Study of performance of bituminous concrete with addition of coir/coconut fiber

Submitted in partial fulfillment of the requirements

Of the degree of

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By

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DECLARATION

I, Ramit Thakur (11502852) hereby declare that this thesis report entitled **"Study of performance of bituminous concrete with addition of coir/coconut fibers "**submitted in the partial fulfillment of the requirements for the award of degree of Master of Civil Engineering, in the School of Civil Engineering, Lovely Professional University, Phagwara, is my own work. This matter embodied in this report has not been submitted in part or full to any other university or institute for the award of any degree.

Date: **Ramit Thakur**

Place:

CERTIFICATE

Certified that this project report entitled "**Study of performance of bituminous concrete with addition of coir/coconut fibers**" submitted individually by student of School of Civil Engineering, Lovely Professional University, Phagwara, carried out the work under my supervision for the Award of Degree. This report has not been submitted to any other university or institution for the award of any degree.

Signature of Supervisor

Mr. Jaspreet Singh

Assistant Professor

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ABSTRACT

Bituminous concrete is the one of the most important material during the construction of the pavement. The main component of the bituminous concrete is the binding material. Instead of the place of the cement bitumen is used as the binding material. Very less research is carried out to find the performance of bituminous concrete with the addition of the coconut or coir fiber. In recent year research has been carried out on the bituminous concrete with the addition of fiber to known the change its properties strength value. Some percentage of fiber is added to bituminous mix and then tests carried out on the specimen to know the strength of the bituminous concrete. Here I am not replacing anything but I am adding some percentage of fiber in bituminous mix and I am using the coir or coconut fiber.

In my research work I am not replacing anything but I am going to add some percentage of fiber in bituminous concrete. From the precious research papers it was found the coconut fibers gives good strength to the bituminous concrete and increase its properties value. So here I am interesting to find out the optimum bitumen content value and optimum fiber content value which gives he max. Stability, max. Unit weight, max. Flow value and max indirect tensile strength. Coconut fiber is the waste material which is obtains from the outer most part of the coconut.

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LIST OF ABBREVIATIONS

%	Percentage
Mm	Millimetre
Cm	Centimetre
M	Metre
L	Length
Sec	Second
D	Diameter
KN	Kilo newton
Kg	Kilograms
OBC	Optimum Bitumen Content
OFC	Optimum Fibre Content
VFB	Voids Filled With Bitumen
VMA	Voids in Mineral Aggregates

CHAPTER 1

INTRODUCTION

1.1 Stone Aggregates:-

Aggregates are the one of the most important part of any structure but in pavement it is the major portion of the structure. Aggregates must have to resist the stress which occurring due to the wheel load and aggregate must have to resist the or bear the abrasive action which occurs due to the movement of traffic. Aggregates mainly used in the construction of pavement as cement concrete, bituminous concrete and as well as it is used in the base course under the top layer of the pavement.

Many of the road aggregates are created from the natural rock. Gravels are the small round stones which have different size and they have generally obtained from the river bed. Sand is the fine aggregates which are obtain by the weathering action on the natural rock. Properties of the aggregates depend upon the properties of the rock and the properties of the rock depend upon the properties of the constituent material and bond which are form between the particles of rock.

Types of natural rock:-

Natural rock is classified on the basis of their origin. There is three type of natural rock on the basis of their origin.

- Igneous Rock
- Sedimentary Rock
- Metamorphic Rock

Most important factor of the rock is the texture of the rock which affects the properties of the rock.

The specification of the aggregates is done on the basis of their texture, shape, gradation and their grain size. Aggregates size is obtain by the sieving and the sieves have square size and arranged in the manner of decreasing size. The size of the aggregates which have required must fulfill the desired gradation. Indian agencies which specified the grading for different type of road making is I.R.C (Indian road congress).

On the basis of strength property the aggregates are classified into two categories

- Hard aggregates
- Soft aggregates

Hard aggregates are used on the top most or superior layer of the pavement to resist the load Which comes from the traffic wheels and also resist the adverse weathering condition but in

case of low cost road the lower layer of the pavement can be constructed by soft aggregates. Examples of soft aggregates are kankar, moorum, brick aggregates and slag.

Desirable properties of stone aggregates:-

- Strength: - Aggregates which are used for the road construction must be strong enough to resist the load which comes from the traffic wheels. Aggregates which are used in the upper most layers should have sufficient strength to resist the crushing.
- Hardness: - Aggregates which are used in the surface layer they are subjected to constant rubbing or abrasion due to the moving traffic. Aggregates which are used in that layer must be strong or hard enough to resist that type of abrasive action of traffic.
- Toughness: - aggregates which are used in the construction of pavement they are also subjected to the impact load due to the moving wheels. Most common impact is hammering which occur due to the heavy loaded steel tiered vehicle. This is also a desirable property of aggregates.
- Durability: - this is also being a most important property of the aggregates. In this property aggregates must resist the adverse weathering condition. This is also called the soundness of the aggregates.
- Shape of the aggregates: - this is also a most common property of the aggregates. There are basically four types of shapes flaky, elongated, round and angular. Flaky and elongated aggregates have less strength so the type of aggregates is avoid to construction of the pavement.
- Adhesion with bitumen: - Aggregates which are used in the bituminous pavement must have less affinity with water when they are compared with bituminous material.

1.2 Bituminous Material:-

In the construction of pavement bituminous binders are used and they include both bitumen as well as tar. Bitumen is basically a petroleum product which is obtained by the destructive distillation of petroleum crude. On the other hand road tar is also obtained by the destructive distillation but the material is different. In road tar it is obtain by the destructive distillation of wood or coal. Both bitumen as well as tar both has similar appearance. Both have black in color but have different characteristics. Both materials can be used for the construction of pavement.

Bitumen is hydrocarbon material and the form in which bitumen is found is solid, semisolid, gaseous, and liquid. It is completely soluble in carbon tetra chloride and carbon di sulphide. Bitumen is basically a very complex material and occurs artificially and also occurs naturally.

Very common material which is used in the construction of pavements is bitumen because it has water proofing property as well as binding property.

Some inert material or minerals when present in the bitumen then it is called asphalt. Natural asphalt or rock asphalt are the form of asphalt.

Paving grades are basically the grade of bitumen which is used for the construction of pavement and construction of airfield. Industrial grade are those grades in which bitumen is used for water proofing structure and also industrial floor.

Bitumen classified into two categories:-

- A type:- paving bitumen from Assam petroleum
- S type:- paving bitumen from other source

Types of bituminous material

Bituminous materials may be divided into two categories:-

- Bitumen
- Tar

Bitumen can be divided into few more categories like petroleum asphalt and native asphalt. Native asphalt is available in various different forms. When the asphalt is present in pure state or nearly pure state then it is called native asphalt. When the native asphalt have large portion of minerals then it is called the rock asphalt. Sometimes the viscosity of the bitumen is reduced then this type of bitumen is called cutback.

1.3 Bitumen:-

From different places crude petroleum is obtain and has different composition. The portion which is present in the petroleum may differ from the bituminous material and it is depend on the source. In the crude petroleum there is some potion of water as well as some portion of crude oil that is why the crude petroleum is firstly dehydrated and then carrying out the distillation. There are basically two types of distillation.

- Fractional distillation
- Destructive distillation

In the fractional distillation the temperature is very high but no chemical changes. Due to high temperature various volatile constituent has separated. The residue obtain in this process is petroleum bitumen. But in case of destructive distillation there is extreme heat and pressure due to this chemical changes occur. This type of process is used for the production of tar.

Requirements of bitumen:-

- Mixing:- viscosity of the bitumen must be adequate at the time of mixing and compaction

- Mix have desirable stability:- due to this property bitumen can be used in the hottest as well as coldest region
- Maintain the stability under adverse weather condition:- in this property bitumen cannot lose its stability under poor weather condition
- Mix must have sufficient flexibility so the cracks are reduced
- Sufficient adhesion property: - due to the effect of water bitumen should not separate from the aggregates.

1.4 Bituminous Concrete:-

The bituminous concrete is the concrete in which the bitumen is used as the binding material. This type of concrete is mainly used in the road construction. In road construction there is two type of pavement.

- Flexible pavement
- Rigid pavement

In rigid pavement cement is used as the binding material but in case of flexible pavement bitumen is used as binding material. In flexible pavement there are four layers.

- Sub grade
- Sub base course
- Base course
- Surface course

In the surface layer of rigid pavement bituminous concrete is used. The bituminous concrete is strong enough to wear the load of the vehicles. Life of the flexible pavement is 5 to 10 year approximately.

1.5 Coir Fiber :-

Extracted part from the outer shell of a coconut is Coconut fiber. Coir, Cocoasnucifera and Arecaceae (Palm), respectively are the family name of the coconut fiber.

There are basically two types of coconut fiber.

- Brown fibers: - This type of fiber is strong, thick and has high abrasion resistance.
- White fibers: -This type of fiber is finer and smoother, but they are very weak in strength.

There are basically three forms of coconut fiber.

- bristle (long fibers)
- mattress (short fiber)
- Decorticated (mixed fibers).

These different types of fibers have different uses depending upon the requirement. In engineering, brown fibers are mostly used.

These fibers are basically a waste product or materials which are the reason of pollution. So they are using in the civil engineering to reduce the quantity and effect on nature.

Advantages of coconut fibers:-

- They are moth-proof
- Resistant to fungi and rot
- Provide excellent insulation against temperature and sound
- Not easily combustible
- Flame-retardant
- Unaffected by moisture and dampness
- Tough and durable
- Resilient
- Springs back to shape even after constant use
- Totally static free and easy to clean.

The monocarp tissue or husk of the coconut fruit are the tissue from the natural coconut fiber is derived. Due to its golden color it is also called the golden fiber. The individual coconut fiber cells are narrow and hollow, with thick walls made up of cellulose.

Due to the more % of lignin than cellulose Brown coir fibers are stronger, but flexibility is very less. Coconut fibers are made up of small threads, each less than 1.3 mm long and 10 to 20 micrometers in diameter.

This fiber is relatively water proof and is the only natural fiber resistant to damage by salt water.

Physical properties of coconut/Coir fiber:-

Table no. 1.5.1 Physical Properties (Majid Ali 2010)

Property	Value
Ultimate length	0.6 mm
Diameter/Width	16 micron
Density	1.6 gm./cc
Breaking Elongation	30%
Air Filled porosity	Up to 70%
Ph.	5.8-6.4
Swelling in Water	5% in Diameter
Water holding capacity	Up to 30%

Basic composition of Coconut fibers:-

- Cellulose,
- hemi-cellulose
- lignin

Due to These compositions different properties of coconut fibers are affected. To change the composition and properties of the fiber pretreatment is given to the fibers. Some-times it improves the behavior of fibers but sometimes its effect is not favorable.

Chemical properties:-

Table: 1.5.2 Chemical Properties (Majid Ali 2010)

Properties	Value
Water soluble	5.25%
Pectin and related compounds	3.30%
Hemi – Cellulose	0.25%
Cellulose	43.44%
Lignin	45.84%
Ash	2.22%

APPLICATIONS IN CIVIL ENGINEERING TECHNOLOGY:-

Plaster: -

Sometimes fibers are used in the plaster work to improve the properties of motor. Due to the properties of fibers it avoids the cracks and increases the life of the plaster.

Roofing material:-

Sometimes fiber is used in the roof as roofing materials sometimes it is used in cement concrete because it avoided the crack and increases the life of the cement concrete. Coconut fibers are good thermal insulation so that is why it is used in the roofing material mostly in cold climate.

Fig 1.5 coir fibre

CHAPTER 2

LITERATURE REVIEW

Kar et. al. (2012) is used to calculate the Marshall properties, OFC, OBC. The value of the bitumen used in the preparation of mix is taken as 4% to 7%. The value of the fiber which is used in the mix as addition is 0.3% to 0.5%.

According to this research paper it is observed that the value of the Marshall stability of using grade of bitumen 60/70 is increased up to certain limit of bitumen content and then it is start decreasing for the more % of bitumen. Same effect is happen to the fiber content the value of the stability is start increasing up to some limit of fiber content and then start decreasing when the % of the fiber is increase. Table for the Marshall Stability value is given below.

Table: 2.1 Marshall Stability (Kar et. al.)

Fiber %	0	0.3	0.5
Max. stability(KN)	14.38	14.55	14.1

Grade of bitumen is 60/70

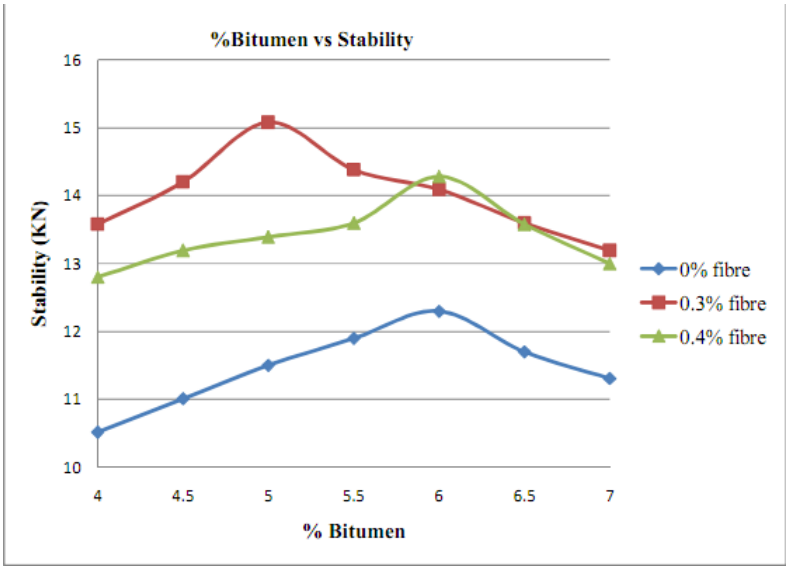

Fig: 2.1 Marshall Stability (Kar et. al.)

According to this figure it is clear that the value of stability is start increasing at the percentage of 0.3 of fiber and then start decreasing at the percentage of 0.5 of fiber. These values are for the grade of the bitumen is 60/70.

Suchismita et al (2009) is used to calculate the Marshall properties, OFC, OBC. The value of the bitumen used in the preparation of mix is taken as 3% to 7%. The value of the fiber which is used in the mix as addition is 0%, 0.3%, 0.5%, 0.7%. The grade of the bitumen is used as 80/100, 60/70.

Table: 2.2: Marshall Stability (Suchismita et al 2009)

Fiber %	0	0.3	0.5	0.7
Max stability	10.43	11.43	13.61	9.16

Grade of bitumen is 80/100

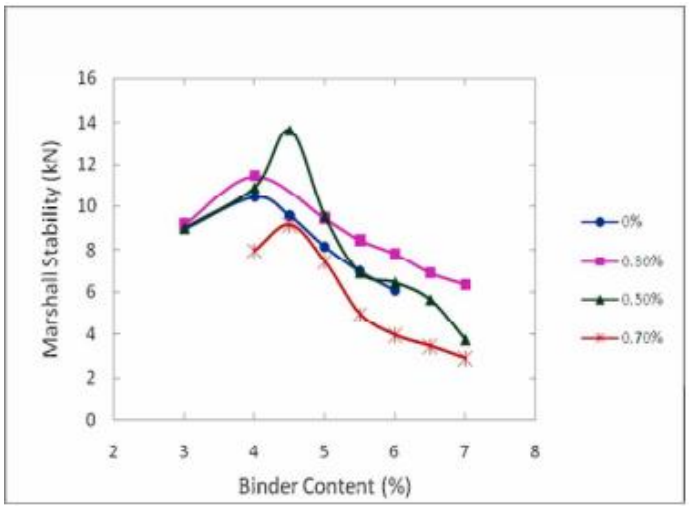

Fig 2.2 Marshall Stability (Suchismita et al 2009)

According to this figure it is clear that the value of the stability is start increasing for the percentage of 0.3 and 0.5 of the fiber and then start decreasing for the percentage of 0.7 of the fiber. These values are for the grade of bitumen 80/100.

Table: 2.3 Marshall Stability (Suchismita et al 2009)

Fiber %	0	0.3	0.5	0.7
Max stability	11.75	12.09	14.52	9.71

Grade of bitumen is 60/70

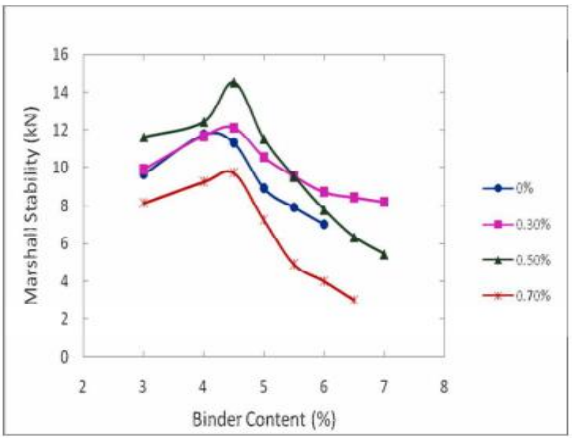

Fig 2.3 Marshall Stability (Suchismita et al 2009)

According to this figure it is clear that the value of the stability is start increasing for the percentage of 0.3 and 0.5 of the fiber and then start decreasing for the percentage of 0.7 of the fiber. These values are for the grade of bitumen 60/70

Table 2.4 Marshall Stability (Suchismita et al 2009)

Fiber %	0	0.3	0.5	0.7
Max stability	12.19	13.61	19.78	10.61

CRMB 60

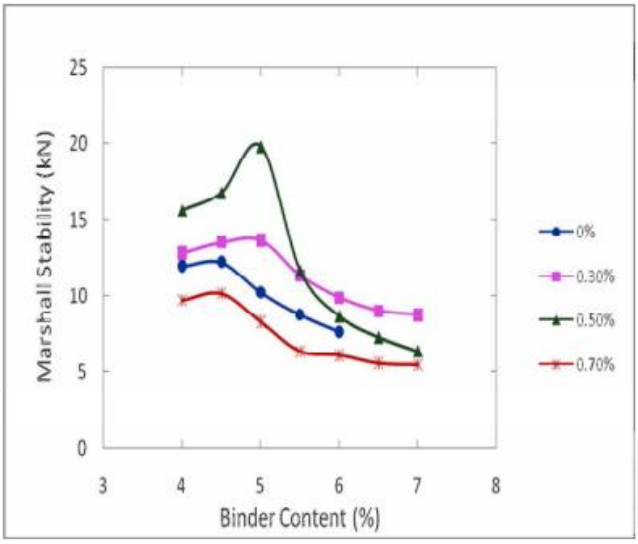

Fig 2.4 Marshall Stability (Suchismita et al 2009)

According to this figure it is clear that the value of the stability is start increasing for the percentage of 0.3 and 0.5 of the fiber and then start decreasing for the percentage of 0.7 of the fiber. These values are for the grade of bitumen CRMB 60.

Manjunath et. al. (2008) is used to calculate the Marshall properties, OFC, OBC. The value of the bitumen used in the preparation of mix is taken as 4% to 7%. The value of the fiber which is used in the mix as addition is 0%, 0.1%, 0.3% to 0.5%. Here the length of the fiber is used as 6mm, 12mm. Stability value in kilogram.

Table: 2.5 Marshall Stability (Manjunath et. al. 2008)

Fiber %	0	0.1	0.3	0.5
Max stability	1308	1536.9	1504.2	1471.5

Length of fiber is 6mm

According to this table it is clear that the value of the stability is start increasing for the percentage of 0.1 of the fiber and then start decreasing for the percentage of 0.3and 0.5 of the fiber. These values are for 6mm fiber length.

Table: 2.6 Marshall Stability (Manjunath et. al. 2008)

Fiber %	0	0.1	0.3	0.5
Max stability	1308	1569.6	1798.5	1504.2

Length of fiber is 12mm

According to this table it is clear that the value of the stability is start increasing for the percentage of 0.1 and 0.3 of the fiber and then start decreasing for the percentage of 0.5 of the fiber. These values are for 12mm fiber length.

Rao et. al. (2006) is used to calculate the Marshall properties, OFC, OBC. The value of the bitumen used in the preparation of mix is taken as 4% to 7%. The value of the fiber which is used in the mix as addition is 0% to 0.4%.length of the fiber is used as 10mm.

According to this research paper it is observed that the value of the Marshall stability of using grade of bitumen 60/70 is increased up to certain limit of bitumen content and then it is start decreasing for the more % of bitumen. Same effect is happen to the fiber content the value of the stability is start increasing up to some limit of fiber content and then start decreasing when the % of the fiber is increase. Table for the Marshall Stability value is given below.

Table 2.7 Marshall Stability (Rao et. al 2006)

Fiber %	0	0.2	0.3	0.4
Max stability	13.312	14.114	16.237	13.576

Length of the fiber is 10 mm

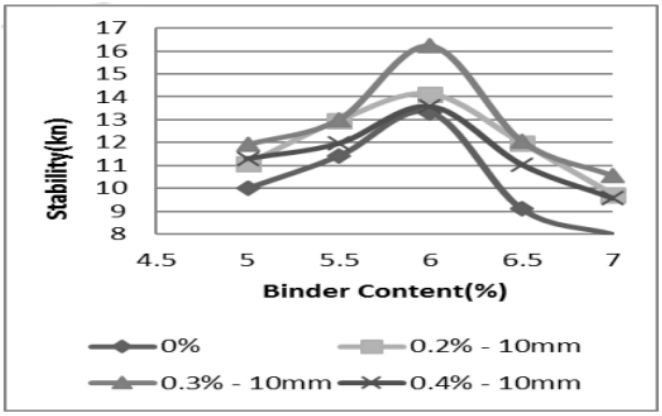

Fig 2.5 Marshall Stability (Rao et. al 2006)

According to this figure it is clear that the value of the stability is start increasing for the percentage of 0.2 and 0.3 of the fiber and then start decreasing for the percentage of 0.4 of the fiber. These values are for 110mm fiber length.

SUBRAMANI et. al. (2012) is used to calculate the Marshall properties, OFC, OBC. The value of the bitumen used in the preparation of mix is taken as 4% to 7%. The value of the fiber which is used in the mix as addition is 0.3%, 0.5%, 0.7%. Here the length of the fiber is used as 10mm, 15mm and 20mm. Marshall Stability value is given below

Table: 2.8 Marshall Stability (SUBRAMANI et. al. 2012)

Fiber %	0.3	0.5	0.7
Max stability(KN)	15.28	16.52	14.26

Length of the fiber is 10mm

According to this table it is clear that the value of the stability is start increasing for the percentage of 0.3 and 0.5 of the fiber and then start decreasing for the percentage of 0.7 of the fiber. These values are for 10mm fiber length.

Table: 2.9 Marshall Stability (SUBRAMANI et. al. 2012)

Fiber %	0.3	0.5	0.7
Max stability(KN)	17.11	17.28	16.01

Length of the fiber is 15mm

According to this table it is clear that the value of the stability is start increasing for the percentage of 0.3 and 0.5 of the fiber and then start decreasing for the percentage of 0.7 of the fiber. These values are for 15mm fiber length.

Table: 2.10 Marshall Stability (SUBRAMANI et. al. 2012)

Fiber %	0.3	0.5	0.7
Max stability(KN)	16.56	17.11	16.51

Length of the fiber is 20mm

According to this table it is clear that the value of the stability is start increasing for the percentage of 0.3 and 0.5 of the fiber and then start decreasing for the percentage of 0.7 of the fiber. These values are for 20mm fiber length.

Suchismita et al (2009) is used to calculate the Marshall properties, OFC, OBC. The value of the bitumen used in the preparation of mix is taken as 4% to 7%. The value of the fiber which is used in the mix as addition is 0%, 0.3%, 0.5%, 0.7%. Different grades of the bitumen is used and they are 80/100, 60/70, CRMB 60.

From this research paper it is observed that the flow value is increased for the % of the fiber is increased for every grade of the bitumen and from this research paper it is also observed that the flow value is max. For 0.7% and the grade of the bitumen is 60/70. The value of the table is given below.

Result values:-

Table: 2.11 Flow value (Suchismita et al 2009)

Fiber%	0	0.3	0.5	0.7
Flow value	4	5	5	6

Value for grade 80/100

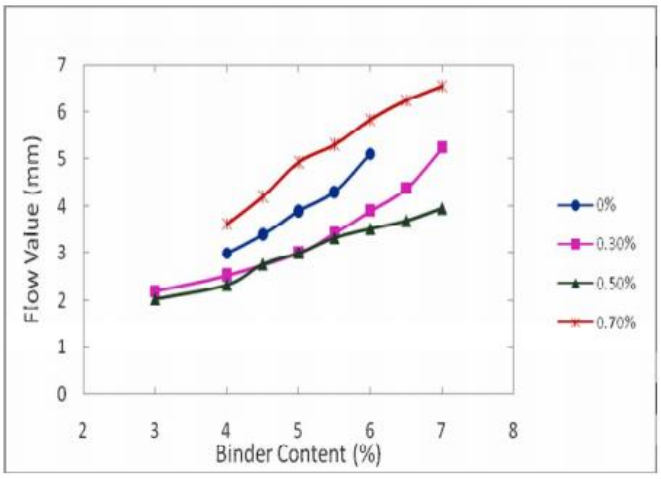

Fig 2.6 Flow value (Suchismita et al 2009)

According to this figure it is clear that the value of the flow is start increasing for the percentage of 0.3 and 0.5 and 0.7. These values are for the grade of bitumen 80/100.

Table: 2.12 Flow value (Suchismita et al 2009)

Fiber%	0	0.3	0.5	0.7
Flow value	4.5	5.3	5.4	5.7

Values for grade 60/70

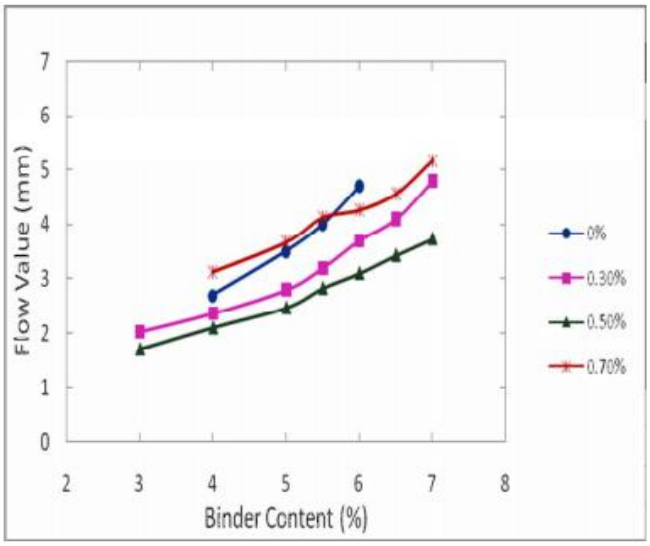

Fig 2.7 Flow Value (Suchismita et al 2009)

According to this figure it is clear that the value of the flow is start increasing for the percentage of 0.3 and 0.5 and 0.7. These values are for the grade of bitumen 60/70

Table: 2.13 Flow value (Suchismita et al 2009)

Fiber%	0	0.3	0.5	0.7
Flow value	4.5	5.3	5.4	5.7

CRMB 60

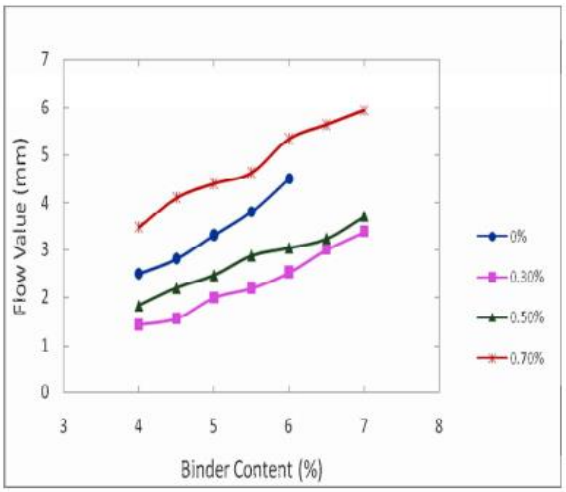

Fig 2.8 Flow Value

According to this figure it is clear that the value of the flow is start increasing for the percentage of 0.3 and 0.5 and 0.7. These values are for the grade of bitumen CRMB

Manjunath et. al. (2008) is used to calculate the Marshall properties, OFC, OBC. The value of the bitumen used in the preparation of mix is taken as 4% to 7%. The value of the fiber which is used in the mix as addition is 0%, 0.1%, 0.3% to 0.5%. Here the length of the fiber is used as 6mm, 12mm.

According to this research paper it is observed that the value of flow is max. For the 0% of fiber and then start decreasing with increase in the % of the fiber.

Result values:-

Table: 2.14 flow value (Manjunath et. al.2008)

Fiber%	0	0.1	0.3	0.5
Flow value	3.8	3.5	3.1	3

Values for 6mm long fiber

Table: 2.15 flow value (Manjunath et. al.2008)

Fiber%	0	0.1	0.3	0.5
Flow value	3.8	3.4	3.3	2.8

Values for 12 mm long fiber

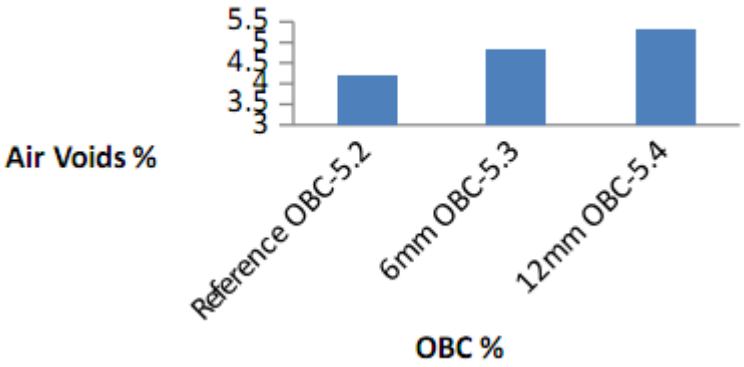

Fig 2.9 OBC Value (Manjunath et. al.2008)

It is clearly observed that the flow value of bituminous concrete without fiber is maximum but it is start decreasing when the % of fiber is increased in the bituminous. It is observed from the result that the minimum flow value for 6mm long fiber at 0.5 % is 3 and the minimum flow value for 12mm long fiber at 0.5% is 2.8.

Rao et. al. (2006) is used to calculate the Marshall properties, OFC, OBC. The value of the bitumen used in the preparation of mix is taken as 4% to 7%. The value of the fiber which is used in the mix as addition is 0% to 0.4%.length of the fiber is used as 10mm.

Table: 2.16 Flow value (Rao et. al 2006)

Fiber %	0	0.2	0.3	0.4
Flow value	5.96	5.02	4.32	5.26

Value for 10mm long fiber

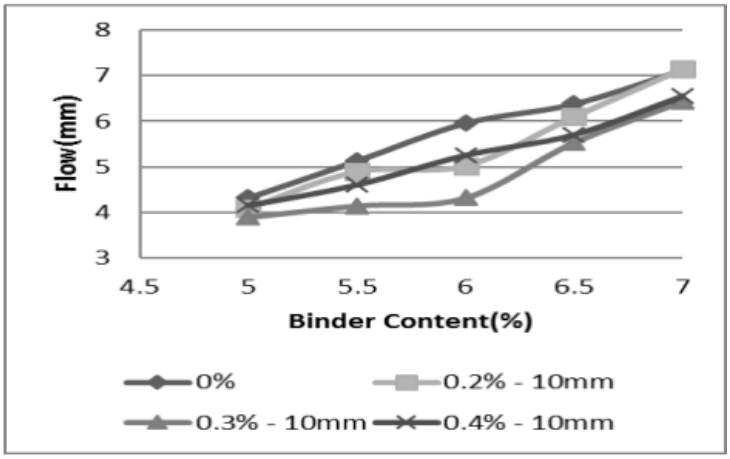

Fig 2.10 Flow Value (Rao et. al 2006)

It is clearly observed that the flow value of bituminous concrete without fiber is maximum but it is start decreasing when the % of fiber is increased in the bituminous. It is observed from the result that the value of value is decreasing at certain % and then start increasing.

From result it is clear that the value of flow is decreasing at0.2%, 0.3% and that start increasing at 0.4%.

SUBRAMANI et. al. (2012) is used to calculate the Marshall properties, OFC, OBC. The value of the bitumen used in the preparation of mix is taken as 4% to 7%. The value of the fiber which is used in the mix as addition is 0.3%, 0.5%, 0.7%. Here the length of the fiber is used as 10mm, 15mm and 20mm. flow value is given below.

From this research paper it is observed that the flow value for 10mm and 15mm long fiber is start increasing with increase in the % of the fiber. But in case of 20mm long fiber the value is different it will start increasing up to some % but then start decreasing.

Flow value:-

Table: 2.17 Flow value (SUBRAMANI et. al. 2012)

Fiber %	0.3	0.5	0.7
Flow value	7.1	7.5	7.9

Value for 10mm long fiber

Table: 2.18 Flow value (SUBRAMANI et. al. 2012)

Fiber %	0.3	0.5	0.7
Flow value	8	7.02	7.2

Value for 15mm long fiber

Table: 2.19 Flow value (SUBRAMANI et. al. 2012)

Fiber%	0.3	0.5	0.7
Flow value	5.26	8.10	7.23

Value for 20mm long fiber

Kar et. al. (2012) is used to calculate the Marshall properties, OFC, OBC. The value of the bitumen used in the preparation of mix is taken as 4% to 7%. The value of the fiber which is used in the mix as addition is 0.3% to 0.5%.

It is observed that the value of the unit of the mix is increased up to some % of the fiber but then it is start decreasing with increasing of the fiber content. The value of the unit weight is given below.

Table: 2.20 Unit weight (Rao et. al 2006)

Fiber %	0	0.3	0.5
Unit weight	2.49	2.45	2.45

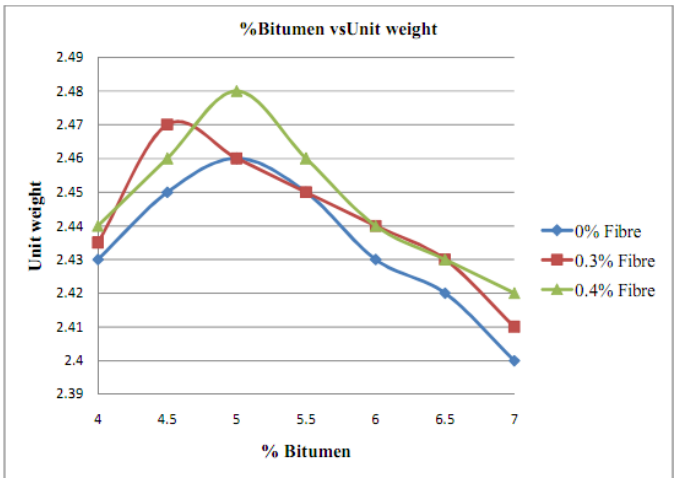

Fig 2.11 Unit Weight (Rao et. al 2006)

According to this figure it is clearly observed that the value of the unit weight is maximum for the 0% of fiber in the mix and then it will decrease for the 0.3% and 0.5%. Value of the unit weight is remaining constant for the 0.3% and 0.5% of fiber.

Suchismita et al (2009) is used to calculate the Marshall properties, OFC, OBC. The value of the bitumen used in the preparation of mix is taken as 3% to 7%. The value of the fiber which is used in the mix as addition is 0%, 0.3%, 0.5%, 0.7%. The grade of the bitumen is used as 80/100, 60/70. The value of the unit weight is given in the table below.

Table: 2.21 Unit weight (Suchismita et al 2009)

Fiber%	0	0.3	0.5	0.7
Unit weight	4.5	4	4.5	4.5

Bitumen grade 80/100

According to this table it clearly observed that the unit weight value is maximum for the 0% of fiber and then it is start decreasing for 0.3% of fiber and then again increasing for 0.5% and 0.7% of fiber. This value for grade of bitumen 80/100.

Table: 2.22 Unit weight (Suchismita et al 2009)

Fiber %	0	0.3	0.5	0.7
Unit weight	4.5	4.4	5	4.5

Bitumen grade 60/70

According to this table it clearly observed that the unit weight value is maximum for the 0.5% of fiber and then it is start decreasing for 0.7% of fiber. This value is for the grade of bitumen 60/70.

Table: 2.23 Unit weight (Suchismita et al 2009)

Fiber %	0	0.3	0.5	0.7
Unit weight	4.5	5	5	5

CRMB 60

According to this table it is clearly observed that the value of unit weight is minimum for 0% of fiber and then is increased and remain constant for 0.5% and 0.7% of fiber. These values are for CRMB 60

Manjunath et. al. (2008) is used to calculate the Marshall properties, OFC, OBC. The value of the bitumen used in the preparation of mix is taken as 4% to 7%. The value of the fiber which is used in the mix as addition is 0%, 0.1%, 0.3% to 0.5%. Here the length of the fiber is used as 6mm, 12mm.

Unit weight:-

According to this research paper it is clearly observed that the value of the unit weight is increased when the % of the fiber in the specimen is increased. Value of the unit weight is given below.

Table: 2.24 Unit weight (Manjunath et. al.2008)

Fiber %	0	0.1	0.3	0.5
Unit weight	3.79	3.88	4.08	4.57

Value for 6mm long fiber

Table: 2.25 Unit weight (Manjunath et. al.2008)

Fiber %	0	0.1	0.3	0.5
Unit weight	3.79	3.73	4.21	5.07

Value for 6mm long fiber

SUBRAMANI et. al. (2012) is used to calculate the Marshall properties, OFC, OBC. The value of the bitumen used in the preparation of mix is taken as 4% to 7%. The value of the fiber which is used in the mix as addition is 0.3%, 0.5%, 0.7%. Here the length of the fiber is used as 10mm, 15mm and 20 mm. Unit weight values is given below

Unit weight:-

Table: 2.26 Unit weight (SUBRAMANI et. al. 2012)

Fiber%	0	0.3	0.5	0.7
Unit weight	2.32	2.26	2.22	2.24

Value for 10mm long fiber

Table: 2.27 Unit weight (SUBRAMANI et. al. 2012)

Fiber %	0	0.3	0.5	0.7
Unit weight	2.32	2.33	2.28	2.31

Value for 15mm long fiber

Table: 2.28 Unit weight (SUBRAMANI et. al. 2012)

Fiber %	0	0.3	0.5	0.7
Unit weight	2.32	2.33	2.31	2.34

Value for 20mm long fiber

Kar et. al. (2012) is used to calculate the Marshall properties, OFC, OBC. The value of the bitumen used in the preparation of mix is taken as 4% to 7%. The value of the fiber which is used in the mix as addition is 0.3% to 0.5%.

Table: 2.29 OBC (Kar et. al. 2012)

Fiber %	OBC
0	4.5
0.3	5
0.5	5.5

From this research paper it is clear that the value of the OBC is increased when the % of the fiber is increased.

Suchismita et al (2009) is used to calculate the Marshall properties, OFC, OBC. The value of the bitumen used in the preparation of mix is taken as 3% to 7%. The value of the fiber which is used in the mix as addition is 0%, 0.3%, 0.5%, 0.7%. The grade of the bitumen is used as 80/100, 60/70. The value of the OBC is given in the table below.

Table: 2.30 OBC (Suchismita et al 2009)

Fiber %	OBC
0	5.9
0.3	4.2
0.5	6.4

Value for grade 80/100

According to this table it is clearly observed that the value of OBC is decreasing for the 0.3% of the fiber and then state increasing at 0.5% of fiber.

Table: 2.31 OBC (Suchismita et al 2009)

Fiber %	OBC
0	6
0.3	4.2
0.5	6.8

Value for grade 60/70

According to this table it is clearly observed that the value of OBC is decreasing for the 0.3% of the fiber and then state increasing at 0.5% of fiber.

Table: 2.32 OBC (Suchismita et al 2009)

Fiber %	OBC
0	6.5
0.3	4.6
0.5	7

CRMB 60

According to this table it is clearly observed that the value of OBC is decreasing for the 0.3% of the fiber and then state increasing at 0.5% of fiber.

Manjunath et. al. (2008) is used to calculate the Marshall properties, OFC, OBC. The value of the bitumen used in the preparation of mix is taken as 4% to 7%. The value of the fiber which is used in the mix as addition is 0%, 0.1%, 0.3% to 0.5%. Here the length of the fiber is used as 6mm, 12mm.

OBC VALUE:-

Table: 2.33 OBC (Manjunath et. al.2008)

Fiber %	0	0.1	0.3	0.5
OBC	5.2	5.2	5.25	5.3

For 6mm long fiber

According to this table it is clearly observed that the value of OBC is max for the 0.5%. It remains consistence for the other % of fiber.

Table: 2.34 OBC (Manjunath et. al.2008)

Fiber %	0	0.1	0.3	0.5
OBC	5.2	5.3	5.3	5.35

For 12mm long fiber

According to this table it is clearly observed that the value of OBC is max for the 0.5%. It remains consistence for the other % of fiber.

2.2. Scope of the Study: - To understand the elastic behaviour of coir fibre reinforced bituminous concrete a systematic study is required as the coir is likely to impart more expandability to the bituminous mix.

To understand the performance of the mix under loading. Experimental investigations on the rutting behaviour of coir fibre reinforced bituminous mixes will help.

Case study on the abrasive resistance of coir fibre reinforced semi dense bituminous concrete may also be attempted.

2.3. Objectives:-

The major objectives of the study are given below:

- To determine the performance of bituminous concrete
- To check the stability and flow value of bituminous concrete and compare with the ordinary mix
- To check the VFB, VMB, and % of voids present in the mix and compare it with the ordinary mix.
- To produce the economical construction material.
- To reduce the effect on environment due to the industrial and agricultural waste materials.
- To provide an alternative light weight material.
- To increase the life of the road or pavement.

CHAPTER 3

MATERIALS AND RESEARCH METHODOLOGY

3.1 Stone Aggregates: - Aggregates are the one of the most important part of any structure but in pavement it is the major portion of the structure. Aggregates must have to resist the stress which occurring due to the wheel load and aggregate must have to resist the or bear the abrasive action which occurs due to the movement of traffic. Aggregates mainly used in the construction of pavement as cement concrete, bituminous concrete and as well as it is used in the base course under the top layer of the pavement.

3.2 Bitumen: - From different places crude petroleum is obtain and has different composition. The portion which is present in the petroleum may differ from the bituminous material and it is depend on the source. In the crude petroleum there is some potion of water as well as some portion of crude oil that is why the crude petroleum is firstly dehydrated and then carrying out the distillation. There are basically two types of distillation.

- Fractional distillation
- Destructive distillation

In the fractional distillation the temperature is very high but no chemical changes. Due to high temperature various volatile constituent has separated. The residue obtain in this process is petroleum bitumen. But in case of destructive distillation there is extreme heat and pressure due to this chemical changes occur. This type of process is used for the production of tar.

3.3 Coir Fibre: - Extracted part from the outer shell of a coconut is Coconut fibre. Coir, Cocoasnucifera and Arecaceae (Palm), respectively are the family name of the coconut fibre. There are basically two types of coconut fibre.

- Brown fibers: - This type of fiber is strong, thick and has high abrasion resistance.
- White fibers: -This type of fiber is finer and smoother, but they are very weak in strength.

There are basically three forms of coconut fibre.

- bristle (long fibers)
- mattress (short fiber)
- Decorticated (mixed fibers).

These different types of fibres have different uses depending upon the requirement. In engineering, brown fibres are mostly used.

3.4 Test on Stone Aggregates:-

Desirable properties of stone aggregates:-

- Strength: - Aggregates which are used for the road construction must be strong enough to resist the load which comes from the traffic wheels. Aggregates which are used in the upper most layers should have sufficient strength to resist the crushing.
- Hardness: - Aggregates which are used in the surface layer they are subjected to constant rubbing or abrasion due to the moving traffic. Aggregates which are used in that layer must be strong or hard enough to resist that type of abrasive action of traffic.
- Toughness: - aggregates which are used in the construction of pavement they are also subjected to the impact load due to the moving wheels. Most common impact is hammering which occur due to the heavy loaded steel tiered vehicle. This is also a desirable property of aggregates.
- Durability: - this is also being a most important property of the aggregates. In this property aggregates must resist the adverse weathering condition. This is also called the soundness of the aggregates.
- Shape of the aggregates: - this is also a most common property of the aggregates. There are basically four types of shapes flaky, elongated, round and angular. Flaky and elongated aggregates have less strength so the type of aggregates is avoid to construction of the pavement.
- Adhesion with bitumen: - Aggregates which are used in the bituminous pavement must have less affinity with water when they are compared with bituminous material.

Test for the road aggregates:-

- Crushing test
- Abrasion test
- Impact test
- Shape test
- Specific gravity
- Water absorption

Most important tests and their limiting values:-

Every test for the aggregates must have their limiting values for the aggregates if the value of the test for the particular aggregates exceeds the limiting value then the aggregates are rejected for the construction of the pavement.

Table: 3.4 aggregates test

Test	Values
Crushing value	Less than 30%
Abrasion value	Less than 30%
Impact value	30% to 35%
Specific gravity	2.6 to 2.9
Water absorption	Less than 0.6%

3.5 Bitumen Test:-

- Penetration test: - This test is very important for bitumen. This test is used to find out the grade of the bitumen.
- Ductility test: - This is also a very important property of the bitumen. This test is used to find the ductility value or property of the bitumen.
- Viscosity value: - this test is very important this property is used during mixing. This test is used find the viscosity value of the bitumen.
- Float test: - This test is used to find out the consistency of the bitumen other test cannot give this value.
- Specific gravity test: - This test is used to find the specific gravity of the bitumen.
- Softening point test: - This test is used to find the softening point of the bitumen. Ring ball test is carried out to find the value.
- Flash point test: - This test is used to carry out to find the flash point and fie point of the bitumen.

Table: 3.5 bitumen test

Test	Values
Penetration test	To find the grade like 30/40 or 80/100
Ductility test	75cm
Specific gravity	0.97 to 1.02

3.6 Marshall Test: - In this method, the resistance to plastic deformation of cylindrical specimen of bitumen mixture when the same is loaded at the periphery at the rate of 5 cm per minute. The test procedure is used in the design of the bituminous paving mix. There are two major feature of the Marshall test of designing mixing.

- Density – Void Analysis
- Stability – Flow test

The stability of the mix is defined as the maximum load carried by a compacted specimen at the standard test temperature of 60 degree. The flow is measured as the deformation in units of 0.25mm between no load and maximum load carried by the specimen during stability test.

Percentage of air voids = (Gt-Gm/Gm)*100

Gm = bulk density of the specimen

Gt = theoretical Specific gravity of mixture

Percentage voids in mineral aggregate (VMA) = Vv+Vb

Vv = volume of air voids

Vb = volume of bitumen = Gm = W4/G4

Percentage voids filled with bitumen (VFB) = 100Vb/VMA

The procedure adopted for the preparation of the Marshall sample was the same as that used in conventional dense gradient mixtures with the modification that the coated fibers were added to the heated aggregate before being mixed with water- Hot asphalt. The mixing and compaction temperatures were maintained at 150 ° C. and 160 ° C., respectively. The compressed sample was cooled to room temperature before the was extracted.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Stones Aggregates Test Result Value:-

Test which are conducted on the selected aggregates are used to check the desirable properties of the aggregates which are compulsory for the construction of the pavement.

Desirable properties are given below:-

- Strength
- Hardness
- Toughness
- Shape of aggregates

Tests which calculate these properties

Crushing test – strength

L.A test - hardness

Impact test - toughness

Flaky & Elongation - shape of the aggregates

Test and values:-

Table: 4.1 aggregates values

Test	Value
Crushing test	28.56%
Abrasion test	27.26%
Impact test	26.1%
Flaky index	13.3%
Elongation index	10.23%

Fig 4.1.1 L.A Test Apparatus

Fig 4.1.2 Impact Test Apparatus

Fig 4.1.3 CTM

4.2 Bitumen Test Value: - Bitumen is the most important material used in the construction of the pavement. Bitumen is a binding material and test which are conducted on the bitumen to check their desirable properties.

- Penetration test: - This test is very important for bitumen. This test is used to find out the grade of the bitumen.
- Ductility test: - This is also a very important property of the bitumen. This test is used to find the ductility value or property of the bitumen.
- Specific gravity test: - This test is used to find the specific gravity of the bitumen.

Table: 4.2 Bitumen value

Test	Values
Penetration test	67cm
Ductility test	75cm
Specific gravity	1.00

Fig 4.2.1 Penetration Test

Fig 4.2.2 Ductility Test

4.3 Marshall Test Values: - In this method, the resistance to plastic deformation of cylindrical specimen of bitumen mixture when the same is loaded at the periphery at the rate of 5 cm per minute. The test procedure is used in the design of the bituminous paving mix. There are two major feature of the Marshall test of designing mixing.

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- Stability – Flow test

The stability of the mix is defined as the maximum load carried by a compacted specimen at the standard test temperature of 60 degree. The flow is measured as the deformation in units of 0.25mm between no load and maximum load carried by the specimen during stability test.

Percentage of air voids = (Gt-Gm/Gm.)*100

Gm. = bulk density of the specimen

Gt = theoretical Specific gravity of mixture

Percentage voids in mineral aggregate (VMA) = Vv+Vb

Vv = volume of air voids

Vb = volume of bitumen = Gm. = W4/G4

Percentage voids filled with bitumen (VFB) = 100Vb/VMA

Properties and Values:-

Table: 4.3 Marshall Value

Properties	0% Fibre	0.2% Fibre	0.4% Fibre	0.6% Fibre	0.8% Fibre
Stability(KN)	13.25	14.23	15.22	14.01	13.56
Flow	5.7	5.3	5	5.5	6
Bulk Density	2.550	2.559	2.552	2.449	2.445
VFB	85.200	86.022	86.522	86.566	86.599
VMA	16.885	16.772	16.662	16.631	16.622
% of Air Voids	2.5	2.333	2.223	2.225	2.190

The above table gives the desirable properties which are calculated by the Marshall method. The percentage of bitumen is used as 5% of the weight of the aggregates. Grade of the bitumen is 60/70.

Fig 4.3.1 Cold Sample

Fig 4.3.2 Marshall Apparatus

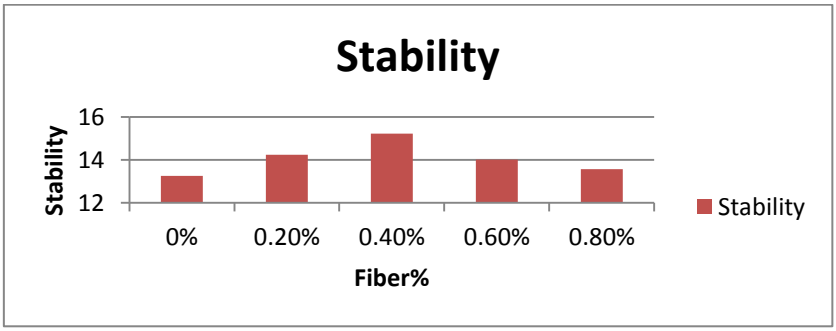

Fig 4.3.3 Stability value

According to this graph it is clear that the value of the stability is increase with increase in the % of fiber up to 0.4 % and then it starts decreasing with increase in the % of fiber. At the 0.4% of fiber the stability value is maximum and at 0% of fiber it is minimum. The main

reason behind the decreasing of stability is that if the fiber content is more than the binding effect of bitumen is less so that is by the stability value is start decreasing.

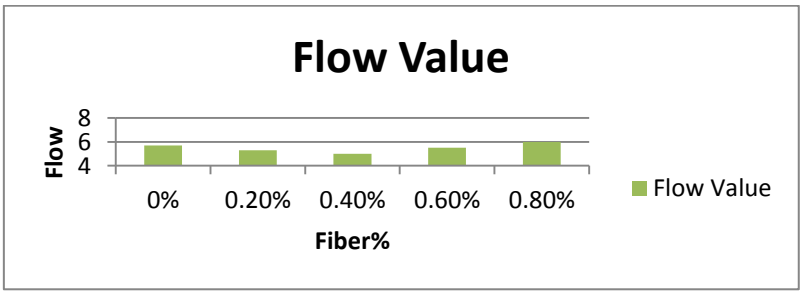

Fig 4.3.4 Flow value

According to above fig. it is clear that the value of flow is increasing with the increasing in the percentage of fiber. The maximum value of the flow is at 0.8% of fiber. The reason behind the increasing in the flow value is that when the percentage of fiber is increased binding capacity of the bitumen is decreased therefore the deformation is increased.

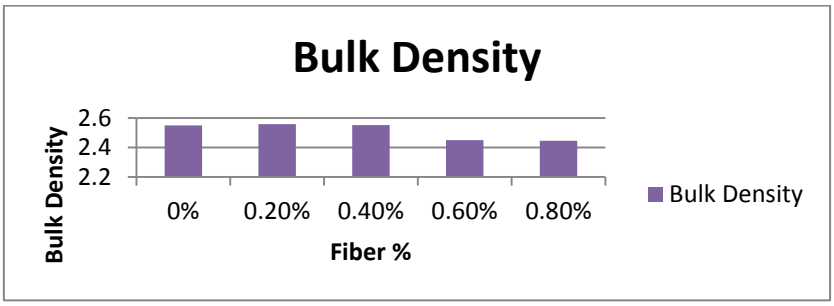

Fig 4.3.5 Bulk Density

According to this fig. it is clear that the value of the bulk density is consistence with increase in the % of the fiber up to 0.4% of fiber and then it starts decreasing with increase in the % of fiber.

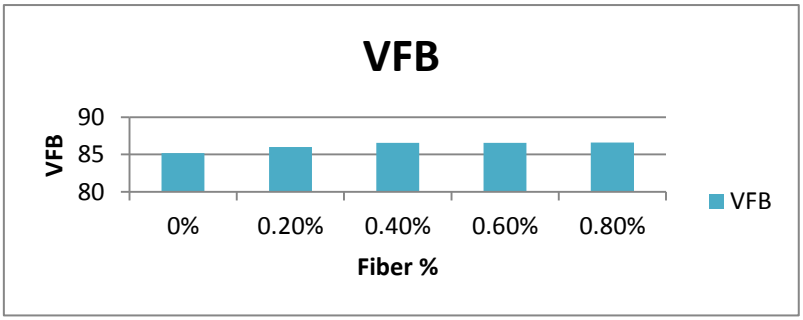

Fig 4.3.6 VFB

According to above fig. it is clear that the value of VFB is increasing with the increasing in the percentage of fiber. The maximum value of the flow is at 0.8% of fiber. The reason behind this is that some voids are filled with the fibers and other is filled with bitumen hence more void are filled when the percentage of fiber is increased that is why the VFB value is increased.

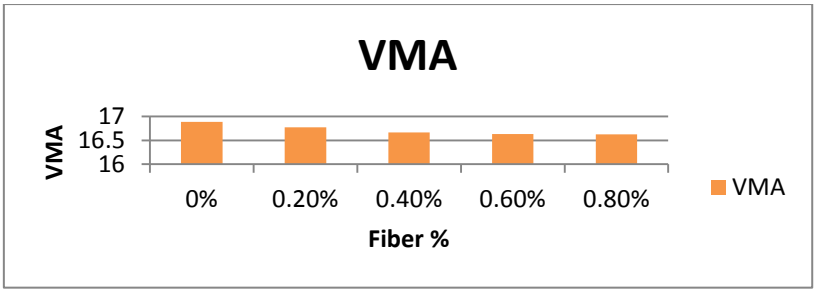

Fig 4.3.7 VMA

According to above fig. it is clear that the value of VMB is decreasing with the increasing in the percentage of fiber. The minimum value of the flow is at 0.8% of fibre. The reason behind this is that the most of the voids is filled with fibres and bitumen and remaining is filled with minerals but when we increased the percentage of the fibres then voids filled with fibres is more and hence reduction in the VMB values.

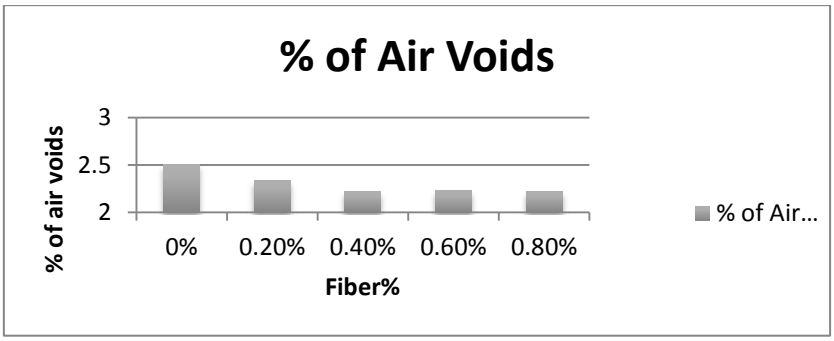

Fig 4.3.8 Air Voids

According to above fig. it is clear that the value of % of air voids is decreasing with the increasing in the percentage of fiber. The minimum value of the% of air voids is at 0.8% of fiber. Reason behind the decreasing of the air voids is that when the percentage of the fibre is increased voids filled with the fiber is also increased that is why there is reduction of the air voids.

CHAPTER 5

CONCLUSION AND FUTURE SCOPE

5.1 General: - In this chapter, the salient features of this project work on coir reinforced bituminous mixes are examined a detailed analysis of the results obtained made the conclusion of the research. The scope for future investigations in the same area of study is also discussed. In this paper fiber as an additive in the bituminous concrete is also studied. The percentage of bitumen is used as 5% of the weight of the aggregates. Grade of the bitumen is 60/70.

5.2 Summary:-

A total of forty samples of semi dense bituminous concrete including the reference mix were tested. The mix variables were as follows.

Table: 5.2 Summaries

Fiber Type	Coir fiber
Fiber content	0.2%, 0.4%, 0.6%, 0.8%
Fiber length	Random size
Bitumen content	5%

5.3 Conclusion

Analyzing the results, following conclusions has been drawn:

- Stability value of bituminous concrete is start increasing up to 0.4% and then start decreasing slightly. The maximum value of the stability is at 0.4% of fiber.
- Flow value of the bituminous concrete is start decreasing up to 0.2% and then again starts increasing. The maximum flow value is at 0.8% of fiber.
- There is slightly change in the bulk density of the bituminous concrete. It is slightly increasing and then slightly decreasing.
- There is slightly change in the bulk density of the bituminous concrete. It is slightly increasing and then slightly decreasing.
- VMA value of bituminous concrete is slightly decreasing from 0% to 0.8%.
- Percentage of air void with addition of coir fiber is decreased.
- The key to effective performance of flexible pavements is to understand the causes of failures and the action needed for correction.

According to this research at the end of the research it is clear that the performance of the bituminous concrete with addition of the coir fibre is increased as compared to the normal or ordinary bituminous concrete. Every property of the bituminous concrete is changed

with the addition of the coir fibre. Hence the coir fibre can be used in the construction work because it increases the life of the material. Coir fibre is the waste product so its utilization in the construction work reduces the harm effect on the environment.

5.4 SCOPE FOR FUTURE WORK: - To understand the elastic behaviour of coir fibre reinforced bituminous concrete a systematic study is required as the coir is likely to impart more expandability to the bituminous mix.

To understand the performance of the mix under loading. Experimental investigations on the rutting behaviour of coir fibre reinforced bituminous mixes will help.

Case study on the abrasive resistance of coir fibre reinforced semi dense bituminous concrete may also be attempted.

REFERENCES

1. Debashish Kar (2012), “A Laboratory Study of Bituminous Concrete Using Natural Fiber”
2. Arpita Suchismita(2010), “A Study of Effects of Binder Quality And Natural Fiber On Stone Matrix Asphalt”
3. Supriya C B1, B H Manjunath(2008) , S V Dinesh(2014), “Influence Of The Fiber On Improving The Mechanical Properties Of The Bitumen Mix”
4. B. Gopi Raju1, K. Naga Sreenivasa Rao (2013), “Characterization of Fibre Reinforced Bituminous Mixes”
5. T Subramani Professor & Dean, Department of Civil Engineering, VMKV Engg College, Vinayaka Missions University, Salem, India(2012), “Experimental Investigation On Coir Fiber Reinforced Bituminous Mix”
6. Camila Nascimento Padilha Silva(2001), “A Study Of Asphalt Mixtures Reinforced With Coconut Fibers In Brazil”
7. Sigit Pranowo Hadiwardoyo(2013), “Evaluation Of The Addition Of Short Coconut Fibers On The Characteristics Of Asphalt Mixtures”
8. Tay Lay Tinga, Ramadhansyah Putra Jayaa, Norhidayah Abdul Hassana, Haryati Yaacoba, Dewi Sri Jayantib(2015), “A Review Of Utilization Of Coconut Shell And Coconut Fiber In Road Construction”
9. Majid Ali(2010),”Coconut Fibre – A Versatile Material and its Applications in Engineering”
10. Remadevi M. Anjali G. Pillai, Elizabeth Baby George, Priya Narayanan, Sophiya Sunny(2014), “Study of Fiber Reinforced Bituminous Concrete”
11. B. Gopi Raju1, K. Naga Sreenivasa Rao (2013), “Characterization of Fiber Reinforced Bituminous Mixes”
12. Department of Environment (DOE), Design of Normal Bitumen Mixes. BRE Publication, United Kingdom, 1997.
13. ASTM C311, 2005. "Standard Test Method for indirect Tensile Strength of Cylindrical Bitumen Concrete Specimens".
14. IS: 10262-1982 (Reaffirmed 2004): Recommended guidelines for Bitumen concrete mix, Bureau of Indian Standard, New Delhi-2004
15. B.S.1881,"Method for determination of Marshall Stability of Bituminous concrete mix”.

16. Thulasirajan k, V L Narasimha 2011, “Studies on coir fiber reinforced bituminous concrete”. International Journal of Engineering Research and Applications (IJERA).volume 06. Pp 835-838.
17. Subramanian T,2012, “Experimental Investigation on coir fiber reinforced Bituminous mixes” International Journal of Engineering Research and Applications (IJERA), volume 2, pp 1794- 1804
18. Beenak's and Bindu c s (2011) “coir fiber as a stabilizing additive in stone mastic asphalt”. International Journal of Earth sciences and Engineering, volume 04 .pp 165-177.
19. Vikas Sharma, Shweta Goyal, (2006), “Comparative study of performance of natural fibers and crumb rubber modified stone matrix asphalt mixtures”, Canadian Journal of Civil Engineering, February, Vol.33, (2), pp134.
20. Tap kin, S., et al (2009) Repeated Creep Behavior of Polypropylene Fiber Reinforced Bituminous Mixtures. Journal of Transportation Engineering, Turkey.
21. Asi IM, (2007): Performance evaluation of super pave and Marshall Asphalt mix designs to suit Jordan climatic and traffic conditions, Construction Building Materials Vol. 21, p.1732-1740.
22. Brown E.R. and Manglorkar H. (1993), “Evaluation of Laboratory Properties of SMA Mixtures”, NCAT Report No. 93-5, Auburn University, Alabama
23. Bradley J. Putman and Serji N. Amirkhanian (2004), “Utilization of Waste Fiber in Stone Matrix Asphalt Mixtures”, Resources, Conservation and Recycling, Volume 42, Issue 3, pp 265-274
24. Majid Ali(2010),”Coconut Fiber – A Versatile Material and its Applications in Engineering”
25. Wu, et al (2009) Investigation of the Dynamic and Fatique Properties of Fibre Modified Asphalt Mixtures. International Journal of Fatuque (31), China, 1598-1602
26. Panda, N. (2010) Laboratory Investigation on Stone Matrix Asphalt using Sisal Fibre for Indian Roads. B.Tech. Project, India.