MUZAFFARPUR INSTITUTE OF TECHNOLOGY

Muzaffarpur, Bihar-842003

LAB MANUAL

Branch: Civil Engineering

Year & Semester: 3rd Year/ 6th Sem

DESIGN OF CONCRETE STRUCTURE-I LABORATORY

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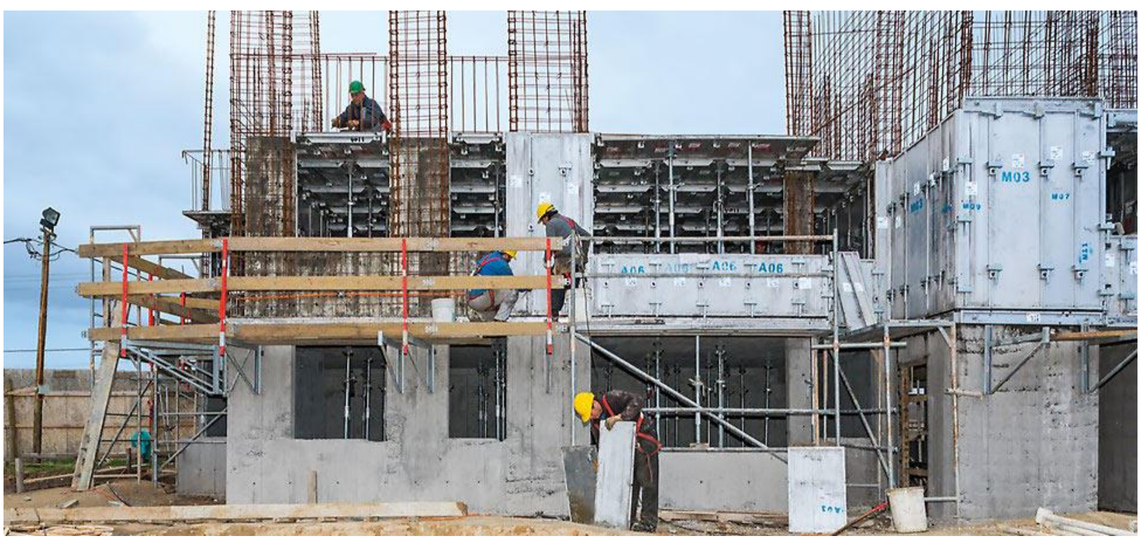

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Introduction:

The concrete structural laboratory is an opportunity for civil engineering students to investigate behavior of concrete in a controlled experimental setting, and to acquire hands-on knowledge of practical testing. Planning and facilitation of concrete structural laboratories is a challenging search for learning about concrete behavior, and optimizing both student and faculty time in the learning process.

The balancing act also includes consideration of:

- Emphasis on learning by students, who will not work in the sites versus learning of concepts that will be the foundation of future construction work.
- Use of sophisticated modern automated equipment versus the manual devices still commonly used in many commercial laboratories,
- Benefits of test simulation software versus real testing, and
- Integrating laboratory work into the course learning versus allowing students to direct the learning independently.

Safety Guidelines

- Seek approval authorization from the lab In-Charge prior to entering the lab working area.
- Safety shoes must be worn at all times at the workshop and helmets must be put on during test.
- Students are not allowed to do any load test on test frame, without supervision by the project supervisor.
- Loading setup must be checked and approved by the project supervisor prior to the commencement of the test.
- Do not try to run and operate any machine without permission and knowledge of the lab Personnel.
- Eye protection should be worn when performing tasks with potential to generate flying particles or debris. Most power tool related tasks generate such hazards.
- Students are not allowed to work in the laboratory after office hours without the approval from the department.
- Get First Aid immediately for any injury, no matter how small it is.
- Do not play with valves, screws and nuts.
- Make sure that you know the location of Fire Extinguishers, First Aid Kit and Emergency Exits before you start your experiments.

List of Experiments

Tests on Aggregates

1. Fineness Modulus of fine aggregates
2. Fineness Modulus of coarse aggregates
3. Specific gravity and water absorption of coarse and fine aggregate

Tests on Concrete

1. Slump value using slump cone
2. Slump value using compaction factor test
3. Compressive strength of cubes

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EXPERIMENT NUMBER – 1

TESTING OF AGGREGATES FOR CONCRETE

OBJECTIVE: To study the particle size distribution of coarse and fine aggregate and determine its fineness modulus.

APPARATUS REQUIRED: IS sieves, weighing balance, sieve shaker, trays.

THEORETICAL BACKGROUND:

Aggregates are broadly classified as coarse and fine aggregates based on their particle sizes. As per Indian standards, particles retaining on 4.75mm sieves are considered coarse, and finer particles are classified as fine aggregates. Sieve sizes recommended by Indian standards are the following:

1. Coarse aggregate: Square hole, perforated plate type

80, 63, 50, 40, 31.5, 25, 16, 12.5, 10, 6.3, 4.75mm

2. Fine aggregate: Finemesh, wire cloth type

3.35, 2.36, 1.18mm, 600, 300, 150, 75micron

The need to determine the aggregate size properties arise from the fact that the concrete mix should have least voids for higher strength and durability. Additionally, the concrete mix should have good workability requiring least work for mixing and compacting, meanwhile not segregating during transportation or placing. With the particle size distribution known, it can be compared to the values recommended by Indian standards and the suitability of aggregates for use can be determined.

Sands (fine aggregates) are generally obtained from river, land quarrying or crushing larger aggregates. Such variation in source leads to variation in particle size distribution. IS 2386 has, therefore, divided fine aggregates into 4 zones. The zone of sand can be determined and necessary steps during design mixing can be taken up.

The size distribution is indicated by the Fineness Modulus of the given aggregate. It is calculated by finding the sum of cumulative percentages of aggregate retained on each sieve and dividing the sum by 100.

PROCEDURE:

As per IS: 2368 (Part-1) – 1963

(a) For Coarse Aggregate

- Take 5kg of coarse aggregate sample.
- Arrange the sieves in decreasing order of size from the top. Place the pan below the smallest sieve.
- Place the sample on the top sieve and close it. Shake the sieves for 20-30 minutes in a sieve shaker.
- Weigh the amount of material retained in each sieve, including the pan.

(b) For Fine Aggregate

- Take 2kg of sample and repeat the steps as performed for coarse aggregate, but with the recommended sieves for fine aggregates. Note the weight of material in each sieve and find the cumulative percent retained. From the cumulative percent retained, calculate the fineness modulus for coarse and fine aggregates.

OBSERVATION TABLE:

(a) Fine aggregates

S.no.	Sieve Size	Wt. retained (kg)	Wt. retained (%)	Cum. wt. retained (%)	Wt. passing (%)
1	4.75mm				
2	2.36mm				
3	1.18mm				
4	600µ				
5	300µ				
6	150µ				
7	PAN				
			SUM (∑W)		

(b) Coarse aggregates (20mm)

S.no.	Sieve Size (mm)	Wt. retained (kg)	Wt. retained (%)	Cum. wt. retained (%)	Wt. passing (%)
1	20				
2	12				
3	10				
4	4.75				
5	2.36				
6	1.18				
7	600µ				
8	300µ				
9	150µ				
10	PAN				
			SUM (∑W)		

(c) Coarse aggregates (10mm)

S.no.	Sieve Size (mm)	Wt. retained (kg)	Wt. retained (%)	Cum. wt. retained (%)	Wt. passing (%)
1	12				
2	10				
3	4.75				
4	2.36				
9	PAN				
			SUM (∑W)		

WORKING FORMULA:

Fineness modulus (both for CA and FA) = $(\sum W)/100$

RESULTS:

INFERENCE:

EXPERIMENT NUMBER – 2

TESTING OF AGGREGATES FOR CONCRETE

OBJECTIVE: Determination of specific gravity and water absorption of coarse and fine aggregate

APPARATUS: Thermostatically controlled oven, Wire bucket (6.3mm mesh), Dry soft cloths, Air tight container, weighing balance, trays, Pycnometer.

THEORETICAL BACKGROUND:

Specific gravity is the ratio of the mass to the volume of the aggregate. The volume is calculated commonly by water, by finding the volume of water displaced by the aggregate. The volume however, thus calculated is susceptible to errors arising due to the pores inaccessible to water in the aggregates, due to which the volume appears more and the apparent specific gravity is less. It is therefore, why the specific gravity value keeps increasing with the crushing of the aggregates, as the earlier inaccessible pores become accessible to water and the volume appears less.

Water absorption of aggregate indicates the amount of accessible pores present. This is required to determine the saturated surface dry (SSD) weight of aggregate while design mixing of concrete. It is to be noted that if the aggregate used in concrete is not SSD, the water intended for hydration of cement may be absorbed by aggregate and result in lesser strength as well as more porosity in concrete. The water absorption is being calculated at ambient temperature since, concrete is generally prepared in this same condition.

PROCEDURE:

As per IS: 2386 (Part-III) – 1968

(a) Specific gravity measurement of coarse aggregates (CA):

- About 2 Kg of the aggregate sample is washed thoroughly and placed in the wire basket when immersed in distilled water. The basket and the sample are then weighed (W1) while suspended in water at a temp of 22C to 32C.
- The basket and aggregates are removed from water and allowed to drain for a few minutes, after which the aggregates are transferred to the dry absorbent clothes.

The empty basket is then returned to the tank of water jolted 25 times and weighed in water (W2).

- The aggregates placed on the absorbent clothes are surface dried till no further moisture could be removed by this cloth. Then the aggregates are transferred to the second dry cloth spread in single layer and allowed to dry for at least 10 minutes until the aggregates are completely surface dry. The surface dried aggregate is then weighed (W3).
- The aggregate is placed in a shallow tray and kept in an oven maintained at a temperature of 110° C for 24 hrs. It is then removed from the oven, cooled in an air tight container and weighted (W4).

(b) Specific gravity measurement of fine aggregate (FA):

Pycnometer method

- A sample of about 1 kg for 10 mm to 4.75 mm or 500 g if finer than 4.75 mm, shall be placed in the tray and covered with distilled water at a temperature of 22 to 32°C.
- Soon after immersion, air entrapped in or bubbles on the surface of the aggregate shall be removed by gentle agitation with a rod. The sample shall remain immersed for 24 +/- 0.5 hours.
- The water shall then be carefully drained from the sample, by decantation through a filter paper, any material retained being return to the sample. The saturated and surface-dry sample shall be weighed (weight A).
- The aggregate shall then be placed in the pycnometer which shall be filled with distilled water. Any trapped air shall be eliminated by rotating the pycnometer on its side, the hole in the apex of the cone being covered with a finger. The pycnometer shall be topped up with distilled water to remove any froth from the surface and so thatthe surface of the water in the hole is flat. The pycnometer shall be dried on the outside and weighed (weight B).
- The contents of the pycnometer shall be emptied into the tray, care being taken to ensure that all the aggregate is transferred. The pycnometer shall be refilled with distilled water to the same level as before, dried on the outside and weighed (weight C)
- The water shall then be carefully drained from the sample by decantation through a filter paper and any material retained returned to the sample.

- The sample shall be placed in the oven in the tray at a temperature of 100 to 110°C for 24 +/- 0.5 hours, during which period it shall be stirred occasionally to facilitate drying. It shall be cooled in the air-tight container and weighed (weight D)

OBSERVATIONS:

For Coarse Aggregates

Weight of saturated aggregate suspended in water with basket = **W1 g**

Weight of basket suspended in water = W2 g

Weight of saturated surface dry aggregate in air = W3g

Weight of oven dry aggregate = W4 g

Weight of saturated aggregate in water = (W1 – W2) g

Weight of water equal to the volume of the aggregate = W3 – (W1–W2)g

For Fine Aggregate

Weight in g of saturated surface-dry sample = A
Weight in g of pycnometer or gas jar containing sample and filled with distilled water = B
Weight in g of pycnometer or gas jar filled with distilled water only = C
Weight in g of oven-dried sample = D

CALCULATIONS:

For Coarse Aggregates

Specific gravity = W3 / (W3– (W1–W2))

Apparent specific gravity = W4/ (W4– (W1–W2))

Water Absorption = ((W3 – W4) / W4) X 100

For Fine Aggregate

Specific gravity and apparent specific gravity shall be calculated as follows:
Specific gravity = D / [A - (B-C)]
Apparent specific gravity = D / [D - (B-C)]

RESULTS:

INFERENCE:

EXPERIMENT NUMBER - 3

DETERMINATION OF SLUMP VALUE USING SLUMP CONE

OBJECTIVE: determination of workability of concrete using slump cone test

APPARATUS REQUIRED: Iron Pan to mix concrete, weighing machine, trowel, slump cone scale and tamping rod.

THEORETICAL BACKGROUND:

Unsupported concrete, when it is fresh, will flow to the sides and a sinking in height will take place. This vertical settlement is called slump. Slump is a measure indicating the workability of cement concrete and also slump gives an idea of W/C ratio needed for concrete to be used for different works. Slump increases with W/C ratio. A concrete is said to be workable if it can be easily mixed and easily placed compacted and easily finished.

This method of test specifies the procedure to be adopted, either in the laboratory or during the progress of work in the field, for determining, by the slump test, the consistency of concrete where the nominal maximum size of the aggregate does not exceed 38 mm.

PROCEDURE:

As per IS : 1199 – 1959

- Multiple concrete mixes is prepared in the ratio 1:1.5:3, and the water cement ratio is taken as 0.45, 0.50, 0.55.
- The internal surface of the mould is to be thoroughly cleaned and is placed on a smooth, horizontal, rigid and non-absorbent surface.
- Place the mixed concrete in the cleaned slump cone in 3 layers each approximately 1/3 in height of the mould. Tamp each layer 25 times with tamping rod.
- Remove the cone immediately, rising it slowly and carefully in the vertical direction.
- As soon as the concrete settlement comes to a stop, measure the subsidence of the concrete in mm, which gives the slump.

OBSERVATIONS

Sl No.	W/C ratio	Slump	Type of slump

RESULTS:

SPECIFICATIONS:

As per IS: 456 -2000

Degree of workability	Slump
Very low	0mm to 25mm
Low	25mm to 50mm
Medium	50 mm to 100 mm.
High	100 mm to 175 mm

INFERENCE:

EXPERIMENT NUMBER - 4

DETERMINATION OF SLUMP VALUE USING COMPACTION FACTOR TEST

OBJECTIVE: To determine the workability of concrete using compaction factor test

APPARATUS: Compacting factor apparatus, Balance, Weights, Trays, Tamping rod and Trowels.

THEORETICAL BACKGROUND:

Compacting factor apparatus consists of two conical hoppers mounted above a cylindrical mould and fixed to a stand one above the other. The hoppers are provided with trap doors at the bottom. The dimensions of various parts are given below.

Upper Hopper	**Dimensions in cm.**
Top internal dia	25.4
Bottom	12.7
Internal height	27.9

Lower Hopper	**Dimension in cm.**
Top internal dia	22.9
Bottom	12.7
Internal height	22.9

Cylinder	**Dimension in cm.**
Internal Diameter	15.2
Internal Height	30.5

Distance between bottom of upper hopper and top of lower hopper is 20.3 cm.

Distance between bottom of lower hopper and top of cylinder is 20.3 cm.

PROCEDURE

As per IS : 1199 – 1959

Three mixes are prepared with W/C ratio taken as 0.45, 0.5, 0.55. The constituents are in the ratio 1:1.5:3

- Mix the dry constituents to get a uniform color and then add water.
- The internal surfaces of the hoppers and cylinder are thoroughly cleaned.
- The sample of concrete to be tested is placed gently in the upper hopper.
- The hopper is filled level with its brim and the trap door is opened so that the concrete falls into the lower hopper.
- If concrete has a tendency to stick to the sides of the hopper, the concrete should be slowly pushed down by inserting the tamping rod into the concrete.
- Immediately after the concrete comes to door of the lower hopper, it is opened and the concrete is allowed to fall into the cylinder.
- The excess of concrete in the cylinder above the top is cut off and made level with trowels. The outside of cylinder is wiped clean.
- The weight of the concrete in the cylinder is then determined. This weight is known as weight of partially compacted concrete.
- The cylinder is refilled with concrete from the same sample in six layers and each is rammed thoroughly.
- The top of fully compacted concrete should be carefully struck off level with top cylinder. The outside of the cylinder is wiped a clean and the weight of fully compacted concrete is found.

OBSERVATIONS:

Weight of cylinder W1 =

Weight of cylinder + partially compacted W2 =

Weight of Partially compacted concrete (W2-W1) =

Weight of cylinder + fully compacted concreteW3 =

Weight of fully compacted concrete (W3-W1) =

Compaction factor (W2-W1) / (W3-W1). =

Sl No.	W/C ratio	W1	W2	W2-W1	W3	W3-W1	(W2-W1)/(W3-W1)
1	0.45						
2	0.5						
3	0.55						

RESULTS:

The value of Compaction factor

INFERENCE:

EXPERIMENT NUMBER - 5

DETERMINATION OF COMPRESSIVE STRENGTH OF CUBES

OBJECTIVE: To determine the compressive strength of concrete cubes

THEORETICAL BACKGROUND:

Concrete mix design

The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required, strength, durability, and workability as economically as possible, is termed as concrete mix design.Concrete mix design is done in accordance with IS:10262-2009.

Compressive Strength of Concrete

The compressive strength of concrete is the utmost important and useful property of concrete. When an uniaxial load is applied upon a concrete specimen, it not only exhibits compressive strains in the direction of load, it would also exhibit some expansion in lateral directions due to Poisson's effect, as manifested by the introduction of lateral tensile strains.. The measured compressive strength decreases with increase in height/lateral dimension ratio and is approximately equal to the uniaxial compressive strength of concrete for values of this ratio equal to or greater than 2. For standard cylinders this ratio is two and as such concrete cylinder strengths is only about 0.75-0.80 times the cube strength whose height/lateral dimension ratio is one.

Cylinder Strength = 0.8 Cube strength

PROCEDURE: As per IS: 516-1959

- The concrete mix is prepared by mixing the ingredients in the proportion as given below in the table.
- Mix the concrete in a laboratory batch mixer.
- Clean the mounds and apply oil
- Fill the concrete in the moulds in layers approximately 5cm thick
- Level the top surface and smoothen it with a trowel
- The test specimens are stored in moist air for 24hours and after this period the specimens are marked and removed from the molds and kept submerged in clear fresh water until taken out prior to test.

- The specimen from water after specified curing time and wipe out excess water from the surface.
- Place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube cast.
- Align the specimen centrally on the base plate of the machine.
- Rotate the movable portion gently by hand so that it touches the top surface of the specimen.
- Apply the load gradually without shock and continuously till the specimen fails.
- Record the maximum load and note any unusual features in the type of failure.

OBSERVATIONS:

Test Specimen Properties

Description	**Cubes**
Dimensions(in mm)	150 X 150 X 150
Loading Rate	140 kg/cm^2/min.

Mix Design:

	Water	**Cement**	**Sand**	**10mm**	**20mm**
Ratio by weights	**0.45**	**1**	**1.5**	**1.2**	**1.8**
Weights					

Sample Type	Sample No.	Strength (MPa)		Average Comp Str.	
		at 7 days	at 28 days	at 7 days	at 28 days
Mix 1	1				
	2				
	3				

RESULTS:

INFERENCE: