

A Comparative Study on The Properties of Course Aggregate Mostly Available in Bangladesh

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Abstract: Over the past decade, a significant number of infrastructure projects have been implemented across Bangladesh, resulting in a rapid increase in demand for construction materials. In the fiscal year 2017 to 2020 alone, approximately 12.7 million tons of aggregate were consumed by the construction industry, of which only 13% were sourced locally. The rest were imported, leading to variability in concrete performance due to differences in aggregate characteristics. This study investigates the influence of commonly used coarse aggregate types on concrete properties, with a focus on developing sustainable infrastructure.

Six widely used coarse aggregate sources Balason, Shebok, Torsha, Dandruff Mine, Pakur Black Stone, and Kothin Shila were selected for analysis. Laboratory tests were conducted to determine the physical, chemical, and petrographic properties of these aggregates, including Aggregate Crushing Value (ACV), Aggregate Impact Value (AIV), Los Angeles Abrasion (LAA), Elongation Index (EI), Flakiness Index (FI), specific gravity, water absorption, and unit weight. Additionally, aggregates were subjected to visual and mechanical preparation including washing, drying, sieving, and shape evaluation using thickness and length gauges. Cement consistency was assessed using Vicat's apparatus.

Concrete mixes with constant gradation and water-cement ratios (0.4) were used to cast cylinders. Tests were conducted to measure compressive strengths. Results revealed that the physical properties of aggregates significantly affect concrete strength, particularly when compressive strength exceeds standard values. Among the samples, Balason aggregate exhibited the highest 28-day compressive strength (267.39 kN), followed by Shebok and Pakur, while Kothin Shila showed the lowest strength (123.10 kN).

The findings provide essential guidance for engineers in selecting suitable aggregate sources based on the required concrete strength, contributing to more durable and reliable infrastructure in Bangladesh.

Keywords: Properties, Aggregates, Concrete, Construction materials.

I. Introduction

Bangladesh is a rapidly progressing nation where the GDP growth rate reached 7.86% during the fiscal year 2017 to 2020. It is widely acknowledged that the construction industry serves as one of the key engines driving the country's economic advancement. This sector significantly contributes to job creation, the expansion of material markets, and various commercial operations. Among all construction materials, aggregate is one of the most extensively utilized in nearly every construction activity. The characteristics of aggregates considerably influence the strength properties of concrete, particularly in high-strength concrete. In the case of conventional concrete, the strength is often controlled by the interfacial transition zone, which acts as the limiting factor (Alexander DE, 1992), (Ezeldin & Aitcin, 1991)(Barai, 2020)

The attributes of the cement matrix and the interfacial transition zone between the cement paste and coarse aggregate predominantly determine the strength of normal concrete. The use of water-reducing agents in high-strength concrete enhances the strength of both the cement matrix and the mechanical properties of the transition zone. As a result, the role of coarse aggregates becomes more significant in producing high-strength concrete. In such mixes, cracks may originate in the matrix or aggregate and propagate through all three phases, resulting in a relatively less tortuous fracture surface (Meddah et al., 2010).

Chemical admixtures and supplementary cementitious materials are often employed to enhance the workability of concrete without adversely affecting its hardened state (Quiroga & Fowler, 2004). The shape, texture, and gradation of aggregates also greatly influence the performance of fresh concrete (Quiroga & Fowler, 2004). Numerous studies have been conducted worldwide on the effects of aggregate properties. These include investigations on different types of coarse aggregates such as grey granite, anorthosite, charnockite, limestone, and gneiss on concrete performance by Vishalakshi et al. (Vishalakshi et al., 2018); the effect of maximum aggregate size on concrete strength by Grabiec et al. (Grabiec et al., 2015); the impact of aggregate mineralogy on the mechanical performance of high-strength concrete by Oraimi et al. (Grabiec et al., 2015); and the influence of aggregate type on the elastic modulus of high-strength concrete by Beushausen et al. .

Nevertheless, comprehensive research on developing high-strength concrete using the locally available aggregates in Bangladesh remains incomplete. Currently, concrete with strengths up to 6,600 psi is commonly produced, which is often inadequate for high-rise construction (Beushausen & Dittmer, 2015). A major obstacle in producing high-strength concrete in Bangladesh is the lack of high-quality stone aggregates (Rashid et al., 2009). The country has scarce natural rock deposits. Owing to this shortage, researchers in Bangladesh are exploring recycled aggregates as viable alternatives (Mohammed1a et al., 2016). Studies indicate that concrete

with strength exceeding 27.5 MPa can be achieved using 100% recycled coarse and fine aggregates. Furthermore, it has been observed that induction furnace slag can also serve as a coarse aggregate for normal-strength concrete (Mahmud et al., 2013).

At present, Bangladesh heavily relies on various international origins for coarse aggregates. The geological and geomorphological conditions responsible for forming rocks differ by region, causing significant variation in the properties of aggregates sourced from different locations. Hence, it is critical to examine the physical and mechanical characteristics of both local and imported aggregates before using them in nationally significant infrastructure projects.

This research investigates how the properties of aggregates from different sources influence concrete strength. A comprehensive series of physical tests were conducted on selected aggregates. Concrete cylinders were then cast and tested for strength performance. Finally, the strength of concrete and aggregate properties was analyzed.

II. Materials and Methodology

This study goal is to assess the viability of different types course aggregate. A few steps are taken in order to ascertain the anticipated outcomes. Sincere efforts were made to prepare the materials and conduct laboratory tests in order to assess the anticipated outcome. When making mortar, the right kind of jute fibber was utilized as sand. This is the thesis work's methodological framework (Onikeku et al., 2019) as Figure 2.1.

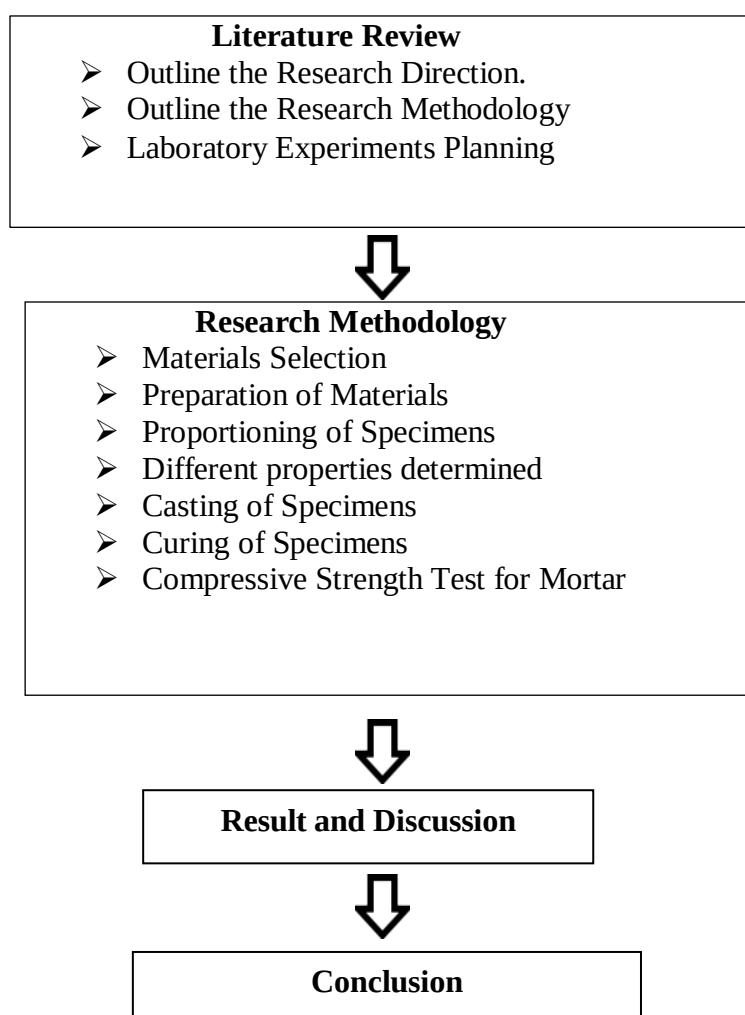


Figure 2.1: Methodological Structure of this Study

Materials

In Figure 2.2 to 2.9, stone, sand, cement, and water were used to prepare concrete for evaluating its mechanical and physical properties. Stone and sand acted as coarse and fine aggregates, while cement and water-initiated hydration. The mixed materials formed specimens tested for compressive (Frías et al., 2012).



Figure 2.2: Balason Stone



Figure 2.3: Shebok Stone



Figure 2.4: Torsha Stone



Figure 2.5: Dandruff Mine Stone



Figure 2.6: Pakur Black Stone



Figure 2.7: Kothin Shila Stone



Figure 2.8: Sand



Figure 2.9: Sample Cement

III. Methods

To evaluate the properties of materials used in concrete, several laboratory tests were conducted. These included the specific gravity and absorption capacity test, sieve analysis, and determination of unit weight, voids, and moisture content. Mechanical properties were assessed through the aggregate impact value, crushing value, flakiness index, and elongation index tests. Cement quality was evaluated using Vicat's apparatus to determine normal consistency and setting time. Additionally, the resistance of small-size coarse aggregates was tested using the Los Angeles machine. Finally, the compressive strength of cylindrical concrete specimens was measured to assess the overall structural performance. The testing procedure were conducted as Figure 2.10 to 2.21.



Figure 2.10: Sample is washed and kept in water for 24 hours.



Figure 2.11: Sample is dried into the dry oven for 24 hours.



Figure 2.12: Samples are sieved by sieve shaker.



Figure 2.13: Impacting a sample stone.



Figure 2.14: Crushing a sample by the crushing machine



Figure 2.15: Identify the thickness of a stone by a thickness gauge



Figure 2.16: Determining a sample's length by a length gauge



Figure 2.17: Determining normal consistency of cement by using vicat's apparatus



Figure 2.18: Cement, sand, stone and water mixing



Figure 2.19: Compacting the mixture



Figure 2.20: Cylinder made of stone chips



Figure 2.21: Determining the compressive strength of a cylinder using compressive load machine

IV. Result and Discussion

The experimental assessment of coarse aggregates from seven distinct sources Balason, Dandruff, Torsha, Shebok, Pakur, Bolder Black Stone, and Kothin Shila was carried out to evaluate their suitability for construction purposes. The properties tested included Aggregate Crushing Value (ACV), Aggregate Impact Value (AIV), Specific Gravity, Water Absorption, Los Angeles Abrasion Value, Fineness Modulus (F.M), Flakiness Index (FI), and Elongation Index (EI). Each test result was compared against standard values to determine compliance and material quality and the result were represented in

Table 3.1 and Table 3.2.

Properties of Coarse Aggregate

Aggregate Crushing Value (ACV)

The Aggregate Crushing Value (ACV) reflects the compressive strength of aggregates. All samples were within the standard limit of less than 30%, indicating adequate resistance to crushing. The ACV values were 21.38% for Balason, 20.6% for Dandruff, 20.87% for Torsha, 20.62% for Shebok, 21.17% for Pakur, 21.82% for Bolder Black Stone, and 22.21% for Kothin Shila.

Aggregate Impact Value (AIV)

The Aggregate Impact Value (AIV) assesses toughness under sudden loads. All values remained below the 30% limit, with Balason at 27.39%, Dandruff at 19.44%, Torsha and Shebok at 21.28%, Pakur and Bolder Black Stone at 14.26%, and Kothin Shila at 14.35%. The notably low values of Pakur, Bolder Black Stone, and Kothin Shila indicated superior resistance to impact.

Specific Gravity

In terms of Specific Gravity, all aggregates met the standard range of 2.3 to 2.9. The values recorded were: Balason (2.39), Dandruff (2.45), Torsha (2.68), Shebok (2.53), Pakur (2.64), Bolder Black Stone (2.63), and Kothin Shila (2.58), indicating their appropriateness for concrete work.

Water Absorption

The Water Absorption test revealed that Balason (5.8%) and Dandruff (7.2%) exceeded the standard maximum of 4%, indicating high porosity and potential durability issues. Torsha (5.11%), Shebok (5.71%), and Kothin Shila (5.62%) also slightly exceeded the limit. In contrast, Pakur and Bolder Black Stone showed acceptable values of 4.0%.

Los Angeles Abrasion

All samples complied with the Los Angeles Abrasion requirement of less than 40%, with Balason at 36.21%, Dandruff at 36.1%, Torsha at 35.91%, Shebok at 35.92%, Pakur at 32.07%, Bolder Black Stone at 27.86%, and Kothin Shila at 20.55%. The latter two showed outstanding abrasion resistance.

Fineness Modulus (F.M)

The Fineness Modulus (F.M) of all samples ranged between 6.75 and 8.00, indicating well-graded aggregates. Values were: Balason (6.8), Dandruff (6.89), Torsha (7.13), Shebok (6.82), Pakur (7.42), Bolder Black Stone (7.01), and Kothin Shila (6.84).

Flakiness Index (FI) and Elongation Index (EI)

Both Flakiness Index (FI) and Elongation Index (EI) were well within limits for all samples. FI ranged from 6.82% to 7.44%, and EI from 18.51% to 19.31%, suggesting good aggregate shape.

Table 3.1: Properties of Coarse Aggregate

SL	1	2	3	4	5	6	7
Sample	Balason	Dandruff	Torsha	Shebok	Pakur	Bolder Black	Kothin Shila
% ACV	21.38	20.6	20.87	20.62	21.17	21.82	22.21
Standard value	<30						14.35
% AIV	27.39	19.44	21.28	21.28	14.26	14.26	14.35
Standard value	<30						2.58
Specific Gravity	2.39	2.45	2.68	2.53	2.64	2.63	2.58
Standard value	2.3-2.9						5.62
Absorption %	5.8	7.2	5.11	5.71	4	4	5.62
Standard value	0.5-4.0						20.55
% of Los Angles	36.21	36.1	35.91	35.92	32.07	27.86	20.55
Standard value	<40%						6.84
F.M	6.8	6.89	7.13	6.82	7.42	7.01	6.84
Standard value	6.75-8.00						7.33
FI %	7.35	7.44	6.82	6.93	6.96	6.86	7.33
Standard value	<30						18.67
EI %	18.65	18.51	19.27	18.9	19.31	18.76	18.67
Standard value	<45						18.67

Compressive strength test of course aggregate.

The compressive strength test results of concrete samples made with coarse aggregates from seven different sources Balason, Dandruff, Torsha, Shebok, Pakur, Bolder Black Stone, and Kothin Shila were evaluated at 7, 14, and 28 days to assess their strength development over time. The results showed a gradual increase in strength for all samples, as expected, with variations depending on the source of aggregate.

At 7 days, the highest compressive strength was observed for concrete made with Balason aggregate, which recorded 183.45 kN, followed by Dandruff at 145.63 kN, Shebok at 153.33 kN, and Pakur at 151.85 kN. Torsha, Bolder Black Stone, and Kothin Shila showed relatively lower strengths of 127.44 kN, 115.89 kN, and 83.71 kN, respectively.

By 14 days, strength increased notably across all samples. Balason again led with 232.89 kN, followed by Shebok at 196.16 kN, Pakur at 194.27 kN, and Dandruff at 186.31 kN. Torsha and Bolder Black Stone showed moderate strength gains to 163.04 kN and 148.26 kN, respectively, while Kothin Shila remained the lowest at 107.09 kN.

At the 28-day mark, which is the standard benchmark for concrete strength, Balason continued to exhibit the highest compressive strength of 267.39 kN. Shebok and Pakur followed closely with strengths of 225.48 kN and 223.30 kN, respectively. Dandruff reached 214.16 kN, while Torsha, Bolder Black Stone, and Kothin Shila reached 187.41 kN, 170.42 kN, and 123.10 kN, respectively.

Table 3.2: Qualitative analysis of compressive load

SL	Sample	7 days Compressive Strength (kN)	14 days Compressive Strength (kN)	28 days Compressive Strength (kN)
1.	Balason	183.45	232.89	267.39
2.	Dandruff	145.63	186.31	214.16
3.	Torsha	127.44	163.04	187.41
4.	Shebok	153.33	196.16	225.48
5.	Pakur	151.85	194.27	223.30
6.	Bolder Black Stone	115.89	148.26	170.42
7.	Kothin Shila	83.71	107.09	123.10

V. Discussion

1. An experimental evaluation was conducted on coarse aggregates from seven sources—Balason, Dandruff, Torsha, Shebok, Pakur, Bolder Black Stone, and Kothin Shila—to assess their suitability for construction. All samples met the standard limits for Aggregate Crushing Value (ACV <30%) and Aggregate Impact Value (AIV <30%), with ACV ranging from 20.6% to 22.21%, and AIV from 14.26% to 27.39%. Specific gravity values were within 2.3–2.9, indicating proper density. However, water absorption for Balason (5.8%), Dandruff (7.2%), Torsha (5.11%), Shebok (5.71%), and Kothin Shila (5.62%) exceeded the 4.0% standard, suggesting high porosity. All samples passed the Los Angeles Abrasion test (<40%), with Bolder Black Stone (27.86%) and Kothin Shila (20.55%) showing superior wear resistance. Fineness Modulus ranged from 6.8 to 7.42, and both FI (6.82%–7.44%) and EI (18.51%–19.31%) were within limits. Overall, Bolder Black Stone and Kothin Shila demonstrated the best performance for high-quality construction.
2. Concrete samples using different coarse aggregates showed increasing compressive strength over 7, 14, and 28 days. Balason performed best (183.45, 232.89, 267.39 kN), followed by Shebok (153.33, 196.16, 225.48 kN) and Pakur (151.85, 194.27, 223.30 kN). Dandruff peaked at 214.16 kN, while Torsha, Bolder Black Stone, and Kothin Shila reached 187.41, 170.42, and 123.10 kN, respectively. Balason, Shebok, and Pakur showed the best strength development.

VI. Conclusion

1. In conclusion, all samples exhibited acceptable mechanical properties. However, Balason and Dandruff showed high water absorption, raising concerns about long-term durability. Conversely, Kothin Shila and Bolder Black Stone performed exceptionally across all parameters, making them most suitable for durable and high-quality construction works.
2. In summary, concrete made with Balason, Shebok, and Pakur aggregates demonstrated superior compressive strength development over time. On the other hand, Kothin Shila and Bolder Black Stone produced the lowest strengths, suggesting they may not be ideal for high-strength concrete applications without further treatment or mix adjustments.

Recommendations

Following recommendations can be extracted from this research work:

- Stone chips should be used for heavy constructions rather than brick chips. Stone chips have more strength than brick chips.
- All of the seven types of stone chips balason stone has more compressive strength than all other stone chips. So balason stone is highly recommended for heavy constructions.
- By doing all the tests we can recommend that balason stone from ponchogar and bolder black stone from chapainababganj are the best stone chips for any kind of constructions.

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References

1. Alexander DE, M. G. & D. (1992). The influence of aggregates on the compressive strength and elastic modulus of concrete. *Civil Engineering= Siviele Ingenieurswese*, 1992(5), 161–170.
2. Barai, M. K. (2020). Introduction: Construction of a development model for Bangladesh. In *Bangladesh's Economic and Social Progress: From a Basket Case to a Development Model* (pp. 3–62). Springer.
3. Beushausen, H., & Dittmer, T. (2015). The influence of aggregate type on the strength and elastic modulus of high strength concrete. *Construction and Building Materials*, 74, 132–139.
4. Ezeldin, A. S., & Aitcin, P.-C. (1991). Effect of coarse aggregate on the behavior of normal and high-strength concretes. *Cement, Concrete, and Aggregates*, 13(2), 121–124.
5. Frias, M., Savastano, H., Villar, E., de Rojas, M. I. S., & Santos, S. (2012). Characterization and properties of blended cement matrices containing activated bamboo leaf wastes. *Cement and Concrete Composites*, 34(9), 1019–1023.
6. Grabiec, A. M., Zawal, D., & Szulc, J. (2015). Influence of type and maximum aggregate size on some properties of high-strength concrete made of pozzolana cement in respect of binder and carbon dioxide intensity indexes. *Construction and Building Materials*, 98, 17–24.
7. Mahmud, S. M. S., Talukder, M. M. A., Ahmed, I., & Raihan, M. A. (2013). Road safety initiatives in Bangladesh. *Jurnal Teknologi (Sciences & Engineering)*, 65(3).
8. Meddah, M. S., Zitouni, S., & Belâabes, S. (2010). Effect of content and particle size distribution of coarse aggregate on the compressive strength of concrete. *Construction and Building Materials*, 24(4), 505–512.
9. Mohammed1a, T. U., Mahmood1b, A. H., Chowdhury1c, I. M., Humayun, A. M., & Ahmed1d, T. (2016). Sustainability of construction materials in Bangladesh."
10. Onikeku, O., Shitote, S. M., Mwero, J., & Adedeji, A. (2019). Evaluation of characteristics of concrete mixed with bamboo leaf ash. *The Open Construction & Building Technology Journal*, 13(1).
11. Quiroga, P. N., & Fowler, D. W. (2004). Guidelines for proportioning optimized concrete mixtures with high microfines.
12. Rashid, M. A., Hossain, T., & Islam, M. A. (2009). Properties of higher strength concrete made with crushed brick as coarse aggregate. *Journal of Civil Engineering (IEB)*, 37(1), 43–52.
13. Vishalakshi, K. P., Revathi, V., & Reddy, S. S. (2018). Effect of type of coarse aggregate on the strength properties and fracture energy of normal and high strength concrete. *Engineering Fracture Mechanics*, 194, 52–60.