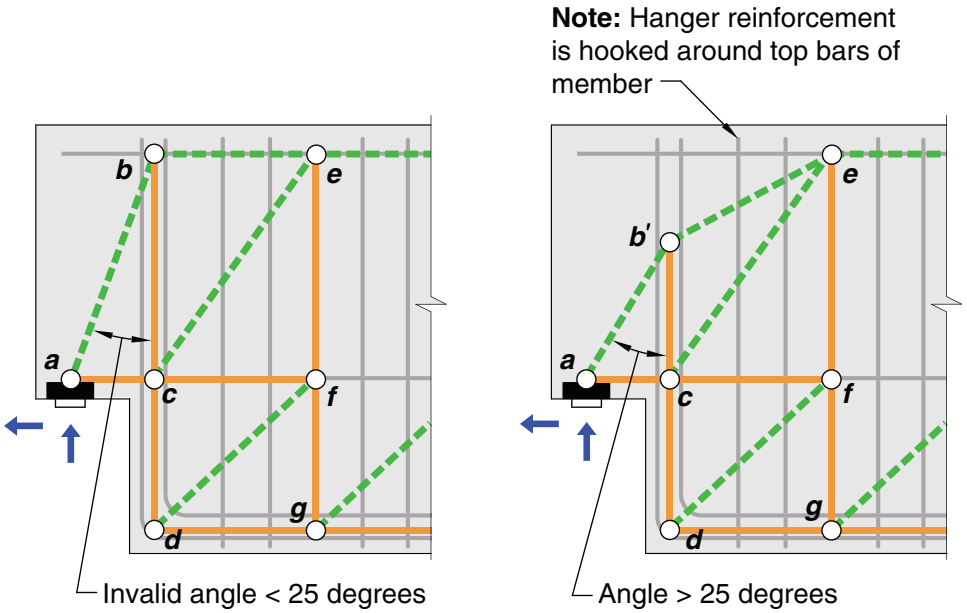
CODE

23.2.7 The angle between the axes of any strut and any tie entering a single node shall be at least 25 degrees.

COMMENTARY

R23.2.7 The angle between the axes of a strut and a tie acting on a node should be large enough to mitigate cracking and to avoid incompatibilities due to shortening of the strut and lengthening of the tie occurring in approximately the same direction. This limitation on the angle prevents modeling shear spans in slender beams using struts inclined at less than 25 degrees from the longitudinal reinforcement (Muttoni et al. 1997).

In some cases, strut-and-tie models can be adjusted to satisfy this requirement without excluding transverse reinforcement close to concentrated loads or reactions as illustrated in Fig. R23.2.7.



(a) Invalid strut-and-tie model

(b) Adjusted strut-and-tie model to satisfy 23.2.7

***Fig. R23.2.7**—Strut and-tie model of dapped connection illustrating adjustment to comply with 23.2.7.*

23.2.8 The effects of prestressing shall be included in the strut-and-tie model as external loads with load factors in accordance with 5.3.11. For pretensioned members, it shall be permitted to assume that the prestress force is applied at the end of the strand transfer length.

R23.2.8 The flow of forces in the strut-and-tie model is unrealistic if prestressing effects are not considered as external loads. Including prestressing effects as external loads is required to identify regions where the effects of other external loads exceed the precompression force and vice versa. Prestressing effects are simulated by concentrated loads at the anchorages and transverse loads equivalent to the effects of tendon deviation or curvature. Provision 5.3.11 requires different load factors depending on the effects of prestressing on the strut-and-tie model. Applying the prestressing force at the end of the transfer length may require a deformed bar tie where the prestress force is being transferred.

23.2.9 Deep beams designed using the strut-and-tie method shall satisfy 9.9.2.1, 9.9.3.1, and 9.9.4.