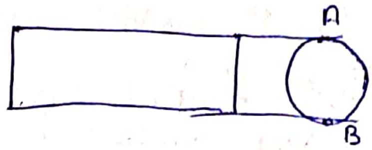
27/12/19

UNIT -2



Completely cyclic Reversible process:

Considering a rotating beam of circular cross section carrying a load of W. This load induces stresses in the beam in cyclic nature.

A little consideration will show that the upper fibre of the beam at a point 'A' under a compressive and lower fibres at a point 'B' under a tensile stresses.

After half revolution the point 'B' occupies position of point 'A' and point 'A' occupies position of point 'B', 'B' has compressive stress and 'A' has tensile stress.

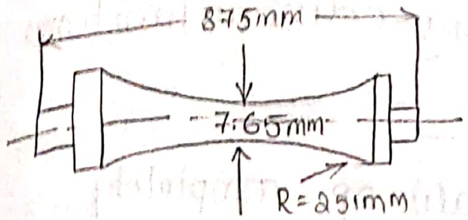
The revolution of shaft the stresses are reversed from compressive to tensile or tensile to compressive are known as completely reversed cyclic process.

The stresses which vary from 0 to A certain maximum value of the same nature ie tensile or compressive are called fluxiating stresses.

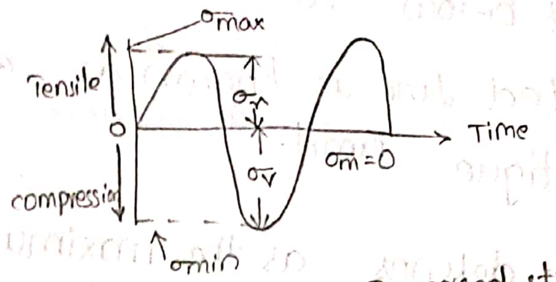
The stresses which vary from 0 to certain maximum value are called repeated stresses.

The stresses which vary from minimum value to maximum value of the opposite nature i.e from a certain minimum compressive to certain a maximum tensile or from minimum tensile from maximum compressive are called alternating stresses.

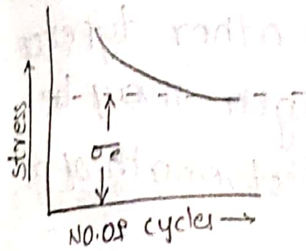
Fatigue and endurance



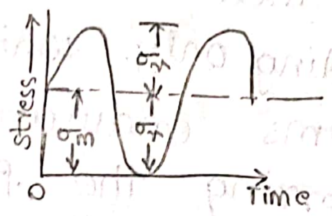
a) Standard specimen



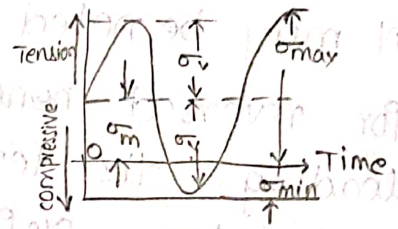
b) Completely Reversed stress.



c) endurance (or) faitigue limit.



d) Repeated stress



e) Fluctuating stress.

When a material is subjected to repeated stresses it fails at stresses below the yield point stresses such a type of failure of a material is called Faitigue.

The failure is caused by means of a progressive crack formation which are usually find and micro-scopic sizes.

The failure of a material may occur even without proper indication.

A record is kept of No.of cycles Required to produce failure at a given stress. As the specimen rotates the bending stress at upper fibre vary from maximum compressive to maximum tensile while the bending stress at lower fibres varies from maximum tensile to maximum compresive.

The little consideration will show the stress is kept below at a certain value is represented by dotted line is known as ~~enyurens~~ endurence limit or faitique limit.

It is defines as the maximum value of completely reversed bending stress which a polished standard specimen can with stand specimen without failure.

It may be noted that the endurens limit is used for reversed bending only. while for other types of loading the terms endurance strength may be used when referring the faitique strength of a material.

Mean (or) avg. stress may be It is defined as the half of half the some of maximum stress and minimum stress

$$\boxed{\sigma_m = \frac{\sigma_{max} + \sigma_{min}}{2}}$$

Reversed stress or alternating stresses or variable stress. It is defined as the half ~~of~~ half of the

$$\boxed{\sigma_v = \frac{\sigma_{max} - \sigma_{min}}{2}}$$

For repeated loading the stress varies from maximum to zero i.e $\sigma_{min} = 0$

$$\therefore \boxed{\sigma_m = \sigma_r = \frac{\sigma_{max}}{2}}$$

Stress ratio is the defined as the ratio of maximum stress to minimum stress. It is donoted by 'R'.

$$\boxed{R = \frac{\sigma_{max}}{\sigma_{min}}}$$

For completely reversed stresses $R = -1$ and for repeated stresses $R = 0$. It may be noted that 'R' cannot be greater unity.

The following relation b/w endurance b/w and stress ratio

$$\boxed{\sigma_e' = \frac{3\sigma_e}{2-R}}$$

σ_e' = endurance limit for any stress ran range represented by 'R'

σ_e = endurance limit for completely Reversed stress.

Effect of loading on endurance limit (load factor):

The endurance limit 'σ_e' of a material is determine by the rotating beam method is for reversed bending load. There are many machine members which are subjected to loads other than the reversed bending loads. Thus the endurance limit will also be different for different types of loads.

K_b = load correction factor for the reversed or rotating bending load is usually taken as one.

K_a = load correction factor for the reversed axial load.

$K_a = 0.8$

K_s = load correction factor for the reversed Tortional or shear load

~~$K_s = 0.5$~~ ~~Ka~~ 0.8

$K_s = 0.55$ (for ductile)

$= 0.8$ (for Brittle)

$\because$

$$\boxed{\begin{aligned} \sigma_{ea} &= \sigma_e \cdot K_a \\ \sigma_{eb} &= \sigma_e \times K_b \\ \tau_{es} &= \sigma_e \times K_s \end{aligned}}$$

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Surface finish Factor: When a machine member is subjected to variable loads the endurance limit of the material for that number depends upon the surface conditions.

When the surface finish factor is known then the endurance limit for the material is obtained by multiplying the endurance limit and surface finish factor.

For a mirror polishing material the surface finish factor is equal to one. If surface finish factor is less than one it indicates the mirror polishing is reduced.

$$\therefore \boxed{\begin{aligned} \sigma_{ea} &= \sigma_e \cdot k_a \times k_{sur} \\ \sigma_{eb} &= \sigma_e \times k_b \times k_{sur} \\ \tau_{es} &= \tau_e \times k_s \times k_{sur} \end{aligned}}$$

Size factor: The size of the standard specimen is increased then the endurance limit will decreases. It is denoted by 'k_{sz}'.

$$\therefore \boxed{\begin{aligned} \sigma_{ea} &= \sigma_e \cdot k_a \times k_{sur} \times k_{sz} \\ \sigma_{eb} &= \sigma_e \times k_b \times k_{sur} \times k_{sz} \\ \tau_{es} &= \tau_e \times k_s \times k_{sur} \times k_{sz} \end{aligned}}$$

In addition of load factors, size factor, surface factor. There are many other factors such as reliable factor (k_r), temparature factor and Impact factor (k_i). Which has effect on the endurance limit of a factor.

Relation b/w endurance limit & ultimate tensile strength:

It has been found experimentally the endurance limit "σ_e" of a material subjected to faitigue loading is a function of altimate tensile strength 'σ_u' &

For steel $\sigma_e = 0.5 \times \sigma_u$

For cast steel $\sigma_e = 0.4 \times \sigma_u$

For cast iron $\sigma_e = 0.35 \times \sigma_u$

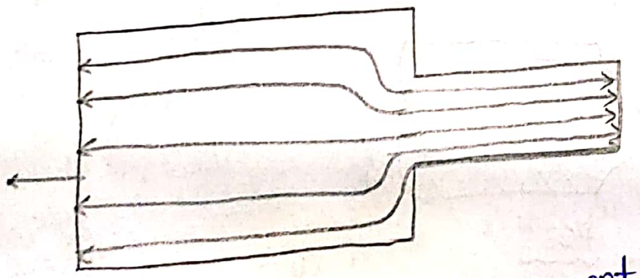
For non-ferrous metals and alloys $= 0.3 \times \sigma_u$

Factor of saftey for faitigue loading: It is defined as the ratio of endurance limit to design or working stress

$$\text{Factor of saftey } (Fs) = \frac{\sigma_e}{\sigma_d}$$

For steel $\sigma_e = 0.8$ to 0.9 times of yield stress.

stress concentration:

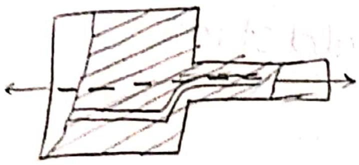


When ever a machine component shape of its cross ection no longer holds of the simple stresses distribution this irregularity discontinuity is different abrupt changes of form stresses distribution caused by concentration it occurs all is called as stress in the presence of fillet, notches, holes, kinds stresses keyways, splints, etc., 04/01/2020

In static loading the stress concentration in ductile material is not so serious as in brittle materials because in ductile materials local deformation are yeilding takes place which reduce the concentration

In cyclic loading the stress concentration in ductile materia is always serious because the ductility of the material is not effective in releving the concentration of stresses caused by cracks, flaws are any sharp discontinuity in the geometrical form of the member.

Methods of Reducing stress concentration:



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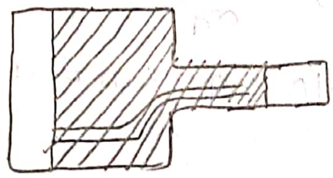

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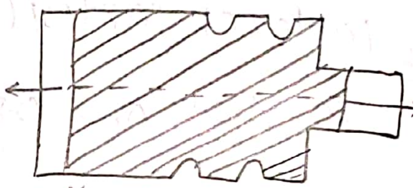

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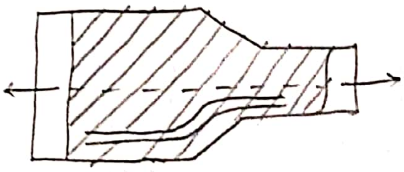
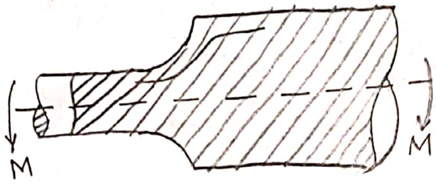


Preferred



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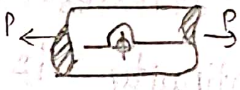

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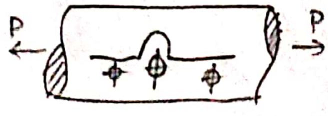


preferred

The presence of stress concentration cannot be totally eliminated but it may be reduced to some extand a device or concept that is useful in essting a design engineer to visualize the prensce of stress concentration and how it may be eliminated of stress flow lines. The elimination of stress concentration means that the stress flow lines shall maintain their space as far as possible.

06/01/2020

Factors to be considered while designing machine parts to avoid faitgue failure.

1. The variation in the size of the component should be gradual as possible.

2. The holes, notches and other stress raises should be avoided.

3. The parts should be protected from corrosing atmosphere

4. A smooth finish of outer surface of the component increase the faitgue life.

5. The material with high faitgue strength should be selected.

Faitgue stress concentration Factor:

When a machine member is subjected to cyclic or faitgue loading. The value of faitge stress concentration factor shall be applied instead of theoritical stress concentration factor. It is defined as the ratio of endurance limit without stress concentration to endurance limit with stress concentration.

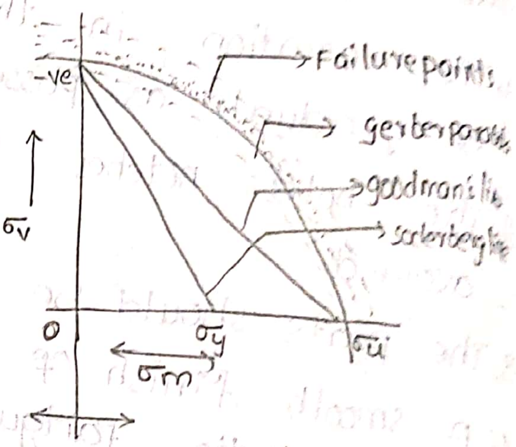
$$K_f = \frac{\text{endurance limit without stress concentration}}{\text{endurance limit with stress concentration}}$$

Notch sensitivity: It is defined as the degree to which the theoritical effect of stress concentration is actually reached.

The stress gradiant depends upon the radius of notch holes or fillet and on the grainsize of the material

$$\boxed{q = \frac{k_f - 1}{k_t - 1}}$$

The relation b/w germer goodman's and soderber failure lines:



Gerber method for combination of stresses: The relation b/w the variable stress and mean stress for axial and bending loading for ductile materials as shown in fig. The point 'σ_E' represents the faitugue strength corresponding to the case of complete reversal i.e $\sigma_m = 0$, and point σ_u represents the static ultimate strength corresponding $\sigma_v = 0$

A parabolic curve drawn b/w the endurance limit and tensile strength is known as Gerber Gerber failure line.

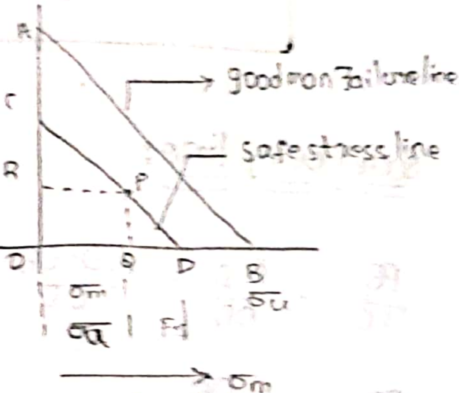
Generally the test data for ductile material fall closer to the parabola line. But because of scatter in the test points a st. line relationship is used for designing the machine components.

$$\boxed{\frac{1}{F.S} = \left(\frac{\sigma_m}{\sigma_u}\right)^2 . F_s + \frac{\sigma_v}{\sigma_e}}$$

If considered stress concentration factor the eq.n maybe

$$\boxed{\frac{1}{F.S} = \left(\frac{\sigma_m}{\sigma_u}\right)^2 . F_s + \frac{\sigma_v}{\sigma_e} . k_f}$$

Good man method for combination of stresses:



A st-line connection the enduranc limit and the ultimate strength is called as good man's failure line. A good man line is used for design machine part based on ultimate strength and may be used for ductile and brittle materials.

$$\frac{PQ}{CO} = \frac{QD}{OD} = \frac{OD - OQ}{OD}$$

$$\frac{PQ}{CO} = 1 - \frac{OQ}{OD}$$

$$\boxed{\frac{\sigma_v}{\frac{\sigma_e}{F.S}} = 1 - \frac{\sigma_m}{\frac{\sigma_u}{F.S}}}$$

$$\sigma_v = \frac{\sigma_e}{F.S}\left[1 - \frac{\sigma_m}{\sigma_u} \times F.S\right]$$

$$= \sigma_e \left[\frac{1}{F.S} - \frac{\sigma_m}{\sigma_u} \times \frac{F.S}{F.S}\right]$$

$$\sigma_v = \sigma_e \left[\frac{1}{F.S} - \frac{\sigma_m}{\sigma_u}\right]$$

$$\boxed{\frac{1}{F.S} = \frac{\sigma_m}{\sigma_u} + \frac{\sigma_v}{\sigma_e}}$$

$$\frac{1}{F.S} = \frac{\sigma_m}{\sigma_u}$$

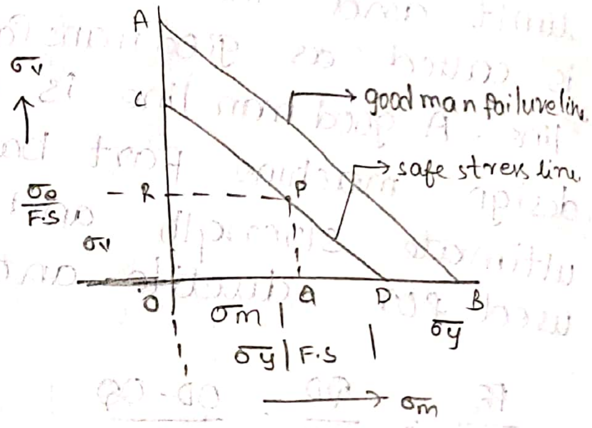
If factors are given eqn may be written as

$$\boxed{\frac{1}{F.S} = \frac{\sigma_m}{\sigma_u} \times k_t + \frac{\sigma_v \times k_f}{\sigma_e \cdot k_b \cdot k_{sur} \cdot k_{sz}}}$$

similarly for reversed torsional load or shear load the eq.n may be

$$\boxed{\frac{1}{F.S} = \frac{\tau_m}{\tau_u} \times K_t + \frac{\tau_v \times k_f}{\tau_e \times k_b \times k_{sur} \times k_{sz}}}$$

soderberg line:



$$\frac{PQ}{CO} = \frac{QD}{OD} = \frac{OD - OQ}{OD}$$

$$\frac{PQ}{CO} = 1 - \frac{OQ}{OD}$$

$$\boxed{\frac{\sigma_v}{\frac{\sigma_e}{F.S}} = 1 - \frac{\sigma_m}{\frac{\sigma_y}{F.S}}}$$

$$\sigma_v = \frac{\sigma_e}{F.S}\left[1 - \frac{\sigma_m}{\sigma_y} \times F.S\right]$$

$$= \sigma_e \left[\frac{1}{F.S} - \frac{\sigma_m}{\sigma_y} \times \frac{F.S}{F.S}\right]$$

$$\sigma_v = \sigma_e \left[\frac{1}{F.S} - \frac{\sigma_m}{\sigma_y}\right]$$

$$\boxed{\frac{1}{F.S} = \frac{\sigma_m}{\sigma_y} + \frac{\sigma_v}{\sigma_e}}$$

$$\boxed{\frac{1}{F.S} = \frac{\sigma_m}{\sigma_y} \times k_t + \frac{\sigma_v + k_f}{\sigma_e \cdot k_b \cdot k_{sur} \cdot k_{sz}}}$$

$$\boxed{\frac{1}{F.S} = \frac{\tau_m}{\tau_y} \times K_t + \frac{\tau_v \times k_f}{\tau_e \times k_b \times k_{sur} \times k_{sz}}}$$

1) An automobile leaf spring is subjected to cyclic stress such that the avg stress is 150 M.Pa, variable stress is 350 M.Pa. The material properties are ultimate strength 400 M.Pa. Yield strength 350 M.Pa. enduuance strength 270 M.Pa. estimate the FOS using good man method & soder berg method. (April 2009) (set-1 9M).

Sol:

$\sigma_m = 150$ M.Pa

$\sigma_v = 350$ M.Pa

$\sigma_u = 400$ M.Pa

$\sigma_{ey} = 350$ M.Pa.

$\sigma_e = \cancel{350}\ 270$ M.Pa

i)

$$\frac{1}{F.S} = \frac{\sigma_m}{\sigma_u} + \frac{\sigma_v}{\sigma_e}$$

$$= \frac{\overset{3}{\cancel{150}}}{\underset{8}{\cancel{400}}} + \frac{35\cancel{0}}{27\cancel{0}}$$

$$\frac{1}{F.S} = \frac{3}{8} + 1.29$$

$$\frac{1}{F.S} = 1.6$$

$$\boxed{F.S = 0.625}$$

ii)

$$\frac{1}{F.S} = \frac{\sigma_m}{\sigma_y} + \frac{\sigma_v}{\sigma_e}$$

$$= \frac{\overset{3}{\cancel{150}}}{\underset{7}{\cancel{350}}} + \frac{35\cancel{0}}{27\cancel{0}}$$

$$\frac{1}{F.S} = 0.428 + 1.29$$

$$\boxed{F.S = 0.5}$$

iii)

$$\frac{1}{(F.S)^2} = \left(\frac{\sigma_m}{\sigma_u}\right)^2 + \frac{\sigma_v}{\sigma_e}$$

$$\left(\frac{150}{400}\right)^2 + \frac{350}{270}$$

$$0.14 + 1.29$$

$$(F.S)^2 = 0.699$$

$$\boxed{F.S = 1.19}$$

2) A connecting rod in a Automobile is subjected to mean stress 150 M.Pa, variable stress 500 M.Pa, ultimate stress 630 M.Pa, yield point stress 350 M.Pa and endurance limit 150 M.Pa, estimate the FOS by using 3. Failure lines.

sol: $\sigma_m = 150$ M.Pa

$\sigma_v = 500$ M.Pa

$\sigma_u = 630$ M.Pa

$\sigma_y = 350$ M.Pa

$\sigma_e = 150$ M.Pa

i) Goodman method:

$$F.S = \frac{\sigma_u}{\sigma_m} + \frac{\sigma_e}{\sigma_x}$$

$$F.S = \frac{630}{150} + \frac{150}{500}$$

$$\boxed{FS = 4.5}$$

ii) Soderberg method:

$$\frac{1}{F.S} = \frac{\sigma_m}{\sigma_y} + \frac{\sigma_v}{\sigma_e}$$

$$\frac{1}{F.S} = \frac{150}{350} + \frac{500}{150}$$

$$\boxed{F.S = 0.26}$$

iii) Gerber method:

$$\frac{1}{F.S} = \left(\frac{\sigma_m}{\sigma_u}\right)^2 . F.S + \frac{\sigma_v}{\sigma_e}$$

$$= \left(\frac{150}{630}\right)^2 . F.S + \frac{500}{150}$$

$$= (0.05) F.S + 3.33$$

$$\frac{1}{FS^2} = 3.38$$

$$\boxed{FS = 0.54}$$

07/01/2020

3) A circular bar of 400mm length is supported at free ends it is acted upon by a central concentrated cyclic load having a minimum value of 20KN and a maximum value of 50KN. Determine the diameter of shaft taking a FOS = 1.5. size effect of 0.85 surface finish factor 0.9. The materials properties of the bar are given by ultimate tensile stress 600 M.Pa yield strength 500 M.Pa and endurance strength 300 M.Pa.

Sol. $K_{sz} = 0.85$

$K_{sur} = 0.9$

$d = ?$

$P_{min} = 20\,kN$

$P_{max} = 55\,kN$

$L = 400\,m$

$F.S = 1.5$

$\sigma_u = 600\,M.Pa$

$\sigma_y = 500\,M.Pa$

$\sigma_e = 300\,M.Pa$

$FOS = 1$

$P_m = \frac{55+20}{2} = 37.5$

$P_v = \frac{55-20}{2} = 17.5$

$M_m = \frac{\omega l}{4}$

$= \frac{37.5\times10^3 \times 400}{4}$

$= 3750000$ N-m

$M_v = \frac{17.5\times10^3 \times 400}{4}$

$= 1750000$ N-mm

$\sigma_m = \frac{M_m}{Z}$

$\sigma_m = \frac{3750000}{\frac{\pi}{32}\cdot d^3} = \frac{38.19\times10^6}{d^3}$

$\sigma_v = \frac{1750000}{\frac{\pi}{32}\cdot d^3} = \frac{17.82\times10^6}{d^3}$

Goodman:

$$\boxed{\frac{1}{FS} = \frac{\sigma_m}{\sigma_u} + \frac{\sigma_v}{\sigma_e \times K_{sz} \times K_{sur}}}$$

$$= \frac{\frac{38.19\times10^6}{d^3}}{600} + \frac{\frac{17.82\times10^6}{d^3}}{300\times0.85\times0.9}$$

$$\frac{1}{1.5} = \frac{2.29\times10^{10}}{d^3} + \frac{4.08\times10^9}{d^3}$$

$$0.6 = \frac{2.29\times10^{10} + 4.08\times10^9}{d^3}$$

$$d^3 = \frac{2.29\times10^{10} + 4.08\times10^9}{0.6}$$

$$d^3 = 2.698\times10^{10}$$

$$\boxed{d = 2.9\times10^3}$$

A/c to soderberg:

$$\boxed{\frac{1}{F.S} = \frac{\sigma_m}{\sigma_y} + \frac{\sigma_v}{\sigma_e \times K_{sz} \times K_{sur}}}$$

4. A 50mm dia shaft is made from having ultimate tensile strength of 630 M.Pa it is subjected to a torque which fluxuates b/w 2000 N-m to -800 N-m using the soderberg method calculate FOS assume suitable value for any data require.

Sol. Endurance limit in reversed bending is taken as half of the ultimate tensile strength i.e $\boxed{\sigma_e = 0.5 \times \sigma_u}$

Endurance limit in shear is taken as $\boxed{0.55 \times \sigma_e}$

The yield stress for shear is taken as 1 half of half of the yield stress in reversed bending

$$\boxed{\tau_y = 0.5 \times \sigma_y}$$

$$\boxed{\sigma_y = 510\ N/mm^2}$$

$K_{surf} = 0.87$

$K_{siz} = 0.85$

$K_f = 1$

$d = 50mm$

$T_{max} = 2000\ N\text{-}mt$

$T_{min} = -800\ N\text{-}mt$

$$T_m = \frac{2000 + (-800)}{2} = 600\ N\text{-}m$$

$$T_v = \frac{2000 - (-800)}{2} = 1400\ N\text{-}m$$

$$T_a = \frac{\pi}{16} \times d^3 \times \tau$$

$$\tau_m = \frac{T_m \times 16}{\pi \times d^3} = \frac{600 \times 10^3 \times 16}{\pi \times 50^3} = 24.4\ N/mm^2$$

$$\tau_v = \frac{T_v \times 16}{\pi \times d^3} = \frac{1400 \times 10^3 \times 16}{\pi \times 50^3} = 57.04\ N/mm^2$$

$$\tau_y = 0.5 \times \sigma_y$$
$$= 0.5 \times 510$$
$$= 255\ N/mm^2$$

$$\tau_e = 0.55 \times \sigma_e$$
$$= 0.55 \times \sigma_u$$
$$= 0.55 \times \cancel{630}\ 315 = \cancel{173.25}\ 173.25$$

$0.55 \times 315 = 173.25$

A shaf... 700 M... Torque... calcula... and ... streng...

Sol. d= ... T_m ... T ... T_{me} ... T_v ... (4)

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A shaft made of steel having ultimate tensile strength 700 M.Pa and yield point 420 M.Pa is subjected to a Torque of 2000 N-m clock wise to 600 N-m anti clock wise. calculate the diameter of the shaft If the FOS is '2' and it is based on the yield point and the endurance strength in shear. (oct 2018/NOV) (7M)

$\tau_e = 0.55 \times \sigma_e$

$\sigma_e = 0.5 \times \sigma_u$

$\tau_y = 0.5 \times \sigma_y$

$\tau_y = 0.5 \times 420$

$= 210$

Sol: $d = ?$

$T_{max} = 2000$ N-mt

$T_{min} = -600$ N-m

$\sigma_u = 700$ M.Pa

$\sigma_y = 420$ M.Pa

$F.S = 2$

$\tau_e = ?$

$$T_{mean} = \frac{T_{max} + T_{min}}{2}$$

$$= \frac{2000 + (-600)}{2}$$

$= 700$ N-m

$$T_v = \frac{T_{max} - T_{min}}{2}$$

$$= \frac{2000 - (-600)}{2}$$

$= 1300$ N-m

$$T_m = \frac{\pi}{16} \times d^3 \times \tau$$

$$\tau_m = \frac{T_m \times 16}{\pi \times d^3}$$

$$= \frac{700 \times 16 \times 10^3}{\pi \times d^3}$$

$$\tau_m = \frac{3565070.725}{d^3}$$

$$\tau_v = \frac{T_v \times 16}{\pi \times d^3}$$

$$= \frac{1300 \times 16 \times 10^3}{\pi \times d^3}$$

$$\tau_v = \frac{6620845.633}{d^3}$$

$$\boxed{\frac{1}{F.S} = \frac{\tau_m}{\tau_y} + \frac{\tau_v}{\tau_e}}$$

$\sigma_e = 0.5 \times 700$

$= 350$

$\tau_e = 0.55 \times 350$

$\boxed{\tau_e = 192.5}$

$$\frac{1}{2} = \frac{\frac{3565070.725}{d^3}}{210} + \frac{\frac{6620845.633}{d^3}}{192.5}$$

$$0.5 = \frac{7486648523 + 1274512784}{d^3}$$

$d^3 = 40463555273$

4. A thin valve cyclindrical vessel of mean diameter 60cm is subjected to a stress of vary from 0 to 40 M.Pa. Find the required thickness FOS based on yield point 400 M.Pa at a endurance limit 22 M.Pa. using soderberg Failure line theory

5, A simply supported beam as a concentrated load at the centre which fluxating from a value of P to 4P the span of the beam is 0.5m and its crossectional is circular with a diameter of 0.06m; taking for the beam of material an ultimate stress of 700 M.Pa yield stree of 500 M.Pa endurance limit of 330 M.Pa for reversed bending and FOS 1.3. calculate the maximum value of 'P' taking a size factor of 0.85 and surface finish factor 0.9

6,

Sol:

$P_{max} = 4P$

$P_{min} = P$

$M_{min} = Wl/4$

$= \frac{P \times 0.5 \times 1000}{4}$

$= 125P$

$M_{max} = Wl/4$

$= \frac{4P \times 0.5 \times 1000}{4}$

$= 500P$

$M_m = \frac{M_{max} + M_{min}}{2}$

$= \frac{500P + 125P}{2} = 312.5P$

$M_v = \frac{M_{max} - M_{in}}{2}$

$= \frac{500P - 125P}{2} = 187.5P$

$\sigma_m = \frac{M_m}{Z} = \frac{312.5P}{\frac{\pi}{32}(0.06 \times 1000)^3} = 0.014P$

$\sigma_v = \frac{187.5P}{\frac{\pi}{32}(0.06 \times 1000)^3}$ $\qquad \sigma_b = \frac{M}{Z}$

$= 8.84 \times 10^{-3} P$

$\frac{1}{F.S} = \frac{\sigma_m}{\sigma_u} + \frac{\sigma_v}{\sigma_e \times K_{sz} \times K_{sur}}$

$\frac{1}{1.3} = \frac{0.014P}{700} + \frac{8.84 \times 10^{-3}}{330 \times 0.85 \times 0.9}$

$\boxed{P = 13.8 \times 10^3 \, N \cong 13.8 \, kN}$

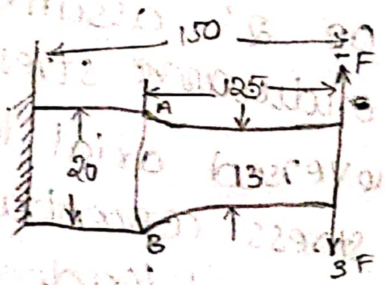
$P_{max} = 4 \times P$

$= 4 \times 13.8$

$= 55.2 \, kN$

09/01/2020

6 A candy lever beam is made of cold drawn carbon steel of circular cross ection as shown in figure. It's subjected to a load which varies from '−F to 3F'. Determine the maximum load that this member can with stand for an indefinite life using a FOS to the 1.42 and, notch from theoritical stress concentration factor is following values. ultimate sensitivity 0.9 assume the yield stress 470 M.Pa, Endurance limit stress 550 M.Pa. and surface finish factor of 275 M.Pa. size factor 0.85



Sol Given data

$P_{max} = 3F$

$P_{min} = -F$

$d = 13mm$

$\sigma_u = 550 MPa$

$\sigma_y = 470 M.Pa$

$\sigma_e = 275 M.Pa$

$K_{sz} = 0.85$

$K_{sur} = 0.89$

$q = 0.9$

$M_{max} = 3F \times 125 = 375F$

$M_{min} = -F \times 125 = -125F$

$$M_{mean} = \frac{M_{max} + M_{min}}{2}$$

$$= \frac{375F + (-125F)}{2}$$

$$= 125F$$

$$M_v = \frac{M_{max} - M_{min}}{2}$$

$$= \frac{375F - (-125F)}{2}$$

$$= 250F$$

$$\sigma = \frac{M}{Z}$$

$$\sigma_m = \frac{M_{mean}}{\frac{\pi}{32} \times d^3}$$

$$\sigma_m = \frac{125F}{\frac{\pi}{32} \times 13^3} = 0.57F$$

$$\sigma_v = \frac{M_v}{\frac{\pi}{32} \times d^3}$$

$$\sigma_v = \frac{250F}{\frac{\pi}{32} \times 13^3} = 1.15F$$

$$\boxed{q = \frac{K_f - 1}{K_t - 1}}$$

$K_f = q(K_t - 1) + 1$

$= 0.9(1.42 - 1) + 1$

$= 1.378$

Goodman:

$$\frac{1}{F.S} = \frac{\sigma_m}{\sigma_u} + \frac{\sigma_v}{\sigma_e}$$

$$\frac{1}{F.S} = \frac{\sigma_m \times k_t}{\sigma_u} + \frac{\sigma_v \times k_f}{\sigma_e \times K_{sz} \times K_{sur}}$$

$$\frac{1}{2} = \frac{0.57 \times F \times 1.42}{550} + \frac{1.15 \times F \times 1.378}{275 \times 0.85 \times 0.89}$$

$$\frac{1}{2} = F\left[\frac{0.5 \times 1.42}{550} + \frac{1.15 \times 1.378}{275 \times 0.85 \times 0.89}\right]$$

$$\boxed{F = 56.812}$$

Max Force $= 3 \times 56.12$

$= 168.36$

lone is subjected to a c