

A6: Bracket Drawings

* flange width change (0.498 in instead of 0.5 in)

02 22 2026

Step 1: rework calculations from A5

Stress Analysis

A

$$\frac{\sigma}{SF} = \frac{Wl}{Z}$$

$$Z = \frac{\pi d^3}{32}$$

$$Z = \frac{l \cdot F \cdot SF}{\sigma} = \frac{\pi d^3}{32}$$

$$d = \sqrt[3]{\frac{l \cdot F \cdot SF \cdot 32}{\sigma \cdot \pi}}$$

$$W = \text{total force} = 2F$$

$$F = 250 \quad SF = 4 \quad \sigma = 20,000 \quad l = \frac{3}{4} \text{ in}$$

$$\therefore d = 0.726 \text{ in}$$

$$\frac{\sigma}{SF} = \frac{2Fl}{Z} = \frac{Fl}{Z}$$

B

$$\frac{\sigma}{SF} = \frac{P}{A}$$

$$\frac{\sigma}{SF} = \frac{2F}{dl}$$

height unaffected

$$d = \frac{2F \cdot SF}{\sigma l}$$

$$P = \text{full load} = 2F$$

$$l = 0.726 \text{ in} \quad F = 250 \quad SF = 4 \quad \sigma = 20,000$$

$$A = d \cdot l$$

$$\therefore d = 0.138 \text{ in}$$

C

$$\frac{\sigma}{SF} = \frac{Wl}{Z}$$

$$Z = \frac{wh^2}{6}$$

$$Z = \frac{2Fl \cdot SF}{\sigma} = \frac{wh^2}{6}$$

$$W = 2F$$

$$h = \sqrt{\frac{2Fl \cdot SF \cdot 6}{\sigma \cdot w}}$$

$$\frac{\sigma}{SF} = \frac{2Fl}{Z}$$

$$F = 250 \quad SF = 4 \quad \sigma = 20,000 \quad l = \frac{3}{4} \text{ in}$$

$$w = 3 + 2 \cdot Dw = 3 + 2 \cdot 0.533 = 4.066 \text{ in} \quad + 0.138 \text{ in}$$

$$\approx 0.888$$

$$h = 0.362 \text{ in}$$

D

$$\frac{\sigma}{SF} = \frac{Wl}{Zz} \quad z = \frac{wh^2}{6} \quad \rightarrow \quad z = \frac{l \cdot F \cdot SF}{2\sigma} = \frac{wh^2}{6}$$

$$W = F$$

$$\frac{\sigma}{SF} = \frac{Fl}{Zz} \quad w = \frac{l \cdot F \cdot SF \cdot 6}{2\sigma \cdot h^2}$$

$F = 250 \quad SF = 4 \quad \sigma = 20,000 \quad h = 0.5$

$l = 0.533$

$w = 0.533 \text{ in}$ use for C

* change to distributed Force not point force

E

$$\frac{\sigma}{SF} = \frac{Wl}{Zz} \quad l = D_w \quad z = \frac{lh^2}{6} \quad \rightarrow \quad z = \frac{D_w F \cdot SF}{2 \cdot \sigma} = \frac{lh^2}{6}$$

$$W = F$$

$$\frac{\sigma}{SF} = \frac{FD_w}{Zz} \quad h = \sqrt{\frac{D_w F \cdot SF \cdot 6}{2 \cdot \sigma \cdot l}}$$

$F = 250 \quad SF = 4 \quad \sigma = 20,000 \quad l = 0.533$

$h = 0.300 \text{ m}$

final $w = 1 + D_w = 1.533 \text{ in}$

Stiffness Analysis

A

$$\frac{\delta}{SF} = \frac{Wl^3}{8EI} \quad I = \frac{\pi d^4}{64} \quad \rightarrow \quad I = \frac{2Fl^3 SF}{8E\delta} = \frac{\pi d^4}{64}$$

$$W = 2F$$

$$d = \sqrt[4]{\frac{2Fl^3 SF \cdot 64}{8E\delta \cdot \pi}}$$

$F = 250 \quad l = 3/4 \text{ in} \quad SF = 4 \quad E = 600,000 \quad \delta = 0.005$

$d = 0.920 \text{ in}$

* I want to constrain depth and height new calculated value = l

B

$$\frac{\delta}{SF} = \frac{Pl}{AE} \quad A = 2F \quad l = h \quad A = d \cdot l \quad \rightarrow \quad l = \frac{2Fh SF}{d E \delta}$$

$F = 250 \quad SF = 4 \quad E = 600,000 \quad \delta = 0.005 \quad d = 0.25 \text{ in}$

$h = 1.5 \text{ in}$

$l = 4 \text{ in}$

$$\frac{C}{\delta} = \frac{Wl^3}{3EI} \quad I = \frac{wh^3}{12} \rightarrow I = \frac{2Fl^3 SF}{3ES} = \frac{wh^3}{12}$$

$$W = 2F$$

$$\frac{\delta}{SF} = \frac{2Fl^3}{3EI}$$

$$h = \sqrt[3]{\frac{2Fl^3 SF 12}{3ESW}}$$

$F = 250 \quad l = 1 \text{ in} \quad SF = 4 \quad E = 600,000 \quad \delta = 0.005$
 $W = 3 + 2 \cdot Dw = 3 + 2 \cdot 4 = 11 \text{ in}$

$$h = 0.624 \text{ in}$$

$$\frac{D}{\delta} = \frac{Wl^3}{8EI} \quad I = \frac{wh^3}{12} \rightarrow I = \frac{Fl^3 SF}{8ES} = \frac{wh^3}{12}$$

$$W = F$$

$$\frac{\delta}{SF} = \frac{Fl^3}{8EI}$$

$$W = \frac{Fl^3 SF 12}{8ES h^3}$$

$F = 250 \quad l = 1 \text{ in} \quad SF = 4 \quad E = 600,000 \quad \delta = 0.005$
 $h = 0.5 \text{ in}$

$$W = 4.00 \text{ in}$$

$$\frac{E}{\delta} = \frac{Wl^3}{3EI} \quad l = Dw \quad I = \frac{lh^3}{12} \rightarrow I = \frac{F(Dw)^3 \cdot SF}{3ES} = \frac{lh^3}{12}$$

$$W = F$$

$$\frac{\delta}{SF} = \frac{F(Dw)^3}{3EI}$$

$$h = \sqrt[3]{\frac{F(Dw)^3 \cdot SF \cdot 12}{3ESl}}$$

$F = 250 \quad Dw = 4 \quad SF = 4 \quad E = 600,000 \quad \delta = 0.005$
 $l = 1 \text{ in}$

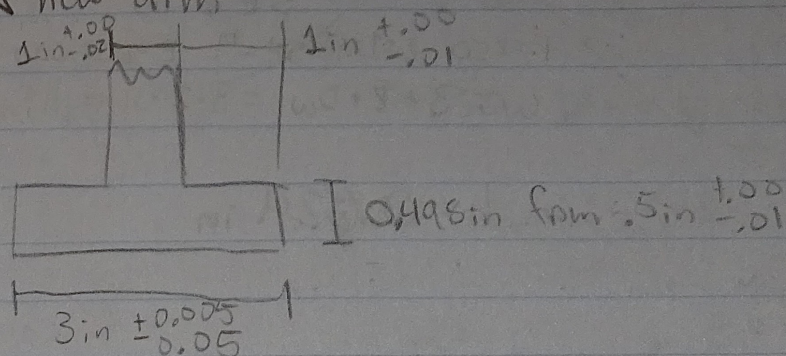
$$h = 4.40 \text{ in}$$

$$E_w = Dw + l = 5 \text{ in}$$

Design For Stiffness Yields larger Values

Define The Fit tolerances for surrounding T-beam

★ new dim

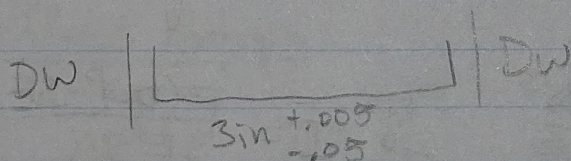


Goal, smooth slide, accuracy not crucial

~~RC7~~

flange length shaft
part lengths - hole

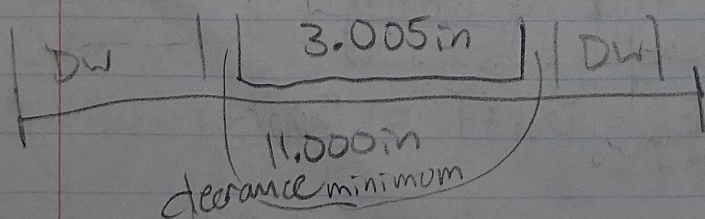
clearance	hole	shaft
4.0	+3.0	-4.0
8.8	0	-5.8



Tolerances for $D_w = ?$

Assume $C_w \pm 0.004$ / -0.000

largest shaft smallest hole



$$\text{clearance} = 11 \text{ in} - 3.005 \text{ in} - 2D_w$$

$$2D_w = 11 - 3.005 - \text{clear min}$$

Can't have negative upper bound
RC7 not possible

$$D_w = 3.9935 \text{ Max upper limit}$$

$$= -0.0065$$

Fit type = RC9

	clear	hole	shaft
3in	9.0	+7.0	-9.0
	20.5	0	-13.5

shaft tolerance total = 0.0045

max T-beam width = 3.005 in
 min T-beam width = 2.950 in

cannot use RC9

max-min = shaft tolerance = 0.055

moving past Standard fits

Desired minimum clearance is say 0.1 inches
(very loose)

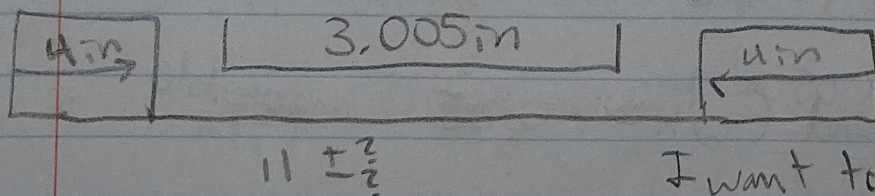
If largest T-beam + smallest Dw/Cw

Clearance =

New Idea!

bound Dw value to a ± 0.000 tolerance
 choose -bound later

Now only worry about finding Cw tolerance



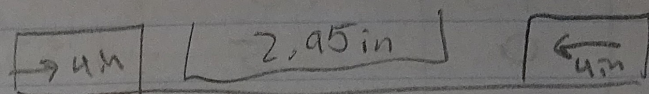
max shaft smallest Cw

change to $\frac{1}{16}$ in
 I want total clearance = ~~0.1~~ inch
 0.0625

11 in with lower bound = $2(4\text{in}) + 3.005\text{in} + \text{total clearance}$ lower bound = 11 ± 0.05 ~~11.05 - 11 = +.05~~lower bound of ± 0.0675

What is the resulting clearance using lower bounded C_w ?

Smallest shaft



$$11.105 \text{ in}$$

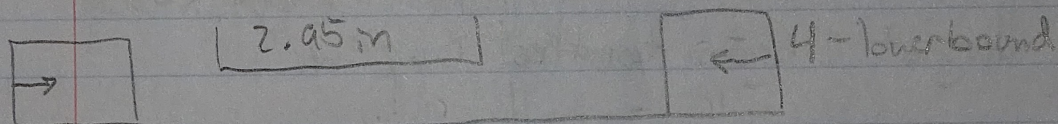
$$11.0675$$

$$\text{total Clearance} = 11.105 - 2 \times 4 - 2.95$$

$$\text{total clearance} = -0.155 \quad 0.1175 \quad \checkmark$$

lets say I am satisfied with a lower bound of $11 + 0.1$ inches

max clearance will be 0.2 inches



$$11 + \text{max tol}$$

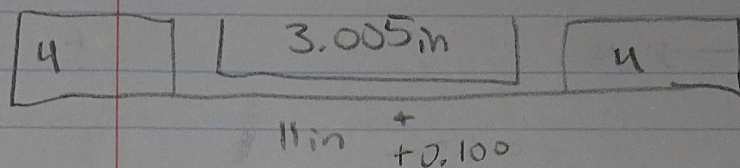
$$\text{max clearance} = 11 + \text{upper tol} - 2.95 - 2(4 - \text{lower bound})$$

two unknowns set D_w lower bound to -0.1 in

$$0.2 = 11 + \text{upper} - 2.95 - 2(4 - 0.1 \text{ in})$$

$$\text{upper bound } C_w = -0.05 \quad \text{impossible}$$

New idea, just dimension the gap
between the walls Dw?



largest shift
smallest gap
target clearance of
0.0625
($\frac{1}{16}$ ")

$$\text{gap} = 11 + 0.100 - 2(4 + 0.000)$$

$$\text{gap} = 3.1$$

$$\text{clearance} = \text{gap} - 3.005$$

$$\text{clearance} = 0.095 > \frac{1}{16}'' \checkmark$$

$$\text{smallest gap} = 3.1$$

$$\text{max gap} = 11 + \text{upper bound} - 2(4 - \text{lower bound})$$

$$\text{max clearance} = \text{max gap} - 2.950$$

$$\text{Set max clearance at double the minimum} \\ = 0.095 \times 2 = 0.19$$

$$\text{max gap} = 3.14$$

$$3.14 = 11 + \text{upper} - 2(4 - \text{lower})$$

$$\text{upper} = 0.15?$$

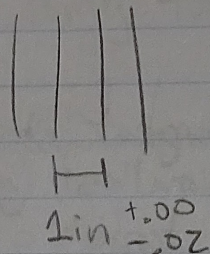
$$\text{lower} = 0.005$$

— doesn't matter if
were not dimensioning
Dw

$$\text{gap final dims} = 3.1 - 3.15$$

↑ easier

T-beam web dimensions to receiving gap



largest shaft smallest gap

$$\text{gap} = 11.1 - 2(5 + .00) = 1.1$$

$$\text{min gap} = 0.1 \text{ in} \rightarrow \text{clearance of } 0.1 \text{ in} \checkmark$$

Assume results from Dwy

$$\text{upper gap} = 1.1 \text{ to } 1.15$$

lastly, flange width

$$\text{flange width} = 0.498 \text{ } ^{+.00}_{-.01}$$

$$\text{nominal gap from design} = 0.50 \text{ in}$$

$$\text{for min clearance} = 0.1$$

$$\text{gap} = 0.548 \text{ close enough to } 0.6$$

$$\text{tol} = \text{}^{+.15}_{-.1}$$