VAISHNO COLLEGE OF ENGINEERING

Affiliated to HPTU, Hamirpur and approved by AICTE

Concrete Technology

Lab Manual

CE-612 (CBCS Syllabus)

Department of Civil Engineering

Vill Thapkour, PO Bhardoya, Tehsil Indora,Distt. Kangra (HP)-176403

Contact: 094183-18394, Web: www.vaishno.edu.in

Vision of Institute

To emerge as an institute of eminence in the fields of engineering, technology and management in serving the industry and the nation by empowering students with a high degree of technical managerial and practical competence.

Mission of Institute

M1 To strengthen the theoretical, practical and ethical dimensions of the learning process by fostering a cultural of research and innovation among faculty members and students.

M2 To encourage long term interaction between academia and industry through the involvement of industry for hands on implementation of the curriculum.

M3 To strengthen and molding students in professional ethical, social and environmental dimensions by encouraging participation in co-curricular extracurricular and CSR activities.

Vision of the Department

To produce engineers having professional and leadership qualities with capacity to take up professional and research assignments in Civil Engineering and allied fields with focus on inter-disciplinary and innovative approach and to compete at the global level.

Mission of the department

1. To impart quality and real time education to contribute to the field of Civil Engineering.

2. To impart soft skills, leadership qualities and professional ethics among the graduates to handle projects independently.

3. To develop graduates to compete at the global level.

Program Educational Objectives (PEOs) of the department

PE01:- To impart quality education and knowledge in contemporary science and technology to meet the challenges in the field of Civil Engineering and to serve the society.

PEO2:- To impart the knowledge of analysis and design using the codes of practice and software packages.

PEO3:-To inculcate the sense of ethics, morality, creativity, leadership, professionalism, self confidence and independent thinking.

PEO4:- To motivate the students to take up higher studies and innovative research projects.

PROGRAM OUTCOMES

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcome (PSOs)

PSO 1: The graduates of this program will be able to meet the needs of public in the design and execution of quality construction work considering principles of mechanics, mathematics and physics to construct sustainable buildings that will ensure safety and durability till the service period.

PSO 2: The graduates will calculate the loads and the stresses acting on the building, analysis for the loads and design sections of structures to sustain the loads using building analysis software packages.

PSO 3: The graduates will be able to work effectively as an individual or in a team having acquired leadership skills and manage projects in multidisciplinary environments.

Lab Syllabus & List of Experiments

Teaching Scheme			Credits	Marks			Duration of End Semester Examination
L	T	P/D	C	Sessional	End Semester Exam	Total	
0	0	2	1	30	20	50	2 hrs

OBJECTIVE:

To expose students to different properties and uses of concrete in different situations. The students will learn the different testing techniques for concrete.

Sr. No.	List of Experiments
1	Effect of w/c ratio on workability (slump cone, compaction factor, V-B test, flow table)
2	Effect of w/c ratio on strength of concrete.
3	Indirect tensile test on concrete.
4	Study of admixtures & their effect on workability and strength of concrete.
5	Modulus of rupture of concrete.
6	Permeability test on concrete.
7	Tests on polymer modified mortar / concrete.
8	Tests on fiber-reinforced concrete.
9	Flexure test on beam (central point load and two point load) (plotting of load deflection curve andfinding value of E)
10	Non-destructive testing of concrete – some applications (hammer, ultrasonic).

Evaluation Scheme

Internal Assessment: 30 marks (pass marks:12)

Distribution of marks for internal assessment:

- Written/presentation/Demonstration: 05
- Viva-voice: 05
- Teacher assessment: Lab Work performance/Report/File Work:15
- Attendance: 05

External Assessment: 20 marks (pass marks: 08)

Total marks 30+20=50, Pass marks = 20

Note: Student has to pass internal & external assessment separately.

GENERAL GUIDELINES AND SAFETY INSTRUCTIONS

1. Sign in the log register as soon as you enter the lab and strictly observe your lab timings.

2. Strictly follow the written and verbal instructions given by the teacher / Lab Instructor. If you do not understand the instructions, the handouts and the procedures, ask the instructor or teacher.

3. Never work alone! You should be accompanied by your laboratory partner and / or the instructors / teaching assistants all the time.

4. It is mandatory to come to lab in uniform and wear your ID cards.

5. Do not wear loose-fitting clothing or jewellery in the lab. Rings and necklaces are usual excellent conductors of electricity.

6. Mobile phones should be switched off in the lab.

7. Keep the labs clean at all times, no food and drinks allowed inside the lab.

8. Intentional misconduct will lead to expulsion from the lab.

9. Do not handle any equipment without reading the safety instructions. Read the handout and procedures in the Lab Manual before starting the experiments.

10. Do your wiring, setup, and a careful circuit checkout before applying power. Do not make circuit changes or perform any wiring when power is on.

11. Avoid contact with energized electrical circuits.

12. Do not insert connectors forcefully into the sockets.

13. Never try to experiment with the power from the wall plug.

S14. Immediately report dangerous or exceptional conditions to the Lab instructor / teacher: Equipment that is not working as expected, wires or connectors are broken, the equipment that smells or “smokes”. If you are not sure what the problem is or what's going on, switch off the Emergency shutdown.

15. Never use damaged instruments, wires or connectors. Hand over these parts to the Lab instructor/Teacher.

16. Be sure of location of fire extinguishers and first aid kits in the laboratory.

17. After completion of Experiment, return the bread board, trainer kits, wires, CRO probes and other components to lab staff. Do not take any item from the lab without permission.

18. Observation book and lab record should be carried to each lab. Readings of current lab experiment are to be entered in Observation book and previous lab experiment should be written in Lab record book. Both the books should be corrected by the faculty in each lab.

20**. Special Precautions during soldering practice**

a. Hold the soldering iron away from your body. Don't point the iron towards you.

b. Don't use a spread solder on the board as it may cause short circuit.

c. Do not overheat the components as excess heat may damage the components/board.

d. In case of burn or injury seek first aid available in the lab or at the college dispensary.

Experiment No: 1

Aim:- Determine compressive strength of concrete by rebound hammer

I Practical Significance

II Minimum Theoretical Background

Non destructive testing is a powerful method for evaluating existing concrete structures with regard to their strength and durability. In certain cases investigation of crack depth, micro cracks and progressive deteriomtion are also studied by this method. Though non destructive testing method relatively simple to perform, the analysis and interpretation of test results are not so easy, therefore special knowledge is required.

Rebound hammer test procedure is used to examine the hardness of concrete particularly when want to carry out repairs of RCC structure. Rebound hammer is an instrument or a device, which is used to assess the relative compressive strength of concrete based on the hardness at or near its exposed surface. The rebound of an elastic mass depends on the hardness of the surface against which its mass strikes. When the plunger of the rebound hammer is pressed against the surface of the concrete, the spring-controlled mass rebounds and the extent of such a rebound depends upon the surface hardness of the concrete. The surface hardness and therefore the rebound is taken to be related to the compressive strength of the concrete. The rebound value is read from a graduated scale and is designated as the rebound number or rebound index. The compressive strength can be read directly from the graph provided on the body of the hammer.

III Practical Set-up

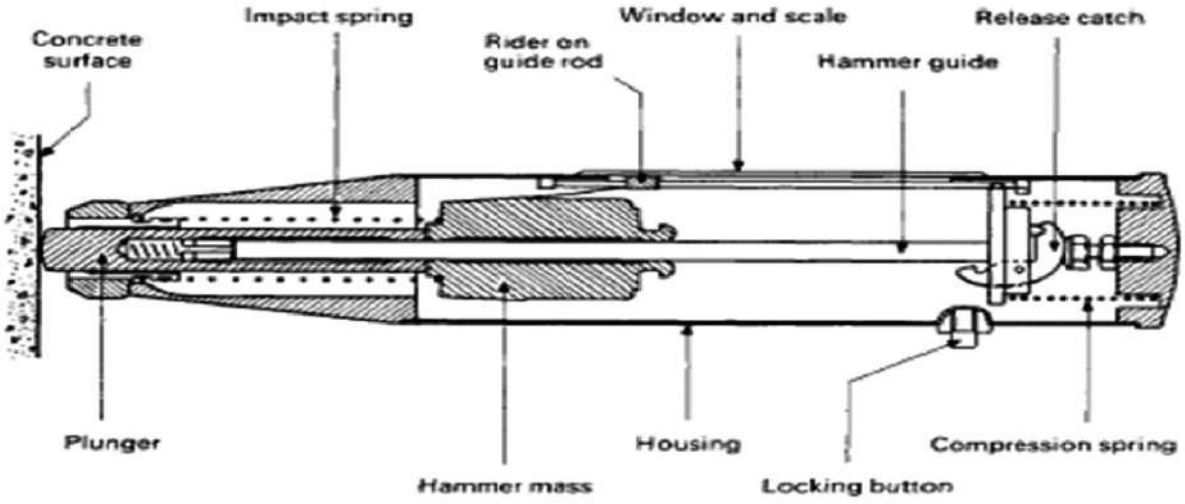


Figure: Rebound Hammer

Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Rebound hammer	As per IS 13311(part 2)-1992	1 No.	

IV Procedure:

1. Test the rebound hammer before commencement of a test to get reliable results, for which the manufacturer of the rebound hammer indicates the range of readings on the anvil suitable for different types of rebound hammer.
2. Apply light pressure on the plunger. It will release it from the locked position and allow it to extend to the ready position for the test.
3. Press the plunger against the surface of the concrete, keeping the instrument perpendicular to the test surface. Apply a gradual increase in pressure until the hammer impacts.
4. Record the rebound hammer number.
5. Take the average of about six readings.

V Precautions to be followed

1. The concrete surface should be smooth, clean and dry.
2. The point of impact of rebound hammer on concrete surface should be at least 20 mm away from the edge or shape discontinuity.

3. The gauging time should be strictly observed.
4. Increase the load gradually during testing.

VI **Actual procedure followed** (Use blank sheet provided if space not sufficient)

VII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

VIII **Observations and Calculations** (Use blank sheet provided if space not sufficient)

Sr. No	Location	Rebound number	Average Rebound no.	Remark
l	Slab			
2				
3				
4				
5				
6				
1	Beam			
2				
3				
4				
5				
6				

IX Results

A) Compressive strength of concrete for Slab= ……

B) Compressive strength of concrete for Beam= ……

X **Interpretation of results** (Give meaning of the above obtained results)

XI **Conclusions and Recommendations (if any)** (Actions/decisions to be taken based on the interpretation ofresults).

XII Practical Related Questions

Note: *Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified* CO. *Write answers of minimum three questions.*

XIII Practical Related Questions

Note: *Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified* CO. *Write answers of minimum three questions.*

1. Explain the need ofNDT.
2. Write limitations of the rebound hammer test.
3. List various types ofNDT with their suitability.
4. State the applications of following approximate impact values for rebound hammer test.
    1. 2.25, ii. 0.75, iii. 30, iv. 0.90

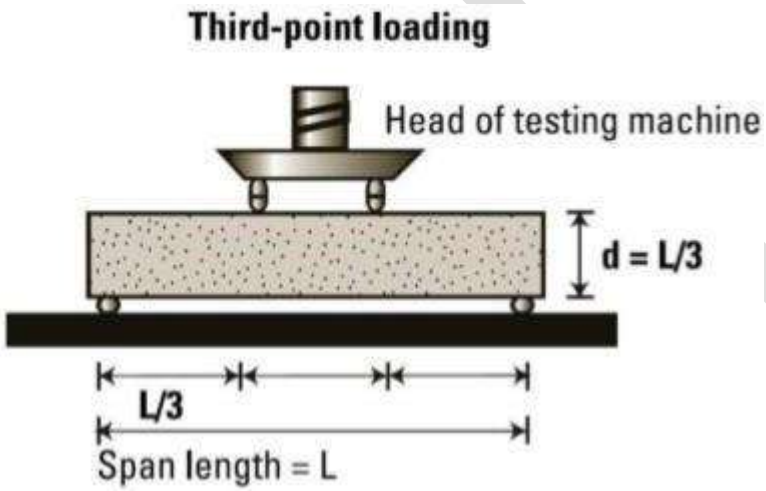
Experiment No: 2

AIM:

To determine the Flexural Strength of Concrete, which comes into play when a road slab with inadequate sub- grade support is subjected to wheel loads and / or there are volume changes due to temperature / shrinking.

APPARATUS:

Beam mould of size 15 x 15x 70 cm, Tamping bar, Flexural test machine.



PROCEDURE:

1. Prepare the test specimen by filling the concrete into the mould in 3 layers of approximately equal thickness.
2. Tamp each layer 35 times using the tamping bar as specified above. Tamping should be distributed uniformly over the entire cross-section of the beam mould and throughout the depth of each layer.
3. Clean the bearing surfaces of the supporting and loading rollers, and remove any loose sand or other material from the surfaces of the specimen where they are to make contact with the rollers.
4. Circular rollers manufactured out of steel having cross section with diameter 38 mm will be used for providing support and loading points to the specimens. The length of the rollers shall be at least 10 mm more than the width of the test specimen. A total of four rollers shall be used, three out of which shall be capable of rotating along their own axes. The distance between the outer rollers (i.e. span) shall be 3d and the distance between the inner rollers shall be d. The inner rollers shall be equally spaced between the outer rollers, such that the entire system is systematic.
5. The specimen stored in water shall be tested immediately on removal from water; whilst they are still wet. The test specimen shall be placed in the machine correctly centred with the longitudinal axis of the specimen at right angles to the rollers. For moulded specimens, the mould filling direction shall be normal

to the direction of loading.

6. The load shall be applied at a rate of loading of 400 kg/min for the 15.0 cm specimens and at a rate of 180 kg/min for the 10.0 cm specimens.

CALCULATION:

The Flexural Strength or modulus of rupture (fb) is given by

$$f_b = pl/bd^2$$

(when a > 20.0cm for 15.0cm specimen or > 13.0cm for 10cm specimen)

or

$$f_b = 3pa/bd^2$$

(when a < 20.0cm but > 17.0 for 15.0cm specimen or < 13.3 cm but > 11.0cm for 10.0cm specimen.)

Where,

a = the distance between the line of fracture and the nearer support, measured on the center line of the tensile side of the specimen

b = width of specimen (cm) d = failure point depth (cm) l = supported length (cm)

p = max. Load (kg)

RESULT:

The Flexural strength of the concrete is reported _____.

VIVA:

1. What is flexural strength?
2. What is equivalent flexural load?
3. What is equivalent flexural strength?
4. What is equivalent flexural strength ratio?
5. Callipers, capable of reading the dimensions of test specimens to an accuracy of _____.
6. Rule (ruler/scale), capable of reading the dimensions of test specimens to an accuracy of _____.
7. Load measuring device shall be capable of measuring loads to an accuracy of _____.
8. The tolerances on the cross-section of the test specimens shall be within ± _____.
9. The flexural strength (or modulus of rupture) is obtained for the first peak load, P_{max} as_____.
10. A data acquisition system capable of digitally recording and storing load and deflection data at least _____.
11. Tensile test can be performed on _____
12. Which machine records the change in length of specimen?
13. How the flexural strength is calculated?
14. What are the precautions to be taken while place the specimen?
15. What are the standard dimensions of the beam mould?
16. Differentiate between three-point loading and two-point loading?

17. Concrete weak in tension and strong in compression (True / False).
18. What is the aim of the experiment?
19. What the load to be applied at 15cms?
20. What is the line of fracture?
21. What is flexural strength?
22. What is equivalent flexural load?
23. What is equivalent flexural strength?
24. What is equivalent flexural strength ratio?
25. Calipers, capable of reading the dimensions of test specimens to an accuracy of_____
26. Rule (ruler/scale), capable of reading the dimensions of test specimens to an accuracy of_____
27. Load measuring device shall be capable of measuring loads to an accuracy of_____
28. The tolerances on the cross-section of the test specimens shall be within ± _____
29. The flexural strength (or modulus of rupture) is obtained for the first peak load, Pmax as:_____
30. A data acquisition system capable of digitally recording and storing load and deflection data at least _____
31. The slump would not exceed 50 mm when compacting concrete with vibrators (TRUE / FALSE).
32. When vibrators are used for compaction, the consistency of concrete depends upon the_____
33. The vibrator should not be immersed through a full depth of freshly laid concrete (TRUE / FALSE).
34. The levelling operation that removes humps and hollows and give a true, uniform concrete surface is called_____
35. The final operation of finishing the concrete surface is called_____
36. The process of removing the irregularities from the surface of concrete left after screeding is called floating.
37. The process of hardening the concrete mixes by keeping its surface moist for a certain period is called _____
38. After the curing of 28 days, the concrete gains strength upto_____
39. The construction joints in cement concrete_____
40. For compacting large sections of mass concrete in structures, the type of vibrator used is _____.
41. In Charpy test specimen, the angle of v-notch section is _____.
42. For hardness test of copper in Brinell hardness tester, the diameter of ball is _____
43. During compression test of cast iron, the failure occurs i.e. the crack appears along the _____
44. The property of a material that resists penetration or indentation by means of abrasion or scratching is known as _____
45. The indenter used in Brinell hardness test is a _____
46. The ability of the material to resist stress without failure is called _____
47. "The shape of specimen used in compression test is Cube and cylinder" _____.
48. Equipment used to test Compression Strength of Concrete?
49. Size of Concrete Cubes?
50. No. of Cube samples required for testing Compression Strength for 100 m3 of concrete?

51. The process of hardening the concrete mixes by keeping its surface moist for a certain period is called _____
52. After the curing of 28 days, the concrete gains strength upto_____
53. The construction joints in cement concrete_____
54. For compacting large sections of mass concrete in structures, the type of vibrator used is _____.
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60. The ability of the material to resist stress without failure is called _____
61. "The shape of specimen used in compression test is Cube and cylinder" _____.
62. Equipment used to test Compression Strength of Concrete?
63. Size of Concrete Cubes?
64. No. of Cube samples required for testing Compression Strength for 100 m3 of concrete?

Experiment No: 3

Aim:

To investigate the effect of different admixtures on the workability and strength of concrete.

Materials:

- Cement (OPC)
- Fine aggregate (sand)
- Coarse aggregate (crushed stone)
- Water
- **Admixtures:**
  - Retarding admixture (e.g., sulfonated melamine formaldehyde)
  - Superplasticizing admixture (e.g., polycarboxylate)
  - Air-entraining admixture (e.g., vinsol)
- Concrete mixer
- Slump cone
- Compression testing machine

Procedure:

1. Preparation of Concrete Mixes: Prepare four different concrete mixes with varying admixture dosages:
   - Mix 1: Control mix (no admixture)
   - Mix 2: Retarding admixture (1% of cement weight)
   - Mix 3: Superplasticizing admixture (0.5% of cement weight)
   - Mix 4: Air-entraining admixture (0.2% of cement weight)
2. Workability Test: Measure the slump of each mix using a slump cone.
3. Strength Test: Cast concrete cubes (150mm x 150mm x 150mm) for each mix and test their compressive strength at 28 days using a compression testing machine.

4. Data Analysis: Record and analyze the data to determine the effect of each admixture on workability and strength.

Results:

| Mix | Admixture | Slump (mm) | Compressive Strength (MPa) |

| --- | --- | --- | --- |

| 1 | Control | 60 | 35.2 |

| 2 | Retarding | 80 | 32.5 |

| 3 | Super plasticizing | 120 | 38.1 |

| 4 | Air-entraining | 90 | 30.8 |

Discussion:

The results show that:

- Retarding admixture increases the slump, but reduces the compressive strength.

- Super plasticizing admixture significantly increases the slump and compressive strength.

- Air-entraining admixture increases the slump, but reduces the compressive strength.

Conclusion:

Admixtures can significantly affect the workability and strength of concrete. The choice of admixture depends on the specific requirements of the project.

Recommendations:

- Use retarding admixture to delay the setting time of concrete.

Use super plasticizing admixture to improve the workability and strength of concrete.

- Use air-entraining admixture to improve the freeze-thaw resistance of concrete.

Limitations:

- The study only investigates the effect of a limited number of admixtures.

- The results may not be applicable to all types of concrete and admixtures.

Experiment No: 4

AIM:

This method covers the determination of the splitting tensile strength of cylindrical concrete specimens.

APPARATUS

Compression testing machine, two packing strips of plywood 30 cm long and 12mm wide.

PROCEDURE:

1. Take the wet specimen from water after 7 days of curing
2. Wipe out water from the surface of specimen
3. Draw diametrical lines on the two ends of the specimen to ensure that they are on the same axial place.
4. Note the weight and dimension of the specimen.
5. Set the compression testing machine for the required range.
6. Keep are plywood strip on the lower plate and place the specimen.
7. Align the specimen so that the lines marked on the ends are vertical and centred over the bottom plate.
8. Place the other plywood strip above the specimen.
9. Bring down the upper plate to touch the plywood strip.
10. Apply the load continuously without shock at a rate of approximately 1421kg/cm2/minute (Which corresponds to a total load of 9900kg/minute to 14850kg/minute).
11. Note down the breaking load(P).

CALCULATIONS:

As per IS456, split tensile strength of concrete. = 0.7fck. The splitting tensile strength is calculated using the formula

Tsp = 2P/ pi DL

Where P = applied load
D = diameter of the specimen L
= length of the specimen

Therefore P = Tsp x pi DL/2
Expected load = P x f.s
Split tensile strength T = 2P/ pi DL.

RESULT:

Splitting tensile strength of given concrete = _____ N/mm².

VIVA:

1. What is the importance of conducting the experiment?
2. What are the precautions to be taken?
3. What is split tensile strength?
4. What are the limitations?
5. What happens if the wet specimen is tested?
6. How the splitting tensile strength is calculated?
7. Differentiate the flexural strength and split tensile strength?
8. What are the standard split tensile strength for the M30 grade of concrete?
9. Differentiate between three-point loading and two-point loading?
10. What are the standard dimensions of the cylinder mould?
11. What is the % of strength when the specimen is testes for 7 days?
12. What is standard deviation?
13. How much load should be applied continuously on the specimen?
14. Load measuring device shall be capable of measuring loads to an accuracy of _____.
15. The flexural strength (or modulus of rupture) is obtained for the first peak load, P_{max} as_____.
16. A data acquisition system capable of digitally recording and storing load and deflection data at least _____.
17. Callipers, capable of reading the dimensions of test specimens to an accuracy of _____.
18. Rule (ruler/scale), capable of reading the dimensions of test specimens to an accuracy of _____.
19. How many strokes to be given for each layer?
20. Why the oil layer is applied to the mould?
21. Generally what is the w/c ratio?
22. The slump would not exceed 50 mm when compacting concrete with vibrators (TRUE / FALSE)
23. The levelling operation that removes humps and hollows and give a true, uniform concrete surface is called_____
24. What is the limitation of plasticizers?
25. What is the allowed reduction of water with super plasticizers without reducing workability?
26. A lower ratio leads to____
27. Silica fume is_____
28. Content of SiO_2 in silica fume?
29. What is the content of Al_2O_3 in fly ash?
30. Find the odd one out.
    a) Water reducing plasticizers
    b) Water reducing plasticizers
    c) High performance plasticizers
    d) Super plasticizers
31. Which machine is preferred for abrasion test?
32. A maximum value of_____percent is allowed for WBM base course in Indian conditions.
33. Aggregates to be used for wearing course, the impact value shouldn't exceed___percent.
34. What is the range of water absorption of aggregates used in road?

35. The loss in weight should not exceed ___ percent when tested with sodium sulphate and __ percent with magnesium sulphate solution.
36. If 60% aggregates doesn't pass through the 2.36mm sieve, then what would be the value of Aggregate impact value?
37. What C31 test under Standard ASTM test method?
38. What C39 test under Standard ASTM test method?
39. What C138 test under Standard ASTM test method?
40. What C143 test under Standard ASTM test method?
41. What C172 test under Standard ASTM test method?
42. What C173 test under Standard ASTM test method?
43. The _____ compressive strength required from structural consideration.
44. The adequate workability necessary for _____ compaction with the compacting equipment available.
45. _____ water-cement ratio content to give adequate durability for the particular site conditions.
46. _____ cement content to avoid shrinkage cracking due to temperature cycle in mass concrete.
47. _____ has designated the concrete mixes into a number of grades as M10, M15.
48. What is the approx. mix proportion for M10?
49. What is the approx. mix proportion for M15?
50. What is the approx. mix proportion for M20?

Experiment No: 5

AIM:

Concrete slump test is to determine the workability or consistency of concrete mix prepared at the laboratory or the construction site during the progress of the work.

APPARATUS:

Mould for slump test, non-porous base plate, measuring scale, temping rod.

INTRODUCTION:

Concrete slump test is carried out from batch to batch to check the uniform quality of concrete during construction. The slump test is the simplest workability test for concrete, involves low cost and provides immediate results. Generally **concrete slump value** is used to find the workability, which indicates water-cement ratio, but there are various factors including properties of materials, mixing methods, dosage, admixtures etc. also affect the concrete slump value.

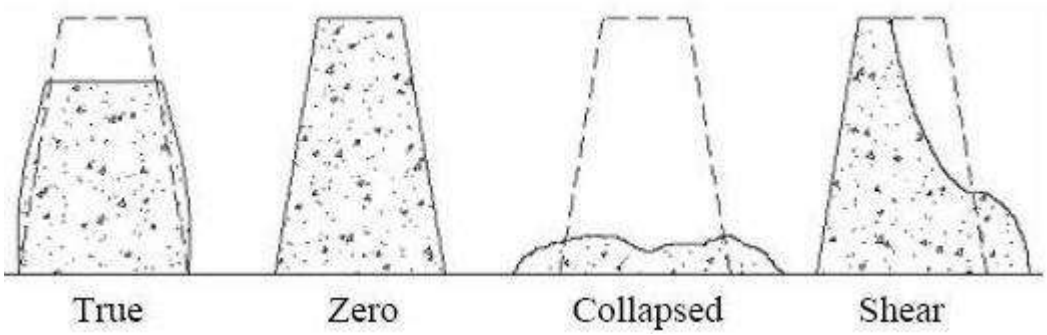
1. Very low workability: slump value 0-25mm or 0-1 inch
2. Low workability: slump value 25-50mm or 1-2 inch
3. Medium workability: slump value 50-100mm or 2-4 inch
4. High workability: slump value 100-175mm or 4-7 inch

True Slump – True slump is the only slump that can be measured in the test. The measurement is taken between the top of the cone and the top of the concrete after the cone has been removed as shown in figure.

Zero Slump – Zero slump is the indication of very low water-cement ratio, which results in dry mixes. These type of concrete is generally used for road construction.

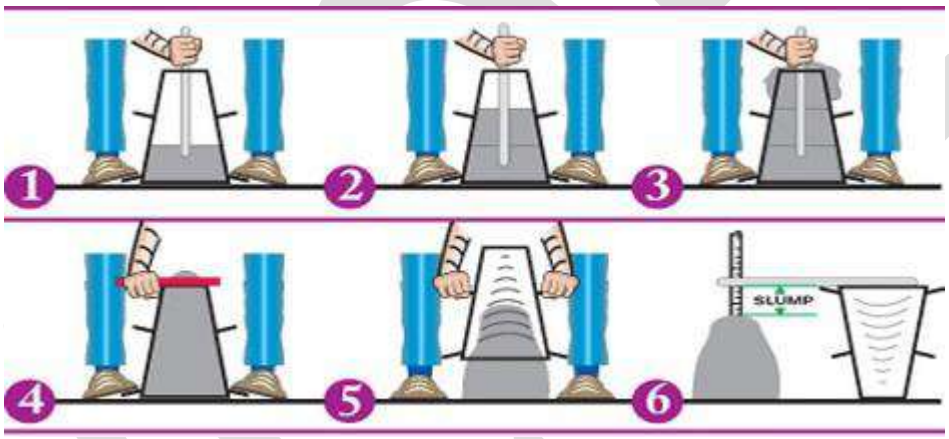
Collapsed Slump – This is an indication that the water-cement ratio is too high, i.e. concrete mix is too wet or it is a high workability mix, for which a slump test is not appropriate.

- **Shear Slump** – The shear slump indicates that the result is incomplete, and concrete to be retested.



PROCEDURE:

1. Clean the internal surface of the mould and apply oil.
2. Place the mould on a smooth horizontal non- porous base plate.
3. Fill the mould with the prepared concrete mix in 4 approximately equal layers.
4. Tamp each layer with 25 strokes of the rounded end of the tamping rod in a uniform manner over the cross section of the mould. For the subsequent layers, the tamping should penetrate into the underlying layer.
5. Remove the excess concrete and level the surface with a trowel.
6. Clean away the mortar or water leaked out between the mould and the base plate.
7. Raise the mould from the concrete immediately and slowly in vertical direction.
8. Measure the slump as the difference between the height of the mould and that of height point of the specimen being tested.



RESULT:

Slump for the given sample = _____mm.

VIVA:

1. A slump of 50-100mm can be used for_____.
2. Concrete is filled in how many layers in slump cone in slump test _____.
3. How many hoppers are there in compaction factor test?
4. What is the standard w/c value for nominal mix of concrete?
5. Slump value required for RCC Slab?
6. What is true slump?
7. Size of Concrete Cubes?
8. What are the dimensions of the slump cone?
9. List out workability tests?
10. How many strokes for each layer?
11. What is the slump value for low workability?
12. Slump value 100 – 175mm indicates _____workability.
13. What is zero slump?
14. What is collapsed slump?
15. What is shear slump?
16. What is segregation of concrete?
17. Workability means?
18. What is the density of concrete?
19. What is the slump value for medium workability?
20. What is the slump value in inch for higher workability?
21. What do you mean by workability?
22. Workability of concrete can be improved by addition
23. List out Workability Tests?
24. Slump value required for RCC Slab?
25. What is Segregation of concrete?
26. What is the standard w/c value for nominal mix of concrete?
27. How many types of tests are there to find workability?
28. These test find workability
29. Workability of concrete is measured by
30. Which test gives good results for rich mixes?
31. Which test used for low workable concretes?
32. Which test Used for high workable concretes?
33. Which test used for fiber reinforced concrete?
34. _____is practical in field test.
35. What is the compaction factor for medium degree of workability?
36. What is the Vee-Bee time for medium degree of workability?
37. The water–cement ratio is the ratio of___
38. A lower ratio leads to____
39. Workability can be resolved_____
40. How to improve the workability of concrete.
41. What is workability?

42. What is the compaction factor for low degree of workability?
43. What is the compaction factor for medium degree of workability?
44. What is the Vee-Bee time for medium degree of workability?
45. Clay minerals are found in most_____
46. Theoretical value for bulk modulus of clay_____
47. Young's modulus for dickite is_____
48. The grain density of the clay powders was measured using_____
49. To avoid trapped air produced by clay flocculation, we used_____in distilled water.

_____

50. For the cold-pressed aggregate samples, porosity, bulk and grain densities were measured with

(B) AIM:

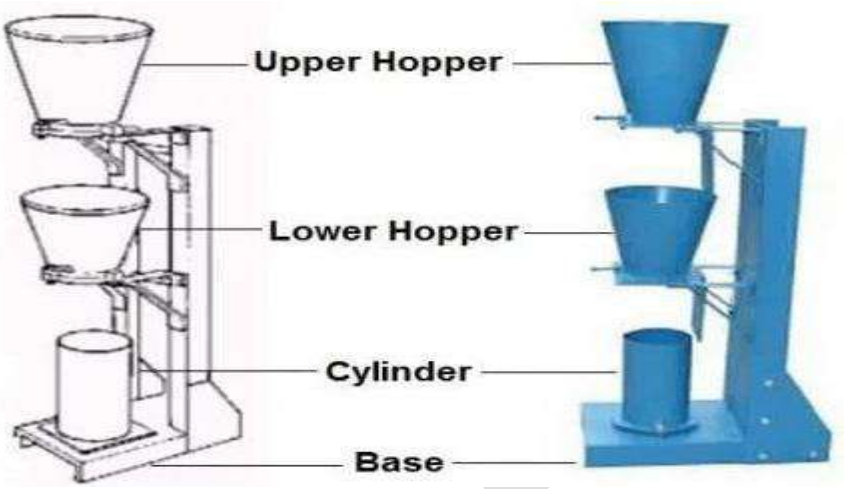
Compaction factor test is the workability test for concrete conducted in laboratory.

APPARATUS:

Compaction factor apparatus consists of trowels, hand scoop (15.2 cm long), a rod of steel or other suitable material (1.6 cm diameter, 61 cm long rounded at one end) and a balance.

INTRODUCTION:

The compaction factor test is used for concrete which have low workability for which slump test is not suitable. The test is sufficiently sensitive to enable difference in workability arising from the initial process in the hydration of cement to be measured. Each test, therefore should be carried out at a constant time interval after the mixing is completed, if strictly comparable results are to be obtained. Convenient time for releasing the concrete from the upper hopper has been found to be two minutes after the completion of mixing.



PROCEDURE:

1. Place the concrete sample gently in the upper hopper to its brim using the hand scoop and level it.
2. Cover the cylinder.
3. Open the trapdoor at the bottom of the upper hopper so that concrete fall into the lower hopper. Push the concrete sticking on its sides gently with the road.
4. Open the trapdoor of the lower hopper and allow the concrete to fall into the cylinder below.
5. Cut of the excess of concrete above the top level of cylinder using trowels and level it.
6. Clean the outside of the cylinder.
7. Weight the cylinder with concrete to the nearest 10 g. This weight is known as the weight of partially compacted concrete (**W1**).
8. Empty the cylinder and then refill it with the same concrete mix in layers approximately 5 cm deep, each layer being heavily rammed to obtain full compaction.
9. Level the top surface.
10. Weigh the cylinder with fully compacted. This weight is known as the weight of fully compacted concrete (**W2**).
11. Find the weight of empty cylinder (**W**).
12. Empty the cylinder and then refill it with the same concrete mix in layers approximately 5 cm deep, each layer being heavily rammed to obtain full compaction.
13. Empty the cylinder and then refill it with the same concrete mix in layers approximately 5 cm deep, each layer being heavily rammed to obtain full compaction.
14. Level the top surface.
15. Weigh the cylinder with fully compacted. This weight is known as the weight of fully compacted concrete (**W2**).
16. Find the weight of empty cylinder (**W**).

17. Empty the cylinder and then refill it with the same concrete mix in layers approximately 5 cm deep, each layer being heavily rammed to obtain full compaction.
18. Level the top surface.
19. Weigh the cylinder with fully compacted. This weight is known as the weight of fully compacted concrete (**W2**).
20. Find the weight of empty cylinder (**W**).

CALCULATION:

The compaction factor is defined as the ratio of the weight of partially compacted concrete to the weight of fully compacted concrete. It shall normally to be stated to the nearest second decimal place.

Compaction Factor Value= (W1-W) / (W2-W)

RESULT:

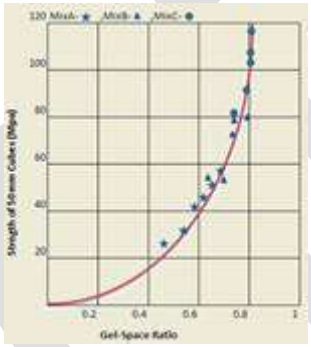
Compaction factor of the concrete =

The Compaction factor values ranges from 0.7 to 0.95.

VIVA:

1. Compaction factor for heavily reinforced section with vibration is _____.
2. Modulus of elasticity, E is calculated using _____.
3. Concrete is filled in how many layers in slump cone in slump test _____.
4. How the compaction factor value is calculated?
5. Higher compaction implies higher _____.
6. Which test is used for the high workable concretes?
7. What is the compaction factor for medium degree of workability?
8. Which test used for low workable concretes?
9. Which test gives good results for rich mixes?
10. Workability of concrete is measured by
11. How many types of tests are there to find workability?
12. What are the dimensions of upper and lower hopper?
13. What is the length and diameter of the cylinder?
14. If compaction factor of concrete is .90, then workability is _____.
15. A compaction factor of .85 for a cement concrete sample indicates _____.
16. What is meant by workability?
17. Workability of concrete can be improved by _____.
18. Workability of concrete is directly proportional to _____.
19. Workability of concrete is inversely proportional to _____.
20. The water–cement ratio is the ratio of _____.
21. IS 456 of 2000 gives the modulus of elasticity as_____
22. What is elastic strains?
23. Static modulus of elasticity of concrete has been related to its_____
24. If the value of f_{ck} is 100 then what will be the modulus of elasticity?
25. Water cement ratio is_____
26. A lower ratio leads to_____
27. For concrete exposed to a very aggressive environment the w/c should be lower than _____
28. What is the range of water in M10?
29. What is the range of water in M15?
30. What is the range of water in M20?
31. What is the range of water in M25?
32. What is the approx. quantity of water in M5?
33. What is the approx. quantity of water in M7?
34. What is the approx. quantity of water in M10?
35. What is the gel/space ratio?
36. Who has established the relation between the strength and gel/space ratio?
37. Power showed that the strength of concrete bears a specific relationship with the gel/space ratio. He found the relationship to be__

38. What does 240 in power's experiment stands for?
39. What does x^3 in power's experiment stands for?
40. What unit is present with the 240?
41. Gel/Space ratio = x = Volume of gel / Space available = 0.657 C / 0.319 C+ Wo. Here C stands for?
42. Gel/Space ratio = x = Volume of gel / Space available = 0.657 C / 0.319 C+ Wo. Here Wo stands for?
43. According to fig. what is the approx. value of strength of 50mm cube in MPa for gel-space ratio .6?
44. Referring to the graph below,what is the approx. value of strength of 50mm cube in MPa for gel-space ratio .8?



45. How many types of tests are there to find workability?
46. Workability of concrete is measured by
47. Which test gives good results for rich mixes?
48. Which test used for low workable concretes?
49. Which test Used for high workable concretes?
50. Which test used for fiber reinforced concrete

VEE - BEE TEST

AIM:

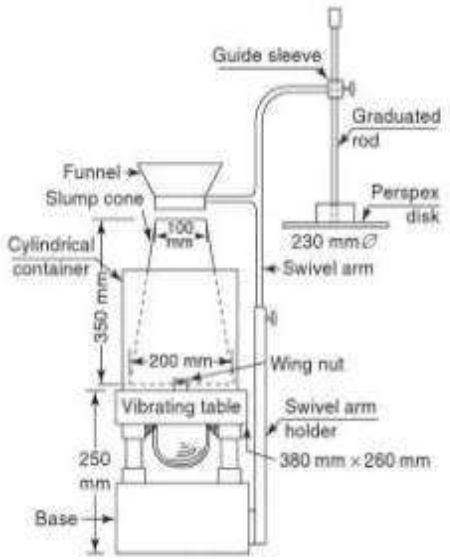
To determine the workability of freshly mixed concrete by using of Vee – Bee consistometer apparatus.

APPARATUS:

Cylindrical container, Vee-Bee apparatus (consisting of vibrating table, slump cone), Standard tamping rod, stop watch and trowels.

INTRODUCTION:

Vee-bee test carries out the relative effort measurement to change the mass of the concrete from a definite shape to the other. That is, as per the test, from the conical shape to the cylindrical shape by undergoing vibration process. The measurement of the effort is done by time measurement in seconds. The amount of work measured in seconds is called as the remoulding effort. The time required for the complete remoulding is a measure of the workability and is expressed in the Vee-Bee seconds. The experiment is named after the developer V Bahrmer of Sweden. The method can be also applied for dry concrete. For concrete that have slump value more than 50mm, the remoulding activity will be so fast that the measurement of time is not possible.



PROCEDURE:

1. Initially the sheet metal slump cone is placed inside the cylinder container that is placed in the consistometer. The cone is filled with four layers of concrete. Each concrete layer is one fourth the height of the cone. Each layer after pouring is subjected to twenty-five tamping with the standard tamping rod. The tamping is done with the rounded end of the rod. The strokes are distributed in uniform manner.

2. This must be done in such a way theta the strokes conducted for the second and the subsequent layers of concrete must penetrate the bottom layers. Once the final layer has been placed and compacted, the concrete is struck off to make it in level with the help of a trowel. This makes the cone to be exactly filled.

3. After the preparation of the concrete cone, the glass disc attached to the swivel arm is moved and is placed on the top of the slump cone placed inside the cylindrical container. The glass disc has to be placed such that it touches the top of the concrete level and the reading is measured from the graduated rod.

4. Now the cylindrical cone is removed immediately by raising the cone slowly in the vertical direction. The transparent disc on the top of the concrete is placed down to the new position and the reading is determined.

5. The difference in the values measured from step 3 and step 4 will give the slump.

6. Now the electrical vibrator is switched on and at the same time we have to start the stop watch. The concrete is allowed to spread out in the cylindrical container. Until the concrete is remolded the vibration is continued. This stage is when the surface of the concrete becomes horizontal and the concrete surface completely adheres uniformly to the transparent disc.

7. The time required for complete remoulding in seconds is recorded. This time in seconds gives us the measure of workability of the fresh concrete. This time is expressed in Vee-Bee seconds.

OBSERVATION AND CALCULATIONS:

1. Initial reading from the graduated rod, before unmoulding (a) in mm
2. The final reading on the graduated rod after removing the mould (b) in mm
3. Slump = a – b in mm
4. The time required for complete remoulding in seconds

RESULT:

Hence the consistency of the concrete is measured in _____vee-bee seconds.

STANDARD VALUES:

WORKABILITY DESCRIPTION	VEE – BEE TIME (IN SECONDS)
Extremely dry	**32 – 18**
Very stiff	**18 – 10**
Stiff	**10 – 5**
Stiff plastic	**5 – 3**
Plastic	**3 – 0**
Flowing	**—**

VIVA:

1. What is Vee – Bee test?
2. State the importance of the test conducting?
3. What are the dimensions of the slump cone?
4. Who is the developer of this experiment?
5. What is the vee – bee time for extremely dry workability?
6. What is the standard value of vee – bee time for stiff plastic workability?
7. Workability Means?
8. What is Segregation of concrete?
9. What is Concrete Maturity?
10. How is aggregate impact value expressed?
11. Mix proportions of M30 grade concrete?
12. What is meant by flakiness index?
13. What is the limitations of this test?
14. Size of cube used for testing of Compression Strength of Cement?
15. Plasticizers are used for?
16. List out some of Admixtures available in market?
17. Explain about the influence of W/C ratio?
18. Nominal Mix vs Design Mix?
19. Density of Concrete?
20. What is bleeding of concrete?
21. What do you mean by workability?
22. Workability of concrete can be improved by addition_____.
23. Workability of concrete can be improved by_____.
24. Workability of concrete can be improved by_____.
25. Workability of concrete is directly proportional to_____.
26. Workability of concrete is inversely proportional to_____.
27. If compaction factor of concrete is .90, then workability is_____
28. A compaction factor of .85 for a cement concrete sample indicates_____
29. Adding water increases_____
30. Why Shape and texture of aggregates is must?
31. What are the factors effect the workability of concrete?
32. How many types of tests are there to find workability?
33. Workability of concrete is measured by
34. Which test gives good results for rich mixes?
35. Which test used for low workable concretes?
36. Which test Used for high workable concretes?
37. _____is practical in field test.

38. What is the compaction factor for medium degree of workability?
39. What is the Vee-Bee time for medium degree of workability?
40. Workability can be resolved _____.
41. Which test gives good results for rich mixes?
42. Which test used for low workable concretes?
43. Which test Used for high workable concretes?
44. Which test used for fiber reinforced concrete?
45. _____is practical in field test.
46. What is the compaction factor for medium degree of workability?
47. What is the Vee-Bee time for medium degree of workability?
48. The water–cement ratio is the ratio of___
49. A lower ratio leads to____
50. How to improve the workability of concrete?

FLOW TABLE TEST

AIM:

To determine the workability of freshly mixed concrete by using of Vee – Bee consistometer apparatus.

APPARATUS:

Cylindrical container, Vee-Bee apparatus (consisting of vibrating table, slump cone), Standard tamping rod, stop watch and trowels.

INTRODUCTION:

As well as getting an accurate measurement of the workability of the concrete, the flow test gives an indication of the cohesion. A mix that is prone to segregation will produce a non-circular pool of concrete. Cement paste may be seen separating from the aggregate. If the mix is prone to bleeding, a ring of clear water may form after a few minutes.

PROCEDURE:

1. Before commencing test, the table top and inside of the mould is to be wetted and cleaned of all gritty material and the excess water is to be removed with a rubber squeezer.
2. The mould is to be firmly held on the centre of the table and filled with concrete in two layers, each approximately one-half the volume of the mould and rodded with 25 strokes with a tamping rod, in a uniform manner over the cross section of the mould.
3. After the top layer has been rodded, the surface of the concrete is to be struck off with a trowel so that the mould is exactly filled.
4. The mould is then removed from the concrete by a steady upward pull.
5. The table is then raised and dropped from a height of 12.5 mm, 15 times in about 15 seconds.
6. The diameter of the spread concrete is the average of six symmetrically distributed calliper measurements read to the nearest 5 mm.

CALCULATION:

The flow of the concrete is the percentage increase in diameter of spread concrete over the base diameter of the moulded concrete, calculated from the following formula.

$$\text{Flow}(\%) = \frac{\text{Spread dia.(cm)} - 25}{25} \times 100$$

RESULT:

The flow measured is _____percentage.

VIVA:

1. What are the factors influencing the choice of mix proportions?
2. State the importance of the experiment?
3. What is the role of water in fresh concrete?
4. Describe the field method for assessing the workability.
5. Explain the significance of w/c ratio.
6. Discuss the factors affecting workability of concrete.
7. Explain any two tests for determining the workability of concrete?
8. How to calculate the percentage of flow?
9. What are the precautions to be taken while conducting the experiment?
10. What is flow table?
11. What is segregation of concrete?
12. What is bleeding of concrete?
13. What is the height of raising and dropping of the table?
14. What are the dimensions of the table?
15. How many strokes to be given with the tampering rod in the mould?
16. Name the apparatus for this experiment?
17. Flow table test determines the _____of concrete.
18. The water–cement ratio is the ratio of _____.
19. A lower ratio leads to _____.
20. A lower ratio leads to _____.
21. _____ is practical in field test.
22. What is the compaction factor for medium degree of workability?
23. What is the Vee-Bee time for medium degree of workability?
24. What is concrete maturity?
25. Maturity methods provide a_____ simple approach for strength of concrete.
26. The maturity method is a _____ approach to predict the early age strength gain of concrete.
27. Maturity concept is a method.
28. It the quantity and cost of sampling and testing
29. What does x^3 in power's experiment stands for?
30. A lower ratio leads to
31. The material used for UHPC provides compressive strengths up to
32. "Where the matrix is extremely dense, a weak aggregate may become the weak". Is this statement (TRUE / FALSE)?
33. What is the compaction factor for medium degree of

worIt is _____ strength and_____ permeability.

35. "High Performance concrete works out to be economical". Is it true or false?
36. "HPC is not used in high span bridges". Is it true or false?
37. Concrete having 28- days' compressive strength in the range of 60 to 100 MPa.
38. Concrete having 28-days compressive strength in the range of 100 to 150 MPa.
39. High-Performance Concrete is _____ as compared to Normal Strength Concrete.
40. The choice of cement for high-strength concrete should not be based only on mortar-cube tests but it should also include tests of compressive strengths of concrete at_____ days.
41. For high-strength concrete, a cement should produce a minimum 7-days mortar-cube strength of approximately MPa.
42. _____mm nominal maximum size aggregates gives optimum strength.

43. Due to low w/c ratio _____.
44. What could be the possible answer among the following for compressive strength of high strength concrete?
45. What could be the possible answer among the following for water cement ratio for high strength concrete?
46. Due to low w/c ratio _____
47. Which type of aggregates are used to produce 70MPa compressive strength?
48. Maximum size of aggregates are used to produce 70MPa compressive strength is_____
49. Maximum size of aggregates are used to produce 100MPa compressive strength is_____
50. "In bridges, HSC is used". Is it (TRUS / FALSE)?

Experiment No: 6

AIM:

To determine the compressive strength of standard cement mortar cubes compacted by means of standard vibration machine.

APPARATUS:

1. Vibration machine and cube moulds of size 7.06 cms (Conforming to IS: 4031- 1988).

STANDARD SAND:

The standard sand to be used in the test shall conform to IS: 650-1991 or sand passing 100 percent through 2 mm sieve and retained 100 percent on 90 microns IS sieve. 2mm to 1mm 33.33 percent 1mm to 500 microns 33.33 percent 500mm to 90 microns 33.33 percent.

INTRODUCTION:

The compressive strength of cement mortars is determined in order to verify whether the cement conforms to IS specifications and whether it will be able to develop the required compressive strength of concrete. The average compressive strength of at least three mortar cubes (area of the face 50 cm^2) composed of one part of cement and three parts of standard stand should satisfy IS code specifications.

PROCEDURE:

Mix proportions and mixing:

1. Clean appliances shall be used for mixing and the temperature of the water and that of the test room at the time when the above operations are being performed shall be 27 ±2°C.
2. Place in a container a mixture of cement and standard sand in the proportion of 1:3 by weight mix it dry, with a trowel for one minute and then with water until the mixture is of uniform colour.
3. The quantity of water to be used shall be as specified below.
4. In any element, it should not take more than 4 minutes to obtain uniform coloured mix.
5. If it exceeds 4 minutes the mixture shall be rejected, and the operation repeated with a fresh quantity of cement, sand and water.
6. The material for each cube shall be mixed separately and the quantity of cement standard sand and water shall be as follows: Cement 200 gms Standard sand 600 gms, Water (P/4 + 3) percent of combined weight of cement and sand, where p is the percentage of water required to produce a paste of standard consistency.

MOULDING SPECIMENS:

1. In assembling the moulds ready for use, cover the joints between the halves of the mould with a thin film of petroleum jelly and apply a similar coating of petroleum jelly between the contact surfaces of the bottom of the mould and its base plate in order to ensure that no water escapes during vibration.
2. Treat the interior faces of the mould with a thin coating of mould oil.
3. Place the assembled mould on the table of the vibration machine and firmly hold it is position by means of suitable clamps.
4. Securely attach a hopper of suitable size and shape at the top of the mould to facilitate filling and this hopper shall not be removed until completion of the vibration period.
5. Immediately after mixing the mortar, place the mortar in the cube mould and rod with a rod.
6. The mortar shall be rodded 20 times in about 8 seconds to ensure elimination of entrained air and honey combing.
7. Place the remaining quantity of mortar in the hopper of the cube mould and rod again as specified for the first layer and then compact the mortar by vibrations.
8. The period of vibration shall be two minutes at the specified speed of 12,000 + 400 vibrations per minute.
9. At the end of vibration remove the mould together with the base plate from the machine and finish the top surface of the cube in the mould by smoothing surface with the blade of a trowel.

CURING SPECIMEN:

1. Keep the filled moulds at a temperature of 27 + 20 C in an atmosphere of at least 90 % relative humidity for about 24 hours after completion of vibration.
2. At the end of that period remove them from the moulds.
3. Immediately submerge in clean fresh water and keep them under water until testing.
4. The water in which the cubes are submerged shall be renewed every 7 days and shall be maintained at a temperature of 27 0C + 20C.
5. After they have been taken out and until they are tested the cubes shall not be allowed to become dry.

TESTING:

1. Test three cubes for compressive strength at the periods mentioned under the relevant specification for different hydraulic cements, the periods being reckoned from the completion of vibration.
2. The compressive strength shall be the average of the strengths of three cubes for each period of curing.
3. The cubes shall be tested on their sides without any packing between the cube and the steel plates of the testing machine.
4. One of the platens shall be carried base and shall be self-adjusting and the load shall be steadily and uniformly applied starting from zero at a rate of 350 Kgs/Cm^2/ min. The cubes are tested at the following periods Ordinary Portland cement 3, 7 and 28 days. Rapid hardening Portland cement 1 and 3 days. Low heat Portland cement 3 and 7 days.

CALCULATION:

Calculate the compressive strength from the crushing load and the average area over which the load is applied. Express the results in N/mm^2 to the nearest 0.05 mm^2.

Compressive strength in N/mm^2 = P/A

Where P is the crushing load in N and

A is the area in mm^2 (5000 mm^2).

PRECAUTIONS:

Inside of the cube moulds should be oiled to prevent the mortar from adhering to the sides of the mould.

RESULT:

The average compressive strength of the given cement at 3 days N/mm^2 at 7 days N/mm^2 at 28 days N/mm^2.

VIVA QUESTIONS:

1. What do you understand by initial and final setting times of a cement sample
2. What precautions do you observe in performing the above tests?
3. What are is specifications for setting times of various types of cements recommended for use on a construction site
4. What is the amount of water to be added for initial setting time
5. What is difference between setting and hardening
6. Differentiate between density and specific gravity of a material.
7. State the importance of this test.
8. Name other methods that can be used for finding the specific gravity of cement.
9. What is the effect on the specific gravity value if the air bubbles are not removed completely.
10. Why constant temperature bath is used in this experiment?
11. What is the average strength of the given cement at 3 days?
12. What are the precautions to be taken while conducting the experiment?
13. What is the significance of the experiment?
14. What is the compressive strength for rapid hardening cement at 3 days?
15. What is the compressive strength for low heat Portland cement at 7 days?
16. What is the compressive strength for ordinary Portland cement at 28 days?
17. What is the compressive strength for low heat Portland cement at 3 days?
18. What is the compressive strength for ordinary Portland cement at 7 days?
19. What is the compressive strength for rapid hardening cement at 7 days?
20. What is the compressive strength for ordinary Portland cement at 3 days?
21. What is the composition of lime in cement?
22. Mention 5 types of cements.
23. How do you determine the slump of the concrete?
24. Differentiate by sketches the terms of true slump, shear and collapse type of slumps
25. Define the workability and consistency of freshly mixed concrete
26. Excess of _____amount causes cement unsound.
27. What do you understand by initial and final setting times of a cement sample
28. What precautions do you observe in performing the above tests?
29. What are is specifications for setting times of various types of cements recommended for use on a construction site
30. What are the properties of GGBS based cement?
31. Compressive strength test for 1:3 cement and sand _____.
32. Which Bouge's compounds are highly responsible for the setting of cement?
33. No. of Cube samples required for testing Compression Strength for 100 m^3 of concrete?
34. What is the standard w/c value for nominal mix of concrete?
35. Equipment used to test Compression Strength of Cement?
36. What does grade 33 cement indicate?
37. Ordinary Portland cement (OPC) has been classified into how many grades?
38. Grade 43 OPC is used widely for _____.
39. After how many days is the strength of cement is tested and graded according to the result?
40. The compressive strength of OPC increases with time (TRUE / FALSE).
41. Grade 43 OPC shall be rejected if it remains in bulk storage in the factory for _____.
42. The ratio of percentage of alumina to iron oxide in OPC 43 grade is_____.
43. What is the required minimum fineness for grade 53 OPC?
44. Which of the following cannot be added in 33 grade OPC after burning stage?
45. How much maximum percentage by mass of performance improvers can be added in grade 33 OPC?
46. What are the specifications of standard sand?

47. Give the formula to calculate the water content.
48. What is dimensions of the mould?
49. Give the list of IS codes for cement.
50. What is compressive strength?

Experiment No: 7

Aim:

To determine the modulus of rupture of concrete using the third-point loading test.

Materials:

- Concrete beams (100mm x 100mm x 500mm)
- Universal testing machine
- Load cell
- Deflection gauges
- Third-point loading apparatus

Procedure:

1. Preparation of Test Specimens: Prepare concrete beams according to the standard specifications.
2. Curing of Test Specimens: Cure the concrete beams in water for 28 days.
3. Third-Point Loading Test: Place the concrete beam on the testing machine and apply a third-point loading using the apparatus.
4. Measurement of Load and Deflection: Measure the load and deflection at the midpoint of the beam using the load cell and deflection gauges.
5. Failure Mode: Observe the failure mode of the concrete beam.
6. Calculation of Modulus of Rupture: Calculate the modulus of rupture using the following formula:

Modulus of Rupture (MR) = (3PL) / (2bd^2)

where:

- P = applied load at failure
- L = span length of the beam
- b = width of the beam

- d = depth of the beam

Results:

| Test Specimen | Applied Load (kN) | Deflection (mm) | Modulus of Rupture (MPa) |

| --- | --- | --- | --- |

| 1 | 120 | 2.5 | 4.32 |

| 2 | 110 | 2.2 | 4.05 |

| 3 | 130 | 2.8 | 4.61 |

Discussion:

The results show that the modulus of rupture of concrete is a measure of its flexural strength. The values obtained are within the expected range for normal-weight concrete.

Conclusion:

The modulus of rupture test is a reliable method to determine the flexural strength of concrete. The results can be used to evaluate the quality of concrete and to design concrete structures.

Recommendations:

- Use the modulus of rupture test to determine the flexural strength of concrete for structural design.

- Consider the test results in conjunction with other mechanical properties of concrete, such as compressive strength and tensile strength.

Limitations:

- The test results may be affected by the specimen size, shape, and surface roughness.

- The modulus of rupture test may not accurately represent the true flexural strength of concrete due to the complex stress state induced by the test.

Experiment No: 8

Objective:

To determine the permeability of concrete using the water penetration test.

Materials:

- Concrete specimens (100mm x 100mm x 50mm)
- Water penetration test apparatus
- Water
- Stopwatch
- Measuring tape

Procedure:

1. Preparation of Test Specimens: Prepare concrete specimens according to the standard specifications.
2. Curing of Test Specimens: Cure the concrete specimens in water for 28 days.
3. Water Penetration Test: Place the concrete specimen in the test apparatus and apply a water pressure of 5 bar.
4. Measurement of Water Penetration: Measure the depth of water penetration into the concrete specimen after 24 hours.
5. Calculation of Permeability: Calculate the permeability of the concrete specimen using the following formula:

$$\text{Permeability } (k) = (d \times t) / (p \times A)$$

where:

- d = depth of water penetration (mm)

- t = time of water penetration (hours)

- p = water pressure (bar)

- A = cross-sectional area of the specimen (mm^2)

Results:

| Test Specimen | Depth of Water Penetration (mm) | Permeability (k) |

| --- | --- | --- |

| 1 | 20 | 2.5 × 10^(-12) m/s |

| 2 | 15 | 1.9 × 10^(-12) m/s |

| 3 | 25 | 3.1 × 10^(-12) m/s |

Discussion:

The results show that the permeability of concrete is a measure of its ability to resist the flow of water. The values obtained are within the expected range for normal-weight concrete.

Conclusion:

The water penetration test is a reliable method to determine the permeability of concrete. The results can be used to evaluate the durability of concrete structures exposed to water.

Recommendations:

- Use the water penetration test to determine the permeability of concrete for structural design.

- Consider the test results in conjunction with other durability tests, such as the chloride penetration test.

Limitations:

- The test results may be affected by the specimen size, shape, and surface roughness.

- The water penetration test may not accurately represent the true permeability of concrete due to the complex flow mechanisms involved.

Experiment No: 8

Aim:

To evaluate the properties of polymer modified mortar/concrete and compare them with those of conventional mortar/concrete.

Tests to be Conducted :

1. Workability Test: To determine the workability of polymer modified mortar/concrete using the flow table test or slump test.

2. Compressive Strength Test: To determine the compressive strength of polymer modified mortar/concrete using the compression testing machine.

3. Tensile Strength Test: To determine the tensile strength of polymer modified mortar/concrete using the tensile testing machine.

4. Flexural Strength Test: To determine the flexural strength of polymer modified mortar/concrete using the flexural testing machine.

5. Water Absorption Test: To determine the water absorption of polymer modified mortar/concrete using the water absorption test apparatus.

6. Chloride Penetration Test: To determine the chloride penetration resistance of polymer modified mortar/concrete using the chloride penetration test apparatus.

7. Freeze-Thaw Resistance Test: To determine the freeze-thaw resistance of polymer modified mortar/concrete using the freeze-thaw testing apparatus.

Test Specimens:

- Mortar: 40mm x 40mm x 160mm prisms

- Concrete: 100mm x 100mm x 100mm cubes or 150mm x 300mm cylinders

Testing Procedure:

1. Prepare the test specimens according to the standard specifications.

2. Conduct the workability test on fresh mortar/concrete.

3. Cure the test specimens in water or in a controlled environment.

4. Conduct the compressive strength, tensile strength, flexural strength, water absorption, chloride penetration, and freeze-thaw resistance tests on the hardened mortar/concrete.

Data Analysis:

1. Compare the test results of polymer modified mortar/concrete with those of conventional mortar/concrete.

2. Evaluate the effects of polymer modification on the properties of mortar/concrete.

3. Analyze the data to determine the optimal dosage of polymer for modifying mortar/concrete.

Conclusion:

The tests on polymer modified mortar/concrete provide valuable information on their properties and behavior. The results can be used to optimize the design and application of polymer modified mortar/concrete in construction projects.

Laboratory Experiment Evaluation Rubric

Category	Outstanding (Up to 100%)	Accomplished (Up to 75%)	Developing (Up to 50%)	Beginner (Up to 25%)
Written/Presentation/Demonstration	The write-up is clear, well-organized, and follows the prescribed format. All required sections (aim, apparatus, theory, procedure, diagram, etc.) are present and well-written. Demonstration is clear and thorough.	The report follows the specified format, but some sections (like the diagram or theory) are missing or incomplete. The demonstration is understandable but lacks depth.	The report includes most sections but lacks clarity, coherence, or completeness in some parts (e.g., diagram missing, unclear theoretical explanation). The demonstration is incomplete or unclear.	The report is poorly written and organized. Many sections are missing or incorrect (e.g., no diagram, incomplete procedure). The demonstration lacks clarity or is missing.
Viva-Voice	Demonstrates a deep understanding of the experiment, underlying principles,	Demonstrates a general understanding of the experiment and principles but struggles	Struggles with some fundamental concepts and principles. Answering questions	Lacks a basic understanding of the experiment. Unable to answer most questions

Category	Outstanding (Up to 100%)	Accomplished (Up to 75%)	Developing (Up to 50%)	Beginner (Up to 25%)
	and outcomes. Answers questions confidently and accurately.	with some aspects. Provides correct answers to most questions.	requires additional prompts, with a few errors in understanding.	accurately. Demonstrates significant gaps in knowledge.
Performance/Report/File Work	Performs the experiment accurately and efficiently. The report is thorough, with correct observations, calculations, and analysis. Data is recorded neatly and with appropriate units. All relevant calculations and interpretations are included.	Performs the experiment well with minor errors or delays. The report is complete but may contain some inaccuracies or missing components in calculations or observations.	Completes the experiment but with notable mistakes, either in the setup or the data. The report has several missing or inaccurate components, including incorrect or incomplete calculations.	Struggles to perform the experiment correctly. Significant errors in setup, data collection, and analysis. The report is poorly structured with major inaccuracies or missing sections.
Attendance	Consistently attends all lab sessions, actively	Attends most lab sessions with occasional	Attends some lab sessions but has frequent	Misses several lab sessions and shows

Category	Outstanding (Up to 100%)	Accomplished (Up to 75%)	Developing (Up to 50%)	Beginner (Up to 25%)
	participates, and engages with the experiment and group discussions.	absences. Participation is generally good but lacks consistency or depth.	absences or minimal participation.	minimal to no participation in class or group activities.