

Storage Racks – Gibraltar-Solid or Hidden Danger?

Warehouses and their storage racks systems have the potential to cause serious injury and even death.

Regretfully, collapses of storage racks do occur, not infrequently.

No matter how well trained or efficient forklift truck drivers are, damage to storage racks system do occur – probably far more often than warehouse managers would wish to admit.

Careful design, professional installation and regular inspections by independent specialists can reduce the risks of accidents and lower the repair bills.

Philip Pinel, Managing Director of Storage Equipment Safety Service Ltd, an international racking safety inspection organization, examines the factors which create risks and suggests how to overcome them.

(This article first appeared in "Occupational Safety and Health" in the UK – It has been adapted by Pierre M. van Hauwaert, Business Manager, Storage Equipment Safety Service Ltd (SESS))

Introduction

Steel Storage Rack Systems ("rackings" for short) come in a variety of configurations. Whether simple or complex, they are assembled from a numerous components, each component performing a specific task. Although each component is, by itself relatively weak, assembling these components results in a remarkably strong structure, capable of holding up thousands of pounds of goods. However, if any of these components are damaged, as the result of being impacted by forklift trucks, or as the result of having been stressed beyond allowable physical limits, the

safety factor characterizing the capacity of the rackings to be safe is reduced. If the safety factor is reduced beyond a certain point, a collapse occurs, causing a veritable avalanche of goods that can be catastrophic. Too often individuals, untrained in understanding of the potential effects of damage to racking components, turn a blind eye, thereby putting others at risk. "It's been like that for months, why should it collapse now?" is often heard – a very dangerous assumption.

Racking is constantly subjected to outside forces and thus deflection, which individually may seem innocuous, but can, over time, reduce the overall factor of safety. What are today

racks that appear to be solidly stable, may in fact be so close to collapsing that a slight jolt may, tomorrow, bring down the whole structure.

Anecdotes abound: a forklift truck attempting to insert a pallet in a bay, will jolt the racking, causing an avalanche of goods to occur; another forklift truck, in backing up, will bend an upright, weakening the structure to the point where the next tremor will cause a collapse.

Operating aisles

The primary objective of any storage layout is to maximize the utilization of the available storage space, at the lowest cost. Therefore the designer is under pressure to keep operating aisles, clearances and other measurements to the minimum.

In determining a layout, vendors usually consult forklift truck manufacturers to obtain their operating characteristics. Truck manufacturers quote minimum aisle widths, usually with only minimal clearances, rack face to rack face. For the average truck driver these minimum aisle widths are far too tight, and, in any case, would assume no pallet overhang into the aisle. In fact, the aisle width should be evaluated pallet face to pallet face, as pallets in most

The Safety of Storage Racks

installations overhang the rack face. There are formulas to calculate aisle widths with due regard to the space required by maneuvers from both truck and load through 90 degrees during stacking and de-stacking. Again, allowances should be made for the fact that pallets are not always square to the truck, and not always seated on the heel of the forks. If the load overhangs the pallet, then this must be taken into consideration. In determining reasonable operating clearances, the density and speed of traffic in the warehouse must be considered. In a high throughput operation, (a grocery or soft drinks distribution centre being typical), the operating clearances should be increased substantially.

Too often in warehouse operations, it is painfully obvious that aisle widths are too tight. The clues are there for all to see: bottom beam levels showing scuff marks where the fork trucks overhead guard catches the beam as the driver turns the truck, dents on storage racks uprights where the fork truck chassis catches the beam as it turns.

Transfer aisles

The width of transfer aisles are equally important. Sufficient space must be allowed for trucks to turn safely and, of course, trucks to pass. In long runs of racking, there is a trend to create a tunnel through racks by leaving out a couple of beam levels. This is normally safe practice provided that:

1) The beam lengths in the bay housing the tunnel are increased to enable trucks to pass comfortably.

2) Adequate vertical clearance for the truck mast is allowed, assuming, of course, the driver has remembered to lower the

mast to a point where it will pass safely under the lowest beam level.

3) The beam level above the tunnel is marked with hazard stripes.

4) A safety net or solid shelf is fitted under the lower beam level to prevent any dislodged goods falling between beams..

5) Due consideration is given to pedestrian traffic, and indeed throughout the rest of the warehouse.

In all situations a clear line of vision is essential.

Handling clearances

An adequate handling clearance should be allowed between pallets and uprights and adjacent pallets. Vertical clearances between top of palletized loads and underside of beams should be adequate, and should increase with height.

Many accidents are caused by inadequate vertical clearances; there is always the danger of the load/pallet dislodging a beam as the load is positioned on the beams.

Allowance must be made for goods that tend to sag or bulge. Before deciding on horizontal clearances for such loads, trials should be undertaken over a period of time to establish how individual products actually behave.

Pallet rack frame bracing members are frequently damaged by the horizontal forces that can arise when loads sag or bulge during storage. The problem must be addressed at the design stage.

Safety Locks

Safety locks are designed to prevent accidental dislodgement of beams. They are designed to fail at a specific upward force to

prevent entire bays being lifted off the ground during faulty truck operations.

Safety locks will not prevent beams from being pushed out horizontally. Such a situation occurs when a load is placed on the beams while the truck forks are on forward tilt. This usually results in an impact force being applied to the rear beam causing damage to the beam and, in some instances, straightening of the hooks on the beam end connectors, allowing the beam to be pushed out of the locating holes in the rack uprights.

Rack protection

Despite the fact that adequate aisles and clearances have been prescribed and are maintained, there will always be the situation whereby collision between truck and upright can occur. End frames and corner uprights are the most vulnerable and should always be protected. Various devices exist to assist with rack protection, most common being the wrap around metallic shield which is bolted to the floor

Often wrap around column guards are too wide and "eat" into handling clearances. If the guard is manufactured from material of adequate thickness, then the clearance between the guard and the upright front and sides could be reduced considerably.

The floor fixings of such guards are prone to damage, particularly when the studs of the fixing project too far above the nut. Inevitably, such fixings are often sheared off making the repair expensive.

Whatever type of protection is chosen, it is essential that the system is effective at the point where most damage is occurring. If, generally, damage is at 20" (500 mm) from ground

The Safety of Storage Racks

level and the protection system is only 12" (300 mm) high, then clearly it will be ineffective.

Some manufacturers offer ingenious impact absorbent "bumpers", secured to the upright. These devices act like mini airbags and are capable of absorbing repeated impacts without being damaged beyond effectiveness.

Pallet condition

Damaged pallets should never be placed in a rack structure. A collapsing pallet, particularly when heavy and bulky goods are stored, could easily cause a collapse. As the pallet collapses, forces are exerted on the beams (for which they are not designed), causing beam failure and possibly collapse of other beam levels and failure of uprights.

All too often pallets are incorrectly positioned on the receiving beams. Incorrect positioning could cause the bottom stringers to fail and trigger the scenario outlined above.

Stability of loads

Unstable loads must never be transported by trucks or stored in rackings. If any doubt exists on load stability, then steps must be taken, e.g. binding or shrink wrapping, to ensure stability.

A single item, dislodged from a high level pallet, could cause a fatality. The heaviest loads should be stored at the bottom of a rack, lightest loads at the top.

Some states require safety nets installed at prescribed heights to avoid falling objects.

Housekeeping

Poor housekeeping is perhaps

one of the most significant contributions to accidents.

Pallets stored in rack aisles and transfer aisles are an obvious hazard. Many collisions between trucks and uprights are caused by fork truck drivers trying to negotiate their way past such obstructions. A clear line of vision must be maintained at all times.

Debris in aisles, particularly where wire guided equipment is used, can throw a truck off course causing a collision between truck and rack. All debris, e.g. pieces of timber broken off pallets, shrink wrapping materials etc must be removed from aisles. In addition to the problems they cause to trucks, such materials are trip hazards to pedestrians.

Driver training

All truck drivers must be professionally trained and attend regular refresher courses. The most common complaint from drivers is that aisles are too tight. In many cases, this is true. Equally there are many cases where the drivers' lack of ability, due to improper training, is the cause of many problems, particularly damage.

Driver training should include raising awareness on the consequences of damage to racking components, on accidents and their causes and most important of all, the consequences of a rack collapse.

Driver supervision

Every warehouse should have a designated person responsible for the training of fork truck drivers. That person should be aware of the factors that contribute to accidents involving collisions between trucks and rackings.

Design and installation

All racking structures should be designed and built to a recognized code of practice. If there is any doubt that an installation is designed or built correctly, then it should be independently checked. The cost, in comparison with the total project cost, will be small. If structures do not meet requirements in design, stability, floor fixing requirements, etc, then the structure is a potential danger. For example, too many structures are built with either no, or insufficient numbers of, floor fixings - usually where a user builds the equipment himself.

The other common situation found, is the lack of ties between frames in double entry racks or too narrow a frame in a single entry rack, thus causing a height to width problem, i.e. stability. In such circumstances a nudge from a truck could be disastrous.

Selection of rackings

End users should take precautionary measures to reduce the likelihood of damages and subsequent repair bills. For example, most manufacturers offer a range of rack, each upright having a different frame loading capacity. In a high throughput warehouse, where a significant amount of damage can occur, specifying a heavier duty upright for the aisle side frames is desirable. The initial cost will be higher but the incidence of damage could be reduced, and increased safety achieved.

Many uprights are damaged by pallets hitting the corner of the upright causing it to rotate. Twisted uprights have a reduced load capacity. Base plates must be anchored with

The Safety of Storage Racks

appropriate anchor bolts, so that twisting is eliminated or reduced.

These measures increase the initial project cost, but in the longer term, should save money.

Overloading of beams

Rackings are not to be loaded beyond their design load. Structures do have safety factors, but once damage occurs, the safety factor is reduced. Overloading in such circumstances could lead to disaster.

Manufacturers should provide "Load and Safety" notices with each installation.

• Modifications

Changes to the configuration of beam levels should not be made without referring to the original supplier or manufacturer. The load carrying capacity of a frame is dependent on the height from floor to first beam level, and on the distance between subsequent beam levels.

The "slender factor" which is the height to depth ratio of a frame is a critical stability factor

Beam deflection

Many racking users are unaware of the allowable deflection when a beam is under load. The allowable deflection at center of the beams can be calculated.

The above points list some of the factors that contribute towards accidents. Any action, that reduces safety factors, particularly where fork lift trucks operate, will have grave consequences. Each factor constitutes a danger but a combination of two or more factors is a disaster waiting to happen.

Injury or fatality

Every collapse, however small, is a potential killer. Racks do not collapse over a lengthy period of time; once failure occurs; the collapse is instantaneous. A collapsing bay can cause a progressive collapse, a domino effect; as a frame collapses, its direction is vertical. This downward force pulls down on the beams causing the frames attached to the beam to bend in. A point is then reached when the beams fail and separate from the uprights. Adjacent frames will then catapult back and probably cause further failures. Hence a progressive collapse can occur. Pallets toppling into the aisles could cause racks on the opposite side of the aisle to fail.

In any event the structure could be left in a potentially dangerous situation and caution must be exercised to ensure the safety of staff when clearing up debris. Following a collapse the

supplier or an independent organization should be brought in to establish its cause. This should be implemented immediately, not when the resulting debris have been cleared away, otherwise the task of establishing the cause is much more difficult. Following injury or fatality, management will have to be involved. If negligence is proven, then the penalties on those at fault (not just the Senior Executive) will be severe. Following a collapse, down-time and disruption in the warehouse will be costly, not to mention the cost of product damage and loss.

Safety inspections: internal audits

Regular internal inspections should be scheduled and observations recorded in a log book. These audits can be undertaken in house by an appointed, trained, person. This person will have been trained by experienced, independent specialists who can explain the inspection procedures to be followed. Our company, Storage Equipment Safety Service (SESS) has developed training procedures based on existing codes of safety practices (RMI, SEMA, FEM) and complemented by their near 2 decades of hands-on experience.

There is a crucial difference between identifying (and recording) trouble spots and deciding what to do about it. Only specialists, have, through years of experience, acquired the know-how to recommend a course of action. Given an out-of-specifications situation, they are able to recommend what needs to be done, when and how. Some situations require immediate remedial action, noting that there is often a good

The Safety of Storage Racks

and a not-so-good way to go about it.

Safety inspections: professional audits

For a thorough, detailed inspection, either use a manufacturer or an organization specializing in storage equipment safety inspections. Whoever is used should be insured with both Professional Indemnity and Public Liability Insurance. They should be able to demonstrate their procedures in accordance with the relevant recommended codes of practice.

There is a significant difference between a damage survey (which provides a list of damaged components) and a safety inspection (which embraces all factors which could contribute singly or jointly to a collapse).

People employed by manufacturers or specialist organizations will have industry experience and expertise to identify problem areas, comment on quality of fork truck driver operations, standards, etc, and submit a detailed and professional report to the user. In the event of an accident, such reports would be viewed as responsible action by the enforcing authorities.

Repairs

Ensure the organization carrying out repairs is either a manufacturer or approved manufacturer's sub-contractor who is aware of the manufacturer's rules and regulations. Too often repairs are carried out that do not meet manufacturer's design rules. A typical example is the practice of cutting through an upright, just above the damaged area and splicing in a new section. Another short cut some

repairers take, is to weld in a foreign section. Such action would not meet the manufacturer's design rules. When placing contracts for repair work, make clear to the contractor that all work must comply to the manufacturer's design rules. Assuming components were designed and installed correctly in the first place, they should always be replaced like-for-like unless advised otherwise by a competent person. Far too often, repairers with good intention, make what they consider to be an effective repair which does not meet design rules. When the structure is next inspected, the repair will be condemned.

Conclusion

The thousands of pounds (or kilos) loaded on racking shelves at heights of 30 ft, or higher, hold a potentially destructive energy which, if unleashed by racking collapses, can cause tremendous damage to goods, equipment and personnel. Significant expenses (Repair to rackings, OSHA fines, damaged goods, worker's compensation, insurance premiums), not to mention moral anguish, can be avoided if rackings are inspected regularly, in-house, and at least twice a year by a body of independent specialists.

For more information on storage racks and safety in the warehouse, please contact Pierre at SESS – Tel 216.486.1915 – or e-mail Pierre@sess.us

Overloading

An extremely dangerous situation, where further collapse could transform this warehouse in a deadly bowling alley. Shored scaffolding had to be build around the half-collapsed bay. All rackings around had to be unloaded and removed. Lifting the drums one by one from the top was a very delicate operation; a special movable lifting device (little clearing at the top) had to be brought in. The entire warehouse had to be checked for overloading. The bill ran into thousands. Observe that there were no load notices present