Moazam Ali, 2024, 14:6
ISSN (Online): 2348-4098
ISSN (Print): 2395-4752

International Journal of Science, Engineering and Technology
An Open Access Journal

Experimental Investigating on Strength Properties of No-fines Concrete with Cloth Jacketing

Engr. Moazam Ali[1], Engr. Nizakat Ali[2], Engr. Muhammad Huzaifa[3], Engr. Hasnain Ahmed[4], Engr. Dr. Zaheer Ahmed[5]

[1]Department of Materials Science and Engineering, North University of China, Taiyuan, China
[2,3,4,5]Department of Civil Engineering, Khwaja Fareed University of Engineering and Infromation Technology, Rahim Yar Khan, Punjab, Pakistan

Abstract- The lightweight structures are being common now a day. No-fine concrete being the lightweight concrete with pervious characteristics and low heat conductivity are in extensive use, but possess a drawback of being low in strength. Steel jacketing is a common practice for conventional concrete to increase its strength however there is lack of bondage of steel with no-fine concrete and it is prone to corrosion. To encounter this problem, the cloth jacketing with locally available used cloth fabrics is opted to increase the strength of no-fine concrete. Cloth fabrics were collected from used cloth market, university hostels and dismantled fabric that, would either be dumped into the landfills or burned away. After the analysis of fabrics, the cloth strips of (500 × 50) mm were prepared from eight available cloth fabrics (such as Atal, Chiffon, Khaddar, Lawn, Silk, Tissue, Shabnamzra and Jeans) for the tensile testing, mass per unit area, yarn count and microscopic analysis of each cloth were conducted. From the tests, it has been concluded that Jeans has shown more tensile strength 19.81 MPa, thus we have used as the jacketing material over no-fine concrete. 19 mm to 10 mm aggregate were opted and 1:6 cement to aggregate ratio was taken for experiment. By performing compression and splitting tensile strength tests on textile reinforced no-fine concrete results give the increased strength of no-fine concrete up to 17.18% and 27.7% for one layer, 20.53% and 31.5% for two layers and 23.88% and 38.0% for three layers of cloth jacketing, respectively. The use of cloth strips as reinforcements also increases the flexural strength of no-fine concrete up to 22.2%. Although there is limitation for the use of jacketing regarding type and timeline of structure, it enhances the strength of no-fine concrete giving innovative approach to construction industry and reasonable use and consumption of waste material.

Keywords— No-fine concrete, Cloth Jacketing, Textile reinforced Concrete, Compressive strength, Light Weight concrete, Splitting Tensile Strength, Flexural Strength

I. INTRODUCTION

The Concrete is substantial construction material obtained by mixing a proportioned amount of cement, fine and coarse aggregate and water. In concrete construction, the self-weight of a building constitutes a significant portion of its total dead load. A reduction in the unit weight of concrete offers several advantages. No-fine concrete is a specialized type of concrete that stands out due to its unique composition, characterized by the absence of fine aggregates such as sand [1, 2]. No-fine concrete often demonstrates improved characteristics during the mixing and casting processes. The reduction in internal friction, attributed to the absence of fine particles, facilitates easier handling and placement during construction activities.

Additionally, the composition of no-fine concrete lends itself to enhanced thermal insulation properties [3]. Further, Reinforcement concrete (RC) is the significant part in the metropolitan framework. Steel support opposes the elastic tension and cement gives the compressive strength. Because of decay of RC structures, retrofitting and fortifying is critically required in the ongoing time. Customary strategies are in practice for the recovery of RC incorporate reinforcing through steel strips and fiber supported polymer (FRP) sheets. Textile

© 2026 Moazam Ali. his is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly credited.

reinforcement is technique for strengthening and rehabilitation of reinforcement structures. [4, 5].

No-Fines concrete is vastly under research for its multiple characteristics. Ali and Kacha [6] planned an examination program to assess connection between strength, porousness and porosity of no-fines concrete. The authors described that the material is at first very reasonable for having low burden. Ushane et al. [7] to concentrate on the properties of no-fines concrete [8]. The creators utilized 19 - 11.4 mm total size and 1:6, 1:8 and 1:10 blend extents. Practically comparative ends were made the creators as that of Rama and Mahalingam [9] then again, actually creators says 1:6 mix extent gives better execution of no-fines concrete [10]. Thombre et al [11] in their exploration work concentrated on the functionality of no-fines concrete, Authors saw that total degree affects the usefulness [12]. Carsana et al. [13] chipped away at the investigation of solidarity properties of no-fines concrete and steel inclusion in it. The creators described the test results observed that since no-fines concrete is pervious in this manner it can not give long haul passivation to typified steel. Consequently, extra estimates will be expected to safeguard the steel utilized in no-fines concrete. At long last, they propose utilization of non-consumption steel bars in no-fines concrete.

In the past, various studies have conducted incorporating textile fabrics for the improved strength and mechanical properties. For instances Portal et al [14]. Investigated tensile response of glass, basalt, and carbon textile materials. The aging and performance improved in the findings. On the other hand the investigation into the tensile behavior of Textile Reinforced Concrete (TRC), with a specific emphasis on carbon textile fabrics, represents a crucial exploration in the realm of advanced construction materials. Valeri et al. [15]: Studied tensile behavior of TRC, focusing on carbon textile fabrics. In conclusion, the in-depth exploration of the tensile behavior of Textile Reinforced Concrete (TRC), with a specific emphasis on carbon textile fabrics, has yielded significant insights that hold transformative implications for the construction industry. Further, Neves and Felicissimo [16]: Explored crack control behavior of TRC with un-resin carbon fibers. High tensile strength and stiffness reported for the TRC. In the comprehensive study on textile reinforced mortar by Tzoura and Triantanfillou [17], 183% higher strength was achieved with heavy fabric. Jahan [18] explored the influence of fabric geometry, fiber type, and testing arrangement on tensile strength and found that the plan weave had higher strength than that of twill weave. In the research of Malik et al. [19], it is reported that polyester-cotton plain weave is stronger than that of 3/1 twill weave fabrics in either direction. Hence, the weave structure is important jn the fabric form. Textile reinforced mortar also been studied by the Tzoura and Triantafillou [20] describing that unit weight had no influence over number of yarns in warp and weft directions. They reported that mass per unit area for lighter fabric was 174 g/m2 and that of heavy fabric it was 348 g/m2. Regarding the strength of TRM, heavy fabric had more strength (133%). Authors also described the variation in layers of fabrics. Two-layered system with heavy fabrics showed higher strength (183%). Moreover, variation in mortar thickness showed no significant changes in strength , a research study done by Larbi et al. [21]. Tran et al. [22] states that transforming textile waste into fiber reinforcement in cementitious composites offers a sustainable approach for enhancing the engineering properties of concrete, including strain capacity, crack control, durability, and energy absorption. This approach can improve compressive strength, lower costs, and benefit the environment, promoting a sustainable textile economy.

There has been a well research on textile incorporation for structural applications in previous studies [23, 24]. However, very scant studies for cloth jacketing are available. Therefore, to increase the strength of no-fine concrete while maintaining its characteristic features the experimental study is done with different types of locally available waste cloths. Various tests like microscopic analysis, mass per unit area and tensile strength were conducted over the fabric prior to selection for jacketing. The most bearing tensile load fabric was selected for material and jacketing was done. The study emphasizes the potential advantages of using no-fine concrete incorporating unconventional textile

fabrics in various structural applications. This innovative approach provides infrastructure stakeholders with a cost-effective and durable method for strengthening and rehabilitating structures. By employing these novel materials, the construction industry can benefit from improved performance and longevity of no-fine concrete structures while also achieving more sustainable and efficient outcomes. This technique represents a valuable option for lightweight and pervious concrete enhancing the resilience and durability of existing infrastructure, aiding in the preservation and extension of its service life.

II. METHODS AND MATERIALS

1. Textile Fabric Selection

Eight types of locally available textile fabric were selected. Fabric includes Atal (polyester), Chiffon (cotton, silk and synthetic mix), Khaddar (100% cotton), Lawn (mix percentage cotton), Silk, Tissue (silk and cotton mix), Shabnamzra (synthetic, silk and cotton fibers) and Jeans (cotton). All fabrics were selected from used cloth market or obtained from dismantled clothes. Individual required pieces of fabric specimen were manually procured for the tests with scissors as shown in Figure 1. Fabric were placed in an environment chamber at 200 Celsius and 65% reality humidity for 8 hours before performing any test.



Figure 1. Preparation of strips from waste Fabrics

The initial step was to carry out a microscopic examination of the textile fabric to analyze its microstructure (Figure 2). After conditioning, three specimen of size 10cm2 were cut from each fabric with scissors & specimen weights were taken and calculated for the mass per unit area (kg/m2). The number of ends and picks were counted within a one-inch space, and the results were expressed as warp yarns (yarns/inch) × weft yarns (yarns/inch). The test was carried out using a simple magnifier and a scale with graduation down to 1/16 inch intervals. First, the specimen's warp side was unraveled until the complete length of yarns was exposed. The pick counter was then positioned at three random spots along the fabric's length, and observations were recorded. The average of the five measurements was calculated. Yarn counting was counted in both warp and weft directions, with three observations taken for each cloth sample. Figure 3 shows the cut specimens for mass per unit area.

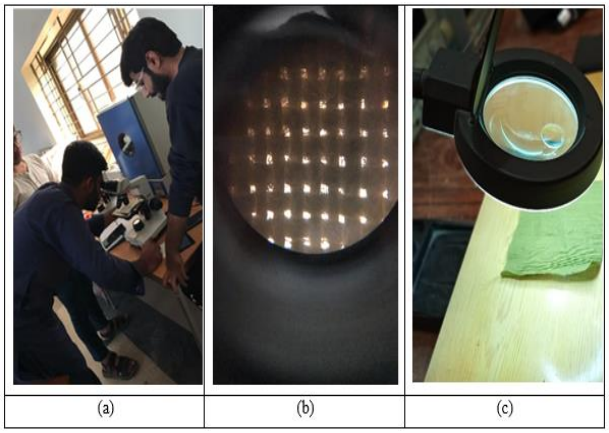


Figure 2. Microscopic analysis of fabric (b) textile fabric under microscope (c) specimen khaddar under magnifier

The yarn number of each tested textile fabric sample was measured according to the ASTM D1059 standard. Small squares of fabric, sized 100 x 100 mm, were cut from each sample (as shown in Figure 3). Full-length yarns were extracted from these fabric patches in both warp and weft directions. The yarns were then trimmed to uniform lengths. Their weights were measured using a balance with the least count up to 10mg, and the weight per unit length was calculated.



Figure 3. Mass per unit area of fabrics (a) Jeans (b) Atal (c) Khaddar (d) Yarn Count of Fabric

Tensile strength test was performed according to ASTM D5035. From every sample three specimen of 500 × 50 mm dimension strips were produced and were placed in the universal testing machine (UTM) (Figure 4) maintaining 2mm/min movement speed. For the strong grip of jaws, 75mm tire tube was stitched onto the extended length of fabric both sides (Figure 5). Three specimen of each fabric were cut manually and performed the peak load for maximum deflection. Upon breaking, the deformation is observed and strength is calculated.

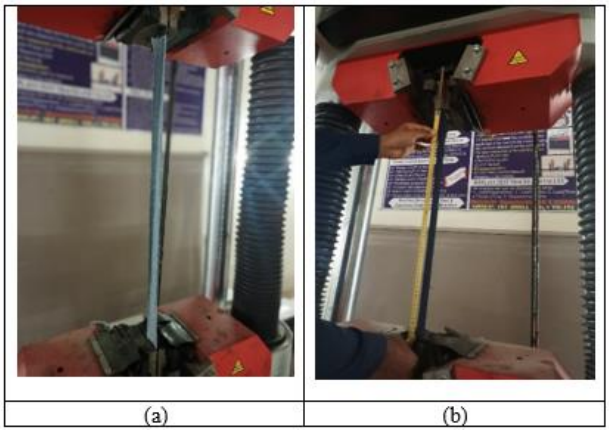


Figure 4. Tensile testing of fabric (a) textile specimen under load (b) Scaling against jaw distance

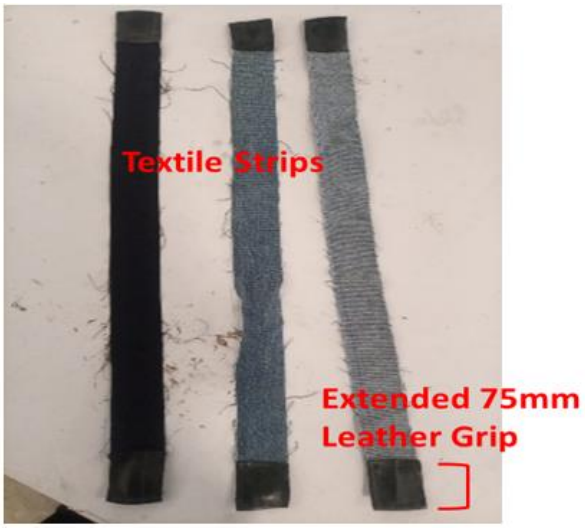


Figure 5. Prepared Samples for Testing

2. Concrete Material Selection

Ordinary Portland cement (OPC) was used throughout the study, such as in casting of no-fine concrete (NFC), neat cement slurry for jacketing and conventional concrete. River sand with fineness modulus of 2.3 was used only in normal concrete. Table 1 shows the cement chemical composition. Coarse aggregate for no-fines concrete is taken according to ASTM C33/C33M-18. The aggregate taken (Figure 6) passes through 19.5mm sieve and retains at 10.0mm sieve opening. These aggregates were then washed to remove any impurities and dried in an oven at a temperature of 105°C for a period of 18 hours. Ordinary water was used for mixing and curing purposes. Table 2 shows aggregate properties.

Table 1. Cement Constituents for Concrete and Slurry Mix

Material	SiO2	CaO	Al2O3	Fe2O3	MgO	Na2O	K2O
Cement	18.06	66.22	5.65	3.55	1.90	1.46	0.9
Material	SiO_2	CaO	Al_2O_3	Fe_2O_3	MgO	Na_2O	K_2O
Cement	18.06	66.22	5.65	3.55	1.90	1.46	0.9



Figure 6. Coarse Aggregate (Sargodha Crush)

Table 2. Physical properties of coarse aggregate

Physical Properties	Coarse aggregate
Source	Sargodha Crush
Maximum size	19mm
Specific Gravity	2.83 (SSD)
Water absorption	0.57
Impact Value	4.59
Crushing Value	13.42%
Average unit weight	1680 Kg/m^3
Compressive strength	20.2 MPa
Air Voids	0.57%

No-fine concrete with 1:6 cement to aggregate ratio is mixed. Manual mixing was done with use of shovel. No-fines concrete gives no slump value. In this scenario, the proper coating of cement should be placed over aggregate for the bonding of the concrete. Compactions or vibration is not required for the batch mixing. Water was added slowly while continuously mixing. As for neat cement slurry, portion wise mixing of ½ kg by total weight was done and cloth strips were coated by dipping into it.

3. Casting of Concrete

Table 3 depicts the proportion for concrete mix. Normal concrete, no-fines concrete and no-fines concrete with cloth jacket was casted into cubes, cylinders and prisms (Figure 7). After 24 hours of setting time, specimens were placed in water for curing. Table 4 shows the matrix for concrete specimen types. After a curing period of 28 days, the specimens were removed from the water and left at room temperature to dry for 3 hours. Capping was done by plaster of Paris to give smooth surface and uniformly loading for compressive testing as shown in Figure 8.

Table 3. Mix Proportions for Normal Concrete and No-fine concrete

Concrete	Cement	Sand	Aggregate	w/c
Normal	1	2	4	0.79
No-fines	1	-	6	0.52
Cement Slurry	1	-	-	0.80

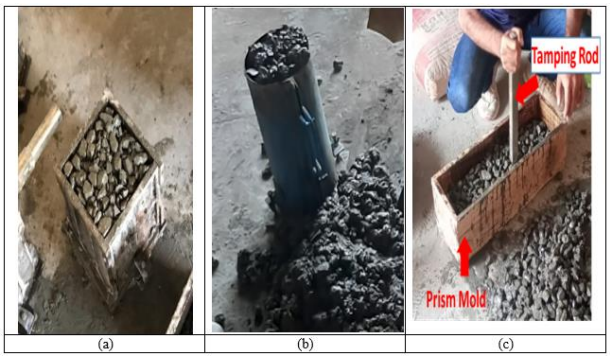


Figure 7. Casting of Specimens (a) Cube (b) Cylinder (c) Prism

Table 4. Matrix for Specimen Casted

Concrete	Cubes (6 in × 6 in × 6 in)	Cylinders (Dia. 6 in, length 12 in)	Prism (6 in × 6 in × 20 in)
Normal	5	5	5
No-fines	5	5	5
No-Fine Concrete with One Layer Jacketing	5	5	5 (Reinforced with 4 textile fabric strips)
No-Fine Concrete with Two Layers Jacketing	5	5	
No-Fine Concrete with Three Layers Jacketing	5	5	



Figure 8. Capping of Concrete specimens for compression test of NFC Cubes

Tests for compressive strength, split tensile strength and flexural strength were conducted. The average strength of the no-fine concrete specimen at 28 days was recorded. After curing of samples, Each cloth of 50mm wide and required circumferential length strip is tighly wrapped with hand over the whole NFC specimen (shown in Figure 9). Specimen was then rested to dry for 24 hours and then cured for a week before subjecting into testing procedure.



Figure 9. Jacketing of NFC (a) wrapping of NFC cylinder (b) cylinder with one layer of jacketing

In case for prisms, three specimen of no-fine concrete having dimention of 20 in × 6 in× 6 in were casted. The first layer of 1 inch NFC was poured. The two textile fabric of 2 inches × 18 inches strips dipped in cement slurry given a single fold were placed on the bottom layer of NFC. Then second layer of NFC was placed and layer was compacted by simple tampling without disturbing the placement of first cloth strips. The space cover for the cloth strips of uper layer is kept 1 inch.from top. Figure 10 shows placement of textile strips for prisms.

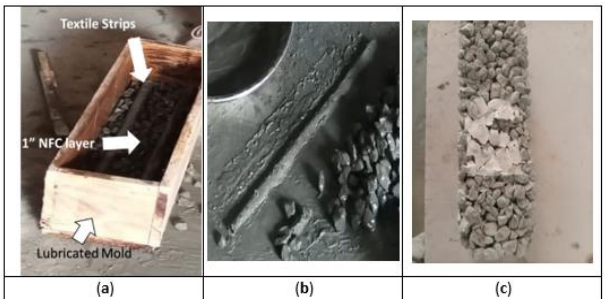


Figure 10. Prism casting (a) mold of prism with two textile strips (b) textile strip (c) textile reinforced prism

4. Testing of Concrete Specimen

Unit Weight

Determining the unit weight of concrete specimens such as cubes, cylinders, and prisms were weighted according to the standardized procedure (ASTM C138). Once cured, each specimen is individually weighed as shown in Figure 11 using a precise balance capable of measuring to the nearest gram. The unit weight, typically reported in kilograms per cubic meter (kg/m^3), reflects the density of the concrete.



Figure 11. Weighing of NFC Cylinder

Compressive Strength

As shown in Figure 12 the compressive strength of concrete was done according to ASTM C39 and BS 1881-116:1983 for cylinders and cubes, respectively. Prior to testing capping was done with thick paste of plaster of Paris to ensure smooth surface. The testing machine was then set up and calibrated ensuring the concrete cubes or cylinders were centrally placed on the lower platen. Rate of loading was set 5kN/s with the start load of 10kN. The test begins with the gradual application of a compressive load to the cubes and cylinders at a specified rate until the sample fails or reaches its maximum load-bearing capacity. During the test, the maximum load the specimen can bear before failure was recorded.

The compressive strength of the cube and cylinders was calculated using the formula:

$$\text{Compressive Strength} = \text{Maximum Load}/\text{Cross Sectional Area} \quad (1)$$



Figure 12. Compression Test (a) NFC Cube without cloth jacketing (b) NFC cube with cloth Jacketing (c) Normal Concrete Cylinder.

Splitting Tensile Strength

Splitting tensile test was done according to ASTM C496/C496M-04 to assess the tensile strength of concrete cylinders. In this test, a cylindrical concrete sample was positioned horizontally between two compression testing machine jaws as depicted in Figure 13. If the surface was rough plaster of Paris was used along the length of cylinder. A uniform load of 0.7 KN/sec to 1.4 KN/sec was applied along the vertical diameter of the cylinder until it splits. The maximum load at which the sample breaks, the reading was recorded.

The splitting tensile strength was calculated by using the following formula:

$$\text{Split Tensile Strength} = (2 \times \text{Load at failure}) / (\pi \times \text{Diameter} \times \text{Height}) \quad (2)$$



Figure 13. Splitting Tensile Testing (a) Normal concrete cylinder failure (b) NFC cylinder with assembly (c) Jacketed NFC Cylinder

Flexural strength

The flexural test of concrete prisms measures the flexural strength, also known as modulus of rupture. Following ASTM C 78/ASTM C 293, a specimen prism with 20 in × 6 in × 6 in was placed on two simple supports as shown in Figure 14. A load was applied at a 1kN/s rate at the prism's midpoint (three-point loading). The test continued until the prism broke, and the maximum load at failure was noted. Flexural strength is calculated using the formula:

$$\text{Flexural Strength} = (\text{Failure load} \times \text{Effective span}) / (\text{breath} \times \text{depth}) \quad (3)$$

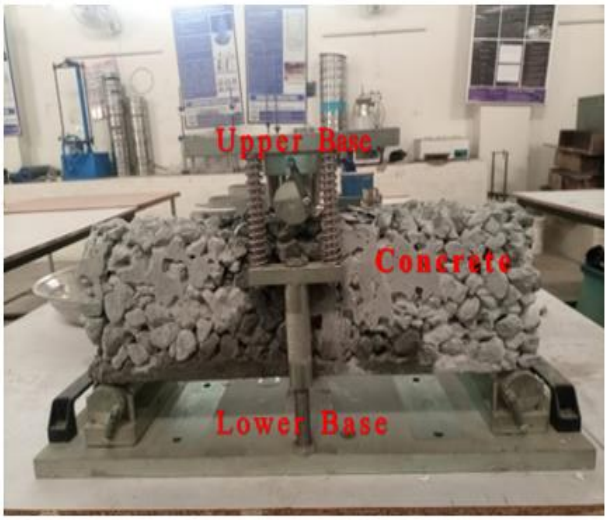


Figure 14. Placement of textile reinforced NFC for flexural test

III. RESULTS AND DISCUSSION

1. Analysis of Fabric Type

Microscopic Analysis of Fabric

Figure 15 shows pictorial views of each fabric. In woven fabrics, each yarn moves alternatively up and down in relation to its perpendicular counterpart. Three common types of weaves in the fabric market are plain, twill (2/1), and twill (3/1). Plain weave is the simplest type, with each yarn alternating up and down against its perpendicular yarn. Twill (2/1) weave occurs when the weft yarn floats over two perpendicular warp yarns before switching direction, creating a diagonal pattern with each new row.

Twill (3/1) weave features the weft yarn floating over three perpendicular warp yarns before alternating direction, also forming a diagonal pattern. In case of available fabrics only plain and diagonal weave fabrics were observed in Microscopic analysis of tested fabrics. Various magnifications (30 to 50×) were used to analyze the weave types of the tested fabrics. Figure 16 depicts fabric types based on quantitative fiber analysis: out of eight tested fabrics, five were plain, two were twill (2/1), and one was twill (3/1) based on microscopic analysis and yarn distribution.

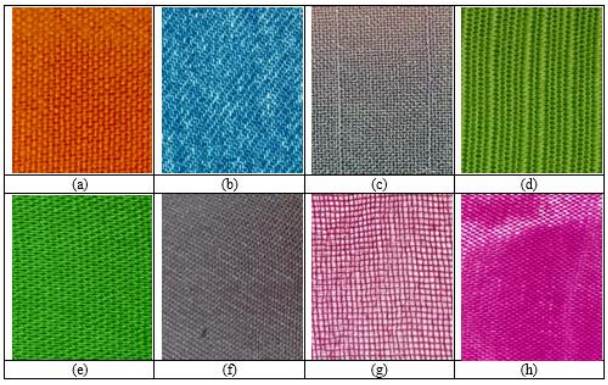


Figure 15. Pictorial view of cloth fabrics (horizontal direction shows the wrap and vertical direction shows the weft (a) Atal (b) Jeans (c) Chiffon (d) Khaddar (e) Lawn (f) Silk (g) Tissue (h) Shabnamzra

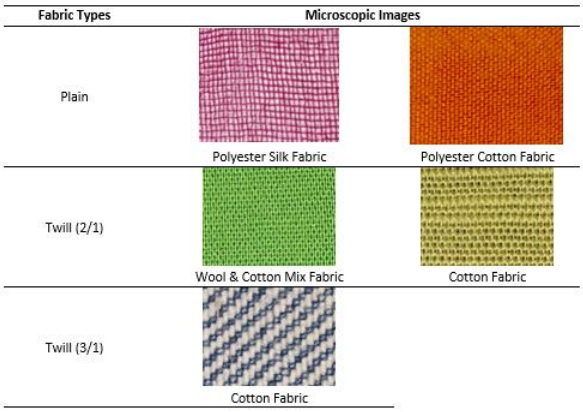


Figure 16. Cloth fabrics types and composition

Warp and Weft Count of Fabric

Table 5 gives value for yarn density, which is directly related to yarn number of fabric. TF8 showed the maximum density in both direction. TF7 had the thinner yarn but spread apart makes it less dense fabric. On the other hand TF2 showed closely packed yarns in microscopic analysis but had the least density thus showing thicker yarns of fabric. Yarn count also dependent on weave type and fabric type.

Table 5. Warp and Weft count of textile fabrics

Sample No.	Fabric	Yarn Count (yarn/inch)	
		Warp	Weft
TF1	Atal	195	205
TF2	Jeans	18	17
TF3	Chiffon	75	68
TF4	Khaddar	110	105
TF5	Lawn	95	85

TF6	Silk	450	350
TF7	Tissue Cloth	170	185
TF8	Shabnamzra	400	310

Mass per unit area of Fabric

The mass per unit area of the tested fabric samples varied significantly, ranging from 0.009 to 0.468 kg/m^2. TF2 had significantly highest mass per unit area shown in Figure 17. These results represent the average of three specimens; with a coefficient of variance is more than 100%. The variation in mass per unit area is largely due to differences in fabric composition, weave type, yarn thickness, and the number of yarns in each direction. Specimen TF2 exhibited the highest mass per unit area (0.468 kg/m^2), while specimen TF7 had the lowest (0.009 kg/m^2). This difference is attributed to TF2's thicker yarns compared to the thinner and spread out yarns of TF7. TF7 clearly shows wide spaces between yarns forming a net structure. TF6 showed the highest density but mass per unit area is significantly low explain that it does not only depends upon the yarns number but also the placement and thickness of single yarn.

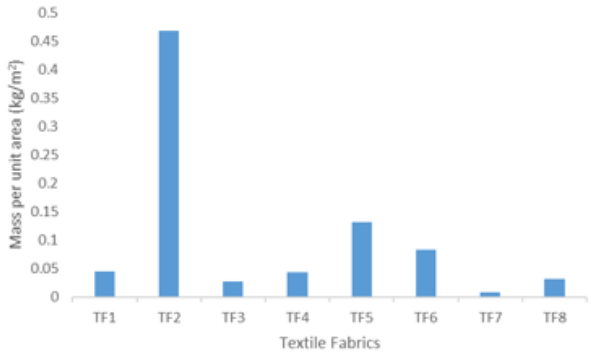


Figure 17. Result of Mass per unit area of textile fabrics

Yarn Number of Fabric

Yarn number is directly related to yarn thickness. Specimen TF2 had the highest yarn number with mass per unit area 0.045kg/m2 while specimen TF7 had the lowest at Yarn number significantly affects the tensile strength of fabric; higher yarn thickness leads to greater density. Figure 18 gives the yarn number taken upon short length of fabric.

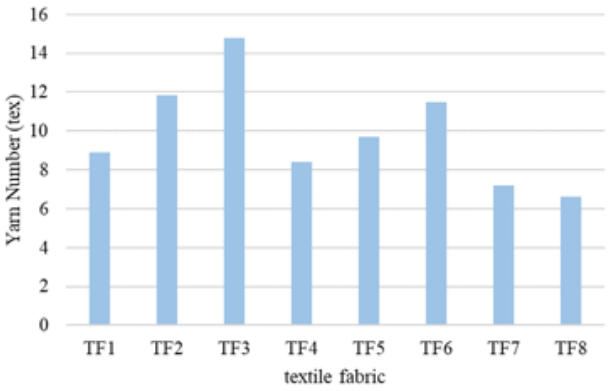


Figure 18. Yarn Number of textile fabrics

Tensile Strength of Cloth Fabrics

In testing eight different cloth fibers for tensile strength, the outcomes demonstrated a range of performance levels across various fabric types shown in Figure 19. Jeans (TF1) displayed the highest peak tensile strength at 891 N, highlighting its durability and toughness. Atal (TF1) ranked second with a peak tensile strength of 854 N, highlighting its strong characteristics. Khaddar, known for its strength, reached a peak tensile strength of 802 N. Silk, a natural fiber, achieved a peak tensile strength of 749 N, indicative of its strength and sophistication. Soft cotton had a peak tensile strength of 644 N, reflecting its moderate strength and gentle touch. Lawn, a lightweight fabric, recorded a peak tensile strength of 610 N. Tissue and chiffon, delicate fabrics, showed peak tensile strengths of 410 N and 399 N, respectively, indicating their fine and fragile nature. These results underscore jeans' superior tensile strength compared to other fabrics, especially those that are lighter and more delicate, such as tissue and chiffon. Thus, Jeans (TF1) strips were used for the jacketing.

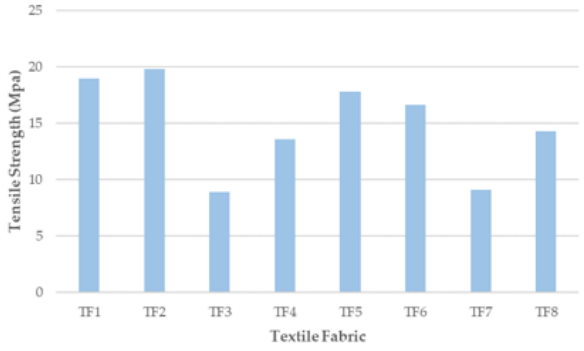


Figure 19. Tensile Strength of Textile Fabrics

2. Concrete Materials

Unit weight of Fine aggregate

The sometime referred as density or specific weight, the unit weight of fine aggregate is the amount of sand per unit volume. Table 6 shows unit weight of fine aggregate. It shows moisture sand has unit weight from 1,900 to 2,100 kg/m3 while dry sand unit weight ranges from 1,500 to 1,700 kg/m3.

Table 6. Unit weight for fine aggregate

Description	Value
Mold Volume	5005g
Mold Weight	3680g
Loose Weight of Sand in Mold	11910g
Compacted Wt. in 3 layers	12400g
Loose Bulk Density	1.64g/cm^3
Compacted Bulk Density	1.74g/cm^3

Sieve Analysis of Coarse Aggregate

The sieve analysis of the coarse aggregate sample revealed a well-graded distribution of particle sizes, ensuring proper compaction and stability as required for the no-fine concrete mix. The majority of the aggregate particles were retained on the mid-sized sieves, indicating a balanced blend of coarse and fine particles. Gradation curve is given in Figure 20. This gradation contributes to the aggregate's strength and durability in our no-fine concrete mix.

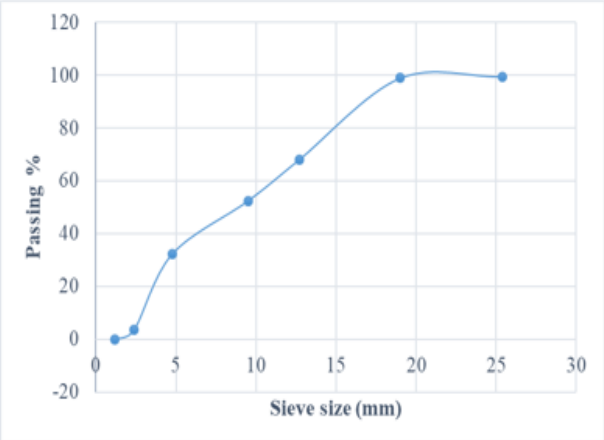


Figure 20. Gradation curve of coarse aggregate

Specific Gravity and water absorption of Coarse Aggregate

The specific gravity test measures the ratio of the weight of a certain volume of a substance to the weight of an equal volume of water. Water, at a temperature of 23°C, has a specific gravity of 1. This test holds significance for several reasons. It helps identify harmful particles that may be lighter than benign compounds. The volume measurement considers only the volume of the aggregate, excluding any water vacuum. The mass measurement includes only the aggregate particle. Apparent specific gravity is determined to calculate the specific gravity of the solid volume alone, making the specific aggregate gravities particularly important. We conducted tests to determine dry oven gravity, specific gravity at SSD (Saturated Surface Dry), and apparent specific gravity. The results of all specific gravity tests are presented in Table 7.

Table 7. Specific gravity for coarse aggregate

Description	Symbol	Value
Oven dry weight of aggregate	A	5000g
SSD weight of aggregate	B	5220g
weight of aggregate in water	C	3375g
Oven dry specific gravity	G_{s1}	2.71
SSD specific gravity	G_{s2}	2.83
Apparent specific gravity	G_{s3}	3.07

Water Absorption

Water absorption testing provides insights into the internal structure of the aggregate. Generally, aggregates with higher porosity are considered unfavorable, unless their porosity is deemed acceptable based on strength, hardness, and impact tests. We conducted water absorption tests to assess the porosity of the coarse aggregate, and the results are presented below for the coarse aggregate.

A= oven dry weight of aggregate = 5020 g
B= SSD weight of aggregate = 5049 g
Water absorption = 0.577

Water absorption = 0.57 %

Impact Value of Coarse Aggregate

Aggregates need to possess enough strength to withstand degradation. The impact value test assesses this property. It measures the ability of the aggregate to resist sudden shocks or impacts, which may differ from its ability to withstand gradually applied compression loads. To evaluate the hardness of the coarse aggregate, we conducted the impact value test. The result for the coarse aggregate's impact value is 6.4%, indicating a satisfactory level of hardness.

Total weight of aggregate = 620 g
Weight of passing aggregate of sieve # 8 = 28 g
Impact value = 4.5%

Crushing Value of Coarse Aggregate

The crush value test provides a relative evaluation of the crushing strength of aggregate under gradually applied compression loads. It measures the percentage by weight of the crushed material obtained when a trial aggregate is subjected to a specific load under standard conditions. The strength of the aggregate is represented by the index in road construction. The coarse aggregate crushing value is used to assess the hardness of coarse aggregates. From this test, the crushing value of the coarse aggregate is determined to be 21.26%, indicating its hardness under compression.

Total weight of aggregate = 3125 g
Weight of passing aggregate of sieve # 8 = 420 g
Crushing value = 13.42%

3. Concrete Testing

Unit Weight of Concrete

Normal concrete typically has a unit weight ranging from 2200 to 2400 kg/m^3. Table 8 gives the value for unit weight of No-fine concrete and cloth jacketed NFC. NFC is lighter due to the absence of fine aggregates, making it ideal for lightweight construction and insulation purposes. Unit weight of NFC concrete is 78.9% of Normal concrete. By the addition of cloth layer NFC unit weight increases up to 4.2%, 5.2% and 5.8% for one, two and three layers, respectively. It is 82.29% of normal concrete thus unit weight of jacketed no-fine concrete remains lower than that of Normal concrete, it combines the benefits of reduced weight and enhanced tensile strength.

Table 8. Unit Weight of Concrete specimen

Types of Concrete	Average Unit weight of Specimen (kg/m^3)	Percentage relative to Normal concrete	Percentage increase in unit weight relative to NFC
Normal Concrete	2395	-	-
No-Fine Concrete	1891	78.9	-
NFC Jacketing one layer	1971	82.3	4.2
NFC Jacketing two layers	1990	83.0	5.2
NFC Jacketing three layer	2002	83.6	5.8

Compression Test of Concrete

By performing compression tests on cubes and cylinders, overall same results are obtained. Figure 21 shows the comparison of compressive strength of normal concrete and simple no-fine concrete with cloth jacketing. Although the compressive strength of normal concrete stands out from other concrete in strength (19MPa), simple no-fine concrete varies between 7.67 MPa and 10.2 MPa, while no-fine concrete with cloth jacketing shows enhanced strengths of 10.5 MPa, 10.8 MPa, and 11.1 MPa for one, two, and three layers, respectively. Compared to the highest strength of simple no-fine concrete, the addition of cloth jacketing increases compressive strength by approximately 17.18% with one layer, 20.5% with two layers, and 23.8% with three layers. Compared to normal concrete it jacketed NFC makes 55%, 56% and 58% for one, two and three layers, respectively. This demonstrates that cloth jacketing

significantly enhances the compressive strength of no-fine concrete.

Hence, compared to simple NFC we have:

- 1 Layer of Cloth Jacketing: 17.18% increase in compressive strength
- 2 Layers of Cloth Jacketing: 20.5% increase in compressive strength
- 3 Layers of Cloth Jacketing: 23.8% increase in compressive strength
- Avg. increase in strength by addition of cloth layers : 1.5%

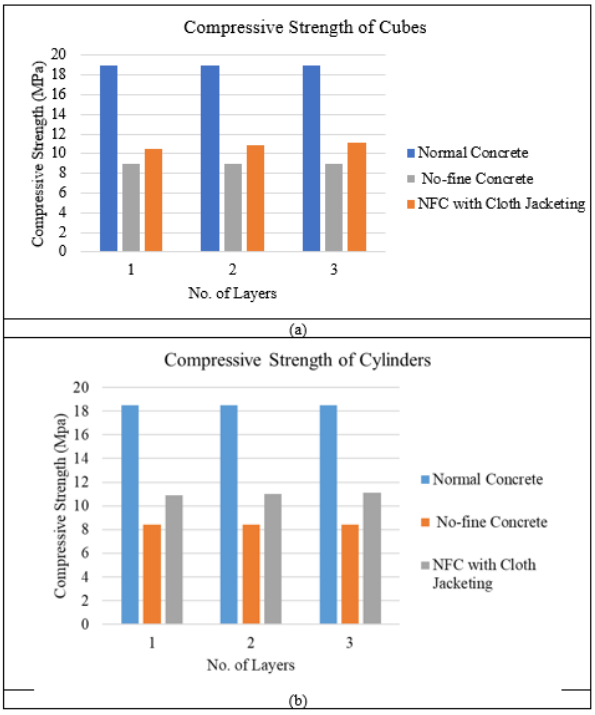


Figure 21. Compression Test of Concrete (a) Cubes (b) Cylinders

It is notable that, the addition of 2nd layer of cloth fabrics only 1.6% increase in strength is observed compared to one layer jacketing while further increase in cloth layer gives 1.7% increase in strength. Thus, it could be concluded that, the addition of 1st layer magnificently enhances the strength of NFC but further increase in layer has a minor effect on strength of NFC concrete.

As shown in Figure 22, bulging is observed in jacketing prior to complete failure of specimen, it improvise the tensile behavior of the concrete thus delaying the complete collapse and improving the strength altogether.



Figure 22. Bulging effect on Jacketed Cylinder upon load application

Splitting Tensile Test of Concrete

Depicted in Figure 23 results show that with one, two and three layers of cloth jacketing, the tensile strengths of no-fine concrete rise to 1.8, 1.9 and 2.1 MPa, respectively. The splitting tensile strength of M15 grade normal concrete falls around 2.8 MPa, which is notably higher than the 1.3 MPa observed in simple no-fine concrete. However, the application of cloth jacketing to no-fine concrete significantly enhances its tensile properties up to 27%, 31.5% and 38% for one, two and three layers, respectively. No-fine concrete shows 46.4% strength compared against normal concrete. By the addition of cloth layers, NFC shows 64.2%, 67.8% and 75% strength of normal concrete.

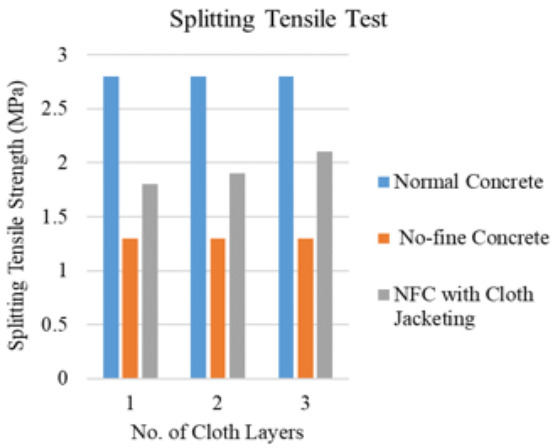


Figure 23. Splitting Tensile Strength Test of Concrete

Figure 24 shows the failure of internal NFC while retaining the outer layer of jacketing. These findings illustrate the effectiveness of cloth jacketing in improving the structural performance of no-fine concrete.



Figure 24. Failure of NFC with one layer jacketing

Flexural Strength test of Textile reinforced NFC

As shown in Figure 25 the incorporation of cloth strips as reinforcement fibers markedly enhances the flexural strength of no-fine concrete (NFC). The average flexural strength of unreinforced NFC obtained is 1.8 MPa, whereas with cloth strips as textile reinforcements, it rises to average 2.2 MPa. Figure 26 shows failure of Textile Reinforced NFC. Result indicates a 22.2% increase in flexural strength of no-fine concrete due to the textile reinforcement, highlighting its efficacy in strengthening the concrete.

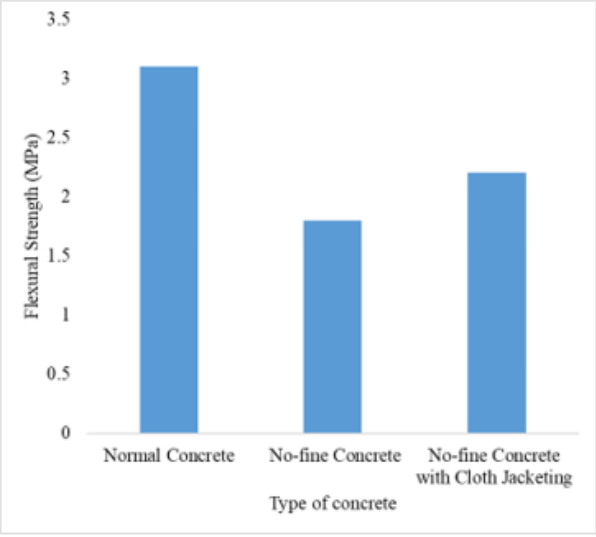


Figure 25. Flexural Strength Test of Concrete

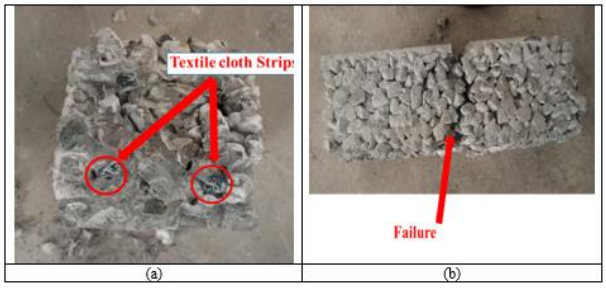


Figure 26. Failure of Textile reinforced no-fine concrete (a) showing Cloth strips (b) Crack pattern of TR NFC

Compared to normal M15 grade concrete, which typically has a flexural strength of around 3.0 MPa, the textile-reinforced NFC, although improved, still falls short (73% of normal concrete). However, the significant enhancement over the unreinforced NFC suggests that cloth jacketing can effectively increase the structural performance of NFC, making it a viable option for applications where increased flexural strength is desirable, albeit not yet matching the performance of standard concrete grades like M15.

IV. CONCLUSIONS

- The cloth jacketing to no-fine concrete has shown increased by 46.5%, which indicates a significant enhancement in the material's ability to withstand compressive forces.
- The cloth jacketing to no-fine concrete has increased strength properties such as compressive the split tensile, flexural strength increased 17.18%, 27.78% and 22.2% respectively.
- These findings demonstrate that cloth jacketing can effectively enhance the overall performance of no-fine concrete.
- The bulging suggests that the cloth jacket plays a crucial role in delaying the onset of structural failure by providing extra resistance, thereby enhancing the durability and overall performance of the concrete under stress.
- By Microscopic observations out of eight fabrics, only Jeans had (3/1) twill weave making 450 angle with warp and weft yarns. It also had the lowest warp and weft count showing densest yarns as found by mass per unit area test. Although silk fabric had highest yarns, it falls

short in mass per unit area, as its threads are so thin and delicate. Tensile strength test of cloth fabrics further proves that the jeans had highest load bearing capacity thus used as jacketing medium.

- While adding a single layer of cloth notably improved the concrete's strength, additional layers did not lead to significant further gains.
- The cloth jacketing led to a modest 5.87% increase in the weight of the no-fine concrete structure. Despite this weight gain, the structure remains lighter than conventional concrete, highlighting the effectiveness of the reinforcement in improving strength without significantly compromising the lightweight advantage of no-fine concrete.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

REFERENCES

1. Nadh, V. S., & Muthumani, K. (2017). Critical review on structural light weight concrete. International Journal of Civil Engineering and Technology, 8(2), 111-127.
2. Ghafoori, N., & Dutta, S. (1995). Building and nonpavement applications of no-fines concrete. Journal of materials in civil engineering, 7(4), 286-289.
3. Raza, S., Khan, M. K., Menegon, S. J., Tsang, H. H., & Wilson, J. L. (2019). Strengthening and repair of reinforced concrete columns by jacketing: State-of-the-art review. Sustainability, 11(11), 3208.
4. Hadi, M. N., Algburi, A. H., Sheikh, M. N., & Carrigan, A. T. (2018). Axial and flexural behaviour of circular reinforced concrete columns strengthened with reactive powder concrete jacket and fibre reinforced polymer wrapping. Construction and Building Materials, 172, 717-727.
5. Neville, A. M., & Brooks, J. J. (1987). Concrete technology (Vol. 438). England: Longman Scientific & Technical.
6. Aïtcin, P. C., & Flatt, R. J. (Eds.). (2015). Science and technology of concrete admixtures. Woodhead publishing.
7. Daczko, J. (2012). Self-consolidating concrete: applying what we know. CRC press.
8. Bunger, A. P., Jeffrey, R. G., Kear, J., Zhang, X., & Morgan, M. (2011, June). Experimental investigation of the interaction among closely spaced hydraulic fractures. In ARMA US Rock Mechanics/Geomechanics Symposium (pp. ARMA-11). ARMA.
9. Phipps, S. (2018). Concrete Poetry: Post-war Modernist Public Art. September Publishing.
10. Hensher, D. A. (2016). Fiber-reinforced-plastic (FRP) reinforcement for concrete structures: properties and applications (Vol. 42). Elsevier.
11. Popovics, S., Rajendran, N., & Penko, M. (1987). Rapid hardening cements for repair of concrete. Materials Journal, 84(1), 64-73.
12. Singh, N. T. (2016). Effective uses of light weight concrete. Journal of Civil Engineering and Environmental Technology, 3(3), 208-211.
13. Patil, P. S., Sonar, I. P., & Shinde, S. (2017). No fine concrete. International Journal of Concrete Technology, 3(2), 18-30.
14. Marshdi, Q. S. R., Hussien, S. A., Mareai, B. M., Al-Khafaji, Z. S., & Shubbar, A. A. (2021). Applying of No-fines concretes as a porous concrete in different construction application. Periodicals of Engineering and Natural Sciences, 9(4), 999-1012.
15. Pateriya, A. S., Dharavath, K., & Robert, D. J. (2021). Enhancing the strength characteristics of No-fine concrete using wastes and nano materials. Construction and Building Materials, 276, 122222.
16. JiaHao, L., Lian, F. C., Hejazi, F., & Azline, N. (2019, November). Study of properties and strength of no-fines concrete. In IOP Conference Series: Earth and Environmental Science (Vol. 357, No. 1, p. 012009). IOP Publishing.
17. Mounika, P., & Srinivas, K. (2018). Mechanical Properties of no Fines Concrete for Pathways. International Journal of Engineering and Techniques, 4(2), 68-81.
18. Rahu, A. A., Memon, B. A., Oad, M., Dahri, S. A., Memon, A. R., & Bhutto, A. H. (2023). Assessment of the Flexural Strength of No-Fines Recycled

Aggregate Concrete Prisms. Engineering, Technology & Applied Science Research, 13(1), 10067-10072.

19. Lomte, M. R. (2018). A review on study and analysis of strength, permeability and void ratio of pervious concrete. International Journal for Research in Applied Science & Engineering Technology, 6(1), 1717-1720.
20. Balsaraf, K. R., Kurhade, D. R., Varpe, K. A., Lohote, N. S., & Mehetre, D. S. (2017). A review paper on no fines concrete. International Journal Of Engineering Sciences & Management, 7(1), 293-303.
21. Sheth, P. D. K., & Patel, M. (2015). Pervious Concrete As Environmentally Friendly Material-A review. Int. J. Eng. Sci, 1, 1-6.
22. Shirgir, B., Mamdoohi, A. R., & Hassani, A. (2015). Prediction of pervious concrete permeability and compressive strength using artificial neural networks. International Journal of Transportation Engineering, 2(4), 307-316.
23. Ramadhansyah, P. J., Mohd Ibrahim, M. Y., Hainin, M. R., & Wan Ibrahim, M. H. (2014). A review of porous concrete pavement: applications and engineering properties. Applied mechanics and materials, 554, 37-41.
24. Patil, P. S., Sonar, I. P., & Shinde, S. (2017). No fine concrete. International Journal of Concrete Technology, 3(2), 18-30.