

CODE

(c) For Grade 420, $6d_b$ of the smallest primary flexural reinforcing bar excluding longitudinal skin reinforcement required by 9.7.2.3

(d) For Grade 550, $5d_b$ of the smallest primary flexural reinforcing bar excluding longitudinal skin reinforcement required by 9.7.2.3

18.6.4.5 Where hoops are required, they shall be designed to resist shear according to 18.6.5.

18.6.4.6 Where hoops are not required, stirrups with seismic hooks at both ends shall be spaced at a distance not more than $d/2$ throughout the length of the beam.

18.6.4.7 In beams having factored axial compressive force exceeding $A_g f'_c / 10$, hoops satisfying 18.7.5.2 through 18.7.5.4 shall be provided along lengths given in 18.6.4.1. Along the remaining length, hoops satisfying 18.7.5.2 shall have spacing s not exceeding the least of 150 mm, $6d_b$ of the smallest Grade 420 enclosed longitudinal beam bar, and $5d_b$ of the smallest Grade 550 enclosed longitudinal beam bar. Where concrete cover over transverse reinforcement exceeds 100 mm, additional transverse reinforcement having cover not exceeding 100 mm and spacing not exceeding 300 mm shall be provided.

18.6.5 Shear strength

18.6.5.1 Design forces

The design shear force V_e shall be calculated from consideration of the forces on the portion of the beam between faces of the joints. It shall be assumed that moments of opposite sign corresponding to probable flexural strength, M_{pr} , act at the joint faces and that the beam is loaded with the factored gravity and vertical earthquake loads along its span.

18.6.5.2 Transverse reinforcement

Transverse reinforcement over the lengths identified in 18.6.4.1 shall be designed to resist shear assuming $V_e = 0$ when both (a) and (b) occur:

COMMENTARY

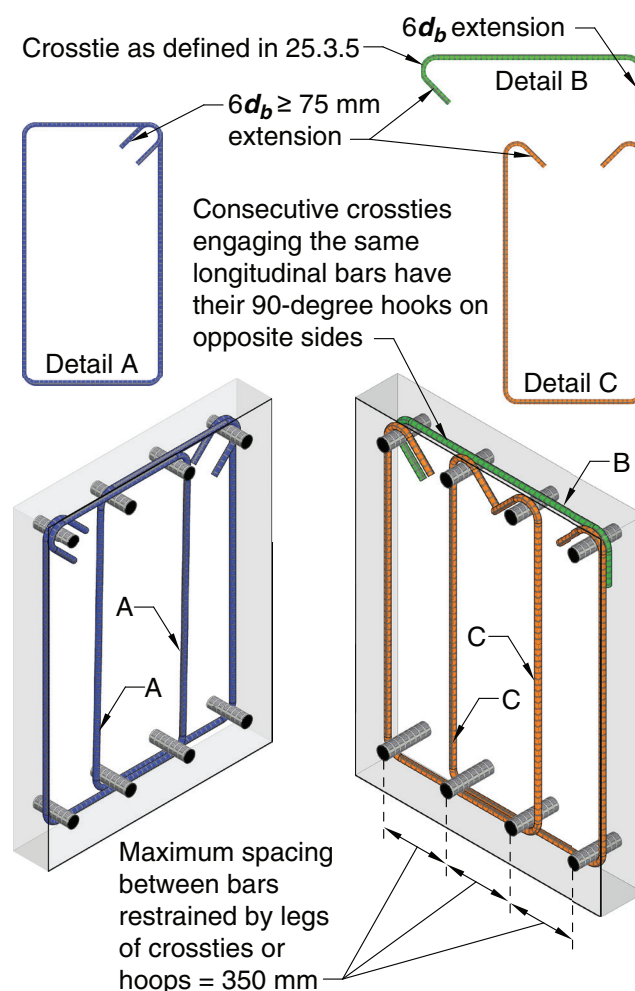


Fig. R18.6.4— Examples of overlapping hoops and illustration of limit on maximum horizontal spacing of supported longitudinal bars.

R18.6.5 Shear strength

Unless a beam possesses a moment strength that is on the order of 3 or 4 times the design moment, it should be assumed that it will yield in flexure in the event of a major earthquake. The design shear force should be selected so as to be a good approximation of the maximum shear that may develop in a member. Therefore, required shear strength for frame members is related to flexural strengths of the designed member rather than to factored shear forces indicated by lateral load analysis. The conditions described by 18.6.5.1 are illustrated in Fig. R18.6.5. The figure also shows that vertical earthquake effects are to be included, as is typically required by the general building code. For example, **ASCE/SEI 7** requires vertical earthquake effects, $0.2S_{DS}$, to be included.

Because the actual yield strength of the longitudinal reinforcement may exceed the specified yield strength and because strain hardening of the reinforcement is likely to