DOWNLOAD PDF INTRODUCTION TO SOLID MECHANICS

Chapter 1 : Solid mechanics - Wikipedia

Best book for solid mechanics!A complete coverage of all topics with in depth blog.quintoapp.com to the authors for publishing such a perfect book. Read more One person found this helpful.

In Depth Tutorials and Information Introduction to Mechanics for Solids and Structures Finite Element Method Part 1 Introduction This topic tries to introduce these basic concepts and classical theories in a brief and easy to understand manner. Solids and structures are stressed when they are subjected to loads or forces. The stresses are, in general, not uniform, and lead to strains, which can be observed as either deformation or displacement. Solid mechanics and structural mechanics deal with the relationships between stresses and strains, displacements and forces, stresses strains and forces for given boundary conditions of solids and structures. These relationships are vitally important in modelling, simulating and designing engineered structural systems. Statics deals with the mechanics of solids and structures subjected to static loads such as the deadweight on the floor of buildings. Solids and structures will experience vibration under the action of dynamic forces varying with time, such as excitation forces generated by a running machine on the floor. In this case, the stress, strain and displacement will be functions of time, and the principles and theories of dynamics must apply. As statics can be treated as a special case of dynamics, the static equations can be derived by simply dropping out the dynamic terms in the general, dynamic equations. This topic will adopt this approach of deriving the dynamic equation first, and obtaining the static equations directly from the dynamic equations derived. Depending on the property of the material, solids can be elastic, meaning that the deformation in the solids disappears fully if it is unloaded. There are also solids that are considered plastic, meaning that the deformation in the solids cannot be fully recovered when it is unloaded. Elasticity deals with solids and structures of elastic materials, and plasticity deals with those of plastic materials. The scope of this topic deals mainly with solids and structures of elastic materials. In addition, this topic deals only with problems of very small deformation, where the deformation and load has a linear relationship. Therefore, our problems will mostly be linear elastic. Materials can be anisotropic, meaning that the material property varies with direction. Deformation in anisotropic material caused by a force applied in a particular direction may be different from that caused by the same force applied in another direction. Composite materials are often anisotropic. Many material constants have to be used to define the material property of anisotropic materials. Many engineering materials are, however, isotropic, where the material property is not direction-dependent. Isotropic materials are a special case of anisotropic material. There are only two independent material constants for isotropic material. This topic deals mostly with isotropic materials. Nevertheless, most of the formulations are also applicable to anisotropic materials. Boundary conditions are another important consideration in mechanics. There are displacement and force boundary conditions for solids and structures. For heat transfer problems there are temperature and convection boundary conditions. Structures are made of structural components that are in turn made of solids. There are generally four most commonly used structural components: In physical structures, the main purpose of using these structural components is to effectively utilize the material and reduce the weight and cost of the structure. A practical structure can consist of different types of structural components, including solid blocks. Theoretically, the principles and methodology in solid mechanics can be applied to solve a mechanics problem for all structural components, but this is usually not a very efficient method. Theories and formulations for taking geometrical advantages of the structural components have therefore been developed. Formulations for a truss, a beam, 2D solids and plate structures will be discussed in this topic. In engineering practice, plate elements are often used together with two-dimensional solids for modelling shells. Therefore in this topic, shell structures will be modelled by combining plate elements and 2D solid elements. The surface of the solid is further divided into two types of surfaces: The solid can also be loaded by body force f b and surface force fs in any distributed fashion in the volume of the solid. On each surface, there will be the normal stress component, and two components of shearing stress. The sign convention for the subscript is that the first letter represents the surface on which the stress is acting, and the second letter represents the direction of the stress. The directions of the stresses shown in the figure are taken to be the positive directions. By taking moments of forces about the central axes of the cube at the state of equilibrium, it is easy to confirm that Figure 2. Four common types of structural components. Their geometrical features are made use of to derive dimension reduced system equations. Therefore, there are six stress components in total at a point in solids. These stresses are often called a stress tensor. They are often written in a vector form of Corresponding to the six stress tensors, there are six strain components at any point in a solid, which can also be written in a similar vector form of Figure 2. Solid subjected to forces applied within the solid body force and on the surface of the solid surface force. Six independent stress components at a point in a solid viewed on the surfaces of an infinitely small cubic block. Strain is the change of displacement per unit length, and therefore the components of strain can be obtained from the derivatives of the displacements as follows: The six strain-displacement relationships in Eq. Constitutive Equations The constitutive equation gives the relationship between the stress and strain in the material of a solid. There are only two independent constants among these three constants. The relationship between these three constants is That is to say, for any isotropic material, given any two of the three constants, the other one can be calculated using the above equation. Dynamic Equilibrium Equation To formulate the dynamic equilibrium equations, let us consider an infinitely small block of solid, as shown in Figure 2. As in forming all equilibrium equations, equilibrium of forces is required in all directions. Note that, since this is a general, dynamic system, we have to consider the inertial forces of the block. The equilibrium of forces in the x direction gives Figure 2. Stresses on an infinitely small block. Equilibrium equations are derived based on this state of stresses. Note that Hence, Eq. The equilibrium equations, Eqs. The above is the general form of the dynamic equilibrium equation expressed as a matrix equation. If the loads applied on the solid are static, the only concern is then the static status of the solid. Hence, the static equilibrium equation can be obtained simply by dropping the dynamic term in Eq. Boundary Conditions There are two types of boundary conditions: The displacement boundary condition can be simply written as on displacement boundaries. The bar stands for the prescribed value for the displacement component. For most of the actual simulations, the displacement is used to describe the support or constraints on the solid, and hence the prescribed displacement values are often zero. In such cases, the boundary condition is termed as a homogenous boundary condition. Otherwise, they are inhomogeneous boundary conditions. The bar stands for the prescribed value for the force component. A force boundary condition can also be both homogenous and inhomogeneous. If the condition is homogeneous, it implies that the boundary is a free surface. The reader may naturally ask why the displacement boundary condition is called an essential boundary condition and the force boundary condition is called a natural boundary conditions. In such a formulation process, the displacement condition has to be satisfied first before derivation starts, or the process will fail. Therefore, the displacement condition is essential. As long as the essential displacement condition is satisfied, the process will lead to the equilibrium equations as well as the force boundary conditions. This means that the force boundary condition is naturally derived from the process, and it is therefore called the natural boundary condition. Since the terms essential and natural boundary do not describe the physical meaning of the problem, it is actually a mathematical term, and they are also used for problems other than in mechanics. Equations obtained in this section are applicable to 3D solids. The objective of most analysts is to solve the equilibrium equations and obtain the solution of the field variable, which in this case is the displacement. Theoretically, these equations can be applied to all other types of structures such as trusses, beams, plates and shells, because physically they are all 3D in nature. However, treating all the structural components as 3D solids makes computation very expensive, and sometimes practically impossible. Therefore, theories for taking geometrical advantage of different types of solids and structural components have been developed. Application of these theories in a proper manner can reduce the analytical and computational effort drastically. A brief description of these theories is given in the following sections. Equations for Two-Dimensional Solids Stress and Strain Three-dimensional problems can be drastically simplified if they can be treated as a two dimensional 2D solid. For representation as a 2D solid, we basically try to remove one coordinate usually the z-axis , and hence assume that all the dependent variables are independent of the z-axis, and all the external loads are independent of the z coordinate, and applied only in the x-y plane. Therefore, we are left with a system with only two coordinates, the x and the y coordinates. There are primarily two types of 2D solids. One is a plane stress solid, and another is a plane strain solid. Plane stress solids are solids whose thickness in the z direction is very small compared with dimensions in the x and y directions. External forces are applied only in the x-y plane, and stresses in the z direction are all zero, as shown in Figure 2. Plane strain solids are those solids whose thickness in the z direction is very large compared with the dimensions in the x and y directions. External forces are applied evenly along the z axis, and the movement in the z direction at any point is constrained. The strain components in the z direction are, therefore, all zero, as shown in Figure 2. It can be recovered easily using Eq.

DOWNLOAD PDF INTRODUCTION TO SOLID MECHANICS

Chapter 2 : Solid Mechanics Part I

Solid Mechanics Part I: An Introduction to Solid Mechanics. This book is primarily aimed at the Part II-III Engineering undergraduate student (although some sections are more appropriate to the graduate student or researcher).

The study of the physics of continuous materials which deform when subjected to a force. Non-Newtonian fluids do not undergo strain rates proportional to the applied shear stress. Newtonian fluids undergo strain rates proportional to the applied shear stress. Response models[edit] A material has a rest shape and its shape departs away from the rest shape due to stress. The amount of departure from rest shape is called deformation , the proportion of deformation to original size is called strain. If the applied stress is sufficiently low or the imposed strain is small enough , almost all solid materials behave in such a way that the strain is directly proportional to the stress; the coefficient of the proportion is called the modulus of elasticity. This region of deformation is known as the linearly elastic region. It is most common for analysts in solid mechanics to use linear material models, due to ease of computation. However, real materials often exhibit non-linear behavior. As new materials are used and old ones are pushed to their limits, non-linear material models are becoming more common. There are four basic models that describe how a solid responds to an applied stress: Elasticity â€” When an applied stress is removed, the material returns to its undeformed state. Viscoelasticity â€” These are materials that behave elastically, but also have damping: This implies that the material response has time-dependence. Plasticity â€" Materials that behave elastically generally do so when the applied stress is less than a yield value. When the stress is greater than the yield stress, the material behaves plastically and does not return to its previous state. That is, deformation that occurs after yield is permanent. Thermoelasticity - There is coupling of mechanical with thermal responses. In general, thermoelasticity is concerned with elastic solids under conditions that are neither isothermal nor adiabatic. Galileo Galilei published the book " Two New Sciences " in which he examined the failure of simple structures Galileo Galilei published the book " Two New Sciences " in which he examined the failure of simple structures.

Chapter 3 : Introduction To Solid Mechanics - Irving Herman Shames - Google Books

Introduction to Solid Mechanics: An Integrated Approach presents for the first time in one text the concepts and processes covered in statics and mechanics of materials curricula following a granular, topically integrated approach.

Chapter 4 : Introduction to Solid Mechanics | Course Web Pages

Text: Statics and Mechanics of Materials, 5e, R.C. Hibbeler, Pearson (), Student Value Edition. The version available at the bookstore has an access code for Mastering Engineering, the software developed to.

Chapter 5 : Solid Mechanics | Civil and Environmental Engineering | MIT OpenCourseWare

An Introduction to Mechanical Engineering - Solid Mechanics (31 ratings) Course Ratings are calculated from individual students' ratings and a variety of other signals, like age of rating and reliability, to ensure that they reflect course quality fairly and accurately.

Chapter 6 : Download An Introduction to Mechanics of Solids by Stephen blog.quintoapp.comll ~ ESM

Introduction to Solid Mechanics has 16 ratings and 0 reviews. A rigorous introduction to solid mechanics.

Chapter 7 : Introduction to Solid Mechanics by Irving H. Shames

Offers students a more meaningful experience and knowledge base to bring to later mechanics-based courses and *careers and will help them retain basics. Ex. Equilibrium, constitutive laws, and compatibility â€”The "three pillars" of solid mechanics, are the basis of all discussions and examples.*

Chapter 8 : Shames & Pitarresi, Introduction to Solid Mechanics, 3rd Edition | Pearson

Introduction to Solid Mechanics by Irving Shames - Free ebook download as PDF File .pdf) or read book online for free.

Chapter 9 : Introduction to Mechanics for Solids and Structures (Finite Element Method) Part 1

Solid mechanics is the branch of continuum mechanics that studies the behavior of solid materials, especially their motion and deformation under the action of forces, temperature changes, phase changes, and other external or internal agents.