I'm not a bot

Introduction When a component is subject to increasing loads it eventually fails. It is comparatively easy to determine the point of failure of a component subject to a single tensile force. The strength data on the material identifies this strength. However when the material is subject to a number of loads in different directions some of which are tensile and some of which are shear, then the determination of the point of failure is more complicated... Metals can be broadly separated into DUCTILE metals and BRITTLE metals. Examples of ductile metals include mild steel, copper etc . Cast iron is a typical brittle metal. Ductile metals under high stress levels initially deform plastically at a definite yield point or progressively yield. In the latter case a artificial value of yielding past the elastic limit is selected in lieu of the yield point e.g 2%proof stress.At failure a ductile metal will have experienced a significant degree of elongation. Brittle metals experience little ultimate elongation prior to failure and failure is generally sudden. A ductile metal is considered to have failed when it has suffered elastic failure, that is when a marked plastic deformation has begun.A number of theories of elastic failure are recognised including the following: Maximum principal stress theory ..... Can be used - with caution for brittle metals Maximum shear stress theory Distortion energy theory.....Favoured for ductile metals Constant distortion energy theory The maximum principal stress theory ..The theory associated with Rankine. This theory is approximately correct for cast iron and brittle materials generally. According to this theory failure will occur when the maximum principal stress in a system reaches the value of the maximum strength at elastic limit in simple tension.For the two dimensional stress case this is obtained from the formula below (ref page on Mohrs circle). The design Factor of Safety for the two dimensional case= FoS = Elastic Limit from tensile test / highest principal stress. The Maximum Shear Stress Theory .. The theory associated with Tresca and Guest. This is very relevant to ductile metals. It is conservative and relatively easy to apply.It assumes that failure occurs when a maximum shear stress attains a certain value. This value being the value of shear strength at failure in the tensile test.In this instance it is appropriate to choose the yield point as practical failure. If the yield point = Sy and this is obtained from a tensile test and thus is the sole principal stress then the maximum shear stress Ssy is easily identified as Sy /2 . (ref to notes on Mohrs circle).. Mohr's Circle Ssy = Sy /2 In the context of a complicated stress system the initial step would be to determine the principle stress i.e. 1, 1 & 3- in order of magnitude 1 > 2 > 3..then the maximum shear stress would be determined from Maximum Shear Stress = max = Greatest of (1 - 2) / 2: (2 - 3) / 2: (1 - 3) / 2= (1 - 3) / 2 The factor of safety selected would be FoS = Sy / (2 . max) = Sy / (1 - 3) The theory is conservative especially if the yield strength is more then 50% of the tensile strength.. For the simple case of a tensile stress x combined with a shear stress xy . The design FOS + FoS = Sy / (x 2 + 4. xy 2)1/2 For a case of a component with 1 > 2 both positive (tensile) and with 3 = 0 then the maximum shear stress = (x - 0) / 2 Distortion Energy Theory Also called Shear Strain Energy TheotyThis theory is also known as the Von Mises-Hencky theory Detailed studies have indicated that yielding is related to the shear energy rather than the maximum shear stress.. Strain energy is energy stored in the material due to elastic deformation. The energy of strain is similar to the energy stored in a spring. Upon close examination, the strain energy is seen to be of two kinds : one part results from changes in mutually perpendicular dimensions , and hence in volume, with no change angular changes: the other arises from angular distortion without volume change.The latter is termed as the shear strain energy , which has been shown to be a primary cause of elastic failure.. It can be shown by strain energy analysis that the shear strain energy associated with the principal stresses 1, 1 & 3 at elastic failure, is the same as than in the tensile test causing yield at direct stress Sy when: (1 - 2) 2 + (2 - 3) 2 + (1 - 3) 2 > = 2 Sy2 In terms of 3 dimensional stresses using Cartesian co-ordinates (x - y) 2 + (y - z) 2 + (z - x) 2 + 6. (xy2 + yz2 + zx2) >= 2 Sy2 In terms of plane stress this reduces to.. (x2 - x . y + y2 + 3 . xy2) >= Sy2 In terms of simple linear stress combined with shear stress.. Factor of Safety FOS = Sy / (x2 + 3 . xy2) 1/2 Strain Energy Theory ..The theory associated with Haigh. This theory is based on the assumption that strains are recoverable up to the elastic limit, and the energy absorbed by the material at failure up to this point is a single valued function independent of the stress system causing it. The strain energy per unit volume causing failure is equal to the strain energy at the elastic limit in simple tension.. The following relationship can be derived from this theory. (Sy is the yield point in simple shear and = poissons ratio.) Failure Occurs with this theory when.... M(1 - 2) 2 + (2 - 3) 2 + (1 - 3) 2 + 2 n. (1.2 + 2.3 + 1.3) Sy Option 2 : Guest's theory Free 20 Questions 20 Marks 20 Mins Explanation: Maximum Shear Stress Theory: Applied satisfactorily to ductile materials. This theory states that the failure can be assumed to occur when the maximum shear stress in the complex stress system is equal to the value of maximum shear stress in simple tension. The relation between the theories of failure, their suitable materials, and graphical representation is given below. Theory Suitable Material Graphical Representation Maximum Normal Stress Theory Or Maximum Principal Stress Theory Or Rankines Theory Brittle material Maximum Normal Strain Theory Or Maximum Principal Strain Theory Or St.Venants Theory Ductile and brittle materialbut results are not accurate in both Maximum Shear Stress Theory Or Guest & Trescas Theory Ductile material Maximum Strain Energy Theory Or Haigh and Beltrami Theory Ductile material Maximum Shear Strain Energy Theory Or Distortion Energy Theory Or Von Mises Henky Theory Ductile material Indias #1 Learning Platform Start Complete Exam Preparation Daily Live MasterClasses Practice Question Bank Mock Tests & Quizzes Trusted by 7.1 Crore+ Students Maximum shear stress theory (Tresca theory) is one of the theories of failure used for the safe design of mechanical components made up of a ductile material. The method is not suitable for hydrostatic stress conditions.In this article, were going to discuss:What is Maximum shear stress theory?Maximum shear stress theory in three-dimensional loading:Maximum shear stress theory for biaxial loading:Yield surface for Maximum shear stress theory in biaxial loading:Maximum shear stress theory formula in form of axial stresses (`\sigma_{x}` and `\sigma_{y}`):Solved Numerical:FAQs:Maximum shear stress theory states that when the maximum shear stress in an object reaches or exceeds the magnitude of yield shear stress in uniaxial loading, the object material undergoes failure.In this theory of failure, the max shear stress developed in an object is a deciding factor for failure.This theory is also known as the Tresca theory, named after French engineer, Henri Tresca.Let me explain this theory simply.Consider an object subjected to biaxial or triaxial loading. Due to the application of load, the objects material experiences different normal stresses and shear stresses.Among all stresses, for this failure theory, we are interested in the maximum value shear stress developed in an object.While the yield shear stress in uniaxial loading `\tau_{\text{y. uniaxial}}` is a property of a material of an object.Thus as per this theory, the material of this object undergoes failure when the maximum shear stress developed in an object (`\tau_{max}`) exceeds or becomes equal to the yield shear stress value in a uniaxial tensile test (`\tau_{\text{y. uniaxial}}`).Thus to prevent failure, there should be,Maximum shear stress yield shear stress (uniaxial)`\tau_{max} \leq \tau_{\text{y. uniaxial}}`As for uniaxial loading, `\tau_{\text{y. uniaxial}} = \frac{\sigma _{\text{yield}}}{2}`, the equation become,`\tau_{max} \leq \frac{\sigma _{\text{yield}}}{2}`This is the formula for the max shear stress theory.Limitations of max shear stress theory:The theory is not suitable for the brittle material.It is not suitable for the hydrostatic loading.Read here: Maximum distortion energy theoryThe below figure shows the principal stresses (`\sigma_{1}, \sigma_{2}, \sigma_{3}`) for the object subjected to the triaxial loading. Each of the plane stress conditions has a maximum in-plane shear stress (`\tau_{12}, \tau_{23}, \tau_{31}`).The maximum shear stress in triaxial loading is equal to a higher magnitude among the in-plane shear stresses, `\tau_{12}, \tau_{23}, \tau_{31}`.`\therefore \tau_{max} = |\tau_{12}, \tau_{23}, \tau_{31}|``\tau_{max} = | \frac{\sigma _{1}-\sigma _{2}}{2},\frac{\sigma _{2}-\sigma _{3}}{2},\frac{\sigma _{1}-\sigma _{3}}{2}|\cdots[1]`For uniaxial loading at the yield point, the relationship between yield stress and shear stress is given by,`\tau_{\text{y. uniaxial}} = \frac{\sigma _{\text{yield}}}{2}\cdots[2]`As per the statement of maximum shear stress theory, the object fails when,`\tau_{max} \leq \tau_{\text{y. uniaxial}}`Put values from [1] and [2] in the above equation,`| \frac{\sigma _{1}-\sigma _{2}}{2},\frac{\sigma _{2}-\sigma _{3}}{2},\frac{\sigma _{1}-\sigma _{3}}{2}|\leq\frac{\sigma _{\text{yield}}}{2}`Hence the conditions for the failure in three-dimensional force can be also written as,`\frac{\sigma _{1}-\sigma _{2}}{2}\leq \frac{\sigma _{\text{yield}}}{2}``\frac{\sigma _{2}-\sigma _{3}}{2}\leq \frac{\sigma _{\text{yield}}}{2}``\frac{\sigma _{1}-\sigma _{3}}{2}\leq \frac{\sigma _{\text{yield}}}{2}`By simplifying, the maximum shear stress theory equations can be written as,`| \sigma _{1}-\sigma _{2} |\leq \sigma _{\text{yield}}``| \sigma _{2}-\sigma _{3} |\leq \sigma _{\text{yield}}``| \sigma _{1}-\sigma _{3} |\leq \sigma _{\text{yield}}`Where, `\sigma_{1}, \sigma_{2}, \sigma_{3}` are the principal stresses.For biaxial loading one of the principal stress will become zero.Hence by putting `\sigma_{3}` = 0 in the above three equations of triaxial loading, we get,`| \sigma _{1}-\sigma _{2} |\leq \sigma _{\text{yield}}` (1)`| \sigma _{2} |\leq \sigma _{\text{yield}}` (2)`| \sigma _{1} |\leq \sigma _{\text{yield}}` -(3)These are the conditions for the maximum shear stress theory for biaxial stresses.Note:- Condition 1 is considered when values of `_{1}` and `_{2}` are different, while conditions 2 or 3 are considered when `_{1}` and `_{2}` are same.For the tensile and compressive yield strength, the equations are written as,Boundaries of region for tensile condition,`| \sigma _{1}-\sigma _{2} |= \sigma _{\text{yield}}` (a)`| \sigma _{2} |= \sigma _{\text{yield}}` (b)`| \sigma _{1} |= \sigma _{\text{yield}}` (c)For the compressive condition,`| \sigma _{1}-\sigma _{2} |= -\sigma _{\text{yield}}` (d)`| \sigma _{2} |= -\sigma _{\text{yield}}` (e)`| \sigma _{1} |= -\sigma _{\text{yield}}` (f)From these equations, the yield surface can be plotted as,The condition for maximum shear stress failure in biaxial loading is,`\sigma _{1}-\sigma _{2}=\sigma _{\text{yield}}`But `\sigma _{1}` and `\sigma _{2}` are principal stresses which are given by,`\sigma _{1}=\frac{\sigma _{x}+\sigma _{y}}{2}+\sqrt{(\frac{\sigma _{x}-\sigma _{y}}{2})^{2}+\tau_{xy}^{2}}``\sigma _{2}=\frac{\sigma _{x}+\sigma _{y}}{2}-\sqrt{(\frac{\sigma _{x}-\sigma _{y}}{2})^{2}+\tau_{xy}^{2}}`Now, by putting the values of `\sigma_{1}` and `\sigma_{2}` in the equation of maximum shear stress theory we get,`\sigma _{1}-\sigma _{2}=\sigma _{\text{yield}}``(\frac{\sigma _{x}+\sigma _{y}}{2}+\sqrt{(\frac{\sigma _{x}-\sigma _{y}}{2})^{2}+\tau_{xy}^{2}})-(\frac{\sigma _{x}+\sigma _{y}}{2}-\sqrt{(\frac{\sigma _{x}-\sigma _{y}}{2})^{2}+\tau_{xy}^{2}})=\sigma _{\text{yield}}``2\times \sqrt{(\frac{\sigma _{x}-\sigma _{y}}{2})^{2}+\tau_{xy}^{2}}=\sigma _{\text{yield}}``\sqrt{(\sigma _{x}-\sigma _{y})^{2}+4\tau_{xy}^{2}}=\sigma _{\text{yield}}`This is the formula or condition of maximum shear stress theory for biaxial stresses.1] The loading on the object has values `_{x}` = 120 Mpa, `_{y}` = 60 Mpa, `\tau_{\text{xy}}` = 30 Mpa while the yield strength of the material of the object is 300 Mpa. Find the F.O.S. by using maximum shear stress theory?Given:-`_{x}` = 120 Mpa`_{y}` = 60 Mpa`\tau_{\text{xy}}` = 30 Mpa`S_{yt}` = 300 MpaSolution:-By using the formula for maximum shear stress theory for biaxial loading.`\sigma _{\text{yield}}=\sqrt{(\sigma _{x}-\sigma _{y})^{2}+4\tau_{xy}^{2}}``\sigma _{\text{yield}}=\sqrt{(120-60)^{2}+4\times (30)^{2}}``\sigma _{\text{yield}}` = 84.85 MpaNow, the factor of safety is given by,F.O.S.`=\frac{S_{yt}}{\sigma _{\text{yield}}}`F.O.S.`=\frac{300}{84.85}`F.O.S. = 3.53 F.O.S. = 3.53 Therefore the FOS by using the maximum shear stress theory is 3.53.What is the application of maximum shear stress theory?The M.S.S. theory is used for the design of ductile material. eg. design of shafts.Is max. shear stress theory is suitable for brittle material?No, this theory of failure is not suitable for the design of brittle material.Read also:Maximum shear stress theory (Tresca theory) is one of the theories of failure used for the safe design of mechanical components made up of a ductile material. 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Due to the application of load, the objects material experiences different normal stresses and shear stresses.Among all stresses, for this failure theory, we are interested in the maximum value shear stress developed in an object.While the yield shear stress in uniaxial loading `\tau_{\text{y. uniaxial}}` is a property of a material of an object.Thus as per this theory, the material of this object undergoes failure when the maximum shear stress developed in an object (`\tau_{max}`) exceeds or becomes equal to the yield shear stress value in a uniaxial tensile test (`\tau_{\text{y. uniaxial}}`).Thus to prevent failure, there should be,Maximum shear stress yield shear stress (uniaxial)`\tau_{max} \leq \tau_{\text{y. uniaxial}}`As for uniaxial loading, `\tau_{\text{y. uniaxial}} = \frac{\sigma _{\text{yield}}}{2}`, the equation become,`\tau_{max} \leq \frac{\sigma _{\text{yield}}}{2}`This is the formula for the max shear stress theory.Limitations of max shear stress theory:The theory is not suitable for the brittle material.It is not suitable for the hydrostatic loading.Read here: Maximum distortion energy theoryThe below figure shows the principal stresses (`\sigma_{1}, \sigma_{2}, \sigma_{3}`) for the object subjected to the triaxial loading. 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Find the F.O.S. by using maximum shear stress theory?Given:-`_{x}` = 120 Mpa`_{y}` = 60 Mpa`\tau_{\text{xy}}` = 30 Mpa`S_{yt}` = 300 MpaSolution:-By using the formula for maximum shear stress theory for biaxial loading.`\sigma _{\text{yield}}=\sqrt{(\sigma _{x}-\sigma _{y})^{2}+4\tau_{xy}^{2}}``\sigma _{\text{yield}}=\sqrt{(120-60)^{2}+4\times (30)^{2}}``\sigma _{\text{yield}}` = 84.85 MpaNow, the factor of safety is given by,F.O.S.`=\frac{S_{yt}}{\sigma _{\text{yield}}}`F.O.S.`=\frac{300}{84.85}`F.O.S. = 3.53 F.O.S. = 3.53 Therefore the FOS by using the maximum shear stress theory is 3.53.What is the application of maximum shear stress theory?The M.S.S. theory is used for the design of ductile material. eg. design of shafts.Is max. shear stress theory is suitable for brittle material?No, this theory of failure is not suitable for the design of brittle material.Read also: It has already been discussed in the previous chapter that strength of machine members isbased upon the mechanical properties of the materials used. Since these properties are usuallydetermined from simple tension or compression tests, therefore, predicting failure inmembers subjected to uniaxial stress is both simple and straight-forward. But the problem ofpredicting the failure stresses for members subjected to bi-axial or tri-axial stresses is muchmore complicated. In fact, the problem is so complicated that a large number of differenttheories have been formulated. The principal theories of failure for a member subjected to biaxialstress are as follows:Maximum principal (or normal) stress theory (also known as Rankines theory).Maximum shear stress theory (also known as Guests or Trescas theory).Maximum principal (or normal) strain theory (also known as Saint Venant theory).Maximum strain energy theory (also known as Haighs theory).Maximum distortion energy theory (also known as Hencky and Von Mises theory).Since ductile materials usually fail by yielding i.e. when permanent deformations occur in thematerial and brittle materials fail by fracture, therefore the limiting strength for these twoclasses of materials is normally measured by different mechanical properties. For ductilematerials, the limiting strength is the stress at yield point as determined from simple tensiontest and it is, assumed to be equal in tension or compression. For brittle materials, the limitingstrength is the ultimate stress in tension or compression.1. Maximum principal stress theory (Rankines theory)According this theory failure or yielding occurs at a point in a member when the maximumprincipal or normal stress in a bi-axial stress system reaches the limiting strength of thematerial in a simple tension test. Since the limiting strength for ductile materials is yield pointstress and for brittle materials (which do not have well defined yield point) the limitingstrength is ultimate stress, therefore according to the above theory, taking factor of safety(F.S.) into consideration, the maximum principal or normal stress in a bi-axial stresssystem is given bySince the maximum principal or normal stress theory is based on failure in tension or compression and ignores the possibility of failure due to shearing stress, therefore it is not used for ductile materials. However, for brittle materials which are relatively strong in shear but weak in tension or compression, this theory is generally used.2. Maximum shear stress theory (Guests or Trescas theory)According to this theory, the failure or yielding occurs at a point in a member when the maximum shear stress in a bi-axial stress system reaches a value equal to the shear stress at yield point in a simple tension test. Mathematically,3. Maximum principal strain theory (Saint Venant theory)According to this theory, the failure or yielding occurs at a point in a member when the maximum principal (or normal) strain in a bi-axial stress system reaches the limiting value of strain (i.e. strain at yield point) as determined from a simple tensile test. The maximum principal (or normal) strain in a bi-axial stress system is given by4. Maximum strain energy theory (Haighs theory)According to this theory, the failure or yielding occurs at a point in a member when the strain energy per unit volume in a bi-axial stress system reaches the limiting strain energy (i.e. strain energy at the yield point) per unit volume as determined from simple tension test.We know that strain energy per unit volume in a bi-axial stress system,5. Maximum distortion energy theory (also known as Hencky and Von Mises theory)According to this theory, the failure or yielding occurs at a point in a member when the distortion strain energy (also called shear strain energy) per unit volume in a bi-axial stress system reaches the limiting distortion energy (i.e. distortion energy at yield point) per unit volume as determined from a simple tension test. Mathematically, the maximum distortion energy theory for yielding is expressed as Maximum shear stress theory (Tresca theory) is one of the theories of failure used for the safe design of mechanical components made up of a ductile material. The method is not suitable for hydrostatic stress conditions.In this article, were going to discuss:What is Maximum shear stress theory?Maximum shear stress theory in three-dimensional loading:Maximum shear stress theory for biaxial loading:Yield surface for Maximum shear stress theory in biaxial loading:Maximum shear stress theory formula in form of axial stresses (`\sigma_{x}` and `\sigma_{y}`):Solved Numerical:FAQs:Maximum shear stress theory states that when the maximum shear stress in an object reaches or exceeds the magnitude of yield shear stress in uniaxial loading, the object material undergoes failure.In this theory of failure, the max shear stress developed in an object is a deciding factor for failure.This theory is also known as the Tresca theory, named after French engineer, Henri Tresca.Let me explain this theory simply.Consider an object subjected to biaxial or triaxial loading. 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Each of the plane stress conditions has a maximum in-plane shear stress (`\tau_{12}, \tau_{23}, \tau_{31}`).The maximum shear stress in triaxial loading is equal to a higher magnitude among the in-plane shear stresses, `\tau_{12}, \tau_{23}, \tau_{31}`.`\therefore \tau_{max} = |\tau_{12}, \tau_{23}, \tau_{31}|``\tau_{max} = | \frac{\sigma _{1}-\sigma _{2}}{2},\frac{\sigma _{2}-\sigma _{3}}{2},\frac{\sigma _{1}-\sigma _{3}}{2}|\cdots[1]`For uniaxial loading at the yield point, the relationship between yield stress and shear stress is given by,`\tau_{\text{y. uniaxial}} = \frac{\sigma _{\text{yield}}}{2}\cdots[2]`As per the statement of maximum shear stress theory, the object fails when,`\tau_{max} \leq \tau_{\text{y. uniaxial}}`Put values from [1] and [2] in the above equation,`| \frac{\sigma _{1}-\sigma _{2}}{2},\frac{\sigma _{2}-\sigma _{3}}{2},\frac{\sigma _{1}-\sigma _{3}}{2}|\leq\frac{\sigma _{\text{yield}}}{2}`Hence the conditions for the failure in three-dimensional force can be also written as,`\frac{\sigma _{1}-\sigma _{2}}{2}\leq \frac{\sigma _{\text{yield}}}{2}``\frac{\sigma _{2}-\sigma _{3}}{2}\leq \frac{\sigma _{\text{yield}}}{2}``\frac{\sigma _{1}-\sigma _{3}}{2}\leq \frac{\sigma _{\text{yield}}}{2}`By simplifying, the maximum shear stress theory equations can be written as,`| \sigma _{1}-\sigma _{2} |\leq \sigma _{\text{yield}}``| \sigma _{2}-\sigma _{3} |\leq \sigma _{\text{yield}}``| \sigma _{1}-\sigma _{3} |\leq \sigma _{\text{yield}}`Where, `\sigma_{1}, \sigma_{2}, \sigma_{3}` are the principal stresses.For biaxial loading one of the principal stress will become zero.Hence by putting `\sigma_{3}` = 0 in the above three equations of triaxial loading, we get,`| \sigma _{1}-\sigma _{2} |\leq \sigma _{\text{yield}}` (1)`| \sigma _{2} |\leq \sigma _{\text{yield}}` (2)`| \sigma _{1} |\leq \sigma _{\text{yield}}` -(3)These are the conditions for the maximum shear stress theory for biaxial stresses.Note:- Condition 1 is considered when values of `_{1}` and `_{2}` are different, while conditions 2 or 3 are considered when `_{1}` and `_{2}` are same.For the tensile and compressive yield strength, the equations are written as,Boundaries of region for tensile condition,`| \sigma _{1}-\sigma _{2} |= \sigma _{\text{yield}}` (a)`| \sigma _{2} |= \sigma _{\text{yield}}` (b)`| \sigma _{1} |= \sigma _{\text{yield}}` (c)For the compressive condition,`| \sigma _{1}-\sigma _{2} |= -\sigma _{\text{yield}}` (d)`| \sigma _{2} |= -\sigma _{\text{yield}}` (e)`| \sigma _{1} |= -\sigma _{\text{yield}}` (f)From these equations, the yield surface can be plotted as,The condition for maximum shear stress failure in biaxial loading is,`\sigma _{1}-\sigma _{2}=\sigma _{\text{yield}}`But `\sigma _{1}` and `\sigma _{2}` are principal stresses which are given by,`\sigma _{1}=\frac{\sigma _{x}+\sigma _{y}}{2}+\sqrt{(\frac{\sigma _{x}-\sigma _{y}}{2})^{2}+\tau_{xy}^{2}}``\sigma _{2}=\frac{\sigma _{x}+\sigma _{y}}{2}-\sqrt{(\frac{\sigma _{x}-\sigma _{y}}{2})^{2}+\tau_{xy}^{2}}`Now, by putting the values of `\sigma_{1}` and `\sigma_{2}` in the equation of maximum shear stress theory we get,`\sigma _{1}-\sigma _{2}=\sigma _{\text{yield}}``(\frac{\sigma _{x}+\sigma _{y}}{2}+\sqrt{(\frac{\sigma _{x}-\sigma _{y}}{2})^{2}+\tau_{xy}^{2}})-(\frac{\sigma _{x}+\sigma _{y}}{2}-\sqrt{(\frac{\sigma _{x}-\sigma _{y}}{2})^{2}+\tau_{xy}^{2}})=\sigma _{\text{yield}}``2\times \sqrt{(\frac{\sigma _{x}-\sigma _{y}}{2})^{2}+\tau_{xy}^{2}}=\sigma _{\text{yield}}``\sqrt{(\sigma _{x}-\sigma _{y})^{2}+4\tau_{xy}^{2}}=\sigma _{\text{yield}}`This is the formula or condition of maximum shear stress theory for biaxial stresses.1] The loading on the object has values `_{x}` = 120 Mpa, `_{y}` = 60 Mpa, `\tau_{\text{xy}}` = 30 Mpa while the yield strength of the material of the object is 300 Mpa. Find the F.O.S. by using maximum shear stress theory?Given:-`_{x}` = 120 Mpa`_{y}` = 60 Mpa`\tau_{\text{xy}}` = 30 Mpa`S_{yt}` = 300 MpaSolution:-By using the formula for maximum shear stress theory for biaxial loading.`\sigma _{\text{yield}}=\sqrt{(\sigma _{x}-\sigma _{y})^{2}+4\tau_{xy}^{2}}``\sigma _{\text{yield}}=\sqrt{(120-60)^{2}+4\times (30)^{2}}``\sigma _{\text{yield}}` = 84.85 MpaNow, the factor of safety is given by,F.O.S.`=\frac{S_{yt}}{\sigma _{\text{yield}}}`F.O.S.`=\frac{300}{84.85}`F.O.S. = 3.53 F.O.S. = 3.53 Therefore the FOS by using the maximum shear stress theory is 3.53.What is the application of maximum shear stress theory?The M.S.S. theory is used for the design of ductile material. eg. design of shafts.Is max. shear stress theory is suitable for brittle material?No, this theory of failure is not suitable for the design of brittle material.Read also:Maximum shear stress theory (Tresca theory) is one of the theories of failure used for the safe design of mechanical components made up of a ductile material. The method is not suitable for hydrostatic stress conditions.In this article, were going to discuss:What is Maximum shear stress theory?Maximum shear stress theory in three-dimensional loading:Maximum shear stress theory for biaxial loading:Yield surface for Maximum shear stress theory in biaxial loading:Maximum shear stress theory formula in form of axial stresses (`\sigma_{x}` and `\sigma_{y}`):Solved Numerical:FAQs:Maximum shear stress theory states that when the maximum shear stress in an object reaches or exceeds the magnitude of yield shear stress in uniaxial loading, the object material undergoes failure.In this theory of failure, the max shear stress developed in an object is a deciding factor for failure.This theory is also known as the Tresca theory, named after French engineer, Henri Tresca.Let me explain this theory simply.Consider an object subjected to biaxial or triaxial loading. 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