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Replacement of River Sand by Waste Foundry Sand In Paver Blocks

Dipankar Haldar [1], Tanmoy Das [2], Ramen Mondal [3], Sagir Ahmed Haldar [4], Md Rafiuddin Molla [5], Subhojit Chattaraj [6]

[1,2,3,4,5] Student, Department of Civil Engineering, Greater Kolkata College of Engineering and Management
[6]Assistant Professor, Department of Civil Engineering, Greater Kolkata College of Engineering and Management

ABSTRACT

This study investigates the use of leftover foundry sand in place of river sand while making paver blocks. For foundries, disposing of the plentiful and occasionally underutilized waste foundry sand—a consequence of metal casting operations—presents a challenge. The study assesses the durability, mechanical properties, and physical properties of paver blocks manufactured with various amounts of leftover foundry sand. The findings indicate that river sand can be effectively substituted with waste foundry sand without sacrificing quality. Paver blocks constructed using waste foundry sand have mechanical and physical properties that are comparable to those of blocks made with ordinary river sand. Tests for durability show satisfactory results, guaranteeing the structural integrity over time. Although this study is in favor of the circular economy and environmentally friendly construction practices, more investigation and implementation are required to maximize.

Keywords: waste foundry sand, materials, concrete, natural sand

I. INTRODUCTION

Alternative materials for construction are being investigated by industry and researchers in response to the depletion of natural resources and growing environmental concerns. Waste foundry sand, which is produced as a byproduct of metal casting operations, is one such substance that is being examined. There is a chance to use waste foundry sand in building because of its availability and the environmental problems associated with disposing of it. This project aims to investigate the possibility of using leftover foundry sand to make paver blocks instead of river sand. Given their widespread usage in pavement and landscaping, paver blocks are a good choice for investigating sustainable material substitutes. This study's main goals are to evaluate the environmental, mechanical, and physical characteristics of paver blocks made with leftover foundry sand. The study seeks to assess the environmental impact, durability, and structural integrity of the paver blocks using different amounts of waste foundry sand through extensive laboratory testing and analysis. Moreover, the study aims to tackle issues about the elimination of leftover foundry sand by offering a workable and sustainable remedy by incorporating it into building supplies. The results of this project should add to our understanding of sustainable building techniques and provide information on the viability and efficiency of producing paver blocks using scrap foundry sand.

II. Literature Review

This study emphasizes the utilization of residual foundry sand in concrete as well as the various applications for concrete. Numerous studies have examined the use of leftover foundry sand as a partial or complete replacement for fine aggregate in concrete.

[1] According to Siddique et al. (2016), there is an improvement in these qualities with age as well as an increase in compressive strength, modulus of elasticity, flexural strength, and splitting tensile strength with a 30% content increase in WFS. According to Siddique, adding WFS to concrete can boost its strength properties by up to 15% for both 28 and 91-day ages. It also raises the UPV value of the concrete while reducing the penetration of chloride ions. The author noted that WFS can be utilized appropriately to produce concrete. Similar findings were obtained for the strength properties, and it was found that 20% of WFS inclusion yields the maximum value. The results for the concrete's abrasion resistance were also comparable to those of the control mix. Siddique investigated the effects of WFS on two classes (M20 & M30) of concrete mixtures when used in part instead of natural sand. According to the author, M20 grade outperforms M30 grade in terms of all strength attributes, UPV, and chloride ion penetration in concrete. Siddique conducted research on the microstructural characteristics, strength, and durability of concrete by substituting fine particles for a portion of the WFS. According to the author, using a 30% replacement level in concrete is ideal and shouldn't go above 50%.

[2] Guney et al. (2016) investigated the possible reuse of WFS in the creation of high-strength concrete through a series of experiments in which fine aggregates were substituted for WFS at various percentages (0%, 5%, 10%, and 15%) in the concrete. The author observed that in terms of strength qualities (compressive strength, modulus of elasticity, and splitting tensile), the 10% of WFS shows about the same value as the control mix. By substituting ordinary sand for WFS at five different percentages (0%, 10%, 20%, 30%, and 40%) by weight, Basar studied the impact of WFS as a partial replacement of fine aggregates (natural sand) on the microstructural, mechanical, and leaching aspects of RMC (ready mix concrete). According to the author, WFS can substitute ordinary sand by 20% without compromising the mechanical and physical characteristics of concrete. Naik studied the behaviour of both fresh and hardened concrete using clean, new foundry sand and waste foundry sand, and by substituting fine particles at 25% and 35% replacement level by weight in the concrete. The author noted that clean/new foundry sand displayed values that were nearly identical to the control mix, while waste foundry sand displayed values that were 20%–30% lower than the control mix.

[3] In 2017, Monosi et al. conducted research on the manufacturing of structural concrete and mortar through the reuse of two different types of waste foundry sand (WFS) collected at two separate phases of the foundry's processing. The author stated that fine aggregates can partially replace these two forms of WFS in mortar and concrete, with replacement levels ranging from 0% to 30%. This method is advantageous for disposal in construction projects. Etxeberria conducted multiple experiments in which fine aggregates were substituted at varying percentages for both chemical and green foundry sand. According to the author, when concrete containing 25%, 50%, or 100% chemical foundry sand was exposed to high temperatures, it demonstrated

superior workability and compressive strength in comparison to traditional concrete. In concrete, Khatib substituted fine aggregates for waste foundry sand in various percentages (0%, 30%, 60%, and 100%). According to the author, as the amount of waste foundry sand in the concrete increased, there was a systematic increase in water absorption, a fall in UPV, and a decrease in compressive strength due to capillary action.

[4] According to Siddique and Singh, WFS is mostly used in concrete and controlled low strength materials (CLSM) with particles sized between 150 and 600 μm. In a similar vein, Prabhu has claimed that WFS with particle sizes ranging from 150 μm to 600 μm can be utilized to make concrete with suitable results. By partially substituting WFS with fine aggregates in concrete from 0% to 50%, the author examined the impact of WFS as fine aggregates in the production process. The results indicated that 20% of waste foundry sand inclusion with fine aggregates could be used effectively in the production of high-quality concrete without compromising concrete standards.

[5] Guney et al. (2018) investigated various influences on the characteristics of concrete and conducted multiple tests on the manufacturing of high strength concrete by substituting waste foundry sand in concrete up to a specific point. According to the author, droop and fluidity decrease as the percentage of WFS increases. In comparison to other combinations, standard concrete (without WFS inclusion) exhibits the largest slumps, measuring 160 mm. Subsequently, there is a systematic decline in strength, with the largest resultant loss recorded at 15% of WFS inclusion in concrete, or 60 mm. The author noted that waste foundry sand contains small particles of a clay type, which reduces the fluidity of concrete and causes a systematic deterioration in strength as the percentage of WFS increases.

[6] In order to examine the characteristics of concrete, Khatib et al. (2018) completely substituted fine aggregates for WFS, or 0%100%). According to the author, slump systematically decreases as the percentage of WFS in concrete increases. The control mix with 0% WFS inclusion, or 200 mm, had the largest slump, which was followed by a systematic decrease in slum to 0% for 100% WFS inclusion in concrete. The author noted that the presence of fine clay particles was responsible for the reduction in slump. Concrete becomes less fluid as a result.

[7] By replacing waste foundry sand with fine aggregates in concrete at predetermined replacement levels up to predetermined percentages, Bilal et al. (2019) examined the properties of the mixture. The author reports almost similar results up to 20% of WFS, or 30 mm, as compared to the control mix, or 32%, and a systematic decrease in slump for up to 31.25% for 40% of WFS as contrasted to the controlled mix. The author also supplied the compaction factor values and reported that, in comparison to the control mix, which had a value of 0.85, the results were almost the same up to 20% of inclusion, or 0.84. After that, the compaction factor steadily dropped to 0.81, or 40% of WFS. The decrease in workability was found to be caused by fine particles detected in waste foundry sand, including ashes, impurities, and clay-type fine particles. Concrete becomes less fluid due to the increased requirement for water caused by these particles.

[8] Prabhu et al. (2019) added fine aggregates to concrete at various replacement levels in place of waste foundry sand in order to examine the mechanical and durability characteristics of the material. According to the author, the highest slump value was recorded at 115 mm for the control mix that contained 0% WFS. The

lowest slump value was recorded at 63 mm for the concrete that contained 50% WFS. The introduction of WFS led to a systematic decrease in slump for all replacement levels, as noted by the author. After 30 minutes, the control mix—96 mm, or 0% WFS—was combined right away. Slump decreased systematically with the addition of WFS for all replacement levels; the lowest slump value was 21 mm for concrete containing 50% of WFS. Following a 60-minute duration, the control mix containing 0% of WFS (51 mm) was seen to be mixed immediately. Slump decreased systematically with WFS addition for all replacement levels; nevertheless, for 50% WFS inclusion in concrete, the lowest slump value was 0 mm.There is a dearth of literature on workability, but what is known from these investigations is that workability systematically decreases when the amount of waste foundry sand in concrete is replaced. Additionally, the value of the compaction factor decreases as the proportion of discarded foundry sand in concrete increases. The presence of tiny clay particles in WFS greatly lowered the fluidity of the concrete, which was the main reason of the drop in slump and compaction factor values in concrete as the percentage increased.

[9] Gadhave, Akshay T. et al. (2020) Regulations on sand extraction have been implemented across India due to environmental concerns raised by excessive dredging, which has a direct financial impact on the manufacture of concrete. Finding a suitable and eco-friendly way to sand is necessary to meet the enormous demand from the concrete production sector. At the same time, up to 40% of waste plastic in India ends up in landfills and is rarely recycled. The long-term environmental problem is the disposal of such compounds, which decompose at extremely low rates, meaning they remain in the environment. The low cost of recycling plastic garbage has a significant impact on the amount of toxins in the environment. The improper disposal of waste foundry sand, a byproduct of the steel casting industry, contributes to environmental problems.

[10] Mushtaq Sheikh Mayesser et al. (2021) Due to its widespread usage as a construction material, concrete has led to an over-exploitation of natural resources, such as river sand and gravel. In the meantime, expanding populations and developing businesses have also led to an enhanced era of waste materials. A large number of those waste materials can be used to make concrete. The impact of one such waste material, known as Waste Foundry Sand (WFS), at concrete homes has been examined in this study. Many researchers have examined the impact of WFS at the mechanical residences of concrete.

Nonetheless, a lack of agreement has been achieved, and there have been reported contradicting outcomes. Furthermore, researchers are no longer as interested in the shrinkage of concrete containing WFS, and there is very little literature available on this feature. This study investigates these concretes' workability, compressive power, split tensile power, and drying shrinkage. WFS was utilized to partially replace the extraordinary combination, with replacement tiers varying from zero to fifty percent in the same increments of ten percent. It was discovered that adding WFS to concrete decreased its cut-up tensile and compressive strengths. On the other hand, the real WFS3 (30% WFS) combination verified a power very similar to manageable concrete. When concrete was manipulated at the age of 28 days, a massive boom of 16.7%, 23.44%, 29.05%, 36.35%, and 45.18% was found to be within the drying shrinkage value, while the amount of WFS in the concrete varied from 10 to 50%. It also became apparent that shrinkage prediction models could not be used to concrete that contained waste foundry sand.

III. MATERIAL SELECTION

The impact of partially replacing fine aggregates with leftover foundry sand containing concrete at different percentages was studied. Moreover, how waste foundry sand affects the mechanical qualities and longevity of concrete.

Cement: Portland pozzolana cement (PCC), which complied with IS 1489-Part1[82], was utilized as the cement. The different physical properties of cement are measured using the following methods as outlined in IS 1489-Part-1.

Natural Sand: The material, which had a nominal maximum fine aggregate size of 4.75 mm, was readily available locally. According to BIS: 383–1970[83], the fine aggregates were evaluated. BIS: 383–1970[83] determined the specific gravity, fineness modulus, water absorption, and sieve analysis.

Coarse Aggregates: The material, which had a nominal maximum fine aggregate size of 4.75 mm, was readily available locally. According to BIS: 383–1970[83], the fine aggregates were evaluated.

Waste Foundry Sand: The leftover foundry sand was supplied in sacks by the cast iron foundry located in Batala, Jalandhar, Punjab. Waste foundry sand was tested in compliance with BIS: 383-1970[83]. The specific gravity, fineness modulus, water absorption, and sieve analysis were measured by BIS: 383–1970[83].

Super Plasticizer: Super plasticizers, also known as water reducers, are produced or utilized in the manufacturing of high-grade concrete. Super plasticizers shorten the concrete's curing time by 30% and lower the amount of water in the concrete. They successfully raise the fresh concrete's performance.

Magnesium Sulphate: The powdered magnesium sulfate was obtained from a nearby pharmacy. It's the mixture that has polycarboxylic ether as its foundation.

Water: A crucial component that aids in giving concrete the necessary strength is water. It needs nearly three-tenths of its water weight to provide the vital function of hydration. A concrete structure may suffer if water is not used in concrete according to the design specifications. Less water used can have an impact on workability, which in turn can have an impact on the mechanical and durability aspects of concrete; more water used can result in bleeding and segregation within the concrete's structure.

• Mix Proportion

• After 28 days of curing, the control mixture (M-1) of concrete was produced with a 40 MPa compressive strength in compliance with Standard Specifications BIS: 10262–1982[84] and BIS 456-2000. More concrete mixtures (M-2, M-3, M-4, M-5, M-6, and M-7) were made by using fine aggregates at weight percentages of 2.5%, 5%, 7.5%, 10%, 12.5%, and 15% with residual foundry sand. For all planned concrete combinations, the water cement ratio is maintained at the same level. The table provides the mix proportion for each type of concrete mixture.

Mix no.	M-1	M-2	M-3	M-4	M-5	M-6	M-7
Cement(kg/m^3)	398.57	398.57	398.57	398.57	398.57	398.57	398.57
Waste foundry sand (%)	0	2.5	5	7.5	10	12.5	15
Waste foundry sand (kg/m^3)	0	21.16	42.34	63.51	84.68	105.85	127.02
Sand (kg/m^3)	850	828.75	807.5	786.25	765	743.75	722.5
W/C	0.35	0.35	0.35	0.35	0.35	0.35	0.35

Water (kg/m^3)	139.5	139.5	139.5	139.5	139.5	139.5	139.5
Coarse aggregates (kg/m^3)	1081.836	1081.836	1081.836	1081.836	1081.836	1081.836	1081.836

Table: Mix design of concrete mix for M40 grade containing waste foundry sand

Specimens Preparation and Casting

The processes of mixing, batching, and casting were carried out with extreme caution. Weighed materials included cement, super plasticizer, coarse and fine aggregates, scrap foundry sand, and water. A fixed amount of waste foundry sand was dry mixed separately to give a uniform color instead of fine particles. To get a consistent hue, the cement, coarse, fine, and waste foundry sand were dry mixed individually. Superplasticizer was individually and in the appropriate quantity applied to water in separate containers. These were combined by hand or mechanically to create a consistent hue on an impermeable surface. The preparation of each concrete mixture sample followed Indian Standard Specifications. BIS: 516–1959.The samples were first allowed to remain in the steel mold at room temperature for a full day. These samples were carefully demolded after a day to prevent breaking at the edges and for proper testing. The samples were then placed in a curing tank that had an ambient temperature of 27± 2 °C and left there to cure for however long the test took or until it was needed.

*All specific details of various tests are given in table.

Results and discussion

Compressive Strength

Test	**Specimen**	**All testing ages**
Compressive strength	150 mm cubes	7, 14 and 28 days
Splitting tensile strength	150 mm cubes	7, 14 and 28 days
Flexural strength	150 mm cubes	7, 14 and 28 days
Sulphate ion resistance	150 mm cubes	14nd 28 days

Concrete's compressive strength gives insight into its properties. This one test can be used to determine whether or not concrete was completed correctly. The primary determinants of concrete's compressive strength are its cement strength, the ratio of water to cement, the quality of the materials used to make it, etc. The strength of concrete mixtures that contained waste foundry sand was nearly equal, and the strength of the concrete rose as the amount of waste foundry sand increased, as indicated in Fig. The improvement in strength was 3.65%, 8.6%, 6.17%, and 3.3% when concrete mixtures M-2 (2.5%), M-3 (5%), M-4 (7.5%), and M-5 (10%) were compared to the control mix without waste foundry sand M-1 (0%) at a curing age of seven days. M-7 (15%) and M-6 (12.5%) concrete mixtures had nearly identical strengths, however there were slight declines of up to 0.13%.

The concrete mixture M-6 (12.5%) demonstrated a slight gain in strength of 0.71% at the 28-day curing age, whereas the concrete mixture M-7 (15%) demonstrated a drop in strength of 3.67%. As opposed to the 42.83 MPa of the control mix M-1 (0%), the concrete mixtures M2 (2.5%), M-3 (5%), M-4 (7.5%), and M-5 (10%) shown improvements in strength of 3.93%, 9.3%, 6.54%, and 5.7%. In comparison to the control mix, which had a strength of 44.37 MPa, concrete mixtures M-2 (2.5%), M-3 (5%), M-4 (7.5), M-5 (10%), and M-6 (12.5%)

shown improvements in strength of 4.87%, 9.45%, 7.8%, 6.27%, and 1.27%, respectively, at 56 days of curing time. A reduction in strength of up to 3.52% was seen in concrete mixture M-7 (15%).Figure makes it simple to see how the values of compressive strength vary. It was revealed that the compressive strength values for M3 (5%) of inclusion exhibited increased strength in comparison to control mix M1 (0%) at all curing ages, and that there was a systematic drop in strength after 5% inclusion of foundry sand for all ages in concrete.

Table Percentage of increment and decrement of compressive strength as compare to control mix

WFS %	7 days	14 days	28 days
0			
2.5	3.65%	3.78%	3.93%
5	8.6%	8.90%	9.3%
7.5	6.17%	6.30%	6.54%
10	3.3%	4.2%	5.7%
12.5	-0.13%	0.29%	0.71%
15	-4.5%	-4.08%	-3.67%

Table Compressive strength versus age

WFS %	7 days (MPa)	14 days (MPa)	28 days (MPa)
0	31.23	31.23	42.83
2.5	32.37	32.37	44.51
5	33.89	33.89	46.81
7.5	33.16	33.16	45.63
10	32.26	32.26	45.25
12.5	31.19	31.19	43.16
15	29.85	29.85	41.26

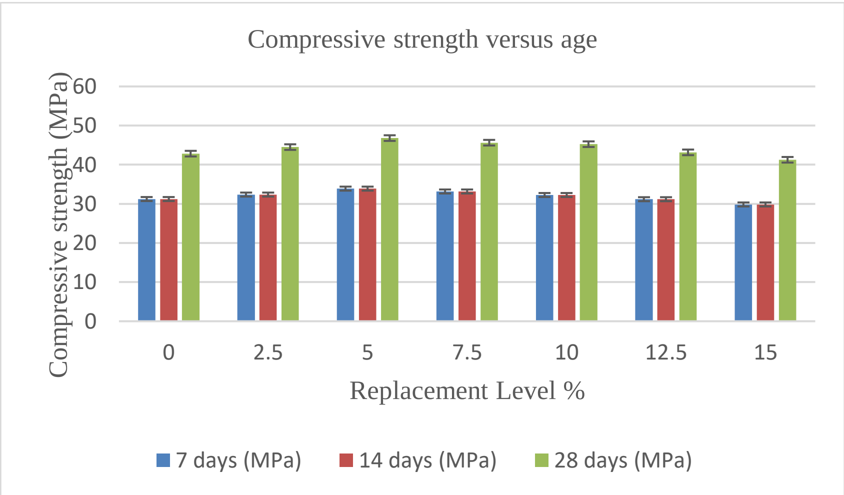

Fig Compressive strength versus age

Splitting Tensile Strength

Tensile strength is one of the basic and crucial properties of concrete that has a big impact on how big cracks get in a construction. Concrete is extremely weak in tension because it is brittle by nature and cannot tolerate direct tension. Consequently, when tensile forces are greater than the tensile strength of concrete, cracks in the concrete elements appear. Splitting tensile strength increases at all of the curing ages shown in the figure when waste foundry sand replacement levels reach a certain threshold. The concrete mixtures M-2 (2.5%), M-3 (5%), M-4 (7.5%), and M-5 (10%) shown improvements in strength of 4.46 percent, 10.8%, 7.97%, and 3.51%, respectively, following seven days of curing. Comparing the concrete mixtures M-7 (15%) and M-7 (12.5%) to the control mix M-1 (0%) revealed roughly the same strength, 1.6%, although the former indicated reductions in strength of 4.78% and 3.24 MPa, respectively.

Table Percentage of increment and decrement of splitting tensile strength as compare to control mix.

WFS %	7 days	14 days	28 days
0			
2.5	4.46%	4.6%	4.8%
5	10.8%	11.08%	11.37%
7.5	7.97%	8.15%	8.34%
10	3.51%	3.76%	4.05%
12.5	1.6%	2.06%	2.53%
15	-4.78%	-4.28%	-3.79%

Following a 28-day curing period, the strength of the concrete mixtures M-2 (2.5%), M-3 (5%), M-4 (7.5%), M-5 (10%), and M-6 (12.5%) increased by 4.8%, 11.37%, 8.34%, 4.05%, and 2.53%, in that order. On the other hand, at 3.96 MPa, the strength of the concrete mixture M-7 (15%) decreased by 3.79% in comparison to the control mix M-1 (0%). The concrete mixtures M2 (2.5%), M-3 (5%), M-4 (7.5%), M-5 (10%), and M-6 (12.5%) demonstrated strength improvements of 5.31, 12.84%, 8.63%, 4.21%, and 3.32%, respectively, following 56 days of curing. On the other hand, the strength of the concrete mixture M-7 (15%) decreased by 3.54% in comparison to M-1 (0%) or 4.52 MPa. The split tensile strength fluctuation is shown in the figure. Strength showed a noticeable rise up to 5% of WFS replacement level; after that, strength at all cure ages continuously dropped. The concrete that had 5% WFS included in it had the maximum strength. Similar findings and observations were reported by Siddique et al. [12], Guney at el. [26], Prabhu et al. [28], Siddique et al. [34], Siddique et al. [40], and Bilal et al. [58].

Siddique et al. [12] reported an increase in strength, or 3.7 MPa and 4.38 MPa with 10% WFS inclusion in concrete at both grades, in comparison to the control mix, which measured 3.42 MPa and 4.32 MPa at 28 days of curing age for both grades of concrete. The author's observations indicate that the split tensile strength of concrete rose with the curing age. Guney at el. [26] observed a rise in split tensile strength and carries maximum strength at 10% of WFS inclusion in concrete, or 3.91 MPa, compared to the control mix after 28 days of curing age, or 3.57 MPa. The author observed that split tensile strength rises with increasing curing age.

According to Prabhu et al. [28], 10% of WFS inclusion in concrete has a marginal decrement of 2.612 MPa in comparison to the control mix's 2.765 MPa, and carries nearly the same strength. The splitting tensile strength of concrete systematically decreased after 10% inclusion of WFS, and the author noted that this strength increased as sample curing age increased. According to Singh & Siddique [34], at 28 days of curing age, the 10%

of inclusion in concrete showed an increase, or 4.64 MPa, and as the percentage of WFS increased, it increased from 3.55% to 10.40% compared to the control mix, which showed 4.21 MPa.

Siddique and colleagues (2019) conducted a series of experiments in which they substituted fine aggregates at varying percentages for WFS. In contrast to the control mix, the author observed a strength improvement of up to 9% from 10% to 30% inclusion of WFS at 28 days of curing ages, or 2.75 MPa. According to Bilal et al.'s [58] observations, there was a slight increase in strength (3.38%) at 10% inclusion of WFS in concrete, as compared to the control mix after 28 days of curing age, or 3.28 MPa. The strength also rises with the proportion, reaching a maximum of 30% of inclusion, or 9.87%.

Table Splitting tensile strength versus age

WFS %	7 days (MPa)	14 days (MPa)	28 days (MPa)
0	3.14	3.50	3.96
2.5	3.28	3.71	4.15
5	3.48	3.94	4.41
7.5	3.39	3.84	4.29
10	3.25	3.68	4.12
12.5	3.19	3.60	4.06
15	2.99	3.40	3.81

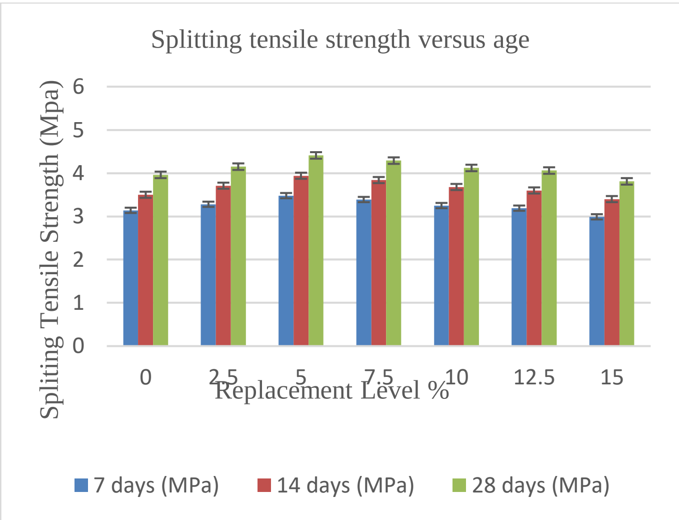

Fig Splitting tensile strength versus age

Flexural strength

Flexural strength, also known as bend strength, transverse of rupture, or modulus of rupture, is a mechanical property of brittle materials. It is the ability of a material to tolerate deformation under different loads. Flexural strength is a basic mechanical property that is connected to compressive and splitting tensile strength. Flexural strength increases as the replacement level of waste foundry sand increases, up to the amount shown in the figure. Following a seven-day curing period, the concrete mixtures with the highest strength increments—

3.46%, 10.09%, 7.21%, 4.33%, and 3.18%—were M-2 (2.5%), M-3 (5%), M-4 (7.5%), M-5 (10%), and M-6 (12.5%). In comparison to the control mix M-1 (0%), or 3.47 MPa, the concrete mixture M-7 (15%) had the greatest strength decline, measuring 4.61%.

Table Percentage of increment and decrement of flexural strength as compare to control mix

WFS %	7 days	14 days	28 days
0			
2.5	3.46%	3.63%	3.81%
5	10.09%	11.18%	12.27%
7.5	7.21%	7.93%	8.66%
10	4.33%	4.80%	5.29%
12.5	3.18%	3.28%	3.39%
15	-4.61%	-4.84%	-5.08%

The concrete mixtures with the highest strength increases, after 28 days of curing, were M-2 (2.5%), M-3 (5%), M-4 (7.5%), M-5 (10%), and M-6 (12.5%). Their respective increments were 3.81%, 12.27%, 8.66%, 5.29%, and 3.39%. In contrast, at 4.73 MPa, the concrete mixture M-7 (15%) displayed the largest strength decrease compared to the control mix M-1 (0%) at 5.08%. Following 56 days of curing, the concrete mixtures with the highest strength increments of 4.92%, 13.26, 10.26%, 7.58%, and 4.93%, respectively, were M-2 (2.5%), M-3 (5%), M-4 (7.5%), M-5 (10%), and M-6 (12.5%). On the other hand, compared to the control mix M-1 (0%), the concrete mixture M-7 (15%) displayed the largest strength decline, measured 5.28 MPa. The flexural strength values vary, as seen in the figure. Strength showed a noticeable rise up to 5% of WFS replacement level; after that, strength at all cure ages continuously dropped. The concrete that had 5% WFS included in it had the maximum strength. Similar findings and observations were reported by Prabhu et al. [28] and Bilal et al. [58].

Prabhu et al. [28] concluded that there was a systematic drop in flexural strength after carrying out a number of studies. At 28 days of curing age, the 10% and 20% WFS inclusions show almost the same strength, 3.986 MPa and 3.988 MPa, respectively, in comparison to the control mix, which is 4.089 MPa. These mix values, however, show less strength than the control mix. 10% addition of WFS in concrete resulted in a minor 3.1% improvement in strength, according to Bilal et al. [58]. At 28 days of curing age (6.15% MPa), the strength grew further as the percentage increased, reaching a maximum of 30% of inclusion (10.15%) in compared to the control mix.

Table Flexural strength versus age

WFS %	7 days (MPa)	14 days (MPa)	28 days (MPa)
0	3.47	4.1	4.73
2.5	3.59	4.25	4.91
5	3.82	4.56	5.31
7.5	3.72	4.43	5.14

10	3.62	4.3	4.98
12.5	3.58	4.23	4.89
15	3.31	3.9	4.49

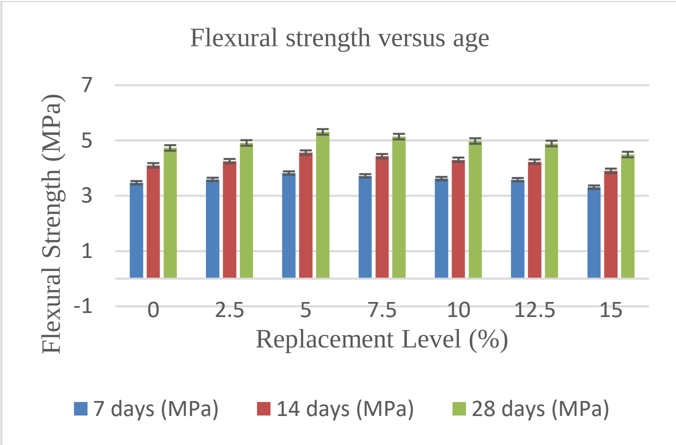

Fig Flexural strength versus age

Durability property

Sulphate Resistance Test

The test for sulphate resistance was conducted using specimens that were 150 x 150 x 150 mm cubes. After casting, the cubes were properly cured in water for a period of 28 days. After 28 days of curing, cubes were immersed in a magnesium sulphate solution, and two more compressive strength tests were carried out at 14 and 28 days of curing.

Conclusion

Ultimately, the experiment successfully demonstrated that waste foundry sand can be substituted for river sand in the creation of paver blocks. It was discovered that the paver blocks created using the leftover foundry sand met or exceeded industry standards with regard to their mechanical, physical, and durability attributes. This addresses the challenges associated with waste management in the foundry industry and offers a sustainable remedy for the depletion of natural resources. In general, the building industry now has a workable and environmentally friendly alternative in the form of paver blocks made from leftover foundry sand, which could lead to the development of more morally and environmentally conscious building techniques in the future.

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