COMPARISON OF STRUCTURAL BEHAVIOUR OF BEAM COLUMN JOINTS WITH CONVENTIONAL CONCRETE AND SELF COMPACTING CONCRETE

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Abstract: ***Beam column joints have an important role in the structural integrity of the building. A high percentage of transverse hoop are recommended at these particular areas, which leads to the congested reinforcement at the joints. Some problems are arising when using conventional concrete in the form of cracks and voids in the interior of the joints. So the present research is going to find out the solution to solve the stability problems at the joints. In view of that, Self Compacting Concrete is one of the best solutions to solve the structural problems at the joints. In this experimental investigation M 25 and M 40 Grade Self compacting concrete properties are analyzed by comparing with conventional concrete. Model test specimens of interior beam column joints have prepared for each grade. These specimens are tested on the loading frame to analyze the carking pattern, load carrying capacity and maximum deflection produced at the joints. These properties are investigated for joints of both grades and results have been concluded.***

Keywords— self compacting concrete, interior beam column joints, GGBS.

1. INTRODUCTION

Concrete is most important material in the construction industry. A lot of research is going on concrete to increase its performance in structural applications. There are different types of concretes available for construction today but some of them are important to use. Each and every type has its own application. In present days Self compacting concrete is one of the special type of concrete which has wide range of applications in construction. It has its own importance and superiority in dealing most of the structural problems where conventional was not able to solve.

Most crucial parts in building which gives structural integrity are the Beam column joints. Joints are crucial zones for the transfer of forces and moments effectively between the connecting elements like beams and columns. The overall structural performance is mainly based on the design of these beam column joints. Generally at areas normal reinforcement is not strong enough to sustain the forces developed by the loading. A high percentage of Transverse hoops were recommended in the core of joints, which leads to congested reinforcement in joints. So the usage of regular conventional concrete will not give satisfactory results in load carrying mechanism.

In framed structures, voids and cracks are the major problems that are identified while using conventional concrete. So researches showed that SCC has the exceptional capacity to solve these problems that are mainly generated in these regions. SCC is a stable concrete that can easily flow even in congested areas with no or little vibration and without undergoing considerable segregation and bleeding. Due to the superior properties like Flowability and filling ability of Self compacting concrete will maintain the uniformity and integrity of the elements like joints. Moreover, SCC insures improved finish, hence reducing surface remedial costs and minimizing wear and tear on formwork.

2. MATERIALS

Cement used is of Ordinary Portland Cement of 53 grade confirming to IS 12269-1987. Fine aggregate used are of Natural River sand from nearest locality in Vijayawada. The maximum sizes of coarse aggregates of 20 mm are used. The coarse aggregates are of crushed granite aggregates obtained from nearest crusher unit.

A good quality of class- C fly ash is obtained from Vijayawada Thermal Power Station. In order to improve the workability and flow ability, GLENIUM SKY 8630 and AURAMIX 450 are used. The dosage of SP is 1% weight of cement. It is confirming to IS 9103-1999 specifications.

Detailed sieve analysis is done for fine aggregate and it is confirming to Zone-II

Table.1properties of Materials Are Shown Below

Material	Specific gravity	Fineness modulus
Cement	3.11	285 m^2/kg
Sand	2.66	2.88
Coarse aggregate	2.80	7.11
Flyash	2.15	380 m^2/kg

3. METHODOLOGY

3.1 EXPERIMENTAL INVESTIGATIONS

The mix design is prepared according to the guidelines in the code IS 10262 - 2009. The W/C ratios for M25 and M40 grades of conventional concrete are taken as 0.48 and 0.40. For SCC water cement ratios for M25 anM40 grades are taken as 0.44 and 0.38. Several trail mixes have been done to finalize the mix ratios for both these grades.

The final mix ratios for both grades are given in the Table.2

Table.2 Mix Proportion Ratios

Grade	Mix Ratio		W/C ratio	
	Conventional	SCC	Conventional	SCC
M 25	1:1.70:3.30	1: 2.05: 2.22	0.48	0.44
M 40	1:1.40:2.70	1:2.1:2.30	0.40	0.38

For calculating the compressive strength, cube specimens are casted of size 150mm x 150mm x 150mm. These are tested for 7days and 28days curing. For testing fresh concrete workability is the main property of concrete. Workability of concrete is calculated by Slump Cone method and compaction factor method. Flow ability is the main property of Self compacting concrete. Flow table test, L – Box test and V – Funnel test are conducted to calculate the flow ability results of SCC.

Fig 1 Flow Table Test

Fig 2 L- Box Test

Fig 3 V – Funnel Test

Table.3 Trial Mix Details For M25 Grade SCC

Trial name	Cement (Kg/m^3)	W/C Ratio	SP Dosage (%)	Sand (%)	GGBS (%)	Flowabilty Range (600 – 800) mm	V – Funnel Range (8 – 12 sec)	L- Box Range (0.8 – 1.1)
SCC 1	430	0.46	1	55	0	690	12	1.1
SCC 2	430	0.44	1	48	20	620	12	1.0
SCC 3	430	0.42	1	48	25	630	10	0.9

Table.4 Trial Mix Details

Trial name	Cement (Kg/m^3)	W/C Ratio	SP Dosage (%)	Sand (%)	GGBS (%)	Flowabilty Range (600 – 800) mm	V – Funnel Range (8 – 12 sec)	L- Box Range (0.8 – 1.1)
SCC 1	500	0.38	1.2	48	20	680	20	0.87
SCC 2	500	0.42	1.2	48	25	630	12	1.0
SCC 3	500	0.42	1.2	48	25	650	10	0.92

3,2 RESULTS:

Workability of concrete:

The workability of concrete is observed by the Slump Cone method. The slump range was 25-100mm.

Table 5: Slump Obtained For M 25 and M 40

Mix	Slump (mm)	
	M 25	M 40
Control Mix	65	46

Compressive strength:

Table.6 Compressive Strength

Mix	Compressive strength (N/mm^2)			
	M 25 grade		M 40 grade	
	7 days	28days	7days	28days
Control	21.5	33.5	38.30	49.2
SCC 1	19.0	28.0	38.25	45.6
SCC 2	21.1	32.0	41.30	46.8
SCC 3	22.0	38.3	43.60	48.9

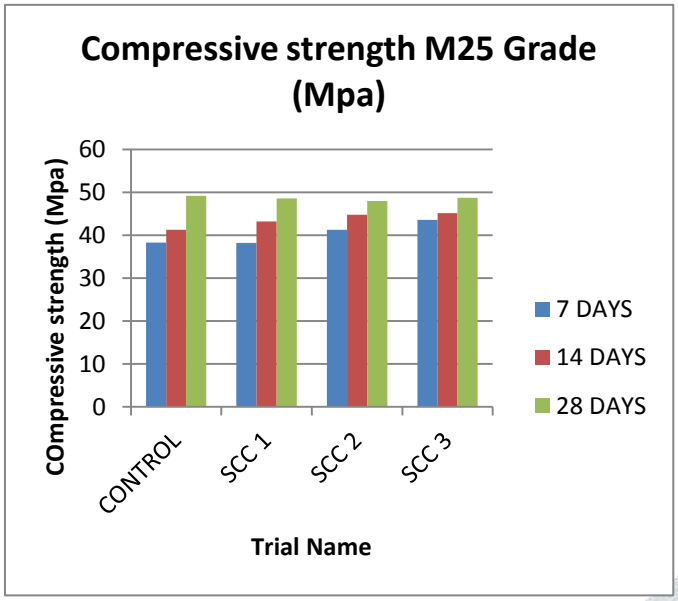

Fig 4 Compressive strength of M25 Grade concrete

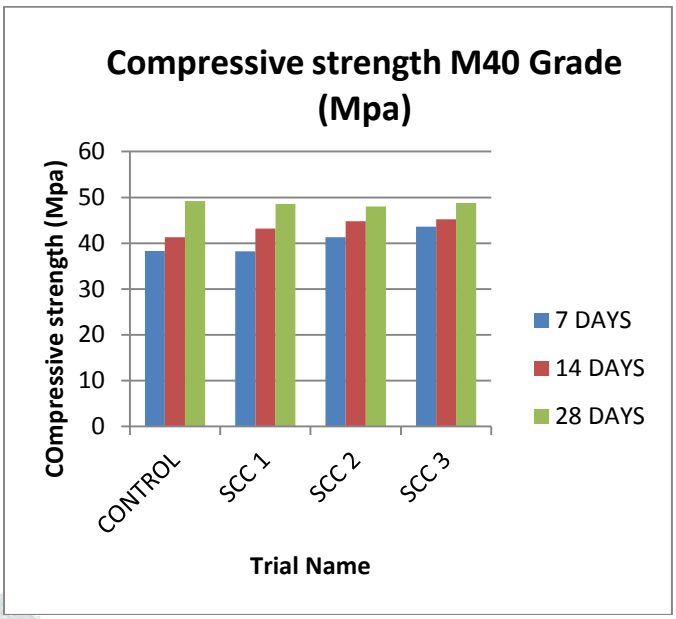

Fig 5 Compressive Strength Of M40 Grade Concrete

4. TESTING OF BEAM COLUMN JOINTS:

Details of the Specimen:

The test specimen having a Beam dimensions of 205 X 150 mm including slab thickness and column of 150 X 230 mm. Height of the column was 1200 mm.

Form work and Reinforcement details:

In order to prepare the test specimen, a mould is prepared with wooden boards according to the specimen dimensions. The inner sides of the mould are oiled to prevent the absorption of the water. The mould was placed over a smooth surface before concreting and a cover of 25 mm was provided at the bottom of the reinforcement.

Reinforcement Details:

The reinforcement details are shown in fig. In this main reinforcement is of 10 mm diameter of 4 No's in Each Beam and column. The stirrups are of 6 mm diameter of 60 mm c/c.

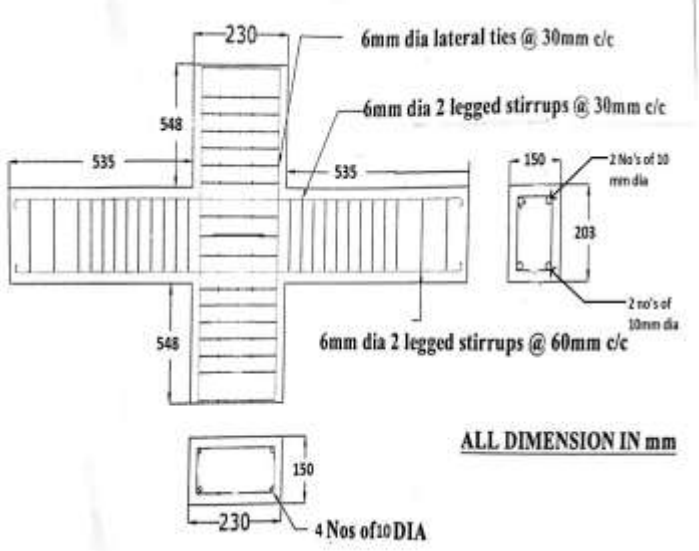

Fig 6 Reinforcement Detailing

Fig 7 Form Work

Casting and Curing:

For Each grade 2 specimens were prepared and cured for 28 days at regular intervals.

Fig 8 Casting Of Joints

Fig 9 Curing Of Beam Column Joints

Test Setup on Loading Frame:

The specimen was tested on a Loading frame. The entire setup was shown in fig. A Hydraulic jack was used to apply load on the joint. In this cyclic loading is applied to measure ultimate load, crack pattern and deflection in every beam column joint at regular loading intervals.

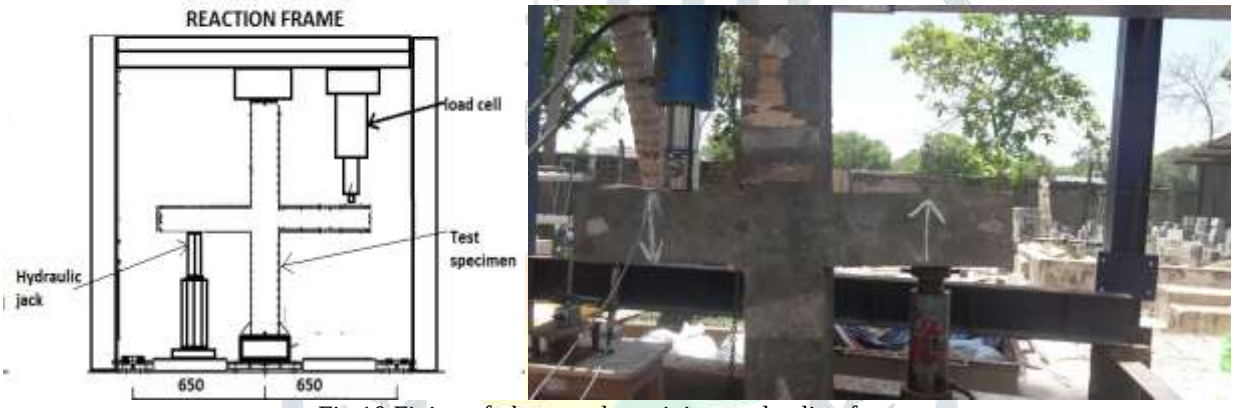

Fig 10 Fixing of beam column joints on loading frame

Observations while Testing:

The basic observation while testing specimen is that the visible crack pattern developed at the joint area. The maximum failure load will be an observation point in this experimental work. Deflection of beam column joint was also a major parameter that needs to be concentrated.

1. **Cracking Pattern**

Initially while the load is applied on the test specimen cracks will develop at the joint areas. Using a marker pen the cracks will marked for observation

Fig 11 Observations of Cracking Pattern

2. **Load Deflection Behavior**

Deflection will produce while the load is applying on the test specimen. The load deflection curve will produce in the data acquisition system. The maximum failure load is noted and the corresponding graphs for the load deflection behaviour were plotted. When comparing

with conventional concrete, the specimens of self compacting concrete have shown better load carrying capacity, minimum deflection and cracking behaviour. The crack widths were also in a minimum rate while compared to Conventional concrete of M25 grade.

Fig 12 Conventional Concrete

Fig 13 Self Compacting Concrete

Table 7 For M 25 Grade Test Specimen

Specimen type	First crack load (P_{cr}) (KN)	Ultimate load (P_u) KN	Maximum Deflection (mm)	Maximum crack width (mm)
Conventional	26.49	35.32	85	5.64
SCC	28.70	37.53	65	5.25

Table8 Load Deflection Behaviour Of M25 Grade Conventional And Self Compacting Concrete Test Specimen

Load(KN)	**Deflection(mm)**
4.41	25
8.83	30
13.2	35
26.49	65
28.70	80
35.32	85
44.15	45
48.57	28
50.77	18
57.40	19

Load(KN)	Deflection(mm)
4.41	22
8.83	30
13.2	35
26.49	55
28.70	60
35.32	65
37.53	60
50.77	28
52.98	15
54.0	10

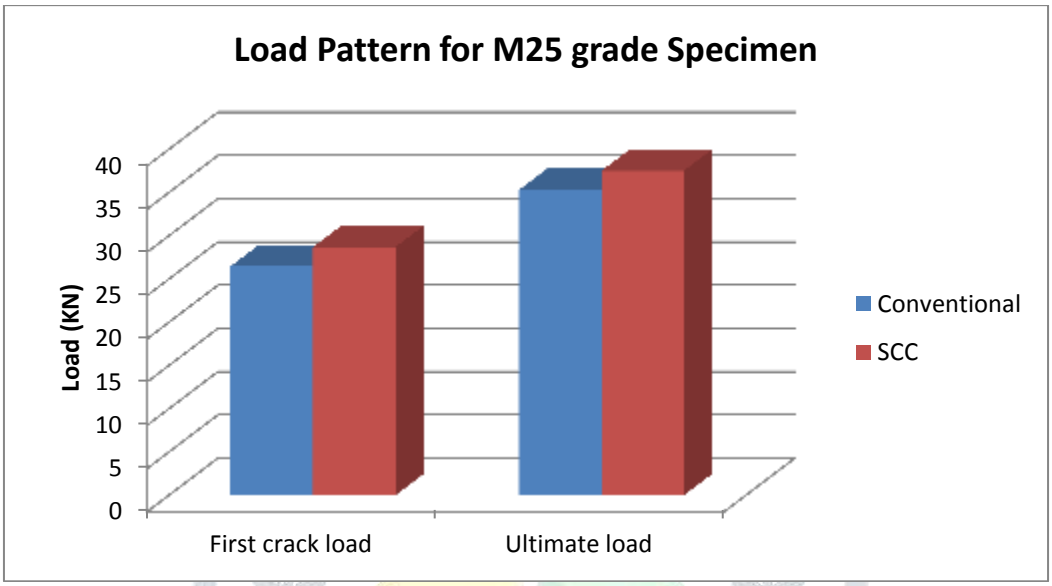

Fig 14 Load Pattern For M25 Grade Specimen

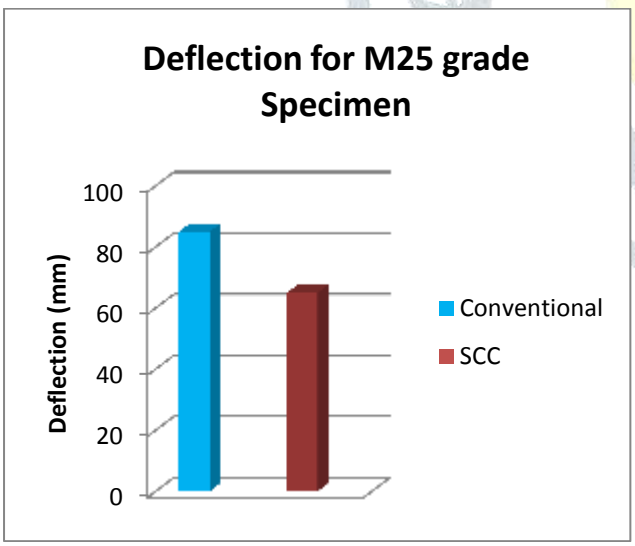

Fig 15 Deflection For M25 Grade Specimen

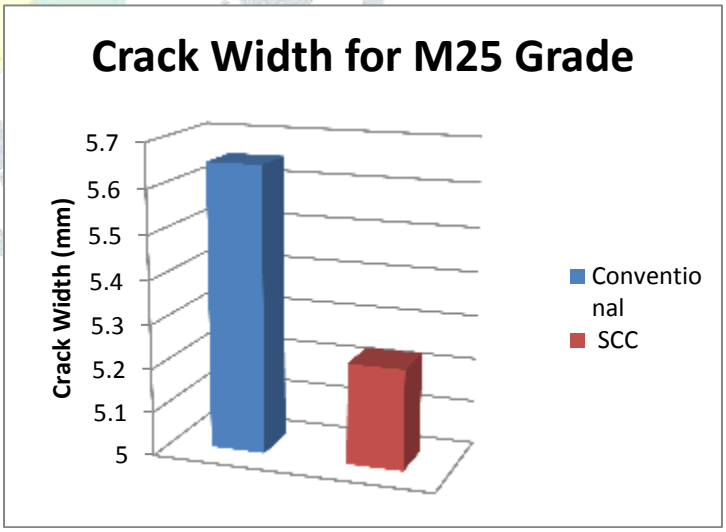

Fig 16 Crack Width For M25 Grade

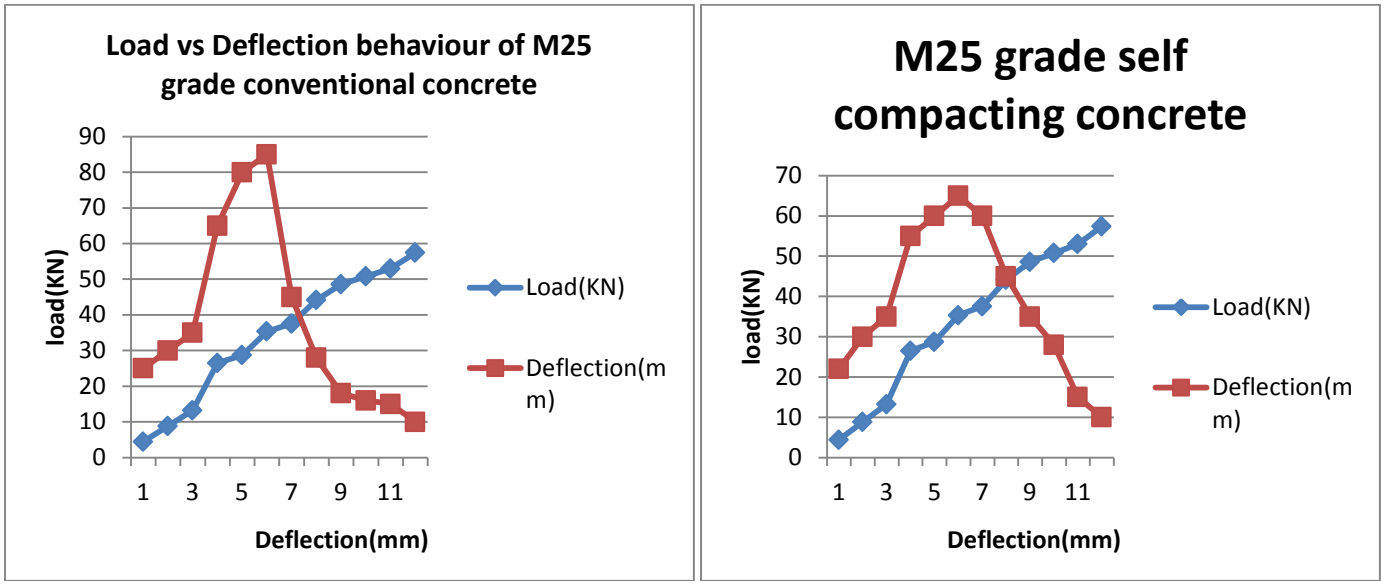

Fig 17 Load & Deflection For M25 Grade Conventional Concrete & Self Compacting Concrete

CONCLUSIONS

- SCC of both M25 and M40 grades have shown better workability results in flow ability, passing ability and filling ability.
- For conventional concrete maximum compressive strength of M25 grade for 28 days is 33.5 N/mm^2 and for M40 grade is 49.2 N/mm^2.
- For Self compacting concrete, for 28 days maximum compressive strength achieved for M25 grade is 38.0 N/mm^2 and for M40 grade is 48.75 N/mm^2.
- The Ultimate load carrying capacity for SCC joints is better than Joints with Conventional concrete But in case of Maximum load carrying capacity, conventional concrete joints have shown better results due to the better interlocking behavior of Aggregate.
- From the load deflection curve it was observed that, minimum deflections were observed for SCC joints when comparing to Conventional concrete joints.
- SCC joints have shown minimum crack widths when compared with Conventional concrete joints due the less void space ratio in the interior of the concrete structure.
- Both of the test specimens (conventional &SCC) failed at the interface of the beam column joint.
- While testing beam column joints on loading frame, joints with SCC have shown better properties than conventional concrete.
- Conventional concrete joints have got maximum failure load than SCC joints due to the more aggregate content.

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