QUANTITY CALCULATION FOR REACTIVE POWDER CONCRETE

C.Bala Santhana Selvi[1], C.J.Ganga Lakshmi[2]
[1]PG Scholar, ME Structural Engineering, [2]Assistant Professor in Civil Engineering,
Dr. Sivanthi Aditanar College of Engineering, Tiruchendur.

Abstract

Reactive Powder Concrete (RPC) is a high strength, new generation concrete, formed from a special combination of constituent materials. The composition of reactive powder concrete includes cement (ordinary Portland cement), fine sand, silica fume, quartz powder, and high tensile steel fibres. Reactive powder concrete is grouped under ultra high performance concrete. This type of concrete has enhanced mechanical and durability properties. This concrete has a very high compressive strength of 200 MPa which can be improved further by introducing steel fibers upto 800MPa. In this project, the quantity calculation for the reactive powder concrete with varying percentage of fly ash for 5%, 7.5%, 10%, 12.5% and 15% by weight of cement will be done.

Key words: fly ash; high performance concrete;fresh density;dry density; compressive strength.

1. Introduction

Reactive Powder Concrete (RPC) is a high strength, new generation concrete, formed from a special combination of constituent materials. The composition of reactive powder concrete includes cement (Ordinary Portland Cement), fine sand, silica fume, quartz powder, and high tensile steel fibres. Reactive powder concrete is grouped under ultra high performance concrete. This type of concrete has enhanced mechanical and durability properties. This concrete has a very high compressive strength of 200 MPa which can be improved further by introducing steel pellets up to 800MPa. This new family of concrete has improved ductile behavior with a flexural strength of 25MPa to binder 40MPa. These performances are due to the improved microstructure properties and highly discontinuous pore structure. Also, the toughness index of this concrete is high when compared with the ordinary confined concrete.

There is almost no carbonation and chloride ion penetration and near zero sulphate attack. Moreover the resistance to abrasion is near to rock. The net effect is a maximum compactness and highly disconnected pore structure. There is also no shrinkage or creep, which makes the material very suitable for application in prestressed and prefabricated structures. The high strength and easiness to produce using customary industrial tool by casting injection, and extrusion makes it suitable for prefabricated structural applications

Many researchers around the world have developed Reactive Powder Concrete that could be classified, as Ultra High Performance Concrete (UHPC). This technology of producing RPC is covered in one of many patents in the range of UHPC known as “Ductal”. This material has a capacity to take high load, deform and support flexural and tensile load, even after initial cracking. Characterization of materials used in RPC has progressed to such an extent that the use of RPC in full-scale structures is distinctively visible on the horizon. Research and observations to date indicate that RPC has the potential to expand its usage in new forms that have been considered impossible until recently.

In here , a general introduction about high strength reactive powder concrete is done. The properties of such concrete show a substantial improvement over conventional concrete of low or medium strength. High Strength Reactive Powder Concrete is a concrete which has an extremely low water to cement ratio (i.e. less than 0.26), higher content, optimum packing density to eliminate capillary pore and provide an extremely dense matrix. It is a high strength material formulated from a special combination of combination of constituent materials which include Portland cement, silica fume, fine aggregate, high-range water reducer and water. The material has the capability to sustain deformation and resists flexural and tensile forces, even after initial cracking.

1.2 Advantages of Reactive Powder concrete

- Reduction in self-weight and a consequent reduction in the foundation cost.
- The ability to withstand large column loads with reasonable sizes of columns.
- Reduction in floor thickness and beam height.
- Elimination of a few footing because of adoption of larger spans.
- Superior durability and long-term performance.
- Lower creep and shrinkage.
- Reduction in member-size,
- Resulting in an increasing in the usable floor space.
- Elimination of coarse aggregate.

1.3 Objectives of Developing Reactive Powder Concrete

- Elimination of coarse aggregate for enhancement of homogeneity.
- Utilization of pozzolanic properties of silica fume.
- Optimal usage of super plasticizer to reduce W/C ratio and at the same time improves compaction.
- Post-set heat treatment for enhancement of the microstructure.
- Addition of small sized steel fibre to improve ductility.

2. Literature review

Pankraj R. Kakad and Ganesh B. Gaikwad (2012) studied about the reactive powder concrete using fly ash. The Ordinary Portland Cement was used. Fine sand (150µ-400µ) was used as fine aggregate. The materials used are silica fume, quartz powder, super plasticizer, and steel fibres. The coarse aggregate was not used. The standard size of cubes (70 mm x 70 mm x70 mm) as per IS specification was used for compressive strength test. The compressive strength of concrete was 71.56 Mpa when 0% of fly ash was added and it was observed that the compressive strength was decreased when fly ash was replaced at 20% and the effect of fly ash in flexural strength was small when compared to compressive strength.

Mahesh K. Maroliya and Chetan D. Modhera (2013) did a comparative study on reactive powder concrete containing steel fibres and recron fibres, the plain reactive powder concrete and the reactive powder concrete with steel fibres and recron fibres were discussed. The water-cement ratio was 0.22. The corrugated steel fibres were used with 0.4mm dia and 12mm length. The ultra high strength reactive powder concrete were used (above 100Mpa).The sand of size 150-600µm were used. The cubes size of 50 mm x 50 mm x 50 mm were tested for compressive strength test and it does not contain coarse aggregate. Maximum particle size used was 800 µm. In this journal, the beam was tested under simply supported condition and the flexural strength of beam was calculated. The compressive strength of SFRPC were 30% more than plain RPC and the compressive strength of RFRPC was reduced to 19%.The split tensile strength of SFRPC and RFRPC in comparison with plain RPC were found to be 50% and 30% increase respectively. The addition of fibres affected split tensile strength. The flexural strength of SFRPC and RFRPC was found to be 60% and 40% higher than plain RPC.

Sarika S. and Dr. Elson John (2014) explained about the study on properties of reactive powder concrete. The ordinary Portland cement 53 grade was used. The specific gravity of cement was 3.14. The water cement ratio was 0.2. The materials used were cement, silica fume, quartz powder, steel fibre, super plasticizer. The slump flow test was conducted to measure the workability of concrete for fresh concrete. The spread of concrete obtained from slump flow test was 260mm. The compressive strength of hardened concrete increased to 130MPa.

3. Scope and objective

The objective is to evaluate the quantity calculation of reactive powder concrete cubes by replacing cement with fly ash at 0%, 5%, 7.5%, 10%, 12.5% and 15%.

4.1. Materials used

4.1.1 Cement

Ordinary Portland Cement (OPC) – The cement used during the experiment is Ordinary Portland Cement of Grade 53 conforming to IS 12269:1987.

4.1.2 Fine Aggregate

Fine aggregate used for RPC should be properly sieved to give minimum void ratio and free from deleterious materials like clay, silt and chloride contamination etc., Here, it is used in the range of 1.16mm sieve.

4.1.3 Water

It should be clean from all the organic impurities as well as other dust particles. It should not be saline in nature.

4.1.4 Silica fume

It is in grey powder form micro silica which contains latently reactive silicon dioxide and no chloride or other potentially corrosive substances. It has 94.3% of silicon dioxide.

Figure 1: *Sample of silica fume*

4.1.5 Silica sand

The crushed quartz/silica sand used in the experiment is in a form of white powdered quartz flour. The particle size range is 70µm. Quartz sand acts as effective filler material at normal water curing. The content of silicon dioxide is 99.9% and it has some trace of ferrous oxide and aluminium oxide.

Figure 2: *Sample of silica sand*

4.1.6 Steel fibres

The fibre used here is a hooked end steel fibre with an aspect ratio of 77 which has a length of 35 mm and a diameter of 0.45 mm. Mostly steel fibres are used in UHSC to improve both the compressive and tensile strength because no other fiber will give the required high strength to the concrete.

4.1.7 fly ash

Fly ash is a coal combustion product that is composed of the particulates that are driven out of coal-fired boilers together with flue gases. It is produced by the burning of powdered coal.

Figure 3: *Sample of fly ash*

4.2 Quantity Calculation

Cement :sand ratio = 1:1.5

Size of cube = 100mm x100mm x100 mm

Volume of 6 cube =no of cubes x size of cubes
= 6 x 0.1 x 0.1 x 0.1
= 0.006m³

Volume of cement req = (1/2.5) x vol of 6 cubes
=(1/2.5) x (0.006)
= 0.0024m³

Volume of silica fume req =(15/100) x vol of cement
=(15/100)x(0.0024)
=0.0036m³

Volume of sand req =(1.5/2.5) x vol of 6 cubes
= (1.5/2.5) x(0.006)
= 0.00036m³

Volume of Quartz sand req = (36/100)x vol of sand
= (36/100)x(0.0036)
= 0.001296m³

Weight of cement req = vol of cement x density
= 0.0024 x 1426
=3.4224kg

Weight of silica fume req = vol of silica fume x density
=0.00036 x 670
=0.2412kg

Weight of quartz sand req = vol of quartz sand x density
=1676x0.001296
=2.17kg

Weight of steel fiber req = vol of steel fibre x density
=(1.5/100)x3.4224
=0.051kg

Amount of super plasticizer req =1% to weight of cement
=(1/100)x3.4224
=34.2ml

Amount of water req = water cement ratio x weight of cement
= 0.5 x 3.422
=1711ml

4.3 SPECIMEN DESCRIPTION

Mix A- cement 85% + sand 64% + silica fume 15% + fly ash 0% + quartz sand 36% + steel fiber 1.5%.

Mix B- cement 80% + sand 64% + silica fume 15% + fly ash 5% + quartz sand36%+steel fiber1.5%.

Mix C- cement 77.5% + sand 64% + silica fume 15% + fly ash 7.5% + quartz sand 36% + steel fiber 1.5%

Mix D- cement 75% + sand 64% + silica fume 15% + fly ash 10% + quartz sand 36% + steel fiber 1.5%.

Mix E- cement 72.5% + sand 64% + silica fume 15% + fly ash 12.5% + quartz sand 36% + steel fiber 1.5%.

Mix F- cement 70% + sand 64% + silica fume 15% + fly ash 15% + quartz sand 36% + steel fiber1.5%.

4.4 Details of Specimen

The specimens for controlled concrete were cast as per the details given in table 1

SPECIMEN	SIZE	MIX A	MIX B	MIX C	MIX D	MIX E	MIX F
CUBE	100mm x100mm x100mm	12	12	12	12	12	12

5. Results and discussion

The quantity calculation of reactive powder concrete was given in table 2

Table 2:*quantity calculation*

Mixes	Cement (kg)	Sand (kg)	Silica fume (kg)	Fly ash (kg)	Quartz sand (kg)	Steel fiber (kg)	Super plasticizer (ml)	Water (ml)
Mix A	3.18	3.89	0.24	-	2.17	0.05	34	1711
Mix B	2.98	3.89	0.24	0.20	2.17	0.05	34	1711
Mix C	2.88	3.89	0.24	0.30	2.17	0.05	34	1711
Mix D	2.78	3.89	0.24	0.40	2.17	0.05	34	1711
Mix E	2.68	3.89	0.24	0.50	2.17	0.05	34	1711
Mix F	2.58	3.89	0.24	0.60	2.17	0.05	34	1711

6. Conclusion

The quantity calculation was arrived for reactive powder concrete for mortar mix 1:1.5. Thus, this quantity calculation can be used for determination of various properties of reactive powder concrete such as mechanical properties and flexural behavior.

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