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Comparison of Deployable Bridges Having Similar Geometry but Different Material- Steel and Bamboo

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Abstract: This study aims to evaluate the structural, environmental, and economic implications of incorporating bamboo into the design of deployable pedestrian bridges.
Deployability adds another layer of complexity, requiring the bridge to be easily transportable, assembled, and disassembled as needed, making it suitable for temporary installations or emergency situations. In this paper to check the comparative analysis of deployable pedestrian bridge by using steel and bamboo materials 2 different cases made, the objectives has decided and the result have drawn. The recommendations have discussed after the conclusion that using steel material, the performance of the steel material is more as compared to bamboo material. As per weight and economic point of view, bamboo concluded as the lighter in weight, cost effective and eco-friendly material.
Keywords: Deployable bridge, Bamboo, hollow Steel tube, pedestrian loading.

I. INTRODUCTION

Pedestrian bridges serve as vital links in urban infrastructure, facilitating safe passage over obstacles and enhancing connectivity within communities. In recent years, there has been growing interest in sustainable construction practices, prompting exploration into alternative materials such as bamboo alongside traditional choices like steel. This analysis delves into the feasibility and performance of a deployable pedestrian bridge constructed with a combination of steel and bamboo materials. The utilization of steel in bridge construction is well-established, offering strength, durability, and versatility. However, concerns over environmental impact and sustainability have prompted researchers and engineers to seek alternatives that reduce carbon footprints without compromising structural integrity. Bamboo has emerged as a promising candidate due to its rapid growth, high strength-to-weight ratio, and renewability.

II. DEPLOYABLE PEDESTRIAN BRIDGE

Deployable pedestrian bridges stand at the forefront of contemporary civil engineering, offering innovative solutions to urban connectivity challenges. These bridges, designed for rapid assembly, disassembly, and transport, provide vital pedestrian access over temporary obstacles such as construction sites, rivers, or event venues. The emergence of deployable bridges reflects a dynamic approach to infrastructure development, catering to the fluctuating demands of modern cities. Unlike conventional permanent structures, deployable pedestrian bridges offer flexible, temporary solutions suitable for emergency situations, special events, or temporary construction needs.
Factors that are used for key areas to focus on:-

1) Structural Considerations
2) Deployment Strategies
3) Transportation Logistics
4) Safety and Accessibility
5) Case Studies and Applications

III. PROCEDURE AND 3D MODELLING OF THE STRUCTURE

Comprehensive input data and its descriptions about the model given below. This input data used for creation of simulation of deployable pedestrian bridge made up of steel and bamboo material and using pedestrian loading under the guidance of IRC 6: 2017.

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Table 1: General data used

Constraint	Data used for both model cases
Width of bridge	1.5m
Span of bridge	5m
Height of bridge	2m
Usage type	Deployable scissor type
Steel tube properties	
Steel pipe section dimensions	Outside diameter – 0.08m Inside diameter – 0.064m
Type of steel section	Circular tube type
Bamboo properties	
Bamboo type	Awi temen type (Gigan tochla atler)
Modulus of elasticity	17.20 Gpa
Poisson’s ratio	0.15
Density	0.76 gm/cc = 74.556 KN/ cu m
Damping	0.63%
Tensile strength	195.250 N/sq. mm = 195250 KN/sq. m
Clum diameter	8 cm =80mm
Thickness of clum wall	8 mm
Total height	12m

Table 2: Loading data used

Constraint	Data used for both model cases
Dead load	Self weight
Live load	5 KN/m pedestrian load
Load combinations (as per IRC 6:2017)	
Load combination 1	DL + LL
Load combination 2	1.35DL + LL
Load combination 3	1.35DL + 1.5 LL

Table 3: Model Description

Models framed for analysis	Abbreviation
Pedestrian bridge made up of Steel section	S1
Pedestrian bridge made up of Bamboo without stiffener-Case 1	BC1

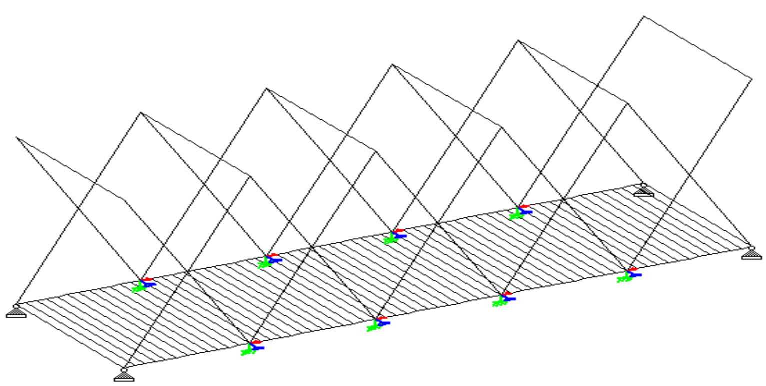

Fig. 1: Plan view of Pedestrian bridge made up of Steel section (S1)

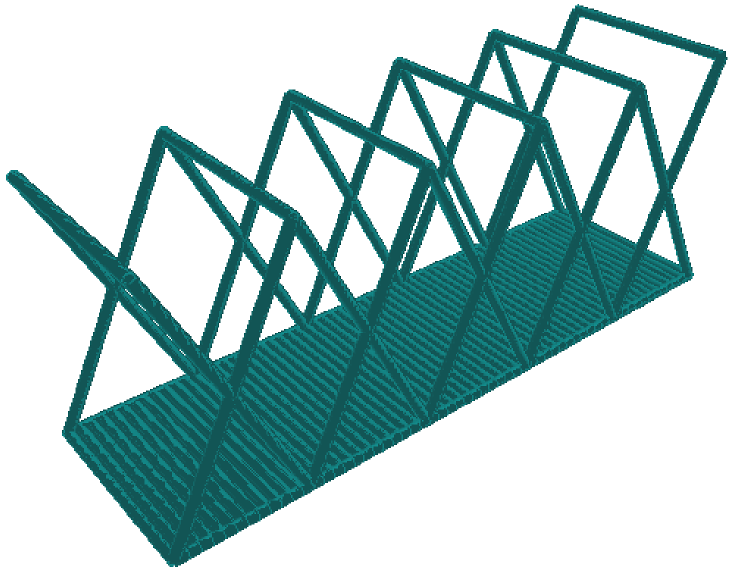

Fig. 2: 3D View of Pedestrian bridge made up of Steel section (S1)

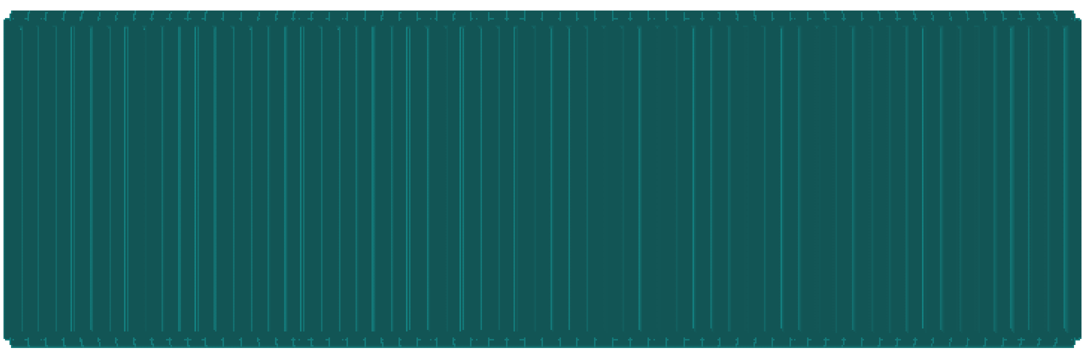

Fig. 3: Deck of Pedestrian bridge made up of Steel section (S1)

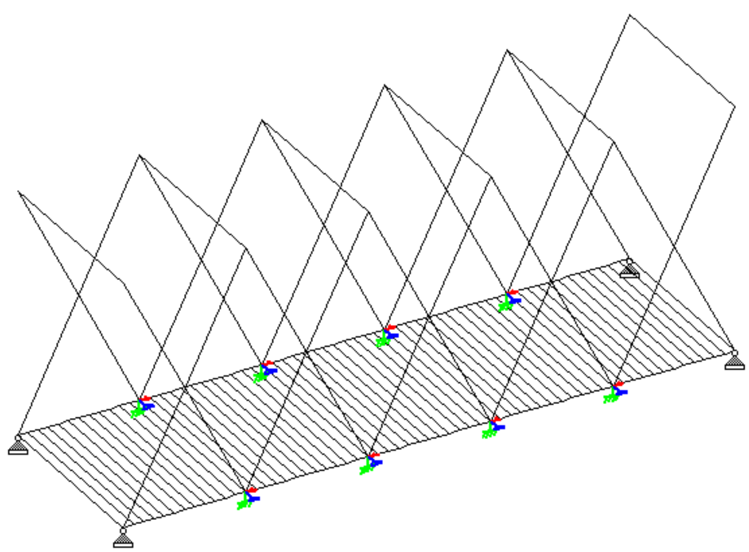

Fig. 4: Plan view of Pedestrian bridge made up of Bamboo without stiffener -Case 1 (BC1)

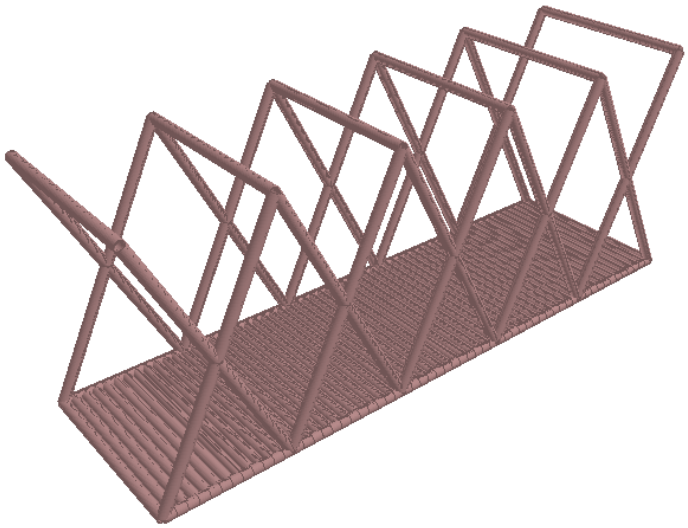

Fig. 5: 3D View of Pedestrian bridge made up of Bamboo without stiffener -Case 1 (BC1)

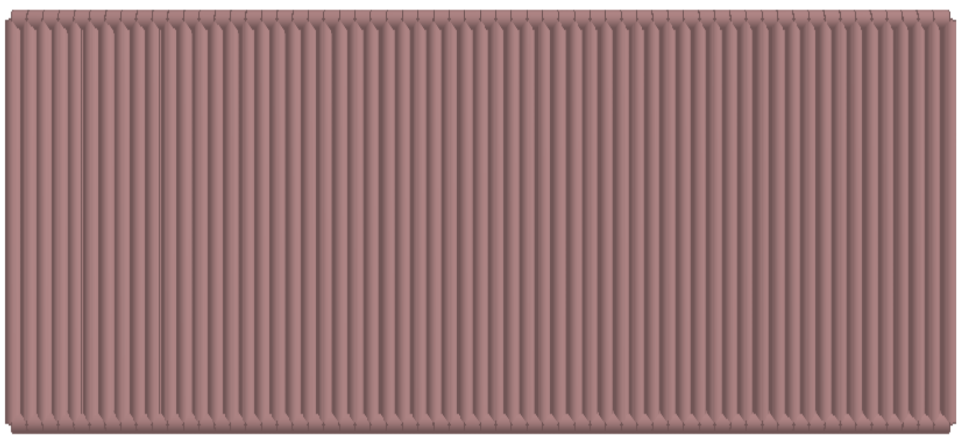

Fig. 6: Deck of Pedestrian bridge made up of Bamboo without stiffener -Case 1 (BC1)

IV. RESEARCH OBJECTIVES

On keeping in mind the problem statement outlined for comparative analysis of deployable pedestrian bridge by using steel and bamboo materials are given below :-

1) To check behavior in the analysis, it is recommended to compare the behavior analysis of steel and bamboo material.
2) To determine and compare maximum displacement in X, Y and Z direction for both steel and bamboo cases.
3) To study the variation in Maximum Axial forces for both steel and bamboo cases.
4) To determine and relate Maximum Shear forces for both steel and bamboo cases.
5) To evaluate Maximum Bending moment for both steel and bamboo cases.
6) To compare Maximum Torsional moment for both steel and bamboo cases.
7) To determine Maximum Axial Stresses for both steel and bamboo cases.
8) To evaluate Maximum Shear stresses for both steel and bamboo cases.
9) To compare Maximum Bending stresses for both steel and bamboo cases.
10) To provide the recommendations that will made a feasible construction reference.

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V. RESULTS ANALYSIS

A comparison of results below for steel bridge and bamboo bridge for various parameters is shown in the form of figures below from fig. 7 to fig. 14 :-

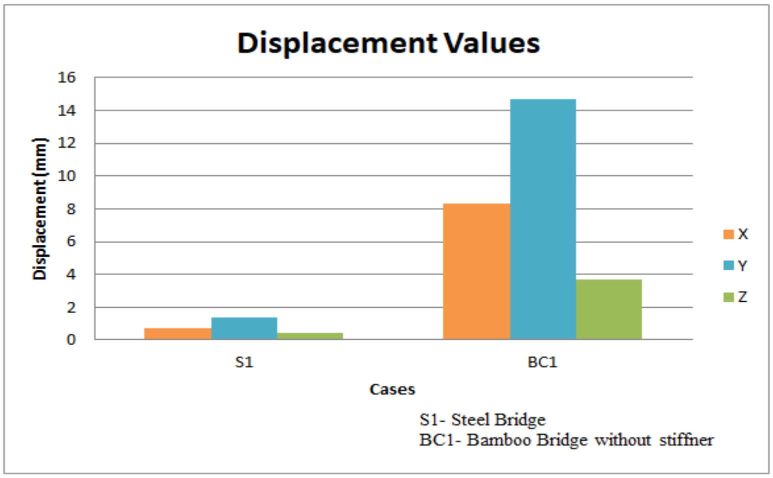

Fig. 7: Maximum Displacement for steel bridge and bamboo bridge

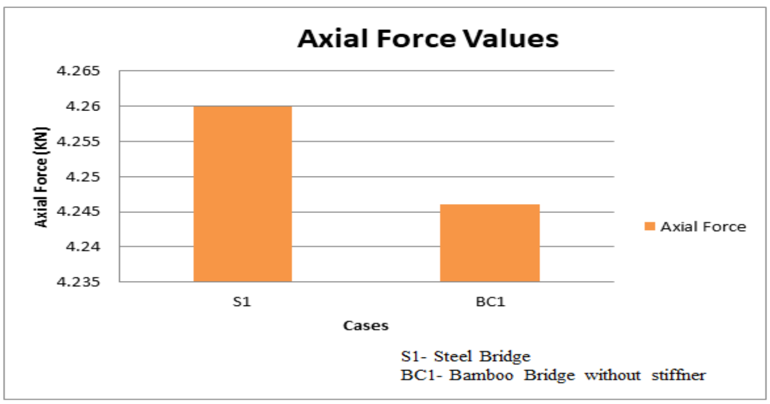

Fig. 8: Maximum Axial forces for steel bridge and bamboo bridge

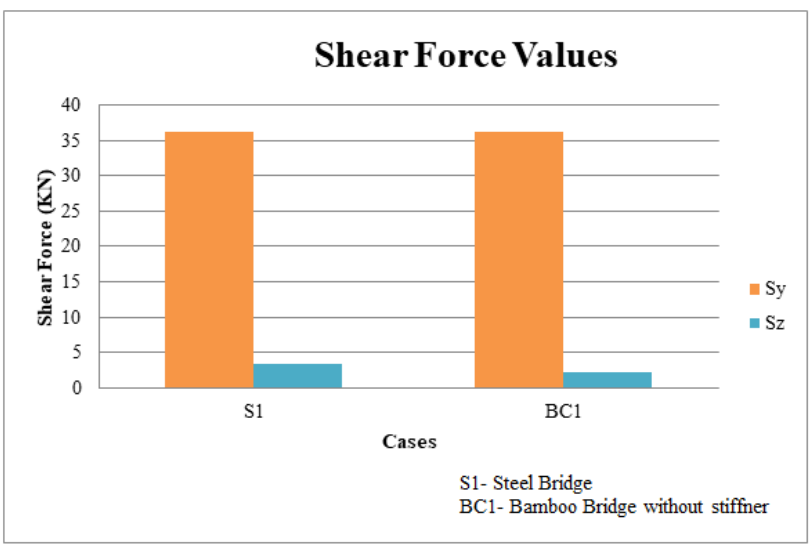

Fig. 9: Maximum Shear forces for steel bridge and bamboo bridge

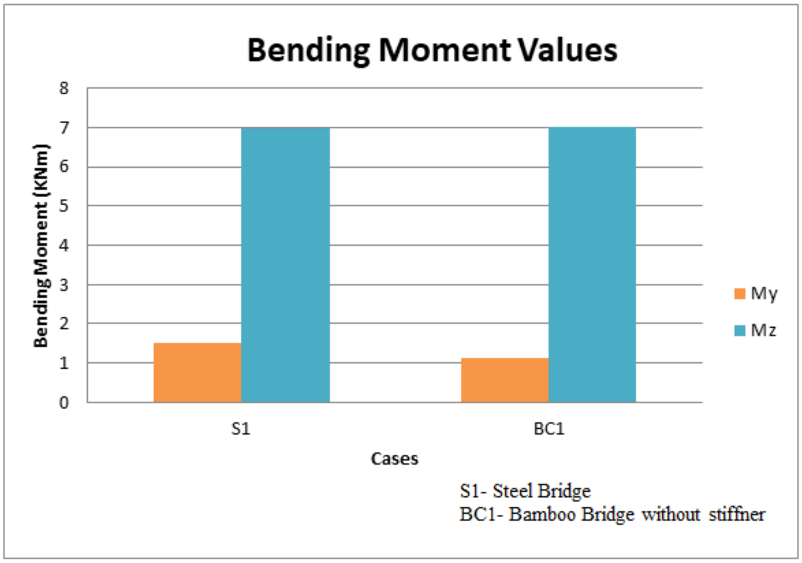

Fig. 10: Maximum Bending moment for steel bridge and bamboo bridge

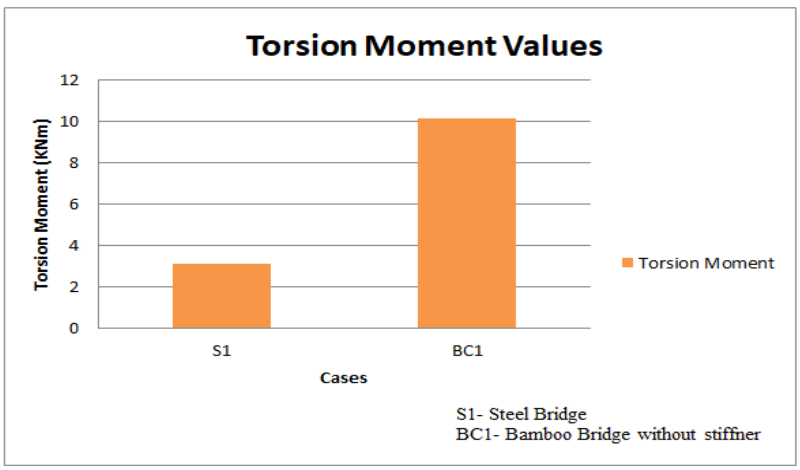

Fig. 11: Maximum Torsional moment for steel bridge and bamboo bridge

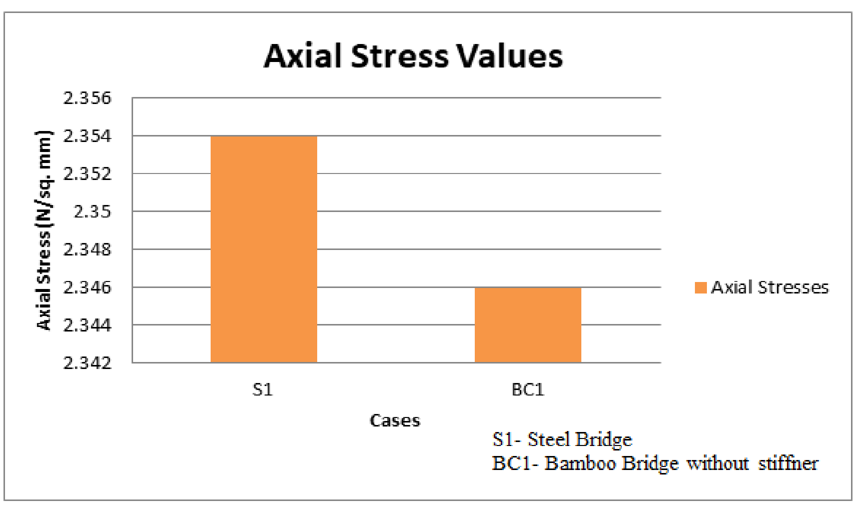

Fig. 12: Maximum Axial Stresses for steel bridge and bamboo bridge

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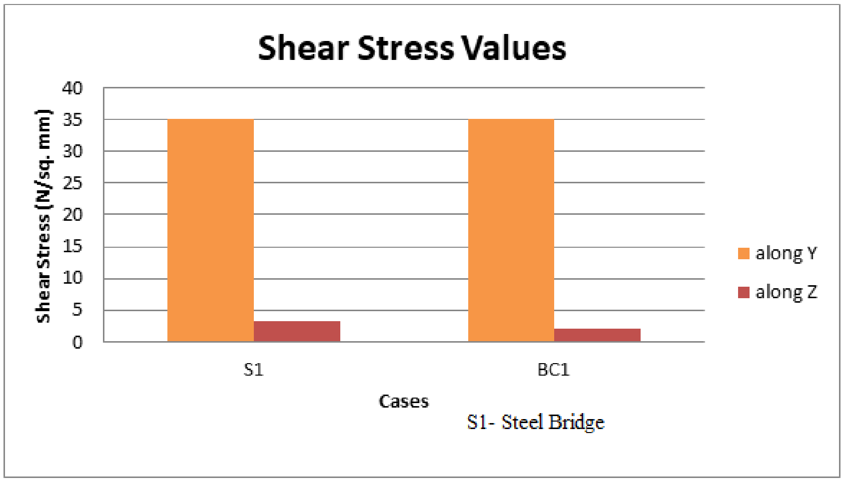

Fig. 13: Maximum Shear stresses for steel bridge and bamboo bridge

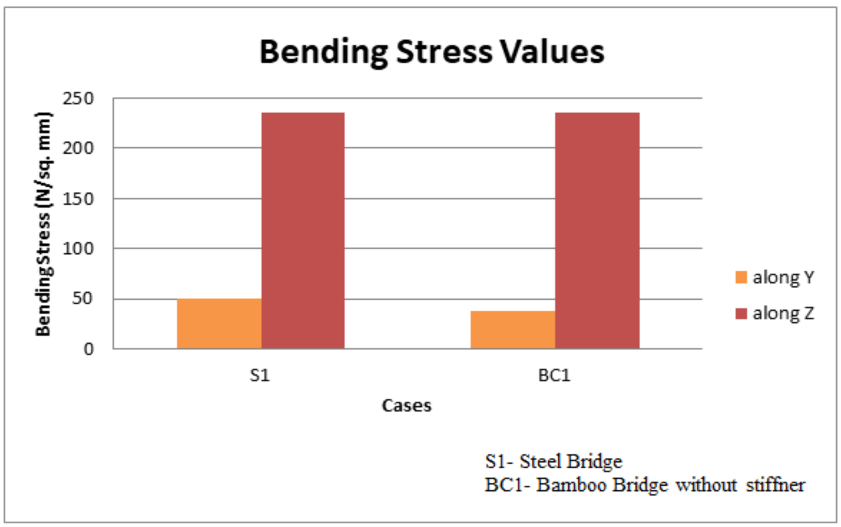

Fig. 14: Maximum Bending stresses for steel bridge and bamboo bridge

VI. CONCLUSIONS

Conclusions for comparison of deployable bridge made up of steel and bamboo material are as follows:-

1) On comparing maximum displacement values, bamboo deployable bridge generates more displacement as compared to steel bridge with a value of 8.342 mm, 14.682 mm and 3.663 mm for x, y and z direction respectively.
2) Observing the axial force values, it is decreasing by 0.33% as compared to steel material used.
3) Comparing the shear forces in members, shear increases along y by 0.38% but shear decreases along z by 34.74% when using bamboo material.
4) Comparing the bending moment in members, moment decreases along y by 25.8% but moment increases along z by only 0.43% when using bamboo material.
5) Torsional moment seems to be more when using the bamboo material with a value of 10.162 KNm.
6) When comparing the stresses values, the axial stresses decreases by 0.34% when using the bamboo material, the shear stresses in members increases along y by 0.04% but stresses decreases along z by 34.74% when using bamboo material. Finally the bending stresses in members, stresses decreases along y by 25.8% but moment increases along z by only 0.44% when using bamboo material.

This part of the project concluded that when using steel material, the performance of the steel material is more as compared to bamboo material. On contrasting to the weight and economic point of view, bamboo concluded as the lighter in weight, cost effective and eco-friendly material.

VII. ACKNOWLEDGEMENT

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REFERENCES

[1] Bapat Himanshu Yogesh, Dr. Siddharth G. Shah, "Analysis and Design of Deployable Bridge Based on Origami Skill", Conference paper, pp. 1-6.
[2] Xiaoming Yu, Yinghua Yang, Yanxia Ji, and Lin Li, (2021), "Experimental Study on Static Performance of Deployable Bridge Based on Cable-Strengthened Scissor Structures", Hindawi-Advances in Civil Engineering, Vol. 2021, Article ID 4373486, 11 pages.
[3] Mohamad Nabil Aklif Biro and Noor Zafirah Abu Bakar, (2018), "Design and Analysis of Collapsible Scissor Bridge", Eureca 2017, MATEC Web of Conferences 152, 02013.
[4] Bing Wang, Juncheng Zhu, Shuncong Zhong, Wei Liang, Chenglong Guan, (2023), "Space deployable mechanics: A review of structures and smart driving", Materials & Design, pp. 1-19.
[5] Yenal Akgüna, Feray Madena, Erinc, (2020), "Weight and Material Optimization of Scissor-hinge Linkages According to Given Span Length", 1st International Conference on Optimization-Driven Architectural Design (OPTARCH 2019), ISSN 2351-9789, Procedia Manufacturing 44, pp. 387–393.
[6] J. Pérez-Valcárcel, M. Muñoz-Vidal, M. J. Freire-Tellado, Isaac R. López-César, F. Suárez-Riestra, (2020), "Expandable covers of skew modules for emergency buildings", International Journal of Innovation Engineering and Science Research, ISSN: 2581-4591, Volume 4, Issue 5, pp. 38-52.
[7] Choy Hau Yan and Tan Aik Aik, (2020), "Design and Analysis of Emergency Deployable Bridge", International Journal of Mechanical Engineering and Robotics Research Vol. 9, No. 10, pp. 1393-1399.
[8] Fernando del Ama, Mariano Molina, M. Isabel Castilla, Dolores Gomez, Pulido , Covadonga Lorenzo, Juan Garcia Millan, Juan C. Sancho, (2020), "A Methodology for Optimal Design and Simulation of Deployable Structures", IOP Conf. Series: Materials Science and Engineering, Issue 960, pp. 1-10.
[9] Niki Georgiou and Marios C. Phocas, (2020), "Kinematics analysis of deployable and reconfigurable bar-linkage structures", The 2020 Structures Congress (Structures20) 25-28, GECE, Seoul, Korea, pp. 1-12.
[10] Rahula and Kaushik Kumar, (2014), "Design and Optimization of Portable Foot Bridge", 12th Global Congress On Manufacturing And Management, GCMM, Procedia Engineering 97, ISSN 1877-7058, pp.1041 – 1048.
[11] Li qiyu, Yuan jiehong, Sun haitao, Zhou shiming and Peng yuxing, (2020), "Design of a New Type of Deployable Bridge", IOP Conf. Series: Materials Science and Engineering 926 (ATDMAE 2020) 012026.
[12] Gökhan Kiper et. al., (2020), "Loop Based Design and Classification of planner scissor linkages", Research square, pp. 1-28.
[13] Manuel J Freire-Tellado et. al., (2022), "Bias deployable grids with horizontal compound scissor-like elements: A geometric study of the folding/ deployment process", International Journal of Space Structures, vol. 37, Issue 1, pp. 22-36.
[14] A.P. Thrall et. al., (2012), "Linkage-based movable bridges: Design methodology and three novel forms", Engineering Structures, ISSN: 0141-0296, Vol. 37, pp. 214–223.
[15] Brittani R. Russell et. al., (2023), "Portable and Rapidly Deployable Bridges: Historical Perspective and Recent Technology Developments", ISSN: 1943-5592, Journal of Bridge Engineering, Vol. 18, Issue 10, pp. 1074-1085.
[16] Pengyuan Zhao et. al., (2020), "Novel Surface Design of Deployable Reflector Antenna Based on Polar Scissor Structures", Chinese Journal of Mechanical Engineering, Vol. 33, Issue 68, pp. 1-15.
[17] A.M.B.B.S. Athauda et. al. (2010), FEASIBILITY OF USING BAMBOO AS A POTENTIAL REINFORCEMENT IN CONCRETE ELEMENT, Conference paper, pp. 1-9.
[18] Xiaoyi Chen et. al., (2021), "Measuring the Damping Performance of Gradient-Structured Bamboo Using the Resonance Method", Forests, Vol. 12, Paper no. 1654, pp. 1-12.
[19] A H D Abdullah et. al. (2017), "Physical and mechanical properties of five Indonesian bamboos", 1st International Symposium on Green Technology for Value Chains 2016, IOP Conf. series: Earth and Environmental Science, Vol. 60, paper 012014, pp. 1-6.