

PREPARED BY: Dearth

DATE: 17 Nov 03

TITLE: Sample Problem - Belt

CHANGE LETTER(S): Reactions - Hand Solution

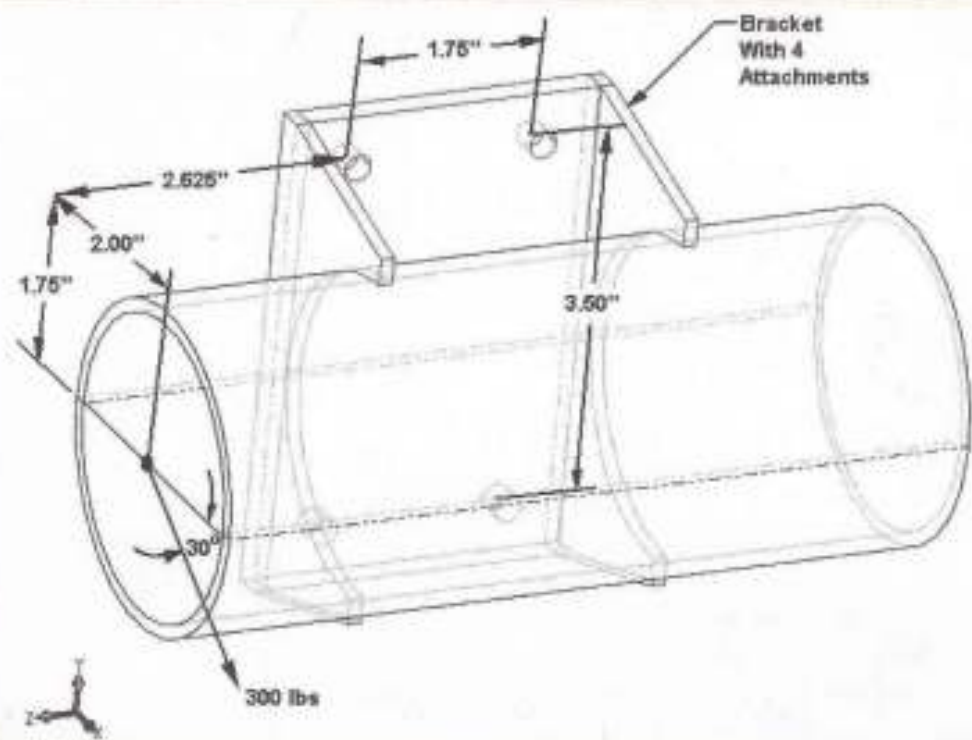
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PAGE: 1 of 5

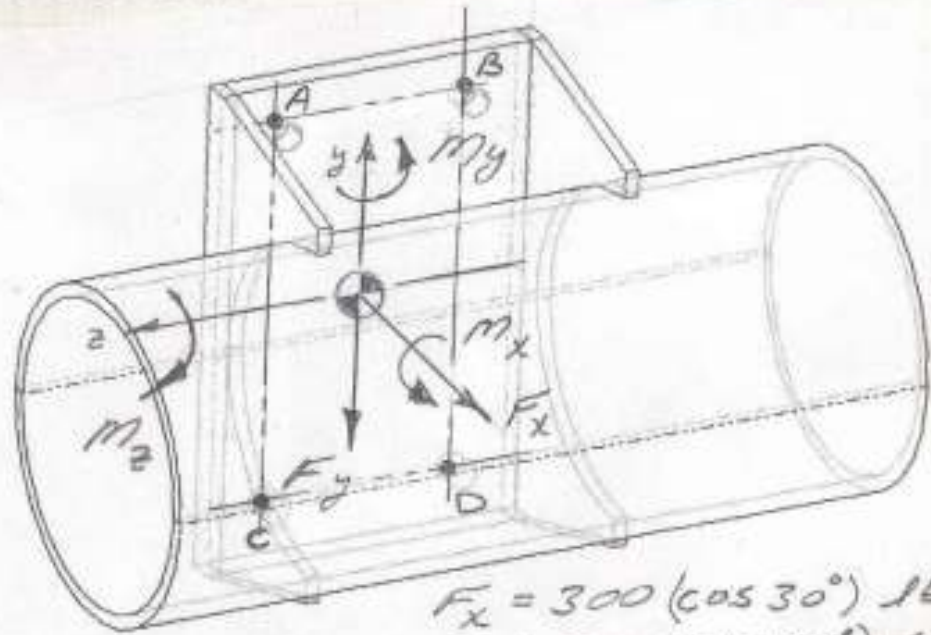
MODEL: _____

REPORT NO.: _____

VOLUME NO.: _____



Equivalent Force System at Center of Belt Pattern



$$F_x = 300 (\cos 30^\circ) \text{ lbs}$$

$$F_y = 300 (\sin 30^\circ) \text{ lbs}$$

$$M_x = 3.50 F_y \text{ in-lb}$$

$$M_y = 3.50 F_x \text{ in-lb}$$

$$M_z = 2.00 F_y \text{ in-lb}$$

Vector Directions
Shown

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 TITLE: Belt Leading (Reactions)
 CHANGE LETTER(S): Hand Estimates Neglect Physical Deformations

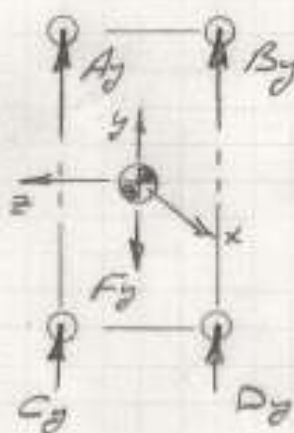
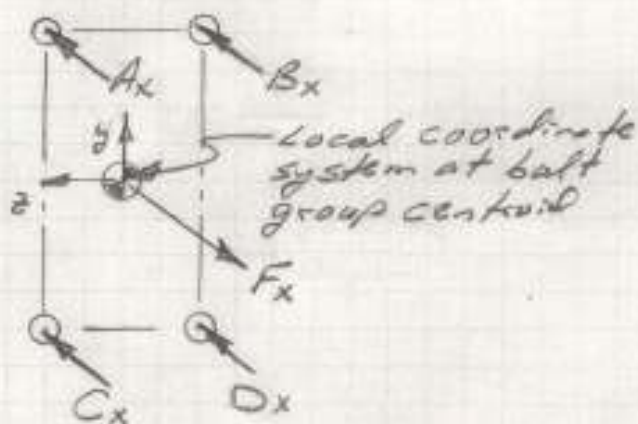
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PAGE: 2 of 5
 MODEL: _____
 REPORT NO.: _____
 VOLUME NO.: _____

Use Super position for Summation of Reactions

Reactions Due to F_x

Reactions Due to F_y



$$A_x = B_x = C_x = D_x = -\frac{F_x}{4}$$

$$= -\frac{1}{4} 300 (\cos 30^\circ)$$

$$= \underline{\underline{-64.95 \text{ lbs}}}$$

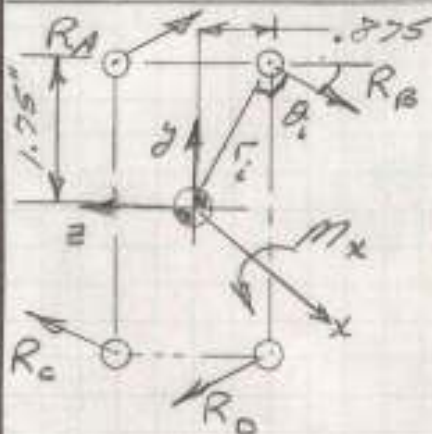
$$A_y = B_y = C_y = D_y = +\frac{F_y}{4}$$

$$= +\frac{1}{4} 300 (\sin 30^\circ)$$

$$= \underline{\underline{+37.50 \text{ lb}}}$$

Reactions Due to M_x

The distance from the belt group centroid to each belt is:



$$r_i = \sqrt{1.75^2 + .875^2} = 1.9566''$$

Since the belts are all the same size.

$$R_i = \frac{M_x \cdot r_i}{4 r_i^2} = \frac{3.50 (300 \sin 30^\circ)}{4 (1.9566)}$$

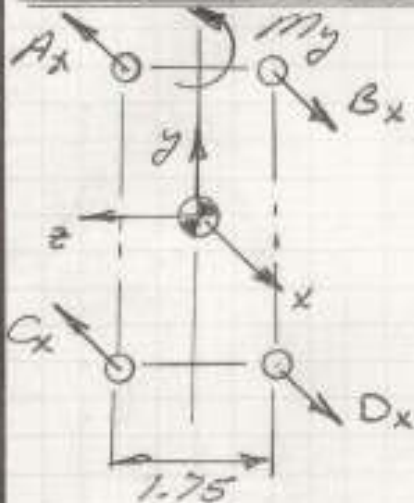
$$R_i = \underline{\underline{67.08 \text{ lbs}}}$$

By Geometry...

$$\theta_i = \tan^{-1} \left(\frac{.875}{1.75} \right) = \underline{\underline{26.57^\circ}}$$

		<u>X-Comp.</u>	<u>Y-Comp.</u>
Belt	A	-60.00	+30.00
"	B	-60.00	-30.00
"	C	+60.00	+30.00
"	D	+60.00	-30.00

Reactions Due to M_y



The perpendicular distance from the bolt group centroid to each bolt is:

$$r_{z_i} = \frac{1.75}{2} = .875"$$

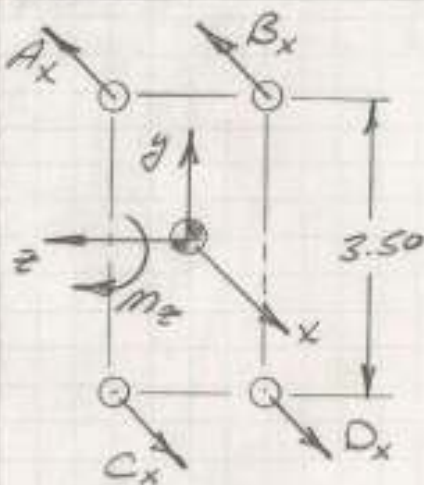
From symmetry the magnitude of reactions $|A_x| = |B_x| = |C_x| = |D_x| = |R_x|$

$$M_y = 3.5 (300 \cos 30^\circ) = 909.33 \text{ in-lb}$$

$$|R_x| = \frac{M_y}{4 r_{z_i}} = \frac{909.33}{4 (.875)} = \underline{259.81 \text{ lbs}}$$

Reaction Vector Directions Shown.

Reactions Due to M_z similar to above...



$$r_{y_i} = \frac{3.50}{2} = 1.75"$$

From symmetry the magnitude of reactions $|R_x| = M_z / r_{y_i}$

$$M_z = 2.0 (300 \sin 30^\circ) = 300 \text{ in-lb}$$

$$|R_x| = \frac{M_z}{4 r_{y_i}} = \frac{300}{4 (1.75)} = \underline{42.86 \text{ lbs.}}$$

Reaction Vector Directions Shown.

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TITLE: Net Total Reactions
CHANGE LETTER(S): _____

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PAGE: 4 of 5
MODEL: _____
REPORT NO.: _____
VOLUME NO.: _____

Use Super position to Algebraically
add Reactions for each Location.

Bolt A

$$\Sigma_x = -64.95 - 259.81 - 42.86 = \underline{-367.62}$$

$$\Sigma_y = +37.50 + 30.00 = \underline{+67.50}$$

$$\Sigma_z = \underline{-60.00}$$

Bolt B

$$\Sigma_x = -64.95 + 259.81 - 42.86 = \underline{+152.00}$$

$$\Sigma_y = +37.50 - 30.00 = \underline{+7.50}$$

$$\Sigma_z = \underline{-60.00}$$

Bolt C

$$\Sigma_x = -64.95 - 259.81 + 42.86 = \underline{-281.90}$$

$$\Sigma_y = +37.50 + 30.00 = \underline{+67.50}$$

$$\Sigma_z = \underline{+60.00}$$

Bolt D

$$\Sigma_x = -64.95 + 259.81 + 42.86 = \underline{+237.72}$$

$$\Sigma_y = +37.50 - 30.00 = \underline{+7.50}$$

$$\Sigma_z = \underline{+60.00}$$

(Spread Sheet)
+237.71

See Summary Spread Sheet Arithmetic

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DATE: 18 Nov 03
TITLE: Summary Spread Sheet
CHANGE LETTER(S): As Shown

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PAGE: 5 of 5
MODEL: _____
REPORT NO.: _____
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Equivalent Force Moment System w.r.t. Bolt Local Coordinate System				Reactions Due to Fx & Fy w.r.t. Local Bolt Coordinate System			
				Bolt Axial Bolt Shear			
Fx =	259.8	lbs	Mx =	525.0	in-lbs		
Fy =	-150.0	lbs	My =	909.3	in-lbs		
Fz =	0.0	lbs	Mz =	-300.0	in-lbs		

Bolt Pattern Properties w.r.t. Local Bolt Coordinate System				Reactions Due to Mx Components of Bolt Reactions Due to Mx Graphically Determine Sign			
Bolt I.D.	z-c.g.	y-c.g.	r-c.g.	Bolt I.D.	Rm=Mx/r _x	R-z1	R-y2
A	0.8750	1.7500	1.9588	A	67.08	-60.00	30.00
B	-0.8750	1.7500	1.9588	B	67.08	-60.00	-30.00
C	0.8750	-1.7500	1.9588	C	67.08	60.00	30.00
D	-0.8750	-1.7500	1.9588	D	67.08	60.00	-30.00
Sum = 1 bolt x =				15.3125 in ²			

Reactions Due to My w.r.t. Local Bolt Coordinate System				Reactions Due to Mz w.r.t. Local Bolt Coordinate System			
				Equivalent Loading at Bolt Pattern C.G.			
				Mz = -300 in-lbs [2.0°Fy]			
				Bolt Axial Bolt Shear			
Bolt I.D.	R-x3	R-y4		Bolt I.D.	R-x4	R-y4	
A	-259.81	259.81		A	-42.86	-42.86	
B	259.81	-259.81		B	-42.86	-42.86	
C	-259.81	259.81		C	42.86	42.86	
D	259.81	-259.81		D	42.86	42.86	

Using Superposition Algebraically Add Individual Reactions Summary Net Total Reactions Hand Estimates					
Bolt I.D.	Total-x	Total-y	Bolt Axial	Bolt Shear	Shear Res.
A	-357.62	67.50	-80.00	90.31	90.31
B	152.00	7.50	-60.00	60.47	60.47
C	-281.90	67.50	60.00	90.31	90.31
D	237.71	7.50	60.00	60.47	60.47