Pony Truss ASD

$F_y := 360 \cdot MPa$ $E := 200000 \cdot MPa$ $\nu := 0.3$ $SF := 2.12$

from 1.50 it would suffice it is indicated in the text
I don't think so would desprend from code

Truss Data

$N_{panels} := 12$ $L_1 := 4 \cdot m$ $L := N_{panels} \cdot L_1$ $L = 48 m$

Floor Beam Data

$L_B := 9 \cdot m$ $h := 68 \cdot cm$ $t_w := 12 \cdot mm$ $b_f := 25 \cdot cm$ $t_f := 16 \cdot mm$

Verticals Data

$L_C := 3 \cdot m$ $H := 25 \cdot cm$ $T_w := 8 \cdot mm$ $B_f := 20 \cdot cm$ $T_f := 11 \cdot mm$

$P := 170 \cdot ton$ service level maximum compression on the compression chord

$seismic := 1$

1 for strong earthquake
0 for weak or no

Moment in the transverse plane for the check of the vertical

$$M_C := 0.3 \cdot \frac{kip}{ft} \cdot L_1 \cdot L_C$$

$M_C = 5.36 m \cdot ton$

check the vertical for this service level moment plus tension or compression (depending upon web setup) from general structure

$M_{C\_u} := SF \cdot M_C$

$M_{C\_u} = 11.36 m \cdot ton$ same but factored at SF

K factor (on panel length L_1) for the compression chord following the Holt procedure

$$I_C := B_f \cdot \frac{H^3}{12} - \left(B_f - T_w\right) \cdot \frac{\left(H - 2 \cdot T_f\right)^3}{12} \qquad I_B := b_f \cdot \frac{h^3}{12} - \left(b_f - t_w\right) \cdot \frac{\left(h - 2 \cdot t_f\right)^3}{12}$$

It is assumed both verticals and floor beam bend in the transversal plane in strong axis

$$C := \frac{E}{L_C^{\,2} \cdot \left(\frac{L_C}{3 \cdot I_C} + \frac{L_B}{2 \cdot I_B}\right)} \qquad C = 1.26 \frac{\text{ton}}{\text{cm}}$$

$$P_c := SF \cdot P$$

$$\beta := \frac{\frac{C}{\frac{\text{kip}}{\text{in}}} \cdot \frac{L_1}{\text{in}}}{\frac{P_c}{\text{kip}}}$$

Now we build the interpolation first by columns, then by horizontals

$$X4 := \begin{pmatrix} 1 \\ .9 \\ .8 \\ .7 \\ .6 \\ .5 \\ .4 \\ .3 \\ .293 \end{pmatrix} \quad Y4 := \begin{pmatrix} 3.686 \\ 3.352 \\ 2.961 \\ 2.448 \\ 2.035 \\ 1.75 \\ 1.232 \\ 0.121 \\ 0 \end{pmatrix}$$

$$X6 := \begin{pmatrix} 1 \\ .98 \\ .96 \\ .94 \\ .92 \\ .9 \\ .85 \\ .8 \\ .75 \\ .7 \\ .65 \\ .6 \\ .55 \\ .5 \\ .45 \\ .4 \\ .35 \\ .3 \\ .259 \end{pmatrix} \quad Y6 := \begin{pmatrix} 3.616 \\ 3.284 \\ 3 \\ 2.754 \\ 2.643 \\ 2.593 \\ 2.46 \\ 2.313 \\ 2.147 \\ 1.955 \\ 1.739 \\ 1.639 \\ 1.517 \\ 1.362 \\ 1.158 \\ .886 \\ .53 \\ .187 \\ 0 \end{pmatrix}$$

$$X8 := \begin{pmatrix} 1 \\ .98 \\ .96 \\ .95 \\ .9 \\ .85 \\ .8 \\ .75 \\ .7 \\ .65 \\ .6 \\ .55 \\ .5 \\ .45 \\ .4 \\ .35 \\ .3 \\ .25 \\ .2 \\ .18 \end{pmatrix} \quad Y8 := \begin{pmatrix} 3.66 \\ 2.944 \\ 2.665 \\ 2.595 \\ 2.263 \\ 2.013 \\ 1.889 \\ 1.75 \\ 1.595 \\ 1.442 \\ 1.338 \\ 1.211 \\ 1.047 \\ 0.829 \\ 0.627 \\ 0.434 \\ 0.249 \\ 0.135 \\ 0.045 \\ 0 \end{pmatrix}$$

$$X10 := \begin{pmatrix} 1 \\ 0.98 \\ 0.96 \\ 0.94 \\ 0.92 \\ 0.9 \\ 0.85 \\ 0.8 \\ 0.75 \\ 0.7 \\ 0.65 \\ 0.6 \\ 0.55 \\ 0.5 \\ 0.45 \\ 0.4 \\ 0.35 \\ 0.3 \\ 0.25 \\ 0.2 \\ 0.15 \\ 0.139 \end{pmatrix} \quad Y10 := \begin{pmatrix} 3.714 \\ 2.806 \\ 2.542 \\ 2.303 \\ 2.146 \\ 2.045 \\ 1.794 \\ 1.629 \\ 1.501 \\ 1.359 \\ 1.236 \\ 1.133 \\ 1.007 \\ 0.847 \\ 0.714 \\ 0.555 \\ 0.352 \\ 0.17 \\ 0.107 \\ 0.068 \\ 0.017 \\ 0 \end{pmatrix} \quad X12 := \begin{pmatrix} 1 \\ 0.98 \\ 0.96 \\ 0.94 \\ 0.92 \\ 0.9 \\ 0.85 \\ 0.8 \\ 0.75 \\ 0.7 \\ 0.65 \\ 0.6 \\ 0.55 \\ 0.5 \\ 0.45 \\ 0.4 \\ 0.35 \\ 0.3 \\ 0.25 \\ 0.2 \\ 0.15 \\ 0.114 \end{pmatrix} \quad Y12 := \begin{pmatrix} 3.754 \\ 2.787 \\ 2.456 \\ 2.252 \\ 2.094 \\ 1.951 \\ 1.709 \\ 1.48 \\ 1.344 \\ 1.2 \\ 1.087 \\ 0.985 \\ 0.86 \\ 0.75 \\ 0.624 \\ 0.454 \\ 0.323 \\ 0.203 \\ 0.103 \\ 0.055 \\ 0.031 \\ 0 \end{pmatrix} \quad X14 := \begin{pmatrix} 1 \\ 0.98 \\ 0.96 \\ 0.94 \\ 0.92 \\ 0.9 \\ 0.85 \\ 0.8 \\ 0.75 \\ 0.7 \\ 0.65 \\ 0.6 \\ 0.55 \\ 0.5 \\ 0.45 \\ 0.4 \\ 0.35 \\ 0.3 \\ 0.25 \\ 0.2 \\ 0.15 \\ 0.1 \\ 0.097 \end{pmatrix} \quad Y14 := \begin{pmatrix} 3.785 \\ 2.771 \\ 2.454 \\ 2.254 \\ 2.101 \\ 1.968 \\ 1.681 \\ 1.456 \\ 1.273 \\ 1.111 \\ 0.988 \\ 0.878 \\ 0.768 \\ 0.668 \\ 0.537 \\ 0.428 \\ 0.292 \\ 0.183 \\ 0.121 \\ 0.053 \\ 0.029 \\ 0.003 \\ 0 \end{pmatrix}$$

$$X16 := \begin{pmatrix} 1 \\ 0.98 \\ 0.96 \\ 0.94 \\ 0.92 \\ 0.9 \\ 0.85 \\ 0.8 \\ 0.75 \\ 0.7 \\ 0.65 \\ 0.6 \\ 0.55 \\ 0.5 \\ 0.45 \\ 0.4 \\ 0.35 \\ 0.3 \\ 0.25 \\ 0.2 \\ 0.15 \\ 0.1 \\ 0.085 \end{pmatrix} \quad Y16 := \begin{pmatrix} 3.809 \\ 2.774 \\ 2.479 \\ 2.282 \\ 2.121 \\ 1.981 \\ 1.694 \\ 1.465 \\ 1.262 \\ 1.088 \\ 0.94 \\ 0.808 \\ 0.708 \\ 0.6 \\ 0.5 \\ 0.383 \\ 0.28 \\ 0.187 \\ 0.112 \\ 0.07 \\ 0.025 \\ 0.01 \\ 0 \end{pmatrix} \quad X32 := \begin{pmatrix} 1 \\ 0.98 \\ 0.96 \\ 0.94 \\ 0.92 \\ 0.9 \\ 0.85 \\ 0.8 \\ 0.75 \\ 0.7 \\ 0.65 \\ 0.6 \\ 0.55 \\ 0.5 \\ 0.45 \\ 0.4 \\ 0.35 \\ 0.3 \\ 0.25 \\ 0.2 \\ 0.15 \\ 0.1 \\ 0 \end{pmatrix} \quad Y32 := \begin{pmatrix} 4 \\ 3.73 \\ 3.478 \\ 3.244 \\ 3.026 \\ 2.822 \\ 2.372 \\ 1.993 \\ 1.673 \\ 1.401 \\ 1.169 \\ 0.97 \\ 0.798 \\ 0.648 \\ 0.519 \\ 0.406 \\ 0.309 \\ 0.226 \\ 0.157 \\ 0.1 \\ 0.056 \\ 0.025 \\ 0 \end{pmatrix}$$

X4 := reverse(X4)   X6 := reverse(X6)   X8 := reverse(X8)   X10 := reverse(X10)   X12 := reverse(X12)

Y4 := reverse(Y4)   Y6 := reverse(Y6)   Y8 := reverse(Y8)   Y10 := reverse(Y10)   Y12 := reverse(Y12)

X14 := reverse(X14)   X16 := reverse(X16)   X32 := reverse(X32)

Y14 := reverse(Y14)   Y16 := reverse(Y16)   Y32 := reverse(Y32)

$vs4 := \mathrm{cspline}(X4, Y4)$ $\quad$ $v4(y) := \mathrm{interp}(vs4, X4, Y4, y)$

$vs6 := \mathrm{cspline}(X6, Y6)$ $\quad$ $v6(y) := \mathrm{interp}(vs6, X6, Y6, y)$

$vs8 := \mathrm{cspline}(X8, Y8)$ $\quad$ $v8(y) := \mathrm{interp}(vs8, X8, Y8, y)$

$vs10 := \mathrm{cspline}(X10, Y10)$ $\quad$ $v10(y) := \mathrm{interp}(vs10, X10, Y10, y)$

$vs12 := \mathrm{cspline}(X12, Y12)$ $\quad$ $v12(y) := \mathrm{interp}(vs12, X12, Y12, y)$

$vs14 := \mathrm{cspline}(X14, Y14)$ $\quad$ $v14(y) := \mathrm{interp}(vs14, X14, Y14, y)$

$vs16 := \mathrm{cspline}(X16, Y16)$ $\quad$ $v16(y) := \mathrm{interp}(vs16, X16, Y16, y)$

$vs32 := \mathrm{cspline}(X32, Y32)$ $\quad$ $v32(y) := \mathrm{interp}(vs32, X32, Y32, y)$

now we interpolate along the horizontal lines

$$XX := \begin{pmatrix} 4 \\ 6 \\ 8 \\ 10 \\ 12 \\ 14 \\ 16 \\ 32 \end{pmatrix} \qquad YY(y) := \begin{pmatrix} v4(y) \\ v6(y) \\ v8(y) \\ v10(y) \\ v12(y) \\ v14(y) \\ v16(y) \\ v32(y) \end{pmatrix}$$

substitute at left in the last position the (even) number of panels you admit the Lutz-Fisher column represents

$vvs(y) := \mathrm{cspline}(XX, YY(y))$

$KK(x, y) := \mathrm{interp}(vvs(y), XX, YY(y), x)$ $\quad$ this function then resumes one interpolation fitting the data

You see our problem is an inverse one, and must find what we have called y conrresponds to β when the number of panels is x. Since the automatical solving feature does not yield proper result, we proceed manually

$K := 1.29718$ vary repeteadly the buckling factor till the quotient below yields 1

$$\frac{KK\left(N_{panels}, \frac{1}{K}\right)}{\beta} = 1$$

$KK\left(N_{panels}, \frac{1}{K}\right) = 1.3951$ $\beta = 1.3951$

when the values in orange are equal you may accept you have found the correct K

Optimum design of the compression chord member as a square box in ASD

Assume a square box shape to be dimensioned by ASD

$b_{max} := 100 \cdot cm$ $b_{min} := 10 \cdot cm$ $t_{max} := 5 \cdot cm$ $t_{min} := 3 \cdot mm$

$b := b_{min}$ $t := t_{min}$ unwarranted guesses

$A(b,t) := b^2 - (b - 2 \cdot t)^2$ $I(b,t) := \frac{b^4}{12} - \frac{(b - 2 \cdot t)^4}{12}$ $r(b,t) := \sqrt{\frac{I(b,t)}{A(b,t)}}$

$\lambda(b,t) := \frac{K \cdot L_1}{r(b,t)}$ $\lambda(b,t) = 130.97$

$C_c := \pi \cdot \sqrt{\frac{2 \cdot E}{F_y}}$ $C_c = 104.72$

$$F_a(b,t) := F_y \cdot \begin{cases} \dfrac{1 - \dfrac{1}{2} \cdot \left(\dfrac{\lambda(b,t)}{C_c}\right)^2}{\dfrac{5}{3} + \dfrac{3}{8} \cdot \dfrac{\lambda(b,t)}{C_c} - \dfrac{1}{8} \cdot \left(\dfrac{\lambda(b,t)}{C_c}\right)^3} & \text{if } \lambda(b,t) \le C_c \\ \dfrac{12 \cdot \pi^2 \cdot \dfrac{E}{F_y}}{23 \cdot (\lambda(b,t))^2} & \text{otherwise} \end{cases}$$

$$P_{max1}(b,t) := 0.85 \cdot 0.85 \cdot F_y \cdot A(b,t) \qquad P_{max2}(b,t) := 0.5 \cdot F_a(b,t) \cdot 0.85 \cdot SF \cdot A(b,t)$$

$$P_{max}(b,t) := \begin{cases} P_{max2}(b,t) & \text{if seismic} = 1 \\ P_{max1}(b,t) & \text{otherwise} \end{cases}$$

$$\lambda_{max} := \begin{cases} \dfrac{110}{\sqrt{\dfrac{F_y}{ksi}}} & \text{if seismic} = 1 \\ \dfrac{238}{\sqrt{\dfrac{F_y}{ksi}}} & \text{otherwise} \end{cases}$$

$$\text{Weight}(b,t) := A(b,t) \cdot 1 \cdot m \cdot 7850 \cdot \frac{kgf}{m^3} \cdot \frac{1}{m}$$

Given

$F_a(b,t) \cdot A(b,t) \geq P$ $\quad b \geq b_{min}$ $\quad b \leq b_{max}$ $\quad t \geq t_{min}$ $\quad t \leq t_{max}$

$\frac{b}{t} \leq \lambda_{max}$ $\quad P_c \leq P_{max}(b,t)$

$\begin{pmatrix} b \\ t \end{pmatrix} := \text{Minimize}(A, b, t)$ $\quad b = 29.86\,\text{cm}$ $\quad t = 1.96\,\text{cm}$

$A(b,t) = 218.84\,\text{cm}^2$ $\quad \text{Weight}(b,t) = 171.79\,\frac{\text{kgf}}{\text{m}}$ $\quad \frac{\frac{b}{t}}{\lambda_{max}} = 1$

$F_a(b,t) = 0.5F_y$ $\quad F_a(b,t) \cdot A(b,t) = 400\,\text{ton}$

allowable capacity may exceed much that required if seismic