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Effects of freezing and thawing on hybrid fibre reinforced concrete

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ABSTRACT

Fibre reinforced concrete is predominantly adapting to enhance the properties of concrete now a days. Majorly banana fibre is one of the largest producing fibres in the world and easily available material. Basalt Fibre is also predominantly using in the construction industry due to its fire resistance property. Concrete has certain deficiencies like brittleness and poor resistance to impact load and low durability are found common in concrete. In the present work banana and basalt Fibres are introduced in to the conventional concrete to overcome certain deficiencies. Addition of Fibres about 0.1%, 0.2% and 0.3% of both basalt Fibre and banana Fibre in the conventional concrete and conducted strength tests like compression, splitting tensile strength, impact and durability tests like salt immersion, freezing and thawing. The results obtained are compared without Fibres samples and the studies concluded that there is an improvement in compressive strength, splitting tensile strength and more improvement observed in impact strength.

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1. Introduction

Now-a-days, the increment of financial, social and natural issues necessarily requires minimal expense and sustainable construction materials [1,2]. Consequently, there is a persistent need to set up advantageous and moderate houses. This is essential since more than one billion people on the planet are either destitute or living in poor houses [3]. Utilizing raw materials from the misuse of plant and materials which are gotten with no skill of labor and effort offers numerous ecological advantages. As of late, utilizing the common materials as a substitute for modern materials is viewed as a harmless to the ecosystem material for a few works. Stiffness and strength much increased by reinforcement, which is helpful in bearing loads. The fibres can be artificially manufactured or naturally obtained which are used as the substitute of reinforcement. Artificial fibres utilized for manufacture of fibre reinforced composites can be addressed by glass, carbon, boron and ceramic substances [4,5]. Past examinations represented that the length and the volume of fibre portion contribute essentially to the strength created by the fibre reinforced composites [6,7]. These examinations showed that the materials which are basically embraced in composites creation can be represented by metals, polymers and ceramic materials. Composite materials procured by consolidating normal fibres with number of components are called (Natural Fibre Reinforced Composites). Most commonly Fibre Reinforced Composites are being utilized in many applications due to their simple availability and eco-friendly nature. Fibre reinforced composites have been utilized in numerous fields of industry like space, aircraft assembling, vehicle and marine ventures, furniture, etc. [6,8]. Jute and untreated banana fibers are used to develop hybrid natural composite and are chocked randomly. Wear test was conducted on the standard prepared sample with different percentages. Results showed that epoxy resin composites materials of 30%, 30% and 40% weight withstanding higher load compared to different mixes fiber composites. Also absorbed that wear and frictional force was increased when load value increased with constant speed [16]. Boerhavia Diffusa root and Luffa fibers are used to study the properties of hybrid natural root fiber reinforced polymer (NRFRP) in epoxy resin matrix. The results showed that NRFRP composites giving good compressive strength and can be used for applications like automotive and engineering where high compressive strength is reuired [17].

1.1. Banana fibre

Banana fibres obtained from the pseudo-stem of the banana plant (Musa sapientum) which is lignocellulosic fibres. Such fibre

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with mechanical properties is suitable to be used as reinforcing material [10,11]. However, the use of banana fibres is as yet restricted using in reinforced concrete constructions and needs more examinations. The sustainability of utilizing such normal and renewable resources in construction materials produces eco-friendly materials and develops the designing innovation [12,13].

1.2. Basalt fibre

In recent times there is wide use of basalt fibre in concrete composites. Basalt fibre originating from volcanic rocks is used in concrete composites. The essential attributes of these inorganic fibres are high strength, having resistance against corrosion, good thermal stability, protection from acids and alkalis [14]. The manufacture of basalt fibre is like that of glass fibre, yet with less energy taken and no added substances likewise in glass or carbon fibres, which makes it less expensive. Further, basalt fibres have less mass loss proportion lower than that of glass in chemical solution so they have good resistance against chemical attacks [15]. The deformation and energy absorption capacity of the concrete is improved by adding basalt fibre without any change in compression strength [9].

1.3. Scope of the work

Erosion and loss of concrete takes place in concrete in seawater. Attack of sea water erosion or loss of constituent of concrete without undue expansion. In this case the effects should be reduced by adding fibres. In concrete freezing and thawing is a process of erosion that happens in cold areas repeated freezing and thawing in concrete cause cell damage to it at temperature where bacteria can grow. As we know that concrete is weak in tension but there is a chance of developing an idea for increasing the tensile strength on concrete. By adding fibres like Banana fibre and basalt fibre to overcome brittle nature of concrete and behavior of marine, freezing and thawing of cement concrete structures.

Table 1
Quantity of materials required for 1 m^3 of M20 grade of concrete are.

Material	Quantity
Cement	406 kg/ m3
Fine aggregate	691.41 kg/ m3
Coarse aggregate	1114.08 kg/ m3
Water cement ratio	0.5

To determine the tensile strength of concrete when fibres are added. To compare strength parameters of concrete by Salt immersion, freezing and thawing and freshwater immersed samples. To determine cracking and breaking point of a fibre reinforced concrete.

2. Materials and methodology

2.1. Materials

Specific gravity and fineness of cement are 3.16 and 8%. Specific gravity, fineness modulus and zone of fine aggregate are 2.75, 2.63 and II respectively. Specific gravity of coarse aggregate is 2.66. The mix proportion according to IS: 10262-2019 is 1: 1.7: 2.74 (see Table 1).

2.2. Methodology

Initially materials were collected and the basic properties were tested and M20 grade of concrete is considered and the mix proportion is designed according to the procedure given in IS 10262-2019**.** Addition of fibres about 0.1%, 0.2% and 0.3% of both basalt fibre and banana fibre in the conventional concrete the samples were shown in Fig. 1**.** and conducted strength tests like compression, splitting tensile strength, impact and durability tests like

Fig. 2. Freezing and Thawing samples.

Fig. 1. Prepared Samples.

fresh water curing, salt curing and freezing and thawing shown in Fig. 2**.** The results shown in Fig. 3**.** obtained are compared without fibres samples and based on the results the conclusions were made.

3. Results

Compressive strength is found using basalt and banana fibers in three different curing conditions like fresh water, salt water, freez-

Fig. 3. Testing of Specimens.

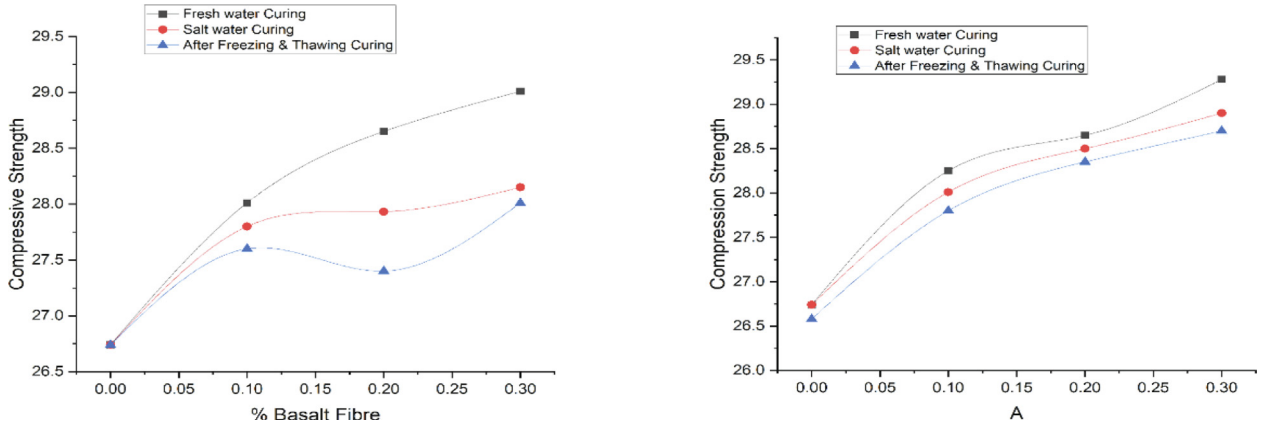

Fig.4. Compressive strength of concrete using different fibre addition.

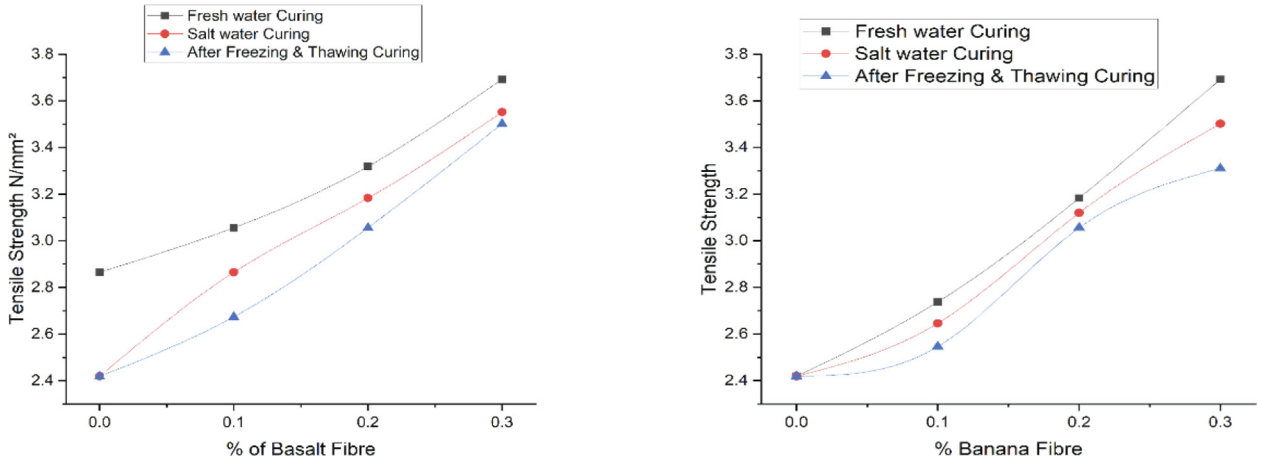

Fig. 5. Split tensile strength of concrete using different fibre addition.

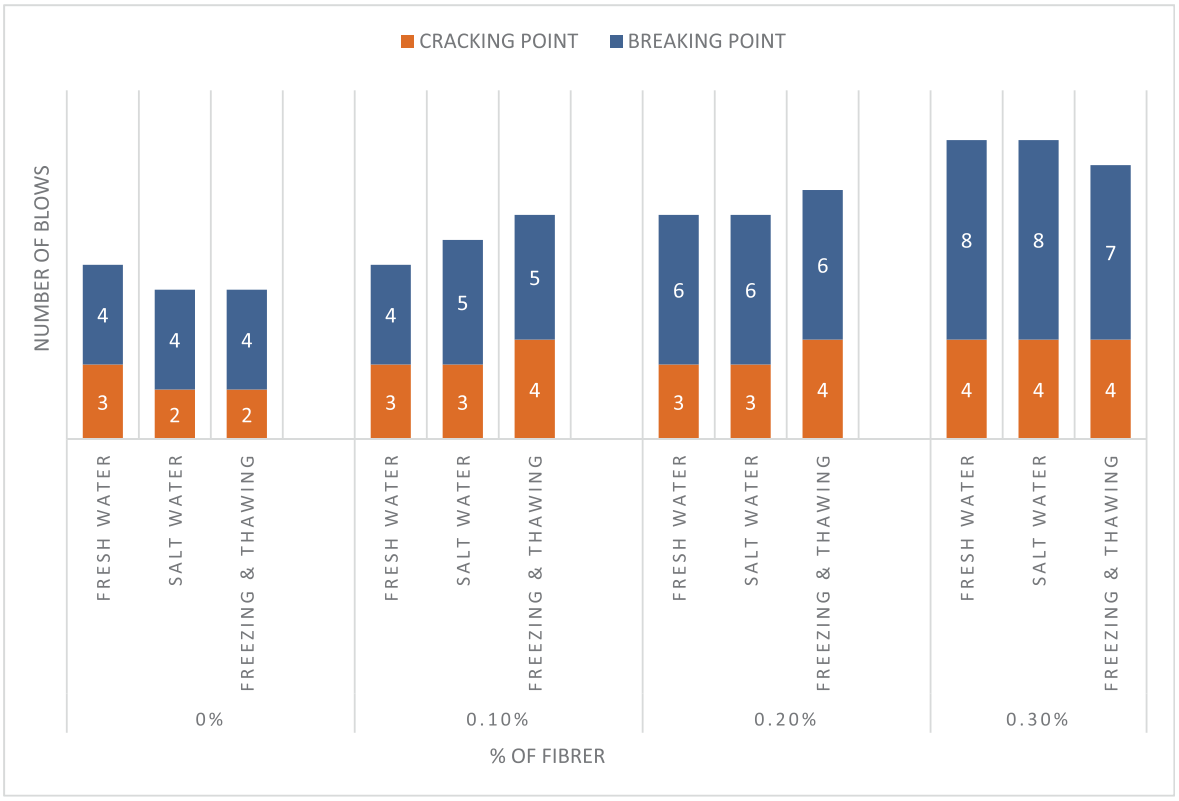

Fig. 6. Impact strength of concrete using different fibre addition.

ing and thawing for three different addition percentages i.e., 0.1%, 0.2%, 0.3% and the results were drawn and are shown in Fig. 4.

Above Fig. 5 shows the split tensile strength of concrete using basalt and banana fibres in three different curing conditions like fresh water, salt water, freezing and thawing for three different addition percentages i.e., 0.1%, 0.2%, 0.3% and the results were drawn.

Impact strength values were represented in Fig. 6 using basalt and banana fibers in three different curing conditions like fresh water, salt water, freezing and thawing for three different addition percentages i.e., 0.1%, 0.2%, 0.3% and the results were drawn.

4. Conclusions

Based on the results the following conclusions were made.

The addition of banana fibre up to 0.3% compressive strength showing better results compared to basalt fibre. And the values are same for all the three different curing conditions.

The addition of 0.3% basalt fibre splitting tensile strength of concrete giving better results compared to banana fibre. And in salt water and freezing and thawing conditions the compressive strength are less than fresh water curing samples.

The impact values like cracking point and breaking point of the basalt and banana fibre when added combinedly the values for salt water curing and freezing and thawing conditions were getting same as fresh water curing condition.

CRediT authorship contribution statement

Swamy Yadav Golla: Conceptualization, Data curation, Formal analysis, Funding acquisition, Methodology, Project administration, Resources, Supervision, Validation, Writing – original draft, Writing – review & editing. **N. Prabhanjan:** Investigation. **M. Sravanthi:** Investigation. **K. Stella:** .

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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