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EXPERIMENTAL STUDY ON HIGH STRENGTH CONCRETE WITH ADDITION OF HEMP FIBER

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Abstract - *Hemp (Cannabis sativa) is one of the most available and widely produced bast fibers with high cellulose content. Interest in these fibers is warranted due to environmental protection challenges as well as their inherent properties such as low density, high specific strength, and stiffness. In addition, advanced research and progress have gone into increasing their mechanical performance through surface treatments and in the development of new materials. The most promising application for hemp fibers is as reinforcement in polymeric composites or through hybridization. Nonetheless, more research is needed to improve their properties and expand their range of applications. The biodegradability issue is one problem that must be addressed when considering long life-cycle applications as the reproducibility of these composites' final properties. This review is a comprehensive literature review on hemp fibers. It includes hemp fibers chemical and mechanical properties, surface modifications, hybrid composites, as well as current and future applications. The focus on High Performance concrete (HPC) has immensely increased due to utilization of large quantity of concrete, thereby leading to the development of infrastructure Viz., Buildings, Industrial Structures, Hydraulic Structures, Bridges and Highways etc. This paper includes the detailed study on the recent developments in High Performance Concrete, stressing more on the earthquake prone areas. It highlights the advantages and importance of High Performance concrete over conventional concrete. In this process adding fly ash and hemp fiber in addition to the High Strength Concrete. According to this the addition of fly ash and hemp fiber varies. The constant adding percentage of fly ash is 15% and hemp fiber varies like 0.05, 0.1, 0.15*

Key Words: Hemp fiber, Bast fiber, Fly ash, High Strength Concrete (HPC), etc..,

1 INTRODUCTION

1.1 General

Concrete is a mixture of cement, fine aggregate and coarse aggregate, which is mainly derived from natural resources. Increasing population, expanding urbanization, climbing way of life due to technological innovations has demanded a huge amount of natural resources in the construction industry, which has resulted in scarcity of resources. This scarcity motivates the researchers to use, solid wastes generated by industrial, mining, domestic and agricultural activities. They also studied the relationship between the concrete made using this type of materials; environmentally friendly concrete and green building rating systems. Issues like emission of carbon dioxide, use of energy, water, aggregates, fillers and demolition waste in concrete look less compatible with environmental requirement of a modern sustainable construction industry. At the same time, concrete made using agricultural wastes has shown better mechanical and durability properties in research which can result in sustainability points in the energy.

1.2 OBJECTIVES

The main objective of this study is to determine the suitable percentage of Fly ash and Hemp fiber in addition to the mixes and also to compare the results of two mixes.

1.3 SCOPE

To determine the properties of the materials. To examine the mechanical properties of hardened concrete. To determine the permeability range.

2 CONCRETE

2.1 LITERATURE REVIEW

The model data is based on a previous experimental study encapsulating natural industrial hemp fibers in plain concrete mixes, where twelve mixes were considered including one without fibers (control mix), one with polypropylene fibers, and ten with industrial hemp fibers [10]. Various physical and mechanical properties of hemp fibres were evaluated to assess their suitability for use as reinforcement incomposite materials [6]. The focus on High Performance concrete (HPC) has immensely increased due to utilization of large quantity of concrete, thereby leading to the development of infrastructure Viz., [8] .Study on the use of natural hemp fibers as a composite in concrete mixes to improve performance of construction components and reduce depletion in natural resources [3]. One method of increasing the mechanical properties of natural fiber composites is by hybridizing them with another synthetic or natural fiber of superior mechanical properties [4].

2.2 PROPERTIES OF HIGH STRENGTH CONCRETE

The properties of high strength concrete are significantly different from those of normal strength concrete. These properties are examined in this section when the concrete is setting and hardening as well as in the hardened state. These properties should be taken into account while designing structures using high-strength concrete.

2.3 ADVANTAGE OF HIGH STRENGTH CONCRETE

The main advantages of high strength concrete are the following: Reduction in member size, resulting in an increasing in the usable floor space, a reduction in the quality of concrete, and a consequent reduction in construction time. Reduction on self-weight and a consequent reduction in the foundation in the foundation cost. Reduction in the area of the formwork and the time required for stripping forms. The ability to withstand large column loads with reasonable sizes of columns. Provision of large spans or elimination of a few columns or smaller beams for comparable spans, leading to a reduction in the story height from headroom considerations. Reduction in axial shortening effects in columns. Reduction in floor thickness and beam height. Elimination of a few footing because of adoption of larger spans. Superior durability and long- term performance. Lower creep and shrinkage. Larger stiffness as a result of a larger value of young's modulus of concrete. Reduced maintenance costs.

2.4 APPLICATION OF HIGH STRENGTH CONCRETE:

In the context of tall buildings and large-span bridges, it is clear that use of high-strength concrete leads to reduced column sizes and beam depths, in addition, if results in improved performance in terms of creep, shrinkages, and other elastic properties that yield a more favorable deformation pattern for tall buildings. The improved elastics properties also limit the sway and reduce elastic shortening and other secondary's effects. Hence high strength concrete has found applications of various structures use.

3 MATERIALS TO BE USED

3.1 CEMENT

Cement is a binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel, produces concrete. Concrete is the most widely used material in existence and is only behind water as the planet's most-consumed resource.

3.2 M-SAND

Manufactured is an alternative for river sand. Due to fast growing construction industry, the demand for sand has increased tremendously, causing deficiency of river sand in most part of the world. Due to depletion of good quality river sand for the use of construction, the use of manufactured sand has been increased. Another reason for use of M Sand is its availability and transportation cost.

3.3 COARSE AGGREGATE

Coarse aggregate is mined from rock quarries or dredged from river beds, therefore the size, shape, hardness, texture and many other properties can vary greatly based on location. Even materials coming from the same quarry or pit and type of stone can vary greatly. Most generally, coarse aggregate can be characterized as either smooth or rounded (such as river gravel) or angular (such as crushed stone).

3.4 FLY ASH

Fly ash is a fine powder that is a by product of burning pulverized coal in electric generation power plants. Fly ash is a pozzolan, a substance containing aluminous and siliceous material that forms cement in the presence of water. When mixed with lime and water, fly ash forms a compound similar to Portland cement.

3.5 HEMP FIBER

Hemp is a bast fiber plant similar to Flax, Kenaf, Jute, and Ramie. Long slender primary fiber on the outer portion of the stalk characterized bast fiber plants. It was probably used first in Asia. *Hemp* is also one of the bast fiber known to ancient Asians, long before the birth of Christ. The outer material contains the prized bast fibers and the inner is the hard, which is made up of short fibers. There are three main stages of producing fiber from industrial hemp – harvesting, retting and separation. Hemp is a sustainable and environmental friendly crop that can provide valuable raw materials to a large number of industrial applications. Traditionally harvested at full flowering for textile destinations, nowadays hemp is mainly harvested at seed maturity for dual-purpose applications and has a great potential as multipurpose crop. However, the European hemp fiber market is stagnating if compared to the growing market of hemp seeds and phytocannabinoids.

Hemp fibers have been used for centuries to manufacture clothes, bags, shoes, paper, building materials and insulation purposes.

Hemp fiber is also used as a food and is not the same as cannabinoids used for intoxication purposes. Hemp is cheaper than wood and it is a better material to be used for insulation purposes. Wood or timber is costly. These days it is not advisable to cut down trees keeping in mind the huge

loss it causes to our environment and biodiversity.Matrix options are limited due to lower processing temperatures. Poor matrix-fiber interfacial adhesion. Flammable, sensitive to UV, microbial, and fungus attack.

4 CONCRETE MIX DESIGN

The study uses the design mix M60 grade of concrete using 43 grades OPC in the study. The Mix design was performed as per IS 10262: 2009. The water cement ration for mix is 0.33. The following mix proportion was obtained from the mix design.

Table -1: MIX DESIGN (CEMENT; SAND; AGGREGATE)

CEMENT	SAND	AGGREGATE
376	620	1285
1	1.649	3.4

5 CASTING & CURING

For compressive strength the standard size of cube mould is 150 mm × 150 mm × 150 mm used. After casting, each cube should be marked with a legible identification on the top of cubes. Leave the sample undisturbed for 24 hours. After the 24 hours, the moulds are opened and immersed in water for curing till the day of testing. Testing is done after 3, 7, 28 days. Three cubes were prepared for each specimen.

6 TESTING

6.1 Compressive Strength: Compressive strength is the maximum compressive stress that under a gradually applied load, a given solid material can sustain without fracture. Compressive strength is carried on cubes i.e. 150 mm × 150 mm × 150 mm specimens. Concrete's compressive strength mostly depends on the concrete mix design, quality of concrete, cement strength, water cement ratio, curing etc. It is also affected by the other factors such as mixing of concrete, placing of concrete, curing of concrete as well as quality of concrete ingredients. The compressive strength of concrete was found by universal testing machine of 1000 kN capacity.

Compressive Strength = P/A

Where, P = Compressive load in kN and A = Area of cube

FIGURE 1

6.2 SPLIT TENSILE STRENGTH TEST

The determination of tensile strength of concrete is necessary to determine the load at which the concrete member cracks. In this test, cylindrical specimens of dimension 150 mm diameter and 300 mm length were cast. The specimens are tested after 7 days and 28 days. The split tension test was conducted by using digital compression machine having 2000 kN capacity.

$f_t = 2P / \pi DL$ (N/mm 2)
where, P = Maximum Load (kN)
D = Diameter of Specimen (150 mm)
L = Length of Specimen (300 mm)
f_t = Tensile strength N/mm 2

7. RESULT AND DISCUSSION

Average strength of 2 specimens was taken as compressive strength at 7 days and 28 days

TABLE 2: COMPRESSIVE STRENGTH OF HEMP FIBER CONCRETE

HEMP FIBER (%)	7 DAYS	28 DAYS
0	44.6	52.1
0.5	42.3	62.2
1.0	38.6	46.8
1.5	33.7	40.88

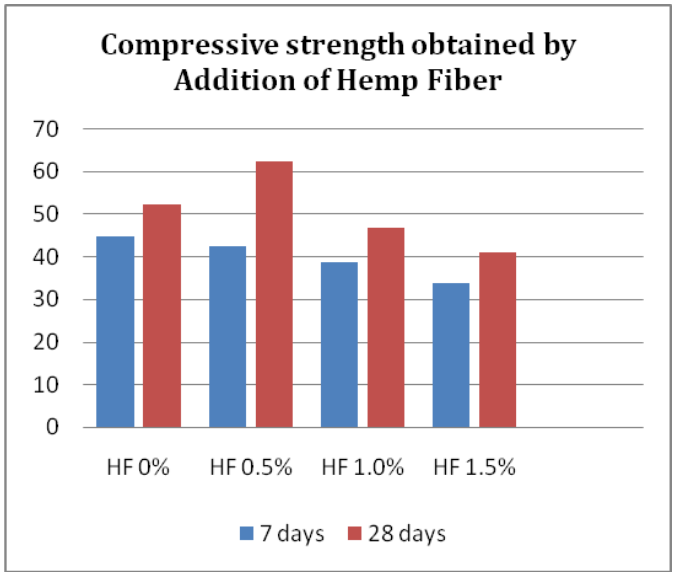

FIGURE 2

From the above Figure 3 the compressive strength of lime concrete at7 and 28 days are compared. Above graph says that optimum compressive strength of Hemp fiber is obtained when lime is added up to 25% by weight of cement. When lime content is increased after 25% then compressive strength decreases gradually.

Triplet specimens was prepared and tested to determine the shear bond strength of cement mortar and lime mortar

TABLE 3 : SPLIT TENSILE STRENGTH OF HEMP FIBER CONCRETE

Cylinder specimens of size 150mm x 300mm were casted for different percentage of addition of hemp fiber as 0.5%, 1.0% and 1.5%. Results are tabulated in table 2 and plotted in Figure 2.

HEMP FIBER (%)	7 DAYS	28 DAYS
0	5.86	6.4
0.5	6.36	9.2
1.0	4.95	6.36
1.5	6.65	9.48

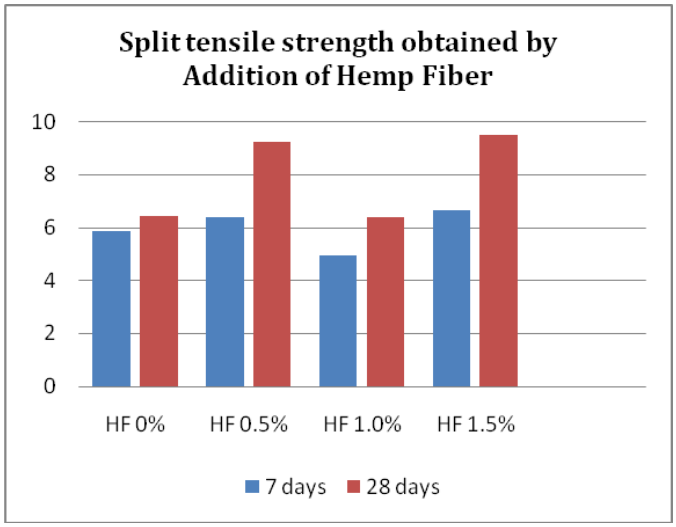

FIGURE 3

8. CONCLUSION

From the above journals it is evident that High Strength Concrete plays a vital role in construction industry. In addition to that the Fly ash and Hemp fiber are added and works been done

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