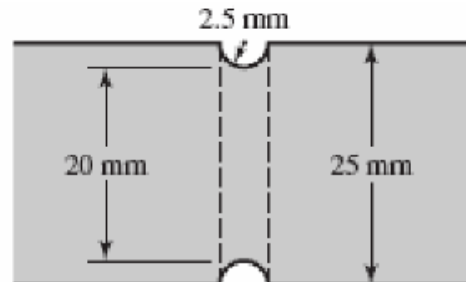

Machine Design - 2

A machined solid round bar, with 25 mm diameter, has a groove 2.5 mm deep with a 2.5 mm radius machined into it (see the Figure). The bar is made of AISI 1018 CD steel and is subjected to a completely reversing torque of 151 N.m.

For this case, answer the following questions. All the required tables and graphs are given in the next pages.



Suggestion: If you have trouble in finding any of the questioned factors, assume an approximate value and continue with solving the problem.

- What are the Tensile, and Yield strengths **(10 Points)**?
- Calculate the theoretical stress concentration factor, K_{ts} **(10 Points)**.
- Calculate the reduced stress concentration factor (commonly called the fatigue stress concentration factor), K_{fs} **(10 Points)**.
- Calculate the midrange and alternating shear stresses **(10 Points)**.
- Calculate the endurance limit (S'_e) **(10 Points)**.
- Calculate the modified endurance limit (S_e) **(30 Points)**.

Hint 1: regarding the endurance limit modifying factors, you need to consider the surface condition modification factor, size modification factor, and the load modification factor. The other factors can be considered equal to 1.

Hint 2:

$$k_b = \begin{cases} (d/0.3)^{-0.107} = 0.879d^{-0.107} & 0.11 \leq d \leq 2 \text{ in} \\ 0.91d^{-0.157} & 2 < d \leq 10 \text{ in} \\ (d/7.62)^{-0.107} = 1.24d^{-0.107} & 2.79 \leq d \leq 51 \text{ mm} \\ 1.51d^{-0.157} & 51 < d \leq 254 \text{ mm} \end{cases}$$

$$k_c = \begin{cases} 1 & \text{bending} \\ 0.85 & \text{axial} \\ 0.59 & \text{torsion} \end{cases}$$

g) For the S-N curve of this material, let $f = 0.9$. Estimate the number of cycles to failure (20 Points).

Hint 3:

$$N = \left(\frac{\sigma_{\text{rev}}}{a} \right)^{1/b}$$

$$a = \frac{(f S_{ut})^2}{S_e}$$

$$b = -\frac{1}{3} \log \left(\frac{f S_{ut}}{S_e} \right)$$

Material properties:

Table A-20 Deterministic ASTM Minimum Tensile and Yield Strengths for Some Hot-Rolled (HR) and Cold-Drawn (CD) Steels [The strengths listed are estimated ASTM minimum values in the size range 18 to 32 mm ($\frac{3}{4}$ to $1\frac{1}{4}$ in). These strengths are suitable for use with the design factor defined in [Sec. 1-10](#), provided the materials conform to ASTM A6 or A568 requirements or are required in the purchase specifications. Remember that a numbering system is not a specification.]

1	2	3	4	5	6	7	8
UNS No.	SAE and/or AISI No.	Processing	Tensile Strength, MPa (kpsi)	Yield Strength, MPa (kpsi)	Elongation in 2 in, %	Reduction in Area, %	Brinell Hardness
G10060	1006	HR	300 (43)	170 (24)	30	55	86
		CD	330 (48)	280 (41)	20	45	95
G10100	1010	HR	320 (47)	180 (26)	28	50	95
		CD	370 (53)	300 (44)	20	40	105
G10150	1015	HR	340 (50)	190 (27.5)	28	50	101
		CD	390 (56)	320 (47)	18	40	111
G10180	1018	HR	400 (58)	220 (32)	25	50	116
		CD	440 (64)	370 (54)	15	40	126
G10200	1020	HR	380 (55)	210 (30)	25	50	111
		CD	470 (68)	390 (57)	15	40	131

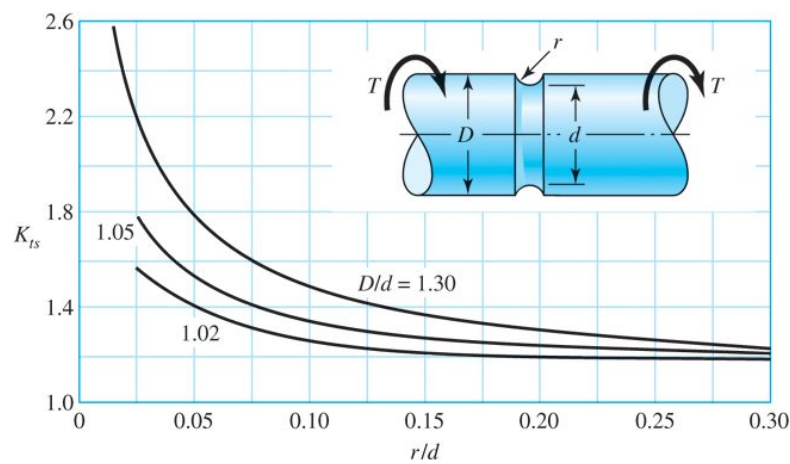
Surface condition modification factor:

Table 6-2

Parameters for Marin Surface Modification Factor, Eq. (6-19)

Surface Finish	Factor a		Exponent b
	S_{utr} kpsi	S_{utr} MPa	
Ground	1.34	1.58	-0.085
Machined or cold-drawn	2.70	4.51	-0.265
Hot-rolled	14.4	57.7	-0.718
As-forged	39.9	272.	-0.995

Theoretical Stress-Concentration Factors for grooved round bar in torsion:



Notch-sensitivity curves for materials in reversed torsion:

