6.5 Furniture, Fixtures, Equipment and Contents

6.5.2 Bookcases, Shelving

6.5.2.1 Bookshelves

Tall wood or metal shelving units frequently tip or overturn in earthquakes unless they are properly anchored.

Provisions

BUILDING CODE PROVISIONS

The seismic design requirements of ASCE/SEI 7-10, *Minimum Design Loads for Buildings and Other Structures*, (ASCE, 2010) Chapter 13 apply to permanent floor-supported library shelving, book stacks, and bookshelves over 6 feet tall in Seismic Design Categories C, D, E, and F. The weight of the contents must be included when determining the seismic loads.

RETROFIT STANDARD PROVISIONS

ASCE/SEI 41-06, *Seismic Rehabilitation of Existing Buildings*, (ASCE, 2007) classifies bookshelves as force controlled, and the principal objective of the code provisions is to prevent the component from sliding or overturning. ASCE/SEI 41-06 requires bookshelves 4 feet in height comply with the anchorage provisions of the standard when the performance level is Life Safety or higher.

Typical Causes of Damage

- Tall, narrow shelving may tip, slide, overturn or collapse and the contents may spill. Overturned shelving may injure occupants and block doors or exits.
- Books, files, medical records may fall and get scrambled or damaged. Clean-up and reorganization of spilled items may take many hours or days and result in costly business interruption.

DAMAGE EXAMPLES

Figure 6.5.2.1-1 Failure of poorly anchored wood and metal book shelves at the Lawrence Livermore Laboratory, Livermore, California (NGDC, 2009).

Figure 6.5.2.1-2 Failure of poorly anchored shelving; toggle bolt pulled out of gypsum board wall in the 1994 magnitude-6.7 Northridge Earthquake (Photo courtesy of Wiss, Janney, Elstner Associates).

Figure 6.5.2.1-3 Bookcase overturned onto desk in the 1971 magnitude-6.6 San Fernando Earthquake (Photo courtesy of Degenkolb Engineers).

Seismic Mitigation Considerations

- Permanent floor-supported shelving or storage cabinets over 6 ft tall must be designed as architectural components per ASCE 7-10, *Minimum Design Loads for Buildings and Other Structures* (ASCE, 2010). Bracing and anchorage for these units should be designed considering the weight of the unit and weight of shelved contents. The details shown in Figure 6.5.2.1-4 and 6.5.2.1-5 are for shelving units up to 6 feet tall.
- Bookcases and shelving should be anchored to an adjacent stud wall or concrete or masonry wall. For freestanding units, see Section 6.5.1.1 for recommended details for bracing units and tying back-to-back units together.
- See Section 6.5.6.1 for recommendations regarding edge restraints and arrangement for shelf-mounted items. Do not locate shelving adjacent to doors or exits if their failure would block the exit.
- Any connections to stud walls must engage the structural studs; do not rely on gypsum or plaster to support shelving. Stud walls and partitions and unreinforced or lightly reinforced heavy partitions may not have adequate lateral capacity to support multiple

shelving units; engineering may be required. The bracing or anchorage of walls and partitions to the structure above must also be checked for adequacy considering the seismic loads imposed by all anchored items.

- Bookcase or cabinet anchorage can be located either outside or inside the unit as long as the attachment properly engages the "structural" studs. Where aesthetics are a concern, it may be preferable to locate the screws or clip angles on the inside of the unit. In a commercial setting where maintenance personnel or movers may need to verify the anchorage or relocate the unit periodically, it may be preferable to provide exterior anchorage that is readily visible.

MITIGATION DETAILS

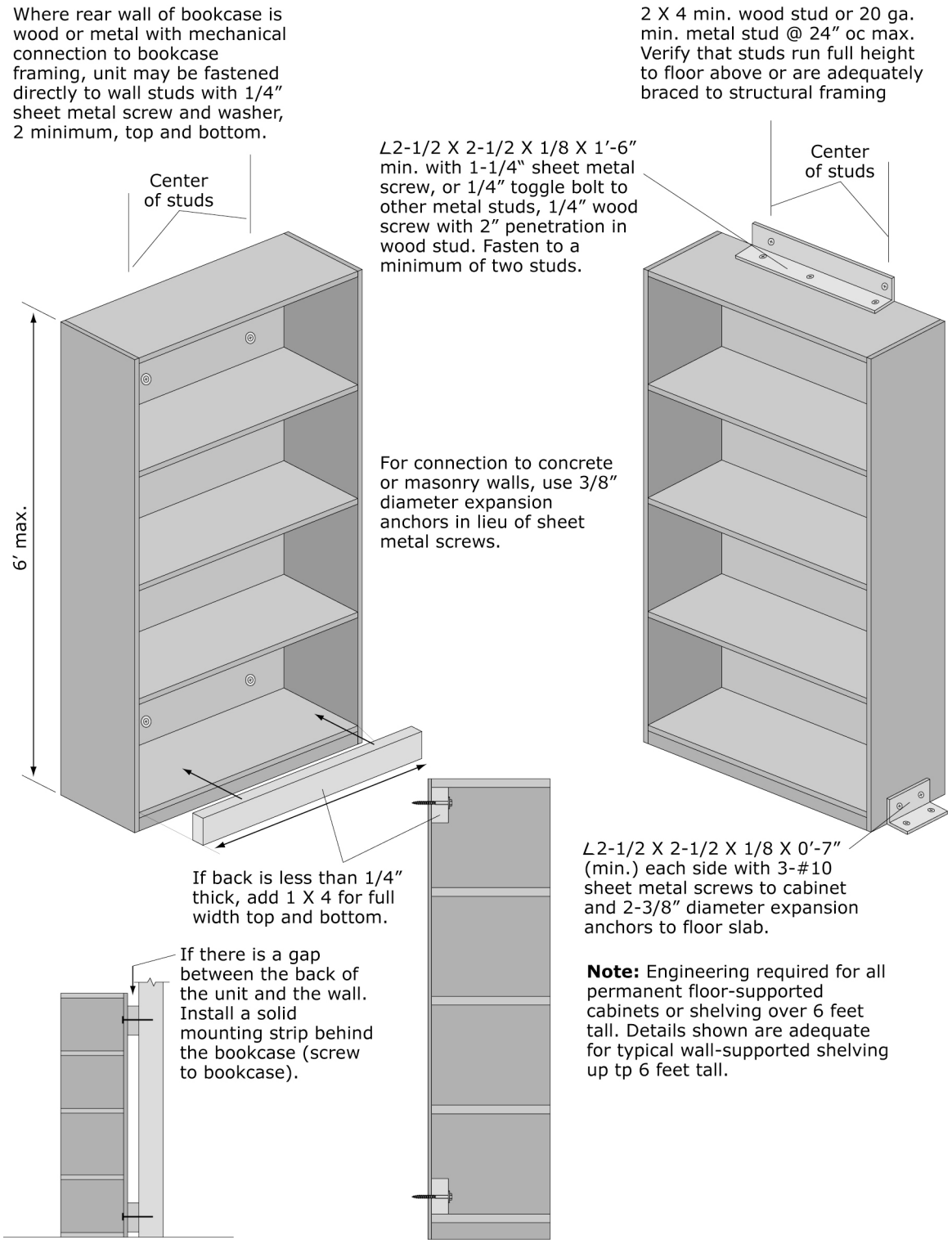
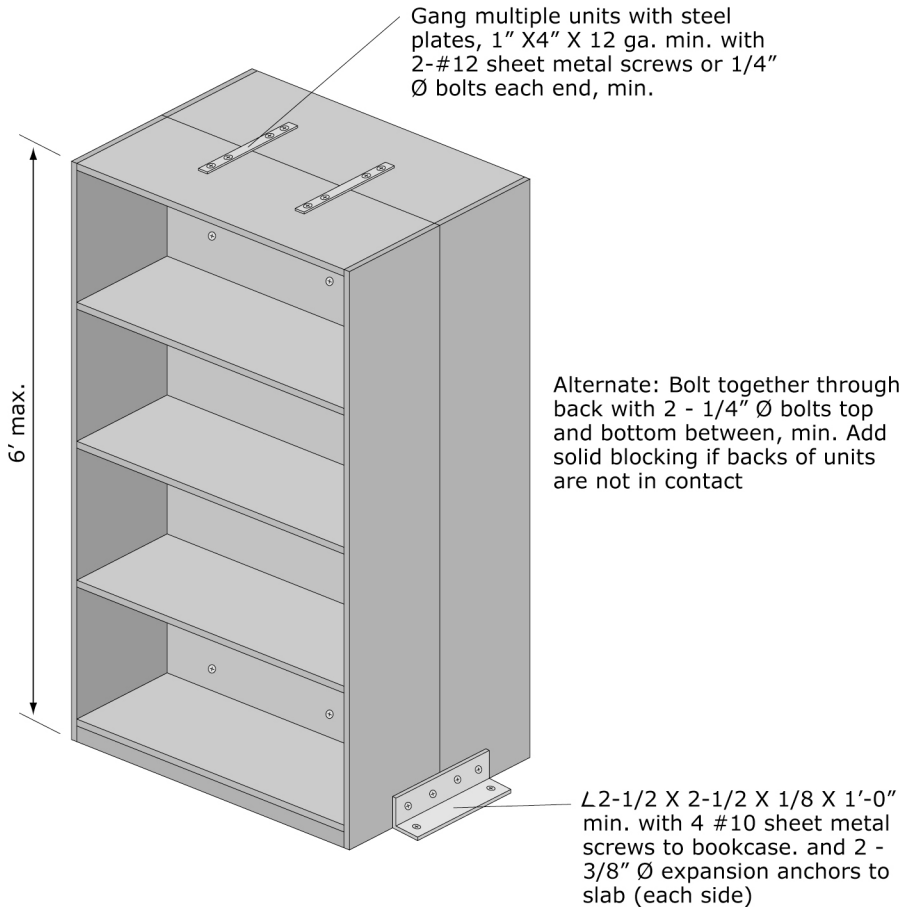


Figure 6.5.2.1-4 Bookshelves against wall (NE, ER).



Note: Engineering required for all permanent floor-supported cabinets or shelving over 6 feet tall. Details shown are adequate for typical shelving 6 feet or less in height.

Figure 6.5.2.1-5 Anchorage of freestanding book cases arranged back to back (NE, ER).