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Effect of Various Coarse Aggregates on the Compressive Strength of Concrete in Jalalabad City, Afghanistan

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ABSTRACT
One of the most frequently used building materials on the globe is concrete. Concrete is composed of aggregate, water, and cement. This study investigated the influence of different coarse aggregates on the compressive strength of concrete. The coarse aggregates used in the experimental design consisted of crushed granite, crushed river stone, and natural gravel, with river sand as the fine aggregate. Sieve analysis and unite weight was performed on specimens frequently used by citizens. Fresh Portland cement and water-cement ratios of 0.55 and 0.7 were both used. To investigate the influence of various aggregates on concrete compressive strength a specimen for 20 N/mm^2 concrete ratio of 1:1.5:3, and 48 concrete cubes measuring 15 cm x 15 cm x 15 cm were casted in the laboratory at Alfalah University. For fresh concrete, the slump test results were 63 mm for crushed granite, 65 mm for crushed river stone, and 50 mm for natural gravel. Crushing the concrete cubes after 7, 14, 21, and 28 days determined the compressive strength. Additionally, the highest compressive strength values achieved for crushed granite were 25.94 N/mm^2, crushed river stone was 23.68 N/mm^2, and natural aggregate concrete was 17.73 N/mm^2. Based on these findings, crushed granite has been recommended for usage in reinforced concrete applications.

Keywords: Coarse Aggregate types, Compressive Concrete, Natural Gravel, Crushed River Stone, Afghanistan

INTRODUCTION
The most widely used building material in the world is concrete. Portland cement, water, fine aggregate, and coarse aggregate are the ingredients. Concrete's compressive strength is influenced by a number of factors, including the degree of compaction, the water-cement ratio, aggregate strength, shape, and size grading. Usually regarded as inert fillers, aggregates contribute 60–80% of the volume of concrete; in addition, aggregates generally constitute 70–85% of the concrete's weight. House development in Afghanistan, particularly in Jalalabad, has been defined by high costs; many individuals attempt to reduce costs by substituting lower-quality materials for higher-quality ones, such as replacing of crushed granite aggregate with river gravel. Concrete's durability, workability, and strength are all impacted by variations in aggregate qualities, while the source of the aggregate has a substantial influence on its mechanical, physical, mineralogical, and geological attributes (Giaccio et al., 1992). Aggregate is the inert of material of concrete it is essential on determining concrete economy, strength, durability, workability, structural integrity, elasticity and thermal of concrete (Thomas & Folliard, 2007). Nowadays the strength of concrete is greater them 100 MPA have employed in high-rise buildings. Strength, durability and structural performance usually depends on aggregate properties shape, texture, surface condition, size, mechanical properties, and modulus of elasticity (Reddy & Ramakrishna, 2017). Selection of aggregate depends on decrease in cost and easy transport to work area. Compressive strength of concrete is a significant mechanical property of concrete this has directs correlation with all related properties, furthermore strength of coarse aggregate depend on elastic properties, shape, surface texture, mineralogical composition (Ogunbayo & Aigbavboa, 2019). Granite crush aggregate when replace 20% with river gravel has the higher compressive strength37.2N/mm^2 in concrete compared to 0, 40, 60, 80, 100 percent replacement water cement ratio has the significant role in these partial replacement of aggregate(Echeta et al., 2013). Compressive strength tests on river gravel, local stone, and granite crushed aggregate show that all three can be used in reinforced concrete. However, only granite-based concrete should be used to achieve a compressive strength of 30 N/mm^2. Increasing the water-to-cement ratio leads to a decrease in the strength of the concrete (Eziefula *et al.*,2020). Concrete strength, according to Neville (1981), is an essential factor in determining its entire performance. When combined with cement, the shape, surface roughness, and cleanliness of the aggregate all play important roles in producing the desired strength. unexpectedly when smooth coarse

aggregates were added, the strength of the resulting concrete fell by around 10% when roughened particles were used (Neville, 1995). It is investigated that compressive strength test results of two types of concrete: one formed with crushed stone and one made with uncrushed stone. The crushed stone concrete exceeded the uncrushed stone concrete in terms of strength. This increased strength can be related to a variety of components, including surface texture, form, strength, water-cement ratio, and aggregate stiffness (Soroka, 1993). concrete made of crush granite strength has best compressive strength, while concrete made with unwashed gravel had the lowest strength it is due to surface nature, cleanliness and internal structure of the aggregate material (Aginam et al., 2013). The type and size of aggregate with water cement ratio has direct effect on concrete compressive strength the study revealed that granite aggregate in concrete has highest strength compare to other types (Bhavya & Sanjeev, 2017). Aggregate thermal, chemical and physical attributes impacts the performance of concrete (Neville & Brooks, 1987). Particle size distribution of coarse aggregate impact on concrete compressive strength it illustrates that coarse aggregate characteristics (grain size distribution, percentage of fine to coarse aggregate, and quantity) are relatively associated with compressive strength (Meddah et al., 2010). A study revealed that for the same workability of concrete natural gravel has higher compressive strength compare to crush aggregate in Kashmir (Chat et al., n.d.). After 28 days, it has been discovered that concrete produced with washed aggregate has the highest compressive strength of 29.7 N/mm^2. Concrete made from unwashed gravel, on the other hand, has a compressive strength of 24.5 N/mm^2. The size of aggregate particles, their grading, internal particle bonding, and the presence of deleterious elements are all factors that influence concrete strength and failure (Bamigboye et al., 2016). The purpose of this research is to investigate the compressive strength of concrete produced from three different types of coarse aggregates: crushed granite, crushed river stone, and natural river gravel. The goal is to look at how different coarse particles affect the compressive strength of concrete. This comparison will provide a better understanding of the relationship between aggregate type and concrete compressive strength.

MATERIALS AND METHODS

This study's experimental component includes several stages such as sampling aggregates from three distinct sources, mixing, casting, watering, and conducting crushing tests.

Cement

For the aim of conducting experimental study, Portland fresh cement obtained directly from the city of origin was used in accordance with the specifications and standard of ACI 318-19.

Fine aggregate

Fine aggregate collected from the riverbed of Laghman province and passing through the No. 4 sieve was selected and used as a fundamental element in all sorts of concrete specimens in accordance with set requirements.

Coarse aggregate

Three different types of coarse aggregates, specimens were prepared for testing crushed granite aggregate of Amberkhana, crushed river stone of Sokhrod, and natural river gravel of Kan Kathraghy.

Water

Ordinary potable water is used for all research, experiments, and specimen curing ASTM C1602/C1602M-18.

Proportion of concrete mix

The study aimed to produce practical examples of M20-grade concrete utilizing three different types of coarse particles. The mix proportion for M20 grade concrete samples was maintained at 1:1.5:3. The water-cement (w/c) ratio was set at 0.55 for granite and crushed river stone, while for natural gravel was 0.7. In addition, 48 cubes with dimensions of 15 cm x 15 cm x 15 cm were cast. To assess the compressive strength of the concrete, these cubes were tested for compressive strength at 7, 14, 21, and 28-days intervals.

Concrete mixing, casting, curing, and crushing of test specimens

The mixing process was carefully carried out utilizing sample lab trays at Alfalah university laboratory. To guarantee a consistent distribution, the dry components, which included cement, fine aggregate, and coarse aggregate, were completely mixed for three cycles. Water was then added, and the mixing procedure was repeated twice more to produce the desired consistency. The concrete instances were carefully casted into their appropriate molds after the desired workability was achieved. All specimens were remolded after 24 hours of casting to allow for optimal curing and strengthening. These remolded specimens were then placed in a curing tank.

Figure 1. Shows mixing, slumping curing and compressive strength test.

RESULTS AND DISCUSSION

Aggregate Unite Weight

The values of table 1 illustrate details regarding the bulk unit weight or density of the aggregates performed by ASTM C29/C29M for coarse aggregates and ASTM C128/C128M for fine aggregates standards.

Table 1. Unit Weight of Aggregate.

S/No	Name	Type of Aggregate	Unite Weight gr/cm^3
1	Amber Khana	Crush Granite	1.68
2	Surkhrod	Crushed River Stone	1.67
3	Kan-Katraghay	Natural River Gravel	2.21
5	Laghman	Sand	1.74

Sieve analysis comparison of various aggregates

Table 2. Sieve analysis of various aggregates.

Sieve Size	Crushed Granite	Crushed River Stone	Natural River Gravel
	Passing%	**Passing%**	**Passing%**
75 µm			1.7
150 µm			7.3
300 µm			25.0
600 µm			34.8
1.18 mm			40.6
2.36 mm			46.7
4.75 mm	14.6	6.0	55.8
9.5 mm	42.8	34.2	69.2
12.5 mm	58.1	37.9	75.2
19.0 mm	97.4	65.4	88.8
25.0 mm	100.0	97.8	94.6

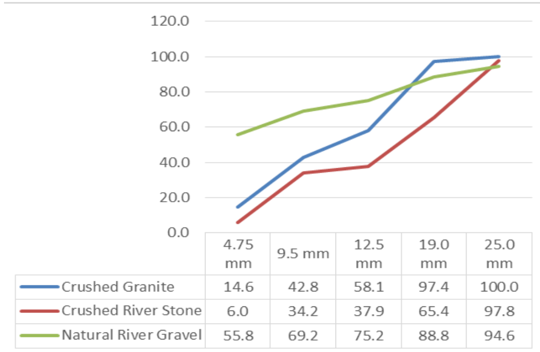

Figure 2. Sieve analysis comparison of various

The sieve analysis results for crushed granite, crushed river stone, and natural gravel are shown in Table 1. Crushed granite passes 100% of the time through the 25mm sieve and retains 61.9% of the time through the 12.5mm sieve. Similarly, crushed river stone passes through the 25mm sieve at 97.8%, whereas 62.1% is retained on the

12.5mm sieve. Natural gravel, on the other hand, passes through the 25mm sieve at a rate of 94.6%, with a retention rate of 25.8% on the 12.5mm sieve. Furthermore, it passes through the 4.75mm sieve with a passing rate of 55.8%, suggesting the presence of both coarse and fine particles in the natural gravel combination. Citizens frequently use these aggregate specimens.

Table 3 illustrates that natural river gravel need more water to achieve good workability than crush granite and river crush stones, furthermore w/c ratio was 0.55 for crush granite and river crush stone and 0.7 was for natural gravel.

Table 3. Slump Test

Type of Aggregate	Slump Value (mm)
Crushed Granite	63
Crushed River Stone	65
Natural River Gravel	50

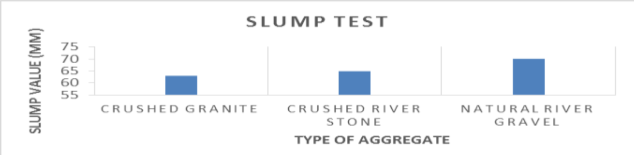

Figure 3. Slump Value Comparison of All Three Types Aggregate

Figure 4 and Table 4 determine the results of a compressive strength comparison for the compressive strength of the crushed granite specimen which was 24.92 N/mm^2 after 7 days, while the crushed river stone and natural gravel specimens achieved 19.7 N/mm^2, 13.47 N/mm^2 respectively. After 28 days crushed granite was 25.94 N/mm^2, crushed river stones 23.68 N/mm^2, and the natural gravel 17.73 N/mm^2. The observed variations in compressive strength explain that crushed granite aggregate had favorable qualities such as a well-graded nature, shape, appropriate surface roughness, and strong bonding with cement. On the other hand, the sieve study of the river crushed stone revealed poor findings, with flaws in both shape and surface qualities. The natural gravel, a blend of fine and coarse aggregates, performed poorly regarding sieve analysis, slump, and unit weight. Furthermore, furthermore problem in mechanical properties and physical properties decreased the compressive strength of natural gravel compare to crush granite and rive crushed stone.

Table 4. Compressive Strength of Concrete N/mm^2

Days	Crushed Granite	Crushed River Stone	Natural River Gravel
7	24.92	19.07	13.47
14	20.82	20.79	16.57
21	27.24	22.19	17.02
28	25.94	23.68	17.73

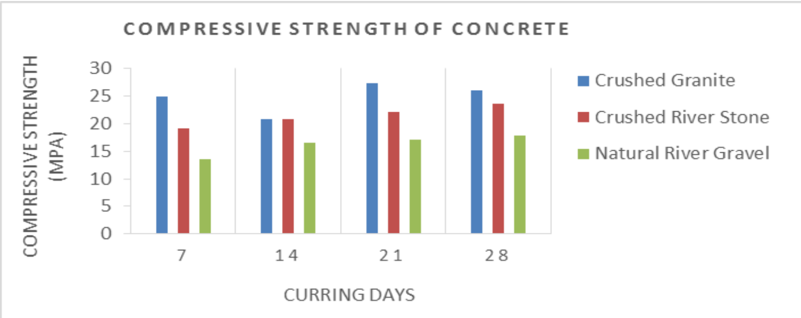

Fig 4. Comparison of Compressive Strength of

CONCLUSION

Effect of three types of coarse aggregate on compressive strength of concrete determine that after 28 days strengths are for crush granite 25.94 N/mm2, crushed river stone was 23.68 N/mm2 and river gravel was 17.73 N/mm2 these. The specimens employed in this study, which are commonly utilized by citizens for concrete applications, revealed significant problems in sieve analysis regarding particle sizes. A slump value for crush granite 63 mm for crushed river stones 65 mm, while w/c was 0.55 and for natural river gravel was 50 mm along with w/c of 0.7.

Recommendations: Concrete mad of crush granite should be used in reinforce cement concrete. Before use of aggregate as substituent of concrete it is prefer to use according to mix design such as particle sizes distribution, workability of concrete and unit weight. Further research need to be performed for a specimen mad of standard mix design specimens and at same workability.

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