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# Performance of Bituminous Mixed With Modified Binders

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## ABSTRACT

*Generally a bituminous mixture is a mixture of coarse aggregate, fine aggregate, filler and binder. A Hot Mix Asphalt is a bituminous mixture where all constituents are mixed, placed and compacted at high temperature. HMA can be Dense Graded mixes (DGM) known as Bituminous Concrete (BC) or gap graded known as Stone Matrix Asphalt (SMA). SMA requires stabilizing additives composed of cellulose fibbers, mineral fibers or polymers to prevent drain down of the mix.*

*In the present study, an attempt has been made to study the effects of use of a naturally and locally available fiber called SISAL fibre is used as stabilizer in SMA and as an additive in BC. For preparation of the mixes aggregate gradation has been taken as per MORTH specification, binder content has been varied regularly from 4% to 7% and fibre content varied from 0% to maximum 0.5% of total mix. As a part of preliminary study, fly ash has been found to result satisfactory Marshall Properties and hence has been used for mixes in subsequent works. Using Marshall Procedure Optimum Fiber Content (OFC) for both BC and SMA mixes was found to be 0.3%. Similarly Optimum Binder Content (OBC) for BC and SMA were found to be 5% and 5.2% respectively. Then the BC and SMA mixes prepared at OBC and OFC are subjected to different performance tests like Drain down test, Static Indirect Tensile Strength Test and Static Creep Test to evaluate the effects of fiber addition on mix performance. It is concluded that addition of sisal fibre improve the mix properties like Marshall Stability, Drain down characteristics and indirect tensile strength in case of both BC and SMA mixes. It is observed that SMA is better than BC in respect of indirect tensile strength and creep characteristics.*

*Key Words*: Bituminous Concrete (BC), Stone Matrix Asphalt (SMA), Sisal Fibre, Marshall Properties, Static Indirect Tensile Strength, Static Creep.

## INTRODUCTION

Construction of highway involves huge outlay of investment. A unique engineering design might also keep large funding as properly a dependable performance of the in-carrier highway can be carried out. Two things are of fundamental concerns in flexible pavement engineering–pavement design and the mix layout. The present take a look at is related to

the mixture design considerations.

A top layout of bituminous mix is expected to bring about a mixture which is satisfactorily (i) Strong (ii) durable (iii) resistive to fatigue and permanent deformation (iv) environment friendly (v) economical and so on. A mix designer tries to achieve those requirements through a number of tests on the mix with numerous proportions and finalizes with the pleasant one. The research work tries to identify some of the problems involved in this artwork of bituminous mix layout and the direction of modern-day research.

## EVOLUATION OF MIX DESIGN

As in line with Das et al.(2004); During 1900's, the bituminous paving technique turned into first used on rural roads – so as to deal with fast removal of fine particles in the shape of dust, from Water Bound Macadam, which was caused due to rapid growth of automobiles. At initial stage, heavy oils were used as dirt palliative. An eye estimation process, referred to as pat test was used to estimate the requisite quantity of the heavy oil in the mix. By this system, the aggregate became patted like a pancake shape, and pressed towards a brown paper. Depending on the extent of stain it made on the paper, the appropriateness of the quantity was adjudged. The first formal mix design approach changed into Hubbard field method, which was in the beginning evolved on sand-asphalt mixture. Mixes with huge aggregates couldn't be treated in Hubbard field approach.

## SELECTION OF BINDER

Different type of binder like convectional 60/70 or 80/100 penetration grade bitumen and many modified binder like Polymer Modified Bitumen (PMB), Crumb Rubber Modified Bitumen (CRMB), Natural Rubber Modified Bitumen (NRMB) is utilized by different researcher for his or her research work. Some researcher extensively utilized super pave performance grade binder like PG 76-22 with bituminous mixture like Bituminous Concrete (BC) and Stone Matrix Asphalt (SMA).

Here in this research a comparative observe is accomplished among BC and SMA with and without the use of fiber where 60/70 penetration grade bitumen is used as binder.

## REVIEW OF LITERATURE

Pavement includes a couple of layer of various material supported by means of a layer called sub grade. Generally pavement is two type flexible pavement and Rigid pavement. Flexible pavements are so named due to the fact the whole pavement structure deflects, or flexes, underneath loading. A flexible pavement structure is normally composed of numerous layers of material. Each layer receives the masses from the above layer, spreads them out then passes on these loads to the next layer underneath. Typical flexible pavement structure along with:

- Surface course. This is the pinnacle layer and the layer that comes in contact with traffic. It can be composed of one or numerous special HMA sub layers. HMA is a mixture of coarse and fine aggregates and asphalt binder
- Base course. This is the layer without delay below the HMA layer and typically consists of combination (both stabilized or un-stabilized).

- Sub-base course. This is the layer (or layers) beneath the base layer. A sub-base isn't always constantly wanted.

## EXPERIMENTAL INVESTIGATIONS

### Introduction

This chapter describes the experimental works achieved on this present investigation. This chapter is split into two components. First element offers with the experiments performed at the materials (aggregates, filler, bitumen, and fiber), 2nd component offers with the exams accomplished on bituminous mixes.

Preparation of Mixes

The mixes were prepared in keeping with the Marshall system specified in ASTM D1559. For BC and SMA the coarse aggregates, nice aggregates and filler were combined according to the adopted gradation as given in Table 3.1. And Table 3.2 respectively. First a comparative look at is done on BC through taking three specific form of filler i.e. Cement, fly ash, stone dust. Here Optimum Binder Content (OBC) become located by means of Marshall Test wherein binder content is very from 0 % to 7 %. Then Optimum Binder Content (OBC) and Optimum fiber Content (OFC) of each BC and SMA became located through Marshall Method where binder content material could be very from 0% to 7% and fiber content material is vary from 0.3 % to 0.5 %. The sisal fibers after being cut in to small pieces (15-20 mm) were delivered without delay to the aggregate sample in extraordinary proportions. The mineral aggregates with fibers and binders were heated separately to the prescribed blending temperature. The temperature of the mineral aggregates changed into maintained at a temperature 10°C higher than the temperature of the binder. Required quantity of binder became brought to the pre heated aggregate-

fiber mixture and thorough mixing was accomplished manually until the colour and consistency of the mixture regarded to be uniform. The blending time become maintained inside 2-5 minutes. The aggregate changed into then poured in to pre-heated Marshall Moulds and the samples were prepared using a compactive attempt of 75 blows on each aspect. The specimens have been saved in a single day for cooling to room temperature. Then the samples have been extracted and examined at 60°C consistent with the same old checking out technique.

Tests on Mixes

Presented below are the different tests conducted on the bituminous mixes with variations of binder type and quantity, and fiber concentration in the mix.

### Marshall Test

Marshall Mix design is a standard laboratory approach, that is followed international for determining and reporting the strength and flow charecteristics of bituminous paving mixes. In India, it is a totally popular technique of characterization of bituminous mixes. This test has additionally been used by many researchers to test bituminous mixes. This check approach is broadly conventional because of its simplicity and low of cost. Considering various blessings of the Marshall approach it was decided to

use this method to determine the Optimum Binder Content (OBC) of the mixes and additionally observe numerous Marshall Characteristics along with Marshall Stability, float price, unit weight, air voids and etc.

**Drain down test**

There are several techniques to evaluate the drain-down traits of bituminous mixes. The drain down approach counselled with the aid of MORTH (2001) turned into followed in this examine. The drainage baskets fabricated domestically in line with the specs given by MORTH (2001) is proven in Figure 3.3. The unfastened un-compacted mixes were then transferred to the drainage baskets and kept in a pre-heated oven maintained at 150 °C for three hours. Pre-weighed plates have been saved underneath the drainage baskets to gather the tired out binder drippings. From the drain down check the binder drainage has been calculated from the equation:-

Drain down equation is $d = \frac{W_2 - W_1}{1200 + X}$

Indirect Tensile Strength Test

Indirect tensile check is used to decide the indirect tensile strength (ITS) of bituminous mixes. In this test, a compressive load is implemented on a cylindrical specimen (Marshall Sample) alongside a vertical diametrical aircraft through two curved strips the radius of curvature of that's same as that of the specimen. A uniform tensile strain is advanced perpendicular to the route of carried out load and alongside the same vertical plane inflicting the specimen to fail by means of splitting. This test is likewise otherwise known as splitting take a look at. This take a look at can be achieved each below static and dynamic (repeated) situations. The static check provides data about the tensile energy, modulus of elasticity and Poisson's ratio of bituminous mixes.

**Static Indirect Tensile Test**

The load turned into carried out and the failure load became noted from the dial gauge of the proving ring. The tensile energy of the specimen become calculated by way of the use of the formulation given in ASTM D 6931 (2007) and referred to in Equation given underneath:-

$$ST = \frac{2000 \times P}{\pi \times t \times d}$$

Where

ST =Indirect Tensile Strength, K Pa

P = Maximum Load, N

t = Specimen top earlier than testing, mm

D = Specimen Diameter, mm

The test temperature was varied from 5°C to 40°C at an increment of 5°C In this test three Marshall samples had been tested at a specific temperature and the tensile power turned into suggested because the common of the 3 test effects.

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**Static Creep Test**

For Static Creep take a look at pattern were organized at their OBC and OFC. The test consists of two tiers. In first stage a vertical load of 6 KN is applied for 30 min. The deformation changed into registered throughout these 0, 10, 20, 30 min the use of a dial gauge graduated in devices of 0.002 mm and it became able to check in a maximum deflection of 5 mm. Secondly, the weight was removed and its deformation were registered all through next 10 min interval of time i.e. 40, 50, 60min. Here in the course of the check temperature is maintained 40°C. A graph has been plot among time-deformation which shown subsequent chapter.

ANALYSES OF TEST RESULTS AND DISCUSSIONS

In this chapter Result and Observation of check carried out in preceding chapter is presented, analyzed and discuss. This chapter is divided into 5 sections. First phase is offers with parameter used for analysis. Second section offers with calculation of Optimum binder Content (OBC) of BC in which cement, fly ash, stone dust is used as filler. Third phase deals with calculation of Optimum binder Content (OBC) and Optimum Fiber content material (OFC), Marshall Properties of BC without or with using fiber. Fourth segment offers with calculation of Optimum binder Content (OBC) and Optimum Fiber content material (OFC), Marshall Properties of SMA without or with the use of fiber. Fifth segment offers with end result of Drain down check and Static Indirect Tensile Stress and static Creep test.

**RESULTS**

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

| Property | Value |
|---|---|
| Marshall stability (KN at 60°C) | >9KN |
| Flow Value (mm) | 2-4 |
| Air Void (%) | 3-6 |
| VFB (%) | 65-75 |
| OBC (%) | 5-6 |

- As BC manufactured from from all of the 3 type filler fulfil above necessities we can use

them as filler.

- Although BC with cement as filler offers maximum stability, as it's far costly-priced we can also use fly ash and stone dust as filler cloth.
- Use of fly ash is beneficial in minimise commercial waste.

### MIX at their OBC and OFC

Different check like Drain down test, Indirect Tensile Strength (ITS), Static creep take a look at is achieved on MIX at their OBC, OFC and its conclusion is given beneath.

1. Drain down of SMA is extra than BC without fibre. At their OFC drain down of binder is decreases.
2. From Indirect Tensile Strength it is concluded that Tensile Strength of SMA is greater than BC.
3. From Static Creep Test it's far concluded that with the aid of addition of fibre to BC and SMA mixes deformation reduced. MORTH encouraged that permanent deformation should no longer be more than 0.5 mm. SMA sample with fibre shows deformation approximately 0.45 mm which is ideal.

## CONCLUSION

- Here two form of mix i.e. SMA and BC is prepared in which 60/70 penetration grade bitumen is used as binder.
- Also a evidently to be had fibre known as sisal fibre is used with various concentration (0 to 0.5%).
- OBC and OFC is located out through Marshall Method of mix design.
- Generally by adding 0.3% of fibre properties of Mix is stepped forward. From special take a look at like Drain down check, Indirect Tensile Strength and static creep take a look at it is concluded that SMA with the usage of sisal fibre offers superb result and may be utilized in flexible pavement.
- Many properties of SMA and BC mixes such as Marshall properties, drain down Charecteristics, tensile power traits had been studied in this research. Only 60/70 penetration grade bitumen and a modified natural fibre called sisal fibre were tried on this investigation.
- However, a number of the residences which includes fatigue properties, moisture susceptibility traits, resistance to rutting and dynamic creep behaviour can further be investigated.
- Some different synthetic and natural fibres and other kind of binder can also be attempted in mixes and compared.
- Sisal fibre used on this take a look at is a low price material, therefore a price-gain evaluation may be made to realize its impact on cost of construction.
- Moreover, to make sure the fulfilment of this new fabric, experimental stretches may be constructed and periodic performances monitored.