estanterías record

Efficient storage systems

PRODUCT TECHNICAL FILE

CONVENTIONAL PICKING RACK

OVER FLOOR

MEZZANINE OVER PICKING

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CONTENTS

1. SCOPE

Estanterías Record, S.L. designs and manufactures several types of metal racking, shelving and storage systems in compliance with applicable standards. Therefore, we have to document the specifications and characteristics of each product line to create a summarised view of the theoretical parameters and structural and functional elements considered in each particular solution.

This product file aims to provide a general description of the shelving system for CONVENTIONAL MANUAL LOADING and its accessories.

It develops an outline of the individual components in the system and the different possibilities to combine them to create the structures which must bear the load of the stored goods. We also describe the materials used to manufacture the components and any other accessories incorporated in the specific, unmodified solution. Finally, it includes a normative justification of the product design calculations and the load-bearing capacities of the product's main elements.

The scope of this report is not exhaustive, but rather it is purely descriptive and aims to provide a broad view of the system's general operation. It is not intended, therefore, to explain all the combinations of uses and components in meticulous technical detail, as this would go beyond the purposes for which it has been conceived; it has been created as an educational, supporting material, so its content should not be considered as a definitive and accurate reference, but rather instructional.

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2. PRODUCT DESCRIPTION

The storage system constitutes an appropriate combination of its structural elements according to the technical and functional parameters for its planned use.

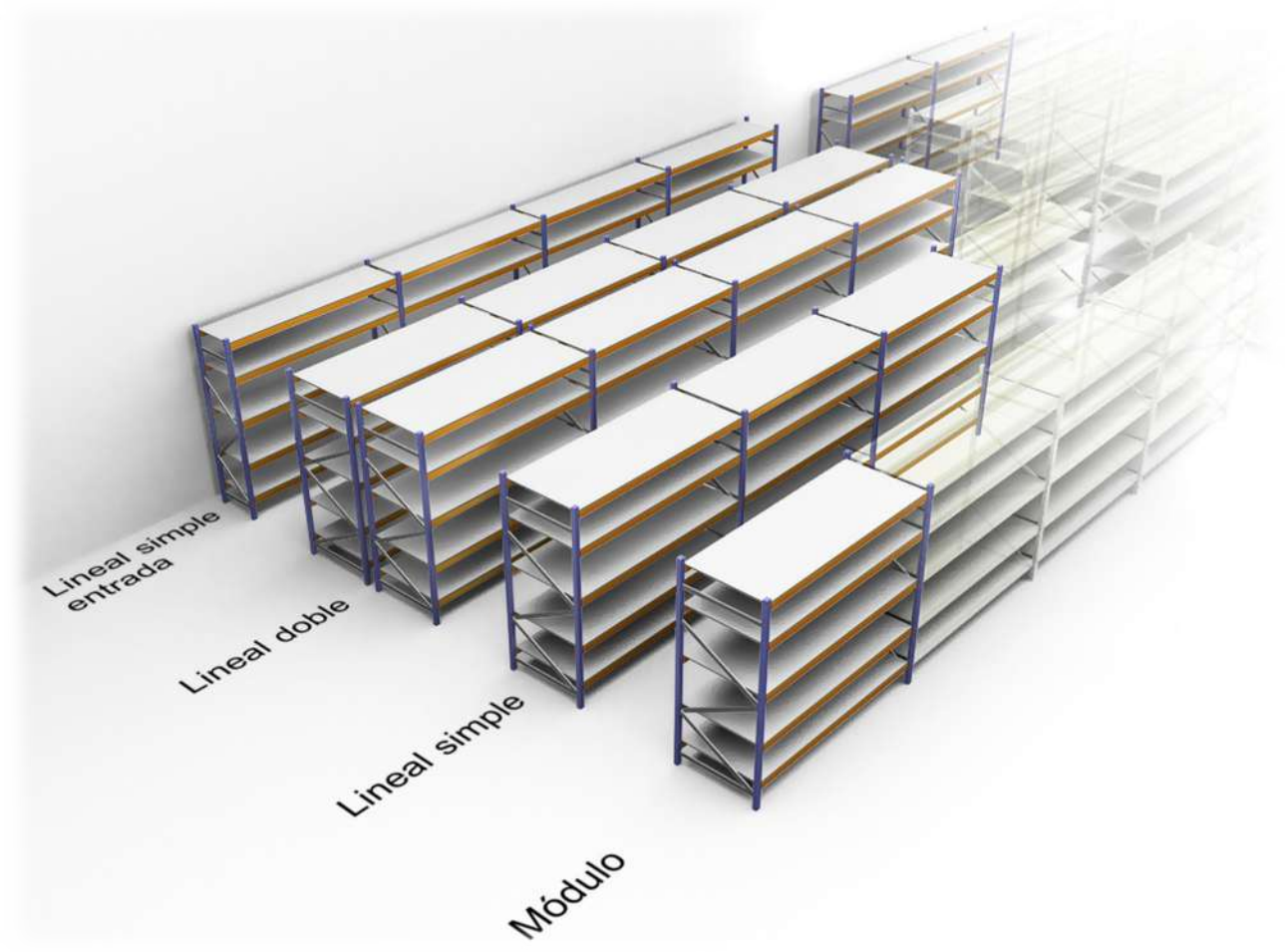
The system's basic components are frames and beams for loading levels. These and some other components are described in more detail below.

Adjoining frames that face each other are connected together using different pairs of beams. Each pair of beams comprises a loading level or surface for the storage of goods.

The volume between two vertically adjacent pairs of beams (a cell) defines the maximum load and the dimensions and quantity of unit loads allowed for the given level.

Each structural unit comprised of two frames and various loading levels is called a module.

Modules are combined to form single or double longitudinal structures called rows. Single rows, or perimeter rows that are usually fixed to the building's walls, are single access storage systems; when two assemblies are braced together they form a double row, i.e., a block of modules with access from both sides.



Lines of parallel blocks form intervening aisles whose width is determined by the applicable standards, by the handling equipment available, and by the means of access to and dimensions of the unit loads.

Main advantages:

- Each item can be located quickly and accessed directly and immediately.
- Easily adapted as requirements change. The range of accessories and configurations means the storage system can be adapted for use with loads of all weights and volumes.
- Strict stock control. Each location corresponds to a selectively accessible and identifiable item; there is no need to move items to handle the required products.
- Intense flow of stock rotation. Flexibility of use saves time and effort, while also preventing warehouse management errors.
- As the system's structural elements follow an excellent assembly design it can be disassembled and relocated quickly. Alternatively it can be reconfigured or amplified according to new storage needs.
- Optimum use of the vertical space. Loading levels can be adjusted quickly and easily to adapt to different volumes of stored goods.

- Versatility of use. The system's configuration options mean the shelves can be used in coordination with any type of handling equipment in function of each project.

- Damaged components can be replaced easily and immediately.

- The construction system means the basic structure can be extended vertically or covered with additional storage surfaces, thus taking full advantage of the space available and adapting perfectly to goods with different formats, weights and volumes.

The user can rest assured that their investment will never become obsolete and that it can evolve and develop in parallel with their business. Once Estanterías Record have completed the appropriate studies, the installed storage system can be reconfigured, expanded or refurbished as and when new circumstances or expansion or relocation requirements arise.

The conventional shelving system for manual loading is designed to optimise stock management and maximise warehouse usage through a controlled investment that is proportional to the benefits and advantages it will bring.

The following diagram provides an example of the design:

Alternatively, in order to increase storage capacity, the basic structure can be replicated vertically, taking full advantage of the warehouse's volume, by installing a system of elevated aisles and walkways. Therefore, the design is supplemented with walkable floors positioned between the storage system's modules which are accessed using conveniently located stairways. The perimeter of these upper levels is protected with guardrails; these can also incorporate access doors, handrails, skirting boards and intermediate guards to act as safety devices.

The following diagram shows an example of this type of structure:

Another possible supplement, and with the aim of increasing the storage surface area and capacity, an open-plan, walkable overhead loft accessed using a conveniently located stairway can be installed above the modules forming the basic installation. The open perimeter of this level is protected with guardrails; these can also incorporate access doors, handrails, skirting boards and intermediate guards to act as safety devices.

The diagram below shows the above configuration:

2.1. MATERIALS

Sections are cold-formed and punched from steel strips before they undergo electrostatic painting in a continuous flow, phosphate, anticorrosive coating and oven curing treatments.

The load-bearing capacity of the racks is determined directly by the type and quality of steel used in their construction, which is established by the applicable standard, and by the physical characteristics and behaviour of each configuration in response to elastic instability phenomena associated with the individual elements and the structural systems formed from combinations thereof.

2.1.1. Steels

The quality, types and characteristics of the steels used to manufacture the different elements varies depending on the structural requirements of the specific solution.

All the pickled steel strips used to manufacture the sections are certified at source.

Depending on each element's end use, nominal values for yield stress, fy, range between 235 N/mm² and 355 N/mm², in accordance with standard EN 10025.

Values for ultimate tensile strength, fu, vary from 360 N/mm² to 510 N/mm², as per standard EN 10025.
They are guaranteed to have the following mechanical characteristics:

Property	Value
Elastic modulus	E = 210 000 N/mm^2
Shear modulus	G = E/2(1+ν) N/mm^2
Poisson's ratio	ν = 0.3
Coefficient of linear thermal expansion	α = 12 x 10^{-6} ° C
Density	ρ = 7850 Kg/m^3

The system's metal elements are grade A1 (M0), according to certification at source, in compliance with Spanish Royal Decree 2267/2004, dated December 3, which approved the fire safety regulations in industrial premises. Elements with a zinc coating of less than 100 µm have a fire rating of M1, class B-s3,d0, in accordance with standard UNE-EN 13501-1:2007.

2.1.2. Finishes

All ungalvanised elements are painted to obtain a surface finish using an automated, double rail, continuous flow process with several treatment stages: cleaning, degreasing, phosphating, anticorrosive coating, pigment spraying and curing. Pieces are degreased before painting by means of phosphate and passivation treatments. A thermosetting epoxy polyester paint is then applied using a robotised electrostatic sprayer and oven cured immediately at 200 °C for 15 minutes.

This produces a glossy, uniform coating approximately 65 µm thick with a high impact, wear and corrosion resistance, a fire rating of M1, in accordance with standard UNE 23727-90, certified at source, tested according to standards UNE-EN 13823:2002 and UNE-EN ISO 11925-2:2002, and classified in line with UNE-EN 13501-1:2007 B-s2,d0, both certified at source. The coatings' mechanical specifications are presented below:

Property	Standard	Result
Gloss	ISO 2813	84
Adhesion	ISO 2409	GTO
Direct and reverse impact	ISO 6272	70 cm
Cupping	ISO 1520	7 mm
Bend test	ISO 1519	5 mm
MEK	IC-101	100 DF
Salt spray hours		500

Vertical elements are painted blue (RAL 5003) and horizontal ones orange (RAL 2009).

Like the paints, all other auxiliary materials used to manufacture the system's elements are selected according to the specifications and requirements of applicable standards, their production and reception processes are certified, and they are constantly subjected to the tests and inspections established by the quality assurance and management procedures in ISO 9001:2008.

2.2. STRUCTURAL ELEMENTS

2.2.1. Frames

The frames correspond to the structure's basic vertical elements. Each frame comprises two uprights connected by a series of horizontal and diagonal bracings secured with grade 8.8 DIN 931 M8x35 bolts. The bolts are made from high strength steel and fitted with DIN 985 self-locking safety nuts and Teflon® washers to ensure they do not become loose with use.

Height (mm)	Depth (mm)
1,000	400
1,500	500
2,000	600
2,500	800
3,000	1,000
3,500	1,200
4,000	
4,500	
5,000	
5,500	
6,000	
6,500	
7,000	
7,500	
8,000	
8,500	

This structure will bear the axial compression load in service conditions and transmit it to the floor. They are also subject to the lateral thrust produced by the mechanical forces acting in the system.

2.2.2. Bracings or trusses

Steel sections with a guaranteed minimum grade of DC01, while higher grades, DC03 and DC04, may be used as per standard UNE-EN 10130. All bracings are C-sections with dimensions of 30x12x6.5 mm and 9 mm diameter holes drilled at both ends. Their length depends on the depth of the frame.

The horizontal and diagonal bracings are appropriately triangulated. Intersections between diagonal and horizontal bracings, or those between two diagonal elements, are fixed to uprights using DIN 931 M8x35 bolts with DIN 985 M8 self-locking nuts.

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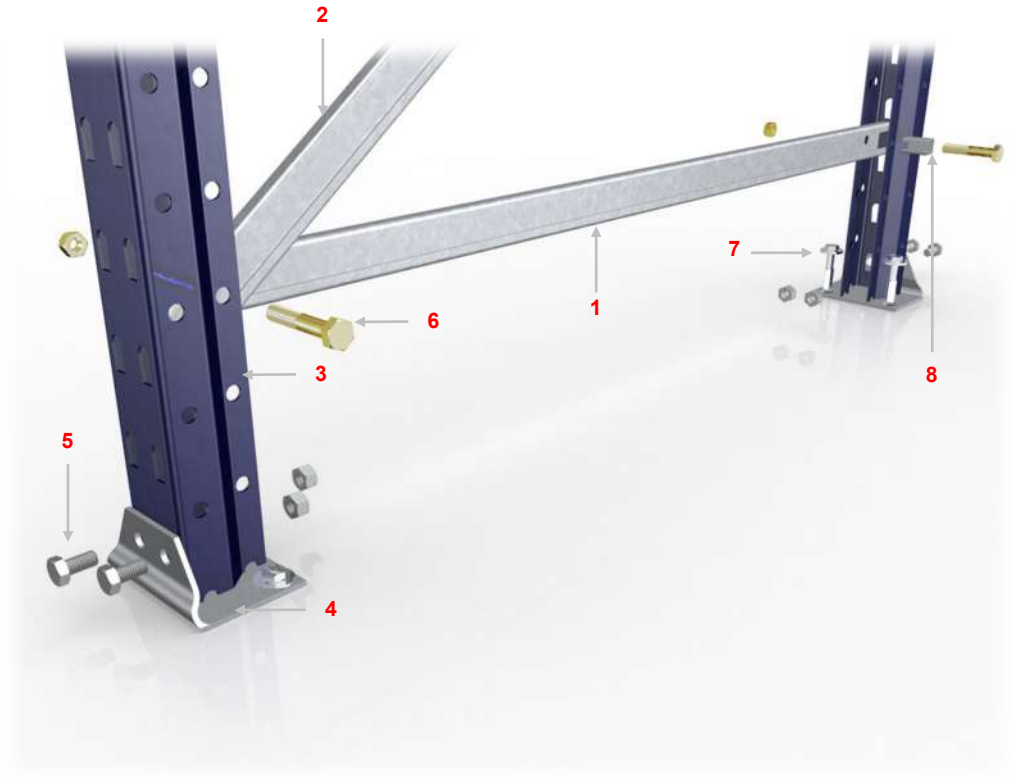
The following diagram shows the start of the bracing structure.



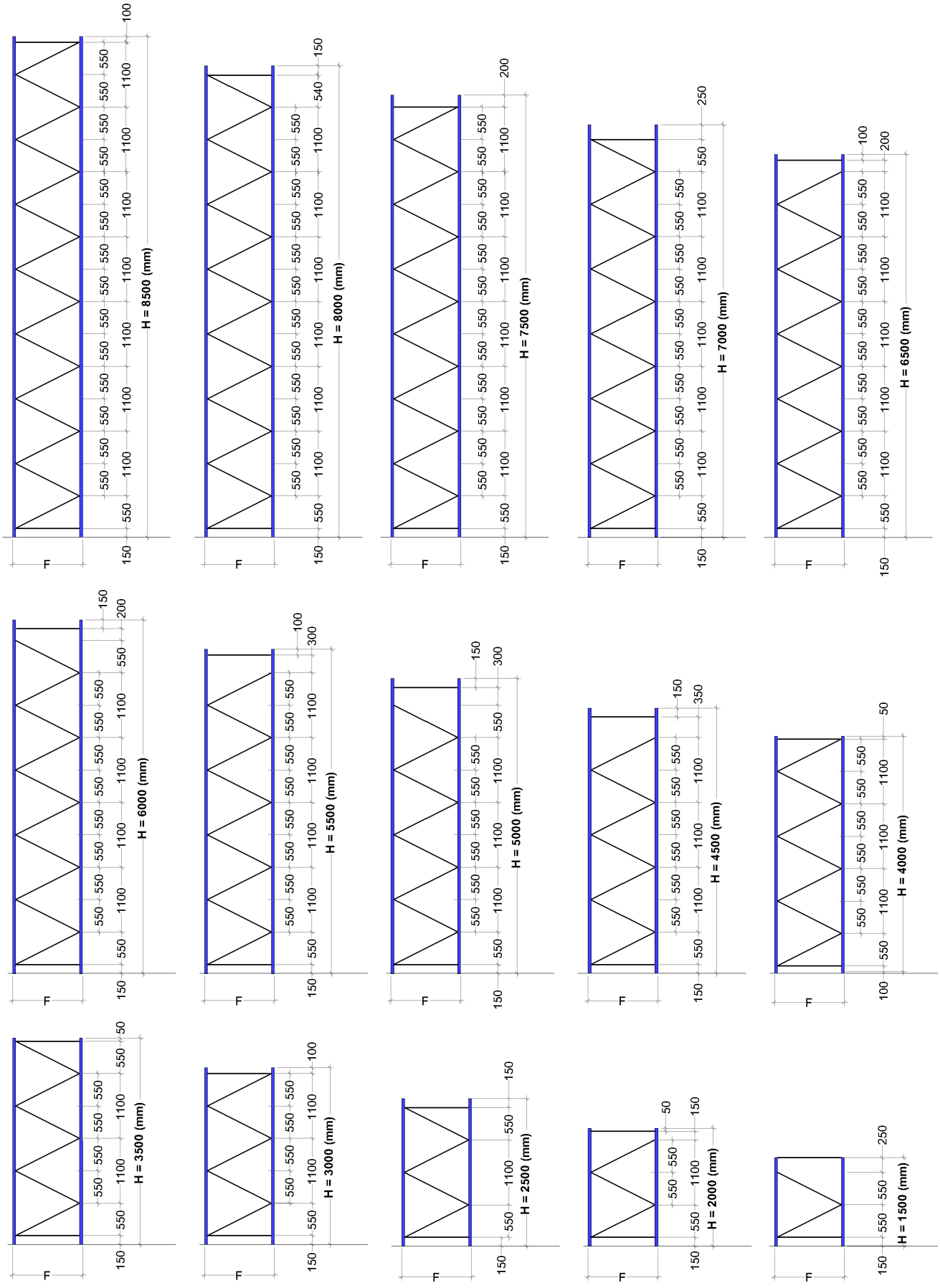
No.	Description
1	Horizontal bracing
2	Diagonal bracing
3	Upright
4	Base plate

No.	Description
5	M8x15 bolt
6	M8x35 bolt
7	Anchor bolt
8	Spacer fitting

The distance between diagonal bracings is fixed at 550 mm for all frames, which gives a maximum span between trusses of 1,100 mm. The angles between diagonal bracings generally ranges from 20° to 70°.

The free ends of the horizontal and diagonal bracings (where there aren't any nodes) are bolted to the uprights. Spacer fittings are used to prevent any slack between bracings and the upright. These are hollow rectangular parts measuring 14x14 mm and 23 mm long which fill the gap between the bracing and the upright.

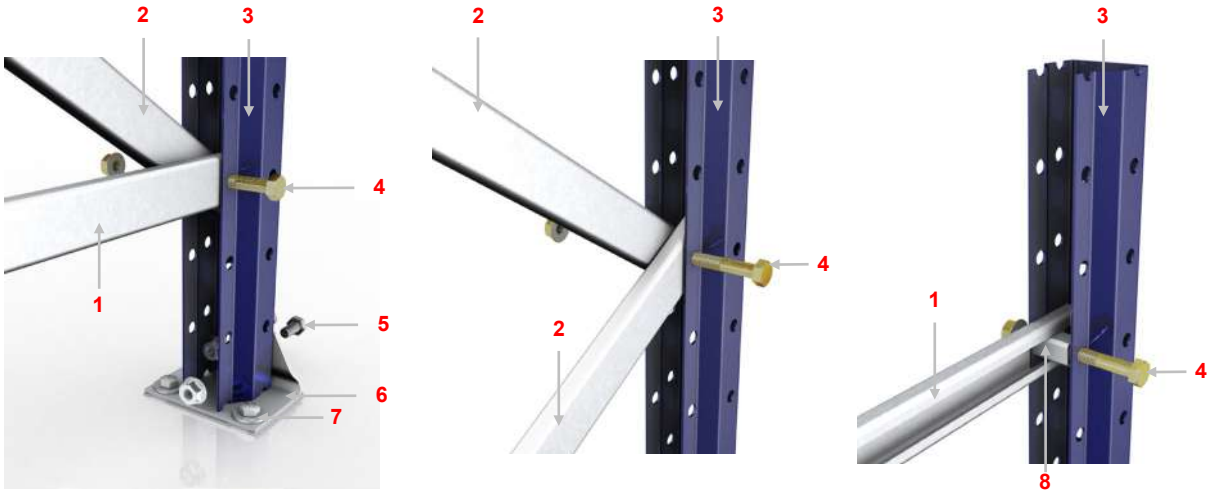
The diagram below shows how the components are arranged in the structure explained above, as well as the assembly dimensions and details for each frame height:


H = 8500 (mm)
H = 8000 (mm)
H = 7500 (mm)
H = 7000 (mm)
H = 6500 (mm)
H = 6000 (mm)
H = 5500 (mm)
H = 5000 (mm)
H = 4500 (mm)
H = 4000 (mm)
H = 3500 (mm)
H = 3000 (mm)
H = 2500 (mm)
H = 2000 (mm)
H = 1500 (mm)
F

The table below shows the bracing components for each height of frame.

Height mm	Uprights Units	Base plate Units	M8x15 bolts Units	Spacer fittings Units	Horizontal bracings Units	Diagonal bracings Units	M8x35 bolts Units
1,500	2	2	4	4	2	2	6
2,000	2	2	4	4	2	3	7
2,500	2	2	4	2	2	4	7
3,000	2	2	4	2	2	5	8
3,500	2	2	4	2	2	6	9
4,000	2	2	4	2	2	7	10
4,500	2	2	4	4	2	7	11
5,000	2	2	4	4	2	8	12
5,500	2	2	4	4	2	9	13
6,000	2	2	4	4	2	10	14
6,500	2	2	4	4	2	11	15
7,000	2	2	4	2	2	12	15
7,500	2	2	4	2	2	13	16
8,000	2	2	4	2	2	14	17
8,500	2	2	4	2	2	15	18

The diagrams below show the different types of node and illustrate whether or not spacer fittings need to be fitted.

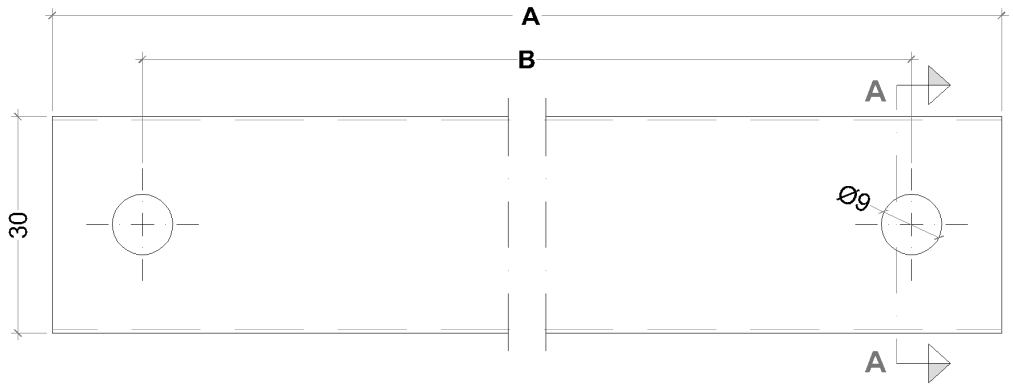


Detailed diagram of bracing elements

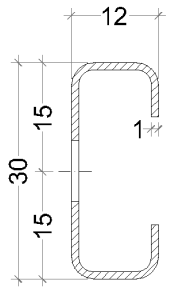
No.	Description
1	Horizontal bracing
2	Diagonal bracing
3	Upright
4	M8x35 bolt

No.	Description
5	M8x15 bolt
6	Base plate
7	Anchor bolt
8	Spacer fitting

Dimensions of horizontal and diagonal bracings:



Elevation view



A-A cross-section

Diagonal bracings		
Depth	**A**	**B**
400	683	633
500	738	688
600	802	752
700	874	824
800	950	900
900	1,032	982
1,000	1,116	1,066
1,100	1,203	1,153
1,200	1,291	1241

Horizontal bracings		
Depth	**A**	**B**
400	363	313
500	463	413
600	563	513
700	663	613
800	763	713
900	863	813
1,000	963	913
1,100	1,063	1,013
1,200	1,163	1,113

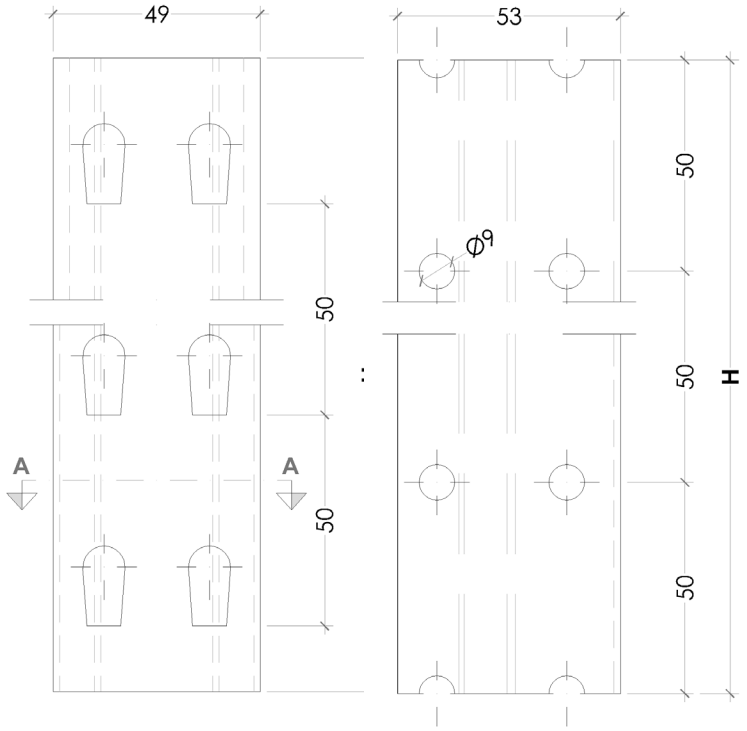
Dimensions in mm

Horizontal/diagonal bracings

2.2.3. Uprights

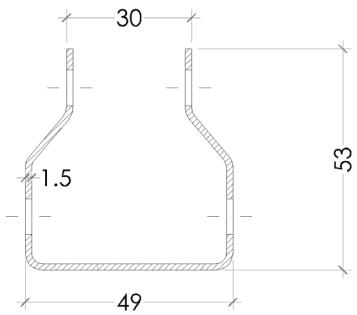
Hot-rolled, as per standard EN 100252:2004, and cold-formed S235JR to S355JR grade steel C-sections, with an appropriate thickness for the load they must bear. They feature two lines of holes, each separated by 50 mm, along their front surface; the connectors for the load-bearing beams slot into these holes. There are also two rows of holes, measuring 9 mm in diameter and again separated by 50 mm, facing each other on both sides of the uprights. These holes are used to attach the bracings. As detailed above, the holes in the front of the uprights can be used to graduate the loading level every 50 mm.

Each flat element subject to compression is duly stiffened to ensure it performs correctly in case it gets dented. To this end, the uprights have six longitudinal pleats which confer excellent stiffness against these phenomena; these pleats have been especially designed so that their inertia in function of their width, length and thickness ensures the structure is sufficiently stiffened for the service conditions which it must endure.



Elevation view

Cross-section



A-A cross-section

Height (mm)	Height (mm)
1,500	5,500
2,000	6,000
2,500	6,500
3,000	7,000
3,500	7,500
4,000	8,000
4,500	8,500
5,000	

Height of standard production frames

2.2.4. Additional frame components

Each upright is fitted with a metal foot or base plate especially designed to transmit the load to the floor and control any punching shear or settlement phenomena in the underlying concrete. This is also affected by the dimensions and characteristics of the concrete floor slab.

Upright with base plate

The surface supporting the racking system must always be of sufficient quality and strength to bear the maximum loads for which the system has been designed. Concrete reinforced with a 4 mm diameter metal mesh measuring 150x150 mm, at a minimum thickness of 150 mm, and with an allowable compressive strength of M200 (200 kg/cm2), or greater, is acceptable for these loads.

What is more, it must be perfectly levelled to ensure the vertical elements are plumbed correctly. Therefore, the maximum permissible unevenness between any two points of the slab must not exceed ± 10 mm.

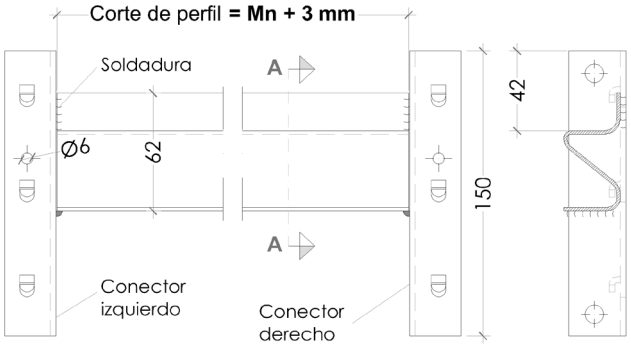
Lastly, and depending on the condition of the concrete floor slab, a levelling plate shall be fitted between the base plate and the floor to correct any unevenness and plumb the frame.

2.2.5. Beams

Beams are the horizontal elements that support the load and, together with the frames, correspond to the basic structural components for storage systems designed for moderate loads and elevated aisles.

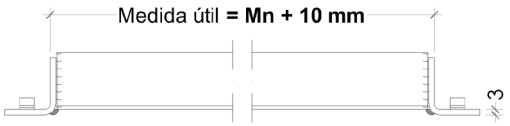
Depending on the product to be stored and the means of accessing the rack for handling purposes, there are different types of beam available for the system's basic modules:

Z beams (Z60 and Z80). These consist of one Z-section profile with two connectors welded onto both ends so they can slot onto frame uprights. They are used in conventional configurations of this type of storage system. Their design is prepared for the installation of an open-plan surface for the direct storage of goods. In this case unit loads will be managed with manual handling equipment. This element is available in different cross-sections (Z60 or Z80, in function of their height) depending on the uniformly distributed weight each pair of beams in a loading level must bear.

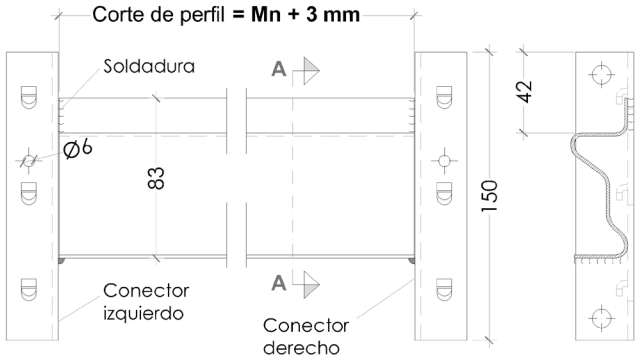


Elevation view

A-A cross-section

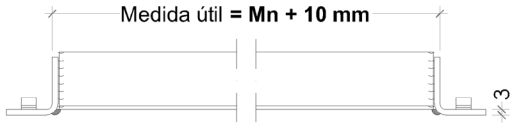


Plan view



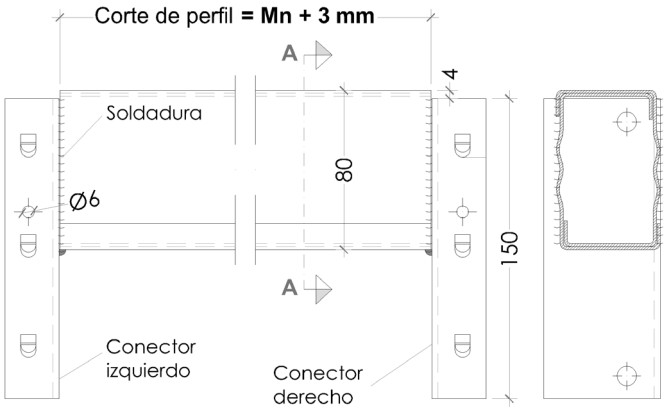
Elevation view

A-A cross-section



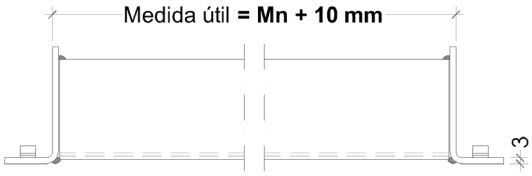
Plan view

Overhead loft beams. These are made up of two C-sections assembled to form a tubular structure. Connectors are attached to both ends using high-strength welding so that the beams can slot onto the frames. They are used when Z beams do not have enough load-bearing capacity to support the required loads. Furthermore, this type of beam is a necessary structural element in the configuration of an elevated aisle or loft.



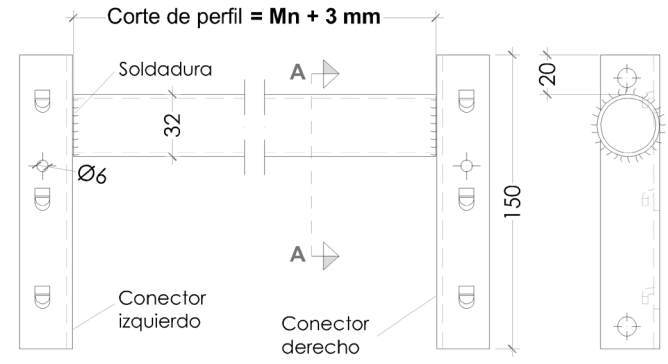
Elevation view

A-A cross-section



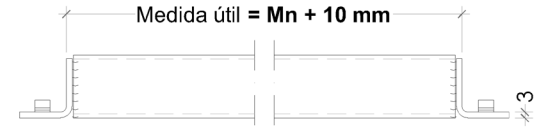
Plan view

Hanger beams. These consist of a 32 mm round tube that slots onto the frames by means of two lateral connectors attached to both ends using high-strength welding. They are used to store items hung from hangers and for various other uses (tyres, reels, etc.). Alternatively, they can be employed as protections in transit areas or at the end of elevated aisles.



Elevation view

A-A cross-section



Plan view

Essentially, the beams are subject to bending and lateral-torsional buckling forces. Each flat element is duly stiffened at each point subject to compression to ensure it performs correctly in case it gets dented. Otherwise, the element could fail under shear loads, bending moments or a combination of the two. The tubular beams incorporate longitudinal ribs along their full length to confer greater stiffness and strength.

Each beam accepts a maximum deformation equal to 1/200th of its total length, as per standard UNE-EN 15620.

The beams are fitted onto the frame by means of beam connectors. These parts transmit the load acting on the beam to the frame. Connectors are cold-formed L-shaped sections measuring 29x28x3 mm; they are attached to the beam by robotic welding, producing a very stiff connection that meets the most demanding tensile strength safety coefficients for the intended function.

They attach to the frame by means of three 7.5-mm hooks projecting from each connector which fit into the corresponding holes in the uprights. This type of connection is specifically designed to transmit the thrusts from the service load correctly, thus minimising strain in the system and self-centring compressive forces to prevent risks associated with shearing stress.

After fitting the connectors to the frame they are locked with safety pins to ensure beams cannot suffer any vertical movements. These pins do not, therefore, fulfil a load-bearing purpose but rather act as a locking device to prevent movements due to external thrusts, primarily when handling goods in a cell.

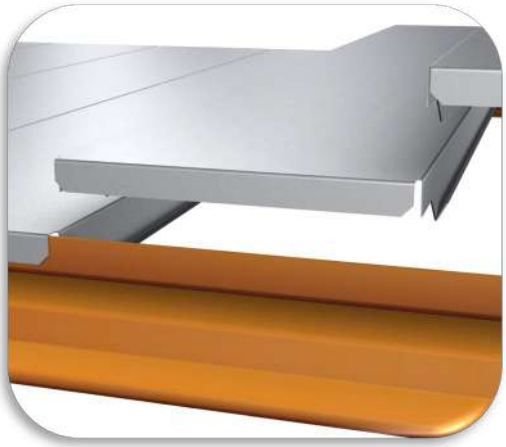
This assembly system provides a great deal of versatility of use, minimises assembly/disassembly times, and confers great longitudinal stability and strength to the overall structure.

2.2.6. Loading levels

When load units are accessed manually, the beams must support the surface where the goods will be stored. There are two options:

Metal panels. These are purpose-designed, galvanised metal panels positioned perpendicularly between two beams. They have matched tongue and groove tabs along the sides so that each group of panels on a level forms a continuous surface, improving their performance and increasing their load capacity. This system is recommended over the one described below because it presents some clear advantages: there is no need for support elements as the actual panels ensure the beams are not subject to lateral-torsional buckling; they are handled with great ease, comfort and flexibility; their metal construction means they are not susceptible to the effects of time or contact with moisture that normally affect fibreboard; greater resistance to scratches, impacts, etc.; increase the overall system's load-bearing capacity given that the metal panels weigh much less than a wooden surface. They are available in lengths of 400, 500, 600, 800, 900, 1,000, 1,100 and 1,200 mm, and with a width of 200 mm.

Galvanised metal panel



Positioning on Z beams

Fibreboards. *Z beams*. These are boards dimensioned to sit in the grooves found on the Z beams, thus creating a loading surface. As the beams are subject to lateral-torsional buckling due to the load's compressive force, the board could break or dislodge from its seating, causing the stored goods to fall. To avoid this problem, and also to prevent the board itself from buckling, a sufficient number of supports must be installed to control these phenomena. The board supports connect to both beams; this stiffens the structure and, thanks to their robust properties, helps increase the storage system's load-bearing capacity.

Board support for Z beams

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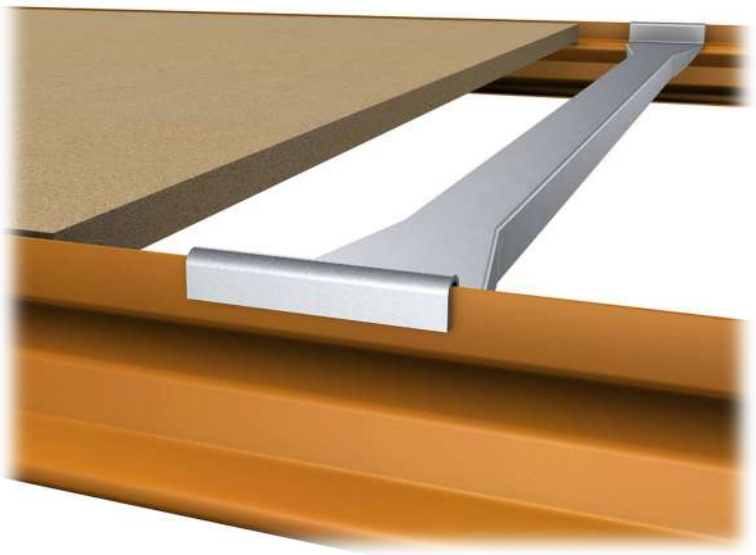


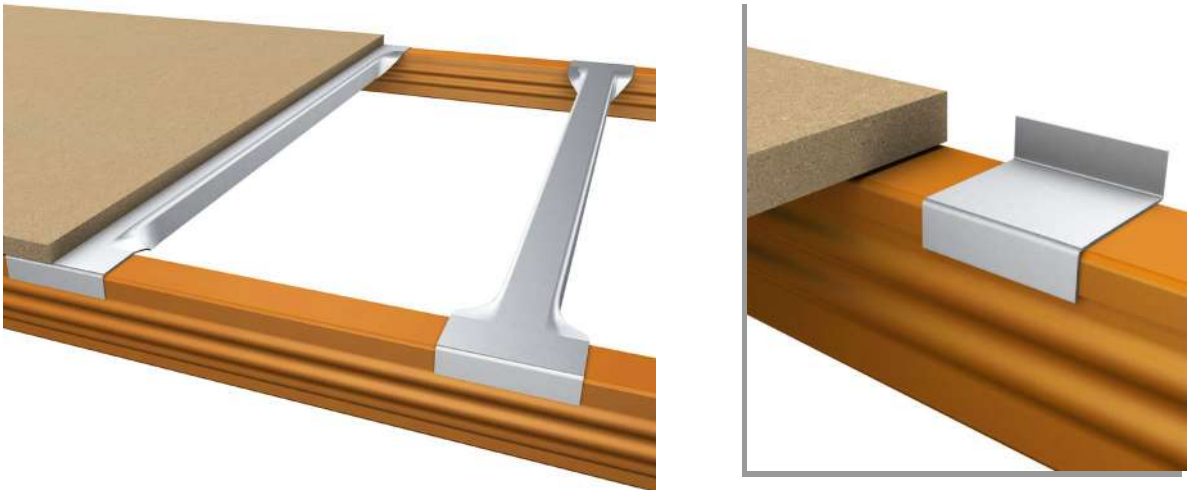
Z level with supports and fibreboard

Fibreboards: Overhead loft beams. These boards are correctly dimensioned to fit over the overhead loft beams and cover the appropriate surface. This solution is selected when the goods to be stored are handled manually but the loft requires a greater load-bearing capacity than that of the Z beams. To ensure beams do not succumb to lateral-torsional buckling, and also to prevent the board itself from buckling, a sufficient number of supports must be installed to control these phenomena. The board supports connect to both beams; this stiffens the structure and, thanks to their robust properties, helps increase the storage system's load-bearing capacity.

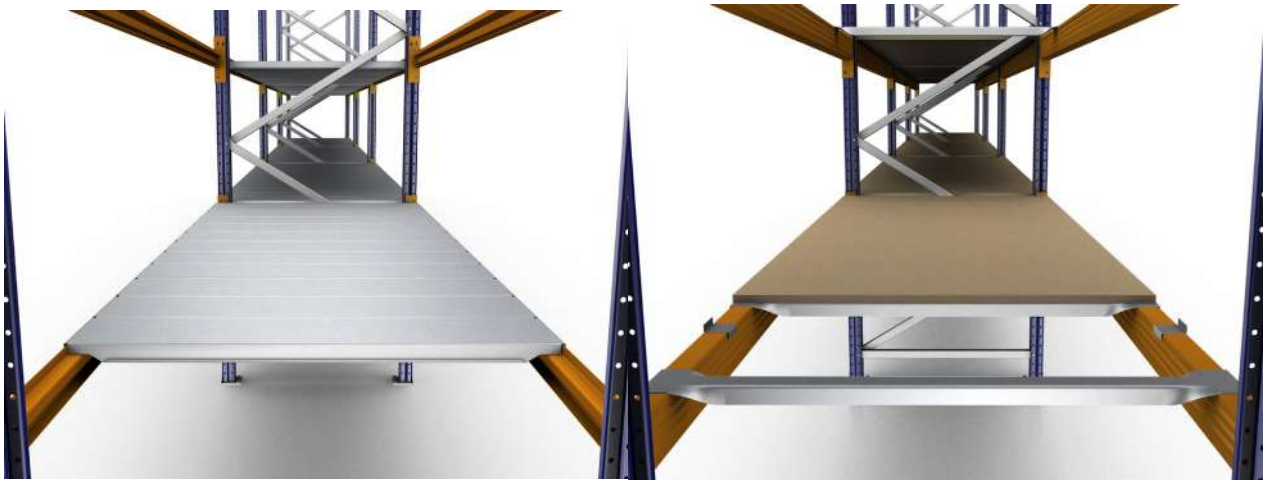
Board support for conventional beams

Both types of support are available in lengths of 400, 500, 600, 800, 900, 1,000, 1,100 and 1,200 mm.

Additionally, in the case of levels constructed from overhead loft beams, board retainers are installed to prevent the boards from being dislodged while handling goods. Normally, four retainers are fitted for each board.



Level with overhead loft beams, supports and retainer



Z beams picking level with metal panels

Picking level with overhead loft beams

2.2.7. Optional elements

The conventional shelving system for manual loading features a wide range of accessories and elements specifically designed for integration into the system described above and to cover diverse requirements depending on the specific conditions of use. Some of these elements are described below:

Compartmentalised shelving system. Comprising front and rear panels, connectors and dividers, this system is used to maintain bulk goods or small dimension packaged goods in separate compartments. The parts are made from grade ST-02 galvanised sheet metal, as per standard DIN 171000.

The front and rear panels have longitudinal pleats and are designed with a series of slots for positioning and attaching the dividers. They are available in lengths of 1,000, 1,200, 1,400, 1,600, 1,800, 2,200 and 2,600 mm.

The panels have holes at each end for attaching connectors using M8x15 bolts. The connectors are steel plates with three hooks that slot into the corresponding holes in the frame uprights.

The system's dividers have a series of perimeter folds to increase their stiffness and so they can be correctly positioned and slotted into the front and rear panels. They are manufactured in lengths of 400, 500, 600 and 800 mm.

400, 200 and 100 panels with connectors and bolts

100 divider

200 divider

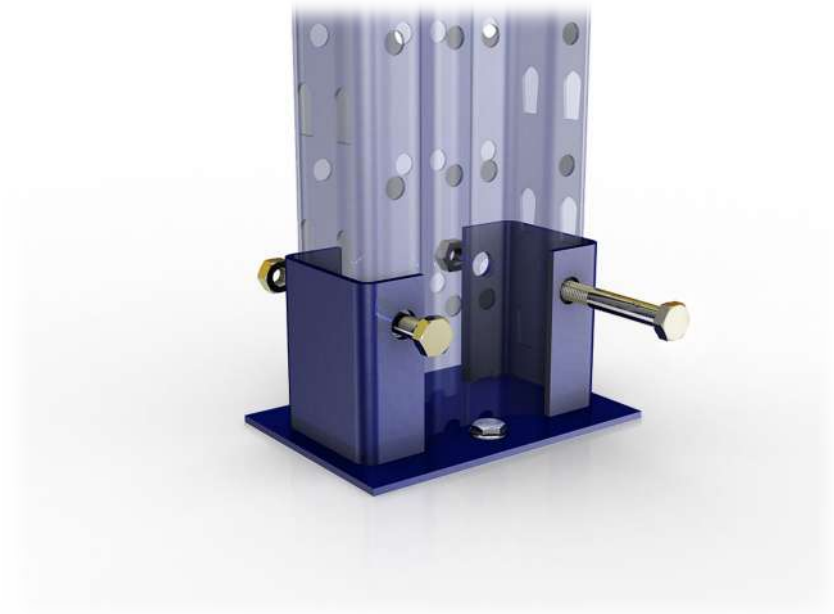
Levels constructed with single/double compartmentalised system

Upright joints. These are used when an upright's loading capacity needs to be increased at a specific point according to the system's overall configuration. They consist of commercial 50x25x1.5 mm sections, are fixed with three DIN 931 M8x65 bolts and arranged every 500 mm along the length of the upright.

Assembly and positioning of upright joints

Double base plates. These consist of one 132x92x3 mm plate and two 57x26x3 mm U-sections, with a guaranteed minimum grade of DC01, although higher grades, DC03 and DC04, may be used as per standard UNE-EN 10130.

They are designed to provide a seat for uprights connected together using the joints described above. They are attached to uprights by means of two DIN 931 M8x65 bolts and to the floor using two M10x90 anchor bolts.

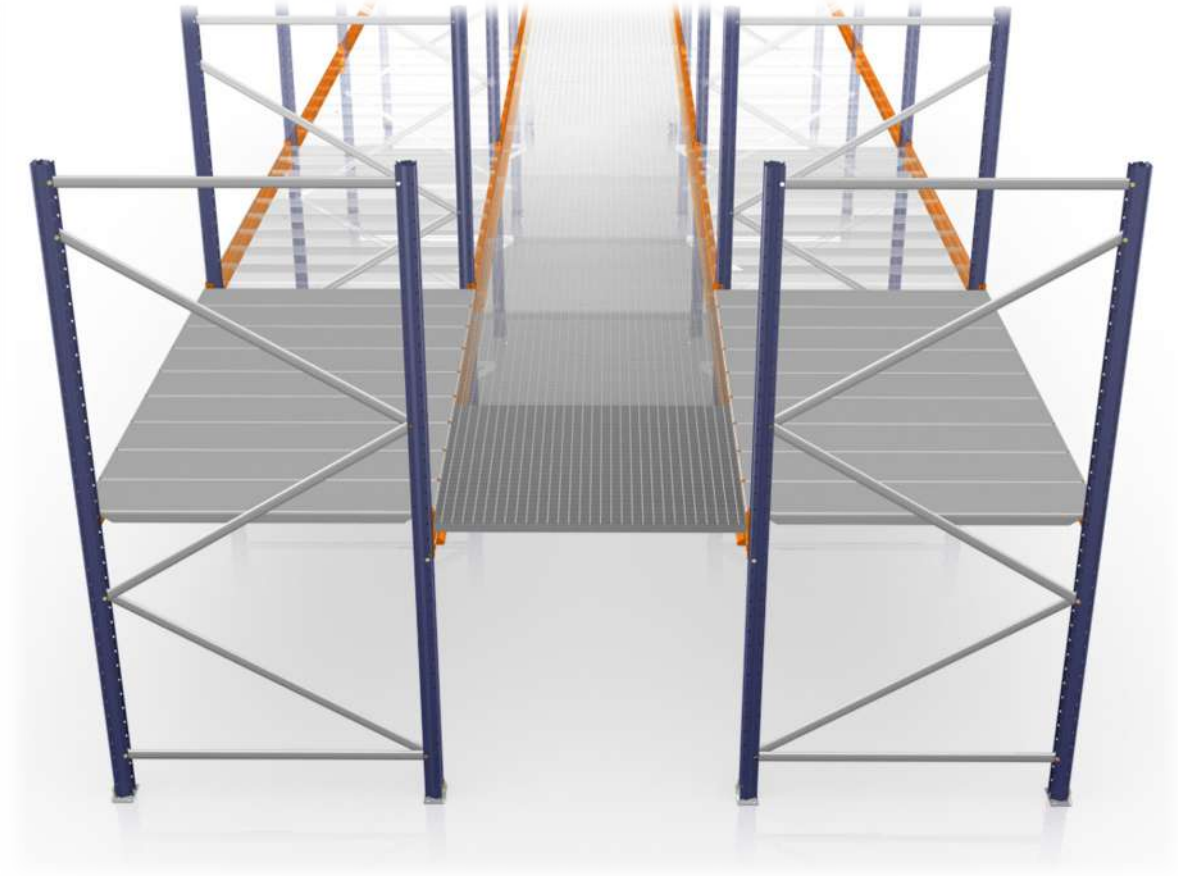


Double base plate with fastening elements for seating uprights

2.2.8. Elevated aisles and walkways

Levels designed for manually loaded shelving must be positioned at the correct height for rapid access to the load units. In order to take full advantage of the warehouse's height, but while preserving accessibility, these systems incorporate beams that can support both the load stored inside the module and the weight of an external aisle.

Intermediate aisles installed between modules allow workers and goods to circulate safely. The use of straightforward and effective anchoring systems facilitates assembly and contributes to the system's overall stability and strength.



Layout of the elevated aisle structure.

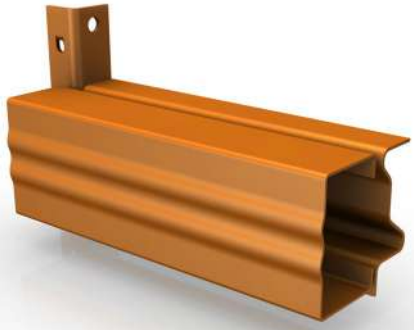
In addition to the aisles installed between modules, this type of system can be feature intermediate walkways between rows of shelving, or also perimeter accesses, providing comfortable communication between the aisles. This produces a greater flow of transit and an overall improvement in the performance of stock handling tasks.

Support structure

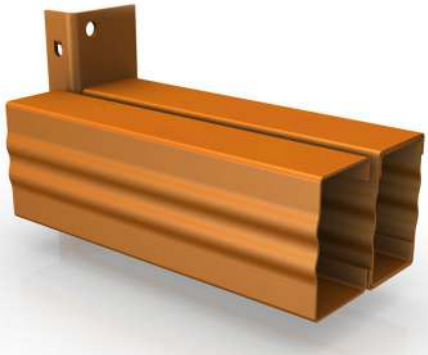
For a description of the materials and technical specifications of the different beams used to construct elevated levels, see section 2.2.5. *Beams*. The specific elements that make up the described structure and form the support for the walkable floor are shown below.

Aisle/reinforced aisle beams. Constructed from one Z-section beam with either a second Z-section or a C-section, for reinforced beams, attached to its external face. They serve two functions: internally, they create a loading level, and externally they represent a structural element for supporting the elevated aisle.

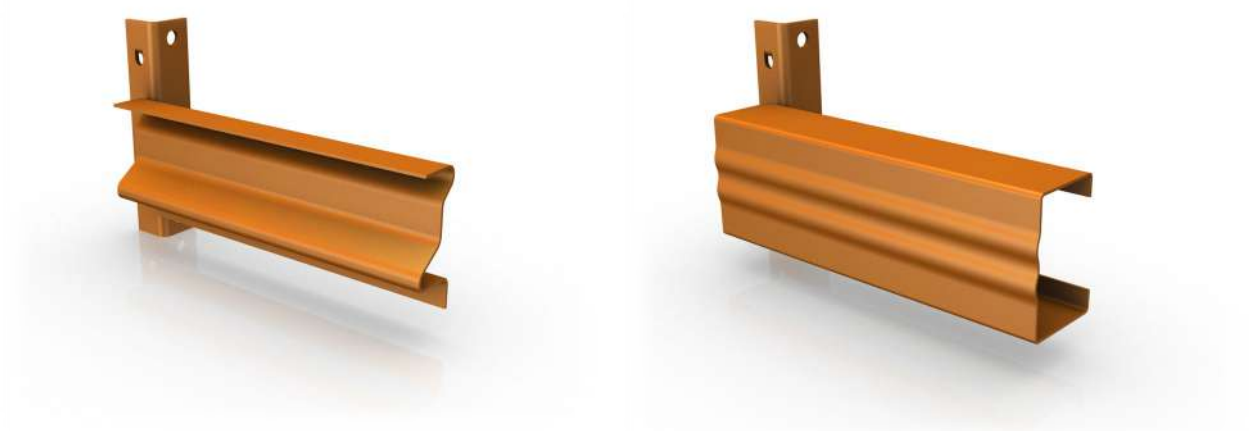

Walkway/reinforced walkway beams. Constructed from one Z-section beam with either a second Z-section or a C-section, for reinforced beams, attached to its external face. They are used to create an access walkway from one row to another.

Stairway/reinforced stairway beams. Constructed from a double C-section beam with either a Z-section or another C-section, for reinforced beams, attached to its external face. They are mainly used to support stairway bases and landings.

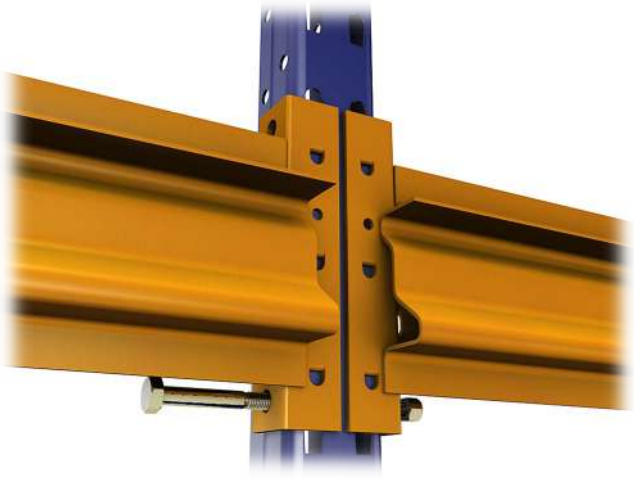



Aisle only/reinforced aisle only beams. Comprised of one Z-section, or a C-section when reinforced, welded onto the external surface of the connectors. Where necessary, these are used when an internal loading level cannot be installed but a support structure is required for elevated aisles.



End of aisle beams. Constructed from one Z-section welded onto the internal surface of the connectors. Where necessary, these are used when an internal loading level cannot be installed but a support structure is required for elevated aisles.

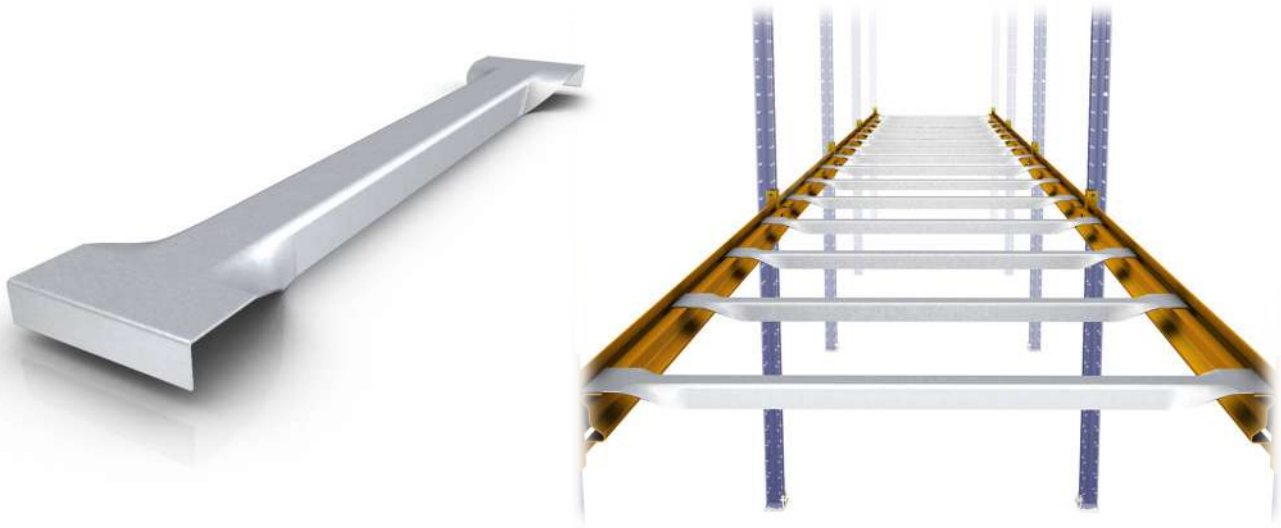
The various beams are attached to the uprights forming the aisle structure using DIN931 M8x65 bolts with self-locking nuts. This ensures the structure is fitted together correctly.



Connection of aisle beams using M8x65 bolts

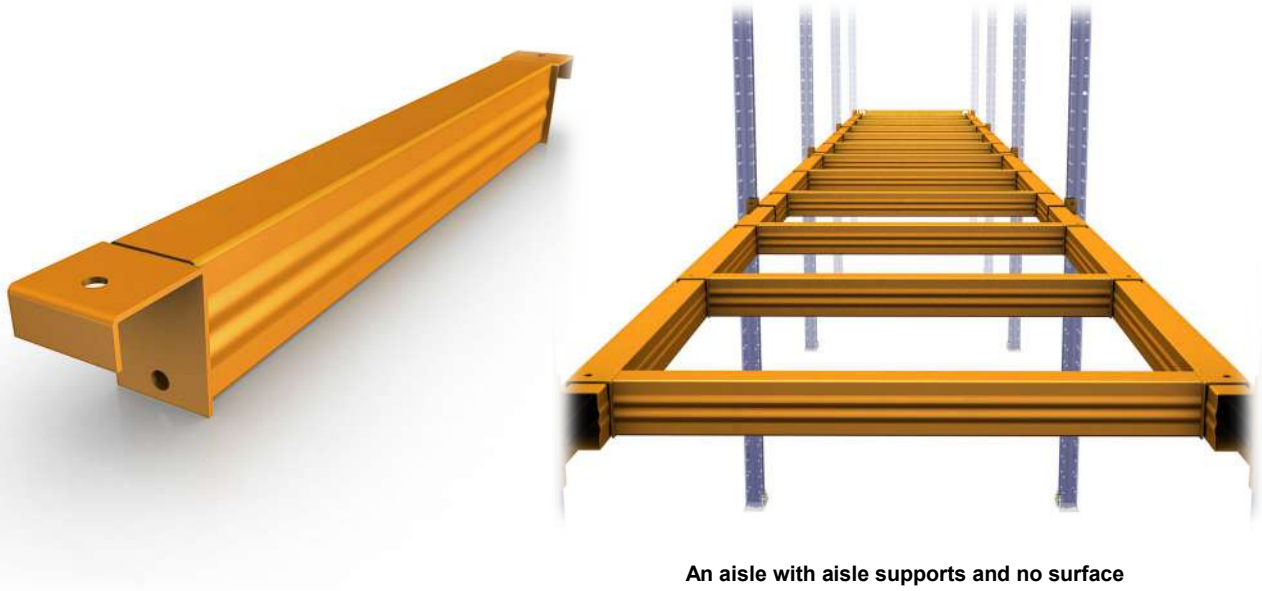
A variety of solutions can be used to construct the support structure for the walkable surfaces of elevated aisles. The choice of solution depends on the specifications of each project.

Board supports. These are fitted onto the aisle beams, without the need for any fastening elements. The separation between each support varies depending on the load-bearing requirements and the surface to be installed.



An aisle with board supports and no surface

Aisle supports. These are fitted onto the reinforced aisle beams, without the need for any fastening elements. The separation between each support varies depending on the load-bearing requirements and the surface to be installed.



An aisle with aisle supports and no surface

Without supports. When a metal deck is installed, whether coarse stamped floorboards or bar grating, and so long as it is compatible with the solution's particular specifications (e.g., load-bearing requirements and aisle

width) and guarantees the structure's strength and stability, then the surface can be fitted directly over the aisle beams.

2.2.9. Open-plan, walkable overhead loft

Taking the structure of a conventional manual loading system as a basis, this storage solution creates an overhead level with an open-plan, walkable surface and characteristics suited to the intended end use. Open perimeter areas are protected with safety guardrails and lofts can be accessed using conveniently located stairways.

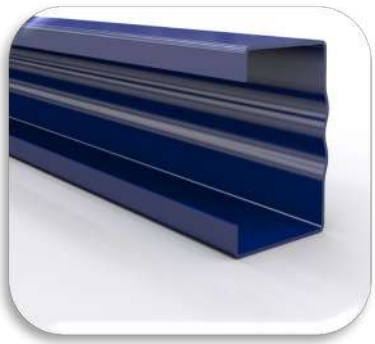
Conventional manual loading system with overhead loft

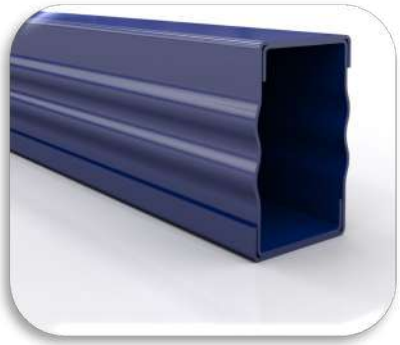
Support structure

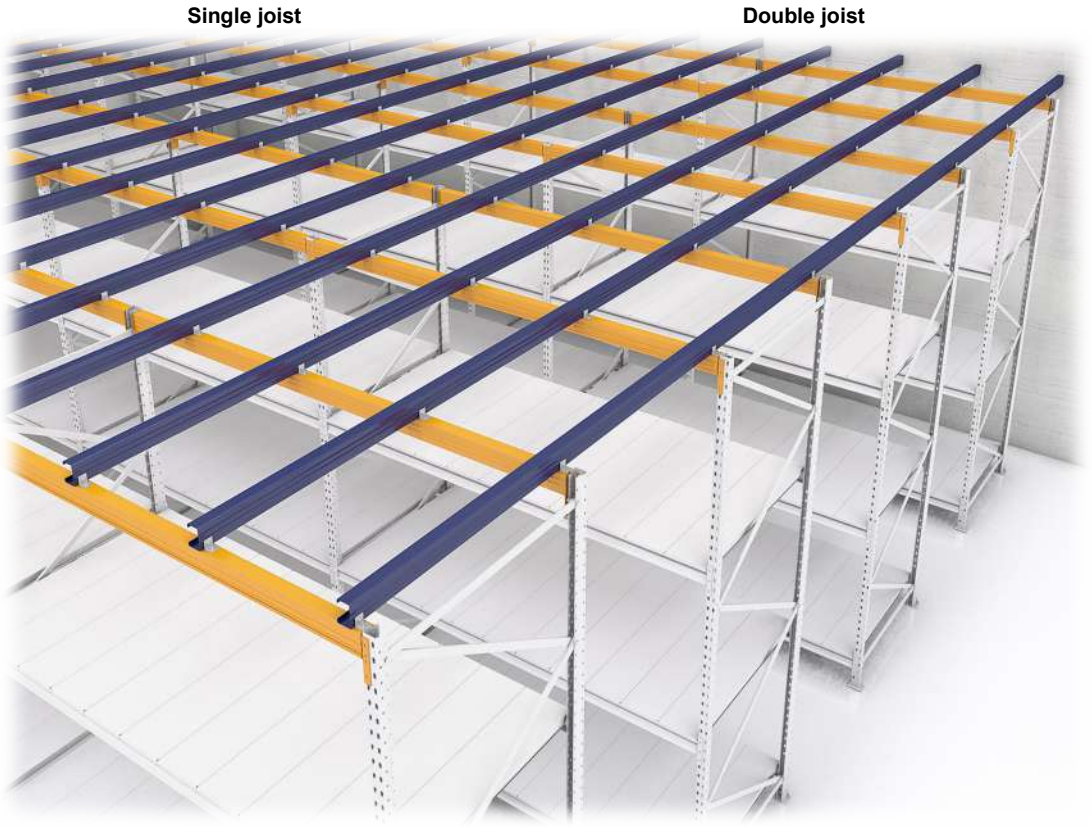
Joists, which are sections that directly support the elements forming the floor's surface, are placed on top of the overhead loft beams, see section 2.2.5. Beams.

The joists are 1.5 mm thick metal sheets folded into a C shape. They are available in different cross-sections according to loading requirements.

They may be formed from single or double C-sections depending on the loads and width of the underlying aisles. There are available in lengths of 4,000, 5,000 and 6,000 mm.



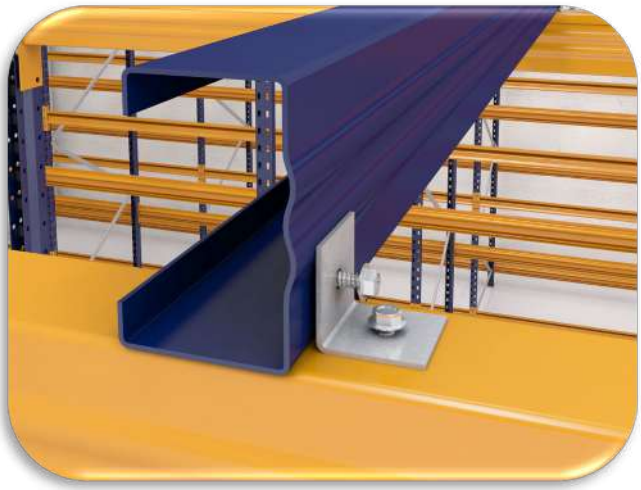




Joists layout

They are laid perpendicularly on top of overhead loft beams with the necessary spacing to ensure sufficient loading capacity and to support the loft's floor.

Joists are secured to the beams using brackets and self-tapping screws, as shown in the following diagram.



Joist Attached using a bracket

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Floor decking

Metal or fibreboard decking, depending on the intended use and load requirements, are installed to create a walkable surface for workers and storing goods in the elevated aisles and lofts.

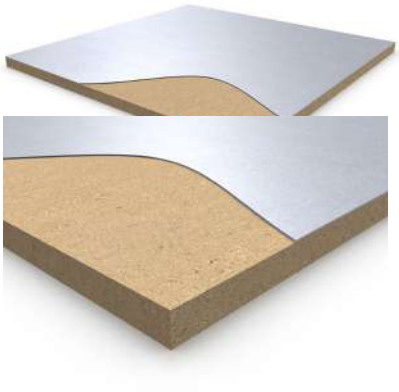
In the case of elevated walkways and aisles, the decking rests on the metal structure comprised of simple or reinforced beams, according to load-bearing requirements, or directly on aisle beams if permitted by their design and loads (metal floorboards or bar grating).

In the case of the overhead loft system, the decking materials are supported by the joists structure and positioned so that they join together exactly in the middle of the joists to guarantee a solid support.

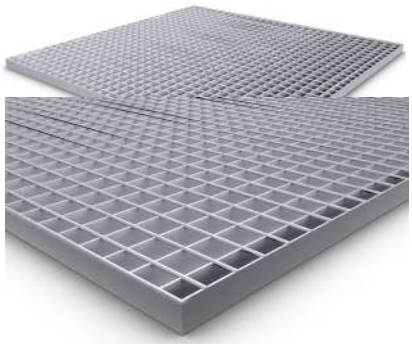
Finally, decking is assembled with the appropriate fixtures and fastenings so that it is secured correctly and to guarantee the stability and safety of the overall structure.

Fibre/melamine/medium-density board galv. plate 1.5 mm

Fibreboard with 3–5 mm tread plate



Fibreboard with 1.5 mm smooth



Bar grating

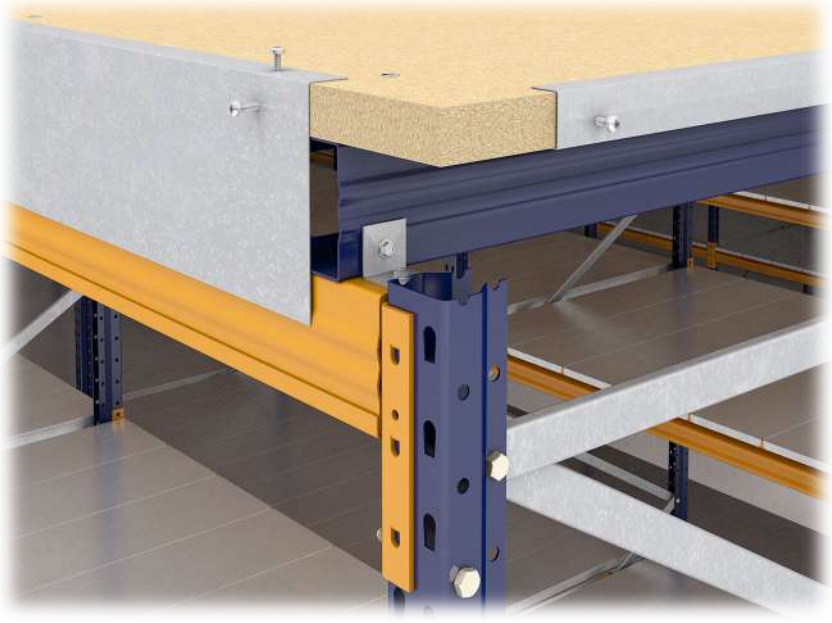
Coarse stamped floorboards

In each case the type of decking is selected according to the storage solution's technical specifications, the intended use and the functional characteristics of the loads and handling equipment used.

Similarly, the fastening method used for each loft ensures the deck is fully immobilised and the parts fit together perfectly to produce a very neat finish.

The diagram below shows the layout of the decking over the joist structure described for the walkable loft system.

Depending on the type of decking used, the exposed sides of the floor and the supporting structure are covered with board joints and/or joist covering sheets, both are secured with 4.8x25 mm sheet metal round head screws.

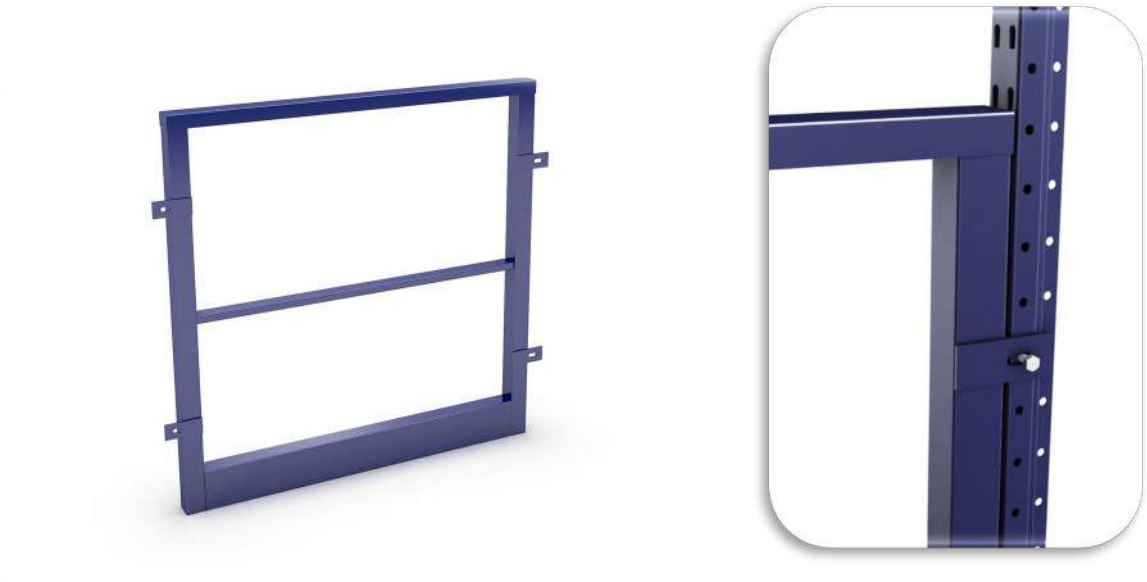


Joist covering sheets and board joints. Positioning

Guardrails

For employee safety, open areas of elevated aisles and lofts (ends of aisles, floor perimeters, openings for stairways, openings for walkways, etc.) are equipped with guardrails.

Guardrails consisting of handrails and protective railings attached directly to the sides of the frames with M8x15 nuts and bolts are generally used for the ends of aisles.



Whereas longer open ends and openings for stairways, amongst others, are usually equipped with guardrails comprised of uprights, handrails, skirting boards and 20 mm diameter protective railings running through the uprights, plus appropriate finishing elements.

Safety guardrail and close-up of finishing elements

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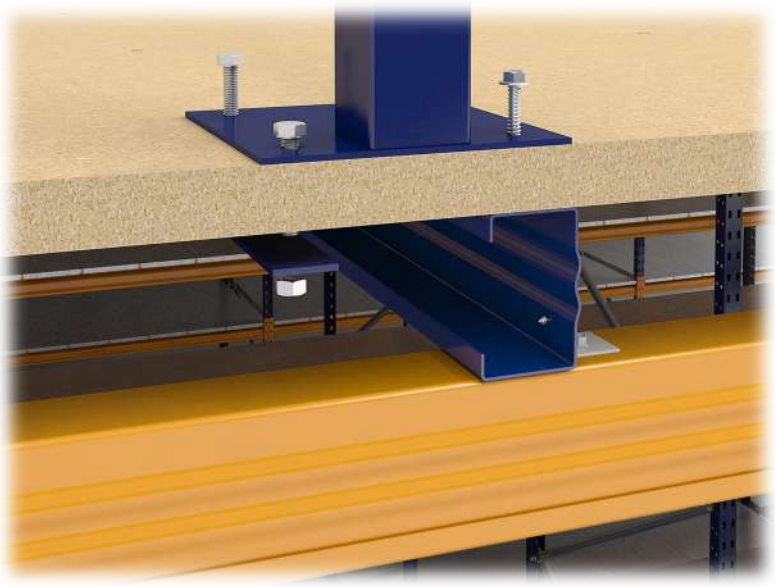
Loft guardrail uprights have a flat support base which is secured to the decking with two sheet metal screws when they are positioned over a joist or with two M8x45 bolts and a counter plate on the lower surface of the decking when they do not coincide with a joist.



Guardrail upright. Both fastening methods are shown

Opening sections can be incorporated into the safety guardrails along the loft's open sides to act as service doors, thus improving access to the storage surface and facilitating goods handling operations.

Hinged door in loft guardrail

Stairways

Elevated surfaces are connected to the ground level using stairways that provide a safe means of access. Stairways are conveniently located for rapid, comfortable transit without reducing the structure's load-bearing capacity.

The demountable stairways are comprised of two stringers, made from cold-rolled steel U-sections, to which the treads and handrails are bolted. Handrails run along the top of the handrail uprights, while there is a 20 mm diameter protective railing running through these uprights. Stairway structures also feature appropriate finishing elements.

The treads are made from galvanised sheet metal and have round bumps stamped on their upper surface to improve grip.

2.2.10. Fastening elements

Shown below are the different types of fastening elements used to assemble the structures described above.

Safety pin

M8x15 nut and bolt

M10x20 nut and bolt

M8x65 nut and bolt

M12x100 anchor bolt

M8x45 nut and bolt

4.8x25 / 6.3x60 sheet metal screws

5.5x60 self-tapping screw

4.8x25 sheet metal round head screw

3. TECHNICAL REPORT

Calculation standards

The design and calculation procedures set out in pre-standard FEM 10.2.06-2 “Hand Loaded Steel Static Shelving”, which in turn conform to standards EN 1990, EN 1993-1-1 and EN 1993-1-3, have been taken as a reference when dimensioning the shelving system for conventional manual loading. The system’s design takes into account the tolerances, deformations and clearances specified in standard EN 15620 and the operational requirements described in standard EN 15635.

Static stability and elastic stability verification, and stress and deformation calculations shall be based on mechanical methods and, in general, the theory of elasticity, which occasionally and implicitly admits local states of plastic strain.

Mechanical testing

Application of the standards implies the need to test both the individual components and the assemblies that make up the structure’s configuration. These tests have been conducted by Laboratori d’elasticitat i Resistència de Materials (LERMA), at the Barcelona School of Industrial Engineering.

Calculation method and conditions

The structural designs were carried out using finite element analysis by applying second-order calculations and considering geometric nonlinearity. The elastic–plastic behaviour of semi-rigid beam–upright and upright–floor connections was also considered.

In particular, the following concepts were observed:

1. Characteristic actions and analysed actions. Their values have been taken according to specific needs; the values considered derive from the application of the safety coefficient established in standard EN 15512.

2. Permanent actions. The structure’s own weight is included in the calculation.

3. Variable actions. The following actions are taken into account:
    a. Overload due to stored materials.
    b. Local imperfections. Buckling effects acting on the uprights subject to compression are considered in the calculation by introducing eccentricity.
    c. Overall imperfection. Horizontal stresses equivalent to 1/200th of the vertical load being stored (according to standard EN 15512) are considered to simulate an out-of-plumb structure and/or load or defects in the material.
    d. Placement loads. The least favourable placement of the load (highest loading level) is determined according to recommendations in standard EN 15512.

4. Static actions. As an initial assumption, loads are considered static and uniformly distributed over each structural element.

5. Dynamic actions. Dynamic loads are not considered in the structural calculation.

6. Structural safety conditions. A double action is considered: an increase in the amount of load to support by means of a load amplification factor and a decrease in the steel’s yield strength by means of a load reduction factor, according to standard EN 15512.

7. The design contemplates the tolerances, deformations and clearances, including interactions with the floor, in accordance with standard EN 15620. The user must ensure maintenance of the appropriate parameters for the installation's safe operation.

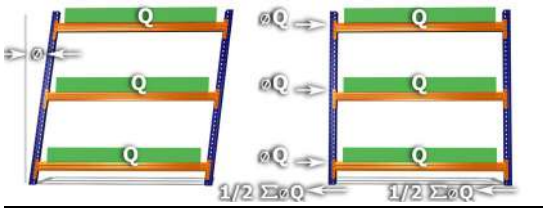
8. Seismic, thermal and wind actions are not considered in the system's calculation.

Structure stability

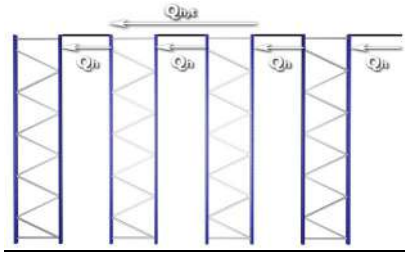
To dimension the manually loaded shelving system correctly, a study was carried out with two calculations corresponding to the two main directions: longitudinal and transverse. These two calculations are independent and cannot be combined.

Longitudinal stability. The longitudinal direction is taken as the direction parallel to the storage system's aisles. The connection between the beam connector and the upright provides a level of coupling that guarantees the assembly's longitudinal stability.

Transverse stability. The transverse direction is understood to be the direction running perpendicular to the storage system's aisles. In the transverse direction, stability derives from the horizontal and diagonal bracings on the frames which consequently behave like trussed girders. All the elements are fixed to the floor, depending on their magnitude, with expansion anchor bolts.



Longitudinal stability



Transverse stability

Load assumptions have been defined according to the directives in standard EN 15512 and the aforementioned calculation conditions, while verifying the strains, deformations, and longitudinal and transverse stability in consideration of the permanent and variable loads acting on the structure.

The maximum allowable deformation in beams is set to 1/200th of their length (L/200), in accordance with the indications of standard EN 15620.

Furthermore, the maximum allowable lateral deformation or displacement for the system's uprights is fixed at 1/200th of their height (H/200), according to the same standard.

To a large degree the safety of the racking system will depend on the characteristics, physical condition and evenness of the surface where it is installed. According to European standard EN 15629, it is essential that the floor can support the planned loads and intended use. The customer must ensure the floor meets the requirements for the particular project.

4. LOADING CAPACITIES

Cross-section 50x53x1.5	
Maximum separation between	**Allowable load**
from 200 to 500 mm	7,000 kg
from 500 to 1,000 mm	6,300 kg
from 1,000 to 1,500 mm	5,400 kg
from 1,500 to 2,000 mm	4,300 kg

Nominal load capacity of frames ≥ 4,000 mm

The loading capacities for frames presented in the previous table are limited not only by the load units, but also by the distance between levels, the buckling height (measured from the floor to the first level), the self-weight of the beams in all the loading levels and, where applicable, the accessories installed on the levels (beams, wood or fibreboards, bar gratings, retainers, stops, grills, fall arrest netting, etc.).

In addition, the self-weight of the load-bearing elements (metal panels, wood or fibreboards, bar gratings, etc.) must be subtracted from the maximum loads of goods to be placed on each level (pair of beams) indicated in the following table. Maximum loads per level will also depend on the total number of levels allowed in function of the frame configuration's total load capacity, the reduction associated with the weight and the use of the elevated aisle or overhead loft installed.

	Length ND (mm)						
	1,000	**1,200**	**1,400**	**1,600**	**1,800**	**2,200**	**2,600**
Z80 section	1,600	1,270	1,040	920	720	610	420
Z60 section	944	752	621	527	456	358	
D55 section	834	710	520	400	315	210	
Hanger beam	600	550	500	450	400	350	

Nominal load capacity per level (pair of beams)
Maximum loads uniformly distributed over two beams. Maximum deflection l/200

In light of the above, the load-bearing capacities reflected in the previous two tables must be taken as preliminary and only for reference purposes, given that they will be adjusted according to load and usage limitations which, in any case, must be determined and observed in each project designed by Estanterías Record. In function of these limitations, the result of calculations will take priority, regardless of the nominal load capacity expressed in the above tables.

5. GUARANTEE

Estanterías Record, S.L. guarantees the supplied materials against all manufacturing and assembly defects for a period of 5 YEARS, so long as installation and maintenance services are performed by teams allocated by Estanterías Record.

In the event these circumstances are not met, the period of guarantee will be 1 year and will only cover manufacturing defects in the elements that constitute the storage system.

If assembly is contracted through Estanterías Record, the start date of this guarantee period will be taken as the date when assembly is completed and handover of the storage system is approved. However, if it is assembled by a third party, then the guarantee period will start from the materials delivery date. In either case, the term will elapse regardless of whether or not the storage system is put to use.

This guarantee only extends to the materials supplied for each specific storage system and is only valid under the following circumstances:

- All of Estanterías Record's instructions contained in the documentation provided to the customer and manuals delivered with the storage system have been followed.
- The storage system has been used in compliance with the original design and intended use, and within the levels of service for which it has been configured pursuant to the specifications in the accepted offer.
- The storage system must be free from any modifications or alterations to the initial assembly, design, function or application, and substitutions or repairs to any components, unless they have been performed with Estanterías Record's prior written consent.
- Appropriate maintenance and technical inspections, as recommended by Estanterías Record, have been completed.
- Any defects detected by the customer must be reported within a maximum of 24 hours, this includes damage or circumstances that could compromise the storage system's stability; furthermore, the customer must have followed any instructions relating to the matter provided by Estanterías Record.
- The customer has fulfilled all the obligations and responsibilities they must undertake pursuant to the contractual relationship.

During this guarantee period Estanterías Record will repair or replace any components that present serious manufacturing or assembly defects. Normal wear and tear resulting from the system's use and the passage of time are not covered by this guarantee. Repairs will be carried out in the shortest time possible and in accordance with the availability of the necessary personnel.

This guarantee will cover the replacement materials and costs of labour. Withdrawn materials will become the property of Estanterías Record.

The following points are excluded from the guarantee will be invoiced separately:

- The materials and labour used to repair or replace materials damaged as a result of their exposure to aggressive, corrosive, inappropriate or exceptional environments that were not originally planned for. Similarly, the guarantee will not extend to elements or the repair of storage systems located outdoors or subject to the action of atmospheric agents or meteorological phenomena.
- The materials and labour required to resolve damage caused by third parties due to inappropriate use or maintenance, the negligence of warehouse operatives or modifications on the storage system performed without Estanterías Record's consent.
- Interventions to repair damage caused by blows, fire, water, theft, exceptional occurrences or any other acts of God or force majeure.

6. STANDARDISATION AND CERTIFICATIONS

The technical report referred to the reference standards for the calculation and development of storage systems designed by Estanterías Record.
These assemblies are load-bearing metal structures for storing goods with various means of access and logistics management. As stated previously, the assembly of the system's basic components, uprights and beams, using specific connectors, produces three-dimensionally stable structures with intervening aisles that provide access to the storage locations. The main components, while they are only standard pieces for each manufacture, differ from traditional gantry structures, with regards to the standardisation of their design, because the uprights are perforated along their entire length, connections are made with coupling fixtures and their structural elements are generally made from thin-walled, cold-formed sections.

Due to the design characteristics of the structural components, details and types of connection, the EN standards require further technical information in addition to requirements demanded by the Eurocodes. The Eurocodes are universal European regulations drafted under consensus based on the interests of the national administrations with respect to each point and therefore they have a higher status than national regulations; they are designed as a comprehensive and updated framework for structural design and are applicable to storage systems.

The European standards (EN) are developed by CEN technical committees (TCs) whose scope is to establish the EN reference standards for the specification, design, installation methods and accuracy in assembly, while also serving as a safety guide for storage system users.

When this is combined with the need for harmonised standards it explains why the European Materials Handling Federation (FEM) decided to take the initiative from Technical Committee CEN/TC 344, Steel static storage systems, and draft a number of European standards regarding specific types of storage system and their particular applications; these now exist as European standards (EN) and working group (WG) activities. CEN/TC 344 Steel static storage systems is directly related to CEN/TC 250 Structural Eurocodes, CEN/TC 135 Execution of steel structures and aluminium structures and CEN/TC 149 Power-operated warehouse equipment. *Safety.*

Since the storage system is a load-bearing structure, there are national regulations that require it to be considered "work equipment" and consequently it must comply with European Directive 89/391/EEC, on the introduction of measures to encourage improvements in the safety and health of workers at work.

Lastly, all of these regulations must be applied in accordance with the provisions of standards EN 1990 Basis of structural design, EN 1991 Actions on structures and EN 1993 Design of steel structures.

The numerical values applicable to the partial safety factors provide an acceptable level of certainty, assuming the work is executed in accordance with appropriate quality standards.

Estanterías Record strictly fulfils the technical regulations applicable to the design and supporting calculations for our products and services. What is more, our business processes conform to mandatory sectoral, national and international regulations as they comply with applicable guidelines regarding normalisation and legislation.

Furthermore, we systematically apply the directives laid down by ISO 9001:2008 concerning quality control, assurance and management systems to our procedures involving design, development, manufacturing, installation and after-sales service. Our company registration certificate is issued by TÜV International Rheinland, under licence for use number 0.04.03229. TÜV performs regular follow-up audits to ensure the operational performance of our ISO system and verify the aforementioned standard is implemented correctly.

As approved systems must meet the highest technical demands in terms of design, guidelines for testing, calculation, manufacturing, etc., then it culminates in more solid and reliable structures. This contributes to increased safety for the stored goods and above all it is beneficial for the storage system's end user because it will minimise handling risks in day-to-day warehouse management.

The possession of a storage system developed according to the strictest regulations applicable implies a high degree of security and confidence in the event of demands for accountability or other procedural matters involving insurance companies, financial entities, public bodies, health and safety inspections, etc.

Finally, Estanterías Record is a member of the FEM-AEM. The purpose of the FEM-AEM (Spanish Material Handling Association) is to collaborate with national and EU bodies in matters concerning the regulation, improvement and unification of its sector, while also cooperating with partner countries and European manufacturers.

As explained above, Estanterías Record is evidently very committed and engaged in terms of meeting the sector's most stringent requirements so we can offer the market products of the highest quality, safety and guarantee.

FEM AEM
Asociación Española de Manutención

TÜV
TÜV Internacional Grupo TÜV Rheinland
UNE-EN ISO 9001:2008
Nº 0.04.03229

F.E.M.
European Materials Handling Federation

FEM AEM Asociación Española de Manutención
ASOCIADO
Nº 44/70 Certificado acreditativo de empresa asociada a FEM-AEM (Comité Nacional de FEM)
FEDERATION OF EUROPEAN MATERIALS HANDLING

7. AFTER-SALES SERVICES

Storage systems suffer wear and tear through continuous or incorrect use, thereby reducing the functionality and load-bearing capacity for which they were designed, and significantly increasing the risk of accidents. Damaged components or which have received blows, even though the damage may not be visible, can generate dangerous stresses that could even result in its, occasionally, instantaneous and sudden collapse.

The user is responsible for ensuring that their storage system is in good condition and proper working order. To assist in this respect, Estanterías Record can, upon request, provide their customers an inspection and revision service for the installed equipment in order to carry out appropriate preventive or corrective maintenance and minimise these risks.

Additionally, we can: offer our customers advice on the correct use of their storage system regarding safety or what to do in case of accidents; provide them with technical and training manuals covering maintenance; monitor and assess preventive maintenance tasks carried out by the user; perform any corrective interventions that may be required, etc.

Standard EN 15635 concerning “Steel static storage systems. Application and maintenance of storage equipment” establishes the need for storage systems to be inspected at least once a year by an external professional expert.

Given the important consequences that could result from this situation, Estanterías Record recommends that users take note of the above and act diligently in this regard.