Sri Chandrasekharendra Saraswathi Viswa Mahavidyalaya

DEPARTMENT OF MECHANICAL ENGINEERING

COURSE MATERIAL

Name of the Course	**:**	**Strength of Materials (SM)**
Name of the Unit	**:**	**Introduction - Strength of Materials**
Name of the Topic	**:**	**Need and Applications of SM**

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SCSVMV

STRENGTH OF MATERIALS

AIM & OBJECTIVE

- To understand the nature of stresses developed in simple and composite bars.
- To understand the nature of stresses developed in beams.
- To understand the slope and deflection developed in beams.
- To calculate the elastic deformation occurring in various simple geometries for different types of loading.
- To understand the nature of stresses developed in cylinders and spheres for various types of simple loads.

PRE-TEST

1. Strain is defined as the ratio of

   (a) change in volume to original volume

   (b) change in length to original length

   (c) change in cross-sectional area to original cross-sectional area

   (d) any one of the above

2. Hooke's law holds good up to

   (a) yield point

   (b) limit of proportionality

   (c) breaking point

   (d) elastic limit

3. The materials having same elastic properties in all directions are called

   (a) ideal materials

   (b) uniform materials

   (c) isotropic materials

   (e) elastic materials.

4. Modulus of rigidity is defined as the ratio of

   (a) longitudinal stress and longitudinal strain

   (b) volumetric stress and volumetric strain

   (c) lateral stress and lateral strain

   (d) shear stress and shear strain

5. The intensity of stress which causes unit strain is called

   (a) unit stress

   (b) bulk modulus

   (c) modulus of rigidity

   (d) modulus of elasticity

6. Which of the following has no unit

   (a) kinematic viscosity

   (b) surface tension

   (c) bulk modulus

   (d) strain

7. Resilience of a material is considered when it is subjected to

   (a) frequent heat treatment

   (b) fatigue

   (c) creep

   (d) shock loading

8. When a body is subjected to two equal and opposite pushes, as a result of which the body tends to reduce its length, the stress and strain induced is--------------

   A. bending stress

   B. shear stress

   C. tensile stress

   D. compressive stress

9. A concentrated load is one which

   A. acts at a point on a beam

   B. spreads non-uniformly over the whole length of a beam

   C. spreads uniformly over the whole length of a beam

   D. varies uniformly over the whole length of a beam

10. The ratio of direct stress to volumetric strain in case of a body subjected to three mutually perpendicular stresses of equal intensity, is equal to

    (a) Young's modulus

    (b) bulk modulus

    (c) modulus of rigidity

    (d) modulus of elasticity

PREREQUISITES

- Engineering Mechanics
- Basic Mechanical Engineering
- Material Science

THEORY BEHIND

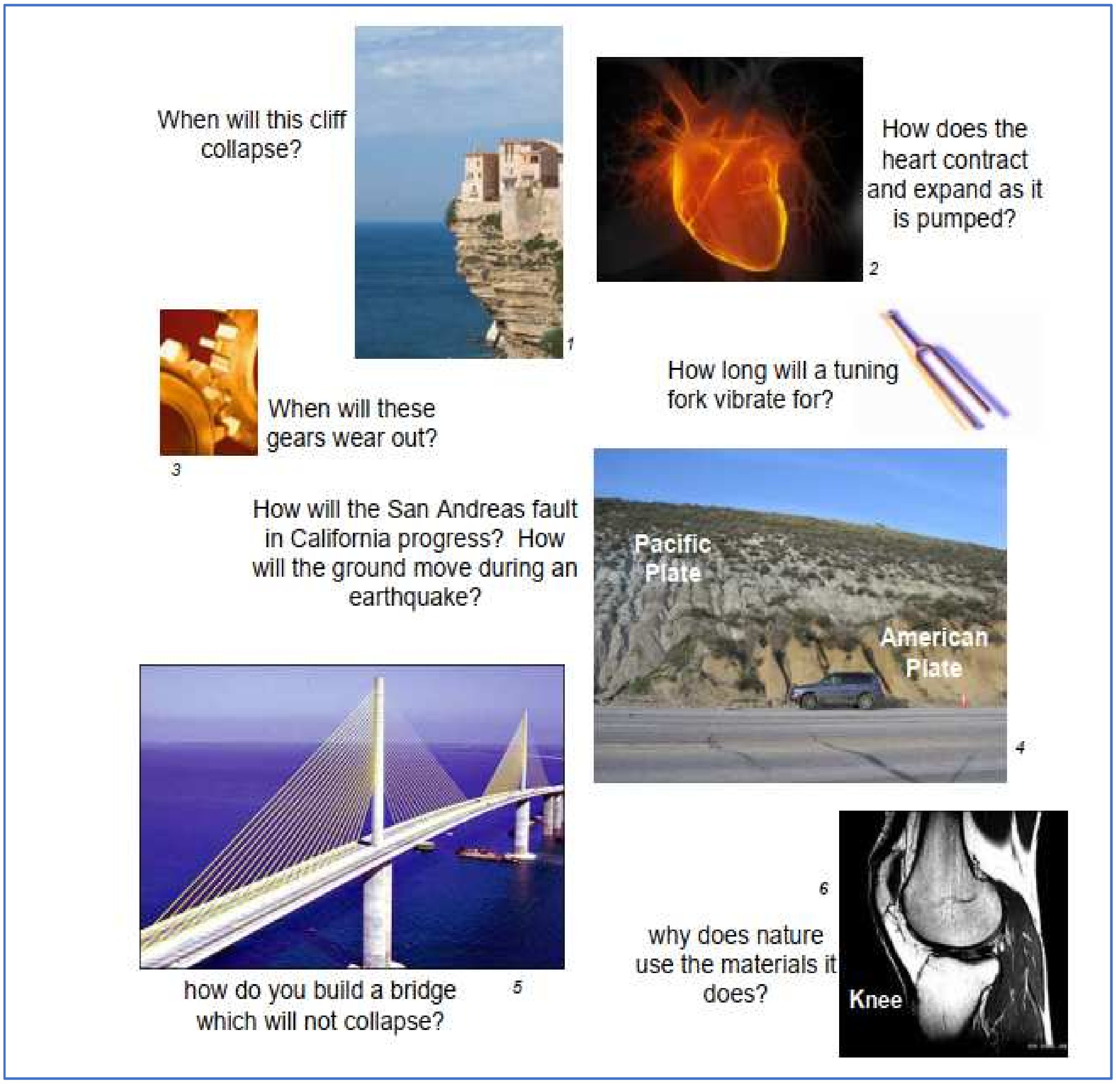
SYLLABUS: STRENGTH OF MATERIALS

UNIT - I SIMPLE STRESS AND STRAIN
Deformation in solids– Hooke's law– stress and strain –tension, compression and shear stresses– composite bars - elastic constants and their relations–Volumetric, linear and shear strains.
UNIT - II SHEAR FORCE AND BENDING MOMENT DIAGRAM
Beams and types–Transverse loading on beams– shear force and bend moment diagrams– Types of beam supports–Simply supported, over-hanging beams and cantilevers– Theory of bending of beams–bending stress distribution and neutral axis–shear stress distribution– point and distributed loads.
UNIT – III DEFLECTION OF BEAMS
Deflection of a beam using double integration method, moment area method and macaulay's method– computation of slopes and deflection in beams–Maxwell's reciprocal theorems.
UNIT – IV TORSION OF SHAFT AND SPRINGS
Torsion–Stresses and deformation in circular and hollow shafts– stepped shafts–Deflection of shafts fixed at both ends–Stresses and deflection of helical springs, laminated spring - principal stresses and principal planes– Mohr's circle.
UNIT – V THIN AND THICK CYLINDER
Axial and hoop stresses in cylinders subjected to internal pressure–Deformation of thick and thin cylinders–Deformation in spherical shells subjected to internal pressure.

INTRODUCTION

Strength of Materials is the study of the deformation and motion of solid materials under the action of forces. It is one of the fundamental applied engineering sciences, in the sense that it is used to describe, explain and predict many of the physical phenomena around us.

Here are some of the wide-ranging questions which strength of Materials tries to answer:

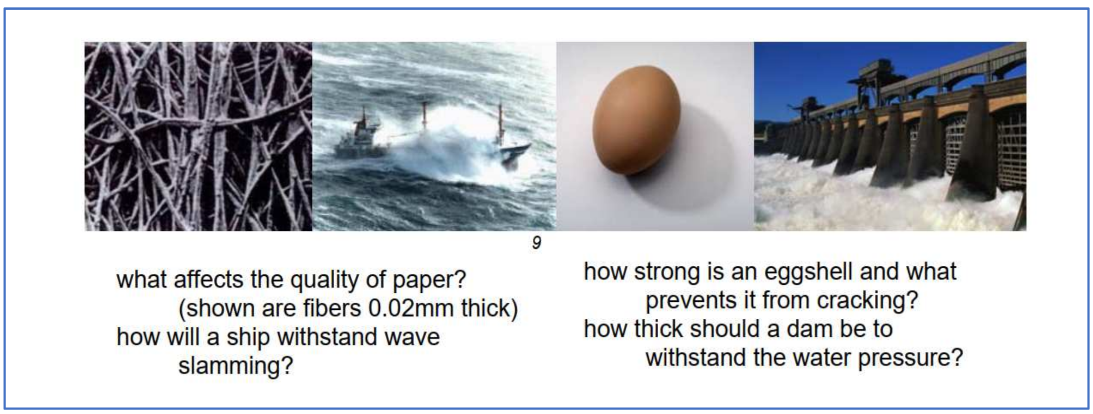


Strength of Materials is a vast subject. One reason for this is the wide range of materials
which falls under its ambit: steel, wood, foam, plastic, foodstuffs, textiles, concrete, biological materials, and so on. Another reason is the wide range of applications in which these materials occur. For example, the hot metal being slowly forged during the

manufacture of an aircraft component will behave very differently to the metal of an automobile which crashes into a wall at high speed on a cold day.

Here are some examples of Solid Mechanics of the cold, hot, slow and fast …

Here are some examples of Solid Mechanics of the small, large, fragile and strong …



Aspects of Strength of Materials:

The theory of Strength of Materials starts with the **rigid body**, an ideal material in which the distance between any two particles remains fixed, a good approximation in some applications. This is the study of some elementary but very relevant deformable materials and structures, for example beams and pressure vessels.

Elasticity theory is used, in which a material is assumed to undergo *small* deformations when loaded and, when unloaded, *returns to its original shape*. The theory well approximates the behaviour of most real solid materials at low loads, and the behaviour of the "engineering materials", for example steel and concrete, right up to fairly high loads **Plasticity theory**, which is used to model the behaviour of materials which undergo *permanent* deformations, which means pretty much anything loaded high enough. Some other topics embraced by Strength of Materials are

Rods, beams, shells and membranes, the study of material components which can be approximated by various model geometries, such as “very thin”

Vibrations of solids and structures, where particles vibrate about some equilibrium position, giving rise to vibration and wave propagation

Composite materials, the study of components made up of more than one material, for example fibre-glass reinforced plastics

Geomechanics, the study of materials such as rock, soil and ice

Fracture and damage mechanics, the mechanics of crack-growth and damage in materials

Stability of structures, the study of whether structures have the ability to return to some equilibrium position after being disturbed, or perhaps catastrophically fail

Variational formulations and computational mechanics, the study of the numerical (approximate) solution of the mathematical equations which arise in the various branches of strength of Materials.

Experimental mechanics, the design and analysis of experimental procedures for determining the behaviour of materials and structures.

APPLICATIONS

- In Civil Engineering to design foundations and structures
- In Geo-Mechanics to model shape of planets, tectonics and predict earthquakes
- In Mechanical Engineering to design load bearing components for vehicles, power generation and transmission
- Strength of materials is lot more important in an industry. In case of civil the positioning and construction of beams and trusses involves strength of materials. For eg suspension bridges involves air bending and friction so strength of materials is important in the distance between support pillars.

- Strength of materials is also responsible for stress distribution. One can even simulate a machine or a component and can define its factor of safety or even a maintenance schedule.
- Pressure-bearing components: pipes and vessels which contain internal pressure (ie almost all pipes/vessels) must be designed so that the walls are strong enough to withstand the hoop stress created by applying radial force on the walls.

- Tension-bearing components: suspended pipe used in drilling must support its own hanging weight.
- Compression-bearing components: pilings and drill collars must withstand compressive loads by not buckling and not shearing. Compressive shear failure is a direct function of yield strength.
- Bending: pipe drilling in deviated holes, cantilever beams, wellheads under side-loading, etc.
- Just about the only use of metal in the oil industry that DOESN'T rely on the strength of materials is as weight/ballast for holding things down.

MCQ POST-TEST

1. The stress induced in a body due to suddenly applied load compared to when it is applied gradually is the internal reaction in bottom 80 cm length will be
   (a) same in both cases
   (b) zero in first case
   (c) different in both cases
   (d) data are not sufficient to determine same
2. The stress induced in a body due to suddenly applied load compared to when it is applied gradually is
   (a) same
   (b) half
   (c) two times
   (d) four times

3. The strain energy stored in a body due to suddenly applied load compared to when it is applied gradually is

 (a) same

 (b) twice

 (c) four times

 (d) eight times

4. If percentage reduction in area of a certain specimen made of material ‘A’ under tensile test is 60% and the percentage reduction in area of a specimen with same dimensions made of material ‘B’ is 40%, then

 a) the material A is more ductile than material B

 b) the material B is more ductile than material A

 c) the ductility of material A and B is equal

 d) the material A is brittle and material B is ductile

5. The shear force of a simply supported beam carrying a central point load changes sign at its -------

 a) Midpoint

 b) End point

 c) Anywhere

 d) None of the above

6. In a beam where shear force changes sign, the bending moment will be

 a) zero

 b) minimum

 c) maximum

 d) infinity

7. When the shear force diagram is a parabolic curve between two points, it indicates that there is a

 (a) point load at the two points

 (b) no loading between the two points

 (c) uniformly distributed load between the two points

 (d) uniformly varying load between the two points

8. When the bending moment diagram is a parabolic curve between two points, it indicates that there is a

(a) point load at the two points

(b) no loading between the two points

(c) uniformly distributed load between the two points

(d) uniformly varying load between the two points

9. A rectangular beam of length l supported at its two ends carries a central point load W. The maximum deflection occurs
   a) At the ends
   b) At l/3 from both ends
   c) At the center
   d) None of these
10. A hollow shaft of same cross-section area as compared to a solid shaft transmit
    a) Same torque
    b) Less torque
    c) More torque
    d) Unpredictable
11. Two shafts 'A' and 'B' transmit the same power. The speed of shaft 'A' is 250 r.p.m. and that of shaft 'B' is 300 r.p.m.
    a) The shaft 'B' has the greater diameter
    b) The shaft 'A' has the greater diameter
    c) Both are of same diameter
    d) None of these
12. The buckling load for a given material depends on

    (a) slenderness ratio and area of cross-section

    (b) Poisson's ratio and modulus of elasticity

    (c) slenderness ratio and modulus of elasticity

    (d) slenderness ratio, area of cross-section and modulus of elasticity
13. Slenderness of a column is zero when
    a. Ends are firmly fixed
    b. Column is supported on all sides throughout the length
    c. Length is equal to radius of gyration
    d. Length is twice the radius of gyration

14. A column is said to be a short column, when
    a. Its length is very small
    b. Its cross-sectional area is small
    c. The ratio of its length to the least radius of gyration is less than 80
    d. The ratio of its length to the least radius of gyration is more than 80

CONCLUSION

Upon completion of this course, Students should be able to

- Recognize various types loads applied on machine components of simple and composite bars.
- Recognize the stresses developed on various types of beams.
- Recognize the slope and deflection developed on various types of beams.
- Evaluate the strains and deformation that will result due to the elastic stresses developed within the materials for simple types of loading.
- Understand the nature of internal stresses.

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VIDEO LINK

https://youtu.be/GkFgysZC4Vc

ASSIGNMENT

1. Explain the applications of strength of materials in mechanical industries.
2. Explain the applications of strength of materials in civil Engineering.