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DESIGN CONSIDERATIONS FOR FLEXIBLE PAVEMENTS IN WATER LOGGED AREA

Mr.Harshal B. Patil*, Prof.Suresh B. Sharma

* P.G Student, Department of Civil Engneering, SSVP;s College of Engineering, Dhule, India.
Associate Professor, Department of Civil Engneering, SSVP;s College of Engineering, Dhule, India

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ABSTRACT

Pavement failure is a common problem in India and especially areas having a high water table are mainly suffered from this problem. To overcome this problem, some methods are studied in this paper to improve the bearing capacity of soil such as the use of Geogrid, soil stabilization using different materials, and proper sub-surface drainage. Soil can be improved by the addition of a stabilizer or excess aggregate. In any case, the traditional undercut & stabilization solution is often costly & always time-consuming. The paper suggests the use of different stabilization methods, plastic coated aggregates and geogrid which helps in increasing the bearing capacity of subgrade soil while greatly reducing the loss of aggregate and cover material into weak, wet or saturated subgrade soils

KEYWORDS: Water logged, pavement failure, geogrid, soil stabilization, fly ash, plastic coated aggregate.

INTRODUCTION

In India road pavement failure is very sensitive and serious issued. We have completed about 70 years of freedom, but till a day we are suffering from road pavement failure, even we have all required manpower and technologies. Especially road pavement failure in waterlogged areas is also a big challenge to the infrastructure ministry of the country.

Various experts done lots of research in this field, but this research unable to fulfill the requirement of the roads because expertise studies their respective areas only. Such as geologist studies soil improvement other studies, drainage and someone focused improvement in pavement material. Their study unable to give whole pavement design consideration required for ideal road pavement in waterlogged areas. This results in increasing life cycle costing of the road project.

In this paper I am doing study of all the research paper and available methods and divide them into three categories as soil improvement, drainage solution and pavement design. The aim of this paper is to make a comparative study of all methods, practices in different areas and find out ideal design consideration for road pavements in waterlogged areas.

LITERATURE REVIEW

- The technique of stabilizing the soil with sand and cement is being carried from long time. Mixing Portland cement, sand and pulverized black cotton soil with the optimum moisture content and compacting the mix to attain required density. The material obtained by mixing soil, cement and sand is known as cement sand soil. Cement in the range of 2 to 5 percent brings remarkable improvement in the engineering characteristics of B.C. soil. Similarly, increasing proportion of sand as stabilizer also improves the properties of soil. (Mrs. Neetu Ramteke, June 2014)
- Fly ash is having good cementing and pozzolanic properties. Use of fly ash in road construction on the black cotton soil is an excellent technique of killing two birds with one stone meaningful utilization of industrial waste and stabilizing this high expansive black cotton soil. (M.D. Zafar Eqyaabal November 2015)

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- Highway drainage is the process of removing and controlling excess surface and sub-surface water within the right way. This includes interception and diversion of water from the road surface and sub-grade. The installation of suitable surface and sub-surface drainage system is an essential part of highway design and construction. (Dr. R. R. Singh, 2014).
- Plastic waste which is cleaned is cut into a size such that it passes through 2-3mm sieve using shredding machine. The aggregate mix is heated and the plastic is effectively coated over the aggregate. This plastic waste coated aggregate is mixed with hot bitumen and the resulted mix is used for road construction. The use of the innovative technology will not only strengthen the road construction but also increase the road life as well as will help to improve the environment. (Ms. Apurva Chavan, April 2013)

SOIL IMPROVEMENT

Soil improvement is an important factor in road pavement design. Subgrade of soil is a weaker required thicker layer, whereas strong subgrade goes well with thinner layers.

Properties of soil can be improved by using following materials.

- Quarry Dust
- Fly Ash
- Sand and Cement

Soil Stabilization Using Quarry Dust

Quarry dust is wastage of product, which is formed in the processing stone which broke down into different size aggregates.

The California Bearing Ratio test results obtained from tests conducted on locally available black cotton soil with replacement of quarry dust. Quarry dust replaced by amount 10%, 20%, 30% and 40%.

Table I CBR test results on black cotton soil replaced by quarry dust.

Sr.no	Amount of quarry dust replacement	CBR value
1	0%	2.82
2	10%	4.20
3	20%	8.02
4	30%	8.28
5	40%	8.68

Soil Stabilization Using Fly Ash

Fly ash is a huge wastage from a thermal power plant and it is very hazardous to the environment. But fly ash is also having pozzolanic and cementing properties which may give benefits as stabilization material.

Table II CBR test results on black cotton soil replaced by fly ash.

Sr.no	Amount of fly ash replacement	CBR value
1	0%	2.82
2	10%	5.80
3	20%	6.20
4	30%	6.00

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5	40%	5.90

Soil Stabilization Using Sand and Cement

Now a day mixing cement and sand in soil is the traditional method of soil stabilization. Generally Portland cement, Sand and pulverized black cotton soil compacting mix with the optimum moisture content to attain required density. 2 to 5% range of cement gives remarkable improvement in engineering properties of soil.

Table III CBR test results on black cotton soil replaced by 2% cement and sand in varying amounts.

Sr.no	Amount of sand replacement (keeping cement 2% constant)	CBR value
1	0%	2.81
2	10%	3.92
3	20%	4.40
4	30%	6.01
5	40%	8.26

Suitability of Soil Stabilization

Material for the soil stabilization should be selected which easily available around the site.

Figure I Comparison of Test Results

As shown in figure I, quarry dust gives its best results at 30%, fly ash at 20% and 40% sand with 2% cement gives best results. This test conducted on the same sample of black cotton soil. Therefore, according to test results Cement and Sand, and Quarry dust is most suitable methods for soil stabilization.

DRAINAGE SOLUTIONS

Drainage is very essential part of pavement construction. Drainage is the process of removing water from surface and subsurface of pavement through a right channel.

Necessity

- More moisture content in subgrade results instability under road surface.
- In some type of soil variation of water causes changed in volume which contributes to pavement failure.
- Excess water on the edges of pavement shoulder causes damage.
- Extra water content causes increase in weight and thus increase in stress and simultaneous reduction in strength in soil mass. This is one of the main reason of failure of earth slope and embankment foundation.
- Soil erosion of subgrade takes place due to excess flowing water.

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Types of Drainage

- Surface Drainage: Surface water is collected by providing camber in proper slope and it's generally kept 1 in 20. The water on the surface is collected in side drains and then disposed off at nearest stream.
- Cross Drainage: For streams crossing alignment of roads cross drainage work is adopted and side drains diverts to cross drainage. For stream having a width less than 6 meters, provides culvert and for more than 6 meter provides the bridge.
- Sub Surface Drainage: Due to fluctuations in ground water table moisture content changes in subsurface. A fluctuation of ground water occurs due to seepage flow, percolation of rain water and movement of capillary water and even vapor pressure. Subsurface drainage provides to keep minimum moisture content in the subsurface.

Advance Methodologies for Effective Drainage System

As per as possible ground water table should below from subsurface about 1.0 to 1.2 meters. If water table is high, almost at ground level, then it is better to provide subsurface on the embankment.

If a vertical filter media will be provided at the outer edge of the U shaped open drain, then the outside water will draw down and will enter to drain through weep holes. The vertical drain of IM depth with Filter media 0.3m boulder, 0.15m metal 0.15 granite quarry dust as granular media at outer side of the drain should create so that the water should be lowered to IM depth and through weep holes, the water entered to drain and finally this water lead to the lowest of the valley, from the drains are so designed

ADVANCED PAVEMENT TECHNOLOGY

Use of Plastic Coated Aggregates

Today, plastic waste treatment is largely hazardous to the environment as most of the plastic is burnt resulting in toxic gasses being released into the environment. By effectively managing the collection, separation and processing of plastic waste, the environmental damages can be limited by eliminating the waste from our streets. We can have international standard roads and pavements which are litter free.

Design steps for plastic coated aggregates

- Collection of plastic waste.
- Segregation of different types of plastics.
- Cleaning and drying of waste plastics.
- Shredding of plastic waste into 2 to 4mm.
- Stone aggregate heated to around 160-170°C.
- Shredded polymer is added to heated stone aggregate for 30-40 seconds and mixed for uniform coating on a surface of the aggregate.
- The coated aggregates are mixed with hot bitumen at temperature ranges from 155-165°C.

The use of recycled waste plastic in pavement, asphalt represented a valuable outlet for such materials. The application of modified bitumen with the addition of processed waste plastic of about 5-10% by weight of bitumen helps in substantially improving the Marshall stability, strength, fatigue life and other desirable properties of the bituminous concrete mix, resulting which improves the longevity and pavement performance with marginal savings in bitumen usage. The process is environmentally friendly. The use of waste plastic in the manufacture of roads and laminated roofing also help to consume large quantities of waste plastics. Thus, these processes are socially highly relevant, giving better infrastructure.

Application of reinforcement (Geosynthesis)

Geogrids are polymeric products formed by joining intersecting ribs. They have large open spaces also known as "apertures". The directions of the ribs are referred to as machine direction, orientated in the direction of the manufacturing process or cross machine direction perpendicular to the machine direction ribs. These are mainly made from polymeric materials, typically polypropylene, high density polyethylene and polyester.

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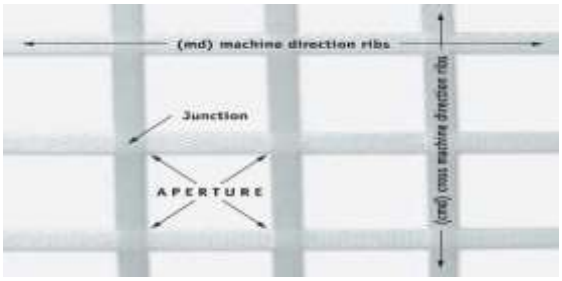
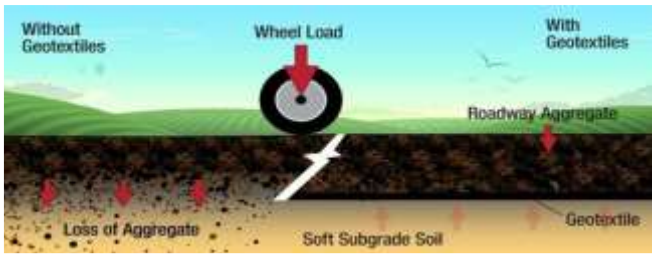
Figure II Geogrid



Geogrid work by interlocking with the granular or soil material placed over them. The apertures allow for strike-through of the cover soil material which then interlocks with the ribs (flat straps/bars) providing confinement of the overlaying granular/soil material due to the stiffness and strength of the ribs.

Figure III Working of Geogrid



CONCLUSION

Traditional pavement design should be avoided as it is costly, time consuming and having a higher life cycle costing. Each every parameter should be considered separately while designing pavement specially soil improvement and drainage.

Stone quarry dust is the best stabilizer for soil improvement than fly ash and cement sand. Subgrade reinforcement by using geogrid is an advanced and effective method against instability pavement subgrade. Use of plastic coated aggregates will be very helpful to increase strength of pavement. A plastic coated aggregate increases crushing, impact values of pavements which contribute in a decrease in thickness of pavement which directly affect the cost of pavement.

Soil improvement by any suitable stabilization method, proper provision of drainage and the use of plastic coated aggregates or soil reinforcement is effective solution for design flexible pavement with water logged area.

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