Literature Review on Mechanical Properties of Reactive Powder Concrete

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Abstract- *reactive powder concrete is a composite material that have ultra-high strength with mechanical properties. It is a mixture of fibre, super plasticizer, silica fume, quartz powder, cement, sand and very low water cement ratio. Quartz powder used instead of ordinary coarse aggregate and coarse aggregate is weakest link in concrete so it is eliminated.*

Keywords- Compressive Strength, Split tensile strength, concrete mix design,

I. INTRODUCTION

Reactive powder concrete is the generic name for a class of cementious composite material developed by the technical division of Bouygues, in the early 1990s.

RPC is composed of very fine powders (cement, sand, quartz powder and silica fume), steel fibres (optional) and superplasticizer. The superplasticizer, used at its optimal dosage, decreases the water to cement ratio (w/c) while improving the workability of the concrete. A very dense matrix is achieved by optimizing the granular packing of the dry fine powders. This compactness gives RPC ultra-high strength and durability6. Reactive Powder Concretes have compressive strengths ranging from 200 MPa to 800 MPa.

II. COMPOSITION OF REACTIVE POWDER CONCRETE

Ming-Gin Lee a,*, Yung-Chih Wang b, Chui-Te Chiu c[4] researched on a preliminary study of reactive powder concrete as a new repair material and evaluate its bond durability to existing concrete. One accelerated aging environment, namely a freeze–thaw cycle acceleration deterioration test, was selected for the evaluation of bond durability of the repair materials. They studied two cement-based repair materials which were used as references in this study are representative of normal strength concrete and a high strength repair mortar. The regular concrete (RC) has a compressive strength of 30 MPa, contains no admixture and yields a slump of 150 mm. The non-shrinkage high strength mortar (HSM), is a prepacked repair mortar, contains 10% silica fume, its compressive strength and low water cement ratio assures good durability. The mix design of regular concrete (RC) and high strength mortar (HSM). The RPC to be used as a prospective

Repair material, contains a type II cement, silica fume, silica sand, quartz powder, steel fiber and a superplasticizer. The mix design of the RPC.

Table 1: Mix design by Ming-Gin Lee a,*, Yung-Chih Wang b, Chui-Te Chiu c

Series	A	B	C
Cement	706	706	706
Silica fume	160	160	160
Coarse sand	403	380	357
Middle sand	805	770	714
Fine sand	201	189	178
Steel fibre		80	160
Admixture	74	74	30
water	122	122	170

Pierre Richard, Marcel Cheyrezy[1] are the first who invented RPC. According to them the mix design is given bellow.

Table 2: Typical RPC compositions (by weight) (Pierre Richard, Marcel Cheyrezy[1])

	RPC 200				RPC 800	
	Non fibered		Fibered			
Portland Cement	1	1	1	1	1	1
Silica fume	0.25	0.23	0.25	0.23	0.23	0.23
Sand 150 - 600 pm	1.1	1.1	1.1	1.1	0.5	-
Crushed quartz d_c= 1 Opm	0.39	-	0.39	-	0.39	0.39
Superplasticizer (Polyacrylate)	0.016	0.019	0.016	0.019	0.019	0.019
Steel fiber L=12 mm	-	-	0.175	0.175	-	-
Steel fiber L=3 mm	-	-	-	-	0.63	0.63
Steel aggregates <800 g.m	-	-	-	-	-	1.49
Water	0.15	0.17	0.17	0.19	0.19	0.19
Compacting pressure	-	-	-	-	50Mpa	50Mpa
Heat treatment temperature	20 C	90 C	20 C	90 C	250-400 C	250-400 C

Table 3: mix design by Tomasz Zdeb[2]

Composition No.	Reference	1	2	3	4
Constituent			[kg/m^3]		
Cement	903	914	923	935	933
Silica fume	181	183	185	187	187
Quartz powder	312	316	319	323	323
Quartz Sand	729	738	744	754	753
Water	217	209	201	191	190
Super plasticizer	18	18	18	18	21
W/C	0.24	0.23	0.22	0.20	0.20
W/B	=0.20	0.19	0.18	0.17	0.17
W/(C+SF)					

Table 4: Widodo Kushartomo, Ika Bali, Budi Sulaiman[3]

	Glass powder content (kg)		
Material	10%	20%	30%
Water	4.008	3.873	3.747
Cement (PPC)	20.040	19.365	18.734
Silica sand	22.044	21.301	20.607
Silica fume	5.010	4.841	4.683
Superplaticizer	0.602	0.581	0.562
Glass powder	2.004	3.873	5.620
Steel fiber	2.665	2.665	2.665

III. COMPRESSIVE STRENGTH

Pierre Richard, Marcel Cheyrezy[1] studied on COMPOSITION OF REACTIVE POWDER CONCREXES and they got result of RPC 200 have compressive strength of 170 to 230MPa and RPC 800 have compressive strength using quartz sand and using steel aggregate are 490 to 680MPa and 650 to 810MPa respectively. And WidodoKushartomo, Ika Bali, Budi Sulaiman[2]have researched with the specimens of RPC with the glass powder content of 10%, 20% and 30% consist of 15 cylinder specimens for compressive strength test and got 97.4, 136.1 and 83.9 respectively.

AN Ming-zhe, ZHANG Li-jun, YI Quan-xingot compressive strength with different amount of % of glass fibre which is shown in below in table.

Table 5: compressive strength with different amount of % of glass fibre [4]

Fibre dosage (By vol.)	50mm	70.7mm	100mm	150mm
0%	101.44	94.96	91.76	87.35
1%	135.01	125.78	119.62	111.53
2%	149.03	141.77	137.11	126.27

Compressive strength of RC in comparison with its repair materials got by Ming-Gin Lee, Yung-ChihWang , Chui-Te Chiu[6] shown below.

Table 6: Compressive strength of RC in comparison with its repair [6]

Curing days	RC	HSM	RPC	HSM/RC	RPC/RC
7 DAYS	22.3	46.1	170.7	36.1	61.4
28 DAYS	34.1	65.8	181.6	39	61.1

IV. FLEXURAL STRENGTH

Pierre Richard, Marcel Cheyrezy[1] got result of RPC 200 have flexural strength of 170 to 230MPa and RPC 800 have flexural strength using quartz sand and using steel aggregate are 30 to 60MPa and 45 to 141MPa respectively.

WidodoKushartomo, Ika Bali, Budi Sulaiman[3]got results on beam of 100x100x40 mm^{3}have avg. flexural strength with 10, 20 & 30% of glass powder content are 20.3, 23.2 and 22.6 respectively.

Flexural strength of RC in comparison with its repair materials researched by Ming-Gin Lee, Yung-ChihWang , Chui-Te Chiu[6] shown in below.

Table 7: flexural strength by Ming-Gin Lee, Yung-ChihWang , Chui-Te Chiu[6]

Curing duration	RC	HSM	RPC	HSM/RC	RPC/RC
7 DAYS	4.7	4.3	16.3	4.6	7.2
28 DAYS	5.9	5.3	19.7	5.4	8.0

V. SPLIT TENSILE STRENGTH

WidodoKushartomo, Ika Bali, Budi Sulaiman[3] have got avg. split tensile strength on specimen of 100dia. x 200 height cylinder with 10, 20 and 30% of glass powder are 14.5, 17.8 and 16.6 respectively.

VI. POROSITY

Marcel Cheyrezy, Vincent Maret, Laurent Frouin[5] done Porosimetric studies by mercury intrusion demonstrated the very low porosity of RPC, which never exceeds 9 % in volume in the pore diameter range of 3.75nm to 100nm. It is nil in that range for pressed RPC cured between 150°C and 200°C.

VII. CONCLUTION

From above literature review has been concluded that we can achieve very high strength up to 800 Mpa by using steel aggregate. The rate of split tensile strength and flexural strength of reactive powder concrete is higher than the high performance concrete.

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