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Behavioural Study on Synthetic Fibre Reinforced Soil Cement Stabilized Blocks

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Abstract

It has been shown that the most prevalent material is soil. It is essential to the manufacture of bricks. It is well known that burned bricks function well for masonry projects, providing durability and structural integrity that are vital for construction applications. Furthermore, a significant amount of heat energy is utilized during the heating process that creates them, thus emphasizing the energy-intensive nature of brick production. In addition, children are frequently taken on trips to distant locations, possibly for educational purposes or exploration. Because these blocks are made in basic, manually or semi-mechanized presses, which are operated using user-friendly methods and techniques, the production process remains accessible. These presses utilize readily stabilized dirt that is already present in the area, making them an economical and environmentally friendly alternative to traditional bricks. This approach not only preserves local resources but also promotes sustainability within the community.In presses, local soil stabilized by cement is used to create soil-cement blocks, also referred to as compressed earth blocks or stabilized mud blocks for load-bearing masonry. This process is not only cost-effective but also utilizes significantly less heat energy compared to traditional methods. When it comes to building materials, soil cement bricks are not only less expensive but also more energy-efficient and unconventional when juxtaposed with the typical burnt mud bricks that are commonly employed to construct homes. In this work, Recron 3S fiber—a specific type of polypropylene fiber—is strategically incorporated to enhance the overall strength and resilience of the soil. This innovative approach contributes positively to the structural integrity of the blocks, making them a viable option for modern construction practices.

Keywords: Fiber reinforced soil,recron fiber,stabilized block, sustainable, reinforcing material

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INTRODUCTION ABOUT SOIL STABILIZED BLOCKS

Soil has universally been used as a major building material in form of mud, adobe, rammed earth and burnt bricks for centuries. However, when used in any other form other than burnt bricks, such buildings are short-lived as they easily erode when they come in contact with water [1].

While burnt bricks are strong and water resistant, they consume a lot of firewood. In some areas, as many as 20 trees are required to burn the bricks required to build one classroom [2]. Burning of bricks for permanent buildings construction is not a viable option as in the long run cause's deforestation [3].

The other option of improving soil qualities to make it suitable for building permanent building is stabilization with cement as the binding agent. When a small amount of cement (5-10%) is added into the soil and then compressed mechanically to make building blocks, the resultant blocks are water resistant and their compressive strength highly increased making it strong enough to build buildings up to 3 stories high without using columns, when using normal blocks that are cemented together with mortar [4,5].

In terms of its performance as a material for repair, how does steel fibre reinforced concrete behave?

It is usual to repair;Steel fiber reinforced concrete (SFRC) with its dysfunctional characteristics using its repaired improve performance properties. The SFRC has a higher resistance to impact, better crack control, and also a good stiffness modulus, and this makes it most often chosen in repair work. The inclusion of steel fibers in the composition of the concrete increases its tensile strength and ductility, which are important properties in helping the structure remain unaffected during load. The fibers repair the cracks and uniformly distribute the load, thus diminishing the possibility of premature failure.

What impact does the addition of fibre reinforcement have on the strength of soils that have been cemented?

Furthermore, not only are fiber reinforcing agents, like microfibers made of polypropylene, important, but cement-treated soils' strength characteristics are also significantly impacted. Thus, fiber-reinforced cementitious soils exhibit greater cohesiveness and shear strength. The fibers play a crucial role in joining the cement and soil particles, giving them an additional source of support in the event of an abrupt force that would cause them to shift, strengthening the material and transforming it into a beam. This reinforcement mechanism's coupling of forces increases the soil's total capacity to support loads, making it appropriate for a variety of building applications where a stronger component is required.

To what extent does cement stabilisation work best with a particular kind of soil?

We have soils with a specific distribution of particle sizes yield the best results when it comes to stabilizing cement; this allows for proper particle binding and optimal product curing. soils that have an ideal ratio of fines, sands, and gravels—all of which contribute to the finest cement stabilization outcomes. By filling in the gaps left by larger particles, fines improve compaction and lower the void ratio. Furthermore, since organic matter can obstruct the chemical reactions required for the cement to cure, soils with a low amount of organic matter are much more desirable. Well-graded sandy and gravelly soils are ideal for cement stabilization because they allow for effective binding and particle interlocking [24,25].

TYPES OF SOIL STABILIZED BLOCKS

Soil may be a composition of organic materials, aggregates, minerals, liquid and other gaseous matter additionally to varied foreign matters. There are constantly various factors at work creating new land. Rocks are broken down by weathering to create soil. A significant amount of stabilization is required on expansive clays, Black cotton soils, or weak chi-soils in order to identify the proper engineering properties [6].

Sherwood pointed out that because fine granular materials offer a larger surface area for small radius particles, they can be consolidated more quickly. Because the particle morphologies in clayey soils are flat and elongated, they have higher surface areas than in other groups. This means mixing and combining different materials to change the qualities of the soil[1,3,5].Soil stabilization is that the process of improving the shear strength characteristic of soil thanks to which bearing capacity of soil increased up to certain limit to face up to structural load. When the soil that is suitable for construction cannot withstand the structural load, soil stabilization is used [7].

It is the preferred method of increasing strength characteristics (shear strength), such as reducing settlement during the use of structural elements, and decreasing permeability, compressibility, and swelling potential of the soil mass during construction on or in it.Soil stabilization involves the utilization of stabilizing agents like lime, cement, fly ash, ceramic, in weak soils to enhance its geotechnical properties like compressibility, strength, permeability and sturdiness [8-10].

The process of stabilizing a road during construction uses gravel or soil for the road's main structure, or pavement layers. Special features for soils intended for road construction should be present where necessary, considering the tensile stresses involved. Unbound materials are typically treated with cementations materials like as cement, lime, fly ash, bitumen, or a combination of these during the soil stabilization process.Civil and structural engineering are needed to create visually appealing properties for poor soils, while also taking description into consideration. Most of the time, either in-situ or ex-situ stabilization can be used to accomplish this [11,13].

For engineers, soil's shearing strength, compressibility, permeability, and compaction are crucial characteristics.Some stabilization techniques are:

1. Lime Stabilization
2. Cement Stabilization
3. Chemical Stabilization
4. Fly ash Stabilization
5. Rice Husk ash stabilization
6. Bituminous stabilization
7. Thermal Stabilization
8. Electrical Stabilization
9. Stabilization by Geo-textile and Fabrics
10. Recycled and Waste Products

Lime Stabilization Inexpensive way of soil stabilization is by lime. The technique of adding lime to the soil to enhance its qualities is known as "lime stabilization." Dolomitic lime, monohydrate dolomite lime, quick lime calcite, and hydrate high calcium lime are among the lime varieties used to improve soil. Lime modification is the term used to describe the strength gain that comes from a force reservoir as opposed of the pozzolanic reaction's hardening effect. Because clayey soils tend to dry out, variations in moisture content have less of an impact on them "[14].

Cement stabilization is the process of using cement to increase the adhesion of soil particles by causing crystals to form and grow larger as a result of the cement particles hardening. This interlocking of the particles results in high compressive strength." The cement must cover more than 50% of these materials' surface area in order to properly fuse the two material particles together. It is crucial to mix cement evenly so that its concentration in the mixture increases in order to establish a strong bond between the cement and the soil (soil cement stabilization), which produces notable compressive strengths [15].

A soil which has a specific particle size distribution is important because it allows water to pass through more easily Soil cementation can also be defined as an extremely dense mix composed of soil(s) aggregate, cement and water Soil cement can also be referred to as cement-stablised subbase or cement-treated aggregate Soil cement becomes difficult and strong through the hydration of cement.Cement stabilization is completed when the compaction process is constant [16].

Because cement fills the voids between the particles to provide their solid connections, the void ratio of the soil may drop and the weight of a soil unit may increase. When cement and water come into touch, the cement interacts with the water to harden [11]. Higher shear strength and greater bearing capacity are also obtained from curing the cement.

Cement reaction isn't hooked in to soil minerals, and thus the key role is its reaction with water which will be available in any soil. Chemical Stabilization Chemical soil stabilization is one of the ways to increase bearing capacity of soil. Because salt is hygroscopic and deliquescent, we employ it as a water retention addition in mechanically stabilized soil bases and surfacing. Evaporation rate drops, physical phenomena rise, and vapor pressure falls [13]. This lowers the melting point of pure water, preventing or lessening frost heave.Frequent application of salt could even be necessary to form up for the loss of chemical by leaching action.

Importance of Soil Stabilized Blocks

Soil Stabilized block are available low price compare to bricks and light in weight. Due to use of this block provide climate comfortable feelings in rooms. This block has given high performance compare to brick. Therefore, this block is very good and highly efficient compare to brick.

Construction of housing and public infrastructure needs to be of greater quality than what was previously used. Past practices of large-scale use of firewood to make burned bricks for construction of housing have resulted in massive deforestation of the country. Such destruction has given rise to the realization that alternative building methods are needed [6].

Introduction to R3s Recron Fiber

R3S Recron Fibres are man-made fibres. Such fibres are made through chemical synthesis. Furthermore, they are made up of synthesised polymers of small molecules. We make fabrics from fibres. Synthetic or artificial fibres have their applications in every field of fibre and textile technology. Some examples of synthetic fibres are nylon, polyester, acrylic and polyolefin. These four artificial fibres are used in approximately 98% of synthetic fibre production polyester alone takes60% [9].

OBJECTIVE OF THE STUDY

With less cement than is often used, compressed stabilized earth blocks will be made in this study, and their resistance will be examined using synthetic Recron Fiber that has been ground into the R3S genotype.By employing distinct sand mixtures, the blocks will be constructed from varied fine fractions of a local Eluru soil. These blocks' future and strength will be evaluated against the standards specified in standard specifications, which are meant to be used with them. In order to address the rising expenses associated with building structures out of earth blocks, this analysis can assist in determining the appropriate mix ratio for usage as an alternative building material. The following goals ought to be fulfilled within the given parameters: [1,6,15]

1. Evaluation of the fiber-containing soils' strength.
2. Research on the deformation of fiber-fortified soil.
3. Fiber-reinforced soil-cement block molding.
4. Assessing the impact of adding R3S Recron fibers in connection to the cement used in strength determination, as well as measuring mechanical strength in terms of the blocks' ability to compress.

METHODOLOGY

Obtaining The Soil And Materials

The red soil is collected from Bhogapuram, Eluru district. Soil lumps are crushed by using rammer and then sieved by using 4.75 mm I.S sieve and then the sieved soil is used for casting of blocks. A cement bag of 50 kgs was bought from the shop. Fibers are purchased from Vruksha composites, T.Nagar, Chennai.

Identifying Proprties of Soil And Materials

We had done the laboratory tests like grain size analysis, compaction and direct shear. From the grain size analysis, the soil had classified as poorly graded reddish sandy soil. And from the direct shear test the angle of internal friction and cohesion are determined. And then from the compaction test the O.M.C and M.D.D of the soil had been determined.

Identifying the Shear Strength Parameters for Soil and Varying Fibers

We had conducted a direct shear test with the addition of various percentages of fibers to the soil sample. By doing this we were able to measure the shear strength of the soil with different levels of fiber reinforcement.

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Design of mix Proportions for Soil Cement Blocks

Based on the M.D.D and the volume of the mould we had measured the quantity of soil required to cast a block. The type of underlying soil will determine how much cement is used: sandy soils require 5%–9% volumes of cement (Najjar 1983; Hamed & Mouta 2006); silt soils require 8%–12%; and clayey types require about 12%–15% for stabilization; adding more cement than 15% is not recommended." As our soil is classified as sandy soil we adopted 9% of cement by volume of soil. We had added various percentages of fibers to the soil sample. The composition of Soil Cement Fibers ratios is prepared.

Casting of Scsb's

At first the soil lumps had been crushed and then the soil passed through 4.25mm IS sieve. From the mix proportions the required amount of soil is taken and then 9% of cement, 11% of water and various percentages of fibers are mixed thoroughly. And then the mixed soil had left aside for 30 minutes for hydration purpose. After completion of 30 minutes mix had placed in wooden mould and compacted in three layers and then taken out from the mould with care and then the blocks cured for a period of 14 or 28 days. The detailed method adopted for casting blocks is presented.

Tests Conducted on Scsb's

As per the Indian Standard Code IS 1725 (1982) we have conducted tests like compression test, flexural test and water absorption test. The detailed procedure of the tests conducted on blocks is presented.

Interpretation of Results

Following the presentation of the test findings, conclusions were drawn.

STUDY ON COMPACTION AND SHEAR PARAMETERS OF FIBER REINFORCED SOIL

Compaction And Shear Behaviour Of 0.1% R3s Recron Fiber Reinforced Soil

A compaction test is carried out to know the optimum moisture content (O.M.C) and maximum dry density (M.D.D) in the presence of the 0.1% of recron fibres.[17-23]

Explanation

Take about 2 kg of dried soil which is passes through 4.75mm sieve

Add 0.1% of fibre and mix it thoroughly with soil and then add 2% of water and conduct the compaction test.

Repeat the procedure by increasing the water percentage by 2%. Note down all the necessary readings Table 1.

Table 1. Compaction test of soil with 0.1% Recron fiber

Amount of water added	2%	4%	6%	8%	10%
Weight of mould, w_1,gm	239	239	239	239	239
Weight of compacted soil+ mould, w_2, gm	424	436	470	488	473
Weight of wet soil (w_2-w_1), gm	185	197	231	249	234
Volume of mould, cm^3	135.71	135.71	135.71	135.71	135.71
Bulk density, g/cc	1.36	1.451	1.702	1.83	1.72
Container no	10	8	2	9	4
Weight of container with lid, m_1, gm	27	30	26	26	30
Weight of container with lid and wet soil, m_2, gm	79	78	64	65	90
Weight of container with lid and dry soil, m_3, gm	77	74	61	60	80
Water content of the soil, %	0.04	0.09	0.08	0.14	0.2
Dry density g/cc	1.31	1.33	1.57	1.60	1.43

Optimum moisture content = 8%
Maximum dry density = 1.60 g/cc

Direct Shear Test

As part of our project on soil blocks reinforced with poly propylene fibers, we conducted a direct shear test by adding 0.1% of fibers to the soil mix. The purpose of this test was to determine how the fibers would affect the shear strength of the soil blocks.To perform the test, we first prepared the soil mix by adding the fibers and water, and then compacted the mixture into a shear box. We then placed the shear box in a direct shear test apparatus, which applies a constant vertical load to the soil while simultaneously applying a horizontal force to the top of the shear box [12].

By measuring the amount of force required to shear the soil along a horizontal plane, we were able to calculate the shear strength of the soil with 0.1% of poly propylene fibers. Our results Table 2 and Table 3 indicated that the addition of fibers resulted in an increase in the shear strength of the soil blocks, suggesting that the fibers were able to reinforce the soil matrix and improve the overall stability of the blocks.

Table 2. Direct shear test of soil with 0.1% Recron fiber.

Horizontal dial reading			Shear displacement			Strain rate	Proving ring reading			Shear force			Shear Stress		
0.5	1	1.5	0.5	0.5	0.5		0.5	1	1.5	0.5	1	1.5	0.5	1	1.5
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	30	30	0.3	0.3	0.3	0.5	2.4	6	7	4.32	10.8	12.6	0.12	0.3	0.35
60	60	60	0.6	0.6	0.6	1	3.2	7.2	9.6	5.76	12.96	17.28	0.16	0.36	0.48
90	90	90	0.9	0.9	0.9	1.5	4	8.8	11.4	7.2	15.84	20.52	0.2	0.44	0.57
120	120	120	1.2	1.2	1.2	2	4.4	9.8	12.8	7.92	17.64	23.04	0.22	0.49	0.64
150	150	150	1.5	1.5	1.5	2.5	4.8	10.4	14	8.64	18.72	25.2	0.24	0.52	0.7
180	180	180	1.8	1.8	1.8	3	4.9	11	15.2	8.82	19.8	27.36	0.245	0.55	0.76
210	210	210	2.1	2.1	2.1	3.5	5.6	11.4	16	10.08	20.52	28.8	0.28	0.57	0
240	240	240	2.4	2.4	2.4	4	5.9	0	17	10.62	0	30.6	0.295	0	0
270	270	270	2.7	2.7	2.7	4.5	6.2	0	17.6	11.16	0	31.68	0.31	0	0
300	300	300	3.0	3.0	3.0	5	6.2	0	18.2	11.16	0	32.76	0.31	0	0
330	330	330	3.3	3.3	3.3	5.5	0	0	18.8	0	0	33.84	0	0	0
360	360	360	3.6	3.6	3.6	6	0	0	19.4	0	0	34.92	0	0	0
390	390	390	3.9	3.9	3.9	6.5	0	0	20	0	0	36	0	0	0
420	420	420	4.2	4.2	4.2	7	0	0	0	0	0	0	0	0	0
450	450	450	4.5	4.5	4.5	7.5	0	0	0	0	0	0	0	0	0
480	480	480	4.8	4.8	4.8	8	0	0	0	0	0	0	0	0	0
510	510	510	5.1	5.1	5.1	8.5	0	0	0	0	0	0	0	0	0
540	540	540	5.4	5.4	5.4	9	0	0	0	0	0	0	0	0	0
Maximum													0.31	0.57	0.76

Table 3. Normal stress and Shear stress of soil with 0.1% Recron fiber.

S.N.	Normal stress (kg/cm^2)	Shear stress (kg/cm^2)
1	0.5	0.31
2	1.0	0.57
3	1.5	0.76

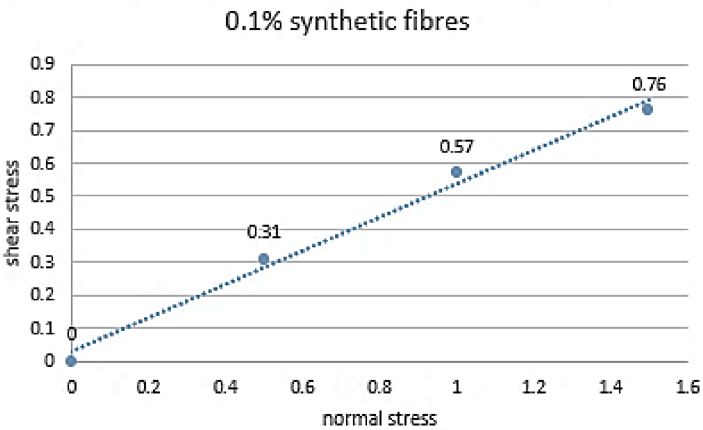

Figure 1. Direct shear of 0.1% Recron fibres.

The cohesion observed in the 0.1% synthetic fiber reinforced soil is 0.02 kg/cm^2.

In soil reinforced with 0.1% synthetic fiber, the angle of internal friction was found in Figure 1 is to be 24^o.

Compaction And Shear Behaviour Of 0.2% R3s Recron Fiber Reinforced Soil

A compaction test is carried out to know the optimum moisture content (O.M.C) and maximum dry density (M.D.D) in the presence of the 0.2% of recron fibres.

Explanation

Take about 2 kg of dried soil which is passes through 4.75mm sieve

Add 0.2% of fibre and mix it thoroughly with soil and then add 2% of water and conduct the compaction test.

Repeat the procedure by increasing the water percentage by 2%. Note down all the necessary readings Table 4.

Table 4. Compaction test of soil with 0.2% Recron fibers.

Amount of water added	2%	4%	6%	8%	10%
Weight of mould, $w_{1,}$ gm	240	240	240	240	240
Weight of compacted soil+ mould, w_2, gm	420	438	465	487	479
Weight of wet soil (w_2-w_1), gm	181	199	226	248	240
Volume of mould, cm^3	135.71	135.71	135.71	135.71	135.71
Bulk density, g/cc	1.33	1.46	1.66	1.82	1.76
container no	10	1	2	9	8
Weight of container with lid, $m_{1,}$ gm	27	26	26	26	30
Weight of container with lid and wet soil, m_2	82	85	76	73	89
Weight of container with lid and dry soil, m_3, gm	79	81	72	71	82
Water content of the soil, %	0.05	0.07	0.086	0.04	0.13
Dry density, g/cc	1.266	1.36	1.53	1.75	1.55

Optimum moisture content = 8%
Maximum dry density = 1.75 g/cc

DIRECT SHEAR TEST

As part of our project on soil blocks reinforced with poly propylene fibers, we conducted a direct shear test by adding 0.2% of fibers to the soil mix. The purpose of this test was to determine how the fibers would affect the shear strength of the soil blocks.

To perform the test, we first prepared the soil mix by adding the fibers and water, and then compacted the mixture into a shear box. We then placed the shear box in a direct shear test apparatus, which applies a constant vertical load to the soil while simultaneously applying a horizontal force to the top of the shear box.

By measuring the amount of force required to shear the soil along a horizontal plane, we were able to calculate the shear strength of the soil with 0.2% of poly propylene fibers. Our results Table 5 and Table 6 indicated that the addition of fibers resulted in an increase in the shear strength of the soil blocks, suggesting that the fibers were able to reinforce the soil matrix and improve the overall stability of the blocks.

Table 5. Direct shear test of soil with 0.2% Recron fiber.

Horizontal dial reading			**Shear displacement**			**Strain rate**	**Proving ring reading**			**Shear force**			**Shear stress**		
0.5	1	1.5	0.5	0.5	0.5		0.5	1	1.5	0.5	1	1.5	0.5	1	1.5
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	30	30	0.3	0.3	0.3	0.5	4.8	32	0	8.64	57.6	0	0.24	0.16	0
60	60	60	0.6	0.6	0.6	1	4.6	5	52	8.28	9	9.36	0.23	0.25	0.26
90	90	90	0.9	0.9	0.9	1.5	5.8	8.2	92	10.44	14.76	16.56	0.29	0.41	0.46
120	120	120	1.2	1.2	1.2	2	6.6	9.2	106	11.88	16.56	19.08	0.33	0.46	0.53
150	150	150	1.5	1.5	1.5	2.5	7.6	10.4	12	13.68	18.72	21.6	0.38	0.52	0.6
180	180	180	1.8	1.8	1.8	3	7.8	11	13.2	14.04	19.8	29.76	0.39	0.55	0.66
210	210	210	2.1	2.1	2.1	3.5	8	11.8	14.4	14.4	21.24	25.92	0.4	0.59	0.72
240	240	240	2.4	2.4	2.4	4	8.2	12	15.6	14.76	21.6	28.08	0.41	0.6	0.78
270	270	270	2.7	2.7	2.7	4.5	8.6	12.6	16.4	15.48	22.68	29.52	0.43	0.63	0.82
300	300	300	3.0	3.0	3.0	5	8.8	13	17.6	15.84	23.4	31.68	0.44	0.65	0.88
330	330	330	3.3	3.3	3.3	5.5	9	13.6	18.2	16.2	24.48	32.76	0.45	0.68	0.91
360	360	360	3.6	3.6	3.6	6	9.2	13.8	19	16.56	24.84	34.2	0.46	0.69	0.95
390	390	390	3.9	3.9	3.9	6.5	9.4	14.4	19.8	16.92	25.92	35.64	0.47	0.72	0.99
420	420	420	4.2	4.2	4.2	7	9.6	16	20.2	17.28	28.8	36.36	0.48	0.8	1.01
450	450	450	4.5	4.5	4.5	7.5	10	0	20.8	18	0	37.44	0.5	0	1.04
480	480	480	4.8	4.8	4.8	8	0	0	0	0	0	0	0	0	0
510	510	510	5.1	5.1	5.1	8.5	0	0	0	0	0	0	0	0	0
540	540	540	5.4	5.4	5.4	9	0	0	0	0	0	0	0	0	0
Maximum													0.5	0.8	1.04

Table 6. Normal stress and Shear stress of soil with 0.2% Recron fiber.

S.N.	**Normal stress (kg/cm^2)**	**Shear stress (kg/cm^2)**
1	0.5	0.5
2	1.0	0.8
3	1.5	1.04

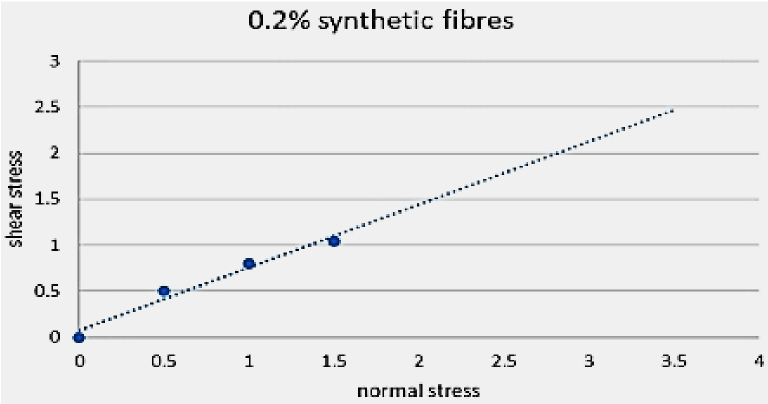

Figure 2. Direct shear of 0.2% Recron fibres.

The Cohesion observed in the 0.2% synthetic fiber reinforced soil is 0.07 kg/cm^2.

In soil reinforced with 0.2% synthetic fiber, the angle of internal friction was found in Figure 2 is to be 34^o.

Compaction And Shear Behaviour of 0.3% R3s Recron Fiber Reinforced Soil

A compaction test is carried out to know the optimum moisture content (O.M.C) and maximum dry density (M.D.D) in the presence of the 0.3% of recron fibres.

Explanation

Take about 2 kg of dried soil which is passes through 4.75mm sieve

Add 0.3% of fibre and mix it thoroughly with soil and then add 2% of water and conduct the compaction test.

Repeat the procedure by increasing the water percentage by 2%. Note down all the necessary readings Table 7.

Table 7. Compaction test of soil with 0.3% Recron fiber.

Amount of water added	2%	4%	6%	8%	10%
Weight of mould, w_1, gm	240	240	240	240	240
Weight of compacted soil+ mould, w_2, gm	432	446	471	481	472
Weight of wet soil (w_2-w_1), gm	193	207	232	242	233
Volume of mould, cm^3	135.71	135.71	135.71	135.71	135.71
Bulk density, g/cc	1.422	1.52	1.70	1.78	1.71
container no	4	5	7	8	2
Weight of container with lid, m_1, gm	30	31	28	30	26
Weight of container with lid and wet soil, m_2	89	78	75	89	81
Weight of container with lid and dry soil, m_3, gm	86	71	72	83	73
Water content of the soil, %	0.053	0.175	0.06	0.11	0.17
Dry density, g/cc	1.35	1.299	1.60	1.60	1.46

Optimum moisture content = 8%
Maximum dry density = 1.6 g/cc

DIRECT SHEAR TEST

As part of our project on soil blocks reinforced with poly propylene fibers, we conducted a direct shear test by adding 0.3% of fibers to the soil mix. The purpose of this test was to determine how the fibers would affect the shear strength of the soil blocks.

To perform the test, we first prepared the soil mix by adding the fibers and water, and then compacted the mixture into a shear box. We then placed the shear box in a direct shear test apparatus, which applies a constant vertical load to the soil while simultaneously applying a horizontal force to the top of the shear box.

By measuring the amount of force required to shear the soil along a horizontal plane, we were able to calculate the shear strength of the soil with 0.3% of poly propylene fibers. Our results Table 8 and Table 9 indicated that the addition of fibers resulted in an increase in the shear strength of the soil blocks, suggesting that the fibers were able to reinforce the soil matrix and improve the overall stability of the blocks.

Table 8. Direct shear test of soil with 0.3% Recron fiber.

Horizontal dial reading			**Shear displacement**			**Strain rate**	**Proving ring reading**			**Shear force**			**Shear stress**		
0.5	1	1.5	0.5	0.5	0.5		0.5	1	1.5	0.5	1	1.5	0.5	1	1.5
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	30	30	0.3	0.3	0.3	0.5	5	4.2	14.4	9	7.56	25.92	0.25	0.21	0.72
60	60	60	0.6	0.6	0.6	1	6	7	17.2	10.8	12.6	30.96	0.3	0.35	0.86
90	90	90	0.9	0.9	0.9	1.5	7.2	8.2	19	12.96	14.76	34.2	0.36	0.41	0.95
120	120	120	1.2	1.2	1.2	2	8.8	9.6	20.2	15.84	17.28	36.36	0.44	0.48	1.01
150	150	150	1.5	1.5	1.5	2.5	9.8	10.4	21.4	17.64	18.72	38.52	0.49	0.52	1.12
180	180	180	1.8	1.8	1.8	3	10.4	14.2	22.4	18.72	25.56	40.32	0.52	0.71	1.17
210	210	210	2.1	2.1	2.1	3.5	11.4	14.6	23.4	20.52	26.28	42.12	0.57	0.73	1.21
240	240	240	2.4	2.4	2.4	4	11.8	15.2	24.2	21.24	27.36	43.56	0.59	0.76	1.25
270	270	270	2.7	2.7	2.7	4.5	12.4	16.4	25	22.32	29.52	45	0.62	0.82	1.31
300	300	300	3.0	3.0	3.0	5	12.8	0	26.2	23.04	0	47.16	0.64	0	1.34
330	330	330	3.3	3.3	3.3	5.5	13.2	0	26.8	23.76	0	48.24	0.66	0	1.39
360	360	360	3.6	3.6	3.6	6	13.7	0	27.8	24.66	0	50.04	0.685	0	1.43
390	390	390	3.9	3.9	3.9	6.5	14	0	28.6	25.2	0	51.48	0.7	0	1.46
420	420	420	4.2	4.2	4.2	7	14.4	0	29.2	25.92	0	52.56	0.72	0	1.5
450	450	450	4.5	4.5	4.5	7.5	0	0	30	0	0	54	0	0	1.51
480	480	480	4.8	4.8	4.8	8	0	0	30.2	0	0	54.36	0	0	1.56
510	510	510	5.1	5.1	5.1	8.5	0	0	31.2	0	0	56.16	0	0	0
540	540	540	5.4	5.4	5.4	9	0	0	0	0	0	0	0	0	0
Maximum													0.72	0.82	1.56

Table 9. Normal stress and Shear stress of soil with 0.3% Recron fiber.

S.N.	**Normal stress (kg/cm^2)**	**Shear stress (kg/cm^2)**
1	0.5	0.72
2	1.0	0.82
3	1.5	1.56

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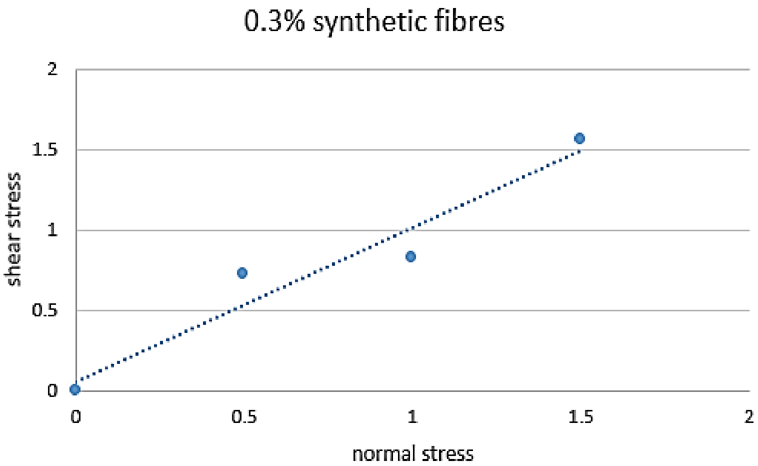

Figure 3. Direct shear of 0.3% Recron fiber

The cohesion observed in the 0.3% synthetic fiber reinforced soil is 0.08 kg/cm$^{2.}$

In soil reinforced with 0.3% synthetic fiber, the angle of internal friction was found in Figure 3 is to be 46^{o}.

Compaction And Shear Behaviour Of 0.4% R3s Recron Fiber Reinforced Soil

A compaction test is carried out to know the optimum moisture content (O.M.C) and maximum dry density (M.D.D) in the presence of the 0.4% of recron fibres.

Explanation

Take about 2 kg of dried soil which is passes through 4.75mm sieve

Add 0.4% of fibre and mix it thoroughly with soil and then add 2% of water and conduct the compaction test.

Repeat the procedure by increasing the water percentage by 2%. Note down all the necessary readings Table 10.

Table 10. Compaction test of soil with 0.4% Recron fiber.

Amount of water added	2%	4%	6%	8%	10%
Weight of mould, w_1, gm	240	240	240	240	240
Weight of compacted soil+ mould, w_2, gm	423	437	445	450	447
Weight of wet soil (w_2-w_1), gm	184	198	206	211	208
Volume of mould, cm^3	135.71	135.71	135.71	135.71	135.71
Bulk density, g/cc	1.35	1.45	1.517	1.55	1.53
container no	1	3	8	6	10
Weight of container with lid, m_1, gm	26	27	28	26	27
Weight of container with lid and wet soil, m_2	74	79	74	81	77
Weight of container with lid and dry soil, m_3, gm	72	75	67	80	74
Water content of the soil, %	0.043	0.083	0.179	0.018	0.063
Dry density, g/cc	1.29	1.33	1.28	1.52	1.43

Optimum moisture content = 8%
Maximum dry density = 1.575 g/cc

DIRECT SHEAR TEST

As part of our project on soil blocks reinforced with poly propylene fibers, we conducted a direct shear test by adding 0.4% of fibers to the soil mix. The purpose of this test was to determine how the fibers would affect the shear strength of the soil blocks.

To perform the test, we first prepared the soil mix by adding the fibers and water, and then compacted the mixture into a shear box. We then placed the shear box in a direct shear test apparatus, which applies a constant vertical load to the soil while simultaneously applying a horizontal force to the top of the shear box.

By measuring the amount of force required to shear the soil along a horizontal plane, we were able to calculate the shear strength of the soil with 0.4% of poly propylene fibers. Our results Table 11 and Table 12 indicated that the addition of fibers resulted in an increase in the shear strength of the soil blocks, suggesting that the fibers were able to reinforce the Soil Matrix and improve the overall stability of the blocks.

Table 11. Direct shear test of soil with 0.4% Recron fiber.

Horizontal dial reading			**Shear displacement**			**Strain rate**	**Proving ring reading**			**Shear force**			**Shear stress**		
0.5	1	1.5	0.5	0.5	0.5		0.5	1	1.5	0.5	1	1.5	0.5	1	1.5
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	30	30	0.3	0.3	0.3	0.5	2.6	2	2.4	4.68	3.6	3.6	0.13	0.1	0.1
60	60	60	0.6	0.6	0.6	1	3.4	5	2.6	6.12	9	4.32	0.17	0.25	0.12
90	90	90	0.9	0.9	0.9	1.5	4	7.4	3.6	7.2	13.32	4.68	0.2	0.37	0.13
120	120	120	1.2	1.2	1.2	2	4.4	8.4	4	7.92	15.12	6.48	0.22	0.42	0.18
150	150	150	1.5	1.5	1.5	2.5	4.8	8.6	4.6	8.64	15.48	7.2	0.24	0.43	0.2
180	180	180	1.8	1.8	1.8	3	5.2	12	5.5	9.36	21.6	8.28	0.26	0.6	0.23
210	210	210	2.1	2.1	2.1	3.5	5.6	13.8	6.6	10.08	24.84	9.9	0.28	0.69	0.275
240	240	240	2.4	2.4	2.4	4	6	15.2	7	10.8	27.36	11.88	0.3	0.76	0.33
270	270	270	2.7	2.7	2.7	4.5	6.4	16.4	8	11.52	29.52	12.6	0.32	0.82	0.35
300	300	300	3.0	3.0	3.0	5	6.6	17	0	11.88	30.6	14.4	0.33	0.85	0.4
330	330	330	3.3	3.3	3.3	5.5	7	17.4	0	12.6	31.32	0	0.35	0.87	0
360	360	360	3.6	3.6	3.6	6	7.2	18.2	0	12.96	32.76	0	0.36	0.91	0
390	390	390	3.9	3.9	3.9	6.5	7.6	18.6	0	13.32	33.48	0	0.37	0.93	0
420	420	420	4.2	4.2	4.2	7	0	0	0	0	0	0	0	0	0
450	450	450	4.5	4.5	4.5	7.5	0	0	0	0	0	0	0	0	0
480	480	480	4.8	4.8	4.8	8	0	0	0	0	0	0	0	0	0
510	510	510	5.1	5.1	5.1	8.5	0	0	0	0	0	0	0	0	0
540	540	540	5.4	5.4	5.4	9	0	0	0	0	0	0	0	0	0
Maximum													0.37	0.93	0.4

Table 12. Normal stress and Shear stress of soil with 0.4% Recron fiber.

S.N.	**Normal stress (kg/cm^2)**	**Shear stress (kg/cm^2)**
1	0.5	0.37
2	1.0	0.93
3	1.5	0.4

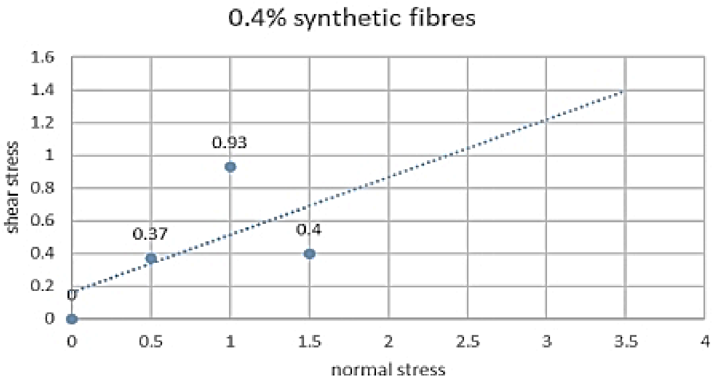

Figure 4. Direct shear of 0.4% recron fibres.

The cohesion observed in the 0.4% synthetic fiber reinforced soil is 0.11 kg/cm^2.

In soil reinforced with 0.4% synthetic fiber, the angle of internal friction was found in Figure 4 is to be 47º.

COMPACTION AND SHEAR BEHAVIOUR OF 0.5% R3S RECRON FIBER REINFORCED SOIL

A compaction test is carried out to know the optimum moisture content (O.M.C) and maximum dry density (M.D.D) in the presence of the 0.5% of recron fibres.

Explanation

Take about 2 kg of dried soil which is passes through 4.7 5mm sieve

Add 0.5% of fibre and mix it thoroughly with soil and then add 2% of water and conduct the compaction test.

Repeat the procedure by increasing the water percentage by 2%. Note down all the necessary readings Table 13.

Table 13. compaction test of soil with 0.5% recron fiber

Amount of water added	2%	4%	6%	8%	10%
Weight of mould, w_1, gm	240	240	240	240	240
Weight of compacted soil+ mould, w_2, gm	428	439	454	474	470
Weight of wet soil (w_2-w_1), gm	189	200	216	235	231
Volume of mould, cm^3	135.71	135.71	135.71	135.71	135.71
Bulk density, g/cc	1.39	1.47	1.59	1.73	1.70
container no	44	11	28	9	4
Weight of container with lid, m_1, gm	30	31	30	28	27
Weight of container with lid and wet soil, m_2	71	80	81	84	68
Weight of container with lid and dry soil, m_3, gm	69	77	77	79	65
Water content of the soil, %	0.05	0.065	0.085	0.098	0.081
Dry density, g/cc	1.32	1.38	1.465	1.575	1.572

Optimum moisture content = 8%
Maximum dry density = 1.575 g/cc

Direct Shear Test

As part of our project on soil blocks reinforced with poly propylene fibers, we conducted a direct shear test by adding 0.5% of fibers to the soil mix. The purpose of this test was to determine how the fibers would affect the shear strength of the soil blocks.

To perform the test, we first prepared the soil mix by adding the fibers and water, and then compacted the mixture into a shear box. We then placed the shear box in a direct shear test apparatus, which applies a constant vertical load to the soil while simultaneously applying a horizontal force to the top of the shear box.

By measuring the amount of force required to shear the soil along a horizontal plane, we were able to calculate the shear strength of the soil with 0.5% of poly propylene fibers. Our results Table 14 and Table 15 indicated that the addition of fibers resulted in an increase in the shear strength of the soil blocks, suggesting that the fibers were able to reinforce the soil matrix and improve the overall stability of the blocks (Tables 1-17).

Table 14. Direct shear test of soil with 0.5% Recron fiber.

Horizontal dial reading			**Shear displacement**			**Strain rate**	**Proving ring reading**			**Shear force**			**Shear stress**		
0.5	1	1.5	0.5	0.5	0.5		0.5	1	1.5	0.5	1	1.5	0.5	1	1.5
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	30	30	0.3	0.3	0.3	0.5	7.4	0	0	1332	0	0	0.37	0	0
60	60	60	0.6	0.6	0.6	1	7.8	102	7.8	1404	18.36	14.04	0.39	0.51	0.39
90	90	90	0.9	0.9	0.9	1.5	8	10.8	8.8	14.1	19.44	15.84	0.4	0.54	0.44
120	120	120	1.2	1.2	1.2	2	11.8	11.4	9.2	2124	20.52	16.56	0.59	0.57	0.46
150	150	150	1.5	1.5	1.5	2.5	12.2	12	9.8	2196	21.6	17.54	0.61	0.6	0.49
180	180	180	1.8	1.8	1.8	3	14.6	12.6	10.2	2628	22.68	18.36	0.73	0.63	0.51
210	210	210	2.1	2.1	2.1	3.5	18.2	13.2	20.6	3276	23.76	37.08	0.91	0.66	1.03
240	240	240	2.4	2.4	2.4	4	0	13.4	28.2	0	24.12	50.76	0	0.67	1.41
270	270	270	2.7	2.7	2.7	4.5	0	18.4	37.6	0	33.12	67.68	0	0.92	1.88
300	300	300	3.0	3.0	3.0	5	0	21.2	0	0	38.16	0	0	1.06	0
330	330	330	3.3	3.3	3.3	5.5	0	0	0	0	0	0	0	0	0
360	360	360	3.6	3.6	3.6	6	0	0	0	0	0	0	0	0	0
390	390	390	3.9	3.9	3.9	6.5	0	0	0	0	0	0	0	0	0
420	420	420	4.2	4.2	4.2	7	0	0	0	0	0	0	0	0	0
450	450	450	4.5	4.5	4.5	7.5	0	0	0	0	0	0	0	0	0
480	480	480	4.8	4.8	4.8	8	0	0	0	0	0	0	0	0	0
510	510	510	5.1	5.1	5.1	8.5	0	0	0	0	0	0	0	0	0
540	540	540	5.4	5.4	5.4	9	0	0	0	0	0	0	0	0	0
Maximum													0.91	1.06	1.88

Table 15. Normal stress and Shear stress of soil with 0.5% Recron fiber.

S.N.	**Normal stress (kg/cm^2)**	**Shear stress (kg/cm^2)**
1	0.5	0.91
2	1.0	1.06
3	1.5	1.88

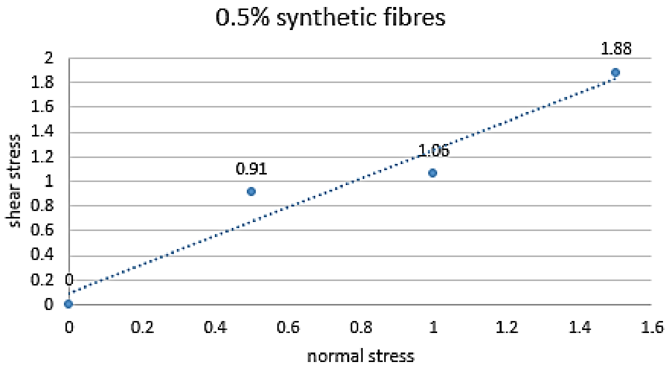

Figure 5. Direct shear of 0.5% recron fibers

The Cohesion observed in the 0.5% synthetic fiber reinforced soil is 0.09 kg/cm^2(Figures 6-7).

In soil reinforced with 0.5% synthetic fiber, the angle of internal friction was found in Figure 5. is to be 51^o.

Discussion On Shear Strength R and Compaction Test Results

The direct shear test showed that adding synthetic fibers like Recron improves the shear strength of soil blocks, indicating better stability. Compaction tests revealed that the maximum dry density increases with fiber addition, optimizing soil performance under varying moisture contents.

Table 16. Relation between cohesion ‘C’ and % of fiber content.

Table 16. Relation between cohesion ‘C’ and % of fiber content.

S.No	% Of Fiber Content	Cohesion [kg/cm2]
1	0.1	0.02
2	0.2	0.07
3	0.3	0.08
4	0.4	0.11
5	0.5	0.09

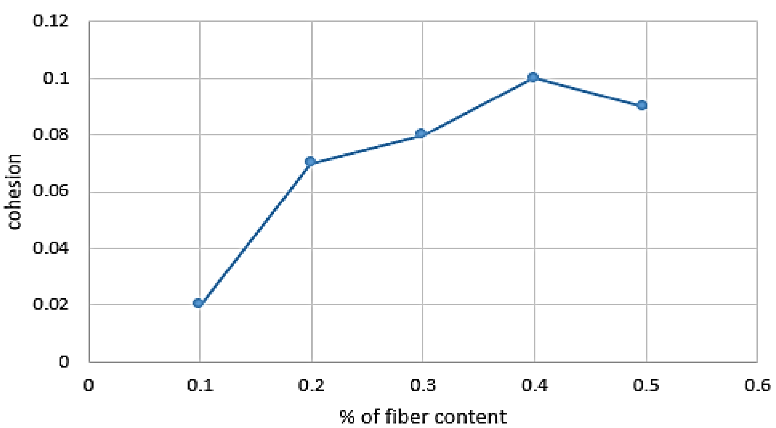

Figure 6. Between cohesion and fibre content

Table 17. Relation between angle of internal friction and % of fiber content.

S.No	% Of Fiber Content	Angle Of Internal Friction
1	0.1	24

2	0.2	34
3	0.3	46
4	0.4	47
5	0.5	51

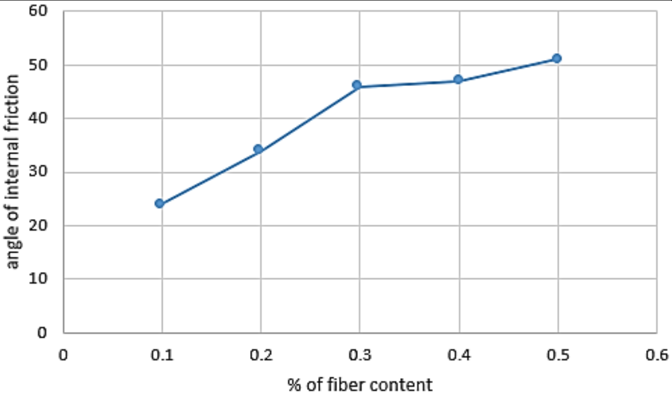

Figure 7. Between angle of internal friction and % fibre content.

SOIL CEMENT STABILIZED BLOCKS

Introduction

Soil cement stabilized blocks are a type of construction material made by mixing soil, cement, and water to create a compacted and hardened block. This technology is commonly used in the construction of low-cost housing, particularly in developing countries where access to conventional building materials is limited.

The process of creating soil cement stabilized blocks involves mixing soil with a small percentage of cement (usually between 5% and 10%) and water. The mixture is then compressed into a block using a manual or hydraulic press and left to cure for several days to allow the cement to harden.

The resulting block is strong and durable, with good thermal insulation properties and resistance to weathering and erosion. It is also relatively inexpensive compared to other construction materials, making it an attractive option for low-cost housing projects.

Soil cement stabilized blocks can be used for a variety of construction purposes, including walls, foundations, and paving. They are particularly useful for constructing structures in areas with poor soil conditions or where conventional building materials are not readily available.

Overall, soil cement stabilized blocks offer an affordable, durable, and sustainable solution for low-cost housing construction, and are increasingly being used in a variety of applications around the world.

Design of Mix Proportions of Soil Cement Stabilized Blocks

A more cost-effective and energy-efficient alternative to traditional burnt clay bricks in building construction are soil cement blocks. Stabilized mud blocks (SMB) or stabilized compressed earth blocks (SCEB) are common terms used to describe these kinds of blocks. Stabilizer is most frequently added to soil in amounts of 5–10% of regular Portland cement. There are also other stabilizers employed, such lime, puzzolana, or lime and cement combinations. Soil cement blocks are faster to produce and require fewer joints because of their bigger size as compared to regular burnt clay bricks. Because there are fewer joints, less masonry mortar mix is used. When it comes to environmental concerns, construction projects that use soil cement blocks save a lot of energy because no fuel is needed in their creation.While in general building construction, soil cement blocks may be used as a substitute for normal burnt clay bricks, their use should be avoided in the case of isolated load bearing columns, piers and such heavily loaded structures [17-23].

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There are five phases involved in manufacturing soil cement blocks.

1. Soil analysis
2. Sorting the soil
3. Mix preparation
4. Block compaction
5. The blocks' curing

Quality Specifications

"In the context of general building construction soil based blocks quality, IS 1725 - 2013 prescribes the standard specifications (Second Revision)."The above standard specifies requirements for soil cement blocks on the following parameters: sizes of blocks, compressive strength, water absorption, and weathering.Owing to the design specifications mentioned above, the following compositions were made.

Procedure Adopted

First we have to take 4kgs of oven dried soil which is passed from 4.75mm sieve ,and after that by considering weight of soil we can take cement content of 9% of weight of soil. Water content can be taken as11 % of weight of soil, after that we can take fibres of 0.1% by considering the weight of soil. Place the all materials in the metallic tray and mix them, where the materials got mixed completely without any lumps in the sample after that divide the whole sample into three parts [17–23].

Take the mould of having dimensions 25.4cm*10.16cm*7.62cm place the one part of the soil in the mould and compact with tamping rod and repeat this process for remaining two parts of soil. And allow it for some time that means not more than 2 to 3 minutes, after that remove it from the mould, place the block at safe place.

Repeat the entire procedure for all fibres of 0.2%, 0.3%, 0.4%, and 0.5%. Every time we can increase only the percentage of fibres, remaining materials of water and cement and soil content is same for all fibres Table 18.

Table 18. Table for untreated soil.

S.N.	Fibres	Cement	Water	Soil	Cement	Water	Ratio
	%	%	%	Grams	Grams	ml	
1	0.0	9	11	4000	360	440	1:11

*Cement Calculation **:** Table 19*

$(9 \div 100) * 4000 = 360grams$

$(11 \div 100) * 4000 = 440ml$

Table 19. Composition of soil cement fibers ratios.

S.N.	Fibers	Cement	Water	Soil	Cement	Water	Ratio
	%	%	%	Grams	Grams	ml	
1	0.1	9	11	4000	360	440	1:11
2	0.2	9	11	4000	360	440	1:11
3	0.3	9	11	4000	360	440	1:11
4	0.4	9	11	4000	360	440	1:11
5	0.5	9	11	4000	360	440	1:11

Cement calculation

$(9 \div 100) * 4000 = 360grams$

Water Calculation: $(11 \div 100) * 4000 = 440ml$

CASTING OF SOIL STABILIZED BLOCKS

Size of the Block

There shall be 3 sizes of soil cement blocks, the dimensions of which shall be as follows [According to IS 1725(1982)]: Table 20.

Table 20. Sizes of the blocks

Length(cm)	Breadth(cm)	Height(cm)
19	9	9
19	9	4
29	19	9

*Size of the block adopted 25.5 * 10.2 * 7.6 in cm*

Mode of Compaction

For compaction purpose we have three of methods

- Rolling
- Compaction
- Ramming

Casting Procedure

- Materials
- Soil mixture with fibers
- Block moulds
- Water
- Trowel
- Flat surface (e.g. plywood board)
- Procedure:

Prepare the soil mixture: Mix the soil 4000 gm with based on percentage of fibers(0.1, 0.2, 0.3, 0.4, 0.5.) thoroughly to ensure an even distribution of fibers throughout the mixture. Add 440 ml of water and 360 gm of cement for 1 block.

Casting is the process of making of soil blocks by using moulds. First, we have to take oven dried soil sample of 4kgs which is passed from 4.75 mm sieve. And then we take 9% of cement by the weight of soil, water content must be taken as 11% by the weight of soil sample, and we add the 0.1% of synthetic fibers.Mixing can be done carefully, because of light weight synthetic fibers are fly away, care must be taken. A metallic tray is taken and place the soil sample on the tray, make a small hole at centre of the soil sample and add 9% of cement and mixed it thoroughly and after add 11% of water content to the mix and mix it thoroughly after that add 0.1% of synthetic fibers and mix it completely until it is ready to mould.

The entire mix can be divided into three equal parts; each part can be placed into the mould and compacted until it gets fully compacted. Allow the mould for 2 to 3 minutes and remove the block from the mould and place the mould at safe place where there is no disturbance.

Repeat this process for remaining four percentages of synthetic fibers that includes 0.2%, 0.3%, 0.4%, 0.5%. While preparing mix for each percentage of synthetic fibers there only change in synthetic fibers weight, other materials is remaining same quantities can take.

Curing of Blocks

Basically, curing can take place, when the blocks are placed at same place in an order and a person can cured it directly with motors pipes.

But in the case of soil cement stabilized blocks curing can be takes place in the area where the wet conditions are not changed, for that we placed the blocks on gunny bags for more time wetting purpose, this curing can be takes place in the morning section only.

Generally the curing can be carried out for 7 days, 14days, and 28days, to get its complete strength, but for this blocks in our project we can curried the blocks for 28 days.

Soil Blocks After Curing

The soil blocks are placed on gunny bags and water is sprinkled until the blocks are completely wetted to get its full strength of soil blocks, in our project curing of soil blocks can be placed in wet area for 28 days and covered with gunny bags to make the soil block more time in wet condition after completion of curing soil blocks are taken out from the wetted area and placed in another area, after some time soil blocks are going to be tested

Testing of Blocks

Testing of soil cement stabilized blocks can be carried at our lab, the following tests can be carried out.

- Compression test
- Flexure test
- Water absorption test

Compression Test

A block's compressive strength, or its ability to bear crushing forces, is determined by how resistant it is to compression in a compressive testing machine. This capacity is determined in a material by its resistance to partitioning forces like fractures and fissures. Bricks are often used to build load-bearing masonry walls, columns, footings, and other structures when masonry construction is required. As a result, the bricks are primarily compressed under such weights. Therefore, before determining whether or not bricks are appropriate for construction, it is crucial to determine their compressive strength.

Compression Test For 0.1% R3s Recron Fiber Block

1. Place the specimen (0.1% soil block) with flat faces horizontal between the plates of the testing machine [Figure 1]
2. Apply axial load at a constant rate of 14 N/mm^2 per minute until failure occurs. When it fails, note down the maximum load.
3. The maximum load at which the machine's indicator reading stays constant is known as the maximum load on failure Table 21.

Figure 1. Compression test for 0.1% Recron fiber reinforced block.

Table 21. Compression test for 0.1% Recron fiber reinforced block.

Specimen (0.1%)	Length [mm]	Breadth [mm]	Deapth [mm]	Applied Load kN	Compressive Strength [Mpa]
1	255	102	76	106.8	4.10611

Compression Test For 0.2% R3s Recron Fiber Block

1. Place the specimen (0.2% soil block) with flat faces horizontal between the plates of the testing machine.
2. Apply axial load at a constant rate of 14 N/mm^2 per minute until failure occurs. When it fails, note down the maximum load.
3. The maximum load at which the machine's indicator reading stays constant is known as the maximum load on failure Table 22.

Table 22. Compression test for 0.2% Recron fiber reinforced block.

Specimen (0.2%)	Length [mm]	Breadth [mm]	Depth [mm]	Wt Per Unit Volume kN	Compressive Strength [Mpa]
1	255	102	76	217.0	8.34

Compression Test for 0.3% r3s Recron Fiber Block

1. Place the specimen (0.3% soil block) with flat faces horizontal between the plates of the testing machine.
2. Apply axial load at a constant rate of 14 N/mm^2 per minute until failure occurs. When it fails, note down the maximum load.
3. The maximum load at which the machine's indicator reading stays constant is known as the maximum load on failure Table 23.

Table 23. Compression test for 0.3% Recron Fiber reinforced block

Specimen (0.3%)	Length [mm]	Breadth [mm]	Depth [mm]	Wt Per Unit Volume kN	Compressive Strength [Mpa]
1	255	102	76	138.5	5.32487

Compression Test For 0.4% R3s Recron Fiber Block

1. Place the specimen (0.4% soil block) with flat faces horizontal between the plates of the testing machine.
2. Apply axial load at a constant rate of 14 N/mm^2 per minute until failure occurs. When it fails, note down the maximum load.
3. The maximum load at which the machine's indicator reading stays constant is known as the maximum load on failure Table 24.

Table 24. Compression test for 0.4% Recron Fiber reinforced block.

Specimen (0.4%)	Length [mm]	Breadth [mm]	Deapth [mm]	Wt Per Unit Volume kN	Compressive Strength [Mpa]
1	255	102	76	92.3	3.53710

Compression Test for 0.5% R3s Recron Fiber Block

1. Place the specimen (0.5% soil block) with flat faces horizontal between the plates of the testing machine.
2. Apply axial load at a constant rate of 14 N/mm^2 per minute until failure occurs. When it fails, note down the maximum load.
3. The maximum load at which the machine's indicator reading stays constant is known as the maximum load on failure. Tables 25, 26 and Figure 8.

Table 25. Compression test for 0.5% Recron Fiber reinforced block.

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Specimen (0.5%)	Length [mm]	Breadth [mm]	Deapth [mm]	Wt Per Unit Volume kN	Compressive Strength [Mpa]
1	255	102	76	151.7	5.83237

Discussion on Compression Test Results

The compression test results demonstrated that the compressive strength of soil blocks reinforced with Recron fibers increased, with higher fiber percentages showing better strength performance, peaking at 0.5% fiber content.

Table 26. Compression test results.

S.N.	Size of block [CM]	% of Fiber	Applied Load [KN]	Resulted Value [N/mm^2]	Standard Value [N/mm^2]
1	25.5 × 10.2 ×7.6	0.1	106.8	4.1	4
2	25.5 × 10.2 ×7.6	0.2	217	8.34	4
3	25.5 × 10.2 ×7.6	0.3	138.5	5.32	4
4	25.5 × 10.2 ×7.6	0.4	92.3	3.53	4
5	25.5 × 10.2 ×7.6	0.5	151.7	5.83	4

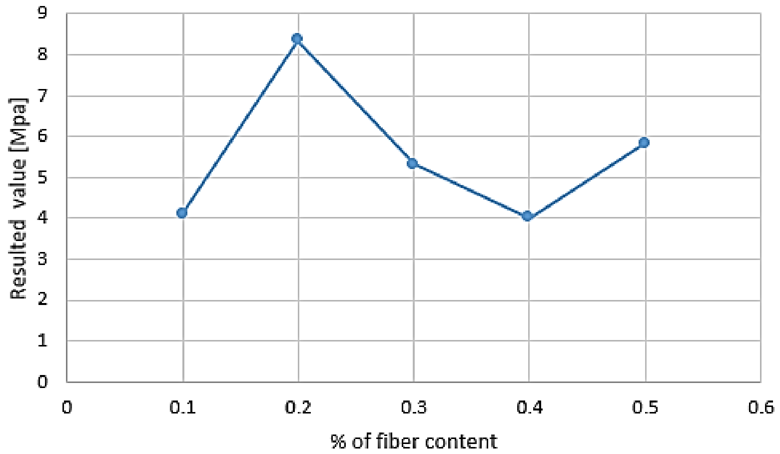

Figure 8. Relation between Compression values and % of fiber content.

Flexural Test For Soil Cement Stabilized Blocks

A flexural test is used to indirectly quantify the specimen's tensile strength. It assesses the soil block's resistance to failure bending after fortified cement has been used to stabilize it. The results of a flexural test are typically expressed as a modulus of rupture, or MR for short, and are typically expressed in mega Pascals or pounds per square inch (mpa, psi). The flexural test on a soil block can be performed in two ways: either with three pointed loads or with a center load test that applies the same point loading principle. Only the center point loading principle, though, is another option. The figure that comes below shows a configuration with each of these tests (Table 22).

Flexural Test For 0.1% R3s Recron Fibers Block

1. Immediately after the specime (0.1%) is removed from the curing condition, the test should be carried out to prevent surface drying, which reduces flexural strength (Table 27).
2. Set up the loading points for the specimen. The specimen's hand-finished surface shouldn't come into contact with any loading points. By doing this, it will be ensured that the specimen and loading points make acceptable contact.
3. Place the loading system in the middle of the force that is being applied.
4. At the loading positions, bring the block imparting force into contact with the specimen surface.
5. The application of loads ranging from 2 to 6 percent of the final load computed.

6. The loading rate as per ASTM standard can be computed based on the following equation

$$r = \frac{Sbd^2}{L}$$

Where

- *r:* loading rate
- *S:* rate of increase of extreme fiber
- *b:* average specimen width
- *d:* average specimen depth
- *L:* length of span

Table 27. Flexure test for 0.1% soil block.

S.No	Block	Flexural Strength (Mpa)
1	0.1%	3.0

Flexural Test For 0.2% R3s Recron Fibers Block

1. Immediately after the specime (0.2%) is removed from the curing condition, the test should be carried out to prevent surface drying, which reduces flexural strength (Table 28).
2. Set up the loading points for the specimen. The specimen's hand-finished surface shouldn't come into contact with any loading points. By doing this, it will be ensured that the specimen and loading points make acceptable contact.
3. Place the loading system in the middle of the force that is being applied.
4. At the loading positions, bring the block imparting force into contact with the specimen surface.
5. The application of loads ranging from 2 to 6 percent of the final load computed.
6. The loading rate as per ASTM standard can be computed based on the following equation.

$$r = \frac{Sbd^2}{L}$$

Where

- *r:* loading rate
- *S:* rate of increase of extreme fiber
- *b:* average specimen width
- *d:* average specimen depth
- *L:* length of span

Table 28. Flexure test for 0.2% soil block.

S.No	Block	Flexural Strength (Mpa)
1	0.2%	3.0

Flexural Test For 0.3% R3s Recron Fibers Block

1. Immediately after the specime (0.3%) is removed from the curing condition, the test should be carried out to prevent surface drying, which reduces flexural strength(Table 29).
2. Set up the loading points for the specimen. The specimen's hand-finished surface shouldn't come into contact with any loading points. By doing this, it will be ensured that the specimen and loading points make acceptable contact.
3. Place the loading system in the middle of the force that is being applied.
4. At the loading positions, bring the block imparting force into contact with the specimen surface.
5. The application of loads ranging from 2 to 6 percent of the final load computed.
6. The loading rate as per ASTM standard can be computed based on the following equation

$$r = \frac{Sbd^2}{L}$$

Where

- *r:* loading rate
- *S:* rate of increase of extreme fiber
- *b:* average specimen width
- *d:* average specimen depth
- *L:* length of span

Table 29. Flexure test for 0.3% soil block.

S.No	Block	Flexural Strength (Mpa)
1	0.3%	3.0

Flexural Test For 0.4% R3s Recron Fiber Block

1. Immediately after the specime (0.4%) is removed from the curing condition, the test should be carried out to prevent surface drying, which reduces flexural strength.
2. Set up the loading points for the specimen. The specimen's hand-finished surface shouldn't come into contact with any loading points. By doing this, it will be ensured that the specimen and loading points make acceptable contact (Table 30).
3. Place the loading system in the middle of the force that is being applied.
4. At the loading positions, bring the block imparting force into contact with the specimen surface.
5. The application of loads ranging from 2 to 6 percent of the final load computed.
6. The loading rate as per ASTM standard can be computed based on the following equation

$$r = \frac{Sbd^2}{L}$$

Where

- *r:* loading rate
- *S:* rate of increase of extreme fiber
- *b:* average specimen width
- *d:* average specimen depth
- *L:* length of span

Table 30. Flexure test for 0.4% soil block.

S.N.	Block	Flexural Strength (Mpa)
1	0.4%	3.0

Flexural Test For 0.5% R3s Recron Fiber Block

1. Immediately after the specime (0.5%) is removed from the curing condition, the test should be carried out to prevent surface drying, which reduces flexural strength.
2. Set up the loading points for the specimen. The specimen's hand-finished surface shouldn't come into contact with any loading points. By doing this, it will be ensured that the specimen and loading points make acceptable contact(Tables 31, 32).
3. Place the loading system in the middle of the force that is being applied.
4. At the loading positions, bring the block imparting force into contact with the specimen surface.
5. The application of loads ranging from 2 to 6 percent of the final load computed.(Figure 9)
6. The loading rate as per ASTM standard can be computed based on the following equation

$$r = \frac{Sbd^2}{L}$$

Where
r : loading rate

- *S:* rate of increase of extreme fiber
- *b:* average specimen width

- *d:* average specimen depth
- *L:* length of span

Table 31. Flexure Test For 0.5%.

S.N.	Block	Flexural Strength (Mpa)
1	0.5%	3.0

Discussion On Flexural Test Results

Flexural tests on fiber-reinforced soil blocks indicated a consistent improvement in flexural strength, with results showing that even a minimal addition of fibers significantly enhances the blocks' resistance to bending, suggesting greater durability under tensile forces.

Table 32. Flexural test results

S.N.	Size Of Brick	% Of Recron Fiber	Applied Load [kN]	Resulted Value [N/mm^2]	Standard Value [N/mm^2]
1	25.5 * 10.2 *7.6	0.1	5	3	1
2	25.5 * 10.2 *7.6	0.2	5	3	1
3	25.5 * 10.2 *7.6	0.3	5	3	1
4	25.5 * 10.2 *7.6	0.4	5	3	1
5	25.5 * 10.2 *7.6	0.5	5	3	1

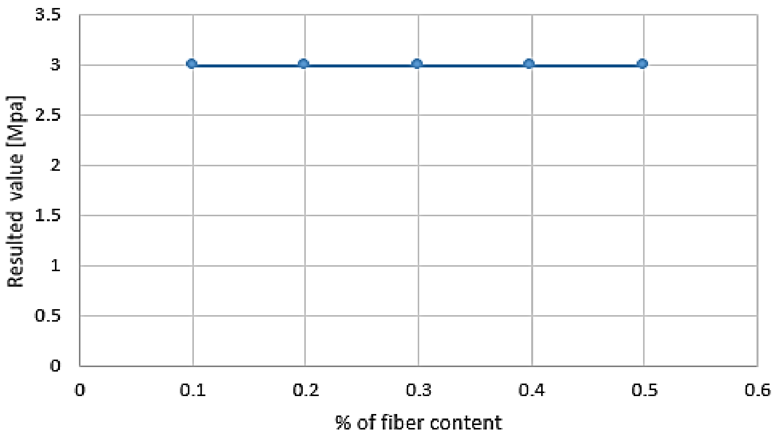

Figure 9. Relation between resulted value and fiber content.

Water Absorption Test For Soil Blocks

Bricks will be put through a water absorption test to determine their resistance to frost and their durability in other weather situations. Bricks with a water absorption content of no more than 7% are thought to be more resistant to all kinds of frost damage.A test for water absorption reveals a brick's level of porosity. Bricks absorb more water when their pore count rises. Thus, the bricks can be referred to as vitrified if their water absorption is less than 3%.

Purpose of water absorption

This purpose is also called as the cob test, measures the quantity of water that is absorbed in a given time. It is a useful method for figuring out how resilient or liquid-absorptive treated and untreated papers, boards, textiles, and other materials are.

Water Absorption test for 0.1% Soil Blocks

- Start by exposing it to a dry temperature until it stops losing weight dramatically.
- If the specimen is too hot to handle, do not use it to determine the weight (M1).
- After drying up, the specimen is submerged for a full day in clean water at 27+2°C.

- Wipe its surface with a damp cloth after removing it from the water to get rid of any moisture residue and find the mass (M2).
- Determine the water absorption percentage of the bricks based on their mass Table 33.

$$W = \frac{M2-M1}{M1} \times 100$$

Table 33. Water absorption test of 0.1% soil block.

S.No	Dry Mass Kg	Wet Mass Kg	Water Absorbed %	Average Water Absorbed%
1	4112	4442	330	8.0259

Water Absorption Test For 0.2% Soil Blocks

- Start by exposing it to a dry temperature until it stops losing weight dramatically.
- If the specimen is too hot to handle, do not use it to determine the weight (M1).
- After drying up, the specimen is submerged for a full day in clean water at 27+2°C.
- Wipe its surface with a damp cloth after removing it from the water to get rid of any moisture residue and find the mass (M2).
- Determine the water absorption percentage of the bricks based on their mass Table 34.

$$W = \frac{M2-M1}{M1} \times 100$$

Table 34. Water absorption Test of 0.2% soil block.

S.N.	Dry Mass Kg	Wet Mass Kg	Water Absorbed %	Average Water Absorbed %
1	4121.5	4473	351.5	8.528

Water Absorption Test for 0.3% Soil Blocks

- Start by exposing it to a dry temperature until it stops losing weight dramatically.
- If the specimen is too hot to handle, do not use it to determine the weight (M1).
- After drying up, the specimen is submerged for a full day in clean water at 27+2°C.
- Wipe its surface with a damp cloth after removing it from the water to get rid of any moisture residue and find the mass (M2).
- Determine the water absorption percentage of the bricks based on their mass Table 35.

$$W = \frac{M2-M1}{M1} \times 100$$

Table 35. Water absorption test of 0.3% soil block.

S.No	Dry Mass Kg	Wet Mass Kg	Water Absorbed %	Average Water Absorbed %
1	4046	4356	310	7.661

Water Absorption Test For 0.4% Soil Blocks

- Start by exposing it to a dry temperature until it stops losing weight dramatically.
- If the specimen is too hot to handle, do not use it to determine the weight (M1).
- After drying up, the specimen is submerged for a full day in clean water at 27+2°C.
- Wipe its surface with a damp cloth after removing it from the water to get rid of any moisture residue and find the mass (M2).
- Determine the water absorption percentage of the bricks based on their mass Table 36

$$W = \frac{M2-M1}{M1} \times 100$$

Table 36. Water Absorption test of 0.4% soil block.

S.No	Dry Mass Kg	Wet Mass Kg	Water Absorbed %	Average Water Absorbed %
1	3826	4237.5	411.5	10.755

Water Absorption test for 0.5% Soil Blocks

- Start by exposing it to a dry temperature until it stops losing weight dramatically.
- If the specimen is too hot to handle, do not use it to determine the weight (M1).
- After drying up, the specimen is submerged for a full day in clean water at 27+2°C.
- Wipe its surface with a damp cloth after removing it from the water to get rid of any moisture residue and find the mass (M2).
- Determine the water absorption percentage of the bricks based on their mass Table 37.

$$W = \frac{M2-M1}{M1} \times 100$$

Table 37. Water absorption test of 0.5% soil block

S.No	Dry Mass Kg	Wet Mass Kg	Water Absorbed %	Average Water Absorbed %
1	4255	4573	318	7.47

Scope For Further Study

1. This study can be further explored with other types of natural fibers available in the nature as well as the synthetic fibers which are posing threat to the environment.
2. Micro photographic study can be carried out on the samples in this study, to get the micro level understanding of fiber-soil-cement behaviour and its effect on the strength behaviour of SCSB's.
3. This study can be carried out with other pozzolonic materials in the place of cement.
4. This study can be carried out with other aspect ratios of fiber content.

CONCLUSION

1. It is observed that the ratio of Maximum Dry Density and Optimum Moisture Content varied linearly with the increment of fiber content owing to the fact that the same L/D ratio is maintained throughout the study.
2. Maximum Dry Density of 1.74 g/cc is observed at 0.2% of Fiber Reinforcement at 8% of Optimum Moisture Content.
3. the cohesion value of 0.09 and 0.16 indicates a higher level of strength and resistance to shearing stresses, which may make it suitable for certain applications.
4. The values of angle of internal friction obtained from our project suggest that the addition of natural fibers to soil cement stabilized blocks has an impact on the shear strength of the blocks. The angle of internal friction is a measure of the resistance of a material to shearing stresses, with higher values indicating greater resistance to shearing.
5. Based on the data we obtained, it seems that increasing the percentage of natural fibers added to the blocks may increase their angle of internal friction, and thus their shear strength. The blocks with the highest angle of internal friction (51) were obtained with a higher percentage of fibers, while the blocks with the lowest angle of internal friction (34) were obtained with a lower percentage of fibers.
6. The 28days compressive strength of Fiber reinforced SCSB with 9% cement is observed as 8.34 Mpa at 0.2% of Fiber Reinforcement which is doubled compared with the typical SCSB's.
7. The flexural strength of the Fiber reinforced SCSB after 28 days curing is found to be 3 Mpa which is 1 for a typical SCSB.
8. The average Water absorption is found to be 10% for the Fiber reinforced SCSB's at 2%, provided the limiting value of 20% water Absorption as per the Indian Standards.

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