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ANALYSIS & DESIGN OF CONVENTIONAL STEEL SHED

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Abstract: Conventional steel buildings or sheds are traditional metal structures constructed by rolled steel sections which are designed individually and fabricated at site using welding and cutting. Now a day's Conventional steel building are replaced by Pre-engineered building. This paper Introduces the Design and Analysis of Conventional steel shed which should be stand for Stability to prevent overturning, sliding or buckling of the structure, or parts of it, under the action of loads. It includes Pratt Type Truss shed design with Crane Loading on the structure and some unpredicted loading, i.e. dead, live, wind & Seismic Loading. Also Create the steel model of designed shed geometry. The Designed is carried out as per IS800-2007, for wind load IS875-part III & for Seismic load IS1893-2002 is Considered.

***Keywords* - Conventional Steel Shed, IS800-2007, IS875-Part III, Pratt type Truss, and bolted joints.**

I. INTRODUCTION

Steel structures are assembly of structural steel shapes joined together by means of riveted / bolted or welded Connections. Steel structures are light weight structures and are extensively used, especially to span large gaps. For single storey industrial buildings, mostly trusses are used as roofs to resist gravity loads. To resist lateral loads and to give lateral stability in horizontal planes, trusses can also be used in walls and horizontal planes. The loads are assumed to be acting only at the nodes of the trusses. Such trusses can be analysed manually by the method of joints or by the method of sections. In this paper whole truss is analysed statically using manual calculations, Excel Design and using Software. Provisions given in IS codes are used to solve the examples. Here focus is only given to truss calculations of Pratt type Truss. In steel structures, a truss is a rigid structure composed of several members joined at their ends. Roof trusses are mostly a part of industrial structures which can be used as auditoriums, workshops, storage houses, ware houses etc. Purpose of providing roof truss is to carry roof dead loads, Live loads and lateral loads due to wind and earthquake. In this study paper, Pratt truss are taken for design. Industrial building is generally classified as braced and unbraced framed structures. In braced buildings, the trusses rest on column with hinges and stability is provided by bracings in three mutually perpendicular planes. The basic function of a bracing is to transfer horizontal loads from frames i.e. loads like wind or earth quake or horizontal surge due to acceleration and breaking of travelling cranes over gantry girders to the foundation. The longitudinal bracing provides stability in longitudinal direction on each longitudinal end provides. The gabble bracing provides stability in the lateral direction. The tie bracing at the bottom chord level transfers the lateral loads (due to wind or earthquake) of truss to the end gabble bracings and similarly the rafter bracing and the bracing system at bottom chords work. Whereas the purlin acts as the lateral bracings to the compression chords of the roof trusses which increases the compression chords design strength. The unbraced frames such as portal frames are the most common type of frames used in industrial building construction because of its simple design, economy, easy and fast erection. This type of frames provides the large utility area with maximum column free space. In such type of structures the inner columns are eliminated, requires considerably less Foundation and its area, the valley gutters and the internal drainage too. The portal frame is a rigid jointed plane made from hot rolled or cold rolled sections, supporting roofing and side cladding.

II. LITERATURE REVIEW

1. **David Alexandre Ferreira Ivo- "Design of a steel structure for a large span roof with emphasis on the verification of bolted connections (July2016)"-** The main objective of the thesis is the conceptual and detailed design of a steel structure for large span roofing by means of lattice girders. These procedures include a conceptual analysis of a proposed roofing system (36x56 meters) as well as the detailed checking of the members and connections in accordance to *EN 1993.* For the purpose of analysis, the structure is modelled with the software SAP2000 as a series of 2D structures, effectively simulating the path of forces in the structure. Regarding the connections, focus is given to detailed design under ultimate limit state of gusset plates as well as spliced plate connections used for chord continuity. Serviceability is evaluated in terms of overall deflection and taking into account the effects of slack recovery.

2. **Dr. S. Biswas- "Design of Large Span Roof Truss under Medium Permeability Condition (2018)"-** RCC structures for covering a larger area become heavy and hence uneconomical. In such cases, steel roof trussed building are used and become economical due to its lighter weight. A 20 metre span steel roof truss is considered in this study. IS: 875 (Part I, II and III) have been considered in the calculation of loadings on roof truss. Finally the analysis as well as design of the roof truss has been carried out by STAAD Pro V8i. Limit State Method is adopted here. A suitable fink roof truss is to be designed for covering an industrial building (45 metre long and 20 metre wide). The building is to be built in New Delhi. Medium permeability condition is used in this study. The trusses are to be spaced at 3 metre intervals. Asbestos cement (AC) sheet is used as roof coverings.

3. **Vivekkumar Vaghela- "Comparative Analysis of Pratt and Howe Truss Considering Different Eave Height and Span"-** In this study paper, Howe and Pratt truss are taken for different spans and eave heights. Four different spans 5m, 10m, 15m and 20 m have taken in to consider with eave height of 5m, 10m, 15m and 20m. Analysis is done using Staad pro software and design for various structural elements like Purlin, Roof Truss, compression member, Tension member etc. were carried out using Microsoft office excel sheet. From various member forces obtained from Staad software, a cost comparison sheet is prepared for pratt and howe truss**.** If height remains constant and span increases, tensile forces and compressive forces are increasing in Howe truss as compared to Pratt truss for Tie beam, Vertical member & Diagonal member.

4. **Vrushali Bahadure, Prof. R.V.R.K. Prasad (January -February 2013)- "Comparison between Design and Analysis of Various Configuration of Industrial Sheds".-** Comparison between various configurations of industrial shed using various types of truss type which gives us that which shed is suitable for the industrial shed and which is more effective in strength and economical point of view. Design of various types of industrial frame by using STAAD-Pro 2007 software which gives us there total design and suitability. A truss is essentially a triangulated system of (usually) straight interconnected structural elements; it is sometimes referred to as an open web girder. The individual elements are connected at nodes; the connections are often assumed to be nominally pinned. The external forces applied to the system and the reactions at the supports are generally applied at the nodes. When all the members and applied forces are in a same plane, the system is a plane or 2D truss. Saw tooth type industrial shed is 65% more economical than portal and A-type frames which means it is economically good.

5. **Milind Bhojkar and Milind Darade (December 2014) on "Comparison of Pre Engineering Building and Steel Building with Cost and Time Effectiveness". International Journal of Innovative Science, Engineering & Technology (IJISET), Vol. 1 Issue 10** They observed that, the Pre-engineered building system is unmatched in its speed and value and that's why they are said to be economical for modern construction. The erection time of the pre-engineered building is 50% of conventional steel building or less than 8 weeks. Clear spans up to 90 meters wide (could be extended up to 150 m in case of Aircraft hangers) and eave heights as high as 30 meters are possible. The cost may be approximate 30% of Conventional steel Building only. The various types of Main frame for the basic supporting component in the PEB systems; main frames provide the vertical support for longitudinal and lateral stability for the building in its direction while lateral stability in the other direction is could be achieved by application of bracing system. The Pre-engineered buildings could be high rise buildings Conventional steel buildings are low rise steel structures with roofing systems of truss with roof coverings. Various types of roof trusses can be used for these structures depending upon the pitch of the truss. For large pitch, Fink type truss can be used; for medium pitch, Pratt type truss can be used and for small pitch, Howe type truss can be used. Skylight can be provided for day lighting and for more day lighting, quadrangular type truss can be used. The selection criterion of roof truss also includes the slope of the roof, fabrication and transportation methods, aesthetics, climatic conditions, etc. Several compound and combination type of economical roof trusses can also be selected depending upon the utility. Standard hot-rolled sections are usually used for the truss elements along with gusset plates.

III. OBJECTIVE

The objectives of structural design is to design the structure for stability, strength and serviceability. It must also be economical and aesthetic. The design of a structure must satisfy three basic requirements:
1) Stability to prevent overturning, sliding or buckling of the structure, or parts of it, under the action of loads,
2) Strength to resist safely the stresses induced by the loads in the various structural members.
3) Serviceability to ensure satisfactory performance under service load conditions - which implies providing adequate stiffness and reinforcements to contain deflections, crack-widths and vibrations within acceptable limits, and also providing impermeability and durability (including corrosion-resistance), etc.
4) Design a structure that is not only appropriate for the architecture, but also strikes the right balance between safety and economy.

IV. COMPONENTS OF ROOF TRUSS

As shown in Figure 1. Shows pratt truss which is normally utilized for span 10 m to 30 m. In Pratt truss, diagonal members are in tension for gravity loads. This truss is utilized where gravity loads are prevalent. Different components of roof truss are shown. Some of the important components which are applicable in this study are defined below:

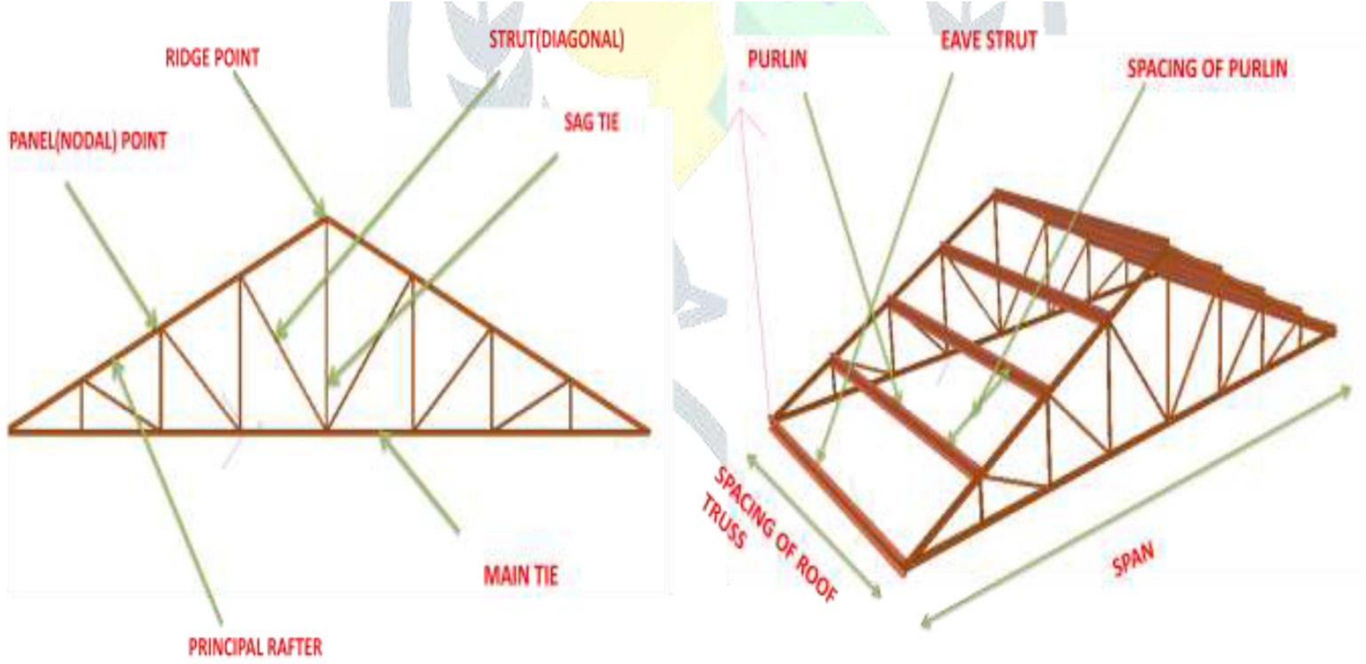

Fig. 1: Components of Roof truss

• Purlins: It is a secondary member which supports the roof covering. In general it is defined as a member supported on the Panel points of two consecutive roof truss.
• Principal Rafter: It is the uppermost diagonal chord of the member just provided beneath Purlin
• Sag tie: It is the central vertical member which is mostly provided to reduce moments and deflection in truss.
• Eave strut: It is a secondary member which mostly supports drain gutters and mostly it is composed of two built-up channels. In general it is defined as the member located at the intersection of roof and exterior wall is known as eave strut.

V. LOADS ON ROOF TRUSS

For analysis of roof truss, different types of loads and Load combinations considered are
Dead Loads: In roof truss, dead loads considered to analyse is confirmed as per IS 875-I (1987). The various loads considered are AC roof sheet, Self-weight of Purlins, Wind bracing weight and Self weight of Roof truss.
Live Loads: Live loads considered is confirmed as per IS 875-II (1987). As it is pitched roof, so slope greater than 100 Live load measured on plan area is taken equal to 750 N/m2 less than 20 N/ m2 for every degree increase in slope over subject to 100 minimum 400 N/ m2. It is calculated as (750-(θ-10)) x 20 N/m2.
Wind Loads: Wind loads considered in analysis of roof truss is confirmed to as per IS 875-III(2015), The wind load, F , acting in a direction normal to the individual structural element or cladding unit is given as F = (C pe – C pi) A pd.
Collateral Load: Collateral load is the weight of additional materials permanently fixed to the building (other than the dead load and the live load of the building) such as fire sprinklers, mechanical systems, electrical systems, false ceilings, partitions, etc.
Crane Load: Crane load is calculated in accordance with Section 6 of the “1996 Low Rise Building Systems Manual” of the Metal Building Manufacturers Association (MBMA). Crane loads and their corresponding vertical, lateral and longitudinal impacts are applied in accordance with the above noted section.
Seismic Load: Seismic load is caused by earthquake forces and is applied horizontally at the centre of mass of the main structure.
Load Combination & Deflection Limits: A load combination results when more than one load type acts on the structure. Building codes usually specify a variety of load combinations together with load factors (weightings) for each load type in order to ensure the safety of the structure under different maximum expected loading scenarios. Allowable deflection is generally expressed as a fraction of the span. A larger number in the bottom of the fraction represents a more stringent limitation.

IS 800-2007
Limit state of serviceability
DL+LL)
(DL+WL/EL)
(DL+LL+CL)
(DL+0.8*LL+0.8*CL+0.8*WL/EL)
Limit state of strength
1.5(DL+LL)
1.5(DL+WL/EL)
0.9*DL+ 1.5*WL/EL
(1.5*DL+1.5*LL+1.05*CL)
(1.5*DL+1.05*LL+1.5*CL)
(1.5*DL+1.05*LL+1.5*CL)
(1.2*DL+1.2*LL+0.6*WL/EL+1.05*CL)
(1.2*DL+1.05*LL+0.6*WL/EL+1.2*CL)

VI. METHODOLOGY

The Design of Conventional shed should be carried out according to following steps.

1. Considered the required data for the shed. and confirm the geometry of the building.
2. Dead load Calculation (due to purlin, roof truss and wind bracing)
3. Live load Calculation
4. Collateral load Calculation
5. Crane Load Calculation
6. Wind Caluclation
   a) Calculation of wind speed
   b) Calculation of wind pressure
   c) Calculation of wind load on individual member.
7. Load Combination
8. Designed sizes of shed and preparing its drawing.

VII. CONCLUSION ON LITERATURE REVIEW

1. Efficient layouts should consider point loads applied only at nodes with diagonals connecting with chords at 35º to 55º. The span more than 20 – 25 meters are often more economical if designed as trusses instead of portal frames.
2. If height remains constant and span increases, tensile forces and compressive forces are increasing in Howe truss as compared to Pratt truss for Tie beam, Vertical member & Diagonal member.
3. Several compound and combination type of economical roof trusses can also be selected depending upon the utility. Standard hot-rolled sections are usually used for the truss elements along with gusset plates.
4. Slope upto 35 deg. is most economical. Gable type Roof have high Suitability.
5. Expected geometry of shed is shown in fig2.

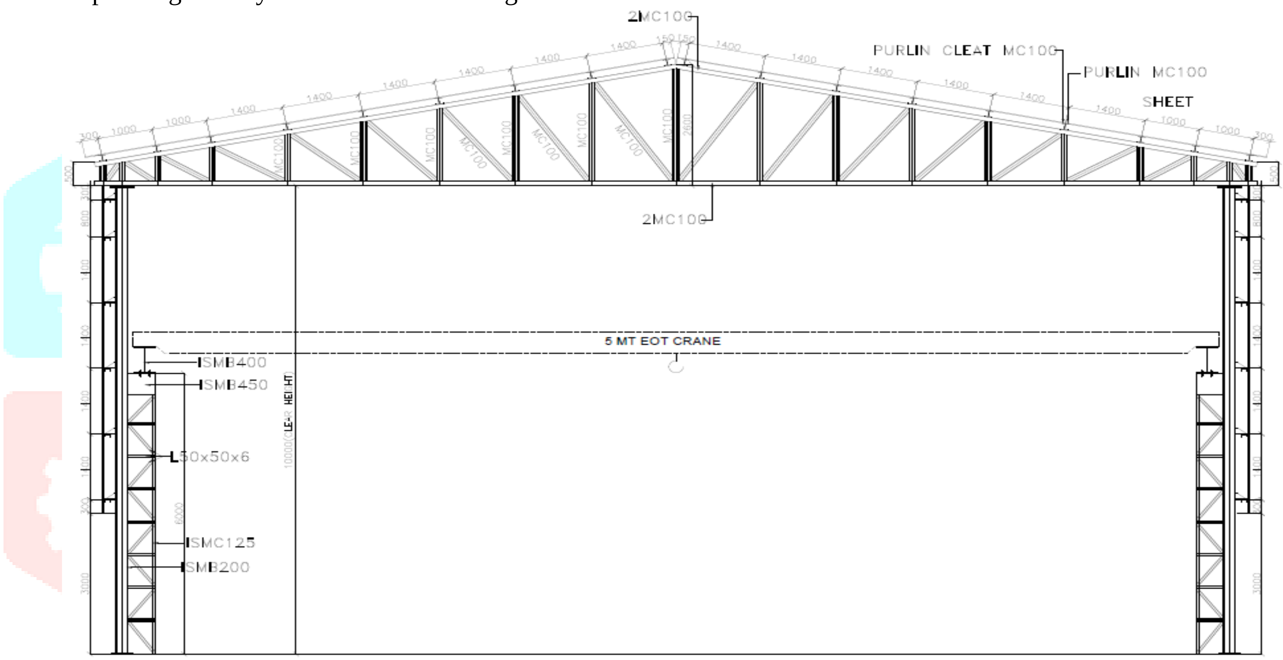

Fig. 2: Expected Geometry of Shed

VII. REFERENCES

[1] David Alexandre Ferreira Ivo- "Design of a steel structure for a large span roof with emphasis on the verification of bolted connections (July2016)"
[2] Dr. S. Biswas- "Design of Large Span Roof Truss under Medium Permeability Condition (2018)"-
[3] Vivekkumar Vaghela- "Comparative Analysis of Pratt and Howe Truss Considering Different Eave Height and Span"
[4] Vrushali Bahadure, Prof. R.V.R.K. Prasad (January -February 2013)- "Comparison between Design and Analysis of Various Configuration of Industrial Sheds".
[5] Milind Bhojkar and Milind Darade (December 2014) on "Comparison of Pre Engineering Building and Steel Building with Cost and Time Effectiveness". International Journal of Innovative Science, Engineering & Technology (IJISET), Vol. 1 Issue 10
[6] IS 800-1984, Code of practice for general construction in steel.
[7] IS 875-1987(part-1) Code of practice for design loads (other than earthquake) for building structures- Dead loads
[8] IS 875-1987(part-2) Code of practice for design loads (other than earthquake) for building structures- Imposed loads
[9] IS 875-2015(part-3) code of practice for design loads (other than earthquake) for building structures – Wind loads
[10] Design of Steel Structure by L.S. Negi L.S
[11] Analysis and Design of Steel Structure by K.S. Sai K.S
[12] Limit State Design of Steel Structure IS 800-2007 by Shah V L et al
[13] Design of Steel Structure by N. Subramanian.
[14] IS456 for R.C.C work.