

I

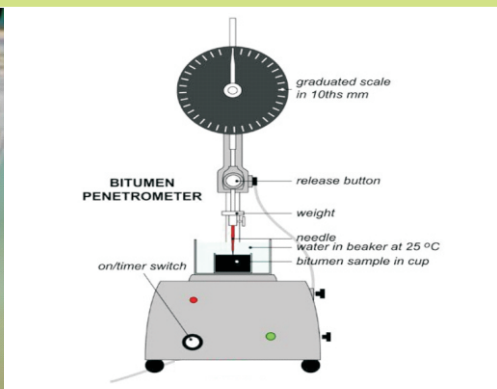
Name _____

Roll No. _____ Year 20 _____ 20 _____

Exam Seat No. _____

CIVIL GROUP | SEMESTER - III | DIPLOMA IN ENGINEERING AND TECHNOLOGY

A LABORATORY MANUAL FOR HIGHWAY ENGINEERING (22302)



MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI
(Autonomous) (ISO 9001 : 2015) (ISO / IEC 27001 : 2013)

VISION

To ensure that the Diploma level Technical Education constantly matches the latest requirements of technology and industry and includes the all-round personal development of students including social concerns and to become globally competitive, technology led organization.

MISSION

To provide high quality technical and managerial manpower, information and consultancy services to the industry and community to enable the industry and community to face the changing technological and environmental challenges.

QUALITY POLICY

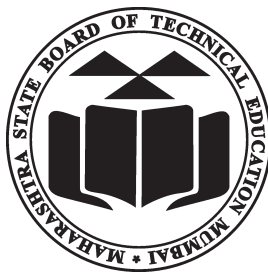
We, at MSBTE are committed to offer the best in class academic services to the students and institutes to enhance the delight of industry and society. This will be achieved through continual improvement in management practices adopted in the process of curriculum design, development, implementation, evaluation and monitoring system along with adequate faculty development programmes.

CORE VALUES

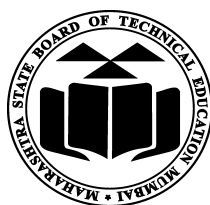
MSBTE believes in the followings:

- Education industry produces live products.
- Market requirements do not wait for curriculum changes.
- Question paper is the reflector of academic standards of educational organization.
- Well designed curriculum needs effective implementation too.
- Competency based curriculum is the backbone of need based program.
- Technical skills do need support of life skills.
- Best teachers are the national assets.
- Effective teaching learning process is impossible without learning resources.

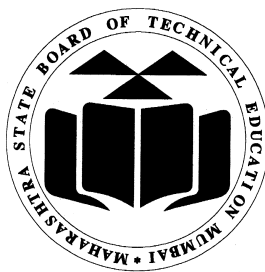
A Laboratory Manual
for
Highway Engineering
(22302)
Semester-III
(CE/CR/CS)



Maharashtra State
Board of Technical Education, Mumbai
(Autonomous) (ISO:9001:2015) (ISO/IEC 27001:2013)



Maharashtra State Board of Technical Education,
(Autonomous) (ISO:9001 : 2015) (ISO/IEC 27001 : 2013)
4th Floor, Government Polytechnic Building, 49, Kherwadi,
Bandra (East), Mumbai - 400051.
(Printed on June, 2018)



MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION

Certificate

This is to certify that Mr. / Ms.
Roll No., of Third Semester of Diploma in
..... of Institute,
.....
(Code:) has completed the term work satisfactorily in course
Highway Engineering (22302) for the academic year 20..... to 20..... as
prescribed in the curriculum.

Place:

Enrollment No:.....

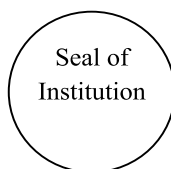
Date:

Exam. Seat No:

Subject Teacher

Head of the Department

Principal



Preface

The primary focus of any engineering laboratory/ field work in the technical education system is to develop the much needed industry relevant competencies and skills. With this in view, MSBTE embarked on this innovative ‘I’ Scheme curricula for engineering diploma programmes with outcome-based education as the focus and accordingly, relatively large amount of time is allotted for the practical work. This displays the great importance of laboratory work making each teacher; instructor and student to realize that every minute of the laboratory time need to be effectively utilized to develop these outcomes, rather than doing other mundane activities. Therefore, for the successful implementation of this outcome-based curriculum, every practical has been designed to serve as a ‘**vehicle**’ to develop this industry identified competency in every student. The practical skills are difficult to develop through ‘chalk and duster’ activity in the classroom situation. Accordingly, the ‘I’ scheme laboratory manual development team designed the practicals to **focus** on the **outcomes**, rather than the traditional age old practice of conducting practicals to ‘verify the theory’ (which may become a byproduct along the way).

This laboratory manual is designed to help all stakeholders, especially the students, teachers and instructors to develop in the student the pre-determined outcomes. It is expected from each student that at least a day in advance, they have to thoroughly read through the concerned practical procedure that they will do the next day and understand the minimum theoretical background associated with the practical. Every practical in this manual begins by identifying the competency, industry relevant skills, course outcomes and practical outcomes which serve as a key focal point for doing the practical. The students will then become aware about the skills they will achieve through procedure shown there and necessary precautions to be taken, which will help them to apply in solving real-world problems in their professional life.

This manual also provides guidelines to teachers and instructors to effectively facilitate student-centered lab activities through each practical exercise by arranging and managing necessary resources in order that the students follow the procedures and precautions systematically ensuring the achievement of outcomes in the students.

Road Transportation is the most effective and economical means of transportation in our country. The need for travel to various places at faster speed has also increased. In order to professionally contribute to the field of highway engineering, the associated engineers and supervisors must have adequate knowledge and skills relating to technical aspects of continuously increasing volume of traffic flow, design of highway intersections/interchanges, geometric alignment and design, materials, structural design of pavement, new developments in road construction and use of modern and waste materials, techniques, design and maintenance of pavements. Agencies like NHAI and State Government and private organisation are intensely involved in improving and building road networks in India. Diploma Engineering students have good scope in jobs related to road construction as well as such infrastructural associated different projects works. This course provides scope of learning about various aspects of roads, carrying out survey, investigation, planning, design, construction and maintenance works related to road constructions.

Although best possible care has been taken to check for errors (if any) in this laboratory manual, perfection may elude us as this is the first edition of this manual. Any errors and suggestions for improvement are solicited and highly welcome.

Programme Outcomes (POs) to be achieved through Practicals of this Course:-

- PO 1. Basic knowledge:** An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.
- PO 2. Discipline knowledge:** An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.
- PO 3. Experiments and practice:** An ability to plan and perform experiments and practices and to use the results to solve engineering problems.
- PO 4. Engineering tools:** Apply relevant civil technologies and tools with an understanding of the limitations.
- PO 8. Individual and Team Work:** Function effectively as leader and team member in Diverse /multidisciplinary team
-
- PSO 1 Construction Planning and Designing:** Perform optimal civil engineering construction, planning and designing activities of desired quality at optima cost.
- PSO 2 Construction Execution and Maintenance:** Execute civil engineering construction and maintenance using relevant materials and equipments

Practical- Course Outcome matrix

Course Outcomes (COs)							
a. Identify the types of roads as per IRC recommendations. b. Implement the geometrical design features of different highways. c. Perform different tests on road materials. d. Evaluate traffic flow characteristics. e. Implement hill road construction using relevant materials, techniques and methods. f. Undertake maintenance of roads and drainage.							
S. No.	Practical Outcome	CO a.	CO b.	CO c.	CO d.	CO e.	CO f.
1.	Draw the sketches showing standard cross sections of NH/SH, MDR/ODR in embankment and cutting on A3 size sheets.	√	√	--	--	--	--
2.	Conduct Flakiness Index Test on the aggregates.	--	--	--	--	--	--
3.	Conduct Elongation Index Test on the aggregates.	--	--	√	--	--	--
4.	Conduct Angularity Number Test on the aggregates.	--	--	√	--	--	--
5.	Conduct Softening point test on bitumen.	--	--	√	--	--	--
6.	Conduct Penetration test on bitumen.	--	--	√	--	--	--
7.	Conduct Flash and Fire Point test on bitumen.	--	--	√	--	--	--
8.	Conduct Ductility test on Bitumen.	--	--	√	--	--	--
9.	Visit the constructed road to suggest the possible remedial measures against the observed defects	√	√	--	--	√	--
10.	Prepare the photographic report containing details for experiment no. 9	√	√	--	√	--	--
11.	Carry out Traffic Volume Study (minimum two hours of peak period) for an important road intersection or roadway in your city/ town/ village.	--	--	--	√	--	--
12.	Perform analysis of traffic volume data of experiment no. 11.	--	--	--	√	--	--
13.	Draw the sketch of collision diagram for any one case.	--	--	--	√	--	--
14.	Visit the hill road constructed site to understand its components and prepare the photographic report containing details.	--	√	--	--	√	--
15.	Prepare the photographic report containing details for experiment no. 14.	--	√	--	--	√	--
16.	Visit the road of any one type (flexible or rigid) to know the drainage condition.	--	√	--	--	√	√
17.	Prepare the photographic report suggesting possible repairs and maintenance for experiment no. 16.	--	√	--	--	√	√

List of Industry Relevant Skills

The following industry relevant skills of the competency '**Undertake construction and maintenance of pavements (Roads).**' are expected to be developed in you by undertaking the practicals of this laboratory manual.

1. Identify the components of roads as per geometric design.
2. Perform the test as per procedure
3. Implement the geometric design of roads
4. Interpret the results of test performed.
5. Analyze the traffic volume count.
6. Undertake the maintenance required for various roads.

Brief Guidelines to Teachers

Hints regarding strategies to be used:

1. For difficult practical if required, teacher could provide the demonstration of the practical emphasizing of the skills which the student should achieve.
2. Teachers should give opportunity to students for hands-on after the demonstration.
3. Teacher should give relevant information to students prior to visit arranged for effective utilization of time and understanding.
4. Teachers shall ensure that required equipment are in working condition before start each experiment, also keep operating instruction manual available.
5. There will be two sheets of blank pages after every practical for the student to report other matters (if any), which is not mentioned in the printed practicals.
6. Assess the skill achievement of the students and COs of each unit.
7. One or two questions ought to be added in each practical for different batches. For this teachers can maintain various practical related question banks for each course.
8. If some repetitive information like data sheet, use of software tools etc. has to be provided for effective attainment of practical outcomes, they can be incorporated in Appendix.
9. For effective implementation and attainment of practical outcomes, teacher ought to ensure that in the beginning itself of each practical, students must read through the complete write-up of that practical sheet.
10. During practical, ensure that each student gets chance and takes active part in taking observations/ readings and performing practical.
11. Teacher ought to assess the performance of students continuously according to the MSBTE guidelines.

Instructions for Students

1. For effective implementation and attainment of practical outcomes, in the beginning itself of each practical, students need to read through the complete write-up including the practical related questions and assessment scheme of that practical sheet.
2. Student ought to refer the data books, IS codes, Safety norms, internet websites etc.
3. Student should not hesitate to ask any difficulties they face during the conduct of practicals/visits.
4. Student should develop the habit of peer discussions/group discussion related to the experiment/exercise so that exchanges of knowledge /skills could take place.
5. Student shall attempt to develop related hands-on skills and gain confidence.
6. Students shall visit the nearby construction site, technical exhibitions, trade fair etc. even not included in the lab manual.
7. Students should develop the habit of not to depend totally on teachers but to develop self-learning techniques.
8. Student should develop habit to submit the practical exercise continuously and progressively on the scheduled dates and should get the assessment done
9. It is necessary to take all precautionary measures by students during site visit.
10. Students should take photographs (which may be different for each student) on their own for deep understanding of the concepts.

Content Page
List of Practicals and Progressive Assessment Sheet

Sr. No	Title of the Practical	Page No.	Date of Performance	Date of Submission	Assessment Marks (25)	Dated Sign. of Teacher	Remarks (If Any)
1	Draw the sketches showing standard cross sections of NH/SH, MDR/ODR in embankment and cutting on A3 size sheets.	1					
2	Conduct Flakiness Index Test on the aggregates.	7					
3	Conduct Elongation Index Test on the aggregates.	14					
4	Conduct Angularity Number Test on the aggregates.	21					
5	Conduct Softening point test on bitumen.	29					
6	Conduct Penetration test on bitumen.	37					
7	Conduct Flash and Fire Point test on bitumen.	45					
8	Conduct Ductility test on Bitumen.	52					
9	Visit the constructed road to suggest the possible remedial measures against the observed defects	60					
10	Prepare the photographic report containing details for experiment no. 9	68					
11	Carry out Traffic Volume Study (minimum two hours of peak period) for an important road intersection or roadway in your city/ town/ village.	76					
12	Perform analysis of traffic volume data of experiment no. 11.	85					
13	Draw the sketch of collision diagram for any one case.	93					
14	Visit the hill road constructed site to understand its components and prepare the photographic report containing details.	102					
15	Prepare the photographic report containing details for experiment no. 14.	109					

Sr. No	Title of the Practical	Page No.	Date of Performance	Date of Submission	Assessment Marks (25)	Dated Sign. of Teacher	Remarks (If Any)
16	Visit the road of any one type (flexible or rigid) to know the drainage condition.	116					
17	Prepare the photographic report suggesting possible repairs and maintenance for experiment no. 16.	122					
	Total						

Note: To be transferred to Proforma of CIAAN-2017.

Practical No. 01: Drawing of Cross Sections of Road

I Practical Significance

Roads are the arteries and veins of worldwide communication. The road constructed in embankment and cutting has different details of cross sections. This exercise is prior important for understanding the basic components of typical pavement. The details of cross sections of various types of roads like National Highway (NH), State Highway (SH), Major District Road (MDR) and Other District Road (ODR) are required to sketch, so that one can easily identify the type of road, components and geometric elements of road.

II Relevant Program Outcomes (POs)

PO 1. *Basic knowledge*: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.

PO 2. *Discipline knowledge*: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.

PO 4. *Engineering tools*: Apply relevant civil technologies and tools with an understanding of the limitations.

III Relevant Course Outcomes

- i. Identify the types of roads as per IRC recommendations.
- ii. Implement the geometrical design features of different highways.

IV Practical Outcome

Draw the sketches showing standard cross sections of NH/SH, MDR/ODR in embankment and cutting on A3 size sheets.

V Competency and Practical Skills

- This practical is expected to develop the following skills for the industry identified competency '*Understand the geometrical components of typical road section.*'

- i. Draw the details of cross sections of NH, SH, MDR and ODR.
- ii. Identify the components and its dimensions of above mentioned roads.

VI Relevant Affective domain related

- a. Follow safety practices.
- b. Practice good housekeeping.
- c. Demonstrate working as a leader/a team member.
- d. Follow ethical Practices.

VII Minimum Theoretical Background

It is the graphical representation of the cross section of road indicating the width and thickness of pavement, width of shoulders, road side drains with width of land required and road side arboriculture. The dimensions of various geometrical features for NH, SH, MDR and ODR are different as per IRC recommendations. The typical cross section of road pavement is as shown below.

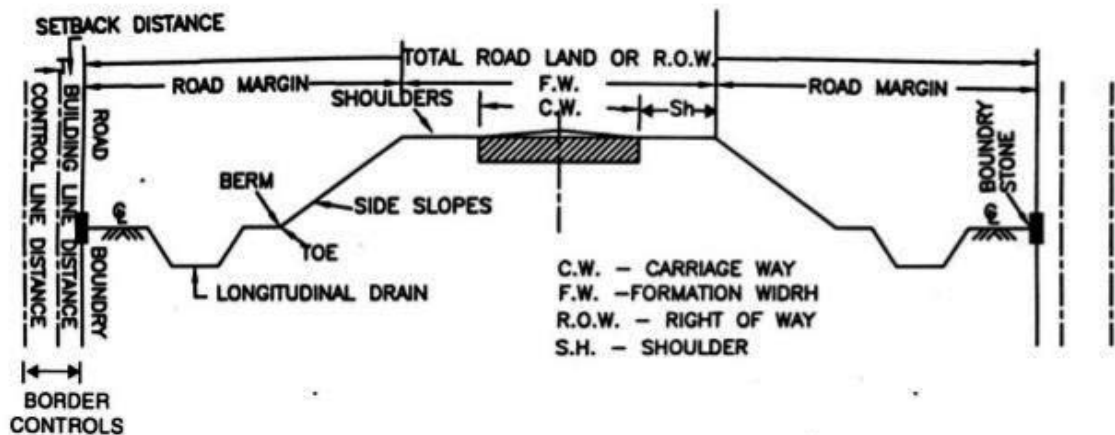
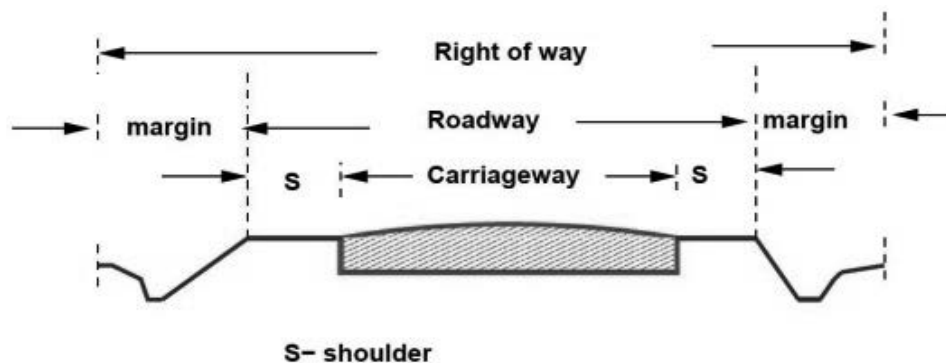


Figure 1: Typical cross sections of roads

VIII Practical Set-up

Photo: Typical cross sections of roads



A typical Right of way (ROW)

Figure 2: Typical cross sections of roads

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Drawing sheet	A3 size sketch plate	3-4 Nos.	
2	Drawing accessories	--	--	
3	Typical drawing of various types of road	--	--	

X Procedure

1. Take the A3 size drawing sheet and necessary drawing accessories.
2. Study the typical cross sections of various roads.
3. Mark the center line of road in the mid portion of particular sheet.
4. Draw the carriage way and shoulder on either sides of center line i.e. alignment of road proportionally.
5. Similarly draw other geometric features like side slope, berm, road side trees, spoil bank, side drain etc. as per typical drawings available.
6. Mark the dimensions and label all the maximum possible components of road in the drawing.
7. Enclose this drawing in the separate file along with this manual.

XI Precautions to be followed

1. The sketches should be drawn in appropriate proportion so as to accommodate the figures on drawing sheet.
2. The detail information should be written on sheet comprising title of sheet, details of students etc.

XII Actual procedure followed (*To be written by students*)

(Use blank sheet provided if space not sufficient)

[Space for Answers]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

XIII Resources used

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

XIV Precautions followed

.....

.....

.....

XV Observations (Use blank sheet provided if space not sufficient)

.....

.....

.....

XVI Results / Summary

.....

.....

.....

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

.....

.....

.....

XVIII Conclusions and Recommendations if any .

.....

.....

.....

XIX 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. Define road way width, carriage way width.
2. Define camber, super elevation.
3. State the standard road width for NH, SH, MDR, ODR and VR as per IRC.
4. State the purpose of provision of shoulder, side drain and berm.
5. Differentiate between road in embankment and road in cutting. (*Min. four points*)

[Space for Answers]

This image shows a full page of a document template designed for handwriting practice or general note-taking. It consists of approximately 28 evenly spaced horizontal dotted lines across the entire width of the page. The background is plain white, and there are no margins, headers, footers, or other markings present.

XX References / Suggestions for further Reading

Sr. No	Title of Book	Author	Publication
1	Highway Engineering	Khanna S.K. , Justo, C E G and Veeraragavan, A.	Nem Chand and Brothers, Roorkee, 2010, ISBN 978-8185240800
2	Road, Railways, Bridge and Tunnel Engg	Birdi, Ahuja,	Standard Book House, New Delhi, March 2010, ISBN: 978-8189401337

XXI Suggested Assessment Scheme

Performance Indicators		Weightage %
Process related : 15 Marks		60 %
1	Neatness and proportionate drawing	20%
2	Details marked in the drawing	30%
3	Working in team	10%
Product related :10 Marks		40 %
4	Conclusions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total : 25 Marks		100%

List of Student Team Members

- 1
- 2
3.
- 4..

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No. 02: Flakiness Index Test

I Practical Significance

The particle shape of aggregates (road metals) is determined by the percentages of flaky and elongated particles contained in it. In case of gravel, it is determined by its angularity number. For base course and construction of bituminous and cement concrete types, the presence of flaky and elongated particles are considered undesirable as they may cause inherent weakness with possibilities of breaking down under heavy loads. Rounded aggregates are preferred in cement concrete road construction as the workability of concrete improves. Flaky and elongated particles may have adverse effects on concrete and bituminous mix. For instance, flaky and elongated particles tend to lower the workability of concrete mix which may impair the long-term durability. For bituminous mix, flaky particles are liable to break up and disintegrate during the pavement rolling process. Angular shapes of particles are desirable for granular base course due to increased stability derived from the better interlocking. Thus evaluation of shape of the particles, particularly with reference to flakiness, elongation of angularity is necessary.

II Relevant Program Outcomes

PO 1. Basic knowledge: *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. Discipline knowledge: *An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 3. Experiments and practice: *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*

PO 4. Engineering tools: *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

III Relevant Course Outcomes

Perform different tests on road materials.

IV Practical Outcome

Conduct Flakiness Index Test on the aggregates.

V Competency and Practical Skills

- This practical is expected to develop the following skills for the industry identified competency '*Recommend the aggregate for the given type of road.*'
 - i. Understand the quality of aggregate in terms of shape requirement.
 - ii. Check the suitability of given aggregate for proposed road construction.

VI Relevant Affective domain related

- a. Follow safety practices.
- b. Practice good housekeeping.
- c. Demonstrate working as a leader/a team member.
- d. Maintain tools and equipment.
- e. Follow ethical Practices.

VII Minimum Theoretical Background

The flakiness index of aggregates is the percentage by weight of particles whose least dimension (thickness) is less than three fifths (0.6) of their mean dimension. The test is not applicable to sizes smaller than 6.3 mm.

In pavement construction flaky and elongated particles are to be avoided, particularly in surface course. In flaky and elongated aggregate are present in appreciable proportions, the strength of pavement layer would be adversely affected due to possibility of breaking down under loads. In cement concrete the workability is also reduced. However, the reduction in strength in cement concrete depends on the cement content.

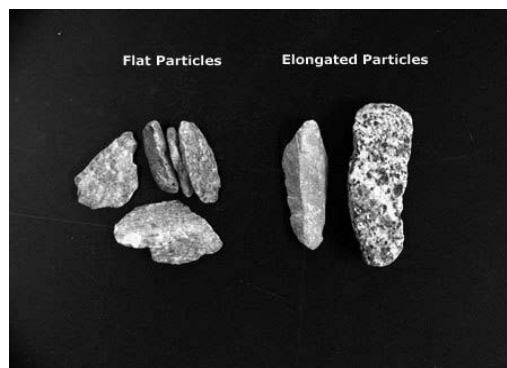


Figure 1 : Flaky and Elongated aggregate

IRC Recommendations:

Sr. No.	Type of Construction	Maximum limit of Flakiness Index
1	Bituminous and Non-bituminous Roads	15 %
2	Combined Flakiness and Elongation Index for Both Bituminous and Non-bituminous Roads	30 % (Combined)
3	Concrete roads	35 %

VIII Practical Set-up

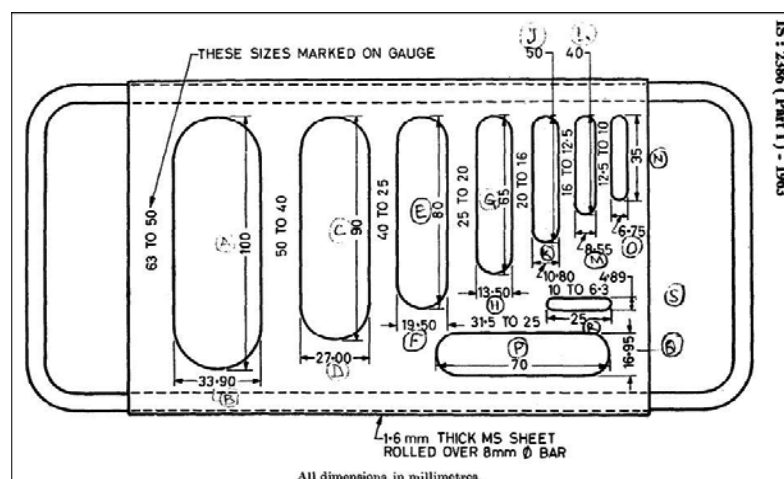


Figure 2: Thickness Gauge

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Thickness Gauge	As per IS:2386(Part-I)-1963	2 Nos.	
2	IS sieves of sizes	63, 50, 40, 31.5, 25, 20, 16, 12.5, 10 and 6.3 mm	1 No. each	
3	Electronic balance	0.001 gm accuracy	1 No.	
4	Aggregate Sample	--	--	

X Procedure

1. Sieve the given aggregate sample through the sieves specified in observation table given below.
2. Take minimum 200 pieces of sieved sample and measure its weight 'W' in grams.
3. Now, pass the each individual aggregate particle thickness wise through various opening of thickness gauge.
4. Note down the weight of aggregate fraction passed through opening of various sizes in the observation table given below as 'W₁' in grams. The weight of aggregate fraction should be measured to an accuracy of at least 0.1 percent of the test sample.
5. Calculate the flakiness index of given aggregate sample as $(W_1 / W) \times 100$ in percentage.

XI Precautions to be followed

The aggregate particle should pass through opening along its thickness only.

The weighing of particles should be done accurately and record the same carefully.

While sieving, care must be taken that the particles that are choked in the sieve must not be forced down into the next sieve. Such particles should be pushed back into the same sieve.

While placing different fractions on the table, place them some distance apart so that no two fractions may get mixed.

Be careful while selecting the opening of the flakiness gauges for any particular fraction.

XII Actual procedure followed (To be written by students)

(Use blank sheet provided if space not sufficient)

[Space for Answers]

.....

.....

.....

.....

.....

.....

.....

.....

XIII Resources used

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

XIV Precautions followed**XV Observations and Calculations** (Use blank sheet provided if space not sufficient)

Sr. No.	Aggregate sample passing through IS sieve (mm)	Aggregate sample retained through IS sieve (mm)	Thickness gauge size (mm)	Weight of aggregate sample taken W (gm)	Weight of aggregates in each fraction passing thickness gauge W_1 (gm)
1	63	50	33.90		
2	50	40	27.00		
3	40	25	19.50		
4	25	20	13.50		
5	20	16	10.80		
6	16	12.5	8.55		
7	12.5	10	6.75		
8	10	6.3	4.89		
				W =	W_1 =
Flakiness Index				$(W_1 / W) \times 100 =$	

Sample Calculations:

XVI Results

The flakiness index of given aggregate sample is%.

.....

.....

.....

XVII Interpretation of results (Give meaning of the above obtained results)

.....

.....

.....

XVIII Conclusions and Recommendations if any (*To be written by students*)

(*Actions/decisions to be taken based on the interpretation of results*).

.....

.....

.....

XIX 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. State the significance of flakiness index test of an aggregate.
2. State the use of flakiness index in case of concrete road works.
3. State the effect of larger value of flakiness index on concrete properties.
4. Enlist the factors affecting the flakiness index of an aggregate.

[Space for Answers]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

[illegible]

XX References / Suggestions for further Reading

Sr. No	Title of Book	Author	Publication
1	Highway Engineering	Khanna S.K. , Justo, C E G and Veeraragavan, A.	Nem Chand and Brothers, Roorkee, 2010, ISBN 978-8185240800
2	Laboratory Manual in Highway Engineering	Duggal, Ajay K. and Puri, V. P.	New Age International (P) Limited, Publishers, New Delhi, 2010, ISBN: 9788122403107
3	Road, Railways, Bridge and Tunnel Engg	Birdi, Ahuja,	Standard Book House, New Delhi, March 2010, ISBN: 978-8189401337
4	IS : 2386 (Part I) – 1963 – Method of test for aggregates for concrete (Part I) Particle size and shape.		

XXI Suggested Assessment Scheme

Performance Indicators		Weightage %
Process related : 15 Marks		60 %
1	Sieving of aggregate using IS sieves	20%
2	Weighing of sample	30%
3	Working in team	10%
Product related :10 Marks		40 %
4	Conclusions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total : 25 Marks		100 %

List of Student Team Members

- 1
- 2
3.
- 4..

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No. 03: Elongation Index Test

I Practical Significance

The particle shape of aggregates (road metals) is determined by the percentages of flaky and elongated particles contained in it. In the case of gravel it is determined by its angularity number. For base course and construction of bituminous and cement concrete types, the presence of flaky and elongated particles are considered undesirable as they may cause inherent weakness with possibilities of breaking down under heavy loads. Rounded aggregates are preferred in cement concrete road construction as the workability of concrete improves. Angular shape of particles is desirable for granular base course due to increased stability derived from the better interlocking. Thus evaluation of shape of the particles, particularly with reference to flakiness, elongation of angularity is necessary.

II Relevant Program Outcomes (POs)

- PO 1. *Basic knowledge:*** *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*
- PO 2. *Discipline knowledge:*** *An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*
- PO 3. *Experiments and practice:*** *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*
- PO 4. *Engineering tools:*** *Apply relevant civil technologies and tools with an understanding of the limitations.*
- PO 8. *Individual and Team Work:*** *Function effectively as leader and team member in Diverse /multidisciplinary team*

III Relevant Course Outcomes

- i. Perform different tests on road materials.

IV Practical Outcome

Conduct Elongation Index Test on the aggregates.

V Competency and Practical Skills

- This practical is expected to develop the following skills for the industry identified competency '*Recommend the aggregate for the given type of road.*'
 - i. Understand the quality of aggregate in terms of shape requirement.
 - ii. Check the suitability of given aggregate for proposed road construction.

VI Relevant Affective domain related

- a. Follow safety practices.
- b. Practice good housekeeping.
- c. Demonstrate working as a leader/a team member.
- d. Maintain tools and equipment.
- e. Follow ethical Practices.

VII Minimum Theoretical Background

The elongation index of an aggregate is the percentage by weight of particles whose greatest dimension (length) is greater than one and fifth times (1.8 times) their mean dimension. The test is not applicable to sizes smaller than 6.3 mm.

In pavement construction flaky and elongated particles are to be avoided, particularly in surface course. In flaky and elongated aggregate are present in appreciable proportions, the strength of pavement layer would be adversely affected due to possibility of breaking down under loads. In cement concrete the workability is also reduced. However, the reduction in strength in cement concrete depends on the cement content.

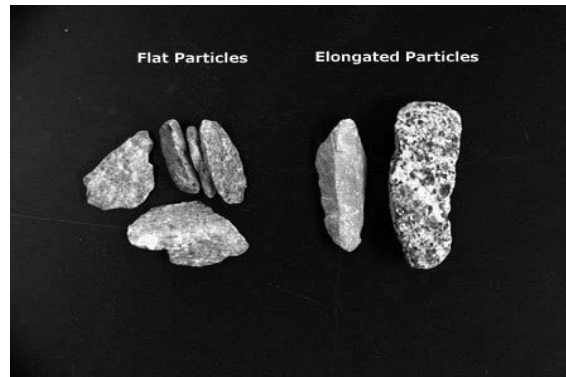


Figure 1 : Flaky and Elongated aggregate

IRC RECOMMENDATIONS:

Sr. No.	Type of Construction	Maximum limit of Elongation Index
1	Bituminous and Non-bituminous Roads	15 %
2	Combined Flakiness and Elongation Index for Both Bituminous and Non-bituminous Roads	30 % (Combined)
3	Concrete roads	35 %

VIII Practical Set-up

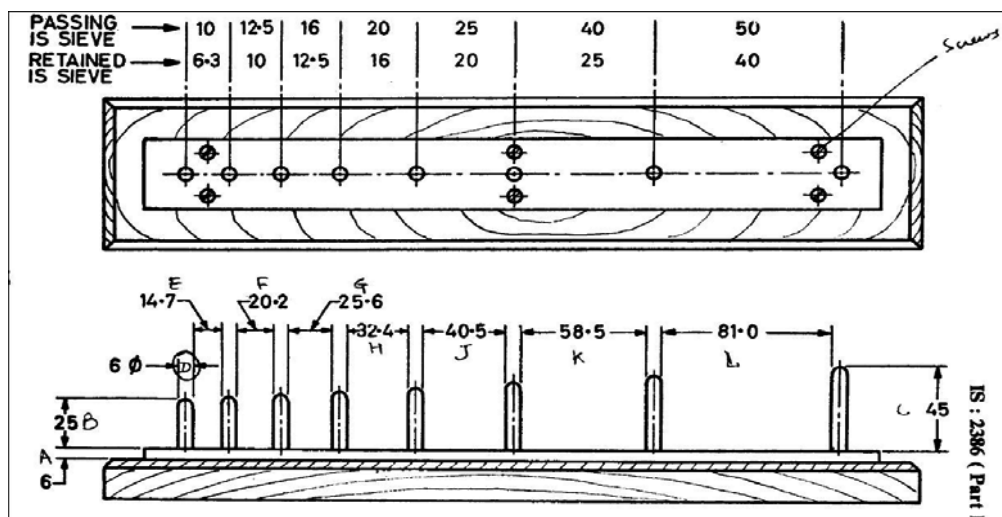


Figure 2 : Length Gauge

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Length Gauge	As per IS:2386(Part-I)-1963	2 Nos.	
2	IS sieves of sizes	63, 50, 40, 31.5, 25, 20, 16, 12.5, 10 and 6.3 mm	1 No. each	
3	Electronic balance	0.001 gm accuracy	1 No.	
4	Aggregate Sample	--	--	

X Procedure

1. Sieve the given aggregate sample through the sieves specified in observation table given below.
2. Take minimum 200 pieces of sieved sample and measure its weight 'W' in grams.
3. Now, pass the each individual aggregate particle thickness wise through various opening of thickness gauge.
4. Note down the weight of aggregate fraction retained on opening of various sizes mentioned in the observation table given below as 'W₁' in grams. The weight of aggregate fraction should be measured to an accuracy of at least 0.1 percent of the test sample.
5. Calculate the elongation index of given aggregate sample as $(W_1 / W) \times 100$ in percentage.

XI Precautions to be followed

1. The aggregate particle should pass through opening along its length only.
2. The weighing of particles should be done accurately and record the same carefully.
3. While sieving, care must be taken that the particles that are choked in the sieve must not be forced down into the next sieve. Such particles should be pushed back into the same sieve.
4. While placing different fractions on the table, place them some distance apart so that no two fractions may get mixed.
5. Be careful while selecting the opening of the elongation gauges for any particular fraction.

XII Actual procedure followed (To be written by students)

(Use blank sheet provided if space not sufficient)

[Space for Answers]

.....

.....

.....

.....

.....

.....

XIII Resources used

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

XIV Precautions followed**XV Observations and Calculations** (Use blank sheet provided if space not sufficient)

Sr. No.	Aggregate sample passing through IS sieve (mm)	Aggregate sample retained through IS sieve (mm)	Length gauge size (mm)	Weight of aggregate sample taken W (gm)	Weight of aggregates in each fraction retained on length gauge W ₁ (gm)
1	50	40	81.0		
2	40	25	58.5		
3	25	20	40.5		
4	20	16	32.4		
5	16	12.5	25.6		
6	12.5	10	20.2		
7	10	6.3	14.7		
				W =	W ₁ =
Elongation Index				(W ₁ /W)x100 =	

Sample Calculations:**XVI Results**

The elongation index of given aggregate sample is%.

[illegible]

XX References / Suggestions for further Reading

Sr.No	Title of Book	Author	Publication
1.	Highway Engineering	Khanna S.K. , Justo, C E G and Veeraragavan, A.	Nem Chand and Brothers, Roorkee, 2010, ISBN 978-8185240800
2.	Laboratory Manual in Highway Engineering	Duggal, Ajay K. and Puri, V. P.	New Age International (P) Limited, Publishers, New Delhi, 2010, ISBN: 9788122403107
3.	Road, Railways, Bridge and Tunnel Engg	Birdi, Ahuja,	Standard Book House, New Delhi, March 2010, ISBN: 978-8189401337
4	IS : 2386 (Part I) – 1963 – Method of test for aggregates for concrete (Part I) Particle size and shape.		

XXI Suggested Assessment Scheme

Performance Indicators		Weightage %
Process related : 15 Marks		60 %
1	Sieving of aggregate using IS sieves	20%
2	Weighing of sample	30%
3	Working in team	10%
Product related :10 Marks		40 %
4	Conclusions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total : 25 Marks		100%

List of Student Team Members

1

2

3.

4.. ..

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No.04: Angularity Number Test

I Practical Significance

Degree of packing of particles of one size depends on their shape. The angularity of aggregates can be estimated from the proportion of voids among particles compacted in a standard manner. Rounded aggregates results to minimum void content and angular aggregates results into more voids. Void in a aggregate system depends on the shape of the aggregate. All other shapes except rounded aggregates result into more voids. This concept is utilized in determining the shape of the aggregate by indirect method i.e Angularity Number. Angularity number is 67- % of solid volume in a vessel filled with aggregates in a standard manner. The number 67 represents solid volume of most rounded gravel.

The particle shape of aggregates (road metals) is determined by the percentages of flaky and elongated particles contained in it. In the case of gravel it is determined by its angularity number. For base course and construction of bituminous and cement concrete types, the presence of flaky and elongated particles are considered undesirable as they may cause inherent weakness with possibilities of breaking down under heavy loads. Rounded aggregates are preferred in cement concrete road construction as the workability of concrete improves. Angular shape of particles is desirable for granular base course due to increased stability derived from the better interlocking. Thus evaluation of shape of the particles, particularly with reference to flakiness, elongation of angularity is necessary.

II Relevant Program Outcomes (POs)

PO 1. Basic knowledge: *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. Discipline knowledge: *An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 3. Experiments and practice: *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*

PO 4. Engineering tools: *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

III Relevant Course Outcomes

- i. Perform different tests on road materials.

IV Practical Outcome

Conduct Angularity Number Test on the aggregates.

V Competency and Practical Skills

- This practical is expected to develop the following skills for the industry identified competency ***‘Recommend the aggregate for the given type of road.’***

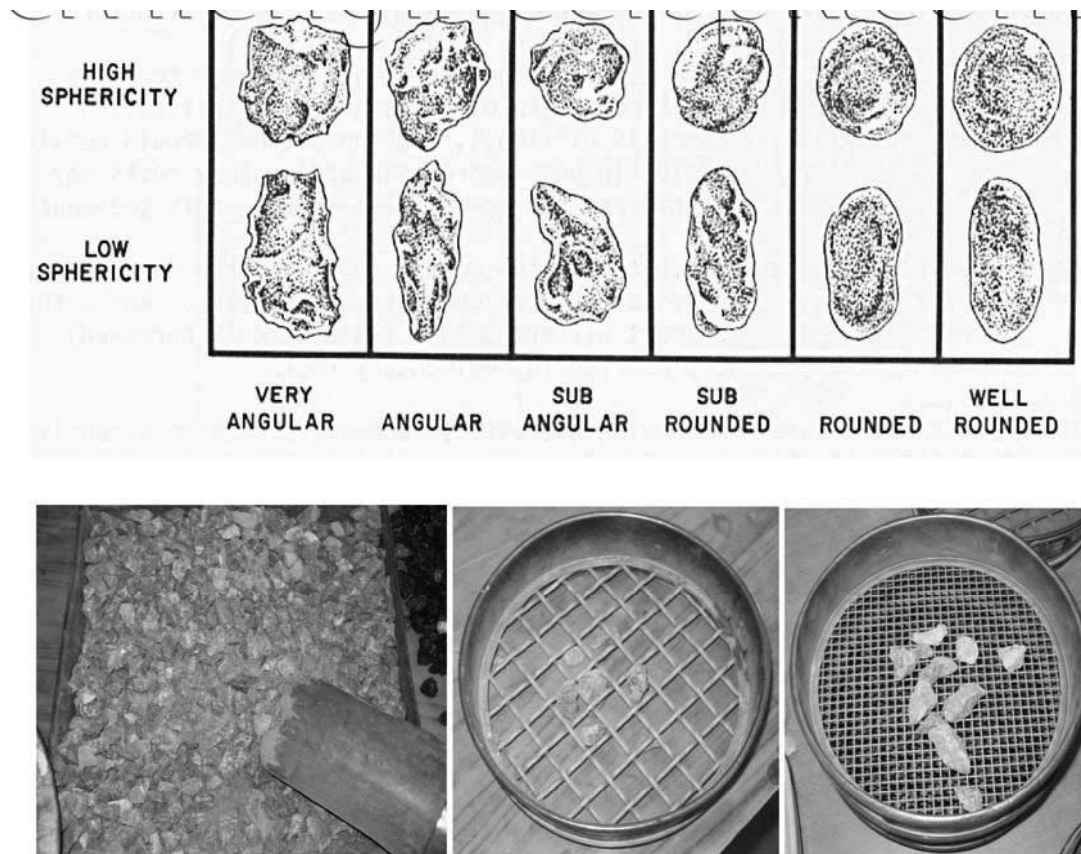
- Understand the quality of aggregate in terms of shape requirement.
- Check the suitability of given aggregate for proposed road construction.

VI Relevant Affective domain related

- Follow safety practices.
- Practice good housekeeping.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical Practices.

VII Minimum Theoretical Background

The angularity number measures the percent voids in excess of 33 % which is for the most rounded gravel. The angularity number range from 0 for highly rounded gravel to about 11 for freshly crushed angular aggregates. Thus, higher the angularity number, more and angular and less workable is the aggregate mix. In cement concrete mixes, rounded aggregates may be preferred because of the lesser specified surface and higher strength for particular cement content. But in Bituminous and water bound macadam construction, angular aggregate with high angularity number is preferred because of higher stability due to better inter locking and friction.



Sample

Coarse Aggregates passing through sieve 3/4" & Retaining on sieve 3/4"

Figure 1: Types of Aggregate and sample sieves

IRC Recommendations:

- The angularity number ranges from 0 for a highly rounded aggregate to about 11 for freshly crushed angular aggregates.
- Higher the angularity number, more angular and less workable is the concrete mix.
- In cement concrete roads (rigid pavements) rounded aggregates are preferred because of better workability and higher strength.
- In bituminous or water bound macadam construction (like flexible pavements), angular aggregates with high angularity number are preferred because of high stability due to better interlocking and friction.
- Higher the angularity number, more angular and less workable is the concrete mix.
- The value of angularity number generally lies between 0 & 11. In road construction angularity number of 7 – 10 is generally preferred.

VIII Practical Set-up



Container



Steel rod
Dia = 16mm
Length = 60cm



Wet aggregates



Aggregates + water



water filled container

Figure 2 : Angularity Number Test

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Metal Cylinder	IS: 2386 (Part I) – 1963; Closed at one end and of about 3 liter capacity, the diameter and height of it being approx. equal.	1 No.	
2	Metal tamping rod	Circular cross section 16 mm dia. And 600 mm in length and rounded at one end	1 No.	
3	Sieves	(20,16,12.5,10,6.3,4.75mm)		
4	Metal scoop	1 liter if heaped capacity of size 200x120x50mm	1 No.	
5	Balance	Capacity 10 kg. to weigh up to 1 gm		
6	Aggregate Sample	--	--	

X Procedure

1. The aggregate to be tested is dried for at least 24 hours in a well ventilated oven maintained at a temperature of 100 to 110°C.
2. The aggregate is compacted in three layers, each layer being given 100 blows using the standard tamping rod at a rate of 2 blows / second by lifting the rod 5 cm above the surface of the aggregate and then allowing it to fall freely.
3. The blows are uniformly distributed over the surface of the aggregate.
4. After compaction the third layer, the cylinder is filled to overflowing and excess material is removed off with tamping rod as a straight edge.
5. The aggregate with cylinder is then weighed. Three separate determinations are made and mean weight of the aggregate in the cylinder is calculated.

XI Precautions to be followed

1. Use safety shoes, mask & aprons at the time of test.
2. Use safety shoes, mask & aprons at the time of test.
3. Thoroughly clean & dry the container before testing.
4. Special care should be taken that no outer air enters when using the balance.
5. After test sieve should be clean by a soft brush.

XII Actual procedure followed (To be written by students) (Use blank sheet provided if space not sufficient)

.....

.....

.....

.....

.....

.....

XIII Resources used

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

XIV Precautions followed

.....

.....

.....

.....

.....

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

Weight of empty cylinder $W = \dots\dots\dots$ gm.

Weight of cylinder filled with water $W_1 = \dots\dots\dots$ gm

Weight of cylinder filled with aggregate $W_2 = \dots\dots\dots$ gm

Sr. No.	Weight of water required to fill the cylinder ($W_1 - W$) gm	Weight of aggregate required to fill the cylinder ($W_2 - W$) (gm)			Mean Weight of aggregate required to fill the cylinder (gm)
		1	2	3	
1					
2					
3					

Sample Calculations:

Angularity Number $= 67 - ((100X W) / (C \times G_s))$

=

=

Where,

W = mean weight of the aggregate filling cylinder.

C = Weight of water required to completely fill the cylinder (i.e. Volume of cylinder)

G_s = Specific Gravity of the aggregate (*Assume $G = 2.5$ to 2.9 for road construction in Maharashtra*)

[illegible]

XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Highway Engineering	Khanna S.K. , Justo, C E G and Veeraragavan, A.	Nem Chand and Brothers, Roorkee, 2010, ISBN 978-8185240800
2	Laboratory Manual in Highway Engineering	Duggal, Ajay K. and Puri, V. P.	New Age International (P) Limited, Publishers, New Delhi, 2010, ISBN: 9788122403107
3	Road, Railways, Bridge and Tunnel Engg	Birdi, Ahuja,	Standard Book House, New Delhi, March 2010, ISBN: 978-8189401337

XXI Suggested Assessment Scheme

Performance Indicators		Weightage %
Process related : 15 Marks		60 %
1	Sieving of aggregate using IS sieves	20%
2	Weighing of sample	30%
3	Working in team	10%
Product related :10 Marks		40 %
4	Conclusions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total : 25 Marks		100 %

List of Student Team Members

- 1
- 2
3.
- 4..

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No. 05: Softening Point Test

I Practical Significance

Bitumen does not suddenly change from solid to liquid state, but as the temperature increases, it gradually becomes softer until it flows readily. All semi-solid state bitumen grades need sufficient fluidity before they are used for application with the aggregate mix. For this purpose, bitumen is sometimes cut back with solvent like kerosene. The common procedure however is to liquefy the bitumen by heating. The softening point is the temperature at which the substance attains particular degree of softening under specified condition of test. For bitumen, it is usually determined by Ring and Ball Test. A brass ring containing the test sample of bitumen is suspended in liquid like water or glycerin at a given temperature. A steel ball is placed upon the bitumen and liquid medium is then heated at a specified rate. The temperature at which the soft bitumen touches the metal plate placed at a specified distance below the ring is recorded as the softening point of a particular bitumen. The apparatus and test procedure are standardized by ISI. It is obvious that harder grade bitumen possess higher softening point than softer grade bitumen.

II Relevant Program Outcomes (POs)

PO 1. Basic knowledge: *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. Discipline knowledge: *An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 3. Experiments and practice: *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*

PO 4. Engineering tools: *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

III Relevant Course Outcomes

Perform different tests on road materials.

IV Practical Outcome

Conduct Softening point test on bitumen.

V Competency and Practical Skills

- This practical is expected to develop the following skills for the industry identified competency ***‘Recommend the bitumen for the given type of road.’***
 - i. Understand the quality of bitumen in terms of degree of softening.
 - ii. Check the suitability of given bitumen sample for proposed bituminous road construction work.

VI Relevant Affective domain related

- a. Follow safety practices.
- b. Practice good housekeeping.
- c. Demonstrate working as a leader/a team member.
- d. Maintain tools and equipment.
- e. Follow ethical Practices.

VII Minimum Theoretical Background

Bitumen is a thermoplastic material and its stiffness is dependent on temperature. The temperature-vs-stiffness relationship of bitumen is dependent on the source of crude oil and the method of refining.

The Bureau of Indian Standards (BIS) introduced paving grade bitumen specifications (IS: 73-1950) for the first time in the year 1950 and classified it on penetration. The specifications were revised in the years 1962 and 1992. To improve the quality of Bitumen, BIS revised IS-73-1992 specifications based on Viscosity (Viscosity at 60°C) in July 2006. As per these specifications, there are four grades VG-10, VG-20, VG-30 & VG-40. A few qualification tests like specific gravity, water content, ductility, loss on heating & Farass breaking point were removed from IS:73-1992 specifications as these tests do not have any relationship either with the quality or performance of the product.

Indian Oil commenced marketing of Bitumen as per Viscosity Grade specifications conforming to IS: 73-1992 from all its refineries from Aug 2009. Therefore, the Penetration grades have been replaced by Viscosity grade Bitumen. According to viscosity (degree of fluidity) grading, higher the grade, stiffer the Bitumen. Tests are conducted at 60°C and 135°C, which represent the temperature of road surface during summer (hot climate, similar to northern parts of India) and mixing temperature respectively. The penetration at 25°C, which is annual average pavement temperature, is also retained.

Different Grades of Bitumen marketed by Indian Oil:

VG-10 BITUMEN: VG-10 is widely used in spraying applications such as surface dressing and paving in very cold climate in lieu of old 80/100 Penetration grade. It is also used to manufacture Bitumen Emulsion and Modified Bitumen products.

VG-20 BITUMEN: VG-20 is used for paving in cold climate & high altitude regions

VG-30 BITUMEN: VG-30 is primarily used to construct extra heavy duty Bitumen pavements that need to endure substantial traffic loads. It can be used in lieu of 60/70 Penetration grade.

VG-40 BITUMEN: VG-40 is used in highly stressed areas such as intersections, near toll booth and truck parking lots in lieu of old 30/40 Penetration grade. Due to its higher viscosity, stiffer Bitumen mixes can be produced to improve resistance to shoving and other problems associated with higher temperature and heavy traffic loads.

IRC Recommendations:

The temperature at the instant when each of the ball and sample touches the bottom plate of support is recorded as softening point value. The mean of duplicate determinations is noted. It is essential that the mean value of the softening point (temperature) does not differ from individual observation by more than the following limits:

Softening Point	Repeatability	Reproducibility
Below 30 °C	2 °C	4 °C
30 °C to 80 °C	1 °C	2 °C
Above 80 °C	2 °C	4 °C



Figure 1: Bitumen and its melting

VIII Practical Set-up

Figure 2: Softening Point Test Apparatus accessories

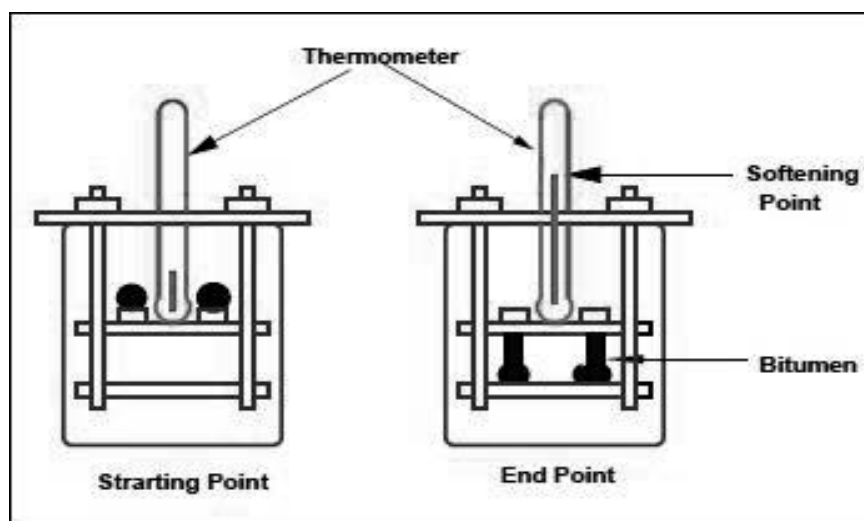


Figure 3: Softening Point Test Apparatus or Ring and Ball Test Apparatus

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Ring and Ball Test Apparatus	As per IS:1205-1978	1 No.	
2	Steel Balls	Each has a diameter 9.5 mm and weighs 2.5 ± 0.5 gm	2 Nos.	
3	Brass Rings	Depth : 6.4 mm Inside diameter at bottom : 15.9mm Inside diameter at top : 17.5 mm Outside diameter : 20.6mm	2 Nos.	
4	Bath and Stirrer	A heat resistant glass container of 85 mm diameter and 120 mm depth is used. Bath liquid is water for materials having softening point above 80 °C, and glycerin for materials having softening point above 80 °C. Mechanical stirrer is used for ensuring uniform heat distribution at all times throughout the bath	1 No.	

X Procedure

1. Sample material is heated to a temperature between 75 °C TO 100 °C above the approximate softening point until it is completely fluid and is poured in heated rings placed on metal plate.
2. To avoid sticking of the bitumen to metal plate, coating is done to this with a solution of glycerin and dextrin.
3. After cooling the rings in air for 30 minutes, the excess bitumen is trimmed and rings are placed in the support as discussed in item (c) above.
4. At this time, the temperature of distilled water is kept at 50 °C. This temperature is maintained for 15 minutes after which the balls are placed in position.
5. The temperature of water is raised at a uniform rate of 5 °C per minute with a controlled bottom plate by sinking of balls. At least two observations are made.
6. For material whose softening point is above 80 °C, Glycerin is used in heating medium and the starting temperature is 35 °C instead of 5°C.

XI Precautions to be followed

1. Use hand gloves, apron while removing containers from hot plate after switching off the hotplate.
2. Record the temperature as soon as steel ball will touch the lower platform.
3. Maintain the room temperature as specified.
4. Distilled water should be used as the heating medium.
5. During the conduct of test the apparatus should not be subjected to vibrations.
6. The bulb of the thermometer should be at about the same level as the rings.
7. Use glycerin for remove of bitumen from the container.
8. Use safety shoes & Apron at the time of test.
9. Equipment should be cleaned thoroughly before testing & after testing.

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

.....

.....

.....

XIII Resources used

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

XIV Precautions followed

.....

.....

.....

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

Sr. No.	Temperature at which bitumen soften and steel ball touches the bottom plate by sinking of ball	Reading 1 in Degree Centigrade (Ball 1 touches plate)	Reading 2 in Degree Centigrade (Ball 2 touches plate)	Mean value in Degree Centigrade
1				
2				
3				
Final softening point temperature in degree centigrade				

Sample Calculations:

.....

.....

.....

XVI Results

The softening point of given bitumen sample is⁰C.

.....

.....

.....

XVII Interpretation of results (Give meaning of the above obtained results)

.....

.....

.....

XVIII Conclusions and Recommendations (if any) (To be written by students)

(Actions/decisions to be taken based on the interpretation of results).

.....

.....

.....

XIX 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. Give the significance of softening point of bitumen for road construction works.
2. State the media used for heating the bitumen sample in this experiment.
3. State the softening point of bitumen of various grades used in bituminous pavement construction.
4. Compare the softening point for asphalt and tar.
5. State the rate of heating the bitumen sample.

[Space for Answers]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

[illegible]

XX References / Suggestions for further Reading

Sr.No	Title of Book	Author	Publication
1	Highway Engineering	Khanna S.K. , Justo, C E G and Veeraragavan, A.	Nem Chand and Brothers, Roorkee, 2010, ISBN 978-8185240800
2	Road, Railways, Bridge and Tunnel Engg	Birdi, Ahuja,	Standard Book House, New Delhi, March 2010, ISBN: 978-8189401337
3	Laboratory Manual in Highway Engineering	Duggal, Ajay K. and Puri, V. P.	New Age International (P) Limited, Publishers, New Delhi, 2010, ISBN: 9788122403107
4	IS : 1205-1978-Indian standard methods for testing tar and bituminous materials (Determination of softening point)		

XXI Suggested Assessment Scheme

Sr.No	Performance Indicators	Weightage %
Process related : 15 Marks		60 %
1	Performing the test accurately	20%
2	Noting down the observations	30%
3	Working in team	10%
Product related :10 Marks		40 %
4	Conclusions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total : 25 Marks		100%

List of Student Team Members

- 1
- 2
3.
- 4..

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No. 06: Standard Penetration Test

I Practical Significance

Bituminous materials are available in variety of types and grades. The penetration test determines the hardness of these materials by measuring the depth in tenth of a millimeter to which a standard needle will penetrate vertically under specified conditions of standard load, time and temperature. The sample is maintained at the standard temperature of 25°C. The total load on needle is 100 gm. The softer the bitumen, the greater will be its number of penetration unit. Indian Standards Institution has standardized the equipment and test procedure vide IS 1203-1958 Penetration test is widely used world over for classifying the bituminous materials into different grades Even though it is recognized recently that the empirical tests like penetration, softening point etc are incompetent to qualify the paving binder for its temperature susceptibility characteristics, its quickness and simplicity of operations cannot be ignored. Correlations are also established between penetration test and absolute viscosity test values.

II Relevant Program Outcomes (POs)

PO 1. Basic knowledge: *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. Discipline knowledge: *An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 3. Experiments and practice: *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*

PO 4. Engineering tools: *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

III Relevant Course Outcomes

Perform different tests on road materials.

IV Practical Outcome

Conduct Penetration point test on bitumen.

V Competency and Practical Skills

- This practical is expected to develop the following skills for the industry identified competency '***Recommend the bitumen for the given type of road.***'
 - i. Understand the quality of bitumen in terms of penetration resistance.
 - ii. Check the suitability of given bitumen sample for proposed bituminous road construction work.

VI Relevant Affective domain related

- a. Follow safety practices.
- b. Practice good housekeeping.
- c. Demonstrate working as a leader/a team member.
- d. Maintain tools and equipment.
- e. Follow ethical Practices.

VII Minimum Theoretical Background

It may be noted that the penetration value is largely influenced by an inaccuracy as regards Pouring Temperature, Size of needles, Weight placed on the needle and Test Temperature. It is obvious to obtain high values of penetration if the test temperature and/or weight (placed over the needle) are/is increased. Higher pouring temperatures than the specified may result into hardening of bitumen and may give lower penetration values. Higher test temperatures have given considerably higher penetration values. It is also necessary to keep the needle clean before testing in order to get consistent results. The penetration needle should not be placed more than 10 mm from the side of the dish

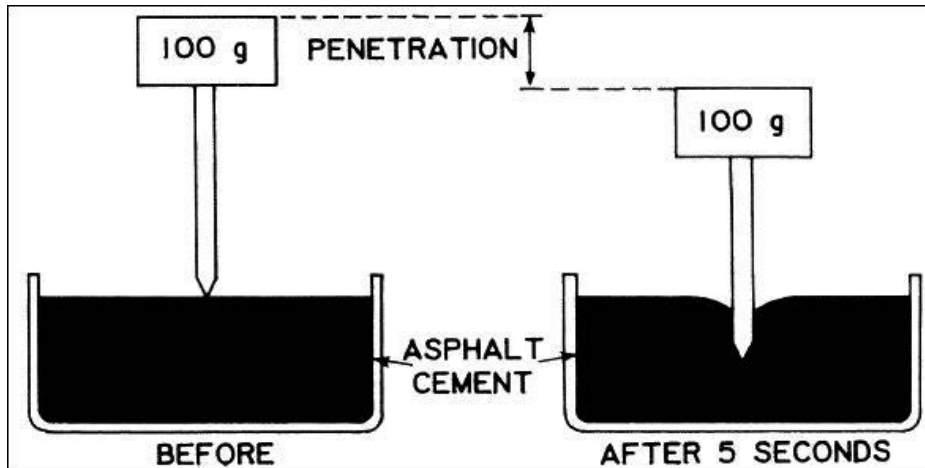


Figure 1: Concept of penetration resistance of bitumen

IRC Recommendations:

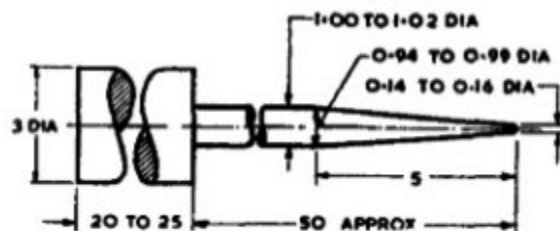
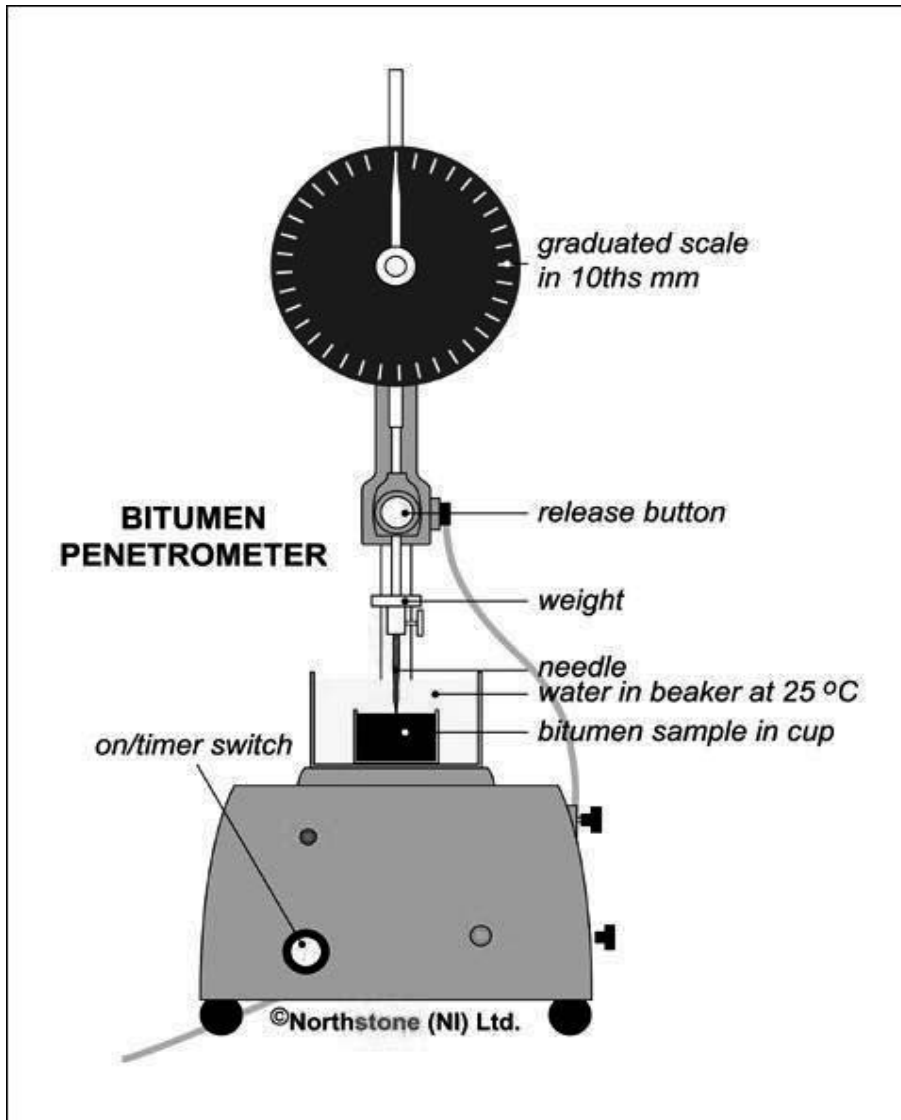
The depth of penetration is reported in hundredths of a centimeter. The mean value of three consistent measurements is reported as the penetration value. It is further specified by I SI that results of each measurements should not vary from the mean value reported above by more than the following: Penetration Grade Repeatability 0-80 4% 80- 225 5% Above 225 7%

Penetration grade	Repeatability
0-80	4 %
80-225	5 %
Above 225	7 %



Figure 2: Bitumen and its melting

VIII Practical Set-up



All dimensions in millimetres.

Figure 3: Standard Penetrometer

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Penetrometer	As per IS: 1203-1978	1 No.	
2	Container	A flat bottomed cylindrical metallic container 55 mm in diameter and 35 mm or 57 mm in height	1 No.	
3	Needle	A straight, highly polished cylindrical hard steel needle with conical end, having the shape and dimensions as shown in fig. Needle is provided with a shank appropriately 3 mm in diameter into which it is immovably fixed.	1 No.	
4	Water Bath	A water bath is maintained at $25 \pm 1^\circ\text{C}$ containing not less than 10 liters of water, the sample is immersed to depth not less than 100 mm from the top and supported on a perforated shelf not less than 50 mm from the bottom of the bath.	1 No.	
5	Transfer Tray	It is an apparatus which allows the needle to penetrate without appreciable friction. It is accurately calibrated to yield results in hundreds of centimeters "These days automatic Penetrometers (electrically operated) are also available. Typical sketch of Penetrometer is shown in figure.	1 No.	

X Procedure

1. The bitumen is softened to a pouring consistency between 75°C and 100°C above the approximated temperature at which bitumen softens
2. The sample material is thoroughly stirred to make it homogenous and free from air bubbles and water
3. The sample material is then poured into the container to a depth at least 15 mm more than the expected penetration
4. The sample containers are cooled in atmosphere of temperature not lower than 18°C for one hour. Then they are placed in temperature controlled water bath at a temperature of 25°C for a period of one hour.
5. The sample container is placed in the transfer tray with water from the water bath and is placed under the needle of the penetrometer.
6. The weight of needle, shaft and additional weight are checked. The total weight of this assembly should be 100 ± 0.25 gm.
7. The needle is now arranged to make contact with the sample surface. This is done by placing a lamp to the rear of the apparatus in such a way that the image of the needle can be checked to make surface contact.
8. Zero reading of the penetrometer dial is taken before-releasing the needle.
9. The needle is released-for- 5 seconds and-the final reading is taken on the dial.
10. At least three measurements are made on this sample by testing at distance not less than 10 mm apart.
11. After each test, the needle is disengaged and wiped with benzene and carefully dried.
12. The sample container is also transferred in the water bath before next testing is done so as to maintain a constant temperature of 25°C .
13. The test is repeated with sample in the other containers.

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

- i. Pouring Temp °C =
- ii. Bath material =
- iii. Period of air cooling at 30 °C temp. =
- iv. Period of water bath at constant temp, of 25 °C =
- v. Room Temp. =
- vi. Depth of Sample =

Sr. No	Sample	Penetration Dial Gauge Reading			Mean Penetration
		Initial	Final	Difference	

Sample Calculations:

.....

.....

.....

XVI Results

The Penetration value of given bitumen sample isin (1/10)th of mm

.....

.....

.....

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

.....

.....

.....

XVIII Conclusions and Recommendations if any (*Actions/decisions to be taken based on the interpretation of results*).

.....

.....

.....

XIX 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. How penetration value is expressed?
2. What are the standard load, time and temperature specified for penetration test?
3. What are the effects of higher test temperature, higher pouring temperature on penetration value of bitumen sample?
4. Bitumen of 80/100 grade means the penetration value is in the range of is according to the standard test.

[Space for Answers]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

XX References / Suggestions for further Reading

Sr.No	Title of Book	Author	Publication
1	Highway Engineering	Khanna S.K. , Justo, C E G and Veeraragavan, A.	Nem Chand and Brothers, Roorkee, 2010, ISBN 978-8185240800
2	Road, Railways, Bridge and Tunnel Engg	Birdi, Ahuja,	Standard Book House, New Delhi, March 2010, ISBN: 978-8189401337

XX Suggested Assessment Scheme

Sr.No	Performance Indicators	Weightage %
Process related : 15 Marks		60 %
1	Performing the test accurately	20%
2	Noting down the observations	30%
3	Working in team	10%
Product related :10 Marks		40 %
4	Conclusions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total : 25 Marks		100%

List of Student Team Members

- 1
- 2
3.
- 4..

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No.07: Flash and Fire Point Test

I Practical Significance

The fundamental reason for the requirement of flash point measurements is to assess the safety hazard of bitumen with respect to flammability. It is used to warn of a risk and to enable the correct precautions to be taken when using such bitumen for road construction. It gives an idea about selecting the bitumen for proposed bituminous road work according to temperature of area. The appropriate use of bitumen leads to better resistance in particular temperature and further such road work shows minimum defects in it. It is necessary to conduct the flash and fire point test prior to its use, so that it can be easily handled even in extreme hot climatic conditions.

II Relevant Program Outcomes (POs)

PO 1. Basic knowledge: *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. Discipline knowledge: *An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 3. Experiments and practice: *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*

PO 4. Engineering tools: *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

III Relevant Course Outcomes

Perform different tests on road materials.

IV Practical Outcome

Conduct Flash and Fire Point test on bitumen.

V Competency and Practical Skills

- This practical is expected to develop the following skills for the industry identified competency '***Recommend the bitumen for the given type of road.***'
 - i. Understand the quality of bitumen in terms of ignition point.
 - ii. Check the suitability of given bitumen sample for proposed bituminous road construction work.
 - iii. Recording the temperature of bitumen for its ignition.

VI Relevant Affective domain related

- a. Follow safety practices.
- b. Practice good housekeeping.
- c. Demonstrate working as a leader/a team member.
- d. Maintain tools and equipment.
- e. Follow ethical Practices.

VII Minimum Theoretical Background

This test is done to determine the flash point and the fire point of asphaltic bitumen and fluxed native asphalt, cutback bitumen and blown type bitumen as per IS: 1209 – 1978. The principle behind this test is given below:

Flash Point – The flash point of a material is the lowest temperature at which the application of test flame causes the vapours from the material to momentarily catch fire in the form of a flash under specified conditions of the test.

Fire Point – The fire point is the lowest temperature at which the application of test flame causes the material to ignite and burn at least for 5 seconds under specified conditions of the test.

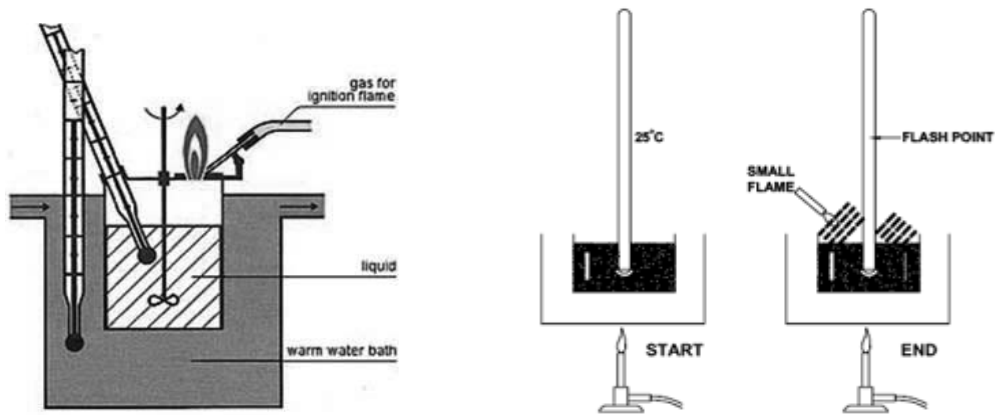


Figure 1 : Schematic Diagram of Flash and Fire Point Test

IRC RECOMMENDATIONS:

The minimum value of flash point by Pensky Martens closed type apparatus is 175°C for all grades of bitumen.

VIII Practical Set-up



Figure 2 : Pensky-Martens Apparatus

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Pensky-Martens apparatus	As per IS: 1209-1978	1 No.	
2	Thermometer	Low Range: -7 to 110°C, Graduation 0.5°C High Range: 90 to 370°C, Graduation 2°C	1 No. each	

X Procedure***For Flash Point***

1. Soften the bitumen between 75 and 100°C. Stir it thoroughly to remove air bubbles and water.
2. Fill the cup with the material to be tested up to the filling mark. Place it on the bath. Fix the open clip. Insert the thermometer of high or low range as per requirement and also the stirrer, to stir it.
3. Light the test flame, adjust it. Supply heat at such a rate that the temperature increase, recorded by the thermometer is neither less than 5°C nor more than 6°C per minute.
4. Open flash point is taken as that temperature when a flash first appears at any point on the surface of the material in the cup. Take care that the bluish halo that sometimes surrounds the test flame is not confused with the true flash. Discontinue the stirring during the application of the test flame.
5. Flash point should be taken as the temperature read on the thermometer at the time the flash occurs.

For Fire Point

6. After flash point, heating should be continued at such a rate that the increase in temperature recorded by the thermometer is neither less than 5°C nor more than 6°C per minute. ii) The test flame should be lighted and adjusted so that it is of the size of a bead 4mm in dia.

XI Precautions to be followed

1. The flash point should be taken as the temperature read on the thermometer at the time of the flame application that causes a distinct flash in the interior of the cup.
2. The fire point should be taken as the temperature read on the thermometer at which the application of test flame causes the material to ignite and burn for at least 5 seconds
3. Keep the body away from flame area. Also use hand gloves to handle heated parts.

XII Actual procedure followed (To be written by students)

(Use blank sheet provided if space not sufficient)

.....

.....

.....

.....

.....

.....

.....

XIII Resources used

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

XIV Precautions followed

.....

.....

.....

.....

.....

.....

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

Sr. No.	Test Property	Test I	Test II	Mean Value
1	Flash point ($^{\circ}\text{C}$)			
2	Fire point ($^{\circ}\text{C}$)			

Sample Calculations:

.....

.....

.....

.....

.....

.....

.....

XVI Results

The flash point of given bitumen sample is $^{\circ}\text{C}$.

The fire point of given bitumen sample is $^{\circ}\text{C}$.

.....

.....

.....

.....

.....

.....

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

.....

.....

.....

.....

XVIII Conclusions and Recommendations if any *(To be written by students)*
(Actions/decisions to be taken based on the interpretation of results).

.....

.....

.....

.....

XIX 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 purpose of flash and fire point test.
2. State the rate of heating of bitumen in flash and fire point test.
3. ‘The flash and fire point should be lesser as far as possible’, justify the statement.
4. What are the factors affecting the value of flash and fire point of bitumen in this test?

[Space to Write Answers]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

[illegible]

XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Highway Engineering	Khanna S.K. , Justo, C E G and Veeraragavan, A.	Nem Chand and Brothers, Roorkee, 2010, ISBN 978-8185240800
2	Road, Railways, Bridge and Tunnel Engg	Birdi, Ahuja,	Standard Book House, New Delhi, March 2010, ISBN: 978-8189401337
3	Laboratory Manual in Highway Engineering	Duggal, Ajay K. and Puri, V. P.	New Age International (P) Limited, Publishers, New Delhi, 2010, ISBN: 9788122403107
4	IS: 1209-1978-Indian standard methods for testing tar and bituminous materials (Determination of flash and fire point)		

XXI Suggested Assessment Scheme

Sr. No.	Performance Indicators	Weightage %
Process related : 15 Marks		60 %
1	Performing the test accurately	20%
2	Noting down the observations	30%
3	Working in team	10%
Product related :10 Marks		40 %
4	Conclusions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total : 25 Marks		

List of Student Team Members

- 1
- 2
- 3
- 4..

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No. 08: Ductility Test

I Practical Significance

In the flexible pavement construction where bitumen binders are used, it is of significant importance that the binders form ductile thin films around the aggregates. It has been stated by some agencies that the penetration and ductility properties go together; but depending upon the chemical composition and the type of crude source of the bitumen, sometimes it has been observed that the above statement is incorrect. It may hence be mentioned that the bitumen may satisfy the penetration value, but may fail to satisfy the ductility requirements. Bitumen paving engineer would however want that both test requirements are satisfied in the field jobs. Penetration or ductility is expressed as the distance in centimeters to which a standard briquette of bitumen can be stretched before the thread breaks. See fig. 1. The test is conducted at $27 \pm 0.5^\circ \text{C}$ and at a rate of pull of 50 ± 2.5 mm per minute. The test has been standardized by the IS1208-1978.

II Relevant Program Outcomes (POs)

- PO 1. Basic knowledge:** *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*
- PO 2. Discipline knowledge:** *An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*
- PO 3. Experiments and practice:** *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*
- PO 4. Engineering tools:** *Apply relevant civil technologies and tools with an understanding of the limitations.*
- PO 8. Individual and Team Work:** *Function effectively as leader and team member in Diverse /multidisciplinary team*

III Relevant Course Outcomes

Perform different tests on road materials.

IV Practical Outcome

Conduct Ductility test on Bitumen.

V Competency and Practical Skills

- This practical is expected to develop the following skills for the industry identified competency ***‘Recommend the bitumen for the given type of road.’***
 - i. Understand the quality of bitumen in terms of ignition point.
 - ii. Check the suitability of given bitumen sample for proposed bituminous road construction work.
 - iii. Recording the temperature of bitumen for its ignition.

VI Relevant Affective domain related

- a. Follow safety practices.
- b. Practice good housekeeping.
- c. Demonstrate working as a leader/a team member.
- d. Maintain tools and equipment.
- e. Follow ethical Practices.

VII Minimum Theoretical Background

This serves as a satisfactory' binder in improving the physical interlocking of the aggregates. The binder material which does not possess sufficient ductility would crack and thus provides pervious pavement surface. This in turn results in damaging effect to the pavement structure.

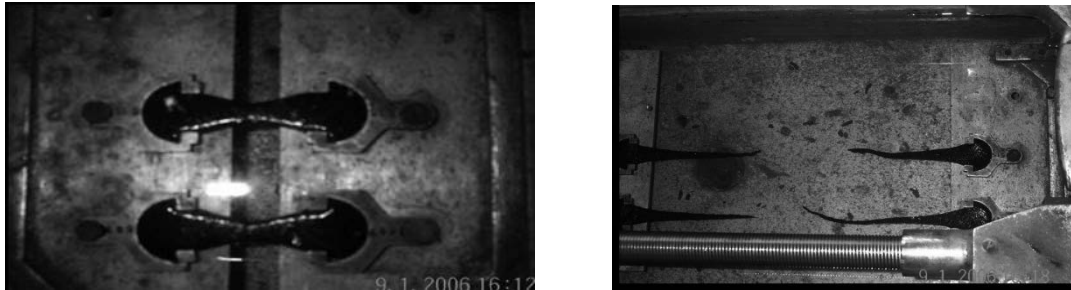


Figure 1: Bitumen sample in briquette mould

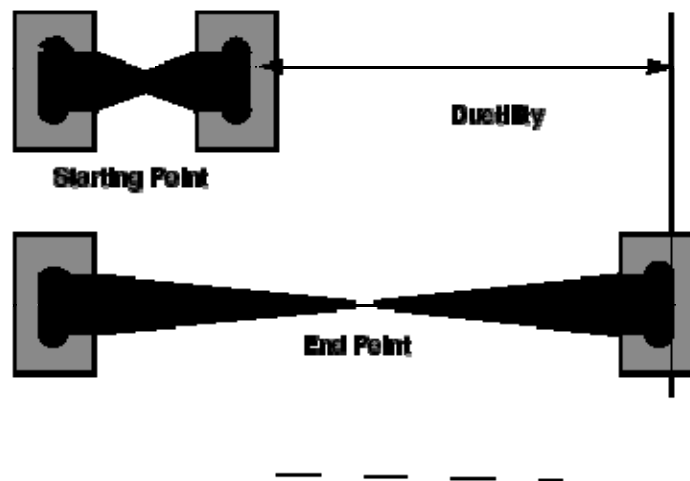


Figure 2: Measurement of Ductility of Bitumen

IRC RECOMMENDATIONS:

The distance traveled up to the point of breaking of thread measured in centimeters is recorded as ductility value. It is recommended by ISI that results should not differ from mean value by more than the following:

Repeatability	Reproducibility
5 %	10 %

Recommended Values of Bitumen Ductility:

Suitability of bitumen is judged depending on its type and proposed use. Bitumen with low ductility value may get cracked especially in cold weather. Minimum values of ductility specified by ISI 1208-1978 for various grades are as follows.

Source of paving bitumen and penetration grade	Min ductility value (cms)
Assam Petroleum A25	5
A35	10
A45	12
A65, A90 and A200	15
Bitumen from sources other than Assam Petroleum S35	50
S45, S65 and S90	75

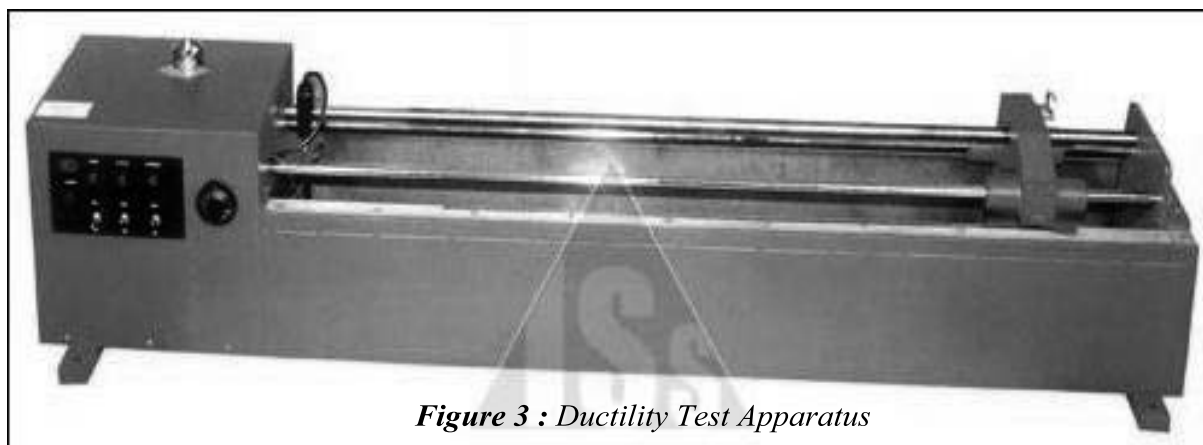
VIII Practical Set-up**Photo:**

Figure 3 : Ductility Test Apparatus

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Ductility Machine	As per IS: 1208-1978. It is equipment which functions as constant temperature water bath and a pulling device at a pre calibrated rate. The central rod of the machine is threaded and through gear system provides a movement to one end where the clip is fixed during initial pavement. The other clip end is hooked at the fixed end of the machine. Two clips are thus pulled apart horizontally at a uniform speed of 50 ± 2.5 mm per minute.	1 No.	
2	Briquette Mould	Mould is made of brass metal with shape and dimensions as indicated in fig. 10 2. Both ends called lips possess circular holes to grip the fixed and movable ends of the testing machine, sidepieces when placed together form the briquette of the following dimensions: Length = 75 mm , Distance between clips= 30 mm , Width at mouth of clip= 20 mm, Cross section at minimum width= 10 mm x 10 mm	1 No.	

X Procedure

1. The bitumen sample is melted to a temperature of 75 to 100°C above the approximate softening point until it is fluid.
2. It is strained through IS sieve 30, poured in the mould assembly and placed on a brass plate, after a solution of glycerin and dextrin is applied at all surfaces of the mould exposed to bitumen.
3. Thirty to forty minutes after the sample is poured into the moulds, the plate assembly along with the sample is placed in water bath maintained at 27°C for 30 minutes.
4. The sample and mould assembly are removed from water bath and excess bitumen material is cut off by leveling the surface using hot knife.
5. After trimming the specimen, the mould assembly containing sample is replaced in water bath maintained at 27°C for 85 to 95 minutes.
6. The sides of the mould are now removed and the clips are carefully hooked on the machine without causing any initial strain.
7. The pointer is set to read zero.
8. The machine is started and the two clips are thus pulled apart horizontally while the test is in operation, it is checked whether the sample is immersed in water at depth of at least 10 mm.
9. The distance at which the bitumen thread breaks is recorded in cm to report as ductility value.

XI Precautions to be followed

1. Before filling the bitumen sample, apply glycerin and dextrin uniformly to the inner surface of mould.
2. The bitumen sample should be filled in briquette mould immediately after its prescribed softening. Also it should be leveled properly by removing extra sample if any.

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

.....

.....

.....

.....

.....

.....

XIII Resources used

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

XIV Precautions followed

.....

.....

.....

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

- i. Grade of Bitumen =
- ii. Pouring temp =
- iii. Test temp. =
- iv. Period of air cooling =
- v. Rate of cooling =

Test Property		Briquette Mould No.			Mean Value
		1	2	3	
Ductility Value in cm to which standard briquette mould having 10x10 cm ² cross-section in center can stretch where thread just break					

Sample Calculations:

.....

.....

.....

XVI Results

The Ductility value of given bitumen sample iscm.

.....

.....

.....

XVII Interpretation of results (Give meaning of the above obtained results)

.....

.....

.....

XVIII Conclusions and Recommendations (if any) (Actions/decisions to be taken based on the interpretation of results).

.....

.....

.....

XIX 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 purpose of ductility test of bitumen.
2. State the rate of pull of bitumen in ductility test.
3. If the grade of two bitumen samples are 30/40 and 80/100, then in which sample the ductility value will be more. Why?
4. Which factors may affect the value of ductility of bitumen?

[Space for Answers]

.....

.....

.....

.....

.....

.....

.....

.....

.....

This image shows a full page of primary-ruled paper. It features approximately 28 horizontal dotted lines spaced evenly down the page, providing a guide for handwriting practice. The paper is otherwise blank, with no margins, text, or other markings.

XX References / Suggestions for further Reading

Sr.No	Title of Book	Author	Publication
1	Highway Engineering	Khanna S.K. , Justo, C E G and Veeraragavan, A.	Nem Chand and Brothers, Roorkee, 2010, ISBN 978-8185240800
2	Road, Railways, Bridge and Tunnel Engg	Birdi, Ahuja,	Standard Book House, New Delhi, March 2010, ISBN: 978-8189401337
3	Laboratory Manual in Highway Engineering	Duggal, Ajay K. and Puri, V. P.	New Age International (P) Limited, Publishers, New Delhi, 2010, ISBN: 9788122403107
4	IS: 1208-1978-Indian standard methods for testing tar and bituminous materials (Determination of ductility)		

XXI Suggested Assessment Scheme

Sr. No.	Performance Indicators	Weightage %
Process related : 15 Marks		60 %
1	Performing the test accurately	20%
2	Noting down the observations	30%
3	Working in team	10%
Product related :10 Marks		40 %
4	Conclusions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total : 25 Marks		100%

List of Student Team Members

- 1
- 2
3.
- 4..

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No. 09: Visit for Identification of Defects in Roads

I Practical Significance

The road may undergo various types of defects in it by the age of road. The usability of road may get affected due to such defects. Therefore it is necessary to examine the road periodically. The maintenance of road can be done after checking the present situation of road surface. This particular assignment helps to observe the different defects in the road by visiting the road site. The possible remedial measures can be suggested against the each defect observed.

II Relevant Program Outcomes (POs)

PO 1. Basic knowledge: *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. Discipline knowledge: *An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 4. Engineering tools: *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

III Relevant Course Outcomes

- i. Undertake maintenance of roads and drainage.

IV Practical Outcome

Visit the constructed road to suggest the possible remedial measures against the observed defects

V Competency and Practical Skills

- This practical is to develop the following skills for the industry identified competency ***'Identify the road defects in various roads.'***
 - i. Observe the road defects in road pavement.
 - ii. Record the various parameters of observed defects.

VI Relevant Affective domain related

- a. Follow safety practices.
- b. Practice good housekeeping.
- c. Demonstrate working as a leader/a team member.
- d. Maintain tools and equipment.
- e. Follow ethical Practices.

VII Minimum Theoretical Background

The various defects in the road may occur in the form of following.

- (i) ***Corrugations on road surface-*** The wavy nature of road surface may occur in WBM road commonly. It is mainly due to insufficient and improper compaction during construction.



Figure 1: Corrugations on road surface

- (ii) ***Formation of pot holes-*** The ditches formed on road surface due to suction of binder material by pneumatic wheel tyres of the vehicle. It is caused due to loose sub-surface of WBM and bituminous road.



Figure 2: Formation of pot holes on Bituminous road surface.

- (iii) ***Formation of cracks-*** The non-compacted sub-layers of road gets settled down under the vehicular load resulting in formation of cracks. The initial cracks may get expanded to greater extent due to temperature variation.



Figure 3: Formation of cracks on bituminous road surface.

- (iv) ***Removal in binding material-*** The wearing surface of WBM road may undergo the loosening of aggregate under vibration. Hence the aggregate gets removed.

- (v) **Rut formation-** A rut is a depression or groove worn into a road or path by the travel of wheels or skis. Ruts can be formed by wear, as from studded snow tires common in cold climate areas, or they can form through the deformation of the asphalt concrete pavement or sub-base material. Rut-like depressions can be formed on gravel roads by the erosion from flowing water.



Figure 4: Rut Formation

- (vi) **Crushing of aggregate-** The aggregate in WBM road may get crushed due to continuous moving or dynamic load. The high contact pressure of iron tyred vehicles induces the attrition which results in breaking of aggregate. The aggregate gets powdered if the strength of aggregate is not tested prior to its use. The strength and durability of road surface reduced proportionally.
- (vii) **Dust nuisance-** The formation of powder of loose aggregate gives rise to dust nuisance in mixed traffic flow.



Figure 5: Dust nuisance

VIII Practical Set-up



Figure 6: Measurement of pot holes and cracks of road

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Measuring Tape	5 Meter Length	1 No.	
2	Marking powder or Lime powder	--	As per requirement	
3	Note pad, Pencil etc	--	1 No. each/student	

X Procedure

1. Identify the accessible site location of the defective road (WBM/Bituminous/Concrete) for the visit.
2. Mark the cracks observed on road surface and measure its length and extent using measuring tape.
3. Also mark the number of pot holes present on road surface using lime powder. Remove the loose material fraction from the marked pot hole. Now measure the dimensions of pot holes in mm i.e. length, width and depth using tape.
4. Identify the other defects in road i.e. rut formation, corrugations, crushing of aggregate and dust nuisance on road surface.

XI Precautions to be followed

1. While marking the cracks, check the cracks extent.
2. The loose material in the potholes should be removed prior to its measurement.
3. While measuring the length and width of pothole, the largest values should be taken into account.

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

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

XIII Resources used

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

XIV Precautions followed

.....

.....

.....

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

Sr. No.	Type of defect observed	Causes of Road Defect
1		
2		
3		
4		

5		
6		
7		
8		
9		
10		

XVI Results

1. The defects occurred in road is due to (Vehicular/ Road users/Natural) effect.
2. The defects observed on given road surface are (repairable/non-repairable)

XVII Interpretation of results (Give meaning of the above obtained results)

.....

.....

.....

XVIII Conclusions and Recommendations if any (*Actions/decisions to be taken based on the interpretation of results*).

.....

.....

.....

XIX 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 effect of defect on usability of road.
2. A defective WBM road surface can be used as sub-base to bituminous road construction. Justify the statement.
3. List the precautions to be taken while road construction to minimize the occurrence of road defects.
4. Compare the defects in flexible and rigid pavement.

[Space for Answers]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

XX References / Suggestions for further Reading

Sr. No	Title of Book	Author	Publication
1	Highway Engineering	Khanna S.K. , Justo, C E G and Veeraragavan, A.	Nem Chand and Brothers, Roorkee, 2010, ISBN 978-8185240800
2	Road, Railways, Bridge and Tunnel Engg	Birdi, Ahuja,	Standard Book House, New Delhi, March 2010, ISBN: 978-8189401337

XXI Suggested Assessment Scheme

Sr.No	Performance Indicators	Weightage %
Process related : 15 Marks		60 %
1	Marking the defects accurately	20%
2	Measurement of parameters of defect.	30%
3	Working in team	10%
Product related :10 Marks		40 %
4	Conclusions with remedial measures	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total : 25 Marks		

List of Student Team Members

- 1
- 2
3.
- 4..

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No. 10: Report on Visit to Defective Road

I Practical Significance

The details collected in site visit to defective road should be reported in the pictorial format. It should include the site photographs showing the observed defects. This report study helps us to know the present condition of road and to predict future usability period. It is necessary to access the existing road for its stability and to ensure its durability. This particular assignment put forth the numerous details of defects observed in previous practical.

II Relevant Program Outcomes (POs)

PO 1. Basic knowledge: *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. Discipline knowledge: *An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 4. Engineering tools: *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

III Relevant Course Outcomes

- i. Undertake maintenance of roads and drainage.
- ii. Diagnose the road defects in various roads.

IV Practical Outcome

Prepare the photographic report containing details for experiment no. 9

V Competency and Practical Skills

- This practical is to develop the following skills for the industry identified competency ***‘Diagnose the road defects in various roads.’***
 - i. Compare the theoretical and practical defects.
 - ii. Analyze the details collected during site visit.
 - iii. Suggest the remedial measures to observed road defects.

VI Relevant Affective domain related

- a. Follow safety practices.
- b. Practice good housekeeping.
- c. Demonstrate working as a leader/a team member.
- d. Maintain tools and equipment.
- e. Follow ethical Practices.

VII Minimum Theoretical Background

Road maintenance is essential in order to (1) preserve the road in its originally constructed condition, (2) protect adjacent resources and user safety, and (3) provide efficient, convenient travel along the route. Unfortunately, maintenance is often neglected or improperly performed resulting in rapid deterioration of the road and eventual failure from both climatic and vehicle use impacts. It follows that it is impossible to build and use a road that requires no maintenance.

In order to plan for road maintenance needs, it is important to keep a complete set of "as built" plans and records of all maintenance operations and observations. The as built plan should contain the following:

1. Complete job index
2. Complete history of project from planning stage to construction
3. Photographic records
4. Exact location and observations of any unstable conditions in relation to the road location
5. Exact location of culverts and other drainage features
6. Wet areas that may have required additional excavation and replacement with more suitable ballast backfield materials
7. All major changes made to the original plan

Probably the most valuable tool for any maintenance program is the knowledge and experience gained by individuals performing the maintenance. Every effort should be made to retain competent, knowledgeable, and experienced individuals in these positions not only from the standpoint of instituting and executing a good maintenance program, but for future road planning needs as well.

In deciding on an appropriate level of maintenance for a particular road or road segment, consideration must be given to the amount and type of vehicle use and physiographic and climatic variables which may impact drainage structures.

Types of Road Maintenance- In Indian scenario, the road maintenance is categorized as under.

1. Routine maintenance
2. Periodic maintenance
3. Special repairs
4. Special repairing to monsoon damage
5. Resurfacing
6. Renewals

VIII Practical Set-up



Figure 1: Measurement of pot holes and cracks of road

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Camera Photographs	Showing defects	Proportional to type of defects.	

X Procedure

1. Write the details of road site that you have visited in the previous practical no. 9.
2. Prepare the list of defects observed and its causes.
3. Suggest the possible remedial measures against the each defect.

XI Precautions to be followed

1. While marking the cracks, check the cracks extent.
2. The loose material in the potholes should be removed prior to its measurement.
3. While measuring the length and width of pothole, the largest values should be taken into account.

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

This image shows a blank sheet of white paper with ten horizontal dashed lines spaced evenly apart, intended for handwriting practice or general note-taking. The lines extend across the full width of the page.

XIII Resources used

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

XIV Precautions followed

.....

.....

.....

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

Sr. No.	Type of defect observed with photograph	Suggestions regarding Remedial measures
1		
2		
3		

4		
5		
6		
7		

8		
9		
10		

XVI Results

1. The maintenance of all the defects observed in road can be classified under..... type (Routine/ Periodic/ Special Repairs).
2. The defects observed on given road surface is (repairable/non-repairable)

XVII Interpretation of results (Give meaning of the above obtained results)

.....

.....

.....

.....

.....

.....

.....

XVIII Conclusions and Recommendations (if any) (To be written by students)

(Actions/decisions to be taken based on the interpretation of results).

XIX 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 effect of defect on usability of road.
2. A defective WBM road surface can be used as sub-base to Bituminous road construction. Justify the statement.
3. List the precautions to be taken while road construction to minimize the occurrence of road defects.
4. Compare the defects in flexible and rigid pavement.

[Space for Answers]

This image shows a full page of white paper with horizontal dashed lines, typical of primary school writing paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

XX References / Suggestions for further Reading

Sr. No	Title of Book	Author	Publication
1	Highway Engineering	Khanna S.K. , Justo, C E G and Veeraragavan, A.	Nem Chand and Brothers, Roorkee, 2010, ISBN 978-8185240800
2	Road, Railways, Bridge and Tunnel Engg	Birdi, Ahuja,	Standard Book House, New Delhi, March 2010, ISBN: 978-8189401337

XXI Suggested Assessment Scheme

Sr.No	Performance Indicators	Weightage %
Process related : 15 Marks		60 %
1	Analyzing the defects accurately	20%
2	Suggesting Remedial Measures	30%
3	Working in team	10%
Product related :10 Marks		40 %
4	Conclusions with remedial measures	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total : 25 Marks		100%

List of Student Team Members

- 1
- 2
3.
- 4..

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No. 11: Traffic Volume Study

I Practical Significance

The traffic on roads is increasing continuously in Indian scenario. The traffic related problems become serious issue. Therefore it is important to come up with solution to regulate traffic on such busy roads. Hence it become necessary to study the instant traffic volume, traffic density on road, traffic capacity of particular road.

This particular practical will help to know the actual traffic flow during peak hours and non-peak hours. Also it will produce the information regarding the type of traffic on particular type of road i.e. arterial or sub-arterial routes. Based on traffic volume count, the most possible and feasible solutions can be drawn to minimize the common problems in traffic engineering.

II Relevant Program Outcomes (POs)

PO 1. Basic knowledge: *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. Discipline knowledge: *An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 3. Experiments and practice: *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*

PO 4. Engineering tools: *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

III Relevant Course Outcomes

Evaluate the traffic flow characteristics

IV Practical Outcome

Carry out Traffic Volume Study (minimum two hours of peak period) for an important road intersection or roadway in your city/ town/ village.

V Competency and Practical Skills

- This practical is expected to develop the following skills for the industry identified competency '*Understand the traffic flow pattern.*'
 - i. Observe the moving vehicles continuously at road intersection/road way.
 - ii. Record the traffic volume.

VI Relevant Affective domain related

- a. Follow safety practices & precautions regarding traffic.
- b. Demonstrate working as a leader/a team member.
- c. Maintain tools and equipment.

VII Minimum Theoretical Background

Traffic Volume Study: It is the survey of number of different vehicles crossing a section of road per unit time during selected period, is called as *Traffic Volume Study*. The study is done at selected points called as *Count Posts* or *Traffic Count Stations*.

This study is made twice a year depending on the importance of road. If the office works between 10 am to 5 pm, then peak traffic will occur 9 am to 12 pm and 4 to 7 pm. Therefore this traffic survey should be done in these hours to get correct information of traffic.

This survey is carried for 4, 8, 12, 16 or 24 hours at predetermined station for selected road intersection.

Objectives of Traffic Volume Study: This traffic volume study is done purposefully to achieve following objectives.

1. Establish relative importance of roads and traffic control devices i.e. signs, signals, markings and islands.
2. Decide the priority for improvement and expansion of a road to allot the funds accordingly.
3. Plan and design the existing and new traffic control devices.
4. Analyze the traffic flow pattern and trends on the road.
5. Design the structural pavements and geometrical parameters of road based on traffic load.
6. Make the modification in regulatory measures like one way, lane separation, route diversion etc. through traffic volume distribution study.
7. Design the side walk, cross walk, pedestrian signals, signal timings by knowing pedestrian volume.

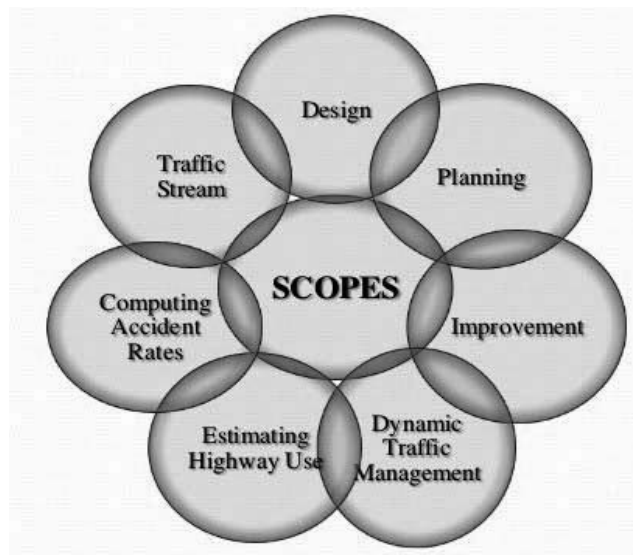


Figure 1: Scope of Traffic Volume Study

VIII Practical Set-up



Figure 2: Manual Method of Traffic Flow Count



Figure 3: Semi manual Method of Traffic Flow Count



Figure 4 : Automatic Recording Method of Traffic Flow Count

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Traffic Enumerators Form	As specified in observation	1 Set.	

X Procedure

1. Select the road intersection/roadway in your city/town/village.
2. Select the time slot for traffic volume count.
3. Take the permission of Traffic police / Municipality.
4. Fill the enumerators form for the selected road intersection.
5. Define the count post or traffic count stations at various points of your intersection.
6. Observe the various types vehicles i.e. two wheelers, three wheelers, four wheelers and heavy or multi-axle vehicles moving actually on road section.
7. Record the left turning, straight going and right turning vehicles and pedestrians in the enumerators form using Roman Counting Method.

XI Precautions to be followed

1. Observe the vehicles without disturbing the traffic flow.
2. There should be mutual coordination between team members throughout this practical.
3. The said work should be divided to group of minimum two members at each count posts, so that no vehicle will remain uncounted.
4. The extra care should be taken during peak hours and record the same in appropriate columns of enumerators form.

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

[Space for Answers]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

XIII Resources used

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

XIV Precautions followed**XV Observations and Calculations** (Use blank sheet provided if space not sufficient)**Sample Enumerators form:****Traffic Volume Survey at Road Intersection**

1. Location of intersection:
2. Type of road and route number (if any):
3. Name of approach road:
4. Date and Time of commencement:
5. Date and Time of completion:

Type of Vehicle	Left Turning		Straight Going		Right Turning	
	Enumeration	Total	Enumeration	Total	Enumeration	Total
Two Wheeler						
<i>Bi-cycle</i>						
<i>Scooter</i>						
<i>Motor Cycle</i>						
Three Wheeler						
<i>Auto Rickshaw</i>						
<i>Tempo</i>						
Four Wheeler						
<i>Car</i>						
<i>Jeep</i>						
<i>Van</i>						
Heavy/Multi-axle						
<i>Bus</i>						
<i>Truck</i>						
<i>Containers</i>						
Others						
<i>Animal/Hand Driven</i>						
<i>Vehicles for Physically Impaired</i>						
<i>Pedestrians</i>						

Format for Traffic Volume study on Roadway

1. Name of Road:
2. Direction of road: fromto.....
3. Date:
4. Time startTime Ends.....

Types of Vehicles	Vehicle count	Total
Two Wheeler		
<i>Bi-cycle</i>		
<i>Scooter</i>		
<i>Motor Cycle</i>		
Three Wheeler		
<i>Auto Rickshaw</i>		
<i>Tempo</i>		
Total		
Four Wheeler		
<i>Car</i>		
<i>Jeep</i>		
<i>Van</i>		

Heavy/Multi-axle		
<i>Bus</i>		
<i>Truck</i>		
<i>Containers</i>		
Others		
<i>Animal/Hand Driven</i>		
<i>Vehicles for Physically Impaired</i>		
<i>Pedestrians</i>		

XVI Results

The total number of regular type of vehicles passing the road section is found to benos.

The total number of other types of vehicles passing the road section is found to benos.

.....

XVII Interpretation of results (Give meaning of the above obtained results)

.....

XVIII Conclusions and Recommendations (if any) (To be written by students)

(Actions/decisions to be taken based on the interpretation of results).

.....

XIX 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. State the type of road intersection observed.
2. State the type of vehicles observed at road intersection.
3. State the peak hours observed at road intersection.
4. Enlist the most common reasons for traffic jams.
5. Explain the role of road signs in traffic control.
6. Write three situations when traffic study is essential.
7. State the different methods of collection of traffic volume count data.

[Space for Answers]

.....

[illegible]

XX References / Suggestions for further Reading

Sr. No	Title of Book	Author	Publication
1	Highway Engineering	Khanna S.K. , Justo, C E G and Veeraragavan, A.	Nem Chand and Brothers, Roorkee, 2010, ISBN 978-8185240800
2	Traffic Engineering and Transport Planning	Kadiyali, L.R.	Khanna Publishers, New Delhi, 2008, ISBN: 978-8174092205
3	Road, Railways, Bridge and Tunnel Engg	Birdi, Ahuja,	Standard Book House, New Delhi, March 2010, ISBN: 978-8189401337

XXI Suggested Assessment Scheme

S.No	Performance Indicators	Weightage %
Process related : 15 Marks		60 %
1	Survey work with proper observations	20%
2	Recording of accurate type of vehicles	30%
3	Working in team	10%
Product related :10 Marks		40 %
4	Conclusions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total : 25 Marks		

List of Student Team Members

1

2

3.

4..

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No. 12: Analysis of Traffic Volume Study

I Practical Significance

The traffic volume study gives us numerical data of actual traffic flow. The total number of vehicles passing the road intersection shows the overall usability of that particular road. It is necessary to take judgment of traffic regulatory measures, so that the traffic related problems can be minimized at certain extent. The traffic flow characteristics like traffic density, traffic capacity can be determined through collected data. The analysis of such data gives us idea about improvement in traffic flow through necessary modification.

II Relevant Program Outcomes (POs)

PO 1. Basic knowledge: *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. Discipline knowledge: *An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 3. Experiments and practice: *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*

PO 4. Engineering tools: *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

III Relevant Course Outcomes

- i. Evaluate the traffic flow characteristics

IV Practical Outcome

Perform analysis of traffic volume data of experiment no. 11.

V Competency and Practical Skills

- This practical is expected to develop the following skills for the industry identified competency '*Analyze the traffic flow pattern.*'

- i. Draw the traffic flow chart for given road intersection.
- ii. Understand the actual number of vehicles moving in various directions.
- iii. Suggest the best possible solution for smooth traffic flow.

VI Relevant Affective domain related

- a. Follow safety practices & precautions regarding traffic.
- b. Demonstrate working as a leader/a team member.
- c. Maintain tools and equipment.

VII Minimum Theoretical Background

Passenger Car Unit (PCU): It is the standard vehicle unit which is considered to convert the other vehicle classes, is called as *Passenger Car Unit* i.e. *PCU*. In case of mixed or heterogeneous traffic flow, vehicles have wide range of static and dynamic characteristics such as length, width, speed, acceleration. Such characteristics are complex to analyze, hence PCU may be considered as a measure of the relative space requirement of a vehicle class as compared to a passenger car.

Table for conversion of vehicles into PCU:

Passenger Car Unit (PCU) is a metric used in Transportation Engineering, to assess traffic-flow rate on a highway. A Passenger Car Unit is a measure of the impact that a mode of transport has on traffic variables (such as headway, speed, density) compared to a single standard passenger car. This is also known as passenger car equivalent. For example, typical values of PCU or PCE are as follows.

Table 1: Values of PCU

Type of Vehicles	PCU equivalent
Car	1.0
Motorcycle	0.5
Bicycle	0.2
LCV	2.2
Bus, Truck	3.5
3-wheeler	0.8

Traffic Density: It is defined as the number of vehicles occupying a unit length of lane of roadway at a given instant, is called as traffic density and usually expressed as vehicles per kilometer.

Traffic Capacity: It is defined as the ability of a road way to accommodate traffic volume, is called as traffic capacity and is expressed as the maximum number of vehicles in a lane or road that can pass a given point in unit time, usually an hour.

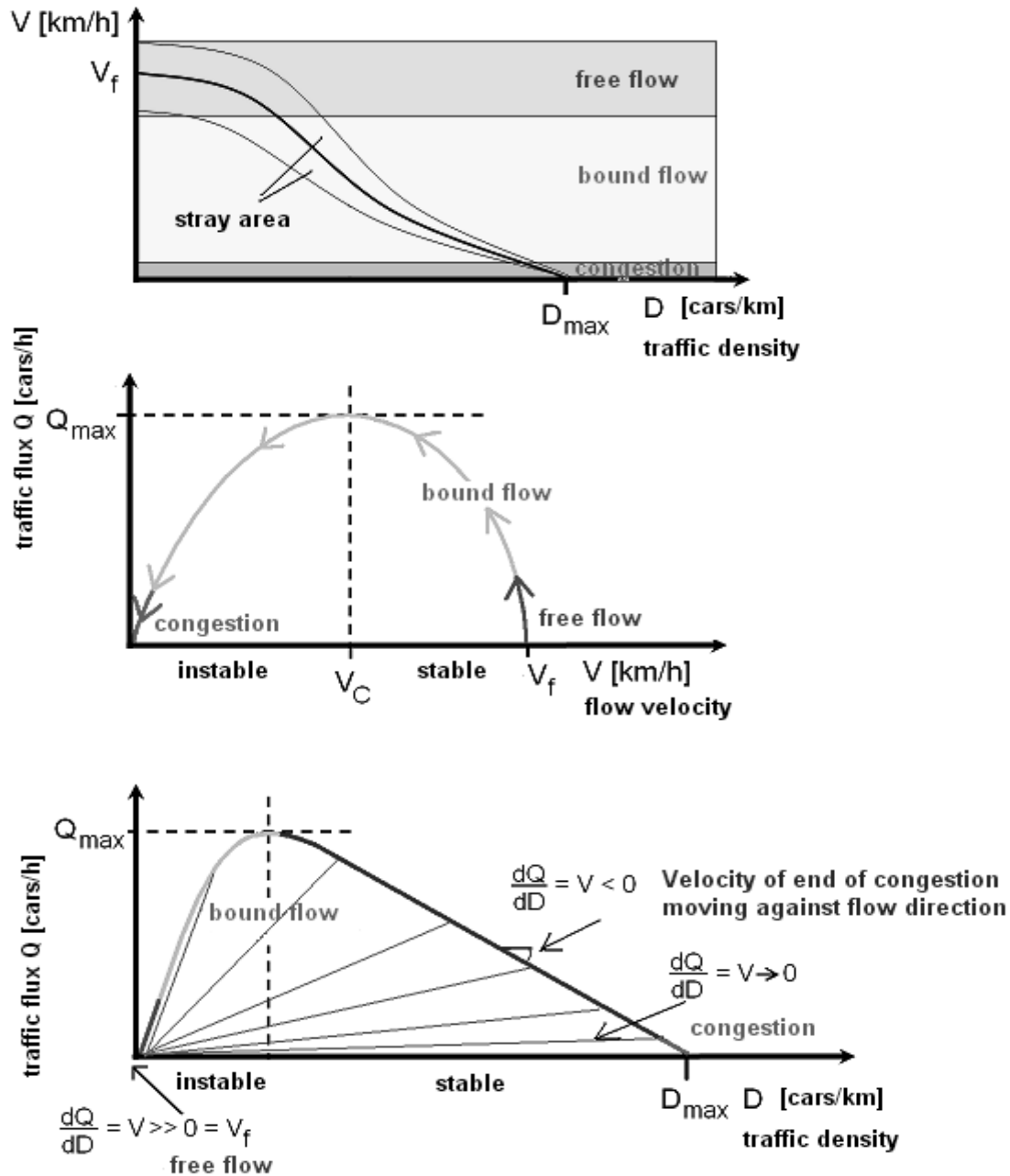
Traffic flow diagram: It is the graphical representation of data collected in traffic volume study, is called as traffic flow diagram.

Fundamental diagram of traffic flow

Fundamental equation of traffic flow:

$$Q = D \cdot V$$

Source: Hendrik Ammoser, Fakultät Verkehrswissenschaften, Dresden, Germany



V_f = "free velocity" - maximum velocity on free lane, selectable by the driver depending on car, skill etc.

V_C = "critical velocity" with maximum traffic flux (about 70...100 km/h)

Figure 1: Fundamental Diagram of Traffic Flow.

VIII Practical Set-up

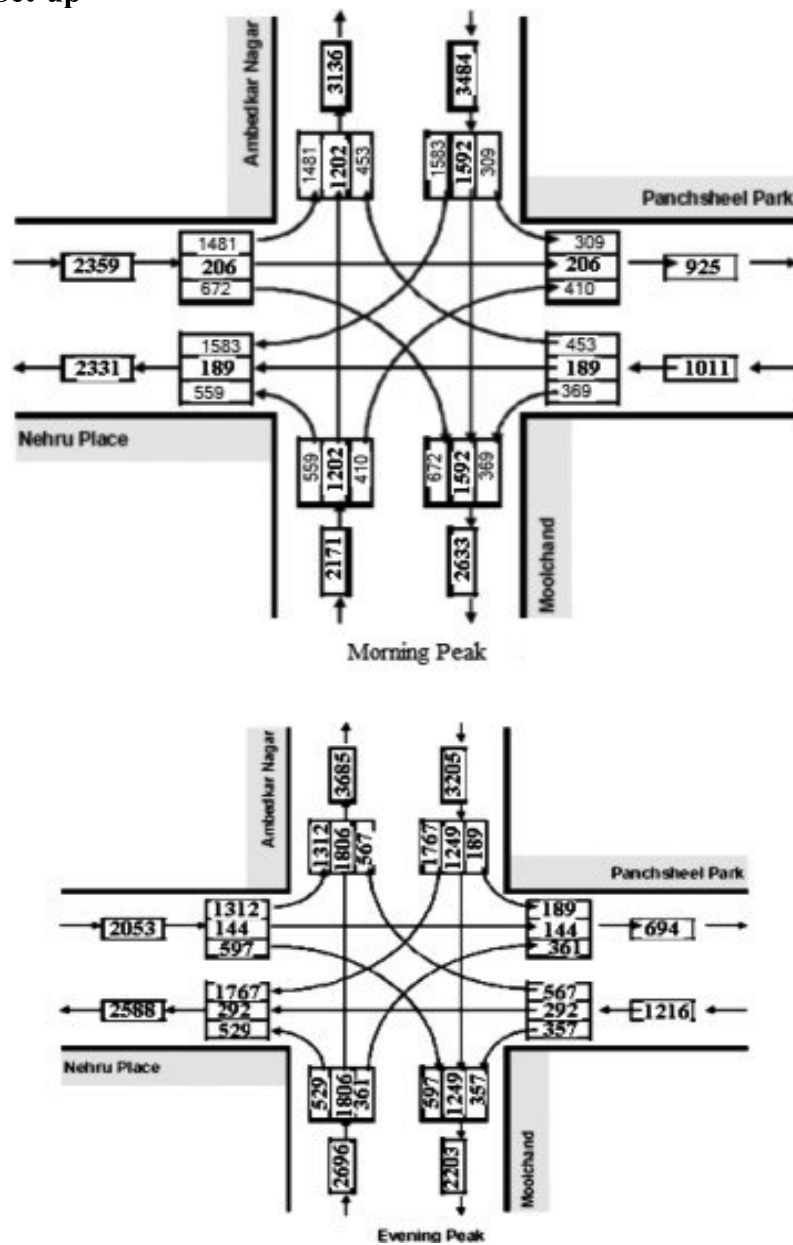


Figure 2: Conceptual Diagram of Traffic Flow Pattern

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Traffic Enumerators Form	As filled in previous experiment	1 set.	

X Procedure

1. Make the summation of the total number of left turning, straight going and right turning vehicles at all locations separately.
2. Take the addition of vehicles in both directions for traffic volume of study on roadway.
3. Also make the summation of the total number vehicles incoming and outgoing from particular road section.
4. Finally calculate the total number of vehicles at selected road intersection by adding the total vehicles at various traffic count stations.
5. Draw the traffic volume diagram indicating number of vehicles at various sections.

XI Precautions to be followed

1. There should be mutual coordination between team members throughout this practical.
2. The said work should be divided to group of minimum two members at each count posts, so that no vehicle will remain uncounted.
3. The extra care should be taken during peak hours.

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

[Space for Answers]

.....

.....

.....

.....

.....

.....

.....

.....

.....

XIII Resources used

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

XIV Precautions followed

.....

.....

.....

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

Analysis of Traffic Volume Observed at Intersection.

From approach Of intersection

1. The total number of left turning vehicles:
2. The total number of straight going vehicles:
3. The total number of right turning vehicles:
4. Inward traffic in intersection from approach:
5. Outward traffic from intersection in approach:

From approach Of intersection

1. The total number of left turning vehicles:
2. The total number of straight going vehicles:
3. The total number of right turning vehicles:
4. Inward traffic in intersection from approach:
5. Outward traffic from intersection in approach:

From approach Of intersection

1. The total number of left turning vehicles:
2. The total number of straight going vehicles:
3. The total number of right turning vehicles:
4. Inward traffic in intersection from approach:
5. Outward traffic from intersection in approach:

From approach Of intersection

1. The total number of left turning vehicles:
2. The total number of straight going vehicles:
3. The total number of right turning vehicles:
4. Inward traffic in intersection from approach:
5. Outward traffic from intersection in approach:

Analysis of Traffic Volume observed on Roadway

1. Name of Road:
.....
2. Number of vehicles in rightward direction in lane:
.....
3. Number of vehicles in leftward direction in lane:
.....
4. Total traffic in PCU per hour on roadway:
.....
5. Traffic Composition observed on roadway:
.....

XVI Results

.....

.....

.....

XVII Interpretation of results (Give meaning of the above obtained results)

.....

.....

.....

XVIII Conclusions and Recommendations (if any) (Actions/decisions to be taken based on the interpretation of results).

.....

.....

.....

XIX 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. Draw the traffic flow chart for your observations.
2. State the composition of traffic observed in traffic volume study.
3. Which type of vehicles in traffic was most dominant?
4. Which type of vehicles in traffic was least dominant?
5. What is meaning of PCU?
6. State the purposes of traffic volume study.

[Space for Answers]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

XX References / Suggestions for further Reading

Sr.No	Title of Book	Author	Publication
1	Highway Engineering	Khanna S.K. , Justo, C E G and Veeraragavan, A.	Nem Chand and Brothers, Roorkee, 2010, ISBN 978-8185240800
2	Traffic Engineering and Transport Planning	Kadiyali, L.R.	Khanna Publishers, New Delhi, 2008, ISBN: 978-8174092205
3	Road, Railways, Bridge and Tunnel Engg	Birdi, Ahuja,	Standard Book House, New Delhi, March 2010, ISBN: 978-8189401337

XXI Suggested Assessment Scheme

Sr. No	Performance Indicators	Weightage %
Process related : 15 Marks		60 %
1	Calculation	20%
2	Data analysis	30%
3	Working in team	10%
Product related :10 Marks		40 %
4	Conclusions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total : 25 Marks		

List of Student Team Members

- 1
- 2
3.
- 4..

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No. 13: Accident Collision Diagram

I Practical Significance

Due to rapid growth of urbanization and industrialization, the traffic with mixed flow of vehicles is expanding continuously. This conditions leads to various accidents on roadways. Traffic engineering drives to accidents studies for minimizing such happening accidents. The collision diagram represents the phenomenal sketching of particular accident case. Hence one can know the types of accident, causes of accident etc. The preventive measures against the accident can be also suggested through collision diagrams.

Condition diagrams are necessary to capture field conditions for later correlating with collision diagrams and crash summaries. The purpose of the condition diagram is to show the intersection and the conditions within the surrounding area as it exists. The diagram should include the intersection alignment, items such as buildings, sidewalks, trees, lighting poles, water hydrants, stop signs, number of lanes, and lane use if required, associated with the streets forming the intersection or segment. At intersections, the Condition Diagram should show the length of all exclusive lanes and associated tapers.

II Relevant Program Outcomes (POs)

PO 1. Basic knowledge: *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. Discipline knowledge: *An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 3. Experiments and practice: *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*

PO 4. Engineering tools: *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

III Relevant Course Outcomes

Evaluate traffic flow characteristics.

IV Practical Outcome

Draw the sketches of collision diagram.

V Competency and Practical Skills

- This practical is expected to develop the following skills for the industry identified competency '**Understand the accident pattern in roadway and road intersection.**'
 - i. Observe the type of vehicles involved in road accident.
 - ii. Draw the sketch of spot accident on single road and road intersection.

VI Relevant Affective domain related

- a. Follow safety practices.
- b. Practice good housekeeping.
- c. Demonstrate working as a leader/a team member.

VII Minimum Theoretical Background

Road Accident: The undesirable struck of a vehicle to any moving or stationry object is known as road accident.

Causes of road accident: The accident may takes place due to following sources.

1. Vehicular causes- like defective steering, break fail during motion, sluggish mirrors, tyre puncture, overheating etc.
2. Road structural causes- like faulty construction, and defects like potholes, cracks, slippery road surface, etc
3. Road users causes- like unskilled driving, over speeding, overtaking, sudden break application, overruling the traffic signs, disobeying traffic signals
4. Natural causes- like road surface reflection in sunny days, heavy smog or fog, heavy rainfall, landslide, rock fall, snow fall,

Collision diagrams: It is used to display and identify similar accident patterns. They provide information on the type and number of accidents; including conditions such as time of day, day of week, climatic conditions, pavement conditions, and other information critical to determining the causes of safety problems. Accident reports should be organized by year of occurrence and accident type for the analysis period. Accidents that occurred after significant changes in highway or local land use should not be included.

Construction of Collision Diagram: Sketch the location diagram for either an intersection or roadway section using a standard form, such as, shown on the following page.

1. The sketch need not be to scale.
2. Show the path of each vehicle involved in the accident with adequate room for information.
3. Place a north arrow for orientation and any other descriptive information: a. Location identification b. Period of analysis c. Label the roads
4. Sketch the path of each vehicle to show vehicle maneuver, type of collision and accident severity, and; a. Time of day b. Day of week c. Date d. Lighting condition e. Pavement condition f. Other important information, e.g., alcohol involvement

Symbols for collision diagram: representing the nature of operation, vehicle or object involved and severity of the accident are adopted. These are shown in the example collision diagram on the following page. Symbols to represent types of collisions diagrams are also standardized.

Accident Patterns: Accident patterns seen on the collision diagram can often suggest possible accident problems. For example, a large number of angle accidents would imply the potential of a sight distance restriction. At the end of this set of notes is a set of Accident Pattern Tables which identify accident type, possible causes, possible studies to determine the problem, and possible countermeasures.

VIII Practical Set-up

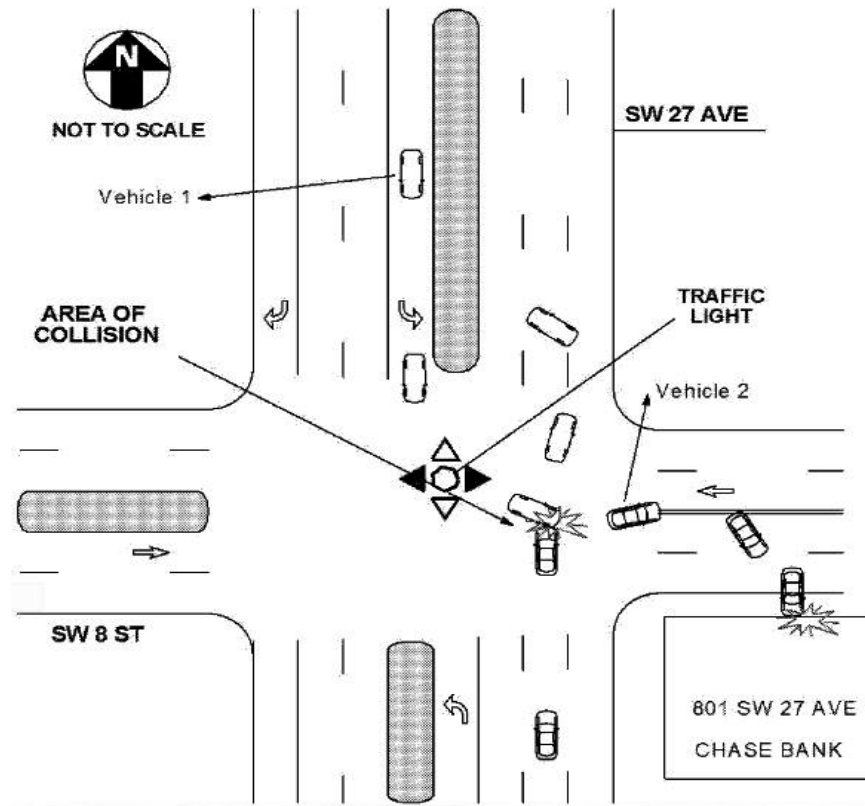


Figure 1: Collision Diagram

Legend

→ Straight	⊠▶ Parked
↶ Left Turn	🚶 Pedestrian
↷ Right Turn	🚲 Bicycle
↺ U-Turn	⊠ Object
↻ Overturned	⊗ Fatal Collision
↘ Ran Off Road	○ Injury Collision
⏹ Stopped	

Figure 2: Legends to be used in Collision Diagram

State of Florida Department of Transportation		Form 750-010-04 TRAFFIC ENGINEERING - 01/13
CONDITION DIAGRAM		
General Analysis Information		
Roadway ID Number	<u>71000000</u>	
Nearby Intersection Name	<u>SR 472</u>	Location <u>Sumter County</u>
Analysis Years	<u>2008-2012</u>	Project Number <u>11730.36</u>
Notes		
1) Condition diagrams are intended to capture detailed information that may not be easily communicated in a table format.		
2) The legend may be used to clarify symbology used.		
Field Data Collection		
SYMBOLS		
TREES SHRUBS HEDGE BUILDING RIGHT OF WAY LINE FENCE GUARDRAIL	POWER POLE TELEPHONE POLE COMBINATION POLE TRAFFIC SIGNAL POLE HYDRANT CONTROLLER CABINET VEHICLE DETECTOR LOOP	SIGN (1 POST) SIGN (2 POSTS) OVERHEAD SIGN TRAFFIC SIGNAL HEAD PED. SIGNAL HEAD PED. PUSHBUTTON RR SIGNAL (W/GATE)
FDOT Design Standards Index No. 002 provides additional Standardized Symbols		

Figure 3 Condition Diagram and legend

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Drawing sheet	A4 size sketch plate	3-4 Nos.	
2	Drawing accessories	--	--	
3	Typical drawing of various types of road	--	--	

X Procedure

1. Select the road intersection or roadway in your city/town/village.
2. Select the time slot for study.
3. Take the permission of Traffic police / Municipality.
4. Observe or collect the data regarding accidents.
5. Analyze the type of collision.
6. Record the types of vehicles involved in accidents.
7. Identify and record the reasons of the accidents.
8. Draw the collision diagram for the cases observed
9. Show the path of each vehicle involved in the accident in the collision diagram.
10. Place a north arrow for orientation and any other descriptive information: a. Location identification b. Period of analysis c. Label the roads

XI Precautions to be followed

1. Collision diagram should be drawn not to scale, but it should be represent with appropriate legends.
2. Observe the record from the officials.
3. There should be mutual coordination between team members throughout this practical.
4. The said work should be divided to group of students.
5. Record the data in appropriate form.

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

[Space for Answers]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

XIII Resources used

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

XIV Precautions followed

.....

.....

.....

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

The collision diagrams for the various cases observed are as follows.

(Note: The type of collision may be of type-Head on Collision, Angular Collision, Injury Collision, Fatal Collision, Side sweep etc.)

1. Location of intersection:
2. Type of road and route number (if any):
3. Name of approach roads:
4. Date and Time of observation:
5. Type of vehicles involved in accident:

Type of collision observed in a accident case	Collision Diagram

--	--

XVI Results

The collision diagram drawn was helpful to representtype of accident /collision.

.....

.....

.....

XVII Interpretation of results (Give meaning of the above obtained results)

.....

.....

.....

XVIII Conclusions and Recommendations (if any) (Actions/decisions to be taken based on the interpretation of results).

.....

.....

.....

XIX Practical Related Questions

1. State the type of accident observed by you.
2. State the purpose of drawing the collision diagram.
3. State the significance of sight distance in avoiding the road accidents.
4. Enlist the most common reasons for road accidents.
5. Write the statistical data of road accidents in India for past three years.

[Space to Write Answers]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

XX References / Suggestions for further Reading

Sr. No	Title of Book	Author	Publication
1	Highway Engineering	Khanna S.K. , Justo, C E G and Veeraragavan, A.	Nem Chand and Brothers, Roorkee, 2010, ISBN 978-8185240800
2	Traffic Engineering and Transport Planning	Kadiyali, L.R.	Khanna Publishers, New Delhi, 2008, ISBN: 978-8174092205
3	Road, Railways, Bridge and Tunnel Engg	Birdi, Ahuja,	Standard Book House, New Delhi, March 2010, ISBN: 978-8189401337

XXI Suggested Assessment Scheme

S.No	Performance Indicators	Weightage %
Process related : 15 Marks		60 %
1	Visit and observation	20%
2	Drawing diagrams	30%
3	Working in team	10%
Product related :10 Marks		40 %
4	Conclusions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total : 25 Marks		100%

List of Student Team Members

- 1
- 2
3.
- 4..

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No.14: Visit to Hill Road Constructed Site

I Practical Significance

The theoretical concepts regarding the road construction can be well understood by actual site visit. The various geometric design parameters of typical road section can be verified through organizing visit to hill road. This particular assignment helps to know actual layout of various components of typical hill road section designed as per IRC. This visit will able to know the comparative difference between road constructions on fairly leveled and hill side.

II Relevant Program Outcomes (POs)

PO 1. Basic knowledge: *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. Discipline knowledge: *An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 3. Experiments and practice: *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*

PO 4. Engineering tools: *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

III Relevant Course Outcomes

- i. Implement hill road construction using relevant materials, techniques and methods.
- ii. Undertake maintenance of roads and drainage.

IV Practical Outcome

Visit to road under construction to observe the components of hill road and construction methodology.

V Competency and Practical Skills

- This practical is to develop the following skills for the industry identified competency **“Implement hill road construction using relevant materials, techniques and methods.”**
 - i. Observe the hill road components.
 - ii. Understand the functions of various components.

VI Relevant Affective domain related

- a. Follow safety practices & precautions.
- b. Demonstrate working as a leader/a team member.
- c. Maintain tools and equipment.

VII Minimum Theoretical Background

There is the difference between the road on fairly leveled ground and road constructed along hill side. Therefore the components of normal road get modified to suit the topography of hill road construction site.

Components of Hill Road : The typical hill road section has following components.

1. Catch water drain
2. Breast wall
3. Side drain
4. Retaining wall with parapet
5. Road bed with pavement
6. Cross drain pipe

Types of hill road curves: The hill road section has following types of curves to be provided, which are different than curves provided in case of normal roads.

1. Hair pin bend curve
2. Salient curve
3. Re-entrant curve

VIII Practical Set-up

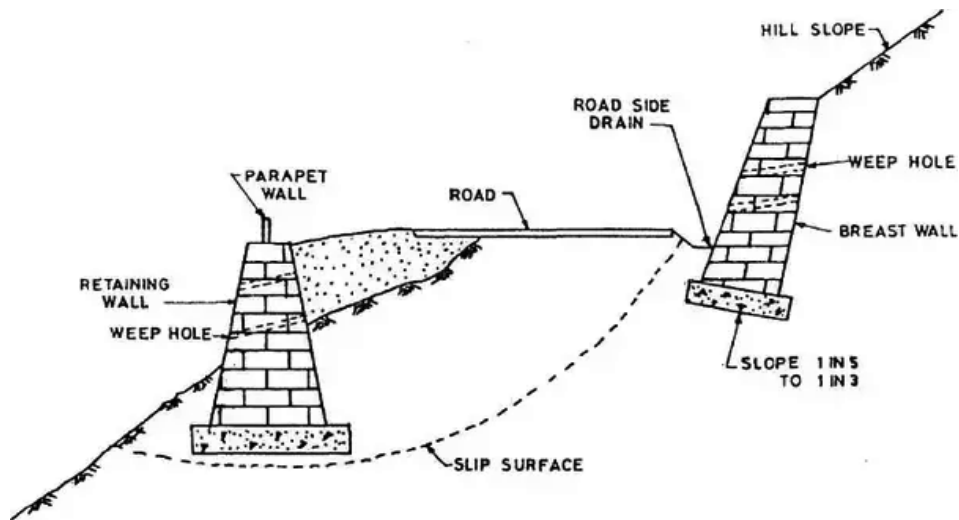


Figure 1: Schematic Diagram Of Hill Road Showing its Components

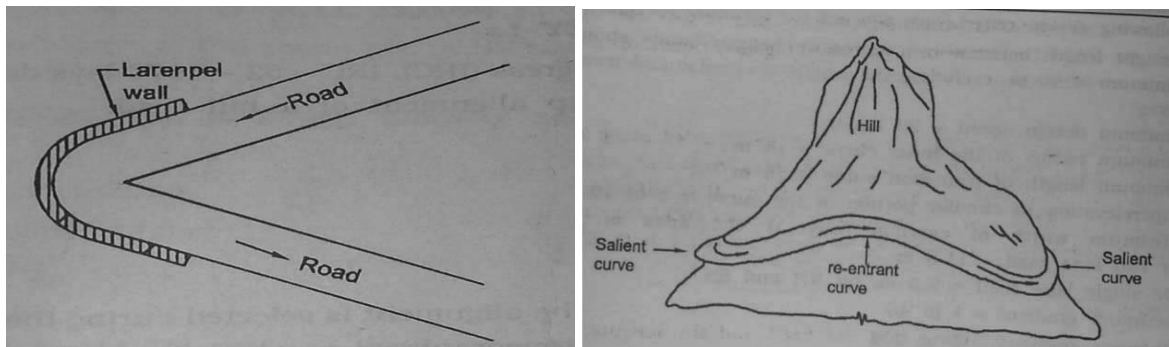


Figure 2: Types of Hill Road Curves

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Camera	As per availability	1 No.	
2	Note pad, Pencil etc.	--	1 No. each/student	

X Procedure

1. Mention the details of visit undertaken i.e. location of visit, date and time of visit, purpose of visit etc as given below.
2. Summarize the photographs of hill road components taken during the site visit.
3. Paste the photographs of each of the identified components and write the functions of the same in the specified format given below.
4. Compare the theoretical and practical profile of hill road section stating the differences.
5. Share the experience of site visit and give the possible measures to be taken to enhance the working of hill road.

XI Precautions to be followed

1. The clear photographs should be paste to understand the actual layout of hill road.
2. The group photograph of site visit should be also attached at the end of this assignment.
3. The suggestions regarding the modifications in hill road section should be given with justification.

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

.....

.....

.....

.....

.....

.....

.....

XIII Resources used

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

XIV Precautions followed

.....

.....

.....

.....

.....

.....

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

Sr. No.	The component of hill road observed with Photograph	Functions of Observed Components
1		
2		
3		
4		
5		

Construction method of hill road observed is as under.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

XVI Results

1. The actual hill road components were (matching/not matching) to the theoretical hill road components.
2. The type of hill road curves were mostly (hair pin bend/salient/re-entrant) type.

XVII Interpretation of results (Give meaning of the above obtained results)

.....

.....

.....

.....

.....

XVIII Conclusions and Recommendations (if any) (To be written by students)
(Actions/decisions to be taken based on the interpretation of results).

.....

.....

.....

.....

.....

XIX 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. State the difference between normal roads and hill roads in terms of its geometric design
2. Enlist the various practical difficulties in hill road construction as compared to normal roads.
3. Enlist the types of side drains provided along hill road. Which is most effective in heavily rainfall regions?
4. State any four typical causes of landslides and also suggest the preventive measures to be taken against each of the cause you stating.
5. The ruling gradient is not feasible to provide in hill road. Justify the statement.

Space to Write Answers

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Highway Engineering	Khanna S.K. , Justo, C E G and Veeraragavan, A.	Nem Chand and Brothers, Roorkee, 2010, ISBN 978-8185240800
2	Traffic Engineering and Transport Planning	Kadiyali, L.R.	Khanna Publishers, New Delhi, 2008, ISBN: 978-8174092205
3	Road, Railways, Bridge and Tunnel Engg	Birdi, Ahuja,	Standard Book House, New Delhi, March 2010, ISBN: 978-8189401337

XXI Suggested Assessment Scheme

S.No	Performance Indicators	Weightage %
Process related : 15 Marks		60 %
1	Identifying the components	20%
2	Understanding the functions of components	30%
3	Working in team	10%
Product related :10 Marks		40 %
4	Conclusions with suggestions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total : 25 Marks		100 %

List of Student Team Members

- 1
- 2
3.
- 4..
5.

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No. 15: Report of Visit to Hill Road

I Practical Significance

The details collected in the previous practical i.e. visit to hill road should be presented in the photographic format. The reporting of visit undertaken may consist of site photographs showing the components of hill road. The physical verification of hill road and its method of construction can be well understood in such photographs. This particular assignment helps to clear the layout of hill road section and structural arrangement of hill road. The diploma students can easily come to know the various parameters of hill road construction.

II Relevant Program Outcomes (POs)

PO 1. Basic knowledge: *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. Discipline knowledge: *An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 3. Experiments and practice: *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*

PO 4. Engineering tools: *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

III Relevant Course Outcomes

- i. Implement hill road construction using relevant materials, techniques and methods.
- ii. Undertake maintenance of roads and drainage.

IV Practical Outcome

Prepare the photographic report containing details for experiment no. 14.

V Competency and Practical Skills

- This practical is to develop the following skills for the industry identified competency ***‘Implement hill road construction using relevant materials, techniques and methods.’***
 - i. Understand the hill road components.
 - ii. Understand the construction procedure of hill road.

VI Relevant Affective domain related

- a. Follow safety practices & precautions.
- b. Demonstrate working as a leader/a team member.
- c. Maintain tools and equipment.

VII Minimum Theoretical Background

The visit undertaken to hill road section can be represented in the pictorial form to visualize and understand the structural arrangement of hill road. It is essential to know the requirements of hill road construction prior to its execution. It is also prior important to go through the alignment survey of the proposed route, which is distinct from normal route alignment. It is necessary to observe the drainage of hill road as it affects the stability and durability of such roads. The various types of road drains are given below.

Common problems in Hill road construction: There are various problems may occur in case of hill road during its construction and after construction. They are summarized as follows.

1. Land slides
2. Erosion of hill road embankment
3. Removal of embankment downside of hill
4. Settlement of road bed
5. Water logging

VIII Practical Set-up

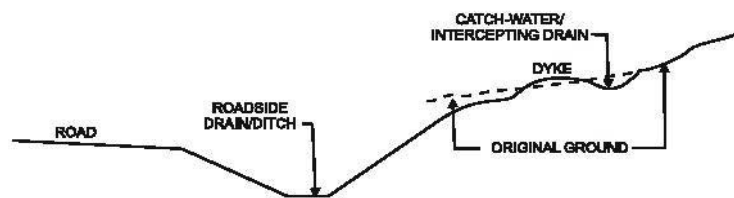


FIG. 2: INTERCEPTING/ CATCH-WATER DRAIN ON A HILL SLOPE

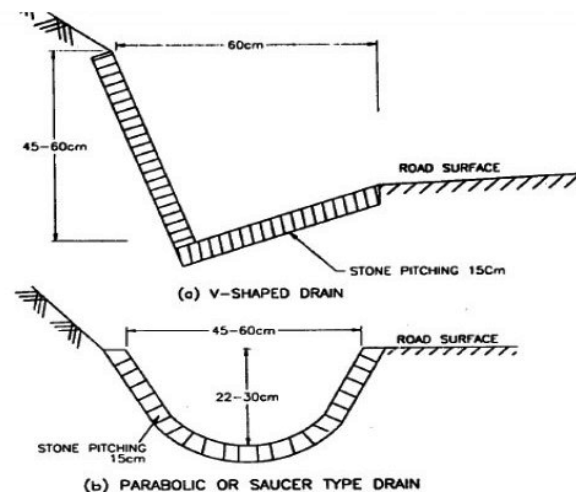


Figure 1. Types of Drains In Hill Road

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Camera	As per availability	1 No.	
2	Note pad, Pencil etc.	--	1 No. each/student	

X Procedure

1. Identify the accessible site location of the hill road (WBM/Bituminous/Concrete) for the visit.
2. Collect the information regarding hill road components i.e. catch water drain, breast wall, retaining wall with parapet, side drain and drainage arrangement
3. Take the actual site photographs using camera after identifying the hill road components.
4. Teacher/Site In charge shall give the brief idea about functions of each identified components.
5. Teacher/Site In charge should also give the information the methodology of construction work of hill road.
6. The teacher should also inform to identify the type of hill road curves of same section.

XI Precautions to be followed

1. The official permission from concerned authorities should be taken prior to proposed visit.
2. The special care should be taken against landslides and traffic flow while visiting the hill road

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

[illegible]

.....

.....

.....

.....

.....

.....

.....

XIII Resources used

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

XIV Precautions followed

.....

.....

.....

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

Sr. No.	The component of hill road observed with photographs	Functions of Observed Components
1		
2		

3		
4		

XVI Results

.....

.....

.....

XVII Interpretation of results (Give meaning of the above obtained results)

.....

.....

.....

XVIII Conclusions and Recommendations (if any) (Actions/decisions to be taken based on the interpretation of results).

.....

.....

.....

XIX 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. State the points to be considered while laying alignment of hill road on ground.
2. Enlist all pre-requisites required for smooth completion of construction of hill road.
3. State the condition of limiting and exceptional gradient.
4. State the difference between salient and re-entrant curve.
5. State the preventive measures against landslides to be occur in hill road.

[Space for Answers]

[illegible]

XX References / Suggestions for further Reading

Sr. No	Title of Book	Author	Publication
1	Highway Engineering	Khanna S.K. , Justo, C E G and Veeraragavan, A.	Nem Chand and Brothers, Roorkee, 2010, ISBN 978-8185240800
2	Road, Railways, Bridge and Tunnel Engg	Birdi, Ahuja,	Standard Book House, New Delhi, March 2010, ISBN: 978-8189401337

XXI Suggested Assessment Scheme

Sr. No.	Performance Indicators	Weightage %
Process related : 15 Marks		60 %
1	Report writing	20%
2	Understanding the functions of components	30%
3	Working in team	10%
Product related :10 Marks		40 %
4	Conclusions with suggestions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total : 25 Marks		100 %

List of Student Team Members

1

2

3.

4.. ..

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No. 16: Visit to Road Drainage System

I Practical Significance

It is very essential that road surface and sub-surface should remain dry for longer period so as to avoid any possible defects in it. Hence it becomes necessary to study the drainage system of proposed road under construction. This particular assignment brought to know the various parameters regarding the effective working of drainage in various roads. The site visit will be able to provide all such details to understand the knowledge regarding road drainage.

II Relevant Program Outcomes (POs)

PO 1. Basic knowledge: *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. Discipline knowledge: *An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 3. Experiments and practice: *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*

PO 4. Engineering tools: *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

III Relevant Course Outcomes

Undertake maintenance of road and drainage

IV Practical Outcome

Visit the road of any one type (flexible or rigid) to know the drainage condition.

V Competency and Practical Skills

- This practical is to develop the following skills for the industry identified competency **‘Understand the necessity of road drainage.’**
 - i. Observe the drainage condition.
 - ii. Identify the parameters of road drainage .
 - iii. Verify the present drainage condition of given road.

VI Relevant Affective domain related

- a. Follow safety practices.
- b. Practice good housekeeping.
- c. Demonstrate working as a leader/a team member.
- d. Follow ethical Practices.

VII Minimum Theoretical Background

Road Drainage – It is the road system which collect, transport and disposed off the surface and sub-surface water away from the road as early as possible.

Types of road drainage system- Depending upon the sources of water coming to road, the drainage system is classified in two categories.

1. Surface Drainage System- In this system the surface water from direct and indirect sources i.e. rainfall and runoff is drained off away from road way.

2. Sub-Surface Drainage System- In this system, the sub-surface water i.e. ground water table, percolated and water from water logged areas is drained off away from road bed.

Types of drains- Depending upon the type of road drainage system, the following type of Drainage structures should be constructed.

Drains provided in Surface Drainage System-

1. Side drain- It is generally provided for the road constructed on fairly leveled ground i.e. in case of moral roads. It is also required in hill road drainage. It is required along either sides of alignment of road.
2. Catch water drain- It is most commonly provided in case of upper side of hill roads. It catches the rainwater coming on hill road surface.

Drains provided in Sub-surface Drainage System-

1. Longitudinal drain (L-Drain)- It is provided along either sides of alignment sufficiently below the sub-surface of road. It is located just below the road edge to collect the sub-surface water from cross drain pipe.
2. Cross water drain (C-Drain) - It is provided along width of road i.e. perpendicular to longitudinal drains. It has some spec

VIII Practical Set-up

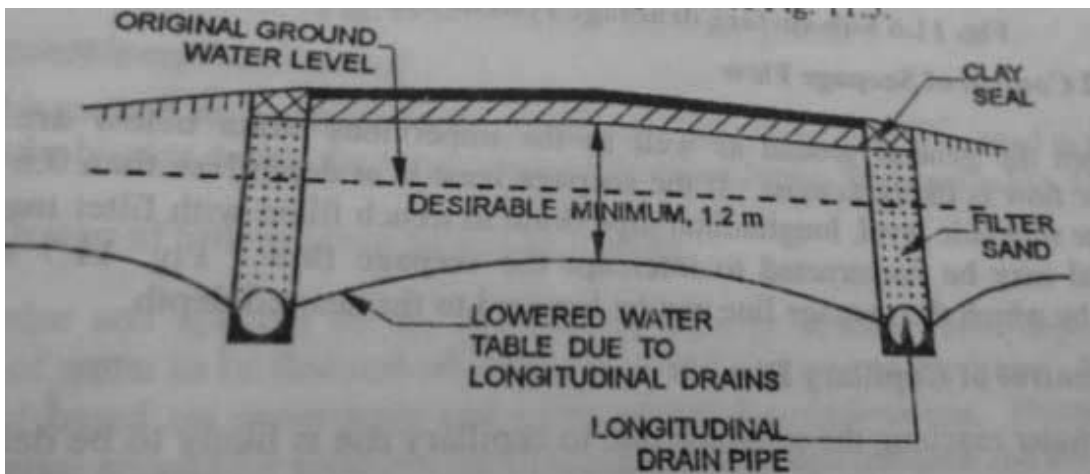


Figure 1: Longitudinal and Cross Drains

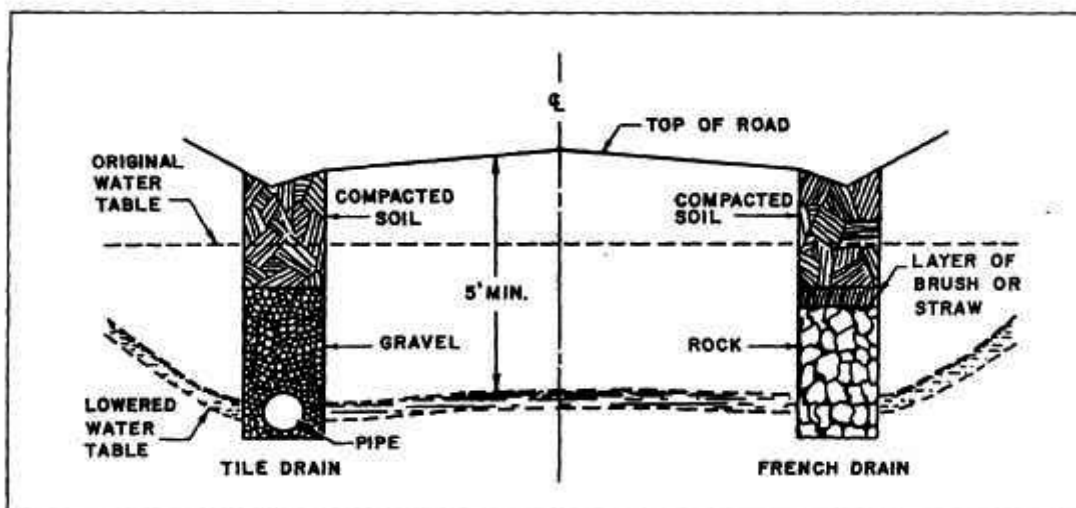


Figure 2: Tile and French Drain

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Camera	As per availability	1 No.	
2	Note pad, Pencil etc.	--	1 No. each/student	

X Procedure

1. Identify the road site having working drainage system.
2. Summarize the photographs of road components taken during the site visit.
3. Paste the photographs of each of the identified components and write the functions of the same in the specified format given below.
4. Compare the theoretical and practical profile of road section stating the differences.

XI Precautions to be followed

1. The clear photographs should be paste to understand the actual layout of road.
2. The group photograph of site visit should be also attached at the end of this assignment.
3. The suggestions regarding the modifications in road section should be given with justification.

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

.....

.....

.....

.....

.....

.....

.....

.....

XIII Resources used

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

XIV Precautions followed

.....

.....

.....

.....

.....

.....

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

Brief description of road drainage condition observed at site is as follows:

.....

.....

.....

.....

.....

.....

.....

.....

.....

XVI Results

The observed drainage condition of Road is(Satisfactory/Unsatisfactory)

.....

.....

XVII Interpretation of results (Give meaning of the above obtained results)

.....

.....

.....

.....

XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Highway Engineering	Khanna S.K. , Justo, C E G and Veeraragavan, A.	Nem Chand and Brothers, Roorkee, 2010, ISBN 978-8185240800
2	Road, Railways, Bridge and Tunnel Engg	Birdi, Ahuja,	Standard Book House, New Delhi, March 2010, ISBN: 978-8189401337

XXI Suggested Assessment Scheme

Sr. No	Performance Indicators	Weightage %
Process related : 15 Marks		60 %
1	Observation of drainage	20%
2	Identifying the components	30%
3	Working in team	10%
Product related :10 Marks		40 %
4	Conclusions with suggestions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total : 25 Marks		100 %

List of Student Team Members

- 1
- 2
3.
- 4..
5.

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No.17: Report of Visit to Road Drainage System

I Practical Significance

The details collected in the visit to drainage system of road, students should represent in this photographic report. It is essential to visualize the actual layout of drainage arrangement for visited road. The working of drainage system can be well judged to fellow diploma engineers. This particular assignment is useful to gain the all requisites of maintenance engineer, so that he is able to take the decision minor and major repairs of drainage system. It is also important to suggest the relevant improvement of functioning of road drainage as well.

II Relevant Program Outcomes (POs)

PO 1. Basic knowledge: *An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.*

PO 2. Discipline knowledge: *An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.*

PO 3. Experiments and practice: *An ability to plan and perform experiments and practices and to use the results to solve engineering problems.*

PO 4. Engineering tools: *Apply relevant civil technologies and tools with an understanding of the limitations.*

PO 8. Individual and Team Work: *Function effectively as leader and team member in Diverse /multidisciplinary team*

III Relevant Course Outcomes

Undertake maintenance of road and drainage

IV Practical Outcome

Prepare the photographic report suggesting possible repairs and maintenance for experiment no. 16.

V Competency and Practical Skills

- This practical is to develop the following skills for the industry identified competency '*Adopt the required repairs for defective drainage.*'

- i. Understand the present condition of road drainage.
- ii. Adopt the required repairs for defective drainage.
- iii. Suggest the possible modification for improvement in road drainage if any

VI Relevant Affective domain related

- a. Follow safety practices.
- b. Practice good housekeeping.
- c. Demonstrate working as a leader/a team member.
- d. Follow ethical Practices.

VII Minimum Theoretical Background

If the drainage of the road would not be effective, then it gives rise to various difficulties in traffic flow. It is therefore necessary to assess it for its effectiveness in terms of structural layout, condition of components of drainage like drain pipe, joints, connections etc. The drainage of road becomes a predominant factor in heavily rainfall regions, where rainwater and ground water rise affects the stability and usability of road.

The drains above and below the road surface are constructed separately. But it requires to be connected to each other for effective disposal of accumulated water to desired location. The following figure shows the provision of drain pipe for the road subsurface.

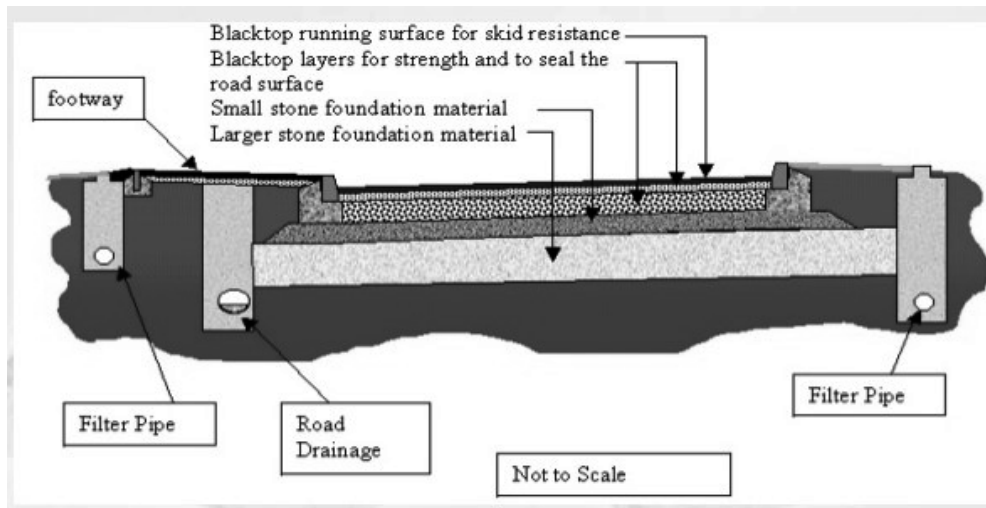


Figure 1: Road Drainage System

VIII Practical Set-up



Figure 2: Improper Road side drainage and Provision of Drain Pipe

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Camera	As per availability	1 No.	
2	Note pad, Pencil etc.	--	1 No. each/student	

X Procedure

1. Identify the road site having working drainage system.
2. Summarize the photographs of road components taken during the site visit.
3. Paste the photographs of each of the identified components and write the functions of the same in the specified format given below.
4. Compare the theoretical and practical profile of road section stating the differences.

XI Precautions to be followed

1. The clear photographs should be paste to understand the actual layout of road.
2. The group photograph of site visit should be also attached at the end of this assignment.
3. The suggestions regarding the modifications in road section should be given with justification.

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

.....

.....

.....

.....

.....

.....

XIII Resources used

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

XIV Precautions followed

.....

.....

.....

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

Brief description of road drainage condition observed at site is as follows:

.....

.....

.....

.....

.....

.....

.....

.....

.....

XVI Results

The Capacity of Observed drain is found to be(Adequate/ Inadequate)

.....

.....

.....

.....

XVII Interpretation of results (Give meaning of the above obtained results)

.....

.....

.....

.....

XVIII Conclusions and Recommendations (if any) (Actions/decisions to be taken based on the interpretation of results).

.....

.....

.....

.....

XIX 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. State the functions of sub-surface drainage system.
2. State the value of slope of longitudinal and cross drain pipes.
3. Write the drainage condition in your city.
4. State the different points in drainage condition in summer and monsoon season.

Space to Write Answers

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

This image shows a full page of white paper with horizontal dotted lines, typical of primary school writing paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Highway Engineering	Khanna S.K. , Justo, C E G and Veeraragavan, A.	Nem Chand and Brothers, Roorkee, 2010, ISBN 978-8185240800
2	Road, Railways, Bridge and Tunnel Engg	Birdi, Ahuja,	Standard Book House, New Delhi, March 2010, ISBN: 978-8189401337

XXI Suggested Assessment Scheme

Sr. No.	Performance Indicators	Weightage %
Process related : 15 Marks		60 %
1	Report writing with photographs	20%
2	Analyzing drainage system	30%
3	Working in team	10%
Product related :10 Marks		40 %
4	Conclusions with suggestions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total : 25 Marks		100 %

List of Student Team Members

- 1
- 2
3.
- 4..
5.

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

List Of Laboratory Manuals Developed by MSBTE

First Semester:

1	Fundamentals of ICT	22001
2	English	22101
3	English Work Book	22101
4	Basic Science (Chemistry)	22102
5	Basic Science (Physics)	22102

Second Semester:

1	Business Communication Using Computers	22009
2	Computer Peripherals & Hardware Maintenance	22013
3	Web Page Design with HTML	22014
4	Applied Science (Chemistry)	22202
5	Applied Science (Physics)	22202
6	Applied Machines	22203
7	Basic Surveying	22205
8	Applied Science (Chemistry)	22211
9	Applied Science (Physics)	22211
10	Fundamental of Electrical Engineering	22212
11	Elements of Electronics	22213
12	Elements of Electrical Engineering	22215
13	Basic Electronics	22216
14	'C' programming Language	22218
15	Basic Electronics	22225
16	Programming in "C"	22226
17	Fundamentals of Chemical Engineering	22231

Third Semester:

1	Applied Multimedia Techniques	22024
2	Advanced Surveying	22301
3	Highway Engineering	22302
4	Mechanics of Structures	22303
5	Building Construction	22304
6	Concrete Technology	22305
7	Strength Of Materials	22306
8	Automobile Engines	22308
9	Automobile Transmission System	22309
10	Mechanical Operations	22313
11	Technology Of Inorganic Chemicals	22314
12	Object Oriented Programming Using C++	22316
13	Data Structure Using 'C'	22317
14	Computer Graphics	22318
15	Database Management System	22319
16	Digital Techniques	22320
17	Principles Of Database	22321
18	Digital Techniques & Microprocessor	22323
19	Electrical Circuits	22324
20	Electrical & Electronic Measurement	22325
21	Fundamental Of Power Electronics	22326
22	Electrical Materials & Wiring Practice	22328
23	Applied Electronics	22329
24	Electrical Circuits & Networks	22330
25	Electronic Measurements & Instrumentation	22333
26	Principles Of Electronics Communication	22334
27	Thermal Engineering	22337
28	Engineering Metrology	22342
29	Mechanical Engineering Materials	22343
30	Theory Of Machines	22344

Fourth Semester:

1	Hydraulics	22401
2	Geo Technical Engineering	22404
3	Chemical Process Instrumentation & Control	22407
4	Fluid Flow Operation	22409
5	Technology Of Organic Chemicals	22410
6	Java Programming	22412
7	GUI Application Development Using VB.net	22034
8	Microprocessor	22415
9	Database Management	22416
10	Electric Motors And Transformers	22418
11	Industrial Measurements	22420
12	Digital Electronics And Microcontroller Applications	22421
13	Linear Integrated Circuits	22423
14	Microcontroller & Applications	22426
15	Basic Power Electronics	22427

16	Digital Communication Systems	22428
17	Mechanical Engineering Measurements	22443
18	Fluid Mechanics and Machinery	22445
19	Fundamentals Of Mechatronics	22048

Fifth Semester:

1	Design of Steel and RCC Structures	22502
2	Public Health Engineering	22504
3	Heat Transfer Operation	22510
4	Environmental Technology	22511
5	Operating Systems	22516
6	Advanced Java Programming	22517
7	Software Testing	22518
8	Control Systems and PLC's	22531
9	Embedded Systems	22532
10	Mobile and Wireless Communication	22533
11	Industrial Machines	22523
12	Switchgear and Protection	22524
13	Energy Conservation and Audit	22525
14	Power Engineering and Refrigeration	22562
15	Solid Modeling and Additive Manufacturing	22053
16	Guidelines & Assessment Manual for Micro Projects & Industrial Training	22057

Sixth Semester:

1	Solid Modeling	17063
2	Highway Engineering	17602
3	Contracts & Accounts	17603
4	Design of R.C.C. Structures	17604
5	Industrial Fluid Power	17608
6	Design of Machine Elements	17610
7	Automotive Electrical and Electronic Systems	17617
8	Vehicle Systems Maintenance	17618
9	Software Testing	17624
10	Advanced Java Programming	17625
11	Mobile Computing	17632
12	System Programming	17634
13	Testing & Maintenance of Electrical Equipments	17637
14	Power Electronics	17638
15	Illumination Engineering	17639
16	Power System Operation & Control	17643
17	Environmental Technology	17646
18	Mass Transfer Operation	17648
19	Advanced Communication System	17656
20	Mobile Communication	17657
21	Embedded System	17658
22	Process Control System	17663
23	Industrial Automation	17664
24	Industrial Drives	17667
25	Video Engineering	17668
26	Optical Fiber & Mobile Communication	17669
27	Therapeutic Equipment	17671
28	Intensive Care Equipment	17672
29	Medical Imaging Equipment	17673

Pharmacy Lab Manual

First Year:

1	Pharmaceutics - I	0805
2	Pharmaceutical Chemistry - I	0806
3	Pharmacognosy	0807
4	Biochemistry and Clinical Pathology	0808
5	Human Anatomy and Physiology	0809

Second Year:

1	Pharmaceutics - II	0811
2	Pharmaceutical Chemistry - II	0812
3	Pharmacology & Toxicology	0813
4	Hospital and Clinical Pharmacy	0816

HEAD OFFICE



Secretary,

Maharashtra State Board of Technical Education

49, Kherwadi, Bandra (East), Mumbai - 400 051

Maharashtra (INDIA)

Tel: (022)26471255 (5 -lines)

Fax: 022 - 26473980

Email: -secretary@msbte.com

Web -www.msbte.org.in

REGIONAL OFFICES:

MUMBAI

Deputy Secretary (T),

Mumbai Sub-region,

2nd Floor, Govt. Polytechnic Building,

49, Kherwadi, Bandra (East)

Mumbai - 400 051

Phone: 022-26473253 / 54

Fax: 022-26478795

Email: rbtemumbai@msbte.com

PUNE

Deputy Secretary (T),

M.S. Board of Technical Education,

Regional Office,

412-E, Bahirat Patil Chowk,

Shivaji Nagar, Pune

Phone: 020-25656994 / 25660319

Fax: 020-25656994

Email: rbtepn@msbte.com

NAGPUR

Deputy Secretary (T),

M.S. Board of Technical Education

Regional Office,

Mangalwari Bazar, Sadar, Nagpur - 440 001

Phone: 0712-2564836 / 2562223

Fax: 0712-2560350

Email: rbteeng@msbte.com

AURANGABAD

Deputy Secretary (T),

M.S. Board of Technical Education,

Regional Office,

Osmanpura, Aurangabad -431 001.

Phone: 0240-2334025 / 2331273

Fax: 0240-2349669

Email: rbteau@msbte.com