estanterías record

Efficient storage systems

PRODUCT TECHNICAL FILE

BRICORD B MANUAL LOADING

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CONTENTS

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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 contains a general description of the BRICORD MANUAL LOADING shelving 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.

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

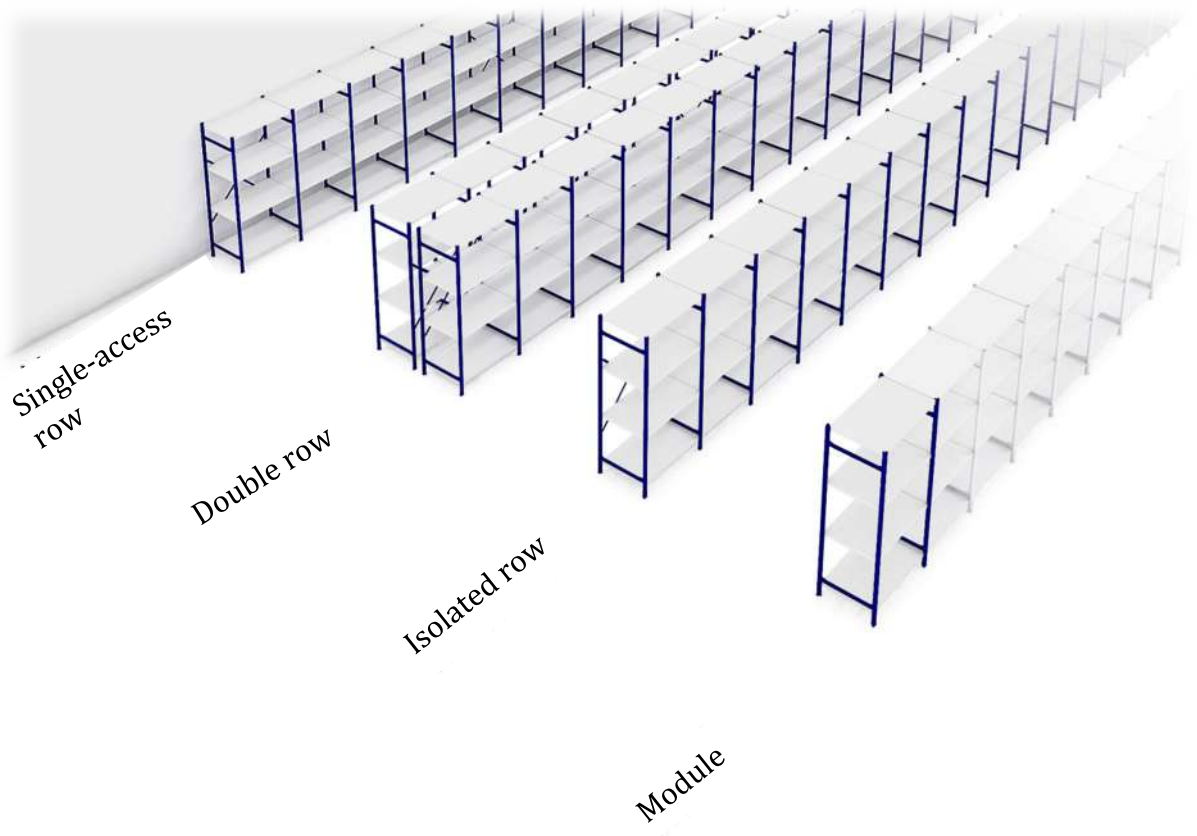
The storage system consists of a suitable combination of its structural elements based on the technical and functional conditions of its intended use.

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, double or isolated longitudinal structures called rows.

Single and isolated blocks are single-access shelving systems when fastened to the walls of the building and double-access when they are isolated; two single isolated blocks 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:

- Exclusive development that combines a considerable load-bearing capacity with a very aesthetic design.
- 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:

2.1. MATERIALS

Sections are cold-formed and punched from steel strips before they undergo electrostatic painting in a continuous flow, as well as phosphate, anti-corrosive 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 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	$G = E/2(1+\nu)\ N/mm^2$
Poisson's ratio	$\nu = 0.3$
Coefficient of linear thermal expansion	$\alpha = 12 \times 10^{-6}\ °C$
Density	$\rho = 7{,}850\ kg/m^3$

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, regarding fire safety regulations in industrial premises. Elements with a zinc coating of less than 100 µm have a fire rating of M1, class Bs3d0, 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:

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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

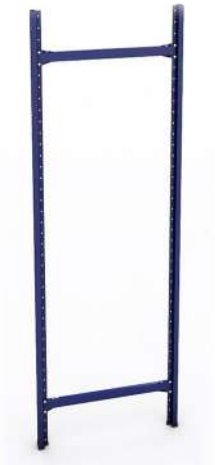
Vertical elements are painted blue (RAL 5003) and horizontal elements are painted pearl grey (RAL 7035).

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 bracing of two or three horizontal sections (type A or B), depending on the height, fastened in place using DIN 933 M6x10 screws. The screws are made from high strength steel and come with nuts.



Height (mm)
2000
2500
3000

Depth (mm)
400
500
600
700
800
900
1000

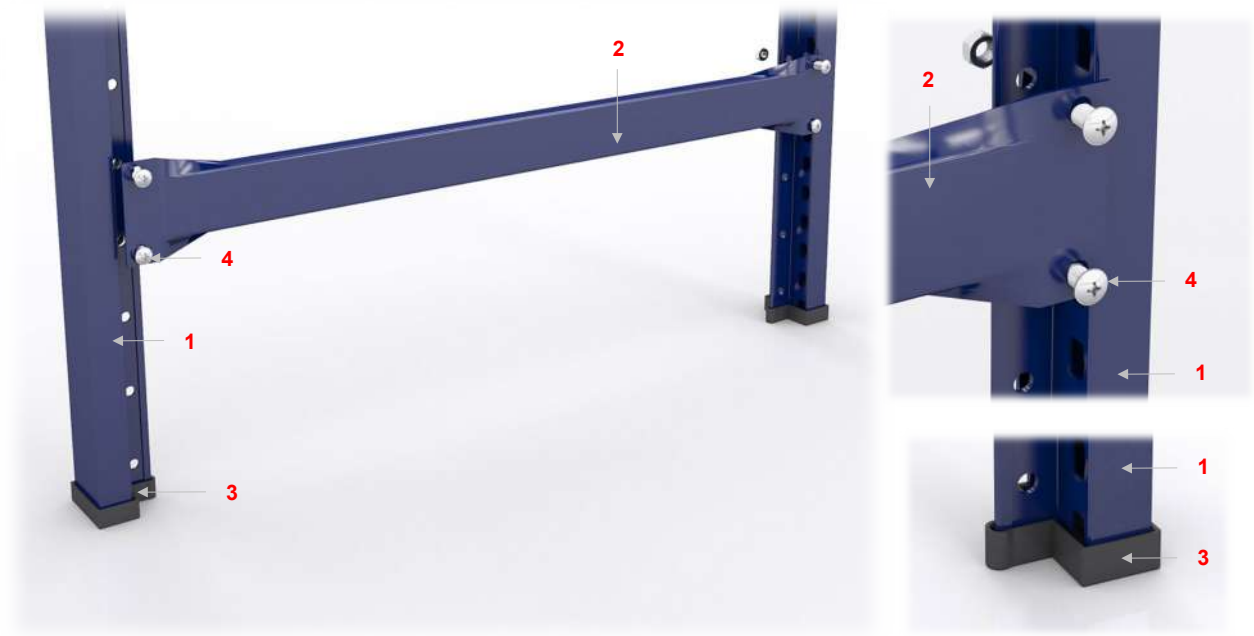
This structure will bear the axial compression load in service conditions and transmit it to the floor. They are also subject to the lateral thrust produced by the mechanical forces acting in the system.

2.2.2. Horizontal bracings

S275JR-quality steel sections according to EN 100252:2004 or equivalent specifications. They are perforated at the ends with two 9x7mm holes.

Horizontal bracings suitably positioned according to the height of the frame are attached to the uprights by means of DIN933 M6x10 screws with M6 nuts.

The following diagram shows the start of the bracing structure.



No.	Description
1	Upright
2	Crossbar

No.	Description
3	Plastic leg
4	6x10 screw

The positioning distance of the lower and upper horizontal bracings is the same for all frames regardless of their type, i.e. between 250 and 300 mm from the end of the upright, while the middle horizontal bracing, when fitted, is positioned approximately at the midpoint of the height of the frame.

The following diagram shows how the components are arranged on the frame, together with the assembly dimensions and details for each height:

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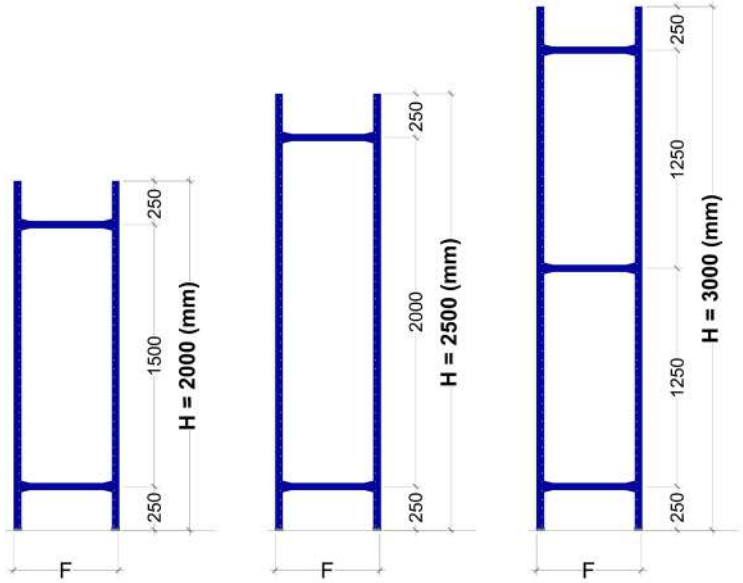
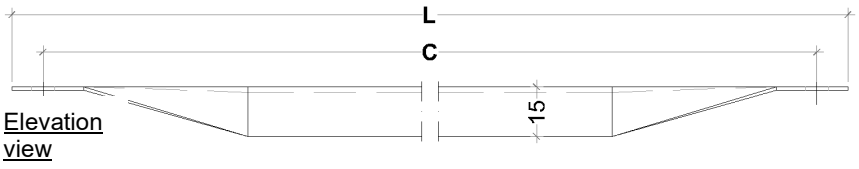


The table shows the frame components for each height.

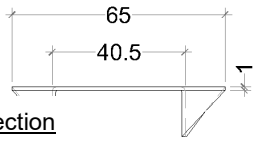
Height mm	Uprights Units	Plastic leg Units	M8x65 M6x10 Units	Horizontal bracings (*) Units
2000	2	2	8	2
2500	2	2	8	2
3000	2	2	12	3

(*) For specific project configurations and load requirements, the frames can be reinforced by increasing the number of horizontal bracings and their fastening points. These specifications will be detailed in the installation plans.

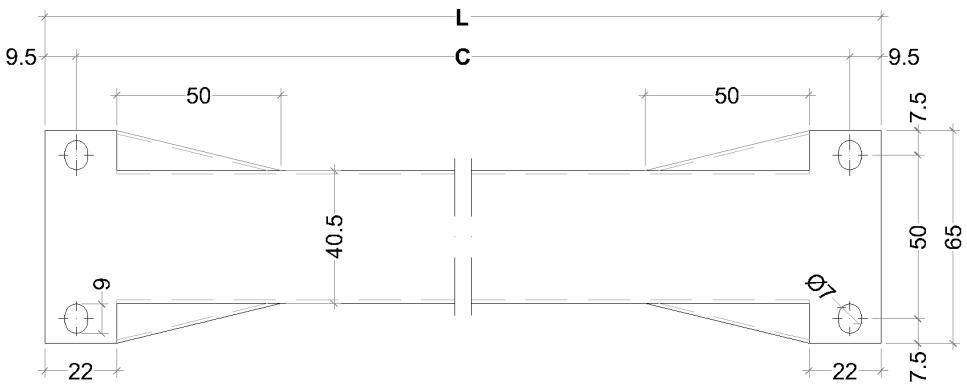
Details of horizontal bracing dimensions:



Elevation view



Section



Plan view

Depth	Type B L	Type B C
400	360	341
500	460	441
600	560	541
800	760	741
1000	960	941

Dimensions in mm

Bricord horizontal bracing

2.2.3. Uprights

Hot-rolled steel sections, S235JR according to EN 100252:2004 and cold-profiled, closed section, 1 mm thick.

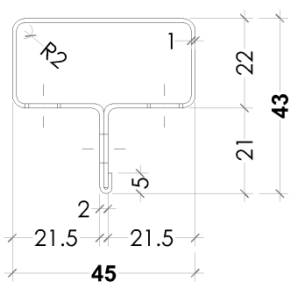
The side and front faces are smooth, with no holes, while on the inside there are two lines of holes 25 mm apart to fit the connector of the loading beam or the hooks for the shelves. The inner reinforcement rib has a row of 7 mm holes 50 mm apart. These holes are used to attach the horizontal bracings.

As detailed above, the holes in the front of the uprights can be used to graduate the loading level every 25 mm.

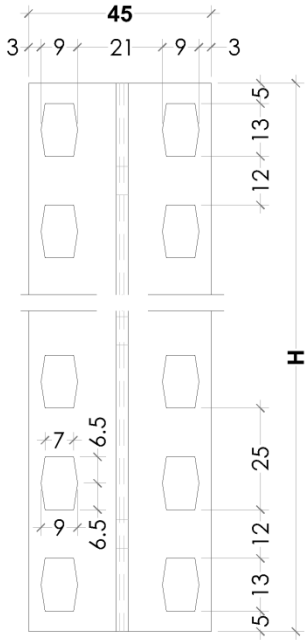
Each flat element subject to compression is duly stiffened to ensure it performs correctly in case it gets dented. The section has six longitudinal folds and an inner reinforcing rib for excellent strength against these phenomena; the folds have been specially designed so that their inertia in function of their width, length and thickness ensures the structure is strong enough for the service conditions the assembly has to endure.

Height (mm)
2000
2500
3000

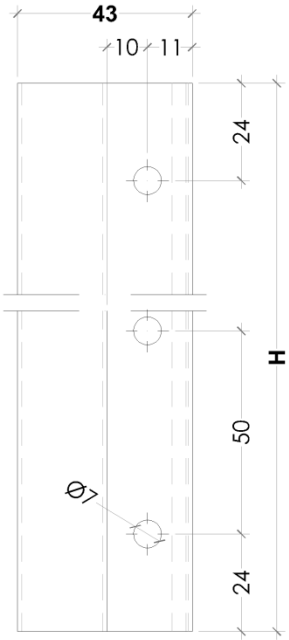
Height of standard production frames



Plan view



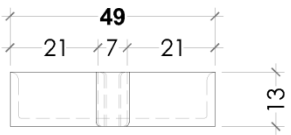
Elevation view



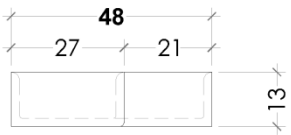
Section

2.2.4. Plastic leg

Each upright is fitted with a plastic foot to prevent damage to the surfaces on which it is positioned.



Elevation view



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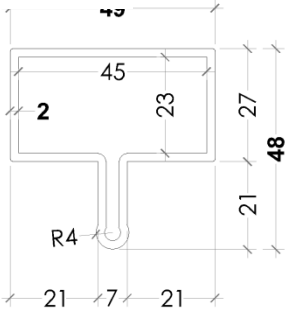

Plan view

Plastic foot

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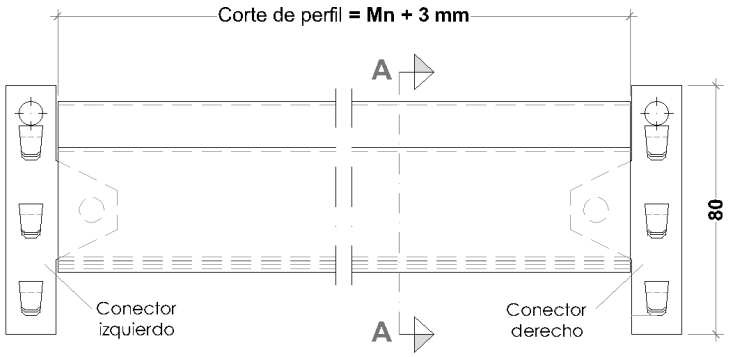
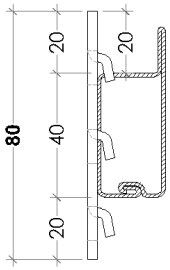
2.2.5. D55 beam

Made of steel plates with a guaranteed minimum grade of DC01, while higher grades, DC03 and DC04, may be used as per standard UNE-EN 10130.Of a minimum thickness of 1 mm and finished in pearl grey (RAL 7035).

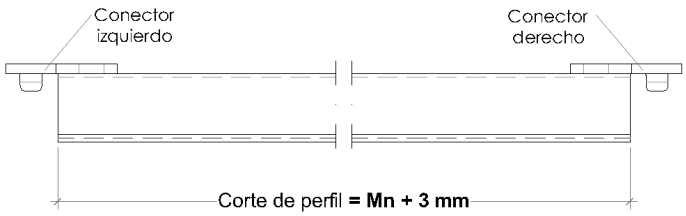
It comprises one d-section with two connectors welded onto both ends for assembly on the uprights of the frame. The design is prepared for the installation of an open-plan surface for the direct storage of goods. In this case unit loads will be managed with manual handling equipment.



Elevation view



A-A cross-section



Plan view

Nominal dimension **Mn**	Section length
1000	1003
1200	1203
1400	1403
1600	1603
1800	1803
2200	2203

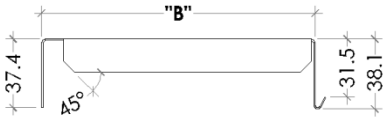
D55 beams and details

2.2.6. Loading levels

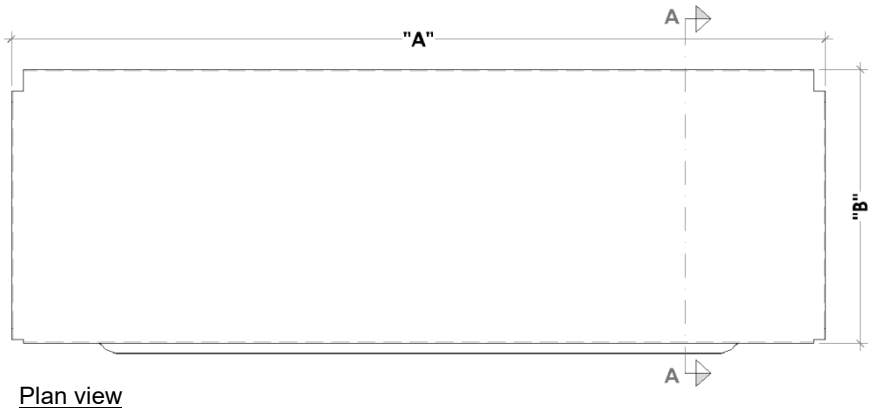
When load units are accessed manually, the beams must support the surface where the goods will be stored. There are two options:

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.

Elevation view



Section



Plan view

Length **"A"**	Width **"B"**
400	200
500	
600	
800	
1000	

Galvanized metal panel

Details of positioning on D55 beam

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Melamine boards. 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 compressive force of the load, the board could break or dislodge from its seating, causing the stored goods to fall. Therefore its use is not recommended when the bottom exceeds 800 mm. However, due to the versatility of uses and environments in which the storage system can be used, the surface may be chosen with a greater depth than described above as a result of the need to withstand loads of large volume and low weight.

Details of the D55 beams with 16-mm melamine board

2.2.7. Fastening elements

The following are the different types of fastening elements used to assemble the structures described above:

8x17 safety pin

M6x10 screw

3. TECHNICAL REPORT

3.1. 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 picking rack. 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.

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. LOAD CAPACITIES

Frame	
Maximum separation between levels	**Allowable load**
500 mm	4,130 kg
600 mm	4,030 kg
700 mm	3,905 kg
800 mm	3,770 kg
900 mm	3,620 kg
1000 mm	3,450 kg

Nominal load capacity of frames

The loading capacities for frames presented in the previous table are limited by the distance between levels, the buckling height (measured from the floor to the first level) and the self-weight of the shelves and beams on every level.

In addition, the self-weight of the load-bearing elements (shelf, wood or fibreboards or similar, etc.) must be subtracted from the maximum loads per level to be placed on each level (pair of beams) indicated in the

following table. They will also be adjusted according to the total number of levels allowed for the frame configuration's total load capacity.

	Bricord B (Lengths mm)					
	1000	**1200**	**1400**	**1600**	**1800**	**2200**
Pair of beams	834 kg	710 kg	520 kg	400 kg	315 kg	210 kg

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 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 Materials 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.

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UNE-EN ISO 9001:2008
Nº 0.04.03229

European Materials Handling Federation

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.