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Highway Surface Drainage System & Problems of Water Logging In Road Section

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----------ABSTRACTS----------

Proper drainage is a very important consideration in design of a highway. Inadequate drainage facilities can lead to premature deterioration of the highway and the development of adverse safety conditions such as hydroplaning. It is common, therefore, for a sizable portion of highway construction budgets to be devoted to drainage facilities. In essence, the general function of a highway drainage system is to remove rainwater from the road and water from the highway right-of-way. Surface water' is another word for rainwater – more specifically, rainwater that falls on the ground, on roofs and roads, pavements and paths. Water that drains from roads and footpaths flows into public drainage systems. This is known as highway drainage. Highway drainage benefits everyone that uses the road system, so there is a case for recovering the costs directly from roads authorities or users. Road drainage design has as its basic objective the reduction and/or elimination of energy generated by flowing water. Water has a number of unhelpful characteristics which impact on highway performance. It is a lubricant reducing the effectiveness of tyre grip on the carriageway wearing surface which can increase stopping distances. Road surfacing materials are traditionally designed to be effectively impermeable, and only a small amount of rainwater should percolate into the pavement layers. It is important that any such water is able to drain through underlying pavement layers and away from the formation. Hazards associated with roads and roadsides were particularly predominant. Adverse roadway elements contributing to highway accidents were substandard road way alignment or geometry, lack of shoulders and shoulder defects, absent or inappropriate pedestrian facilities, narrow and defective lanes and bridges/bridge approaches, roadside hazards, undefined pavement center and edge lines, poor sight distances and visibility, unmarked and inappropriate design of intersections, serious allocation deficiencies along the route, haphazard bus shelters/stops, and others are causes of water logging problem in highway. The problem given above should be solved immediately; otherwise the road network is unsuitable for use before its lifetime.

KEY WORDS : *Removal of rainwater from the carriageway, Surface Drainage System, Uses of software, Problem of highway Drainage*

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I. INTRODUCTION:

Roads will affect the natural surface and subsurface drainage pattern of a watershed or individual hill slope. Road drainage design has as its basic objective the reduction and/or elimination of energy generated by flowing water. Therefore, water must not be allowed to develop sufficient volume or velocity so as to cause excessive wear along ditches, below culverts, or along exposed running surfaces, cuts, or fills. Provision for adequate drainage is of paramount importance in road design and cannot be overemphasized. The presence of excess water or moisture within the roadway will adversely affect the engineering properties of the materials with which it was constructed. Cut or fill failures, road surface erosion, and weakened subgrades followed by a mass failure are all products of inadequate or poorly designed drainage. As has been stated previously, many drainage problems can be avoided in the location and design of the road: Drainage design is most appropriately included in alignment and gradient planning.

Removal of rainwater from the carriageway : Water has a number of unhelpful characteristics which impact on highway performance. It is a lubricant reducing the effectiveness of tyre grip on the carriageway wearing surface which can increase stopping distances. Spray from rainwater being thrown up by car tyres can reduce visibility which can lead to delays in reacting to events on the carriageway. Drag on car tyres from local rainwater ponding can alter the balance of vehicles travelling at speed which can be alarming or cause skidding. It is incompressible therefore standing water effectively acts as a jackhammer on the wearing course right

through to the sub-base when vehicles pass over head. In extreme storms, rainwater can simply wash away roads on embankment should the culvert become blocked or lack capacity.

Surface Drainage System : Surface drainage is removal of water collects on the land and surface. Provision must be made for removal of water, from rain or melting snow, or both, that falls directly on a road or comes from the adjacent terrain. The road should be adequately sloped to drain the water away from the travel lanes and shoulders and then directed to drainage channels in the system, such as natural earth swales, concrete gutters, and ditches, for discharge to an adjacent body of water. The channels should be located and shaped to minimize the potential for traffic hazards and accommodate the anticipated storm-water flows. Drainage inlets should be provided as needed to prevent ponding and limit the spread of water into traffic lanes.

Surface Drainage Methods : For rural highways on embankments, runoff from the roadway should be allowed to flow evenly over the side slopes and then spread over the adjacent terrain. This method, however, can sometimes adversely impact surrounding land, such as farms. In such instances the drainage should be collected, for example, in longitudinal ditches and then conveyed to a nearby watercourse. When a highway is located in a cut, runoff may be collected in shallow side ditches. These typically have a trapezoidal, triangular, or rounded cross section and should be deep enough to drain the pavement subbase and convey the design-storm flow to a discharge point. Care should be taken to design the ditches so that the toe of adjoining sloping fill does not suffer excessive erosion.

- ***Inlets*** These are parts of a drainage system that receive runoff at grade and permit the water to flow downward into underground storm drains. Inlets should be capable of passing design floods without clogging with debris. The entrance to inlets should be protected with a grating set flush with the surface of gutters or medians, so as not to be a hazard to vehicles. There are several types of inlets. A drop inlet is a box-type structure that is located in pipe segments of a storm-water collection system and into which storm water enters from the top. Most municipal agencies maintain design and construction standards for a wide variety of inlets, manholes, and other similar structures, but some large structures may require site-specific design. A curb inlet consists of a vertical opening in a curb through which gutter flow passes. A gutter inlet is a horizontal opening in the gutter that is protected by a single grate or multiple grates through which the gutter flow passes. A combination inlet consists of both gutter and curb inlets with the gutter inlet placed in front of the curb inlet. Inlet spacing depends on the quantity of water to be intercepted, shape of ditch or gutter conveying the water, and hydraulic capacity of the inlet.

Figure 1 Inlet & Strom Sewer

- **Storm Sewers** These are underground pipes that receive the runoff from a roadside inlet for conveyance and discharge into a body of water away from the road. Storm sewers are often sized for anticipated runoff and for pipe capacity determined from the Manning formula. In general, changes in sewer direction are made at inlets, catch basins, or manholes. The manholes should provide maintenance access to sewers at about every 500 ft.

- **Open Channels** The ditches may be trapezoidal or V-shaped. The trapezoidal ditch has greater capacity for a given depth. Most roadway cross sections, however, include some form of V shaped channel as part of their cross-sectional geometry. In most instances, it is not economical to vary the size of these channels. As a result, this type of channel generally has capacity to spare, since a normal depth must be maintained to drain the pavement subbase courses. When steep grades are present, the possibility of ditch erosion becomes a serious consideration. Erosion can be limited by lining the channel with sod, stone, bituminous or concrete paving, or by providing small check dams at intervals that depend on velocity, type of soil, and depth of flows.

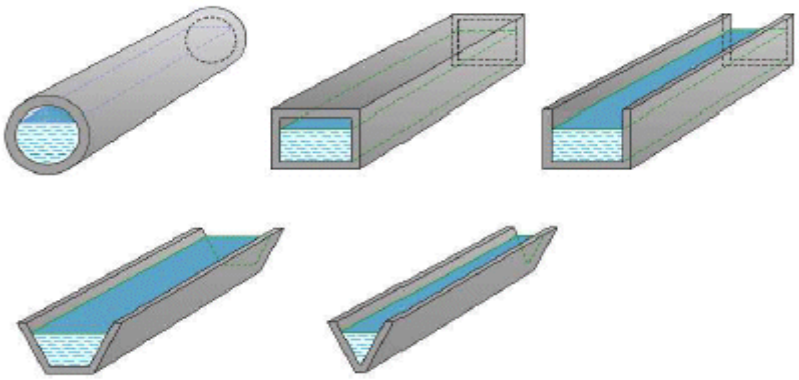

Figure 2 Types of open Channel

Culverts A culvert is a closed conduit for passage of runoff from one open channel to another. One example is a corrugated metal pipe under a roadway. Figure (1) shows various types of culvert cross sections and indicates material types used in highway design. For small culverts, stock sizes of corrugated metal pipe may be used. For larger flows, however, a concrete box or multiple pipes may be needed. If the culvert foundation is not susceptible to erosion, a bridge may be constructed over the waterway (bridge culvert). The section of a culvert passing under a highway should be capable of withstanding the loads induced by traffic passing over the culvert. Since corrugated metal pipes are flexible, they are assisted by surrounding soil in carrying gravity loads. Reinforced concrete culverts, however, have to support gravity loads without such assistance.

Figure 3 Design of Culvert

Figure 4 Air port kerb & highway surface drainage system

Figure 5 Collector of surface water

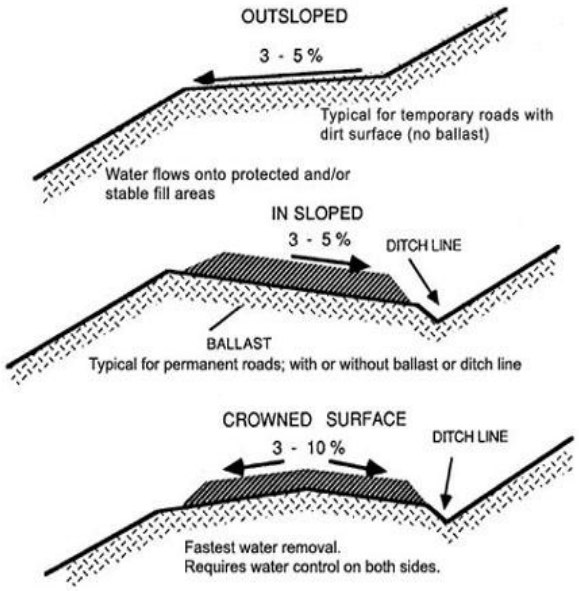

Figure 6 Typical highway drainage system

Figure 7 Transverse & Longitudinal slope

EFFECT OF ROAD GEOMETRY ON DRAINAGE

- Road surfacing materials are traditionally designed to be effectively impermeable, and only a small amount of rainwater should percolate into the pavement layers. It is important that any such water is able to drain through underlying pavement layers and away from the formation. Rainfall which does not permeate the pavement surface must be shed towards the edges of the pavement.
- Drainage is a basic consideration in the establishment of road geometry and vertical alignments should ensure that: a) outfall levels are achievable; and b) subgrade drainage can discharge above the design flood level of any outfall watercourses. These considerations may influence the minimum height of embankments above watercourses. They could also influence the depth of cuttings as it is essential that sag curves located in cuttings do not result in low spots which cannot be drained. Drainage can then be effected over the edge of the carriageway to channels, combined surface water and ground water drains or some other form of linear drainage collector. Gullies may be required at very close spacings on flat gradients.
- Safety aspects of edge details are generally functions of the location, form and size of edge restraint detail, and any associated safety barrier or safety fence provision. Roadside drainage features are primarily designed to remove surface water. Since they are placed along the side of the carriageway, they should not normally pose any physical hazard to road users. It is only in the rare event of a vehicle becoming errant that the consequential effects of a roadside drainage feature upon a vehicle become important.

Kerbs and Gullies

- An indirect hazard to vehicles can be presented by edge details that permit adjacent build-up of widths of water flow, which may intrude into the hard shoulder, hard strip or carriageway of the highway. This can occur with edge details that do not immediately remove water linearly from the adjacent pavement in all storm situations.
- One advantage of kerbs and gullies is that a longitudinal gradient to carry road surface runoff to outfall is not dependent upon the longitudinal gradient of the road itself, and can be formed within a longitudinal carrier pipe.
- Road gullies will generally discharge to associated longitudinal carrier drains except on low embankments with toe ditches where it may prove more economical to discharge gullies direct to the toe ditches via discrete outfalls.

Figure 8 Hinged Kerb Gully gate

Surface Water Channels

- Surface water channels are normally of triangular concrete section, usually slip-formed, set at the edge of the hard strip or hard shoulder and flush with the road surface.
- Significant benefits can include ease of maintenance and the fact that long lengths, devoid of interruptions, can be constructed quickly and fairly inexpensively. It may be possible to locate channel outlets at appreciable spacings and possibly coincident with watercourses.
- It is reasonable to assume that the relative risk to vehicles and occupants from impingement on surface water channels is lower than would be expected from impingement on other drainage features such as kerbs, embankments and ditches, as the channels present a much lower risk of vehicles losing contact with the ground or overturning.

Figure 9 Garden Drainage

Figure 10 Surface Water Drainage System

Linear Drainage Channels : They are in all cases set flush with the carriageway and contain a drainage conduit beneath the surface into which surface water enters through slots or gratings. They can also be of in situ concrete.

Figure 11 Linear Drainage System

II. THE USE OF SPECIALIST DESIGN SOFTWARE

While highway drainage schemes are relatively straightforward to model when compared to things like housing estates or large urban areas they do require computer modelling unless extremely small. This is done to calculate peak flow rates, storage volumes and flow control devices and are based on further calculations done using computers to calculate peak "green field" run-offs.

Highway drainage problem & water logging:

- Hazards associated with roads and roadsides were particularly predominant. Adverse roadway elements contributing to highway accidents were substandard road way alignment or geometry, lack of shoulders and shoulder defects, absent or inappropriate pedestrian facilities, narrow and defective lanes and bridges/bridge approaches, roadside hazards, undefined pavement center and edge lines, poor sight distances and visibility, unmarked and inappropriate design of intersections, serious allocation deficiencies along the route, haphazard bus shelters/stops, and others. The problems that identified are as follows: a) Drainage problems. b) Shoulder problems. c) Horizontal clearance problem. d) Environmental pollution problem.
- Water logging: When water from any source find no path to escape or drain out and create a hazardous situation is known as water logging. Excessive rainfall, inadequate drainage sections, conventional drainage system with low capacity and gravity, natural siltation, absence of inlets and outlets, indefinite drainage outlets, lack of proper maintenance of existing drainage system, and over and above disposal of solid waste into the drains and drainage paths are accounted for the prime causes of water logging. From the observation of road network in RCC it has been found that during rainy season many roads are affected by water logging. This is cause due to absence of any drainage system, improper maintenance of drainage facilities etc.
- The problem given above should be solved immediately; otherwise the road network is unsuitable for use before its lifetime. Some remedial measures should be suggested to eliminate all the problems. Maintenance work should be done regularly by the authority. The people should be aware about the traffic rules and use the road properly

Figure 12 Highway Water Logging Problem

III. CONCLUSION:

Highway drainage is a process of removing & controlling excess surface water with in ROW. During rains part of the rain water flows on surface and part of it percolates through the soil mass. Some water is retained in the pores of the soil mass and surface of soil particles by surface tension and adsorptive forces, which cannot be drained of natural gravitational methods and this water is termed as held water. Adverse roadway elements contributing to highway accidents were substandard road way alignment or geometry, lack of shoulders and shoulder defects, absent or inappropriate pedestrian facilities, narrow and defective lanes and bridges/bridge approaches, roadside hazards, undefined pavement center and edge lines, poor sight distances and visibility, unmarked and inappropriate design of intersections, serious allocation deficiencies along the route, haphazard bus shelters/stops, and others are causes of water logging problem in highway. The problem given above should be solved immediately; otherwise the road network is unsuitable for use before its lifetime.

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