

5.5. HIGHWAY ENGINEERING

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RATIONALE

Construction of roads is one of the major areas in which diploma holders in Civil Engineering may get very good opportunities for employment. The diploma holders are responsible for construction and maintenance of highways and airports. Basic concepts of road geo-metrics, surveys and plans, elements of traffic engineering, road materials, construction of rigid and flexible pavements, special features of hill roads, road drainage system and various aspects of maintenance find place in above course.

COURSE OUTCOMES

After undergoing the subject, the students will be able to:

- CO1 Classify the roads as per IRC types and geometrics
- CO2 Explain various components of a flexible/rigid pavement
- CO3 Select various highway materials and test them for different quality parameters
- CO4 Supervise construction of a highway in plain areas and hilly areas
- CO5 Use various road construction equipment
- CO6 Describe basic terminology of various components of an airport.

DETAILED CONTENTS

UNIT-I

1.1 Introduction

- 1.1.1 Importance of Highway engineering
- 1.1.2 Functions of IRC, CRRI, MoRT&H, NHAI
- 1.1.3 IRC Classification of roads

1.2 Elements of Road Geometrics

- 1.2.1 Glossary of terms used in road geo-metrics and their importance: Right- of- way,

Formation width, road margin, road shoulder, carriage way, side slopes, kerbs, formation levels

- 1.2.2 Concept of camber and gradients- their types and functions
 - 1.2.3 Concept of Design speed, average running speed, stopping and overtaking sight distance.
 - 1.2.4 Curves- Necessity and types (horizontal and vertical curves including transition curves)
 - 1.2.5 Super elevation-Definition, methods of providing super elevation and concept of widening of roads on curves
 - 1.2.6 Sketch of typical cross-sections in cutting and filling on straight alignment and at a curve
- (Note: No design/numerical problem to be taken)**

UNIT-II

2.1 Highway Surveys, Alignment and Plan

- 2.1.1 Topographic Map-Concept and uses
- 2.1.2 Road surveys for highway location-Stages of road surveys (map study, reconnaissance, preliminary surveys, final location and detailed surveys)
- 2.1.3 Highway alignment-Definition and requirements
- 2.1.4 Standards for preparing highway plans- Stages and objectives.
- 2.1.5 Basic considerations governing alignment for a road in plain and hilly area
- 2.1.6 Setting out alignment of road- Highway location, bench marks and control pegs for embankment and cutting.

2.2 Highway Materials

- 2.2.1 Different types of road materials – (Soil, Aggregates and Binders) their common types, functions & requirements.
- 2.2.2 Introduction to California Bearing Ratio, method of finding CBR value and its significance.
- 2.2.3 Bitumen and Tar their properties as per BIS specifications, penetration, softening point, ductility and viscosity test of bitumen, procedures and significance.
- 2.2.4 Cut back, emulsion and Bitumen modifiers (CRMB, PMB) their functions.

UNIT-III

3.1 Highway Pavements Construction

- 3.1.1 Highway pavement: Flexible and rigid pavement, their merits and demerits, typical cross-sections, functions of various components

- 3.1.2 Sub-grade preparation: - Borrow pits, making profiles of embankment, construction of embankment, compaction, preparation of subgrade, and methods of checking camber, gradient and alignment as per recommendations of IRC, equipment used for subgrade preparation.
- 3.1.3 Stabilization of subgrade. Types of stabilization mechanical stabilization, lime stabilization, cement stabilization; fly ash stabilization etc. (introduction only)
- 3.1.4 Stabilization of sub base & base course: Granular base course:
- a) Water Bound Macadam (WBM)
 - b) Wet Mix Macadam (WMM)
 - c) Bitumen Courses:
 - (i) Bituminous Macadam
 - (ii) Dense Bituminous Macadam (DBM)
- *Methods of construction as per MoRT&H
- 3.1.5 Surfacing: Definition and types of surfacing
- a) Prime coat and tack coat
 - b) Surface dressing with seal coat
 - c) Open graded premix carpet
 - d) Seal coat
 - e) Bituminous Concrete
 - f) Bituminous penetration macadam.
- * Methods of constructions as per MORT&H specifications and quality control; equipments used for above.
- 3.1.6 Rigid Pavements:- Construction of concrete roads as per IRC specifications: Form work laying, mixing and placing the concrete, compacting and finishing, curing, joints in concrete pavement, equipment used. Roller compacted concrete.

UNIT-IV

4.1 Hill Roads:

- 4.1.1 Introduction: Typical cross-sections showing all details of a typical hill road, partly in cutting and partly in filling

4.2 Special problems of hill areas

- 4.2.1 Landslides: Causes, prevention and control measures, use of geo-grids, geo-flexibles, geo-synthetics
- 4.2.2 Drainage

- 4.2.3 Soil erosion
- 4.2.4 Snow: Snow clearance, snow avalanches, frost
- 4.2.5 Land Subsidence

4.3 Highway Drainage:

- 4.3.1 Necessity of road drainage work, cross drainage works
- 4.3.2 Surface and subsurface drains and storm water drains: - Location, spacing and typical details of side drains, side ditches for surface drainage.
- 4.3.3 Intercepting drains, pipe drains in hill roads, details of drains in cutting embankment, typical cross sections.

UNIT-V

5.1 Highway Maintenance:

- 5.1.1 Common types of road failures of flexible pavements: Pot hole, cracks, rutting, alligator, cracking, upheaval - their causes and remedies (brief description)
- 5.1.2 Maintenance of bituminous road such as crack sealing, patch-work and resurfacing.
- 5.1.3 Maintenance of concrete roads-filling cracks, repairing joints, maintenance of shoulders (berms)

5.2 Highway Safety:

- 5.2.1 Best practices in engineering design for road safety: Geometry of the road, Segregation of local traffic, Pedestrian facility, Bus bays, Illuminations, Development of junction, Signage and road safety audit.
- 5.2.3 Essential road construction safety tips: Wear the proper safety equipment, Control traffic, Avoid blind spots, Be Constantly Aware of Surroundings

5.3 Airport Engineering:-

- 5.3.1 Concept of Airport engineering.
- 5.3.2 Factors to be considered while selecting a site for an airport with respect to zoning laws.
- 5.3.3 Introduction to Runways, Taxiways, Apron and Hanger.
- 5.3.4 Types of pavement used in airport runway.

***An expert may be invited from field/industry for extension lecture on this topic.**

PRACTICAL EXERCISES

1. Determination of penetration value of bitumen
2. Determination of softening point of bitumen

3. Determination of ductility of bitumen
4. Determination of impact value of the road aggregate
5. Determination of abrasion value (Los Angeles') of road aggregate
6. Determination of crushing strength of aggregate
7. Determination of flakiness and elongation index of aggregate
8. Determination of the California bearing ratio (CBR) for the sub-grade soil
9. Determination of stripping value of aggregates.
10. Demonstration of working of hot mix plant through a field visit
11. Visit to highway construction site for demonstration of operation of:
Tipper, tractors (wheel and crawler), scraper, bulldozer, dumpers, shovels, grader, roller, dragline, road pavers, paver finisher JCB
12. Demonstration of working of mixing and spraying equipment (Asphalt mixer & tar boiler) through a field visit

RECOMMENDED BOOKS

1. "Highway Engineering" by Khanna, SK and Justo, CEG; Nem Chand and Bros., Roorkee
2. "A Text Book on Highway Engineering and Airport" by Sehgal, SB; and Bhanot, KL; SChand and Co, Delhi
3. "A Course on Highway Engineering" by Bindra, SP; Dhanpat Rai and Sons, New Delhi
4. "Laboratory Manual in Highway Engineering" by Duggal AK, Puri VP; New Age Publishers (P) Ltd, Delhi,
5. "Laboratory Manual in Highway Engineering", by NITTTR, Chandigarh
6. "Maintenance of Highway – a Reader by Duggal AK; NITTTR, Chandigarh
7. "Types of Highway Construction" by Duggal AK; NITTTR Chandigarh
8. e-books/e-tools/relevant software to be used as recommended by AICTE/HSBTE/NITTTR.
9. MoRTH Specifications for Road and Bridge Works (Fifth Revision)
10. MoRTH Pocket book for Highway Engineers, 2001
11. MoRTH Manual for Maintenance of Roads, 1983

SUGGESTED WEBSITES

1. <https://swayam.gov.in/>
2. <https://www.udemy.com/>
3. <https://www.upgrad.com/>

INSTRUCTIONAL STRATEGY

While imparting instructions, it is recommended that emphasis should be laid on constructional details and quality control aspects. Students should be asked to prepare sketches and drawings, clearly indicating specifications and constructional details for various sub components of a highway. It will be also advantageous to organize field visits to show the actual construction of roads at site. This subject contains five units of equal weightage.