A Study on Comparison between physical properties of coconut coir fibre reinforced concrete and ordinary concrete: A Review

Amandeep[1], Dr. Sanjay Sharma[2], Jasvir Singh Rattan[3]

[1]M. E. Scholar, [2]Professor, [3]Senior Technical Assistant, Civil Engineering Department, National Institute of Technical Teachers Training and Research Chandigarh, India.

The test includes flexural strength and compressive strength of concrete. The compressive strength test of concrete was conducted in which the cubes of size 150mmx150mmx150mm were cast and their strength was tested at age of 7days and 28 days each. The percentage replacements were (0%, 0.5%, 1.5%, 2.5%). It was seen that compressive strength increased in each case as compared to conventional concrete. It was observed that the compressive strength at 28 days increased at 0.5% addition of coconut fibers about 1.8% of the normal hardened concrete and at 1.5% addition it was about 6% of the normal concrete. At 2.5%, the value of compressive strength was ultimate among all the percentages of coconut fibers and at this percentage the strength value was about 8.5%. Also beams having size 500mmx100mmx100mm were cast to test the flexural strength of concrete at 7days and 28 days. Replacement percentages were same as that of the compressive strength i.e (0%, 0.5%, 1.5%, 2.5%). In flexural strength test, the value of flexural strength at 0.5% addition of coconut fibers increased by 1.5% of ordinary concrete. At 1.5%, the flexural strength was increased by 4.5% of normal concrete and the maximum strength was observed at 2.5% addition of these fibers and it was about 9.5 % after 28days of curing. So almost 48 samples were casted and for both 7days and 28days testing. The design mix used in this research was M20 and all material properties were tested and the results obtained are all mentioned in this report.

Hence, the results showed that the strength of concrete improved with the increase in proportion of coconut coir fibres. The maximum strength obtained for a mix is with the proportion of 2.5% addition of coconut fibres. The use of these coir fibers reduces the environmental effects, produces economically and eco-friendly concrete.

Keywords: coconut coir fibre, Mortar, Thermal conductivity of coir reinforced fibre.

I. INTRODUCTION

Among the Engineering fields Civil Engineering is widest of all. Civil Engineering focus on the infrastructure of the world which include Water works, Sewers, Dams, power Plants, Transmission Towers, Roads, Highways, Tunnels, Irrigation Channels, River Navigation, Shipping Canals, Traffic Control, Mass Transit, Airport Runways, Terminals, Industrial Plant Buildings, etc. and for this purpose we need concrete. Concrete is the most important component used in construction industry throughout the world.

Concrete is main constituent in construction of structures. It is composite material composed of cement, sand, water, coarse aggregates or sometimes admixture to attain some desired properties. When these ingredients are mixed together, they form a fluid mass that can easily be moulded into any desired shape. At 7 days, the cement forms a hard matrix which binds the rest of ingredients together into a durable material with many uses. Often additives and fibres are included in the mixture to achieve the desired physical and mechanical properties of the finished material.

There are two ways for revolution of construction industry. The advancement of construction techniques is one of them, for instance automated tools are used in construction nowadays. The development of high-performance construction materials is another way; high strength concrete is the best example of it. Fibre reinforced concrete (FRC) is achieving popularity among these high- performance materials. In this era, the development and research of fibres and matrix materials related to construction industry have grown by leaps and bounds. The main merit of use of these materials over another construction material is tensile strength, these are able to mould into desirable shapes and provide resistance to adverse environmental conditions, as a result maintenance cost is relatively low. Due to this FRC is a good solution. They are applicable in either new construction of building or up-gradation of existing structures and can be applied for different structures, offshore platforms, buildings and bridges are the best example of it.

Major problems of using steel fibres in high performance concrete are high costs, corrosion and availability. Coconut fibres are more ductile as compared to other naturally available fibres and can be used as reinforcement in ordinary concrete. As we know these are biodegradable due to which impact on environment is less. It is also the best way to use the waste from coconut coir in manufacturing of high strength materials. They are in abundance that's why they are easily available and cheap. It is considered that the usage of coconut fibre in concrete is alternative solution for cost-effective earthquake-resistant housing.

In this study, identification of change in strength characteristics of ordinary concrete after addition of these fibres was the main aim. The various merits of use of coconut fibre in normal concrete are good thermal insulation, low density, specific strength, minimum

impact on environment. So physical properties of concrete with coconut fibres as reinforcement improved as compared to normal concrete, it is becoming a solution for sustainable management of environmental.

II. RESEARCH AND STUDIES ON COCUNUT COIR REINFORCED FIBRE STRENGTH

Relevant research work and studies are reviewed here:

Majid Ali, **(2010)** concluded that coconut fibres have the potential to be used in composites for different purposes. The use of coconut fibres has given some marvellous products, there is still possibility of the invention of new products containing coconut fibres with improved results. In civil engineering, coconut fibres have been used as reinforcement in composites for non-structural components. There is a need of investigating the behaviour of coconut fibre reinforced concrete to be used in main structural components like beams and columns.

M. A. Aziz et al.,**(1981)** studied the effective utilization of natural fibres from coconut husk, sisal, sugarcane bagasse, bamboo, jute, wood, akwara, plantain and musamba for making concrete. Factors affecting the properties of natural fibre reinforced concrete both in fresh and hardened states are critically discussed. An outline is also given of the prospects of this new material for potential applications in construction.

Syed Intikhab Zia,**(2015)** conducted test on a concrete block made having dimensions 200x100x80mm in which coconut fibre is use. Coconut fibre were added in proportion of 0.1% , 0.2%, 0.3%, 0.4% and 0.5% in volume of concrete. The comperssivestrength, flexural strength and water absorption were determined at and of 7 and 28 days. The paper also shows the cost comparison per each block.

Majid Ali et al., **(2011)** done a experiment on natural coir fibres having a length of 7.5 cm and a fibre content of 3 % by weight of cement are used to prepare CFRC beams. Coconut rope having a diameter of 1cm and tensile strength of 7.8 MPa is added as the main reinforcement. Compressive strength, splitting tensile strength, modulus of elasticity and modulus of rupture for CFRC are investigated. The dynamic behaviour and load carrying capacity of CFRC beams as structural members without and with coconut rope are discussed.

Kshitij Nadgouda,**(2015)** studied flexural strength of a concrete mix was designed to achieve the minimum grade of M20 (by taking 1:1.5:3 as nominal mix) as required by IS 456 – 2000. The investigation was done by taking 3%, 5%, and 7 % (by the weight of cement) of coconut fibre in the concrete mix.

Nitin Sam et al., **(2016)** did experiment to evaluate the durability properties of concrete reinforced with coir fibres. The durability study includes the acid attack, Sulphate attack, and water absorption test. The test was conducted for 28 and 56 days after curing period. The coir fibre with length 1.5 and 3cm and proportion of 1%, 2% and 3% by weight of cement used in investigation. From the present study, it is concluded that the concrete reinforced with coir fibres shows improved durability properties when compared with no fibre.

Bhatia, (2001) studied the usefulness of fibre reinforced concrete in various civil engineering applications. Fibres include steel fibre, natural fibres and synthetic fibres- each of which lends varying properties to the concrete. The study revealed that the fibrous material increases the structural integrity. These studies made us adopt natural fibres which are abundantly available and cheap.

Chouw et al., (2012) studied the viability of using coconut-fibre ropes as vertical reinforcement in mortar-free low cost housing in earth quake prone regions. The rope anchorage is achieved by embedding it in the foundation and top tie-beams. The bond between the rope and the concrete plays an important role in the stability of the structure and the rope tensile strength is also found to be fairly high. The rope tension generated due to earthquake loading should be less than both the pull out force and the rope tensile load to avoid the structure collapse. The study concluded that the pull out energy increases with an increase in embedment length, rope diameter, cement and fibre content in the matrix.

Li et al., (2007) studied fibre volume fraction by surface treatment with a wetting agent for coir mesh reinforced mortar using non-woven coir mesh matting. They performed a four-point bending test and concluded that cementitious composites, reinforced by three layers of coir mesh with a low fibre content of 1.8%, resulted in 40% improvement in flexural strength compared to conventional concrete. The composites were found to be 25 times stronger in flexural toughness and about 20 times higher in flexural ductility. To the best knowledge of authors the only research work on static CFRC properties is the test done on concrete reinforced with coir fibre of length 4 cm. With regard to dynamic properties of CFRC, no study has been reported yet. Dynamic tests had been performed only for concrete reinforced by other fibres, e.g. polyolefin fibres or rubber scrap. To reveal the consequence of fibre length for CFRC properties, thorough investigations involving more fibre lengths and other parameters are required in order to arrive at reliable conclusions. The knowledge of static and dynamic properties of CFRC is essential to understand the potential of such concrete in cheap housing in earth quake prone regions. But the scope of which requires stringent investigations CFRC blocks are used as pavement materials in parking areas to avoid shrinkage crack. The high crack resistance offered by coconut fibre made us adopt coconut fibre reinforced concrete.

Reis, (2006) performed third-point loading tests on concrete reinforced with coconut, sugarcane bagasse and banana fibres to investigate the flexural strength, fracture toughness and fracture energy. The study revealed that fracture, toughness and energy of coconut fibre reinforced concrete were the highest compared to other natural fibres with an increase in flexural strength of up to 25%. The advantages of coconut fibre over other natural fibres made us conclude to use coconut fibre as the reinforcement material in our project.

Asasutjarit et al.,(2006) determined the physical (density, moisture content, water absorption and thickness swelling), mechanical (modulus of elasticity, modulus of rupture and internal bond) and thermal properties of coir-based light weight cement board after 28 days of hydration. The physical and mechanical properties were measured by Japanese Industrial Standard JIS A 5908-1994 and the thermal properties using JIS R 2618. The parameters studied were fibre length, coir pre-treatment and mixture ratio. 5 cm long boiled and washed fibres with the optimum cement: fibre: water weight ratio of 2:1:2 gave the highest modulus of rupture and internal bond amongst the tested specimens. The board also had a thermal conductivity lower than other commercial flake board composite. These paper made us choose 5cm fibre length after proper treatment of the fibre for the removal of the coir dust.

Liu et al., (2011) studied the influence of 1%, 2%, 3% and 5% at fibre lengths of 2.5, 5 and 7.5 cm on properties of concrete. For a proper analysis the properties of plain cement concrete was used as reference. It was seen that damping of CFRC beams increases with the increase in fibre content. It was observed that CFRC with a fibre length of 5 cm and fibre content of 5% produced the best results. In this study the optimum percent of coconut fibre added was 5%,which made us to adopt addition of 4%,5% and 6% coconut fibre by weight of cement in our research work.

Kelleret al., (2005) investigated the shear behaviour of reinforced concrete beams strengthened by the attachment of different configurations and quantities of carbon fibres. The study revealed that the strengthening by using carbon fibres increased the resistance to shear and also spalling of concrete.

III. Conclusions

Based on the various research carried out by many researchers, it may be concluded that:

- From various research papers, it has been concluded that coconut coir fibre can be used as a replacement for steel strips in Mortar in low rise building.
- It was observed that CFRC with a fibre length of 5 cm and fibre content of 5% produced the best results.
- Various influencing parameter on coconut coir reinforced fibre are alkaline solution concentration , sodium silicate to sodium hydroxide mass ratio , curing temperature , curing time , aggregate shape etc.
- Compressive strength done a experiment on natural coir fibres having a length of 7.5 cm and a fibre content of 3 % by weight of cement are used to prepare CFRC beams. Coconut rope having a diameter of 1cm and tensile strength of 7.8 MPa is added as the main reinforcement.
- The compressive strength increases with increase in air curing time from 7 days to 28 days.
- The coconut coir fibres improve physical and chemical properties of structure i.e. reduction of carbonation, heat of hydration resistant.

REFERENCES

1) Achudhan et.al., " Experimental Study on Coir Fibre Mixed Concrete" International Journal of Pure and Applied Mathematics Volume 118, 2018.
2) S. Sastha et. al., "Experimental Study on Behavior of Coir Fibre Reinforced Concrete", International Research Journal of Civil Engineering and Technology (IRJCET), Volume: 8 Issue:2, February 2017.
3) Nitin Sam, "Durability Study on Coir Fibre Reinforced Concrete", International Research Journal of Engineering and Technology (IRJET), Volume: 05 Issue: 08, Sep-2016.
4) Nawawi Chouw et. al., "Coir Fibre and Rope Reinforced Concrete Beam under Dynamic Loading", 2015.
5) Kshitija Nadadgounda, "Coconut Fibre Reinforced Concrete", International Journal of Mechanical And Production Engineering, ISSN: 2320-2092, Volume- 3, Issue-1, Jan.-2015.
6) Syed Intikhab Zia, "Use of Coconut Fibre Concrete" International Research Journal of Engineering and Technology (IRJET), Volume: 02 Issue: 06, Sep-2015.
7) Majid Ali, "Coconut Fibre – A Versatile Material and its Applications in Engineering", Second International Conference on Sustainable construction Materials and Technologies June 28 to June 30, 2010.
8) M. A. Aziz et. al., "Prospects for Natural Fibre Reinforced Concretes in Construction" The International Journal of Cement Composites and Lightweight Concrete, Volume 3, Number 2, May 1981.
9) IS 456-2000, "Plain and reinforced concrete code of practice": BIS, New Delhi.
10) IS 2386: Part-1, "Method of Test for Aggregate for Concrete".
11) IS10262:2009, "Concrete Mix Proportioning Guidelines".

12) IS189 Part-1, "Portland-Pozzolana Cement Specification (Fly Ash Based)".
13) IS 4031 Part-4 "Methods of Physical Tests for Hydraulic Cement(Determination of Standard Consistency of Cement Paste)"
14) IS 4031 Part-5, "Methods of Physical Tests For Hydraulic Cement (Determination of Initial and Final Setting Times)".
15) Concrete Technology by M.S.Shetty.
16) Concrete Technology by M.L.Ghambir.

Author's Profile

1* Er. Amandeep 2* Dr. Sanjay Sharma 3* Er. Jasvir Singh