iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 12 **Issue:** X **Month of publication:** October 2024

DOI: https://doi.org/10.22214/ijraset.2024.64618

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue X Oct 2024- Available at www.ijraset.com

Analysis and Design of Pre-Engineered Industrial Warehouse Building with Different Standard

Shubham Tomar[1], Mr. Rakesh Grover[2]
[1]ME Student, Department of Civil Engineering, Jabalpur Engineering College, Jabalpur (M.P)
[2]Associate professor, Department of Civil Engineering, Jabalpur Engineering College, Jabalpur (M.P)

Abstract: Over the years, pre-engineered building (PEB) has emerged as a sustainable alternative to conventional concrete construction as well as conventional steel construction. In this paper, pre-engineered industrial warehouse building will be design with different codal provision using software Staadpro and analyzed with different loads on building i.e. dead load, live load, collateral load, wind load and load combinations on building .The main objective of this study to find the optimum weight of steel quantity in building with use of different country codel provision .
Keywords: Pre-engineering steel building, Industrial building and Warehouse building , Staad-Pro, Analysis, Design, etc.

I. INTRODUCTION

A pre-engineered building, or a PEB as it's called, is a structure which is manufactured and fabricated in the factory and thereafter assembled at the site of construction. The construction of these steel structures is overseen by pre-engineered building manufacturers. These structures consist of roofing and exteriors, beams and columns. Then other panels like exterior plates are assembled, along with any other required structural and design element. Each building is unlike the other, as per the requirement and budget of the project. In short, PEB buildings are created by PEB structure manufacturers and are designed to meet a variety of structural needs. These steel structures comprise of beams welded together to create a framework which is then customized to meet the needs of the customer. The introduction of prefabricated industrial buildings has improved the construction scenario in India. Also, with the government's Smart City initiative, there has been an upsurge in the demand for infrastructure from all corners of the country. However, due to the disadvantages of traditional construction methods (it is time consuming, and much more expensive than PEB's), it has been tough to meet the increased demand for infrastructure from sectors such as logistics, warehousing, power, automotive, retail, and so on. With the rise in the awareness of the advantages of prefabricated industrial buildings, the demand for these products is gradually increasing and PEB (pre-engineered building) structure manufacturers have been taking the growing demand into account. PEB is now used for all type of buildings such as low rise, medium rise and skyscrapers. Due to the attractive features of prefabricated structures, it is taking over traditional construction.

A. Aim of Study

The aim of study is structure will perform their function properly for the design period in terms of strength and serviceability with optimum weight.

B. Objective of the study

1) To identify and design the structure as per the various loads and load combinations acting on the structure.
2) To design the industrial warehouse as per IS codes and AISC standard
3) To compare the both design and analysis output as per both standard
4) To find the optimum weight of structure

II. COMPONENTS OF PEB

A. Primary Members (Main Frame)

Column
Rafters

B. Secondary members

Purlin, Girt, Roof sheet, Wall cladding, Sky light, etc.

III. METHODOLOGY

A. Loading parameter

1) Dead load

According to IS: 875 (part 1) - Dead load comprises of self-weight of the structure+weights of roofing, bracings and other accessories. (0.15KN/m2)

2) Live load

According to IS: 875 (Part 2) - for roof with no access provided, the live load can be taken as 0.75 kN/m2

3) Wind load

According to IS: 875 (part 3)

B. Load combinations

Load combination is as per IS800:2007 (TB:04)

IV. ANALYSIS USING STAAD PRO CONNECTION EDITION

Staad-Pro Connect addition software was used to analyze and design pre-engineered building structures for both Indian and American standard in this project. In the staad pro tools we can model our primary structure, apply loading and design parameter as per required codal provision and than analysis and design the structure by assuming various condition such as base connection , and types of connection at any joint , tension member, etc.

V. LITERATURE REVIEW

Syed Firoz, et. al (2012) observed that the pre-engineered steel construction system presents great advantages for single-story buildings, a practical and efficient alternative to conventional constructions, representing the system a central model within several disciplines. Pre-engineered construction creates and maintains support in real-time is currently being implemented by Staad Pro Choosing steel to design a pre-engineered steel frame building is choosing a material that offers low cost, strength, durability, design flexibility , adaptability and recyclability. Steel is the basic material used in the materials used for pre-engineered steel construction.

J.D. Thakar, P. Patel (2013),Pre-engineered building are steel building wherein the framing members and other components are fully fabricated in the factory after designing and brought to the site for assembly, mainly by nut-bolts, thereby resulting into a steel structure of high quality and precision. In conventional steel construction, we have site welding involved, which is not the case in P.E.B using nut-bolt mechanism. These structures use hot rolled tapered sections for primary framing and cold rolled sections (generally “Z” and “C” sections) for secondary framing as per the internal stress requirements, thus reducing wastage of steel and the self-weight of the structure and hence lighter foundations.

Naidu & et. al. (2014) In this work Long Span, Column free structures are the most essential in any type of industrial structures and Pre Engineered Buildings (PEB) fulfills this requirement along with reduced time and cost as compared to conventional structures. The present work involves the comparative study and design of Pre Engineered Buildings (PEB) and Conventional steel frames. Design of the structure is being done in Staad Pro software and the same is then compared with conventional type, in terms of weight which in turn reduces the cost. Three examples have been taken for the study. Comparison of Pre Engineered Buildings (PEB) and Conventional steel frames is done in two examples and in the third example, Pre Engineered Building structure with increased bay space is taken for the study. In the present work, Pre Engineered Buildings (PEB) and Conventional steel frames structure is designed for wind forces. Wind analysis has been done manually as per IS 875 (Part III) – 1987.

Sagar Wankhede et.al (2014) presented a review article on comparisons of conventional steel buildings and pre-engineered buildings. The article begins with a discussion of various elements of industrial construction such as purlins, rafters, main beams, roof trusses, gantry beams, brackets, column and column base, beam rods, bracing. In addition, transported by study load and load combination as per IS 875-1987. Then, he gave an overview of the concepts of Pre-engineering of Construction, informing their advantages, effective use and about their structure.

Meena & et. al. (2015) In this work effectively conveys that Pre-Engineered steel Buildings can be easily designed by simple design procedures in accordance Low weight flexible frames of PreEngineered steel Building offer higher resistance to earthquake loads. After analysing, the following are the conclusions of Pre-Engineered steel Building when compared with Conventional Steel Buildings.

Bhagatkar & et. al. (2015) In this work From the past advancement, the use of PEB is implemented and continuously increasing, but its usage is not throughout the construction industry. It is reviewed that PEB structures can be easily designed by simple design procedures in accordance with country standards, it is energy efficient, speedy in construction, saves cost, sustainable and most important its reliable as compared to conventional buildings. Thus PEB methodology must be implemented and researched for more outputs.

Shrunkhal V. Bhagatkar et. al (2015), presented a study on Pre-Construction with a review of several authors of articles on Pre-Construction. The work aimed to evaluate from the past advance, if the use of PEB is implemented and in constant increase, its use is not in the entire construction industry.

Chavanke & Tolani (2017) In this work Long span, Column free structures are the most essential in any type of industrial structures and Pre Engineered Buildings (PEB) fulfill this requirement along with reduced time and cost as compared to conventional structures. The present investigation aims at comparison of conventional steel building and pre-engineered building. In this investigation analysis of and design of pre-engineered building and conventional steel building will be carried out for spans like 15m, 20m, 25m, and 36 m using computer software STAAD Pro v8i.

Katkar & Phadtare (2018) In this work recent years, the introduction of Pre-Engineered Building (PEB) concept in the design of structures has helped in optimizing design. Long span, Column free structures are the most essential in any type of industrial structures and Pre Engineered Buildings (PEB) fulfil this requirement along with reduced time and cost as compared to conventional structures. This methodology is versatile not only due to its quality predesigning and prefabrication, but also due to its light weight and economical construction. The present work presents the comparative study and design of conventional steel frames with concrete columns and steel columns and Pre Engineered Buildings (PEB). In this work, an industrial building of length 44m and width 20m with roofing system as conventional steel truss and pre-engineered steel truss is analyzed and designed by using STAAD Pro V8i.

VI. DESIGN AND ANALYSIS

A. Building Parameters

Length = 73m

Width = 30.5m

Height =9.3m

Brick wall height = 3.0m

Location = Bhopal

Basic wind speed = 47 m/s

Roof Slope type = Dual slope

Support type : Pinned support

Roof slope = 1:10

Bay spacing = 7.3m

Nos of intermediate column = 1 nos

B. Load Calculation

1) Dead Load

Total Weight of sheeting , purlin, sag rod, etc. = 15kg/m2

So, Dead load = 0.15 KN/m2

Bay spacing = 7.3 m

Dead load on frame = 0.15 * 7.3 = 1.1 KN/m2

2) Live Load

Live load for non-accessible roof = 0.75KN/m2

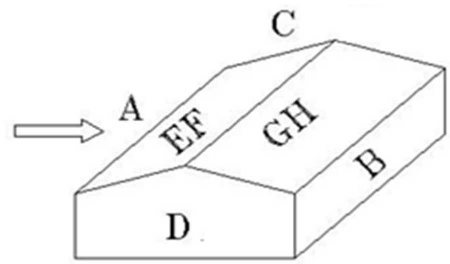
Live load on frame = 0.75 * 7.3 = 5.475KN/m2

3) Wind Load

Basic wind speed = Vb

Design wind speed Vz = Vb *k1*k2*k3*k4

K1 = 1.0
K2= 0.91 (TC:3)
K3 = 1.0
K4 = 1.0
Vz= 47 m/s2
Pz= 0.6* Vz2*0.8
Pz = .878 KN/m2
Design pressure, Pd=kd*ka*kc*pz
Kd = 0.9
Ka = 0.87
Kc = 1
Pd = 0.6875 KN/m2
Cpi = 0.2
Cpe = As per Table 5(IS875:2015)
H/W =0.3049< 0.5
L/W = 2.3934 (1.5<2.3934<4)



4) Load Combinations : Auto load combination generated by staad as per IS800:2007(TB 04)

LOAD COMB 101 ULC, 1.5 DEAD + 1.5 LIVE
1 1.5 2 1.5
LOAD COMB 102 ULC, 1.2 DEAD + 1.2 LIVE + 0.6 WIND (1)
1 1.2 2 1.2 3 0.6
LOAD COMB 103 ULC, 1.2 DEAD + 1.2 LIVE + 0.6 WIND (2)
1 1.2 2 1.2 4 0.6
LOAD COMB 104 ULC, 1.2 DEAD + 1.2 LIVE + 0.6 WIND (3)
1 1.2 2 1.2 5 0.6
LOAD COMB 105 ULC, 1.2 DEAD + 1.2 LIVE + 0.6 WIND (4)
1 1.2 2 1.2 6 0.6
LOAD COMB 106 ULC, 1.2 DEAD + 1.2 LIVE + 0.6 WIND (5)
1 1.2 2 1.2 7 0.6
LOAD COMB 107 ULC, 1.2 DEAD + 1.2 LIVE + 0.6 WIND (6)
1 1.2 2 1.2 8 0.6
LOAD COMB 114 ULC, 1.2 DEAD + 1.2 LIVE
1 1.2 2 1.2
LOAD COMB 115 ULC, 1.2 DEAD + 1.2 LIVE + 1.2 WIND (1)
1 1.2 2 1.2 3 1.2
LOAD COMB 116 ULC, 1.2 DEAD + 1.2 LIVE + 1.2 WIND (2)
1 1.2 2 1.2 4 1.2
LOAD COMB 117 ULC, 1.2 DEAD + 1.2 LIVE + 1.2 WIND (3)
1 1.2 2 1.2 5 1.2
LOAD COMB 118 ULC, 1.2 DEAD + 1.2 LIVE + 1.2 WIND (4)
1 1.2 2 1.2 6 1.2
LOAD COMB 119 ULC, 1.2 DEAD + 1.2 LIVE + 1.2 WIND (5)
1 1.2 2 1.2 7 1.2
LOAD COMB 120 ULC, 1.2 DEAD + 1.2 LIVE + 1.2 WIND (6)
1 1.2 2 1.2 8 1.2
LOAD COMB 127 ULC, 1.5 DEAD + 1.5 WIND (1)
1 1.5 3 1.5
LOAD COMB 128 ULC, 1.5 DEAD + 1.5 WIND (2)
1 1.5 4 1.5

LOAD COMB 129 ULC, 1.5 DEAD + 1.5 WIND (3)
1 1.5 5 1.5
LOAD COMB 130 ULC, 1.5 DEAD + 1.5 WIND (4)
1 1.5 6 1.5
LOAD COMB 131 ULC, 1.5 DEAD + 1.5 WIND (5)
1 1.5 7 1.5
LOAD COMB 132 ULC, 1.5 DEAD + 1.5 WIND (6)
1 1.5 8 1.5
LOAD COMB 139 ULC, 1.5 DEAD
1 1.5
LOAD COMB 140 ULC, 0.9 DEAD + 1.5 WIND (1)
1 0.9 3 1.5
LOAD COMB 141 ULC, 0.9 DEAD + 1.5 WIND (2)
1 0.9 4 1.5
LOAD COMB 142 ULC, 0.9 DEAD + 1.5 WIND (3)
1 0.9 5 1.5
LOAD COMB 143 ULC, 0.9 DEAD + 1.5 WIND (4)
1 0.9 6 1.5
LOAD COMB 144 ULC, 0.9 DEAD + 1.5 WIND (5)
1 0.9 7 1.5
LOAD COMB 145 ULC, 0.9 DEAD + 1.5 WIND (6)
1 0.9 8 1.5
LOAD COMB 152 ULC, 0.9 DEAD
1 0.9
LOAD COMB 153 ULC, 1 DEAD + 0.35 LIVE
1 1.0 2 0.35
LOAD COMB 154 ULC, 1 DEAD + 1 LIVE
1 1.0 2 1.0
LOAD COMB 155 ULC, 1 DEAD + 0.8 LIVE + 0.8 WIND (1)
1 1.0 2 0.8 3 0.8
LOAD COMB 156 ULC, 1 DEAD + 0.8 LIVE + 0.8 WIND (2)
1 1.0 2 0.8 4 0.8
LOAD COMB 157 ULC, 1 DEAD + 0.8 LIVE + 0.8 WIND (3)
1 1.0 2 0.8 5 0.8
LOAD COMB 158 ULC, 1 DEAD + 0.8 LIVE + 0.8 WIND (4)
1 1.0 2 0.8 6 0.8
LOAD COMB 159 ULC, 1 DEAD + 0.8 LIVE + 0.8 WIND (5)
1 1.0 2 0.8 7 0.8
LOAD COMB 160 ULC, 1 DEAD + 0.8 LIVE + 0.8 WIND (6)
1 1.0 2 0.8 8 0.8
LOAD COMB 167 ULC, 1 DEAD + 0.8 LIVE
1 1.0 2 0.8
LOAD COMB 168 ULC, 1 DEAD + 1 WIND (1)
1 1.0 3 1.0
LOAD COMB 169 ULC, 1 DEAD + 1 WIND (2)
1 1.0 4 1.0
LOAD COMB 170 ULC, 1 DEAD + 1 WIND (3)
1 1.0 5 1.0
LOAD COMB 171 ULC, 1 DEAD + 1 WIND (4)
1 1.0 6 1.0

LOAD COMB 172 ULC, 1 DEAD + 1 WIND (5)
1 1.0 7 1.0
LOAD COMB 173 ULC, 1 DEAD + 1 WIND (6)
1 1.0 8 1.0
LOAD COMB 180 ULC, 1 DEAD
1 1.0

C. *Design Codes*

Case 01) IS800:2007
Case 02) AISC-360:16 (LFRD)

VII. RESULT AND DISCUSSION

A. *Weight of Structure*

S.NO	WEIGHT AS PER IS800:2007	WEIGHT AS PER AISC-360:16(LFRD)
1	31.6 MT	28.2 MT

B. *Base Reaction Of Intermidiate Bays*

For End Column

DIRECTION	AS PER IS800:2007	AS PER AISC-360:16(LFRD)
FX	17.40 KN	27.26 KN
FY	88.16 KN	83.71 KN
FZ	0.0 KN	0.0 KN

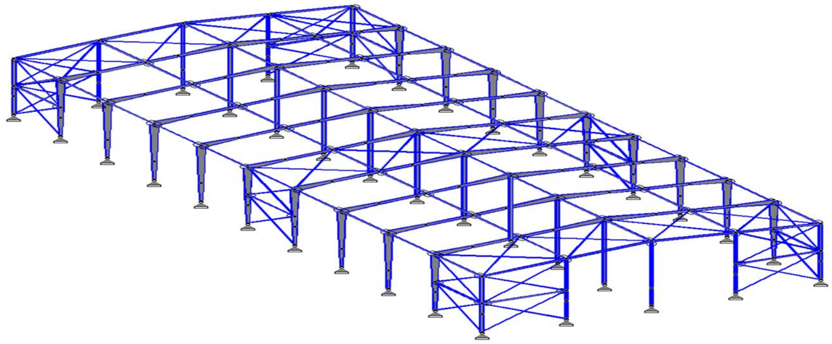
For Intermidiate Column

DIRECTION	AS PER IS800:2007	AS PER AISC-360:16(LFRD)
FX	0 KN	0 KN
FY	186 KN	190 KN
FZ	0 KN	0 KN

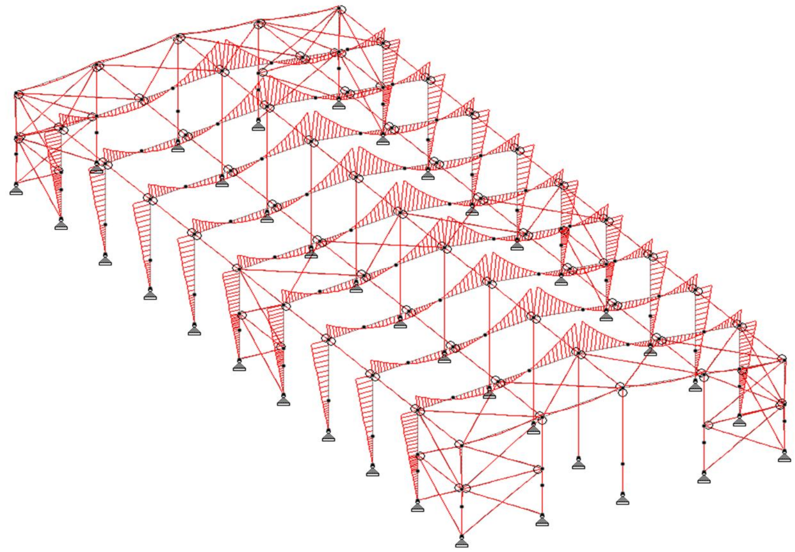
Maximum Defelection

DIRECTION	AS PER IS800:2007	AS PER AISC-360:16(LFRD)
IN X DIRECTION	60.70 MM	74.82 MM
IN Y DIRECTION	35.6 MM	40.71 MM
IN Z DIRECTION	31.66 MM	38.123 MM

C. *Diagrams*



Isometriv View Of Structure



Bending Moment Diagram

VIII. CONCLUSIONS

Based on above result following conclusion can be made ;

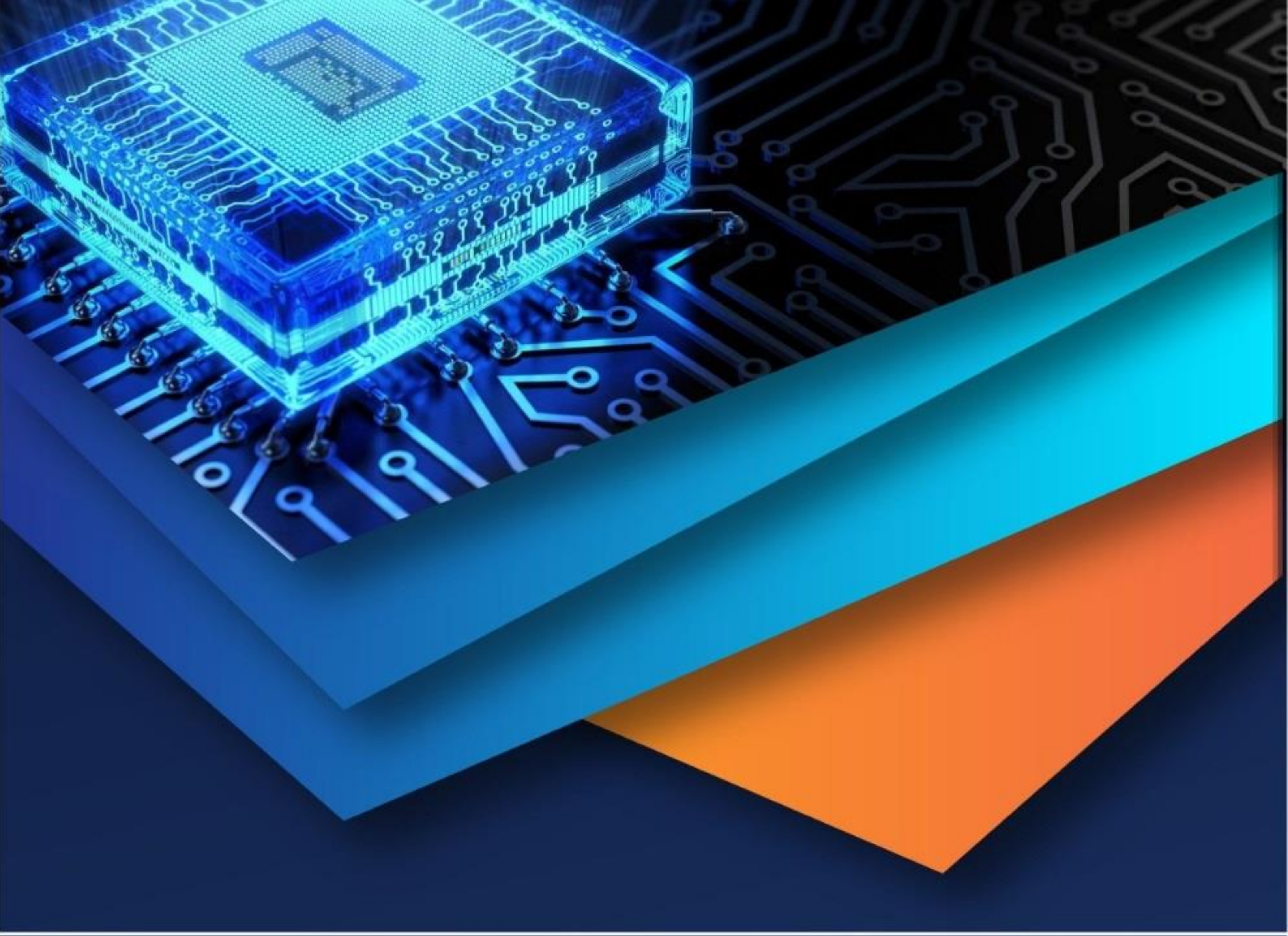
1) Weight of structure is approx 11% less when design is done as per american standard as compared to indian standard
2) As american design provide less weight by which transportation cost , painting cost ,erection cost , machinary cost etc. is reduced
3) As american standard provided more optimum section for given loading by which deflection is more in structure as compared to indian standard.
4) When overall weight of structure is less in american standard than foundation cost also reduceses.

IX. FUTURE SCOPE OF THE STUDY

PEB technology provides the much-required design flexibility for steel structures. This is important as no other type of construction provides this level of advantage. PEB structure is the most cost-effective choice. But it is also favoured for its recyclability. All material is practically recyclable. If you need to get the prefabricated structure dismantled due to some reason, then it is easy to do. There will be hardly any wastage in it. In our study it is concluded that American code design less weight structure as compared to Indian code but less stable in case of pinned support .

REFERENCES

[1] IS 875 (part 1)1987 Code of practice for Dead load.
[2] IS 875 (part 2)1987 Code of practice for Live load.
[3] IS 875 (part 3)2015 Code of practice for Wind load.
[4] IS: 800-2007: Code of practice for general construction in steel.
[5] AISC-360:16 Code of practice for general construction in steel.
[6] Dipali K. Chhajed1, Dr Sachin B. Mulay “Design and Analysis of Pre Engineered Steel Building with Indian Standard Code and International Code” IRJET Volume: 07 Issue: 09 Sep 2020.
[7] Muhammad Umair Saleem * and Hisham Jahangir Quresh “Design Solutions for Sustainable Construction of Pre Engineered Steel Buildings” MPDI 15 April 2018; Accepted: 25 May 2018; Published: 28 May 2018.
[8] Syed Firoz1 , Sarath Chandra Kumar B1 , S.Kanakambara Rao “DESIGN CONCEPT OF PRE ENGINEERED BUILDING” IJERT Vol. 2, Issue 2,Mar-Apr 2012, pp.267-272.
[9] A.S. Kumar, et al., Design and Analysis of Pre Engineered Industrial Buildings (PEB), Int. J. Appl. Sci., Eng. Manag. ISSN, 2320–3439.
[10] T. Mythili, Analysis and comparative study of conventional steel structure with PEB structure, Int. J. Sci. Res. (IJSR), ISSN (Online) (2015) 2319–7064.
[11] C. Meera, “Pre-engineered building design of an industrial warehouse”, Int. J. Eng. Sci. Emerg. Technol. 5 (2) (2013) 75–82.
[12] G.S. Kiran, A.K. Rao, R.P. Kumar, “Comparison of design procedures for pre engineering buildings (PEB): a case study”, Int. J. Civ., Arch., Struct. Constr. Eng. (IJCASCE) 8 (4) (2014).



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY