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Effect of Bamboo Fibre on the Properties of Pavement Quality Concrete

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Abstract: ***In this report we discusses about the settlement of rigid pavements utilizing bamboo fibre. The study aims to examine the practicability of using bamboo as a fibre in pavement quality concrete with 0.38 water/binder ratios. This report presents the detailed amount of fibre used ranging from 0 to 1.5% with a variation of 0.5% on trial basis.***
Since the concrete used in pavements requires high strength because of the high volume of traffic so the concrete has been made using silica fume with 3% by weight of cementitious material and which adds to the longer life of fibre. Also using mineral admixtures makes concrete less permeable and less the permeability more durable the concrete is.
Adding bamboo fibre up to 0.5% the compressive strength gets increased and beyond 0.5% of fibre addition the strength starts decreasing and as we keep on mounting the fibre percentage up to 1.5% the flexural strength also rises.

I. INTRODUCTION

A. *General*

Pavement is usually defined as an arrangement of layers and their prime function is to distribute the practical load to the sub grade. Rigid pavements have usually three layers namely sub grade, base layer and top most layers known as concrete slab. This concrete slab should be of above M35 grade of concrete as per IS recommendations and is called as paving quality concrete. Pavements are of two types namely flexible pavements and rigid pavements.

Since the controlled concrete alone cannot satisfy the strength requirements of pavements to overcome that we provide dowel bars near the expansion and longitudinal joints. Steel being too costly and difficult to transport makes it a lesser choice to be used in the pavements and a designer looks for an alternative that can provide close results. Bamboo having relatively high tensile strength almost 370 mpa makes it an effective alternative to the steel. Bamboo provides good results when used with the concrete and makes the concrete feasible and economical. But while using bamboo it should be kept in mind that whether the bamboo used is seasoned or not because bamboo should be free from moisture only then it can provide you good results.

The following points highlight the assortment of bamboo as reinforcement in concrete structures:

1) The plant should be three years of age at least having brown colour.
2) Culms with largest diameter should be preferred.
3) Unseasoned bamboo should be avoided.
4) Bamboo with moisture should also be avoided.

B. *Properties of Bamboo [Priyadarshee et al. (2014)]*

1) *Physical Structure of Bamboo:* This material has got the resemblance with wood because of its comparable chemical structure. However physical structure separates it from wood. Wood carries grains oriented within the identical direction in the course of the entire arrangement. On the outside periphery of every knot, twigs form special kinds of grass looking leaf structures. Bamboo consists of matching fibres that are armoured along the axial route of the Culm.
2) *Shrinkage and Swelling:* Gaining or losing moisture leads to the changes in the dimensions of bamboo. Since bamboo readily takes moisture from the surroundings, for that reason the dampness adjustments with the modifications within the relative wetness and temperature of the encompassing surroundings.
3) *Bending:* This factor decides the feasibility of bamboo as a building material, because of the bending skill of bamboo; it is supposed to be the best alternative to the steel in building structures.
4) *Elasticity:* Since the bamboo possesses excessive suppleness which makes it a unique construction material for earthquake threatened areas. Any other gain of bamboo is its low weight; it could be lifted and operated with an ease, hence eliminating the use of cranes and other hefty equipments.

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II. METHADOLOGY

This chapter draws the basic procedures regarding the study. This chapter basically helps us in getting a proper idea about the research and finally leads us to finish our work. The path followed so as to make this research successful is highlighted below:

1) Studying about pavement quality concrete and its design.
2) Studying of research and review papers to get the basic idea
3) Collection of all the materials so as to know their properties before starting the work
4) To prepare the design mix and to get the accurate quantity of materials.
5) To make the perfect use of both the mineral and chemical admixtures
6) Preparing controlled concrete so as to get the target mean strength
7) Preparing of concrete to get the required strength as per grade of concrete.
8) Casting of the specimens.
9) Tests on hardened concrete.
10) Analysis and conclusion about the project.

III. MATERIALS

Selection of materials plays an important role in designing a grade of concrete and their selection wholly depends upon the respective grades and the required slump. The materials that have been used in this research are Silica fume, bamboo fibre, coarse and fine aggregates and Ordinary Portland cement of 43 grade and chemical admixture namely Poly carboxylic ether. The blend for concrete of M40 grade has been designed as per IS 10262 : 2009 and IS 456-2000.

IV. RESULTS AND CONCLUSION

This part of research draws the conclusion on the research as it includes all the test results. The portion includes all the 7 days and 28 days test results for both the compressive strength and flexural strength and apart from that it includes all the properties of materials used .

Table.3: Average 7 days Compressive strength test results

Percentage of fibre (%)	Slump value mm	Average load in KN	Avg. Compressive strength N/mm^2
0	36	630	28
0.5	35	650	28.88
1.0	33	612	27.2
1.5	30	595	26.44

Table.4: Average 28 days compressive strength test results

Percentage of fibre (%)	Slump value (mm)	Average load in KN	Average Compressive strength N/mm^2
0	36	920	40.88
0.5	35	962	42.75
1.0	33	910	40.44
1.5	30	880	39.11

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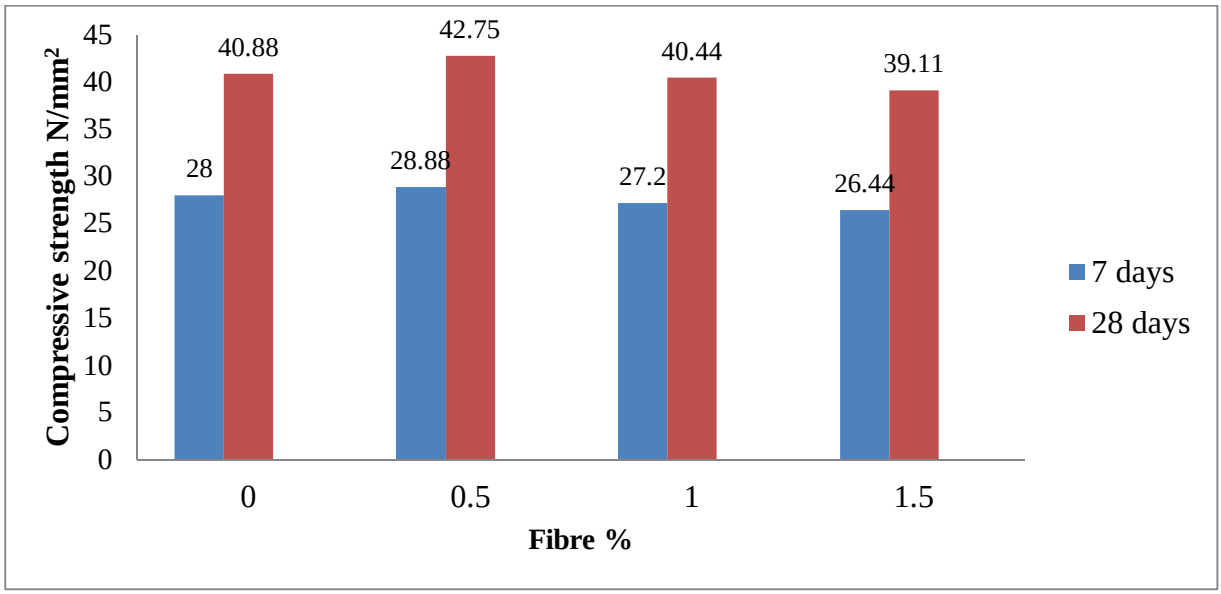


Fig. 3: 7 and 28 days Compressive strength results

A. Flexural Strength Test

To check the bending ability of beams usually flexural strength test machine is used but here slabs were casted so the flexural strength was checked on universal test machine using three point loading. A total of two supports were provided and a point load was applied on the slab apart from this two strain gauges were fixed on the opposite corners of slab and moreover slabs were kept diagonally on the supports. The two strain gauges providing the deflection and the two supports provided help the slab in bending. The dimensions of the slabs were 600mm*500mm*75mm and total of sixteen slabs were casted for 7 days and 28 days of curing including four extra slabs with steel reinforcement, the test results showed that with the enhance in fibre percentage up to 1.5 % the flexural strength keeps on increasing and after that the results were compared with the steel reinforced slabs.

B. Discussion

As the compressive strength decreases with the increase in fibre percentage the reason being lesser dimensions of the specimens which is not allowing the extra fibre to get mixed properly along with the other materials present in the mix, but in case of slabs the flexural strength keeps on increasing with the increase in fibre percentage. Since the dimensions of the slabs are larger it helps the fibre in spreading uniformly and the fibre gets a chance of forming a proper bond in between the aggregates as a result it increases the bending ability of specimens.

Table.5: Average 7 days flexural strength

Size of the specimens = 600mm*500mm*75mm								
Percentage of fibre	Gauge A		Gauge B		Time(min)	Load KN	Displacement	Flexural strength N/mm^2
	Initial	Final	Initial	Final				
0	0	0.43	0	0.93	6	45	0.1	1.2
0.5	0	0.20	0	0.30	6	48.95	0.1	1.3
1.0	0	0.10	0	0.05	6	52.5	0.1	1.4
1.5	0	0.10	0	0.03	8	57	0.1	1.52

Table 6: Average 28 days flexural strength

Percentage of fibre	Gauge A		Gauge B		Time(min)	Load KN	Displacement	Flexural strength N/mm^2
	Initial	Final	Initial	Final				
0	0	0.90	0	0.40	8	55	0.4	1.46
0.5	0	0.60	0	0.40	9	63	0.1	1.68
1.0	0	0.40	0	0.25	9	78	0.2	2.08
1.5	0	0.20	0	0.03	12.5	86	0.2	2.29

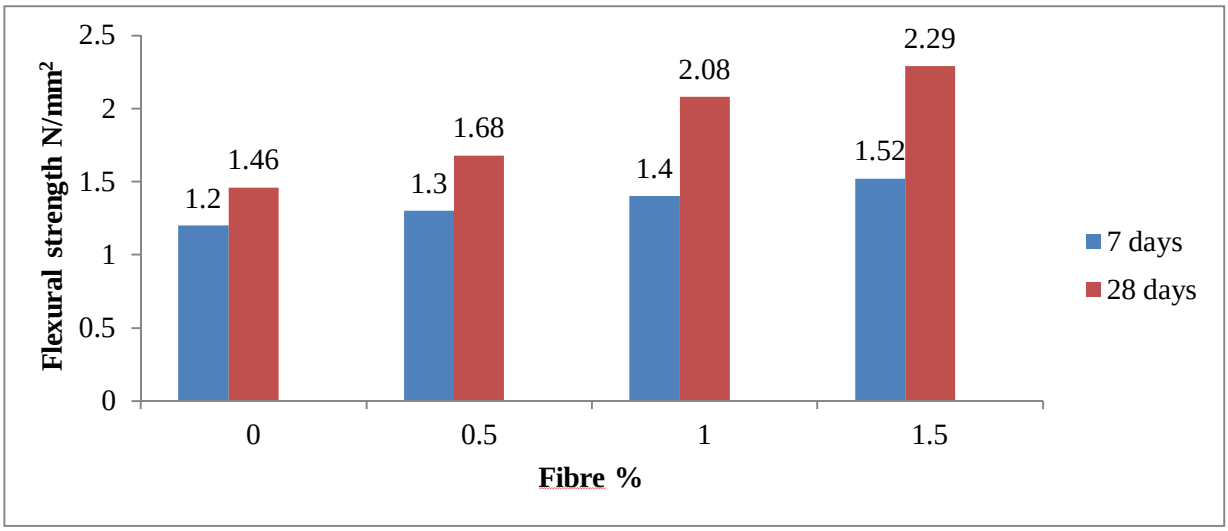


Fig. 4: 7 and 28 days flexural strength results

Table 7: Average 7 days and 28 days flexural strength of slabs with steel reinforcement

Size of the specimens = 600mm*500mm*75mm,Minimum area = 0.12% of b*d Dia. Of bars = 8mm								
Age of days	Gauge A		Gauge B		Time (min)	Load KN	Displacement (mm)	Flexural strength N/mm^2
	Initial	Final	Initial	Final				
7 days	0	0.8mm	0	0.6mm	3	65	0.1	1.73
28 days	0	0.4mm	0	0.1mm	13	96	0.1	2.56

V. CONCLUSION

1) After designing the proper mix for M40 grade of concrete, the percentage of super plasticizer fixed to get the required slump for controlled concrete was changed as the bamboo fibre was added to the concrete. Since the fibre absorbs too much moisture and for high grades of concrete like M40 we are supposed to reduce the quantity of water to get the desired strength so adding fibre to the concrete decreases the workability. To make the concrete workable the percentage of super plasticizer was increased. So with the increasing fibre percentage the slump value decreases but lies within the range.

2) To get the required 28 days strength for M40 grade of concrete it usually takes too many trials to achieve the feat. Initially the strength of controlled concrete was achieved after almost taking 6 trials, but the target was getting the strength of fibre reinforced concrete. Since the fibre absorbs moisture that makes concrete more permeable this in turn decreases the strength so the use of mineral admixture is recommended. Using 0.6% of poly carboxylic ether and 3% of silica fume the compressive strength for both the controlled and silica fume based concrete is satisfied.

3) Since the dimensions of cubes are lesser this does not allow extra quantity of fibre to get mixed properly so the strength decreases after increasing the percentage of fibre. That is why earlier accomplishment of strengths was seen with the increase in fibre percentage up to 0.5%.

4) Beyond 0.5% of fibre the strength started decreasing as the extra fibre could not make the proper bond in between the aggregates.

5) As we keep on increasing the percentage of fibre the flexural strength keeps on increasing and the chances of resisting bending also increases. This is due to the reason that the dimensions of slabs are larger which helps the fibre in spreading uniformly and the fibre gets a chance of forming a proper bond in between the aggregates as a result it increases the bending ability of specimens.

6) Up to 1.5% of fibre addition the flexural strength gets close to that of steel with the minimum reinforcement of 0.12% of b*d and of dia. 8mm.

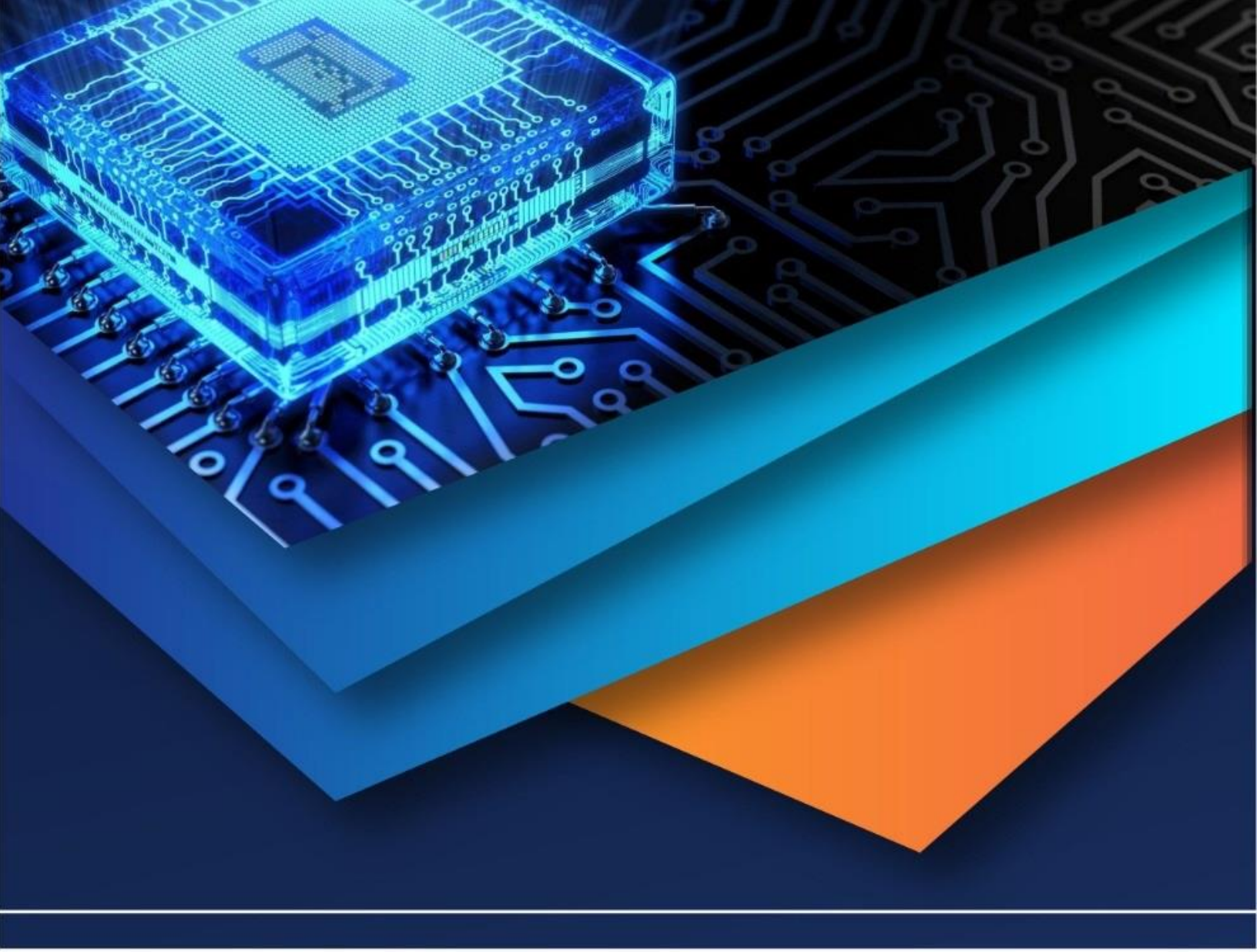
7) The compressive strength of normal based curing is far different from sodium hydroxide based solution.

8) The weight of the specimens along with the strength also decreases with the effect of bases.

9) Changes in the dimensions have also been noticed because of the sodium hydroxide effect on specimens.

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