CORRELATION BETWEEN AGGREGATE CRUSHING VALUE OF COARSE AGGREGATE AND COMPRESSIVE STRENGTH OF CONCRETE

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ABSTRACT
Aggregate Crushing Value (ACV) is an index of loss of coarse aggregate (CA) under sustained loading. However, ACV is not considered in concrete mix design according to ACI 211.1(ACI 211.1, 2009). In this paper effect of ACV of CA on compressive strength of concrete has been explored. Coarse Aggregate was collected from five different sources. Concrete mix design was conducted for target strengths of 3000, 4000 and 5000 psi according to ACI. Total 135Concrete cylinders were tested for compressive strength at 7, 14 and 28 days. ACV test for each type of Coarse aggregate was performed. Achieved strength Vs. ACV was plotted for each sample. It is observed that, compressive strength is inversely related to the ACV. Higher strength concrete is more dependent on ACV. To achieve target strength at 28 days, ACV should be less than 30, 29, and 28 for 3000 psi, 4000 psi and 5000 psi respectively.

Keywords: Aggregate crushing value; compressive strength; target strength; mix design

INTRODUCTION
Concrete is a versatile engineering material consisting of cementing substance, aggregates, water and often controlled amount of entrained air. It is initially a plastic, workable mixture which develops strength from hydration due to reaction between cement and water. Concrete is said to be as man-made rock. Reason behind its popularity is its high strength, fire resistance, durability and workability.
Compressive strength of concrete is the most important property of concrete. This property depends on various factors (constituting material properties and their proportion, method of preparation, curing, test condition). Aggregate Crushing Value (ACV) is one of the important properties of coarse aggregate.
ACV gives a relative measure of resistance to crushing under gradually applied compressive load. Thus ACV is inversely related to strength of coarse aggregate.
In concrete pavement design ACV of coarse aggregate is given much importance. In concrete mix design ACV of coarse aggregate is not considered. ACV may have effect on the strength gaining of concrete.
The objective of the study is to observe the variation of compressive strength of concrete with different coarse aggregates, the variation of aggregate crushing value of different coarse aggregates, strength gain of concrete with time for different coarse aggregates and to establish a relation between aggregate crushing value of coarse aggregate and compressive strength of concrete.
In the study, Portland Composite Cement (PCC) has not been used. Only Ordinary Portland Cement (OPC) has been used. Same type of fine aggregate has been used for all tests. Admixture has not been used for concrete mix.

METHODOLOGY
Concrete cylinder test was performed in the laboratory using cylindrical molds (4"× 8") according to ASTM standard C 470(ASTM C470, 2009).Total 135 concrete cylinders were tested. Five different CA samples were collected from different sources named Fazilpur, Meghalaya, Volagonj, Priggable and Aluvutu. Two sizes of aggregates were used. One is ½" and the other is ¾". Total fifteen sets of mix design was conducted using the five samples of aggregate for three different target strength 3000 psi,

4000 psi, 5000psi. The process of concrete mix design and determination of Aggregate Crushing Value according to ACI 211.1(ACI 211.1, 2009) and BS 812-110 standards (BS 812-110, 2009)was used in our project work respectively. For ACI mix design procedure required material information are Sieve analyses of both fine and coarse aggregates (ASTM C136, 2006), unit weight (ASTM C29, 2009), specific gravities, and absorption capacities of fine aggregates (ASTM C128, 2009) and coarse aggregates (ASTM C127, 2007).

Properties of coarse aggregate

The aggregate properties that were determined during the study are given in the following Table.

Table 1: Properties of Coarse Aggregates of Five Sources

Properties of Aggregate	Name of Aggregate				
	Meghalaya	Fazilpur	Volagonj	Priggable	Aluvutu
Bulk Specific Gravity(OD Basis)	2.6	2.5	2.6	2.52	2.52
Bulk specific Gravity(SSD Basis)	2.67	2.6	2.64	2.6	2.6
Apparent Specific Gravity	2.79	2.76	2.71	2.73	2.74
Absorption Capacity (%)	2.6	3.7	1.6	3.2	3.2
Unit weight (kg/ m^3)	1480	1560	1560	1690	1700
Moisture content (%)	1.197	3.17	0.42	1.24	2.98
Aggregate Crushing Value(ACV)	23	24	23	30	26

RESULTS AND DISCUSSIONS

In this study, compressive strength and ACV of various samples has been determined. The results are shown in Figures 1 to 3.

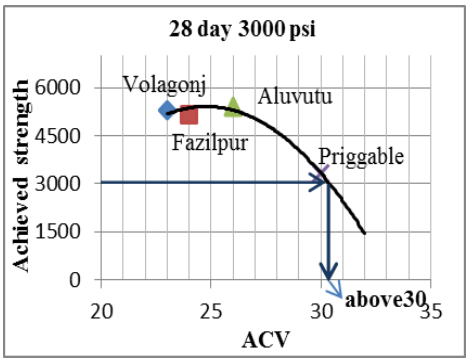

Fig. 1

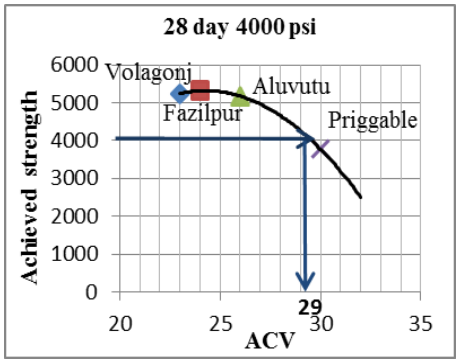

Fig. 2

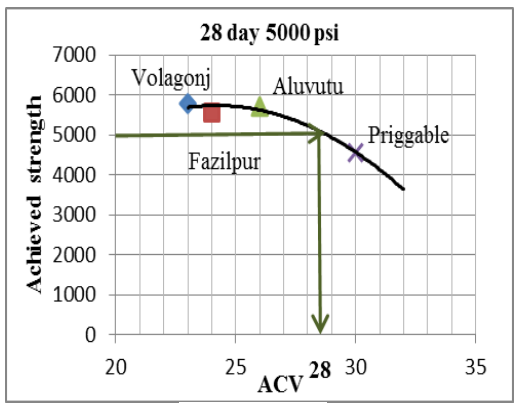

Fig. 3

Fig. 1 shows that, Compressive strength has an inverse relationship with the ACV. It also shows that all stones have reached 3000 psi in 28 days. Aluvutu, Fazilpur and Volagonj have reached greater than the target strength 3000 psi. To achieve 3000 psi, ACV should be less than 30.
Fig. 2 shows that, all the stones except Priggable have reached strength beyond 4000 psi in 28 days. For 4000 psi, deviation from the points of the curve is lesser than that of 3000 psi strength curve. To achieve 4000 psi, ACV should be less than 29.
Fig. 3 shows that, all the stones except Priggable have reached strength beyond 5000 psi in 28 days. For 5000 psi, deviation from the points of the curve is lesser than that of 4000 psi strength curve. To achieve 5000 psi, ACV should be less than 28.

Differences in Pattern in Strength Gain of Concrete with Time
Strength gain of concrete cylinders at 7, 14 and 28 days have been shown in the same graph for 3000 psi, 4000 psi and 5000 psi.

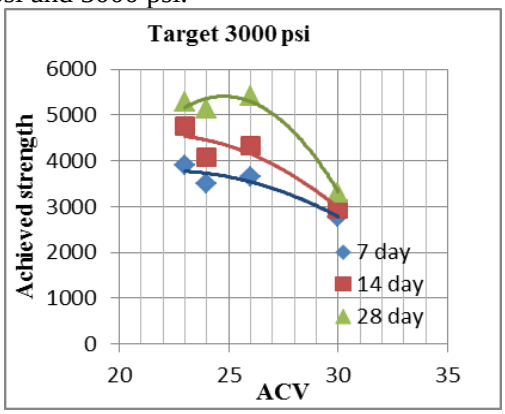

Fig. 4

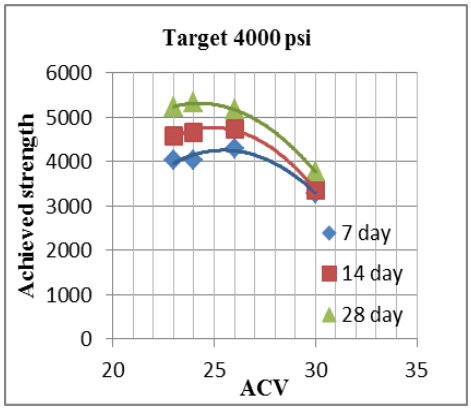

Fig. 5

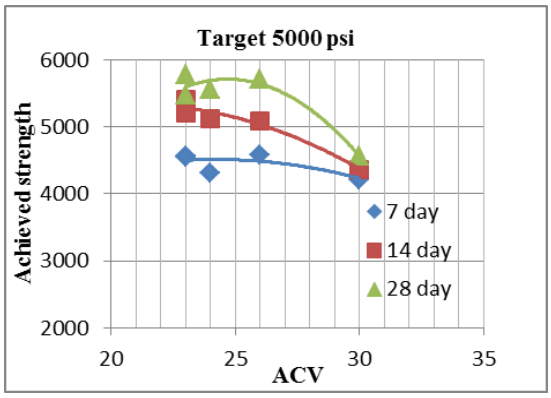

Fig. 6

Fig. 4 shows that, with the increase of time, the nature of graph tends to be more erratic. Fig. 5 shows that, the curves at 7, 14 and 28 day follow almost similar pattern. Fig. 6 shows that, the curves at 7, 14 day follow almost similar pattern. But the 28 day curve is slightly of different pattern.
From Fig. 5 to 6, it is observed that-

- Graphs for 3000 psi and 4000 psi strengths are more erratic in nature than 5000 psi strength.
- Though Volagonj and Meghalaya have same ACV, but they have different compressive strengths.

CONCLUSIONS

This study gives a general scenario of strength development characteristics of concrete for different coarse aggregates having different ACV. It can be expected that these findings will be useful for construction of concrete structure.

Observing the obtained experimental results for concrete with different coarse aggregate having different ACV, the following conclusion can be drawn:

- Higher strength (4000 psi & 5000 psi) concrete is more dependent on ACV than lower strength (3000 psi).
- To achieve 3000 psi, 4000 psi and 5000 psi strength at 28days, concrete should have coarse aggregate having ACV less than 30, 29 and 28 respectively.
- For higher strength concrete, differences between strengths for various coarse aggregate are decreased. So Compressive Strength Vs ACV curve is smoother for higher strength concrete.
- For 7days, all the samples have achieved 65% of target strength.
- For 14days, all the samples have achieved 90% of target strength for 3000 psi target strength. But in case of 4000 psi and 5000 psi target strength, only Priggable could not achieve 90% of target strength.

ACKNOWLEDGMENTS

Thanks to Almighty Allah for His graciousness, unlimited kindness and with the blessings of whom the good deeds are fulfilled.
We would like to extend our heartfelt appreciation to all who have contributed to the study especially:

- Our thesis supervisor, Dr. Raquib Ahsan, professor, Department of Civil Engineering, BUET
- Concrete lab assistants of Department of Civil Engineering, BUET
- Our parents and family
- NDE, the aggregate supplier
- The Civil Department of BUET

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