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Use of Fly Ash in Bituminous Mixes for Flexible Pavements: A Review

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Abstract: ***This paper summarizes the various researches done regarding the use of fly ash in bituminous mixes for flexible pavements. Many studies regarding the use of fly ash in bituminous mixes for flexible pavements were studied and their results were also analysed. In India flexible pavements with bituminous surfacing are mostly used. These pavements are subjected to repeated distresses not only due to increased intensity of wheel loads, but also due to increased traffic. A bituminous mix consists of aggregates blended in bitumen to form a surface which is durable and strong and is also able to withstand wheel loads safely. Considerable attention has been received in recent times for modification of bituminous mixes, to enhance its performance characteristics. Various types of modifiers like polymers and fibres have been used for enhancing the performance of bitumen mixes. This research reports the investigations carried on bituminous mixes with fly ash as a mineral filler. Fly ash which is an industrial waste is generated by thermal power plants all over the country and poses health and environmental concerns if not disposed properly. In this research the properties of bituminous mixes with fly ash as a mineral filler at varying proportions of bitumen content will be investigated.***

Keywords: Fillers, Fly ash, Voids in Mineral Aggregates (VMA), Marshall Stability value, Marshall flow value, Asphalt

I. INTRODUCTION

India has one the fastest growing economies in the world. Transportation infrastructure plays an important role in economic growth and development of a country. India being the country in the world with 2nd largest highway and road network system. In fact, roads form the spine of any emerging economy; roads become a prime concern for every nation big or small. The road transport is an ancient and perhaps the most widely adopted mode of transport used by mankind. The road transport system in India witnessed a massive growth after the independence mainly due to rapid industrial and economic development of the country. Pavements form the key elements of infrastructure of any developing country, which serve as connecting links between any two parts, also whose functions are to promote transport activities, economic activities and to improve the standard of living. In India majority of pavements are flexible, built for the purpose of withstanding wheel load traffic. These flexible pavements not only undergo functional deterioration but structural deterioration as well, simultaneously due to the combine effects of climate, environment and traffic loads. Pavement deterioration starts immediately after opening the road to traffic.

The main objective of a highway engineer is to provide safe, smooth, imperishable, and economical pavement that are capable of carrying present as well as the anticipated loads safely. To achieve this objective, many specialists, engineers and researchers are anxious and dedicated to select different paving material that can curtail pavement distress and upgrade the performance of asphalt pavements. Various fillers, can be used as one of the constituent in an asphalt mixture, and play a major part in determining the properties and performance of the mixture, especially its binding and interlocking effects. Coal-Based power plants consumed nearly 640 million tons of coal by the year end of 2017, which are around three fourths of the total coal used in the country. India's coal is of poor quality with almost 40-45 per cent ash, which means the plants burn 0.74 Kg/KWh of power generation, which is 41 percent higher than the global average. Fly ash generation, which was nearly 180 metric tons by 2017, is expected to reach nearly 221 metric tons by 2018. Current levels of efforts have resulted in nearly 56% utilization of ash by year ending 2017 and efforts are being made for 100% utilization of ash[1]. One of the effective methods of utilization of fly ash is using fly ash as a filler in bitumen mixes. Effective utilization of fly ash not only reducing problem of disposal, but also reduces the environmental and health hazards associated with it.

II. STATUS OF PAST RESEARCHES

1) *Rosner et.al [1981] [2]* studied the effectiveness of fly ash as replacements for portland cement and hydrated lime in the production of bituminous mixtures. Properties of bituminous concrete containing fly ash at 1%, 3%, 6% were studied. It was concluded that acceptable bituminous concrete mixtures can be produced with fly ash up to 6% by weight of aggregate.

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2) *Abdul Rahman Saleh [1986] [3]* investigated the use of fly ash in bitumen mixes, it was concluded that the adjusted voids in the mineral aggregate were found to be very useful in judging how well fly ash (or filler) can be used in bituminous concrete mixes.
3) *Cross, Stephen A [1995] [4]* studied the use of fly ash on bituminous mixes, on the basis of the test results it was concluded that fly ash decreases the permeability of the cold recycle mixes thereby increasing the resistance of the mix to the detrimental effects of moisture damage, also fly ash increases the strength of the mix and decreases its potential for wheel path rutting.
4) *Chan, J S et.al [1996] [5]* studied the effect of fly ash on the properties of bitumen mixes. Fly ash as a mineral filler not only increased the stripping resistance, but addition of fly ash also did not reduce performance of bitumen mix in terms of rut depth and serviceability.
5) *Kavussi, A [1997] [6]* characterized the role of fillers in bituminous mixtures. Four types of filler (limestone, quartz, fly ash, and kaolin) with different physical properties were evaluated. The characteristics of the fillers were determined using several different physical tests. For the fillers tested in this research, the maximum toughness corresponded to a region of filler/bitumen ratio between 0.25 and 0.75.
6) *Raymond T. Hemmings [2000] [7]* concluded that when fly ash is used as a filler in amounts of greater than 45% by volume or greater than 70% by weight. There is considerable increase in the mechanical properties of the bitumen mixes such as tensile strength and tear strength while decreasing the cost to produce the bitumen mixes.
7) *Asi and Assaad [2005] [8]* used fly ash, a by-product of oil shale combustion, in bitumen concrete mix as partial or full replacement of mineral filler. The samples were prepared with different percentages of fly ash and various tests like Marshall stability, indirect tensile strength, stripping resistance, resilient modulus, dynamic creep, fatigue and rutting tests were conducted. It was concluded, the addition of fly ash improved both strength, and water sensitivity of the asphalt concrete mixes
8) *Singh (2005) [9]* compared the effect of using fly ash, lime-fly ash and lime as filler in bituminous mixes. Indirect tensile strength increased with increase in the fly ash content and was higher than that of the mixes with other fillers indicating improved resistance against low temperature cracking and fatigue cracking. Tensile Strength Ratio (TSR) and retained stability were increased with the increase in the fly ash content.
9) *Serkan Tapkın [2008] [10]* investigated the effect of fly ash as a filler replacement on the properties of bitumen mixtures It was observed that there was a definite increase in Marshall stability and decrease in flow values Based on this study, it is demonstrated that fly ash can be used effectively in a dense-graded wearing course as a filler replacement.
10) *Vishal Sharma et.al [2010] [11]* evaluated bituminous mixes containing fly ash as a filler. Various tests like Marshall stability, tensile strength ratio, and static creep tests were conducted. The study indicated that fly ashes as a filler are suitable for use in bitumen concrete mixes. The optimum filler content was found to be 7% and properties of fly ash bituminous concrete mixes are better than those of conventional mix.
11) *Anthony J. et.al [2011] [12]* studied the effect of adding fly ash as a filler in bitumen mixes for reducing bituminous moisture induced damage. Anti-stripping properties of fly ash as a filler, along with cement kiln dust were evaluated, it was concluded that fly ash can satisfactory improve the anti-stripping properties of bitumen mixes, besides increasing its overall stability.
12) *Ajay Kumar et.al [2014] [13]* concluded that in bitumen mixes containing fly ash as a filler, the optimum bitumen content decreases with an increase in fly ash content. The Marshall stability values are also found to increase, while the flow values tend to decrease, which indicates that resistance to permanent deformation increases with addition of fly ash
13) *Poorna Prajna.S et.al [2014] [14]* studied the effect of fly ash at varying percentages on the properties of bitumen mixes .it was concluded that the maximum value of Marshall stability value was found with 8% fly ash at an optimum bitumen content of 5.5%.the maximum value of bulk density was found at 6% fly and an optimum bitumen content of 5%
14) *Debashish Kar et.al [2014] [15]* studied the effect of fly ash as a filler in bitumen paving mixes, it was observed that the mixes with fly ash as filler exhibit marginally inferior properties compared to control mixes and satisfy desired criteria specified by a much higher margin. Hence, it has been recommended to utilize fly ash wherever available, not only reducing the cost of execution, but also partly solve the fly ash utilization and disposal problems.
15) *B. Durga Priyanka et.al (2015) [16]* studied the use of fly ash as a mineral filler in dense bituminous mix. It was concluded that 4.25% was the optimum bitumen content for dense bituminous mix, the Marshall properties of the mix with 4-12% fly ash were found to be within desirable limits, besides 4% fly ash gave the best results.

III. CONCLUSION

After going through the researches, it can be concluded that using fillers in bituminous mixes enhances its various properties. Use of fillers not only helps in improving the quality of mixes but also helps in usage of various waste materials as the basic ingredients of

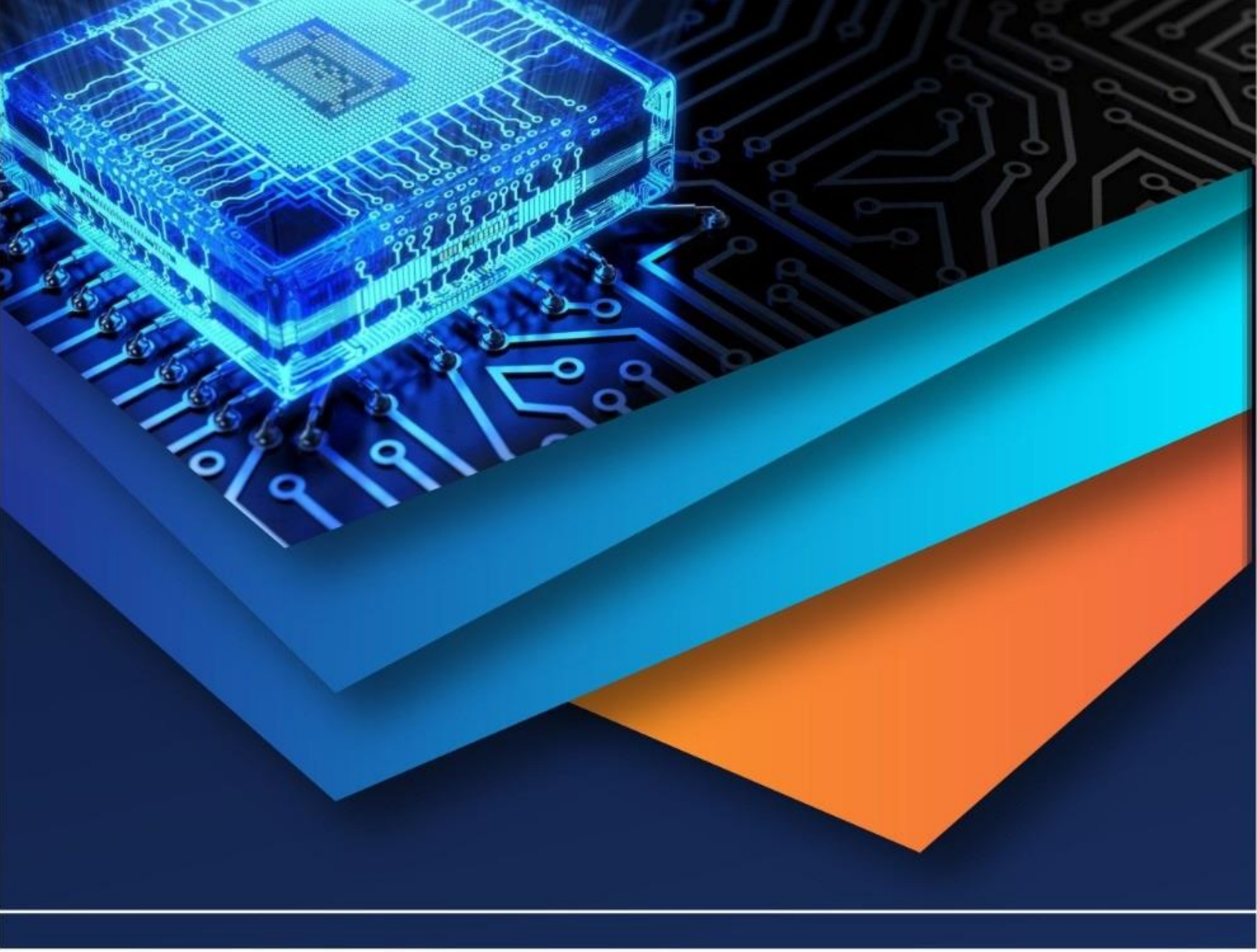
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the paving mixes thus, reducing the problem of these materials going as a waste. In such a way a by-product such as fly ash can be put to a judicious use. Fly ash can be a hazardous to health if not used. In short, we can say appropriate amount of fillers improve the Marshall Stability and flow values of the bituminous mix.

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