COMPARATIVE EVALUATION OF CONCRETE FLEXURAL STRENGTH OF RIVER BED AND CRUSHER RUN COARSE AGGREGATE IN POKHARA VALLEY

Er. Tek Bahadur Katuwal[*1]

ABSTRACT

Concrete is fundamental construction material widely used for every building structure and other infrastructure. Aggregate has significantfunctions as concrete making materials for the solidity and strength of concrete.The objective of this research was comparative evaluation of crusher and river bed coarse aggregate in respect to the flexural strength of M20 grade concrete with nominal mix. For this research, sample were taken from Kotre Crusher(KC), Kotre River Bed (KR), Hemja Crusher (HC) and Hemja River Bed (HR) considering sand from single source and cement remains singlebrand.Nine cubes (500 mm × 100 mm×100mm) were cast for each sampled source and the flexural strength was determined using a single point load flexural testing machine after 7 days, 14 days and 28 days of curing.

The mean flexural strength for the KC, KR, HC and HR sources were 4.86 N/mm2, 4.34 N/mm2, 4.58 N/mm2 and 4.1N/mm2, respectively. Also, the percentageincrement of flexural strength for KC, KR, HC and HR sources are 23.31, 19.11, 19.88and 18.12 from 7 days to 14 days and 20.90, 16.04, 18.65 and 16.48 from 14 days to 28days respectively. Modulus of rupture of all aggregate sources are greater than theminimum flexural strength as per IS: 456 – 2000. Finally, outcomes of the study indicated that the flexural strength of Kotre Crusher aggregate is more than other sources and all selected samples applicable for construction work.

Key words: *Aggregate, Concrete, Flexural strength*

1. INTRODUCTIONS

Concrete is a fundamental construction material used in building construction and other infrastructures. Concrete is principally composed of the mixture of cement, fine and coarse aggregates, and water.

The constituents of concrete are cement, water, aggregates (fine and coarse aggregates), aggregates take about three-quarter of the volume of concrete with the coarse aggregates taking between 50 and 60% of the concrete mix depending on the mix proportion used (1). The research work reveled that the aggregates are assumed to be of inert characteristics. The larger percentage of coarse aggregate in concrete mix makes it to contribute a lot to the strength of concrete. Its properties like shape, size, density, soundness, hardness, specific gravity and toughness also affect the strength of concrete.

1 Department of civil and Geomatics Engineering
Tribhuvan University, Institute of Engineering, PashchimanchalCampus, Nepal
* *Corresponding author*
E-mail : tekkatuwal184@gmail.com

Flexural strength (Modulus of rupture) is a measure of the tensile strength of concrete. It is a measure of the capability of a concrete beam or slab to resist failure resulting from bending stresses. Flexural strength is the theoretical maximum tensile stress reached in the bottom fiber of a test sampled beam during a flexural strength test. The flexural test measures the force required to bend a beam under single or double point loading condition (2).

The flexural strengthproperty of concrete is significant particularly when theconcrete structure constructed without steel reinforcement. Forexample, unreinforced concrete roads and runways rely ontheir flexural strengths to safely distribute concentratedloads over wide areas (3). This appears to be also true fortensile strength property of concrete. Hence, findings fromthis research will have great significance in providingapplicable data for the analysis and design of structures in the construction industry of Pokhara valley.

The studies carried out on the strength characteristics of concrete produced using different aggregate materials and using different brands of cement but slight or no consideration have been focused on the flexural bond stress between reinforcement and concrete. Use of poorly graded coarse aggregate in concrete matrix also has it share in the causes of structural failure due to the development of horny comb in the concrete. This also results in a cohesionless composite of concrete and steel with poor flexural bond (4,5,6). The research work revealed that the concrete will not be able to effectively transmit the inducedexternal (flexural) load to the reinforcement, thus resulting in structural failure as the concrete will be subjected to tensile stresses than it can accommodate. Therefore, it is imperative to determine the effect of coarse aggregate size on the flexural bond strength of concrete.

2. MATERIALS AND METHODS

2.1 Materials

2.1.1 Fine and coarse aggregates

For this research, sampled coarse aggregate(25mm down) were taken from Kotre Crusher, Kotre River Bed, Hemja Crusher and Hemja River Bed with considering sand from single source available in the Pokhara valley of Gandaki province.

2.1.2 Cement

The cement remains single brands used is the commercially available Ordinary Portland cement. Portable water free from any noticeable impurities was used for the research.

2.2 Methods

2.2.1. Batching of materials and Workability

The batching of materials for concrete production was for M_{20} grade with nominal mix. Nine similar concrete beams (500mm x100mm x 100mm) were prepared for each sampled source. The casting was made by filling each mould with freshly mixed concrete in three layers. Each layer was compacted manually using a 25mm diameter steel tamping rod to give 25 strokes on a layer. The beam moulds were stored for 24 hours at room

temperature. Apart from the variation in the Coarse aggregate sources the concreting procedures andwater/cement ratio were kept constant for all the samples.

2.2.2 Flexural Strength tests

Further the beam was removed from the mould and put into the fresh water in fully submerged condition. At the end of the 7 days, 14 days and 28 days of casting three beam samples were taken out for each sampled source. The excess water was allowed to drain off. The beam sample was marked at the center and placed at the flexural testing machine. Single point load was applied gradually and uniformly till the failure occurs and maximum breaking load was noted.

Flexural strength of the beam = $(1.5*WL/bd^2)$

3. Results and Discussion

3.1 Flexuralstrength Results

The experimental results of M20 grade of concrete cube with different sources of aggregate are given in Table 1.

Source	Compressive strength (Mpa)		
	Seven Days	Fourteen Days	Twenty-Eight Days
Kotre Crusher	3.26	4.02	4.86
Kotre River	3.14	3.74	4.34
Hemja Crusher	3.22	3.86	4.58
Hemja River	2.98	3.52	4.1

Table: 1Flexural Tensile Strength of M20 Grade of Concrete

KC source has highest and HR has lowest modulus of rupture. Flexural strength of concrete of HR source is lower than the KC by 8.59 % in 7 days, 12.44 % in 14 days and 15.64 % in 28 days. The MOR with KC source is higher by 3.83 % than HC and 7.76 % than HR. Also MOR of HC is higher by 9.81 % than HR. The percentage increment of flexural strength for KC, KR, HC and HR sources are 23.31, 19.11, 19.88 and 18.12 from 7 days to 14 days and 20.90, 16.04, 18.65 and 16.48 from 14 days to 28 days respectively. Modulus of rupture of all aggregate sources are greater than the minimum flexural strength as per IS: 456 – 2000. Which shows that all sampled sources are appropriate for construction work.

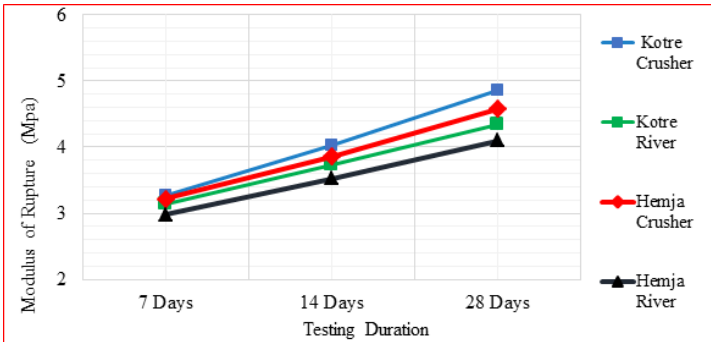

Figure 1 Flexural Strength of M20 Grade of Concrete Beam

Above graph clearly shows that the flexural strength of aggregate from KC is higher than that from KR and HC is higher than that from HR. So it is found that the flexural strength of concrete with crusher aggregate is higher than that from corresponding river bed source. It is because, the load resisting capacity, specific gravity and density of crusher aggregate is higher than the river bed aggregate. Also it is due to the sampled crusher aggregate has less water absorption value, more crushing and abrasion value, which possess good bonding strength between the concrete matrix and developed high flexural strength than the river bed aggregates.

4. Conclusions and Recommendations

4.1 Conclusions

Based on the results of this investigation carried out, the aggregate from KC source has highest and HR has lowest modulus of rupture. Flexural strength of concrete of HR source is lower than the KC source by 8.59 % in 7 days, 12.44 % in 14 days and 15.64 % in 28 days. The MOR with KC source is higher by 3.83 % than HC and by 7.76 % than HR. It has been concluded that the flexural strength of concrete with crusher aggregate has higher value than that of corresponding river bed source.

4.2 Recommendations

Based on the above conclusion, it is recommendations that theflexuralstrengthresultsofall selectedsourcesin7day,14daysand28days are lies within the limit as per NS/ IS code so all sampled sources are suitable for the flexural resisting constructions.[2]

[1] *Waziri, B.S., Bukar, A.G., and Gaji, Y.Z.A., "Applicability of Quarry Sand as a Fine Aggregate in the Production of Medium Grade Concrete", Continental J. Engineering Science, Vol. 6, pp. 1-6, 2011.*

[2] *Ajamu, S.O., and Ige, J. A., "Effect of Coarse Aggregate Size on the Compressive Strength and the Flexural Strength of Concrete beam", Journal of Engineering Research and Applications, Vol. 5, pp. 67 – 75, 2015.*

[3] *Mtallib M.O.A. and Marke A.I., "Comparative evaluation of the flexural strength of concrete and colcrete", Nigerian Journal of Technology, Vol. 29, pp. 13- 22, 2010.*

[4] *Wu, K-R., Chen, B., Yao, W., and Zhang, D., "Effect of Coarse Aggregate Type on Mechanical Properties of High-Performance Concrete", Cement and Concrete Research, Vol. 31, pp. 1421-1425, 1997.*

[5] *Abdullahi, M., "Effect of aggregates type on compressive strength of concrete" International Journal of Civil Engineering and Structural Engineering, Vol. 2, pp.791-800, 2012.*

[6] *Joseph, O., Ukpata and Maurice, E., "Flexural and Tensile Strength Properties of Concrete using Lateritic Sand and Quarry Dust as Fine Aggregate".,ARPN Journal of Engineering and Applied Sciences, Vol. 7, pp. 324-331, 2012.*