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Concrete using Coconut Fiber –An Alternative

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Abstract: *Use of Fiber is one of the vital and emerging trends in Construction Technology. Fiber can be considered as an alternative in the use of an air entraining agent providing sufficient freeze thaw protection and moreover as a reinforcing material. Fiber reinforced materials are composite materials that typically consist of strong fibers embedded in resin matrix. It is a composite obtained by adding a single type or a blend of fibers to the conventional concrete mix. The fibers provide strength and stiffness to the composite and generally carry most of the applied loads. The matrix acts to bond and protect the fibers and to provide for transfer of stress from fiber to fiber through shear stresses. Fibers can be in form of steel fibers, glass fibers, natural fibers, synthetic fibers, etc. The mechanism by which fibres produce resistance to freezing and thawing is that fibres introduction reduces water absorption of the concrete increasing penetration resistance to de-icing salts. Reduced water absorption is a function of the fibres to reduce plastic shrinkage cracking, reducing the ability of water to permeate into the bleed in a concrete. So this research paper describes experimental studies on the use of coconut fibre as enhancement of concrete.*

Introduction

In the recent times it is very difficult to point out another material which is as versatile as concrete. Moreover some studies show that it is the second most widely used material after water. It is by far, the most widely used construction material which is constantly expanding and reshaping in this booming time of development of the infrastructure. With the recent advances in concrete it has now become possible to control the various factors and to obtain a concrete of certain specific requirements.

With the quest for affordable housing system for both the rural and urban population and other infrastructure, various proposals focussing on cutting down conventional building material costs have been put forward. One of the suggestions in the forefront has been the sourcing, development and use of alternative, non-conventional local construction materials including the possibility of using some agricultural wastes as construction materials. Natural reinforcing materials can be obtained at low cost and low levels of energy using local manpower and technology. Utilisation of fibres as a form of concrete enhancement is of particular interest to less developed regions where conventional construction materials are not readily available or are too expensive. So from there comes the idea of Fibre reinforced concrete.

Fiber reinforced concrete is concrete containing cement, water, aggregate, and discontinuous, uniformly dispersed or discrete fibers. It is a composite obtained by adding a single type or a blend of fibers to the conventional concrete mix. Fibers can be in form of steel fibers, glass fibers, natural fibers, synthetic fibers, etc. Main role of fibers is to bridge the cracks that develop in concrete and increase the ductility of concrete elements. There is considerable improvement in the post-cracking behaviour of concrete containing fibers due to both plastic shrinkage and drying shrinkage. They also reduce the permeability of concrete and thus reduce bleeding of water. Some types of fibers produce greater abrasion resistance in concrete and impart more resistance to impact load.

Concrete made with Portland cement has certain characteristics: it is strong in compression but weak in tension and tends to be brittle. The weakness in tension can be overcome by the use of conventional steel bar reinforcement and to some extent by the inclusion of a sufficient volume of certain fibres. The use of fibres also alters the behaviour of the fibre-matrix composite after it has cracked, thereby improving its toughness. The overall goal for this research is to investigate the

potential of using waste and low energy materials for building any type of infrastructure. The objective of this research is to experiment on the use of coconut fibres as an enhancement of concrete. Coconut fibres are not commonly used in the construction industry but are often discarded as wastes.

Coconut fibres obtained from coconut husk, belonging to the family of palm fibres, are agricultural waste products obtained in the processing of coconut oil. Coconut fibre has been used to enhance concrete and mortar, and has proven to improve the toughness of the concrete and mortar in this research.

Advantages of Fiber Reinforced Concrete

Fibre reinforced concrete has high modulus of elasticity for effective long-term reinforcement, even in the hardened concrete. Moreover it does not rust nor corrode and requires no minimum cover. Fibre reinforced concrete has ideal aspect ratio (i.e. relationship between Fiber diameter and length) which makes them excellent for early-age performance. These are easily placed, cast, sprayed and less labour intensive. Moreover they have greater retained toughness in conventional concrete mixes and higher flexural strength, depending on addition rate. They can be made into thin sheets or irregular shapes and possesses enough plasticity to go under large deformation once the peak load has been reached.

Methodology

The following materials were used for preparing the concrete mix:-

1. OPC of 53 grades
2. Fine aggregate i.e. sand
3. Coarse aggregate
4. Coconut fibers
5. Water

Ordinary Portland cement of grade 53 was used in this research. The fine aggregate was natural sand which is freely available and the coarse aggregate having a size of20mm and 10mm (smaller size aggregate as suitable for the mould used for casting).The fibres were coconut fibres with length 6mm with approximate mean aspect ratio. Coconut Coir Fibre: Fibres were collected from the local temples, cleaned, sun dried, removed dust to analyze its properties. Coconut fibres require no pre-treatment, except water treatment. Coconut Fibre has high water absorption. Due to this property, the coconut fibres were pre soaked in water for 24 hours.

Preparation and Testing of Specimen

Standard 15cm x 15cm x 15cm cubes are taken and three cubes for different % of fibers. Finally the compressive strength of concrete with and without coconut fiber is tested. The average of three results of same percentage of coconut fibers is considered and effect is seen. The different properties of ingredients are tabulated in table below.

Test Results of The Ingredients

Sr.No.	Items	Results
1.	Cement	OPC-53 GRADE
2.	Sp. Gravity of cement	3.2
3.	Sp. Gravity of coarse aggregate	2.7
4.	Sp. Gravity of fine aggregate	2.8
5.	Water absorption of coarse aggregate	1%
6.	Water absorption of fine aggregate	4%
7.	Free moisture content of coarse aggregate	-
8.	Free moisture content of fine aggregate	-
9.	Fineness modulus	3.92
10.	Zone of fine aggregate	III

The influence of coconut fiber on concrete has been studied for three different grades of concrete that are M20, M25, and M30. The coconut fiber is used of 0% (no fibres), 0.2%, 0.4%, 0.6%, 0.8% and 1.0%.

Mixing Procedure

The dry cement and aggregates were mixed for two minutes by hand. The mixing continued for further few minutes while about 80% of the water was added. The mixing was continued for another few minutes and the fibres were fed continuously to the concrete for a period of 2–3 min while stirring. Finally, the remaining water was added and the mixing was continued for an additional two minutes. This ensured a complete distribution of fibres throughout the concrete mix.

Method of Compaction

The moulds with half filled fresh concrete were vibrated vertically on the vibrated table while casting for about 30 seconds. The moulds were then fully filled with fresh concrete and vibrated further for about 60 seconds. This method of compaction was to align the fibres normal to the direction of vibration.

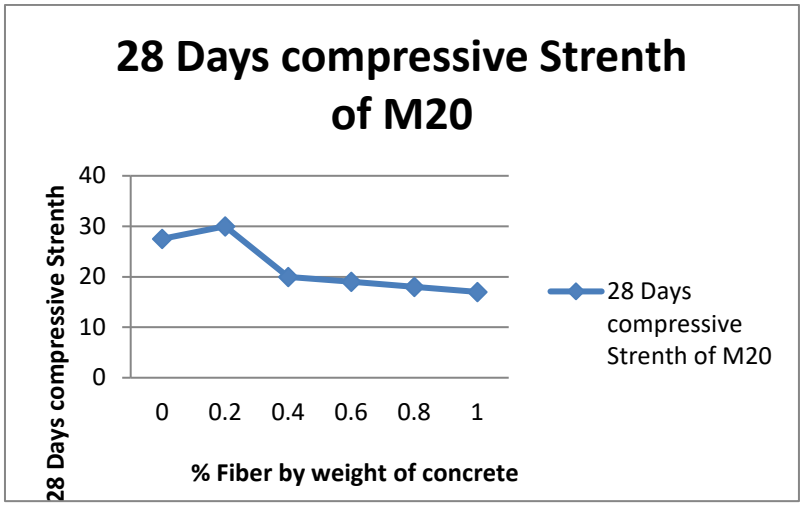
Curing

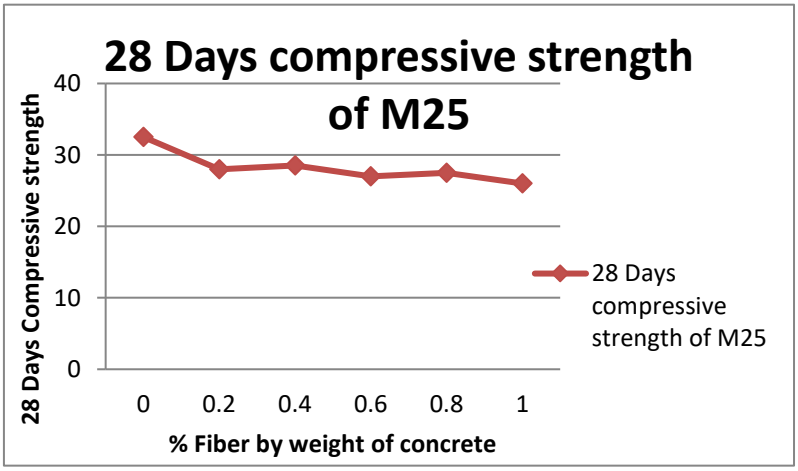
The specimens were stripped from the moulds 24 hours after casting and submerged in water until testing. Specimens were removed from the water after 28 days of submersion in water for testing the 28-day strength.

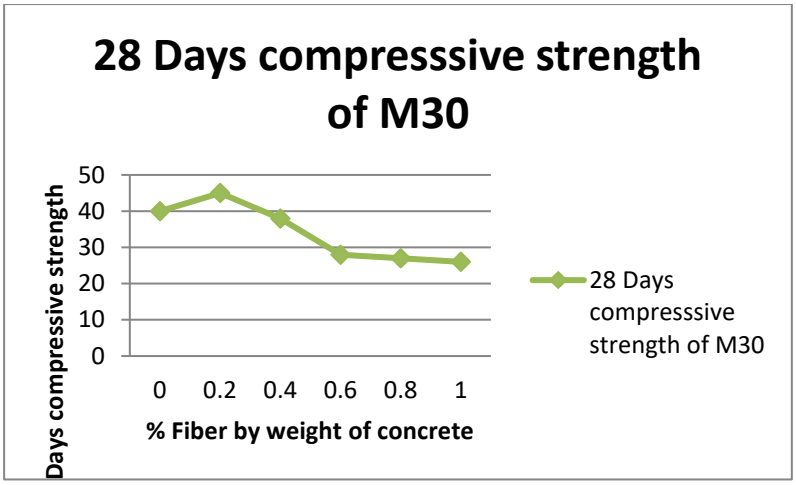
Testing and Result Analysis

All the cubes were tested in a 'Compressive Testing Machine' to determine the compressive strength of the cubes.

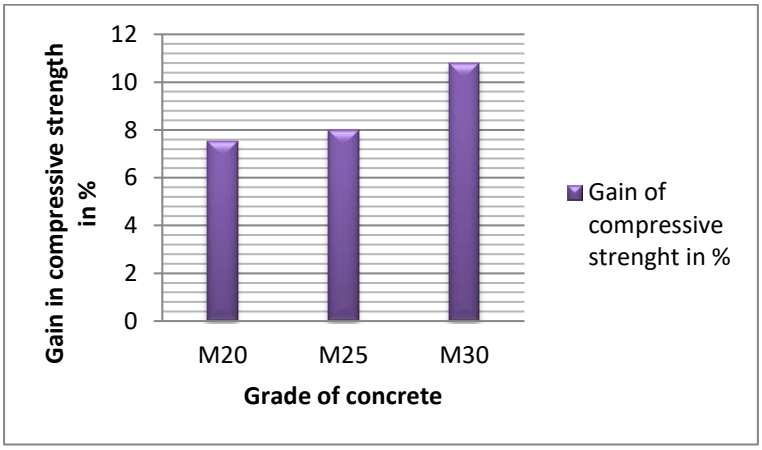
The procedure is as follows: - Compression test of cube specimen is made as soon as practicable after removal from curing pond. Place the specimen centrally on the location marks of the compression testing machine and load is applied continuously, uniformly and without shock. The rate loading is 2kN/Sec continuously. The load is increased until the specimen fails and record maximum load carried by the each specimen during the test.







These results show that compressive strength of concrete increases just at 0.2% fibres. It is because at this fibre content it fills the voids. It is also seen that compressive strength of concrete reduces drastically when fibres content is increased beyond 0.2%. The amount of gain of compressive strength is shown in table below: -



Conclusion

The compressive strength of concrete increases at certain aspect ratio of fibres and at a specific 0.2%. Compressive strength of concrete decreases beyond 0.2%. The amount of gain of compressive strength gradually increases with increase in grade of concrete and it can be concluded that addition of coconut fiber will reduces the quantity of ingredients to achieve same strength and thus it becomes economic.

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