

## CODE

**12.5.1.3** Design strengths shall be in accordance with (a), (b), (c), or (d):

(a) For a diaphragm idealized as a beam whose depth is equal to the full diaphragm depth, with moment resisted by boundary reinforcement concentrated at the diaphragm edges, design strengths shall be in accordance with 12.5.2 through 12.5.4.

(b) For a diaphragm or a diaphragm segment modeled as a strut-and-tie system, design strengths shall be in accordance with 23.3.

(c) For a diaphragm idealized with a finite-element model, design strengths shall be in accordance with Chapter 22. Nonuniform shear distributions shall be considered in design for shear. Collectors in such designs shall be provided to transfer diaphragm shears to the vertical elements of the lateral-force-resisting system.

(d) For a diaphragm designed by alternative methods, such methods shall satisfy the requirements of equilibrium and shall provide design strengths at least equal to required strengths for all elements in the load path.

**12.5.1.4** It shall be permitted to use precompression from prestressed reinforcement to resist diaphragm forces.

**12.5.1.5** If nonprestressed, bonded prestressing reinforcement is designed to resist collector forces, diaphragm shear, or tension due to in-plane moment, the value of steel stress used to calculate resistance shall not exceed the lesser of the specified yield strength and 420 MPa.

#### 12.5.2 Moment and axial force

**12.5.2.1** It shall be permitted to design a diaphragm to resist in-plane moment and axial force in accordance with 22.3 and 22.4.

## COMMENTARY

**R12.5.1.3** Different design strength requirements apply depending on how the diaphragm load-path is idealized.

Section 12.5.1.3(a) addresses requirements for the common case where a diaphragm is idealized as a beam spanning between supports and resisting forces within its plane, with chord reinforcement at the boundaries to resist in-plane moment and axial force. If diaphragms are designed according to this model, then it is appropriate to assume that shear flow is uniform through the diaphragm depth. Diaphragm depth refers to the dimension measured in the direction of lateral forces within the plane of the diaphragm (refer to Fig. R12.4.2.3a). If vertical elements of the lateral-force-resisting system do not extend the full depth of the diaphragm, then collectors are required to transfer shear acting along the remaining portions of the diaphragm depth to the vertical elements. Sections 12.5.2 through 12.5.4 are based on this model. This design approach is acceptable even if some of the moment is resisted by precompression as provided by 12.5.1.4.

Sections 12.5.1.3(b) through (d) permit alternative methods for design of diaphragms. If diaphragms are designed to resist moment through distributed chords, or if diaphragms are designed according to stress fields determined by finite-element analysis, then non-uniform shear flow should be taken into account.

**R12.5.1.4** In the typical case of a prestressed floor slab, prestressing is required, at a minimum, to resist the factored load combination  $1.2D + 1.6L$ , where  $L$  may have been reduced as permitted by the general building code. For wind or earthquake design, however, the gravity load to be resisted by prestressing is reduced because the governing load combination is  $1.2D + f_1L + (W \text{ or } E)$ , where  $f_1$  is either 1.0 or 0.5 depending on the nature of  $L$ . Thus, only a portion of the effective prestress is required to resist the reduced gravity loads. The remainder of the effective prestress can be used to resist in-plane diaphragm moments. Additional moment, if any, is resisted by added reinforcement.

**R12.5.1.5** Nonprestressed bonded prestressing reinforcement, either strand or bars, is sometimes used to resist diaphragm design forces. The imposed limit on assumed yield strength is to control crack width and joint opening. The Code does not include provisions for developing nonprestressed, bonded prestressing reinforcement. Stress limits for other provided reinforcement are prescribed in Chapter 20.

#### R12.5.2 Moment and axial force

**R12.5.2.1** This section permits design for moment and axial force in accordance with the usual assumptions of 22.3 and 22.4, including the assumption that strains vary linearly through the depth of the diaphragm. In most cases, design for moment and axial force can be accomplished satisfacto-