Urgent need for a new aggregate standard

Discussion by N. Subramanian

Replies by D. Satish Kumar, L.R. Manjunath, M.C. Nataraja, M. Kaza and S.M.R. Prasad

READER'S QUERY

This has reference to the point of view feature titled 'Urgent need for a new Aggregate Standard', authored by D. Satish Kumar, L.R. Manjunath, M.C. Nataraja, M. Kaza and S.M.R. Prasad, published in The Indian Concrete Journal (May 2016, Vol. 90, No. 5, pp. 65-72).

The authors are to be appreciated for a timely paper in which they cite several codes of other courtiers such as Australia, European Union, Hong Kong, Japan, Korea, and USA, where the use of alternative aggregates have been permitted and guidelines provided. Hence they urge the Bureau of Indian Standards to include similar provisions in Indian codes pertaining to aggregates such as IS 383, IS 2116 and IS 1542.

But surprisingly they have cited 1970 version of IS 383 [the year is wrongly printed as 1997 in Reference list (Ref. 20) of the paper], though the draft for the Third Revision of IS 383 was under circulation from 14th November 2014, the final draft was issued by the Bureau of Indian Standards on 16th March 2015 and subsequently the code has been published in 2016. Now IS 383:2016 includes provisions regarding quality requirements of iron slag, steel slag, copper slag, recycled aggregate (RA) and recycled concrete aggregates (RCA), along with necessary provisions relating to their utilization. A brief note on manufacture of various types of such manufactured aggregates is also given at Annex A. According to this standard, a crusher dust (or quarry dust) produced from the fine screening of quarry crushing cannot be called crushed sand. It also specifies that such crusher dust cannot be expected to perform as efficiently as properly crushed sand.

References

41. _____ *Coarse and fine aggregates for concrete-specification*, IS 383:2016, Third Revision, Bureau of Indian Standards, New Delhi

– **Dr. N. Subramanian,** Consulting Engineer, Gaithersburg, MD, USA

AUTHOR'S REPLY

The authors thank the discusser for his interest in our paper and suggesting few points as mentioned in their paper. The authors are well aware of the draft code which was on circulation. The authors have sent their comments on the draft to BIS for possible consideration and discussion and later to incorporate few important things in the final code. This paper published in ICJ has been sent for possible review long back and its publication was delayed. In the mean time the BIS has released the final version of IS 383:2016 in January 2016[1].

I agree with the discussers that the new code IS 383:2016 includes provisions regarding iron slag, steel slag, copper slag, recycled aggregate (RA) and recycled concrete aggregates (RCA), along with necessary provisions relating to their utilization in concrete. There are many issues related

to durability of manufactured aggregates which are not addressed in the 2016 code. In addition as mentioned by the discusser, a brief note on manufacture of various types of manufactured aggregates is also given in the Annex A [1].

The discusser highlights about the draft code. As the code is still not accepted and released, one cannot take any provisions as accepted and published. Information available in the draft is for comments only and not to be reproduced without the permission of BIS or used as an Indian Standard. The authors are well aware of these draft codes but not aware as to when the final version of IS 383 will be published by BIS and made available to the public. In the mean time authors thought that it would be more appropriate to publish an elaborate paper on manufactured aggregates taking the information from many national and international standards so that many new things could be addressed in the new version of IS 383.

The authors agree that the earlier code IS 383 was first released in 1970 [2]. We cannot quote the code as 1970 code. The reason for mentioning the year as 1997 is to inform the readers that the discussion is based on the ninth reprint of IS 383 published in September 1993 and reaffirmed in 1997, which was reaffirmed further in 2002.

The authors would like to inform the discussers that the IS 383:2016 though has many new provisions with regard to manufactured aggregates, it is still not comprehensive when compared to international codes of practices. Everybody should appreciate and compliment BIS for its efforts in bringing this new code. Some of the points which need to be addressed in the subsequent revisions are as follows.

Durability of m-sand for use in aggressive environment, as for coarse aggregates, needs to be addressed seriously. Many important properties such as strength, hardness, toughness (energy absorption capacity) and the ability to resist abrasion (wear and tear) are equally important. Although the sand will not tend to carry load in the structure to the same extent as the jelly (coarse aggregate), the m-sand (fine aggregate) must be sufficiently durable so that it will not break away on the concrete surface, nor should the particles be soft enough that they can be abraded due to wearing action. M-sands are tested for durability using either the Sand Equivalent test, the Degradation Factor Fine Aggregate, or the Sodium Sulfate loss in countries like Australia (AS 1282 and AS 1141). These tests to certain extent measure clay minerals present in m-sand. Another important test to be addressed is the Methylene Blue Value (MBV) test which has some relation with the results obtained from the above tests. The Sand Equivalent measures clay in the microfines of the aggregate grading while the Degradation Factor and the Sodium Sulfate are affected by minerals within the broken rock particles in the coarser portion of a m-sand. As per the literature it is observed that Sodium Sulfate and Degradation Factor may be more suited for testing washed sands while the sand equivalent is better suited for unwashed sands [3-5].

Another important test to be addressed is the 'hardness' or 'toughness' of m- sands [5]. In Australia, for this purpose the Micro Deval procedure is recommended and the facility is available only with few companies. With this apparatus it is possible to assess abrasion resistance, which is particularly required for m-sands used in concrete roads, pavements and industrial floors [6].

Lots of studies in the direction of durability have been taken up at Sri Jayachamarajendra College of Engineering, Mysore [7]. Sand equivalent, MBV and flow characteristics are some of the properties addressed. The MBV of the manufactured sand is evaluated by the International Slurry Seal Association (ISSA) to identify and quantify the amount of harmful clays of the montmorillinite group, organic matter and iron hydroxides present in m-sand. The test method titled "Determination of Methylene Blue Adsorption Value (MBV) of Mineral Aggregate Fillers and Fines," is contained in Technical Bulletin 145 of ISSA. The main principle followed in testing is to add certain quantities of a standard aqueous solution of the dye (methylene blue) to m-sand sample until adsorption of the dye ceases. M-sand is generally considered suitable for concrete if the multiple of the MBV and the passing 75-micron size of the sample is 150 or less. However, the value of the multiple (MBV x passing 75-micron) for the fine aggregate used in concrete should be maintained at a value of 100 or less, this means that any m-sand with a value greater than 100 must be used in a blend with another m-sand or a natural sand so that the combination of materials conforms to the 100 limit [8-11]. In fact the blending of different sands and m-sands in permitted in IS 383:2006 as well. As these blends are usually produced at the production plant, some responsibility for the control of the blend must rest with the producer. Deleterious fines may be controlled using the Sand Equivalent procedure.

Another important property of m-sand is its ability to flow through an opening. This method of characterization should be adopted before using any manufactured sand in mortar or concrete [12]. This characterization based on the un-compacted void content of m-sand as per ASTM C 1252 [13] and NZS 3111 [14]. The equipment were fabricated as per the code by one of the authors and m-sands from different sources and their combinations were tested in the laboratory as per the code. When this test is done on a sample of known grading, we will get an idea about aggregate shape and surface texture and this can be compared with other samples to determine the best suited fine aggregate. When the as received grading sample is taken, the void content measured gives us an indication of the effect of this fine aggregate on the workability and water demand of the mix in which it will be used. Based on the test results it can be concluded that any m-sand can be easily characterized to know its performance in concrete. These tests also helps manufacturer to control the crushing process to enhance the quality of m-sand. Bureau of Indian standards should look in to this method seriously for inclusion in the code [15,17].

References

1. _____*Specification for coarse and fine aggregate for concrete*, IS 383:2016, Bureau of Indian Standards, New Delhi, India, January 2016.

2. _____*Specification of coarse and fine aggregate from natural sources for concrete*, IS 383:1970 (reaffirmed 1997), Bureau of Indian Standards, New Delhi, India

3. F. N. Hveem, "Sand Equivalent Test for Control of Materials During Construction," Proceedings, Highway Research Board, Vol. 32, 1953.

4. International Slurry Seal Association, "Test Method for Determination of Methylene Blue Absorption Value (MBV) of Mineral Aggregate Fillers and Fines," ISSA Bulleting 145, 1989.

5. D. Satish Kumar, L.R. Manjunath, M. C. Nataraja, Marutiram Kaza, and S.M.R. Prasad, 'Urgent need for a new aggregate standard', The Indian Concrete Journal, Vol. 90, No. 5, pp. 65-72

6. Guide to the Specification and Use of Manufactured Sand in Concrete, Cement Concrete & Aggregates Australia, CCAA T60, 2008.

7. S. Karthik, 'Characterization of m-sand based on the flow characteristics. M. Tech. Thesis submitted to Visvewaraya Technological University, Belagavi, Karnataka, 2015

8. Ilker Bekir Topcu and Abdullah Demir, Relationship between methylene blue values of concrete aggregate fines and some concrete properties, Canadian Journal of Civil Engineering, Vol. 35, No. 4, 379-383, 2008.

9. H. E. H. Seleem and A. Ei-Hefnawy, "Evaluating the effects of gravel fine impurities on concrete performance", Journal of Engineering and Applied Science, Vol. 50, 1073-1090, 2003.

10. A. I. G. Yool, T. P. Lees and A. Fried, "Improvements to the methylene blue dye test for harmful clay in aggregates for concrete and mortar", Cement and Concrete Research, Vol. 28, No. 10, pp. 1417-1428, 1998.

11. N. B. Higgs, "Preliminary studies of methylene blue adsorption as a method of evaluating degradable smectite-bearing concrete aggregate sands", Cement and Concrete Research, Vol. 16, No. 4, pp. 525-534, 1986

12. M. C. Nataraja, S. Karthik and A. N. Madhusudan, 'Characterization of manufactured fine aggregates based on uncompacted void content as per ASTM C 1252-03 – Urgent need for Indian scenario', The Indian Concrete Journal, Vol. 90, No. 1, 2016, pp. 59-68.

13. ASTM C1252, Standard test methods for uncompacted void content of fine aggregate (as influenced by particle shape, surface texture, and grading), Philadelphia, PA: American Society for Testing and Materials.

14. T279, Flow Cone Test Method for determining flow time and voids content of fine aggregate by flow cone. T279 is a NSW government document based on NZS 3111:1986.

15. M. C. Nataraja, Ranjitha Manohar, Navya Anu Varghese and Romika R Kotian, 'Parametric and experimental studies on the performance of Self Compacting Concrete using alternative sands through mix design', The Indian Concrete Journal, Vol. 90, No. 6, pp. 51-62

16. M. C. Nataraja and H. R. Priyanka, 'Characterization of Blended Manufactured Sand (M-sand) Based on New Zealand Flow Cone Method', Indian Journal of Advances in Chemical Science, Special issue, An international peer reviewed chemistry journal, ISSN No.: 2320-0898 (Print); 2320-0928 (Electronic), S1, May 2016, pp. 230-235

17. M. C. Nataraja, 'Characterization of manufactured sand based on international codes of practices', Invited technical talk, Proceedings of the International Conference on Advanced Materials and Technology (ICMAT-16), Sri Jyachamarajendra College of Engineering, India, 26-28 May 2016.

– Reply on behalf of all authors, by **Dr. M.C. Nataraja**, Professor, Civil Engineering Department, Head of the Department of Construction Technology and Management, JSS Science and Technology University (Formerly Sri Jayachamarajendra College of Engineering), Mysore 570 006, Karnataka.