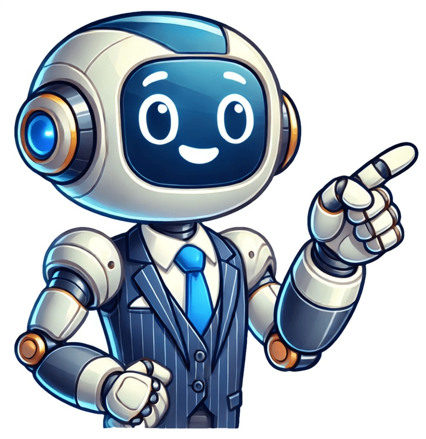

RoyMech Resources Mechanics Loaded Flat Plates Mechanics Index Loaded Flat Platess Introduction..... Symbols..... Circular Plates..... Rectangular Plates..... Circular Plates with central holes..... Introduction This page includes simple formula for the calculation of the maximum stress and deflection for thin flat plates under a variety of support and loading conditons. The equations are only valid if the deflection is small compared to the plate thickness. The plates are all assumed to be steel with a poisson's ratio of 0,3. The equations are also only reasonably accurate if the thickness is less than 10% of the diameter. The results can be used for initial estimates - For more accurate results it is recommended that quality reference books are used i.e "Roark's Formulas for Stress and Strain". I also recommend Mitcalc.com see link 1 below - a suite of calculators based on Excel. The loading scenario for the simply supported rectangular plates assume that the upper edges of the loaded surface are restrained from lifting such that all of the edges are in contact during the the loading condition. Note: I have checked the results from some of the equations against results using Mitcalc.com . The deflections and stresses resulting are generally resonably accurate. I have checked my results against Roark and they seem to be OK. I would recommend that for more comprehensive calculations including greater detail with more accuracy standard reference texts are used e.g Roarks book. Symbols / Units r = radius of circular plate (m) a = major length of rectangular plate (m) a = outside dia or ring (m) b = minor length of rectangular plate (m) b = inside dia of ring(m) t = plate thickness (m) p = uniform surface pressure on plate (compressive) (N/m2) P = Single concentrated force (compressive) (N) σ m = maximum stress(N/m2) ym = maximum deflection (m) E = Young's moudulus of elasticity (N/m2) ν = Poissan's ratio -Assumed to be 0,3 for steel. D = Flexural rigidity = E.t3 / 12 (1-v2) Circular Plates Circular Plate , uniform load , edges simply supported . Circular Plate , uniform load , edges clamped . Circular Plate , Centre Load , edges simply supported . Circular Plate , Centre Load , edges clamped . Rectangular Plates Rectangular Flat Plate , uniform load ,edge simply supported. Rectangular Flat Plate , uniform load ,edge clamped. Rectangular Flat Plate , concentrated load at centre,edge simply supported. a/b 1,01,11,2 1,41,61,8 2,03,04 -> k1 0,1270,1380,1480,1620,170,1770,1800,185 0,185 k2 0,4350,5650,6500,7890,8750,9270,9581,000 0,000 Rectangular Flat Plate , concentrated load at centre, edge clamped a/b 1,01,21,41,61,82,03 -> k1 0,0610,0710,0760,0780,07860,07880,0791 k2 0,7540,8940,9620,9911,0001,0041,008 k3 -0,238-0,00780,0110,0530,0680,0670,067 Circular Flat Plate with central hole , concentrated load at hole, simply supported at outer edge a/b 1,25 1,5 2 33 4 5 k1 k2 k1 k2 k1 k2 k1 k2 k1 k2 k1 k2 0,341 0,100 0,519 1,26 0,672 1,48 0,734 1,88 0,724 2,17 0,704 2,34 Circular Flat Plate with central hole , uniform load over ring, simply supported at outer edge a/b 1,25 1,5 2 3 4 5 k1 k2 k1 k2 k1 k2 k1 k2 k1 k2 k1 k2 0,184 0,592 0,414 0.976 0,664 1,44 0,824 1,88 0,830 2,08 0,813 2,190 Circular Flat Plate with central hole , Concentrated load at hole, clamped at outer edge a/b 1,25 1,5 2 3 4 5 k1 k2 k1 k2 k1 k2 k1 k2 k1 k2 k1 k2 0,00504 0,194 0,0242 0.320 0,0810 0,454 0,172 0,673 0,217 1,021 0,238 1,305 Circular Flat Plate with central hole , uniform load over ring, clamped at outer edge a/b 1,25 1,5 2 3 4 5 k1 k2 k1 k2 k1 k2 k1 k2 k1 k2 k1 k2 0,00199 0,105 0,0139 0.259 0,0575 0,480 0,130 0,657 0,162 0,710 0,175 0,730 Circular Flat Plate with guided central hole , uniform distributed load, simply supported at outer edge a/b 1.25 1,5 2 3 4 5 k1 k2 k1 k2 k1 k2 k1 k2 k1 k2 k1 k2 0,00343 0,122 0,0313 0,336 0,125 0,740 0,221 1,210 0,417 1,450 0,492 1,590 Circular Flat Plate with guided central hole , uniform distributed load, fixed at outer edge a/b 10 3 2 1,5 1,1 k1 k2 k1 k2 k1 k2 k1 k2 k1 k2 0,149 0,728 0,074 0,58 0,023 0,36 0,003 0,151 - 0,019 Additional notes to be added Mechanics Index 15 Jul 2024 Tags: Mechanical Engineering Solid Mechanics Bending of Plates Bending of Plates Popularity: Bending of Plates This calculator provides the calculation of bending stresses and shear stress in a rectangular plate subjected to a point load at the center. Explanation Calculation Example: The bending of plates is a fundamental concept in structural analysis and mechanical engineering. It involves the calculation of stresses and deflections in plates subjected to various types of loads. This calculator provides the calculation of bending stresses and shear stress in a rectangular plate subjected to a point load at the center. Q: What are the assumptions made in this calculator? A: This calculator assumes that the plate is thin, isotropic, and elastic. It also assumes that the load is applied at the center of the plate and that the plate is simply supported at its edges. Q: How can I use this calculator to design a plate? A: This calculator can be used to determine the bending stresses and shear stress in a plate subjected to a point load. This information can be used to design a plate that is strong enough to withstand the applied load without failing. Variables | —— | —- | —- | Calculation Expression Bending Stress in X-Direction: The bending stress in the x-direction at the center of the plate is given by ?x = (3 * P * a) / (2 * ? * t^2 * b) (3 * P * a) / (2 * ? * t^2 * b) Bending Stress in Y-Direction: The bending stress in the y-direction at the center of the plate is given by ?y = (3 * P * b) / (2 * ? * t^2 * a) (3 * P * b) / (2 * ? * t^2 * a) Shear Stress in XY-Plane: The shear stress in the xy-plane at the center of the plate is given by ?xy = 0 Calculated values Considering these as variable values: P=1000.0, a=2.0, b=1.0, t=0.01, E=2.0E11, ? =0.3, the calculated value(s) are given in table below | —— | —- | Bending Stress in Y-Direction 2.38732*10^6 Bending Stress in X-Direction 9.5493*10^6 Shear Stress in XY-Plane 0 Similar Calculators Explore Calculator Apps Gear Design in 3D & Learning Academic Chapters on the topic Matching 3D parts for bending of plates calculation App in action The video below shows the app in action. For a flat rectangular plate subjected to uniform loading, stress and deflection can be calculated using the following equations. Note that these equations are based on the assumption that the plate is thin, simply supported along all edges, and made from a homogeneous, isotropic material. The maximum bending stress in the plate can be calculated using the following formula: σ_max = (6 * q * a^2) / (t^2 * D) where: σ_max = maximum bending stress (Pa or psi) q = uniform pressure or load on the plate (Pa or psi) a = shorter dimension of the plate (m or in) t = plate thickness (m or in) D = flexural rigidity of the plate, which can be calculated as (E * t^3) / (12 * (1 - ν^2)) E = modulus of elasticity of the plate material (Pa or psi) ν = Poisson's ratio of the plate material (dimensionless) The maximum deflection in the plate can be calculated using the following formula: w_max = (q * a^4) / (64 * D) where: w_max = maximum deflection of the plate (m or in) q, a, and D are defined as above These equations allow you to calculate the maximum stress and deflection in a flat rectangular plate subjected to uniform loading. However, keep in mind that these formulas are applicable under specific assumptions and conditions, and results may not be accurate for cases that deviate from those assumptions. What would be the purpose to do this calculation? There are several purposes for performing stress and deflection calculations for a flat rectangular plate subjected to uniform loading. Some of these purposes include: Structural design and analysis: These calculations help engineers and designers to ensure that a structure, component, or system can safely withstand the applied loads without failure or excessive deformation. The stress and deflection values can be compared to allowable limits, which are based on material properties and safety factors, to determine if the design meets the necessary performance criteria. Material selection: By comparing the calculated stress and deflection values with the material properties (such as yield strength, ultimate strength, and modulus of elasticity), engineers can determine if the chosen material is suitable for the application or if a different material should be considered. Optimization: These calculations can be used to optimize a design by minimizing material usage, weight, or cost, while ensuring that the structure can safely withstand the applied loads. Engineers can iteratively adjust dimensions, material, or loading conditions to find the most efficient and cost-effective design. Failure analysis: In case of structural failures, these calculations can help engineers identify the cause of the failure and develop appropriate solutions or modifications to prevent future failures. Maintenance and inspection planning: Understanding the stress and deflection behavior of a structure helps in planning maintenance and inspection schedules. It provides insights into potentials areas of concern, which can be monitored more closely to detect signs of damage, wear, or fatigue. Validation of numerical models: Stress and deflection calculations can be used to validate finite element models or other numerical simulations by comparing the analytical results with the numerical results. It is important to note that the calculations for stress and deflection in a flat rectangular plate subjected to uniform loading are based on simplifying assumptions. In real-world applications, it is crucial to consider additional factors such as non-uniform loads, boundary conditions, plate geometry, and material properties to ensure accurate analysis and design. Flat Rectangular Plate stress and deflection Calculator Try the calculator below. Uniform pressure/load (q): Pa Shorter dimension (a): m Plate thickness (t): m Modulus of elasticity (E): Pa Poisson's ratio (ν): Maximum bending stress (σ_max): - Pa Maximum deflection (w_max): - m What are the units used here In the provided calculator example, the units for each variable are as follows: Uniform pressure/load (q): Pascals (Pa). Note that you can also use other units of pressure such as psi (pounds per square inch) if you prefer, but ensure that all other relevant units are consistent. Shorter dimension (a): Meters (m). If you prefer to use other units, such as inches, make sure all other relevant units are consistent. Plate thickness (t): Meters (m). Similarly, you can use other units like inches, but ensure consistency with other units. Modulus of elasticity (E): Pascals (Pa). You can also use other units like psi, as long as it is consistent with the units used for pressure/load. Poisson's ratio (ν): Dimensionless, as it is a ratio and does not have any specific units. The calculated results will also be in the following units: Maximum bending stress (σ_max): Pascals (Pa) or the same units as used for pressure/load (e.g., psi). Maximum deflection (w_max): Meters (m) or the same units as used for the shorter dimension and plate thickness (e.g., inches). It is essential to maintain unit consistency across all variables and calculations. If you choose different units for any variable, make sure to adjust the units for other variables accordingly to ensure accurate results. Possible variations of the stress and deflection of a Flat Rectangular Plate calculator: There are several variations of stress and deflection calculations for plates, which can depend on factors such as loading conditions, boundary conditions, plate geometry, and material properties. Some of these variations include: Different loading conditions: Non-uniform loading, where the load distribution is not constant across the plate. Partially distributed loading, where only a portion of the plate is subjected to loading. Concentrated or point loads, where a single force is applied at a specific point on the plate. Line loads, where the load is distributed along a line on the plate. Different boundary conditions: Simply supported edges, where the plate is free to rotate but cannot move vertically. Clamped or fixed edges, where the plate is restrained from both rotation and vertical movement. Free edges, where the plate is not supported or restrained along the edge. Elastic support, where the edge support is provided by an elastic foundation or a spring. Different plate geometries: Circular or elliptical plates. Plates with irregular shapes or cutouts. Plates with varying thickness or material properties across their surface. Different material properties: Orthotropic or anisotropic materials, where material properties such as the modulus of elasticity and Poisson's ratio vary in different directions. Non-linear or viscoelastic materials, where material properties change with the magnitude of stress, strain, or time. Dynamic loading conditions: Impact loads, where the load is applied suddenly and may cause transient responses. Cyclic or fatigue loads, where the load is repeatedly applied over time and may lead to fatigue failure. Vibrations and resonance, where the plate is subjected to oscillatory forces that may cause excessive stress or deflection. Each of these variations may require different analytical or numerical methods to accurately calculate stress and deflection. Classical plate theories, such as Kirchhoff-Love and Mindlin-Reissner, can be used for some cases, while more complex cases may necessitate the use of finite element analysis (FEA) or other numerical techniques. For More Online Engineering Calculators try searching out main blog page here Tags: StructX > Resources > Statics > Plate Formulas Many components of structures may be logically idealized as laterally loaded, rectangular plates (or slabs). By identifying not only the loading condition but also the type of edge supports it is possible to use classical plate theory as one method to annalise a structure in smaller more manageable idealised sections. Classical plate theory assumes the following independent conditions: The in-plane plate dimensions are large compared to the thickness. Loads act transverse to the longitudinal axis and pass through the shear centre eliminating any torsion or twist. Self-weight of the plate has been ignored and should be taken into account in practice. The material of the beam is homogeneous and isotropic and has a constant Young's modulus in all directions in both compression and tension. The centroidal plane or neutral surface is subjected to zero axial stress and does not undergo any change in length. The response to strain is one dimensional stress in the direction of bending. Deflections are assumed to be very small compared to the overall length of the beam. The cross-section remains planar and perpendicular to the longitudinal axis during bending. Membrane strains have been neglected. Poisson's ratio has been assumed to be 0 unless stated otherwise in the notation section. A note about bending moments: In structural engineering the positive moment is drawn on the tension side of the member allowing beams and frames to be dealt with more easily. Because moments are drawn in the same direction as the member would theoretically bend when loaded it is easier to visualise what is happening. StructX has adopted this way of drawing bending moments throughout. Refer bottom of page for boundary conditions and loading Notation. Supported Rectangular Plates with UDL Supported Rectangular Plates with VDL Supported Rectangular Plates with Point Load Plate Icon Interpretation The above plate icons show a series of letters representing the restraint conditions of the plate in question with the first letter dictating the support type on the left hand side followed by all the edges in a clockwise direction. The following notations have been used to describe the supports and loading conditions: UDL = Uniformly Distributed Load VDL = Varying Distributed Load PL = Point Load S = Simply Supported Edge: Shown as a dashed line on the edge that is simply supported C = Clamped Edge: Shown as series of fine lines on the edge that is clamped F = Free Edge P = Corner Supported by Post: Shown as a small square on the corner that is supported by a post Additional Resources Lekhnitskiĭ, S. G. Anisotropic Plates. New York: Gordon and Breach, 1968. Print. Mikhelson, Ilya. Structural Engineering Formulas. New York: McGraw-Hill, 2004. Print. Roark, Raymond J and Warren C Young. Roark's Formulas For Stress And Strain. New York: McGraw-Hill, 1989. Print. Timoshenko, Stephen and S Woinowsky-Krieger. Theory Of Plates And Shells. New York: McGraw-Hill, 1959. Print. Engineering Calculators Menu Engineering Analysis Menu Flat Plates Stress, Deflection Equations and Calculators: The follow web pages contain engineering design calculators that will determine the amount of deflection and stress a flat plate of known thickness will deflect under the specified load and distribution. Many of the stress and deflection equations and calculators referenced from Roark's Formulas for Stress and Strain. Please note that most of the calculators do require a premium membership for full functionality. Flat plate behavior: The plate deflects. The middle surface (halfway between top and bottom surfaces) remains unstressed; at other points there are biaxial stresses in the plane of the plate. Straight lines in the plate that were originally vertical remain straight but become inclined; therefore the intensity of either principal stress at points on any such line is proportional to the distance from the middle surface, and the maximum stresses occur at the outer surfaces of the plate. ** Search this PAGE ONLY, click on Magnifying Glass ** Related: Plate Shear Webs with Beads Critical Shear Stress Equation and Calculator Shear Buckling of Unstiffened Plates Formula and Calculator Circular Membrane Stress and Deflection Design Calculator and Equations Long Rectangular Membrane Stress and Deflection Design Calculator and Equations Unstiffened Plates in Compression Buckling Formula and Calculator Short Rectangular Membrane Stress and Deflection Design Calculator and Equations Flat Rectangular Plate with All Edges Simply Supported Stress and Deflection with circular Load applied at center Equation and Calculator. Flat Rectangular Plate Uniformly Increasing Loading Along Length Stress and deflection Equation and Calculator. Per. Roarks Formulas for Stress and Strain Formulas for flat plates with straight boundaries and constant thickness Flat Rectangular Plate Uniformly Increasing Loading Along Width Stress and deflection Equation and Calculator. Per. Roarks Formulas for Stress and Strain Formulas for flat plates with straight boundaries and constant thickness Flat Rectangular Uniform over entire plate plus uniform over entire plate plus uniform tension P lb=linear in applied to all edges Stress and deflection Equation and Calculator. Per. Roarks Formulas for Stress and Strain Formulas for flat plates with straight boundaries and constant thickness Uniformly Increasing Force Applied Flat Rectangular Plate; Three Edges Simply Supported, one Edge (b) Free Stress and Deflection With Uniformly increasing along the a side Equation and Calculator. Flat Rectangular Plate; Three Edges Simply Supported, one Edge Fixed Stress and Deflection With Uniformly increasing along the a side Equation and Calculator. Per. Roarks Formulas for Stress and Strain. Flat Rectangular Plate; Three Edges Simply Supported, one long Edge Fixed Stress and Deflection With Uniform Loading over entire plate Equation and Calculator Flat Rectangular Plate; two long edges simply supported, two short edges fixed Uniform loading over entire plate Stress and Deflection Equation and Calculator. Per. Roarks Formulas for Stress and Strain Flat Rectangular Plate; two long edges fixed, two short edges simply supported Uniform loading over entire plate Stress and Deflection Equation and Calculator. Per. Roarks Formulas for Stress and Strain Flat Rectangular Plate; one edge fixed, opposite edge free, remaining edges simply supported loading 1/3 of plate from fixed edge Stress and Deflection Equation and Calculator. Per. Roarks Formulas for Stress and Strain Formulas Flat Rectangular Plate; one edge fixed, opposite edge free, remaining edges simply supported loading Uniformly decreasing from fixed edge to free edge Stress and Deflection Equation and Calculator. Per. Roarks Formulas for Stress and Strain Formulas Flat Rectangular Plate; one edge fixed, opposite edge free, remaining edges simply supported loading Uniformly decreasing from fixed edge to zero at 2/3 b Stress and Deflection Equation and Calculator. Per. Roarks Formulas for Stress and Strain Flat Rectangular Plate; one edge fixed, opposite edge free, remaining edges simply supported loading distributed line load w lb/in along free edge Stress and Deflection Equation and Calculator. Per. Roarks Formulas for Stress and Strain Flat Rectangular Plate; all edges fixed. Uniform loading over small concentric circle of radius ro (note definition of r'o) Stress and Deflection Equation and Calculator. Per. Roarks Formulas for Stress and Strain Flat Rectangular Plate, Three Edges Fixed, One Edge (a) Simply Supported Loading Over Entire Plate Stress and Deflection Equation and Calculator. Per. Roarks Formulas for Stress and Strain Flat Rectangular Plate, Three Edges Fixed, One Edge (a) Simply Supported Uniform Loading over 2/3 of plate from fixed edge Stress and Deflection Equation and Calculator. Per. Roarks Formulas for Stress and Strain Flat Rectangular Plate, Three Edges Fixed, One Edge (a) Simply Supported Uniform Loading over 1/3 of plate from fixed edge Stress and Deflection Equation and Calculator. Per. Roarks Formulas for Stress and Strain for flat plates Flat Rectangular Plate, Three Edges Fixed, One Edge (a) Simply Supported Loading Uniformly decreasing from fixed edge to simply supported edge Stress and Deflection Equation and Calculator. Per. Roarks Formulas for Stress and Strain for flat plates Flat Rectangular Plate, Three Edges Fixed, One Edge (a) Simply Supported Loading Uniformly decreasing from fixed edge to zero at 2/3b Stress and Deflection Equation and Calculator. Per. Roarks Formulas for Stress and Strain Flat Rectangular Plate, Three Edges Fixed, One Edge (a) Simply Supported Loading Uniformly decreasing from fixed edge to zero at 1/3b Stress and Deflection Equation and Calculator. Per. Roarks Formulas for Stress and Strain Flat Rectangular Plate, Three Edges Fixed, One Edge (a) Free Supported Loading Uniformly Over Entire Plate Stress and Reaction Loading Equation and Calculator. Per. Roarks Formulas for Stress and Strain for flat plates Flat Rectangular Plate, Three Edges Fixed, One Edge (a) Free Loading Uniform over 2/3 of Plate from Fixed Edge Equation and Calculator. Per. Roarks Formulas for Stress and Strain Flat Rectangular Plate, Three Edges Fixed, One Edge (a) Free Loading Uniform over 1/3 of Plate from Fixed Edge Equation and Calculator. Per. Roarks Formulas for Stress and Strain Flat Rectangular Plate, Three Edges Fixed, One Edge (a) Free Loading Uniformly decreasing from fixed edge to zero at free edge Equation and Calculator. Per. Roarks Formulas for Stress and Strain Flat Rectangular Plate, Three Edges Fixed, One Edge (a) Free Loading Uniformly decreasing from fixed edge to zero at 2/3b Equation and Calculator. Per. Roarks Formulas for Stress and Strain Flat Rectangular Plate, Three Edges Fixed, One Edge (a) Free Loading Uniformly decreasing from fixed edge to zero at 1/3b Equation and Calculator. Per. Roarks Formulas for Stress and Strain Flat Rectangular Plate, Two Edges Fixed, Two Edges Free Loading Uniform over Entire Plate Equation and Calculator. Per. Roarks Formulas for Stress and Strain for flat plates with straight boundaries and constant thickness Flat Rectangular Plate, Two Edges Fixed, Two Edges Free Uniform Loading over Plate from z = 0 to z = (1/3) b Equation and Calculator. Per. Roarks Formulas for Stress and Strain Flat Rectangular Plate, Two Edges Fixed, Two Edges Free Load Uniformly Decreasing from z = 0 to z = b Equation and Calculator. Per. Roarks Formulas for Stress and Strain Flat Rectangular Plate, Two Edges Fixed, Two Edges Free Load Uniformly Decreasing from z = 0 to z = (2/3) b Equation and Calculator. Per. Roarks Formulas for Stress and Strain Flat Rectangular Plate, Two Edges Fixed, Two Edges Free Load Uniformly Decreasing from z = 0 to z = (1/3) b Equation and Calculator. Per. Roarks Formulas for Stress and Strain Continuous Plate Supported at Equal Intervals "a" on Circular Supports of Radius ro Uniform Loading of Entire Plate Stress Equation and Calculator. Per. Roarks Formulas for Stress and Strain for flat plates Continuous Plate Supported on an Elastic Foundation of Modulus k (lb/in2/in) Stress and Deflection Equation and Calculator. Uniform Loading over a snall circle of radius ro remote from the edges. Per. Roarks Formulas for Stress and Strain Continuous Plate Supported on an Elastic Foundation of Modulus k (lb/in2/in) Stress and Deflection Equation and Calculator. Uniform loading over a small circle of radius ro, adjacent to edge but remote from corner. Per. Roarks Formulas for Stress and Strain Continuous Plate Supported on an Elastic Foundation of Modulus k (lb/in2/in) Stress and Deflection Equation and Calculator. Uniform loading over a small circle of radius ro, adjacent to corner. Per. Roarks Formulas for Stress and Strain Parallelogram plate (skew slab) all edges simply supported with uniform loading over entire plate Stress and Deflection Equation and Calculator. Per. Roarks Formulas for Stress and Strain Parallelogram plate (skew slab) shorter edges simply supported, longer edges free with uniform loading over entire plate Stress and Deflection Equation and Calculator. Per. Roarks Formulas for Stress and Strain Parallelogram plate (skew slab) all edges fixed with uniform loading over entire plate Stress and Deflection Equation and Calculator. Per. Roarks Formulas for Stress and Strain Equilateral triangle; all edges simply supported with uniform loading over entire plate Stress and Deflection Equation and Calculator. Per. Roarks Formulas for Stress and Strain Equilateral triangle plate; all edges simply supported with uniform loading over small circle of radius ro at x = 0; z = 0 Stress and Deflection Equation and Calculator. Per. Roarks Formulas for Stress and Strain Right-Angle Isosceles Triangle; all edges simply supported with uniform loading over entire plate Stress and Deflection Equation and Calculator. Per. Roarks Formulas for Stress and Strain Regular polygonal plate; all edges simply supported with uniform loading over entire plate Stress and Deflection Equation and Calculator. Per. Roarks Formulas for Stress and Strain Regular polygonal plate; all edges fixed with uniform loading over entire plate Stress and Deflection Equation and Calculator. Per. Roarks Formulas for Stress and Strain Rectangular plate, uniform load, clamped (Empirical) equations and calculator Rectangular plate, uniform load, clamped (Empirical) equations and calculator Symbols used: a = minor length of rectangular plate, (m, in) b = major length of rectangular plate, (m, in) p = uniform pressure loading, (N, lbs) v = Poisson???s ratio Concentrated load at center of Plate, clamped edges (empirical) equation and calculator Rectangular plate, circular concentrated load at center, clamped edges (empirical) equation and calculator. Baseplate with Large Moment to AISC LRFD Spreadsheet Calculator Moments and Reactions for Rectangular Plates using the Finite Difference Method This book of monograph presents a series of tables containing computed data for use in the design of components of structures which can be idealized as rectangular plates or slabs. Typical examples are wall and footing panels of counterfort retaining walls. The tables provide the designer with a rapid and economical means of analyzing the structures at representative points. The data presented, as indicated in the accompanying figure on the frontispiece, were computed for fivl: sets of boundary conditions, nine ratios of lateral dimensions, and eleven loadings typical of those encountered in design. Design Thickness of Pipe Blanks Caps Formula and Calculator per. ASME B31.5 Restrained Plate, Uniformly Heated Stress Calculator and Equations Partially Restrained Square Plate in Frame, Uniformly Heated Stress Calculator and Equations Partially Restraint of a Uniformly Heated Rectangular Plate Stress Calculator and Equations Plate Shear Buckling Stress Calculator and Equations Structural Composite Sandwich Stiffness Equation and Calculator Structural Composite Sandwich Wrinkling Stress Equation and Calculator Structural Composite Honeycomb Core Wrinkling Stress Equation and Calculator This calculation deals with the deflection, stress and variation of forces in the loaded flat plates. The calculation is designed for plates that are flat, homogeneous, with the same thickness and made from one material. The plates may be circular, annular circular and rectangular. The plates may be loaded evenly (unevenly) on the whole surface (or its part) or they may be loaded by the force distributed on the circle. The programme enables: Selection from circular, annular circular or rectangular plates Selection of various types of loading (distributed, forced...) Calculation of deflection, slope, moment and stress in a random point Display of graphs of the shape of the figures calculated Calculation of safety coefficient Calculation of the minimum plate thickness or maximum loading The calculation uses the data, procedures, algorithms and information from the professional literature (Roark formulas, Machinery's Handbook 26th, Teorie desek a skořepin [doc. Ing. Ladislav Šubrt, CSc.] and others) User interface. Download. Purchase, Price list. Control, structure and syntax of calculations. Information on the syntax and control of the calculation can be found in the document "Control, structure and syntax of calculations". Information on the project. Information on the purpose, use and control of the paragraph "Information on the project" can be found in the document "Information on the project". Theory- Foundations. A plate is the flat construction element (two dimensions are multiply larger than the third one - thickness) loaded mainly in bend. In terms of the shape, the plates are circular, rectangular and with general shape. To get the notion of stress, we may use the circular rotation-symmetrical plate, from which we remove an element and display the respective forces that may be present. We assume the linear shape of normal stresses sr, st with a neutral axis, which is not in the centre of the plate thickness. Based on this assumption, the normal stress (both radial and tangential) may be split into two components. - Bending stress (the shape as for a simple bend) - sr', st' - Diaphragm stress (the stress is constant along the whole plate thickness) - sr'', st'' Then the normal stress sr = sr' + sr'' possibly st = st' + st'' and the stress on element A may be displayed as follows: Similarly, the state of stress may be drawn for other, more complicated cases - e.g. the rotation-asymmetrical plates, rectangular plates etc. These cases would only differ from this one if more components of the shear stresses were t added. The individual components of stress then result in the presence of the respective types of deformations. The bending stresses result in the slew of line segments or whole sections. The diaphragm stresses result in the elongation (or shortening) of individual plate elements. The shear stresses result in the chamfer of individual elements. As there are several elements arranged on top of each other along the plate thickness, the chamfer of individual elements will result in the distortion of originally straight perpendicular lines to the central plane of the plate. Based on this knowledge, the plates may be divided into individual groups according to the stress, specifically into: thick plates medium thickness plates (Kirchhoff plates) thin plates producing large deflections diaphragms The "plate thickness" is considered in relation to the stress, prevailing stresses, and the method of handling. A) Thick plates The deflections of a thick plate are very small and therefore the elongation of fibres after deformation may be ignored. As the fibre elongation is caused by diaphragm stresses, the diaphragm stresses may obviously be ignored. However, as a result of the large thickness, the bending stresses are also small and therefore they are comparable with shear stresses. The solution therefore considers the bending and shear stressing. As the shear results in the distortion of the line segments perpendicular to the central plane of the plate, the theoretical solution is rather complicated. This type of plate is not frequently used in the common machine structures. B) Medium thickness plates (Kirchhoff plates) These plates have smaller thickness, which results in higher bending stresses which prevail over the shear stress. Therefore the shear stresses may be ignored as well as their result, i.e. distortion of the originally straight perpendicular lines to the central plane of the plate. On the other hand, the deflection is not so big to result in a significant elongation of the fibres in the central plane (the plane dividing the plate in the middle of the thickness). Therefore the diaphragm stress may also be ignored. Only the bending stress is considered for these plates with linear distribution of the bending stresses along the plate thickness and the zero bending stress in the central plane of the plate. In terms of the calculation, this is the simplest type of plate. In practical applications, the overall majority of the plates is calculated using the calculation procedures prepared for the medium thickness plates, although this is not always fully justified. C) Thin plates producing large deflections In the case of these plates, the effects of the shear are even less significant than for the "medium thickness" plates and therefore its effects may again be ignored. The bending must be taken into consideration and in addition, the diaphragm stresses also act, which cannot be ignored for the thin plates. It is due to the fact that there are larger deflections which does not go without changes in the length of the central plane fibres. These length changes are related to the acting diaphragm stresses. However, the diaphragm stresses are also present in the case of the push fit. The edges could come close to each other, but if deformed, the originally flat plate changes to a non-developable rotation surface which does not go without the length changes of individual fibres in the central plane. That is why the bending and diaphragm stresses are considered even for the push fit of the thin plates. In addition, this type of plate is non-linear, i.e. deformations and stresses are not directly proportional to the loading, even if the linear Hook principle applies. It is the so-called geometrical non-linearity which results from high deformations - specifically as a result of high turning angles. D) Diaphragms Diaphragms are the plates so thin that their bending rigidity is negligible (as well as the bending stress) and only the tension stress is considered (e.g. various rubber barometric diaphragms). As a result of high deformations these are again geometrically non-linear. Naturally, this division of plates is not fixed, it only refers to certain possibilities of simplification which provides for the simplification of analytical solution while preserving the suitable accuracy in view of the other inaccuracies (including the inaccuracies in fit, machining, material constants etc.). Field of applicability of individual calculation models. The picture displays the dependence of the dimensionless deflection "y/t" on the dimensionless loading "q*a^4/(E*t^4)", with: y...maximum deflection t...plate thickness q...continuous loading a...plate radius E...modulus of elasticity and individual curves represent: B) Medium thickness plates (Kirchhoff plates) C) Thin plates producing large deflections D) Diaphragms It follows from the picture that the simplifications adopted for the "Medium thickness plates" may be used for very small dimensionless deflections. The "Thin plates" type of calculation must be used for higher dimensionless deflection. It also follows from the picture that the limits for individual calculation models cannot be specified unambiguously. It depends on how big an error can be tolerated. If the admissible error is marked delta, then the respective limits for individual calculations may also be specified. Like for the deflection (see the picture), the procedure may be used for the stress. For practical applications it is useful to know at least roughly the position of the boundary between the calculation models (B and C). If an error smaller than 5 % is required, the deflection should be smaller than one third of the plate thickness; for an error smaller than 10 %, the deflection should be smaller than one half of the plate thickness. The approximate estimate of an error depending on the deflection related to the plate thickness: Deflection [% of thickness] Error [%] 10% 0.5% 25% 3% 33% 5% 50% 10% 75% 20% 100% 30% If the calculation model B (Medium thickness plates) and higher dimensionless deflection (deflection related to the thickness) are used, the error increases sharply, as seen in the picture. Even if the error is on the part of safety, the use of inappropriate calculation results in unnecessarily overdesigned and heavy structures. Note: We recommend the use of special literature for detailed deriving of the formulas applied. General principles applicable in calculations The calculations and formulas applied are based on the following conditions. The plates are flat, with the same thickness, from the homogeneous isotropic material. The plate thickness is not higher than one quarter of the smallest lateral dimension. For circular plates it is not higher than 1/5 of the radius (1/10 of the radius, in the case of higher accuracy demands). All forces, loading and reactions are perpendicular to the normal of the plate surface. The plate is not stressed over the elasticity limit (the linear Hook principle applies). Method of calculation When handling the deflection (stress, safety) of the circular or rectangular plate, proceed as follows. Choose the material of the plate, or fill in material properties [1.0] Depending on the type of the plate (circular, annular circular, rectangular), select the respective paragraph for calculation [2.0, 3.0, 4.0] Select the mounting of the plate and the type of loading [2.1, 3.1, 4.1] Set the dimensions and loading and run the calculation [2.8, 3.9] If the deflection of the plate is higher than the half of its thickness, select paragraph [5.0, 6.0] for the calculation If the deflection or safety coefficient are not suitable, change the dimensions of the plate and repeat the calculation. Selection of material and units setting [1] Use this paragraph to select units for the calculation and select the material of the designed/checked plate. 1.1 Calculation units Use the drop-down menu to choose the required system of units for the calculation. After the units are switched, all values will be re-calculated immediately. 1.2 Material Use the drop-down menu to choose the proper plate material. If the material constants of your material differ from the material constants specified on line [1.3 - 1.8], uncheck the check box on line [1.3] and set the customized material properties. 1.9 Requested safety coefficient Select the requested safety coefficient. The selection of the safety coefficient does not affect the deflection or stress calculation. The safety coefficient affects the design of the maximum loading [2.5, 3.6, 4.6] or the minimum plate thickness [2.2, 3.2, 4.2]. At the same time, the exceeding of the partial safety coefficients in individual paragraphs is checked. Hint: General procedures of determination of safety coefficients can be found in the document "Coefficients of safety". Circular plates [2] This calculation is used to detect the shape of deflection, stress and slope of medium thickness circular plates, including the maximum values. At the same time it is possible to design the minimum thickness, or the maximum loading which can be applied to the plate. As the diaphragm stress is ignored for this type of calculation (see the theory section), it is necessary to check the maximum deflection which should be smaller than half of the plate thickness. For a deflection higher than 1/2 of the plate thickness, use the calculation in paragraph [5.0]. 2.1 Loading and mounting type Use the drop-down menu to select the type of plate that meets your loading and boundary values. After the selection, the schematic picture of the plate is displayed. 2.2, 2.3 Plate dimensions Set the plate thickness, outer radius, or inner radius. The plate thickness should be smaller than 1/5 of the radius (1/10 of the radius, in case of higher accuracy demand). If you press the "

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