ADVANCED CONCRETE LABORATORY

MANUAL

Course Code	:	**BSTB10**
Regulations	:	**IARE – R18**
Class	:	**I Semester (STE)**

Prepared By

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INSTITUTE OF AERONAUTICAL ENGINEERING

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Dundigal – 500 043, Hyderabad

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DEPARTMENT OF CIVIL ENGINEERING

Program: Master of Technology (M. Tech)

VISION OF THE DEPARTMENT

To produce eminent, competitive and dedicated civil engineers by imparting latest technical skills and ethical values to empower the students to play a key role in the planning and execution of infrastructural & developmental activities of thenation.

MISSION OF THE DEPARTMENT

To provide exceptional education in civil engineering through quality teaching, state-of-the-art facilities and dynamic guidance to produce civil engineering graduates, who are professionally excellent to face complex technical challenges with creativity, leadership, ethics and social consciousness.

INSTITUTE OF AERONAUTICAL ENGINEERING

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Dundigal, Hyderabad - 500 043

DEPARTMENT OF CIVIL ENGINEERING

Program: Master of Technology (M. Tech)

Program Outcomes	
PO1	Independently carry out research / investigation and development work to solve practical problems.
PO2	Write and present a substantial technical report / document.
PO3	Capable to apply the core, multidisciplinary knowledge for understanding the problems in structural engineering and allied fields.
PO4	Apply appropriate techniques, resources, modern engineering and Information Technology (IT) tools including predictions, modeling of complex structural engineering activities.
PO5	Able to identify and analyze the impact of Structural Engineering in development projects and find a suitable solution from number of alternatives.
PO6	Conceptualize and design civil engineering structures considering various socio-economic factors.
PO7	Ability to demonstrate in-depth knowledge of Structural Engineering and build capability to apply that knowledge to real problems.

ADVANCED CONCRETE LABORATORY SYLLABUS

Exp. No.	List of Experiments
1.	Stress strain curve for concrete
2.	Correlation between cube strength and cylinder strength
3.	Determination of split tensile concrete
4.	Determination of modulus of rupture concrete
5.	Correlation between compressive strength and cylinder strength
6.	Relation between compressive and modulus of rupture
7.	Non-destructive testing of existing concrete members
8.	Behavior of beams under flexure
9.	Behavior of beams under shear
10.	Behavior of beams under torsion

ATTAINMENT OF PROGRAM OUTCOMES (POs)

Exp No.	BSTB10 – Advanced Concrete Laboratory	Program outcomes
1.	Stress strain curve for concrete	PO3
2.	Correlation between cube strength and cylinder strength	PO3
3.	Determination of split tensile concrete	PO3, PO4
4.	Determination of modulus of rupture concrete	PO3
5.	Correlation between compressive strength and cylinder strength	PO3
6.	Relation between compressive and modulus of rupture	PO5,PO6
7.	Non-destructive testing of existing concrete members	PO3
8.	Behavior of beams under flexure	PO3, PO4
9.	Behavior of beams under shear	PO3
10.	Behavior of beams under torsion	PO3, PO4

MANDATORY INSTRUCTIONS

1. Students should report to the labs concerned as per thetimetable.
2. Record should be updated from time to time and the previous experiment must be signed by the faculty in charge concerned before attending thelab.
3. Students who turn up late to the labs will in no case be permitted to perform the experiment scheduled for the day.
4. After completion of the experiment, certification of the staff in-charge concerned in the observation book isnecessary.
5. Students should bring a notebook of about 100 pages and should enter the readings/observations/results into the notebook while performing theexperiment.
6. The record of observations along with the detailed experimental procedure of the experiment performed in the immediate previous session should be submitted and certified by the staff memberin-charge.
7. Not more than TWO students in a group are permitted to perform the experiment on a set up.
8. The group-wise division made in the beginning should be adhered to, and no mix up of student among different groups will be permittedlater.
9. The components required pertaining to the experiment should be collected from Lab- in-charge after duly filling in the requisitionform.
10. When the experiment is completed, students should disconnect the setup made by them, and should return all the components/instruments taken for thepurpose.
11. Any damage of the equipment or burnout of components will be viewed seriously either by putting penalty or by dismissing the total group of students from the lab for thesemester/year.
12. Students should be present in the labs for the total scheduledduration.
13. Students are expected to prepare thoroughly to perform the experiment before coming toLaboratory.
14. Procedure sheets/data sheets provided to the student groups should be maintained neatly and are to be returned after theexperiment.
15. DRESS CODE:

a. Boys - Formal dress with tuck in and shoes.
b. Girls - Formal dress(salwarkameez).
c. Apron in blue color for both boys andgirls.
d. Wearing of jeans is strictly prohibited

CONTENTS

EXPERIMENT NO: 01

STRESS STRAIN CURVE FOR CONCRETE

Theory: The stress-strain curve for hardened cement paste is almost linear as shown in the figure. The aggregate is more rigid than the cement paste and will therefore deform less (i.e. have a lower strain) under the same applied stress.

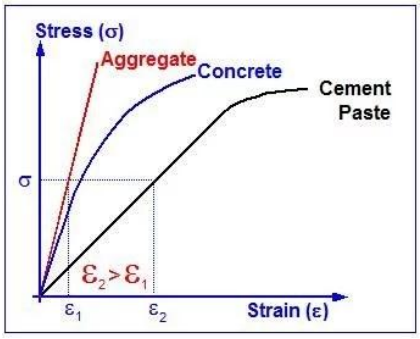


Fig. 1. Stress strain curve for different materials

The stress strain curve of concrete lies between those of the aggregate and the cement paste. However this relationship is non-linear over the most of the range. The reason for this non-linear behaviour is that micro-cracks are formed.

- At the interface between aggregate particles and cement paste as a result of the differential movement between the two phases, and
- Within the cement paste itself.

These cracks are formed as a result of changes in temperature and moisture and the application of load.Concrete taken through a cycle of loading and unloading will exhibit a stress-strain curve as shown in the figure below**.**

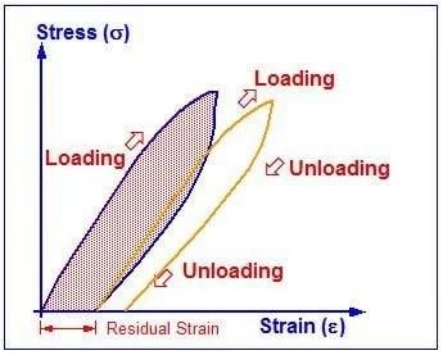


Fig. 2. Stress strain curve for concrete under cyclic loading

The concrete will not return to its original length when unloading mainly due to creep and micro-crackling, in other words, there will be a residual strain at zero load. This is known as

hysteresis loop which is largely related to micro-cracking.

Aim: To determine the stress strain curve for concrete.

Apparatus: Testing machine, Extensometer, Test specimen.

Procedure:

1. Prepare test specimen cylinder.
2. After curing, take out the specimen and place the specimen in Extensometer.
3. After setting, the specimen is placed in a testing machine.
4. Apply the load "Q" gradually on the specimen.
5. Now Extensometer gives the change in length of the specimen.
6. Now note down the applied load and change in the length of specimen.
7. Calculate the stress and strain of the specimen.

Observations and calculations:

1. Stress = Load / Area
2. Strain = Change in length / Original Length

Area of the specimen $=\frac{\pi d^2}{4}$

S. No.	Load (kN)	Change in length	Stress	Strain

Result: Stress strain curve for concrete

Viva Questions:

1. What is the specimen size for the test to find the stress strain curve?
2. What is the least count of dial gauge?
3. What is the name of the fixture used to find the stress strain curve?

EXPERIMENT NO: 02

CORRELATION BETWEEN CUBE STRENGTH AND CYLINDDER STRENGTH

Theory: The compressive strength of standard specimen is determined in two different ways is to be: Cubes and Cylinders. In Great Britain, Germany and Europe cubes are used. In the United States of America, France, Australia, and Canada cylinders are used as standard specimens. The restraining effect of platens of the testing machine extends over the entire height of the cube but leaves unaffected a part of a test cylinder. According to the expression for conversion the strength of the cores in to equivalent cubes in BS 1881: part 120:1983 the strength of the cylinder is equal to 0.8 times the strength of the cubes but in reality, there is no definite relation between the strengths of the specimens of these two shapes.

Apparatus: Cube specimen (150x150x150mm), Cylinder specimen (150x300mm), compression testing machine.

Procedure:

1. Prepare the 10 samples of cube and cylinder specimen's.
2. Cast and cure the specimens properly.
3. After 28 days, specimens are tested for strength.
4. Now specimens are placed one after the other and apply the load.
5. Note down the load at which the specimen is failed.
6. Now calculate the compression strength of the cube and cylinder specimen's.
7. Compare and obtain a relation between cube and cylinder specimen's.
8. The main difference between cube and cylinder specimen is capping.
9. Usually cylinder ends are not plane with platens of compression testing machine.

So they should be clamped with suitable material for proper distribution of the applied load.

Observations and calculations:

S. No.	Cube strength	Cylinder strength

Result: The relation between cube strength and cylinder strength is _____ .

Cube strength / Cylinder strength =_____.

Viva Questions:

1. Define characteristic compressive strength of concrete.
2. What is the difference between cube strength and cylinder strength?
3. As IS which is mould should use to find the compressive strength.

EXPERIMENT NO: 03

SPLIT TENSILE STRENGTH OF CONCRETE

Theory:

Concrete is a material, which is weak in tension. So it becomes very important to know tensile strength for concrete used in designing structures. Finding tensile strength for concrete is done by using two methods (1) Direct methods (2) Indirect methods. The direct method is not more suitable to determine design tensile strength of concrete, because it represents holding difficulties of specimen in testing machine. Sometimes there is greater possibility of load being applied eccentrically on the specimen of concrete.In the indirect method, compressive force is applied to the concrete sample to make the specimen fail after the development of tensile stresses in concrete. Tensile stress developed in the concrete at which the failure will occur is known as tensile strength in concrete.

Aim: To determine split tensile strength of concrete specimen.

Apparatus: Compression testing machine, cylindricalmoulds (150 x 300mm),Cylindrical moulds.

Procedure:

1. Prepare cylindrical concrete specimen of size 150mm diameter and 300 long
2. After dry curing keep cylindrical specimen for 24 hours in water before testing.
3. Keep casted specimen on the base plate of Compression Testing Machine after marking along horizontal axis direction.
4. Place wooden placing in specimen and apply the load 1.2 N/mm^2 /min till specimen fails.
5. Note down maximum applied load and splitting tensile of cylindrical specimen is calculated by formula:

$Fct = 2p/\pi ld$

Where,

l= Length of Cylinder specimen

d=Diameter of cylinder specimen

Observations and calculations:

Load = 150 KN

$\tau = 2p/\pi\ l\ d$

Result: The splitting Tensile strength of specimen is _____.

Viva Questions:

1. Define tensile strength of concrete.
2. How will you perform the experiment?
3. What are the different methods for finding the tensile strength of concrete?

EXPERIMENT NO: 04

DETERMINATION OF MODULUS OF RUPTURE OF CONCRETE

Theory: The flexural strength would be the same as the tensile strength if the material were homogeneous. In fact, most materials have small or large defects in them which act to concentrate the stresses locally, effectively causing a localized weakness. When a material is bent only the extreme fibers are at the largest stress so, if those fibers are free from defects, the flexural strength will be controlled by the strength of those intact 'fibers'. However, if the same material was subjected to only tensile forces then all the fibers in the material are at the same stress and failure will initiate when the weakest fiber reaches its limiting tensile stress. Therefore, it is common for flexural strengths to be higher than tensile strengths for the same material. Conversely, a homogeneous material with defects only on its surfaces (e.g., due to scratches) might have a higher tensile strength than flexural strength.

Aim: To determine the modulus of rupture of concrete specimen.

Apparatus: Moulds of 15cm x15cm x70cm, Tamping rod,Trowel,Testing Machine.

Procedure:

1. Weigh the material (cement, Fine aggregate and coarse aggregate) asper mix design and mix the material uniformly till we obtain uniform colour.
2. Add the water in dry mix and mix it till we get Homogenous mix.
3. Pour the concrete in moulds, compact it and level it.
4. Cover with wet cloth to mould and allow dry curing for 24 hours.
5. After 24 hours remove the specimen from mould and keep in curing tank which contains fresh water at temperature 24ºC to 30ºC.
6. Remove the specimen from curing tank and keep steel roller of flexural testingmachine as per two point loading.
7. Now apply load on the specimen till specimen fails.
8. Note down the failure load ‘p’ distance between line of fracture and nearer support ‘d’ and depth in cm of specimen at point of failure.
9. Flexural strength of specimen is expressed as modulus of rupture.

$Fb = pl/bd^2$ If, a >20cm for 15cm specimen

a> 13.3cm for 10cm specimen

$Fb = 3Pa/bd^2$ If, a < 20cm for 15cm specimen

a< 13.3cm for 10cm specimen

where, P = Maximum load.

l = length in cm.

b = measured width in cm.

d = measured depth in cm.

Observations and calculations:

S. No.	Load	Modulus of rupture

Result: Modulus of rupture of concrete is_____.

Viva Questions:

1. Define modulus of rupture of concrete.
2. What is the need of modulus of rupture?
3. What are the dimensions of specimen used for modulus of rupture?

EXPERIMENT NO: 05

RELATION BETWEEN COMPRESION STRENGTH AND SPLIT TENSILE STRENGTH

Theory: The value of tensile strength of concrete affects the performance of structures, such as the shear force resistance and the load-bearing capacity of anchors with concrete cone failure as decisive failure mode. Hence, as concrete compressive strength, tensile strength is another critical mechanical property, which should be appropriately considered in structure design. The real value of the in situ tensile and compressive strengths of concrete deteriorated under authentic service environments for long time provide a necessary basis for the evaluation of structures, especially for those, which have existed for long period already. Considering the complexity, cost, and time-consuming nature of performing tensile tests, many researchers and building guidelines are interested to predict the tensile strength from compressive strength and their relationship in a simplified method with satisfactory accuracy. Most correlations proposed by building codes or literatures are based on normal curing conditions and testing age of 28 days. In reality, there are many different time, load and environment-dependent impacts on concrete existing in real service conditions for long term.

Aim: To determine the relation between compressive strength and split tensile strength of concrete

Apparatus: Compressive testing machine, cube moulds of 150mm size, cylindrical moulds of 150x300mm.

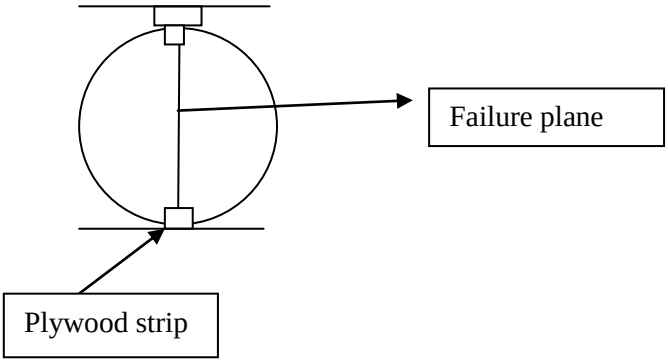
Procedure:

1. Prepare cylindrical concrete specimen of size 150mm diameter and 300mm long.
2. After dry curing keep cylindrical specimen for 24hrs in water before testing.
3. Keep casted specimen on the base plate of compression testing machine after marking along the horizontal axis.
4. Place wooden placing on specimen and apply the load 1.2N/mm^2/min to 2.4 N/mm^2/min till specimen fails.
5. Note down maximum applied load and splitting tensile of cylindrical specimen is calculated by formula

$$F_{ct} = \frac{2P}{\pi ld}$$

Where l = length of cylinder specimen.

d = diameter of cylinder specimen.



Compression strength test:

1. First prepare the cube samples with proper mix ratio.
2. Cast the samples for 24hrs and leave it in room temperature.
3. After 24hrs remove the samples from mould and place them in water.
4. After 7 days or 28 days the samples are taken out from water and dry the surface.
5. The specimen is placed in the compression testing machine and load is applied on the axis of specimen.
6. Note down the maximum load at which the sample gets failure.
7. Compressive strength = Maximum load / cross sectional area.

Observationsand calculations:

S. No.	Compressive strength	Split tensile strength

Result: The relation between compressive strength and split tensile strength is _____

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Viva Questions:

1. Define split tensile strength of concrete.
2. What is the relation between compressive strength and split tensile strength?
3. What are the dimensions of specimen used for split tensile strength?

EXPERIMENT NO: 06

RELATION BETWEEN COMPRESSIVE STRENGTH AND MODULUS OF RUPTURE

Theory: The theoretical compressive strength of concrete is eight times larger than its tensile strength. This implies a fixed relation between the compressive and tensile strength of concrete. In fact there is a close relation but not a direct proportionality. The ratio of tensile to compressive strength is lower for higher compressive strengths.Experimental results also have shown that concrete in compression and tension (both direct tension and flexural tension) are closely related but the relationship is not of direct proportionality type. The ratio of tensile strength to compressive strength depends upon the strength of concrete. Thus higher the compressive strength, higher the tensile strength, but the rate of increase of tensile strength is of decreasing order. The tensile strength of concrete is more sensitive to improper curing than the compressive strength.

Aim: To determine the relation between compressive strength and modulus of rupture of concrete.

Apparatus: Compressive testing machine, cube moulds of 150mm size, beam or prism moulds of 150mm x150mm x700mm.

Procedure:

Compressive strength test:

1. First prepare the cube samples with proper mix ratio.
2. Cast the samples for 24hrs and leave it in room temperature.
3. After 24hrs remove the samples from mould and place them in water.
4. After 7 days or 28 days the samples are taken out from water and dry the surface.
5. The specimen is placed in the compression testing machine and load is applied on the axis of specimen.
6. Note down the maximum load at which the sample gets failure.
7. Compressive strength = Maximum load / cross sectional area.

Modulus of rupture test:

1. Weigh the material (cement, Fine aggregate and coarse aggregate) as per mix design and mix the material uniformly till we obtain uniform colour.
2. Add the water in dry mix and mix it till we get Homogenous mix.
3. Pour the concrete in moulds, compact it and level it.
4. Cover with wet cloth to mould and allow dry curing for 24 hours.
5. After 24 hours remove the specimen from mould and keep in curing tank which contains fresh water at temperature 24ºC to 30ºC.
6. Remove the specimen from curing tank and keep steel roller of flexural testing machine as per two point loading.
7. Now apply load on the specimen till specimen fails.
8. Note down the failure load 'p' distance between line of fracture and nearer support 'd' and depth in cm of specimen at point of failure.
9. Flexural strength of specimen is expressed as modulus of rupture.

$Fb = pl/bd^2$ If, a >20cm for 15cm specimen

a> 13.3cm for 10cm specimen

$Fb = 3Pa/bd^2$ If, a < 20cm for 15cm specimen

a< 13.3cm for 10cm specimen

where, P = Maximum load.

l = length in cm.

b = measured width in cm.

d = measured depth in cm.

Observations and calculations:

S. No.	Compressive strength	Modulus of rupture

Result: The relation between compressive strength and modulus of rupture is _____.

Viva Questions:

1. Define compressive strength of concrete.
2. What is the relation between compressive strength and modulus of rupture.
3. Define modulus of rupture.

EXPERIMENT NO: 07

NON-DESTRUCTIVE TESTING OF EXISTING CONCRETE MEMBERS

Theory: Recent development in concrete is high strength concrete, which is mixture of cement, sand, aggregate, water and admixtures. The compressive strength of concrete is its one of the most valuable property. To determine compressive strength of concrete is a major task of engineers/researchers for existing concrete structures. There are two aspects of determination of compressive strength of concrete which are destructive tests (DT) and non-destructive tests (NDT). The DT of concrete is not always appropriate method to find compressive strength of concrete and concrete structures because it affects the durability and lifespan of concrete. Hence, the NDT method is only one predominant method to find the strength of existing concrete and concrete structures, and to judge the quality of concrete. The NDT method is direct and easy tool to find in situ compressive strength of concrete. The NDT test methods include rebound hammer, ultrasonic pulse velocity test, penetration test, radiography test, sonic integrity tests etc. There are two distinct areas in civil engineering works where it has to be relied on NDT for practical and theoretical purposes. The first ones are the old monumental structural systems like ancient temples and edifices. The second ones are the buildings which are coming up so fast in the urban areas as the result of burgeoning housing industry, which badly needs quality control for mass safety and security of the people.

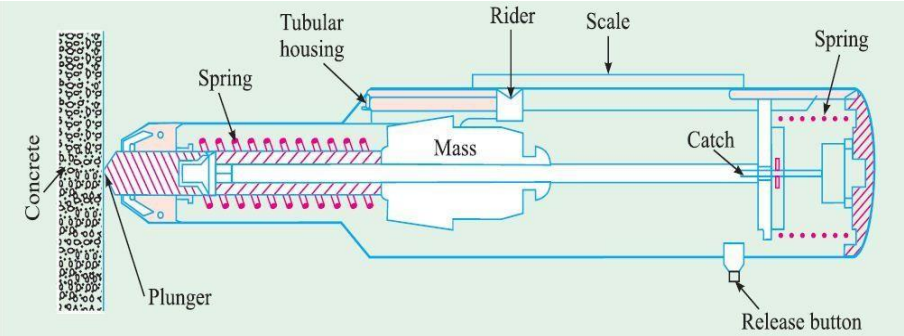
Aim: To determine the compressive strength and quality of concrete using non-destructive testing.

Apparatus: Rebound hammer, ultrasonic pulse velocity equipment, cubes of 150mm size.

Procedure:

1. Take the concrete block which is to be tested and mark one side of the surface into 9 parts to obtain average strength of the block.
2. Do the same for minimum 4 sides of the concrete block.
3. Press the rebound hammer on to the surface of the concrete block so that the plunger is pushed inside the hammer.
4. When the plunger against the surface of the concrete, the mass rebound from the plunger.

5. The distance travelled by mass, is called the rebound number. It is indicated by the rider moving along a graduated scale.
6. Hold it and lock the plunger with lock button provided on the top of the hammer.
7. Note the reading on the graduated scale present on the rebound hammer which is known as rebound number.
8. Follow the same procedure for four sides of the block where each side is divided into 9 parts.
9. After taking reading press the hammer on to the surface and the plunger gets released due to the spring action.
10. Take the corresponding strengths with respect to the rebound number which is present on the table on the hammer.
11. Take the average of all the strengths and obtain average strength of the concrete block.



Rebound hammer

Observations and calculations:

	Side 1		Side 2	
S. No.	Rebound number	Strength (kg/cm^2)	Rebound number	Strength (kg/cm^2)
1				
2				
3				
4				
5				

6				
7				
8				
9				

	Side 3		Side 4	
S. No.	Rebound number	Strength (kg/cm^2)	Rebound number	Strength (kg/cm^2)
1				
2				
3				
4				
5				
6				
7				
8				
9				

Average strength of the concrete= _____kg/cm^2

Result: The average strength of the concrete is _____N/mm^2

Ultrasonic pulse velocity test:

Aim: To determine the quality of concrete by ultrasonic pulse velocity method.

Apparatus: Electrical pulse generator, transducer, amplifier, electronic-timing device and concrete specimen (150mmX150mmX150mm).

Procedure:

1. Take the specimen and mark the suitable number of locations on the specimen to be tested.
2. First take the distance between the two points on the surface for testing.
3. Before testing make sure that the surface of the concrete specimen is smooth. If the surface of the specimen is rough apply grease to it before testing.
4. Take the UPV tester and fix the wires to it which transducers are fixed at the end.
5. Calibrate the instrument by the reference bar. The pulse time for calibration is engraved on the reference bar.
6. After calibration place the transducers on the surface and press it hard onto the surface. A value of pulse time in microsecond is displayed on the screen and it is noted.
7. According to the placing of transducers the respective length is also measured.
8. This is followed for number of marked points to be tested. After obtaining the pulse time value and the distance, velocity is calculated.
9. Based on the value of velocity the quality of concrete is determined as per IS code 13311(part-1)-1992, table-2.

Ultrasonic Pulse velocity meter

Observations and calculations:

S.No.	Pulse velocity time(T)-µs	Distance (L)-mm	Velocity km/s

Formula:

Pulse velocity time (V) = length (L) / Pulse time (T)

As per IS code 13311 part-1Table-2: velocity criterion for concrete quality grading.

S. No.	Pulse velocity by cross probing (km/sec)	Concrete quality grading
1	Above 4.5	Excellent
2	3.5 to 4.5	Good
3	3.0 to 3.5	Medium
4	Below 3.0	Doubtful

Result: The average pulse velocity of the specimen is _____ (km/s).

Quality of the specimen is _____.

Viva Questions:

1. Why we need the NDT for concrete.
2. Which code used for NDT.
3. What are the different types of NDT for materials?

EXPERIMENT NO: 08

BEHAVIOR OF BEAMS UNDER FLEXURE

Theory: Flexural strength, also known bend strength or transverse rupture strength is a material property.Defined as the stress in a material just before it yields in a flexure test.The transverse bending test is most frequently employed, in which a specimen having either a circular or rectangular cross-section is bent until fracture or yielding using a three point flexural test technique. The flexural strength represents the highest stress experienced within the material at its moment of yield. It is measured in terms of stress, here given the symbol ' σ'.The flexural strength is stress at failure in bending. It is equal or slightly larger than the failure stress in tension.When an object formed of a single material, like a wooden beam or a steel rod, is bent. It experiences a range of stresses across its depth. At the edge of the object on the inside of the bend (concave face) the stress will be at its maximum compressive stress value. At the outside of the bend (convex face) the stress will be at its maximum tensile value. These inner and outer edges of the beam or rod are known as the 'extreme fibers'. Most materials generally fail under tensile stress before they fail under compressive stress, so the maximum tensile stress value that can be sustained before the beam or rod fails is its flexural strength.

Aim: To determine the flexural strength of concrete specimen.

Apparatus: Moulds of 10cm x10cm x50cm, Tamping rod,Trowel,Testing Machine.

Procedure:

1. Weigh the material (cement, Fine aggregate and coarse aggregate) as per mix design and mix the material uniformly till we obtain uniform colour.
2. Add the water in dry mix and mix it till we get Homogenous mix.
3. Pour the concrete in moulds, compact it and level it.
4. Cover with wet cloth to mould and allow dry curing for 24 hours.
5. After 24 hours remove the specimen from mould and keep in curing tank which contains fresh water at temperature 24ºC to 30ºC.
6. Remove the specimen from curing tank and keep steel roller of flexural testing machine as per two point loading.
7. Now apply load on the specimen till specimen fails.

8. Note down the failure load ‘p’ distance between line of fracture and nearer support ‘d’ and depth in cm of specimen at point of failure.
9. Flexural strength of specimen is expressed as modulus of rupture.

$Fb = pl/bd^2$ If, a >20cm for 15cm specimen

a> 13.3cm for 10cm specimen

$Fb = 3Pa/bd^2$ If, a < 20cm for 15cm specimen

a< 13.3cm for 10cm specimen

where, P = Maximum load.

l = length in cm.

b = measured width in cm.

d = measured depth in cm.

Observations and calculations:

S. No.	Load	Flexural strength

Result: Flexural strength of concrete is_____.

Viva Questions:

1. What is the specimen size used in the experiment.
2. How to calculate the flexural strength of concrete.
3. Which type of loading used in experiment.

EXPERIMENT NO: 09

BEHAVIOR OF BEAMS UNDER SHEAR

Theory: To know the behavior to shear of structural elements in reinforced concrete, such as columns and beams intangential action, it is necessary to consider the pure shear acting either alone or with tension.Indeed, the major difficulty lies in developing an experimental procedure sufficiently reliable to adequatelyrepresent the shear behavior of concrete and relatively easy for industrial purpose. Different methods developedin this context are used to explain the mechanism of shear transfer. This ratio is an important parameter for the calculation method. Methods based on direct shear are practically applicable to the advanced calculation ofreinforced concrete beams, curved structures and foundations.This research focuses on the mechanism of shear transfer in concrete alone by developing an experimental procedure to determine the influence of the orientation of the surface of shear failure on the force-slip relationship. The experimental study is intended to develop a test on a concrete specimen where a surface of shear failure is created following an off-axis loading.

Aim: To determine the shear strength of concrete specimen.

Apparatus:L shape moulds,Tamping rod,Trowel,Compression Testing Machine.

Procedure:

1. Prepare the L shaped concrete specimen and curing is done for 28 days.
2. Measure the specimen dimensions (L – Shape).
3. Place the concrete specimen in compression testing machine.
4. Set the dial gauge to zero.
5. Apply the load gradually till the specimen fails.
6. Record the load when the specimen failed.
7. Repeat the procedure for four specimens and take the average value.

Observations and calculations:

Specimen surface area = _____

S. No.	Load	Shear strength

Result: Shear strength of concrete is_____.

Viva Questions:

1. Define shear strength.
2. How to calculate the shear strength of concrete.
3. Define shear modulus.

EXPERIMENT NO: 10

BEHAVIOR OF BEAMS UNDER TORSION

Theory:

For transmitting power through a rotating shaft it is necessary to apply a turning force. The force is applied tangentially and in the plane of transverse cross section. The torque or twisting moment may be calculated by multiplying two opposite turning moments. It is said to be in pure torsion and it will exhibit the tendency of shearing off at every cross section which is perpendicular to the longitudinal axis.

Aim: To determine the modulus of rigidity.

Apparatus: Torsiontestingmachine, testing sample.

Procedure:

1. Select the driving dogs to suit the size of the specimen and clamp it in the machine by adjusting the length of the specimen by means of a sliding spindle.
2. Measure the diameter at about three places and take the average value.
3. Choose the appropriate range by capacity change lever
4. Set the maximum load pointer to zero.
5. Set the protractor to zero for convenience and clamp it by means of knurled screw.
6. Carry out straining by rotating the hand wheel in either direction.
7. Load the machine in suitable increments.
8. Then load out to failure as to cause equal increments of strain reading.
9. Plot a torque- twist (T- θ) graph.
10. Read off co-ordinates of a convenient point from the straight line portion of the torque twist (T-θ) graph and calculate the value of G by using relation.

Observations and calculations:

Gauge length of the specimen, L = _____

Diameter of the specimen, d = _____

Polar moment of inertia, $J = \pi d^4 /32$ = _____

S. No.	Torque Kg-cm	Torque N - mm	Angle of twist		Modulus of Rigidity(G) N/mm^2	Average GN/mm^2
			Degrees	Radians		

Result: Thus the torsion test on given mild steel specimen is done and the modulus of rigidity is _____ N/mm^2.

Viva Questions:

1. Define torque.
2. Give the expression for torque.
3. Define modulus of rigidity.
4. Give the values of G for different materials.