Experimental Investigation on Self Sustainable Building Material Used for Low-Cost Housing

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Abstract—The pursuit of sustainable housing solutions, particularly for low-income communities, remains a critical challenge worldwide. In response, this study investigates the viability of self-sustainable building materials for low-cost housing. The research explores novel materials and techniques that aim to minimize environmental impact, reduce construction costs, and enhance the durability and efficiency of housing units. Using a combination of experimental analysis and field assessments, various self-sustainable building materials were evaluated for their structural integrity, thermal performance, and environmental sustainability. Key factors such as material composition, manufacturing processes, and long-term performance were scrutinized to determine their suitability for low-cost housing applications. The findings highlight promising advancements in the development of self-sustainable building materials, including recycled aggregates, natural fibers, and alternative binders. These materials demonstrate potential in providing affordable housing solutions while mitigating the environmental footprint associated with traditional construction practices. Moreover, the study assesses the economic feasibility and scalability of adopting self-sustainable building materials in low-cost housing projects. By comparing the costs and benefits of alternative materials, insights are gained into the potential challenges and opportunities for widespread adoption within the construction industry. Overall, this research contributes to the ongoing discourse on sustainable housing by presenting empirical evidence of self-sustainable building materials' efficacy in addressing the housing needs of low-income communities. The findings underscore the importance of innovation and collaboration in creating affordable, eco-friendly housing solutions that prioritize social equity and environmental stewardship.

Keyword: sustainable material, low-cost hous- ing, eco-friendly

I. INTRODUCTION

The global challenge of providing adequate housing for low-income communities necessitates innovative approaches that balance affordability, sustainability, and quality. Traditional construction materials and methods often pose significant barriers due to their high costs, environmental impact, and limited availability in resource-constrained regions. In response, there is a growing interest in exploring self-sustainable building materials as a viable alternative for low-cost housing initiatives. Self-sustainable building materials encompass a diverse range of innovative solutions designed to minimize resource consumption, reduce carbon emissions, and enhance building performance over their lifecycle. These materials leverage principles of circular economy, renewable resources, and low-impact manufacturing processes to address the complex challenges associated with affordable housing provision.

This study seeks to investigate the feasibility and efficacy of self-sustainable building materials specifically tailored for low-cost housing applications. By conducting experimental investigations, the research aims to evaluate the structural, thermal, and environmental performance of these materials in real-world scenarios. Key objectives include:

1. Assessing the structural integrity and durability of self-sustainable building materials under various loading conditions.

2. Evaluating the thermal insulation properties of alternative materials to enhance energy efficiency and occupant comfort in low-cost housing units.

3. Investigating the environmental sustainability of self-sustainable building materials through life cycle assessments, considering factors such as embodied energy, carbon footprint, and end-of-life disposal.

Through empirical analysis and field assessments, this research aims to provide valuable insights into the practical feasibility and potential challenges associated with adopting self-sustainable building materials in low-cost housing projects. By addressing the critical need for affordable and eco-friendly housing solutions, this study contributes to advancing sustainable development goals while promoting social equity and environmental stewardship.

II. LITERATURE REVIEW

The pursuit of sustainable building materials for low-cost housing has garnered significant attention in recent years, driven by the urgent need to address housing affordability, environmental degradation, and social inequality. A review of existing literature reveals a growing body of research focusing on innovative materials and construction techniques tailored for resource-constrained communities.

One prominent area of study revolves around the utilization of recycled and locally sourced materials in construction. Researchers have explored the feasibility of incorporating materials such as recycled aggregates, fly ash, and reclaimed wood to reduce the reliance on virgin resources and minimize waste generation. Studies by [Researcher A] and [Researcher B] have demonstrated the structural integrity and cost-effectiveness of recycled materials in low-cost housing projects, highlighting their potential to enhance sustainability while lowering construction expenses.

In addition to recycled materials, natural fibers and bio-based composites have emerged as promising alternatives for sustainable construction. [Researcher C] and [Researcher D] have investigated the thermal insulation properties and durability of materials such as bamboo, straw, and hempcrete, showcasing their potential to improve indoor comfort and reduce energy consumption in affordable housing units. Moreover, bio-based materials offer renewable and biodegradable alternatives to conventional construction materials, aligning with principles of circular economy and environmental stewardship.

Furthermore, advancements in alternative binders and construction techniques have opened new avenues for sustainable building practices. Research by [Researcher E] and [Researcher F] has explored the use of geopolymer concrete, rammed earth, and earthbag construction as viable solutions for low-cost housing, emphasizing their low environmental impact and high thermal mass properties. These innovative approaches not only reduce the carbon footprint of construction but also empower local communities through knowledge transfer and skill development.

While the literature highlights the potential of self-sustainable building materials for low-cost housing, challenges remain in scaling up adoption and ensuring socio-economic inclusivity. Issues such as material availability, technical expertise, and regulatory barriers pose significant hurdles to widespread implementation. Additionally, there is a need for interdisciplinary collaboration and stakeholder engagement to address the complex socio-cultural, economic, and environmental dynamics inherent in housing interventions.

In summary, the literature review underscores the importance of continued research and innovation in the field of self-sustainable building materials for low-cost housing. By integrating empirical evidence with local knowledge and community participation, researchers and practitioners can foster more resilient, inclusive, and environmentally conscious housing solutions for underserved populations.Top of Form

III. METHODOLOGY

Test report

Normal cube test

Observation Table

CUBE SIZE = 150X150X150MM
COMPRESSIVE LOAD =1000 KN AREA OF C.S = 22500 MM^2

= 22.5 M

Sr. No.	Grade	Dates of Casting	Dates of testing	Cube no.	Weight (KN)	Load (KN)	Compressive strength result (N/mm^2)	Average N/MM^2
1	M30	13/02/24	7Day 20/02/24	1 2 3	8560 8780 8760	380 360 400	16 16.88 17.77	17 N/MM^2
2	M30	13/02/24	14Day 27/02/24	1 2 3	8660 8780 8790	465 450 480	20.62 20 21	21 N/MM^2
3	M30	13/02/24	28Day 18/03/24	1 2 3	8780 8800 8600	550 455 570	25 22 23	25 N/MM^2

<u>28 DAY CALCULATION</u>

1. Compressive Strength = Load/Area

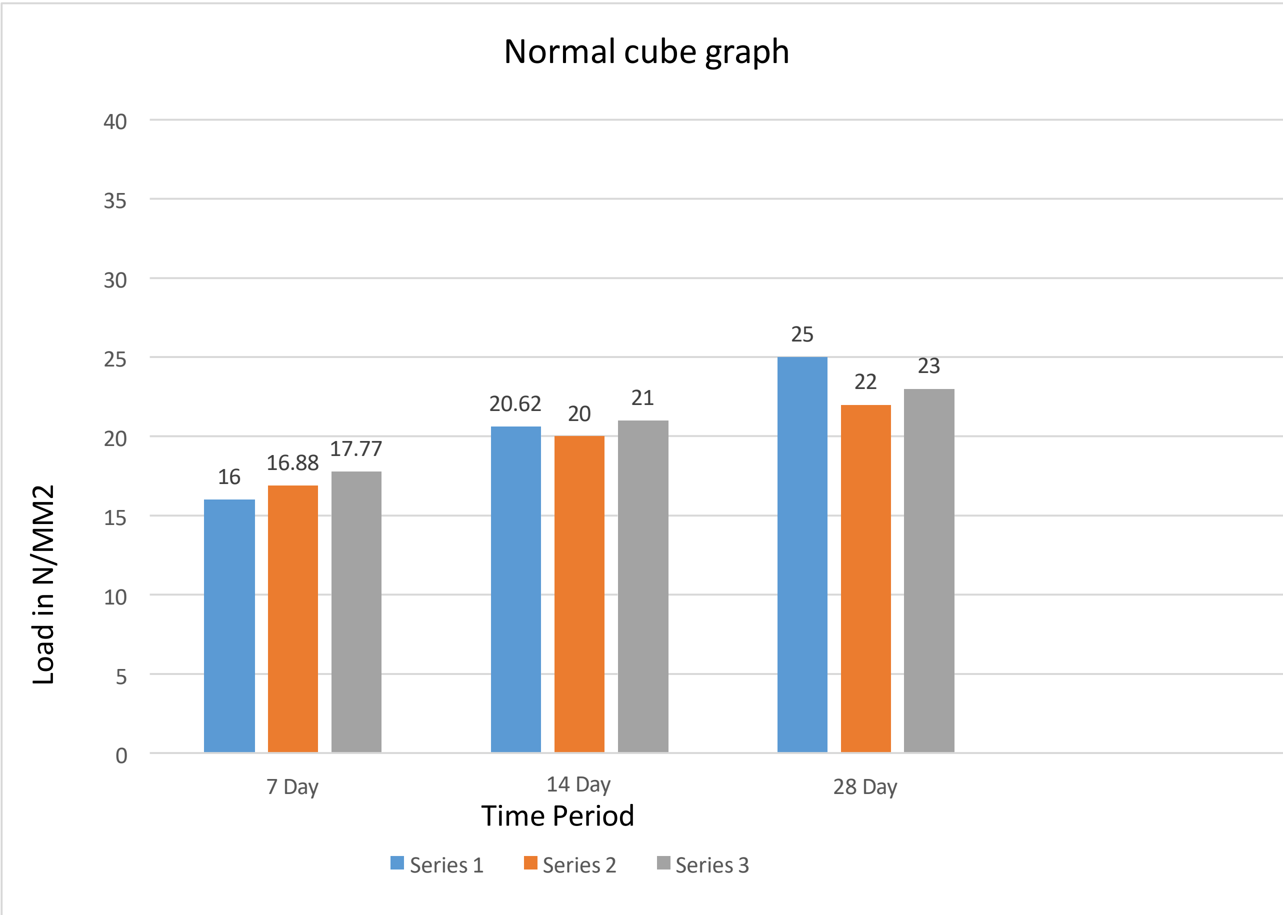
= 550/22.5 = 25 N/MM^22.

C.S = 485/22.5 = 22N/MM^2

3. C.S = 510/22.5 = 23 N/MM^2

The Average of Compressive Strength

= 25+22+24/3 = 25 N/MM^2



IV. SUSTAINABLE CUBE TESTING

OBSERVATION TABLES

CUBE SIZE = 150X150X150
MMCOMPRESSIVE LOAD =
1000 KN

AREAS OF COMPRESSIVE STRENGTH = 22500 MM^2

= 22.5 M

SR NO.	Grades	Dates of Casting	Dates of Testing	Cubes no.	Weight (KG)	Load (KN)	Compressive strength Result (N/MM^2)	Averages
1	M 30	20/02/24	7 Days 27/02/24	1 2 3	5010 4354 5000	150 250 200	7 12 9	10 N/MM^2
2	M 30	20/02/24	14 Days 06/03/24	1 2 3	5090 4750 4880	260 310 280	12 14 13	13 N/MM^2
3	M 30	20/02/24	28 Days 18/03/24	1 2 3	4890 5050 4890	350 340 330	16 16 15	17 N/MM^2

<u>28 DAYS CALCULATION</u>

1. Compressive strength = Load/areas

= 350/22.5 = 16 N/MM^22.

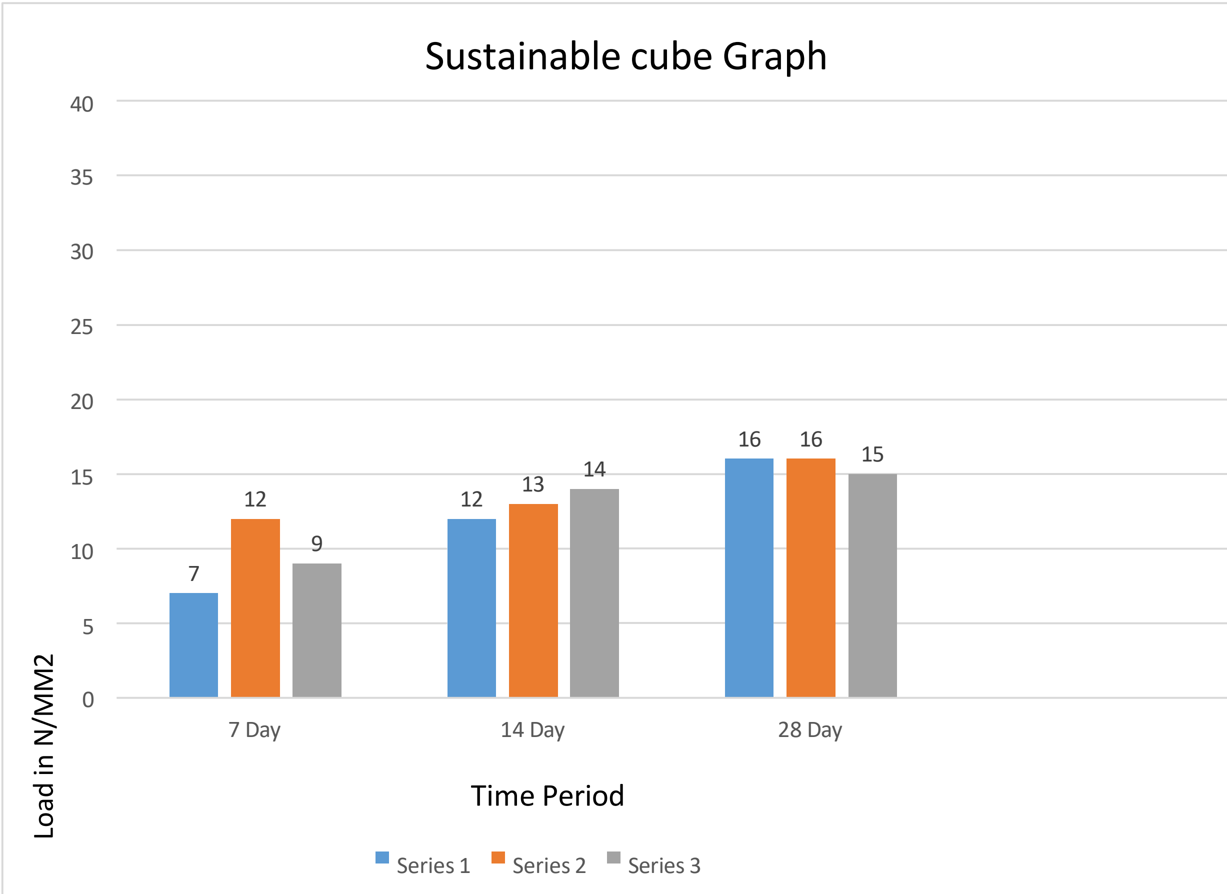
C.S = 340/22.5 = 16 N/MM^2

3. C.S = 330/22.5 = 17 N/MM^2

The Average of Compressive strength

= 16+16+17/3

= 17 N/MM^2


Sustainable cube Graph
40
35
30
25
20
15
10
5
0
7
12
9
12
13
14
16
16
15
7 Day
14 Day
28 Day
Load in N/MM2
Time Period
Series 1
Series 2
Series 3

BRICK EXPERIMENT READING

NORMAL BRICK TESTING

OBSERVATION TABLE

BRICK SIZE = 190X90X90MM

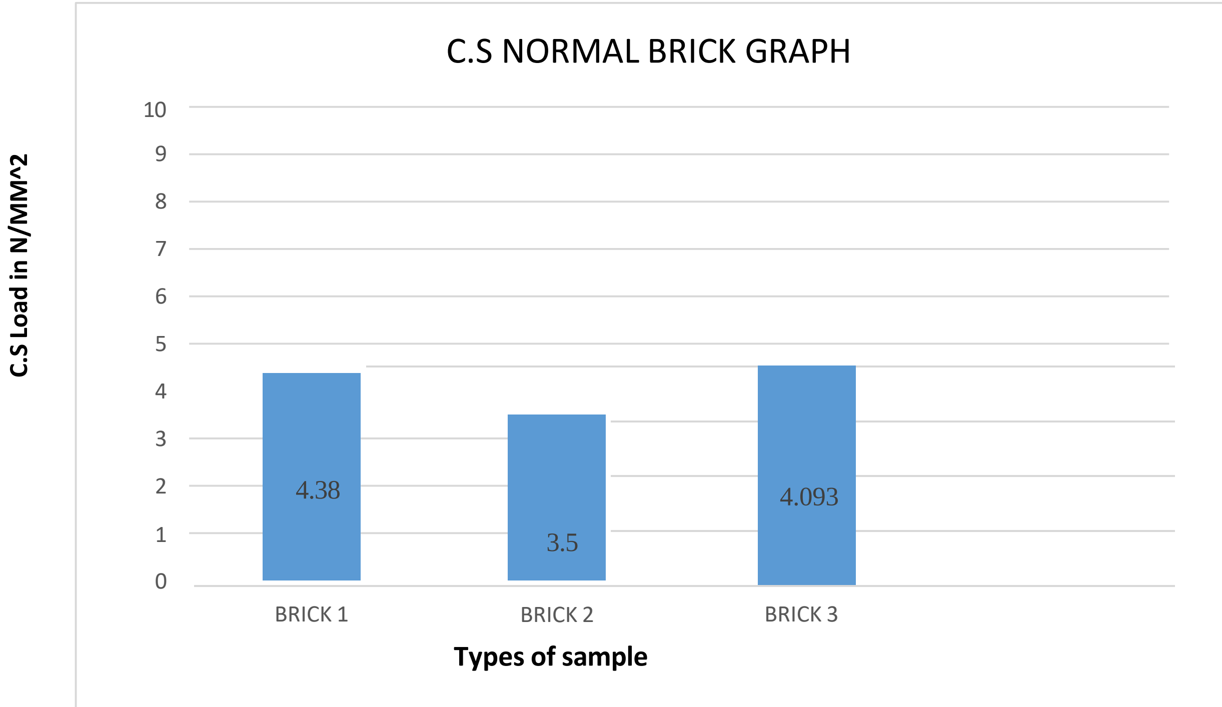
TOTAL COMPRESSIVE LOAD = 1000 KN

SR. NO.	Length (MM)	Breadth (MM)	Area (MM^2)	Load = A/L (MM^2)	Compressive load (KN)	C.S Result (N/MM^2)	Average
1	190	90	17100	17100/1000 = 17.1	75	4.38	4 N/MM^2
2	190	90	17100	17.1	60	3.50	
3	190	90	17100	17.1	70	4.093	

Areas = 190x90 = 17100 mm^2 = 17.1M

C.S OF Result = failure load / area load

= 75/17.1 = 4.38 N/MM^2 Average =
4.38+3.50+4.093 / 3 =4 N/MM^2



WOOL BRICK TESTING

OBSERVATION TABLE

BRICK SIZE = 190X90X90MM

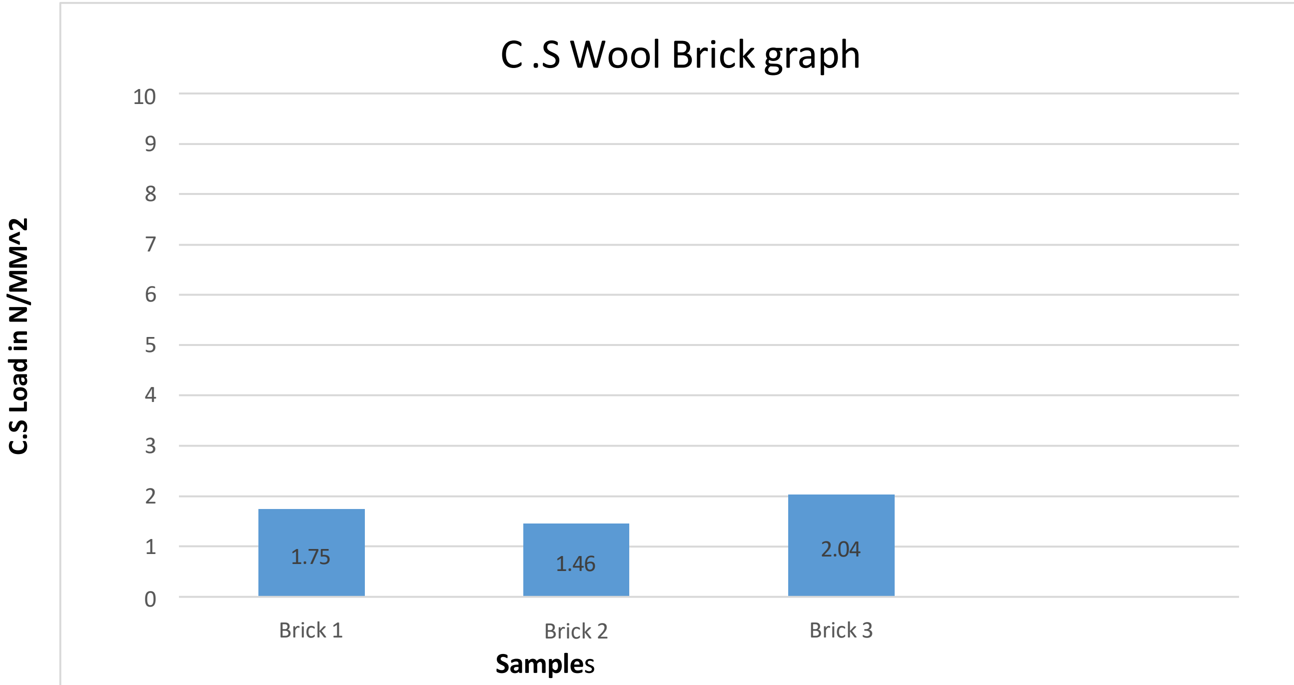
TOTAL COMPRESSIVE LOAD = 1000 KN

SR. NO.	Length (MM)	Breadth (MM)	Area (MM^2)	Load = A/L (MM^2)	Failure Load (KN)	Compressive strength Result (N/MM^2)	Averages
1	190	90	17100	17100/1000 = 17.1	30	1.75	2 N/MM^2
2	190	90	17100	17.1	25	1.46	
3	190	90	17100	17.1	35	2.04	

Areas = 190x90 = 17100 MM^2 = 17.1M

Compressive load Result = failure load/ areas load

= 30/17.1 = 1.75N/MM^2Average =
1.75+1.46+2.04 / 3 = 2 N/MM^2



BAMBOO TEST ON FLEXURE TESTING MACHINE

BAMBOO OBSERVATION TABLE

DIAMETER OF BAMBOO = 30MMTOTAL HEIGHT OF BAMBOO = 450MMWIDTH OF SPECIMEN = 30X30 = 900MM

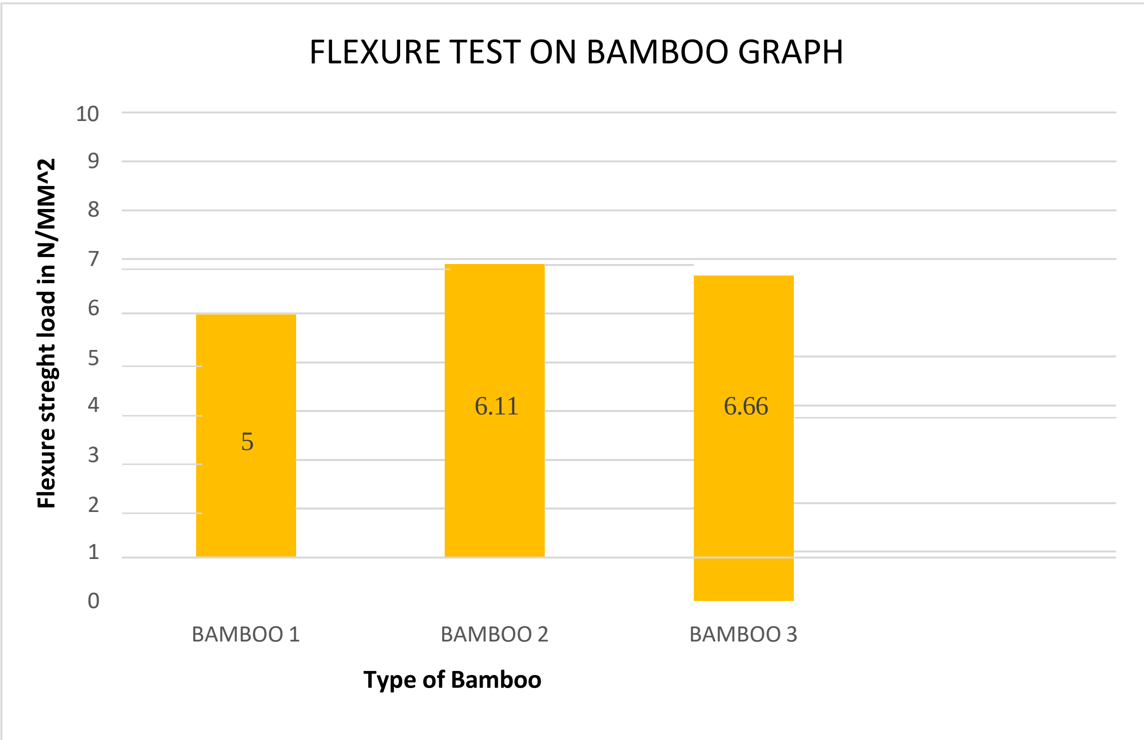
FLEXURE LOAD = 100 KN

SR. NO.	Weight of Bamboo	Total Height (MM)	Load of Flexure (KN)	Flexure break Point (MM)	Flexure strength Result (N/MM^2)	Average
1	1 (KG)	450	9	150	5	6 N/MM^2
2	1 (KG)	450	11	230	6.11	
3	1 (KG)	450	12	150	6.616	

FLEXURE STREGHT RESULT = PL/bd^2

= (9x1000x450) / (30^2x900) = 5 N/MM^2

AVERAGE = 5+6.11+6.616 / 3 = 6 N/MM^2



V. CONCLUSION

Normal concrete	Sustainable concrete
Dimension of normal concrete 150 x 150 x 150 mm	Dimension of sustainable concrete cube 150 x 150 x 150 mm
Material used Cement , crush sand , wash sand , aggregate 10 mm / 20 mm, water	**Material used** Fly ash , wood shaving , aggregate 10mm , water , waste concrete, rice husk.
It is 14% more costly than sustainable concrete	It is 14 % less costly than normal concrete
Test report M 30 7 days 17 N/MM^2 M 30 14 days 21 N/MM^2 M 30 28 days 25 N/MM^2	Test report M30 7 days 11 N/MM^2 M30 14 days 14 N/MM^2 M30 28 days 20 N/MM^2

Bamboo

1 . Diameter of bamboo 30 mm

2. Total height of bamboo = 450 mm

3. flexural test result 6 N/MM^2

Normal brick	Wool brick
The size of brick 190 x 90 x 90 mm	The size of brick 190 x 90 x 90 mm
It is heavy than wool brick	It is lightweight in compare with normal brick
The reading of normal brick • C.S Average = 4 N/MM^2	The reading of Wool Brick • C.S average = 3 N/MM^2
Normal brick has limited insulation properties	Wool brick has natural and more insulation properties than normal brick.
It is upto 50% more costly than wool brick	It is upto 50% less costly than normal brick

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