zms systemy magazynowe®

VOLUME 3

PALLET RACKS

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OPERATION AND MAINTENANCE MANUAL FOR PALLET RACKS

Racks – a multi-level spatial structure intended for stacking of stocks.
Stationary racks – racks with their structural elements permanently fixed during the process of stacking of stocks; the racks may be fixed to the floor or not.
Frame racks – racks with recurrent framework systems as their basic structural elements.
Frame – a lattice structure composed of poles and braces. In commercial nomenclature, a frame is also referred to as a leg.
Poles – vertical bearing elements of the rack frame.
Braces – elements connecting poles and creating the frame of racks with poles.
Traverse beam – a horizontal beam connecting poles in a single socket; a pair of transverse beams constitutes a socket base.
Stacking level – the height of stacking place as measured from the floor level.
Socket – a stacking place limited with frames on the racks sides.
Pallet place – a place for one pallet in/on the rack socket.
A racks segment – a structure including two frames (legs) and a specified number of transverse beams creating sockets. One frame can be used for construction of two adjacent segments.
A series of racks – a structure made of one or several adjacent rack segments.
A block of racks – a structure made of one or several series of racks connected with one another with special elements referred to as inter-rack connectors.
A rack assembly module – a transitional stage in the process of assembly of racks (2 frames, 2 transverse beams).
A rack assembly module is not a rack and it cannot be loaded.
Rack loading – the weight of load placed on/in racks.
Nominal load (bearing capacity of a rack) – maximum weight of load placed on/in racks and specified by a manufacturer.
Longitudinal static stability of racks – ability of racks to maintain permanent balance (of the whole structure and its elements) under the influence of horizontal forces along the vertical longitudinal plane of the rack symmetry.
Transverse static stability of racks – ability of racks to maintain permanent balance (of the whole structure and its elements) under the influence of forces perpendicular to the vertical longitudinal plane of the rack symmetry.
Components of racking systems:
Basic elements of the system – parts indispensable for proper assembly of one- or multi-segment series of racks.
Additional elements of the system – parts installed in warehouse racks as necessary to comply with additional conditions imposed by a design. For some solutions additional elements are mandatory, which is always indicated precisely by a design or OMM [Operation and Maintenance Manual].
Accessories – elements allowing for provision of tailored structures. Accessories are not mandatory and can be used optionally in order to improve using of the system.

The system is a family of high-bay stationary frame racks, shelf racks and racks with stationary shelves (up to 12 m).

The idea of a racking system involves an option to construct series of racks composed of one, two or several segments with various numbers of stacking levels in each of them. The use of recurring basic elements (frames and transverse beams) allows for a flexible attitude to designing of warehouse space. The wide range of products and their diversified characteristics make it possible to select tailored solutions. All elements are assembled only with the use of screws and clicks, which gives an opportunity to reuse the system components. One common frame is used for construction of two adjacent segments when creating series of racks in HX system.

Configuration of a warehouse rack – spacing of poles, mutual location of series of racks and their length is determined as based on a customer's needs and in consideration of admissible load of the structure and conditions ensuring static stability of the same.

Fig. 2 and 3. Basic measurements of EPAL-EUR pallet.

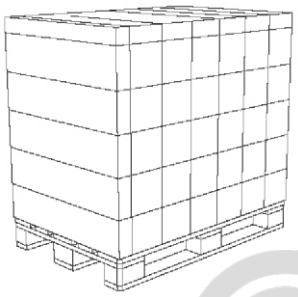


Fig. 2. EPAL-EUR type pallet with load

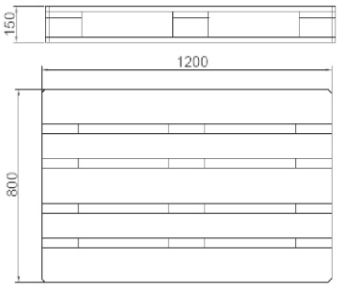


Fig. 3. Basic measurements of EPAL-EUR pallet

Fig. 4. 1200 x 1200 pallet with load

Components of HX systems, their size relations and envisages recommendations relating to organization of a warehouse have been created, above all, for stacking of goods with the use of EPAL-EUR flat wooden pallets. A pallet with its load constitutes a standard loading unit.

Fig. 4. 1200 x 1200 pallet with load

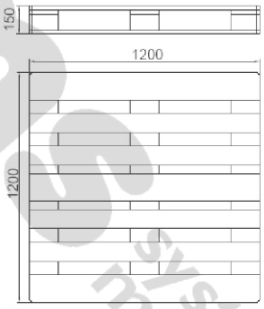


Fig. 5. Pallet measurements

Fig. 5. Measurements of an industrial pallet

In order to enable stacking of non-standard loading units (pallets with other measurements) and non-palletized stacking (goods in bulk, easily rolled goods etc.), accessories such as separators, shelves and lattices have been used. However, this requires additional agreements and has to be approved by designers of the manufacturer of racks.

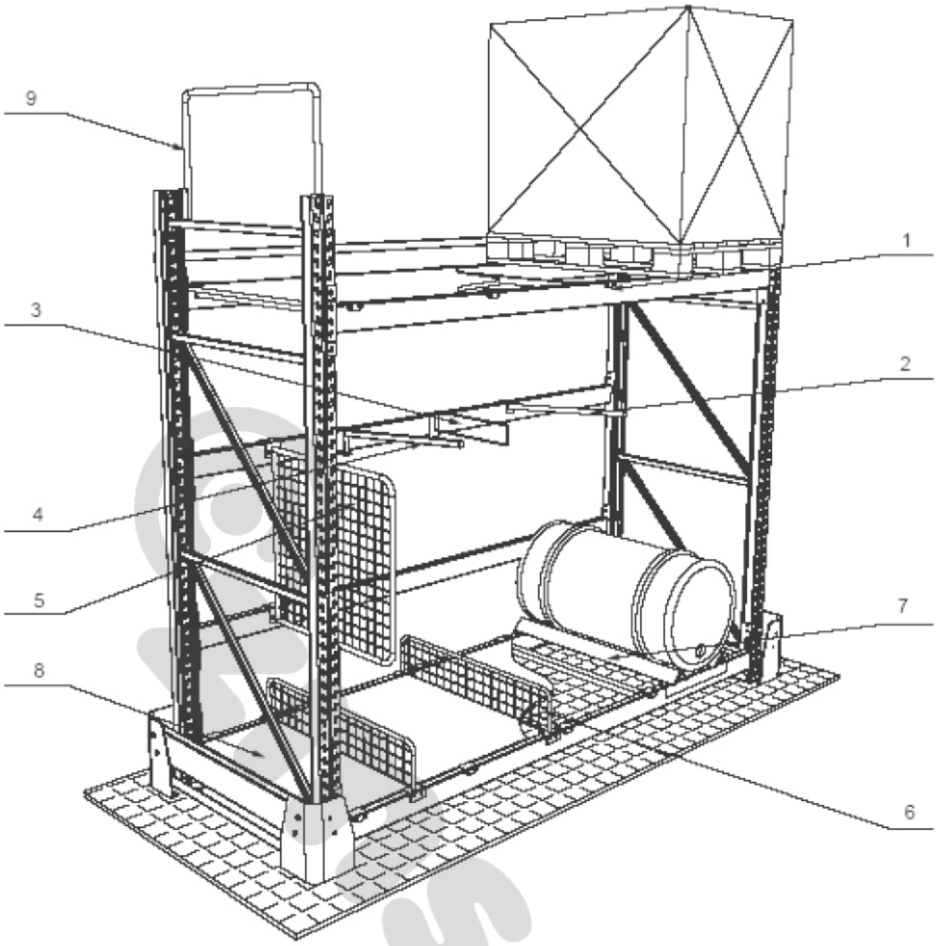
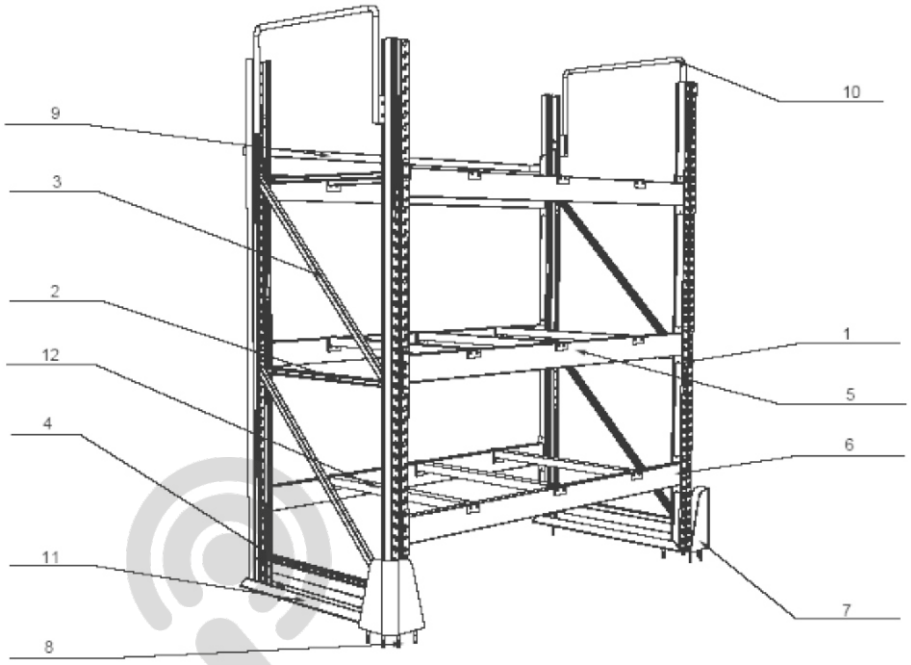


Fig. 6. Applications of HX system of racks: Accessories: 1 – a beam; 8 – a shelf, 9 – side pallet protection for the shelf, 2, 3, 4, 5, 6, - separators; 7 – a base for easily rolled elements

Fig. 7. A single segment of HX racks
Basic elements: 1 – a pole (section, foot, screws with nuts); 2 – a horizontal brace; 3 – a diagonal brace, 4 – a screw, nut, spacing sleeve; (points 1-4 create the rack frame (leg); 5 – a traverse, 6 – a traverse protection. Additional elements: 7 – a corner bump rail; 8 – an anchor: 9 – rear pallet protection; 10 – side pallet protection, 11 – a reinforcing beam for the frame, 12 – a transverse beam



The frame in HX system is a lattice structure made of two poles connected with braces. The poles are made of perforated open steel sections with external measurements of 82x70 and 102x70. In the poles there are two rows of assembly homes located vertically every 50 mm.
Hx82 pole Hx122 pole Hx102 pole

Fig. 8. A complete rack frame (leg) before and after assembly
The frame with a system of “S” braces The frame with a system of “ZZS” braces

The frame with a system of “S” braces The frame with a system of “ZZS” braces

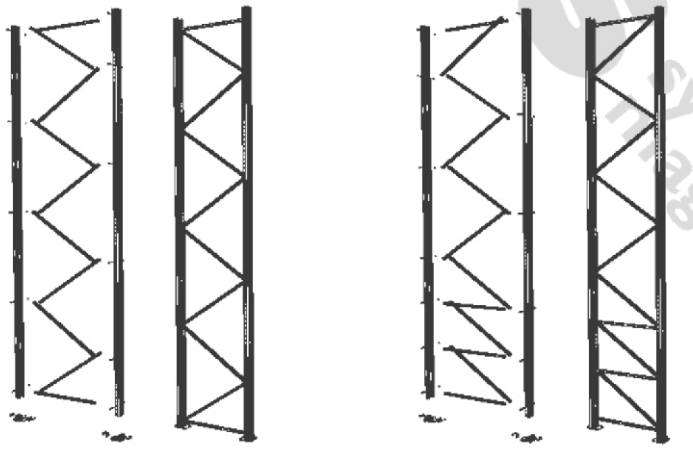
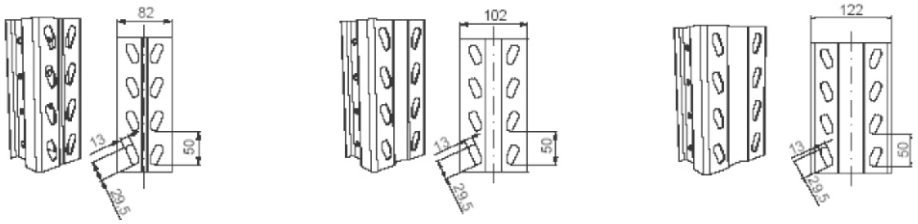


Fig. 8. A complete rack frame (leg) before and after assembly

Leg (frame) poles of HX raking system create a type series with its measurements allowing for construction of frames with diversified bearing capacities so that, in each case, it would be possible to select an optimum solution. Available poles enable construction of frames with total bearing capacity up to approx. 17000 kg.
In order to avoid errors with assembly, extension or any replacement of damaged elements, every pole is marked with a symbol containing, among others, a manufacturer’s sign, pole symbol and production date (year).



HX82 pole HX102 pole HX122 pole

Spacing between poles in frames (rack depths) have been selected for typical sizes of pallets, in consideration of the condition of correct placing of pallets on spreader beams (acc. to FEM 10.3.01). However, depths of typical pallet racks cannot be lower than 600 mm and higher than 1150 mm.

The foot, on which a pole stands, ensures correct carrying of load onto the floor and the system of holes facilitates driving of rotary hammers and enables selection of a hole for an anchor. This is particularly important, if under one of the holes in the floor, the floor is reinforced or features an expansion gap.
Braces serve joining two poles in a frame complex. Due to the method of fixing, we can distinguish between two types of braces:
- horizontal – mounted perpendicularly to the poles
- diagonal – mounted between two subsequent horizontal braces

Traverses are steel beams intended for fixing to rack legs in order to create a stacking level.
HX system features a series of traverses diversified with respect to sizes, types of sections used and bearing capacity resulting from the above. Each traverse ends with lugs allowing for fastening of the same in perforation of the leg pole. Additionally, owing to high rigidity of the beam-pole hook connection, traverse beams ensure longitudinal static stability of the racks. In order to prevent accidental lifting and puling of traverses by transport equipment, protection elements are used as mandatory.

Fig. 9 Fastening of a traverse with MX-A00010053 protection
Fig. 9 A traverse

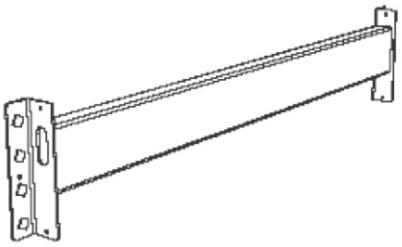


Fig. 9 A traverse

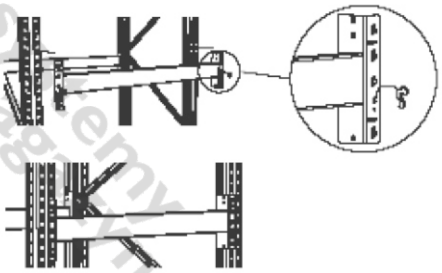
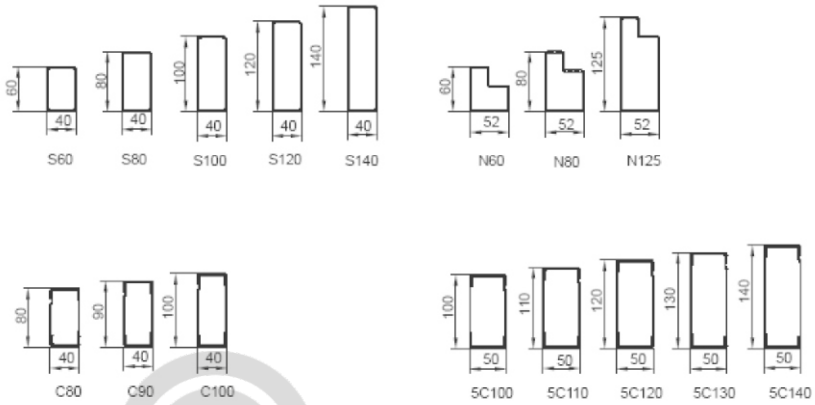


Fig. 9 Fastening of a traverse with MX-A00010053 protection

Traverse beams are made of various types of steel sections with their cross-sections and markings presented below.

Fig. 10 Available transverse sections

Traverse beams are made of various types of steel sections with their cross-sections and markings presented below.



Depending on properties of a section, lugs with the height of 200 or 250 mm are used.

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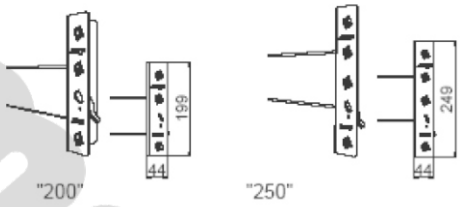


Fig. 12 Two standard types of traverse lugs: 200 mm, 250 mm

Fig. 12 Two standard types of traverse lugs: 200 mm, 250 mm

Considering specific demands of some users, transverse beams are welded to lugs in three positions:

- upper – so-called upper traverse
- standard
- lower – so called lower traverse

Fig. 11 Location of lugs determining a traverse beam type:
a) upper, b) medium, c) lower

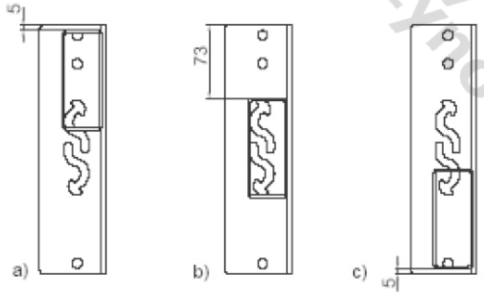


Fig. 11 Location of lugs determining a traverse beam type:
a) upper, b) medium, c) lower

Protections constitute a separate group of the system components. These are additional elements, which in some cases, are necessary in order to ensure safety of use of the system.

Fig. 20 Side protection

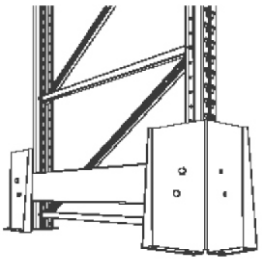


Fig. 20 Side protection

Despite absence of recommendations specified in standards and as based on long experience in organization of warehouse spaces, we suggest using protective elements of side walls of racks/series of racks. Owing to use of a beam, elements protect rack braces, which is particularly important in busy warehouses with limited space for preparation of load.

Accessories and additional elements allow for adjustment of the structure to a customer's requirements and adjustment of the same aims at improvement of use of the system. Accessories and additional elements offered by the manufacturer are fully compatible with HX system.
Available sizes and types can be replenished, depending on a customer's individual demands. The products offered are included in the company's catalogue of products.

Principles of stacking of materials in a socket (a view of the rack front)

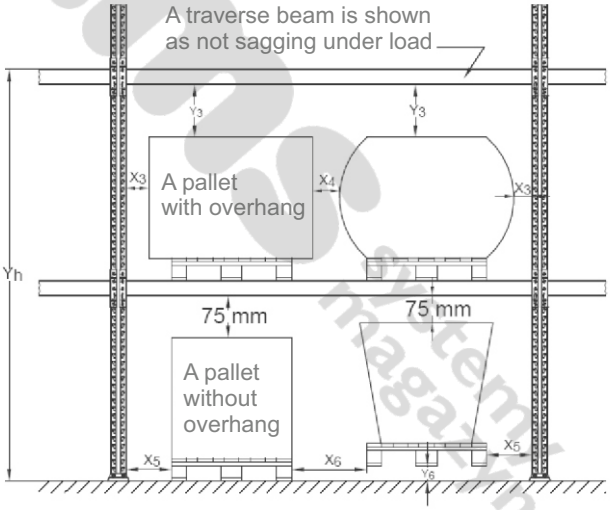


Fig. 21 Minimum spacing in the socket as required under FEM 10.2.03

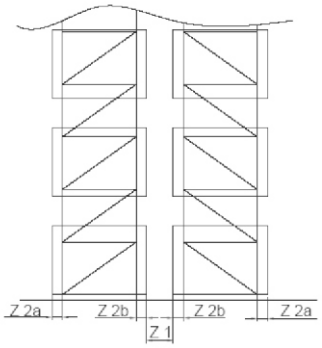
Fig. 21 Minimum spacing in the socket as required under FEM 10.2.03

- **300A** – racks handled with the use of loading trucks equipped with a carriage lifting an operator up to the stacking level
- **300B** – racks handled with the use of trucks with an operator's cabin located on the floor level
- **400** – racks handled with the use of trucks controlled and supervised from the floor level, with the boom height of up to 11 m with an option of maneuvering of the truck with goods lifted.

	Regały klasy 400		Regały klasy 300A		Regały klasy 300B	
Wysokość umocowania gniazda Y_h do... [mm]	X_3 X_4 X_5 X_6	Y_3	X_3 X_4 X_5 X_6	Y_3	X_3 X_4 X_5 X_6	Y_3
3000	75	75	--	--	--	--
6000	75/100	100	75	100	100	100
9000	75/100	125	75	125	125	125
12000	--	--	75	150	150	150

Fig. 22 Minimum required spacing between loads in a double series

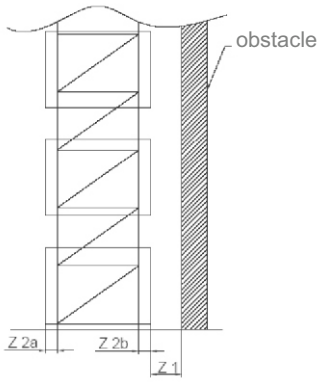
Principles of stacking of materials in a socket (a view of the rack side), double series



Z2a, Z2b – a pallet overhanging the socket traverse breams. Z1 – spacing between loading units
Ideal: Z2a = Z2b = 50 mm
Z1 = 2Z2a = 100 mm
Admissible: 2 x Z2a 60 mm
Recommended: 0 Z2 100 mm
40 mm Z2b 100 mm
Z2b Z2a

Fig. 23 Minimum required spacing between loads in a single series

Principles of stacking of materials in a socket (a view of the rack side), single series



For a single series of racks (rack):
Recommended: as for a double series
In cases, where a series of racks is limited by an adjacent obstacle (a building wall, pallet protection etc.)
Recommended: Z2a = 50 mm
Z1 Z2a
Admissible: Z2a 30 mm

Transport aisles

The minimum width of transport aisles depends on the type of loading trucks used in a warehouse (method of loading, truck size, methods of driving in the aisle).
FEM 10.3.01 standard distinguishes among 5 types of loading trucks. The minimum required width of an aisle is determined as based on division of the aisle into groups considering sizes of a truck and loading unit. For forklift trucks with front loading, the aisle has to be at least 200-300 mm wider (in case of busy traffic – 350 mm) than the maximum width of the lift truck (measured diagonally) with load, in consideration of space required for rotation (turning) of the lift truck with its front to the rack front during loading.
For warehouse trucks with side loading, which do not have to rotate when loading, the aisle has to be 200-300 mm wider (in case of busy traffic – 350 mm) than the maximum width of the truck with load.
As recommended by a standard relating to the sector, the aisle has to be marked with lines painted on the floor. For individual designs, the width of aisles is determined as based on information provided by the customer and such information constitutes a document prevailing over general recommendations included in an OMM.

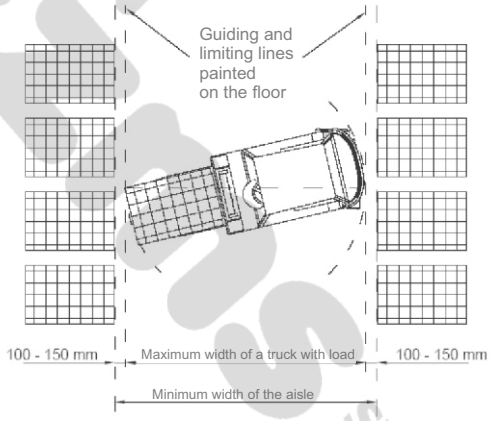


Fig. 24 Minimum measurements of aisles under FEM 10.3.01 (in case of a truck with front loading)

3.5. Bearing capacity (admissible load)

3.5.1. Requirements relating to the floor

The floor should carry any loads from a structure of fully loaded racks placed on the floor.

Important!

Under prEN 15629:2007 (E), a facility owner or investor is responsible for ensuring of the floor with appropriate bearing capacity. A proof of appropriate construction of racks is given with the assumption that the floor is characterized by appropriate strength and rigidity in order to carry the assumed loads.

The remaining part of this chapter includes information and descriptions of general principles of selection of determination of properties of the floor, on which warehouse racks will be installed as well as principles of installation of racks on the floor. The floor is understood foundations and floor cooperating with each other and placed on the ground with specified properties.

Floors – top layers

The floor material is commonly understood as top layers of the floor such as asphalt, paving blocks, concrete and its resin finishing.
Apart from appropriate compressive strength, top layers of the floor should enable carrying of full extracting loads as declared by the manufacturer of anchors and ensure permanent character of all strength parameters. Due to the fact that it is impossible to ensure effective anchoring, paving blocks (Bauma or other) are not applicable for responsible structures of warehouse racks. For the same reasons, asphalt floor is not recommended either – both materials are subject to subsidence, in this case being uneven subsidence, of the rack feet, which causes high deviations from the vertical of rack poles during use.
As the phenomenon of subsidence of racks on asphalt floor is usually connected with local exceeding of bearing capacity onto pressures, the type of floor can be admitted under conditions of appropriate anchoring. However, it should be remembered that pressures for asphalt are approximately 24 times lower as compared to concrete. This means that loading of a rack placed on asphalt floor should be decreased by 24 times as compared to admissible loading of racks installed on the recommended concrete floor.

The floor structure

The whole floor structure affects its strength. The floor constitutes the ground cooperating with foundations and structures layers set on it and creating the floor.

Determination of strength should start with determination of bearing capacity of the ground, on which the floor structure is to be built.
f004 and FEM 10.2.02 (prEN 15512).

Depending on known loads of warehouse racks and assuming that loads, in a global aspect, constitute a system of point applied forces and, locally, they constitute permanent loads (pressures), the floor structure should be checked and planned so that it could ensure correct operation of the racks.
Considering the above-mentioned assumptions, a constructor should show appropriate strength of the floor to combinations of loads of the floor structure and foundations as provided for in PN-EN 1991-1-1:2004 and FEM 10.2.02 (prEN 15512).

Deformations

The floor structure in a high-bay warehouse should be prepared in consideration of behaviour of racks. In this case, location of expansion gaps and floor ribbing supports, in which greatest deformations (flexions) are to be expected, are particularly significant. Normative assumptions relating to the value of inaccuracies in assembly or structure imperfections should be increased by the expected floor deformation values, which may lead to decrease of load capacity of the racks.

Important!

Racks should not be installed above expansion gaps.

Admissible inaccuracies in delivery of the floor

Admissible values of deviations from the reference level are specified in table 1 (prepared on the basis of prEN 15620:2007, a draft European standard).

Table 1. Admissible values of deviations of the floor between adjacent nodal points of the grid with the scale of 3 m.

Classification	Rack height	Deviation
Racks handled by trucks without an option to move pallets	Above 11 m	2,25 mm
	From 8 to 11 m	3,25 mm
	Up to 8 m	4 mm
Racks handled by trucks with an option to move pallets	Any	4 mm

Additionally, no point of the grid with the scale of 3 m should deviate by more than 15 mm from the reference level for the entire facility or its considerable parts (e.g. warehouse part).
prEN 15620:2007 also includes recommendations relating to flatness of the floor, considering lift trucks operating in the warehouse.

Important!

In accordance with requirements of FEM 10.2.02, every rack structure has to be verified with respect to its strength and static stability. The verification is made by a supplier of racks before final approval of the design.
A structure described in the verified design can only be deemed a safe structure.

Complete documentation includes:
1. A document confirming verification of static stability of the structure (a Statistic Calculation Report)
2. A vertical view of arrangement of racks and necessary cross-sections and drawings showing details of special equipment.
3. Characteristics of racks with precise descriptions of bearing capacity of every rack segment in the warehouse.

The tables referred to in par. 3 enable a user to place in appropriate places in the warehouse with plates marks with admissible load capacity of racks used.
Racks are marked with plates and stickers. Chapter 4.7. Marking (page 32).
Complete documentation should be delivered to a user on commissioning of the structure of racks at the latest.

Important!

Powder-coated elements have to be stacked in closed rooms.
Stacking of powder-coated elements of racks in a different manner will result in loss of guarantee rights.

Assembly of a rack leg

RACK LEGS ARE DELIVERED AS ASSEMBLED AND READY TO BE STOOD VERTICALLY. Poles arranged as parallel are connected with dedicated braces using delivered screws, nuts and spacing sleeves. The fee of rack legs should be screwed to the created lattice.

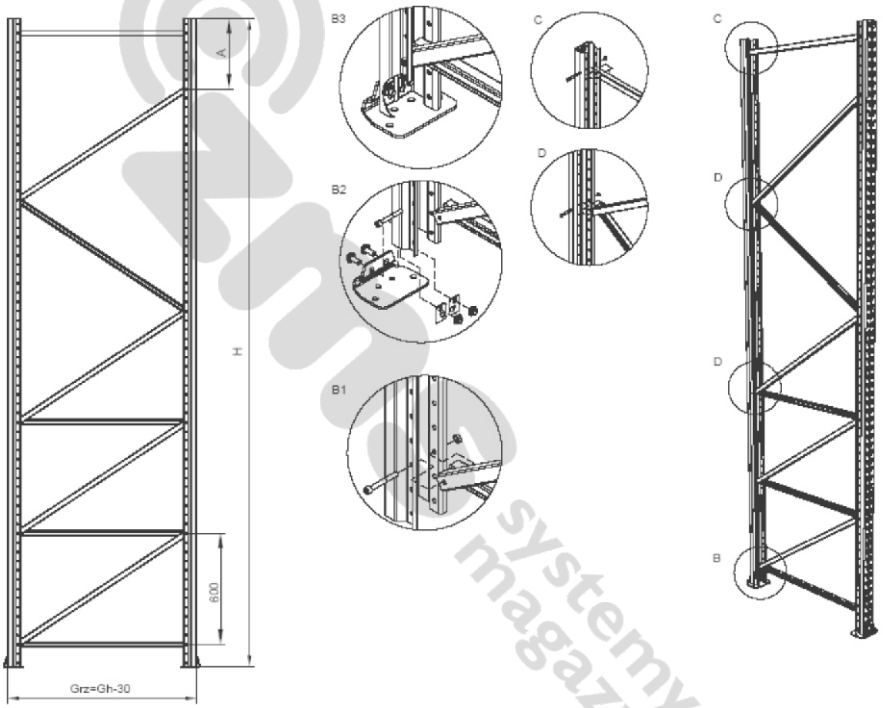


Fig. 25b Assembly of a frame with HX 92 (ZZS) poles. ZZS brace system.

The list of parts in a single HX 82 (ZZS) frame

Leg height H [mm]	Leg section	Horizontal brace	Diagonal brace	L-47 sleeve	M8x65 screw	M8 nut	Foot	Fixing washer	M10x25 screw	M10 nut
2600	2	4	4	2	9	9	2	2	4	4
3200	2	4	5	2	10	10	2	2	4	4
3800	2	4	6	2	11	11	2	2	4	4
4400	2	4	7	2	12	12	2	2	4	4
5000	2	4	8	2	13	13	2	2	4	4
5600	2	4	9	2	14	14	2	2	4	4
6200	2	4	10	2	15	15	2	2	4	4
7000	2	4	11	4	17	17	2	2	4	4

Setting up of racks

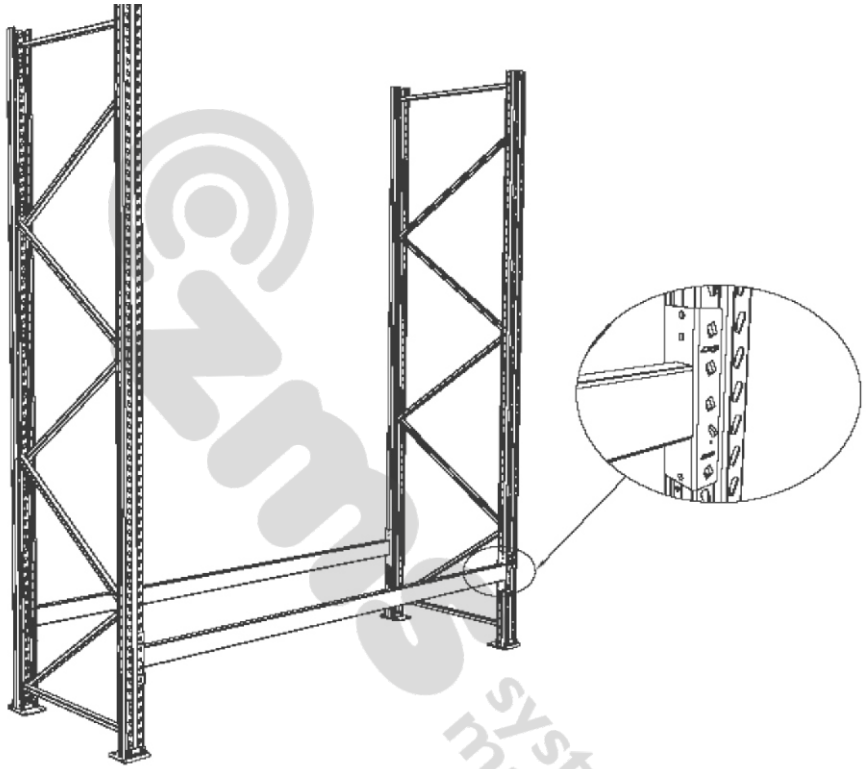


Fig. 26 A complete rack assembly module

Two complete rack legs and two traverse beams are used for setting up of a single rack assembly module. A rack assembly module is not a proper rack and it is not suitable for carrying loads!
In order to set up an assembly module, lift two legs to working position (vertically) and then fasten them with two traverse beams (4 traverse beams should be used for modules with the height exceeding 4 m). The traverse beams should be fastened at an even level up to 0.4 m above the floor and an additional pair of traverse beams (if necessary) can be fastened at a level above 1.0 m.

Important!
Every traverse beam fastened has to be protected with two protective elements.

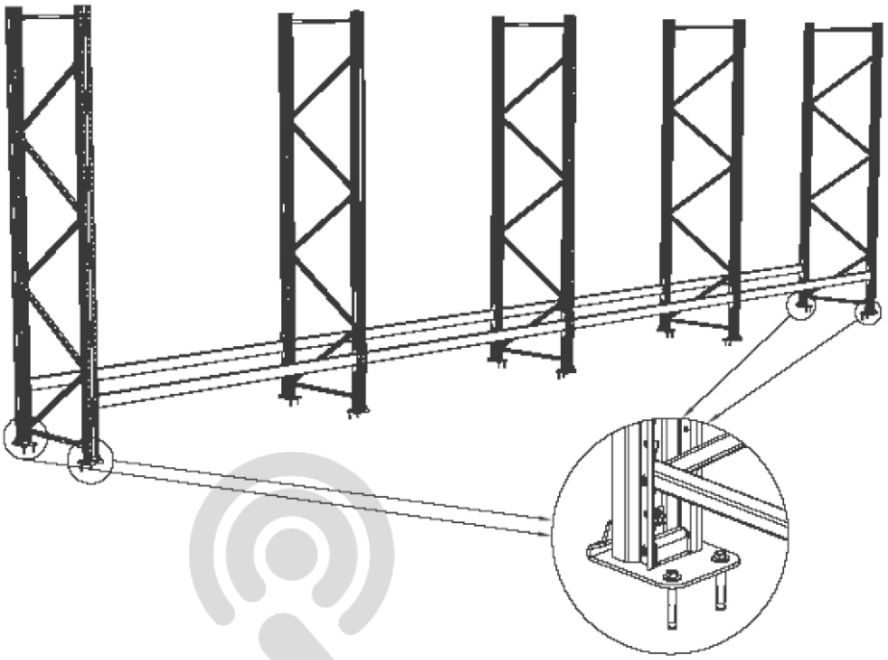


Fig. 27 A complete series of assembly modules

Following verification of correct arrangement of legs, anchors for fastening of legs to the floor should be added. If necessary, a series should be levelled with the use of a levelling inserts.

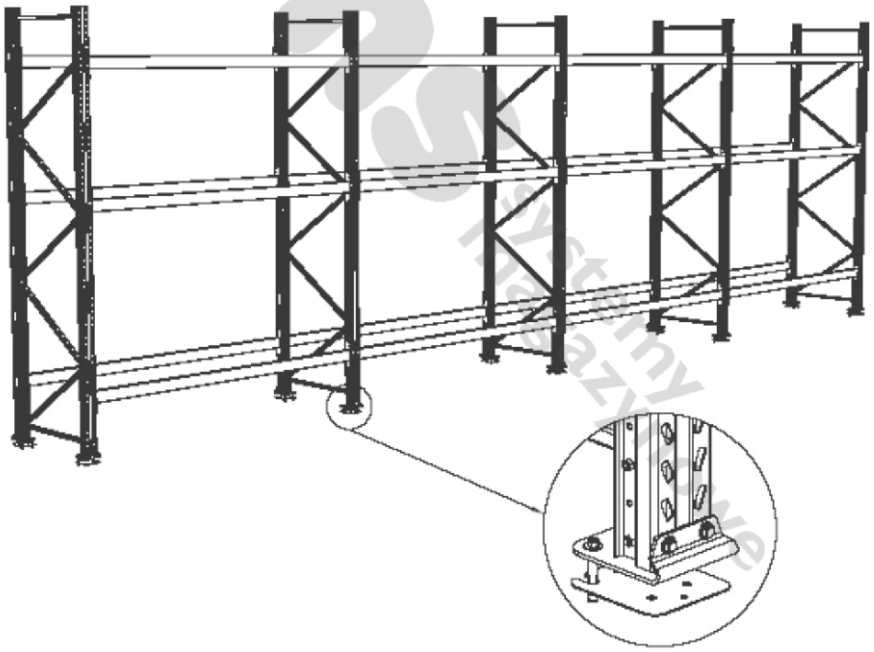


Fig. 28 Levelling of a series of racks with the use of inserts

A single series – in order to create a series of racks, a series of assembly modules should be created. Extension of a series involves attachment of subsequent legs with traverse beams (creating of subsequent assembly modules).

A double series – for assembly of double series, maintenance of a distance between the same is very important. Parallel assembly of both series is recommended. Rack frames should be stood symmetrically to one another.

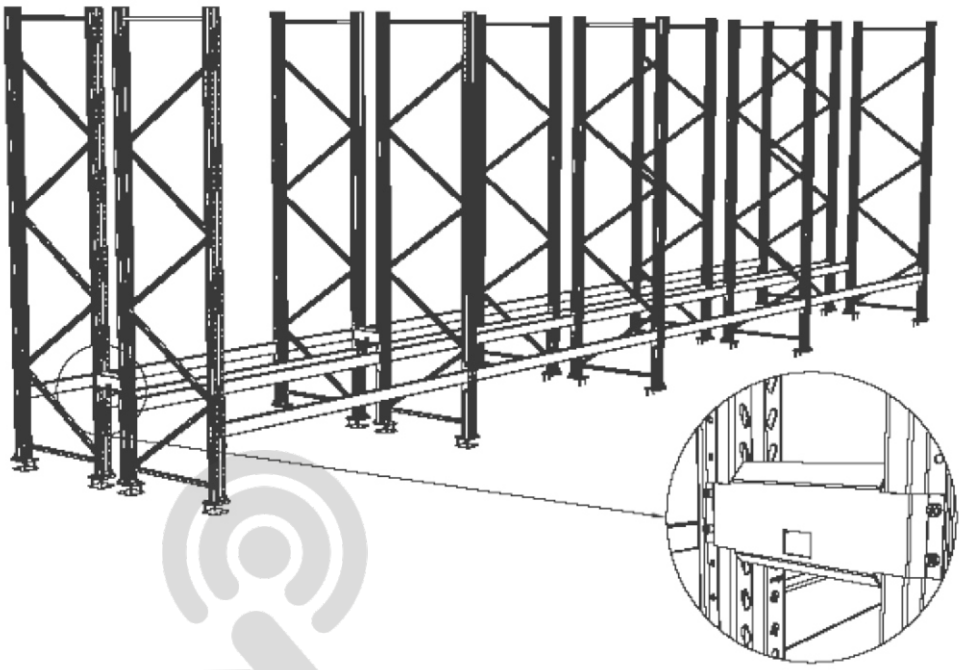


Fig. 29 A complete double series of assembly modules with braces

After setting up of a double series of rack assembly modules (similar to a single series), check their mutual arrangement and, if necessary, level with the use of levelling inserts. Following necessary adjustments of arrangement, feet should be anchored to the floor.

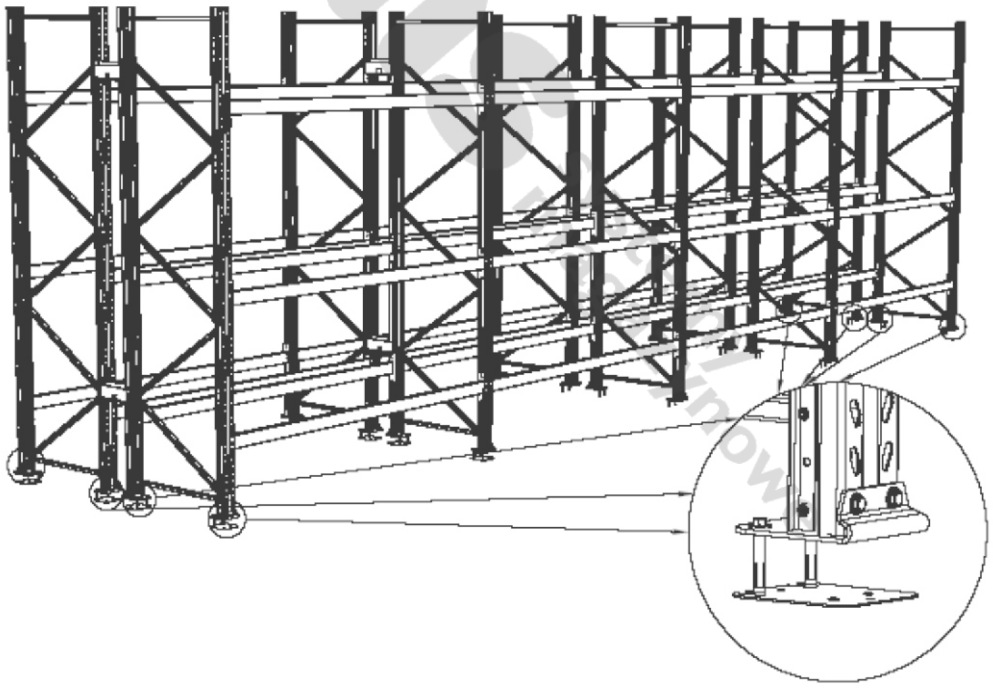


Fig. 30 A complete double series of racks

Anchoring

The number of traverse beams as indicated in a design is added to anchored series of racks. Every transverse beam has to be protected.
After setting up of series of racks, protections (bump rails) provided for in a design are installed.

The remaining elements and accessories provided for in a design are installed as part of the last stage of assembly of the system.

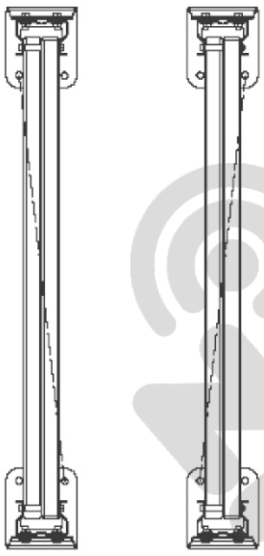


Fig. 31 A recommended arrangement of anchors for a single frame.

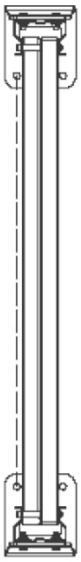


Fig. 32 Arrangement for an outer lane of a series of racks (4 anchors)

The rack frames have to be fastened with anchors to the floor, if the height of the rack exceeds 4 time sits depth and in cases described in the paragraph relating to static stability. Steel anchors should be used for heavy fastening in solid materials. An anchoring element and bump rails should be attested by ITB or other authority for the above-mentioned applications and for racks to be used in a contained space protected against the wind anchors should be characterized by minimum admissible load for pull-out from the floor equal or greater than 4 kN.

The accuracy of assembly

Based on recommendations of annex B in FEM 10.3.01, the tolerance of assembly of racks (a series of racks, a group of racks/series of racks) should fall within limits specified in the below tables:

Horizontal tolerances for X and Z directions		
SPECIFICATIONS	RACK CLASS	
	400	300 A and B
A - A deviation from the nominal size of the width of a socket. (A distance between both leg poles above any of the stacking levels)	± 3 [mm]	± 3 [mm]
At – A deviation from the minimal length of a series or racks as a resultant of deviations of “n” number of segments/sockets in a series of racks. Measured on the floor level.	± 3n [mm]	± 3n [mm]
B		
B – Deviations in alignment of opposite poles arranged on opposite sides of the driving aisle. A resultant of deviations for “n” number of segments/sockets. Measured on the floor level.	± 10 [mm] or ± 1,0n [mm]	± 10 [mm] or A: ± 1,0n [mm] B: ± 0,5n [mm]
Bo – A deviation from the planned line of first rack legs (on the side of the handling zone) creating a series of series. Measured on the floor level.	± 10 [mm]	± 10 [mm]
Cx		
Cx – A deviation from the vertical of each of the poles of racks in x direction (parallel to the inter-rack aisle)	± 10 [mm or H/350]	± 10 [mm] or H/500

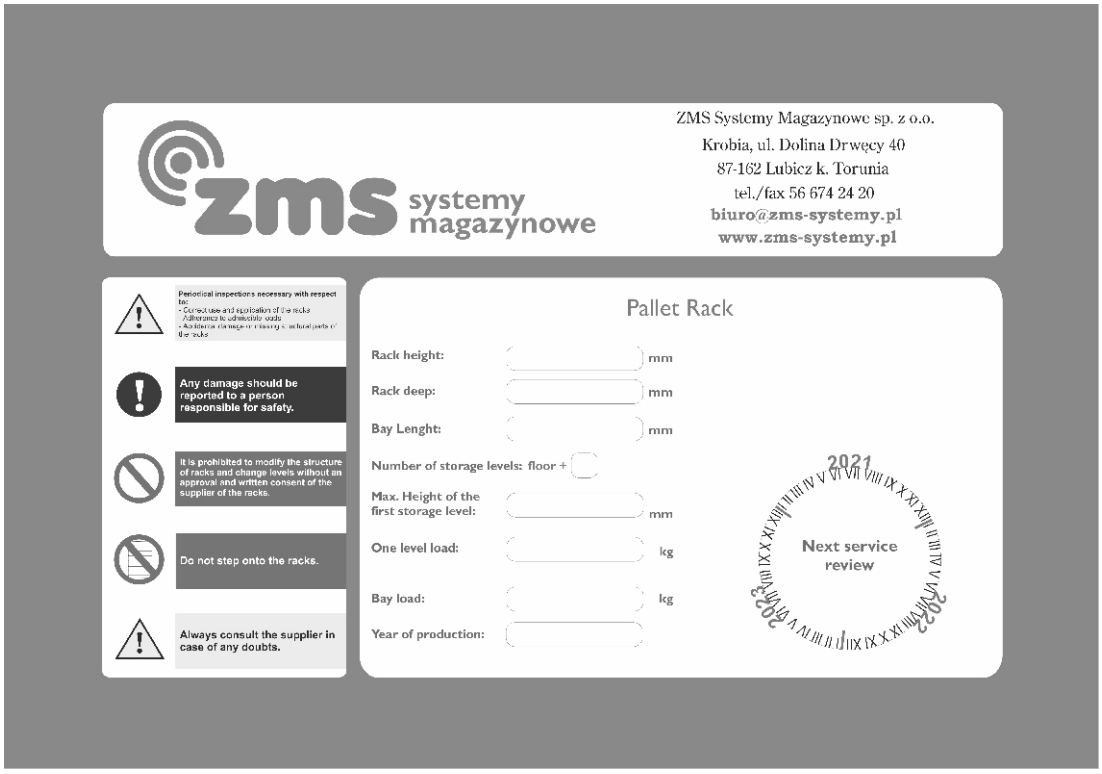
The table relates to measurements of not loaded, but complete racks/a series of racks.

Horizontal tolerances for X and Z directions		
Cz		
Cz – A deviation from the vertical of each of leg poles in Z direction (direction of the rack depth)	± 10 [mm] or H/350	± 10 [mm] or A: H/500 B: H/750
D – A deviation from the nominal depth of the racks.	± 3 [mm]	± 3 [mm]

The table relates to measurements of not loaded, but complete racks/a series of racks.

The accuracy of assembly

After completion of assembly, name plates should be attached to the racks. The plates are attached to a leg of the first segment in a row at the eye level.



In order to avoid any errors during assembly, extension of possible replacement of damaged elements, each pole is marked with a symbol including, among others, the manufacturer's mark, pole symbol and production date (year).

Operation

General requirements

Physical workers operating mechanical devices in the warehouse are persons, who:

a. are able to perform required physical activities in a responsible manner;
b. have appropriate education and training;
c. are aware of the risk and hazards connected with work performed;

The employer shall be liable for safety at work and ensuring of appropriate training for his staff. A forklift truck operator is responsible for correct delivery of instructions given at work and he/she shall act in compliance with the following principles:

a. a forklift truck should always be driven carefully and at a speed guaranteeing safety (without any collisions and accidents)
b. measurements and weight of pallets with load have to comply with load capacity, arrangement and configuration of racks
c. pallets have to be put and selected carefully in accordance with instructions gen in the description of use
d. pallets should be laid symmetrically to the rack depth and socket width
e. manoeuvring routes between racks cannot be obstructed with any objects
f. in case of damage to racks, a person responsible for safety in the warehouse should be notified immediately

Adherence to recommendations included in the operation and maintenance manual ensures long-term and safe use of HX racking systems. However, sometimes extraordinary situations may occur during use and such situations may result in damage to relevant elements of the structure. Periodical inspections of the system are recommended in order to ensure safe use (FEM 10.2.04).
Types of inspections depend on frequency of performance and scope of the following:

Daily inspections:
Daily inspections should be performed during daily work by operators of loading trucks and other warehouse operatives. Warehouse operatives should be notified of any important risks related to use of the racks and consequential hazards. A maintenance officer should be notified immediately of any emergency situations.

Weekly and monthly inspections:
Weekly and monthly inspections should be performed by a maintenance officer of the facility. Results of an inspection should be noted, archived and included in a monthly report submitted to the management staff of the facility.

Semi-annual and annual inspections – performed by experts:
Depending on intensity of use, racks should be inspected by experts once every 6 or 12 months. A maintenance officer of the facility will determine frequency of inspections.
Such inspections will be performed by persons authorized by the system manufacturer. During such inspections, all damages affecting safety of the structure will be marked. An expert will prepare a report, which, apart from damage and irregularities found, will also include suggestions and recommendations relating to maintenance. The report will be submitted to the management staff of the facility and included in the manufacturer's files.

Important!
During an inspection defects are marked with stickers in accordance with the colour code, see: "Defects and their classification"

The scope of an inspection:
Particular attention should be paid during inspections to:
- destruction and scale of destruction of elements of racks inflicted as a result of hitting with a loading/transport truck
- excessive leaning of the rack poles
- completeness of detachable joints such as screws, anchors and traverse beam protections

every 6 months:
- any cracks in materials and joints
- the floor condition (any visible cracks, subsidence or defects in the floor)
- the quality of tightening of rack anchors and bump rails (which, in case of warehouses, are used every month intensely)

every 12 months:
- tightening of screws connecting braces with rack frames
- completeness of racks (poles, braces, traverse beams, frame **connecting elements, protections, shelves, bump rails and any required accessories)**

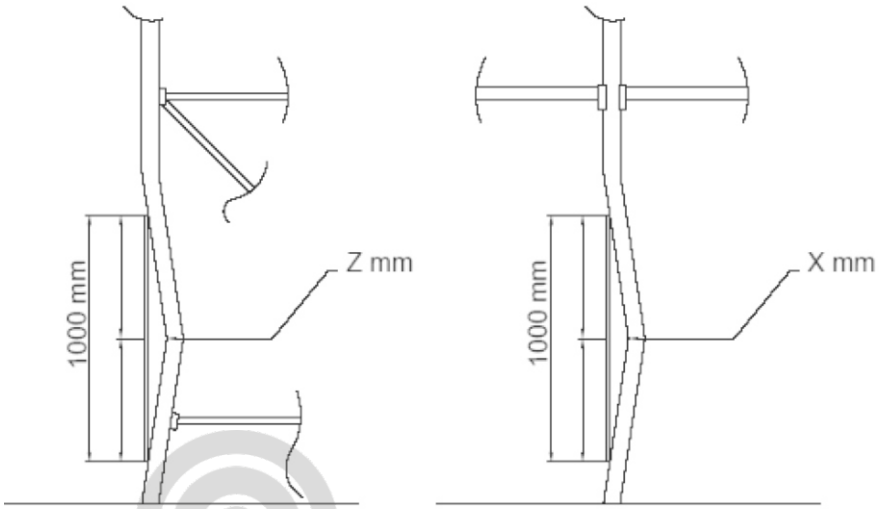


Fig. 32 Measurement of deflection of poles.

- limit values measured in the direction of the length of traverse beams:

X < 5 mm – GREEN ALARM
5 mm X 10 mm – ORANGE ALARM
x > 10 mm – RED ALARM

- limit values measured in the direction of the frame depth:

X < 3 mm – GREEN ALARM
3 mm Z 5 mm – ORANGE ALARM
Z > 5 mm – RED ALARM

In order to facilitate maintenance activities, it is recommended to mark defects and irregularities with colours. The colour code applied under FEM 10.2.04:

RED ALARM – "Destruction that needs to be supervised".
Elements may be used, but they have to be marked and examined carefully during further inspections.

ORANGE ALARM – "Dangerous defect that requires undertaking activities as soon as possible." The defect should be removed (or element should be replaced) within 4 weeks and during the period the element may be used provided that load is limited to 50% of nominal load.

RED ALARM – "Very serious destruction that requires immediate action." The destruction will require removal of goods and exclusion of the affected rack zone from further use.

Classification of deflections observed at considerable lengths. Deflections are measured with the use of a 1m slat attached to the rack pole. A deflection is read at the half of the slat length.

In case of a pole with deflections, measurements should be made for two directions separately. For braces of rack legs (frames), deflection cannot exceed 10 mm in any direction.

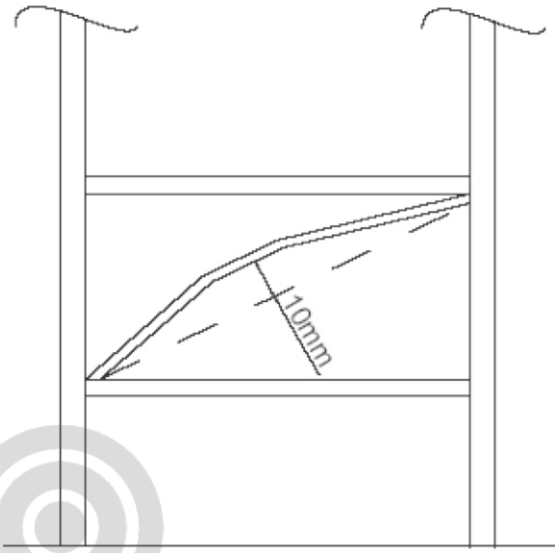


Fig. 33 Admissible deformation of braces of the rack leg.

Tearing and splitting of material is qualified for replacement of the same.
For local deformations such as bends and bulges found in a section shorter than one meter, limits values of defects should be decreased in proportion to the change of length of the measurement base. For instance, measurement length – 500 mm, X 2.5 mm and Z 1.5 mm.

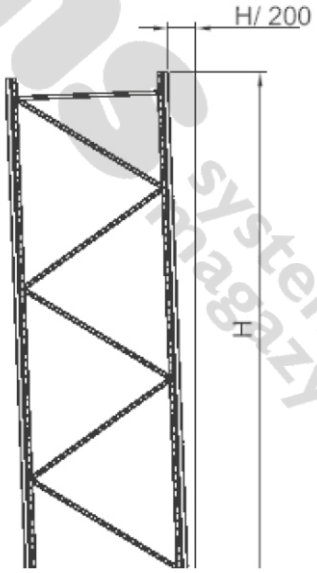


Fig. 34 Admissible operating tilt.

If a pole tilts in any direction by a value exceeding H/200, this means that the rack structure is overloaded and requires immediate adjustment (levelling).

Important!
Deviation of a structure from vertical often results from use of inappropriate floor. In case any destruction of the floor in the form of cracks or deformations, a geodetic survey should be performed and, based on its results, accuracy of calculations of the flor load capacity should be verified.

ZMS Systemy Magazynowe sp. z o.o. does not provide for any failures or critical situations in HX system upon the condition of adherence to principles of safe operation.
Users have to comply, in particular, with the following requirements:

- **admissible load of the rack socket and correct stacking:**

Large load or uneven and non-centralized load may result in permanent deflection of a traverse beam, destruction of joints or damage to a pole in the form of twisting, bending or cracking;

- **cautious loading and unloading of sockets:**

It is inadmissible to hit a traverse beam with cargo. Such situations most often occur during operation of a lift truck and result from haste and lack of precision;

- **ensuring of required load capacity of the floor for envisaged load:**

A failure to comply with the requirement leads to destruction of the floor as a result of loss of static stability of the rack;

- **meet conditions of inspections and maintenance:**

Warehouse racks have to be maintained in proper technical condition, which can be ensured by periodical inspections and maintenance activities.

The admissible value of deflection of a loaded traverse beam cannot exceed f=L/200 (L – a traverse beam tube length). Admissible permanent deflection of a traverse beam cannot exceed respectively:

- in vertical: 50% of f (admissible defection under working load)
- for vertical direction: 20% of f

Permanent deflections should be measured without load!
In case of values greater than indicated, condition of a traverse beam should be evaluated by the manufacturer's representative – **GREEN ALARM**
Damage to lugs/teeth of a traverse beam (any visible, permanent) – **RED ALARM**
Cracks in joints or traverse beam/lug material (any visible) – **RED ALARM**

Replacement of a pole/frame:
Remove goods from segments created by a damaged element and release adjacent segments from load. Proceed to replace the element.