STATIC AND DYNAMIC INVESTIGATION OF SCS SANDWICH PANELS WITH NOVEL CONNECTORS

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Abstract - *This paper investigates the behavior of SCS sandwich panels with novel connectors under static and dynamic loading. In order to reduce the self-weight of the structure and achieve composite action between the steel and concrete, ultra- lightweight cement composite and novel shear connectors have been developed and applied in the SCS sandwich composite structures. The results show that the J hook novel connector enhances the overall structural integrity of the sandwich structures.*

Key Words: Steel Concrete Steel (SCS) panel, Novel connector, Static and dynamic loading, Structural integrity.

1. INTRODUCTION

Steel-concrete-steel (SCS) sandwich structures consist of two steel face plates infilled with cement composite material. Infilled cement composite material is light weight. The apparent advantages of the system are that the external steel face plates act as both primary reinforcement and permanent formwork, and also as impermeable, impact and blast resistant membranes. To improve the strength-to-weight performance of SCS panels novel connectors are used.

1.1 Objectives

The main objective of this thesis is to determine the deflection and load carrying capacity of plate connector and J hook connectors with varying diameter. Types of J hook connectors with varying diameter are,

- J-12-8-12
- J-8-12-8
- J-10-10-10
- J-10-18-10-alternate

MODELLING

Modelling of SCS sandwich panels with novel connectors was done using ANSYS WORKBENCH 16.1.

1.2 Specimen details

The SCS sandwich slabs had cross-sectional dimensions of 1200*1200 mm^2 and a thickness of 80 mm .Thickness of steel face plate is 5.96mm .Spacing between the connectors is 100mm .Grade of concrete provided is 25 MPa and grade of 500 (Fe 500)is provided for steel and connectors .

In case of plate connectors, length of plate is 60mm, width of plate is 50mm and thickness of plate is 0.7mm .In case of J hook connectors, radius of the hook is 25mm. Table 1 shows the material properties of sandwich panels with plate connectors. Table 2 shows the material properties of sandwich panels with J hook connectors. Figure 1 shows the detailed dimensions of plate connector. Figure 2 shows the detailed dimensions of J hook connector.

Table -1: Material properties of steel, concrete and connector

Property	Steel	Concrete	connector
Young's modulus (MPa)	$2x10^5$	25000	$2x10^5$
Density (kg/m^3)	7860	2400	7860
Yield strength(MPa) for plate connector	250	3.6	345
Yield strength (MPa) for J hook connector	250	3.5	415
Poisson's ratio	0.3	0.15	0.3

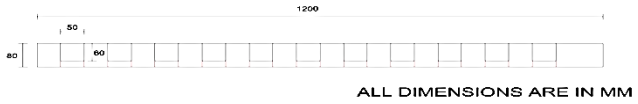


Fig – 1: Detailed dimensions of plate connector

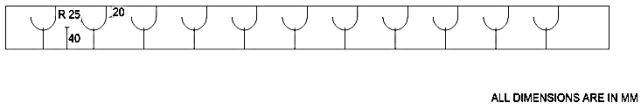


Fig – 2: Detailed dimensions of J hook connector

2.2 Finite element models of SCS sandwich panels with novel connectors

The sandwich slabs with novel connectors was done using ANSYS WORKBENCH 16.1. The properties of steel, concrete and connector used for manufacture are different for different connectors. Here static and dynamic loading was applied at the center of the sandwich slab. Support condition of the slab is fixed.

Table -2: Description of models

PC	Plate Connector
J-12-8-12	J hook with varying diameter 12-8-12
J-8-12-8	J hook with varying diameter 8-12-8
J-10-10-10	J hook with diameter 10
J-10-8-10-alternate	J hook with diameter 10 and 8 alternatively

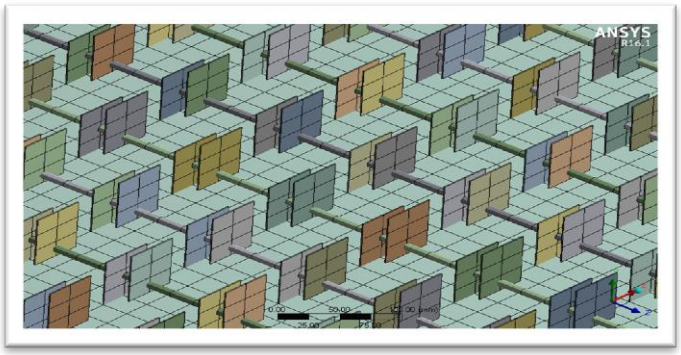


Fig – 3: P C

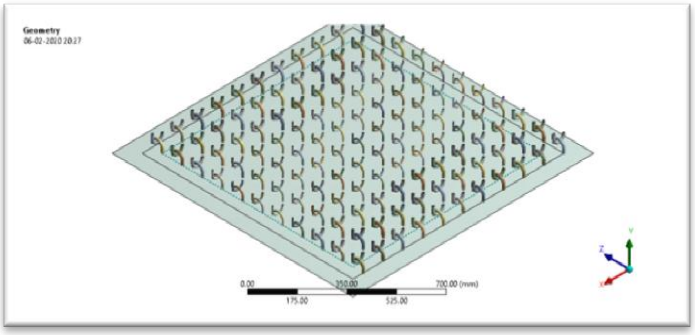
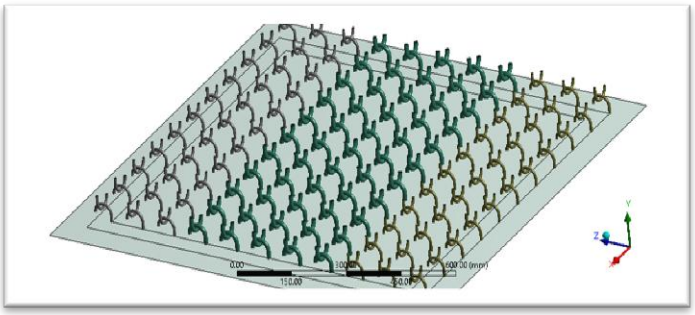


Fig – 4: J-12-8-12



Fig–5:J-8-12-8

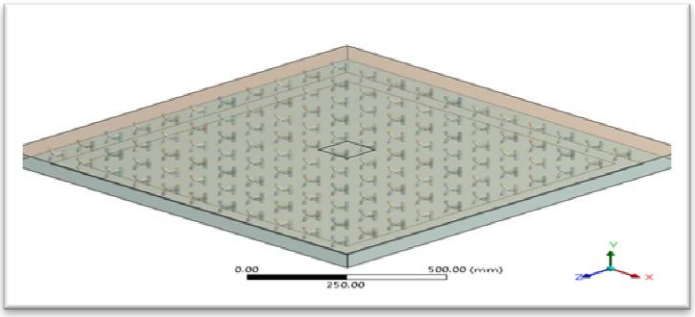


Fig – 6: J-10-10-10

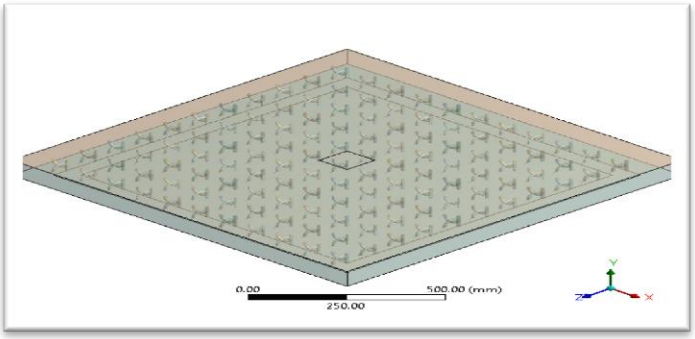


Fig – 7: J-10-8-10-alternate

3. RESULTS AND DISCUSSION

The behaviour of SCS sandwich panels with different novel connectors were analysed using finite element analysis in ANSYS WORKBENCH 16.1.

3.1 Load carrying capacity

The deflection is a key parameter for determining load carrying capacity of the sandwich slabs. Table 3 shows the analysis results in the terms of load carrying capacity of SCS sandwich panels with novel connectors. Based on the analytical results, the ultimate load carrying capacity of sandwich slabs with J hook connector having varying diameter 8-12-8 (J-8-12-8) is found higher than that of sandwich panels with plate connector as shown in table 3. Chart 1 shows the load vs deflection curves of models. From the graph it is clear that sandwich slabs with plate connectors deforms very fastly because,

- ✓ Area of plate used in plate connector is high
- ✓ Concrete bond get disturbed
- ✓ Plates can be easily slipped
- ✓ Bond strength of plates is less

Table -3: Analytical results of load carrying capacity of models

Model	Deflection (mm)	Ultimate load (kN)	%
P C	24.392	324.00	29%decrease
J-12-8-12	65.002	365.00	20%increase
J-8-12-8	65.007	546.00	20%increase
J-10-10-10	65.006	455.00	-
J-10-8-10-alternate	65.002	361.00	20%increase

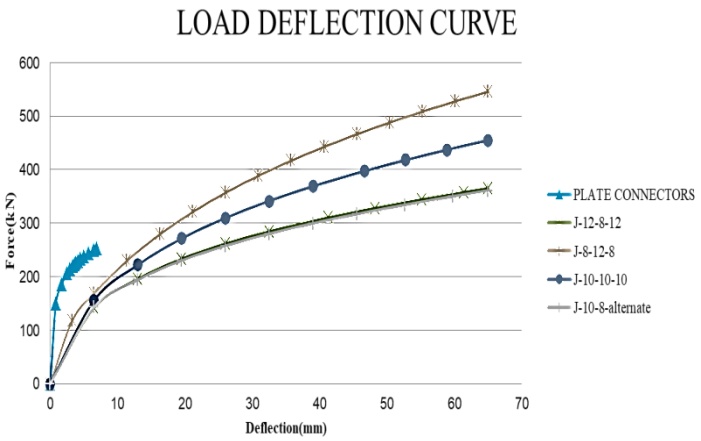


Chart – 1: Load vs deflection curves of models

It was observed that maximum load carrying capacities by PC, J-12-8-12, J-8-12-8, J-10-10-10, J-10-8-10-alternate were 324.00, 365.00, 546.00, 455.00, 361.00 respectively.

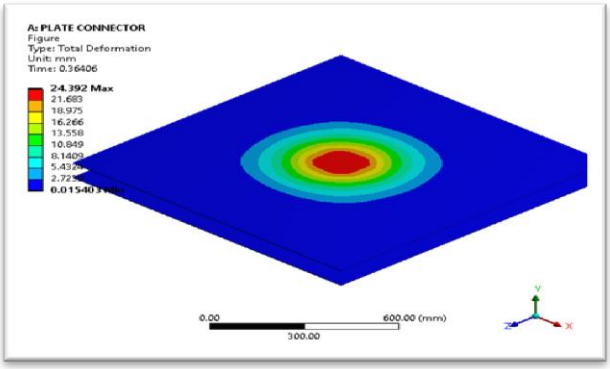


Fig – 8: Deformed shape of PC

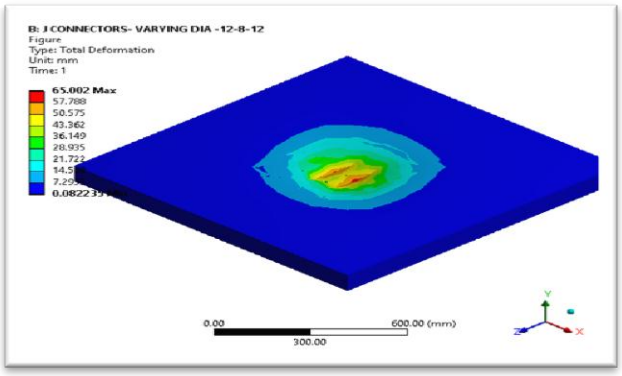


Fig – 9: Deformed shape of J-12-8-12

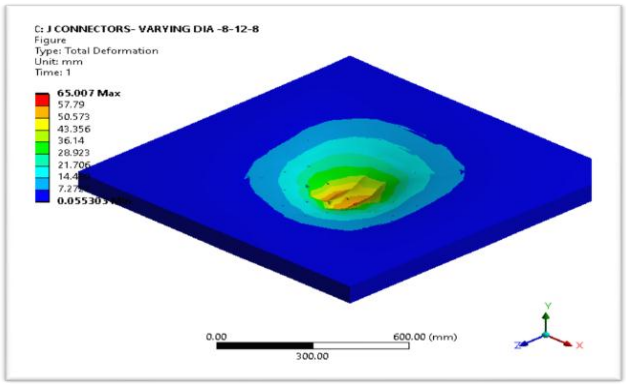


Fig – 10: Deformed shape of J-8-12-8

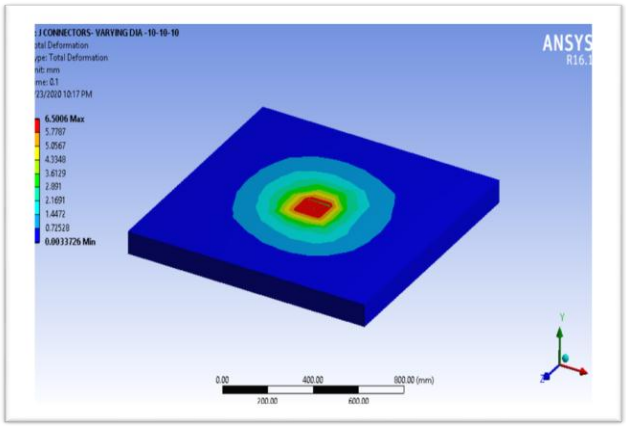


Fig – 11: Deformed shape of J-10-10-10

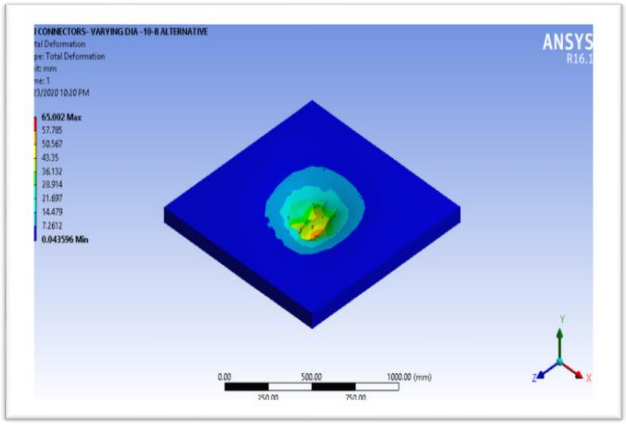


Fig – 12: Deformed shape of J-10-8-10-alternate

4. CONCLUSIONS

The following conclusions were obtained from the analysis carried out in this work.

- While comparing plate connector and J hook connector from the graph, plate connector has less load carrying capacity than J hook novel connector with varying diameter 10-10-10 (J- 10-10-10) by a percentage of 29.
- J hook novel connector with varying diameter 8-12-8 (J-8-12-8)have high resistance to deflection than J hook with varying diameter 10-10-10(J-10-10-10) by 20%.
- J hook with varying diameter 12-8-12(J-12-8-12) have low performance as compared to J hook with varying diameter 10-10-10 (J-10-10-10) by 20%.
- Performance of J-10-8-10-8-alternate is same as that of J-12-8-12.
- From the above models J hook with varying diameter 8-12-8(J-8-12-8) has very good load carrying capacity than other connectors.

REFERENCES

[1] Liew JYR and Sohel KMA (2010) "Structural performance of steel–concrete–steel sand- wich composite structures". Adv Struct Eng; 13(3):453–70.

[2] Liew JYR, Koh CG and Sohel KMA (2009) "Impact tests on steel–concrete–steel sandwich beams with lightweight concrete core". Eng Struct; 31(9):2045–59.

[3] Liew JYR and Sohel KMA (2009) "Lightweight steel–concrete–steel sandwich system with J-hook connectors". Eng Struct; 31(5):1166–78.

[4] Narayanan R, Roberts TM and Naji FJ (1994) "Design guide for steel–concrete–steel sandwich construction". Volume 1: general principles and rules for basic elements. Ascot (Berkshire): The Steel Construction Institute.

[5] Malek N, Machida A, Mutsuyoshi H and Makabe T (1993) "Steel–concrete sandwich members without shear reinforcement". Trans Japan Concr Inst ;15(2): 1279–84.