Table 15.7-4 Maximum Material Strength

Material	Minimum Ratio F_u/F_y	Max. Material Strength Vessel Material	Max. Material Strength Threaded Material[a]
Ductile (e.g., steel, aluminum, copper)	1.33[b]	90%[d]	70%[d]
Semiductile	1.2[c]	70%[d]	50%[d]
Nonductile (e.g., cast iron, ceramics, fiberglass)	NA	25%[e]	20%[e]

[a]Threaded connection to vessel or support system.
[b]Minimum 20% elongation per the ASTM material specification.
[d]Based on material minimum specified yield strength.
[c]Minimum 15% elongation per the ASTM material specification.
[e]Based on material minimum specified tensile strength.

a. Attachments and supports transferring seismic loads shall be constructed of ductile materials suitable for the intended application and environmental conditions.
b. Anchorage shall be in accordance with Section 15.4.9, whereby the anchor embedment into the concrete is designed to develop the steel strength of the anchor in tension. The steel strength of the anchor in tension shall be determined in accordance with ACI 318 Appendix D Eq. D-3. The anchor shall have a minimum gauge length of eight diameters. The load combinations with overstrength of Section 12.4.3 are not to be used to size the anchor bolts for tanks and horizontal and vertical vessels.
c. Seismic supports and attachments to structures shall be designed and constructed so that the support or attachment remains ductile throughout the range of reversing seismic lateral loads and displacements.
d. Vessel attachments shall consider the potential effect on the vessel and the support for uneven vertical reactions based on variations in relative stiffness of the support members, dissimilar details, nonuniform shimming, or irregular supports. Uneven distribution of lateral forces shall consider the relative distribution of the resisting elements, the behavior of the connection details, and vessel shear distribution.

The requirements of Sections 15.4 and 15.7.10.5 shall also be applicable to this section.

15.7.12 Liquid and Gas Spheres

15.7.12.1 General

Attachments to the pressure or liquid boundary, supports, and seismic force-resisting anchorage systems for liquid and gas spheres shall be designed to meet the force and displacement requirements of Section 15.3 or 15.4 and the additional requirements of this section. Spheres categorized as Risk Category III or IV shall themselves be designed to meet the force and displacement requirements of Section 15.3 or 15.4.

15.7.12.2 ASME Spheres

Spheres designed and constructed in accordance with Section VIII of ASME BPVC shall be deemed to meet the requirements of this section providing the force and displacement requirements of Section 15.3 or 15.4 are used with appropriate scaling of the force and displacement requirements to the working stress design basis.

15.7.12.3 Attachments of Internal Equipment and Refractory

Attachments to the pressure or liquid boundary for internal and external ancillary components (refractory, cyclones, trays, etc.) shall be designed to resist the seismic forces specified in this standard to safeguard against rupture of the pressure boundary. Alternatively, the element attached to the sphere could be designed to fail prior to damaging the pressure or liquid boundary providing the consequences of the failure does not place the pressure boundary in jeopardy. For spheres containing liquids, the effect of sloshing on the internal equipment shall be considered if the equipment can damage the pressure boundary.

15.7.12.4 Effective Mass

Fluid–structure interaction (sloshing) shall be considered in determining the effective mass of the stored material providing sufficient liquid surface exists for sloshing to occur and the T_c is greater than 3T. Changes to or variations in fluid density shall be considered.