International Journal of Scientific Research in Civil Engineering
© 2019 IJSRCE | Volume 3 | Issue 6 | ISSN : 2456-6667

Structure Optimization Assessment for Steel Truss

Hariram Sahu[1], Rahul Satbhaiya[2]
[1]P. G. Scholar, Department of Civil Engineering, Infinity Management & Engineering College, Sagar, Madhya Pradesh, India
[2]Assistant Professor, Department of Civil Engineering, Infinity Management & Engineering College, Sagar, Madhya Pradesh, India

ABSTRACT

The Truss Structure consists of members/elements that takes only tension or compression and no bending moment in what so ever form. In the engineering term the Truss is defined as the two-force member, where the members are so assembled that the assemblage works as a single unit. The truss structure is generally provided when we need a large open space. In this study we are presenting Non linear analysis of three different type of truss arrangement i.e. Flink, Howe and King post for long span open area of dimension 35m x 25m. In this study we will also discuss the variations occur due to different type of sections such as ISMB, Channel section and Angle section. For analysis purpose we will use staad.pro
Keywords : Steel Structure, Analysis, Truss, Staad.Pro, Steel Sections.

I. INTRODUCTION

Steel frames are usually the choice when constructing a larger building that needs a big open space because of the economical aspect and efficiency of building a single-storey unit. However, a problem that might occur is when designing for a cost effective solution the slenderness may be decreased, that in the end may contribute to an instability of the entire structure.

A typical frame will in ultimate limit state (ULS) have compression forces and bending moments that are of big concern. The reason for this is that they may cause one element to buckle and deform. Because the elements are connected to each other, this may result in a deformation of the neighbouring element which in the end may lead to severe deformations and instability of the entire system of the frame.

Truss Roof:

Long span rooftops are commonly characterized as those that surpass 12 m in span. Long span rooftops can make adaptable, section free inside spaces and can lessen substructure expenses and development times. They are generally found in a wide scope of building types, for example, production lines, distribution centers, horticultural buildings, overhangs, huge shops, open lobbies, exercise rooms and fields.

Their essential capacities are, like ordinary rooftops, commonly, ensuring against the climate, limiting the spread of flame, giving sound and warm protection, etc. Be that as it may, as they may offer the main basic framework other than the border dividers, they may likewise need to offer help for building administrations, get to courses, lifting hardware, lighting, etc.As a generally new building material, steel has turned out to be particularly helpful when joined into built steel trusses and steel plate associated timber trusses. Endeavors were made in the seventeenth and eighteenth hundreds of years to utilize iron as fortifying and auxiliary individuals, particularly in extension structure for railways and other substantial burden applications. In any case, it turned out to be disastrously obvious that basic iron quality control and plan strategies didn't have the important dependability and cost components required for boundless use. With the advancement of the Bessemer procedure in 1858 the expense of assembling steel started to drop, and with the Linz-Donawitz process 100 years after the fact steel started to truly contend with wood as an auxiliary framing component. Electric circular segment heaters empowered effective steel reusing forms, further diminishing creation costs. At long last, the virus moved procedure for creating steel truss individuals currently empowers ease generation of steel floor trusses, steel rooftop trusses, whole steel truss buildings, and the components utilized in the plan of steel truss spans. All have now turned out to be practical, solid, and safe options in contrast to increasingly customary auxiliary framing materials.

Fig 1 : Truss Arrangements

Wind Load:

Wind is air moving with respect to the outside of the earth. The essential driver of wind is followed to earth's pivot and contrasts in earthbound radiation. The radiation impacts are for the most part in charge of convection current either upwards or downwards. The wind by and large blows flat to the ground at high speeds. Since vertical parts of climatic movement are generally little, the term 'wind' means only the flat wind while 'vertical winds' are constantly distinguished all things considered. The wind paces are evaluated with the guide of anemometers or anemographs, which are introduced at meteorological observatories at statures for the most part shifting from 10 to 30 meters over the ground.

Objectives behind the study

The main objectives of this study are as follows:

1 To determine the most suitable type of truss arrangement for long span.
2 To determine the type of steel section most effective in resisting deformation.
3 To justify the utilization of analysis tool in steel sections analysis.

Scope & Need of the study:

Long span structures are needed to resist lateral forces over the span length without vertical members at the mid spans, for such structures truss arrangement is more beneficial to distribute tension and compression of each members. Benefits of truss structures are as follows:

1. To provide lateral stiffness to the structure.
2. To minimize structure weight and support divisions.
3. Fast assembling and arrangement at the site.
4. The present investigation will encourage the utilization of steel truss arrangement for long

span structures which may be cost effective, easy and fast in assembling.

II. LITERATURE REVIEW

D. Harod and S. Pahwa (2019) [1] the authors research paper presented the comparison of tubular and steel structure in terms of weight, efficiency and deflection. This analysis and design was performed step-by-step using Ansys software considering Self weight, Live Load. This presented study on behavior and economical of roof truss by using spatial geometry. The conclusion derived from the results stated that total deformations due to combined load on roof truss structures showed Maximum deformations in Flink roof truss structure and minimum deformation found in Howe roof truss structure, as per total weight analysis maximum weight found on Flink Roof truss structure and minimum weight found on Howe roof truss structure.
A. Pathan et. al. (2018) [2] here the author considered a 20 metre span steel roof truss on basis of IS:875 (Part I, II and III) for the calculation of loadings on roof truss and on the later staged the analysis as well as design of the roof truss has been carried out by STAAD Pro V8i adopting Limit State Method.

Here the results stated that All loads for the 20 metre span roof truss have been calculated by considering IS:875 (Part I, II and III). The analysis and design for the same have been carried out by STAAD.Pro v8i. Effect of stress reversal has been taken into account in the analysis of the truss.

Chitte et. al. (2018) [3] here the author represents the analysis and design of Pratt Truss for 30m span by Limit State Method (IS 800:2007) and Working Stress Method (IS 800:1984) where the data's was calculated using Indian Standard code IS 875-1975 (part I, II & III), IS 800 – 2007 using limit state method, IS 800-2007 using working stress method and the section properties of the specimens was obtained using steel table. The truss is analyzed for the dead load, live load and wind loads. The structure was designed under Wind loading with fixed supported condition with a primary objective to provide the method which was economical, more load carrying capacity and high flexural strength. The research paper concluded that the limit state method design provided high load caring capacity with minimum quantity of steel required as compared to working stress method, which results in economical design of truss design (For the same configuration of truss, total percentage saving in weight of steel is by limit state method is 23% as compare to working stress method).

III. METHODS AND MATERIAL

Cases assigned in present study are as follows:

Case I- Howe Truss:

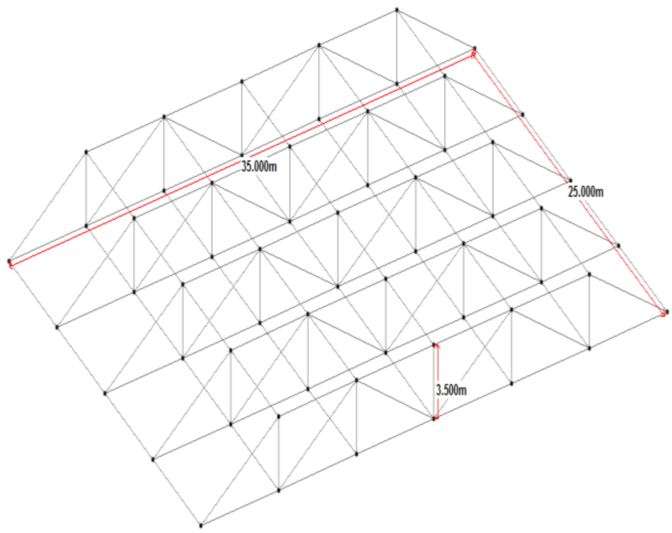

Fig 2 : Howe truss

Case II- King Post Truss:

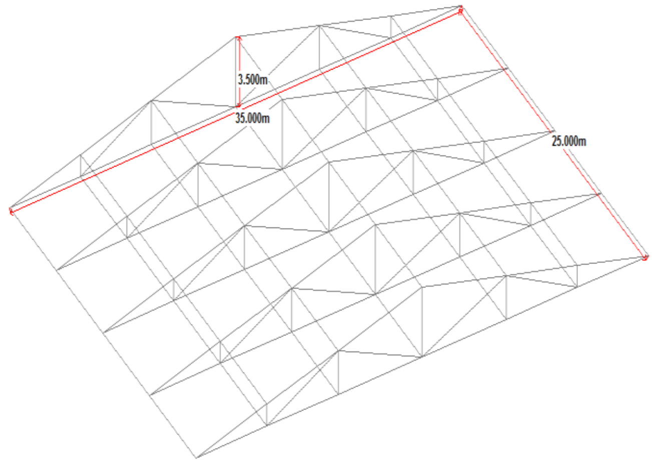

Fig 3 : King post Truss

Case III- Flink Truss:

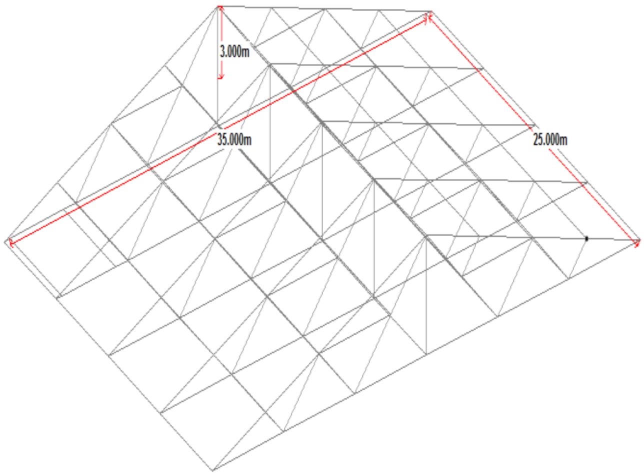

Fig 4 : Flink Truss

Steps Followed in this study are as follows:

Step-1 : Modelling of the structure in Staad.pro

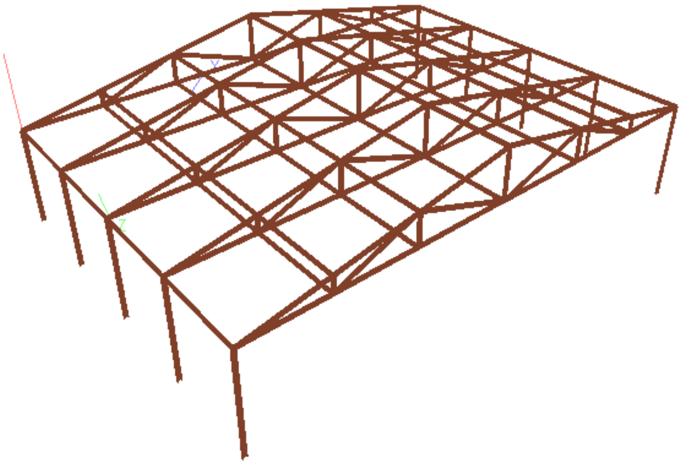

Fig 5 : Modelling of the structure in staad.pro

Step-2: Assigning Sectional properties and members as per Steel Table.

Step-3: Assigning Support Condition

Step-4: Assigning load conditions:

Step-5: Analysis of structure

Analysis of structure is done as per finite element analysis considering lateral forces

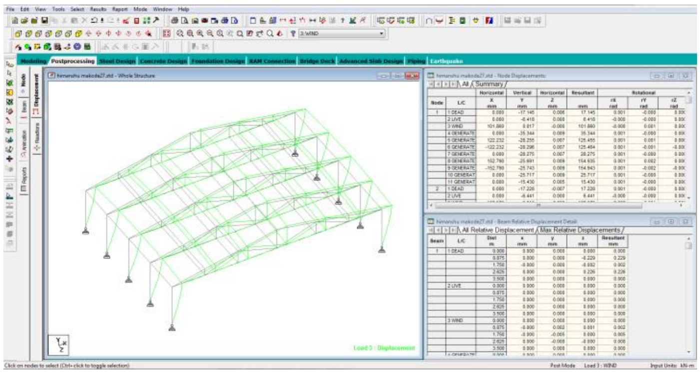

Fig 6 : Lateral Load analysis

Table 1 : Geometrical description

Design data of building	Dimension
Plan dimension	25 x 35 m
No. of bay in X direction	6 Bay
No. of bay in Y	4 Bay

direction	
Typical storey height	3.50 m
Sections	I.S.M.B, CHANNEL & ANGLE
Truss	Howe, Flink & King Post
Grade of steel	Fe-345

IV. RESULTS AND DISCUSSION

Analysis Results

Flink Truss:

Table 2 : Flink truss with angel section

Analysis of Flink Truss (Angel Section)						
OutputCase	**Global FX**	**Global FY**	**Global FZ**	**Deflection X**	**Deflection Y**	**Deflection Z**
Unit	KN	KN	KN	mm	mm	mm
NODAL	-1.2407	3.921	8.7607	0.34	1.35	0.98
NODAL	-3601.175	1.3506	0.033	0.25	1.21	1.05
NODAL	-7.3106	-802.93	-1.54905	0.16	1.07	1.12
NODAL	133.13	-15.071	-9.561	0.07	0.93	0.32
NODAL	180.773	-5.1605	-339.059	-0.02	0.79	0.21
NODAL	680.661	1.8605	2.082	-0.11	0.65	0.1
NODAL	1090	-826.638	-0.011	-0.2	0.51	-0.01
NODAL	159.906	0.001067	1742.263	-0.29	0.37	-0.12
NODAL	-13957.37	7.6105	-34.765	-0.38	0.23	-0.23
NODAL	-1275.911	33.13	-279.003	0.47	0.09	-0.34
NODAL	-2.03E-05	3.162	0.001781	0.56	-0.05	-0.45
NODAL	910.178	-0.0001389	-5621.168	-0.65	-0.19	-0.56

Table 3 : Flink truss with Channel section

Analysis of Flink Truss (Channel Section)						
OutputCase	**Global FX**	**Global FY**	**Global FZ**	**Deflection X**	**Deflection Y**	**Deflection Z**
Unit	KN	KN	KN	mm	mm	mm
NODAL	-2.2407	1.921	5.2307	0.34	0.75	1.03
NODAL	1094	1.98	-3.497	0.25	0.89	0.96
NODAL	-7.3106	38.06	-5.07905	0.16	1.03	0.89
NODAL	0.01333	-13.071	-13.091	0.07	1.17	0.82

NODAL	10.773	-6.1605	-342.589	-0.02	1.31	0.75
NODAL	106.661	2.605	-1.448	1.3	0.55	0.68
NODAL	-0.184	-716.638	-3.541	2.66	0.12	0.61
NODAL	739.906	0.001067	1738.733	2.17	-0.31	0.54
NODAL	-121.365	6.105	-38.295	1.68	-0.74	0.47
NODAL	-13.911	1.05	-282.533	1.19	-1.17	0.4
NODAL	-2.0305	15.162	-3.528219	0.7	-0.05	-0.45
NODAL	43.178	-0.0001389	-59624.698	0.21	-0.19	-0.56

Table 4 : Flink truss with Beam section

Analysis of Flink Truss (Beam Section)						
OutputCase	**Global FX**	**Global FY**	**Global FZ**	**Deflection X**	**Deflection Y**	**Deflection Z**
Unit	KN	KN	KN	mm	mm	mm
NODAL	-5.7707	-16.601	1.7007	0.03	0.21	0.043
NODAL	1024.21	-9.6905	-7.027	0.1	-0.25	0.098
NODAL	-10.8406	-0.925	-8.60905	0.16	-0.71	0.153
NODAL	-3.51667	-720.168	-16.621	0.07	-1.17	0.208
NODAL	7.243	-3.528933	-346.119	0.135	1.32	0.263
NODAL	103.131	2.575	-4.978	0.153	1.25	0.318
NODAL	-3.530184	-2.48	-7.071	0.171	1.18	0.373
NODAL	736.376	11.632	1735.203	0.189	1.11	0.428
NODAL	-124.895	-3.5301389	-41.825	0.207	1.04	0.483
NODAL	-1349.441	30.605	-286.063	1.19	0.97	0.538
NODAL	-3.53002	2003.162	-7.058219	0.7	0.9	0.593
NODAL	39.648	-0.0001389	-59628.228	0.21	0.83	0.648

Howe Truss

Table 5 : Howe truss with Angel section

Analysis of Howe Truss (Angel Section)						
OutputCase	Global FX	Global FY	Global FZ	**Deflection X**	**Deflection Y**	**Deflection Z**
Unit	KN	KN	KN	mm	mm	mm
NODAL	-7.6207	-18.451	-0.1493	0.56	2.56	0.57
NODAL	1022.36	-11.5405	-8.877	0.6	2.32	0.89
NODAL	-12.6906	-2.775	-10.45905	0.64	2.08	1.21

NODAL	-5.36667	-722.018	-18.471	0.68	1.84	1.53
NODAL	5.393	-5.378933	-347.969	0.72	1.6	-0.29
NODAL	1082	0.725	-6.828	0.76	1.36	-0.45
NODAL	-5.3801837	-4.33	-8.921	0.8	1.12	-0.61
NODAL	734.526	9.782	1733.353	0.84	0.88	-0.77
NODAL	-126.745	-5.3801389	-43.675	0.88	0.64	-0.93
NODAL	-1351.291	23.13	-287.913	1.2	0.4	-1.09
NODAL	-5.38002033	30.35	-8.908219	-1.41	0.16	-1.25
NODAL	37.798	-1.8501389	-59630.078	-1.58	-0.045	-1.41

Table 6 : Howe truss with Channel section

Analysis of Howe Truss (Channel Section)						
OutputCase	Global FX	Global FY	Global FZ	**Deflection X**	**Deflection Y**	**Deflection Z**
Unit	KN	KN	KN	mm	mm	mm
NODAL	-4.8407	-15.671	2.6307	0.29	1.34	0.24
NODAL	1088	-8.7605	-6.097	0.12	1.21	0.15
NODAL	-9.9106	0.005	-7.67905	-0.05	1.08	0.55
NODAL	-2.58667	-719.238	-15.691	-0.22	0.95	0.13
NODAL	8.173	-2.598933	-345.189	-0.39	0.82	-0.29
NODAL	104.061	3.505	-4.048	-0.56	0.69	-0.71
NODAL	-2.6001837	-1.55	-6.141	-0.73	0.56	-1.13
NODAL	737.306	12.562	1736.133	-0.9	0.43	-1.55
NODAL	-123.965	-2.6001389	-40.895	-1.07	0.3	-1.97
NODAL	-1348.511	32.5	-285.133	-1.24	0.17	-2.39
NODAL	-2.60002033	2004.092	-6.128219	-1.41	0.04	-2.81
NODAL	40.578	0.9298611	-59627.298	-1.58	-0.09	-3.23

Table 7 : Howe truss with Beam section

Analysis of Howe Truss (Beam Section)						
OutputCase	Global FX	Global FY	Global FZ	**Deflection X**	**Deflection Y**	**Deflection Z**
Unit	KN	KN	KN	mm	mm	mm
NODAL	-7.1507	-17.981	-0.3207	0.021	0.19	0.021
NODAL	1018	-11.0705	8.407	0.09	0.24	-0.24
NODAL	-12.2206	-2.305	9.98905	0.159	0.29	-0.501
NODAL	-4.89667	-721.548	18.001	0.228	0.34	-0.762

NODAL	5.863	-4.908933	347.499	0.297	0.39	0.14
NODAL	101.751	1.195	6.358	0.366	0.44	0.05
NODAL	-4.9101837	-3.86	8.451	0.435	0.49	-0.04
NODAL	734.996	10.252	-1733.823	0.504	0.54	-0.13
NODAL	-126.275	-4.9101389	43.205	0.573	0.59	-0.22
NODAL	-1350.821	19.85	287.443	0.642	0.64	-0.31
NODAL	-4.91002033	20.05	8.438219	0.711	0.69	-0.4
NODAL	38.268	-1.3801389	59629.608	0.78	0.74	-0.49

King Post Truss:

Table 8 : King post truss with Angel section

Analysis of King post Truss (Angel Section)						
OutputCase	Global FX	Global FY	Global FZ	**Deflection X**	**Deflection Y**	**Deflection Z**
Unit	KN	KN	KN	mm	mm	mm
NODAL	-1.2407	3.921	8.7607	0.051	0.12	1.23
NODAL	-3601.175	1.3506	0.033	0.42	0.32	0.67
NODAL	-7.3106	-802.93	-1.54905	0.789	0.52	0.89
NODAL	133.13	-15.071	-9.561	1.158	0.72	0.98
NODAL	180.773	-5.1605	-339.059	1.527	0.92	1.07
NODAL	680.661	1.8605	2.082	-0.552	-0.71	1.16
NODAL	1087	-826.638	-0.011	0.23	-0.79	1.25
NODAL	159.906	0.001067	1742.263	0.12	-0.87	1.34
NODAL	-13957.365	7.6105	-34.765	0.01	-0.95	1.43
NODAL	-1275.911	28.13	-279.003	-0.1	-1.03	1.52
NODAL	-0.00002033	3.162	0.001781	-0.21	0.69	1.61
NODAL	910.178	-0.0001389	-59621.168	-0.32	0.71	1.7

Table 9 : King post truss with Channel section

Analysis of King post Truss (Channel Section)						
OutputCase	Global FX	Global FY	Global FZ	**Deflection X**	**Deflection Y**	**Deflection Z**
Unit	KN	KN	KN	mm	mm	mm
NODAL	-1.2427	3.884	7.496	0.057	0.45	0.45
NODAL	-3611.121	1.2967	0.029	0.42	0.21	0.67
NODAL	-8.111	-898.21	-1.59547	0.783	-0.03	0.89
NODAL	132.49	-16.451	-10.979	1.146	-0.27	1.11
NODAL	178.243	-7.3124	-340.01	0.297	-0.51	0.14

NODAL	675.745	1.671	1.921	-0.552	-0.75	-0.83
NODAL	1090	-819.398	-0.069	-1.401	-0.99	-1.8
NODAL	154.74	0.001045	1741.263	0.504	0.54	-0.13
NODAL	-13967.757	6.156	-35.452	0.409	0.59	-0.2
NODAL	-1281.633	35.69	-287.55	0.314	0.44	-0.11
NODAL	-0.0000214	2.789	0.001756	0.219	0.69	-0.24
NODAL	901.545	-0.0001411	-60121.168	0.124	0.71	-0.41

Table 10 : King post truss with Beam section

Analysis of King Post Truss (Beam Section)						
OutputCase	Global FX	Global FY	Global FZ	Global MX	Global MY	Global MZ
Unit	KN	KN	KN	KN	KN-m	KN-m
NODAL	-3.8127	1.314	4.926	-2.513	-2.12	-2.12
NODAL	-3613.691	-1.2733	-2.541	-2.15	-2.36	2690.59
NODAL	-10.681	-900.78	-4.16547	-1.787	-2.6	-1.68
NODAL	129.92	-19.021	-13.549	-1.424	-2.84	-1.46
NODAL	175.673	-9.8824	-342.58	-2.273	-3.08	-2.43
NODAL	673.175	-0.899	-0.649	-3.122	-3.32	-3.4
NODAL	1020	-821.968	-2.639	-3.971	-3.56	-4.37
NODAL	152.17	-2.568955	1738.693	-2.066	-2.03	-2.7
NODAL	-13970.327	3.586	-38.022	-2.161	-1.98	-2.77
NODAL	-1284.203	30.65	-290.12	-2.256	-2.13	-2.68
NODAL	-2.5700214	0.219	-2.568244	-2.351	-1.88	-2.81
NODAL	898.975	-2.5701411	-60123.738	-2.446	-1.86	-2.98

Table 10 : Cost Analysis

Cost Analysis				
Section	Truss	Qty KN	Rate/KN	Total Cost
Angel Section	Flink Truss	438.97	470	206316
	King Post Truss	439.21	470	206429
	Howe Truss	411.45	470	193382
Channel Section	Flink Truss	464.85	470	218480
	King Post Truss	437.2	470	205484
	Howe Truss	423.55	470	199069
Beam Section	Flink Truss	461.99	470	217135
	King Post Truss	428.68	470	201480
	Howe Truss	395.37	470	185824

V. CONCLUSION

Following Conclusions are made as per the results observed in above chapter are:

1. It has been observed that stability in terms of resisting axial force and shear force is comparatively 18.5% more in Howe type truss arrangement in comparison to other two types.
2. As observed in above chapter Beam section is best suitable for truss arrangement than angel and channel section.
3. It is observed that howe type truss arrangement with beam section is comparatively more economical by 14.95% than others. Whereas Flink type truss with channel section is observed as most costly.
4. In this study it is observed that deflection is 4.8% less in beam section than other two.

VI. SUMMARY

In this study, it is concluded that in truss arrangement howe type truss is comparatively best suitable whereas in terms of sections beam section is more resistible and economical.

VII. REFERENCES

[1]. D. Harod and S. Pahwa, "Static Structural Analysis of Pratt, Flink and Howe Steel Truss using Ansys Software", International Journal of Advances in Engineering Research", Volume 7 Issue III, Mar 2019

[2]. A. Pathan, "Design of Large Span Roof Truss under Medium Permeability Condition", "IJSTE - International Journal of Science Technology & Engineering",| Volume 4, Issue 10, April 2018

[3]. C. Chitte, "Analysis and Design of Pratt Truss by IS 800:2007 & IS 800:1984" "International Journal of Computational Engineering & Management", Vol. 21 Issue 2, March 2018.

[4]. H. Dewangan & K. Majumdar "A review on comparision of different types of trusses in vibration analysis using staad pro", "International Journal of Engineering and Research", ISSN: 2277-9655, CODEN: IJESS, 2018.

[5]. M.Indrajit, standardization of truss profile for various span and loading conditions, ISSI, 2018.

[6]. C. Jha and M.C. Paliwal, "Fully Stressed Design of Howe Truss using STAAD.Pro Software", "International Journal of Research and Development", Volume 5, Issue 3, ISSN: 2321-9939, 2017.

[7]. O. Qasim, "Analysis and Design of Steel Truss Stadium", "World Conference on earthquake science", IInd edition, 2017

[8]. T. Parekh, D. Parmar, Y. Tank, "Analysis of Howe Roof Truss using Different Rise and Span", "International Journal of Engineering Trends and Technology (IJETT)", Volume 47 Number 3 May 2017

[9]. R. Palya & D. Raghuvanshi, "Study on different truss structures for ware house design", "International journal of research and development", Volume- 5, Issue-11, Nov.-2017

[10]. A. Patrikar & K. K. Pathak, "Fully Stressed Design of Fink Truss Using STAAD.Pro Software", "Open Journal of Civil Engineering", 2016, pp. 631-642.

Cite this article as :

Hariram Sahu, Rahul Satbhaiya, "Structure Optimization Assessment for Steel Truss", International Journal of Scientific Research in Civil Engineering (IJSRCE), ISSN : 2456-6667, Volume 3 Issue 6, pp. 88-97, November-December 2019.

URL : http://ijsrce.com/IJSRCE193613