CODE

(b) If compression reinforcement is included in Eq. (20.3.2.3.1), the term

$$\left[\rho_p \frac{f_{pu}}{f'_c} + \frac{d}{d_p}\frac{f_y}{f'_c}(\rho - \rho')\right]$$

shall not be taken less than 0.17.

Table 20.3.2.3.1—Values of γ_p for use in Eq. (20.3.2.3.1)

f_{py}/f_{pu}	γ_p
≥ 0.80	0.55
≥ 0.85	0.40
≥ 0.90	0.28

20.3.2.3.2 For pretensioned strands, the strand design stress at sections of members located within ℓ_d from the free end of strand shall not exceed that calculated in accordance with 25.4.8.3.

20.3.2.4 *Stress in unbonded prestressed reinforcement at nominal flexural strength*, f_{ps}

20.3.2.4.1 As an alternative to a more accurate calculation of f_{ps}, values of f_{ps} calculated in accordance with Table 20.3.2.4.1 shall be permitted for members prestressed with unbonded tendons if $f_{se} \geq 0.5f_{pu}$.

Table 20.3.2.4.1—Approximate values of f_{ps} at nominal flexural strength for unbonded tendons

ℓ_n/h	f_{ps}	
≤ 35	The least of:	$f_{se} + 70 + f'_c/(100\rho_p)$
		$f_{se} + 420$
		f_{py}
> 35	The least of:	$f_{se} + 70 + f'_c/(300\rho_p)$
		$f_{se} + 210$
		f_{py}

COMMENTARY

reason, if d' exceeds $0.15d_p$, Eq. (20.3.2.3.1) is applicable only if the compression reinforcement is neglected.

R20.3.2.3.1(b) The ρ' term in Eq. (20.3.2.3.1) reflects the increased value of f_{ps} obtained when compression reinforcement is provided in a beam with a large reinforcement index. If the term $[\rho_p(f_{pu}/f'_c) + (d/d_p)(f_y/f'_c)(\rho - \rho')]$ is small, the neutral axis depth is small, the compressive reinforcement does not develop its yield strength, and Eq. (20.3.2.3.1) becomes unconservative. For this reason, the term $[\rho_p(f_{pu}/f'_c) + (d/d_p)(f_y/f'_c)(\rho - \rho')]$ may not be taken less than 0.17 if compression reinforcement is taken into account when calculating f_{ps}. The compression reinforcement may be conservatively neglected when using Eq. (20.3.2.3.1) by taking ρ' as zero, in which case the term $[\rho_p(f_{pu}/f'_c) + (d/d_p)(f_y/f'_c)(\rho)]$ may be less than 0.17 and an acceptable value of f_{ps} is obtained.

Table R20.3.2.3.1—Ratio of f_{py}/f_{pu} associated with reinforcement type

Prestressing reinforcement type		f_{py}/f_{pu}
High-strength prestressing bars	ASTM A722 Type I (Plain)	≥ 0.85
	ASTM A722 Type II (Deformed)	≥ 0.80
Stress-relieved strand and wire	ASTM A416 ASTM A421	≥ 0.85
Low-relaxation strand and wire	ASTM A416 ASTM A421	≥ 0.90

R20.3.2.4 *Stress in unbonded prestressed reinforcement at nominal flexural strength*, f_{ps}

R20.3.2.4.1 The term $[f_{se} + 70 + f'_c/(300\rho_p)]$ reflects results of tests on members with unbonded tendons and span-to-depth ratios greater than 35 (one-way slabs, flat plates, and flat slabs) (Mojtahedi and Gamble 1978). These tests also indicate that the term $[f_{se} + 70 + f'_c/(100\rho_p)]$, formerly used for all span-depth ratios, overestimates the amount of stress increase in such members. Although these same tests indicate that the moment strength of those shallow members designed using $[f_{se} + 70 + f'_c/(100\rho_p)]$ meets the factored load strength requirements, this reflects the effect of the Code requirements for minimum bonded reinforcement as well as the limitation on concrete tensile stress that often control the amount of prestressing force provided.