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COMPARATIVE ANALYSIS AND DESIGN OF AN AIRCRAFT HANGAR FOR AIR BUS A-380 AS A CONVENTIONAL STEEL FRAMED STRUCTURE BY USING AISC AND IS – CODE

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Keywords: conventional steel Building (CSB), AirCraft Hangar design, Air Bus A-380.

Abstract: Convensional steel framed structure is a structure which is used for the purpose of industrial buildings, commercial complexes, ware houses, storage rooms for chemical products,car servicing centres, work shops,laboratories etc. Conventional frame building is commonly abbriviated as C.S.B. In this type of buildings combination of steel members such as hot rolled sections and cold formed sections are used as primary members and secondary members. In this research work two different unique models of steel building for the purpose of maintainence of an airbus A-380 have been designed by using two diffrent design codes namely, indian standard code of practice(IS:800-2007) and american institute of steel construction code of practice(AISC code). Analysis and design have been done to compare the quantity of steel that how much quantity is obtained through IS-code and how much quantity of steel is optimised with the help of AISC code.
Therefore in this research work two unique model using staad-pro software have been designed by taking all three dimentions in to account. For designing the aircraft hangar for airbus A-380 zone-II has been identified and in zone –II place has been selected. Therefore this design has been performed by selecting hyderabad place because in hyderabad minimum wind speed of 44m/s is recorded. In this unique models firstly the dimensions have been finalised as 120m is the front elevation width of the hangar which is usually called as a span of the building and the length of the building is asumed as 115m along y-axis and a clear height of 30m is assumed by keeping in mind the dimensions of the air bus A-380. As the dimentions of airbus A-380 includes the length as 73m(239.5feets),wingspan width is 79.8m(261.8feets) and height 24.1m(79feets). In the airbus A-380 the minimum seating capacity of passengers are 555 members and a maximum capacity of 840 members.

Introduction

In olden days the concept of steel structure was not there, people used to construct their houses with the help of stones, bamboos, and some other material for roofing purpose as in the world when population started increasing day by day and year by year the construction of structures have been improved from lower level to higher level. Due to continuous improvement in the material technology there were many changes in the building materials and construction planning. In early 1960's the concept of load bearing structure was there with wall thicknesses more than that is required later on the composite material commonly known as concrete which was introduced as a universal building material due to its high compressive strength since concrete is very strong in compression but weak in tension so to avoid this tension from the concrete, steel were introduced in the concrete material because of its high tensile strength. The concrete without the steel is known as plain cement concrete and if steel is introduced within the concrete it can be called as reinforced cement concrete. As in this world of population many industries are taking part in manufacturing the products. For storing the products and for making the products in large numbers it required larger place for machineries, so for that reason a huge structure is required to construct for storing and making material. Concrete structures were not suitable for industrial building because of time consuming process later in this world of population a new concept of buildings were introduced called as steel structures. Steel structures include both concrete as for foundation as a sub structure element and steel is used for super structure elements. In super structure we provide columns as a vertical member of the structure and rafters are used as inclined members and gusset plates are used for making the joints between foundation and column and between column to rafters and between rafters to rafters so that it can form a rigid frame. The columns and rafters are joined with the help of anchor bolts. To erect the steel structures we need skilled labours and with the help of lifting cranes the members are lifted up and get erected and roofing materials are provided over the purlins of cold forms sections. For ventilation and exhaust skylights and turbo ventilators are provided.

Literature Review

Asswani M.Kadam, Prashant G.Chavan, Vinod.L.Patil, Pravin.S.Chanvanke, Azim.S.Shaikhi. 2020.“*Load analysis on an aircraft hangar”*. In the above research the authors explains the utility of the steel is increasing day by day particularly in induatrial buildings in the construction industries. Every owner of the industrial buildings want their structure to be ready for use in less time and want estimated cost very less. Thus to achieve the suggested requirement by the clients it essential to use steel to its smaal quantity for that purpose an attempt has been made by studying the modeling and desing has been made for aircraft hangar with maximum dimensions with span width 8.5m and length 78.35m in plan outer to outer distance and depth of roof truss is restricted to 3m. For the above building SAP2000 software is being used. After doing all experimental analysis and design in the SAAP software the authors concludes that usage of PEB reduces the weight of the structure also reduces the dead loads and finally due to reduction in dead loads leads to reduce the size of founadtion so that maximum cost can be saved.

Mayuri Patil, 2019.*“comparative study of analysis and design of pre-engineered building using IS:800-2007 and various international codes”*. From the above title of the research work it explains that the pre-engineered building system is very much advantageous over conventonal structures due to its adaptibility and design optimization process. In this research work a building has been designed at the location pune(maharashtra) for the maximum dimensions such as span width is 15.2m , length of the building is 35m and eave height is 15m. In the design zone –III has been selected with a basic wind speed of 39m/s, wind terrian catagory come under 2, and wind class C, life span will be given as max.50 years from the date of project completion. In this research work the special thing is the slope provided is nill it is just a flat roof due to this we can expect good results that means section properties may be less. This research work involves the values for importance factor for this above building is 1.5 and response reduction factor is identified as 5. The author concludes in her research with the following points. After designing it was found that as per IS:800-2007 due to serviceability criteria deflection limits are higher when compare to any other international codes. The reseaon behind increasing the weight in PEB structure is due to the limiting slenderness value in bracing members. It is also observed in the design that all the sections are classified as plastic, compact, semi-compact and slender whereas in AISC code of practice is was found that all the sections are classified as seismically compact and compact sections. After designing the building using AISC code the tonnage of steel showed less due to its limiting ratios and its serviceability criteria.

Shashank pattan shetti, sachin kulkarni, 2017.*“Comparative study on the economy between pre-engineered building and conventional steel buildings”*. From the above title it is observed that a research work has been done by designing a steel building under the concept of P.E.B and C.S.B to know the quantity of steel consumed by both the building by using a design software called as staad-proV8i and models have been designed in a 3d form and weight comparison done. From the above design for conventional steel building and pre-engineered building the following results have been are obtained as discussed in the table1 below.

Table 1 steel quantity and rate analysis

S.No	Type Of Structure	Columns ,Rafters,Purlins & Girts	Quantity Of Steel Obtained In Kgs	Total Estimated Cost
1.	pre-engineered building system	hot rolled mild sections	21929.114 kg	Rs. 9,86,810.13/-
		hot rolled tube sections	19710.554 kg	Rs.8,86,974.93/-
2.	conventional steel building system	cold form Z-sections	14700.687 kg	Rs.7,86,881.83/-

In the above research it is concluded that the weight of steel for pre-engineered building resulted to be 33% less compared to C.S.B. Indian standard medium weight channels has been replaced to hollow tubes in the research due to which the more 10.10 % of steel has been saved in the design.it has proved that in the research that pre-engineered building is light weight structure when compare to conventional. The following dimensions were considered for the design span of the structure is 12m and length of the structure is 24m and eave height is 6m.

A.Sravan Kumar, Sanjeev Rao, Madan Mohan, Dr.Sreenatha Reddy, 2014. *"design and analysis of pre-engineered induatrial building (PEB)".* In the above title it is mentioned that a real time project for a maximum span width 69m, a maximum length of 173m and a clear eave height of 6m is considered. The building has been designed as a textile building for the manufacturing of various types of clothes by using IS:800-2007 code of steel. For designing the textile building as a pre-engineered building the staad-pro software has been used. It the real time project constructed in the location called ahmadabad, india. The bay spacing is provided as 8m centre to centre and total number of frames are 21out of which 19 frames are in between and 2 frames are starting and ending frame. In this research work the seismic zone is being selected as Zone-III where basic wind speed is recorded as 39m/s and wind terrian catagory is being considered as 2,wind class C , life span of the designed structure is given as 50 years from the year of construction. For the above design the roof slope is given as 1:10,soil type is medium, importance factor 1, response reduction factor is 5. The spacing of purlins is being provided as 1500mm and spacing for girt is designed as 1800mm.
The authors from the above design concludes that this structure after designing has consumed the total quantityof steel as 590 metric tonne and also if the same structure is designed as per CSB norms then the weight of the structure would increase by 30% i.e it will go up to 767 metric tonne.

C.M Meera, 2013,*"pre-engineered building design of an industrial ware house".* This research work explains that the pre-engineered building concept is a latest technology in construction industry and and it is versatile not only in its pre-designing but also in pre-fabrication in workshop itself and directly transfer the materials to the construction site for its erection. In this research work two different models have been design as a P.E.B and C.S.B as a container ware house single storey industrial structure at Ernakulam place in India. The total area of the selected site was 43348m^2 out which built up area is 22979m^2. In this research work number of bays in front face are 4 bays with maximum bay spacing 30m and side face are 16 bays with maximum bay length as 12m each centre to centre and eave height for all the frames is kept as 12m, also the support conditions are assumed in the design software is hinged support. The roof slope for P.E.B is considered to be 5 degree and for C.S.B is considered to be 15 degree. In this research the load calculations have been done according to IS:875-1987 and IS:1893-2000. For this structure the wind load is found to be very critical than earthquake load. The dead load calculations have been performed in accordance with IS:875-1987 (part-1),the live load concept applied in this design by following IS:875-1987 (part-2), and wind load concept is applied by practicing IS:875-1987 (part-3). The basic wind speed in the above design is considered to be 39m/s. after doing analysis and design it is found that in P.E.B structure the quantity of steel material is estimated as 53.221KN and in C.S.B it is estimated as 84.595KN. therefore when it is compared with steel quantity the pre-engineered building is consuming less steel than conventional steel. Hence the above research conveys that PEB structures can easily be designed by simple method by following standard design codes in the given design the author concluded that PEB is advantageous over CSB.

Methodology

The present study includes a design in which a steel building by name conventional steel framed building has been designed by practicing two different codes namely , Indian standard code of practice and american institute of steel construction code of practice to compare the tonnage of steel and cost impact over two buildings. The structural design for CSB first model is in accordance with the specifications of the General construction in steel AISC-2010/MBMA-2012, and wind load applications as per MBMA-2012 and Earth Quake Analysis per IS-

1893(Part-4)-2016. The structural design for CSB second model is in accordance with the specifications of the General construction in steel IS: 800-2007 limt state design method(LSD), and wind load applications as per IS: 875 -2015(Part –III) and Earth Quake Analysis per IS-1893(Part-4)-2016.

Conventional Steel Building

In olden days the concept of building structure was not there, as the population of the world increases day by day it was necessary for human being for leaving their life in a better way to have shelter as a roofing system and to save from weather conditions walls were required so many small structures were come in to existence as the days increased due to lot of development in the various countries in fast construction industries and it was required for manufacturing products and storing purpose R.C.C structures were not feasible at that time and was affecting huge cost of construction. therefore in order to safe the cost of construction, the steel structures was introduced in the early 1960's as structural material for many types of building such as industrial buildings, ware houses, workshops, storage rooms etc. since the steel structure construction was introduced so many engineers were designing steel structure as a hot rolled members as we know that steel structure consists of primary members and secondary members and accessories etc. therefore conventional steel framed structure means all the members are hot rolled sections and are not prepared in the factory it has to make on site and it requires skilled labour and lifting machines etc.

Application Of Conventional Steel Framed Buildings

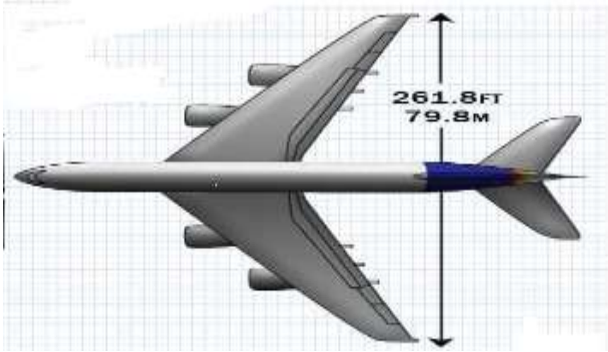
The conventional steel framed building system can be applied to the following steel structures.

1. Industrial Buildings
2. Ware Houses
3. Air Craft Hangars
4. Commercial Complexes
5. Design Offices
6. School Buildings
7. Indoor Stadiums
8. Outdoor Stadiums
9. Metro Stations
10. Parking Lots
11. Stadiums
12. Railway Platforms
13. Bus stops
14. Laboratories
15. Canteens and religious places etc.

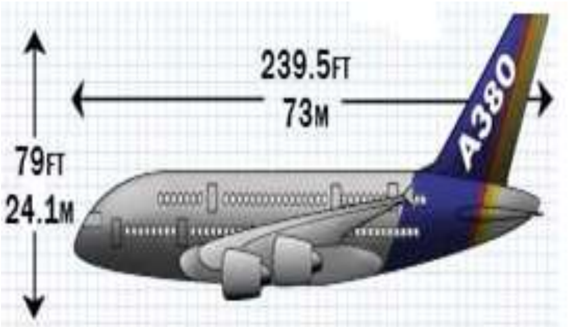
Aircraft Hangar For Air Bus A-380

An aircraft hangar is a steel framed building which is usually constructed in the domestic, national and international airports by taking permission from airport authorities for different countries. Hence it is mandatory for every airport to have this type of buildings so that every aircraft after its journey it has to go for checking its various parts of the aircraft and servicing has to be done for a particular aircraft. For servicing the aircraft we need to see the aircraft maximum dimensions such as its length, wing span and height from bottom of the floor to tail of the aircraft so that other amenities can be planned and we can decide the dimensions of the structure for designing. Hence in this research work a steel building has been designed by providing partly hot rolled members in the structure to avoid the maximum cost. The dimensions for air bus A-380 are shown in the figure below.

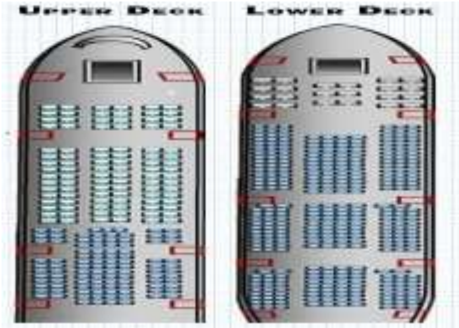
Figure(1) A model of airbus A-380 of scale 1:200



figure(2) wing span dimensions



Figure(3) Longitudinal Dimensions.



Figure(4) Plan And Seating Arrangement For Upper And Lower Deck

From the above figures it is clear that the airbus A-380 consists of two decks one is upper deck and second one is lower deck. The above airbus is a wide body aircraft in which each deck system has been divided in to number classes one is first class seating arrangement consists of 22 number of seats, business class seating arrangement consists of 96 number of seats and in economy class seating arrangement in upper deck is 103 number of seats and in lower deck is 334 number of seats are available. The three dimensions of airbus A-380 are length 73m (239.5feets), wing span width is 79.8m(261.8feets) and height of aircraft from the bottom of the tyre level to the top most level of the tail of airbus is 24.1m(79feets). By keeping in mind the above dimensions a research work has been done for maximum dimensions to design a unique model.

Design Codes

The following design codes have been used in this design of pre-engineered building for an aircraft hangar for airbus A-380.

Table -1 { Design Codes for IS and AISC Code of Practice}

S.No	IS-Codes	Code No's	S.No	Particulars and Codes used in the design
1.	Indian Standard Code of Practice	(IS-800 2007)	1.	Loads on the building are applied in accordance with: MBMA
2.	Indian Standard Code of Practice for Cold Formed Light gauge structures	(IS-801-1975)	2.	Hot rolled sections and Built Up Sections are designed in accordance with: AISC
3.	Indian Standard Code of Practice for Design Loads Part-1	(IS: 875-1987)	3.	Cold formed members are designed in accordance with:AISI

4.	Indian Standard Code of Practice for Design Loads Part-2	(IS: 875-1987)	4.	Welding is applied in accordance with: The Edition (2006) of Structural Welding Code - Steel (AWS D1.1M: 2006) By American Welding Society (AWS).
5.	Indian Standard Code of Practice for Design Loads Part-3	(IS: 875-2015)	5.	Wind Speed is calculated in accordance with:IS 875 (Part 3): 1987 Code of practice for Design Loads
6.	Indian Standard Code of Practice for Earth Quake	IS 1893 (Part-IV) 2016.	6.	Seismic Load Is Calculated In Accordance With:Is 1893 (Part 1): 2002 Criteria For Earthquake Resistant Design Of Structures.

Materials Specifications for conventional building as per IS-Code

The following is the list of the material standards and specifications for which the steel structure components for airbus A-380 have been designed.

Table 2 {Materials Specification and their minimum strength}

S.No	Materials	Specifications	Minimum Strength
1.	**Primary Members**		
	a) Beams & Columns	IS 2062: 2006 Grade E-350 (or) its Equivalent.	F_y = 34.5 kN/cm^2
	b)Tubes	IS 4923: 2017	F_y = 21.0 kN/cm^2
	c) ISMC & ISMB	IS 2062: 2011 Grade E250	F_y = 25.0 kN/cm^2
2.	**Secondary Members – Zee & Cee Sections.**		
	a) Material Finish	G.I – IS 277_2018 or equivalent	F_y = 34.5 kN/cm^2
3.	**Sheeting**		
	a) Bare / Colour coated Galvalume steel	Comprising of 55% aluminum + 43.5% zinc + 1.5% silicon as per ASTM A-755/A-792M	F_y = 55.0 kN/cm^2
4.	**Gutters & Downspouts**		
	Gutters will usually be made from the materials used for Wall sheeting.		
5.	**X-Bracing Members**		
	a)Rods	IS 2062: 2011 Grade E250	F_y = 25.0 kN/cm^2
	b)Angles	IS 2062: 2011 Grade E250	F_y = 25.0 kN/cm^2
6.	Anchor Bolts	IS 2062: 2011 Grade E250 (or) its Equivalent,	F_y = 25.0 kN/cm^2 F_u = 40.0 kN/cm^2
7.	High Strength Bolts (For Primary Connections)	ASTM A 325 (or) its Equivalent	F_u = 83.0 kN/cm^2
8.	Connection Bolts	IS 1367 CL 4.6 (or) its Equivalent	F_u = 40.0 kN/cm^2

Fy = Yield Strength, Fu = Ultimate Tensile Strength

Materials Specifications for conventional building as per AISC-Code

The following is the list of the material standards and specifications for which the steel structure components for airbus A-380 have been designed.

Table 3{Materials Specification and their minimum strength}

S.No	Materials	Specifications	Grade (F_y)
1.	Built-Up Members	ASTM A572 Grade 50 & A570	350 Mpa
2.	Cold Formed Secondary Members	ASTM A1011 Grade 50 / Plain	350 Mpa
		ASTM A 653 Grade 50 / Galvanized	350 Mpa
3.	Hot-Rolled Section	I.S.-2062 E 250	250 Mpa
4.	Sheeting Panels	ASTM A 792 Grade 3450 class 2	345 Mpa
5.	Tubes	IS 1161 for Pipes	240 Mpa
		IS 4923 for RHS / SHS	240Mpa
6.	X- Bracings-Rod	IS:2062 & IS:1161	250 Mpa
7.	Anchor Bolts	I.S. 2062	250 Mpa
8.	High Strength Bolts	ASTM A325 Type1 Electro Galvanized (Grade 8.8)	635 Mpa 12mm-25mm dia
			560 Mpa 25mm-38mm dia
9	Welding	70ksi Electrode	480 Mpa

Design Assumptions

Standard assumptions which are usually used in desiging of conventional buildings as per codes are also used in desiging the hanagar for airbus A-380 in the study.

Structure Configuration Details

The following are the structure configuration details for an aircraft hangar for airbus A-380 as a conventional steel framed building.

Table 4{ Details of Structure Configuration }

S.NO	Description Of Steel Building	DETAILS
1.	BUILDING TYPE	AIRCRAFT HANGAR FOR AIRBUS A-380
2.	WIDTH	120M O/O OF STEEL LINE
3.	LENGTH	115M O/O OF STEEL LINE
4.	ROOF SLO PE	1/10
5.	PEAK RAFTER HEIGHT	30 METER FROM F.F.L
6.	BAY SPACING	1@7.1875mO/C+14@7.1875mC/C+1@7.1875mC/O
7.	ROOF COVER	0.50 mm thick TCT (Bare Galvalume Sheet).
8.	WALL COVER	0.50 mm thick TCT (Pre Painted Galvalume Sheet).

9.	SHEETING CONDITION	
a.	Side walls	Axis A / (1-17): 3.0m Self supporting brick wall and above sheeted.
		Axis Y/ (1-17): 3.0m Self supporting brick wall and above sheeted.
b.	End walls	GL - 1 : 3.0m Self supporting brick wall and above sheeted.
		GL - 17: 3.0m Self supporting brick wall and above sheeted from GL-(A-C) and 0.5m sheeted from eave and open for access from GL-(C-V) and 3.0m Self supporting brick wall and above sheeted from GL-(V-Y).

Design Process And Principles

For designing aircraft hangar for airbus A-380 as a conventional steel framed building we required a design software called staad-pro that means it is a structural analysis and design software. In the staad-pro software the design process and principle is firstly we need an auto-cad software drawings in plan so that we can mark the centre to centre distance after marking the distances we double click the staad pro software then software will show one dialogue box in that we have to provide centre to centre distances. In staad pro software we follow the node system or else we can merge the drawing from Autocad software to staad pro software and we will assign the supports by using support commands and it will be considered as fixed, then we can go for member properties and for CSB building system we provide hot rolled section with the help of node systems we use add beam and add column commands and we assigned the section details. After that we go for loads system and we will create deal load, live load, wind load and seismic loads are not necessary for steel buildings in zone II and this design comes under zone II and then we will assign all the loads system to the frame and then we provide the details for all the remaining frame then we have to run the analysis and need to check for any errors are occurring or not, if it is there then we have to modify the member properties and again we do run analysis till we the degree of precision.

Staad -Pro

The staad pro soft ware is structural analysis and design software used to design the various structures in civil engineering such as reinforced cement concrete structures such as building beams and columns, dams, road bridges etc. by using this software we can perform modeling ,analyzing and we can design the structure. This software supports standards of various countries and it consists of various codes Indian standard code, American institute of steel construction, Euro codes. This software provides various commands in analysis and design of beams and columns. This software is an effective and user-friendly tool for analyzing and designing a three dimensional model and helps in multi-material designs.

Loads Calculations For Conventional Steel 3D Frame

In the present study the following loads have been calculated for CSB structure and found some differences in various loads which are tabulated in the table below.

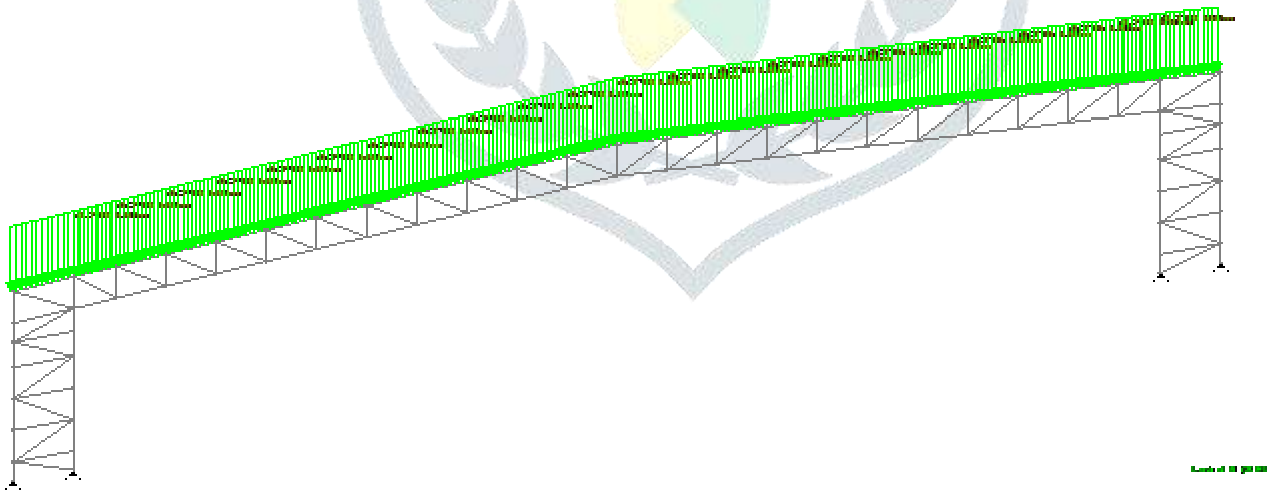
Table 5{loads calculations and its differences }

S.No	IS-Model	S.No	AISC-Model
1.	**DEAD LOAD:** Dead load has been considered as 0.1 kN/m^2 due to weight of sheeting+Purlins and Roof insulation +Self weight of frame.	1.	**DEAD LOAD:** Dead load has been considered as 0.1 kN/m^2 due to weight of sheeting+Purlins and Roof insulation +Self weight of frame.
2.	**LIVE LOAD:** Live load on roof has been considered as - 0.75 kN/m^2	2.	**LIVE LOAD:** Live load on roof has been considered as - 0.57 kN/m^2
3.	**COLLATERAL LOADS:** Light load – 0.15kn/m	3.	**COLLATERAL LOADS:** Nill
3.	**WIND LOAD:** V = 44 m/sec, K1 = 1.00(for 50years). K2 = 1.095 as per IS 875(Part-III)-2015.	3.	**WIND LOAD:** V = 44 m/sec, Wind Exposure-C Importance factor -1.0

	K3 = 1.0 K4 =1.0 Vz = Vb x K1 x K2 x K3 Pz = 0.6(Vz) ^{2} = 1.4 kN/m^2. Pd = Ka x Kd x Kc x Pz Pd = 0.8 x 0.9 x 0.9 x 1.4 Pd=0.90kn/m^2 Internal pressure coefficient = +/-0.5		Roof and wall -Enclosed qh = 0.00256 KzKztKdV2I (Eqn 6-13) qh = 0.00256 x 1.22 x 1.0 x 0.85 x 44 qh = 1.25 kN/m^2. Internal pressure coefficient = +/-0.18
4.	**EARTHQUAKE LOAD:** Earthquake load as per IS 1893(Part-IV) – 2016. Zone-II = 0.10 Importance factor = 1.5 Response reduction factor = 4.0	4.	**EARTHQUAKE LOAD:** Earthquake load as per IS 1893(Part-IV) – 2016 Zone-II = 0.10 Importance factor = 1.5 Response reduction factor = 4.0
5.	**SERVICEABILITY CRITERIA:** i) Main Frame : Vertical deflection : Span / 180 Lateral deflection : Height / 150 ii) Purlins & Girts : Span / 150	5.	**SERVICEABILITY CRITERIA:** i) Main Frame Vertical deflection : Span / 150 Lateral deflection : Height / 100 ii) Purlins & Girts : Span / 150
6.	**PRIMARY LOADS :** i) D.L : Dead Load ii) L.L : Live Load iii) WL : Wind Load with internal coefficient +/- 0.5 iv)S.L : Seismic Load	6.	**PRIMARY LOADS:** i) D.L : Dead Load ii) L.L : Live Load iii) WL : Wind Load with internal coefficient +/- 0.18 iv) E.L : Seismic Load

Analysis And Design as per IS-code and AISC.

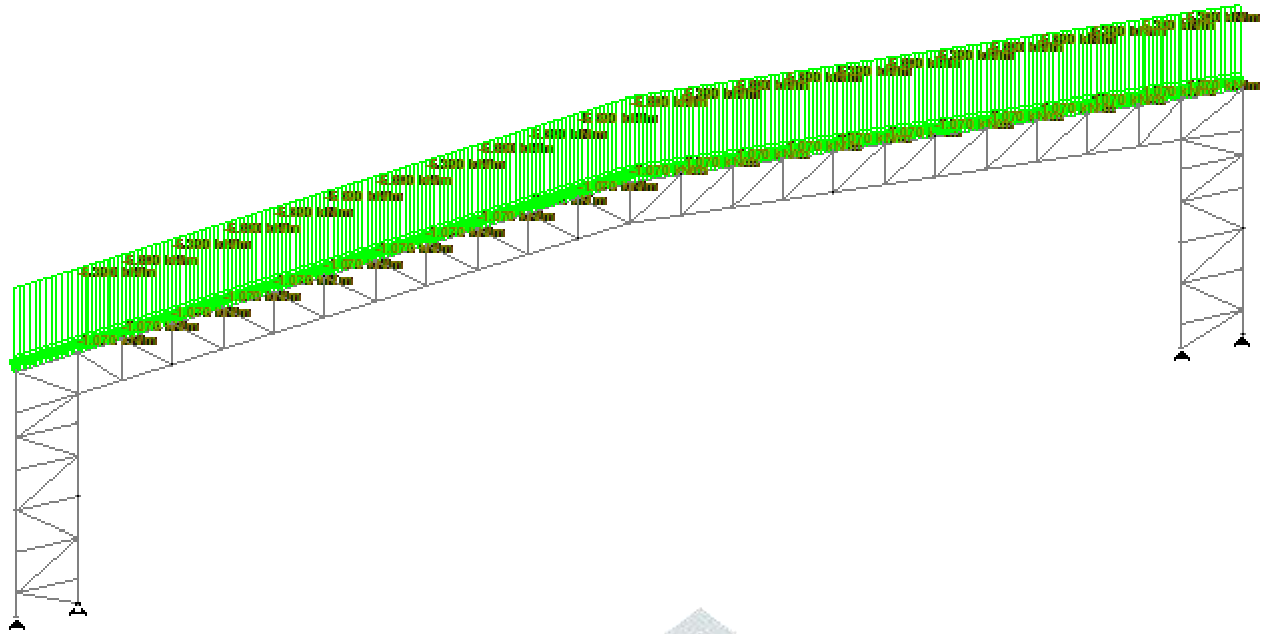
DEAD LOAD – 0.1Kn/m2 = 0.1 x 7.1875 = 0.719Kn/m



Figure(5) Dead Loading Diagram common for both

LIVE LOAD - 0.75Kn/m2 = 0.75 x 7.1875 = 5.391kn/m

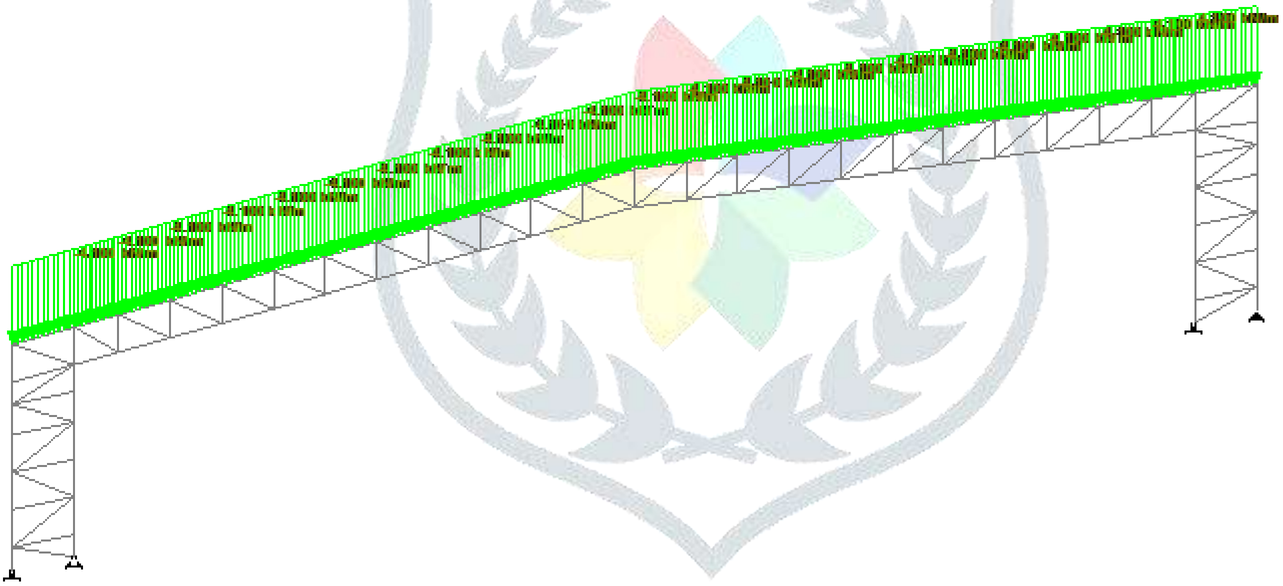
COLLATERAL LOAD - 0.15Kn/m2 = 0.15 x 7.1875 = 1.07kn/m



figure(6) live loading diagram as per IS-code.

LIVE LOAD - 0.57 Kn/m2 = 0.57*7.1875 = 4.1kn/m

COLLATERAL LOAD - 0.0Kn/m^2



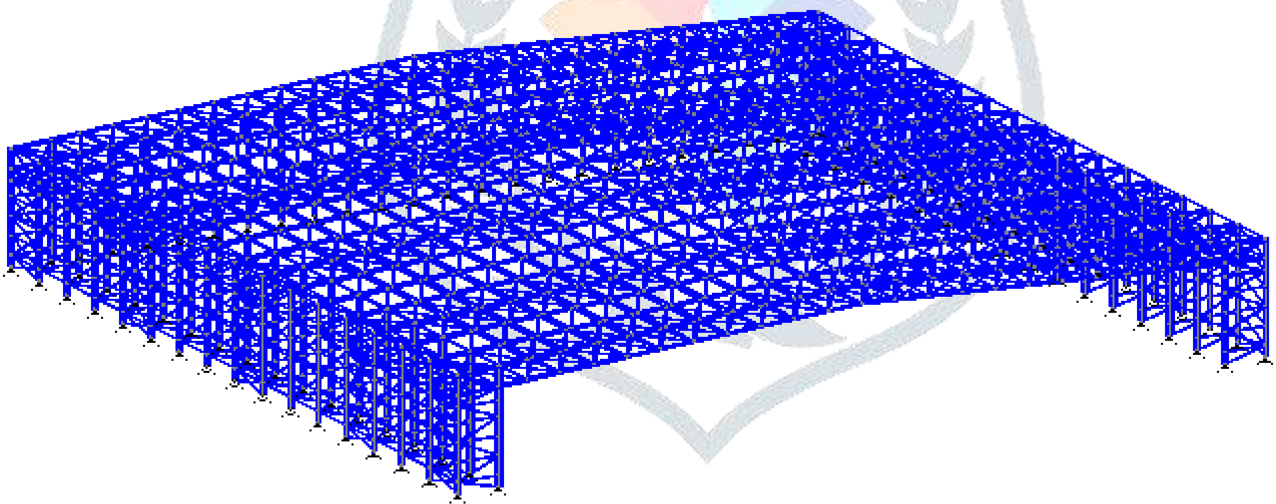
Figure(7) live loading diagram as per AISC code.

Table 6{wind application for IS and AISC model }

<table>
<tr><th>Wind application on staad members for High bay as per IS code.</th><th>Wind application on staad members for High bay as per AISC</th></tr>
<tr><td>H/W=25/ 120 = 0.209
L/W = 115/120 = 0.959
Wind Speed = 44 m/sec
K1 = 1; K2 = 1.095 ; K3 = 1
V_z= 44 x 1 x 1.095 x 1 = 48.18 m/sec
$P_z = 0.6 \times Vz^2 = 1393/1000 = 0.908\ Kn/m^2$
C1 = 0.7
C2 = -0.2
C3 = -0.95
C4 = -0.4
Cpi = 0.5
Ka = 0.8
Kd = 0.9
Kc = 0.9
Design Wind Pressure
$P_d = K_a \times K_d \times K_c \times P_z$
$P_d = 0.8 \times 0.9 \times 0.9 \times 1.4$
$P_d = 0.908 kn/m^2$</td><td>V = 44 m/sec,
Wind Exposure-C
Importance factor -1.0
Roof and wall -Enclosed
qh = 0.00256 Kz x Kzt x Kd x V2I (Eqn 6-13)
qh = 0.0025 x 1.22 x 1.0 x 0.85 x 44
qh = 1.25 kN/m^2.
Internal pressure coefficient = +/-0.18
<table><tr><th>Coefficient</th><th>Bay spacing</th><th>qh</th><th>Load on member</th></tr><tr><td>0.226</td><td>7.188</td><td>1.251</td><td>2.033</td></tr><tr><td>-0.870</td><td>7.188</td><td>1.251</td><td>-7.822</td></tr><tr><td>-0.555</td><td>7.188</td><td>1.251</td><td>-4.992</td></tr><tr><td>-0.477</td><td>7.188</td><td>1.251</td><td>-4.285</td></tr></table></td></tr>
</table>

STAAD MEMBER DIAGRAM

The following diagram shows the various members such as roof truss system ,columns of the frames, and bracings provided in between each frame has been shown in the diagram below which is known as staad member diagram.



Figure(8) staad 3d model

LOAD COMBINATIONS

The following are the load combinations used for the design of steel framed building as per IS- code and AISC model which are tabulated in the table below.

Table 7{load combinations used for IS and AISC model}

S.No	IS-Code Model	S.No	AISC –Model
Load combinations for design and serviceability		Load Combination For Design & Serviceability	
1.	DL+LL	1.	DL+CL+LL, DL+0.6WLL P, DL+0.6WLL S
2.	DL+WL	2.	DL+0.6WLL S, DL+0.6WLR P, DL+0.6WLR S
3.	DL+EL	3.	DL+0.6WLE P, DL+0.6WLE S, (0.6DL+0.6WLL-0.2P)
4.	DL+0.8LL+0.8WL	4.	(0.6DL+0.6WLR-0.2P), (0.6DL+0.6WLR-0.2S)
5.	1.5(DL+LL)	5.	(0.6DL+0.6WLP-0.5P), (0.6DL+0.6WLP-0.5P)

6.	1.5(DL+WL)	6.	(DL+ CL + 0.75LL + 0.75(0.6WLL-0.2P)
7.	1.5(DL+EL)	7.	(DL+ 0.75LL + 0.75(0.6WLR-0.2P)
8.	0.9DL+1.5EL	8.	(DL+ CL + 0.75LL + 0.75(0.6WLL-0.2S)
9.	1.2DL+1.2LL+1.2WL	9.	(DL+ CL + 0.75LL + 0.75(0.6WLR-0.2S)
10.	1.2DL+1.2LL+1.2EL	10.	(DL+ CL + 0.75LL + 0.75(0.6WLP-0.5P)
		11.	(DL+ CL + 0.75LL + 0.75(0.6WLP-0.5P)
		12.	(DL+ CL + 0.75LL + 0.75(0.7EL-VE)
		13.	(DL+ CL + 0.75LL + 0.75(0.7EL+VE)
		14.	(DL+ CL + 0.75LL + 0.75(0.7EL-VE)
		15.	(DL+ CL + 0.75LL + 0.75(0.7EL+VE)
		16	(0.6DL+0.7EL-VE), (0.6DL+0.7EL+VE), (0.6DL+0.7EL-VE).

Node Displacement Summary For IS-Code Design

Postprocessing: Displacements Reactions Beam Results Plate Results Solid Results Dynamics

All Summary

	Node	L/C	Horizontal X mm	Vertical Y mm	Horizontal Z mm	Resultant mm	Rotational rX rad	rY rad	rZ rad
Max X	563	120	19.235	-14.252	32.163	40.095	0.001	0.002	0.003
Min X	543	120	-19.371	-14.282	32.218	40.215	0.001	-0.002	-0.003
Max Y	207	103	-1.640	52.276	-62.756	81.694	-0.006	-0.000	-0.000
Min Y	553	101	-0.047	-172.307	41.283	177.183	0.005	0.000	0.000
Max Z	1442	108	-0.010	-0.130	272.399	272.399	0.000	0.000	0.000
Min Z	1442	109	-0.010	-0.561	-253.978	253.978	0.001	-0.000	0.000
Max rX	1438	108	0.000	0.000	0.000	0.000	0.024	0.000	0.000
Min rX	1438	109	0.000	0.000	0.000	0.000	-0.023	-0.000	0.000
Max rY	159	108	-3.190	-0.348	77.339	77.406	-0.011	0.004	-0.000
Min rY	149	108	3.159	-0.347	77.414	77.479	-0.011	-0.004	0.000
Max rZ	560	101	13.823	-77.863	15.940	80.671	0.000	0.001	0.004
Min rZ	546	101	-13.944	-78.073	15.979	80.903	0.000	-0.001	-0.004
Max Rst	1442	108	-0.010	-0.130	272.399	272.399	0.000	0.000	0.000

Maximum Deflection = 172.307 mm(vertical) ,

Limiting deflection (V/180) = 120.0m/180

= 666.66mm

Hence safe in Deflection

Maximum Deflection = 19.235 mm(Horizontal)

Limiting deflection (H/150) = 25.0m/150

= 166.66mm

Hence safe in Deflections

Node Displacement Summary For AISC-Code Design

Postprocessing: Displacements Reactions Beam Results Plate Results Solid Results Dynamics

All Summary

	Node	L/C	Horizontal X mm	Vertical Y mm	Horizontal Z mm	Resultant mm	Rotational rX rad	rY rad	rZ rad
Max X	1133	101 DL+CL+L	16.407	-1.966	3.329	16.857	0.000	0.001	-0.000
Min X	1119	101 DL+CL+L	-16.423	-1.966	3.324	16.871	0.000	-0.001	0.000
Max Y	205	112 (0.6DL+0.	-0.644	25.577	-33.421	42.090	-0.003	0.000	0.000
Min Y	553	101 DL+CL+L	-0.011	-160.266	39.377	165.033	0.005	-0.000	-0.000
Max Z	1442	107 DL+0.6W	0.387	-0.077	184.538	184.539	-0.002	0.000	-0.000
Min Z	1442	112 (0.6DL+0.	-0.394	-0.247	-182.001	182.001	0.002	-0.000	0.000
Max rX	1438	107 DL+0.6W	0.000	0.000	0.000	0.000	0.017	0.000	-0.000
Min rX	1438	112 (0.6DL+0.	0.000	0.000	0.000	0.000	-0.017	-0.000	0.000
Max rY	153	119 (DL+ CL	0.652	-0.600	70.158	70.164	-0.009	0.002	0.000
Min rY	143	119 (DL+ CL	0.315	-0.647	70.300	70.304	-0.009	-0.002	-0.000
Max rZ	560	101 DL+CL+L	13.695	-73.361	15.242	76.169	0.001	0.001	0.004
Min rZ	546	101 DL+CL+L	-13.717	-73.352	15.243	76.165	0.001	-0.001	-0.004
Max Rst	1442	107 DL+0.6W	0.387	-0.077	184.538	184.539	-0.002	0.000	-0.000

Maximum Deflection = 160.266 mm (vertical) ,

Limiting deflection (V/180) = 120.0m/180

=666.66mm

Hence safe in Deflection

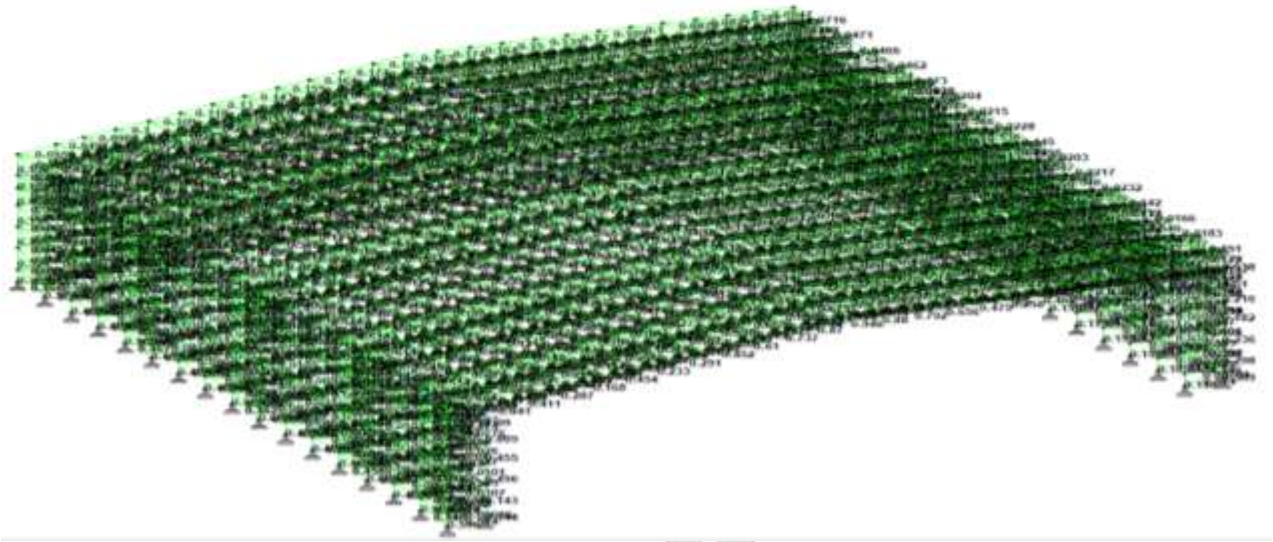
Maximum Deflection = 16.407 mm (Horizontal)

Limiting deflection (H/100) = 25.0m/150

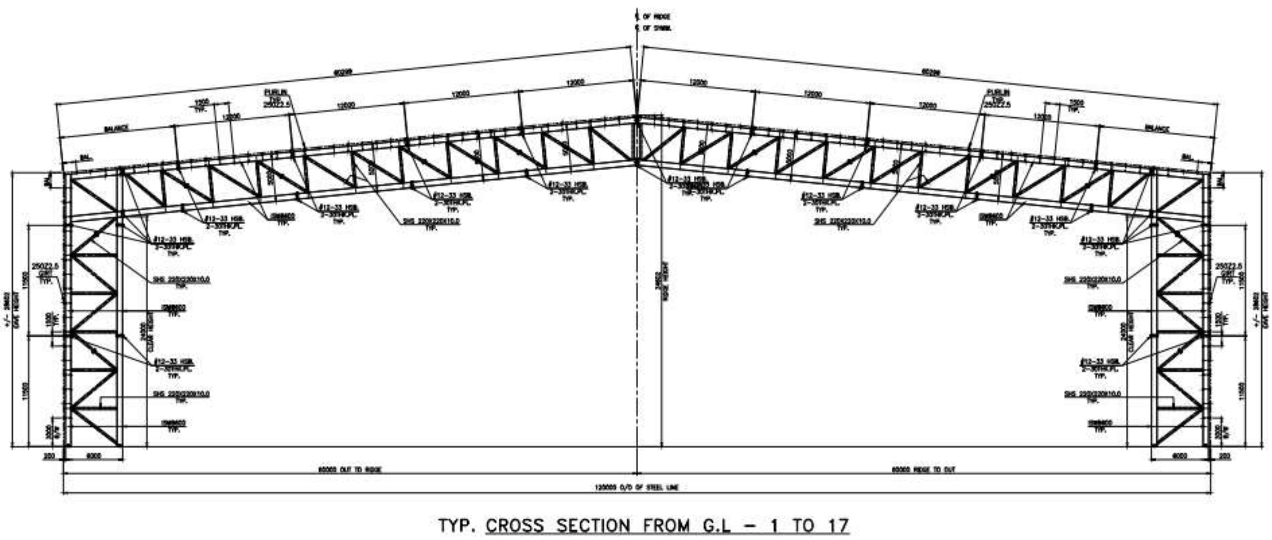
= 166.66mm

Hence safe in Deflection.

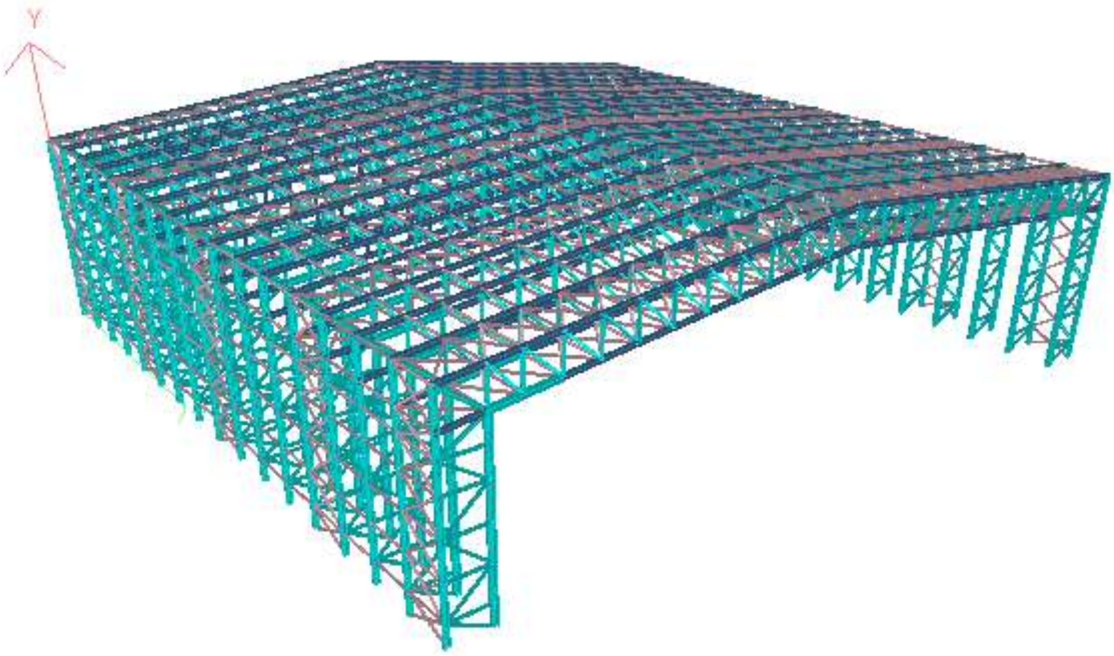
Drawings Of Conventional Steel Framed Building



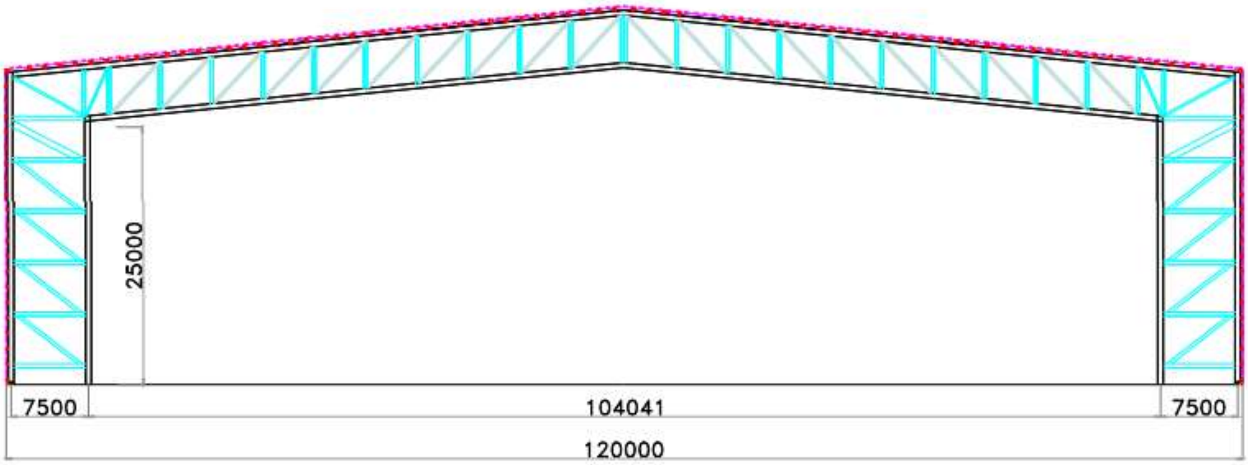
Figure(9) Unity check diagram for airbus A-380 C.S.B hangar



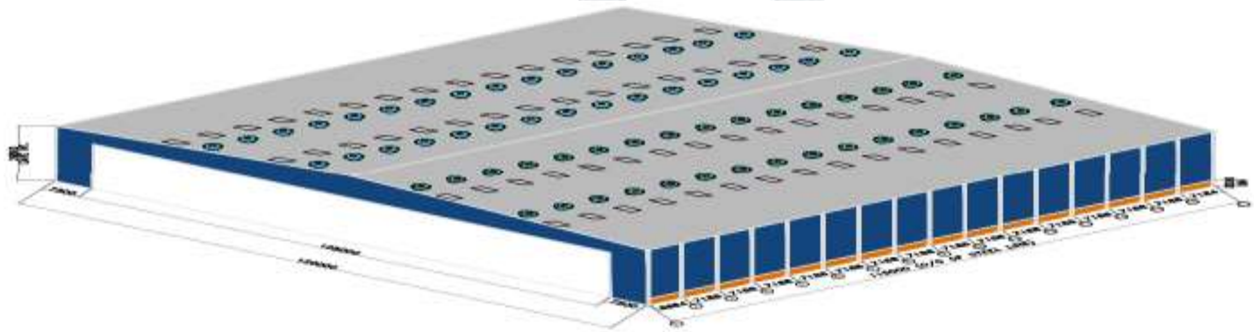
Figure(10). Sectional elevation for air-bus A-380 C.S.B hangar.



Figure(11). Staad model in 3D



Figure(12) front elevation of conventional steel framed building



Figure(13) Architectural 3d drawing

Results And Discussion

The structural analysis and design has been done for airbus A-380 hangar as a conventional steel framed building by considering the maximum dimensions as 120M x 115M x 25 m eave height and 31M clear height as from floor finish level to the top of the frame. For designing the conventional steel frame building hangar staad-pro soft ware has been used. In this design 3d analysis has been done and in the above all the structural details and drawings have been mentioned. The following results have been obtained from this design.

Table(8) {software results and summary}

IS-CODE model				**AISC-CODE model**		
Maximum Displacements in mm				**Maximum Displacements in mm**		
s.no	X-axis	Y- axis	Z- axis	X-axis	Y- axis	Z- axis
1.	19.235mm	-14.252mm	32.163mm	16.407mm	-1.966mm	3.329mm
Rotational Displacements in radians				**Rotational Displacements in radians**		
s.no	X- axis (Rx)	Y- axis (Ry)	Z- axis (Rz)	X- axis (Rx)	Y- axis (Ry)	Z- axis (Rz)
2.	0.001rad.	0.002rad.	0.003rad.	0.000 rad.	0.001rad.	-0.000rad.
Estimated Quantity Of Steel In Metric Tonne for IS-model						
	Primary members hot rolled	hot rolled CHS/SHS	roof sheeting PRP 0.5 thick TCT	wall sheeting PRP 0.5 thick TCT	Anchor Bolts And High Strength Bolts	Total Quantity Of Steel Obtained
3.	2388.88MT	990.02MT	72.39MT	59.45MT	46.6MT	3557.34MT
Estimated Quantity Of Steel In Metric Tonne for AISC-model						
4.	2092.79MT	929.72MT	72.39MT	59.45MT	43.84MT	3198.19MT

Conclusion

Analysis and design in this study yielded the following conclusions;.

1. The structure designed in this research for a maximum dimensions of 120MX115M X 31M as a conventional steel framed building as an hangar for the maintenance of an air bus A-380 has consumed the total quantity of steel as 3557.34MT using IS code and 3198.19MT using AISC code.
2. The above design concludes that the obtained amount of steel mainly depends on primary members and type of purlins of the structure.
3. While designing the conventional steel framed building structure it is seen that when bay spacing is provided between two frames quantity of steel will get decreased but there is a increment in steel for secondary members due to increase in secondary members length.
4. To resist the wind load effect hot rolled members for conventional building can be provided because hot rolled structural members offers better resistance against the wind forces.
5. If we design the structure using AISC code of practice the weight of structural members i.e primary and secondary members is reduced then it may leads to economical sizes for footings and foundations.
6. The aircraft hangar for air bus A-380 designed in this research is a unique design with conventional building design concept in accordance with Indian standard codes and American institute of steel construction code of practice . from the above design it thus obvious that is code is consuming quantity of steel compare to other countries codes due to higher deflection limits.

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