# A Practical Performance Model for Reinforced Concrete Bridge Columns

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A practical method has been developed for estimating the likelihood of spalling of the concrete cover and buckling of the longitudinal reinforcement in a reinforced concrete bridge column. The methodology, which is based on plastic-hinge analysis, was calibrated using the damage observations from cyclic tests described in the Pacific Earthquake Engineering Research center (PEER) structural performance database (*http://nisee.berkeley.edu/spd/*).

According to this methodology, the drift ratio at the onset of spalling ($\frac{\Delta_{spall_calc}}{L}$) can be estimated as:

$$\frac{\Delta_{spall_calc}}{L}(\%) \cong 1.6\,(1-\frac{P}{A_g f'_c})\,(1+\frac{L}{10D}) \qquad (1)$$

where $P$ is the column axial load, $A_g$ is the gross area of the cross section, $f'_c$ is the concrete compressive strength, $L$ is the distance from the column base to the point of contraflexure, and $D$ is the column depth.

The drift ratio at the onset of buckling ($\frac{\Delta_{bb_calc}}{L}$) of the longitudinal bars can be estimated as follows:

$$\frac{\Delta_{bb_calc}}{L}(\%) = 3.25\left(1+k_{e_bb}\rho_{eff}\frac{d_b}{D}\right)\left(1-\frac{P}{A_g f'_c}\right)\left(1+\frac{L}{10D}\right) \qquad (2)$$

where $k_{e_bb} = 40$ for rectangular-reinforced columns and 150 for spiral-reinforced columns, $\rho_{eff} = \rho_s f_{ys} / f'_c$, $\rho_s$ is the volumetric transverse reinforcement ratio, $f_{ys}$ is the yield stress of the transverse reinforcement, and $d_b$ is the diameter of the longitudinal reinforcing steel, . Because little data was available for large values of the transverse reinforcement spacing to the longitudinal bar diameter ($s/d_b$), $k_{e_bb}$ should be taken as 0.0 for columns in which $s/d_b$ exceeds 6.

For the 33 spiral-reinforced bridge columns most representative of bridge engineering practice, the ratio of the observed displacement to the calculated displacement at spalling of the concrete cover had a mean of 1.05 and a coefficient of variation of 34%. The ratio of the observed displacement to the calculated displacement at the onset of buckling of the longitudinal bars had a mean of 1.01 and a coefficient of variation of. 25%. The methodology can be used to evaluate existing columns and to design new ones.