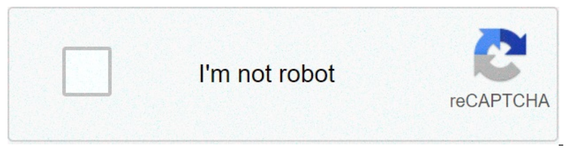

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Compressive yield strength

Compressive strength vs tensile strength, hi guys in this article we know about what is compressive and tensile strength?, what is compressive stress & strain. And also know about difference between compressive strength and tensile strength and their relationship. You know that properties of Material compressive strength and tensile strength is require for prediction of measuring various strength of column,beam,slab and truses. All the concrete structure divided into three categories on the basis of compression and tension 1) compressive member,2) tension member and 3) Flexural member. Compressive strength vs tensile strength | Stress & Strain Beam and slab experience both compression and tension, that's why they are called as flexural. They experience compression in upper part of neutral axis which resist by providing concrete and reinforcement and experience tension in lower part of neutral axis which is resist by providing main reinforcement, that's why beam and experience both compression and tension and their failure is by bending. Column is compressive member in which all the load of slab and beam horizontally transfer to column acting vertically downward, compressing dimension of column along the length,so column experience compressive load acting downward due to load of slab and beam and other structure. And also column due to internal force experience compressive force in upward direction which tends to resist the load acting in downward, so column will experience both opposite and equal forces of compressive load, that's why column is compressive member and their failure is by buckling. Compressive strength is ability of material which resist or withstand against compressive load acting both face along rising length (cross-sectional area) by reducing its size prior to failure. It is resistance of material against pushing force in equal and opposite direction. Tensile strength is ability of material with resist or withstand against tensile load acting on both face along rising length by stretch or elongate prior to failure or crack. It is Resistance of material against using pulling force in equal and opposite direction. In this article we discuss about difference between compressive strength and tensile strength (compressive strength vs tensile strength). Before this,let us discuss about elasticity and plasticity properties of Material which help in understanding compressive and tensile strength. Elastic properties of Material like concrete and steel, when tensile forces acting on both face of concrete or steel, stretch it, and develop stress, if material regain its original shape size without deformation after removing stress is known as elastic properties of Material. Plastic properties of Material like concrete and steel, when tensile forces acting on both face of concrete or steel, stretch it and develop stress, if material do not regain its original shape and size after removing stress, material will deform is known as plastic properties of Material. What is compressive strength? Stess & Strain Compressive strength is the capacity of material or structure to resist or withstand under compressive load. The Compressive strength is determined by the ability of the concrete material to resist failure in the form cracks and fissure. The maximum load at which the specimen breaks is taken as a compressive load. What is compressive strength? Stess & Strain Compressive strength is defined as resistance of material under compression prior to failure or fissure, it can be expressed in terms of load per unit area and measured in MPa. For example compressive strength of M20concrete is 20MPa. In compressive strength test of concrete, steel and other construction material the push force applied on the both faces of material specimen and the maximum compression that specimen bears without failure is noted. Compressive Force acting on concrete testing specimen helps us to majorly focus on the Compressive strength of concrete because it helps us to quantify the ability of concrete to resists Compressive stresses among structures where-as other stresses such as axial stresses and tensile stresses are catered by reinforcement and other means. As we know compressive strength is measured by compressive strength test machine (CTM) or Universal testing machine (UTM) Mathematically, Compressive strength is defined as ratio of compressive load applied by UTM machine to cross sectional area of material. Compressive strength is represented by F which is equal to F = P/A, where F = compressive strength,P= total load applied by CTM machine & A = cross sectional surface area. Generally compressive strength in English system of unit measured in pound force per square inch represented as psi, and MPa or N/mm2 in SI unit which is used in India and other country. What is compressive stress? Compressive stress is load acting per unit area under compression in which material is push by equal and opposite force along length of rising, material is compressed and develop compressive stress which is the represented by symbol Sigma (σ). material reduce in size to resist or withstand compressive stress prior to failure of structure. The maximum load at which the specimen breaks is taken as a compressive load and maximum stress at which specimen is break or failure is known as compressive stress. Mathematically compressive stress is defined as ratio of maximum load to the cross-sectional area of specimen,such as Compressive stress = load/Area σ = F/A Where σ = compressive stress F = maximum load acting on a specimen A = cross sectional area of specimen. Simply we can say that compressive stress is equal to compressive strength of material. What is compressive strain? Compressive strain is ratio of decrease in length to original length under compression stress. The material which are under compression reduce in size to withstand with compressive load prior to failure.(ε = Δℓ/ℓ0) Consider specimen have lo length before compression and their final length is l after compression, so decrease in length (Δℓ = l – lo). Compressive strain is fractional decrease in length which is represented by formula ε = _ (Δℓ/ℓ0) Compressive strain = decrease in length/ original length Compressive strain ε = _ (Δℓ/ℓ0)) Where ε = compressive stress _ (Δℓ/ℓ0)) = fractional degree in length. What is elastic modulus? Elastic modulus measure the stiffness of material when stress is applied and it experience is strain, the material concrete and steel have elastic properties. Mathematically elastic modulus is the ratio of stress to strain, it is represented by E = σ/ε. Elastic modulus = stress/strain E = σ/ε or F/A ÷ (Δℓ/ℓ0)) E = (F × ℓ0)/(A×Δℓ) Where, E = elastic modulus F/A = σ = stress (Δℓ/ℓ0 = ε = strain. What is tensile strength? Stress & Strain Tensile strength is resistance of material under tension. When two equal and opposite pulling forces is applied over specimen, stress is develop known as tension stress which causes stretching or elongation in specimen, so tensile strength is maximum strength of material to resist or withstand against tension prior to failure. What is tensile strength? Stress & Strain The maximum load at which the specimen breaks is taken as tensile load and maximum stress at which specimen break is taken as tensile stress. The material which are under tension are increased in size stretch or elongate. In general words tensile strength is define as resistance of material to Breaking under tension stress. Tensile strength is maximum load that a material can support without fracture when being stretched. Tensile strengths is mathematically represented as force per unit area Tensile strength = Load/Area F = P/A Where F = tensile strength P = maximum tensile load acting on specimen A = cross sectional area of specimen Tensile strength measured in psi in the English system of measurement are commonly expressed in units of pounds per square inch, often abbreviated to psi and MPa in SI used in India and other country,1MPa is equal to N/mm2. stresses less than the tensile strength are removed, a material returns either completely or partially to its original shape and size. As the stress reaches the value of the tensile strength, however, a material, if ductile, that has already begun to flow plastically rapidly forms a constricted region called a neck, where it then fractures. What are types of tensile strength? There are three types of tensile strength 1) Yield strength,2) Ultimate strength and 3) Breaking or splitting strength. ● 1) Yield strength: the tensile stress of a material can withstand or resist without permanent deformation. When pulling forces is applied on specimen, it will elongate or strech upto elastic limit without deformation,it means Yield strength is stress of material at the point of end of Elastic stage and beginning of plastic property, when tensile stress is removed material regain its shape and size without deformation. ● 2) Ultimate strength:- the maximum tensile stress a material can withstand or resist without breaking, ultimate strength is maximum stress at the point of end of plastic stage in strain stress curve prior to break. When tensile stress is removed material do not regain its original shape and size because stretching beyond the elastic stage upto end of plastic stage. Material in plastic stage experience Irreversible and in elastic stage is a reversible. Due to ultimate stress material will deform but do not break. ● 3) Breaking or splitting strength: the maximum tensile stress a material can not able to withstand or resist causing breaking. It is defined as resistance of a material to breaking under tensile stress. Breaking tensile stress is developed at the end of plastic stage of material in strain stress curve. So it is clear that value of breaking tensile strength is higher than ultimate strength and yield strength in respective manner such as breaking tensile strength > ultimate strength > Yield strength. What is tensile stress? Tensile stress is load acting per unit area under tension in which material is pull by equal and opposite force along length of rising, material is strech and develop tensile stress which is the represented by symbol Sigma (σ). What is tensile stress? material increase in size to resist or withstand tensile stress prior to failure of structure. The maximum load at which the specimen breaks is taken as a tensile load and maximum stress at which specimen is break or failure is known as tensile stress. Mathematically tensile stress is defined as ratio of maximum load to the cross-sectional area of specimen,such as Tensile stress = load/Area σ = F/A Where σ = tensile stress F = maximum load acting on a specimen A = cross sectional area of specimen. Simply we can say that tensile stress is equal to tensile strength of material. What is tensile strain? Tensile strain is ratio of increase in length to original length under tension stress. The material which are under tension increase in size to withstand with tensile load prior to failure. Consider specimen have lo length before compression and their final length is l after compression, so increase in length (Δℓ = l – lo). Tensile strain is fractional increase in length which is represented by formula ε = + (Δℓ/ℓ0) Tensile strain = increase in length/ original length Tensile strain ε = + (Δℓ/ℓ0)) Where ε = tensile stress + (Δℓ/ℓ0)) = fractional increase in length. Compressive strength vs tensile strength Let us now discuss difference between compressive strength and tensile (strengthCompressive strength vs tensile strength). There are following difference between two Compressive strength vs tensile strength is comparison of strength in which compressive strength is pushing force tends to reduce the size of material after compression whereas tensile strength is pulling force tends to increase the size of material after tension. ● 1) compressive strength of concrete is higher than tensile strength, concrete experience good behave in compression whereas poor behave in tension. Maximum compressive strength of M20 concrete is 20MPa whereas maximum tensile strength is only about 10 to 12% of compressive strength. Assume compressive strength of concrete is 20MPa,consider its tensile strength about 10%,then 10% of 20MPa = 2MPa, so concrete tension stress is 2MPa. So concrete experience good behaviour in compression whereas poor behaviour in tension. ● 2) tensile strength of steel is higher than compressive strength, steel experience good behave in tension whereas poor behave in compression. Yield strength and tension strength of Fe250 is 250MPa and 410MPa respectively, tensile strength is 410MPa whereas maximum compressive strength is only about 35 to 40% of tensile strength. Assume tensile strength of Fe250 steel is 410MPa,consider its compressive strength about 35% to 40%,then 30% to 40% of 410MPa = 140MPa to 160MPa, so steel compression stress is ranging between 140MPa to 160MPa. So steel experience good behaviour in tension whereas poor behaviour in compression. ● 3) in compression stress there is fractional decrease in length where as intention is stress there is fractional increase in length, so compressive strain is negative and tensile strain is positive. Fractional decrease in length ε = _ (Δℓ/ℓ0) Fractional increase in length ε = + (Δℓ/ℓ0) ● 4) compressive strength is pushing force which is equal and opposite force apply along the both face of length of rising of material, compressed it, and thereby decreasing its length, whereas tensile strength is pulling force which is equal and opposite force apply along both face along length of rising of material,it stretch and thereby increasing its length. ◆You Can Follow me on Facebook and Subscribe our Youtube Channel You should also visits:- 1)what is concrete and its types and properties 2) concrete quantity calculation for staircase and its formula Reader Interactions This article needs additional citations for verification. Please help improve this article by adding citations to reliable sources. Unsourced material may be challenged and removed.Find sources: "Compressive strength" – news · newspapers · books · scholar · JSTOR (May 2014) (Learn how and when to remove this template message) Measuring the compressive strength of a steel drum Compressive strength or compression strength is the capacity of a material or structure to withstand loads tending to reduce size, as opposed to Tensile strength which withstands loads tending to elongate. In other words, compressive strength resists being pushed together, whereas tensile strength resists tension (being pulled apart). In the study of strength of materials, tensile strength, compressive strength, and shear strength can be analyzed independently. Some materials fracture at their compressive strength limit; others deform irreversibly, so a given amount of deformation may be considered as the limit for compressive load. Compressive strength is a key value for design of structures. Compressive strength is often measured on a universal testing machine. Measurements of compressive strength are affected by the specific test method and conditions of measurement. Compressive strengths are usually reported in relationship to a specific technical standard. Introduction TensionCompression When a specimen of material is loaded in such a way that it extends it is said to be in tension. On the other hand, if the material compresses and shortens it is said to be in compression. On an atomic level, the molecules or atoms are forced apart when in tension whereas in compression they are forced together. Since atoms in solids always try to find an equilibrium position, and distance between other atoms, forces arise throughout the entire material which oppose both tension or compression. The phenomena prevailing on an atomic level are therefore similar. The "strain" is the relative change in length under applied stress; positive strain characterizes an object under tension load which tends to lengthen it, and a compressive stress that shortens an object gives negative strain. Tension tends to pull small sideways deflections back into alignment, while compression tends to amplify such deflection into buckling. Compressive strength is measured on materials, components,[1] and structures.[2] By definition, the ultimate compressive strength of a material is that value of uniaxial compressive stress reached when the material fails completely. The compressive strength is usually obtained experimentally by means of a compressive test. The apparatus used for this experiment is the same as that used in a tensile test. However, rather than applying a uniaxial tensile load, a uniaxial compressive load is applied. As can be imagined, the specimen (usually cylindrical) is shortened as well as spread laterally. A stress–strain curve is plotted by the instrument and would look similar to the following: True Stress-Strain curve for a typical specimen The compressive strength of the material would correspond to the stress at the red point shown on the curve. In a compression test, there is a linear region where the material follows Hooke's law. Hence, for this region, σ = E ϵ {\displaystyle \sigma =E\epsilon } , where, this time, E refers to the Young's Modulus for compression. In this region, the material deforms elastically and returns to its original length when the stress is removed. This linear region terminates at what is known as the yield point. Above this point the material behaves plastically and will not return to its original length once the load is removed. There is a difference between the engineering stress and the true stress. By its basic definition the uniaxial stress is given by: σ = F A {\displaystyle \sigma ={\frac {F}{A}}} where, F = Load applied [N], A = Area [m2] As stated, the area of the specimen varies on compression. In reality therefore the area is some function of the applied load i.e. A = f(F). Indeed, stress is defined as the force divided by the area at the start of the experiment. This is known as the engineering stress and is defined by, σ e = F A 0 {\displaystyle \sigma _{e}={\frac {F}{A_{0}}}} A0=Original specimen area [m2] Correspondingly, the engineering strain would be defined by: ϵ e = l − l 0 l 0 {\displaystyle \epsilon _{e}={\frac {l-l_{0}}{l_{0}}}} where l = current specimen length [m] and l0 = original specimen length [m] The compressive strength would therefore correspond to the point on the engineering stress-strain curve (ϵ e ∗ , σ e ∗) {\displaystyle (\epsilon _{e}^{*},\sigma _{e}^{*})} defined by σ e ∗ = F ∗ A 0 {\displaystyle \sigma _{e}^{*}={\frac {F^{*}}{A_{0}}}} ϵ e ∗ = l ∗ − l 0 l 0 {\displaystyle \epsilon _{e}^{*}={\frac {l^{*}-l_{0}}{l_{0}}}} where F* = load applied just before crushing and l* = specimen length just before crushing. Deviation of engineering stress from true stress Barrelling In engineering design practice, professionals mostly rely on the engineering stress. In reality, the true stress is different from the engineering stress. Hence calculating the compressive strength of a material from the given equations will not yield an accurate result.[clarification needed] This is because the cross sectional area A0 changes and is some function of load A = φ(F). The difference in values may therefore be summarized as follows: On compression, the specimen will shorten. The material will tend to spread in the lateral direction and hence increase the cross sectional area. In a compression test the specimen is clamped at the edges.[dubious – discuss] For this reason, a frictional force arises which will oppose the lateral spread. This means that work has to be done to oppose this frictional force hence increasing the energy consumed during the process. This results in a slightly inaccurate value of stress obtained from the experiment.[citation needed] The frictional force is not constant for the entire cross section of the specimen. It varies from a minimum at the center, away from the clamps, to a maximum at the edges where it is clamped. Due to this, a phenomenon known as barreling occurs where the specimen attains a barrel shape.c Comparison of compressive and tensile strengths Concrete and ceramics typically have much higher compressive strengths than tensile strengths. Composite materials, such as glass fiber epoxy matrix composite, tend to have higher tensile strengths than compressive strengths. Metals are difficult to test to failure in tension vs compression. In compression metals fail from buckling/crumbling/45deg shear which is much different (though higher stresses) than tension which fails from defects or necking down. Compressive failure modes If the ratio of the length to the effective radius of the material loaded in compression (Slenderness ratio) is too high, it is likely that the material will fail under buckling. Otherwise, if the material is ductile yielding usually occurs which displaying the barreling effect discussed above. A brittle material in compression typically will fail by axial splitting, shear fracture, or ductile failure depending on the level of constraint in the direction perpendicular to the direction of loading. If there is no constraint (also called confining pressure), the brittle material is likely to fail by axial spitting. Moderate confining pressure often results in shear fracture, while high confining pressure often leads to ductile failure, even in brittle materials.[3] Axial Splitting relieves elastic energy in brittle material by releasing strain energy in the directions perpendicular to the applied compressive stress. As defined by a materials Poisson ratio a material compressed elastically in one direction will strain in the other two directions. During axial splitting a crack may release that tensile strain by forming a new surface parallel to the applied load. The material then proceeds to separate in two or more pieces. Hence the axial splitting occurs most often when there is no confining pressure, i.e. a lesser compressive load on axis perpendicular to the main applied load.[4] The material now split into micro columns will feel different frictional forces either due to inhomogeneity of interfaces on the free end or stress shielding. In the case of stress shielding, inhomogeneity in the materials can lead to different Young modulus. This will in turn cause the stress to be disproportionately distributed, leading to a difference in frictional forces. In either case this will cause the material sections to begin bending and lead to ultimate failure.[5] Micro-cracks, Leading Cause of Failure in Compression for brittle and quasi brittle material Micro-cracks are a leading cause of Failure in compression. Sliding along crack tips leads to tensile forces that stretch the along the crack tip. Hence micro cracks will form around any pre-existing crack tips. In all cases it is the overall global compressive stress interacting with local microstructural anomalies to create local areas of tension. Sources of those pre-existing "crack tips" are listed below: 1. Porosity is the controlling factor for compressive strength in many materials. These micro-cracks in turn begin to stretch out from the pores, until about they reach approximately the same diameter as the pores, that cause them. (Figure 1 part a) 2. Stiff inclusions within a material such as a precipitate can cause local areas of tension a certain distance away from the material. (See Fig 1part B below) When inclusions are grouped up (such as in precipitates), this effect can be amplified. 3. Even without pores or inclusions a material can develop micro-cracks between weak inclined (relative to applied stress) interfaces. These interfaces can slip and create a secondary crack. These secondary cracks continue opening as the slip of the original interfaces acts like a jack, wedging open further the secondary crack. (Fig 1 part C), The slipping of interfaces alone is not solely responsible for secondary crack growth as inhomogeneities in the materials young modulus can lead to an increase effective misfit strain. Cracks that grow this way are known as a wing tip microcracks.[6] Figure 1: microcrack nucleation and propagation It is important to emphasize that the growth of microcracks is not the growth of the original crack/imperfection. The cracks that are nucleating are doing so perpendicular to original crack and are known as secondary cracks.[7] The figure below emphasizes this point for wingtip cracks. A secondary crack growing from the tip of a preexisting crack These secondary cracks can grow to as long as 10-15 times the length of the original cracks in simple (uniaxial) compression. However, if a transverse compressive load is applied. The growth is limited to a few integer multiples of the original crack's length.[8] Shear Bands: If the sample size is too big such that the worse defect's secondary cracks cannot grow large enough to break the sample, other defects within the sample will begin to grow secondary cracks as well. This will occur homogenously over the entire sample. These micro-cracks form an echelon that can form an "intrinsic" fracture behavior, the nucleus of a shear fault instability. Shown right: shear band formation Eventually this leads the material deforming non-homogenously. That is the strain caused by the material will no longer vary linearly with the load. Creating localized shear bands on which the material will fail according to deformation theory. "The onset of localized banding does not necessarily constitute final failure of a material element, but it presumably is at least the beginning of the primary failure process under compressive loading." [9] Typical values Material Rs [MPa] Porcelain 500 Bone 150 concrete 20-80 Ice (0 °C) 3[10] Styrofoam ~1 Compressive strength of concrete Compressive strength test of concrete in UTM For designers, compressive strength is one of the most important engineering properties of concrete. It is a standard industrial practice that the concrete is classified based on grades. This grade is nothing but the Compressive Strength of the concrete cube or cylinder. Cube or Cylinder samples are usually tested under a compression testing machine to obtain the compressive strength of concrete. The test requirements differ country to country based on the design code. Use of a Compressometer is common. As per Indian codes, compressive strength of concrete is defined as: The compressive strength of concrete is given in terms of the characteristic compressive strength of 150 mm size cubes tested after 28 days (fck). In field, compressive strength tests are also conducted at interim duration i.e. after 7 days to verify the anticipated compressive strength expected after 28 days. The same is done to be forewarned of an event of failure and take necessary precautions. The characteristic strength is defined as the strength of the concrete below which not more than 5% of the test results are expected to fall.[11] For design purposes, this compressive strength value is restricted by dividing with a factor of safety, whose value depends on the design philosophy used. The construction industry is often involved in a wide array of testing. In addition to simple compression testing, testing standards such as ASTM C39, ASTM C109, ASTM C469, ASTM C1609 are among the test methods that can be followed to measure the mechanical properties of concrete. When measuring the compressive strength and other material properties of concrete, testing equipment that can be manually controlled or servo-controlled may be selected depending on the procedure followed. Certain test methods specify or limit the loading rate to a certain value or a range, whereas other methods request data based on test procedures run at very low rates.[12] See also Buff strength Container compression test Crashworthiness Deformation (engineering) Schmidt hammer, for measuring compressive strength of materials Plane strain compression test References ^ Urbanek, T; Lee, Johnson. "Column Compression Strength of Tubular Packaging Forms Made of Paper" (PDF). 34, 6. Journal of Testing and Evaluation: 31–40. Retrieved 13 May 2014. 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