Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 13 Issue 4, April 2024

Structural Optimization of I Section Web with Varied Corrugation Patterns

Reema Pius
Civil Engineering Adi Shankara Institute of Engineering
And Technology Ernakulam, India

Bristo K Benny
Civil Engineering Adi Shankara Institute of Engineering
And Technology Ernakulam, India

Abin Joseph
Civil Engineering Adi Shankara Institute of Engineering
And Technology Ernakulam, India

Sreekutty Sasi
Civil Engineering Adi Shankara Institute of Engineering
And Technology Ernakulam, India

***Abstract*— Corrugation profoundly impacts the strength and durability of I-section structures in structural engineering. This project focuses on analyzing two distinct types of corrugations—trapezoidal and triangular—using advanced computation platforms like Ansys Workbench for Finite Element Analysis (FEA). Our primary objective is threefold: firstly, to discern how these different corrugation forms influence the robustness and weight distribution within an I-section structure. Secondly, by leveraging FEA simulations on the Ansys Workbench platform, we aim to precisely compute and compare their individual strength-to-weight ratios, providing crucial insights into their structural performance. Lastly, the project aims to formulate definitive conclusions from these analyses, offering valuable inputs for future studies or applications in materials science and civil architecture disciplines where such knowledge is indispensable. Through this investigation, we seek to advance understanding in structural engineering and contribute to the optimization of design methodologies, thereby fostering innovation in related fields**

***Keywords*— Corrugation, I-Section, FEA**

I. INTRODUCTION

I-sections have a high strength-to-weight ratio and effective stiffness qualities, which make them useful in a variety of engineering structures. Nonetheless, the web of an I-section frequently continues to be a somewhat inefficient component since a large amount of material is concentrated in places that don't really add to the overall strength or stiffness. By carefully adding more material and raising the web's moment of inertia, corrugation can provide a viable way to increase efficiency. Because of the element's increased stiffness and rigidity from its corrugated design, it can support a greater load without bending or deflecting unduly. This is especially helpful for bridges, which must sustain high traffic volumes. When designing corrugated shapes, less material is needed than for flat ones to have the same strength. This may result in less money being spent and a lighter structure—which is necessary for lengthy spans. Additionally, by more efficiently channelling loads, the corrugated design can increase the structure's efficiency. This may lengthen life and assist lower concentrations of stress. An eye-catching accent can be added with corrugated shapes. This may be particularly crucial for vehicles or aircraft. Aerospace and automotive structures utilize corrugate structure stiffness without appreciably increasing its bulk.In order to save weight and maximize strength and stiffness, corrugated steel webs are utilized in both automotive and aviation constructions. The corrugations give the structure stiffness without appreciably increasing its mass since they function similarly to ribs.

II. OBJECTIVES

- To find the better corrugated pattern on the I- section.
- To evaluate the following Parameters with different dimensions of corrugation

1. Load Bearing Capacity
2. Total Deformation

III. METHODOLOGY

LITERATURE REVIEW
↓
MODELLING OF STRUCTURES
↓
IMPORTING INTO FEA SOFTWARE
↓
APPLYING MATERIALS

↓

APPLYING BOUNDRY CONDITIONS AND LOAD

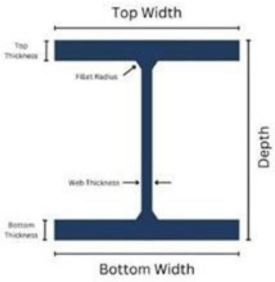
↓

SOLVING FEA MODELS

↓

READING THE RESULT

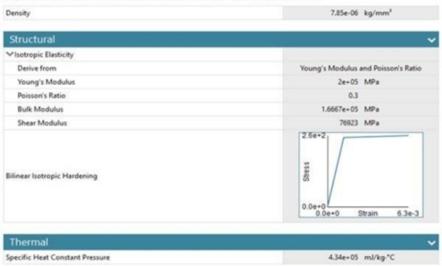
IV. MEASUREMENT



Dimension	Value
Depth	200 mm
Top Width	100 mm
Top Thickness	8.5 mm
Bottom Width	100 mm
Bottom Thickness	8.5 mm
Web Thickness	5.6 mm
Fillet Radius	12 mm

FIGURE. 4.1 MEASUREMENT OF I-SECTION

	Table Column Head		



Structural Steel NL

Fatigue Data at zero mean stress comes from 1998 ASME BPV Code, Section 8, Div 2, Table 5-110.1

Density	7.85e-06 kg/mm³
Structural	
Isotropic Elasticity	
Derive from	Young's Modulus and Poisson's Ratio
Young's Modulus	2e+05 MPa
Poisson's Ratio	0.3
Bulk Modulus	1.6667e+05 MPa
Shear Modulus	76923 MPa
Bilinear Isotropic Hardening	
Thermal	
Specific Heat Constant Pressure	4.34e+05 mJ/kg·°C

Head			
copy	More table copy[a]		

Figure. 4.2 Required Material Property

V. BOUNDARY CONDITION

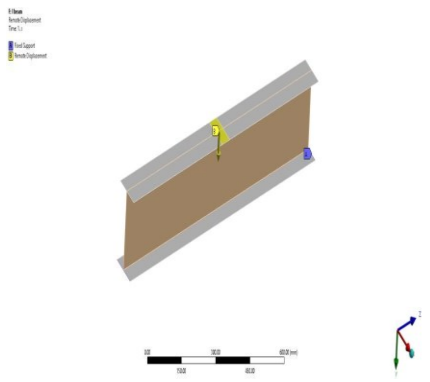


Figure. 5.1 Boundary Condition a.

VI. MESH DEPENDENCY

When performing finite element analysis (FEA) simulations with Ansys or other comparable software, mesh dependency is a crucial factor to take into account. It speaks about the simulation results' sensitivity to changes in the mesh density and quality that are applied to the geometric model. The density of the mesh, which is determined by the quantity and dimensions of finite elements utilized to discretize the model, has a major impact on the analysis's precision and computing effectiveness. Although a finer mesh frequently necessitates more computer power and longer simulation durations, it can capture more minute aspects of the geometry and produce results with more realism. The quality of the mesh's elements is just as important as its density. Highly deformed or skewed elements are examples of poorly shaped elements that can cause numerical instability and imprecise forecasts. Ansys provides instruments for evaluating and enhancing element quality, guaranteeing the mesh's resilience and dependability. To assess mesh dependency, mesh convergence studies are frequently carried out. These investigations involve running simulations with increasingly finer meshes until a stable solution is reached. Convergence study results are useful in figuring out the ideal mesh density needed to produce precise and trustworthy results for a certain investigation. In mesh dependency management, accuracy and computational efficiency must be balanced. Based on the intricacy of the model, the physics involved, and the required degree of detail in the output, engineers must optimize the mesh density. In crucial areas of the model, local mesh refinement can be used to improve resolution were enquired without sacrificing total effectiveness. To further evaluate the accuracy of the model, simulation findings must be validated against experimental data. This validation procedure depends on mesh dependency studies, which guarantee that the simulation faithfully captures the physical behaviour of the system under study.

Edge Sizing Element Size	Mesh Nodes	Mesh Elements	Equivalent Stress Maximum	Total Deformation Maximum
mm			MPa	mm
30	776	762	306.5286	12.54603
25	871	839	325.176	14.13881
20	995	929	314.126	11.94413
15	2070	2008	333.5741	12.20133
10	4748	4661	344.8382	12.50359
8	7861	7777	363.5522	12.69662
6	11786	11655	368.9568	12.67782

Table.6.1. Mesh Dependency

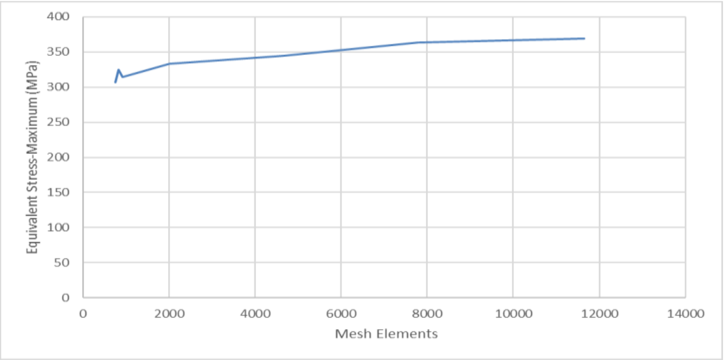


FIGURE.6.2 EQUIVALENT STRESS MAXIMUM VS MESH ELEMENT

VII. RESULT

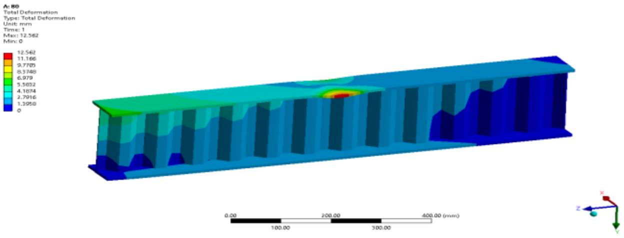


Figure.7.1 Total deformation (Corrugation pitch 80mm)

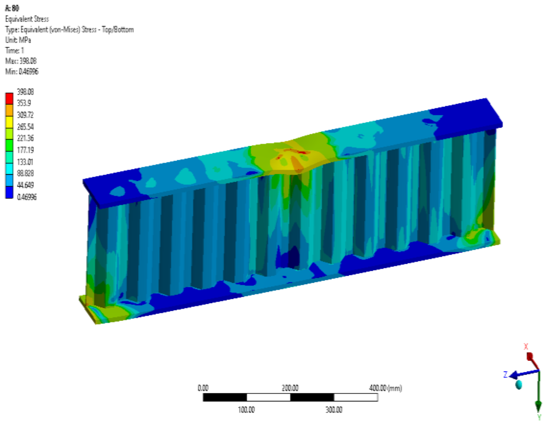


Figure.7.2 Equivalent stress (Corrugation pitch 80mm)

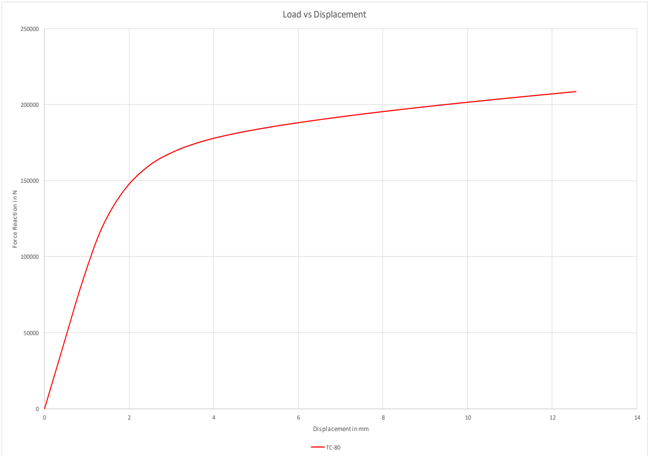


Figure.7.3. Load Vs Displacement

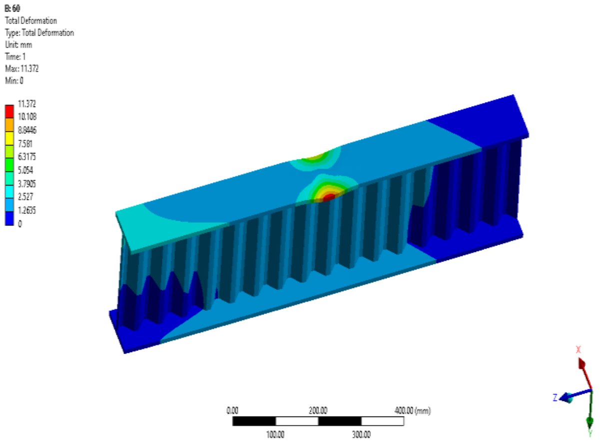


Figure.7.4 Total deformation (Corrugation pitch 60mm)

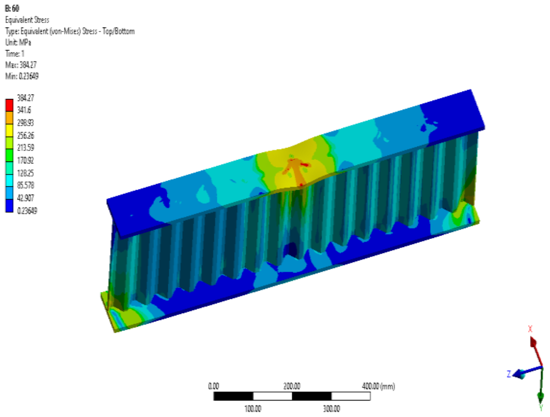


Figure.7.5 Equivalent stress (Corrugation pitch 60mm)

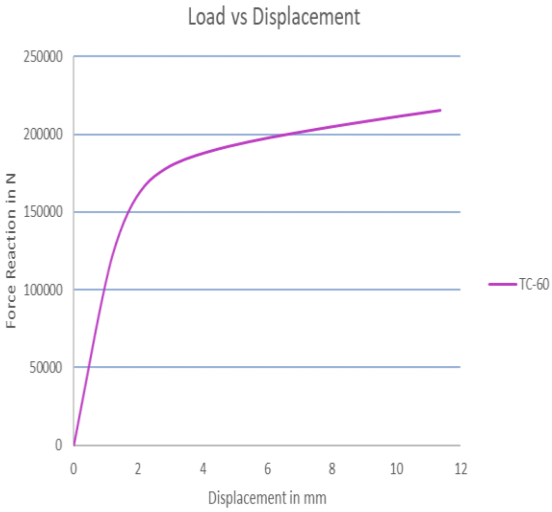


Figure.7.6. Load Vs Displacement

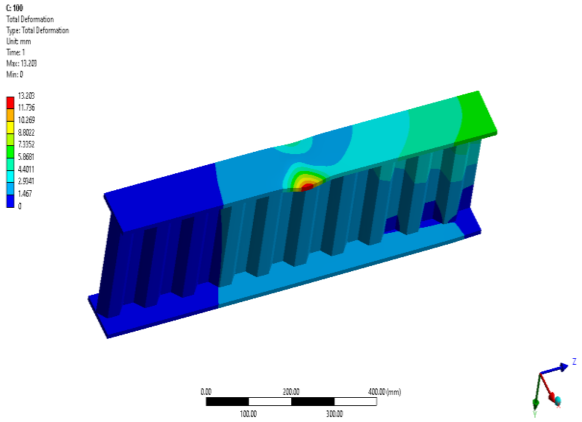


Figure.7.7 Total deformation (Corrugation pitch 1000mm)

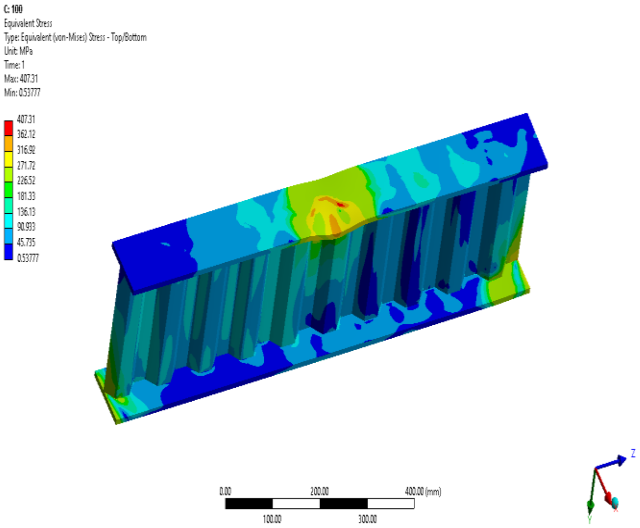


Figure.7.8 Equivalent stress (Corrugation pitch 100mm)

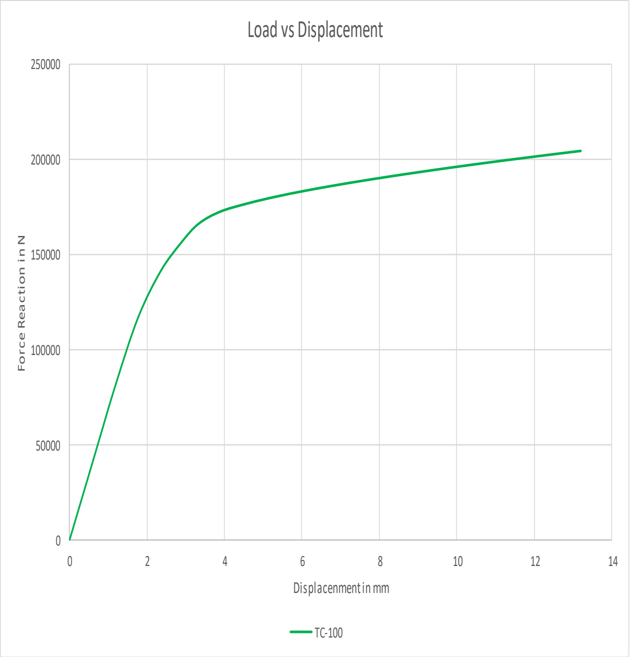


Figure.7.9. Load Vs Displacement

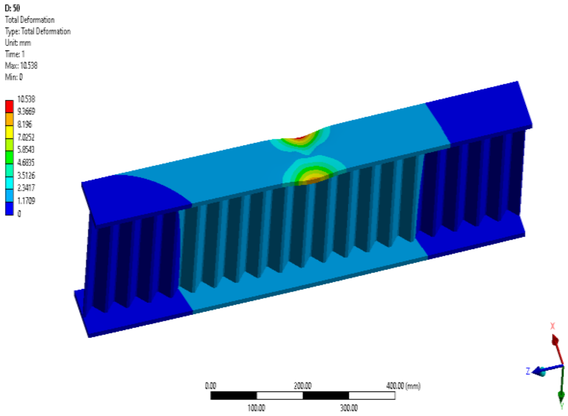


Figure.7.10 Total deformation (Corrugation pitch 50mm)

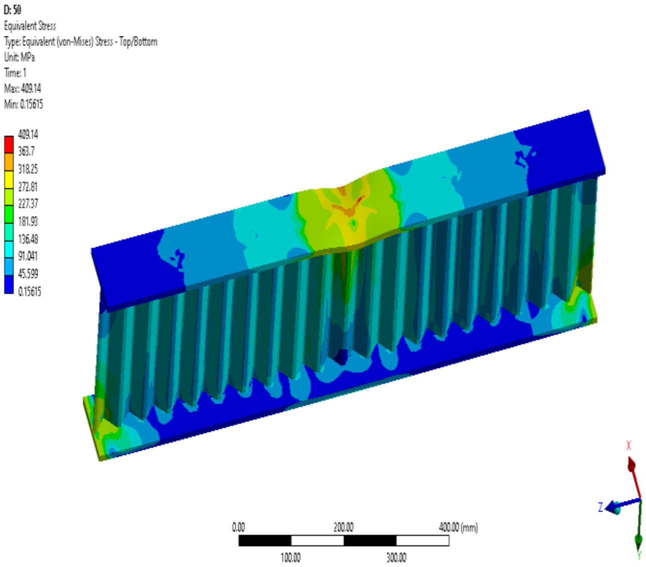


Figure.7.11Equivalent stress (Corrugation pitch 50mm)

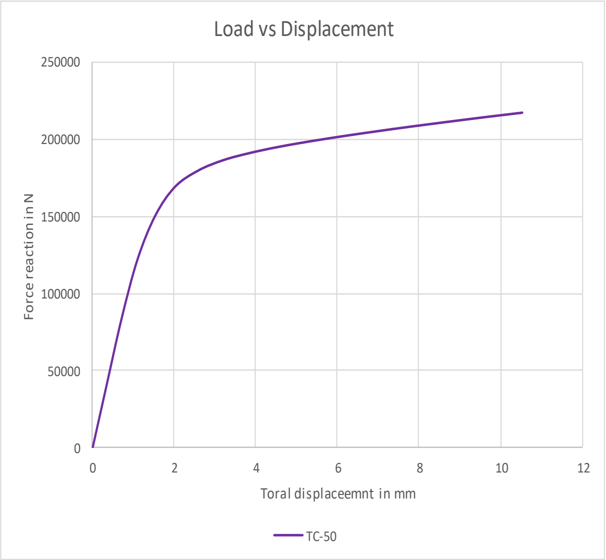


Figure.7.12. Load Vs Displacement

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 13 Issue 4, April 2024

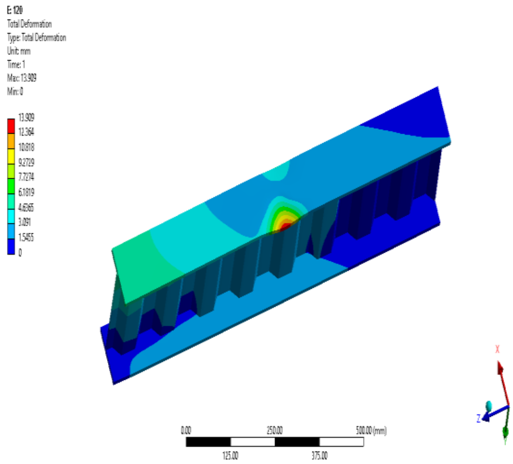


Figure.7.13 Total deformation (Corrugation pitch 120mm)

“

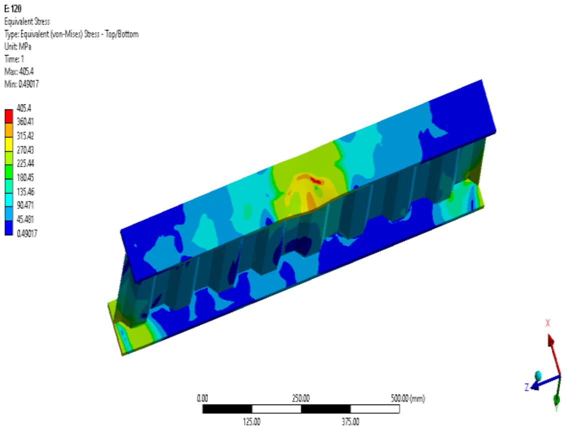


Figure.7.14 Equivalent stress (Corrugation pitch 120mm)

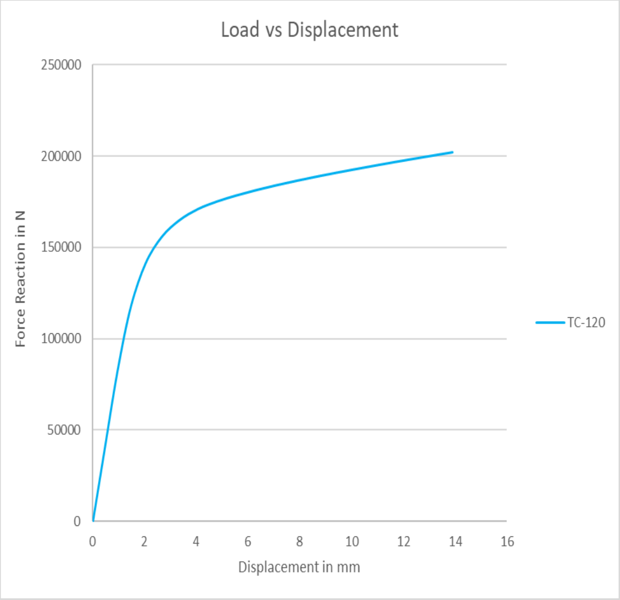


Figure.7.15 Load Vs Displacement

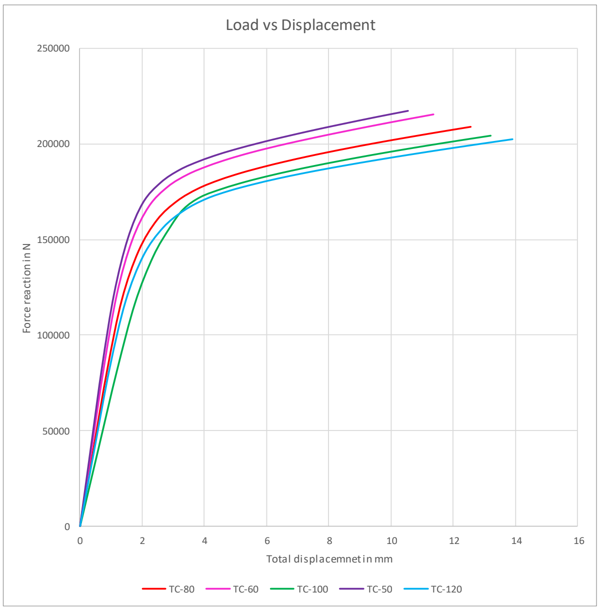


Figure.7.16 Companied Graph

REFERENCES

[1] B. and Dunaj Geri, L (2021). Nonlinear imperfect analysis of corrugated web beams subjected to lateral-torsional buckling. Engineering Structures, 245, p.112888.

[2] Guo, C., Mao, J. and Xie, M. (2022). Analysis of energy absorption characteristics of corrugated top beams of anti-impact hydraulic supports. Alexandria Engineering Journal, 61(5), pp.3757-3772.

[3] Farzampour, A., Mansouri, I., Lee, C.H., Sim, H.B. and Hu, J W(2018). Analysis and design recommendations for corrugated steel plate shear walls with a reduced beam section. Thin-walled structures, 132, pp.658-666

[4] Nie, J.G., Zhu, L., Tao, M.X. and Tang, (2015). Shear strength of trapezoidal corrugated steel webs. Journal of constructional steel research, 85, pp.105-115

[5] Hao Liang, Krishanu Roy, Zhiyuan Fang and James B. P. Lim, (2021) A Critical Review on Optimization of Cold-Formed Steel Members for. Better Structural and Thermal Performances

[6] Hafsamol, Ranjan Abraham (2020) International Research Journal of Engineering and Technology (IRJET) “Finite Element Analysis of Corrugated Web Beams, Column and Slab Connection Under Loading Condition”.

[7] MDPI, Moussa Leblouba, Abdul Saboor Karzad, Sami W. Tabsh and Samer Barakat, (2021) “Plated versus Corrugated Web Steel Girders in Shear: Behavior, Parametric Analysis, and Reliability-Based Design Optimization

[8] Harini, B. Lingeshwaran, N, Perumal, K. Aravinthan, K (2020). Sustainable design of cold formed steel. Mater. 881–885. Harini, B. Lingeshwaran, N. Perumal, K. Aravinthan, K. Sustainable design of cold formed steel.

[9] Pengfei Xu, Yingjie Wei, Yuyou Yang, Xiong Zhou (2022) Application of fabricated corrugated steel plate in subway tunnel supporting structure

[10] Alexandria Engineering Journal, Chenghu Guo, jun Mao, Miao Xie, (2021) “calculating the elastic shear buckling strength of trapezoidal corrugated steel webs considering three different shear buckling modes

.