10		0,016	3,200	115,
0,0	2	pc	HANDLE SCREW CSK METRIC DIN 965 GALV M5X30 PH		0,004	0,400	19,
0,0	32	pc	NAIL CORNER PIN 4.5x7.1		0,001	0,100	4,
						14,478	

	Required	Unit	Description	Colour	Weight [kg]	Weight [kg]	PricePU [EU
	11,3	m	OUTSIDE GLAZING GASKET PLUGGED 3mm EPDM	BLACK	0,050	10,000	41,
	11,3	m	GLAZING GASKET 4mm EPDM	BLACK	0,043	10,750	32,
	9,9	m	CENTRAL GASKET M9660 EPDM	BLACK	0,209	15,675	72,
	20,8	m	SEAL GASKET FRAME DUAL WALL 3.5mm EPDM	BLACK	0,028	8,400	39,
						44,825	
				Total:		109,065	

Figure 2.21. Materials needed to construct a window

For other aluminium constructions, where no software is available, the costing of the raw materials and components is done by reference to the weight or the measure of the aluminium profiles. The knowledge of the required time to assemble the frame in the production, for each frame of all typologies.

Time that adds value from time wasted must be separated, by estimating the assembly times to produce integrated frames.

Machining	Time
Single saw: time to cut a piece	30 sec.
Double saw: time to cut a piece	15 sec.
Processing press: punching time	10 sec.
Gutter or vent on the sheet with a milling cutter	30 sec.
Glue mounting and c corner closure in crimping machine	1,5 min.
Corner: Angle time per corner	1 min
Screw angle: mounting and screwing time per angle	40 sec.
Mounting gaskets on a rolling sheet	2 min
Mounting gaskets in an opening case	3 min
Fitting brushes in sliding frame	2 min
Mounting brushes on sliding sheets	3 min
Mounting single-leaf 16 mm mechanism	3 min
Euro groove mechanism single-leaf mounting	5 min
Mounting mechanism on sliding sheet	9 min
Mounting roller on sliding sheet	3 min
Placing glass in an opening	2 min
Single saw: time to cut a piece	1 min
Double saw: time to cut a piece	1 min
Processing press: punching time	2 min
Gutter or vent on the sheet with a milling cutter	2 min
Glue mounting and c corner closure in crimping machine	5 min
Corner: Angle time per corner	6 min
Screw angle: mounting and screwing time per angle	2 min

Table 2.1. Time of assembling a frame

The next step is to have the mount time for each typology like the one below.

Typology of fenestration	Time
Opening single leaf window	60 min
Opening single door	65 min
Opening double leaf window	100 min
Opening double door	125 min
Lift-sliding door	140 min
Sliding door 1 leaf	50 min
Sliding door 2 leaves	90 min

Table 2.2. Assembling time for each typology

The split of cost helps to identify cost drivers, if achieved. Direct labour and materials are relatively easy to trace directly to products, but it is more difficult to directly allocate indirect costs to products. Where products use common resources differently, is needed in the cost allocation process. The cost driver is a factor that creates or drives the cost of the activity.

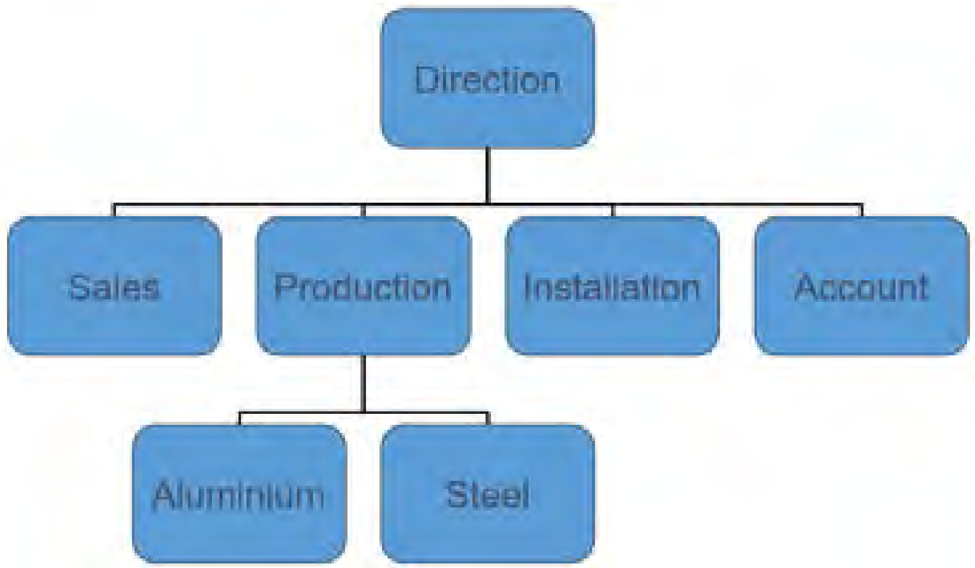


Figure 2.22. Organization breakdown of a company

In addition to the raw materials and the cutting and mounting work, for the cost of production of the frame we also must allocate overheads (resources):

- Rentals - loans ....
- Various accounts
- Consumables
- Etc.

	per Month	Total
Electricity	....	
Phones	....	...
Taxes	...	...
Interest		
Consumables		
Fuel		
Insurance		
Cars		
Maintenance		
Factory rent		
....		

Table 2.3. Overheads

How (cost drivers) and where (cost object) should we allocate costs? The first step is to calculate the cost of each activity (labour and materials, the next one to distribute the activities to the respective activity centres and finally to divide (cost drivers) costs into products and services (cost object).

Example of overhead cost allocation with three difference cost drivers: Quantity, Production time and Consumption of energy. If the electricity is 1000€ per month and the production of frames is 100 pieces, how much electricity is allocated to each window (which cost driver will use)?

1. Cost drivers: pieces, i.e. 1000/100 = 10 - € power / frame.
2. Cost drivers: Production time, i.e. 10 out of 100 frames consumed 30% of production time and the remaining 90 pieces 70%. Electricity is divided as follows: In 10 frames 300/10 = 30 - € power / frame, and at 90 windows 700/90 = 7.7 € / window.
3. Cost drivers: Consumption of engines, i.e. of the 100 frames 20 used 30% of the quantity (kw), 30% 20%, and 50% 50%. Electricity is divided as follows: At 300/20 = 15 € / window, at 200/30 = 6.6 € electricity / window, and at 500/50 = 10 € / windows.

Therefore, it is very important to determine the correct way of allocating overheads for each product or service we want to cost. Since the final cost depends on the final quantity produced, we should also have the statistics for each product separately:

	Pieces per Year
Casement 1 sash	100
Casement 2 sashes	200
Sliding 2 sashes	160
Tilt & turn 2 sashes	.....
....	

Table 2.4. Quantity produced

They are three kind of cost estimation:

- **Historical cost:** cost based on prior years data and is a real cost.
- **Estimated cost:** forecasting cost based on analysis of past data and experience
- **Standard cost:** cost at which the product must have (as the "should be" cost).

2.3. Acquaintance with production area, personnel - machines, for metal and mixed production

Key Words

Production: the action of making or manufacturing from components or raw materials, or the process of being so manufactured

To be achieved upon learning outcome completion

KNOWLEDGE

- Layout of machinery in the production site to minimize dead time
- Organize human resources based on production skills and needs
- Data collection knowledge on production costing

SKILLS

- Arrange mechanical equipment for saving time and protect aluminium from metal constructions
- Isolate the treatment of metals from aluminium
- Create auxiliary structures, devices, templates and flat patterns
- Practical and productive knowledge
- Knowledge of production methods
- Use skills in the appropriate production location
- Plan coordinate and agree work with line managers, with colleagues and with other work divisions using technical terminology
- Data collection, timesheets etc.
- Update timetables for cost accounting

COMPETENCIES

- Exploit the ideal layout of machinery, tools and consumables in relation to production requirements
- Select personnel with common knowledge
- Select alternatives, for optimum results
- Create additional schedules or modify existing ones if needed

2.3.1. Optimum layout of machinery in the production site

In manufacturing systems, facility layout is considered as one of the important criteria which has a significant effect towards manufacturing productivity in terms of cost and time. The objectives of a layout are to minimize material handling cost, improve flexibility for arrangement and operation, utilize the available area and minimize overall production time.

A facility layout is an entity that provides the performance of any tasks that include a machine tool, a work centre, a manufacturing cell, a machine shop, a department and a warehouse.

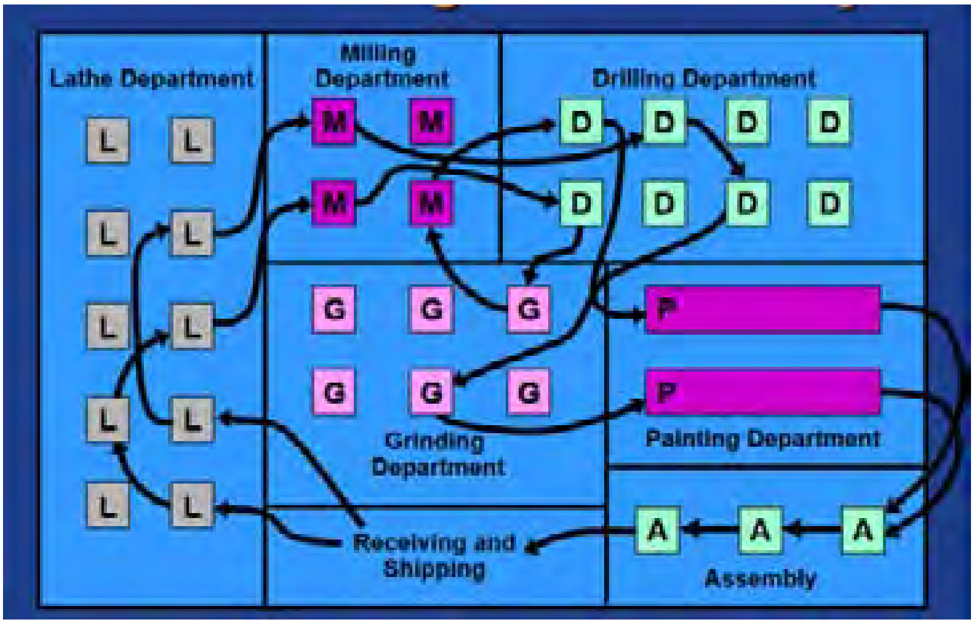


Figure 2.23. Manufacturing process layout

The product layout or continuous production is the type of layout that all the machines are arranged in the sequence, as required to produce a specific product. This line is suitable for big production for the same product, and there is no possibility of flexibility - change of production in a short time.

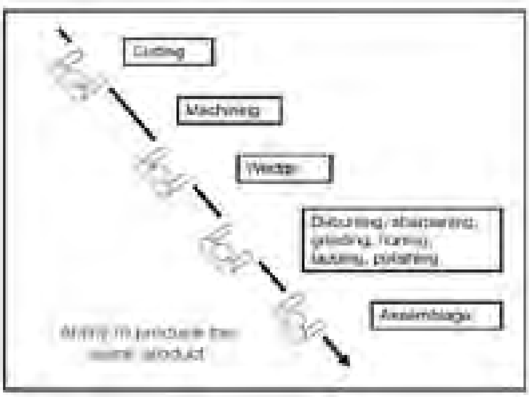


Figure 2.24. Production layout

Cellular Manufacturing is a lean manufacturing approach that helps companies build a variety of products for their customers with as little waste as possible. In cellular manufacturing, equipment and workstations are arranged in a sequence that supports a smooth flow of materials and components through the process, with minimal transport or delay.

One-piece flow is a condition that exists when products move through a manufacturing process one unit at a time, at a rate determined by the needs of the customer. The opposite of one-piece flow is mass production with batches and queues. One-piece flow focuses on flow efficiency rather than on resource efficiency. Applying one-piece flow allows to:

- Minimize stocks and thereby reduce transport and inventory wastes
- Deliver quicker
- Minimize damage, deterioration, and obsolescence.

How to operate in a U-shaped Cell?

Reduce travel distance by arranging equipment and workstations closer together. The beginning of the process must be close to the the end of the process. The goal is to minimize the travel distance between each steps and cycles.

What do you need in order to implement Cellular Manufacturing?

- Organize your operations and equipment in a logic and validated U-Shaped Cell
- Empower your operators and set multimachine and multiskilled operators as a standard
- Favour small, flexible machines
- Using automation to eliminate machine watching

How to design cells for Cellular Manufacturing?

1. Analyse & document the process today (ASIS Situation)
2. Define the product family that the cell will produce and calculate the cell's TAKT Time
3. Balance the work to create flow between workstations that meets demand constraints
4. Design the cell for ergonomics
5. Implement, test and improve the cell through continuous improvement

Figure 2.25. Cellular layout

The layout of the space with machines to produce metal and mixed constructions has the same principle as aluminium, that is, two different layouts of space, depending on the type of production we have. The technical difference is that instead of assemblage with corners cleat, use different type of connection, like bolt or welding.

Figure 2.26. Various types of connection

The main parts in the laboratory for mounting are the welding and pre-processing section for drilling for connection to bolts.

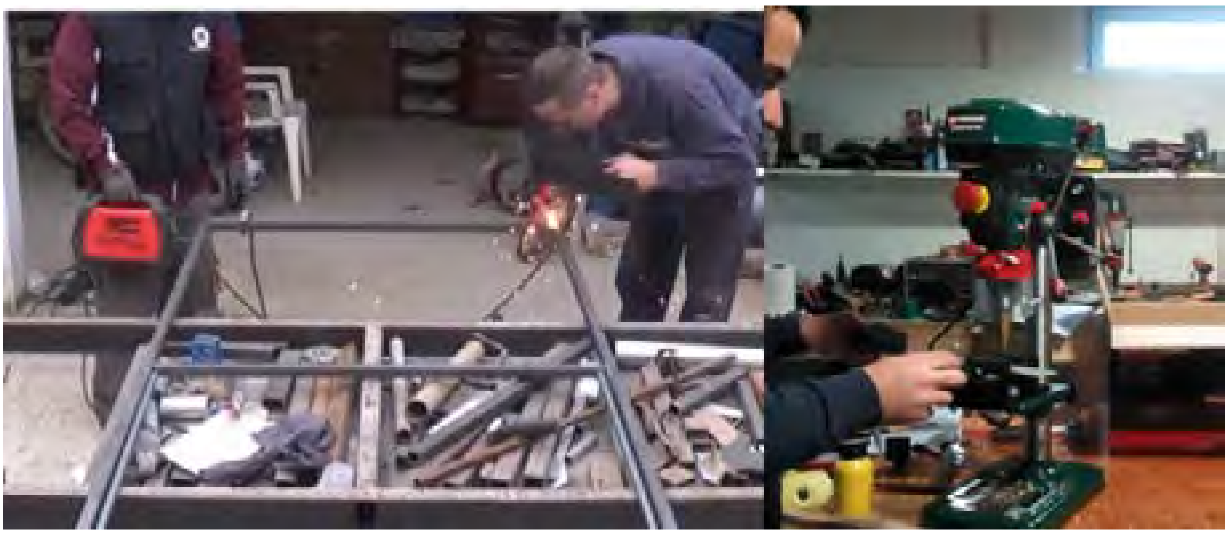


Figure 2.27. Welding/drilling

In the following figure layout for different kind of metal products (cell), for the production of many different products or for frequent production changes

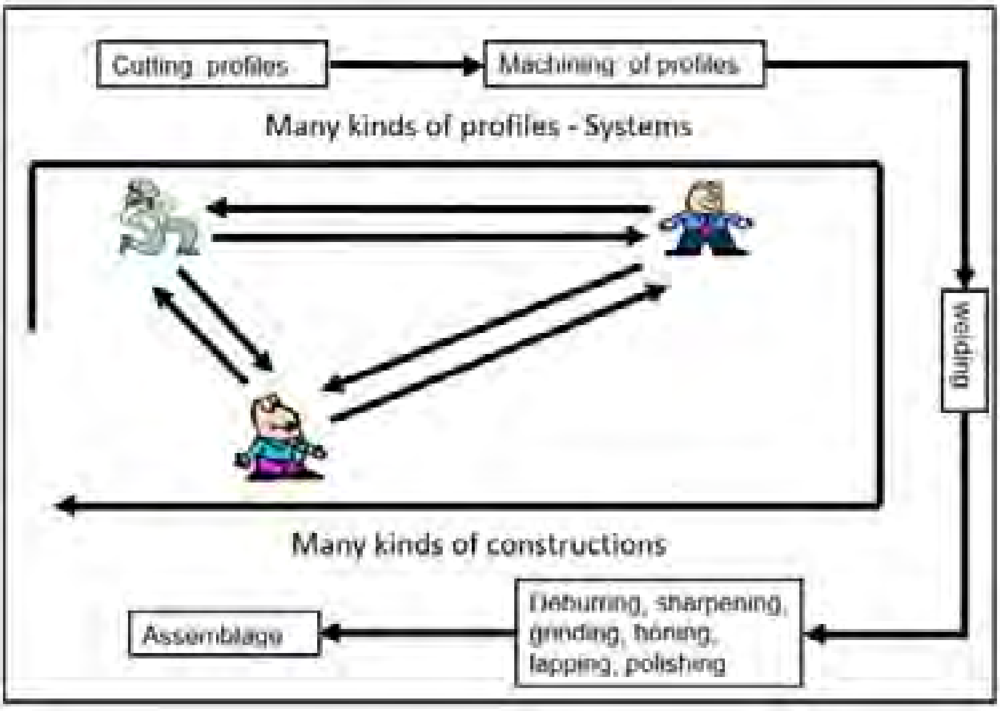


Figure 2.28. Cell layout

The steel production area should be separated so that the aluminium profiles are not damaged.

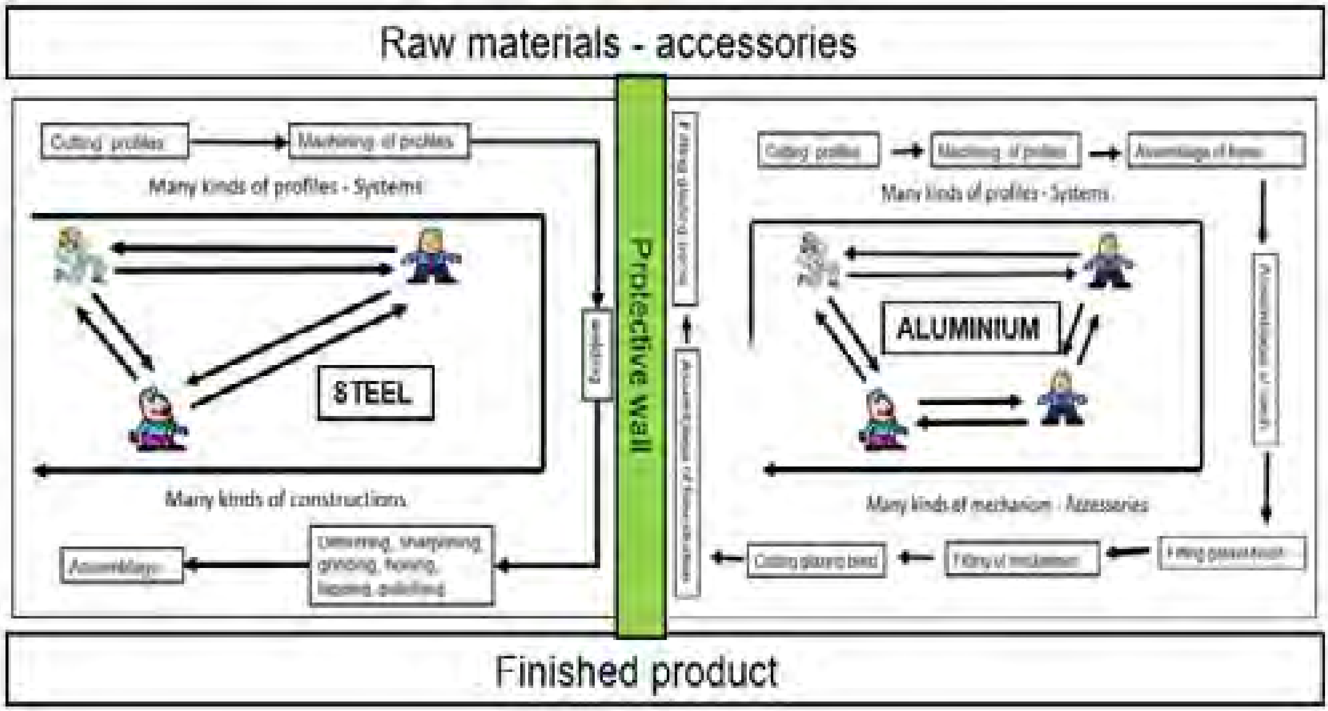


Figure 2.29. Production aluminium & steel

Figure 2.30. Divider welding screens

2.3.2. Organize human resources based on production requirements

Key Words

Production requirements: the sum of authorized stock levels and quantity products needs

Work Environment: the physical and social environment in the workplace

Historically, selection procedures were developed for specific jobs or job families. This often remains the case today, and traditional work analysis methods are still relevant and appropriate in these situations. However, organizations that experience rapid changes the external environment, the nature of work, or processes for accomplishing work may find that traditional jobs are being transformed or no longer exist.

In light of changes to the nature of work over the past decades, increasing numbers of organizations are shifting **from job-specific knowledge, ability, and skill requirements** when describing work, **to a focus on broader competency-based requirements**. Competency models are often used by organizations for many different purposes.

The term "analysis of work" is used throughout the Principles and subsumes information that traditionally has been collected through work and job analysis methods, and more recently, competency modelling efforts as well as other information about the work, worker, organization, and work environment. **Personnel is selected based on the production needs** of the company, i.e. products and customers.

Mobility of employees has several benefits. Firstly, it is a good motivation factor for people to give the opportunity of career paths and increase productivity.

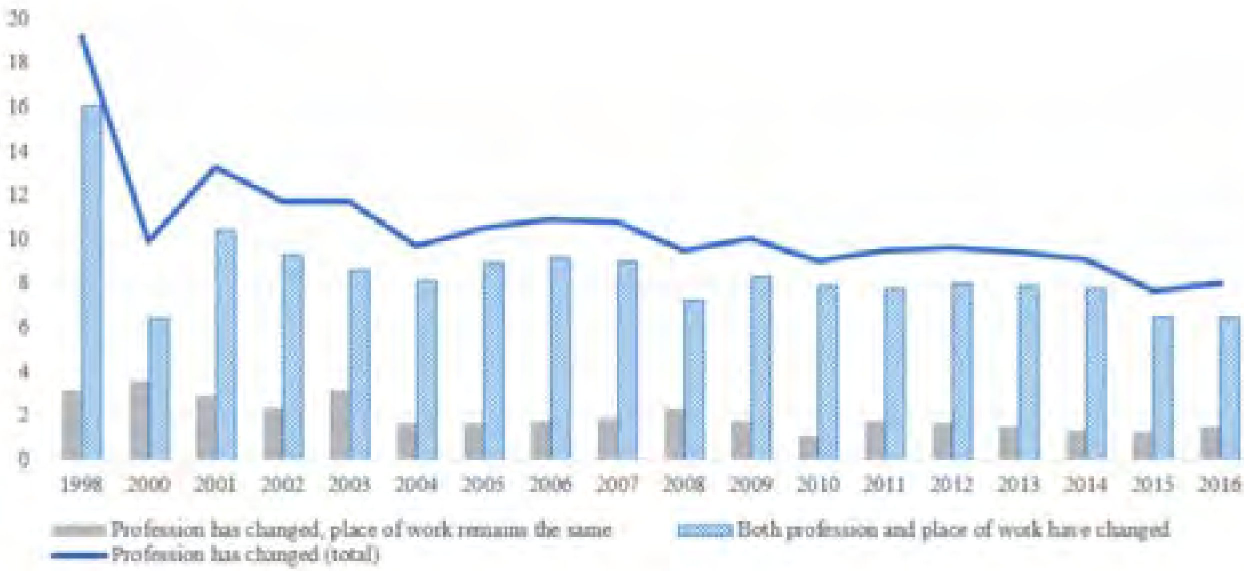


Figure 2.31. Dynamics of employees performing horizontal professional mobility, considering movements in the external and internal labour market, 1998 – 2016

Secondly, mobility helps to ensure the flexibility of staff – employees will be better prepared to occupy different positions. This is an important prerequisite to react to a changing environment and supports better problem solving. This is especially important when statistical production methods change. Mobility may give employees a better understanding of overall issues of the company. To improve mobility, top management commitment and less bureaucracy is required together with delegation of tasks and responsibilities. Increasing mobility requires a clear strategy and rewards.

Figure 2.32. Training

Training and skills development comprise a broad range of activities and arrangements, including formal and informal training, job-rotation, traditional class-room courses, internal vs external training. Another important issue is the cost/benefits of training and how to measure and evaluate the outcome of training activities.

The importance of training is stressed by a growing gap between existing competences and skills and those competences and skills that are required to meet future challenges and ensure a successful modernization of official statistics. A framework of skills/capabilities begins with a gap analysis and a description of how to close the gap. Lack of resources is a major barrier.

To stay updated, employees need to be assessed and trained regularly, adapting production to change. This is sometimes referred to as competence management or as development plan.

2.3.3. Principles for cost estimation- Data collection, timesheets etc.

Key Words

Cost estimation: the art of assigning value to a particular cost

Previous Work: same work repeatedly

New work: work or projects completely new

Repetitive work: repeated production or work process

Companies often carry out the same work repeatedly. This is especially true if a company specializes in a particular type of work and accepts contracts to carry it out. In such cases the cost estimation can be based on data from previous work and adjust accordingly if needed.

These estimates are fairly accurate as long as the current work is the nearly the same as in previous contracts. When the same products using same processes are produced, costing is easy.

This latter, however, is not always the case. Sometimes work or projects are completely new and the list of materials, and the process workflow is not easy to predict. In such cases cost estimation shall be based on values from bibliography, or on relevant software if available.

In metal constructions and in cases where there is special costing software the raw materials and components cost is made by reference to the weight, or to the linear meter of the profiles, For the mounting components, such as bolts, screws, etc. the cost is per item.

For processes the cost can be based on a time basis, i.e. the time required for a process to be completed and checked. In the next Table an example of such data is given.

Cutting/Machining	Time
Saw: time to cut a piece of tubular shape	30 sec
Saw: time to cut a piece of massif shape	60 sec
Saw: time to cut a piece of H shape	10 sec
Welding: per cm. linear	10 sec
Bolding: Screw bolt …	30 sec
………	50 min

Table 2.5. Time data for the repetitive work

In these cases, the cost estimation is done per time required per process step.

2.4. Health and safety practices in production & packaging & storage

Key Words

Health: factor that measures the physical, psychological or even mental state of a living organism

Security: term of protection against danger or loss

Accident: an unexpected, unusual event that happens without obvious apparent causes but with significant negative effects

Accident at work: a sudden, unexpected, unusual, and violent event that occurs while performing work that causes damage to the health or loss of life of the employee.

Safety and health at work: guidelines to protect the safety and health of workers by taking appropriate preventive measures, while creating a satisfactory working environment

To be achieved upon learning outcome completion

- Health and safety practices in the production area
- Health and safety practices in equipment handling
- Health and safety practices after product manufacturing.

KNOWLEDGE

- Document work and initiate quality assurances, health & safety at work and environmental protection measures
- Implement health & safety rules at work
- Carry out work assignments autonomously and work as part of a team according to safety regulations, technical documentation and work orders
- Implement logistics and warehouse good practices
- Secure loads, transport components and sub-assemblies and use lifting gear
- Implement good working practices (suitable vehicle, appropriate means of support)
- Load on a truck and transport the construction in safety

SKILLS

- Adapt production steps to occupational health and safety rules
- Adapt equipment handling to occupational health and safety rules
- Adapt health and safety rules in the field of corridors, storage, loading, transport & unloading

COMPETENCIES

2.4.1. Health and safety practices in the production area

Employees are exposed to hazards at work daily, which often results in accidents at work. **Indicative causes of accidents** are:

- failure to follow work instructions & instructions,
- inadequate or incorrect instructions,
- poor working method,
- lack or insufficient supervision,
- excessive rush,
- overestimation of employee's capabilities,
- inadequate equipment maintenance,
- use of improper or defective equipment, (lighting, noise, temperature etc.),
- lack or failure to use appropriate protective measures and personal protective equipment,
- failure to observe known safety rules,
- inadequate training,
- carelessness or inappropriate my worker etc.

If we were to classify them into two major categories, those would be:

1. Dangerous situations at work area and
2. Employees' dangerous actions

Dangerous situations in the workplace can be addressed through technical and organizational measures. Dangerous actions are due to the human Labelling factor, and have to do with the person's relationship to the object of its work, knowledge and application of safety rules pertaining its job, as well as its prevailing psychology.

Labelling of the work environment shall be clear and in good condition. One of the main advantages of using an organized safety symbol system is that it is universal, recognized across languages and levels of experience. The use of images and symbols warn people faster and easier than words.

Figure 2.33. Various Signs

Inside a workplace, **signs** are also placed as reminders to workers of the hazards surrounding them. Despite the training that workers have, there may be times when they forget the immediate risks around their work. Using safety symbols and signs,it ise consistently reminded to take more precaution. Safety symbols can also be utilized in the workplace to inform people of certain dangers and how to avoid them.

The term **safety colours** is used to describe the standard use of colours for safety purposes in the workplace. Depending on the situation, each colour is assigned a different meaning, which allows people to immediately determine what type of safety hazard is in the area, even if they are too far away to read any actual writing. For example:

- **RED** – Means Danger Alarm/Prohibited. A red symbol indicates the need to avoid or otherwise evacuate a premise or any dangerous behaviour within an area. Examples: Do Not Enter, Do Not Touch
- **YELLOW/AMBER** – Means Warning. Anyone encountering a yellow symbol must take more precaution and be cautious as well as aware of the area or situation. Examples: General Warning, Magnetic Field, Electric Shock
- **BLUE** – Means Mandatory. Any sign with Blue symbols dictates a specific safety behaviour such as wearing the proper personal protective equipment (PPE). Examples: Wash Hands, Safety Glasses Required
- **GREEN** – Means Emergency Escape. It also indicates no danger and first aid. Green signs can be placed on exit doors and escape routes. Examples: First Aid Kit, Eyewash Station, Emergency Exit.

Safety and / or health marking of the work environment is divided into:

- **permanent**: includes prohibition, warning, obligation, rescue or relief signs, firefighting equipment and signalling of obstacles, dangerous signs and traffic routes
- **occasional:** includes light signs, audible signs, oral communication and gestures.

Safety signs are divided into categories according to the type of message they are intended to convey. Each category is assigned a specific format and set of colours:

- **Prohibition signs** are circular shapes. Black pixel on a white background, with a red perimeter (red should cover at least 35% of the surface of the plate) and a red erase line (descending from left to right, all length of the pictogram at an angle of 45 °).
- **Warning signs** are triangular shapes. Black symbol on a yellow background with a black border (the yellow colour should cover at least 35% of the surface of the plate).
- **Obligation signs** are circular shapes. White symbol on a blue background (blue should cover at least 35% of the surface of the plate)
- **Rescue or relief signs** are rectangular or square shapes. White symbol on green background (green color should cover at least 50% of the surface of the plate).
- **Signs of firefighting equipment or equipment** are rectangular or square shapes. White symbol on red background (red should cover at least 50% of the surface of the plate).

Figure 2.34. Safety Signs Categories

Particularly important for avoiding accidents is the flexibility around the equipment. Some remarks about good planning are as follows:

- Adequate space should be available around machinery for human and material circulation (as well as for the intermediate storage of materials during production) and if possible, spaces should be marked for better control.
- The space where the equipment operator can move is not in a traffic corridor and, if necessary, protected by a railing.
- Provide benches and wheeled for the necessary tools and accessories to minimize operator displacement and avoid scattering hazardous tools.
- Waste materials accumulate in special containers and spaces and be regularly inspected.
- Avoid using rough drafts as seats, especially where there is reduced stability or high height.
- Engine mounting shall be such as to minimize static and dynamic load (vibration),

Figure 2.35. Industrial Workplace

2.4.2. Health and safety practices in equipment handling

Key Words

Personal protective equipment: clothing and personal protective equipment (PPE)

Qualified person: an individual who, by possession of a recognized degree, certificate or professional standing, or who by extensive knowledge, training and experience, has successfully demonstrated his ability to solve or resolve problems relating to the work

Pneumatic tools: tools powered by compressed air

Machine tool operators such as lathes, planes, milling machines, CNC, wheels face risks that can cause personal injury and property damage. The most common injuries are caused by moving mechanical parts (bumps, crushes) or by protruding elements (cutting debris, insufficiently fastened pieces), but also when transporting, removing pieces or cutting residues (grease). These kind of tools are also complemented by drops of liquids, oils and garbage around them.

About 80% of accidents at work are caused by employees reckless actions, errors, lack of personal protective equipment or improper use. Another 15% of them is due to poor working conditions, dangerous condition of machinery and tools, or building installations. Only a 5% comes as consequence of various unforeseen events.

For the right choice of **personal protective equipment** (**PPE**) covering every job, it is necessary to research the workplace and try to identify potential sources of risk. Impacts, punctures, compressions, chemical agents, temperature, harmful powders, light radiation, falls, etc. are risk categories to be considered.

Essential equipment for a machine operator is:

- Work wear
- Protective goggles
- Protective shields
- Helmets
- Protective hats
- Masks
- Earplugs
- Safety shoes
- Fall protection equipment

For **choosing the right personal protective equipment**, you should take into consideration:

- To be selected based on specific conditions and needs, appropriate for the risks to be prevented while their use will not entail new risks
- To be in accordance with the provisions of their design and manufacture
- To be customized and intended for personal use
- To be utilized only for intended use and in accordance to the manufacturer's instructions
- To be maintained, repaired, and regularly cleaned and replaced when worn out or expired
- To be kept in special places or places with good hygiene
- To be compatible and effective when used with more than one instruments
- To carry CE marking on them and on their packaging in such a way as to be visible and legible and to remain indelible for their expected life.

Figure 2.36. Personal protective equipment

There are five basic **safety rules to prevent hazards** associated with the **use of hand and power tools**:

1. Keep all tools in good condition with regular maintenance.
1. Use the right tool for the job.
2. Examine each tool for damage before use and do not use damaged tools.
3. Operate tools according to the manufacturers' instructions.
4. Never push unless you hold the tool with your palm open. Point sharp tools (e.g., saws, chisels, knives) laying on benches away from aisles and handles should not extend over the edge of the bench top. Maintain tools carefully. Keep them clean and dry and store them properly after each use.

Ten good practices that **minimize the respective risks** are:

1. Workers must inspect hand tools before use to ensure that they are in proper working order. Damaged or defective tools must be reported to the supervisor and must be repaired or removed from service.
2. Supervisors must periodically inspect shop tools to ensure that tools are in proper working condition and meet appropriate guidelines.
3. Tools and jigs especially designed for a specific purpose should be checked by a qualified person to ensure that there are no inherent or hidden safety hazards.
4. Proper and appropriate personal protective equipment must be worn when using all tools.
5. All tools must be cleaned and properly stored after use. Each tool must have its own storage area to prevent damage. This is particularly important with power tools.
6. Tools must not be used beyond their manufacturer's designed capacity since such use may create a personal hazard. Tools must be used solely for their intended purpose. The designed capacity of tools must not be exceeded by unauthorized attachments.
7. Power drills, disc sanders and grinders, (when used in the hand-held mode) must be operated with deadman controls that require constant hand pressure.
8. Face shields or goggles must be worn when operating a grinder.
9. Power saws, grinders, and other power tools must have proper guards in place at all times and must be properly grounded. Those with automatically adjusting guards must be inspected for proper movement.
10. All fuel-powered tools must be shut down while being refuelled. Smoking is prohibited during refuelling operations. Other nearby sources of ignition, such as cutting and welding, also must be halted during refuelling operations.

The **Dangers of Power Tools** shall be in any case recognized and appropriate personal protective equipment such as safety goggles and gloves must be worn to protect against hazards that may be encountered while using hand tools. Workplace floors shall be kept as clean and dry as possible to prevent accidental slips with or around dangerous hand tools.

Figure 2.37. Power tools

Power tools must be fitted with guards and safety switches; they are extremely hazardous when used improperly. The types of power tools are determined by their power source: electric, pneumatic, liquid fuel, hydraulic, and powder actuated. To **prevent hazards associated with the use of power tools**, workers should follow general precautions, such as:

- Never carry a tool by the cord or hose.
- Never yank the cord or the hose to disconnect it from the receptacle.
- Keep cords and hoses away from heat, oil, and sharp edges.
- Disconnect tools when not using them, before servicing and cleaning them, and when changing accessories such as blades, bits, and cutters.
- Keep all people not involved with the work at a safe distance from the work area.
- Secure work with clamps or a vise, freeing both hands to operate the tool.
- Avoid accidental starting. Do not hold fingers on the switch button while carrying a plugged-in tool.
- Maintain tools with care; keep them sharp and clean for best performance.
- Follow instructions in the user's manual for lubricating and changing accessories.
- Be sure to keep good footing and maintain good balance when operating power tools.
- Wear proper apparel for the task. Loose clothing, ties, or jewellery can become caught in moving parts.
- Remove all damaged portable electric tools from use and tag them: "Do Not Use."
- The exposed moving parts of power tools (belts, gears, shafts, pulleys, sprockets, spindles, drums, flywheels, chains, or other reciprocating, rotating moving parts) shall be safeguarded.

Figure 2.38. Monitoring power supply (electrical, pneumatic, etc) is of crutial importance for Health and Safety Issues (video)

Critical points for health and safety to be monitored, include:

- Point of operation
- In-running nip points
- Rotating parts
- Flying chips and sparks

Safety guards must never be removed when a tool is being used. Portable circular saws having a blade greater than 2 inches (5.08 centimetres) in diameter must be equipped at all times with guards. An upper guard must cover the entire blade of the saw. A retractable lower guard must cover the teeth of the saw, except where it makes contact with the work material. The lower guard must automatically return to the covering position when the tool is withdrawn from the work material.

Hand tools are tools that are powered manually. Hand tools include anything from axes to wrenches. The greatest hazards posed by hand tools result from misuse and improper maintenance. This type of work can result in what is now called "musculoskeletal" injuries. Some examples include the following:

- If a chisel is used as a screwdriver, the tip of the chisel may break and fly off, hitting the user or other employees.
- If a wooden handle on a tool, such as a hammer or an axe, is loose, splintered, or cracked, the head of the tool may fly off and strike the user or other employees.
- If the jaws of a wrench are sprung, the wrench might slip.
- If impact tools such as chisels, wedges, or drift pins have mushroomed heads, the heads might shatter on impact, sending sharp fragments flying toward the user or other employees.

The employer is responsible for the safe condition of tools and equipment used by employees. Employers shall not issue or permit the use of unsafe hand tools. Employees should be trained in the proper use and handling of tools and equipment. On the other hand, employees, when using saw blades, knives, or other tools, should direct the tools away from aisle areas and away from other employees working in close proximity.

Figure 2.39. Typical Hand tools in everyday use in a Aluminium and Metal Construction Shop

Furthermore:

- Knives and scissors must be sharp; dull tools can cause more hazards than sharp ones.
- Cracked saw blades must be removed from service.
- Wrenches must not be used when jaws are sprung to the point that slippage occurs. Impact tools such as drift pins, wedges, and chisels must be kept free of mushroomed heads.
- The wooden handles of tools must not be splintered.

Iron or steel hand tools may produce sparks that can be an ignition source around flammable substance. Where this hazard exists, spark-resistant tools made of non-ferrous materials should be used where flammable gases, highly volatile liquids, and other explosive substances are stored or used. (osha.gov)

Employees using **electric tools** must be aware of several dangers. Among the most serious hazards are electrical burns and shocks. Electrical shocks, which can lead to injuries such as heart failure and burns, are among the major hazards associated with electric-powered tools. Under certain conditions, even a small amount of electric current can result in fibrillation of the heart and death.

An electric shock also can cause the user to fall off a ladder or other elevated work surface and be injured due to the fall. To protect the user from shock and burns, electric tools must have a three-wire cord with a ground and be plugged into a grounded receptacle, be double insulated, or be powered by a low-voltage isolation transformer. Three-wire cords contain two current-carrying conductors and a grounding conductor. Any time an adapter is used to accommodate a two-hole receptacle, the adapter wire must be attached to a known ground. The third prong must never be removed from the plug.

Double-insulated tools are available that provide protection against electrical shock without third-wire grounding. On double-insulated tools, an internal layer of protective insulation completely isolates the external housing of the tool.

The following general practices should be followed when using electric tools:

- Operate electric tools within their design limitations.
- Use gloves and appropriate safety footwear when using electric tools.
- Store electric tools in a dry place when not in use.
- Do not use electric tools in damp or wet locations unless they are approved for that purpose.
- Keep work areas well lighted when operating electric tools.
- Ensure that cords from electric tools do not present a tripping hazard.

In the construction industry, employees who use electric tools must be protected by ground-fault circuit interrupters or an assured equipment-grounding conductor program.

Portable abrasive grinding, cutting, polishing, and wire buffing **wheels** create special safety problems because they may throw off flying fragments. Abrasive wheel tools must be equipped with guards that:

1. cover the spindle end, nut, and flange projections
2. maintain proper alignment with the wheel
3. do not exceed the strength of the fastenings

Figure 2.40. Portable Grinders & Abrasive Wheels

Before an abrasive wheel is mounted, it must be inspected closely for damage and should be sound- or ring-tested to ensure that it is free from cracks or defects. To test, wheels should be tapped gently with a light, non-metallic instrument. If the wheels sound cracked or dead, they must not be used because they could fly apart in operation. A stable and undamaged wheel, when tapped, will give a clear metallic tone or "ring."

To prevent an abrasive wheel from cracking, it must fit freely on the spindle. The spindle nut must be tightened enough to hold the wheel in place without distorting the flange. Always follow the manufacturer's recommendations. Take care to ensure that the spindle speed of the machine will not exceed the maximum operating speed marked on the wheel.

An abrasive wheel may disintegrate or explode during start-up. Allow the tool to come up to operating speed prior to grinding or cutting.

The employee should never stand in the plane of rotation of the wheel as it accelerates to full operating speed. Portable grinding tools need to be equipped with safety guards to protect workers not only from the moving wheel surface, but also from flying fragments in case of wheel breakage.

When using a powered grinder:

- Always use eye or face protection.
- Turn off the power when not in use.
- Never clamp a hand-held grinder in a vise.

Pneumatic tools are powered by compressed air and include chippers, drills, hammers, and sanders. There are several dangers associated with the use of pneumatic tools. First and foremost is the danger of getting hit by one of the tool's attachments or by some kind of fastener the worker is using with the tool.

Pneumatic tools must be checked to see that the tools are fastened securely to the air hose to prevent them from becoming disconnected. A short wire or positive locking device attaching the air hose to the tool must also be used and will serve as an added safeguard.

Figure 2.41. Pneumatic tools

If an air hose is more than 12.7 millimetres in diameter, a safety excess flow valve must be installed at the source of the air supply to reduce pressure in case of hose failure. In general, the same precautions should be taken with an air hose that are recommended for electric cords, because the hose is subject to the same kind of damage or accidental striking, and because it also presents tripping hazards.

When using pneumatic tools, a safety clip or retainer must be installed to prevent attachments such as chisels on a chipping hammer from being ejected during tool operation. Pneumatic tools that shoot nails, rivets, staples, or similar fasteners and operate at pressures more than 100 pounds per square inch (6,890 kPa), must be equipped with a special device to keep fasteners from being ejected, unless the muzzle is pressed against the work surface.

Airless spray guns that atomize paints and fluids at pressures of 1,000 pounds or more per square inch (6,890 kPa) must be equipped with automatic or visible manual safety devices that will prevent pulling the trigger until the safety device is manually released.

Never forget that (U.S. Department of Labor Elaine L. Chao, Secretary):

- Eye protection is required, and head and face protection is recommended for employees working with pneumatic tools.
- Screens must also be set up to protect nearby workers from being struck by flying fragments around chippers, riveting guns, staplers, or air drills.
- Compressed air guns should never be pointed toward anyone.
- Workers should never "dead-end" them against themselves or anyone else.
- A chip guard must be used when compressed air is used for cleaning.
- Use of heavy jackhammers can cause fatigue and strains.
- Heavy rubber grips reduce these effects by providing a secure handhold.
- Workers operating a jackhammer must wear safety glasses and safety shoes that protect them against injury if the jackhammer slips or falls.
- A face shield also should be used.
- Noise is another hazard associated with pneumatic tools.
- Working with noisy tools such as jackhammers requires proper, effective use of appropriate hearing protection.

Risks from **gas cylinders** can be classified into the following categories:

1. **General dangers of the large weight of the bottles.** Precautionary measures:
   - Store and use the bottles vertically.
   - Protect bottles from falling. Use appropriate chains or metal frames for this purpose.
   - Transport the bottles using all the heavy transport of objects (e.g. trolleys, clarks, cranes, etc.).
   - During transport protect the cylinder valves with the special metal cover.
2. **Risks of High Pressure or Low Temperature During Gas Expansion.** Precautionary measures:
   - Avoid damage to the cylinders (e.g. broken rounds, etc.).
   - Only connect the bottles to the equipment appropriate to them (e.g. reducers and manometers of appropriate size). Avoid excessive safety systems on the cylinders. The more these systems are, the more likely they are to be sources of damage or leakage.
   - Store the cylinders away from heat sources, away from the sun.

- Remove cylinders from fires.
- Avoid corrosion of the bottles which reduces the strength of the walls.
- At very low temperatures you avoid mechanical impacts because the steel becomes brittle.
- The sudden gas expansion causes cooling and "cold burns". Wear gloves.

3. **Dangers of the properties of each gas** (eg gaseous oxidants, flammable, irritant, corrosive, inert, etc.)

Figure 2.42. Gas cylinders

a. Flammable gases (e.g. acetylene). Precautionary measures:

- Appropriate fire protection systems (detection, alarm, fire extinguishing equipment) must be in place for the use of flammable gases.
- In some installations it is particularly useful to install flammable gas bottles in special high heat resistant metal cases equipped with appropriate temperature sensors. In any case, however, flammable gases must be stored separately from oxidants in a well-ventilated area.
- Acetylene bottles should never be stored in a lateral position.
- Avoid leaks. Check for leaks with soapy water (e.g. a dilute solution of detergent in water) at the connection points and / or in the pipes. The appearance of bubbles indicates the presence of a leak at that point.
- Never use the cigarette lighter flame to detect flammable gas leakage.
- If there are leaks, avoid any sources of ignition and ventilate.
- Smoking is prohibited in flammable storage areas or in areas where they are used.
- If a bottle is heated, follow these steps:
    i. Close the valve (using protective gloves) and remove the bottle from the fire.
    ii. If part of the cylinders is warmer, cool it with water.
    iii. If the bottle is particularly hot, splash it with water from a safe distance.
    iv. Continue cooling until the bottle is cold by itself.

- In the event of a fire, the safest way to extinguish is to cut off the gas supply. Otherwise flammable clouds are created.
- Close the valve using protective gloves.
- Always use acetylene bottles with a special non-return valve (flame trap) because otherwise there is a risk of explosion of the bottle.
- Use acetylene at the appropriate low pressure (the safety valve is preset, e.g. at 1.8 bar).
- It is recommended to install flammable gas sensors in the storage and use area at the appropriate height.
- Copper couplings and tubes should not be used in acetylene bottles because they create copper acetylides which can cause an explosion in the event of an impact.
- A steel grid is usually used.
- Use of appropriate equipment (e.g. electrical) in the storage and use of bottles, based on the classification of explosive zones.

b. **Oxidizing gases (e.g. oxygen).** Precautionary measures:
- Operate valves with low pressure.

Figure 2.43. Pressure gauges

- Keep the oxygen supply system (e.g. piping) clean of oils or oats.
- It is forbidden to lubricate the oxygen supply system.
- Use materials that are proven to be safe with oxygen, ie materials that do not ignite.
- Avoid indoors where oxygen may be present at high concentrations. Check the atmosphere of these areas with special portable detectors.
- Avoid using oxygen if you can use compressed air or other gases for the same job.
- 3. Inert gases (e.g. nitrogen, helium, argon etc.)
- Precautionary measures:
- Ventilate the enclosures well as the leaks can cause oxygen deficiency and can cause suffocation.

c. **Toxic, irritating & corrosive gases** (e.g. carbon monoxide). Precautionary measures:
- Check regularly for possible leaks.
- Use protective equipment (e.g. masks).

2.4.3. Health and safety practices after product manufacturing

Key Words

Ratchet: strap for fastening

A-frame: special removable metal case for loading

Good handling techniques for lifting shall be followed in order to minimize health and safety risks and avoid damages. To lift something manually:

- Reduce the amount of twisting, stooping, and reaching
- Avoid lifting from floor level or above shoulder height, especially heavy loads
- Adjust storage areas to minimize the need to carry out such movements
- Consider how you can minimize carrying distances
- Assess the weight to be carried and whether the worker can move the load safely or needs any help – maybe the load can be broken down to smaller, lighter components.

Figure 2.44. Accident statistics

There are some simple steps to follow before and during the lift/carry:

- Remove obstructions from the route.
- For a long lift, plan to rest the load midway on a table or bench to change grip.
- Keep the load close to the waist.
- The load should be kept close to the body for as long as possible while lifting.
- Keep the heaviest side of the load next to the body.
- Adopt a stable position and make sure your feet are apart, with one leg slightly forward to maintain balance
- Think before lifting/handling. Plan the lift.
- Can handling aids be used?
- Where is the load going to be placed?
- Will help be needed with the load?
- Remove obstructions such as discarded wrapping materials. For a long lift, consider resting the load midway on a table or bench to change grip.
- Adopt a stable position.
- The feet should be apart with one leg slightly forward to maintain balance (alongside the load, if it is on the ground).
- Be prepared to move your feet during the lift to maintain your stability. Avoid tight clothing or unsuitable footwear, which may make this difficult.

Figure 2.45. Manual handling

- Get a good hold. Where possible, the load should be hugged as close as possible to the body. This may be better than gripping it tightly with hands only.
- Start in a good posture. At the start of the lift, slight bending of the back, hips and knees is preferable to fully flexing the back (stooping) or fully flexing the hips and knees (squatting).

- Don’t flex the back any further while lifting.
- This can happen if the legs begin to straighten before starting to raise the load.
- Keep the load close to the waist.
- Keep the load close to the body for as long as possible while lifting.
- Keep the heaviest side of the load next to the body.
- If a close approach to the load is not possible, try to slide it towards the body before attempting to lift it.
- Avoid twisting the back or leaning sideways, especially while the back is bent.
- Shoulders should be kept level and facing in the same direction as the hips.
- Turning by moving the feet is better than twisting and lifting at the same time.
- Keep the head up when handling.
- Look ahead, not down at the load, once it has been held securely.
- Move smoothly.
- The load should not be jerked or snatched as this can make it harder to keep control and can increase the risk of injury.
- Don’t lift or handle more than can be easily managed.
- There is a difference between what people can lift and what they can safely lift.
- If in doubt, seek advice or get help.
- Put down, then adjust. If precise positioning of the load is necessary, put it down first, then slide it into the desired position. (Great Britain’s independent regulator for work-related health, HSE)

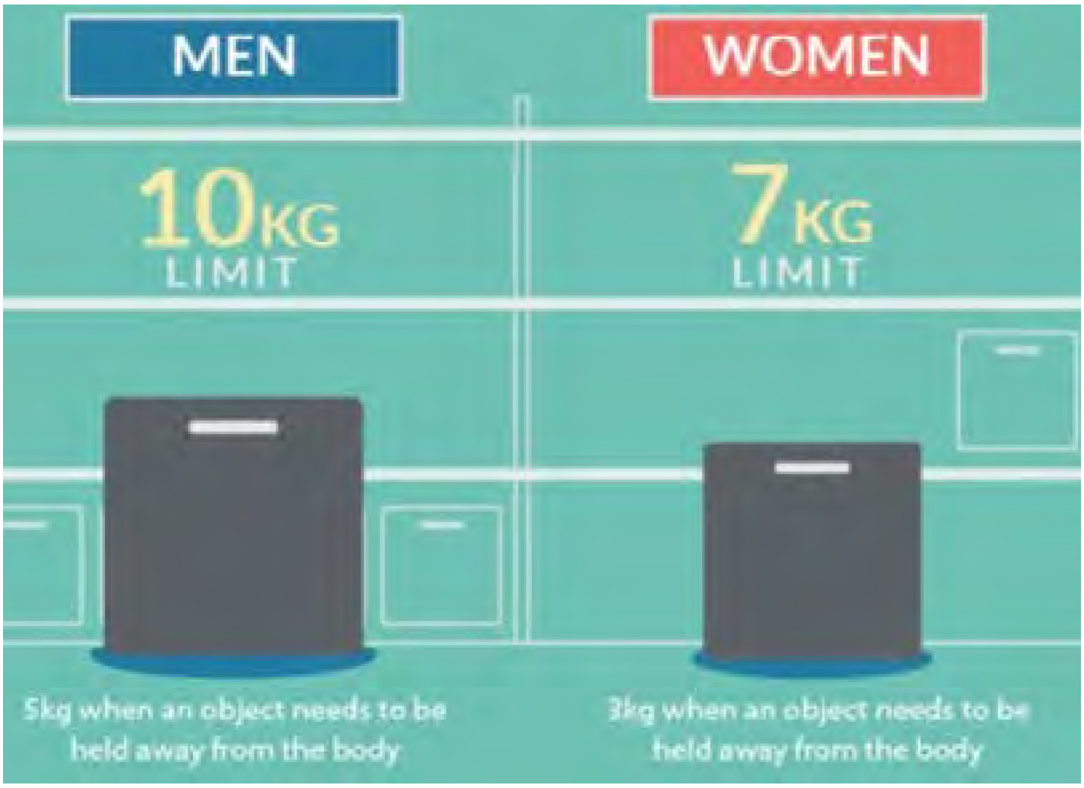


Figure 2.46. Lifting weights by gender

For heavier loads Hydraulic Power Tools - Forklift, or pallet jack shall be utilized. To use lifting equipment:

- Consider whether you can use a lifting aid, such as a forklift truck, electric or hand-powered hoist, or a conveyor.
- Think about storage as part of the delivery process – maybe heavy items could be delivered directly, or closer, to the storage area.
- Reduce carrying distances where possible.
- The fluid used in hydraulic power tools must be an approved fire-resistant fluid and must retain its operating characteristics at the most extreme temperatures to which it will be exposed.
- The exception to fire-resistant fluid involves all hydraulic fluids used for the insulated sections of derrick trucks, aerial lifts, and hydraulic tools that are used on or around energized lines. This hydraulic fluid shall be of the insulating type.
- The manufacturer's recommended safe operating pressure for hoses, valves, pipes, filters, and other fittings must not be exceeded.
- All jacks -- including lever and ratchet jacks, screw jacks, and hydraulic jacks -- must have a stop indicator, and the stop limit must not be exceeded.
- Also, the manufacturer's load limit must be permanently marked in a prominent place on the jack, and the load limit must not be exceeded.
- A jack should never be used to support a lifted load.
- Once the load has been lifted, it must immediately be blocked up.
- Put a block under the base of the jack when the foundation is not firm and place a block between the jack cap and load if the cap might slip.

Useful Tips for operating a forklift safely, could be considered:

1. Operators must be qualified
2. Appropriate clothing must be worn.
3. Examine Equipment before use
4. Starting up the forklift
5. Consider the surrounding environment
6. Operate at a safe speed
7. Avoid Hazards
8. Ensure your load is stable and secure
9. Make sure you have clear visibility
10. Forklifts are for Carrying Loads only
11. Keep Clear of the Mast
12. Driving on Ramps
13. Ensure the forklift is not Over-loaded
14. Ensure the Load is evenly distributed

Figure 2.47. Forklift Stacker

During transport, the load must be attached to the truck with straps capable of stabilizing the cargo based on the forces acting on it. There should be straps at the front to hold the load at 80%, at the rear and rear 50% and up to 20% of the load.

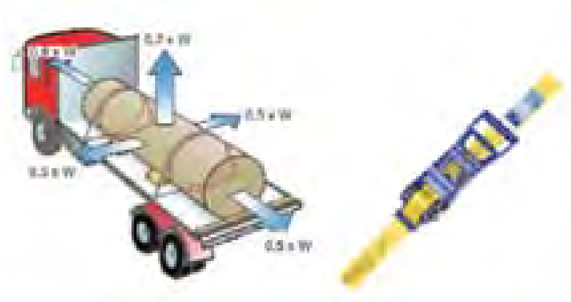


Figure 2.48. Transporting- fastening / ratchet for web lashing

A-frames are very often used to transport large flat objects as glass, curtain walling and fenestrations. The A-frame can be permanently fixed on the vehicle or can be removable and A-frame can be oriented in the driving direction for moor easy fastening.

Figure 2.49. A-frame

Top over lashing can be used to prevent sliding and tipping in traverse direction.

Figure 2.50. Top over lashing

Metal corners should be placed the corners where the support strap will pass.

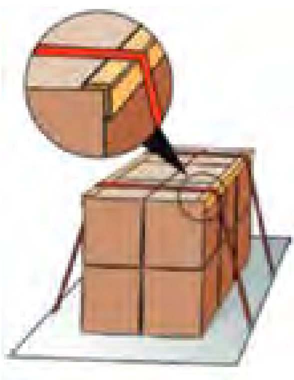


Figure 2.51. Metal Corners

02 MODULE Conclusions

Proper handling and maintenance of equipment are an integral part of achieving a proper and quality product.

Employees are handling a wide range of mechanical equipment.

The maintenance of mechanical equipment is a prerequisite for maintaining it at a satisfactory level, so as to enable the machining and production of quality products to be carried out.

The correct layout of the equipment and the production line plays a very important role in increasing productivity and reducing non-conformities.

The risks to workers in the production and installation of aluminium and iron structures are several and occur daily during work. The risks to workers' safety may come from the infrastructure, equipment and incorrect practices that workers follow. It is therefore necessary to apply all relevant legislative requirements and to take appropriate measures to prevent and address risks.

Self Assessment Questions

Improvement begins with assessment.
Self Assessment is the first step to all assessment.
Start by choosing the correct answers.

1. What is Equipment?
   a. a tool
   b. a machine
   c. tools and machines
   d. a set of tools that are used to achieve a specific objective
2. What is a tool?
   a. a device or implement, used to carry out a particular function
   b. a car
   c. a camion
   d. a compressed air networks
3. What are consumables?
   a. products that consumers use repeatedly for the function of the machineries
   b. machines' motor
   c. electricity
   d. rent
4. What is maintenance?
   a. the reparation after damage
   b. to consume less electricity
   c. the process of preserving a good condition in function
   d. the good function of a machine
5. Are there any differences between hand and handheld tools?
   a. no
   b. hand tools function with electricity, while handheld without
   c. handheld tools are only for drilling while hand for screwing
   d. hand tools function without electricity while handheld with
6. Why electrical tools must be grounded?
   a. to keep the engine from crashing
   b. to work well
   c. to provide protection against electricity
   d. to consume less electricity

7. What is a CNC machine?
    a. a computer
    b. a machine in which pre-programmed computer software dictates the movement of factory tools
    c. a group of machines
    d. all big machines

8. What is the benefit of a CNC machine?
    a. it can perform the entire treatment cycle on its own
    b. it consumes energy
    c. the speed of production
    d. the quality of treatment

9. What is code G?
    a. the production number of machines
    b. the colour of a machine
    c. any word in a CNC program that begins with the letter G
    d. the type of a machine

10. What does code G do?
    a. starts a function
    b. stops a function
    c. tells the machine tool what type of action to perform
    d. calculates opening hour

11. Where should tools be stored?
    a. on a machine
    b. on a workbench
    c. in the tool cabinets
    d. at the warehouse

12. How many categories of maintenance are there?
    a. preventive maintenance
    b. scheduled & corrective maintenance
    c. corrective e & preventive maintenance
    d. predictive, corrective, scheduled & preventive maintenance

13. Which is the best kind of maintenance?
    a. preventive maintenance
    b. scheduled maintenance
    c. corrective maintenance
    d. predictive maintenance

14. How many categories of gases are there?
    a. 1
    b. 2
    c. 3
    d. 4

15. What is Process layout?
    a. when all machines performing similar type of operations are grouped at one location
    b. when all machines performing similar type of operations are in different location
    c. when all machines are in line
    d. when the machines are positioned opposite to each other

16. What is dead time in production?
    a. the time that production stops
    b. the time that does not add value on the product
    c. the time of maintenance
    d. the time that electricity isn't consumed

17. What is unit or Job type of production?
    a. the layout of machines / people for high production
    b. the layout of machines / people for good quality of products
    c. the layout of machines / people for cheaper product
    d. the layout of machines / people for most different kind of products

18. .What is lot type of Production?
    a. the layout of machines / people for cheaper product
    b. the layout of machines / people for big lot of products
    c. the layout of machines / people for high quality
    d. the layout of machines / people for cheaper product

19. What is the advantage of unit or Job type of production (beehive)?
    a. large quantities may be produced
    b. good quality
    c. flexibility of changes in production
    d. cheaper products

20. In which case the unit type of production is suitable?
    a. for non-standard products
    b. for different qualities
    c. for different quantities
    d. for different typologies

21. What is the different between direct and Indirect Costs?
    a. direct costs can be directly attributed to the production, indirect costs are overheaded
    b. direct costs are overheaded, indirect costs can be directly attributed to the production
    c. they are the same
    d. direct costs are the product´s cost, indirect costs are the labour cost

22. What are the advantages of fenestration software use?
    a. it calculates the expenses
    b. it organizes the personnel
    c. It calculates the profile/accessories and makes cutting optimization
    d. it calculates production time

23. Why production data sheet is important?
    a. in order to know the costs
    b. it is mandatory by law
    c. for the balance sheet
    d. for the assets of the company

24. What are cost drivers?
    a. costs of transport
    b. camions' costs
    c. a factor that distributes the cost of variable costs
    d. cost of production shift

25. What is historical cost?
    a. the history of the economic data
    b. the labour cost
    c. the cost based on prior years data
    d. the cost of raw materials

26. What are the main differences between historical & estimated cost?
    a. historical cost is high
    b. estimated cost is all about taxes
    c. time that data is collected
    d. data is different

27. What affects the quantity produced?
    a. quality
    b. product cost
    c. overtime labour
    d. production time

28. Why does the production area between aluminium & steel should be separated?
    a. for better cleanliness
    b. for protecting aluminium
    c. for the noise
    d. it is provided by law

29. What is the main difference between steel & aluminium in connection?
    a. aluminium has accessories for all kind of connections
    b. there are not differences
    c. the labour needed
    d. the layout

30. Who is responsible for accidents at work?
    a. dangerous situations at work area
    b. dangerous situations at work area and employees' dangerous actions
    c. employees' dangerous actions
    d. incomplete laws

31. What are the safety categories of labelling / marking?
    a. permanent marking
    b. occasional marking.
    c. permanent marking & occasional marking
    d. total marking

32. Why spacing around machines is important?
    a. for cleanliness
    b. for the staff's circulation
    c. for avoiding accidents
    d. for space saving

33. What is the shape of prohibition signals?
    a. circle
    b. triangle
    c. square
    d. polygon

34. What is the shape of obligation signals?
    a. circle
    b. triangle
    c. polygon
    d. square

35. Who is responsible for most accidents?
    a. staff
    b. machines
    c. space
    d. electricity

36. What are the greatest hazards posed by hand tools?
    a. electricity
    b. falling
    c. hand breaking
    d. musculoskeletal injuries

37. What are the greatest hazards posed by electric tools?
    a. falling
    b. hand breaking
    c. musculoskeletal injuries
    d. electric shock

38. How do we distinguish gas cylinders content?
    a. from the size
    b. from the valve
    c. from the price
    d. from the colour

39. Which of the following storing position of acetylene bottles is dangerous?
    a. lateral position
    b. upright position
    c. on trolley
    d. in warehouse

40. In which of the following gases should a mask be used?
    a. oxygen
    b. carbon dioxide
    c. argon
    d. acetylene

41. What does the straps to attach loads to trucks depend on?
    a. camion
    b. fenestration
    c. dimensions
    d. weight

42. Which straps carry the most weight?
    a. lateral ones
    b. front ones
    c. back ones
    d. top ones

43. How does the strength of the strap to be used is calculated?
    a. * % weight
    b. 2*weight
    c. = dimension
    d. 2 * hight

44. How does the strength of front straps is calculated?
    a. 10% * weight
    b. 20% * weight
    c. 50% * weight
    d. 80% * weight

45. What is the angle's joint difference the between aluminium and metal?
    a. there is no difference
    b. aluminium is joined with accessory, metal is welded or screwed
    c. different kinds of screws
    d. different kinds of glue

46. What is the meaning of red colour in safety signs?
    a. mandatory
    b. no problem
    c. pay attention
    d. danger

47. What is the meaning of blue colour in safety signs?
    a. mandatory
    b. no problem
    c. pay attention
    d. danger

48. How are prohibition signals shaped?
    a. square
    b. triangular
    c. circular
    d. polygonal

49. How rescue or relief signals are shaped?
    a. square
    b. circular or polygonal
    c. rectangular or square
    d. triangular

50. Which metal should not be used in acetylene bottles?
    a. steel
    b. stainless steel
    c. tin
    d. copper

51. With which gas oil is dangerous?
    a. acetylene
    b. propane
    c. oxygen
    d. argon

52. How do we lift a load manually?
    a. we keep it close to the shoulders
    b. we keep it close to the waist
    c. we keep it close to the legs
    d. we keep it close to the head

53. What are the permissible weights per gender?
    a. man 15 - woman 10
    b. man 12 - woman 10
    c. man 10 - woman 7
    d. man 8 - woman 5

54. At what angle should we load frames in the A-frame?
    a. 100
    b. 200
    c. 700
    d. 900

MODULE

Production of aluminium constructions

Processes for the production of an aluminium construction industry, in order to meet the energy-related targets

03 MODULE

Production of aluminium constructions

Processes for the production of an aluminium construction industry, in order to meet the energy-related targets

Introduction - Learning Objectives
Special features of processes application in construction industries

This module covers all parts of the processes for the production of an aluminium construction industry. It also presents the necessary technical skill requirements for the workers in such industries, such as production processes, cutting, assembling, inspection & packaging. In order to meet the energy-related targets part of these skills shall be considered also as green skills. In this chapter also non-technical parts will be covered such as trading, marketing and sales techniques and costing.

The renovation /upgrade of old constructions is also covered herein, with particular focus on the energy efficiency improvement of the building that is taking place along with such works. This entails exploitation of green skills that will be also covered in this chapter.

It shall be noted, in this point, that green skills include also typical technical skills along with which the energy related targets are being met. In this context a strict distinction between some technical and green skills is far from easy.

New, distinctly green skills, such as management of the recyclable materials are also covered herein.

Finally, the identification of the customer needs covers horizontally this chapter, that necessitates all technical, green and horizontal skills. Communication and flexibility in solving problems set by the customer, in conjunction with application of technical and green skills will help to attain the optimum technical solution.

Knowledge Objectives to be achieved through this learning module are:

- Suggest alternative technical solutions using software and present them through a written offer
- Predict the cost and the time needed to complete a project
- Understand the legal and regulatory requirements for aluminium constructions
- Calculate thermal properties (e.g. U-value) for various constructions, using appropriate software.
- Understand & calculate the energy performance of products (energy labelling)
- Understand the environmental performance of products (environmental product declaration)
- Understand the demands and the specifications for Near to Zero Energy Buildings (nZEB)
- Organize the file of each completed project
- Negotiate the final price and payment terms
- Keep a record of offers and track the sales outcome
- Understand basic corporate finances
- Use production manuals, directories, profiles for cutting dimensions and the list of accessories
- Handle technical manuals for the manufacture of aluminium systems
- Apply the requirements of technical manuals when n order to achieve maximum energy outcomes
- Apply standards and guidelines to ensure product quality and continuous improvement
- Supply of materials according to the technical requirements of manufacture
- Perform quality control of the raw materials, hardware and supplementary materials
- Apply good practices for raw materials and final products storage
- Make logistics on the incoming materials
- Group the cutting by production type to avoid errors
- Measure and test mechanical and physical values
- Dismantle and assemble components and sub-assemblies
- Check monitor and treat errors and malfunctions
- Carry out routine repairs to control systems and components and document results
- Apply all stages of production, cutting, processing, assembly of all types of frames
- Organize and apply the appropriate measurement and construction techniques

For the Teacher

Learning Outcome 3.1
Development of communication skills. Performing basic technical drawings, energy performance calculations, costing and offering tasks

Learning Unit 3.1.1 - 4h
Understanding customer/project needs. Relevant European & national legislation
Learning Unit 3.1.2 - 3h
Accounting and cost estimation software
Learning Unit 3.1.3 - 3h
Negotiations and final agreement

Learning Outcome 3.2
Use of technical - production manuals, catalogues

Learning Unit 3.2.1 - 6h
Use of technical – production manuals, catalogues
Learning Unit 3.2.2 - 2h
Procurement of raw materials. Production planning
Learning Unit 3.2.3 - 2h
Cutting, machining, Recycling

Learning Outcome 3.3
Assembling profiles for various typologies & types of aluminium construction products

Learning Unit 3.3.1 - 6h
Use of technical – production manuals, catalogues
Learning Unit 3.3.2 - 2h
Production planning
Learning Unit 3.3.3 - 2h
Assembling, fenestration & outdoors systems

Learning Outcome 3.4
Health and safety good practices

Learning Unit 3.4.1 - 6h
2.4.1. Quality control
Learning Unit 3.4.2 - 2h
Health and safety good practices
Learning Unit 3.4.3 - 2h
Project documentation and monitoring

Erasmus+

3.1. Development of communication skills. Performing basic technical drawings, energy performance calculations, costing and offering tasks

Key Words

Fabrication manuals: documents that provide guidance on specific work activity, such as assembling of fenestrations

To be achieved upon learning outcome completion

KNOWLEDGE

- Basic communication principles for understanding customer needs and sales
- Procurement of raw materials
- Knowledge of accounting and costing software and relevant European legislation on the performance of construction.
- Negotiation knowledge of the final agreement, ways of archiving and monitoring works

SKILLS

- Communicate & inform engineers and clients on the various construction types & the selected ones
- Communicate and share information with the building engineer, e.g. the architecture engineer
- Organize collaboration with external partners
- Implement good working practices
- Apply the relevant European and national legislation
- Plan and organize autonomously the works that need to be done within the timetable and the cost constraints
- Reading of technical drawing
- Procure information
- Extract the dimensions of the construction
- Extract the dimensions from blueprints, drawings, sketches etc.
- Measure correctly and extract dimensions
- Understand the peculiarities of each project
- Take project measurements (products' dimensions) on site

COMPETENCIES

- Understand the customer's needs in relation to the applicable legislation in order to give the ideal technical - financial offer
- Alternative proposals for quality upgrading of buildings with better thermal performance
- Understand customer-supplier intentions for better sales-purchase agreement and follow-up capability

3.1.1. Understanding customer/project needs. Relevant European & national legislation

The craftsmen shall have good communication skills, so that they can express themselves in a positive and clear manner, both when speaking to people and in writing, within the company and outside. Communication is one of the main ingredients for personal success. Demonstrating strong communication skills is about being able to convey information to others in a simple and unambiguous way. It involves the distribution of messages clearly and concisely, in a way that connects with the audience. Good communication is about understanding instructions, acquiring new skills, making requests, asking questions and relaying information with ease. Listening carefully, speaking clearly and putting others at ease are very valuable attributes to possess.

When communication occurs, it typically happens in one of three ways: verbal, non-verbal and visual. People very often take communication for granted. Communicators constantly exchange information, meaning people always seem to be either receiving or giving information. Understanding the different methods of exchanging information is important especially in business and professional settings. Many adults have chosen to go back to school and pursue a communication degree online to ensure they have strong communication skills for a competitive job market.

Verbal communication seems like the most obvious of the different types of communication. It utilizes the spoken word, either face-to-face or remotely. Verbal communication is essential to most interactions, but there are other non-verbal cues that help provide additional context to the words themselves. Pairing non-verbal communication with the spoken word provides a more nuanced message.

Non-verbal communication provides some insight into a speaker's word choice. Sarcasm, complacency, deception, or genuineness occur within non-verbal communication. These things are often communicated through facial expressions, hand gestures, posture and even appearance, all of which can convey something about the speaker. For instance, a dishevelled speaker with wrinkled clothes and poor posture would communicate a lack of confidence or expertise. A speaker with a nice suit, who stood up straight and spoke clearly, may appear more serious or knowledgeable.

Visual types of communication include signs, maps or drawings as well as colour or graphic design. These typically reinforce verbal communication, and they help to make a point. Visual aids can help a speaker remember important topics, give the audience something to look at, and generally help convey the message being presented.

By utilizing all three types of communication, a speaker ensures he or she has the necessary tools to avoid miscommunication and misconceptions. The best way to ensure effective communication is with a good understanding of the types of communication, which you can study and fine-tune.

The purpose of communication skills is to enable the manufacturer to understand the customer's needs so as to make the ideal proposal. Therefore, the follow principal should be seriously taken into consideration:

1. **Cohesion and Clarity**

   Good communication is much more than saying the right thing; it is about communicating messages clearly and concisely. Before you start a conversation, type an email, or begin a discussion, have in mind what the purpose of the communication is and what information you hope to obtain as a result.

   Lack of clarity and cohesion can result in poor decisions and confusion.

2. **Respect**

   Empathy leads into the next communication skill, respect. If you respect the ideas and opinions of others, they will be more likely to communicate with you. Active listening or simply using the name of the person you are speaking to can both be effective.

3. **Listening**

   Good communication is all about listening effectively. Take the time to listen to what the other person is saying and practice active listening. Pay attention to ask questions and clarify points and rephrase what they have said so that you know you have understood correctly.

4. **Open-Mindedness**

   Try to enter communications without having a strict predefined agenda. Strong communications require an open mind and a commitment to understanding other people's points of view. If you disagree with the people you are speaking to, try to reach a middle ground that benefits all parties. Approaching a discussion with an open mind is more likely to result in a successful outcome.

5. **Asking Good Questions**

   Good questions can help conversations flow and improve the outcome. During a conversation, always aim to ask open-ended questions. These are questions with prompts which encourage the recipient to speak about certain points and they require more detailed responses. During a conversation include a mixture of questions including clarification, 'what if' scenarios and open-ended questions to make sure that you achieve what you set out to do at the beginning of the call or conversation.

Figure 3.1. **Kind of communication skills**

On the other hand, non verbal communication refers to the use of communication without using spoken language. Nonverbal communication often referred to as body language is very important in getting what you want in life, especially in selling.

The message you convey in a sales conversation is 55% body language and non-verbal communication, 38% tone of voice, and only 7% in the words that you use. When selling to customers, your non-verbal communication skills - such as active listening and interpreting non-verbal cues - are just as important as what you say.

Developing these skills will help you understand what your customers want, so you can offer them the most suitable products and services. People are highly visual, they are most affected by the predominant message that you convey, and this is usually communicated by the way you hold and use your body.

Figure 3.2. Facial expressions

Non-verbal communication can play five roles:

- **Repetition:** It repeats and often strengthens the message you're making verbally.
- **Contradiction:** It can contradict the message you're trying to convey, thus indicating to your listener that you may not be telling the truth.
- **Substitution:** It can substitute for a verbal message. For example, your facial expression often conveys a far more vivid message than words ever can.
- **Complementing:** It may add to or complement your verbal message. As a boss, if you pat an employee on the back in addition to giving praise, it can increase the impact of your message.
- **Accenting:** It may accent or underline a verbal message. Pounding the table, for example, can underline the importance of your message (The Importance of Effective Communication, Edward G. Wertheim, Ph.D.).

The many different types of non-verbal communication or body language including:

- **Facial expressions:** The human face is extremely expressive. The facial expressions for happiness, sadness, anger, surprise, fear, and disgust are the same across cultures.
- **Body movement and posture:** Consider how your perceptions of people are affected by the way they sit, walk, stand, or hold their head.
- **Gestures:** Gestures are woven into the fabric of our daily lives. You may wave, point, beckon, or use your hands when arguing or speaking animatedly etc.

Figure 3.3. Gestures

- **Eye contact:** Since the visual sense is dominant for most people, eye contact is an especially important type of non-verbal communication.
- **Touch:** We communicate a great deal through touch.
- **Space:** We all have a need for physical space, although that need differs depending on the culture, the situation, and the closeness of the relationship.
- **Voice:** It's not just what you say, it's how you say it.

When the manufacturer understands the needs, he/she must make an official offer. Often the dimensions of fenestrations are taken from the drawings and need the person responsible shall understand the metric scale. He/She must be able to read and understand both the dimensions and the typology of the frame. On the floor plans, that is to say a horizontal section of the building, one can read the dimensions , or even measure them in scale, and find the actual measures to offer. The metric scale reduces the object to be designed so that it can be imprinted on plain paper. So, when we say that the scale is 1/100, we mean that the object we have in the drawing is 100 times smaller than reality. That is, 1 centimetre in the drawing is 1 meter in fact. The framing of the openings in the architectural drawings is captured by recording the direction in which they are opened.

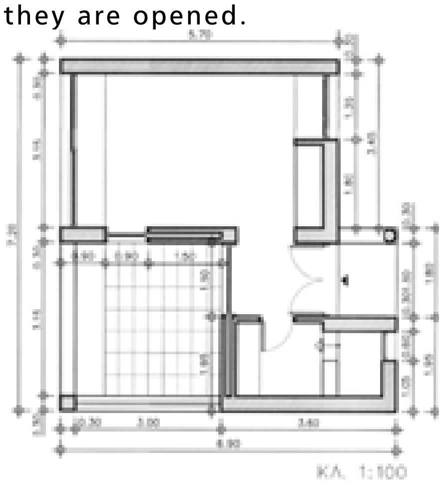


Figure 3.4. Understanding an architectural plan example

From the architectural drawings one can take all the measures and typology, see the location of the window or the construction, understand if there are obstacles, and discuss with the customer possible changes.

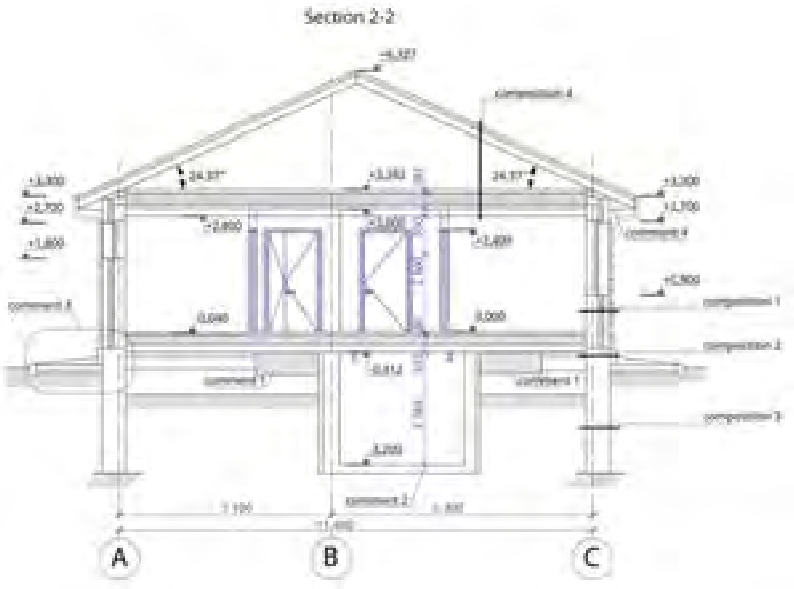


Figure 3.5. Cross Section of a building

There are frames list also, from which can also take the dimension of frames, typology and location.

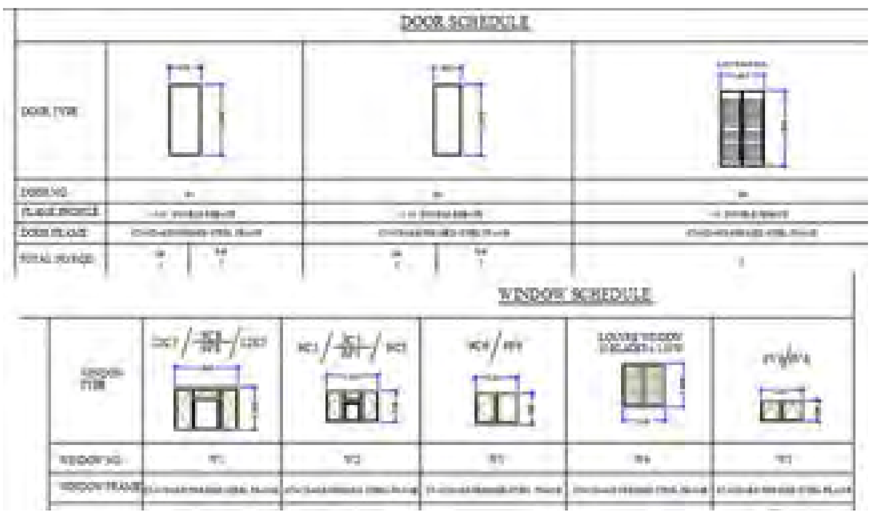


Figure 3.6. Door schedule

The offer to the customer shall be in accordance with European legislation. The **CE marking** is a requirement for the legal circulation of products in the Member States of the European Union, which means that European legislation in conjunction with European standards is of particular importance.

The latest European Union legal requirement in the field of Construction Products is Regulation 305/2011, which applies to all countries from 01/07/2013 and replaces the Construction Products Directive 89/106 / EEC. The Regulation lays down harmonized conditions of marketing for construction products. As part of its Better Law making initiative, this regulation clarifies the basic concepts and use of the CE marking and sets out simplified procedures, which can reduce costs incurred by businesses, in particular small and medium-sized enterprises. The main categories of requirements of Building Products Regulation 305/2011 for Construction Products are:

- Mechanical strength and stability
- Safety in case of fire
- Health, health and environment
- Security and accessibility of use
- Noise protection
- Energy saving and heat retention
- Sustainable use of natural resources

For the fenestrations the manufacturer shall understand the specification from at least the basic certifications:

1. Resistance to wind load

The following table presents the test results

ASSESSMENT OF CHARACTERISTIC – RESISTANCE TO WIND LOAD:
CLASSIFICATION ACCORDING TO EN 12210

Class	Measurement of frame deflection at pressure P1, Pa	Wind load +/- at pressure P2, Pa	Safety test +/- at pressure P3, Pa
0		npd	
1	400	200	600
2	800	400	1200
3	1200	600	1800
4	1600	800	2400
5	2000	1000	3000
Exxx	xxx		

Class	Frame deflection at pressure P1
A	< 1/150
B	< 1/200
C	< 1/300

Table 3.1. Assessment of resistance to wind load

- A, B, C are different deflections measurement methods. A: l / 150, B: l / 200, C: l / 300 (A = looser, C = tighter)
- Each test starts with 50 charge cycles, continues with constant charge (where the deflection is measured and ends with 7 + 7 seconds of pressure and suction charging)
- Pressures on the above tests depend on the chosen category (see “Pressure” column)

Class	Measurement of frame deflection at pressure P1, Pa	Wind load +/- at pressure P2, Pa	Safety test +/- at pressure P3, Pa
4	1600	800	2400

Table 3.2. Example

- The C4 wind category measures the deflection with the formula l / 300, the frame is subjected to a constant pressure of 1600 pa (when the deflection was measured), the frame is subjected to 50 pressure / suction cycles at 800 pa, the frame is subjected to 7 seconds of pressure at 2400 pa followed by 7 seconds of suction at 2400 pa.

2. Water tightness

They are two options.

- **Fenestration non shielded**
- **Fenestration shielded.**

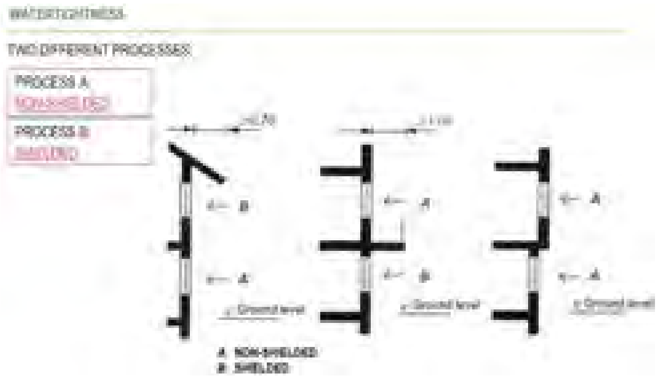


Figure 3.7. Shielded / no shielded

The test is started by soaking the sample at zero pressure for 15 minutes. The spraying is then continued with increasing pressure every five minutes.

WATERTIGHTNESS

ASSESSMENT OF CHARACTERISTIC - WATERTIGHTNESS		
CLASSIFICATION ACCORDING TO EN 12208		
Test pressure (Pa)	CLASSIFICATION	
	Process A NON-SHIELDED	Process B SHIELDED
-	NPD	NPD
0	1A	1B
50	2A	2B
100	3A	3B
150	4A	4B
200	5A	5B
250	6A	6B
300	7A	7B
450	8A	-
600	9A	-
> 600	Exxx	-

Table 3.3. Assessment of characteristic water-tightness

3. Air permeability

The air permeability of the windows gives us information about the flow of air that passes through our window when it is closed, depending on the pressure the air has on the window. Thus a measure of the air sealing is provided, as the relevant test is intended to measure the air losses through the window-masonry under various pressure conditions, which are proportional to the wind speed.

The frame air permeability test measures its:

1. **total surface area**
2. **joints**

A comparison of these two results in the final classification. So, if a window is in the same class in both categories, that is the class that is finally classified.

If the classes in the two classes are adjacent, then the window gets the most favourable for that class. If there is a difference between the two classes, then the frame gets the middle class. The classification is based on the amount of air volume dispersed, or for each linear joint measure or on the entire surface.

AIR PERMEABILITY

AIR PERMEABILITY CHARACTERISTICS OF WINDOW			
CLASSIFICATION ACCORDING TO EN 12207			
Class	Air permeability		maximum test pressure, Pa
	on length of joint, m³/hm	on overall area, m³/hm²	
0	npd		
1	12,5	50	150
2	6,75	27	300
3	2,25	9	600
4	0,75	3	600

Table 3.4. Air permeability

CE marking is a requirement for the legal circulation of products in the Member States of the European Union. The Performance Statement accompanies the products and is given to the customer in paper or electronic form. Alternatively, the manufacturer can post it on his website but ensure that it is maintained for at least 10 years. The Declaration of Performance should be accompanied by information on the content of hazardous substances (if any) in the construction product. The manufacturer may use the results of press tests obtained by a third party (transfer of tests from the system manufacturer to the manufacturer or transfer between licensed manufacturers / contractors).

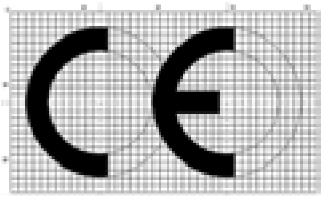


Figure 3.8. CE marking label

Of course, the manufacturer must adhere to complete Technical Documentation (Labelling, Performance Statement, Production Control System). The manufacturer who performed the Tests shall remain responsible for the accuracy, reliability, and consistency of these test results.

The basic requirement of construction for the sustainable use of natural resources should take due account of the recyclability of materials and their parts. The manufacturer should maintain a record (printed or electronic) for at least 10 years of the necessary Technical Documentation (e.g. Testing) and the Performance Declaration for each project he performs.

Products placed on the market must be accompanied by the CE marking as specified by the corresponding harmonized standard for the product (EN 14351-1 for frames, EN 13659 for rollers & shutters, EN 13561 for screens, EN 1279- 5 for glazing, EN 13830 for glazing) and the Performance Declaration.

The CE marking should only be affixed to construction products for which the manufacturer has drawn up a performance statement. **If no performance statement has been drawn up, the CE marking should not be affixed.**

Another key element of Regulation 305/2011 is the preparation by the manufacturer of a technical file for the product, which will include all information to demonstrate compliance of the product with the relevant requirements.

The Technical Document must be kept and kept at the disposal of the Competent State Authorities for inspection (at least ten years after the last date of manufacture of the product) and shall contain the following:

1. Manufacturer's details
2. Technical description of the product
3. Material Specifications / Certificates
4. Manufacturing & testing methodology
5. Relevant standards applicable
6. Instructions for use & maintenance of the product
7. Model of declaration of performance
8. Test reports (either by the manufacturer or by an outside body).

U-Factor measures the rate of heat transfer through a product. Thus, its rating indicates how well the window insulates. This measurement represents both heat loss during cold weather and heat gain during warm weather. U-Factor considers conductance, airflow, and the heat radiation or reflection of the glass. The lower the U-Factor, the better the insulation.

The calculation of the thermal insulation coefficient of Uw, depends on all the products involved in the construction of the window, such as the profile, the glass, the glass spacer and their surfaces or the current meters. **Uf** is the first parameter for calculating Uw, i.e. Uf the coefficient of the aluminium profile. The Uf coefficient determines the resistance of the aluminium cross section in heat transfer through it. It strictly characterizes only the cross section of aluminium and its components (tires, thermal insulation materials such as polyamide, etc.) and does not take into account the glass.

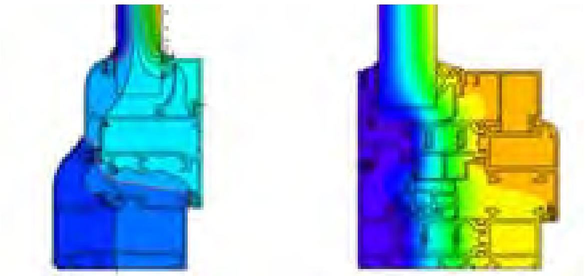


Figure 3.9. Calculations of Uf from a software

Uf is calculated using special programs that simulate the aluminium cross-section with the finite element method, defining each material that makes up that particular cross-section. Thus, all materials entering the aluminium cross-section should be adequately defined by their own thermal insulation characteristics and through the program it is possible to extract and certify the Uf factor. The process of calculating this rate is specific and is described by the European standard EN 10077-2, on the basis of which most of the software on the market operate. Once the Uf factor has been calculated, we are now able to calculate the total Uw thermal insulation coefficient, which is also the institutional requirement of each country.

Again, the method of calculating the **Uw** coefficient is determined by the European standard EN 10077-1, so that the results are always comparable between all the frames that are marketed. It is obvious from the above that in one window there may be many Uf coefficients. This is because depending on the typology of the window, there are different profile combinations. Taking for example the following typology, we find the number of different Uf values entering the construction.

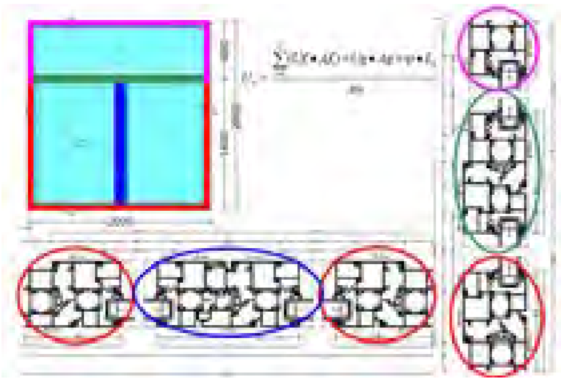


Figure 3.10. Use of Uf to calculate the Uw

With the different colours we symbolize the four different Uf values that exist in the above construction and they must have been calculated so that it is possible to calculate the total Uw factor. These values are different from each other, because as shown in the figure they contain different profiles and different geometries.

The computational method of the Uw factor is based on an algorithm, taking into account:

$$U_w = \frac{\sum_{i=1}^{n} (Uf_i \bullet Af_i) + Ug \bullet Ag + \psi \bullet L_g}{Aw}$$

Ufi : the various Uf coefficients that enter the window (W / m²K)

Afi : the areas of aluminium cross sections corresponding to the various Uf (m²)

Ug : the thermal loss coefficient of the glass (W / m²K)

Ag : the area of the glass (m²)

ψ : the correction factor derived from the spacer (W / mK)

Lg : the total perimeter of the glass (m)

Aw : the total area of the window

The Ug glass heat loss coefficient is provided by the glass supplier and is one of the most important factors influencing the final result of the Uw calculation.

This is obvious due to the large participation of the glass, in terms of surface, on the total surface of the window.

The length Lg is the perimeter of the glass of the construction and is multiplied by the coefficient ψ, which is determined by the construction material of the “spacer” of the double or triple glazing.

The coefficient ψ, is quite a critical size, which can increase the overall thermal insulation of the window from 5% to 10% if a thermally insulated advanced “spacer” of glazing is used.

This "spacer" is always the weak point of the glazing and through it most of the heat loss of the glass occurs.

Figure 3.11. Spacer

Technology has evolved in this area and is no longer recommended to use metal "spacers" but advanced thermal spacers glazing, that minimizes heat transfer through glazing.

The Uw window factor should comply with the maximum requirements applicable in each region and country. Regarding the frames, there is a specific table with the maximum allowed values of thermal insulation of windows (Uw) which in no case should exceed each window installed in the project. For example, in the following picture the four climatic zones of Greece and the corresponding maximum allowable thermal insulation values of the frames for each of these climatic zones, are depicted.

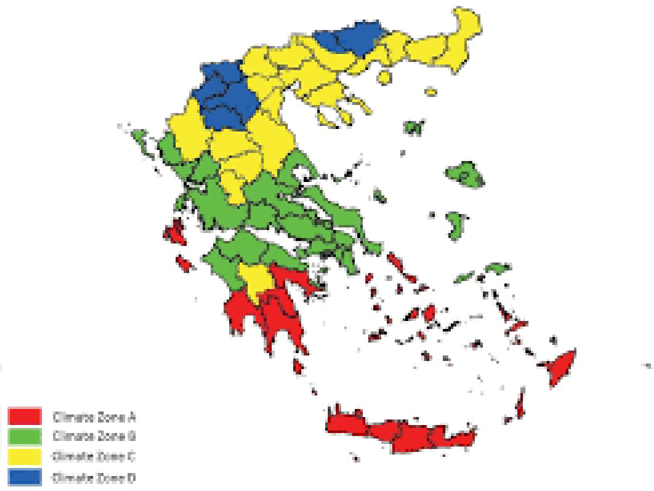


Figure 3.12. Climatic zones of Greece

The Energy Performance of Buildings Directive requires all new buildings to be nearly zero-energy by the end of 2020. All new public buildings must be nearly zero-energy by 2018. The term **Nearly Zero-Energy Building** (commonly abbreviated as **NZEB**) was introduced and defined as a "building that has a very high energy performance... the nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby" (Art. 2). The Directive states that, from January 2019 for public buildings and January 2021 for others, all new-build construction should reach the target NZEB as defined at the national level. Article 9 of the EPBD goes on to require Member States to not only set a national standard for NZEB but also to actively promote a higher market uptake of such buildings.

Figure 3.13. **Passive house principles**

The debate around the definition of NZEB crosses EU boundaries and involves the international technical and scientific community. Several EU and non-EU governments have established ambitious policies and targets for zero-energy buildings (ZEBs) to become standard or commonplace.

A range of terms are used to describe these very low energy buildings, including: zero energy building, nearly zero energy building, net zero energy, zero carbon, zero energy, zero net carbon, and zero net energy.

Despite the slight difference in names, these buildings are all aiming for zero-energy consumption or emissions. In addition, whatever energy is consumed within the building will be offset by renewable sources, usually on-site.

The passive building is a building in which the internal thermal comfort (ISO 7730) is provided exclusively by preheating or pre-freezing the amount of fresh air required (DIN 1946) for the correct indoor atmosphere, without the use of additional air recirculation. The buildings are passively heated, ie they make efficient use of the sun, internal heat sources and heat recovery, with the result that conventional heating systems are not necessarily even on the coldest days of winter.

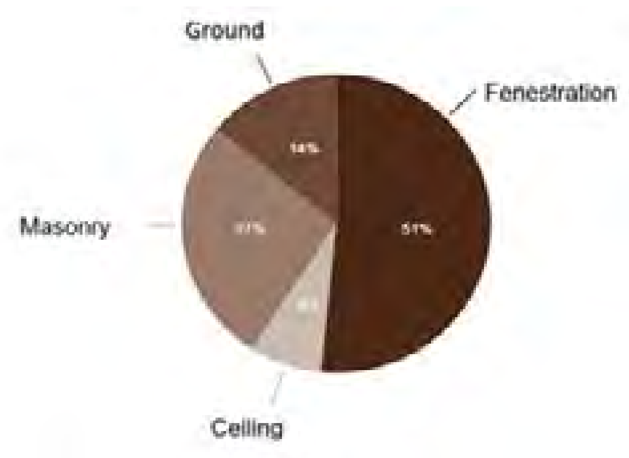


Figure 3.14. Energy losses from the building enclosure (source: passive premium files in Brussels)

In the passive domain, windows are the breaches of a fortified enclosure. For the average passive housing, half of the thermal losses of the envelope takes place through exterior joinery! Indeed, these are 5 to 8 times less insulating than the opaque walls. In order to satisfy the first criterion of the passive standard (maximum 15 kWh / m^2. year of net energy needs for heating), the windows of a passive construction must balance their contributions and losses by playing on:

- The various qualities of the glazing
- The qualities various chassis
- The size and orientation of the fenestrations

Recommended value for **airtightness** of the chassis: class 4, but this does not guarantee success. The overall air tightness of the building is checked during the "blower door" test, the result of which must be <0.6 h-1 (volume per hour at a pressure difference of 50 pascals. The placement of the window is very important for the final performance of the building. After installation, on-site inspection for air leaks between the frame and the wall with a special device.

Figure 3.15. Testing the airtightness of a building (Photo © PHI)

Climate zones and the corresponding maximum allowable thermal insulation values of the frames for each of these.

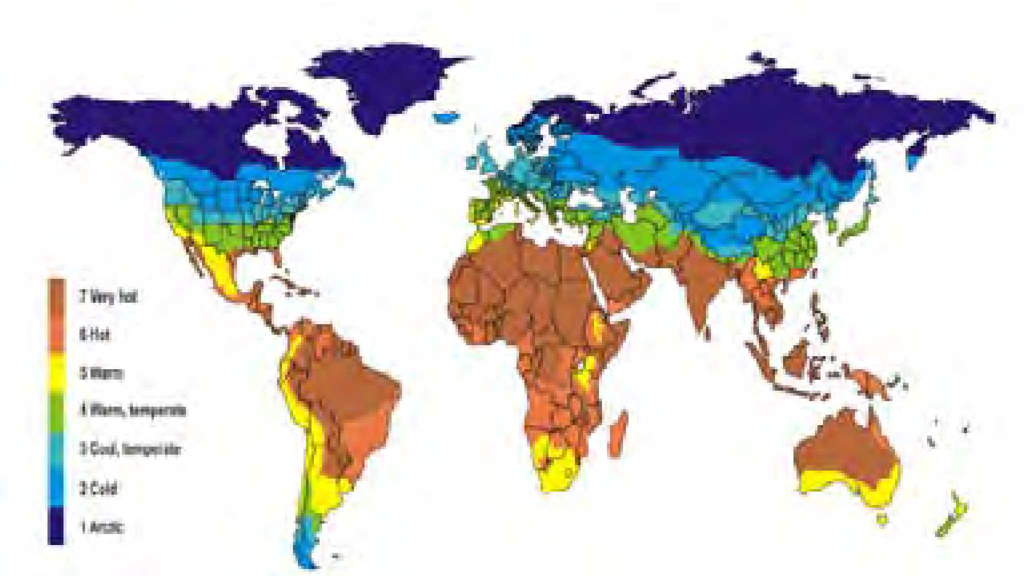


Figure 3.16. Climate zone Passive House

Climate zone	Hygiene criterion $f_{Rsi=0.25\,m^2K/W} \geq$	Orientation	Component U-value [W/(m²K)]	U-value installed [W/(m²K)]	Reference glazing[1] [W/(m²K)]
1 Arctic	0.80	**Vertical**	**0.40**	**0.45**	**0.35**
		Inclined (45°)	0.50	0.50	Actual U-value[2]
		Horizontal	0.60	0.60	
2 Cold	0.75	**Vertical**	**0.60**	**0.65**	**0.52**
		Inclined (45°)	0.70	0.70	Actual U-value
		Horizontal	0.80	0.80	
3 Cool-temperate	0.70	**Vertical**	**0.80**	**0.85**	**0.70**
		Inclined (45°)	1.00	1.00	Actual U-value
		Horizontal	1.10	1.10	
4 Warm-temperate	0.65	**Vertical**	**1.00**	**1.05**	**0.90**
		Inclined (45°)	1.10	1.10	Actual U-value
		Horizontal	1.20	1.20	
5 Warm	0.55	**Vertical**	**1.20**	**1.25**	**1.10**
		Inclined (45°)	1.30	1.30	Actual U-value
		Horizontal	1.40	1.40	
6 Hot	none	**Vertical**	**1.20**	**1.25**	**1.10**
		Inclined (45°)	1.30	1.30	Actual U-value
		Horizontal	1.40	1.40	
7 Very hot	none	**Vertical**	**1.00**	**1.05**	**0.90**
		Inclined (45°)	1.10	1.10	Actual U-value
		Horizontal	1.20	1.20	

Figure 3.17. Climate zone Passive House

The space that will be selected, as an exhibition - **product demonstration**, should cover the needs of the owner in terms of size and location, in relation to the goal that interests him. The **attractive showcase** is an important tool for promoting products. It Communicates corporate and product messages related to specific products and services. Specifically a showcase:

- must be attractive
- present innovative products in an elegant way
- have Thematic stickers
- must be renewed at regular intervals
- include messages of service and quality of products and services
- must be properly designed, and the products properly classified to facilitate the stay and the correct information of the customer
- should inform the customer about the philosophy and the range of products of the exhibition, while at the same time he/she senses (sees, touches and feels) the quality
- include simple tools with which the customer will understand the technical advantages

In the showroom, it would be ideal to have the chocolate and dry ice machine. Thermal break is just as necessary in the cold and heat. Give your customers a tangible example of thermal break and convince them with the following images:

Figure 3.18. Thermal break

Alternatively, the corresponding photos can be used in colour printing.

Necessary components of an showroom of aluminium products are a number of different typologies of samples. The exhibits will be complete frames, placed in sections that would represent masonry, as if they were in the building, so that they are understandable to the end user. Must not forget that a lawyer, plumber, greengrocer, housewife, etc. do not have technical knowledge, and with an image he must understand the final product he will receive.

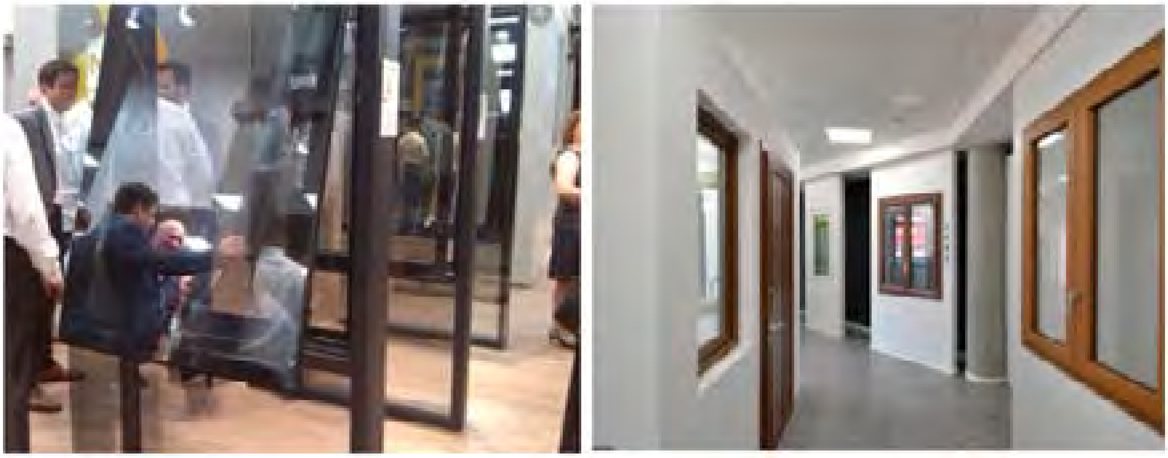


Figure 3.19. Fenestrations in showroom

In the samples, a form with the specifications of the window should be placed. This form should include a 3d drawing and technical information about the specific system with which the window has been made, and the relevant certificates from the tests.

In order, for the whole sale package, to be understandable to the customer, there should be a stand with the accessories available on the board, especially the handles, the colours, etc.

Figure 3.20. Photo in showroom

It is good for the best explanation of the technical characteristics to have small cross-sectional angles 300 x 400 so that it is more understandable to the customer the system he will choose.

Figure 3.21. Section in showroom

The external appearance of the sellers must be careful and inspire the prospective customers with confidence and trust in the face of the seller and the company. They should wear clean and well-groomed clothes, clean shoes, and have fresh breath. Sellers must always be polite, patient and listen carefully to the needs of consumers.

Note in special forms the details, the needs-peculiarities of the construction of the customer and the systems that were proposed to him. In case they end up with an order, then it is deemed necessary to complete the order form (a copy of which the customer also receives). If a prospective customer enters the business and all the sellers are busy, then they should greet the customer politely, approach him and inform him that they are serving another customer, while emphasizing that he will be served immediately by the first seller when he can.

Sellers should be aware of the products and colours that are being promoted the most, based on a specific commercial policy, to give priority to the areas of action of the Marketing plan. They promote products according to the customer's needs. When a product is advertised, they should know it and report it to the customer, because it makes it easier for them to sell, because the advertised products and services also have the advantage of recognizability and public display, so it is easier to sell.

The product we manufacture to sell must be tailored to the needs of our customer. It's not a ready-made product on the shelf, just take it and give it to the customer, but we need to understand what the customer wants and build it just for him. Therefore, in order to communicate with the customer, how easy it must be: Have basic technical knowledge for the promotion of goods, sales knowledge. That is, with a different combination of the same codes we can have a different final product

We have many potential recipes with the same raw material and auxiliary material.

We are actually selling x codes that can be converted to multiple final product.

If we take into account that a window consists of 35-45 codes and an architectural system has 40-50 different profiles and 30-100 different components and we have for sale 5-10 different systems and the colours that are circulated are 60-100 different, in as a whole it is practically like we have to decide on 1000-2000 different end products.

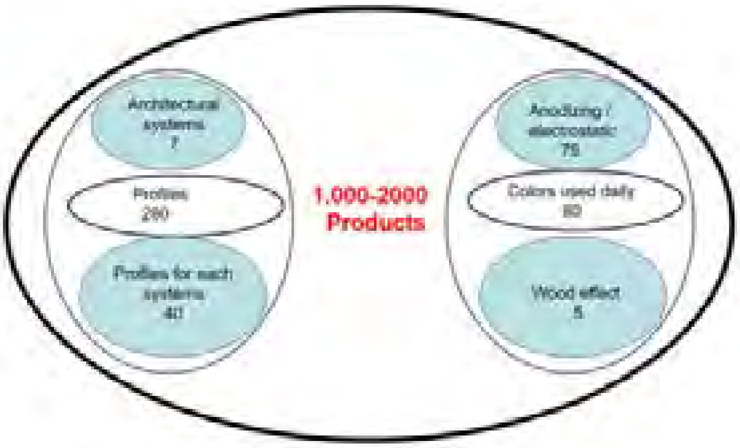


Figure 3.22. Number of final products (recipes) that the manufacturer can create from raw materials. (profiles and accessories)

Most of the time we must act as customer advisors, explaining which product is the right one for the use they want so that we can choose the codes that make it up and make the final proposal-offer. The secret to success as a salesperson is to understand that he are not selling a product but a "recipe". Because for each customer must first make the recipe (profile, accessories) after the form (typology) to offer it to the customer (window) as ready-made food.

Do we need to keep in mind when negotiating with the customer to increase sales as much as possible in two ways? Cross-sell means that together with a product e.g. aluminium window one can buy a complementary product e.g. roll or mosquito net. Up-sell we have when together with a product e.g. aluminium window someone buys something even more expensive, e.g. aluminium window with electric mechanism. In a customer-centric culture, selling is like a consulting business and the sales consultant is a small entrepreneur. Do not sell fenestration, but the "solution" to the customer's problem.

Smart and effective marketing of each construction company profile and aluminium applications helps in:

- building the image of the company and increasing its recognition in the area where it operates,
- increasing the number of visitors to the company's exhibition spaces,
- expanding the customer base in professional sales.

Figure 3.23. Think local

The performance of added value is a mixture of products, services and know-how. Therefore, it:

- helps to increase the company's turnover,
- helps increase market share by drawing customers from the competition.
- utilizes production capabilities as it enhances the flow of orders from a larger clientele,
- keeps the name of the company and the products in a high position in the minds of the customers,
- strengthens the resistance to a possible price war,
- highlights the company's comparative advantages, one of the most important is the know-how & security of the systems.

Investing in building corporate identity & image requires a long-term targeting horizon because it is an effort that is amortized over time both by expanding our customer base & traffic to our exhibitions and by creating added value to our quality products.

The annual communication & promotion budget ranges from 2.5% to 7% of its turnover.

The personnel shall highlight the stigma that differentiates our company from the competition by highlighting our comparative advantages. Use symbolism, humour, human emotions that connect the principles of the company, high quality, know-how & experience with the most intense needs of our customers (e.g. security, warmth, family warmth).

An important role is played by the corporate central message and the logo, which must be highly aesthetic & immediately recognizable and its applications.

The vehicles to communicate the stigma of our corporate identity are:

a. registrations in Local Press,

b. registrations in the Branch Press,

c. outdoor advertising such as pizza, billboards, landmarks,

d. spot program on selected radio stations,

e. sponsorships to active associations & institutions of the local community and

f. events for the safety & protection of homes.

The common mistake many showrooms make is to display a photo of the space stating the address and & we wiped & finished. But that doesn't say much more than what it shows.

The set of actions for the promotion of the exhibition must have a common component that will consist of:

a. total integrated solutions for customers,

b. smart value-for-money options for all spaces and

c. the Retail Experience that characterizes us.

The main tools for promoting the company and the product / service mix in the professional sales channel are:

- Creating a folder with high aesthetics printed material by product category, service mix & corporate profile
- Sending printed material to specific target markets
- Website Utilization on the Internet
- Invitation to associates in corporate events.
- Cost allocation,
  - Media actions 50% - 60%.
  - Printed material, exhibition space material, production & distribution costs, participation in a branch exhibition 25% - 30%.
  - Public relations events, sponsorships, gifts, etc. 15%.

  to achieve the maximum possible coverage provided by mass communication & the optimal utilization / activation of the clientele.

When planning a comprehensive local marketing campaign, we should consider the following:

a. seasonality for every activity and for every medium,
b. coherence of all actions so that all actions are strategically complementary and add value to each other,
c. competition & movements,
d. quantitative & qualitative data of each selected media such as the releases, the audiences, the qualitative characteristics of the public of each media, the geographical coverage, the cost-benefit ratio,
e. specifications of the printed material and the purpose of each form,
f. positions of the outdoor media and their costs,
g. purpose of each event / participation in an exhibition and the optimal attraction of the appropriate audiences,
h. updating of the shop windows,
i. clear recording of messages & symbolism and the direction of the spots and
j. observance of the clientele and its optimal utilization.

3.1.2. Accounting and cost estimation software

Key Words

Accounting: involves the basic principles, concepts and accounting practice, recording, financial statement preparation, and the use of accounting information in management

Software: a collection of functions and instructions that enable the user to interact with a computer, its hardware, or perform tasks

Resources: a stock or supply of money, materials, staff, and other assets that can be drawn on by a person or organization in order to function effectively

Cost: the disposal or investment of purchasing power for the acquisition of material or intangible goods for the purpose of using them to make sales revenue or to cover social goods

Output: spent within a management period to generate revenue

Expenditure: act or follow the necessary procedures for implementing an investment in material goods and services, such as e.g.

ABC (Activity Based Costing): costing method that identifies activities in an organization and assigns the cost of each activity to all products and services according to the actual consumption by each

Cost objects: any item for which costs are being separately measured

Cost drivers: the unit of an activity that causes the change in activity's cost. cost driver is any factor which causes a change in the cost of an activity

Activities: all actions that, through the consumption of resources, seek a specific result

Resource drivers: links between activities and indirect resources

Resource activities: links between activity costs and cost objects

Accounting is now one of the most important disciplines in the world. This is an area in which businesses and organizations seek to achieve their strategic goal. Accounting is divided into Financial and Administrative. In general, the separation of these two subcategories is easily discernible. Financial Accounting provides valuable information and data to entities other than the financial entity: owners, shareholders, creditors, lenders, tax authorities, monetary authorities, etc. In general, it offers a past picture of the business that aims to highlight its performance. Its main occupation is the preparation of reports that are developed and drafted in accordance with the Generally Accepted Accounting Authorities. These assure external users that any accounting information captures the true picture of the events to which they refer and achieve the comparability of time-lapse training.

Administrative accounting does not have to follow the Generally Accepted Accounting. Financial entities that choose to use Administrative Accounting should consider whether the expected benefits they may have will offset the cost of data collection, analysis and citation. Administrative accounting provides information useful for the operation of the entity and enhances the targeted decision-making of administrative matters by persons within the organization.

Citing data and compiling reports that aim to design future-oriented design, control and evaluate performance. One shall not need an accounting background to keep in-house books.

On the contrary, today's construction contractor is operating in a complex industry, and a good set of record sis as necessary as any modern piece of equipment. The sales data is a detailed record of all your income from operations. These details are essential for financial statements.

It also provides a good way for you to see how you're doing compared to last year, last month, or last week.

The comparison of income to past performance is very important for planning. No matter what direction a business takes, one should have an estimation of the expected cash flow — how much cash will be coming in, and when.

One cannot make detailed plan without the knowledge of the future income potential. Keeping track of sales gives the information you need. The method of keeping track of the received incomes is important to the accuracy of your billings, your collections, bad debts, and financial statements. One needs to account for these withheld amounts separately from your normal trade receivables.

Finding a good method isn't always easy. Not only will you waste a lot of time writing down the same information two or even three times, but you soon lose touch with the real purpose for the work.

When you send a bill for work after the job is done (instead of receiving cash immediately) it's inevitable that you'll never collect some of your receivables (on credit). Understanding the direction your bad debts are going gives you two advantages: you can budget for them and take the steps necessary to tighten up on collection procedures. This could reduce your bad debt losses. When you check historical information on receivables and bad debts, you may discover a trend. (Reference: www.Craftsman-Book.com)

Most businesses today, even the smallest ones, use a computer, but many of them use it only for word processing.

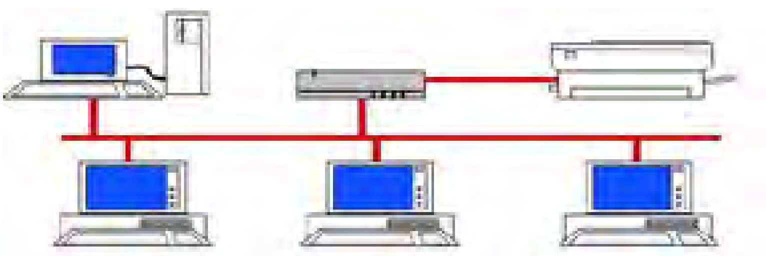


Figure 3.24.   Network

There’s comprehensive, affordable **accounting software** available for any size business. And these are easy to learn and easy to use. Having your entire accounting system on a computer makes sense from every angle—they simplify your record keeping and save you time you can better spend out on the job site.

It’s no longer so much a decision about whether or not to automate, but rather a decision about which system you’ll use. To keep up with current record-keeping requirements and considering the variety of functions you need to perform, computerization is something you will eventually end up doing. But if you pick a system that does not do the job need, you’ll just end up fighting it and manually filling in for its short comings. You need a system that integrates accounting with job cost analysis tracks costs and reports by the job and lets you upgrade as your business grows.

The formulation of the appropriate **techno-economic proposal** to the client is a very important event and the manufacturer should pay particular attention to it because it will support the subsequent course of each project. Once the manufacturer has settled on the optimal technical solution depending on the building and the energy-saving levels that need to be achieved, he must make a clear quotation indicating both the technical and the financial terms. Based on the technical characteristics of the project, the manufacturer should select the appropriate materials and properly cost the project. Should then invoice the project taking into account factors that affect pricing. The result of the above actions will be the issuance of a techno-economic offer detailing the technical characteristics of the products and the amount of money the customer will be required to pay.

The final offer will be all their materials costs, labour, operating and overheads and profit.

The operating costs of a manufacturing workshop contribute a significant proportion to the cost of construction and therefore should not be overlooked.

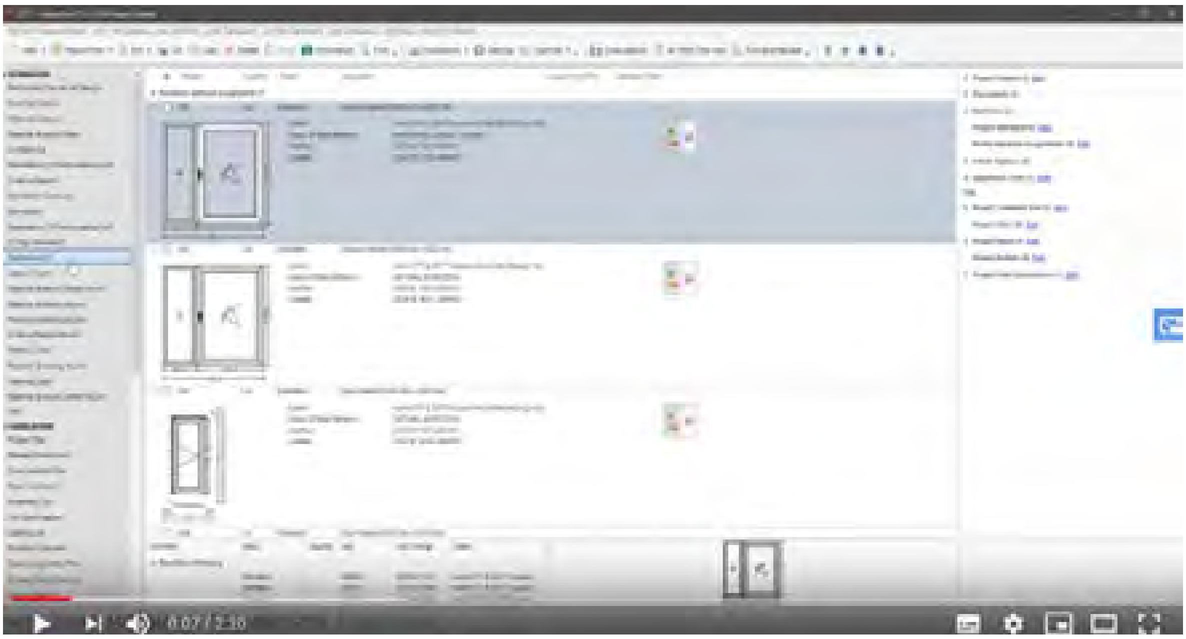


Figure 3.25. Snapshot of a software for fenestrations costing

Operating expenses depend on the type and degree of organization of the constructor, the place of installation and operation, etc. The costs to be calculated on operating expenses are:

- renting a building, or depreciating a building,
- depreciation of machinery,
- depreciation of means of transport,
- means of transport (fuel, repairs, insurance etc.),
- repairs, machinery maintenance,
- electricity, water, telephone, internet etc.,
- consumables (drills, saw trays, electrodes etc.),
- promotion & advertising actions and
- other

The customer should receive a detailed analysis of the offer and the method of payment, with all the certificates laid down by European legislation.

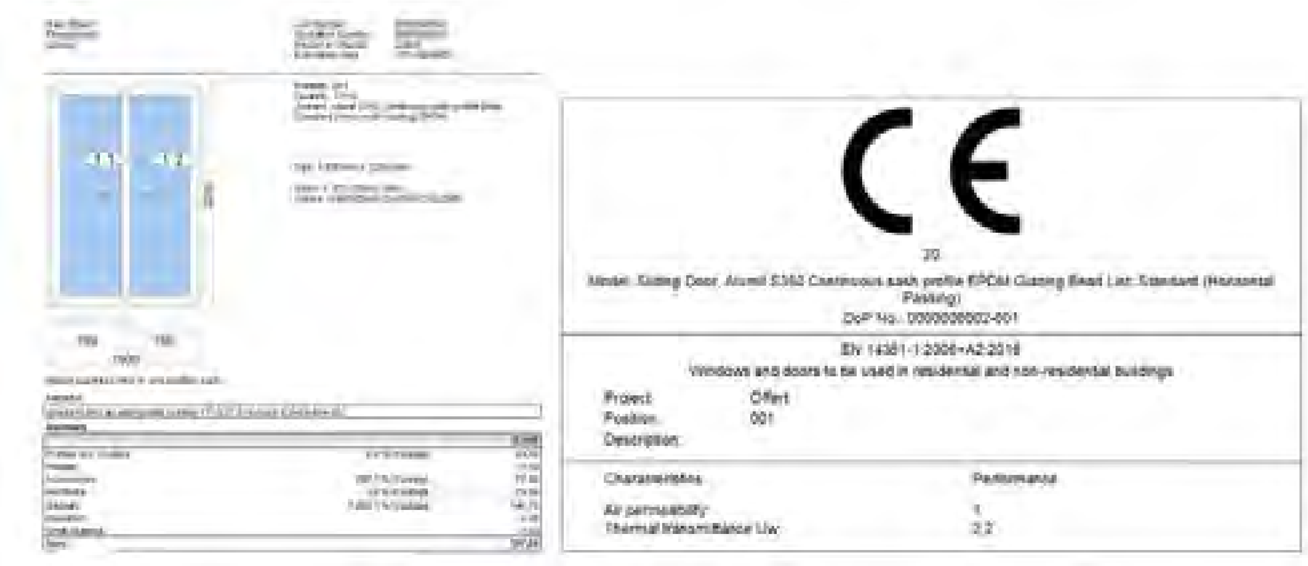


Figure 3.26. Example of an offer and pertinent certificates

In addition to calculating raw materials, profiles, fittings and consumables, need to first calculate **the cost of production and distribution** of the product in order to calculate the selling price. Because in today's business world, which is characterized by intense competition, the need to make strategic decisions is imperative.

We need to have the appropriate knowledge, skills and experience in the field of costing to use the valuable literature and choose the appropriate method of determining the cost of goods sold or services provided by the entity.

We must also take decisive action for the longevity of the business, maintaining and maximizing its profitability level. In addition, the results determined through the costing process provide the upper echelons with reliable and accurate financial results for the smooth running of any entity.

However, the methods that a company will use and how they contribute to determining the cost of a business are of particular importance. The costing methods that a business can use are either traditional or modern.

Traditional costing methods consist of:

1. complete-absorbing costing and
2. partial-marginal costing.

Modern methods consist of:

1. ABC (Activity Based Costing), is a costing method that identifies activities in an organization and assigns the cost of each activity to all products and services according to the actual consumption by each. The main questions that arise are:
    - What are the costing methods used by modern financial entities?
    - What methods are used in the costing process of service providers?
    - What costing process do service companies adopt?
    - What are the essential differences between traditional and modern costing methods?
    - What are the most important points where traditional costing methods differ?
    - Which cost method is considered the most appropriate and should its use be adopted by financial entities?

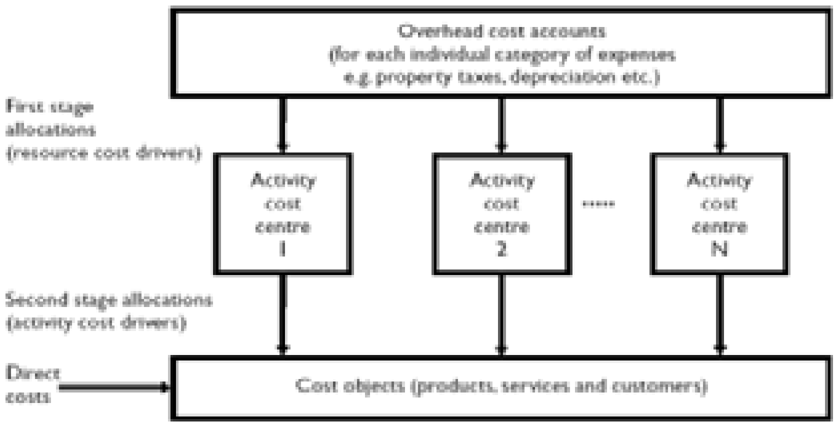


Figure 3.27. Costing stages ABC (Drury 2000 pag. 33)

2. Business accounting or simply costing, as it is also called, has as main mission to:
    a. determine the cost of projects (products - services) and exploitation,
    b. control the economy,
    c. determine in short-term the result of the operation and
    e. verify the gross profit margin on the basis of the partial... ..exploitation. (Anastasios P. Kouleris, 2011, Business Costing)

3. Additional costing is the process followed in a business to determine the cost of a good, service, activity or operation and is achieved through the systematic collection, classification, recording and sharing of costs. Cost calculation is one of the most important internal procedures as it is considered a prerequisite for the structure of financial statements.

Before we explicitly develop costing methods, it is important to describe the basic concepts, such as cost, output and expense. (Reference: Karagiorgos and Petridis (2017) claim that "According to the E.G.L.S.).

Cost is the disposal or investment of purchasing power for the acquisition of material or intangible goods for the purpose of using them to make sales revenue or to cover social goods. Furthermore, any consumption of goods and services dictated by the production and disposal of a project, product and in general supply of labour as well as the maintenance of the productive readiness of the holding shall be considered as costs. (Anastasios P. Kouleris 2011, Business Costing)

Output means that it is spent within a management period to generate revenue. The output is an independent size that is related to the revenue to determine the result. (Reference: Georgios Konomos and Ioannis Patestis, 2018, Control and Costing). The Output, is the accrued cost, ie the cost that has already been incurred and will be borne by the result of the work of the financial unit. Essentially the Output comes from the cost and has been created by it. Output related to the products or services sold within a year are classified as "cost of goods sold".

The difference between **turnover** and the cost of sales of a business in one use, gives us its **gross profit** for that particular use. To calculate the **net profit** of the company for the fiscal year, we deduct the costs of administration, marketing, research and development and financing from the gross profit of the business.

The differences between the output and the cost are:

- Output is a cost that expires and is deducted from the income of the fiscal year.
- The output has come from the cost and has pre-existing as a cost, without the reverse.
- This behaviour is not always detected.
- Noting that some expenses such as those of sales are not found to have been incurred as costs because they do not burden inventory reserves.
- During the sale of a good, the cost will expire and be converted into an expense, which will be charged to the revenue that will flow in at that time.
- The following is the definition of expenditure and its main differences in cost.
- The term expenditure is called "the process or action of carrying out the cost or expense.

Expenditure includes the necessary procedures for implementing an investment in material goods and services, such as e.g.

In order to fully understand the difference between the three terms cost, output and expense, we analyse the process of buying and selling goods within an entity.

In order to carry out the **costing process**, the cost data is initially determined. The cost of a product consists of direct materials, direct labour and general industrial costs. The direct materials found in a company are the raw materials, the semi-finished materials, as well as all these materials that are integrated in the produced product and constitute the immediate cost of the company.

With the purchase of **raw materials**, the production costs are not directly burdened, but they are transported to the storage areas and increase the previous stock of raw materials. When raw materials are used in the production process then they burden the cost of production. Essentially, the raw materials are consumed and removed from the stocks.

Another element of cost is **direct labour**, which includes the wages of workers engaged in the processing of materials.

Finally, the third element of cost is the general industrial products that are the **indirect costs** for a company. Indirect costs are the electricity produced, third party fees, etc. Indirect labour related to the production of the product may also be included in the general industrial costs.

The sum of all the above cost data, as can be seen in the figure below, is called **production costs**. Whereas, the sum of direct materials and direct labour is called the **initial cost** and the sum of direct labour and general industrial products is called the **cost of conversion**.

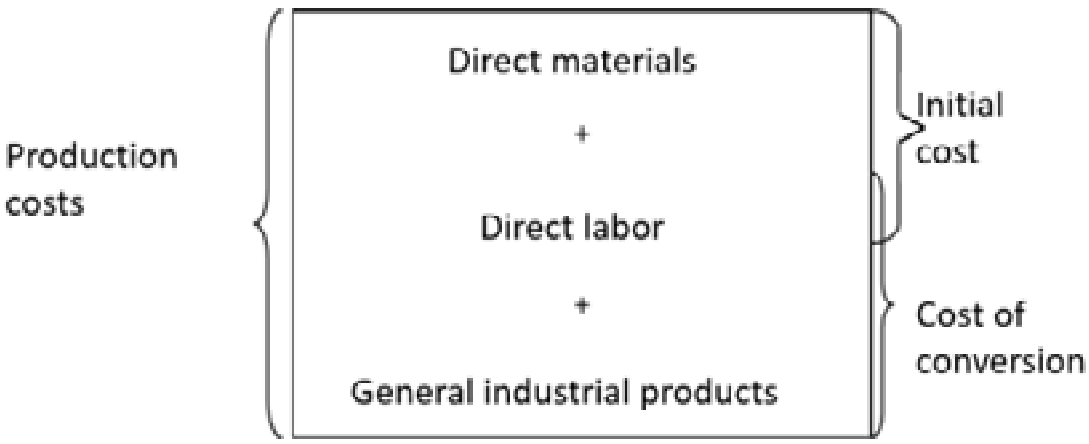


Figure 3.28. Parameters of the production cost

In addition to production, which creates the direct costs of raw materials and direct labour, there are other categories of operating costs, which create costs for the business, which are generally called **operating costs** and are shown in the results statement.

These functions are management, disposal, research and development and financing costs. The costs of such operations are not included in the cost incurred in acquiring or producing a product, in the cost of the product, but appear as an expense in the results of the period in which they are created.

Costs created and not included in production costs are called **period costs**. The period costs that a company may incur are classified according to the function to which they belong,

1. Management Expenses are expenses incurred by the company with the ultimate goal of being organized and managed. These costs include the salaries of executives, accounting executives, senior executives and expenses directly related to the cost of running the business (e.g. rent, electricity, heating, etc.).
2. Another function is that of Disposal, which includes all the expenses that the company has to promote and advertise its products. Also, the costs of sales staff (car and petrol supply, catering, hotels), the cost of promotion and advertising, the cost of providing free samples of the product, the cost of storing, managing and shipping products are some examples of the costs of the category of it.
3. Research and Development Expenses include the costs with which the business is burdened to develop new, innovative products and production processes. Some examples that represent the function are the cost of laboratories, the salaries of researchers, the cost of production and testing of products, the cost of studying and designing new products.
4. Finally, the operation of the Financing incurs those expenses of the company for the financing of its investments such as, for example, the interest on the loans, the supplies and the expenses of the banks, etc.

The following diagram shows the composition of the product cost based on complete and direct costing. Thus, we can distinguish the essential difference between these two methods.

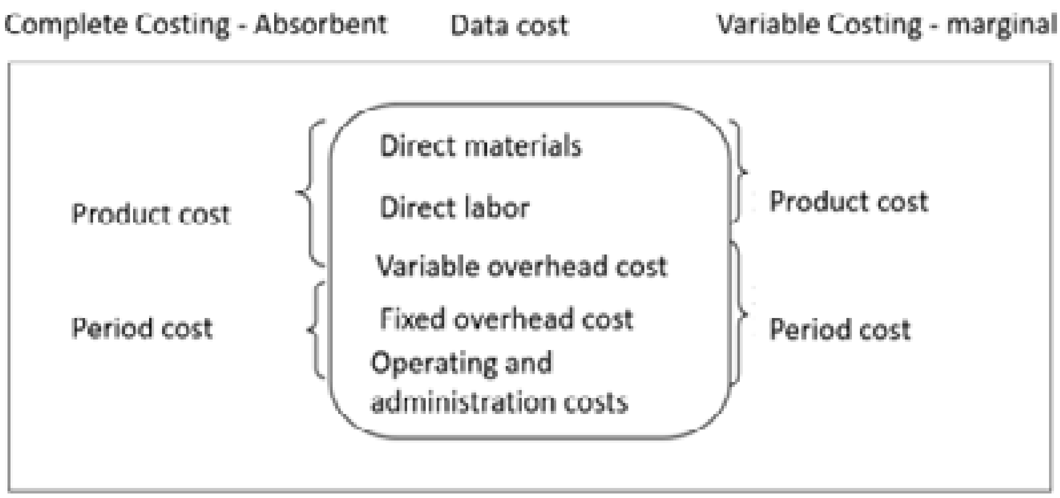


Figure 3.29. Differences between complete & variable cost

To determine the cost based on the prevailing methods, we define the areas that accumulate during the operation of the business the amount of exit as **cost centres.** Cost centres or (Positioning) Costs are defined as "the smallest unit of activity or area of responsibility for which an accounting cost is accrued in order to measure its effectiveness.

Cost centres are divided into main and auxiliary. The **main cost centrers** are the costs that come from the main activities, i.e. the production of intermediate or final products. While in the **auxiliary cost centres** are attributed those that come from the auxiliary activities of the organization, which aim at serving the main activities.

As already mentioned, there are the following three costing methods:

1. **Complete Costing - Absorbent,**
1. **Variable Costing - marginal and**
1. **ABC costing.**

The first two methods are the traditional costing methods. while ABC Costing is a modern costing method that aims to allocate costs based on the critical activities of an organization. Companies that are asked to decide which of the above costing methods to use, choose to serve their specialized needs. For this reason, we can observe companies operating in the same sector following different costing methods.

Full costing is the costing method according to which the total cost of the production process is borne by the cost of production of the products. To calculate the full cost of the product, all the cost elements required to produce a product unit are taken into account, ie the direct materials, direct labour and general industrial costs, whether they are fixed or variable. The costing method used to determine the full cost is called full or absorbent costing.

The calculation of the unit direct and indirect costs is considered a prerequisite for the preparation of the financial statements. To find the unit cost for each of the above items, the total amount of each must be divided by the total number of units of the product. Thus, we will determine the unit cost of direct labour of direct materials and indirect costs, where the sum of these will give us the unit total cost of the product according to Full Costing. At the same time, the costs of management and sales are not included in the cost of the product but are treated as period costs and deducted from the revenue as they enter the business.

Example of complete costs

During the year, the production of the aluminium window manufacturing company, with 5 people (including Owner) amounted to 1.014 units and sales to 930 units. Applying the complete costing system to calculate the unit cost of the product and compile the status of results for the year we are going through. The following are tables with the data needed:

Data Company 5 people (including the Owner)	
Resources	Total
Materials of Fenestrations	300147
Direct labor	100000
Fixed general industrial costs	40000
Variable general industrial costs	10000
Fixed Operating Expenses.	30000
Variable Operating Expenses.	15000
Total	495147
Fenestrations production (cost objects)	1014
Sold pieces	930

The company produces 4 different types of frames, i.e. 4 types of products:

Cost Object			
Typology	Production Pieces	Solded pieces	Selling price
Sliding	450	410	540
Casement	317	300	580
Minimal	133	115	790
Main Entrance	114	105	670

In full costing, in order to determine the total cost of the product per unit it is necessary to calculate the unit cost of direct and indirect costs. In the complete costing must share all costs except operating, equally on all products. So it is:

Complete (absorbent) costing					
Resources	Sliding	Casement	Minimal	Main Entrance	Total
Production pieces	450	317	133	114	1014
Solded pieces	410	300	115	105	930
Selling price	540	580	790	670	
Materials	283	245	450	308	
Direct labor /pieces	99	99	99	99	
Fixed General Industrial Expenditure /pieces	39	39	39	39	
Variable general industrial costs/pieces	10	10	10	10	
Incomes from sales	221400	174000	90850	70350	556600
Materials	127500	77697	59850	35100	300147
Total Direct labor	44379	31262	13116	11243	100000
Total Fixed General Industrial Expenditure	17751	12505	5247	4497	40000
Total Variable general industrial	4438	3126	1312	1124	10000
Total Fixed & Direct cost	194068	124590	79525	51964	450147

The operating cost must share, based on a factor, usually the labour, on all products. The operating cost = 45.000 / 100.000 labour = 45%.

Complete (absorbent) costing of products A,B,C,D	Cost	Percentage
Fixed Operating Expenses.	30000	67%
Variable Operating Expenses.	15000	33%
Total Operating cost	45000	100%
Cost of Direct labor as driver	100000	
Total Variable cost/Cost of Direct labor= Index	45,0%	

Multiplying this factor by the work of each product we get the result.

Complete (absorbent) costing					
Resources	Sliding	Casement	Minimal	Main Entrance	Total
Production pieces	450	317	133	114	1014
Solded pieces	410	300	115	105	930
Selling price	540	580	790	670	
Total fixed & direct cost	194068	124590	79525	51964	450147
Incomes from sales	221400	174000	90850	70350	556600
Contribution margin (Incomes-cost)	27332	49410	11325	18386	106453
Operating cost (Intex % * Labor)	19970	14068	5902	5059	45000
Profit before tax (Contribution margin- Oper. cost)	7362	35341	5423	13327	61453
Gross profit/piece	16	111	41	117	
Gross profit margin	3,0%	19,2%	5,2%	17,4%	

Marginal Costing or Variable Costing or Direct Costing or Approach to Contribution, is the costing method according to which only the part of the production costs that is directly related to the production process is taken into account for the calculation of the production costs of the products. Thus the cost of a product, operation, department, or service is formed only by the cost elements that directly burden it and are, as a rule, variable. Such are the direct materials, the direct labour and the variable part of the general industrial expenses.

Essentially, the difference we find in relation to full costing is that the fixed cost of production does not burden the products produced, because it is considered to be related to the time period in which it is created and is not influenced by either production volume or mixture of products produced. Consequently, fixed production costs should be deducted from the gross operating profits of the period when determining the result in the preparation of financial statements.

Example of variable cost

Labour and direct costs are shared equally among all products, while fixed costs are shared with the labour driver:

Variable (limit) costing					
Resources	Sliding	Casement	Minimal	Main Entrance	Total
Production pieces	450	317	133	114	1014
Solded pieces	410	300	115	105	930
Selling price	540	580	790	670	
Materials /pieces	283	245	450	308	
Direct labor /pieces	99	99	99	99	
Variable Operating Expenses/pieces	15	15	15	15	
Variable general industrial costs/pieces	10	10	10	10	
Incomes from sales	221400	174000	90850	70350	556600
Materials	127500	77697	59850	35100	300147
Total Direct labor	44379	31262	13116	11243	100000
Total Variable Operating Expenses	6657	4689	1967	1686	15000
Total Variable general industrial	4438	3126	1312	1124	10000
Total Direct cost	182973	116775	76245	49153	425147

Variable (limit) costing of products A,B,C,D	Cost	Percentage
Fixed Operating Expenses.	30000	43%
Fixed General Industrial Expenditure	40000	57%
Total Operating cost	70000	100%
Cost of Direct labor as driver	100000	
Total Variable cost/Cost of Direct labor	70,0%	

Variable (limit) costing					
Resources	Sliding	Casement	Minimal	Main Entrance	Total
Production pieces	450	317	133	114	1014
Solded pieces	410	300	115	105	930
Selling price	540	580	790	670	
Total direct cost	182973	116775	76245	49153	425147
Incomes from sales	221400	174000	90850	70350	556600
Contribution margin	38427	57225	14605	21197	131453
Fixed cost (Operating & industrial)	19970	14068	5902	5059	45000
Profit before tax	18456	43157	8702	16138	86453
Gross profit/piece	41	136	65	142	
Gross profit margin	7,6%	23,5%	8,3%	21,1%	

When compiling the status of results of use based on marginal costing, the concept of contribution margin is developed. The contribution margin is the difference between total sales and total variable costs, i.e. sales and management costs.

The contribution margin is also called the participation margin or contribution margin. The difference between the two methods is the different treatment of indirect industrial costs, which is the reason for creating the term contribution margin.

Also, solving the same example with traditional costing methods, we find that separating constants from variable costs in the marginal costing method is the reason why pre-tax profits differ. The main difference between the two different methods is in the different handling of GBE. That is, with marginal costing, fixed General Industrial Expenses are not included in the production costs of the products, but are considered part of the period costs.

Thus, at the end of the fiscal year, we observe that the stocks of ready-made and semi-finished products that appear in the warehouse do not include the fixed General Industrial Expenses.

On the contrary, absorbent costing means that the cost of stocks includes fixed General Industrial Expenses.

Some basic concepts for better understanding of ABC Costing are:

- Resource is anything (from raw materials, buildings and machinery, to money and human resources) that the company has in its possession to operate and serve the purpose of its existence.
- The cost objects, according to the A.B.C. method, is the recipient of all the activities of a business, ie on the one hand the products and services produced and on the other the customers.
- Activity cost drivers are those who actually link the cost of the activity to the cost carriers. That is, they are the mechanisms that transfer the costs from the activities to their respective bodies.
- Activities can be characterized as all the actions which, through the consumption of resources, seek a specific result.
- Resource distributors are those who actually link activities to indirect resources.
- Activity distributors operate in the same way as resource distributors, except that in this case the distributors are the link between activity costs and cost carriers.

In order to be able to analyse and share the costs of products, we need to look at their structure. The unit of construction of all the fenestrations is the casing. I.e. casing are the frame and the sash.

Figure 3.30. Fenestration's structure

The casement 1 sash has frame + sash = 2 casing, casement 2 sash has frame + 2 sashes = 3 casing etc.

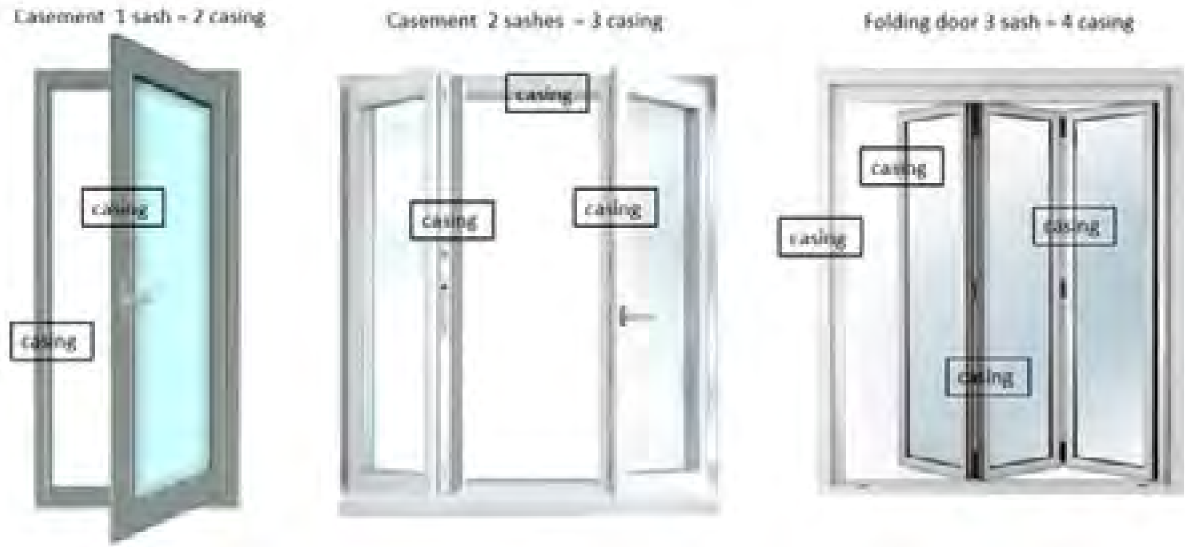


Figure 3.31. Fenestration's structure

By calculating the cost of the casing can have the cost of all typologies consisting of many of the same category of casing. The following is a table of data that we must have collected.

Activites	Resources
Production	Direct labor
Assembling-Control	Indirect labor
Management	Consumables
Sales	Electricity
Accounting	Communications
	Movement / transport
	Other Operating Expenses

Figure 3.32. Data of resources per activity

The next step is to have the table with the resource's distribution drivers. It is a difficult and arduous task to find the right ones. That is, electricity is distributed based on consumption.

ABC Activitis center - Resource drivers						
Resources	Distribution criterion	Production	Assembling-Control	Management	Sales	Accounting
Direct labor	Working hours %	77%	23%			
Indirect labor	Working hours	30%	20%	10%	10%	30%
Consumables	%	10%	10%	20%	20%	40%
Electricity	Kw/h	80%	10%	4%		6%
Communications	Contact hours	5%	10%	30%	40%	15%
Movement / transport	Km	5%		20%	70%	5%
Other Operating Expenses	%	20%	20%	20%	20%	20%
Financially	Purchase of equipment	70%	10%		10%	10%

Figure 3.33. Resource drivers

The next question is the drivers for the distributes the activity. I.e. for the production is the casing, for Sales is the number of orders etc.

Activiti cost Drivers					
	Production	Assembling-Control	Management	Sales	Accounting
Activity Cost Drivers	Casing	Casing	Working hours	Per Order	By issuing a document
Quantity of Drivers	3000	3000	1600	260	700

Figure 3.34. Activity cost drivers

The calculations follow:

ABC Costing Resource activities													
Resources	Total	Distribution criterion	Production		Assembling-Control		Management		Sales		Accounting	
Direct labor	90000	Working hours %	77%	69300	23%	20700	0%	0	0%	0	0%	0
Indirect labor	10000	Working hours	30%	3000	20%	2000	10%	1000	10%	1000	30%	3000
Consumables	6000	%	10%	600	10%	600	20%	1200	20%	1200	40%	2400
Electricity	20000	Kw/h	80%	16000	10%	2000	4%	800	0%		6%	1200
Communications	4000	Contact hours	5%	200	10%	400	30%	1200	40%	1600	15%	600
Movement / transport	10000	Km	5%	500	0%		20%	2000	70%	7000	5%	500
Other Operating Expenses	10000	%	20%	2000	20%	2000	20%	2000	20%	2000	20%	2000
Financially	45000	Purchase of equipment	70%	31500	10%	4500			10%	4500	10%	4500
Total	195000	Total		123100		32200		8100		17300		14200
		Activity Cost Drivers	Casing		Casing		Working hours		Per Order		By issuing a document	
		Quantity of Drivers	3000		3000		1600		260		700	
		Cost / unit	41,0		10,7		5,1		66,5		20,3	

Figure 3.35. ABC costing

Given that the activity, assembling control, is different for each cost object (product) must define the degree of difficultv:

Resource Drivers		
Cost Objects	Production Pieces	Degree of
Sliding	450	0,8
Casement	317	1
Minimal	133	1,55
Main Entranc	114	1,27
Total	1014	

Figure 3.36. Resource drivers in ABC costing

The table with the calculations follows:

Distribution of resources to cost Objects													
Cost objects	Pieces of casings	Production	Assembling-Control	Difficulty Factor	Assembling-Control	Working hours	Management	Total of Orders	Sales	Total of invoices	Accounting	Total
Sliding frames	1500	61550	16100	0,80	12880	550,00	2819	110	7319	330	6694	91262
Casements frames	801	32868	8597	1,00	8597	450,00	2306	65	4325	190	3854	51951
Minimal frames	399	16372	4283	1,55	6638	100,00	1538	83	5523	120	2434	32505
Main Entrance frames	300	12310	3220	1,77	4089	400,00	1538	2	133	60	1217	19287
	3000	123100	32200		32205	1600	8200	260	17300	700	14200	195005

Figure 3.37. Distribution of resources to cost Objects

From the table above we can find the cost for each product by dividing the total by the pieces of casings.

Cost objects /Casing (except mat.)	
Cost objects/Typology	Total cost /casinig (except materials)
Sliding casing	61
Casements Casing	65
Minimal Casing	81
Main Entrance Casing	64

Figure 3.38. Cost objects

The final table with the calculations follows:

ABC Costing					
Resources	Sliding	Casements	Minimal	Main Entrance	Total
Production pieces	450	317	133	114	1014
Solded pieces	410	300	115	105	930
Selling price	540	580	790	670	
Materials	283	245	450	308	
Production	61550	32868	16372	12310	123100
Total Assembling-Control	12880	8597	6638	4089	32205
Total Management	2819	2306	1538	1538	8200
Total Sales	7319	4325	5523	133	17300
Total Accounting	6694	3854	2434	1217	14200
Incomes from sales (Selling price *Sold pieces)	221400	174000	90850	70350	556600
Total Materials	127500	77697	59850	35100	300147
Production / pieces	137	73	36	27	
Assembling Control /pieces	29	19	15	9	
Management /pieces	6	5	3	3	
Sales /pieces	16	10	12	0	
Accounting / pieces	15	9	5	3	
Total cost	218762	129648	92355	54387	
Gross profit / pieces	6	140	-11	140	
Gross profit margin	1,09%	24,12%	-1,43%	20,90%	

Figure 3.39. ABC cost

The following is a summary table with the results of the three different methods.

Gross profit margin				
	Sliding	Casement	Minimal	Main Entrance
Complete (absorbent) costing	3,0%	19,2%	5,2%	17,4%
Variable (limit) costing	7,6%	23,5%	8,3%	21,1%
ABC	1,09%	24,12%	-1,43%	20,90%

Figure 3.40. Results of 3 methods

In the above chart, we my see the differences between the three methods, since each method has a different approach. But in order to have the right results, we need to do a better analysis of all the products, that is, not the slides in general but each typology of slides in particular.

When we produce the same products or 2-3 different categories, we can use the first two methods. However, in metal constructions each construction is different from the previous one and therefore we suggest using the method based on the activities (ABC), with great activity analysis in all final products (cost objects).

Cost objects /Typology					
Only Materials	Pieces	Cost Exept materials	Only Materials	Total	Total cost /pieces
Sliding parallel 2 sashes	300	54757	76500	131257	438
Sliding parallel 3 sashes	150	36505	51000	87505	583
Casement 1 sash	150	19457	29100	48557	324
Casement 2 sashes	167	32493	48597	81090	486
Main entrance 1 sash	51	6558	11934	18492	363
Main entrance 2 sash	60	11572	21060	32632	544
Accordeon 5 sashes	3	1157	2106	3263	1088
Minimal sliding 2 sashes	133	32505	59850	92355	694
Total	1014	195005	300147		

Figure 3.41. Data

The calculations follow based on cost per casing are:

ABC Casting per Typology										
Cost objects	Pieces Fenestrations	Casings / fenestration	Total Casing	Materials/ casing	Material/ fenestration	Total materials	Total cost/casing except materials	Other cost per fenestration	Total cost	Total (Materials + Various cost)
Sliding parallel 2 sa	300	3	900	85	255	76500	61	183	54757	131257
Sliding parallel 3 sa	150	4	600	85	340	51000	61	243	36505	87506
Casement 1 sash	150	2	300	97	194	29100	65	130	19457	48557
Casement 2 sashes	167	3	501	97	291	48597	65	195	32493	81090
Main entrance 1 sa	51	2	102	117	234	11934	64	129	6558	18492
Main entrance 2 sa	60	3	180	117	351	21060	64	193	11572	32632
Accordeon 5 sashes	3	6	18	117	702	2106	64	386	1157	3263
Minimal sliding 2 s	133	3	399	150	450	59850	81	244	32505	92355
Total	1014		3000			300147			195005	495152

Figure 3.42. ABC costing per typology

We can get the total cost for each casing:

Cost per Typology per Fenestration	
Typology	Total cost per Fenestration (Material + Other cost)
Sliding parallel 2 sashes	438
Sliding parallel 3 sashes	583
Casement 1 sash	324
Casement 2 sashes	486
Main entrance 1 sash	363
Main entrance 2 sash	544
Accordeon 5 sashes	1088
Minimal sliding 2 sashes	694

Figure 3.43. Total cost for each casing

Following all Data for the final costing:

Cost Object			
Typology	Production	Solded pieces	Selling price
Sliding parallel 2 sashes	300	280	137
Sliding parallel 3 sashes	150	130	648
Casement 1 sash	150	138	459
Casement 2 sashes	167	162	689
Main entrance 1 sash	51	49	509
Main entrance 2 sash	60	53	764
Accordeon 5 sashes	3	3	1528
Minimal sliding 2 sashes	133	115	790
Total	1014	930	

Figure 3.44. Cost object

Following final costing:

ABC Cost									
Cost objects	Sliding parallel 2 sashes	Sliding parallel 3 sashes	Casement 1 sash	Casement 2 sashes	Main entrance 1 sash	Main entrance 2 sash	Accordeon 5 sashes	Minimal sliding 2 sashes	Total
Production pieces	300	150	150	167	51	60	3	133	1014
Solded pieces	280	130	138	162	49	53	3	115	930
Selling price	486	648	459	689	509	764	1528	790	
Incomes from sales	136080	84240	63353	111556	24951	40481	4583	90850	
Total Cost	131257	87505	48557	81090	18492	32632	3263	92355	
Profit	4823	-3265	14795	30465	6459	7849	1320	-1505	
Profit /pieces	16	-22	99	182	127	131	440	-11	
Gross profit margin	3,3%	-3,4%	21,5%	26,5%	24,9%	17,1%	28,8%	-1,4%	

Figure 3.45. ABC final costing

The following is a table comparing the different costing methods:

Comparison of results for all methods								
	Sliding		Casement			Minimal	Main Entrance	
Complete (absorbent) costing	3,0%		19,2%			5,2%	17,4%	
Variable (limit) costing	7,6%		23,5%			8,3%	21,1%	
ABC	1,1%		24,1%			-1,4%	20,9%	
ABC per typology	Sliding 2 sashes	Sliding 3 sashes	Casement 1 sash	Casement 2 sashes	Accordeon 5 sashes	Minimal 2 sashes	Main entrance 1 sash	Main entrance 2 sashes
Gross profit margin	3,3%	-3,4%	21,5%	26,5%	23,8%	-1,4%	24,9%	17,1%

Figure 3.46. Comparison of results per product

From the chart above we see that in each method we have different results. With the ABC method we can share the costs better in the final products or services based on the activities and have a better and more accurate approach to the real cost. In addition, we share in all product categories and services such as the latest analysis where we have the different typology categories. From the results of the above analysis we can conclude the results of the company's use but also for each product gains or losses. E.g. we observe that the sliding 2 sashes has profit 3,3% in relation to sliding 3 sashes which has damages 3,4%. In this case we will have to adjust the prices, based on the cost, in order to have profits or to stop the production of the specific product.

A key element of a company's marketing is the process of **pricing** its products, as it continues to be one of the most important factors in determining a company's market share and efficiency. After all, price is the only one of the components of the marketing mix that generates revenue. Invoicing should not only be cost-oriented but should consider the specifics of different products, departments, and markets. The pricing strategies include the following five strategies:

1. Cost-plus pricing—simply calculating your costs and adding a mark-up.
2. Competitive pricing—setting a price based on what the competition charges.
3. Value-based pricing—setting a price based on how much the customer believes what you're selling is worth.
4. Price skimming—setting a high price and lowering it as the market evolves.
5. Penetration pricing—setting a low price to enter a competitive market and raising it later.

The main goal of pricing should be first the survival of the business and the positive balance sheet. In case of a medium-sized metal construction industry, the classical method followed is the first. That is, a gain is added to the total cost of materials and overheads.

Figure 3.47. **Pricing**

The price list is configured per piece or square meter of product, depending on the market.

But since the cost of a set of frames for a sale is different for each case with many parameters to shape it, the cost analysis is done for each project separately. The list of materials is made with the special software for each sale, and on it are added the variable and fixed costs. We could utilize classic price lists on products, such as mosquito nets, handles, etc.

3.1.3. Negotiations and final agreement

Key Words

Win-win: situation or result is one that is good for everyone who is involved

Negotiation: a formal discussion between people who are trying to reach an agreement

Agreement: a decision or arrangement, often formal and written, between two or more groups or people

Sales B2C: process of selling products and services directly between a business and consumers who are the end-users of its products or services

Sales B2B: a situation where one business makes a commercial transaction with another

When we go to make a deal, the only choice we have is how well we are negotiating. We all go through some sort of negotiation each day. We promote products, services. A win-win negotiation settlement is an integrative negotiated agreement. In theory, this means the negotiating sides have reached an agreement after fully considering each other's interests, such that the agreement cannot be improved upon further by any other agreement.

Give & Take.

When a person gives something up or concedes on part of a negotiation, always make sure to get something in return. Otherwise, you're conditioning the other party to ask for more while reducing your position and value.

Maintaining a balance will establish that both parties are equal. The negotiating process is continual, not an individual event. Good negotiating outcomes are a result of good relationships and relationships must be developed over time. Because of that, good negotiators are constantly looking for opportunities to enhance the relationship and strengthen their position.

You can find a solution leaving all parties feeling like winners by adopting the aptly named "**win-win**" approach to negotiation. A win-win negotiation is a careful exploration of both your own position and that of your opposite number, in order to find a mutually acceptable outcome that gives you both as much of what you want as possible. Establishing a strong position is a good starting point for a negotiation. But if you become too entrenched, conflict can quickly arise and the discussion may break down.

The Harvard Law School professor Roger Fisher,academic, anthropologist, and negotiation expert William Ury argued that negotiations are successful when they encourage cooperation toward a common goal, at the five stages of principled negotiation:

1. Separate People from the Problem

Avoid identifying your opposite number as your "opponent." Be sure to focus on the issue at hand and try to ignore personality differences. To do this, be aware of three factors: perception, emotion and communication. Perception means "putting yourself in their shoes". Finally, make sure that your communication is clear and precise, to avoid misunderstandings. Use active listening techniques, such as looking directly at the speaker, listening carefully, allowing each person to finish before responding.

2. Focus on Interests, Not Positions

People are seldom "difficult" just for the sake of it, and almost always there are real and valid differences sitting behind conflicting positions. The way that each person sees the issue may be influenced by many factors, such as their values, beliefs, status, responsibilities, and cultural background. Try to keep the conversation courteous and avoid attributing blame. Once everyone knows that their interests have been considered, they are more likely to be receptive to different points of view.

Eg. If you're negotiating with your boss to get more resources for your team, consider that he may be under pressure to reduce costs. If you look beyond your positions, you may find that you have a common interest, such as increasing your team's productivity.

3. Invent Options for Mutual Gain

By now, each side will likely have a better understanding of the other's interests, and a solution might be obvious. You may even be on the verge of agreement. If not, stay open to the idea that a completely new position may exist and use the negotiation process to explore your options.

To return to our example, let's say that you've identified increased productivity as a mutual interest, but your company can't afford new staff or equipment. You could see this as an opportunity to assess working practices, training opportunities, and inexpensive ways to increase efficiency.

4. Use Objective Criteria

This isn't just "setting out the facts," as different underlying needs, interests, opinions, and goals can cause people to interpret facts differently, or cause you to select only those facts that support your position. Try to agree on a set of objective criteria that provide a framework for your discussion.

5. Know Your BATNA (Best Alternative To a Negotiated Agreement)

Your BATNA is your favoured fall-back option if you can't get everything that you want. This is not the same as a "bottom line," which is a fixed position that can limit your options and may prevent you from discovering a new course of action.

Many negotiators underestimate themselves because they don't perceive the power, they have inside of themselves accurately. In most negotiating situations, you have more power than you think. You must believe that the other party needs what you bring to the table as much as you want the negotiation to be a success. Finally:

- Make sure that positivity is visible during the negotiation.
- Be aware of the tone of your voice and non-verbal body language while interacting
- Prepare
- Always have in mind that information is crucial for negotiation
- Research the history, past problems or any sensitive points of the other party. The more knowledge you have about the situation of the other party, the better position you'll be in to negotiate.
- Never forget that the most important part of preparation is Practice.
- Think about the best & worst outcome before the negotiations begin.
- Don't be upset if things don't go your way. In these instances, it's a good time to re-evaluate all positions and return to the table.
- In most cases, as long as you know the highest and lowest expectations of each party a middle ground can usually be reached in the overlapping areas.
- Be articulate & build value. This is key, and it's what separates the good negotiators from the masters.
- Remember that when you have a strong belief in what you're negotiating for, you will shine. Become a master at presenting your thoughts and ideas so that others see the value.

Selling is a technique that improves with experience and study. The following is an example of a dialogue-negotiation-agreement.

Some basics for the customer:

- He is not a number, he is a person with feelings and desires.
- The customer does not depend on us but us on him.
- He gives us an opportunity to "serve" him.
- We are not alone in the market.
- The continuity depends on us

Who are the retail customers?

Doctors, Lawyers, Merchants, Housewives,Retirees, Teachers, Professors, Engineers, etc.

That is, retail customers are,

All professions and characters, with different knowledge, economic and social levels and culture, incomplete product knowledge, different aesthetic point of view.

So they have different needs

- But the commune needs are to buy
- However, this need is interpreted by each customer differently depending on the profession, experiences, culture, etc.
- It's like a fingerprint. Unique for every customer

Therefore,

- The sale starts from understanding the customer's need
- The key to success for a successful sale

How to understand the needs:

1. With questions
2. With many questions
3. We do not talk
4. We ask and listen

Customer approach methods:

The way in which the philosopher Socrates drew information from his interlocutors is timely. Dialectics was the means of controlling and drawing conclusions. Socratic dialectic is:

1. the gradual, step-by-step, revocation of the interlocutor's objections and,
2. then they also gradual attempt to draw a new conclusion

Maternity method needs:

- By asking we learn the customer's needs
- Asking him we lead him to the right conclusions
- Finally we agree on what is really needed
- Understanding the need is the beginning of the sales process

Example

Chat with customer...

We ask : *What exactly do you want?*

Customer : *I would like to change the frames in my apartment*

We ask : Why?

Customer : *It's old and I don't have good insulation*

We ask : *In which area is the apartment?*

Customer : *It is in the centre, on the second floor*

We ask : *Do you have a problem with noise?*

Customer : *Yes, it's true that I have...*

We ask, we ask,

We listen, we listen, we listen, we listen, we listen...

<u>First conclusion</u>

We understand that the customer wants to change the frames because he has some problems with the thermal insulation.

We continue...

We ask : *Ok, so you want good performance...*

Customer : *Exactly, and I would like the colour to be...*

We ask : *Do you allow the building's articles of association to change colour?*

Customer : *You're right, I have to see it...*

We ask : *Do you want the same typology, that is, sliding...?*

Customer : *Depends on...*

We ask : *If you have a problem with noise on the main avenue we may see...*

We ask, we ask,

We listen, we listen, we listen, we listen, we listen...

We summarize

Ok, so you are looking for:

1. Good thermal insulation
2. Good sound insulation
3. Selection of typology in relation to the existing ones for better performance
4. Colour... but it depends on the regulation.

<u>Now we know the customer's needs. We are on the right track</u>

Second phase - Desire

- Understanding needs is the first step
- Turning needs into desire is the next step. In other words, we need to turn the customer's problems and needs into a strong emotional trigger
- Converting need to desire
- To create the values that the customer perceives. In this way we will create the customer's desire to buy.

We lead the customer...

We ask : *Would you like frames with good sound insulation - thermal insulation?*

Customer : *Yes to solve the problem...*

We ask : *Are you obviously interested in profiting from heating?*

Customer : *You're right I pay a lot...*

We ask : *Do you really want peace?*

We create values...

- Therefore, with the above proposed changes, 30% of the heating will be gained, i.e. approximately 300-400 euros per year.
- You will be able to sleep peacefully at night without noise...
- The frames will insure at night....
- Of course, the property is also upgraded.

<u>Now we have created values for the customer. We are on the right track.</u>

Desire. We recommend,

However, you want sliding x type so that they do not take up space in the opening to cover all the technical requirements ...... and for the balcony doors I recommend the better-quality y type.

Values become desire.

Desire become a proposal.

Of course, if we want to "insure" the noise on the boulevard, we can come up with the sliding

Sx that covers all the technical issues in relation to the yx...

We give an alternative.

We also recommend an opening y7 that now covers all the technical requirements compared to the x6...with a small cost difference compared to the performance...

Of course we can combine, depending on the position of the window, both systems....

Related products

At this point we have the opportunity to promote related products, which the customer may not know or consider necessary.

And we go on...

Cross sale

Of course, I also recommend the sieves, so that you do not have the problem with insects in the summer.

We could now see the security of the entrance to the apartment.

We are increasing sales with related products

... Something better and more expensive. In the opening balcony door I advise to put the horizontal screen movement with tracks ... And maybe for better safety in the slides we can put in the lock and key...

We increase the turnover with related products (up sale)

If the customer agrees with what is stated in the offer, then acceptance of the offer must be validated. This can be done either by the manufacturer's and customer's signatures on the offer or by drawing up a private contract. The manufacturer must agree and commit to the customer for the time the construction is delivered.

In order to be able to meet the requirements of the project, the manufacturer must plan a series of things such as:

1. Availability of staff
2. Availability of raw materials
3. Availability of production equipment
4. Availability of vehicles as required
5. Product installation team availability as required

When the final negotiation is done, the work agreement is made, with a detailed description of the patients and services and the final payment method agreed.

3.2. Planning and supply necessary raw materials, cutting and machining profiles

Key Words

Production manuals: documents that include step-by-step processes of machining and assembly of products

To be achieved upon learning outcome completion

KNOWLEDGE

- Use of technical manuals, catalogue of technical – production manuals, catalogues
- Procurement of raw materials
- Production planning
- Cutting, machining
- Recycling
- Technical – production manuals, catalogues
- Select the ideal cross sections

SKILLS

- Manage raw materials
- Manage materials supplies according to the technical requirements
- Make quality control of raw materials, hardware and supplementary materials, considering the technical data-sheets, and the quality system
- Apply good practices for raw materials and final products storage
- Make logistics on incoming materials
- Group the cutting by production type
- Measure mechanical & physical values
- Dismantle & assemble components Check, monitor & remedy errors
- Carry out routine repairs to control systems and components
- Apply all stages of production
- Organize & apply appropriate measurement & construction techniques
- Cut profiles with precision & safety
- Tune the cutting parameters
- Select profiles positioning on the saw
- Perform & document quality controls
- Categorize the cut profiles and label them appropriately
- Treat and protect surfaces
- Drill the appropriate holes
- Handle recyclable materials
- Identify critical checkpoints

COMPETENCIES

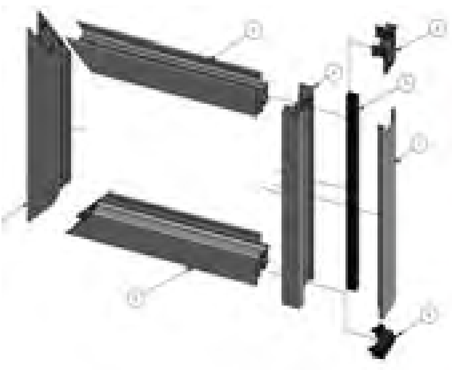
- Exploit the ideal layout of machinery, tools and consumables in relation to production requirements
- Select alternatives, for own employee, for optimum results
- Create additional schedules or modify existing ones if needed

3.2.1. Use of technical – production manuals, catalogues

For any product that the manufacturer has agreed to manufacture, the necessary raw materials and their correct combinations shall be known. E.g.. for the construction of a frame the manufacturer must be aware of the use of the system manufacturer's technical directories in order to use the appropriate profiles and components.

The manufacturer will be asked to decide according to the type of product:

1. the materials used for its construction
2. the parts of which it is composed
3. the production system
4. the accessory
5. how to assemble it.



PARTS LIST			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	570718_Vertical	
2	1	570718_Upper	
3	1	570718_Lower	
4	1	060-00-714-00	
5	1	570722	
6	1	315-14-704-03	
7	1	570704	
8	1	315-11-704-03_LEFT	

Figure 3.48. Assembly details, with part list and the respective part numbers

Before supplying raw materials for the construction of frames the technician shall first check the manufacturing details of the assembly details and the required materials list. The tools needed to machine profiles shall also be checked.

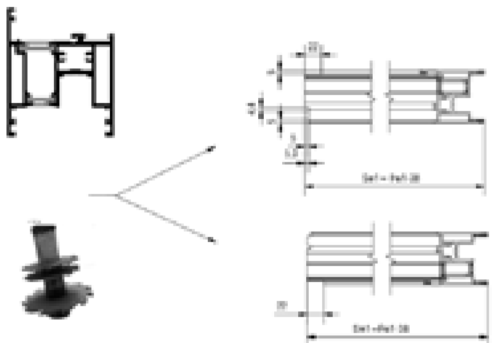


Figure 3.49. Tools to machining profiles

The materials ordered must meet the specifications of the product for which we have agreed with the customer.

3.2.2. Procurement of raw materials - Production planning

Key Words

Raw materials: materials and parts from which a product is made

Accessories: parts that can be added to something else to make it functional

Production planning: the planning of production and manufacturing modules in a company or industry. It utilizes the resource allocation of activities of employees, materials and production capacity, in order to serve different customers.

Time management : practice of using the time that you have available in a useful and effective way, especially in your work

The manufacturer should utilize the technical catalogues to find the appropriate certified profiles and components to use in the manufacture. It is important to use certified **raw materials** so that under European law the certification of the final product can be achieved. From the recipes in the technical catalogues, the manufacturer will also find the right quantities. Orders will be sent to each supplier separately, profiles, accessories, glass, consumables, etc. Of course, we can get the list of raw materials from all suppliers from software.

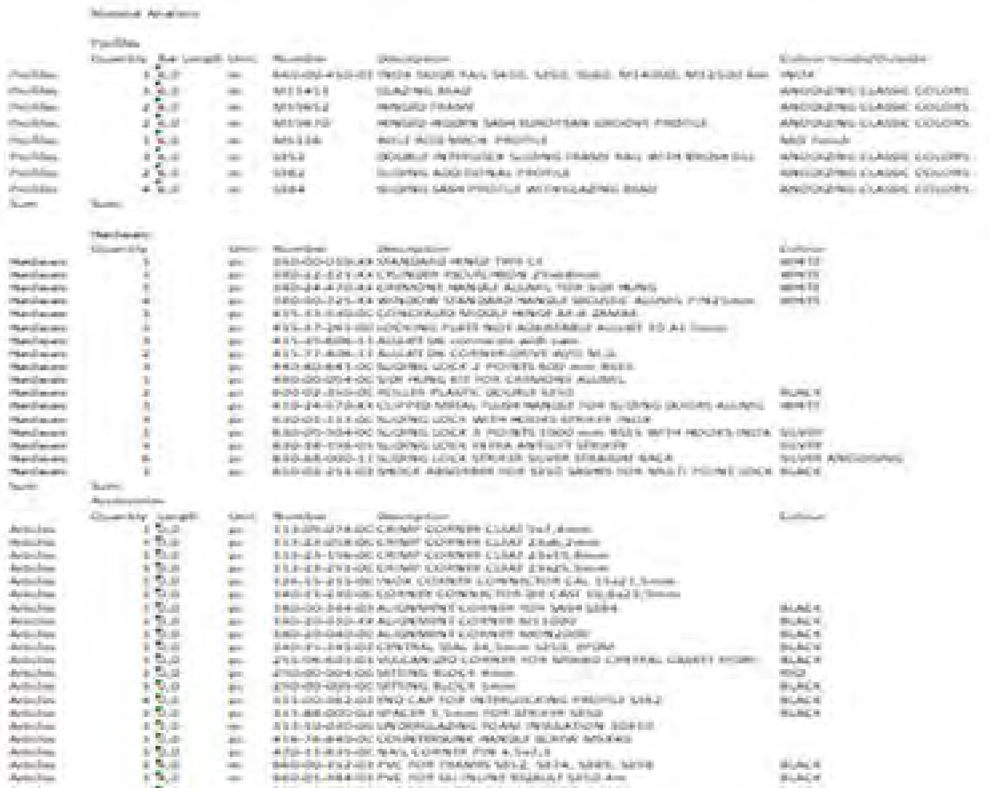


Table 3.5. Complete list of raw materials

But in any case, checking the catalogues is necessary to avoid mistakes.

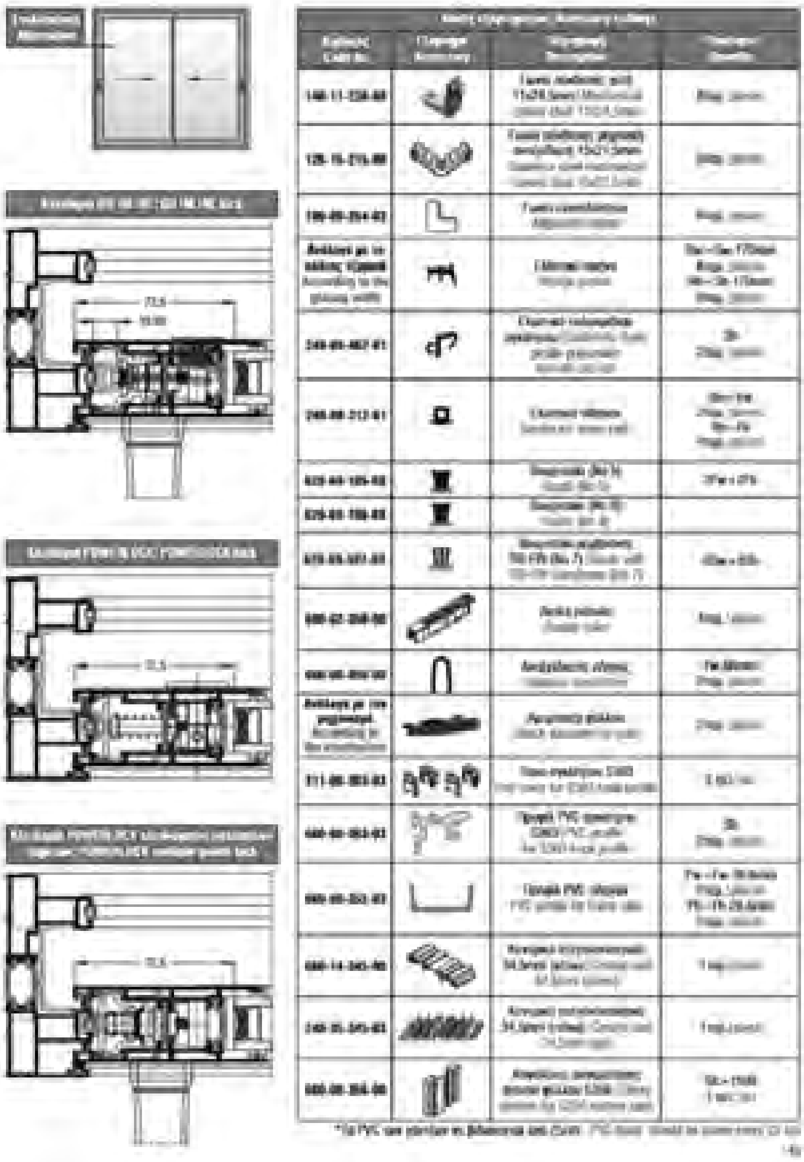


Table 3.6. Technical catalogues - accessories

When we have the final list of materials, we should check the warehouse for any stocks. If they are not in stock, the manufacturer must order from their supplier and be in frequent contact in order to receive them at the appropriate time.

The different temperature and the movement of the structural elements of the building require specific tolerances between the frame and the masonry.

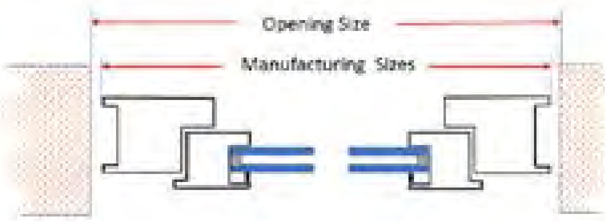


Figure 3.50. Tolerance to fitting

The following table has a **linear expansion coefficient** for 50 degrees of difference, from -10 to +40C degrees and for one meter in length, the four basic materials from which the frames are made.

Kind of Material	α	Δl (mm)
Aluminum	$24*10^{-6}$	1,2
Wood	$5*10^{-6}$	0,25
PVC	$70*10^{-6}$	3,5
Steel	$12*10^{-6}$	0,6

Table 3.7. Typical thermal coefficient for various materials

One meter of aluminium profile has a difference, winter - summer 1.2 mm. Therefore, when measuring production measures, we must remove the tolerances. With continuous dimensions larger than 6 meters, expansion joints, that is to say an independent frame, should be provided.

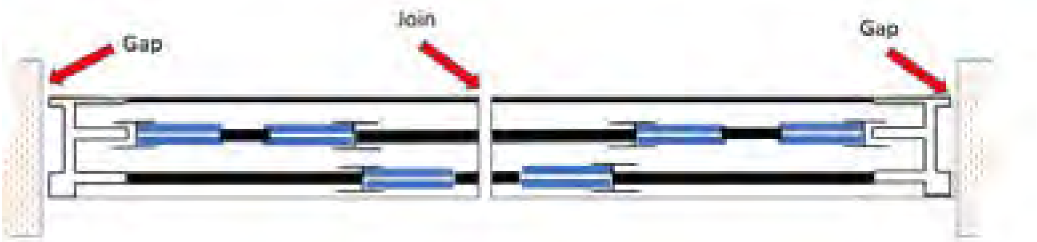


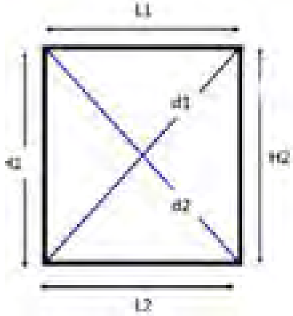
Figure 3.51. Tolerance to fitting

Table of tolerances applies to the type of frame.

Kind of Material	until 1,5 μ.	from 1,5-3,0	from 3,0 - 4,0	Up from 4
Aluminum	10	10	15	20
Steel	8	10	12	15
Wood	10	10	10	10
PVC - White	10	15	20	25
PVC - Color	15	20	25	30

Table 3.8. Gaps between frame & wall

When the masonry opening is compatible, i.e. about three square meters, then we can only measure the width and height. By leaving the tolerances provided, it will be possible to have a successful placement of the window in the "opening", even if it is paragon. However, in case the opening we have to measure is larger, we must also take into account the diagonals (δ1, δ2) as shown in the figure, in order to confirm the correctness of the opening.



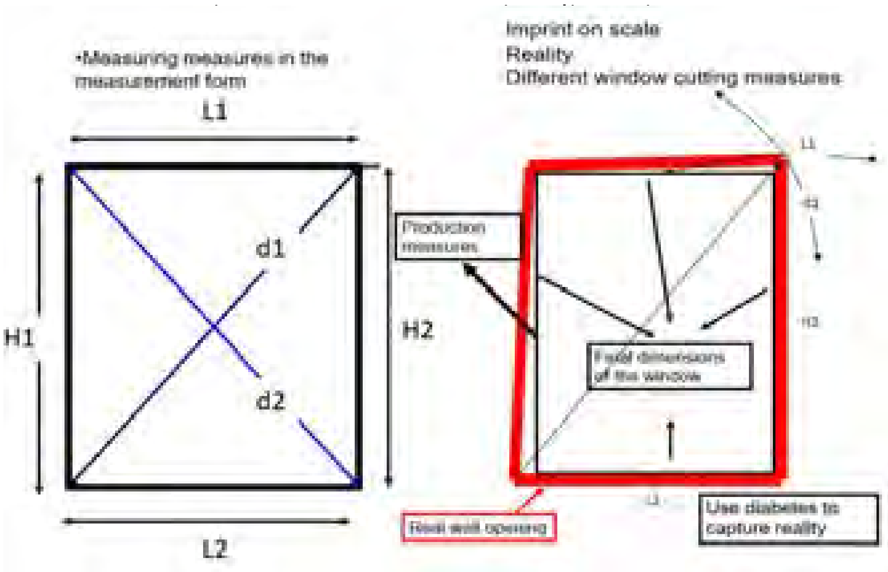


Figure 3.53. Confirmation of construction measures for large openings

Production planning provides answers for two major questions, viz.,

1. What work should be done?
2. How much time will be taken to perform the work?

Production planning help in efficient manufacturing of a product:

- to the determination of the required product mix and factory load to satisfy customer's needs
- for matching the required level of production to the existing resources.
- for scheduling and choosing the actual work to be started in the manufacturing facility.
- for setting up and delivering production orders to production facilities.

In order to develop production plans, the production planner needs to work closely together with the marketing department and sales department. The "work is usually selected from a variety of product types which may require different resources and serve different customers.

A critical factor in production planning is the accurate estimation of the productive capacity of available resources, yet this is one of the most difficult tasks to perform well.

They are four steps:

Figure 3.54. Steps, techniques or essentials in the process of production planning & control

1.Routing is the first step in production planning and control. Routing can be defined as the process of deciding the path (route) of work and the sequence of operations.

Routing fixes in advance:

- The quantity and quality of the product.
- The men, machines, materials, etc. to be used.
- The type, number and sequence of manufacturing operations, and
- The place of production.

In short, routing determines 'What', 'How much', 'With which', 'How' and 'Where' to produce.

E.g.: Construction of 4 frames 1 sliding double leaf 1 opening Single leaf and 2 opening 2 leaves:

- The quantity is 4 pieces and the quality are 1 sliding and 3 casements
- Staff consists of 1 craftsman and2 assistants, and materials will be from the software list.
- The type, number and sequence of manufacturing operations:
    i. Cutting profile
    ii. Machining of profiles
    iii. Fitting brush
    iv. Assembling of 1 frame
    v. Assembling of 2 frames
    vi. Assembling of .... frames
    vii. Fitting gasket
    viii. Fitting of mechanism
    ix. Cutting glazing bend
    x. Fitting glazing panel
    xi. Assemblage of frame
    xii. Quality controlling
- The construction and assembly will be done in the production department, cell A.

2. Scheduling is the second step in production planning and control. It comes after routing.

Scheduling means to:

- Fix the amount of work to do.
- Arrange the different manufacturing operations in order of priority.
- Fix the starting and completing, date and time, for each operation.

Scheduling is also done for materials, parts, machines, etc. So, it is like a timetable of production. Time element is given special importance in scheduling. There are different types of schedules; namely, Master schedule, Operation schedule and Daily schedule. Scheduling helps to make optimum use of time.

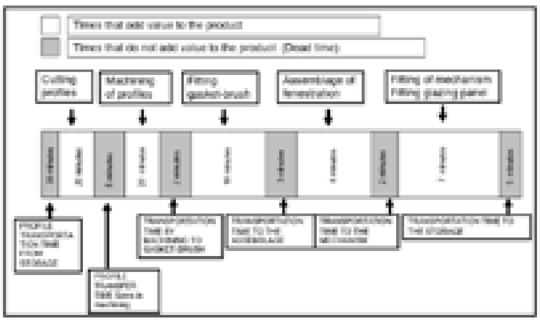


Figure 3.55. Scheduling

3. Dispatching is the third step in production planning and control. It is the action, doing or implementation stage. It comes after routing and scheduling. Dispatching means starting the process of production. It provides the necessary authority to start the work. It is based on route-sheets and schedule sheets. Dispatching includes the following:

- Issue of materials, tools, etc., which are necessary for actual production.
- Issue of orders, instructions, drawings, etc. for starting the work.
- Maintaining proper records of the starting and completing each job on time.
- Moving the work from one process to another as per the schedule.
- Starting the control procedure.
- Recording the idle time of machines.

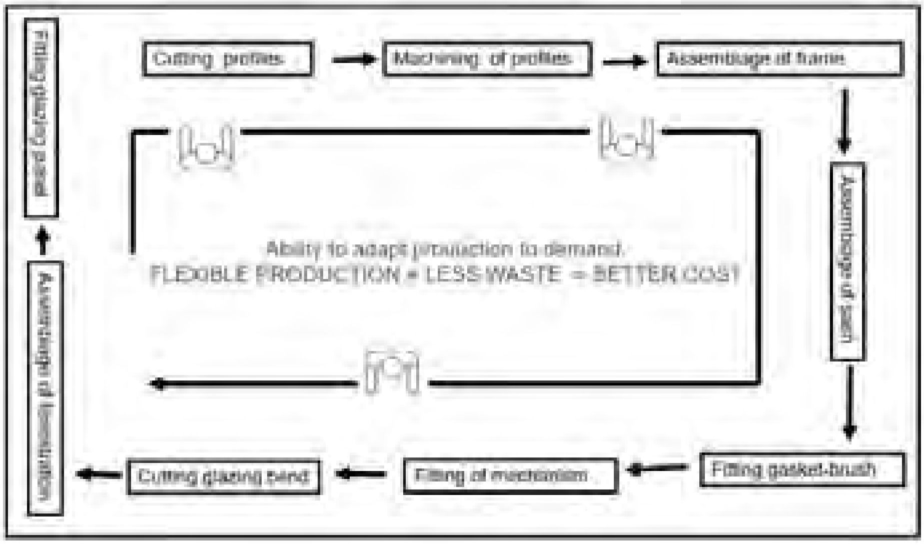


Figure 3.56. Dispatching

4. Follow-up or expediting is the last step in production planning and control. It is a controlling device. It is concerned with evaluation of the results. It finds out and removes the defects, delays, limitations, bottlenecks, loopholes, etc. in the production process. It measures the actual performance and compares it to the expected performance. It maintains proper records of work, delays, and bottlenecks. Such records are used in future to control production.

Follow-up is necessary when production decreases even when there is proper routing and scheduling. Production may be disturbed due to breakdowns of machinery, failure of power, shortage of materials, strikes, absenteeism, etc. It removes these difficulties and allows a smooth production. For each step there is the recording of all the data so that in case of exclusion the correct times are restored, and the desired quality and quantity of the product remains.

Typology of fenestration	Time
Opening single leaf window	60 min
Opening single door	65 min
Opening double leaf window	100 min
Opening double door	125 min
Lift-sliding door	140 min
Sliding door 1 leaf	50 min
Sliding door 2 leaves	90 min

Table 3.9. Data

Good **time management** is essential to success. And it's not limited to success in the workplace. Success as a friend, parent, spouse, fitness, anything… requires good time management skills.

"Time management is not a peripheral activity or skill. It is the core skill upon which everything else in life depends "(Brian Tracy).

Five Steps to Get on Top of Your Schedule:

Step 1. Define your goals and priorities

If you are not clear about your goals, values, and priorities, it's hard to make a plan and hard to make a good decision on the fly. Get specific, write them down.

Good time management requires planning and conscious decision making. It requires defining your priorities and choosing to put them first. It requires being aware of how you spend your time.

Step 2. Make a list of everything you need to do,adding anything else you usually do.

There may be goals you are supporting that you don't realize for better or worse.

It's important to write down your to do list because your brain can't operate at its best when you try to keep track of all your to-do's in your head.

Let me give you another example. Let's say your brain is a smart phone. You've been taking pictures and your phone storage is full. It's operating slow and refusing to take more photos. What do you do? Upload. You get those photos off of your phone so that your phone can continue operating as a phone, not a photo warehouse.

An efficient mind works the same. At some point you can become overloaded with things to do. In order to clear some working space you need upload so that your brain has space to think and create, not just store repeated meaningless information "I gotta clean that closet."

Step 3. Apply the Eisenhower Matrix

The Eisenhower matrix is one of the most popular tools for helping set priorities and, it's named after our 34th President Dwight D. Eisenhower! The first step is to organize all of your tasks into one of four categories:

- Urgent and important (tasks you will do immediately – high deadline cost)
- Important, but not urgent (tasks you will schedule to do later)
- Urgent, but not important (tasks to delegate to someone else or automate)
- Neither urgent nor important – Do Last or Not at All

Step 4. Make a prioritized plan

You now should have all the information that you need to make a solid plan. Set up a blank calendar. It can be a spreadsheet, paper, or application. Schedule your time inflexible, high priority activities first. Schedule your deep or hard work around your highest energy levels. Figure out when your brain is most engaged & schedule your hardest studying or most challenging and important tasks then, in 15 – 45-minute chunks of time

Step 5. Stick to the plan

Perhaps this is stating the obvious, but It's the unplanned in-the-moment decision making that most often kills productivity. The purpose of the plan is to have the decisions made so.

3.2.3. Cutting, Machining, Recycling

Key Words

Profiles Trolley : specially designed wheeled shelves for profile transport

Drainage: profile holes to let water out on the outside

Optimization cuts: list of profiles and how to cut so that there is almost zero waste

Molds: pieces of wood or plastic material placed on the saw to hold the profile

The process of cutting is the following :

- Collection of profile from the warehouse and quality control. If there is a problem (scratch, paint etc.) we return it to the defective materials department.
- If it's good we place, by code on a trolley, closer to the saw, so can optimize the cuts, so that have as few wastages as possible.

Figure 3.57. Trolley for 6 m. bar

Aluminium profiles must be cut only with cutting saws or other forming and shaping machines / equipment which is specially designed and intended only to be used for aluminium. Use of other non-conforming tools will significantly affect the finish quality of the end product.

Some of the most important saw characteristics which must be known to the fabricator are the useful cutting width, useful cutting length, cutting disk maximum diameter, single or twin head operation at either a fixed or a variable angle, provision for vise grip use etc.

All the above parameters must comply with the totality of the profile geometries which are to be shaped through its use during the fabrication procedure. The geometry of aluminium profiles and the cutting direction of the cutting disk, both affect the finished cutting quality. For example, the profile's flat surface should always be positioned against the saw's flat back if a proper cut is to be made.

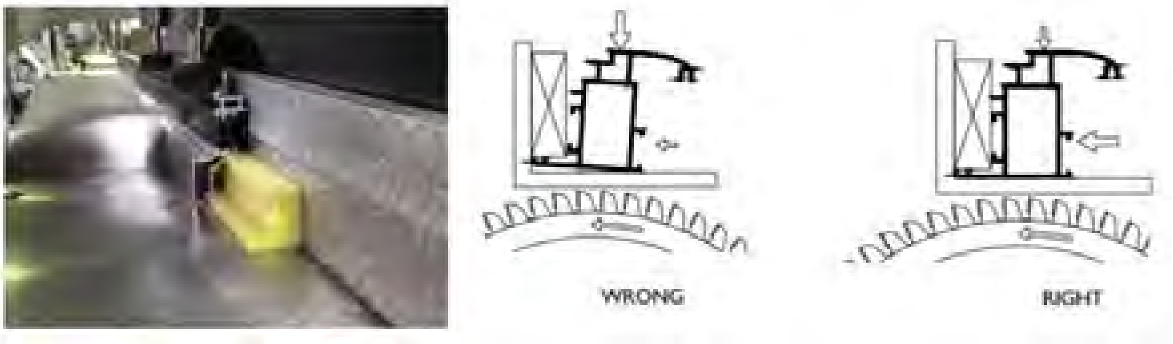


Figure 3.58. Cutting

If we wish to have more than one flat surface on a profile, then special molds must be formed by the fabricator, which will offer additional flat positioning surfaces. The following rules should be considered as cutting aids:

- The profile's flat surface should be placed against the saw's back, to be cut properly.
- The hack saw must be equipped with pneumatic vise grips if the profiles are to be safely and properly positioned.
- The use of the pneumatic vise grips should be such, that the point of contacts will not deform the profiles. This implies that the vise grips should be set at different gripping points based on the profile's geometry.
- It is often the case that when intricate profiles are to be cut, the pneumatic grips should be positioned and set in such a way, that they offer more grip in the cutting direction.
- It is advisable that a transporting trolley exists next to the hack saw so that the profiles can be easily and safely transported within the shop, to minimize the chances of dents or scratch marks.
- Prior to the cutting procedure we should always double check the required cut, and after the cutting step, this measurement should be verified.
- Always MEASURE TWICE, AND CUT ONCE
- Insert the measures manually or with USB or via network or by miter tape.

Figure 3.59. Insertion of the measures manually or with UPS

- Utilized software optimization cuts. This way we cut so many pieces from each bar that we have almost zero wastage.

Alumil M11451	1 Pcs. @ 6.000 mm	GLAZING BEAD Colour: ANODIZING CLASSIC COLORS Width: 19,2 mm / Height: 26,6 Wastage: 526 mm = 8,8 % (Incl. Residual Lengths)
Usable Residual Length: 0 mm	Saw Cut Deduction: 10 mm	End Deduction Total: 40 mm
1 x	[illegible] (1) · [illegible] (2) · [illegible] (3) · [illegible] (4)	445
Alumil M19652	2 Pcs. @ 6.000 mm	HINGED FRAME Colour: ANODIZING CLASSIC COLORS Width: 56,0 mm / Height: 55,0 Wastage: 5.800 mm = 48,3 % (Incl. Residual Lengths)
Usable Residual Length: 0 mm	Saw Cut Deduction: 10 mm	End Deduction Total: 40 mm
1 x	2100 (1) · 2100 (2) · 1000 (3)	[illegible]
1 x	1000 (4)	[illegible]
Alumil M19670	2 Pcs. @ 6.000 mm	HINGED HIDDEN SASH EUROPEAN GROOVE PROFILE Colour: ANODIZING CLASSIC COLORS Width: 63,5 mm / Height: 74,5 Wastage: 6.016 mm = 50,1 % (Incl. Residual Lengths)
Usable Residual Length: 0 mm	Saw Cut Deduction: 10 mm	End Deduction Total: 40 mm
1 x	2046 (6) · 2046 (5,H=1023) · 946 (7)	[illegible]
1 x	946 (5)	5004

Table 3.10. Optimization list

- Cut the profile with all the safety measures and put on profile the barcode label.

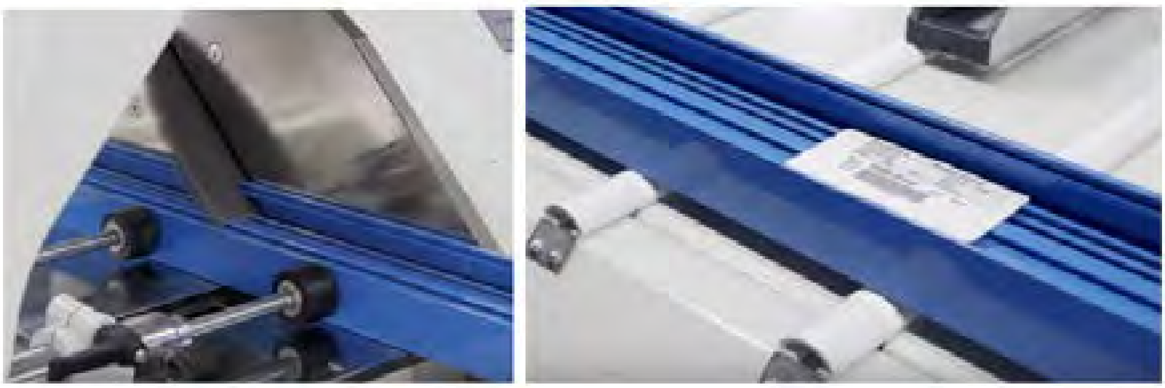


Figure 3.60. Cutting- barcode label

- Put the wastages (scraps and small pieces) in special bins for recycling
- Put the profiles on the special trolley in each case the profiles for each frame

Figure 3.61. Troller after the saw

- Finally, the cutting profiles transported in the machining department

For the proper **machining** of aluminium profiles, the most important parameter is that of proper tool condition. Such tools could be punch presses, drill bits, cutting disks, milling bits etc.

Figure 3.62. Machining

By complying to the following simple rules, we can obtain excellent machining results:

1. Always clean left-over sand residues from previous machining operations.
2. Suitable and scheduled lubrication of vital moving parts.
3. Proper and scheduled main tenancy of tools. Replacement of defective / worn parts if needed or if in doubt.

Prior to every new machining procedure (i.e. a procedure that the fabricator is not acquainted) a few test runs are always advisable in order to check both the quality of the finished cut and its respective dimensions based on what these should be. In case of discrepancies between measured and design ed dimensions, the tool should be recalibrated or check ed for defective / damaged part.

All aluminium machining must be such that they will accommodate for proper water drainage which may either be the result of water vapour humidification or water entrainment from external sources. The goal, here, is to create an internal pathway of controlled leakage which is to be formed in such a way that it will guide the accumulating water to the exterior side of the frame for final drainage. For this reason, specified lower regions of the sash and the Frame must be vented accordingly to allow for proper water evacuation as haw been previously denoted in picture. They are 3 different kind of machining:

1. Punch press
2. With drill bit
3. With milling machine as CNC, Pantograph, router.

The simplest way of machining is with the punches machines with which we can drill gutters, handles and holes for mechanical corner cleat placement.

Figure 3.63. Punches machine

For moor complicate machining use the CNC, Pantograph and router.

Figure 3.64. Milling/pantograph machine

For conventional frames (often called “open type”) the required weep holes are machined using the appropriate punch press. In cases of “tubular frames” where the exterior side of the frame protruding, a special machining is required thus. In either case, the final cut should be free from debris, so as to allow for proper water circulation and to avoid water accumulation. The weep hole machining of T-profiles is governed by the exact same rules.

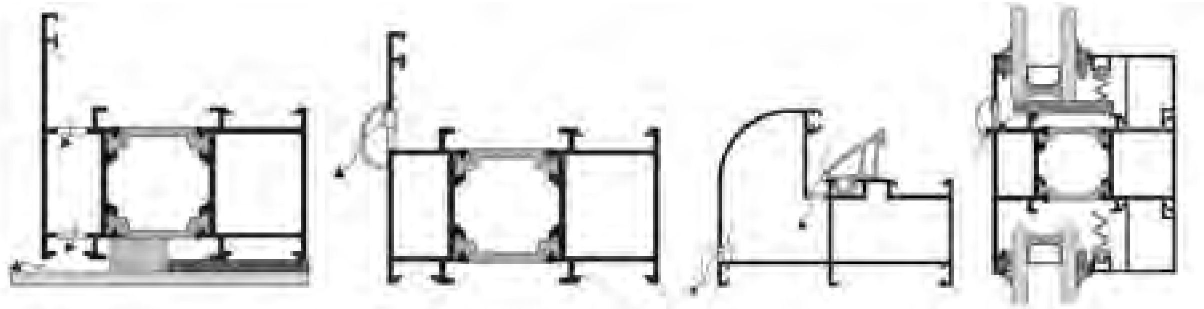


Figure 3.65. Concealed Drainage, Conventional Drainage, Tubular Frame, T-profile weep holes

The frame of fenestrations must have a minimum number of weep holes per sash (as they are show the picture below).This number holds ground for relatively protected windows (i.e. under balconies or installed at the inner face of a wall). In cases of fully exposed windows, the weep hole number per frame must be increased by 1 weep hole respectively, while the use of water shedding profiles is strongly recommended. In any case, the spacing between two weep holes should never exceed 1m.

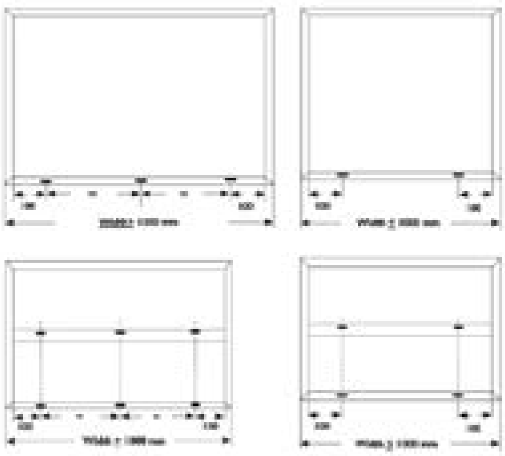


Figure 3.66. Minimum weep hole number per frame / T-Profile

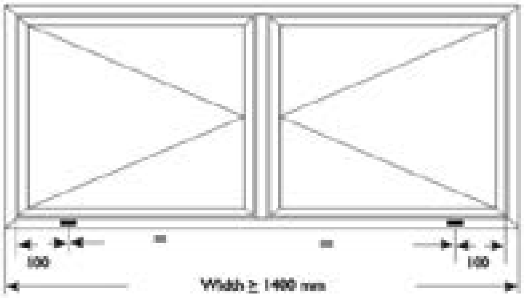


Figure 3.67. Minimum weep hole number in twin leafed windows

For windows which are to be used in more harsh environments, in order to protect the sealing integrity of the external gasket joint, the use of a water shedding profile is strongly recommended in order to reduce the amount of water that will attack the exterior gasket. This technique does not apply for negative lay pressurized systems.

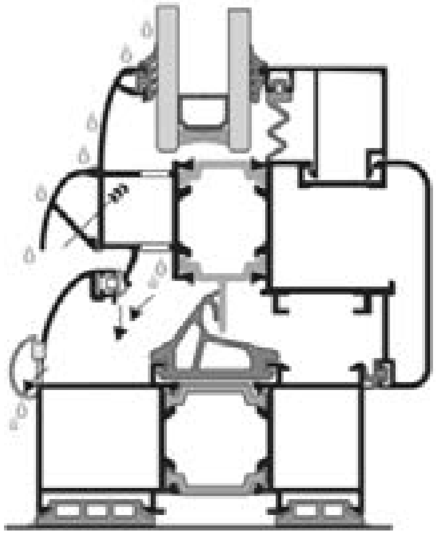


Figure 3.68. Water shedding profile

The weep holes for a given sash are always drilled at the lower side of it, after the physical position of the crimp corner and towards the centre of the sash profile. They are drilled either with a 8 mm drill bit, or with a mill bit to the dimensions of 25 mm X 5 mm (as depicted in the picture below).

In twin chambered sashes (i.e. thermally broken ones) the top and bottom weep holes (holes No 2) must be misaligned by at least 60 mm. Great care must be taken so that the sash weep holes do not coincide with the frame weep holes (holes No 4).

If such a situation exists, whistling of the window will occur under certain wind loading conditions and should be avoided. Furthermore, if pressure equalization is to be achieved at the interior side of the sash and for the proper ventilation of the glazing, side vents should be drilled at the upper sides of the sash.

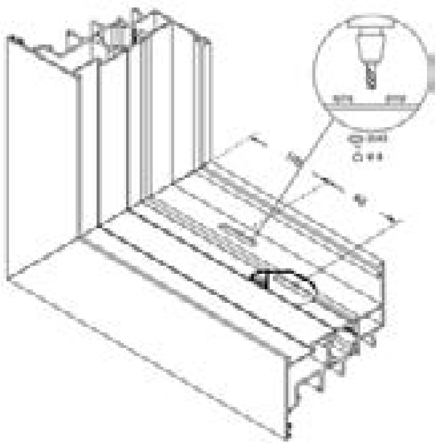


Figure 3.69. Sash weep holes machining.

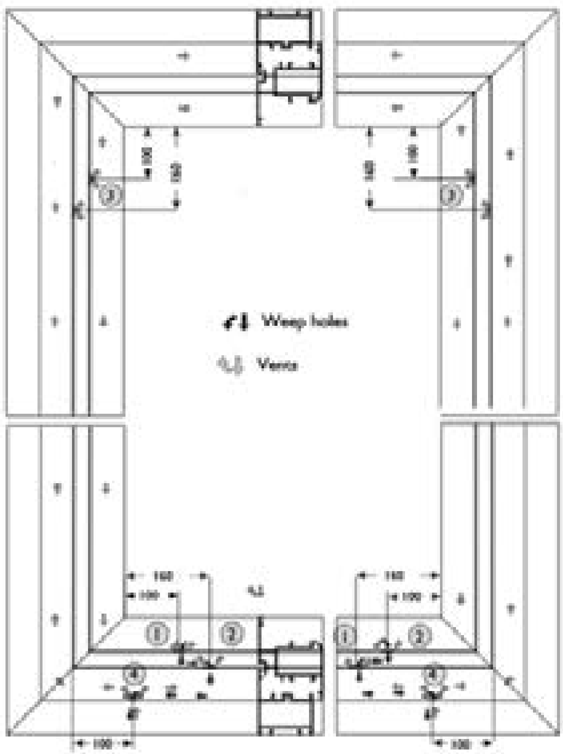


Figure 3.70. Total ventilation and drainage window schematic representation

In sliding windows and door, the bulk of the water entrainment accumulates in its lower profile between the two rail guides. The design of the sliding systems is such that a water barrier is created by the existence of the rail guides which obstructs the water from being evacuated.

For this reason, the number of weep holes per unit length should be higher than the casement windows. Based on this, the maximum distance between weep holes in a slider should never and under no circumstances exceed 500 mm.

Special care shall be taken in the case of parallel sliding windows, that the weep holes are machined on that portion of the lower framing profile which corresponds to the effective track length of the external moving sash.

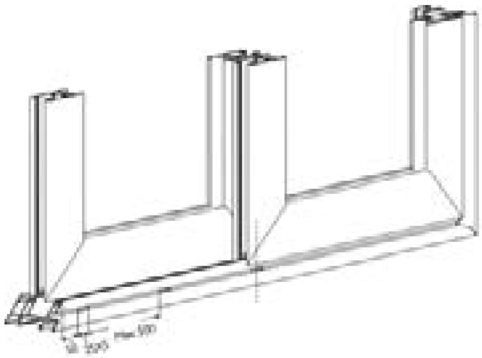


Figure 3.71. Minimum number of weep holes on a typical slider

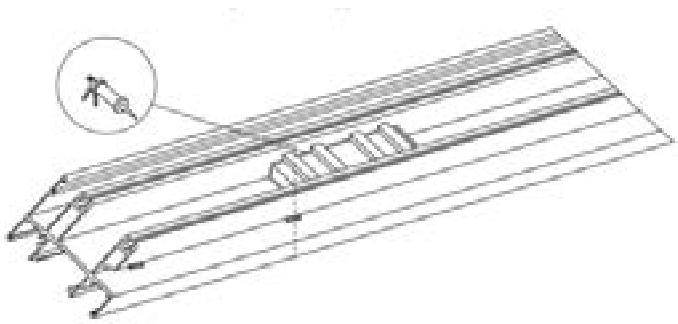


Figure 3.72. Sealing of a central sealant on a typical slider

A good way for offering additional water protection on a slider against weather conditions is the use of a water dripping profile which can be added on the head profile. This profile offers protection against direct rain intrusion of the window through the winged part of the exterior sliding sash.

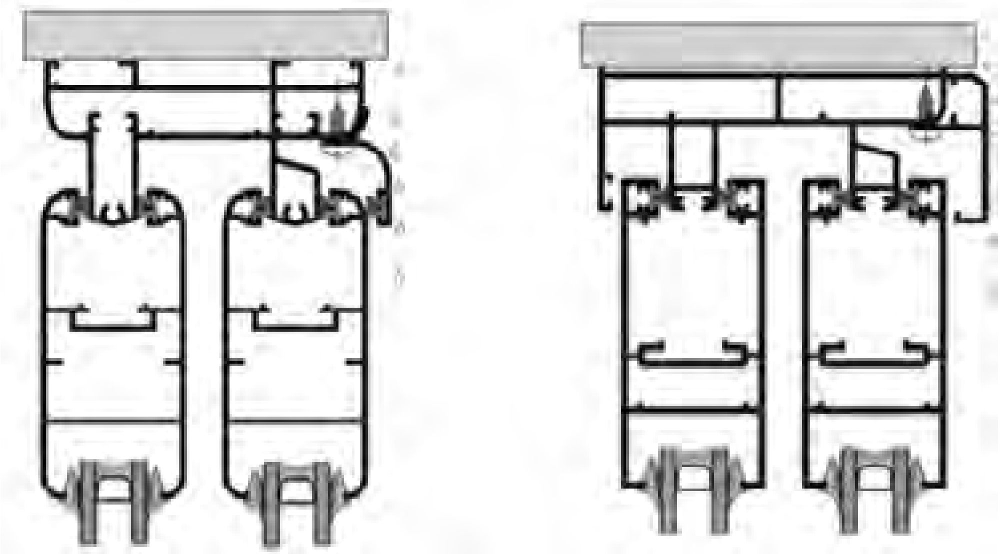


Figure 3.73. Sealing of a central sealant on a typical slider

In total, the casement systems offer a selection of 5-6 different types of joining corners which can either be used separately based on the profile application or in a combination. These 5 types are:

1. Conventional crimping corners and a crimping machine.
2. Crimping corners combined with a nail.
3. Extruded screwed-in corners.
4. Casted screwed-in corners.
5. Combinations of the above.

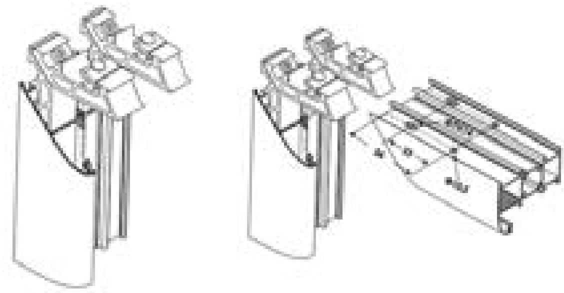


Figure 3.74. Use and machining of screwed-in corners

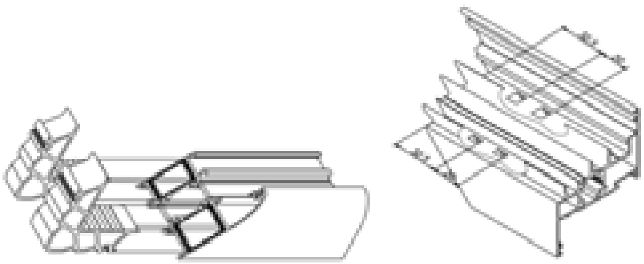


Figure 3.75. Use of crimping corners

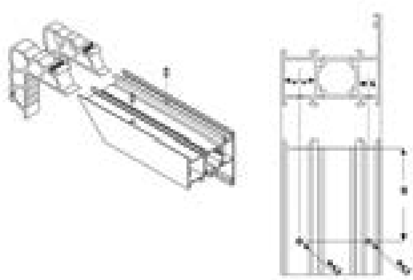


Figure 3.76. Use and machining required for a crimp and nail corner

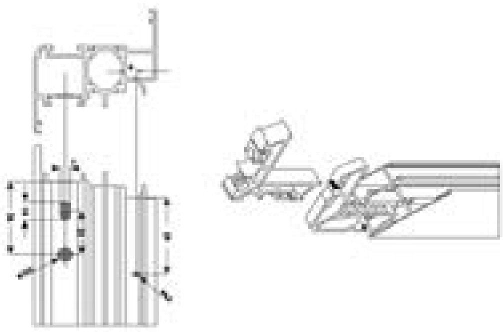


Figure 3.77. Combined corners

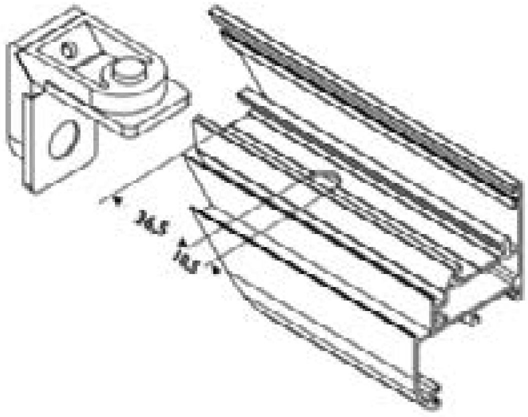


Figure 3.78. Use and machining of casted corners

Regardless the connection method used, it is of imperative importance to have a corner that "fills" the profile's chamber since the best mitered joinery is achieved in this way. This is very crucial for large openings since it significantly contributes towards long lasting construction integrity of the mitered frame.

The machining for the handles of the mechanisms depends on the type of mechanism. There is a simple handle as well as a lock.

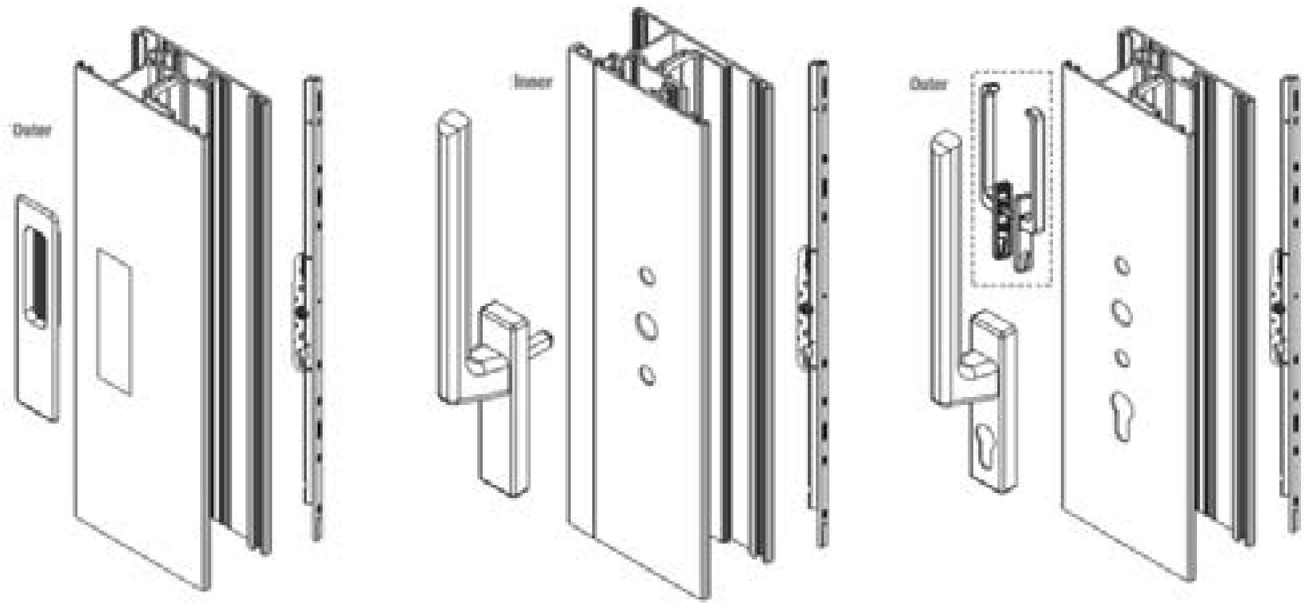


Figure 3.79. Machining of handless

Aluminium is an infinitely recyclable material, and it takes up to 95 percent less energy to recycle it than to produce primary aluminium, which also limits emissions, including greenhouse gases. Today, about 75 percent of all aluminium produced in history, nearly a billion tons, is still in use.

Figure 3.80. Logo for aluminium recycling / An aluminium recycling symbol

The waste price of the aluminium used is generally high enough to offset the investment made in modern waste collection and sorting equipment. Thus, the metal pieces and the waste collected during the processes that led to the final construction, shall be collected in a bin and delivered to recycling companies. With this the environment is protected and also a small income by selling is secured.

3.3. Assembling profiles for various typologies & types of aluminium construction products

Key Words

Fabrication manuals: are written to provide guidance for specific work activity as assembling of fenestrations

To be achieved upon learning outcome completion

KNOWLEDGE

- Production planning
- Assembling, fenestration & outdoors systems
- Quality control

SKILLS

- Process procedure appropriate to the material used
- Assemble & dismantle components
- Group assembly per type production, sliding, casement etc., to avoid errors
- Write, implement and check work orders
- Measure and test mechanical and physical values
- Check monitor and remedy errors and malfunctions
- Carry out routine repairs to control systems and components and document results
- Comply with National and European Legislation, e.g. Construction Products Regulation 305/2011/EU, CE-marking, Buildings Energy Performance Regulations
- Assemble all types of fenestrations and outdoor, fencing, railing systems etc.
- Install locks,handles etc.
- Position materials
- Recognize & apply systems' designer's technical manuals requirements when assembling frames, in order to achieve maximum energy outcomes
- Assemble products in energy-efficient ways according to designer's requirements
- Check the functionalities of a construction

COMPETENCIES

- Utilize the best and fastest appropriate process of production stages
- Implement the appropriate measurement techniques for quality control

3.3.1. Use of technical – production manuals, catalogues

Fabrication manuals are written guidelines for specific work activity such as assembling of fenestrations. Since each typology has a different assembly method, the procedure is described in detail in the respective fabrication manual. For all typologies the method of assembly is written in details. A typical example is given below for double sash sliding frame. By following the manual, the proper assembly is achieved.

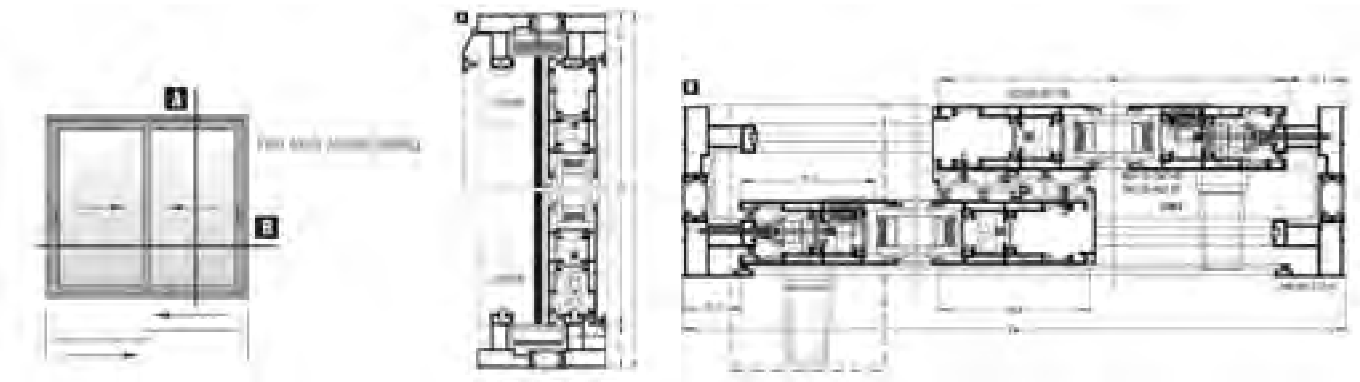


Figure 3.81. Framing two sash parallel sliding

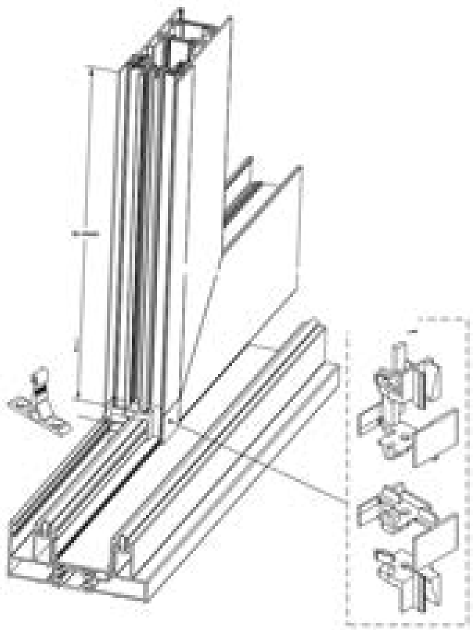


Figure 3.82. Framing two sash parallel sliding, accessories

On the other hand, must verify the maximum permitted dimensions. There are charts that set the maximum permissible dimension based on the weight of the glazing panes.

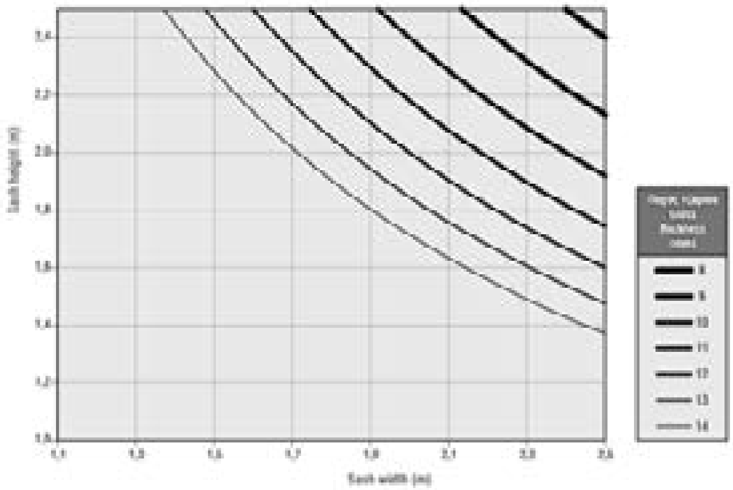


Figure 3.83. Maximum permitted sash dimensions.

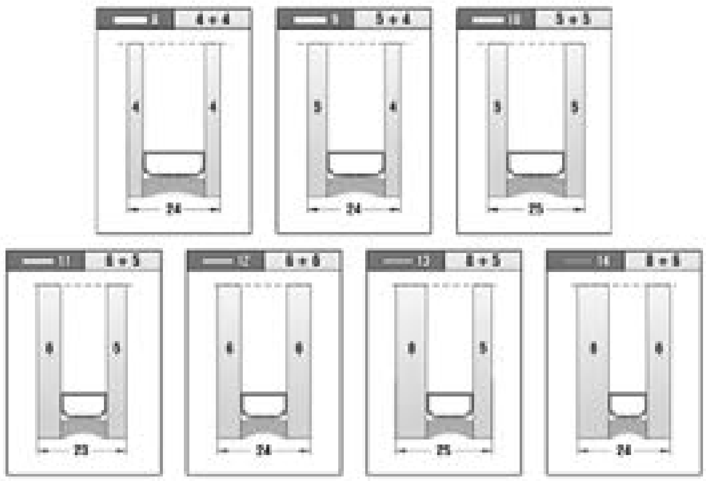


Figure 3.84. Maximum sash dimensions for given glass thickness

There are also charts that set the maximum permissible dimension based on the frame's dimensions in relation to air pressure.

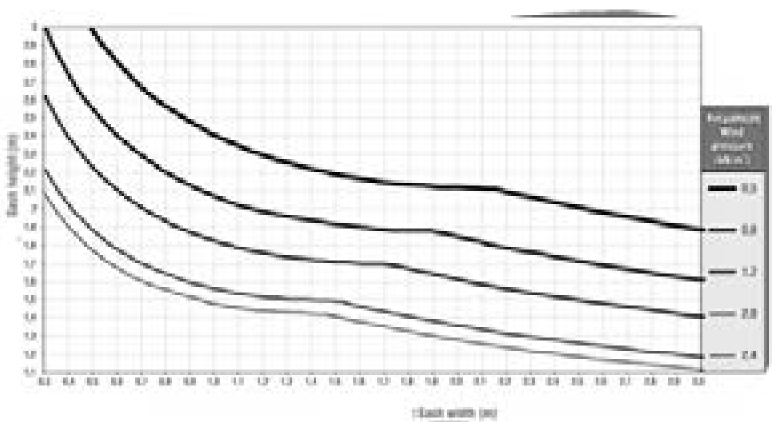


Figure 3.85. Maximum permitted dimensions

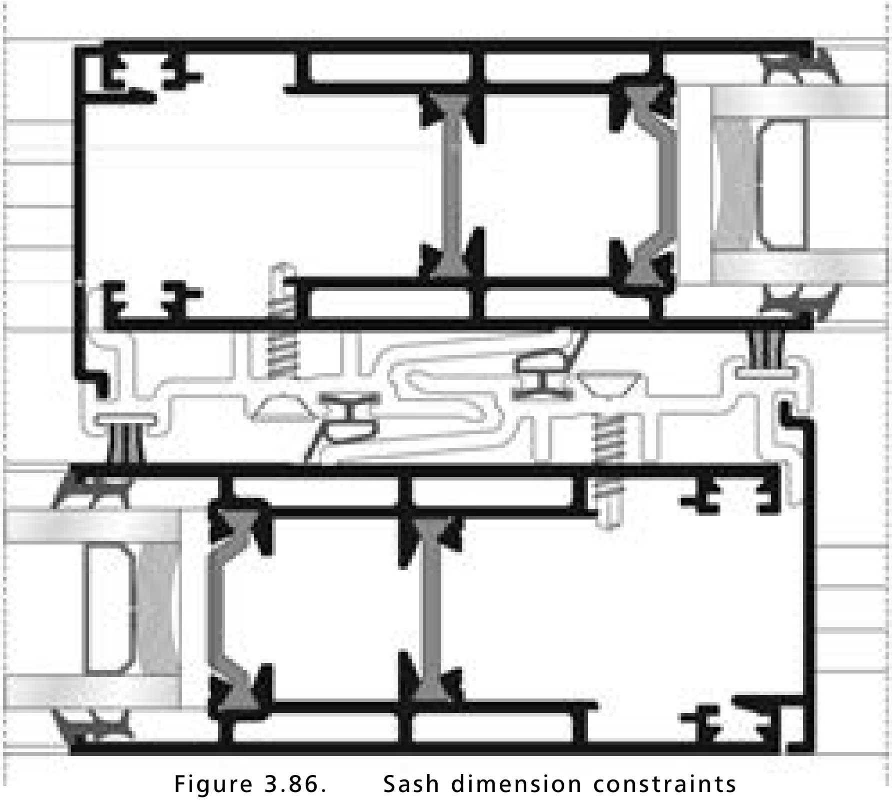


Figure 3.86. Sash dimension constraints

There are also charts that set the maximum permissible dimension based on the frame's dimensions for each different combination of profiles.

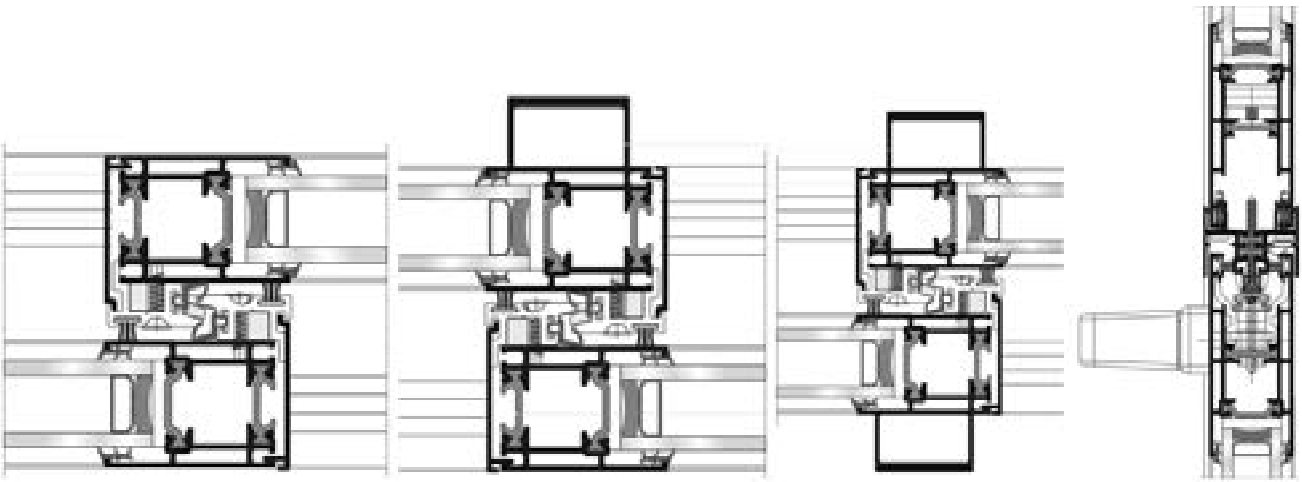


Figure 3.87. Different combinations of profiles mean different charts

3.3.2. Production planning

Key Words

Coordination: the lack of communication between parts of the company

Production Planning: the process of aligning demand with manufacturing capacity to create production and procurement schedules for finished products and component materials

Most companies lack enough coordination of production processes and work-flows between departments. As a result, it is difficult to validate that the products being assembled match the customer order that was received. This leads to costly rework and delivery delays. Also, many times the necessary staffing is not planned, resulting in many delays. Worldwide regulatory requirements are becoming more stringent and complex. Planning on managing supplies and necessary space. Companies not only have to be compliant within home-country requirements, they also must comply with regulations in countries where they do business. Regulatory and environmental requirements apply to the whole product, as well as to all its components.

When digital product designs are part of the virtual manufacturing environment, manufacturer scan simulate the entire production process before they build a plant's assembly lines, purchase machines and equipment and allocate appropriate resources.

This approach supports the development of manufacturing processes, production work cells, line balancing and work-flows that anticipate and mitigate production bottlenecks and potential supply chain problems.

Using 3-D visualization tools within a PLM environment, engineers can walk through the plant and simulate all aspects of the assembly process as if they were physically present.

Partners, suppliers and remote facilities can upload their most current information to the central repository (including plant capacity, capability and location, parts and component availability and pricing), where it is accessible to production planners.

Ergonomics studies and actual task durations can be captured and used to evaluate cycle time even in manual production environments.

In this way, engineers can ensure that planned cycle times are ergonomically feasible.

They also can pre-test material flow, analyse product variants and batch scenarios and confirm logistics. Using rich applications that support experimentation, such as "what-if scenarios," engineers can virtually evaluate capacity, product mix and feasibility at current and planned facilities.

These applications also can be used to model work-flow at the work cell and production line level and to create balanced assembly sequences. In this way, companies can leverage existing capabilities to meet objectives and avoid unnecessary capital investments.

In addition, opportunities for concurrent design and manufacturing can be thoroughly analysed. **(SiemensPLMSoftware)**

3.3.3. Assembling, fenestration & outdoors systems

Key Words

Assembling: fit or join together the parts of fenestration

The use of the **production manual** is crucial for the proper assembly of the frame. During the stage of assembling the cut profiles into a window frame, the use of anti-corrosive agents along with a one or two component glue is imperative.

The fabricator should bear in mind that the critical areas of a frame for the initiation and propagation of corrosion are the machined sections.

Thus, application of a corrosion detergent agent (e.g. Weiss or other similar) should always be used.

One or two component glue should be applied to the mating surfaces prior to joining as well as over the finished joint, the result of which is a watertight and a aesthetically correct joint.

Figure 3.88. Treatment of cut surface

Prior to the installation of the crimping corner, a special crimping glue should be used in the profile chamber. The application of the glue should be such done in such a way and in such an amount that over spill of the glue through the crimping holes will be guaranteed.

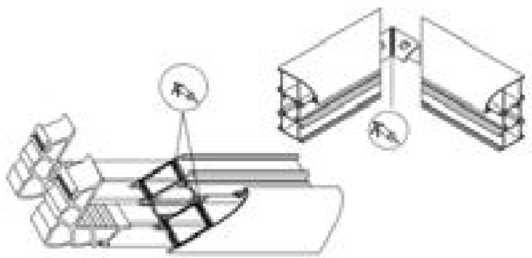


Figure 3.89. Application of glue profile chambers and alignment corner

The use of a glue is obligatory regardless of the type of joining corner used (e.r crimp / nail / screw / etc.). Structural integrity along with water tightness are greatly enhanced by its use.

In order to achieve a proper trimmed and matching profile joinery, a test cut, and assembly is always recommended. It is best practice to maintain et of customized cutting/milling tools for the profiles most commonly used, so as to be able to achieve the best join possible.

Figure 3.90. Example machining of a T-Profile.

The connection of T-profiles in achieved either with screws or with the use of special connectors depending on the system used. In any case, and upon connection of the profiles, the resulting joint must be properly sealed along its perimeter.

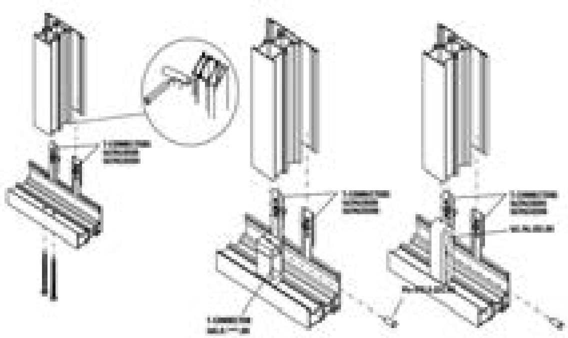


Figure 3.91. Connection ways for T-Profiles

The application of corrosion detergent agents during fabrication is imperative to the finished joint quality.

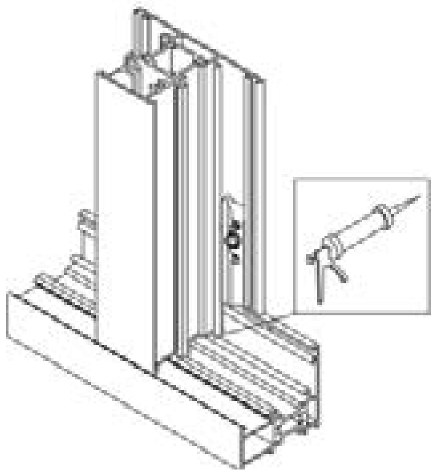


Figure 3.92. Sealing off a finished join

For dual leafed windows, a special profile called meeting style profile is used. During its installation, the following accessories depicted in the picture must be used. Special machining steps are not required for the installation the meeting style profile but fix in grand sealing of the profile onto the adjoining sash must always be done in accordance to the following schematic.

The cutting dimensions required for the meeting style profile can be found in each system's respective technical catalogue.

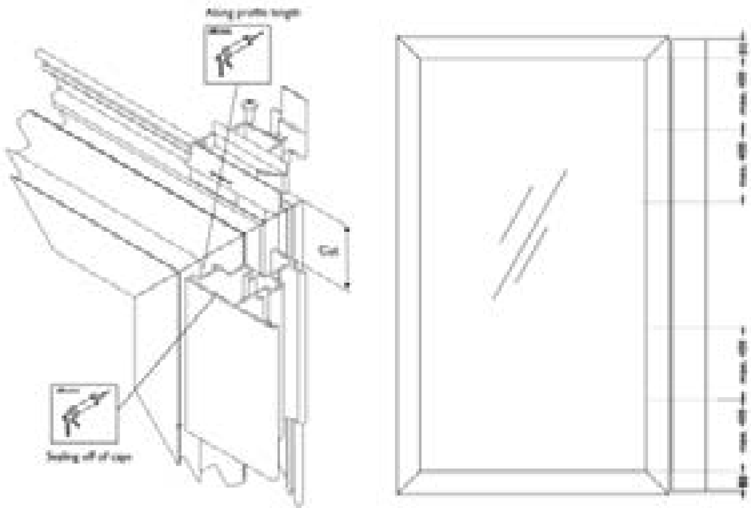


Figure 3.93. Installation of meeting style onto the sash – Fixing dimensions

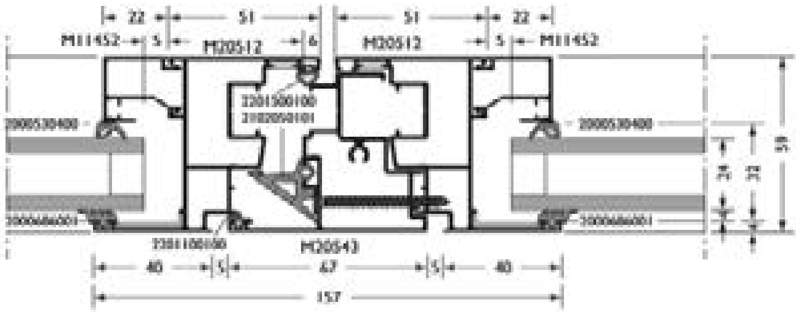


Figure 3.94. Fixing points

One the most important steps in a window fabrication sequence is that of **gasket** installation. Extra care should be taken during this process since gaskets are the most vital part of the system in terms of water/airtightness, sound proofing etc. Even the best window system, utilizing the best fabrication and installation techniques will be well below specs unless the proper gaskets are used. For the proper and efficient gasket installation, the following steps must be applied each time a gasket is installed:

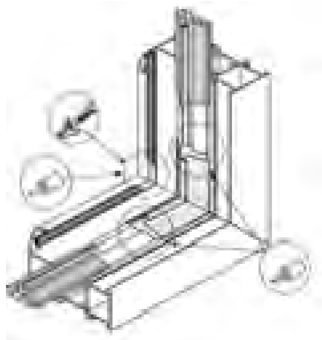


Figure 3.95. Gaskets installation

1. The central gasket must be cut and glued with extra care since it is the heart of the system, ensuring that no water will breach its plane. Nevertheless, and due to the fact that central gasket shapes are quite intricate and thus quite trivial in being properly cut at 45 degrees, the use of vulcanized corner gaskets is deemed as obligatory.
2. The glue which will be used for connecting the vulcanized corners, must be compatible with vulcanized gaskets and not just any plain glue. If an incompatible glue is used, the sealing capabilities of the window are dramatically reduced.
3. The external frame gasket is very carefully cut at 45 degrees and glued into place.

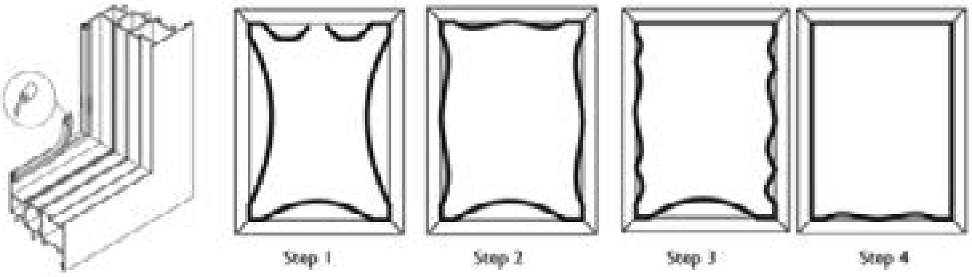


Figure 3.96. Installation of Glazing gaskets – steps

4. The external glazing gasket is carefully glued with a vulcanized glue.
5. The interior gasket is installed following the above shown 4 steps, while we take care that the two gasket ends are always at the top of the window (either at one of the two upper corners, or mid-way along the header profile).
6. The application of gaskets should be done using a special roller tool and not by hand. If applied by hand, they are overstretched and after a short period of time they will contract back to their original length thus either shearing their corner joints or popping out of their glazing channels.
7. The length of gasket must be 2-5% longest.

There are many products such as pergola, railing, photovoltaic bases where mounting is the simplest process. Practically, we fasten the pieces with special accessories.


Figure 3.97. Railing

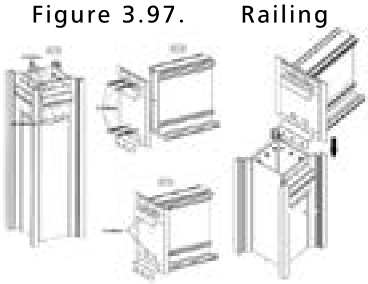


Figure 3.98. Pergola

Glazing and its proper installation is a very crucial part in the window manufacturing process. Regardless of the window type, the glass must never be in contact with the frame otherwise shattering through the mal shock will be inevitable.

The glazing dimensions should less than the available glazing space provided by the frame profiles by at least 5 mm on each side.

The basic c**asement fenestrations concepts**, should take into consideration the following:

- How large will the bend be
- It depends on the height and width of the beam.
- The more height it has, the less it will be the bend.
- The surface of the cross section is characterized by the so-called Moment of inertia - IX & IY

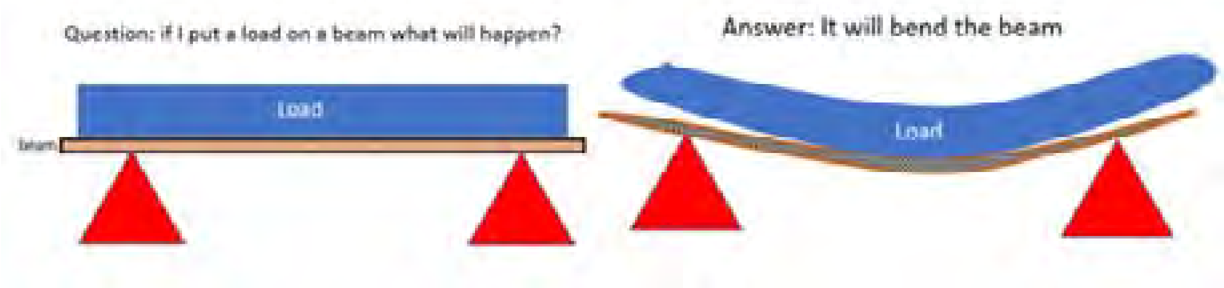


Figure 3.99. Load on beam

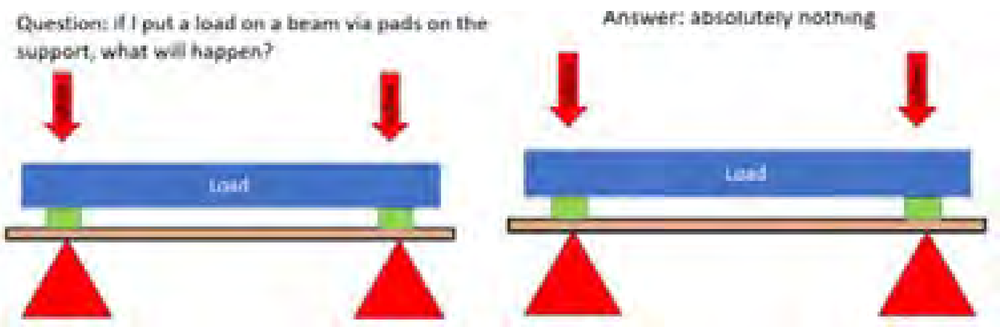


Figure 3.100. Load on beam with pads

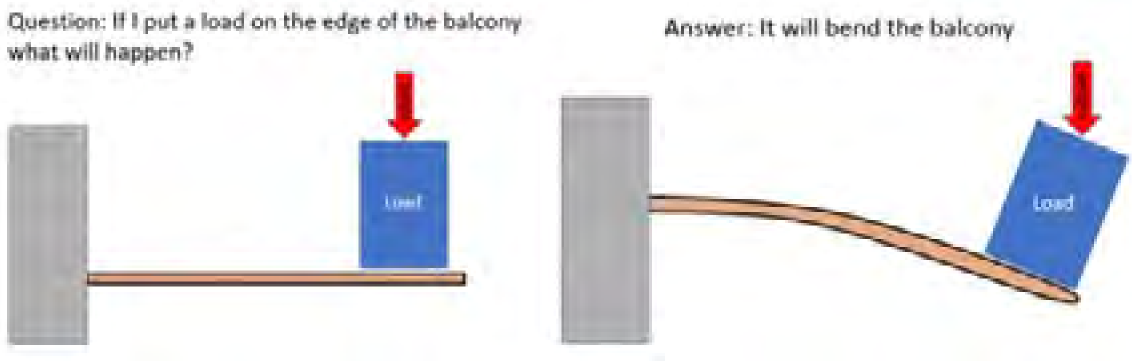


Figure 3.101. Load on the balcony

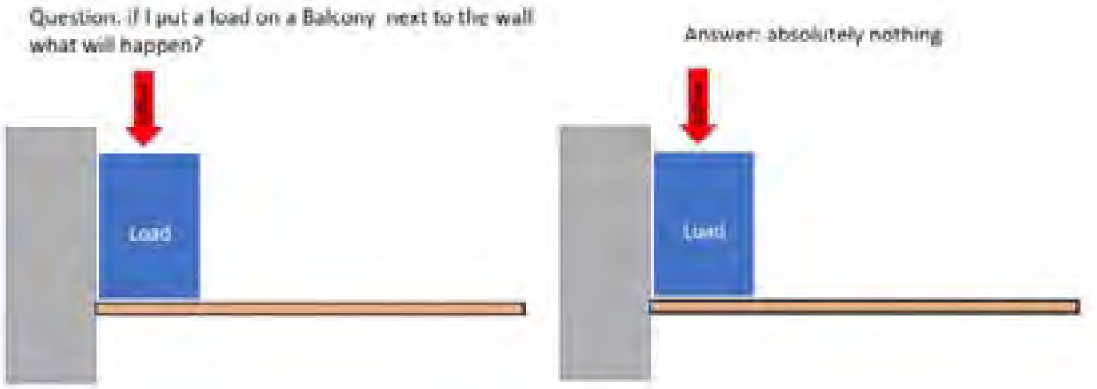


Figure 3.102. Load on the balcony

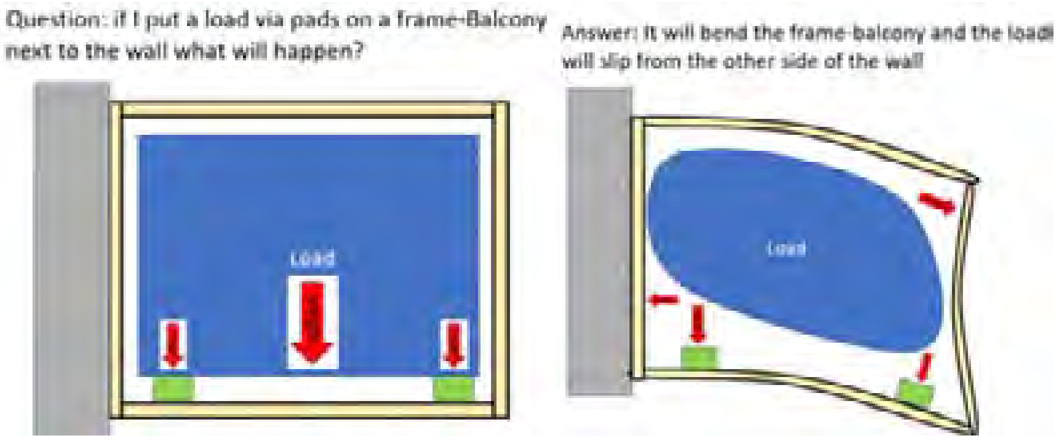


Figure 3.103. Load on the balcony

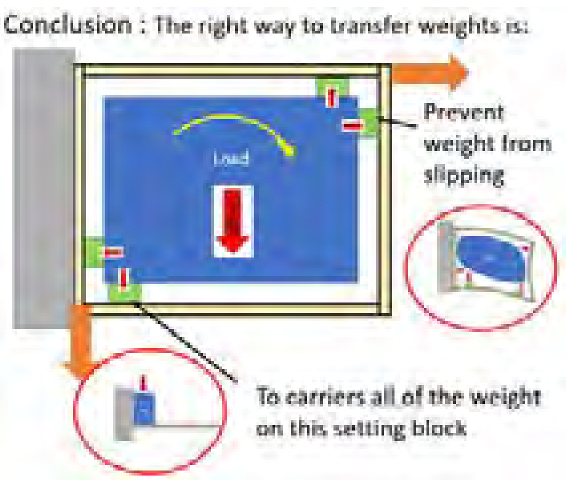


Figure 3.104. The right way to shimming

The pads carry the weight of the glazing pane, via of the frame, on the hinges. There are 2 different kind of using the pads:

1. carry the weight of the load,
2. help hold the sash shape.

The right mood of the first shim are the most important for the functionality of fenestration

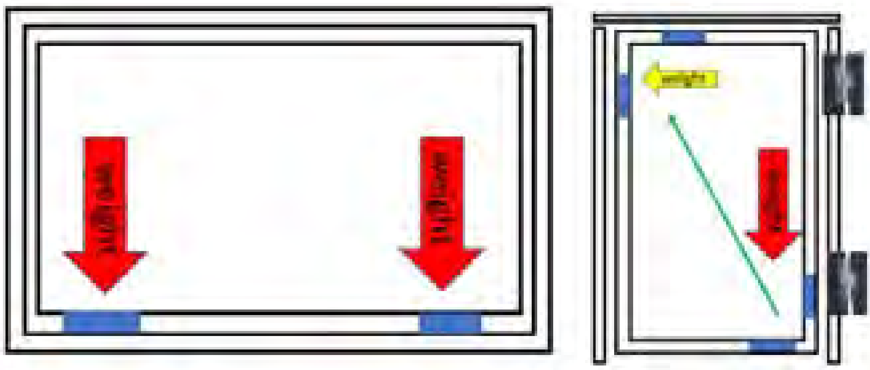


Figure 3.105. The right way to shimming Fixed & casement fenestrations

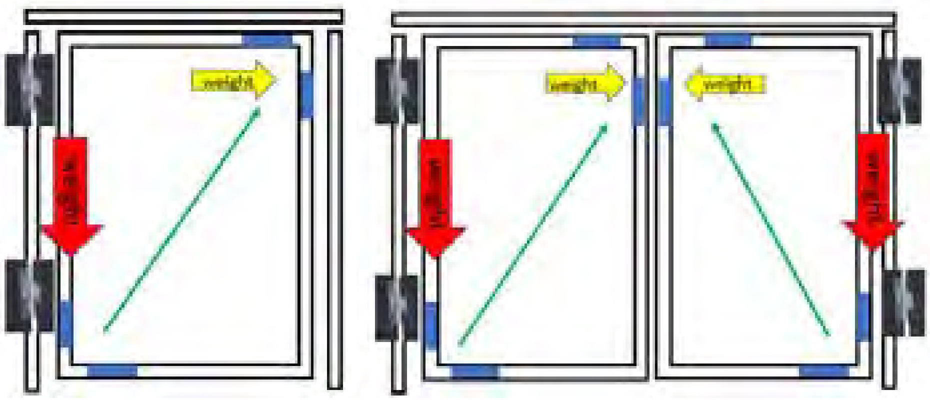


Figure 3.106. The right way to shimming casements fenestrations.

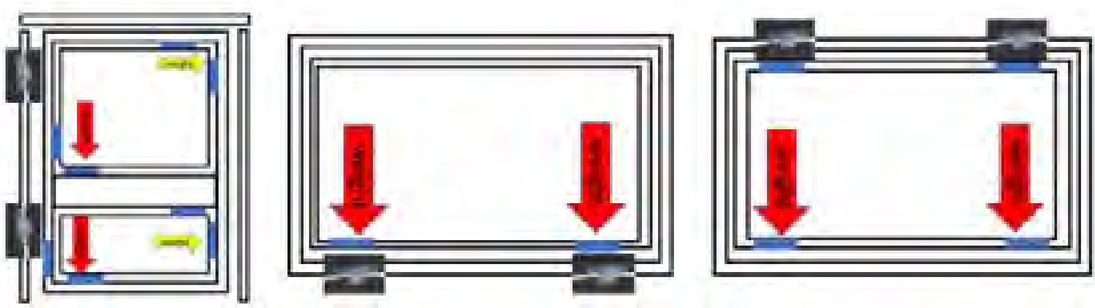


Figure 3.107. The right way to shimming casements fenestrations.

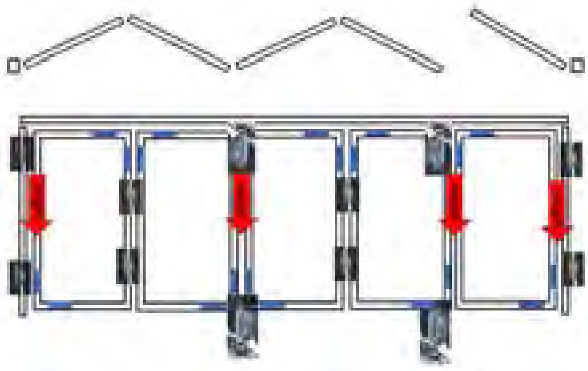


Figure 3.108. The right way to shimming folding door

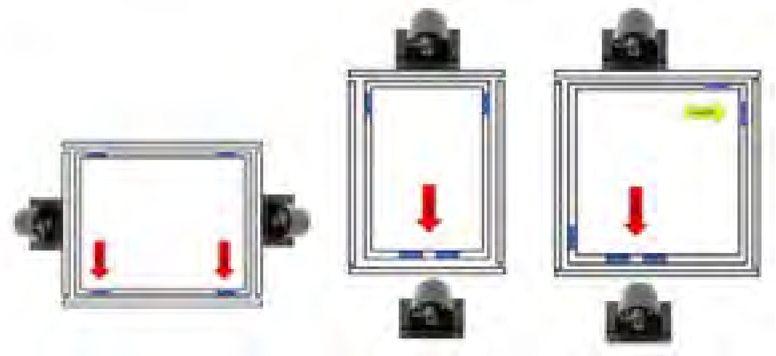


Figure 3.109. The right way to shimming pivoting door

The load on the pads is transferred to the rollers.

Figure 3.110. The load in sliding door

Side yellow pads serve when the sheet closes and strikes the frame, not to move.

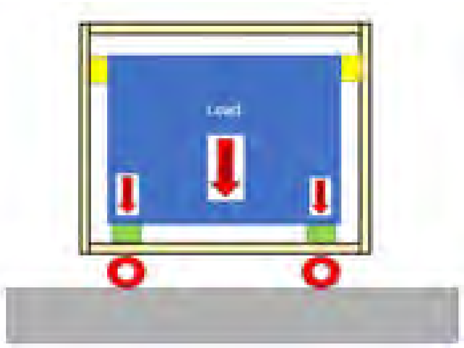


Figure 3.111. Loads in sliding door

Shimming curtain wall transom.

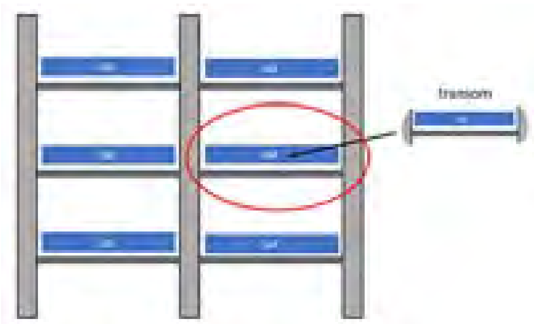


Figure 3.112. The load in CW

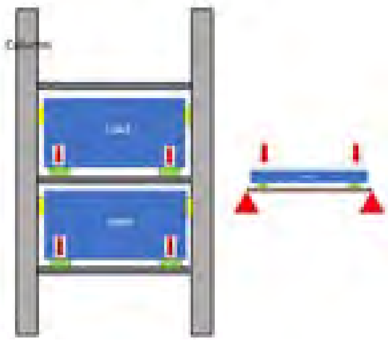


Figure 3.113. The load/pads in CW

The placement of the fillings and panels on the sheet of the frames was done in exactly the same way as the glass.

In contrast to the classic frames in which the glass is placed with gaskets, there is a special category where the glass is glued/sealed on the sash.

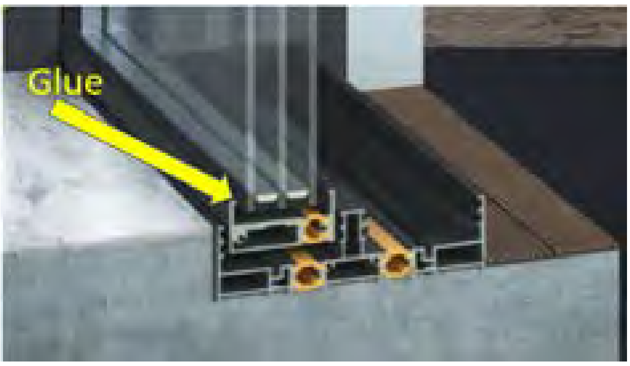


Figure 3.114. Glass is glued/sealed to the sash.

The procedure to be followed is:

1. Clean the glue from the glass so that there is smooth surface.
2. Place a primer on the surfaces to be glued, glass and sheet, for each surface different primer.

Figure 3.115. Clean the glue/sealant from the glass / Primer application

3. Use two components glue, to the sash in a special way (photo) on both sides.

Figure 3.116. Application of the glue/sealant

4. Immediately place the two sides of the sash on the glass.
5. Repeat the above work for the other two sides of the sash.

Figure 3.117. Finish the sash

6. Screw the sides of the sash.
7. A gasket is placed on both sides, inside and out, between sash & glass, to secure the glue until it dries.

Figure 3.118. Screw the sides of the sash & placed gasket on both sides

8. Control the diagonals of sash.
9. It remains for as many hours as to dry the glue

There is also panel mounting on the sash with glue (instead of gasket) on the outside. The steps to be followed are:

Figure 3.119. Fenestration with glued/sealed panels

1. Clean the surface of the frame and the panel to be glued with a different primer.

Figure 3.120. Cleaning the surface with primer

2. A special double-sided adhesive tape is applied.

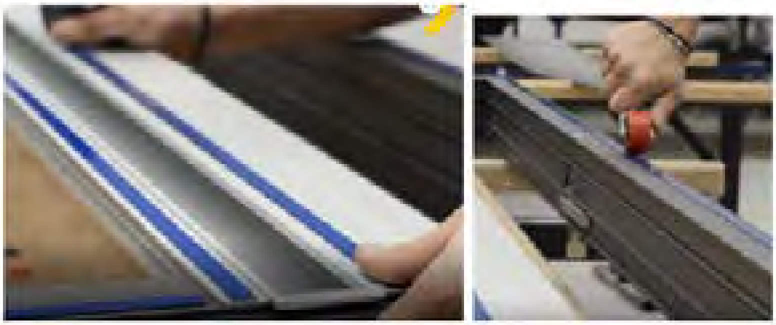


Figure 3.121. Application of an adhesive tape

3. Special glue is applied, and the security paper is removed from the film.

Figure 3.122. Glue/Sealant application

4. The panel is installed

Figure 3.123. Panel installation

5. The door is placed in a press for 12 hours.

Figure 3.124. Pressing door panels

There is also **glazing panel mounting** on the sash with glue on the outside. In practice, the process is the same, but there is now a profile, with silicate, to absorb moisture between the gap of the two panels. On the surface where the glass sticks to the profile, the glass must be painted to be aesthetically pleasing.

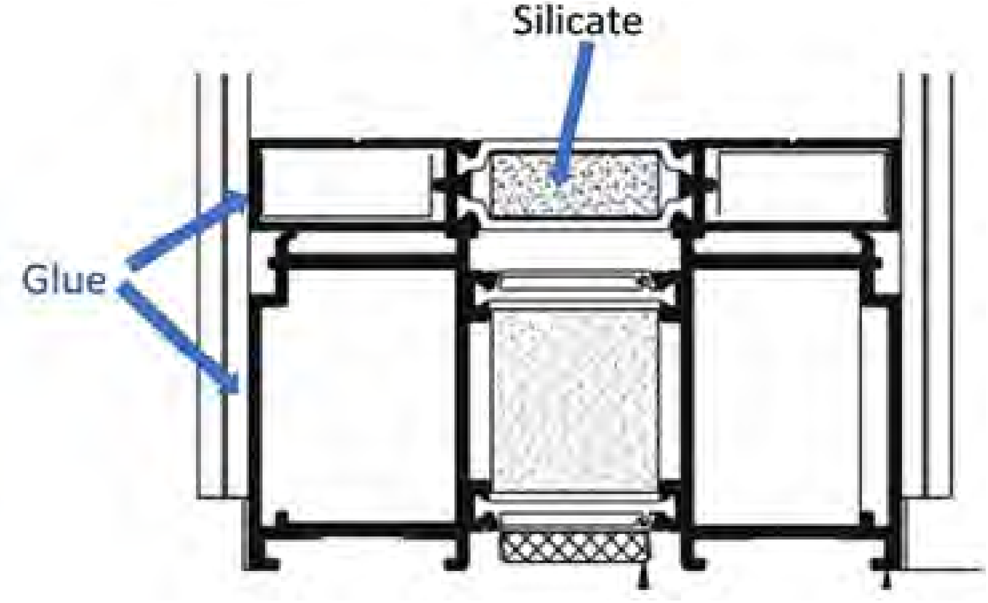


Figure 3.125. Cross section of a door with glazing panels

3.4. Quality control experience. Work monitoring & evaluation. Implementing health & safety practices

Key Words

Quality: degree to which a set of inherent characteristics fulfils requirements

Quality Management: coordinated activities to direct and control an organization

Quality assurance: part of quality management focused on providing confidence on quality requirements to be fulfilled

Quality control: part of quality management focused on fulfilling quality requirements

Quality management system: system to direct and control an organization's quality

Factory Production Control (FPC): permanent, internal production control conducted by a manufacturer, according to the relevant harmonized standards

Process: set of interrelated or interacting activities which transform inputs into outputs

Procedure: specified way to carry out an activity or a process

Specification: document stating requirements

Product production process: any industrial process or action performed with main objective the development or completion of each phase for a product creation

To be achieved upon learning outcome completion

KNOWLEDGE	SKILLS	COMPETENCIES
• Health and safety practices • Ways of archiving and monitoring the implementation of the work	• Implement health and safety rules at work • Carry out work assignments autonomously and work as part of a team according due consideration to the relevant regulations and safety provisions and on the basis of technical documentation and work orders • Document work and initiate quality assurances measures and measures for health and safety at work and environmental protection • Safely package the products for transport • Organize the file of each completed project	• Implement all protective measures at work • Apply file creation to track and record each task

3.4.1. Quality control

Quality control is a key element for the completion of a construction. Controls will be conducted in accordance to specific standards and carried out in a well-structured manner. The factory production control system should be established and implemented by every manufacturer. This system should provide an organizational chart of the company, analysing the responsibilities of personnel and describing the way important tasks are executed and documented. The most important element of the factory production control system maybe the file documentation, which will be used to testify its correct application.

Figure 3.126. An inspector in charge of quality control

Referring to Quality we usually refer to elements which characterize it, using for this reason, aesthetic, taste, technical or other standards, but it is difficult to express the full dimension and give a full definition. In simple words, we can say that quality is the implementation of an agreement between a Customer and a Supplier.

To achieve the quality of the product, companies have developed quality control and management systems. Company's Quality Policy is at the top of a Quality Assurance system, as it is the reference point for the quality system development, while the base of the system consists of the development and implementation of written working instructions and the documentation of quality controls.

The basic requirement for a successful development of a Quality System in any company is the development and management of the Quality Control. Quality control is the "heart" of every Quality System establishment and it mainly includes:

- Incoming and raw materials controls
- Final controls
- Intermediate controls
- Processes controls (e.g. adequacy of used equipment or production operations, etc.)

It is worth noting that the cost of the final control, or the random quality controls, as the sole process under which products are been checked, leads to a considerable loss of money for any business, because the problems are identified after their creation.

There is a significant difference between quality assurance and quality control: By quality assurance it is ensured that the design, the production, the inspection and the control have been completed in accordance to certain standards, while quality control refers to the actual physical actions taken e.g. inspections, measurements and tests.

Any proposal relevant to the product quality improvement is suggested to follow the sequence that is known as quality circle **PDCA** (Plan)- (Do) - (Check) - (Act) (see Figure below).

Plan how to improve the quality, apply the plans and manufacture the product, check the results of the effort, and take the necessary actions according to the success level of the results.

The quality cycle is repeated as many times required until the result i.e. the desired product's quality has been achieved.

Figure 3.127. Quality cycle (Deming cycle)

The control and improvement of quality can be achieved by applying a factory production control system according to the requirements of the relevant harmonized standard or with the establishment and implementation of a quality management system according to ISO 9001 standard.

Every company, based on the above quality cycle, should integrate into its culture the philosophy of continuous improvement. The PDCA cycle should be applied spirally repeatedly, continuously increasing the knowledge of the system, in order to achieve the ultimate goal. We could associate/compare it to a spring where each loop is a PDCA cycle and each complete cycle indicates an increase in our knowledge about the system.

Quality management systems according to ISO 9001 standard, have as a purpose to make companies adopt the processes of continuous improvement, in order to increase customer satisfaction and prosperity of the business.

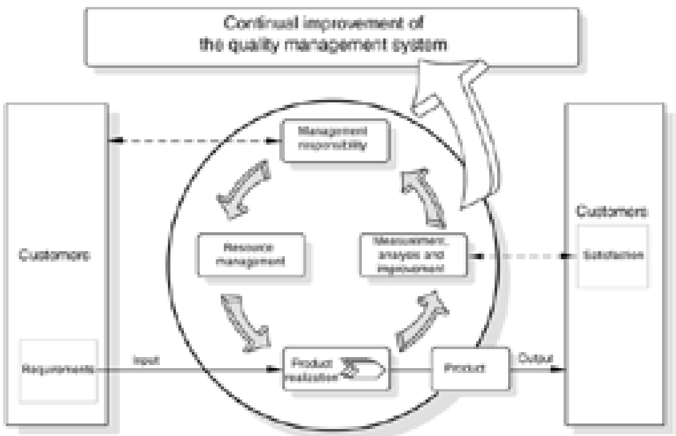


Figure 3.128. Continual improvement according to ISO 9001 requirements

For the best and more efficient operation of the quality control system and the business in general, there should be an elementary organizational chart showing all the various departments of the company, according to the way it is organized and its operating needs. For the higher-level jobs which are more important, there should be a documentation of the main responsibilities and duties of the people holding these positions, such as:

- General Manager
- Administration Department
- Production Department
- Installation Department

As an example, we mention some of the responsibilities that the Head of the Factory Production Control system should have:

- Company's policy implementation
- Company's procedures & working instructions application
- Required controls execution
- Profiles cutting
- Constructions final quality control
- Work assignment to the production technicians (what to whom!)
- Factory Production Control system supervision
- Quality Control of Incoming Products
- Mechanical equipment maintenance

Most of us have observed in various types of products (e.g. toys, electrical appliances, mobile phones, etc.) the **"CE" mark**. The CE marking is a mark placed on certain categories of products and confirms that the product is safe and complies with the European Legislation.

CE marking is the products' passport for the European market and applies only to product categories for which there has been a relevant legislation issue by the EU. Essentially, CE marking is the product's identity.

According to the above, the European legislation in conjunction with the European standards are of particular importance. For the declaration of performance of the essential characteristics for construction products (Construction Products Regulation 305/2011), the manufacturer should follow one of the five systems of assessment and verification of constancy of performance, which are:

- System 1+
- System 1
- System 2+
- System 3
- System 4

For steel structures, we must take into consideration the Eurocodes which fall within the bearing structures and metal parts to be used in bearing structures.

According to section 6 EN 1090-1 standard, "any steel structure construction company must have a fully documented Factory Production Control (FPC)".

Factory Production Control (FPC), specifies requirements for the design and design controls, staff qualifications and training, equipment maintenance and calibration, control of non-conforming products and documentation.

If a company is certified according to ISO 9001, it should fully meet the above requirement for Factory Production Control compliance, also including requirements of EN 1090 and ISO 3834 standards.

EN ISO 3834 standard specifies the requirements for welding quality and has been prepared in order to identify the necessary controls and procedures. It is accompanied with six standards, which determine both the specific quality requirements of various construction risk categories, and how to apply the requirements in each execution category (EXC1, EXC2, EXC3 and EXC4).

We could state that for products CE marking, all standards require the following steps as they are presented in Figure.

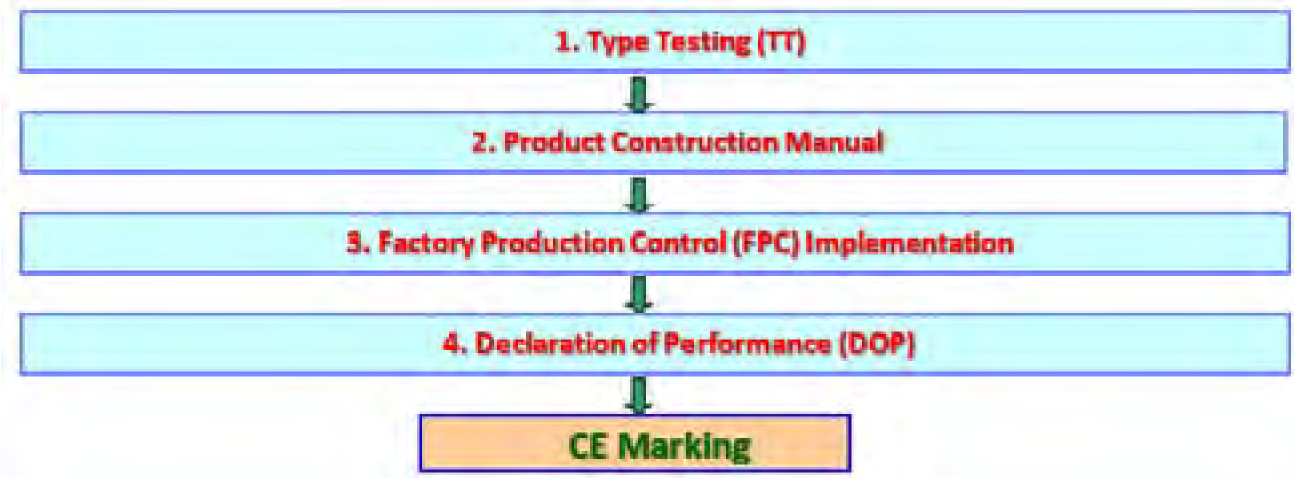


Figure 3.129. Basic steps for CE marking

Harmonized standards are European standards, which are adopted by European standardization bodies (e.g. CEN, CENELEC, ETSI), prepared in accordance to the general guidelines agreed between the Commission and the European standards organizations, and follow a mandate issued by the Commission after consultation with Member States.

As an example, we can mention the essential harmonized standards that are applicable for some of the most known aluminium construction products:

- EN 14351-1: «Windows and doors - Product standard, performance characteristics – Part 1: Windows and external pedestrian doorsets without resistance to fire and/or smoke leakage characteristics»
- EN 13830: «Curtain walling. Product standard»
- EN 13659: «Shutters and external venetian blinds. Performance requirements including safety»
- EN 13561: «External blinds. Performance requirements including safety»
- EN 1279-5: «Glass in building. Insulating glass units. Evaluation of conformity».

The manufacturer can cooperate with external bodies - laboratories which will carry out inspections and tests to certify the performance of the products.

So, he can test components like rollers, locks, tilt mechanisms, doors and windows (resistance to wind load, water tightness, air permeability etc.) the welding quality with destructive or non-destructive tests etc.

The benefits for a company been certified according to the previous mentioned standards are many, and most important are the following:

- Declaration of Commitment on compliance with European and international standards.
- Proof of the effectiveness and efficiency of manufacturing processes.
- Company's staff capability demonstration

Factory Production Control (FPC) system implementation is mandatory and ensures that the level of performance reached during Type Testing apply to all other similar products which are produced by the manufacturer.

The relevant requirements for factory production control are referred to each harmonized standard. Paragraph 7.3 of EN 14351-1 standard specifies the FPC requirements for doors and windows manufacturing companies regardless of the construction material (aluminium, iron, wood, plastic).

Manufacturers having an FPC system which complies with EN ISO 9001 and which addresses the requirements of this standard are recognized as satisfying the FPC requirements.

Factory Production Control requirements according to EN 14351-1 (§7.3) are the following:

- **Personnel.** The responsibility authority and the relationship between personnel that manage, perform or verify work affecting product conformity, shall be defined. This applies in particular to personnel that needs to initiate actions preventing non-conformities from occurring, actions in case of non-conformities and to identify and register product conformity problems. Personnel performing work affecting product conformity shall be competent based on appropriate education, training, skills and experience for which records shall be maintained.
- **Equipment.** Weighing measuring and testing equipment shall be calibrated and regularly inspected according to documented procedures, frequencies and criteria.
- **Manufacturing.** Equipment used in the manufacturing process shall be regularly inspected and maintained to ensure use, wear or failure does not cause inconsistency in the manufacturing process. Inspections and maintenance shall be carried out and recorded in accordance with the manufacturer's written procedures and the records retained for the period defined in the manufacturer's FPC procedures.
- **Raw materials and components.** The specifications of all incoming raw materials and components shall be documented, as shall the inspection scheme for ensuring their conformity.
- **Production process.** The manufacturer shall plan and carry out production under controlled conditions. The FPC system shall document the various stages in the production, identify the checking procedure and those individuals responsible for all stages of production. During the production process itself, a record shall be kept of all checks, their results, and any corrective actions taken. This record shall be sufficiently detailed and accurate to demonstrate that all stages of the production phase, and all checks, have been carried out satisfactorily.

- **Product testing and evaluation.** The manufacturer shall establish procedures to ensure that the declared values of all the characteristics are maintained. The means of control are:
  - test and/or inspection of non-finished products or parts hereof during the production process.
  - test and/or inspection of finished products.
  - test and/or inspection shall be performed and evaluated in accordance with a test plan (including frequencies and criteria) prepared by the manufacturer and in accordance with any suitable part of relevant test standards.
- **Traceability and marking.** Individual products or product batches shall be identifiable and traceable with regard to their production origin. The manufacturer shall have procedures ensuring that processes related to affixing traceability codes and/or markings are inspected regularly.
- **Non-conforming products.** The manufacturer shall have written procedures which specify how non-conforming products shall be dealt with. Any such events shall be recorded as they occure and these records shall be kept for the period defined in the manufacturer's written procedures
- **Corrective action.** The manufacturer shall have documented procedures that instigate action to eliminate the cause of nonconformities in order to prevent recurrence.

As it is understood FPC shall consist of procedures and working instructions which will set workflows, as well as any construction details and quality control of product. FPC implementation has to be documented by using appropriate forms and keeping records. FPC could be developed as a pyramid shape as presented in the figure below. It should be noted that quality management systems according to ISO 9001 have similar development structure (pyramid shape), where at the top stands the quality policy which is devised and implemented by each company.

Figure 3.130. Factory production control development as a pyramid shape

Every company's Factory Production Control system should describe in detail the requirements of standards and legislation, having been simplified so it adapts to the real needs of every construction site.

The right "setup" during FPC establishment, will help every company in continuous application. We should not forget that the FPC should be applied to each project undertaken by the company.

The FPC implementation does not mean that the manufacturer has to make products in any different way than he already did until now. It means that he must learn to record all the controls he applies at every step of the production process. By this way, the reliability of his work is documented and is protected against possible sanctions.

Technical manuals of system house are an integral part of the Factory Production Control system for windows manufacturing. Technical manuals describe the construction details for each series, which must be followed accurately, in order that the manufacturer can reproduce products with the same performance level compared to that achieved during type testing.

Traceability of products and materials - components is a very important point and makes the manufacturer able to recall a product if a problem arises.

Product recall can be done by publicizing the problem and by visiting building sites where non-conforming products have been installed, in order to examine and address non-conformities.

For every project undertaken by the manufacturer there should be a proper check of supplied raw materials according to the relevant specifications.

The manufacturer should issue a purchase order to the supplier, where any requirements, for the materials he intends to buy, would be clearly outlined. When materials arrive at the company, the requisite controls should be carried out (visual, dimensional, etc.) and should be documented properly (e.g. signature on the raw materials purchase order).

Materials that are mainly involved in these constructions are:

- Aluminium profiles
- Hardware: rollers, locks, brushes, connection corners etc.
- Auxiliary materials: screws, sealants etc.
- Roller shutters, insect screens, glazing
- Other materials

As an example, we could mention an aluminium profile purchase order. The manufacturer calculates the required profile for windows construction according to the requirements of each project and then he orders the necessary quantities.

The profile purchase order should be as clear as possible by reporting all the required technical specifications like quantity, profile codes, electrostatic painting or anodizing code.

During the delivery of profiles, the manufacturer should carry out quality and quantity control by checking indicatively the following:

- The profiles quantity by taking appropriate measurements (length or weight)
- The profile codes and their technical characteristics (e.g. cross-sectional shape)
- The surface treatment colour (electrostatic painting / anodizing) and the thickness of the electrostatic painting (if he has the suitable equipment)
- The geometry of the received profile (visual check for profile deflection)
- The profiles surface for nibs, oxidations, dents, scratches, unpainted parts by visual inspection.

During windows production there should be checks at intermediate stages of manufacture and at the end product. The final control is required for product release from the manufacturer's premises. Final control and product release approval is usually done by the Head of Factory Production Control System. Possible control stages during the production of aluminium windows can be:

- Cutting of aluminium profiles
- Weep hole machining
- Machining for mechanisms, joining corners etc.
- Crimping
- Gaskets gluing / brushes installation
- Mechanisms and accessories
- Window framing
- Glazing installation
- Roller shutters installation (if it is specified)
- Final quality control
- Packaging

If the quality auditor identifies deviations in any of the above steps, he should take the necessary corrective actions immediately. Additionally, it is considered very important the manufacturer's ability to take preventive action so that none such or similar problem reappears.

Measuring and control instruments, used for production monitoring, should be calibrated at regular intervals, to ensure their capability for correct measurements. The manufacturer's ability to provide the necessary, appropriate facilities and equipment is also very important. Finally, we should not forget the appropriate conditions for employee's health and safety.

3.4.2. Health and safety good practices

The vast majority of workplace accidents are preventable. Typically, they occur when an individual doesn't understand the risks associated with their actions, they haven't been provided with sufficient training, or when suitable safety equipment is not provided. This means the most powerful Health and Safety tool at your disposal is training.

Training is much like a suit of armour: if there is a weak link anywhere in the chainmail it could prove disastrous or potentially deadly.

It takes one individual who has not been provided with health and safety training to put everyone else at risk.

Consequently, every employee on site who is exposed to potentially dangerous equipment, machinery, substances, or work practices needs to be schooled in **Health and Safety**.

Manufacturing employees should be put through a mandatory induction course that predominantly focuses on Health and Safety.

Risks exist at every stage of the manufacturing process. Since manufacturing employees work in ways that are potentially quite dangerous, we often forget about the risks associated with less dangerous work. Just because an employee is not operating heavy machinery, does not mean that they are not exposed to risk.

Contrary to popular belief, Health and Safety law does not stipulate that employers must remove all risk from the workplace. In reality, this would be impossible. Instead, it states that employers must do what they can to minimize risk as much as is reasonably practicable.

This means that **employers are not responsible for predicting every workplace accident**.

They are only legally responsible for those risks that they could reasonably anticipate and avoid. Granted, this is a lot more difficult in the manufacturing industries, as there are many more risks to consider, but employers are not expected to make the workplace entirely hazard free.

Figure 3.131. Management risk

A Health and Safety policy should list the various risks identified in the Health and Safety survey. It should then detail how the company is going to act to mitigate these risks and limit employee exposure to danger. Finally, it will name the individual responsible for ensuring these actions are carried out and for the overall monitoring of that aspect of Health and Safety.

Health and Safety is not a one-way process. When drafted in the most effective manner, it's a multi-party dialogue between employer, employees Health and Safety specialists, and other relevant organizations.

As with most things, the broader range of perspectives you gather, the more complete a picture you have. All manufacturing companies should consult their employees on Health and Safety practices. Primarily, this is because they work on the front line and understand the day-to-day dangers, they face better than anyone.

This consultation can occur in many ways. Employers can have informal conversations with individual employees. They can dedicate a part of the monthly meeting to safety concerns.

They can have an anonymous submissions box.

Every type of manufacturing job depends on specialist equipment and facilities. Without this specialist equipment, employees are put in an unreasonable amount of danger, and the work should not be carried out. However, it's easy to forget about the maintenance of equipment and facilities or to lose information detailing when they should be checked or replaced.

A comprehensive list of safety equipment should always be collated and kept safe.

This should detail the manufacturer and model, the purchase date, the maintenance date, any information about faults or concerns, and a suggested replacement date. Likewise, information relating to safety facilities should be kept up to date. This includes welfare facilities, such as toilets and bathrooms, as well as canteens, changing rooms and accommodation.

If an employer takes an easy approach to Health and Safety in manufacturing, results in putting his/her employees in danger. Health and Safety policies need to be workplace specific, and they need to take the peculiarities of each industry into account.

3.4.3. Project documentation and monitoring

There are two main reasons why we should monitor our work:

1. Collect all the data we need,
2. Check and follow the planning (deliveries, financial, etc.)

It is, therefore, very important to monitor the progress on the work to ensure it does not get too far from your original plan. Once you veer away from your plan, it can be very difficult (sometimes impossible) to get things back on track with the original plan. As with other aspects of the project, you must determine the frequency in which you are going to monitor project activities. Monitoring is really an on-going activity; however, you must strike a balance between how much time you spend tracking activities (you do not want to micro-manage your team) and the value of the effort.

Regular progress reports or weekly/monthly meetings are an effective way to help you in the monitoring of production. Progress reports do not have to be formal or pretty; just a clear concise listing of important points will do. If possible, try to hold regular status meetings at predetermined days/times to allow people to be prepared.

A general guideline that will work well for most projects is: No more than once per week, but no less than once per month. Throughout the project communicate, communicate, and communicate. Good communication is a major key success factor of any project. Giving your stakeholders access to information is a vital part of any project communications strategy.

The major purpose of project management is to align and motivate people. Also, constant feedback to your team members can help the success of your project. Feedback should be specific (not general and vague) and it should always include everyone that worked on a particular portion of the work.

As mentioned earlier, to be a good communicator, you must be a good listener first. So, listen intently to your project team — your team members will appreciate that you value their opinions and encourage discussion. Listening also is very useful as it provides you feedback on whether your team members understand your messages.

The following are the three main steps of programming monitoring:

1. **Schedule progress:**
    - What is the status of the activities that have been scheduled (per week, month etc.)?
    - How are activities progressing? Ahead, behind or on-schedule?
    - Are any course corrections required?
2. **Budget:**
    - How much of the budget have you spent to date?
    - How much is remaining?
    - Do you have a revised estimate to complete the work?
3. **Scope:**
    - Is your team working on activities that are in-scope or out-of-scope?
    - Have any changes occurred that will require a scope addition?

All work must be recorded in order to have statistics for each job- work place such as cutting, processing, mounting time, etc. The records are for every frame-construction typology so that in the end we can have the real cost of construction or work. Below are two tables with data:

Machining	Time
Machining	Time
Single saw: time to cut a piece	30 sec.
Double saw: time to cut a piece	15 sec.
Processing press: punching time	10 sec.
Gutter or vent on the sheet with a milling cutter	30 sec.
Glue mounting and corner closure in crimping machine	1,5 min.
Corner: Angle time per corner	1 min
Screw angle: mounting and screwing time per angle	40 sec.
Mounting gaskets on a rolling sheet	2 min
Mounting gaskets in an opening case	3 min
Fitting brushes in sliding frame	2 min
Mounting brushes on sliding sheets	3 min
Mounting single-leaf 16 mm mechanism	3 min
Euro groove mechanism single-leaf mounting	5 min
Mounting mechanism on sliding sheet	9 min
Mounting roller on sliding sheet	3 min
Placing glass in an opening	2 min
Single saw: time to cut a piece	1 min
Double saw: time to cut a piece	1 min
Processing press: punching time	2 min
Gutter or vent on the sheet with a milling cutter	2 min
Glue mounting and c corner closure in crimping machine	5 min
Corner: Angle time per corner	6 min
Screw angle: mounting and screwing time per angle	2 min

Table 3.11. Assembling time for each step of production

Typology of fenestration	Time
Opening single leaf window	60 min
Opening single door	65 min
Opening double leaf window	100 min
Opening double door	125 min
Lift-sliding door	140 min
Sliding door 1 leaf	50 min
Sliding door 2 leaves	90 min

Table 3.12. Assembling time for each typology

03 MODULE Conclusions

The construction of each project and the quality control should be carried out according to specifications and carried out in a well-structured way, because it is a key element in the completion of a proper construction product.

The construction of each project and the quality control should be carried out according to specifications and carried out in a well-structured way, because it is a key element in the completion of a proper construction product. The manufacturer should apply good manufacturing practices and should follow all the manufacturing details contained in the technical manuals of the system producer.

Each manufacturer should install and implement a factory production control system in accordance with the requirements of the relevant harmonised standards. The factory production control system should describe the flow of work within the undertaking and how it is carried out. Particular care should be taken to keep the appropriate records so that the application of the factory production control system could be documented.

The CE marking is a legal and regulatory requirement for all construction products. European Regulation 305/2011 lays down the requirements for the free movement of construction products within the European Union and introduces certain changes to those currently applicable to CE marking. In products made of aluminium (doors, windows, shutters, screens, etc.) CE marking has been mandatory for years. Each manufacturer of aluminium systems shall be obliged to comply with the requirements of the harmonised standards as they apply to each product.

Self Assessment Questions

Improvement begins with assessment.
Self Assessment is the first step to all assessment.
Start by choosing the correct answers.

1. Why do technicians need communication skills?
    a. for understanding customer/project needs
    b. to earn more money
    c. it is mandatory by law
    d. to understand plans

2. What is the most important communication skill?
    a. speaking
    b. listening
    c. learning
    d. taking notes

3. What is non-verbal communication?
    a. written communication
    b. verbal communication
    c. non-verbal communication
    d. visual communication

4. Why architectural plans are important to craftsmen?
    a. to know the house surface
    b. to see the space
    c. to recover the frame's measures for offer
    d. to know the name of architect

5. Why metric scale is important?
    a. for the costs
    b. for the typology
    c. for the real dimensions
    d. for the quantity

6. Can we understand the typology of fenestrations in an architectural plan?
    a. yes
    b. no
    c. it depends on the typology
    d. it depends on the architect

7. What is law 305/2011 about?
    a. the European Union legal requirement in the field of Construction
    b. the USA legal requirement in the field of Construction
    c. the European Union legal requirement in the field of transportation
    d. the European Union legal requirement in the field of medicine

8. What is the certification of resistance to wind load about?
    a. the strength of the glazing to wind
    b. the durability of the mechanism
    c. the durability of the accessories
    d. the strength of the frame to wind

9. On which parameter does the method of measuring wind resistance depend on?
    a. colour
    b. dimensions
    c. deflection
    d. accessories

10. How many categories of deflection are there?
    a. 1
    b. 2
    c. 3
    d. 4

11. What does NPD as assessment mean?
    a. very hight performance
    b. it is the name of a law
    c. medium performance
    d. no Performance Determined

12. What are the 2 options that make water tightness test?
    a. fenestrations shielded & not shielded
    b. fenestrations hight & small
    c. fenestration of 2 different colours
    d. fenestration of different typologies

13. What does shielded fenestration mean?
    a. in a bathroom
    b. in a matrimonial room
    c. under the balcony
    d. in the ground

14. What does classification in weather tightness 5A mean?
    a. withstands pressure up to 200 Pa
    b. withstands pressure up to 300 Pa
    c. withstands pressure up to 400 Pa
    d. withstands pressure up to 500 Pa

15. What does frame air permeability test measure?
    a. the total surface area
    b. the frame area
    c. the total surface area and their joints
    d. the joints

16. How many classes of air permeability are there?
    a. 2
    b. 3
    c. 4
    d. 5

17. What is CE marking about?
    a. quality
    b. identity
    c. colour scheme
    d. measurement unit

18. What should the manufacturer issue according to Regulation 305/2011?
    a. declaration of conformity
    b. declaration of performance
    c. declaration of product
    d. all of the above

19. When should quality controls be carried out?
    a. during raw materials receipt
    b. in intermediate production stages
    c. before product release from the company's premises
    d. all the above

20. How should the CE marking be displayed?
    a. as the customer wishes
    b. as the manufacturer wishes
    c. it is defined by law
    d. it depends on the product

21. Why is CE needed?
    a. to know the price
    b. to know the fabricator
    c. for the legal circulation of products in the markets
    d. for quality

22. How many years should a manufacturer maintain a record (hard-copy or digital) according to the technical documentation?
    a. 2
    b. 3
    c. 5
    d. 10

23. Where should CE marking be affixed?
    a. on the fenestration
    b. in the contract
    c. given to lower
    d. on the entrance

24. How many years should product's instructions for use and maintenance be kept?
    a. 5
    b. 10
    c. 15
    d. 20

25. What is the main cause of having a showroom?
    a. it is mandatory by law
    b. to sell in higher prices
    c. to show products to the customer
    d. to make more sales

26. Why should we have fenestrations samples?
    a. for the customer to understand the product
    b. to see the colours
    c. to see the glass
    d. it is mandatory by law

27. What should be considered as a proper appearance of a seller?
    a. wear expensive clothes
    b. be nicely dressed and clean
    c. have work clothes
    d. It doesn't matter what he/she looks like

28. Why is it difficult to sell a window?
    a. because of its many colours
    b. because of its different systems
    c. because it is expensive
    d. because we must get the “recipe” first and then sell it

29. What does local marketing help with?
    a. prices
    b. quantity of the products
    c. quality
    d. customizing marketing to different channels and audiences

30. In what way does software help with the cost of materials?
    a. to have better prices
    b. to have precise results concerning items, quantity and price
    c. to have the specials items
    d. to find the suppliers

31. How many costings are there?
    a. Complete, partial & ABC (Activity Based Costing)
    b. Partial costing
    c. Complete costing
    d. Medium costing

32. What kind of data is needed for costing?
    a. prices
    b. quantities, labours
    c. fixed and variable cost
    d. all the above

33. What is the advantage of ABC costing?
    a. it distributes the costs to each product
    b. it is easier to apply
    c. it takes less time
    d. It is costless

34. What is the simplest method to make a price list?
    a. cost + tax
    b. cost + labour
    c. cost + profit
    d. cost + labour + tax

35. What is B2C sales?
   a. sales to consumers
   b. sales to staff
   c. sales to public service
   d. wholesale

36. How does accounting help?
   a. to know clients
   b. it is very important in planning
   c. to know the suppliers
   d. to pay the staff

37. Why is it important to use a computer?
   a. for wording
   b. for costing and offers
   c. for internet use
   d. for payments

38. Why is software use important for production?
   a. it provides used codes, quantities and optimization
   b. it calculates the cost
   c. it provides the debit balance
   d. it is mandatory by law

39. What does the final offer include?
   a. the raw materials
   b. the labour
   c. the raw materials and labour
   d. the raw materials, labour, overhead cost & profit

40. What must be given with the offer?
   a. a gift
   b. the fenestration's dimension
   c. certification
   d. a folder with all details

41. What is a win-win deal?
   a. when the result is good for everyone involved
   b. when the result is good for the client
   c. when the result is good for the technician
   d. when the price is low

42. What is crucial for a good negotiation?
    a. the economic level of client
    b. the information
    c. the kind of fenestration
    d. the place of construction

43. How is an offer substantiated?
    a. by the manufacturer's signatures on the offer
    b. by the customer's signatures on the offer
    c. by the manufacturer's and customer's signatures on the offer
    d. by a lawyer's signatures on the offer

44. Why is catalogues use important?
    a. for ordering the right raw materials
    b. for seeing the price
    c. for choosing between available colours
    d. for choosing between appropriate glazing

45. Why is fabrication manual use important?
    a. for selecting the right combination of profiles and accessories
    b. for calculating the profile's price
    c. for choosing the available accessories
    d. for calculating the assembling time

46. Who provides information concerning the necessary tools to be used?
    a. suppliers
    b. internet
    c. technicians
    d. fabrication manuals

47. Why should the fabricator certify his products and himself?
    a. it is mandatory
    b. for having better prices
    c. for finding clients easily
    d. in order to be exempted from duties

48. What should a fabricator do after having a materials list?
    a. order materials immediately
    b. order materials as soon as the production starts
    c. wait for the customer
    d. check the warehouse for stocks

49. Why does the frame must be smaller than the wall that to be installed?
    a. to be more beautiful
    b. for easy installation
    c. its dimensions are altered due to temperature change
    d. for estimating the cost

50. What is the problem with temperature change in metals?
    a. expansion
    b. contraction
    c. there is no problem
    d. breaking

51. How can we measure the appropriate gap between the frame & the wall?
    a.. ask the supplier
    b. see the catalogue
    c. check the guidelines of installation
    d. estimate 10 mm anyway

52. Should there be a gap between the union of two large windows?
    a. no
    b. yes
    c. it depends on the typology
    d. it depends on the dimensions

53. Why production planning is crucial?
    a. it facilitates the production requirements needed
    b. it facilitates the staff
    c. it minimizes raw materials cost
    d. it is mandatory by law

54. What should be done before cutting?
    a. frame & sashes should be separated
    b. uncoloured profiles should be cut
    c. sashes should be cut
    d. quality controlling

55. What determines good profiles cutting?
    a. dimensions
    b. colours
    c. geometry & direction
    d. typology

56. Where should molds be used in the cutting process?
    a. to uncoloured profiles
    b. to large profiles
    c. to small profiles
    d. for having better fix in saw

57. How is measure for cutting inserted?
    a. Via network or miter tape
    b. via network or UPS
    c. By miter tape
    d. Manually or all the above

58. What is the advantage of software cuts?
    a. time
    b. precision
    c. quality
    d. Optimization

59. How many kinds of machining are there?
    a. punch press
    b. drill bit
    c. milling machine as CNC, Pantograph, router
    d. punch press, milling machine, drill bit, punch press

60. How many weep holes must a frame has?
    a. 2
    b. 3
    c. 10
    d. it depends on the dimension and the typology

61. Why should attention be paid to twin chambered sashes top and bottom weep holes?
    a. because they be misaligned by at least 60 mm
    b. because they have to be on the same straight
    c. because no second hole is needed
    d. no attention should be paid

62. Why is drilling applied at the upper sides of the sash?
    a. for ventilation
    b. for humidity protection
    c. for screwing the mechanism
    d. for aesthetic reasons

63. What is the reason for sliding weep holes length being higher than the casement windows?
    a. the sliding is bigger than casements
    b. the sliding has smaller profiles
    c. because of the typology
    d. water barrier created by rail guides that obstructs water from being evacuated

64. In case of parallel sliding windows, where are weep holes machined?
    a. on the upper external profile
    b. on lateral profile
    c. on the lower framing profile corresponding to the effective track length of the external moving sash
    d. on the lower framing profile corresponding to the effective track length of the internal moving sash

65. Where should the central sealant in the sliding systems be put?
    a. in the middle of the framing profile, upper & down
    b. in the middle of the framing profile, upper
    c. in the middle of the framing profile, down
    d. in the middle of the framing profile, on the side

66. How many types of joining corners are there?
    a 2
    b. 3
    c. 4
    d. 5

67. What should be done before installing the screwed-in corners?
    a. screwing the profile
    b. put glue in the chamber
    c. cleaning the chamber of the profile
    d. drilling the profile

68. On what does machining of handles depend on?
    a. the kind of the profile
    b. the kind of the handles
    c. the typology
    d. the mechanism

69. What is achieved through following a manual?
    a. money
    b. time
    c. proper assembly
    d. space in production

70. How can the maximum permitted dimensions of fenestrations be verified?
    a. by experience
    b. it doesn't need verification
    c. by the manual's charts
    d. by the supplier

71. Why should vulcanized corner gaskets be used for?
    a. the glazing pane outside
    b. the central gasket
    c. the glazing pane inside
    d. the sash inside

72. What kind of glue should be used for connecting vulcanized corners?
    a. any glue
    b. silicon neutral
    c. silicon aside
    d. vulcanized compatible glue

73. What is the maximum permissible sash dimension based on?
    a. the kind or rollers
    b. on the typology
    c. the weight of the glazing & on the load of wind
    d. the country

74. How many steps of glazing gaskets installation are there?
    a 2
    b. 3
    c. 4
    d. 5

75. How much longer should the length of the gaskets be?
    a. 1-2%
    b. 3%
    c. 2-5%
    d. 10%

76. What should be done before assembling a frame?
    a. put silicon
    b. put protection for corrosion on the profiles section
    c. clean it with water
    d. install gaskets

77. Where should protection for corrosion been applied?
    a. all profile's section, drainages, corners, handles etc..
    b. corners
    c. handles
    d. drainages

78. What will by happen if glazing pane isn't shimmed appropriately?
    a. absolutely nothing
    b. handles will be damaged
    c. frame will be bended
    d. sash will be bended

79. What is the main concept of casement's sashes shimming?
    a. to transfer the glazing's load on the frame
    b. to transfer the glazing's load on the sash
    c. to transfer the glazing's load on the corners
    d. to transfer the glazing's load on the hinges

80. What is the main concept of sliding sashes shimming?
    a. to transfer the glazing's load on the corners
    b. to transfer the glazing's load on the sash
    c. to transfer the glazing's load on the rollers
    d. to transfer the glazing's load on the frame

81. Is there a different kind of shimming between right & left opening casement?
    a. no
    b. yes
    c. it is the same
    d. it depends on the system

82. Is there a different kind of shimming between right & left sliding sash?
    a. no
    b. yes
    c. it is the same
    d. it depends on the system

83. What do we place in the same way as the glass on the leaves?
    a. the handles
    b. the panel
    c. the mechanisms
    d. the hinges

84. Can we install glass with glue?
   a. no
   b. yes in special typologies
   c. yes
   d. it depends on the client

85. Can we place adhesive panels on the sash?
   a. no
   b. yes
   c. it depends on the low
   d. yes in special typologies

86. What does quality control and management systems help with?
   a. to achieve good price of the product
   b. to achieve good circumstances of labour
   c. to achieve quality of the product
   d. to achieve lower taxes

87. What is the most important element of the factory production control system?
   a. space
   b. staff
   c. capital
   d. file documentation

88. What is the different between quality assurance and quality control?
   a. It is the same
   b. control refers to inspections, measurements and tests, while assurance ensures that the control have been completed
   c. control refers to products, while assurance refers to accounting
   d. control refers to production, while assurance refers to staff

89. What does PDCA stands for?
   a.. Pay- Do- Check - Act
   b. Plan -Do - Close - Act
   c. Place -Do - Check - Act
   d. Plan -Do - Check - Act

90. What does CE marking confirm?
   a.. that the product is safe and complies with the European Legislation
   b. that the product complies with the US Legislation
   c. the origin of the product
   d. the cost

91. How many systems of assessment should the manufacturer follow for the declaration of performance of the construction products essential characteristics?
    a.. 3
    b. 4
    c. 5
    d. 6

92. Are companies obliged to have Factory Production Control (FPC) systems?
    a.. no
    b. only big companies
    c. yes, it is mandatory
    d. it depends on the products

93. How should non-conforming products be dealt with?
    a.. they should be sold cheaper
    b. they should be reconstructed with the same materials
    c. they should be thrown away
    d. they should be recorded, while those records should be kept for a period defined in the written procedures

94. In what projects should FPC be applied?
    a.. to large projects
    b. to public buildings projects
    c. it is not mandatory to be applied
    d. it should be applied to each undertaken project

95. What should we always have in mind concerning measuring and control instruments?
    a.. they should be calibrated at regular intervals
    b. they should be renewed at regular intervals
    c. there should be more in stock than necessary
    d. they should be maintained

96. What does a company at least need to define regarding production?
    a. the head of the commercial department
    b. the head of the Factory Production Control
    c. the head of the maintenance department
    d. the head of the accounting department

97. What is at the top of a Quality System according to ISO 9001 pyramid?
    a. production control
    b. quality policy
    c. personnel duties
    d. measuring equipment

98. How does a manufacturer make a product recall?
    a. by publicizing the problem and by visiting building sites where non-conforming products have been installed, in order to examine and address non-conformities
    b. by providing product declarations of conformity
    c. by placing CE marking stickers on the product
    d. by publicizing the problem to the production

99. What does quality control mainly include?
    a. incoming and raw materials controls
    b. final controls
    c. intermediate controls
    d. all the above

100. What is the first action in the series of the quality cycle?
    a. check
    b. do
    c. plan
    d. act

101. How many systems of assessment and verification of constancy of performance exists, according to Regulation 305/2011?
    a. 2
    b. 3
    c. 4
    d. 5

102. Are most workplace accidents preventable?
    a. no
    b. yes
    c. it depends on the staff
    d. it depends on the kind of the production

103. Does the information related to safety facilities also include other facilities except for the equipment?
    a. yes, for the equipment
    b. yes, but only for transportation
    c. yes, but only for the production
    d. yes, it includes welfare facilities

104. Do peculiarities of each industry need to be taken into account?
    a. no
    b. it depends on the owner of the company
    c. yes
    d. it depends on the size of the company

105. Is it important to monitor the progress of the production?
   a. no
   b. yes, as it is mandatory
   c. it depends on the production
   d. yes, in order to ensure that it is in-line with the original plan

106. How many steps of monitoring programming are there?
   a. 2
   b. 3
   c. 4
   d. 5

107. What is the most important element in the implementation of FPS?
   a. clients
   b. money
   c. file documentation
   d. tax

108. Why is file documentation important for FPS?
   a. it will be used to testify its correct application
   b. to know the production
   c. to know the equipment
   d. just for information

109. What is the purpose of quality management systems according to the ISO 9001 standard?
   a. to make companies adopt the processes of continuous improvement
   b. to minimize the cost of the products
   c. to have better salaries
   d. to have less labour

110. Are the vast majority of workplace accidents preventable?
   a. no
   b. it depends on the production
   c. it depends on the equipment
   d. yes

111. Who needs to be schooled for Health and Safety?
   a. no one
   b. clients
   c. drivers
   d. every employee on site who is exposed to potentially dangerous equipment

112. What is need to be considered regarding safety, besides law regulations?
   a. the capital of the investment
   b. the site of the company
   c. the peculiarities of each industry
   d. the country

113. How can risks of machinery be minimized?
   a. by buying new one
   b. by having a voltage of 110v
   c. by having proper and regular maintenance
   d. by having enough space

114. Why is it important to monitor the work progress?
   a. it is mandatory
   b. to collect all the needed data and check the planning
   c. to know the time of the production
   d. to know the different kind of products

115. How should the time during monitoring be managed?
   a. by spending as much time as possible
   b. by spending as much time as convenient
   c. by striking a balance between the time spent on tracking activities and the value of the effort
   d. by spending time based on own judgement

116. What is the key to success in any work?
   a. communication
   b. nice production space
   c. nice offices
   d. nice showcase

117. What is the major purpose of project management?
   a. to be strict with subordinates
   b. to align and motivate people
   c. to be polite to the management
   d. to be polite to the clients

118. What are the main steps of programming monitoring?
   a. scope
   b. budget
   c. schedule progress
   d. schedule progress, budget, scope

119. Which list of data should we monitor?
   a. labour
   b. machining
   c. milling
   d. all the above

120. Why should works be recorded?
   a. it is mandatory
   b. to have statistics for each task
   c. to know the time of production
   d. to know the performance of workers

MODULE

Production of metal constructions

Administrative and steel production processes compliant with National and European Legislation

MODULE 04

Production of metal constructions

Administrative and steel production processes compliant with National and European Legislation

Introduction - Learning Objectives
Special features of processes application in construction industries

This chapter covers the field of steel constructions. As in the case of Aluminium constructions, covered in previous chapters, steel production processes will be outlined within the present module. It is important to mention that in a facility that processes Aluminium, steel shall be processed in a distinct area, i.e. to be separated from the Aluminium processing. All parties involved in the process play a critical role, from the office to the plant (steel production and fabrication), to the field (quality assurance).

The key items to be covered are:

- Production processes - cutting, machining, assembling, controlling & packing
- Renovation/upgrade of old constructions
- Management of recyclable materials
- Adoption of the administrative and production processes to the available resources
- Identification of the customer needs and flexibility in solving problems arising from customers, employees, products, and production processes.

Knowledge Objectives to be achieved through this learning module are:

- Understand relevant European legislation on the static loads and construction performance.
- Handle software to calculate the profiles weight and the construction cost
- Perform quality control of the raw materials, hardware and supplementary materials
- Select the suitable metal profiles and consumables for corrosion protection
- Use of loads charts/tables, features and weights of the metal profiles for proper bid
- Choose the ideal profile for the metal construction based on the required loads
- Combine metal profiles with aluminium systems
- Use the appropriate of equipment for cutting & machining
- Implement all stages of production, cutting, processing, assembly of all types of frames
- Treat and protect surfaces
- Manufacture parts, assemblies, and metal constructions from sheets, tubes or profiles
- Identify cut and steel shaping for reinforcement points
- Implement health and safety good practices at work
- Implement standards and guidelines to ensure product quality and continuous improvement.
- Use mechanical equipment in relation to the subsequent mounting process
- Use the suitable consumables - electrodes, gas, etc. for welding.
- Understand the strength of joints and the consequences of failure
- Communicate and share information with the building engineer, e.g. the architecture engineer
- Assemble fenestration, outdoors, etc.
- Comply with National and European Legislation, e.g. Construction Products Regulation 305/2011/EU, CE-marking.
- Understand the details of construction and the consequences from the wrong selection in the static, aesthetic & corrosion robustness of the construction.
- Implement the appropriate measurement techniques for quality control
- Organize archives of each completed project

For the Teacher

Learning Outcome 4.1
Cost individual metal construction or combination of metal & aluminium

Learning Unit 4.1.1 - 4h
Costing techniques and relevant European and National legislation
Learning Unit 4.1.2 - 3h
Use of loads charts/tables & technical-economic characteristics of metal profiles
Learning Unit 4.1.3 - 3h
Combining metal profiles with aluminium systems

Learning Outcome 4.2
Plan & supply raw materials. Cutting & welding for architectural use

Learning Unit 4.2.1 - 6h
Appropriate equipment for machining & welding
Learning Unit 4.2.2 - 2h
Suitable consumables
Learning Unit 4.2.3 - 2h
Metal joining techniques, with bolts or welding

Learning Outcome 4.3
Assembling profiles in different typology of metal constructions as well as with steel-aluminium

Learning Unit 4.3.1 - 6h
Technical – production manuals, catalogues
Learning Unit 4.3.2 - 2h
Mixed constructions assembling
Learning Unit 4.3.3 - 2h
Artistic aspects, finishing of joints & special structures

Learning Outcome 4.4
Quality control. Health and safety practices. Archiving and monitoring.

Learning Unit 4.4.1 - 6h
Quality control
Learning Unit 4.4.2 - 2h
Health and safety practices
Learning Unit 4.4.3 - 2h
Project documentation and monitoring

4.1. Cost individual metal construction or combination of metal & aluminium

Key Words

Eurocodes: European standards for all aspects of buildings' structural design and development

To be achieved upon learning outcome completion

- Software and relevant European legislation on the static loads and the performance of construction
- Use of loads chairs/tables, features and weights of metal profiles for proper offering
- Combining metal profiles with aluminium systems for composite offering

KNOWLEDGE

- Offer for individual metal construction or metal-aluminium combination
- Handle software for calculating the profiles weight and constructions cost
- Perform quality control of raw materials, hardware and supplementary materials, considering technical datasheets and quality systems
- Make logistics on incoming materials
- Choose the ideal profile for metal construction based on required loads
- Read technical drawings
- Make the ideal profile choice for individual metal construction or metal-aluminium combining
- Identify and prevent corrosion problems
- Make separable and inseparable connections

SKILLS

- Correct choice of metal profiles and consumables to protect aluminium from oxidation
- Select the appropriate cross sections according to the offer requested
- Understand alternative choice of metal profiles for the best financial offer
- Make the right choice of metal profiles by combining the required durability and desired aesthetics

COMPETENCIES

4.1.1. Costing techniques and relevant European and National legislation

Traditional costing techniques do not provide detailed information. They can lead to erroneous decision making by ignoring the fact that complex products need more resources than simply the breakdown of the structured products. In recent years, companies have drastically reduced their reliance on traditional costing technique by developing activity-based and target cost management systems.

Traditional costing technique of assigning costs can be very inaccurate because there is no actual relationship between the cost pool and the cost driver. Considering the numerous factors influencing pricing decision in manufacturing companies, cost is considered the basic factor which can be managed efficiently. In lieu of this, accurate cost information seems to be the basis for pricing decision. Cost information is not only needed for effective decision making, but also needed to achieve the company's objectives set by the management.

However, with the progress of social productivity and a higher level of market demand, great changes have taken place in the manufacturing environment, which results in serious information distortion provided by traditional cost method, and cannot satisfy the demand of the enterprise's product pricing management any more.

Activity based costing (ABC) was developed to cover up for the deficiencies emanating from the use of traditional costing technique around overhead cost allocation to product. It can provide relatively accurate cost information and better serve the enterprise's product pricing decision. Usually product cost is divided into variable cost, activity cost and fixed cost. Due to the overlapping between those three costs, the cost basis of product pricing is not accurate. According to the product's cost behaviour analysis, product cost can be divided into:

- unit level,
- batch level,
- product-sustaining level and
- facility level activity costs.

As there is no overlapping between those four costs, it can provide a more accurate and reliable cost information for product pricing. ABC system is a very valuable tool of control as it offers several advantages to the management, such as:

1. It brings costing data accuracy and reliability in determination of the cost of the products
2. it facilitates cause and effect relationship to exercise effective cost control
3. It provides management necessary cost information for deciding on any business matte
4. it is much helpful in fixing the cost and selling price of a product
5. It facilitates overhead costs allocated directly to the specific product
6. It focuses on managing activities rather than costs
7. It helps to remove all types of wastages and inefficiencies
8. It provides valuable evaluation information on the relative efficiencies of various plants and machinery
9. It has, through Cost Driver Rates, significant impact on the development of new products or modification of existing ones

In the 1980s, businesses began to realize the inaccuracies of "traditional" costing systems. The latter gave more basis to the costing of direct labour and direct materials, which were necessary for the production process, and not to other general expenses which were characterized as an unpredictable factor. The emphasis of direct labour was that which prevailed, with the distribution of general expenses being done arbitrarily, but in an arbitrary manner.

In other words, the general expenses were divided according to the units that the companies produced and the sales of the products. This system made the "traditional" methods of calculating costs relatively unreliable because many of the overall costs involved corresponded to exogenous activities, unrelated to the main "trunk" of production. Thus, the phenomenon of either over-costing or under-costing of products was common.

Therefore, there was a need to shift from "traditional" systems to a system that would focus on the distribution of general costs, due to changes in production technologies, control methods and more generally in the forms of competition and the market. Over the years and with indirect costs (generally costs) in many cases exceeding 60% of the total cost, the need arose for a costing system that would respond to the unreliability of "traditional" methods. That was the A.B.C. The information it provided was intended to accurately calculate the cost of support activities and to indirectly support the overall strategic decisions of a business.

To this must be added the fact that companies have now produced a large number of differentiated products and this diversity (volume, size and complexity), are the factors that lead to the unreliability of "traditional" methods and the need for a new approach. The consequence of all these changes is that the producer must have a lot of data, production times, raw materials, product typologies, etc. so that it can share the general costs of each product based on the activities.

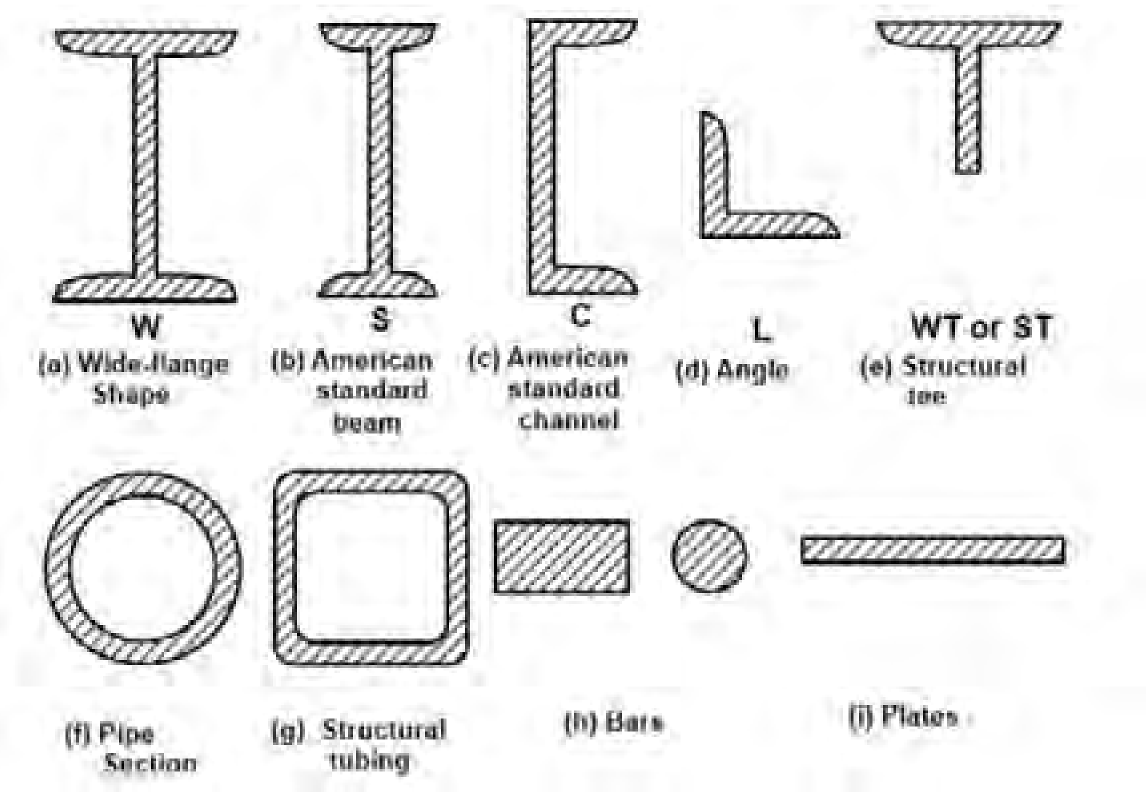


Figure 4.1. **Structural-steel-sections**

A proper tool is required for each type of profile, like disk saw for hollows profiles and metal scissors, CNC for sheet.

Figure 4.2. **Disk saw, Band saw, metal scissors, CNC**

The data is recorded in tables by category, as follows:

Cutting	Time
Disk saw: time to cut a piece hollow tubing/pipe	1 min
Band saw: time to cut a piece plate	45 sec
Band saw: time to cut a piece wide flange ……..	2 min
Band saw: time to cut a piece structural T ……..	25 sec
Metal scissors	2 min
CNC	20 sec/ml
Plasma	3 min
Forming	3 min/piece
Hydraulic CNC Bending Machine	10 min/piece
Hydraulic CNC rolling Machine	10 min

Figure 4.3. **Hydraulic CNC Bending /rolling Machine**

Regarding the standard constructions as metal fenestrations assembling times can vary as in the following Table.

Typology of fenestration	Time
Opening single leaf window	100 min
Opening single door	110 min
Opening double leaf window	150 min
Opening double door	180 min
Garage door	250 min
Sliding door 1 leaf	80 min
Sliding door 2 leaves	130 min

Regarding the unit constructions the assembling time vary as in the following Table.

Steps	Time
Welding	10 sec/cm
Adhesive cleaning	1min
Screw bolt	30 sec /piece

Figure 4.4. Assembling

In order to understand better the difference in costing between the classic method and ABC, a costing example for metal bench is presented below.

Figure 4.5. Metal bench product A & product B

Features of the two products:

Sales Price	Product A	Product B
	Higher	Lower
Purchase of materials	More supplies but fewer orders	Less supplies but more orders
Production cycles	More steps	Fewer steps
Machine settings	More	Less
Energy/space m^2	Less	More
Immediate work	More required	Less required
Direct materials	Higher cost	Lower cost

Revenue from sales and direct costs

	Product A	Product B	Total
Production & Sales (units)	100	300	400
Sales price / unit	230,00 €	150,00 €	
Direct labour / unit cost	70,00 €	35,00 €	
Direct materials costs / unit	45,00 €	30,00 €	
Revenue from sales	100 x 230,00 = 23.000 €	300 x 150 = 45.000	68.000 €
Direct labour costs	100 x 70 = 7.000 €	300 x35 = 10.500 €	17.500 €
Cost of direct materials	100 x 45 = 4.500	300 x 30 = 9.000 €	13.500 €
Total direct costs	7.000+4.500 = 11.500 €	10.500 + 9.000 = 19.500 €	**31.000€**

In the traditional costing method, only the total indirect cost is used (16.500 euro). The total indirect cost will be divided into products A and B, based on the proportional use of a resource corresponding to the direct cost data. In this case, the resource to be used will be the cost of direct labor (17.500 euros).

Therefore, according to the above, indirect costs will be distributed as a percentage of the cost of direct labour. That is: 16.500/17,500 = 94,28%.

For product A the cost of direct labour amounts to € 7.000. So, the distribution of indirect costs for A is: 94,28% x 7.000 = € 6599,2.

For product B, the cost of direct labour is € 10.500 respectively. Therefore, the distribution of indirect costs for this is: 94,28%x 10.500 = € 9899,4

Following is a table summarizing the costs (per unit of product but also in total), gross profit and gross profit margin.

	Product A	Product B	Total
Production & Sale (unit)	100 €	300	400
Total direct costs	11.500	19.500	31.000
Total indirect costs	7000*94,28%= 6599,6	10500*94,28%= 9899,4	
Sales price / unit	230	150	
Direct cost / unit.	11500/100= 115	19500/300= 65	
Indirect cost / unit	6599,6/100= 65,99	9899,4/300= 32,99	
Gross profit / unit.	230-115-65,99 = 49,01	150-65-32,99= 2,01	
Gross profit margin	49,01/230 = 21,3%	52,01/150 = 34,67%	

In ABC costing, the same example will be used in order to have comparable results with this method, if the resources that influence the cost and the basic activities are determined, then the calculation of the cost of each one and their grouping in cost tanks (pools cost) follows. Cost tanks are the set of all activities that have a common goal and are required to complete a project. Then, with the help of cost drivers, the costs are allocated to the appropriate tank. Cost drivers are the connecting links between the cost of activities and cost carriers. For example, the total cost of the "materials purchase order" tank is determined by the number of purchase orders (cost guide).

Activity cost tanks	Activity cost guide	Cost / batch of activity	Activities (at batch levels)	Product A Total indirect cost
Rent/Electricity	Quantity/m^2	8000/400= 20	100	20*100=2000
Order materials	Number of purchase orders	1500/15-100	10,0	100*10=1000
Machinery setting	Number of settings	2500/50=50	40,0	50*40=2000
Machinery maintenance	Number of maintenances	3000/25=120	15,0	120*15=1800
Consumables	Quantity	1500/400=3,75	100,0	3,75*100=375
Total indirect costs				**7175,0**

Activity cost tanks Activity cost guide Cost / batch of activity Activities (at batch levels) Total indirect cost for product B.

Activity cost tanks	Activity cost guide	Cost / batch of activity	Activities (at batch levels)	Product B Total indirect cost
Rent/Electricity	Quantity/m²	8000/400= 20	300 €	20*300=6000
Order materials	Number of purchase orders	1500/15-100	5	100*5=500
Machinery setting	Number of settings	2500/50=50	10	50*10=500
Machinery maintenance	Number of maintenances	3000/25=120	10	120*10=1200
Consumables	Quantity	1500/400=3,75	300	3,75*300=1125
Total indirect costs				**9325**

Activity cost tanks	Product A Total indirect cost	Product A Costs/unit	Product B Total indirect cost	Product B Costs/unit	Total indirect cost A+B
Rent/ Electricity	2000	2000/100=20	6000	6000/300=20	2000+6000=8000
Order materials	1000	1000/100=10	500	500/300=1,66	1000+500=1500
Machinery setting	2000	2000/100=20	500	500/300=1,66	2000+500=2500
Machinery maintenance	1800	1800/100=18	1200	1200/300=4	1800+1200=3000
Consumables	375	75/100=3,75	1125	25/300=3,75	375+1125=1500
Total indirect costs	7175	71,75	9325	31,08	**16500**

Results

	Product A	Product B
Production & Sale (unit)	100 €	300
Total direct costs	11.500	19.500
Total indirect costs	7175	9.325
Sales price / unit	230	150
Direct cost / unit	115	65
Indirect cost / unit	71,75	31,08
Gross profit / unit	230-115-71,75 = 43,45	150-65-31,8= 53,2
Gross profit margin	43,45/230 = 18,89%	53,2/150= 35,46%

The following are the results of the two different costing methods: Product A has less profit when running ABC analysis compared to the traditional method of analysis. The reason is that in ABC analysis you consider the costs of the activities that each product needs. Product A absorbs more activity per piece.

Traditional method	Product A	Product B
Gross profit / unit	230-115-65,99 = 49.01	150-65-32,99 = 52,01
Gross profit margin	49,01/230 = 21,3%	52,01/150 = 34,57%

Activation costing (ABC)	Product A	Product B
Gross profit / unit	230-115-71,75 = 43.45	150-65-31,8 = 53,2
Gross profit margin	43,45/230 = 18,89%	53,2/150 = 35,46%

Eurocodes are ten European standards (EN; harmonised technical rules) specifying how structural design should be conducted within the European Union (EU) member countries. These were developed by the European Committee for standardisation upon the request of the European Commission. The purpose of the Eurocodes is to provide:

1. means to prove compliance with the requirements for mechanical strength and stability and safety in case of fire established by European Union law.
2. a basis for construction and engineering contract specifications.
3. a framework for creating harmonized technical specifications for building products (CE mark).

By March 2010, Eurocodes are mandatory for the specification of European public works and are intended to become the de facto standard for the private sector. CE Marking for all construction products, covered by a harmonized European standard, or conforming to a European Technical Assessment became mandatory on 1 July 2013. For fabricated structural steelwork, CE Marking became mandatory on 1 July 2014.

CE Marking (originally Conformité Européenne) demonstrates compliance with the appropriate manufacturing standard for a product.

Under the **Construction Products Regulation (CPR)**, new legal obligations have been placed on manufacturers, distributors and importers of construction products used within the EU to CE Mark their products where they are covered by either a harmonised standard or European Technical Assessment (ETA). This applies not only to constituent products (such as steel beams, bolts etc) but also to fabricated elements and systems made from both CE Marked and non-CE marked products.

4.1.2. Use of loads charts/tables & technical-economic characteristics of metal profiles

Key Words

Dead load: The intrinsic weight of a structure, excluding the load.

Moment of inertia: a factor that depends on the geometry of the profile

The forces that apply on the constructions are:

- Air
- Snow
- Dead load
- Temperature difference
- Mobile loads for floor / roof

The calculation of cross sections is more complicated, but for simple constructions there are tables for each cross section and for each load. In the following table wind loads are depicted.

m/s	km/h	Pa	Beaufort
8,0-10,7	29-38	40-72	5
10,8-13,8	39-49	73-119	6
13,9-17,1	50-61	120-183	7
17,2-20,7	62-74	184-268	8
20,8-24,4	75-88	269-373	9
24,5-28,4	89-102	374-505	10
28,5-32,6	103-117	506-665	11
32,7-36,9	118-133	666-853	12
37,0-41,4	134-149	854-1060	
41,5-46,1	150-166	1070-1320	
46,2-50,5	167-183	1330-1610	
51,0-56,0	184-201	1620-1990	
60,0-80,0	215-290	2250-4000	

Figure 4.6. Wind loads

E.g. for wind speed 118-113 Km/h, there is load 666-853 Pa / m^2, which is approximately 85 kg/m^2.

For the metal fenestration they are for each profile the adequate dimensioning chart, with different kind of load.

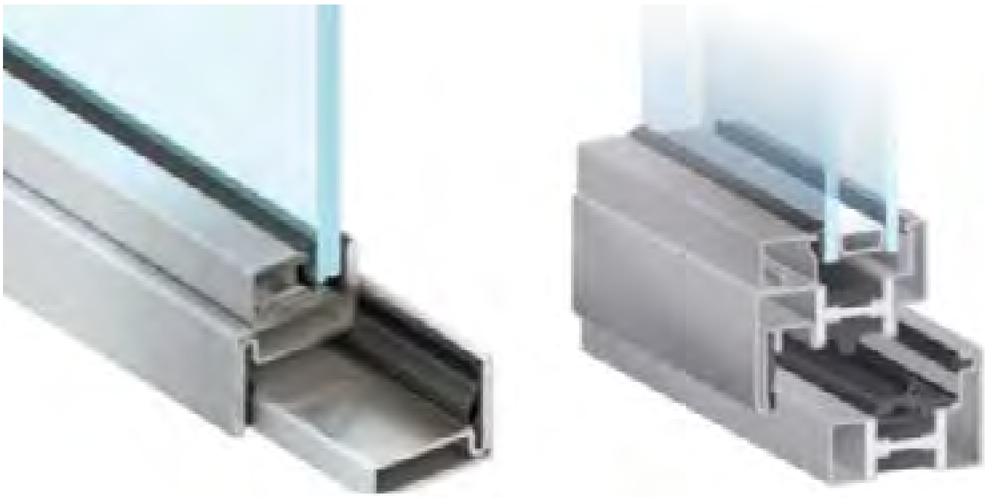


Figure 4.7. **Metal fenestrations**

In metal curtain walling constructions, there are many different profiles with different moment of inertia, a factor that depends on the geometry of the profile.

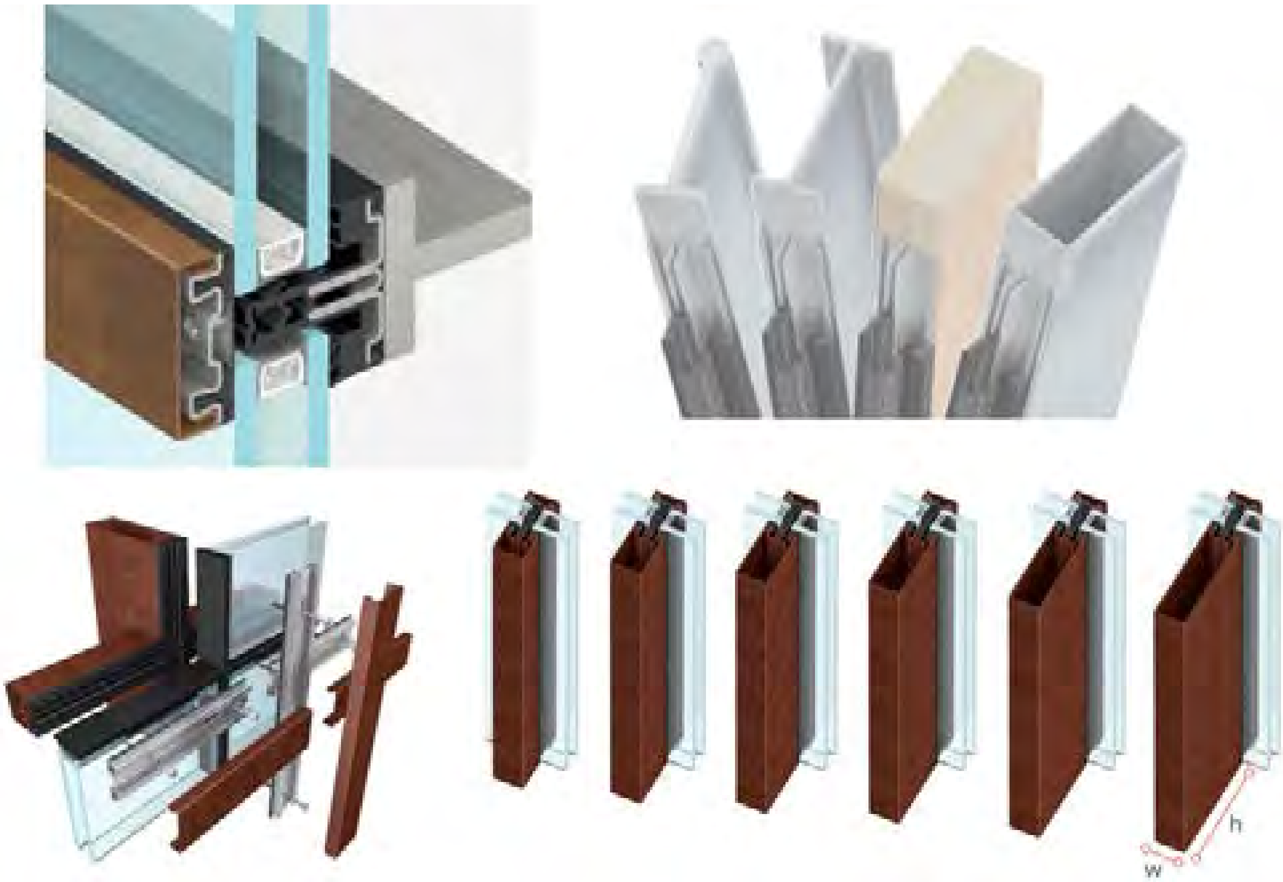


Figure 4.8. **Metal curtain walling**

In curtain walling systems, the selection of the profile to be used at a particular structure is based on the calculation of the required **Moment of Inertia** (I) of the profiles, which depends from the profile geometry. The mullion must be stiff enough, in order not to deform excessively when is subjected to the maximum design loads. The amount of mullion bending should be small enough to prevent the glazing from cracking.

The main loading of the mullions is due to the wind pressure. It is assumed that each mullion is loaded by the force that half glass panel transmits to it on one side, and half glass panel on the other side, resulting in rectangular loading. The mullions can be supported in different ways, and the corresponding formula for the Moment of Inertia must be used during calculations.

In addition to the moment of inertia, it is very important to know how to fasten the structure to the building. In the next figure three different mullion support configurations are presented.

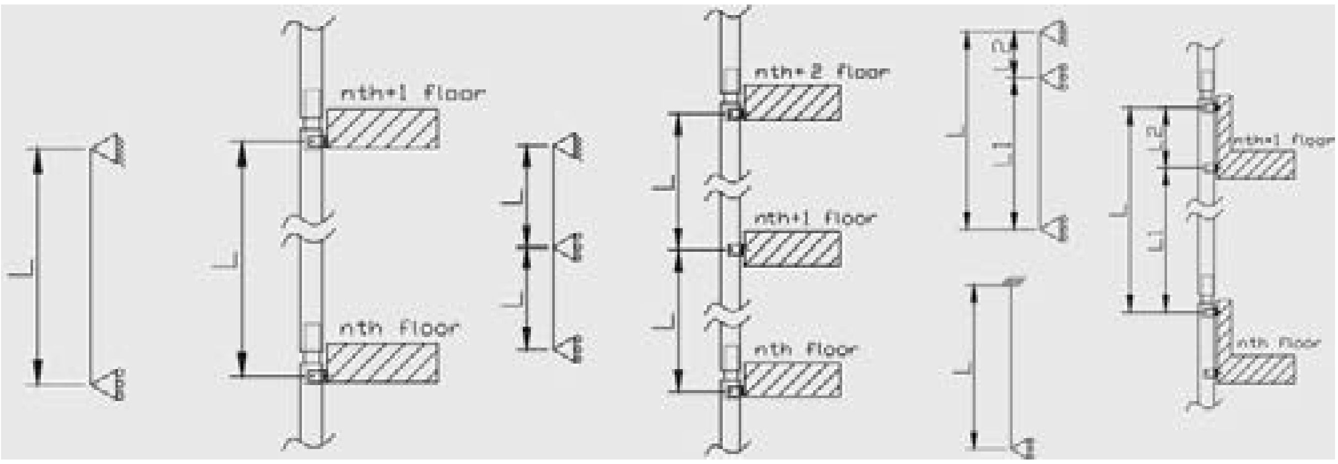


Figure 4.9. Kind of fastening, 2 points, 3 points & 3 different points

The chart in figure below presents = that for a specific cross section, fixed in two points and for a load of 2,4 kN/m² (240 kg) it can be the largest dimension, length 3,4 meters and the distance between mullions has to be 1 meter.

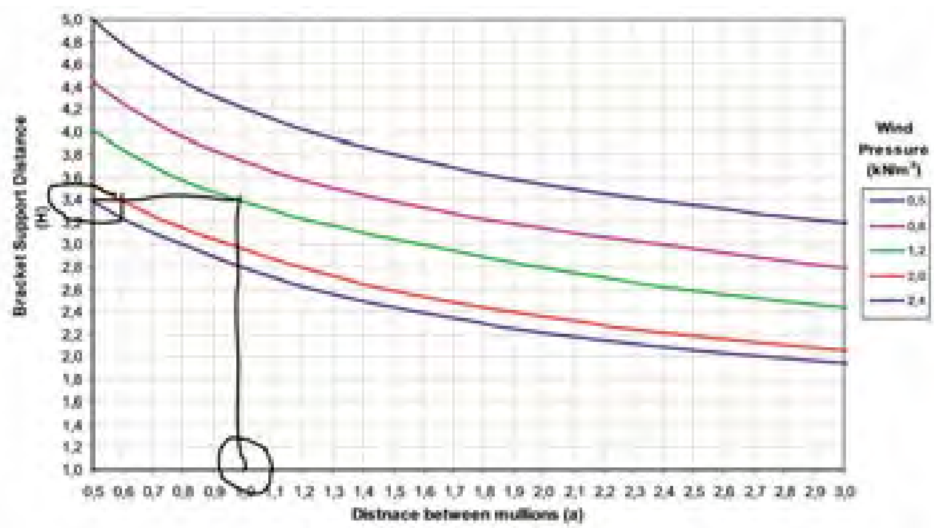


Figure 4.10. Dimensioning chart (Alumil)

Metal has three basic specific techniques that allow us to construct in any desired shape:

1. Forging: By forging profiles or sheets are formed in various shapes
2. Mechanical processing / bending / rolling: profiles and sheets could be rolled in different ways, as well as the leaves could be bended in any desired shape.
3. Welding: This means that under certain conditions, the metal material can also be welded with the corresponding components according to the design requirements.

These technical characteristics, in combination with the painting techniques (electrostatic painting, as well as painting on site with different kind of colours), give a good aesthetic result.

Since the end of World War II, the iron and steel industry has been the driving force behind the EU's industrial and economic development. With the establishment of a consortium in 1951, the steel industry became the first sector to be overseen in the history of Europe as part of a partnership of six European states. This cooperation has gradually expanded to other economic and political activities in the form of the modern European Union, which lists 28 official Member States.

Historically, steel was used as the first material during World War II and as a material for the reconstruction of peace after its end, the road networks, merchant ships and railways that ensured the faster transport of goods leading to the spread of international trade. Steel soon became the basis of many European value industries, thus contributing to the improvement of the economy and competitiveness of its European industry as well as in the field of electricity and electrical appliances and home appliances and the development of international trade.

Moreover, steel has a positive effect on the development of macroeconomic growth indicators in the European economy. It is used as an intermediate product for the production of final products in the manufacturing sector that contribute to the formation of GDP and is directly related to employment. The EU is the world's third-largest exporter of iron and steel products with a competitive advantage over third countries and is equally important in the world in the production of high quality steel, using innovations, high technology and investment capital in the production process.

As a result of today's tough economic situation, general cost reduction requirements put a high pressure on the fabrication costs of a construction project, as fabrications costs are responsible for a growing share of the overall costs for such a construction. In addition to these economic aspects, sustainability and the environmental impact are progressively becoming a major issue in the building sector, as well as in general industry. Due to its high percentage of recyclability, steel can serve already as an interesting basis for many of such sustainable constructions.

To follow the arising economic and ecological requirements the steel making industry is continuously developing more sophisticated steel grades. This will lead to improved material as such and additionally cut down on the cost and energy consumption of the subsequent processing steps. Thermo mechanically rolled steels must be mentioned as a good example in this context. Another good sample for an economical consumption of raw material is given by the usage of modern high strength steels.

In addition, nowadays sustainability is gaining more and more importance. This ecological aspect is quite new, and many research groups are addressing this topic in order to evaluate a measure or guideline for sustainability in the building sector. As steel as such is due to its unlimited recyclability already a very sustainable material, its usage. The steel-making industry has continuously developed more sophisticated steel grades to meet these arising economic and ecological requirements.

4.1.3. Combining metal profiles with aluminium systems

Key Words

Corrosion: a natural process that converts a refined metal into a more chemically-stable form such as oxide, hydroxide, or sulfide

Mixed constructions: Constructions with a combination of two or more different materials

Combining a metal support base with aluminium is in many cases a technically robust and low-cost solution. Corrosion is happening when two different metal parts come in contact into corrosive environments. This type of corrosion is purely electrochemical and is called galvanic corrosion.

Measures must therefore be taken to ensure that aluminium does not come into electrically conductive contact with other materials that may cause damage to their appearance and strength (iron steel, lime, etc.). Aluminium-steel contact must be avoided because aluminium corrodes dangerously (in wet areas or coastal environments). It is necessary to insulate the two metals with the intervention of the appropriate dielectric, namely electrically insulating material (Gaskets, wood, plastic, etc.).

To set up a galvanic cell between two conducting materials (metals or graphite), the two metals must have differing electrode potentials or be more or less 'noble' than each other. The more noble metal (cathode) is protected as the less noble metal (anode) sacrificially corrodes.

The table presented below is an example of these 'metal to metal' relationships, including graphite as conductive non-metal.

ANODIC (Least Noble)
Magnesium
Zinc
Aluminium
Carbon steel or cast iron
Copper alloys (brass, bronze)
Lead
STAINLESS STEEL
Nickel alloys (Incoloy 825,Hastelloy B)
Titanium
Graphite
CATHODIC (Most Noble)

Figure 4.11. **'nobility' table**

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The further apart the metals are, in terms of relative electrode potentials, the greater the driving force in a cell. So, for example, stainless steel in contact with copper is less likely to be a risk than when it is in contact with aluminium or galvanised (zinc coated) steel.

To complete the cell, a conductive liquid must bridge the two metals that are in contact. The more electrically conductive the liquid is, the greater the danger of corrosion. Seawater or salt laden moist air produces a more corrosive environment than contact rainwater or drinking water.

If the metals are dry, bimetallic (galvanic) corrosion cannot take place. Aluminium and stainless steel together also appears to be a bi-metallic corrosion risk, based on the table above.

Figure 4.12. **Aluminium corrosion**

With this combination the effect of relative surface area on corrosion is important. A large area of 'cathode' relative to 'anode' will accelerate the anodic corrosion. Although aluminium is more anodic compared to stainless steel, large relative surface areas of aluminium to stainless steel can be acceptable, dependent on local conditions.

Stainless steel fasteners in aluminium plates or sheets are normally considered safe, whereas aluminium rivets or bolts holding stainless steel parts together is an unwise combination, as there is a practical risk of corrosion.

An example of the safe use of stainless steel and aluminium together is where stainless steel fasteners and hold down bolts are used to secure aluminium roadway or bridge parapet guards.

Even with no electrical insulation between the metals, there should be a little corrosion risk. In contrast, in a marine environment, severe localized pitting corrosion to the aluminium treads has been observed where uninsulated stainless-steel bolts were used to secure the treads in place.

On the same ladder however, bolts with sound insulating washers did not show any pitting on the surrounding aluminium. This illustrates the beneficial effect of breaking the corrosion cell by isolating the two 'dissimilar' metals in marginal cases.

Figure 4.13. **Mix construction of curtain walling**

But in any case, when there is a mixed construction (e.g. glass curtain walling systems), electrically insulating materials must be placed between the metal frame and the aluminium in order to avoid corrosion.

Stainless steel consists of iron, chromium, nickel, manganese, and copper. Chromium is added as an agent to provide corrosion resistance. Moreover, the non-porous surface increases corrosion resistance.

Aluminium has a high resistance to oxidation and corrosion mainly due to the passive layer that is formed on its surface upon exposure to the atmosphere. When aluminium oxidises, its surface will turn white and sometimes it will create crack. In some extreme acid or basic environments, aluminium can corrode quickly with fatal results.

4.2. Plan & supply raw materials. Cutting & welding for architectural use

Key Words

Band saw: cutting saw with ribbon for large profiles

Handle for cutting/welding: accessory for cutting / welding with acetylene

To be achieved upon learning outcome completion

KNOWLEDGE

- Supply necessary raw materials. Using the appropriate of equipment for cutting & machining
- Use of suitable consumables - electrodes, gas, etc. for welding
- Metal joining techniques, with bolts or welding

SKILLS

- Supply necessary raw materials
- Select & operate machinery according to manufacturer’s specifications
- Select the suitable profiles positioning on saw technical solutions
- Organize and apply appropriate measurement & construction techniques
- Treat and protect surfaces
- Manufacture parts, assemblies, and metal constructions from sheets, tubes or profiles by means of manual and mechanical production methods
- Cut and steel shaping for reinforcement points
- Positioning and assembling of steelwork for reinforcement points
- Organize steel workings for reinforcement points
- Implement health & safety rules
- Apply standards and guidelines to ensure product quality and continuous improvement of work processes
- Select the appropriate consumables for welding / cutting
- Carry out welding processes practicing
- Apply appropriate technique to the joints of steel structures based on the drawings of the construction

COMPETENCIES

- Use mechanical equipment in relation to the subsequent mounting process
- Proper selection and use of consumables to avoid accidents
- Understand the union’s strength and the consequences of failure

4.2.1. Appropriate equipment for machining & welding

When raw materials are procured based on the technical specifications of the project and with the help of the relevant diagrams, the appropriate equipment for cutting and welding should be selected.

The use of equipment for cutting metal depends on the shape and dimensions of the profile. The smaller profiles are cut by using a saw disc and the larger ones by a saw band. In both cases, the profile we have to be secured before cutting, otherwise there is danger for the equipment handler.

Figure 4.14. **Disk saw, Band saw**

When the cut (or welding) are going to be made by using a gas, the appropriate type of gas must be used. Welding and cutting of metals using an oxygen-acetylene / propane flame is a very common procedure.

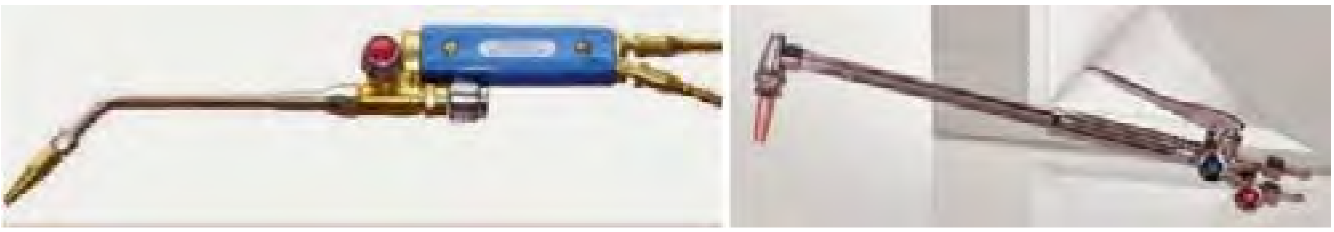

Figure 4.15. Handle for welding for acetylene / handle for cutting

OXYGEN - BASIC CHARACTERISTICS

- Non-flammable gas, necessary to burn, air content under normal conditions about 20%
- In case of excess it causes acceleration of combustion or even explosion
- Even non-combustible materials, in normal conditions, in the presence of excess oxygen burn.

ACETYLENE - BASIC CHARACTERISTICS

- Pure oxygen is required to burn acetylene and produce flame
- Acetylene has a high calorific value (approximately 13000 kcal / mÑ at atmospheric pressure) and burns rapidly.
- Its flame produces temperature up to 3500 oC.

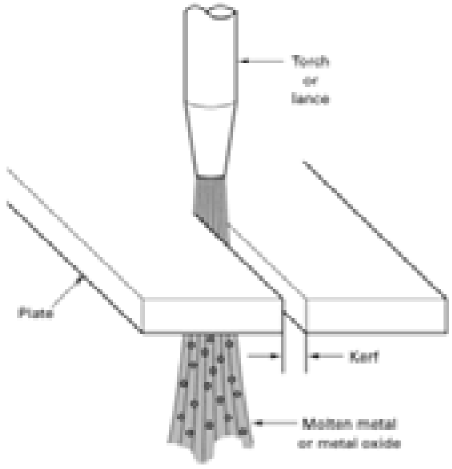

Figure r, 1999)

PROPANE-BASIC BASIC CHARACTERISTICS

- Propane is a gaseous fuel
- It has a characteristic fishy smell
- It is heavier than atmospheric air. The result is that it accumulates - in the event of a leak - in the lower layers, creating explosive mixtures on a case-by-case basis.
- It is invisible
- The propane explosive area is between 2% - 9%
- Ignition point 450 oC.

The welding method and the relevant equipment depends on the type of profiles and the construction. The arc welding or electric welding, is based on the creation of an electric arc between the part that are going to be glued, and an electrode, which is at the same time an adhesive. When electric welding is executed in an inert atmosphere, it ensures the insulation of the welding point from the air (essentially from the oxygen and nitrogen that affect the welding). Gases such as Argon (Ar) and Helion (He) are used for this insulation. Argon is used in most cases due to its lower production cost. The advantages of the inert welding method compared to simple electric welding are:

- Stable electric arc,
- Welding points with high mechanical strength,
- Small heating deformations,
- Absence of harmful fumes.

Inert welding takes place in three methods, the T.I.G. (hard electrode and slow gas), the M.I.G. (consumable electrode and slow gas) and the M.A.G. (consumed electrode and carbon dioxide). The T.I.G. method is used for most metals welding. A special application is the welding of thin objects due to the excellent quality of welding and the quality of the final surface. Moreover, this method does not create smoke or fumes. The TIG method can be performed in all positions - flat, horizontal, vertical or sky. The M.A.G. and M.I.G methods because they use welding material are then must cleaned the area.

4.2.2. Suitable consumables

Key Words

symbol E: It characterizes all types of electrodes

The international standardization system as it has predefined by ISO, uses a set of letters and numbers, each of them symbolizing an electrode feature. In table ... is presented more details for electrodes standardization. The general symbol E symbolizes the electrode. It is followed by three numbers that refer to their technical characteristics and are: 0 to 6 for tensile strength, 1 to 5 for % elongation and 1 to 5 for impact resistance.

	Minimal tensile strength Kg/cm2	Extension%	Minimal impact resistance Kg/m2
0	_	_	_
1	41	14	5
2	44	18	7
3	48	22	9
4	52	26	11
5	56	30	13
6	60	_	_

Figure 4.17. Technical characteristics of electrodes

Additionally, a symbol that characterizes the type of covering and is usually the initial letter of the Latin word that identifies to the type of electrode (Oxidant, Basic, Rutile, Acide, Cellulose and U for the other types).

A number that determines the welding position from 1 to 5. i.e.: 1 for all positions 2, for all positions except descending welding, 3 for flat/horizontal position 4 for flat position and 5 for flat/horizontal/vertical-down position.

Symbol	Welding positions in accordance with ISO 6947
1	PA, PB, PC, PD, PE, PF, PG
2	PA, PB, PC, PD, PE, PF
3	PA, PB
4	PA
5	PA, PB, PG

Figure 4.18. Welding positions according to ISO 2560

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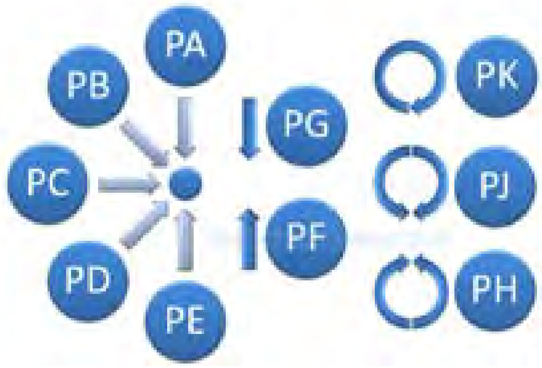

Figure 4.19. Welding positions

Welding intensity depends on the thickness of the profiles and the diameter of the electrode as presented in the following table.

Welding intensity depending on the thickness of the profiles and the diameter of the electrode

emm	Φ 1,6	Φ 2	Φ 2,5	Φ 3,15	Φ 4	Φ 5	Φ 6,3
1	25A	–	–	–	–	–	–
2	35	45A	55A	-	-	-	–
3	–	6	70	90 A	-	-	–
4	–	–	85	100	130 A	-	–
5	–	-	90	110	130	160	
6	–	-	-	120	140	18	
8	–	-	-	125	150	170	–
10	–	-	–	130	160	190	230 A
12	–	-	-	-	170	200	250
15	-	-	-	-	180	210	270
20	–	-	-	-	190	220	300
25	-	-	-	-	200	230	320
30	-	-	-	-	200	250	320
	-	-	-	-	-	250	350
80	-	-	-	-		250	350
100	-	-	–	-	-	25	350

Figure 4.20. **Welding Intensity /diameter of electrode**

The type of covering of an electrode depends substantially on the types of slag-forming components. The symbols indicating the covering type shall be in accordance with table below.

Symbol	Type of covering
A	Acid covering
C	Cellulosic covering
R	Rutile covering
RR	Rutile thick covering
RC	Rutile-cellulosic covering
RA	Rutile-acid covering
RB	Rutile-basic covering
B	Basic covering
NOTE A description of the characteristics of each of the types of covering is given in Annex B.	

Figure 4.21. Symbol for type of covering

4.2.3. Metal joining techniques, with bolts or welding

Key Words

Eurocode: ten European standards (EN; harmonized technical rules) specifying how structural design should be conducted within the European Union.

Shear force: a force acting in a direction parallel to a surface or to a planar cross section of a body, as for example the pressure of air along the front of an airplane wing

Attractive force: the force by which one object attracts another

Tensile strength: a measurement of the force required to pull something such as rope, wire, or a structural beam to the point where it breaks

Carbon: a chemical element with the symbol C and atomic number 6.

Based on Eurocode 3 section 1.8 there are the following type of bolts, characterized by their diameter.

M12	M16	M20	M22	M24	M27	M30	M36

Figure 4.22. Bolt's diameter (Eurocode 3)

The number in the name corresponds to the bolt's diameter i.e. M 20 means 20 mm bolts diameter, A screw connection is designed to receive:

1. Shear force - perpendicular to the axis of the trunk
2. Attractive force - parallel to the axis of the trunk
3. Shear and tensile strength at the same time

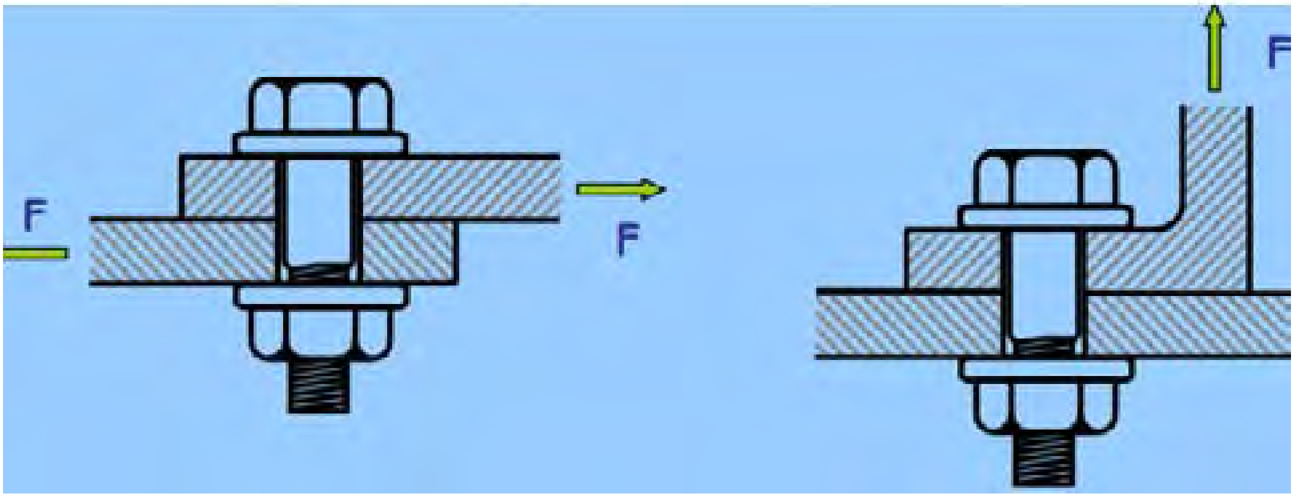

Figure 4.23. Forces exerted on bolts

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There are two basic ways for jointing a bolt. With plate welded to the beam or with corners.

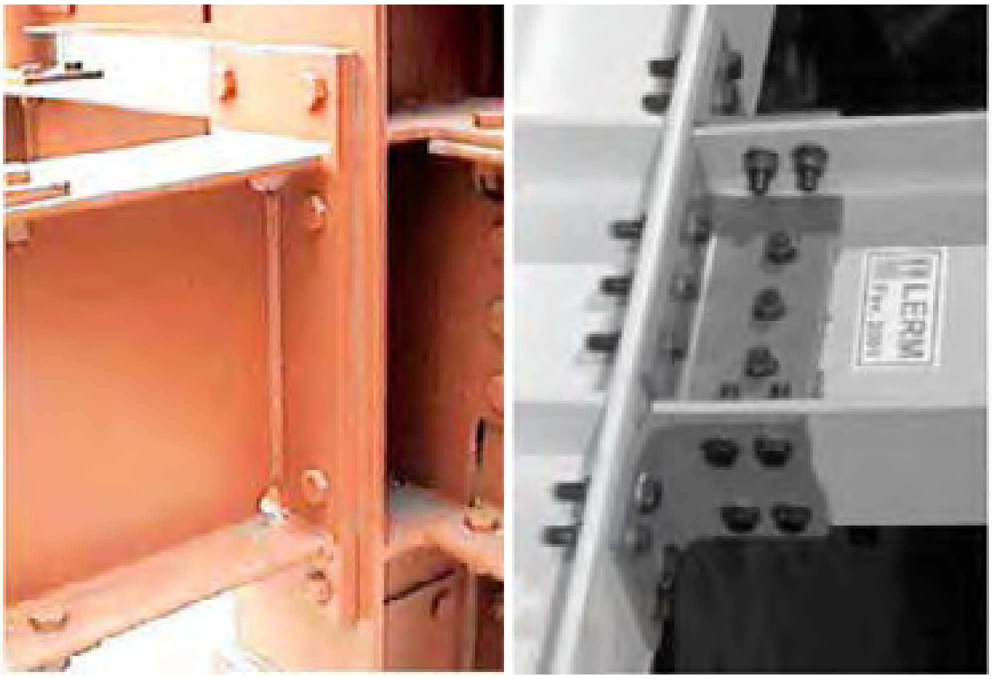


Figure 4.24. Bolt’s categories

The adhesiveness of steels mainly depends on their carbon content (%C). The less carbon a steel has, the greater its adhesion, i.e. it be welded more easily. The upper limit of carbon content for easy welding is 0.25%. If a steel has a carbon content more than 0.25%, then welding can only be successful under special conditions. These steels, with a limit of more than 0.25%, can be welded if preheated. This preheating depends on the carbon content and reaches up to 425 oC for steels with a carbon content of 0.8%.

Aluminium alloys can be easily welded. Alloys with more than 5% magnesium are excluded.

- The welding material must be of greater strength than the parent metal (electrode selection)
- Simultaneous welding and soldering to receive the same load should be avoided
- All welding must be done indoors under controlled conditions (not on site)

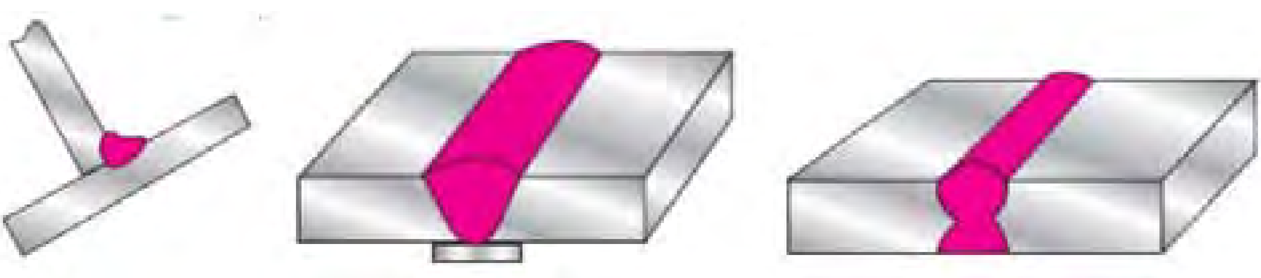


Figure 4.25. Connections that require significant filling with weld metal

4.3. Assembling profiles in different typology of metal constructions as well as with steel-aluminium

Key Words

Heterogeneous welds: welding of two different metals

To be achieved upon learning outcome completion

KNOWLEDGE	SKILLS	COMPETENCIES
• Assemble fenestration, outdoors, etc. • Mixed constructions • Artistic processing and finishing of joints - welding of special structures • Quality controlling	• Recognize and apply the requirements of the system designer's technical manuals when assembling frames • Dimension basic profiles from the technical chart of different loads and select the appropriate mounting mode • Apply Statics and Load stress, Dynamic load & Wind load knowledge • Use technical tables for selecting the ideal profile • Communicate and share information with the building engineer, e.g. architecture engineer • Comply with National & EU Legislation • Apply all production stages for assembling all types of fenestrations & outdoor, fencing, railing systems etc. • Process procedure appropriate to the material used • Realize workmanships on metal sheets • Process material appropriate procedure • Communicate and share information with the building engineer, e.g. the architecture engineer for the big constructions • Appy tools and consumables for perfect aesthetic restoration of glued joints • Apply welding finishing techniques	• Understand the details of construction and perception of the consequence of the wrong choice in the static, aesthetic & corrosion in structure of construction • Understand the need for good aesthetic results in steel structures for architectural use

4.3.1. Technical – production manuals, catalogues

1. Architectural metal systems: As in case of aluminium frames, we can assemble metal frames in the same way. To this end, the instructions of the system designer's technical manuals should be taken into account. The manual will guide the assembler for cutting, machining and connect profiles with other related components. In case of welding, the indicated method (technique and equipment) should also be followed. So, casements, tilt & tern, sliding, roller shutter, railing, curtain walling must be assembled according to the guidelines specified by the technical manual.

Figure 4.26. **Steel architectural systems**

2. To assemble a construction designed by engineer, the details of the construction as described in the architectural and static designs should be followed.

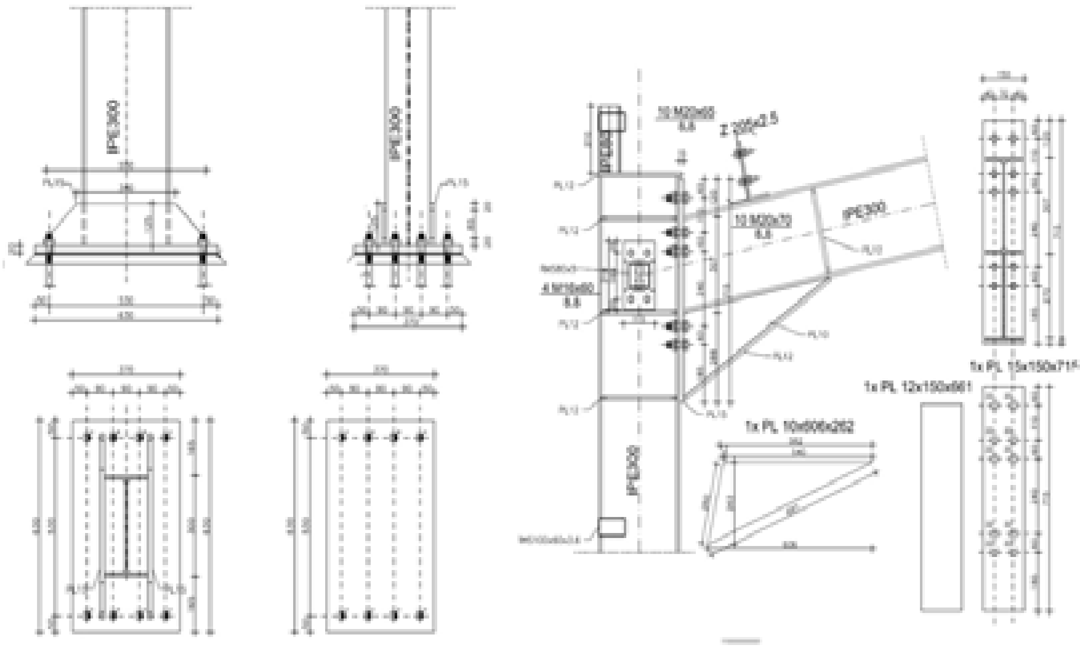


Figure 4.27. **Application plans**

3. In order to assemble another unique metal construction, the instructions for each step, i.e. the process of cutting, processing, welding, etc. as described by European standards (Eurocode 3) should be followed. For example, a connection with bolts is needed, the relevant tables with the bolts strengths should be taken into consideration.

4.3.2. Mixed constructions assembling

Key Words

Heterogeneous welds: Welding of two different metals

For mounting or joining two different metals, electrically insulating neutral material, such as plastic, wood, etc shall be intervened.

Figure 4.28. Mixed steel/aluminium construction

Heterogeneous welds allow us to join pieces made of different materials such as steel with copper, steel with cast iron, etc. The heat required for adhesive, due to the low relative temperatures, is provided by many different sources as the oxygen-acetylene burner, etc. The main heterogeneous welds are:

- bronze welding
- silver welding, called also hard welding due to the high welding temperature (600 - 900 oC)
- tin (solding) welding
- lead welding, called also soft welding due to the low welding temperature (180 - 400 oC).

The table below shows some welding temperatures for the most common metals.

Materials	Welding Temperature (oC)
Steel	750-900
Cast Iron	650-800
Copper	890
Aluminium	500
Screw bolt	30 sec /piece

Figure 4.29. Welding Temperature (oC)

The separation of heterogeneous welds into soft and hard is not only due to the difference in melting temperature but mainly to the mechanical strength of the welded product. The mechanical strength in the soft ones is low while in the hard ones it is quite high. Another important difference between these two welds is the fact that in hard welds the pieces to be glued are heated to a temperature lower than that of the solder, while in the soft ones they are heated to a higher than the melting point of the adhesive.

Bronze welding (brazier) is widely used in repairing of pieces of cast iron, steel, bronze, copper as well as in gluing different materials such as cast-iron steel, copper, etc. In particular it is used in steel connections showing poor adhesion to other methods. The adhesive materials used in the brazier are copper and zinc alloys for ordinary bonding and copper, zinc and nickel for high bonding requirements. Bronze welding is relatively simple to perform.

An oxygen-acetylene burner with an acetylene supply of 50 - 60 L / hour for front gluing is commonly used.

Fasten with the pieces that will stick either with their own weight, or with the help of clamps or even by tying them, while making sure that they have good contact. Flame must be direct applied to the thickest part. Heating the piece to the appropriate temperature, which ranges from 750 to 920 ° C and in the next step approaching the melting adhesive forming the seam.

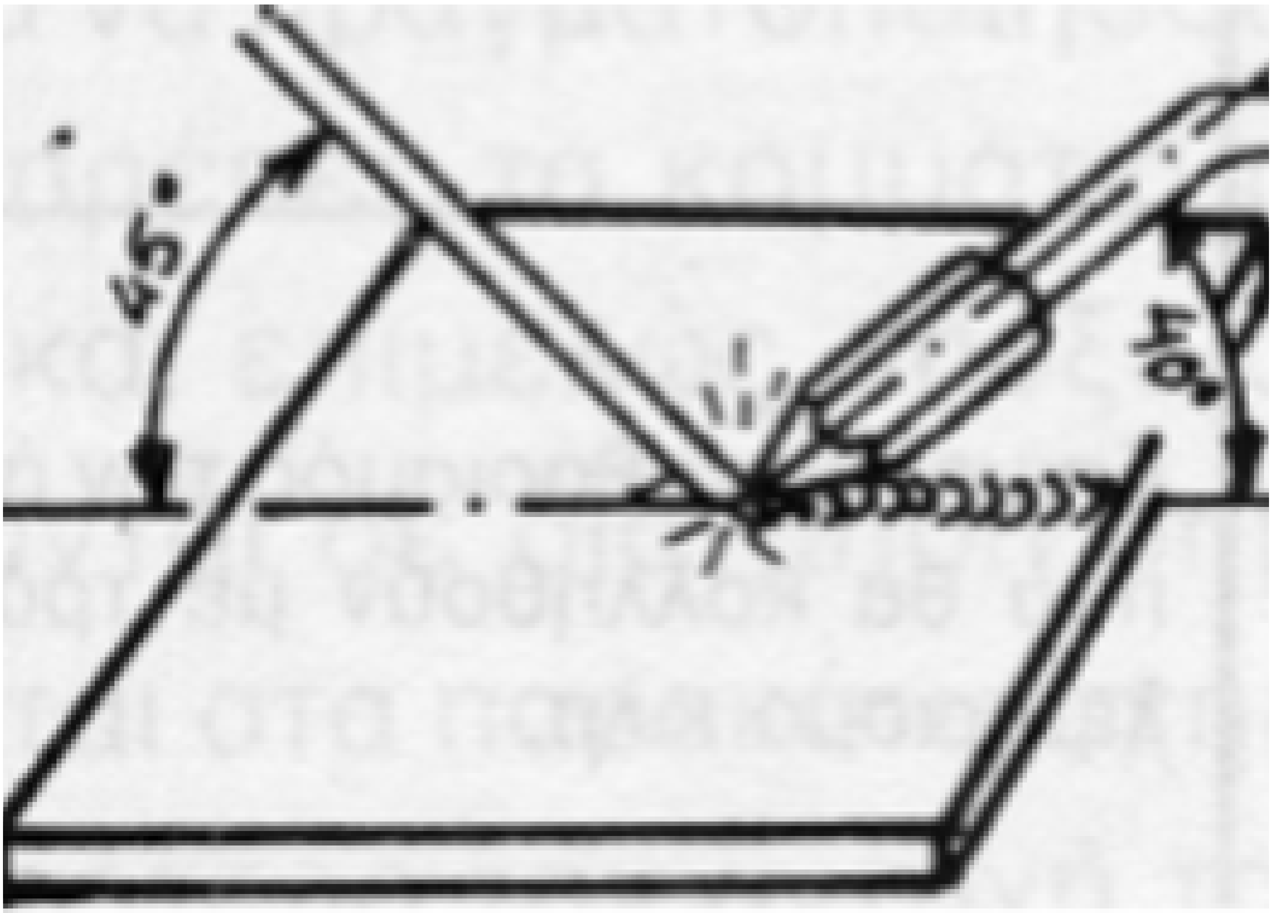


Figure 4.30. Welding

4.3.3. Artistic aspects, finishing of joints & special structures

Key Words

Appropriate straps: surface treatment of welding

Artistic welding: When the aesthetic requirements are as basic as the mechanical strength of the welding.

The primary selection from the of various types of joining and welding methods, is done based on the strength and mechanical durability of the structures, while the aesthetic requirements and limitations are secondary. Production of high quality architectural constructions, such as railing, requires careful selection of welding technology. The main factors that affect the quality of welding in the manufacture of metal art objects are the following:

- equipment mobility,
- access to the welding area,
- thickness of the welded parts,
- material bonding capability.

All these factors affect the appearance of welds, which are the main quality criteria for products. Complex shapes require free access to the welding zone, as well as the mobility of the welding equipment.

In architectural systems it is necessary that all the mechanical properties are satisfied and at the same time uniform surface aesthetics will be visible. In the connection of various sections of stainless steel, visible joints are not generally preferable. There are two surfaces types of the final product:

- satin
- glossy (mirror)

It takes a lot of effort and time to meet the respective visual specifications. In other words, the joints of stainless steel with welding must not be visible in the final product. In order to achieve, a surface treatment is necessary.

By using the appropriate straps (thick red ribbons), the welding material is removed locally so that the connection is not visible.

However, because the coarse-grained strips leave a lot of roughness, they have to be processed gradually until the desired result of satin will be reached. If the final satin surface will be observed with a microscope, the roughness (grooves) continues to exist despite the surface treatments with the straps (from the coarse-grained to the fine-grained). This in practice satisfies the desired aesthetic effect. Such applications are made in railings, windows for commercial buildings, lighting fixtures, mirrors, etc.

In the satin quality between the two grooves of roughness, various e.g. (environmental dust, dirt, use by-products, etc.) are trapped. For this reason, further treatment of the surface is proceeded in order to achieve the neutralization of roughness (i.e. glossy surface like the mirror). It is achieved by using very fine-grained straps and then fabric using very fine grains trapped in "paste" and at high speeds. These sails are usually made of cotton or in exceptional cases of silk.

On these sails a "paste" which contains very thin grains of abstract material are spreader, joined with "soap" that acts as a binder of these grains. By this method, it is achieved a surface on which we can literally mirror ourselves. The result is an aesthetically perfect product and offers the promotion of the two main components of stainless steel, namely chromium and nickel. Finally, it does not allow the coating and adhesion of foreign materials to the surface.

Figure 4.31. Construction from stainless steel and glass (gnb-architects.com)

Zircon belts and ceramic materials are divided into three categories:

- The standard type who have their grains placed vertically and close to each other.
- The open type who have their grains placed vertically but sparsely and finally.

Figure 4.32. Grinding Belts

There is also a class of straps that have more concentrated and less sharp grains. These straps are made of aluminium oxide or carbon fibre and are combined with phenolic resin. During sanding, grain layers are constantly removed, and this process is repeated until all the layers of the belt are used.

The parameters of sanding are:

1. **Grinding speed**

   The grinding speed is given to us by the grinding tool. The higher the grinding speed, the less material is removed from the treatment surface. The result of this high speed is the smallest roughness on the surface as well as the increase in temperature of the material in the grinding zone. A low cutting speed increases the mechanical stress on the belt grains when all other conditions are the same. Depending on the processing material, there is a cutting speed limit, which helps us achieve the desired result. In the case of stainless steel it ranges from 18 to 27 m / s. In summary, the grinding speed is a very important factor for this process and that the high speed reduces the mechanical stress of the grains and increases the thermal stress of the sanding zone.

2. **Power supply level**

   The degree of supply of the material determines the productivity of a grinding process. The higher the feed rate of the material, the greater the thickness of the surface removed from the processing material. Also, the high degree of efficiency yields higher roughness and low temperature in the grinding zone. It can be noted that the higher the feed rate, the greater the grain detachment from the belt. As for the degree of supply and the temperature of the material, it should be kept low so that it can be achieved an increase in the degree of supply.

3. **Pressure surface**

   The higher the pressure surface, the deeper the belt grains penetrate the machining material, resulting in fewer grains being used during the process. The higher the surface pressure, the higher is the process temperature.

4. **Drum**

   The contact drum (where the belt rotates) is necessary to support the belt, as well as to absorb and reduce vibrations created during grinding. The hardness of the drum must be chosen according to its function because the characteristics of the drums play an important role in the desired result of the treated surface. The larger the diameter of the contact drum, the larger the processing area during the rotation of the drum between the belt and the surface of the material. Another result of the large diameter is the reduction of hardness and the increase of the surface temperature of the material in the grinding zone. The maximum diameter of a contact drum is between 250 and 350 mm. The softer the drum, the larger the contact area created between the belt and the material. Different materials are used depending on the type of drum required. The most common materials are rubber, plastic and metal. The choice of material also determines the hardness of the drum, which is divided into three categories. The higher the hardness, the greater the roughness of the surface. In this case it can also be noticed a decrease in temperature. As with the diameter, so with the hardness of the drum, an optimal use is recommended, which ranges between 50° and 70°.

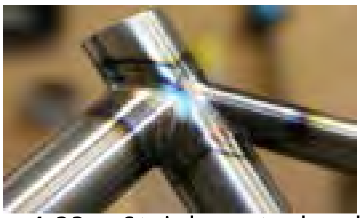


Figure 4.33. Stainless steel welding

Tooth contact causes the geometry to change on the surface of the treatment. Teething reduces the contact surface and increases the roughness of the belt. Smooth contact drums give us less hardness and a higher temperature, while hardened drums have a higher hardness and the temperature decreases because air passes through which cools the belt. Tooth decay can also prolong or reduce the life of the belt, depending on the type of grain it carries and its size. The most appropriate step of the teeth is between 5 and 10 mm.

4.4. Quality control. Health and safety practices. Archiving and monitoring.

Key Words

European Technical Assessment (ETA): An alternative for construction products not covered by a harmonized standard. It is a document providing information on their performance assessment

Factory Production Control (FPC): A documented, permanent and internal control of production in a factory, in accordance with the relevant harmonised technical specifications.

To be achieved upon learning outcome completion

KNOWLEDGE	SKILLS	COMPETENCIES
• Quality controlling • Health and safety practicing • Ways of archiving and monitoring the implementation of the work	• Check the functionalities of the construction, and the proper treatment of the joints • Oxidation test • Safely package the products for transport • Load on a truck and transport the construction in safety • Load and fasten the packages on the appropriate truck • Organize the file of each completed project	• Implement the appropriate measurement techniques for quality control • Implement all protective measures at work • Apply file creation to track and record each task

4.4.1. Quality control

CE Marking for all construction products, covered by a harmonized European standard or conforming to a European Technical Assessment became mandatory on 1 July 2013. For fabricated structural steelwork, CE Marking became mandatory on 1 July 2014. This represents a major development for engineers, contractors and steelwork specialists and it demands careful attention to the new obligations imposed.

Under the **Construction Products Regulation (CPR)**, new legal obligations have been placed on manufacturers, distributors and importers of construction products used within the EU to CE Mark their products where they are covered by either a harmonized standard or European Technical Assessment (ETA).

This applies not only to constituent products (such as steel beams, bolts etc.) but also to fabricated elements and systems made from both **CE Marked and non-CE marked products**. The EN 1090 standard series are covering fabricated structural steelwork.

Part 1 (**EN 1090-1**) sets the Requirements for Conformity Assessment of Structural Components. It describes how manufacturers can demonstrate that the components they produce meet the declared performance characteristics (the structural characteristics which make them fit for their particular use and function).

Part 2 (**EN 1090-2**) sets the Technical Requirements for Steel Structures. It specifies the requirements for the execution of steel structures to ensure adequate levels of mechanical resistance and stability, serviceability and durability. It determines the performance characteristics for components that the manufacturer must achieve and declare through the requirements of Part 1.

In order to be able to CE Mark the fabricated structural steelwork that they produce, steelwork contractors are required to declare performance according to the System 2+ System of Assessment and Verification of Constancy of Performance (as described in Annex V of the CPR-Construction Products Regulation). This requires them to undertake:

- Initial type-testing of the product
- Factory Production Control (FPC), which will include:
  - implementation of FPC system procedures
  - appointment of a responsible welding coordinator (RWC)
  - implementation of welding quality management system (WQMS) procedures
- Further testing of samples taken at the factory in accordance with the prescribed test plan

They must also be assessed by a notified body that will carry out:

- Initial inspection of the manufacturing plant
- Initial inspection of the FPC
- Continuous surveillance, assessment, and approval of the FPC, which will typically include an audit to ensure continued competence to the declared Execution Class (EN 1090-1, sets out minimum levels for the routine surveillance intervals)

The notified body will then issue a FPC certificate and Welding Certificate identifying the Execution Class that the steelwork contractor has achieved.

Figure 4.34. Welding

For steelwork contractors to demonstrate their ability to CE Mark their products, they must provide the following three documents:

1. Factory Production Control certificate (FPC) – issued by a notified body
2. Welding certificate - issued by a notified body
3. Declaration of Performance (DoP) – issued by the steelwork contractor

The client or main contractor engaging the steelwork contractor should carry out due diligence before appointing them. Likewise, insurers should complete a similar due diligence process before giving Professional Indemnity insurance to steelwork contractors who want to CE Mark their products.

Figure 4.35. **Various certifications**

4.4.2. Health and safety practices

Key Words

Energy sources: supply of energy in the form of electric, mechanical, hydraulic, pneumatic, air

The selection and the implementation of specific measures for preventing employees from occupational accidents and diseases in the iron and steel industry depend on the recognition of the principal hazards, and the anticipated accidents and diseases.

Below are the most common causes of accidents and diseases in the iron and steel industry:

- slips, stumbles and falls on the same level
- falls from height
- unguarded machinery
- falling objects
- working in confined spaces
- moving machinery, on-site transport, forklifts, and cranes
- exposure to controlled and uncontrolled energy sources
- exposure to asbestos
- exposure to mineral wools and fibres
- inhalable agents (gases, vapours, dusts, and fumes)
- skin contact with chemicals (irritants (acids, alkalis), solvents and sensitizers
- contact with hot metal
- fire and explosion
- extreme temperatures
- radiation (non-ionizing, ionizing)
- noise and vibration
- electrical burns and electric shock
- manual handling and repetitive work
- exposure to pathogens (e.g. legionella)
- failures due to automation
- ergonomics
- lack of OSH training
- poor work organization
- inadequate accident prevention and inspection
- inadequate emergency first-aid and rescue facilities
- lack of medical facilities and social protection

The craftsman commonly uses different sources of energy (electric, mechanical, hydraulic, pneumatic, etc.). The safe control of energy should be addressed by procedure and carried out by appropriately trained personnel in accordance with the nature of the energy source and the characteristics of the facilities.

To the extent possible, the source of energy itself should be isolated rather than the control mechanism. Energy sources for equipment should be turned off or disconnected or de-energized and the switch locked or labelled with a warning tag. Workers working in the hazard area should be trained in the hazard and the protective measures in place.

All electrical installations should be appropriately designed and should include appropriate protection systems, such as automatic shut-off systems, interlocks, and emergency controls. All electrical installations should be installed or maintained by certified personnel.

Facilities should be installed and used in accordance with the requirements of the manufacturer and in compliance with the competent authority. The energy distribution facilities should be appropriately situated and protected, and access limited to authorized personnel only. Energy sources and facilities should be appropriately labelled.

A risk assessment should be conducted before isolating the energy source to ensure that the consequences have been evaluated. All facilities and equipment undergoing servicing, renovation or maintenance should be appropriately isolated, locked out and labelled to ensure that all persons are protected. There should be the appropriate documentation on pipes and cables, and they should be properly labelled. Pipes and cables not in use should be removed as soon as possible.

The use of work equipment, including machinery and hand and portable power tools, may result in accidents, many of which are serious and some fatal. Of the many factors that can cause risk, particular areas of concern include:

- a lack of guards or inadequate guards on machines which can lead to accidents caused by entanglement, sheering, crushing, trapping, cutting, etc.
- failure to keep guards, safety devices, controls, etc., properly maintained and in place so that the machines or equipment become unsafe
- a lack of appropriate safety systems, interlocks or other automatically functioning safety devices and emergency stopping devices
- insufficient strength of materials and inappropriate design of machines
- failure to provide the right information, instruction and training for those using the equipment
- hammers with broken or cracked handles, chisels and punches with mushroom heads, bent or broken wrenches and wrenches with sprung jaws should not be used by employees
- most hand-held electrical power tools should be equipped with a “dead man” or “quick release” control, so that the power is automatically shut off wherever the operator releases the control
- all hand-held portable electrical equipment should have its frame earthed or be doubly insulated and identified as such
- all power tools should be used with appropriate shields, guards and attachments and in accordance with the recommendations of the manufacturers. Workers should be trained in the use of power tools and safety requirements
- pneumatic power tools should be positively secured to the hose to prevent the tool from becoming disconnected; also, a tool retainer should be used on tools to prevent the attachment from being disconnected
- mailers, staplers, and similar automatic feed equipment should have a muzzle to prevent the tool from ejecting material unless the muzzle is in contact with the work surface.

4.4.3. Project documentation and monitoring

Key Words

Project stages: the various stages from the start to the delivery of a project / product

The success of any project depends on how well the following four key aspects are aligned with the contextual dynamics affecting the project:

1. **Plan** : The planning and forecasting activities.
2. **Process** : The overall approach to all activities and project management.
3. **People** : Including dynamics of how they collaborate and communicate.
4. **Power** : Lines of authority, decision-makers, organograms and policies for implementation.

There are several approaches for organizing and completing project activities, including: phased, lean, iterative, and incremental. There are also several extensions to project planning, for example based on outcomes (product-based) or activities (process-based). Regardless of the methodology employed, careful consideration must be given to the overall project objectives, timeline, and cost, as well as the roles and responsibilities of all participants and stakeholders.

The phased (or staged) approach breaks down and manages the work through a series of distinct steps to be completed and is often referred to as "traditional" or "waterfall". Although it can vary, it typically consists of five process areas (four phases plus control). The typical development phases of a project are:

- initiation
- planning and design
- construction
- monitoring and controlling
- completion or closing

Many industries use variations of these project stages and it is not uncommon for the stages to be renamed, in order to suit better to the organization. For example, when working on mezzanine design and construction, projects will typically progress through stages like pre-planning, conceptual design, schematic design, design development, construction drawings (or contract documents), and construction administration.

While the phased approach works well for small, well-defined projects, it often results in challenge or failure on larger projects, or those that are more complex or have more ambiguities, issues and risk.

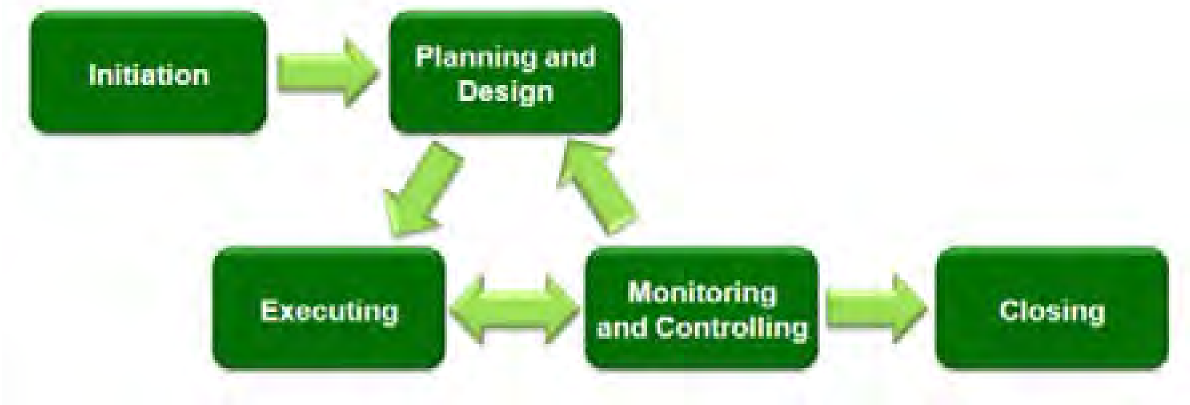


Figure 4.36. Typical development phases

Monitoring and controlling consists of those processes performed to observe project execution so that potential problems can be identified in a timely manner and corrective action can be taken, when necessary, to control the execution of the project. The key benefit is that project performance is observed and measured regularly to identify variances from the project management plan. Monitoring and controlling includes:

- Measuring the ongoing project activities ('where we are')
- Monitoring the project variables (cost, effort, scope, etc.) against the project management plan and the project performance baseline (where we should be)
- Identifying corrective actions to address issues and risks properly (How can we get on track again)
- Influencing the factors that could circumvent integrated change control so only approved changes are implemented
- Project maintenance is an ongoing process, and it includes:
- Continuing support of end-users
- Correction of errors
- Updates to the product over time

Over the course of any construction project, the work scope may change. **Change** is a normal and expected part of the construction process. Changes can be the result of necessary design modifications, differing site conditions, material availability, contractor-requested changes, value engineering and impacts from third parties, to name a few. Beyond executing the change in the field, the change normally needs to be documented to show what was constructed. The increasing legality pertaining to the construction industry's maintenance of correct documentation has caused the increase in the need for document management systems. When changes are introduced to the project, the viability of the project must be re-assessed. It is important not to lose sight of the initial goals and targets of the projects. When the changes accumulate, the forecasted result may not justify the original proposed investment in the project.

During the process of monitoring and control of the project, the tables are completed with all the production / manufacturing data, such as working hours, installation time, etc., to be used in costing and pricing.

04 MODULE Conclusions

The processing of metals and their alloys takes place on a daily basis in the construction companies of aluminium and steel construction products.

Workers should be aware of the basic principles for the work they perform, the equipment used, and the correct techniques they should apply.

The choice of the most appropriate machining, as well as the proper execution of it, is a key element for the project completion.

Particular attention should be paid because metal working processes poses many risks to workers safety.

Self Assessment Questions

Improvement begins with assessment.
Self Assessment is the first step to all assessment.
Start by choosing the correct answers.

1. Why accurate cost information is needed?
   a. Is mandatory by law
   b. For make the payment of staff
   c. For manage our suppliers
   d. To be the basis for pricing decision

2. Why is the traditional costing technique so inaccurate?
   a. It does not count labour
   b. because there is no actual relationship between the cost pool and the cost driver
   c. It does not calculate the overhead
   d. It does not calculate the fixed costs

3. Why a suitable is tool required for each type of profile?
   a. Because there are many different profiles in dimension and shape.
   b. To spend less time
   c. It is mandatory from the procedures
   d. It costs less in the company

4. How does recording production time help us with different tasks?
   a. To pay the staff
   b. To pay the suppliers
   c. To know the kind of products
   d. We can plan production and cost the product

5. What are Eurocodes?
   a. They are the Europe-wide standards for all aspects of the structural design and development of buildings.
   b. They are laws of Europe
   c. Code for introduction to European legislation
   d. Production laws

6. Does the CE apply to accessories or finished products?
   a. Only for finished products
   b. Only for accessories
   c. For both
   d. For neither

7. Is cost the same whether it is calculated it with a classic method or another one?
   a. Yew is the same
   b. No, it’s different
   c. Depends on the product
   d. Depends on the production

8. What is the reason we use stainless steel screws for connection to aluminium?
   a. For beauty
   b. For safety
   c. The law stipulates it
   d. Aluminium does not oxidise

9. What gases can we use to weld and cut metals?
   a. With oxygen-acetylene / propane flame
   b. With oxygen
   c. Argon
   d. Methane

10. What changes on the device for cutting or welding?
    a. The valve
    b. The handle
    c. Pressure
    d. The power hose

11. Which of the T.I.G., M.I.G. and M.A.G., electrodes are ideal for small thickness welding?
    a. M.I.G.
    b. M.A.G.
    c. Electrodes
    d. T.I.G

12. What do the 3 numbers on an electrode package indicate?
    a. Tensile strength, temperature, and extension
    b. Diameter, impact, and extension
    c. Diameter, impact, and length
    d. Tensile strength, impact, and extension

13. Does temperature affect the construction?
    a. Yes, the colour changes
    b. Must use different profiles
    c. Yes, it creates contraction-expansion.
    d. Need to use large profiles

14. What does the weld density depend on?
    a. Thickness of profile and diameter of electrode.
    b. The colour of the profile
    c. The moment that make the weld
    d. Temperature

15. Are there different types of covered electrode coverage?
    a. No
    b. Yes, they are.
    c. Only for the steel
    d. Only for the copper

16. What does oxygen help in gases?
    a. Is moor easy
    b. In combustion
    c. The welding makes less time
    d. Is moor safety

17. What does the number in the name that characterizes a bolt mean?
    a. The size
    b. The length
    c. The colour
    d. The diameter

18. How many categories of bolts materials are there?
    a. 5
    b. 3
    c. 2
    d. 8

19. What does the first letter in the decimal number that defines materials' categories of bolts mean?
    a. The diameter
    b. The length
    c. The size
    d. Multiplying by 10 the leakage force

20. What could happen when two different metal parts meet each other?
    a. Temperature
    b. Corrosion
    c. Colour change
    d. Expansion

21. Do heterogeneous welds have the same welding temperature?
    a. Yes
    b. Some time
    c. Depend from the kind of welding
    d. No, they have different one

22. How do we remove the coating and adhesion of foreign materials for a perfectly welded surface?
    a. With the angle grinder
    b. With the special belts (straps)
    c. With sandblasting
    d. With oxygen

23. How can we understand leakage from propane?
    a. From the smell
    b. From the colour
    c. From the noise
    d. From the valve

24. Are all electrodes suitable for welding in vertical direction?
    a. Yes
    b. Depends on the quality of material
    c. Depends on the thickness of material
    d. No there are special electrodes

25. Besides CE marking on metal products other than FPS and declaration of conformity, what other document is needed?
    a. Nothing
    b. Welding certification
    c. Authorized
    d. 5 years of experience certificate

MODULE

5

Constructions Installation

Selection and application methods for installation pertinent to building elements, geographical area, residence’s type etc.

MODULE 05

Constructions Installation

Selection and application methods for installation pertinent to building elements, geographical area, residence’s type etc.

Introduction - Learning Objectives

Techniques and materials for adequate waterproofing and insulation, compatible to the adjacent structural element, in order to minimize thermal loses/bridges

In this learning module are presented good construction preparation practices, in order to achieve maximum energy savings rates after frames installation. Good manufacturing and installation practices of pre-frame are also presented. The installation of the frame to the masonry is the last stage of each project. Good frame fixing practices which should be carried out in accordance with the specifications of the system producer.

In order to achieve maximum energy efficiency, special care should be taken to avoid the creation of thermal bridges. Finally, the good sealing practices that should be followed during the installation of the construction are presented. The manufacturer should take care of the specificities of each project, while following the specifications of the system producer when they exist.

Knowledge Objectives to be achieved through this learning module are:

- Appropriate site preparation.
- Set up workplaces at building sites.
- Work autonomously or in a team, based on regulations and safety provisions, technical documentation and work orders.
- Recognize & apply technical guidelines requirements during product installation, to achieve maximum energy outcomes.
- Uninstall a construction appropriately without damaging the components. Repair wall damages.
- Install and affix the construction correctly, considering the peculiarities of the building's thermal insulation.
- Communicate and collaborate with other workers on the field.
- Apply the shimming, according to the typology of the construction to the building block.
- Apply the anchors to the correct position.
- Select the appropriate materials and materials combinations based on the technical specifications and guidelines.
- Apply the instructions in the relevant anchor dimension table.
- Install and finish a construction.
- Apply intermediate protective materials when joining / fastening mixed construction.
- Apply waterproofing products.
- Seal the construction achieving maximum energy efficiency.
- Apply insulation products.
- Install all necessary supporting elements considering minimization of thermal losses and voidance of thermal bridges.
- Inform customers about technical characteristics & explain Declaration of Performance and CE Marking information.
- Communicate and inform clients and/or the engineer on the good operation practices.
- Demonstrate the functions of the construction (product) demonstrating the use and handling of the mechanisms.
- Explain operating and maintenance product instructions , warranty's rules and manufacturer's obligations.
- Clean the field and leave the place uncluttered, clear and tidy up tools.
- Check functionalities and regulate mechanisms.
- Keep files with projects details and particularities.
- Knowledge of proper levelling and shimming.
- Interpret the forces applied in the construction and analyse the typology of the anchor's position.
- Connection and installation mixed aluminium-steel construction.
- Knowledge of external and internal construction conditions for the selection and application of waterproofing materials.
- Knowledge of waterproofing and insulation for mixed metal aluminium construction
- Communication with the customer about the quality of the constructions delivered, as much as how to maintain and clean structures.

For the Teacher

Learning Outcome 5.1
Aluminium & metal constructions applications in building components

Learning Unit 5.1.1 - 4h
Architectural drawings and building regulation requirements. Installing and uninstalling constructions
Learning Unit 5.1.2 - 3h
Proper levelling
Learning Unit 5.1.3 - 3h
Proper shimming

Learning Outcome 5.2
Placing and fitting of aluminium and metal constructions in building components

Learning Unit 5.2.1 - 6h
Interpretation of the forces applied in the construction and analysis of the typology of the anchor position
Learning Unit 5.2.2 - 2h
Selection of the appropriate anchor number and diameter, length
Learning Unit 5.2.3 - 2h
Connection and fastening of mixed aluminium-steel constructions

Learning Outcome 5.3
Insulation

Learning Unit 5.3.1 - 6h
External and internal construction conditions for the selection and application of waterproofing materials
Learning Unit 5.3.2 - 2h
Evaluation of the base's level of construction for the selection and application of insulation materials
Learning Unit 5.3.3 - 2h
Waterproofing and insulation of mixed metal aluminium construction

Learning Outcome 5.4
Product Demonstration

Learning Unit 5.4.1 - 6h
Illustration of the product 's technical features/performance
Learning Unit 5.4.2 - 2h
User manual explanation
Learning Unit 5.4.3 - 2h
Maintenance and cleaning products instructions

5.1. Aluminium & metal constructions applications in building components

Key Words

Installation of fenestration: process of transferring waterproofing fastening and show of technical characteristics and how to maintain of window

Qualitative assessment: performance of technical characteristics

Fenestration shielded: window protected from the weather, placed in a recess

Blower doors test: checking air leaks between frame and wall in the site with a special device

To be achieved upon learning outcome completion

KNOWLEDGE

- Interpretation of architectural designs and building regulations for the placement of the construction
- Identification of the different location options of the structures in the building block
- Uninstall and repair old construction
- Proper levelling
- Proper shimming

SKILLS

- Install construction appropriately to points, interpreting designs
- Prepare field for installation
- Set up workplaces at building sites
- Carry out work assignments autonomously or in a team according to relevant regulations and safety provisions on the basis of technical documentation and work orders
- Recognize and apply the requirements of technical guidelines during product installation, in order to achieve maximum energy outcomes
- Install and affix the construction, taking into account the building's thermal insulation peculiarities
- Uninstall the construction without damaging components
- Repair damaged walls
- Apply levelling inside, outside, diagonally, up & down
- Communicate and collaborate with other workers on the field
- Apply the shimming to the building block, according to the typology of the construction

COMPETENCIES

- Exploit - evaluate alternative installation location
- Adapt to any structural failure

5.1.1. Architectural drawings and building regulation requirements. Installing and uninstalling constructions

Knowledges and skills concerning windows installation have been identified as necessary, in order to ensure that performances of the installed product are equivalent to them achieved during laboratory testing. To reach the end user for operation, the frames must be:

1. **manufactured,**
2. **packaged,**
3. **transported,**
4. **safely stored on site,**
5. **installed.**

According to EN 14351-1 standard, when the fabricator does not install the product, he must supply the installer with the relevant Guidelines. The involved parts in installation process are:

1. **architects,**
2. **contractors,**
3. **system designers,**
4. **fabricators,**
5. **installers.**

Installation must support the window's qualitative assessment at least in 3 basic characteristics:

1. **resistance to wind load**
2. **water tightness**
3. **air permeability**

Wrong or incomplete installation cancel the relevant performances and hence the quality of the frame. Used materials must be relevant with the mechanical and chemical properties of aluminium and building blocks so that they all work together. Example: Water tightness. They are two options of installation:

A. **fenestration non shielded,**
B. **fenestration shielded.**

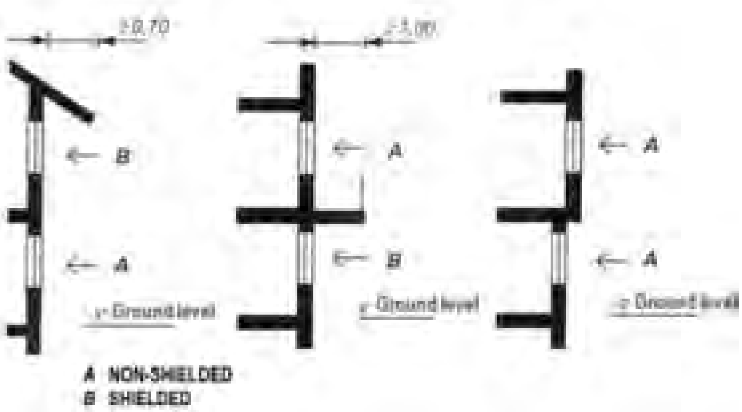


Figure 5.1. Possible ways of installation

When the window is non shielded it receives more rain and the waterproofing materials have to be resistant to sun radiation. The choice of installation location and materials to be used depends on eight key factors:

1. **point of installation of the frames in the building,**
2. **ground category,**
3. **use of the building,**
4. **fenestration's material,**
5. **typology,**
6. **type of masonry,**
7. **place of installation in the masonry,**
8. **building orientation.**

Figure 5.2. Position of the window in the masonry (Technical Manual of Windows Installation, POVAS 2019)

The manufacturer must be able to understand from the architectural drawings the location where the window should be placed, and in addition be aware of the ideal location based on the performance of the window mounted on the masonry.

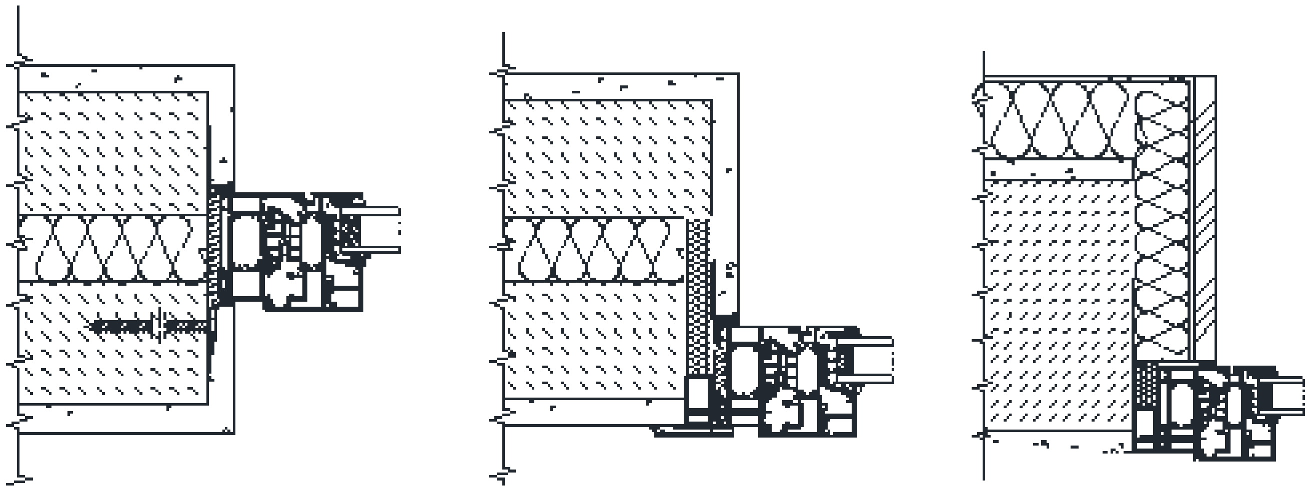


Figure 5.3. Architectural drawings with different position of the frame in the masonry (Alumil)

Installation point affects the thermal performance of the fenestrations.

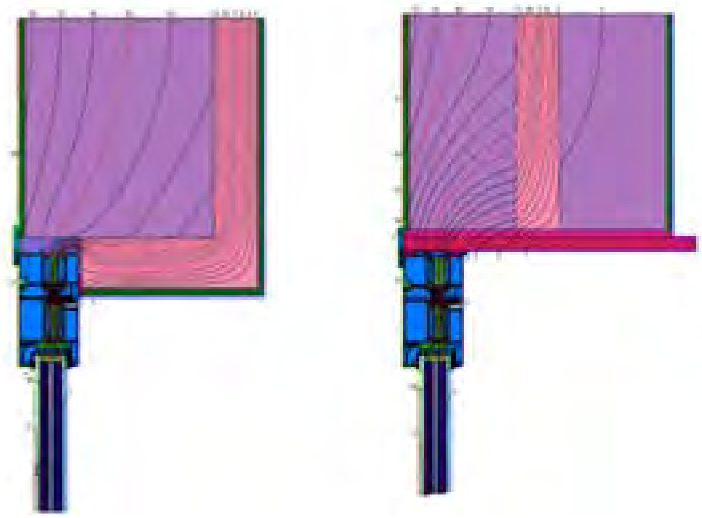


Figure 5.4. Thermal performance of fenestrations (Alumil)

During windows transportation and working on site, all the health & safety precautions required by the relevant legislation must be taken into account. Transportation of windows must be done safely by using special protective materials and tied in a safe manner.

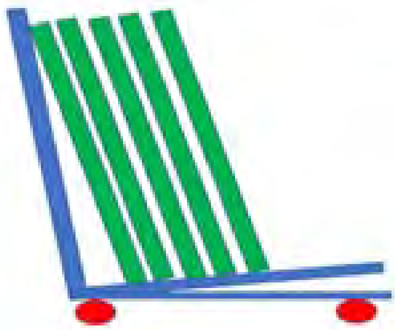


Figure 5.5. Wright way of transportation

Products should be deposited at the project site in a safe manner.

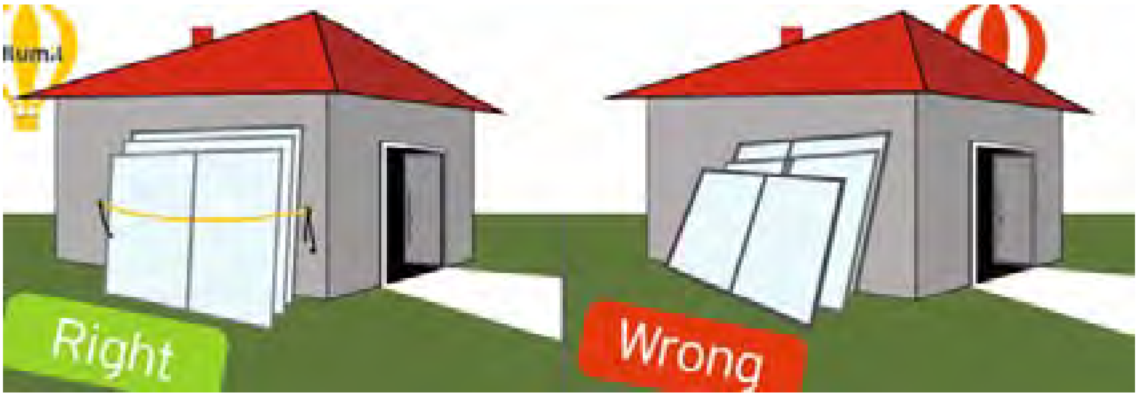


Figure 5.6. Deposition on building site (Alumil)

Erasmus+

Before starting the installation, technicians should:

- **clean any material residues from previous works,**
- **check that they have all the required materials for installation,**
- **check the dimensions in relation to the masonry (required voids).**

If there are existing windows in the building, they must be uninstalled in such a way in order not to damage the masonry. The frames of the existing windows must be cut in 45 degrees and afterwards the connecting elements to the masonry should be cut. Before installing the new one, all the materials must be removed and the place must be cleaned very well.

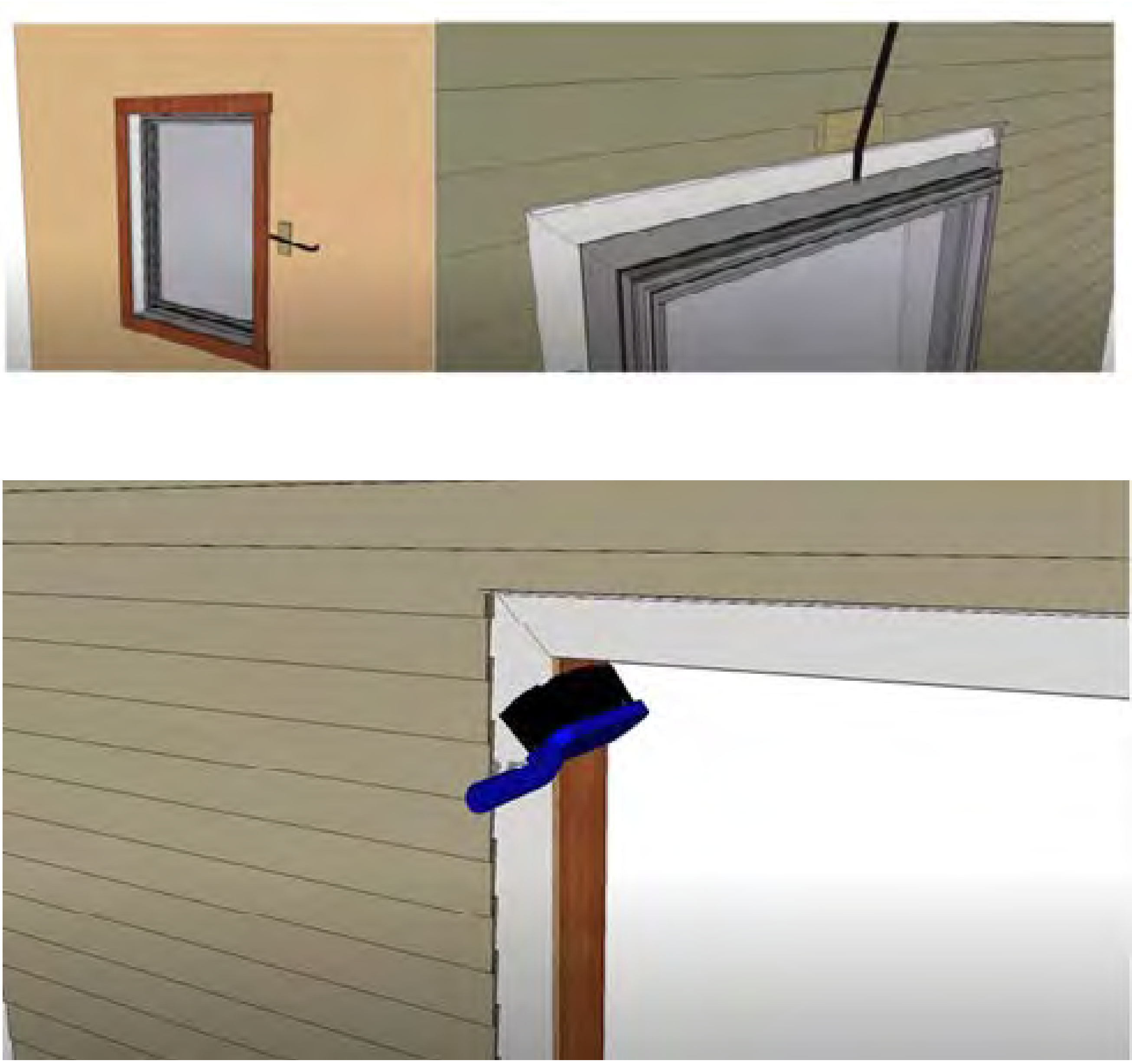


Figure 5.7. Basic steps to uninstall existing windows

5.1.2. Proper levelling

Key Words

Square: when the angles of the frame are at 90 degrees

Level: when the bottom and top of the crate are parallel to the ground, while two others vertical

Plumbing: when the frame is vertically at 90 degrees except from the square Plumb

In each construction the levelling must be done on three axes.

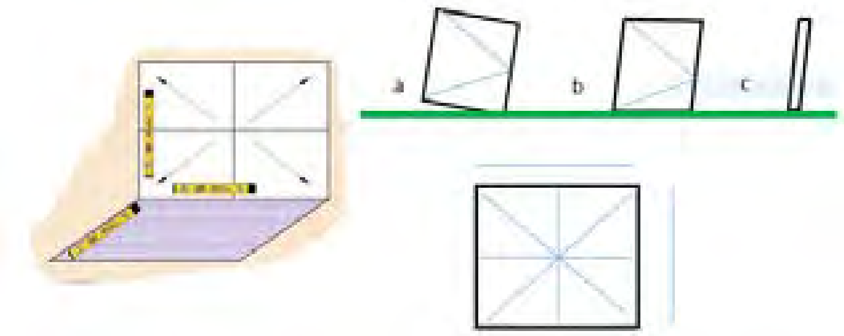


Figure 5.8. Frame levelling

In metal constructions, the classic column support technique, is to have a metal plate at the base of the column so that it can be levelled with the existing bolts on the 3 axes.

Figure 5.9. Columns of metal construction levelling

The bases of the columns in a construction should be at the same level.

Figure 5.10. Points a, b, c, d must be at the same level

5.1.3. Proper shimming

Key Words

Shim: a thin slip or wedge of metal, wood, etc., for driving into crevices, as between the gap of wall-frame or wall-floor, in order to level them

The shimming of the frame on the masonry is based on the principle of carrying the loads to the masonry, at points that can absorb the load via the frame without deforming it.

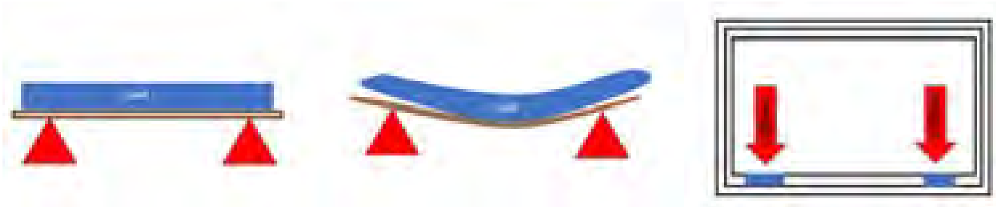


Figure 5.11. Load application on frame

Crucial point: the frame must be on shims (≥ 5 mm) in order not to be deformed in case the floor is not flat.

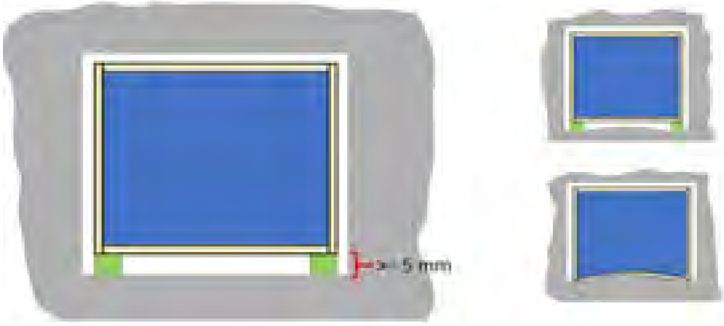


Figure 5.12. Frame shimming

In all typologies sashes' are the moving parts, while in opening windows they move in every direction, as shown in the below figure.

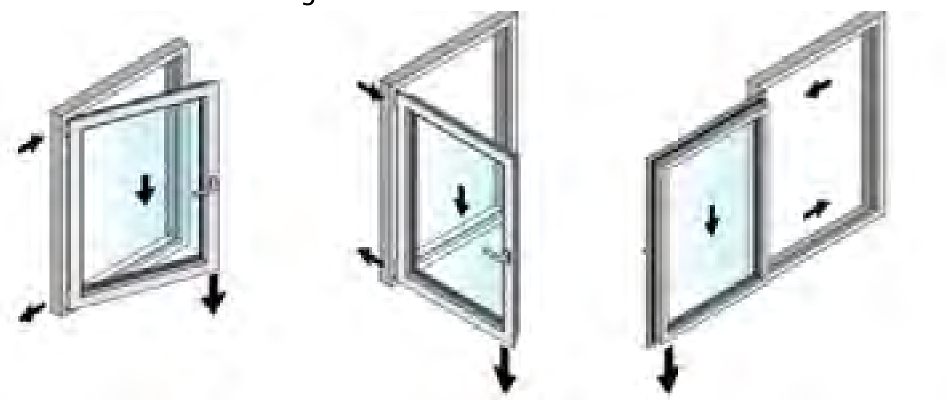


Figure 5.13. Points of loads transfer (Technical Manual of Windows Installation, POVAS 2019)

The sashes load could be transferred on frame via the hinges.

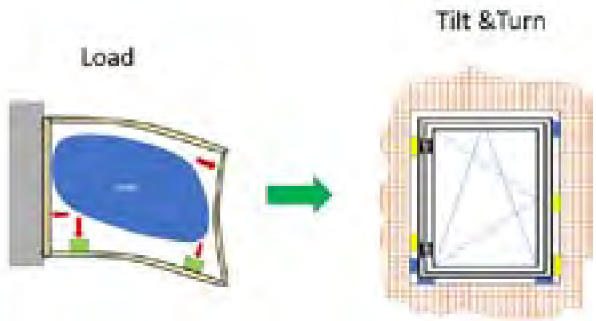


Figure 5.14. Shimming for tilt & turn window (Technical Manual of Windows Installation, POVAS 2019)

At the entrance door's threshold, shims are placed every 200 mm in order to avoid deformation.

Figure 5.15. Shimming of entrance door (Technical Manual of Windows Installation, POVAS 2019)

In sliding fenestration, the load must be transferred directly to the rollers via the shims.

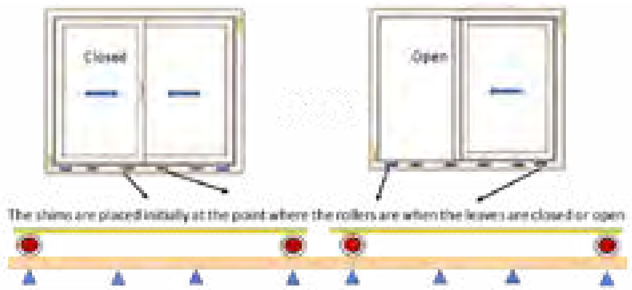


Figure 5.16. Sliding fenestration shimming (Technical Manual of Windows Installation, POVAS 2019)

At the remaining intervals we place the shims at a distance of ≤ 400 mm

When we have stacked sashes on one side, such as three-slide / four-slide, shims are placed per 300 mm, on the side where sashes the leaves are gathered.

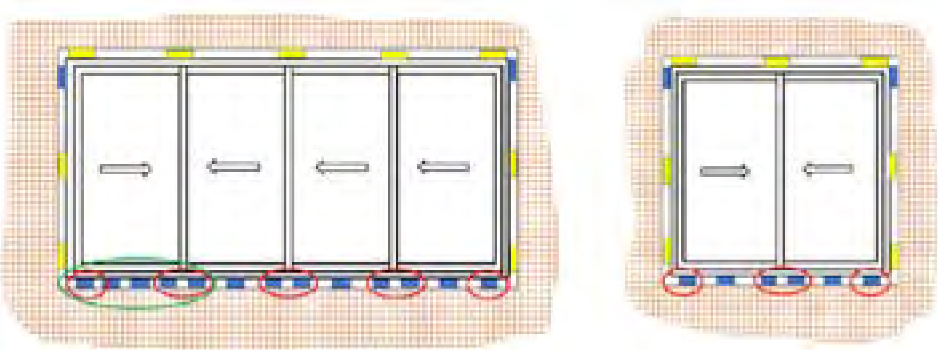


Figure 5.17. Sliding fenestration shimming (Technical Manual of Windows Installation, POVAS 2019)

The same procedures apply to metal structures.

5.2. Placing and fitting of aluminium and metal constructions in building components

Key Words

Screw: metal pin of different cross-sections used for fastening the frame to the building structure

Gap: the space between frame and the building structure

Bracket: metal blade of various designs for fixing the frame to the building structure

To be achieved upon learning outcome completion

KNOWLEDGE

- Interpretation of the forces applied in the construction and analysis of the typology of the anchor position
- Selection from tables of appropriate anchor number and diameter, length
- Connection and installation
- Knowledge of mixed aluminium-steel construction

SKILLS

- Apply anchors to the correct construction position
- Select the appropriate materials and materials combinations based on the technical specifications and guidelines
- Apply instructions in the anchor dimension table
- Install and finish the construction
- Apply intermediate protective materials when joining / fastening mixed construction

COMPETENCIES

- Use the shimming table by construction typology
- Assess load tables for fitting the ideal quantity and place of anchors
- Exploit the ideal antioxidant products between metal and aluminium

5.2.1. Interpretation of the forces applied in the construction and analysis of the typology of the anchor position

Fastening absorbs all the applying forces, which are:

- **dead loads,**
- **dynamic load,**
- **air,**
- **load from earthquake,**
- **handling.**

Fastening screws are used to secure the points of the frame carrying the loads to the masonry.

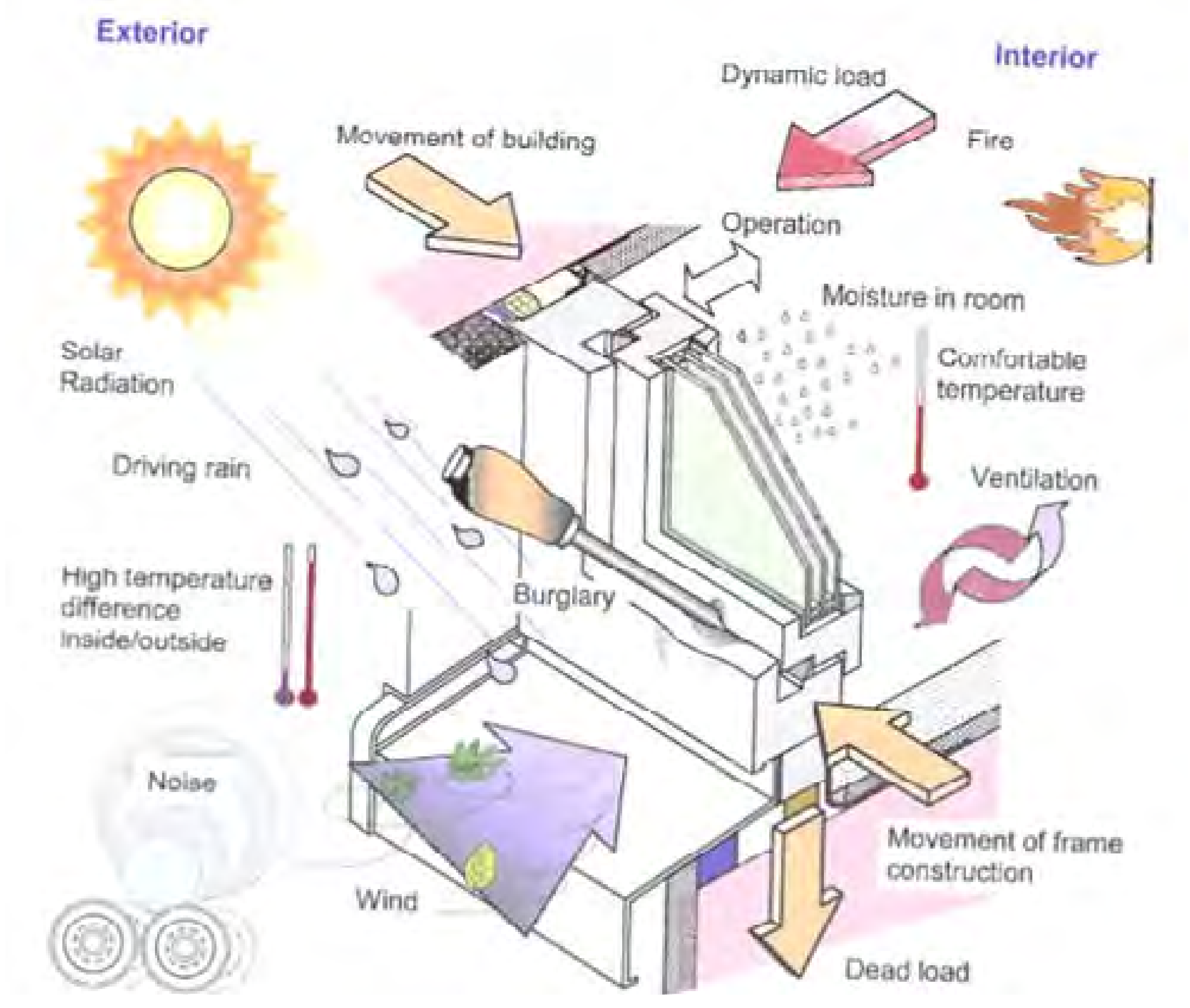


Figure 5.18. Forces that act on the fenestrations (ift Rosenheim)

The basic principle is that the loads are transferred to the masonry through columns and transoms. The following figure shows the points where support should be done initially.

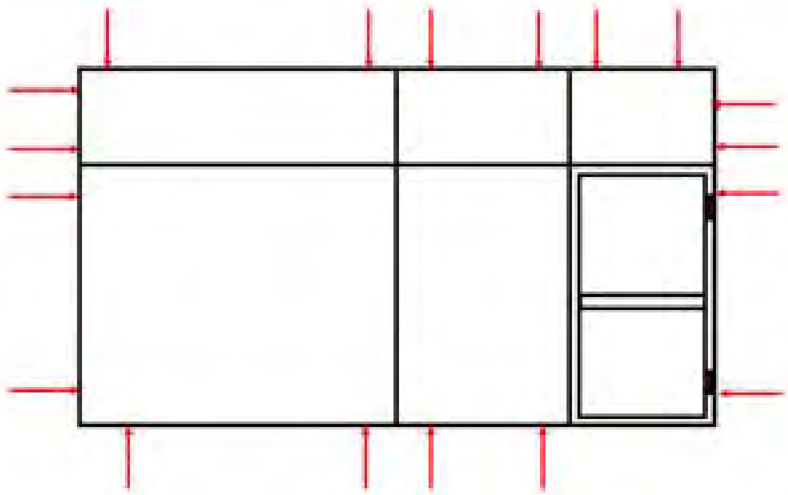


Figure 5.19. Points of fixing (Technical Manual of Windows Installation, POVAS 2019)

Steps: Start from the corners to fit the screws per 100-150 mm on both sides, fix the columns points / transoms, on either side 150 mm and share the other dimensions. The remaining space is divided as it is described in the below table, according to the frame material.

Frame material	Gap in mm
Aluminium	800
Steel	900
uPVC White	750
uPVC Color	700

Figure 5.20. Distances between anchors

Moreover, it has to be taken into consideration the typology and the dimension of the frame, as well as the typology of masonry.

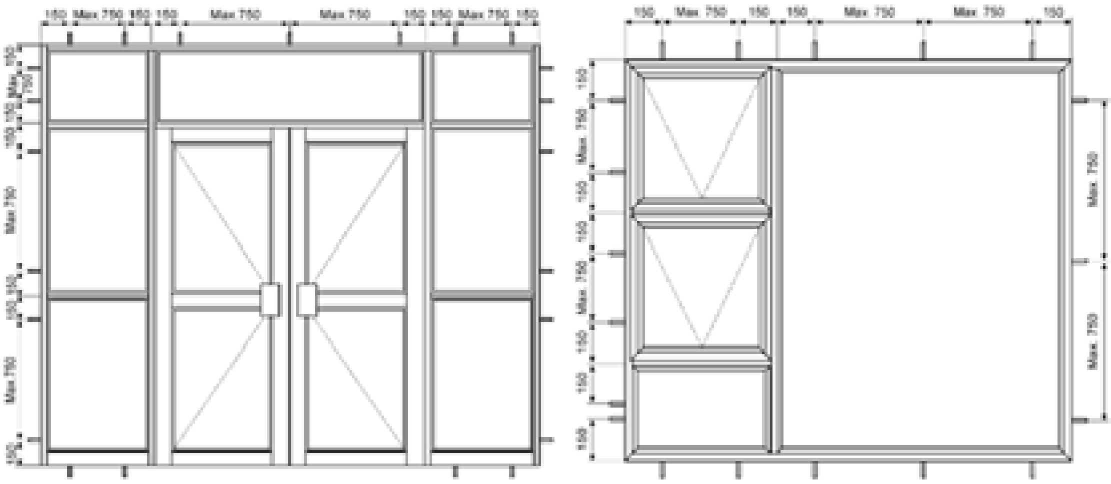


Figure 5.21. Table Example of distances between anchors (Technical Manual of Windows Installation, POVAS 2019)

The bottom of the window is not fastened directly with a screw, but only with a clicked flat plate in order to avoid water penetration.

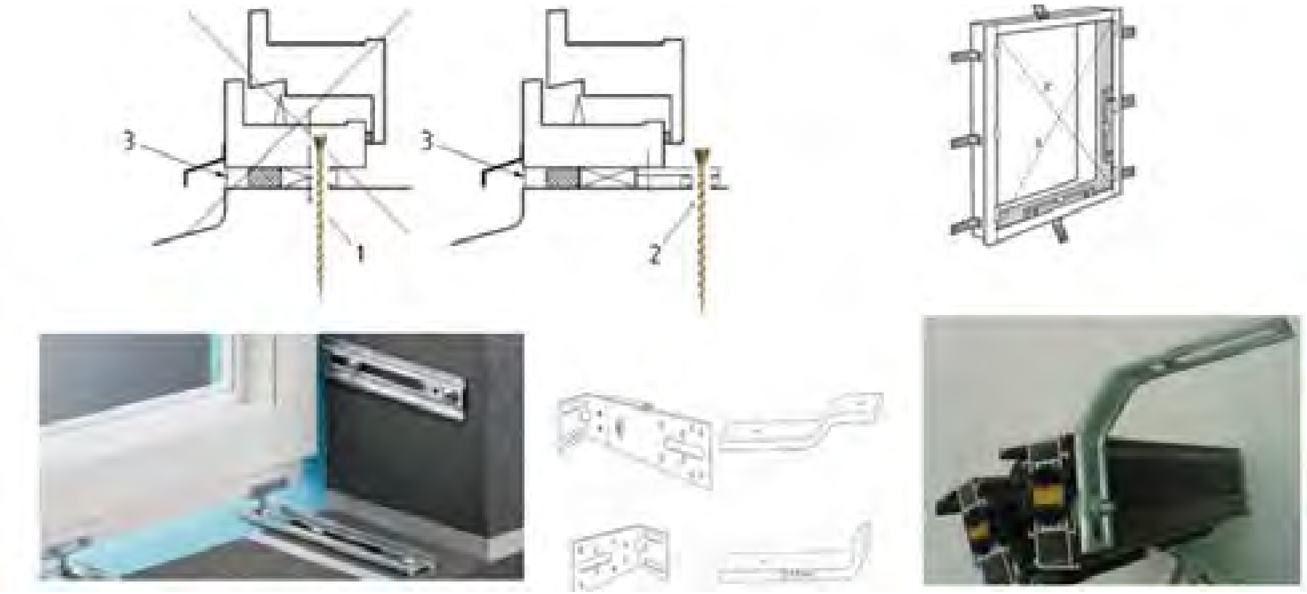


Figure 5.22. Fastening the bottom of fenestration with brackets (Alumil)

However, the clicked flat plate is useful when placed on the same level as the insulation.

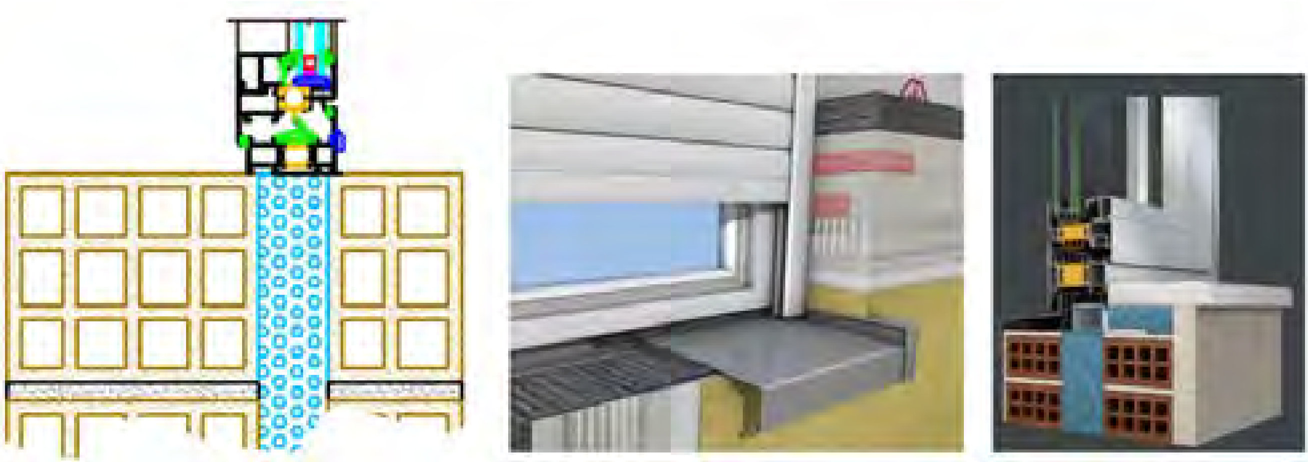


Figure 5.23. Bottom of fenestration (Alumil)

5.2.2. Selection of the appropriate anchor number and diameter, length

The category of materials that the masonry is built by, affects the type of anchor and the fixing way.

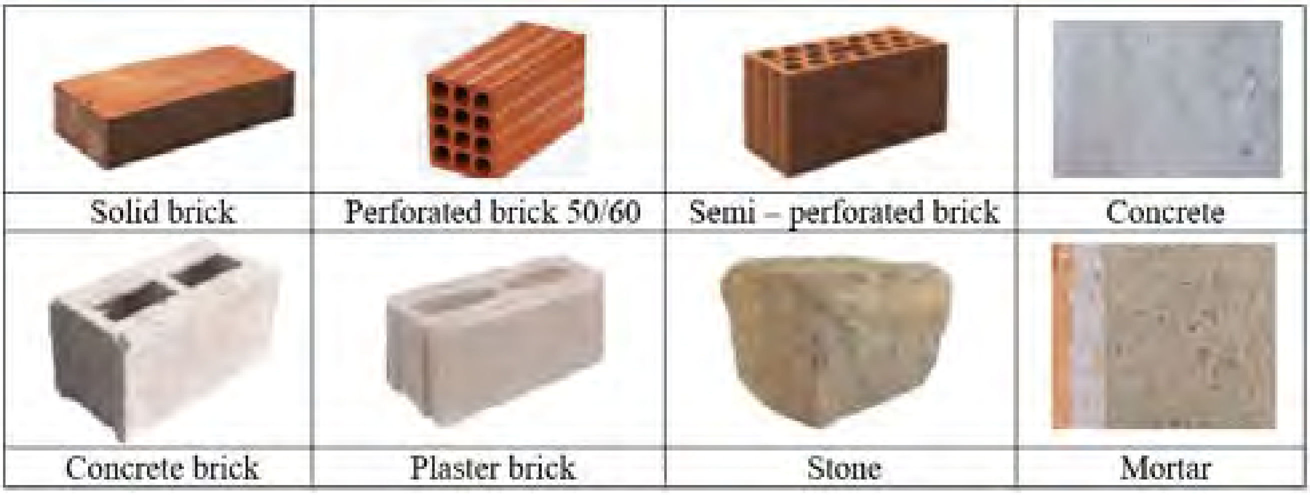


Figure 5.24. Masonry materials (Technical Manual of Windows Installation, POVAS 2019)

The choice of the correct screw (diameter, length, quantity) for the window fastening, depends on:

1. **the type of masonry**
2. **the window size**
3. **the window typology**
4. **the position that the window will be installed**
5. **the sides of the window that is mounting to the masonry (4,3,2).**

There are nine categories of screws and each one has specific mechanical strengths.

Category	Yield strength (Mpa)	Shear strength (Mpa)
4,6	240	400
4,8	320	400
5,6	300	500
5,8	400	500
6,8	480	600
8,8	640	800
10,9	900	1000
12,9	1080	1200
14,9	1260	1400

Figure 5.25. Category of screws

However, apart from the strength of the screw in the horizontal shear, there should be a distribution of forces (per meter) in the masonry, so that there is no point loading with consequent cracking or deformation of the frame.

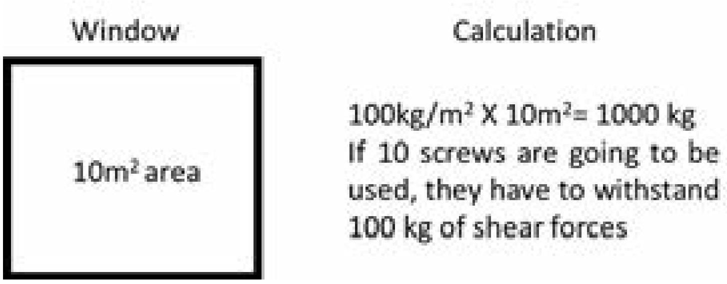


Figure 5.26. Distribution of forces in the masonry

The screw fixing, also depends on frame mounting sides at the masonry, which can be 4, 3, and 2.

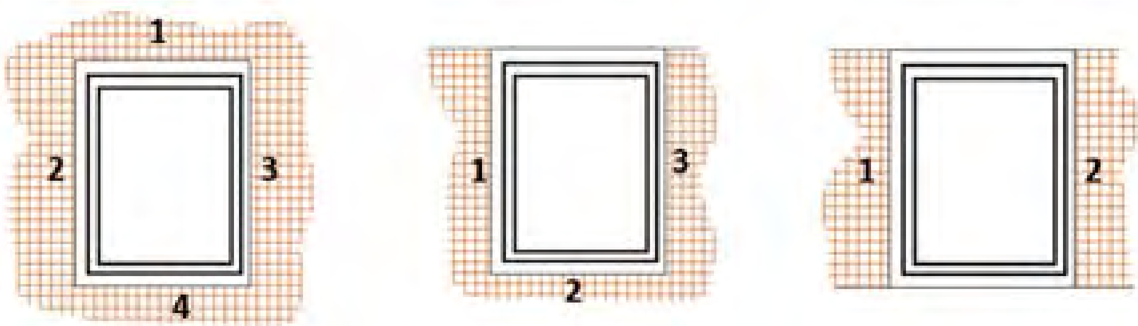


Figure 5.27. Mounting sides of the frame

The appropriate screw length depends on the type of masonry.

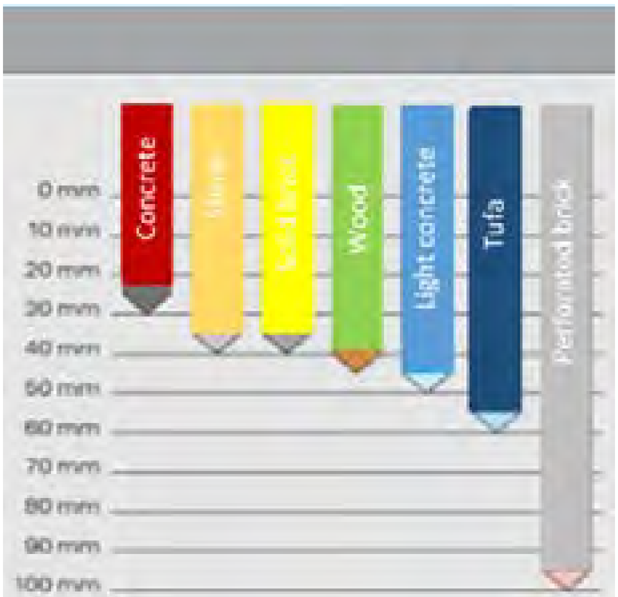


Figure 5.28. Recommended lengths for screws

The total length of the screw is the total length of the penetration + the frame-masonry gap + the height of the frame.

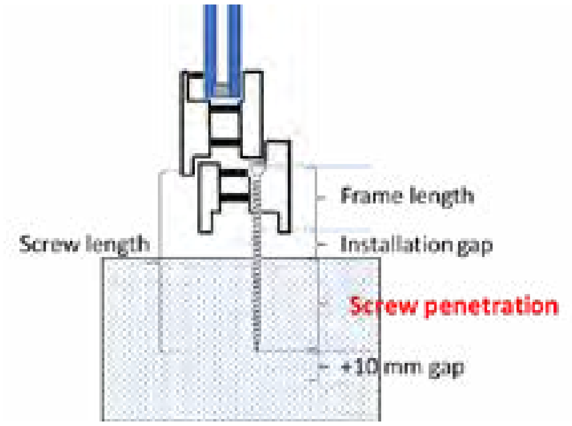


Figure 5.29. Lengths of screws (Technical Manual of Windows Installation, POVAS 2019)

In the perforated brick the screw should penetrate at least 2 holes vertically or laterally.

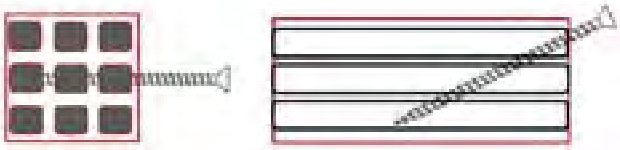


Figure 5.30. Anchor in perforated brick (Technical Manual of Windows Installation, POVAS 2019)

Screws shall not be fastened in the thermal barrier of the profile, in order to achieve the durability of installed product.

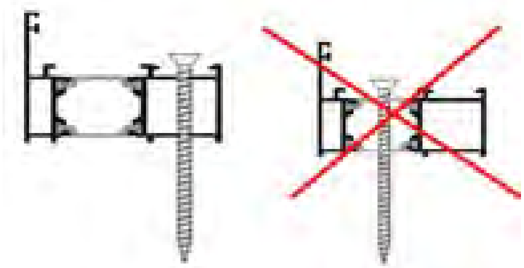


Figure 5.31. Anchor in thermo-break profile (Technical Manual of Windows Installation, POVAS 2019)

During screw expansion the anchor causes a point-to-point displacement around the applied mass and consequently causes cracks. There are guidelines, with the distances that should be kept when mounting to the corner of the masonry. The drilling of the hole is done by rotating and impacting on the concrete, stone and brick joints and by simply rotating at the rest of the materials. The hole length in which the screw is inserted, has to be at least 2 times bigger than the screw diameter.

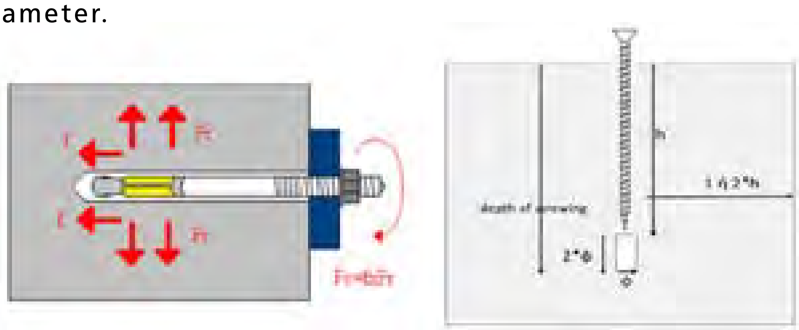


Figure 5.32. Strength of the material from the screw expansion (Technical Manual of Windows Installation, POVAS 2019)

5.2.3. Connection and fastening of mixed aluminium-steel constructions

Key Words

Pre-frame: frame made of metal or wood or plastic or other material placed in the masonry at the point where the window will enter

EPS: expanded polystyrene styrofoam materials for thermal insulation and other work

PVC: polyvinyl Chloride material also used for window profiles

When a pre-frame is used, the fastening procedure is presented in the figure below.

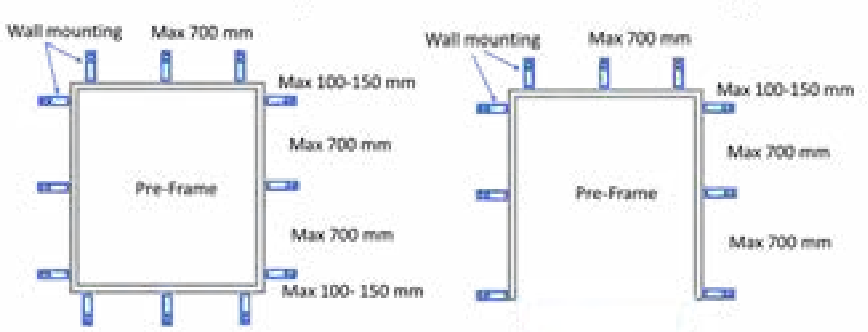


Figure 5.33. Windows fastening by using a pre-frame (Technical Manual of Windows Installation, POVAS 2019)

The material, the shape, and the installation method of the pre-frame is very important for the performance of the window. In the case of frame with thermal breaks, we must ensure the continuity of thermal breaks. In case of a metal pre-frame, it depends on the shape and the point installation.

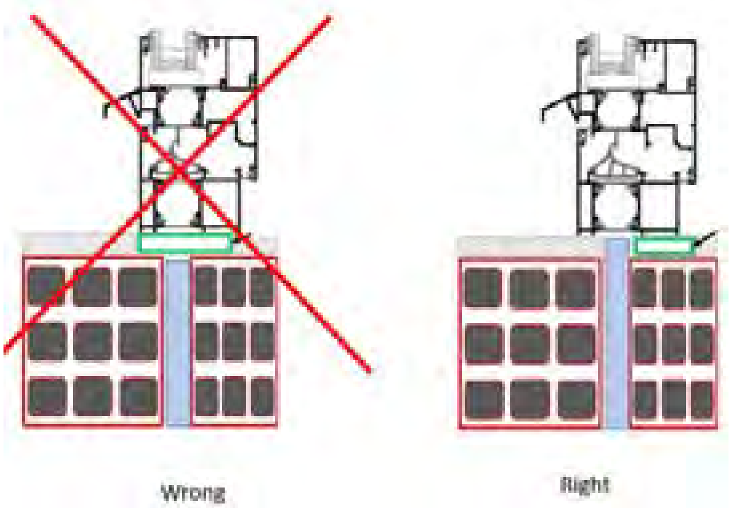


Figure 5.34. Position of pre-frame aluminium frame (Technical Manual of Windows Installation, POVAS 2019)

5.3. Insulation

Key Words

Condensation: water which collects as droplets on a cold surface when humid air is in contact with it

Dew point: the atmospheric temperature (varying according to pressure and humidity) below which water droplets begin to condense and dew can form

To be achieved upon learning outcome completion

KNOWLEDGE

- Assessment of the external and internal construction conditions for the selection and application of waterproofing materials
- Evaluation of the level of construction of the base for the correct selection and application of insulation materials
- Waterproofing and insulation for mixed metal aluminium construction

SKILLS

- Apply waterproofing products
- Seal the construction to achieve maximum energy efficiency
- Apply insulation products
- Install all necessary supporting elements taking into account minimization of thermal losses and voidance of thermal bridges
- Application of insulation and waterproofing products in metal / aluminium construction

COMPETENCIES

- Exploit the climatic parameters and features of the construction for the ideal choice of waterproofing products
- Exploit the way of mounting and features of the construction for the ideal choice of insulation products
- Apply similar products to neighbouring locations

5.3.1. External and internal construction conditions for the selection and application of waterproofing materials

Incomplete or poor insulation around the windows frame, creates a thermal bridge, resulting in the contraction of water vapor and the formation of mold.

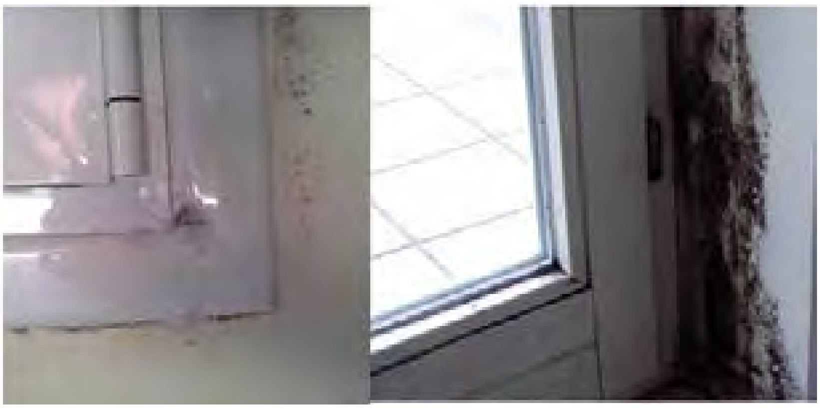


Figure 5.35. Wear from the appearance of water vapor due to poor waterproofing (Technical Manual of Windows Installation, POVAS 2019)

The goal is to intervene in three zones, inside, outside and on the axis of the window, with the corresponding appropriate materials.

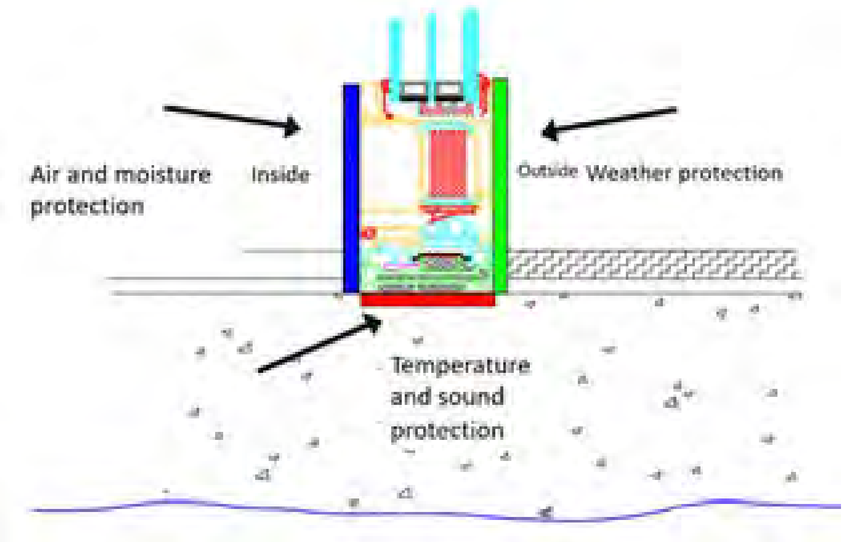


Figure 5.36. Intervention zones for insulation and waterproofing (Technical Manual of Windows Installation, POVAS 2019)

It is important to emphasize that to perform the proper insulation-waterproofing we need to have access to these three zones with the first one between the frame and the masonry. There are two main categories of materials used, with different chemical and mechanical properties:

- **Waterproofing materials**
- **Materials for insulation**

The basic principles of waterproofing and insulation are:

- External waterproofing is carried out to protect against water penetration
- The inner seal is made to prevent hot air from escaping to the outside
- Between the wall and the window, the sealing must provide thermo - acoustic insulation
- Sealing and insulation materials must have elasticity in order to absorb the expansion - contraction of masonry - fenestrations.

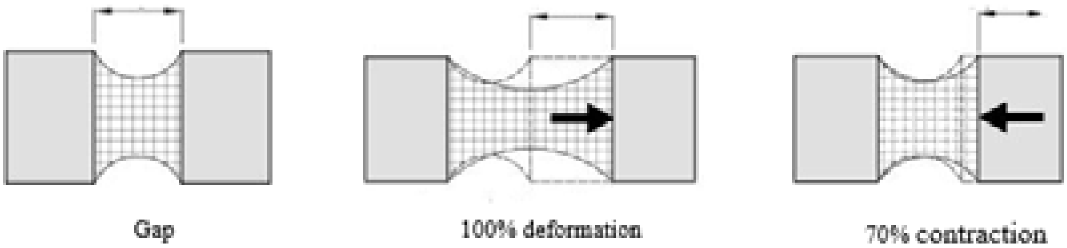


Figure 5.37. Elasticity of waterproofing materials (Technical Manual of Windows Installation, POVAS 2019)

Sealing materials prevent air and water from moving between the two zones (inside and outside). There are three main categories of sealing materials:

1. **The fluid seals**
2. **Films**
3. **Self-expanded tapes**

Liquid sealants must be compatible with adjacent materials and the surface must be properly prepared. The parameters that have to be taken into consideration for the selection of the appropriate sealant are:

1. **The elastic model**
2. **Chemical compatibility with adjacent elements**
3. **Resistance to physical weathering**
4. **Mechanical deformation**

Depending on their chemical composition, sealants are divided into the following main categories:

1. **Acrylic**
2. **Polysulfone (for glazing)**
3. **Polyurethane**
4. **Silicone**
   4.1 Acid
   4.2 Neutral
5. **Hybrid**

Sealants categories based on their elasticity:

1. **Low elastic modulus - LM <0,4 N / mm2**
2. **Medium elastic modulus - MM between 0.4 - 0.6 N / mm2**
3. **Large elastic modulus – HM > 0.6 N / mm2**

Sealants categories based on their deformation, are:

1. **Elastic (E)** - no deformation remains and returns to the original form more than 40%
2. **Plastic (P)** - deformation remains and returns less than 40%

Return % volume	Sealing category
>70%	Elastic
>40%<70%	Plastic-Elastic
>20%<40%	Elastic-Plastic
<20%	Plastic

Figure 5.38. Sealants Deformation

Sealants in tape format are very practical in their application as they cover the gaps between the fenestrations and the wall.

Figure 5.39. Sealants in tape form (Technical Manual of Windows Installation, POVAS 2019)

These materials can also be applied in liquid form directly to the wall.

Figure 5.40. Application of sealing materials in liquid form (Technical Manual of Windows Installation, POVAS 2019)

The depth of application of the sealing material depends on the gaps and must follow the rule b =a/2. The proper depth allows the mechanical properties of the sealing materials to be maintained.

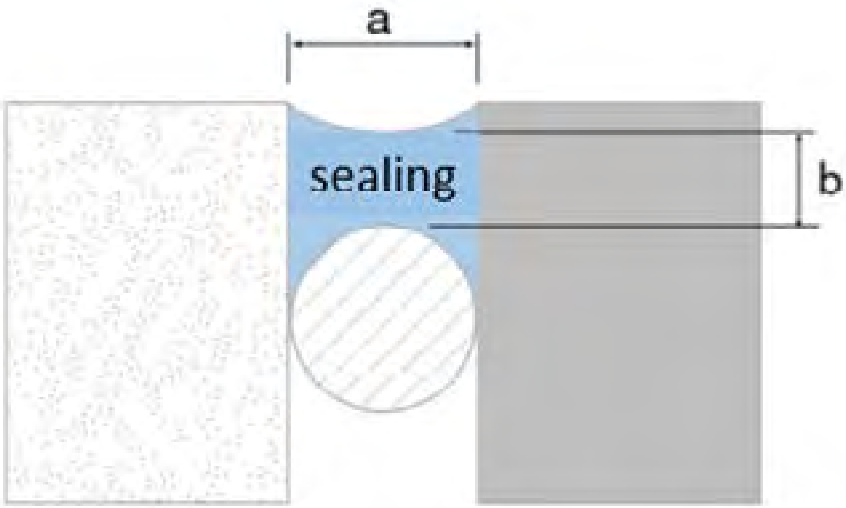


Figure 5.41. Depth of sealing materials application (Technical Manual of Windows Installation, POVAS 2019)

In order for the properties of the materials to work correct, they must be applied only on two surfaces and not on the three surfaces.

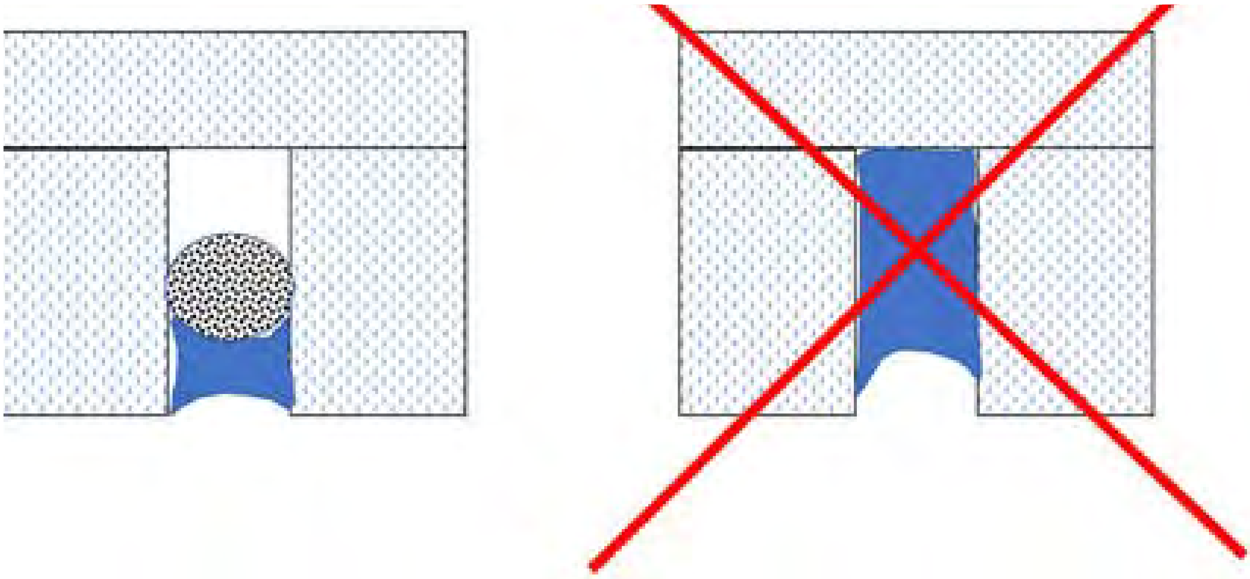
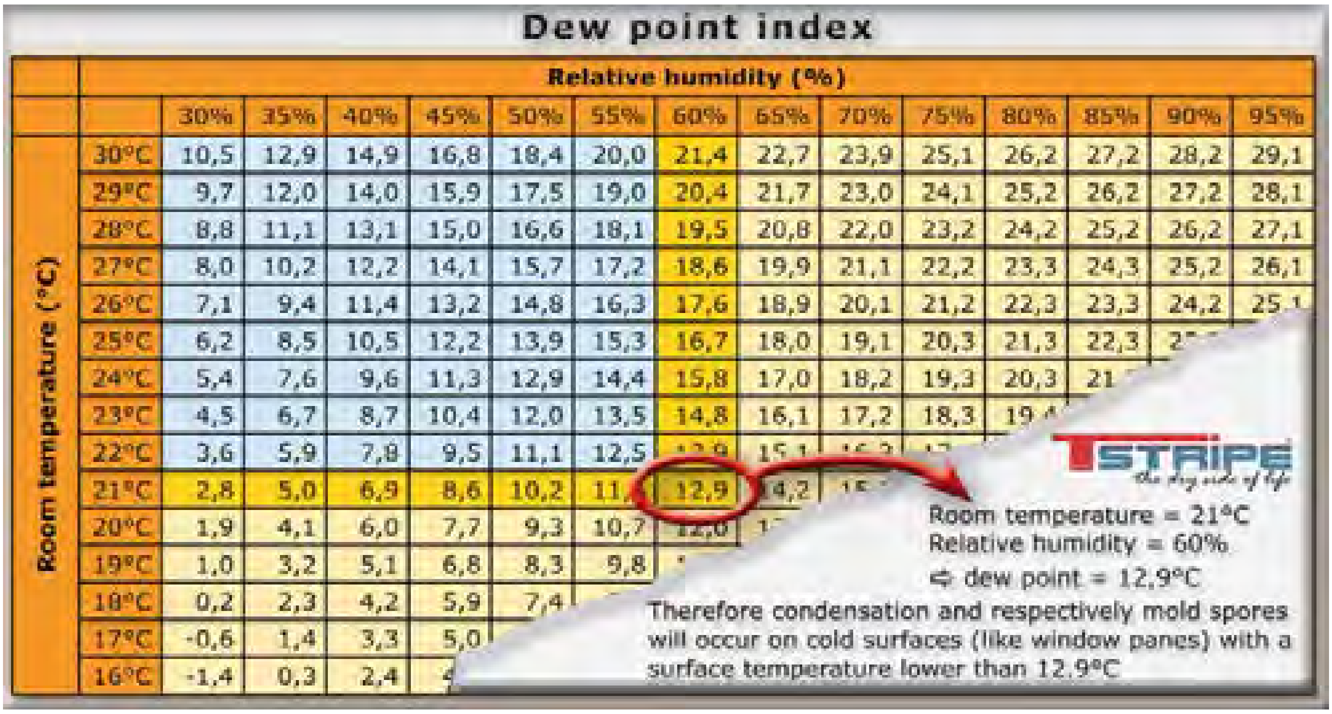


Figure 5.42. Application surfaces of sealing materials (Technical Manual of Windows Installation, POVAS 2019)

It is important to prevent air to enter and remain in the space between the window and the masonry in order to prevent condensation. The internal temperature should be greater than that of liquefaction. The following table defines the ideal conditions in relation to the indoor temperature and relative humidity of the house.



Dew point index

Room temperature (°C)	Relative humidity (%)													
	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%
30°C	10,5	12,9	14,9	16,8	18,4	20,0	21,4	22,7	23,9	25,1	26,2	27,2	28,2	29,1
29°C	9,7	12,0	14,0	15,9	17,5	19,0	20,4	21,7	23,0	24,1	25,2	26,2	27,2	28,1
28°C	8,8	11,1	13,1	15,0	16,6	18,1	19,5	20,8	22,0	23,2	24,2	25,2	26,2	27,1
27°C	8,0	10,2	12,2	14,1	15,7	17,2	18,6	19,9	21,1	22,2	23,3	24,3	25,2	26,1
26°C	7,1	9,4	11,4	13,2	14,8	16,3	17,6	18,9	20,1	21,2	22,3	23,3	24,2	25,1
25°C	6,2	8,5	10,5	12,2	13,9	15,3	16,7	18,0	19,1	20,3	21,3	22,3	[illegible]	
24°C	5,4	7,6	9,6	11,3	12,9	14,4	15,8	17,0	18,2	19,3	20,3	[illegible]		
23°C	4,5	6,7	8,7	10,4	12,0	13,5	14,8	16,1	17,2	18,3	[illegible]			
22°C	3,6	5,9	7,8	9,5	11,1	12,5	[illegible]	[illegible]	[illegible]	[illegible]				
21°C	2,8	5,0	6,9	8,6	10,2	[illegible]	12,9	[illegible]	[illegible]					
20°C	1,9	4,1	6,0	7,7	9,3	10,7	[illegible]	[illegible]						
19°C	1,0	3,2	5,1	6,8	8,3	9,8	[illegible]							
18°C	0,2	2,3	4,2	5,9	7,4									
17°C	-0,6	1,4	3,3	5,0										
16°C	-1,4	0,3	2,4	[illegible]										

Figure 5.43. Sealing materials in liquid form

Example: If the internal temperature is 21 oC and the relative humidity is 60%, liquefaction on surfaces below will be created at 12.9 oC

The choice of foam depends on its Elasticity and the Expansion time. The speed of expansion depends on the ambient temperature. The higher the temperature, the faster it dissipates.

Generally, in small gaps we use foam with a slow expansion rate. Prior of their use, thorough cleaning of the area and use of water is required. Only the required quantity must be applied and any excess quantity should not be cut because the foam loses its properties. The foam should not be exposed to UV radiation. The use of foam is intended to insulate the window and not to fastening it. For its application there should be a gap between the frame and the masonry at least 7-10 mm and it is applied from the base of the frame to the top as it is depicted in the figure below.

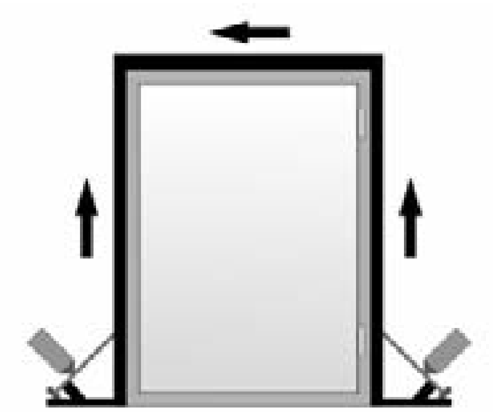


Figure 5.44. The right way to infuse foam (Technical Manual of Windows Installation, POVAS 2019)

5.3.2. Evaluation of the base's level of construction for the selection and application

Key Words

Self-adhesive tape: a combination of material and adhesive film and is used to connect or join objects together and seal the gap

Polyurethane foam (PUR and PU): a polymer consisting of organic units combined with carbamate in liquid form, which when in contact with air becomes foam

The choice of the type of insulation to be inserted between the frame and the masonry depends on the type of masonry and the way and process of installation of the frame.

The insulating materials are polyurethane foam and self-adhesive tapes. When there is space on one side between the frame and the wall, polyurethane is placed.

Figure 5.45. Polyurethane application (Technical Manual of Windows Installation, POVAS 2019)

In case there is no access, we place the self-adhesive tape first and then the frame.

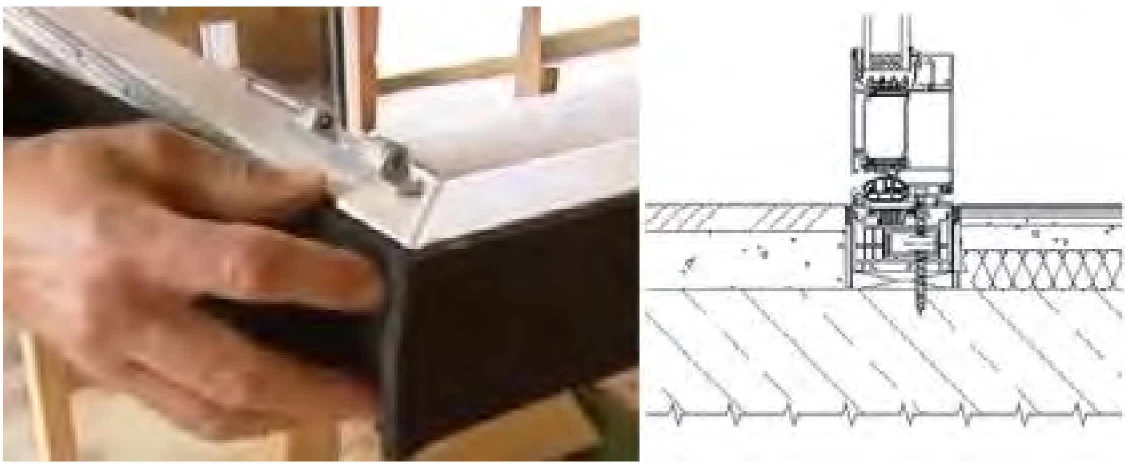


Figure 5.46. Self-adhesive tape application before installation (Technical Manual of Windows Installation, POVAS 2019)

5.3.3. Waterproofing and insulation of mixed metal aluminium construction

Key Words

Membranes: tapes made of special material to prevent water and air from entering from one side to the other

In case there is a combination of two different materials in the installation of a window, such as metal with aluminium or wood with aluminium or aluminium with bricks etc., it should be included in the insulation and waterproofing. In the figure below, two cases of curtain walling insulation with masonry are presented.

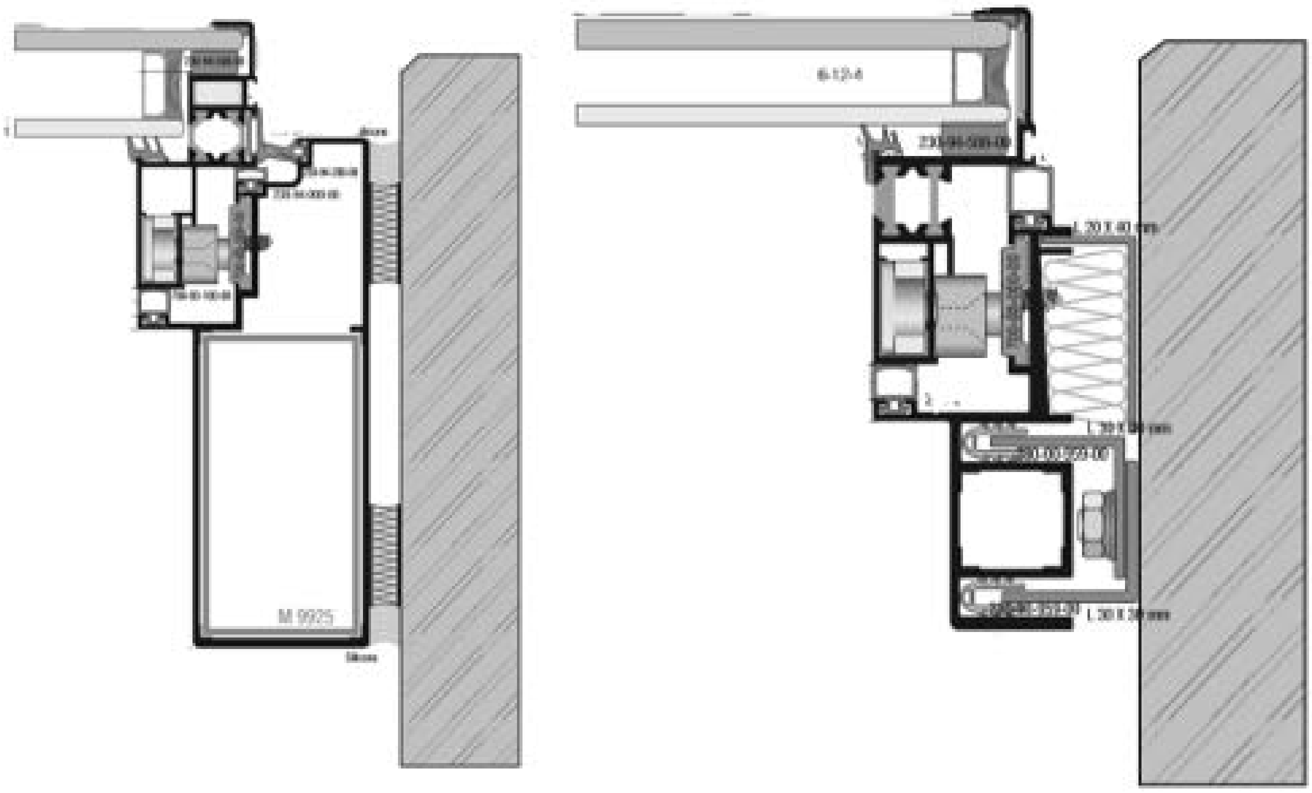


Figure 5.47. Insulating curtain walling with masonry (Alumil)

However, it is possible to apply sealing membranes (indoor for air and outdoor for water) in order to achieve very good insulation.

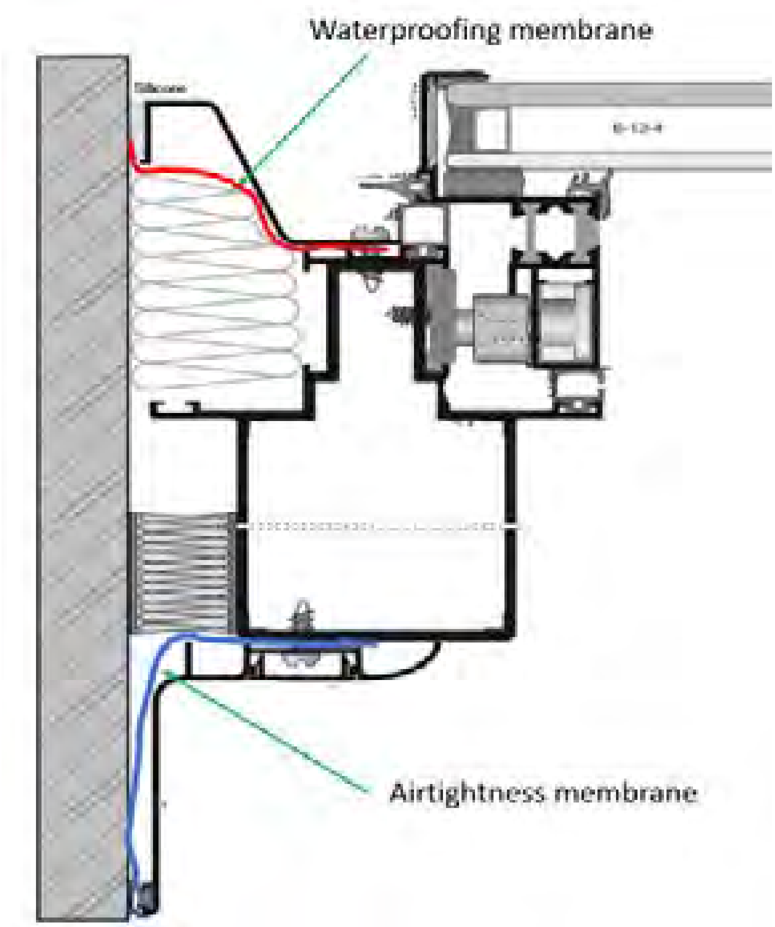


Figure 5.48. Insulation with membranes (Alumil)

In case there is a metal preframe, the technique of insulation and waterproofing is done in relation to the point of masonry that it is exists. In the figure below, a case where the window and the pre frame are located on the inside of the building, is presented.

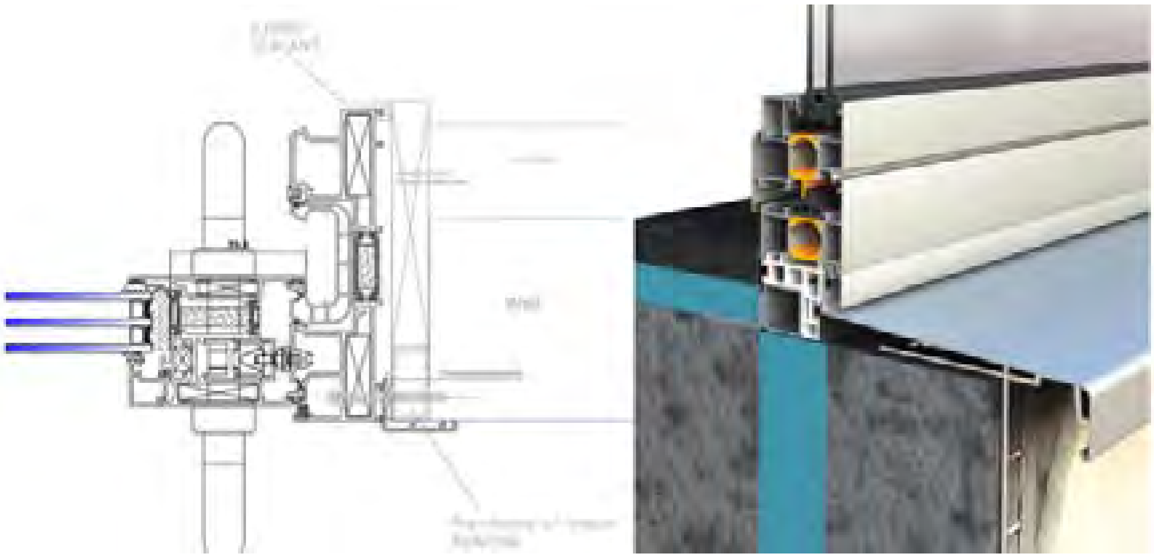


Figure 5.49. Insulation with metal/pvc preframe (Alumil)

5.4. Product demonstration

Key Words

Technical features: performance to air permeability, thermal conductivity, wind resistance, water tightness and sound insulation

To be achieved upon learning outcome completion

KNOWLEDGE

- Communication with the customer about the quality of the constructions delivered
- Communicate with the customer on how to use and handle construction

SKILLS

- Inform the customer about the technical characteristics of the constructions and the CE performance
- Explain the information contained in the Declaration of Performance and CE products Marking
- Communicate and inform clients and/or the engineer on good operation practices
- Inform about the use and handling of the mechanisms
- Demonstrate the functions of the construction (product)
- Explain the operating and maintenance instructions for the products, the rules of the warranty and its obligations as a manufacturer

COMPETENCIES

- Ability to be informed about the certified deliverable
- Assess customer perception on technical issues for relevant explanations

5.4.1. Illustration of the product ‘s technical features/performance

Products available on the market must be accompanied by a Declaration of Performance (DoP), as specified by the relevant harmonised standards (EN 14351-1 for doors and windows, EN 13659 for shutters & roller shutters, EN 13561 for insect screens, EN 1279-5 for insulating glass units, EN 13830 for curtain walling).

CE marking shall be affixed to all products in the construction sector for which the manufacturer has stated a DoP in accordance with the Construction Products Regulation (305/2011/EU). If no DoP statement has been prepared, the CE mark should not be placed. In some cases, it should be noted here that CE marking and DoP can be combined in a document that will accompany the products.

The manufacturer shall apply all the necessary compliance assessment procedures (Product Technical File, DoP and CE marking) and must confirm that the product complies with the relevant requirements (harmonized standards & Regulation 305/2011), having the responsibility of placing the product in the market.

Some of the essential characteristics for doors & windows that should be stated in the DoP and CE marking are the following:

- Air permeability
- Thermal transmittance
- Wind resistance
- Water tightness
- Sound insulation
- Presence of harmful substances
- Carrying capacity of the safety mechanism
- Dimensions, free passage capability (for emergency exits) only for external doors
- Solar factor and light transmittance for the insulating glass units that have been used

However, the Manufacturer has the ability, as long as there is no special legislation of the country in which the constructions are going be placed, to declare “npd” (no performance determined). For example, in Greece it is obligatory to declare the thermal transmittance of a window, while in Germany it is obligatory to declare thermal transmittance and air permeability.

CE	
19	
Manufacturer	
DOP Number:	
EN 14351-1:2006+A2:2016	
Notified body:	
Product Type: .... **intended to be used in domestic and commercial buildings**	
Unique Product Code:	
Resistance to wind load – Test pressure (Class 1 - 5 or EXXXX)	
Resistance to wind load – Frame deflection (Class A, B, C)	
Watertightness – Non-shielded (A) (Class 1A - 9A or EXXX)	
Watertightness – Shielded (B) (Class 1B - 7B)	
Air permeability (Class 1 - 4)	
Load-bearing capacity of safety devices	
Dangerous substances	
Radiation properties – Light transmittance (τv)	
Radiation properties – Solar factor (g)	
Thermal transmittance Uw (W/m2*K)	
Acoustic performance Rw (C;Ctr) (dB)	

Figure 5.50. CE label

5.4.2. User manual explanation

Key Words

User manual: a document that describes how the product works and is maintained

At the end of the work, the manufacturer or the installer is responsible for demonstrating the correct operation of the window to the consumer. In addition, it should inform the owner about how to maintain and clean the products.

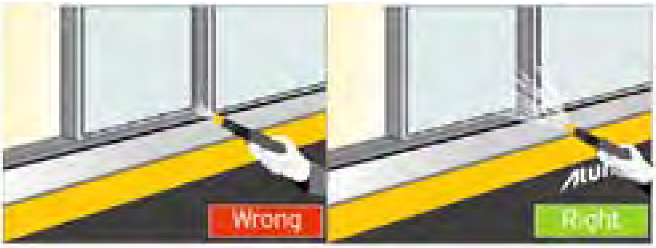


Figure 5.51. Demonstrating the wrong and right method to rinse the constructions

5.4.3. Maintenance and cleaning products instructions

Key Words

pH: the negative log of hydrogen ion concentration in a water-based solution

Clients should take written instructions for operation, maintenance and cleaning of windows, as much as at least 2 years good operation guarantee. Guidelines should provide information on how to, maintain mechanisms, clean and protect the fenestrations (e.g. lubricate moving parts with silicon spraying, clean with neutral soap 6.5 pH), protect sliding drivers for good sealing and operation, cover floor profiles during repairs (e.g. painting), and install ramps if wheeled vehicles pass over.

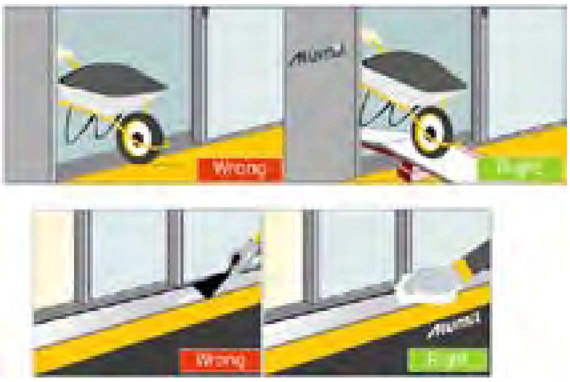


Figure 5.52. Demonstrating the correct method

05 MODULE Conclusions

The installation of the construction is the last stage of each project. It has been observed that a misplaced placement degrades the quality and functional capacity of an excellently manufactured product.

The frames should be properly fastened, and when using a pre-frame, appropriate measures should be taken to prevent the creation of thermal bridges.

Thermal bridges created between the frame and the wall affect the energy behaviour of the building leading to heat loss. In order to avoid the creation of “weak” points on the building shell, the manufacturer should apply appropriate techniques when installing the frames. The goal is to have minimal thermal losses by reducing the ψ coefficient or even zeroing it.

The waterproofing of the construction is the last stage of the installation with which each project is completed. The manufacturer should follow good practices and pay attention to the specificities of each project.

Self Assessment Questions

Improvement begins with assessment.
Self Assessment is the first step to all assessment.
Start by choosing the correct answers.

1. Who is responsible for the installation?
   a. the fabricator
   b. the client
   c. the architect
   d. the contractor
2. What are the consequences of incomplete placement?
   a. it is not aesthetically pleasing
   b. it costs less
   c. it has a problem with the threshold
   d. it cancels the certification categories and hence the quality of the frame
3. What are non shielded windows?
   a. windows with not visible sash
   b. windows not protected by a balcony or recess in the building
   c. windows with not visible frame
   d. windows with not visible handle
4. What is a blower doors test?
   a. a test for small windows
   b. a test for main doors
   c. a test for installed windows measuring the air permeability between frame and wall
   d. a test for installed windows measuring the air permeability between frame and sash
5. What does affect the different position of the window on a wall?
   a. thermal insulation and waterproofing
   b. more installation times
   c. the cost of consumable
   d. aesthetics
6. Why do frames need to be installed on site appropriately?
   a. in order not to hinder the movement of employees
   b. for employees and attendees safety
   c. to protect from the sun
   d. to protect from the rain

7. What is the main principle for shimming a frame?
    a. to transfer the loads in the masonry at points absorbing the load via the frame without deforming it
    b. to be horizontal to the frame
    c. to transfer the loads in the sash
    d. to place the anchors

8. What is the first step in uninstalling frames?
    a. unscrew the screws of frame
    b. cutting the frame in two opposite sides at 45 degrees
    c. cut the frame into small pieces
    d. cut the mounting brackets

9. Why is it necessary to have a lot of pads in doors threshold?
    a. for levelling the frame
    b. for the best operation
    c. for floor finishing
    d. because there are a lot of loads when there is traffic

10. What is the basic principle of frame shimming in the sliding?
    a. shimming the guide, where the sashes rollers are when it is closed
    b. shimming the guide on the edges
    c. shimming every 200 cm
    d. shimming every 500 cm

11. At which points of the frame do we screw for wall installation?
    a. as it suits us
    b. in the corners on both sides
    c. in the traverses on both sides
    d. in the places where there are columns, traverses and in the corners

12. What should be the minimum distance between the mounting brackets?
    a. there is a table for each type of fenestration.
    b. every 200 cm
    c. every 400 cm
    d. every 400 cm

13. What is the recommended solution for fastening the threshold?
    a. To put only silicon
    b. To screw only at both ends
    c. To use brackets in order to no drilling
    d. To screw every 200 cm

14. How many categories of plugs are there?
    a. 4
    b. 5
    c. 9
    d. 10

15. On how many sides can a frame be attached to a wall?
    a. 2, 3, 4
    b. 3
    c. 4
    d. 2, 4

16. On what does the appropriate length of an anchor depend on?
    a. on the type of fenestration
    b. on the type of the fenestration's material
    c. on the type of the masonry
    d. on the type of the screw

17. On what does the appropriate diameter of an anchor depend on?
    a. on the type of the masonry
    b. on the typology
    c. on the dimension of the fenestration
    d. on the load

18. On what does the number of anchors to be used in an installation depend on?
    a. on the architect will
    b. it is the sum of the minimum necessary and those related to the dimensions
    c. as many as the client wants
    d. as many as per 500 cm

19. How should we place the screw in perforated bricks?
    a. the screw should penetrate at least 2 holes vertically or laterally
    b. as it is easier
    c. 10 cm in depth
    d. 20 cm in depth

20. Why don't we screw on the edge of a wall?
    a. support is not stable
    b. the wall may crack due to the expansion of the plug
    c. it is prohibited by law
    d. it is not right for the frame

21. What do we achieve with perfect sealing?
    a. no temperature leaks
    b. no thermal bridges
    c. no external noise
    d. make the perimeter of the frame with the wall nice

22. Why should sealing and insulation materials have elasticity?
    a. to absorb their weight
    b. to absorb the expansion - contraction of masonry
    c. for earthquakes protection
    d. for easier fastening

23. What materials are elastic?
    a. materials that no deformation remains and returns to the original form more than 40%
    b. gaskets
    c. silicon
    d. accessories

24. On what does the depth of application of the sealing material depend on?
    a. the kind of typology
    b. the weight of the fenestration
    c. the gaps between frame and masonry
    d. the kind of masonry

25. What should we do to avoid condensation?
    a. avoid air intrusion and stay in the space between the window and the masonry
    b. have special glass the fenestration
    c. have special hardware
    d. make good fastening

26. What is the property of foam?
    a. to watertight
    b. to fasten the frame
    c. to work as base for the plaster
    d. to insulate the window

27. Apart from foam, what other insulating materials can we use?
    a. silicon
    b. self-adhesive tape before installing
    c. sealing membranes (films)
    d. pvc membranes

28. When do we use self-adhesive tapes?
    a. after shimming
    b. before installing a window
    c. when the installation is complete
    d. before cleaning

29. How many types of sealing membranes (films) are there?
    a. sealing in air, water, and air/water
    b. sealing in air
    c. sealing in water
    d. sealing in air/water

30. Why should we explain the operation & maintenance of a window to the customer?
    a. to get paid
    b. to get more money
    c. for advertising reasons
    d. to avoid problems with mishandling

31. Why should we explain the technical characteristics of a frames to the customer?
    a. to avoid problems with mishandling
    b. to handle the mechanisms appropriately
    c. to understand the limits of the frames technical possibilities
    d. to earn more money

Resources List

Web

T-STRIPE
Heating system against condensation water on window panes
https://www.t-stripe.com/en/pages/condensation-water/dew-point/

European Aluminium
The voice of the aluminium industry in Europe
https://www.european-aluminium.eu/resource-hub/sustainability-of-aluminium-in-buildings/

Wikipedia
About eurocodes
https://en.wikipedia.org/wiki/Eurocodes

Wikipedia
About project management
https://en.wikipedia.org/wiki/Project_management

BSSA
British Stainless Steel Association
https://bssa.org.uk/

SteelConstruction.info
Free encyclopedia for UK steel construction information
https://www.steelconstruction.info/CE_marking

Standards

EN 13830
«Curtain walling. Product standard», applicable to the whole of the curtain walling, including the flashings, closures and copings.

EN 14351-1
«Windows and doors - Product standard, performance characteristics – Part 1: Windows and external pedestrian doorsets without resistance to fire and/or smoke leakage characteristics»

EN 13659
«Shutters and external venetian blinds. Performance requirements including safety»

EN 13561
«External blinds. Performance requirements including safety»

EN 1279–5
«Glass in building. Insulating glass units. Evaluation of conformity»

EN 1090-1
«Execution of steel structures and aluminium structures. Requirements for conformity assessment of structural components»

Publications

Lamprakopoulos Stylianos (2014)
New Techniques of Aluminum - Steel Construction Products, IME GSEVEE, ISBN: 978-618-5025-42-7

Károly JármaiJózsef
Farkas Design (Editors), Fabrication and Economy of Metal Structures, International Conference Proceedings 2013, Miskolc, Hungary, April 24-26, 2013

UPSWING project
Energy Efficiency in Aluminum Building Constructions, Training material of BUILD UP Skills, Athens 2016

POVAS (2019)
Technical Manual of Windows Installation

EU Regulation 305/2011
Laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC

Satisfaction lies in the effort, not in the attainment, full effort is full victory.

Mahatma Ghandi

Module 1 Self Assessment Answers							
Q	A	Q	A	Q	A	Q	A
1	c	16	a	31	c	46	a
2	a	17	d	32	a	47	d
3	c	18	a	33	a	48	a
4	d	19	a	34	a	49	b
5	a	20	c	35	d	50	d
6	d	21	b	36	d	51	a
7	b	22	b	37	b	52	c
8	c	23	c	38	c	53	d
9	b	24	c	39	b	54	c
10	b	25	b	40	c	55	a
11	d	26	d	41	b	56	a
12	c	27	c	42	b	57	d
13	c	28	d	43	a	58	a
14	a	29	d	44	b	59	c
15	b	30	d	45	a	60	b

Module 2 Self Assessment Answers							
Q	A	Q	A	Q	A	Q	A
1	d	15	a	29	a	43	a
2	a	16	b	30	b	44	d
3	a	17	d	31	c	45	b
4	c	18	b	32	c	46	c
5	d	19	c	33	a	47	a
6	c	20	a	34	a	48	c
7	b	21	a	35	a	49	c
8	a	22	a	36	d	50	d
9	c	23	a	37	d	51	c
10	c	24	c	38	d	52	b
11	c	25	c	39	a	53	c
12	d	26	c	40	b	54	d
13	a	27	b	41	d		
14	c	28	b	42	b		

Module 3 Self Assessment Answers									
Q	A	Q	A	Q	A	Q	A	Q	A
1	a	25	c	49	c	73	c	97	b
2	b	26	a	50	a	74	c	98	a
3	c	27	b	51	c	75	c	99	d
4	c	28	d	52	b	76	b	100	c
5	c	29	d	53	a	77	a	101	d
6	a	30	b	54	d	78	d	102	b
7	a	31	a	55	c	79	d	103	d
8	d	32	d	56	d	80	c	104	c
9	c	33	a	57	d	81	b	105	d
10	c	34	c	58	d	82	a	106	b
11	d	35	b	59	d	83	b	107	c
12	a	36	b	60	d	84	b	108	a
13	c	37	a	61	a	85	d	109	a
14	a	38	d	62	a	86	c	110	d
15	c	39	c	63	c	87	d	111	d
16	c	40	d	64	c	88	b	112	c
17	b	41	a	65	a	89	d	113	c
18	b	42	b	66	d	90	a	114	b
19	d	43	c	67	d	91	c	115	c
20	c	44	a	68	b	92	c	116	a
21	c	45	a	69	c	93	d	117	b
22	d	46	d	70	c	94	d	118	d
23	a	47	a	71	b	95	a	119	d
24	b	48	d	72	d	96	b	120	b

Module 4 Self Assessment Answers							
Q	A	Q	A	Q	A	Q	A
1	d	8	d	15	b	22	b
2	b	9	a	16	b	23	a
3	a	10	b	17	d	24	d
4	d	11	d	18	a	25	b
5	a	12	d	19	d		
6	c	13	c	20	b		
7	b	14	a	21	d		

Module 5 Self Assessment Answers							
Q	A	Q	A	Q	A	Q	A
1	a	9	d	17	d	25	a
2	d	10	a	18	b	26	d
3	b	11	d	19	a	27	b
4	c	12	a	20	b	28	b
5	a	13	c	21	b	29	a
6	b	14	c	22	b	30	d
7	a	15	a	23	a	31	c
8	b	16	c	24	c		

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