ANCHOR BOLT DESIGN (Canadian Code CSA A23.3 - 94):

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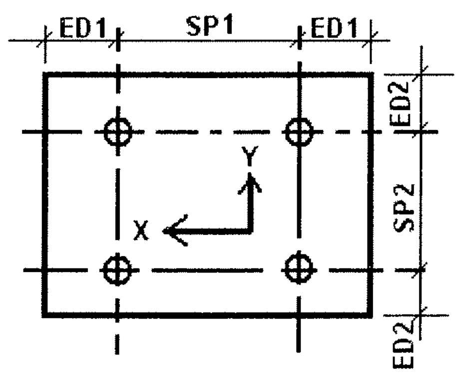

ANCHOR BOLT PLAN

Edge distance, $ED_1 = 310\ mm$ $ED_2 = 310\ mm$

Bolt Spacing, $SP_1 = 130\ mm$ $SP_2 = 130\ mm$

Bolt dia, $d_a = 25\ mm$ Total Bolt Length, $L_b = 750\ mm$

Bolt Projection: $Projection = 150\ mm$

Emebeded Length $L_{emb} = L_b - Projection - 2\ d_a$

$L_{emb} = 550\ mm$

Hexagonal nut dia. $d_{hex} = 1.5\ d_a$ $d_{hex} = 37.5\ mm$

Compressive strength of concrete, $f_c = 30\ MPa$ Bolt area, $A_b = \frac{\pi}{4} d_a^2$ $A_b = 490.87\ mm^2$

Resistance fators for bolts, $\phi_{ar} = 0.67$ Tensile strength of anchor bolt, $F_{su\_AB} = 414\ MPa$

Maximum Tension, $T_{f1} = 200\ kN$ Maximum Shear, $V_{f1} = 20\ kN$ (Column support reaction)

Tension on each Bolt, $T_f = \frac{T_{f1}}{4}$ $T_f = 50\ kN$ Maximum Shear, $V_f = \frac{V_{f1}}{4}$ $V_f = 5\ kN$

Dia of Vertical rebar, $\phi_{25} = 25\ mm$ Total no. $\phi_{no} = 16$ Area of 25 dia bar $A_{25} = 500\ mm^2$

Total area of Rebar, $A_{rebar} = \phi_{no} A_{25}$ $A_{rebar} = 8000\ mm^2$

Factor for reinforcing bar, $\phi_s = 0.85$ Yield strength of rebar, $f_y = 400\ MPa$ Concrete factor, $\phi_c = 0.60$

Edge Distance Check,

$$ED_{min} = \max\left(4\ d_a, d_a \sqrt{\frac{\frac{F_{su\_AB}}{MPa}}{6\sqrt{\frac{f_c}{MPa}}}}\right) \qquad ED_{min} = 100\ mm$$

$$ED_{check} = if\left(ED_{min} > \min(ED_1, ED_2), \text{"CHECK"}, \text{"OK"}\right) \qquad ED_{check} = \text{"OK"}$$

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Bolt Strength Check,

Steel Strength Refer table 12.1 of Concrete Handbook, pg #12-9

Tensile capacity of each bolt, $T_1 = 0.5\frac{\pi}{4} d_a^{\ 2} F_{su\_AB}$ $T_1 = 101.61\ kN$

Bolt Check, $Check1 = \begin{cases} \text{"Bolt Safe"} & \text{if } \left(T_f + \frac{V_f}{0.5}\right) \le T_1 \\ \text{"CHECK"} & \text{otherwise} \end{cases}$ $Check1 = \text{"Bolt Safe"}$

Ductility Check,

Concrete Strength (Refer CSA A23.3-94, Appendix-D),

Effective stress area for tension in each bolt,

$A_{ten} = \left(ED_1 + 0.5\ SP_1\right)\left(ED_2 + 0.5SP_2\right)$ $A_{ten} = 1406.25\ cm^2$

Tensile capacity of each bolt, $T_2 = 0.30\ \phi_c \sqrt{\frac{f_c}{MPa}}\ MPa\ A_{ten}$ $T_2 = 138.64\ kN$

Check Ductility, $Check2 = \begin{cases} \text{"DUCTILE"} & \text{if } T_2 \ge T_1 \\ \text{"Reinforcement requd."} & \text{otherwise} \end{cases}$ $Check2 = \text{"DUCTILE"}$

$Ten = \begin{cases} T_1 & \text{if } Check2 = \text{"Reinforcement requd."} \\ 0\ kN & \text{otherwise} \end{cases}$ $Ten = 0\ kN$

Area of rebar required for ductile failure, $A_{st} = \frac{Ten}{\phi_s\ f_y}$ $A_{st} = 0\ mm^2$

Development length of rebar depends on diameter of rebar.

Modified dia of rebar, $\phi_{mod} = \phi_{25} \frac{A_{st}}{0.25 A_{rebar}}$ $\phi_{mod} = 0\ mm$

Refer clause 12.2.3 of CSA - A23.3-94

For normal density concrete, $k_1 = 1.0$ $k_2 = 1.0$ $k_3 = 1.0$ $k_{4\_20} = 1.0$ $k_4 = 0.8$

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Development length of bar,

$$L_d = \begin{cases} 0.45\ k_1\ k_2\ k_3\ k_{4\_20} \dfrac{\frac{f_y}{MPa}}{\sqrt{\frac{f_c}{MPa}}}\ \phi_{mod} & \text{if } \phi_{mod} \le 20\ mm \\ 0.45\ k_1\ k_2\ k_3\ k_4 \dfrac{\frac{f_y}{MPa}}{\sqrt{\frac{f_c}{MPa}}}\ \phi_{mod} & \text{if } \phi_{mod} > 20\ mm \end{cases}$$

$L_d = 0\ mm$

Development length available, $L_{d\_avail} = L_{emb} - \left(\max\left(ED_1, ED_2\right) - 50mm - 25mm\right)$ $L_{d\_avail} = 315\ mm$

Checking of Development of Rebar, $Check3 = \begin{cases} \text{"OK"} & \text{if } L_{d\_avail} \ge L_d \\ \text{"CHECK."} & \text{otherwise} \end{cases}$ $Check3 = \text{"OK"}$

<u>Concrete Spalling check for shear force</u>, Refer Figure D3, Appendix D, clause D4.3.6 (c)

Effective stress area for shear along X-X

$A_{vx} = \left(ED_1 + 0.5\ SP_1\right)\left(2ED_2 + SP_2\right)$ $A_{vx} = 281250\ mm^2$

Effective stress area for shear along Y-Y,

$A_{vy} = \left(ED_2 + 0.5\ SP_2\right)\left(2ED_1 + SP_1\right)$ $A_{vy} = 281250\ mm^2$

Effective Stress area for Shear, $A_v = \min\left(A_{vx}, A_{vy}\right)$ $A_v = 281250\ mm^2$

Shear Capacity of concrete, $V_{conc} = 0.30\ \phi_c \sqrt{\frac{f_c}{MPa}}\ MPa\ A_v$ $V_{conc} = 277.28\ kN$

Checking of concrete spalling, $Check4 = \begin{cases} \text{"OK"} & \text{if } V_{conc} \ge V_{f1} \\ \text{"CHECK."} & \text{otherwise} \end{cases}$ $Check4 = \text{"OK"}$