

SRM VALLIAMMAI ENGINEERING COLLEGE
(AN AUTONOMOUS INSTITUTION)
SRM NAGAR, KATTANKULATHUR— 603 203

ST3164 - STRUCTURAL ENGINEERING LABORATORY

As per Anna University
Autonomous Regulation 2023



(Academic Year 2026-27)

DEPARTMENT OF CIVIL ENGINEERING

M.E STRUCTURAL ENGINEERING

PREFACE

This instruction manual has been prepared by the Department of Civil Engineering to facilitate instruction doing practical classes and further to be used as a reference manual by the Structural Engineering students of this college. This manual covers explanation of experiments included in the syllabus of the Anna University according to Autonomous **Regulation 2023** in Advanced Structural Engineering Laboratory Manual for the M.E (Structural Engineering) degree course

Dr. S.Sureshababu

Associate Professor

Specific Rules and Hazards Associated with this Lab Include

Capacity-Normal Occupancy during teaching labs is 18

- Students should enter the lab with proper uniform and ID card.
- Always keep work areas clean and tidy.
- Observe safety alerts in the laboratory.
- Always wear shoes that completely cover your feet. No sandals or opened toed shoes are allowed.
- Follow all written and verbal instructions carefully.
- Observe the safety alerts in the laboratory.
- Don't forget to bring Lab manual, Record, observation, calculator, graph sheet and other accessories when you come to lab.
- In the absence of Instructor no student shall be allowed to work in the laboratory.
- Don't use mobile phones during lab hours.
- Place tools and equipment in proper place after use.
- Turn off the power switches of weighing balance and equipments after used.
- Report to the staff if any injuries.
- Dont try to repair any faulty instruments.

COURSE OBJECTIVES:

- To understand the test procedure and flexural behavior of the RC beams.
- To gain knowledge on various NDT test.
- To study about the structural behaviour of steel sections.
- To understand the test procedure and Compressive behavior of the RC Columns.
- To understand the Fresh properties of Self Compacting Concrete.

LIST OF EXPERIMENTS

1. Concrete Mix Design- I.S. code Method
2. Fresh properties of Self Compacting Concrete using slump flow, L Box and V Funnel Tests
3. Fabrication, casting and testing of simply supported reinforced concrete beam for strength and deflection behavior.
4. Testing of simply supported steel beam for strength and deflection behavior.
5. Fabrication, casting and testing of reinforced concrete column subjected to concentric and eccentric loading.
6. Non-Destructive Test on concrete
 - i. Rebound hammer and
 - ii. Ultrasonic Pulse Velocity Tester.
7. Determination of Impact Resistance of concrete
8. Determination of Permeability of concrete
9. Measurement of Cracks

LIST OF EQUIPMENTS

1. Strong Floor
2. Loading Frame
3. Hydraulic Jack
4. Load Cell
5. Proving Ring
6. Demec Gauge

7. Electrical Strain Gauge with indicator
8. Rebound Hammer
9. Ultrasonic Pulse Velocity Tester
10. Dial Gauges
11. Clinometers
12. Vibration Exciter
13. Vibration Meter

TOTAL: 60 PERIODS

COURSE OUTCOMES:

1. On completion of this laboratory course students will be able to cast and test RC beams for strength and deformation behavior.
2. They will be able to test dynamic testing on steel beams
3. They will be able to static cyclic load testing of RC frames
4. They will be able to non-destruction testing on concrete.
5. Will have knowledge on various admixtures used in concrete mixes as per IS Code.

REFERENCES:

1. Dally J W, and Riley W F, "Experimental Stress Analysis", McGraw-Hill Inc. New York, 1991

CO	PO			PSO		
	1	2	3	1	2	3
1	3	2	2	3	3	3
2	3	1	-	2	1	1
3	2	-	2	3	2	3
4	3	1	2	3	2	2
5	3	-	1	2	1	1
Average	2.8	1.3	1.8	2.6	1.8	2.0

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4.	Testing of simply supported steel beam for strength and deflection behaviour.		
5.	Fabrication, casting and testing of reinforced concrete column subjected to a) Centric loading b) Eccentric loading.		
6.	Non-Destructive Test on concrete a) Rebound hammer and b) Ultrasonic Pulse Velocity Tester.		
7.	Determination of Impact Resistance of concrete		
8.	Determination of Permeability of concrete		
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AIM :

To select the suitable ingredients of concrete and determining their relative proportions with the object of producing concrete of certain minimum strength & durability as economically as possible by Concrete Mix Design Procedure as per IS 10262 – 2009 for the given grade of concrete

PROCEDURE FOR CONCRETE MIX DESIGN REQUIRES FOLLOWING STEP BY STEP PROCESS:

1. Determine the mean target strength f_t from the specified characteristic compressive strength at 28-day f_{ck} and the level of quality control.
$$f_t = f_{ck} + 1.65 S$$
where S is the standard deviation obtained from the Table of approximate contents given after the design mix.
2. Obtain the water cement ratio for the desired mean target using the empirical relationship between compressive strength and water cement ratio so chosen is checked against the limiting water cement ratio. The water cement ratio so chosen is checked against the limiting water cement ratio for the requirements of durability given in table and adopts the lower of the two values.
3. Estimate the amount of entrapped air for maximum nominal size of the aggregate from the table.
4. Select the water content, for the required workability and maximum size of aggregates (for aggregates in saturated surface dry condition) from table.
5. Determine the percentage of fine aggregate in total aggregate by absolute volume from table for the concrete using crushed coarse aggregate.
6. Adjust the values of water content and percentage of sand as provided in the table for any difference in workability, water cement ratio, grading of fine aggregate and for rounded aggregate the values are given in table.

7. Calculate the cement content from the water-cement ratio and the final water content as arrived after adjustment. Check the cement against the minimum cement content from the requirements of the durability, and greater of the two values is adopted.
8. From the quantities of water and cement per unit volume of concrete and the percentage of sand already determined in steps 6 and 7 above, calculate the content of coarse and fine aggregates per unit volume of concrete from the following relations:

$$V = \left[W + \frac{C}{S_c} + \frac{1}{p} \frac{f_a}{S_{fa}} \right] \times \frac{1}{1000}$$

$$V = \left[W + \frac{C}{S_c} + \frac{1}{1-p} \frac{C_a}{S_{ca}} \right] \times \frac{1}{1000}$$

where V = absolute volume of concrete = gross volume (1m³) minus the volume of entrapped air

S_c = specific gravity of cement

W = Mass of water per cubic metre of concrete, kg

C = mass of cement per cubic metre of concrete, kg

p = ratio of fine aggregate to total aggregate by absolute volume

f_a, C_a = total masses of fine and coarse aggregates, per cubic metre of concrete, respectively, kg, and

S_{fa}, S_{ca} = specific gravities of saturated surface dry fine and coarse aggregates, respectively

9. Determine the concrete mix proportions for the first trial mix.
10. Prepare the concrete using the calculated proportions and cast three cubes of 150 mm size and test them wet after 28-days moist curing and check for the strength.
11. Prepare trial mixes with suitable adjustments till the final mix proportions are arrived at.

RESULT :

The Concrete Mix proportions for Trial Mix for a given Grade of Concrete

Ex No: 2

FRESH PROPERTIES OF SELF COMPACTING CONCRETE

AIM :

To determine the workability of fresh self Compacting concrete by the following test :

- a) Slump flow
- b) L Box
- c) V Funnel Tests

a) SLUMP FLOW TEST

Aim:

- This test is done to know the horizontal flow of concrete in the absence of obstructions.
- It gives good assessment of filling ability.
- This test can be done in the field itself

Apparatus required:

Slump cone with Metal Baseplate, Tamping Rod, Bond, Trowel, Mixing Tray, Scale (60cm),
Measuring Jar 1000ml.

Materials required:

- Coarse Aggregate
- Fine Aggregate
- Cement
- Water
- Admixtures (Conplast/SP 420)

Procedure:

1. A normal slump cone and a flat square plate is taken . Some concentric circles are drawn on square plate . A firm circle of 500 mm diameter is drawn.
2. The slump cone is filled with about 6litre of concrete and is raised vertically and allow the concrete to flow free in horizontal direction.
3. Measure the final diameter of concrete in 2 perpendicular directions and note the average of two diameters.
- 4.



Acceptability:

1. The higher the flow rate , the greater is the ability to fill form work
2. A value of at least 650 mm is required for SCC.

T₅₀ SLUMP FLOW TEST

1. The procedure for this test is as same as for slump flow test.
2. When the slump cone is lifted , start the stop watch and find the time taken for concrete to reach 500 mm mark.
3. This time is called as T50 time.
4. A lower time indicates greater flowability.
5. It is suggested that T50 time may be 2 to 5 seconds

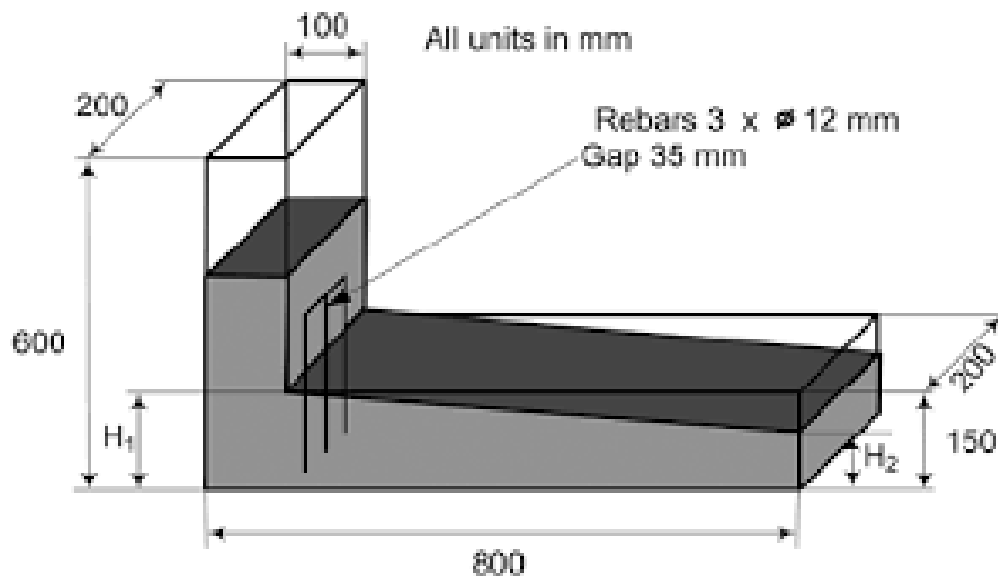
b) L-BOX TEST

Aim:

This test is used to know the passing ability of concrete.

PROCEDURE:

1. About 14 litres of concrete is taken and fill the vertical section of L-BOX.
2. Lift the gate and allow the concrete to flow out into the horizontal section.
3. Start the stop watch and note down the time taken to reach 200 and 400mm marks.
4. When the concrete stop flowing the heights H_1 and H_2 are measured.
5. Calculate blocking ratio H_2/H_1 .
6. The test is to be performed within 5 min.



ACCEPTABILITY:

If the concrete flows like water then $H_2/H_1=1$

The minimum acceptable value is 0.8.

c) V Funnel Tests

Aim:

1. V-funnel test is used to find filling ability of aggregates of maximum size of 20 mm
2. V-funnel at T5 min is used to find segregation resistance

PROCEDURE:

V-FUNNEL TEST :

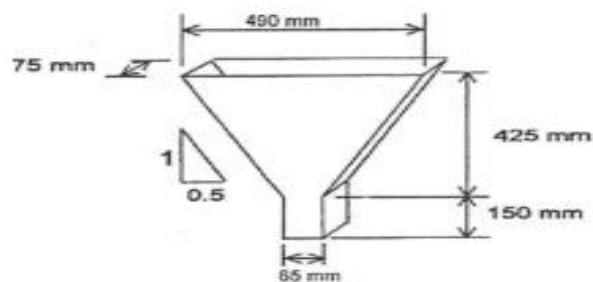
1. The door present below the v-funnel is closed and about 12 litre of concrete is poured inside.
2. open the door within 10 seconds and record the time taken for concrete to flow down.
3. The whole test is to performed within 5 minutes.

V-FUNNEL AT T₅ MIN :

1. Do not clean or moisten the inside surface of funnel.
2. Close the trap door and refill the v-funnel.
3. Now open the trap door after 5 min and allow the concrete to flow down.
4. Calculate the time taken for complete fall of concrete. It is called the flow time at T5 min.

ACCETABILITY:

1. For v-funnel test the flow time should be b/w 8to12min
2. for v-funnel at T5 min,+3 sec is allowed i.e.,11 to 15 min



V-funnel test

Result:

Thus the workability of fresh self-Compacting concrete is tested by the following methods:

- a) Slump flow b) L Box c) V Funnel Test

Ex No: 3 TESTING OF SIMPLY SUPPORTED RC BEAM FOR STRENGTH AND DEFLECTION BEHAVIOUR

AIM:

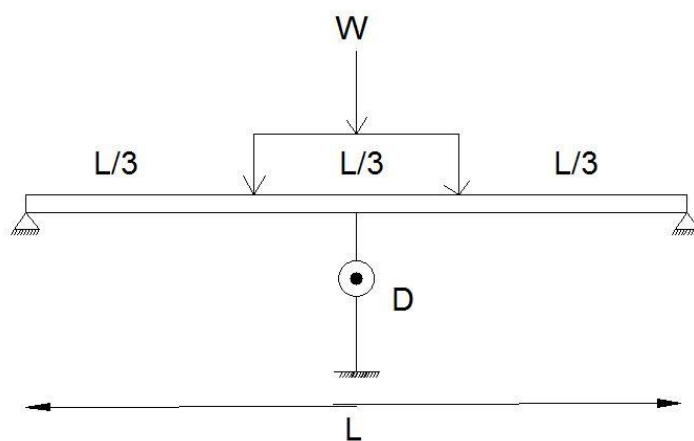
To determine strength and deflection of the given RC beam and also type of failure by using loading frame.

APPARATUS REQUIRED:

- i. RC beam of size 1.2 x 0.1 x 0.15 m
- ii. Loading frame (500KN capacity)
- iii. Load Cell with Indicator
- iv. Hydraulic jack
- v. LVDT

PROCEDURE:

- 1) The RC beam is casted and used for 28 days.
- 2) The beam is placed on the support arrangement where as support to support distance is 1.2m.
- 3) The load is applied at the centre of the beam and LVDT is placed at the soffit of the beam.
- 4) Adjust both the loading indicator and displacement indicator to zero.
- 5) The load is gradually applied by hydraulic jack and the loading values are displaced in load indicator .
- 6) The another end of LVDT is attached to the 10ch displacement indicator spl.
- 7) By gradually increasing the load, the values of the load is noted by the loading indicator, subsequently the displacement corresponding to the load should be noted.
- 8) Similarly for increasing the load by 2.5KN. The corresponding value should be noted in the displacement meter.
- 9) The load should be given until the failure has reached. The failure load is noted.
- 10) Finally the type of failure is identified by visual inspection.



TABULATION:

SL. NO.	LOAD (TONNE)	LOAD (KN)	DEFLECTION (MM)
1			
2			
3			
4			
5			
6			

RESULT:

Failure load =

Maximum deflection under point load =

Type of failure =

Ex No: 4

TESTING OF SIMPLY SUPPORTED STEEL BEAM FOR STRENGTH AND DEFLECTION BEHAVIOUR.

Aim:

To conduct a flexure test on simply supported steel beam and study the load deflection behavior and moment curvature relationship.

Apparatus Required:

- Steel beam
- Loading frame
- Hydraulic jack with load cell
- LVDT or Dial Gauges

Theory:

If a beam laterally restrained and compact is loaded progressively it deflects and its bending curvature varies along the length of the beam. The behavior is linear elastic during the initial stages of loading. The variation of strain along the depth of the member can be obtained.

Procedure:

- The steel beam made of RSJ is fitted with electrical strain gauges at the specified loading to measure the strain readings.
- The steel beam is placed over the supports of the Loading Frame.
- The span length and other dimensions are measured. Two point loading is applied at middle third points.
- Dial gauges are fixed at the points under each load at the centre of the span.
- The load is applied gradually and the deflection readings well taken at regular intervals of loading.
- The corresponding strain readings are also noted down.

Observation:

Area of the section =
Moment of Inertia =
Section modulus =
Span length =

Tabulation:

Sl.no	Load in kN		Load in N	Deflection in mm

Formula used:

$$\text{Maximum Deflection } (\delta) = \frac{23Wl^3}{648 EI}$$

Where,

w - Load on specimen

l - Span

E - Young's Modulus

I - Moment of Inertia

Graph:

Draw the graph between load and deflection.

Result:

- 1) Maximum Deflection (Theoretical)=
- 2) Maximum Deflection (Experimental) =

Ex No: 5	FABRICATION, CASTING AND TESTING OF REINFORCED CONCRETE COLUMN SUBJECTED TO CONCENTRIC AND ECCENTRIC LOADING.
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Aim:

To determine the behavior of RC column under axial and eccentric loading conditions.

Apparatus Required:

- RC Columns
- Loading Frame
- Dial gauges
- Strain gauges.

Theory:

In general the strain of the cross section, increase with age, on account of creep and shrinkage due to stress. Unlike service load conditions, the behavior of the axially compressed short column is fully predictable under ultimate load conditions. As axial loading is increased, axial shortening of the column increases linearly up to about 80% of the ultimate load. This behavior is found to be independent of the type of transverse reinforcement. However beyond the ultimate load the behavior depends on the type and amount of transverse reinforcement.

Procedure:

1. The size of the column is 150 mm x 150mm and of length 600mm. The reinforcement consists of 4 numbers of 10mm diameter bars and tied with 6mm diameter bar spaced at 100mm c/c.
2. M₂₀ concrete is used for casting the column.
3. The column specimens were cast and immersed in water after 24 hours for 28 days curing.
4. The axial/eccentric load is applied gradually and the strain readings were taken at regular intervals of loading.
5. The loading is continued up to the ultimate load level and the failure pattern has been studied.

Formula used

$$P = C_c \times A_c + S_c A_{sc}$$

Where

C_c - Permissible stress in concrete in direct compression

A_c - Permissible stress in concrete in direct compression

S_c - Permissible compressive stress for column bars

A_{sc} - C/S area of the longitudinal steel

Observation:

Cross section of the specimen =

Least Count of Dial gauge =

Area of steel =

Tabulation:

S.No	Load (kN)	Deflection	Remarks

Result:

First crack load (P) =

Ultimate load carrying capacity of the column (P_u) =

i) DETERMINATION OF IN-SITU CONCRETE STRENGTH USING REBOUND HAMMER***Aim:***

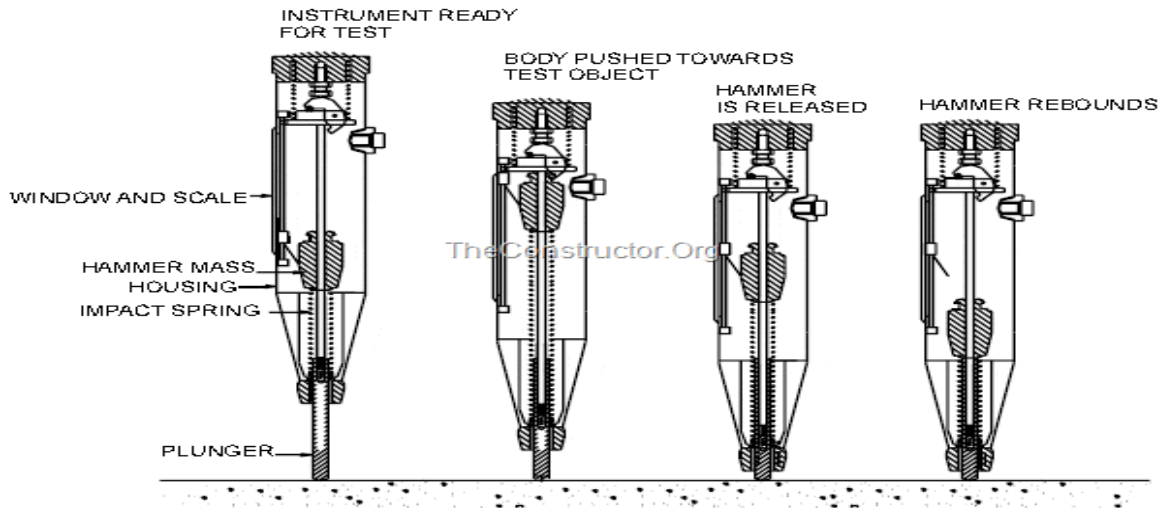
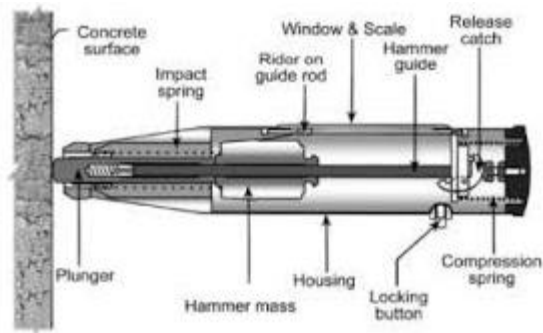
To determine the insitu concrete strength by Non-Destructive testing using Rebound Hammer

Apparatus Required:

- Cube specimen
- Rebound hammer or Schmidt's hammer
- Compression testing machine
- Measuring scale

Procedure:

1. Check the rebound hammer against the testing anvil, and confirm the reliability of result.
2. Remove wetness of cured specimen and kept in the laboratory atmosphere for about 2 hours before testing.
3. Measure the dimensions of the specimen and mark 3×3 grid lines on the smooth faces of the cube specimen. Before marking the grid remove all loose adhered scales by using grinding wheel or stone. Rough surfaces resulting from incomplete compaction, loss of grout, spalled or tooled surfaces do not give reliable results and should be avoided.
4. Keep the cube specimen in a compression testing machine under a fixed load. The amount of fixed load depends upon the amount of impact energy to be applied. For example the fixed load of in the order of 7N/mm^2 is applied when the impact energy of the hammer is about 2.25 N-m for testing normal weight concrete. (IS specifies different energy for different applications.)
5. While keeping the specimen in compression testing machine care shall be taken that the testing faces shall be available and specimen is concentric to the line of applied fixed load.
6. Hold the rebound hammer perpendicular to the concrete surface and depress the hammer by applying a gradual increase in pressure until it impacts. Note down the scale reading on the hammer.
7. While testing it can bear in the mind that, the point of impact should be at least 20mm away from any edge or shape discontinuity.
8. Nine readings shall be taken on each faces of the cube and corresponding rebound is recorded.
9. Find the average of the rebound index after deleting outliers as per IS 8900: 1978. Interpret the concrete strength using calibration chart.



Operation of the rebound hammer

Observation:

The size of the specimen =

The area of the specimen =

Tabulation:

Sl.no	Date of casting	Date of testing	Specimen marking	Rebound number (R)	Compressive strength (N/mm^2)

Result:

- The compressive strength of the given cube specimen = N/mm^2
- The Rebound Number (R) =

ii) ULTRASONIC PULSE VELOCITY TEST

Aim:

To determine the in situ concrete strength by Non-destructive testing using ultrasonic pulse velocity tester.

Apparatus Required:

- Cube specimen
- USPV setup
- Petroleum gel
- Measuring scale

THEORY:

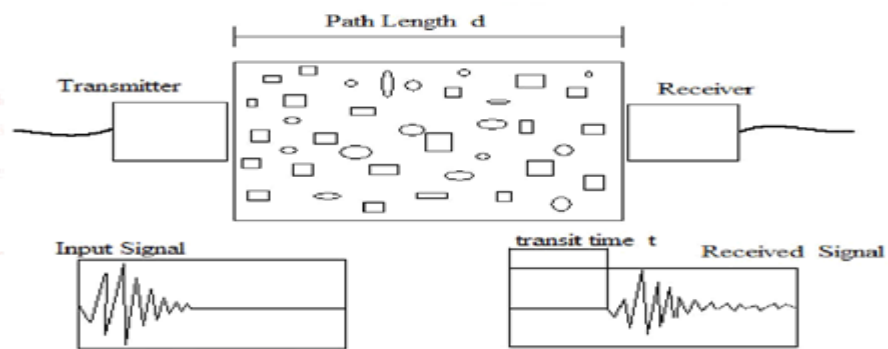
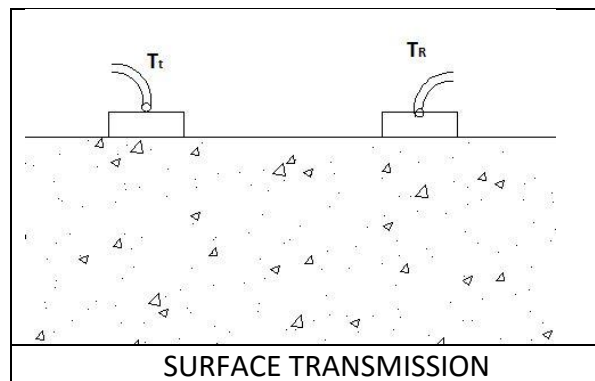
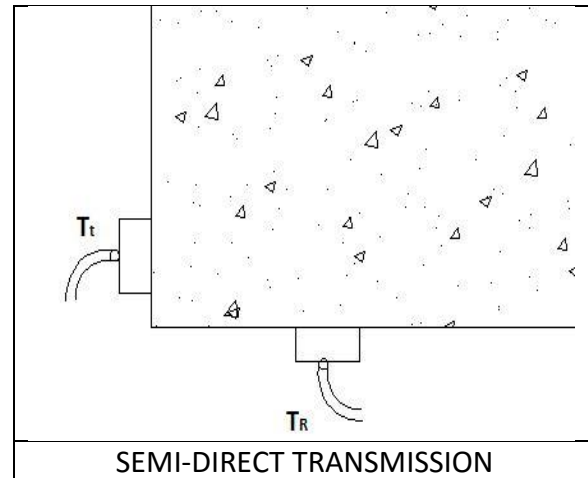
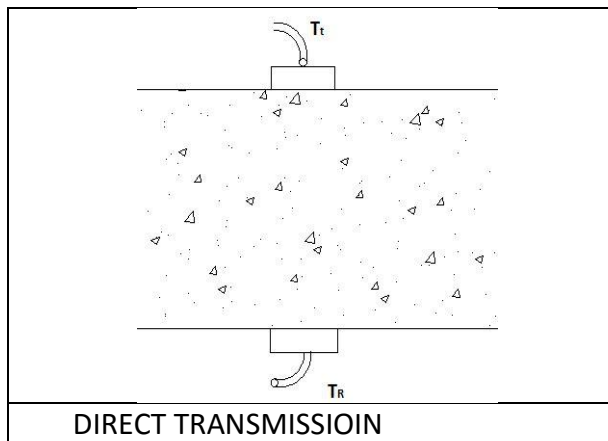
- The ultrasonic pulse velocity method has gained considerable popularity, when mechanical impulse are applied in a solid mass, three different type are generated, these are generally known as longitudinal waves, shear waves and surface waves. These three waves travel at different speeds. The longitudinal and compressional travel about twice as fast as the other two waves. The shear and transverse waves are not so fast. The surface waves are the slowest.

Procedure:

- Remove the wet cured test specimen from wet storage and keep it in the laboratory atmosphere for about 24 hours before testing. Since presence of moisture content of concrete increases pulse velocity the specimen shall be tested under dry condition.
- In order to ensure proper acoustical contact, the surface of the specimen shall be smoothened by removing loose adhered scales and also use coupling medium such as petroleum jelly, grease, liquid soap and kaolin glycerol paste on the surface of specimen.
- Switch on the testing instrument which contains electrical pulse generator, transducer, amplifier and electronic timing device. Then set the mode and feed the measured path length. Now the instrument is ready.
- Place the transducer on one place of the cube and place the receiver on the other side such that both transducer and receiver are in one line (i.e. exactly opposite). This is called as cross probing or direct transmission.
- Now press the start button in the instrument, after few seconds the velocity of the pulse and time taken is displayed in the electronic display.
- Repeat the procedure for three to more trial, to have reliable quality, at different place of the concrete cube surface.
- Now calculate pulse velocity $v = L/T$ ($T = s$) and compare with velocity criterion for concrete quality grading specified in Table 2 of IS 13311 (part 1): 1992 and grade the concrete as excellent, good, medium, doubtful.

- In case of “doubtful” quality it may be necessary to carry out further tests.

METHODS OF MEASURING PULSE VELOCITY IN CONCRETE



Pulse Velocity (km/second)	Concrete Quality (Grading)
Above 4.5	Excellent
3.5 to 4.5	Good
3.0 to 3.5	Medium
Below 3.0	Doubtful

Result:

The Quality of given in-situ concrete cube is :

ExNo: 7

DETERMINATION OF IMPACT RESISTANCE OF CONCRETE

AIM:

To measure surface of the hardness concrete

APPARATUS RERUIRED :

Schmidt'shammertest (Rebound Hammer)

THEORY :

Impact strength: resistance to sudden shock or load.

Impact strength is of importance in driving concrete piles, in foundations for machines exerting impulsive loading, and also when accidental impact is possible, e.g. when handling precast concrete members.

PROCEDURE:

1. Press the plunger against the force of the spring.
2. Push the button the rider will held in positions and note down the reading.
4. The compressive strength of the concrete can be interpolated from the chart.
5. This shows the relationship between compressive strength and rebound number.

Result:

- The compressive strength of the given cube specimen = N/mm^2
- The Rebound Number (R) =

AIM

To Determine the permeability of cement mortar or concrete is of particular significance in structures which are intended to retain water or which come into contact with water. The test permits measurement of the water entering the specimen as well as that leaving it.

Apparatus Required

Concrete Permeability Apparatus

Theory

The permeability cell shall consist of a metal cylinder with a ledge at the bottom for retaining the specimen, a flange at the top, a removable cover plate and a sheet metal funnel which can be securely bolted to the cell. A rubber or neoprene O-ring or other suitable gasket, seated in matching grooves, shall be used between the cell and the cover plate to render the joint water-tight.

PROCEDURE**PREPARATION OF TEST SPECIMEN**

1. Specimens shall be cylindrical in shape with height equal to the diameter. The standard size of specimen shall have diameter (and height) of 150 mm. In the case of specimens containing aggregates whose nominal size does not exceed 20 mm, the diameter (and the height) of the specimen may be reduced to 100 mm. In the case of specimens containing aggregates whose nominal size exceeds 40 mm, the diameter (and the height) of the specimen should not be less than about four times the nominal size of the aggregate.
2. The mortar or concrete mix shall be cast in split moulds of the required size, with a removable collar of about half the height set on the top. The material shall be compacted either by hand rodding or vibration, as proposed to be done during construction. The collar shall then be removed and the mould shall be struck off level with a straight-edge using a sawing motion without further travelling or finishing, which might raise the fines to the surface. The specimen shall be cured for 28 days unless otherwise specified by the engineer-in-charge.

PRESSURE HEAD

1. The standard test pressure head to be applied to the water in the reservoir should be 10 kg/cm². This may, however, be reduced up to 5 kg/cm² in the case of relatively more permeable specimens where steady state of flow is obtained in a reasonable time, and may be increased up to 15 kg/cm² for relatively less permeable specimens and where sealing could be ensured to be fully effective.
2. With the reservoir drain-cock and the shut-off valve between the reservoir and the cell closed, and with the air bleeder valve open, the reservoir shall be filled with water. The reservoir drain-cock shall then be opened to flush out any air and closed again. The reservoir shall be refilled to a point above the zero mark of the gauge-glass scale; the bleeder valve shall be closed and the desired air pressure applied. The drain-cock shall be carefully opened to bring the water to the zero mark and quickly closed. Water shall then be drawn off and caught in 250 ml increments in a graduated jar and the level in the gauge-glass read on the scale. The calibration constant for the reservoir shall be expressed in millilitres per division of the scale.

Sealing of Test Specimen

1. The specimen shall be surface-dried and the dimensions measured to the nearest 0.5 mm. It shall then be centred in the cell, with the lower end resting on the ledge. The annular space between the specimen and the cell shall be tightly caulked to a depth of about 10 mm using a cotton or hemp cord soaked in a suitable molten sealing compound. The rest of the space shall be carefully filled with the molten sealing compound, level with the top of the specimen. Any drop in the level due to cooling shall be made up, using a heated rod to remelt the solidified compound before pouring fresh material over it. A mixture of bees-wax and rosin, applied smoking hot, forms an effective seal. The proper proportions are best chosen by trial. Other suitable materials are stearine pitch, marine glue, and various asphaltic compounds.

Testing the Seal

1. It is essential that the seal is watertight. This may be checked very conveniently by bolting on the top cover plate, inverting the cell and applying an air pressure of 1 to 2 kg/cm² from below. A little water poured on the exposed face of the specimen is used to detect any leaks through the seal, which would show up as bubbles along the ledge. In case of leaks the specimen shall be taken out and resealed.

ASSEMBLING THE APPARATUS

1. After a satisfactory seal has been obtained, the funnel shall be secured in position and the cell assembly connected to the water reservoir. With the air bleeder valve, the valve between the reservoir and the cell, and the drain-cock in the cell open, de-aired water shall be allowed to enter the reservoir. When water issues freely through the drain-cock, it shall be closed and the water reservoir filled. The reservoir water inlet and air bleeder valves shall then be closed.

RUNNING THE TEST

1. With the system completely filled with water, the desired test pressure shall be applied to the water reservoir and the initial reading of the gauge-glass recorded. At the same time a clean collection bottle shall be weighed and placed in position to collect the water percolating through the specimen.

The quantity of percolate and the gauge-glass readings shall be recorded at periodic intervals. In the beginning, the rate of water intake is larger than the rate of outflow. As the steady state of flow is approached, the two rates tend to become equal and the outflow reaches a maximum and stabilizes. With further passage of time, both the inflow and outflow generally register a gradual drop.

Permeability test shall be continued for about 100 hours after the steady state of flow has been reached and the outflow shall be considered as average of all the outflows measured during this period of 100 hours.

2. Test shall preferably be carried out at a temperature of 27°C +/- 2°C. In case arrangements are not available for maintaining the above temperature, a record shall be maintained of the actual temperature. An approximate correction may be made on the basis that each 5°C increase of temperature above the standard temperature, results in 10 percent increase in the coefficient of permeability and vice versa.

The Coefficient of Permeability shall be calculated as follows:

CALCULATION

$$K = Q / (A * T * H / L)$$

where,

K= Coefficient of permeability (cm/sec),

Q = quantity of water in millimeters percolating over the entire period of test after the steady state has been reached,

A = area of the specimen face in cm^2 , T = time in seconds over which Q is measured, and

H/L = ratio of the pressure head to thickness of specimen, both expressed in the same units.

6. Precautions

1. The seal around the specimen shall be effective. Leakage through it can give rise to entirely misleading results. Obtaining a good seal is a matter of experience and only a general guidance can be provided.
2. It is important that the air content of the water entering the specimen should not exceed about 0.2 percent. Excessive amounts of dissolved air can result in air locks in the specimen and apparent reduction in permeability. Periodical samples shall be drawn from the cell drain-cock and the dissolved air determined. The system shall be drained and replenished with fresh de-aired water, as soon as the air content exceeds the above limit.
3. The flow should be permitted to attain the steady state before the coefficient of permeability is calculated. Examination of the inflow and outflow rate data or suitable graphs of the same may be used to determine the establishment of the steady state.
4. The observation of outflow from the specimen is liable to be influenced by evaporation of the percolate during collection. The collection bottle may be housed in a humid chamber, or alternatively, blank observations on a similar bottle containing water should be made and the necessary correction for evaporation loss applied. The inflow measurement provides an additional check.
5. It is very important that the specimen surface is carefully prepared by sand blasting or chiseling, as even a thin highly -impervious skin can result in considerable underestimation of the permeability.

RESULT :

Thus the permeability of concrete of concrete is determined

EXNO: 9

MEASUREMENT OF CRACK

Aim:

The demountable mechanical strain gauge (DEMEC) was developed at the Cement and Concrete Association to enable strain measurements to be made at different parts of a structure using a single instrument.

Apparatus required:

DEMEC Gauge with Test Setup

Materials required:

Beam or Column Specimen

Theory:

The DEMEC consists of a standard or a digital dial gauge attached to an Invar bar. A fixed conical point is mounted at one end of the bar, and a moving conical point is mounted on a knife edge pivot at the opposite end. The pivoting movement of this second conical point is measured by the dial gauge.

Procedure:

1. Care is required in fixing the discs to the surface. The surface should first be emery-papered or, if necessary, ground to remove irregularities, so that the surfaces of the two discs are as nearly as possible in the same plane
2. A number of fairly obvious points are to be taken into consideration.
3. The Invar bar should be supported so that application of the instrument does not cause bending, and if the Invar is contained in, say, a wooden housing, this should not apply any restraint resulting in straining of the Invar due to movement of the wood.
4. The 'Demec' mechanical strain gauge has one fixed location point and one moveable measuring point at the gauge length.
5. Changes in this gauge length are transmitted through a pivot to the measuring dial gauge. The pivot lever has a nominal ratio of 1:2, i.e. 0.5:1
6. Therefore, 0.5 mm real movement at the gauge length will read 1.0 mm on the dial gauge.

7. Is the increase in length from the original gauge length and is measured in mm.
(Extension).
8. Is extension expressed in relation to the original gauge length. **(Strain)**

$$\text{strain} = \frac{\text{extension}}{\text{gauge length}}$$



DEMEC Mechanical Strain Gauge

Demountable Mechanical Strain Gauge developed at the BCCA - British Cement and Concrete Association

Results

Thus the Measurement of crack in concrete is determined by Demec gauge.

TOPIC BEYOND SYLLABUS
STUDY OF MECHANICAL STRAIN GAUGE

AIM:

To study the function and types of strain gauges.

INTRODUCTION:

Mechanical strain gauges are also called as extensometer. It is used in gradually varying load conditions. These gauges are usually provided with two knife edges, which are camped firmly in contact with the test component by means of a clamping spring at a specific distance of gauge length. When the specimen under testing is strained, the knife edge undergoes displacement. The displacement is amplified by a mechanical linkages and strain is displaced on a calibrated scale.

TYPES OF STRAIN GAUGES:

Berry strain gauges:

These strain gauges uses a level magnification with dial indicator to show magnified motion. It consists of one pointer rigid frame and two conically pointed contact pointers. One pointer is rigidly fixed to the plane while the other is pivoted at a point in the frame. The displacement in the lever is magnified and indicated in the dial indicator.

Huggenbeger extensometer:

This extensometer has a set of component levers which are relatively small in size and has high magnification factor. These gauges are highly accurate. The movable knife edge rotates the lever at lower pivot, the lever in turn rotates the indicator pointer at the upper pivot point with the help of a link.

Johanson extensometer:

This extensometer uses tension tape on twisted metal strip between two knife edges. Half of this strip between two knife edge is twisted to other direction and a pointer is fixed at a centre of the strip. On the application of load , displacement is this movable knife edge takes place with high amplification due to stiching of twisted metal strip.

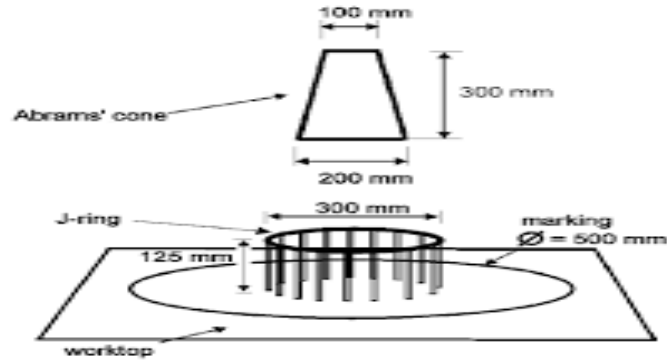
RESULT:

Function of mechanical strain gauges and their types are studied.

J RING TEST

Aim

To determine the passing ability of Self Compacting Concrete



J ring set up

Apparatus

- Mould,
- Base plate
- Trowel
- Scoop
- Ruler

Procedure

- About 6 litre of concrete is needed to perform the test, sampled normally.
- Moisten the base plate and Place the JRing centrally on the base-plate and the and the slump-cone centrally inside it and hold down firmly.
- Fill the cone with the scoop. Do not tamp, simply strike off the concrete level with the top of the cone with the trowel. Remove any surplus concrete from around the base of the cone.
- Raise the cone vertically and allow the concrete to flow out freely.
- Measure the final diameter of the concrete in two perpendicular directions.
- Calculate the average of the two measured diameters. (in mm).
- Measure the difference in height between the concrete just inside the bars and that just outside the bars.
- Calculate the average of the difference in height at four locations (in mm).

Result

The passing ability of the given sample is found to be mm.

VIVA VOCE QUESTION

1. Define: Hydraulic jack, Load Cell, Strain Gauge and their types?
2. Difference between Ductility and Stiffness.
3. What is meant by Energy Dissipation?
4. Difference between flexural and split tensile strength.
5. How do you understand the vertical and horizontal deflection?
6. How to choose an effective Steel sections?
7. What is minimum number of reinforcement are provide in circular column?
8. What are the minimum percentage of steel?
9. What is meant by crippling load?
10. What are the purpose of reinforcement providing in compression members?
11. What is meant by critical zone in column?
12. What are the reason of surface crack?
13. Difference between destructive and non-destructive methods.
14. Difference between strength and quality.
15. What are the uses of rebound and USPV methods.
16. Define: Rebound Number.
17. How to protect the surface crack?
18. What is meaning of Consistency in concrete?
19. What is slump of concrete?
20. What is the significance of shear slump?
21. What is segregation?
22. What is Bleeding
23. What is admixture? And Their types? And Their uses?
24. What is Workability? And Low workability?
25. What are the limitation of slump?
26. What are the limitation of slump?
27. What is the difference between fully compacted and partially compacted concrete?
28. What is the significance of compacted concrete?
29. How does strength correlate with other properties of hardened concrete?
30. What are the requirements for curing the specimens?
31. What is the rate of loading in flexure test?
32. What is the principle of Compression test?
33. What is the principle of Flexural test?
34. Differentiate between ultimate stress and breaking stress.
35. What is the principle of Split tensile test?
36. What is free body diagram.