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ANALYSIS OF PRE-FABRICATED BUILDING WITH EPS WALL PANELS

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Abstract: The world faces environmental pollution and increasing demand for housing, leading to the establishment of power plants and fly ash disposal issues. To address these issues, new environmentally friendly technologies have been developed. In India, the "Housing for All" program was approved by the Union Cabinet, aiming to revitalize impoverished residents, encourage affordable housing, and provide financial assistance for individuals. The Technology Sub-Mission recommends adopting innovative technologies and materials for green buildings, with earthquake and disaster-resistant designs. Rising EPS Panels Building Systems are now popular in the building industry worldwide. In this research paper, we have conducted an analysis of a building model using STAAD Pro software. Additionally, we have performed a flexural strength & dry density test to evaluate the EPS wall panel.

Index Terms – Pre-Fabricated Building, EPS Wall Panels, STAAD Pro

I. INTRODUCTION

Pre-engineering steel buildings are factory-built structures that use a combination of built-up sections, hot rolled sections, and cold formed elements. These structures are ideal for industrial buildings and warehouses due to their cost, speed, and ability to be dismantled and moved. They are often called 'metal boxes' or 'tin sheds' and are typically low-rise, with a maximum eave height of 25-30 meters. The structural framework comprises of pre-manufactured and pre-painted steel columns and beam sections, which are assembled using bolts at the construction site. The beams can be tailored to optimum structural efficiency, with deeper beams carrying greater loads and shallower ones carrying less. The most economical cladding for these structures is light corrugated metal sheeting, coated with an aluminium-zinc alloy for corrosion protection and an attractive paint finish. These sheets are installed over a grid of purlins, supporting the roofing material. This study aims to analyze pre-engineered buildings using STAAD Pro and examine their effects on mass and affordable housing, quality construction, earthquake-prone areas, and lightweight buildings in poor soil conditions. Applications include industrial, commercial, institutional, recreational, aviation, military, and agricultural structures.

II. LITERATURE REVIEW

[1] **Madhulee S. Dhake et.al (2022)** studied about the EPS panels outperforms conventional brick panels in terms of compressive strength, flexural strength, and water absorption capacity. This technology reduces construction costs and time, making it ideal for re-housing, new housing, or industrial construction. EPS panels are less time-consuming, cost-effective, and environmentally friendly, making them suitable for quick rehabilitation and quick rehabilitation. They are also less dense and lighter in weight, making them ideal for thermally insulated walls. EPS panels are the best replacement for conventional wall construction methods

[2] **Aquib Zafar Ansaret et.al (2022)** is said the increasing demand for housing systems necessitates the development of high-quality, low-cost materials and technologies. Precast lightweight sandwich technology offers a solution, but foamed concrete, a cellular lightweight concrete, is reluctance due to its higher cost and lack of strength. Finite element analysis is used to validate experimental

findings, and a semi-empirical equation is produced. The research aims to provide a quick and cost-effective method for constructing low- to medium-rise residential structures.

[3] **Mr.Hardik Mandwe et.al (2021)** analyze that brick wall structures have more Deflection due to higher density of brick, while EPS Panels have a lower density, resulting in less concrete and steel, resulting in lower construction costs. The seismic impact on wall panels doesn't affect the panel itself, but affects structural elements like beams and columns.

[4] **Aisswarya.R et. al (2018)** The EPS panel system is a new construction method that offers a strong alternative to traditional masonry and wood construction. It can be designed as a cantilevered shear wall system, with failure mechanisms mainly caused by cracks near openings. With 900 million houses needed in the next 25 years, EPS panel buildings offer significant advantages in sustainability and energy consumption, making them an attractive option for more developed countries.

[5] **P. S. Nalawade et.al (2018**) compares the properties of Reinforced Expanded Polystyrene (EPS) wall panels with conventional brick panels. The results show that EPS panels have superior compressive strength, flexural strength, and water absorption capacity compared to brick panels. They are also less prone to fire at high temperatures and have a lower density, making them easier to handle. EPS panels are ideal for various building applications, as they are strong, lightweight, and cost-effective. They are also environmentally friendly, cost-effective, and suitable for quick rehabilitation. Compared to traditional brick or stone masonry, EPS panels are less labor-intensive and more suitable for thermal insulation. Overall, EPS panels are a suitable replacement for conventional wall construction methods.

III. EPS WALL PANEL

The Expanded Polystyrene (EPS) core Panel system is a modern, efficient, safe, and economical construction system for buildings. It consists of a 3D welded wire space frame with a polystyrene insulation core, welded reinforcing meshes, and self-extinguishing expanded polystyrene uncoated concrete. Shotcrete is applied to the panel for its bearing capacity. Properties of such a panel are, it is rigid, closed cell foam plastic with low thermal conductivity, high compressive strength, and light weight. It's versatile for building, design, and household use. It's processed from resin with pentane gas, expanding up to 40% with steam. EPS density is crucial for mechanical properties like compression, shear, tension, flexural, and stiffness, and its manufacturing cost is linearly proportional to density (Density of EPS shall be 15, 20, 25, 30 or 35 kg/m3), as per IS 4671: 1984.

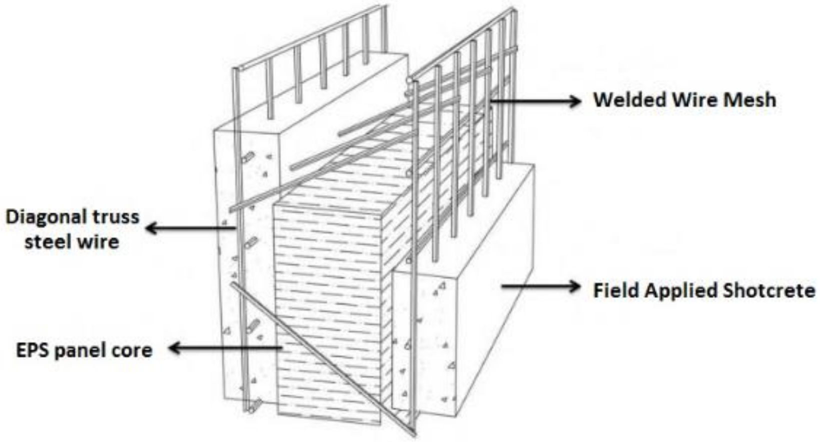

Figure-01- Typical cross section of EPS wall panel

IV. GENERALIZED CONSTRUCTION STANDARDS AND GUIDELINES OF EPS WALL PANEL

• The design must comply with the standards outlined in IS 456, IS 1905, IS 11447, IS 875 (Part1-5), IS 1893 (Part 1), IS 4326, and IS 13920.
• Clear cutting drawings are required for panel cutting at the manufacturing plant.
• Panels should be marked for proper placement during erection at the construction site.
• Ground floor walls should be founded on reinforced concrete (RC) plinth beams.
• Starter bars should be embedded staggered to ensure connections of the super structure with the foundation.
• Plinth beams should be supported on suitable foundations.

• For multi-storey buildings in high seismic zones, proper transfer of base shear should be ensured.
• EPS panels must be applied with shotcrete using concrete of at least M20 grade and aggregate smaller than 5mm in size.
• The insulation core of EPS must comply with ASTMC578 and IS 4671: 1984.
• Each panel should achieve a fire rating of 90 minutes with 40mm of shotcrete applied.
• Reinforcement mesh with steel wires should be used in accordance with ASTMA185.
• Diagonal truss wires and wire used in welded Wire fabric must conform to ASTM A82.

V. STRUCTURAL DETAIL'S

Table No.1,"Structural details of model"

Sr. No.	Title	Description
1.	**Size of Plan**	7.6m X 10. 6m
2.	Height of Building	6.4 meter
3.	EPS Panal Size (Without shotcrte weight of 20KG)	1.2m X 3m
4.	Size of Main Beam	ISMB300
5.	Size of Sub-Main Beam	ISMB200
6.	Size of Column	ISMB400
7.	Soil Type	Medium Stiff
8.	Importance Factor	1
9.	Building Frame System	Special RC Moment-Resisting System
10.	Zone Factor	0.16
11.	Wind Speed	44 m/s
12.	Height of Storey	3.2 meter
13.	Grade of Steel	Fy 415
14.	Grade of Concrete	M20

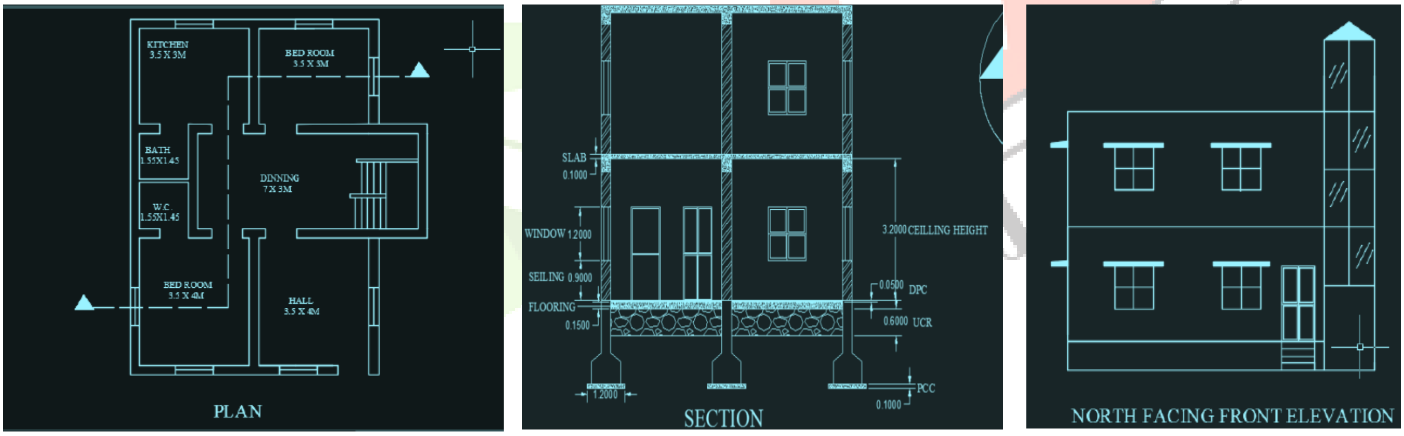

Figure-02, " Model of Building"

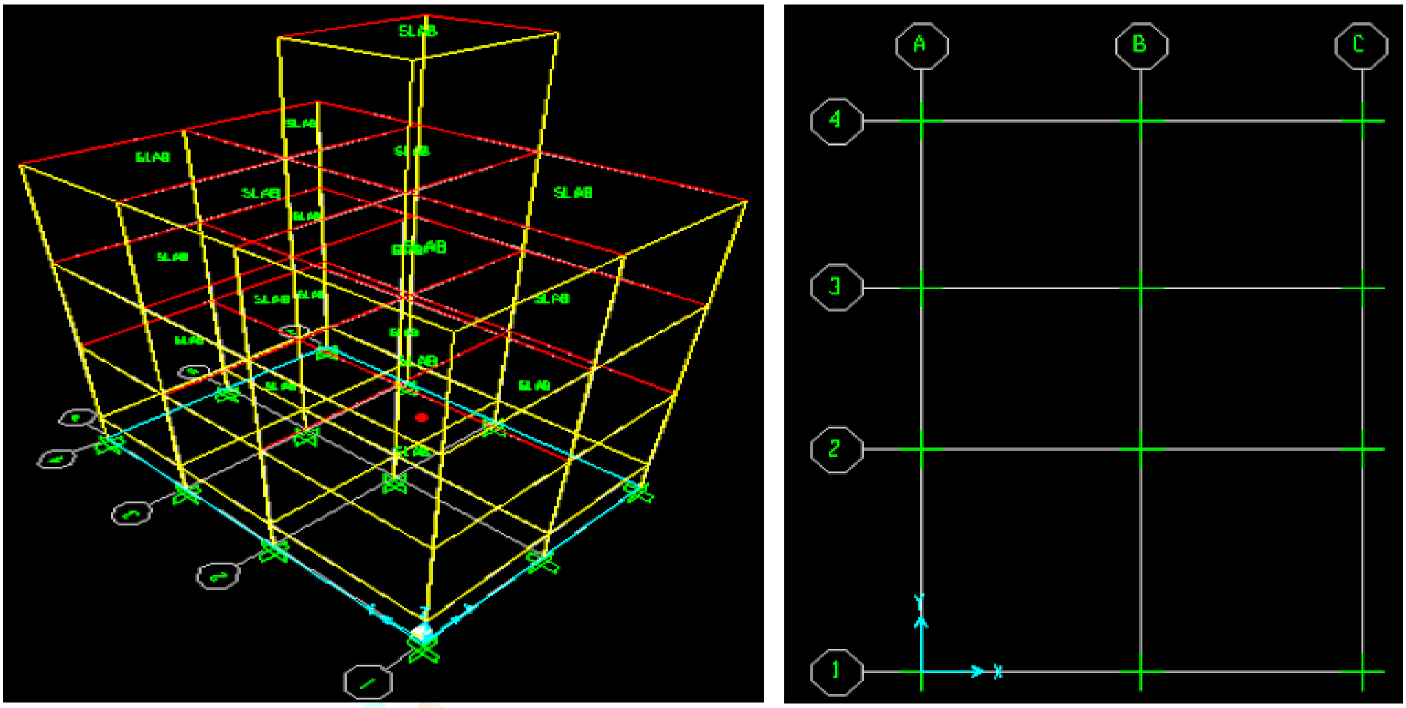

Figure-03, "Modeling in STAAD pro"

VI. LOADING CALCULATIONS

1) Dead Loads:

- Permanent construction material loads compressing roof, floor, wall, and foundation systems.
- Includes claddings, finishes, and fixed equipment.
- Automatic assignment of dead load in STAD-Pro using self weight in local Y-direction downward.
- Constant in magnitude and fixed in position throughout the structure's lifetime.

1) GA Sheet = 0.007 KN
2) Slab Load = 3.75 KN
3) Roof Load = 1.5 KN
4) Wall Load = 7.4*0.15*2.5 =2.775 KN/m²
5) Suspended Metal Lath = 0.49 KN

2) Live Loads

- Produced by human occupants, furnishings, storage, and construction activities.
- Presented in terms of uniform area loads, concentrated loads, and uniform live loads.
- Uniform and concentrated live loads should not be applied simultaneously on a structural elevation.
- Concentrated loads can be applied to a limited area or surface aligned with specific application.

Live loads, also known as transient loads, which varying in magnitude and position and are produced by intended occupancy in a building. They include distributed, concentrated, impact, vibration, and snow loads. Code IS: 875-1987 (Part 2) defines the principal occupancy for which a building is used. Concentrated loads should be applied to specific areas for maximum load effect.

1) Pressure on Full Plate = 2 kN/m²
2) Floor Load = 1.2 kN/m²

3) Wind Load

The wind exerts pressure on the structures. The pressure exerted may be both external and internal. The pressure exerted will depend upon the geographical location of the structure. The internal pressure depends upon the permeability of the structure. A structure with large opening subjected to internal pressure. In STAD-Pro the pressure intensity at the height of the structure is applied. The wind intensity is defined in STAD-Pro software and assign in +ve X, -ve X, +ve Y, -ve Y direction.

Basic wind speed (Nagpur) = 44 m/sec

Wind load analysis conduct as per IS875-Part. The 0-degree case acts on the side elevation and 0 wind load case acts on the front or back elevation. Each elevation will be analyzed separately and the highest calculated load will be applied throughout the entire structure. Therefore, this technique is deemed to be conservative.

Analysis is conducted for a wide range of cases, with the aim of overturning global stability and maintaining control. Comprehensive explanation of the global stability analysis follows ,

Design wind pressure (N/m^2) Pz = 0.6 x Vz2 (IS875-1987 Part-3; Clause: 5.4)
The formula for calculating the design wind speed (m/s) is Vz = Vb x K1 x K2 x K3 as per IS875-1987 Part-3; (Clause: 5.3).
IS 875(Part 3)-1987 provides the reference for obtaining the basic wind speed (m/s) Vb.
Risk coefficient factor (K1) can be considered from IS 875(part 3)-1987; Table: 1Clause: 5.3.1)
Terrain, height and Structure factor (K2) IS 875(part 3)-1987; Table 2; Clause: 5.3.2)
Topographic factor (K3) (IS 875(part 3)-1987; Clause 5.3.3.1)

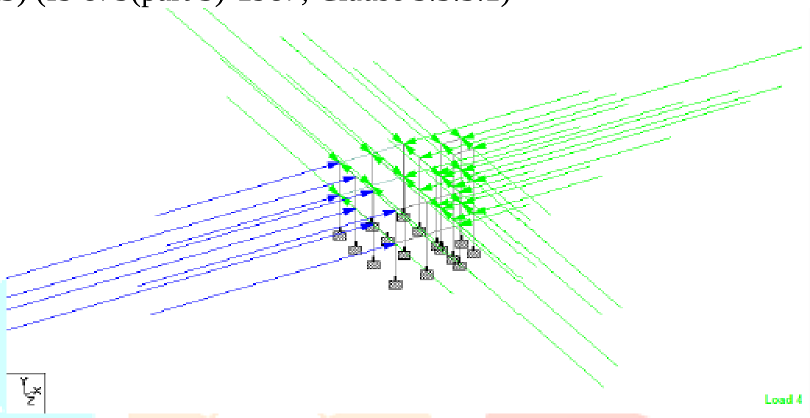

Figure-04, “Wind direction from +X direction”

VII. RESULTS AND DISCUSSION

Unit Weight or Dry Density Test

Table No.02,”Dry Density of Specimen”

Size of Panel (L XBXT) mm	Weight	Average	Dry Density (Kg/m^3)
2240x610x60	51.4	51.39	576.8
	51.25		
	51.52		
2240x610x90	78.5	78.66667	586.2
	79.1		
	78.4		
2240x610x120	106.25	106.4733	595.4
	106.45		
	106.72		

Table No.03, Flexural Strength of Specimen

SR. No	Size of Panel (L XBXT) mm	Flexural Strength Test (Mpa)			Mean Strength of 28 Day’s (Mpa)
		7 Days	14 Days	28 Days	
1	2240x610x60	0.375	0.75	1.54	1.52
2		0.385	0.77	1.50	
3		0.384	0.77	1.52	
1	2240x610x90	0.380	0.76	1.52	1.55
2		0.395	0.79	1.58	
3		0.395	0.77	1.54	
1	2240x610x120	0.405	0.81	1.62	1.62
2		0.410	0.825	1.65	
3		0.395	0.79	1.58	

Figures-05 and 06 depict the displacement graph of the Beam element under the influence of Dead load and live load. The maximum displacement in Fig. 07 is observed at nodes X-68, Y-32, and Z-23, with values of -0.0569358mm, -0.47093mm, and 0.066282mm

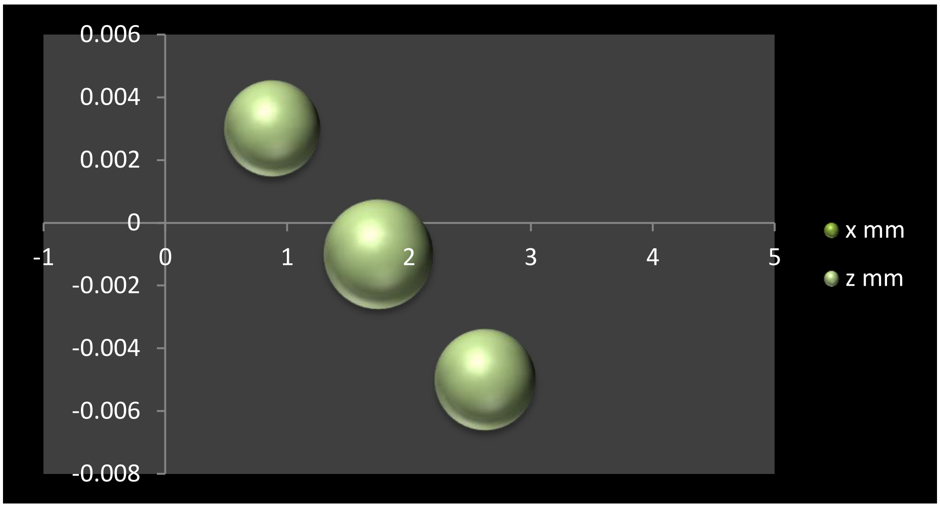

Figure-05, "Displacement in structure (Beam-1DL)"

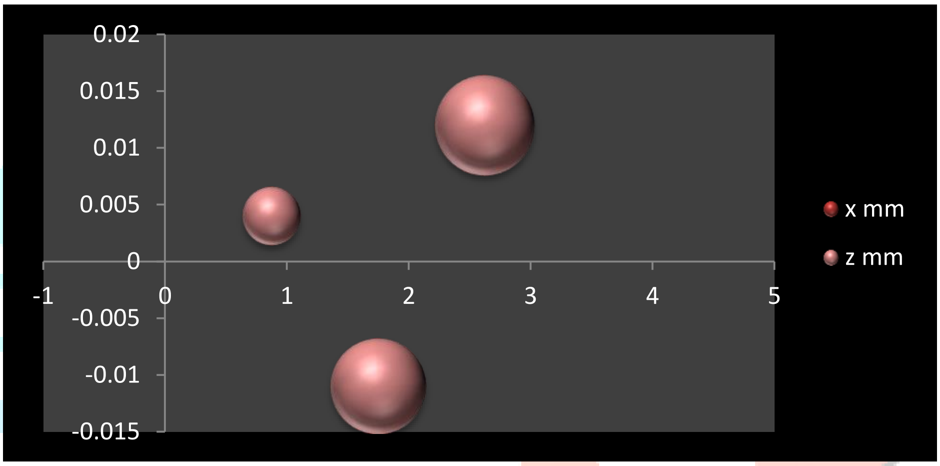

Figure-06, "Displacement in structure (Beam-2LL)"

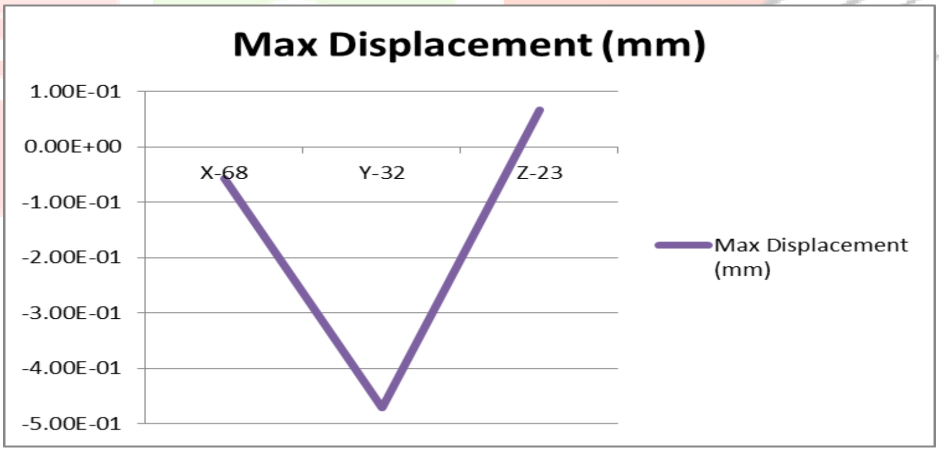

Figure-07, "Max Displacement in Model"

Figures 8 and 9 display the reaction graph at Node-2 and Node-3, respectively. The highest reaction is observed when combining DL and LL in the Fy direction, while the lowest reaction is observed when considering wind load in the Fz direction. The overall maximum reaction is observed at nodes 27, 65, and 38, with values of 0.000954477 KN, -0.000104359 KN, and 0.000372222 KN, respectively. This information is depicted in Figure-10.

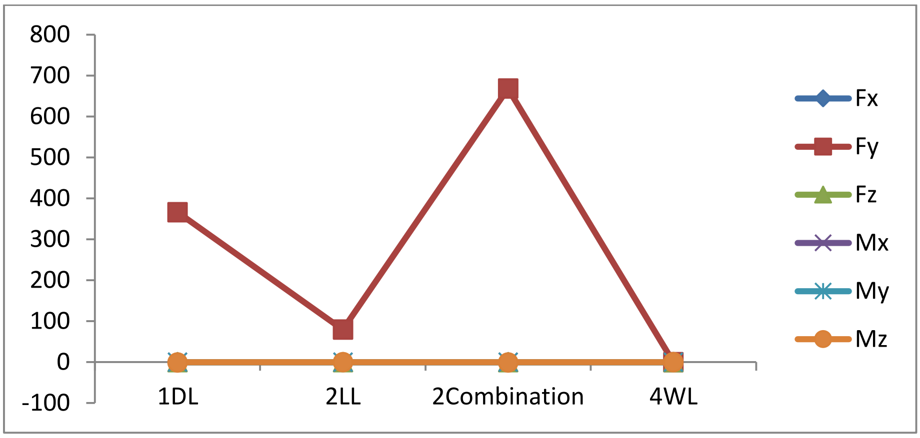

Figure-08,“Reaction in structure (Node-02)”

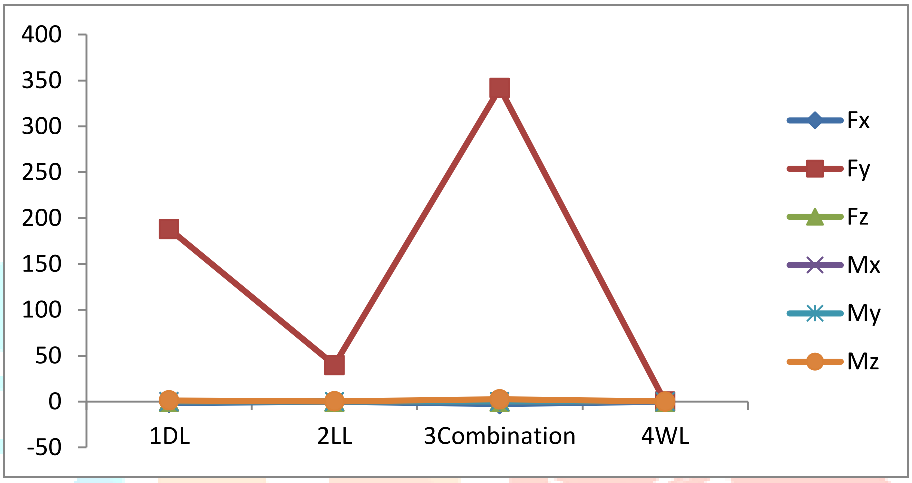

Figure-09,“Reaction in structure (Node-03)”

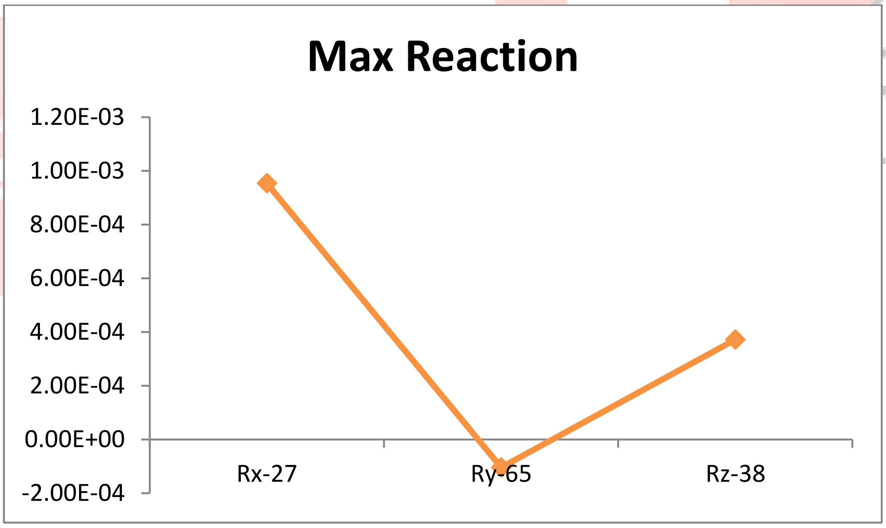

Figure-10,“Max reaction in model”

Conclusions

- EPS-based walls are versatile, suitable for single-storey construction and multi-storey buildings, offering flexural strength comparable to other masonry materials. They are lightweight and can facilitate rapid wall construction, making them ideal for construction projects.
- EPS Panel outperforms conventional brick panels in Compressive Strength, Flexural Strength, and Water Absorption capacity.
- Pre-engineered metal building concepts are unique.
- The presence of polystyrene makes EPS Panel a suitable choice for thermal insulated walls, as it is not only environmentally friendly but also reduces the time required for installation.

REFERENCES

1. Madhulee S.Dhake & Nirmal Borse (2022), "Experimental Study on EPS Sandwich Panel & Cost Analysis"- Light House Project," INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS – IJCRT, Volume 10, Issue 8 August 2022 | ISSN: 2320-2882 .
2. Prof. Aquib Zafar Ansaret et.al (2022), "A REVIEW ON EXPANDED POLYSTYRENE MONOLYTIC PANELS – EPS", International Journal of Research Publication and Reviews, Vol 3, no 5, pp 522-525.
3. Prof. Aquib Zafar Ansari et.al (2022) , " A STUDY ON EPS PANELS AS AN ALTERNATE BUILDING MATERIAL IN EARTHQUAKE ZONE", JETIR May 2022, Volume 9, Issue 5 www.jetir.org (ISSN-2349-5162).
4. Mr.Hardik Mandwe, Simran Kagale, Pooja Jagtap, Kalyani Patil (2021), "Seismic Analysis of Multistorey Building with Shear Wall using STAAD Pro", International Journal of Engineering Research & Technology, Vol. 10 Issue 06, ISSN: 2278-0181.
5. Aisswarya.R, Jagadesh Kannan.S, Nithila.S, Karthikeyan.M (2018), "EXPERIMENTAL STUDY ON EPS SHOTCRETING PANEL", International Journal of Pure and Applied Mathematics, Volume 119 No. 14, 155-164 ISSN: 1314-3395.
6. P. S. Nalawade P. P. Dalavi, P. Y. Jadhav, S. R. Shinde, G. K. More (2018), "A Study on Application of Reinforced Expanded Polystyrene Wall Panel Technology", International Journal for Scientific Research & Development| Vol. 6, Issue 03, 2018 | ISSN (online): 2321-0613.
7. P. Poluraju and G. Appa Rao, "Behaviour of EPS panels for structural applications under general loading: a stateof-the-art", IJRET: International Journal of Research in Engineering and Technology eISSN: 2319-1163, ISSN: 2321-7308
8. Nahro Radi Husein, An experimental study on using lightweight web sandwich panel as a floor and slab. International journal of Innovative Technology and exploring engineering., 2013, (IJITEE) ISSN: 2278-3075
9. Yong Lu (2002), "Comparative Study of Seismic Behavior of Multistory Reinforced Concrete Framed Structures", JOURNAL OF STRUCTURAL ENGINEERING /DOI: 10.1061/~ASCE!0733-9445~2002!128:2~169!