USE OF BAMBOO FIBER IN PAVEMENT QUALITY CONCRETE SLAB

A PROJECT REPORT

in partial fulfillment for the award of the degree of

MASTER OF TECHNOLOGY

IN

CIVIL ENGINEERING

Submitted by

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School of Civil Engineering

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DECLARATION

I **VISHAL JAMWAL(11302229**),hereby declare that this submission is my own work and that to the best of my insight and conviction, its content no material beforehand distributed or composed by other individual or office. No material which has been acknowledged for reward of some degree or certificate of the college or other organization of higher learning with the exception of where due affinitions have been made in the content. It was arranged and under the direction and supervision of **Mr. PARAMVEER SINGH.**

Date:- VISHAL JAMWAL

Place:- 11302229

CERTIFICATE

Certified that this project report entitled "**Use of bamboo fiber in pavement quality concrete slab**" submitted individually by **Vishal Jamwal** bearing registration number **11302229** of Civil Engineering Department, Lovely Professional University, Phagwara , Punjab. He did his thesis project work under surveillance of **Mr. Paramveer Singh** for the Award of Degree. The submission of this report is not done at any other institution or university.

SIGNATURE

Mr. PARAMVEER SINGH

Assistant Professor

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Furthermore I like to acknowledge the role of the staff of Lovely Professional University who gave the permission to use the labs and materials to complete the task .A thanks to my team mate, who help me to do the experiments and gave suggestion about the task "Pavement Quality Concrete". At last many thanks go to the in charge who gave us this report so that we can explore and gain our knowledge. I have to thanks the guidance given by other faculty members as well as the panels who gave me such an interesting topic for my research help and help in doing my research.

ABSTRACT

The construction pavements have high strength, better durability good serviceability and have moderate economy for a long period of time. The pressure nowadays is to make light and green pavements of better serviceability, which can resist the loads of high intensity. The main objective of this study is making pavement quality concrete (PQC) mixtures incorporating bamboo fiber to be use with steel bars. The goal is to the make the PQC slab pavement having optimum thickness using the calculated flexural strength of the concrete. The flexural strength examined for different percentages of bamboo with replacement of steel bars (by weight) i.e. for 10%, 20% and 30%. As for PQC, flexural strength is optimized by designing thickness of slab for different percentage(%) of bamboo and compared with normal control mix.

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INTRODUCTION

1.1 GENERAL

Large scale construction of highways and bridges are going on in India and over the world. These all requires a rigid pavements which are made up of Pavement Quality Concrete. Concrete is a very useful material but due to temperature variations and shrinkage it starts to develop cracks over time. Pavement Quality Concrete is a type of concrete which is used for construction of rigid pavements where the intensity of load is rapid and more such as roads, runways, toll plazas etc. In this case the strength of pavements is more than 40Kg/cm2. A high strength material should be used to make a good quality concrete pavement. Concrete because of its rigid mechanism and high elastic properties provides better strength in bending. The PQC thickness is primarily dependent on the flexural strength of concrete and on the intensity of axle or wheel load. The PQC slabs initial cost is really high that's why we can't use stage construction in these type of roads. We have to provide lots of joints in these slab so this prove an additional places of weakness.

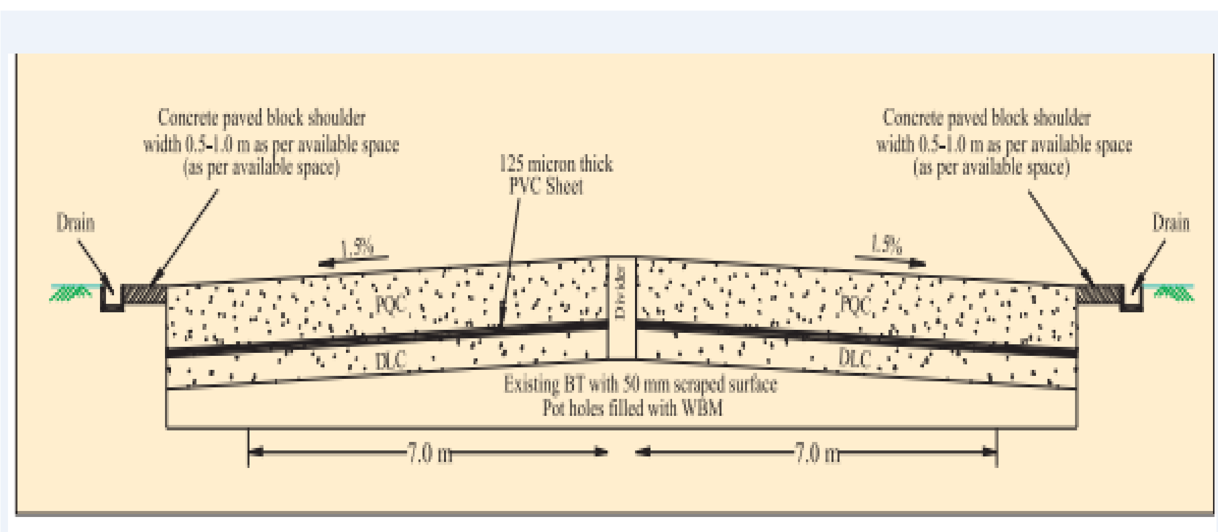

Fig 1.1: Cross Section of PQC

Today, the main aim is to reduce the cost of construction; either by replacing some materials by waste products or by adding natural occurring materials. The maximum cost and the lack of reinforcing steel in many parts of the world has create to increase interest in the possible use of available materials for the reinforcement of concrete. In present study bamboo is used in addition to steel reinforcement so as to reduce a part of cost of construction and check the behavior of bamboo fiber under flexural and tensile loading. Bamboo is a natural material which is cheap and easily available and it will lead to provide good strength.

1.2 Bamboo

Bamboo is a type of grass with a hard, woody, hollow stem. The resistant of tensile stresses in bamboo make the bamboo a versatile product. Bamboo is superior to timber and to reinforcing steel for withstanding tensile force. Depending on the types, bamboo can be grown in one to five years v/s 10-50 years for softwood and hardwood. Bamboo is one of the most traditional building materials used by humans. Bamboo advantages like ability to grow fast with a high yield and also it matures faster. As bamboo is a natural material so its cost is also less that' make it more economical and it can be grown on large scale. Bamboo is the most trusted material as compare to the other materials in construction.

Table1.1-Properties of Bamboo

Specific gravity	0.57 to 0.65
Average weight	0.62kg/m
Modulus of rupture	610 to 1600 kg/cm^2
Modulus of Elasticity	1.5 to 2.0 kg/cm^2
Ultimate compressive stress	794 to 864kg/cm^2
Safe working stress in compression	105kg/cm^2
Safe working stress in tension	160 to 350 kg/cm^2
Safe working stress in shear	115 to 180 kg/cm^2

1.2.1 Advantages of Bamboo

The major advantages of bamboo are :

- Bamboo is Light, strong and versatile material.
- It is an environment friendly material,
- It is accessible to the poor people also.
- It is having a quality of self-renewing.
- Its fastest growing material.
- It is a productive material.

1.2.2 Disadvantages of Bamboo

- Bamboo actually requires preservation.
- It is shaped by nature.
- Durability–bamboo can be hit by worms, insects.Due to this reason untreated bamboo is going to have an expected life of less than 5 years.
- Lack of design steps and IS codes.
- It easily catches fire very fast due to the friction amongst the joints during strong wind, and sometimes create forest fires.

CHAPTER-2

LITERATURE REVIEW

Paramveer Singh et al (2015) shows the optimum design of pavement quality concrete using RHA and he examined the flexural strength of RHA for different percentages with replacement of cement for 5%, 10%, 15% and 20%(by weight).Maximum flexure strength of pavement quality concrete is achieved for 5% RHA replacement but at 10 % RHA replacement strength decrease slightly from control mix strength. It mainly includes to test:

- Properties of materials used for making concrete.
- Mix design for pavement quality concrete and RHA reinforced concrete.
- Concrete samples curing and its casting.
- The flexural, compressive and Split Tensile strength of steel Fibre reinforced concrete (FRC).

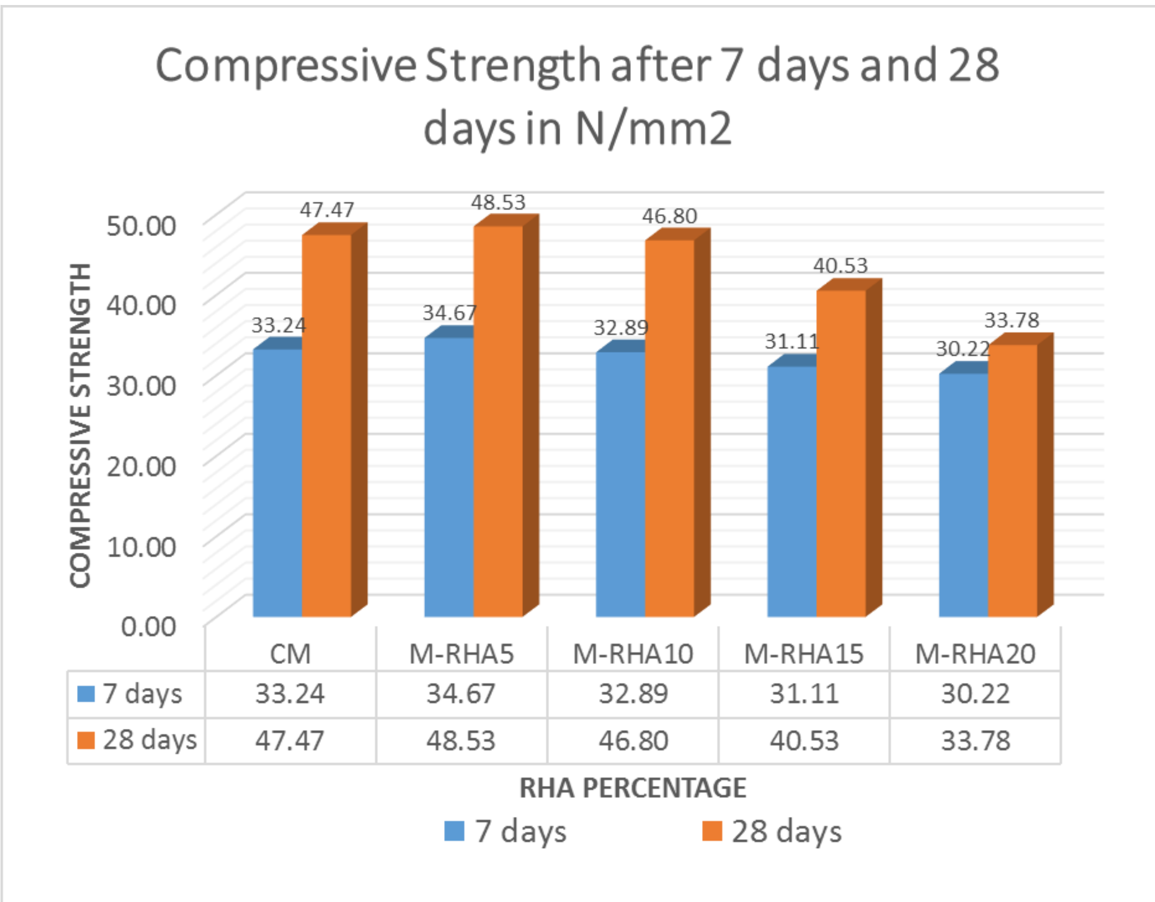

Fig 2.1: Strength (Compressive) after 7 and 28 days in N/mm2(Paramveer Singh)

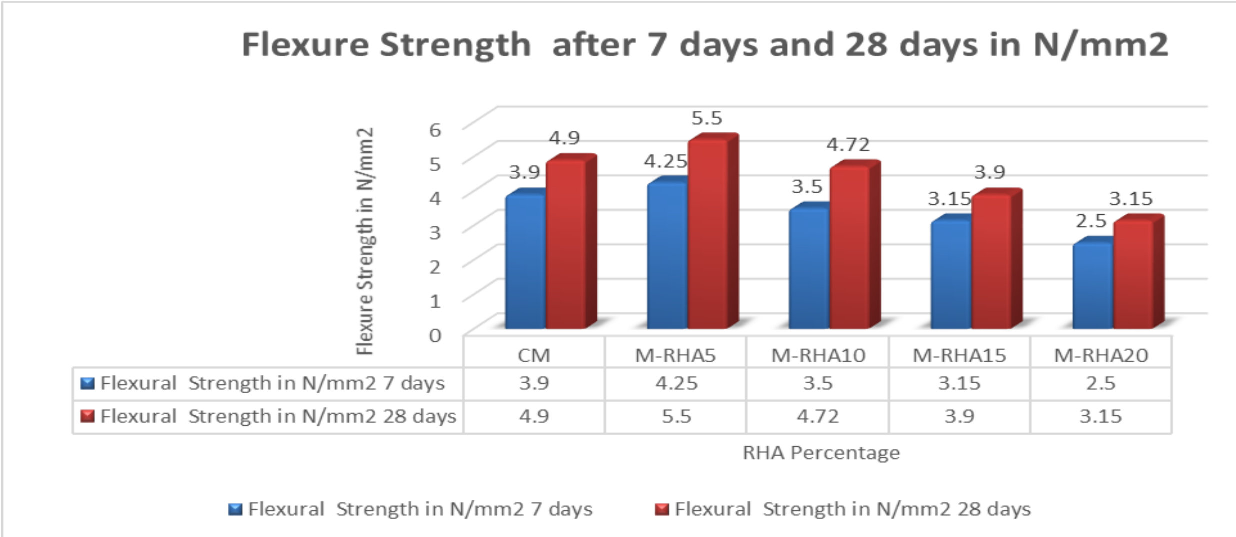

Fig 2.2 : Strength(Flexural) after 7 and 28 days in N/mm^2(Paramveer Singh)

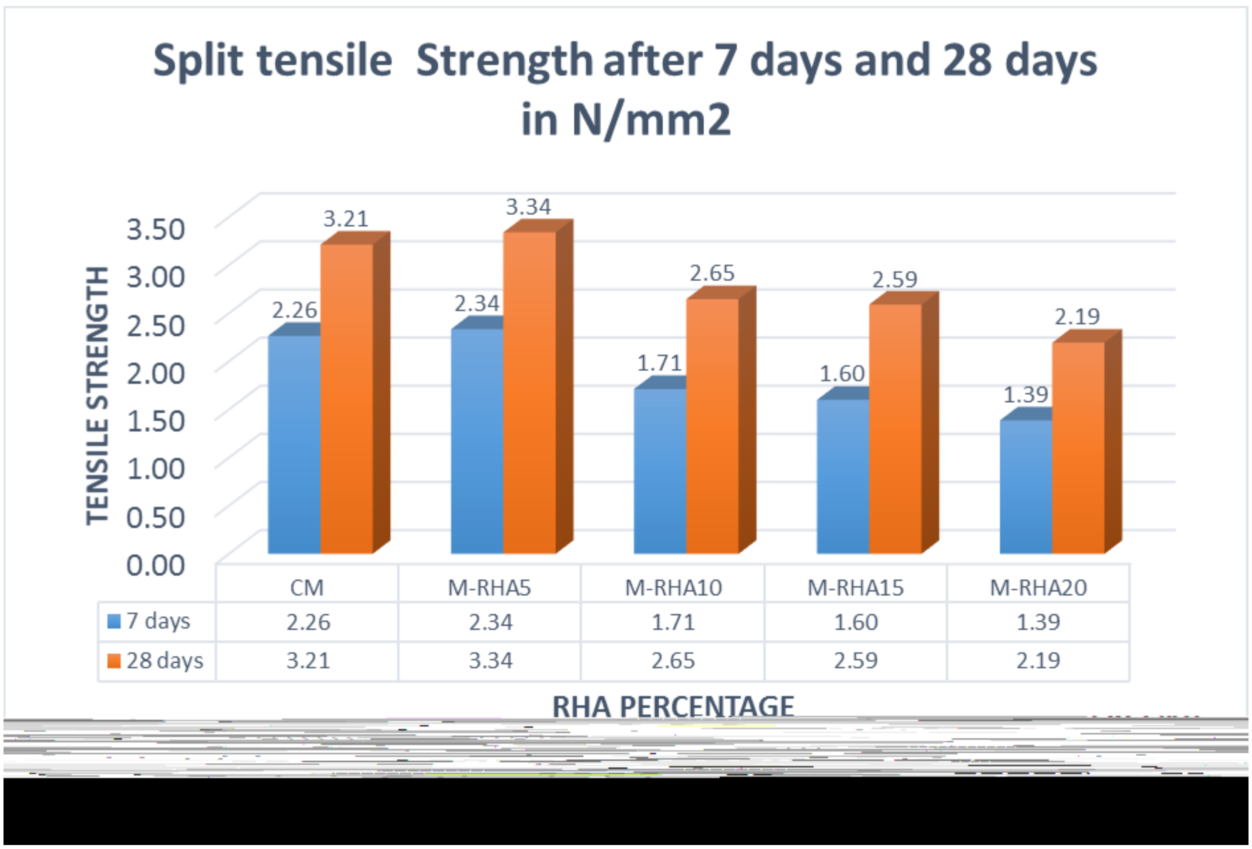

Fig 2.3: Strength(Split Tensile) after 7 and 28 days in N/mm^2(Paramveer Singh)

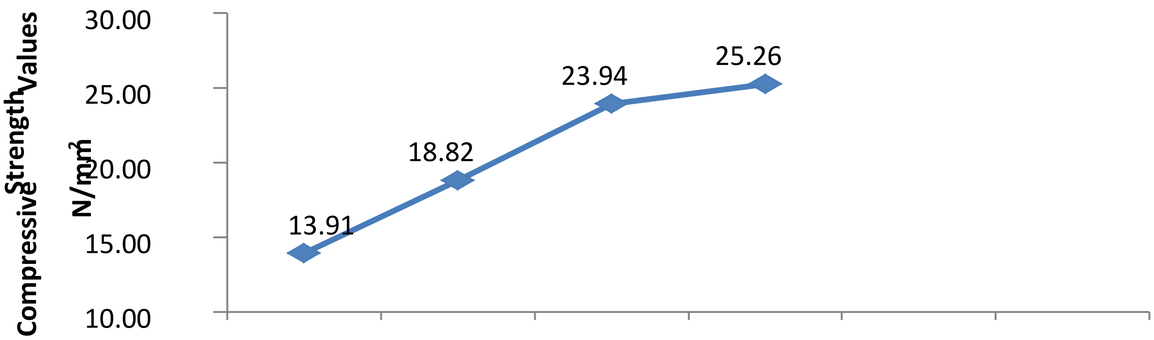

Figure2.5: Compressive Strength (N/mm^2)(Raheem S B and Awogboro O.S)

Dheeraj Kumar (2014) characterize the tensile properties of bamboo(treated) natural fiber polymer composite and states that the composite of bamboo-epoxy tensile strength increases to a level and then starts declining on further loading. 25 %(weight) of fibre load is the highest value of tensile strength.

Table 2.1: Bamboo fibre polymer composite Tensile strength

Designation	**Fibre Content (%)**	**Orientation (degree**	**Tensile Strength (MPa)**
B	0	RANDOM	18.16
B1	5	RANDOM	26.22
B2	10	RANDOM	37.98
B3	20	RANDOM	45.28
B4	25	RANDOM	53.61
B5	30	RANDOM	46.91

Dinesh Bhonde1,P.B.Nagarnaik,U.Waghe(2014)investigates the Bamboo Reinforced Concrete(BRC) Slab and found that BRC elements follows same pattern (crack pattern, load-elongation curve) as those in steel RCC structural member.

Easwary P and Annie J.P et al (2014) analyses the pavement quality concrete and dry lean concrete. In this study, he did not use the thickness of PQC and DLC (37.5mm) each but he used 75mm thick PQC slab. It was observed that

1. The failure load is higher for this size of the slab tested.
2. Deflection observed is very large before failure.
3. The DLC slabs can withstand the load for design deflection of 1.25 mm, which are prescribed for cement concrete pavements, without failure.
4. Load deflection curve appear to be ductile when compared with PQC slabs.
5. DLC slab withstand only 25 percent load when compared with PQC slab.
6. Among these slabs, the Pavement quality concrete and Dry lean concrete have same thickness (37.5 mm) and it yield the same load taking capacity as that of PQC slab of 75 mm.The multilayer slab with 2.5cm PQC meets the desire requirement of IRC58:2001 for stress of 4Mpa .

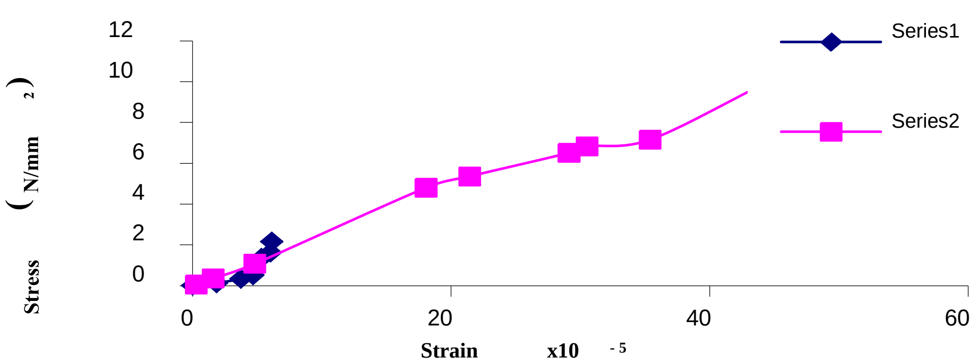

Figure2.6: Stress and Strain relationship of DLC and PQC(Easwary P and Annie J.P)

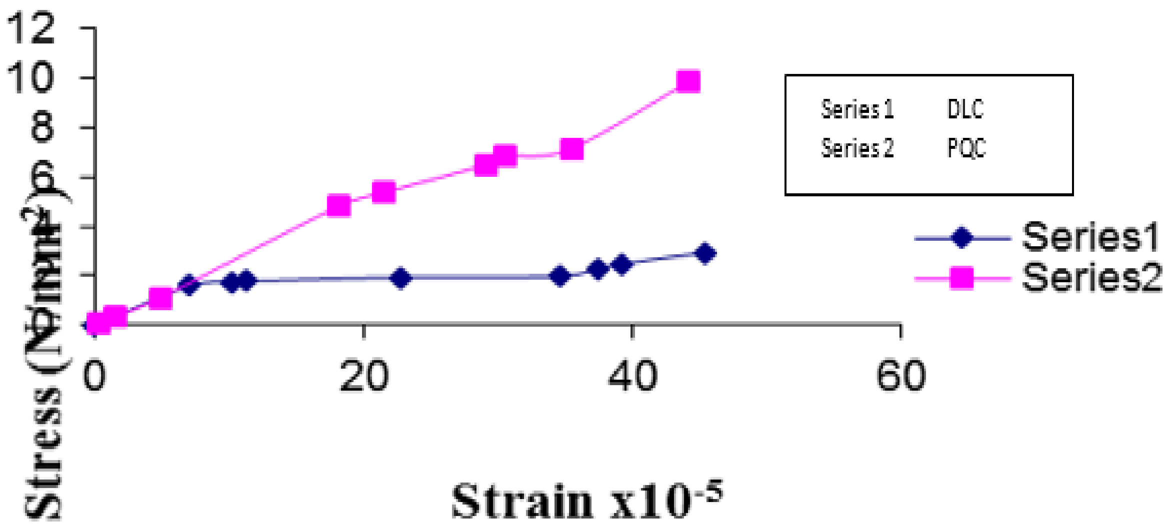

Fig 2.7: Stress and strain relationship of DLC 37.5 mm and PQC 37.5mm(Easwary P and Annie)

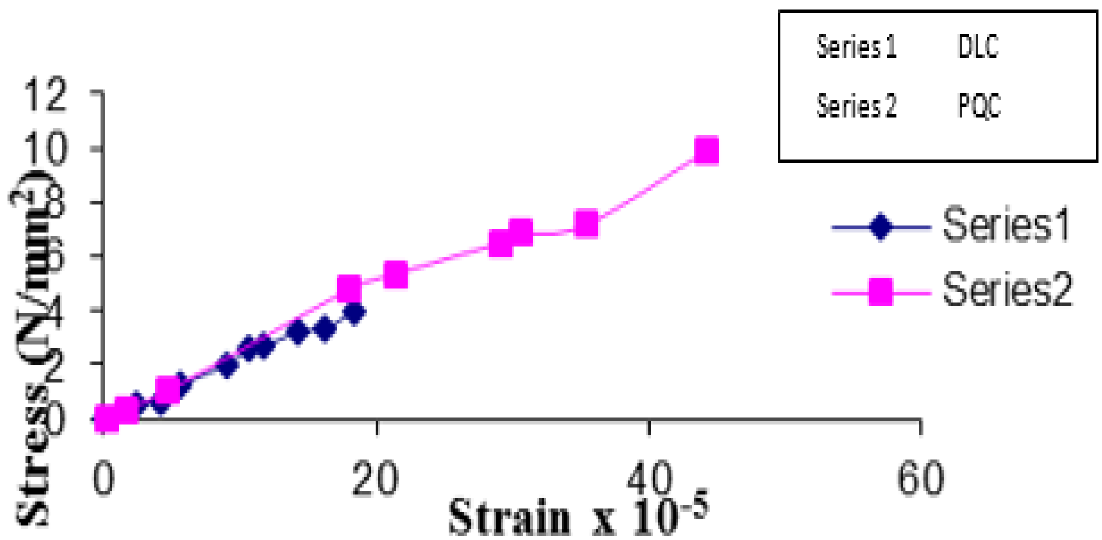

Fig 2.8 : Stress an strain relationship of DLC 50 mm(Easwary P and Annie J.P)

Panditaradhya B J et al (2014) shows the behavior of PQC with reclaimed asphalt pavement (RAP) aggregate. In this, RAP aggregate are replace with aggregate (natural) by percentage amount of 100, 75, 50 and 25%.

It was observed that

1. 25% replacement of RAP gives high compressive strength in comparison to other replacement percentages.

2. Highest flexural strength is shown by the reference mix and it is even higher than RAP replaced mixes. The strength of NC is near to the 25% RAP aggregates.

3. The mix 4 fail according to IS as its value is less up to 0.85 stress ratio. The concrete with RAP aggregates is generally use for pavements,roads; so its mostly used for pavements having low traffic.

b. Use of RAP aggregates also lower the load on aggregates for increasing the aggregates demand.

c. It helps in limiting the environmental imbalances and pollution.

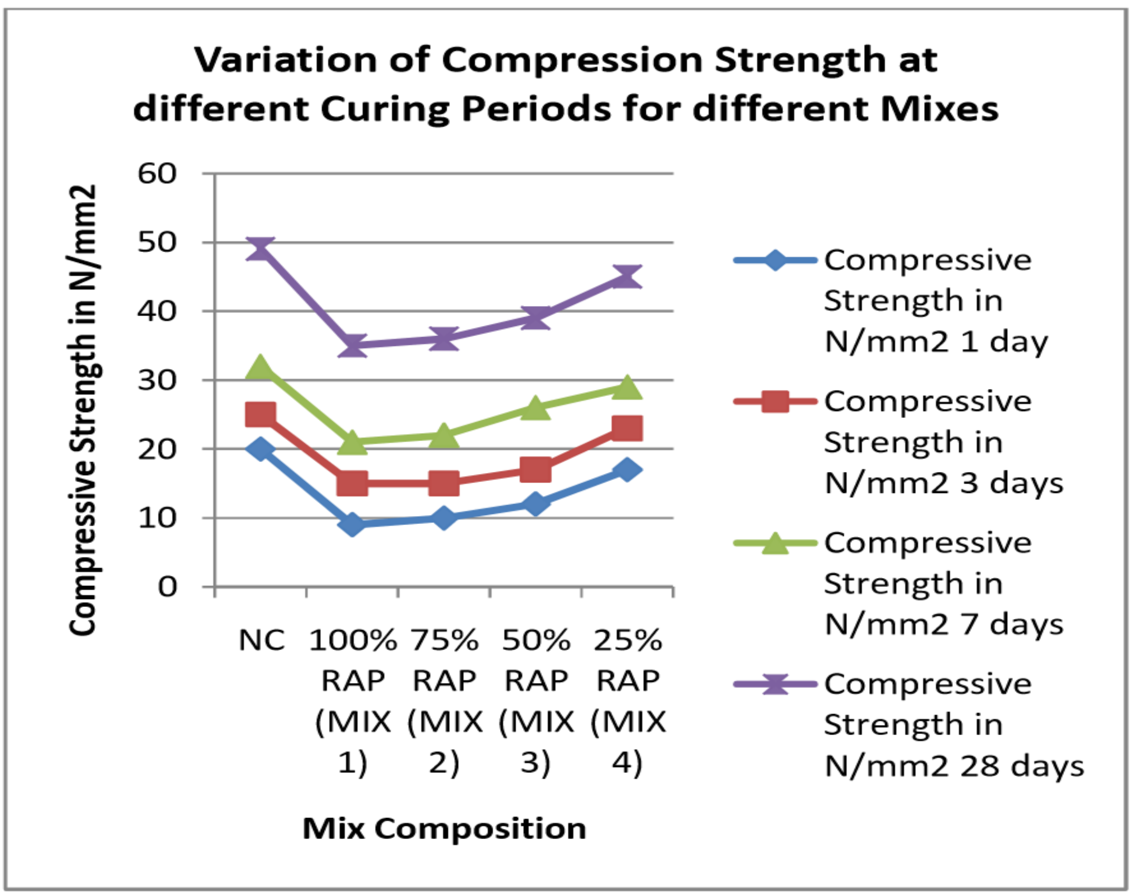

Figure 2.9: Compressive Strength Development(Panditaradhya B J)

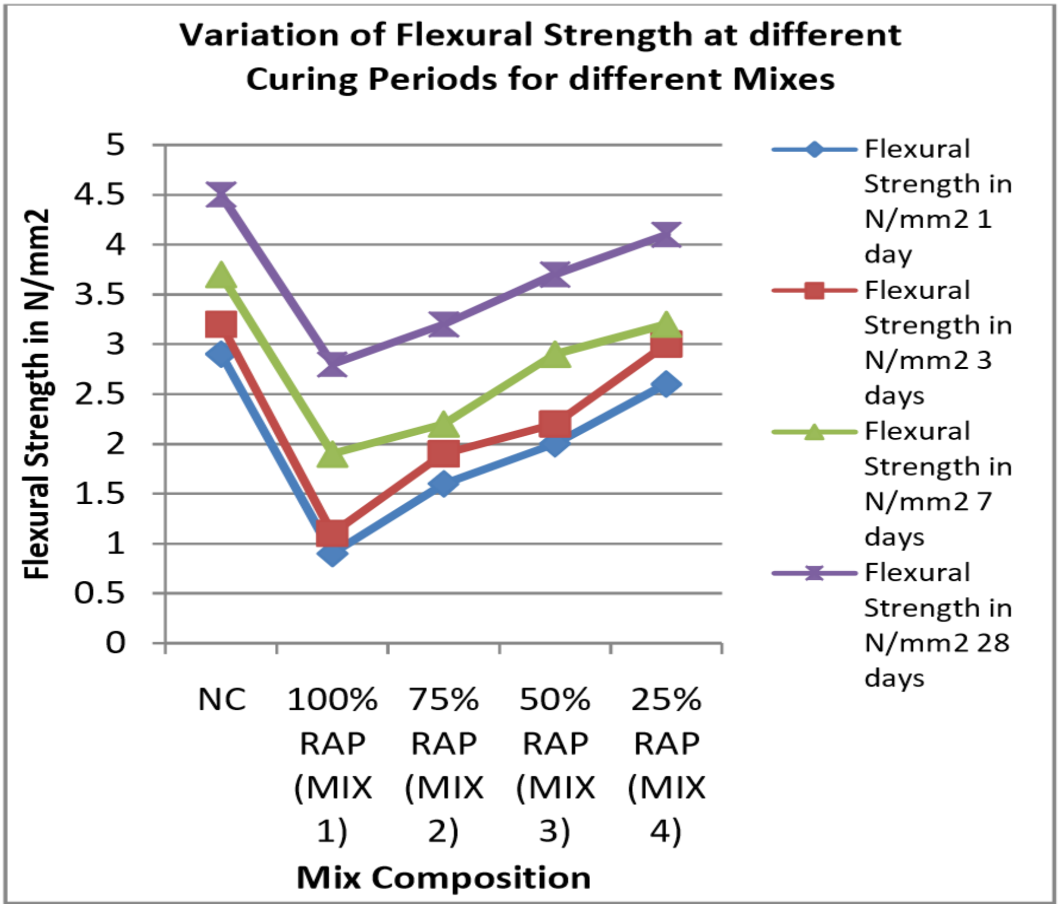

Figure 2.10: Flexural Strength Development of different mixes(Panditaradhya B J)

Anurag Nayak, Arehant S Bajaj, Abhishek Jain et al (2013) investigates the cost analysis of steel and bamboo reinforced slab. They conclude that structures reinforced with bamboo are more cheaper than steel reinforcement.

Table 2.2 : Cost estimation of steel and bamboo reinforcement

Item	Steel(Rupees)	Bamboo(Rupees)
Slab	20371	9146
Beam 1	5008	640
Beam 2	4162	454
Column and Footing	5110	530
Total	33072	10770

CHAPTER-3

OBJECTIVES OF THE STUDY

In my research work the main motive is to get high strength for M40 grade of concrete for different % replacement of steel reinforcements with bamboo fiber. The main objective for project is: -

1. To find the effect on flexural strength of concrete and optimize the thickness of pavement quality concrete by adding bamboo fiber into steel for different percentages.

Firstly my main objective is to examine the flexural strength of concrete by replacement of steel with bamboo fiber for Pavement Quality concrete as per MORTH specifications.

CHAPTER-4

SCOPE OF THE STUDY

High strengthen concrete M40 grade is used for experimental work. The steel is to be replaced (by weight) by bamboo by 10%, 20% and 30% to get optimized results. The properties like compressive strength and flexural strength for various mixes is to be examined at a different quantity of bamboo fiber. And the normal concrete specimens i.e., concrete specimens with no replacement also would cast out. The results are taken out after replacing steel compared with the normal concrete(NC) mix and then best result is taken into considered for practical application. This study is helpful in saving the overall cost of the project and help in using a natural occurring material as a replacement of steel.

CHAPTER-5

RESEARCH METHODOLOGY

5.1 MATERIALS

5.1.1 Cement

In this study OPC 43 grade cement for design mix as per IS 269-2015.The various properties of cement are found out i.e. compressive strength after 3, 7 and 28 days, specific gravity, consistency and initial and final setting of cement as shown in Table 6.1.

5.1.2 Coarse Aggregate

Coarse aggregate used in the experiment are mainly obtained from crashed stone with 20 mm and 10 mm size in 50:50 fraction respectively.

5.1.3 Fine Aggregate

Fine aggregate used for experimental work is of Zone II. The specific gravity examined is 2.68.

5.1.4 Water

The potable water is reasonable for mixing and curing of concrete.The water fit for drinking used for making concrete available in laboratories. This should be clear from any contaminants and should be of good quality.

5.2 Test Methods

The methods used to test the materials like cement, sand, aggregates (coarse) and concrete are given below:

5.2.1 Specific Gravity

It is define as the proportion of the weight of particular volume of a material to the weight of an equal volume of some mention substance, or consistently the ratio of the masses of equal volumes of 2(two) substances.

5.2.2 Sieve Analysis as per IS: 2386 (Part I) – 1963

The sieve analysis is used to distribute particle size and find the fineness modulus of aggregates.

Specific gravity of Coarse aggregates is 2.65 and that of fine is 2.68

5.2.3 LOS ANGELES TEST

Fig 5.1: Los Angeles testing machine

5.2.4 IMPACT VALUE TEST

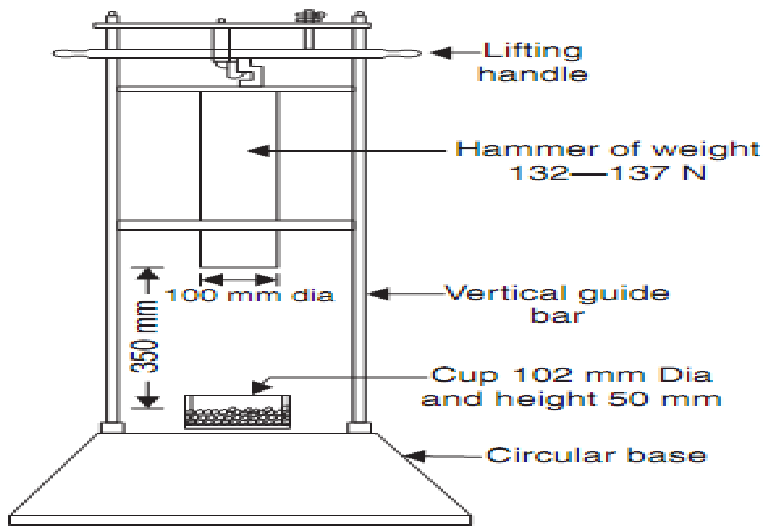

Fig 5.2: Aggregate Impact Testing Machine

In this study ,Design of Pavement Quality Concrete is to be done with the help of Bamboo fiber. Here we will partially replace the steel reinforcement with some percentage of bamboo fiber (i.e.10%,20%,30%) and we will check at which percentage it will give the maximum flexural strength .

The cubes and beams will be made and then we will check there compressive, tensile, flexural properties by using Compressive Testing Machine, UTM etc.

5.3 Flexural Testing of Concrete

Beams of sizes 100mm x 100mm x 500mm will be casted and then the flexural test will be done on these beams. The beams will be taken out from the curing tank after 7 and 28 days of curing and then allowed to place on the compression testing machine on beam attachment. The beams will will be tested by placing them uniformly. There are two types of flexural test basically. Two point and three point test. For a distance of 1/3rd from support from both ends.

Formula used for flexural strength ‘fb’

Fb=P.L/b.d2

When a distance is less than 13.3cm

Fb =3.P.a/b.d2

When a distance is less than 13.3 but greater than 11 cm.

And ‘a’ is the distance between the line of fracture and the nearer support measured in cm.

Specimen Width (W) = 100 mm

Specimen Depth (D) = 100 mm

Specimen Span (L) = 500 mm

The beams will be casted with the help of cement, fine and coarse aggregates in addition to bamboo as reinforcement along with steel bars and water. The different proportion of mixes will be casted like using bamboo as 10%, 20%, 30% replacement of steel. Before using the bamboo in the concrete mix we should use resin spray on bamboo so as to fulfill the water absorbation of bamboo fiber. Then we will fill the concrete mix into the moulds and leave it on vibrator so as to ensure proper compaction. The top of the concrete surface will be finished using trowel. At last the moulds will be placed in the curing tank and will be taken out from there after 7 and 28 days for testing.

Fig 5.3: Flexural testing machine

CHAPTER-6

RESULTS AND DISSCUSSIONS

6.1 EXPERIMENTAL RESULTS

6.1.1 CEMENT

Table 6.1: Properties of OPC 43 grade Cement

S .no.	Characteristics	Value obtained Experimentally
1.	Specific Gravity	3.15
2.	Standard Consistency	30.5%
3.	Initial Setting Time	150 minutes
4.	Final Setting Time	255minutes
5.	Compressive Strength	
	3 days	32.9 N/mm^2
	7 days	42.6 N/mm^2
	28 days	47.5N/ mm^2

6.1.2 COARSE AGGREAGTES

Table 6.2: Properties of Coarse aggregate

Characteristics	Description
Color of aggregates	GREY
Shape of aggregates	ANGULAR

6.2 SIEVE ANALYSIS

6.2.1 COARSE AGGREGATES(20mm)

Table 6.3: Sieve Analysis of Coarse aggregates (20mm)

S.no.	**IS-Sieve**	**Wt. retained (gram)**	**%age retained**	**% passing**	**Cumulative retained**
1	80	0	0	100	0
2	40	0	0	100	0
3	20	53	1.77	98.23	1.77
4	10	2938.5	97.95	.28	99.72
5	4.75	5.5	.18	.10	99.9
6	Pan	3	.10	0	
	Total=3000gm			SUM=201.38 FM=(201.38+500)/100=7.01	

6.2.2 COARSE AGGREGATES (10mm)

Table 6.4: Sieve Analysis of Coarse aggregate (10mm)

S.no.	**IS-Sieve**	**Wt. retained**	**%age retained**	**%passing**	**Cumulative retained**
1	100	0	0	100	0
2	80	0	0	100	0
3	40	0	0	100	0
4	20	0	0	100	0
5	10	201.2	67.07	32.93	0
6	4.75	958	31.93	1	67.93
7	Pan	30	1	0	99
	Total=3000gm			Sum=166.07 FM=(166.07+500)/100=6.66	

6.2.3FINE AGGREAGTES

Table 6.5: Sieve Analysis of fine aggregate

S.no.	IS-Sieve	Wt. retained	%age retained	%passing	Cumulative retained
1	4.75	6	.6	99.4	.6
2	2.36	5.9	5.9	93.5	6.5
3	1.18	22.	22	71.5	28.5
4	600micron	159	15.9	55.6	44.4
5	300micron	316.5	31.65	23.95	76.05
6	150micron	196.5	19.65	4.3	95.70
7	Pan	43	4.3	0	
	Total=3000gm			Sum=251.57 FM=251.57/100=2.51	

6.3 LOS ANGELES TEST

Weight of sample (w1) =5000gm

Weight of sample retained after rolling in machine for 500 times (W2) =4020gm

Weight of sample passing through 1.7mm sieve=W1-W2=880gm

L.O.A= (W1-W2)/W1=**19.75%**

6.4 IMPACT VALUE TEST

Weight of sample taken (W1) =0.589Kg

Weight of sample passing through 2.36mm sieve (W2) =0.160Kg

Impact value of aggregates= (W2/W1)*100=**27.3%**

6.5 Design Mix of Pavement Quality Concrete (PQC)

Step 1: As per clause **602** of MORTH Specification

Cement of 43 grade OPC as per **IS 8112** as per **602.2.2**

Coarse aggregate of 20 mm and 10 mm as per **602.2.4**

Los angles Abrasion (L.O.A) value should not be greater than 35%

Impact value should not be greater than 30%

Fine aggregate is Natural sand as per **IS 383 and of ZONE II**

Step 2: Design Parameter:

Characteristics flexural strength required at 28 days = 4.5 N/mm2

Maximum water cement ratio = 0.40 as per clause **602.3.3.1**

Maximum size of coarse aggregate = 20 mm

Degree of quality control = Good

Minimum cement content = 350 kg/m3 as per clause **602.3.2**

Maximum cement content = 425 kg/m3 as per clause **602.3.2**

Volume of cement=0.112m3

Volume of water=0.140m3

Volume of aggregates==0.747m3

Mass of coarse aggregates=1228kg

Mass of fine aggregates==761kg

So for M40 the ratio will be=1:2.17:3.5(cement: sand: coarse)

Water cement ratio =0.40

Table 6.6: Mix design for M40

MEAN TARGET FLEXURAL STRENGTH (N/mm^2)	MAXIMUM SIZE OF AGGREGATE (mm)	MIX PROPORTION (C:S:C.A)	W/C RATIO	WATER (Kg/m^3)	CEMENT (Kg/m^3)	FINE Kg/m^3	COARSE AGGREAGTE (Kg/m^3)
4.5	20	1:2.17:3.5	0.4	140	350	761	1228

C: Cement, S: Sand, C.A: Coarse aggregates, W/C: Water Cement

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