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Study of Surface and Sub Surface Highway Drainage System

Prof. Deepak Sahu[1], Prof. Pradeep Nirmal [2], Kunal Kumar Sahu[3], Tikesh Kumar Sahu[4], Bhavna Dewangan[5] , Suman Kuldeep[6], Bindu Urvasha[7]

[1,2] Assistant Professor, [3,4,5,6,7] Under Graduated Student
RSR Rungta College of Engineering & Technology, Bhilai, Chhattisgarh, India

Abstract *- One of the major reasons of deterioration of roads is rain water. During Rainfall, Part of water flows on ground surface and part of it percolates through soil mass until it reaches the ground water below water table. Due to percolation of water in highway pavement moisture content of soil increases which reduce the bearing capacity of the soil. Thus stability of highway is reduced. Drainage of the highway is the process of removing and controlling surplus water on the surface and sub soil water in sub surface with in the right way which is detailed explain in this paper.*

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 *- Drainage, surface water, sub surface water*

I. NTRODUCTION

Highway drainage is an essential part of highway design and construction which remove the surplus water with in the highway limits and satisfactory dispose it .Road way drainage is mainly due to surface runoff from adjacent area, precipitation of rain and moisture rising by capillarity from the ground water table. Removal and diversion of surface water from road way and adjoining land is known as surface drainage.

Removal of excess sub soil water from the subgrade is termed as sub surface drainage.

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.

II. IMPORTANCE OF HIGHWAY DRAINAGE

The importance of drainage is one of the most important aspects for location and design of highway because of following
reasons:

- To prevent subgrade failure: Soil subgrade excess moisture reducing the stability of pavement which leads to subgrade failure.
- To prevent reduction in strength of pavement material: The strength of pavement material like stabilized soil and WBM (water bound macadam) is reduced.
- To prevent frost action: In flexible pavement the formation of waves and corrugation take place due to poor drainage.
- Decrease volume changes: Volume of subgrade is change especially in clayey soils due to variation in moisture content. This sometimes leads to pavement failure.
- Prevent mud pumping failure: Mud pumping is due to presence of water in subgrade soil especially in rigid pavement.
- To prevent shoulders and pavement edge: Excess water on shoulders and pavement edge cause considerable damage.
- Prevent slope failure: Excess moisture causes increase in weight and thus increases in stress and simultaneously reduction in strength of soil mass which result into failure of earth slopes and embankment foundations.
- Prevent erosion of soil: Due to surface water, erosion of soil from top of road and slope of embankment. Thus drainage is the important factors governing the highway design and construction.

III- SURFACE DRAINAGE METHODS

Table-I -Recommended values of camber for different types of road surface

Sr.No	Type Of Road Surface	Range of camber in areas of	
		Heavy rainfall	Low rainfall
1	Cement concrete and thick bituminous surface	1 in 50 or 2 %	1 in 60 or 1.7 %
2	Thin bituminous surface	1 in 40 or 2.5%	1 in 50 or 2 %
3	Water bound macadam and gravel pavement	1 in 33 or 3%	1 in 40 or 2.5 %
4	Earth road	1 in 25 or 4%	1 in 33 or 3 %

A. ***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.

B. **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.

C. **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.

IV- 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 estraint 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.

V- COMMON DRAINAGE METHOD

A. 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.

B. 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.

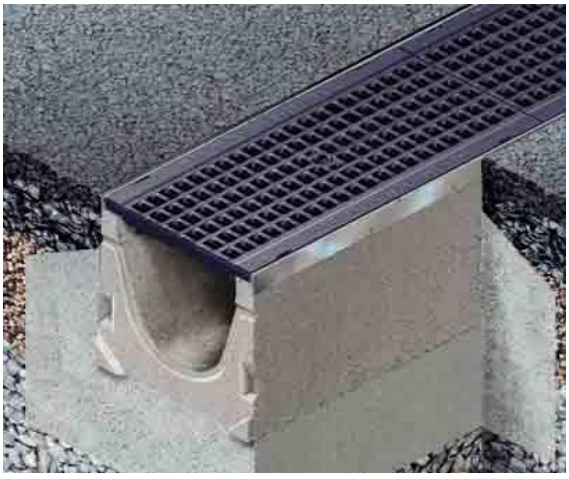

Fig 4- Surface Water Drainage System

C. 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.

VI- CONCLUSION

Based on above study we can say that Highway drainage is process of removing and controlling excess surface and sub soil water with in the right way. Highway drainage is an important part for design and construction of highway. In surface drainage, surface water is intercepted and diverted to a natural stream. If it is not done the surface water causing erosion. In sub surface water drainage, sub surface water is intercepted and disposed of to safe place.

REFERENCES

[1] *American Association of State Highway and Transportation Officials, AASHTO Guide for Design of Pavement Structures. Washington, D.C., 1998.*

[2] *Apul, D., Gardner, K., Eighmy, T., Benoit, J. and Brannaka, L. A Review of Water Movement in the Highway Environment: Implications for Recycled Materials Use, Recycled Materials Resource Center, University of New Hampshire, Durham, New Hampshire, 2002.*

[3] *Ariza, P. and Birgisson, B. Evaluation of Water Flow through Pavement Systems, Minnesota Department of Transportation, Report No. MN/RC - 2002-30, 2002.*

[4] *Ariza, P. Evaluation of Water Flow through Pavement Systems, M.Sc. Thesis, University of Florida, Minnesota Department of Transportation, 2002.*

[5] *Canelon, J. D. and Nieber, J. L. Evaluating Roadway Subsurface Drainage Practices. Minnesota Department of Transportation, Research Services Section, 2009.*

[6] *Cedergreen, H.R., O'Brien K.H., and Arman J.A. Guidelines for the Design of Subsurface Drainage Systems for Highway Structural Sections. Publication No. FHWA-RD-72-30, Washington, D.C., 1972.*

[7] *Ceylan, H., Gopalakrishnan, K., Kim, S., and Steffes, R. F. Evaluating Roadway Subsurface Drainage Practices. InTrans Project Report 12-428. Ames, Iowa: Institute for Transportation, Iowa State University, 2013.*

[8] *FHWA, Drainable Pavement Systems - Instructor's Guide, Demonstration Project 87, Publication No. FHWA-SA-94-062, Office of Technology Applications and Office of Engineering, Federal Highway Administration, Washington, D.C., 1994.*

[9] *Mustafa Hamid Abdulwahid and Kadhim Naief Kadhim. Application of Inverse Routing Methods to Euphrates River (IRAQ). International Journal of Civil Engineering and Technology, **4**(1), 2013, pp. 97 - 109.*

[10] *Forsyth, R.A. the Economic Impact of the Pavement Subsurface Drainage. Transportation Research Record 1121, Transportation Research Board, National Research Council. Washington, D.C., 1987.*

[11] *Freeze, R.A. and Cherry, J.A. Groundwater. Prentice-Hall, Inc. Englewood Cliffs, New Jersey, 1979.*

[12] *Lytton, R.L., Pufahl, D.E., Michalak, C.H., Liang, H.S., and Dempsey, B.J. An Integrated Model of the Climatic Effects on Pavements. FHWA-RD-90-033, Federal Highway Administration, 1989.*

AUTHOR TABLE

S.NO	AUTHOR NAMES	EMAIL S &MOBILE ID	DETAILS	PHOTO
1	KUNAL KUMAR SAHU	**420luckysahu@gmail.com** **9644270709**	**BE / CIVIL** 8TH SEM STUDENT RSR RCET Bhilai (C.G)	
2	TIKESH KUMAR SAHU	**tikeshsahu214@gmail.com** **9753962075**	**BE / CIVIL** 8TH SEM STUDENT RSR RCET Bhilai (C.G)	
3	BHAVANA DEWANGAN	**bhavnadewangan@gmail.com** **9754911914**	**BE / CIVIL** 8TH SEM STUDENT RSR RCET Bhilai (C.G.)	
4	SUMAN KULDEEP	**Kuldeepsuman865@gmail.com** **8226080090**	**BE / CIVIL** 8TH SEM STUDENT RSR RCET Bhilai (C.G.)	

5	BINDU URVASHA	**Binduurvasha670@gmail.com** **8959120602**	**BE / CIVIL** 8TH SEM STUDENT RSR RCET Bhilai (C.G.)	
6	MR. DEEPAK SAHU	**ppraja59@gmail.com** **9981234977**	**Assistant Prof.** **CIVIL ENGG. Dept.** RSR RCET Bhilai (C.G.)	
7	MR. PRADEEP NIRMAL	**ppraja59@gmail.com** **8839698895**	**Assistant Prof.** **CIVIL ENGG. Dept.** RSR RCET Bhilai (C.G.)