Mix-Design Decision Making of Gap Graded Porous Concrete

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Abstract - Choice of aggregate particle size will affect the compressive strength of porous concrete. Using gap-graded aggregates to cast porous concrete will significantly affect the packing arrangements of concrete in a cube, and compaction of concrete mix would further affect the packing. To study the influence of aggregate gradation and compaction efficiency, the cubes with five different aggregate proportion of two size range aggregates (12 – 18 mm and 18 – 25 mm) and eight different level of compaction were practiced for two different aggregate to cement ratios of 2.5 and 5.0. The results show that the compressive strength of porous concrete is found to be depend on the aggregate gradation and also the compaction energy. The compressive strength varies around 4 – 16 MPa for Aggregate to cement ratio of 5.0 and around 4 – 30 MPa for Aggregate to cement ratio of 2.5. The rate of strength development is found to be more for the mixture with the higher proportion of smaller aggregate (P0.1 and P0.2) and with the adequate binder content.

Keywords: Gradation, Gap-graded, Porosity

I. INTRODUCTION

Porous concrete is widely used in constructing eco-friendly structures like permeable pavements, thermal insulator, noise absorber and concrete bed for vegetation. Especially it is used in large scale for load bearing, non-load bearing cast in-situ external walls for single story and multi-storeyed buildings. Even the mass production is high in the industrial applications, all the mix proportions used up to now is from the trial-and-error methods [1], because of the uniqueness of each application. And it is not cost-effective. So, the need of mix-design by optimizing porosity [2] with the compressive strength [3] is inevitable in successful industrial scale application

II. MATERIALS AND METHOD

Our project is aimed to prepare a mix design of gap graded porous concrete, for the gap gradation of aggregates, initially locally available aggregates were sieved with the range of 1inch 0.5 inch. Then all the aggregates which passes 1-inch Sieve net and retained on 0.50 sieve net is again sieved by 0.75-inch sieve net in order to get two size rage particles of 0.50-0.75 inch and 0.75-1.0 inch and finally these two rages of aggregates were separated. In order to ensure the quality of an aggregate, aggregate impact value test, aggregate absorption test and specific gravity test of the aggregates were carried out according to the ASTM (American Society for Testing of Materials) standard.

Generally, W/C (Water to Cement) ratio between 0.30-0.35 is practiced in order to get optimum results [4] but the results didn't indicate 0 slump. As per the theory, porous concrete should be having 0 slump, in order to attain 0 slump, the cubes of W/C ratios between the ranges of 0.30-0.35 are casted and the results were analysed. The cubes were casted with analysed water to cement ratio in order to develop the mix design.

Cement and the coarse aggregates are the material used to cast the cubes, the aggregates ranged between 0.75 inch to 1 inch is proportionally mix with the aggregates ranged between 0.5 inch to 0.75 inch for a constant water to cement ratio of 0.31 as optimum value obtained. And it is followed for two aggregate to cement ratios of 2.5 and 5.0 to evaluate the clear variations, also 8 different level of compaction up to 75 blows were practiced, in each mix proportion, 4 cubes were casted and average is taken for the analysis. For each time of preparing the concrete cubes. Coarse aggregate, cement and water are measured according to the specified proportion and initially weighed aggregates and the cement are well mixed for 2 minutes and then after water is added in two-time intervals to get a proper mixture. Then the concrete mixture is poured in 150*150*150 mm cube with the planned compaction blows using standard proctor. Control cubes were casted to ensure the quality of the results.

III. RESULTS AND DISCUSSION

Fig 1 shows the variation of the compressive strength and the porosity with eight different level of compaction for A/C (Aggregate to Cement) of 2.5; likewise, it was followed for A/C of 5.0. Density is an important factor in deciding a compressive strength.

The study resulted that the wet and dry densities are little same, and the density is decreasing with the increase of A/C, for all the aggregate proportions as it has less amount of cement content. The density is increased with the compaction because of reduction in porosity, even though the deviation of the resulted density for each A/C is very high for same compaction blow. The higher proportion of larger aggregates (P0.1) resulted high density for A/C-2.5 and less density for A/C-5.0

while the p0.5 resulting approximately same density for both A/C, but it shows a slight increment of density with compaction blows later, with that A/C-2.5 is considerable A/C of 2.5 showing unevenness in the variation of density up to 30 blows while A/C of 5.0 behaving it up to 15 blows.

As shown in the graph, porosity of the cubes decreases with the compaction blows and the reduction is low for A/C-5.0 than A/C-2.5, and also the rate of reduction for all aggregate proportion is same for all aggregate to cement ratio except P0.5. In the case of A/C-2.5 the proportions of 0.3, 0.4 and 0.5 has same initial porosity, later proportions 0.3 and 0.4 are eventually decreases and showing similarities with the rest of proportions 0.1 and 0.2 while 0.5 has less reduction in porosity (highlighted in the graph).

The compressive strength variation for all aggregate proportion is not same for A/C -2.5, because of different packing structure due to the gradation of aggregate. Up to 30 blows of compaction, all the proportions are little linear in variation with a small deviation but at 75 blows it shows a huge deviation, because of sudden increment by the P0.1 and P0.2, and both proportions didn't reach the saturation level up to 75 blows while other proportions are reached, whereas in the case of A/C-5.0 it is going inverse that, P0.5 has more strength while other proportions are behaving less than and little same.

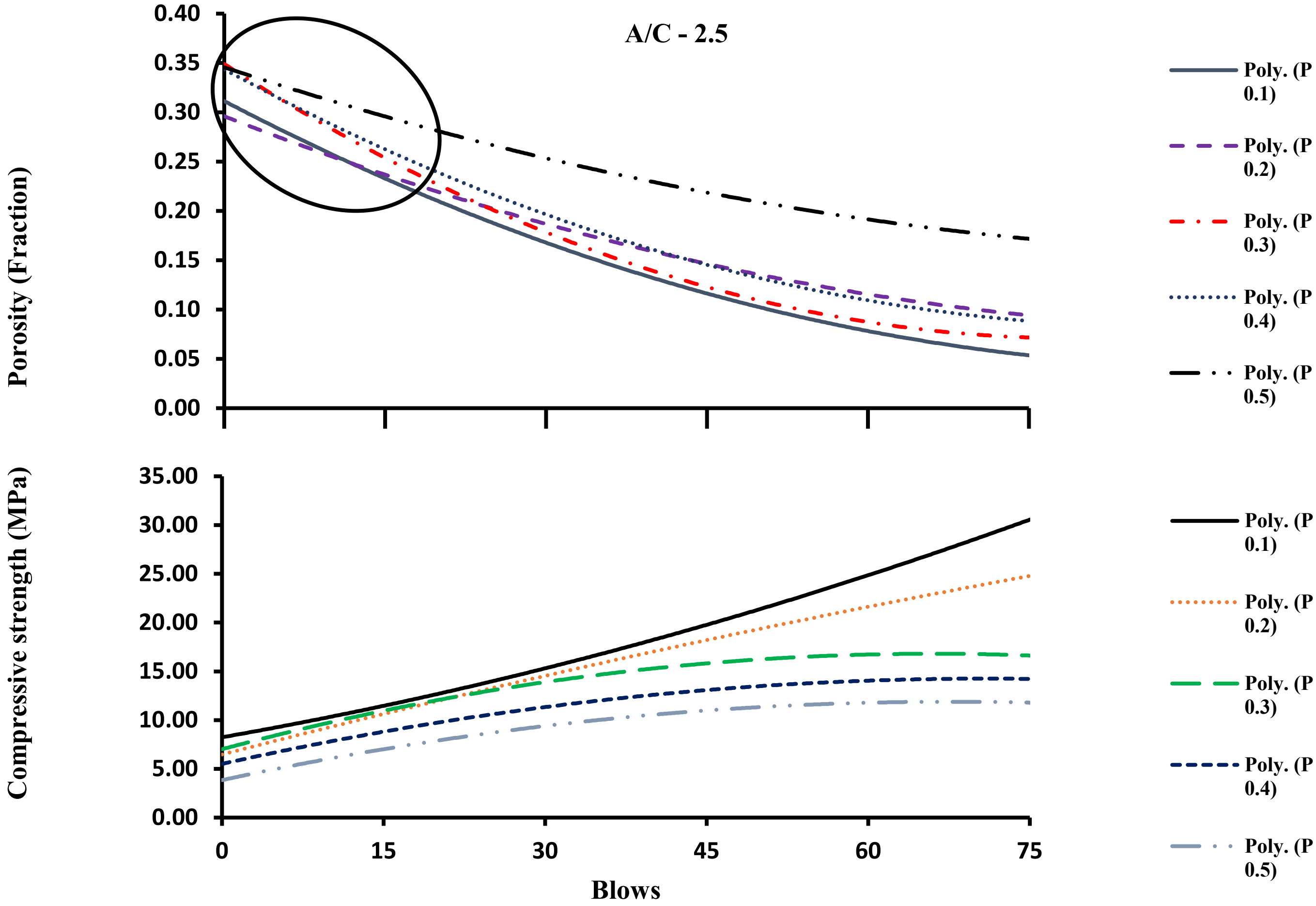

Fig 1: Variation of compressive strength and porosity with compaction blows for A/C-2.5

IV. CONCLUSIONS

The variation of porosity in A/C-2.5 is mostly depend on the portion of binder (filling the pores) rather packing of aggregate. The excess amount of paste content (A/C-2.5) is not suitable in bringing a proper mix design with compaction blows as it takes more amount of blows to reach the stable packing and showing randomness. Also, the effect of compaction on the porosity is very law for the mixture P0.5 because of all the aggregates are with a stable packing, as it has more number of aggregates inside the cube.

Higher proportion of 12-18mm (P0.5 and P0.4) aggregates is very supportive in developing compressive strength for mixture with adequate binder content. P 0.1 of A/C -5.0 and P0.4 A/C-2.5 are more effective in optimizing Porosity with Compressive strength.

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