18.12.7 *Reinforcement*

18.12.7.4 Type 2 splices are required where mechanical splices on Grade 60 reinforcement are used to transfer forces between the diaphragm and the vertical elements of the seismic-force-resisting system. Grade 80 and Grade 100 reinforcement shall not be mechanically spliced for this application.

18.12.7.5 Longitudinal reinforcement for collectors shall be proportioned such that the average tensile stress over length (a) or (b) does not exceed $\boldsymbol{\phi f_y}$ where the value of $\boldsymbol{f_y}$ is limited to 60,000 psi.

(a) Length between the end of a collector and location at which transfer of load to a vertical element begins
(b) Length between two vertical elements

18.12.7.6 Collector elements with compressive stresses exceeding $\mathbf{0.2}\boldsymbol{f_c'}$ at any section shall have transverse reinforcement satisfying 18.7.5.2(a) through (e) and 18.7.5.3, except the spacing limit of 18.7.5.3(a) shall be one-third of the least dimension of the collector. The amount of transverse reinforcement shall be in accordance with Table 18.12.7.6. specified transverse reinforcement discontinued where compressive stress is less than $\mathbf{0.15}\boldsymbol{f_c'}$.

If design forces have been amplified to account for the overstrength $\mathbf{0.2}\boldsymbol{f_c'}$ shall be increased to $\mathbf{0.5}\boldsymbol{f_c'}$, and $\mathbf{0.15}\boldsymbol{f_c'}$ increased to $\mathbf{0.4}\boldsymbol{f_c'}$.

Table 18.12.7.6—Transverse reinforcement for collector elements

Transverse reinforcement	Applicable expressions		
A_{sh}/sb_c for rectilinear hoop	$0.09\dfrac{f_c'}{f_{yt}}$		(a)
ρ_s for spiral or circular hoop	Greater of:	$0.45\left(\dfrac{A_g}{A_{ch}}-1\right)\dfrac{f_c'}{f_{yt}}$	(b)
		$0.12\dfrac{f_c'}{f_{yt}}$	(c)

18.12.3 *Seismic load path*

18.12.3.1 All diaphragms and their connections shall be designed and detailed to provide for transfer of forces to collector elements and to the vertical elements of the seismic-force-resisting system.

18.12.3.2 Elements of a structural diaphragm system that are subjected primarily to axial forces and used to transfer

diaphragm shear or flexural forces around openings or other discontinuities shall satisfy the requirements for collectors in 18.12.7.6 and 18.12.7.7.

R18.12.3.2 This provision applies to strut-like elements that occur around openings, diaphragm edges, or other

discontinuities in diaphragms.

R18.12.2 *Design forces*

R18.12.2.1 For collector elements, the general building code in the United States specifies load combinations that amplify earthquake forces by a factor $\boldsymbol{\Omega_o}$. The forces amplified by $\boldsymbol{\Omega_o}$ are also used for the local diaphragm shear forces resulting from the transfer of collector forces, and for local diaphragm flexural moments resulting from any eccentricity of collector forces.

R18.12.7 *Reinforcement*

R18.12.7.1 Minimum reinforcement ratios for diaphragms correspond to the required amount of temperature and shrinkage reinforcement (refer to 24.4).

R18.12.7.6 In documents such as ICBO 1997, collector elements of diaphragms are designed for forces ampl ified by a factor Ω_o to account for the overstrength in the verti cal elements of the seismic-force-resisting systems.

R18.12.7.7 This section is intended to reduce the possibility of bar buckling and provide adequate bar development conditions in the vicinity of splices and anchorage zones.

18.12.9 *Shear strength*

18.12.9.1 $\boldsymbol{V_n}$ of diaphragms shall not exceed:

$$V_n = A_{cv}\left(2\lambda\sqrt{f_c'}+\rho_t f_y\right) \qquad (18.12.9.1)$$

18.12.9.2 $\boldsymbol{V_n}$ of diaphragms shall not exceed $\mathbf{8}\sqrt{\boldsymbol{f_c'}}\boldsymbol{A_{cv}}$.

18.12.9.3 Above joints between precast elements in noncomposite and composite cast-in-place topping slab diaphragms, $\boldsymbol{V_n}$ shall not exceed:

$$V_n = A_{vf} f_y \mu \qquad (18.12.9.3)$$

where $\boldsymbol{A_{vf}}$ is the total area of shear friction reinforcement within the topping slab, including both distributed and boundary reinforcement, that is oriented perpendicular to joints in the precast system and coefficient of friction, $\boldsymbol{\mu}$, is $\mathbf{1.0}\lambda$, where $\boldsymbol{\lambda}$ is given in 19.2.4. At least one-half of $\boldsymbol{A_{vf}}$ shall be uniformly distributed along the length of the potential shear plane.

R18.12.9 *Shear strength*

$\boldsymbol{A_{cv}}$ refers to the gross area of the diaphragm, but may not e xceed the thick- ness times the width of the diaphragm. This corresponds to the gross area of the effective deep beam that forms the diaphragm.

Distributed slab reinforcement $\boldsymbol{\rho_t}$ used to calculate shear strength of a diaphragm in Eq. (18.12.9.1) is positioned perpe ndicular to the diaphragm flexural reinforcement.

In addition to satisfying 18.12.9.1 and 18.12.9.2, cast-in-place topping slab diaphragms must also satisfy 18.12.9.3 and 18.12.9.4.

The coefficient of friction, $\boldsymbol{\mu}$, in the shear friction model is t aken equal to 1.0 for normalweight concrete due to the presen ce of these shrinkage cracks.

Provision 18.12.9.4 limits the maximum shear that may be transmitted by shear friction within a topping slab diaphragm.