6.3 Architectural Components

6.3.2 Interior Partitions

6.3.2.2 Interior Partition Walls, Light

Light partitions are those that are built using wood or metal studs with gypsum board or lath and plaster finish. The studs may be full height (extending from floor-to-floor) or partial height, extending to the ceiling but not to the structural framing above. Partitions with partial height studs may be braced by the ceiling, but more commonly are braced with diagonal braces or wires independent of the ceiling, particularly at ceilings of lay-in acoustical tiles. The finish material may also run full height or stop at the ceiling, depending on fire or acoustical separation requirements.

In recent testing of a full scale 5-story building performed at the UC San Diego shake table (see Section 6.1.3), all floors included full height gypsum wall board partition wallboard partitions on metal studs that were subjected to severe earthquake motions and inter-story drifts. The partition walls were installed in accordance with normal installation practices. Severe gypsum wallboard damage and metal stud distress were observed following the strongest shaking but none of the walls collapsed. Additional tests were conducted to examine the potential consequences of fire initiated by earthquakes. Following the shake table testing, one of the floors was subjected to controlled burn and pressure tests to gauge how much the fire resistance of the fire-rated walls had been impaired by earthquake damage. The tests demonstrated that gypsum wallboard partitions may have reduced fire resistance following the earthquake, as compared to the fire resistance before the earthquake. This subject is the focus of ongoing study.

Provisions

BUILDING CODE PROVISIONS

Building code provisions for light interior partition walls limit deflections under out-of-plane loading, specify minimum out-of-plane loads, and have prescriptive bracing requirements when the height or weight of the partition exceed certain limits:

- The minimum out-of plane lateral load for partition walls is the larger of 5 psf or that computed in ASCE/SEI 7-10, *Minimum Design Loads for Buildings and Other Structures*, (ASCE, 2010) Chapter 13. When computing the lateral load, the weight of casework, shelving, and wall-mounted items should be considered.

- Deflection limits in *International Building Code* (IBC, 2012) for interior partitions are based on the type of the partition finish. They range from the partition height, L, divided by 120, L/120, for flexible finishes to L/360 for brittle finishes. These deflection limits are checked using the 5 psf minimum load noted above.
- Partitions greater than 6 feet in height must be laterally braced to the structure, independent of any ceiling lateral bracing

Although crucial for controlling damage due to story drift, there are no code requirements governing the detailing at the head of the wall.

RETROFIT STANDARD PROVISIONS

ASCE/SEI 41-06, *Seismic Rehabilitation of Existing Buildings*, (ASCE, 2007) classifies light interior partitions as both acceleration and deformation sensitive.

- Light interior partitions are subject to the requirements of ASCE/SEI 41-06 when the performance level is Immediate Occupancy.
- Acceptance criteria focus on verifying that the partitions have sufficient strength to resist out-of-plane forces, and verifying building drift limits.

Typical Causes of Damage

- In-plane (parallel with the wall) damage can occur to light partitions as a result of deformations of the structure (drift). Full-height partitions in flexible structures may be damaged in this way unless they are isolated from the building deformations. Typical damage consists of cracked or spalled finishes, deformed partition framing, and failed connections. Damage to ceilings may occur at partial height partitions, due to the in-plane stiffness of the partition and the flexibility of the ceiling suspension and bracing.
- Metal studs are often installed with a deflection track at the top that provides lateral support but also accommodates potential movement of the floor above due to changing gravity loading. See Figures 6.3.2.2-3A through C. In order for the deflection track to be effective in allowing vertical movement, neither the stud nor the finish material should be attached to the track. This lack of connection is often in conflict with fire or acoustical approvals of partitions systems. In addition, ASTM C754-11, *Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products*, covering installation of steel studs requires studs to be attached at jambs and partition intersections. To satisfy this condition, some installers attach such studs with angles with slotted holes to allow for vertical movement and prevent stud buckling. Deflection track details, if not compromised by occasional stud

attachment or finish attachment, will also allow in-plane lateral movement, minimizing damage to the finishes due to structural drift. However, even with no direct attachment to the floor above, sliding along the top track is incompatible with the rigid out-of-plane support of perpendicular partitions at corners. The local corner damage from this incompatible movement is difficult to avoid.

- Out-of-plane (perpendicular to the wall) damage is due to inertial loading on the wall from the floor accelerations (shaking). This loading is proportional to partition weight, so partitions with heavy finishes or hung book or storage shelves are more susceptible. Typically, damage from this loading occurs at the top connection of the partition to the structure or ceiling and may include local connection damage or complete failure leading to overturning of the partition. Such partition failures may create falling hazards, block corridors, and endanger occupants attempting to exit from damaged buildings.
- Partitions are also used to provide lateral support for floor supported storage shelves, equipment or other nonstructural items. This additional loading was often not anticipated in the design of the partition and damage could occur at the equipment connection, in the studs themselves, or at the wall-to-structure connections. The supported item could also be damaged due to unanticipated sliding or overturning.

DAMAGE EXAMPLES

Figure 6.3.2.2-1 Out-of-plane failure of inadequately braced partial height metal stud partitions in the 1994 Northridge Earthquake (Photo courtesy of Wiss, Janney, Elstner Associates).

Figure 6.3.2.2-2 In-plane damage to wood stud wall spanning floor-to-floor caused by differential movement between the two floors in the 1994 Northridge Earthquake (Photo courtesy of Wiss, Janney, Elstner Associates).

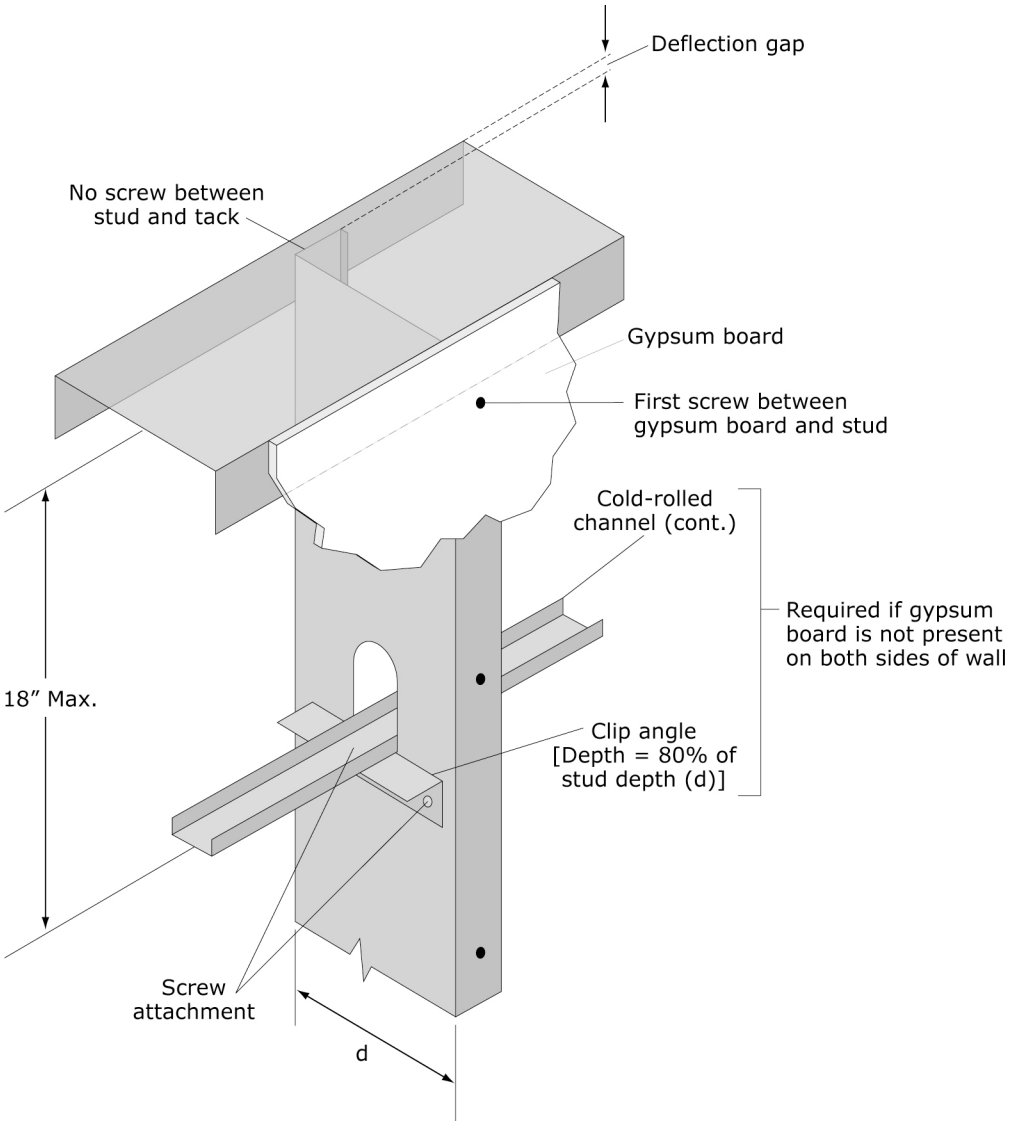

Figure 6.3.2.2-3a Top connection for metal studs with deflection channel.

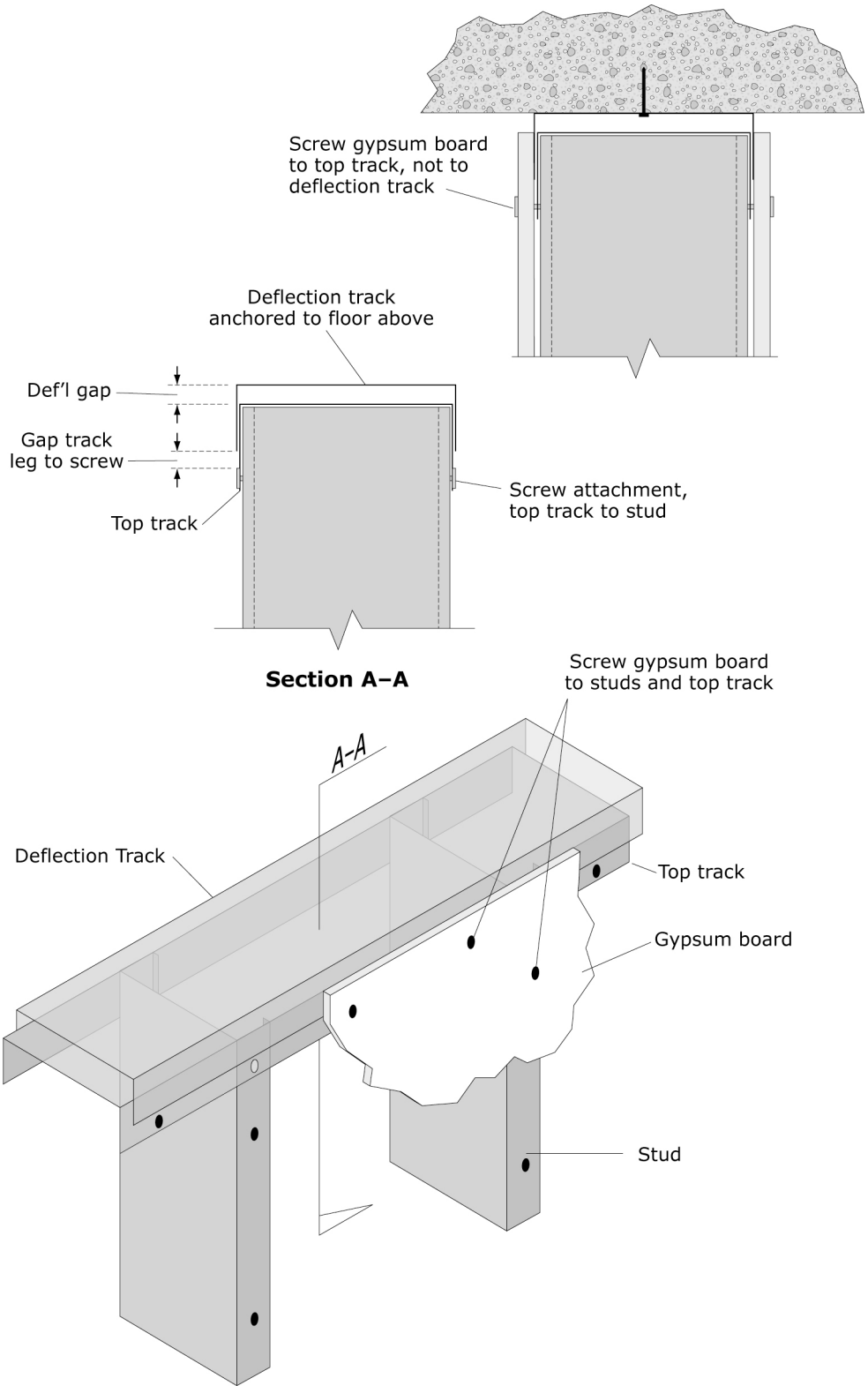

Figure 6.3.2.2-3b Top connection for metal studs with deflection channel with double track. Studs can be attached to insider channel without compromising vertical or lateral movement.

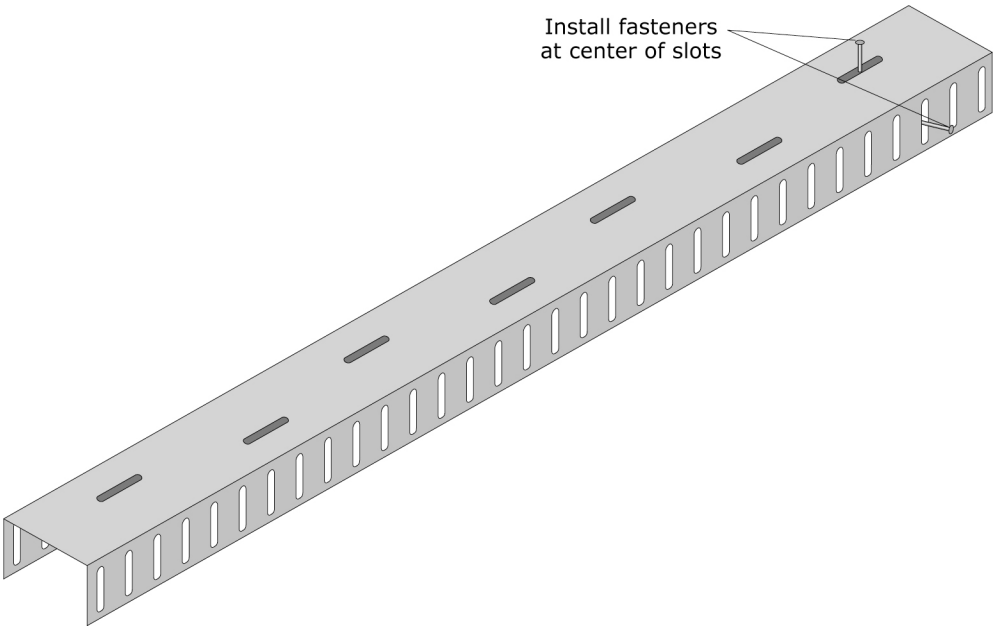

Figure 6.3.2.2-3c Example proprietary top track metal stud connection system. Studs are connected to the track through vertically slotted holes to allow for vertical movement. The connection of the track to the overhead structure through longitudinally slotted holes can accommodate in-plane slip to minimize damage from drift. The longitudinal slip capability can be inadvertently compromised by installing screw connections through the solid web, by overtightening screws through the slots, or by interruptions of the vertical alignment of the track at beams or changes in elevation of the overhead structure. This system does not solve the local damage at partition corners.

Seismic Mitigation Considerations

- Both laboratory testing and earthquake experience have shown that light interior partitions are vulnerable to damage due to story drift, even in low levels of shaking. The detailing at the head of the partition (the "top track") plays a critical role in determining the nature and severity of earthquake damage.
- For multistory and other engineered buildings, damage to non-load bearing full-height steel stud partitions can be minimized by avoiding connection of stud and finish to the top track. This can be accomplished by using a double track system or slotted tracks. . Note that special details need to be coordinated with requirements to meet fireproofing, sound proofing, weatherproofing, or insulation requirements. More elaborate details would be needed to minimize or eliminate damage at interconnected perpendicular walls since the out-of-plane restraints along one wall may prevent slip on the perpendicular wall. If fire or acoustical requirements allow, partial height partitions are less susceptible to in-plane damage, but should be braced to the overhead structure and not the ceiling.
- In wood framed buildings, partitions on wood studs are often installed with fixed connections top and bottom, although slip connections can also be developed in such cases. In small wood framed buildings gypsum or plaster non bearing partitions often provide additional lateral support against seismic shaking.If partition walls will be used to provide lateral restraint for other nonstructural items, the walls and the lateral connections at the top should be checked for adequacy.
- New or improved restraint systems for steel stud partitions are under development; one such scheme was tested at Stanford University in July 2010 that allows for over 1.5" of displacement in any horizontal direction, which would provide protection against damage at intersection of perpendicular walls. Check the internet for additional restraint options.

MITIGATION EXAMPLES

Figure 6.3.2.2-4 Bracing of partial height stud partition (Photo courtesy of Degenkolb Engineers).

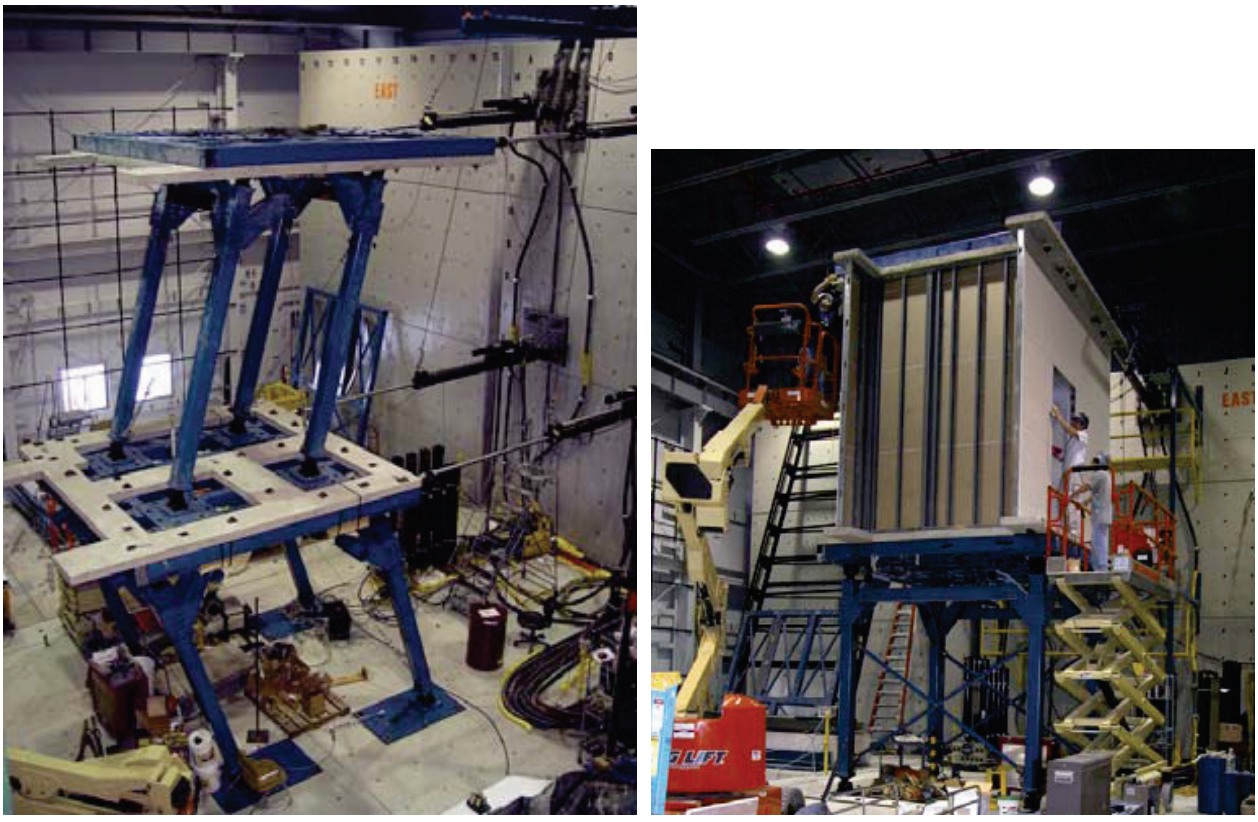

Figure 6.3.2.2-5 Two-story nonstructural component simulator at the University of Buffalo, SUNY shown at left. Preparation for dynamic testing of stud partitions for the NEES Nonstructural Project shown at right. Tests such as these improve understanding of the seismic behavior of nonstructural components (Photos courtesy of University of Buffalo, SUNY).

MITIGATION DETAILS

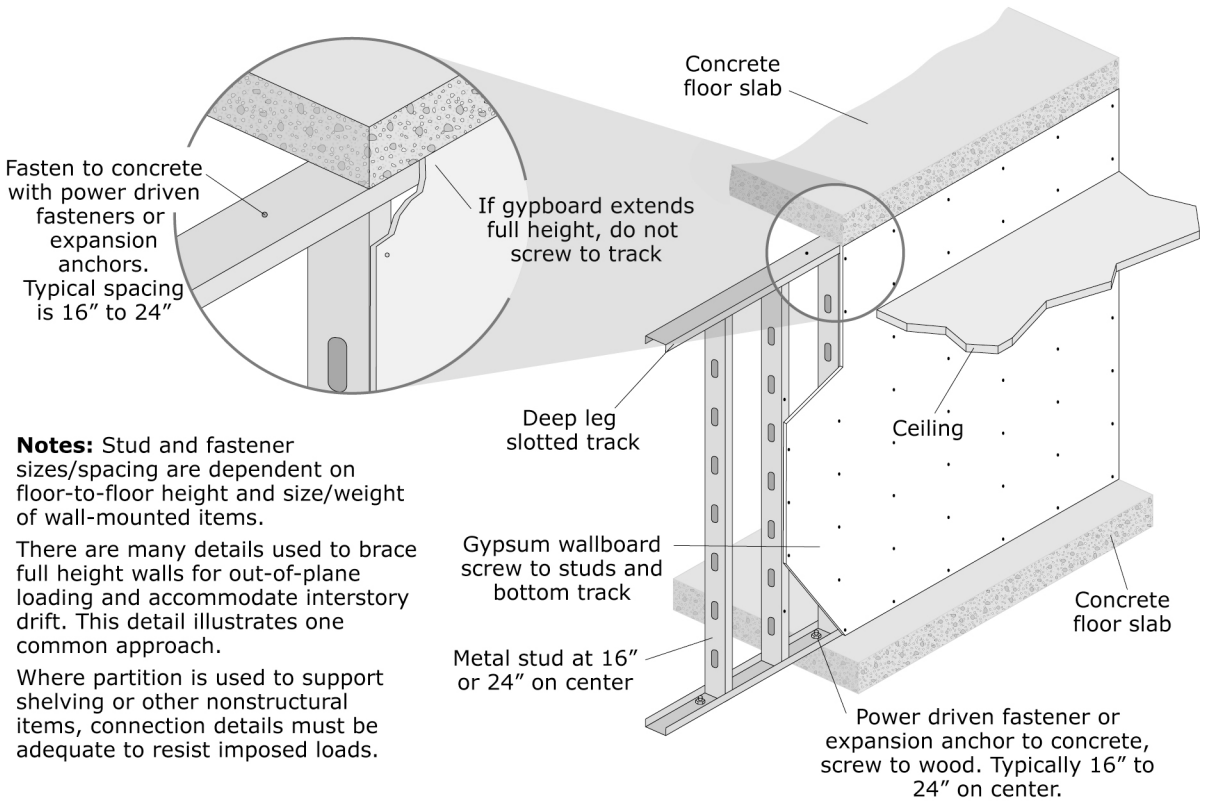

Figure 6.3.2.2-6 Full height nonbearing stud wall (ER).

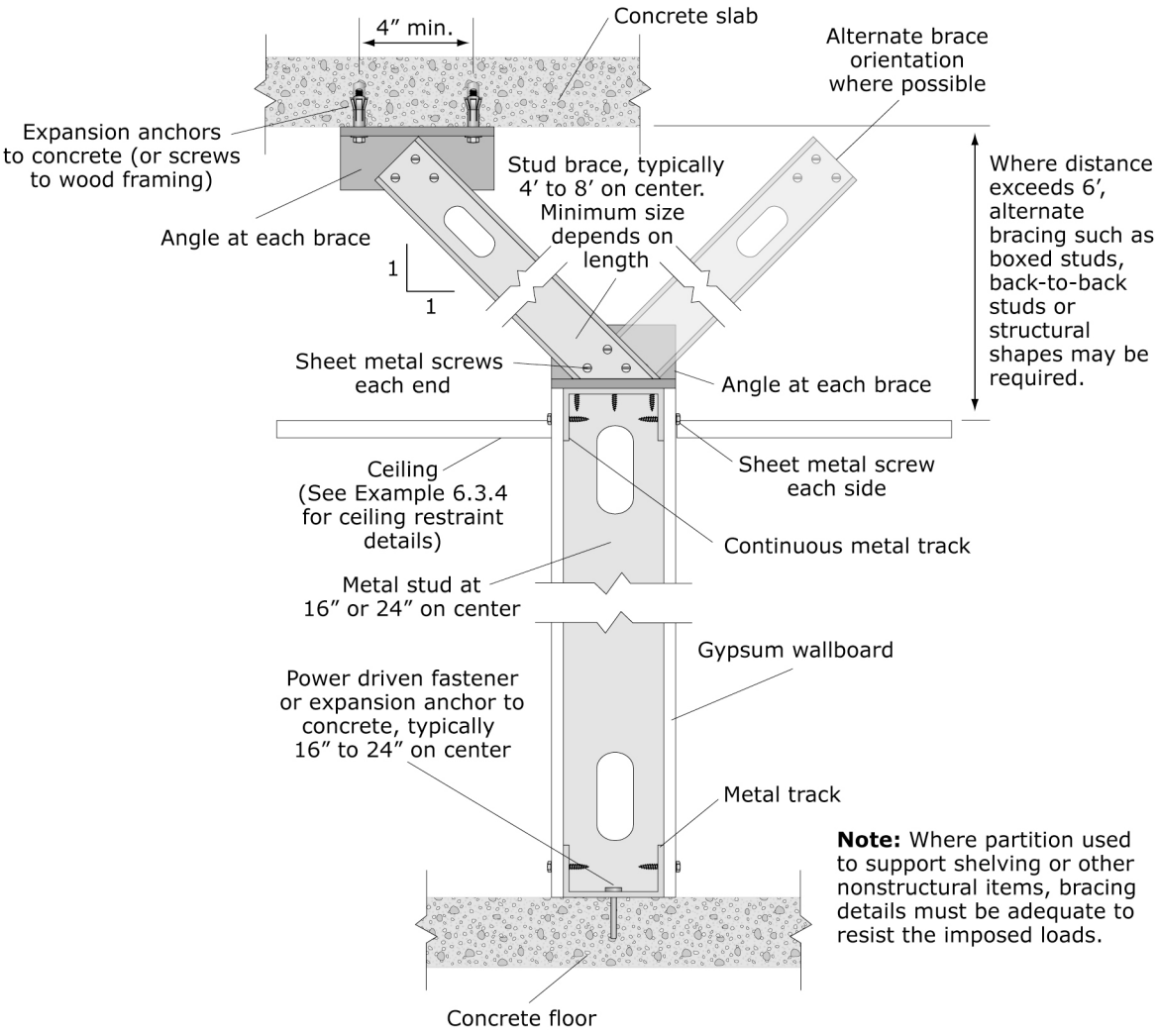

Figure 6.3.2.2-7 Partial height nonbearing stud wall (ER).