COMPRESSIVE STRENGTH OF CONCRETE USING NATURAL AGGREGATES (GRAVEL) AND CRUSHED ROCK AGGREGATES-A COMPARATIVE CASE STUDY

K Bijaya Kumar[1] Durga Prasad Subudhi[2]
[1]Civil Engineering, Gandhi Engineering College (GEC, Bhubaneswar), India
[2]Civil Engineering, Gandhi Engineering College (GEC, Bhubaneswar), India

ABSTRACT

Coarse Aggregates are the main component of concrete and occupy around 45% of the total volume of concrete. Their Properties have a profound effect on the various properties of concrete when wet as well as after hardening. There are many sources in Kashmirwhich have abundant supply of natural aggregates (gravel) cheaply available than machine (jaw crushers) crushed rock aggregates. In our work a comparison of the various properties of concrete made from machinecrushed rock aggregates and natural aggregates (gravel)was done. Need was felt for this study as the major private constructions (some Government constructions) that are carried out in most of Srinagar, Bandipora and Ganderbal districts use natural aggregates procured from nearby Nallas and rivers flowing through Ganderbal District of Jammu and Kashmir. In this study the common practices adopted while making of concrete here in Kashmir were simulated.

The properties compared include workability, strength and permeability. In this paper the compressive strength of the two types of concrete are compared. The compressive strength was found after 28 days on 15cmx15cm cubes as per the guidelines of is 456 2000 and the workability was measured by slump test. The strength was compared for a particular value of workability as in many construction works water is added to concrete till a workable concrete is produced.The workability of the wet concrete was found during mixing and water was added gradually to result in required workability.Two grades of concrete were made M15and M20 from nominal mix ratios of 1:2:4 and 1:1.5:3 respectively.The cement used was 43 grade (locally available brand), sand (Zone-IV), natural andcrushed rock aggregates were procured from east Kashmir (District Ganderbal). Two sizes of coarse aggregates were used 20mm-10mm (60%) and 10mm-4.76mm (40%).It was observed that for the same workability concrete made by using natural aggregate has higher strength as compared to concrete made by using crushed rock aggregates. Workability was kept same as in ordinary constructions in Kashmir.

Keywords: Compressive strength of Concrete, Workability, Natural aggregates, Crushed Aggregates, Aggregates from Kashmir.

INTRODUCTION

Concrete is one of the most Annual global production of concrete is about 5 billion cubic yards. (Source: Cement Association of Canada) Twice as much concrete is used in construction around the world than the total of all other building materials, including wood, steel, plastic and aluminium. (Source: Cement Association of Canada)Concrete is a composite of cement sand, aggregates. Aggregate is granular material such as sand, gravel, crushed stone, blast-furnace slag, and lightweight aggregates that usually occupies approximately three-fourth of the volume of concrete. Aggregate properties significantly affect the workability of plastic concrete and also the durability, strength, thermal properties, and density of hardened concrete. The importance of using the right type and quality of aggregates cannot be overemphasized. The fine and coarse aggregates generally occupy 60% to 75% of the concrete volume (70% to 85% by mass) and strongly influence the concrete's freshly mixed and hardened properties, mixture proportions, and economy. Without the study of the aggregate in depth and range, the study of the concrete is incomplete.

Cement is the only factory made standard component in concrete. Other ingredients, namely, water and aggregates are natural materials and can vary to any extent in many of their properties. The depth and range of studies that are required to be made in respect of aggregates to understand their widely varying effects and influence on the properties of concrete cannot be underrated. Aggregates are classified into fine and coarse aggregates. Fine aggregates generally consist of natural sand or crushed stone with most particles smaller than 4.76 mm .Coarse aggregates, that are used in general construction, consist of one or a combination of particles generally having size between 4.76mm and 20mm. Coarse aggregates can be – natural (gravel), or machine crushed rock aggregate. Natural gravel and sand are usually dug or dredged from a pit, river, lake, or seabed. Crushed stone is produced by crushing quarry rock, boulders, cobbles, or large-size gravel. Close to half of the coarse aggregates used in Portland cement concrete are gravels; most of the remainder are crushed stones.

METHODOLOGY

The mixing of the ingredients wasdone manually on a dry platform. The cement used for making concrete was 43 Grade. Zone IV sand was used. Two sizes of coarse aggregates were used 20mm-10mm (60% of total weight of coarse aggregates) and 10mm-4.76mm (40% of total weight of coarse aggregates).Nominal mix ratios were employed in making the concrete. For M15 the ratio of Cement: Sand: Aggregate was taken as 1:2:4 and in M20 the ratio taken was 1:1.5:3. Water was added intermittently to produce the required workability in the concrete (Common Practice). Slump test (Figure 1) was done simultaneously to find the workability. 15cm cubes were casted following the procedure laid down in IS456-2000. The cubes were watered regularly. Compression strength test was carried out after 28 days of casting on a compression testing machine (figure 2, figure 3). The failure load was noted and the strength (stress at

failure) was calculated by dividing the load by area of a face of the cube.i.e,Stress= load at failure/area, where Area being = 15x15 cm^2.

Figure 1: Proceeding of Slump test

Figure 2: Cube specimen loaded in compression testing machine

Figure 3: Cube specimen after failure

DISCUSSION

From those above results concrete made from natural aggregates has higher compressive strength than the concrete made by using crushed rock aggregates (at same workability of 75 mm) by 9% in case of M15 grade and 6.7% in case of M20 grade . Thus it is evident that to produce the same workable concrete using natural aggregates and crushed rock aggregates the resulting concrete from the natural aggregates hasa higher compressive strength than concrete made from crushed rock aggregates. The reason being that natural aggregates have lesser surface area than crushed rock aggregates and thus lesser surface area would use up lesser amount of water to wet their surface for making a workable concrete. Thus for producing a particular workability in concrete natural aggregates require lesser amount of water as compared to crushed rock aggregate concrete. It is established that lower water content in concrete will result in higher strength. Thus, since lower water content was needed by natural aggregate concrete than crushed rock aggregate concrete, the concrete made by using natural aggregate concrete shows higher strength than concrete made by using crushed rock aggregate.

CONCLUSION

From the study it is clear that the concrete that natural aggregates (gravel) result in higher strength than the concrete made from crushed rock aggregates for same workability. Also natural aggregates require less water to produce a particular workability than crushed rock aggregates.

REFERENCES

[1] American Society for Testing and Materials (1988) Standard descriptive nomenclature of constituentsof natural mineral aggregates, ASTM C294–98.

[2] British Standards Institution (1992) Specification for aggregates from natural sources for concrete, BS 882.
[3] British Standards Institution (2002) Aggregates for concrete, BS EN 1260.

[4] Fookes, P.G., Gordon, D.L. and Higginbottom, I.E. (1975) Glacial landforms, their deposits and engineering characteristics, in the engineering behaviour of glacial materials. Proceedings of a symposium of Midland Soil Mechanics and Foundation Engineering Society, reprinted by Geoabstracts, Norwich, 1978.

[5] Fookes, P.G. and Higginbottom, I.E. (1980) Some problems of construction aggregates in desert areas, with particular reference to the Arabian Peninsula. I – Occurrence and special characteristics. II – Investigation, production and quality control, Proc. of the Institution of Civil Engineers, Part 1, 68, Feb. pp. 39–90.

[6] IS:456-2000, “Plain And Reinforced Concrete - Code Of Practice” (Fourth Revision) .

[7] IS: 383-1970, “Specification For Course And Fine Aggregates From Natural Sources For Concrete” (Second Revision) – 9th reprint Sept-1993.

[8] IS 7861 “Code Of Practice For Extreme Weather Concreting”.(Part-II)- Sixth reprint Oct-2000.
[9] M S Shetty, “Concrete technology theory and practice”, 2005.
[10] M L Gambhir, “Concrete Technology”, 2013.
[11] Pike, D.C. (ed.) (1990) Standards for Aggregates, Chichester: Ellis Horwood.

[12] Smith, M.R. and Collis, L. (2001) Aggregates: Sand, Gravel and Crushed Rock Aggregates for Construction Purposes, Engineering Geology Special Publications,
[13] Primel, L. and Tourenq, C. (eds) (2000) Aggregates (English Translation), Rotterdam: A.A.
[14] Balkema.17, London: Geological Society.

[15] Smith, M.R. and Collis, L. (eds) (1993) Aggregates, sand, gravel and crushed rock aggregates forconstruction purposes, 2nd edn. Geological Society Special Publication No. 9, London.

[16] Smith, M.R. and Collis, L. (eds.) (2001) Aggregates, sand, gravel and crushed rock aggregates for construction purposes, 3rd edn. Geological Society Special Publication No. 9, London.

[17] Pinal C. Khergamwala, Dr. Jagbir Singh and Dr. Rajesh Kumar, “Effect of Recycled Coarse Aggregates on Characteristic Strength of Different Grades of Concrete” International Journal of Civil Engineering & Technology (IJCIET), Volume 4, Issue 6, 2013, pp. 186 - 192, ISSN Print: 0976 – 6308, ISSN Online: 0976 – 6316.

[18] M. Venu & P. N. Rao, “Study of Rubber Aggregates in Concrete: An Experimental Investigation” International Journal of Civil Engineering & Technology (IJCIET), Volume 1, Issue 1, 2013, pp. 15 - 26, ISSN Print: 0976 – 6308, ISSN Online: 0976 – 6316.
[19] Madan Mohan Reddy. K, Sivaramulu Naidu. D, Sanjeeva Rayudu. E, “Studies on Recycled Aggregate Concrete by Using Local Quarry Dust and Recycled Aggregates” International Journal of Civil Engineering & Technology (IJCIET), Volume 3, Issue 2, 2012, pp. 322 - 326, ISSN Print: 0976 – 6308, ISSN Online: 0976 – 6316.