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STUDY ON HIGH PERFORMANCE CONCRETE BEAM UNDER CYCLIC LOADING CONDITIONS BY PARTIAL REPLACEMENT OF FLY ASH AND QUARRY DUST

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ABSTRACT

This research paper describes the study on high performance concrete while partially replace the fly ash and quarry dust as a cement and fine aggregate. These are replaced at the percentages of 0%, 10%, 20%, 30%, 40% and 50%. The high performance concrete has been designed at M60 grade concrete. Especially this study observes the behavior and performance of concrete, when the cements and fine aggregate replaced partially. The conplast SP430 super plasticizer was used in concrete. This super plasticizer reacts as a water reducing agent in high performance concrete. This is adding 0.5% in concrete. The steel fibers also additionally added into the concrete while casting. Fibers are added into the fly ash concrete at 0.75% and 1%. The aspect ratio of the steel fiber was 50% and the size of the fiber was 0.6mm and 0.7mm. in this study 0.6mm diameter of steel fibers were used. Finally this study shows the strength, deflection, residual strength and stiffness degradation of the high performance fly ash and quarry dust concrete under cyclic loading conditions.

Key words: Fly ash, quarry dust, cyclic loading, Stiffness degradation.

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1. INTRODUCTION

Fly ash is the most common and well known alternative material in building constructions. These materials are introduced because of lack of cement material and requirements of building contractors. It will capable for the brick works, floor works etc. fly ash having a similar property like cement. It is more fineness and adhesive material. That's why it should be more suitable for the building, road and construction works.

Quarry dust is a dust from the rocks and stones. It's behaving as a filling material like fine aggregate. In most of construction field the quarry dusts are partially replaced as a fine aggregate. These are the fine particle and having a specific gravity of 2.65. In construction side the lagging of raw materials are closely affect the growth of the construction field. So that these alternative materials are used in construction process. Now a day's Fly ash and quarry dust are the most common alternative material in construction field. It's should not be affect the any physical property of concrete in any manner.

Fly ash and quarry dust are most efficiency and cheap material in construction. When the demand of raw materials is high in that place we can use those materials as a cement and fine aggregate. Which means it will reduce the effective cost of cements and fine aggregate and also improve the quality of construction works.

2. MATERIAL PROPERTIES

- The specific gravity for cement = 3.1
- The specific gravity of coarse aggregate = 2.80
- The specific gravity of Fine aggregate = 2.7
- The specific gravity of Quarry dust = 2.65

Super Plasticizer

Conplast SP 430 is used as high range water reducing agent to attain required slump with minimum water-cement ratio.

Details of Fibres

Table 1 Details of crimped steel Fibres

Sl.No	Aspect Ratio (L/D)	Length Of Fibres (mm)	Diameter (mm)
1.	60	48	0.8
2.	50	30	0.6

3. EXPERIMENTAL RESULTS

Figure 1 Test setup for cyclic loading

Table 2 Load vs deflection for Conventional Beam under cyclic loading

Position of load cell	Load (in t)	Deflection in mm							
		Cycle 1		Cycle 2		Cycle 3		Cycle 4	
		Loading	Unloading	Loading	Unloading	Loading	Unloading	Loading	Unloading
Load cell at top	0	0	0	0	0	0	0	0	0
	0.2	0.23	0.3	0.3	0.4	0.3	0.4	0.4	0.5
	0.4	0.45	0.5	0.4	0.5	0.5	0.6	0.6	0.8
	0.6	0.63	0.7	0.6	0.7	0.8	0.9	0.9	1
	0.8	0.9	1	1	1	1	1.2	1.1	1.3
	1	1.1	1.1	1.2	1.2	1.3	1.4	1.5	1.7
	1.2					1.6	1.8	1.7	1.9
	1.4					1.9	2.1	2.1	2.3
	1.6					2.3	2.4	2.5	2.6
	1.8					2.6	2.7	2.9	3
	2					3.1	3.1	3.3	3.4
	2.2							3.6	3.7
	2.4							3.9	4.1
	2.6							4.3	4.4
	2.8							4.6	4.7
	3							5.1	5.1
Load cell at bottom	0	0	0	0	0	0	0	0	0
	0.2	0.3	0.3	0.35	0.3	0.3	0.5	0.4	0.5
	0.4	0.5	0.6	0.55	0.6	0.6	0.7	0.5	0.7
	0.6	0.8	0.9	0.9	0.9	0.9	1	0.9	1.2
	0.8	1	1.1	1.1	1.2	1.3	1.5	1.3	1.5
	1	1.3	1.3	1.4	1.4	1.6	1.8	1.6	1.8
	1.2					1.9	2	2	2.2
	1.4					2.2	2.4	2.5	2.6
	1.6					2.6	2.8	3	3.1
	1.8					3.1	3.2	3.4	3.5
	2					3.5	3.5	3.8	4
	2.2							4.2	4.4
	2.4							4.6	4.7
	2.6							5	5.2
	2.8							5.4	5.5
	3							5.9	5.9

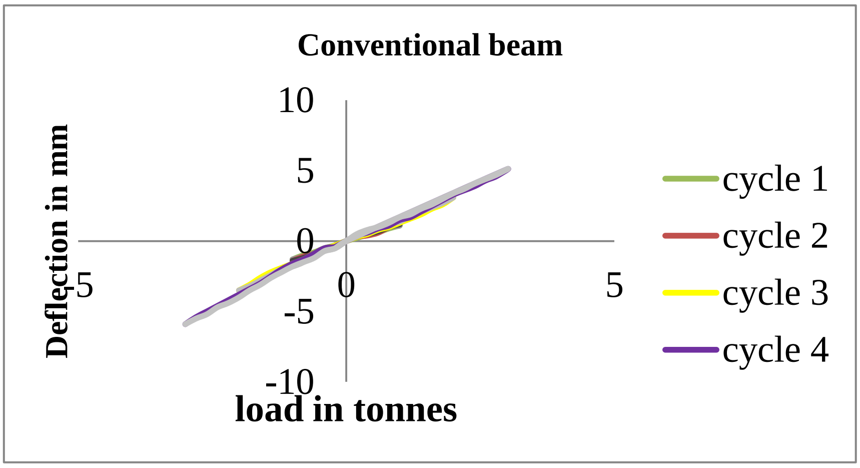

Figure 2 Load vs deflection curve of control beam

Table 3 Load vs deflection for 20% beam under cyclic loading

Position of load cell	Load (in t)	Deflection in mm							
		Cycle 1		Cycle 2		Cycle 3		Cycle 4	
		Loading	Unloading	Loading	Unloading	Loading	Unloading	Loading	Unloading
Load cell at top	0	0	0	0	0	0	0	0	0
	0.2	0.15	0.23	0.16	0.25	0.18	0.28	0.2	0.36
	0.4	0.39	0.49	0.4	0.46	0.47	0.56	0.56	0.81
	0.6	0.77	0.92	0.8	0.9	0.92	1.15	1.05	1.28
	0.8	1.04	1.12	1.15	1.18	1.2	1.35	1.26	1.52
	1	1.32	1.32	1.36	1.36	1.52	1.69	1.58	1.9
	1.2					1.81	1.96	1.92	2.2
	1.4					2.05	2.22	2.12	2.4
	1.6					2.42	2.5	2.56	2.7
	1.8					2.76	2.82	2.85	3.1
	2					3.21	3.21	3.28	3.42
	2.2							3.6	3.8
	2.4							3.92	4.05
	2.6							4.32	4.4
	2.8							4.63	4.7
	3							5.1	5.1
Load cell at bottom	0	0	0	0	0	0	0	0	0
	0.2	0.23	0.3	0.27	0.53	0.32	0.55	0.36	0.65
	0.4	0.58	0.86	0.62	0.76	0.68	0.86	0.72	0.98
	0.6	0.98	1.13	1.02	0.94	1.1	1.27	1.15	1.36
	0.8	1.2	1.27	1.26	1.56	1.34	1.48	1.42	1.56
	1	1.56	1.56	1.61	1.61	1.68	1.85	1.74	1.94
	1.2					1.96	2.16	2.05	2.24
	1.4					2.34	2.52	2.38	2.56
	1.6					2.78	2.85	2.81	2.99
	1.8					3.12	3.22	3.19	3.27
	2					3.41	3.41	3.48	3.62
	2.2							3.74	3.97
	2.4							4.12	4.32
	2.6							4.49	4.68
	2.8							4.86	4.96
	3							5.41	5.41

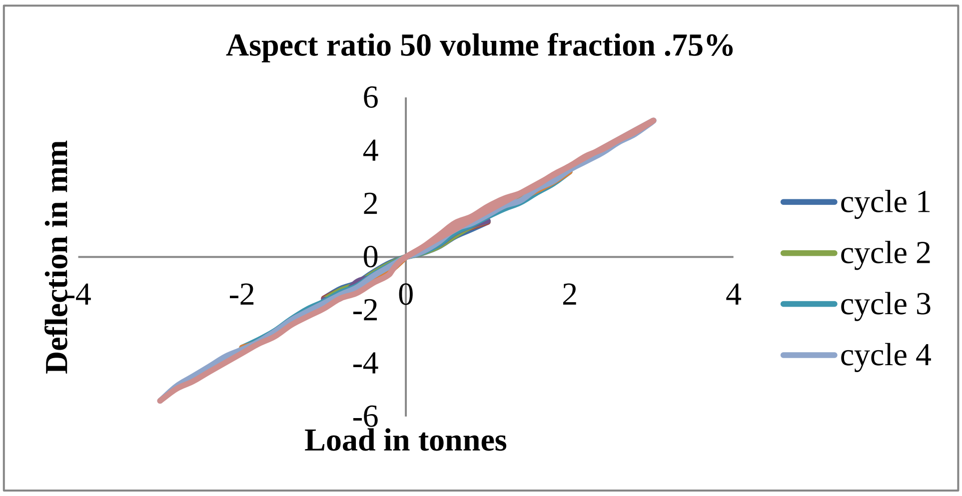

Figure 3 Load vs deflection curve of 20% FA & QD Beam

Table 4 Load vs deflection for 30% beam under cyclic loading

Position of load cell	Load (in t)	Deflection in mm							
		Cycle 1		Cycle 2		Cycle 3		Cycle 4	
		Loading	Unloading	Loading	Unloading	Loading	Unloading	Loading	Unloading
Load cell at top	0	0	0	0	0	0	0	0	0
	0.2	0.15	0.23	0	0.25	0.06	0.16	0.2	0.24
	0.4	0.39	0.49	0.3	0.46	0.35	0.44	0.44	0.69
	0.6	0.77	0.92	0.7	0.9	0.8	1.03	0.93	1.16
	0.8	0.92	1.12	1	1.18	1.08	1.23	1.14	1.4
	1	1.2	1.2	1.2	1.24	1.4	1.57	1.46	1.78
	1.2					1.69	1.84	1.8	2.08
	1.4					1.93	2.1	2	2.28
	1.6					2.3	2.38	2.44	2.58
	1.8					2.64	2.7	2.73	2.98
	2					3.09	3.09	3.16	3.3
	2.2							3.48	3.68
	2.4							3.8	3.93
	2.6							4.2	4.28
	2.8							4.59	4.66
	3							5.01	5.01
Load cell at bottom	0	0	0	0	0	0	0	0	0
	0.2	0.13	0.17	0.2	0.41	0.21	0.43	0.26	0.54
	0.4	0.49	0.75	0.5	0.65	0.57	0.75	0.62	0.83
	0.6	0.87	1.01	0.9	0.94	0.98	1.15	1.04	1.25
	0.8	1.2	1.25	1.3	1.32	1.22	1.36	1.31	1.45
	1	1.45	1.45	1.5	1.5	1.58	1.73	1.63	1.82
	1.2					1.85	2.05	1.94	2.13
	1.4					2.23	2.41	2.25	2.45
	1.6					2.63	2.75	2.7	2.86
	1.8					2.99	3.1	3.07	3.17
	2					3.3	3.3	3.36	3.51
	2.2							3.63	3.86
	2.4							4.01	4.21
	2.6							4.38	4.56
	2.8							4.76	4.84
	3							5.29	5.29

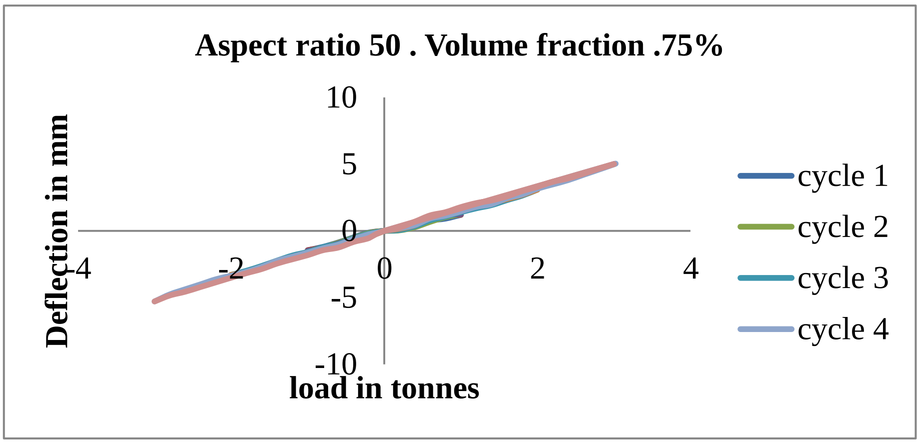

Figure 4: Load vs Deflection curve of 30% FA & QD Beam

Table 5 Load vs deflection for 40% beam under cyclic loading

Position of load cell	Load (in t)	Deflection in mm							
		Cycle 1		Cycle 2		Cycle 3		Cycle 4	
		Loading	Unloading	Loading	Unloading	Loading	Unloading	Loading	Unloading
Load cell at top	0	0	0	0	0	0	0	0	0
	0.2	0.1	0.23	0.1	0.23	0.12	0.26	0.14	0.17
	0.4	0.26	0.34	0.27	0.35	0.28	0.43	0.32	0.49
	0.6	0.66	0.74	0.68	0.73	0.68	0.79	0.71	0.89
	0.8	0.94	0.99	0.96	0.97	0.99	1.1	1.05	1.19
	1	1.22	1.22	1.23	1.23	1.24	1.42	1.28	1.54
	1.2					1.61	1.72	1.65	1.89
	1.4					1.99	2.17	2.05	2.23
	1.6					2.36	2.5	2.42	2.56
	1.8					2.64	2.71	2.68	2.77
	2					2.87	2.87	2.92	2.99
	2.2							3.24	3.31
	2.4							3.52	3.59
	2.6							3.76	3.87
	2.8							3.97	4.09
	3							4.27	4.27
Load cell at bottom	0	0	0	0	0	0	0	0	0
	0.2	0.11	0.21	0.13	0.23	0.14	0.25	0.15	0.29
	0.4	0.27	0.39	0.28	0.45	0.29	0.38	0.32	0.52
	0.6	0.67	0.75	0.69	0.81	0.84	0.93	0.86	1.09
	0.8	1.05	1.07	1.08	1.14	1.17	1.23	1.19	1.31
	1	1.35	1.35	1.37	1.37	1.39	1.42	1.41	1.52
	1.2					1.64	1.72	1.66	1.81
	1.4					1.98	2.09	2.03	2.14
	1.6					2.34	2.41	2.37	2.49
	1.8					2.69	2.71	2.72	2.81
	2					2.94	2.94	2.96	3.1
	2.2							3.31	3.41
	2.4							3.71	3.81
	2.6							3.99	4.05
	2.8							4.27	4.37
	3							4.59	4.59

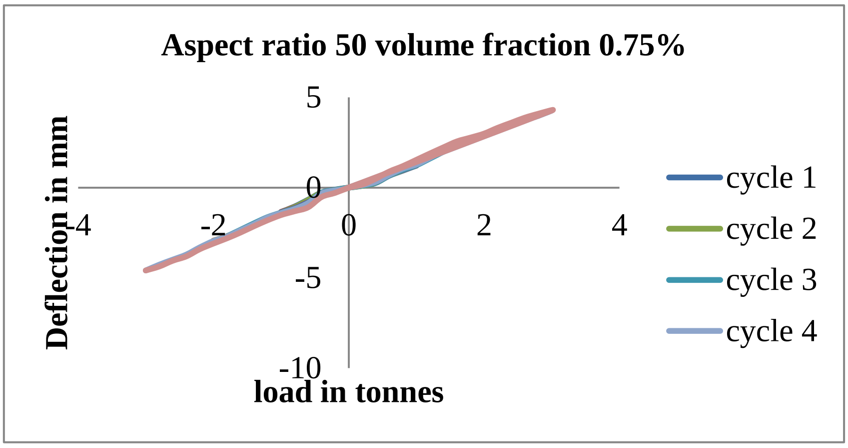

Figure 5 Load vs deflection curve of 40% FA & QD Beam

Table 6 Load vs Deflection for 50% beam under cyclic loading

Position of load cell	**Load (in t)**	**Deflection in mm**							
		Cycle 1		**Cycle 2**		**Cycle 3**		**Cycle 4**	
		Loading	**Unloading**	**Loading**	**Unloading**	**Loadin g**	**Unloading**	**Loadin g**	**Unloadin g**
Load cell at top	0	0	0	0	0	0	0	0	0
	0.2	0.13	0.08	0.06	0.13	0.15	0.26	0.25	0.33
	0.4	0.22	0.37	0.27	0.33	0.42	0.55	0.44	0.63
	0.6	0.61	0.68	0.64	0.73	0.79	0.88	0.82	0.98
	0.8	0.84	0.88	1	1.03	1.06	1.16	1.08	1.2
	1	1.09	1.09	1.11	1.11	1.16	1.24	1.18	1.25
	1.2					1.32	1.44	1.35	1.49
	1.4					1.62	1.68	1.65	1.84
	1.6					1.88	1.98	2.01	2.12
	1.8					1.96	2.12	2.22	2.36
	2					2.34	2.34	2.41	2.51
	2.2							2.68	2.81
	2.4							2.81	2.94
	2.6							2.96	3.15
	2.8							3.27	3.41
	3							3.62	3.62
Load cell at bottom	0	0	0	0	0	0	0	0	0
	0.2	0.11	0.17	0.16	0.26	0.26	0.37	0.39	0.45
	0.4	0.32	0.47	0.37	0.35	0.44	0.66	0.68	0.79
	0.6	0.71	0.78	0.74	0.84	0.89	0.97	1.01	1.12
	0.8	0.94	0.98	1.1	1.14	1.15	1.25	1.32	1.44
	1	1.19	1.19	1.22	1.22	1.25	1.39	1.44	1.56
	1.2					1.56	1.67	1.72	1.86
	1.4					1.86	1.96	2.12	2.21
	1.6					2.12	2.2	2.32	2.41
	1.8					2.32	2.48	2.56	2.66
	2					2.56	2.56	2.69	2.82
	2.2							2.89	2.96
	2.4							3.12	3.26
	2.6							3.49	3.56
	2.8							3.78	3.86
	3							4.02	4.02

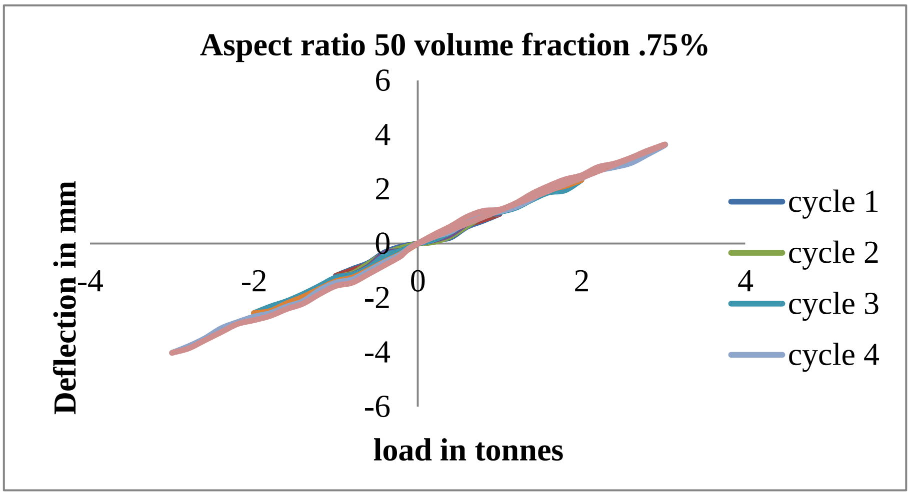

Figure 6 Load vs Deflection curve of 50% FA & QD Beam

4. CONCLUSIONS

[1] The flexural strength results has shown that FA & QD concrete with steel fibre of aspect ratio 50 and volume fraction 1% has got highest flexural strength.

[2] While comparing the results the high performance concrete with aspect ratio 50 and volume fraction 1% has gained maximum strength which 2.33% higher than conventional concrete.

[3] High performance concrete mix with steel fibre of aspect ratio 50 and volume fraction 0.75% has achieved 31.25% higher value than conventional concrete.

[4] The percentage increase in flexural strength is 17.54% when compared with conventional concrete.

[5] High Performance concrete beams after four cycles of full cyclic loading are loaded till ultimate load leading to failure of beam.

[6] The residual strength of high performance concrete with steel fibre of aspect ratio 50 and 60 with volume fraction of 1% has 29% higher residual strength when compared with conventional concrete.

[7] The results show that the good strength, greater durability and addition of FA & QD exhibits increase in compressive strength up to 50% replacement.

[8] The stiffness of the conventional concrete has degraded very much after applying four cyclic loading, where as the high performance concrete with steel fibres was able to retain its stiffness when compared with conventional concrete.

[9] While comparing the graphical representation of stiffness degradation curve, we can identify that concrete with aspect ratio 50 and volume fraction 1% has very less stiffness degradation when compared with all other beams.

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