OPTIMIZATION AND RATIONALIZATION OF TRUSS DESIGN

Upendra Pathak[1], Dr. Vivek Garg[2]

[1] PG Scholar, Structural Engineering, Maulana Azad Institute of Technology, Bhopal, India
[2] Assistant Professor, Department of Civil Engineering, Maulana Azad Institute of Technology, Bhopal, India

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Abstract - ***In design of steel trusses different types of geometries (A-type truss, Fink truss, Pratt truss, Howe truss, King post truss, Queen post truss etc) and sections (Angle section, Tube section, Square hollow section etc) are widely used. In present work, roof truss of span 16m has been analyzed for different geometries and sections to get the desired optimum truss design. The design is further optimized for varying slopes of truss. The support conditions (fixed/hinged) and type of connection (welded/bolted) between truss members also effect the forces in truss members. Although in the truss design, it is assumed that purlins are supported on truss joints, but due to specification of roof sheet, there may be a limitation of maximum purlin spacing which may cause the purlins resting on truss members instead of joints. The various truss analyses are performed by using structural analysis software i.e. STAAD Pro. The analysis results are compared to obtain optimum and accurate truss design. The results indicate that A-type truss has lesser weight compared to other truss geometries. The truss consists of tube/square hollow section is having much lesser weight compared to angle section. The optimum truss slope is found nearly 24^0. The truss with rigid connection between members is found heavier than the truss with pin connection. Similarly truss supported on fixed base/purlins resting on truss members causes bending moment in top chord of the truss members which in turn modify the sectional requirement of the members. Hence case specific analysis is necessary for rational solution of truss design.***

Key Words: *Truss optimization, A-type truss, Staad Pro., Member connectivity, Support condition*

1. INTRODUCTION

A roof truss is a framed structure formed by adjoining various members in a particular pattern of triangles depending upon span, type of loading, slope and other requirements. Steel trusses are widely used in industrial buildings for many years. Every structure should have to fulfill the structural and economical requirements. Hence there is need of optimization of truss design to obtain minimum weight. All of the methods used for reducing the weight tend to reach an optimum design having a set of design constraints. The optimum design of a structure should satisfy various constraint limits such as displacement limits, stress and local stability conditions. As it is well known that the optimum shape of a truss depends not only upon its topology, but also upon the distribution of element cross-sectional areas. Different types of geometries (e.g. A-type truss, Pratt truss, Fink truss, Belgian truss), sections (e.g. Angle section, Square hollow section, Tube section, T-section etc), slope of truss, support conditions influence the truss design. The support conditions and connection of members (bolting/welding) also affect the structural behavior. Although purlins are provided on truss joints but due to maximum purlin spacing limitations/field constraints, there may be a situation when purlins are provided on truss members.

Thomas et al. (1977) presented an algorithm encompassing the application of optimization methods to the least-cost elastic design of roof systems composed of rigid steel trusses, web joists and steel roof deck where the systems are normally used in gymnasiums, field houses, warehouses and other public and industrial facilities. The study showed that the design can be formulated as a nonlinear programming problem. The flexibility and generality of the design approach are also demonstrated through the given examples.

Gil and Antoni (2001) presented a method for the identification of the optimum shape and cross sections of a plane truss under stress and geometrical constraints.

The optimization algorithm includes the treatments of constraints using penalty function, optimization of cross section and optimization of nodal coordinates. In the study, the cross section optimization is achieved by the fully stress design (FSD) strategy and the coordinates optimization is driven by the conjugate-gradients strategy. The obtained structures bear loads better by avoiding local failure and reduce the quantity of material needed.

Kusum et al. (2009) proposed a real coded genetic algorithm named MI-LXPM for solving integer and mixed integer constrained optimization problems. The proposed algorithm is a suitably modified and extended version of the real coded genetic algorithm, LXPM, of Deep and Thakur. The algorithm incorporates a special truncation procedure to handle integer restrictions on decision variables along with a parameter free penalty approach for handling constraints. Performance of the algorithm is tested on a set of twenty test problems selected from different sources in literature, and compared with the performance of an earlier application of genetic algorithm and also with random search based algorithm, RST2ANU, incorporating annealing concept.

Kravanja and Zula (2010) presented the simultaneous cost, topology and standard cross-section optimization of single-storey industrial steel building structures. The optimization is performed by the mixed-integer non-linear programming approach, MINLP. The MINLP is a combined discrete and continuous optimization technique. It handles with continuous and discrete binary 0–1 variables simultaneously. While continuous variables are defined for the continuous optimization of parameters (dimensions, stresses, deflections, weights, costs, etc.), discrete variables are used to express different structure/ topology and standard cross-section discrete decisions. The element (the portal frame or purlin) is then selected to compose the structure if its subjected binary variable takes value one ($y = 1$), otherwise it is rejected ($y = 0$). Binary variables also define the choice of discrete/standard cross-sections.

Kalyanshetti and Mirajkar (2012) analyzed modified howe truss of span 24m for different types of sections. This study reveals that tubular sections are economical than any other type of sections used. There is almost 50% to 60% saving in overall cost of truss using tubular section.

Dubey et al. (2013) analyzed the steel roof truss having 12 m span using tubular sections for truss members. The comparative study has been done between design of truss as per revised provisions of wind load calculations given in IS 875 (Part3):1987 and designs obtained as per calculations made in SP 38(S&T):1987. Indian Standard Code IS: 875(Part 3)-1987 includes consideration for different conditions of class of structure, topography factor, enlarged provisions of permeability conditions, Terrain, height & structure size factor and various wind zones. These provisions of wind load calculations are different from the considerations used in SP 38(S&T):1987.

Xiao et al. (2014) proposed a novel fitness estimation based particle swarm optimization algorithm with an adaptive penalty function approach (FEPSO-AP) to handle this problem. FEPSO-AP adopts a special fitness estimate strategy to evaluate the similar particles in the current population, with the purpose to reduce the computational cost. Furthermore, a laconic adaptive penalty function is employed by FEPSO-AP, which can handle multiple constraints effectively by making good use of historical iteration information. Four benchmark examples with fixed topologies and up to 44 design dimensions were studied to verify the generality and efficiency of the proposed algorithm. Numerical results demonstrate that three out of four benchmarks, to which the FEPSO-AP based optimization is applied, delivered the best feasible designs to the author's knowledge. Moreover, the convergence rate of the FEPSO-AP algorithm is quite competitive comparing to other algorithms published in the former literatures.

Shallan et al. (2014) studied an approach based on the genetic algorithm for optimum design of plane and space trusses using nodal deflections as design variable instead of the member sections in addition to the nodal coordinates as constraints. This will reduce the length of genotype as nodes are always less than members in truss and as the range of nodal displacement is less than the range of available steel sections for truss members. In addition, according to loads and configurations the direction of deflection can be expected which reduces the deflection variables to 50% which can improve the calculations. The proposed approach was applied on benchmark problems of 10 bar and 25 bar truss repeated in literature, the proposed approach resulted in more optimized results with less mathematical effort.

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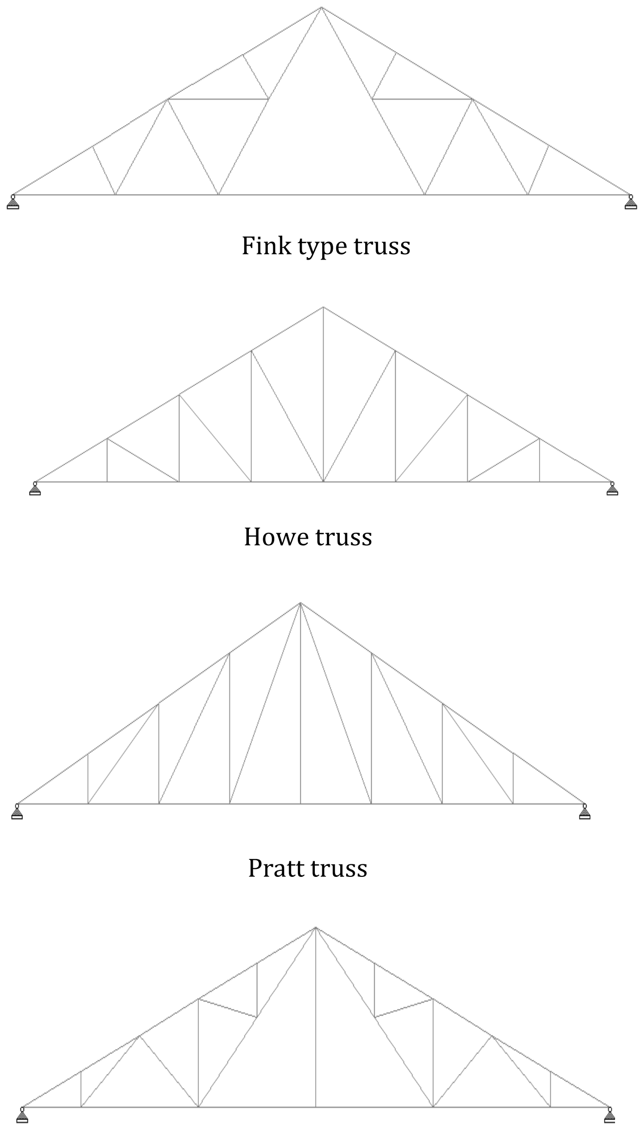
Solanki and Kauswala (2015) presented a Comparative Study of Design of an Industrial Workshop with Pre-Engineering Building. The objective of this paper is to analyze and designs a Pre-Engineered Building (PEB) using cold formed steel 'Z' purlin section and compare it with Conventional Steel Building (CSB) with fink type truss. The objective is achieved by designing a typical frame system of a proposed Industrial Workshop Building using both the concepts and analyzing the designed frames using the structural analysis and design software Staad Pro V8i. By comparing weight wise, it is found that the total weight of PEB Frame including cold form Z purlin comes out to be 30% less that of conventional roof truss including channel purlin. Thus it is concluded that Price per square meter is around 30% lower than conventional steel building due to lighter weight. Moreover heavy foundation is required for conventional roof truss due to heavy loads on column.

The main objectives of this study are as follows:

a) Optimization of different truss geometries for different type of steel sections.
b) Further optimization of truss for different truss slopes.
c) Effect of type of connection between truss members on truss design.
d) Effect of different support conditions on the structural performance of the truss.
e) Effect of purlin position on truss design.

2. MODELLING

Truss with different geometries and sections are made in Staad Pro software to select most optimum truss geometry and section. Different type of truss geometries and sections used in modeling are shown in fig 1 and 2 respectively. Truss is further optimized for various truss slopes. Four truss model having rise 2.5 m, 3.0 m, 3.5 m, 4.0 m are made to obtain optimum truss slope.



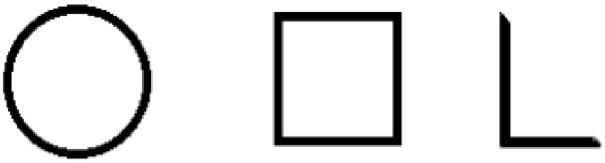
Fink type truss

Howe truss

Pratt truss

A-type truss

Fig.-1: Type of truss geometries



Tube Section Square Hollow Section Angle Section

Fig.-2: Type of sections

Truss model with pin connected and rigidly connected members are made to study the effect of member connectivity on truss design. The effect of different support conditions on the structural performance of the truss is studied by comparing two models of A type truss, one with both end hinged and another with one end fixed and other end hinged.

Two truss models of different purlin position are made to study the effect of purlin position on truss design. In first model purlins are resting on truss joints while in second purlins are located at regular interval of 1.4 m. Parameters used for truss design are depicted in table 1

The trusses have been analyzed for dead load, live load and wind load according to IS:875. Dead load includes the self-weight of the structure, weights of roofing material, weight of purlins. The wind load, F, acting in a direction normal to the individual structural element or cladding unit is:

$$F = (C_{pe} - C_{pi}).A.P_z$$

where, C_{pe} = external pressure coefficient,

(for h/w = 0.375 and $\theta = 26.57^0$, $C_{pe} = \pm 0.7$)

C_{pi} = internal pressure coefficient,

$= \pm 0.2$

A = surface area of structural element

Pz = design wind pressure

Table-1: Parameters for truss design

S.No.	Particulars	Data
1	Span of truss	16 m
2	Spacing between trusses	8 m
3	Location	Bhopal
4	Roofing	Asbestos sheets (dead weight = 171 N/m^2)
5	Self weight of purlin	318 N/m
6	Live Load	750 N/m^2
7	Wind zone	5
8	Basic wind speed (V_b)	39 m/s
9	Probability factor or risk coefficient (k_1)	1.0 (for 50 years)
10	Terrain, height and structure size factor (k_2)	0.96 (for terrain category 2, class B structure and building height 6 m)
11	Topography factor (k_3)	1.0 (for plain land)
12	Design wind speed (V_z)	37.44 m/sec
13	Design wind pressure (Pz)	0.85 KN/ m^2

3. ANALYSIS

The various analyses have been made using a computer program Staad Pro. The different load combinations considered in the analysis are as follows:

1.5 DL + 1.5 LL

1.5 DL + 1.5 WL

1.2 DL + 1.2 LL +1.2 WL

0.9 DL +1.5WL.

The results of various analyses for different geometries, section, member connectivity, support condition and purlin position are compared for optimization and rationalization of truss design. The member numbering and nomenclature of A-type truss is shown in fig.3 and table 2 respectively.

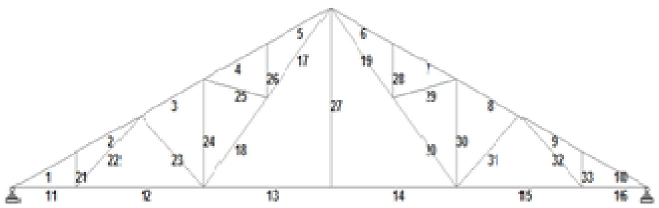


Fig-3 Member numbering in A-type truss

Table-2: Nomenclature of A-type truss members

S.No	Element	Member No.
1	Top Chord (Rafter)	1 To10
2	Bottom Chord (Main Tie)	11 To 16
3	Main sling	17 To 20
4	Struts	21 TO 26 & 28 To 33
5	Web	27

4. RESULT AND DISCUSSION

The results of various analyses for different geometries, section, member connectivity, support condition and purlin position are compared for optimization and rationalization of truss design.

4.1 Optimization for truss type and section

From the analyses results shown in table 3, it is seen that from all four types of truss analyzed, A-type truss is optimum. As far as sections are concerned, tube section and square hollow section gives lesser weight compared to angle section. However square hollow section is adopted for further analysis due to ease in fabrication.

Table-3: Weight of different truss geometries for various steel sections

Truss Geometry	Type of Section	Member Weight (kN)			Total Weight (kN)
		Top Chord	Bottom Chord	Other members	
Fink truss	Angle Section	2.38 (ISA 90×60×6 LD)	2.87 (ISA 100×100× 6 LD)	2.19 (ISA 80×80×6 & ISA 65×45×5)	7.43
	Tube Section	1.54 (TUB OD-101.6,t-3.65)	1.33 (TUB OD-88.9, t-4.05)	1.01 (TUB OD-48.3, t-2.9 & TUB OD-60.3, t-3.65)	3.87
	Square Hollow Section	1.47 (89×89×4.5 SHS)	2.02 (89×89×3.6 SHS)	0.90 (63×63×3.2 SHS & 40×40×3.2 SHS)	4.38
A-type truss	Angle Section	1.86 (ISA 70×70×5 LD)	1.41 (ISA 60× 60×5 LD)	2.12 (ISA 100×100×6 & ISA 70×70×5)	5.50

	Tube Section	1.48 (TUB OD-88.9, t-4.05)	0.91 (TUB OD-76.1, t-3.25)	1.39 (TUB OD-48.3, t-2.9 & TUB OD-60.3, t-4.5)	3.68
	Square Hollow Section	1.51 (75×75×4.0 SHS)	0.92 (63×63×3.2 SHS	1.41 (63×63×3.2 SHS & 45×454×2.6 SHS)	3.83
Pratt truss	Angle Section	2.38 (ISA 90×60×6 LD)	0.65 (ISA 45×45×3 LD)	4.68 (ISA 90×90×6 & 130×130×8)	7.70
	Tube Section	1.54 (TUB OD-101.6,t-3.65)	0.51 TUB OD-48.3 , t-2.9)	2.15 (TUB OD-60.3, t-4.5 & TUB OD-76.1, t-3.65)	4.20
	Square Hollow Section	1.64 (89×89×3.6 SHS)	0.52 (45×45×2.6 SHS)	2.33 (70×70×3.25 SHS & 63×63×3.2 SHS)	4.49
Howe truss	Angle Section	2.34 (ISA 110×110×8 LD)	0.77 (ISA 65×65×5 LD)	4.19 (ISA 130×130×8 & ISA 125×95×6)	7.31
	Tube Section	1.54 (TUB OD-101.6,t-3.65)	0.51 (TUB OD-48.3 , t-2.9)	2.06 (TUB OD-60.3, t-4.5 & TUB OD-88.9, t-3.25)	4.11
	Square Hollow Section	1.64 (89×89×3.6 SHS)	0.52 (45×45×2.6 SHS)	2.02 (70×70×3.25 SHS & 63×63×3.2 SHS)	4.19

4.2 Optimization for slope

Inclination of top chord with the horizontal changes live load and wind load on truss. Hence there is need to analyze the truss for optimum slope. The truss is further optimized for various slopes. The analyses results are shown in table 4 which shows that the optimum slope is 23.63^0.

Table-4: A-type truss with square hollow section for various slopes

S.No.	Rise (m)	Slope (θ)	Member Weight (kN)			Total Weight (kN)
			Top Chord	Bottom Chord	Other Members	
1	4.0	20.56	1.93	1.03	1.18	4.14
2	3.5	23.63	1.60	0.92	1.29	3.81
3	3.0	26.56	1.51	0.92	1.41	3.83
4	2.5	29.35	1.45	0.92	1.68	4.41

4.3 Effect of member connectivity

Truss members can be connected by various modes (bolting, welding etc). Each type of connection has different effect on the performance of truss. Welded connection behaves like rigid connection while bolted connection behaves similar to pin connection. The bending is developed in truss members due to rigidity of connection. In this study pin jointed truss and rigid jointed truss are analyzed and their results are compared. Comparison of designed axial forces in pin connected and rigidly connected members of A-type truss is shown in table 5. The results indicate that there is reversal in the sign of designed axial force in main sling members due to rigidly connecting the members. A significant moment is developed in top chord members of rigidly jointed truss which changes the structural design of truss members.

Comparison of weight in pin connected and rigidly connected members of A-type truss is shown in the table 6. An overall increase in weight of nearly 35% is seen in rigid jointed truss as compared to pin jointed truss. An increase of 70% in weight of top chord members is found in rigid jointed truss compared to pin jointed truss due to change in sectional requirement from 89×89×3.6 SHS in pin jointed

Table-5: Comparison of force between pin connected and rigidly connected member of truss

Member no.	Element name	Pin connection (Bolted)		Rigid connection (Welded)	
		Axial Force (kN)	Moment (kN-m)	Axial Force (kN)	Moment (kN-m)
1	Top Chord	184.40	0.00	180.43	-2.71
2		184.40	0.00	178.76	-2.77
3		143.43	0.00	143.6	0.65
4		157.08	0.00	151.08	-3.25
5		157.08	0.00	147.85	5.38
6		157.08	0.00	147.85	5.38
7		157.08	0.00	151.08	-3.25
8		143.43	0.00	143.6	0.65
9		184.40	0.00	178.76	-2.77
10		184.40	0.00	180.43	-2.71
11	Bottom Chord	20.39	0.00	-33.28	-0.27
12		6.82	0.00	13.78	0.15
13		46.87	0.00	35.83	-0.22
14		46.87	0.00	35.83	-0.22
15		6.82	0.00	13.78	0.15
16		20.39	0.00	-33.28	-0.27
17	Main sling	53.60	0.00	-62.45	0.42
18		40.20	0.00	-52.86	-0.29

19		53.60	0.00	-62.45	0.42
20		40.20	0.00	-52.86	-0.29
21	Struts	16.42	0.00	12.51	0.06
22		18.02	0.00	13.96	-0.03
23		24.94	0.00	25.46	-0.04
24		24.64	0.00	22.17	0.02
25		-12.81	0.00	4.7	0.02
26		16.42	0.00	8.81	-0.13
27		0.00	0.00	0.00	0.00
28		16.42	0.00	8.81	-0.13
29		-12.81	0.00	4.70	0.02
30		24.62	0.00	22.17	0.02
31		24.94	0.00	25.46	-0.04
32		18.02	0.00	13.96	-0.03
33		16.43	0.00	12.51	0.06

Table-6: Comparison of weight between pin connected and rigidly connected member of truss

S.No	Member	Pin jointed truss		Rigid jointed truss		% Change in weight
		Section Adopted	Weight (kN)	Section Adopted	Weight (kN)	
1	Top Chord	89×89×3.6 SHS	1.60	113×113×4.8 SHS	2.72	70.00
2	Bottom Chord	63×63×3.2 SHS	0.92	63×63×3.6 SHS	1.02	10.88
3	Main Sling	63×63×3.2 SHS	0.54	49×49×3.6 SHS	0.46	-15.50
4	Struts	45×45×2.6 SHS	0.64	63×63×3.2 SHS	0.54	4.69
5	Web	45×45×2.6 SHS	0.11	63×63×3.2 SHS	0.20	81.82
Total Weight			3.81		5.15	35.17

4.4 Effect of support conditions

The support condition may change the structural performance of the truss. The comparison of member forces for different support conditions is shown in table 7. The results shows that designed axial force decreases in most of the members of truss resting on one end fixed and other end hinged support compared to both ends resting on hinged support. Due to fixidity of support, the strut members nearby support experiences very less force as compared to forces in members nearby hinged support. The moment in top chord members increases while in bottom chord member decreases except in member 11 which is connected to fixed support.

Table-7: Comparison of forces in truss members for different support conditions

Member no.	Element name	Both end hinged support		One end fixed and other end hinged support		Comparison of analyses	
		Axial Force (KN) (1)	Moment (KN-m) (2)	Axial Force (KN) (3)	Moment (KN-m) (4)	Ratio (3/1)	Ratio (4/2)
1	Top Chord	180.43	-2.71	159.77	12.83	0.89	-4.73
2		178.76	-2.77	153.93	-6.01	0.86	2.17
3		143.60	0.66	138.61	0.78	0.97	1.18
4		151.08	-3.24	141.88	-5.70	0.94	1.76
5		147.85	5.38	136.23	10.05	0.92	1.87
6		147.85	5.38	138.83	10.06	0.94	1.87
7		151.08	-3.24	144.58	-5.87	0.96	1.81
8		143.60	0.66	141.46	0.81	0.99	1.23
9		178.76	-2.77	172.78	-4.94	0.97	1.78
10		175.33	-2.71	175.54	-4.89	1.00	1.80
11	Bottom Chord	33.28	-0.27	15.51	0.72	0.47	-2.67
12		13.77	0.15	11.97	0.10	0.87	0.67
13		35.83	-0.22	31.55	-0.18	0.88	0.82
14		35.83	-0.22	31.55	-0.18	0.88	0.82
15		13.77	0.15	15.77	0.11	1.15	0.73
16		33.28	-0.27	33.21	-0.21	1.00	0.78
17	Main sling	62.45	0.42	50.00	0.34	0.80	0.81
18		52.86	0.12	46.99	-0.19	0.89	-1.58
19		62.45	0.42	53.57	0.34	0.86	0.81
20		52.86	0.12	50.84	-0.20	0.96	-1.67
21	Struts	12.51	0.06	0.50	-0.22	0.04	-3.67
22		13.96	-0.03	0.44	-0.06	0.03	2.00
23		25.47	-0.04	21.47	-0.03	0.84	0.75
24		22.17	0.02	20.51	0.03	0.93	1.50
25		4.70	-0.02	2.03	-0.04	0.43	2.00
26		8.81	-0.13	2.91	-0.17	0.33	1.31
27		0.19	0.00	0.15	0.00	0.79	*
28		8.81	-0.13	2.67	-0.18	0.30	1.38
29		4.70	-0.02	1.84	-0.04	0.39	2.00
30		22.17	0.02	20.53	0.03	0.93	1.50

31		25.47	-0.04	25.77	-0.04	1.01	1.00
32		13.96	-0.03	11.21	0.04	0.80	-1.44
33		12.51	0.06	9.71	0.04	0.78	0.67

Note: * indicated insignificant value

Due to change in support condition of truss, the sectional requirement also changes. The section required for top chord members changes from 113×113×4.8 SHS in case of truss having both end on hinged supported truss to 150×150×5.0 SHS in case of truss having one end fixed and other end on hinged support. The total weight of top chord members is increased by nearly 40%. The overall weight of truss is also increased by nearly 21%.

Table-8: Comparison of weight of truss members for different support conditions

S. No	Member	Both end hinged		One end fixed and other end hinged		% Change in weight
		Section Adopted	Weight (KN)	Section Adopted	Weight (KN)	
1	Top Chord	113×113×4.8 SHS	2.72	150×150×5.0 SHS	3.81	40.07
2	Bottom Chord	63×63×3.6 SHS	1.02	63×63×3.2 SHS	0.92	-9.80
3	Main Sling	63×63×3.2 SHS	0.54	63×63×3.2 SHS	0.54	0.0
4	Struts	40×40×3.2 SHS	0.67	48×48×2.9 SHS	0.75	11.94
5	Web	63×63×3.2 SHS	0.20	63×63×3.2 SHS	0.20	0.0
Total Weight			5.15		6.22	20.78

4.5 Effect of purlin location

Generally in truss design, purlins are provided on truss joints. Due to roof sheet size specifications, there may be limitation of maximum purlin spacing. Due to these limitations, sometimes purlins rest on truss members. In present study, A-type truss having span 16m and height 3.5m is analyzed considering purlins are provided at regular interval of 1.4m. Fig 4 shows A-type truss with purlins resting on top chord members of truss.

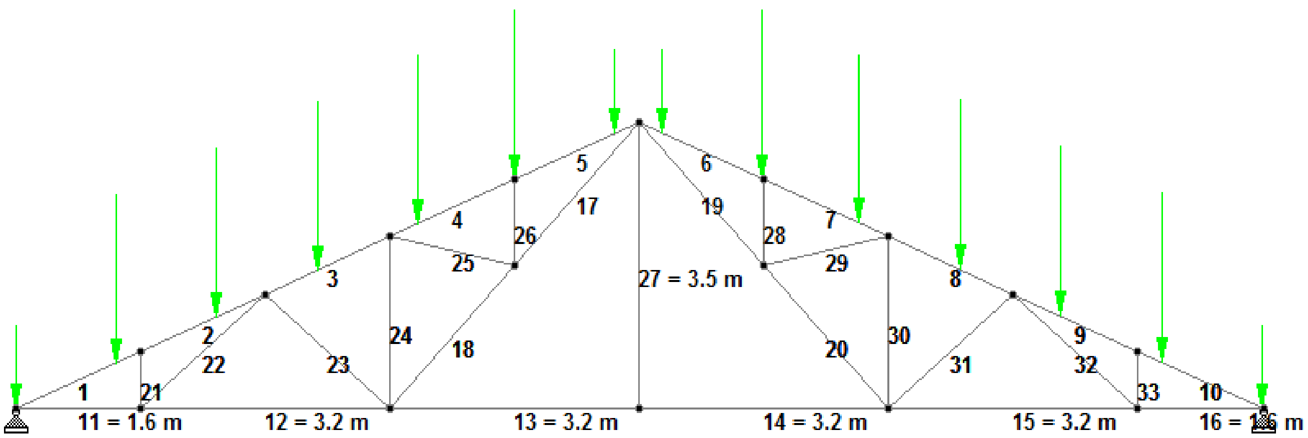


Fig-4: A-type truss with purlins resting on top chord members of truss

The results of analysis of truss with purlins resting on members are compared with that of purlins resting on joints. The comparison of forces for different purlin location is shown in table 9. The results show that there is reversal in sign of designed axial force in main sling members. It changes from tension in case of purlins on members to compression in case of purlins resting on members. Also the value of force is decreased in these members. The moment in top chord members increases significantly compared to other members.

Table 10 shown comparison of weight of A-type truss of different purlin location. The results show that overall weight of truss in case of purlins provided on members is increased by nearly 35% compared to truss when purlins are provided on joints. Weight of top chord is increased by nearly 66%. The sectional requirement of top chord is increased from 113×113×4.8 SHS in case of purlins on joints to 150×150×5.0 SHS in case of purlins on members.

Table-9: Comparison of forces in truss members for different purlin location

Member No.	Element name	Purlins resting on truss joints		Purlins resting on truss members		Comparison of analyses	
		Axial Force (KN) (1)	Moment (KN-m) (2)	Axial Force (KN) (3)	Moment (KN-m) (4)	Ratio (3/1)	Ratio(4/2)
1	Top Chord	180.43	-2.71	200.89	-5.94	1.11	2.19
2		178.76	-2.77	196.91	4.52	1.10	-1.63
3		143.6	0.65	166.57	4.47	1.16	6.88
4		151.08	-3.25	163.53	-7.20	1.08	2.22
5		147.85	5.38	153.89	15.78	1.04	2.93
6		147.85	5.38	153.89	15.78	1.04	2.93
7		151.08	-3.25	163.51	-7.09	1.08	2.18
8		143.6	0.65	166.53	4.46	1.16	6.86
9		178.76	-2.77	196.85	4.51	1.10	-1.63
10		180.43	-2.71	200.04	-5.90	1.11	2.18
11	Bottom Chord	-33.28	-0.27	-36.36	-0.19	1.09	0.70
12		13.78	0.15	-22.69	-0.17	-1.65	-1.13
13		35.83	-0.22	40.88	0.21	1.14	-0.95
14		35.83	-0.22	40.88	0.21	1.14	-0.95
15		13.78	0.15	-22.71	-0.17	-1.65	-1.13
16		-33.28	-0.27	-36.36	-0.19	1.09	0.70
17	Main sling	-62.45	0.42	31.48	-0.10	-0.50	-0.24
18		-52.86	-0.29	29.71	0.06	-0.56	-0.21
19		-62.45	0.42	30.06	-0.10	-0.48	-0.24
20		-52.86	-0.29	29.97	0.05	-0.57	-0.17
21	Struts	12.51	0.06	12.00	0.07	0.96	1.17

22		13.96	-0.03	-17.99	-0.06	-1.29	2.00
23		25.46	-0.04	30.89	-0.06	1.21	1.50
24		22.17	0.02	23.67	0.05	1.07	2.50
25		4.70	0.02	-0.07	-0.07	-0.01	-3.50
26		8.81	-0.13	1.00	-0.20	0.11	1.54
27		0.00	0.00	0.00	0.00	*	*
28		8.81	-0.13	0.14	-0.20	0.02	1.54
29		4.70	0.02	-0.10	-0.02	-0.02	-1.00
30		22.17	0.02	23.68	0.05	1.07	2.50
31		25.46	-0.04	30.91	-0.06	1.21	1.50
32		13.96	-0.03	-17.98	-0.06	-1.29	2.00
33		12.51	0.06	11.98	0.08	0.96	1.33

Note: * indicated insignificant value

Table-10: Comparison of truss weight for different purlin location

S. No	Member	Purlins resting on truss joints		Purlins resting on truss members		% Change in weight
		Section Adopted	Weight (KN)	Section Adopted	Weight (KN)	
1	Top Chord	113×113×4.8 SHS	2.72	150×150×6.0 SHS	4.51	65.81
2	Bottom Chord	63×63×3.6 SHS	1.02	63×63×3.6 SHS	1.02	0.00
3	Main Sling	63×63×3.2 SHS	0.54	48×48×3.65 SHS	0.45	-16.67
4	Struts	40×40×3.2 SHS	0.67	45×45×3.2 SHS	0.76	13.43
5	Web	63×63×3.2 SHS	0.20	63×63×3.6 SHS	0.22	10.00
Total Weight			5.15		6.96	35.15

5. CONCLUSION

In present work the optimization of truss and effect of member connectivity, support condition and purlin location on a truss is studied. The main findings of this study are mentioned below:

1. A-type truss is having lesser weight compared to other truss geometries (fink truss, howe truss, pratt truss). A significant reduction in weight of truss is found by using Tube/Square Hollow Section compared to angle section. The optimum truss slope is nearly 24^0.
2. The rigid connection between trusses joint develops the bending moment in truss members which changes the structural requirements of the truss members.
3. The fixidity of the support causes bending moment in top chord members of truss therefore section requirement of top chord increases. The overall weight also increases.
4. In case when purlins are located on top chord of truss members, designed axial force and bending

moment increases significantly in top chord of truss members.

The present study shows that type of connection between truss members, support condition and purlin location on truss changes the structural performance of the truss. Hence case specific analysis is necessary for rational solution of truss problem.

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BIOGRAPHIES

Upendra Pathak,
Post Graduate Student, Civil Engineering Department,
MANIT, Bhopal,
Madhya Pradesh, India

Dr. Vivek Garg,
Assistant Professor,
Civil Engineering Department,
MANIT, Bhopal,
Madhya Pradesh, India