## **GOVERNMENT POLYTECHNIC, NAYAGARH**

## **STRENGTH OF MATERIALS**

3 RD SEMESTER, MECHANICAL ENGG.

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\* Strength of Materials [crash course] We study about real solids (1) Effect of Enternal force. (?) Elbert of mechanical South adi-Energy. of badies at nest / stationary. > External forces Nethous physical contact With physical contact ( Body fonce) (Surbace Force) 7 point Load, concentrated load Ex = Gravity Force Weight ob body. for nest Condition 之fy=0 TR -> LOAD: Enterenal force which is acting on a body. force can change shape, size and state of motion, change in shape & cize > Debormation !! (ii) cipante (i) -> Condition of static equilibrium is Zfx =0, Efy=0, ZFz=0 ZMx=0, ZMy=0, ZMZ=0 1. Elorgation America B KLO X - Force is moving away from -KLO X - Force will stress - the body -fonce is moving away from the scoreface here E-fx=0, Body is at rest. 1 and sound P-P=0, so et zi in statie (+) (+) equilibrium (-) CW (+) Lf-Lo= Charge in length Ccwl (-) cize is increased. (Sign Conventions) These fonces are called tensile fonce (Ettert is clorgation) -V9f/war -10-2. Contraction ( former ig towards) the surbace Scanned with OKEN Scanner

These Fonces are called Compressive forces in 1 3. Shear / cutting / box Tangential Force The force which change the shape Rigidly Fined Colled shear force and loons a 5-Ax=0 re R=V Telo physical confact 411 41. Bending Ra 5. Twisting / Torision will . Villeton (0) TO T= FX9 - + strongto of material in study of three Sto and 2000 (i) strongty (ii) stitters (iii) stability if again a sound contilion of chafe equilitation \* stross 4 strain change is long th (5L) = "L-f-Lo  $L_{7} \longrightarrow \mathbb{P}$ - Resisting bones per uni area in known as strass- il Internal To find rusisting bonce we use method nesisting of section. (South States States) in this method we vertically cult the member So that It will fallow Condition of static equilibrium 2 (i)🔘 🖉 Scanned with OKEN Scanner

\* Tensile Strass & Strain (二) 是当月(12) 21 M ST 112 tensile load (Increase length) 1.2001 , horgitudinal avig XTR 4 lateral anis/transverise anis, Robits 2 9 11 3-1 Anial loading 00110 12017 Junio 22110 P(Tensile Force), Dait P K 情報 FR = Roy Che (1)Oblique plane, Oblique section, 7 FR for static equilibrium Zfx=0, i.e. P-fr=0 word Sin Q = AAtormal Resisting sanch priteria AI Normal direction  $-\pi l = -\frac{4}{\text{sing}}$ Force fr sind on fe = P PSind 0 Privite AN > Tangential direction Resistant fq coro on peoso This borry will Normal stress (Gn) Tangentia Normal resisting force Lbillo Resisting carrying normal to Resisting .... Arcea tonce (A)  $= \frac{P sig}{A} \frac{\partial r}{\partial r} \frac{\partial r}{\partial r}$ List Sizof Nd (P) \$12 0 0310 P=-force in longitudional Sina at deborconali direction TO STORE A SCITT Crogge-sectional plane (-A) Normal stress on = longitudional strass 6=fr=ton Privato Greasting force. SI

stricts ze one type of kongitudional striss/ Norma \* tensile cross-sectional plane in stress 07 Tongile strassor JUDEN2 PN1210 5 = A (+) length zy inerceased Tennile strain (Longitudional strain). E = Deforemention Original Dimension  $= \frac{|\underline{L} + \underline{L} - \underline{L}|}{|\underline{O}| + |\underline{O}|}$ · 0000 = <u>or</u> -> charge is length plaining in Original lingth. comprossive stress and strain E= P/A  $p = \frac{P}{A} (comprossive)$ to the 2 -) Any = Streain (compressive) [ longi-tudional strain] E = Deformation Original Dimension No 5 L (-) (LZ < LE) & Compression us Infogative to the mouse mand is 2 great Normal stress Longitudional striess Charles A Margar S.C. - ansile Compressive

Shear Stress & Strain 13-41 F-7 shoan bonce/ Tagontial Force , shoare plane Atten of Shoere plane, V = shear borice/ win (Shearing) Resisting Targantial -\$6/+ pree Resisting Shean bonce Arcea under Shear BI CU imon'i AKOL-)A' B Slip Hand C D C f rainly cinsi and OL \* sf Very Emay 11 -the, fan & ~ o shedy force  $\gamma = q$ force farial phi ch st debourga \* HOOKer Law:-+ ( for Elastic materials folid material is homogenious & Isotropic 10 in gradually applied load 20 lumal stress striess concentration. e ze constant during loading 3. There is no 4. Temperiat Stress & Strain Jorprossive. x Fee

-> Normal stress (En) & Normal strain (En) -> longitudional strass (=) & longitudional strain (E) > Shear stress (2) & Shear Strain => Bulk stress & Bulk strain (EV) 101 0 10 (Gb) Volumetric strain. 67 CENDER & Eal -Collinson & 101, 104 + 62 1000 201/10 0 5507 Beelk, Avg = 62 SV - change in Volume inodeller 1 -for hydrostatic Cond ? Mulu som PEGY Do to Streek streets 20 a same. three dimensional 616=-P Bulk straking & mand 62=1 GB=K'EN LEK=BULK modely \* Normal Stross En = E: En E= Young's modelus of Elasticity OTC 6=E:E dimensionless strain 24 50 EFER Percel Street? - MLT = = Pa (Pascals) Terstal 200 head inder = atto = Mi 1N/m2 = 1 Pascals 106 N/m2 = 1 mega pescal, Ininoton Strain, ze a dimensionley 109 N/m2 = 1 giga pascal (d-10) IN/mm<sup>2</sup> = 1 maga pascal [] 13 => SI unit of E = = N/m2 sv to all sector Christin

The ELEN THE SHARE FULL & MARINE PLANE 51 = dobormation/charge in longth AE = OL ON OL = BU MANNE MAR R=E.E. -> Linear equations. \* The material which follows hooks law is ay linear clastic material. -> Shean Strey & Straig V Z = GN G= modulus ob Regidity ( Thodulus of G= TZ SI unit of G'ég same os 'E Pa ( N/m2). > Bulk Stress 4 Strain Mult 66=K.EV K= Bulk modulus  $K = \frac{661}{2} - unit \frac{2}{2} \left( \frac{N}{2} \right)$ Tcharge in lateral fin? Poisons Ratio - (0) or - m) Ul = - Latenal Strain (Ed) - Original Latenal lorgitudional Strain (Ed) y -ve sign choos that lateral & longitudional Stresses are apposit in Nature. Up in const. for a material .  $M = -\frac{\mathcal{E}d}{\mathcal{E}_0} = -\frac{(bt-b)}{b}$ (14-5) driven two one should be (-vo) So (-ve) &-ve be dome (+ve) (uf=+ve) always for Elastic material.

= for elastic moetarial. 14 = [Lataral Strain] Longitudional Strain] nealth prisona seafio Theoritical poissons matio ronge () - Jes 210 -1 5 4 \$ 0.5 nac in laterea G 16a Nonvernit 015 -> il value for various materials. I most motorial . Corch (0) Corche (0,2) Cheese (0,45) with motion Corchete (0,2) Cheese (0,45) with motion Steel & Copper (0,3) Alter aluminium (0,35) Nod out 12 Contraction (0,5) Lecture - 4 :== Poissous statio strong the structure 2 .0 = 101 de presente length increased and the LE > Le : [ Landres of sites latereel dimensionsilarce dfldi decreased 10 E = 361( lateral anipper of (146-1) 12 4 longitudinal anis E= <u>4K9</u> lateral aris. 2 Cup # 10 woll Shart (for 2 Cup # 10 woll Shart (for 2 Compre. 2 Compre. 2 Compre. 2 Compre. 2 Compre. Laterel Straig W= Longitudianal Strain -1 & M & O.5 (generally) elastic material, 0 < 4, < 0, 5 (For Elastic neterical)

ton @ O<US :- 37 we provide langle bone +Ve poisons matio - then the length inertease and - the Caterial dimension All deenwase. \* for cel=0:- Jf we provide tensile bonee then the length is increases and there ty no change in the lateral dimension \* for MI-1 < 1460 :- If we provide tousile barrie they ve poison's matio the length is increases and also the lateral dimensions are Increases. i.e. lateral Strain - Îdi and longitudinal strain both are of the same reiture \* ul= 0.5 : Incompressible ori falcal plastie material. I means vol. in not changing + Relationship between Elastic Constant: +1 4. 4= 3K-29 1. E= 26(1+14) 2. E= 3K (1-244) que brisbution of +6K 3.  $E = \frac{9KG}{3K+G}$ - Generalized Hookes taw := (3D loading) 62 -60 Gar MAG

Ethertot Strain in Strain in Strain in 1 Fight NOPITIONA Z dir? y din? Stre85 157018 W-CM En His Con Huller - 4 ( Gon ) Ga 67 ant pille Gy E  $-4\left(\frac{62}{E}\right)$ 62  $\frac{6_2}{F}$ 61 1. ol -\* strain in & dir? (Ex) =  $\frac{G_{x}}{F} - 4 \frac{G_{y}}{F} - 4 \frac{G_{z}}{F}$ 0500 - 4 62 - 4 6a Generali - 4 62 - 4 6a Generali \* Strain in y dire (Ey) = Gy Hookes \* Strainin Z din? (Ex) = 62 - 44 Ex +4 Ex 100 Lan + Volumetric ctrain (Ex) = East Ey + Ez 10 EL Varchez  $E_{V} = \frac{6 \alpha + 6 y + 6 z}{1 - 2 4}$ member to memberc. 4 Volumetric strain \* Memberris in Services Inceliera. 0 ſ P← 20 E members 05 RE 0 2 FBD P P  $\epsilon$ P ()RA+RO.S  $(\delta l)_n = \sum_{n=1}^{n} \delta l_n$ -for memberes in Servies, N=1 total PL 1 🔘 🛯 Scanned with OKEN Scanner

Memberre in parcallel tolan S=Steel .... A= Allumpinique case () & Rigid bor must remain horizontal S case Rigid bar is tilling 20.00 memberg 50 K- Rigid bar (Not detorinable). 13.1 -\* Load is always shared bet membors £ 01 7 for case ine rigid bour remain horizontel in -this case the memberg are equally deborred and Deboremation of member's must be same -7 for case (2) He Rigid ban in (-telting") - the debormation of memberes ze varying Trai Jolamati El varies linearily from member to member. (106-10/10+101= V= 12 Volumetrice strain 51,-SL. empeted in Services \* Lecture - 5 Statically indeterminate members T d'2 7P RB di RB - 42 081  $\Sigma f x = 0$ RATRB=P-Zfy=0 102 (if known mit-ZMA=0

here in this question there are two controuses buswe have jonly one aquation ( it of filed) -> mathematically we Know that bor n' number of un-Knowns we need in number of equations Y So we can't solve this question with one equation -y So we can't solve this guestion So this Kind of preabler is called statically indeterminate So here we require another one equation, i.e compartibility equation. FBD (step-1) y P-1 K-RB to she is annes have it is the shere find ZF = Fret ( Don't count reactions, only count the loads) now put the reaction, opposit to fret. The Loads) RA+RR-P KA+KB=P > (+) y static equilibrium Eqr. ↔ (Stop-3) (step-y) put comparitibility Equat  $\sum_{n=1}^{N-1} \nabla U_n = 0$  $( \mathbf{\nabla} \mathbf{L} )$ total <u>PL-</u> AE-9-7 FR= RA , 20  $f_{x} = 0$  $(\dagger)$ FR fR+P=RA=0 $\overline{z} f p = 0$ , |FR = RA-P  $( \mathbf{5L} ) = \left( \frac{\mathbf{FR} \cdot \mathbf{L}}{\mathbf{AE}} \right) + \left( \frac{\mathbf{FR} \cdot \mathbf{L}}{\mathbf{AE}} \right) +$ MA

4. A horizontal bar with a Constant Crossection is subjected to loading at shows in the bigcere The youngs modulus for the saction & AB 1 BC are 3E and E respectively, the deblection at c to be zero. The ratio Pif ze to prix givi voite to sha and mill one of our on RA RA LARIE (1-912) here in question it is given that the deblection at is to be zero. i.e (80) = zero will word to the long = total = the foreit of the to feet of the total + (1) « front and a line of the control of the former of the  $\sum f_{x=0} 0 = \int J_{0} \sum_{i=1}^{i=N} = (J_{0})$   $F - P - f_{x} \sum_{i=1}^{i=N} J_{0} \sum_$  $\frac{1}{AE} \left( \frac{f_R L}{AE} \right)_{I} + \left( \frac{f_R L}{AE} \right)_{I} + \dots = 0$  $\left(\frac{FK}{AF}\right)_{1} + \left(\frac{f-P}{A3E}\right) = 0$ =  $rac{F+}{2}=0$ FR.+P =RA=0 10=x7- $= \frac{3F+F-P}{3} = 0$ -y TRE RA-P YF-P=0 P=YFA +(出)+(出社)=(18)+(出社)+ =>) = = Y Any

Q. A borizontal bar fined at one end, has a length of 1 meter, crossactional area 2, A = 100 mm<sup>2</sup>. The Young's modulus E(n) = 100 engpa ( a is in meters). An anual tensile load is applied at bree end ine IOKNI. the anial displacement at the brace end in mm? - A = 100mm 102 = 400 Ang >10 KN South Last was not out Le muterial will debourg -109-Jon Pini outly Print of the de = charge in length of element, Joodney pipis  $= \frac{P d\alpha}{A\alpha \cdot E\alpha}$ N=L -for change in length of bare Oil = An Ea  $\delta l = \int \frac{10 \times 10^3 \text{ N} \times d\alpha}{100 \times 10^{-6} \text{ m}^2} \times \frac{100}{200} \cdot \frac{1}{2 \times 10^9} \frac{1}{\text{ particular}}$ all of othe  $= \int \frac{-10 \times e^{2} d_{11} \times 10^{3}}{100} \times 10^{3} \times 100$ Florke  $= 1.718 \times 10^{-3} m$ > Parcentage. Closepeton So of = 1. 718 mm (-Ans), of alongation and the x100% Lecture-6 Stress Strain Diagram A-HA \*Rigid material (hypothetical) of \* linear Elastic material. 5 Annolo which follows hooks law. Ductile Makerligh. ( Brittle Matylial. ع 528 🔘 🖉 Scanned with OKEN Scanner

\* I deal plasfic on Elastico de pund sound selas una perbert hypopplastic is some hoppid brond in the print of plastic detoring ation (1) = (1) = \$ i-e deboremation cender Compt Stries Jeild and displacement Electric debormation Temporcary monor undon Constant Stress NOIS the material will deborry Continiously \* Rigid perfect plastice de ciprol de épielo Morpiet = P. dre Rigid BathBeharrouted Danie John Fai Ling Pigid BathBeharrouted Danie Long IN of barrouted Danie Ling In Early Ling I and the Street Ani. Eat Gy \* Elastoplastic material with strain handening of Hardening [-10xe day x103 0-100 ×10 ×100 Flastic AF51X81.15F -> <u>Percentage</u> <u>Elongation</u> 1. (18 (mm) (- Amy). % elongation = <u>L7-Lo</u> x100% el urice - 6 riess Strain Diagram Types of Material Ductile Material. 3 Brittle Material, 320 13

Brittle Material. Ductile Material & Solid materials can under -> + Solid materials that enhibit regligible plastic go substantial plastic déboremation priore to fracture, déforimation ariencoulied. are called ductile materials 111 brittle materials 111 -> % Elongation < 5% -> % Elongation > 5% Pris K Prog : 10-1 Also . R. Y. L. N solo ( % Elongation ( 15%) Arre knows as prtermediate Charts we meeting liston stand Hamill & Amil 2. Elongation 715%) Are known as completely ductile Inling stranil 10.0 mætergal. I De Anachara -> Enample of duetile material: -> Enamples of brittle material: mild steel aluminum Coppere Cast Irion, cercamice such as most plastics. glass, cement, concrete, stone ice \* Stress-Strain d'agrean for Duetile material. 25 plotte Ronge Meld Steel 15=(P/A) A = original area of Crossection -\* store build not see al 25/24 ultimete Strass ~ 21 W 13 X AG Fractures den Moul non Xrupture Yeild Joekanioal Maypentics (1) 6 94 601 Stress rad as non permanent Elastic de loins len= 56 ALLEN SIX Range after the bonds. ≥ Qngji 10 0A : l'inearc behavioure/deboremation ? 1000 (Initeal linearcity) + 11 1 100 S Assilves 2. A: limit ob proportionality SPACE TO STATIS 3. B: Elastic acticity is mostly measured 4. C: Upper yeild point Scanned with OKEN Scanner

6 D. Lower yell point in a point of the state of the state of the 7. EF: Strain hardening in miling of siching no bibb 8. F: Ultimate point ou Ultimate strassing 1 9. G: Fracture, point, which the figother will a 10. FGI: Neekingt mil die in in and 1. ( of Blogation ( 15 for ) . \* Stress-Stream Diagram for Brittle Material. Elastic limit (CASTI IRON) al 3 c= Ultimate point didtile didtile point un t D = Fracture Sciently didtile in the point of the Valletial ale proportionality repaired allowing a standard is material generat convit sconerate store (1)Elastic plastic Range Int merphilo stant? - uppt Range contration plastic (119) - 31 12 brittle material Elastic / plastic (119) - 31 \* for brittle material Elastic -\* for Duchte materials glustic / plastic \* Mechanical Properties O Elasticity: It is debined as non-permanent debormation it is the ability of material to resume it original size and shape, abter the borce is removed. some materials are more elastic than "others", but there ig no 1 material which is perfectly elastic throughout the entire range of stress de cepto repture limit of Elasticity is mostly measured is terms of stress: 8 or classic limit.

Elastic limit is the manimum strass that a material in capable to withstand, without permanent deboremation The more elastic material will have higher value of elasticity limeters elle can't notice the tepinisticites 2. Plasticity : 11- 13 Amior plus nound and pros him It is the ability of material to be permanently debormed without bracture even abter the removal of borree All materials are plastic to some extent. plasticity - y other extrance opposit of classicity Chevender. The plashicity of a material is it's ability to undargo Some degree et permanent debormation without repture. plastic debormation will take place only after the elastic rearge has been enceded. + A generical expression of plastic action would involve the time note of strain since the plastic state 3. Striength (maximum striess which a material cap withstand) Striength may be debined as the copacity of matel to with stringth may be debined as the copacity of matel to with stand blog of the expression as force per unit area of Cross-section of the material here to withstand different types of load such as tensile bending, to reion, compressive and shear load. Hence, strength 2, Known as tensile bending storesion, compressive and shear strength. Tensile, torision, bending and sheart strongth are greater in quetile materials, while the compression strongth zy Lowers for brittle material L'he stone bruck and cast gron, the ulfimate compression strongth will be much higher than the tell ultimate tansile strongth + Duefile materials are weak in shear lotori Mitano of Brittle materials are weak in tension,



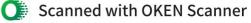
-7 Sut = ultimate strangth (Brittle material). Syt = Yeild Strangth (Duefile meeterials) \* for some materials we can't notice the upper yeight point and the lower yeild point Ex-Allungunium, tor these cases we take 0.2% of straig and parofraw a percallel line with the linear curre ob the diagram . the point where the line cut the curre prise called officer yeild streets on on Strength. The plasticity of the sector acting ally acting to the first ma laterie 200:00 ansignate the long of 10 the wet Yeilg Stress Strength plastic planting ation will the place put the strength all allester having has been larceashing in - general expression of plashing <del>(ichon</del> - time reate object than sinces the plastice Sta Steele. 4) Duckility (f) <u>Ductility</u> lebe from a divite be drawn into lemelt? At ze the ability of material to be drawn into lemelt? Section from a large-leastion is positob to pom dipart It is also expressed as plastic debournation at breaking point. 9tig value ze emptassed as clongation inel 202 2000 percentage elongation zi most widely used to measure and its white are came as strain !? quefility Any treatment which increases strength, decreases the ductility. The strongth and pluck lity of . sins material are appreciably abbeeted by temperature As temperiature Prerieases, the strangty and clasticity limit decreases and ductility cheredgest . and Exo \_ Coppen, alanunium, nickel, and lead and have puelle metalssiper one weak is shareston elitarly Onrithe waters of one water is donner



21000 High carbon steel Chalob Protovicor 1 NOTAT Medium Canbon Steel Low carbon steel linit volum is the anount of anorgy souch bebaria it bing trances. When a muse 1 to on Tils train all it roant Jong Long and Male Brinn - Ricard Robert & S. Richter (1) hick 01:000 and a star way the part of the light morce Duefility ze degree of plastic detormation Wildstand Ender debournation means, more quetility to Undergo Large redu--> Duetility zy obility of material ction in crossectional area under action of tensile Forces housed to distance house the strength energances -> Ductility decreases, as MADOGA PROLT The property bracturing a material without warring or appreciable debormation is called brittleness. Bruttlenoss & opposit to ductility -> Most of brittle materials have high compressive strongth Usually, tensile strongth of brittle materials only a braction of the compressive strength -y cent gron, concrete and glass, are brittle materials · Cast groz chouse a little deborenation bebore repture · Materdials having less than 5% elongation are comidered on brittle. Spida 6. Hardness Handness of a material is defined as the resistance of a material to see scratch, wear or penetration of it's Surbace by hander boolies. Hendues is mostly measured by determining the revistance to penetriation (indentation)

debterant methods as Brinell, Rockwell and

Virkery hardness tests manaparts ships



BHN R= Locopolant R 4 4 2P an = D = ofia of Protentor HB. TD(D-VD2-d2) ind = dia ob vindentation. 7. Toughness It is the amount of energy that whit volume of materia can absorb bebore et bracture. when a meterial ig hereted it's toughniss decreases desirable proparity bore -> Thus toceghners & highly machine parts which have to and Stretunal withstand shock and Vibration the meth \$ 11:51:10 Toceghness, 20 usually represent by area lendere stricts Strain cenve Strain curve is the work enpanded in deborming one cubic meters of the material untill of breefered;" This work & also called modulus of toughnets 15-1950(1 steel, mang anen and Wrought frog arte Brows, meld Astodond ( 10 materials . Ling all find films tough pricesable debourgation is opposit to dietich white stress 18218211 1331 Modelia of Man bid of the alting Theophon to i-el Arrea under strian striain CHGU Etprovide printing of gliagra price hool DEP- Strong apt . Fride furie ( adult from Train 9476 B n diagram of quetile meterial arther I having along 30.92=+ 1.351115 598, 45 matures of a material of defined with intercial to see condition, manie, on harder booties. HandyAr N-m 140 () wid Toles m3) content as m201. soustands modules of mate General peri cent Volume, i.d. Toughness,

To Toughness it is a reading that and a reading the area It is the amount objenergy that material can absorb, beborn o lastice breachered have a charles in the second construction of the When a material is healed it's toughness decreases -y The total arrea under "sitressi stration churcher is the worth expanded in debourning one cubic meters of the induterial unfill of breachuries This work en also called modulus ation togghness dilica provident of bernolado principality - Toughness ze usually represented by area under a l Vs Deborentation curve and worsught inon are tought mæterials it plate, Atumunium, coppare, Mero, plationer, Merolo -> Stephness ze the presperety of material which phables mate 8. Stittness reial to resist debormation. To puplind all supstral all The material which subtores less alabormation under Load has high degree of stittness. The greater the stress required to produce a given straip, the stebbore ze the distance and the stebbore ze the material. - The materials which follow hook's law stheir stebbrossi ze measured by young's modulus of clasticity milli The materials, which do not bollow hookes law, theire stibbness varies with strass. - +. The tercin Henibility is opposit to stibbness. The overall stituess on blenibility is the bunction of dimensions, shape and characteristics of the materialing all t 9. Resplience ; which amount of energy absorbed by materuad within elastic limit. This property is important inportant -> The manimum energy which can be stored in a body upto classic limet is called proof rossilience.

proof resilience per unit volume je called modatus rasilience. Thus the energy stored per unit, volume at clastic limit is the modulus of resilience - pressience is also of importance bon materials require toubearce shoeks and vibrations when sous all a 10: Malleabeletyn andre hereden and principales is below -> Malleability zo the property of material of getting permanently deborened by compression without reptiere -> Malleability requires that the material should be plastic but not so much dependent on stringth - The common metals which are malleable: Gold, Silver, Alumunium, copper, Tin, platinum, Lead Dizine, fron, and Mickel, photomy all 11. fatigue The failure of metal under alternation Stress 20 Known as fatigues not as double lo biller of and and a state of the long of the 12. Creep notite The slow and progressive debormation of a material with time lat constant stress is called creep. along al. - After creep sets in, it continues until subbicient Strain thas occurred so that a necking down and a requetion of cross-solional area occurs After This and untill repture, the reate of debormation increases because there is less area to support the load. -> The phanomenon of creep is observable in matels, conic and covalent crystals, and amorphous netels Such as glass and polymeres. Metals generically enhébit creep at high temperature, whereas plastic rubbers and similar amorphous materials are very temperature - s'ensitive to creep in monivery



creep is entremely structure sensitive and is much more attracted by grain size, micro stricture and previous Strain history, for instance, cold work and many 134-1-1001 other factors the repaired of the international of the second the Lecture -7 + Tooliumal, strais Archinain :- + 1 \* True stress and Strain:= Engineering stress and strain based on original dimension. True stress and strain based on Enstant anious dimension. - Relation between trice stress & Engg. Stress. caper 2 train (E-16) - the reash Alters Aig Kropp in it can breed to your aron. 2 1 412 = 4 3 True At >> Ets & AT for Ideal plastic debormation  $\beta_{15} = \alpha \Delta T + - (1)$ &= contrictent of - theremal expension / limine = vBunio= VB  $K = \frac{0b}{EM} = M$ X = perc deg °C or perc Kalvig; E = 3K(1 - 2U4)St AT= L (B) Ago () =>[U]=0.5] for ideal plastic deburmation & ==== Ao Lo = Af Lf= Ail - no and alt no hungan could priored y. Grue = Af = P x Ao = & x Lt { Ly-Lo= othy & = N+3 True Stross and Engg. Strets Anostime? \* True Strain 12 Temperature 24 basing changed. But the (124th) pots introom 25 Coloradane at al

serio two strain to cray. Summer .  $\frac{\mathcal{E}}{4\pi\omega} = L_{0}\left(\frac{L_{0}+\delta L}{L_{0}}\right)$ e = ln (1+E) Theremal stress & stream Tf Space 10/100 5-Hy = L'-L Thermal expansion without -the rastriction 1 g Known Theremal Stream (E.th) as brue empagision. Eth= OLth => Ety & AT I don't plastic, deban media Eth= XAT q = co-ablicient of thermal expansion/ linear Expansion. a = perc deg °C or perc Kelvin. 97 AT= 1 in agn () 101= 0.5 -fois édent plastie dépensiona Em= x \* During true expansion the stress or their mal stress = 0  $\frac{\Lambda_{0}}{\Lambda_{1}} = G \times \frac{1}{2}$ Eth= &AT free enpannios of ban is 56-1 = X AT L ( - 1) × 0 Joho I y Theremal Strives (5+4) (3 Corditions 10 Temperature 24 being changed. 2. The expansion of restricted, etthen bully or 🔘 🐌 Scanned with OKEN Scanner

1. fully restricted 2º partially Restricted AT OL total = 20 dus jo 1X. 1 convento do stolo - 7 K XATL-(PL)=0 900 026 9 50 Hotel Gap Lagmous q & ATL - (PL) = gap ! 2  $\frac{N=N}{\sum_{n=1}^{N} (AATL) - \sum_{n=1}^{N} \frac{PL}{AE} = 0$  $\sum_{n=1}^{n=n} (dATL) = \sum_{n=1}^{n=n} (\underline{PL}) = Gap$ put genericalizias books lind. 3º Cincular bar Poside a tube 21 1d2 x17 x2 (00.0X  $\overline{VIA} \rightarrow P$ NON 250 mpa PTA ->> P COIX 000 -for Rod (XATL) - (PL) (final length) = (00.0X & - 1 Tube (XATL) 2+ (PL) (final length) A-) 2.01- W solid ban ab energy of (976%) seet (99) beer (174%) le Remember port and 2 10 x 102 x 2 00 mod all do and

$$\begin{array}{c} \hline \Box_{++} = P \\ \hline \Box_{++} = P \\$$

$$\frac{1}{12} \frac{1}{12} \frac{1}{12}$$

P/17/14 8 KN/m that is the reelationship bon allowable ball eag earcing in this ing .K-HILL WITH MARKING STAR = 1 6 BRNOTO HE 13 SKN MIL 4 10 KN 12-2 8 X1.25 11 12 1 19 1 19 RA RA = 19 KNsupported in the start 2: Reaction from support. Il In Galles Bunds 10111111 FR wond fR +8 00-19 = 0 pritimil no cimp - y fR = 19-8 00 KM. 19 KN  $= \frac{f_{R} \times 10^3}{400} \left( \frac{1 - 1}{2} \frac{19 - 800}{400} \times 10^9 \right) \frac{1}{2} \frac{1}{2} \frac{1}{2} \frac{19 - 800}{400} \times 10^9 \frac{1}{2} \frac{$ Stress: 997 the bar of made of brass, d= 40 may allow = 800pc = 47.5 x100- 2000x1045 Loda = (47.5-202) MPar, will by px pz 0 2 will - 1001 Liecture-9:--- Sam /4 03 x might 12:0= An elastic bar of length l, uniborry, crossectional area A, co-etticient of thermal expansion of Young's modulus El. in bined not two ends, 9% the temperature of the bar Endoubled the anial stran would be! and in the length and interview traded that as shown Apparent The colours council show in the barr

CONTENT - ITA D Q,E, AT=T 076x - 00 x 300 x 00 x 10 200 X103 (: 'both side bened) is from (4 one of 1-51=0 Min & AT LI-1 Plus begins of ogual legis and our of the 12 TA & all trobal estimate AF at a distance of 110 cm as showinging ATY = (the show one bined to the signed with E a ATE ( Co ze is dependent of Lo) nonol mont which country a contract load of didward batwood De 200 mm long strustice rigg at room temperature is held between two immovable rigid walls, temperature of the read to unibormly raised by 250 97 The the youngs modulus zu 200 gpa & coethicient of -thermal expansion 1×105. The magnitude of Longitudioncel stress develop & ? 17 = 1000 Kg N=01-19 S= XATE = 1×10 5 × 250 × 200 × 103 1.0 01 × 29 - 0= AME 675 = 500 mpa,  $p = \frac{p_X y_0 \cdot 2}{2} = \frac{p_y}{2}$ S. A circular metalic riod of 250 mm ze placed beth -two rigid immovable wally. In the figure the rod 2 in purbert contact with the wall in the left side f there is a gap of 00.2 mm bet the rood and the wall on the reight side of the temperature of the is increased by 200°C the arial stress developed rod 🔘 🐌 Scanned with OKEN Scanner

X ATL - PL =0.2 T. TA CAR  $10^{-5}$  x 200 x 250 -  $5 \times 250$  $200 \times 10^{3}$  0.2Sto Two bares of equal length are suspended repticall at a distance of 40 en as shown 22 the bigure below there appen and are fined to the sealing while their lower (end) & Stepport of right horizontreet bar which carrier a centrue loud of midway between the wirres. defuils of the two wirres are given. What & the reation of elongation, - two innovable nigit 2 wally - the percention 1T = 1000 Kg S 13 100 120 1201-2 PI-+Pa=W S= XATE ZMA=0 - P3 X400 0.4 ET Nox8 2 - 396 X - 01×1 = Gb= 5:00 Mpa.  $P = \frac{W \times 0.2}{0.4} = \frac{W}{2}$ A concentere metalle read of 350 cm 31 placed bet? to regid smaavable wally. In the figure the red 20Accu = 1 Pi Lint - 1 500 × 4 1000 lood on on looding of the roal the roal of the roal the road the roal the road the roal the roal the road the roa Asteel = A2E2 = 1 2 2 2 Minble Scanned with OKEI

So the bar is going to ramain in the horizontal position. Ac 1 As



Strain Principal Stress & 11 11201 complex stress on strain mm Anial Loading 1 Tru-anial Bianial Unionial Loading loading Loading Q2 199 A Gy 691-11 pc 10 by min Ga Ga Ga . 275 Fn Concept is rectinged in Pin 1. centionial Locoling DROBSCOTCE/1VESSEL lindicitea! longitudional Snot orgitudinal Strugs Strain 2 1000 1:051 3 Dreineipal G= P/A 8=06 (A) , a, 2. Bianual Loading Ex= Inflated ballon, Gas cylinder, cylinders bor welding them have pressurerised gers. All of re janne ASS DWERET Vore fiedl 7 0.11 ON 201 UNBOULAS an freal is their Ligeren . alonva 11 LAPK-APROCHED INTIN 67 aut the above 369 > Pa Ga 164 Normal Jones. Croft . lormal 1100 for uniania loading. Force 110 -1 P < (V)share tomal? P PE sfore cut a line at O degree ande 🔘 🔋 Scanned with OKEN Scanner

FOR bi-anial loading also, for and all and Sy (Py) 7 Pn printing no (2014) Fon (Pn) Priboud Joint NV Trillic Ridler Browial Inication Renieturial in parland 560 We have to study about the Normal strass on oblique plane and the shear stress of oblique plane here m this chaptere. 6% 1 ' 44 > This concept is required En. This cylindrical pressure vessel . filond lainsin Theore of failure. Combined bendergifte toresion of stipped 58021-55 - \* principal strats and strain P/A Gy (Py) local 7 For (Par) Product Logaria 1. Statistich buillon, gas coperter, En All of -Illaro have prassarcica ZA Iways take the vertical plane as reterence plane mainly take the right side vertical plane as the ret. => 90 the above figuerie the 0'is present in clock wise direction from the right side verifical plane. => 97 we cut the above figuerce Phy Normal Forree. Por Pronv + Tapgaufial force (F Shear force (V) PTO

let Arreat A' ob obleque plane. In mining on in Gn=Pn, C=M -> 36 the oblique plane present in O'degree angle. 1 Shear Normal K. Shross as a stansort. -> At ditterent value of 0 we will get ditterent Value ob En and T., At dibberrent Oblique uplane arrea (A) of plane will change. elastimpopul - 18011-D -> 0 = location ob oblique planeil wirdt reference plane principal plane of There will be an oblique plane at at which shear stress is Zero (7=0). Oblique plane at which z=0, such plane ze Knows Struss - 100000 as principal plane. ↑ Gy (Py) Exis part ax5 En ( noil transfer). for bianial loading there are two methody perpendicielarq' principal plane. - Boute of strate of -> Location of principal plane = written as Op Winit reference plane -> Normal strass acting on principal plane ig Known as principal stress, > There grane two type of principal streets there are two principal plane i've mutually perpendi cular to each other. -> The plane which carcries greatest value of En of Onia 18 -is called major principal plane. 12 sonte doider -> The plane which careries lowest value of En ze called minor principal plane.



7 Majore principal Stross présent in majore principal plane and minore principal struss present in minor preincipal plane. a tasjond . J. wanton \* Stress as a tensor 1 28:003 1. 1. 24 6 1 2 Stress zy a 11 Second ander tensor quantit -y Any sealar quantity zy a zereo ordere tensore. - magnétude . op 1545 This hold the Stress directional upildo do coil pal = plane of application. -> vectores are birat oredere denson quantity Second order tensoit quantity, 7 Stross ze a see Stress tensor principal planes (49) KEPA tan Try Zaz Herein cut and yz. A Representation of BUT DEVE Stress tensor J.G.Zinn G. Zzyrin ZZZ plane < 3-D state of Stress pruitten as Localtop of I principal you gotto Cry () (2) arteade. 729200 NY TU pland play zyald 00 1800K2 Nonnee () The plane og preinei peut Zyz which Stress ty action 222 01 Those is the i Alla Allas John and out and man Zay dia deas at- moli ZXX The plane which educated and Vertue of Nota 2) Din? i? > Zyn which stress antice mayore print ze acting where zyzicht toinnos destres evolge out partices have bleve Manin pollo

Znochanisting find & called astinormal strossor. > or direction. (13) 245 Monto 10 to 10 0 x-plane -> Tan = En d-18 md Plane Shriss TXGY CA, CA, CARD CARANTO VOXIT 272= 6211/0 1 11102 complementary shear stress 418 5 Serve XV PETERYZIN TOUT TO NO plane r (2 -> Zxx Tra Gar &-\* 3- Dimonsional State of Stripes 10 0 212111011 Z 7 7 Aprily Real method about Mhen in two direction stress is 300 present and in one direction < The stress is less on negligeble then It become 2- Dimensional State of struss 1 Sy 760 Gn ia) ormal Shows of ablique. enold This is also called as plane stress OF to Car 10 Complex Stress 64103 and GB Zny - wert Alisan wassing - 100 Kunder of 6m reperconec plane Try Gy

(ii) Shear stress on oblique Plane, Zor ZO = - ( Gn-Gy) sin 201+ Try cos 20. , Call = - 52 wby  $\theta = (+ve)$  it measured a clock wise broom vertical plane \* OG of= (-ve) it measured Anticlock wise broom vertical plane \* 97 in the question only statement is given no diagram in there then assume to isg't be ine clock wise broom 1.C. art the ventical reterence plane. - y Gazy (+ve) when tensile of (-ve) when compressive. Gy ze (+ve) When tensile of (-ve) when compressive 180012 A 24 1 W. 8 2 pul of 0 2 8 8 200 host be as at the 0=- ( 64-64) Ch 20 + Cay Cos O ze in anticloer wise Q = in clockwise from the reterance planes = p prom the reterance plane -> put 0 = -0 en all bornulae born calculation it 0 ig anti-clock wise broom vertical repertence plane. Shear stress (Try) 105 5 = 98 ppl-10-00 -> Take Try as (+ve) of giving a dock wise rotation.  $\left( \begin{array}{c} \mathbf{c} \mathbf{w} \end{array} \right)$ Take Try as (-ve) 97 giving a auti-clockwise restation. Scanned with OKEN Scanner

$$G_{n} = 50 \text{ mpa}$$

$$G_{n} = 50 \text{ mpa}$$

$$C_{ny} = -25 \text{ mpa}$$

$$T_{ny} = -25 \text{ mpa}$$

$$G_{n} = \pi \sigma_{0}$$

$$G_{n} = \sigma_{0}$$

To takion ob plane ob Maximum Shart Stress  

$$7 \frac{d\tau}{d\theta} = 0$$
  
 $\Rightarrow -\left(\frac{Gu - Gy}{2}\right) \approx \cos 8\theta + \left\{-2 \operatorname{Cuy} \operatorname{Sin} 8\theta\right\} = 0$   
 $\left(\frac{Gu - Gy}{2}\right) 2 \operatorname{cos} 8\theta + \left\{-2 \operatorname{Cuy} \operatorname{Sin} 8\theta\right\} = 0$   
 $\left(\frac{Gu - Gy}{2}\right) 2 \operatorname{cos} 8\theta = -2 \operatorname{Tay} \operatorname{Sin} 8\theta$   
 $\operatorname{Cos} 8\theta = \frac{Gu - Gy}{-2 \operatorname{Tay}}$   
 $-4 \operatorname{cos} 8\theta = \frac{Gu - Gy}{-2 \operatorname{Tay}}$   
 $\theta = \frac{1}{3} + \operatorname{an}^{-1} \left(-\frac{Gu - Gy}{2 \operatorname{Tay}}\right)$   
 $\operatorname{cos} \operatorname{respressend} \operatorname{tbis} \operatorname{cy} \phi$   
 $\varphi = \frac{1}{2} + \operatorname{an}^{-1} \left(-\frac{Gu - Gy}{2 \operatorname{Tay}}\right)$   
 $\operatorname{cos} \operatorname{respressend} \operatorname{tbis} \operatorname{cy} \phi$   
 $\varphi = \frac{1}{2} + \operatorname{cn}^{-1} \left(-\frac{Gu - Gy}{2 \operatorname{Tay}}\right)$   
 $\varphi = \frac{1}{2} + \operatorname{an}^{-1} \left(-\frac{Gu - Gy}{2 \operatorname{Tay}}\right)$   
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 $\varphi = \operatorname{an}^{-1} + \operatorname{an}^{-1} \left(-\frac{Gu - Gy}{2 \operatorname{Tay}}\right)$   
 $\varphi = \operatorname{an}^{-1} + \operatorname{an}^{-1}$ 

61,2=1-75±13 (100010 ) (100010) Major A 7 44 By - 1- 88 Miles 0= -88 (080% Major 60+90 (K2-20) Transformation of stresser 9 Copor Go eo. Pre V A By  $0 = \frac{1}{2i} + 4in \left( -\frac{6i}{72} + \frac{6i}{2} + \frac{6i}{72} \right)$  $G_{n} = \left(\frac{G_{0} + G_{0} + \eta_{0}}{2}\right) + \left(\frac{G_{0} - G_{0} + \eta_{0}}{2}\right)^{2} C_{0} + (2 \times 30) + 7 C_{0} + 7 C_{0}$  $Gy = \frac{G_0 + G_{0+q_0}}{2} + \frac{G_{0+z}}{2} = \frac{G_{0+q_0}}{2} + \frac$  $T_{xy} = -(\frac{60-60+90}{2}) \sin(\frac{100}{2}) + C \cos(2x30^{\circ})$ 1007-9021 2 Jugor 60K (12) \*  $0_{1,2} = \left(\frac{6n+6}{20}\right)$ 4:+1 7 Gu 220012 Orgerogord GI= Mayorc -s prideround head for the Ga= Minor Geren state of stress. -refind out normal strusses on an oblique plane at 0° from 'A' ( vorifical plane je the reperence plane) oblique plane at 0°

7 find out state ob Stress when alement is notated by  

$$\theta$$
 degreep.  
 $G_0 = \frac{G_0 + G_0}{2} + \frac{G_0 - G_0}{2} \cos 20 + Zay Go 2 = 0$   
 $G_{0+q_0} = \frac{G_0 + G_0}{2} + \frac{G_0 - G_0}{2} \cos 20 + Zay Go 2 = 0$   
 $G_{0+q_0} = \frac{G_0 + G_0}{2} + \frac{G_0 - G_0}{2} \cos 20 + Zay Go 2 = 0$   
 $= \frac{G_0 + G_0}{2} + \frac{G_0 - G_0}{2} \cos 20 + Zay Go 2 = 0$   
 $= \frac{G_0 + G_0}{2} + \frac{G_0 - G_0}{2} \cos 20 + Zay Go 2 = 0$   
 $= \frac{G_0 + G_0}{2} + \frac{G_0 + G_0}{2} \cos 20 - Zay Go 2 = 0$   
 $G_0 + G_{0+q_0} = \frac{G_0 + G_0}{2} + \frac{G_0 - G_0}{$ 

By adding 
$$G_1 \downarrow G_2$$
  
 $G_1 + G_2 = G_0 + G_y$   
 $Hasimus dear stress$   
 $f = \frac{1}{2} + e_0 + \left( + \frac{1}{2} + \frac{1}{2}$ 

Resultant Stress Li Egite Fred Gri is colculated on any oblique planes. ) = 00 m GRE an example a semilar 762  $\mathbb{S}_{n} = \sqrt{\mathbb{S}_{n}^{2} + \mathbb{Z}_{n}^{2}}$ Mar Charmer Kinkle a by 108-108) / 4- ( 10 + 12) ( 4 1 4 3  $-\tan\beta=\frac{z}{c_{0}}$ Supressing 1 ALL'AN Z B = tap ( 2 ) 1 10 - 1 40 N/mm2-Congress / (10 - 20) + C. 100 - 5 manine shared - 10085. /30 > 80 N/mm2 Cman = 91-927 30 N/mm2 (10-12) - 1 - 01-1 for the given state of strass; calculate (i) Normal and shear stresses on oblique plane (ij) principal strass and it's location. (iij) maximum shear strass and it's plane. (ir) Obliquity and resultant stress. Tort of  $B = \cdot |ao'| \left(\frac{z}{z}\right) orc \cdot |ao'| \left(\frac{z}{z}\right)$ Any. To find OGn, Fof Tor Co There claid 2 6, f 62 f 0p (m) 38 = 0
3 Tman 1 p The BC H/man 2month op y B, Or - 80 M (mar -

2 South 2 Call -formalae  $G_{n} \text{ or } G_{0} = \left(\frac{G_{n} + G_{y}}{2}\right) + \left(\frac{G_{n} + G_{y}}{2}\right) \cos 2\theta + C_{ny} \sin 2\theta$ I Normal stress on any oblique plane,  $Z \text{ or } To = -\left(\frac{6\pi - 6y}{2}\right) \sin 20/7 \ Tay \ \cos 20, \$ -Sheare stress at as oblique plane  $\Theta_{1,2} = \left(\frac{\Theta_{n+\Theta_{y}}}{2}\right) + \sqrt{\left(\frac{\Theta_{n-\Theta_{y}}}{2}\right)^{2} + C_{ny}^{2}}$ - preincipal strassor. Han Bar Gar  $\theta_p = \frac{1}{2} + \tan^{-1}\left(\frac{2\xi_{yy}}{6\alpha - \beta_y}\right) = 0$ Location of preincipal plane  $\operatorname{Condu} \equiv \sqrt{\left(\frac{\vartheta_{n}-\vartheta_{y}}{2}\right)^{2}+7\pi y^{2}}$ - manumum sheare stress,  $T_{max} = \frac{\beta_1 - \beta_2}{\beta_1 - \beta_2}$  $\phi = \pm \pm an^{-1} \left( - \frac{6\pi - 6y}{27mg} \right)^{-s} manifer los interesting of plane of maximum shears strugger all$ Normal and Elanne Share Share on able 15 - - - -Foliquity & Resultant Strast and conte Jugioning in On = Voo + 20 . would and that have prove prover ho  $\beta = -\tan^{-1}\left(\frac{70}{50}\right) \text{ or } +\tan^{-1}\left(\frac{2}{5n}\right)$ to To Repet as a s + starie () Given data  $\Theta = 30^{\circ} (cw)^{\circ} + \frac{1}{2} + \frac{1}{2} = 0$ For = 80 N/mm2 Gy = - 40 N/mm<sup>2</sup> D. B. J. Ste Z. my = - 80 N/mm2 a plane y direction stress

1. Normal strass on oblique plane  $G_{n} = \bigoplus \Re\left(\frac{G_{n}+\beta y}{2}\right) + \left(\frac{\beta x - \beta y}{2}\right) \cos 20 + \cos 20 + \cos 20$  $= \frac{80 - 40}{2} + \frac{80 - (-40)}{2} c_{e_{\mu}}(2 \times 30^{\circ}) + (-80) sin(2 \times 30^{\circ})$ : ann 14 001 Qn = -19.28 N/mm<sup>2</sup> plane of reasingen sheen shows 2. Shear Stress on oblique plane -1) tool = = (0.1 )  $\operatorname{Con} \operatorname{Co} = -\left(\frac{\operatorname{En} - \operatorname{Ey}}{2}\right) \operatorname{Sin} 20 + \operatorname{Tny} \operatorname{Cos} 20$  $= -\left(\frac{80 - (-40)}{2}\right) \sin(60) + (-80) \cos(60)$ Z = -91.96 N/mm² Sherre -ve meand 2 22 autiverticent plane is electronise direction. 3. Principal stresses  $\Theta_{1/2} = \left(\frac{\Theta_{x} + \Theta_{y}}{2}\right) \pm \sqrt{\left(\frac{\Theta_{x} - \Theta_{y}}{2}\right)^{2} + \frac{1}{2} \frac{1}{2}$ = (80 440) 70 V (80740) 2/ (-80) 2/ (-80) 2/ (-80) = 20 tongo -) A (80. PI-) / = for (+ve) 20+100 = 120 N/mm2 2 only compare =fort + (-ve) (20- 100) = = = 80 N/mm2 - magnetreaser p G1 = 120 N/mm2 -> major principal stress E2= - 800 N/mm -> minor principal strast 4. Location of preincipal plane, Op= (=) tan, (27mg) principal plane ", at 26.56". from vertical  $\mathfrak{I} = (\Lambda) = \mathfrak{I} - (\mathfrak{I} \times (-\mathfrak{so}))$  place is anti-clockwise =  $\mathfrak{I} = \mathfrak{I} - \mathfrak{I} - \mathfrak{I} - \mathfrak{I} - \mathfrak{I} = \mathfrak{I} - \mathfrak{I}$ 

b. Charge = 
$$\sqrt{\left(\frac{6\pi - 6y}{4\pi^2}\right)^2 + 7 cm^2}$$
 (11 + 13) +  $\left(\frac{100}{5}\right)^{10}$  =  $\sqrt{10}$   
=  $\sqrt{\left(\frac{80}{32}+\frac{1}{32}\right)^2 + \left(-80^2\right)}$  (11 + 13) +  $\left(\frac{100}{5}\right)^{10}$  =  $\sqrt{10}$  +  $\frac{100}{5}$  =  $\sqrt{10}$   
=  $160$  N/m<sup>2</sup>.  
(11 + 10) (12 + 10

OTC Lingar P Gn zy towards the Scenbace So 'et 20 Compressive. \* How to salet reference plane 40 N/mm2 The plane which carries Ro N/mm<sup>2</sup> manum strikes In a given problems should 101 80 N/mm 1. a part-Based on be taken of returnmagne-tude right ceupsplane uslow; On 100 N/mm2 Rebarcence plane - all estavoid evoles all-of > 20 N/mm2 60 Earlant John Tables + (En-E) plane represe 10110 IN YOU 0=60° - month of the highest stores value Cny Should be taken as En I shear stress on or-plane and y-direction. 97 this type of a figure is 1 Simply rotate 90° 30 N/mm2 QCVED. Zyn > 100 N/mm2 60 ( Coy = 50 N/mm? 0 = 60° fanti-clock wise } 23 for c Mohre's Circle Method cw 121 => tre AZ > shear stress ACWIUN => oredinate. Abserssa > (Tensile) -0,00,0 Normal Stress (Compressive)

This point represent a plane. and the state of the way A ( 5 1, 21) 21 were a los for a privated the liter 671 Sim/11 (1) > Each plane on a given state of stress has a certain values of songlithing on To 4 to 7 50 and 2 vorent so and to all togethere indicates a part iceelan obliques planes in -> In the above figuerce the point of represents a part écular oblique plane. Immilisos -> A point drawn on (En-2) plane represents a plane on State of stress of a planet. OR Slave Stress 600 gr, plane Vers M direction. -\* Try= Eyn 0 > En CON SO M/mro Assume Gny Gy 2 1 y Loo Alfron 2290 50 0,0 J not Chiele JV4 golomne smally En (Torsile 910 reprint stress (wither of

Sign Convention min Line an am Tensile (tive) and to the point bit without Comprossive Give surfaces is C The work of the contraction of t Aew in plane (-ve) . el suite voidon Or of the friend reterrance (+ve) and will all? ACRO Friding resterance (tre) lundt estal po units plane (mon ) of The figure we can waasure the man 0 K = 500 (1000 ACBN, Try). B ( Gy, Zyn) zyn L 9m . 1x m 29 = 05 = x1+ Logar ruy 20180112 raissigner lans and pariosinal Gn-z plane. Locate point A' 4 B' 00 Step-1 for given state of stress take suitable seale To convert ex= 100 mpa -> 10 cm (H)Stress interms 1 mpa(11) 10 km = 0.1 cm Of length (mm) mpa -> 5 cm 50 3 Repercence plane A (6a, Zzy) AC: Rebenence ine 20 >6n (0,0) 20 Gy GI out and are rophies cinels respicate 00 50 the water and weller with 1 Cousni Sno 6m Sight oblique

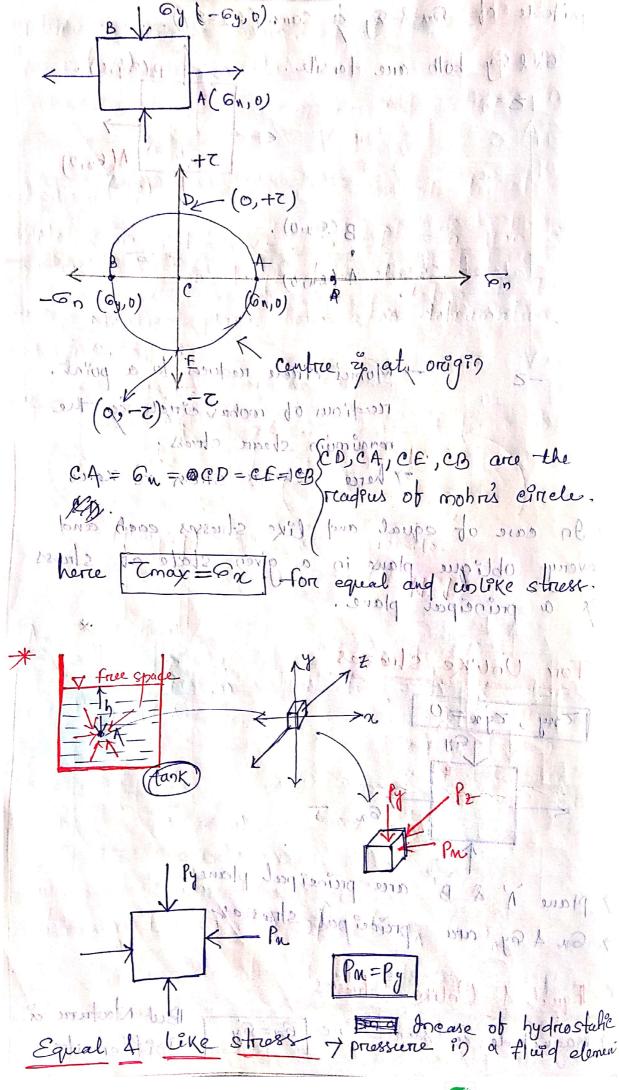
Step-2: Join A 4 B Step-3: The intersection of line ABI with En anis te C'. C as centre, AC on CB as reading greaw a circle. This circle is called as mohris circele. (our) and in with Note: - The angles between any fixed planes on mohris Circle is twice that ( of them actual angle. -friend the figure we can measure the = To (mm)  $OK = \overline{OO} (mm).$ ex! - +1K = 15 mm ex! (211/2 1/08) (1) - 7 1/2 tlK=Zo=15mm × 1 mpa = 15 mpa principal plane and principal strasses \* toeation of ent plays of chasol take 1-901 i.e 0p, 61, 4.92 to seargy op plane H' zy fr 1 +2 Ŧ (m) 01 .2 A of as = X= 150 mpa active Gates A (6x, 2x4) m from Aci 20, - Reterrence plane. 110.19 20p (0,0) 6 E principal plane 202 plane B LACH = 01 In plane of Tmayo AC: Rolfing - At principal plane the schear stress is zerio -y Each and every point on the mobiles cincle represe nt a plane circumpterence of mohrs circle have infinite -y The number of points and each point represents particular state of stress at a particula

plane. -y Location ob principal plane ty LACF = 20pmill 20p= LACF = elonge widon de motion Op = LACF (cluder wie a) sints vindom de l'unhampidi I from the mobile circle we can see that At point 'G' and F' the value of z' ze zero so G'& F' point are the principal planes !! ( av -) upm >= I.D > F'zy the major (principal plane Coz value of normal Stross ze highest and the G'zy the minor principal plane coz the value of pormal stress zy Lowest. -> Location of minor principal plane. Minure 2012= LACG 00=00+00 OP2 = LACG ( CLOCK Wise) 12- NO + 69 -> principal stress mayor presnespal stress 20 OF=6, (12 mm) minor principal stress  $z_{g} = 061 = 8_2 (100 mm) = 90$ -> The point in here of the mobile concle potensect the Enfancis ze called at principal plane. \* Maximers shear stress and El's plane - The point on the mobre's circle where the value of Z zo manimum that point zo Known as manimum Shear strussing) + > Draw a perpendicular line from on anis from point c'ire centre of mobres circele si NOW CH = Tman (tve) cloer wire makimum shear strus ( = equal to the readius of the mohry concle. and have a strength of the second strength of

-> GF = Diameter 10th mohres cincle Chant ire readious of mohres creele = 41F > Diameter of mohris circle i e GIF = E1+E2 CI = -Cmag (-ve) i.e. Anticloex wire 7 In plane of manimum shearing stress portmal stress ze of the kighest and the not zero. -> OC = Distance of centre of mohris circle brom location of minute principal planner. Repipio 20P3 = 1 118.61 0C = 0D + DC= 6y + 6x - 6y (pairs xoup) [1831] 10 majore musaetpat strast  $\frac{2}{3}$  of =  $\frac{1}{3}$   $\frac{1}{5}$   $\frac{1}{5}$   $\frac{1}{5}$   $\frac{1}{5}$   $\frac{1}{5}$   $\frac{1}{5}$   $\frac{1}{5}$ 0c = (exc+eg) = 0 = 10 is crown 2 logie of 100 monthsDistance of centre of mohresoleineles from ( Manual elicatic elices out the plana Resultant strass and obliquity into the formation oblight for that portuging + (60, 304) 12 mod line Them as mail mon point ) Draw a perpending 65 Ô circle าค c' re centrie ob Mailes Zaorz ine Shear the contraction of the plant Kr know normal stress or oblige plane

I what ze preneiped strass in the case. To to it we know that the strien acting on the preincipal plan ty called as principal strass. So For \$ , Gy pire the 5+ 68 1/ 100 principal strasses. Joff on On Tay cl-Meigh NOGI + En 62= by -> Mohrds Circles, for above case. Hould to state would isonal plan will for a garage 110 B ( Fy , 10) (Gn ,0) C (64,0 stresses. for tensile B (-64,0) (- 6y,0) 11 mp A(- En, 0) 62007 (-64,0) for like straked over is sitt forcent comprises ve arrest plus For 1 & I buty tensils in nature. strasser i by isolong -> for equal and like 6x 4 6y Mature zy sa i.e enolg ( ( tensite Compressive

magnitude of Grat Gy Ze same (Fox=Fy). B(Gy)o) out by both are lonsile. ul (0,0 5 -A(60,0) (5+,0) B (Gyo). A (Bu, 0) 0:00) cipility Mobris circle reduces to a point. ۷ 2reedious of mohrs cinete zy the Maningum sheart stress. Cheat Stress is Zetio herce readens of mobres cinete. > In case of equal and like stresses each and every oblique plane in a given state of shoes principal plane. 04 Unlike stresses \* For Try, Tyn=0 169 ( dok) Gn, > plane à' & B' arre principal plane. -> Gu & Gy are prine pal stresses. \* Equal 4 Unlike Strasses But Natura is Magnitude zy same i.e Gr=Gy Different.

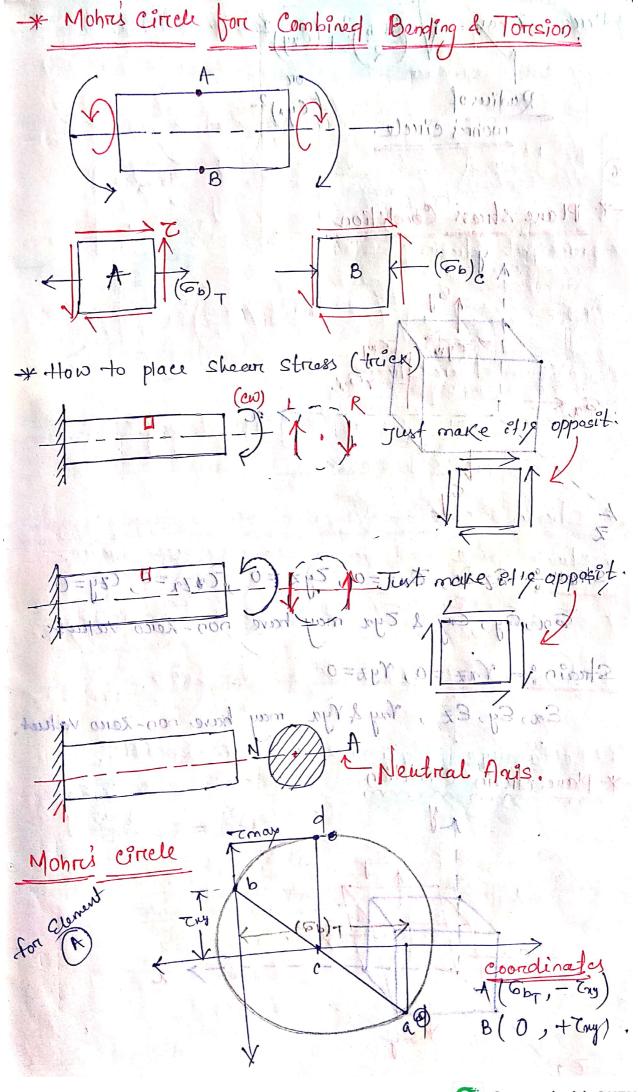


prossierce hydreo static (-Gx10) Indi- cion X UA 25 Shirad temperial - ligno 0.0 100 DREAD 25 C (mas) ension Tensile stress B lans? (a. N Bending comp. C compressive P stress moment Hore zonal members is called beam. Beam canny vertical local in transverse deraction, = 1000 mg. rde 6. 100 M=f.d. ZMa> Summation of moment ob forces upto Section. -> Due to application of Berding moments the tanile 4 Comprassive stron are setup in a in-the beam these lewile and comprassive strong are called Indervet strugg

After Cutting the bears, (+ve) (6b) T Sil Moult. (6b)c (uixe: (-ve) \*Inle Know that 5x8. So 9f 5=0, they 8=0 If there is no temperature change. -\* In Neutreel plane there is no deborimation. E=0, 61=0 tensile -\* Comp comp. (Hogging) Tensile Sagging 100 6(0,0) (Gb)\_ 6b)e Hagging (A) For Hord Societ man Byre of called bacing. Tmayo the Arrand Jana Eppens county weithead loved a(6bT,0)  $C_{mayo} = \frac{6-bT}{2}$ b EMAN Summation of money of three upto = (Trough) good ty profition (65) 451 (66) 310 of 2010 (mayo) Compidence is were among so hep pa and Rose Controlo and compressive chines CIRC indirace 1 she is .

E LIDXP For Hogging (S) ined a read pair source in languate l'encer. alozh. 1. P-Ra material 6(0,0) 10141 - D (TEbr) 0) > Shaan Shan tebangar only Jostital 01 Keeping the real indo Level indi See Runo asus 19to reatherior Para - 160 stor 0'1 toot 9.00 Tishear seefing of the shaft 2 - F= Torque . Sport -7 lon Shearc Palat Twist prioduced due to exteringly applied torque "" Known as purce. pure toresion 1=0 Y,=0 the cars torderion, Totalie Manifamas Y (5+,0) active sheering a 7 Toraional shear stren is function of nadices z = f(n)1.6 Z & Madius, ()-10] C C Contrac 00 ette - 12 0 = Angle of twist \$ = Shearc Strain.

According hrows law 
$$\overline{tag}$$
 of there is no change  
i) temperature.  
St the material is homogeney and Scotnepie then.  
 $\overline{t} = \overline{G} \phi$   
I shear stren changes only is notical direction.  
I officiance constant they in that case the she  
Stress will not change at any section ob the sheb  
Mohre's constant they in that case the sheb  
 $\overline{M} \circ \overline{t} \circ \overline{t}$ 



-> + lercen Trays = 1 (16b) 2+ (Twy) 2 (Tyn)2 Radiusof mohre's circle 26 \* Plane stress Condition A James ) 405712 Sha cure place Ga え Stress - 162=0, Triz=0, Zyz=0, Tozz=0, Tzy=0 En, Ey, Try & Tyx may have non- Zero Values, Straig = Vaz = 0, Yyz=0 Ex, Ey, Ez, Yny & Yya may have non-zero valuet. \* Plane strain Condition \_y 107 x E)

$$rained strain on an obligue plane of the strain of the second strain o$$

Location of place of maximum sheat strain:  

$$\frac{dY}{d\theta} = 0$$

$$\frac{d}{d\theta} = \frac{1}{2} + \sin^{-1} \left( -\frac{2\pi}{2} - \frac{8\pi}{2} \right)$$

$$\frac{dY}{d\theta} = 0$$

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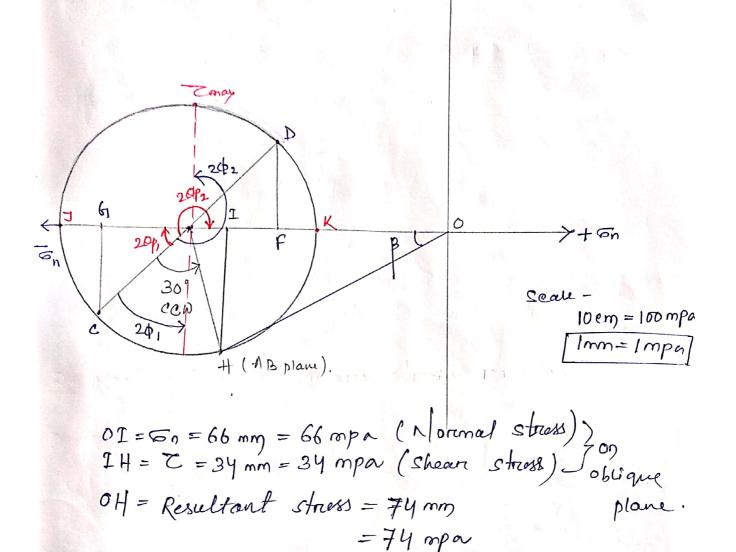
$$\frac{dY}{d\theta} = \frac{1}{2} + \sin^{-1} \left( -\frac{2\pi}{2} - \frac{8\pi}{2} \right)$$

$$\frac{dY}{d\theta} = \frac{1}{2} + \sin^{-1} \left( -\frac{2\pi}{2} - \frac{8\pi}{2} \right)$$

$$\frac{dY}{d\theta} = \frac{1}{2} + \sin^{-1} \left( -\frac{2\pi}{2} - \frac{8\pi}{2} \right)^{2} + \left( \frac{4\pi}{2} - \frac{8\pi}{2} \right)^{2} + \frac{8\pi}{2} \right)^{2} + \left( \frac{4\pi}{2} - \frac{8\pi}{2} \right)^{2} + \left( \frac{4\pi}{2} - \frac{8\pi}{2} \right)^{2} + \frac{8\pi}{2} \right)^{2} + \left( \frac{4\pi}{2} - \frac{8\pi}{2} \right)^{2} + \frac{8\pi}{2} \right)^{2} + \frac{8\pi}{2} \right)^{2} + \frac{8\pi}{2} + \frac{8\pi}{2} \right)^{2} + \frac{8\pi}{2} \right)^{2} + \frac{8\pi}{2} + \frac{8\pi}{2} \right)^{2} + \frac{8\pi}{2} \right)^{2} + \frac{8\pi}{2} + \frac{8\pi}{2} \right)^{2} + \frac{8\pi}{2} + \frac{8\pi}{2} \right)^{2} + \frac{8\pi$$

part values 10t '0' 10 10 20 20 4 100 201 001 001 001 001  
En = 
$$\frac{2}{2}$$
 +  $\frac{2}{2}$  (cos 20 4  $\frac{1}{2}$   $\frac{1}{2}$ 

27) A machine component is subjected to the stresses as shown in figure find the normal stress and Shear stress on plane AB. Pretined at an angle of 60 with X-anis. also find resultant to strass on the section by mohre's circle. 50 mpa (-50,25) Anel i ~ 35 mpa eomp Dn = 100 mpa = -100 por b 6 y = 50 mpa = - 50 200 mp. Vertical planes arre ocer 100 mpail 19 60 (2100) 100, 00° out rieberience plane. Cry = 35 mpa (icew) moup? no mpassi = - 25 mpa  $\theta = 60^{\circ} (cew)$ 0=UL,º ( ) = ( 30° ( ccw) = -30° weight 2 agreation 10 OF Loompa + 5 cm 1 mg (1) $lmm = \frac{20}{10} = \frac{2}{10}$ may ! 50,+25 Nort. 83 = -100,-25 By solving - 11:050 three aquations, hav the me San 2 Stresser - 11 rec. 16 326112013 +1311)  $\varepsilon_1 = E[\varepsilon_1 + u | \varepsilon_1)$ 5-111-1 8113-1



 $OP = ?, \phi = ?, \Theta_1 + \Theta_2 = ?, Concyp = ?, B = ?$ let us tring these values. OJ = 61 -> majore principal Stress # OK = E2 -> minore principal stress. 20PI - Location ob major principal plane. 20Pa + location ob minor principal plane.

