LABORATORY MANUAL
18CVL38 BUILDING MATERIAL TESTING LABORATORY

2020-21

DEPARTMENT OF CIVIL ENGINEERING
ATRIA INSTITUTE OF TECHNOLOGY
Adjacent to Bangalore Baptist Hospital
Hebbal,Bangalore-560024

Atria Institute of Technology

(Affiliated to VTU, Belgaum & Approved by AICTE, New Delhi) (**NAAC Accredited & ISO 9001:2015 Certified Institution)**

Adjacent to Bangalore Baptist Hospital
Hebbal,Bangalore-560024

SYLLABUS

Building Materials Testing Laboratory (18 CVL 38)

As per Choice Based Credit System (CBCS) Scheme

Number of Lecture Hours/Week:	**03**	CIE Marks:	**40**
Credits:	**02**	SEE Marks:	**60**
		Exam Hours:	**03**

Experiments:

1. Tension test on mild steel and HYSD bars.
2. Compression test on mild steel, cast iron and wood.
3. Torsion test on mild steel circular sections.
4. Bending Test on Wood Under two point loading.
5. Shear Test on Mild steel- single and double shear.
6. Impact test on Mild Steel (Charpy & Izod).
7. Hardness tests on ferrous and non-ferrous metals – Brinell's, Rockwell and Vicker's.
8. Test on Bricks and Tiles.
9. Tests on Fine aggregates – Moisture content, Specific Gravity, Bulk density, Sieve analysis and Bulking.
10. Tests on Coarse aggregates – Absorption, Moisture content, Specific Gravity, Bulk density and Sieve analysis.
11. Demonstration of Strain gauges and Strain Indicators.

Question paper pattern:

- Group experiments - Tension test, compression test, torsion test and bending test.
- Individual Experiments - Remaining tests.
- Two questions are to be set - One from group experiments and the other as individual experiment.
- Instructions as printed on the cover page of answer script for split up of marks to be strictly followed.
- All exercises are to be included for practical examination.

Reference Books:

1. Davis, Troxell and Hawk, "Testing of Engineering Materials", International Student Edition – McGraw Hill Book Co. New Delhi.
2. M L Gambhir and Neha Jamwal, "Building and construction materials- Testing and Quality control", McGraw Hill education (India)Pvt. Ltd., 2014
3. Fenner, "Mechanical Testing of Materials", George Newnes Ltd. London.
4. Holes K A, "Experimental Strength of Materials", English Universities Press Ltd. London.

5.Relevant IS Codes.

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Department of Civil Engineering

Building Materials Testing Laboratory (18CVL 38)

Course Objective

The objective of the Materials Testing Laboratory is to demonstrate the basic principles in the area of strength and mechanics of materials to the undergraduate students through a series of experiments.

- Ability to apply knowledge of mathematics and engineering in calculating the mechanical properties of structural materials.
- Ability to function on multi-disciplinary teams in the area of materials testing.
- Ability to use the techniques, skills and modern engineering tools necessary for engineering.
- Understanding of professional and ethical responsibility in the areas of material testing.
- Ability to communicate effectively the mechanical properties of materials.

Course Outcome

After successful completion of the course, the students will be able to:

- Reproduce the basic knowledge of mathematics and engineering in finding the strength in tension, compression, shear and torsion.
- Identify, formulate and solve engineering problems of structural elements subjected to flexure.
- Evaluate the impact of engineering solutions on the society and also will be aware of contemporary issues regarding failure of structures due to undesirable materials.

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Sl. No	Name of the Experiment	Date			Manual Marks (Max .20)	Record Marks (Max. 10)	Signature of Faculty
		Conduction	Repetition	Submission of Record			
Average							

Note:

- **If the student fails to attend the regular lab, the experiment has to be completed in the same week. Then the manual/observation and record will be evaluated for 50% of maximum marks.**

Instructions to the Candidates

1. Students should come with thorough preparation for the experiment to be conducted.
2. Students will not be permitted to attend the laboratory unless they bring the practical record fully completed in all respects pertaining to the experiment conducted in the previous class.
3. All the calculations should be made in the observation book. Specimen calculations for one set of readings have to be shown in the practical record.
4. Wherever graphs are to be drawn, A-4 size graphs only should be used and the same should be firmly attached to the practical record.
5. Practical record should be neatly maintained.
6. They should obtain the signature of the staff-in-charge in the observation book after completing each experiment.
7. Theory regarding each experiment should be written in the practical record before procedure in your own words.

ATRIA INSTITUTE OF TECHNOLOGY
Department of Civil Engineering

LAB MANUAL

(2015-16)

Materials Testing Lab

(15CVL36)

III A&B Semester

Name:____

U.S.N: :____

Batch:__Section:_

Table of contents

Expt. No. 1 **Date:**

Tension test on mild steel and HYSD Bars

Aim:

- To determine the maximum tensile strength of the given specimen
- To find out Young's modulus of the given specimen
- Determine the yield stress of the given specimen

Apparatus : Universal testing machine (UTM) , Extensometer ,slide calipers, Dial gauge and scale,

Theory

The term Static Tension Test usually refers to tests in which a prepared specimen is subjected to gradually increasing (i.e. Static) uniaxial load until failure occurs. In simple tension test, the operation is accomplished by gripping opposite ends of the piece of material and pulling it apart. In tension test of metals the properties usually determined are yield strength (Yield point of ductile metals), tensile strength, ductility (elongation and reduction area) and type of fracture**.** For brittle material only the tensile strength and character of fracture are commonly determined.

At the beginning of the test the material extends elastically: this signifies that if load is released, the sample will return to its original length.

The material is said to have passed its elastic limit when the load is sufficient to initiate plastic or non recoverable deformation in other words, it will no longer return to its original length if the load is released.

Stress the deformation of the body caused by the force per unit area is called Stress. It can be defined as resistance per unit area is called stress. I t can also be defined as resistance per unit area to deformation of the body by applying a force i.e.

$$\text{Stress (p)} = \frac{\text{Load of force acting on the body}}{\text{Area of the body.}}$$

Strain: when a force is applied on a body, it gets deformed. This deformation per unit length is called Strain. i.e.

$$\text{Strain } (\epsilon) = \frac{\text{Change in length}}{\text{Original length}} = \frac{\Delta L}{L}$$

Hooke's Law: It states that stress is directly proportional to strain with in the elastic limit.

Procedure

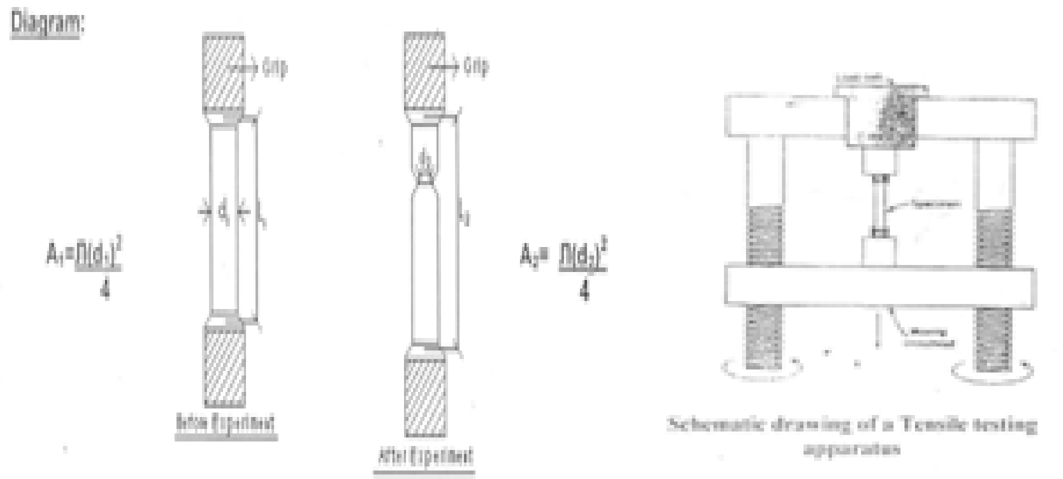
- Measure the gauge length (L_1) and diameter (d1) of the given tension specimen using scale and slide calipers respectively.
- Fit the tension specimen in the UTM machine firmly and fit the dial gauge on the anvil of the UTM machine.
- Apply the load with an increment of 5 KN and note down the change in length of the specimen (at every increment of load) from dial gauge until the specimen fails.
- Collect failed specimen and hold together. Measure and record the change in length (L_2) and diameter (d_2) .We observe that

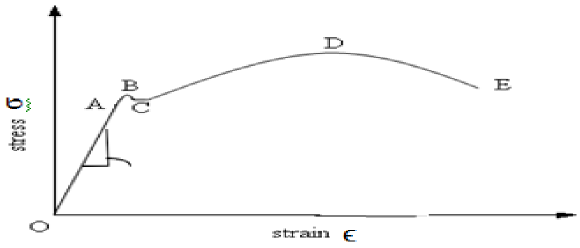
  $l1<l2$ and $d1>d2$
- Calculate

  % Elongation = (l2-l1/l1) X 100 mm

  % Reduction = ((A1-A2)/ A1)) X 100 mm^2

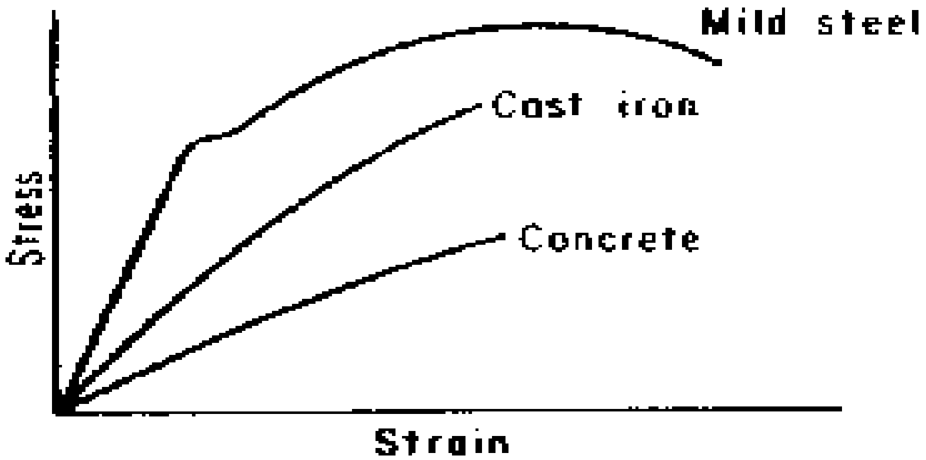
- Plot the graph of Stress vs Strain for mild steel specimen subjected to tension.
- Find the Young's modulus, yield stress and maximum tensile str





tanΘ = stress/ strain A – Elastic limit
tanΘ = (σ/ε) B – Upper yield stress
C – Lower yield stress
D – Ultimate stress
E – Breaking stress

Stress – Strain curve



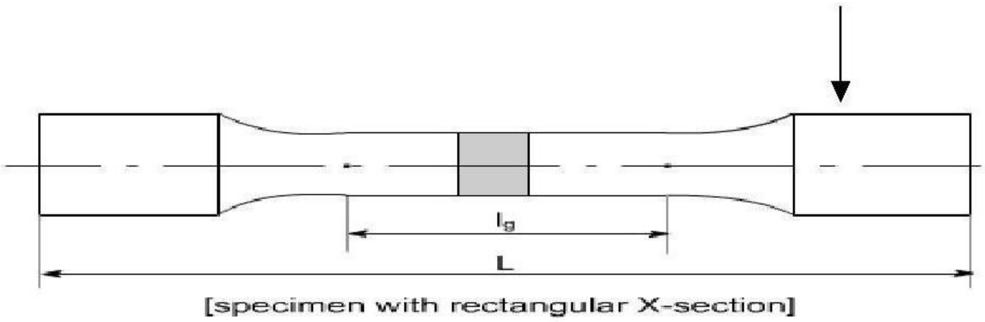


Fig- Standard Specimen

Observation & calculations

Reading in Slide Calipers

Trial no	MSR (cm)	CVD	TR= MSR+ (CVDXLC) cm

LOAD	Area A1 (mm^2)	Stress (kn/mm^2)	Initial length l_1	Δl mm	Δl/l
0					
5					
10					
15					
20					
25					
‘					
‘’					
‘’					
‘’					
‘’					
300					

Results:

1. % increase in area = (A2-A1)/A1 X100 =-----------------
2. % Reduction in length =(l1 – l2)/ l1 X100 = -------------------
3. Young’s Modulus = ----------------------------

Expt. No. 2 **Date:**

Compression test on mild steel, Cast iron and wood

Aim:

- To determine the crushing strength of the given specimen.
- Find out the Young's modulus of the given specimen.

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Apparatus : Universal testing machine (UTM), slide calipers, scale Dial gauge and compress meter

Theory:

The term Static compression test usually refers to tests in which a prepared specimen is subjected to a gradually increasing (i.e. Static) uniaxial load until failure occurs. In simple compression test, the operation is accomplished by subjecting a piece of material to end loading, which produces crushing action. In a compression test, the piece shortens. The ratio of length to diameter of a compression specimen appears to be more or less of compromise between several undesirable conditions. As the length of the specimen increases, there is an increasing tendency toward bending of the specimen, with consequent non-uniform distribution of stress over right specimen height to diameter ratio of 10 is suggested as a practical upper limit.

Type	h/d Ratio (all dimensions in mm)
Short specimen	0.9 (Dia = 30,Ht = 27)
Medium specimen	3.0 (Dia = 13 to 30,Ht = 39 to 90)
Long specimen	10 (Dia = 20 to 32 , Ht = 160 to 320)

Table showing height to diameter ratio and range of diameter and height for various types of metallic materials

Stress the deformation of the body caused by the force per unit area is called Stress. It can be defined as resistance per unit area is called stress. I t can also be defined as resistance per unit area to deformation of the body by applying a force i.e.

$$\textbf{Stress (p)} = \frac{\textbf{Load of force acting on the body}}{\textbf{Area of the body.}}$$

Strain: when a force is applied on a body, it gets deformed. This deformation per unit length is called Strain. i.e.

$$\textbf{Strain } (\epsilon) = \frac{\textbf{Change in length}}{\textbf{Original length}} = \frac{\Delta L}{L}$$

Hooke's Law: It states that stress is directly proportional to strain with in the elastic limit.

P α Є

P = E Є (E = Young's Modulus)

Procedure

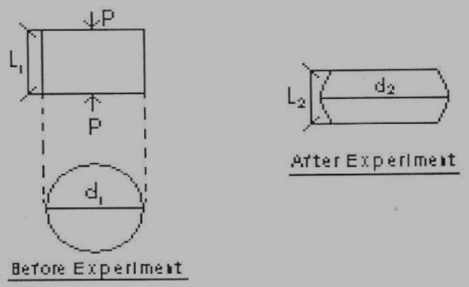
- Measure the diameter D1 and length L1 of the given compression specimen using slide calipers and scale.
- Place the specimen in the UTM such that it is ready for the application of the load on to the specimen.
- Fix the dial gauge to the bottom platform of the UTM to measure the contraction.
- Apply the load on to the specimen and note down the dial gauge reading at every increment of 2 KN and tabulate it until the specimen fails.
- Measure the final length L2 and Diameter D2 of the specimen .We observe that

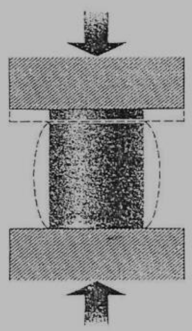
  L1>L2 and D1 <D2
- Plot the graph of Stress Vs Strain for mild steel specimen subjected to compression.
- In compression test definite yield point cannot be obtained as in case of tension test. So you need to apply offset method.
- Take 0.1% L of the specimen on the strain axis and draw a line to the initial curve to cut the curve at the yield point and the corresponding stress is called as yield stress.

  Compressive stress = Maximum compressive load

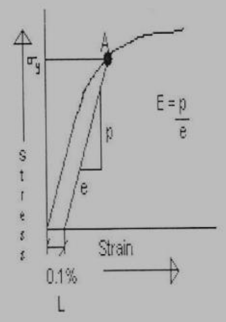
  Initial cross sectional area

Diagram:





Compression test of a ductile material showing "barreling"



Observations and Calculations:

Reading in Slide Calipers:

Trial NO	MSR(cm)	CVD	TR= MSR+(CVDXLC) cm

Load P (KN)	Area A1 (mm2)	Stress (N/mm2)	Initial Length L1 (mm)	ΔL (mm)	Strain = ΔL ------ L

Results

1. % increase in area = (A2-A1)/A1 * 100 =
2. % Reduction in length = (L1- L2)/L1 *100 =
3. Young's Modulus =

Expt.No.3 **Date:**

TORSION TEST ON MILD STEEL CIRCULAR SECTIONS

Aim:

- To find out Polar Modulus of a given specimen
- To Determine Torsional Rigidity to Stiffness of a Shaft

Apparatus

Torsion testing machine, Scale and Screw gauge

Theory and Scope

A member is said to be in torsion when subjected to moment about its axis. The effect of torsional moment on the member is to twist it and hence a Torsional moment is also called as twisting moment or torque.

In engineering problems many members are subjected t torsion .Shafts transmitting power from an engine to the rear axle of an automobile, from a motor to machine tool and from a turbine to electric motors are common examples.

The torsion equation is given as

$$\frac{T}{J} = \frac{q}{r} = \frac{G\theta}{L}$$

Where T = Torsion moment
J = Polar moment of inertia
q = Shear stress in the element
G = Modulus of rigidity
θ = Angle of twist
L = Length of the shaft.

Procedure

- Using Screw gauge measure the diameter (All along the specimen) of the specimen and note the average reading. Take the length of the specimen using scale and note down the reading.
- Then adjust the torsion machine to read zero and then insert the specimen into the two heads. See that each end is centered inside each head. Then fix he specimen firmly into the head.
- Apply load at a slow speed. Take readings of torque and twist simultaneously without stopping the machine. Note the readings of twist and load till the specimen fails.
- Plot the diagram from the origin, showing the relation between torque in (Kn-m) and angle of twist in (Radians)
- Compute the quantities required and tabulate
- Using the formula calculate Polar modulus and Torsional rigidity or Stiffness of the shaft.

Formulae

$$\text{Polar modulus} = \frac{T}{J} = \frac{q}{r}$$

$$\text{Torsional rigidity} = \frac{T}{J} = \frac{G\theta}{L}$$

Diagram

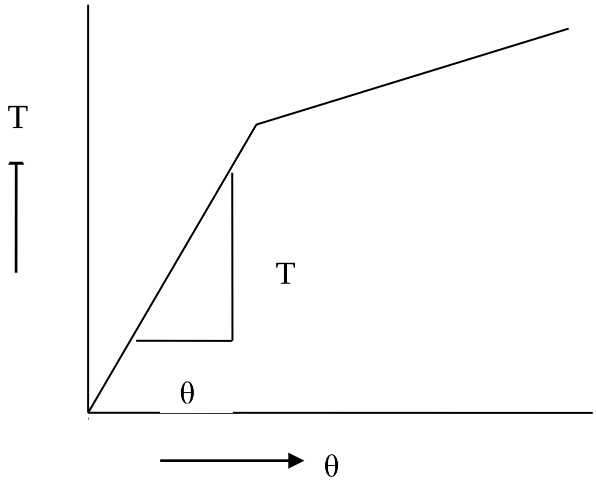


Fig- Specimen after torsion test

Fig-Conduction of torsion test

Observations and Calculations:

Reading in Screw gauge

Trial No	MSR (cm)	CVD	TR = MSR + (CVD X LC) cm
1			
2			
3			

Torque (Kn-m)	θ1 (Radians)	θ2 (Radians)	(θ1- θ2) (Radians)

Result:

Polar modulus of the shaft (J) = ____________________________

Torsional rigidity or Stiffness of the shaft (G) = _____________________

Expt. No. 4 **Date:**

BENDING TEST ON WOOD UNDER TWO POINT LOADING

- To find the modulus of Elasticity of the given specimen subjected to bending.
- To calculate the bending stress of the given specimen subjected to bending.

Apparatus:

Scale, Universal Testing Machine (UTM) & dial gauge.

Theory and Scope:

If forces act on a piece of material in such a way that they tend to induce compressive stresses over one part of a cross section of the piece and tensile stresses over the remaining part , the piece is said to be in bending. The common illustration of bending action is a beam acted on by transverse loads: bending can also be caused by moments or couples such as may results for example from eccentric loads parallel to the longitudinal axis of a piece.

In structures and machines in service, bending may be accompanied by direct stress, transverse shear, or Torsional shear. For convenience, however, bending stresses may be considered separately, and in tests to determine the behavior of materials in bending, attention is usually confined to beams

The bending stress equation is

$$\mathbf{M/I = f_b/Y = E/R}$$

Where M= maximum bending moment for point load M = WL/ 4

I = moment of inertia = $BD^3/12$

F_b = bending stress = $3WL/2BD^2$

Y = D/2

E = Modulus of elasticity

R = radius of curvature

The modulus of elasticity is calculated as follows, the maximum deflection for a point load acting at the centre of the beam deflection will be maximum at center that is given by

$$\Delta = \mathbf{WL^3/48EI}$$

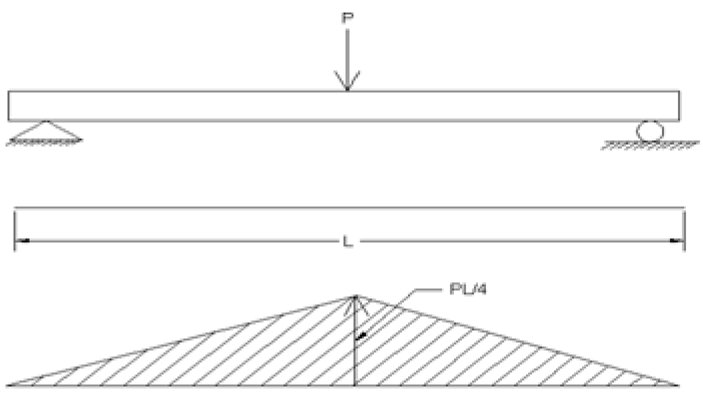
$$\mathbf{E = WL^3/ 48\delta I}$$

(w/δ is obtained from the graph)

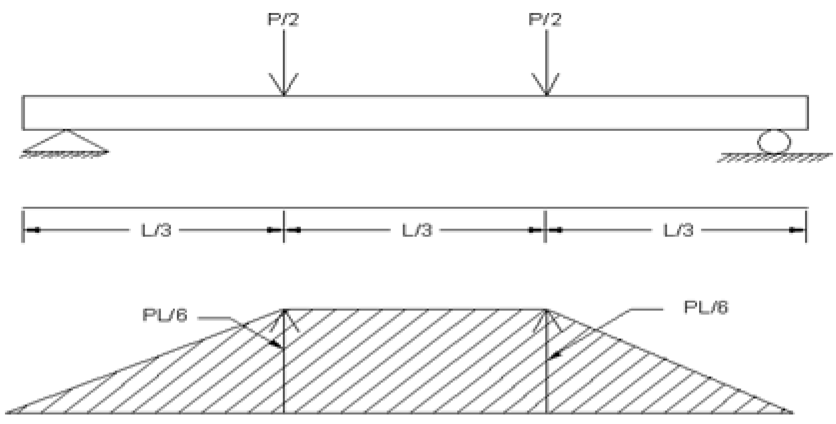
Procedure:

- Measure the length L, breadth B, depth D of the given specimen.
- Place the specimen on the UTM platform in simply supported position. Measure the effective length l
- Bring the platform of UTM such that the load is applied at the centre of the specimen
- Before the application of the load fix the dial gauge to measure the deflection.
- Apply the load at an increment of 2KN and also note down the deflection in the dial gauge until the specimen fails.
- Plot the graph of load v/s deflection and obtain w/δ at the initial straight line portion of the curve.

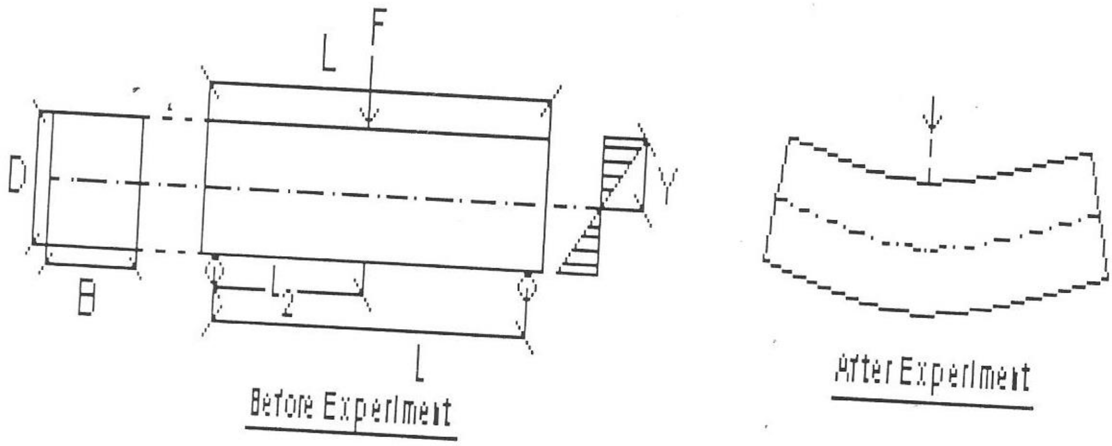
l



Single point loading Bending Moment Diagram



Two point loading Bending Moment Diagram



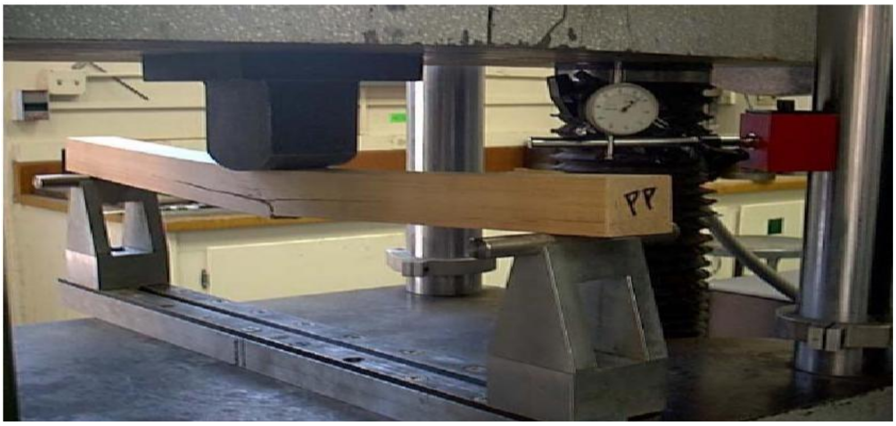


Fig-Wooden specimen at failure under Bending

Load (KN)	Deflection (δ)

R**esults**

1. Modulus of Elasticity = ______________________
2. Bending stress = ________________________

Expt.No.5 **Date:**

SHEAR TEST ON MILD STEEL

Aim

To determine experimentally the Ultimate shear strength (maximum shear strength) in single shear and double shear of the following specimens.

- Mild steel
- Cast iron
- Aluminum
- Brass

Under standard conditions.

Apparatus

Universal Testing Machine (UTM), Micrometer calipers or Vernier calipers, Testing ring consisting of Guide block, punch and positioning and Holding nuts.

Theory and scope

A shearing stress acts parallel to a plane, as distinguished from tensile and compressive stresses which acts normal to a plane. Direct shear and torsional shear are the loadings causing shear condition that are of principal interest in materials testing.

Direct shear: If the resultants of parallel but opposed forces act through the centroids of sections that are spaced infinitesimal distances apart, it is convincible that the shearing stresses over the section would be uniform and state of pure, direct shear would exist. This condition may be approach but never realized practically. An approximation of pure direct shear is the case of a rivet in shear for practical prurposes.direct shear may be considered to exist within in the rivet planes X-X and Y-Y .because two planes are involved simultaneously, the condition is called double shear

Procedure:

- The average diameter of the specimen is measured using vernier calipers.
- The specimen is fixed to UTM and the load is applied slowly at right angles to axis of the piece through the central block.
- Care should be taken to see that the testing devices holds the specimen firmly and preserves good alignment.
- The maximum load to fracture the specimen is determined by direct reading on the testing machine and the shear strength is obtained from maximum load in accordance to the formula.

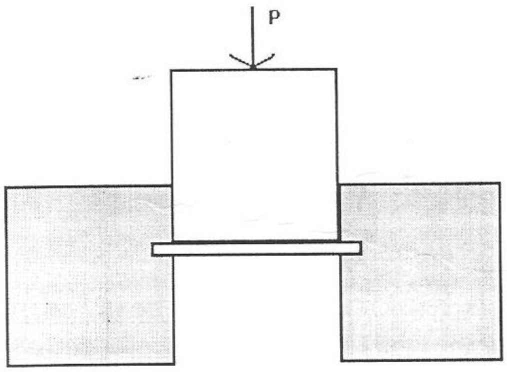
Ultimate shear stress = P/A

Where, P = Failure load in single shear

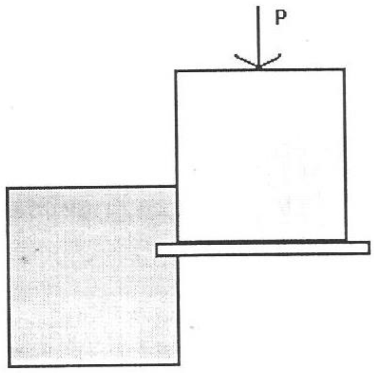
A = Area of cross section

- The shape of the texture of the fractured surface is reported.

- Care should be taken to distinguish pire shear failures and failures that may occur as a result of bending stresses or of diagonal tensile stresses.



Double Shear Arrangement



Single Shear Arrangement

Observations and calculations

Reading in Slide Calipers

Trial no	MSR (Cm)	CVD	TR= MSR + (CVD XLC) (cm)

Failure load in single shear (P) =
Failure load in double shear (P)=

$A = \pi D^2/4$

Result:

1. Single ultimate shear stress = ___________
2. Double ultimate shear stress = ________________

Expt No 6 **Date:**

IMPACT TEST ON MILD STEEL

Aim

To study the impact testing machine of pendulum type and to determine the impact resistance of the given material in the form of notched bar Charpy and Izod specimen.

Apparatus

Impact machine which consists of frame , pendulum , supporting device and graduation , Slide calipers , Allen key, screw positioning gauge , Wedge shaped and knife edge striker.

Theory and Scope

An important type of loading is dynamic loading in which the load is applied suddenly, as from the impact of a moving mass. In the design of many types of structures and machines that must take impact loading , the aim is to provide for the absorption of as much energy as possible through elastic action and then to rely on some kind of damping to dissipate it. in structures or machines the resilience (i.e. is the elastic energy capacity) of the material is a significant property and resilience data derived from static loading may not be adequate. The mechanics of the impact involved not only the question of stresses induced but also consideration of energy transfer and energy absorption and dissipation. As the velocity and the kinetic energy of the striking body are changed, a transfer of energy must occur; work is done on the parts receiving the blow.

Satisfactory performance of certain types of machine parts, such as parts of percussion drilling equipment, parts of automotive engines and transmissions parts of rail road equipments, track and buffer devices, highway guard rails, and so on depends on the toughness of the parts under shock loadings. Although a direct approach to this problem would seem to be the use of tests that involve impact loads, the solution to the problem is not the use of tests that involve impact loads, the solution to the problem is not simple .Beyond doubt the results of the impact tests have contributed indirectly to the improved design of certain types of parts but in general such tests are of only limited significance in producing basic design data.

IZOD IMPACT TEST

Procedure

- A V – notched specimen is used in this experiment. The length (L) breadth (B) and depth (D) of the specimen is noted.
- The hammer is fixed with the wedge shaped striker with the help of clamping devices.
- The hammer is freely suspended from an angle of 85 degrees to check for the error in the Izod scale, if there is some error it is corrected.

- The specimen is then fixed to the bottom platform of the machine with the help of socket and screw such that the V- notch should face the hammer.
- Then the hammer is suspended from the same position and the reading us noted from the Izod scale., and the impact resistance of the specimen is calculated using the formula

Impact resistance = E/A

Where E = energy required to break the specimen

A = Area below the V- notch

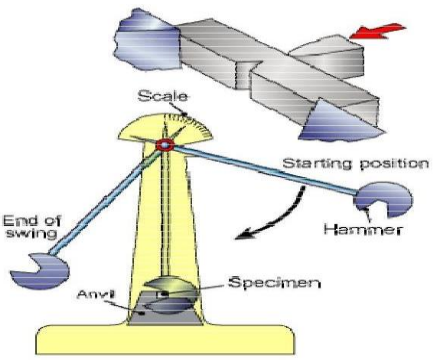
Observations and Calculations

Reading in slide calipers: Breadth of specimen

Trial no	MSR (cm)	CVD	TR= MSR+ (CVDXLC) cm

Reading in slide calipers: Depth of specimen

Trial no	MSR (cm)	CVD	TR= MSR+ (CVDXLC) cm



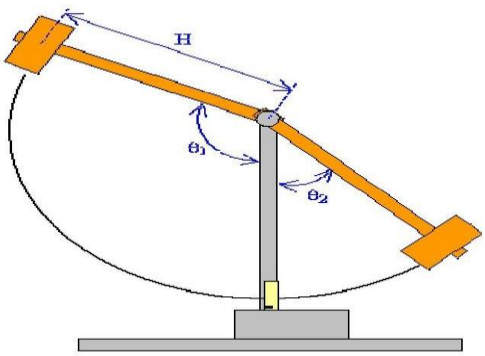


Fig (a)-Impact Testing Machine   Impact Testing Machine-Pendulum Movement

Charpy Impact test.

Procedure

- A U – notched specimen is used in this experiment. The length (L) breadth (B) and depth (D) of the specimen is noted.
- The hammer is fixed with the knife edged striker with the help of clamping devices.
- The hammer is freely suspended from an angle of 140 degrees to check for the error in Charpy scale. If there is some error it is corrected.
- The specimen is then freely suspended from the same position and the reading is noted down. From the Charpy scale. and the impact resistance of the specimen is calculated using the formula

Impact resistance = E/A

Where E = energy required to break the specimen

A = Area below the U- notch

Observations and Calculations

Reading in slide calipers: Breadth of specimen

Trial no	MSR (cm)	CVD	TR= MSR+ (CVDXLC) cm

Reading in slide calipers: Depth of notch

Trial no	MSR (cm)	CVD	TR= MSR+ (CVDXLC) cm

Results

1. Izod impact resistance = ____________________
2. Charpy impact resistance = ____________________

Expt.No.7 (a) **Date:**

BRINELL HARDNESS TEST

Aim :

To determine the hardness number of the given specimen

Apparatus:

Brinell hardness tester & micrometer microscope

Theory:

- Hardness is the resistance of the metal to the deformation (Indentation).
- Hardness test reveals the hardness of a material by applying specific load on material for some seconds.
- Brinell's hardness test consists of indenting the test material by 10 mm diameter hardened steel, subjected to load of 3000kg.
- The load and time period for loading varies depending on the type of material

For softer materials the load can be reduced to 1500 kg or 500 kg, and time period of 10 to 15 seconds.

- After indentation the diameter of the indentation is measured with a low power microscope.
- The hardness is obtained by dividing value of load applied and the surface area of the indentation.
- The Brielle's hardness value is denote by a code "75HB10/500/30"

This means Brinell's hardness of 75 was obtained using 10 mm dia of hardened steel with a 500 kg load applied for a period of 30 seconds.

- Compared to other hardness test method Brinell's harness test gives more accurate value because the indentation is wider in this method.

SPECIFICATIONS OF BRINELLS HARDNESS TESTING MACHINE

1. Can determine hardness values up to 500 BHN
2. Diameter of the indenters are 2.5mm , 5mm , 10mm
3. Maximum application of load = 3000kg
4. Method of load application = Lever type.

Procedure:

- The load F and the diameter of the ball D & must be selected in accordance with the expected hardness of the material.
- Place the specimen on the anvil so that its surface will be normal to the direction of the applied ball.
- Raise the anvil by means of hand wheel until the specimen just makes the contact with the bar.
- Apply the selected load by operating the load lever for 5 to 20 seconds
- .Release the load & remove the specimen from the anvil.
- Measure the diameter of the indention made on the specimen by using traveling microscope or micrometer microscope and measures the BHN.
- Make 3 trials on each specimen

Observations and calculations

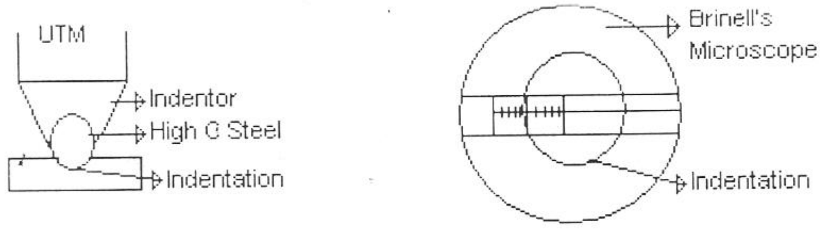
SR.NO	Material	Diameter of ball D	Time (secs)	Diameter of indentation(mm)	Load (Kgs)	BHN

Brinell hardness number or BHN (Kg//mm)

$$BHN = \frac{2F}{\pi D (D - \sqrt{D^2 - d^2})}$$

F = Load applied in Kg
D = Diameter of the ball indenter in mm
d = Dia of the indentation in mm

Diagram:



Test	Indenter	Shape of Indentation: Side View	Shape of Indentation: Top View	Load	Formula for Hardness Number
Brinell	10 mm sphere of steel or tungsten carbide	D, d	d	P	$BHN = \frac{2P}{\pi D(D - \sqrt{D^2 - d^2})}$
Vickers	Diamond pyramid	136°	d_1, d_1	P	$VHN = 1.72 P/d_1^2$
Knoop microhardness	Diamond pyramid	$l/b = 7.11$ $b/t = 4.00$	b, l	P	$KHN = 14.2 P/l^2$
Rockwell					
A	Diamond cone	120°		60 kg	$R_A =$ 100-500t
C	Diamond cone			150 kg	$R_C =$ 100-500t
D	Diamond cone	t		100 kg	$R_D =$ 100-500t
B	$\frac{1}{16}$ in. diameter steel sphere			100 kg	$R_B =$ 130-500t
F	$\frac{1}{16}$ in. diameter steel sphere			60 kg	$R_F =$ 130-500t
G	$\frac{1}{16}$ in. diameter steel sphere	t		150 kg	$R_G =$ 130-500t
E	$\frac{1}{8}$ in. diameter steel sphere			100 kg	$R_E =$ 130-500t

**Specimens : ** Specimen must be chosen with care in order to obtain good results Brinell test is not suitable for extremely hard materials because the ball itself would deform too much nor it is satisfactory for the pieces because the usual indention may be greater than the thickness of the case and because of the yielding of the soft core invalidates the results, the surface of the specimen should be flat & reasonably well polished.

Result

1. BHN for Mild steel =
2. BHN for Aluminum =
3. BHN for stainless steel =
4. BHN for Cast iron =
5. BHN for brass =
6. BHN for Copper =

Expt.No.7 (b) **Date:**

ROCKWELL'S HARDNESS TEST

Aim: To determine the Rockwell's hardness number for ferrous materials such as mild steel, Cast iron & for nonferrous materials such as copper, brass & aluminum.

Apparatus: Rockwell hardness tester, diamond cone indenter of 120^0 apex angle for testing hard materials.1/8 steel bar indenter for moderately hard material like copper brass & Aluminum

Theory

Hardness is the resistance offered by a material against penetration. The Rockwell hardness test method consists of indenting the test material with a diamond cone indenter. The indenter is forced into the material under preliminary minor load of usually 10 kg. the minor load is applied for gripping the indent position and to clear the surface of specimen from oil, grease, etc: while the preliminary minor load is still applied an additional major load is applied with resulting increase in penetration. Removal additional major load allows a partial recovery , so reducing the depth of penetration , resulting from the application and removal of the additional major load is used to calculate the Rockwell hardness number

Typical Application of Rockwell Hardness Scales

HRB--- Copper alloys, brass, soft steels, aluminium alloys, malleable Irons etc.
HRC___ Steel, hard cast Irons, case hardened steel and other materials harder than 100 HRB
HRD___Thin steel and medium case hardened steel and pearlitic malleable Iron.
HRG___ Phosphor bronze, beryllium copper, malleable irons
HRH__ Aluminium, Zinc, Lead.

Procedure :

Place the specimen whose hardness is to be tested on the platform select the required indenter and insert it to the sleeve & tighten the screw. Set the required load for the corresponding specimen by using the knob provided at the side of the machine raise the anvil by using the hand wheel slowly so that the specimen makes contact with the indenter continue to raise the anvil slowly until the small pointer comes to red dot or Δ mark & the long pointer "O" on the outer 'c' scale & "B30" on the inner B scale. This indicates that minor load of 10kg is being applied on the specimen .Now apply the major load by operating the hand lever away from the observer. The indenter moves down into the specimen. This can be seen from the dial. The long pointer starts to move during the period of loading &stops. Now release the load by using the band wheel. The reading on the long pointer on the selected scale is taken which given the RHN. At least 3 independent readings are taken at separate locations on the specimen & the average value gives the R.H.N

Advantages

- Direct hardness value is obtained, no calculation required.
- In Rockwell test , hardness measure is the depth of indentation, where as in other tests it the indentation area.
- Simple and time saving.

Specifications

- B scale: Bulk indenter, hardened steel of diameter 1/16”
- C scale: diamond cone indenter of 120 degrees radius of nose 0.2mm

Observations and calculations

scale	Material	Type of indenter	Minor Load F0	Major load F1	RHN	T1	T2	T3	AVG

Result:

Copper -
Aluminium -
Brass -
Cast Iron -
Mild Steel -
Stainless Steel -

Expt.No. 7(c) **Date:**

VICKERS HARDNESS TEST

AIM:

To find the Vickers hardness number of the given specimen by using Vickers hardness tester.

APPARATUS:

Vickers hardness testing machine

THEORY:

An indenter in the form of a right pyramid with a square base and an angle of 136 (α) between opposite faces, when forced into the meter under a load P applied for 10 to 15 seconds, causes an indentation which has a square base. If'd' is the diagonal of the indentation left on the surface of the test piece after the removal of the load, then the Vickers hardness VH is the quotient of the test load P(kg) and sloping area (sq mm) of indentation.

$$VH = \frac{Load}{Sloping\ area\ of\ indentation} = \frac{P}{d^2/2 \sin 136°/2} = 1.854 P/d^2$$

One of the advantages of the Vickers machine is in the measurement of indentation: a much more accurate reading can be made of the diagonal of the square than can be made of the diameter of a circle. Also, it is a fairly rapid method that can be used on metal as thin as 0.006 inch.

OBSERVATIONS:

Value of one division of the measuring scale

Main scale	=	mm
Vernier scale	=	mm
Micrometer	=	mm

TABULAR COLUMN

Sl.No	Material	Load (P) Kg	Diagonal of indentation in mm			Vickers Hardness Number
			d1	d2	Average d	

CALCULATION:

Vickers Hardness Number VHN = $1.854\ P/d^2$ kg/ mm^2

PROCEDURE:-

- The specimen is cleaned from dirt, oil, scale etc and the test area is made neven and polished.
- Care is taken to see the thickness of the test piece is not less than 1.5times the diagonal of the indentation and that the distance from the centre of any indentation to the edges of the test piece or edges of any other indentation is not less than 2.5times the diagonal of the indentation.
- Proper value of the load is selected which could vary from 1 to 120kg. Normally either 10kg or 30kg is selected.
- The penetrate is inserted in the thrust piece of the machine and screwed.
- The prepared specimen is placed on the supporting table and the hand wheel is turned on the right, until the surface of the specimen is sharply imaged on the screen. The clamping sleeve is turned to the left to clamp the specimen.
- After ascertaining that there are enough gaps for the thrust piece to move in, the controlling current key is pushed in till the hand lever starts rising.
- The full load will act on the specimen when the hand lever reaches its top position. The load is allowed to act for duration of 10 to 15 seconds after which the hand lever is pushed down to remove the load.
- The image of the impression will now be clearly visible on the screen and the two diagonals are measured.

Result:

Vickers Hardness Number of the given specimen=

Expt.No.8 (a) **Date:**

TESTS ON BRICKS

Aim

To determine the compressive strength of the given brick.

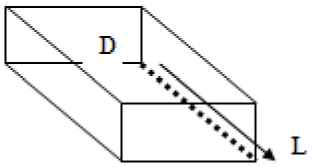
Apparatus

Compression testing machine, steel scale and Brick

Procedure

- The brick whose compressive strength is to be determined is taken and kept on the compressive testing machine in between the two iron circular bars and the valve is tightly fitted.
- The two levers are opened and then start the machine
- Before keeping the brick for compression test the length (L) and breadth (B) of the brick are noted.
- At some loading the brick fails, at that point the reading is noted down.
- After this the specimen is removed by loosening the valve and the circular steel hand set of the specimen is taken out which is failed.
- The usual crushing strength of common moulded and well burnt brick is 50-100 kg/cm^2. the compression strength of the given brick sample is given by

$$\text{Crushing strength} = \frac{\text{Maximum load at failure}}{\text{Bearing Area}}$$



Observations and Calculations

Length of brick = ________ cm
Breadth of the brick = __________ cm

Result

Compressive strength of the given brick sample= ________

Expt.No.8 (b) **Date:**

TESTS ON BRICKS

Aim:

To determine the water absorption of bricks

Apparatus

Brick and Oven

Procedure:

1. Select five bricks at random out of the given sample.
2. Dry the bricks in a ventilated oven at a temperature of $105^{o} \pm 5^{o}C$ till these attain constant mass.
3. The weight (W1) of the brick is recorded after cooling them to room temperature.
4. The bricks are then immersed in water at a temperature of $27^{o} \pm 2^{o}C$ for 24 hours.
5. Remove the bricks from water and wipe off its surface with a damp cloth.
6. Weigh the brick within three minutes after its removal from water. Let its weight be W2 Kg.

7.Water Absorpt ion Capacity = $\frac{W2 - W1 \times 100}{W1}$

8.Take the average value of the Water Absorption capacities of the five bricks.

9.Water Absorption shall not be more than 20 percent by weight upto class 12.5 and 15 percent by weight for higher classes.

The percentage of water absorption is a very valuable indication of the degree of burning

TABULAR COLUMN:

Brick No.	Dry weight of brick w1 (gms)	Wet weight of brick w2 (gms)	Difference (w2 – w1) gms	% water absorption {(w2 – w1) / w1}*100
1				
2				

3				
4				
5				

CALCULATION:

Result:

Average water absorption of bricks =

Expt.No.9 **Date:**

TEST ON TILES

AIM:

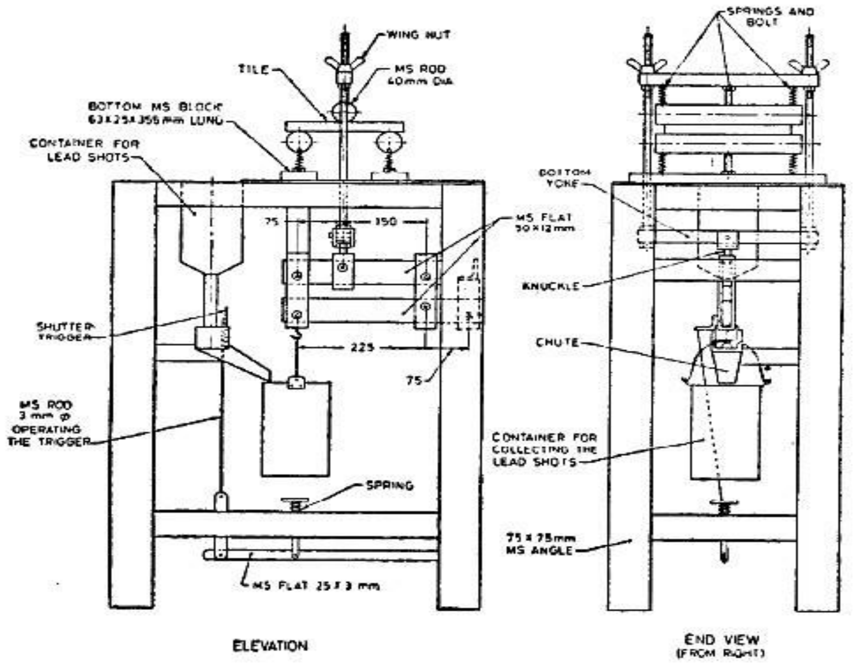
To determine the flexural strength flexural of given roof tile.

APPARATUS:

Flexural tile testing machine, lead shots, balance.

THEORY:

The flexural test is conducted on a clay tile in a condition similar to its position in a tiled roof. The tile is placed on buttons regular intervals. The battens act like two simple supports on which the tile rests. The flexural strength is measured terms the maximum point load that caused failure of the tile, when supporting on two simple supports This machine is a lever-operated machine. It consists of two adjustable supports on which the tile rests. The tile is loaded at its centre by a cylindrical bar. The loading is done by continuously adding lead shots in the loading pan. The load on the tile is calculated as K times the weight of lead shots collected in the loading pan, where K is a constant for the machine depending on the length of levers.

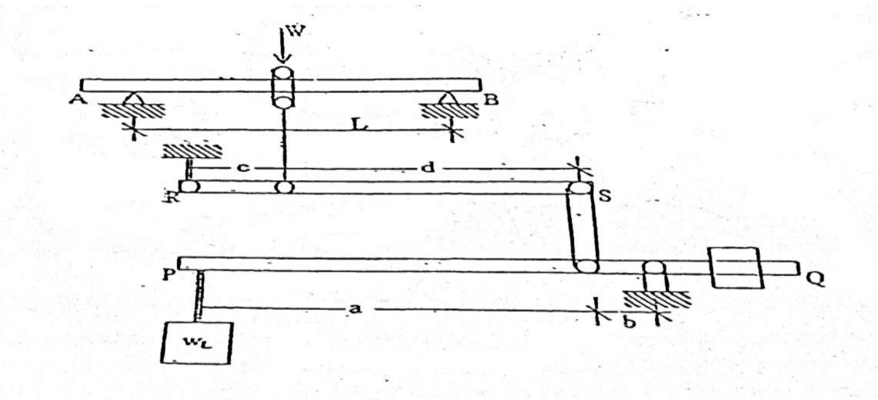


All dimensions in millimetres.

Fig. Tile Testing Machine

PROCEDURE:

Measure the distance a, b, c and d of the levers, Fix supports A & B suitably and measure the Span L (L —200mm)
Place the tile to be tested on the two Supports symmetrically.
Adjust the loading arm C to come in contact with the tile.
Make the lever (PQ) horizontal by adjusting the position of the balancing weight.
Open the loading knob; the lead shots start pouring in the loading pan.
When the load on the tile reached its maximum value, the tile breaks and simultaneously the loading knob closes.
Note down the weight of lead shots collected in the loading pan W_1. Calculate the maximum load carried by the til



OBSERVATIONS AND CALCULATION:

Calculate the maximum load carried by

the tile, Wu = W1 (a+b) (c+d) / (axc)

Wu = 12 W1

Where,
W1= Weight of the lead shots

Calculate Ultimate Moment of

Tile, Mu = (WuL)/4

Result:

The flexural strength flexural of given roof tile.=

Expt.No.10 **Date:**

TESTS ON FINE AGGREGATES

MOISTURE CONTENT OF FINE AGGREGATES

Aim

To determine the moisture content (or surface moisture) in fine aggregates by drying method

Apparatus

Balance (capacity 2kg or more and sensitive to 0.5 gms), Weight box, Metal tray (frying pan) and a source of heat.

Theory and scope

The determination of moisture content of an aggregate is necessary in order to determine net water content ratio for a batch of concrete. High moisture content will increase effective water cement ratio to an appreciable extent and may even make the concrete weak unless a suitable allowance is made.

Procedure

- Weigh approximately 1000gms of aggregates from the material to be tested by the method of quartering in a metal tray.
- Heat the aggregates in the tray for about 20 min
- Weight the tray with dry aggregate.
- Take the aggregate out and clean the tray thoroughly and weigh it.
- Express the loss in mass as a percentage of the dried sample to give the moisture content

Observations and calculations

Material	
Mass of tray and sample W1 gms	
Mass of tray and dry sample W2 gms	
Mass of empty tray W3 gms	
Moisture (by difference) W1-W2 = Wm gm	
Mass of dry aggregate W2-W3 = Wa gms	
Moisture content %w = Wm/Wa) *100	

Result

Moisture content in the given concrete aggregate = _______%

Expt.No.11 **Date:**

SPECIFIC GRAVITY & WATER ABSORPTION OF FINE AGGREGATE

Aim: To determine the specific gravity & water absorption of the fine aggregate.

Apparatus:

1. Balance,
2. Pycnometer (64mm diameter at top and 90 mm dia at bottom and 73mm height)
3. Tamping rod 25mm diameter,
4. Metal tray, (area 32500mm^2)
5. Conical mould.

Theory:

Specific gravity of an aggregate is defined as ratio of the mass of a given volume of a sample to the mass of a equal volume of water at the same temperature. The specific gravity of fine aggregate is generally required for calculations related to concrete mix designs, for determination of moisture content and for calculations of volume yield of concrete. The specific gravity also gives information on quality and properties of aggregates.

Specific gravity also indicates the change in shape and grading og aggregates used in mix design

Absorption: It influences the behavior of aggregate in concrete in several important aspects. A highly absorptive aggregate is used in dry condition, will reduce effective water cement ratio to an appreciable extent and may even make the concrete unworkable unless a suitable is allowance is made. Hence determination of absorption of aggregate is necessary to determine net water cement ratio.

Procedure:

Specific gravity

- Take the empty weight of the flask , let the weight be W1
- Take the sample of fine aggregate for which the specific gravity has to be found out (note: the sample must be saturated and surface dry i.e. free from surface moisture) and transfer that to the empty flask and then it is weighed let the weight be W2
- The flask with the sample is filled with water up to a mark (made on the flask) and its weight is taken .The flask should be completely dry on the outer surface
- Let its weight be W4
- Calculate the specific gravity of the fine aggregate by using the formula

$$\text{Specific gravity} = \frac{\text{dry weight of aggregate}}{\text{Weight of equal volume of water}}$$

$$= \frac{(W2-W1)}{(W2-W1) - (W3-W4)}$$

Absorption test

- Take the sample of the fine aggregate and soak it in water and keep it for 24+ ½ hours. The temperature should be 27+/- 5 degrees
- Weigh the sample of saturated surface dry (it should be saturated and free from surface moisture i.e surface dry condition)Let this weight be W1
- Dry the sample in an oven at the 100-110 deg c for a period of 24 hours. And take the weight of the dry sample let that be W2
- Calculate the absorption of the fine aggregate by the formula

Water absorption in percent =

$$\frac{(W1-W2)}{W2} \times 100$$

Observation and calculation

Material	Trial1	Trial 2	Trial 3	Average
Specific Gravity				
Mass of empty flask **W1 gm**				
Mass of flask + Fine aggregate **W2 gm**				
Mass of flask+ fine aggregates+ water **W3 gm**				
Mass of flask+ water **W4** gm				
Water Absorption				
Mass of saturated agg W1 gm				
Mass of oven dry aggregates W2 gm				

OBSERVATION:

1. Mass of empty dry flask or pycnometer = w gms
2. Mass of Pycnometer + water = w1 gms
3. Mass of saturated surface dry sample = w2 gms
4. Mass of Pycnometer + sample + Water = w3 gms
5. Mass of empty tray = we gms
6. Mass of tray + saturated surface dry sample (ws –We)= W4 gms
7. Mass of tray + oven dry sample = Wo gms
8. Mass of oven dry sample (Wo - We) = W5 gms

Gross Apparent Specific Gravity =

$$\frac{W2}{W2 - (W3 - W1)}$$

SPECIFIC Gravity =

$$\frac{A}{A - (B - C)}$$

Water Absorption =

$$\frac{W4 - W5}{W5} \times 100$$

Result

1. The specific gravity of given fine aggregate = ______________________
2. The water absorption of given fine aggregate = ________________________

Expt.No.12 **Date:**

BULK DENSITY OF FINE AGGREGATE

Aim: Determination of the Bulk Density of fine aggregate and coarse aggregate

Apparatus: Measuring jar, balance, Cylindrical Containers.

Theory and scope:

The bulk density clearly depends on how densely the aggregate is packed, and it follows that for a material of a given specific gravity the bulk density depends on the size distribution and shape of the particles .It is well know that in the metric system the density of a material is numerically equal to specific gravity although of coarse the latter is a ratio while density is expressed in Kg per liter. However in concrete practice, is to express the density in Kg per cubic meter is more common. When aggregate is be actually batched by volume it is necessary to know the weight of aggregate that would fill a continue of unit volume .This is known as bulk density of aggregate and this density is used to convert quantities by weight to quantities by volume .they are two types of bulk density viz Loose bulk density (Uncompacted) and Compacted bulk density

Procedure:

- Depending on the size of the testing aggregate the size of the container is taken. The container is calibrated (i.e. empty weight and volume of container is measured). Let weight be w1 and volume be v
- Then dried aggregate is filled in three layers into the container and each layer is compacted uniformly using tampering rod of 10mm diameter with round nosed (25 blows are given on each layer).
- After the aggregate is completely filled in container, weight of aggregate and container is measured. Let the weight be w2
- The compacted bulk density of the aggregate is given by the formula

$$\textbf{Bulk density } (\rho) = \frac{\textbf{Weight of the aggregate}}{\textbf{Volume of the container}} \quad \frac{\textbf{Kg}}{\textbf{m}^3}$$

Observation and calculations

Material	**Trial 1**	**Trial2**	**Trial 3**	**Average**
Empty weight of container W1 gm				

Weight of the empty jar + loose sand = ***W2 gm***				
Weight of empty jar + water = ***W3gm***				
Weight of jar + Fine aggregate + water = ***W4gm***				

Bulk density in loose condition $= \dfrac{W_2 - W_1}{W_3 - W_1} =$

% of voids $= \dfrac{W_4 - W_3}{W_2 - W_1} =$

Bulk Density of compacted coarse aggregates $= \dfrac{W3 - W_1}{W_2 - W_1} =$

Result

Double density of given fine aggregate = ____________________kg/m^3

Bulk density of Compact Sand = ____________________kg/m^3

Bulk density of Compact Coarse= ____________________kg/m^3

Expt.No.13 **Date:**

SIEVE ANALYSIS: FINENESS MODULES OF FINE AGGREGATE.

Aim:
To determine fineness modulus and grain size distribution of the given fine aggregates

Apparatus :
I.S. Sieve Set (4.75mm,2.36mm,1.18mm.600mm,300mm,150mm),Sieve Shaker., Balance

Theory:
The sieve analysis is a simple test consisting of sieving a measured quantity of material through successively smaller sieves. The weight retained on each sieve is expressed as a percentage of the total sample. The sedimentation principle has been used for finding the grain size distribution of fine soil fraction: two methods are commonly used.viz, Pipette method and Hydrometer method of distribution of soil particles. Most of the methods for soil identification and classification are based on certain physical properties of the aggregate. The commonly used properties for classification are the grain size distribution. Grain size analysis also known as mechanical analysis .It determines the percentages of individual grain size present in the sample. The result of the test is of great value in soil classification. In mechanical stabilization of soil and for designing soil aggregate mixture the result of the gradation tests are used. Conclusions have also been made between the grain size distribution of soil and the general soil behaviors as sub grade material and the performance such as susceptibility to frost action. Pumping of rigid pavements etc. Sand is the fine aggregate used in mortar. Coarse aggregate that is the broken stone or gravel and the mixed aggregate which is the combination of coarse and fine aggregates are used in concrete. The coarse aggregate unless mixed with fine aggregates does not produce good quality concrete for construction works.

Fineness Modulus
Fineness modulus is only a numerical index of finess giving some idea of the mean size of particles in the entire body of aggregate

Table 1

Type of Aggregate	**Max size of aggregate in mm**	**Finess Modulus**	
		Min	Max
Fine aggregate	4.75	2.00	3.5

The object of finding the fineness modulus is to grade the given aggregate for obtaining a
Most economical and workable mix.

Procedure:

1 Take 1Kg of sand in a clean dry plate. from a sample of 10Kg, by quartering & breaking clay lamps if any

2 Arrange the sieves in order of IS Sieve No: 4.75mm, 2.36mm, 1.18mm, 600mm, 300mm,150mm.Fix them in a Sieve Shaking machine with a pan at the bottom &Cover at the top.

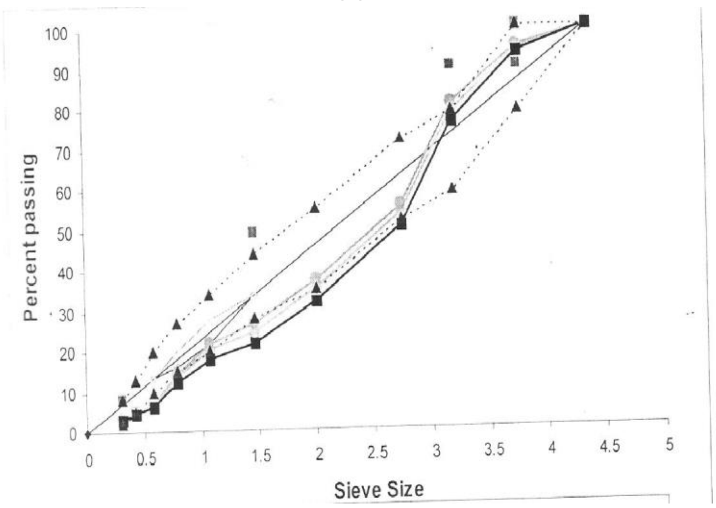
3 Keep the sand in the top Sieve Carry out the Sieving in the set of Sieves as arranged before for not less than 10minutes.

4 Find mass retained on each Sieve & tabulate the reading in the observation sheet.

5 The grain size greater than 75 micron is determined by sieving set of sieves of decreasing order. Sieve opening place one below the other and separating out the different size ranges. Two methods of sieve analysis are as follows

- Wet sieving applicable to soil and
- Dry sieving applicable only to soil which has negligible proportion of clay and silt.

$$\textbf{Fineness Modulus} = \frac{\textbf{Cumulative \% of weight retained on sieves}}{\textbf{100}}$$



Observation:

SL. NO	Sieve size	Weight of sand retained	Weight of sand passing	% weight of Sand retained	% weight of Sand Passing	Cumulative% weight of Sand retained
1	4.75mm					
2	2.36mm					
3	1.18mm					
4	600µm					
5	425 µm					
6	250 µm					
7	150 µm					
8	75 µm					
9	Pan					

Weight of fine aggregates for sieving = ______________gms

Formula : $\sum C = \frac{\sum C}{100}$

RESULT: Fineness Modules of fine aggregate (Sand)

Expt.No.14 **Date:**

BULKING OF FINE AGGREGATES

Aim

To determine the bulking of fine aggregates and to draw curve between water content and bulking.

Apparatus

Balance, Cylindrical container, graduated cylinder, Beaker, Metal tray, Steel rule and Oven

Theory and scope:

In concrete mix design, the quantity of fine aggregates used in each batch should be related to know the volume of cement. The difficulty with measurement of fine aggregate by volume is the tendency of sand to vary s in bulk according to moisture content. The extent of this variation is given by this test.

If sand is measured by volume and no allowance is made for bulking the mix will be richer than specified because for given mass, moist sand occupies a considerable larger volume than the same mass of dry sand, as the particles are less closely packed when the sand is moist. If as usual the sand is measured by loose volume, it is necessary in such a case to increase the measured volume of the sand, in order that the amount of sand put into concrete may be the amount intended for the nominal mix used (based on the dry sand). It will be necessary to increase the volume of sand by the best, but a correction of the right order can easily be determined and should be applied in order to keep the concrete uniform.

This experiment is intended to cover the field method of determining the necessary adjustment for bulking of the aggregate.

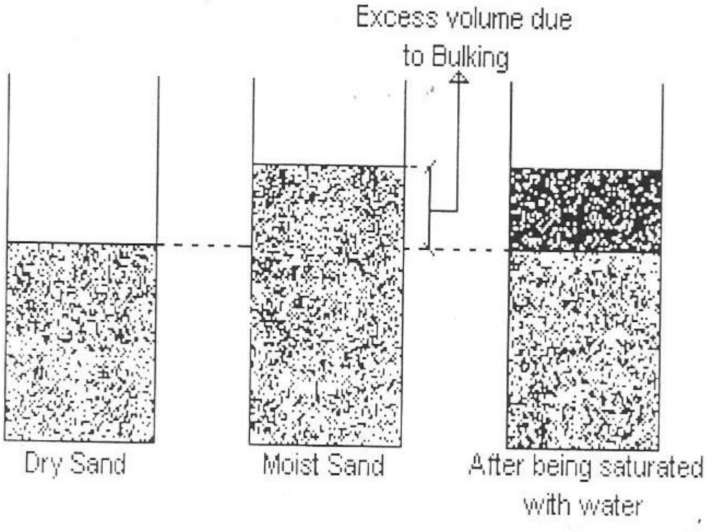
Procedure:

- Put sufficient of the oven dry sand loosely into the container until it is about two third full. Level off the top of sand and weigh the container. Calculate the mass of sand by deducting the mass of container.
- Push a steel rule vertically down through the sand at the middle to the bottom and measure the height of the sand. Let it be hmm3
- Empty the sand out into a clean metal tray without any loss.
- Add 2 percent of water by mass of sand. Mix the sand and water thoroughly by hand (1)
- Put the wet sand loosely into the container without tamping it.
- Smooth and level the top surface of the moist sand and measure its depth at the middle with the steel rule. Let it be h_1 mm (2)
- Repeat the steps (1) and (2) of the above procedure with 2% of water by mass .

Go on increasing the percentage by one till bulking is maximum and a start falling down ultimately bulking is Zero. i.e. saturated sand occupies the same volume as dry sand

$$\textbf{Percentage Bulking} = \frac{h1 - h}{h} \times 100$$

<u>Diagram:</u>



Observations and calculations

Material details	
Mass of container with oven dry aggregate (gm)	
Mass of empty container gm	
Mass of fine aggregate (sand) , gm	
Height of dry sand h, mm	

Mass of sand (ml)	% of water added	Water added in ml	Final volume (height h**1)**	% Bulking = h1-h/h *100
250	2%	5		

Result .

Bulking of fine aggregate = ____________________%

Expt.No.15 **Date:**

MOISTURE CONTENT OF COARSE AGGREGATES

Aim :
To determine the moisture content (or surface moisture) in concrete aggregates by drying method

Apparatus:
Balance (capacity 2kg or more and sensitive to 0.5gm), Weight box, Metal tray (frying pan) and a source of heat.

Theory and scope
The determination of moisture content of an aggregate is necessary in order to determine net water cement ratio for a batch of concrete. High moisture content will increase effective water-cement ratio to an appreciable extent and may even make the concrete weak unless a suitable allowance is made.

Procedure
- Weigh approximately 1000gm of aggregate from the material to be tested by the method of quartering in a metal tray.
- Heat the aggregate in the tray for about 20 minutes
- Weigh the tray with dry aggregate.
- Take the aggregate out and clean the tray thoroughly and weigh it.
- Express the loss in mass as a percentage of the dried sample to give the moisture content.

Observations and Calculations

Material	**Coarse aggregates**	
Mass of tray and sample W1 gm		
Mass of tray and dry sample W2 gm		
Mass of empty tray W3 gm		
Moisture (by difference) (W1-W2)= Wm gms		
Mass of dry aggregates (W2-W3) = Wa gm		
Moisture content % w = (Wm/Wa)X100		

Result :
Moisture content in the given coarse aggregates = ______________ %

Expt.No.16 **Date:**

SPECIFIC GRAVITY AND WATER ABSORPTION OF COARSE AGGREGATES

Aim

To determine the specific gravity and water absorption of given coarse aggregates

Apparatus

Balance, Wire basket (not more than 6.3mm mesh) Container, Air tight container, Oven, shallow tray and two dry absorbent clothes

Theory and scope

The specific gravity of an aggregate is defined as the ratio of the mas of a given volume of the sample to the mass of equal volume of water at the same temperature specific gravity of fine aggregate is generally required for calculations in connection with concrete mix design.

It is used in calculations f volume yield of concrete, moisture content and it gives information on the properties of aggregates. I t also indicates the change in shape grading of aggregates used in mix design (if the value of specific gravity departure from its sub standard value)

The specific gravity of an aggregate is considered to be a measure of strength or quality of the material. Stones having low specific gravity are generally weaker than those with higher specific gravity value. The specific gravity test helps in identification of stones.

Water absorption gives an idea of strength of rock. Stones having more water absorption are more porous in nature and generally considered unsuitable unless they are found to be acceptable based on strength, impact and hard ness test.

Absorption influences the behavior of aggregate in concrete in several aspects. For example a highly absorptive aggregate. If used in dry condition, will reduce "effective water cement ratio". Which in turn results in unworkable concrete mix, if a highly absorptive aggregate is used in construction of flexible pavement consumes cause quantity of binder (bitumen) which leads to higher cost

Procedure

- About 2kg of the aggregate sample is washed thoroughly o remove fines.
- Thoroughly washed aggregates sample is place in a wire basket and immersed in water at a temperature between 22 to 32 degree centigrade (a minimum of 5 cm of water has to be maintained above the top of the basket).
- Immediately after the immersion, in order to remove the entrapped air from the wire basket, it is jolted 25 times at a rate of 1jolt/sec with in the water level.
- The basket and the aggregate should remain completely immersed in water for 24+/_ ½ hr
- The basket and the sample are weighed while suspended in water and weight is taken as W1 Gms.
- The aggregates are transferred to one of the dry absorbent cloth.
- Then the empty basket is suspended in water and the weight is taken as W2gms.
- Aggregates placed on the absorbent cloth are completely surface dried (the aggregate should not be exposed to direct sun light or any other source of heat while surface drying. A gentle current of unheated air may be used during the first 10 min to accelerate the drying of aggregate surface.)
- Then the surface dried aggregates are weighed and the weight is taken as W3 gms.

- Then the aggregate is placed in an oven and a temperature of 105 deg -110 deg is maintained for 24 hours.
- The aggregates is removed from the oven cooled to atmospheric temperature and the weight of the aggregate is taken as W4 gms

Bulk specific gravity = dry weight of aggregate

Weight of equal volume of water

$$= \frac{W4}{W3-(W1-W2)}$$

Apparent specific gravity = Dry weight of aggregate

(Wt of equal volume of water excluding air voids in aggregates)

$$= \frac{W4}{W4-(W1-W2)}$$

Absorption test

- Take the sample of the coarse aggregate and soak in water and keep it for 24 .The temperature should be 27+/- 5 deg
- Weigh the sample of saturated. Surface dry (i.e. it should be saturated and free from surface moisture i.e. surface dry condition). Let this weight be W1.
- Dry the sample in an oven at 100deg -110deg for a period of 24 hrs .And take the weight of the dry sample and let that be W2.
- Calculate the absorption of the coarse aggregate by the formula

$$\text{Water absorption in percent} = \frac{(W1-W2)}{W2} \times 100$$

Observation and calculation:

material	Trial 1	Trial 2	Trial 3	Avg
Specific gravity • Mass of empty flask + Sample suspended in water W1 gm • Mass of flak W2 gm • Mass of surface dried sample W3 gm • Mass of oven dried sample W4gm				
Water absorption • Mass of saturated agg W1 gm • Mass of oven dry agg W2 gm				

Result

- The specific gravity of given coarse aggregate= ___________________
- The water absorption of given coarse aggregate = _________________

Expt.No.16 b **Date:**

BULK DENSITY OF A GIVEN COARSE AGGREGATE

Aim

To determine the bulk density of a given coarse aggregate

Apparatus

Balance, Weight box, Container, Taming rod and Oven.

Theory and scope

The bulk density clearly depends on how densely the aggregate is packed and it follows that for a material of a given specific gravity the bulk density depends on the size distribution and shape of the particles. It is well known that in the metric system the density of a material is numerically equal to its specific gravity although of course, the latter is ratio while density is expressed in Kg per liter. However in concrete practice is to express the density in Kg per cubic meter is more common. When aggregate is to be actually batched by volume it is necessary to know weight of aggregate that would fill a continue unit volume. This is known as bulk density of aggregate and this density is used to convert quantities by weight to quantities by volume. There are 2 types of bulk density i.e. loose bulk density (uncompacted) and compacted bulk density.

Procedure

- Depending on the size of the testing aggregate the size of the container is taken. The container is calibrated (i.e. empty weight and volume of container is measured).Let weight between W1 and volume be V
- Then dried aggregate is filled in three layers into the container and each layer is compacted uniformly using tampering rod of 10mm diameter with round nosed (25 blows are given on each layer).
- After the aggregate is completely filled in container, weight of aggregate and container is measured .Let the weigh be W2
- The compacted bulk density of the aggregate is given by the formula

$$\textbf{Bulk density } (\rho) = \frac{\text{weight of aggregate}}{\text{Volume of the container}} = \quad Kg/m^3$$

$$= \frac{W2 - W1}{V}$$

Observation and calculation

Material	Trial 1	Trial 2	Trial 3	Average
Empty weight of the container W1 gm				
Volume of the container V in m^3				
Weight of aggregate and container W2 gm				

Result

Double density of given coarse aggregate ______________________ kg/m

Expt.No.17 **Date:**

SIEVE ANALYSIS OF A GIVEN COARSE AGGREGATE

Aim

To conduct sieve analysis of a given coarse aggregate and grade the aggregates

Apparatus

Balance, Weight box, I.S Sieve set and Sieve shaker

Theory and Scope

The sieve analysis is a simple test consisting of sieving a measured quantity of material through successively smaller sieves .The weight retained on each sieve is expressed as a percentage of total samples. The sedimentation principle has been used for finding the grain size distribution of fine soil fraction: two methods are commonly used viz. Pipette method and Hydrometer method of distribution of soil properties. Most of the methods for soil identification and classification are based on certain physical properties of the aggregates. The commonly used properties for the classification are the grain size distribution. Grain size analysis is also known as mechanical analysis. It determines the percentages of the individual grain size present in the sample. The results of the test are of great value in soil classification. In mechanical stabilization of soil and for designing soil aggregates mixture the result gradation tests are used. Conclusions have also been made between the grain size distribution of soil and the general soil behaviors as a sub grade material and the performance such as susceptibility to frost action. Pumping of rigid pavement etc. Sand is the fine aggregate used in mortar. Coarse aggregate that is
Broken stone or gravel and the mixed aggregate which is the combination of coarse aggregate, unless mixed with fine aggregate does not produce good quality concrete for construction works.

Fineness Modulus:

Fineness modulus is only a numerical index of fineness giving some idea of the mean size of particles in the entire body of aggregate.

Limits of fineness modulus for coarse aggregates:

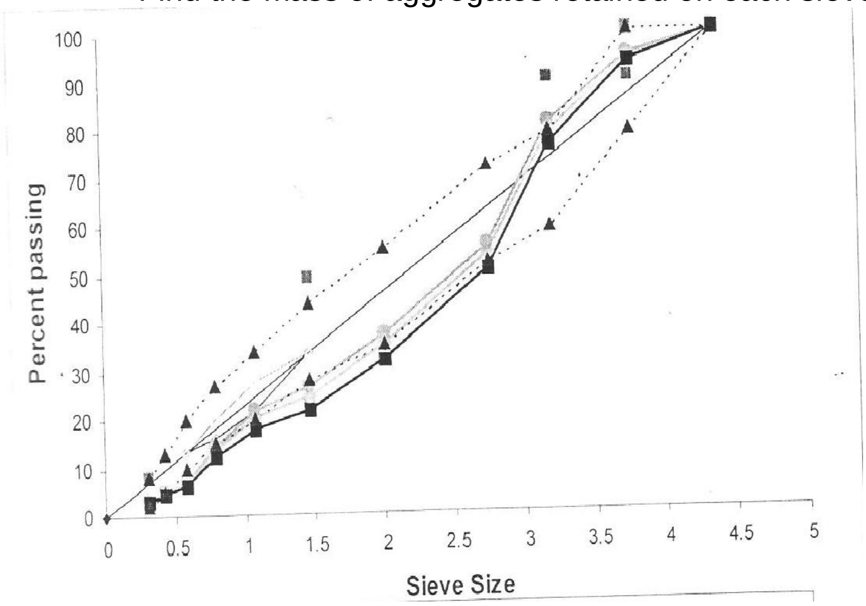
Type of aggregate	Max size of aggregate in mm	Fineness Modulus Min	Max
Coarse aggregate	20	6.0	6.90
	40	6.9	7.5
	75	7.5	8.0

The object of finding the fineness modulus is to grade the given aggregate for obtaining most economical and workable mix

$$\textbf{Fineness Modulus} = \frac{\textbf{Cumulative percentage weight retained}}{\textbf{100}}$$

Procedure

- Take 10 kg of coarse aggregates sample of 10 kg by quartering
- Arrange the sieves in descending order. Place the coarse aggregate in the top sieve.
- Fix them in the sieve shaking machine with the pan at the bottom and cover at the top and sieve it continuously for 10 min
- Find the mass of aggregates retained on each sieve In order and tabulate the result.



Observations and Calculations

Sl no	Sieve Size in mm	Weight retained (kgs)	% Weight Retained	Cumulative % retained	Cumulative % passing
1	31.5				
2	25				
3	20				
4	12.5				
5	10				
6	8				
7	6.3				
8	4.75				
9	Pan				

Results

- Finess modulus of coarse aggregates = __________________

Expt.No:18 **Date:**

Strain gauges and Strain indicators.

Aim: To study various types of strain gauges.

Theory: A strain gauge may be defined as an instrument or device that is employed to measure the linear deformation over a given gauge length, occurring in the material of a structure during the loading of structures. Depending upon the magnification system the strain gauges

1) Mechanical
   a) Wedge and screw
   b) Lever- simple and compound
   c) Rock and pinion
   d) Combination of lever and rack and pinion
   e) Dial Indicators
2) Electrical
   a) Inductance
   b) Capacitance
   c) Piezoelectric and piezoresiotue

1. **Accuracy & repeatability**: - Sensitive does not ensure accuracy. Usually the very sensitive instruments are quite prone to error unless they are employed with utmost care. Before selecting a particular type of gauge following factors must also be carefully evaluated. Readalutity
2. Ease of Mounting
3. Required operator skill
4. Weight
5. Frequency Response
6. Cost

Mechanical Strain Gauges:-

a) Wedge and Screw orignification:-

   The wedge gauge is simply a triangular plate with its longer sides related at 1:10 slope when inserted between two shoulders dipped to the test specimen, extension could be detected nearest 0.05mm. A single screw extensometer which is one of the pioneer instruments used for measurement of strain. The magnification in this instrument is accomplished solely by a screw micrometer a measures the relative motion of two coaxial tubes.

1. Magnetic 2.Acoustical 3.Pnuematic 4.Scratch Type 5. Photo stress gauge

Fig – Strain Gauge Test Apparatus

Characteristics of a strain gauge:-

A strain gauge has the following four basic characteristics

Gauge length: The gauge size for a mechanical strain gauge is characterized by the distance between two knife edges in contact with the specimen and by width of a movable knife edges non linear strum which should be as small as possible

2. **Sensitivity:** It is the smallest value of strain which can be read on the scale associated with strain gauge. Sensitivity can be defined in two way:

Strain Sensitivity = (Deformation sensitivity / Base length)

Deformation sensitivity = (Smallest reading of scale / multiplication factor)

Range: This represents the maximum can be recorded without resetting or replacing the strain gauge. The range and sensitivity are

Simple Mechanical lever magnification:- The simple lever strain gauge gains its magnification factors by a suitable positioning of fulcrum cap's multiplying divider is an important extensiomeus of this category. The magnification of this type of gauge is unlimited. The gauge length of cap's divider is 5cm and strain magnified 10:1 on graduated scale. which utilize the compound magnification are illustrated by Barry gauge and tinusis oisen strain gauge. The Barry strain gauge consists of a frame a with two conically painted contact points. One point b is rigidly fixed to frame while other c is provided from a frame and is internal with a lever armed which alone magnifies the strain about 5.5/ A screw micrometer or dial indicator is used to measure the motion of arm, thus permitting measurements of strain to nearest 0.005 m with a 0.025mm micrometer.

a) Compound lever Magnification:- Two gauges of this category are Huggenberger strain gauge and parter lipp strain gauge. In these instruments the magnification system is composed of two or more simple levers in serus. They have relatively small size and high magnification factor.

b) Mechanical by rack and pinion:- The rack and pinion principle alone with various types of gear strain is employed in gauge in which the magnification system is incorporated in an indicating dial. In general a dial indicator consists of an encased in grain train actuated by a rack cut in spindle which follows the motion to be measured. A spring imposes sufficient spindle force to maintain a reasonably uniform and positive contact with the moving part. The gear train terminates with a light weight pointer which indicator spindle travel on a graduating dial. Lost motion in gear trauma is minimized by positive force of a small coil spring the dial gauge extensometer is the most popular gauge of this type used in a material testing laboratory. Dial gauge indicator are frequently attached permanently to a structure to indicate the deflection on deformation obtained under working condition.

Acoustical strain gauge*:* - The vibrating wire or acoustical gauge consists essentially of a steel wire tensioned between two supports a predetermined distance apart. Vibration of the distance alerts the natural frequency of vibration of the wire and thus change in frequency may be correlated with the change in strain causing. An electromagnet adjacent to the wire may be used to set the wire in vibration and this wire movement will generate on oscillating electrical signal. The signal may be compared with the pitch adjustable standard wire, the degree of adjustment necessary to match of two signal frequencies being provided by a tensioning screw on the slandered wove calibration of this screw allows direct determination of change of length of a measuring gauge to be made once the standard gauge has been tuned to match the frequency of measuring wire.

NUTSHELL OF BMT LABORATORY

TENSILE TEST:

In this, the operation is accomplished by gripping opposite ends of the specimen and pulling it apart. Here, the specimen elongates in a direction parallel to the applied load. It is most commonly made and one of the simplest test among the mechanical tests.

The versatility of the test lies in the fact that it permits both strength and ductile properties to be measured. In conducting the test, a specimen of the steel is subjected to an increasing tensile pull until it fractures.

COMPRESSION TEST:

It is similar to tension test, expect that the loading is in opposite direction, i.e., compressive load which produce crushing action. It is used for testing brittle materials such as stone, concrete, cast iron, glass etc. The result of this is so affected by the frictional force occurring at the ends of the specimen.

For ductile material such as mild steel or copper, lateral distortion takes place due to the influence of the friction at the load faces; the cross-section becomes greatest at the center, the specimen taking up a barrel shape. Failure finally occurs by cracks appearing on the surface and spreading inwards.

For brittle material the behavior is quite different from that of ductile material. But there is definite load at which specimen breaks. Materials fails by shearing along thee plane inclined at 50o deg and to the longitudinal axis.

HARDNESS TEST:

Hardness is the resistance of the metal to the penetration of another harder body which does not receive a permanent set. It is the ability of a material to resist scratching, abrasion cutting or penetration.

It consists of measuring the resistance to plastic deformation of layers of metal near the surface of the specimen. In the process of the hardness determination, when the metal is intended by a special tip (ball indentor), the tip first overcomes the resistance of the metal to elastic deformation and then a small amount of plastic deformation.

SCOPE:

Hardness number cannot be utilized directly in design or analysis but it is used to grade the available materials, according to hardness and indicate utility for certain use.

USES:

Similar materials may be graded according to hardness.

Quality of the material or products may be checked or controlled.

By establishing a co-relation between hardness and some other desired property like tensile strength, etc.

Used to test the result of heat treatment like case hardening etc.

TYPES OF HARDNESS MEASUREMENTS:

Scratch hardness

Indentation hardness

Rebound or Dynamic hardness

Scratch hardness is of primary interest to mineralogists. With this measure of hardness various materials and other are rated on their ability to scratch one another. It is measured according to the Mohr’s scale.

Indentation hardness test is performed by impressing into the specimen, which is resting on a rigid platform, an indentor of fixed and known geometry, under a known static load applied by means of lever system.

Depending upon the test, the hardness is expressed by a number that is either inversely proportional to the depth of indentation for a specified load and indentor or proportional to a mean load over the area of indentation.

In rebound hardness measurements, the indentor is usually dropped onto the metal surface, and the hardness is expressed as the energy of impact. The shore Scleroscope measures the hardness in terms of the height of the rebound of the indentor.

ROCKWELL HARDNESS TEST:

In this the hardness of a material is determined by the depth of indentation of a diamond cone or small steel ball. This is conducted in a specially designed machine that applies load through a system of weights and levers. This test utilizes the depth on indentation under constant load as a measure of hardness. Minor load minimizes the amount of surface penetration needed and reduces the tendency for sinking in by the indentor. The dial is reversed so that a high hardness, which corresponds to a small penetration, results in high hardness number.

BRINELL HARDNESS TEST:

It is oldest and most used type. This is static test using relatively large indentors.

Advantages of Rockwell Hardness Test over Brinell hardness Test:

Due to the application of minor load to the penetrator, any effects due to surface imperfections are eliminated.

Unskilled labour can operate.

The dial indicator eliminates the necessity for a microscope for measuring the indentation and so that the test can be done quickly and more accurately.

On account of small impression made, the test is suitable for the majority of finished components.

Note: 75HB 10/500/30 indicates a Brinell hardness of 75 measured with a ball of 10mm diameter and load of 500kg applied for 30seconds.

IMPACT TEST:

The principal measurement is the energy absorbed in fracturing the specimen. After breaking the test bar, the pendulum rebounds to a height which decreases as the energy absorbed in fracture increases. The energy absorbed in fracture, usually expressed in joules, is read directly from calibrated graduated scale on the machine.

SCOPE:

Useful in designing those components of machine which are subjected to a sudden applied loads.

It gives necessary energy required to rupture the specimen.

For evaluating the uniformity of properties in similarly heat treated steels.

Gives guidance to the sensitivity of the material to notch propagation, or the resistance of the material to the propagation of the crack, once it is formed.

SHEAR TEST:

A type of forces which tends or causes two continuous parts of the body to slide relative to each other in a direction parallel to their plane of contact is called shear force.

The stress required to produce fracture in the plane of cross-section acted on by the shear force is called shear strength.

A shearing force acts parallel to a plane whereas the tensile and compressive forces act normal to a plane.

There are two main types of shear stresses used in the laboratory.

Direct or transverse stress- stress encountered in rivets, bolts and beams.

Pure or torsional stress- stress encountered in a shaft subjected to pure torsion.

Direct shear tests are conducted to obtain a measure of shear strength and pure shear tests are employed to evaluate the basic shear properties of a material.

For direct shear stress of metal, a bar is usually sheared in some device that clamps a portion of the specimen while the remaining portion is subjected to a load by means of suitable dies. If the force is resisted by failure through one plane and single area, then the material is said to be single shear. If two areas resist the fracture, then the material is said to be in double shear.

IS CODES

Sl no.	Specification	Is code no.	Title
1	Tension Test	IS 1606-2008	Metallic Materials - Tensile Testing at Ambient Temperature
2	Compression Test	IS –13780-1993	Hardmetals - compression test
3	Torsion Test	IS 1717:2012	Metallic materials – Wire – Simple torsion test
		IS 4176:1967	Method for simple Torsion test of aluminium and aluminium alloy wire
4	Shear Test	IS –5242-1979	Method of test for determining shear strength of metals
5	Izod Impact Test	IS –1598-1977	Method for Izod impact test of metals
6	Charpy Impact Test	IS –1499-2003	Method for Charpy impact test (u-notch) for metals
7	Rockwell Hardness Test	IS 1586-2000	Method for Rockwell hardness test for metallic material
8	Brinell Hardness test	IS 1500-2005	Method for Brinell hardness test for metallic materials
9	Vickers Hardness test	IS 1501-2002	Method for Vickers hardness test for metallic materials
10	Test on bricks	IS 3495 part I -1992	Methods of tests of burnt clay building bricks(determination of compressive strength)

THEORY

ENGINEERING MATERIALS:

A material is that out of which anything is done. It is the stuff of which something is made. It comprises a wide range of metals and non-metals, which must be operated up on to form the finished product.

PROPERTIES OF MATERIALS:

The term property indicates that defines a specific characteristic of a material. It provides a basis for predicting its behavior under various conditions like forces, temperatures, pressures, etc.

Physical Properties: Shape, size, finish, colour, specific gravity, density, porosity, structure, etc

Mechanical Properties: Strength, stiffness, elasticity, plasticity, ductility, creep, brittleness, hardness, toughness, resilience, impact, fatigue, bending, malleability

Thermal Properties: Specific heat, heat of transformation, thermal expansion, thermal conductivity, thermal stresses, thermal fatigue, thermal shock, latent heat of fusion, melting point etc.

Chemical Properties: Corrosion resistance, atomic weight, equivalent weight, valency, molecular weight, acidity, alkalinity, atomic number, chemical composition.

Optical Properties: Colour, diffraction, fluorescence, reflectivity, hysterisis, luminescence, refractive index, etc.

TESTS ON MATERIALS:

Destructive tests: After being destructively tested, the component or specimen either breaks or remains no longer useful for further use.

Ex: Tensile test, Compression test, Torsion test, Shear test, fatigue test.

Non- Destructive tests: A component does not break and even after being tested so, it can be used for the purpose for which it was made.
Ex: Radiography test, ultrasonic inspection, dye-penetrant test, magnetic particle test, etc.

DEFINITIONS:
Stress:
The force per unit area of resistance offered by a body against deformation is called the stress.
Tensile Stress:
Stress induced in the uniform cross sectional area ‘A’ subjected to equal and opposite collinear forces ‘P’ resulting in the elongation of the member.
Compressive Stress:
When two equal and opposite collinear are applied to a member resulting in the reduction in the length of the member, then the stress induced is called compressive stress.
Strain:
It is defined as change in length per unit length, also termed as linear strain.
Strain = (elongation / original length of specimen)
Yield Stress:
Stress at which considerable elongation first occurs in the test piece without increase in the load.
Direct Stress:
The resistance developed in a material due to the action of direct load or axial load passing through the centroidal axis of the section is termed as direct stress.
Shear Stress:
The stress caused by forces which are parallel to an area of cross section and tend to produce sliding of one position over another is termed as shear stress.
Young’s Modulus:
It is defined as ratio of linear stress to the linear strain or the ratio of normal stress to the axial strain within elastic limit.
Bulk Modulus:
When a body is subjected to three mutually perpendicular direct stress of equal intensity, the ratio of direct stress to the corresponding volumetric strain is known as Bulk modulus.
Lateral Strain:
It is the ratio of change in lateral dimension to original is called lateral strain.
Volumetric Strain:
It is the ratio of change in volume to original volume is called volumetric strain**Elasticity constants:**
They are the properties of materials such as young’s modulus, rigidity modulus, Bulk modulus and Poisson’s ratio.
Young’s Modulus = Linear Stress / Linear Strain
Bulk Modulus = K = (Volumetric stress / Volumetric strain) Poisson’s ratio = (Lateral stress / Longitudinal strain) Rigidity Modulus: (Shearing stress / Shearing strain)
Elastic Length:
It is the maximum load attained within the elastic limit divided by the cross sectional area of the specimen.
Deflection:
A beam when loaded gets deflected. The axis of the loaded beam bends in a curve known as the elastic curve. The deflection at any point on the axis of the beam is the vertical distance between its position before the load and after loading.
Ultimate stress:
The maximum load to which a bar is subjected to in a test divided by its original cross-sectional area gives a nominal stress which is known as ultimate stress.

Breaking Stress:
The stress corresponding to fracture load is called breaking stress.
Factor of Safety:
The ratio of ultimate strength to allowable stress is called factor of safety.
Ductile material:
It is an important property of the material that enables it to be drawn into a wire
Brittle material:
A material is said to be brittle if it undergoes only small permanent deformation prior to fracture.
Malleability:
It is the property of the material that enables it to get rolled into structural shapes and sheets.

Shearing Force:
The algebraic sum of all the vertical force to one side of the section in a beam is called its shearing force.
Tangential Stress:
Tensile stress induced in the wall along the circumference of the cylinder is known as tangential stress.
Longitudinal Stress:
If the ends of the cylinder are closed, then the pressure at the ends will lead to stress in the walls in the direction parallel to longitudinal axis of the cylinder and this stress is termed as longitudinal stress.
Resultant Stress:
The resultant of normal and tangential stress acting on any plane is called resultant stress.
Complementary Stress:
The stress which acts right angles to the original active stress is called complementary stress.
Hooke's Law:
Within the elastic limit, stress is proportional to strain.
Elastic Limit:
It is the limit of stress upto which the material will behave elastically (and regains its original shape on removal of load).
Proportional Limit:
It is the limit of stress upto which the stress of the material is proportional to strain.
Yield Point:
It is the strain at which the elastic nature is completely lost and the materials develops permanent deformation.
Yield Limit: It is the limit of stress at which considerable elongation first occurs in the test piece without increase in the load.
Ductility:
It is indicated by the amount of deformation that is possible until fracture.
Toughness:
It is its ability to absorb energy in the plastic range.
Elasticity:
It is the property by which a body returns to its original shape after the removal of external load.
Gauge length:
It is the failure length of the parallel portion of the specimen over which extensions are measured.
Resilience:
The strain energy stored in a body due to external loading within the elastic limit is known as resilience and the maximum energy which can be stored in a body upto the elastic limit is called as proof resilience.
Plasticity:
It is the property of material by which no strain disappears when it is relieved from the stress.

Proof stress:
It is the stress at which the stress-strain diagram departs by a specified percentage of gauge length from the produced straight line of proportionality (0.2%).
Brittleness:
A material is said to be brittle when it cannot be drawn out by tension to smaller section. Here, failure takes place with small deformation.

VIVA-VOCE MODEL QUESTIONS
TENSION TEST ON MILD STEEL
What is the nature of failure for brittle and ductile materials in tensile test?
Distinguish between
Yield point and yield strengthb) Elastic limit and Proportionality limit
Why percentage elongation increases as the gauge length decreases.
COMPRESSION TEST
Explain the behavior of ductile material and brittle material under compression?
Why a short specimen should be used in compression test?
The plane of failure in brittle material subjected to compression is at about 45o, state the reason.
Name the devices used to measure deformation in tension and compression tests.
State the reason a) Tension test is preferred to compression test for determining the modulus of elasticity.
TORSION TEST ON MILD STEEL CIRCULAR SECTIONS
What is a shaft? Give practical Examples.
How angle of twist is measured in a torsion test.
What mechanical property of material is determined from torsion test and how?
Define torsion rigidity, polar moment of inertia and rigidity modulus.
SHEAR TEST ON MILD STEEL
Distinguish between Single shear and Double shear.
Why modulus of rigidity is not determined by shear test.
IMPACT TEST ON MILD STEEL
Give three examples of machine parts or structural members subjected to impact loading.
Distinguish between Charpy and Izod tests.
Why is a notch provided in the specimen for impact test?

BRINELL HARDNESS TEST
Very hard material cannot be tested in Brinell hardness testing machine-state the reasons.
How do you select the load for Brinell hardness test in case of following materials?
Aluminium, Brass, Mild steel, Cast iron, Copper.
What are the values of P are for steel and aluminium for conducting the Brinell hardness test using a 10mm diameter ball indenter?
ROCKWELL HARDNESS TEST
What is the purpose of applying minor load in case of Rockwell Hardness test?
What are the types of indenters used in hardness tests?
VICKERS HARDNESS TEST
What is static loading and dynamic loading applied to hardness test?
What are the types of indenters used in hardness tests?
BENDING TEST ON WOOD UNDER TWO POINT LOADING
Define a) Elastic limit, b) Flexural Rigidity
Proportionality limits d) Modulus of rupture as applied to bending test.

Define a) Section modulus b) Moment of resistance
c) Tensile failure as applied to bending test.
Why two-point symmetrical loading is preferred in bending tests.

TESTS ON AGGREGATE

Define bulk density and specific gravity. Which one is most oftenly used in concrete calculations in the field?
What is the range of values of specific gravity of ordinary aggregates like gravel and crushed granite?
What are light weight aggregates and where do you use them?
Why is the knowledge of water absorption of fine aggregate essential?
Define bulking of aggregates and discuss its significance.
Discuss the Why the bulking takes place only n sand and why not in coarse aggregate? Is this test actually needed in field? If so explain why?
If no allowance is made for bulking of sand, how is it going to affect the mix proportions?
How does specific gravity vary with hardness of stone?
Give the average figures for specific gravity of the aggregate:
a)Gravel, b) limestone, c) granite.
Define moisture content? Where do we need the knowledge of moisture content
relative bulking tendencies of coarse sand

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