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ANALYTICAL APPROACH IN VARIATION OF THE GEOMETRICAL PARAMETERS ON ROOF TRUSSES

[1]MOHD IRFAN, [2]DR FRANKLIN F R FREDRICK

[1]CIVIL STRUCTURES ENGINEER GLOBAL INSTITITE OF ENGG & TECHNOLOGY

[2]ASSISTANT PROFESSOR GLOBAL INSTITITE OF ENGG & TECHNOLOGY

ABSTRACT

Building used for industry to store unrefined materials or for manufacturing products of industry is called an Industrial Building. The significant components of mechanical structures are purlins, rafters, rooftop support, wind bracings and pillars. These structures are utilized for workshops, factories and so on. Steel is extensively used in the construction of modern structure of large lengths where concrete construction is not practical. Generally have difficulty in terms of location of construction, transport facility, material availability A multi storied modern structure is considered and is properly analyzed and drafted. The study and designing was done by hand. The investigation of structure was done physically and all the auxiliary parts were planned physically. The Industrial Steel truss Building comprise of loads. Loads considered in displaying are self weight, movable loads, wind load alongside the mixes as indicated in IS code. Examination results are watched for pillar base. A metal building that comprise of light gauges metal standing rooftop a steel purlins spacing over between inflexible casings with light measure metal wall cladding. The investigation of a structure commonly includes the assurance of quality caused about by the given load and/or the outer impacts.The project attempt to design and analyse of Warren truss and Fink truss of span 9.144m, height 1.828m with loads such as live load, dead load, lateral load and load combination. As the Indian standards code are use to impose the loads. The geometrical study was to find out efficient roof truss among warren truss and fink truss Later on compare displacement, shear force, bending moment, maximum stresses, maximum cross section in terms column section area, etc.

INTRODUCTION

1.1 Introduction

Steel-confined structures are ordinarily being used for modern purposes. They are ordered into three general classes:

- Warehouse and production line structures.
- Large length stockpiling structures.
- Huge mechanical plant structures.

The design of industrial buildings, load conditions and geometrical factors will dictate the levels of difficulty and hence the economy. In this way, an optimum balance between safety, function and economy can be achieved. Accordingly, as of the best possible result for safety, serviceability and economy requires choosing of suitable truss for installation. The design dimensions of an industrial building are usually determined from a combination of functional and design considerations. Likewise the overall length is usually readily determined by the owner, but the designer should give thought to the optimum bay length. Using various sources to calculate internal and external pressure coefficients for wind loads is studied. Tried many methods like method of joints, method of section and graphical method for finding the forces in truss members but failed in analysing the truss in method of joints and graphical method and finally succeeded in analysing the truss by method of section. Later on calculated many unneeded value due to lack of knowledge.

1.2 Project Study

The design of structure is done as follows.

- In the initial step the arrangement zone is assessed from the overview results.
- Suitable building drawing is produced using AUTOCAD software.
- Depending upon the span, lighting, roofing material, ceiling etc. available type of truss configuration is decided and a line diagram of the truss is prepared by using AUTOCAD software.
- Deepness, pitch and incline of the truss are evaluated as per the code Indian Standard: 875(part-3):1987.
- Unlike weights like movable load, self wt load and Lateral loads are consider by Indian Standard: 875(part-3):1987 code terms.
- The roof truss is analyzed by using manual aided techniques and STAADPRO.
- As per IS code specifications column bases are designed.
- Suitable column section is designed on the basis of the loads.
- At last truss members i.e. purlins, rafters, tie members and splices (connections) are designed.
- The final stage in the project work is development of drawings using AUTOCAD software

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

The chapter involves the discussion of various research papers reviewed for achieving the aim of the project. The following research papers have discussed about behaviour of the steel, analysis and design of truss and industrial building. In this research papers they discussed different methods for analysis and design of truss members. They aimed to design an economical structure with good efficiency to resist the loads.

2.2 Literature Review on Methods for Design and Analysis of Steel Truss

Dr. K. Manjunathan, Sathosh Kuumar C N has made an effort to evaluate the consistency of the elements of a steel truss. Using random values the truss is analyzed by using STAAD PRO. This is done for 100 cycles. Randomness of each member is modeled then after resistance part is modeled. This is done by applying conditions according to Indian standard 800 – 2007, again utilizing Monte Carlo method. The possibility of stresses is considered by limit state to ensure safety in compression and tension failures. The dependability examination of every part is finished by FOSM (1st order second moment) and HFOSM (Higher 1st order second moment) techniques.They concluded that the obtained values of

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reliability analysis by FOSM and AFOSM are almost same when randomness of variables is not considered. If the randomness is considered coefficient of variation of member forces varies from 25% to 35%.

Dr. S. K. Dubey, Prakash Sangamnerkar, Prabhat Soni illustrates the analyzation of steel roof truss under the normal permeability condition of wind according to IS: 875 (part 3.0) – 1986 by allowing for diverse situation. They balance the effect to get with the answers through the SP-38.0 1986. As indicated by Indian Standard Code in which, power of lateral load is determined considering various conditions like class of structure, territory, geography aspect and in our situation. While in SP-38.0 there is no deliberation of unlike circumstances. They concluded that analysis made in SP38:1987 cannot be followed without considering various conditions.

2.3 (a) Literature Review on Design of Joints

Barron Kevin C, Kim Jai B gives a system to build up a semi-inflexible non-straight heel joint model by utilizing the product SAP 2000. A decent understanding exists between exploratory information assembled by heel joint model created. A plan and testing system for metal plate is finished by both TPF (Truss plate foundation) and WTCA (wood truss chamber of America). Finally they conclude that the modeling of non-linear behavior of truss heel joint by using SAP gives very accurate results which correspond to Deierlein predicted response from the Bucknell data determined by Guinther.

N Arlekar, C. V. R. Murthy, Jaswant presents the after-effects of 18 in number pivot steel welded pillar section meeting with Joint reinforcement by utilizing FEM. The associations plan utilized most in steel MRF (moment resist frame). They additionally present a non iterative strategy for plan of beam to strut association utilizing a support for getting associated force, in this they utilizes the plastic pivot. The improved truss model correctly locates the K- truss to start at the end of the connection reinforcement region, which is verified by FEM analysis.

(b) Literature Review on Different Behavior of Steel Trusses

Hitesh K Dhameliya, Jaiprakash B sharma, Yogendra Tandel shows an attempt to compare various trusses with same span, pitch, spacing of truss regarding the weight aspects. The entire truss have been analyzed and designed by STAADPRO, for the span of 20m. Structural enhancement strategies are utilized in design. Influence of span to height of truss keeping all parameters as constant, the least weight is obtained at certain height in which increase or decrease in height of truss leads to loss of economy.

CHAPTER 3
MANUAL DESIGN OF ROOF TRUSS
3.1 Introduction

Steel brackets are generally utilized in high rise industrial structures. They are pre-fabricated to arrange and are made in an open web design. They are axially loaded segments which are highly capable in refraining peripheral loads since the cross segment is evenly stressed. They are widely used mainly to cover large spaces in between simply supported steel columns. Trusses are utilized in tops of single story modern structures, long range floors and tops of multi story structures, to oppose gravity loads.

The benefit of utilizing steel brackets for building is that they are more grounded than wood and more open space inside a structure is conceivable. They are perfect for huge stockpiling structures, warehouses, industrial factories and for commercial structures.

3.2 Selection of Truss

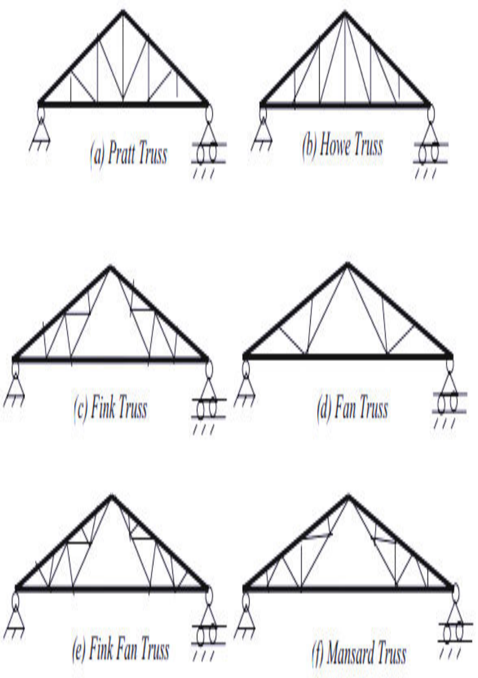

Figure 3.1: Types of Roof Tops.

Most essential sorts of rooftop are pitched rooftop. Wherein the principal rafters is provided with inclination to smooth the process of flow of rain water and removal of snow/dust gathering. These brackets have large depths at the main tie. Because of this despite the total bending moment (BM) is greater at the centre of the joist. The major sling and minor sling have stresses which are near close to main tie and far closer to the supports. The joist span to highest depth ratio of pitch roofs tops are in values of 4 to 8. Longer the span, larger the ratio, results in low economy of rooftops. Pitched roof top might have various formats. In Pratt rooftop [Fig. no: 3.1(a)] minor slings are designed so that under gravity loads, long tie segments experience tension whereas strut segments experience compression. The short members experience strain. Whereas, application of lateral loads causes stress reversal in these segments and obtain equilibrium.

The inverse of Pratt is Howe rooftop [Fig. no: 3.1(b)]. This is mostly utilized in light weight roofs. So that, due to reversed lateral loads, tension is experienced by larger span diagonals.

Fink supports [Fig. no: 3.1(c)] are utilized for larger spans having high pitch roof, since the strut is sub-divided into minor slings.

Fan supports [Fig. no: 3.1(d)] are utilized when the top chord segments of the roof tops must be divided into odd number of panels. A combination of fink and fan [Fig. no: 3.1(e)] can be used to obtain suitable number of panels in most of the cases.

Mansard section [Fig. no: 3.1(f)] are different from fink supports, which have shorter leading diagonals even in larger span rooftops, not like the fink and fan type rooftop.

Finally we selected to the fink truss on the basis of span, lighting, roofing, load distribution, pitch; slope etc., because fink truss is economical for the spans between 6m – 12m. From the drawings the span of truss is 30feets i.e.,

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9.144m. So fink truss is selected because it is a longer span.

3.3 Truss Configuration

- Rectangular area = 2250 sq.ft
- Dimensions = 75′×30′
- Span = 30′ = 9.144m

As per IS code specifications

- Depth (or) height of truss $= \frac{span}{6}$ to $\frac{span}{5}$

Hence,

Height (H) $= \frac{span}{5} = \frac{30}{5} = 6'$

- Pitch $= \frac{height}{span} = \frac{6'}{3'} = 0.2$
- Slope $= \frac{height}{\left(span/2\right)} = 2 \times pitch = 2 \times 0.2 = 0.4$
- Roof inclination (θ) $= \tan^{-1}(slope) = \tan^{-1}(0.45) = 22.8^{\circ}$
- Span of rafter $= \sqrt{\left(\left(\frac{9.144}{2}\right)^2 + 1.8288^2\right)} = 4.924m$
- Measurement lengthwise of each panel $= \frac{4.924}{4} = 1.231m$
- Distance end to end of panel in plan $= 1.251 \times \cos 22^{\circ} = 1.1141m$
- Truss spacing = 15′ = 4.572m
- Area of panel $= 1.141 \times 4.572 = 5.218m^2$

3.4 Design of Structure Member

S. No	Specifications	Results
1	Span of truss	30feet (9.144m)
2	Height	6 feet
3	Roof angle	21.8°
4	Total dead load	3.09KN
5	Live load	2.68KN
6	Wind load	E & F=17.93 KN, G & H=15.7KN
7	Latticed I-section Column	C-channel section ISJC 125 @10.07cm² 6mm flats are connected with 16mm diameter bolts
8	Slab base	Provide 190x140x20mm steel plate
9	Purlins	Provide ISMB 100 @ 1.4m c/c spacing
10	Connection between I-angle and slab base	It requires 6 bolts
11	Connection between I-angle and C-section	It requires 6 bolts
12	Both C-section	It requires 6 bolts
13	Connection of truss members	
	a) rafter	ISA 60x40x8mm,2 bolts of 20mm diameter with gusset plate of 10mm thickness
	b) main tie	ISA 75x45x8mm,2 bolts of 20mm diameter with gusset plate of 10mm thickness
	c) strut	ISA 55x55x10mm,1 bolts of 20mm diameter with gusset plate of 10mm thickness
	d) minor sling	ISA 60x60x8mm,2 bolts of 20mm diameter with gusset plate of 10mm thickness
	e) main sling	ISA 75x50x8mm,2 bolts of 20mm dia with 10millimeter thick plate

3.11 Conclusion

For a span of 30', a pitched roof truss is considered in that fink truss is selected on the basis of span and roof shape. The dimensions of truss are derived from the formulas and code specifications. The shape of the truss is triangular. It consists of 8 panels and 27 members. The length of the rafter is obtained from the triangular law. The area of each panel is determined by considering plan view, in the plan view it look like a rectangle.

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CHAPTER 4

ANALYSIS AND DESIGN OF ROOF TRUSS

4.0 WARREN TRUSS ANALYSIS

4.1 Introduction

Building loads or activities are forces, deformation or acceleration applied to a structure or its parts. Loads cause stresses, deformation and displacement in structures. There are different types of loads acting on commercial structure. Loads vary from location to location depending upon the climatic conditions. The structural loads are as follows:

1. Dead load
2. Live load
3. Wind load
4. Earthquake load

Evaluation of their effects is examined by structural analysis. Mostly, roof top sections can be considered to be joined together in order to transfer the axial forces and not bending moment and shears from one segment to other (they are viewed as being pinned joints). The assumption is made that the loads are applied on the nodes of the roof tops. The rooftops are simply supported over a single span with two end support in which they are statically determinate. Such rooftops can be examined manually by the technique for joints or by the strategy for segments. STAAD Pro is utilized for the examination of rooftop.

4.2 ANALYSIS

Analysis of truss is done by using method of sections and method of joints

4.2.1 Analysis of self weight

Total self weight on each panel = 3.09 kN

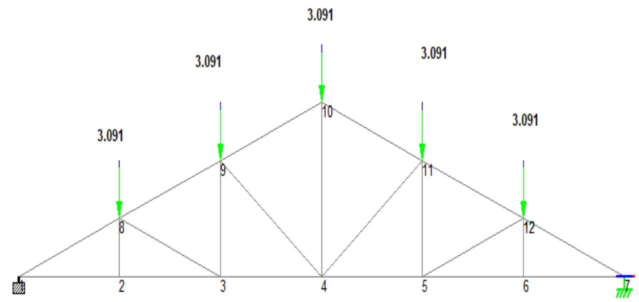

Figure 4.3: Self weight at panel points

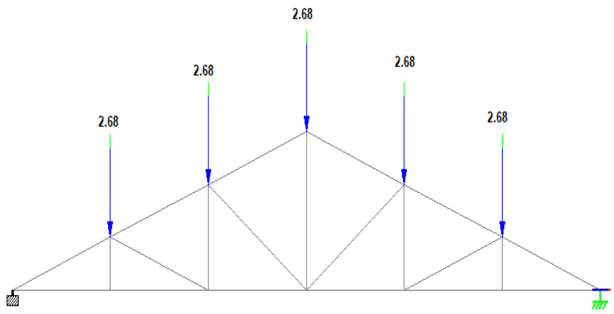

Figure 4.4: Movable loads at panel points

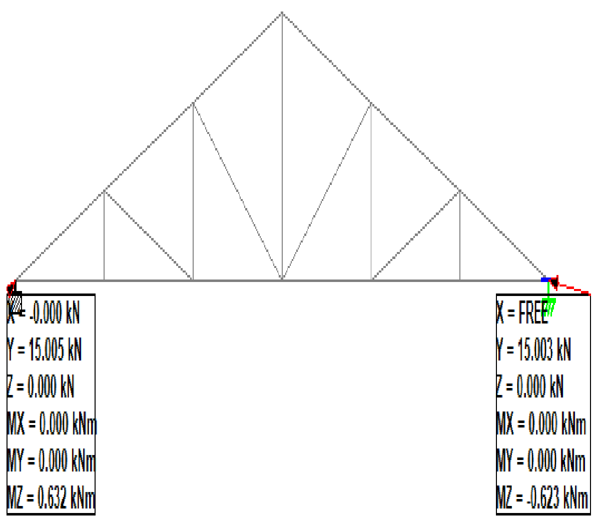

Fig. no. 4.5: Support Reactions

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Table 4.5: Support Reactions

			Horizontal	Vertical	Horizontal	Moment		
	Node	L/C	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
Max Fx	7	1 LOADING	0	15.003	0	0	0	-0.623
Min Fx	1	1 LOADING	0	15.005	0	0	0	0.632
Max Fy	1	1 LOADING	0	15.005	0	0	0	0.632
Min Fy	7	1 LOADING	0	15.003	0	0	0	-0.623
Max Fz	1	1 LOADING	0	15.005	0	0	0	0.632
Min Fz	1	1 LOADING	0	15.005	0	0	0	0.632
Max Mx	1	1 LOADING	0	15.005	0	0	0	0.632
Min Mx	1	1 LOADING	0	15.005	0	0	0	0.632
Max My	1	1 LOADING	0	15.005	0	0	0	0.632
Min My	1	1 LOADING	0	15.005	0	0	0	0.632
Max Mz	1	1 LOADING	0	15.005	0	0	0	0.632
Min Mz	7	1 LOADING	0	15.003	0	0	0	-0.623

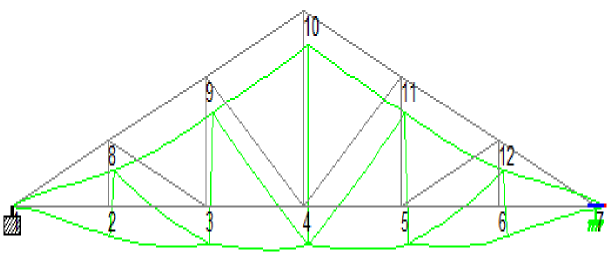

Figure 4.6: Displacements

Table 4.6: Displacement of Members

Beam	L/C	Dist m	x mm	y mm	z mm	Resultant mm	Max z mm	Dist m	Max mm	Dist m	Span/Max
1	1 LOADING	0	0	0	0	0					
		0.381	0	0.764	0	0.764					
		0.762	0	0.586	0	0.586					
		1.144	0	0.117	0	0.117					
		1.525	0	0	0	0					
2	1 LOADING	0	0	0	0	0					
		0.381	0	-1.079	0	1.079					
		0.762	0	-1.407	0	1.407					
		1.144	0	-1.028	0	1.028					
		1.525	0	0	0	0					
3	1 LOADING	0	0	0	0	0					
		0.381	0	-0.528	0	0.528					
		0.762	0	-0.995	0	0.995					
		1.144	0	-0.958	0	0.958					
		1.525	0	0	0	0					
4	1 LOADING	0	0	0	0	0					
		0.381	0	-0.588	0	0.588					
		0.763	0	-1	0	1					
		1.144	0	-0.904	0	0.904					
		1.525	0	0	0	0					
5	1 LOADING	0	0	0	0	0					
		0.381	0	-0.839	0	0.839					
		0.763	0	-1.438	0	1.438					
		1.144	0	-1.315	0	1.315					
		1.525	0	0	0	0					
6	1 LOADING	0	0	0	0	0					
		0.381	0	0.251	0	0.251					
		0.762	0	0.621	0	0.621					
		1.144	0	0.682	0	0.682					
		1.525	0	0	0	0					
7	1 LOADING	0	0	0	0	0					
		0.41	0	0.783	0	0.783					
		0.821	0	0.542	0	0.542					
		1.231	0	0.032	0	0.032					
		1.641	0	0	0	0					
8	1 LOADING	0	0	0	0	0					
		0.41	0	-0.871	0	0.871					
		0.821	0	-1.08	0	1.08					
		1.231	0	-0.747	0	0.747					
		1.641	0	0	0	0					
9	1 LOADING	0	0	0	0	0					
		0.41	0	-0.206	0	0.206					
		0.821	0	-0.296	0	0.296					
		1.231	0	-0.236	0	0.236					
		1.641	0	0	0	0					
10	1 LOADING	0	0	0	0	0					
		0.41	0	-0.12	0	0.12					
		0.821	0	-0.3	0	0.3					
		1.231	0	-0.327	0	0.327					
		1.641	0	0	0	0					
11	1 LOADING	0	0	0	0	0					
		0.41	0	-0.65	0	0.65					
		0.821	0	-1.09	0	1.09					
		1.231	0	-0.983	0	0.983					
		1.641	0	0	0	0					

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12	1 LOADING	0	0	0	0	0					
		0.41	0	0.135	0	0.135					
		0.821	0	0.555	0	0.555					
		1.231	0	0.699	0	0.699					
		1.641	0	0	0	0					
13	1 LOADING	0	0	0	0	0					
		0.152	0	-0.108	0	0.108					
		0.303	0	-0.047	0	0.047					
		0.455	0	0.038	0	0.038					
		0.607	0	0	0	0					
14	1 LOADING	0	0	0	0	0					
		0.303	0	0.133	0	0.133					
		0.607	0	0.001	0	0.001					
		0.91	0	-0.132	0	0.132					
		1.213	0	0	0	0					
15	1 LOADING	0	0	0	0	0					
		0.455	0	0	0	0					
		0.91	0	0	0	0					
		1.365	0	0.001	0	0.001					
		1.82	0	0	0	0					
16	1 LOADING	0	0	0	0	0					
		0.303	0	-0.13	0	0.13					
		0.607	0	0.001	0	0.001					
		0.91	0	0.131	0	0.131					
		1.213	0	0	0	0					
17	1 LOADING	0	0	0	0	0					
		0.152	0	0.122	0	0.122					
		0.303	0	0.056	0	0.056					
		0.455	0	-0.038	0	0.038					
		0.607	0	0	0	0					
18	1 LOADING	0	0	0	0	0					
		0.41	0	-0.828	0	0.828					
		0.821	0	-1.346	0	1.346					
		1.231	0	-1.187	0	1.187					
		1.641	0	0	0	0					
19	1 LOADING	0	0	0	0	0					
		0.487	0	-0.392	0	0.392					
		0.974	0	-0.594	0	0.594					
		1.462	0	-0.494	0	0.494					
		1.949	0	0	0	0					
20	1 LOADING	0	0	0	0	0					
		0.487	0	-0.394	0	0.394					
		0.974	0	-0.598	0	0.598					
		1.462	0	-0.498	0	0.498					
		1.949	0	0	0	0					
21	1 LOADING	0	0	0	0	0					
		0.41	0	-0.827	0	0.827					
		0.821	0	-1.355	0	1.355					
		1.231	0	-1.201	0	1.201					
		1.641	0	0	0	0					

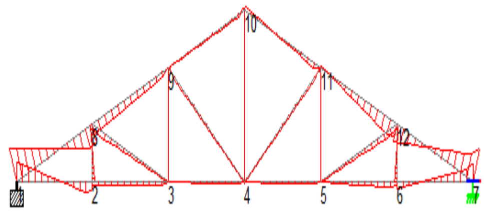

Figure 4.7: BMD of TRUSS

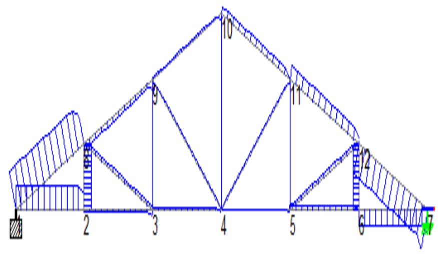

Figure 4.8: SFD of TRUSS

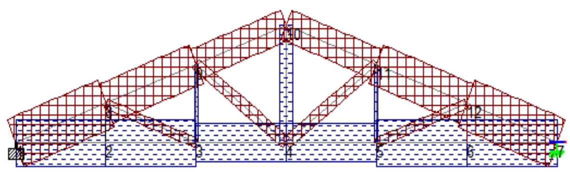

Figure 4.9: AXIAL DIAGRAM of TRUSS

4.5 FINK TRUSS ANALYSIS AND DESIGN

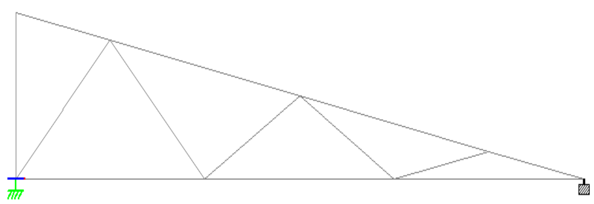

Figure 4.10: FINK TRUSS PANEL MEMBER

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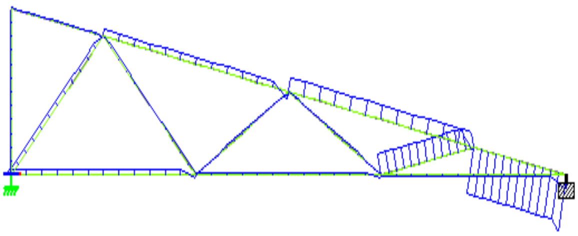

Figure 4.11: SFD OF FINK TRUSS SECTION

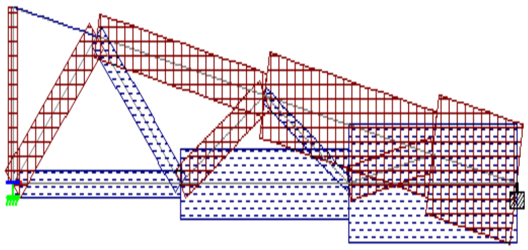

Figure 4.12: AXIAL DIAGRAM OF FINK TRUSS SECTION

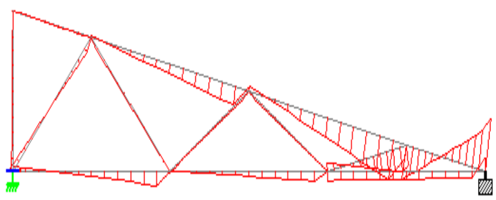

Figure 4.13: BMD OF FINK TRUSS SECTION

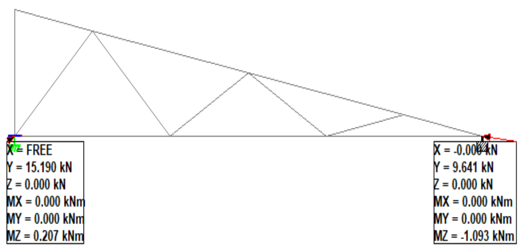

Figure 4.14: END FORCES OF FINK TRUSS SECTION

Conclusion:

DESCRIPTION	WARREN TRUSS	FINK TRUSS
Max displacement	9.059 mm	11.553mm
Max Axial	36.148	42.237
Reactions	Ray=15.005 Maz=0.632 Rby=15.003 Mbz=-0.623	Ray=15.190 Maz=0.207 Rby=9.641 Mbz=-1.093
Max c/s	ISA 75X75X6	ISA 125X125X6
Max Stress	24.573	31.490

CONCLUSION

Conclusion

- Results illustrates that WARREN TRUSS has better results in Displacement, Economy, Stability in terms of Moment compare to FINK TRUSSI
- Latticed column is designed and I-section is provided for column.
- For column design provide 48 ISF 6mm flats at 45˚ and connect them to centre of gravity of channels with one bolt of 16mm nominal diameter.
- A rectangular steel base plate is used for slab base. The dimensions are 190 × 140 × 20 mm. The steel plate is fixed on concrete base with bolted connections.
- I-section of ISMB 100 with 1.4m c/c spacing is provided for purlins.
- 4 bolt of 25mm diameter are provided for connections of L Angle & slab base and L angle & C section and both the C sections.

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