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SEISMIC SPECIFICATION

- SDS-1.

SEISMIC QUALIFICATION APPROACH

- Equivalent static coefficient analysis.
  - Anchorage or adequate restraint of tables, and so forth.

REFERENCE FIGURES FOR INSTALLATION DETAILS

- 4.9, 4.14, 4.15, 4.34, 4.58, 4.61, 4.62, 4.63, 4.110

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor to moderate.

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Dislodged equipment.
- Toppled equipment
- Possibly inoperable equipment.
- General cleanup required.

Data Processing Systems

Tape Drives

Tape drives (Figure 3.35) are generally tall and slender pieces of equipment susceptible to toppling

EQUIPMENT SEISMIC CATEGORY

- "B" support equipment.

SEISMIC SPECIFICATION

- SDS-1

SEISMIC QUALIFICATION APPROACH

- Equivalent static coefficient analysis.
  - Base anchorage.
  - Top bracing where possible
- Seismic test/dynamic analysis.
  - Manufacturer may wish to undertake a more ambitious generic qualification to assure equipment operability and frame/component integrity.

REFERENCE FIGURES FOR INSTALLATION DETAILS

- 4.9, 4.14, 4.15, 4.34, 4.35.

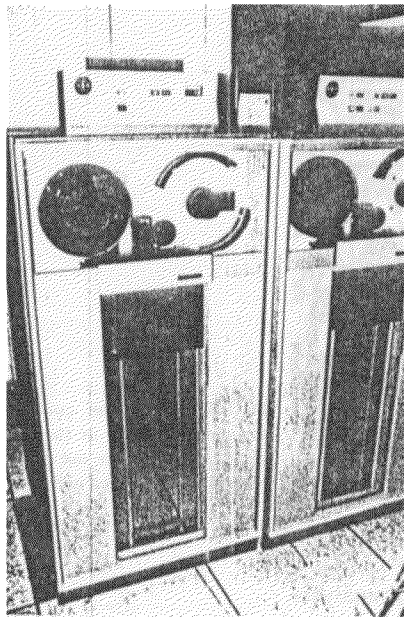

FIGURE 3.35. Tape drives are likely to topple during an earthquake if they are not properly anchored

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor to moderate.

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Toppled equipment.
- Possibly inoperable equipment
- General cleanup required.

Data Processing Systems

Tape Storage

Tape storage units (Figure 3.36) should be base anchored and shelf restrainers should be employed to keep the tapes on the shelves.

EQUIPMENT SEISMIC CATEGORY

- "C" support equipment.

SEISMIC SPECIFICATION

- SDS-2.

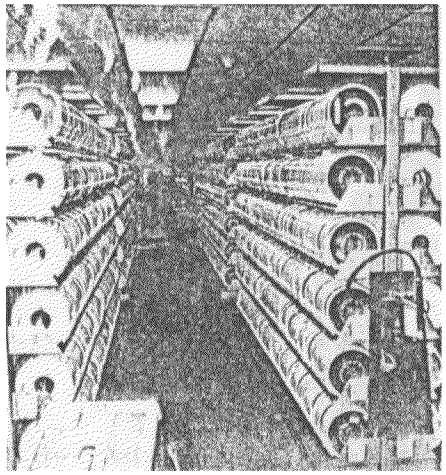

FIGURE 3.36 The contents of tape storage units such as these may spill if shelf restraints are not employed along with base anchorage and top bracing.

SEISMIC QUALIFICATION APPROACH

- Equivalent static coefficient analysis.
  - Base anchorage
  - Top bracing and anchorage.
  - Longitudinal "X" bracing.
- Design team judgment
  - Provide restraints to keep tapes on the shelves.

REFERENCE FIGURES FOR INSTALLATION DETAILS

- 4.35, 4.53, 4.54, 4.55, 4.56, 4.73, 4.104

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Toppled shelves
- Tapes spilled onto floors.
- General cleanup required.

Elevator Systems

Passenger elevators are divided into two general types: the oil-hydraulic elevators and the traction elevators. The former generally performs well

with a minimum of earthquake protection. The traction type elevators, however, are more complicated and consequently are more likely to fail as a result of strong shaking. Most of the emphasis of legislation currently in existence for elevators is directed at the traction elevators (see Appendix 1, CAC 24-7 for California retrofit requirements). Elevator manufacturers may wish to consider generic seismic test programs to qualify the elevator system so that it will remain operational after a major earthquake. Current California legislation will have to be revised so that elevators are not restricted from operation (see Appendix 1). Oil-hydraulic elevators are commonly composed of the following earthquake sensitive subcomponents:

- Pump.
- Electric motor
- Electric control panel
- Hydraulic control.
- Cab guide rails

Traction elevators are commonly composed of the following earthquake sensitive subcomponents:

- Hoist machine
- Motor control panel
- Motor generator.
- Selector panel.
- Counterweights and rails.
- Car and car rails.

SYSTEM SEISMIC CATEGORY

- "A" critical system.

SYSTEM FOUND IN

- All multistory facilities.

Elevator Systems—Oil-Hydraulic Elevator

Cab Guide Rails

Inadequately designed and anchored guide rails can fail and cause elevator system inoperability (see Figure 3.37).

EQUIPMENT SEISMIC CATEGORY

- "A" critical equipment.

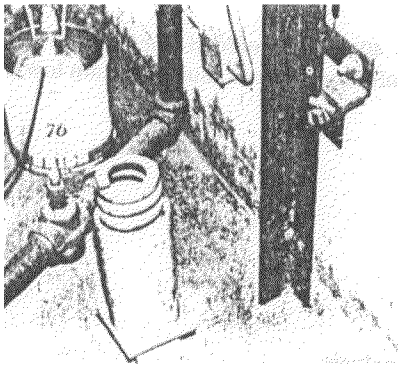

FIGURE 3.37. Cab guide rails need adequate anchorage provisions to prevent failure. Shown here is an inadequate example.

SEISMIC SPECIFICATION

- SDS-1.

SEISMIC QUALIFICATION APPROACH

- Equivalent static coefficient analysis
  - Rail anchorage
  - Rail characteristics.

REFERENCE FIGURE FOR INSTALLATION DETAILS

- 4.22

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor to moderate.

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Derailed car
- Inoperable elevator.

Elevator Systems—Oil-Hydraulic Elevators

Electric Control Panel

If the electric control panel (Figure 3.38) is not solid-state and if it contains dynamically sensitive subcomponents such as relays or mercury switches, it should be qualified to prove operability.

EQUIPMENT SEISMIC CATEGORY

- "A" critical equipment.

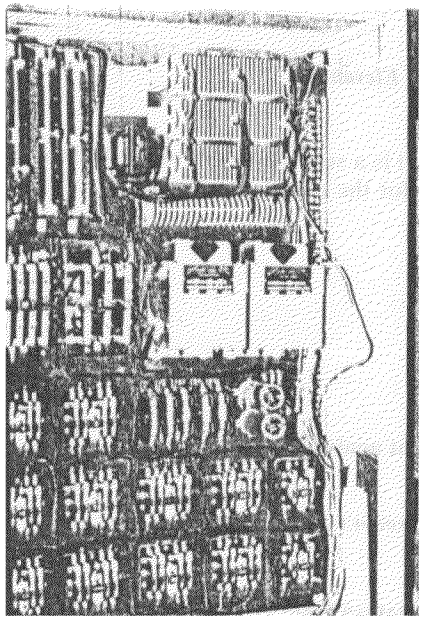

FIGURE 3.38. Electric control panels are securely attached to walls. Some of the subcomponents may be dynamically sensitive.

SEISMIC SPECIFICATION

- SDS-1.

SEISMIC QUALIFICATION APPROACH

- Equipment static coefficient analysis.
  - Base anchorage and top bracing if solid state.
- Seismic test
  - To prove operability if dynamically sensitive subcomponents are used.

REFERENCE FIGURE FOR INSTALLATION DETAILS

- 4.25

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor to moderate.

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Shifted equipment.

- Toppled equipment
- Inoperable as a result of failure of dynamically sensitive subcomponents (transient failure).

Elevator Systems—Oil-Hydraulic Elevators

Electric Motor

The electric motor (Figure 3.39) is a subcomponent of the hydraulic control unit and must remain in place for the elevator system to be operational.

EQUIPMENT SEISMIC CATEGORY

- "A" critical equipment.

SEISMIC SPECIFICATION

- SDS-1.

SEISMIC QUALIFICATION APPROACH

- Equivalent static coefficient analysis.
  - Base anchorage.

REFERENCE FIGURE FOR INSTALLATION DETAILS

- 4.28.

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor to moderate.

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Shifted motor.
- Inoperable elevator.

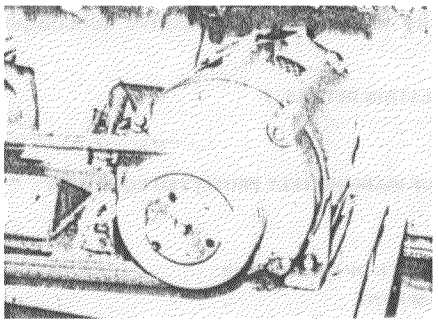

FIGURE 3.39. The electric motor should be firmly anchored to the control frame as shown here.

Elevator Systems—Oil-Hydraulic Elevators

Hydraulic Control Unit

The hydraulic control unit (Figure 3.40) must remain in place for the elevator system to be operational and hydraulic supply lines must maintain low flange loads to prevent oil spills.

EQUIPMENT SEISMIC CATEGORY

- "A" critical equipment

SEISMIC SPECIFICATION

- SDS-1.

SEISMIC QUALIFICATION APPROACH

- Equivalent static coefficient analysis.
  - Base anchorage.
- Design team judgment.
  - Flexible fluid supply lines.

REFERENCE FIGURE FOR INSTALLATION DETAILS

- 4.28.

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor to moderate

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Shifted equipment
- Broken supply lines.
- Inoperable elevator.

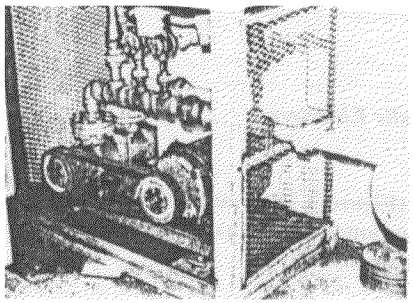

FIGURE 3.40. The hydraulic control unit must be anchored and flexible line connections should be employed. Hard connections, as shown here, are likely to fail

REFERENCE FIGURE FOR EXAMPLE OF DAMAGED EQUIPMENT

- 3.162.

Elevator Systems—Oil-Hydraulic Elevators

Pump

The hydraulic pump (Figure 3.41) is a subcomponent of the hydraulic control unit and must remain in place to be operational, and fluid supply lines must maintain low flange loads to prevent oil spills.

EQUIPMENT SEISMIC CATEGORY

- "A" critical equipment.

SEISMIC SPECIFICATION

- SDS-1

SEISMIC QUALIFICATION APPROACH

- Equivalent static coefficient analysis.
  - Fixed anchorage.
- Dynamic analysis
  - Vibration isolation (motion restraint required)
- Design team judgment.
  - Flexible fluid supply lines.

REFERENCE FIGURE FOR INSTALLATION DETAILS

- 4.28.

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor to moderate.

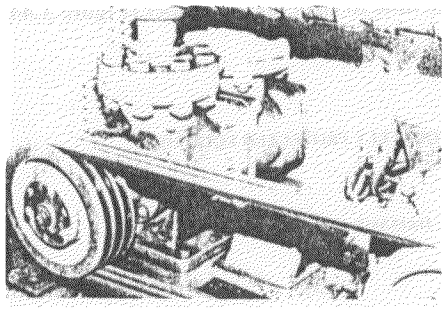

FIGURE 3.41. The hydraulic pump, and other subcomponents, should be securely anchored to the control frame.

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Shifted equipment.
- Broken supply lines.
- Inoperable elevator.

Elevator Systems—Traction Elevators

Car Rails

Elevator car rails (Figure 3.42) have generally performed better in past earthquakes than the counterweights. Ayres and Sun (1973) only reported 18 cars out of their rails or out of alignment as a result of the 1971 San Fernando earthquake. This observation does not mean that car rails should not be considered; they should.

EQUIPMENT SEISMIC CATEGORY

- "A" critical equipment.

SEISMIC SPECIFICATION

- SDS-1.

SEISMIC QUALIFICATION APPROACH

- Equivalent static coefficient analysis.
  - Rail anchorage.
- Stress analysis.
  - For the rail
- Design team judgment.
  - Select guide shoe for shoes with earthquake provisions.

REFERENCE FIGURE FOR INSTALLATION DETAILS

- 4.22

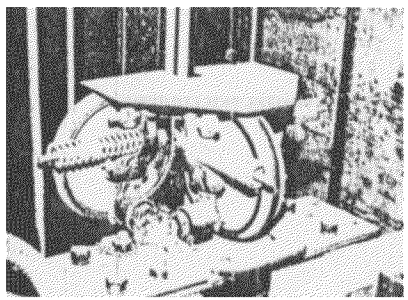

FIGURE 3.42 Car rail with roller guide. Photograph taken from car top.