HIGHWAY ENGINEERING
MODULE-IV

1. HIGHWAY DRAINAGE.
2. HILL ROAD
3. ROADSIDE DEVELOPMENT.
4. ROAD ADMINISTRATION AND FINANCE
There are just **three factors** necessary for getting good road.

1) Drainage.
2) Drainage and
3) More drainage.
4) Cheap drainage ➞ Costly pavements
Question in GTU from this topic

(b) Write short note on

i) Surface drainage

ii) Sub-surface drainage

Q.4 (a) What are the essential requirements of a good highway drainage system?
Gradients

As per AASHTO – Quality of drainage is defined on the basis of maximum period of time during which water will be removed from the pavement.

<table>
<thead>
<tr>
<th>Quality of drainage</th>
<th>Water removed within</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>2 Hours</td>
</tr>
<tr>
<td>Good</td>
<td>1 day</td>
</tr>
<tr>
<td>Fair</td>
<td>1 Week</td>
</tr>
<tr>
<td>Poor</td>
<td>1 Month</td>
</tr>
<tr>
<td>Very Poor</td>
<td>Water will not drain</td>
</tr>
</tbody>
</table>
1 HIGHWAY DRAINAGE

- Surface drainage arrangement.
- Subsurface drainage arrangement.
- Sketches and its design.
HIGHWAY DRAINAGE

- Importance of Highway drainage
- Surface drainage
  - Related to road way and adjoining land.
- Subsurface drainage.
  - Related to subgrade

- Sources of intrusion of water in the road.

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HIGHWAY DRAINAGE

- Problems to Pavement due to improper highway drainage.
  - Lowering of stability
  - Reduction in strength.
  - Variation in volume in case of clayey soil
  - Stripping of bitumen resulting -> potholes
  - Rigid pavement- Mud pumping
  - Shoulder- Reduction in strength.
  - Frost action- in case of low temperature.
  - Damage to embankments slope

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Requirement of Good Drainage

1. Camber (As per IRC standard-road type and rainfall)
2. Gradient.
3. Cross drainage work.
4. Side drains.
5. Intercepting drain.—in case of hill road
6. Water table. (at least 1.2 mt below GL)
7. Highest flood level (at least 0.6 mt above H.F.L.)
8. Adjoining land.
Surface drainage
METHODS OF SURFACE DRAINAGE

1. Longitudinal side drains- incase of embankment and cutting
2. Catch basin and inlets in urban area.
3. Providing Damp proof course on the road surface
4. Provide camber
5. Provide sufficient side slope.
6. Provide catch basin parallel to road in case of cutting
7. Keep carriage way +60 cm above HFL.
Cross section of Urban Road – BRT - Rajkot

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METHODS OF SURFACE DRAINAGE

1. By Longitudinal side drain

Case-I Side drain for Road in Embankment

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METHODS OF SURFACE DRAINAGE

1. By Longitudinal side drain

Case-I Side drain for Road in Embankment

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METHODS OF SURFACE DRAINAGE

1. By Longitudinal side drain

Case-II  Side drain for Road in Cutting

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1 By Catch basin and Inlets in Urban area.

Case-I - Catch basin
METHODS OF SURFACE DRAINAGE

By Vertical Inlets in Urban area.

Case-II – Vertical inlet
Design of surface drainage system
DESIGN OF SURFACE DRAINAGE SYSTEM

Divided in two phase

1) Hydrologic design
2) Hydraulic design
First phase Hydrologic design

Objective:
To estimate the maximum quantity of water expected to reach the element of drainage system under consideration

\[ Q = C_i A_d \]
Second phase Hydraulic design

Objective:

3. Design of drain

4. \( Q = \frac{A}{V} \)

5. \( A = \frac{Q}{V} = \_\_\_\_\_\_\_\_\_\_\_\text{sq.mt} \)

\[
V = \frac{1}{n} \left( \frac{2}{R^3} \right)^{\frac{1}{2}} \frac{1}{S^2}
\]

\( R = \frac{A}{P} \)

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Subsurface drainage
Removal or diversion of excess soil-water from the sub grade is termed as subsurface drainage.

Situation or location required Sub surface drainage

1. Road in cutting
2. Water flowing from hill
3. Water rises through capillary action.
4. Road near drain

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METHODS OF SUBSURFACE DRAINAGE

1) Lowering of water table.
2) Controlling seepage flow.
3) Controlling capillary water.
METHODS OF SUBSURFACE DRAINAGE

1) Lowering of water table.- in sandy/gravelly soil
Fig. 9. Typical sub-surface drains with geotextile
METHODS OF SUBSURFACE DRAINAGE

1) Lowering of Water table. In silty / clayey soil

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2 Controlling seepage flow

Drainage of side slopes in cutting by providing perforated drains.
METHODS OF SUBSURFACE DRAINAGE

1) Controlling capillary water.

Case –I – Granular capillary layer

Case-II Impermeable capillary cut-off
METHODS OF SUBSURFACE DRAINAGE

1) Controlling capillary water.
   Case –I – Granular capillary layer

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METHODS OF SUBSURFACE DRAINAGE

1) Controlling capillary water.

Case –II – Impermeable capillary cut-off
DESIGN OF SUBSURFACE DRAINAGE

Design of filter material
- Have adequate permeability.
- Can resist the flow of fine material (piping)

Design filter material-
Two important criteria
1) Permeability
2) Pumping

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Design step
Step-1  Do sieve analysis- For foundation soil- Draw GSD curve
Step-2  Find $D_{15}$ (Size of foundation soil)

\[ \frac{d_{15 \text{ of filter}}}{D_{15 \text{ of Foundation}}} \text{ should be } > 5 \]

Step-3  To prevent piping

\[ \frac{d_{15 \text{ of filter}}}{D_{85 \text{ of Foundation}}} \text{ should be } < 5 \]
DESIGN OF SUBSURFACE DRAINAGE MATERIAL - DESIGN OF FILTERS
# Camber or Side Slope

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Types of road surface</th>
<th>Range of camber in area of rainfall range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Light</td>
</tr>
<tr>
<td>1</td>
<td>Cement concrete surface</td>
<td>1.7 %</td>
</tr>
<tr>
<td>2</td>
<td>Thin bituminous surface</td>
<td>2.0 %</td>
</tr>
<tr>
<td>3</td>
<td>WBM surface</td>
<td>2.5 %</td>
</tr>
<tr>
<td>4</td>
<td>Earth surface</td>
<td>3.0 %</td>
</tr>
</tbody>
</table>
FIG. 8.11 TYPICAL CROSS - SECTION OF URBAN ROAD
FIG. 8.13 SCHEMATIC ARRANGEMENT IN STRAIGHT REACH

Storm water can be discharged into Natural X-drain

Piping/channel min dia. of pipe 450mm
SHOULDER DRAINAGE

- Unpaved shoulder
- Paved shoulder
- Two-Lane Carriage-way
- Surfacing
- Wearing clearance
- Granular material
- Filter
- Subgrade
- Granular sub-base
- Base Course
- Filter
- 150mm
Drainage of Rotaries

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