SWAMI VIVEKANANDA SCHOOL OF ENGINEERING & TECHNOLOGY

LECTURE NOTE

MACHINE DESIGN

ER. ABHIJIT CHAND

Machine Desine

The subject machine Desine is the creaction of new machinals & improving the existing one's.

Claffication of machaine Desine

Q The machine Desine may be Classified (i) AdAptive Desine.
(ii) Development Desine.
(iii) New Desine.

ADAPtive Desine

(i) ADAPtive Desine in which there is no need of special knowlge or skill.
(ii) The Desiner only makes mainer modefication in the existing in the Produce.

Development Desine

(i) Development Desine the type of Desine which need's scientific traning, Skill, & desine ability in order to modeffy the exenting with a new idea.
(ii) In this case the Desiner start from the exiting Desine but the final Produce quite different from the orginal one.

New Desing

(i) This Type's of Desine cost's or reach seren techanical ability, creatuvity of thinking. In this case the Desiner makers Complietly new Produce.

General Considension of machine Desine.

(i) Type's of load & stres's cost by the load.
(ii) motion of the Part's of kinametic machine
(iii) Selection of material's
(iv) form & size of Part's.
(v) firction resistance & lubrication.
(vi) Convenient & economical future's.
(vii) use of standed Part's.
(viii) Safety of operation.
Ix workshop fasility's.
(x) Number of machine to be manufactur.
(xi) Cost of Consetraion. assembeling

Important

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General ~~[illegible]~~ Prossigen machine Desine

In Desineing of maanine componet There is no fixed role.

(ii) The problem may be Shorty in various way's but the General Prosigen to Shortive a Desine problem is as followis.

Need / AIM

↓

Synthesis (mechanism

↓

Analysis of Force

↓

Material Selection

↓

Design of Element's

↓

modification

↓

Detailed Drawing

↓

Production

Recofication of Need

make a Compleet Statement of the Problem, indicating the need, AIm or Porpose for which the machine is to be Desine.

Synthesis (mechanism) :-

select the possiable mechanism or group of mechanism which give's the Desere motion.

Analysis of forces :-

Find the forces acting in each member in machine & the energy transmited by each member.

Material selection :-

Select the material which is best sweetable for each member of machine.

Design of element's :-

find the size of each member of the machine by Considering the force acting on the member's & the Permissible stress material used.

Modification :-

modified the size of member to agree with past expressionence & Jugment to facilitate manufactur.

(4) modification may also nessayery by consedersion of manufacturing to redase overal cost.

Detailed Drawing

Draw the Detail Drawing of each componet on the assemble machine with complete specification.

Production

The component as per the Drawing is manufacture on the work shop To make the machine.

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Enginerring material & their

The knowledge of material & their proper-ties are very important for an engineer during machine desine.

(II) Enginer boatedly classified into broks

a) Metal / Alloy's - Iron, steel, copper, broang, bragh.

Non metal's : wood, sand, plastics rabber, fiber,

Again the metal's is classified in 2 group's

(i) ferrous metal's :- (contain Iron%)
(ii) Non ferroes metals (doesn't contain Iron persent)

Ferrous metal's - cast Iron, rot Iron,

Perpoties of the materials

(i) Physical Perpoties

The physical perpoties of metal inclade colour, size, save, density melting point, frizing point, electrical thermal condovity ets.

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Mechanical Properties

Strength

It is the ability's of a material to resist externally applied force without breaking.

Stiffness :

It is the ability of a material to ~~regest~~ resist deformation

Elasticity

It is the perroties of material to regain to it's original sheape after defer mation when the external forces are remove.

Plasticity

It is the perroties of material which retain the defer-mation produce the load permandently

Dactility :

It is the property of a material enabling it to be drawn into wire with the application of a tensile force. in which we are to be drawn into were by the application fansi.

Ex: mild steel, copper, aluminium, nickel, zinc, tin & lear.

Brittleness :

It is the Property of a material opposite to ductility.

Ex - cast iron

Malleability :

It is a special case of ductility which Permit's/allows material's to be rolled or hammered into thin sheets.

Ex - soft steel, wrougth iron, copper & aluminium.

Toughness

It is the Propertiy of a material which refers to a relative case with which a material can be cut

Resilience

It is the Property of a material to absorb energy & to resist shock & impact loads.

Machineability

It is the Property of material which refers a relative case which material can be cut

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Hardness

It is the perpoties of the materl which resist to way, scrach, deformation & machineability etc.

Creep

when a part is subject to a constant stress at high temp for a long period of time. It will undergo & show slow & permanent deformation call creept.

Fatigue perpoties

When a material is subjected to rerected stress & It fail's hard stress below the eild point stress such type of feillern of a material is non as fatigue.

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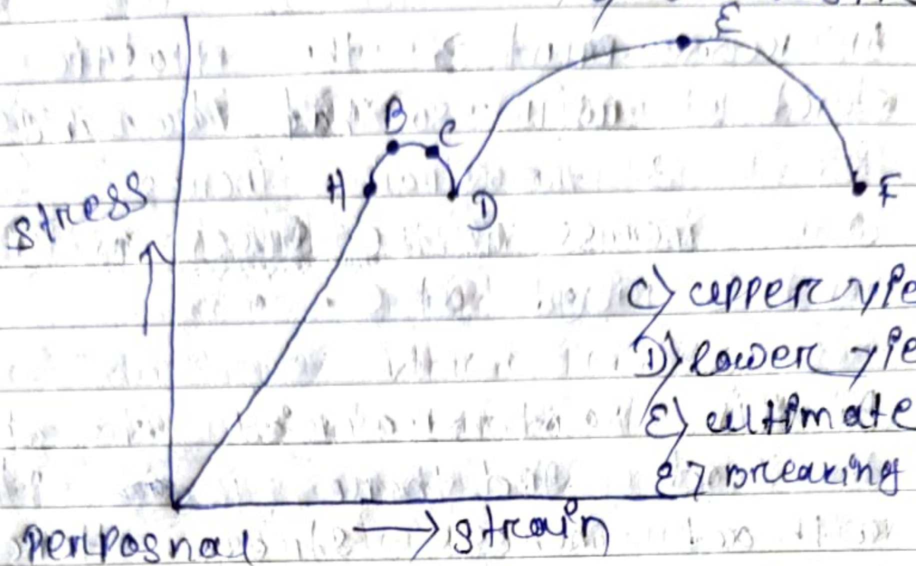
load

:- It is defined as any external force acting upon a macine part. A load may be 4 type's

(i) Dead or stady load
(ii) leave's or varyable load
(iii) sanndonely applyed or shock load.
(iv) Impact load

Stress strain daigram (mild steel)

A) Proportional limit
B) Elastic limit



C) upper yield point
D) lower yield point
E) ultimate stress
F) breaking stress.

Perposnal

(i) When a mild steel is given to tensile stress we find various point's in the strain stress curved.

(ii) The various point are perpos porpasnall limited :-
In the diagram from the point 'o' to a reach a state line which represent that the stress is perposnal to strain.

(iii) After point A the curved sidely change from the state line

Elastic limet

It may be noted that even in the load is enoress beyond point A of do point B, the material will reagain it's save & size when the load is removed.

This means the material has Elastice Properties of to Point B.

Yield Point

After the point B the plastic stage start at now so that beyound the point B the strain incress faster with incress in the stress until the point is raised at C.

At this point material its before the load And there is strain with out incress stress. Hence there are two yeild point known as upper yield point & lower yield point

Ultimate Stress

At point D the mild steel reagain some strength and Higher value of stress are required for higher strain.

The stress or load goes on incressing till the point E is raised. The gradul incress strain of the mild steel is follow with the uniform redisation of it's cross section of area. At point E the stress which Attempe value which is ultimate stress.

Breaking Stress

After the mild steel has reasted ultimate stress, a neck is from which is decress the cross sectional area of the mild steel.

There force the stress is reduse untill the mild steel break away at point f. the stress corres ponding the point f is non as breaking stress.

Working Stress

When designing machine part it is desireable to keep the stress lower than the maximum or ultimate stress at which feilure of the material take's place.

This stress is known as the working stress or design stress. It is also known as shape or allowable stress. by feil over lots not actual mater breaking of the material. Some machine part should be feil when they have plastic deformation, and they no more perform function.

Factor of Safty

It is defined as the ratio between maximum stress or working stress.

Factory of Shafty
= maximum stress / working stress

* In case of ductility material mild steel where the yeild point clearly factor of shafty is base upon the yield point stress.

F.O.S = Yield point stress / Working stress

* In case of Brittle material cast iron the yield point is not defined as for ~~ductility~~ material there fore Brittle the factore of shafty the Brittle material base of
factor of Shafty = Ultimate stress / Working stress.

Selection of factory of shafty

Stress in compositels Bar

A composite Bar may be defined as A bar made off two or more material joint together in such a manner that the system extend contrat as one unit when subjected to tension or compression.

1) The extension or contraction of a bar being equal to the strain

(iii) The Total external load on the bar is equal to the some of the load carried by different material.

formula

$$P = P_1 + P_2$$

$$= \sigma_1 A_1 + \sigma_2 A_2$$

where P_1 or P_2 = load carried by bar one or bar 2

σ_1 & σ_2 = Equal to stress Produce by bar 1 or bar 2.

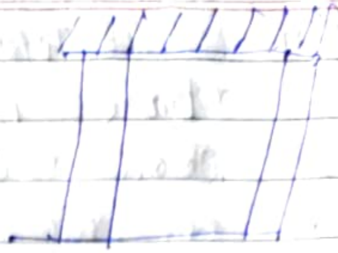
A_1 or A_2 = Cross sectional area of Bar 1 & Bar 2.

A Bar 3 m long is made of 2 bar is one of copper having $E = 105$ g N/m^2 & other steel having is equal to 210 gN/m^2 each bar 25 mm broat & 12 mm thick this compound bar is streech by a load 50 kN find the incress in length of the compound bar & the stress produce steel & copper, the length of copper as well as steel is 3 m.

Young's modulus $(E)(P) = 105$ g N/m^2

thickness = 12 mm

ω = 50 kN



$L_C = L_S = 3m = 3 \times 10^3$ mm
$E_C = 105$ GN/m^2
$E_S = 210$ GN/m^2
$b = 25$ mm
$d = 12.5$ mm
$P = 50$ kN

~~Area~~ The compound bar, cross sectional area where area of the copper ~~of~~ = ~~th~~ area of the steel.

$SE = AS \times BT$
$B = 25 \times 12.5 = 312.5$ mm^2

Load share by the copper bar

$$P_C = P \times \frac{A_C \times E_C}{A_C E_C + A_S E_S}$$

$$= \frac{P \times E_C}{E_C + E_S}$$

$$= \frac{50 \times 105}{105 + 210}$$

$$= 16.67 \text{ kN}$$

Load share by steel bar

$P_S = P - P_C = 50 - 16.67 = 33.33$

Net elongation

$$dl = \frac{P_C L_C}{A_C E_C} = \frac{P_S L_S}{A_S E_S}$$

$$= \frac{16.67 \times 3 \times 10^3}{312.5 \times 105}$$

$$= 1.52 \text{ mm}$$ (Ans)

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We know that stress produced in the steel bars $\sigma_s = \frac{E_s}{E_c} \times \sigma_c$

$= \frac{210}{105} \times \sigma_c$

$= 2\sigma_c$

The total load $P = P_s + P_c = \sigma_s \times A_s + \sigma_c \times A_c$

$\delta l_c = \delta l_s$

$\frac{P_c l_c}{A_c E_c} = \frac{P_s l_s}{A_s E_s}$

$\frac{P_c}{A_c E_c} = \frac{P_s}{A_s E_s}$

$P_c = P_s \frac{A_c E_c}{A_s E_s}$

$P = P_c + P_s$

$= \frac{P_s A_c E_c}{A_s E_s} + P_s$

$\Rightarrow P_s \left(\frac{A_c E_c}{A_s E_s} + 1 \right)$

$P_s \left(\frac{A_c E_c + A_s E_s}{A_s E_s} \right)$

$P_s = P \left(\frac{A_s E_s}{A_c E_c + A_s E_s} \right)$

Thermal stress (stress due to change in temp)

When ever there is some incress or dreoress in the temp of the body it causes the body will expand or contract a little consiederstion is so that if the Body Allow to expand & contrate freely with the rise ~~or~~ fall of the temp ~~then~~ no stress are induse in a body.

But if the Diformation of the Body it's previnted some stress induse in the Body such stress is non a thermal stress.

$$\delta L = L \alpha \gamma T$$

where δL = incress or dreeress in length.

L = Rise or fall of temp in the Body.

α = Cofficient of thermal expansion.

If the End of the Body is fixed to rigid support so that the expansion is prevented. then the compression strain in induse in the Body.

$$\epsilon c = \frac{dl}{l} = \frac{L\alpha}{T} = \alpha T$$

Thermal stress

$$\gamma = \epsilon c \times E = \alpha T e$$

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Working Stress

when desine machine part, it is deserable keep the stress lower than the maximum or ultimate stress at which failure take place the stress in known as working stress. It is also called desine stress, safe stress or Allowable stress

Factor of Shafty

In General it is define the ratio of maximum stress to working stress

Mathematical

$$F.O.S = \frac{\text{max}^n \text{ Stress}}{\text{Working / safe Stress}}$$

If the working stress of the machine is 200 KN/m² & the ultimate stress of the machine is 450 KN/m² what is the f.o.s the machine

working Stress of the machine = 200KN/m²
& the ultimate stress = 450 KN/m²

$$\text{The F.O.S} = \frac{\text{ultimate stress}}{\text{working stress}}$$

$$= \frac{450 \text{ KN/m}^2}{200 \text{ KN/m}^2}$$

$$= 2.25$$

Ch-2

Design of Fastening Element's

Joint:- Joint is the Process in which we fix to more than to similar or different material by temporary or parmanent.

Type's of Joint or Fastening

The fastaning may be classified into two group's (1) permanent fastening
(2) temporary "

Permanent Fastening The permanent are those fastening in which can't be saparated with out Damaging the connecting material or Componen't's

Ex:- soldering, Brazing, rebating, welding etc.

Temporary fastening

Temporary fastening those fastening can be saparated with out damazing the connected material or component's.

Ex- Knote & bolt, screw, key, spind's.

Welded ~~Joint~~ Process

Welding joint is a process in which we fixed to or more than two similar or dis similar material by the application of heat with or with out pressure.

Type's of welding

Welding process may be classified in to two group's

(i) Fission welding (without pressure)

(ii) Forge welding (non fission) (with pressor)

Fission welding :

In fission welding we only heat

Type's - Thermet welding

- Gas welding

- Electric arc welding etc

Forge welding :

In non-fission welding we used both heat & pressure

ex - Electric resistance welding

Type's of welding joint's

The welding joint may be 2 type's

(i) Lap joint

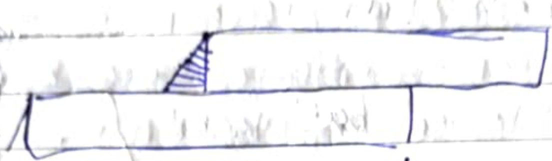
(ii) butt joint

Lap Joint

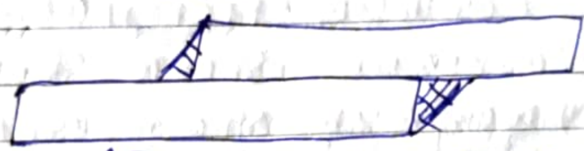
The lap joint the rivet joint is often by over lapping the plates and that welding the edges the plated

Types

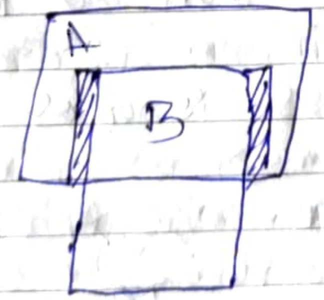
Lap joint may be single transverse's lap joint (ii) double transverse's lap joint (iii) parallel lap joint's.



(Single transverse's)



(Double transverse fillet)



(Parallel Filled)

Butt Joint's

The butt joint's is often by placing the plate's edge to edge in butt welding the plate edge's don't required bevelling if the thickness of the plate is less than 5 mm. But than other hand if the plate thickness is 5 to 12.5 mm the edge should be bevel to V or U groove in single or both side's.

Types

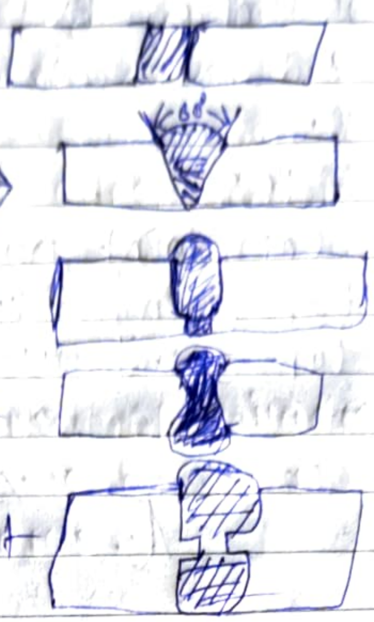
Squar batt joint →

single V batt joint →

single U batt joint

Dubble V batt joint

Dubble U batt joint



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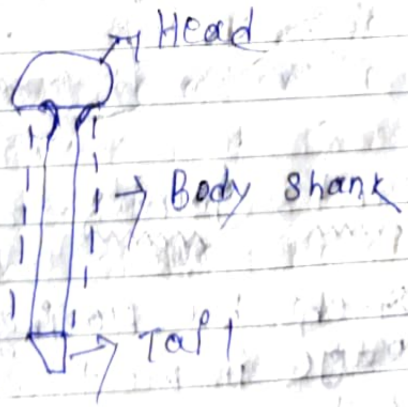
Rebert joint is the joint which is A permanent joint used to connect to or more than to material's by using bebbet.

This process is non as Rebbeting.



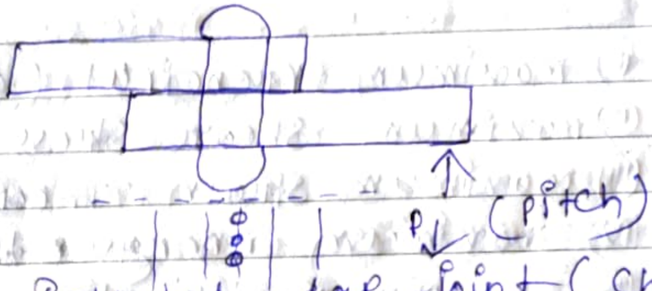
Type's of Rebbet Joint's

Basically the Rebbet Joint's devided into 2 groups → Lap Joint, Bolt Joint

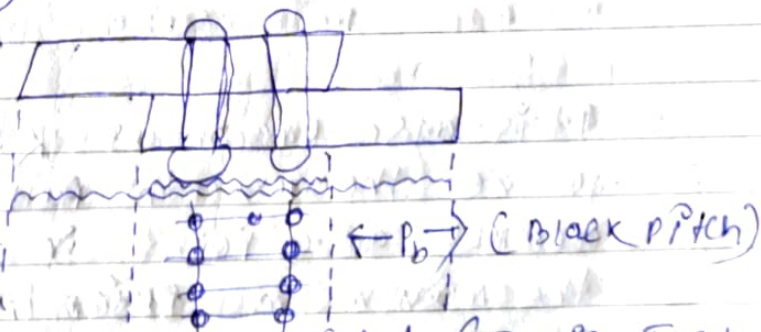
Lap Joint

A Lap Joint is that in which one plate over lap of the other & the two plate's are rebbeted together.

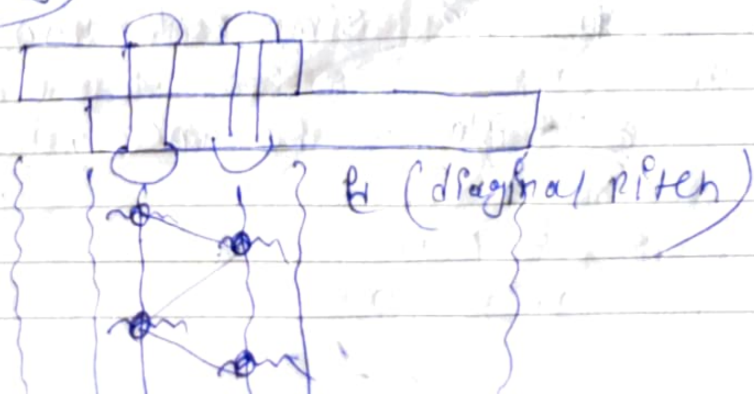
Single Rebbeted Lap Joint :-



Dubbel Rebbeted Lap Joint (Chain Rebbeting)



Dubbel Rebbeted Lap Joint (zig Jack Rebbeting)



Theory of failure

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Theory of failures of the static load the properties are ... when mild ... simple tension, compressive load ... predicting the failure of member is subjected under a stress both simple state forward ... the problem of predicting the failure stress for member subjected to ... axial or ... axial stress is much more complicated.

(iii) The principal theory of failure of a member subjected to by axial stress are edge followers.

(i) maximum principal (or normal) given theory
(ii) maximum shear stress theory.
(iii) maximum strain theory
(iv) maximum energy theory.
(v) maximum distortion ... energy theory.

It is also known as Rankine's According to the theory, the failure or yielding occurs at a point in a member when the maximum principal & normal stress of the by axial stress system limiting strength of the material in the simple tension text.

Ex - Blash furnace,

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maximum ~~principal~~

(ii) Maximum shear stress theory :

According to this theory failure or yielding occurs at a point in a member maximum shear stress in any axial stress system reaches the value equal to the shear stress at yield point in a uniaxial tension stress.

$\tau_{max} = \frac{\tau_{y}}{F.O.S}$

τ_{max} - maximum shear stress
τ_{yt} = shear yield stress
F.O.S -
This failure mostly used for design of ductile material.

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(iii)

Maximum principle strain theory :
saint

The other name ma saint venants theory
According the this theory
the failure the yielding occure at a point in a number when the maximum principle or normal strain in a By axial stress system reach est the limiting value of strain (that is strain and yield point) As determind A simple tensile stress.

(iii) The maximum tension a normal stress by a bi axial stress system.

ε_{max} = ~~the maximum strain~~

$$\frac{\sigma_{t1}}{E} - \frac{\sigma_{t2}}{m \cdot E} = \frac{\sigma_{yt}}{E \times F.O.S}$$

m = possition ratio

ε_{max} = maximum shear strain
σ_{t1} & σ_{t2} = maximum & minimum by axial stress system.

E = youngls modoulous.
F.O.S = factory of safety.

This theory is not used in general because is early given relaible in patticullare cases.

maximum strain energy theoryem:
High theoryem
Accordind this theoryem the failour or yeilding occured at a point in a member when the strain per unit volume my axial stress system reaches the strain energy. (i.e, strain energy in a yield point per unit volume as determined simple tensile stress.

(iv)
The ~~strain energy~~

maximum strain energy theorem

$$U = \frac{1}{2E}\left[(\sigma_1)^2 + (\sigma_2)^2 - 2\sigma_1 \times \sigma_2\right]$$

This theory may be ductility material.

maximum destruction energy theorem / Hencky von mises theory.

According to this theory, the failure or yield occure in a point of the member when the destruction strain energy per unit volume in a by axial stress system reaches the limiting per unit volume n determind simple tensile test.

(ii) The maximum destruction energy theorem the yiek is express

$$(\sigma_1)^2 + (\sigma_2)^2 - 2\sigma_1 \times \sigma_2 = C$$

It is applicable to ductility ma

It is shear strain theory energy em.

Resilience

(i) when a body is load with in elastic limit it changes its dimension & on the removal load it regain the original Dimension.

(ii) As long age it regain loaded it has store energy it said on the removing load the energy store is given of is the strike or spring.

(iii) This energy in observed the body when strained or elastic limited is known as strain energy.

(iv) The strain energy is always applicable for some one.

(v) Strain energy store in a body due to external body, within elastic limit is known as resilience.

(vi) The maximum energy which can be store in a Body, elastic limit is called proof resilience.

Modulus of resilance:

The proof resilience per unit volume or a material is called modulus of resilance.

mathematically $\frac{\sigma^2}{2E}$

σ - tensile / compressive stress

E - Young's modulus

Engineering

Different mechanical materials 1.10.22

Cast iron

Primary an alloys and carbon composition of cast irons and 1.7 to 5%

Cast iron are the material can't you in mass of machinery which are subject to cas.

low cost good casting High compressive strain, wire resistant & the everwear machinery

Compressive strain of cast iron is more of cast iron.

Types of Cast Iron

(1) Grey cast iron
(2) white cast iron
(3) Child cast iron
(4) mottled "
(5) malleable cast iron.

Grey cast iron - The composition grey cast iron 3 to 3.5%, silicon 1 to 2.75%, mag 0.40 to 1.0%, P 0.15 to 1%, sulphur 0.02 to 0.15% & the rest are iron.

Grey color due to carbon are present free graphite.

* This material are used low tensile stress strength on high compressive strength No ductility. due to free graphite they are use lubricant (sliding action & desive) machine tool body, Automatic cylinder block, head & Houses, fly wheel, pipes & pipe fetting

White cast iron

Composition of white cast iron carbon 1.75-2.3%, silicon 0.85 to 1.2% mg less than 0.4%, P less than 0.2% sulpher less than 0.12% & the remaining part the iron.

Have a high tensile strain & low compressive strain not use in machine with ordinary cutting tool but require grinding a shapping machine.

Chilled cast iron

After pouring white cast iron chilled Iron.
use in any face of a casting which are require have to with stand wire friction.

mottled cast iron :

Produce between grey or white cast iron, composition colour greyy pece ty.
use in casting whering surface

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malleable Cast iron :- This cast iron which solidified in the condition of graphite flees stature total carbon contand is present in it's combine from of cementite.
(ii) It is ductile it is bend without breaking of fractering of section.
(iii) tensile strain good & have excellent machining quality.
(iv) use of the steel, forcing could be expansive.
(v) use hobs of small fitting for railways rolling shock, break support's part's of agree calture carinaway, pipe feeting, Henchi Hingish, lock's

Alloy's cast iron. • 15/10/22

(i) some amount of silion, mg, P, Phalonecs
(ii) and also have nickel, crominium, coppar maybdelnum.
(iii) more strength & result in improve profit.
(iv) Increasing strength High wear resistance corrorresistance & heat resistance.

(v) used in alloy's cast iron in gear's, Automobile part like cylinder, piston's, piston ring, crank, crankshaped, wheel, pully break, break Durm, shoes & part off crushin & the griending machineing

Wrought iron

(i) Purest iron

Iron composition : iron 99.5 %
(ii) Carbon 0.2 %, silicon 0.12%, sulpher ... , phosphorous 0.02 %, slag 0.0...

(iii) Produce by oxidation by Puddling furnace

(iv) have a property, toughness, malleable
(v) not used for forging or welding
(vi) used for the ... chain, crain hook, ... , stream pipe, water.

Steel :

Steel is alloys of Iron or carbon. Carbon 1.5 %, some amount of silicon, S, P, Mn.

Type of Steel
(i) Dead mild steel of to 0.15 %
(ii) low carbon or mild steel 0.15 % to 0.45
medium carbon steel 0.45 to 0.8 % car...
High carbon steel 0.8 % 1.5 % car...

Free cutting Steel :

Free cutting steel are sulphur & phosphorous
carbon 0.1 to 0.7 % , sulpher 0.6 ...
lead 0.05 to 0.2 %

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Alloys Steel

Steel with more amount of carbon, Alloys is done for special properties increasing wear resistance, corrosion resistance & to improve to electrical & magnetive perpoties.
use in steel are nickel, crominium, cobalt, silicon, mg, tungsten

Hook's law

With in elastic limit
$\sigma \propto \varepsilon$

Mode's of failures

(i) A starting load is a force which gradually applied to a mechanical component of system which does not change with magnitude & derection with respect to time.

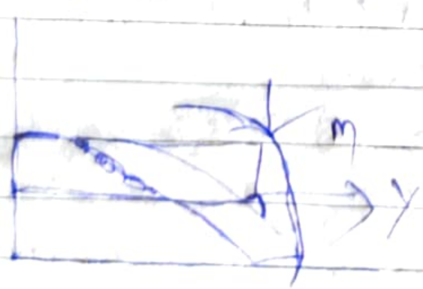
(ii) engineering materials to classified into 2 Groups - ductility, brittleness.

(iii) The ductility material that is aluminium structure steel one have a retelevel high tensile strength before fracture takes place.

(iv) other hand, A Brittle material that cast iron has a releatiable to a tensile strain before factore.

Three mode of failures
(i) ~~deflection~~ failure's by electric
(ii) defelection
(ii) failure by General yielding
(iii) failue by factorter.

failure of electric defelection



in application like tranmition shaper supporting Gear's the maximum force acting in the shaped with out effecti is performance limited by the permissible elastic deflection.

(ii) lateral or torsional rigidity is considered as the criterion of design in such cases.

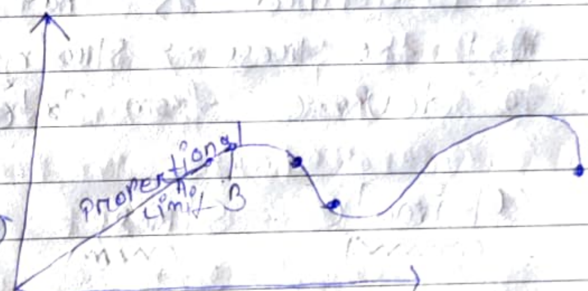
(ii) failure by General yielding

(i) for the mechanical component made off ductility material losses its engineering useful ness due to a large amount of plastic deformation after the yield point stress in reached.

(ii) considable porison of the of the component is subjected to plastic deformation to called General yielding.

B = elasticity limit

C = yield stress

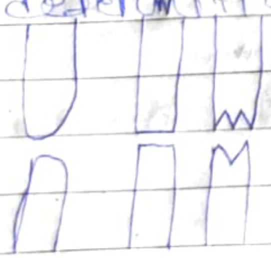


mild steel

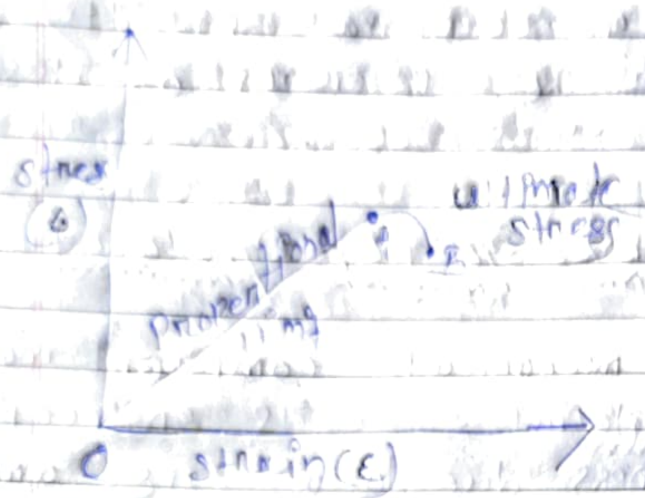
(iii) failure by fapure

component made off brittle material function santisfactory because of the sudden factor with our plastice deformition.

(i)



Stress & strain diagram of cast iron



Proportional limite

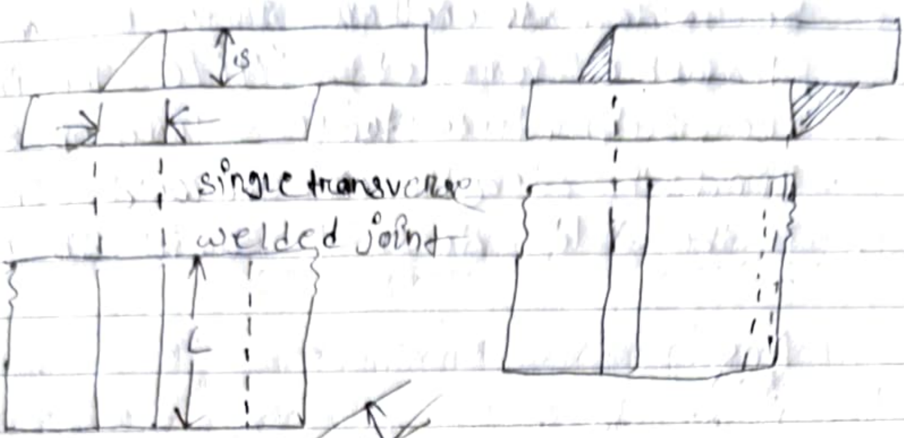
OA express hook's law it is known as perpotional limite. It is defined as that stress at which the stress & strain curved begin's to deviate from state line.

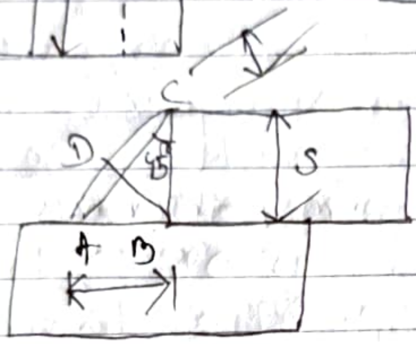
Ultimate stress

At the specimen reach some stress of higher value or stress are required for higher strain than those between A & B.

18/10/2022

Strength of Transverse fiuet / Lap Joint welding:





Let T = Throat thickness endy welding to the perpandercular length of high potamoses

~~The perp~~ high pothanous

The perpendular length of edge welding to the perpenducalan length of high potanous.

Edge size of well

The throught thickness (t) = S x sin 45°

Area of weld = L x T

= L x 0.707S

σ_t = tensile stress

External force (P)

$P = \sigma_t \times l \times 0.707 S$

for dubbile transver welding P = $2 \times \sigma_t \, l \times 0.707 S$

20, 10, 22

① A Plate 100 mm wide & 10 mm thick is to be olded to another Plate by means of double parallel fillete. The Plate are subject to static load of 80 kN load find the length of the weld. shear stress in the weld doesn't omit 55 MPA

Ans

Given
wide = 100mm, thickness

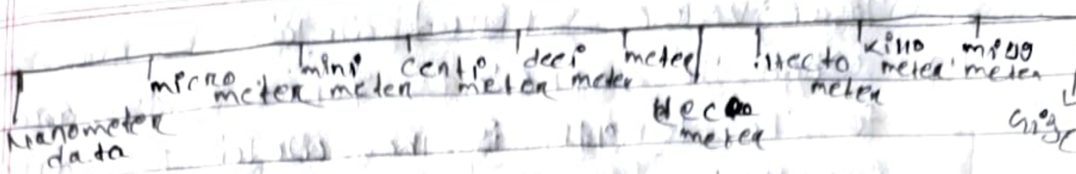
55 mpa

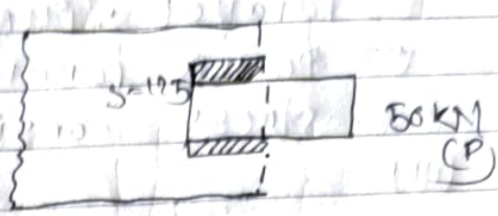
21, 10, 22

② A Plate 100 mm wide & 12 mm thich is to be olded to another plate by means of parallel 12 the plate are subject to static load of 8·50 kN load find the length of weld shear stress in the weld doesn't 50 MPA : first under static loading on ~~static~~ fatigue

Given data
width = 100mm
thick = 12·5 mm
load (P) = 50 kN = 50×10^3 N N

σ max = 56 mPa = 55 N/mm^2





$P = 6max \times 2 \times 0.707 \times S \times L$

$50\times10^3 = 55\times 2\times 0.707 \times 12.5 \times L$

$\Rightarrow L = \dfrac{50\times10^3}{55\times 2\times 0.707 \times 12.5}$

effective $= 51$ mm

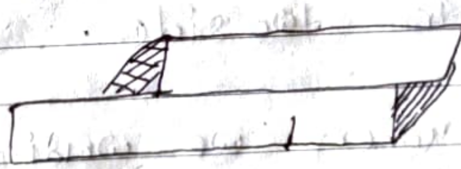
length $= 51 + 12.5 = 63.5$

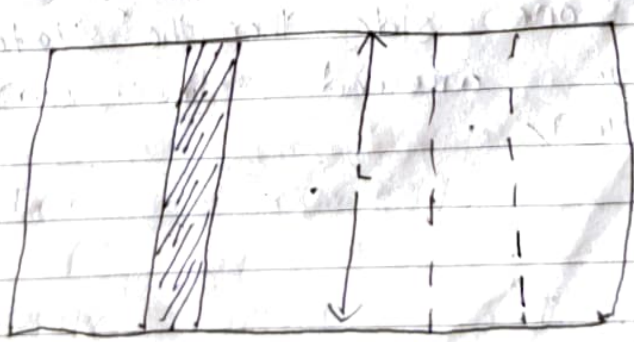
Transverse fillet weld

1) when the applied force is perpendicular to the length of the weld is called Transverse fillet weld.

(ii) In this fillet weld consider the simple stress

(iii)





Parallel
~~Transverse~~ fillet weld

(i) When the applied force is parallel to the length is the weld is called parallel fillet weld

(ii) In this parallel fillet joint shear stress consider.

(iii)

In the static load stress ~~consede~~ concentration factor is one that means ~~stress~~

$$\text{effective stress} = \frac{\text{stress}}{\text{concentration factor}}$$

fatigue load stress ~~consedering~~ concentration factor is 2.7 that means effective stress = $\frac{\text{stress}}{\text{concentration factor}}$

Combination of single transvers and parrale welding

Why parrale filler welding are ~~occure~~ cause in two side.

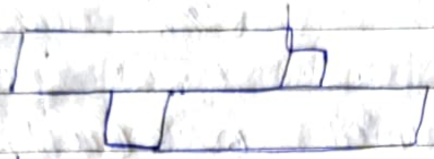
because when we welding in 1 side the center of gravity is change in the one side then the plate are remove around the canter of gravity.

Bult welding 28,10,22

Lap joint

(i) In the Lap joint the plane of the welding of the two plate ~~90~~ is called angle is 90° is called Lap joint.

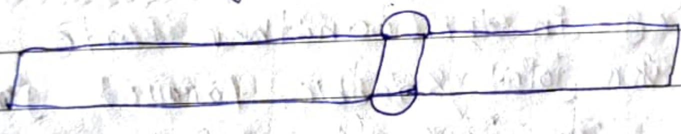
(ii) 1 plate is over lapping the other plate.

(iii) 

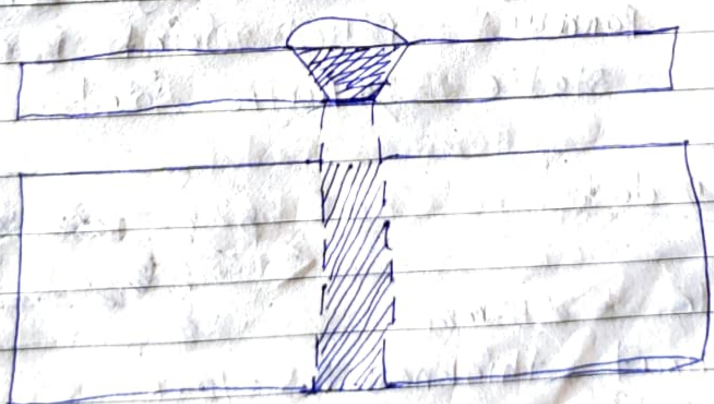
Bult joint

(i) The plane of plate's ~~is~~ of Bult joint is same.

(ii) In Bult joint two side of the plate are welding.

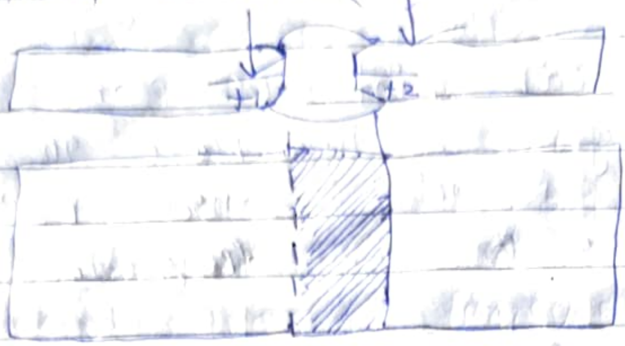
(iii) 

Strength of the Bult joint



Single V. Bult joint

(1) In Butt joint the size of weld (s) = throat or thickness (t)



Load carried by butt joint

$P = \text{Area} \times \text{stress}$

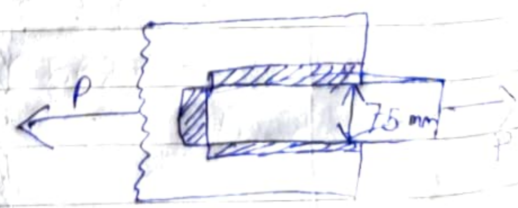
$= t \times L \times \sigma_t / 2$

$P = \text{Area} \times \text{stress}$

$= (t_1 + t_2) \times L \times \sigma_t / 2$

A plate 75 mm wide & 12.6mm thick is joining in the another plate single transverse joint & double parallel joint as soon in figure the maximum tensile & shear stress 70 MP & 56 MP respectable. Find the length of the each parallel fillet joint is subject both static & fatic joint

Given data



wide = 75 mm

throut thickness = S = 12.5

$\sigma_t = 70 \text{ MPa} = 70 \text{ N/mm}^2$

$Z = 56 \text{ MPa} = 56 \text{ N/mm}^2$

effective length for transverse weld
75 mm - 12.5 m
= 62.5 mm

Let
l_1 = length of the Transverse weld
l_2 = length of the parrallel fillet weld

Length of the each parrallel stating load
Now total load appleied the plate
P = Area × Stress
= 75 × 12.5 × 70
= 65625 N

load of transverse used
P_1 = Area × Stress
= l_1 × t_1 × 70
= 62.5 × 12.5 × 70
54687.5 N
load of Parallel filled weld
P_2 = Area × stress
= 2 × l_2 × t × 56
= 2 × l_2 × 12.5 × 56
= 1400 l_2

P = P_1 + P_2
65625 N = 54658 + 1400 l_2

P_1 = load applied to the transver use
stress × Area of weld
= 56 × l_1 × 0.707 S
= 70 × 62.5 × 0.707 × 12.5
= 38664.06 ≅ 38664 N

P_2 = load applied to the parallel fillet weld.

Total load (P) $P = P_1 + P_2$

$= \frac{65625 - 38665}{990}$

$= 27.23$ fatigue

length of weld for ~~static~~ load

Effective stress of transverse weld

$= \frac{6t}{1.5} = \frac{70}{1.5} = 46.66 \simeq 47\ N/mm^2$

Effective stress on parallel weld

$= \frac{Z}{2.7} = \frac{56}{2.7} = 20.74 \simeq 21\ N/mm^2$

P_1 = load applied to transverse

= stress × Area

$= 47 \times 62.5 \times 0.707 \times 12.5$

$= 25960 \simeq 25960$

P_2 = load applied to parallel weld

= stress × Area

$= 21 \times 2 \times 0.707\ S \times L_2$

$= 21 \times 2 \times 0.707 \times 12.5 \times L_2$

$= 371.175\ L_2$

Total load $P = P_1 + P_2$

$L_2 = \frac{65625 - 25960}{371}$

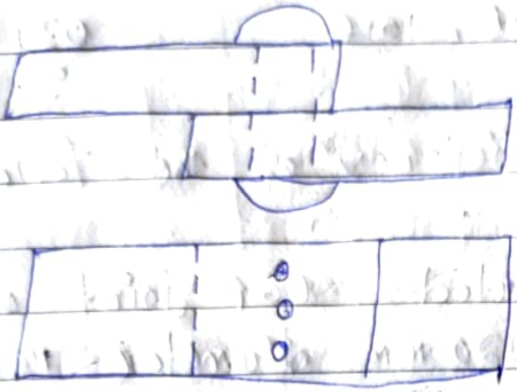
$L_2 = 160.97 \simeq 167$ mm

effective length parallel weld

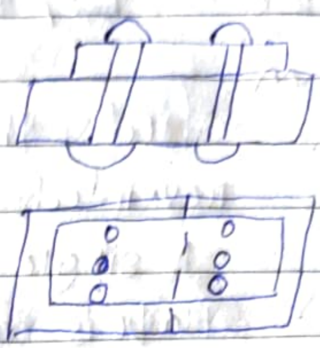
$= 107 + 12.5 = 119.5$ mm

$\simeq 120$ mm

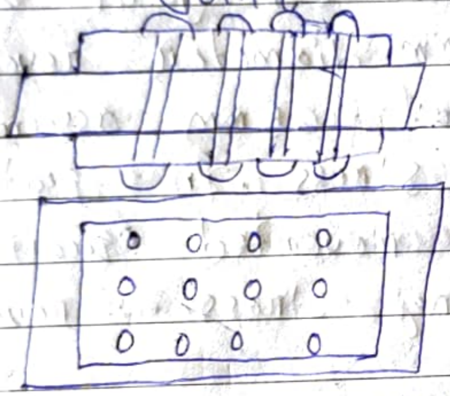
Based on no. of rivet on plate rivet:



single lap Riveted joint



single butt Riveted joint



Strap Butt Double Riveted joint.

Terminology

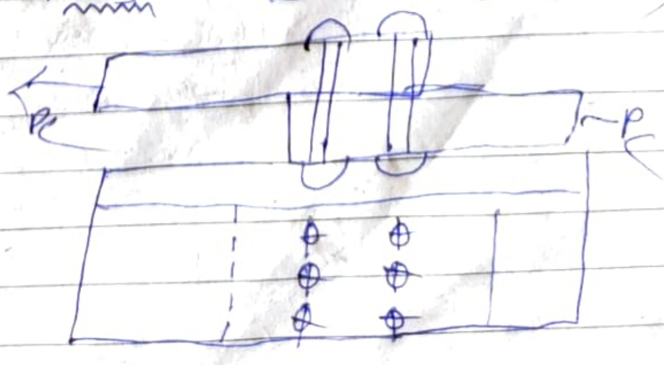
w = width or plate

p =

d = diameter of rivet

$d = 6\sqrt{t}$

Compressive stress or (Crushing stress)



P_c = Stress × Area
= σ_c × n × d × t
= σ_c × n × d × t

9.1, 9.2, 9.3, 10.1, 10.4, 10.5, 10.6 — 03/11/2021

Q —

Find the efficiency of the following reverted joint.
i) A single reverted lap joint of 6mm plate's with 20 mm diameter reverted having a pitch of 50 mm.
ii) Double reverted lap joint of 6 mm plate's with 20mm diameter revent's having a pitch of 65 mm assume permissiable tensile stress in plate 120 mpa permissiable in reverted equal to 90 mpa permissiable crossing stress in reverted 180 mpa.

Given data

Single riverted lap joint

$t = 6mm$

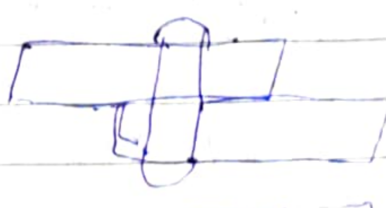
$d = 20mm$

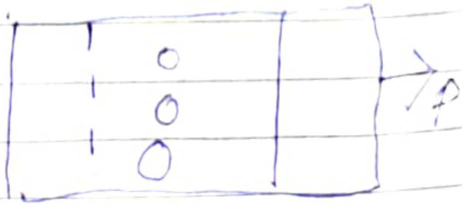
$p = 50mm$

σ_t = 120 mpa = 120 N/m2

τ = 90 mpa = 90 N/m2

σ_c = 180 mpa = 180 N/m2





In case of tensile load

$= \text{Stress} \times \text{Area}$

$= 120 \times (P - d) \times t$

$= 120 \times (50 - 20) \times 6$

$= 21600\ N$

In case of shear stress

$P_s = 2 \times n \times \frac{\pi}{4} d^2$

$= 90 \times n \times \frac{\pi}{4} \times (20)^2$

$= 28274\ N$

In case of compressive stress

$P_c = \sigma_c \times n \times d \times t$

$= 180 \times 1 \times 20 \times 6$

$= 21600\ N$

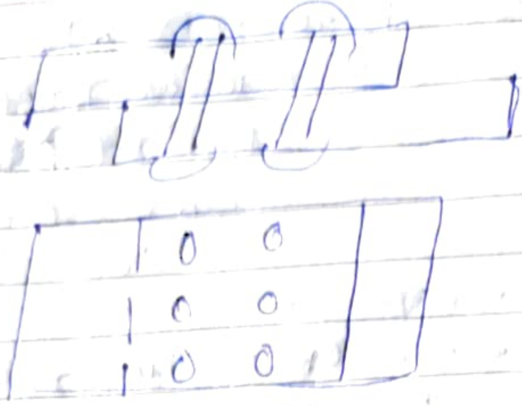
$\eta = \dfrac{\text{strength of riverted joint of plate}}{\text{strength of un riverted joint of plate joint}}$

$= \dfrac{21600}{120 \times 50 \times 6}$

$= 0.6$

Efficiency $= 0.6 \times 100$

$= 60\ \%$ (Ans)



Given data

$p = 65$ mm
$d = 20$ mm
$t = 6$ mm
$\sigma_t = 120$ mpa $= 120$ N/m2
$\tau = 90$ mpa $= 90$ N/m2
$\sigma_c = 180$ mpa $= 180$ N/m2

in case on tensile load

$P_t = \sigma_t \times (p - d)\, t$
$= 120 \times (65 - 20) \times 6$
$= 32400$ N

in case of Shear load

P

Strain of ~~the~~ an riveted joint

$P = P \times d \times \cancel{\sigma}t$

$= 65 \times \cancel{20} \times 120$

$= 46800$ N

Efficiency = $\dfrac{\text{strength of Riveted of plate joint}}{\text{strength of un-Riveted of plate joint}}$

$= \dfrac{32400}{4680} = 69$

$\Rightarrow 69 \times 100 = 69\%$ An

A double Riveted double cover bot joint in plate 20mm thick is made with 25mm diameter riveted 100 mm (P) the permisanable stren are : tensile = 120 mpa, 100 mpa 150 mpa find the efficiency of joint taking taking the strengt of the riverted in dobble age twise then the single shear shear.

Given Data

$t = 20$ mm , $P = 100$

$d = 25$ mm

$\sigma_t = 120$ mpa $= 120$ N/m^2

$\tau = 100$ mpa $= 100$ N/m^2

$\sigma_c = 150$ mpa $= 150$ N/m^2

tensile load

$P_t = \sigma_t \times (P-d) \times t$

$= 120 \times (100 - 25) \times 20$

$= 180000$ N

Shear stress =

$P_s = \tau \times 2 \times n \times \frac{\pi}{4} d^2$

$= 100 \times 2 \times 2 \times \frac{\pi}{4} \times 25^2$

$= 196349$ N

Compressive stress

$\sigma_c \times n \times d \times t$

$= 1500 \times 2 \times 5 \times 20$

$= 150000$

Efficiency $= \dfrac{\text{strength of riveted joint}}{\text{strength of un riveted joint}}$

$= \dfrac{150000}{120 \times 100 \times t}$

$\eta = 0.625 \times 100$

$= 62.5\ \%$ (Ans)

04, 11, 2022

Design of Boiler joint.

A Boiler has a longitudinal joint as well as circumference joint

The longitudinal joint is used to joint is to join the end of the plate to get the required diameter of the boiler.

ii) The circumference joint is used to get required the length boiler.

Longitudinal Bat joint of a Boiler.

$$t = \frac{PD}{2\sigma_t \eta_l} + 1 \text{ (Corrosion allowance)}$$

Soumya

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P = steam pressure / gauge pressure in Boiler

D = Internal Diameter on Boiler sell.

δ_t = ~~Permiss~~ mmissable

η_c = ~~[illegible]~~ efficiency of longitudinal

Note

The thickness of the boiler sell should not be less than 7 mm

If the thickness of the boiler sell is less than 7

2) Diameter of ~~Rivet~~ Boiler.

If $t \geq 8mm$
$d = 6\sqrt{t}$

If, $t < 8$
$Pt = Pc$

Margin - 1.5d

3) Pitch of the rivert

$P = Ct\,t + 41$

Distance between

$P_b = 0.33P + 0.67d$
(zigzig)

$P_b = 2d \rightarrow$ Chain

Thickness of the Bolt Joint

$t_1 = 1.125\,t$ (single cover)

$t_1 = 0.625\,t$

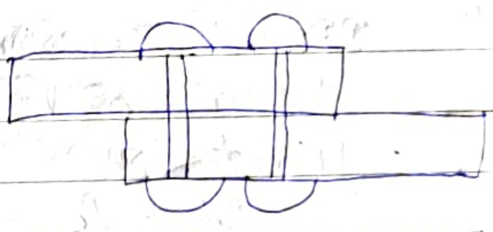
$t_1 = 1.125\,t\ \left(\frac{p \cdot d}{p - 2d}\right)$ (single cover alternating rivet)

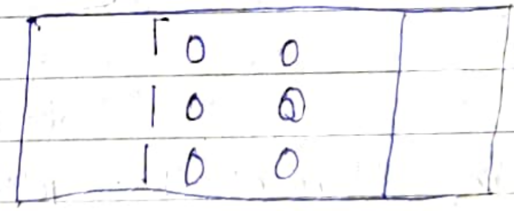
$t_1 = 0.625\,t\ \frac{p \cdot d}{p - 2d}$

$t_1 = 0.75\,t$ (inside butt...)

05/11/22

Ex - A Double riveted lap joint with zig zag riveted design for is to be design for 13 mm thick plate. Assume $\sigma_t = 80$ mPa $\tau_s = 60$ mPa $\sigma_c = 120$ mPa. State how the joint will fail & find the efficiency of joint.





$t = 13$ mm

$\sigma_t = 80$ mPa $= 80$ N/mm2

$\tau = 60$ mPa $= 60$ N/mm2

$\sigma_c = 120$ mPa $= 120$ N/mm2

(1) thickness of Bolt

$t =$

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Diameter of rivet
$d_1 = 22$ mm

3) Pitch of the rivet's
$P_{max} = Ct + 41$
$= 2.62 \times 13 + 41$
$= 75.06$ mm

$P_t = (P - d) \times t \times \sigma_t$
$= (P - 23) \times 13 \times 80$

$P_s = (n \times 2) \times \frac{\pi}{4} \times d^2 \times \tau$

$= (n \times 2) \times \frac{\pi}{4} \times (23)^2 \times 6$
$= (n \times 2) \times 2492$
$= 49857$ N

$P_t = P_s$
$\Rightarrow (P - 23) \times 13 \times 80 = 49857$
$\Rightarrow (P - 23) = \frac{49857}{13 \times 80}$

$P = 47.88 + 23 = 71$
Pitch of rivet $= 71$ mm

4) Distance b/w rows of rivet
P_b
$= 0.33P + 0.67d$
$= 0.33 \times 71 + 0.67 \times 23$
$= 38.84$
≈ 39 mm

5 margine

$m = 1.5d$

$= 1.5 \times 23$

$= 34.5$ mm

$P_t = (p-d) \times t \times \sigma_t$

$= (71-23) \times 13 \times 80$

$= 49920$ N

$P_s = (n \cdot n) \times \frac{\pi}{4} \times d^2 \times \tau$

$= 2 \times \frac{\pi}{4} \times 23^2 \times 60$

$= 49857$ N

$P_c = (n \cdot n) \times (d \times t)\,\sigma_c$

$= 2 \times 23 \times 13 \times 120$

$= 71760$

Q) Efficiency of riveted joint

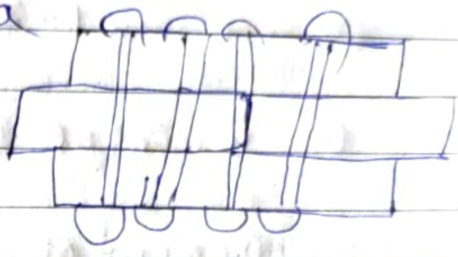
$\eta = \dfrac{\text{least of } P_t / P_s / P_c}{p \times t \times \sigma_t}$

$= \dfrac{49857}{71 \times 13 \times 80}$

$=$

9.4, 9.5, 9.6, 9.7, 9.8, 9.9

Q. 7 Designe a Dabble riveted but joint with 2 covered plate for a longitudynal seam of a boiler shell 1.5 m diameter subjected to a steam pressure 0.95 N/mm2 Assume joint efficiency η 75% allowable tensile stress in the plate 90 megapascal compressive stress 140 mPa & shear stress in the riveted 56 mPa



Given data :

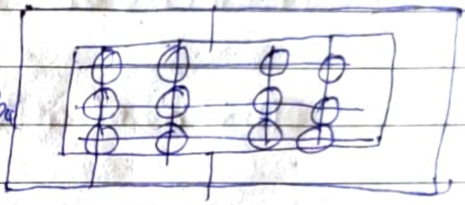
$D = 1.5 = 1500\,mm$

$P = 0.95\,N/mm^2$

$\eta = 75\% = 0.75$

$\sigma_t = 90\,mPa = 90\,N/mm^2$ / $\sigma_c = 140\,mPa$

$140\,N/mm^2$ / $\tau = 56\,N/m^2$



Given data

thickness of plate :

$$t = \frac{PD}{2 \times \sigma_t \times \eta} + 1$$

$$= \frac{0.95 \times 1500}{2 \times 90 \times 0.75} + 1$$

$$= 11.5 / 12\,mm$$

Diameter of the riveted

$= 6.05\sqrt{t}$

$= 6.05\sqrt{12} = 20.98 / 21\,mm$

pitch $= (P-d)\,t \times \sigma_t$

$= (P-21) \times 12 \times 90$

$= (P-21) \times 1080\,N$

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Shearing strength of riveted
$= P_n = (n \times R) \times \frac{\pi}{4} d^2 \times Z$
$= (n \times 2 \times \frac{\pi}{4} \times (21)^2 \times 56$

$P = 38792$ ⟵ (2)

Eq(1) or (2) Put

$p - 21 = \frac{38792}{1080}$

$p = \frac{38792}{1080} + 21$

$= 56.91$ mm
$= 57$ mm

Pitch of riveted 57 mm (Ans)

Distance between rows of rivet (P_b)
$= 0.33p + 0.67d$
$= 0.33 \times 57 + 0.67 \times 21$
$= 32.88 = 33$ mm (Ans)

Assume Chain drive
$P_b = 2d$
$= 2 \times 21$
$= 42$ mm (Ans)

5) thickness of Strap
$t_1 = 0.625t$
$= 0.625 \times 12$
$= 7.5$ mm (Ans)

margin $= 1.5 \times d$
$= 1.5 \times 21$
$= 31.5$ (Ans)

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The load of the point

2nd CHAPTER

Shaft's and key's 11/01/2021

m moment of shaped (force x Perpendicular distance (N/mm)

Moment of Inertia =

σ_b - Bending Stress (N/mm^2)

12/01/22

Shaft is a rotational machine element which is used to transmite power one place to another.

Function of shaft

(i) The power is deliver to the shaped by some trangentiction & resultand force. Forque (Twisting) moment set of with in the shaped transmite the Power to the transfer to various machine link of shaft.

(ii) In order to transfer the power 1 shaft to another the various member such as a Pully gear etc are mounted on it.

(iii) These members anole with the forces encarted upon them of cause the shaft to bending.

(iv) In other word, we may say that A shafted is used to for the transmission torque or bending moment.

(v) The various member's are mounted on the shafted by means the key & splines

material used for the shafted

(i) It should be high strain.
(ii) It should good machine ability.
(iii) It should have low notch sensitivity nature.
(iv) It should be good heat treatment property.
(v) It should be high wear resistance property.
(vi) The material use for the shaft have in this property is necessary.

Type's of shaft

They are 2 type of shaft used in design
(i) Transmitation.
(ii) machin shaft & rigid shaft

Transmination shaft

These shaft transmite power between the source & the machine's absourcing power

The counter shaft, line shaft or over head shaft & old factor shaft are transmination shaft. Sence these shaft carry machine part such as pulley gear etc. there fore they are subjected to

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bending in addition to twisting.

(iv) These shaft from internal part of the machine part the crank shaft on cam shaft & the ex of the machine shaft.

Design of Shaft :-

① Consider twisting moment / Torque -

$$\frac{T}{J} = \frac{\tau}{R} = \frac{C\cdot\theta}{l}$$

$$= \frac{T}{J} = \frac{\tau}{R}$$

$$= \frac{T \times R}{J}$$

$$= \frac{T \times \frac{d}{2}}{\frac{\pi}{32} \times d^3}$$

$$\frac{T}{J} = \frac{\tau}{R}$$

$$= R = \frac{\tau \times J}{T}$$

$$\Rightarrow \frac{d}{2} = \frac{\tau \times \frac{\pi}{32} \times d^4}{T}$$

$$d = 2 \times \tau \times \frac{\pi}{\cancel{32}\,16} \times d^4$$

$$d = \frac{\tau \times \frac{\pi}{16} \times d^4}{T} \qquad d = \frac{\tau \times \pi \times d^4}{16 \times T}$$

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(1) Consider the torsion
(2) " " the bending stress
(3) Combination of torsion and bending

Hollow

$T = \frac{J \times \tau}{r}$

$\frac{d_o}{2} = \frac{\pi}{32} \times (d_o - d_1)^4 \times 2 / T$

$d_o = \frac{\pi \times (d_o - d_1) \times \tau \times 2}{32 \times T}$

$d_o \Rightarrow \frac{\pi \times (d_o - d_1)^4 \times 2}{16 \times T}$

$J = \frac{\pi}{32} \times d_o^4 - d_1^4$

$P = \frac{2\pi \times N \times T}{60}$

A line shape rotating on 100 RPM is to transmite 20 kW the shaped may be assume to be made mild steel Allowle shear stress 42 MP determine the shape. Negliting the bending moment on the shape.

Given data

$N = 100$ RPM

$P = 20$ kW $= 20 \times 10^3$

$T = \frac{20 \times 10^3 \times 60}{2 \times \pi \times 100}$

$= 1909.85$

$= 1910$ N-mm

$d = \sqrt[3]{\frac{16T}{\pi \times 2}} = \sqrt[3]{\frac{16 \times 1910}{\pi \times 42}} = 6.14$

$= 6$ mm

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Find the diameter of solid shaft to transmit 20kW at 200 rpm. The ultimate shear stress of the steel may be taken 360 mPa and the factor of safety is 8. If hollow shaft is to be used in place of the solid shaft find the of the diameter when the ratio on inside on out side diameter 0.5

Given data:

$P = 20kW = 20 \times 10^3 W$

$N = 200 rpm$

ultimate shear stress $= 360 mPa$

$= 360 N/mm^2$

Solution

allowable shear stress

$$Z = \frac{\text{ultimate stress}}{F.O.S}$$

$$= Z = \frac{360}{8} = 45 N/mm^2$$

$= 45$

$$\text{Power } (P) = \frac{2\pi N \times T}{60}$$

$$20 \times 10^3 = \frac{2 \times \pi \times 200 \times T}{60}$$

$$T = \frac{20 \times 10^3 \times 60}{2 \times \pi \times 200}$$

$= 954.92$ say 955 N-mm

Solid shape

Diameter of shaft

$$= d = \sqrt[3]{\frac{16 \times T}{\pi \times 45}} = 4.76 mm$$

$= 5$ mm

For hollow cylinder shaft

$$d_o = \sqrt[3]{\frac{16 \times 1983}{\pi \times 45 \times \{(1-(0.5)^4\}}}$$

$= 4.86 \simeq 5\,mm$

$d_i = k \times d_o$

$= 0.5 \times 5$

$= 2.5\,mm$

2)

Shaft subjected to bending

$$\Rightarrow \frac{M}{I} = \frac{\sigma_b}{y} = \frac{E}{R}$$

$$\Rightarrow \frac{M}{I} = \frac{\sigma_b}{y}$$

$$\Rightarrow \frac{I}{M} = \frac{y}{\sigma_b}$$

$$\Rightarrow \frac{\frac{\pi}{64} \times d^4}{M} = \frac{d}{2 \times \sigma_b} \Rightarrow \frac{\pi \times d^4}{64 \times M} = \frac{d}{2 \times \sigma_b} \Rightarrow \frac{\pi \times d^3}{32 \times M} = \frac{1}{\sigma_b}$$

$$\Rightarrow d = \sqrt[3]{\frac{32 \times M}{\pi \times \sigma_b}} = \left(\frac{32 \times M}{\pi \times \sigma_b}\right)^{1/3}$$

For hollow shaft

$$\frac{M}{\frac{\pi}{64} \times (d_o^4 - d_i^4)} = \frac{\sigma_b}{\frac{d_o}{2}}$$

$$M = \frac{\sigma_b \times 2}{d_o} \times \frac{\pi}{64} \times (d_o^4 - d_i^4)$$

$$= \frac{\sigma_b \times \pi}{32} \times \left(\frac{d_o^4 - d_i^4}{d_o}\right)$$

$$M = \frac{\pi \times \sigma_b}{32} \times \frac{d_o^4}{d_o} \left\{1 - \left(\frac{d_i}{d_o}\right)^4\right\}$$

$$M = \frac{\pi \times \sigma_b}{32} \times d_o^3 \times (1 - k^4)$$

$d_o = \sqrt[3]{\frac{32 \times M}{\pi \times \sigma_b \times (1-k)^4}}$

14.4 A pair of wheel of a railway wagon carries a load's of 50 kN on each axle box. Acting at a distance 100 mm outside the wheel base. The gauge of the rail 1.5 mm. Find the dia of axle between the wheel if the stress is not to axis 100 MPa

Given data

$F = 50 kN = 50 \times 10^3 N$

$L = 1.4 m = 1.4 \times 10^3 mm$

$\sigma_b = 100 MPa = 100 N/mm^2$

m = Force × ⊥ distance

$= 50 \times 10^3 \times 100$

$= 5 \times 10^6 Nmm$

$d = \sqrt[3]{\frac{32 \times 5 \times 10^6}{\pi \times 100}}$

$= 79.85$ say 80 (Ans)

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Shaft subjected both torsion & Bending

maximum shear stress

$$\boxed{\tau_{max} = \frac{1}{2}\sqrt{(\sigma_b)^2 + (4\tau)^2}}$$

due to torsion

maximum normal stress

$$\boxed{\sigma_{b_{max}} = \frac{1}{2}\sigma_b + \frac{1}{2}\sqrt{(\sigma_b)^2 + 4\tau^2}}$$

Bending moment

$$\frac{M}{I} = \frac{\sigma_b}{y}$$

$$\Rightarrow \sigma_b = \frac{M \times y}{I}$$

$$\Rightarrow \sigma_b = \frac{M \times \frac{d}{2}}{\frac{\pi}{64} \times d^4}$$

$$\Rightarrow \sigma_b = \frac{M \times \cancel{d} \times \cancel{64}\,32}{\pi \times \cancel{d^4}^{3} \times 2} \Rightarrow \boxed{\sigma_b = \frac{M \times 32}{\pi \times d^3}}$$

ME

Torsion eqution
Torsion eqution

$$\frac{T}{J} = \frac{\tau}{R}$$

$$= \tau = \frac{T \times R}{J}$$

$$= \tau = \frac{T \times \frac{d}{2}}{\frac{\pi}{32} \times d^4}$$

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

TE

$$\tau_{max} = \frac{1}{2}\sqrt{(\sigma b)^2 + 4\tau^2}$$

$$= \frac{1}{2} \times \sqrt{\left(\frac{32m}{\pi d^3}\right)^2 + \left(4 \times \frac{16T}{\pi d^3}\right)}$$

$\tau_{max} \Rightarrow$

$$\sigma b_{max} = \frac{1}{2}\sigma b + \sqrt{\frac{1}{2}(\sigma b)^2 + 4\tau^2}$$

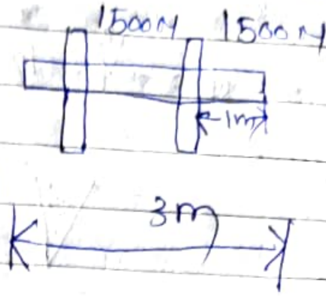
$$= \frac{1}{2} \times \frac{32}{\pi d^3} + \sqrt{\frac{1}{2}\left(\frac{32m}{\pi d^3}\right) + 4\left(\frac{16T}{\pi d^3}\right)}$$

$$= \frac{16m}{\pi d^3} + \frac{16}{\pi d^3}\sqrt{m^2 + T^2}$$

$$(\sigma b)_{max} = \frac{16}{\pi d^3}\left[m + \sqrt{m^2 + T^2}\right]$$

A shaft made of mild steel is required to transmit 100 kW at 300 rpm. The supported length of the shaft is 3m, It carry to pully each weighting 1500 N. supported at a distance of 1m from the end respectable. Assumeing the safe value of stress.

Given data



$N = 300$ rpm

$P = 100$ kW $= 100 \times 10^3$ W

$W = 1500$ N

$L = 3$ m $= 3 \times 10^3$ mm

We know that

$$P = \frac{2\pi NT}{60}$$

$$\Rightarrow 100 \times 10^3 = \frac{2\pi \times 300 \times T}{60}$$

$$= \frac{100 \times 10^3 \times 60}{2\pi \times 300}$$

$$= 3183.09 \text{ N-mm}$$

maximum Bending moment at C, D

$m = 1500 \times 100$

$= 15 \times 10^5$ Nm

Equivalent Torque

$$\boxed{\frac{\pi}{16} \times d^3 \times Z = \sqrt{m^2 + T^2}}$$ — formula

Assume, $Z = 60$ N/mm²

$$\frac{\pi}{16} \times d^3 \times 60 = \sqrt{m^2 + T^2}$$

$$= \frac{\pi}{16} \times d^3 \times 60 = \sqrt{(15 \times 10^5)^2 + (3183)^2}$$

$$= (15 \times 10^5 \text{ mm}) + (3183 \times 10^3$$

$$\sim 3518.7 \times 10^3 \text{ N-mm}$$

$$\sim 3519 \times 10^3 \text{ N/mm}$$

$$d = \sqrt[3]{\frac{15\times10^5\times10}{\pi\times60}}$$

$= 66.87$ say 67 (Ans)

19)

240 RPM. determind the diameter of the shaft If the maximum torque transmited exceed a mean torque by 20 %. Take the maximum allable shear stress edge 60 mpa.

Given data

$P = 1mw = 1\times10^6 w$

$N = 240$ R.P.M

$T_{max} = 20\%\ T_{mean}$

$= \frac{20}{100}\times T_{mean}$

$= 0.2\times T_{mean}$

$\tau = 60$ mpa $= 60$ N/mm²

we known that

$P = \frac{2\pi N\times T}{60} \Rightarrow P_{mean} = \frac{P\times60}{2\pi N}$

$\Rightarrow \frac{1\times10^6\times60}{2\pi\times240} \Rightarrow 39788.73$ N.m

$\Rightarrow 39788.73\times10^3$ mm²

T_{max}

$= 0.2\times39788872\times10^3$

$= 7957746$

$$d = \sqrt[3]{\frac{16T}{\pi\tau}}$$

$$= \sqrt[3]{\frac{16\times7957746}{\pi\times60}}$$

$= 87.74$ mm (Ans)

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Key's

A key is a piece of mild steel inserted between the shaft & hub on boss of a pully to connected these together in order to Prevent relative motion between them.

It is always inserted Parallel to the axis to the shaft.

Function of key

Key's are used to temperory fastering & subjected to considerable crossing & shearing stress.

The key way is a slote or recess in a shaft & hub of the pully to accomodate a key

Types of key

The following types of key Important

(1) Sunk key (5) Round key
(2) Saddle key (6) Splines
(3) Taper key
(4) Tangent key

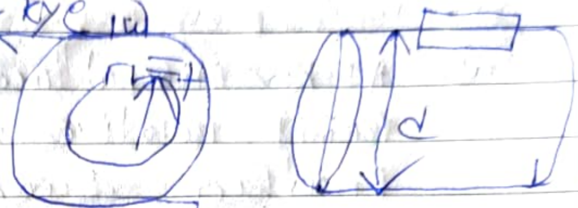
Note

In shearing ~~case~~ stress The key are failure in case of crushing stress the shaft

Sunk ~~kye~~ key.

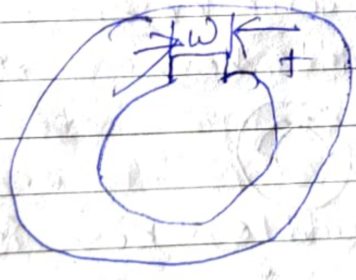
1. Rectangular Sunk key
2. Square Sunk key
3. Paralled Sunk key
4. Gib - head Sunk key
5. feather Sunk key

1) Rectangular Sunk kye (w)



$$\boxed{\begin{aligned} w &= \frac{d}{4} \\ t &= \frac{d}{6} \end{aligned}}$$

2) Square Sunk kye:

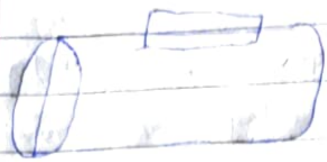


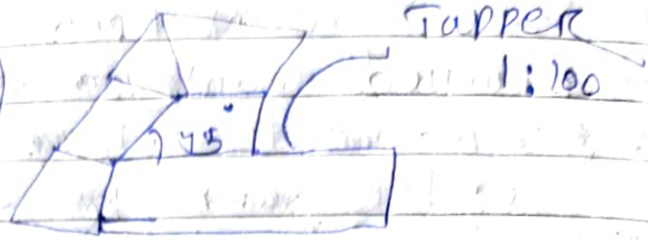
$$w = t = \frac{d}{4}$$

Parralled Sunk key may be of rentangular & squar seaction uniform in width & thickness throught out.

It may be noted that A Parallel tapper less & is used where the pully gear or other mating piece is Required to the slide along the shaft's.

Gib-head Sank key





(i) A key attached member or any pair & which permit relative axial moment is non as feather Sank key.

(ii) It is special type of parral key a turing moment & also permit also axial moment moment. It is fastened either to the shaft & hub to the key being a sliding feed in the key way of the moving piece.

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Type's of saddle key
Flate saddle key

A flate saddle key is a Tapper key which is fit in a key way in the hole and is flate on the saft.

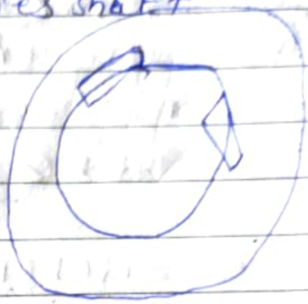
ii) It is likely to slip round the shaft under load. there for it is used to Comparatively lite load.

Hole saddle key

is a tapper key which fits in a key way on the hub and the bottom of the key save 2 feet the curved surface.

Tangent key :

A Tangent key are the fitted in pain in write angle. is key to with stand troson in one direction only. These are used large heavy duties shaft.



Round key

A Round key, are circular & cross section & fit into hollow drilled partly in the shaft & partly in the hub.

Splines

key's are made integral with the shaft which feel in the in the hub such shaft is known as splineled shaft.

$D = 1.125d$

$b = 0.25 D$

Design of key

torque = force × distance

$$\sigma_c \times l \times \frac{t}{2} \times \frac{d}{2}$$

$2 \times w \times \sigma_c \times \frac{t}{2} = \sigma_c \frac{wt}{2}$

$\Rightarrow \frac{2w}{t} = \frac{\sigma_c}{2}$

$\Rightarrow \frac{w}{t} = \frac{\sigma_c}{2\tau}$

$\frac{T}{J} = \frac{\tau}{R} = \frac{C\theta}{L}$

$T = \frac{\tau \times J}{R} = \frac{\tau \times \frac{\pi}{32} \times d^4}{\frac{d}{2}}$

$= \frac{\tau \times \pi \times d^{4} \times 2}{32 \times d} = \frac{\tau \times \pi \times d^3}{16}$

Design a Rectangular Key for a Shaft of 50 mm d, the shearing, crushing stress for the key material are 42 MPa, 70 MPa

Rectangular key.
Given data

$d = 50$ mm

$\tau = 42$ MPa $= 42$ N/mm²

$\sigma_c = 70$ MPa $= 70$ N/mm²

Rectangular key

$\therefore w = 16$

$t = 10$

Shearing Strength $(P_s) = w \times L \times \tau$

$= 16 \times L \times 42$

$= 672\, L$

Shearing Torque $= P_s \times \frac{d}{2}$

$= 672 \times 25$

$= 16800\, L$ N-m

$$T = \frac{\tau}{R} \times J \Rightarrow 2 \times \frac{\pi}{32} \times d^4 \; \frac{}{\frac{d}{2}} = 2 \times \frac{\pi}{16} \times d^3$$

$$= 42 \times \frac{\pi \times (50)^3}{16} = 1030833.1 \cdot 380 \text{ say } 1030833$$

$16800\,L = 1030833$

$$L = \frac{1030833}{16800} = 61.35 = 61 \text{ mm}$$

Crushing strength $(P_c) = L \times \frac{t}{2} \times \sigma_c = L \times \frac{10}{2} \times 70$

$\Rightarrow 8600 \text{ N} \quad L \times 5 \times 70$

$= 350$

Crushing Torque $= 350L \times \frac{d}{2}$

$= 350L \times 25$

$= 8750L \text{ N-m}$

$8750L = 1030833$

$$L = \frac{1030833}{8750}$$

$= 117.80 \text{ mm} = 118 \text{ mm}$

Effect of key ways

$$e = 1 - 0.2\left(\frac{\omega}{d}\right) - 1.1\left(\frac{h}{d}\right)$$

e = effect factor shaft strength factor

ω

(i) A little Consederation that the key way's curved or shaft lode carring capasity of the shaft.

(ii) This is due to stress Consedention neat the conner key way & the readuction cross section of the shaft.