# PROPERTIES OF BRICK AGGREGATE CONCRETE CONTAINING SLAB DEMOLISHED WASTE AS A PARTIAL REPLACEMENT OF COARSE AGGREGATE

**M. K. Hossain[1], M. A. Noaman[2], T. N. Aishee*[3], M. K. H. Kawsar[4] and M. R. Karim[5]**

[1] *Undergraduate Student, DUET, Gazipur, Bangladesh, e-mail: khce.duet@gmail.com*
[2] *Postgraduate Student, DUET, Gazipur, Bangladesh, e-mail: noamance07@gmail.com*
[3] *Assistant Professor, DUET, Gazipur, Bangladesh, e-mail: tnaishee@duet.ac.bd **
[4] *Postgraduate Student, DUET, Gazipur, Bangladesh, e-mail: kawsar.ce.duet@gmail.com*
[5] *Professor, DUET, Gazipur, Bangladesh, e-mail: rezaul@duet.ac.bd*

***Corresponding Author**

## ABSTRACT

The increasing demand for construction materials and the necessity to minimize waste disposal have drawn interest in alternative materials. Using recycled materials, particularly slab demolished waste (SDW), in brick aggregate concrete (BAC) offers a promising and sustainable solution to conserve natural aggregates and reduce construction waste. Therefore, the objective of this study is to determine the properties of BAC containing slab demolished waste (BSDW) as a partial replacement of coarse aggregate (CA). To achieve this, discarded SDW was collected and used as coarse aggregate. Material properties were tested and complied with relevant standard requirements. Concrete was prepared with a volumetric mix of 1:1.5:3 (cement: fine aggregate: coarse aggregate) and a water-to-cement ratio of 0.50. SDW was partially replaced with crushed brick aggregate at 10%, 15%, 20%, and 25% by volume. The fresh property of BSDW was measured for workability (slump) and then cylindrical (100 × 200 mm) and prismatic (150 × 150 × 600 mm) specimens of BSDW were cast and tested for hardened density, mechanical properties (compressive strength, split tensile strength, flexural strength, modulus of elasticity, and Poisson's ratio), and durability (water absorption and porosity) at several curing ages. Test results indicated that the workability and hardened density of BSDW improved as SDW content increased. The compressive strength of BSDW was enhanced with SDW replacement up to 20%, while the optimum strength was obtained at 15% replacement compared to the control BAC, regardless of curing age. After 28 days, split tensile strength peaked at 15% replacement, although an overall improvement was observed up to 20%. Flexural strength showed a gradual increase with increasing SDW content up to 20%, with the maximum value recorded at 15% replacement. The modulus of elasticity followed the same rising trend and showed its peak at 15% replacement, whereas Poisson's ratio increased consistently with SDW replacement up to 25%. However, there was a gradual decline in water absorption and porosity with up to 25% SDW replacement, despite being raised. These findings suggest that slab SDW can be effectively used as a partial replacement of coarse aggregate in BAC, improving both mechanical and durability properties.

***Keywords:*** *Coarse aggregate, slab demolished waste, brick aggregate concrete, workability, mechanical properties, durability*

# 1. INTRODUCTION

Concrete is the most widely used construction material in the world. Its production requires large quantities of natural aggregates, which leads to the depletion of natural resources and significant environmental impacts. The continuous expansion of urban infrastructure and the increasing rate of reconstruction have generated large amounts of demolished waste (DW). These wastes consist mainly of crushed concrete and debris and are often discarded in open environments. Such improper disposal occupies valuable land and contributes to pollution and carbon emissions (Adams et al., 2019). Specifically, the construction sector is responsible for 35.28 MT of $CO_2$ emissions (Marzouk & Azab, 2014) and 30–38% of outdoor air pollutants (Balali et al., 2023). Over the past decade, solid waste generation in Bangladesh has been rising rapidly. It is predicted to reach approximately 47,000 tons per day by the end of 2025 (Ashikuzzaman & Howlader, 2020). Among these, construction and demolition wastes (CDW) represent a substantial portion, estimated at 15–30% by weight (Fatemi, 2012). Materials such as concrete, mortar, brick, metal, and timber account for more than 90% of CDW (Islam et al., 2019). Demolished waste alone constitutes 89% of CDW (Rafiq et al., 2024). Nearly 98% of CDW end up in landfills, while only about 2% are recycled (Islam et al., 2019). This is mainly due to the lack of effective recycling knowledge or techniques, which leads to unauthorized disposal in open spaces and landfills (Khandaker et al., 2023). Improper disposal further elevates the levels of environmentally hazardous heavy metals (Balali et al., 2023). Therefore, reusing DW in new concrete production offers an effective approach to sustainable construction and environmental conservation (Tam & Tam, 2008).

In developing countries like Bangladesh, the need for a sustainable alternative to natural aggregate is pivotal. This is because they are often expensive or unavailable in many regions, leading to the widespread use of brick aggregate in concrete construction. Brick aggregates are locally abundant and affordable. However, they have relatively high porosity and lower strength compared to stone aggregates (Rashid et al., 2009). Nevertheless, several studies demonstrated that properly designed brick aggregate concrete (BAC) can achieve adequate compressive, tensile, and flexural strengths (Noaman et al., 2018). The recycling of DW into concrete has been widely investigated across the world, particularly through the use of recycled coarse aggregate (RCA) obtained from crushed concrete. These aggregates generally possess rough surfaces, irregular shapes, and higher porosity due to the presence of adhered mortar and micro-cracks from previous use (Kou and Poon, 2009; Silva et al., 2014). These characteristics tend to reduce workability and strength but can improve interlocking and bonding between aggregates and cement paste. The properties of DW are nearly similar to those of conventional concrete, as it contains mainly hydrated cement paste and natural aggregates, with major oxides such as CaO, $SiO_2$, and $Al_2O_3$ (Kou & Poon, 2012). Studies have suggested that the use of recycled aggregates up to levels, typically 20–30%, can enhance the mechanical and durability properties (Tabsh & Abdelfatah, 2009; Nagaraj & Pauline, 2024; Tang et al., 2024). Moreover, the use of recycled aggregates reduces landfill usage, conserves natural stone reserves, and lowers overall project costs, resulting in economical construction (Marinković et al., 2010).

Although numerous studies have been conducted on concrete made with DW, these investigations have focused primarily on stone-based concrete (Korouzhdeh et al., 2022; Kou & Poon, 2012; Kou and Poon, 2009; Marinković et al., 2010; Nagaraj & Pauline, 2024; Silva et al., 2014; Tabsh & Abdelfatah, 2009; Tang et al., 2024). The combined use of brick aggregates and DW in structural concrete has largely been overlooked. To the best of the authors' knowledge, there is limited evidence on the use of slab demolished waste (SDW) as recycled aggregate in brick aggregate concrete (BAC). This knowledge gap hinders the understanding of the properties of BAC containing SDW. Given the increasing amount of DW and the widespread use of BAC in Bangladesh, research on the properties of BAC incorporating SDW as coarse aggregate is not only relevant but also meaningful. Hence, this study aims to investigate the properties of BAC containing SDW as a partial replacement of coarse aggregate.

# 2. MATERIALS AND METHODOLOGY

## 2.1 Materials

For this experiment, ordinary Portland cement (OPC Type I) of a local brand was used as the binding material. Locally available river sand was utilized as the fine aggregate, and well-graded crushed brick aggregates and SDW with a maximum size of 19 mm were used as the coarse aggregate. SDW, which was collected from construction and demolition sites in Gazipur, Bangladesh, was used as a partial replacement for brick aggregates (BA). The waste was mainly generated from fragments of reinforced concrete slabs. The materials were cleaned, crushed, and sieved through a 19 mm sieve to obtain 19 mm downgraded coarse aggregates. Laboratory drinking water was used for both mixing and curing purposes.

### 2.2 Tests on Materials

Several laboratory tests were conducted following ASTM standards to determine the physical properties of the materials. The physical properties of coarse aggregate, including fineness modulus and unit weight, were determined as per ASTM C136 (2019) and ASTM C29 (2017a), respectively; specific gravity and water absorption were characterized following ASTM C127 (2007); aggregate crushing value (ACV) and aggregate impact value (AIV) were evaluated with ASTM C131 (2014). For fine aggregate, fineness modulus, unit weight, and moisture content were measured in accordance with ASTM C136 (2019), ASTM C29 (2017a), and ASTM C566 (2013), respectively, while specific gravity and water absorption were evaluated according to ASTM C128 (2015). The normal consistency, setting time, and compressive strength of OPC were determined based on ASTM C187 (2016), ASTM C191 (2021), and ASTM C109 (2016a), respectively.

### 2.3 Mixing of Materials

Concrete mixtures were prepared with a volumetric ratio of 1:1.5:3 (cement: fine aggregate: coarse aggregate) and a constant water-to-cement (w/c) ratio of 0.50. Sylhet sand and local sand were used at a proportion of 1:1 as fine aggregate. Five different concrete mixes were produced in which brick aggregates were replaced by SDW at 0%, 10%, 15%, 20%, and 25% by volume. Table 1 presents the detailed proportions of materials used to produce 1 $m^3$ of concrete. A tilting drum mixer was employed to ensure uniform blending of all ingredients. Initially, the dry materials, cement, sand, brick aggregates, and SDW were mixed for about two minutes. Water was then added gradually, and mixing continued for an additional one to two minutes until a homogeneous mix was achieved.

Table 1: Proportions of materials used to produce 1 $m^3$ of concrete containing SDW (BSDW)

| Mix ID | SDW (%) | Coarse aggregate (kg) | | Fine aggregate (1:1), (kg) | | OPC (kg) | Water (kg) |
|---|---|---|---|---|---|---|---|
| | | SDW | BA | Sylhet sand | Local sand | | w/c = 0.50 |
| BSDW0 | 0 | 0 | 977.95 | 311.95 | 409.10 | 409.10 | 204.60 |
| BSDW 10 | 10 | 97.79 | 880.16 | 311.95 | 409.10 | 409.10 | 204.60 |
| BSDW15 | 15 | 146.70 | 831.25 | 311.95 | 409.10 | 409.10 | 204.60 |
| BSDW20 | 20 | 195.59 | 782.36 | 311.95 | 409.10 | 409.10 | 204.60 |
| BSDW25 | 25 | 244.49 | 733.46 | 311.95 | 409.10 | 409.10 | 204.60 |

Note: BSDW0 to BSDW25 denote BAC containing 0% to 25% SDW, respectively.

### 2.4 Workability of Fresh Concrete

After mixing the fresh concrete, the workability of BSDW was measured using the slump test, conducted in accordance with ASTM C143 (2020). The slump test was performed using a frustum-shaped mold with a bottom diameter of 200 mm, a top diameter of 100 mm, and a height of 300 mm. Fresh concrete was filled into the mold in three equal layers, and each layer was tamped using a tamping rod. The mold was lifted vertically within 5 ± 2 seconds after levelling the top surface. Slump was measured as the vertical distance between the top of the mold and the highest point of the vertically subsided concrete.

### 2.5 Preparation of Specimens

Steel cylindrical molds of 100 mm diameter and 200 mm height, and beam molds of 150 mm × 150 mm × 600 mm were used. The molds were cleaned, oiled, and assembled before casting. Fresh concrete was placed into the molds in three equal layers, and each layer was compacted using a tamping rod to remove air voids, following ASTM C31 (2022). After casting, the specimens were covered with wet burlap to minimize evaporation and were demolded after 24 hours. The demolded specimens were then cured in a water tank for 7 and 28 days.

### 2.6 Tests on Specimens

After 7 and 28 days of curing, specimens were subjected to compressive strength tests following ASTM C39 (2021). After 28 days, hardened density tests were carried out as per ASTM C642 (2013). Split tensile strength and flexural strength tests were performed on the specimens according to ASTM C496 (2011) and ASTM C293 (2016), respectively. Modulus of elasticity and Poisson's ratio were obtained from stress-strain relationships developed under axial compression using dial gauges. Durability properties were evaluated by conducting water absorption and porosity tests in accordance with ASTM C642 (2013). Three specimens were tested for each parameter at every replacement level, and the average values were reported to ensure reliability.

## 3. RESULTS AND DISCUSSIONS

### 3.1 Properties of Materials

The physical properties of materials are presented in Table 2. The table demonstrates that the properties of aggregates closely align with the previous studies (Nagaraj & Pauline, 2024; Noaman et al., 2018). Moreover, the properties of cement are within the acceptable range of OPC specified in the ASTM C150 (2021). Therefore, properties of materials confirm their suitability for concrete production.

Table 2: Properties of materials

| Properties of materials | | Coarse aggregate | | | | Fine aggregate (1:1) | | | | OPC | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SDW | | BA | | Sylhet sand | | Local sand | | | |
| | | Present study | Nagaraj & Pauline (2024) | Present study | Noaman et al. (2018) | Present study | Noaman et al. (2018) | Present study | Noaman et al. (2018) | Present study | ASTM C150 (2021) |
| Fineness modulus | | 6.77 | - | 6.99 | 7.0 | 2.89 | 3.11 | 1.46 | 1.10 | - | - |
| Unit weight ($kg/m^3$) | | 1190 | 1390 | 1080 | 925 | 1590 | 1504 | 1250 | 1268 | - | - |
| Specific gravity (dry) | | 1.78 | 2.68 | 2.56 | 2.56 | 2.54 | 2.65 | 2.63 | 2.70 | - | - |
| Water absorption (%) | | 13 | 3.52 | 15 | 16.38 | 0.80 | 1.01 | 1.00 | 1.08 | - | - |
| ACV (%) | | 35.13 | - | 35.44 | - | - | - | - | - | - | - |
| AIV (%) | | 32.78 | 24.24 | 28.97 | - | - | - | - | - | - | - |
| Moisture content (%) | | - | - | - | - | 1.01 | 2.56 | 1.47 | 2.60 | - | - |
| Normal consistency (%) | | - | - | - | - | - | - | - | - | 30 | 28-32 |
| Setting time (min) | Initial | - | - | - | - - | - | - | - | - | 120 | ≥ 45 |
| | Final | - | - | - | - - | - | - | - | - | 315 | ≤ 375 |
| Compressive strength (MPa) | 3 d | - | - | - | - - | - | - | - | - | 28.38 | 12.0 |
| | 28 d | - | - | - | - - | - | - | - | - | 33.75 | 28.0 |

### 3.2 Workability of Fresh BSDW

Figure 1 shows the workability of BAC containing SDW (BSDW) at a w/c ratio of 0.50. The figure reveals that the workability of BSDW increased noticeably with the increase in SDW content. The slump value of control concrete was relatively low (20 mm), indicating a stiff mix. However, as the replacement increased to 25%, the slump reached 110 mm, which demonstrates a significant enhancement in flowability. This may be attributed to the presence of residual mortar attached to SDW particles, which reduces internal friction and enhances lubrication between aggregates, resulting in a higher slump value. This may also be due to the lower water demand of SDW compared to BA. Another reason may be owing to SDW holding more surface moisture compared to BA beyond the aggregate saturation water (Tang et al., 2024). Tang et al. (2024) also reported that DW contains higher initial free water, which results in an increase in slump value. However, Smith (2018) reported a lower slump compared to the control concrete, in which stone aggregate was used along with recycled concrete aggregate made from natural aggregate. Therefore, it can be concluded that the incorporation of SDW into BSDW as a partial replacement for BA leads to better workability, which can be advantageous in construction applications where higher flowability is desired.

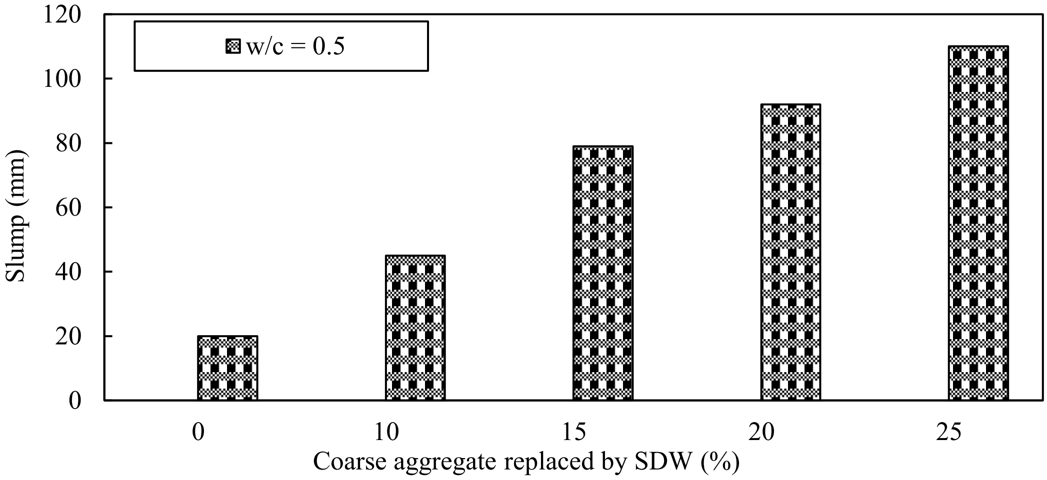


Figure 1: Slump of BAC containing varying percentages of SDW

### 3.3 Hardened density of BSDW

Figure 2 shows the density of hardened BSDW after 28 days of curing. The figure reveals a gradual increase in hardened density with the increase in SDW content. The density increased from 1638 kg/m³ for the control mix (0% SDW) to 1692 kg/m³ at 25% replacement level. This increment in density may be attributed to the relatively higher unit weight of SDW aggregates compared to BA.

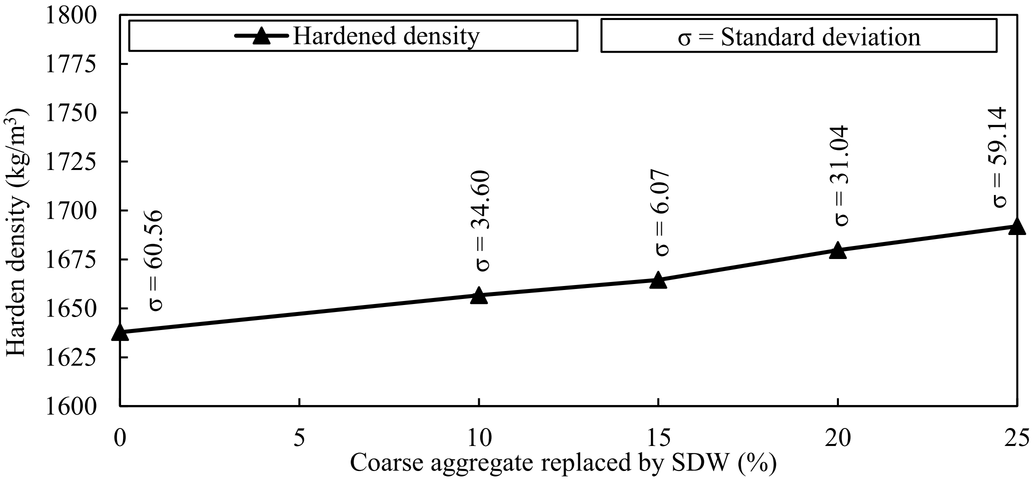


Figure 2: Hardened density of BAC containing varying percentages of SDW

Table 2 shows that the unit weight of SDW is 10.2% higher than BA, confirming that hardened density increases by 3.3% due to the incorporation of SDW into BSDW up to 25% replacement level. Similar findings were also reported by several authors (Opara et al., 2016; Tang et al., 2024). Tang et al. (2024) demonstrated that the density of DW is 7.9% higher than that of the natural coarse aggregates. The authors (Tang et al., 2024) also reported that the density of concrete with a w/c ratio of 0.50 increased by 0.7% as the DW content increased from 0 to 50%. Moreover, the higher standard deviation is likely due to cylindrical specimen geometry and the heterogeneity of SDW, including residual mortar and brick fragments. Consequently, the inclusion of SDW as a partial replacement for BA enhances the overall compactness of BAC. Furthermore, the densities of BSDW (0–25%) meet the density range of structural lightweight concrete (1360–1920 kg/m³) as specified by ACI Committee E-701 (2007). Thus, BSDW can reduce the self-weight of structural elements compared to conventional concrete.

### 3.4 Mechanical Properties of BSDW

The mechanical properties of BAC containing SDW (BSDW) are discussed in the following sections.

#### 3.4.1 Compressive Strength

Figure 3 illustrates the compressive strength of BAC containing varying percentages of SDW at 7 and 28 days of curing. The figure shows that the compressive strength of BAC exhibits an increasing trend with the inclusion of SDW up to 20%, after that a gradual decline is observed. From 7 to 28 days, the strength also increases, which may be due to the continued hydration of OPC. The control mix (0% SDW) achieves compressive strengths of around 27.7 MPa and 29.2 MPa at 7 and 28 days, respectively. The strength increases by about 10.5%, 11.3%, and 4.7% with 10%, 15%, and 20% replacement of BA by SDW, respectively, compared to the control concrete at 7 days. After 28 days, the strengths increase by 9.4%, 14.1%, and 5.4% with 10%, 15%, and 20% replacement, respectively, compared to the control mix. This enhancement in strength may be attributed to the better interlocking characteristics of SDW, which contribute to improved bond formation between the aggregate and the cement paste. Similar observations were reported in previous studies (Ahmed, 2013; Jones et al., 2003). Ahmed (2013) suggested that the strength of concrete gained slightly with 25% RCA, likely due to the presence of unhydrated cement within the mortar adhering to the RCA. The unhydrated cement is activated during the mixing process and subsequently enhances the strength of concrete (Banthia and Chan, 2000). Similarly, Korouzhdeh et al. (2022) reported that incorporating DW in concrete can improve the compactness and impermeability of the concrete. The peak value is observed at 15% replacement, which indicates the most favorable and balanced replacement for bond interaction. However, at 25% SDW replacement, the strength decreases by about 3.6% and 8.2% at 7 and 28 days, respectively, likely due to the existence of several weak interfacial transition zones and porous structures in the CDW aggregates that reduce the overall cohesion of the concrete matrix (Tang et al., 2024). Furthermore, the compressive strength at all replacement levels surpassed the minimum requirement of 17 MPa for structural concrete (ACI Committee E-701, 2007). This finding validates BSDW as suitable for structural concrete. Although the 15% mix shows the highest value, the 20% SDW mix still exhibits higher strength than the control.

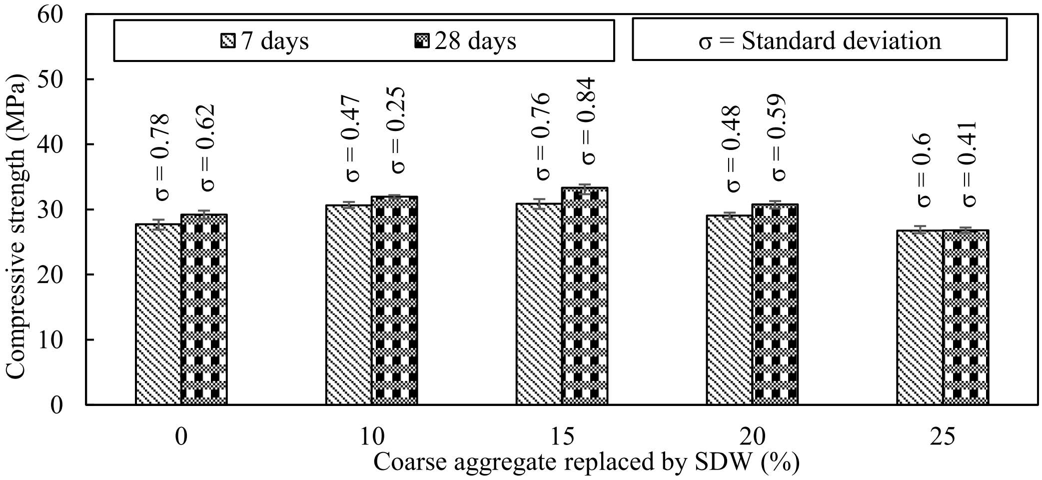


Figure 3: Compressive strength of BSDW at 7 and 28 days

#### 3.4.2 Split Tensile Strength

The split tensile strength of BAC containing varying percentages of SDW at 28 days of curing is illustrated in Figure 4. The figure shows that the split tensile strength of BAC increases with increasing

SDW content up to a certain limit, after which a gradual decline is observed. The split tensile strength of the control mix (0% SDW) is approximately 2.7 MPa. This strength increases by about 7.5%, 13.2%, and 11.3% with 10%, 15%, and 20% replacement of BA by SDW, respectively, compared to the control concrete. This improvement is likely due to the better interlocking characteristics of SDW (Ahmed, 2013; Jones et al., 2003). The highest strength is observed at 15% replacement, which may be considered the ideal level of BA replacement by SDW. Beyond 20% replacement, the strength decreases by about 11.3%, likely due to the increased presence of adhered mortar, and weaker aggregate-matrix bonding, which promote premature crack initiation under tensile stress (Shaikh, 2016). The author noted that the reduction in tensile strength is caused by the presence of microcracks in the RCA and at the interface with adhered mortar, which reduce the resistance of concrete to tension. Furthermore, the tensile-to-compressive strength ratio obtained in this study ranges between 8.8% and 9.6%, while Sagoe-Crentsil et al. (2001) observed a ratio between 8.9% and 12.1% for recycled aggregate concrete. Although the 15% mix shows the highest strength, the 20% SDW mix still exhibits higher strength than the control.

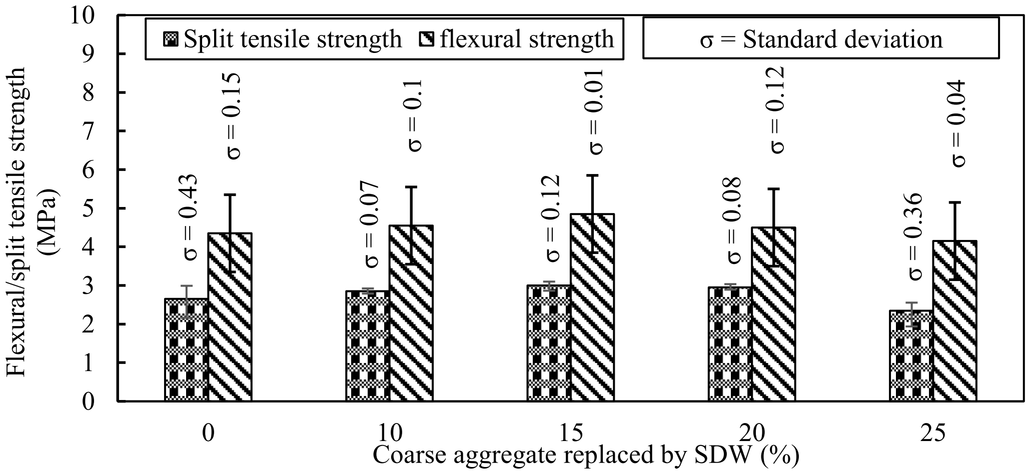


Figure 4: Split tensile and flexural strength of BSDW at 28 days

### 3.4.3 Flexural Strength

Figure 4 illustrates the flexural strength of BAC containing varying percentages of SDW (BSDW) after 28 days of curing. It can be observed that the flexural strength increases with SDW content up to a certain level, followed by a gradual decline. The control mix (0% SDW) exhibits a flexural strength of 4.33 MPa. When BA is partially replaced by SDW, the strength improves by about 4.5%, 11.5%, and 3.6% for 10%, 15%, and 20% replacement levels, respectively. This improvement is attributed to the stone-like quality of SDW (ACV of SDW < ACV of BA) compared to BA, as presented in Table 2. It may also result from enhanced mechanical interlocking between SDW aggregates and the cement matrix (Ahmed, 2013; Jones et al., 2003). Similar findings were reported by past researchers (Yong and Teo, 2009; Tam et al., 2006; Ahmed, 2013). Ahmed (2013) concluded that using up to 25% RCA can improve flexural strength, while Yang et al. (2008) emphasized the role of aggregate water absorption. The maximum strength is observed at 15% replacement, which indicates the most favorable proportion of BA substitution by SDW. At 25% replacement, the flexural strength decreases by nearly 4.1%, likely due to the increased mortar-adhered SDW (Shaikh, 2016). The author (Shaikh, 2016) reported that residual mortar on recycled aggregates promotes premature cracking and reduces bending resistance. Although the 15% replacement yields the highest strength, the 20% SDW mix still performs better than the control.

### 3.4.4 Modulus of Elasticity

Figure 5 shows the stress-strain curve of BSDW after 28 days of curing. The modulus of elasticity was determined according to ASTM C469 (2011) using the secant tangent modulus method. In this method, the stress was calculated corresponding to 40% of the maximum compressive strength. The stress–strain curve is illustrated in Figure 5, while the modulus of elasticity is shown in Figure 6. The modulus of elasticity of BSDW increases with the addition of SDW, reaching higher values up to 20% replacement before gradually decreasing. The control mix (0% SDW) exhibits a modulus of about 14.04 GPa. Replacing BA with SDW improves stiffness, with increases of approximately 4.7%, 7.0%, and 2.1% for 10%, 15%, and 20% replacement levels, respectively, likely due to the corresponding improvement in compressive strength. The highest modulus of elasticity occurs at 15% replacement, indicating that this proportion provides the most effective balance between strength and aggregate characteristics. Alexander and Mindness (2005) reported that the modulus of elasticity of concrete is largely governed by porosity, with higher porosity resulting in a lower modulus. At 25% SDW, the modulus declines by about 11.4%, which may be attributed to the corresponding reduction in compressive strength. Similarly, Thomas et al. (2018) noted that a higher content of mortar-adhered recycled aggregate tends to reduce the modulus of elasticity. Kou and Poon (2013) observed that a greater replacement of natural aggregates could reduce the modulus of elasticity by up to 25%. Despite this, the modulus of BSDW (14.04–15.02 GPa) remains within the typical range for BAC (10–30 GPa) reported by Brandt (2009). Despite the decline at higher replacement levels, the 20% SDW mix still exhibits better elasticity than the control.

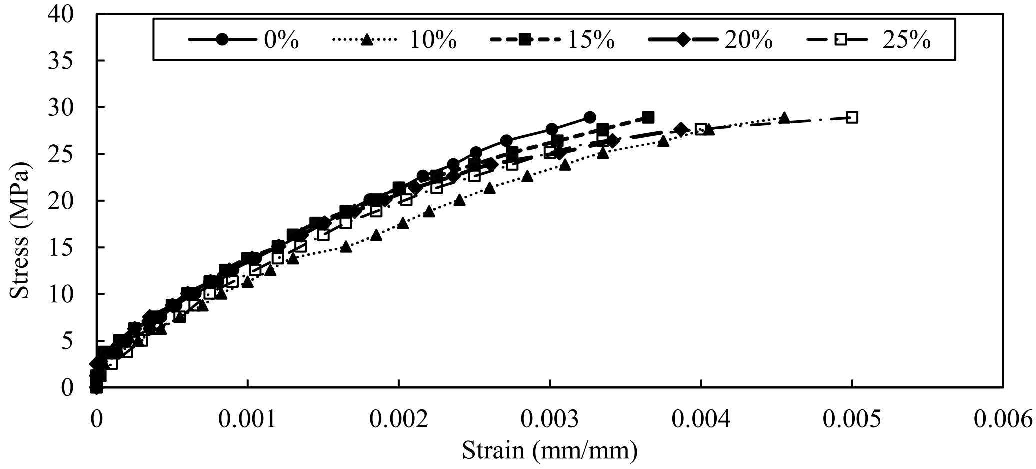


Figure 5: Stress-strain diagram of BSDW at 28 days

### 3.4.5 Poisson’s Ratio

Figure 6 illustrates the Poisson’s ratio of BSDW after 28 days of curing. Poisson’s ratio increases as the SDW content increases.

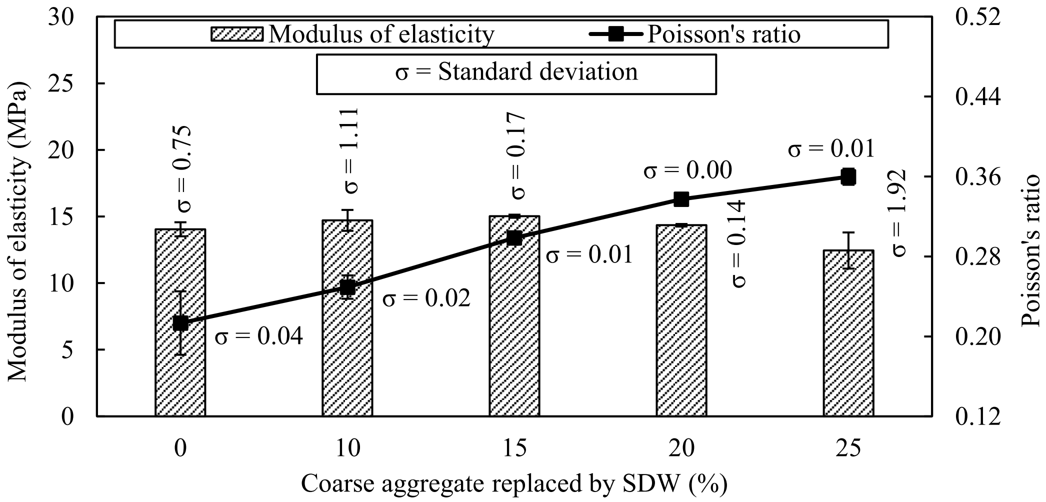


Figure 6: Modulus of elasticity and Poisson’s ratio of BSDW at 28 days

The control mix (0% SDW) has a Poisson’s ratio of 0.213, which rises to 0.249, 0.298, 0.337, and 0.360 for 10%, 15%, 20%, and 25% SDW replacement, respectively. These values correspond to increases of

16.9%, 39.9%, 58.0%, and 68.6% compared to the control. The increase is likely due to the lower stiffness and higher deformability of the SDW, which allows greater lateral strain and a less brittle failure mode under axial stress. Therefore, the Poisson's ratio of BSDW falls within the typical range for BAC.

### 3.5 Durability Properties of BSDW

The following subsections describe the durability properties of BAC incorporating SDW (BSDW).

#### 3.5.1 Water Absorption

The water absorption of BSDW at 28 days is shown in Figure 7. The figure demonstrates that the water absorption of BSDW decreases with increasing SDW content. The control mix (0% SDW) exhibits a water absorption of 9.54%, which decreases to 9.26%, 8.85%, 8.65%, and 8.23% for 10%, 15%, 20%, and 25% SDW replacement, respectively. This reduction is likely due to denser packing and better interlocking of aggregates, which limit water penetration. Similar findings were also reported by several researchers (Jones et al., 2003; Korouzhdeh et al., 2022).

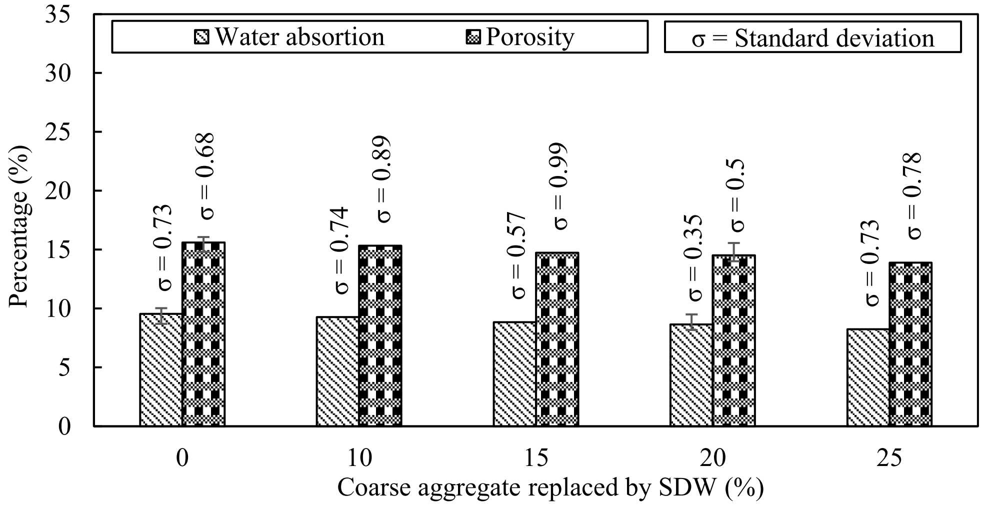


Figure 7: Water absorption and porosity of BSDW at 28 days

Jones et al. (2003) indicated that the presence of fine filler particles in RCA contributes to improved aggregate packing and a reduction in internal voids within the concrete matrix. Likewise, Korouzhdeh et al. (2022) found that the use of demolished waste (DW) in concrete promotes a denser matrix, improving compactness and hindering water penetration. Therefore, it can be concluded that incorporating SDW reduces water absorption and may enhance the durability of BAC.

#### 3.5.2 Porosity

Figure 7 also shows the porosity of BSDW at 28 days. The figure reveals that the porosity of BSDW decreases as SDW content increases. The control mix has a porosity of 15.59%, which decreases to 15.33%, 14.73%, 14.53%, and 13.90% for 10%, 15%, 20%, and 25% SDW replacement, respectively. This reduction may be attributed to the crushed concrete particles in SDW providing a denser internal structure and better particle packing within the concrete matrix (Jones et al., 2003). A similar observation was also made by Korouzhdeh et al. (2022). The authors reported that incorporating DW in concrete can improve the compactness and impermeability of the concrete. Thus, it can be concluded that the addition of SDW lowers the porosity of BSDW and contributes to enhanced durability and mechanical performance of BAC.

## 4. CONCLUSIONS

Based on the experimental results, the following conclusions have been drawn:

(i) The properties of materials satisfied the requirements for the production of BSDW.
(ii) Workability and hardened density of BSDW improved due to the inclusion of SDW.

(iii) BSDW demonstrated superior mechanical properties (compressive strength, split tensile strength, flexural strength, and modulus of elasticity) with SDW replacement up to 20%, while the highest values were observed at 15%.
(iv) Poisson's ratio of BSDW progressed with SDW incorporation up to 20% and yielded the maximum at 25% replacement.
(v) Durability of BSDW was enhanced due to the reduction of water absorption and porosity with the substitution of SDW up to 25%.
(vi) Overall, 20% SDW can be considered the optimal replacement for the production of BSDW based on strength and durability performance. Although BSDW can be used as structural concrete, environmental considerations are highly recommended for future investigation.

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**DECLARATION OF USE OF AI**
ChatGPT (OpenAI) was used for grammatical correction and language polishing of the revised manuscript, but the data, analyses, and interpretations are original.

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