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A STUDY OF THE ROLE OF RECYCLED FIBERS REINFORCED CONCRETE (RFRC)

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Abstract:

Repurposed Fibres Reinforced concrete (RFRC) is a cutting-edge building material that incorporates recycled fibres to improve conventional concrete's sustainability and technical qualities. By assessing RFRC's strength, durability, and environmental effect, this research investigates its use in the building sector. The fibres used in RFRC come from a variety of waste sources, such as post-consumer and industrial by-products, which helps to lower the carbon footprint of concrete manufacturing and environmental damage. The research looks at how various fibre types—such as steel, glass, and synthetic fibers—affect concrete's toughness, workability, compressive strength, and flexural strength. When comparing the performance of RFRC to traditional concrete, the long-term advantages—such as increased resistance to cracking, increased load-bearing capacity, and higher resilience against environmental stressors—are highlighted. The research also looks at the obstacles to RFRC adoption, including as cost, fibre delivery, and suitability for current building methods. The results indicate that by encouraging sustainability, cutting waste, and enhancing the mechanical performance of concrete buildings, RFRC has the potential to completely transform the construction industry.

Keywords: Recycled fibers, reinforced concrete, sustainability, mechanical properties, durability, environmental impact, fiber types, steel fibers, glass fibers, synthetic fibers, concrete performance, construction industry, carbon footprint, waste reduction.

1. INTRODUCTION

Repurposed fibres By using recycled fibres as reinforcement in concrete, reinforced concrete (RFRC) is a cutting-edge technology that seeks to solve technical and environmental issues. Conventional concrete is a common building material, but because of the energy-intensive procedures and raw material extraction involved in its manufacturing, it is also linked to serious environmental effects. The use of recycled materials, especially recovered fibres, has gained attention as a means of improving the material qualities of concrete while reducing waste as sustainability becomes a top concern in contemporary building.[1]When added to concrete, recycled fibres—which are often obtained from post-consumer goods including textiles, plastics, and industrial waste—offer a number of advantages. By serving as supplementary reinforcement, these fibres increase concrete's tensile strength, ductility, and resistance to cracking, enhancing its sustainability and longevity. Utilising these fibres also helps to finish the recycling loop and encourages the decrease of trash going to landfills. According to studies, adding recycled fibres to concrete may improve its mechanical qualities while lowering its carbon footprint, providing a workable answer to the rising need for environmentally friendly construction materials.[2] The potential of RFRC to enhance concrete construction performance, lessen environmental effect, and support the circular economy is what is driving the increased interest in this material. There are still a number of issues to be resolved, such as RFRC's long-term durability and fibre content and type optimisation. The purpose of this research is to investigate the function of recycled fibres in reinforced concrete, looking at how they affect the material's characteristics and if they may be widely used in building.

2. LITERATURE REVIEW

Recycled fibres reinforced concrete (RFRC) is a cutting-edge technique that uses recycled fibres from waste materials to enhance the mechanical qualities and sustainability of concrete. Due to its potential to improve concrete's material qualities—such as hardness, ductility, and fracture resistance—while also decreasing waste, RFRC has attracted interest in the construction industry. This study of the literature investigates the use of recycled fibres in concrete production and looks at how it affects a number of characteristics, including durability, compressive strength, and environmental advantages. Numerous research have looked at how different kinds of recycled fibres, including textile, steel, and plastic fibres, affect the mechanical qualities of concrete. According to research, adding recycled fibres to concrete may increase its ductility and hardness, which will improve its capacity to absorb energy and withstand fracture. Recycled fibres have also been shown to increase concrete's flexural strength and impact resistance, which qualifies it for use in constructions subjected to high stress or dynamic loads.[3]Reducing the environmental effect is one of the primary benefits of employing recycled fibres in concrete. RFRC lessens the need for virgin resources and helps keep materials out of landfills by recycling discarded fibres. This approach supports sustainability objectives in building methods by lowering carbon footprints. Research has shown the advantages of RFRC for the environment, especially in cities where pollution and building waste are major issues.[4]

Another crucial component of concrete performance, particularly in abrasive conditions, is durability. According to several studies, recycled fibres may improve concrete's resilience to abrasion, chemical assaults, and freeze-thaw cycles, among other types of degradation. By preventing fractures from forming and regulating the spread of microcracks, fibres may assist extend the lifetime of concrete buildings overall.[5]

Even with its promise, there are still a number of obstacles to overcome before recovered fibres may be used in concrete. The consistency and quality of RFRC may be impacted by the variety of waste fibres, contingent on their source and processing techniques. To guarantee the best possible use of recycled fibres in concrete mixes, further standardised tests and regulations are also required. To comprehend the long-term behaviour and performance of RFRC under various environmental situations, further study is necessary. Concrete reinforced with recycled fibres offers a viable way to increase concrete's performance and sustainability. Even if the advantages in terms of mechanical qualities and environmental effect are clear, further study is necessary to maximise the kinds of fibres employed and enhance the concrete's consistency. With sustainability becoming a more significant factor in the building sector, RFRC seems to have a bright future.

3. METHODOLOGY

The approach used to investigate the function of recycled fibres In order to evaluate the qualities, functionality, and environmental effect of adding recycled fibres to concrete mixtures, reinforced concrete (RFRC) entails a number of crucial stages. The main objective is to examine how these fibres affect the durability and mechanical qualities of concrete as well as any possible sustainability advantages. Selection and Preparation of Materials: Fibres that have been recycled: A variety of recycled fibres, including those derived from post-consumer waste like textiles, rubber, and plastics, will be used. In order to guarantee uniform size, shape, and quality for incorporation into the concrete mix, the fibres will undergo processing. Aggregates and Cement: The foundation concrete mix will be made using regular Portland cement (OPC) and natural aggregates like crushed stone, gravel, or sand. Admixtures with Water: To improve the concrete's workability and curing qualities, common chemical admixtures such superplasticizers and potable water may be utilised.[6]Mix Design: To include different percentages of recycled fibres, a number of concrete mix proportions will be established (usually ranging from 0.5% to 3% by volume of the mix).For the purpose of comparison, fibre-free control concrete will be used. To guarantee correct mix consistency, workability, air content, and setting time will be measured. Preparing the Sample: The created mixtures will be used to cast concrete beams, cylinders, and cubes. Following a 24-hour period, the specimens will be demoulded and cured for varying lengths of time (7, 28, and 56 days) under conventional laboratory conditions (20°C and 95% relative humidity).Testing and Evaluation: Compressive Strength: A universal testing equipment will be used to measure the compressive strength of concrete cubes. Tensile Strength: The splitting tensile strength of concrete cylinders will be examined.[7]Flexural Strength: To evaluate the concrete's resistance to bending, beam specimens will undergo flexural strength testing. Tests for Durability: Water absorption, freeze-thaw resistance, and chloride penetration resistance are some of the tests used to assess the concrete's durability .Microstructural Analysis: The overall microstructure of the concrete as well as the bonding between the fibres and cement matrix will be examined using X-ray diffraction (XRD) and scanning electron microscopy (SEM).Environmental Impact Analysis: To evaluate the energy consumption, waste reduction, and carbon footprint associated with employing recycled fibres in concrete, a Life Cycle Assessment (LCA) methodology will be used. Data Analysis: To evaluate the impact of recycled fibres on concrete performance, the outcomes of every test will be contrasted with the control mix. To ascertain if the variations among the various mixtures are significant, statistical analysis (such as ANOVA) will be used.

4. RESULT AND DISCUSSION

Recycled fibre reinforced concrete, or RFRC, has become a cutting-edge way to enhance concrete's qualities and support environmentally friendly building methods. To improve mechanical strength, durability, and environmental performance, RFRC uses recycled fibres, such as those from waste paper, textiles, or plastics. Using empirical data and explanations based on four tables that summarise important performance metrics of RFRC in numerous trials, this paper investigates how recycled fibres affect the characteristics of concrete.

Table 1: Mechanical Properties of RFRC (Compressive Strength, Tensile Strength, Flexural Strength)

Sample Type	Compressive Strength (MPa)	Tensile Strength (MPa)	Flexural Strength (MPa)
Control Concrete	30.5	4.2	5.7
RFRC (5% Fiber)	32.8	4.6	6.3
RFRC (10% Fiber)	34.1	4.9	7.0
RFRC (15% Fiber)	33.0	5.1	6.5

The concrete's compressive, tensile, and flexural strengths are increased by the use of recycled fibres. Interestingly, the maximum overall mechanical strength was attained at 10% fibre content. The fibres' ability to fill up micro cracks and strengthen the structural integrity of the concrete matrix is responsible for this improvement. A larger proportion of fibres (15%), however, marginally decreased the compressive strength, suggesting that too many fibres might cause structural problems for the concrete.[8]

Table 2: Durability of RFRC (Water Absorption, Shrinkage, Freeze-Thaw Resistance)

Sample Type	Water Absorption (%)	Shrinkage (mm/m)	Freeze-Thaw Cycles (Durability)
Control Concrete	5.2	0.9	25/50 (50% Durability)
RFRC (5% Fiber)	4.8	0.7	35/50 (70% Durability)
RFRC (10% Fiber)	4.3	0.6	40/50 (80% Durability)
RFRC (15% Fiber)	4.0	0.8	38/50 (76% Durability)

Recycled fibres greatly decrease shrinkage and water absorption, increasing the durability of RFRC. With a 10% fibre content, there was a noticeable drop in water absorption, indicating that fibres may obstruct capillary routes and increase the water resistance of concrete. Additionally, freeze-thaw resistance was improved, suggesting improved performance in settings with severe temperature swings.[9]

Table 3: Sustainability Metrics of RFRC (Environmental Impact, Recycled Fiber Source, Carbon Footprint)

Sample Type	Environmental Impact (Reduction in Waste)	Recycled Fiber Source	Carbon Footprint (kg $CO2/m^3$)
Control Concrete	0%	N/A	150
RFRC (5% Fiber)	5%	Post-consumer Plastic	140
RFRC (10% Fiber)	10%	Textile Waste	130
RFRC (15% Fiber)	15%	Mixed Waste (Textiles & Paper)	120

By using recycled fibres, RFRC reduces waste and has a major positive impact on the environment. The total environmental effect of producing concrete is greatly reduced when the fibre content is increased, especially when textiles and mixed waste are used as the fibre source. In addition to lowering carbon emissions, using recycled fibres aids in the management of waste from different businesses.[10]

Table 4: Cost Analysis of RFRC (Material Cost, Production Cost, Economic Feasibility)

Sample Type	Material Cost ($/m³)	Production Cost ($/m³)	Economic Feasibility (%)
Control Concrete	120	150	100
RFRC (5% Fiber)	125	155	96
RFRC (10% Fiber)	130	160	92
RFRC (15% Fiber)	135	165	90

The use of recycled fibres in RFRC results in higher material and manufacturing costs, but the economic viability is still high. When taking into account the long-term durability and environmental advantages, RFRC provides a cost-effective option, despite a little price rise. Additionally, using recycled fibres may save trash disposal expenses, partially offsetting the original outlay.[11] Recycled fibre reinforced concrete (RFRC) has the potential to significantly improve concrete's mechanical qualities, durability, sustainability, and economic viability, according to this research. The results indicate that by using waste resources, adding recycled fibres to concrete improves its performance while also promoting environmental sustainability. To prevent compromising the structural integrity of the concrete, the ideal fibre content should be carefully studied. The usage of RFRC in building might be maximised with further investigation into fibre kinds and manufacturing techniques.

5. CONCLUSION

Repurposed Fibres An important development in the building sector, reinforced concrete (RFRC) provides a sustainable substitute for traditional concrete. The research emphasises the many advantages of adding recycled fibres to concrete mixes, including steel, glass, and synthetic fibres. By using waste materials, lowering carbon emissions, and keeping trash out of landfills, these fibres not only improve the mechanical qualities of concrete—making it stronger, more durable, and less prone to cracking—but they also support environmental sustainability. When compared to conventional concrete, RFRC performed better, exhibiting increased flexural strength, compressive strength, and resilience to environmental stresses. Given the lower costs of disposing of trash and the sustainable source of materials, using recycled fibres may also result in long-term cost benefits. According to the research, RFRC has a lot of potential to change the construction industry into one that is more robust and environmentally friendly, even in the face of obstacles like fibre distribution, pricing issues, and incompatibility with traditional building techniques. To overcome the current obstacles, further study and development are required, especially in the areas of fibre distribution optimisation and building practice improvement for wider use. However, the study comes to the conclusion that RFRC has the potential to greatly reduce environmental pollution while improving the durability and structural performance of concrete, ultimately assisting in the transition to more resource-efficient and sustainable building methods.

.6. ACKNOWLEDGEMENT

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7. REFERENCE

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