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Comparison Between Conventional Steel Structures And Tubular Steel Structures

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ABSTRACT

Most of the steel structures are builted-up with conventional sections of steels which are designed and constructed by conventional methods. This leads to heavy or uneconomical structures. Tubular steel sections are the best replacements to the conventional ones with their useful and comparatively better properties. It is obvious that due to the profile of the tube section, dead weight is likely to be reduced for many structural members .which derives overall economy. This study is regarding the economy, load carrying capacity of all structural members and their corresponding safety measures. Economy is the main objective of this study involving comparison of conventional sectioned structures with tubular sectioned structure for given requirements. For study purpose superstructure-part of an industrial building is considered and comparison is made. Study reveals that,upto 40 to 50% saving in cost is achieved by using tubular sections.

Key words -,IS 800,IS 806,IS 875, Tubular sections.

1.0 INTRODUCTION

This study is about designing components of industrial buildings using conventional steel sections, square tube, circular tube and rectangular Tube sections and assigns most suitable section according to its dead weight and ease of connection methods. Experimental and theoretical studies have been carried by, S. Poonaya, U.Teeboonma, C.Thinvongpituk [9] regarding plastic collapse analysis of thin walled circular tubes subjected to bending. Design of circular steel arch with hollow sections is presented by C.A. Demopoulos, C.J. Gantes [10] , they have suggested that Tubular sections are an economical, efficient and strong alternative to conventional sections used in steel structure.

1.1 ADVANTAGES OF TUBULAR SECTIONS:

1. For tubular sections, higher strength to weight ratio could result in upto 30% savings in steel .
2. Due to the high torsional rigidity and compressive strength, Tubular sections behave more efficiently than conventional steel section.
3. For dynamic loads tubes have higher frequency of vibration than any other rolled section.
4. Ease of maintenance.
5. Free from sharp edges.
6. Ease of fabrication and erection.

2.0 PROBLEM:

To determine the effectiveness of tubular sections an industrial shed is considered Analysis and design is carried out using conventional steel sections and tubular steel sections. In tubular circular, rectangular and square shapes are considered. Cost comparison is made for all above sections.

Following data is considered for analysis and design of industrial shed.

Data for Industrial building

1) Plan area around:- 800 sq.m.
2) Location: - Solapur, MIDC Area, Maharashtra –India.
3) Roof truss:- Modified Howe type
4) Geometry of truss:- span 24 m,θ=16.26˚,
5) 10 panel Points spacing of purlins 1.425 m.
6) Length of sheet=3.05m, sloping length=12.5 m.
7) Spacing of truss = 5m, No of trusses = 8

Configuration of truss is shown in fig 1.

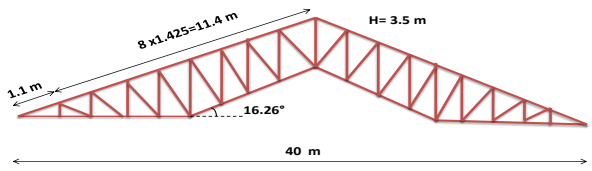


Figure1: Geometry of truss

3.0 APPROACH:

1. Dead load analysis is done according to IS 875 (Part1) with the help of STAAD-PRO
2. Live load analysis is done according to IS 875 (Part2) with the help of STAAD-PRO

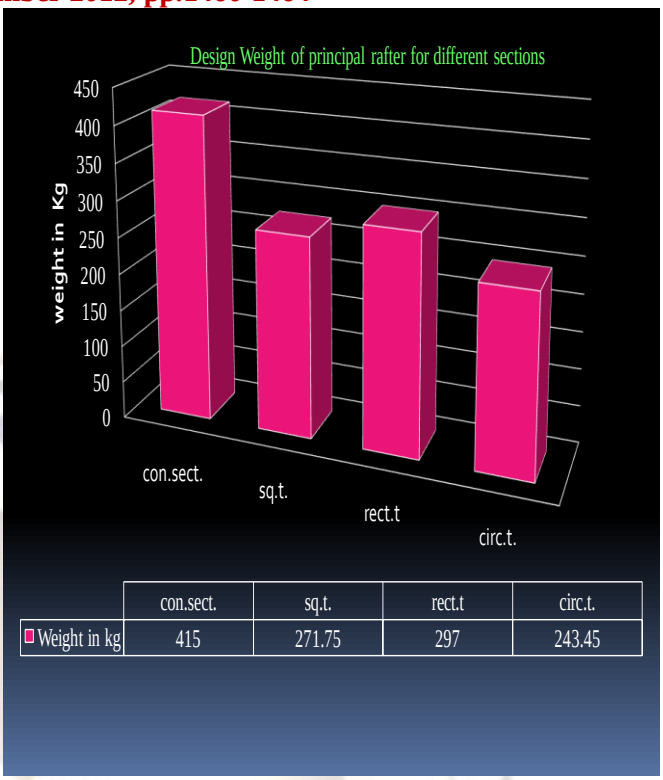
3. Wind load analysis is done according to IS 875 (part 3) with the help of STAAD-PRO
4. Designing is done according to IS 800,IS806 and STAAD PRO
   Conventional design is carried out as per IS 800 and tubular sectioned design is carried out as per IS 806.

4.0 RESULTS AND DESCUSSIONS

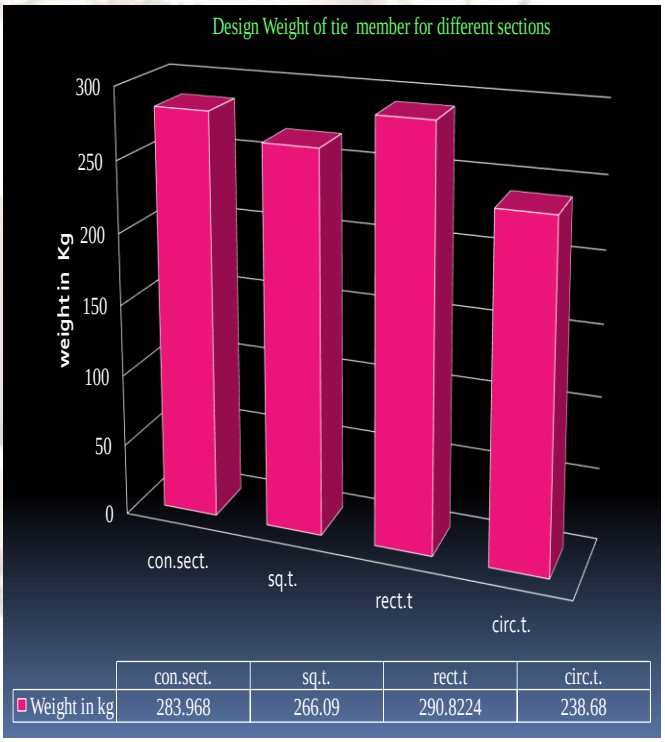
A) Total Dead Load.
1) On central purlin =3.133 kN
2) On intermediate purlin=2.8318 kN
3) On end purlin=1.5133 kN
B) Total Live Load
1) On central purlin =2.849 kN
2) On intermediate purlin=2.5241 kN
3) On end purlin [1.1]/2 x cos16.26x 5x0.41653= 1.099kN
C) Total Wind Load
1) On central purlin= -7.5981 kN
2) On intermediate purlin=-6.533 kN
3) On end purlin=-2.846 kN

Using above results design is carried out for required load carrying capacity. Optimum sections are assigned to truss members and purlin members.Comparison is made for self weight and cost of various elements of truss such as principal rafter,tie member,strut member, sling member, purlin member. Results for single truss are presented graphically in graph 1 to graph 5. These results shows that considerable amount of saving is achieved using Tubular sections
Also analysis is carried out for total shed area of 800 sq.m. consisting 8 numbers of trusses. In this case also comparison is made for various elements of truss. Results are presented in tabular form i.e. table 1 to table 5. Study reveals that considerable saving in cost can be achieved by using tubular sections.

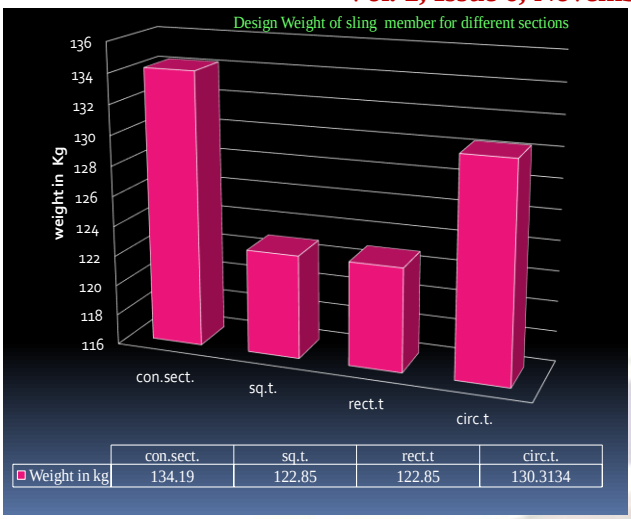
Graph 1. Variation of design weights for principal rafter of Modified Howe Truss



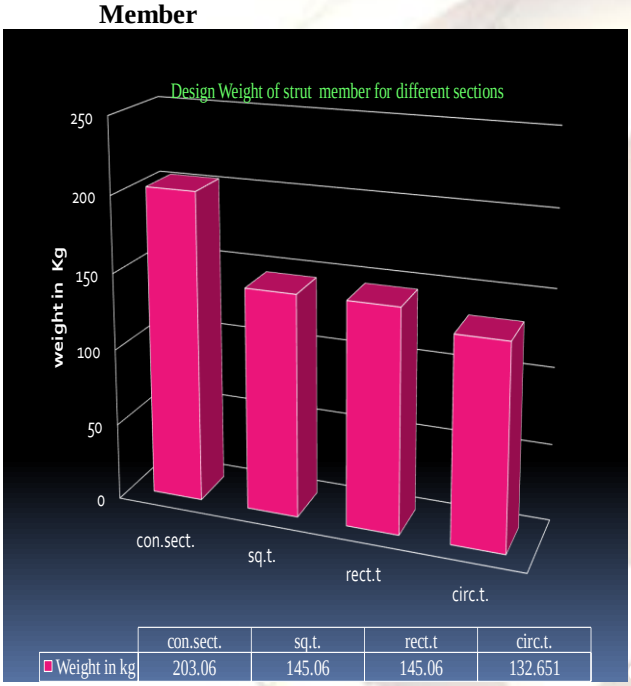
Graph 2. variation of design weights for Tie Member of Modified Howe Truss



Graph 3. variation of design weights for sling member



Graph 4. variation of design weights for Strut Member



Graph 5. variation of design weights for Purlin Member

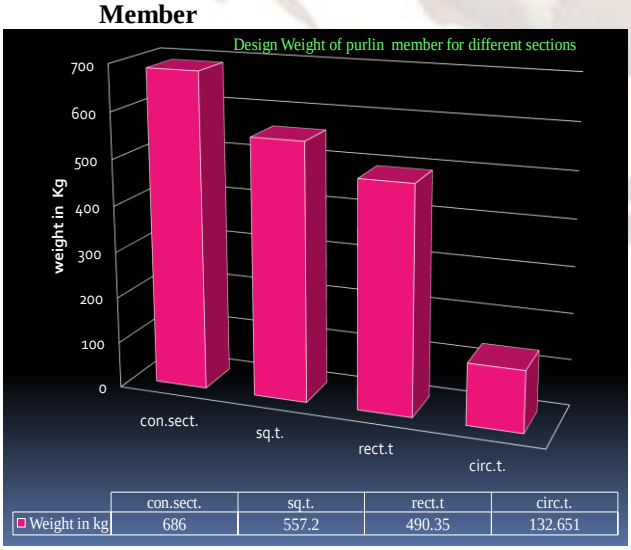


Table 1: comparison for principal rafter

section	conventional	Square Tube	Rect.tube	Circ. tube
Section	2ISA65x65x6	80x80x4.8	122x61x4.5	O.D.114.3.7, N.B.100 ,t=3.6
Weight in kg/m	2x14.9=29.8	9.66	11.88	6.42
Wight for 8 trusses(kg)	3814.4	1236.4	1520.64	822.08
Reduction in kg		142.9632	-54.83	1198.75
Rate for 8 trusses Rs	113587.2	117084	127961	105019.2
Total saving Rs		-3497	-143748	8568
% save saving		3.07% (loss)	12.65 (loss)	7.54 saving

Table2: comparison for strut member

section	conventional	Square Tube	Rect.tube	Circ. tube
section	ISA65x65x8	60x60x3.2	80x40x3.2	O.D60.3, N.B50 ,t=3.6
Weight in kg/m	7.7	5.5	5.5	5.03
Wight for 8 trusses (kg)	1624.51	1160.48	1160.48	1061.20
Reduction in kg		464.03	464.03	563.31
Rate for 8 trusses Rs	81225.76	63826.4	63826.4	58366.4
Total saving Rs		17399.36	17399.36	22859.36
% total saving		21.42%	21.42%	28.142

Table 3: comparison for Tie member

section	conventional	Square Tube	Rect.tube	Circ. tube
	2ISA70x70x8	80x80x4.8	122x61x4.5	O.D.114.3,N.B.100 ,t=3.6
Weight in kg/m	16.6	10.87	11.88	9.75
Wight for 8 trusses(kg)	3320	2174	2376	1950
Reduction in kg		1146	944	1370
Rate for 8 trusses Rs	166000	119570	130680	107250
Total saving Rs	____	46430	35320	58750
% total saving		27.96%	21.27%	35.39%

Table 4: comparison for sling member

section	conventional	Square Tube	Rect.tube	Circ. tube
section	**ISA50x50x6**	**50x50x3.2**	**60x40x2.9**	**O.D48.3,N.B40 ,t=4**
Weight in kg/m	4.5	4.12	4.12	4.37
Wight for 8 trusses(kg)	1073.52	982.8	982.8	1042
Reduction in kg		90.72	90.72	31.02
Rate for 8 trusses (Rs)	53676	54054	54054	57337
Total saving Rs		-378(loss)	-378 L	-3661 L
% total saving		0.7%(loss)	0.7% (loss)	6.8% (loss)

Table 5: comparison for Purlin member

section	conventional	Square Tube	Rect.tube	Circ. tube
	ISA125x95x12	**113.5x113.5x4.8**	**122x61x5.4**	**O.D.139.7,N.B.125 ,t=4.5**
Weight in kg/m	19.6	15.92	14.01	15.00
Wight for 20 purlins(kg)	13720	11144	9807	10500
Reduction in kg		2576	3913	3220
Rate for 20 purlins Rs	686000	612920	539380	577500
Total savings		73080	146620	438500
% total saving		10.65%	21.37%	15.81%

4.1 TOTAL COST:

. Total cost for modified Howe truss using conventional sections: Rs 1,46496.62 /-

. Total cost for modified Howe truss using square tube sections: Rs 74,962.83 /-. (% saving in cost =48.83%)

. Total cost for modified Howe truss using rectangular tubee sections: Rs 74034.26 /- (/% saving in cost=49.46%)

. Total cost for modified Howe truss using circuar tube sections: Rs 60996.68 /- (% saving=58.36%)

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. 5.0 CONCLUSION

Above study reveals that tubular sections proves to be economical. Total saving of almost 50 % to 60 % in cost is achieved. Out of circular, square and rectangular shapes, due to connection difficulties of circular tube sections, it is suggested to adopt rectangular or square tube sections. This study is for a given area of 800 sq.m. and truss of modified howe type. Effectiveness of Tubular section can be verified for different plan areas for various types of trusses.

From above observations and results one can conclude that, the structural members having larger unsupported lengths can be assigned tubular sections which will derive overall economy. For smaller unsupported lengths one will have to assign minimum sections for both conventional and tubular sections so that economy is not considerably achieved. In such cases due to larger initial cost it becomes uneconomical. Initial cost for tubular sections is more however ,due to

reduction in total dead weight, it is overall economical not only for industrial buildings but also for various steel structures like transmission towers, bridge structures etc.

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