CODE

COMMENTARY

0.003 unless special confinement reinforcement is provided to increase the limiting concrete compressive strain.

The maximum value of yield strength for calculation purposes is limited to 690 MPa for both nonprestressed deformed reinforcement and plain spiral reinforcement in Tables 20.2.2.4(a) and (b), respectively, when used for lateral support of longitudinal bars or for concrete confinement. The research that supports this limit for confinement is given in Saatcioglu and Razvi (2002), Pessiki et al. (2001), and Richart et al. (1929). For reinforcement in special moment frames and special structural walls, the research that indicated that higher yield strengths can be used effectively for confinement reinforcement is given in Budek et al. (2002), Muguruma and Watanabe (1990), and Sugano et al. (1990).

The limit of 420 MPa on the values of f_y and f_{yt} used in design for most shear and torsional reinforcement is intended to control the width of inclined cracks under service-level gravity loads. The higher yield strength of 550 MPa permitted in shear design for welded deformed wire reinforcement is also intended to control width of inclined cracks and is based on Guimares et al. (1992), Griezic et al. (1994), and Furlong et al. (1991). In particular, full-scale beam tests described in Griezic et al. (1994) indicated that the widths of inclined shear cracks at service load levels were less for beams reinforced with smaller diameter welded deformed wire reinforcement cages designed on the basis of a yield strength of 520 MPa than beams reinforced with deformed Grade 420 stirrups.

For strength-level earthquake load effects, tests of members using higher strength reinforcement have shown acceptable behavior (Wallace 1998; Aoyama 2001; Budek et al. 2002; Sokoli and Ghannoum 2016; Cheng et al. 2016; Huq et al. 2018; Weber-Kamin et al. 2019), leading to the allowance of ASTM A706 Grade 550 reinforcement for special seismic systems and ASTM A706 Grade 690 for special structural walls in the 2019 Code, as indicated in Table 20.2.2.4(a).

Footnote [6] of Table 20.2.2.4(a) is provided because ASTM A1064 and A1022 only require the welds to develop 240 MPa in the interconnected wires. Hoops, stirrups, and other elements used in special seismic systems should have anchorages that are capable of developing $\mathbf{1.25}f_y$ or $\mathbf{1.25}f_{yt}$, as applicable, or tensile strength of the bar or wire, whichever is less, so that moderate ductility capacity can be achieved. A welded product that is capable of developing these stress limits could be approved for use through Code Section 1.10.

Footnote [3] of Table 20.2.2.4(a) limiting slab and beam bars passing through or extending from special structural walls to reinforcement meeting 20.2.2.5 provides for greater ductility of these members that are not designated as part of the seismic-force-resisting system but are likely to undergo large nonlinear rotational demands.

The 550 MPa limit on f_y for ties of members or regions of members designed using the strut-and-tie method is imposed because of scarcity of test data justifying a higher limit. The yield strength f_y of "other" ties is limited to 420 MPa for consistency with the usage "shear."