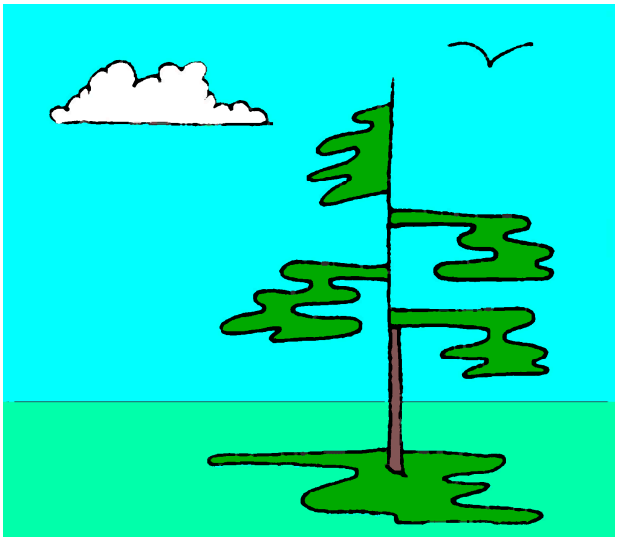
NorthWoods Software



Program Name: Conc-Punching_Shear

Project Name: -

Project Number: -

Project Description: -

Project Designer: Dik

Last Revised (yy-mm-dd): 21-03-19

Reference: NBCC, CSA A23.3

Created using SMath Studio, a MathCAD workalike from https://en.smath.info/view/SMathStudio. The User is responsible to verify data using an alternative method

Menu:

..... Input Data ..... Important Output ..... Logical Constructs **Blue** **Units**

..... Sum / For **Red** **Important Note**

Defined Units:

$K := kip$ Force

$K\_ft := K\ ft$ $kN\_m := kN\ m$ $K\_in := K\ in$ $kN\_mm := kN\ mm$ $lb\_in := lbf\ in$ Moment

$pcf := \frac{lbm}{ft^3}$ $kNpcm := \frac{kN}{m^3}$ $kgpcm := \frac{kg}{m^3}$ Density

$Klf := \frac{K}{ft}$ $plf := \frac{lbf}{ft}$ $kNpm := \frac{kN}{m}$ $Kpi := \frac{K}{in}$ $kNpmm := \frac{kN}{mm}$ Force/Unit Length

$psf := \frac{lbf}{ft^2}$ $Ksf := \frac{K}{ft^2}$ $Ksi := \frac{K}{in^2}$ $kNpsm := \frac{kN}{m^2}$ $psi := \frac{lbf}{in^2}$ Pressure

$pci := \frac{lbf}{in^3}$ Subgrade Modulus

$psfpf := \frac{psf}{ft}$ $kPapm := \frac{kPa}{m}$ Pressure per Depth

$pmcf := \frac{lb}{ft^3}$ $lb := lbf$ Force

$mph := \frac{mi}{hr}$ $kph := \frac{km}{hr}$ Velocity

User Defined Functions: *c* *b* *a*

```
Check(arg) := if arg = 1
                Check := "...OK"
              else
                Check := "...NG"
```

b

$Check(2 = 3) = \text{"...NG"}$

$Check(2 \neq 3) = \text{"...OK"}$

a

$Check(2 \leq 3) = \text{"...OK"}$

$Check(3 \geq 2) = \text{"...OK"}$

Material Property Factors

$\varphi_c := 0.65$ Concrete

$\varphi_s := 0.85$ Reinforcing Steel

Load Factors:

$\alpha_D := 1.25$

$\alpha_L := 1.50$

Concrete Properties:

Concrete Strength: $conc_{NDX} := 2$

NDX f'c

$$conc := \begin{bmatrix} 1 & 20\ \text{MPa} \\ 2 & 25\ \text{MPa} \\ 3 & 30\ \text{MPa} \\ 4 & 35\ \text{MPa} \\ 5 & 40\ \text{MPa} \end{bmatrix} \qquad f'_c := conc_{conc_{NDX}\,2}$$

$\gamma_c := 2400\ \text{kgpcm}$

Concrete Density Factor
>2240 Regular Weight
>1840 Semi-Low Weight
>1440 Low Density

```
if γc ≥ 2240 kgpcm
    λ := 1.00
    type := "Regular Weight Concrete"
else
    if γc ≥ 1840 kgpcm
        λ := 0.85
        type := "Semi-Low Density Concrete"
    else
        if γc ≥ 1440 kgpcm
            λ := 0.75
            type := "Low Density Concrete"
        else
            λ := 0.00
            type := "Not Defined"
```

Support Properties:

$b_1 := 9\ \text{in}$	$b_1 = 228.6\ \text{mm}$	Support Dim (X-Axis)
$b_2 := 9\ \text{in}$	$b_2 = 228.6\ \text{mm}$	Support Dim (Y-Axis)
$T := 6\ \text{in}$	$T = 152.4\ \text{mm}$	Thickness of Slab
$D := 6\ \text{in}$	$D = 152.4\ \text{mm}$	Thickness of Drop Panel
$c_c := 1.5\ \text{in}$	$c_c = 38.1\ \text{mm}$	Clear Concrete Cover

Column Location Factor: $as_{NDX} := 1$

$$as := \begin{bmatrix} 1 & \text{"Interior Column"} & 4 \\ 2 & \text{"Edge Column"} & 3 \\ 3 & \text{"Corner Column"} & 2 \end{bmatrix} \qquad des_{as} := as_{as_{NDX},2} \qquad a_s := as_{as_{NDX},3}$$

Factored Loading:

$V_f := 17.7\ K$		$V_f = 78.7\ kN$	Reaction Shear Load
$M_{fx} := 1\ K\_ft$		$M_{fx} = 1.4\ kN\_m$	Factored Moment (X-Axis)
$M_{fy} := 1\ K\_ft$		$M_{fy} = 1.4\ kN\_m$	Factored Moment (Y-Axis)
$\beta_c := \frac{\max([\,b_1\ b_2\,])}{\min([\,b_1\ b_2\,])}$	$\beta_c = 1.00$		
$d := T + D - c_c$	$d = 10.50\ in$	$d = 266.70\ mm$	Flexural Depth
$b_o := 2\cdot(b_1 + 2\cdot d + b_2)$	$b_o = 78.00\ in$	$b_o = 1981.20\ mm$	Shear Perimeter Interior
$Ix := \frac{b_1 \cdot b_2^{\,3}}{12}$	$Ix = 547\ in^4$	$Ix = 2.28\cdot 10^8\ mm^4$	Moment of Inertia (X-Axis)
$Iy := \frac{b_2 \cdot b_1^{\,3}}{12}$	$Iy = 547\ in^4$	$Iy = 2.28\cdot 10^8\ mm^4$	Moment of Inertia (Y-Axis)
$J := Ix + Iy$	$J = 1094\ in^4$	$J = 4.55\cdot 10^8\ mm^4$	Moment of Inertia (Polar)
$v_{r1} := \left(1 + \frac{2}{\beta_c}\right)\cdot 0.19\cdot\lambda\cdot\varphi_c\cdot\sqrt{\frac{f'_c}{MPa}}\ MPa$			**Equation 13.5**
	$v_{r1} = 0.27\ Ksi$	$v_{r1} = 1.85\ MPa$	
$v_{r2} := \left(\frac{a_s\cdot d}{b_o} + 0.19\right)\cdot\lambda\cdot\varphi_c\cdot\sqrt{\frac{f'_c}{MPa}}\ MPa$			**Equation 13.6**
	$v_{r2} = 0.34\ Ksi$	$v_{r2} = 2.37\ MPa$	
$v_{r3} := 0.38\cdot\lambda\cdot\varphi_c\cdot\sqrt{\frac{f'_c}{MPa}}\ MPa$			**Equation 13.7**
	$v_{r3} = 0.18\ Ksi$	$v_{r3} = 1.24\ MPa$	
$v_r := \min([\,v_{r1}\ v_{r2}\ v_{r3}\,])$	$v_r = 0.18\ Ksi$	$v_r = 1.24\ MPa$	

```
if d > 300 mm
  v'_r := (1300 mm / (1000 mm + d)) · v_r
else
  v'_r := v_r
```

$v'_r = 0.18\ Ksi$ $\quad v'_r = 1.24\ MPa$

$$\gamma_v := 1 - \frac{1}{1 + \frac{2}{3} \cdot \sqrt{\frac{b_1}{b_2}}} \qquad \gamma_v = 0.40$$

Equation 13.8

$$e_x := \frac{b_1 + d}{2} \qquad e_x = 9.75\ \text{in} \qquad e_x = 247.7\ \text{mm}$$

$$e_y := \frac{b_2 + d}{2} \qquad e_y = 9.75\ \text{in} \qquad e_y = 247.7\ \text{mm}$$

$$v_f := \frac{V_f}{b_o \cdot d} + \frac{\gamma_v \cdot M_{fx} \cdot e_y}{J} + \frac{\gamma_v \cdot M_{fy} \cdot e_x}{J}$$

Equation 13.9

$$v_f = 0.11\ \text{Ksi} \qquad v_f = 0.74\ \text{MPa}$$

Summary:

Material Property Factor for Concrete	$\varphi_c = 0.65$	
Material Property Factor for Steel	$\varphi_s = 0.85$	
Dead Load Factor	$\alpha_D = 1.25$	
Live Load Factor	$\alpha_L = 1.50$	
28 day Concrete Strength	$f'_c = 3.63\ \text{Ksi}$	$f'_c = 25\ \text{MPa}$
Concrete Density	$\gamma_c = 149.8271\ \text{pcf}$	$\gamma_c = 2400\ \text{kgpcm}$
Type of Concrete	$type = \text{"Regular Weight Concrete"}$	
Lambda Factor	$\lambda = 1$	
Support Dim (X-Axis)	$b_1 = 9.00\ \text{in}$	$b_1 = 228.6\ \text{mm}$
Support Dim (Y-Axis)	$b_2 = 9.00\ \text{in}$	$b_2 = 228.6\ \text{mm}$
Thickness of Slab	$T = 6.00\ \text{in}$	$T = 152.4\ \text{mm}$
Thickness of Drop Panel	$D = 6.00\ \text{in}$	$D = 152.4\ \text{mm}$
Clear Concrete Cover	$c_c = 1.50\ \text{in}$	$c_c = 38.1\ \text{mm}$
Reaction Shear Load	$V_f = 17.7\ \text{K}$	$V_f = 78.7\ \text{kN}$
Factored Moment (X-Axis)	$M_{fx} = 1\ \text{K\_ft}$	$M_{fx} = 1.4\ \text{kN\_m}$
Factored Moment (Y-Axis)	$M_{fy} = 1\ \text{K\_ft}$	$M_{fy} = 1.4\ \text{kN\_m}$
Column Location (Designation)	$des_{as} = \text{"Interior Column"}$	
Column Location Factor	$a_s = 4.00$	
Beta Factor	$\beta_c = 1$	
Flexural Depth	$d = 10.5\ \text{in}$	$d = 266.7\ \text{mm}$
Shear Perimeter	$b_o = 78\ \text{in}$	$b_o = 1981.2\ \text{mm}$
Moment of Inertia (X-Axis)	$Ix = 547\ \text{in}^4$	$Ix = 2.28 \cdot 10^8\ \text{mm}^4$
Moment of Inertia (Y-Axis)	$Iy = 547\ \text{in}^4$	$Iy = 2.28 \cdot 10^8\ \text{mm}^4$
Moment of Inertia (Polar)	$J = 1094\ \text{in}^4$	$J = 4.55 \cdot 10^8\ \text{mm}^4$
Minimum Concrete Shear Resistance	$v_r = 0.18\ \text{Ksi}$	$v_r = 1.24\ \text{MPa}$
Minimum Concrete Shear Resistance (Corrected for d)	$v'_r = 0.18\ \text{Ksi}$	$v'_r = 1.24\ \text{MPa}$
Eccentricity Load Centroid to Shear Face (X-Axis)	$e_x = 9.75\ \text{in}$	$e_x = 247.7\ \text{mm}$
Eccentricity Load Centroid to Shear Face (Y-Axis)	$e_y = 9.75\ \text{in}$	$e_y = 247.7\ \text{mm}$
Factored Concrete Shear	$v_f = 0.11\ \text{Ksi}$	$v_f = 0.74\ \text{MPa}$

$Check\left(v'_r \geq v_f\right) = \text{"...OK"}$