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A Case Study on Highway Drainage

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Abstract

Roadway as part of land transportation is very important to actualize human or commodity movements. Roadway should be able to show good performance. It is known that inundation at roadway is very serious problem, and often causes disruption to road users. Conventional drainage system that has been applied with the concept of discharging or draining water to the drainage channel has not been able to evade rain water that falls on the road surface. To date, the load of drainage channel is increasing. This is contributed by the decrease of the drainage function in order to flow water through the channel. To overcome the problem, a new concept of drainage is introduced. This study aims to develop a good highway drainage system by increasing the ability to measure the efficiency and effectiveness of the drainage system.

Keywords: *Inundation, disruption, conventional drainage, evade*

1. Introduction

Highway drainage consists of removing or controlling surface water and subsurface water away from the road surface and the subgrade supporting it. Part of the rain water flows on the ground or road surface, while the other part percolates into the ground and reaches the ground water table, raising its level.
In fact, constructing an efficient drainage system for the road is considered to be a cheaper, yet effective method to enhance its life than the current practice of the designing pavements for soaked subgrade conditions, which leads to the formation of thicker road sections.

1.TYPES OF DRAINAGES

1.1 SURFACE DRAINAGE SYSTEM

The surface water is to be collected and then disposed off. The water is first collected in longitudinal drains, generally in side drains and then the water is disposed off at the nearest stream, valley or water course. Cross drainage structures like culverts and small bridges may

1.2 SUB-SURFACE DRAINAGE

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

1.3 REQUIREMENTS OF GOOD DRAINAGE SYSTEM

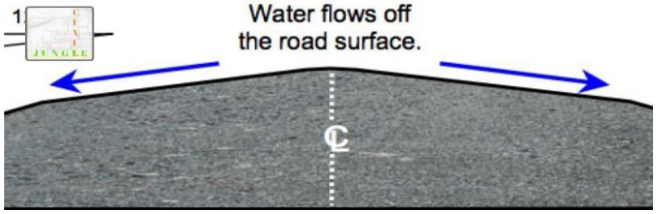
i. Camber
ii. Gradient
iii. Side Drains

CAMBER

Camber is the slope provided to the road surface in the transvers direction to drain off the rainwater from the road surface. It is also known as cross slope of the road.

ADVANTAGES OF CAMBER

a. Camber provides quick drainage of rainwater
b. Camber saves the foundation course of the road structure from weakening by thepercolation of rainwater to it.



GRADIENT

It is defined as the rate of rising or falls along the length of the road with respect tothe horizontal is known as Gradient of road. In another word, it is the longitudinal slopeprovided to the formation level of the

road along its alignment**.** It is generally expressed in 1 inn (where 1 is a vertical unit to n is a horizontal unit**).**

PURPOSE OF PROVIDING GRADIENT

a. The gradient also helps to drain off rainwater from the surface of the roads.

1.4 IMPORTANCE OF ROAD DRAINAGE

An increase in moisture content causes in strength or stability of a soil mass; the variation in soil strength with moisture content also depend on the soil type and the mode of stress application.

HIGHWAY DRAINAGE IS IMPORTANT BECAUSE OF THE FOLLOWING REASONS:

a. Excess moisture in soil sub-grade causes considerable change in its stability. The pavement is likely fail due to sub-grade failure.
b. Increase in the moisture cause reduction in strength of many pavement materials like stabilized soil and water bound macadam.
c. In some clayey soils, variation in moisture content causes considerable variation involume of sub-grade.This sometimes contributes to pavement failure.
d. One of the most important causes of pavement failure by the formation of waves and
corrugation in flexible pavements is due to poor drainage.

1.5 TYPES OF PROBLEM IN PAVEMENTS DUE TO DISTRESS

1. Environmental distress
2. Structural distress

ENVIRONMENTAL DISTRESS

The outside influence that affects the pavement performance are categorized under environmental factors. These include snow, the chemicals, water and problems with aging. These types of distress are observed from the top down. The remedy for such problems is a surface application. These include crack sealing, seal coating, chip seals, skin-parching. In certain situations, a hot mixed overlay is added to the surface as part of treatment.

TYPES OF PROBLEM IN PAVEMENTS DUE TO ENVIRONMENTAL DISTRESSES

1. Bleeding
2. Block Cracking

BLEEDING

The phenomenon of formation of a film of asphalt binder over the surface of the pavement surface is called as bleeding. The occurrence of bleeding will give a shiny glass like reflecting surface. The layer will have bubbles which are seen as blisters. The asphalt binder formed will be sticky in nature. The filling of asphalt binder into the aggregate voids during hot weather conditions and their expansion in later situations will result in bleeding. As the process of bleeding cannot be reverted in cold temperatures, they remain on the top of the pavement as such.

BLEEDING

BLOCK CRACKING

This is also called as thermal cracking. The cracking is happening in the form of blocks. These cracks are interconnected making the pavement to divide into rectangular pieces (almost rectangular). The size of each rectangle may vary from one foot by one foot to ten foot by ten foot. This is spread over a wide pavement area. But these are observed in areas of no traffic. This is an after effect of environmental exposure, hence it is called thermal cracking. The temperature effects and aging are the possible reasons.

STRUCTURAL DISTRESS

The structural are categorized as the physical failures that are found on the pavement and the sub-base. These structural failures are occurred due to overloading, wet subgrade, frosting effect or lower standards of design. This kind of distress is found from bottom up. The only remedy for these is removal and their replacement, mentioned as (R & R) of the area that is affected. Or repaving that includes total removal, milling, pulverizing the area and then paving back.

CAUSES OF POOR DRAINAGE

There are two causes of poor drainage

1.6 PAVEMENT FAILURE

The asphalt road is exposed to many distresses due to of the high stress on the pavement so it causes cracks

and a lot of defects. These defects cause a lot of problems for road users such as discomfort and the road will not be safe.

All kinds of pavement need proper maintenance as a result of affected over load, temperature change rate, Impact of climate (rains) and others factor. If cracks occur on the surface of the road due to one of the factors affecting it, it requires maintenance work but sometimes the maintenance is expensive to treat cracks or to reconstruct.

THE MOST COMMON TYPES CRACKS IN ROAD

a. Block cracking
b. Longitudinal Cracks
c. Edge Cracking
d. Pothole

POTHOLE

1.7 SHOULDER DROP-OFF

Shoulder is an ideal roadway part. It provides feature for vehicles. when emergency and a recovery land when vehicles depart the driving lane. Shoulder of granular material implementation is low cost and hence it is widely used. Stillthey result in a failure named as shoulder edge drop off.

Properties of shoulders consists of clear lane marking between traffic lanes and shoulders, required camber for proper drainage, more width for emergency purpose and also guard rail adopting, stability of structure, less total and construction costs.

SHOULDER DROP-OFF

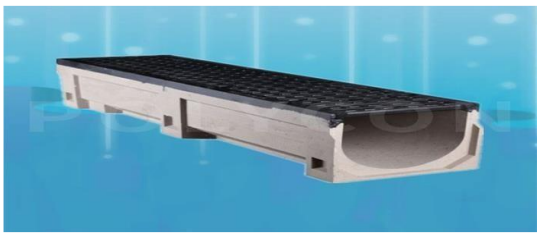
FAILURES IN SHOULDER

The various failures we can generally observed in the shoulder Are:
a. Edge drop off
b. Settlement
c. Blow out

2.SOLUTION TO PREVENT HIGHWAY DRAINAGE

2.1 POLC DRAIN

POLC Drain was founded in 2006, has more than 10 years the production experience of polymer concrete drainage solutions. The primary purpose of a road drainage system is to remove the water from the road and its surroundings. The road drainage system including the following elements:
1. Channels
2. Sump Units
3. Gratings
4. Locking system
5. Bucket
6. Lateral outlets



POLC DRAIN

Polymer concrete is increasingly used for drain channels because of its zero water absorption, strength, as well as anti-corrosive properties. Made of resin, silicon, mineral aggregates and adhesives, it is not easily breakable, and can withstand very high pressure.

Though four times stronger than conventional concrete, polymer concrete is only half its weight, making its usage that much more attractive. Given its inherent strength, it does not bend or get dislocated.

ADVANTAGES

High quality polymer concrete with integrated side ribs for perfect anchoring in the concrete bed
1.Perfectly frost resistant, wear-free and almost maintenance free
2. Modular light weight construction
3. Recyclable materials
4. Capillary-free for fast water drainage and dirt removal
5. Highly resistant against chemicals

2.2 HIDDEN DRAINAGE SYSTEM IN JAPAN

There's a hidden system in Japan that can save the world from drowning Located in Saitama prefecture, on the outskirts of Tokyo city, there lies the world's largest underground floodwater diversion facility. Known as the Metropolitan Area Outer Underground Discharge Channel, it is about 50 meters in height and goes about 6.3kms in length. This underground tunnel drainage system is designed to de-clog the city during rain and typhoon. This Matrix-like chamber with massive pillars and tunnels shall drain out the water into the Edo River. Work on the project started in 1992 and was completed by early 2006.

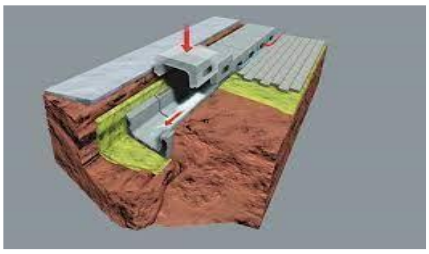
Hidden Drainage System

FACTS ABOUT THE TUNNEL

a. The water is discharged at a maximum rate of 200 cubic meters, which simply means that a 25-meter swimming pool will be emptied in a second.
b This system has saved the city in August 2008, when violent rains hit the area. This system drained around 12 million cubic meters of water, which is almost equal to 25,000 25-meter swimming pools.
c This Avant-garde technology has sought worldwide attention and has baffled flood control experts from countries like China and South Korea.
d The pressure-adjusting water tank is s larger than a soccer pitch. It is 177 meters long and 78 meters wide.
e The ceiling of the water tank is supported by 59 pillars which are 18 meters tall and weigh 500 tons each.

2.3 BEANY BLOCK

The Technicrete Beany Block is a simple and practical system with excellent surface drainage efficiency for many roadway designs. The large flow capacity/unit ratio makes it superior and more cost effective than conventional kerbing and drainage systems.



BEANY BLOCK

The system consists of a series of Base Blocks of standard channel section and Top Blocks of inverted channel section with an opening in one side face. When laid end to end they form a combined kerb and surface water drainage unit strong enough to withstand normal traffic loading. Each standard Top and Base Block is 500mm in length and weighs approximately 85kg.

The Top Block oval openings give an aesthetic appearance and provide for greater inlet capacities than conventional kerb inlets. Standard blocks may be used for curve radii of 30m or more. "Splay" blocks are available to order for radii between 6m and 30m.

ADVANTAGES

a. Time saving (design and construction)
No long drainage sections required in the contract documents when Beany Blocks are used.
b. Cost saving
Substitutes for kerbs, stormwater pipework, kerb inlets and parts of footways. Contractual claims due to damaged services etc., are less likely than when laying conventional drainage.
c. Solving specific problems in conventional drainage:
• Insufficient fall
• Conflicting levels of service mains and cables
• Ponding adjacent to low points
• Traffic safety and control on existing carriageways.
d. Additional cost savings can be achieved on schemes involving: • Wide carriageways plus footways
• Carriageways having 'flat' longitudinal falls
• Rock in sub-grade
• Shallow outfall.

Conclusion

Adequate drainage is the single most important element in pavement performance, and drainage systems can be extensive and expensive. Drainage involves handling existing watercourses, removing water from the pavement surface, and controlling underground water in the pavement structure. the drainage system must be able to carry the storm water produced by this design storm without flooding the roadway or adjacent property. horizontal drainage layer is often inserted between base course and natural ground in order to remove water from the pavement structure and stop upward capillary movement of any natural groundwater. Underground drains can also be used to lower the groundwater level by both preventing water entry and removing water that does enter the pavement structure. In this project we have discussed three solutions to the present drainage system. Out of this three, we concluded the POLC drain system is considered as most effective and efficient as it is economical in cost and also installation of this drains are easy when compared to the others

Future Scope

• To design the POLC for Indian Drainage System.
• To estimate the cost and material for POLC drain