A STUDY ON USE OF WASTE POLYTHYLENE IN BITUMINOUS PAVEMENT MIXES

[1] AJIT KUMAR, [22]N MANOJ KUMAR

[1]PG SCHOLOR, [2]ASSISTANT PROFESSOR,
Department of CIVIL ENGINEERING,
GIET UNIVERSITY, GUNUPUR, INDIA

Abstract:

Bituminous mixes are most ordinarily used everywhere the planet in versatile pavement construction. It consists of asphalt or hydrocarbon (used as a binder) and mineral combination that are mixed along, ordered down in layers so compacted. below traditional circumstances, conventional hydrocarbon pavements if designed and dead properly perform quite satisfactorily however the performance of hydrocarbon mixes is incredibly poor below varied things. Today's mineral concrete pavements are expected to perform higher as they're experiencing increased volume of traffic, inflated hundreds and inflated variations in daily or seasonal temperature over what has been intimate within the past. additionally, the performance of bituminous pavements is found to be terribly poor in wetness iatrogenic things. Considering this a great deal of labor has been done on use of additives in hydrocarbon mixtures and still as on modification of hydrocarbon. analysis has indicated that the addition of polymers to asphalt binders helps to extend the surface cohesiveness of the bond between the combination and the binder which may enhance several properties of the asphalt pavements to assist meet these increased demands. However, the additive that's to be used for modification of combine or binder should satisfy each the strength needs still as economical aspects. Plastics are all over in today's mode and are growing quickly throughout significantly in a developing country like Bharat. As these are non-biodegradable there's a significant drawback posed to the society with reference to the management of those solid wastes. rarity polyethylene (LDPE) has been found to be a decent modifier of hydrocarbon. Even, the saved polyethylene originally fabricated from LDPE has been determined to switch hydrocarbon. within the gift study, a shot has been created to use saved polythene that has been obtained from plastic packets utilized in packaging of a really common whole of milk named OMFED, in dry form with the aggregates sort of a fibre in an exceedingly hydrocarbon combine. careful study on the results of these regionally waste polythene on engineering properties of hydrocarbon concrete (BC), iii Dense hydrocarbon macadam (DBM) and Stone mastic asphalt (SMA) mixes, has been created in this study. The present regionally on the market OMFED polythene used as stabilizer in SMA, BC and DBM mixes to fulfil this need of paving mixes. Optimum binder content (OBC) and optimum polythene content (OPC) are derived by victimization Marshall Procedure. The OBCs are found to be four-dimensional for SMA and four.5% for each BC and DBM by victimization stone dust as filler. By replacement some gradation of fine combination by coarse furnace

scum and ash as filler the OBCs are found to be five-hitter of hydrocarbon for SMA and four-dimensional of bitumen for each BC and DBM mixes. Similarly, OPC has been found to be a pair of by weight of mixes for SMA and DBM and one.5% for BC mixes wherever stone dirt has been used as filler. After replacement of some gradation of fine combination by scum and considering ash as filler the OPCs are found to be one.5% of polythene for every type of mixes. Then considering OBC and OPC, the SMA, BC, and DBM mixes are ready and totally different performance take a look as like Drain down test, Static indirect durability take a look at and Static Creep take a look at have been distributed to judge the results of polythene as Associate in Nursing stabilizer on combine properties. It is complete from gift investigation that addition of OMFED polythene to mixes improve the mix properties like Marshall Stability, Drain down characteristics and indirect tensile strength.

I. INTRODUCTION

General Bituminous binders square measure wide utilized by paving trade. generally, pavements square measure classified into a pair of teams, i.e. versatile and rigid pavement. Flexible Pavement Flexible pavements square measure those, that on the full have low flexural strength and square measure rather flexible in their structural action below masses. These varieties of pavement layers replicate the deformation of lower layers on-to the surface of the layer. Rigid Pavement If the surface course of a pavement is of Plain Cement Concrete then it's referred to as rigid pavement since the entire pavement structure can't bend or deflect because of traffic masses. Pavement style and therefore the combine style square measure 2 major concerns just in case of pavement engineering. this study is simply associated with the combo style of versatile pavement considerations. the look of asphalt paving mixtures could be a multi-step method of choosing binders associate degreed mixture materials and proportioning them to produce an acceptable compromise among many variables that have an effect on mixture behaviour, considering external factors like traffic loading and climate conditions.

II. OBJECTIVES OF BITUMINOUS MIX DESIGN: -

A comparative study has been created during this investigation between SMA, BC, and DBM mixes with variable binder contents (3.5% - 7%) and synthetic resin contents (0.5% - 2.5%). The objectives of this investigation square measure to watch the followings;

- Study of Marshall properties of mixes exploitation each
  1. Stone mud as filler and,
  2. dross as fine mixture and ash as filler.
- The result of synthetic resin as admixture on the strength of hydrocarbon combine with different filler and commutation some proportion of fine mixture by dross
- The performance of hydrocarbon combines underneath water with and while not synthetic resin admixture with completely different filler and commutation some proportion of fine mixture by slag.
- To study resistance to permanent deformation of mixes with and while not polyethylene.

 analysis of SMA, BC, and DBM mixes exploitation completely different take a look at like Drain down take a look at, Static Indirect lastingness take a look at, Static Creep take a look at etc.

Main objectives of hydrocarbon combine style square measure to find;

1. Optimum hydrocarbon content to confirm a sturdy pavement,
2. decent strength to resist shear deformation underneath traffic at higher temperature,
3. correct quantity of air voids within the compacted hydrocarbon to permit for added compaction done by traffic,
4. decent workability, and
5. decent flexibility to avoid cracking thanks to continual traffic load.

III. REVIEW OF LITERATURE: -

Awwad and Shbeeb (2007) indicated that the changed mixture encompasses a higher stability and VMA share compared to the non-modified mixtures and so completely influence the rutting resistance of those mixtures. in line with them modifying asphalt mixture with HDPE polythene enhances its properties way more than the improvements completed by utilizing LDPE polythene.

Khan and Gundaliya (2012) declared that the method of modification of bitumen with waste polyethylene enhances resistance to cracking, hollow formation and rutting by increasing softening purpose, hardness and reducing baring because of water, thereby improving the overall performance of roads over a protracted amount of your time. in line with them the waste polyethylene used within the combine forms coating over aggregates of the mixture that reduces consistency, absorption of wetness and improves binding Property.

Prusty (2012) studied the behaviour of B.C. mixes changed with waste polyethylene. He used numerous percentages of polyethylene for preparation of mixes with a specific aggregate grading as given within the IRC Code. Marshall Properties like stability, flow value, unit weight, air voids square measure accustomed verify optimum polyethylene content for the given grade of hydrocarbon (80/100) in his study. Considering these factors he observed that a lot of stable and sturdy combine for the pavements are often obtained by polymer modifications.

Verma (2008) studied that plastic will increase the temperature of the hydrocarbon and makes the road versatile throughout winters leading to its long life. in line with author while a standard “highway quality” road lasts four to 5 years, plastic-bitumen roads can last up to ten years and it might be a boon for India’s hot and very wet climate, wherever temperatures oft cross 50°C and torrential rains produce disturbance, leaving most of the roads with huge potholes.

Jain et al. (2011) studied mitigation of rutting in hydrocarbon roads by use of waste polymeric packaging materials and terminated that rutting of hydrocarbon combine are often reduced to three.6 millimeter from a worth of sixteen.2 millimeter once application of two0,000 cycles, by adding optimum amount of polythene in hydrocarbon combine for building, ultimately improves pavement performance, besides assuaging disposal issues of

WPPM for clean and safe surroundings. Aslam and Rahman (2009) studied each dry and wet combine and terminated that the dry process is a lot of economical and useful for construction of versatile pavements. Because just in case of upper share of polyethylene in wet method they get separate from hydrocarbon on cooling, thus it desires some additives. The Indian Roads Congress Specifications Special Publication: fifty-three (2002) indicate that the period of next renewal could also be extended by five hundredth just in case of egress with modified hydrocarbon as compared to unmodified bituminous. Casey et al. (2008) studied the event of a recycled compound changed binder for use in stone mastic asphalt. From their study it had been found that the addition of four-dimensional recycled HDPE into a pen grade binder made the foremost promising results, and results obtained from wheel track and fatigue tests show that though the binder will not deliver equivalent performance means that does not perform to a similarly high levels as a proprietary compound changed binder, it will out-perform ancient binders employed in stone mastic asphalt.

IV. CHARACTERISTICS OF MATERIAL USED IN BITUMINOUS MIX: -

Constituents of a mixture Bituminous combine consists of a combination of aggregates unceasingly hierarchical from most size, typically but twenty-five millimeter, through the fine filler that's smaller than zero.075mm. Sufficient bitumen is additional to {the combine|the combination|the combo} in order that the compacted mix is effectively impervious and can have acceptable dissipative and elastic properties. The bituminous mix design aims to determine the proportion of bitumen, filler, fine aggregates, and coarse aggregates to supply a mix that is possible, strong, sturdy and economical.

The basic materials used ar as follows:

- Aggregates
- Fly Ash
- Slag
- Bituminous Binder
- Polythene

Aggregates

There are numerous forms of mineral aggregates accustomed manufacture bituminous mixes may be obtained from completely different natural sources like glacial deposits or mines and might be used with or while not more process. The aggregates may be more processed and finished to achieve good performance characteristics. Industrial by-products like steel slag, blast furnace slag, ash etc. generally employed by substituting natural aggregates to reinforce the performance characteristics of the combo. mixture contributes up to 90-95 you look after the mixture weight and contributes to most of the load bearing & strength characteristics of the mixture.

Coarse aggregates

The aggregates maintained on four.75 millimeter sieve are known as as coarse aggregates. Coarse mixture should be screened stone, angular in form, free from dirt particles, clay, vegetations and organic matters which supply compressive and shear strength and shows

smart interlocking properties. In gift study, stone chips ar used as coarse mixture with relative density

Fine aggregates

Fine mixture ought to be clean screened quarry dusts and will be free from clay, loam, vegetation or organic matter. Fine aggregates, consisting of stone device dusts were collected from an area device with fractions passing four.75 millimeter and maintained on zero.075 mm IS sieve. It fills the voids within the coarse mixture and stiffens the binder. during this study, fine stones and scoria ar used as fine mixture whose relative density has been found to be 2.6 and 2.45.

Filler

Aggregate passing through zero.075 millimeter IS sieve is termed as filler. It fills the voids, stiffens the binder and offers porosity. during this study, stone and ash are used as filler whose specific gravity has been found to be 2.7 and 2.3.

Fly Ash

At present, as per the report of the ash utilisation Programme (FAUP), out of the large quantity of ash created, solely concerning thirty fifth finds its use in industrial applications like mass concrete, asphalt paving filler, light-weight mixture, stabilizer to road bases, raw material for concrete, additives to soil, construction of bricks etc. the rest ash may be a waste requiring massive disposal space, inflicting a large capital loss to power plants and simultaneously inflicting AN ecological imbalance and connected environmental issues (Dhir, 2005). during this investigation ash is employed joined kind of filler.

Coarse furnace slag

Granulated blast furnace slag (GBFS) may be a by-product obtained within the manufacture of pig iron in the furnace and is made by the mix of ore with rock flux. If the molten scoria is cooled and coagulated by fast water extinguishing to a glassy state, it results granulated furnace slag of sand size fragments, typically with some friable clinker- like material. The organic structure and gradation of coarse slag rely on the presence of chemicals like lime, alumina, oxide and mineral, whose percentages might vary depending on the character of ore, the composition of rock flux and therefore the reasonably iron being created. In gift study coarse furnace scoria is employed as fine aggregates by replacing some gradation of natural aggregates.

Bituminous Binder

Bitumen acts as a binding agent to the aggregates, fines and stabilizers in bituminous mixtures. bitumen should be treated as a visco-elastic material because it exhibits each viscous as well as elastic properties at the traditional pavement temperature. At cold it behaves like an elastic material and at high temperatures its behaviour is sort of a viscous fluid. Asphalt binder VG30 is employed during this analysis work. Grade of bitumen employed in the pavements ought to be elect on the idea of atmospheric condition and their performance in past. It fills the voids, cause particle adhesion and offers solidness.

Polythene

Stabilizing additives ar employed in the mixture to produce higher binding property. Now-a days polypropylene, polyester, mineral and polyose ar usually used as fibers. during this gift study polythene is employed as stabilising additive to boost performance characteristics of pavement.

V. EXPERIMENTAL INVESTIGATIONS

Effect of polyethylene concentration on Marshall properties of SMA, BC and DBM mixes with stone dust as filler. Here result in variation of Marshall properties with different binder content where polyethylene content is taken as 0%, 0.5%, 1%, 1.5%, 2% and 2.5% for SMA and DBM and 0%, 0.5%, 1%, 1.5%, 2% for BC are explained below.

Marshall stability

It is observed from graphs that with increase in bitumen concentration the Marshall stability value increases up to certain bitumen content and there after it decreases. That particular bitumen content is called as optimum binder content (OBC). In present study OBC for conventional SMA, BC, and DBM mixes are found as 6%, 4.5%, and 4.5% and similarly OBC are found as 4% for modified SMA, BC and DBM mixes with polyethylene at different concentration. From the graphs it can be observed that with addition of polyethylene stability value also increases up to certain limits and further addition decreases the stability. This may be due to excess amount of polyethylene which is not able to mix in asphalt properly. That polyethylene concentration in mix is called optimum polyethylene content (OPC) which is found as 2% for SMA and DBM and 1.5% for BC mixes.

Retained stability

Retained stability is calculated for SMA, BC, and DBM mixes for both of with polyethylene and without polyethylene. It is observed that the addition of polyethylene to the mixture the retained stability value increases. It is analyzed that the BC with polyethylene results in 53 highest retained stability followed by DBM with polyethylene and then SMA with polyethylene.

Drain down test

Drain down test is carried out for both SMA and BC for both of following cases;

(a) Stone dust with and without polyethylene and66

(b) Fly ash and slag with and without polyethylene.

From test results it is observer that the drain down effect is not significant for un-compacted conventional mix samples. There is no drain down for both cases further with addition of polyethylene to the mixes at their OPC and OBC.

Air Void

It is observed that with increase in binder content air void decreases. But with addition of polyethylene to mix with fly ash and slag the air void increases than that of both conventional mixes and mixes with fly ash and slag.

Void filled with bitumen (VFB)

It is observed that VFB values of different mixes increase at sharp rate with increase in bitumen concentration. From these graphs it is observed that with addition of polyethylene to mixes with fly ash and slag the VFB increases than that of both conventional mixes and mix with fly ash and slag without polyethylene

VI. ANALYSIS OF TESTS

Effect of synthetic resin concentration on Marshall properties of SMA, BC and DBM mixes with stone dirt as filler. Here polyethylene variation of Marshall properties with completely different binder content wherever polyethylene content is taken as 1/3, 0.5%, 1%, 1.5%, 2% and 2.5% for SMA and DBM and 0%, 0.5%, 1%, 1.5%, 2 for BC are explained below.

5.3.1 Marshall stability

It is determined from graphs that with increase in bitumen concentration the Marshall stability value will increase up to bound bitumen content and there when it decreases. that individual bitumen content is termed as optimum binder content (OBC). In gift study OBC for conventional SMA, BC, and DBM mixes square measure found as 6 June 1944, 4.5%, and 4.5% and equally OBC are found as four-dimensional for changed SMA, BC and DBM mixes with polyethylene at completely different concentration. From the graphs it may be determined that with addition of synthetic resin stability value also will increase up to bound limits and additional addition decreases the soundness. This may be due to excess quantity of synthetic resin that isn't ready to combine in asphalt properly. That polyethylene concentration in combine is termed optimum polyethylene content (OPC) that is found as two for SMA and DBM and one.5% for BC mixes.

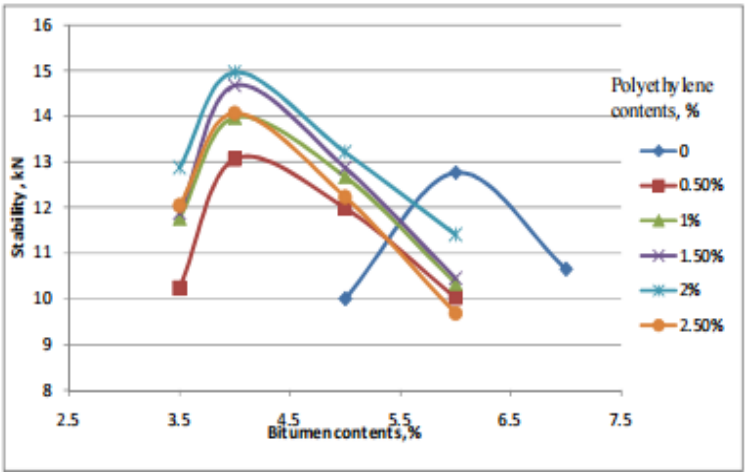

Table 5.1 Optimum binder contents

Types of mix	Optimum polyethylene content (%)	Optimum binder content (%)
SMA without polyethylene	0%	6%
SMA with polyethylene	2%	4%
DBM without polyethylene	0%	4.5%
DBM with polyethylene	2%	4%
BC without polyethylene	0%	4.5%
BC with polyethylene	1.5%	4%

Retained stability

Retained stability is calculated for SMA, BC, and DBM mixes for each of with synthetic resin and while not polyethylene. it's determined that the addition of polyethylene to the mixture the retained stability worth will increase. it's analyzed that the BC with polyethylene ends up in fifty-three highest maintained stability followed by DBM with synthetic resin so SMA with polyethylene.

TABLE-5.8 RETAINED STABILITY OF SMA, BC, AND DBM WITH AND WITHOUT POLYETHYLENE WITH FLY ASH AND SLAG

Types of mix with fly ash and slag	Avg. stability after half an hour in water at 60 °c	Avg. stability after 24 hours in water at 60 °c	Avg. retained Stability, in %	Design requirement
SMA without polyethylene	13.94	10.87	74.98	Minimum 75% (as per MORTH Table 500-17)
SMA with polyethylene	16.24	13.28	80.8	
DBM without polyethylene	12.98	10.31	77.48	
DBM with polyethylene	18	14.72	81.78	
BC without polyethylene	14.23	11.51	75.9	
BC with polyethylene	18	14.48	84.45	

Drain down check

Drain down check is disbursed for each SMA and BC for each of following cases;

(a) Stone dirt with and while not synthetic resin and66

(b) ash and dross with and while not synthetic resin.

From check results it's observer that the drain down result isn't important for un-compacted conventional combine samples. there's no drain down for each case additional with addition of polyethylene to the mixes at their OPC and OBC.

Table 5.9 Drain down of mixes without polyethylene

Mixes with stone dust	Drain down value (%)
SMA	1.8
BC	1.2
Mixes with fly ash and slag	**Drain down value (%)**
SMA	1
BC	0.8

Table 5.10 Drain down of mixes with polyethylene

Mixes with stone dust	Drain down value (%)
SMA	0
BC	0
Mixes with fly ash and slag	**Drain down value (%)**
SMA	0
BC	0

Air Void

It is determined that with increase in binder content air void decreases. However, with addition of polyethylene to combine with ash and dross the air void will increase than that of each typical mixes and mixes with ash and dross.

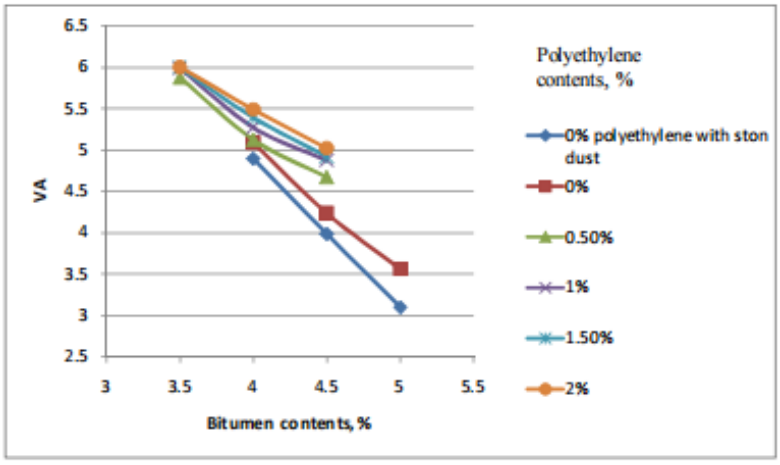

Fig. 5.30 Variations of VA values of BC with different binder and polyethylene contents

Void full of bitumen (VFB)

It is determined that VFB values of various mixes increase at sharp rate with increase in bitumen concentration. From these graphs it's determined that with addition of synthetic resin to mixes with ash and dross the VFB will increase than that of each typical mixes and blend with ash and dross while not synthetic resin.

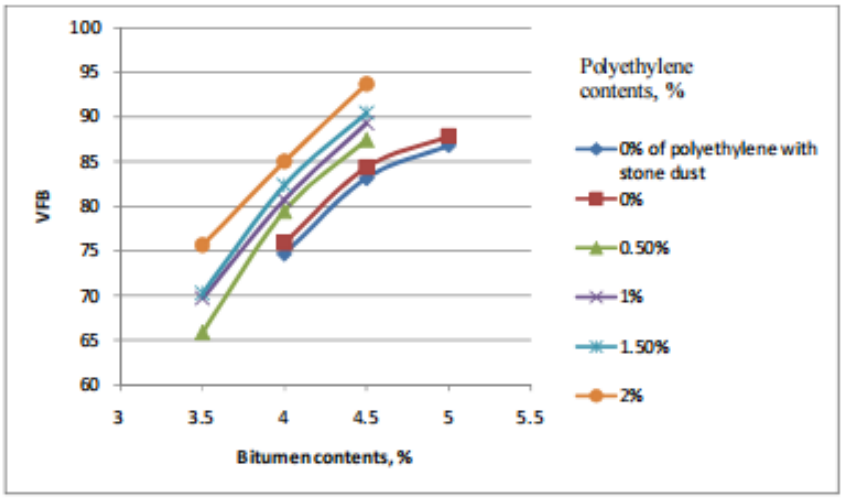

Fig. 5.36 Variations of VFB values of BC with different binder and polyethylene content

VII. CONCLUSION

In this study, 3 forms of mixes i.e. SMA, DBM and before Christ are ready with VG30 grade bitumen used as a binder. The impact of addition of waste polyethylene in kind of regionally available artificial milk with whole OMFED packets within the bituminous mixes has been studied by varied concentrations of synthetic resin from third to a pair of.5% at AN increment of zero.5%. using Marshall methodology of combine style the optimum bitumen content (OBC) and optimum polyethylene content (OPC) are determined for various forms of mixes. It has been ascertained that addition of twenty-two synthetic resin for SMA and DBM mixes and one.5% polyethylene for before Christ mixes ends up in optimum Marshall Properties wherever stone dirt is used as filler. however once tiny fraction of fine aggregates is replaced by coarse blast furnace slag and filler is replaced by ash, optimum Marshall Properties for every type of mixes result with only one.5% synthetic resin addition. The OBCs just in case of changed SMA, BC and DBM mixes by victimization stone dirt as filler are found four-dimensional and OBCs just in case of modified (i) SMA, and (ii) BC, and DBM by victimization ash and slag are found to be five-hitter and four-dimensional severally victimization identical Marshall specimens ready at their OPCs and OBCs by victimization each (i) stone dirt as filler and (ii) substitution of stone dirt by ash and fine mixture by scoria, for check underneath traditional and wet conditions it's ascertained that the maintained stability will increase with addition of synthetic resin within the mixes, and BC with synthetic resin ends up in highest retained stability followed by DBM with synthetic resin then SMA with synthetic resin.

Addition of synthetic resin reduces the drain down impact, though these values don't seem to be that significant. it should be noted that the drain down of SMA is slightly quite BC while not polyethylene. However, for all mixes ready at their OPC there's no drain down.

Normally, it's ascertained that the Indirect strength (ITS) price decreases with increase in temperature and for a selected binder, once synthetic resin gets additional to the mixes the worth more will increase in each case. The BC mixes with synthetic resin lead to highest indirect strength values compared to SMA, followed by DBM.

It's observed that by addition of polyethylene to the mixture, the resistance to moisture susceptibility of combine additionally will increase. BC with synthetic resin ends up in highest tensile strength quantitative relation followed by DBM mixes with synthetic resin and SMA mixes with polyethylene for each case. It's observed from the static creep check that deformation of combine typically decreases by addition of synthetic resin in the least check temperatures used. The BC mixes with synthetic resin result minimum deformation compared to others. From the on top of observations it's over that use of waste synthetic resin in kind of packets used in milk packaging regionally ends up in improved engineering properties of bituminous mixes. Hence, this investigation explores not solely in utilizing most beneficially, the waste non-degradable plastics, however additionally provides a chance in leading to improved pavement material in surface courses so creating it additional sturdy.

FUTURE SCOPE:

Many properties of SMA and B.C. mixes like Marshall properties, drain down characteristics, lastingness characteristics are studied during this investigation. solely 60/70 penetration grade hydrocarbon and a changed fibre referred to as sisal fibre are tried during this investigation. However, a number of the properties like fatigue properties, wet condition characteristics, resistance to rutting and dynamic creep behaviour will more be investigated. different|another} artificial and natural fibres and other kind of binder may also be tried in mixes and compared. Sisal fibre employed in this study may be a low-price material, thus a analysis will be created to understand its impact on price of construction. Moreover, to confirm the success of this new material, experimental stretches is also created and periodic performances monitored.