estanterías record

Efficient storage systems

PRODUCT TECHNICAL FILE

CANTILEVER

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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 CANTILEVER RACKING system.

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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The information in this document may be altered without prior notice because of changes related to the products' manufacturing characteristics, because of technical or functional obsolescence of certain elements which may be replaced with others, or because of other adequately justified modifications which have a direct or indirect impact on the content of the text.

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 columns, bases, bracings and load arms. These and some other components are described in more detail below.

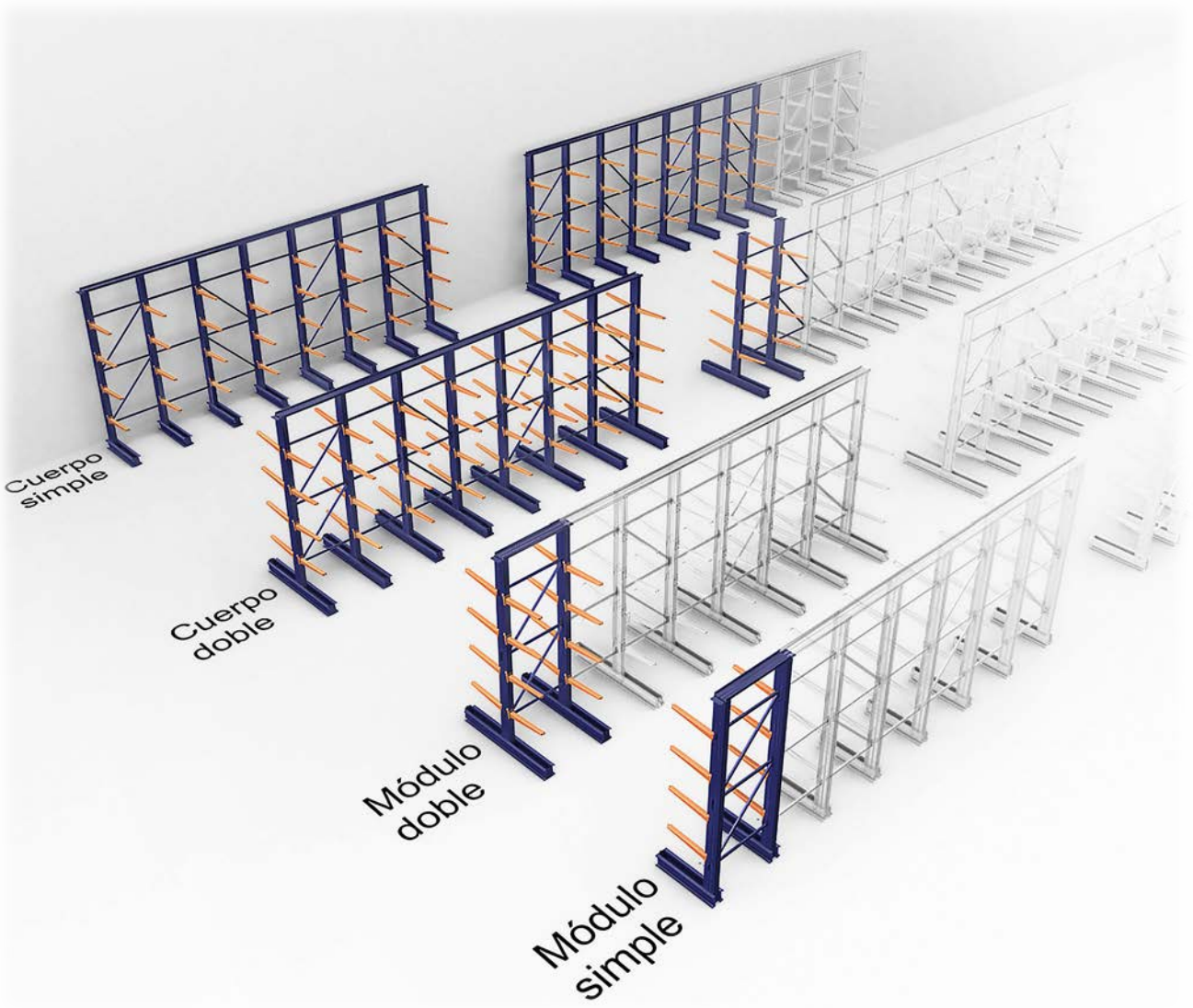
Each column has a left and right base (with the same specifications) attached perpendicularly at ground level, thus forming an L-shaped structure. These column-base assemblies are trussed together in pairs in the vertical plane using horizontal and diagonal bracings to stiffen the structure.

Load arms are evenly distributed along the height of each column. Each pair of arms on two adjacent columns, or more if the load requires, constitutes a loading level.

The volume between two loading levels defines the maximum space available and the acceptable dimensions and quantity of unit loads per level.

Each structural unit comprised of two columns, their bases and various loading levels is called a module.

Modules are combined to form single or double longitudinal structures called blocks. Single blocks, often perimeter structures that are usually fixed to the building's walls, are single access storage systems because the load arms can only be reached from one side of the columns; double blocks comprise rows of double access modules, i.e., their loading levels can be accessed from both sides of the columns.



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 product can be located quickly and accessed directly and immediately, thus ensuring an intensive flow of stock rotation. Flexibility of use saves time and effort, thereby preventing warehouse management errors.

- Cantilever racking systems are especially suitable for awkwardly shaped loads that cannot be stored in conventional racks or grouped together on pallets. They are designed to store long items, such as tubing, different metal sections, sheets, furniture, irregularly sized and/or shaped materials, etc.

- Easily adapted as requirements change. The height of the arms can be changed quickly and easily, while their wide range of dimensions means the configuration can be adapted for use with loads of all weights and volumes.

- Strict stock control. Each location corresponds to a selectively and immediately accessible and identifiable item; there is no need to move loads to handle the required products. This also helps streamline inspection and inventory tasks.

- 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. Furthermore, damaged components can be replaced easily and immediately.

- The structure is designed so that none of its elements impede load handling; it does not need to be secured to any of the building's existing structural elements because, thanks to its physical characteristics, it functions independently and does not need to transfer forces.

- Versatility of use. The system's configuration options mean the racks can be used in coordination with any type of handling equipment used in the warehouse según las distintas casuísticas (transpaletas, carretillas elevadoras contrapesadas, retráctiles, trilaterales, etc.) This guarantees the most profitable use of the system.

- The construction system provides a vertically efficient logistics management system by 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 cantilever racking system 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 system's design guarantees the structure bestows absolute stability. The welding and fastening methods employed result in very strong connections that ensure the structure has the necessary stiffness for the service conditions it will endure.

The following diagrams provide an example of the design:

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 structure is determined directly by the quality of steel used in their construction and by the physical characteristics of each configuration in response to elastic instability phenomena associated with the individual elements and their combinations to form this type of structural system.

2.1.1. Steels

The quality 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	$E = 210000\ N/mm^2$
Shear modulus	$G = E/2(1+\nu)\ N/mm^2$
Poisson's ratio	$\nu = 0.3$
Coefficient of linear thermal expansion	$\alpha = 12 \times 10^{-6}\ ^{o}C$
Density	$\rho = 7850\ Kg/m^3$

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

The columns, bases and bracings are painted blue (RAL 5003), the arms orange (RAL 2009) and all other components are made from galvanised steel.

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. Columns

The posts are the structure's basic vertical elements. Each column comprises two C-sections with their open sides facing each other, two anchoring plates and double or triple bracing connectors, all join together using welding and specific fastening elements.

They support the loads located in the system's horizontal levels and transfer their weight through the structure's base and into the floor. The columns have holes drilled in their sides every 100 mm which are used to adjust the loading levels at these intervals and along the full height of the columns.

Their details are specified below:

C-section. Formed from cold-rolled S-355-JO steel in accordance with standard UNE-EN 10025. The sections have dimensions of thickness t and cross-section "A", appropriate for the loads the structure must support.

The diagram below provides details of these dimensions:

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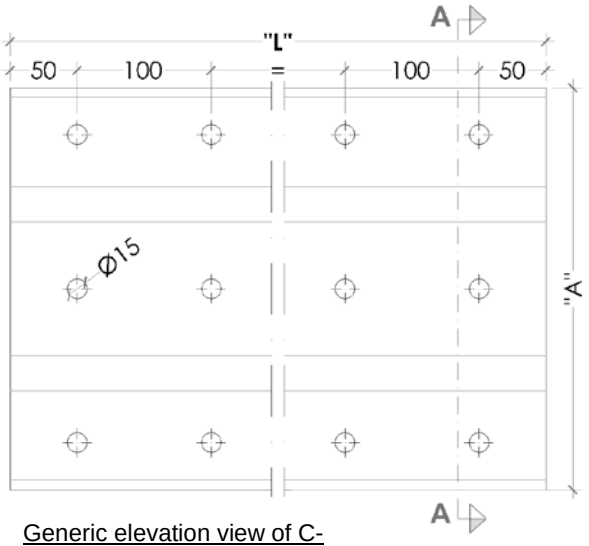
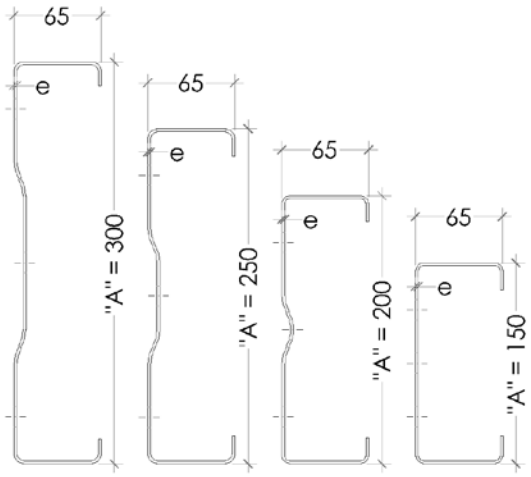


Generic elevation view of C-section
L = length of section

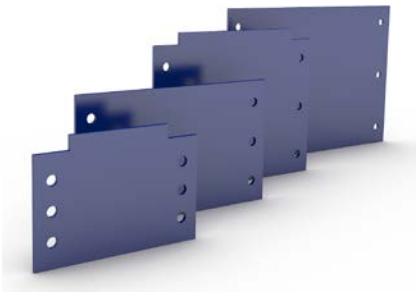


A-A cross-section of C-sections
e = 2, 2.5, 3 or 4 mm

C-sections

Column anchoring plates. These are made from steel plates with a guaranteed minimum grade of DC01, while higher grades, DC03 and DC04, may be used as per standard UNE-EN 10130. They have a minimum thickness of 6 mm. They serve to position and secure the bases, both single and double bases. Two plates are attached to each column, one on either side.

Double/triple bracing connector. These are constructed from steel plates with a guaranteed minimum grade of DC01 in accordance with standard UNE-EN 10130. They have a minimum thickness of 3 mm. The connectors provide a point of attachment for fixing the horizontal and diagonal bracings installed between columns. The quantity, arrangement and type (double or triple) depends on the height and type of column.

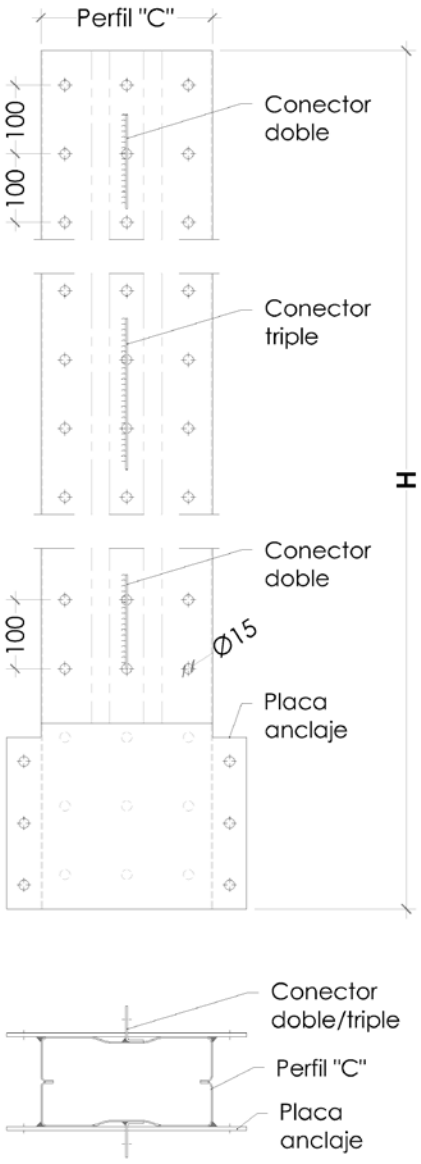


Anchoring plates

Double connectors

Triple connectors

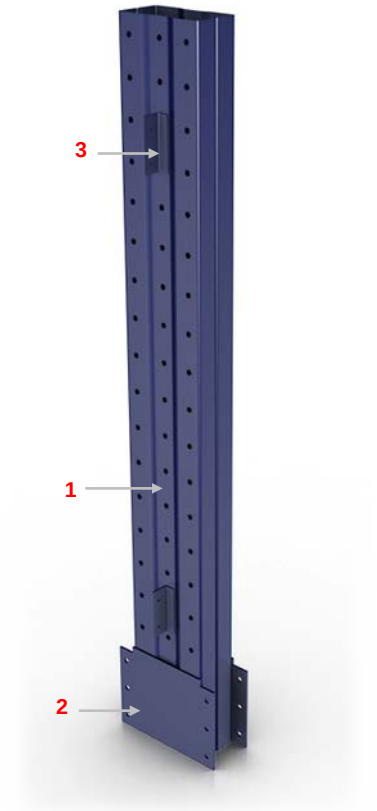
The tables and diagrams below describe the heights of columns available for cantilever racking systems and illustrate their structures:



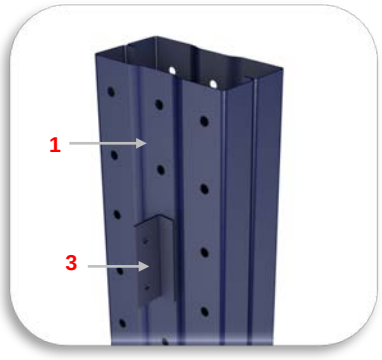
Generic plan and elevation views of columns

Height H	Height H	Height H
2,000	4,000	6,000
2,500	4,500	6,500
3,000	5,000	7,000
3,500	5,500	7,500

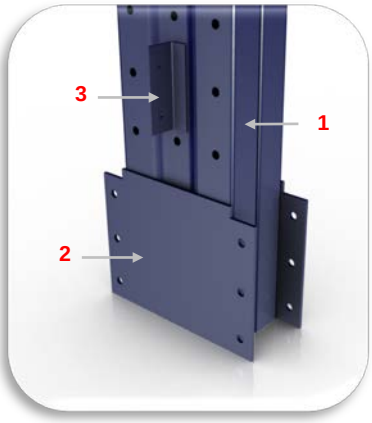
Dimensions in mm



Column



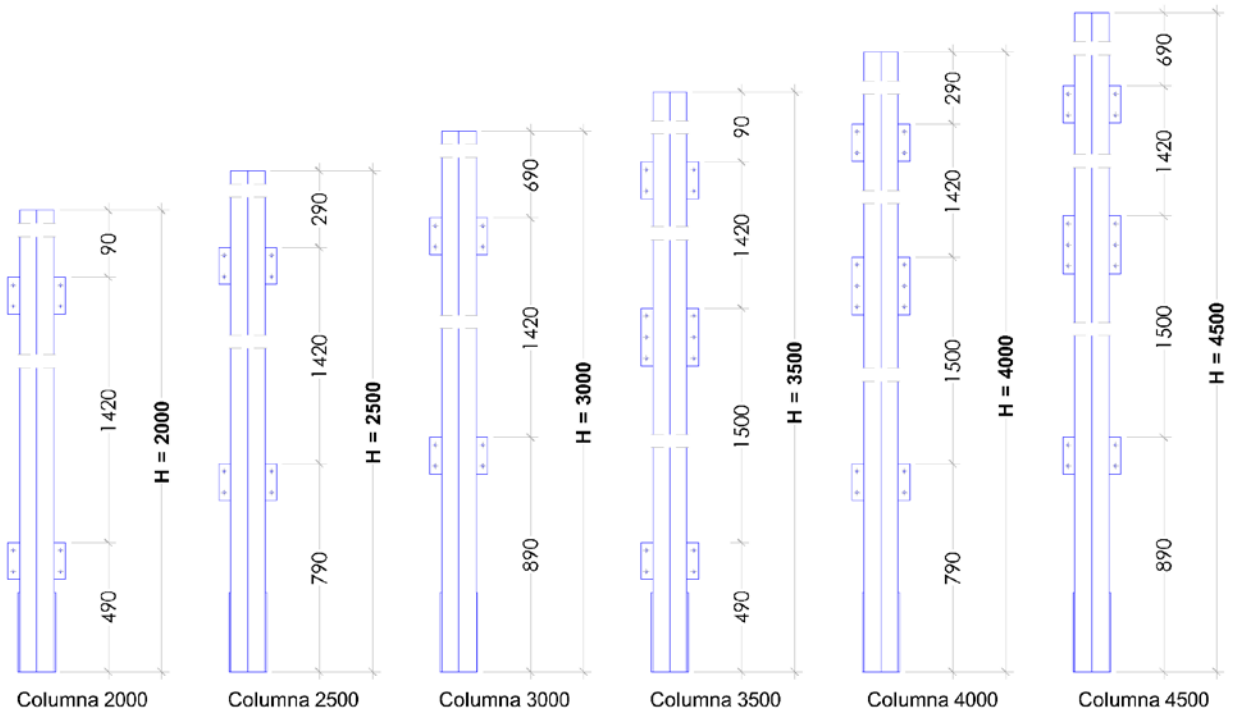
Top of a column

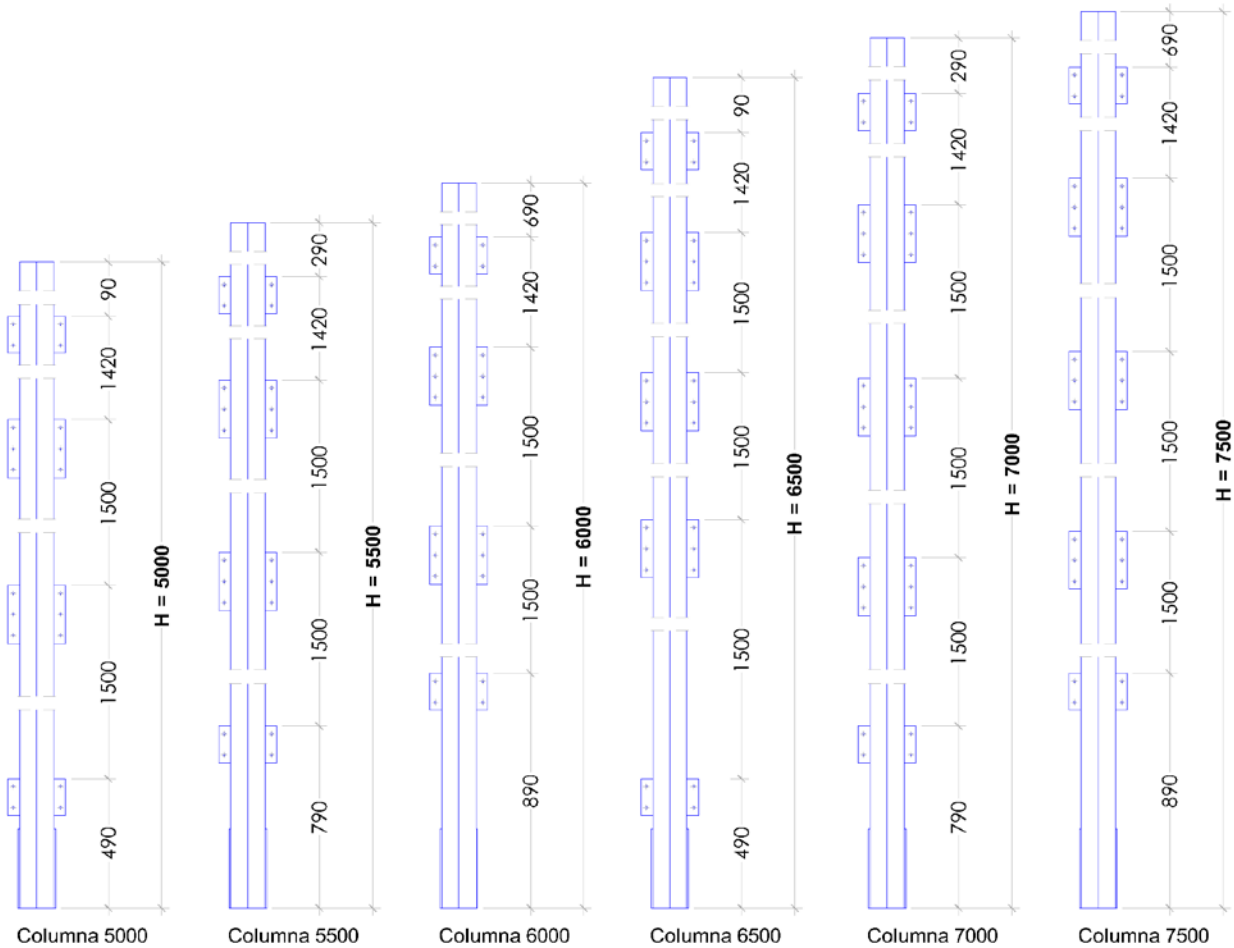


Bottom of a column

No.	Description
1	Column
2	Column anchoring plate
3	Double or triple bracing connectors

The arrangement of column elements and the composition of their assembly are detailed below for each height available:


90
1420
490
H = 2000
Columna 2000
290
1420
790
H = 2500
Columna 2500
690
1420
890
H = 3000
Columna 3000
90
1420
1500
490
H = 3500
Columna 3500
290
1420
1500
790
H = 4000
Columna 4000
690
1420
1500
890
H = 4500
Columna 4500


90
1420
1500
1500
490
H = 5000
Columna 5000
290
1420
1500
1500
790
H = 5500
Columna 5500
690
1420
1500
1500
890
H = 6000
Columna 6000
90
1420
1500
1500
1500
490
H = 6500
Columna 6500
290
1420
1500
1500
1500
790
H = 7000
Columna 7000
690
1420
1500
1500
1500
890
H = 7500
Columna 7500

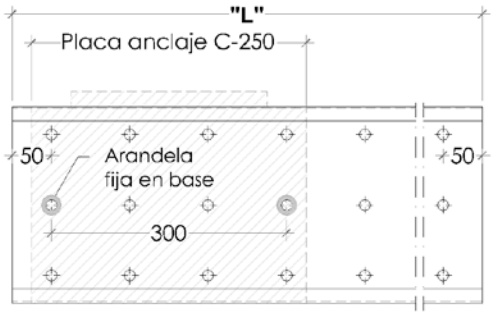
2.2.2. Bases

These are the structure's basic horizontal elements. There are comprised of the same C-sections as the columns but positioned perpendicularly at the base of the columns and flush with the floor.

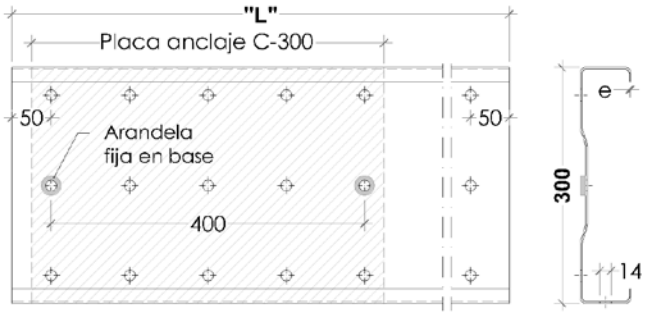
Their purpose is to transfer and distribute the strain from the load to the floor and stabilise the system.

Depending on the planned functionality of the system, bases may be single, for single access blocks, or double in the case of modules and blocks accessible from both sides of the structure. In the former case, loading levels are only installed on one side of the columns and these configurations are normally used around the storage system's perimeter or next to the building's walls. In the second case, loading levels for goods storage are installed on both sides of the columns and these configurations are normally used in the storage system's central blocks.

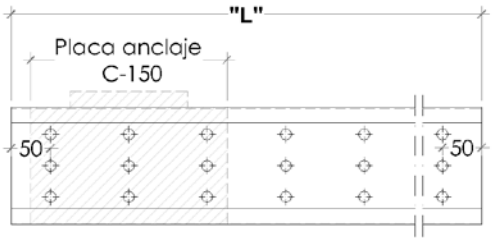
Left/right single base. For single access cantilever racking systems, each column is connected to two bases, one on each face forming an L-shaped configuration, with the aid of anchoring plates and six grade 8.8 DIN 933 M14x30 bolts.



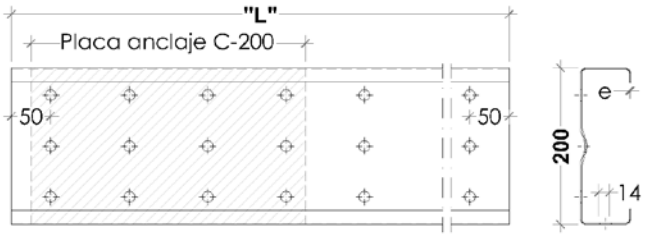
Elevation and cross-section, single base



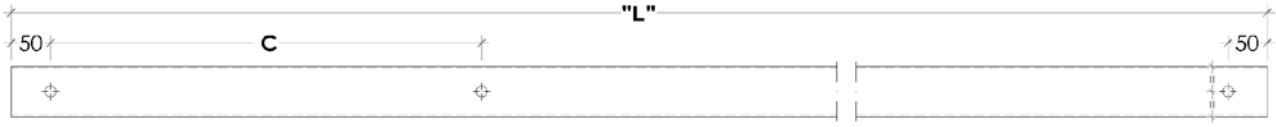
Elevation and cross-section, single base



Elevation and cross-section, single base



Elevation and cross-section, single base 200



Generic plan view, single base (lt./rt.)

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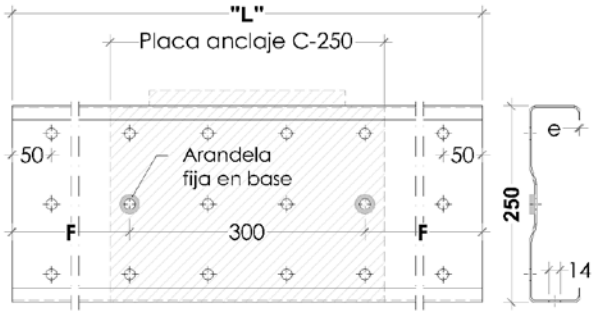
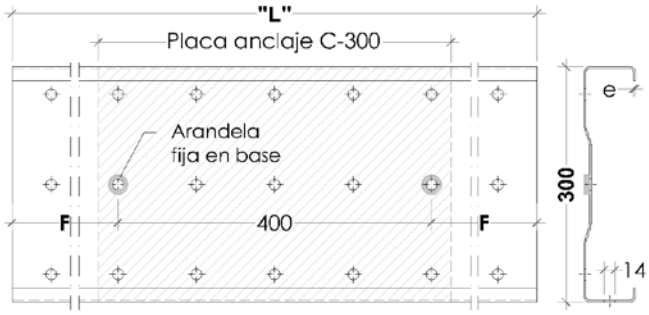
Nominal	C-sections							
	C-150		C-200		C-250		C-300	
	"L"	C	"L"	C	"L"	C	"L"	C
500	800	200	800	300	900	300	900	400
600	900	200	900	300	1,000	300	1,000	400
700	1,000	200	1,000	300	1,100	300	1,100	400
800	1,100	200	1,100	300	1,200	300	1,200	400
900	1,200	200	1,200	300	1,300	300	1,300	400
1,000	1,300	200	1,300	300	1,400	300	1,400	400
1,100	1,400	200	1,400	300	1,500	300	1,500	400
1,200	1,500	200	1,500	300	1,600	300	1,600	400
1,300	1,600	200	1,600	300	1,700	300	1,700	400
1,400	1,700	200	1,700	300	1,800	300	1,800	400
1,500	1,800	200	1,800	300	1,900	300	1,900	400

Lengths of single bases. Dimensions in mm

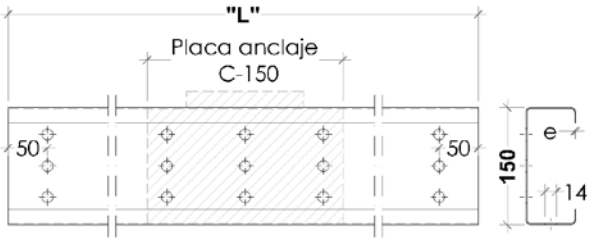
Double left/right base. When the cantilever system is accessed from both sides, each column is connected to two bases, one on each face forming an inverted T configuration, with the aid of anchoring plates and six grade 8.8 DIN 933 M14x30 bolts.



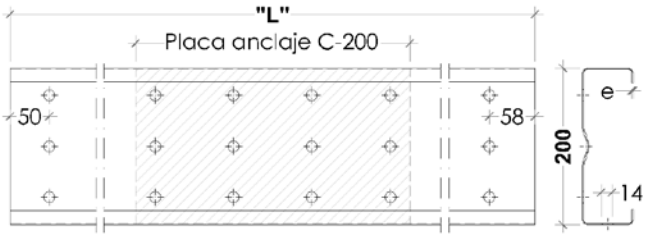
Elevation and cross-section, **double base**



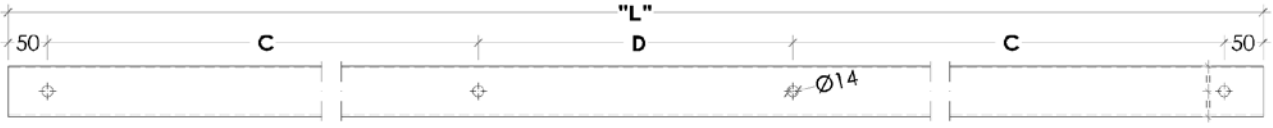
Elevation and cross-section, **double base**



Elevation and cross-section, **double base**



Elevation and cross-section, **double**

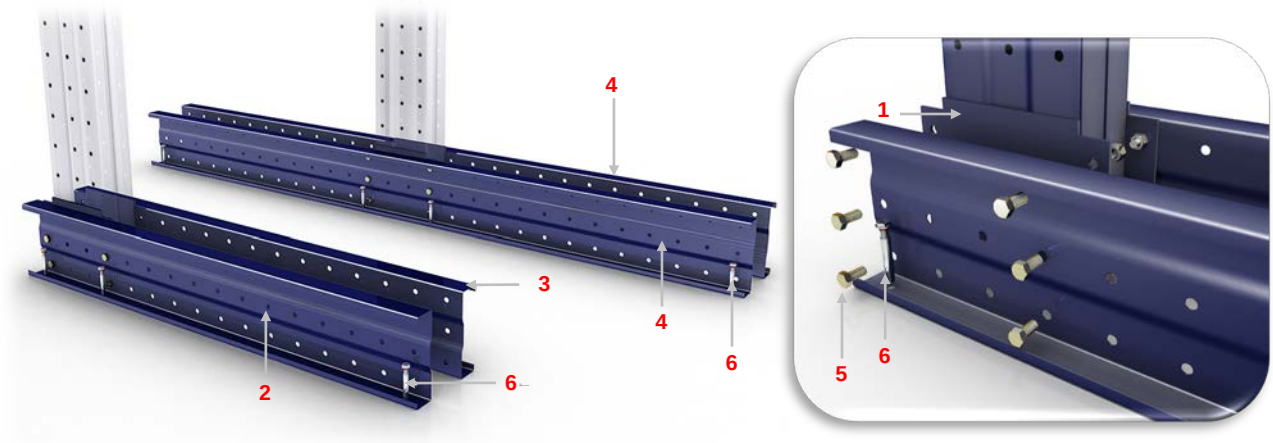


Generic plan view, **double base**

Nom. Dim.	C-sections															
	C-150			C-200			C-250				C-300			
	"L"	C	D	"L"	C	D	"L"	C	D	F	"L"	C	D	F
500	1,300	475	250	1,200	400	300	1,300	450	400	550	1,150	400	400	450
600	1,500	575	250	1,600	500	300	1,500	550	400	650	1,150	500	400	550
700	1,700	675	250	1,800	600	300	1,700	650	400	750	1,150	600	400	650
800	1,900	775	250	2,000	700	300	1,900	750	400	850	1,150	700	400	750
900	2,100	875	250	2,200	800	300	2,100	850	400	950	1,150	800	400	850
1,000	2,300	975	250	2,400	900	300	2,300	950	400	1,050	1,150	900	400	950
1,100	2,500	1,075	250	2,600	1,000	300	2,500	1,050	400	1,150	1,150	1,000	400	1,050
1,200	2,700	1,175	250	2,800	1,100	300	2,700	1,150	400	1,250	1,150	1,100	400	1,150
1,300	2,900	1,275	250	3,000	1,200	300	2,900	1,250	400	1,350	1,150	1,200	400	1,250
1,400	3,100	1,375	250	3,200	1,300	300	3,100	1,350	400	1,450	1,150	1,300	400	1,350
1,500	3,300	1,475	250	3,400	1,400	300	3,300	1,450	400	1,550	1,150	1,400	400	1,450

Lengths of double bases. Dimensions in mm

The bases, positioned perpendicularly at the bottom of both sides of the columns and flush with the floor, are attached using three or four anchor bolts for single and double bases, respectively.



Diagrams of single and double bases and a close-up of their attachment to columns

No.	Description
1	Column anchoring plate
2	Left single base
3	Right single base

No.	Description
4	Double base
5	M14x30 bolt
6	Anchor bolt

Front covers. These are made from steel plates with a guaranteed minimum grade of DC01, while higher grades, DC03 and DC04, may be used as per standard UNE-EN 10130.They have a minimum thickness of 3 mm. They are attached to the front end of bases using four M10x20 bolts. Their front face features a curved flat which forms a slot for housing the detachable stops.

Front cover and positioning

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.

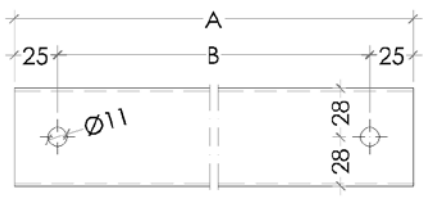
What is more, it must be perfectly levelled to ensure the vertical elements are plumbed correctly. Therefore, the maximum permissible unevenness between any two points of the slab must not exceed ± 10 mm. If necessary, any unevenness can be corrected with the installation of levelling plates.

Each column/base assembly is especially designed to transmit the load to the floor and control any punching shear or settlement phenomena acting on the concrete. However, this is significantly affected by the dimensions and characteristics of the concrete floor slab.

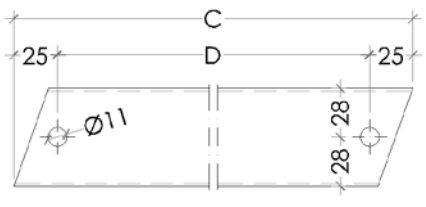
2.2.3. Bracings

These elements serve to connect the system's columns, while maintaining the designed layout and ensuring the assembly's longitudinal stability.

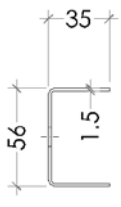
Horizontal and diagonal bracings. These are made from cold-rolled S-355-JO steel in accordance with standard UNE-EN 10025. They are constructed from U-sections and fixed to the column bracing connectors using M10x20 bolts.



Elevation of horizontal



Elevation of diagonal



Cross-section

	Horizontal bracings		Diagonal bracings	
Nominal dimension	A	B	C	D
800	668	618	1,526	1,476
900	768	718	1,570	1,520
1,000	868	818	1,620	1,570
1,100	968	918	1,674	1,624
1,200	1,068	1,018	1,733	1,683
1,300	1,168	1,118	1,795	1,745
1,400	1,268	1,218	1,861	1,811
1,500	1,368	1,318	1,929.5	1,879.5

Longitudinal dimensions of bracings. Dimensions in mm

Bracings. Details of their attachment to columns

These horizontal and diagonal elements are arranged in the vertical plane delimited by the columns in each module/block, thus forming the longitudinal bracing for the assembly. Their number and position depends on the height of the columns. Standard configurations are shown below.

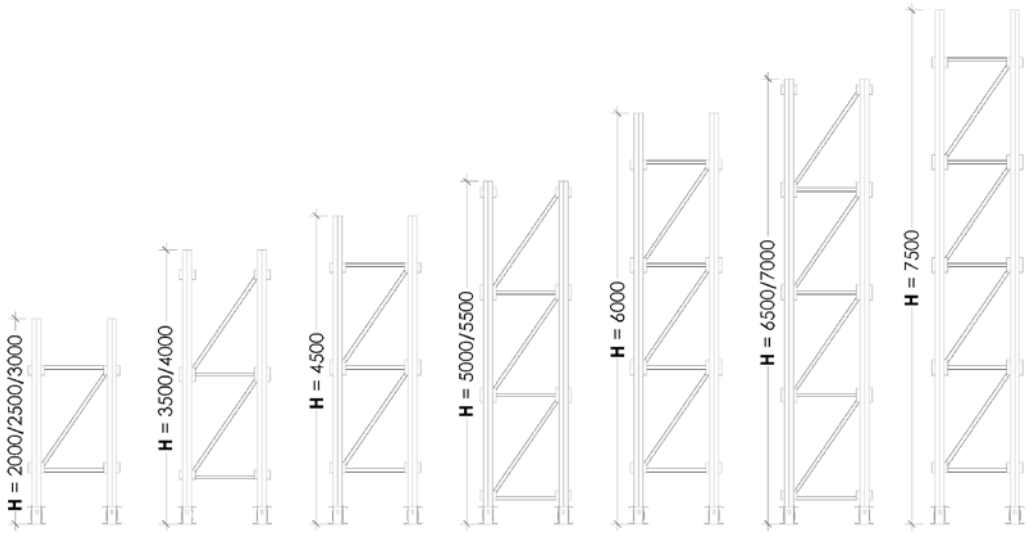


Diagram of bracing distribution in function of column height

Horizontal bracings are fitted in all modules; diagonal bracings are installed on the first and last module in a block and every other module, changing their direction symmetrically about the vertical axis. If the block has an even number of modules, diagonal bracings are installed in the two end modules. Nevertheless, the designed deemed necessary in function of each specific project's circumstances will take precedence over this general rule.

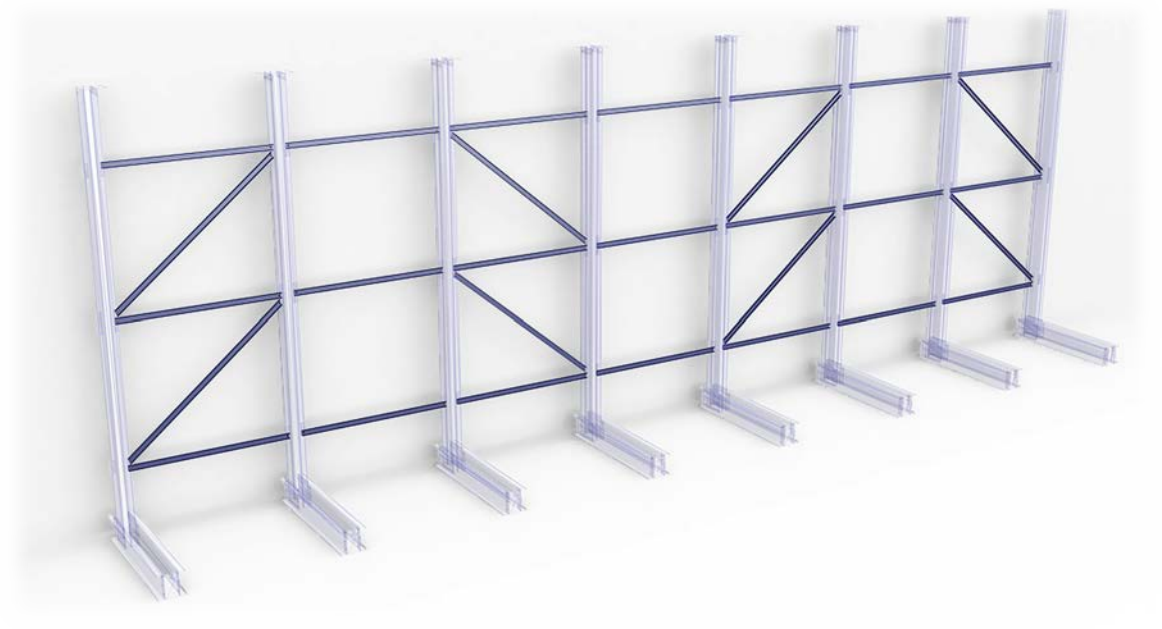


Diagram of the standard arrangement of horizontal and diagonal bracings

Top bracings. These are C-sections formed from cold-rolled S-355-JO steel, in accordance with standard UNE-EN 10025, and with the same cross-section as columns.

They are placed at the top of columns with a height of over 3,000 mm and along the full length of each block. Their function is to increase the structure's stability by sharing the transfer of forces and loads. They are attached using bracing brackets, with dimensions that vary depending on the type of section, and M10x20 bolts.

Diagram of the top bracings and details of their attachment using M10x20 bolts

2.2.4. Arms

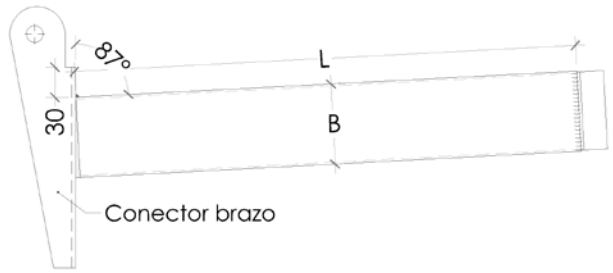
The purpose of these elements is to maintain and support the stored goods.

There are two types of arm in function of the loads they must bear and the intended use: rectangular arms for light loads and variable cross-section arms for heavier loads. Both consist of an arm connector, an arm (rectangular or variable cross-section) and a curved flat at the end which forms a slot for inserting detachable stops.

The use of either type of arm, its length, cross-section, thickness and the type of connector are determined by the load-bearing requirements of the structure, the handling equipment to be used, the system's functionality and other technical conditions specific to the planned design.

Arm connectors. These elements are made from steel with a guaranteed minimum grade of DC01, while higher grades, DC03 and DC04, may be used as per standard UNE-EN 10130. In each case, the thickness of the connector's sheet metal depends on the arm's specific characteristics and the loads to which it will be subjected. They could be types PL. 4, PL. 6, PL. 8, or PL. 10, in line with their thickness of 4, 6, 8 or 10 mm, respectively.

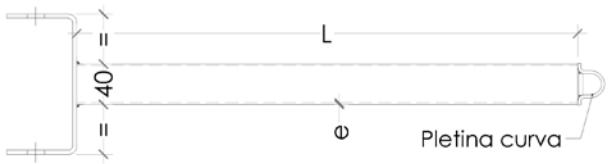
Rectangular arms. These comprise a PL. 4 connector welded to a rectangular section, with a cross-section and thickness that vary according to load requirements, at an angle of 3° with respect to the horizontal plane.



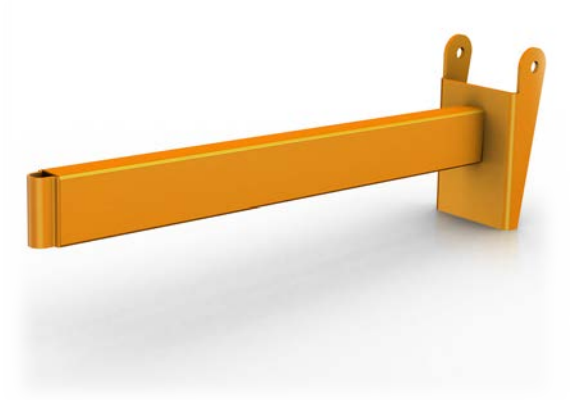
Elevatio

B cross-section	e
60	1.5
80	1.5
100	2

Dimensions in mm

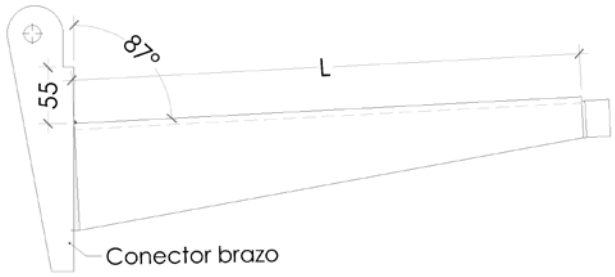


Plan



Rectangular arm

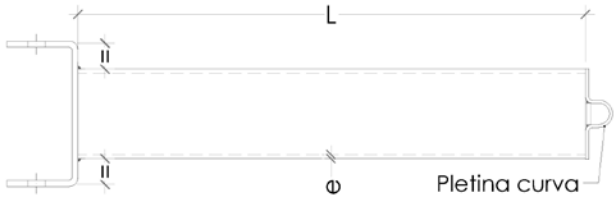
Variable cross-section arms. These comprise a connector welded to a variable cross-section U-section made from steel with a guaranteed minimum grade of DC01, while higher grades, DC03 and DC04, may be used as per standard UNE-EN 10130. Their thickness and length is defined by the weight they must support. These arms also include a 3° angle with respect to the horizontal plane.



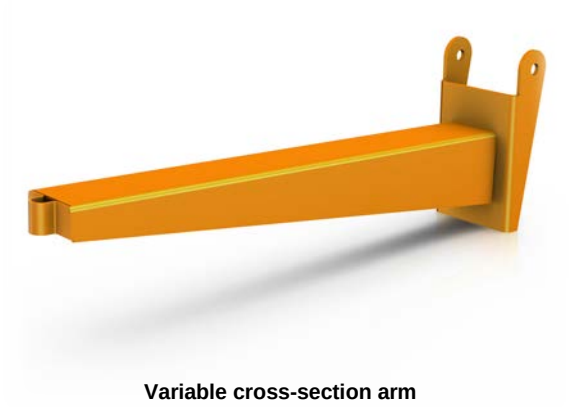
Elevatio

Type of	e
PL. 4	3
PL. 6	4
PL. 8	6
PL. 10	6

Dimensions in mm



Plan



Variable cross-section arm

Both types of arm are available in lengths “L” of 400 to 1500 mm, at 100 mm increments.

Arms are attached to columns using just one DIN 931 M14x160 bolt. Besides reducing assembly times, this connection provides great versatility of use because arms can swing vertically and therefore protect the structure by absorbing any accidental impacts.

Movement and attachment of arms

2.2.5. Stops

These are galvanised steel elements with a 20 mm diameter, circular cross-section. They are inserted vertically in the purpose-designed curved flats positioned at the front end of the arms and bases.

They extend upwards from their housing by a length that ranges from 100 to 1,000 mm, in 50 mm increments, depending on the type of material to be stored.

Their function is to retain goods placed on the loading levels which are susceptible to move around when stacked, whether because of their very nature (sections, tubing, etc.) or because they are stored without packaging or any other type of subjection.

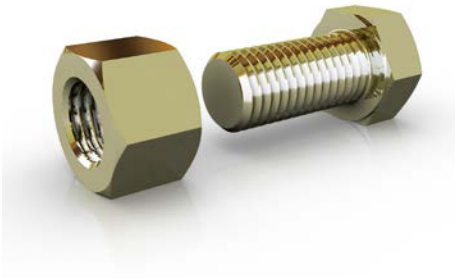
Stops. Insertion in arms and bases

Stops. Positioning and function

2.2.6. Fastening elements

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

M10x20 nut and bolt



M14x30 nut and bolt

M14x160 nut and bolt

M12x120 anchor bolt

The structure's design amply covers the compressive load requirements to which it will be subjected and supports the thrusts produced by mechanical forces in the system, such that it ensures totally safe use in line with the planned functionality.

All of the structure's elements are carefully designed and adequately stiffened so that their behaviour, according to their dimensions and location, endows the assembly with the stability necessary to meet the functional requirements.

The welding techniques employed guarantee very stiff connections that fully comply with the applicable tensile strength safety coefficients. Furthermore, connections made using fastening elements provide not only excellent behaviour and stiffness under service conditions, but also great versatility of use by optimising handling times so the storage system can be reconfigured quickly and easily. All fixtures, therefore, are designed to transmit the thrusts from the service load correctly, thus minimising strains in the configuration.

The storage system's longitudinal stability, which is taken as being parallel to the blocks of racking, is guaranteed by the level of coupling derived from the bracing system and connections which perfectly stiffen the entire structure.

The transverse stability, that is, in a direction perpendicular to the rows of racking, is guaranteed by the bracing structure itself and the constructive solution used to stabilise the columns with bases that deflect the bending moments produced by the load. Additionally, the other thrusts are efficiently counteracted by securing the system to the floor with expansion anchor bolts.

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3. TECHNICAL REPORT

Calculation standards

Static stability and elastic stability verification, and stress and deformation calculations for the systems described above shall be based on mechanical methods and, in general, the theory of elasticity, which occasionally and implicitly admits local states of plastic strain. The design procedures given in standard FEM 10.02.09 have been taken as a reference for the calculation of stresses and deformations.

Mechanical testing

Both the horizontal and vertical components comprising the structural system designed herein have undergone strength tests to verify their mechanical characteristics.

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 column–column, column–base and base–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 particular needs; the weighted values derive from the application of the safety coefficient established in standard FEM 10.02.09.

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 columns 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 FEM 10.02.09) 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 is determined according to recommendations in standard FEM 10.02.09.

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 FEM 10.02.09.

7. The design contemplates the tolerances, deformations and clearances, including interactions with the floor, in accordance with standard FEM 10.02.09. 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.

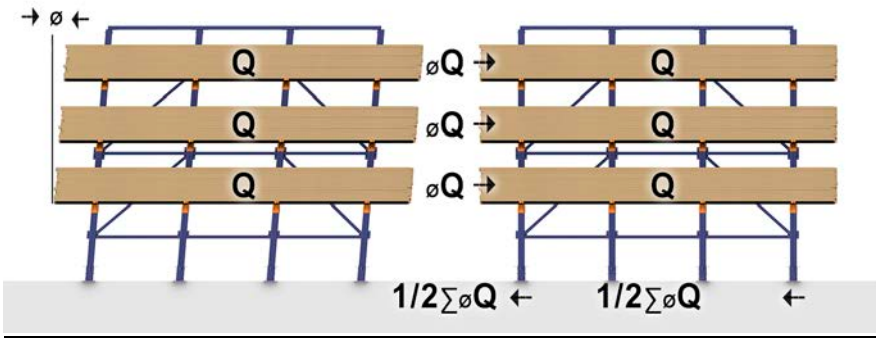
Structure stability

To dimension the cantilever racking 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.

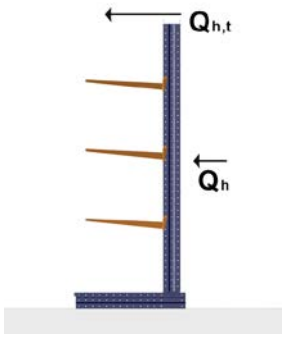
Longitudinal stability. The longitudinal direction is taken as the direction parallel to the storage system's aisles. The connection between the columns and bracings provides a level of coupling that guarantees the assembly's longitudinal stability.

Transverse stability. The transverse direction is understood to be the direction running perpendicular to the storage system's aisles. The transverse stability is provided by the mechanical solution used to stabilise the columns with bases that counteract the bending moments produced by the load.

All the elements positioned on the ground 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 FEM 10.2.09 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 arms is set to 1/200th of their length (L/200) for the case of arms measuring less than 1,200 mm long, and 1/300th of their length (L/300) for those measuring equal to or greater than 1,200 mm, as set out in standard FEM 10.2.09.

Furthermore, the maximum allowable lateral deformation or displacement for the system's columns is fixed at 1/300th of their height (H/300), according to the same standard.

To a large degree the safety of the mezzanine 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 user must ensure the floor meets the requirements for the particular project.

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 structures 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, columns, bases and arms, using specific connectors, produces three-dimensionally stable structures that enclose intervening aisles which provide access to the storage positions. 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 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.

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