CODE

20.3.1.3 Prestressing reinforcement resisting earthquake-induced moment, axial force, or both, in special moment frames, special structural walls, and all components of special structural walls including coupling beams and wall piers, cast using precast concrete shall comply with ASTM A416 or ASTM A722.

20.3.2 *Design properties*

20.3.2.1 Modulus of elasticity, E_p, for prestressing reinforcement shall be determined from tests or as reported by the manufacturer.

20.3.2.2 Tensile strength, f_{pu}, shall be based on the specified grade or type of prestressing reinforcement and shall not exceed the values given in Table 20.3.2.2.

Table 20.3.2.2—Prestressing strands, wires, and bars

Type	Maximum value of f_{pu} permitted for design calculations, MPa	Applicable ASTM Specification
Strand (stress-relieved and low-relaxation)	1860	A416
Wire (stress-relieved and low-relaxation)	1725	A421
		A421, including Supplementary Requirement S1 "Low-Relaxation Wire and Relaxation Testing"
High-strength bar	1035	A722

20.3.2.3 *Stress in bonded prestressed reinforcement at nominal flexural strength,* f_{ps}

20.3.2.3.1 As an alternative to a more accurate calculation of f_{ps} based on strain compatibility, values of f_{ps} calculated in accordance with Eq. (20.3.2.3.1) shall be permitted for members with bonded prestressed reinforcement if all prestressed reinforcement is in the tension zone and $f_{se} \geq 0.5f_{pu}$.

$$f_{ps} = f_{pu}\left\{1-\frac{\gamma_p}{\beta_1}\left[\rho_p\frac{f_{pu}}{f'_c}+\frac{d}{d_p}\frac{f_y}{f'_c}(\rho-\rho')\right]\right\} \qquad (20.3.2.3.1)$$

where γ_p is in accordance with Table 20.3.2.3.1.

If compression reinforcement is considered for the calculation of f_{ps} by Eq. (20.3.2.3.1), (a) and (b) shall be satisfied.

(a) If d' exceeds $0.15d_p$, the compression reinforcement shall be neglected in Eq. (20.3.2.3.1).

COMMENTARY

R20.3.2 *Design properties*

R20.3.2.1 Default values of E_p between 197,000 and 200,000 MPa are commonly used for design purposes. More accurate values based on tests or the manufacturer's reports may be needed for elongation checks during stressing.

R20.3.2.2 ASTM A416 specifies two grades of strand tensile strength: 1725 and 1860 MPa.

ASTM A421 specifies tensile strengths of 1620, 1655, and 1725 MPa, depending on the diameter and type of wire. For the most common diameter, 6 mm, ASTM A421 specifies a tensile strength of 1655 MPa.

R20.3.2.3 *Stress in bonded prestressed reinforcement at nominal flexural strength,* f_{ps}

R20.3.2.3.1 Use of Eq. (20.3.2.3.1) may underestimate the strength of beams with high percentages of reinforcement and, for more accurate evaluations of their strength, the strain compatibility and equilibrium method should be used. If part of the prestressed reinforcement is in the compression zone, a strain compatibility and equilibrium method should be used.

The γ_p term in Eq. (20.3.2.3.1) and Table 20.3.2.3.1 reflects the influence of different types of prestressing reinforcement on the value of f_{ps}. Table R20.3.2.3.1 shows prestressing reinforcement type and the associated ratio f_{py}/f_{pu}.

R20.3.2.3.1(a) If d' is large, the strain in compression reinforcement can be considerably less than its yield strain. In such a case, the compression reinforcement does not influence f_{ps} as favorably as implied by Eq. (20.3.2.3.1). For this