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Review on Effect of Anti-Stripping Agent and Cement on Indirect Tensile Strength of Bituminous Concrete

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Abstract: ***Pavement engineers much concerned about the tensile properties of bituminous mix because of the problems associated with cracking. Hence tensile strength of bituminous concrete mix is important in pavement applications. The Indirect Tensile Strength (ITS) test is used to assess the tensile properties of the bituminous mix. Addition of cement or lime is known to impart Anti-Stripping properties to bituminous mixes. For adverse conditions however use of Anti-Stripping chemicals is desired. It is important to ensure that addition of such compound may not have adverse effect on other properties. Many researches were done on ITS individually; however, a combination has not been tried yet. In this proposal, an effort has been made to study the techniques of addition of Anti-Stripping and Cement material both individually and combined in suitable proportions on bituminous concrete.***
Keywords: Cement, ITS, Anti-Stripping Agent and Bituminous Concrete.

I. INTRODUCTION

"The resistance of bituminous mixtures to fatigue cracking is dependent upon its tensile properties, notably its tensile strength and extensibility characteristics. The layers in a flexible pavement structure are subjected to continuous flexing as a result of the traffic loads that they carry, resulting in tensile stresses and strains at the bottom of the bituminous layers of the pavement. The magnitude of the strain is dependent on the overall stiffness of the pavement. Indirect tensile strength test is an indicator of strength and adherence against fatigue, temperature cracking and rutting. Tensile strength is difficult to measure directly because of secondary stresses induced by gripping a specimen so that it may be pulled apart. Therefore, tensile stresses are typically measured indirectly by a splitting tensile test". In present days different types of fillers are used in bituminous mixes for enhancing the durability of roads. Average growth of the number of vehicles per annum has also been increasing over recent years affecting the performance of the pavement. Research activities are continuously carrying out in order to enhance the properties of bitumen to make advanced flexible pavements to meet the present challenges. Therefore, there is vast scope and need to improve the properties of bituminous pavement.

II. NEED AND SCOPE OF STUDY

Over past decade the road network has grown rapidly and the same trend shall be followed in near future. New road is to be constructed and existing roads need to be upgraded to meet the present requirement of transportation. A large number of defects appear during rainy season. Rock also deteriorates faster in areas with poor drainage particularly in urban areas. In order to minimize the drainage and also resulting expenditure, it is necessary to make the bituminous mixes more resistance to stripping. Many researchers are working on explanation use of Anti-Stripping Agent and filler materials and other materials. Some work is done on use of Anti-Stripping and Cement material; however, a combination has not been tried. This study is a little ahead of them in a way that here it is utilizing the Anti-Stripping Agent and Cement material in bituminous mixes. When there is addition of Anti-Stripping Agent and Cement material in bituminous mixes, it is likely to affect the performance of mix on other parameters.

III. OBJECTIVES

Following are the objectives of present study:

1) To determine the Optimum Binder Content of the control mix prepared for BC.
2) To study the effect of Addition of Anti-stripping Agent and Cement material in BC mix on Indirect Tensile Strength.

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3) To determine the changes in Optimum Binder Content on account of addition of Anti-Stripping Agent and Cement at various percentages.

IV. LITERATURE REVIEW

Here, relevant studies and research on indirect tensile strength in bituminous mix are reviewed.

John P.Z and Geetha Srinivasan (2004) "made evaluation of indirect tensile strength to identify asphalt concrete rutting potential. This prompted the National Cooperative Highway Research Program to sponsor projects for the development of a simple performance test for rutting potential of asphalt mixtures. Anderson et al [2003] found that rutting potential can be evaluated using the indirect tensile strength, compaction slope measured with the Superpave Gyratory compactor and voids in mineral aggregate. In this research the main factors included in the experiment were binder type, asphalt content, sand content, nominal maximum aggregate size, and gradation. Rutting potential was evaluated with the Asphalt Pavement Analyzer (APA). The parameters that were evaluated as independent variables include the IDT strength, volumetric parameters, compaction slope, and the compacted aggregate resistance. IDT was measured using the Marshall Stabilimeter with a split tensile head and with the samples at 60^0 C. The analysis of variance demonstrated significant effects of all the main factors and their interactions on rutting potential" [1].

Huang B., Shu X., & Tang Y. (2005**)** "did the comparative study of semi-circular bending and indirect tensile strength test for hot mix asphalt. The IDT test a standard test method of AASHTO and ASTM, which is adopted by most highway agencies. Two types of aggregate are used (lime stone and gravel) and two types of asphalt binder (PG64-22) and (PG76-22) were considered.

The permanent deformation under the loading strips is undesirable and in same case un bearable for the calculating of the cracking potential of asphalt mixes. Semi-circular bending test could significantly reduce the loading strip-induced permanent deformation and thus is more suitable indirect tensile test for calculating tensile properties of hot mix asphalt mixtures. The results from this study indicated that semi-circular bending and indirect tensile strength test were fully comparable and convertible" [2].

Anurag K., Xiao F. and Amirkhanian S.N. (2009) "did laboratory investigation of indirect tensile strength using roofing polyester waste fibers in hot mix asphalt. The use of these materials was proved to be economical, environmentally sound and effective in increasing the performance properties of the asphalt mixture in recent years.

The primary objective of this research was to determine whether homogeneously dispersed roofing waste polyester fibers improve the ITS and moisture susceptibility properties of asphalt concrete mixtures containing various lengths and percentages of the fiber in various aggregate sources. The results of the experiments found that, in general, the addition of the polyester fiber was beneficial in improving the wet tensile strength and TSR of the modified mixture, increasing the toughness value in both dry and wet conditions, and increasing the void content, the asphalt content, the unit weight, and the Marshall stability" [3].

Katman H.Y., Ibrahim M.R., Matori M.Y., Norhisham S. and Ismail N. (2013) "study the reclaimed asphalt pavement on indirect tensile strength test of foamed asphalt mix tested in dry condition. Indirect tensile strength (ITS) test was conducted to analyses strength of the foamed asphalt mixes incorporating reclaimed asphalt pavement. Preparation of sample was followed closely to Marshall procedure in accordance with ASTN D6926 and tested with ASTM D6926-07. Samples were tested for ITS after cured in the oven at 40oC for 72 hours. This testing condition known as dry condition or unconditioned. Laboratory results show that reclaimed asphalt pavement (RAP) contents insignificantly affect the ITS results. ITS results significantly affected by foamed bitumen contents "[4].

Peng Y, Wan L. & Sun L-J. (2017) "describe the three-dimensional discrete element modelling of influence factors of indirect tensile strength of asphalt mixtures properties which contain asphalt content and three asphalt mixtures AC13, AC16 and AC20 were used in this study. AC13, AC16 and AC20 had nominal maximum aggregate size of 13.2, 16 and 19 mm, respectively. Based on this model, the effect of aggregate gradation, asphalt content and loading velocity on IDT strength were numerically simulated. Result reveal that the IDT test at 20^0 C can be simulated.

The strength of asphalt mixtures is remarkable affected by the aggregate gradation, asphalt content and loading velocity. In these experimental measurements are not too large compared to typical variation due to a number of samples is not large enough and the experimental IDT strength is low" [5].

Gupta L. & Suresh G. 2018) "evaluating the indirect tensile strength of bituminous concrete mix by using stone dust and cement as filler materials.

Tensile strength of bituminous concrete mix is important in pavement applications. For the preparation of bituminous concrete mix specimens using stone dust and cement as filler materials, optimum bitumen content was determined by adopting Marshall technique of bituminous mix design. Bituminous mix properties were determined at optimum bitumen content.

Indirect tensile strength (ITS) and Tensile strength ratio (TSR) of bituminous concrete mix were evaluated by varying test temperatures at 15 °C, 20 °C, 25 °C, 30 °C and 35 °C. Marshall stability and optimum bitumen content as independent variable for each filler material. As the test temperature increases the ITS and TSR values of bituminous concrete mix decreases irrespective of type of filler material.

Based on the analysis of data, it was observed that at any test temperature, ITS and TSR values of bituminous concrete mix prepared using cement as filler material were higher when compared to bituminous concrete mix prepared using stone dust as filler material. It may be concluded that the behavior of bituminous concrete mix prepared using cement as filler material is superior in terms of mix properties, ITS and TSR" [6].

Islam M. R., Hossain M. I. & Tarefder R. A. (2015) "describe the comparison in laboratory and field aged sample to study the dynamic modulus, diametrical resilient and loss of ductility these parameters are most common to study aging by indirect tensile strength (ITS) test.

The air void of the sample before conditioning ranges from 5.1% to 5.9% with an average value of 5.4%. the design binder was a performance grade binder, which was used 4.4% by weight of the mixture.

The maximum size of the aggregate was 19mm. In this aged in the field and laboratory and then loaded diametrically to determine indirect tensile strength value and flow number.

Two types of sample compacted sample and loose mix sample performed indirect tensile strength of laboratory long term and field aged sample increase with aging period and indirect tensile strength of short-term oven aged loose sample is concave down with aging period. Sample prepared using a super pave gyratory compactor following the AAHTO T 312-07 test protocol. Overall, the flow number will be decreases as aging intensity increases, that is the brittleness increases with aging".[7].

Shunyashree, B. tejas, Archana M.R. and Amarnath M.S. (2013) "study of the effect of use of recycled materials on indirect tensile strength of asphalt concrete mixes.

For the laboratory investigations reclaimed asphalt pavement (RAP) from NH-4 and crumb rubber modified binder (CRMB-55) was used. Foundry waste was used as a replacement to conventional filler. Laboratory tests were conducted on asphalt concrete mixes with 30, 40, 50, and 60 percent replacement with RAP. These test results were compared with conventional mixes and asphalt concrete mixes with complete binder extracted RAP aggregates. Mix design was carried out by Marshall Method. The Marshall Tests indicated highest stability values for asphalt concrete (AC) mixes with 60 percent RAP. The optimum binder content (OBC) decreased with increased in RAP in AC mixes. The Indirect Tensile Strength for AC mixes with RAP also was found to be higher when compared to conventional AC mixes at 30^0 C" [8].

As per the study of (Breen and Stephens), "the split cylinder test is preferred to assess the tensile strength of bituminous concrete mix at temperatures from 0^0 to 40^0 F" [9].

Al-Sayed "has done comprehensive investigation on the use of filler material type and recommended the utilization of the crushed limestone (fines passing than 0.975 mm) that improves the characteristics of asphalt mixes and accordingly, reduces cracking and rutting of pavements" [10].

Zulkati et al. "represents that performance of asphalt concrete mix is affected by the involvement of filler material in three traditions i.e., Firstly the amount of asphalt content in a mix largely depends upon filler material, secondly workability during mixing and compaction, and lastly the resultant properties of asphalt-filler mastic contribute to the performance of mix" [11].

V. GAPS IN LITERATURES REVIEW

A. Changes are proposed in the current bituminous mix design for improvement in them to appreciate the performance of mixes.
B. The studies were on the basis of lab performance; no evaluation is done on the basis of field aspects.
C. No clear guidelines are existing regarding the usage of Anti-Stripping and Cement materials Bituminous mix in BC mix in any papers.
D. Various observation on ITS test which have been used in bituminous mix earlier but none or little work has been done on ITS in BC mix.

VI. PROPOSED WORK AND RESEARCH METHODOLOGY

In this study, sample of BC mix will be made by using anti-stripping agent and cement materials. The control mis properties shall be determined by Marshall Method. By Indirect Tensile Strength test the tensile strength of bituminous concrete mix shall be determined. Samples of bituminous concrete mixes shall be prepared with varying Anti-Stripping agent and Cement contents.

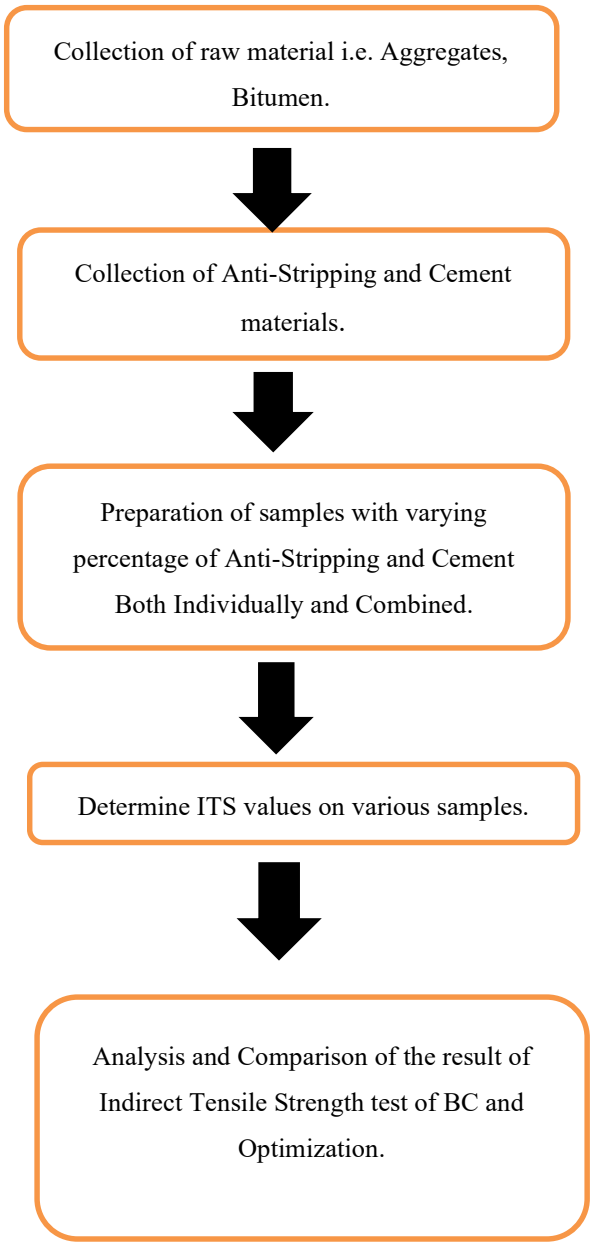
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The following combination are proposed for testing. Anti-Stripping Agent (0.50%, 0.75% and 1.0%) and Cement content (2%, 3% and 4%).

In order to finish the entire scope of study, equipment namely Indirect Tensile Strength machine is used as per ASTM D6931. For this test material (aggregate, binder, anti-stripping and filler) should be properly selected. specifications of BC for (grading 2) given by MORTH specification for road and bridge work, 5th revision.

For the selected gradation establishment of optimum binder content is done as per Marshall Method.

In this research proposal, the chronological order of method to perform the analysis is given:



VII. EXPECTED OUTCOMES

The expected outcomes of this study are as given below: -

1) Addition of Anti-stripping Agent increases the Indirect Tensile Strength value.

2) A higher dose of Anti-Stripping chemical may result is reduction of ITS values.

3) Addition of Anti-Stripping additive improve the Bulk Density of the Bituminous Concrete mix.

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VIII. CONCLUSIONS

Conclusions by studying various research papers are as follows:

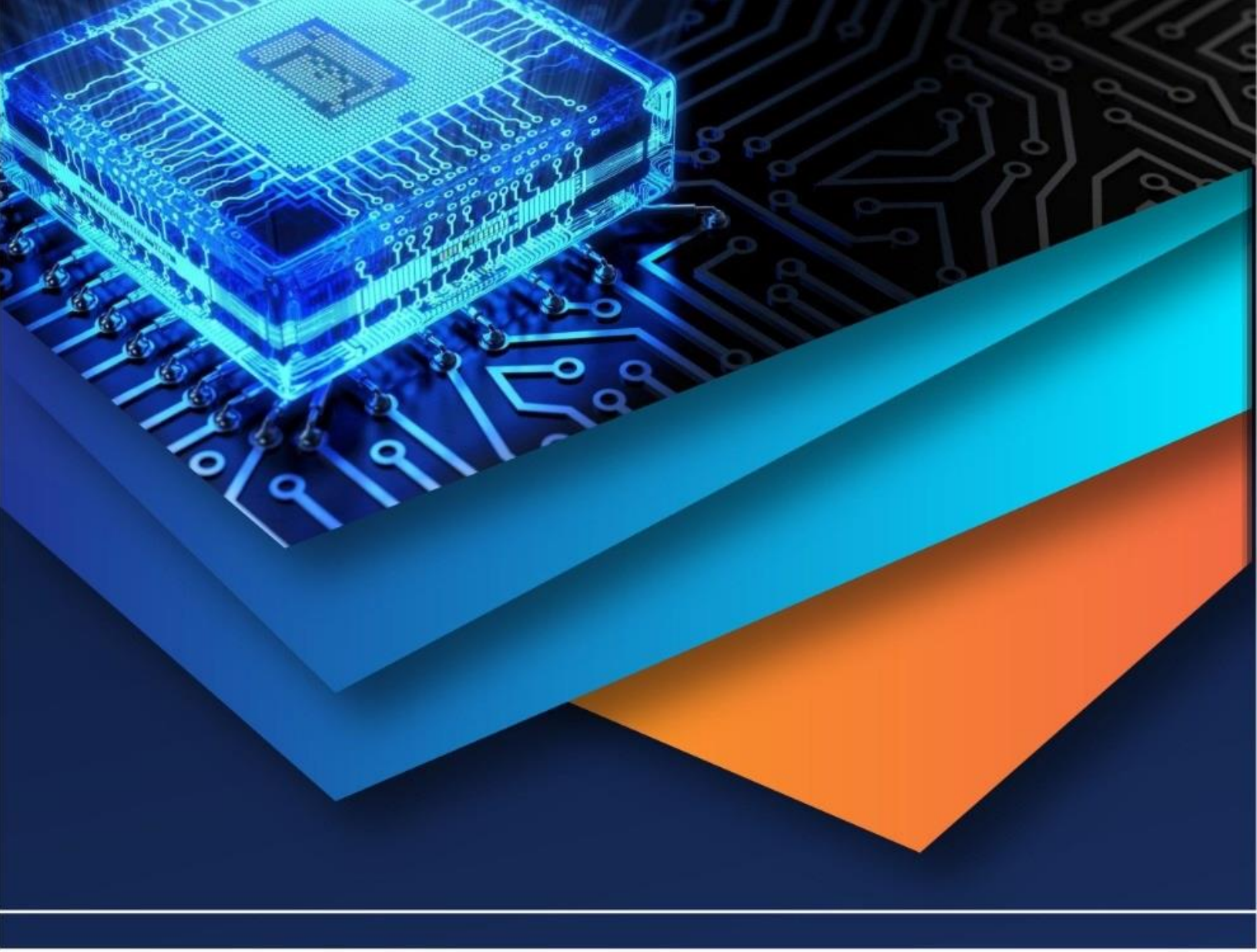
1) Use of stone dust and cement as filler materials to evaluate the effect on the tensile strength of bituminous concrete mix.
2) Tensile strength is compared with long term and short-term aging.
3) Polyester fiber addition improves the wet tensile strength and tensile strength ratio (TSR).
4) ITS value of viscoelastic material is highly influenced by the test temperature.
5) Also improves the level of performance and the service life of the road.
6) Cement has not only improved the properties of bitumen, but also improve the properties of mixes.

Thus, the use of Anti-Stripping Agent and Cement ultimately improve the quality and performance of flexible pavement.

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