"Documento original en mal estado"

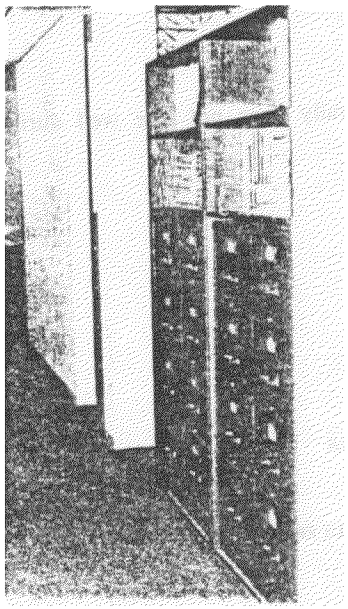

FIGURE 3.143. Filing cabinets if properly detailed as these are, will not present a problem in the event of an earthquake. Photograph courtesy of Ruhnau Evans Ruhnau Associates.

REFERENCE FIGURES FOR INSTALLATION DETAILS

- 4.108, 4.109

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor.

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Toppled filing cabinets.
- General cleanup required.
- Potential for personnel injury.

REFERENCE FIGURES FOR EXAMPLES OF DAMAGED EQUIPMENT

- 3.194, 3.195, 3.196.

Miscellaneous Equipment

Monitors, CRT

CRT monitors (Figure 3.144) should be installed per manufacturer recommendations.

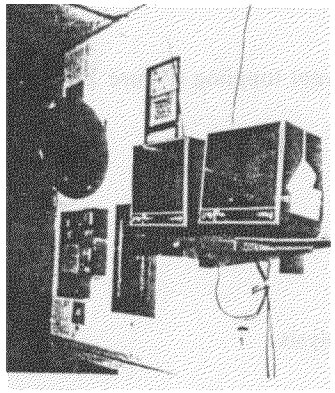

FIGURE 3.144. These unsecured CRT monitors have been installed on a shelf that is designed for one set. Note that they are sitting on a thin board because they were too large for the shelf.

EQUIPMENT SEISMIC CATEGORY

- "C" support equipment

SEISMIC SPECIFICATION

- SDS-2

SEISMIC QUALIFICATION APPROACH

- Equivalent static coefficient analysis.
  - Bracket anchorage to wall
  - CRT anchorage to bracket.
- Dynamic analysis
  - Manufacturers may wish to perform generic qualification programs for mounting monitors on their brackets.

REFERENCE FIGURE FOR INSTALLATION DETAILS

- 4.67.

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor to moderate.

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Toppled CRTs.
- Inoperative equipment
- Potential for personnel injury.
- General cleanup required

REFERENCE FIGURE FOR EXAMPLE OF DAMAGED EQUIPMENT

- 3.172.

Miscellaneous Equipment

Personnel Lockers

These items need anchorage to prevent toppling (Figure 3.145).

EQUIPMENT SEISMIC CATEGORY

- "E" miscellaneous equipment.

SEISMIC SPECIFICATION

- SDS-2.

SEISMIC QUALIFICATION APPROACH

- Equivalent static coefficient analysis
  - Base anchorage
  - Attach to walls where possible.
  - Braced tops

REFERENCE FIGURES FOR INSTALLATION DETAILS

- 4.108, 4.109

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor to moderate.

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Toppled lockers.
- General cleanup required.

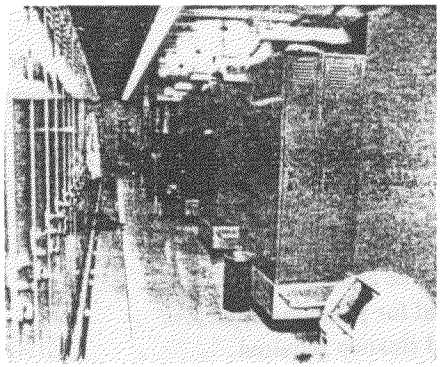

FIGURE 3.145 An example of personnel lockers that have been properly installed. They are base anchored at regular intervals to their foundation

Miscellaneous Equipment

Storage, Ad Hoc

Ad hoc storage (Figure 3.146) generally does not fare well during an earthquake.

EQUIPMENT SEISMIC CATEGORY

- "E" miscellaneous equipment.

SEISMIC SPECIFICATION

- SDS-2.

SEISMIC QUALIFICATION APPROACH

- Design team judgment.

REFERENCE FIGURES FOR INSTALLATION DETAILS

- 4.102, 4.103, 4.104.

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor to moderate

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Toppled storage
- Spilled shelf contents.
- General cleanup required.

REFERENCE FIGURE FOR EXAMPLE OF DAMAGED EQUIPMENT

- 3.197.

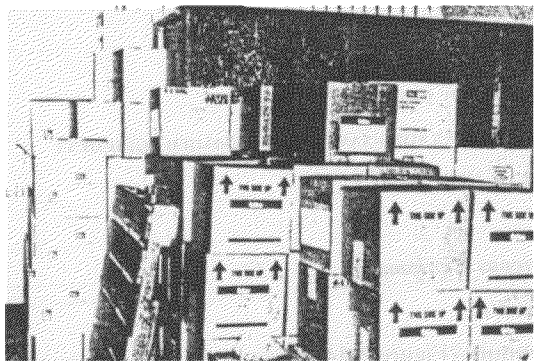

FIGURE 3.146. Example of ad hoc storage that is likely to collapse during an earthquake.

Miscellaneous Equipment

Storage Shelves

General storage shelves (Figure 3.147) must be considered with respect to the shelving as well as the shelf contents.

EQUIPMENT SEISMIC CATEGORY

- "1" miscellaneous equipment

SEISMIC SPECIFICATION

- SDS-2.

SEISMIC QUALIFICATION APPROACH

- Equivalent static coefficient analysis.
  - Base anchorage
  - Top bracing and anchorage.
- Design team judgment.
  - Provide shelved item restrainers

REFERENCE FIGURES FOR INSTALLATION DETAILS

- 4.53, 4.54, 4.55, 4.56, 4.102, 4.103, 4.104.

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor to moderate.

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Shelf units topple
- Items fall from shelves.
- General cleanup required

REFERENCE FIGURES FOR EXAMPLES OF DAMAGED EQUIPMENT

- 3.191, 3.192, 3.193, 3.198

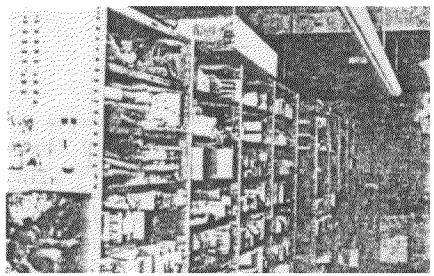

FIGURE 3.147. General storage shelves such as those shown here require base anchorage, longitudinal bracing, top bracing, and shelf parapets. This shelving unit has not received any of this protection.

Miscellaneous Equipment

Typewriters

Although typewriters are not necessary for the operation of any facility they do pose a threat to facility personnel if they fall and can add to the general cleanup required if they are not considered.

EQUIPMENT SEISMIC CATEGORY

- "E" miscellaneous equipment.

SEISMIC SPECIFICATION

- SDS-2.

SEISMIC QUALIFICATION APPROACH

- Design team judgment.
  - Anchor to desk.
  - Provide lips on desk to prevent their sliding off.

REFERENCE FIGURE FOR INSTALLATION DETAILS

- 4.110

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor.

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- General cleanup required
- Possibility for personnel injury

EXAMPLES OF DAMAGED EQUIPMENT

This section is included to illustrate the potential for damage to equipment by an earthquake. The preceding section of this chapter contains references to this section under the individual equipment items wherever possible.

All the example damage photographs are of equipment failures that resulted from one of three Southern California earthquakes, the San Fernando earthquake (1971, M 6.6), the Santa Barbara earthquake (1978, M 5.1), and the Imperial County earthquake (1979, M 6.6). The reader will note that these are relatively moderate earthquakes and yet the damage in many cases is quite striking. A larger magnitude earthquake produces the same types of damage, only over a larger area.

A thorough study of these photographs will give the designer, manufacturer, facility owner, and so on a much clearer picture of what to expect if

building equipment is not adequately protected. These photographs address the structural integrity of equipment rather than its operational capabilities. Equipment that must remain operational may look good after an earthquake, but because of internal failures or support equipment failures may be completely inoperable. This concept must be borne in mind, especially when dealing with critical equipment.

It is hoped that the review of these photographs will underscore the importance of seismic qualification programs for all types of equipment, not just selected items that are specifically required by building codes. Designers and manufacturers have the opportunity to use this section on new facilities, while facility owners can use it as a checklist on walk-through tours of their existing buildings to improve the chance for survival of their equipment. Many existing facilities desperately need such backfitting programs even if they are not required by the existing codes.

The author wishes to apologize for the quality of some of the photographs contained in this section. They have been taken from various sources and in some cases the originals could not be located, which necessitated copying them directly from the original publication, a less than desirable procedure. It was felt, however, that the points that they illustrate are important enough to justify their reproduction.

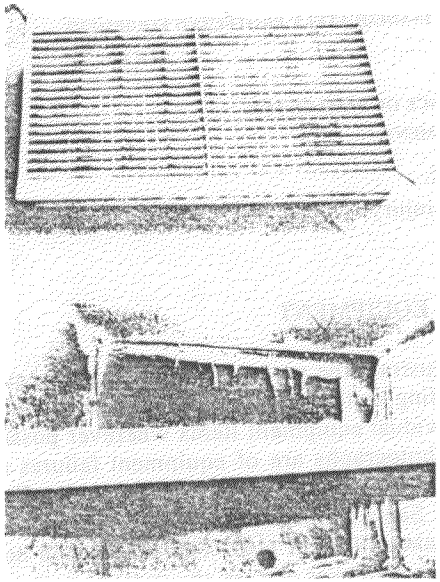

FIGURE 3.148. Air grill that dislodged and fell. Positive attachment and a safety wire would have prevented this potentially dangerous situation. Photograph courtesy of Richard Miller and the National Science Foundation.

FIGURE 3.149. Separation of air plenum as viewed from inside the ducting. Photograph courtesy of Richard Miller and the National Science Foundation.

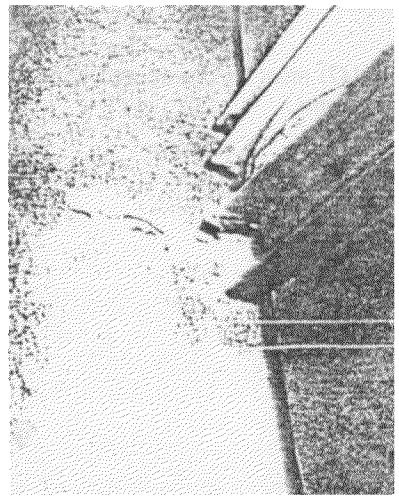

FIGURE 3.150. Damage to wall where inadequately restrained ducting pounded during the earthquake. This photograph illustrates the need for separating equipment that could collide during an earthquake with the potential for damage to critical equipment by support equipment. Photograph courtesy of Richard Miller and the National Science Foundation.

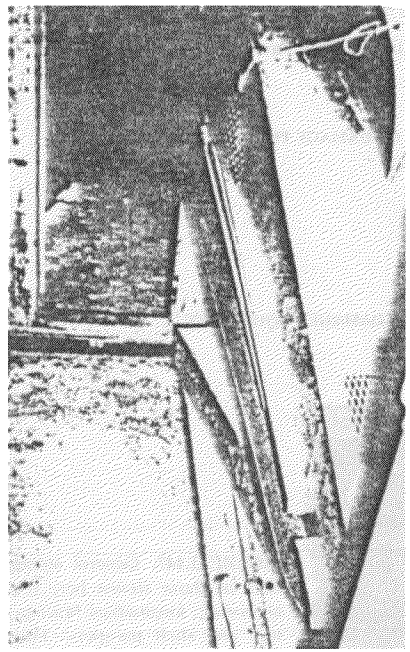

FIGURE 3.151. Unrestrained air handling unit slab that shifted. These slabs must be restrained if the equipment they support is to remain operational. Photograph courtesy of Richard Miller and the National Science Foundation.