Modulus of elasticity, modulus of rupture and compressive strength relationships of concrete containing GGBFS

Dear Sir,

This has reference to the paper titled 'Modulus of elasticity, modulus of rupture and compressive strength relationships of concrete containing GGBFS' authored by M. Shariq, J. Prasad, A. Masood and A.K. Ahuja, published in the November 2013 issue of The Indian Concrete Journal (Vol. 87, No. 11 pp. 53-60).

I appreciate the author's work for finding out the values experimentally and indeed it is a good work done by them. I have a small doubt in the concrete mix proportions as printed in Table 2 [vide page number 55]. The quantities of cement, FA, CA, w/c ratio given for the Mix ID (mentioned in the above Table 2) are presented in the table shown below.

I request the author to inform me the 'Exposure condition' and the zone number for sand. I presume that the total weight of cement, FA, CA and water should exceed / equal the usually assumed density of concrete of 2400 kg /m^3. Here, I notice that all the three sample weights of such concrete are below 2400 kg per m^3. Is it correct to accept the quantities of FA, CA as given in view of this ? I request the authors to enlighten me more on this topic.

Thanking you,

Yours faithfully,

S. Lakshmanan, BE., MIE., FIV., MSEI., C.ENGG[IND]., DA.,
Chartered Engineer,
'Sri Sai Nivas ', Ovium Apartment,
Block III, Flat I, Perumal Malai Road,
Narasothypatty, Salem-636004.

Mix group	Mix id	Cement (kg/m^3)	FA (kg/m^3)	CA (kg/m^3)	w/c ratio	Weight of water	Total weight
Mix-I	S.10	400	665	1107	0.45	180	2352
Mix -II	S. 20	350	680	1132	0.50	175	2337
Mix-III	S 30	320	688	1145	0.55	176	2329

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THE AUTHORS' REPLY

Dear sir,

The query raised by one of the ICJ's readers is quite interesting. The discussion of the above query (on the total weight of ingredients of concrete) is given below.

Query-1: The 'Exposure condition' and the Zone number for sand.
Answer: The exposure condition is mild exposure and the sand used in the present research work is lying in zone-II (already given in paper).

Query-2: I presume that the total weight of cement, FA, CA and water should exceed / equal the usually assumed density of concrete of 2400 kg /m^3. Here, I notice that all the three sample weights of such concrete are below 2400 kg per m^3. Is it correct to accept the quantities of FA, CA as given in view of this ? I request you to enlighten me more on this topic.
Answer / comments: The concrete mixes given in Table 2 were decided on the basis of method of trials and keeping view the guidelines of mix design of Indian Standard Code IS 10262:1982. The quantities of ingredients for one cubic metre of concrete were calculated by using the *absolute volume method*. The ratio of fine aggregate to coarse aggregate (FA/CA) was kept constant i.e. 0.6 from the consideration of maximum density of combined aggregate. Amount of entrapped air was taken as 2 percent of total volume.

It has been observed that the volumetric content of the ingredients of concrete mix proportioning affects the density of concrete. In practice, the density of normal weight concrete has been calculated within the range of 2200 to 2600 kg/m^3 (A.M. Neville, "Properties of concrete", Fourth edition, Pearson Education, New Delhi, 2005).

It has also been observed that the total weight of ingredients of concrete mixes calculated by using absolute volume method is lower than the density of concrete of 2400 kg/m^3 (N. Krishna Raju, "Design of concrete mixes", Fourth edition, CBS Publishers and Distributors, New Delhi, 2004).

The benefits of using concrete with lower density are:

1. Used in load bearing elements of smaller cross section
2. Reduction in the size of foundation
3. Construction on ground with low load bearing capacity
4. Gives better thermal insulation

Finally, it has been concluded that the concrete mixes designed by the absolute volume method or by using the recommended guidelines of IS 10262:1982 gives the total weight of ingredients of concrete i.e. cement, FA, CA and water lower than the density of concrete of 2400 kg/m^3. The reason may be attributed due to the consideration of volume of air entrapped in the IS mix design procedure, result in reducing the absolute volume of fresh concrete.

Mohd Shariq PhD, BE, ME
Assistant Professor
Civil Engineering,
University Polytechnic,
Aligarh Muslim University
Aligarh, Uttar Pradesh