# Comparative Study between Framed Truss and Conventional Truss System for Industrial Building

**Prasad. R. Vaidya[1], Sarika P. Gangurde[2], Renuka P. Kale[3] Meghana S.Pawar[4]**

*[1]Assistant Professor, Civil Engineering Department, Gokhale Education Society's , R.H. Sapat College of Engineering, Management studies and Research, Nashik, Maharashtra, India*
*[2,3]U.G. Student, Civil Engineering Department , Gokhale Education Society's , R.H. Sapat College of Engineering, Management studies and Research, Nashik, Maharashtra, India*

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**Abstract:** Construction projects require many decisions. A key decision is to find the most effective option, as well as determining which process could produce ideal results.This paper presents comparison between conventional and frame truss system for large span industrial buildings. Two different truss systems are adopted for same industrial building. The building is analyzed and designed for wind load using STAAD pro software package. Seismic load is not considered in the present study since wind load is governing lateral load for most of the industrial buildings. The main objective is to suggest most optimized truss system for large span industrial buildings. Both types of trusses are designed and optimized keeping the demand and capacity ratios roughly same for each of the members. The parameters such member sizes, force demand deflections, member utilization ratios, material quantity etc are compared and presented. Finally the most optimized system for large span industrial building is suggested based on analysis and design results

**Key Words:** Conventional truss, frame truss, Comparative study, Staad Pro

## 1. INTRODUCTION

Steel industry is growing rapidly in almost all the parts of the world. The use of steel structures is not only economical but also ecofriendly at the time when there is a threat of global warming. Here, "economical" word is stated considering time and cost. One may think about its possibility, but it's a fact many people are not aware about framed structure. If we go for conventional steel structures, cost will be more. Makes it uneconomical.

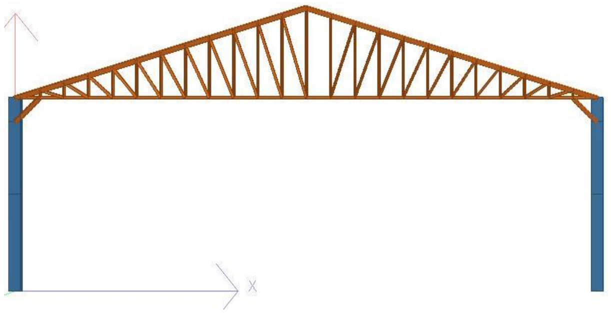
The structural performance of these buildings is well understood and, for the most part, adequate code provisions are currently in place to ensure satisfactory behaviour in high winds. Steel structures also have much better strength-to weight ratios than RCC and they also can be easily dismantled. Frame structures may have bolted connections and hence can also be reused after dismantling. Thus, frame structure can be shifted and/or expanded as per the requirements in future. In many cases it is observed that the performance of framed truss structure is much better than conventional truss system in view point of economy and control of deflection. In this paper an attempt was made to compare conventional truss system with framed truss system for various performance parameters.

## 2. METHODOLOGY

In the present study two different models was prepared using two different types of truss system namely framed truss and conventional truss. The span, height of building and all other parameters are kept same in both of the buildings. Since wind load is the governing load in industrial steel building only wind load is considered and seismic load is ignored for the purpose of this paper. The building is modelled in FEM software STAAD pro. The columns are modelled as two nodded beam elements with six DOF at each node. The top chord and bottom chord of the trusses are modelled as beam elements where as diagonals and verticals are modelled as truss element to avoid any instability. The efforts are mode to keep utilization ratios of all the members in both the models approximately same for comparison of quantities. Finally the various performance parameters such as deflection, forces in various members etc are compared and presented. The design of members are performed using STAAD pro and quantities of various members are worked out based on member sizes. The comparison between the quantities are presented between conventional and framed truss system. Following type of models are prepared. The Data used for analysis is shown in Table 1.1 below

Model 1: Conventional Truss system

Model 2: Framed truss system



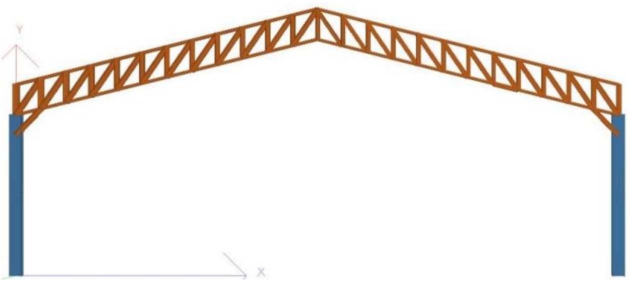


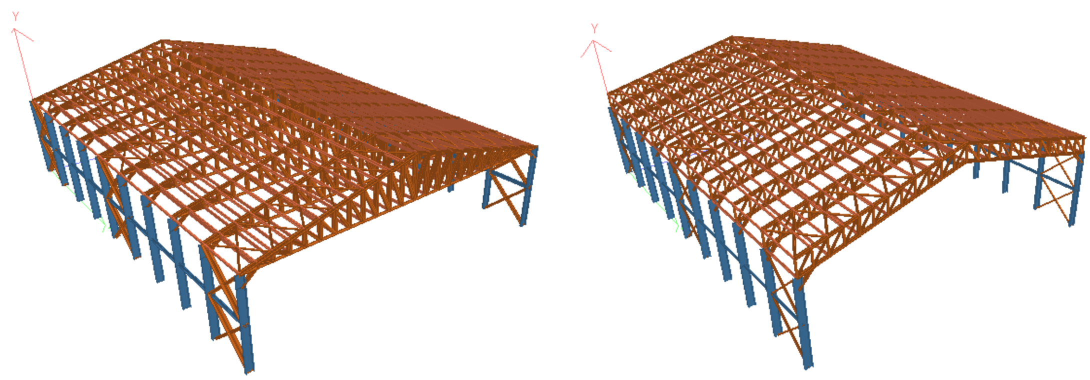
**Fig. 1:** Model 1- Conventional truss system **Fig. 2:** Model 2 -Frame truss system

**Table 1.1: Data used for Analysis**

| | |
|---|---|
| Location | Gujarat, India |
| Total length of building | 40.5m |
| Bay length | 4.5m |
| Span | 30m |
| Clear height | 8m |
| Wind speed | 44m/s |
| Wind terrain category | 2 |
| Wind class | c |
| Rise | 3m |
| Panel size | 1.2 m |
| Type of conventional truss | Howe |
| Wind load standard | IS 875:2015 |

### 4. MODELLING, ANALYSIS & DESIGN

The building is modelled using FEM software STAAD pro. Wind load calculations are done as per IS 875:2015(Part 3). The dead load consists of self weight of members, roofing material and connections and fixtures are worked out as uniform load over top chord of trusses. The live load intensity is worked out as per IS 875 considering the roof as inaccessible and applied as uniform load over top chord.



**Conventional truss Framed truss**

**Fig. 2:** Mathematical Models

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Wind load is calculated along each of the wind direction and applied in primary load cases

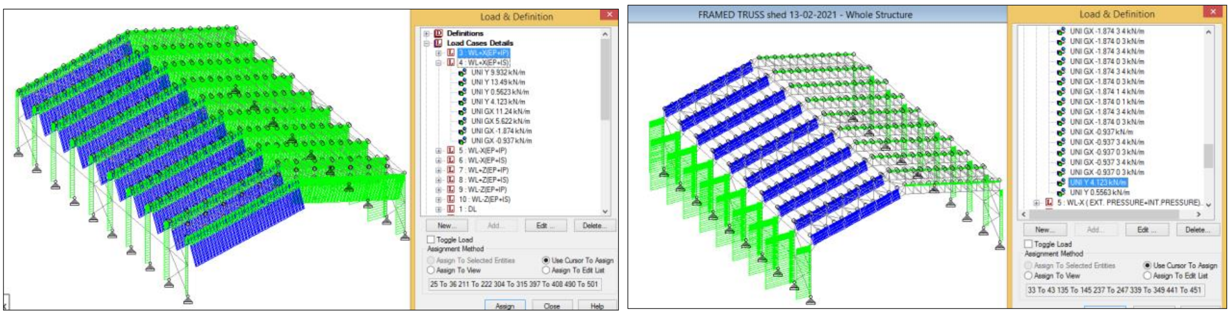



**Fig. 3:** Wind load application

## 5. RESULTS AND DISCUSSION

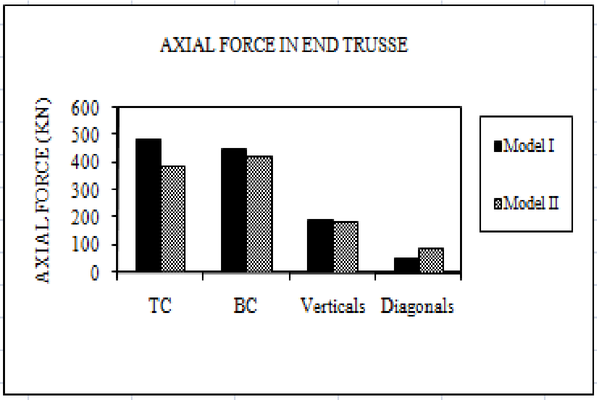
### (i) Maximum axial force in member

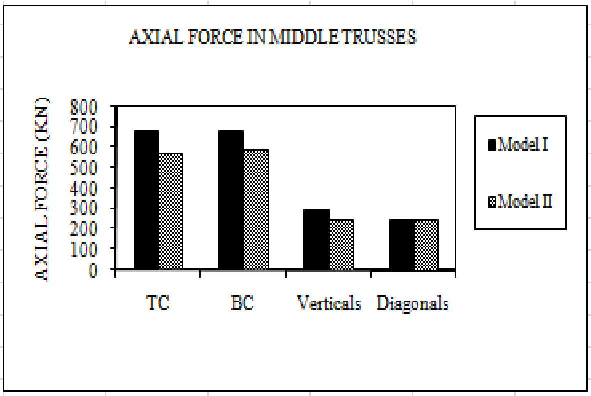
It is observed that there is considerable reduction in axial force for top chord of framed truss compared to conventional force for both end and middle trusses, however for all other members the forces are approximately same. The force is diagonal members of framed truss is found to be more than conventional truss

**Table 1.2: Comparison of Axial forces for different members**

| **End truss** | | | |
|---|---|---|---|
| Member | Frame truss | Conventional | Difference in weight |
| TC | 387.49KN(T) | 485KN(T) | -97.51 |
| BC | 423.40KN(C) | 450.40KN | -27 |
| vertical | 186.40KN | 190.40KN | -4 |
| Diagonal | 86.25KN(T) | 50KN | 36.25 |

| **Middle truss** | | | |
|---|---|---|---|
| Member | Frame truss | conventional | Difference in weight |
| TP | 568.80KN(T) | 685.49KN(T) | -116.69 |
| BC | 586.16KN(C) | 681.00KN | -94.9 |
| vertical | 243.3KN | 290KN | -46.7 |
| Diagonal | 248.53KN(T) | 250KN | 1.47 |



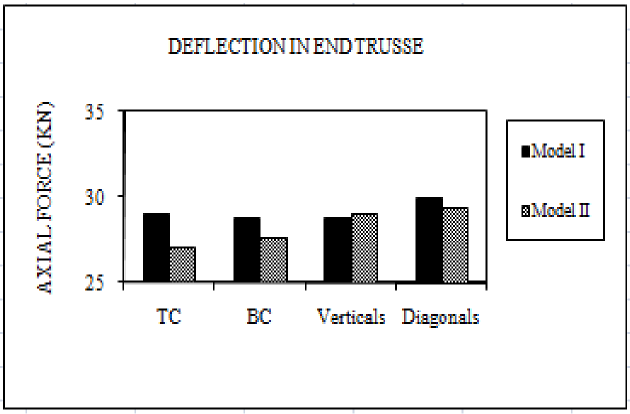



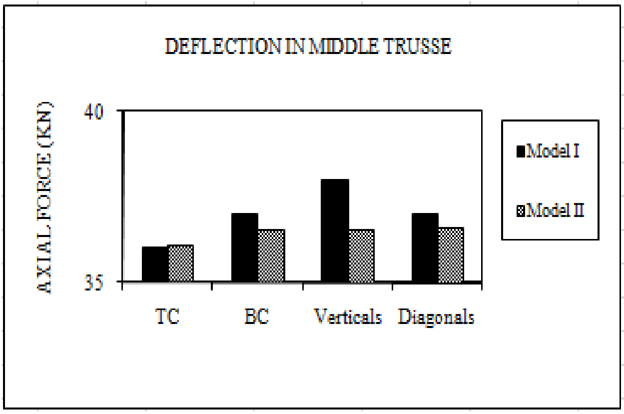

### (ii) Deflection of members

The deflection of various members are compared and presented below, it was observed that the deflection in almost all members of framed truss is found to be less than conventional truss. The deflection control in essential for serviceability and it was observed that by using framed truss instead of conventional truss a good control over deflection can be achieved.

**Table 1.3: Comparison of Deflection for different members**

| End truss | | | |
|---|---|---|---|
| Member | Frame truss | Conventional | Different in weight |
| TP | 27 | 28.97 | 4.52 |
| BP | 27.63 | 28.81 | -0.06 |
| vertical | 29 | 28.79 | -19.568 |
| Diagonal | 29.41 | 30 | -1.026 |
| **Middle truss** | | | |
| Member | Frame truss | Conventional | Different in weight |
| TP | 36.07 | 36 | -11.781 |
| BP | 36.53 | 37 | -43.48 |
| vertical | 36.53 | 38 | -1.028 |
| Diagonal | 36.58 | 37 | -4.826 |




**(iii) Comparison for structural steel quantities**

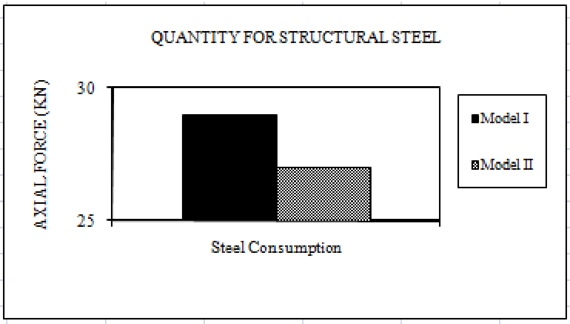
The overall material consumption for the framed truss is found to be less than conventional truss. Foe the present case there is around 8-10% saving can be achieved by using framed truss. Most of the saving is because of the reduced depth of truss resulting in reduced length of diagonal and verticals and due to the reduction in axial forces.

**Table 1.4: Comparison of Quantities for structural steel members**

| **Member** | **Profile** | **Length(m)** | **Weight(KN)** |
|---|---|---|---|
| SD | ISA180X180X20 | 632.57 | 663.791 |
| SD | ISA150X150X15 | 1070.06 | 906.934 |
| ST | ISMC225 | 1012.50 | 259.007 |
| D | ISMC125 | 526.50 | 134.79 |
| ST | ISMB200 | 81.00 | 19.165 |
| ST | ISA55X55X5 | 373.36 | 15.115 |
| | | | **Total=1968.257** |

| **Member** | **Profile** | **Length(m)** | **Weight(KN)** |
|---|---|---|---|
| ST | ISA180X180X20 | 300.00 | 157.403 |
| SD | ISA180X180X15 | 309.14 | 247.451 |
| SD | ISA180X180X20 | 1100.33 | 1154.638 |

| | | | |
|---|---|---|---|
| D | ISMC125 | 1012.50 | 258.229 |
| ST | ISMB225 | 931.50 | 238.286 |
| ST | ISMB300 | 81.00 | 36.525 |
| ST | ISA80X80X12 | 373.34 | 51.049 |
| SD | ISA150X150X10 | 32.02 | 14.363 |
| | | | **Total=2157.945** |




**Conclusion:**

It was observed that the framed truss proved to be better over conventional Howe truss in view point of resisting deflection and structural steel consumption. The steel consumption for the current case is found to be 8-10% less in framed truss compared to conventional truss system. The axial forces in framed truss system is found to be 15 to 20% less than conventional truss system, mostly in top chord and bottom chord of the truss. The deflection is around 5-10% less in framed truss compared to conventional trusses. The current study focus on typical large span truss and the results obtained are represented here, however for further investigation is suggested for variation in span and other parameters.

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