

Study on Different Truss Structures for Ware House Design

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Abstract - The present work presents a sizing optimization procedure for composite steel-3-dimensinal frames. An evolutionary optimization method is employed to minimize structural cost subject to constraints associated with:

- (a) Indian provisions for safety of steelstructures,
- (b) I.S. 800:2007 provisions for safety of steelmembers,
- (c) Structuralsystem.

For the numerical analysis of steel structure, a variety of damage scenarios is considered. The results obtained demonstrate the effectiveness of the proposed optimization approach of particular importance is the investigation of the variation in the structural cost achieved when collapse resistance constraints are incorporated in the design process. By enforcing the satisfaction of additional design requirements on system resistance and safety against local failure, structural cost is inevitably increased. This increase is quantitatively explored by comparing designs obtained with and without collapse resistance constraints.

Here in this research work we will analyze two structures of same geometry and loadings with optimization of steel by using two different sections.

Keyword: - Steel-section, Structural Optimization, Progressive Collapse, analysis, Staad-pro.

1. INTRODUCTION

This paper deals with the weight minimization of planar steel trusses by adopting a differential evolution-based algorithm. Angel & s-shape sections are considered. The design optimization refers to size, shape and topology. The design variables are represented by the geometrical dimensions of the cross sections of the different components of the truss, directly involving the size of the structure, and by some geometrical parameters affecting the outer shape of the truss. The topology is included in the optimization search in a particular way, since the designer at different runs of the algorithm can change the

number of bays keeping constant the total length of the

truss, to successively choose the best optimal solution. The minimum weight optimum design is posed as a single-objective optimization problem subject to constraints formulated in accordance with the current India code. The optimal solution is obtained by a Differential Evolutionary (DE) algorithm. In the DE algorithm, a particular combination of mutation and crossover operators is adopted in order to achieve the best solutions and a specific way for dealing with constraints is introduced. The effectiveness of the proposed approach is shown with reference to two case-studies. The analysis results prove the versatility of the optimizer algorithm with regard to the three optimization categories of sizing, shape, topology as well as its high computational performances and its efficacy for practical applications. In particular useful practical indications concerning the geometrical dimensions of the various involved structural elements can be deduced by the optimal solutions: in a truss girder the cross section of the top chord should be bigger than the one of the bottom chord as well as diagonals should be characterized by smaller cross sections with respect to the top and bottom chords in order to simultaneously optimize the weight and ensure an optimal structural behavior.

1.1 Types of sections used in the design of Warehouse:

Angle section: These are typically In “Angle” Shape made by welding of two inclined bars giving it a shape of angle

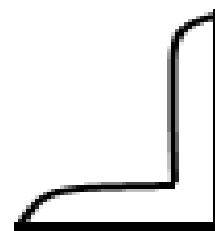


Fig -1 Angle section Design

S-Shape: These typically have rounded corners with supporting design.

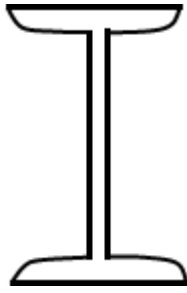


Fig 2 S-section Design

Based on the fact of not having a single best optimization method for steel trusses, it would be of interest to have a package of some optimum design procedures by the most efficient optimization methods.

The design variables in the presented procedure of the optimum design of steel trusses are the cross-sectional areas of truss members. Each cross section is assumed to be described by a single design variable. In fact, considering buckling, the cross section should be described at least by two design variables, namely, the area and the radius of gyration corresponding to the maximum slenderness ratio of the member. But, because of doubling the design space dimension, the use of these two kinds of variables is computationally inconvenient. At any optimization problem, the aim is to minimize the objective function, subject to the satisfaction of the defined constraints. In this work, an analysis tool was used in order to determine the design with the minimum cost for each scenario considered.

2. LITERATURE REVIEW

M.G.Kalyanshetti, G.S.Mirajkar, (2012)[1] This research involves the economy, load carrying capacity of all structural members and their corresponding safety measures. Economy was the main goal 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. Research reveals that, up to 40 to 50% saving in cost is achieved for square and rectangular tubular sections.

Trilok Gupta, Ravi K. S Harma, (2013)[2] The research involves various kinds of industrial roof trusses by using computer software. It also involves the knowledge regarding steel roof trusses and the design philosophies with worked examples. From the observations they concluded that, the sections designed using limit state methods are more economical than the sections using working stress method. It was observed that the tubular section designed by limit state method was the most economical among the three sections which were used.

Vaibhav B. Chavan et. al. (1990)[3] This research's objective was to estimate the economic importance of the Hollow Sections in contrast with conventional sections. This paper was carried out to find out the percentage economy accomplished using Hollow Sections so as to understand the importance of cost efficiency. The technique used in order to reach the objective involves the comparison of various profiles for different combinations of height and material cross-section for given span and loading conditions. The analysis and design phase of the project was done utilizing STAAD PRO V8i. The results of STAAD analysis were validated with the results of Manual analysis.

Davison and Birkemoe (1982)[4] determined that there are two residual stress gradients in the longitudinal direction, one across the tube face and around the cross section, denoted as membrane, and the other perpendicular to the tube face through the material thickness, denoted as bending. "The perimeter (membrane) residual stress gradient represents the variation in the mean value of the longitudinal residual stress [and] the through thickness (bending) residual stress gradient is the deviation from this mean value normal to the perimeter through the material thickness".

Do Dai Thang et. al. (2009)[5] presented a paper in which, optimum cost design of steel box girder bridge is carried out by varying of closed rectangular and open trapezoidal sections.

3. OBJECTIVES

1. To determine the 3d analysis of steel structure using staadpro.
2. Preparing best economical design for ware house using different sections.
3. To determine the cost effectiveness between angel section and S-Shape section.
4. Compare forces resistivity in both sections.
5. Compare economical in terms of weight.

Material properties	Values
Density of STEEL	7480 kG/ m ³
Density of CONNECTION	7480 kG/ m ³
Young's modulus of STEEL	2.17 x 10 ⁴ N/mm ²
Poisson ratio, μ	0.17
Tensile strength	415 N/mm ²
Steel	F _e 415

4. Methodology

- (a) The analysis of trussed frame for the gravity loads or vertical loads and horizontal loads can be done by analysis tool Staadpro,

- (b) For the static and lateral analysis of truss frame have moment resisting frame
- By STAAD Pro. Software Method
 - Equivalent static lateral force method – For Static analysis only. Discussed as per IS 875 part-3 for regular buildings only.

Table-1 Material properties of Steel

Description	Value/type
Number of storey's	1
Number of bays in X- direction	1
Number of bays in Z- direction	1
Storey height	7 m
Column height below plinth beam	1.5m
Bay width in X- direction	3m
Bay width in Z- direction	35 m
Plan size	12×35m
frame height	10.5m (3.5m truss)

Table-2 Above table shows the geometrical properties considered in analysis

- (a) The analysis of Trussed Warehouse for the gravity loads or vertical loads and horizontal loads can be done by analysis tool Staadpro,
- (b) For the wind load analysis of Trussed Warehouse have moment resisting frame
- By STAAD Pro. Software Method
 - Equivalent static lateral force method – For Static analysis only. Discussed as per IS 875(part-3).

Loading:

1) Dead Load: This is the self-weight of the track structure, mainly reinforced concrete which is given by its volumetric weight.

$$DL = \text{truss} * \text{Thickness} * \text{Volumetric Concrete}$$

$$= 2.54 * 0.265 * 24$$

$$= 16.15 \text{ kN/m}$$

2) Super Imposed Dead Load:.

$$= 0.6 + (0.2/0.6) = 0.93 \text{ kN/m}$$

3) Live Load: According to wind load value at

the maximum capacity, as per IS 875 part 2 it will be 0.75kN. Formation of load combination (8 load combinations in x & z-direction)

Cases considered in the Study:

Load Case no.	Load cases
1	D.L
2	L.L
3	W.L
4	(D.L+L.L)
5	(D.L+W.L)
6	1.5(D.L+L.L)
7	1.5(D.L+W.L)
8	1.2(D.L+L.L+W.L)

Table- 3 Cases Considered for the study

5. RESULTS

TRUSS SECTION	MEMBER	WEIGHT IN KN
Warehouse With Angel Section With Pipe As Vertical Members	Angels	5.83 KN
	Pipe	3.2 KN
TRUSS SECTION	MEMBER	WEIGHT IN KN
Warehouse With S Shape Section With Pipe As Vertical Members	S- Shape	9.43 KN
	PIPE	3.35 KN

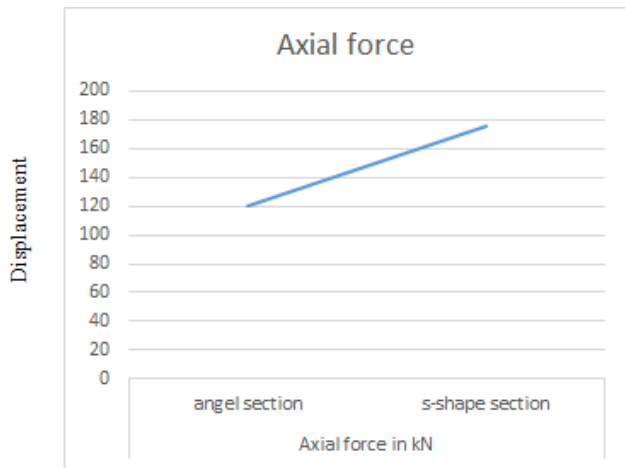
Table- 4 Weight of truss

Here results show that for same loading conditions and geometry of structure there is a wide variation in weight of both the frames due to change in shape of section.

Calculated Axial Force

Axial force in KN	
Angel section	s-shape section
120.38	175.447

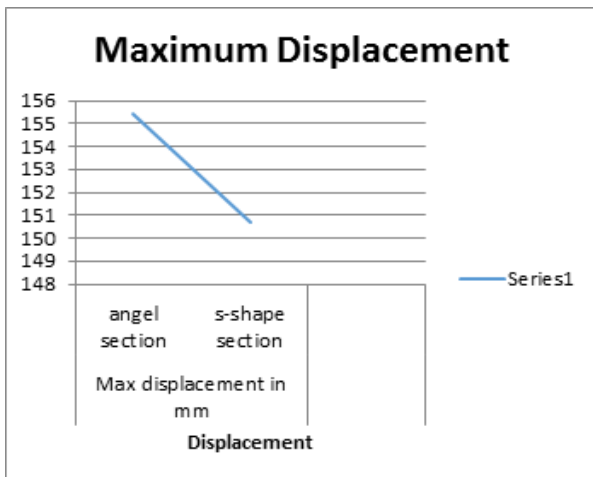
Here with the same supports applied on both the frame structure with s shape is showing more reactions at support because of its heavy weight.



Graph 1 For maximum axial force (KN)

Max displacement in mm	
Angel section	s-shape section
155.46	150.69

Calculated Maximum Displacement



Graph 2 For maximum displacement

Here this variation shows that angel shape will show more displacement due to wind load as compared to s shape structure.

5. CONCLUSIONS

In present study comparative study is done on a 3-dimensional ware house for same loadings with different section to find out the best section which will be cost effective, economical and easily available.

- In this study weight is determined, here results shows that

angel section is more economical.

- The difference in weight is approx. 35% which is really beneficial for a developing country
- This deduction in cost is not disturbing the load carrying capacity of structure.
- Implementation of sections is as per practical use so that we can practically implement it.

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