

6.3 Architectural Components

6.3.1 Exterior Wall Components

6.3.1.1 Adhered Veneer

Adhered veneers are typically thin materials such as tile, masonry, stone, terra cotta, ceramic tile or stucco that are attached to a backing substrate using an adhesive. These may pose a significant falling hazard. The risk to life safety rises significantly for thicker, heavier veneers.

Provisions

BUILDING CODE PROVISIONS

Building code provisions for adhered veneers are prescriptive, and have not changed substantially since the late 1960's. The current provisions are found in TMS402-11/ACI530/ASCE 5-11, *Building Code Requirements for Masonry Structures* (ACI, 2011). The code limits the thickness, size, and weight of adhered veneers.

- The code specifies minimum shear strength between the adhered veneer unit and the backing substrate. Performance of adhered veneers depends on the adhesion of the veneer to the backing substrate.
- Out-of-plane deflections of walls with brittle finishes (including adhered veneers) under wind or seismic loads are limited to the span length, L , divided by 240 ($L/240$). It should be noted that this deflection limit is not sufficient to prevent cracking of the veneer, and many industry groups recommend more conservative limits. For example, the Tile Council of America recommends a limit of $L/360$, and Brick Industry Association recommends limiting out-of-plane deflections to a range between $L/600$ and $L/720$. The less conservative deflection criteria in the building code reflect the assumption that even if the veneer cracks under lateral load, safety performance should be adequate if there is a good bond between the veneer and the substrate.

RETROFIT STANDARD PROVISIONS

ASCE/SEI 41-06, *Seismic Rehabilitation of Existing Buildings* (ASCE, 2007) classifies adhered veneers as primarily deformation sensitive. Adhered veneer is subject to the requirements of ASCE/SEI 41-06 when:

- The performance level is Immediate Occupancy or Life Safety.

- The performance level is Hazards Reduced and heavy veneer is located over areas of public access or egress.

Acceptance criteria focus on limiting the in-plane and out-of-plane deflections of the anchored veneer.

Typical Causes of Damage

- Adhered veneers are generally deformation sensitive in-plane and out-of-plane and may crack or become dislodged due to deformation of the backing substrate. Adhered veneers placed directly over shear walls or structural elements that are designed to undergo large deformations may be particularly vulnerable.
- Poorly adhered veneer may come loose due to direct acceleration out-of-plane. This may be a particular problem where the adhesive bond has deteriorated due to water intrusion or degradation of the backing substrate.

DAMAGE EXAMPLES



Figure 6.3.1.1-1 Failure of adhered masonry veneer at the Atascadero City Hall in the 2003 magnitude-6.5 San Simeon Earthquake (Photo courtesy of Mike Mahoney, FEMA).



Figure 6.3.1.1-2 Close-up of failed adhered veneer. (Photo courtesy of Eduardo Fierro, BFP Engineers).



Figure 6.3.1.1-3 Cracked and spalled adhered veneer reveals incipient structural damage to concrete piers in Viña del Mar following the 2010 magnitude-8.8 Chile Earthquake. In this case, the areas of structural and nonstructural damage coincide; the adhered veneer remained intact over portions of the shear wall that did not deform significantly (Photo courtesy of Santiago Pujol, Purdue University).



Figure 6.3.1.1-4 Failed adhered veneer fallen from parapet in Santiago following the 2010 magnitude-8.8 Chile Earthquake. (Photos courtesy of Antonio Iruretagoyena, Rubén Boroscheck & Associates)

Seismic Mitigation Considerations

- Repair any cracked or loose veneer; repair any damage or deterioration of the backing substrate.
- Remove adhered veneer above exits or pedestrian walkways, especially larger units if they are mounted above 10 feet.
- Design a structural canopy to resist the weight and impact of falling veneer; particularly above exits or walkways.
- Restrict pedestrian access below the veneer by providing a barrier or wide landscaping strip.
- Provide positive connections to attach the veneer to the structure; see Figure 6.3.1.2–5, in the Anchored Veneer example or Figure 6.3.3.1–3 in the Interior Veneer example.
- If the expected seismic building drifts are substantial and replacement of the veneer is an option, consider substituting anchored veneer for adhered veneer. Anchored veneer can be designed accommodate larger story drifts.

MITIGATION EXAMPLES



Figure 6.3.1.1-5 Landscaping strip restricts pedestrian access adjacent to adhered veneer façade. Larger units used within lower 6 feet; smaller units used above (Photo courtesy of Cynthia Perry, BFP Engineers).

MITIGATION DETAILS

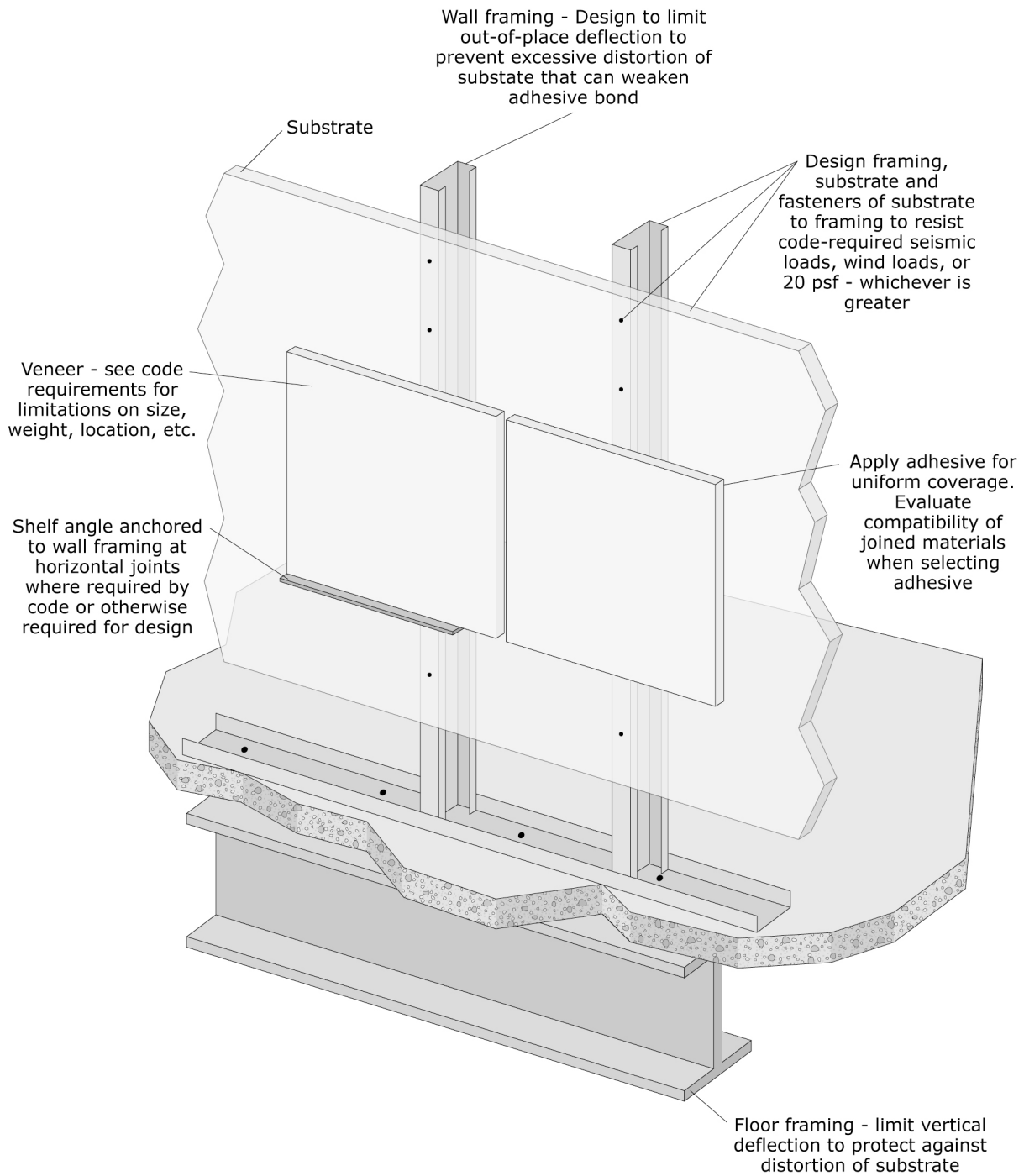


Figure 6.3.1.1-6 Adhered veneer (ER).