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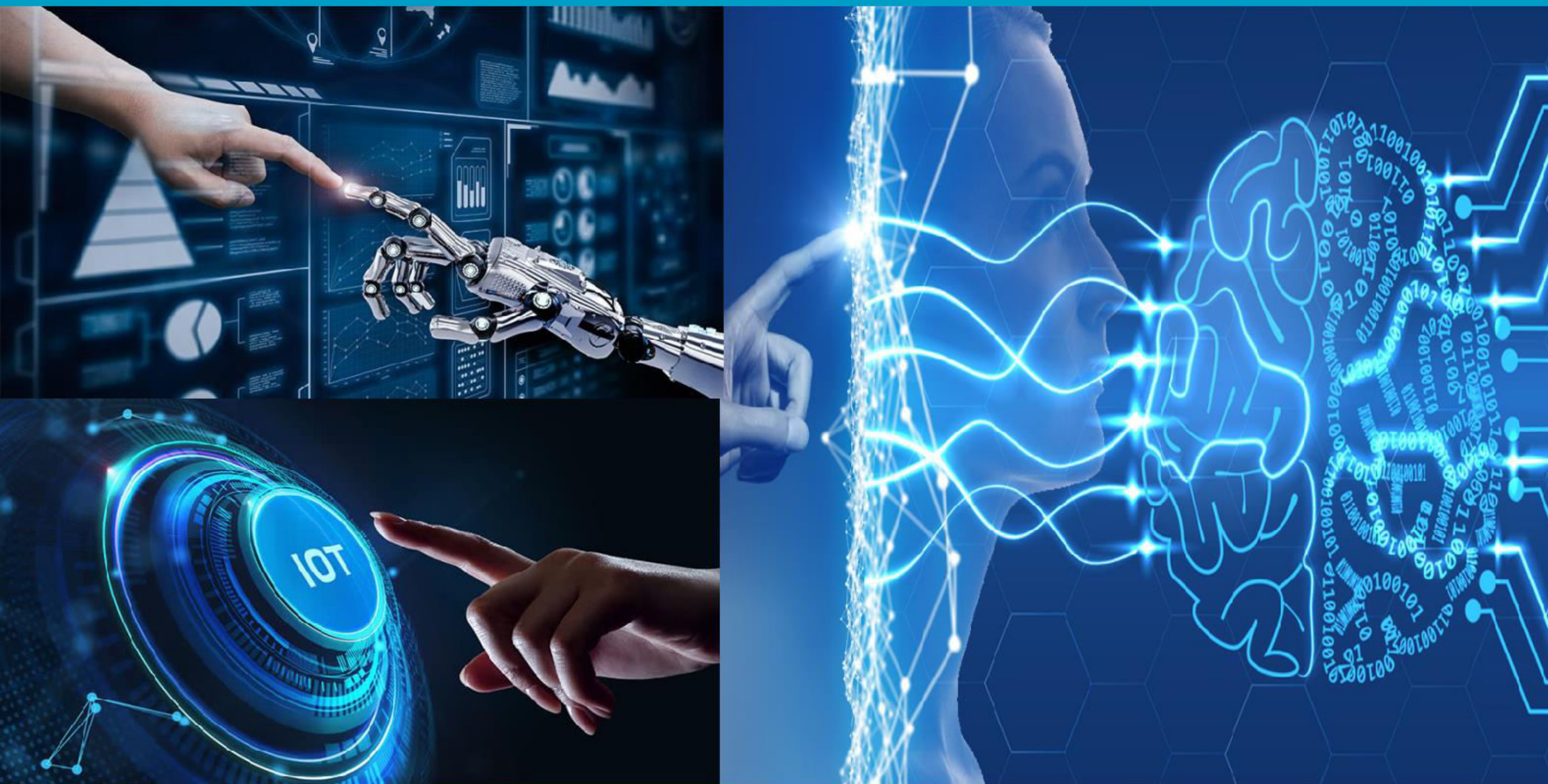

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A Reviews on SMARC Mixes and Marshall Characteristics and Moisture Susceptibility Attribute for Flexible Pavements

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ABSTRACT: In this investigation of SMARC mixes, the Marshall characteristics, drain down properties, tensile strength property attributes, fatigue property attributes, and moisture susceptibility attribute have all been examined. In this investigation, three distinct types of binders, including one that had been modified, as well as a natural fibre, were put through their paces. Resistance to rutting and creep behaviour are two characteristics that might be the subject of more research. Mixtures created using SMARC may also be evaluated using a variety of natural and synthetic fibres. Due to the fact that there is only one here, it is easy to compare numerous gradations that have been presented by various agencies. Because the coconut fibre that was used in this study was very affordable, a cost-benefit analysis could be carried out to estimate the effect that it would have on the expenses of constructing buildings. It is possible to construct trial stretches and monitor their performances on a regular basis in order to further ensure that this new material will be successful. In addition, it has been observed that the addition of fibre to mixtures, regardless of the kind of binder that is used, leads in a significant increase in the tensile strength of the mixture. This is the case regardless of the type of binder that is employed. According to the findings of the study, it is feasible to utilise any of the SMARC mixes that were made with three different kinds of binders in the wearing courses of flexible pavements.

I. INTRODUCTION

1.1 General

Traditionally, bitumen-bound aggregates are utilised in the building and maintenance of flexible pavements all over the globe. This kind of pavement is quite widespread in the paving business because of its ability to withstand heavy traffic loads when properly planned and installed. However, dense graded aggregates may not always be accessible on the site. SMARC, a bituminous mix mostly composed of gap-graded aggregates, may be used in these types of conditions. For studded tyre damage, Zichner of Straubag-Bau AG's Central Laboratory developed SMARC in 1960s Germany.Even after the usage of studded tyres was made illegal, the use of SMARC continued due to the material's exceptional resilience to deformation under the stress of heavy traffic at high temperatures. Coarse aggregate makes up 70–80 percent of gap-graded SMARC, while binder accounts for 6-7 percent, filler ranges from 8–13 percent, and fibre or modifier makes up the remaining 1 percent (0.3-0.5 percent). This creates a "architectural skeleton" that allows for more stone-on-stone contact and results in higher rusting resistance.Even in densely graded mixes, there is aggregate-to-aggregate contact; however, it is confined to a SMARCller portion of the fine aggregate particles, which do not provide the same shear resistance as coarse aggregates. SMARC traffic loads are handled by coarse aggregate particles rather than fine asphalt-mortar particles, according to Brown and Manglorkar (1993). The blend is more durable because of the greater binder concentration. During manufacture, transit, and laying, fibres or modifiers retain the binder in the mixture and prevent the binder from drying out.For high-volume roads, SMARC has shown to be more cost-effective than thick graded mixtures. The performance of SMARC mixes is influenced by a variety of parameters, according to Brown (1992), such as changes in the binder supply and grade as well as the kind of aggregate used, ambient conditions, manufacturing processes, and so on. An analysis of these characteristics is necessary in order to determine the SMARC's performance over the long run and to provide information for future changes to be made to accommodate a variety of environmental variables. In their definition, the FHWA's SMARC Technical Working Group refers to "a gap graded aggregate hot mix asphalt" as "a stable stone-on-stone skeleton, kept together by a rich blend of binder, filler, and stabilising additives." This is what they mean when they say "a gap graded aggregate hot mix asphalt."

1.2 Comparison to Traditional Bituminous Mixtures

SMARC pavements are superior in terms of strength, durability, and lifetime than conventional asphalt pavements. SMARC is superior than traditional mixes in a number of ways. Improved skid and noise resistance, reduced

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permeability and sensitivity to moisture are some of the advantages of SMARC over conventional alternative pavement surfaces. Additionally, it offers improved resiliency in the face of the rutting that may occur as a result of slow, heavy, and high-volume traffic. It has properties that are advantageous at low temperatures and has a high level of resistance to plastic deformation even when subjected to heavy traffic loads combined with high tyre pressures. After the traffic has removed the binder's surface coating, the rough roughness of SMARC's surface offers excellent friction. SMARC has a longer life expectancy than traditional thick graded mixes, according to Kamaraj et al. (2004). In addition, it is anticipated that it will cost around 20 to 25 percent more than the conventional thick graded mixes; however, the increased longevity of the road may make this additional expense justifiable. SMARC has been shown to be superior than HMA blends because of these benefits.

1.3 Choosing Between Different Binders

Some of these binders include polymer modified binder (PMB), crumb rubber modified binder (CRMB), and natural rubber modified binder (NRMB). Some of the researchers have also used PG 76 -22, which is a high-performance binder similar to Superpave. In comparison to combinations that have not been treated in any way, the mixtures that include CRMB are significantly enhanced (Reddy and colleagues 2006). In view of this fact, research on SMARC mixes that included. SMARC mixtures seldom include 80/100 bitumen, according to an examination of relevant literature. SMARC mixes including an 80/100 bitumen binder were tried in this study in an effort to see whether they could be employed in the presence of fibres and to learn more about their potential.

II. LITERATURE REVIEW

2.1 General

The sections that follow provide a comprehensive analysis of the published research on SMARC mix studies. The bulk of the roads across the globe typically feature of bituminous material on top, and sometimes in the basic course as well. This is followed by layers of granular material in the base and subbase courses. Hot mix asphalt, often known as asphalt concrete pavement, is the term used to refer to the bonded layers that make up the surface course of a flexible pavement design. Premix bituminous material is the most popular kind of flexible pavement covering utilised in India., which is more often referred to as hot mix asphalt in countries outside of India (HMA). In the production of HMA, coarse aggregates and asphalt binder are blended. The HMA material is a substance that is first heated, then blended, then placed, and finally compressed, as its name suggests. It is usual practise to lay down layers of HMA in order to give the surface course or friction course with the required structural support. This is because the bottom layer aggregates are subject to more wear and tear than the top layer aggregates. HMA mixes may be purchased in a wide variety of guises because to the fact that there are so many different names for them. This bundle consists of the most common varieties of Dense Graded Mix (DGM), as well as SMARC and numerous Open grades of HMA. Also included in this product is a variety of HMA. The maximum aggregate size, the gradation, and the quantity of binder or the kind of binder that is used are some of the key characteristics that differentiate one HMA mix from another. Other differences include the gradation.

Fig. 2.1 Dense graded HMA surface **Fig. 2.2 SMA surface**

Fig. 2.3 Open graded friction course surface

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Aggregates in high volume bound by an appropriate grade and a modest amount of bitumen make up the surface course of flexible pavements. It is common practise to utilise a thick graded HMA mix on the surface course of highly used roadways.

2.2 Stone Matrix Asphalt

The Asphalt Paving Association of the United States (NAPA) defines SMARC as "a robust, stable, rut-resistant mix that relies on aggregate-to-aggregate contact for strength and rich mortar binder for durability." State transportation authorities in Washington state have alluded to this description of SMARC. These objectives are often accomplished by using a matrix with a high asphalt content, gap-graded aggregate, and either fibre or polymer modification in combination. In order to maintain the consistency of the SMARC mixture over time, stabilising chemicals are added to it. Rutting and wear and tear are no match for the tenacity of SMARC's construction. Mineral filler has a considerable influence on the features of SMARC mixes, including air gaps, voids in mineral aggregates, and the ideal binder concentration. This is because mineral filler helps to create voids in the aggregates. It is required to add stabilising chemicals avoid the of binder material throughout the manufacturing process and the installation process, which both take place at high temperatures.

2.3 Physical Attributes and Qualities

2.3.1 Mineral aggregates

Bituminous mixtures may be made using a variety of mineral aggregates. Bituminous mix aggregates may be sourced from a variety of natural sources, including glacial deposits and mines. Natural aggregates may be utilised without additional processing and are referred to as such. According to Deori (2006), these materials are referred to as "back run or pit run" if they are utilised directly without further processing. The performance of a concrete mix may be improved by using industrial byproducts like steel slag and blast furnace slag in the mix, along with other aggregates. Aggregates for bituminous mixtures may be obtained from reclaimed bituminous pavement, which is a plentiful resource.Aggregates are critical to the strength of SMARC mixes since they make up a larger percentage of the overall matrix. Coarse aggregate accounts for 70% to 80% of the overall stone content in SMARC. creates high when more coarse material is utilised in the skeleton-type structure of the mixture. This is especially true when more coarse aggregate is used. According to, who highlighted of SMARC largely vital for SMARC's strength to have a strong coarse aggregate skeleton. Resiliently resisting movement, the R form and texture is very cube-like with a rough surface.

- A hardness that can withstand high traffic loads without cracking.
- A high polishing resistance and A a high abrasion resistance.

2.3.2 Mineral fillers

The characteristics of SMARC mixes are greatly influenced by the inclusion of mineral fillers in the mix. The rigidity of the asphalt mortar matrix is improved by the use of mineral fillers. HMA mixes' workability, moisture resistance, and ageing properties are also affected by mineral fillers, As a result, assist to limit the quantity of asphalt that is drained out of the mix during construction, increasing the mix's endurance. Maintaining appropriate voids in the mix is also aided by this. Mineral fillers like as stone dust, OPC, slag cement, fly ash, and hydrated lime are all used in SMARC mixes. According to Brown and Mallick (1994), the kind of filler utilised has a considerable impact on the mix's binder drain down. reduced when contains more filler. When Brown et al. (1996) conducted Superpave binder testing, they found that each of the SMARC mortar components had a significant impact on total performance. an HMA plant were utilised as mineral fillers in SMARC mixtures. They determined that the mineral fillers in the mortar are responsible for the majority of its stiffness. SMARC mixtures may include Portland cement as a filler, according to their findings.Studying the influence of mineral fillers on the characteristics of SMARC mixes was done by Mogawer and Stuart (1996) There were a total of eight different types of mineral fillers that they considered for inclusion in the composite. As a result, they looked at things like mastic drain down and moisture susceptibility along with other features like rutting and low-temperature cracking.Stone dust and cement were used as fillers in the SMARC combination that was developed by Ravi Shankar and colleagues (2009). They used a filler component that was 10 percent of the total, and they divided it up as follows:

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Their research was a comparative analysis of the design mixes' performance in comparison to that of the Marshall mix design process. Dynamic stability, water sensitivity, and fatigue life were all taken into consideration while evaluating the mixtures.

In accordance with the Marshall and Superpave mix design approach, an MSWI ash substitution ranging from 8 to 16 percent satisfy SMARC combination criteria.

2.3.3 Bitumen

An important function of bitumen in SMARC mixes is to keep aggregates, particles and stabilisers together by forming an impermeable layer. SMARC mixtures include a lot of mortar binder, which makes the mix more durable. Temperature sensitivity, viscoelasticity, and ageing are all effects of bitumen on bituminous mixture behaviour. Bitumen's behaviour is temperature and loading time dependent. Lower temperatures and shorter loading periods make it stiffer. In the SMARC mix, the bitumen functions as a stabiliser together with other additives (fibres, polymers, etc.). Stabilizers such as polymer modified bitumen may be employed with or without additives. Researchers have employed a variety of bitumen kinds to examine the SMARC mixture's qualities. SMARC mixes are evaluated using penetration grade bitumen, modified bitumen, and Superpave performance grade bitumen.

III. CONCLUSIONS

3.1 General

The following conclusions are formed from the findings and comments of experiments on various SMARC mixtures.

3.2 Marshall Properties

Marshall Stability

Variations show that binder stiffness has a direct effect on stability, with stiffer binders providing more stability. More binder is needed for optimal stability with a stiffer binder, but that extra binder is worth it. A higher fibre content in the mix (i.e., more than 0.5 percent) enhances the stability value, while additional fibre content.

Flow Value

The flow value falls as the stiffness of the binder increases, but the flow value rises as the binder content rises. The flow value reduces even more when fibre is introduced to the mix, compared to a regular SMARC mix without fibre. In contrast, a larger percentage of fibres in the mix improves flowability.

Unit Weight

Up to a particular binder level, the weight of the unit rises, but thereafter drops. After, the unit weight decreases and the stiffness of the binder in the mix increases. Fiber content affects the unit weight as well. Its unit weight rises when 0.3 percent of fibre is added to the mix, but additional fibre addition reduces.

Air Voids

Binder content minimises the number of air spaces in the mix. The amount of fibre in the mix also affects the amount of fibre in the final product. In the combination, the 0.3 percent fibre content is found to have the lowest air spaces.

Optimum Binder Content

According to the Marshall test findings, the optimal binder content (OBC) of the SMARC mixes is seen to rise, based on the Marshall test results. The optimal binder level of the mixture is reduced when coconut fibre is added.

Optimum Fiber Content

According to the findings of the Marshall tests, the optimal quantity of binder for each of the blends is 0.3 percent, at which point they all display the highest quality characteristics. Therefore, 0.3 percent of the mix should be comprised of the optimum fibre content (OFC) for all SMARC mixes.

3.3 Drain down Characteristics

When it comes to drain down, mixtures with or without fibre that use CRMB 60 modified binder perform the best. Drainage of binder is too low in mixtures using CRMB 60 binder and no fibre. When fibre is added to 80/100 and

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60/70 bitumen mixtures, there is a tiny proportion of drain down, but when no fibre is present, there is no drain down of the binder.

3.4 Tensile Strength

The tensile strength of 60/70 bitumen mixes is greater than that of 80/100 bitumen mixes at a certain test temperature. Using CRMB 60 binders at low temperatures results in poorer tensile strength than using unmodified binders at higher temperatures, however this is reversed at higher temperatures. In comparison to blends without fibre, the tensile strength of blends with fibre is greater.

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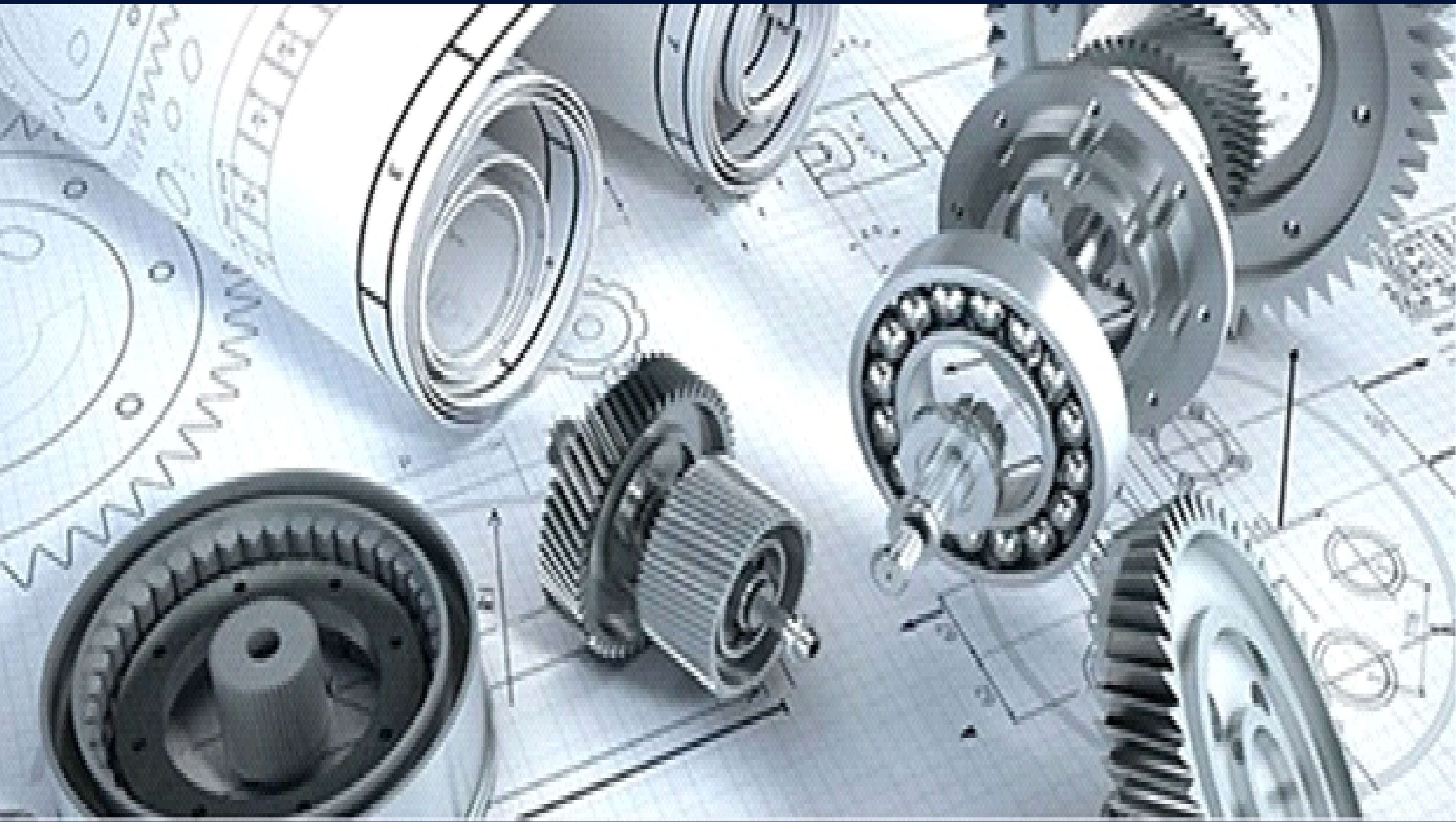

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