ISSN No:-2456-2165

Experimental Study on Mechanical Behaviour of Composite Beam Using SCC with Shear Connectors

A. Ananthakumar*, KAnisha
Assistant Professor/Department of Civil Engineering
UG student/Department of Civil Engineering
Vivekanandha College of Technology for Women, Tiruchengodu

Abstract:- The project aims at an experimental investigation of composite beam to predict the structural performance. The composite beam consists of two steel plates placed at top and bottom to be filled with concrete. The steel plates are interconnected using headed stud and J hook shear connectors with 100mm and 120mm spacing to improve composite beam action between the plates and concrete. The concrete core consists of superabsorbent polymer as internal curing represents standard weight concrete. The strength of the self-curing concrete grade of M25.Mix proportion in accordance with IS10262:2000. Super absorbent polymer can be used in 0.3% and 0.4% weight of cement. In SCS, normal curing is not applicable because of corrosion of steel plate and shear connectors which occurs due to the interaction of water. Since it is a prime factor, to develop a self-curing concrete using super absorbent polymer as self-curing agents. The strength of concrete containing of self-curing agent was tested and compare with conventionally cured concrete.

A mild steel plate of 4mm thickness in both the faces of the composite beam. The composite beam size to be tested in this project is 450x150x150mm of 8nos of varying spacing of shear connectors. The composite beam is loaded and tested under the two-point bending systems.

Keywords:- *Composite Beam, Sandwich, Self-Curing Concrete, Shear Connectors.*

I. INTRODUCTION

In current trends civil engineering structures depends upon the materials and increasing load carrying capacity. In structural performance is very comfortable for building and environment. In current scenario building construction challenges are more. These challenges are based on loads and environmental pollution. Steel-Concrete-Steel (SCS) sandwich composite structures was increased in many countries but curing process and erection process is very difficult. This paper explained the curing process is very easy and improve the strength simultaneously. In last 30years, most of the research and development of SCS sandwich construction. cohesive binding materials (e.g., epoxy) and different types of mechanical shear connectors such as headed stud, J hook, Bi - steel connector, angle shear connector, plate connectors etc., was proposed to bind the steel plate and concrete core.

Considering the existing SCS system, commonly used shear connectors is headed stud, and J hook connectors was studied in the researches.

II. OBJECTIVE

In this paper, an experimental inspection of a self-curing concrete sandwich steel beam with shear connector is proposed. The objective of the study is,

- To check the mechanical properties of the steel plate.
- To determine the strength of concrete using an internal self-curing agent of trial dosage of 0.3% and 0.4%.
- To examine the flexural behaviour of sandwich steel beam using headed stud and J hook shear connectors with 100mm and 120mm spacing.
- To study the structural performance of the SCS sandwich steel beam.

III. SCOPE

Various parameters used are

- To provide the thickness of steel plates 4mm.
- To provide the Steel-concrete-beam size is 450mm×150mm×150mm.
- Self-curing concrete grade of M25
- 0.3 % and 0.4 % SAP is used in the weight of the cement.
- To check the performance of concrete with an optimum dosage of the self-curing agent in concrete to be used for the SCS beam.

IV. MATERIALS REQUIRED

➢ *Super Absorbent Polymer (SAP)*

The super absorbent polymer can absorb more amount of water in mixing of concrete and form large inclusions containing free water, to prevent desiccation during cement hydration. Self-curing provides extra curing water consistently throughout the entire microstructure of the concrete. The use of self-curing admixtures is essential of the concrete that water resources are getting daily. To refer the properties of SAP, this literature of Vedhasakth k and

Saravanan M (2010) studied the improvement of standard strength and high strength self-curing concrete with super absorbing polymer (SAP) and comparison of characteristics of strength.

Fig 1:- Super Absorbent Polymer

➢ *Steel Plate*

Typical mild steel plate with 4mm thickness was used and fabricate the steel skin plate. The Steel coupon test were prepared and tested under tension to ASTM can obtain the material properties.

Fig 2:- Mild Steel Plate

V. TESTING OF STEEL PLATE FOR SANDWICH

As per IS 513:2008, coupon test were conducted for Mild steel plate of 4mm thickness. The following tests,

1. Tensile strength test
2. Bend Test
3. Hardness Test

Fig 3:- Test Specimen for Steel Plate

Test Particulars	
Description	MS Plate
Material Specification	17A Grade D
Plate thickness	4x150x300 mm

Table 1:- Basic Properties of Steel Plate

➢ *Tensile Test for steelplate*

Tensile strength test is preferably worked on material testing laboratory. The ASTM D638 is among the most common tensile testing protocols. The ASTM D638 measures plastics tensile properties including Ultimate Tensile Strength, Yield Strength, Elongation, and Poisson's ratio. The strain measurements are equally measure with an extensometer but strain gauges was used frequently in small test specimen or when Poisson's ratio is being measured.

Fig 4:- Tensile Tests for Steel Plate

Material Specification	YIELD LOAD (kN)	YIELD STRESS N/mm^2	TL (kN)	TS N/mm^2	%E
S275	34.29	402.92	45.81	538.29	25.70

Table 2:- Tensile Test Resulton Mild Steel Plate

➢ *Bend Test for SteelPlate*

Two legs of steel plate remains of plane perpendicular to the axis of the bending. In this case of 180° bend, the two lateral surfaces have been depended on the requirements of the material. Standard, lie flat against each other or may be parallel to the specified distance, an insert hasto be used to control the distance.

Fig 5:- Bend Test for Mild Steel Plate Specimen

➢ *Hardness Test for SteelPlate*

Hardness test requirement by the way of departure from the Indian standards; It is permitted to the visible deformation of the backside specimen. The values are determined by this way to identified using symbols HRBm and HR30Tm.So as to differentiate the hardness values are determined of thicker products (which are not allowed to exhibit a visible deformation on the backside of the specimen).

Fig 6:- Hardness Test for Mild Steel Specimen

A. Shear Connectors

Shear connectors are mechanical devices that are employed to unite steel beamsto concrete slabs, absorbing the shear flow at the beam-slab interface and preventing a vertical separation between the two elements (uplift). In this project shear connectors used is headed stud and J hook connectors provided with a spacing of 100mm and 120mm in the steel plate of both top and bottom.

Fig 7:- Headed Stud and J Hook Shear Connectors

Mix	Slump in mm	Compaction Factor
M25	115	0.95

Table 3:- Slump Value and Compaction Factor Value of Self-Curing Concrete

B. Casting Of specimen

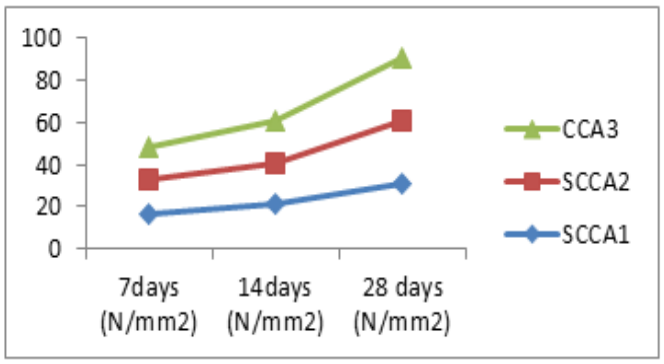
The casting of specimens was done as per IS 10086-1982, When prepared the materials to involved the casting of cubes, cylinders, beams. The weighting, compacting, and curing of concrete are done according to IS: 516-1959. The samples of cubes, cylinders and beam specimens with normal curing and self-curing specimen .for internal curing using of SAP with the dosage of 0.3% and 0.4% is cured for 28 days at room temperature by placing them in the shade.

Fig 8:- The casting of various % SAP and CC specimen

C. Compressive Strength Test for Concrete

The aim of hardened concrete test was confirm that the concrete used on site have been developed the required strength. Compressive strength test of cube is the most common test conducted by hardened concrete. The specimens are placed on 2000kN capacity of compression testing machine. The specimen axis is carefully aligned with the testing machine. The maximum load applied on the specimens is recorded and note the appearances of the cracks.

ISSN No:-2456-2165



Graph 1:- Effect of Compressive Strength of Concrete

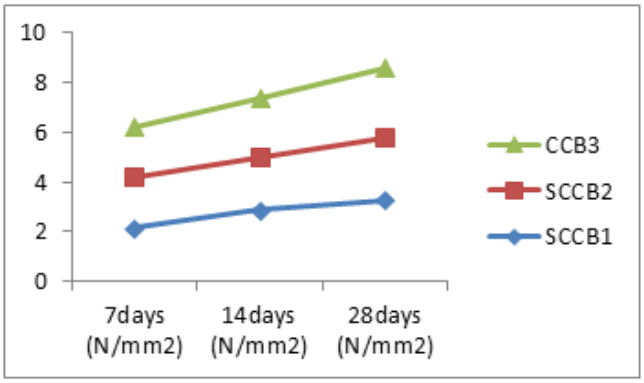
➢ *Result and Discussion*

- The compressive strength the concretes were studied their self curing with conventional concretes (reference concrete), which increases gradually with time in rates of during air curing.
- The compressive strength the cubes is gradually decreasing with the percentage of increasing SAP to the weight of the cement.
- The compressive strength of self-curing concrete of 0.3% of SAP attains 18.13% more than the conventional concrete and 0.4% of SAP in the weight of the cement.
- Though there is an increase in percentage, the results explained that the decrease of strength of the concrete and the weight of the cube also increased due to the presence of SAP in concrete. This occurred due to the swelling of concrete.

D. Split Tensile Testresults

The split tensile strength results at varies ages, such as 28 days for different percentage levels. The load applied in maximum to specimen have been observed and tabulated below.

Formula for obtaining Split Tensile Strength: Split Tensile Strength (N/mm^2) = $2P / \pi DL$



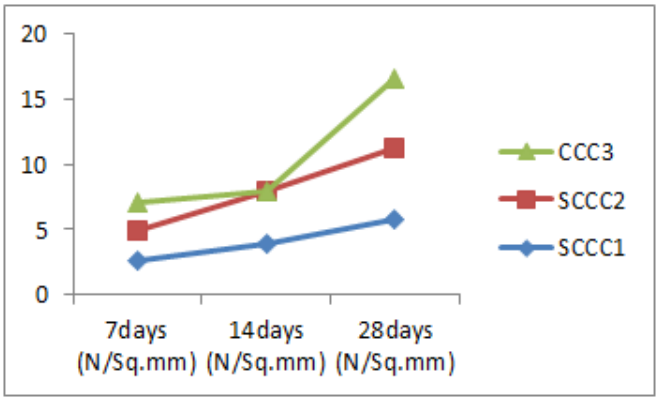
Graph 2:- Effect of the Split Tensile Strength of Concrete

➢ *Results & Discussion*

- Split tensile strength of 0.3% of SAP attains the strength is 26.6% more than the conventional concrete and 0.4% of SAP.
- The split tensile strength of 0.3% of SAP is increased and 0.4% of SAP is decreased.

E. Flexural Strength Test results

Flexural strength test results at varies ages, such as 28 days for different percentage levels. The maximum load applied on specimen have been observed and tabulated below. Refer the formula for given literature paper of strength characteristics in self-curing concrete (M.V. Jagannadha Kumar and Srikanth). If the specimen breaks at the middle third of the specimen of the span, then the modulus of rupture is given by f (rup) (N/mm^2) = WL/bd^2



Graph 3:- Effect of flexural strength of concrete

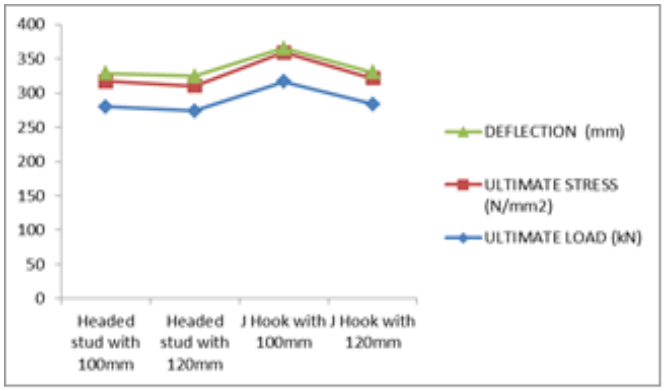
➢ *Result and Discussion*

- The self-curing concrete of 0.3% of SAP attains flexural strength is 30% more than the conventional concrete and 0.4% of SAP in the weight of the cement
- Increase in SAP percentage will decrease the strength of the concrete.

F. Steel Concrete Steel Beam Test results

From the compressive test, split tensile and flexural strength of the concrete can attains more strength in the 0.3% of SAP when compared to the other specimen of 0.4% of SAP. So, the SCS beam is cast with 0.3% of SAP used concrete core to attain the ultimate load-carrying capacity of the SCS beam. The SCS beam was tested under two points load, and the result was discussed.

ISSN No:-2456-2165



Graph 4:- The Ultimate Load-Carrying Capacity of SCS Beams

Fig 9:- Failure of the Headed Stud Beam

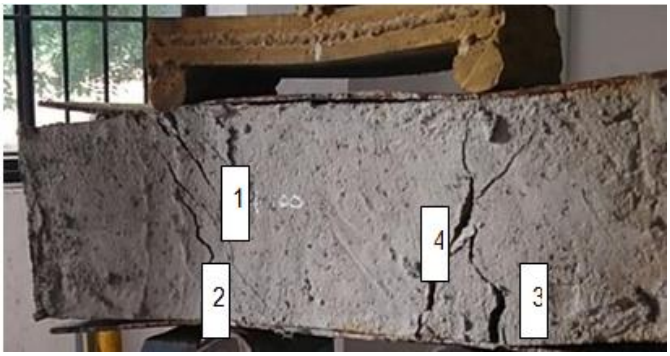


Fig 10:- Failure of the J-Hook Beam

Fig 11:-Shaer Failure of the Beam at the Ultimate Stage

It is stated that there is a minimum number of cracks were formed in the concrete core. It is connectivity of J hook shear connectors in the concrete which delay the formation and propagation of cracks as a result of which the load carrying capacity of beam will be maximum when compared to headed stud shear connectors. The concrete core failure is observed ductile and not brittle due to the presence of shear connectors, which prevents the formation of cracks and delays the failure of the beams.

VI. CONCLUSION

1. Though the compressive strength, split tensile strength, modulus of rupture and modulus of elasticity values are remarkably increased up to 0.3%, it slightly decreased later. So, the optimum percentage of SAP to be added in SCC for internal curing is 0.3%. Then the extends of the hydration and thereby increases the strength of concrete. Therefore, self-curing concrete with SAP is recommended for field application where curing is difficult and water scarcity areas.
2. The experimental works state that the load-carrying capacity of the self-curing concrete with J-hook shear connector beam is 12% higher than that of headed stud composite beam.
3. The shear resistance of the self-curing concrete core is maximum because of using j-hook connectors instead of headed stud.
4. The strength of the beam J Hook composite beam of spacing 100mm and Headed stud composite beam of spacing 100mm is calculated to be maximum when compared to Headed Stud composite beam 120mm and J Hook composite beam 120mm
5. The concrete core failure observed is ductile due to the presence of shear connectors and also it prevent the formation of cracks.
6. The beam collapsed by slipping off the lower steel plate. The slipping of the plate more occurs in the headed stud beam that showed the lower ductility in the lower steelplate.

REFERENCES

[1]. HaiNguyen, Hiroshi Mutsuyoshi, WaelZatar Push-out tests for shear connections between UHPFRC slabs and FRP girder. Volume 35, pp194-200.
[2]. IS 10262:2009 “Indian standard concrete mix proportioning-guidelines”
[3]. IS 516:1959 “Indian standard methods of tests for strength ofconcrete.”
[4]. Jia-Bao Yan, Wei Zhang (2017) Numerical analysis on steel-concrete-steel sandwich plates by damage plasticity model: From materials to structures. Volume 121(2016), pp 50-64.
[5]. Jia-Bao Yan, J.Y. Richard Liew, M.H. Zhang Tensile resistance of J-hook connectors used in the steel-Concrete-Steelsandwich structure.volume 100, pp146-

162.
[6]. J.Y. Richard Liew-, K.M.A. Sohel Lightweight steel-concrete-steel sandwich system with J-hook connector. Volume 130, pp202-221.
[7]. Mr.Vivek, Mrs.Bhavana B, etal.,(2015) "Experimental Investigation on Properties of Self-Compacting and Self-Curing Concrete with Silica Fume and Light Weight Aggregates" International Journal of Engineering Research & Technology (IJERT),4(6),2278-0181
[8]. P.Muthukumar , K. Suganya Devi(2015), "Flexural Behaviour Of Self-compacting Self Curing Concrete Beam," International Journal On Engineering Technology and Sciences: 2(4),2349-3968.
[9]. R. Karthick and P. Jayajoth (2015), "Investigation on Self-compacting Concrete using Self-curing Agents," Journal of Civil Engineering and Environmental Technology, 2(8),2349-8404.
[10]. YonghuiWang ,XimeiZhai, Responses of curved steel-concrete-steel sandwich shells subjected to blast loading. Volume 102, pp301-315.
[11]. Yu-Bing Leng, Xiao-Bing Song, Experimental study on shear performance of steel– concrete–steelsandwich beams volume 106, pp101-125.
[12]. 12. P.Muthukumar , K. Suganya Devi(2015), "Flexural Behaviour Of Self-compacting Self Curing Concrete Beam," International Journal On Engineering Technology and Sciences: 2(4),2349-3968.
[13]. 14.R. Karthick and P. Jayajoth (2015), "Investigation on Self-compacting Concrete using Self-curing Agent," Journal of Civil Engineering and Environmental Technology, 2(8),2349-8404.
[14]. Mr.Vivek, Mrs. Bhavana B, etal.,(2015) "Experimental Investigation on Properties of Self-Compacting and Self-Curing Concrete with Silica Fume and Light Weight Aggregates" International Journal of Engineering Research & Technology (IJERT),4(6),2278-0181