Parametric Study of Cold Formed Steel Sections And Hot Rolled And Standard Steel Sections

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Abstract- *The performance of cold formed steel structure and hot rolled steel structure, Two structures of same dimensions and same type with different materials have been studied and compared One structure is completely designed and analyzed in hot rolled steel while the same model is designed in cold formed steel. Both the structure are designed in STAAD Pro. Results of the present study would be handy in designing a structure that leads to optimal use of material, In constructions of residential and industrial buildings, the use of cold-formed steel (CFS) structures has now grown-up considerably, and now it is becoming a suitable alternative to general and conventional methods due to its massive advantages, like it is very light weight, it has high quality, and ease of construction. The results shall be checked with the ultimate goal of reducing the tonnage. Structural analysis and design shall be carried out in STAAD.Pro.V8i SS6 by Bentley.*

Keywords- Cold formed steel, Hot Rolled Steel, STAAD Pro, Weight, Steel Structure.

I. INTRODUCTION

Cold-formed, light-gauge stuccoworks have been one of the most prolific areas for research and improvement in the field of structural steel work over the last few decades leading straight to greatly increased use of these members as primary structural elements. While the forming process for cold-formed sections allows a lot greater freedom than is the case for heavier hot-rolled members, considerable inventiveness in cross sectional shapes has been possible, bringing with it the benefits of more competent material usage but also the challenge of need to consider more complex structural response. This arises from two basic properties of the product, (a) the slimness of the plate elements in typical structural shapes; and (b) the complexity of the structural behavior resulting from both this thinness and the greater variety and complexity of shapes possible in the cold-rolling process. CFS sections are comparatively lighter in weight than hot rolled steel sections. CFS has no definite sections, so it can be molded into any desired sections and as it can be molded into any section, the aesthetic view of the structure can be greatly be enhanced. The principal objective of this research is to carry out the analysis and design of steel warehouse with 6m span using Hot rolled steel sections and cold formed steel sections. The results shall be achieved with the ultimate goal of reducing the tonnage. Structure analysis and design shall be carried out in STAAD Pro. V8i SS6 Software. Cold formed steel is used in building construction, for wall coverings, floor decking etc. Cold formed steel is a basic component in construction of lightweight prefabricated structures like stud frame panels, trusses and portal frames. Cold formed steel sections can be made easily available at any place whereas hot rolled sections difficult to produce. The structure is a model using constant parameters such as bracing systems, height. Span with various load combination.

II. STEEL SECTIONS

A. *Cold Formed Steel Sections*

Cold-formed steel (CFS) section is the term used for products which are made by rolling or pressing thin gauges of steel sheets into goods. CFS goods are created by the working of thin steel sheets using stamping, rolling or presses to deform the steel sheets into a proper product which are usable. The manufacturing of CFS products occurs at the room temperature with the use of rolling/pressing. The buckling property is used to analyze the strength of elements. The applications of CFS members includes the buildings, bridges, car bodies, storage tanks, highway products, railway coaches, transmission towers, drainage facilities, etc. There is a change in the mechanical properties of steel material due to the cold working material as it is formed using pressing. The yield strength and ultimate strength of the steel section which is formed from steel plates/sheets are increased. The coating of zinc or galvanizing is made to protect the cold-formed steel sections and this provides the protection against the corrosion in the environment. Cold-formed steel elements are having types of stiffened or unstiffened. The stiffened elements obtained by an element supported by webs along both longitudinal edges. While the unstiffened element is obtained when the element supported along any one longitudinal edge only and the other edge can have the displacement.

B. *Hot Rolled Steel Sections*

Hot Rolling is usually used to produce the standard section. In this process, the molten steel is poured in to continuous casting systems where it is passed through a series of rollers which squeeze it to the desired shape before if solidifies completely. It is subsequently cut in to desired standard lengths. Cross section and size of the members are governed by optimum use of material, functional requirement etc. Usually sections with larger modulus of section compared to cross sectional area are preferred. IS Handbook 1 published by BIS provides the dimensions, weights and other sectional properties of various standard sections as per IS 800:2007. Rolled steel sections are available in various forms for use in Steel Construction. Shapes, sizes and properties of these rolled steel sections are discussed. Steel is one of the important building materials in construction industry. It can be used in many ways for many purposes. Different steel members are manufactured in the factories based theirusage. Rolled steel sections are casted in continuous casting molds without any joints. Different shapes or forms of rolled steel sections are explained below.

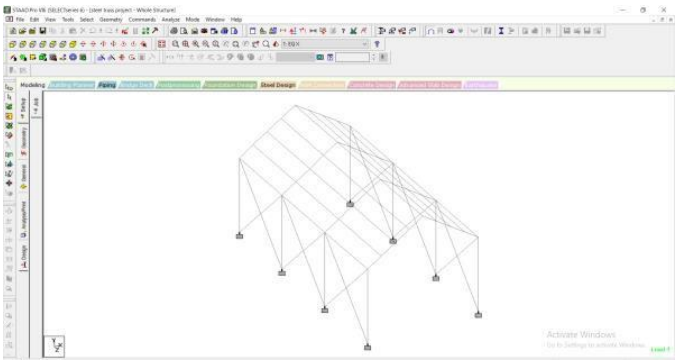
Different Forms of Rolled Steel Sections

Various forms of rolled steel sections are as follows:

1. Angle sections
2. Channel sections
3. T- sections
4. I-sections
5. Rectangular hollow sections
6. Circular hollow sections

III. MODELLING APPROACH (STAAD Pro)

The principal objective of this research is to carry out the analysis and design of steel warehouse with 6m span using Hot rolled steel sections and cold formed steel sections. The results shall be achieved with the ultimate goal of reducing the tonnage. Structure analysis and design shall be carried out in STAAD Pro. V8i SS6 Software. Cold formed steel is used in building construction, for wall coverings, floor decking etc. Cold formed steel is a basic component in construction of lightweight prefabricated structures like stud frame panels, trusses and portal frames.



A. Loads and Forces

Clause 3.2 of IS 800:2007 specifies the various loads and forces that has to be considered while performing the design of steel structures. As per Cl. 3.2.1 of IS 800:2007, for the purpose of designing any element, member or a structure, the following loads (actions) and their effects shall be taken into account, where applicable, with partial safety factors and combinations (Cl. 5.3.3 of IS 800:2007). (a) Dead loads; (b) Imposed loads (live load, crane load, snow load, dust load, wave load, earth pressures, etc); (c) Wind loads; (d) Earthquake loads; (e) Erection loads;(f) Accidental loads such as those due to blast, impact of vehicles, etc; and (g) Secondary effects due to contraction or expansion resulting from temperature changes, differential settlements of the structure as awhole or of its components, eccentric connections, rigidity of joints differing from design assumptions. *Dead loads (Cl. 3.2.1.1 of IS 800:2007):*

The dead load includes loads that are relatively constant over time, including the weight of the structure itself, and immovable fixtures such as walls, plasterboard or carpet. The roof is also a dead load. Dead loads are also known as permanent or static loads. Building materials are not dead

loads until constructed in permanent position. IS 800:2007 give unit weight of building materials, parts, and components.

Live loads or imposed loads (Cl. 3.2.1.2 of IS 800:2007):

IS 800:2007 specifies in Cl.3.2.1.2 that imposed loads for different types of occupancy and function of structures shall be taken as recommended in IS 875 (Part 2). Imposed loads arising from equipment, such as cranes and machines should be assumed in design as per manufacturers/suppliers data (Cl. 3.5.4 of IS 800:2007).

Wind loads (Cl. 3.2.1.3 of IS 800:2007):

The force exerted by the horizontal component of wind is to be considered in the design of building. Wind loads depends upon the velocity of wind, shape and size of the building. The method of calculating wind loads on structure is given in IS 875 (Part- 3):1987.

Seismic Load/Earthquake Loads (IS 1893- 2002/2005):

Seismic loading is one of the basic concepts of earthquake engineering which means application of a seismic oscillation to a structure. It happens at contact surfaces of a structure either with the ground or with adjacent structures. Seismic loading depends, primarily on seismic hazard, geotechnical parameters of the site, and structure's natural frequency etc. The higher mass of the structure will imply that the earthquake loading will also be high. Earthquake load depends on the following factors, 1) Seismic hazard,
2) Parameter of the structure and 3) Gravity load.

IV. STRUCTURE GEOMETRY (STAAD Pro)

No. of Bays in X- Direction=1
No. of Bays in Z- Direction=3 Span of steel warehouse=12m Purlin distance=0.901m
Height of steel warehouse structure at edge=4m Total Height of structure= 6m
Support condition for hot rolled structure= Fixed Support condition for cold formed structure=Fixed

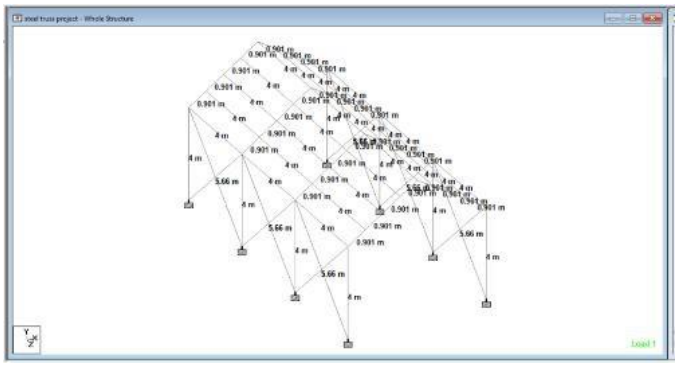


Figure1: 6m span hot rolled steel structure geometry with dimension

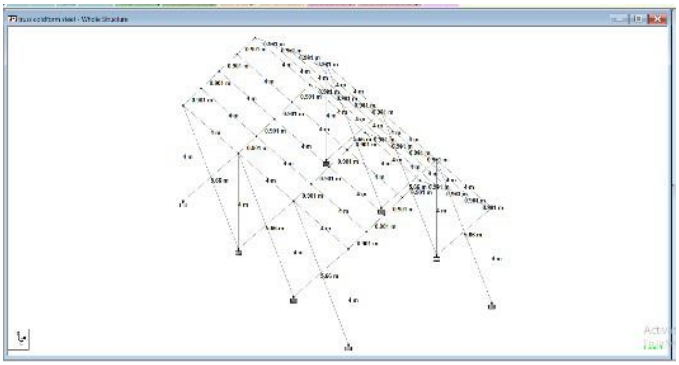


Figure2: 6m span cold formed steel structure geometry with dimension

A. *Loading Application (STAAD Pro)*

Wind Load:

As per IS 875 (part 3) it was suggested that if the structure or building which is greater than 10m we need to apply the wind load in case otherwise skip the wind load condition. So for this respected warehouse considered height is 6m that's why eliminated wind loading condition.

Seismic loads:

Zone factor (zone IV) = 0.24 Response reduction factor (RF) = 1 Importance factor (I) = 1
Rock and soil site factor (SS) = 1 Damping ratio (DM) = 0.05% Self-weight factor= 1

Loadcase Details:

Under seismic loads-
Earthquake load at X direction (EQ X) - factor 1 Earthquake load at Z direction (EQ Z) - factor 1 Live load:
Live load (fy) = -20kn Dead Load:
Self-weight= -1Kn/m
Member load=0.05x1=0.05kn/m Load combinations:

Table 4 Partial Safety Factors for Loads, γ_f, for Limit States
(*Clauses* 3.5.1 *and* 5.3.3)

Combination	Limit State of Strength					Limit State of Serviceability			
	DL	LL[1]		WL/EL	AL	DL	LL[1]		WL/EL
		Leading	Accompanying				Leading	Accompanying	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
DL+LL+CL	1.5	1.5	1.05	—	—	1.0	1.0	1.0	—
DL+LL+CL+	1.2	1.2	1.05	0.6	—	1.0	0.8	0.8	0.8
WL/EL	1.2	1.2	0.53	1.2					
DL+WL/EL	1.5 (0.9)[2]	—	—	1.5	—	1.0	—	—	1.0
DL+ER	1.2 (0.9)[2]	1.2	—	—	—	—	—	—	—
DL+LL+AL	1.0	0.35	0.35	—	1.0	—	—	—	—

[1] When action of different live loads is simultaneously considered, the leading live load shall be considered to be the one causing the higher load effects in the member/section.
[2] This value is to be considered when the dead load contributes to stability against overturning is critical or the dead load causes reduction in stress due to other loads.
Abbreviations:
DL = Dead load, LL = Imposed load (Live loads), WL = Wind load, CL = Crane load (Vertical/Horizontal), AL = Accidental load, ER = Erection load, EL = Earthquake load.
NOTE — The effects of actions (loads) in terms of stresses or stress resultants may be obtained from an appropriate method of analysis as in 4.

Clause 3.2 of IS 800:2007 specifies the various loads and forces that has to be considered while performing the design of steel structures.

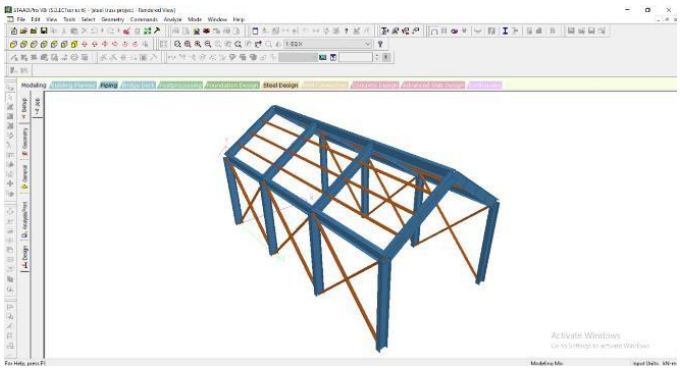


Figure: 3D View of hot rolled steel warehouse structure

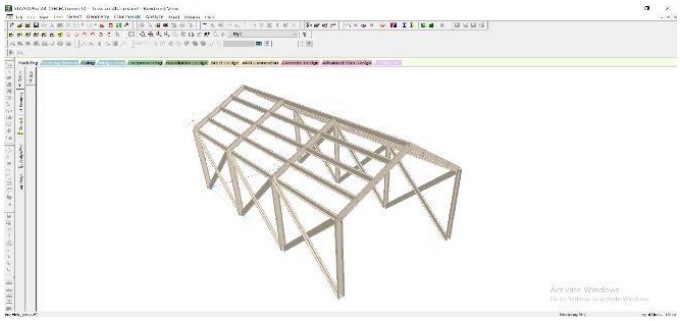


Figure: 3D View of cold formed steel warehouse structure

V. WEIGHT OF HOT ROLLED STEEL STRUCTURE AND COLD FORMED STEEL STRUCTURE

Table: 1Weight of hot rolled Structure

Property	Weight (KN)
IW350 300X10	71.233

Table: 2 Weight of cold formed Structure

Property	Weight (KN)
250CS 80X5	38.4464
TOTAL WEIGHT	38.4464 KN
TOTAL WEIGHT	3921.54 Kg

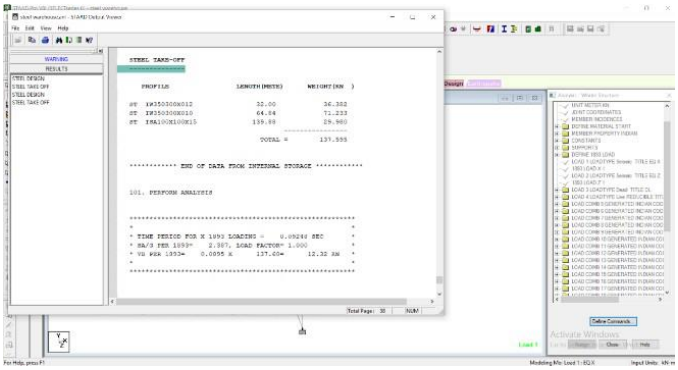


Figure: weight of hot rolled steel warehouse structure

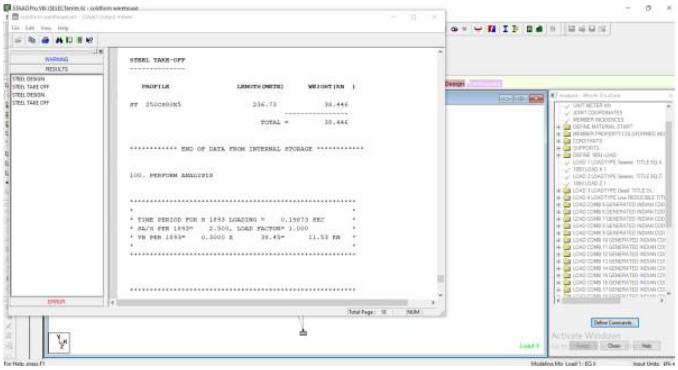
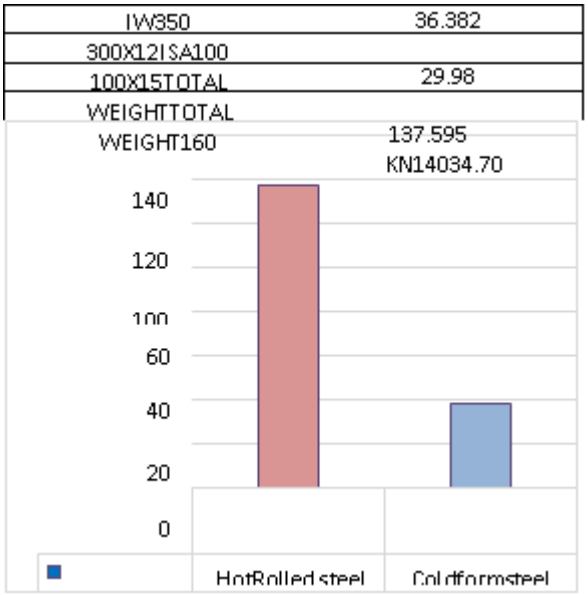


Figure: weight of cold formed steel warehouse structure

VI. RESULT AND DISCUSSION

From the tables and below graph is observe that steel consumption is more in steel warehouse structure using hot rolled steel sections as compare to steel warehouse structure using cold formed steel sections. The weight is more in steel warehouse which use of hot rolled sections.



Steel Warehouse

VII. CONCLUSION

The steel warehouse structure of hot rolled sections and cold formed sections with 6m span are design and analyzed using STAAD- Pro. V8i SS6 software. From preceding results and discussion following conclusions can be made:

The weight of steel warehouse with cold formed sections are 10114 Kg reduced than steel warehouse structure with hot rolled sections. The weight of steel warehouse with cold formed sections are reduced with 72% than steel warehouse structure with hot rolled sections. So from the above conclusion, steel warehouse with cold formed sections is very economical than steel warehouse with hot rolled sections.

VIII. ACKNOWLEDGMENT

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