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COMPARATIVE STUDY ON ANALYSIS OF STEEL TRUSS STRUCTURE AND RIGID FRAME BY USING STAAD PRO

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Abstract - *The Steel structure is most widely using in now days due to less time required for construction and less cost to build it with easy handling, now these are constructing at everywhere and it is considered that rigid frames are economic to build. But this project is made to decide is rigid frames play more economic role in construction as compared to the steel structure, So this project takes standard bay of structure (industrial warehouse) and rigid frame with same span of 16m and having same rise height of 2m, by the help of software we analyze both their metallic structure and foundation, and the spacing between bays was 5m. The analysis is carried out through Staat pro software and two models were made to find their weight of steel which decides the cost of the structure and axial load which decides the size of foundation and cost of foundation. The following conclusions were obtained: When the steel weight and its cost is considered steel structure is economical than rigid frames and also in the foundation cost, due to the high axial loads the foundation cost also increases for rigid frames with same span of 16m compared to the steel structure.*

***Key Words*: Rigid Frame, Steel Structure, steel take off (weight of steel), Optimization, Principle rafter, Purlin, STAAD Pro**

1. INTRODUCTION

The truss structure is made with strait slender steel member consisting pinned or hinged or riveted or welded together to construct a steel rigid structure, so trusses derive the strength from triangle, so now a day's steel structure are using every ware due to less cost and easy in construction and it can be installed quickly and takes less time for installation

1.1 Rigid fame: It is a structure which consisting rigid connections at members ends with load resisting skeleton structure constructed with the tapered or straight members of column or beam, so this structure got the capacity to take vertical loads without any additional members or diagonal members, due to the rigid attachment or bond between the members it resists movements produced in the joints the structural members can withstand safely by taking shear force, bending moment axial loads, in this structure support conditions were taken as fixed or pinned or hinged in this project the support conditions were taken as fixed support.

Fig 1. Rigid frame structure

1.2 Steel truss structure: In steel structure the members connecting at the joints considered as frictionless pins and at the end of the member they will be no moments, the members can carry axial loads (compression and tension) by this reason all members are equally stressed throughout their c/s member design for truss in steel structure is economical, in this structure support conditions are taken as pinned.

Fig 2. Steel truss structure

1.3 DESIGN CODE CHECKING

It provide the guide & selection of structural member made by the software whether the member is going take all design loads by indicating pass or fail, this works on principle of IS code checking provided in software, according to the code the steel will be designed. The software will analyze the specified member forces and moment acting on it & utilize the code checking calculation and finally the report were displaced by the software.

2. SCOPE OF THE PROJECT

The work consists of comparative study on design and analysis of trus in rigid frames and steel structure with help of staad pro software to determine the optimistic, adequate and economic structure, creating two models with same plan area, same rise height, same topographical condition then the loads are applied according to the Is 875 code, assigning different steel sections such as channel, I-sections, rolled sections etc. Then computing the cost of structure by obtaining weight of steel, size of foundation and cost by obtaining axial load at the support.

3. Description of Model

The two models are created by considering same plan area and situated in same location the same loading conditions are applied, after analysis structural members are designed for the best possible economic section as per optimization technique, then comparison is between two structures and best optimistic and economic structure is adopted for construction.

Table 1-Specification of the Structure

S.NO	particulars	Data
1	Span of the truss	16m
2	Spacing between truss	5m
3	Location	Ahmadabad
4	Basic wind speed (Vb)	39 m/s
5	rise of truss	2 m
6	Height above ground level	5 m
7	Terrain category	3
8	Class	A
9	Live load	446.6 N/M²
10	slope is less than	3 degrees
11	risk factor (k1)	0.9 (for 25 years)
12	size factor (K2)	0.91
13	Topography Factor(k3)	1
14	Design wind velocity (Vz)	36.23 m/s
15	Design wind pressure(Pz)	0.64 KN/m2

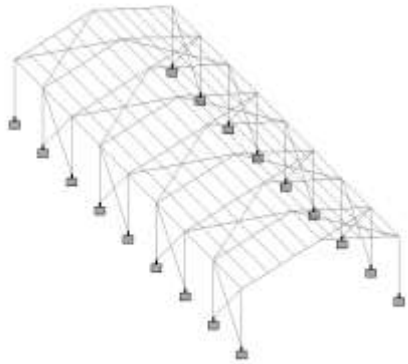


Fig 3: Staad model for rigid frame

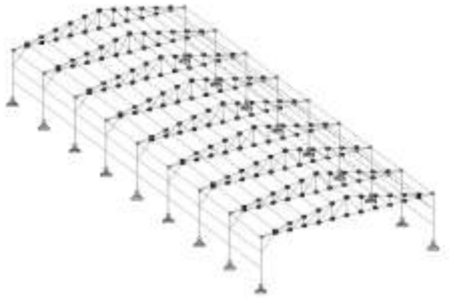


Fig 4: Staad model for steel structure

4. RESULT AND DISCUSSIONS

Table 2- steel design for rigid frame

SECTION ADOPTED FOR RIGID FRAME AND WEIGHT		
MEMBERS	**PROPERTY**	**WEIGHT(KN)**
Columns	IS HB 400	68.239
Principle Rafter	IS HB 350	97.947
Purlins	IS MC 75	72.702
Others	ISA 200X200X12 & PIP1651L	40.761 & 26,902

Table 3- steel design for steel structure

SECTION ADOPTED FOR STEEL STRUCTURE AND WEIGHT		
MEMBERS	**PROPERTY**	**WEIGHT(KN)**
Columns	IS HB 200	31.624
Principle Rafter	IS MB 125	19.384
Purlin	IS MC 75 FR	72.702
Lower Chord	ISA 80X80X12	19.690
Web Members	ISA 75X75X10	30.163
Diagonal members		
Others	ISA 150X150X15 & ISA 150X150X16	52.854 & 13.488

RIGID FRAME - Design Results:-

All / Failed Members

Beam	Analysis Property	Design Property	Actual Ratio	Allowable Ratio	Normalized Ratio (Actual/Allowable)	Clause	L/C
1	ISHB300	ISHB300	0.394	1.000	0.394	IS-7.1.1(A)	6
2	ISHB300	ISHB300	0.226	1.000	0.226	IS-7.1.1(A)	6
3	ISHB350	ISHB350	0.498	1.000	0.498	IS-7.1.1(A)	6
4	ISHB350	ISHB350	0.578	1.000	0.578	IS-7.1.1(A)	6
8	ISHB300	ISHB300	0.169	1.000	0.169	IS-7.1.1(A)	6
9	ISHB300	ISHB300	0.150	1.000	0.150	IS-7.1.1(A)	6
10	ISHB300	ISHB300	0.209	1.000	0.209	IS-7.1.1(A)	6
11	ISHB300	ISHB300	0.218	1.000	0.218	IS-7.1.1(A)	6
12	ISHB300	ISHB300	0.221	1.000	0.221	IS-7.1.1(A)	6
13	ISHB300	ISHB300	0.207	1.000	0.207	IS-7.1.1(A)	6
14	ISHB300	ISHB300	0.178	1.000	0.178	IS-7.1.1(A)	6
15	ISHB300	ISHB300	0.110	1.000	0.110	IS-7.1.1(A)	6
16	ISHB300	ISHB300	0.317	1.000	0.317	IS-7.1.1(A)	6
17	ISHB300	ISHB300	0.620	1.000	0.620	IS-7.1.1(A)	6
18	ISHB150	ISHB150	0.063	1.000	0.063	7.1.2 BEND C	6
19	ISHB150	ISHB150	0.069	1.000	0.069	7.1.2 BEND C	6
20	ISHB150	ISHB150	0.078	1.000	0.078	7.1.2 BEND C	6
23	ISHB150	ISHB150	0.036	1.000	0.036	7.1.2 BEND C	6
24	ISHB150	ISHB150	0.035	1.000	0.035	7.1.2 BEND C	6
25	ISHB150	ISHB150	0.039	1.000	0.039	IS-7.1.1(A)	6
26	ISHB150	ISHB150	0.040	1.000	0.040	IS-7.1.1(A)	6
27	ISHB150	ISHB150	0.041	1.000	0.041	7.1.2 BEND C	6
28	ISHB150	ISHB150	0.051	1.000	0.051	7.1.2 BEND C	6
29	ISHB150	ISHB150	0.053	1.000	0.053	IS-7.1.1(A)	6
30	ISHB150	ISHB150	0.057	1.000	0.057	7.1.2 BEND C	6
31	ISHB150	ISHB150	0.064	1.000	0.064	IS-7.1.1(A)	6
32	ISHB150	ISHB150	0.069	1.000	0.069	7.1.2 BEND C	6

Fig 5. Rigid frame design result with actual ratio

STEEL STRCTURE - Copy - Design Results:-

All / Failed Members

Beam	Analysis Property	Design Property	Actual Ratio	Allowable Ratio	Normalized Ratio (Actual/Allowable)	Clause	L/C
1	ISMB125	ISMB125	0.456	1.000	0.456	IS-7.1.1(A)	8
2	ISMB125	ISMB125	0.582	1.000	0.582	IS-7.1.1(A)	8
3	ISA80X80X1	ISA80X80X1	0.219	1.000	0.219	IS-7.1.1(A)	9
5	ISMB125	ISMB125	0.727	1.000	0.727	IS-7.1.1(A)	8
6	ISMB125	ISMB125	0.740	1.000	0.740	IS-7.1.1(A)	8
7	ISMB125	ISMB125	0.690	1.000	0.690	IS-7.1.1(A)	8
8	ISMB125	ISMB125	0.614	1.000	0.614	IS-7.1.1(A)	8
9	ISMB125	ISMB125	0.627	1.000	0.627	IS-7.1.1(A)	8
10	ISMB125	ISMB125	0.637	1.000	0.637	IS-7.1.1(A)	8
11	ISMB125	ISMB125	0.564	1.000	0.564	IS-7.1.1(A)	8
12	ISMB125	ISMB125	0.226	1.000	0.226	IS-7.1.1(A)	5
14	ISA80X80X1	ISA80X80X1	0.157	1.000	0.157	IS-7.1.2	8
15	ISA75X75X1	ISA75X75X1	0.005	1.000	0.005	IS-7.1.2	9
16	ISA80X80X1	ISA80X80X1	0.157	1.000	0.157	IS-7.1.2	8
17	ISA75X75X1	ISA75X75X1	0.240	1.000	0.240	IS-7.1.1(A)	8
18	ISA80X80X1	ISA80X80X1	0.191	1.000	0.191	IS-7.1.2	8
19	ISA75X75X1	ISA75X75X1	0.121	1.000	0.121	IS-7.1.1(A)	8
20	ISA80X80X1	ISA80X80X1	0.220	1.000	0.220	IS-7.1.2	8
21	ISA75X75X1	ISA75X75X1	0.045	1.000	0.045	IS-7.1.1(A)	8
22	ISA80X80X1	ISA80X80X1	0.240	1.000	0.240	IS-7.1.2	8
23	ISA75X75X1	ISA75X75X1	0.015	1.000	0.015	IS-7.1.2	4
24	ISA80X80X1	ISA80X80X1	0.239	1.000	0.239	IS-7.1.2	8
26	ISA80X80X1	ISA80X80X1	0.180	1.000	0.180	IS-7.1.2	8
27	ISA75X75X1	ISA75X75X1	0.162	1.000	0.162	IS-7.1.1(A)	8
28	ISA80X80X1	ISA80X80X1	0.197	1.000	0.197	IS-7.1.2	8
29	ISA75X75X1	ISA75X75X1	0.069	1.000	0.069	IS-7.1.1(A)	8
30	ISA80X80X1	ISA80X80X1	0.202	1.000	0.202	IS-7.1.2	8

Fig 6. Steel structure design result with actual ratio

STEEL TAKE-OFF

PROFILE		LENGTH(METE)	WEIGHT(KN)
ST	ISHB350	148.43	97.947
ST	ISMB400	90.00	68.239
FR	ISMC75	520.00	72.702
ST	ISA200X200X12	113.14	40.761
ST	PIP1651L	154.30	26.907
		TOTAL =	306.556

************ END OF DATA FROM INTERNAL STORAGE ************

Fig 4.1(b): Steel take off for rigid frame

STEEL TAKE-OFF

PROFILE		LENGTH(METE)	WEIGHT(KN)
ST	ISMB125	148.43	19.384
ST	ISA80X80X12	144.00	19.690
ST	ISA75X75X10	280.46	30.163
FR	ISMC75	520.00	72.702
ST	ISHB200	86.67	31.624
ST	ISA150X150X15	160.00	52.852
ST	ISA150X150X16	38.42	13.488
		TOTAL =	239.903

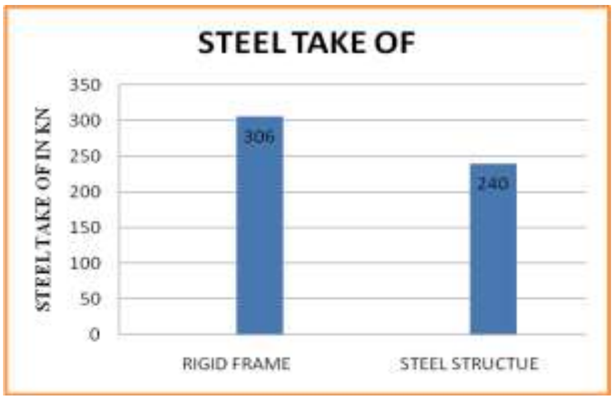
************ END OF DATA FROM INTERNAL STORAGE ************

Fig 4.1(b): Steel take off for steel structure

COMPARISONS

4.2.1 Comparison on steel take off

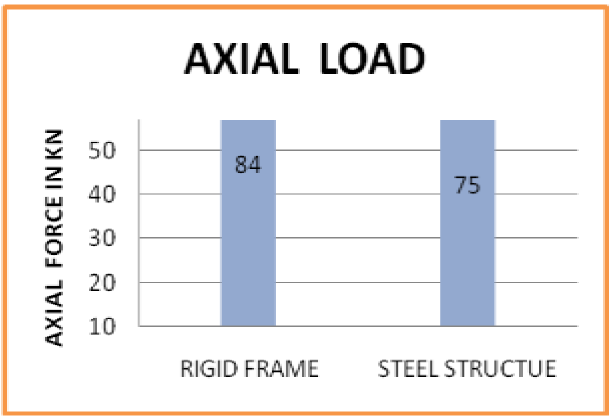
Steel take of is amount of steel materials required to construct the structure which is obtained from staad out put file after design procedure, so here the comparison is made for the two structure and which structure requires more steel for the same plan area ,same spacing truss, same height and Topography condition ,same loads etc



Here steel take off for steel truss structure less as compare to rigid frame,

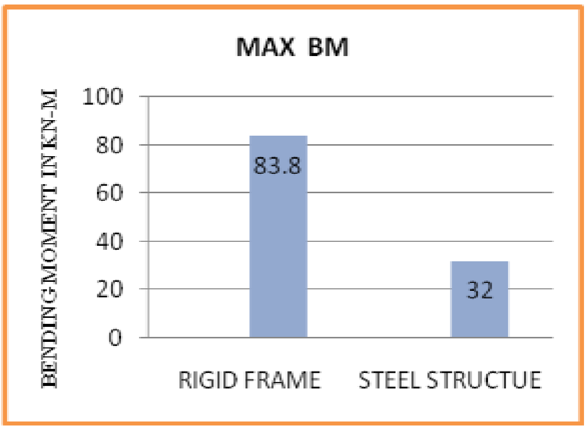
Comparison on axial force

Axial force is vertical force which is obtained at base of structure after analysis, in this the comparison is made that which structure has maximum axial load,



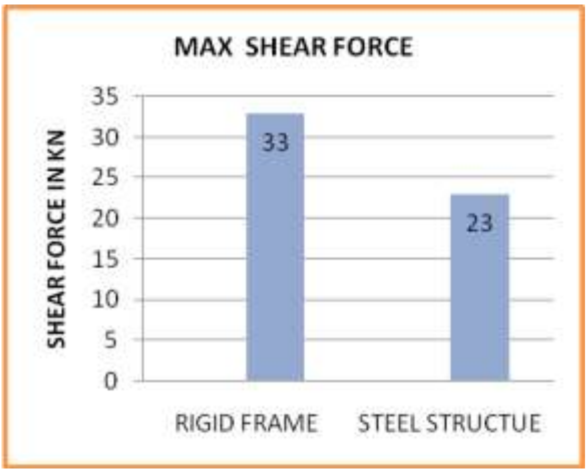
Comparison on max bending moment

From the graph it is observed that there is un favorable bending moment for rigid frame, the BM is more for rigid frame.



4.2.4 Comparison on max shear force

For the rigid frame as span increases shear force increases and as post height increases shear force decreases, the graph getting more value of SF because of the smaller the post height, so that the sheer force increases in the post base. The maximum values of shear forces are observed in rigid frame.



CONCLUSION

This project work consist of optimization of truss is made and economical section is designed and analyzed for rigid frames and steel structure and comparison is made between them. So the project work consist of 2 models i.e rigid frame and steel structure which are built in same topographical area, having same area (length and breadth),having same span(L),same rise height, With same loadings and combinations. The results are obtained as follows.

- After analysis by the optimization techniques the economical section for the members is designed for the two structures by the help of perform code checking or member selection provided in the software.
- Comparative study on rigid frame versus steel structure with respect to weight of material required to build the structure, by the analysis we obtained less weight of material for steel structure. the optimistic structure i.e steel structure which is having less weight of material is good one to built , if one of structure is getting less weight of material the cost also less required for getting that material and it is economic to built as compared rigid frame.
- Comparative study on rigid frame versus steel structure with respect to the axial force or reaction at the base, by the analysis result we got more base reaction for rigid frame structure so for more axial load large foundation size is required to construct the footing and also it requires more cost for foundation.
- By the study of project rigid frame members are unable to resist bending moments as compared to steel structure.
- For the construction of rigid frame structure the heavy sections are used for the members and it does not contain any intermediate members like steel structure which contains intermediate members like upper cord, lower cord and diagonal members.

So the factor is steel is less costly and it requires less time and cost for construction as compare to concrete structure if we consider only the steel structure, it can be concluded that steel truss member design is economic as compared with the rigid frame.

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