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Repair of Road Distress and Potholes with using Organosilane Based Technologies

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Abstract -*Potholed roads are a common sight across rural and urban India especially during and after monsoons. Every year crores and crores of rupees are spent by the road agencies in extensive pothole patch repairs. Stripping of bitumen is one of the most commonly occurring distresses in bituminous pavements. This occurs as a result of de-bonding between aggregate particles and bitumen. Cold patch asphalt mixture (CPAM) is used to repair pavement pothole by many highway maintenance departments for convenience and rapidness. But the repaired pavement with CPAM would soon reappears as new pavement distress. This is a reoccurring phenomenon throughout India. Organosilane based technologies are important development in recent year for bituminous pavement. Organosilane based chemical additives works for HMA and also cold mix. These additives are expected very helpful to solve de-bonding problems. Orgasilane compounds are very well known for decades for their applications in the composite material and surface modification of natural inorganic substrates such as aggregates and soil. Recent development of water based Organosilane coupling agents made possible for new applications in bitumen emulsion (cold mix). These compounds imparts surface modification at neno level. This research work includes evaluate these chemical compounds as antistripping agent for bituminous mixes for flexible pavement.*

Key words: Organosilane, potholes, stripping, bitumen emulsion, hot mix asphalt, etc.

1. INTRODUCTION

India has the second largest road network in the world spanning about 4.69 million km comprising different categories of roads. Only half of the total road network is paved and of the paved roads, 90% of them are bituminous pavements. Pavement design is the process of developing the most economical combination of pavement layers to suit the soil foundation and the cumulative traffic to be carried during the design life. Pavement design consists of mainly two parts: (i) Design of the material mixture, to be used in each pavement component layer; (ii) design of pavement structure (design of thickness and type of different component layers). The main factors to be considered in the pavement design are: traffic; climate, road geometry; and position, soil and drainage. Highway pavement is deteriorating fast due to lack of timely maintenance Thus, timely maintenance of the highway pavement is essential. Road maintenance is one of the important components of the entire road system. Right maintenance treatment is to be given to the right place at the right time.

A flexible pavement failure is defined by formation of pot holes, ruts, cracks, localized depressions, settlements, etc.

The localized settlement of any one component layer of the flexible pavement structure could be enough to cause pavement failure. This demands that each one of the layers should be carefully designed and laid. Thus to maintain the stability of the pavement structure as a whole, each layer should be stable within itself and thereby making the total pavement maintain its stability.

Micro surfacing and slurry seal are high-performance mixes, formulated with polymers and chemical additives used for quick curing overlay for the distressed bituminous road. Since micro-surfacing cures quickly, it can be placed thicker than slurry seals and used to fill ruts and for minor re-profiling. These seals can be placed on both asphalt and concrete pavements. Micro-surfacing now is recognized not only as the most cost-effective way to treat the surface wheel-rutting problem, but also a variety of other road surface problems.

These are the mainly common deficiencies occurred in flexible pavement.

[1] Potholes
[2] Alligator cracking
[3] Rutting
[4] Ravelling and pitting
[5] Transverse cracking
[6] Longitudinal cracking

2. CONCEPT OF ORGANOSILANE BASED TECHNOLOGY

Orgasilane based technologies are very well known for decades for their applications in the composite material and surface modification. Silanes are versatile products that react with a wide variety of organic and inorganic materials. Recent development of water based Organosilane coupling agents made possible for new applications. This technology offers unique applications in construction, environmental and other industries.
Silane coupling agents are silicon-based chemicals that contain two types of reactivity – inorganic and organic in the same molecule. They are known as Organofunctional silanes. Most of the widely used organosilanes have one organic substituent and three hydrolyzable substituents.. A typical general structure is

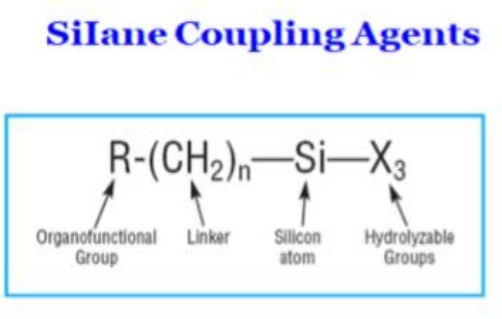

Figure 1: Genaral Structure of Silane Coupling Agents

where X is a hydrolyzable group, such as methoxy, ethoxy, or acetoxy, and R is an organofunctional group, such as amino, methacryloxy, epoxy, alkyl, etc.

Cost of nano size organosilane chemical is only 600 Rs. Per Kg. and it will be use only 0.1% weight of mix. Bitumen content (one gram per one Kg of bitumen) So it is very economical to use in repair of road distress or road construction.

Nano size organosilane additives are is important recent development for asphalt pavement. organosilane compounds are known for their reactivity with inorganic substrates. The reaction of organosilane compound with inorganic substrates, such as clay, sand, aggregate, modifies the surfaces. The surface of these substrates can be altered to make for better interaction and bonding with asphalt. Use of these compounds as antistripping additive in HMA and as a bonding agent in asphalt emulsion gave significant improvement, in moisture sensitivity and bonding in tack coat.

3. CRITICAL LITERATURE REVIEW

The following are the previous research review based on application of value engineering in building construction project.

Cesare Oliviero Rossi et.al. (2017) conducted study on the performances of a modified bitumen as a function of the concentration of an added organosilane modifier was examined in terms of its consistency, adhesion properties. A quantitative evaluation of the modified bitumen's performance was carried out by a contact angle test and boiling test. The modification of the bitumen with the organosilane surfactant visibly increases the adhesion properties of the bitumen. Moreover, contact angle tests were carried out and the results were compared with those obtained with the Boiling Test method. Concluded that the modifier guarantees excellent performance at 0.01 wt% loading, and almost complete resistance to water at 0.03 wt% loading.

Shivani Singh Dhriyan et.al. (2017) conducted study on bitumen is replaced by bitumen emulsion for the construction of flexible pavement. And The conventional method of road construction involves the burning of bitumen which produces toxic gases which degrades the environment. In colder region it is difficult to maintain the paving temperature of hot mix. To overcome these problems and conserve the energy bitumen emulsion is considered as good option. Conclude that Heating is not required when bitumen emulsion is used as binder for the construction of the road. Therefore the construction is possible during rainy season and colder regions. And Optimum binder content for mix design is 10%.

Tanuj Parmar et.al. (2016) they studied on chemicals used in the creation of the asphalt emulsions have considered more inventive employments of cold mix technology. The utilization of cold mix procedures can fill a void in the zone of restoration and recreation. This paper displays an outline of the different cold mix procedures being used crosswise over India and the state to which these procedures have been raised as cold mix technology has extended and improved. Depending on the process it can be used as base or as a surface course. As placement of cold mix is accomplished at ambient temperature.

Mahmoud Nazirizad et.al. (2015) main aim of this study is determining the effects of two different anti-stripping additives, namely hydrated lime and a liquid anti-stripping agent (Iterlene In/400-S) on hot mix asphalt (HMA). The results indicated that the addition of hydrated lime and liquid anti-stripping agent increased moisture resistance of asphalt mixes. Concluded that mix samples prepared using the liquid anti-stripping additive imparted more correlation and greater resistance to water damage.

N.F. Ghaly et.al. (2014) conducted study on they describe Poor bonding between two layers of hot mix asphalt (HMA) is the cause of many highway pavement problems. Normally, hot asphalt cements, emulsified asphalts or cutback asphalts are used as tack coat. The interface bonding strength in this study was estimated by measuring the shear strength of the test specimens at the

interface. Test results indicated that latex modified asphalt emulsion has the highest interface bond strength. It was also found that applying low viscosity tack coat asphalt emulsion at two layers is more effective than a tack coat asphalt emulsion high viscosity one layer coat.

Nyoman Arya Thanaya et.al. (2014) In this paper Cold Asphalt Emulsion Mixtures (CAEMs) can be produced at room temperature. CAEMs can incorporate milled old road pavement. Objective of the experiment was to evaluate the Properties of Cold Asphalt Emulsion Mixtures (CAEMs) from Old Road Pavement Milling, with and without the addition of cement. Before producing mixtures, the residual asphalt content was initially estimated using the formula from the Asphalt Institute:

$$P = (0.05A+0.1B+0.5C)*(0.7)$$

Where, P=% of initial residual asphalt content
A= % coarse aggregates (retain on 2.36 mm)
B = % fine aggregates (passing 2.36 mm retain on 0.075 mm)
C=% of filler

They concluded that CAEMs can incorporate a high portion (72.73%) of reclaimed asphalt pavement (RAP),where their properties well meet the specifications.

Bhrugu Kotak et.al. (2014) conducted study on Failure in pavements takes place because of shearing, loading and deflection of materials. Generally the pavement failure is done because the water get entry, the presence of water in pavement will ultimately result in pavement deterioration. If the pavement has cracked, the water can easily enter which will lead to failure of it. The application of geo sheet in potholes repairing work gives durability to the work. After applying it, the seepage through base will reduce which will improve the durability of repaired pothole.

Rajesh s. Gujar et.al. (2013) conducted study on microsurfacing is a preventive maintenance technique involving three to six millimeter sized bitumen aggregate treated with a special emulsion. Microsurfacing is a mixture of polymerized bitumen emulsion, specially graded fine aggregates, cement, water and necessary additives. Microsurfacing machine, uniformly spread immediately over a properly prepared surface evenly by means of a spreader box attached behind the machine. They concluded that microsurfacing techniques shows that this method is not only an economical solution for preventive maintenance but also it's also provide safety and riding quality by improving skid resistance and reducing roughness respectively.

LIU Tao et.al. (2013) conducted study on Cold patch asphalt mixture (CPAM) is used to repair pavement pothole by many highway maintenance departments for convenience and rapidness. But the repaired pavement with CPAM would soon appear new pavement diseases, such as water destroy, rutting disease and so on, for its bad road use performance. To discuss the influence of CPAM gradation on pavement performance, three types of mineral gradations CPAM are prepared for the performance experiments: original strength test, molding strength test, cohesion test and anti-stripping test. Through the comparation between the inside test and the outer local experiment pavement, the conclusion is drawn that the mineral grade of CPAM has important influence on the pavement performance. Tongji University have concluded a empirical formula for appropriately determining the optimal asphalt content. The empirical formula is provided by:

$$P = 0.021a + 0.056b + 0.099c + 0.12d + 1.2$$

Where;
P = asphalt content %,
a = the rate of granule's quality by exceeding 2.36 mm %,
b = the rate of granule's quality by 0.3~2.36mm %,
c = the rate of granule's quality by 0.075~0.3mm %,
d = the rate of granule's quality below 0.075 mm %.

Om prakash yadav et.al. (2012) conducted stud on mixes with and without filler the Volumetric properties, dry and wet Marshall Stability, Marshall Flow and ITS. Based on this present study it has been found that mix with cement and hydrated lime as filler each 2% both showed better results compared to mix with no filler. It has been seen that mix with 2% cement as filler showed better results compared to hydrated lime and there was no much difference in the properties for six and eight days cured specimen and hence could be concluded that six days curing period can be taken as optimum. Concluded that the optimum Emulsion content (OEC) is same for three mixes with and without filler such as cement and hydrated lime, the bulk density, dry and soaked Marshall Stability, Indirect tensile strength increased with the increase the curing period without and with the addition of 2% cement and hydrated lime as filler, Cement as filler provides better results as compared to as filler hydrated lime and without filler.

4. SUMMARY

Potholed roads are a common sight across rural and urban India especially during and after monsoons. Every year crores and crores of rupees are spent by the road agencies in extensive pothole patch repairs. Cold patch asphalt mixture (CPAM) is used to repair pavement pothole by many highway maintenance departments for convenience and rapidness. But the repaired pavement with CPAM would soon re-appears as new pavement distress. Organosilane based chemical additives works for HMA and also cold mix. These additives are expected very helpful to solve de-bonding problems. Use of these compounds as antistripping additive in HMA and as a bonding agent in

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