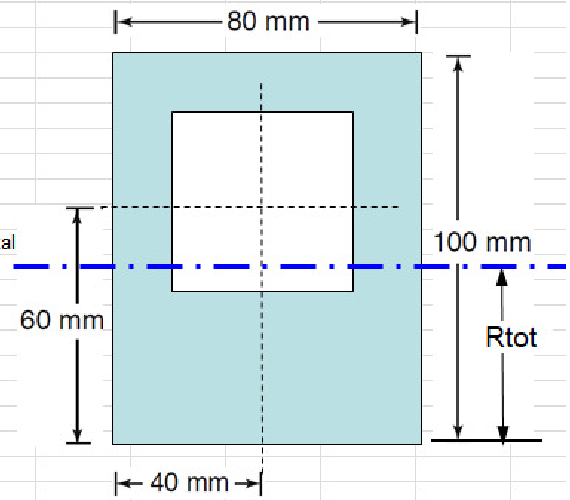
HW 2.1

Wrectangle	80	mm	
Hrectangle	100	mm	
Wsquare	40	mm	
Hsquare	40	mm	Square could be rectangular!
PosnSquare	60	mm	
Arectangle	8000	mm^2	=Wrectangle*Hrectangle
Asquare	-1600	mm^2	=-Wsquare*Hsquare
Atotal	6400	mm^2	=Arectangle+Asquare
Calculate the location of the Neutral Axis of the combined shape.			
Rtot	47.500	mm	=(Arectangle*Hrectangle/2+Asquare*PosnSquare)/Atotal
Area Moments of Inertia of the Rectangle and Square about their own centroids.			
The Square is negative because it is a hole.			
Irectangle	6,666,666.67	mm^4	=Wrectangle*Hrectangle^3/12
Isquare	-213,333	mm^4	=-Wsquare*Hsquare^3/12
These are the distances that the centroids of the Rectangle and the Square			
are from the centroid of the combined shape.			
d_Rect	2.5	mm	=Hrectangle/2-Rtot
d_Square	12.5	mm	=PosnSquare-Rtot
This is the Area of the Rectangle and Square times the square of the distances			
from their centroids to the new centroid			
Ad2 rect	50,000	mm^4	=Arectangle*d_Rect^2
Ad2 sqr	-250,000	mm^4	=Asquare*d_Square^2
Now the result of the Parallel Axis Theorem			
Ishift rect	6,716,666.67	mm^4	=Irectangle+Ad2_rect
Ishift sqr	-463,333.33	mm^4	=Isquare+Ad2_sqr
I total	6,253,333	mm^4	=Ishift_rect+Ishift_sqr



HW 2.2

L	500	m	
P	5	MN	
Sigma	150	N/mm^2	
E	70000	Mpa	
Because Stress, Sigma = P/A			
A	0.0333	m^2	=P/Sigma
Amm	33333.33	mm^2	=A*1,000,000
Radius	103.01	mm	=SQRT(Amm/PI())
Dia	206.01	mm	=2*Radius
Strain	0.002143		=Sigma/E $\sigma = \varepsilon E$
Delta	1.071	m	=Strain*L $\varepsilon = \frac{\Delta L}{L}$
also	1.071	m	=P*L/(A*E) $y = \frac{PL}{AE}$
Stiffness = Load / Deflection			
K	4.667	MN/m	=P/Delta

HW 2.3

Power	500,000	W	
RPM	3600		
TauMax	60,000,000	N/m^2	

Convert RPM to Radians/sec

Rad/sec	376.991	s^-1	=RPM/60*2*PI()
Torque	1326.291	Nm	=Power/Rad_sec

Torsional Shear = Tr/J

$$\tau = \frac{Tr}{J}$$

For a circular cross section, J = Pi/2 * r^4

or J = Pi/32 * d^4

$$J = \frac{\pi}{2} r^4 = \frac{\pi}{32} d^4$$

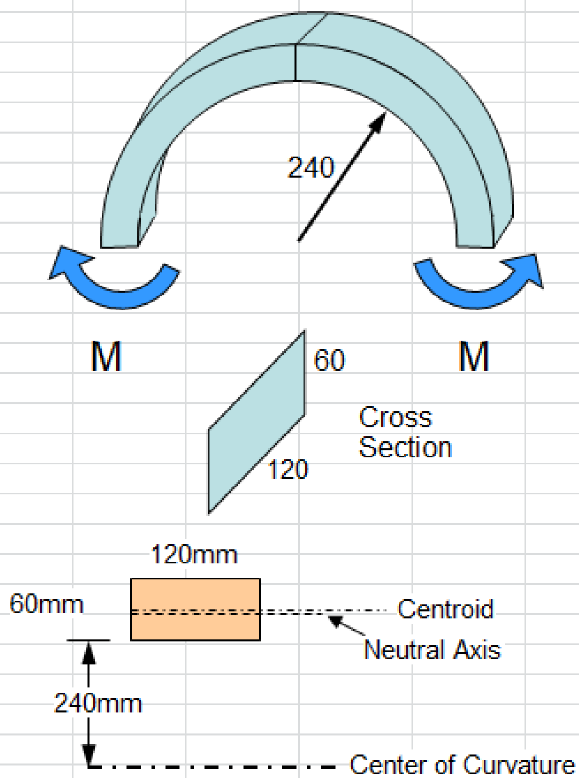
Then Torsional Shear = T * (d/2) / (Pi/32 * d^4)

or = T / (Pi/16 * d^3)

D^3	0.0001126	m^3	=16*Torque/(PI()*TauMax)
D	0.04828578	m	=D_3^(1/3)
	48.29	mm	=D*1000

HW 2.4

Ro	300	mm	
Ri	240	mm	
W	120	mm	Width
M	4000	Nm	Moment



This is a rectangular shape, so the Neutral Radius is

Rn	268.885	mm	=(Ro-Ri)/(LN(Ro/Ri))

The Centroidal Radius is

Rc	270	mm	=(Ro+Ri)/2

Eccentricity

e	1.1148	mm	=Rc_-Rn

Cross Sectional Area

A	7200	mm^2	=(Ro-Ri)*W

Distances from Neutral Axis to Inner and Outer surfaces

Ci	28.885	mm	=(Ro-Ri)/2-e
Co	31.115	mm	=(Ro-Ri)/2+e

Stresses at Inner and Outer Surfaces
Inner is Tensile because arc is being stretched open.
Outer is Compressive.

Sigmai	59.979	MPa	=M*Ci/(A*e*Ri)*1000
Sigmao	51.687	MPa	=M*Co/(A*e*Ro)*1000

Area Moment of Inertia

I	2,160,000	mm^4	=W*(Ro-Ri)^3/12

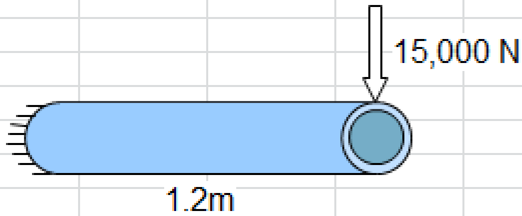
The bending stress if the bar was't curved = Mc/I

Sigma	55.56	MPa	=M*0.5*(Ro-Ri)/I*1000

This value is between Sigmai and Sigmao - where it shoud be.

HW 2.5

OD	100	mm	Outer Diameter
T	10	mm	Wall Thickness
L	1.2	m	Length
F	15000	N	Force
Ro	50.00	mm	=OD/2
Ri	40.00	mm	=Ro-T
MomOfI	2,898,119.22	mm^4	=PI()/4*(Ro^4-Ri^4)
M	18,000.00	Nm	=F*L
c	50	mm	=Ro



Convert Nm to Nmm by multiplying by 1000. Newtons/mm^2 = MPa

SigmaBend	310.546	MPa	=M*c_/MomOfI*1000

Calculate transverse shear: 2F/A for a hollow tube.

Area	2827.433	mm^2	=PI()*(Ro^2-Ri^2)
Shear	10.610	MPa	=2*F/Area