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Study on Effect of Water Resisting Materials in Bituminous Concrete Surface Layer Regarding Its Drainage

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Abstract: Highway drainage is the process of removing and controlling excess surface and sub- surface water within the roadway or right of way. Adequate drainage is essential for the protection of the investment made in the highway structures. Therefore design, construction, and maintenance of appropriate highway drainage system is one of the most important task of a highway engineer. It is important to provide an effective drainage system for all categories of roads in rural and urban areas in order to prevent early deterioration and failures of various components of a road including the road pavements.

The main focus of the work is to prevent flooding, ponding and seepage and thus keep the carriageway free of standing water. The basic requirement to be ensured is the fast removal of the falling water and guiding it to the natural watercourse. A good highway drainage is the need of the hour as it also results into vehicular hazards, flooding of adjacent properties and loss to the nation as the traffic is stranded.

KEYWORDS: Highway drainage, Removing and controlling excess surface and subsurface water, Traffic Safety, Adequate drainage, prevent flooding, ponding and seepage, Road Accident etc.

I. INTRODUCTION

The rapid growth in road traffic in terms of number as well as increase in magnitude and frequency of loading of commercial vehicles has posed challenging problems to the Highway engineering professionals dealing with planning, design, construction, maintenance and management of the road network. The road users concerned with the functional condition of the road such as smooth and comfortable riding quality and high operating speed to reduce travel time so that they can reach their destination comfortably and safely. The Highway engineer has to meet the challenges in the design, construction, operation and maintenance of sustainable road infrastructure in the country using alternate and new materials and also in the selection of appropriate pavement type, duly considering life cycle cost. In the process of advancement and betterment of the highway in the country, Highway Drainage is very important aspect that need to be covered well while planning and designing stage of the highway pavement.

Highway drainage is the process of removing and controlling excess surface and sub- surface water within the roadway or right of way. Adequate drainage is essential for the protection of the investment made in the highway structures. Therefore design, construction, and maintenance of appropriate highway drainage system is one of the most important task of a highway engineer. It is important to provide an effective drainage system for all categories of roads in rural and urban areas in order to prevent early deterioration and failures of various components of a road including the road pavements.

Poor drainage causes early pavement distresses leading to driving problems and structural failures of road. To prevent or minimize premature pavement failures and to enhance the road performance, it is imperative to provide adequate drainage. It is of great importance during road construction to ensure that, the constructed road is put to use without failure before the actual design life. It causes the failure of road in different ways and as well economic hardship on inhabitants of affected communities with devastating effect of sicknesses as a result of breeding of mosquito especially on streets in towns with poor drainage capacity. 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. Therefore effective engineering practices should be considered necessary during design, construction and management of roads and drainage channels

It is always preferred to take care of drainage at the primary stage because post construction measures are not only costly but also time consuming and sometimes may lead to accidents of vehicles leading to loss of precious lives.

Highway drainage systems are installed to capture surface water run off to alleviate flooding and protect the fabric of the road. The need of an adequate highway drainage is crucial for proper functioning of the traffic. The main focus of the project is to prevent flooding, ponding and seepage and thus keep the carriageway free of standing water. The basic requirement to be ensured is the fast removal of the falling water and guiding it to the natural watercourse. A good highway drainage is the need of the hour as it also results into vehicular hazards, flooding of adjacent properties and loss to the nation as the traffic is stranded.

Roads are an important asset for any nation. However, merely creating this asset is not enough. It has to be preserved carefully because if not protected and maintained, it deteriorates fast. The society has to pay heavily for an inefficient and ill preserved road network. Over the years, user expectations and demand for better level of service from roads have also been increasing and the demand for quality in maintenance with appropriate timely operations has been rising. Thus highway authorities while making a case for enhanced allocations have to be innovative and strive not only for better management and durability of maintenance works but also better management of the road assets as a whole. India is now faced with the tremendous challenge of preserving and enhancing the transportation system. Maintenance plays an essential and integral part in the life of a pavement. Pavements which are left to deteriorate without timely maintenance and treatments are likely to require major rehabilitation and reconstruction much sooner than those which are properly maintained while the recognition of the need for the pavement maintenance has more recently changed over time, the priority given to pavement maintenance generally remains low.

II. LITERATURE REVIEW

The chapter includes the review of different literature in the field of Sub surface highway drainage is a wide variety of analyses and phenomena of their different type of parameters. Attention is focused on a few key aspects of parameter that are considered important and relevant to measure the Highway sub surface drainage.

Review of Research Paper

Rokade et al. (2012) have presented research paper on drainage related performance of flexible highway pavements. They suggested that the Water in the pavement system can lead to moisture damage, modulus reduction, and loss of strength. Pavement service life can be increased by 50% if infiltrated water can be drained without delay. They gave some in depth knowledge on need for sub surface drainage, its terminology, different types of highway drainage systems and their needs. As per researchers, there are three types of drainage system; a) Surface drainage, b) Sub surface drainage, c) Cross drainage. They suggests some design consideration for the combating of moisture from the pavement and removal of free moisture through subsurface drainage. Four approaches commonly employed to control or reduce moisture problems; Prevent moisture from entering the pavement system. Use materials that are insensitive to the effects of moisture. Incorporate design features to minimize moisture damage. Quickly remove moisture that enters the pavement system.

Tejas D. Khediya (2016) presented that, one of the many 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. Researcher has suggested different methods for the drainage of the road by taking various aspects of them in mind. For surface drainage researcher has suggested three different terminologies when; Road in embankment, road in cutting, and road on ground line. For sub surface drainage; Control of subsoil flow, control of high water table and control of capillary rise methods are used.

Tiza et al. (2016) gave some basic idea of the effect of poor drainage on the road pavement. As per them, Poor drainage causes early pavement distresses leading to driving problems and structural failures of road as pointed out by researchers. To prevent or minimize premature pavement failures and to enhance the road performance, it is imperative to provide adequate drainage. This review covers the importance of highway drainage system in road construction, requirements of highway drainage system, and effects of bad drainage system on roads. The research pointed out areas of concern for drainage designers and road engineers that are of great importance during road construction to ensure that, the constructed road is put to use without failure before the actual design life. The review concluded that effect of poor drainage condition on a road is very adverse. It causes the failure of road in different ways and as well economic hardship on inhabitants of affected communities with devastating effect of sicknesses as a result of breeding of mosquito especially on streets in towns with poor drainage capacity. 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. Therefore effective engineering practices should be considered necessary during design, construction and management of roads and drainage channels.

Mr. Dipanjan Mukherjee (2014) tried to identify the problems of water logging in the road section as well as he provided some ideas on highway surface drainage system. As per him, proper drainage is a very important consideration in design of highway. Inadequate drainage facilities can lead to premature deterioration of the highway and the development of adverse safety condition such as hydroplaning. Water that drains from roads and footpaths flows into public drainage systems. This is known as highway drainage as per the researcher. It is a lubricant reducing the effectiveness of tyre grip on the carriageway wearing surface which can increase stopping distances. He discussed some methods for surface drainage and effect of road geometry on drainage.

Raymond A et al. (2014) had lighted on the economic impact of bad drainage by giving idea on road builders have recognized the role of water in pavement deterioration since the last century, with the development of the irrational" methods of pavement design evolved a strong reliance on the ability to build pavements stout enough to resist damage without the benefits of good drainage. Even today most designers attempt to improve the strength and quality" of the pavement and base layers used in road construction and neglect rapid drainage. Much of the water that falls on pavements penetrates the structural section through cracks, Joints, and porous surfaces. Conventional slow-draining pavements are deteriorating more rapidly than is necessary because of the impacts of heavy vehicles on flooded structural sections. The most positive pavement drainage system use an open-graded drainage layer under the full width of a roadbed with adequate collector pipes and outlet pipes. However, the California I) Department of Transportation has found that retrofit edge drains are greatly reducing the rate of step faulting of existing Portland cement concrete pavements. The impact of positive rapid drainage features on the performance of number of pavements is reviewed, with particular emphasis on the establishment of a cost- benefit relationship. The results of this evaluation indicate that the increased cost of effective pavement drainage is almost incidental to the savings realized through improved performance.

D. Kaya et al. (2017) presented that asphalt pavement industry faces two major issues. These two major issues are the increasing demand for eco-friendly asphalt mixtures and the costs of raw materials. The use of reclaimed asphalt pavement will be an essential attempt to reduce the costs of aggregates and bitumen in the final mixture. On the other hand, the main challenge for implementing RAP (Reclaimed Asphalt Pavement) is to overcome quality issues. RAP doesn't perform like a fresh pavement since it is an aged material and needs to be improved. This puts forward the requirement for extra practices like using of rejuvenating agents. Since bitumen loses its oily constituents when it ages, the use of oil- containing additives can be effective. In this study, two kinds of waste oils were used to rejuvenate aged asphalt mixture. Optimum contents of Waste Engine Oil (WEO) and Waste Vegetable Oil (WVO) additives were determined in order to implement various RAP contents. The effects of these two oily based rejuvenators on utilization of RAP in bituminous mixtures were investigated. The results represented that the use of WEO and WVO as rejuvenators for mixtures containing RAP enhances the amount of RAP used in bituminous mixtures.

Umesh Sharma et al. (2014) claimed that Geo-textiles are the permeable fabrics which, when used in association with soil have the ability to separate, filter, reinforce, protect, or drain. Typically made from polypropylene or polyester, geo-textile fabrics come in three basic forms: woven, needle punched, or heat bonded. The original and still sometimes used term for geo-textiles is filter fabrics. Geo-textiles have many applications and currently support many civil engineering applications including roads, airfields, embankments, retaining structures, reservoirs and construction site. Geo-textiles have a major role in construction of paved roads over areas having high ground water table. There are several key applications, construction of pavements, in asphalt concrete overlays and for drainage systems, which helps

in enhancing the performance and extending the service life of roads. Drainage of water from pavements has always been an important consideration in road design. When functioning as a drain, geo-textiles acts as a conduit for the movement of liquid or gases in the plane of geo-textile. Some of the geo-textiles used for drainage are wick drains and blanket drains. In this paper, various options available to the civil engineers in the use of geo-textile in the pavement drainage systems have been highlighted.

Apurva J. Chavan (2013) has described that the disposal of waste materials including waste plastic bags has become a serious problem and waste plastics are burnt for apparent disposal which cause environmental pollution. Utilization of waste plastic bags in bituminous mixes has proved that these enhance the properties of mix in addition to solving disposal problems. 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. Plastic roads would be a boon for India's hot and extremely humid climate, where temperatures frequently cross 50°C and torrential rains create havoc, leaving most of the roads with big potholes. In this research work author have done a thorough study on the methodology of using plastic waste in bituminous mixes and presented the various tests performed on aggregates and bitumen.

K. V. Priya et al. (2015) presented that the applications, innovations, developments in the field of nanotechnology in various applied fields is receiving widespread attention. It is essential to note that these applications are improving general well-being of the public. The development of nanotechnology and its significance in civil engineering practice is illustrated in this paper for enhancing the vision of nanotechnology in the field of road pavements. Although good pavements can be constructed using existing techniques and available materials, there are a number of areas where the judicious application of nanotechnology techniques should be able to improve the longevity and performance of the service provided by the pavement facility. These include improved and smart materials and characterization of materials. Nanotechnology is focused on materials in nanoscale while civil engineering infrastructure (especially road pavements) focused on the macro scale (100s of kilometre in length). This paper focuses on the nanomaterial which gives the effective results on the operation and maintenance cost of the road pavement.

Devangi G. et al. (2016) presented the paper on zycosil as admixture. She suggested that construction and subsequent maintenance of pavements in good condition has become quite problematic especially in areas where soft bitumen is met with. During Rainy season the natural bitumen become failure and pose serious problem. To the movement of vehicular traffic, treatment and strengthening of bitumen appear to be the only solution for keeping the pavement of surfaces serviceable. The pavements even when constructed according to the conventional methods are failing due to the bitumen undergoing deformations during monsoon and become unserviceable. Treatment of the bitumen with Zycosoil has used recently to obtain the desired strength. In view of the present investigation, an attempt is made to conduct different types of experiments on bitumen mix with Zycosoil and to study the changes in the engineering properties of the bitumen. Penetration, ductility, specific gravity, flashpoint, Marshall mix Tests were conducted on the bitumen mixed with Zycosoil with different percentages such as 0.1%, 0.2%, 0.3% and 0.4%.

AvulaVamshi (2013) suggested that bottles, containers and packing strips etc. is increasing day by day. As a result amount of waste plastic also increases. This leads to various environmental problems. Many of the wastes produced today will remain in the environment for many years leading to various environmental concerns. Therefore it is necessary to utilize the wastes effectively with technical development in each field. Many by-products are being produced using the plastic wastes. Our present work is helping to take care of these aspects. Plastic waste, consisting of carry bags, cups and other utilized plastic can be used as a coating over aggregate and this coated stone can be used for road construction. The mix polymer coated aggregate and tyre modified bitumen have shown higher strength. Use of this mix for road construction helps to use plastics waste. Once the plastic waste is separated from municipal solid waste, the organic matter can be converted into manure and used.

III. SUMMARY

Research studies present in this chapter gives an idea of the highway drainage and its different methods. There has been lot of research work been done regarding drainage. Each different method is to be used in every different scenario for the drainage point of view. From this study it can be said that there are huge scope of work regarding waste plastic for the drainage point of view because till now most of work is done based on the stability of the flexible pavement

IV. METHODOLOGY

In the present study an attempt has been made to analyse the present moving traffic and the rainfall in the area of state highway which will be prone to heavy traffic in near future. Variation in traffic flow and distresses according to commercial vehicles will be computed. Many of the existing national highways in India are being widened and strengthened. Also new highways and expressways are being constructed to handle the demand of the rapidly increasing traffic volumes and to help the growth of economic activities at a faster rate. It is obvious that the highway infrastructure that has been created at a great cost needs to be evaluated on a regular basis to assess the requirements of rehabilitation measures. So it is important with the increase in demand for efficient road network, awareness to use rational or mechanistic pavement and overlay design procedures is also increasing, so that more efficient use of materials can be made to improve the pavement performance and lower the life cycle cost.

A highway pavement is a structure consisting of superimposed layers of processed materials above the natural soil subgrade, whose primary function is to distribute the applied vehicle loads to the subgrade. The pavement structure should be able to provide a surface of acceptable riding quality, adequate skid resistance, favourable light reflecting characteristics and low noise pollution. The ultimate aim is to ensure that the transmitted stresses due to wheel load on waterlogged road are sufficiently reduced so that they will not exceed bearing capacity of the subgrade.

Methodology

In fig methodology chart is shown. It shows the one by one step to be done in the dissertation. It starts with title selection and problem definition and end with the conclusion.

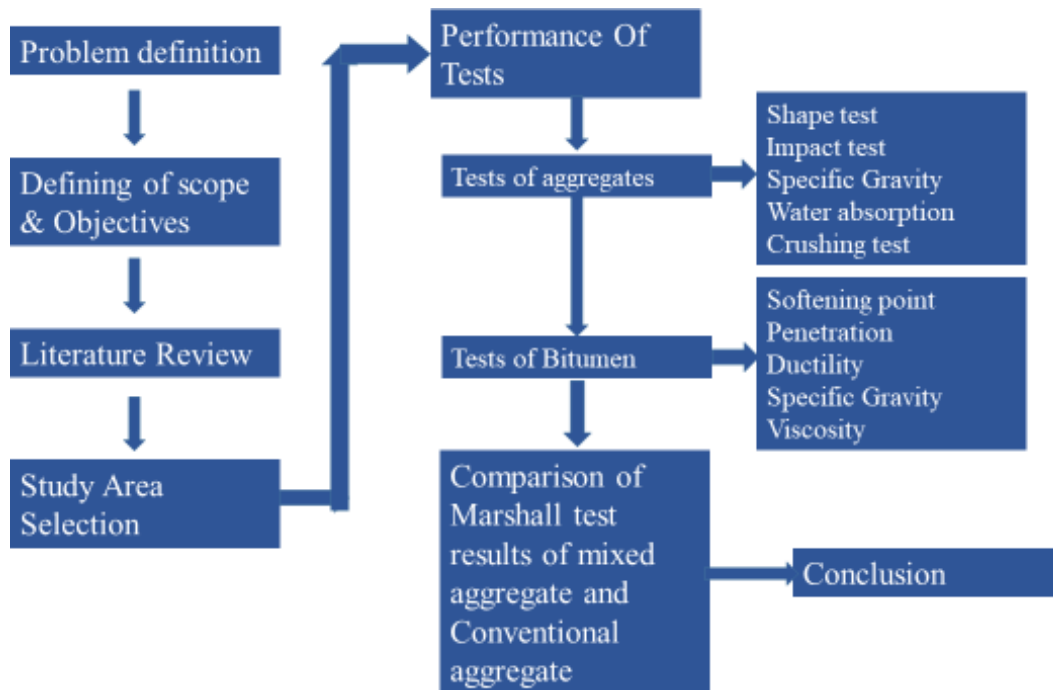


Fig Methodology chart

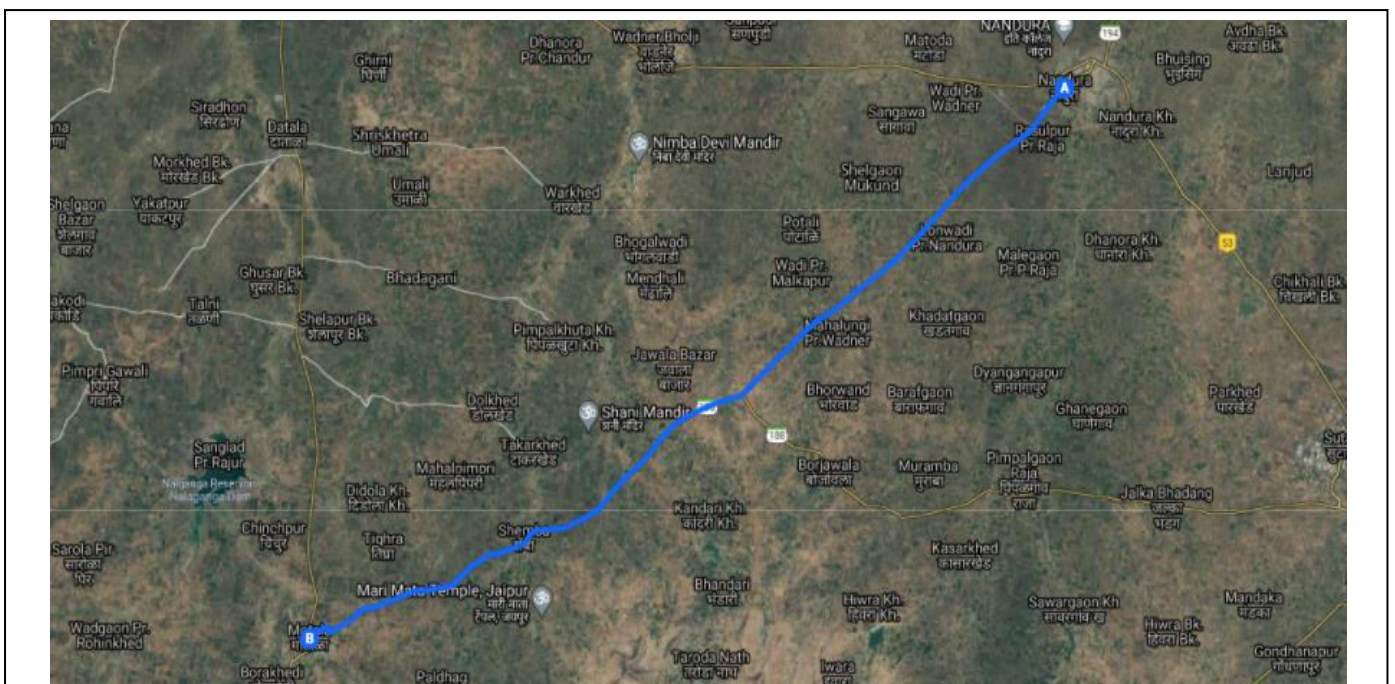
Materials can be used: VG 30 Bitumen, Aggregates, Lime as Filler, Stone Dust, Plastic waste, Used and burnt engine oil, Geotextile, Zycosil.

V. SITE SELECTION STUDY AREA

The Buldhana district of Maharashtra state has been selected as an area of the research topic.

<u>Sr. No.</u>	<u>Study area location</u>	
<u>1.</u>	<u>Study</u>	<u>Nandura</u>
<u>2.</u>	<u>Route of road</u>	<u>Nandura – Shemba – Motala</u>
<u>3.</u>	<u>Location</u>	<u>MH SH 272</u>
<u>4.</u>	<u>Length of road - km.</u>	<u>33.121</u>
<u>5.</u>	<u>Width of road carriageway – mt.</u>	<u>7</u>
<u>6.</u>	<u>Area</u>	<u>Plain terrain</u>
<u>7.</u>	<u>Lane</u>	<u>Two lane carriage way</u>

Location Map:-



☐ Guidelines for the use of plastic waste in bituminous mix for surface course as per IRC SP 98: 2013 is as shown in table

Properties	Requirements
Stability (KN)	Min 12
Flow (mm)	2 – 4
Air Voids %	3 – 5
VMA (%)	Min. 16
VFB (%)	65 - 75

: % Optimum Bitumen Content for % Waste plastic

└ % Optimum Bitumen Content for 7.5% Waste plastic

$$= (4.9+4.6+4.5+4.6+5+5.5)/6$$

$$= 4.85 \%$$

└ % Optimum Bitumen Content for 9% Waste plastic

$$= (5.5+5.7+4.5+5.5+4.5+5.5)/6$$

$$= 5.2 \%$$

└ % Optimum Bitumen Content for 10.5% Waste plastic

$$= (5.8+5.5+4.5+6.0+5.3+4.5)/6$$

$$= 5.26 \%$$

└ % Optimum Bitumen Content for 12% Waste plastic

$$= (5.5+6.0+4.5+5.5+5.8+4.5)/6$$

$$= 5.30 \%$$



Result of Marshall Test on bituminous concrete using 7.5 % of Waste plastic of size 1.18 mm to 2.36mm

% Bitumen	% Waste plastic by Wt. of Bitumen	Avg Stability (KG)	Avg Flow (mm)	Marsh all Quotient	CDM (g/cc)	SGMA	SGM	CDM A	VIM %	VMA %	VFB %
4	7.5	1225	2.8	4.375	2.3085	2.62	2.4591	2.2197	6.125	17.5	65
4.5		1320	2.9	4.551	2.3119	2.62	2.4412	2.2123	5.296	16.55	68
5		1350	3.2	4.219	2.3037	2.62	2.4237	2.194	4.95	16.5	70
5.5		1200	3.4	3.53	2.2987	2.62	2.4066	2.1789	4.482	16.6	73
6		1276	3.5	3.646	2.2853	2.62	2.3899	2.156	4.375	17.5	75

VI. FUTURE SCOPE

- The OBC of VG 30 bitumen is to be compared with the OBC of VG 30 Bitumen + Plastic waste. Then its find out that OBC of VG 30 Bitumen + Plastic waste give a require stability with high economy.
- The improvement in the values of stability is to be noted when VG 30 is mixed with plastic waste.
- The Marshall moulds will be tested for Permeability.

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