Recycling of Concrete as Coarse Aggregates: Bangladesh Perspective

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Coarse aggregate, fine aggregate, cement and water are the major constituents to make concrete. All of these components are generally derived from natural resources. The sources of crushed stones or shingles for use as coarse aggregates are limited in Bangladesh. So graded crushed bricks are also used historically as an alternative coarse aggregate. Since, the coarse aggregate forms the major volume of concrete there lies an potential opportunity to reduce the use of natural resources by recycling the demolished concrete as coarse aggregates in a country like Bangladesh where natural resources are limited but anticipated pace of infrastructure development is quite fast. The changed development scenario of the country further indicates towards maximizing the land use through demolishing old low-rise structures with the high-rise ones. Therefore, recycling of demolished concrete can save the environment further by efficient and cost effective management of generated solid wastes.

Figure 1: Stone aggregate (S) concrete

In view of this, a need based research project was initiated in the Civil Engineering Department of Bangladesh University of Engineering and Technology (BUET) with the objectives to obtain a reliable and cost effective method of producing aggregates from recycled concrete by using locally available indigenous techniques, to determine the various fundamental material properties of recycled stone aggregate concrete (RS), recycled brick aggregate concrete (RB) when used as coarse aggregates, to ascertain the problems of using ACI mix design methodology for making concrete with such recycled aggregates, to study the effect of discontinuous curing on the concrete from RS, RB and also to ascertain the correlations like the rebound number vs. concrete strength and the penetration value vs. concrete strength for various NDT techniques, e.g. Schmidt Hammer, Windsor Pin methods, respectively. To this end, the results obtained from concrete made by using RS and RB are compared with those concretes made of crushed stone (S) and crushed brick (B), respectively.

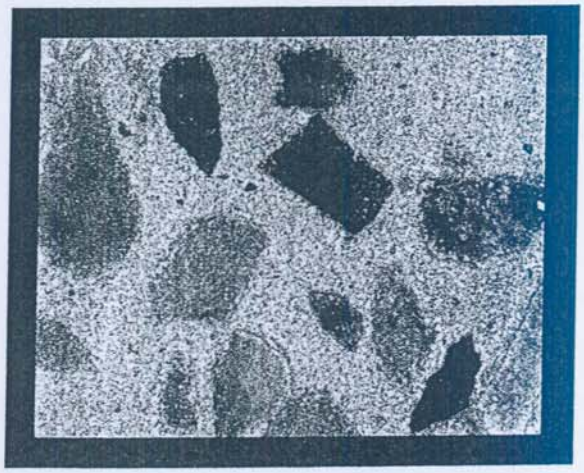


Figure 2: Rec ycled stone aggregate (RS) concrete

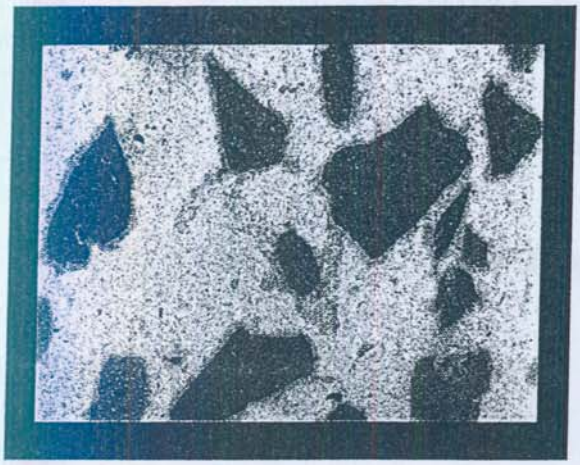
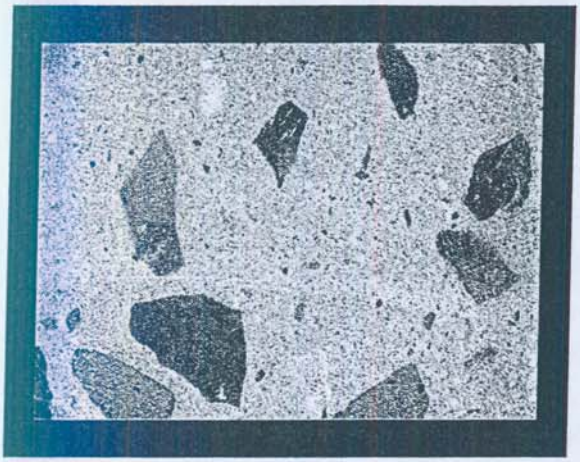


Figure 3: Brick aggregate (B) concrete Figure



4: Recycled brick aggregate (RB) concrete

The initial results indicate that brick aggregates or recycled brick aggregates are remarkably low in unit weight and specific gravity than stone aggregates or recycled stone aggregates. The absorption vales indicate the presence of larger void fraction in the aggregates of lighter unit weight.

Furthermore, due to the presence of some weak mortars, recycled aggregates have higher Loss Angeles abrasion value than their parent aggregates. In general, for given cement content, concretes from recycled aggregates were distinctly found to give higher strengths than those from their parent aggregates. The surface characteristics of recycled aggregates may have a role behind displaying this interesting feature, but shows the possibility of reducing cement content for achieving the target strength.

The study on the effect of discontinuous curing on strength attainment shows that concrete made from aggregates with higher absorption values are lesser sensitive to discontinuous curing. The absorbed water that remains within the aggregate pores are found to cure the concrete internally at the event of discontinued external curing.

In proportioning the mixes with aggregates of lighter unit weights, the ACI mix design method was found to suggest higher proportion of fine aggregate content for a given cement content. Due to higher fine aggregate content with larger surface area and a limited presence of cement as binder, strength attainment feature of such a mix proportions should not be encouraging. To correct the mix proportion, the combined gradation was carefully studied and then a correction factor has been proposed. By applying such a correction factor, it was possible to obtain mixes that yielded 28-day compressive strength up to 6700 psi (45 MPa) with recycled aggregates. This clearly shows the great potential of obtaining high strength mixes with recycled aggregates.

Finally, attempts are made to obtain and compare the NDT correlations between the locally available aggregates and recycled aggregates. To this end, the Rebound number vs. compressive strength and the penetration value vs. compressive strength for Schmidt Hammer, Windsor Pin methods, respectively were obtained. The results suggest for using different correlations for the variation of aggregates.