Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 08, August-2020

Analysis and Design of Web Tapered Beams and Columns using Finite Element Analysis in Portal Frame Buildings

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***Abstract*—A need is identified to introduce web-tapered portal frames to Indian conditions and practices, due to the apparent financial advantages and the unstable supply of hot-rolled members locally. This study will bring together various aspects that need to be considered for the design of web-tapered portal frames and review if this method of construction is safe and worth pursuing as an alternative to conventional building techniques. The present investigation aims at comparison of conventional steel building and building. In this investigation analysis of and design of web tapered portal frames building and conventional steel building will be carried out for spans like 20m using computer software Staad Pro v8i. 11 Web tapered steel portal frames is ideal for construction in remote and hilly areas.**

Keywords*—Web-tapered portal frames, Conventional Steel building, Staad Pro v8i.

I. INTRODUCTION

To achieve greater economy in material use, web-tapered steel members, where deeper cross-sections are used within the regions subjected to larger internal forces, are commonly employed within steel structures. However, the methods provided in current structural steel design specifications for the instability assessment of web-tapered steel members are based largely on those developed for prismatic steel members, often leading to overly conservative estimations of their ultimate strengths and thus limiting the efficiency gains achieved through their use.

A. Objectives of the Present Study

1.Create a structural optimization algorithm capable of finding the lightest possible frame, when subjected to various load combinations and design constraints.
2.Confirm the reported material savings potential of web-tapered portal frames designed with Finite element Analysis method against conventional portal frames.

B. Web tapered portal frames

Web tapered portal frames are on an average 30% lighter through efficient use of steel. Primary members are tapered built up sections, with large depths in the ares of highest stress. n this type of buildings all the structural elements are designed as per the bending moment diagram obtained. According to the bending moment diagram the steel sections are tapered. The specimens are manufactured at the factories as per the customers
requirement and then it is transported to the site. At the site by proper cutting and welding erection process is completed.

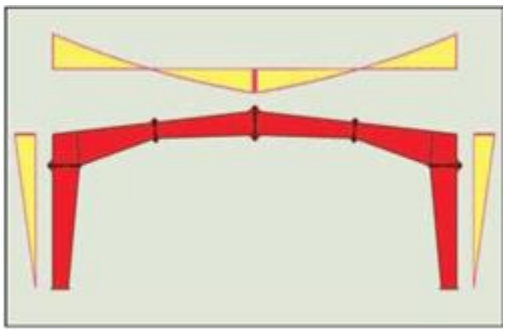

Fig.1 Web tapered portal frames

C. Advantages of Web tapered Steel portal frames

There are many advantages of web tapered steel portal frames which are as follows:
1.Quality control is the main advantage as all the structural member are engineered beforehand, standards of different codes also taken into consideration and these components are made in factory under the supervision of quality control Engineer.
2.Lower cost due to the saving in design, manufacturing and on-site erection cost.
3.Minimizing time of construction due to the use of software for design of the structural components.
4.Low maintenance due to use of standard quality of paints over steel members, which increases the ability to withstand and finally the maintenance cost will be low as compare to conventional building
5.Quick erection, as all the members are pre manufactured and skilled labor is used for connections of different components

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ISSN: 2278-0181
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6.Warranty on Web tapered steel portal frames, mostly warranty period of 20 years given by manufactures for Web tapered steel portal frames.

D. Conventional Steel Buildings

Primary steel members are selected from standard hot rolled I section, which are, in many segments of the members, heavier than what is actually required by design. Members have constant cross sections regardless of the varying magnitude of the local stresses along the member length. Steel has many advantages like ductility, flexibility, strength etc. because of this factor they are more stable and steel offers high speed for the construction from the start of work. Usually for conventional steel buildings hot rolled structural members are used. In CSB all the steel members are fabricated at the manufacturing unit and transported to the site. By welding and cutting erection process is done. Trusses are the examples of conventional steel buildings.

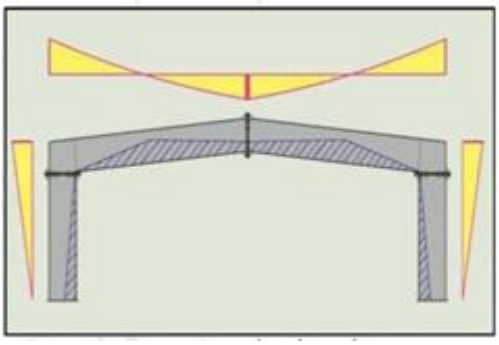

Fig.2 Conventional Steel Buildings

II. PROBLEM STATEMENT

A. Problem Statement of web tapered steel portal frames buildings and conventional steel buildings:

Long span column free structures are most essential in any type of industrial structure and web tapered steel portal frames fulfil this requirement along with reduced time and cost as compared to conventional structures. In this project range of spans will be decided for which web tapered steel portal frames can be provided economically. A comparative study of web tapered steel portal frames buildings and conventional steel building for spans 20m is to be carried out.

1 Conventional Steel Building Structure Parameters

TABLE NO 1 CONVENTIONAL STEEL BUILDING STRUCTURE PARAMETERS

Sr. No	Type of building	Industrial building
1	Type of structure	Single storey industrial structure
2	Location	Pune
3	Area of building	800m^2
4	Eave height	5.5m
5	Span width	20m
6	Number of bays	10 No's
7	Single bay length	4m
8	Total bay length	40m
9	Support condition (conventional steel buildings)	fixed
10	Conventional steel building roof slope	21.8^0
11	Column	ISMB 400
12	Bottom chord	ISA-2L-90X90X10
13	Top Rafter chord	ISA-2L-90X90X10
14	Vertical and inclined section	ISA-2L-80X80X8
15	Purlin	ISMC200

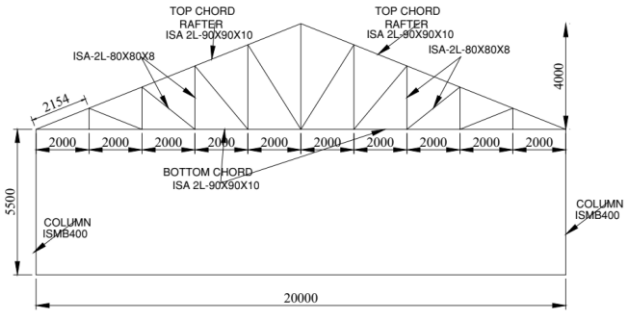

Fig.3 Elevation of Conventional steel building

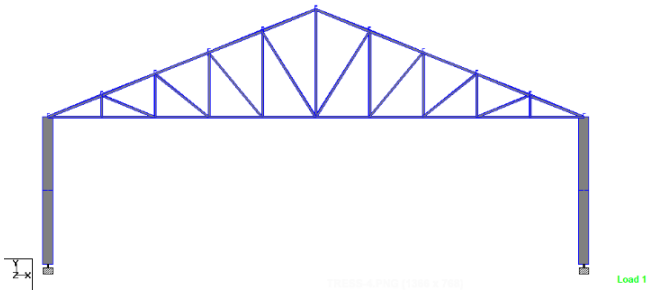

Fig.4 Staad-Pro Generated frame Elevation of Conventional steel building

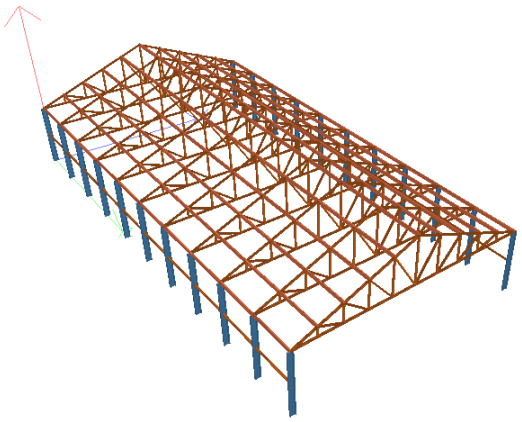

Fig. 5 Staad-Pro Generated 3D View of Conventional steel building

2 Web tapered portal frames structure parameters

TABLE NO 2 WEB TAPERED PORTAL FRAMES STRUCTURE PARAMETERS

Sr. No	Type of building	Industrial building
1	Type of structure	Single storey industrial structure
2	Location	Pune
3	Area of building	800m^2
4	Eave height	5.5m
5	Span width	20m
6	Number of bays	10 No's
7	Single bay length	4m
8	Total bay length	40m
9	Support condition	fixed
10	(Web tapered portal frames) roof slope	5.71^0

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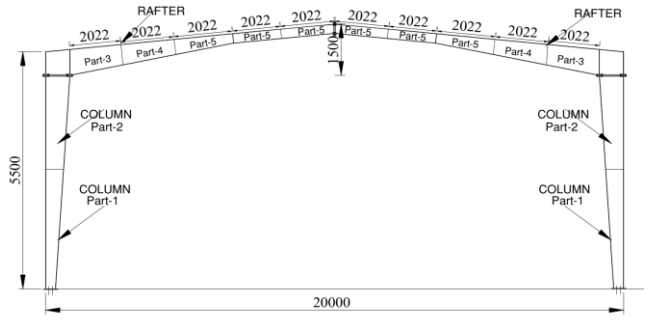

Fig.6 Elevation of Web tapered steel portal frames.

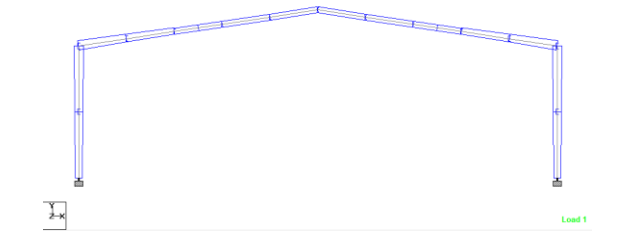

Fig.7 Staad-Pro Generated Elevation of Web tapered steel portal frames

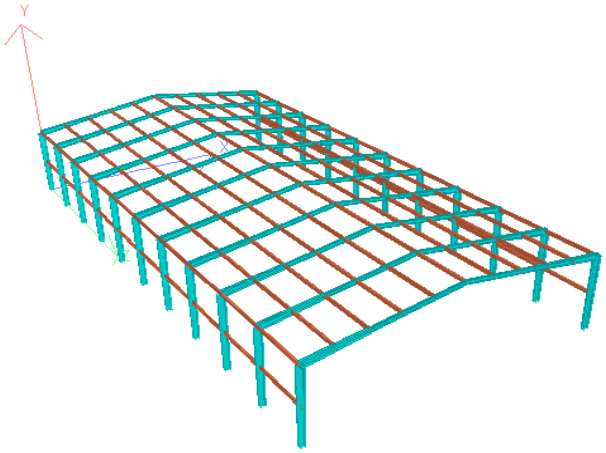

Fig.8 Staad-Pro Generated 3D View of Web tapered steel portal frames

III. RESULTS AND DISCUSSION

A. Maximum deflection (in mm) at centre for 1.5(DL+LL)

Maximum deflection at center for Web tapered portal frames and Conventional Steel Buildings by using staad pro software

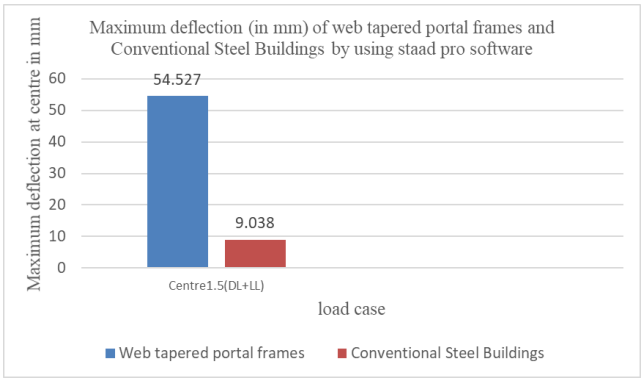

Fig.9 Maximum deflection (in mm) of web tapered portal frames and Conventional Steel Buildings by using staad pro software

B. Weight of Steel (Steel Take-Off) for Purlin in kg

Weight of Steel (Steel Take-Off) for Purlin of Web tapered portal frames and Conventional Steel Buildings by using staad pro software.

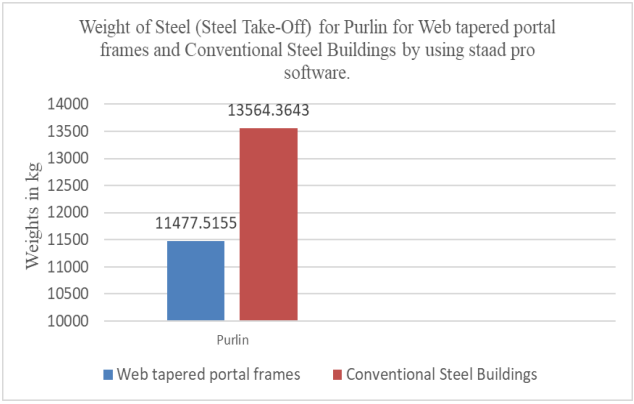

Fig.10 Weight of Steel (Steel Take-Off) for Purlin of Web tapered portal frames and Conventional Steel Buildings

C. Weight of Steel (Steel Take-Off) for Column in kg

Weight of Steel (Steel Take-Off) for Column of Web tapered portal frames and Conventional Steel Buildings by using staad pro software.

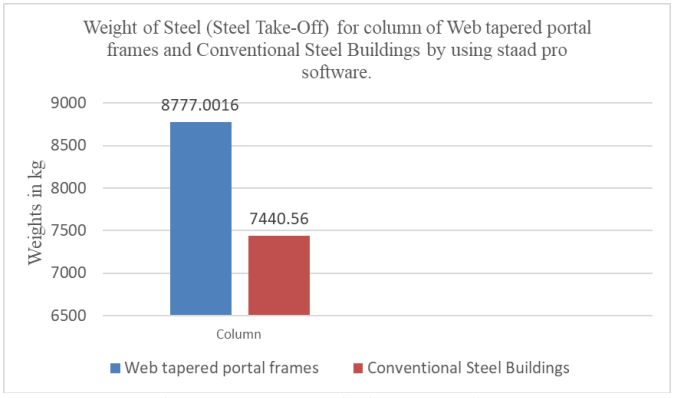

Fig.11 Weight of Steel (Steel Take-Off) for column of Web tapered portal frames and Conventional Steel Buildings

D. Weight of Steel (Steel Take-Off) for rafter, vertical and inclined members in kg

Weight of Steel (Steel Take-Off) for rafter, vertical and inclined members in kg of Web tapered portal frames and Conventional Steel Buildings by using staad pro software.

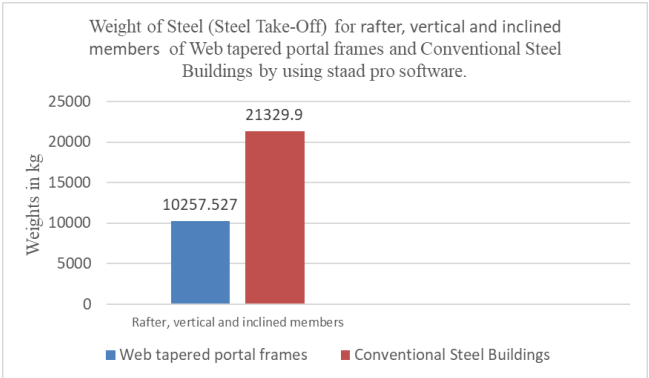

Fig.12 Weight of Steel (Steel Take-Off) for rafter, vertical and inclined members of Web tapered portal frames and Conventional Steel Buildings

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E. Weight of Steel (Steel Take-Off) for tie member to column in kg

Weight of Steel (Steel Take-Off) for tie member to column in kg of Web tapered portal frames and Conventional Steel Buildings by using staad pro software.

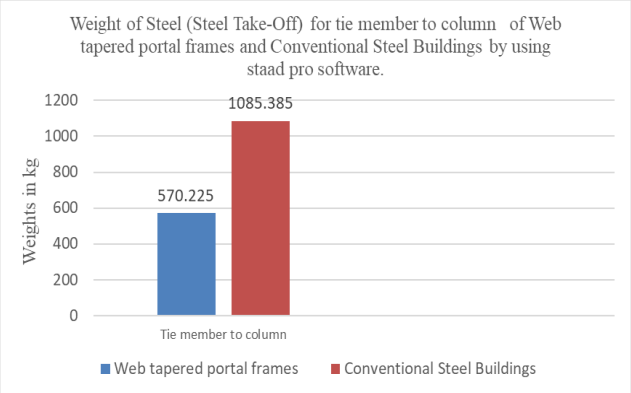

Fig.13 Weight of Steel (Steel Take-Off) for tie member to column in kg of Web tapered portal frames and Conventional Steel Buildings

F. Total Weight of Steel (Steel Take-Off) in kg

Total Weight of Steel (Steel Take-Off) in kg of Web tapered portal frames and Conventional Steel Buildings by using staad pro software.

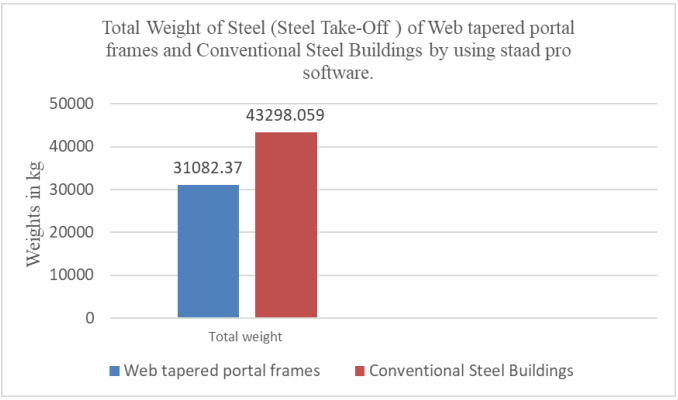

Fig.14 Total Weight of Steel (Steel Take-Off) in kg of Web tapered portal frames and Conventional Steel Buildings

G. Total Reactions in kN for 1.5(DL+LL)

Total Reactions in kN of Web tapered portal frames and Conventional Steel Buildings by using staad pro software**.**

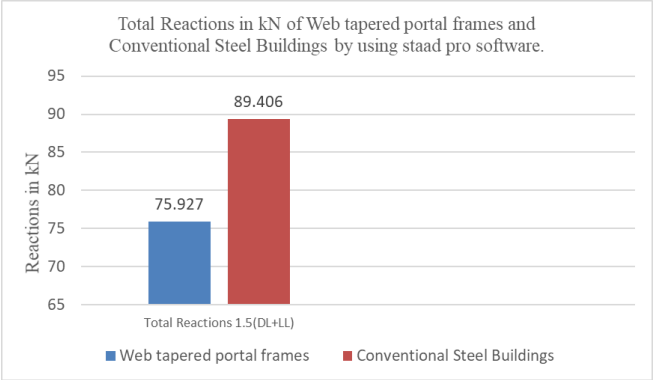

Fig.15 Total Reactions in kN of Web tapered portal frames and Conventional Steel Buildings.

IV CONCLUSIONS

Now a days Web tapered steel portal frames concept has been very successful and well established

1.The Maximum deflection (in mm) of web tapered portal frames is more 83.42% than of Conventional Steel Buildings.
2.The Weight of Steel (in kg) of web tapered portal frames is less 15.38% than of Conventional Steel Buildings.
3.The Weight of Steel (in kg) for column of web tapered portal frames is more 15.22% than of Conventional Steel Buildings.
4.The Weight of Steel (in kg) for rafter, vertical and inclined members of web tapered portal frames is more 15.22% than of Conventional Steel Buildings.
5.The Total Weight of Steel (in kg) in kg of web tapered portal frames is less 28.21% than of Conventional Steel Buildings.
6.The Total Reactions in kN of web tapered portal frames is less 15.076% than of Conventional Steel Buildings.
7.Web tapered steel portal frames construction reduces the weight of building than conventional steel structures
8.It reduces the amount of steel requirement, reduction in dead load reduces the size of foundation
9.Web tapered steel portal frames construction is 30 to 40% faster than conventional steel structures.
10.Provide good insulation effect and would highly suitable for a tropical country like India.
11.Web tapered steel portal frames is ideal for construction in remote and hilly areas.

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