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A4: Motor Mount

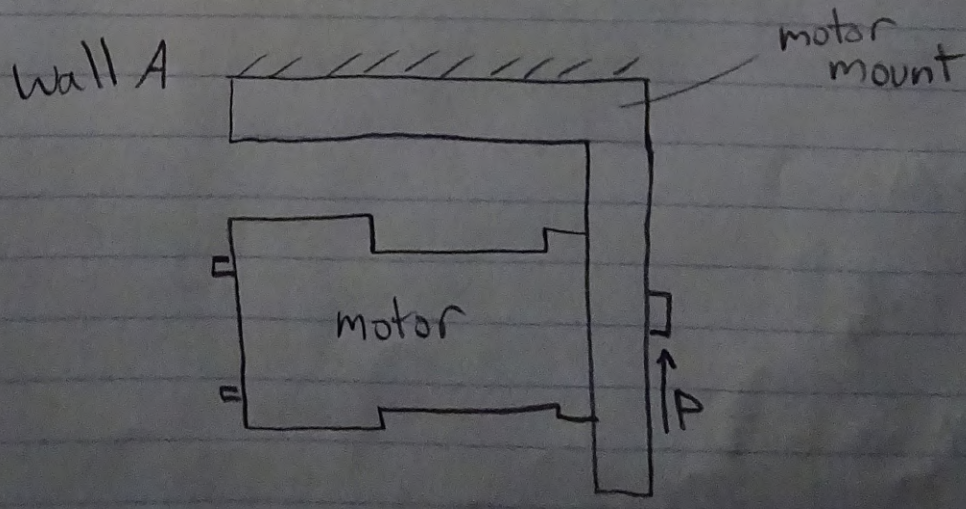
Design for S_y then δ_{max} (0.30mm)

Select ABS, PETG, or PLA material

- ABS: good but a hot motor would make it bad
- PETG: okay with heat, super high E, high density
- PLA: great even at high temp, low density, high E

For SW custom material - Source Matweb.com using avg metric values

		SW
Mass Density	1.00-3.41 g/cc	2205 $\frac{kg}{m^3}$
Elastic Modulus	0.00232-13.8 GPa	6401.16 N/mm^2
~~Tensile Strength~~		
Tensile Strength, Yield	8.00-103 MPa	55.5 N/mm^2



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★ Safety Factor = 3
neglect motor weight

Feature 1:
mount that attaches to the motor
model as a cantilever beam

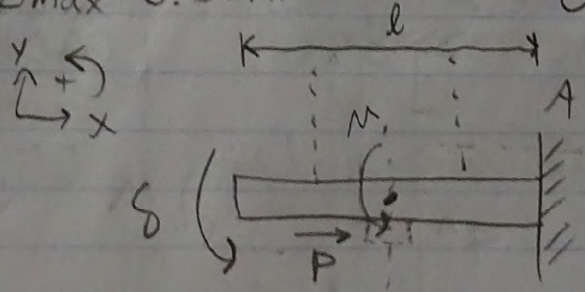
known

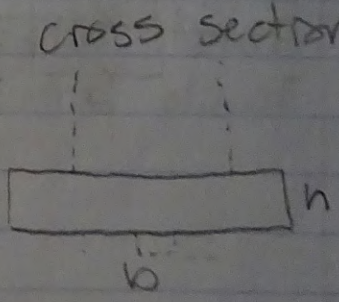
shaft length = 18mm

$E = 6901.16 MPa$
$S_y = 55.5 MPa$
$SF = 3$
motor $\phi = 27.7mm \times 36mm$
$P = 300N$
$\delta_{max} = 0.30mm$

unknown

b > 28mm
h < 1/2·18mm ← from motor dimensions
l > 28mm
I
M
$c = \frac{h}{2}$





$$I = \frac{bh^3}{12}$$

$P \rightarrow M$

$$M = P \cdot \frac{shaft}{2}$$

I want 1/2 of shaft to stick out

M acts @ $\frac{l}{2}$

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Feature 1 Design For Stress

$\sigma_{max} = \frac{S_y}{SF}$ $\quad I = \frac{bh^3}{12}$ $\quad c = \frac{h}{2}$

$\sigma_{max} = \frac{Mc}{I}$ $\quad M = P \cdot \frac{shaft}{2}$

$$\frac{S_y}{SF} = \frac{\left(P \cdot \frac{shaft}{2}\right)\left(\frac{h}{2}\right)}{\frac{b h^3}{12}} = \frac{P \cdot shaft \cdot h \cdot 12}{2 \cdot 2 \cdot b \cdot h^3}$$

too many unknowns, let $b = l > 28mm$
test $b = l = 30mm$ want $h < 9$ mm

$\frac{S_y}{SF} = \frac{3P(shaft)}{b h^2}$ solve for h

$$h = \sqrt{\frac{3P(shaft)SF}{b S_y}}$$

test $b = 30mm \rightarrow h = 5.4$ mm

$$h = \sqrt{\frac{3(300N)(18mm)3}{(30mm)(55.5MPa)}} = 5.4mm$$

dimensions of feature 1

$b = l = 30mm \quad h = 5.4mm$

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Feature 1 Design for Deflection

$$\delta_{max} = \frac{M\ell^2}{2EI} \qquad I = \frac{bh^3}{12} \qquad M = P\frac{shaft}{2}$$

$$\frac{\delta_{max}}{SF} = \frac{P\frac{shaft}{2}\ell^2}{2E\left(\frac{bh^3}{12}\right)} = \frac{P\frac{shaft}{2}\ell^2}{\frac{2Ebh^3}{12}}$$

$$\frac{\delta_{max}}{SF} = \frac{P_{shaft}\ell^2 12}{2\cdot 2Ebh^3} = \frac{3P_{shaft}\ell^2}{Ebh^3}$$

$$h = \sqrt[3]{\frac{3P_{shaft}\ell^2 SF}{Eb\,\delta_{max}}}$$

test $b = \ell = 30mm \rightarrow h = 8.90mm$

$$h = \sqrt[3]{\frac{3(300N)(18mm)(30mm)^2 3}{(6901.16MPa)(30mm)(0.30mm)}}$$

$$\ell = b = 30\,mm \qquad h = 8.90mm$$

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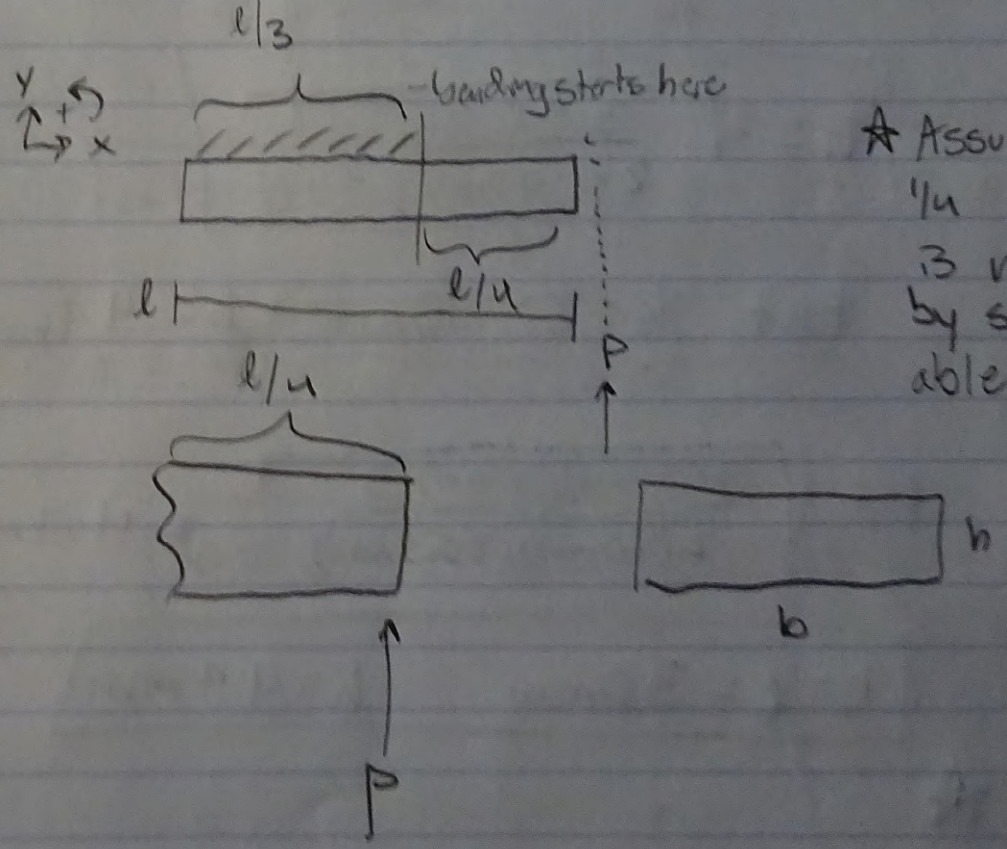
Feature 2:

Known	unknown
$E = 6901.16 MPa$	b
$S_y = 55.5 MPa$	h
$SF = 3$	l
$P = 300 N$	I
$\delta_{max} = 0.30 mm$	M
	c

> no motor dimension restrictions



* Assume only 1/4 of L is not supported by screws & able to bend

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Design for Stress

$$\frac{\sigma_{max}}{SF} = \frac{WL}{Z} \qquad Z = \frac{bh^2}{6}$$

$$W = P \qquad L = \ell/4$$

$$\frac{\sigma_{max}}{SF} = \frac{P\ell/4}{\frac{bh^2}{6}} = \frac{6P\ell}{4bh^2} = \frac{3P\ell}{2bh^2}$$

$$h = \sqrt{\frac{3P\ell\, SF}{2b\,\sigma_{max}}}$$

test $b = \ell = 30mm \rightarrow h = 4.9mm$

$$h = \sqrt{\frac{3(300N)(30mm)\,3}{2(30mm)(55.5MPa)}} = 4.9mm$$

$b = \ell = 30mm \qquad h = 4.9mm$

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Design for Deflection

$$\frac{\delta_{max}}{SF} = \frac{wL^3}{3EI} \qquad I = \frac{bh^3}{12}$$

$w = P$

$L = \ell/4$

$$\frac{\delta}{SF} = \frac{P\left(\frac{\ell}{4}\right)^3}{3E\frac{bh^3}{12}} = \frac{12P\ell^3}{64 \cdot 3Ebh^3} = \frac{P\ell^3}{16Ebh^3}$$

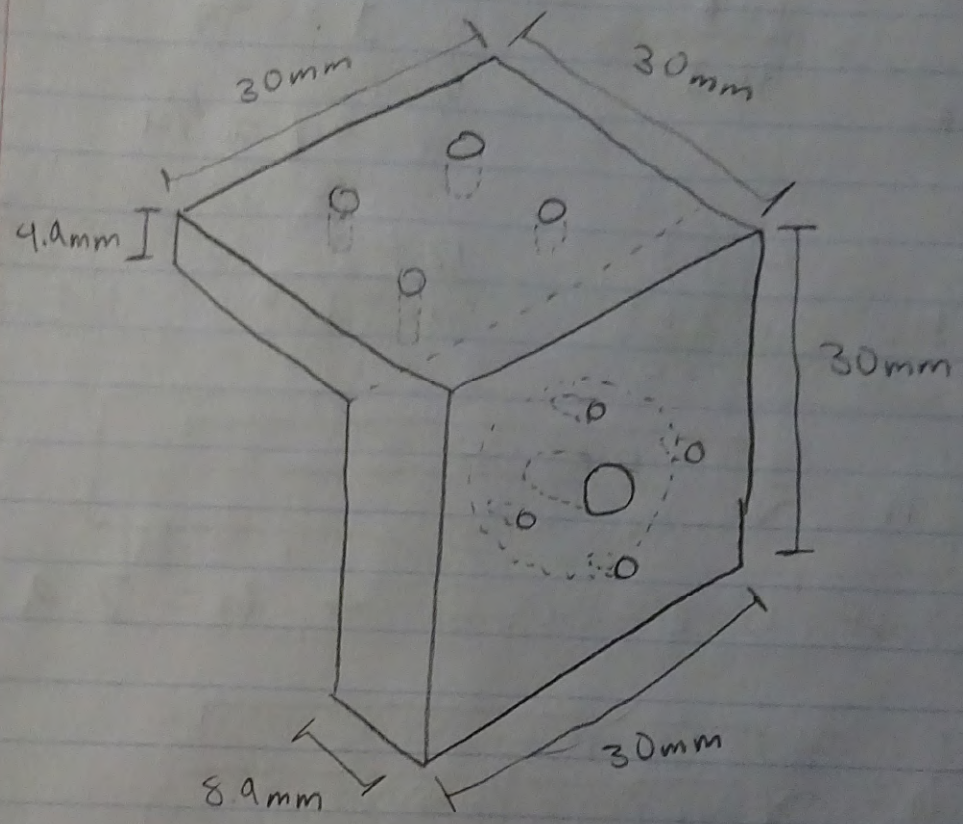
$$\boxed{h = \sqrt[3]{\frac{P\ell^3 SF}{16Eb\delta}}}$$

test $b = \ell = 30mm \rightarrow h = 2.9\,mm$

$$h = \sqrt[3]{\frac{(300N)(30mm)^3\,3}{16\,(6401.16MPa)(30mm)(.3mm)}}$$

$$\boxed{b = \ell = 30mm \qquad h = 2.9mm}$$

Isometric Sketch of Motor Mount



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