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Pavement Evaluation Studies Using Asphalt Concrete and Bituminous Mix

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***Abstract*- now day's highway pavement, bridges,parking, and other commercial structures becoming functionally deteriorating due to repeated of vehicular load and effect of climatic condition. non-destructive testing methods are desirable to evaluate existing flexible pavement. in the study consisted of two tasks: during visual inspection of the existing pavement failures. second, investigated the actual causes of these failures. in the found that most of the damaged pavement sections suffered from severe cracking and rutting failures. in the structure evaluation of flexible pavement in the deflection is measure by benkelman beam. functional evaluation of pavement is like roughness, rutting, crack, patch, potholes, and ravelling. the present study is to carry out the flexible pavement condition index survey studies by irc 81-1997.**

***Key words* - pavement evaluation, benkelman beam, deflection, flexible pavement, asphalt concrete.**

I. INTRODUCTION

Construction of highway involves huge outlay of investment. A precise engineering style might save appreciable investment likewise a reliable performance of the in-service road is achieved. 2 things are a unit of major concerns in versatile pavement engineering– pavement style and also the combine style. This study is said to the combo style concerns. A good style of hydrocarbon combine is predicted to end in a mixture that is satisfactorily

- Robust
- Sturdy
- Resistive To Fatigue And Permanent Deformation
- Surroundings Friendly
- Economical Then On.

A mixture designer tries to realize these needs through variety of tests on the combo with varied proportions and finalizes with the most effective one. Pavement consists of over one layer of various material supported by a layer referred to as sub grade. Usually pavement is too sort versatile pavement and rigid pavement. Versatile pavements area unit thus named as a result of the overall pavement structure deflects, or flexes, beneath loading.

a versatile pavement structure is usually composed of many layers of fabric. Every layer receives the hundreds from the on top of layer, spreads them out then passes on these masses to successive layer below. Typical versatile pavement structure consisting of Surface course. This is the top layer and the layer that comes in contact with traffic. It may be composed of one or several different HMA sub layers. HMA is a mixture of coarse and fine aggregates and asphalt binder

- Base course. This is the layer directly below the HMA layer and generally consists of aggregate (either stabilized or un-stabilized).
- Sub-base course. This is the layer (or layers) under the base layer. A sub-base is not always needed.

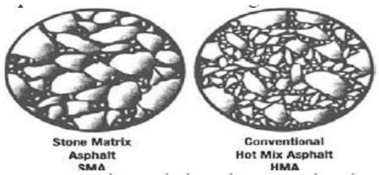

Fig.1 Stone Matrix Asphalt and Conventional Hot Mix

1.Asphalt Concrete Or (Bituminious Mixture):- Asphalt concrete is a composite material commonly used in construction projects such as road surfaces, airports and parking lots. It consists of asphalt (used as a binder) and mineral aggregate mixed together, then are laid down in layers and compacted. Mixing of asphalt and aggregate is accomplished in one of several ways.

2. Hot Mix Asphalt Concrete: -Hot combine asphalt concrete (normally condensed as HMAC or HMA) is made by warming the black-top folio to diminish its consistency, and drying the whole to expel moistness from it before mixing. mixing is for the foremost half performed with the whole at around three hundred °F (about a hundred and fifty °C) for virgin black-top and 330 °F (166 °C) for compound adjusted black-top, and therefore the black-top bond at two hundred °F (95 °C). Clearing and compaction should be performed whereas the black-top is sufficiently hot. In varied nations clearing is proscribed to summer months in lightweight of the very fact that in winter the compacted base can cool the black-top loads before it's ironed to the perfect air content. HMAC is that the variety of black-top cement most typically utilised on extremely dealt asphalts, as an example, those on important thruways, circuits and landing strips.

II. ADVANTAGES OF STONE MATRIX ASPHALT

The advantages of Stone Matrix Asphalt are

- High stability against permanent deformation
- High wear resistance
- Slow aging and durability to premature cracking of the asphalt
- Good low temperature performance
- Longer service-life
- Better long-life behaviour

III. DISADVANTAGES OF BITUMINOUS MIXES

The general problems while using bitumen in paving mixes are as follows.

- Difficulty in mixing
- Ensuring attainment of desired stability of mix
- Cracking of bituminous surface
- Ensuring sufficient adhesion with the aggregates in the mix

Variations in temperature and fatigue induce the formation of cracks in the bituminous surface. The pavement deformations (plastic and elastic deformations) due to repetition of loads may lead to permanent deformations and even permanent failure. Cracking and plastic failure (rutting) in bituminous surface course are caused due to excessive strain in the pavement layers. The undulations and unevenness of the surface due to plastic deformations of the pavement causes vertical oscillations, consumes more fuel, causes wear of the vehicle components and increases vehicle operation cost. As a result, this causes discomfort and fatigue to the passengers. Hence it is necessary to address the problems of rutting and cracking in flexible pavements to overcome the difficulties in use and maintenance of flexible pavements. It is also required to take the necessary steps to keep elastic deformations within the permissible limits since the stresses under the wheel loads cause deformations due to repeated load applications.

1. Objectives

For the most part we utilize a few sorts of changes to the bituminous asphalts so as to expand the quality and strength of Hot Mix Asphalt. Strands have been widely used to increment rheological properties of designing materials for long occasions. The impact of Carbon fiber on black-top cover explored in this examination. In this paper we are going to perceive how carbon polymer strands will indicate sway on black-top blend, fiber improving black-top conduct. A past research paper passes on that by expansion or change of Asphalt blend expands the quality, sturdiness and opposition towards jerk, weakness and rutting condition. The main objectives of the present study are as follows:

- To find the suitability of fibers as a stabilizer for use in Stone Matrix Asphalt
- To compare the Marshall properties of SMA samples with varying binder Concentrations and to obtain optimum binder content with the help of Marshall Test data.

IV. LITERATURE REVIEW

E S Dinesh Babu and K Banupriya (2017) assess the presentation of CS as balancing out added substances and spent lime as filler in SMA blend to decide the ideal measurements at which the channel down examination give under 0.3% by weight of blend.

Gazia Khurshid Khan and Ar. Sukhmanjit (2017) contemplated three noteworthy sorts of black-top surfacing, described by a blend of bitumen and stone total. These are: Dense Graded black-top (DGA); Stone Mastic Asphalt (SMA) and Open Graded Asphalt (OGA).Stone Matrix Asphalt (SMA) is a hole reviewed blend, described by high coarse totals, high black-top substance and polymer or fiber added substances as stabilizers. In contrast with thick.

reviewed blends SMA has higher extent of coarse total, lower extent of moderate size total and higher extent of mineral filler. It opposes perpetual disfigurement and has the potential for long haul execution and sturdiness. Four of various total degrees with two sorts of fillers, for example, Bamboo Fiber and Cellulose Fiber have been pursued for planning of blends. Around 2450 gm of test totals were taken and kept in broiler until it dried. Warming of totals was done up to 135oC before the expansion of bitumen. Bitumen blend was added differing from 3 to 7% at an augmentation of 1%.

GaziaKhurshid Khan and Jyoti Narwal (2017) examined different applications and properties of SMA blends. Additionally the investigations done by different creators are surveyed in this examination.

Abhishek Mendigeri and Dr. H S Jagadeesh (2017) acquired an ideal degree according to particular given by IRC: SP: 79: 2008 by utilizing locally accessible totals and different materials and to decide the ideal fastener content for warm blend added substances and ideal fiber content. To decide the above said properties the shifting rates of folio content from 5.8%, 6%, 6.2%, 6.4% and 6.6%, fiber content 0.30%, 0.35%,0.40% and 0.45% by all out weight of totals and the changing rates of warm blend added substances for example Sasobit from 1%,2% and 3%, Zychotherm from 0.05%,0.1% and 0.15% have been considered for the exploration work.

M.Satyavathi et al (2016) checked the possibility of strands as balancing out added substances wherein the stream esteems and security esteems were dissected by performing Marshall Stability test. Different rates, for example, 5.5%, 6%, 6.5% and 7% of bitumen are chosen for this examination. Channel down test is at first performed to locate the ideal fiber substance lastly to locate the ideal bitumen content. The test results for both grade-1 and grade-2 blends by the utilization of filaments decreased the channel down esteem and most extreme security esteem for both grade-1 and grade-2 blends is gotten for coir fiber when contrasted and pineapple fiber.

Anuj Narwal (2016) checked on the results of utilization of a normally and locally possible fiber referred to as SISAL fiber is utilized as stabilizer in SMA and as an added substance in BC. For arrangement of the blends total degree has been taken according to MORTH determination, fastener content has been changed regularly from 4% to 7% and fiber content differed from 0.33 to greatest 0.5% of all out blend. As a segment of fundamental examination, fly fiery remains has been found to result tasteful Marshall Properties and in this manner has been utilized for blends in resultant works. Utilizing Marshall Procedure Optimum Fiber Content (OFC) for each BC and SMA blends was observed to be 0.3%. Likewise Optimum Binder Content (OBC) for BC and SMA were observed to be 5-hitter and 5.2% severally.

V. PREPARATION OF MIXES AND EXPERIMENTAL PLAN

1. Gradation of Aggregates

Sieve analysis is performed and aggregates of appropriate sizes are collected and stored in place with sizes as per MORTH specification. Here weight of one sample is 1200 gm. The distributions of samples are taken as per below table as per IRC: SP- 79.

Table.1 Gradation table for sample without banana fiber

Sieve Size	% Retained	Bitumen Content				
		4 %	5%	5.5 %	6.5 %	7 %
13.2	5	57.6	57	56.7	56.4	55.8
9.5	33	380.16	376.2	374.22	372.24	368.28
4.75	29.5	339.84	336.3	332.33	332.76	329.22
2.36	8	92.16	91.2	90.72	90.24	89.28
1.18	3.5	40.32	39.9	39.69	39.48	39.06
0.6	2.5	28.8	28.5	28.35	28.2	27.9
0.3	2.5	28.8	28.5	28.35	28.2	27.9
0.15	4	46.08	45.6	45.36	45.12	44.64
0.075	1.5	17.28	17.1	17.01	16.92	16.74
Aggregate in mix		1031.04gm	1020.3gm	1012.73 gm	1009.5gm	998.82 gm
Bitumen in mix		48 gm	60 gm	66 gm	78 gm	84 gm
Filler		120.96 gm	119.7 gm	121.27 gm	112.44gm	117.18 gm
Wt. of mix		1200 gm	1200 gm	1200 gm	1200 gm	1200

VI. DATA ANALYSIS

1. Weights of Samples-Once the sample is prepared its dry weight, weight after wax coating and weight in water is taken. By these values bulk volume of the sample is calculated and hereafter G_{mb} is calculated by formula 5 given above. For calculation of bulk volume, volume of paraffin is deduced from total volume. Specific gravity of wax is taken as 0.9 g/cc and for water it is taken as 1 g/cc for calculation.

Here, W_{pca} = wt. of wax coated sample in air
W_{pcw} = wt. of paraffin coated sample in water
Ws = wt. of sample in air
B_{vs} = bulk volume of sample
G_{mb} = bulk specific gravity of the mix

2. Weights and Specific Gravities Of Mix Without Banana Fiber- Data obtained in this case is tabulated below.

VII. MARSHALL TEST RESULTS AND DISCUSSIONS

Results of mix design and their discussion for the reference mixtures and fibre stabilized mixtures are given separately in this work

1. Marshall Test Results Of Mix Without And With Banana Fiber-Variation of Marshall Properties of bituminous concrete (BC) with varying percentage of bitumen without and with banana fiber is explained below. The results of the Marshall Test i.e. Marshall Stability and flow values and void parameters for the bituminous mixes without and with banana fiber are given in Table 2.

Table 2 Parameters of reference mix without and with banana fiber

	Bitumen content %	Stability, KN	Flow, mm	V_V %	VFB %
Without Banana fiber	4	7.57	2.2	4.97	65.31
	5.5	8.16	2.5	2.32	83.73
	6	6.9	3.7	2.09	86.13
	6.5	5.76	4.5	1.19	92.74
	7	4.77	5.4	1.02	94.11
With Banana fiber	4	8.14	2.68	5.04	68.42
	5.5	9.49	3.01	3.21	82.46
	6	7.27	4.19	2.24	89.68
	6.5	6.45	4.67	2.13	94.25
	7	5.49	5.75	1.14	95.36

2. Marshall Stability - It is observed that stability value increases with increase binder content up to certain binder content; then stability value decreases. This is due to with increase in bitumen content, the bond between the aggregate and the bitumen increases but with further increase, the strength between them decreases as the contact point between the aggregates become immobilize. Due to which mix become weak against plastic deformation. Simultaneously the stability Values also decreases. Variation of Marshall Stability value with different binder content it is evident that the presence of fibre in the SMA mixtures effectively improves the stability values, which will result in an improvement of mixture toughness. This result indicates that the mixture using fibre would result in higher performance than using the control mixture.

3. Flow Value - Flow is the deformation undergone by the specimen at the maximum load where failure occurs. The flow value increases with the increase in the bitumen content both the mixes with and without fibers .The increase is slow initially, but later the rate increases with the increase in the bitumen content. The flow value of mixes with fibers is more than that without fibers initially, This may be due to the reason that , at lower bitumen content the fibers fills up the voids effectively contributing to the homogeneity and thus providing the stability required to resist any deformation under load. But as the bitumen content increases the this homogeneity is lost , due to which the binder property dominates which makes the fibers to form lumps , reducing stability and increasing deformation under load.

VIII.CONCLUSIONS

Based on the results and discussion of experimental investigation carried out on mixes i.e. SMA and BC following conclusion are drawn.

- The SMA samples were prepared using varying bitumen content of 4%, 5.5%, 6%, 6.5%, and 7%. This was done to find out the effect of increasing bitumen content on the stability value. This plot also helps us to find the Optimum binder content for this mix. The plot indicates that the stability value increases initially with increase in bitumen content but then decreases gradually.

This can be attributed to the fact that with initial increase in bitumen content, the aggregate bitumen bond gradually gets stronger, but with further increase in the bitumen content, the applied load is transmitted as hydrostatic pressure, keeping the fraction across the contact points of aggregates immobilized. This makes the mix weak against plastic deformation and the stability falls. The same principle applies to mix with fibers, but this mix shows higher stability value at the same binder content than the mix without fibers. This can be attributed to the fact that , the fibers in the mixes act as stabilizers which not only fills up the voids in the sample but also reduces the drain down significantly, thus holding up the binder in the mix. The addition of fibers also provides homogeneity to the mix.

- The flow value increases with the increase in the bitumen content both the mixes with and without fibers. The increase is slow initially, but later the rate increases with the increase in the bitumen content. The flow value of mixes with fibers is more than that without fibers initially, This may be due to the reason that , at lower bitumen content the fibers fills up the voids effectively contributing to the homogeneity and thus providing the stability required to resist any deformation under load . But as the bitumen content increases the this homogeneity is lost , due to which the binder property dominates which makes the fibers to form lumps , reducing stability and increasing deformation under load.
- The Air Voids (VA) decreases with increase in the bitumen content because with increase in bitumen content it goes on filling the air voids progressively. The VA of mix with fiber is much less than that without fiber. This is because the fiber already filled up some portion of air voids (VA) which further decreases as the bitumen goes on filling the air voids with increase in bitumen content. At 6% binder the VA values for sample with fiber are quite more than that without fiber which may be due to improper mixing.
- The Voids Filled Bitumen (VFB) is expressed basically as a fraction of VMA. . The VFB of a mix generally increases with the increase in the bitumen content. Here in our result too, we can clearly observe that VFB increases since increase in bitumen content causes more and more bitumen to fill the voids present in the mix as well as that inside the aggregates causing the overall increase in the bitumen inside the voids or VFB.
- It may be noted that all fibre stabilized mixtures gave the maximum stability at 5.5 % fibre content. Comparing different fibre stabilized mixtures, it is evident that the mixtures with banana fibre have the highest stability (9.49 KN), indicating their higher resistance and better performance than mixtures with sisal fibre. The percentage increase in stability with respect to the control mixture is about 16.58 % for SMA with banana fibre and about 3.97 % for SMA with sisal fibre.

IX.FUTURE SCOPE

Many properties of SMA and BC mixes such as Marshall Properties, drain down characteristics, tensile strength characteristics have been studied in this investigation. Only 60/70 penetration grade bitumen and a modified natural fibre called sisal fibre have been tried in this investigation. However, some of the properties such as fatigue properties, moisture susceptibility characteristics, resistance to rutting and dynamic creep behaviour can further be investigated. Some other synthetic and natural fibres and other type of binder can also be tried in mixes and compared. Sisal fibre used in this study is a low cost material, therefore a cost-benefit analysis can be made to know its effect on cost of construction. Moreover, to ensure the success of this new material, experimental stretches may be constructed and periodic performances monitored.

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