

5-34 NORTON

HANDCALCS FOR ROW A (POINT A)

ME340

10/10/98

PAGE 1 OF 2

DISTORTION ENERGY THEORY FACTOR OF SAFETY

SAME AS VON MISES — USE VALUES FROM 5-33

$$FOS = \frac{400 \text{ MPa}}{30.2 \text{ MPa}} = 13.2$$

MAXIMUM SHEAR STRESS THEORY FACTOR OF SAFETY

$$\sigma_{1,3} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

USING VALUES FROM 5-33

$$= \frac{8.38}{2} \pm \sqrt{\left(\frac{8.38 - 0}{2}\right)^2 + 16.76^2}$$

$$= 4.19 \pm 17.28$$

$$\sigma_1 = 21.5 \text{ MPa}$$

$$\sigma_3 = -13.1 \text{ MPa}$$

$$\tau_{\max} = \frac{\sigma_1 - \sigma_3}{2} = \frac{21.5 + 13.1}{2} = 17.3 \text{ MPa}$$

$$F.O.S. = \frac{0.5(S_y)}{\tau_{\max}} = \frac{0.5(400)}{17.3} = 11.6$$

MAXIMUM NORMAL STRESS THEORY

$$F.O.S. = \frac{S_y}{\sigma_{1,3}} = \frac{400}{21.5} = 18.6$$

COMMENTS: DISTORTION ENERGY IS MOST ACCURATE FOR DUCTILE MATLS. MAXIMUM SHEAR IS MORE CONSERVATIVE. MAX NORMAL IS NOT SAFE TO USE WITH DUCTILE MATERIALS. (SEE FIG 5-4 & FIG 5-5, PG 296)

SEE SPREADSHEET (PG 2) FOR ADDITIONAL ROWS.

Data from Table PS-3							Stresses at Point A (Mpa)						Stresses at Point B (Mpa)					
ROW	l (m)	a (m)	F (N)	od (m)	id (m)		Sigma	Tau-torsion	Tau-bending	Sigma	Tau-torsion	Tau-bending	Sigma	Tau-torsion	Tau-bending			
a	0.100	0.400	50	0.020	0.014		8.38	16.76	0	0	16.76	0.42	0	0	0.40	0.42		
b	0.070	0.200	85	0.020	0.006		7.64	10.92	0	0	10.92	0.40	0	0	0.48	0.40		
c	0.300	0.100	95	0.025	0.017		23.64	3.94	0	0	3.94	0.48	0	0	0.17	0.48		
d	0.800	0.500	160	0.046	0.022		14.14	4.42	0	0	4.42	0.17	0	0	0.62	0.17		
e	0.085	0.350	900	0.055	0.024		4.86	10.01	0	0	10.01	0.62	0	0	8.01	0.62		
f	0.050	0.180	950	0.050	0.030		4.45	8.01	0	0	8.01	1.01	0	0	0.87	1.01		
g	0.160	0.280	850	0.045	0.019		15.71	13.75	0	0	13.75	0.87	0	0	7.32	0.87		
h	0.200	0.100	800	0.040	0.024		29.27	7.32	0	0	7.32	1.33	0	0	2.95	1.33		
i	0.400	0.150	950	0.065	0.037		15.76	2.95	0	0	2.95	0.56	0	0	4.51	0.56		
j	0.200	0.100	600	0.045	0.032		18.03	4.51	0	0	4.51	1.02	0	0	5.99	1.02		
k	0.120	0.180	890	0.060	0.047		7.99	5.99	0	0	5.99	1.07	0	0	7.42	1.07		
l	0.150	0.250	750	0.052	0.028		8.90	7.42	0	0	7.42	0.66	0	0	10.55	0.66		
m	0.070	0.100	500	0.036	0.030		14.77	10.55	0	0	10.55	2.14	0	0	9.99	2.14		
n	0.085	0.150	820	0.040	0.015		11.32	9.99	0	0	9.99	1.01	0	0		1.01		

Prob. 5-34																	
Stresses at Point A (Mpa)					FOS at Point A				Stresses at Point B (Mpa)					FOS at Point B			
ROW	von mises	Sigma1	Sigma2	Sigma3	Tau max	distortion energy	Max Shear	Max Normal	von mises	Sigma1	Sigma2	Sigma3	Tau max	distortion energy	Max Shear	Max Normal	
a	30.2	21.5	0	-13.1	17.3	13.2	11.6	18.6	28.8	17.2	0	-17.2	17.2	13.4	11.6	23.3	
b	20.4	15.4	0	-7.7	11.6	18.6	17.3	26.0	19.6	11.3	0	-11.3	11.3	20.4	17.7	35.4	
c	24.6	24.3	0	-0.6	12.5	16.3	16.0	16.5	7.7	4.4	0	-4.4	4.4	52.2	45.2	90.5	
d	18.1	15.4	0	-1.3	8.3	24.9	24.0	26.0	7.9	4.6	0	-4.6	4.6	50.4	43.6	87.2	
e	18.0	12.7	0	-7.9	10.3	22.2	19.4	31.4	18.4	10.6	0	-10.6	10.6	21.7	18.8	37.6	
f	14.6	10.5	0	-6.1	8.3	27.5	24.1	38.0	15.6	9.0	0	-9.0	9.0	25.6	22.2	44.4	
g	28.5	23.7	0	-8.0	15.8	14.0	12.6	16.9	25.3	14.6	0	-14.6	14.6	15.8	13.7	27.4	
h	31.9	31.0	0	-1.7	16.4	12.5	12.2	12.9	15.0	8.6	0	-8.6	8.6	26.7	23.1	46.3	
i	16.6	16.3	0	-0.5	8.4	24.1	23.8	24.6	6.1	3.5	0	-3.5	3.5	65.6	56.8	113.7	
j	19.6	19.1	0	-1.1	10.1	20.4	19.8	20.9	9.6	5.5	0	-5.5	5.5	41.8	36.2	72.4	
k	13.1	11.2	0	-3.2	7.2	30.5	27.8	35.7	12.2	7.1	0	-7.1	7.1	32.7	28.3	56.6	
l	15.6	13.1	0	-4.2	8.7	26.6	23.1	30.5	14.0	8.1	0	-8.1	8.1	28.6	24.7	49.5	
m	23.5	20.3	0	-5.5	12.9	17.0	15.5	18.7	22.0	12.7	0	-12.7	12.7	18.2	15.8	31.5	
n	20.7	17.1	0	-5.8	11.5	19.3	17.4	23.3	19.1	11.0	0	-11.0	11.0	21.0	18.2	36.4	