

Merits of rack supported, automated and safe steel warehouse

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Dear Reader,

Storing coils or sheet packs or heavy plates or long products in a compact area vertically, utilizing the height helps on easy tracking and shipping as well as saving space and costly buildings. Rack supported warehouse with ASRS (Automatic storage and retrieval system) is an innovative method of best utilizing the storage racks for supporting the side cladding and roof sheets of the ASRS building thus avoiding separate building for the warehouse and saving approximately 3 times the area and 2/3rd of the cost of the warehouse building.

Today, with the digital controlled warehouse management system (WMS) and rack supported ASRS building, steel logistics and warehousing have become a cake walk with the assurance of total safety, total quality and prompt dispatch to enhance profitability and CRM.

In this paper an attempt has been made to list out the concept, objectives, functions, methodology and merits of "Rack Supported Steel Warehouse".

Key words: ASRS (Automatic storage and retrieval system), WMS (Warehouse management system) and CRM (Customer retention management)

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Introduction

A rack supported warehouse is where the racking meant for holding the material is also used to support the walls and roof of the warehouse. It makes sense to utilize the racking (with storage of steel coils/plates/sheet packs/long products), which has the high modulus of rigidity and bulk strength for supporting the roof and side claddings with appropriate purlins. Considering that the cost of land, materials and labour continue to rise, the rack supported building concept becomes a more economical warehousing solution to high bay storage of above 25 meters with automatic warehouse management system (WMS).

These warehouses consist of the racking system that provides the basic structural support for the building's roof and walls. Maximum density storage solution possible for every type of pallet rack reduces the construction costs, lead times and building footprint. Rack supported building concept is obviously the optimum solution to store at a large heights making the most of the available surface.

With the warehouse management system and total automation, total safety is assured for the operators as there is no human interference required within the fenced warehouse functions.

There are two ways to build the racking:

1. Rack supported Building

Walls and roof are mounted directly to the rack as clad rack system. Clad rack construction means that the system is roof and wall bearing. This has as a consequence that the racking has to take up, besides bay load the crane loads and seismic forces, as well external loads like for example forces from wind snow, wall and roof cladding. Please refer to figures 1 and 2.



Figure 1



Figure 2

2. Free standing rack construction

Free standing rack construction means that the system has to take up bay load, crane loads and seismic forces, but no external loads like wind, snow, wall and roof cladding. This has the benefit that the racking construction can be built approximately 10% lighter, but needs another separate building which could cost 60% more with many operating constraints. Figure 3.



Figure 3

Rack Support Concept

The specialty of this construction is that it does not require conventional structural columns to support the walls and roof. They are fixed directly on to the racking structure to complete the building. There are no interference with building columns and also huge savings can be realized in construction time and cost. One significant financial advantage is the shorter depreciation which is equal to machinery.

The components of rack supported buildings are namely:

- a) Racks - simple or conventional/double deep or multi deep (Figure 4) or single cantilever types.
- b) Roof truss supported on the racks
- c) Purlins – supported on the roof truss for the roof sheeting and side racks for the side wall cladding.
- d) Roof sheeting and Side Cladding Sheets. These sheeting could be galvanized or galvalume and colour coated. Please refer to figures 5 to 8 and table 2 below.
- e) Civil work. – anchor bolt foundation pits, floor rafts and slabs, draft walls, fencings, gates and doors
- f) Lighting
- g) Ventilation
- h) Water drain system
- i) Safety systems: safety interlocks and automatic monitoring system for any intrusions and manual interference to insure total safety



Figure 4

Integrated Racks and cladding simple concept picture

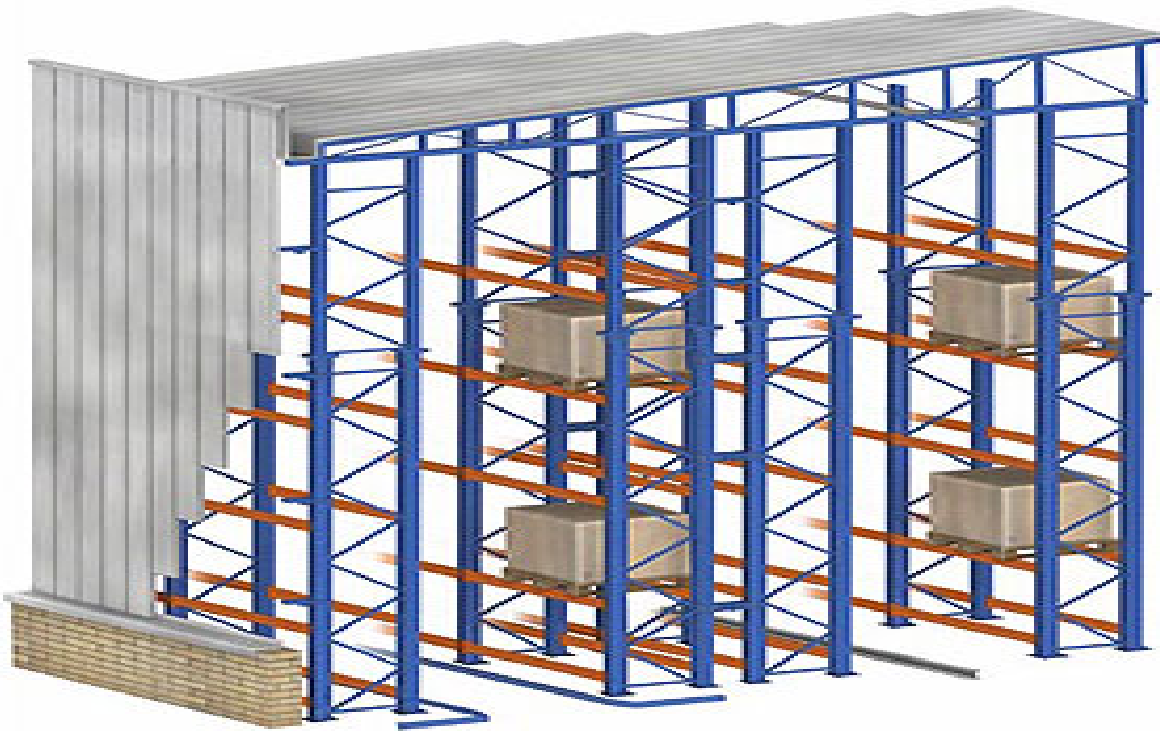


Figure 5

Construction sequence and configuration features comparison

Normal warehouse	Rack supported Warehouse (RSW)
Heavy foundation work	Construction can start with raft and slab and light unit foundation work per ton stored
Large redundant columns	Uniform racks
Roofing and side cladding, supported on columns and trusses	Supported on racks, no truss required
Gable end wind girders	Not required
After this flooring and then racking work starts	RSW is complete in the previous step
Less height for storage	More height for storage
Static building	Dynamic building with WMS
Less utilization space	Best utilization of space and volume
Low storage capacity per unit	High storage capacity per unit area
Low efficiency and throughput	High operating efficiency and throughput
Costly considering low efficiency and high resource requirement and stringent monitoring requirement	Most cost effective with lowest life cycle cost
Semiautomatic Yard Management System (YMS)	Totally automatic Warehouse Management System (WMS)
Less safe due to human interface	Total safety with no people physical interface

Table 1: Construction sequence and configuration features comparison

Typical construction sequence

Construction of rack supported building begins with pouring of the slab and anchors and erection of the rack. Since there is ample space due to the lack of enclosures, the multiple frames are assembled on the ground and then lifted and held to stand up on the slab and bolted up. This type of construction could assure accurate alignment, thus minimizing the time required to complete the plumbing of the racks during erection.

Rack supported ASRS with total automation and total safety

In automatic ASRS there are no people needed in the warehouse during operation which makes it totally safe. There are tracking software to track bar code or RFID tags, diagnostic software, safety software and warehouse management software all of which insure total automation with assured safety to the supervisor who would be outside the warehouse area or in the control room generally. The total ASRS is within the fence and the gates are with interlocks for safety.

When supervisor or maintenance technician need to enter the storage area for inspection, the total system has an interlock at the gate and the operation of the stacker crane stops with zero risk. Further the stacker cranes are with inbuilt diagnostic software, which insures correct weight of material only is lifted by it and if the load is excess or not properly packed, the material would be looped out for repair or change.

As the warehouse building is part of the ASRS itself due to rack supported warehouse concept, there is no movement of people possible within the ASRS which adds to further safety. Depending on the statutory requirement there can be fire detectors and fire protection system integrated with the ASRS for fire safety.

Typical construction details of rack supported warehouse

ROOF DETAILS – example with insulation

1. PVC membrane (t=1,2mm)
2. Insulation Paroc ROS 50, t=50mm (or similar)
3. Vapour barrier, Eurotex ALU (or similar)
4. Load bearing sheet, T45-30L-905/0,8mm, PE (plastic covered)
5. Roof structure
6. Fasteners (4 pcs per sheet)
7. Fasteners

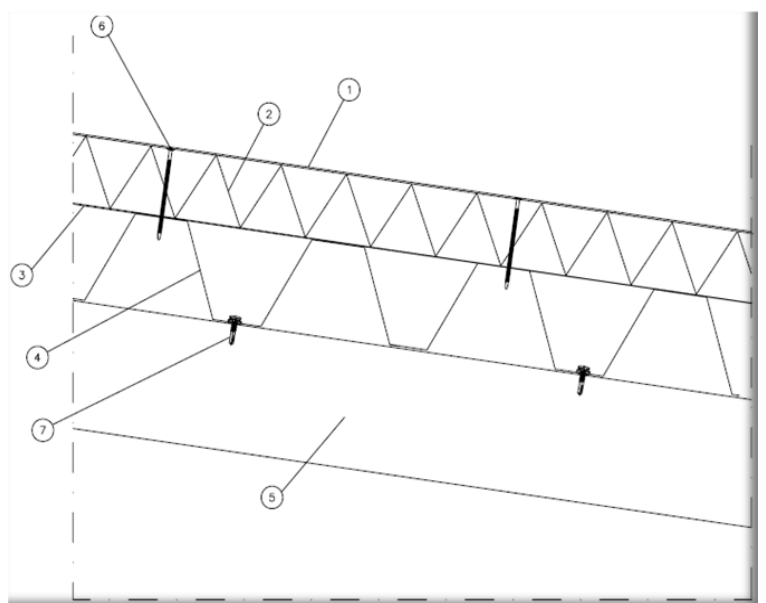


Figure 6

EAVE DETAILS - example

1. PVC membrane (t=1,2mm)
2. Insulation paroc ROS 50, t=50mm
3. (or similar)
4. Vapour barrier, Eurotex AL (or similar)
5. Load bearing sheet, T45-30L-905 / 0,8mm
6. Roof structure
7. Fasteners
8. Column
9. Flashing
10. Flashing
11. Plywood
12. Flashing
13. Seal
14. Flashing (U102*40*1,0, Cover column end)
15. Net (cover between columns)
16. Fasteners

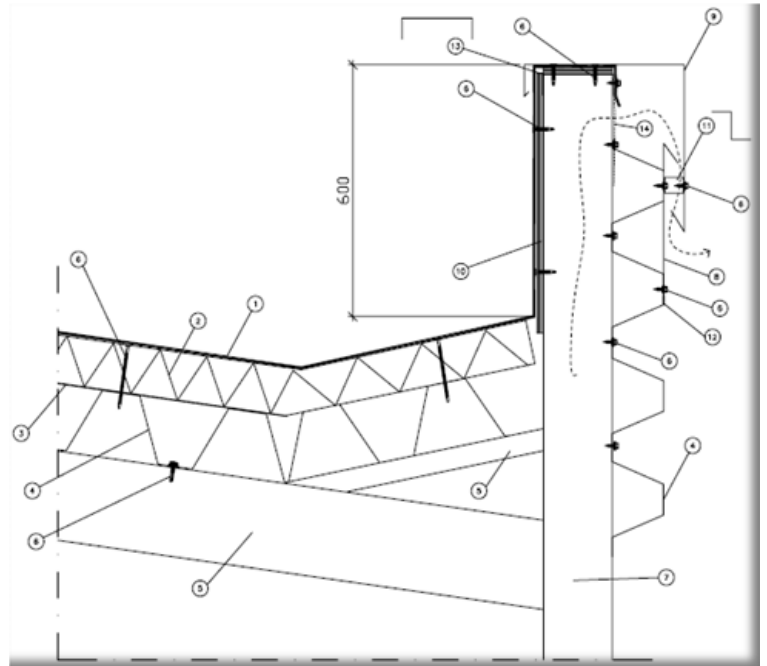


Figure 7

WALL DETAILS – example sheet wall

- Cladding sheet detail
1. Thickness 0,6 mm
 2. Z275 + PVDF

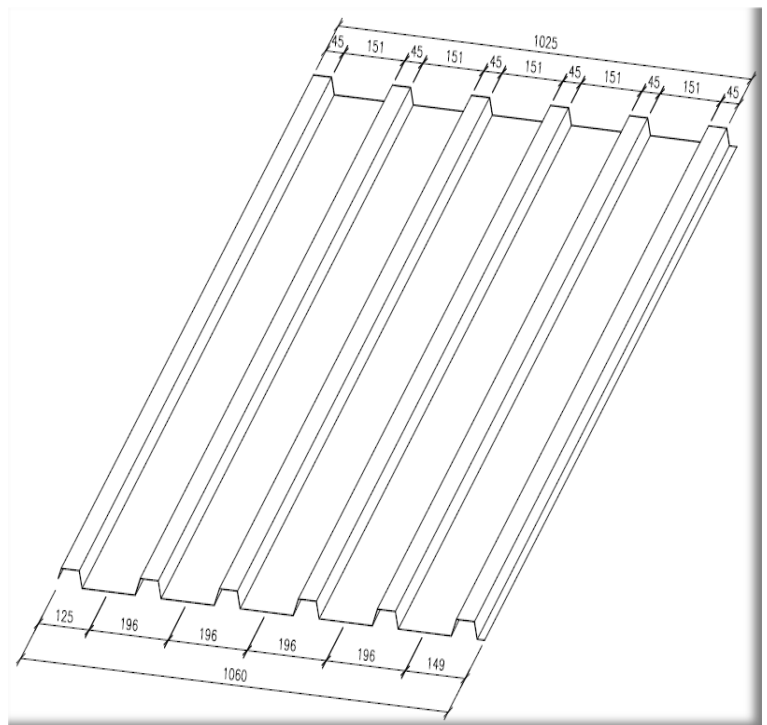


Figure 8

Design criterias - example

Designing rack supported building and cladding, wind load (shape of the building), terrain category and building class are the key factors.

Design codes		
Item	Value	Note
Basis of structural design	EUROCODE 0	
Loadings	EUROCODE 1	
Steel structures	EUROCODE 3	
Consequence class	CC2	

Wind load		
Item	Value	Note
Wind speed	Vmax = 69m/s	hurricane SS4 3 seconds gust value
Wind pressure design value	$q = 1,25 \times 69 \times 69 / 2 = 3,0$ kN/m ²	No form factors, as 3 seconds gust value is taken

Main dimensions		
Item	Value	Note
Total length (X)	105 830 mm	
Total height (Y)	27 530 mm	
Total width (Z)	55 960 mm	
Volume	163 000 m ³	
Floor area	5 922 m ²	
Wall area	8 300 m ²	
Roof area	6 100 m ²	

Table 2

Rack supported Warehouse (RSW) Advantages

- Depreciation like in equipment (as a part of AS/RS)
- Turnkey solution
- Integrated easily with an AS/RS system
- Eliminates building columns since rack supports the structure
- Can be built at heights >100ft (30M)
- Inclement weather and seismic conditions have less impact on RSW
- Utilizes height instead of large land mass
- Improved energy efficiency
- Economical due to savings in cost of construction
- Lighter rafter and purlin sections due to close spacing of the racks
- Optimal spacing with high efficient material handling equipment like vertical stacker cranes
- No lighting required and may be required for the aisles for maintenance inspection
- No building columns interfere with the storage or material handling
- Shorter installation time
- Engineering and architectural time reduced

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