ABSTRACT

Concrete technology has made tremendous strides in the past decade. The development of specifying a concrete according to its performance requirements, rather than the constituents and ingredients has opened innumerable opportunities for producers of concrete and users to design concrete to suit their specific requirements. One of the most outstanding advances in the concrete technology over the last decade is “self compacting concrete” (SCC). Self-compacting concrete is a highly flowable, stable concrete which flows readily into places around congested reinforcement, filling formwork without any consolidation and significant segregation. The hardened concrete is dense, homogeneous and has the same engineering properties and durability as that of traditional vibrated concrete. The use of SCC eliminates the need for compaction thereby saves time, reduces labour costs and conserves energy. Furthermore use of SCC enhances surface finish characteristics.

Extensive studies have been made on Self Compacting Concrete with different combinations of mineral and chemical admixtures (chapter 2). However, no significant work has been done on the behaviour of SCC with GGBS and RHA as mineral admixtures.

Hence, the present experimental work is aimed to study the behaviour of combination of GGBS and RHA in different grades of concrete mixes: M20 (low grade), M40 (medium grade) and M60 (high grade). The main aim is to obtain specific experimental data to
understand SCC’s fresh and hardened properties, to evaluate the efficiency of GGBS and RHA combination in SCC, along with the studies on its stress-strain behaviour, flexural behaviour of beams, and durability aspects.

Detailed experimental investigations were carried out to understand the structural behavior of self compacting with GGBS and RHA. In this process, SCC mixes with satisfactory properties in fresh state and having more compressive strengths for different percentage replacement of cement with GGBS and RHA combination were developed. By adding suitable proportions of RHA to the constituent materials the effect of RHA was studied and its strength efficiency is quantified. SCC specimens are tested and models for the prediction of stress-strain behavior of SCC with GGBS and RHA combination were developed.

SCC beams are casted and tested in flexure under controlled deflection. The load-deflection, moment-curvature relationships and deflection profiles were plotted, crack patterns were also observed reasoned and inferred. Using analytical equations developed for the stress-strain behaviour of SCC, theoretical moments were calculated for SCC and curvatures were calculated from the strain distribution over the cross section. From this, moment-curvature relationships were developed and compared with experimental moment-curvature relationships. Finally durability studies are carried out on different grades of SCC mixes with GGBS and RHA.
Based on the present investigations the following important conclusions are drawn-

1. The addition of RHA to GGBS mixes has shown improved performance in terms of strength and durability in all grades of SCC. This is due to the presence of highly reactive silica in GGBS and RHA.

2. Studies indicated that there is a good compatibility between mineral combinations GGBS and RHA along with the chemical admixtures such as SP and VMA when used in SCC.

3. The Bolomey’s empirical expression can be used to predict the strength efficiency of the GGBS and RHA in SCC at different percentage of replacement levels.

4. Similarly experimental studies on efficiency of GGBS and RHA combination in SCC confirmed the enhanced performance in terms of both strength and durability aspects with respect to performance of GGBS alone in SCC.

5. Based on the stress-strain curves of SCC mixes with and without steel confinement it is observed that the stress-strain pattern is to be almost similar. But the GGBS-RHA mixes have shown improved stress values. It is observed that for higher grades of concrete with increase in stress there was decrease in strain.

6. Empirical equations for the stress-strain response of SCC mixes have been proposed in the form of \( Y = \frac{Ax}{(1+Bx^2)} \), where \( x \) is normalized strain and \( Y \) is normalized stress. The same empirical formula is valid for
both ascending and descending portions with different values of constants.

7. It is observed that there is an increase in the peak compressive strength for different SCC mixes made with GGBS and RHA mixes. The increase is due to high reactivity of RHA with GGBS.

8. Addition of GGBS and RHA control the initiation of micro cracks, improve the first crack load, the ultimate load and ductility of SCC specimens under flexure. They are also effective in resisting deformation at all stages of loading from first crack to failure.

9. Load deflection behaviour for all SCC beams is observed to be similar except the increased values of loads at ultimate and at first crack due to addition of GGBS and RHA to SCC mixes.

10. Theoretical moment-curvature relationships for SCC and beams followed similar pattern as that of experimental values. The only difference noticed is the values of theoretical moments calculated are lesser than the experimental values. But the variation is very less, thus theoretical values of moments almost coincide with experimental values. This shows a good correlation between them.

11. The Acid durability factors (ADF) were found to be more in SCC made with GGBS and RHA in all grades. The Acid Attack Factors (AAF) has shown that the GGBS and RHA mixes are more resistant for acid attack.

12. The strength loss and weight loss observed to be less in mixes with GGBS and RHA.