IJCRT.ORG ISSN : 2320-2882
INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

Mechanical Behaviour And Mechanical Properties Of Sandwich Shape Beam Structure.

[1]Prof. Dhananjay A. Borude, [2]Prof. Shital A. Mangude.
Assistant Professor,
Civil Engineering Department,
Adsul's Technical Campus, Chas, Ahilyanagar.

Abstract: Sandwich beams are composite structure having high stiffness and Strength ratios and are used as light weight load bearing components. The use of thin, strong skin sheets adhered to thicker, lightweight core materials has allowed industry to build strong, stiff, light, and durable structures. This study examines the behaviour of sandwich shape beams driven by the viscoelastic rubber core. Finite element (FE) method is used to analyze the overall transient responses, harmonic responses and the static responses of the sandwich systems subject to a concentrated point load at the mid span of the beam.

The innovative form of SCS sandwich beam design, their mode of failures, their static response has been thoroughly studied from the journals for initiating the project. The preliminary tests were carried out for normal weight concreting materials. From preliminary tests results all the material properties were arrived. From that results mix proportion of M30 grade of concrete has been achieved. By using this mix ratio concrete cube were casted for attaining desired strength of parameters. All the tests were conducted for hardened concrete. From that results we obtained concrete for compressive strength. Lastly the SCS beams, normal beams and SCS beams with inclined connectors were casted and testing was carried out on it.

Index Terms - Component, Sandwich, viscoelastic, deformation fields.

I. Introduction

Sandwich Beams are extensively used in the construction of aerospace, civil, marine, automotive and other high performance structures due to their high specific stiffness and strength, excellent fatigue resistance, long durability and many other superior properties compared to the conventional metallic materials. In general, these structures require high reliability assurance for which, the prediction of the maximum load that the structure can withstand.

The need for large structure with high specific strength and stiffness is increasing. Modern Engineering requires the use of sophisticated and optimized structural design. One way to achieve this goal is to use materials in a way that will optimize their inherent properties. It is especially true that we have to increase pay load to structure weight ratios. To deliver such structures engineers can either find a new structural material or produce a new structural technology. The former method is however quite difficult to complete because qualification of new material is expensive and time consuming. So in the early days SCS sandwich structure were developed for infrastructures to resist loading due to accidental impact and loading. A Beam is an important slender structural member in engineering structures such as supporting members in building, Railway bridges, Satellites, Robot arms, Aeroplane wings etc. SCS combines the advantages of steel structures and reinforced concrete structures such as bearing capacity, high ductility and integrity. It has also exhibited crack control and enhancing the construction efficiency. It is easy to understand the advantages of SCS sandwich structures are heavily dependent on the interference bonding quality between the steel plate and core concrete.

There are different types of sandwich structures. Metal composite material (MCM) is a type of sandwich formed from two thin skins of metal bonded to a plastic core in a continuous process under controlled pressure, heat, and tension. Recycled paper is also now being used over a closed- cell recycled craft honeycomb core, creating a lightweight, strong, and fully repulpable composite board. This material is being used for applications including point-of-purchase displays, bulkheads, recyclable office furniture, exhibition stands, and wall dividers. To fix different panels, among other solutions, a transition zone is normally used, which is a gradual reduction of the core height, until the two fiber skins are in touch. In this place, the fixation can be made by means of bolts, rivets, or adhesive.

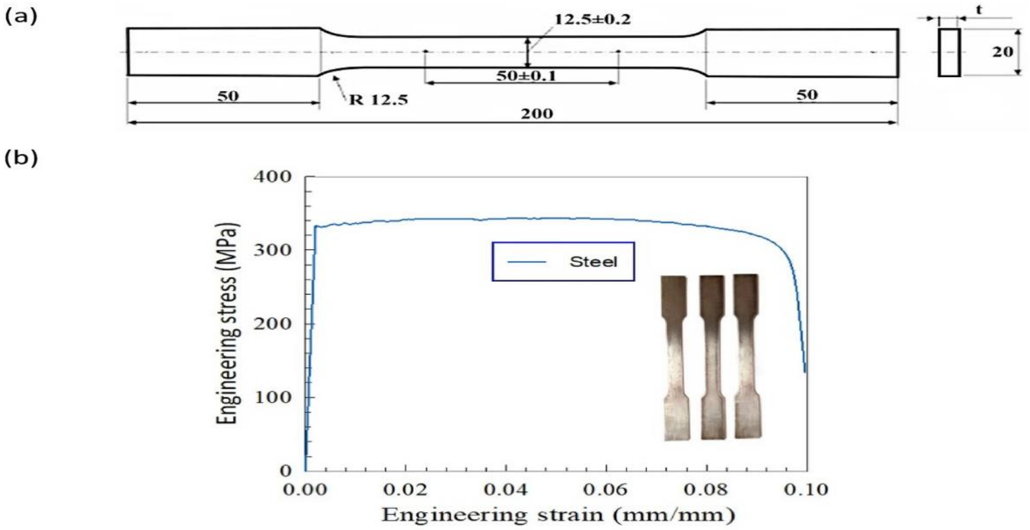
THE STRENGTH OF THE COMPOSITE MATERIAL IS DEPENDENT LARGELY ON TWO FACTORS:

1. The outer skins: If the sandwich is supported on both sides, and then stressed by means of a force in the middle of the beam, then the bending moment will introduce shear forces in the material. The shear forces result in the bottom skin in tension and the top skin in compression. The core material spaces these two skins apart. The thicker core material the stronger the composite. This principle works in much the same way as an I-beam does.
2. The interface between the core and the skin: Because the shear stresses in the composite material change rapidly between the core and the skin, the adhesive layer also sees some degree of shear force. If the adhesive bond between the two layers is too weak, the most probable result will be delamination.

II. MATERIALS:

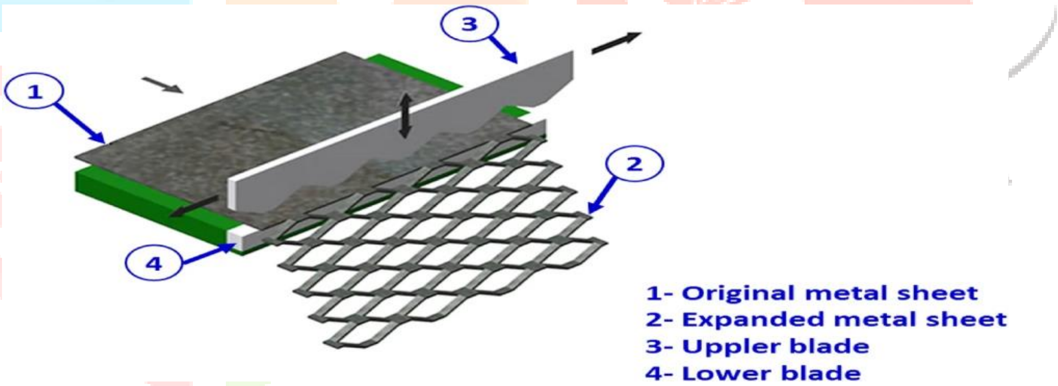
1. **Core Material:** Different types of concrete have been developed and used in SCS. In the existing research normal concrete has been used as the core materials. Normal weight concrete has been widely used in SCS sandwich structure in order to develop the SCS sandwich structure for weight resistive structures. Light weight concrete were introduced to reduce the overall self-weight. Light weight concrete has density of 1450 to 1800 kg/m^3 and compressive strength about 30 Mpa. From the experimental investigation. The light weight concrete with density of 1610kg/m^3. It shows the greater advantage in terms of strength to weight ratio. A concept of using light weight core in sandwich plates was proposed for ship hull and marine structures. This recommended SCS sandwich concrete structures with potential application in marine structures. More recently high strength and ultra-light weight with density 1450kg/m^3 and compressive strength 65 mpa has been developed and

proposed for the SCS Sandwich structure. It further increases the strength to weight ratio of the SCS sandwich structures and offer alternative core material.



2. **Core Fabrication:**

The production of expanded metal mesh, initially known as slashed metallic screening, involves the simultaneous slitting and stretching of a metal sheet, producing a diamond-shaped pattern. This process improves the material's strength-to-weight ratio, rendering it well-suited for sandwich panel structures across various applications. Expanded metal sheets are routinely fabricated in two basic types: standard expanded metal (SEM) and flattened expanded metal.



2.1 Material used:

i. Cement: OPC53
ii. Fine Aggregate: River Sand
iii. Coarse Aggregate: 20mm
iv. Core Material: Concrete
v. Steel - Top and Bottom face sheet of thickness 3 to 5 mm
vi. T - Hook – connectors (Straight and Inclined)

2.2 Concrete Mix Design:

For Concrete mix design is a process of selecting suitable ingredients of concrete and determining their relative proportions with the object of producing concrete of certain minimum strength and durability as economically as possible. IS method is used for design of concrete

- Minimum compressive strength = 30 Mpa
- Type of cement = PCC

- Grade of cement = 53
- Sp. Gravity of cement = 3.15
- Sp. Gravity of fine aggregate = 2.43
- Sp. Gravity of coarse aggregate = 2.83
- Water absorption in fine aggregate = 3%
- Water absorption in coarse aggregate = 1.76%

Now,

1. Target mean strength

   T.M.S= fck+t.Xs

   = 30 + (1.65 x 5)

   = 38.25 MPa 2)

2. Selection of water cement ratio w/c ratio

   = 0.45

   w/c ratio selected from the curve of compressive strength of concrete and water cement ratio.

3. Estimate entrapped air

   For maximum aggregate size = 20 mm

   Entrapped air = 2%

4. Water content = 186 kg/m3

   Hence,

   Cement content = 186/0.45

   = 413.33 Kg/m3

5. Determination of aggregate

   a) Fine aggregate:

   V = (W + (C/Sc) + (1/ρ) x (Fa/Sfa)) x (1/1000)

   (1-0.02) = 186+ (413.33/3.15) +[(1/0.315) x (Fa/2.43)] X (1/1000)

   0.98 = (186+131.21) + (1.291Fa) x (1/1000)

   (1.291Fa) = (980 - 186 – 131.21)

   Fa = 659.37 Kg/m3

   b) Coarse aggregate:

   Ca = ((1-ρ)/p) X (Fa) X (Sca/Sfa)

   = ((1-0.315)/0.315) X659.37X (2.83/2.43)

   Ca = 1178.6 kg/m3

MIX DESIGN:

Water	Cement	Sand	C.A	Remark
186lit	413.35kg	640.40kg	1180.36kg	Per m3 of concrete
0.45	1	1.60	2.90	Mix proportion

III. RESEARCH METHODOLOGY:

Method of Experiment:

It is important that the material of concrete remain uniformly distributed within the concrete mass during various stages of handling. The tests were carried out according to IS standard lastly the results were note down.

Tests on Fresh and Hardened Concrete :

Workability test such as slump test were carried out for fresh concrete as per BIS specification. Flexural test were carried out on a hardened concrete steel-concrete-steel beam specimen of size 100 X 100 X 500mm. The six specimen were taken for the testing purpose out of which three were normal beams and three were steel-concrete steel sandwich beam and lastly comparison were made for normal as well as sandwich beam.

3.1. SCS Beam Specimen Categorization:

Specimen	Beam c/s (mm)	Thickness of beam plate (mm)	Spacing of shear connectors (mm)
1.	100x100	3	100
2.	100x100	3	100

3.2. Characteristics of SCS Beams :

Sr. No	Discription	Details
1.	Length of beam	500mm
2.	C/S of beam	100x100mm
3.	Size of steel plates	3mm
4.	Types of connectors Used	T-Shaped
5.	Support condition	Simply supported
6.	Types of loading	Two point loading
7.	Grade of concrete	M30
8.	Grade of steel	Fe415

3.3. Test results of SCS Beam:

Beam	Max. Load (KN)	Max. Elongation (mm)	Ultimate Load (KN)	Flexural Strength (Mpa)
1	400	100	30.80	$16.5x10^3$
2	400	100	32.50	$14.25x10^3$

IV. Conclusion:

1. All the ingredients of concrete mix design were tested and obtained M30 concrete. Compressive strength test were performed on hardened mix.
2. Literature was studied and hence proposed SCS beam with face plate of thickness 3mm and concrete as core material.
3. Results of flexural test on specimen, shows that ultimate load load of normal beam was 4437.5 KN where as for sandwich beam, it was 16187.5 KN. Hence load carrying capacity of SCS beam is 37.76% greater than normal beam.
4. Static response of SCS beam with straight connectors holds good compare to normal beam and SCS beam with inclined connectors. Deflection of SCS beam was 1.4mm whereas for normal beam 0.4mm.

V. References:

1. J.Y.Richard Liew , Jia-Bao Yan , Zhen-Yu Huang “Steel-concrete-steel sandwich composite structures-recent innovations”, Journal of Constructional Steel Research (2017) 202-207.
2. J.Y.Richard Liew , Jia-Bao Yan , Zhen-Yu Huang “Steel-concrete-steel sandwich composite structures-recent innovations”, Journal of Constructional Steel Research (2017) 202-207.
3. C. Rajesh and J. S. Kumar, “Free Vibration Analysis Of Various Viscoelastic Sandwich Beams”,indiam Journal Of Science And Technology,vol-9 (S1),doi :10.17485, Dec 2016.
4. J.Y.Richard Liew , Jia-Bao Yan , Zhen-Yu Huang “Steel-concrete-steel sandwich composite structures-recent innovations”, Journal of Constructional Steel Research (2017) 202-207.
5. M. Azeem R. Ansari “Medium Velocity Impact on Sandwich Beams”, International Journal of Innovative Research in Advanced Engineering (IJIRAE), ISSN: 2349 2163,Volume 1, Issue 5, (June 2014).