SEISMIC RESTRAINT FOR EQUIPMENT

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Earthquake damage of inadequately restrained equipment and building contents can dominate earthquake losses and result in a prolonged road to recovery of full operations. MRP Engineering observations following recent worldwide earthquakes demonstrate this need to protect critical equipment, utilities, and contents (see below example photographs).

Toppled unrestrained lab workstations (2011 M9.0 Japan earthquake)

Transformer damage can lead to prolonged downtime (2010 M8.8 Chile earthquake)

Traditionally, building codes for new construction have focused on life-safety performance for structures, and "position retention" for equipment and non-structural elements. However, an enhanced level of seismic performance is often desired, or required, for a facility to resume its operations without lengthy or expensive post-earthquake repairs. In general, seismic performance (or extent of damage) of in-building equipment is influenced by:

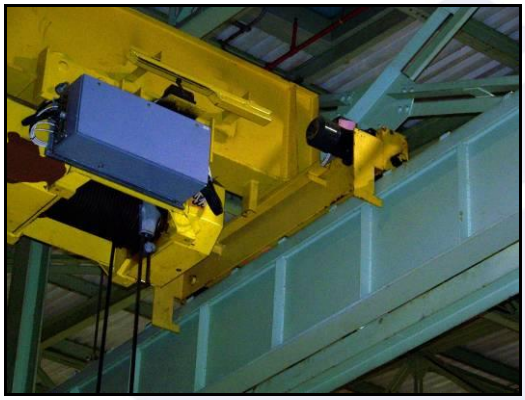
- Site ground-shaking intensity (distance to active faults and soil conditions)
- Building structural system (stiffness and height) and in-building equipment location (elevation)
- Equipment geometry (height-to-width ratio) and its overall mass
- Ruggedness of equipment internals and restraint of sub-components
- Interaction (impact) with adjacent equipment or structural elements
- Cabling or piping flexibility at utility connections

Strong ground-shaking creates significant inertial vertical and horizontal forces on equipment that can cause it to slide, roll, or overturn. Structural response (building deformations or pounding between adjacent structures) can also lead to equipment damage. Release of fluids, gases, or other hazardous substances also represents a significant concern. Replacement of damaged unique components may require a relatively long lead time. MRP Engineering's systematic approach to reducing nonstructural earthquake impacts for existing facilities begins with a screening of equipment to identify potentially vulnerable critical components and to understand their impacts. The next steps involve adding system redundancy or design/installation of seismic restraints (or flexibility) to provide a reliable performance in the event of a major earthquake. The following photographs illustrate seismic protection measures for common equipment and non-structural components.

EXAMPLES OF SEISMIC PROTECTION MEASURES

Floor-mounted manufacturing equipment anchorage

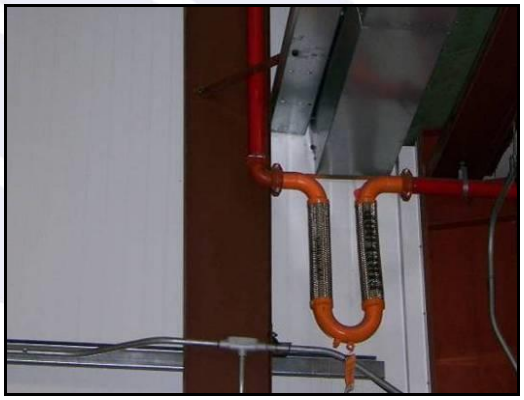
Bracing of suspended ceiling grid



Bridge crane vertical restraint

Raised-access floor bracing system

Lateral and vertical bracing for piping



Flexible coupling for piping

MRP ENGINEERING

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