"Review Study on Compressive Strength of Concrete using Coconut Coir and Recycled Aggregate"

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I.ABSTRACT:

This study investigates the feasibility of incorporating recycled coarse aggregates and coconut coir fibers into concrete to increase sustainability and structural performance. The study looks at how recycled materials and natural fibers affect the workability and mechanical qualities of concrete, namely compressive and flexural strength. Experimental trials were carried out on concrete samples with varied RCA proportions (ranging from 0% to 100% in 10% increments) and a fixed coconut coir fiber content of 1% by cement weight, with fiber dimensions of 60 mm in length and 0.35 mm in diameter. Concrete cubes and beams were cast and tested under normal loading conditions. RCA was sourced from buildings aged 7, 13, 21, and 62 years to assess the association between source age and aggregate performance. Test results showed that concrete with 20% RCA substitution had the highest compressive and flexural strength, indicating an optimal mix of sustainability and mechanical performance.

Key Words: Recycled Aggregate (RCA), Coconut Coir Fibers, Compressive Strength, Flexural Strength, Sustainable Concrete.

II.INTRODUCTION:

Environmental preservation is a key problem in today's construction sector. With India's rising urbanization, concerns about resource depletion and construction waste management have motivated engineers and researchers to seek sustainable solutions. One such strategy is to use demolished concrete waste as recycled aggregate in new concrete production, so reducing the impact on natural resources while managing trash efficiently. Similarly, using natural fibers such as Coconut coir, which are biodegradable and readily available, provides an environmentally acceptable reinforcement option. This study contributes to the sustainable construction movement by studying concrete mixtures using RCA and coir fiber, with the goal of assessing their performance and viability as alternatives to traditional materials.

Over the past 50 years, construction has accounted for around 42% of India's development investment, contributing to the country's progress. Construction is the primary source of income for 15% of the national workforce. It provides over 5% to the nation's GDP and 80% to gross capital formation. The construction sector's share of the total GFC in India ranged from 60% in 1970-71 to 34% in 1990-91. Since then, it increased to 48% in 1993-94 and 44% in 1999-2000. In the 21st century, the construction sector now accounts for a larger share of GDP.

The development business in India includes over 220 enterprises in the corporal segment, as well as approximately 120,000 Class A temporary workers enrolled with various government development offices. There are several minor contractors, including primary contractors, who compete for modest assignments or serve as subcontractors for primary and other contractors. In 2004-05, construction industry transactions totaled Rs. 428855 million, up from Rs. 214518 in 2000-01.

1) Building Material:

The construction business employs a diverse range of building materials to construct structures. Engineers and project managers use these material and item classifications to specify the materials and procedures used in construction projects. Some building materials, including as cold-rolled steel framing and supports and I-segment steel, are regarded more efficient than traditional methods like wood and square work. When selecting building materials, it's important to consult the manufacturer to ensure quality and suitability for specific requirements.

2) Demolition Waste:

Since the early 20th century, India has witnessed major growth in its infrastructure, including the development of highways, bridges, water supply systems, dams, canals, and sewage networks. A significant portion of this expansion occurred during the mid-1900s, especially with the creation of the

Interstate Highway System in the 1950s through the 1970s. At that time, land affected by pollution or previous construction was often seen as unusable. Currently, the demolition of buildings contributes heavily to the country's waste generation. India produces approximately 23.80 million tonnes of demolition waste each year. This waste typically includes Materials like concrete, bricks, mortar, sand, and tiles. If not managed properly, these materials can reduce soil fertility and cause environmental degradation.

3) Use of Recycled Aggregates in Construction:
Recycled materials like crushed concrete and glass are widely used as aggregates in concrete production. Other tested alternatives include fiberglass and granulated coal, which have proven effective in maintaining the strength and durability of concrete. For recycled materials to be viable in construction, they must: Deliver sufficient strength to the final product Maintain overall quality Perform comparably to traditional aggregates. Using recycled demolition waste as coarse aggregates plays a crucial role in reducing the demand for virgin materials and promoting more sustainable building practices.

4) Coconut Coir as a Natural Resource:
Coconut coir is a natural fiber found between the hard shell and the outer layer of the coconut. It is known for being tough and durable, especially the older, brown coir which has higher resistance to abrasion compared to the softer white fibers.
Globally, around 260,000 tonnes of coconut coir are produced each year. India, particularly the Pollachi region and coastal areas of Kerala, accounts for 60% of the global supply. India is also the largest consumer, using over half of the world's coir fiber output. Together, India and Sri Lanka produce about 90% of the total global coir production.
Due to its eco-friendly nature and resilience, coconut coir is increasingly being used in construction, agriculture, and other industries as a sustainable alternative to synthetic fibers.

III.LITERATURE REVIEW:

Stephen Adeyemi Alabi (2020) addressed the escalating cost of traditional building materials, prompting a shift toward sustainable alternatives. His study focused on the impact of using recycled fine aggregates (from crushed sandcrete blocks) and recycled coarse aggregates (from crushed abandoned concrete cubes), along with a consistent percentage of coconut fiber (CF), on the behavior of concrete. The research began with control concrete using natural aggregates (NA) without CF. Subsequent mixes incorporated CF with varying levels of recycled aggregates (25%, 50%, 75%, and 100% by weight). Tests on both fresh and hardened concrete properties were conducted using standard procedures to determine the optimal mix configuration.

Sharma and Bansal (2020) investigated the role of coconut fiber in enhancing the mechanical and hydrological performance of pervious concrete—a type known for its environmental benefits, particularly in managing storm water. Their study incorporated coconut fiber and different proportions of recycled concrete aggregate (RCA) at 25%, 50%, 75%, and 100%. Parameters such as compressive strength, flexural strength, and permeability were evaluated to understand how these modifications affected the concrete's overall behavior.

J. Sahaya Ruben and Dr. G. Baskar focused on the structural performance of concrete reinforced with coir fiber—a biodegradable natural fiber with mechanical properties comparable to synthetic fibers. To prevent moisture-related degradation, the coir fibers were pre-treated with natural latex. Concrete specimens were tested for compressive and
split tensile strength at 28 days, using fiber lengths of 20 mm, 25 mm, and 30 mm at volume fractions of 0.5%, 0.75%, and 1%. The study emphasized the importance of encouraging the use of locally available natural fibers in sustainable construction.

KrishnaPrasad Guruswamy et al. conducted a study using the response surface method (RSM) to optimize the use of coir fibers in concrete. They examined how fiber volume fraction (ranging from 4% to 12%) and fiber length (0.4 cm to 1.2 cm) influenced compressive strength. The optimal configuration—4% fiber volume and 10 mm length—yielded a compressive strength of 34 N/mm². It was also observed that higher fiber content reduced workability. Additionally, long-term durability tests using FTIR and XRD revealed no significant degradation in the coir fibers after one year, confirming their stability in concrete.

Babar Ali et al. reviewed the ecological benefits of replacing synthetic fibers in concrete with natural alternatives like coir. While synthetic materials such as steel, polypropylene, and glass offer durability and crack resistance, their production contributes heavily to environmental degradation. Coir fibers, due to their high toughness and renewable nature, present a promising alternative for green construction.

Isiaka Oluwole Oladele et al. emphasized the growing interest in bio-based materials, particularly coir fibers, for their eco-friendly properties and utility in various composites. Their study outlined the use of both treated and untreated coir fibers in concrete and polymer-based composites. The paper highlighted the expanding role of natural fibers in applications such as automotive, packaging, electronics, and structural components, advocating for their increased adoption in sustainable development.

David R. Wilburn et al. (1998) provided an economic analysis of recycled aggregate production based on data from the Denver, Colorado region. They noted that costs associated with recycled aggregates—such as processing and transportation—vary across regions due to factors like market demand, landfill tipping fees, and local material availability. Typically, the price of conventional aggregates (crushed stone, sand, and gravel) plays a significant role in setting the market rate for recycled aggregates, highlighting the importance of regional context in feasibility assessments.

The Government of Hong Kong (2007) conducted a comprehensive evaluation of concrete produced with varying proportions of recycled aggregate (20% and 100%) and pulverized fuel ash (PFA) at 0% and 35%. Their findings showed that concrete with 20% recycled aggregate exhibited properties comparable to those of conventional concrete. However, at 100% replacement, there were marked reductions in mechanical performance, workability, and increased shrinkage. Tests included compressive strength (at 7 and 28 days), chloride penetration, elasticity, and water absorption.

Dr. Chetan D. Modhera et al. (2011) explored how recycled concrete aggregates influence strength characteristics. Their study concluded that concrete containing up to 20% recycled fine aggregate or 30% coarse aggregate retained comparable strength to conventional concrete. Beyond these thresholds, a notable decline in compressive strength was observed—up to 40%. They also found that the water/cement ratio plays a pivotal role, with high ratios minimizing strength loss. The authors promoted the use of recycled aggregates as a sustainable option, particularly given the projected rise in global construction activity.

Nawawi Chouw and Majid Ali focused on dynamic load testing of concrete beams reinforced with coconut fiber and rope. The aim was to develop low-cost, earthquake-resistant housing solutions. The study used 7.5 cm long coir fibers, incorporated at 3% by weight of cement, with a diameter of 1 cm and tensile strength of 7.8 MPa. Tests revealed that while coir fibers enhanced mechanical properties such as compressive and tensile strength and modulus of elasticity, they also posed challenges in terms of workability due to their fibrous nature.

Yasser Abdelghany Fawzy (2016) analyzed how recycled gravel sourced from low and medium-strength concrete affected new concrete when blended with dolomite as the natural course aggregate. The mixes were prepared with varying recycled gravel proportions (0% to 75%) at different water/cement ratios (0.50, 0.55, and 0.60). The study found that increased recycled content led to reduced slump and mechanical performance. However, the inclusion of bonding admixtures or 10% silica fume improved overall strength, suggesting practical methods to mitigate performance losses in recycled concrete.

IV.OBJECTIVES OF THE STUDY:

- To examine the mechanical behavior of conventional concrete, focusing on key properties such as compressive and flexural strength, in both its fresh and hardened conditions.
- To investigate the influence of incorporating coconut coir fibers into concrete mixtures where natural coarse aggregates are partially substituted with recycled coarse aggregates (RCA).
- To compare the structural performance of coir fiber-reinforced concrete against standard concrete made with natural aggregates and no fiber additives.
- To validate experimental findings and evaluate the feasibility of using recycled aggregates and coconut coir fibers as sustainable, eco-friendly alternatives in concrete production.

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