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February 24th, 2022
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Attn: Mr. Erik Johnson

Subject: 840 Wire Mesh Partition "Free Standing" Analysis

The 12'-5 ¼" high 840 wire mesh partition using a 3 high stack of MH104 steel wire panels supported with a 1 ¼" x 1 ¼" x 1/8" steel angle frame at the perimeter and two vertical 2" x 2"x14 ga. steel post attached to 4" x 9" x 3/8" steel base plates via 3/8" mounting fasteners in concrete has been verified to meet the free standing (gravity load only) requirements. Additionally, the system has been analyzed for a cross slope mounting of up to 30 degrees with induced horizontal loadings at a number of locations on the panels. It is not recommended to mount the partition on a cross slope though the analysis indicates it is possible. Detailed calculations of the structural analysis can be found in the attached Appendix.

In conclusion, the 12'-5 ¼" high 840 wire mesh partition can withstand the following load conditions:

- 69 lb horizontal load applied at the top of a vertical post which will induced 6.8" of horizontal deflection.
- 172 lb distributed horizontal load applied to the top panel only, inducing a 6.8" horizontal deflection.
- 62 lb horizontal load applied at the top of a vertical post when attached on a 15 deg cross slope.
- 1560 lb vertical load applied directly downward and centered on the cross section on a vertical post with no cross slope without buckling.
- 33 lb horizontal load applied at the top of a vertical post without permanent deformation of the foot base plate
- 67 lb horizontal distributed load over 1 ft^2 area on the mesh.

Horizontal loads are defined as loads perpendicular to the mesh partition while vertical loads are perpendicular to the ground.

Appendix

Parameter inputs for an 840 wire mesh partition using a triple high stack of 104 panels.

$h := 2\text{in}$ cross sectional height of square tubing

$b := 2\text{in}$ cross sectional width of square tubing

$FS := 5$ Factor of Safety

$t := 0.083\text{in}$ wall thickness of 14 ga square tubing

$H := 12\text{ft} + 5.75\text{in}$ height of the vertical post

$H_{104panel} := 4\text{ft}$ height of a single 104 panel

$L_{104panel} := 10\text{ft}$ length of a single 104 panel

$N_{panelstack} := 3$ Number of 104 panels stacked

$E := 29 \cdot 10^3 \text{ksi}$ Elastic modulus of steel

$S_{yASTMa513} := 44.2\text{ksi}$ Yeild strength of ASTM A513 steel

$S_{utASTMa513} := 132\text{ksi}$ Tensile strength of ASTM A513 steel

$A := b \cdot h - (b - 2t) \cdot (h - 2t)$ $A = 0.636 \cdot \text{in}^2$ Cross sectional area of 14 ga square tubing

$I := \frac{1}{12} \cdot \left[b \cdot h^3 - (b - 2t) \cdot (h - 2t)^3 \right]$ $I = 0.391 \cdot \text{in}^4$ Area moment of inertia of 14 ga square tubing

1. Concentrated horizontal load at the top of a single vertical post, Pmax

Maximum horizontal loading at the top of the vertical post without exceeding the ultimate tensile strength of the material in the vertical post.

$$P_{max} := \frac{2S_{utASTMa513} \cdot I}{FS \cdot H \cdot h} \qquad P_{max} = 69 \cdot \text{lbf}$$

Note: this load will induce permanant deformation.

Deflection at the top of the single vertical post under maximum loading P_{max}.

$$\delta := \frac{P_{max} H^3}{3E \cdot I} \qquad \delta = 6.8 \cdot \text{in}$$

Slope or angular deflection at the top of the single vertical post under maximum loading P_{max}.

$$\theta := \frac{P_{max} \cdot H^2}{2 \cdot E \cdot I} \qquad \theta = 3.9 \cdot \text{deg}$$

2. Uniformly distributed bending load over upper panel using two vertical post, Wmax

Maximum distributed loading without exceeding the ultimate tensile strength of the material in the vertical post.

$$W_{maxdist} := \frac{4S_{utASTMa513} \cdot I}{FS \cdot \left[\left(N_{panelstack} - 0.5 \right) \cdot H_{104panel} \right] \cdot h} \qquad W_{maxdist} = 172 \cdot \text{lbf}$$

$$w_{maxdist} := \frac{W_{maxdist}}{L_{104panel} \cdot H_{104panel}} \qquad w_{maxdist} = 4.3 \cdot \frac{\text{lbf}}{\text{ft}^2}$$

Deflection at the top of the two vertical post assuming wire mesh panel distributes load equally

$$\delta := \frac{W_{maxdist}\cdot\left[\left(N_{panelstack} - 0.5\right)H_{104panel}\right]^{2}\cdot\left[3\cdot H - \left(N_{panelstack} - 0.5\right)H_{104panel}\right]}{12E\cdot I} \qquad \delta = 6.805\cdot in$$

Slope or angular deflection at the top of the single vertical post under maximum loading P_{max}.

$$\theta := \frac{W_{maxdist}\cdot\left[\left(N_{panelstack} - 0.5\right)H_{104panel}\right]^{2}}{4\cdot E\cdot I} \qquad \theta = 3.1\cdot deg$$

3. Effect of cross slope on free standing 104 3 panel stack

$W := 260lbf$ Weight of entire 3 Stack 104 panel and post partition

$\varphi := 15deg$

$$h_{cg} := \frac{N_{panelstack}\cdot H_{104panel}}{2} \qquad h_{cg} = 72\cdot in$$

$P_x := W\cdot\sin(\varphi)$ $P_x = 67.293\cdot lbf$ Transverse post loading

$P_y := W\cdot\cos(\varphi)$ $P_y = 251.141\cdot lbf$ Axial post loading

$$P_{xmax} := \frac{\frac{2S_{utASTMa513}\cdot I}{h} - P_x\cdot h_{cg}}{FS\cdot H} \qquad P_{xmax} = 62\cdot lbf$$

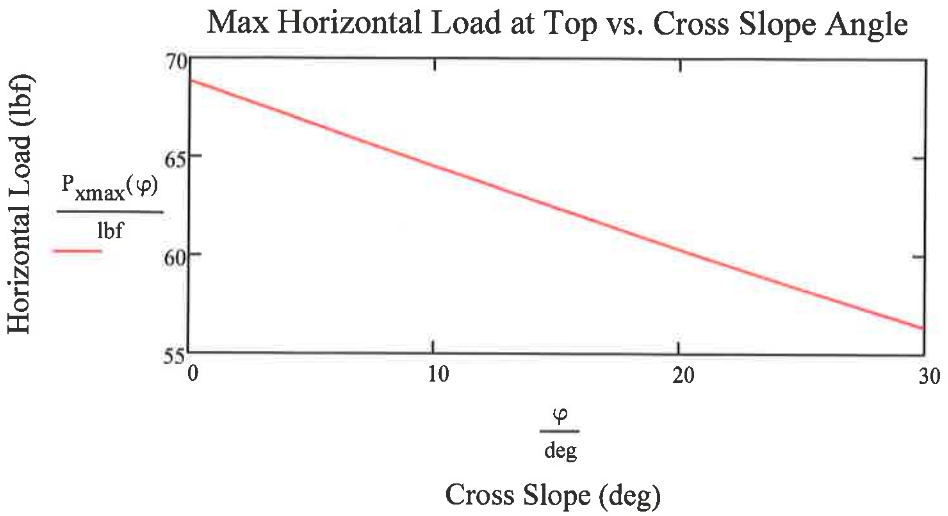
Note: this maximum transverse load will induce permanant deformation.

$$P_{ymax} := \frac{\left(S_{utASTMa513}\cdot A - P_y\right)}{FS} \qquad P_{ymax} = 16752\cdot lbf$$

This is the maximum axial load ignoring buckling.

$\varphi := 0deg, 0.5deg .. 30deg$

$$P_{xmax}(\varphi) := \frac{\frac{2S_{utASTMa513}\cdot I}{h} - W\cdot\sin(\varphi)\cdot h_{cg}}{FS\cdot H}$$



4. Column buckling assuming fixed footing and pinned top

$L_e := 0.8H$

$\rho := \sqrt{\frac{I}{A}}$ $\rho = 0.783 \cdot in$ radius of gyration

$\frac{L_e}{\rho} = 152.934$ slenderness ratio

$EorJCol := \sqrt{2 \cdot \pi^2 \cdot \frac{E}{S_{yASTMa513}}}$ $EorJCol = 113.803$ Johnson Euler transition point

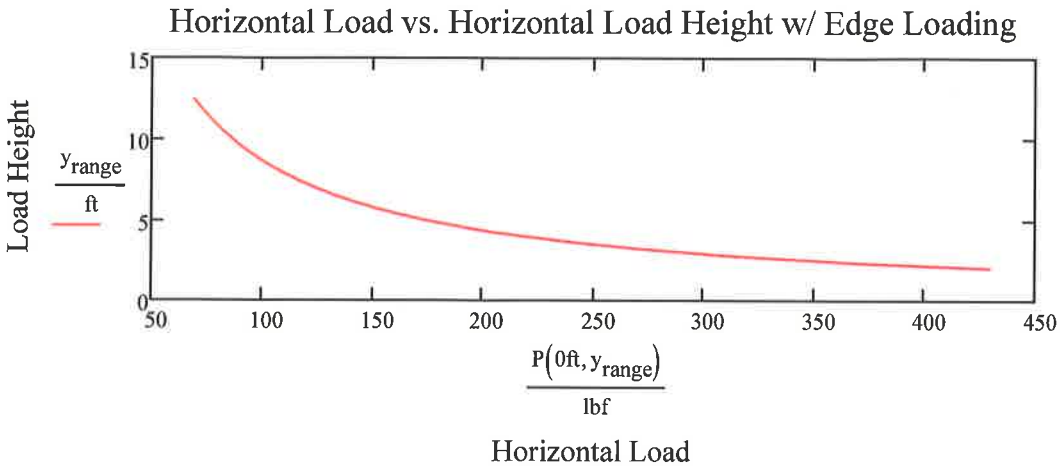
$if\left(EorJCol < \frac{L_e}{\rho}, \text{"Euler Column"}, \text{"Johnson Column"}\right) = \text{"Euler Column"}$ Column type

$$P_{cr} := if\left[EorJCol < \frac{L_e}{\rho}, \frac{\pi^2 E \cdot I}{FS\, L_e^2}, A \cdot \left[S_{yASTMa513} - \frac{S_{yASTMa513}^2}{4 \cdot FS \cdot \pi^2 \cdot E} \cdot \left(\frac{L_e}{\rho}\right)^2\right]\right]$$ $P_{cr} = 1558 \cdot lbf$

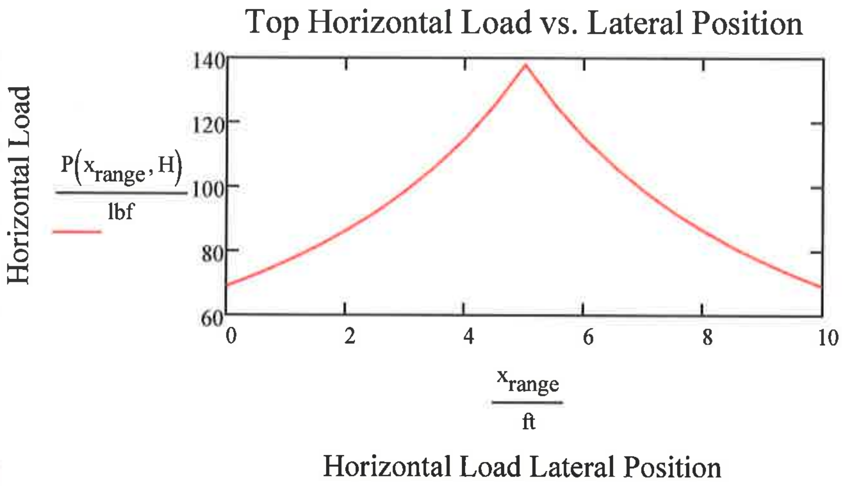
$$P(x,y) := \frac{2S_{utASTMa513} \cdot I \cdot L_{104panel}}{FS \cdot \left(\left|\frac{L_{104panel}}{2} - x\right| + \frac{L_{104panel}}{2}\right) \cdot y \cdot h}$$ Load based on bending stress in base of vertical post as a function of load position.

$x_{range} := 0ft, 0.5ft .. 10ft$ x moves from left right across the wire mesh panel starting at one vertical post and moving to the next vertical post.

$y_{range} := 24in, 25in .. H$ y moves from floor to top up the wire mesh panel starting at the floor and moving up to the top of the vertical post.



Note: Figure shows that the load decreases as height increases.
The minimum load at full height is $P(0ft, H) = 68.85\ lbf$



Note: Figure shows that as the load is placed at the side near the vertical post at x=0, the load is minimum, then increases to a maximum at the center of the panel at x=5 ft, and then increases again to minimum load as it approaches the other vertical post at x=10 ft.

$P(0ft, H) = 68.85\ lbf$ $P(5ft, H) = 137.7\ lbf$

5. Foot Plate Bending for fixed supports at bolts

$w_{plate} := 4in$ Width of the foot base plate

$t_{plate} := 0.375in$ Thickness of the foot base plate

$L_{plate} := 9in - 2 \cdot 0.75in$ Length of the base plate

$I_{plate} := \frac{1}{12} \cdot w_{plate} \cdot t_{plate}^{3}$ $I_{plate} = 0.018 \cdot in^{4}$

$P_{max} := \frac{4 S_{utASTMa513} \cdot I_{plate}}{FS \cdot H \cdot t_{plate}}$ $P_{max} = 33 \cdot lbf$ Load acting on single post. This is underestimated as it does not account for the welding, post stiffness, or concrete.

$\delta := \frac{P_{max} \cdot H \cdot L_{plate}^{2}}{216 \cdot E \cdot I_{plate}}$ $\delta = 0.003\ in$

6. Mesh Panel Bolt Shear Load

$N_{bolts} := 4$ Number of bolts supporting each mesh

$d_{bolt} := \frac{3}{8} \cdot in$ Diameter of bolts supporting the mesh

$S_p := 85ksi$ Proof Strength of Grade 5 Bolts

$S_y := 92 \cdot ksi$ Yield strength of Grade 5 Bolts

$A_t := 0.0875in^{2}$ Shear area at threads in the bolts

$A_{bolt} := \frac{\pi}{4} \cdot d_{bolt}^{2}$ $A_{bolt} = 0.11\ in^{2}$ Area for shear of the bolts

$F := 0.58 \cdot S_y \cdot \frac{A_{bolt}}{N_{bolts}}$ $F = 1473\ lbf$ Maximum panel vertical load for bolts

7. Foot plate bolt tensile load

$P_{max} := \frac{S_p \cdot A_{bolt} \cdot L_{plate}}{FS \cdot H}$ $P_{max} = 94\ lbf$ Maximum horizontal load at top of the 3 stack panel partition

8. Wire mesh out of plane loading (horizontal) over 1ft^{2} area

Wire mesh esitmates based on the assumption of the number of wires per sq.ft. being distributed evenly over all wires and all be uniformly distributed and effectively alligned in the same direction

$d_{wire} := 0.129in$ diameter of the wire

$L_{wire} := 1ft$ length of the loaded section of the wire

$p_{Hwire} := 2in$ horizontal wire pitch (spacing)

$p_{Vwire} := 1in$ vertical wire pitch (spacing)

$A_{wire} := \frac{\pi}{4} \cdot d_{wire}^{2}$ $A_{wire} = 0.013 \cdot in^{2}$ Cross sectional area of a single wire strand.

$I_{wire} := \frac{1}{64} \cdot \pi \cdot d_{wire}{}^{4}$ $\quad I_{wire} = 1.359 \times 10^{-5} \cdot in^{4}$ Area moment of inertia of single wire strand.

$N_{Hwires} := \frac{L_{wire}}{p_{Hwire}}$ $\quad N_{Hwires} = 6$ Number of wires in horizontal direction

$N_{Vwires} := \frac{L_{wire}}{p_{Vwire}}$ $\quad N_{Vwires} = 12$ Number of wires in vertical direction

$N_{wires} := N_{Hwires} + N_{Vwires} = 18$ Total effective number of wires to carry the loading

Maximum horizontal loading without exceeding the ultimate tensile strength of the material in the wires.

$$P_{maxwire} := \frac{16S_{utASTMa513} \cdot I_{wire} \cdot N_{wires}}{FS \cdot L_{wire} \cdot d_{wire}}$$

$P_{maxwire} = 67 \cdot lbf$

Note: this load will induce permanant deformation however this is likely grossly underestimated based on geometry assumptions and lack of welding or weaving contributions in the wire mesh.

Deflection of a single wire strand in the vicinity of the loading assuming a 4'-0" run between supports

$$\delta := \frac{P_{maxwire} \cdot \left(H_{104panel}\right)^{3}}{48E \cdot I \cdot N_{wires}} \qquad \delta = 0.001 \cdot in$$

Kind regards,
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2/24/2022
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