# INTERACTION DIAGRAMS FOR RECTANGULAR COLUMN WITH ROUNDED ENDS

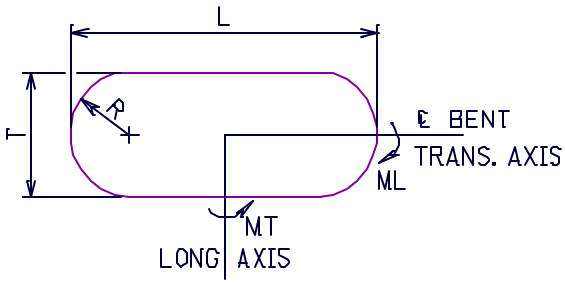
**INPUT VALUES** $fy := 60$ $f'c := 3$

$\beta 1 := if[\, f'c \le 4, 0.85, if[\, f'c \ge 8, 0.65, 0.85 - (f'c - 4)\cdot 0.05\,]\,]$ $\beta 1 = 0.850$

Longitudinal column dimension = $L := 96$ (along the CL. of the bent)

Transverse column dimension = $T := 48$

Radius of the rounded portion = $R := \frac{T}{2}$ $R = 24.000$




SIZE OF BAR; AREA OF ONE BAR; AND NUMBER OF EACH REQUIRED FOR 1% STEEL $EA := 0, 1 .. 5$

$$B := \begin{pmatrix} 7 \\ 8 \\ 9 \\ 10 \\ 11 \\ 14 \end{pmatrix} \qquad A := \begin{pmatrix} 0.60 \\ 0.79 \\ 1 \\ 1.27 \\ 1.56 \\ 2.25 \end{pmatrix} \qquad N_{EA} := floor\left[\frac{\left[\pi\cdot R^2 + T\cdot(L - 2\cdot R)\right]\cdot 0.01}{A_{EA}} + 1\right] \qquad N = \begin{pmatrix} 69 \\ 53 \\ 42 \\ 33 \\ 27 \\ 19 \end{pmatrix}$$

**VERY IMPORTANT: USE EVEN NUMBER OF BARS ONLY**

$$\begin{pmatrix} \text{dia} \\ \text{cover} \\ \text{Asone} \\ \text{dia2} \\ \text{cover2} \\ \text{Asone2} \\ \text{dia3} \\ \text{cover3} \\ \text{Asone3} \\ \text{nbars} \\ \text{nbars2} \\ \text{nbars3} \\ \text{sbars} \\ \text{sbars2} \\ \text{sbars3} \\ \text{Ast\_total} \end{pmatrix} :=$$

| | ROW ONE | ROW TWO | ROW THREE |
|---|---|---|---|
| **number of bars** | 42 | 0 | 0 |
| **size of bars** | 9 | 0 | 0 |
| **diameter** | 1.128 | 0 | 0 |
| **cover** | 3.064 | 0 | 0 |
| **Area of one bar** | 1 | 0 | 0 |
| | | | |
| Total Area | 42 | | |

Input only the values that are in RED

Area of steel (total in the section) = $\text{Ast\_total} = 42.000$

**Minimum reinforcement LRFD 5.7.4.2**

Gross concrete area = $Ag := T\cdot(L - 2\cdot R) + \pi\cdot R^2$ $Ag = 4113.557$

$$\text{minr}_{EA} := \frac{\text{Ast\_total}\cdot fy}{Ag\cdot f'c} \qquad \text{minr} = \begin{pmatrix} 0.204 \\ 0.204 \\ 0.204 \\ 0.204 \\ 0.204 \\ 0.204 \end{pmatrix}$$

$$\text{check}_{EA} := \begin{cases} \text{"NG"} & \text{if } \text{minr}_{EA} < 0.135 \\ \text{"OK"} & \text{otherwise} \end{cases} \qquad \text{check} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \\ \text{"OK"} \\ \text{"OK"} \\ \text{"OK"} \\ \text{"OK"} \end{pmatrix}$$

Capacity reduction factor for concrete = (usually 0.85) $\phi concrete := 0.85$

Capacity reduction factor for steel = (usually 0.90) $\phi steel := 0.90$

Number of iteration points $ip := 100$ $q := 1.. ip$

Modulus for steel $Es := 29000$

Capacity Reduction Factor = see 8.16.1.2.2 $\phi max := 0.90$ $\phi min := 0.70$

Max strain is steel $\varepsilon max := \frac{fy}{Es}$ $\varepsilon max = 0.002$

Theoretical max strain in concrete (ACI suggests 0.003) = $\varepsilon maxconc := 0.003$

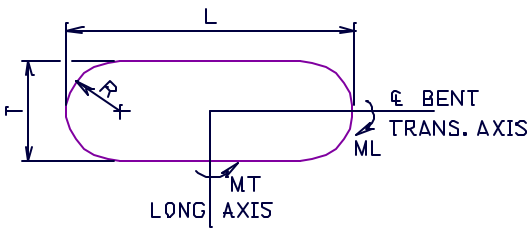
Z := READPRN("col_rect.prn")

Count the number of data points

$$G := \left| \begin{array}{l} \text{for } j3 \in 0..100 \\ \quad F \leftarrow 0 \text{ on error } \left| \begin{array}{l} B \leftarrow j3 \text{ if } Z_{j3,0} > 0 \\ \text{break otherwise} \end{array} \right. \\ B \end{array} \right.$$

G = 4.000

n := 0.. G




MuL is assumed to rotate the column about the CL. of the bent. While MuT is assumed to rotate the column about the longitudinal axis of the column.

## APPLIED LOADS

Pu (k) MuT (k*ft) MuL (k*ft)

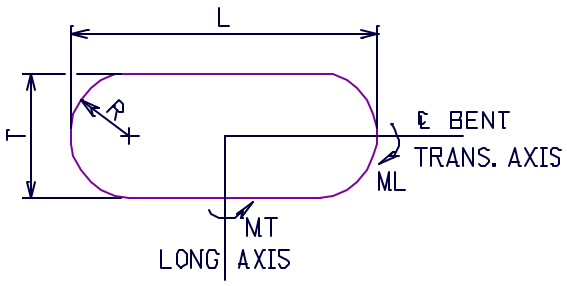
Z =

| | 0 | 1 | 2 |
|---|---|---|---|
| 0 | 1415.000 | 1189.000 | 4023.000 |
| 1 | 1300.000 | 951.900 | 3103.000 |
| 2 | 910.600 | 1612.000 | 548.900 |
| 3 | 1043.000 | 164.400 | 0.000 |
| 4 | 1300.000 | 1737.000 | 3400.000 |
| 5 | 0.000 | 0.000 | 0.000 |
| 6 | 0.000 | 0.000 | 0.000 |
| 7 | 0.000 | 0.000 | 0.000 |
| 8 | 0.000 | 0.000 | 0.000 |
| 9 | 0.000 | 0.000 | 0.000 |
| 10 | 0.000 | 0.000 | 0.000 |
| 11 | 0.000 | 0.000 | 0.000 |
| 12 | 0.000 | 0.000 | 0.000 |
| 13 | 0.000 | 0.000 | 0.000 |
| 14 | 0.000 | 0.000 | 0.000 |
| 15 | 0.000 | 0.000 | 0.000 |

$PT := Z^{\langle 0 \rangle}$ $PL := Z^{\langle 0 \rangle}$ $ML := Z^{\langle 2 \rangle}$ $MT := Z^{\langle 1 \rangle}$

| | | | | |
|---|---|---|---|---|
| Capacity reduction factors = | $\phi max = 0.900$ | $\phi min = 0.700$ | $L = 96.000$ | $XX := 0$ |
| Max tension force = | $Pt := -Pten \cdot \phi max$ | $Pt = -2041.200$ | $T = 48.000$ | $f'c = 3.000$ |
| Max compression force = | $Pc := Pcomp \cdot \phi min$ | $Pc = 8855.330$ | $R = 24.000$ | $fy = 60.000$ |

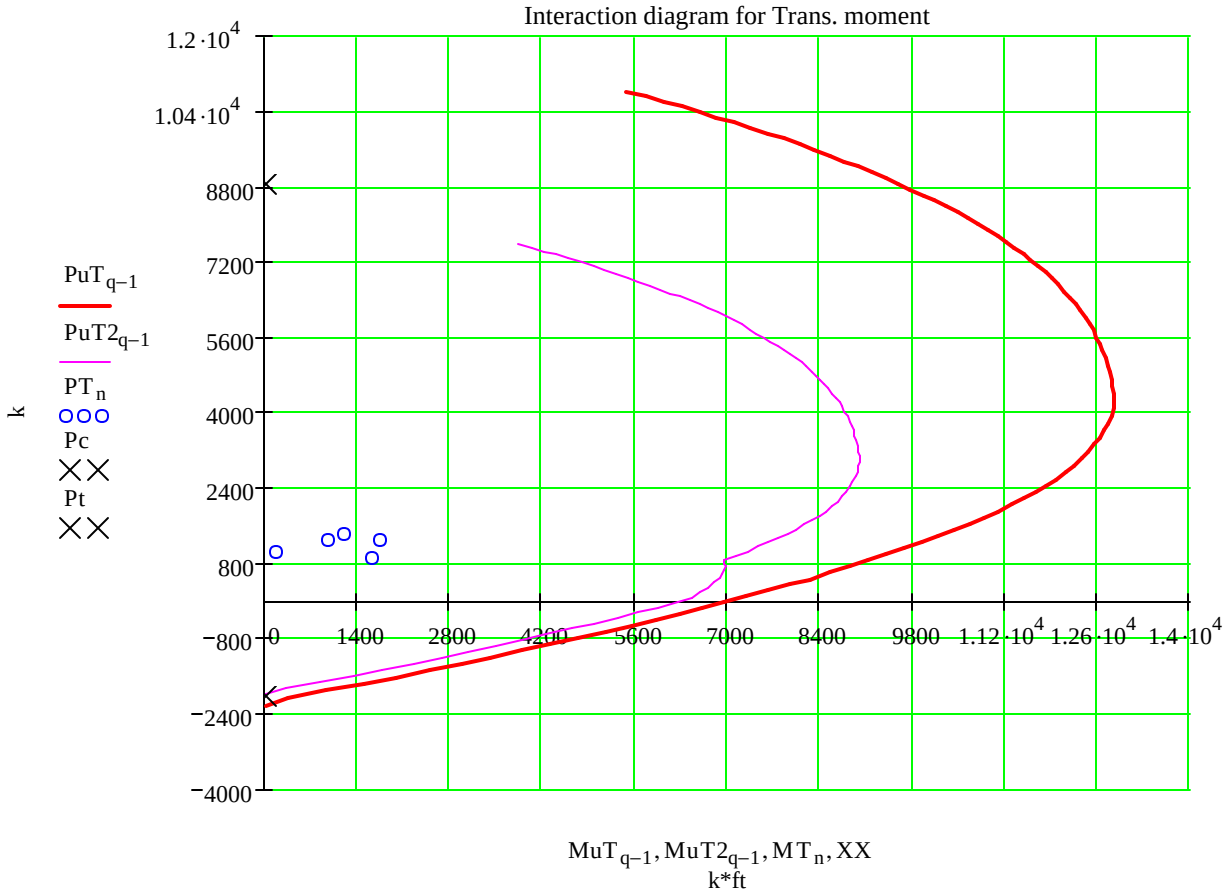
| | row 1 | row 2 | row 3 |
|---|---|---|---|
| **number of bars** | $nbars = 42.000$ | $nbars2 = 0.000$ | $nbars3 = 0.000$ |
| **size of bars** | $sbars = 9.000$ | $sbars2 = 0.000$ | $sbars3 = 0.000$ |
| **cover** | $cover = 3.064$ | $cover2 = 0.000$ | $cover3 = 0.000$ |




$Ast = 42.000$ $bspace = 5.418$

$Ag = 4113.557$ $innerper = 227.545$

Percent steel $100 \cdot \left( \frac{Ast}{Ag} \right) = 1.021$



## SAFETY FACTOR

$\min(SF) = 4.314$

$$\min\left(\begin{pmatrix} SF1_n \\ SF2_n \end{pmatrix}\right) =$$

| |
|---|
| 6.258 |
| 6.812 |
| 4.314 |
| 8.490 |
| 4.434 |

| | | | | |
|---|---|---|---|---|
| Capacity reduction factors = | $\phi max = 0.900$ | $\phi min = 0.700$ | $L = 96.000$ | $XX := 0$ |
| Max tension force = | $Pt := -Pten \cdot \phi max$ | $Pt = -2041.200$ | $T = 48.000$ | $f'c = 3.000$ |
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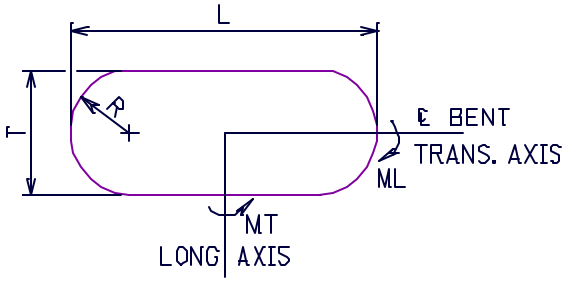


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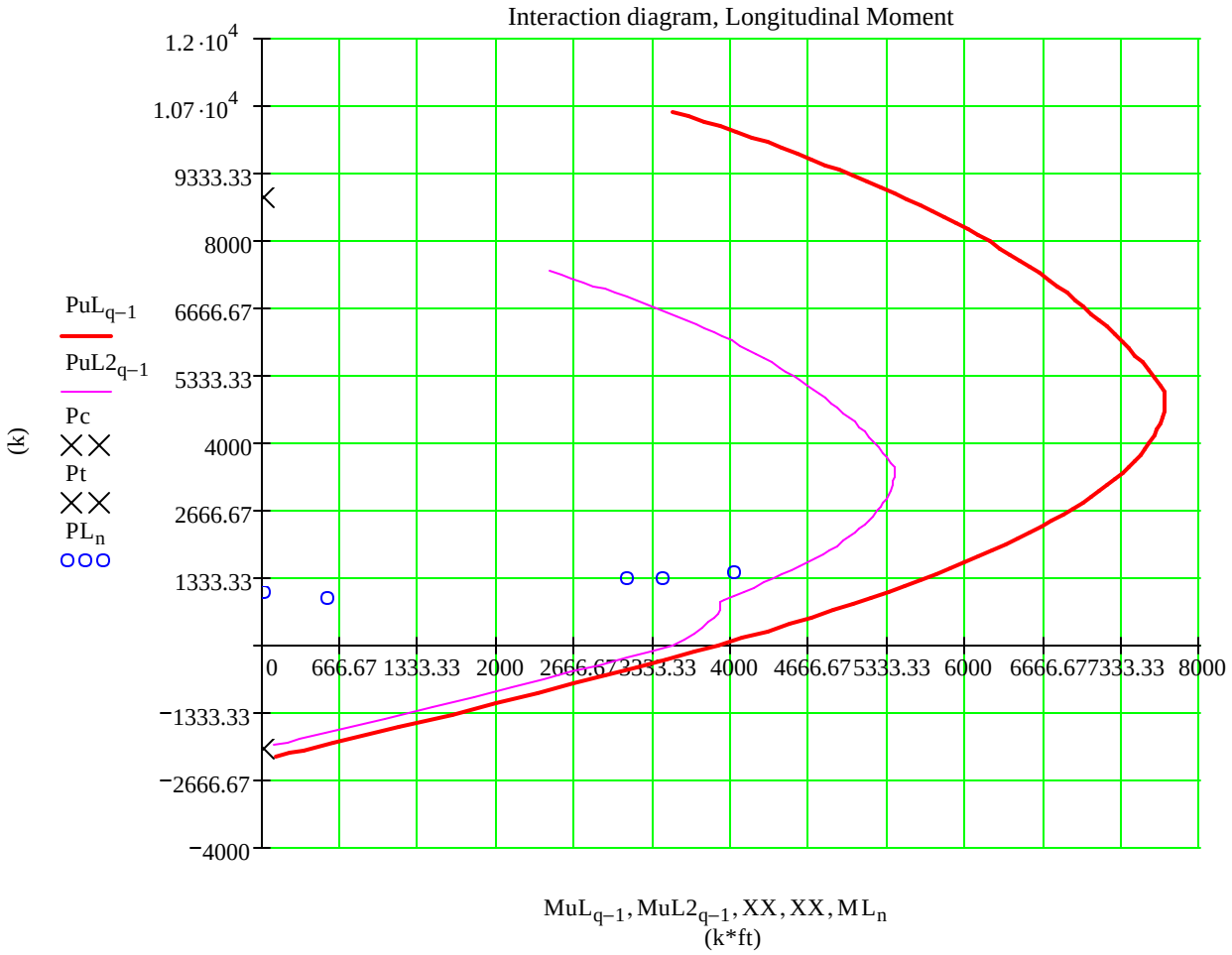

## SAFETY FACTOR

$\min(SF) = 1.109$

$$\min\left(\begin{pmatrix} SF1_n \\ SF2_n \end{pmatrix}\right) =$$

| |
|---|
| 1.109 |
| 1.402 |
| 7.165 |
| 8.490 |
| 1.280 |