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COMPARITIVE STUDY OF NORMAL CONCRETE COLUMN AND MODIFIED REACTIVE POWDER CONCRETE COLUMN

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***Abstract*— Abstract- Reactive Powder Concrete (RPC) is a developing composite material that will allow the concrete industry to optimize the material use, generate benefits by build structures that are strong, durable and sensitive to environment. This study is intended to explore the suitability of providing the reactive powder layer as cover to the normal column (M30). In this study Modified RPC is given in two different layer thickness (2.5cm thick and 5cm thick) and finding the compressive strength and durability of the newly composite structure. Modified Reactive Powder Concrete (MRPC) refers to the mix which is free from quartz sand and steel fibers, which are normally present in RPC; and MRPC column is the column having an inner core filled with normal concrete (M30) and outer portion with MRPC mix. MRPC mix is provided in two different thicknesses for checking its effectiveness and durability of each type of column. Specimen of 650 mm height and 200 mm diameter is casted for compressive strength test and 150 mm height and 200 mm diameter is casted for durability test. Seven day and 28 day compressive strength of the newly modified column shows more compressive strength than the normal concrete column and the 5cm thick layer shows more strength. So we can provide the MRPC as cover to the normal column.**

***Index Terms*— RPC, MRPC, Durability**

I. INTRODUCTION

RPC is a special mixture that is cured especially to have a higher compressive strength than that of concrete. Adding steel fibers can greatly improves its tensile strength and bending strength, impact resistance and toughness. Its main features include a high percentage ingredient of Portland cement, very low water-to-binder (cement + silica fume) ratio which ranges from 0.15 to 0.25, a high dosage of super plasticizer, and the presence of very fine crushed quartz and silica fume. RPC represents one of the most recent technological leaps witnessed by the construction industry. Among already built outstanding structures, RPC structures lie at the forefront in terms of innovation, aesthetics and structural efficiency. The unique properties for RPC make it extremely attractive for structural applications.

One of the limitations of RPC is its high cost than the normal concrete. So its usage is less compared to conventional mix. This study is emerged from this limitation and leads to the provision of RPC as a protective layer to the structural element were durability issues the risk and also needs high compressive strength. Need is the mother of innovations and the need for more strength leads to the development of ultra high strength materials like RPC.

As construction and material costs escalate, demand has increased for stronger materials like RPC. Durability of each specimen is carried out with dipping it in potable water for seven days and then in acid solutions. Hydrochloric acid and Sulphuric acid are used for durability tests in 2% concentration. The loss of weight is the durability parameter and MRPC is highly durable and have less penetration. Different kinds of research works are carried out in normal RPC mix and this is a new attempt in this field. This positive results will definitely improves the use of MRPC as it costs less than the RPC but shows greater strength than the normal concrete.

II. EXPERIMENTAL PROGRAMME

A. Materials

The cement used for this study is 53 grade Ordinary Portland Cement as per IS 12269-1987. Silica fume is collected from Madurai, Tamil Nadu with a specific gravity of 2.32. For normal concrete as well as reactive powder concrete mix manufactured sand is used as fine aggregate with a specific gravity of 2.697. Coarse aggregate of 20 mm size is used for both mixes and 12 mm diameter bars are used as reinforcement for the columns. Specific gravity of coarse aggregate is 2.745. For reducing the water cement ratio Conplast sp430 is used as super plasticizer in MRPC mix. Hydrochloric acid, Sulphuric acid and Sodium Sulphate are used for durability test.

Fig: 1. Super plasticizer

Fig: 2. Hydrochloric acid

A. Mix Proportioning

In this study different trial mixes are tested to fix an appropriate MRPC mix. Apart from pure RPC mix here steel fibers and quartz sand is absent. Normal concrete mix is also calculated with a water cement ratio of 0.45 and also it is updated according to the specific gravity of materials used. Silica fume and Super plasticizer tried in different dosages and the mix is confirmed after got a consistent workable with comparatively high strength. M30 grade is used for normal columns.

TABLE 1. DETAILS OF M30 MIX

Mix	Cement (kg/m3)	FA (kg/m3)	CA (kg/m3)	Water (kg/m3)
M30	425.73	699.89	1114.18	191.58

TABLE 2. DETAILS OF MRPC MIX

Mix	MRPC
Cement (kg/m3)	700
FA (kg/m3)	1230
Silica fume (kg/m3)	105
Super plasticizer (1%) (kg/m3)	8.05
Water (kg/m3)	182
w/c ratio	0.26

High dosage of super plasticizers will increase the workability but according to the atmosphere at which the tests carried out, the setting time will increase. So optimum amount of SP and Silica fume are fixed by number of trials.

B. Casting of Specimens

Cubes of 150 mm x 150 mm x 150 mm are casted to fix M30 mix. Columns of 650 mm height and 200 mm are casted for compressive strength test. Durability tests are carried with a miniature of columns in the form of a disc. The dimensions of the discs are 150 mm height and 200 mm diameter.

Fig: 3. Normal Column

III. EXPERIMENTS CONDUCTED

A. Preliminary tests

Physical properties of concrete are obtained from preliminary tests. Initial and final setting time of cement, standard consistency of cement, specific gravity, sieve analysis and slump tests are carried out.

B. MRPC trial mixes

The general mix is selected from an international journal and alterations associated with the components give the optimum mix. The mix with 15% silica fume gives better compressive strength. Numbers of trials are conducted with different water cement ratios. All kinds of trial mixes are carried out in a cube of size 10 mm x 10 mm x 10 mm. RPC is free from coarse aggregate and need of 150 mm sided cube is not necessary.

Compressive strength of each cube is find out by varying the water cement ratio and super plasticizer content. Suitable mix obtained is 1% SP with 0.26 w/c ratio. After that silica fume is added in different % starting from 5 to 25. Most of the mixes with higher amount of SP do not set in the time of demoulding and mix with fewer amounts of water and SP remain in its powdered form. Series of alternate iterations gives the proper MRPC mix. From the trials conducted mix with 0.26 water cement ratio and 1% SP gives high compressive strength than other mixes. RPC is rich with high amount of SP and silica fume. As per economy is considered this modified mix requires only less amount of SP and low water cement ratio.

TABLE 3. MRPC TRIAL MIXES

Trials	w/c ratio	SP (% by wt.)
1	0.18	0.6 0.8 1 1.2 2 5
2	0.2	0.6 0.8 1 1.2 2 5
3	0.24	0.6 0.8 1 1.2 2 5
4	**0.26**	0.6 0.8 **1** 1.2 2 5
5	0.3	0.6 0.8 1 1.2 2 5

I. Compression test on columns

Columns of 650 mm height and 200 mm diameter are tested for compression. Normal column is with M30 mix and other two set of columns with varying MRPC thick layers.

Fig: 4. Compression testing of column

Modified RPC exhibits less compressive strength than RPC but have a greater strength than normal concrete mix.

TABLE 4. 7 DAY COMPRESSIVE STRENGTH

No:	Specimen	Compressive strength (MPa)
1	Normal concrete	15.118
2	MRPC(2.5 cm thick)	29.45
3	MRPC(5 cm thick)	38.50

TABLE 5. 28 DAY COMPRESSIVE STRENGTH

No:	Specimen	Compressive strength (MPa)
1	Normal concrete	26.07
2	MRPC(2.5 cm thick)	42.63
3	MRPC(5 cm thick)	51.05

IV. DURABILITY TESTS

A. Durability Tests On Concrete

The durability of cement concrete is defined as its ability to resist weathering action, chemical attack, abrasion, or any other process of deterioration. Durable concrete will retain its original form, quality, and serviceability when exposed to its environment. For determining the resistance of concrete specimens to aggressive environment such as acid attack, the durability factors as described in ASTM C 666 has been adopted as the base.

B. Chloride Attack Test

Chloride attack is one of the most important aspects for consideration when we deal with the durability of concrete. Chloride attack is particularly important because it primarily causes corrosion of reinforcement. Statistics have indicated that over 40 per cent of failure of structures is due to corrosion of reinforcement. The Bureau of Indian Standard earlier specified the maximum chloride content in cement as 0.05 per cent. But it is now increased the allowable chloride content in cement to 0.1 per cent.

C. Sulphate Attack Test

The term sulphate attack denotes an increase in the volume of cement paste in concrete or mortar due to the chemical action between the products of hydration of cement and solution containing sulphates. In the hardened concrete, calcium aluminate hydrate (C-A-H) can react with sulphate salt from outside. The product of reaction is calcium sulphoaluminate, forming within the framework of hydrated cement paste. Because of the increase in volume of the solid phase which can go up to 227 per cent, a gradual disintegration of concrete takes place.

All kinds of durability tests are carried out with a specimen of 200 mm diameter and 150 mm height.

TABLE 6. 28 DAY WATER CURING

Specimen	Age (days)	Compressive strength (MPa)	Weight (kg)
NC	28	31	13.60
MRPC(2.5 cm thick)	28	48.09	12.455
MRPC(5 cm thick)	28	56.55	11.551

TABLE 7. 28 DAY Hcl CURING

Specimen	Age (days)	Compressive strength (MPa)	Weight(kg)
NC	28	28	13.32
MRPC(2.5 cm thick)	28	42.47	12.14
MRPC(5	28	51.71	11.503

cm thick)			

TABLE 8. 28 DAY H2SO4 CURING

Specimen	Age (days)	Compressive strength (MPa)	Weight(kg)
NC	28	27.8	13.15
MRPC(2.5 cm thick)	28	41.02	12.07
MRPC(5 cm thick)	28	49.46	11.43

TABLE 9. 28 DAY Na2SO4 CURING

Specimen	Age (days)	Compressive strength (MPa)	Weight (kg)
NC	28	28.5	13.55
MRPC(2.5 cm thick)	28	43.67	12.31
MRPC(5 cm thick)	28	54	11.508

V. TEST RESULTS AND CONCLUSIONS

A. General

The details of the results obtained from different experiments conducted are explained here.

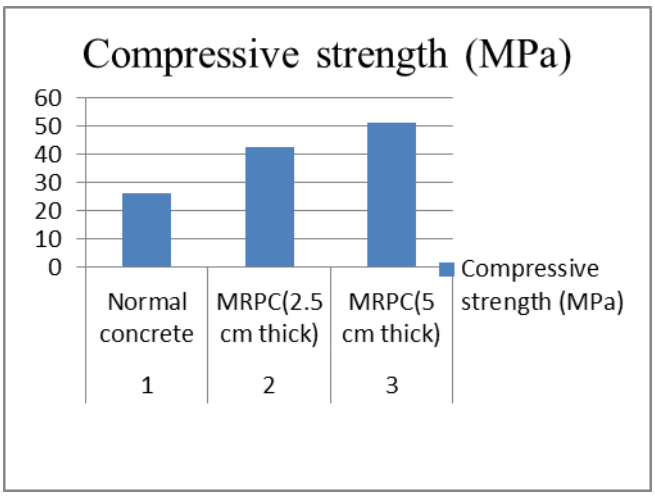

Fig: 5. 28 day Compression strength of column

The compressive strength of MRPC is higher than that of conventional concrete. 5 cm thick layered MRPC takes more loads than 2.5 cm thick layered column and so that it can be used as a cover to the normal column.

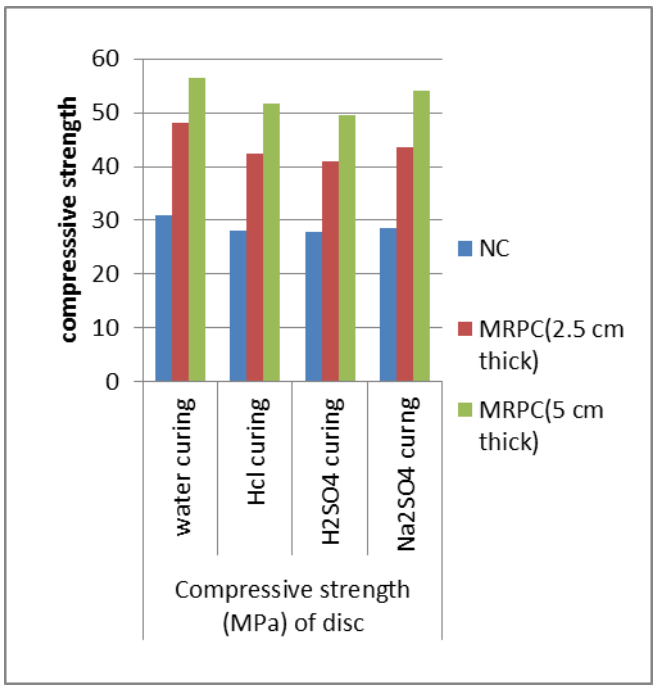

Fig: 6. 28 day Compressive strength of Disc

The durability of concrete specimen is finding out by measuring the weight loss. If the weight loss is less, then it will consider as more durable than the other specimen.

TABLE 10. DURABILITY RESULTS

Description	Solution	NC	MRPC (2.5 cm thick)	MRPC (5 cm thick)
Loss of weight (kg)	Hcl H2SO4 Na2SO4	0.28 0.45 1.05	1.06 1.39 1.15	0.48 0.22 0.07
Loss of compressive strength (MPa)	Hcl H2SO4 Na2SO4	32.92	3.2 4.07 1.74	2.5 1.145 1.11

The relative % of loss of compressive strength is less in 5 cm thick MRPC. Thus the result shows that that specimen is more durable in worst conditions.

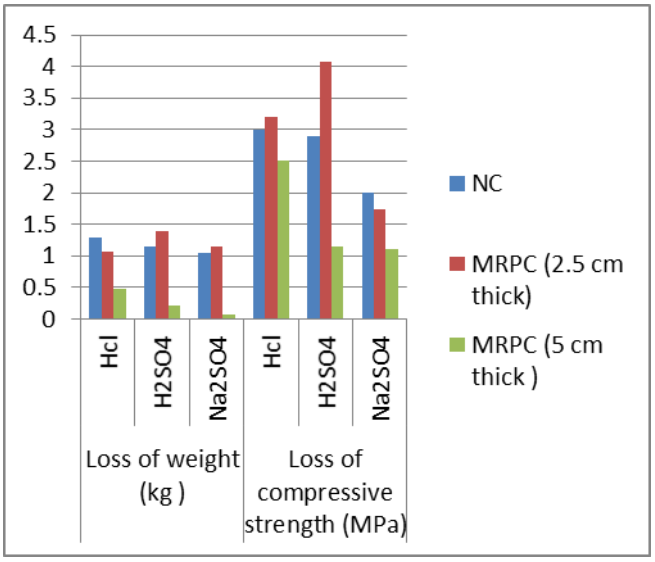

Fig: 7. Loss of weight and CS of disc

All kinds of results show higher strength for 5 cm thick MRPC mix.

B. Future scope

Further studies are emerged from the limitations. One of them is its placement difficulty and elapsed time duration. Later works can be carried out according to reduce the construction time and erase the placement problems.

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