INFLUENCE OF MIXING SPEED AND DURATION ON THE FRESH AND HARDENED PROPERTIES OF REACTIVE POWDER CONCRETE

Shreekant kerai[1], Farhan A.Vahora[2]

1 Research Scholar, Department of Structure Engineering, L.J.InstituteOfEngineering&Technology, Ahmedabad

2 Asst .Prof, Department of Structure Engineering, L.J.InstituteOfEngineering&Technology, Ahmedabad

ABSTRACT

Reactive Powder Concrete is a new generation concrete, is one type of high strength and highdurable concrete which is formed with a special combination of constituent materials. The reactive powder concrete is a composition of cement, silica fume, fine sand, quartz powder. This concrete is capable to achieve a very high compressive strength. Production methodology of Reactive Powder Concrete (RPC) is not clearly established yet, as several parameters have a varied influence on the resulting fresh and hardened properties of RPC. Even for the same composition, the fresh and hardened properties differ significantly by changing mixing speed and mixing time/duration. The present investigation is an attempt to study the effect of speed and duration, on the fresh and hardened properties of RPC. Production methodology of Reactive Powder Concrete (RPC) is not clearly established yet, as several parameters have a varied influence on the resulting fresh and hardened properties of RPC. Even for the same composition, the fresh and hardened properties differ significantly by changing mixing method, mixing speed and mixing time/duration. The present investigation is an attempt to study the effect of mixing method, speed and duration, on the fresh and hardened properties of RPC. The study also deals with the microstructure investigation of RPC mixes.

Keyword- *RPC, Silicafume, Metakaoline, Fresh And Hardened Properties, Drying Shrinkage*

1.1 INTRODUCTION

Reactive Powder Concrete (RPC) is an emerging cementitious construction material which is characterized by its superior properties like high compressive strength, flexural and tensile strength with addition of fibers. The microstructure of RPC is more dense and homogeneous compared to normal concrete. RPC due to its superior performance has provoked many construction practitioners throughout the world in its application to special civil engineering structures, nuclear power plants, petroleum plants, municipal, marine and military uses. The other projects like, roof of stadium, long span bridges, space structures, blast resistance structures, high pressure pipes and isolation and containment of nuclear waste, RPC has been utilized for such specialized applications throughout the world . The ultra-high mechanical performance of RPC, reduces thickness of concrete members leading to large savings in both materials and costs. Owing to its high compressive resistance, precast structural elements can be fabricated in slender form to enhance aesthetics of structure. RPC possesses good durability due to its low porosity nature and dense microstructure. RPC construction requires low maintenance costs in its service life.

2. MATERIALS AND METHODS

2.1. Materials

2.1.1. Cement

Ordinary Portland cement of 53 grades that complies with IS: 12269-1987 was used throughout the experiments.

2.1.2. Silica fume

Undensified silica fume was used in the present study, which complies with ASTM C 1240-95a, and IS: 15388-2003. It exists in grey powder form that contains latently reactive silicon dioxide and no chloride or other potentially corrosive substance.

2.1.3. Silica sand

All RPC mixes were produced using silica sand by replacing coarse aggregate inconventional concrete. The particle sizes used in the experiments is in the range of150 lm–600 lm. The sand used confirms to zone IV grading requirements as per IS:383-1970.

2.1.4. Superplasticizer

In the present study superplasticizer (SP) based on second generation polycarboxylic ether polymers, developed using nano-technology was used from BASF India Ltd. The superplasticizer is an extremely high water-reducing agent that meets requirements of IS: 9103-1999.

2.1.5. Metakaoline

Metakaolin (MK) is a pozzolanic material. It is obtained by the calcination of kaolinitic clay at a temperature ranging between 500 °C and 800 °C. The raw material input in the manufacture of metakaolin ($Al_2Si_2O_7$) is kaolin.

2.2 Parameters

Procedure for studying the effect of mixing speed and duration on the performance of RPC are explained as follows;

2.2.1. Mixing speed.

RPC was produced, using normal Digital Mortar Mixer, which is facilitated with variable frequency drive, the speed of mixing blades can be varied from 5 to 150 RPM. The selected mixing speeds considered for study were 50, 100 and 150 RPM.

2.2.2. Mixing duration.

The present study is an attempt to find an optimum total mixing duration for production of RPC. The total mixing duration is defined as the time elapsed between the loading of all ingredients in first phase to the final discharge of the concrete at last phase. The total duration of mixing studied were10, 15, 20 min.

3. RESULTS AND DISCUSSION

3.2. Effect of mixing speed

3.2.1. Fresh properties

Fresh properties of RPC with different mixing speeds are evaluated It is observed that mixingspeed of 100 RPM has shown higher flow value compared to other mixing speeds (50 and 150 RPM). The lowest flow value is obtained for 50 RPM. This may be due to improper distribution ofwater throughout the mix. With this speed, it is very difficult tobreak down lumps, which gets formed in during mixing process.These unbroken lumps hold water and superplasticizer, as a resultall particles do not get sufficient moisture and superplasticizer. Thereduced flow rate at 150 RPM may be due to high mixingspeeds allowing moisture to evaporate from the mix at a fasterrate. In production of RPC, during mixing process, the point wheresemi-harsh plastic mix gets converts to flowable mix is calledchange point.

3.2.2. Hardened properties

Compressive strength results of RPC with different mixingspeeds are presented in fig. It is noticed thatresults obtained for 7 and 28 days with 100 RPM, have shownhigher strength value compared to other mixing speeds. Thereduced early strength in case of RPC specimen prepared with mixingspeeds of 50 RPM is due to improper mixing speed andnon-uniform distribution of moisture hinders the hydration process.And also, there may be presence of agglomerated particles,due to insufficient mixing speed which slow down the process ofhydration. The reduced 28 days strength values at speeds 50 RPM may be due to agglomerated particles hindering in thehydration process that may lead to development of unhealthy CS-H gel and less quantity C-S-H product at the end of curing.Reduction in compressive strength can be observed for RPC specimen produced with speeds 150 RPM. Thisreduced strength may be due to the escape of bonded water fromthe mix leading to formation of pores.

3.4.3. Effect of mixing duration

This finding is in accordance with compressive strength results in which RPC specimen produced with mixing duration of 20 min has shown lowest strength value compared to RPC specimen produced with mixing duration of 15 min. The results have shown thatmixing duration of 15 min is a beneficial one for RPC production,where in RPC constituents are optimally packed.

5.1.2. Effect of superplasticizer dosage on shrinkage behaviour for RPC

Superplasticizers are chemical admixtures that are incorporatedinto the concrete to increase the workability in its fresh state. Many investigations showed that significant SP dosage is needed to decrease theamount of water required without loss of workability.The high drying shrinkage strain and shrinkage rate are foundfor RPC with higher SP dosages. The high SP dosage would causechanges in the pore structure which influence the state of theevaporable water (or physical bound water) and consequentlythe shrinkage behaviour.

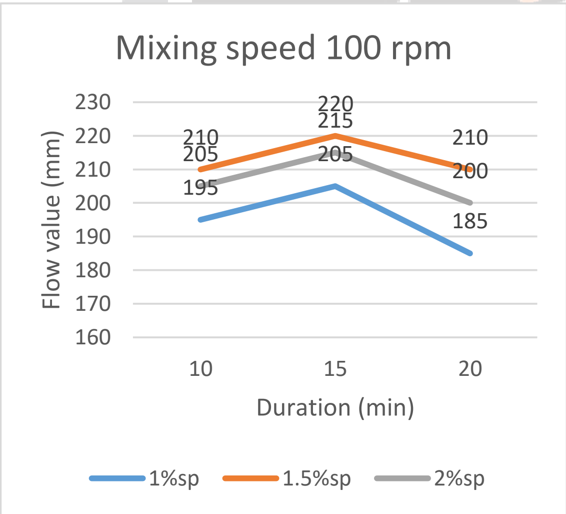

Fig 1: Flow result of different mixing

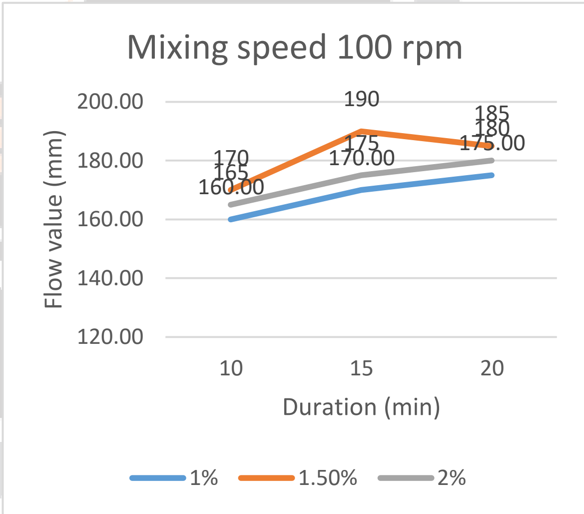

Fig 2: Flow result of different mixing

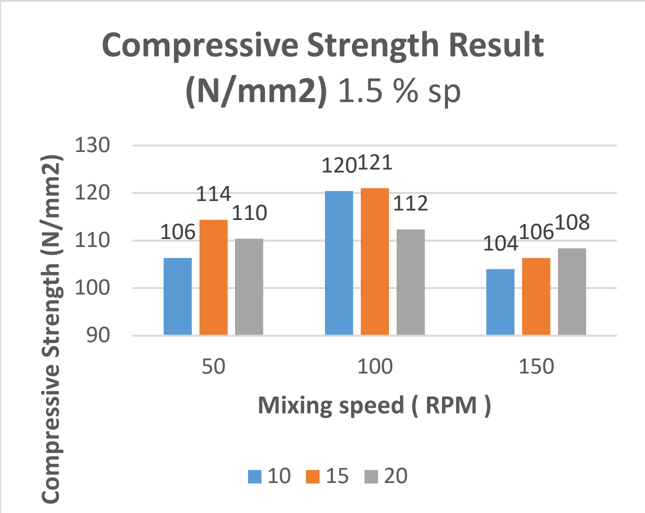

Fig 3: Compressive strength of different mixing mixing

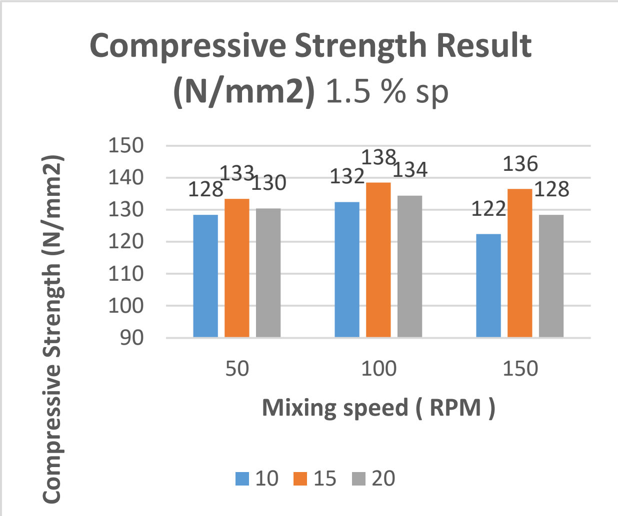

Fig 4: Compressive strength of different

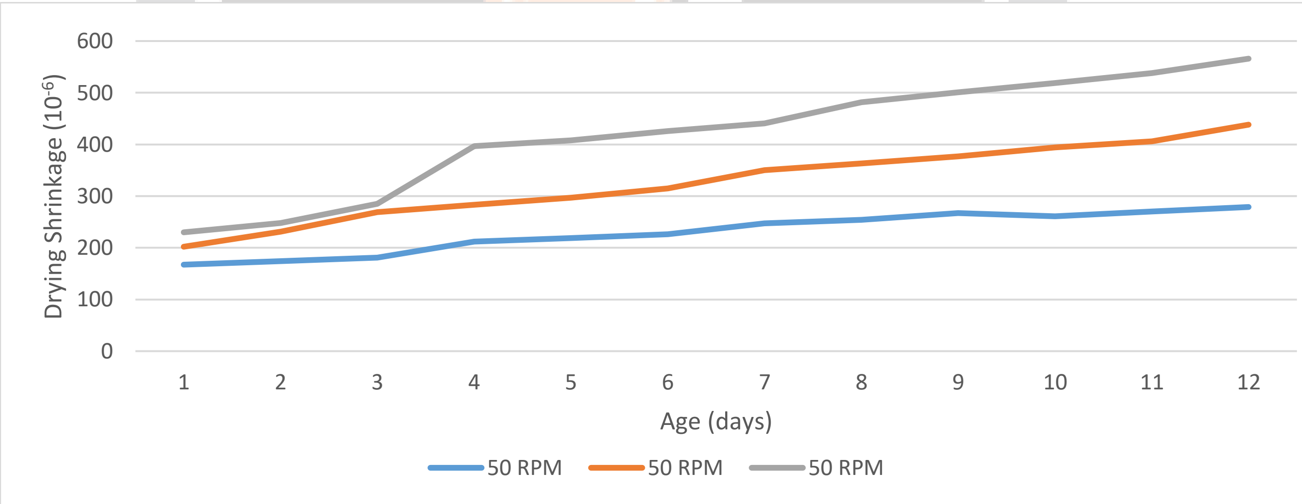

Fig 5:Drying Shrinkage of different mixing

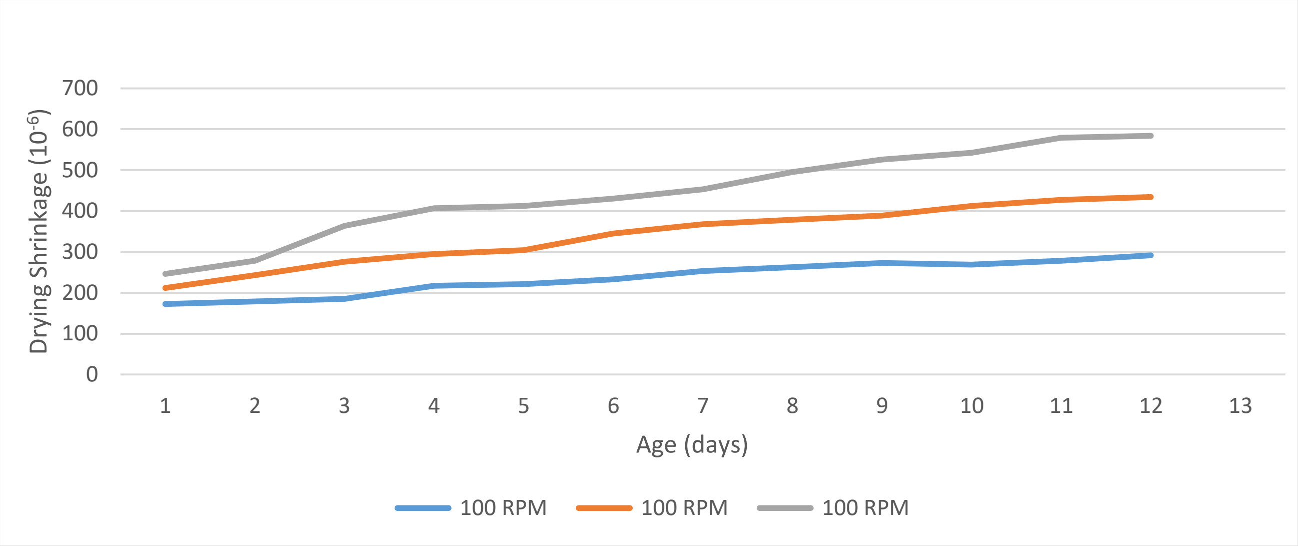

Fig 6:Drying Shrinkage of different mixing

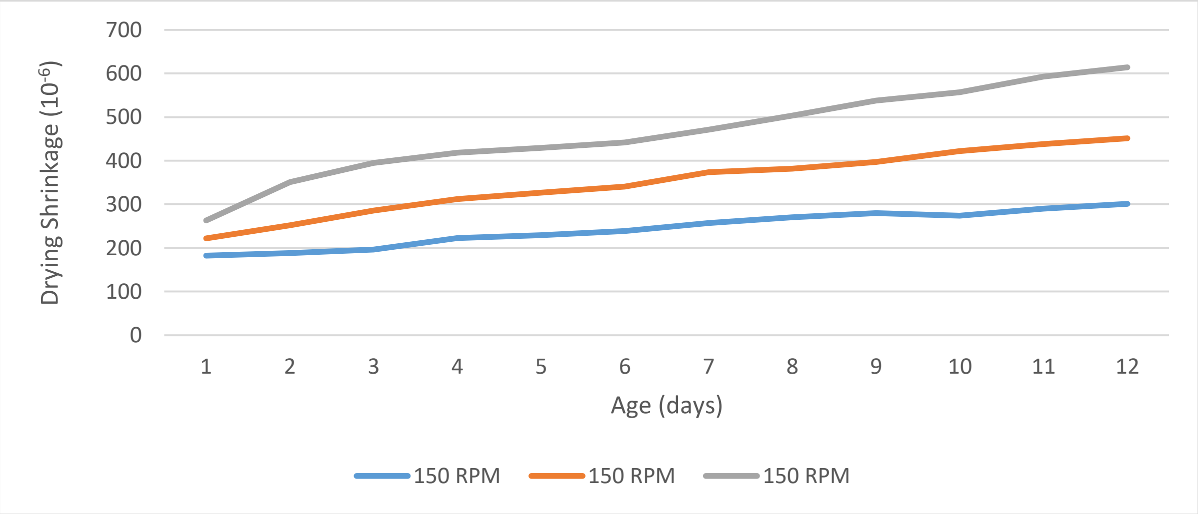

Fig 7:Drying Shrinkage of different mixing

4. CONCLUSIONS

The following conclusions are drawn from this study.

1) As mixing speed increases, the flow and strength characteristics also increase up to 100 RPM. Higher mixing speeds of 150 RPM decreases strength of concrete. Concluding from results of compressive strength presented in chapter 5 it could be summarised that compressive strength of silica fume is on an average 4.5% higher than metakaoline which is very low.

2) Results of flow table test suggest that workability of RPC is more by metakaoline over silica fume. RPC prepared with mixing duration of 15 min has shown better flow and strength characteristics compared to other RPC mixes prepared with different mixing durations (10, 15 and 20 min).

3) It is recommended to use metakaoline over silicafume because though strength is slightly decreased but it is more enough for safe construction practice.

4) Higher SP dosages give higher drying shrinkage strains and shrinkage rate development. This is because high SP dosage would cause changes in the pore structure which influences the state of the evaporable water and consequently the shrinkage behaviour.

5) The optimum superplasticizer dosages were typically found as 1-1.5%.

5. REFERENCES

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