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Mechanical and Structural Behavior of Reinforced Self-Compacting Concrete Beam

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ABSTRACT- In this study, punching shear of slabs and the flexural and shear behaviour of reinforced concrete beams were investigated in connection to the type of concrete (self compacting concrete (SCC) and normal concrete (NC)), and compressive strength (40 MPa). To achieve these objectives, two beam have been furnished, tested, and reviewed. First, one consists of SCC beam and the second one consists of NC beam. We are add admixtures like fly ash and GGBS. According to test results, for beams that failed in flexure, SCC beams showed a similar ultimate load to NC beams. When it came to slender beams collapsing in shear, NC beams showed a 6.75% higher ultimate load than SCC beams for beams , whereas beams with fc' 40 MPa showed nearly the same ultimate load value. The final loads for SCC and NC beams for beams did not differ noticeably. It was discovered that SCC slabs displayed a 17.25% higher ultimate punching shear load than NC slabs for the six geometrically similar slabs (three slabs made with SCC and three slabs made with NC of various concrete strengths) that were intended to fail in punching shear.

KEYWORDS- Self-Compacting Concrete, Structural Behavior, Flexure, Shear, Punching Shear, Super Plasticizer, Reinforcement.

I. INTRODUCTION

Due to the rebar's' packed structure in reinforced concrete (RC) parts like columns and beams, it is difficult to properly compact concrete when using a mechanical vibrator. Unfilled voids and macro-pores that develop in the concrete as a result of incorrect vibration and compaction are one of the potential reasons of concrete deterioration. [8] Self- compacting concrete (SCC), also known as self-consolidating concrete or rheodynamic concrete, does not require vibration for placement and compaction. Even in the midst of crowded reinforcement, it can flow under its own weight, completely filling forms and attaining full compaction.

The main objective of this research aims to increase the concrete strength and durability.

Super plasticizer used to increase the strength and workability of the concrete , super plasticizers are Fly Ash and GGBS (ground granulated blast furnace slag), During concrete casting, the need for vibration is minimal and thus labor and time are saved. Creating a smooth concrete surface facilitates the gauging process. It increases the durability by creating a space-free structure between concrete and iron reinforcement, by preventing segregation, it provides a homogeneous concrete without air bubbles. The permeability of self-compacting concrete is lower than normal concrete, its insulation values are higher [1]. Demonstrated that the load deflection response and mechanism of failure of the beams cast with SCC and regular concrete were comparable. It was found that, for concrete with a compressive strength of 60 MPa, [4] the ultimate moment capacity of the SCC beam was similar to that of the NC beam and that its maximum deflection was marginally greater than that of the reference beam [7]. The shear strength of the interface between pre fractured surfaces under various levels of normal stress was taken into consideration in Chisels. Zilch's studies from 2001[2] on the contribution of aggregate interlock to the shear [5]. It was found that, as the shear span to effective depth ratio decreased from 1.2 to 0.8, the percentage of increase in the failure load was about 32.5 %.The percentage of increase in the failure load were 42.6%, 27.7%, 19.1%, as both horizontal and vertical, horizontal only and vertical only web reinforcement ratios increased from 0% to 0.168%. Up to date, a number of researches on structural behavior and performance of RC structures made with SCC was carried out [6]. However, there is limited number of experimental and theoretical studies on the structural behavior reinforced beams and slabs made with SCC.

II. METHODOLOGY

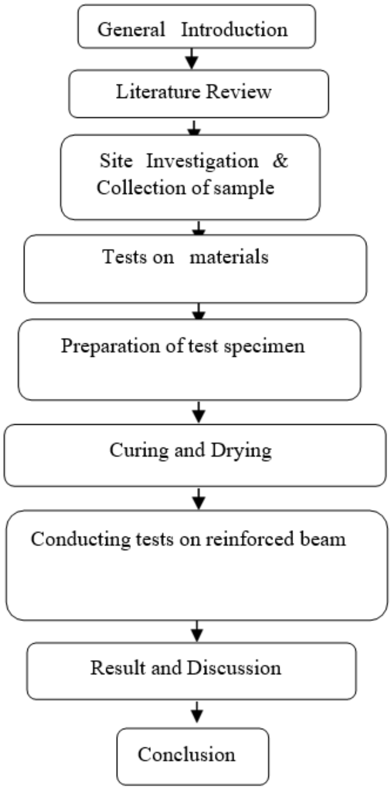

Figure 1: Methodology

III. PREPARATION OF SPECIMEN

The Engineering College's Building Materials Lab PACE Institute of Technology& Sciences was where the six concrete mixtures for this investigation were cast. The qualities of the freshly mixed concrete were tested, and beams and slabs were immediately cast into pre-made wooden shapes. SCC beams were built by pouring concrete into the formwork from one side and letting it flow to the other without needing any consolidation (shown in figure 2).

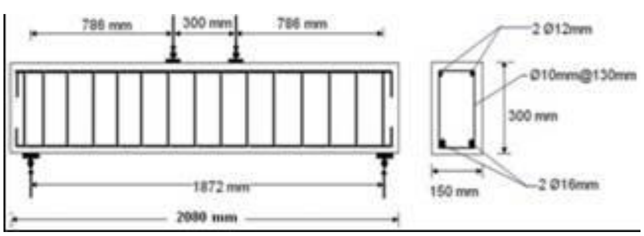

Figure 2: Preparation of specimen

IV. RESULTS AND DISCUSSION

The outcomes of the experiments done on the First cracking load, ultimate load, measured moment at ultimate load, and deflection at service load for beams intended to fail in flexure were among the test observations. Examples of deflection, crack width, and crack pattern for certain specimens California Bearing Ratio. In the below table 1, showing the Mix proportion of SCC (Self Compacting Concrete) and NC (Normal Concrete) and table 2 is showing the properties of fresh SCC and NC

Table 1: Mix proportion of SCC and NC

Concrete type	SCC		NC	
Mix symbol	**SCC40**	**SCC50**	**NC40**	**NC50**
Cement (kg/m^3)	385	451	384	550
LSP (kg/m^3)	151	113	0	0
Water (kg/m^3)	181	175	181	175
Sand (kg/m^3)	767	779	725	675
Gravel (kg/m^3)	956	892	1155	1115
SP/C %by wt.	0.78	0.89	0	0.2

Table 2: Properties of fresh SCC and NC

Concrete type	SCC		NC	
Mix symbol	**SCC30**	**SCC50**	**NC30**	**NC50**
Slump flow (mm)	707	703	-	-
T 500 (sec)	2.25	2.70	-	-
V-funnel (sec)	8.15	8.65	-	-
BR	0.82	0.93	-	-
SI %	7.3	6.6	-	-
Slump mm	-	-	100	100

Figure 3: Test setup of tested specimen's beams

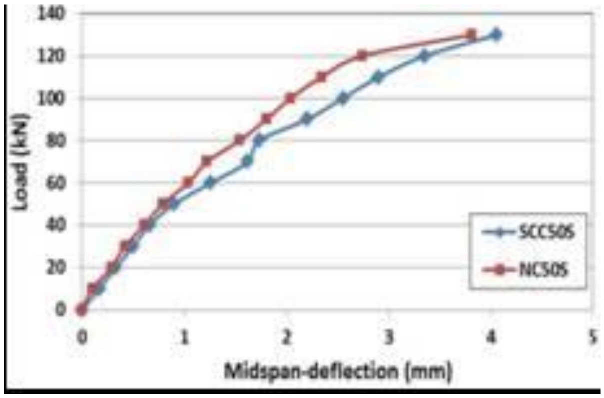

Figure 4: Load – Midspan deflections curve for SCC and NC slender beams failed in shear

Figure 4 is showing the crack pattern of SCC and NC slender beams failed in shear. However, the ultimate load rises with an increase in fc' for both types of concrete, with beam (SCC50S) displaying a higher ultimate load than beam (SCC30S) of 18.2% and beam (SCC62S) displaying a higher ultimate load than beam (SCC50S) of 37.3%. While the ultimate loads of beams (NC50S) and (NC62S) are, respectively, 15.1% and 26% greater than beam (NC30S). This is attributed to that, after an angled fracture appeared, the dowel force in the longitudinal reinforcement began resisting shearing displacement at the crack, and that resistance tended to generate tensile stresses in the tension steel surrounding concrete. Splitting cracking along the reinforcing and a failure in the tension zone occurred when forces surpassed the concrete's tensile strength. As a result, the dowel force increases as fc' grows because fc' It is clear that the effect of concrete compressive strength is more obvious for beams failed in shear than for those failed in flexure (SCC), which display somewhat higher midspan deflection than equivalent beams of group (NC) at all loading stages. The lower elastic modulus of the self-compacting concrete utilised to make these beams is what is responsible for the rise in deflection for beams (SCC). When concrete's compressive strength is increased, both SCC and NC beams' deflections are reduced.

In Table 3, we are showing the test results of beams designed to fail in flexure. SCC for concrete made at 40F and 50F degrees performs better than concrete made at such temperatures in general.

According to the test findings, SCC40F has a greater weight carrying capacity than NCC40F. In contrast, NC50F outperformed SCC50F in terms of results.

Table 3 Test results of beams designed to fail in flexure

Beam	**SCC40F**	**SCC50F**	**SCC50F**	**NC50F**
Cracking load (kN) (1)	42	43	36	38.5
Ultimate load (kN)-2	165	170	163	175
Ratio (1)/ (2) %	25.4	24.8	21	22.3
Ultimate moment KN.m (3)	6502	66.5	62.1	65.8
Calculated moment KN.m -4	48.62	50.52	48.26	52.3
Ratio (3)/(4)	1.286	1.236	1.922	1.096
Service Load (KN)	102.57	105.02	102.45	105.28
Measured Deflection at service load(mm) (5)	3.58	3.49	3.25	3.15
Calculated Deflection at service load(mm) (6)	3.35	3.55	3.28	3.35
Ratio (5)/(6)	0.95	0.96	3.28	0.97

Table 4 Test results of beams designed to fail in shear with a/d=3 (Slender Beams)

Beam		**SCC30 S**	**SCC50 S**	**NC30 S**	**NC50 S**
Flexural cracking load (kN)-1		42	43	35	37
Ultimate load(kN) (2)		112	135	115	139
Ratio (1)/ (2) %		35.37	33.2	30.35	26020
Predicte d ultimate load (kN)	**ACI (3)**	75.2	91.6	30.35	92.1
	EC-2 (4)	97.5	109.4	96.3	110.5
	BS811 0 (5)	93.7	102	94.1	105.2
Ratio (2)/ (3)		1.32	1.45	1.59	1.49
Ratio (2)/(4)		1.15	1.19	1.25	1.28
Ratio (2)/(5)		1.19	1.22	1.26	1.35

From table 4, it can be shown that NC50S concrete performs better than all other mixtures.

V. CONCLUSION

From the test results obtained in this study the following conclusions can be drawn:

For beams designed to fail in flexure, beams made with SCC showed 11.6% higher cracking load than similar beams made with NC. For the ultimate load, no considerable difference between NC and SCC beams was observed. NC.For the ultimate load and for beams with fc' of about 32 and 48 MPa, NC beam showed 6.75 % higher ultimate load compared with SCC beams. For the ultimate load of SCCand NC beams with fc' of about 62 MPa, SCC beam gave almost the same ultimate load value.SCC beams showed an inclined cracking load that Was no discernible difference between NC and SCC beams for the final load. By lowering the a/d ratio, the ultimate shear force was significantly increased. Reducing the a/d ratio from 3 to 1 resulted in a rise of (433%) for SCC beams without web reinforcement. SCC slabs showed a 16.6% greater flexural cracking load than comparable NC slabs for slabs that failed in punching shear. SCC slabs showed a 17.25% greater ultimate loadthan comparable NC slabs for the ultimate load.

Was 7.3% higher than that of comparable NC beams for deep beams (a/d=1) that collapsed in shear. There load.

All NC beams had fewer flexural fractures than comparable SCC beams, but the SCC beams' flexural cracks were narrower. The deflection of SCC beams for the same loading amount was marginally greater than for comparable NC

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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