STUDY ON PREPARATION OF CONCRETE BY USING TWO STAGE MIXING APPROACH

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Abstract :*Two-stage concrete (TSC), also known as preplaced aggregate concrete, is a special type of Concrete that is produced using a unique procedure which differs from that of conventional concrete. Exhaustion of landfill areas redevelopment programe in many parts of the country has prompted the use of recycled aggregate. However, the inferior quality of recycled aggregate (RA) has restricted its use to low-grade applications such as roadwork sub-base and pavements, while its adoption for higher-grade concrete is rare because of the lower compressive strength and higher variability in mechanical performance of RA. A new concrete mixing method, that is the two-stage mixing approach (TSMA), was advocated to improve the quality of RA concrete (RAC) by splitting the mixing process into two. The current paper describes the variation of compressive strength by experimental analysis involving the modified mixing method with some alteration to the two-stage mixing approach by proportioning ingredients with the percentage of recycled coarse aggregates (RCA) and fly ash. Based on experimental works and results, improvements in strength to RAC were achieved with TSMA. This can be attributable to the porous nature of RA and the premixing process that fills up some of its pores and cracks, resulting in a denser aggregate and concrete. An improved interfacial zone around RA gives a higher strength than the normal mixing approach (NMA).*

I. INTRODUCTION

Backbone of infrastructural development is construction. Material for the development is concrete, which forms the Indispensable material for construction, can be considered as The second most highly used item in the world after water. The basic constituents of concrete are the natural resources i.e., stone, aggregate, sand and water, suggesting this industry has degrading impacts on these environmental assets. In addition, the quarrying and transportation of aggregates further lead to ecological imbalance and pollution. Not only this, the disposal of the debris of the demolished concrete structures has also become a big problem in various cities due to paucity of landfill sites. India doesn't have a totally focused lean construction forum while some novel initiatives are being taken in some parts of India to adopt leaner construction practices. The paper presents a comparison of the compressive also as flexural strength characteristics of the concrete made through NMA and TSMA. Concept of use of recycled material in concrete is in great demand to make concrete saving both resources and time. Researches are administered on recycled materials which will be utilized in concrete everywhere the planet . one among the recycled material which will be utilized in concrete is recycled aggregates..

II. LITERATUREREVIEW

As per the experimental work done by **Deshpande N.K, Kulkarni S.S and Pachpande H.(2012)[2],** For M25 grade concrete the flexural strength of nominal M25 grade concrete is 3.5N/mm2[3]. Conventional materials satisfies the need with 3.76N/mm2. Split tensile test and Flexural strength both are tests for lastingness of concrete. Concrete made by using recycled aggregates showed slightly lower values of lastingness also as flexural strength, hence the loss in lastingness should be considered while designing members using recycled aggregate concrete.Two-stage concrete (TSC) is defined as concrete produced by placing coarse aggregate Particles in the designed formwork, then filling the internal gaps with a special grout mixture. TSC is known worldwide under different terms that are listed in Table 2.1. These different Names of TSC reflect the difference in its production methods. For instance, in the United Kingdom it is known as "Colcrete" as they mix the grout in a colloidal mixer before injecting It into the coarse aggregate.Generally, the TSC grouting process can be done either by gravity or by a pumping Process **(Abdul Awal, 1984).** In thegravity process (i.e. penetration method), the grout is Poured on the top surface of the preplaced aggregate and allowed to penetrate through the Aggregate body to the bottom of the section under its own weight. However, this method is Particularly useful for grouting thin sections with a depth of less than 300 mm [12 in] **(Champion and Davis, 1958).** In the pumping process, the grout is pumped into the aggregate Mass from the bottom through a network of pipes as illustrated in Figure 2.1. The minimum coarse aggregate size plays a major role in selecting the suitable grouting method. For Instance, the gravity process can be successfully used for aggregates with a minimum size of 50 mm [2 in], while the pumping method is preferred with lower void content coarse Aggregate (i.e. finer aggregates) (Casson and Davies, 1986).

Vyas C.M and Bhatt D.R(2013)[8], in their research on use of recycled Coarse aggregates in concrete have stated that the experimental results show that the early compressive strength of concrete made of natural coarse aggregate and recycled coarse aggregate are approximately same. As the percentage of recycled aggregate are increased then the workability decreases. The compression test result indicates an increasing trend of compressive strength in the early age of the concrete specimens with 60% recycled aggregates. The results also show that the recycled aggregate can be used in concrete with 40% replacement of natural coarse aggregate

TSC differs from conventional concrete in several aspects. First, all ingredients of Conventional concrete are mixed together and then placed in the formwork, while in TSC the Grout ingredients are mixed separately and then injected into the pre-placed aggregate mass As mentioned earlier. Second, TSC has a higher coarse aggregate content (about 60% of the Total volume) than that of conventional concrete (about 40% of the total volume) (Abdelgader, 1996). Hence, TSC can be considered as a skeleton of coarse aggregate Particles resting on each other, leaving only internal voids to be filled with grout (Abdelgader, 1996). Conversely, in normal concrete the aggregates are rather dispersed. Therefore, TSC has a specific stress distribution mechanism at which the stresses are Transferred through contact areas between aggregate particles (Figure 2.2) (O'Malley and Abdelgader, 2009). These stresses can be responsible for the fracture and tearing of aggregate

Particles away from the grout **(Abdelgader and Górski, 2003). Vyas C.M and Pitroda J.K(2013)[9]**, have worked on the mixture of RCA and ash and have concluded that the applications of RCA within the construction area are very wide. the most aim of using RCA is to scale back the utilization of natural aggregates. Another improving method is using ash along side RCA. Application of ash within the recycled coarse aggregate concrete can improve the sturdiness also as strength characteristics of the RAC.

The analysis done by **Puri N., Kumar B. and Tyagi H.(2013)[7],** shows that a big increase in flexural strength was observed when natural aggregates were replaced with RCA. However a decrease in flexural strength wasobserved when natural aggregates were replaced with PVC aggregates. Very low flexural stre ngth has been shown by concrete during which fine aggregates were replaced by pulverized leather waste..

Katz A.(2003)[5], by experimental analysis on the properties of concrete made with recycled aggregate from partially hydrated old concrete and two differing types of cements showed that the difference within the quality of the 2 sorts of cement was clearly seen and therefore the refore the ratios of the flexural and the splitting strengths to the compressive strength values were within an inexpensive range. the upper values of the flexural and splitting strengths relative to the anticipated ones were clearly seen especially for the OPC recycled concrete. Smaller values than the anticipated ones are expected for lightweight aggregate concrete.

Tam V.W.Y et al(2005)[8], proposed the technique of modified mixing of concrete. They concluded that the poor quality of RAC was thanks to higher water absorption and better porosity. The weaker interfacial transition zone (ITZ) between Recycled Aggregates(RA) and cement mortar restricts the appliance of RAC for higher grade applications. during this study, the weakness of RAC is strengthen by the two-stage mixing approach(TSMA), weak link is found at the ITZ of the RA. TSMA provides how for the cement slurry to gel up with the RA, which successively provides a stronger ITZ by filling up the pores and cracks within RA. Laboratory tests shows that the compressive strength has been improved. This TSMA can provide an efficient method for enhancing the compressive strength and other properties of RAC, and thus, the approach exposes a wider scope of RAC applications.

III.MATERIALS USED

A. Coarse Aggregate

The engineering properties of TSC depend to a large extent on the properties of the coarse aggregate used. As mentioned early, the applied stresses in TSC are transferred first to the coarse aggregate particles and then to the hardened grout (Abdelgader, 1996). Hence, choosing the coarse aggregate is a key aspect in TSC mixture design. According to ACI 304.1 "Guide for the Use of Preplaced Aggregate Concrete for Structural and Mass Concrete Applications", the coarse aggregate used in TSC should be washed, free of surface dust and fines, and chemically stable in order to achieve a high bond with the injected grout (ACI 304.1, 2005). Moreover, the shape, texture and mineralogy of the coarse aggregate particles significantly affect the developed bond.

B. Cementitious Materials

Ordinary Portland cement (OPC) is the commonly used cementitious material for TSC grouts. Supplementary cementitious materials (SCMs) including ground granulated blast furnace slag (GGBFS), and silica fume (SF), and metakaolin (MK) had also been used in TSC. Generally, SCMs contribute to the hardened properties of TSC through enhanced particle packing, pozzolanic activity, or both depending on their chemical and physical properties. Hence, SCMs addition is expected to provide several benefits to TSC such as reducing its permeability and improving its mechanical properties and durability (Malhotra, 1993). For instance, the effect of using OPC and fly ash on the mechanical properties of TSC was investigated (Abdelgader, 1999). The addition of class F fly ash led to several benefits, including improvement of the grout flowability, extending the grout's handling time, and reducing the water demand and bleeding of the TSC grout. Adding up to 33% of fly ash as partial replacement for OPC was recommended for TSC mass concrete as it reduces the heat of hydration significantly (ACI 304.1, 2005).

C. Fine Aggregate

The used fine aggregate should be hard, dense, and stable (ACI 304.1, 2005). The grading of the fine aggregate plays a significant role in controlling the flowability of the used grout. Table 2.4 summarizes recommended fine aggregate gradations and sizes for TSC. It was reported that using a well graded fine aggregate increased the stability of the grout and reduced segregation (O'Malley and Abdelgader, 2009). On the other hand, using fine aggregate with a high fineness modulus will increase the water demand, leading to a reduction in compressive strength and an increase of drying shrinkage. It was recommended that the fineness modulus of the used fine aggregate should range from 1.2 to 2.0 (King, 1959).

D. Recycled coarse aggregates

Recycled coarse aggregate (RCA) made from waste concrete is not a suitable structural material as it has high absorption of cement mortar, which adheres on the aggregate surface and on the tiny cracks thereon. Moreover, the carbonation due to cement mortar adhesion was measured through a carbonation test.

E. Fly Ash

Fly ash is employed as partial replacement of cement which replaces 10% of total cementitious material altogether the cases of the experiments. Class F ash is employed from haryana having relative density as 2.4 and satisfying IS 3812-1999[13].

1)Methodology

NMA follows the following steps

1. First, coarse and fine aggregates are mixed.
2. Second, water and cementitious materials are added and mixed.
3. However, TSMA follows different steps:
4. First,coarseandfineaggregatesaremixedfor60secondsandthenhalfofwaterforthespecimenisadded

andmixedf oranother60seconds.

5. Second,cementitious materialisaddedandmixedfor30seconds.
6. Thirdly,therestofwaterisaddedandmixedfor120seconds. ThespecificprocedureofTSMAcreatesathinlayerofcementslurryonthesurfaceofRAwhichisexpectedtogetintotheporous old mortar and fill the old crack sand voids.
7. Using recycled concrete as the basematerialforroadwaysreducesthepollutioninvolvedintruckingmaterial.

IV. EXPERIMENTAL OBSERVATIONS

Following tableshows theexperimentalobservationsofthetestsamples madefromTSMAand nominal mixbyNMA.

M-25(10-25)signifiesthespecimenmixhaving10%flyashand25%RCAcontent.

1. M-25(10-50)signifiesthespecimenmixhaving10%flyashand50%RCAcontent.
2. M-25(10-25)signifiesthespecimenmixhaving10%flyashand75%RCAcontent.
3. M-25(10-25)signifiesthespecimen mixhaving10%flyash and100%RCAcontent

DISCUSSIONS

1. The specimen mix M-25(10-25) shows an increase of 5.46% in 7 day and 6.52% in 28 day compressive strength and shows an increase of 7.98% in 7 day and 7.60% in 28 day flexural strength, however, specimen mix M-25(10-50) shows an increase of13.32% in 7 day compressive strength and 3.72% in 28 day strength and shows an increase of3.04% in 7 day and decrease of0.27%in28dayflexuralstrengthwithrespecttonominalmixspecimen.
2. The specimen mix M-25(10-75) shows an increase of 26.17% in 7 day and 3.72% in 28 day compressive strength and shows a decrease of 3.42% in 7 day and 4.07% in 28 day flexural strength, whereas, specimen mix M-25(10-100) shows decrease of15.10% in 7 day and 11.70% in 28 day compressive strength and shows a decrease of 14.06% in 7 day and 19.02% in 28 day flexural strength with respect to nominal mix specimen.
3. From 28 day strength point of view, specimen M-25(10-25) shows optimum increase in compressive strength i.e 6.52% andflexuralstrengthi.e7.60%withrespecttonominalmixspecimen.

IV.CONCLUSIONS

1. This chapter reports the development of fuzzy logic models for predicting the flowability and Mechanical properties of two-stage concrete. Based on the results obtained in this study, the Following conclusions can be drawn:
2. □ The developed FL models offer simple and flexible tools for predicting the grout Flowability and mechanical properties of TSC in which a variety of SCMs are Incorporated. The properties predicted by the FL models were very close to the actual Experimental results, providing evidence for the potential of these models as predictive Tools.
3. □ The models exhibit adequate capacity of generalization beyond the training stage, as Verified by the fact that the predictions obtained for the new test data that is unfamiliar to The models were within a similar range of accuracy to those obtained for the training Database.
4. o The proposed FL models represent reasonably accurate tools for designing TSC mixtures in which several types and dosages of SCMs are incorporated, and they can also save time as well as reduce wastage of materials and design costs.
5. □ The FL models thus developed are flexible and can be easily updated and modified according to new findings and to accommodate data that might emerge in the future. Indeed, such models are adaptable and can encompass new parameters and new test data.

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