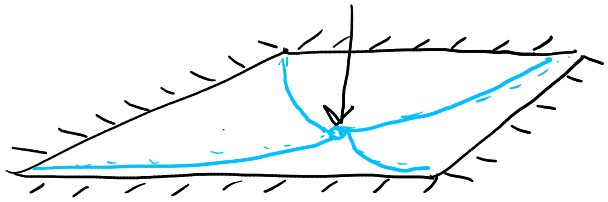


Givens / Assumptions

* 47 x 47 x 47 in ; Polyester Material
* Model 10989-1 ultrapopp

Assume: Evenly distributed load
top only - neglecting the Aluminum Frame, all fixed
top is very thin - shear is negligible
∴ treat as a membrane

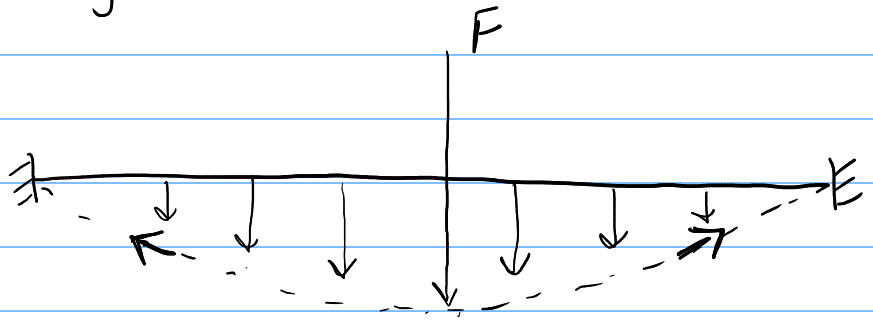
Goal: To see how much the plate bends and if that will exceed the elastic limit, ie will it fail? $\delta = ?$

For Polyester: [OOC-C6H4-COO-C6H10]

* Elastic limit = 5.80151 ~ 8.70226 Ksi
* Young's Modulus (E) = $0.362594 \sim 0.6381166 \times 10^6$ psi

Assuming thickness (t) = 0.004 ~ 0.006 in
For all of these values, I chose the conservative values
* These values were taken from AZO materials

Assuming Force of 50 lbs



This has to be treated as a membrane because it cannot experience compression as it would just change shape.

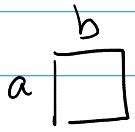
Solving for δ

For something to be considered a membrane if

$$\frac{P}{E}\left(\frac{\text{base}}{t}\right)^4 > 100$$

$$\text{pressure} = P = \frac{F}{A} = \frac{50}{47^2} = 0.0226 \ lbf/in^2$$

$$\frac{0.0226}{0.362594 \times 10^6}\left(\frac{47}{0.004}\right)^4 = \boxed{1.18989 \times 10^9}$$ so yes this can be treated as a membrane!



- **Stress Equations**

longitude / latitude $\frac{a}{b} = \frac{47}{47} = 1 \rightsquigarrow$ n values (aspect ratio)

From Air Force Engineering graph with $a/b = 1$

$n_1 = \sim 0.33$
$n_2 = n_3 = \sim 0.26$
$n_4 = n_7 = \sim 0.10$
$n_5 = n_6 = \sim 0.35$

$$\gamma = \sqrt[3]{p^2 E (a/t)^2}$$

$$f = n_x \gamma$$

@ Center of plate $\left(x = \frac{b}{2}; y = \frac{a}{2}\right)$

$f_x = n_2 \gamma$
$f_y = n_3 \gamma$
$\Big\}$ $F_x = f_y = 0.26 psi$

@ center of short side $\left(x = \frac{b}{2}; y = 0\right)$

$f_x = n_4 \gamma = 294.905 psi$
$f_y = n_5 \gamma = 1032.166 psi$

@ center of long side $\left(x = 0; y = a/2\right)$

$f_x = n_6 \gamma = 1032.166 psi$
$f_y = n_7 \gamma = 294.905 psi$

$$\delta_{max} = n_1 a_3 \sqrt[3]{\frac{Pa}{Et}}$$

$$= \boxed{1.39876 \text{ inches}}$$

Based on a max stress of 1032 psi or 1.032 Ksi, it does not exceed the elastic limit of 5.8 Ksi

∴ Safe!

* This is an estimate of uniform pressure with a membrane Fixed on all sides using conservative parameters and by neglecting the wire.