Finite Elemental Analysis of Industrial Structure using Cold Formed Steel

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Abstract— Increasing world population and natural resource limitations has led to a growing demand for more efficient structural systems to achieve a sustainable economy and society. Cold-formed steel CFS) Structural systems are increasingly adopted as primary or secondary structural members in modern building construction because of their light weight, speed of construction, recyclability, and sustainability. The pre-engineered steel building system construction has great advantages to the single storey buildings, practical and efficient alternative to conventional buildings, the System representing one central model within multiple disciplines. Pre-engineered building creates and maintains in real time multidimensional, data rich views through a project support is currently being implemented by Staad pro software packages for design and engineering. In this research work we will design Industry using analysis tool SAP 2000 and use Novel cold formed steel structure and compare it with general steel available in Indian market. Here we will compare both in terms of strength and weight of structure with bolted and welded connections.

Keywords: Cold Formed Steel, Analysis, Stadd.Pro, Industrial Building, Cost Analysis, Forces

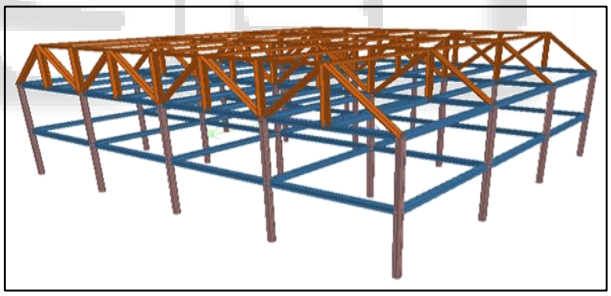
I. INTRODUCTION

Generally, the Large Industrial Warehouses or Manufacturing units are single storey steel structures. Auxiliary structure separates between the essential building edges of metal building frameworks. It performs a perplexing job that reaches out past supporting rooftop and divider covering and conveying outside burdens to centralized servers. Auxiliary structure, as these individuals are now and again called, may fill in as rib supporting for essential surrounding and may work as a piece of the building's horizontal load– opposing framework. Rooftop optional individuals, known as purlins, regularly structure a basic piece of flat rooftop stomachs; divider auxiliary individuals, known as girts, are habitually found in divider propping gatherings. Most of steel structures being manufactured are just low-ascent structures, which are for the most part of one story as it were. Mechanical structures, a sub-set of low-ascent structures are regularly utilized for steel plants, vehicle enterprises, light, utility and procedure businesses, warm power stations, distribution centers, get together plants, stockpiling, carports, little scale ventures, and so forth. These structures require vast section free regions. Henceforth inside segments, dividers and segments are regularly disposed of or kept to a base.

Comparative investigation of use of cold formed steel over traditionally used Hot Rolled steel Structures in order to create a new set up the base for using a conservative, steady and lightweight material for its quick amassing and transportation. For the examination and configuration process, we have utilized the investigation device STADD.PRO.

A. Cold formed steel structures

As the name derives Cold Formed Steel (CFS) units are generally processed from rolling sheets of steel or steel strips or sometime steel plates treated on room temperature. The material thicknesses for such slight walled steel membranes more often than not extend from 0.0147 in. (0.373 mm) to about ¼ in. (6.35 mm). Steel plates and bars as thick as 1 in. (25.4 mm) can likewise be cold-framed effectively into basic shapes (AISI, 2007b).Cold Formed Steel products were first introduced in initial introduction of codified standards in 1946. Use of Cold Form Steel is highly prevalent in Civil Industry including both Structural and Non, Structural elements which are generated from thin gauges of steel sheets. Cold formed steel is quite a versatile products which is used in the manufacturing of small structures like warehouses to even large scale structures which included bridges, buildings, Transmission towers, transmission poles etc. In particular construction industry, cold formed steel is generally used in construction of beams columns, sections bars.



B. Optimization of Structure

Plan advancement is approximately characterized by Papalambros and Wilde (2000) as the choice of the "best" structure inside the access methods. Whenever expressed so basically, enhancement appears a conspicuous target of any structure undertaking. However when the issue is badly organized (characterized by Simon (1973) as lacking definition in some regard), including a conceivable nonappearance of suitable apparatuses and learning, or if the consumption in finding an ideal arrangement puts a high premium on the structure cost, a great plan that meets a characterized resilience on all necessities is commonly acknowledged.

C. Wind Analysis

High rise buildings and Mid-rise buildings faces damages due to strong winds and manufacturing plants generally face severe damages generally proposed in coastal areas highly prone to strings wind waves. The specified wind loads were applied on the mid-rise manufacturing plant in order to

prevent the failures of design of the building because of strong winds. The strong winds generally affect the coastal zones in India accompanied with tropical or extra tropical cyclone or many a times come sin form of tornadoes. The previous are expansive scale wonders that are spread over about 1000km in a flat plane, and their temperament is similarly outstanding. Down-blasts are blasts because of plummeting wind streams brought about by serious precipitation in created cumulonimbus. Since the size of these wonders is little, few are grabbed by the meteorological perception organize. It is realized that tornados are little scale wonders a few hundred meters wide at most having a rotational breeze with a quick climatic weight plunge. The qualities of the solid breeze and weight change brought about by tornados are not known. The quantity of events of downbursts and tornados is generally substantial, yet their likelihood of assaulting a specific site is little contrasted and that of the tropical or extratropical twisters.

D. Objectives

The main objective of this study is to justify the implementation of cold reformed steel in Indian continent buildings as an alternative for small buildings and industrial frames instead of R.C.C. and general steel sections. Following are the objectives:

1) To determine the variation in strength of CFS and steel sections.
2) To determine the weight variation in both.
3) To determine its implementation on a live project using wind load.
4) To determine the technique of optimization of steel using software.
5) To determine the 3d analysis of steel structure using STadd.Pro

II. LITERATURE REVIEWS

Ragavan et. al. (2018) (seismic analysis of steel structure) Here the author considered a seismic analysis of a cold formed steel bare frame structure using the application SAP 2000 where they considered three divergent steel frame models as a 10 storey, 20 storey and a 30 storey building for the examination. Distinctive stacking conditions like the dead burden, live burden, seismic burden and wind load are connected in our examination. Straight investigation (Time History Analysis) and Non - direct investigation (Pushover investigation) are embraced for the assessment of seismic conduct of the distinctive sorts of steel outline structures under examination. Straight and Nonlinear investigation of the three distinct kinds of building structures gives a thought regarding the obstruction ability of the inspected structures against substantial horizontal powers. Aside from the incorporation of different burden designs diverse properties have been doled out to the structures as bracings. Knee props, reversed knee supports and erratic props have been received in this undertaking study. Relocations or distortions and sheer powers at basic segments have been inspected with the arrangement of programming examination.

Marsel Garifullin and Udo Nackenhorst (2015) (Computational Analysis of Cold-Formed Steel Columns with Initial Imperfections) Here the author stated his experience with application of cold formed steel structures where he faced complications while buckling along with post-buckling performance. The nearness of any sort of vulnerabilities confuses the estimation of such structures. Slender walled CFS individuals are known to be especially defenceless against the impact of beginning geometric flaws. These blemishes might be the result of the assembling procedure, transportation and capacity or the development procedure. The article gives the consequences of nonlinear clasping examinations of CFS C-molded compacted segments and assesses the impact of blemishes on the heap bearing limit of the tried individuals.

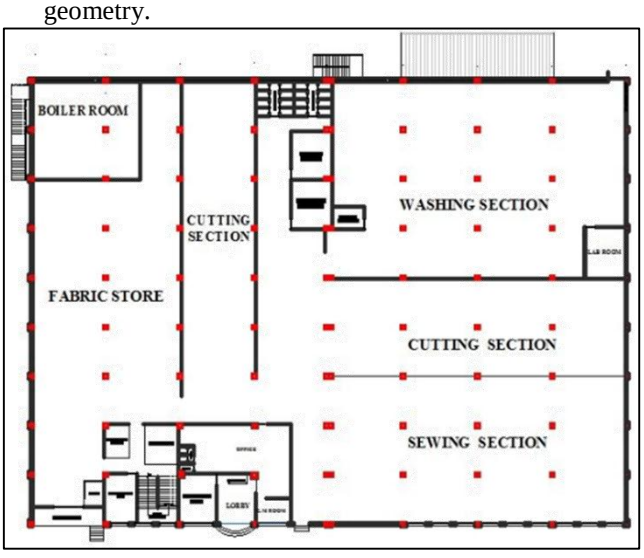
Harun Mugo Thande (2014) (Structural Analysis and Design of a Warehouse building) Here the author analyzed the different structures adopted for building warehouses considering the various assemblies used in the connection of the structures. The pieces of the building picked were viewed as the most critical particularly given the stacking conditions. The three noteworthy burdens following up on the structure included: snow load, wind load and the structure's very own weight. The fundamental motivation behind the examination was to distinguish portions of the building which experienced high burdens.

III. PROBLEM IDENTIFICATION

In this examination, a similar report dependent on two unique sorts of materials, for example, Cold-framed steel and Hot moved steel type utilizing Non-straight investigation in Stadd.Pro are readied, thinking about a similar stacking. In this investigation, we will likewise set up a cost examination of both the structures utilizing S.O.R. C.P.W.D. 2014.

IV. METHODOLOGY

1) Step-1 first step of our study is to select building geometry.



Plan of Industrial Building

2) Step-2 Selection of different materials (CFS & STEEL) can be use.
3) Step-3 Selection of wind zone (47m/s) as per IS- 875 (part-III):1987, Appendix – A for high wind intensity region.
4) Step-4 Formation of load combination (8 load combinations in x & z-direction)

A. Load combinations as per I.S. 875-IV

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)

5) Step-5 Modeling of building frames using STADD.PRO software.
6) Step-6 Analysis of truss considering same loading.

B. Geometrical properties of the structure

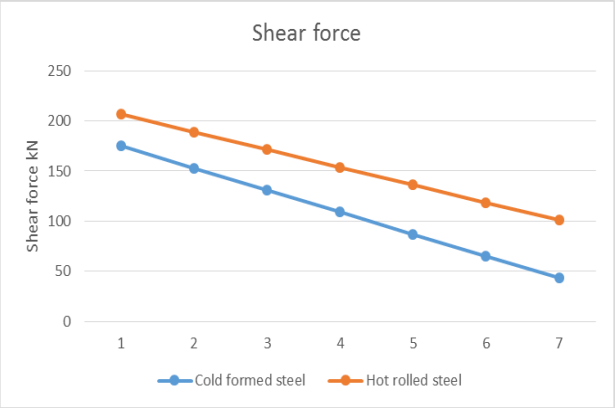
Geometrical details	
Building	Industrial building
Section type	As per Indian Standards
Support Condition	Pinned/Hinged support
Length	40 meter
Bays in Z direction	8 spans of 5 m each
Width	20 meter
Bays in X direction	4 spans of 5 m each
Column height	8 meter

C. Material properties

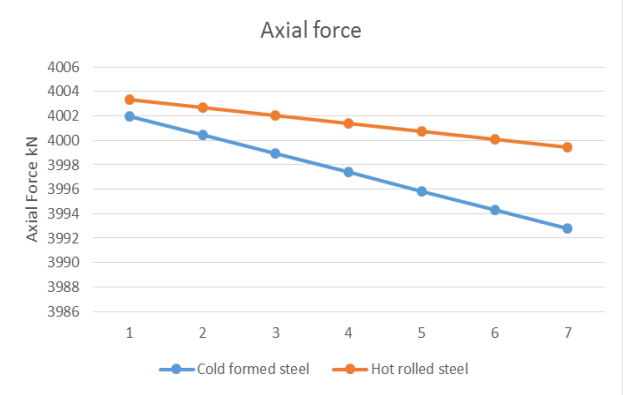
Material properties	Values
Density of STEEL	7480 kG/ m^3
Density of Cold Formed Steel	8000 kG/ m^3
Young's modulus of STEEL	2.17 x 10^4 N/mm^2
Poisson ratio, μ (Steel)	0.17
Poisson ratio, μ (C.F.S)	0.3
Tensile strength of Steel	415 N/mm^2
Elastic Modulus of C.F.S.	3447.3 MPa
Tensile Strength of C.F.S.	550 N/mm^2

V. RESULT ANALYSIS

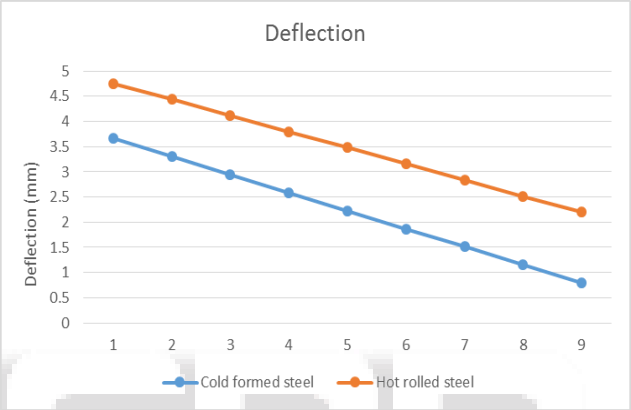
A. Shear Force Kn



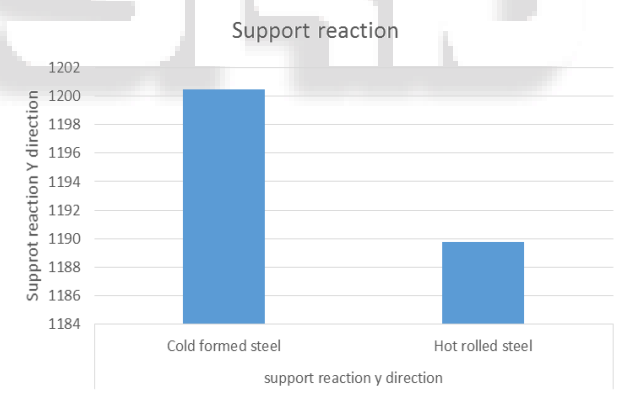
B. Axial Force



C. Deflection at Different Joints



D. Support Reaction



E. Cost Analysis

Cost Analysis in Rupees				
Type	Qty. Kg	Rate	Total	Remark
Steel Section	10380	136	1411680	14% Cost reduction is observed in C.F.S. structure
C.F.S. Sec	8700.43	140	1218060	

VI. CONCLUSION

In present study comparative study is done on a 3-dimensional ware house for same loadings with different section to find out the best material either cold formed or general steel section which will be stable, good in stiffness, cost effective, economical and easily available.

Shear force: As shear force is generated due to unbalancing at the joints connecting different members, here in above chapter it is observed that C.F.S structure can minimize the forces unbalancing by approximately 22% thus making structure more stable.

A. Axial Force:

In building with truss structures like (ex: Consider an Mobile Communication Tower structure, ware house, industrial frame). Every truss element of the structure is designed to take only Axial forces (Either Tension or Compression). Axial forces can cause Buckling in long slender members. In our study it is observed that minor variation of 4-5% is obtained in C.F.S. frame.

B. Support Reactions:

A support reaction is the reaction force/forces that are attributed to a support for the system. In our study it is observed that distribution of forces to the support and support to the below ground is more effective in C.F.S. frame.
Deflection: The deflection distance of a member under a load is directly related to the slope of the deflected shape of the member under that load, and can be calculated by integrating the function that mathematically describes the slope of the member under that load. In results above it is observed that C.F.S. frame structure is resisting deflection comparing to general structure

C. Cost Analysis:

As India is a developing nation thus development of new construction with cost effectiveness is important for its proper and budgeted development. Here results shows that using C.F.S. one can minimize the cost by 14% of the total cost.

D. Future Scope

- C.F.S. analysis of heavy and tall structure can be proceed in future.
- Seismic analysis can be proceed.
- Study of connections can be investigate in future.

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