



IJRASET

International Journal For Research in
Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 Issue: VI Month of publication: June 2021

DOI: <https://doi.org/10.22214/ijraset.2021.36010>

www.ijraset.com

Call:  08813907089

E-mail ID: ijraset@gmail.com

Analysis of Coconut Shell Concrete in the Sandwich Beam using ANSYS

Meenu Prasad¹, Riyana M. S²

¹ PG Scholar, Civil Engineering Department, Sree Narayana Institute of Technology, Adoor, Kerala, India

² Head of the Department, Civil Engineering Department, Sree Narayana Institute of Technology, Adoor, Kerala, India

Abstract: SCS consists of a layer of unreinforced concrete core, sandwiched between two relatively thin steel plates with novel enhanced C-channel connectors. Compared to C-channel connectors, ECs directly link the two external steel faceplates. The cost of traditional materials used in the concrete is the major factor which increases the cost of constructions, so it is necessary to research for alternative construction materials. In this project, the concrete core is used as the coconut shell concrete. Coconut Shell is a waste, generated by industrial and agricultural processes, and has created disposal and management problems that pose serious issues of environmental pollution. The first objective is to analyze the composite properties at 0%, 10%, 20% and 30% of coconut shell in the sandwich beam using rules of mixture. The Rules of Mixture is an analytical equations that are used to calculate the composite properties of the material. Then analyze the effect of coconut shell sandwich beam in ANSYS software. Also compare the conventional sandwich beam and coconut shell sandwich beam. Analyze the strength and decaying of coconut shell sandwich beam using ANSYS.

Keywords: Sandwich beam, coconut shell concrete, composite properties, rules of mixture, ANSYS

I. INTRODUCTION

Steel-concrete-steel (SCS) sandwich structures are a new form of construction. Recently, steel-concrete-steel (SCS) sandwich structure (SCSSS) has become popular in both onshore and offshore engineering infrastructures. SCS consists of a layer of unreinforced concrete core, sandwiched between two relatively thin steel plates with novel enhanced C-channel connectors. In steel-concrete-steel sandwich composite structures, the steel and concrete are the main materials that are used to resist tension and compression forces. In this project, the concrete core is used as coconut shell concrete.. Sources of conventional aggregates occupy the major part of the concrete. Extraction and processing of aggregates is also a major concern for environment. Therefore consumption of alternative waste material in place of natural aggregate in concrete production not only protects environment but also makes concrete a sustainable and environment friendly construction material. Coconut shell is categorized as light weight aggregate. The coconut shell when dried contains cellulose, lignin, pentosans and ash in varying percentage. In Asia, the construction industry is yet to realize the advantages of light weight concrete in high rise buildings. Coconut shells are not commonly used in construction industry and are often dumped as agricultural waste, therefore, an economic and interesting option. Therefore coconut shell is utilised as a partial replacement of coarse aggregate and analyse the optimum percentage of coconut shell in the sandwich beam using ANSYS software.

II. EQUATIONS FOR CALCULATING COMPOSITE PROPERTIES OF A MATERIALS BY RULE-OF-MIXTURES

It is great importance to be able to predict the properties of a composite, given the component properties and their geometric arrangement, various micromechanical aspects of composites. A particularly simple case is the rule-of-mixtures, a rough tool that considers the composite properties. It is an analytical equations that are used to calculate the composite properties of the material. In the case of mechanical properties, there are certain restrictions to its applicability. When more precise information is desired, it is better to use more sophisticated approaches based on the theory of elasticity.

A. Young's Modulus

$$E_1 = E_m + V_f(E_f - E_m)$$

$$1/E_2 = V_m/E_m + V_f/E_f$$

Young's modulus of fiber (E_f)

Young's modulus of matrix (E_m)

Volume fraction of fiber (V_f)

Volume fraction of matrix (V_m)

Young's modulus of fiber and matrix represent the Young's modulus of coconut shell and concrete.

B. Poisson's Ratio

$$\nu_{12} = \nu_{13} = \nu_{f12} V_f + \nu_m V_m$$

$$\nu_{23} = \frac{E_{22}}{2G_{23}} - 1$$

Poissons Ratio of fiber (ν_f)

Poissons Ratio of matrix (ν_m)

Volume fraction of fiber (Vf)

Volume fraction of matrix (Vm)

Here also fiber and matrix represent coconut shell and concrete

C. Shear Modulus

$$G_{12} = G_{13} = \frac{G_m}{1 - \sqrt{V_f(1 - \frac{G_m}{G_{f12}})}}$$

$$G_{23} = \frac{G_m}{1 - \sqrt{V_f(1 - \frac{G_m}{G_{f23}})}}$$

Shear modulus of fiber(Gf)

Shear modulus of matrix(Gm)

Volume fraction of fiber (Vf)

Here fiber and matrix represent coconut shell and concrete

D. Tensile Strength

$$\sigma_{t1} = \sigma_f V_f + \sigma_m V_m$$

Stress in the fiber (σ_f)

Stress in the matrix(σ_m)

Volume fraction of fiber (Vf)

Volume fraction of matrix (Vm)

III.MODELLING

First creating the geometry of beam with the size of 200, 100, and 1900 mm in width, depth, and length is taken for the analysis. Figure 1 shows the model of sandwich beam in Ansys The mesh is for the discretization for the analysis. Figure 2 shows the mesh model of sandwich beam. The material properties of varying percentage of coconut shell in the sandwich beam are calculated using Rules of Mixture. The above equations are used for calculating the composite properties of a material.

TABLE I

Material properties of varying percentage of coconut shell in the sandwich beam

Material Properties	0% coconut shell	10% coconut shell	20% coconut shell	30% coconut shell
Young's modulus	$3.00 \times 10^{10} \text{ N/m}^2$	$2.76 \times 10^{10} \text{ N/m}^2$	$2.53 \times 10^{10} \text{ N/m}^2$	$2.29 \times 10^{10} \text{ N/m}^2$
Shear Modulus	$1.27 \times 10^{10} \text{ N/m}^2$	$0.588 \times 10^{10} \text{ N/m}^2$	$0.453 \times 10^{10} \text{ N/m}^2$	$0.396 \times 10^{10} \text{ N/m}^2$
Poisson's Ratio	0.18	0.186	0.192	0.198
Tensile Strength	$4.00 \times 10^7 \text{ N/m}^2$	$4.29 \times 10^7 \text{ N/m}^2$	$4.58 \times 10^7 \text{ N/m}^2$	$4.87 \times 10^7 \text{ N/m}^2$

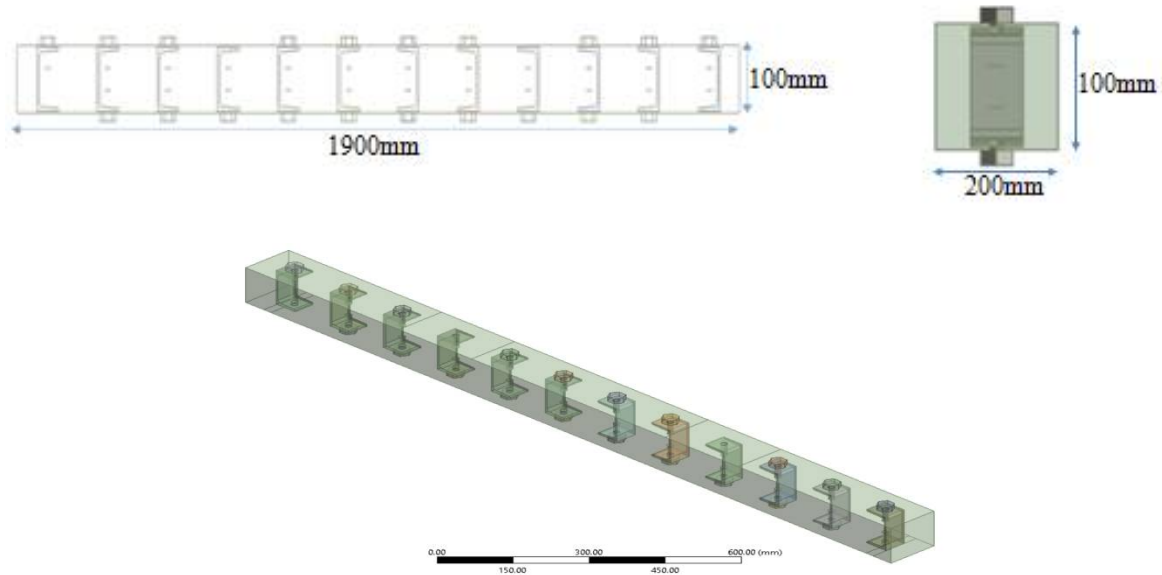


Fig. 1 Model of sandwich beam



Fig 2 Mesh model of sandwich beam

IV. ANALYSIS

Ansys finite element analysis software is used to analyse the coconut shell sandwich beam. The beam is simply-supported at their left and right ends. The loading was applied firstly as the displacement of -50 mm pushing downward. In addition, the displacements, strains, and reaction forces are also measured. The figure 3 shows the Loading and Support condition in the sandwich beam. Finally the deformation pattern is analysed and finding out the optimum percentage of coconut shell is added.

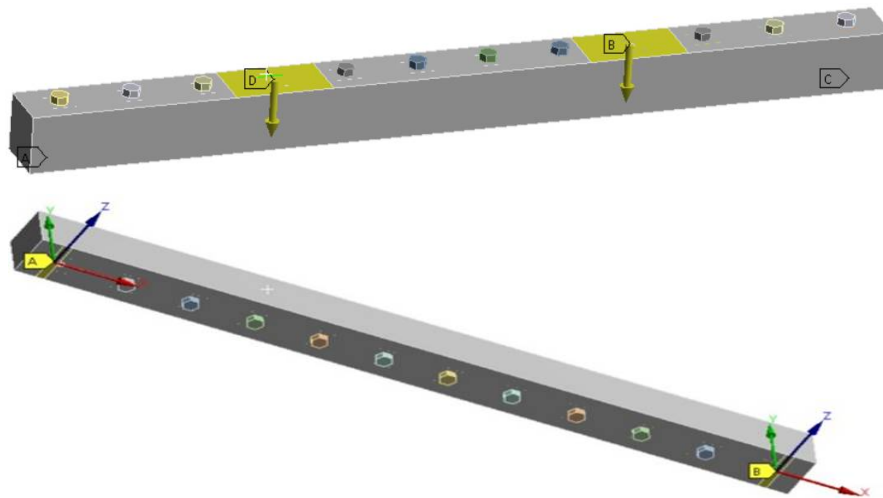


Fig. 3 Loading and Support condition of sandwich beam

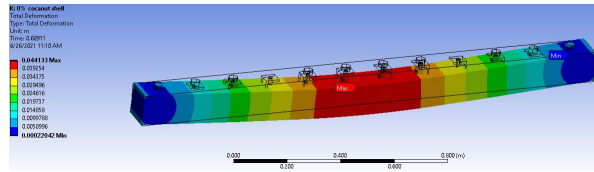


Fig 4: Deformation in 0% coconut shell sandwich beam

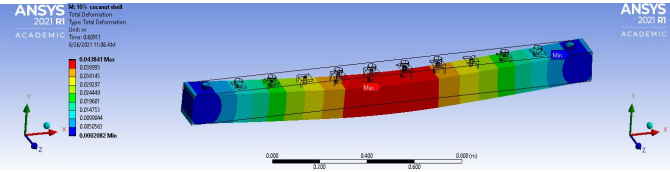


Fig.5 Deformation in 10% coconut shell sandwich beam

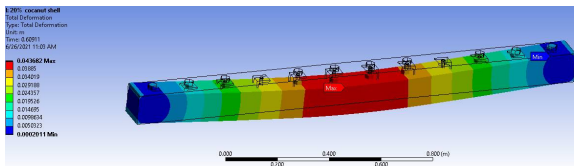


Fig.6: Deformation in 20% coconut shell sandwich beam

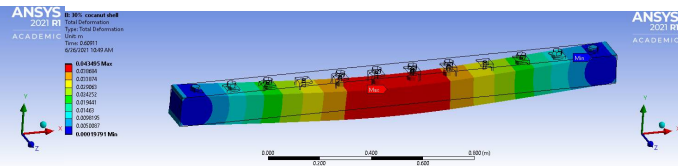


Fig.7 Deformation in 30% coconut shell sandwich beam

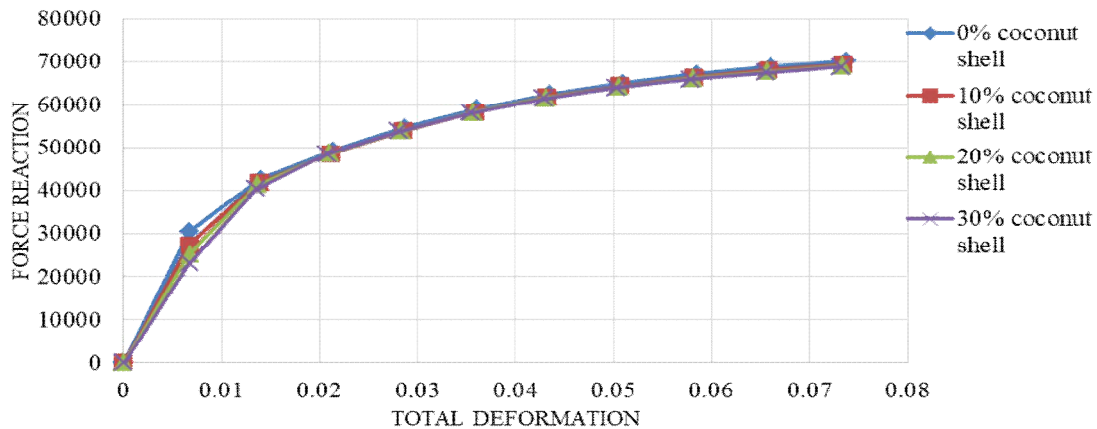


Fig 8. Load deformation graph of sandwich beam

From the result the load deformation curve, the failure load in conventional sandwich beam and the 10% replaced coconut shell sandwich beam is almost same, that is the failure load at conventional sandwich beam is 30555N and 10% coconut shell sandwich beam is 27551 N. If further increase in the percentage of coconut shell the failure load will reduce. Therefore, we can replace coarse aggregate with 10% coconut shell in the sandwich beam, without any significant reduction in any of the property of the sandwich beam.

V. DEGRADATION ANALYSIS

Degradation analysis is done in the 10% coconut shell sandwich beam by using the equation for calculating the composite property of a material by Rules of Mixture. The above same equation that used for finding out the composite property of a material for the degradation analysis. But the volume ratio is calculated as,

$$\text{Volume Ratio} = \frac{\text{Volume of reinforcement} - \text{Void Volume}}{\text{Total Volume}}$$

TABLE II
Material properties of degradation in 10% coconut shell sandwich beam

Material Properties	Values
Young's modulus	$2.45 \times 10^{10} \text{ N/m}^2$
Shear Modulus	$0.602 \times 10^{10} \text{ N/m}^2$
Poisson's Ratio	0.15428

D: 10% coconut shell degradation
 Total Deformation
 Type: Total Deformation
 Unit: m
 Time: 0.60911
 29-05-2021 19:24

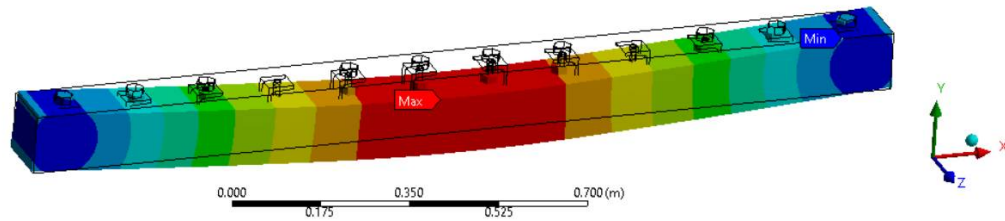
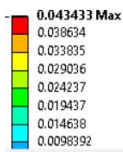


Fig 9: 10% coconut shell degradation in the sandwich beam

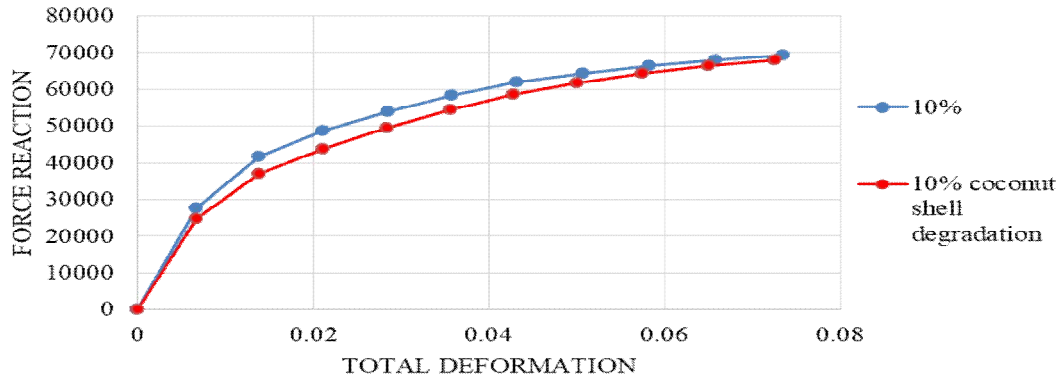


Fig 8. Load deformation graph of degradation analysis

From the load deformation curve, the failure load in 10% coconut shell sandwich beam and 10% coconut shell degradation in the sandwich beam is almost same, that is the failure load at 10% coconut shell sandwich beam is 27551N and 10% coconut shell degradation sandwich beam is 24787 N. Therefore, even if degradation happened there is no much variation in any of the property of the sandwich beam.

VI. CONCLUSION

The conclusions derived from the effect of coconut shell content on the in the sandwich beam as follows,

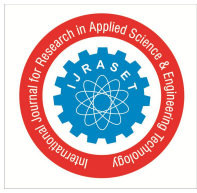
- A. Coconut shells are waste materials that causing pollution. Using coconut shell will help to reduce environmental problem which is a big concern for the whole world.
- B. Using coconut shell can also achieve a light weight sandwich beam.
- C. From the strength analysis, we can we can replace coarse aggregate with 10% coconut shell in the sandwich beam, without any significant reduction in any of the property of the sandwich beam.
- D. From the degradation analysis, even if degradation happened there is no much variation in any of the property of the sandwich beam.

VII. ACKNOWLEDGMENT

The Authors wish to express their special gratitude to Riyana M S, HoD and Assistant Professor, Sree Narayana Institute of Technology, Adoor. Above all authors thank GOD Almighty for his grace throughout the work.

REFERENCES

- [1] Jia-Bao Yan et.al. "Steel-UHPC-steel sandwich composite beams with novel enhanced C-channel connectors: Tests and analysis" Journal of Constructional Steel Research, January 2020
- [2] Hayhder A. Abdul Razzaq. et.al "Structural behavior of steel-concrete-steel sandwich structure with new type of shear connectors"- Kufa Journal of Engineering, Vol. 10, No. 3, July 2019, P.P. 33-52
- [3] Pramod Kumar M. V et.al(2018) "Study on Axial Stress-Strain Relation and Poisson's Ratio Effect on Coconut Shell Concrete" International Journal of Civil Engineering and Technology, Volume 9, Issue 4, pp. 365-371.
- [4] Victor Birman et.al "Review of current trends in research and applications of sandwich structures" Composites Part B: Engineering, Volume 142, 1 June 2018
- [5] Srija Juluru et.al(2017) "Study On Determination Of Coefficient Of Modulus Of Elasticity For Coconut Shell Concrete" International Journal of Civil Engineering and Technology, Volume 8, Issue 3, pp. 654-661



- [6] Chakravarthy et.al(2017) "Properties of concrete partially replaced with coconut shell as coarse aggregate and steel fibres in addition to its concrete volume" Materials Science and Engineering, Volume 183, No. 1, p. 012028.
- [7] J.Y. Richard Liew, Jia-Bao Yan, Zhen-Yu Huang. "Steel-concrete-steel sandwich composite structures-recent innovations" Journal of Constructional Steel Research, December 2016
- [8] T Anju, K KSmitha. "Finite Element Analysis of Composite Beam with Shear Connectors"-International Conference on Emerging Trends in Engineering, Science and Technology (ICETEST), 2015
- [9] Bhaskar, J., & Singh, V. K. (2013). "Physical and mechanical properties of coconut shell particle reinforced-epoxy composite". J. Mater. Environ. Sci.; 4(2), 227-232.
- [10] P.S.Patil, M.G.Shaikh. "A Study of Effect of Shear Connector in Composite Beam in Combined Bending and Shear by Ansys"-International Journal of Innovative Technology and Exploring Engineering (IJITEE),2013
- [11] Chawla, K. K (2012) "Composite materials": science and engineering. Springer Science & Business Media.
- [12] I. M. Daniel et.al "Failure Modes of Composite Sandwich Beams" International Journal of Damage Mechanics, October 1, 2002



10.22214/IJRASET



45.98



IMPACT FACTOR:
7.129



IMPACT FACTOR:
7.429



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089  (24*7 Support on Whatsapp)