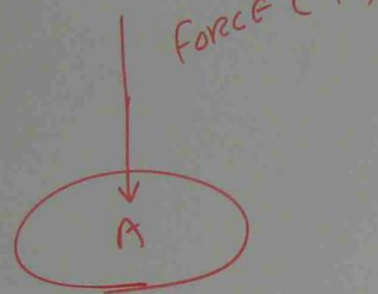
STRESS AND STRAIN

DIRECT AXIAL STRESS



$$STRESS = \frac{FORCE}{AREA}$$

$$f = \frac{F}{A}$$

F = FORCE (N)
A = AREA (m^2)
f = STRESS (N/m^2 (OR) PASCAL)

ph

IF

To

pb/ IF A BAR OF MILD STEEL 20mm X 10mm IN CROSS SECTION IS SUBJECTED TO A TENSILE FORCE OF 18.8 KN. DETERMINE THE STRESS IN THE MATERIAL.

$$f = \frac{F}{A} = \frac{18.8 \times 10^{3}}{20 \times 10^{-3} \times 10 \times 10^{-3}} = \frac{18.8 \times 10^{3}}{200 \times 10^{-6}} = \frac{18800}{200} \times 10^{6}$$

$$= 94 \times 10^{6} \text{ Pascal}$$

$$= 94 \text{ mPa}$$

FACTOR OF SAFETY (F.S)

$$\text{FACTOR OF SAFETY} = \frac{\text{ULTIMATE STRENGTH (UTS)}}{\text{WORKING STRESS } (f)}$$

FACTOR OF SAFETY

MATERIAL	STATIC LOAD	CYCLIC LOAD
STEEL, DUCTILE MATERIALS	$3 \rightarrow 4$	8
CAST IRON, BRITTLE MATERIAL	$5 \rightarrow 6$	$10 \rightarrow 12$
TIMBER	7	15

Pb DETERMINE THE MINIMUM REQUIRED DIAMETER OF A HIGH TENSILE STEEL ROD TO CARRY A TENSILE LOAD OF 26 KN WITH A SAFETY FACTOR OF 3.5.

ULTIMATE STRENGTH OF TENSILE STEEL = 590 N/mm^2

$$F.S = \frac{UTS}{f}$$

$$f = \frac{UTS}{FS}$$

$$f = \frac{590}{3.5}$$

$$= 168.6\ N/mm^2$$

$$f = \frac{F}{A}$$

$$168.6 = \frac{26000}{A}$$

$$A = \frac{26000}{168.6} = 154.2\ mm^2$$

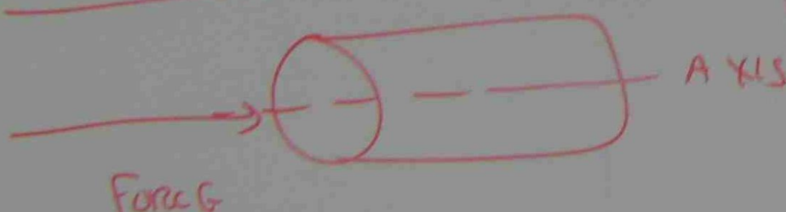
$$\frac{\pi D^2}{4} = A = 154.2 \text{ mm}^2$$

$$0.7854\, D^2 = 154.2 \text{ mm}^2$$

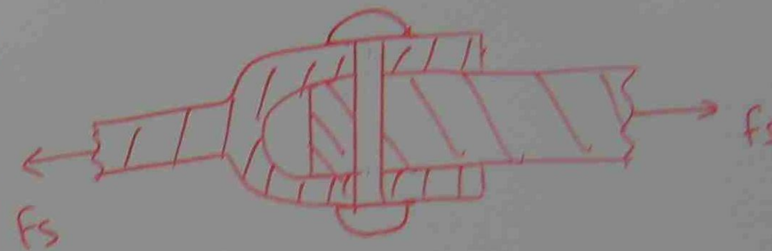
$$D = \sqrt{\frac{154.2}{0.7854}}$$

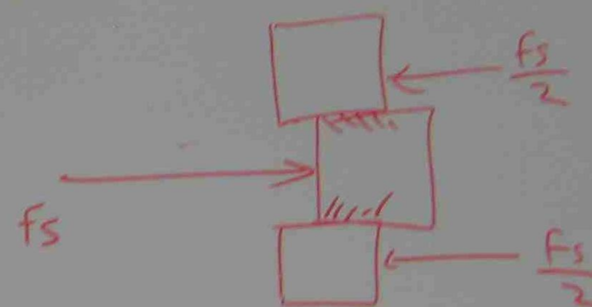
$$= 14 \text{ mm}$$

AXIAL STRESS



SHEAR STRESS





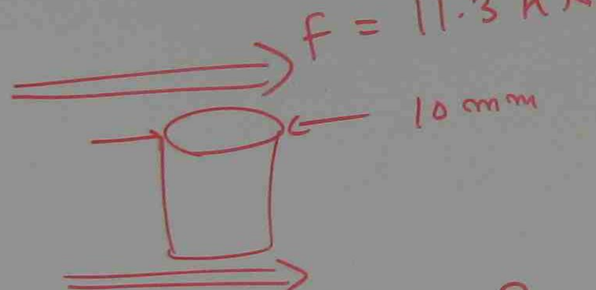
$$f_s = \frac{F}{A}$$

SHEAR STRESS

P.b

IF THE DIAMETER OF MILD STEEL PIN IN GIVEN FIGURE IS 10mm AND THE MAXIMUM FORCE APPLIED TO THE COUPLING IS 11.3 KN. WHAT IS THE SHEAR STRESS IN THE MATERIAL OF THE PIN AND THE FACTOR OF SAFETY?

(ULTIMATE SHEAR STRENGTH OF MILD STEEL = 360 N/mm²)



$$A = 2 \times \frac{\pi}{4} D^2$$

$$= 2 \times 0.7854 \times (10)^2$$

$$= 157 \, mm^2$$

$$f_s = \frac{F}{A} = \frac{11300 \, N}{157 \, mm^2}$$

$$f_s = \frac{11300}{157 (10^{-3})^2}$$

$$= \frac{11300}{157} \times 10^6$$

$$= 72 \, MPa$$

$$F_S = \frac{USS}{f_s}$$

$$= \frac{360 \, MPa}{72 \, MPa}$$

$$= 5$$

pb

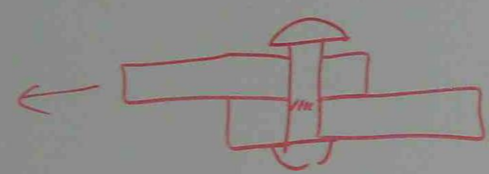
DETERMINE THE REQUIRED DIAMETER OF A SINGLE MILD STEEL BOLT, HOLDING TWO OVERLAPPING STRIPS OF METAL, AGAINST A SHEAR FORCE OF 4.5 KN. IF THE ALLOWABLE STRESS IN SHEAR IS 40 mpa.

$$f_s = \frac{F}{A}$$

N

mm^2

mpa



$$f_s = \frac{F}{A}$$

$$90 = \frac{4.5\,kN}{A}$$

$$40 = \frac{4500\,N}{A}$$

$$A = \frac{4500}{40}$$

$$A = 50\ mm^2$$

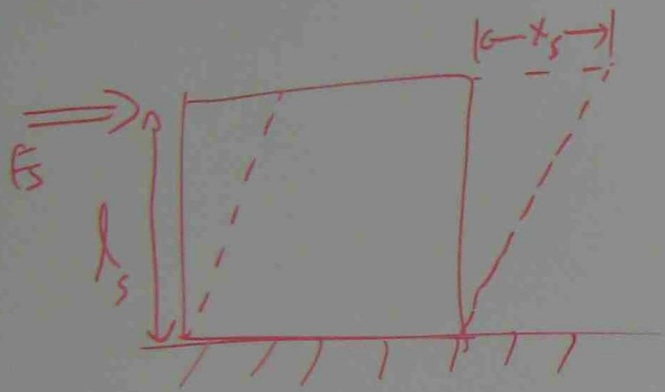
$$\frac{\pi}{4} D^2 = 50$$

$$0.7854 \times D^2 = 50$$

$$D = \sqrt{\frac{50}{0.7854}}$$

$$= 7.98\,mm$$

SHEAR MODULUS OF RIGIDITY



SHEAR STRAIN $e_s = \dfrac{x_s}{l_s}$

MECHANICAL PROPERTIES OF FLUIDS

PNUEMATICS $\longrightarrow$ APPLICATION OF Com

PROPERTIES

FLUIDS $\rightarrow$ COMPRESSIBILITY

FLUIDS $\rightarrow$ VISCOSITY

DENSITY OF FLUID $\rho = \dfrac{\text{MASS}}{\text{VOLUME}}$

RELATIVE DENSITY $= \dfrac{\text{DENSITY OF FLUID}}{\text{DENSITY OF WATER}}$

MECHANICAL PROPERTIES OF FLUIDS

PNUEMATICS ⟶ APPLICATION OF COMPRESSIBLE FLUIDS.

PROPERTIES

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RELATIVE DENSITY = $\frac{\text{DENSITY OF FLUID}}{\text{DENSITY OF WATER}}$

LIQUID	DENSITY kg/m³	RELATIVE DENSITY
PETROL	700	0.7
ALCOHOL	790	0.79
TURPENTINE	870	0.87
PETROLEUM OIL	880	0.86
VEGETABLE OIL	930	0.93
WATER	1000	1
BEER, MILK	1030	1.03
SEA WATER	1030	1.03
HYDROCHLORIC ACID	1200	1.20
GLYCERINE	1280	1.28
MERCURY	13590	13.59