TERMO STEEL CONSTRUCTION TECHNIQUES

THE FUTURE HILL BE BUILT WITH STEEL

TERMO STEEL

THE MATERIALS

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The Construction Materials

THE STEEL

For over 150 years, steel has been used in the North American market. Today, all over the world, it remains one of the most resistant and durable materials. In spite that it is usually associated with skyscrapers and bridges, steel has now become a material of choice in the construction of homes.

The word ' steel' usually suggests images of a heavy and difficult material to work with. However, the galvanized steel used in the construction of homes is precisely the opposite of that. Galvanized steel is light, easy to handle, dimensionally stable and of high resistance. Also, using this durable material, which at the same time is easily recyclable, satisfies more and more the environmental concerns.

In TERMO STEEL buildings hot-dipped galvanized cold–formed steel that is used has great resistance and low weight. All the metallic components are resistant to corrosion, non-flammable, stable and durable. They are also compatible with virtually all the materials traditionally used for finish and decoration.

A flat sheet of steel is not very strong, but when the sheet is molded to acquire the form of ' C' section, the brims act as lateral reinforcements increasing the resistance of the piece dozens of times. The rigidity of the piece depends more on the form it takes after being molded than the actual thickness of the piece, all the steel members have excellent force ratio/weight and they are extremely resistant to deformation. Different from other materials (Concrete, brick, wood, etc.), the resistance of steel to tensional pressures is extraordinary considering it is still a malleable material and offers superior anti-seismic qualities.

To add to this level of safety, steel structures are always fixed or fastened with galvanized steel screws or rivets avoiding the inherent weak points associated with such methods as welding.

Physical and Mechanical Characteristics

The cold-formed steel sections used starts as a galvanized steel plate, and possess the physical and mechanical characteristics standards as outlined by the American Society for Testing and Materials and en Europe the future Euro Codes III, Part 1-3.

Galvanization

The steel plate used by TERMO STEEL constructions is protected against corrosion through the immersion process in a hot bath (hot-dipped galvanization) of zinc or zinc-aluminum. According to the patterns referred in ' Prescriptive Method for Residential Cold-Formed Steel Framing', the steel used in the structure should possess a galvanization of G60/Z180 in conditions of normal use and of G90/Z275 in adverse conditions as in the coastal zones.

Molding / Forming

The galvanized steel plate used in TERMO STEEL constructions are molded in the form of "C" and "U" sections through roll-forming machines. This process guarantees pieces of accurate dimensions and perfect angles necessary to a technically advanced constructions system. The

studs and beams are manufactured with perforations at regular spacing in which to allow for passage of electrical wiring and plumbing.

Dimensions

The studs and beams are manufactured with appropriate lengths to suit your purpose. Structural members such as the roof and floor beams can reach a maximum length of 40'/12 meters. Selection of the members will also vary according to the planed application and will usually follow the table below.

Wall Studs		
Exterior	4" or 6"	90 or 150 mm
Interior	4"	90 mm
Beams		
For the roof	6" or 8"	150 or 200 mm
For the ceiling	6"	150 mm
For the floor	10" or 8"	250 or 200 mm

Thickness

The thickness varies according to the planned purpose of the member. In general, thicknesses are used from 0.023"/0.6 mm in non-load bearing walls to the 0.098"/2.5 mm in the floor beams.

Weight

According to the industrial standards, the weight of a certain piece is calculated in the following way:

DEVELOPMENT X 7.85 X THICKNESS X LENGTH

This way, the lineal measurement of a stud with a profile of 4"/90 x 2"/43 x 0.59"/15 mm with 0.059"/1.5 mm thickness will weigh 5.348lb/2,426 Kg in the same way that a floor beam with the profile of 10"/250 x 2"/43 x 0.59"/15 mm and 0.098"/2.5 mm of thickness will weigh 15.83lb/7,183 Kg.

Consider that the metallic structure in a building of two floors with about 1076.39ft^2 (100 m^2) in each will have a weight exceeding eight tons of galvanized steel.

THE SHEETS OF PARTICLE BOARD (OSB)

Sheets of particleboard designated as OSB (Oriented Strand Board) are available in several dimensions and thickness. These sheets are produced from obtaining wood particles of fast growing trees with small diameters, primarily the marine pine. These particles, with average dimensions of 3.93"/10 by 0.98"/2.5 cm, are agglomerated under heat and pressure using resins and chemical products that turn the wood completely inert and resistant to water. Some manufacturers will also be able to add products that increase the resistance to fire. Using advanced technology and sophisticated machinery, the wood particles are guided in an only one direction and placed in crossed layers forming a sheet of great structural resistance.

The sheets of particleboard appeared in the United States at the beginning of the 80's and quickly they won acceptance among the technicians, engineers and builders. In 1994, more than 250 million sheets were used in the industry in United States and Canada alone. More than two dozens of large groups of companies began the production of OSB much in the North American continent as well as in Europe, namely in United Kingdom and in France. At this point a representative association for this industry appeared. The Structural Board Association was

not only responsible for promoting and it developing this product, it also took part in the standardization quality control of the product. Sheets of particleboard are generally applied as the covering for steel structure on the walls and on the roofs, improving the structural stability.

They serve as support for the interior insulation and the external covering, acting also as a thermal shield dispenser.

In a time of growing environmental concerns, OSB reveals to be a quite advantageous material. The trees used as the primary material for these sheets are grown in special forests that are continuingly replanted. The production process uses more than 90% of the log being the rest used in the production of energy. Due to newness of OSB, each factory was built to satisfy the most stringent quality, environmental and safety standards, which meant an investment of millions of dollars in each of them. The sheets are cured completely during the manufacturing process so no measurable emanation of gases exists as they being handled and applied.

OSB is a product recognized by the construction codes of the United States and Canada for structural purposes. The specification and application is regulated in the document DOC PS2-92 Wood-Based Structural Use Panels approved by Congress in the United States in August of 1992

In Europe, the trademark OSB is actually used by TERMO STEEL, which has been certified by the following organizations

AFAQ ISO 9002 1995/3962 EQNET
CTBA MQ 83
BBA 88/2079
KOMO 32565/94
UBAM Z 91326
ETA MK 5.40/1237
WIMLAS 26, 27/95
AITIM EN 120:1992

The specification and application of its use is regulated in the document pr EN 300: The European Committee for Standardization.

Standard dimensions

Length	8.53’	2600 mm
Width	3.93’	1200 mm

Thickness

The sheets used for the covering of walls and roofs have a thickness of 0.43”/11 mm. Sheets with 0.70”/18 mm of thickness are used for the floors. However, according to the requirements of the application, sheets can be used with thickness’ varying from the 0.23”/6 mm to the 0.86”/22 mm

Density

Mean Weight	39.95lb/ft^3	640 Kg/m^3

Mechanical Properties

Module Rotura

a)	36 MPa
b	16 MPa

Module of Elasticity

A) 5200 MPa

b) 2100 MPa

a) Parell placement

b) Perpendicular placement

Tolerances

Thickness	0.03"	0.8 mm
Length and Width	0.07"	2.0 mm
Square	0.05"	1.5 mm
Density		10%

Joint Expansion

Foreseeing possible movements, the adjacent sheets should be applied with an interval of 0.07"/2 mm between them.

Dimensional Stability

In conditions of where the relative humidity is between 30% and 85%.

Length 0.15%
Width 0.25%

Formality Variance

The average formality variance is below 1.1E-04oz/3mg per 0.00353oz / 100 mg and does exceed 2.8E-04oz/8 mg per 0.00353oz /100 mg.

Acoustic Insulation

R 32

Thermal Resistance

The coefficient of thermal resistance of a material is the quantification of the resistance offered to the passage of the heat being influenced by the density and thickness of the material. In sheets of 11 mm in thickness this value is of

$R = 0.232 ft^2\ ºC / W.$ $R = 0{,}071\ m^2\ ºC / W.$

Humidity Content

6% a 12%

After immersion in water for 24 hours the sheet suffers a maximum expansion of 15% in thickness and of 0.40% in the width and in the length.

Initial Fire Resistance

The sheets used by TERMO STEEL are considered to be combustible resistant, having been tested in agreement with
BS 476: Part 7 reached a classification of level 3. With the addition of appropriate retardants during the manufacturing process the resistance to fire of the sheets can increased.

Mechanical Fixation

The sheets can be screwed or nailed with a maximum distance of 0.23”/6 mm from the extremity without risk of splitting. Ideally for structural applications it is best to screw or nails at a maximum distance of 0.39”/10 mm.

Gluing

The sheets can be affixed with any glue usually used for wood. For strong fixations it is recommended sanding the surfaces slightly before applying the glue.

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THERMAL INSULATION

One of the main concerns of the TERMO STEEL system is to guarantee a home with balanced temperature during the whole year keeping the occupants comfortable. According to the climatic demands, the insulation process most appropriate for the given situation is chosen. A good insulation should stabilize the interior temperature independently of the external conditions while still allowing the building to breathe. One method of reaching these conditions is to use mineral wool or similar material for the external walls and roofs. Because steel is a good thermal driver it should be insulated properly to impede the diffusion of heat from the home. The sheets of particleboard (OSB), totally cover the metallic structure, already act as thermal shield dispenser, however TERMO STEEL buildings applies sheets of extruded polystyrene, which is applied to the exterior (See topic on EIFS), further increasing the thermal protection of the building

Mineral Wool

This material from the mineral fibres of volcanic rock, impregnated and agglomerated by resins, presented in sheet or blanket form, and is inserted in the spacing between beams or steel profiles, it is totally immune to fire and possess excellent insulating properties. Insulating with mineral wool guarantees an excellent comfort level within the home. This level of comfort is very difficult to attain with many construction methods. Some of the main advantages mineral wool is that it provides excellent levels of thermal and acoustic insulation, it does not provoke allergies, does not absorb water, there is no deterioration, it allows the passage of air and has limitless durability.

Standard Dimensions

Semi-rigid Panels	4’.42” x 1.96”	1350 x 600 mm
Sheets	4’.62” to 8’.85” x 3’.93”	800 to 2700 x 1200 mm

Thickness

According to the thermal calculation several thicknesses can be used. Mineral wool comes in sheets and blankets, and is available from 0.13’/40 to 0.65’/200 mm of thickness

Density

Average Weight	2.49lb/ft^3	40 Kg / m^3

Behavioural Characteristics with Water

Since mineral wool insulation has a non-capillary structure it doesn't retain. It is permeable to the vapour of water and doesn't lose any structure integrity in its presence.

Dimensional Stability

Being a stable material the dimensional variations are null.

Fire Resistance

Incombustible material, classified as M0 and whose melting point is reached at 1200 ºC.

Thermal Resistance

In sheets of 2.75"/ 70 mm thickness the value is
R = 19.91ft^2 ºC / W. R = 1.85 m2 ºC / W.

Acoustic Insulation

Extenuating index in
Noise levels: DL = 23dB (A)
Residual Levels in
Noise levels: Ln = 60dB (A)

Expanded Polystyrene

Plastic foam of a sealed cellular structure, presented in form of sheets, was especially developed to eliminate thermal bridges such as those formed by the use of studs. Possessing a null capillarity, it is resistant to the diffusion of water vapour and is impermeable to rain. It is easy to work with and dispenses the need of a vapour barrier or air pocket and can be used as a superficial finish, which facilitates the adherence of the final finish.

Standard Dimensions

Length	4.10'	1250 mm
Width	1.96'	600 mm

Thickness

According to the actual thermal calculation several thicknesses can be used. The sheets of extruded polystyrene are available from 0.065'(20mm) to 0.262'(80 mm) of thickness.

Density

Average weight + 0.936lb/ft^3 (15 Kg/m^3)

Behavioural Characteristics with Water

High resistance to humidity, with an index of absorption below 0.3% of the volume.

Dimensional Stability

Being a stable material the dimensional variations is minimal.

Thermal Resistance

In sheets of 1.18"/30 mm of thickness the value is
R = 9.79ft^2 ºC / W. R = 0.91 m2 ºC / W.

Fire Resistance

Material is non-flammable. The sheets contain an additive to increase its resistance to fire in order to avoid combustion in the case of a small fire source. However, if exposed to intense fire, the sheets are combustible, melting at contact with the source of heat.

SHEETS OF DRYWALL (SHEETROCK)

In a TERMO STEEL home, all the interior walls are usually covered to sheets of drywall. This material is not a new product and has been used in construction for many years.

The first use Drywall dates back to 1890 in the United States and was introduced in Europe in 1917. More than a hundred thousand million square meters has been used all over the world.

This material is chemically a sulfurate of calcium, semi-anidro or anidro that, in contact with the water, solidifies being reconstituted the bi-moisturized natural plaster. When kneaded and when solidifying it retains 20% of your weight in water being slowly evaporated over time.

When the process is complete a porous plaster structure with alveoli of air turning is formed. During the manufacturing process, the plaster, the water and the additives are incorporated in a mixture that are fed into a continuous belt where they flow into two cardboard strips that serve as the skin. This combination passes through laminating rolls that gauge the thickness and determine the width and the board. The board is cut and then and the sheets go to a dryer where they acquire the physical and mechanical properties. Listed below are some advantageous characteristics:

Protection against Fire

The two molecules of water for each one of plaster represent 0.26gal (1 lt) of water per 10.76ft^2 (1 m²) in sheets of 0.142' (13 mm). Before it catches fire an extreme amount of heat for dehydration: 4034 cal/m² is required. While total dehydration doesn't happen, the plaster stays between 100ºC and the 160ºC, avoiding thermal shock and the transmission of the heat, delaying the spread of the fire during for one hour. Being incombustible and fire resistant, drywall limits the dilation of the structures, especially steel, allowing the thermal flow to be evenly distributed, avoiding points of heat concentration that would damage the structure.

Acoustic Insulation

The sheets of drywall form a continuous surface and although they are not of high density or great thickness, the porous interior structure, as well as its significant elasticity, are characteristics that allow it be to be absorbent and thus a good acoustic shock absorber.

Thermal Insulation

A home that is badly isolated it requires a larger consumption of energy to provide a comfortable atmosphere. However, a powerful heating source doesn't guarantee a comfortable atmosphere, the air in the vicinity of the source may heat up, but the walls remain cold. A continuous wall made of drywall of only 0.042' (13 mm), has a low coefficient of thermal

conductivity (0,26 Kcal/h/m ºC), and guarantees an evenly comfortable atmosphere with an insulating power three times better than brick and four and a half times superior than concrete.

Behavioural Characteristics with Water

The average production of vapour in an inhabited home of four people is, approximately, 44.09lb (20 Kg) to 55.11lb (25 kg) in every 24 hours. When the volume of air reaches a 100% of relative humidity the existing vapour condenses primarily on the coldest surfaces Given that drywall is a porous material, it absorbs the excess humidity and later returns it to the atmosphere when it is drier. In this manner, a room of 129.16ft² (12 m²) (13.12' (4 m) x 9.84' (3 m), covered with 516.66ft²(48 m²) of sheets of drywall has the ability to absorb about 52.91lb (24 kg) of water vapour in one day, which is the equivalent to the amount produced in the whole house during the same period. Since drywall is an insulating material, condensation associated with cold walls is avoided and it impedes the formation of mushrooms that blacken the walls and the ceilings.

Drywall is a lightweight material making it easy to use and apply; it can also be finished with all the normally used materials, from ceramic tiles to all manner of paints.

A high resistance micro fibre tape is applied over the joints created when sheets of drywall are placed side by side. This tape has an adhesive base in order to glue itself to the drywall thus providing a smooth seam. Protecting the edges and corners is a corner protector of reinforced galvanized steel.

Standard Dimensions

Sheets of drywall are manufactured in various sizes, types and thickness. Normally a TERMO STEEL Home uses the following dimensions:

Length 8.53' (2600 mm)
Width 3.93' (1200 mm)

Thickness

Thickness for Walls 0.042' (13 mm)
Thickness for Ceilings 0.049' (15 mm)

Density

Average Weight 49.92lb/ft^3 –(800 Kg/m^3)

Dimensional Satiability

Stable material. Null dimensional variances.

Water Vapour Resistance

1.13' (347 mm) Hg. m^2 dia/g

Fire Resistance

This material is considered non-flammable, and is not easily combustible, and is classified as M1. For more demanding situations sheets of drywall which have glass fibre incorporated into it can be used to increases your resistance to fire.

Thermal Resistance

The coefficient of thermal resistance of a material is the quantification of resistance offered to the passage of heat, which is influenced, by the density and thickness of the material. In plates of 0.43”(11mm) of thickness this value is R = 1.00ft² (0,093 m2) ºC / W.

THE EXTERIOR FINISH (EIFS)

The external finish of a house is much more than just an aesthetic or ornamental property. It will also serve as the skin of a body; it will protect the structure and the interior of the home while at the same time that allows your home to breathe. Just as a crack or cut in the skin of a human body is a weak point , a crack in the skin of your home is as well, through which unavoidably will penetrate humidity provoking damage not only at the structural level, but well damage the furniture inside the house and worse still, can affect the occupants' health.

An effective protection is more than just simply using a stucco or paint. In a TERMO STEEL home a “system” which comprises a number of involved components which have been properly tested and when combined guarantee the most effective possible protection is used.

Internationally, this system is known as EIFS (External Insulation and Finishing Systems). All the products involved in such a system should be compatible with each other, at all levels from mechanical to adherence properties, and be perfectly suitable to the structure and the base covering to which they are being applied. This is what happens in the EIFS system used by TERMO STEEL.

When compared with the conventional stuccos, this system has the advantage of increasing the thermal protection of the building. The first element of the system is the sheets of extruded polystyrene referred to earlier in this manual. Next a polymeric mortar is applied which is obtained when two components are mixed together: a grey powder with a cement base and a white liquid an acrylic resins. After these two components have been mixed the result is a tixotrópica paste, some companies already have this product in a ready to use form. This paste is applied in layers of 0.07” (2 mm) to the sheets of polystyrene; a mesh of glass fibre with anti-alkaline treatment is imbedded in the paste, which acts as additional protection against the shocks and or cracks. Finally, an impermeable covering roll is applied, which is highly resistant and yet still flexible. It is a pasty liquid consistency, which is applied to the base and provides extraordinary resistance to the bad weather. In more extreme situations, you can alternatively use a final covering comprised of an elastic and impermeable membrane formulated of pure acrylic resins, which is water resistant and able to withstand both mild and bad weather. Both of these solutions can be use as the final finish, depending on taste or the required levels of protection.

All the materials included in the insulation and finishing of the exterior are recognized and properly approved. However, several companies include the complete system of insulation and possess all the approval documents, guaranteeing their total effectiveness and the compatibility among the several that are required to create an EIF system. There also exist organizations that can supply detailed information about these different companies that offer these systems. Among those available we recommend the American EIMA - EIFS Industry Members Association.

The following data presented can vary according the company that you choose.

Base Paste

Density

Powder	873.02lb/gal	1,500 Kg/Lt
Liquid	582.01lb/gal	1,000 Kg/Lt
Resulting Mix	960.33lb/gal	1,650 Kg/Lt

Return

Average weight 0.81lb (4kg) to 1.024lb (5 Kg)/ ft^2 (m^2)

Behavioural Characteristics with Water

A sheet of 0.078" (2 mm) doesn't allow passage of water after 24 hours under a layer of 0.039" (1 cm) of water. After 2 hours of immersion it shows absorption of 4.3% of the water.

Impact / Shock Resistance

Able to support the impact of a 11.02lb (5 Kg) ball falling from a height of 1.47' (45 cm) resulting in a deformation 0.19" (5 mm) in depth.

Fire Resistance

It is an incombustible material, and will not allow the fire to spread.

Wire mesh

Dimensions

Length	16.40'	5000 mm
Width	3.28'	1000 mm
Thickness	0.0019' to 0.0023'	0.58 to 0.72 mm
Square	0.016x0.016	5 x 5 mm

Weight

0.403lb (183g) to 0.469lb (213 g)

Impermeable Coverings

Density

At 20 ºC about 0.872lb/gal (1.5 Kg/Lt)

Return

About 36.82gal/ft^2 (1,500 Lt/m^2)

Permeability
In spite of being totally water resistant it is permeable to both air and the vapour.

Resistance to Tearing
Depending to how the coatings are applied, this can resist cracks as 0.129 " (3.3 mm)

The Certifications And Approvals

THE CONSTRUCTION PROCESS

Alter three years of studies and research by the National Association of Home Builders Research Centre with the patronage and assistance of the American Iron and Steel Institute and the United States Department of Housing and Urban Development and the help of steel producers, official inspectors, technicians, engineers and builders a set of regulations and standards were Published regarding Lightweight Steel Framing.

This set of regulations is called the Prescriptive Method for Residential Cold-Formed Steel Framing and was published in May of 1996. The objective was to establish a set of regulations and rules that can be applied to structures that are being built with light gauge steel.

The document regulates the basic pieces of cold formed steel, it presents a universal system for identification of steel members and establishes the minimum values for protection against corrosion, it also includes standard dimensions of the width of floor, ceiling and roof beams, standard dimensions for wall studs, norms for wall reinforcement and fastening. These specifications are supplemented with appropriate constructive details with and to read format. The Prescriptive Method is consistent with current constructive codes in the United States, and with engineering regulations and industrial specifications.

The Steel

According to the previously referred regulation (Prescriptive Method for Residential Cold-Formed Steel Framing), the galvanized steel sheets from which the structural studs are formed will possess the physical and mechanical characteristics specified in the norms AT 653, AT 792 and 875 published by the ASTM - American Society for Testing and Materials. The sections, forms, dubbing angles, dimensions, intermediate spaces and methods of fixation of the steel studs and channels are regulated in the normative sections previously mentioned.

The Sheets of Oriented Strand Board (OSB)

This material is recognized by the constructive codes of the United States and Canada for structural support. Their specification and application is regulated in the document DOC PS2-92 Wood-Based Structural Panels Uses approved by the congress of the United States in August of 1992.

In Europe, the OSB is certified by the following organizations:

AFAQ ISO 9002 1995/3962 EQNET
CTBA MQ 83
BBA 88/2079
KOMO 32565/94
UBAM Z 91326
ETA MK 5.40/1237
WIMLAS 26, 27/95
AITIM EN 120:1992

The specification and application of OSB is regulated in the document prEN300: 1995-AND approved in October of 1995 by the European Committee for Standardization.

The Exterior Insulating Finishing System (EIFS)

All the materials included in the insulation and external finishing are properly certified and approved. However the complete system of (EIFS) possesses approval documents, guaranteeing the total effectiveness and compatibility among its diverse elements that include: the sheets of polystyrene, the polymeric cement, the fibre mesh and the final paints. This certification was approved by regulating bodies in both North America and Europe.

All Remaining Materials

All the other materials used in a TERMO STEEL construction are known and already widely used for many years in the national and international civil construction markets and have been properly approved and certified by all proper governing bodies.

Modern steel structures ♦ Thermal and acoustic insulation ♦Adaptable to any form of Architecture ♦ Less time to complete project ♦ Advanced CAD system ♦ Plumbing and electrical wiring easily installed ♦ Retains original appearance longer ♦ Minimum maintenance ♦ Maximum energy efficiency ♦ Advanced construction technology ♦ Supported by AMSTEEL INTERNATIONAL ♦ Guaranteed supply of material ♦ 3 phase adaptation ♦ Modular Construction ♦ Renovations ♦ Applicable to other forms of Construction

Many more Advantages
Information available from our Commercial Department