

Effect of Partial Replacement of Stone Dust (SD) With River Sand (RS) On the Mechanical Properties of Interlocking Tiles

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Abstract

Case Studies

Interlocking tiles are masonry units designed to lock together or fit-in along their edges without the need to use mortar for binding the units. Thus, by removing the requirement for mortar in binding the masonry units, interlocking tiles not only offer economy in designs but also maintain environmental sustainability. It is one of the most popular pavements for footpaths, outdoor flooring and landscaping techniques in modern times. The normal interlocking tiles in Nigeria are produced with cement as the binder, stone dust as the fine aggregate and water for hydration. But stone dust is not readily available in every place since it is found in quarries usually located near rock deposits which again cannot be found everywhere. River sand however is much easier to get due to geological activities such as weathering, deposition, and transportation. Consequently, this study sorts to understand the behaviour of interlocking tiles produced with the blending of stone dust and river sand, as a way of making such vital flooring masonry units available in places with less availability of stone dust. Two mix ratios were chosen for the study; 1:3 and 1:6 with a water cement ratio of 0.45. The river sand substitution levels adopted were; 0%, 10%, 20%, 30%, 40%, and 50% as a percentage of total dry weight of stone dust in the mix. Results showed that interlocking tiles have better durability performance when the two aggregate materials; stone dust and river sand, are blended together, than when they are used separately in the production of interlocking tile. It was observed in from the study, from both durability and compressive strength point of view, that the 50% SD + 50% RS outperformed the other replacement levels considered, and thus, is adjudged the optimum blending ratio for interlocking tiles. It was also noted that the 1:3 mix ratio performed better than 1:6 mix ratio both in durability and in compressive strength.

Keywords: Interlocking, Tiles, mechanical properties, Stone dust, River sand.

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1: Introduction:

Interlocking tiles are masonry units designed to lock together or fit-in along their edges without the need to use mortar for binding the units. Interlocking tiles can be made of bricks, or concrete. It is one of the most popular pavements for footpath, outdoor flooring and landscaping

techniques in modern times. Interlocking tiles are produced in different shapes and patterns, designed to fit-in together without the need of cement mortar for binding the units. The load applied at any given location is distributed across nearby tiles, and is thus ideal for managing vehicular movement, heavy load, and regular



traffic. Unlike conventional masonry pavers that rely on edge restraint for their stability, interlocking tile develop formidable stability from their locking system. It is easy to maintain a damaged interlocking tile by just replacing the individual tile without affecting the surrounding tile, thereby making repair work faster, easier and cheaper. Interlocking tiles also has the advantage of draining water through the joints, and thus solving the issue of waterlogging that damages most pavements. By removing the requirement for mortar in binding the masonry units, interlocking tiles not only offer economy in designs but also environmental sustainability. It is in view of the fore-going assertion that this topic “effect of partial replacement of stone dust with river sand on the mechanical properties of interlocking blocks” was chosen for study. The normal interlocking tiles in Nigeria are produced with cement as the binder, stone dust as the fine aggregate and water for hydration. But stone dust is not readily available in every place since it is found in quarries usually located near rock deposits which again cannot be found everywhere. River sand however is much easier to get due to geological activities such as weathering, deposition, and transportation. Consequently, this study seeks to understand the behaviour of interlocking tiles produced with the blending of stone dust and river sand, as a way of making such vital flooring masonry unit available in places with less availability of stone dust.

2. 0: Background Study:

Owing to its less requirement for manpower, efficiency, and improved productivity rate, the application of interlocking masonry has witnessed increased growth in the last few decades, (Al-Fakih et al, (2018), and Edwards et al, (2010)). Interlocking block has a lot of advantages such as; improved structural integrity, enhanced quality, lesser construction time, however, its structural behavior is still not adequately known as a result of mechanism of interconnection and changing geometry, Nasim et al (2025). Ahmed et al, (2022) carried out a review on design and properties of various types of interlocking concrete blocks. The study summarized the factors imparting on the

compressive strength of interlocking concrete tiles to include; the water-cement ratio, type and ratio of inclusion of additives in the mix, the source, age, and replacement ratio of recycled aggregates, among other things. It noted that the compressive strength of interlocking concrete blocks reduces with increasing water cement ratio, and higher percentage inclusion of recycled aggregates. Meghana et al, (2018), undertook a comparative study on interlocking masonry block and the traditional brick masonry. The two masonry units were subjected to physical and mechanical tests. Results of the study showed that the interlocking masonry block outperformed the traditional bricks in compressive strength, water absorption, modulus of elasticity, shear strength and in other physical and mechanical properties. Sojobi (2016), sort to determine the potency of sawdust waste as a substitute for fine aggregate, while using laterite as cementitious material for the production of lightweight interlocking masonry unit, for pavements. Shi et al, (2021), conducted a research on the compressive strength of interlocking blocks by numerical and experimental methods. ABAQU was used to produce a 3D prism model of the masonry unit. Modes of failure and stress concentration of the interlocking surfaces were studied using the two methods. The study produced by curve fitting of the parameters investigated in the study, a formular for determining the compressive strength of interlocking brick prisms. Parinita et al, (2020), undertook a research to determine the impact of additives on the compressive strength of interlocking concrete tiles. M35 concrete made with standard superplasticizer as an admixture was adopted in the study. The study revealed that additives such as superplasticizers have significant effects on the compressive strength of concrete interlocking tiles. A recommendation was made to add between 1.45 to 1.48% by weight of the total mass of concrete, to achieve optimum compressive strength. Muizzatun et al, (2022), reported an upgrade in the mechanical properties of interlocking hollow blocks with the addition 2% fly ash as percentage of cement in the concrete mix, with the specimens recording a maximum compressive strength of 10 MPa. Lee et al, (2003) noted in a study on the performance of concrete tiles admixed with pigments, that compressive

strength of interlocking blocks could be enhanced if dyed with iron pigments. Vipin, (2019), in an effort to produce light weight interlocking blocks for temporary structures, studied the impact of fly ash mixed with stone dust on the mechanical properties of interlocking blocks. The compressive strength, and the water absorption capacity of the specimens were compared with that of a traditional burnt brick. The study revealed that the interlocking tiles produced with various blends of fly ash, and stone dust gave a better performance both in compressive strength and durability. Deepak (2012) in a study on Hydraform interlocking, opined that creating grooves inside a block can enhance its mechanical performance. Karasawa et al, (2003), studied the effectiveness of fly ash as an alternative to fine aggregate in outdoor concrete pavement blocks. The result revealed 25% optimum substitution of fine aggregates with fly ash, at which level, a flexural strength of 6 MPa and a record low value of plastic deformation of 1mm was achieved. Nasim et al (2025), studied the performance of light weight interlocking blocks using adhesive pastes to substitute for mortar while using grout and rebar as reinforcing elements. It was noted from the findings of the study that applying loads perpendicular to the longitudinal axis of the rebar improves ductility and capacity of the block, compared to when grout was used as reinforcement. It was also noted that rebar improves flexural and shear capacity of the interlocking blocks, while grout enhances diagonal tension and compression capacity. Kasinikota and Deb-Dulai, (2022), also investigated the impact of grout and rebar reinforcing elements on the out-of-plane flexural performance of walls build with normal-weight interlocking blocks. It was noted in the findings that both rebar and grout reinforcements enhance the flexural performance of wall.

3.0: Material and Methods:

3.1: Materials:

The cement used for this experimental study is ordinary Portland cement (OPC), conforming to BS EN 197 – 1:2011. The cement plays the role of binder in the mix. It was stored in cool dry place, maintaining all the storage protocols

specified in the code of practices to prevent carbonation and ingestion of moisture which could affect results of the study. The stone dust is the traditional fine aggregate in the mix, which will be replaced with river sand at various levels. The organic matters present in the samples were removed. All standard procedure for preparing sand samples were observed, including oven drying at 105°C for 24 hours and gradually cooling in a desiccator to avoid re-entrainment of moisture. The stone dust used for the study is considered waste remnant of granite crushing process. It has reasonable percentage of fractions with fines below 75 micrometers. It was screened to removed organic materials that may affect results of the test, and dried, cooled and stored in similar way as the river sand. Portable water conforming to BS EN 1008:2002 was used for the study, for proper curing and hydration. The water was sufficiently clean, free from contaminants such as organic matters and sulphate contents that may affect hydration process and impair results of the study. All the materials were sourced locally, from the building material Dealers in Ilaro community where the research was carried out.

3.2 Research Methods:

The study applies experimental methods with a controlled laboratory procedure to establish the relationship between the substitution of stone dust content and the properties of interlocking blocks. The approach to accomplishing the set goals involved; characterization of the materials (such as the grading of the aggregates, moisture content, specific gravity, bulking, and bulk density), development of mix design, preparation of the test samples, and the sample testing. The quantity of stone dust in the sample mix is the independent variable. The level of substitutions ranges from 0% to 50% at 10% intervals, giving us; 0%, 10%, 20% 30%, 40% and 50% substitution levels. The dependent variables are the physical properties (such as the water absorption capacity and the density of the interlocking blocks), and mechanical property (the compressive strength). There are equally control variable such as; the water- cement ratio, batching technique, production process, and the curing process. All the experimental procedure

undertaken in this study were carried out in accordance with the relevant British standard codes of practice to ensure uniformity and

industrial relevance. Results of the study are presented in section 4.



Figure 1: Casting of the Interlocking Tiles

3.3: Manufacturing and curing the interlocking blocks:

A standard 60mm x 80mm x 100mm commercial size interlocking tiles specimens were produced for the tests, with a 1: 3, and 1: 6 mix ratios representing the proportions by weight of cement and the fine aggregates respective. The 1:3 for the load bearing floors and the 1:6 for the non-load bearing tiles. The water cement ratio of 0.45 was maintained constant throughout the test. The river sand substitution levels are; 0%, 10%, 20%, 30%, 40%, and 50% as a percentage of total dry weight of stone dust in the mix. Material proportioning was carried out by weight batching, taking into account the specific gravity and the moisture content of the aggregates, in order to maintain a constant water-cement ratio.

In addition to cleaning the mould before casting, a thin layer of mineral oil was lightly rubbed on the inside of the moulds to act as release agents and for a quality surface finish. The mixing was thorough in order to produce a homogeneous mix. The pouring was done in three layers, with each layer tamped with a tamping rod to remove the voids by expelling the entrapped air in the mix. The same number of strokes was applied to each of the three layers. The top was levelled and smoothed, after which a plastic sheet was used to cover the specimens to avoid uneven hydration as result of excessive loss of moisture by evaporation. The cast specimens were left for 24 hours to gain the early strength that can enable it to be handled without getting damaged. The demoulding was carefully done to

remove the specimens from the moulds. The specimens were cured in line with provisions of BS EN 12390-2:2009 for 7days, 14days, 21days, and 28day. The fresh sample was tested for slump in line with BS EN 12350-2:2009, while the hardened specimens were tested for water absorption in line with BS EN 772-11:2011, compressive strength in line with BS EN 12390-3:2009, and density in line with BS EN 12390-

7:2009. The results of the above tests are presented in section 4.

4.0: Results and Discussions:

The results of the study are hereby presented and discussed.

4.1: Material Properties

Table 1: Sieve Analysis of 100% River Sand

| Dia (mm) | Soil Retained (g) | Cumulative Soil Retained | Soil Retained (%) | Cumulative % Retained | Soil Passing |
|----------|-------------------|--------------------------|-------------------|-----------------------|--------------|
| 4.75 | 13 | 13 | 5.49 | 5.49 | 94.51 |
| 2.36 | 31 | 44 | 13.08 | 18.57 | 81.43 |
| 1.18 | 56 | 100 | 23.63 | 42.19 | 57.81 |
| 0.6 | 59 | 159 | 24.89 | 67.09 | 32.91 |
| 0.3 | 47 | 206 | 19.83 | 86.92 | 13.08 |
| 0.15 | 23 | 229 | 9.70 | 96.62 | 3.38 |
| 0.075 | 6 | 235 | 2.53 | 99.16 | 0.84 |
| Pan | 2 | 237 | 0.84 | 100.00 | 0.00 |
| Total | 237 | | | | |
| | | | FM | 4.16 | |

The River sand falls in zone 2 grading with a Finess Modulus of 4.16 which is above the range of 2.3 – 3.1 stipulated in BS 882 (1992), and thus, it is categorized as coarse sand. It has a coefficient of uniformity of 5.23 which is broad enough in its particle variation, as it is above the minimum of 3.0 stated in the code, and a coefficient of curvature of 0.87 just a little below

the 1.0 minimum specified in the code. With this grading properties, we see that the river sand though coarse, has a broad range of particle variation to minimize void. It is also relatively uniformly graded, and can make a good concrete if blended with finer fractions. The grading curve of 100% river sand is presented in Figure 2.

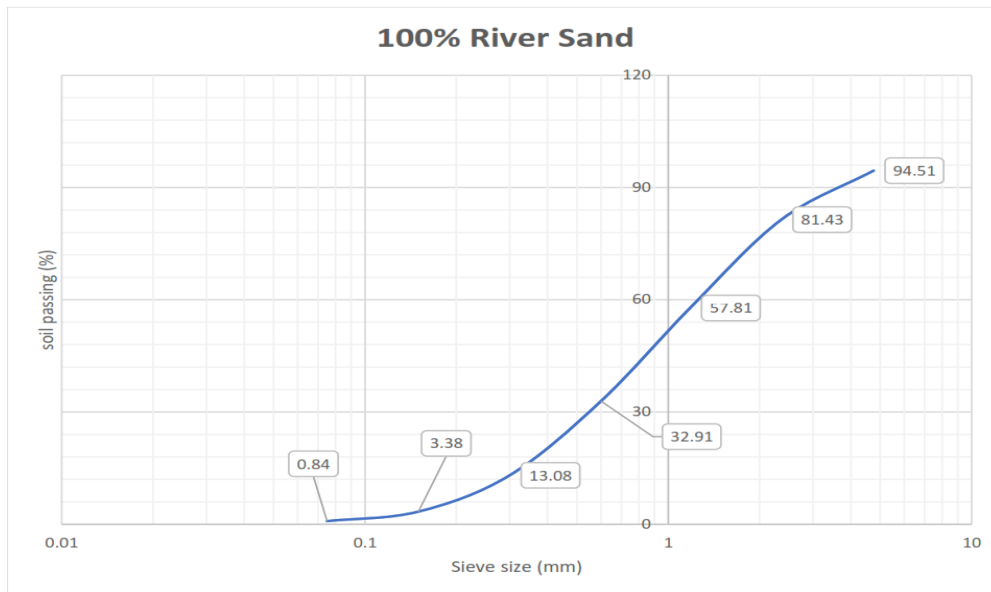


Figure 2: Grading Curve of 100% River Sand

| Dia. (mm) | Soil Retained (g) | Cum. Soil Retained | Soil Retained (%) | Cum. % Retained | Soil Passing |
|-----------|-------------------|--------------------|-------------------|-----------------|--------------|
| 4.75 | 69 | 69 | 23.5 | 23.5 | 76.5 |
| 2.36 | 31 | 100 | 11 | 34.1 | 65.9 |
| 1.18 | 56 | 156 | 19.1 | 53.2 | 46.8 |
| 0.6 | 59 | 215 | 20.1 | 73.4 | 26.6 |
| 0.3 | 47 | 262 | 16.0 | 89.4 | 10.6 |
| 0.15 | 23 | 285 | 7.8 | 97.3 | 2.7 |
| 0.075 | 6 | 291 | 2.0 | 99.3 | 0.7 |
| Pan | 2 | 293 | 0.84 | 100 | 0 |
| Total | 293 | | | | Fm = 4.70 |

From sieve analysis of stone dust as presented in Table 2, the Finess Modulus is 4.7, a figure way bigger the recommended value range of range of 2.3–3.1 in BS 882 (1992), and thus, it is categorized as coarse fine aggregate material, with very low fraction of the particles passing 600 μm sieve size. It has a coefficient of

uniformity of 3.93 which is broad enough in its particle variation, as it is above the limit of 3.0 stated in the code, and a coefficient of curvature of 1.02 above the 1.0 minimum specified in the code. With this grading properties, we see that the stone dust though coarse, has a broad range of particle variation to minimize void and it is

well-graded, and can make a good concrete if blended with finer fractions. The angular nature of the stone dust is a big advantage for creating a good bond in the interlocking tiles, even though

the workability may suffer if the mix design is not properly managed by blending with finer materials. The grading curve of stone dust is presented in Figure 3.

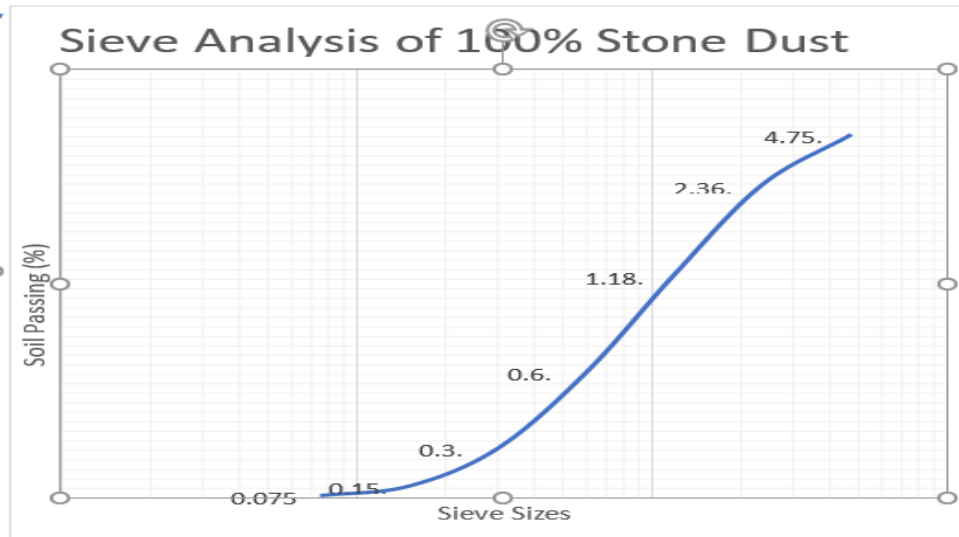


Figure 3: Grading curve of 100% Stone Dust + 0% River Sand

Table 3 presents the full results of the material grading properties based on the substitution level of stone dust in the mix.

| Table 3: Summary of grading properties of the blended aggregates at various substitution levels | | | |
|---|-------------|---------------------------|--------------------------|
| Replacement (%) | Finess Mod. | Coefficient of Uniformity | Coefficient of Curvature |
| 100% River Sand | 4.16 | 5.23 | 0,87 |
| 90% Stone Dust + 10% River Sand | 4.09 | 5.66 | 0.78 |
| 80% Stone Dust + 20% River Sand | 4.40 | 9.37 | 0.7 |

| | | | |
|---------------------------------|------|--------------|------|
| 70% Stone Dust + 30% River Sand | 4.42 | 10.64 | 0,62 |
| 60% Stone Dust + 40% River Sand | 4.42 | 11.89 | 0.6 |
| 50% Stone Dust + 50% River Sand | 4.57 | 11.74 | 0.92 |
| 100% Stone Dust | 4.70 | 3.93 | 1.02 |

From Table 3, it is observed that all the aggregates are sufficiently coarse, with Finess moduli ranging from 4.09 for 90% Stone Dust + 10% River Sand, to 0 4.7 for 100% Stone Dust. The coefficient of uniformity ranges from 3.93 for 100% Stone Dust to 11.89 for 50% Stone Dust + 50% River Sand, showing that the aggregates have a good range of particle variation to minimize voids, and thus are well graded according to BS EN 933-1:1997. The coefficient of curvature ranges from 0.6 for 60% Stone Dust + 40% River Sand, to 1.02 for 100%

Stone Dust, an indication that the aggregates are moderately uniform in grading, apart from 100% Stone Dust which has Cc of 1.02 above 1.0 limit for a well graded aggregate. With this grading, a carefully controlled mix design is required in order to meet up with the workability standard required for a durable concrete.

Table 4 presents the full results of the material properties based on the substitution level of stone dust in the mix.

Table 4: Physical Properties of the Blended Stone Dust and River Sand Mixes

| Replacement (%) | Finess | | Moisture Silt | | Bulk Density | Bulky Test |
|----------------------|--------|------------------|---------------|------|----------------------|------------|
| | Mo | Specific Gravity | (%) | (%) | (kg/m ³) | (%) |
| 100% River Sand | 4.16 | 2.63 | 2.2 | 11.4 | 1550 | 9.89 |
| 90% Stone Dust + 10% | 4.09 | 2.65 | 2.0 | 7.51 | 1600 | 3.21 |
| 80% Stone Dust + 20% | 4.40 | 2.67 | 1.8 | 8.22 | 1650 | 3.89 |
| 70% Stone Dust + 30% | 4.42 | 2.68 | 1.6 | 8.68 | 1680 | 4.23 |

| | | | | | | |
|----------------------|------|------|-----|------|------|------|
| 60% Stone Dust + 40% | 4.42 | 2.69 | 1.4 | 8.21 | 1710 | 4.56 |
| 50% Stone Dust + 50% | 4.57 | 2.71 | 1.2 | 9.22 | 1740 | 5.45 |
| 100% Stone Dust | 4.70 | 2.74 | 0.9 | 7.1 | 1780 | 2.04 |

The specific gravity ranges from 2.63 for 100% River Sand to 2.74. There is a linear increase in specific gravity as the percentage substitution of stone dust with river sand increases. The values are in line with the recommended value range of specific gravity for fine aggregates as specified in BS EN 1097-6:200. Percentage of Silt rose from 7.1 for 100% stone dust to 11.4 for 100% River Sand, with optimum substitution being 90% stone dust + 10% River Sand which gave a silt content of 7.51, below the 8.0 threshold required to make a good concrete according to BS 882:1992. Moisture content ranges from 0.9 for 100% Stone Dust to 2.2 for 100% River Sand. This value will be used to adjust the w/c ratio in order to maintain the same water content in the mix. Bulking value

ranges from 2.0% for 100% stone dust to 9.89 for 100% River Sand. All the values are well below the 15% limit specified in BS 812 Part 2. The loose bulk density ranges from 1550kg/m³ to 1780kg/m³ which are also within the limit of 1200kg/m³ to 1800kg/m³ for light weight aggregates. It is observed from that above data that with proper control the chosen aggregates can make a good concrete.

4.2: Properties of the Fresh Interlocking Tiles

The results obtained from the slump test are presented in Table 5 and Figure 3, and are discussed below.

Table 5: Slump (mm) of the Interlocking Tiles for Various Replacement Levels

| Replacement (%) | 1:3 Slump (mm) | 1:6 Slump (mm) |
|-----------------|----------------|----------------|
| 100% Stone Dust | 43 | 54 |
| 90% SD + 10% RS | 51 | 62 |
| 80% SD + 20% RS | 54 | 66 |
| 70% SD + 30% RS | 58 | 69 |
| 60% SD + 40% RS | 64 | 76 |
| 50% SD + 50% RS | 69 | 81 |
| 100% River Sand | 73 | 86 |

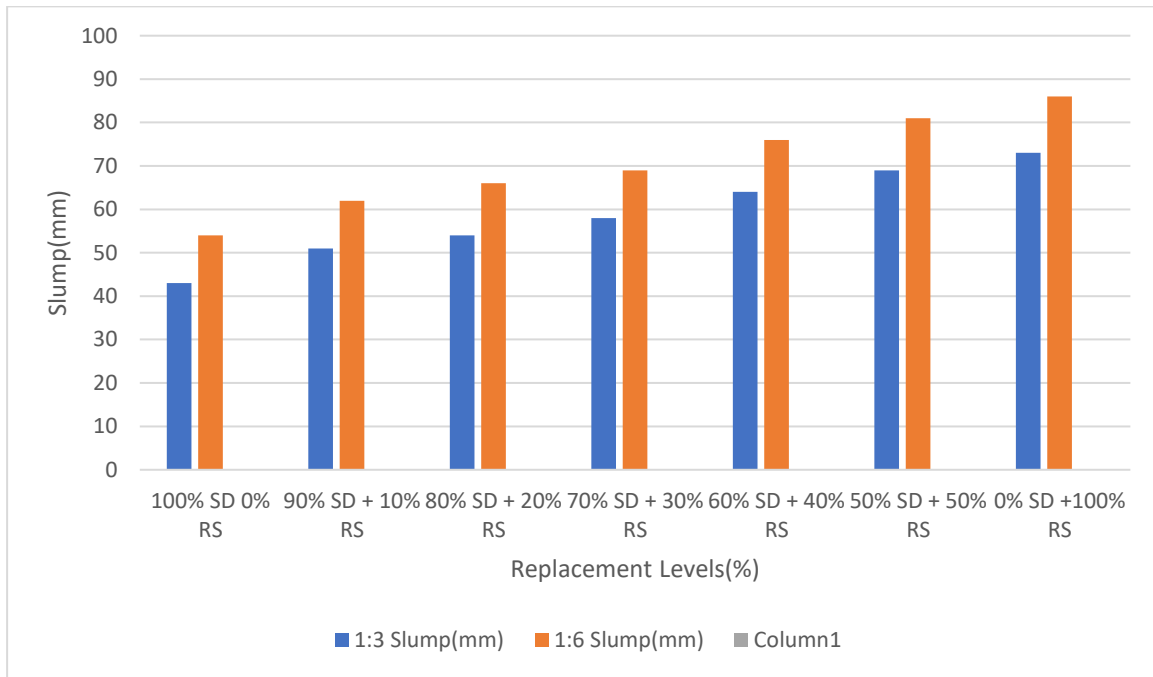


Figure 4: Variation of Slump with Replacement Levels Quarry Dust in the Interlocking Tiles

Figure 5 presents the variation of slump with replacement levels of quarry dust in the interlocking tiles for the two mix ratios considered (1:3 and 1:6). It shows that the slump increases as the quantity of stone dust in the mix decreases. The slump also increases with increasing mix ratio, as 1:6 produced higher slump than 1:3 across the replacement levels. The slump achieved by 1:3 mix was 43mm for 100% Stone Dust + 0% River sand. This value increased to 51mm for 90% Stone Dust + 10% River sand, and to a maximum of 73mm for 0% Stone Dust + 100% River sand. Similarly, the slump achieved by 1:6 mix was 54mm for 100% Stone Dust + 0% River sand. This value increased to 62mm for 90% Stone Dust + 10% River sand,

and to a maximum of 86mm for 0% Stone Dust + 100% River sand. Generally, the slump produced by the two mixes across all the replacement levels are okay for regular construction, considering specifications in BS EN 12350 – 2:2000.

4.2: Properties of the Hardened Interlocking Tiles

5.2.1: The Water Absorption Test Results

The results of water absorption test are presented in Table 6, and are discussed below.

Table 6: Water Absorption of Interlocking Concrete Blocks at Different Replacement Levels and Curing Ages for (m % Stone Dust + n% River).

| Replacement (%) | Mix Ratio | 7 Days (%) | 14 Days (%) | 21 Days (%) | 28 Days (%) |
|-----------------|-----------|------------|-------------|-------------|-------------|
| 100% Stone Dust | 1:3 | 4.72 | 4.51 | 4.33 | 4.12 |
| | 1:6 | 5.68 | 5.41 | 5.19 | 4.96 |

| | | | | | |
|----------------------------|-----|------|------|------|------|
| 90% Stone Dust + 10% River | 1:3 | 4.32 | 4.15 | 3.98 | 3.82 |
| | 1:6 | 4.88 | 4.65 | 4.43 | 4.26 |
| 80% Stone Dust + 20% River | 1:3 | 4.21 | 4.05 | 3.89 | 3.71 |
| | 1:6 | 4.45 | 4.26 | 4.07 | 3.89 |
| 70% Stone Dust + 30% River | 1:3 | 4.15 | 3.98 | 3.81 | 3.65 |
| | 1:6 | 4.31 | 4.14 | 3.98 | 3.80 |
| 50% Stone Dust + 50% River | 1:3 | 3.78 | 3.62 | 3.47 | 3.31 |
| | 1:6 | 4.09 | 3.91 | 3.75 | 3.58 |
| 100% River Sand | 1:3 | 4.35 | 4.17 | 4.00 | 3.83 |
| | 1:6 | 4.67 | 4.48 | 4.29 | 4.11 |

Table 6 presents the variation of Water absorption with replacement levels of stone dust in the interlocking tiles for the two mix ratios considered (1:3 and 1:6), and at various ages; 7days, 14days, 21days and 28days. The water absorption for 1:6 was higher than that of 1:3 across all ages and for all the replacement levels. For the 1:3 mix ratio, as the quantity of stone dust decreases, the water absorption decreases. At age 7days, water absorption decreased from 4.72% for 100%SD + 0% RS to 4.32% at 90%SD + 10% RS, and then decreased steadily to 3.78% at 50%SD + 50% replacement. The trend is

maintained for all ages of the specimens; 14 days, 21 days, and 28 Days. There is a repeat of the same trend for 1:6 mix ratio. These results show that the two materials perform better in durability when blended together, than when they are used separately for the production of interlocking tiles. The study revealed an optimum replacement of 50% SD + 50% RS for better durability of interlocking tiles. It also revealed that durability improves with age of curing across all replacement levels and for the two mix ratios. It was also noted that 1:3 produced more durable tiles than 1:6 mix ratio.

5.2.2: Results of the Compressive Strength of the Interlocking Tiles

Table 7: Compressive Strength of Interlocking Tiles (Stone Dust + River Sand, 1:3 Mix Ratio)

| Replacement (%) | 7 Days (MPa) | 14 Days (MPa) | 21 Days (MPa) | 28 Days (MPa) |
|-----------------|--------------|---------------|---------------|---------------|
| 100% Stone Dust | 32.416 | 44.362 | 13.425 | 42.352 |
| 90% + 10% RS | 41.651 | 43.226 | 15.542 | 20.201 |
| 80% + 20% RS | 34.163 | 62.187 | 14.452 | 18.132 |

| | | | | |
|--------------|--------|--------|--------|--------|
| 70% + 30% RS | 21.310 | 32.325 | 19.341 | 26.257 |
| 60% + 40% RS | 20.101 | 47.139 | 14.213 | 24.216 |
| 50% + 50% RS | 30.124 | 33.146 | 29.170 | 30.031 |

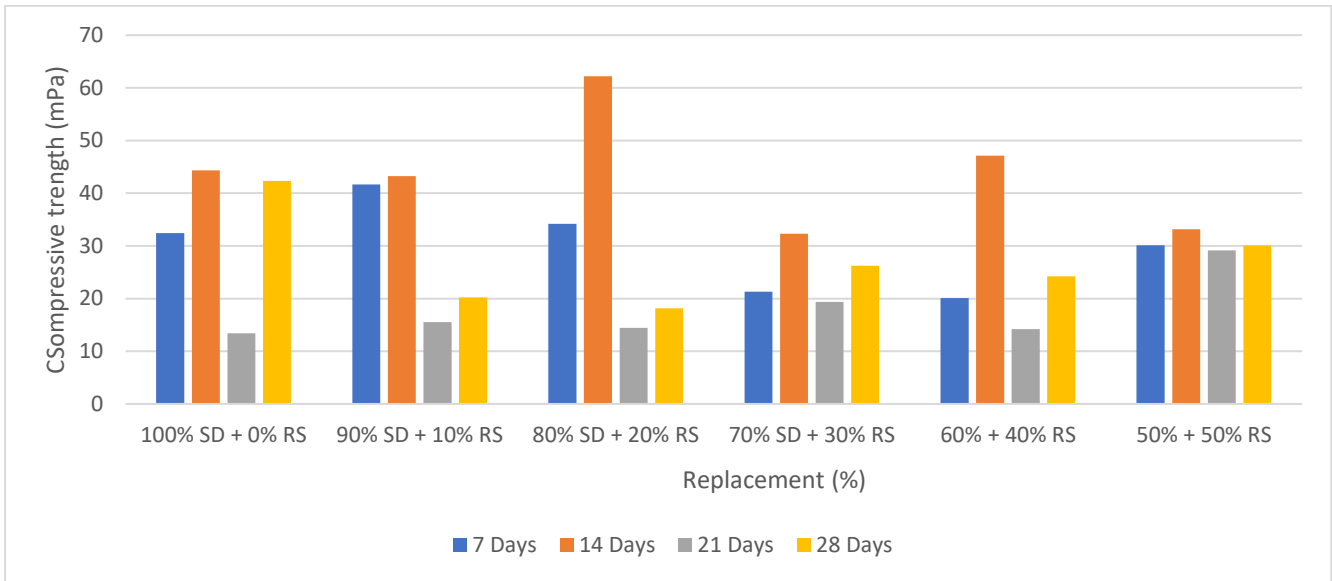


Figure 5: Compressive Strength of Interlocking Tiles (Stone Dust + River Sand, 1:3 Mix Ratio)

The compressive strength of the interlocking tiles for 1:3 mix ratio at various ages (7 Days, 14 Days, 21 Days, and 28 Days) for the replacement levels considered, are presented in Table 7 and Figure 5. There is a clear early strength gain for all the replacement levels. 100% SD + 0% RS had a strength gain of 32.416 mPa at 7 days to 44.364 mPa at 14 days, and then decreased to 13.425 mPa at 21 day before rising again to 42.352 mPa at 28days. 90% SD + 10% RS rose from 41.652mPa at 7 days to 43.220 mPa at 14 days, and then dropped to 15.542 mPa at 21 day before rising again to 20.201 mPa at 28days. This trend was maintained to 50% SD + 50% RS, which increased from 30.124 mPa at 7 days to 33.146 mPa at 14 days representing 10.3% increase, and then decreased to 29.17 mPa representing 12.0% drop at 21 day before rising

again to 30.30.031 mPa representing 2.95% increase at 28days. Only 50% SD + 50% RS gave that gradual and consistent rise and fall in the value of compressive strength of the tiles, as the rest replacements showed abrupt rise and fall in compressive strength probably due to inadequate blending of the two particles. It was also observed that the 50% SD + 50% RS outperformed the other replacement ratios considered even though its compressive strength ranked below the control 100% SD + 0% RS. The enhanced performance of 50% SD + 50% RS in the study might be due to better blending of the two aggregate materials and more uniform hydration of matrix. The 28 days strength of 30.031 mPa achieved by 50% SD + 50% RS is reasonable enough for regular constructions.

Table 8: Compressive Strength of Interlocking Tiles (Stone Dust + River Sand, 1:6 Mix Ratio)

| Replacement (%) | 7 Days (MPa) | 14 Days (MPa) | 21 Days (MPa) | 28 Days (MPa) |
|-----------------|--------------|---------------|---------------|---------------|
| 100% Stone Dust | 22.514 | 30.798 | 11.011 | 28.562 |
| 90% + 10% RS | 28.232 | 29.828 | 12.452 | 18.299 |
| 80% + 20% RS | 25.746 | 42.366 | 13.524 | 17.433 |
| 70% + 30% RS | 17.328 | 25.121 | 15.768 | 20.545 |
| 60% + 40% RS | 14.228 | 32.132 | 13.899 | 19.234 |
| 50% + 50% RS | 21.657 | 25.817 | 21.445 | 24.199 |

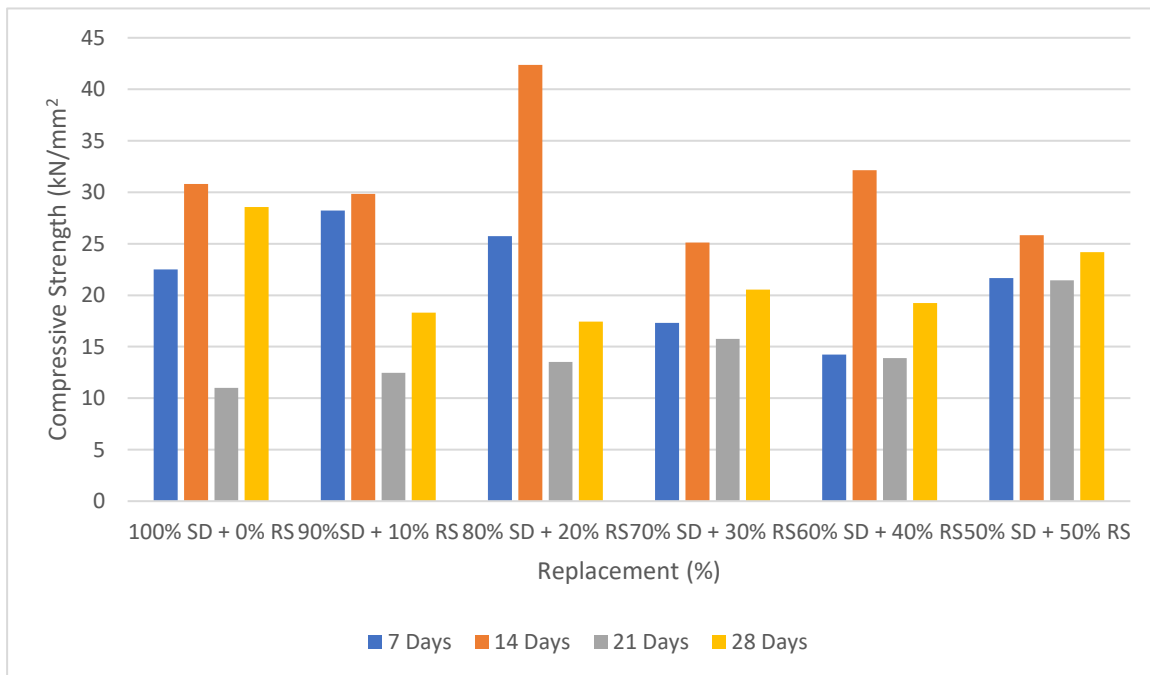


Figure 6: Compressive Strength of Interlocking Tiles (Stone Dust + River Sand, 1:6 Mix Ratio)

The compressive strength of the interlocking tiles for 1:6 mix ratio at various ages (7 Days, 14 Days, 21 Days, and 28 Days) for the replacement levels considered, are presented in Table 8 and Figure 6. The performance followed the same pattern as that of 1:3. 100% SD + 0% RS had a strength gain of 22.514 mPa at 7 days to 30.798 mPa at 14 days, and then decreased to 11.011mPa at 21 day before rising again to 28.562 mPa at 28days. 90% SD + 10% RS rose from 28.232mPa at 7 days to 29.828 mPa at 14

days, and then dropped to 12.453 mPa at 21 day before rising again to 18.299 mPa at 28days. This trend was maintained to 50% SD + 50% RS, which increased from 21.657 mPa at 7 days to 25.817 mPa at 14 days representing 19.2% increase, and then decreased to 21.445 mPa representing 20.40% drop at 21 day before rising again to 24.199 mPa representing 12.8% increase at 28days. Again only 50% SD + 50% RS gave that gradual and consistent rise and fall in the value of compressive strength of the tiles,

as the rest replacements showed abrupt rise and fall in compressive strength probably due to inadequate blending of the two particles. It was also observed that the 50% SD + 50% RS outperformed the other replacement ratios considered even though its compressive strength ranked below the control 100% SD + 0% RS, as was the case in 1:3 mix ratio. The enhanced performance of 50% SD + 50% RS in the study might be due to better blending of the two aggregate materials (the stone dust and the river sand). The 28 days strength of 24.199 mPa achieved by 50% SD + 50% RS is also reasonable for regular constructions.

5.0: Conclusions and Recommendations

5.1: Conclusions:

From results of the study, the following conclusions are made;

1. The interlocking tiles have better durability performance when the two aggregate materials; stone dust and river sand, are blended together, than when they are used separately in the production of interlocking tile.
2. It was observed that durability of the interlocking tiles was a function of age, improving with the age of the tile when proper curing is carried out.
3. It was noted in the study, an early strength gain for the two mix ratios studied and for all the replacement levels considered, after which there was an abrupt decrease in strength before eventually rising again at 28 days strength.
4. From both durability and compressive strength point of view, the 50% SD + 50% RS outperformed the other replacement levels considered, and thus, is adjudged the optimum blending ratio for interlocking tiles.
5. As expected, the 1:3 mix ratio outperformed the 1:6 mix ratio in both durability and compressive strength.

5.2: Recommendations:

The following recommendations are made from the study;

1. For places where stone dust is not readily available for the production of interlocking tiles, the stone dust maybe blended with river sand at 50%/50% ratio as fine aggregate, for better durability and enhanced compressive strength performance.
2. More research is required at understanding the effect of curing methods, on the mechanical properties of interlocking tiles.

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