Civil and Environmental Research www.iiste.org
ISSN 2224-5790 (Print) ISSN 2225-0514 (Online)
Vol 1, No.1, 2011

Effects of Bad Drainage on Roads

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Abstract

Drainage is an important feature in determining the ability of given pavement to withstand the effects of traffic and environment. While planning and executing the work the contractor shall take all adequate precautions against drainage system to keep the road free from water. Even though many roads are of poor conditions due to different reasons .Poor drainage is one of those reasons. An increase in moisture content decreases the strength of the pavement. Bad drainage causes the premature failure of the pavement. The paper discusses the various effects of bad drainage on road conditions.

Keywords: Surface Drainage, Sub surface Drainage, Blockage of drains, Moisture content, Water table, Capillary rise.

1. Introduction

During the rains part of the rain water flows on surface and part of it percolates through the soil mass as gravitational water until it reaches to the ground water. Some water is retained in the pores of the soil mass and on the surface of soil particles which cannot be drained by normal gravitational methods and this water is termed as held water. It is required that the surface water from the carriageway and shoulder should effectively be drained off without allowing it to percolate to subgrade. The surface water from adjoining land should be prevented from entering the roadway. The side drains should have sufficient capacity and longitudinal slopes to carry away all the surface water collected. Also in waterlogged areas special precautions should be taken. There are many such roads which are not having the proper drainage system. This causes the failure of the roads due to many reasons like increase in moisture content, decrease in strength, mud pumping, formation of waves and corrugations, Stripping of bitumen, cutting of edges of pavement, frost action etc.

2. Types of Drainage System

This work shall consist of constructing surface or sub-surface drains in accordance with the requirements of these Specifications and to the lines, grades, dimensions and other particulars shown on the drawings or as directed by the Engineer.

2.1 Surface Drainage

The surface water is collected and disposed off. The water is first collected in the longitudinal drains, generally in the side drains and then it is disposed off at the nearest stream, valley or water course. Cross drainage structure like culverts and small bridges may be necessary for the disposal of the surface water from the road side drains.

2.2 Sub Surface Drainage

Changes in the moisture content of sub grade are caused by fluctuations in ground water table, seepage flow, percolation of rain water, movement of capillary water and even water vapour. In sub surface drainage of highways, it is attempted to keep the variation of moisture in sub grade soil to a minimum. However only gravitational water is drained by usual drainage system.

3. Effects of Poor Drainage on Roads

An appropriate understanding of the dynamics of water flow in roads is important for many reasons. Road engineers, geotechnical engineers and environmental scientists are three groups of professionals that have a natural interest for moisture related questions. It is well known that the rate of road deterioration increases if the water content of the granular material increases. Diefenderfer *et al*. (2001) presents no less than six adverse effects related to excess water: reduction of shear strength of unbound materials, differential swelling on expansive sub grade soils, movement of unbound fines in flexible pavement base and sub base layers, pumping of fines and durability cracking in rigid pavements, frost-heave and thaw weakening, and stripping of asphalt in flexible pavements. In a recently performed accelerated load test, Erlingsson (2009) used a Heavy Vehicle Simulator (HVS) to show that the rate of rutting increased in all layers of a flexible construction when the ground water table was raised. On the positive side, ensuring proper (optimal) water content greatly improves packing of the road during construction, and may also increase its resilience when trafficked, even though this effect is often neglected. In conclusion, initially maintaining adequate water contents in granular road materials is beneficial but if the water content increases with time, negative effects will most likely emerge. It is generally desired to keep the road as close to or less than optimum water content as possible over time. As stated by Dawson (2008): ‘Water and road construction do not make for a harmonious couple!’ From this it can be seen that there is a very serious effect of poor drainage on the condition of roads. The different effects of water on roads which are supplemented with the case studies are given below.

3.1 Service road to Mumbai Pune Expressway

The construction of Mumbai Pune Expressway was carried out in 2004. The drainage conditions of this road are getting damaged by the passage of time. The service road provided to this Expressway is mainly getting affected by the poor drainage conditions. The blockage of drainage by derbies and vegetation causes the drain water to flow on the surface of the road (Fig.1 and Fig. 2).The condition remains same throughout the year. This causes the failure of pavement due to stripping of bitumen from aggregates. Fig. 3 and fig. 4 shows the detachment of bituminous pavement layer due to continuous contact of water. The pattern of failure is getting repeated at every 200 m distance on the service road.

3.2 Walhekarwadi Chowk road

This location contains the presence of black cotton soil and water logged area around the road. The swelling Index of soil is more than 50 % which indicates that the soil is highly expansive. As it seen that variation in the moisture content causes considerable variation in Volume of sub grade, this contributes to the pavement failure (Fig.4). One of the most important causes of failure in this area is formation of waves and corrugations due to poor drainage (Fig.5 and Fig.6). Also excess moisture causes increase in weight and thus increases the stress causing the simultaneous reduction in strength of soil mass.

3.3 Nehru nagar Road, Pimpri

At this location the removal of bitumen has taken place which is followed by the loosening of aggregates. There are two reasons for this. The location is having water logged area on one side and other reason is improper provision of drainage of road. Some of the water is flowing away due to gravity but large amount of water is getting collected on the road surface and then getting penetrates into the road. This causes the increase in moisture content of the sub grade and hence the potholes are getting developed. Also the pore pressure causes the removal of aggregates from its place and accumulates on road sides (Fig.7).

3.4 Holkar Bridge Chowk, Khadaki

The present area is badly affected by the presence of water surrounding the road. The highest level of water table should be fairly below the level of sub grade in order that the sub grade and pavement layer are not subjected to excessive moisture. From practical consideration it is suggested that the water table should be kept at least 1.0 to 1.2 m below the sub grade. But at this location the water table is very high and hence the capillary rise through sub grade is taking place. This causes the water to come out on road surface (Fig.8). When vehicles are passing on this road, because of its load water is getting emerged from the road which also brings the clay particles on the surface .This causes the formation of potholes and the pavement is also becomes weak.

3.5 Akurdi Railway Station Road

The road is having a nala parallel to it which is running full of water almost throughout year. The nala is also getting flooded due to the drainage water of surrounding houses. The result of this is increase in moisture content of the area. Secondly the sub grade soil is highly expansive clayey soil results in formation of potholes (Fig.9).

3.6 Approach Road to railway tunnel near Akurdi Railway Station

The major failure at this location of road is due improper drainage of water. The road is flooded under water due to rainwater in rainy season and the drainage water from the surrounding houses in other seasons. The roads at this location are completely cut of due to the flow of water. (Fig.10 and Fig.11)

5. Conclusion

The effect of poor drainage condition on road is very adverse. It causes the failure of road in different ways. Proper drainage system provided to the road increases the life of roads. But the improper drainage system causes the failure of the road at its early edge.

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Figure 1**:** Road under water near Punawale village

Figure 2**:** Cuts in road due to water

Figure 3**:** Stripping of bitumen

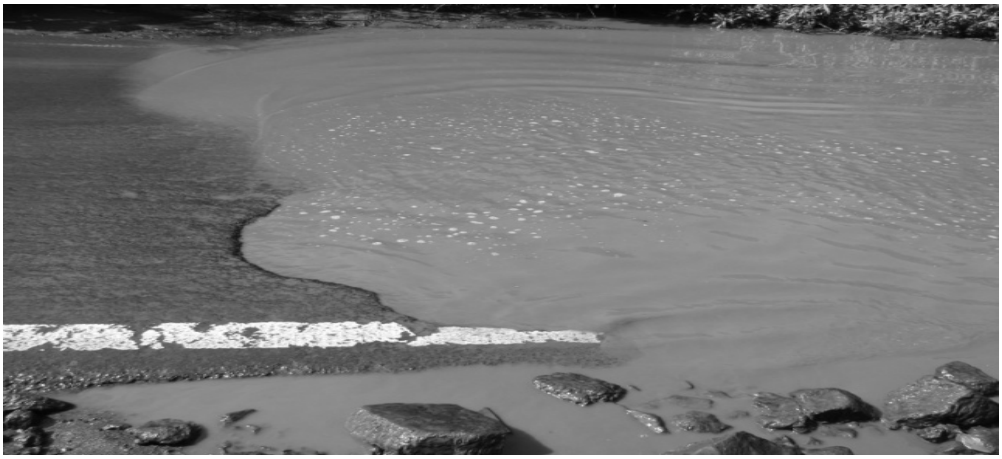

Figure 4**:** Cuts in road due to Water

Figure 5**:** Expulsion of water from road

Figure 6: Formation of waves and corrugations

Figure 7: Formation of potholes due to Poor Drainage

Figure 8: Expulsion of water due to Capillary action

Figure 9: Formation of potholes due settlement of sub grade

Figure 10: Road affected by flow of water

Figure 11: Cuts in roads due to the flow of water