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## Warehouse rack storage and seismic risk

Example of double-braced frames. Photo courtesy of RACKsteel Inc.

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Pallet racking is designed to sway during an earthquake. Spatial separation between racks and the building is essential to prevent the two from pounding together during an earthquake.

3

“Seismic design” does not make racks earthquake-proof. Modern seismic design tends to emphasize ensuring life safety rather than post-earthquake usability, minimizing initial costs but with higher lifecycle ownership costs. But rack contents and business interruption during repairs can cost much more than the marginal cost for stronger racks. Consider requesting a degree of over-design: ask the engineer to design for 50% or 100% greater strength than code minimum. Cost tends to increase more slowly than strength, so 100% overstrength may cost much less than doubling the cost of the rack. The best insurance is often more steel.

Buildings with warehouse space that include open frame/pallet racks should include seismic-rated rack storage if the facility is located in a seismic risk zone. Seismic rated rack storage is specifically designed to resist and counteract the ground motions created by an earthquake.

A seismic study of a facility can be performed by a qualified licensed structural engineer to evaluate proper design, including appropriate uprights, beams, connections, height, anchorage, average pallet loads, rack layout, and so on, for new and existing rack storage systems for a facility located in a particular seismic zone.

Always consult with a licensed and insured expert. Building and fire codes, occupational health and safety and other relevant laws/bylaws and regulations always supersede suggested guidance detailed below.

### Considerations for rack storage

1

Rack structures installed in areas of moderate to high seismicity may require:

- Large welded baseplates able to counteract earthquake forces
- Many large anchor bolts with adequate spacing
- Higher anchorage demands
- Double posted and/or braced frames
- Large beams with four and five pin beam-to-column connectors
- Use of row spacers and cross-aisle ties for built-in redundancy and cohesiveness



Example of anchored baseplate. Photo courtesy of RACKsteel Inc.



Examples of large welded baseplates. Photo courtesy of RACKsteel Inc.

4

Wire decking can be installed to promote product stability and prevent items from falling through the racking during an earthquake.

5

Wire mesh or barriers can be used on the face and rear of the racks to prevent items from falling from the front or back side of the racks.

6

Heavier items should be strategically stored on the bottom of racking to reduce the potential for damage of the racks.

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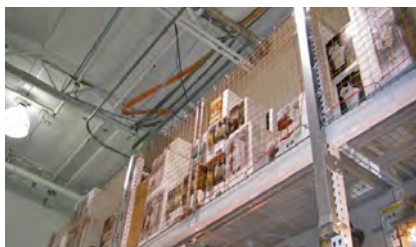
Liquids should be segregated and stored on the bottom of racking with a wire mesh or barrier on the face and rear of the rack to prevent items from falling out of the rack. Combustible/flammable liquids in storage racks may also have additional fire protection requirements not discussed here. Always consult with a licensed and insured expert.



Applicable jurisdictional codes may require that racking used in public spaces, like warehouse stores, have stricter requirements. Photo: Dr. Keith Porter

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Segregate and store Level 2 and 3 aerosols on the bottom of racking with a wire mesh or barrier on the face and rear of the rack to prevent items from falling out of the rack. Level 2 and 3 aerosols in storage racks may also have additional fire protection requirements not discussed here. Always consult with a licensed and insured expert.



**Top left:** Anchorage pull-out. Photo: Terence N. Mitchell.

**Bottom left:** Example of rack webbing. Photo: Dr. Keith Porter.

**Top right:** Sideways rack collapse. Photo: Michel Bruneau and GC Clifton.

**Bottom right:** Fractured beam column, Christchurch, NZ. Photo: Clifton et al.

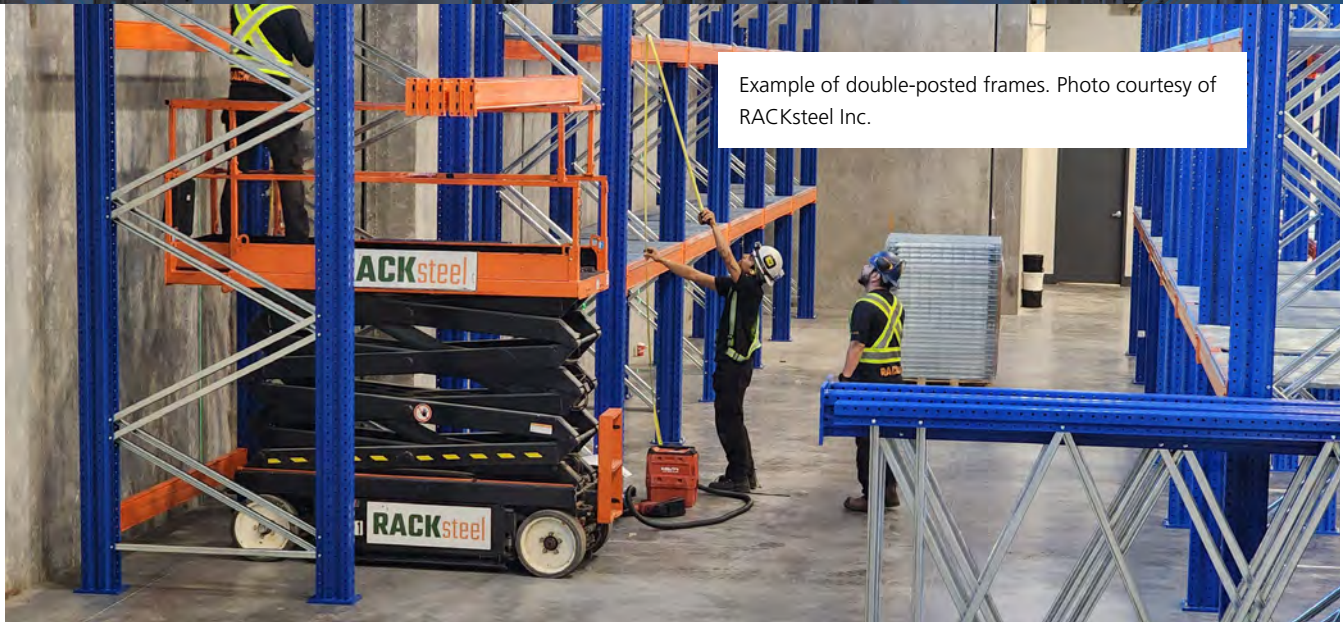


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Racks that include in-rack sprinklers should include proper bracing of sprinkler piping.

10

Rack structures should never be overloaded and capacity signage should be clearly posted and adhered to at all times.



Example of double-posted frames. Photo courtesy of RACKsteel Inc.

11

Provincial occupational health and safety laws and regulations may require regular workplace inspections, training and maintenance/repair of storage racking. Such regulations may also require racking capacity and other requirements be calculated and individually certified by a professional engineer. Always consult a licensed and insured expert.

12

Consideration should always be made for proper access and egress. Products stored on the lower levels of racking must not obstruct walkways and exit routes.

13

Once designed and approved by a certified and insured engineer, and inspected for compliance with the design after construction, the racking must not be modified or altered versus the engineered drawings without consulting an expert. This includes moving and/or changing beam levels.

14

In Canada, see [CSA A344:17 \(R2022\) User guide for steel storage racks](#). Also see [CSA S16-19 Annex N Design of steel structures](#).

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See WorkSafe BC's *Pallet Rack Inspection Checklist* at <https://www.worksafebc.com/en/resources/health-safety/checklist/pallet-rack-inspection-checklist?lang=en>

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Also see the RACKsteel blog 'Why Earthquake Engineering is Crucial for Pallet Racking Design in B.C.'

<https://racksteel.com/blogs/why-earthquake-engineering-is-crucial-for-pallet-racking-design-in-b-c/>

**Institute for Catastrophic Loss Reduction**

**Mission**

To reduce the loss of life and property caused by severe weather and earthquakes through the identification and support of sustained actions that improve society's capacity to adapt to, anticipate, mitigate, withstand and recover from natural disasters.

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