1.0 SLS / ULS External Load

<table>
<thead>
<tr>
<th>Item</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Span, L</td>
<td>10.000 m</td>
</tr>
<tr>
<td>SLS beam loading, $F_{\text{SLS,LA}}$</td>
<td>50.0 kN/m</td>
</tr>
<tr>
<td>ULS beam loading, $F_{\text{ULS,LE}}$</td>
<td>70.0 kN/m</td>
</tr>
</tbody>
</table>

Note.

2.0 SLS Equivalent Load

| Span, L | 10.000 m |
| Distance between points of inflection, $s$ | 2.000 |
| Total shape between points of inflection, $s_k$ | 10.000 |
| VLS equivalent load, $F_{\text{VLS,LE}}$ | 231.6 kN/m |

Note: The SLS equivalent load is chosen to balance the SLS external load by 100%. Note that the total SLS equivalent load will always be zero (Cl.A.1.1.1 TR.43). A non-zero value here is an indication that the tendons are not horizontal at termination and thus produces a vertical SLS equivalent load component to a total of this magnitude.

3.0 SLS / ULS External Load Effects

- SLS / ULS external effects bending moment
- SLS / ULS external effects shear force
- SLS / ULS external effects reactions.

4.0 (SLS / ULS) Equivalent Load Effects

- (SLS / ULS) equivalent load effects bending moment
- (SLS / ULS) equivalent load effects shear force
- No (SLS / ULS) equivalent load effects reactions (ignoring secondary effects).

5.0 Summation of SLS External Load and (SLS / ULS) Equivalent Load Effects

The summation of the SLS external load and the (SLS / ULS) equivalent load effects is effectively zero as the SLS equivalent load was chosen to balance the SLS external load by 100%. Any residual non-zero effect must be resisted by the concrete material itself, this check being undertaken by the SLS stress check or the Magnel Diagram check.

6.0 Summation of ULS External Load and (SLS / ULS) Equivalent Load Effects

The summation of the ULS external load and the (SLS / ULS) equivalent load effects is not zero as the SLS equivalent load was chosen to balance the SLS external load by 100% and not the ULS external load. This non-zero effect must be resisted by steel reinforcement or the concrete material itself, this check being undertaken by the ULS bending and shear design.
The bending moment capacity, $M$, must be greater than the ULS external effects bending moment plus the (SLS / ULS) secondary effects bending moment, $M_{ULS} = M_{ULS,E} + M_{ULS,S}$. The shear force capacity, $V_c$, must be greater than the ULS external effects shear force plus the (SLS / ULS) secondary effects shear force, $V_{ULS} = V_{ULS,E} + V_{ULS,S}$. Equivalent loads will automatically generate primary and secondary effects when applied to the structure. SLS calculations do not require any separation of the primary and secondary effects, and analysis using the equivalent loads is straightforward. However, at ULS the two effects must be separated because the secondary effects are treated as applied loads. The primary prestressing effects are taken into account by including the tendon force in the calculation of the ultimate section capacity. This primary prestressing effect is represented by:

- $f_{pu}A_p(d_m - 0.45x)$ in the bending moment capacity
- $K \cdot P \cdot \sin \beta$ in the uncracked shear capacity
- $M_u / M$ in the cracked shear capacity.

The equations for the bending and shear capacities are:

\[ M = f_{pu}A_p(d_m - 0.45x) \text{ (Rectangular) or (Flanged - NA in Flange)} \]
\[ M = f_{pu}A_p(d_m - 0.45x) \cdot 0.45f_{pu} \cdot (0 - b_p)(c_m - 0.45h) \text{ (Flanged - NA in Wall)} \]

\[ V_c = (V_{ucr}, \text{MIN}(V_{ucr}, V_{cr}) \text{ cracked}) \]
\[ V_{cr} = 0.4f_{pu}A_p \left( f_c + 0.8k \right) \]
\[ V_{ucr} = (1 - 0.5k) \cdot f_{pu}A_p + M_u / M \]