

4.6 Highway Drainage

Highway drainage may be defined as the process of interception and removal of water from over, under and the vicinity of the road surface. Road drainage is very important for safe and efficient design of the road way and hence is an essential part of highway design and construction

Effects of Improper Drainage

One of the major causes of road failure is its improper drainage. Improper drainage of the road causes destruction in the following ways:

- ✓ Road surface if made of soil, gravel or water bound macadam, it will become soft and lose strength
- ✓ The road sub-grade may be softened and its bearing capacity reduced.
- ✓ Variation in moisture content in expansive soils, causes variation in the volume of sub-grade and thus causes failure of roads.
- ✓ Failure of formation slopes is also attributed to poor drainage.

Highway Drainage Requirements

- ✓ Surface water should not be allowed to remain standing on the road pavement and shoulders. Measures should be taken to drain off this water immediately.
- ✓ The surface rain water from the adjoining area, should not be allowed to come towards the road surface. For this, general slope of the ground adjoining road, should be made sloping away from the road. This objective can be achieved by aligning road on ridge.

Types of Highway Drainage

1. Surface Drainage

It is the road drainage in which the surface water of the road is collected and disposed within right-of-way of the road.

Surface drainage is basically designed to prevent the flow of surface water to the shoulders, sub-grade or any other layer of the road surface.

Basic Functions of Surface Drainage :

- To maintain the road surface completely dry from water.
- To collect the drained off water from the road surface.
- Increase the stability of the road or highway.

- By using the gravitational force, carrying of collected water into nearby stream or river or nallah.

1a. Side Gutter :

Side gutters are generally constructed parallel to the side of the road and it disposes the surface water efficiently.

Below figure shows the side gutter or side drain in cutting and embankment provided for proper surface drainage. The section of side drain is generally trapezoidal, but generally triangular side gutters are also provided in cutting.

They are basically provided parallel to the road surface only when the designed depth of the side drains is less and the road is subjected to light traffic.

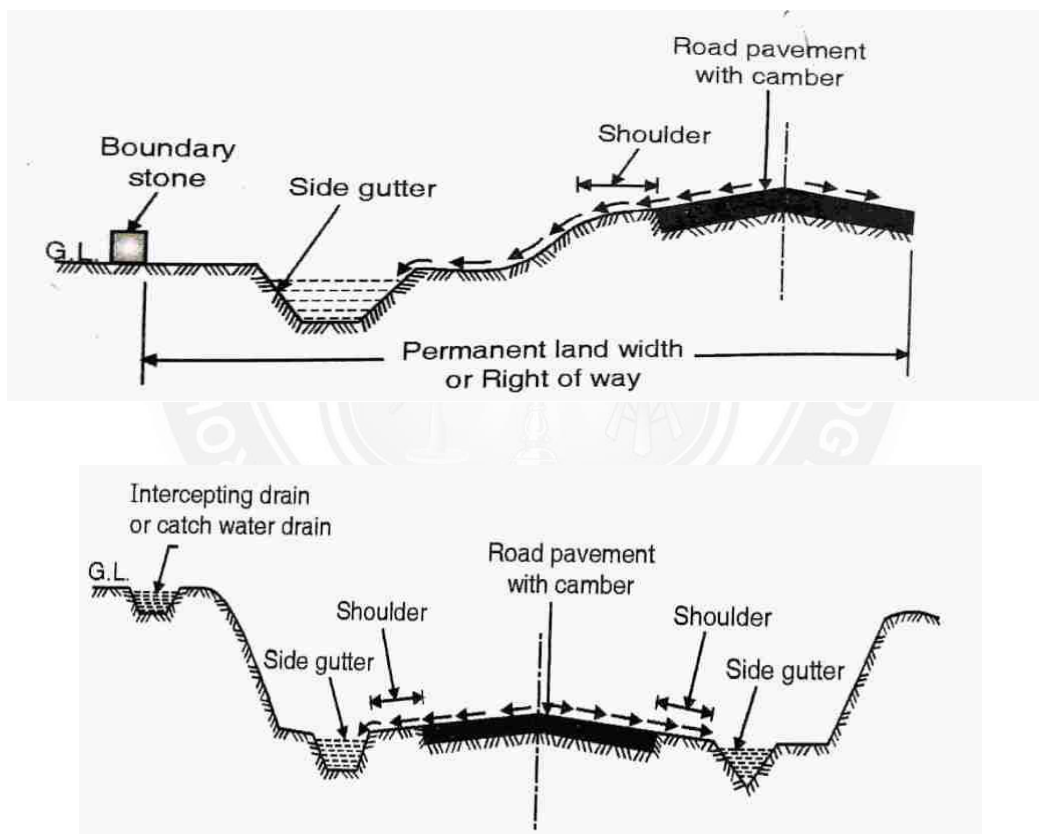


Figure 4.6.1 Side Gutter

[Source: "Highway Engineering" by S.K.Khanna,C.E.G.Justo, Page: 530]

Functions of Side Gutter :

- The main function is to collect the surface water and further these side drains ultimately join the natural streams and nalla or rivers.
- They can be constructed and maintained in very low budget. But they give unpleasant look due to deep ditch. Hence they are not adopted when the traffic is heavy.

1b. Catch Water Drain :

When the gutters or drains are additionally provided parallel to the road at higher level for collecting and disposing the surface water is known as catch water drain.

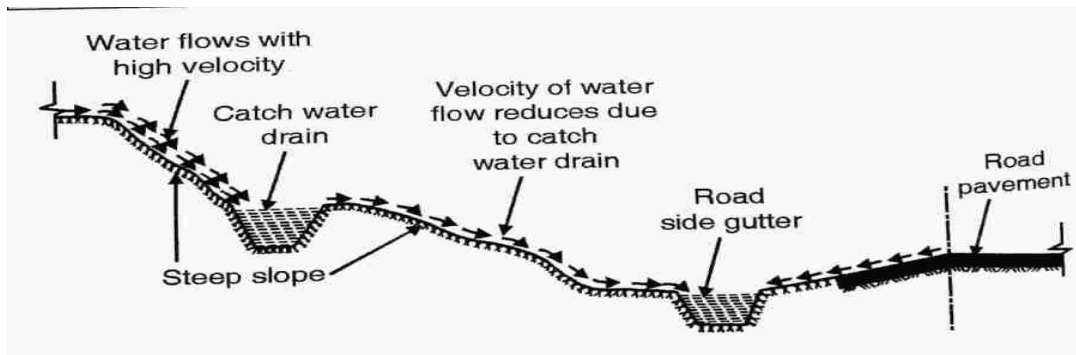


Figure 4.6.2 Catch Water Drain

[Source: "Highway Engineering" by S.K.Khanna, C.E.G.Justo, Page: 532]

Generally catch water drain is provided under following conditions :

- When the adjoining ground is steep towards roadside.
- In case of hill roads, when the rainfall is heavy.
- When the quantity of water flow on sloping ground is more.

Functions of Catch Water Drain :

The catch water drain intercepts the large quantity of the surface water flow and also breaks the continuity of flow and thereby reduces the velocity of water and prevents the erosion and landslides and thereby protect the road pavement. Catch water also help in reducing the size of side gutters or side drains.

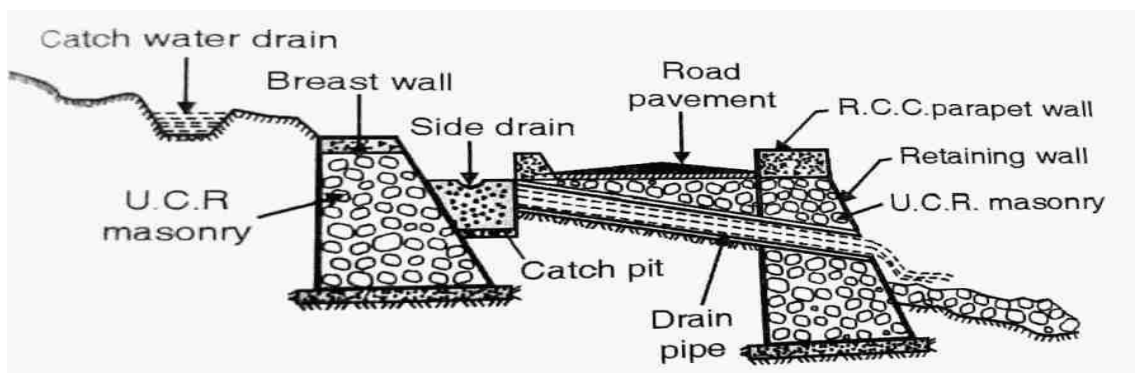


Figure 4.6.3 Sectional Area Catch Water Drain

[Source: "Highway Engineering" by S.K.Khanna, C.E.G.Justo, Page: 532]

Sectional area of catch water drains are generally 0.9 m*0.9 m* and should be constructed normally at 4.5 m from the road edge.

If surface water flowing from the high level ground towards the road is large then it is desirable to take this water across the road at regular intervals and then allow this water to flow through the pipe drain constructed through the road embankment to the natural stream.

2.Sub-surface Drainage of Road

Sub-surface drainage is the system in which the sub-soil water from underside of road pavement is collected and removed efficiently. It is generally adopted to control the moisture content of road sub-grade.

If the moisture content in the sub-soil increases, it can weaken the road structure. Hence it becomes more important to control the moisture of road sub-grade.

Factors increasing the sub-soil moisture content are as follows :

- Increase in ground water table.
- Water seepage from adjoining areas.
- Surface water percolation through joints and cracks.
- Rise of the moisture above ground water table which is caused by the capillary action.

Thus longitudinal drains, cross drain and impervious bituminous layer are provided to prevent the rise in sub-soil moisture or sub-surface moisture and its specially provided to control the capillary rise.

Functions of sub-surface drainage :

- It prevents and controls the moisture content of the road sub-grade.
- To maintain the bearing capacity of the sub-grade soil by restricting the entry of water into it.
- To reduce the capillary rise, because sometimes due to capillary action, the water rises into the sub-grade from the ground water.

Longitudinal Drains (L-Drains) and Cross Drains :

Water table can be lowered by providing longitudinal drains and cross drains below the pavement structure at the specified depth.

Longitudinal pipes are placed with open joints butting against each other and laid on a bed of sand, crushed stone of 150 mm thick.

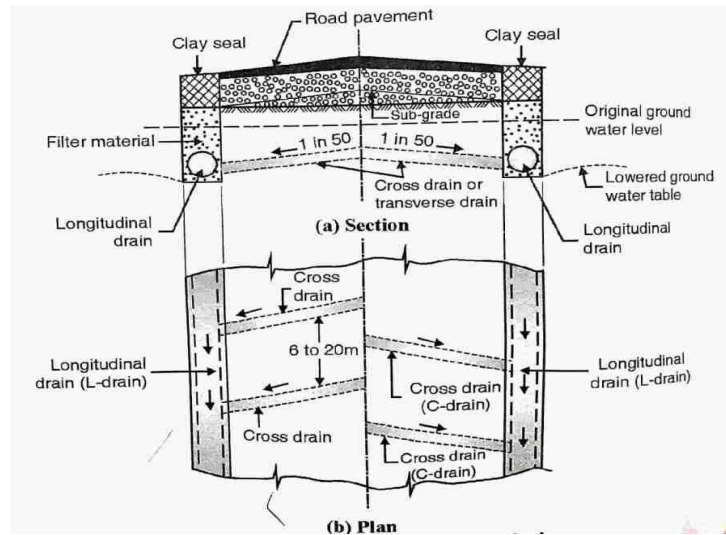


Figure 4.6.4 Longitudinal Drains(a)

[Source: "Highway Engineering" by S.K.Khanna, C.E.G.Justo, Page: 534]

The diameter of L-drain pipes varies from 150 mm to 200 mm. In addition to longitudinal drains, Cross drains (C-drains) or transverse drains consisting porous pipes or perforated pipes are laid cross from the center of the road and opened to the L-drains with slope of 1 in 50.

The diameter of C-drains varies from 60 to 100 mm. There are two cases of providing the longitudinal and cross drains.

In first case, the main longitudinal drain pipes may be provided on both the sides as shown in fig.

In this case, slope of cross drains is kept 1 in 50 from center towards the sides. This case of providing the L-drains on both the sides is comparatively costly but can be easily constructed and maintained.

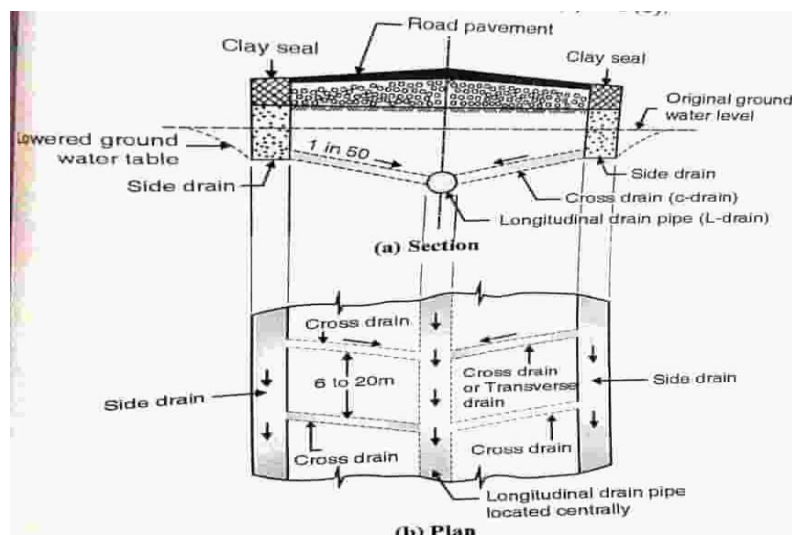


Figure 4.6.5 Longitudinal Drains(b)

[Source: "Highway Engineering" by S.K.Khanna, C.E.G.Justo, Page: 534]

In second case, the main longitudinal drain pipes may be provided at the center sufficiently below the road pavement and side drains may be opened to the cross drains consisting porous or perforated pipes.

The slope of the cross drains or transverse drains is kept 1 in 50 from side drains towards the main longitudinal drain pipe

