

DEVELOPMENT OF HYBRID CONCRETE USING BASALT AND RECORN 3s FIBERS

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Abstract- This study focuses on the development of hybrid concrete using basalt fibers and Recron 3s fibers to improve the strength and durability of normal concrete. Basalt fibers are used for increasing strength, while Recron 3s fibers help in reducing cracks and improving resistance to shrinkage. In this work, different percentages of fibers are added to the concrete mix, such as basalt fibers (0.2% to 0.5%) and Recron 3s fibers (0.1% to 0.3%). Various tests like compressive strength, split tensile strength, and flexural strength are carried out and compared with plain concrete. The expected results show that hybrid concrete gives better performance than normal concrete. Compressive strength may increase by about 10% to 20%, split tensile strength by 15% to 25%, and flexural strength by 20% to 30%. Crack formation is reduced significantly, and durability is improved. The optimum fiber content is expected around 0.3% basalt fiber and 0.2% Recron 3s fiber, where maximum strength and good workability are achieved. This hybrid concrete can be effectively used in structures like roads, bridges, and water tanks where high strength, crack resistance, and long life are required.

Key Words: : Hybrid Concrete, Basalt Fiber, Recron 3S Fiber, Compressive Strength, Split Tensile Strength, Flexural Strength, Durability, Crack Resistance.

1 INTRODUCTION

Portland cement is commonly regarded as the main component of concrete, which is among the most frequently utilized construction materials. The widespread use of concrete as a building material is driven by the infrastructure advancements resulting from rampant urbanization and industrial development. Cement production is expected to grow from around 1.5 billion tons in 1995 to 2.5 billion tons by 2015. Globally, concrete is utilized in the construction of highways, bridges, buildings, runways, sidewalks, and dams. Given the necessity of cement in construction, it has a strong connection to the economy.

1.1 Recorn 3s Fibre

- Recron 3S fiber is a synthetic polyester fiber developed by Reliance Industries Limited to reduce cracking and improve concrete durability.
- It consists of fine, lightweight fibers that act as secondary reinforcement, controlling micro-cracks caused by plastic shrinkage.

- Recron 3S improves concrete quality by reducing shrinkage cracks, bleeding, segregation, and water penetration, thereby enhancing durability.
- The recommended dosage is 0.1%–0.3% by weight of cement (about 600–900 g/m³ of concrete), and it is commonly used in slabs, pavements, roads, and water-retaining structures

1.2 Basalt Fibre

- Basalt fiber is a natural fiber made from volcanic basalt rock and is used in concrete to improve strength and durability.
- It has high tensile strength and stiffness, which increases the tensile and flexural strength of concrete.
- Basalt fiber reduces cracking, improves ductility, toughness, and impact resistance, making concrete less brittle.
- It offers excellent fire, heat, corrosion, and chemical resistance, making it suitable for harsh environmental conditions.

1.3 HCL

In durability studies of concrete, HCl (Hydrochloric Acid) is used to check the acid resistance and durability of concrete. Concrete specimens are immersed in HCl solutions to study the effect of acidic conditions on strength, weight loss, and surface damage. This test helps to evaluate how well concrete can resist chemical attacks in aggressive environments such as industrial areas, sewage plants, and chemical industries.

2 MATERIALS AND METHODOLOGY

2.1 Fine Aggerate (IS 2386 Part-1)

Table 1 Properties of Fine Aggerate

Properties	Sand
Sieve analysis	Zone II
Fineness modulus	2.871
Specific Gravity	2.64
Water Absorption	1.77
Bulk Density	1.62 (Loose) 1.76 (Compacted)

2.2 Coarse Aggerate (383-1987)

Table 2 Properties of Fine Aggerate

Properties	20mm	10mm
Specific Gravity	2.88	2.99
Water Absorption	1.46%	0.29%
Aggregate Impact Value	9.81%	9.33%
Aggregate Crushing Value	11.75%	9.98%
Flakiness Index	10.89%	25.26%
Elongation Index	6.84%	7.66%
Bulk Density	1.62 (Loose) 1.75(Compact)	1.53 (Loose) 1.79(Compact)

2.3 Properties of Fly ash

Table 3 Properties of fly ash

Properties	Description
Fiber Length	6 mm / 12 mm, similar
Specific Gravity	1.30 – 1.38
Water Absorption	Very Low
pH Value	Neutral
Flammability	Non-inflammable

2.4 Mix Design (10262-2019)

- For M30 Grade Concrete mix

Table 4 mix proportion (per cubic meter)

water	Cement	FA	CA	Total
160	430	760	1170	2520
0.37	1.00	1.77	2.72	5.86

- For M35 Grade Concrete mix

Table 5 mix proportion (per cubic meter)

water	Cement	FA	CA	Total
153.26	394.32	808.9	1179.7	2554.2
0.40	1.00	2.11	3.12	6.64

- For M40 Grade Concrete mix

Table 6 mix proportion (per cubic meter)

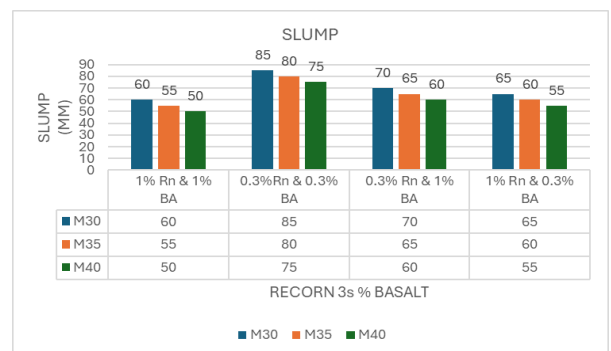
water	Cement	FA	CA	Total
160	400	660	1168	2480
0.40	1.00	1.65	2.92	5.97

3. RESULT

3.1 Workability

- Workability is the property of fresh concrete which determines the ease of mixing, placing, compacting, and finishing without segregation.
- Good workability ensures better strength, durability, and surface finish of concrete
- The workability of concrete is tested according to IS 1199.

Chart-1 slump value comparison



3.2 Compressive test result

- Bureau of Indian Standards suggests that the compressive strength of concrete be considered as the basis for determining all properties and studying response of concrete.
- Compressive Strength Test evaluation @ (7 Days, 14 Days and 28 Days)
- Concrete cubes are standard specimens used in the compressive strength test to determine the strength of concrete. Generally, cubes of size 150 mm × 150 mm × 150 mm are cast, cured, and tested in a Compression Testing Machine.

Where, $f_c = P/A$

f_c = Compressive strength (N/mm^2)

P = Maximum load applied (N)

A = Area of cube specimen (mm^2)

Chart-2 Compressive test result of 7 days

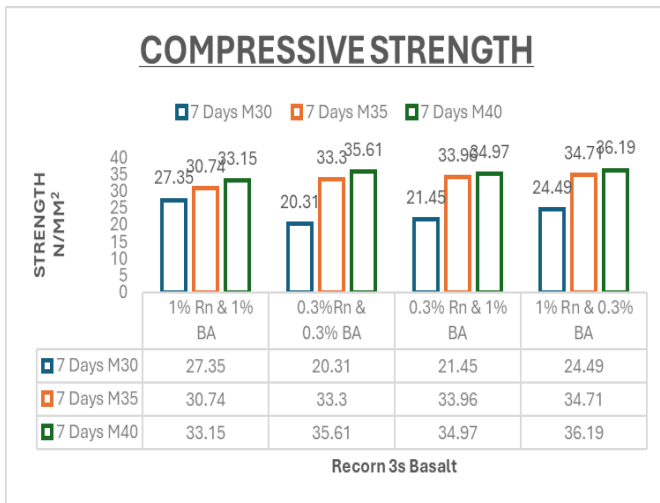


Chart-3 Compressive test result of 14 days

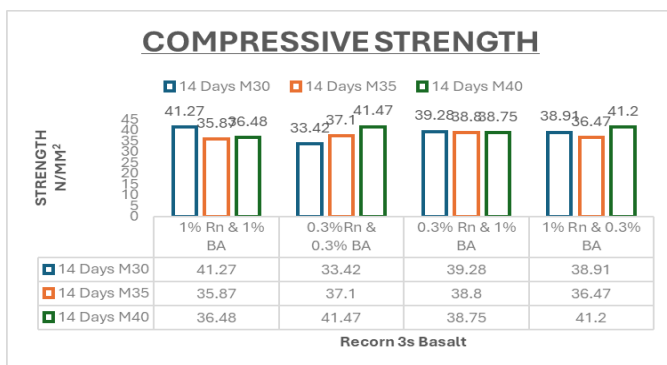
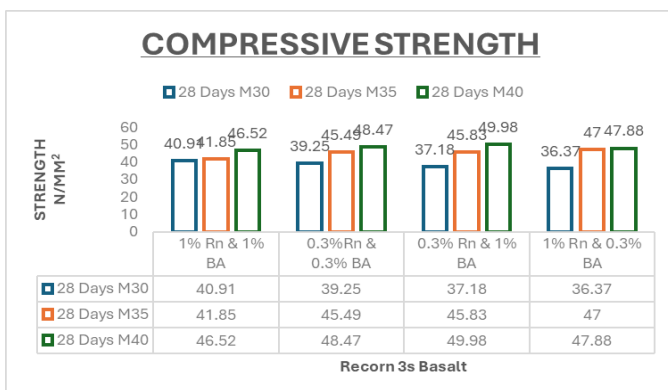


Chart-4 Compressive test result of 28 days



3.3 Split Tensile test result

- Concrete cylinders were cast to determine split tensile strength. 28 days split tensile strength of concrete was determined and results of test shown below in tabular form.

- The load is applied gradually until the cylinder splits into two halves due to tensile stress developed along the vertical diameter.
- Cylinders of size 150 mm diameter and 300 mm length are used. The test is conducted after curing periods such as 7 days and 28 days

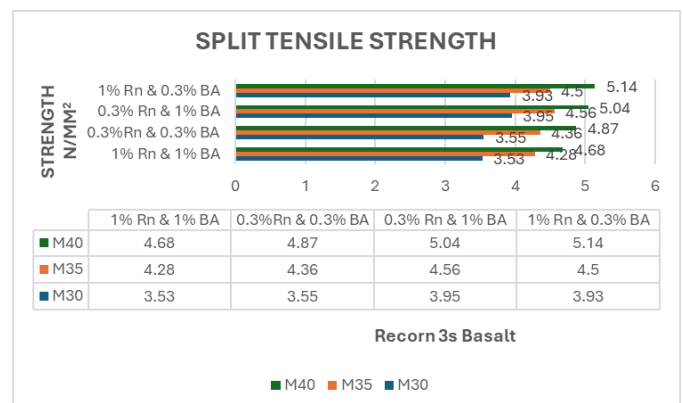
$$f_t = 2P / 3.14DL$$

P= Maximum load applied (N)

D= Diameter of cylinder (mm)

L= Length of cylinder (mm)

Chart-5 Split Tensile test result



3.4 Durability test result

- Durability of concrete is the ability of concrete to resist weathering action, chemical attack, abrasion, and other harmful effects while maintaining its strength and stability for a long period of time.
- In durability testing, Hydrochloric Acid (HCl) solution is used to study the resistance of concrete against acid attack.
- Concrete specimens are immersed in HCl solution for 28 days, and the changes in weight, surface condition, and compressive strength are observed to evaluate the chemical resistance and long-term performance of concrete.
- The durability requirements are specified in IS 456

Chart-6 Durability test result for M30

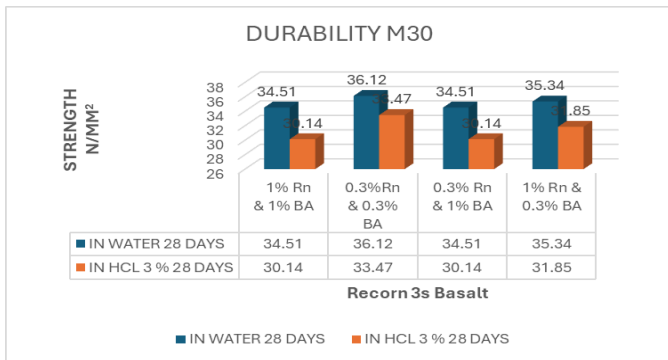


Chart-7 Durability test result for M35

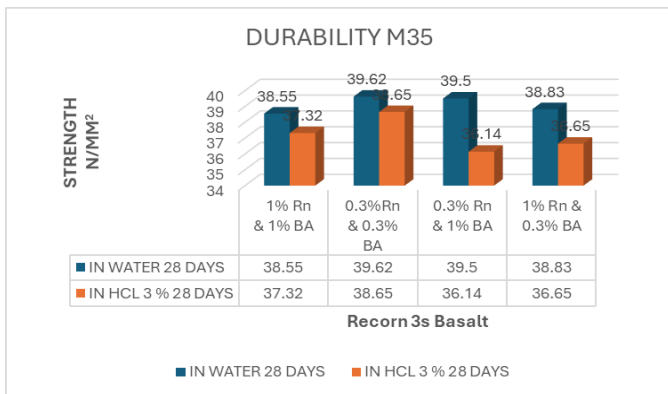
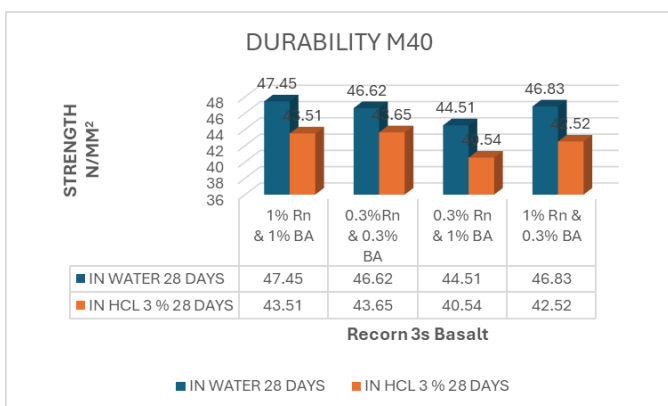


Chart-8 Durability test result for M40



- Molds for flexural strength testing of 150x150x600mm beams were prepared, with 3 specimens tested at each age using different mix design ratios (beams tested at 7 days and 28 days).
- All freshly cast specimens were left in molds for 24 hours before being removed and then submerged in water for curing until strength testing was carried out.

Chart-9 Comparison of flexural strength values at 7 days

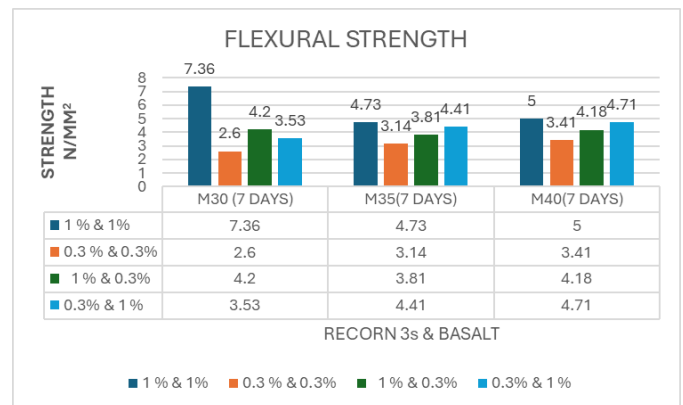
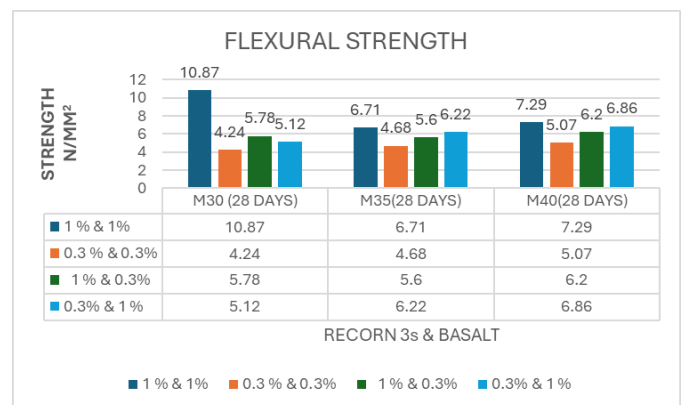


Chart-10 Comparison of flexural strength values at 28 days



3.5 Flexural Strength test Beam Result of M30, M35, M40 Grade of Concrete

- In this study, 24 beams and 24 cubes were used, totaling 48 specimens for control.
- Cement was substituted with fly ash at varying percentages of 1%, 1.5%, 0.3%, while sand was replaced with stone dust at percentages of 8%, 1%, 0.3%, and 1.5%.

4. CONCLUSION

- ✓ The incorporation of Recron 3s and Basalt fibers in M30 concrete resulted in a noticeable enhancement in compressive strength compared to conventional concrete.
- ✓ All fiber-reinforced mixes satisfied the strength requirements and exhibited improved performance at 28 days.
- ✓ An increasing trend in compressive strength was observed with the increase in total fiber content

- ✓ The mix with higher fiber dosage showed maximum strength development, indicating the effectiveness of hybrid fiber reinforcement.
- ✓ Mixes with lower fiber content demonstrated adequate strength along with better workability, making them suitable for practical applications.
- ✓ Basalt fibers contributed significantly to strength enhancement and load-carrying capacity, owing to their high tensile properties
- ✓ Recron 3s fibers played an important role in controlling micro-crack propagation and improving ductility of concrete.
- ✓ However, an increase in fiber content led to a reduction in workability, which may affect compaction and uniformity of the mix.
- ✓ The study confirms that hybridization of fibers provides a synergistic effect, improving both strength and durability characteristics.
- ✓ Therefore, an optimum proportion of fibers is necessary to achieve a balance between mechanical performance and workability

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