"PRE-ENGINEERED BUILDING STRUCTURE OF GHAZIABAD RRTS STATION: A CASE STUDY"

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ABSTRACT- *This paper provides a concise overview of erection process of structural steel involves the assembly of steel components into a frame on the site which also forms the major part of project cost. This process briefly involves lifting and placing components into position, then connecting them as a whole member and finally bolting. So, to ensure that the processes should be completed safely, quickly and economically, it has to be greatly influenced by the decisions made before the erection commences. Erection cost comprises of 7-10% of the total project cost which is mainly dependent on the speed of execution of erection of the structure. During execution of erection of structure, it is subjected to carry temporary loads which would not be the part of loading in future. The aspects that are to be ensured during execution are safe erection procedures and structural stability of the structure. To focus these aspects, the guidelines for the erection process are presented in this paper.*

Keywords- Regional Rapid Transit Rail (RRTS), Pre-Engineered building (PEB).

I. INTRODUCTION

Pre-engineered buildings offer numerous merits that make them a popular choice for construction projects. These buildings are cost-effective, as they are designed and manufactured off-site, reducing construction time and labour costs. They also offer flexibility in design, allowing for customization to meet specific project requirements.The future of pre-engineered buildings looks promising, as advancements in technology continue to improve the efficiency and sustainability of these structures. With the ability to incorporate renewable energy sources, such as solar panels, and utilize eco-friendly materials, pre-engineered buildings are becoming increasingly environmentally friendly.

Additionally, the speed of construction and durability of pre-engineered buildings make them an attractive option for a variety of applications, from industrial warehouses to commercial office spaces. As the demand for efficient and sustainable building solutions grows, pre-engineered buildings are likely to play a significant role in shaping the future of construction.In the present study, Pre-Engineered buildings concept is relatively new technique that are used to design from low rise to high rise multilevel buildings, parking, Industrial buildings for manufacturing plants and Aircraft Hangars etc. Pre-Engineered Steel Buildings are manufactured or Produced in the plant itself. The manufacturing of structural members is done on customer requirements. The detailed structural members are designed for their respective location and are numbered, which cannot be altered, because members are manufactured with respect to design features. These components are made in modular or completely knocked condition for transportation. These materials are transported to the customer site and are erected. Welding and cutting process are not performed at the customer site. No manufacturing process takes place at the customer site.

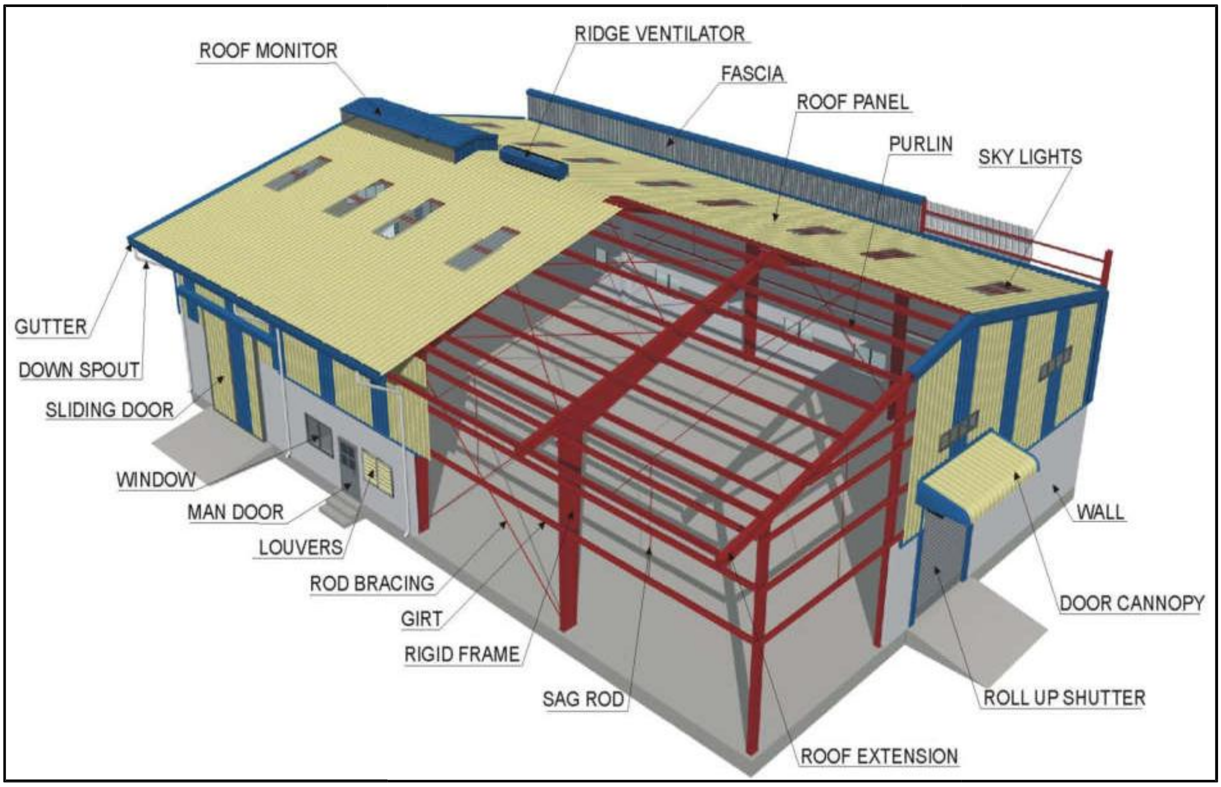

FIGURE 1 PRE-ENGINEERED BUILDING ELEMENTS

II. OBJECTIVES

The prime objective of this study is to study the benefits and application of the pre-engineered industrial buildings.The objective of pre-engineered buildings is to provide a cost-effective and efficient solution for construction projects. These buildings are designed and manufactured off-site, then assembled on-site, saving time and money compared to traditional construction methods. The goal is to create durable, high-quality structures that meet the specific needs of the project while also being sustainable and environmentally friendly.

III. ERECTION OF PRE-ENGINEERED BUILDINGS

Pre-engineered buildings (PEB) steel parts are required to be installed in a specific order due to structural safety requirements and to the logical sequence of erection. However, shipping, transportation, unloading and on-site storage does not consider the erection order of the assembly. As a result, considerable time is consumed locating, sorting, and identifying steel components.

Erection Drawings:

Erection drawings provide the field erection crew (raising gang) with the roadmap of how to erect (put together) the steel assemblies after they are delivered to the field. Essentially, they are a set of instructions on how to put the puzzle pieces together.

Anchor Bolt Setting:

It is extremely important that anchor bolts be placed accurately in accordance with the anchor bolt setting plan. All anchor bolts should be held in place with a template or similar means, so that they will remain plumb and in the correct location during placing of the concrete.

Unloading and Preparing Parts assembly:

The vehicle transporting your building parts must gain access to the building site from the adjacent highway or road. Such access should be studied and prepared in advance of arrival.

Blocking under the columns and rafters protects the splice plates and the slab from damage during the unloading process. Extra care should always be exercised in the unloading operation to prevent injuries from handling the steel and to prevent damage to materials.

Location of Building Parts:

All the parts are placed around the foundation so that they will be in the most convenient locations for installation. Bolts and nuts are placed where they will be accessible to the parts. Purlins and girts, depending on the number of bundles, are usually stored near the sidewalls clear of other packages or parts.

FIGURE 2 GHAZIABAD RRTS PRE-ENGINEERED BUILDING

COMPONENTS ERECTION:

The major components comprise of rigid frame, columns and rafter, eave struts, purlins, girts, flange braces, end-wall columns and bracing systems which may be cables, rods angles or portals. All materials for the first bay erection are prepared. The rafter sections required are identified by part number, and then assembled as near as possible to their lifting positions. Then the first four columns are erected at the braced bay, meanwhile the part number, Orientation and position over anchor bolts were verified. Next step is to position the crane for lifting the assembled rafter sections.

Raising Rigid Frames:

The intermediate or interior frames nearest the bearing endwall are usually erected first. This bay usually contains the diagonal bracing. The proper completion and plumbing of this first bay is extremely important to the successful completion of the building. Although several methods are used to erect rigid frames, it has been found most satisfactory to erect the columns first, tie them together with the girts and tighten the anchor bolts.

Completing and Plumbing the First Bay:

After the first intermediate or interior frames have been set, all purlins, girts, and eave struts be installed in the braced bay and the entire bay plumbed, aligned and braced before proceeding further. If the building is designed without cable bracing, the erector is responsible for providing temporary erection bracing. When this bay is properly and accurately plumbed and braced, the remaining members, to a large degree, will automatically plumb and align when installed.

Erecting column Beam end walls:

Column and beam end walls of 50 feet or less in span may be raised into position and set on the anchor bolts as a unit. All rafters, column, girts (except outside endwall girts which connect to the sidewall girts), door headers, door jambs, clips, diagonal brace rods, etc. should be assembled on the ground with the bolts left finger tight. A spreader bar should be used to raise the endwall frame. Because of the flexibility of the column and beam frames, care must be taken in locating the points of attachment of the cables, and in raising the frame, to avoid bending about the minor axis.

Erecting the remaining frames:

The remaining frames are erected in like manner, initially with only a few purlins being installed in each bay, as shown below, working from one end of the building to the other. To lend overall rigidity to the structure, install flange braces to the purlins at specified locations. All purlin, girt and eave strut connection bolts are left loose so that the entire skeleton framework can be plumbed without undue difficulty.

Installation of Bracing:

Diagonal bracing in metal buildings is critical. They provide support for wind loads or other longitudinal loads, such as those created by an overhead crane in the completed structure. Many times, additional temporary bracing is needed to stabilize the structure during erection. On some smaller buildings, diagonal bracing is not needed for the building design, so the erector must furnish any erection bracing needed.

Bolting Procedure in steel structures:

This procedure applies to the permanent fixing of steel structures including the erection of steel. Construction drawings shall indicate the grade and diameter of all bolts, nuts and washers required for the construction. Drawings shall indicate whether a “Friction-Type” or “Bearing- Type” connection is required. The nominal size of the bolt holes (other than holes in a base plate) shall be 2mm larger than the nominal bolt diameter for a bolt not greater than 24mm in diameter and not more than 3mm larger for bolts of diameter more than 24 mm.

Alignment and assembly

The parts to be joined shall line up in such a way that a drift of equal diameter to the bolt can pass through the bolt holes. Drifting to align the bolt holes shall be done is such a 3 way as not to bend or damage the parts nor enlarge the holes. Packing shall be provided as required to ensure parts have full contact over the mating surfaces. Prior to inserting the bolts, the nut should be run up the threads to ensure there are no thread defects that would impede the tightening process.

Bolt Tightening (Snug Tightening)

Bolt Tightening is required for all Bearing-Type Connections and as a pre-requisite to Friction- Type connections. The sequence of tightening the bolts shall proceed from the stiffest part of the connection towards the free edges. High strength bolts that are to be tensioned may be tightened during erection to facilitate assembly, but they shall not be finally tensioned until all bolts have been snug tightened in the correct sequence.

Roof Insulation:

Precast roof insulation to reach from eave to eave allowing approximately 2 feet of additional length to facilitate handling. Hold insulation at one sidewall and roll out insulation across the purlins, vapor barrier to the inside of the building. Stretch the insulation to provide a tight and smooth inside surface. Double sided tape or contact adhesives can be used to hold insulation in place while the roof sheets are being installed. Trim excess insulation to the edge of the eave trim and cut fiberglass approximately 4 inches from end leaving only facing. Fold facing over end of blanket insulation to seal the end.

Aligning the Girts
Installation of the building walls is generally done before the roof. Before starting the wall installation, check to be sure that the eave strut and girts are straight and plumb. One method ofaligning the girts is to cut temporary wood blocking to the proper length and install between the lines of girts. This blocking can be moved from bay to bay, which will reduce the number of pieces required. Normally, one line of blocking per bay will be sufficient. Banding can also be used to hold the girts straight and plumb.

Screw alignment
Good alignment of the screws, especially on the wall panels, will give a professional appearance to the wall panel installation. One way this can be accomplished is by pre-drilling holes in the panels at identical locations. Up to 15 panels can be stacked together and drilled using a template panel. 1/8” or 5/32” diameter drill bit is used for panel to structural fasteners and a 1/4” diameter bit for the side lap clearance holes. It is important to clean metal filings off panel surfaces after drilling to avoid rust stains.

Installation of wall Panels:
Adjoining panels are installed with the overlapping rib toward the last erected panel. Position panel to structural making sure that it is kept plumb and install fasteners at lapped rib. Check for proper coverage and correct as necessary. Install remaining fasteners.

Fastener Installation:
Correct fastener installation is one of the most critical steps when installing roof panels. Drive the fastener in until it is tight, and the washer is firmly seated. Do not overdrive fasteners: A slight extrusion of neoprene around the washer is a good visual tightness check. Always use the proper tool to install fasteners. A fastener driver (screw gun) with and rpm of 1700-2500 is used for self-drilling screws.

Preparing the Eave:
After installing the first run of insulation, prepare the eave for the first roof panel by applying tape sealant along the eave outside of the insulation and leaving release paper in place. Sealant must be applied in a straight line and without voids. Splice a full closure to the starting closure and apply along the top of the eave sealant. If roof is subject to ice and snow build-up, the splice in the closure strip must be caulked to insure weather tightness.

Installation of the first roof panel:
Once the eave is prepared, the first roof panel may be installed. The roof panel is set in place over the inside closure (after removing the paper from the mastic) ensuring the major ribs of the panel nest properly with the inside closure.

Roof Sheeting Sequence:
It is recommended that both sides of the ridge of a building be sheeted simultaneously. This will keep the insulation covered for the maximum amount of time and the panel ribs can be kept in proper alignment for the ridge panel.

Final Installation
While back lapping the last roof panel (to match panel coverage with the building length) is routinely done, this installation method can compromise the integrity of the roof by trapping moisture between the panels. This moisture could, in time, create an environment conducive to rust and metal failure. Manufacturer recommends field cutting the final panel lengthwise to create the desired panel width necessary to finish off the building.

Skylight Installation:
Skylight panels are installed using the same procedures as a steel panel. Care should be taken when installing fasteners in the skylights to avoid cracking the material. Install roof panels, leaving the light-transmitting panel run open, except for lower light transmitting panel run panel.

IV. CONCLUSION

Steel is such a versatile material that every object we see in our daily life has used steel directly or indirectly. There is no viable substitute to steel in construction activities. Steel remains and will continue to remain logical and wide choice for construction purpose, environmentally also, as much of the steel used is recycled.Steel building offers more design and architectural flexibility for unique or conventional styling. Its strength and large clear spans mean the design is not constrained by the need for intermediate support walls. As your requirements changes over the years, you can reuse, relocate, & modify the structure.

Pre-engineered Metal building concept forms a unique position in the construction industry in view of their being ideally suited to the needs of modern Engineering Industry. It would be the only solution for large industrial enclosures having thermal and acoustical features. The major advantage of metal building is the high speed of design and construction for buildings of various categories.

After doing detailed analysis of Pre -Engineered Building and Conventional Structural Building, it is observed that total saving in overall material and cost reduction resulted as28%.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

REFERENCES

1) IS: 875 (Part 1) – 1987 Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures (Dead Load)
2) IS: 875 (Part 2) – 1987 Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures (Imposed Load)
3) IS: 875 (Part 3) – 2015 Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures (Wind Load)
4) IS 1893(Part 1) –2016 Criteria for Earthquake Resistant Design of Structures 5. IS: 800 – 2007 Indian Standard General Construction in Steel – Code of Practice.
5) Kiran, G. S., Rao, A. K., & Kumar, R. P. (2014). Comparison of design procedures for pre-engineering buildings (PEB): a case study. International Journal of Civil, Architectural, Structural & Construction Engineering (IJCASCE), 8(4), 4
6) Mehendale, A. P., Gupta, A. K., & Desai, D. B. (2016). Overview of Pre-Engineered Buildings. Imperial Journal of Interdisciplinary Research, 2(6), 1421-1425.
7) Sharma, H. (2017). A Comparative Study on Analysis & Design of Pre-Engineered & Conventional Industrial Building. International Journal for Innovative Research in Science & Technology, 3(10).
8) Zoad, M. D. P. (2012). Evaluation of pre-engineering structure design by IS-800 as against pre-engineering structure design by AISC. International Journal of Engineering Research & Technology (IJERT), 1(5), 8.
9) Thakar, J. D., & Patel, P. G. (2013). Comparative study of pre-engineered steel structure by varying width of structure. International journal of advanced engineering technology, 4(3), 56- 62.
10) Aijaz Ahmad Zende, Prof. A. V. Kulkarni, Aslam Hutagi, "Comparative Study of Analysis and Design of Pre-Engineered Buildings and Conventional Frames", IOSR Journal of

Mechanical and Civil Engineering (IOSR-JMCE) ISSN: 2278-1684 Volume 5, Issue 1(Jan. – Feb. 2013), pp 32-43.

11) Shrunkhal V. Bhagatkar, Farman Iqbal Shaikh, Bhanu Prakash Gupta, Deepak Kharta, “A Study on Pre-Engineered Building – A Construction Technique”, International journal of Research and Applications, ISSN :2248 - 9622, Vol. 5, Issue 3, (Part-2) March 2015.
12) http://ncrpb.nic.in Travel Demand Forecast Study, Delhi-Meerut Corridor.
13) http://ncrpb.nic.in Feasibility report of RRTS corridor including escalation and IDC (with Central and State Taxes).
14) http://ncrpb.nic.in Functional Transport Plan for NCR, 2032.
15) A. Purba, The challenge of developing high-speed rail projects: Recent evidence from
16) Y. Ma, W. Dong, M. Zhang, X. Sun, X. Lu, Research on regional rail transit travel planning system based on passenger flow prediction, in: IEEE 23rd International Conference on Intelligent Transportation Systems, Vol. 2020, ITSC, 2020, pp. 1–7, http://dx.doi.org/10.1109/ITSC45102.2020.9294404.
17) Q. Luo, Y. Hou, W. Li, X. Zhang, Stop plan of express and local train for regional rail transit line, J. Adv. Transp. 2018 (2018) http://dx.doi.org/10.1155/2018/ 3179321. [23] L.L. Losada-Rojas, C. Gkartzonikas, V.D. Pyrialakou, K. Gkritza, Exploring intercity passengers’ attitudes and loyalty to intercity passenger rail: Evidence from an on-board survey, Transp. Policy 73 (C) (2019) 71–83, http://dx.doi.org/10. 1016/j.tranpol.2018.10.011.
18) F. Xuemei, J. Zhicai, Exploring the psychosocial factors associated with public transportation usage and examining the gendered difference, Transp. Res. Part A: Policy Pract. 103 (C) (2017) 70–82, http://dx.doi.org/10.1016/j.tra.2017.05.017
19) BS 8110. BS 8110: Part 1,2,3: 1985 – Structural Use of Concrete. British Standards. 1985.
20) S. Jagadeshkannan, V. Vanitha, “Comparison of Various Types of Roofs in PEB”, International journal of Engineering Trends and Technology (IJETT) – Volume 22 Number 8 – April 2015.
21) S.D. Charkha, Latesh S. Sanklecha, “Economizing Steel Building using Pre-engineered Steel Sections”, International journal of Research in CivilEngineering, Architecture & Design Volume 2, Issue 2, April-june, 2014, pp. 01-10.
22) Pradeep V., Papa Rao G., “Comparative Study of Pre Engineered and Conventional Industrial Building”, International journal of Engineering Trends and Technology (IJETT) – Volume 9 Number 1 – March 2014.