HIGHWAY ENGINEERING
MODULE-IV

1. HIGHWAY DRAINAGE.
2. HILL ROAD
3. ROADSIDE DEVELOPMENT.
4. ROAD ADMINISTRATION AND FINANCE

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Scope of study

Elementary principle in alignment in hilly area and drainage.
2. DEFINITIONS

2.1. Steep terrain, is a terrain where cross slope of the country is generally greater than 60 per cent.

2.2. Mountainous terrain, is a terrain with cross slope ranging from 25 to 60 per cent.

2.3. Rolling terrain, is a terrain with cross slope between 10 and 25 per cent.

2.4. Plain terrain, is a terrain where cross slope of the country is generally less than 10 per cent.

2.5. Ruling gradient, is a gradient which in the normal course must never be exceeded in any part of a road.

2.6. Limiting gradient, is a gradient steeper than the ruling gradient which may be used in restricted lengths where keeping within the ruling gradient is not feasible.

2.7. Exceptional gradient, is a gradient steeper than the limiting gradient which may be used in short stretches only in extra-ordinary situations.

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Question asked in GTU from this topic

1) Explain elementary principle of alignment in hilly areas.
HILL ROAD —

- Classified based on terrain.

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Type of terrain</th>
<th>Cross slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Plain or Level terrain</td>
<td>0 to 10%</td>
</tr>
<tr>
<td>2</td>
<td>Rolling terrain</td>
<td>10 to 25</td>
</tr>
<tr>
<td>3</td>
<td>Mountainous</td>
<td>25 to 60</td>
</tr>
<tr>
<td>4</td>
<td>Steep</td>
<td>Above 60</td>
</tr>
</tbody>
</table>

- Roads located in terrain having Cross slope of 25% or more considered Hill road or Ghat road

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HILL ROAD

- **Characteristics**
  - Cross slope of 25% or more
  - Widely differing elevation
  - Steep slope
  - Great number of water courses.

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HILL ROAD

- Our objectives
- Shortest route
- Safe route
- Economy
- Less VOC (Vehicle operating cost)
- Less maintenance.

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Problems with Hill Road

- Alignment
- Stability.
- Soil erosion
- Land slides
- Maintenance.
- Drainage.
- Snow fall

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Importance of Hill Road

- Economic development.
- Industrial development
- Forest wealth.
- Strategic consideration.
- Tourism
Classification of Hill Road

1) According to Boarder Road Organization (B.R.O.)
   - NH,
   - Class-9 (6m wide),
   - Class-5 (4.9 mt wide),
   - Class-3 (2.45 to 3.65 mt wide)

2) According to general classification.
   - N.H., S.H., MDR, ODR, VR

3) According to use.
   - Motor road (for fast vehicle),
   - Bridle Road (for pedestrian, horse),
   - Village track.

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Elementary Principles of Alignment in Hilly area

Features of Good alignment for Ghat road

1) Minimum cost
2) Comfortable travel
3) Lower VOC
4) Stable and safe road.
5) Sharp curve with small radius.
6) Easy gradients.
7) Minimum cutting and filling.
8) Minimum walling and bridging.

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Elementary Principles of Alignment in Hilly area

Principles for **Ghat road at a glance**

1) Stability. (Common problem land slide)
2) Drainage. (Minimum C.D. works)
3) Geometric standards of Hill Road.
4) Resisting length. (as low as possible)
   - Ineffective rise - minimum
   - Excessive fall - minimum

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Elementary Principles of Alignment in Hilly area

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Types of Curves in alignment of Hill Road

- **Hair pin Bend**
  - Min straight length-20mt,
  - Min design speed 20 kmph
  - Min. R=14mt, e= 1in 10
  - Gradient =Min. 1 in 200, Max 1 in 40

- **Corner bend**
- **Salient curve**
- **Re-entrant curve**
CORNER BEND CURVE
Corner band

Diagram: A corner band with a labelled wall and roads.
Salient curve (Convex curve) and Re-entrant curve (Concave curve)
RECOMMENDATIONS ABOUT THE ALIGNMENT SURVEY AND GEOMETRIC DESIGN OF HILL ROADS
(First Revision)

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HILL ROAD-ALIGNMENT SURVEY

- IRC-52
- ALIGNMENT SURVEY
  - 1) Reconnaissance survey and Trace cutting (foot path for detail survey)
  - 2) Preliminary survey
  - 3) Determination of final centerline.
  - 4) Final location survey.

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GEOMETRIC DESIGN STANDARDS OF HILL ROAD

- Width of carriage way, Shoulder, Roadway and land.
- Camber.
- SSD (same).
- OSD
- Gradient.
- Superelevation.
- Radius of horizontal curve
- Widening of curve
- Transition curve

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### Pavement width

#### Table 4.1. Recommended Design Service Volumes for Hill Roads

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Type of Road</th>
<th>Design Service Volume in PCU/day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Carriageway width</td>
</tr>
<tr>
<td>1.</td>
<td>Single lane</td>
<td>3.75 m</td>
</tr>
<tr>
<td>2.</td>
<td>Intermediate lane</td>
<td>5.5 m</td>
</tr>
<tr>
<td>3.</td>
<td>Two lane</td>
<td>7 m</td>
</tr>
</tbody>
</table>
Hill Road cross section

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6.3.1. The design speeds for various categories of hill roads are given in Table 6.1.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Road Classification</th>
<th>Mountainous Terrain</th>
<th>Steep Terrain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ruling</td>
<td>Min</td>
</tr>
<tr>
<td>1</td>
<td>National and State Highways</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>2</td>
<td>Major District Roads</td>
<td>40</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>Other District Roads</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>4</td>
<td>Village Roads</td>
<td>25</td>
<td>20</td>
</tr>
</tbody>
</table>
Camber/crossfall on straight section should be as follows:

a. Earth road - 3 to 4 per cent (1 in 33 to 1 in 25)
b. Gravel or WBM surface - 2.5 to 3 per cent (1 in 40 to 1 in 33)
c. Thin bituminous surfacing - 2.0 to 2.5 per cent (1 in 50 to 1 in 40)
d. High type bituminous surfacing - 1.7 to 2.0 per cent (1 in 60 to 1 in 50)
FIG. 7.1B. TYPICAL ZIG

CATCH WATER DRAIN
RETAINING WALL
BREAST WALL

IRC:SP:48-1998
Sight distance
Drainage in Hill Road - surface drainage

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Drainage in hill road

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(e) U-SHAPED DRAIN

(f) TRIANGULAR DRAIN

(g) KERB AND CHANNEL DRAIN

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Drainage

FIG. 8.17. CULVERT IN EMBANKMENT - PIPE CULVERT

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MAINTENANCE PROBLEMS IN HILL ROAD

1) Maintenance of drainage structures
2) Snow clearance.
3) Control of avalanches*.
   * (large mass of loosened snow, Earth)
4) Prevention of land slides.
   (i) Falls (free flow)
   (ii) Slides (shear failure)
   (iii) Flows (movement within displaced mass)
   (iv) complex land slides (combination)

Possible solution to prevent land slides
(i) Effective drainage measure
(ii) Slope treatment
(iii) Construction of buttress at toe and retaining wall
(iv) Realignment

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PROTECTIVE WORKS FOR HILL ROAD

- 1) Retaining wall.
- 2) Parapet wall.
Protective works for hill roads

FIG. 9.11 PROTECTIVE WORKS FOR HILL ROADS

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