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STUDY ON BITUMEN MODIFIED WITH CRUMB RUBBER

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ABSTRACT

Dense Bituminous Macadam (DBM) and Bituminous Concrete (BC) are a composite material mostly used in construction projects like road surfacing, airports, parking lots etc. It consists of asphalt or bitumen (used as a binder) and mineral aggregate which are mixed together & laid down in layers then compacted. Now a days, the steady increment in high traffic intensity in terms of commercial vehicles, and the significant variation in daily and seasonal temperature put us in a demanding situation to think of some alternatives for the improvisation of the pavement characteristics and quality by applying some necessary modifications which shall satisfy both the strength as well as economical aspects. Increase in environmental concerns has been leading to develop innovative and ecofriendly ideas to re-use the waste byproducts from industries and domestic use. The abundance and increase of waste tyre disposal is a serious problem that leads to environmental pollution. It can be used as a cheap and environmentally friendly modification process to minimize the damage of pavement due to increase in service traffic density, low maintenance services which has deteriorated and subjected road structures to failure more rapidly. Use of crumb rubber leads to excellent pavement life, driving comfort and low maintenance. The rheology of CRMB depends on internal factors such as crumb rubber quantity, type, particle size, source and pure bitumen composition, and external factors such as the mixing time, temperature, and also the mixing process. This report presents a research conducted to study the behavior of DBM, BC mixes modified with crumb rubber. Various percentages of crumb rubber are used for preparation of mixes with a selected aggregate grading as given in the IRC Code. The role of crumb rubber in the mix is studied for various engineering properties i.e Ductility Test, Penetration Test, Softening Point Test, Viscosity Test and Flash & Fire Point Tests by preparing Marshall samples of DBM, BC mixtures with and without crumb rubber. Marshall properties such as stability, flow value, unit weight, air voids, are used to determine optimum crumb rubber content for the used grade of bitumen (100/120).

Key words : Dense Bituminous Macadam(DBM), Bituminous Concrete (BC), Marshall stability, Flow value, Optimum Crumb rubber Content

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I.INTRODUCTION

India has a road network of over 5,472,144 kilometres (3,400,233 mi) as on 31 March 2015, the second largest road network in the world. It has primarily flexible pavement design which constitutes more than 98% of total road network. Being a vast country, India has widely varying climates, terrains, construction materials and mixed traffic conditions both in terms of loads and volumes. Increased traffic factors are such as heavier loads, higher traffic volume and higher tyre pressure demand higher performance pavements. So to minimize the damage of pavement surface and increase durability of flexible pavement, the conventional bitumen needs to be improved. There are so many modification processes and additives that are currently used in bitumen modifications such as styrene butadiene styrene (SBS), styrene-butadiene rubber (SBR), ethylene vinyl acetate (EVA) and crumb rubber modifier (CRM). In present scenario disposal of rubber wastes produced from different Industries is a big problem. These materials lead to be environmental pollution in the atmosphere nearby locality due non biodegradable property. Most of the construction materials used for roads are soil, stone aggregate, sand, bitumen, cement etc. The availability of natural materials is declining. Also, cost of extracting good quality of natural material is increasing. To overcome this problem, it is recommended to use alternative materials for highway construction, by which the pollution and disposal problems may be reduced. The need for these solid wastages in India, it is required to test these materials and develop specifications for usage of waste tyres in road construction in which it may lead higher economic returns. The possibility of using these materials should be developed for low volume roads construction in various parts of our country. The necessary specifications should be formulated to maximize the use of solid wastes in different layers of the road pavement.

Crumb rubber is recycled rubber produced from automobiles and truck scraped tires. During the recycling process of this rubber crumb, steel and tire cord (fluff) are removed, and tire rubber are produced with a granular consistency. Crumb rubber usually consists of particles ranging in size from 4.75 mm (No. 4 sieve) to less than 0.075 mm (No. 200 sieve). Most processes that incorporate crumb rubber as an asphalt or bitumen modifier use particles ranging in size from 0.6 mm to 0.15 mm (No. 30 to No. 100 sieve).

Figure 1. Crumb rubber sample

II.LITERATURE SURVEY

2.1 General reviews about crumb rubber in different bituminous mixes

Souza et al. (1994) studied the particles size disruption of crumb rubber influenced the physical properties of bitumen rubber blend. Asphalt containing 0.2 and 0.4 mm size rubber indicated the best laboratory results, In general, small difference in the particles size has no significant effects on blend properties. However, the crumb rubber size can certainly make a big difference in bituminous properties.

Shankar et al. (2009) crumb rubber modified bitumen (CRMB 55) was blended at specified temperatures. Marshall's mix design was carried out by changing the modified bitumen content at constant optimum rubber content and subsequent tests have been performed to determine the different mix design characteristics and for conventional bitumen (60/70) also. This has resulted in much improved characteristics when compared with normal bitumen and that too at reduced optimum modified binder content (5.67 %).

Nuha S. Mashaan et al. (2012) studied the road pavement construction, the use of crumb rubber in the modification of bitumen binder is considered as a smart solution for sustainable development by reusing waste materials. It is believed that crumb rubber modifier (CRM) could be one of the alternative polymer materials in improving bitumen binder performance properties of hot mix asphalt. This study aims to present and discuss the findings from some of the studies, on the use of crumb rubber in asphalt pavement.They concluded the application of crumb rubber modifier in the asphalt modification of flexible pavement. From the results of previous studies, it aspires to consider crumb rubber modifier in hot mix asphalt to improve resistance to rutting and produce pavements with better durability by minimising the distresses caused in hot mix asphalt pavement. Hence, road users would be ensured of safer and smoother roads. Furthermore, the use of crumb rubber modifier as an additive in bitumen modified binder would reduce pollution problems and protect our environment as well.

Sharma Pavan Kumar (2013) studied that waste Crumb Rubber as a modifier the properties of bitumen will be change and this change in physical properties like softening point, penetration value, elastic recovery and Marshall stability was checked by different test. In this study we used modifier in proportion 8%, 10%, 12% and 14% by the weight of VG-30 bitumen. They conclude that crumb rubber modified bitumen reveals that the Marshal Stability value, which is the strength parameter of bituminous concrete, has shown increasing trend and the maximum values have increased by about 18% by addition of crumb rubber. This will provide more stable and durable mix for the flexible pavements. Thus, these processes are socially highly relevant, giving better infrastructure.

Mohd Rasdan Ibrahim (2013) evaluated the performance of Rubber crumbs can be mixed with aggregates within the asphaltic mix (dry process) or blended in bitumen at a specific temperature where rubber crumbs serves as a binder modifier (wet process). Crumb rubber modification by the wet process has been shown to have the ability to help improve the rutting resistance,

resilience modulus, and fatigue cracking resistance of asphaltic mixes. Crumb rubber modifications of bitumen have been proven to improve characteristics of bituminous binder such as the viscosity, softening point, loss modulus, and storage modulus. This subsequently improves the rutting resistance, resilience, and improving fatigue cracking resistance of asphaltic mixes. In order to achieve a superior and balanced CRMB in term of high and low temperature properties, factors such as the mixing time, temperature, characteristics, and source of the crumb rubber and bitumen type must be considered since these are the factors that govern the resulting performance of asphaltic mixes.

Harpalsinh Raol et al. (2014) studied to take care of both these aspects. Plastic waste, consisting of carry bags, cups, thermocoles, etc. can be used as a coating over aggregate and this coated stone can be used for road construction. Secondly the waste tires are powdered and the powder is blended with bitumen and this blend is used along with plastic coated aggregate. Crumb Rubber Modified Bitumen is hydrocarbon binder obtained through physical and chemical interaction of crumb rubber (produced by recycling of used tires) with bitumen and some specific additives. Crumb rubber gives the satisfactory results by using it in 15% of proportion to replace the bitumen for various tests of bitumen & bitumen mix. Crumb rubber gives the Marshall Stability value of 1615.84 kg by using 15% of crumb rubber powder with bitumen mix, which is 1.6 times greater than the Marshall Stability value of conventional bitumen mix.

III.EXISTING SYSTEM

An existing system for the study of bitumen modified with crumb rubber typically involves the use of waste tire rubber particles, known as crumb rubber, as an additive to enhance the properties of bitumen, commonly used in road construction. Crumb rubber is obtained by grinding discarded tires, and its incorporation into bitumen aims to improve its performance characteristics such as durability, flexibility, and resistance to aging and temperature variations. The process generally includes the blending of crumb rubber with bitumen through mechanical or thermal methods, which alters the bitumen's chemical and physical structure. This modification enhances the binder’s elasticity, improves resistance to rutting, and extends the lifespan of asphalt pavements. Research on this system often includes the evaluation of various crumb rubber contents, modification techniques (e.g., dry and wet processes), and the comparison of the resulting modified bitumen with conventional bitumen in terms of properties like viscosity, penetration, softening point, and performance in real-world conditions. Additionally, studies may explore the environmental benefits of recycling waste tires and reducing the carbon footprint of road construction materials.

IV.PROPOSED SYSTEM

The present study visualize the use of waste material i.e. waste tyres mixed with bitumen, which has potential use in highway

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and construction industry. The large scale use of such materials will not only help in conserving the ecological balances, but will open up opportunities for the industries to produce a low cost material based on these waste, for mass scale applications. The study also encourages the use of these potentially hazardous wastes for mass scale without affecting the environment, cultivation, human and animal lives. As in the part of the study, an attempt was made to assess the stabilization of the bitumen by adding crumb rubber with different percentages by bitumen weight and performing basic tests such as Ductility Test, Penetration Test, Softening Point Test and Flash & Fire Point Tests. On the basis of the performance of the modified bitumen, the range of optimum percentages of crumb rubber waste were selected for further investigations of Dense Bituminous Macadam (DBM) and Bituminous Concrete (BC). Finding out the Marshall Values, namely Marshall Stability Value, Marshall Flow Value, Voids present in air, Voids in Aggregates and Voids in Bitumen, determined from Marshall Stability Test.

V.SYSTEM ARCHITECTURE

Fig 5.1 System Architecture

VI.OUTPUT SCREENSHOT

Figure 6.1 Penetration test of Bitumen

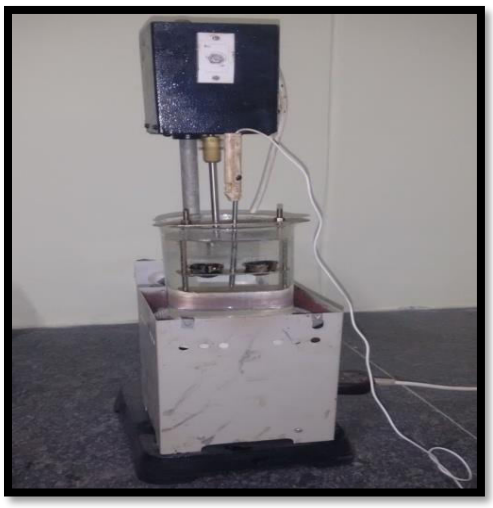

Figure 6.2 Softening point test of Bitumen

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Figure 6.3 Ductility test of Bitumen

Figure 6.4 Flash and Fire Point Tests of Bitumen

VII.CONCLUSION

By studying the test results of common laboratory tests on plain bitumen and crumb rubber modified bitumen it is concluded that the penetration values and softening points of plain bitumen can be improved significantly by modifying it with in addition of crumb rubber which is a major environment pollutant. Use of crumb rubber leads to be excellent pavement life, driving comfort and low maintenance.Overall, the rheological and mechanical test results were made it apparent that crumb rubber modification exhibits superior performance with respect to bitumen and mixture properties. In addition, 12% of crumb rubber content for BC and 14% of crumb rubber content for DBM was determined to be the most suitable content, yielding much better test results than unmodified bitumen and the other mixtures. The use of crumb rubber will also prevent the accumulation of this waste material in the environment. it can be observed that the DBM sample prepared using 14% crumb rubber with fine size (0.3-0.15mm) give the highest stability value of 2365.312 kg, minimum flow value, maximum unit weight, maximum air voids and minimum VMA and VFB % values. From it can be observed that the BC sample prepared using 12% crumb rubber with fine size (0.3-0.15mm) give the highest stability value of 2302.1758 kg, minimum flow value, maximum unit weight, maximum air voids and minimum VMA and VFB % values. Con factors we can assure that we more stable and durable mix for the pavements by binder modifications. This small investigation not only utilizes beneficially, the waste non-degradable crumb rubber but also provides us an improved pavement with better strength.

VIII.FUTURE SCOPE

The future scope of research on bitumen modified with crumb rubber is promising, with several avenues for further exploration and advancement. As sustainability becomes increasingly important, the use of crumb rubber not only addresses the issue of tire waste but also enhances the performance and longevity of asphalt pavements, which could significantly reduce maintenance costs and improve road infrastructure durability. Future studies could focus on optimizing the processing methods, such as exploring novel blending techniques and temperatures, to improve the efficiency of crumb rubber incorporation into bitumen. Additionally, research into varying the types of waste tire materials and their effects on bitumen properties could lead to more tailored and

cost-effective solutions. Advances in nanotechnology could also be explored to improve the dispersion and interaction of crumb rubber with bitumen at a molecular level, enhancing its overall performance. Furthermore, integrating recycled rubber into new pavement design technologies, including high-performance or smart roads with sensors and self-healing capabilities, could open new frontiers in road construction and maintenance. The environmental impact of crumb rubber-modified bitumen can also be further assessed, ensuring that the long-term ecological benefits outweigh any potential drawbacks, and paving the way for the widespread adoption of this sustainable material in the construction industry.

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