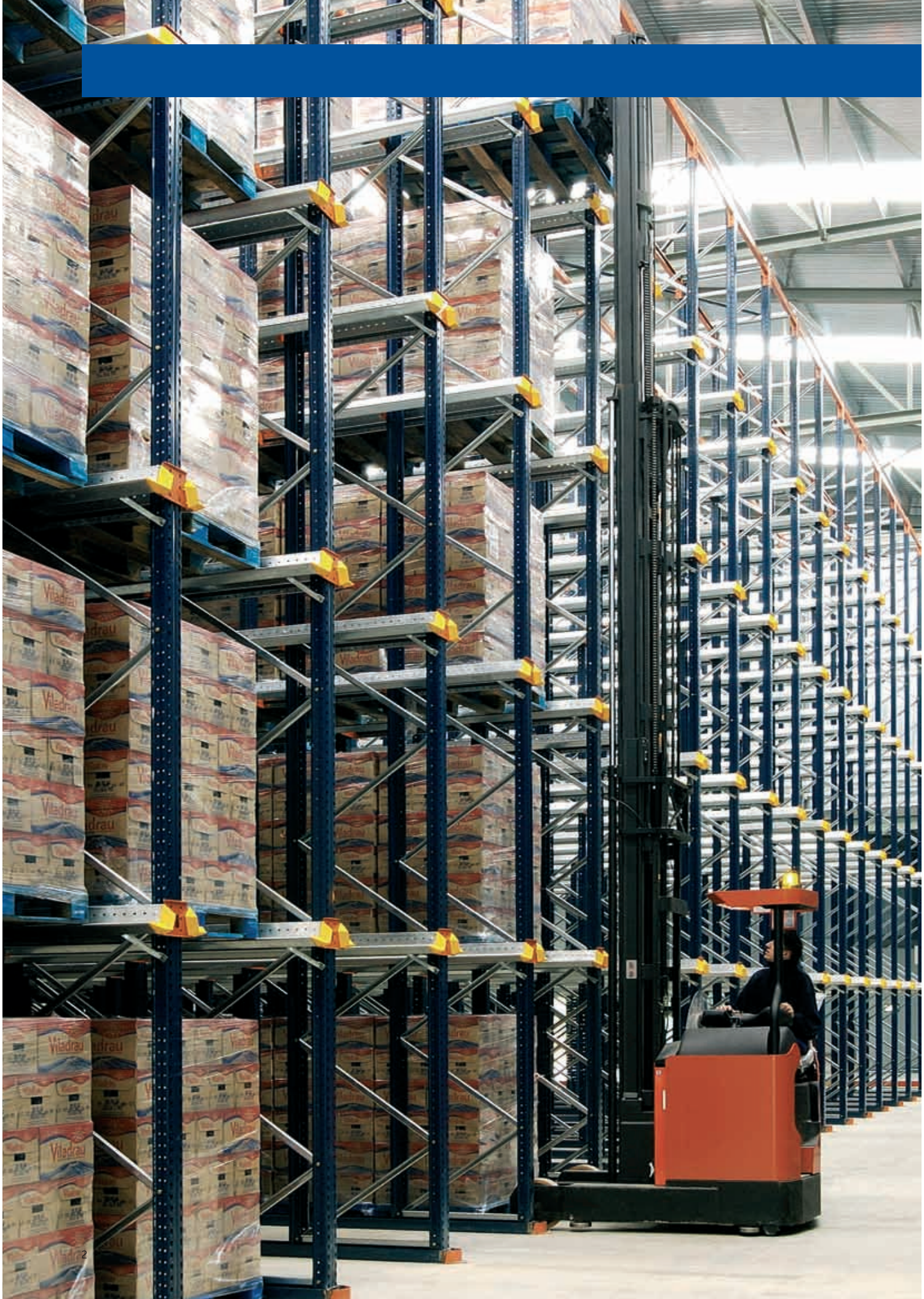
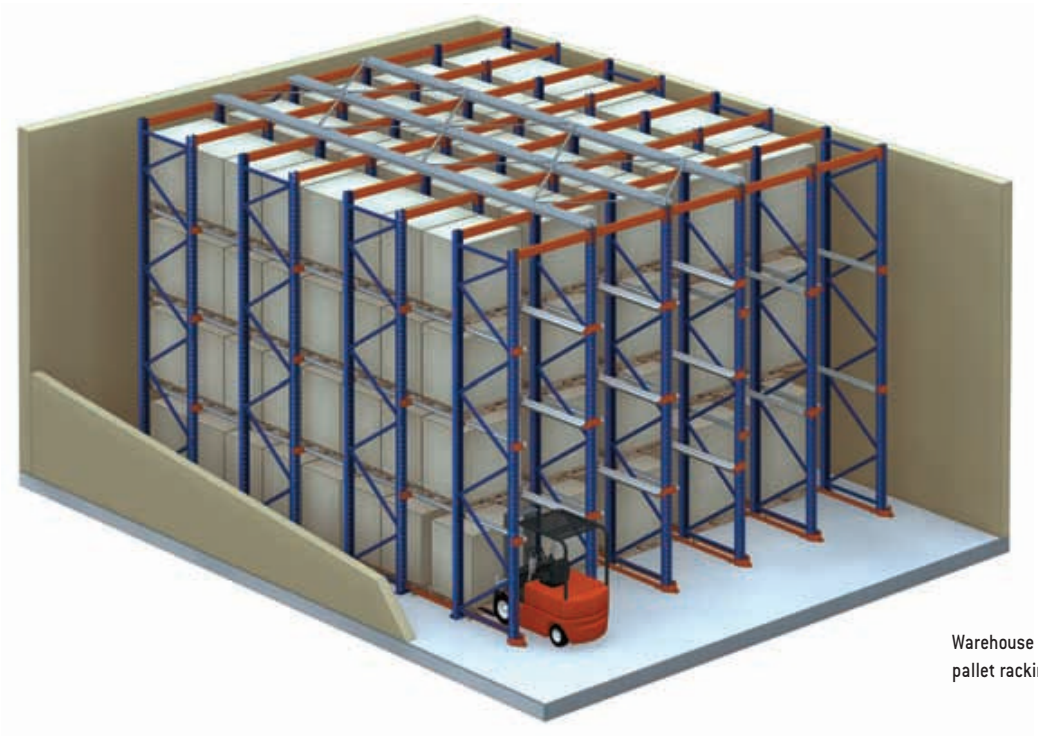

Viladrau

Drive-in racking is designed for the storage of homogenous products. It accommodates a large number of pallets for each SKU. This system makes better use of the available surface and height space than any other.

The installation is made up of a set of racking units that form inner loading aisles, with support rails for the pallets. The forklift trucks enter these inner aisles with their load held higher than the level at which it is to be deposited.

Each loading aisle has support rails on both sides. These are arranged on different levels and the pallets are placed on top. This racking system is made of extremely robust material, thus making it suitable for storing fully-loaded pallets.



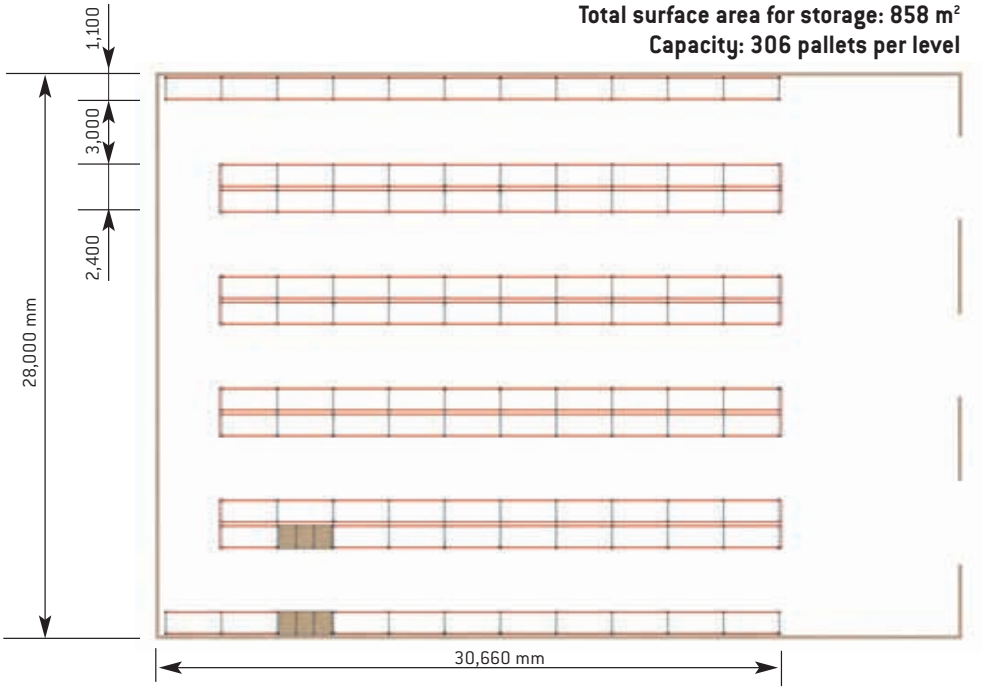
Warehouse with drive-in pallet racking.

General Specifications

The drive-in system can accommodate as many SKU's as there are loading aisles. The number of pallets will depend on the depth and height of the loading aisles. It is advisable to store products with the same SKU in each loading aisle, in order to avoid unnecessary pallet manoeuvres. The depth of each aisle will depend on the number of pallets per SKU, the space available and the length of time they will be stored.

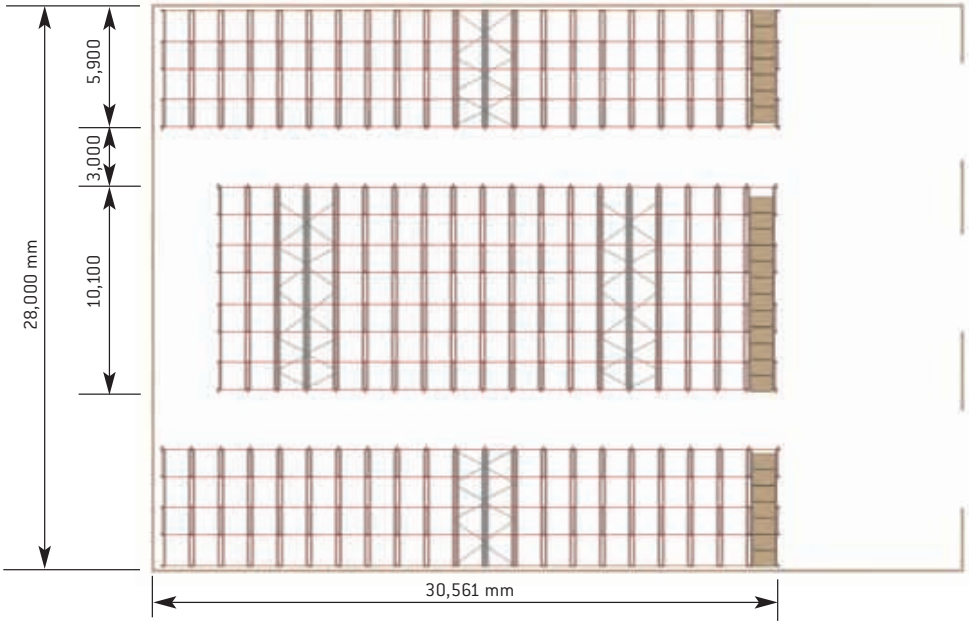
As shown in the following illustrations, the drive-in system has a greater storage capacity than the conventional pallet racking system. The illustrations show one facility with three different distributions and capacities.

Total surface area for storage: 858 m²
Capacity: 306 pallets per level



Conventional distribution

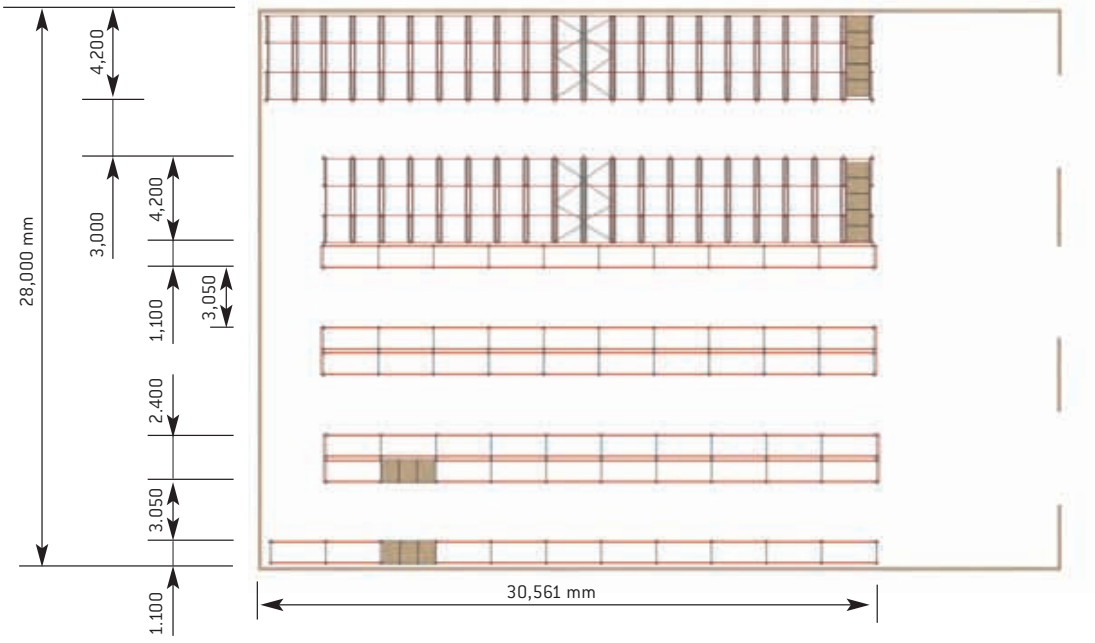
Total surface area for storage: 855 m²
Capacity: 522 pallets per level



Drive-in distribution

Conventional pallet racking and drive-in systems are usually combined in one warehouse. The drive-in system is used for products with a faster turnover.

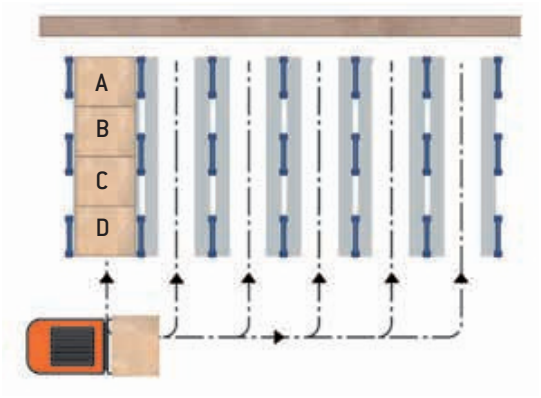
Capacity: 383 pallets per level
(200 pallets on drive-in system and 183 pallets on conventional pallet racking)



Load Management on a Drive-in System

Drive-in

This is the most common way of managing loads in a drive-in system. The racking units work like a warehouse depot. There is just one access aisle, from which loading and unloading are carried out in reverse order.

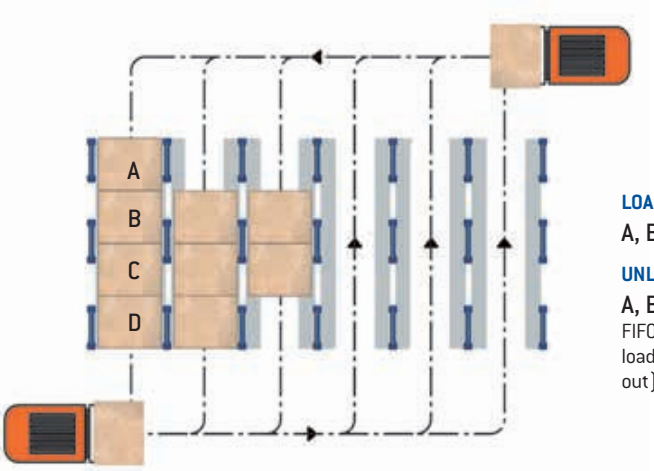


LOADING order:
A, B, C, D

UNLOADING order:
D, C, B, A
LIFO system (the first load in is the last one out).

Drive-through

In this case, the load is managed using the racking unit as a controlling warehouse, with two load access points, one on each side of the unit. With this system, it is possible to control production differences, for example between manufacture and dispatch, between production phase 1 and phase 2, or between production and loading bays.



LOADING order:
A, B, C, D

UNLOADING order:
A, B, C, D
FIFO system (the first load in is the first one out).

Forklift trucks

The forklift trucks enter the storage aisles with their load held higher than the level at which it is to be deposited. Counter-balanced forklifts and standard reach trucks are the types used with drive-in systems.

Unlike the conventional system, the pallets are handled perpendicular to their stringers. In drive-in pallet racking, the forklift truck deposits the pallet by resting the stringers on the support rails. An extreme amount of pressure is exerted on the stringers, so the pallets used must be in very good condition.

The following illustrations show the correct way to place the pallets (figure 1).

Pallets can only be placed the other way around if they are strong and rigid enough, and if the weight of the load allows it.

If the load overhangs the pallet, dimensions A and B (the pallet measurements) may be different to A' and B' (the load measurements), which will influence the dimensions of the racking and supports, as shown in the pages relating to tolerances.

Figure 1

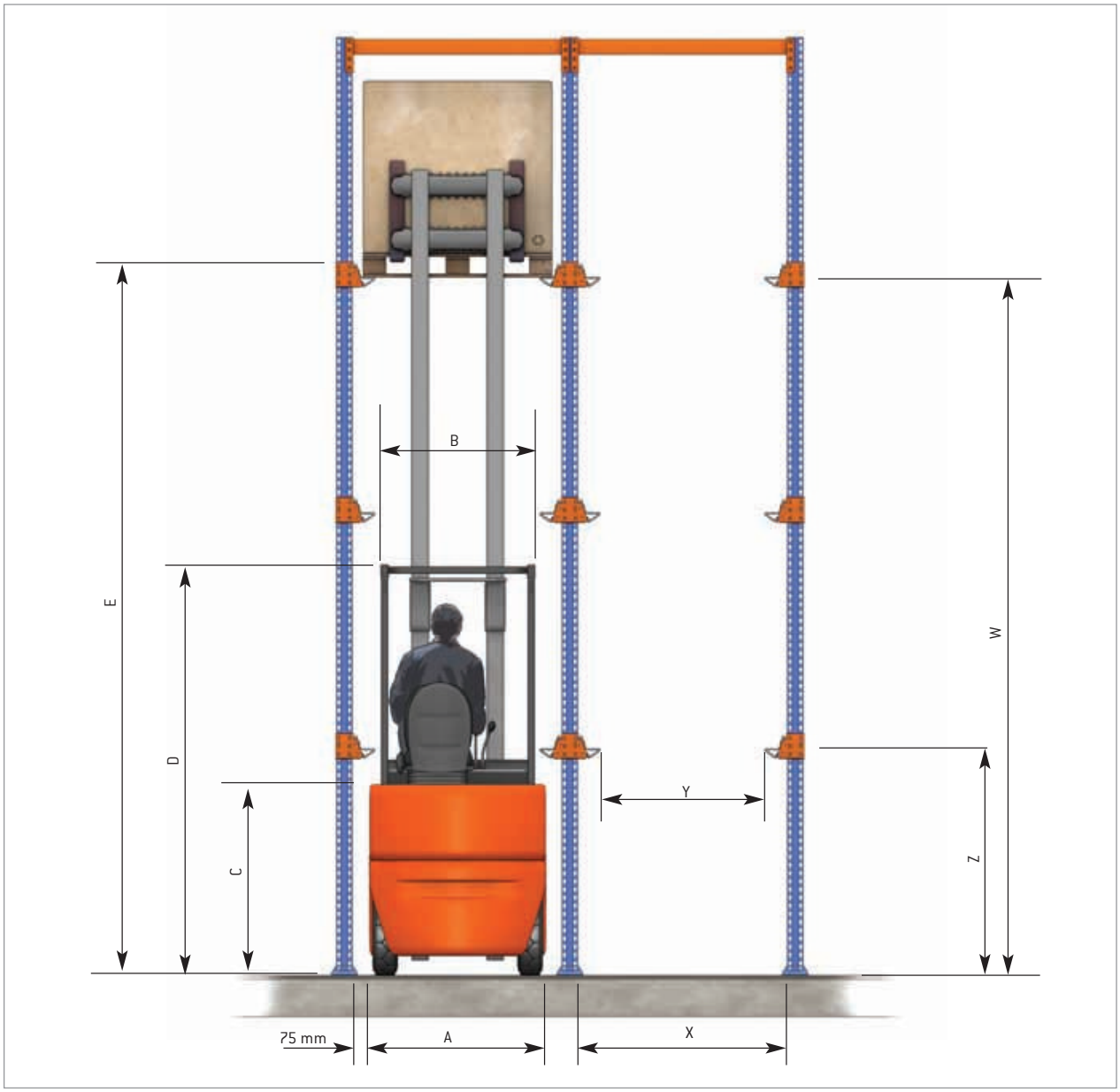


Figure 2

The forklift trucks travel along the insides of the storage aisles, so the necessary margins must be calculated in order to work safely. Certain measurements must be taken into account when designing an installation:

A. Total width of the forklift truck. There must be a minimum tolerance between the forklift truck and the vertical elements of the racking units of 75 mm on each side. Dimension X, the distance between the uprights, must include this.

B. Operator's protection structure. A minimum tolerance of 50 mm to the support rails is needed (dimension Y).

C/D. Height of the base and protection of the forklift truck. Dimension Z and dimension Y must be cleared comfortably.

E. Maximum elevation height. Must be at least 200 mm greater than dimension W.

Guidelines and recommendations

There are a number of guidelines and recommendations governing the market. While fulfilment of these is not obligatory and specific reference is not made to structures of this type, some headings do include a set of criteria and directives that are used by Mecalux when making calculations for drive-in systems.

NBE-EA-95. Steel structures in building
FEM. Document 10.2.07 (Draft)
RAL-RG 614/2. Lager und Betriebseinrichtungen Gütesicherung (Germany)
SIMMA. Syndicat des Industries de Matériels de Manutention (France)
SEMA. Storage Equiment Manufacturer Association (Great Britain)

Calculation criteria

Mecalux makes its calculations for drive-in systems in accordance with the directives indicated in the aforementioned guidelines and directives. These directives apply in particular to the following calculations:

1. Horizontal forces due to possible defects in manufacture or assembly.
2. Impacts from the forklift truck.
3. Maximum deformation of the uprights.
4. Minimum pallet support.
5. Maximum deflection of the pallet support rails.
6. Safety factors

1. Horizontal forces

In addition to the vertical loads resulting from the pallets, another factor that must be considered in making the calculation is the effect of a system of horizontal forces applied to each support with a value of P/200 (P being the value of the load per support, due to the pallets stored) (figure 1).

These forces include possible defects in manufacture or assembly.

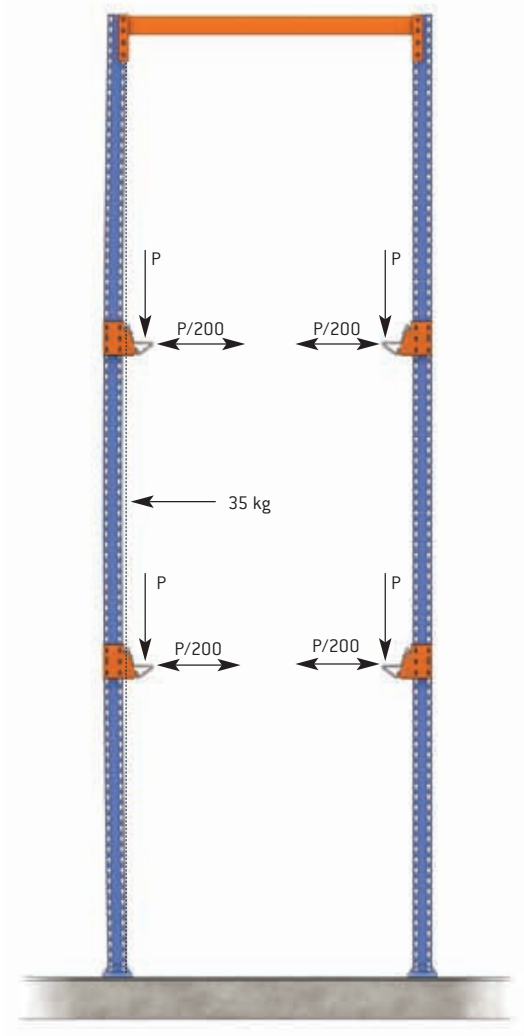


Figure 1. Forces taken into account when making the calculation.

2. Impacts from the forklift truck

In accordance with the guidelines and recommendations, the calculation makes allowance for an impact to the value of 35 kg from a forklift truck, at the least favourable point (figure 1).

3. Maximum deformation of the uprights

The calculation takes into account that the maximum deformation of the uprights must not exceed 25 mm (figure 2) when forces and reactions from vertical and horizontal loads are applied.

The fact that the load may overhang the pallet has a huge influence on the dimensions and length of the supports and therefore also on the calculation of the uprights. The longer the support, the greater the pressure exerted on the upright, so the edgings used should in turn be stronger.

4. Minimum pallet support

As a safety measure, if the pallet is displaced completely over to one side, there should be a minimum support of 30 mm on the other side (figure 3).

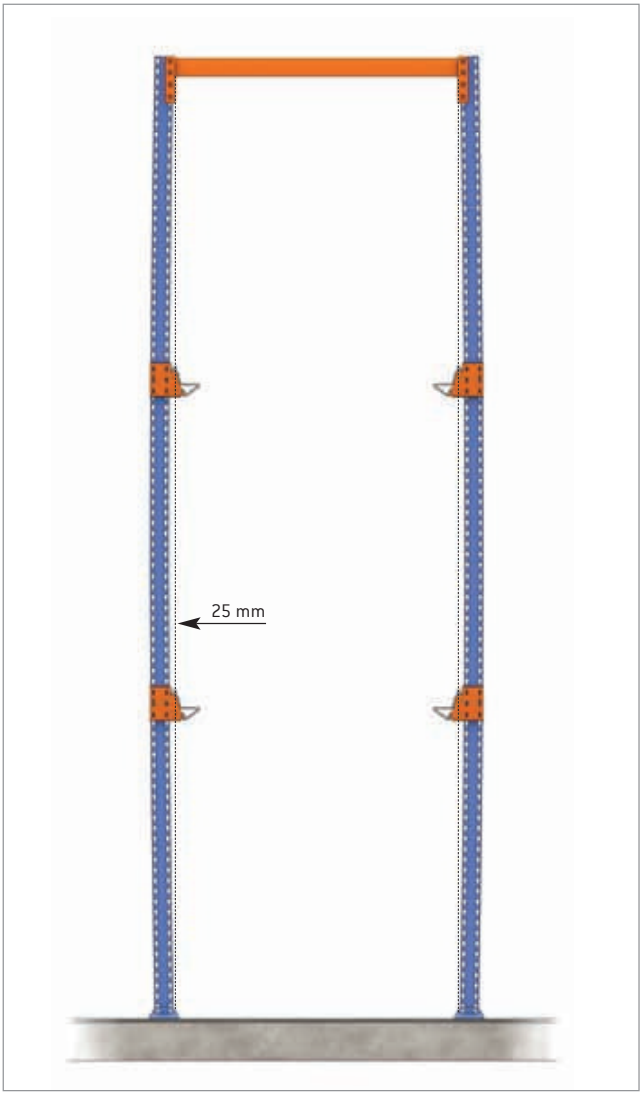


Figure 2. Deformations to the upright.

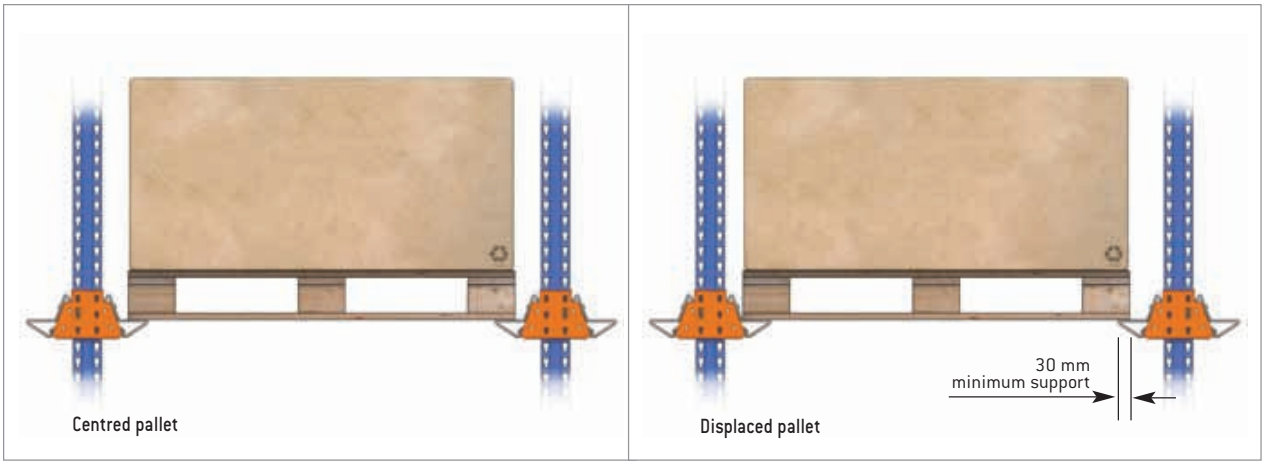


Figure 3

5. Maximum deflection of the pallet support rails

The maximum deflection or deformation of the pallet support rail is limited to the distance between supports/200. As these are open profiles with non-symmetrical shapes, the rails are calculated using finite element programs (figure 4).

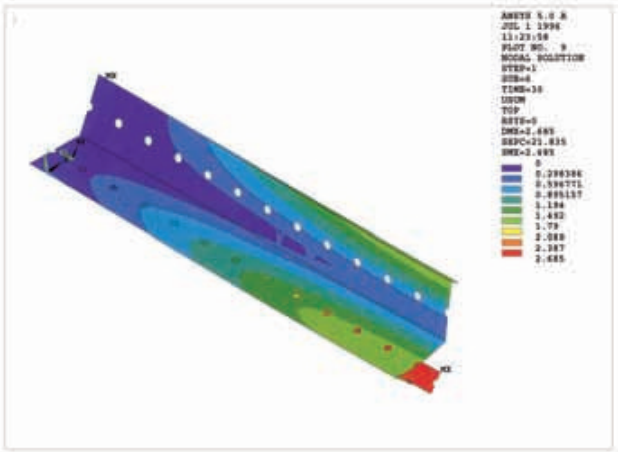


Figure 4. Example of a rail test for drive-in pallet racking.

6. Safety factors

Factors of 1, 1.33 or 1.5 are used as a load increase value depending on the combination of loads being tested. The results obtained will determine the type of upright and support to be used.


3

Racking stability

The stability of the racking system is paramount, both width and length ways. The transversal plane includes the frames and the longitudinal plane lies perpendicular to the storage aisles (figures 5 and 6).

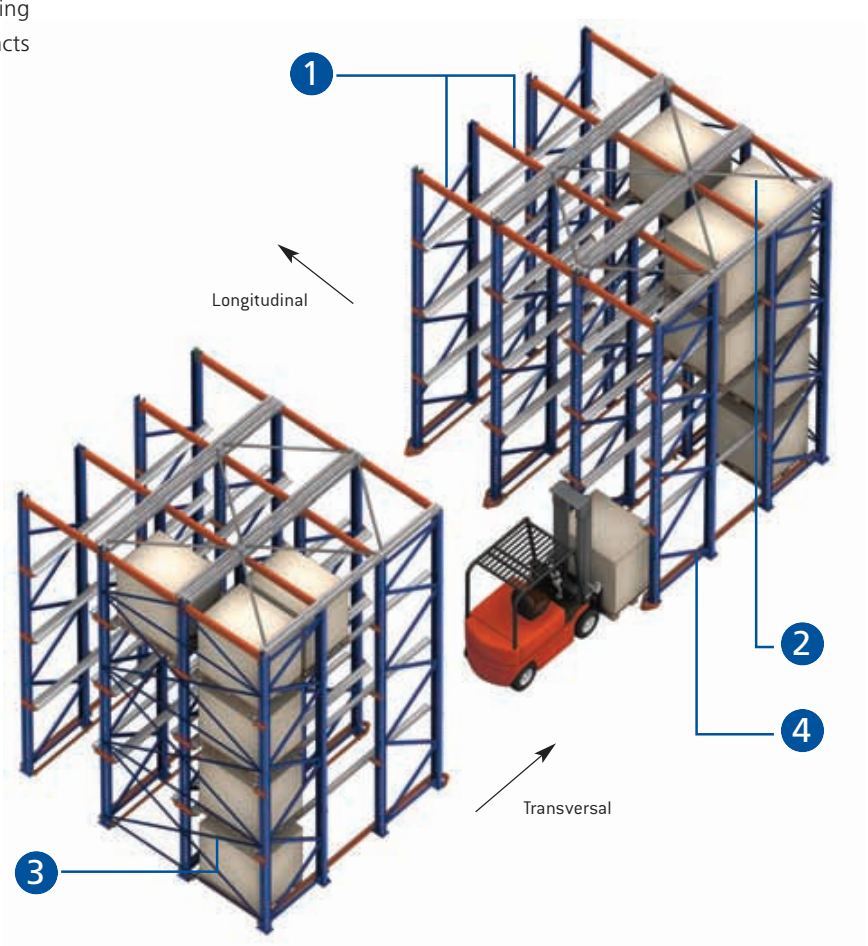
Transversal stability

Stability is guaranteed by the rigidity of the frames and the diagonals and also due to the fact that these are interconnected by their own support rails.

Longitudinal stability

Stability is guaranteed by the following factors:

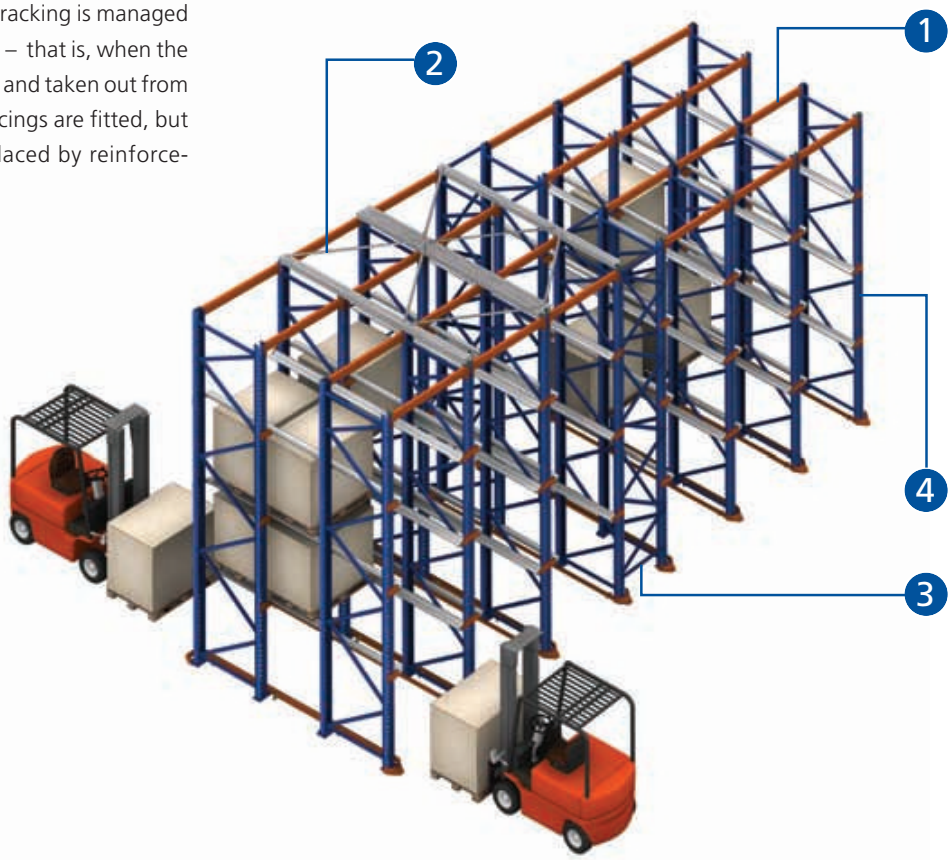
- The anchor bolts of the frames (2 on each footplate).
- A system of horizontal braces on the upper plane. Their function is to ensure that the structure retains its shape.
- The upper tie beams.
- A set of vertical braces at the back of the racking (in the drive-in system), which carry any impacts directly to the floor.



1) **Upper tie braces**
2) **Horizontal bracings**
3) **Vertical bracings**
4) **Frame**

Figure 5. Racking stability with the Drive-in system.

- When the load placed on the racking is managed with the drive-through system – that is, when the goods are put in from one side and taken out from the other – the horizontal bracings are fitted, but the vertical bracings are replaced by reinforcement structures (figure 6).



1) **Upper tie braces**
2) **Horizontal bracings**
3) **Vertical stiffening cable**
4) **Frame**

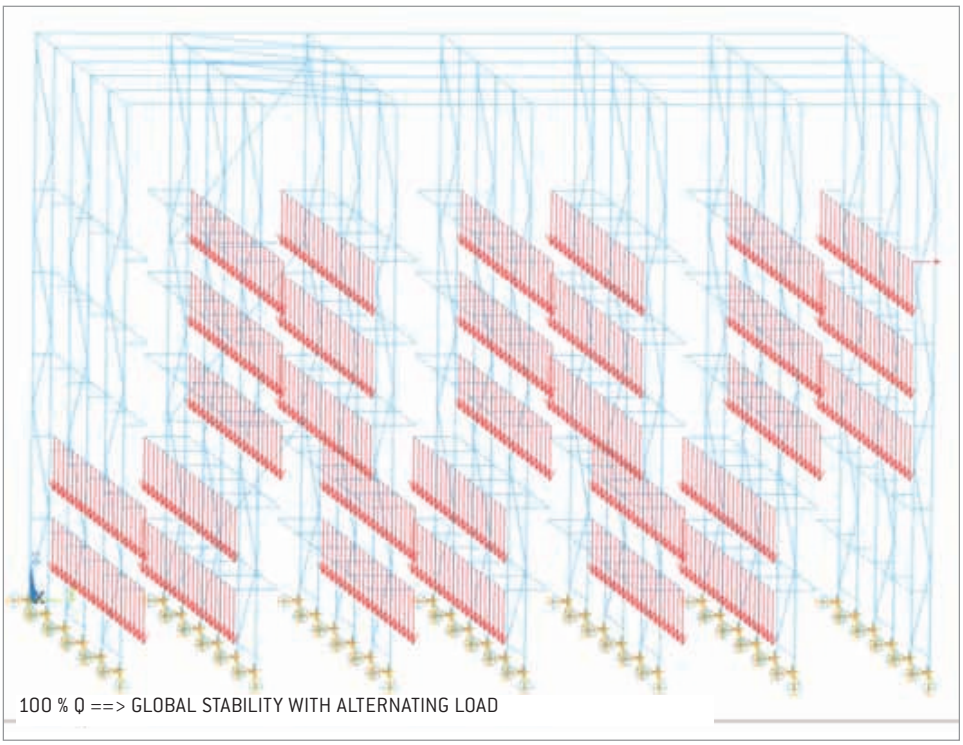
Figure 6. Shelving stability with the Drive-through system.

Calculating the uprights

The upright is one of the main elements of drive-in racking and must therefore be very carefully calculated. Unlike what happens with other storage systems, with racking of this type the upright is not only subjected to forces of compression but also of flexion, making it necessary to provide the upright with the necessary inertia.

Mecalux has a powerful computer program that studies the different loads and forces that act upon the installation and calculates all the possible load combinations, obtaining the worst-case hypothesis as regards tension and deformation (figure 7).

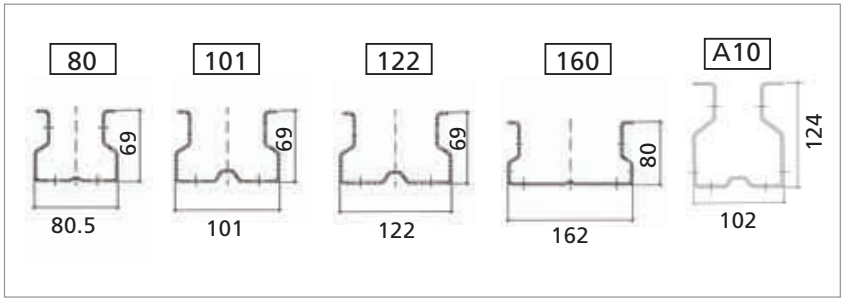
Figure 7. Load combination when calculating the upright.



The uprights obtained as a result of these calculations have been developed with geometries that are specific to each type of installation and cover all storage needs regarding height, load and distribution of the installation (figure 8).

NUMBER OF LOAD LEVELS	NUMBER OF COMBINATIONS CALCULATED (not counting the floor)
1	5
2	29
3	185
4	1,241
5	8,525
6	59,189

Figure 8. Uprights used.

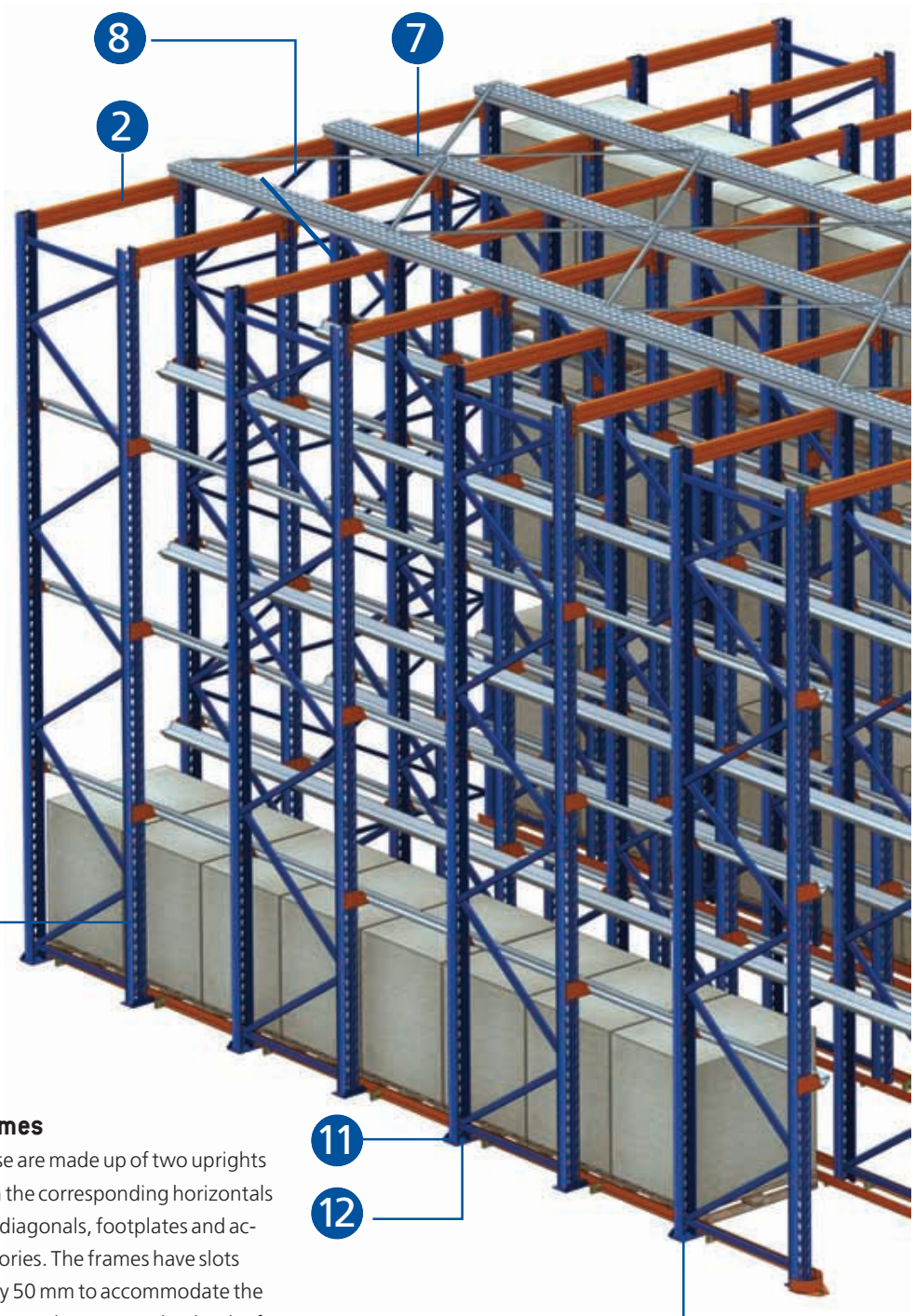


(in mm)

Components

The basic elements of a drive-in system

1) Frame
2) Drive-in beam
3) Bracket
4) GP-4 rail
5) C-rail
6) Upright footplate
7) Upper cross bracing
8) Back cross bracing
9) Guide rail protector
10) Guide rail
11) Levelling plates
12) Anchor bolts



Frames

These are made up of two uprights with the corresponding horizontals and diagonals, footplates and accessories. The frames have slots every 50 mm to accommodate the beams and supports. The depth of the frame is determined by the dimensions of the storage aisle and the height, measurements and weight of the pallets.

Upright footplate

This is part of the frame. It is designed to be fitted with two anchor bolts and the levelling plates.

GP-4 rail

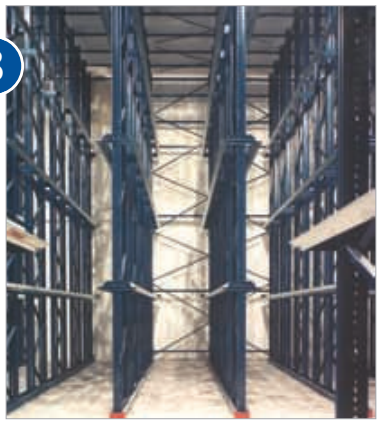
This is a pallet support profile, made of triangular-shaped galvanised steel. It enables pallet centralisation with minimal loss of space (50 mm). The profiles are supported on and joined to the uprights using GP-4 brackets.

C-rail

Steel clad C-shaped 100 mm-high profile for supporting pallets without centralising. Used when the load overhangs the pallets. Supported on and joined to the uprights using C brackets.

Guide rails and protectors

These make it easier for the forklift trucks to gain access around and reduce the possibility of accidental damage.



Cross bracing set

Depending on the layout, 2 adjacent aisles are cross braced to guarantee stability. The upper horizontal aisles must coincide with the back vertical aisles, as these transmit forces to the ground. The number of cross braced aisles will depend on the forces produced. These depend on the weight of the load, the height of the installation, the number of levels and the depth of the lane.

Construction system with a GP-4 rail

The GP-4 rail is ideal when all of the pallets to be stored are the same size, as it means that they can be centralised which eliminates the merchandise from colliding with the sides of the racking structure.

The fact that the GP-4 support is triangular in shape gives it a huge load capacity, with a loss in height of only 50 mm (the part of the profile that is under the pallet). This means that the space between levels can be reduced, or work tolerances increased (figure 1).

The aisle width is determined by the front measurement of the pallets plus the minimum necessary clearances. If the load overhangs the pallet, the aisle needs to be wider and the supports longer, as a minimum pallet support of 30 mm must be ensured when the pallet is completely displaced to one side, as indicated on page 71 of this catalogue (figure 2).

FRONTAL TOLERANCES (in mm)				
A	B	C	D	E
1.200	1.200	141	1.066	1.350
1.200	1.250	166	1.066	1.400
1.200	1.300	191	1.066	1.450
1.200	1.350	216	1.066	1.500
1.200	1.400	241	1.066	1.550

There is a minimum tolerance of 75 mm. For high pallets, we advise increasing this tolerance level.

The frontal dimensions are calculated for pallets measuring 1200 mm along the front, at the base. The same criteria must be used for pallets of other sizes (figure 3).

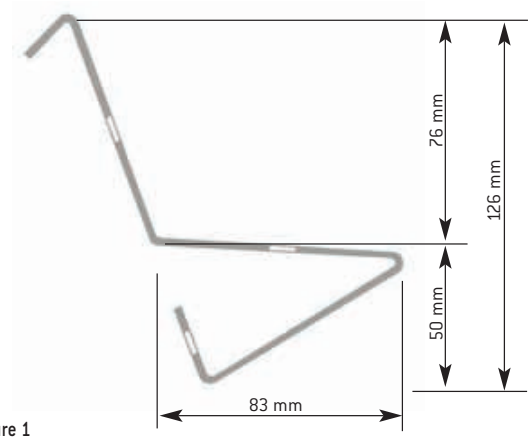


Figure 1

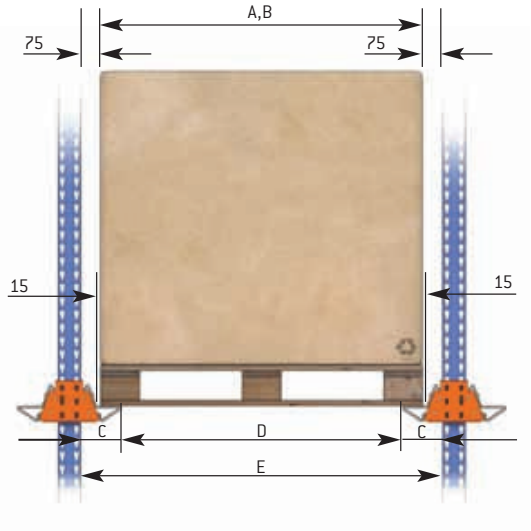


Figure 2. The load does not overhang the pallet.

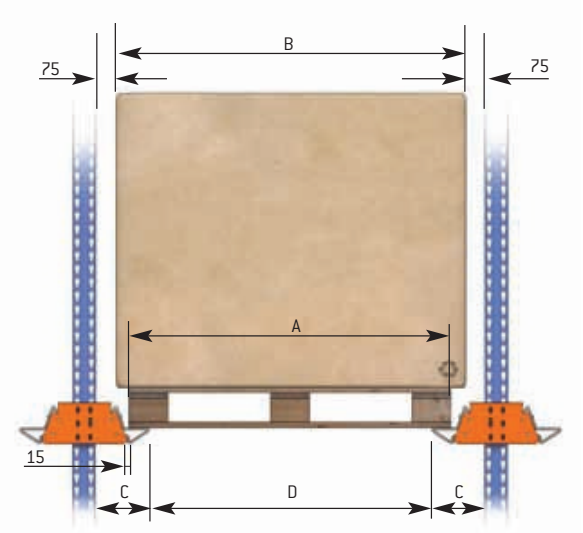


Figure 3. The load overhangs the pallet.

Height

The minimum height measurements required are as follows:

F: Height of the lower and intermediate levels = height of the pallets + 150 mm
G: Height of the upper level = Height of the pallets + 200 mm
H: Total height = at least, the sum of all the levels.

Dimensions F, G and H must always be multiples of 50 mm (figure 4).

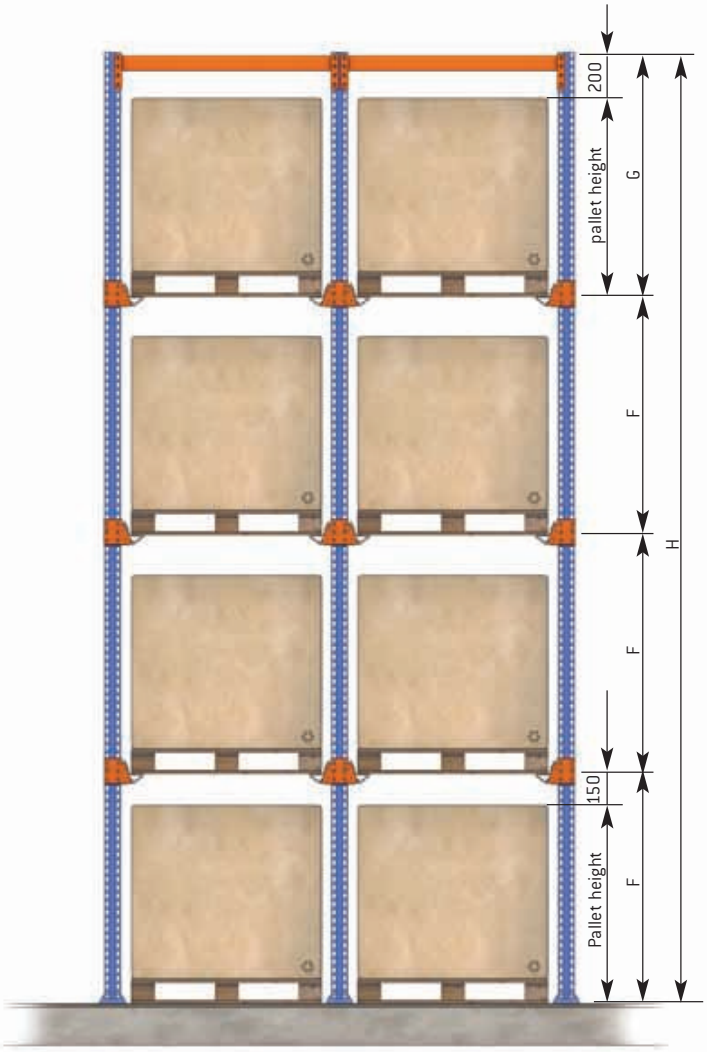


Figure 4

Depth

The minimum depth measurements to be taken into consideration are as follows:

X: Sum of the depth of all the pallets (if the load overhangs the pallet, this measurement must also be included) plus a positioning tolerance of between 35 and 50 mm per pallet, depending on the number of pallets (the greater the number of pallets, the smaller the tolerance that must be accounted for) (figure 5).

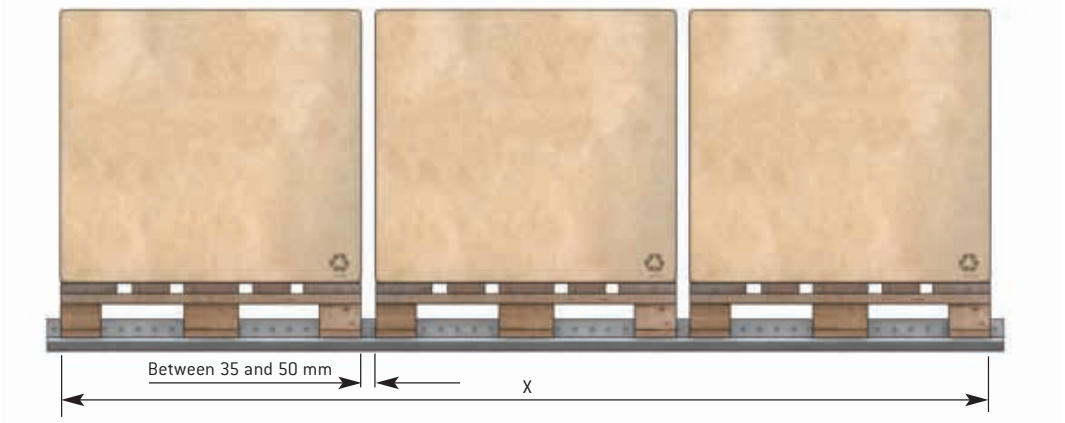


Figure 5

Construction system with C-rails

This system is installed when the pallets used have different frontal measurements, and for very large storage units requiring greater support tolerances.

With C-rails it is not possible to auto-centralise the different pallets that may be stored in an aisle. The system also means that the operators have to be more careful when manoeuvring forklifts (figure 6).

The pallets must be analysed before defining the support measurements.

The following illustrations show solutions for storing 1300 mm-and 1200 mm-wide pallets, where the load does not overhang the pallet in either case (figures 7 and 8).

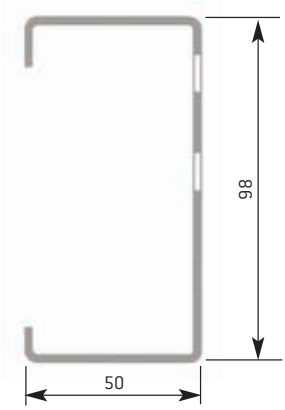


Figure 6

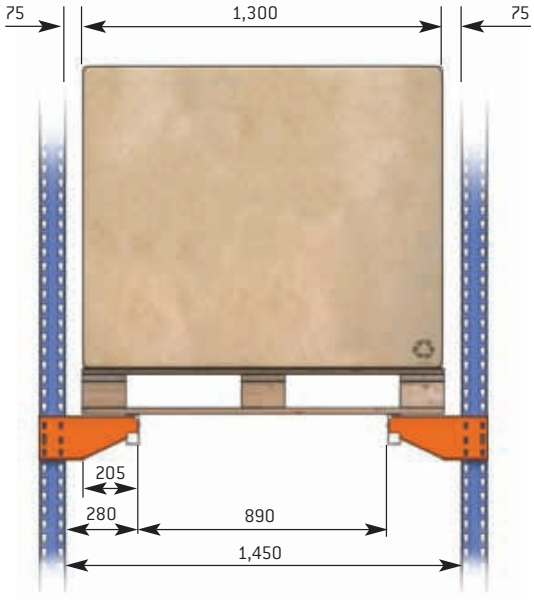


Figure 7

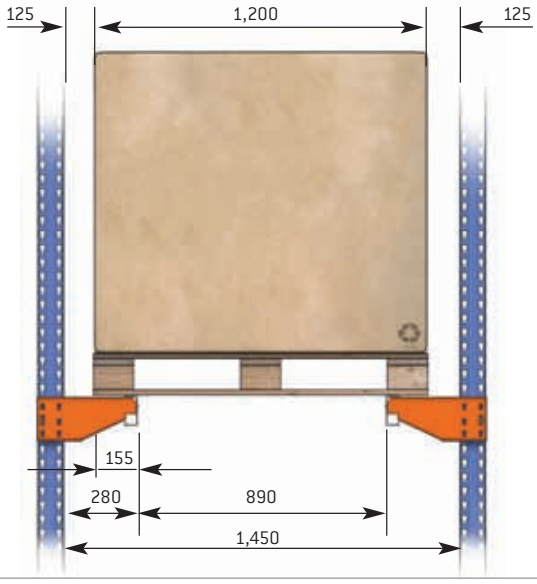


Figure 8

(in mm)

Height

The height tolerance levels to be taken into account are as follows:

F: Height of the lower and intermediate levels = Height of the pallets + 300 mm.
G: Height of the upper level = Height of the pallets + 200 mm.
H: Total height = at least the sum of all the levels.

Dimensions F, G and H must be multiples of 50 mm (figure 9).

For depth tolerance levels, use the same criteria as for the GP-4 rail (figure 5).

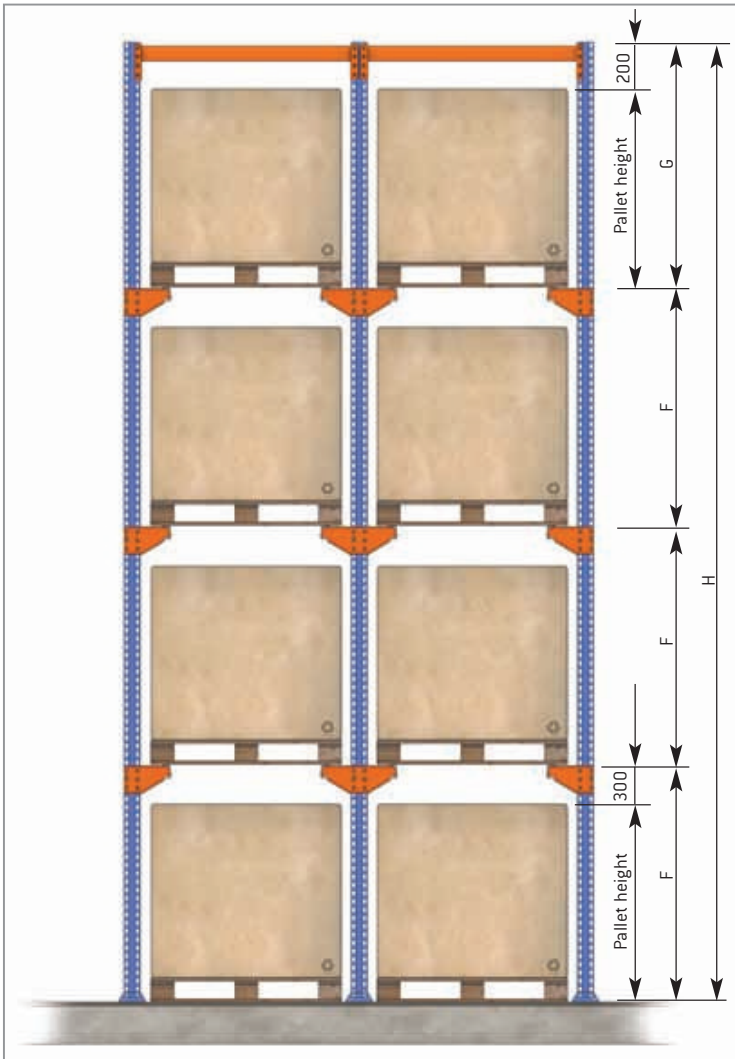


Figure 9

(in mm)

Lower guide rails

The guide rail system is used to:

- Prevent the pallets colliding with the sides of the racking structure.
- Enable the forklift trucks to be equipped with side wheels so that they are centralised when moving inside the storage aisles.
- Avoid the risk of the racking being hit, preventing possible damage to the load and simplifying manoeuvres.

It is advisable that they are installed in very long aisles.

Whenever guide rails are installed, it is important to bear in mind that the width of the aisle is calculated based on the distance the forklift needs to move, plus the width and tolerances of the rail profiles.

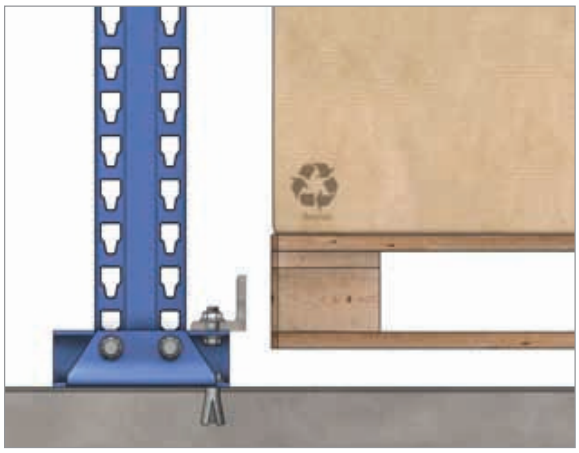
The most common system is that which uses LPN50 profiles set onto supports that are fixed to the ground, with centralising protectors on the front of the shelving units. These are joined to the profiles and also anchored to the floor.

This system prevents shocks and vibrations being transmitted to the racking structure itself.

Single or double profiles can be used in construction.

Guided, with single profile

The single-profile solution is sufficient when it is only necessary to guide the pallets.



The measurements between guides with LPN50 profiles and standard protectors are as follows:

TOLERANCES IN GUIDES AND STANDARD PROTECTORS (in mm)	
X	**Y**
1,350	1,240
1,400	1,290
1,450	1,340
1,500	1,390
1,550	1,440

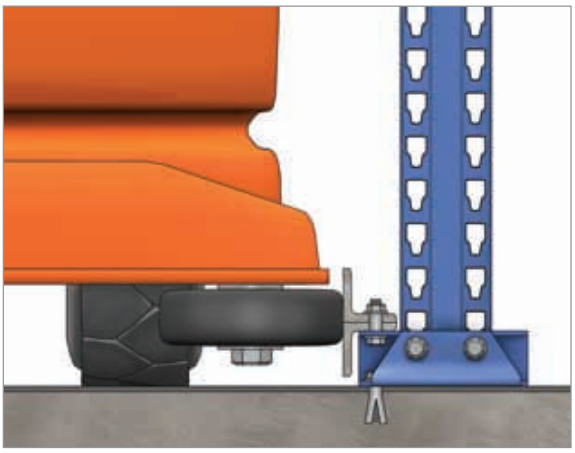
Another guiding system that can be used is with U-shaped profiles placed at the bottom of the racking uprights and held to the floor using the same anchor bolts.

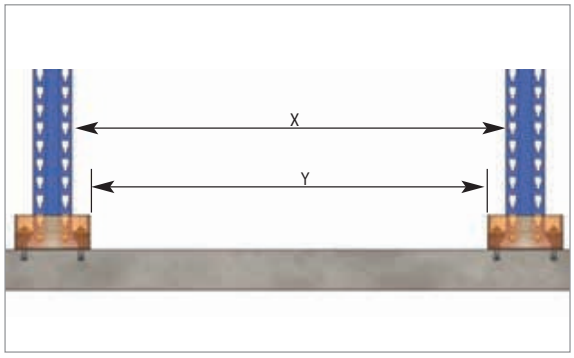
This guiding system allows for greater separation between guides for wide-chassis forklift trucks, without the need for wider aisles. Front protectors can also be installed.

Specific analysis is required before a particular system is chosen.

Guided, with double profile

The double-profile solution is more common when the machine is guided with wheels and the dimensions and shocks they transmit make it essential.

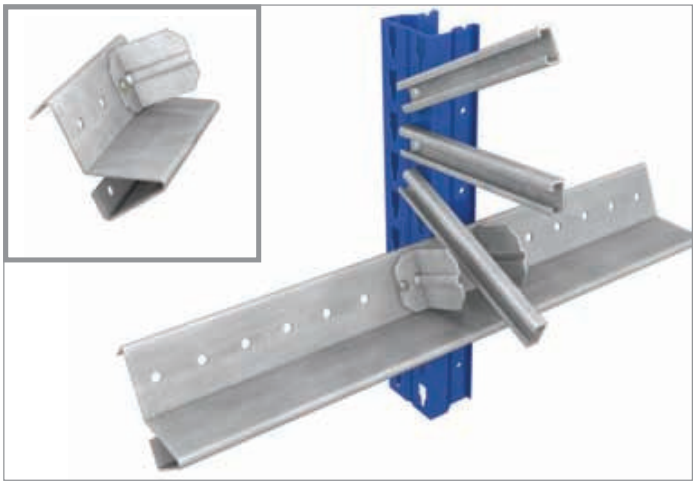




GP-4 rail stop

The GP-4 rail stop retains the pallet so that it does not hang over the rail at the back. There are stops on the two rails that make up a load level.

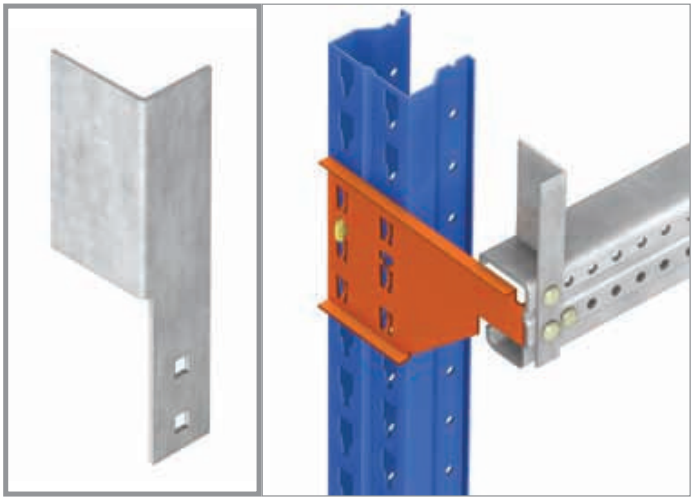
These stops can also be installed at the centre of a level to separate pallets in double access shelving units.



GP-4 rail stop.

C-rail stop

This is installed with C-type load rails. It has the same function as the GP-4 rail stops.



C rail stop.

GP-4 rail centralisers

GP-4 rail centralisers are installed at the end of GP-4 rails in each of the loading aisles of a compact pallet racking system.

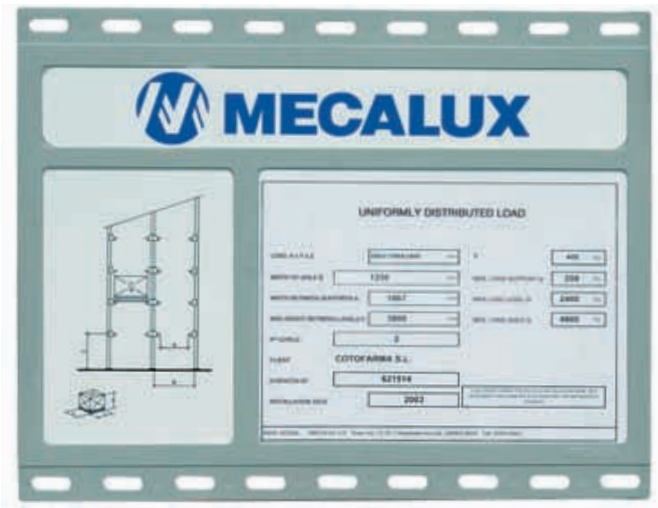
These are very strong injected plastic parts which are attached to the ends of the front parts of the rails. They help to guide the pallet at the entrance to each aisle.

Upright reinforcements

These are installed at the front of the first upright of each row of frames and provide protection against possible minor impacts.

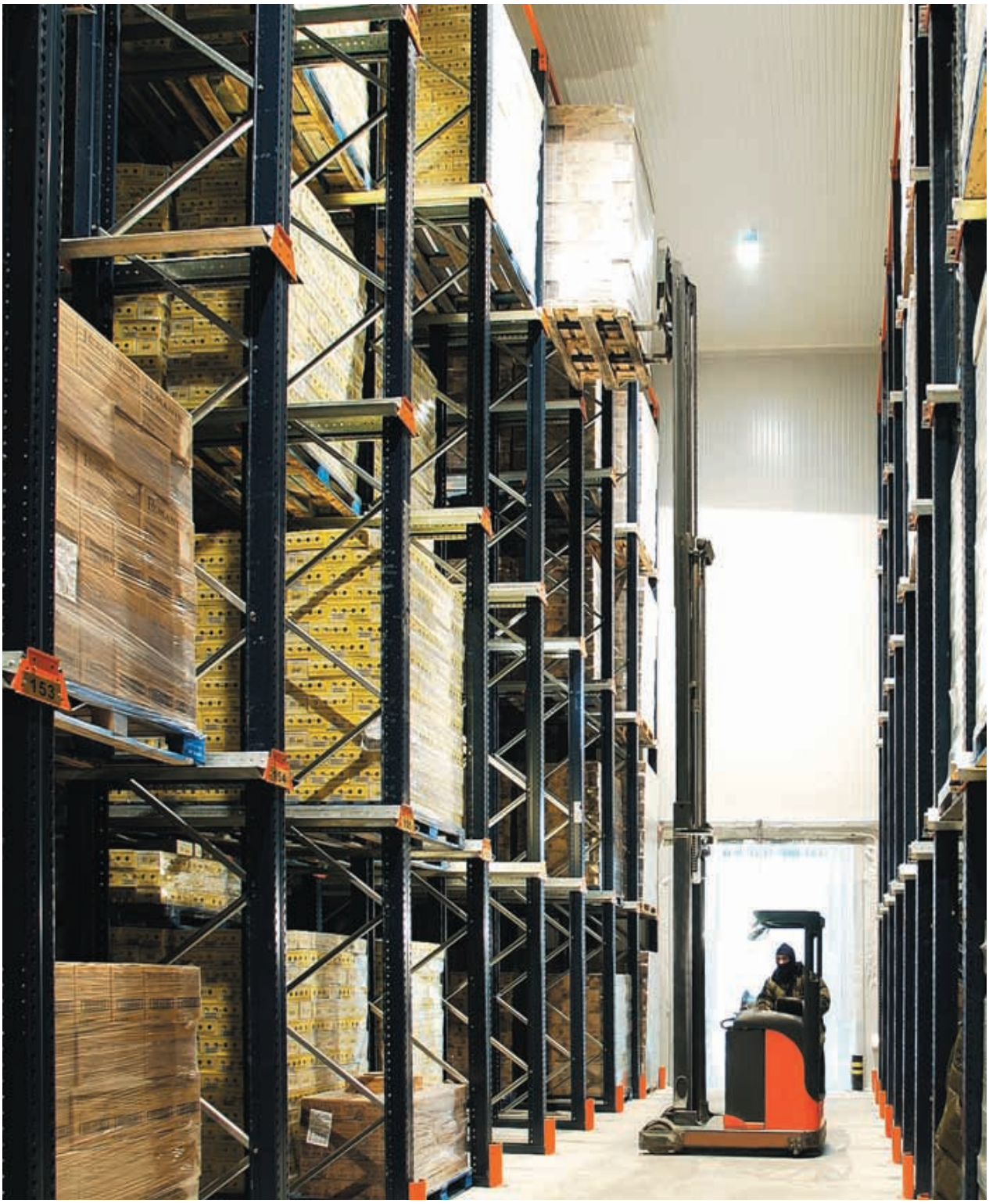
Loading signs

These signs describe the specifications of the installation, particularly the load capacity for which it was designed.



Cold Chambers with a Drive-in System

This storage system is widely used in cold chambers – both refrigeration and freezing – where it is important to make maximum possible use of the space set aside for storage of products at a controlled temperature.

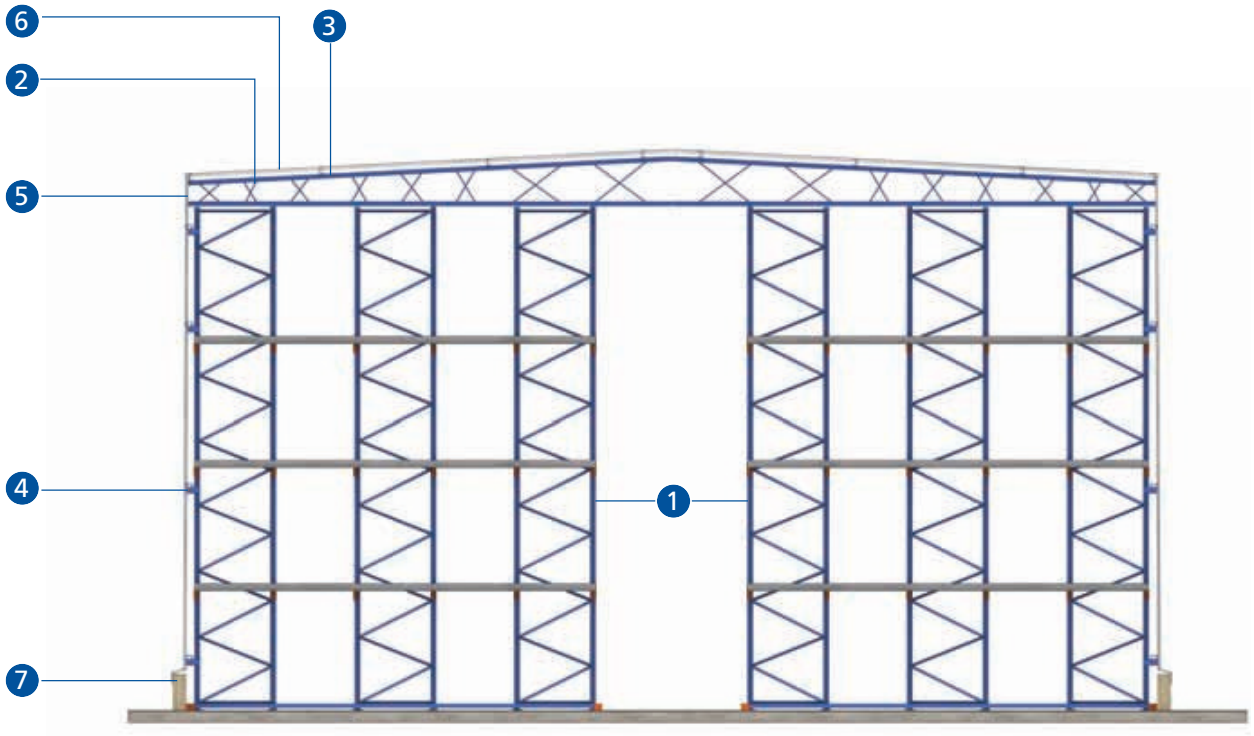


Integral Warehouses with a Drive-in System

Drive-in pallet racking can also be used to build self-supporting warehouses. The main characteristic of these warehouses is that there is no need for an existing building, which translates into time and cost savings.

In installations of this type, the racking structure support their own weight, the weight of the products stored in them and the corresponding additional forces, just like a traditional warehouse. In addition, they support the weight of the structure and protect against external forces (wind, snow, etc.)

These warehouses can be designed to store products at room temperature or as cold chambers.



Section B-B'

1) **Drive-in racking**
2) **Trusses resting on the racking structure**
3) **Roof joists**
4) **Façade joists**
5) **Façade cladding**
6) **Roof cladding**
7) **Watertight wall**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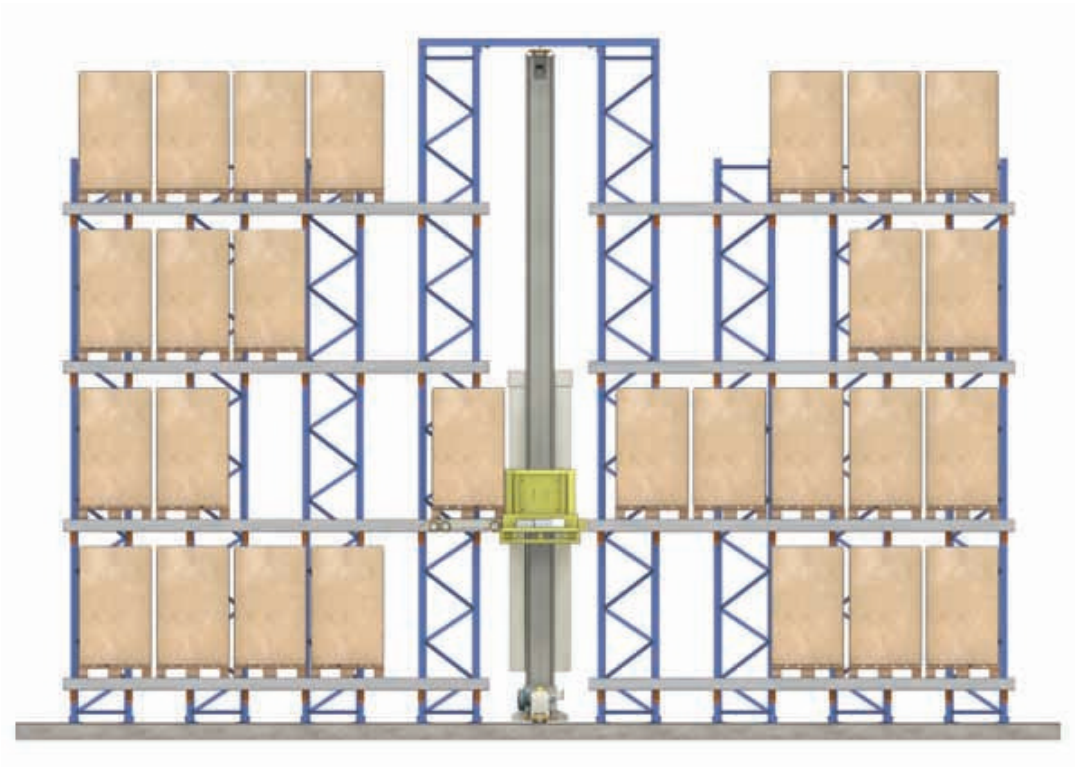
Automated Warehouses with a Drive-in System

The drive-in system is also used in conjunction with stacker cranes, which deposit a satellite trolley on the loading platform. This satellite trolley, which is directed by the warehouse management computer system, puts in and takes out pallets without human intervention.



Section B-B'

Installations of this type need to be studied in great detail. Mecalux recommends that you request further information from our technical and sales department.