HIGHWAY ENGINEERING

By
Rangwala

ISBN : 9789385039294
Size : 170 mm × 235 mm
Binding : Paperback
Pages : 408 + 16 = 424

ABOUT THE BOOK

This text-book deals with the design methods of construction, planning, alignment and maintenance of all types of highways; and various other topics such as traffic management, road making machineries, drainage, arboriculture and lighting, highway economics, etc. connected with the subject of Highway Engineering.

The book is divided into sixteen well-arranged chapters: therein it contains—

* 280 Self-explanatory and neatly drawn sketches
* 31 Illustrative problems
* 54 Important tables
* 316 Typical questions at the end of each chapter.

The salient features of the book are:

* Comprehensive presentation
* Clear exposition and brief description
* Step-by-step treatment
* Simple and lucid language.

The book should prove to be extremely useful to the Civil Engineering students preparing for the Degree Examinations of all the Indian Universities, Diploma Examinations conducted by various Boards of Technical Education, Certificate Courses as well as for the A.M.I.E., U.P.S.C., G.A.T.E., I.E.S. and other similar competitive and professional examinations. It should also prove of interest to the practising professionals.

CONTENT

1. INTRODUCTION
2. HIGHWAY PLANNING AND ALIGNMENT
3. GEOMETRICAL DESIGN OF HIGHWAYS
4. LOW COST ROADS
5. BITUMINOUS ROADS
6. CEMENT CONCRETE ROADS
7. TESTS FOR HIGHWAY MATERIALS
8. DESIGN OF HIGHWAY PAVEMENTS
9. OTHER TYPES OF PAVEMENTS
10. HILL ROADS
11. HIGHWAY DRAINAGE
12. HIGHWAY MAINTENANCE
13. HIGHWAY MAKING MACHINERIES
14. TRAFFIC ENGINEERING
15. HIGHWAY ARBORICULTURE AND LIGHTING
16. HIGHWAY ECONOMICS
APPENDIX 1 : TYPICAL TRAFFIC SIGNS
APPENDIX 2 : ABBREVIATED TERMS
INDEX
Chapter 1 INTRODUCTION
1-1. General
1-2. History of road construction
   (1) Roman roads
   (2) Tresquet construction
   (3) Metcalf construction
   (4) Telford construction
   (5) Macadam construction
1-3. Development of roads in India
   (1) Roads in ancient India
   (2) Roads in Mughal period
   (3) Road development during British rule
   (4) Road development in free India
1-4. Modes of transportation
   (1) Transportation by land
   (2) Transportation by water
   (3) Transportation by air
1-5. Characteristics of road transport
1-6. Advantages of roads
1-7. Importance of roads in India
1-8. Requirements of an ideal road
1-9. Scope of highway and transportation engineering
1-10. Transportation in India
1-11. Indian Institutions for Highway at National Level
   (1) Indian Road Congress (IRC)
   (2) Ministry of Road Transport and Highways (MORTH)
   (3) National Highway Authority of India (NHAI)
   (4) Central Road Research Institute (CRRI)
QUESTIONS 1

Chapter 2 HIGHWAY PLANNING AND ALIGNMENT
2-1. General
2-2. Objects of highway planning
2-3. Classification of highways
2-3-1. According to location and function
   (1) National highways (NH)
   (2) State highways (SH)
   (3) Major district roads (MDR)
   (4) Other district roads (ODR)
   (5) Village roads (VR)
   (6) Border roads
   (7) Express highways
2-3-2. Build, Operate and Transfer (BOT) projects
   (1) Kundli–Manesar–Palwal (KMP) expressway
   (2) Delhi–Gurgaon expressway
   (3) Gwalior–Jhansi Highway BOT (Annuity) project
   (4) Lucknow–Sitapur Highway
2-3-3. According to transported tonnage
2-3-4. According to traffic
   (1) Character of traffic
   (2) Designed speed
2-4. Formulas for road lengths
   (1) First 20-year road plan (1943-61) or Nappur road plan
   (2) Second 20-year road plan (1961-81) or Bombay road plan
   (3) Third 20-year road plan (1981-2001) or Lucknow road plan
2-5. Saturation system
   (1) Population
   (2) Products
2-6. Highway alignment
   (1) Easiness
   (2) Economics
2-7. Factors affecting highway alignment
   (1) Availability of road building materials
   (2) Crossings
   (3) Geological features
   (4) Land acquisition
2-8. Planning surveys
   (1) Economic studies
   (2) Engineering studies
2-9. Engineering surveys

Chapter 3 GEOMETRICAL DESIGN OF HIGHWAYS
3-1. General
3-2. Road structure
3-3. Width of pavement or carriageway
3-4. Traffic separators or medians
3-5. Kerbs
3-6. Road margins
3-7. Width of roadway or formation
3-8. Right of way
3-9. Typical cross-sections of roads
3-10. Camber
3-11. Design speed
3-12. Stopping sight distance (SSD)
3-13. Crossing sight distance
3-14. Overtaking sight distance
3-15. Overtaking zones
3-16. Sight distance at intersections
3-17. Road gradient

QUESTIONS 2
Chapter 4 LOW COST ROADS

4-1. General

4-2. Classification of low cost roads
   (1) Earth roads
   (2) Kankar roads
   (3) Gravel roads

4-3. Dust prevention
   (1) Application of road oil
   (2) Sprinkling with water
   (3) Tar or asphalt surfacing
   (4) Use of hygroscopic material

4-4. Soil stabilized roads
   (1) General
   (2) Objects of soil stabilization

4-5. Soil stabilizers
   (1) Bituminous materials
   (2) Cementing agents

4-6. Methods of soil stabilization
   (1) Mechanical stabilization
   (2) Bituminous stabilization
   (3) Cement stabilization
   (4) Lime stabilization
   (5) Chemical stabilization
   (6) Miscellaneous methods of stabilization

4-7. Special problems in soil stabilization work
   (1) Choice of method of stabilization
   (2) Design of the stabilized mix
   (3) Thickness of layer

4-8. Problems of soil stabilization of roads in black cotton soil and desert sand
   (1) Stabilization of black cotton soil
   (2) Stabilization of desert sand

4-9. Soil survey
   (1) General
   (2) Stages of soil survey

4-10. Characteristics of soil
   (1) Centrifuge moisture equivalent
   (2) Colour
   (3) Field moisture equivalent
   (4) Grain shape
   (5) Lineal shrinkage and volumetric change
   (6) Particle sizes and distribution
   (7) Plasticity
   (8) Presence of fines
   (9) Specific gravity
   (10) State of compaction

4-11. Soil classification systems
   (1) Grain or particle size classification
   (2) Textural classification
   (3) Highway research board classification of soils
   (4) Indian Standard soil classification

QUESTIONS 3

Chapter 5 BITUMINOUS ROADS

5-1. General

5-2. Advantages of bituminous roads

5-3. Disadvantages of bituminous roads

5-4. Bituminous materials
   (1) Asphalt
   (2) Bitumen
   (3) Cutback bitumen
   (4) Bitumen emulsion

5-5. Methods of application of bituminous materials
   (1) Surface dressing
   (2) Prime coat
   (3) Tack coat
   (4) Seal coat

5-6. Construction of bituminous roads
   (1) Surface dressing with single coat
   (2) Surface dressing with two coats
   (3) Full grout surface of 50 mm and 75 mm thicknesses
   (4) Semi-grout surface of 50 mm thickness
   (5) Bitumen bound macadam
   (6) Bituminous carpet of thickness about 20 mm to 25 mm
   (7) Bituminous concrete
   (8) Sheet asphalt of 25 mm thickness

5-7. Hot Mix Asphalt (HMA) and Warm Mix Asphalt (WMA) Pavements
   (5-7-1. General
   (5-7-2. Effect of HMA on Environment
   (5-7-3. Advantages of reducing temperature of HMA
   (5-7-4. HMA Pavement with Hydrated Lime
   (5-7-5. Warm Mix Asphalt
   (5-7-6. The Future of Warm-mix Asphalt

QUESTIONS 5

Chapter 6 CEMENT CONCRETE ROADS

6-1. General

6-2. Advantages of cement concrete roads

6-3. Disadvantages of cement concrete roads

6-4. Comparison between bituminous concrete roads and cement concrete roads

6-5. Methods of construction of cement concrete roads
   (1) Alternate bay method
   (2) Continuous bay method
   (3) Expansion joint and strip method

6-6. Construction procedure for cement concrete roads
   (1) Preparation of subgrade and sub-base
   (2) Placing of forms
   (3) Watering the prepared subgrade or sub-base
   (4) Mixing and placing of concrete
   (5) Compaction and finishing
   (6) Belting, brooming and edging
   (7) Curing
   (8) Opening to traffic

6-7. Joints in cement concrete roads
   (1) Reasons for providing joints
   (2) Requirements of a good joint
   (3) Types of joints

6-8. Arrangements of transverse joints
   (1) Uniform spacing
   (2) Staggered spacing
   (3) Skew spacing

6-9. Design of dowel bars

6-10. Design procedure

6-11. Joint fillers and sealers

6-12. Other forms of cement concrete roads
   (1) Bonded concrete roads
   (2) Cement macadam roads
   (3) Colloidal concrete roads
   (4) Creteways
   (5) Prestressed concrete roads
   (6) R.C.C. roads
   (7) Rolled concrete roads

QUESTIONS 6

Chapter 7 TESTS FOR HIGHWAY MATERIALS

7-1. General

7-2. Types of road aggregates
   (1) Natural aggregates
   (2) Artificial aggregates

7-3. Requirements of a good road aggregate
   (1) Adhesion with bitumen
   (2) Cementation
   (3) Durability
   (4) Hardness
   (5) Shape
   (6) Strength
   (7) Toughness
7-4. Tests for road aggregates
   (1) Abrasion test (5) Soundness test
   (2) Crushing test (6) Specific gravity and water absorption test
   (3) Impact test (7) Stripping value test
   (4) Shape test

7-5. Functions of bituminous materials
   (1) Binding effect (2) Cushion
   (3) Resistance to weathering agencies
   (4) Sealing of surface

7-6. Tests for bituminous materials
   (1) Ductility test (6) Softening point test
   (2) Flash and fire (7) Solubility test
   point test (8) Specific gravity test
   (3) Float test (9) Spot test
   (4) Loss on heating test (10) Viscosity test
   (5) Penetration test (11) Water content test

QUESTIONS 7

Chapter 8 DESIGN OF HIGHWAY PAVEMENTS

8-1. General
8-2. Types of pavement
   (1) Flexible pavements (2) Rigid pavements
8-3. Factors affecting the design of pavements
   (1) Climate (4) Pavement materials
   (2) Environment (5) Subgrade soil
   (3) Geometry (6) Traffic

8-4. Design of bituminous paving mixes
   (1) Marshall method of mix design
   (2) Hveem method of mix design

8-5. Design of flexible pavements
   (1) Group index (G.I.) method
   (2) California bearing ratio (C.B.R.) method

8-6. Design of rigid pavements
   (1) Plain concrete
   (2) Reinforced concrete
   (3) Continuously reinforced concrete
   (4) Prestressed concrete

8-7. Design parameters for rigid pavements
   (1) Traffic parameters
   (2) Environmental parameters
   (3) Foundation strength
   (4) Foundation surface characteristics
   (5) Characteristics of concrete
   (6) Modulus of Elasticity and Poisson’s ratio
   (7) Co-efficient of thermal expansion
   (8) Design of slab thickness

8-8. I.R.C. Recommended design procedure

QUESTIONS 8

Chapter 9 OTHER TYPES OF PAVEMENTS

9-1. General
9-2. Brick pavements
   (1) Brick and block pavement
   (2) Vitrified brick pavement
   (3) Brick edging
9-3. Stone pavements
9-4. Wooden block pavements
   (1) Preparation of rigid and smooth foundation
   (2) Laying of blocks (3) Surface dressing
9-5. Asphaltic block pavements
9-6. Cast-iron block pavements
9-7. Rubber block pavements

QUESTIONS 9

Chapter 10 HILL ROADS

10-1. General
10-2. Importance of hill roads
   (1) Development in stages
   (2) Initial cost (3) Length

10-3. Classification of hill roads
   (1) According to the Border Roads Organization
   (2) According to general classification
   (3) According to use

10-4. Basic principles of planning of hill roads
   (1) Construction work (4) Master plan
   (2) Existing routes (5) Natural climatic conditions
   (3) Intensity of traffic (6) Use of contours

10-5. Method of surveying
   (1) Delay in work (4) Man-power
   (2) Details of area (5) Remote areas
   (3) Information

10-6. Alignment of hill roads
10-7. Geometric standards of hill roads
   (1) Widths of carriageway, shoulder, roadway and land
   (2) Camber
   (3) Stopping sight distance
   (4) Overtaking sight distance
   (5) Gradients
   (6) Super-elevation
   (7) Radius of horizontal curve
   (8) Widening at curves
   (9) Transition curves
   (10) Hairpin bends
   (11) Cut slopes
   (12) Setback distance
   (13) Passing places
   (14) Vertical clearance
   (15) Lateral clearance

10-8. Protective works for hill roads
   (1) Retaining walls (3) Parapet walls
   (2) Breast walls

10-9. Drainage in hill roads
   (1) Sub-surface drainage (2) Surface drainage

10-10. Maintenance of hill roads
   (1) Control of avalanches
   (2) Drainage structures
   (3) Prevention of land slides
   (4) Snow clearance

QUESTIONS 10

Chapter 11 HIGHWAY DRAINAGE

11-1. General
11-2. Sources of water entering the road structure
   (1) Capillary action of water
   (2) Floods
   (3) Rain water falling on road surface
   (4) Rain water from surrounding area

11-3. Defects due to improper highway drainage
11-4. Requirements of good highway drainage system
   (1) Adjoining land
   (2) Camber
   (3) Cross-drainage works
   (4) Gradient
   (5) Highest flood level
   (6) Interceptor drains
   (7) Side drains
   (8) Underground sources of water
   (9) Water-logged areas
   (10) Water table

11-5. Surface drainage
   (1) Side drains for road in embankment
   (2) Side drains for road in cutting
   (3) Design of side drains

11-6. Drainage of city or urban roads
   (1) Catch basins (2) Inlets

11-7. Sub-surface drainage
   (1) Causes of changes in moisture content
   (2) Situations requiring sub-surface drainage
   (3) Methods of sub-surface drainage

11-8. Design of filter for drainage trenches
   (1) Permeability ratio (2) Piping ratio

11-9. Road construction in waterlogged areas
   (1) Control of capillary (4) Sand drains
   (2) Pavement thickness (5) Sub-surface drainage system
   (3) Raising the road level

QUESTIONS 11
Chapter 12 HIGHWAY MAINTENANCE

12-1. General

12-2. Causes of failure of pavements
   (1) Failures in flexible pavements
   (2) Failures in rigid pavements

12-3. Typical flexible pavement failures
   (1) Alligator or map cracking
   (2) Consolidation of pavement layers
   (3) Formation of waves
   (4) Frost heaving
   (5) Lack of binding with the lower course
   (6) Longitudinal cracking
   (7) Reflection cracking
   (8) Shear failure

12-4. Typical rigid pavement failures
   (1) Mud pumping
   (2) Scaling of cement concrete
   (3) Shrinkage cracks
   (4) Spalling of joints
   (5) Structural cracks
   (6) Warping cracks

12-5. Maintenance of earth roads
   (1) Normal maintenance
   (2) Preventive maintenance

12-6. Maintenance of gravel roads
   (1) Normal repairs
   (2) Periodical renewal

12-7. Maintenance of W.B.M. roads
   (1) Fast moving vehicles
   (2) Grinding of stones
   (3) Hoofs of the animals
   (1) Normal repairs
   (2) Surface renewal

12-8. Maintenance of bituminous roads
   (1) Patch repairs
   (2) Preventing skidding of vehicles
   (3) Reducing reflection cracking
   (4) Stripping and ravelling
   (5) Waves and corrugations

12-9. Maintenance of cement concrete roads
   (1) Maintenance of joints
   (2) Mud jacking
   (3) Patch repairs
   (4) Treatment of cracks

12-10. Pavement evaluation
   (1) Poor riding quality
   (2) Slipperiness
   (3) Structural deterioration
   (4) Other surface deterioration

12-11. Strengthening of existing pavements

12-12. Important principles in road improvement
   (1) Economy of road improvement
   (2) Use of low cost roads
   (3) Wear of roads

12-13. Benefits of improved highways

QUESTIONS 12

Chapter 13 HIGHWAY MAKING MACHINERIES

13-1. General

13-2. Excavating equipments
   (1) Tractor
   (2) Bulldozer and angle-dozers
   (3) Grader
   (4) Scraper
   (5) Excavators
   (6) Dredgers
   (7) Ripper or rooter
   (8) Trencher or ditcher

13-3. Compacting equipments
   (1) Road rollers
   (2) Vibratory compactors
   (3) Earth rammers
   (4) Jetting and pounding

13-4. EquipmentS for bituminous roads
   (1) Bitumen heaters
   (2) Bitumen mixers
   (3) Bitumen truck mixers
   (4) Pavers

13-5. EquipmentS for cement concrete roads
   (1) Batching plant
   (2) Concrete mixer
   (3) Vibrating screed
   (4) Internal vibrator
   (5) Float
   (6) Straight edge
   (7) Belt
   (8) Fibre brush
   (9) Miscellaneous

13-6. Travelling plant

QUESTIONS 13

Chapter 14 TRAFFIC ENGINEERING

14-1. General

14-2. Objects of traffic engineering

14-3. Traffic surveys

14-3-1. Accident survey
   (1) House interview method
   (2) License plate method
   (3) Postal questionnaire method
   (4) Route interview method
   (5) Tag-on-car method

14-3-3. Parking survey
   (1) Parking accumulation
   (2) Parking duration
   (3) Parking load
   (4) Parking turnover
   (5) Parking volume

14-3-4. Spot speed survey

14-3-5. Speed and delay survey

14-3-6. Traffic volume survey
   (1) Objects of traffic volume survey
   (2) Methods of traffic volume survey
   (3) Information collected in traffic volume survey
   (4) Uses of traffic volume survey

14-4. Road accidents

14-4-1. Causes of road accidents
   (1) Defective vehicles
   (2) Drivers
   (3) Moving of animals
   (4) Passengers
   (5)Pedestrians
   (6) Road design
   (7) Traffic volume
   (8) Weather

14-4-2. Measures to prevent road accidents
   (1) Educational methods
   (2) Enforcement methods
   (3) Engineering methods

14-5. Parking
   (1) Kerb or on-street parking
   (2) Off-street parking
   (3) General public
   (4) Road users
   (5) Transport personnel

14-6. Methods of parking

14-7. Traffic congestion

14-8. Traffic control

14-9. One-way streets

14-10. Road junctions or intersections

QUESTIONS 14
14-11. Types of intersections
14-11-1. At-grade intersections
   (1) All-paved or unchannelized intersections
   (2) Channelized intersections
   (3) Roundabouts or rotaries
14-11-2. Grade separations
   (1) Direct ramp
   (2) Semi-direct ramp
   (3) Indirect ramp
14-12. Traffic control devices
14-12-1. Road markings
14-12-2. Road signs
   (1) Purposes of road signs
   (2) Limitations of road signs
   (3) Design and location of road signs
   (4) Types of road signs
14-12-3. Traffic signals
   (1) Advantages of traffic signals
   (2) Limitations of traffic signals
   (3) Modern development
14-12-4. Speed breakers

QUESTIONS 14

Chapter 15 HIGHWAY ARBORICULTURE AND LIGHTING
15-1. General
15-2. Highway arboriculture
15-3. Spacing of trees
   (1) Distance from edge of road
   (2) Location of trees
   (3) Planting on both sides
15-4. Types of trees
15-5. Planting operations
   (1) Excavation of pits
   (2) Preparation of seedlings
   (3) Transplanting of seedlings
   (4) Protection of young plants
   (5) Watering
   (6) Numbering of trees
15-6. Maintenance of trees
   (1) Disposal of dead and fallen trees
   (2) Disposal of fruits for fruit-bearing trees
   (3) Protection against pests
   (4) Pruning and lopping of branches
15-7. Highway lighting
15-8. Design factors of highway lighting
   (1) Contrast
   (2) Glare
   (3) Lamps
   (4) Lateral placement of lighting poles
   (5) Lighting layouts
   (6) Luminaires distribution of light
   (7) Mounting height and overhang
   (8) Spacing of lighting units
15-9. Benefits of highway lighting
   (1) Appreciation by police forces
   (2) Increase in business
   (3) Planning
   (4) Recreation centres
   (5) Reduction in night-time accident rate
   (6) Reduction in serious crimes
15-10. Cost considerations of highway lighting
   (1) Design variables
   (2) Roadway variables

(3) Miscellaneous variables
(1) Design variables
(2) Roadway variables
(3) Miscellaneous variables

QUESTIONS 15

Chapter 16 HIGHWAY ECONOMICS
16-1. General
16-2. Qualifications of an administrator
16-3. Economics and economy
16-4. Engineering economy
16-5. Principles of economic analysis
   (1) Analyse all the alternatives
   (2) Analyse with and without the proposed project
   (3) Compare alternatives by their differences
   (4) Consider all consequences
   (5) Discount all costs and returns to same time period
   (6) Disregard past investments
   (7) Ignore the method of financing
   (8) Use the same analysis period for each alternative
16-6. Application of economic analysis to highways
   (1) Project evaluation
   (2) Project formulation
16-7. Methods of economic analysis
   (1) Equivalent uniform annual cost method (EUAC)
   (2) Present worth of costs method (PWOC)
   (3) Equivalent uniform annual net return method (EUANR)
   (4) Net present value method (NPV)
   (5) Benefit/cost ratio method (B/C)
   (6) Rate of return method (ROR)
   (7) Cost effectiveness method (CE)
16-7-1. Points to be remembered for economic analysis
16-7-2. Choice of method for economic analysis
   (1) Character of the proposed project
   (2) Experience of the analyst
   (3) Necessity of decision maker
16-8. Highway costs and consequences
16-8-1. Highway costs
16-8-2. Highway consequences
16-9. Highway finance
16-10. Highway administration

QUESTIONS 16

Appendix A TYPICAL TRAFFIC SIGNS
A-1. Mandatory/regulatory signs
   (1) Stop and give way signs
   (2) Prohibitory signs
   (3) No parking and no stopping signs
   (4) Speed limit and vehicle control signs
   (5) Restriction ends sign
   (6) Compulsory direction control and other signs
A-2. Typical cautionary/warning signs
A-3. Informatory signs
   (1) Direction and place identification signs
   (2) Facility information signs
   (3) Other useful information signs
   (4) Parking signs
A-4. Traffic Lights

Appendix B ABBREVIATED TERMS
Index