



# Municipality of Anchorage

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## Handout S.02

### Storage Racks

There has been some confusion concerning the use of storage racks and the design requirements the Municipality of Anchorage Building Safety Division imposes as part of code compliance. This brief discussion is designed to clarify these matters.

The Municipality has concern for storage rack stability, for how materials are stored, how high they are stored, and how stable those racks and their contents are during normal conditions and especially how those racks respond and how stable the loads are during an earthquake or other laterally imposed force. Being in a very high seismic zone, racks are particularly subject to failure during an earthquake, resulting in loss of property, time, and injury or possible loss of life of employees and customers. In order to assure that racks used in stores and warehouses are reasonably secure, the Municipality employs rack design criteria produced by the International Code Council (ICC) as part of the 2000 International Building Code. The Municipality's Building Safety Division requires that all storage racks over eight (8) feet in height be designed by a professional engineer registered in the State of Alaska in keeping with the design guidelines of the 2000 International Building Code, Section 2210, Steel Storage Racks, and updates thereto as they may be approved. Other storage racks of wood or other possible materials over eight feet must also be designed by a registered engineer to the seismic loads and material conditions provided in the Uniform Building Code.

It is important to note that although the Municipality does not impose the same strict design requirements on storage racks below eight feet in height, it is within the Building Official's authority to require design for lesser heights if unusual loads, type of rack, or unusual application conditions are determined to exist. All legitimate rack suppliers, warehouse storage rack users, and retail store owners should be required to consider the impact of methods of storage, use of lift equipment, and the possible effects of earthquake or other laterally applied forces on their racks.

Many retail stores, while having racks designed to meet the IBC Section 2210 requirements, place the physical integrity of their racks at risk and the safety of the public and their employees at risk by stacking additional materials along the rack's top shelf well above what was intended by design, thus shifting the center of gravity of the load and storing loose packaging which is unrestrained. This is done once the racks have been designed, approved, and installed and a final Certificate of Occupancy has been issued. This practice is strongly discouraged by the Building Safety Division and Fire Prevention since it is in violation of the approved design and could lead to severe personal injury to employees or shoppers, should the loads shift or be subject to an earthquake or other lateral load, causing stored materials to fall, the rack to be unstable, or in the extreme, to fail. Subsequent inspections where this practice is noted could result in the storeowners being cited.

Less visible to the public, but of equal importance is the use of storage racks by warehouses, both private and public. The current marketing trend of major warehouse retailers certainly exposes the public to the safety concerns of being present around tall storage racks. It is no less important in private warehouse buildings where operators and other employees are subject to the same conditions of working near storage rack systems. In fact, lift truck speeds tend to be faster in private buildings and therefore the aspect of rack abuse, in addition to the possibility of failure due to earthquake activity, tends to need greater attention than may normally be expected in a public environment. The same Municipality design and safety criteria applies to storage rack systems used in public and private sectors.

When racks are overloaded or top loaded, they may have been vertically and laterally stable under the original design conditions, but under additional imposed loads, column, beam, brace, connection, base plate or anchor bolt capacities may be exceeded and additional column and bracing stiffening or connection redesign may be required. This is very often overlooked and is a potential hazard that must be considered. If added stability is needed, building columns or walls may be considered to further provide additional restraint. However, when this arrangement is proposed, column and wall stability and capacity must be rechecked as a result of the additional imposed loads. When any of these conditions occur, or when modifications to a manufactured and designed

storage rack is contemplated., the store or warehouse owner is advised to obtain the services of a knowledgeable rack engineer, registered as a Professional Civil Engineer in Alaska with a Structural specialty (hereinafter referred to as a Registered Structural Engineer), to determine if the rack is still safe, if loading needs to be reduced, or if additional strengthening of members is required.

It is of equal importance to assure that rack systems are designed to sustain unintentional impact loads from lift trucks. To limit damage resulting from excessive speed and careless handling, lift truck operators should receive proper training in safe operation of their lift equipment. Safe speed limits should also be posted and enforced.

It is a code requirement that racks be clearly posted with the load capacity limitations for high storage racks. This is not always done. Owners are advised that these posted loads are for the benefit of all concerned and serve to limit overloading. This is further discussed below. In addition, it is advised that owners should perform, preferably through a Registered Structural Engineer or inspection service, a periodic, scheduled inspection of all racks over 8 feet in height (as a minimum), or those carrying heavy loads or subject to unusual abuse to assure the continued integrity of these racks. This inspection should extend to the anchor bolts and base plates, condition of the concrete around the rack supports, and to the struts used to laterally stabilize racks to building columns, walls or other racks.

It is recommended that stores and warehouses not use racks that have not been certified as designed by a Registered Structural Engineer. It is further strongly recommended that owners not replace damaged rack parts with ones that were not designed for the rack under consideration. These replacement parts may not be structurally adequate. If there is any question concerning a rack's integrity, contact a Registered Structural Engineer to have them verify the member or rack in question. When used racks are purchased for a store or warehouse, it is especially important to obtain full certification and information on the racks for the application from the seller. When this is not available, have a Registered Structural Engineer check the rack system out.

An excellent article has been written by the Materials Handling Magazine concerning storage racks seismically sensitive areas, which pin points the Municipality's concerns for life safety as it pertains to racks in general. The magazine has been good enough to allow us to reproduce this for informational purposes. The attached article gives rack owners some sound advice. Use the racks to the extent for which they were designed. Do not overload the racks, monitor their loading and the way they have been loaded. Stacking heavy materials high up on the rack is discouraged. The rack may survive, but will your customers or your staff in the event of an earthquake?

### **Policy**

The following policy will generally be followed by Building Safety concerning racks and rack design:

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| a. New rack, 8'0" in height or under, and new rack 12' 0" and under where the load on any shelf does not exceed 50 lbs. and shelves are not used to store pallets. | No design required by Code. Suggest owner have rack manufacturer check design for load and IBC Seismic Design Category D and integrity.   |
| b. New rack, 8'0" in height or under with unusual loads  | Building Official may require design in accordance with IBC Section 2210 and the Rack Manufacturers Institute (RMI) "Specification for the Design, Testing, and Utilization of Industrial Steel Storage Racks" 1997 edition.  |
| c. New rack over 8'0"  | Must be designed by Alaskan Registered Structural Engineer to meet IBC Section 2210 and the Rack Manufacturers Institute (RMI) "Specification for the Design, Testing, and Utilization of Industrial Steel Storage Racks" 1997 edition.   |
| d. Existing rack relocated   | This applies whether a rack is purchased from one entity by another or a rack is relocated within a single owner's facilities, such as from one warehouse to another. If rack is over 8'0", the rack's integrity must be verified for new condition and arrangement in accordance with Item c. This information may be available from previous owner or from rack |

manufacturer.

If rack is 8'0" or under, rack shall be in physically sound condition. New owner should consider advice in Item a.

If rack is owned by same firm and is relocated or rearranged, it must be demonstrated that the rack is in sound condition. If rack loading changes from that for which it was designed or loadings that are in excess of posted level loadings, rack stability and integrity under new conditions should be verified by an Alaskan Registered Structural Engineer.

If rack is being relocated by original owner to a new location or facility, whether the loading is changed or not, if over 8'0" in height, the rack will need to be verified for integrity and stability and new supporting floor and soils conditions. In this case, Building Safety will require the rack to be rechecked by an Alaskan Registered Structural Engineer, even if the loading is proven to be less than what the rack was originally designed for, unless calculations are produced proving structural integrity for proposed load and condition. As part of the rack verification, calculations will have to demonstrate that the rack complies with 2000 IBC Section 2210 and RMI Specifications for the Design, Testing and Utilization of Industrial Steel Storage Racks, 1997 edition, or its equivalent later Code Standard and that the columns adequately anchored and will not punch through the new floor.

e. Bracing, struts and ties

In addition to the requirements for stable rack designs, ties between back-to-back racks, or struts or bracing between lines of racks on either side of an aisle may be needed, should these measures be required for added stability or to comply with the requirements of special portions of the 2000 IBC Section 2210 and RMI Specifications for the Design, Testing and Utilization of Industrial Steel Storage Racks, 1997 edition. The Registered Structural Engineer should evaluate the need for this bracing and/or struts. Should bracing tie to a column or building wall system, the effects of the transmitted loads must be evaluated in addition to all other considerations. Struts and bracing that may pose an obstruction to fork lift movement or that could be caught with a high load shall be painted with safety yellow or other fluorescent color or appropriately signed with warning notation, that will draw the fork lift operator's attention to the possible hazard. Wherever possible, this type of hazard shall be avoided.

f. Impact loads

Apply vertical and lateral impact load criteria of the Code as a minimum to rack systems and elements.

g. Floor/Slab

Provide adequate floor support and anchorage. Adequate anchorage of rack column base plates is crucial to the integrity and structural stability of the

rack system. It is imperative that base plates are adequately anchored down to the floor. Special Inspection will be required. In the case of relatively thin concrete slabs, the Registered Structural Engineer must check punching shear. Local column forces on wood floors must also be checked.

h. Posting of loads

Maximum loads limitations shall be posted for each rack's shelf for racks over 8'0", and advisedly for storage racks of lower height with unusual load conditions. Posting shall be on front beam of the shelving using conspicuous labeling or by attached durable, metal signs identifying same. This posting shall be clearly visible to fork lift operators and personnel stacking shelves.

**Records**

Structural calculations that may have been prepared at the time of original installation are often lost or mislaid. It is important for the rack's owner to obtain calculations when purchasing the rack and to keep a record of the rack's history including rack vendor information, calculations supporting rack design and load capacity, plan view or original configuration, and load postings should the rack ever be moved, sold, or loaded differently from what it was designed for. This information becomes especially important when a rack is purchased from a company outside of Alaska. Supporting information of this type will be required by Building Safety and by the Registered Structural Engineer performing checks. This can become a time consuming, frustrating and costly research project if the information is not held on file.

**Fire / Life Safety**

The fire/life safety considerations for racks are equally important. These must also be satisfied before approval can be given. The owner must present a full layout of the racks showing arrangement in the facility where they are to be located. Information shall be provided showing intended type(s) of materials(s) to be stored on the racks and their arrangement within individual racks, dimensions of racks, height of racks, aisle spaces between racks and around racks, lengths of continuous racks, exits for the facility in relation to the racks and the aisles, special smoke curtains and ventilation arrangements, fire extinguishers planned for and location of same, and sprinkler arrangement and clearances in relation to the racks. This list is not all-inclusive. The owner is directed to the International Fire Code (IFC) and the special requirements therein for high pile storage and to the Fire Plan Reviewers for any additional requirements.

**Submittals**

The owner or the owner's representative shall submit all information to Building Safety for review and approval in accordance with the requirements for Commercial Submittals. Calculations prepared by an Alaskan Registered Structural Engineer, appropriate plans, and details shall be submitted with all other necessary information for rack systems over 8'0" in height and for other special cases.

**Special Inspection**

Special Inspection in accordance with the 2000 International Building Code, Section 1707.5 shall be required for assembly of all racks over 8'0" and those racks identified by the Building Official or his representative as requiring such. Inspection will include inspection of the assembled rack frame, anchorage, and posting.

**Further Assistance and Guidance**

The Municipality hopes this information is of some use and provides guidance to store owners, warehouse owners, contractors, rack vendors, design professionals and others who may deal with storage conditions and applications. Should there be questions or if you have unusual circumstances, please feel free to contact a Structural Plan Review Engineer at the Municipality of Anchorage Building Safety Division within the Department of Public Works.

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Ron Thompson, Building Official  
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