CSA A23.3-19 Standard Revisions Impact on StructurePoint Software

General Themes & Summary

CSA A23.3-19 includes several key changes as follows:

- The "c/d" limit for flexural design is revised
- M_1/M_2 ratio now equals to 1.0 if $M_2 < M_{2,min}$
- Selection criteria is added for the effective flexural stiffness, $(EI)_{eff}$
- New provision defining critical section around circular columns is introduced for two-way shear calculations
- New provision for the curtailment of reinforcement within band width, b_b, is added

The impact of CSA A23.3-19 Standard Revisions to StructurePoint software is discussed in detail below:

The limit of c/d is revised for improved flexural ductility:

CSA A23.3-19, 10.5.2 states that *"for flexural members without axial loads, the area of tension reinforcement shall be limited such that*

$$\frac{c}{d} \le 0.8\left(\frac{700}{700+f_y}\right)$$

Note: if this criterion is satisfied, the tension reinforcement has yielded."

The limit in CSA A23.3-14 was as follows:

$$\frac{c}{d} \le \left(\frac{700}{700+f_y}\right)$$

The previous c/d criteria was to limit the maximum amount of tension reinforcement in flexural members such that the strain in the tension reinforcement, ε_s cannot be less than the balanced strain value of $\varepsilon_y = f_y / E_s$. CSA A23.3-19 requires the strain in the tension reinforcement, ε_s, not be less than 0.003375 in order for the section to be considered as tension-controlled.

This revision provides more flexural ductility by ensuring that the tension reinforcement yields prior to ultimate strain in concrete is attained. The revised criteria will impact maximum reinforcement, $A_{s,max}$, calculations per CSA A23.3-19, and therefore, needs to be implemented in spSlab and spBeam programs.

$M_{2,min}$ definition is added:

CSA A23.3-19, 3.2 add the definition of $M_{2,min}$ as:

> *"$M_{2,min}$ = minimum value of M_2 equal to $P_f(15+0.03h)$ where h is the overall thickness of the column in the direction under consideration."*

The spColumn program already utilizes this definition of $M_{2,min}$. Therefore, there is no impact in software implementation.

M_1/M_2 ratio equals to 1.0 if $M_2 < M_{2,\min}$:

CSA A23.3-19, 10.15.2 for non-sway frames states that *"M_1/M_2 shall be taken as positive if the member is bent in single curvature and shall be taken as 1.0 if M_2 is less than $M_{2,min}$."*

This change makes column designs more conservative as compared to CSA A23.3-14 as it lowers $\frac{kl_u}{r}$ limit for a section to be considered as slender in non-sway frames in cases where M_2 is less than $M_{2,min}$.

If both M_1 and M_2 are equal to zero, spColumn conservatively assumes the ratio $M_1/M_2 = 1.0$. The new provision requiring the M_1/M_2 ratio to be equal to 1.0 if M_2 is less than $M_{2,min}$ needs to be implemented in spColumn program.

The effective flexural stiffness, $(EI)_{eff}$. selection is redefined:

CSA A23.3-19, 10.15.3.1 states that *"$(EI)_{eff}$ may be taken as the larger value from*

$$(EI)_{eff} = \frac{0.2E_cI_g + E_sI_{st}}{1+\beta_d} \qquad \textit{Equation 10.19}$$

or

$$(EI)_{eff} = \frac{0.4E_cI_g}{1+\beta_d} \qquad \textit{Equation 10.20"}$$

CSA A23.3-14 allowed the use of either of the equations. Since the equation that produces the larger value for $(EI)_{eff}$ would yield higher critical axial load, P_c. This in turn will lower the amplification factor for the effects of member curvature. It is plausible the equation producing the larger value would have been the most likely choice of the designer that utilized CSA A23.3-14.

It is important to note that Eq. 10.19 is more "accurate" than Eq. 10.20 as it accounts for the actual amount and disposition of reinforcement. If the reinforcing steel is not yet chosen though, I_{se} cannot be computed and Eq. 10.20 is the only option to compute an initial value for $(EI)_{eff}$.

spColumn program utilizes Eq. 10.19 for the calculation of the effective flexural stiffness and no change is planned.

Effective depth, d, for two-way shear calculations is defined:

CSA A23.3-19, 13.3.1.2 states that *"the effective depth, d, used in two-way shear calculations shall be the average of the effective depths in two-orthogonal directions."*

spSlab program already utilizes this definition of the effective depth, d, for two-way shear calculations. Therefore, no software revision is required.

Critical section around circular columns is defined for two-way shear calculations:

CSA A23.3-19, 13.3.3.3.2 states that *"for circular or regular polygon-shaped load or reaction areas, it shall be permitted to assume a square of equivalent area when determining the critical section for two-way shear calculations."*

This new clause leads to an equivalent square critical punching shear perimeter that is approximately 16% greater than that of actual circular critical punching shear perimeter. This overestimation results in unconservative punching shear stress values as compared to the actual punching shear stresses based on circular load or reaction area.

spSlab program utilizes the exact circular punching shear perimeter approach which reflects the actual condition accurately for circular supports.

New clause is added for flexural tension reinforcement placed within band width, b_b:

CSA A23.3-19, 13.10.8.4 states that *"flexural tension reinforcement placed within width b_b shall be curtailed a minimum distance of $h + \ell_d$ beyond the critical section for two-way shear specified in Clause 13.3.3, or be suitably anchored on each side of the critical section for the force F_{lt} specified in Clause 11.3.9.2 with θ taken as 35 degrees."*

The new clause is to safeguard against the possibility of a flexure-driven punching shear failure for two-way slabs without interior beams.

This change affects the calculation of the top reinforcement lengths within band width, b_b, and therefore, needs to be implemented in spSlab program.