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Performance of Coconut Fibre Reinforced Synthetic Gypsum Concrete

B. Tejeswar Reddy [a], D. Mohammed Rafi [b]

[a] *Student, Civil Engineering, CRIT Anantapur, Andhra Pradesh, India*
[b] *Asst. Prof., Civil Engineering, CRIT Anantapur, Andhra Pradesh, India*

A B S T R A C T

Building industry is revolutionizing in two great ways. One way to do so is to build building methods, such as using digital construction equipment. The other is developments in high-performance construction materials, such as the launch of high-resistance concrete. Fibre-reinforced concrete (FRC) is slowly gaining acceptance from civil engineers among these high-performance materials. Concrete is the most commonly used building material, particularly without cement, we cannot expect the world of construction, and cement production involves a lot of carbon emissions that are directly proportional to carbon footprint. Many studies are underway these days to find a suitable material to substitute cement so that we can reduce the cost of cement production and also the carbon footprint, thereby minimizing global warming. Although there is no suitable material that can completely replace cement, we do have few materials that have similar properties to cement and can replace cement to some degree, thus increasing concrete strength to some extent of replacement. Because of increasing environmental concerns and the need to conserve energy and resources, efforts have been made to use waste material from industrial and agro products in the construction sector as a substitute in ordinary Portland cement. Synthetic gypsum is one such material.

Keywords: stone waste, aggregates, sustainable, , coconut shell.

Density, ease of availability, enhanced energy recovery, biodegradability, ability to be recycled in nature in a carbon neutral manner, resistance to fungi moth and rot, excellent insulation to sound, flame, moisture and dampness, toughness, durability, resilience.

Concrete will remain the most critical infrastructure building material but the majority of concrete structures are vulnerable to cracking. Small gaps on the concrete surface make the entire structure vulnerable as water floods in to weaken the concrete and corrode the insulation of the steel, significantly weakening a building's life span. Concrete can very well withstand the compressive forces but not the tensile forces. This starts to crack when subjected to heat, which is why it is reinforced with steel; to withstand the tensile forces. Structures such as subterranean basements and marine structures are especially susceptible to corrosion by the steel reinforcement in a high water setting.Also the motorway bridges are vulnerable because the salts used to de-ice the roads infiltrate the concrete cracks and can accelerate the steel reinforcement corrosion. Friction forces can cause cracks in many structural engineering structures, and these can occur relatively soon after completion of the structure.

1.3 OBJECTIVES AND SCOPE OF STUDY:

The objectives of study are to find compressive, flexural and split tensile strength of coconut fiber reinforced synthetic gypsum concrete and also to find water absorption of this concrete.

Scope of project:

This project restricts its area to rural residential buildings

1.4 EXPERIMENTAL WORK:

In order to achieve the aims of this research , experimental programming was performed to investigate the effect of synthetic gypsum and coconut fibers on the compressive strength of concrete. Different experiments were conducted on cement, fine aggregate , coarse aggregate and on hardened concrete specimens after the correct healing time of 7, 14 and 28 days with and without synthetic replacement of cement.

1.5 CONCRETE MIXES:

Mix design for concrete grade M40 was carried out using the guidelines laid down in IS: 10262- 2009 & IS: 456- 2000.

1.6 MATERIALS:

The required strength or target strength of concrete can be achieved by careful material selection, proper material grading, accurate water measurements and good workmanship in the mixing, transporting, positioning, compacting, finishing and healing of concrete during construction work. The properties of the material used to manufacture the concrete mix are calculated in the laboratory according to the codes of practice applicable. The different materials used for this research included cement, synthetic gypsum, coconutfibres, coarse aggregates, fine aggregates, and soil. The analysis of various material properties is used to check the appearance to the codal requirements

1.7 ORDINARY PORTLAND CEMENT:

While all materials that go into concrete mix are necessary, cement is often the most important, because it is typically the chain's delicate connection. This comprises only about 20 per cent of the total volume of concrete mix; it is the active part of the binding medium and is the only element in concrete that is scientifically regulated. Cement from Portland branded as (Ordinary Portland Cement) It is the most important type of cement produced by grinding Portland cement clinker and is a fine powder. The OPC is divided into three classes depending on the strength of 28 days, namely 33 Grade, 43 Grade, 53 Grade. For this test the OPC grade 53 cement is adopted.

Cement was carefully stored due to contact with the humidity to prevent deterioration in its properties. The different cement tests are initial and final setting time, specific gravity, fineness and compressive force.

1.8 AGGREGATE:

Aggregates are the bulk of a concrete mixture, which offer concrete dimensional stability. The aggregates make up about 75 per cent of the concrete's body and its effect is therefore extremely important. Therefore, if the concrete is to be workable, solid, robust and economical they should meet certain specifications. The aggregates have to be properly formed, clean, smooth, strong and good

1.8.1 COARSE AGGREGATE:

The aggregate that is stored over 4.75 mm of the IS Sieve is called the coarse aggregate. The coarse aggregates can include: -

1. Crushed grave or stone collected by gravel or hard stone crushing.

2. Uncrushed gravel or stone resulting from natural rock decomposition

3. Partially crushed gravel obtained as product of blending of above two types.

The standard maximum size is slowly 10-20 mm; however in Self Compacting Concrete particle sizes of up to 40 mm or more were used. In this work the locally available coarse aggregate with the maximum size of 20 mm was used. To extract dust and dirt, the aggregates were washed, and dried to dry surface condition. The aggregates had been checked according to IS: 383-1970.

Fig: 1.1 coarse aggregate

1.8.2 FINE AGGREGATE:

The aggregates often moving through IS sieve 4.75 mm are called fine aggregates. The fine sum may have as follows:

1. Solid sand, that is, fine aggregate resulting from natural rock decomposition.

2. Crushed sand in stone, that is to say fine aggregate formed by crushing hard stone.

3. Crushed sand of gravel, that is to say, fine aggregate formed by crushing natural gravel.

Depending on their thickness, the fine aggregate can be defined as coarse, medium, and fine sands. The fine aggregate was divided by the particle size distribution IS: 383-1970, into four ranking zones (Grade I to IV). From grading zone I to IV the grading zones are increasingly finer. Fine aggregate was procured locally in this experimental system, and conformed to Indian Standard Specifications IS: 383-1970. The sand was sieved through a 4.75 mm sieve to remove any particles larger than 4.75 mm and to conform to the grading of zone II. It was light brown and rugged in color. Sieve 's analysis and the physical properties of fine aggregates were tested as per IS:383-1970.

Fig: 1.2 fine aggregate

1.9 CEMENT:

Cement is known to be the best binding material and is widely used in the construction of various engineering structures as a binding material today. Portland cement is the most significant form of cement called ordinary Portland cement, a fine powder formed from the Portland cement clinker grinding. Portland cement, dirt, and aggregates are used for the concreting process. Cement constitutes about 20 per cent of the overall amount of concrete. Portland cement is a hydraulic cement which hardens in water to form a water absorbing material. The hydration products serve as binders to tie together the aggregates to form concrete. The name Portland cement comes from chemical combination of the cement compounds with water that yields submicroscopic crystals or a gel-like material with a high surface area. Because of their hydrating properties, constructional cements, which will even set and harden under water, are often called hydraulic cements. The most important of these is port land cement.

Classification of Aggregates Based on Shape:

We know that aggregate is derived from naturally occurring rocks by blasting or crushing etc., so, it is difficult to attain required shape of aggregate. But, the shape of aggregate will affect the workability of concrete. So, we should take care about the shape of aggregate. This care is not only applicable to parent rock but also to the crushing machine used.

Aggregates are classified according to shape into the following types

- Rounded aggregates
- Irregular or partly rounded aggregates
- Angular aggregates
- Flaky aggregates
- Elongated aggregates
- Flaky and elongated aggregates

Fine Aggregate

Sand that is available in nearby locality has been used as fine aggregate. Other foreign matter present in the sand has been separated before use. The specific gravity of sand used in this investigation is 2.52

The tested physical **properties** of the both **fine** and **coarse aggregates** were specific gravity and density. Fineness modulus was determined for both **river sand**and quarry dust, whereas **aggregate** impact and Los Angeles abrasion of the crushed granite were tested. Concrete mix ratio was batched by weight.

Typically, coarse aggregate sizes are larger than **4.75 mm** (5 mm in British code), while fine aggregates form the portion below **4.75 mm**. A maximum size up to 40 mm is used for coarse aggregate in most structural applications, while for mass concreting purposes such as dams, sizes up to 150 mm may be used

Lightweight Concrete Using Coconut Shells as Aggregate:-

Aggregates provide volume at low cost, comprising 66 percent to 78 percent of the concrete. With increasing concern over the excessive exploitation of natural and quality aggregates, the aggregate produced from industrial wastes and agriculture wastes being viable new source for building material. This study was carried out to determine the possibilities of using coconut shell as aggregate in concrete. Utilising coconut shell as aggregate in concrete production not only solves the problem of disposing this solid waste but also helps conserve natural resources. In this paper, the physical properties of crushed coconut shell aggregate were presented. The fresh concrete properties such as density and slump and 28-day compressive strength of a lightweight concrete made with coconut shell as coarse aggregate also presented. The findings indicated that water absorption of the coconut shell aggregate was high about 24 % but the crushing value and impact value was comparable to that of other lightweight aggregates. The average fresh concrete density and 28-day cube compressive strength of the concrete using coconut shell aggregate were 1975 kg/m^3 and 19.1 N/mm^2 respectively. It is concluded that crushed coconut shells are suitable when it is used as substitute for conventional aggregates in lightweight concrete production.

Quartz

The silica polymorph that is most stable at the Earth's surface is αquartz. Its counterpart, β-quartz, is present only at high temperatures andpressures. These two polymorphs differ by a "kinking" of bonds this change in structure gives β-quartz greater symmetry than α-quartz, and they are thus also called high quartz (β) and low quartz (α).

Super Plasticizers

Plasticizers or **water reducers**, and superplasticizers or **high** range **water reducers**, are chemical **admixtures** that can be added to **concrete mixtures** to improve workability. Unless the mix is "starved" of **water**, the strength of **concrete** is inversely proportional to the amount of **water** added or **water-cement** (w/c) ratio

Superplasticizers, also known as high range water reducers, are chemical admixtures used where well-dispersed particle suspension is required. ... The

Casting

A pan type concrete mixer was used for the preparation of concrete mix. The mixing operation of concrete ingredients is shown in the Fig. 2.6.1. The Micro silica is added slowly and mixed thoroughly to avoid balling and slurry in the concrete. The specimens are cast in five batches, each batch consisting of six cubes for compressive strength, two prisms for flexural trength, two cylinders for split tensile strength, one cylinder for rapid chloride penetration test and sorptivity.

Curing:

Curing is the process of controlling the rate and extent of moisture loss from concrete during cement hydration. It may be either after it has been placed in position (or during the manufacture of concrete products), thereby providing time for the hydration of the cement to occur. Since the hydration of cement does take time – days, and even weeks rather than hours – curing must be undertaken for a reasonable period of time if the concrete is to achieve its potential strength and durability. Curing may also encompass the control of temperature since this affects the rate at which cement hydrates.

Table:5.19 WATER ABSORPTION TEST RESULTS:

Grade of concrete	Percentage replacement in cement	Water absorption
M40	Conventional concrete	3.71
M40	5% Synthetic gypsum,1% coconut fibres	3.64
M40	10% synthetic gypsum,1% coconut fibres	3.49
M40	15% synthetic gypsum,1% coconut fibres	3.75

Table:5.20WATER ABSORPTION TEST RESULTS:

Grade of concrete	Percentage replacement in cement	Water absorption
M40	5% Synthetic gypsum,2% coconut fibres	4.55
M40	10% Synthetic gypsum,2% coconut fibres	4.46
M40	15% Synthetic gypsum,2% coconut fibres	4.69

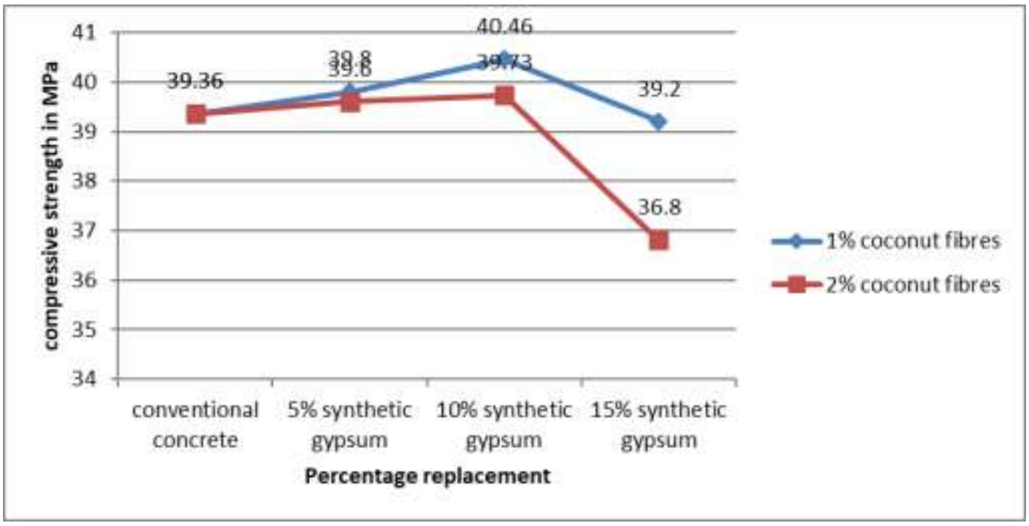

Fig:5.1 Graphical representation of compressive strength of concrete replaced with synthetic gypsum in different proportions and coconut fibres in 1% and 2% for 28 days in MPa.

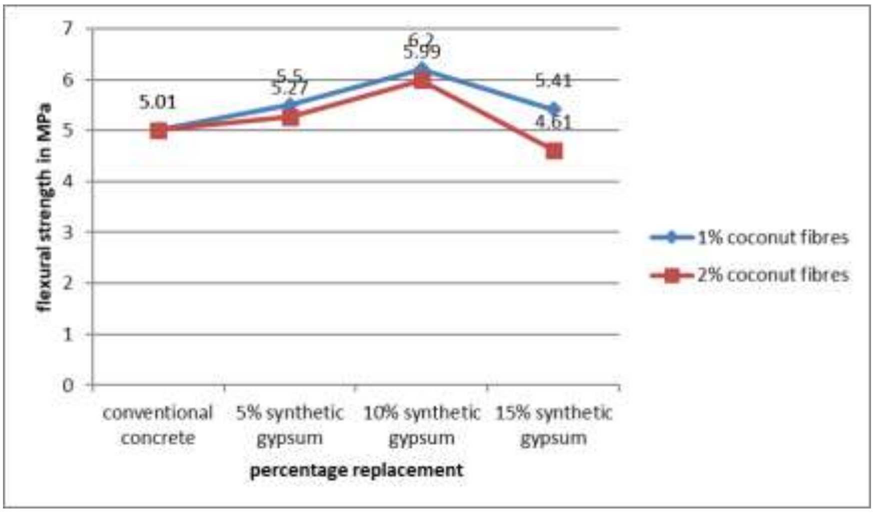

Fig:5.3 Graphical representation of flexural strength of concrete replaced with synthetic gypsum in different proportions and coconutfibres in 1% and 2% for 28 days in MPa.

CONCLUSION

1) The low density coconut fiber lowers the total weight of the reinforced concrete material, so it can be used as a lightweight structural concrete.

2) By strengthening the concrete with readily available coconut fibres, we can reduce the environmental waste.

3)The use of Coir fiber provides a natural cooling effect due to its thermal conductivity is close to zero.

4) It's obvious that coir won't run the risk of being corroded like steel so that's an added bonus.

It can be used effectively in concrete by removing the cement to some extent. Usage of industrial waste such as synthetic gypsum not only addresses environmental issues but also provides the building industry with a new resource.

5)The compressive strength is higher for 10% replacement of synthetic gypsum and 1% coconut fibers and later on strength gradually decreases also it is very near to strength of conventional concrete hence we can safely replace cement with synthetic gypsum and 1% coconut fibres. But coming to 2% coconut fibres strength is decreasing so it is better to opt 1% coconut fibers.

6)The split and flexural strength is also higher for concrete which is replaced with 10% synthetic gypsum and 1% coconut fibres and it is higher when compared to conventional concrete and it gradually decreases with 15% replacement.

LIMITATIONS OF PROJECT:

1) This study is restricted to rural residential constructions.
2) This can be mostly used in areas where frequent earthquakes occursbut we need a detailed study regarding that.

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