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COMPARATIVE ANALYSIS OF CIRCULAR ROOF FOR SWIMMING POOL BY COLD FORMED AND HOT ROLLED STEEL SECTIONS

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Abstract

This study presents a comparative analysis of circular roof structures designed for swimming pools, employing both cold-formed and hot-rolled steel sections. The research investigates the structural performance, cost-effectiveness, and material efficiency of these two construction methods within the context of circular roofing systems.

The methodology involves structural modeling and analysis utilizing advanced computational tools and engineering software. Design considerations, load-bearing capacities, and structural behaviors of cold-formed and hot-rolled steel sections in circular roof configurations are thoroughly examined.

Key parameters such as strength-to-weight ratios, material properties, deflection characteristics, and construction feasibility are evaluated for both construction techniques. The analysis includes considerations of manufacturing processes, installation complexities, and environmental impacts associated with each method.

The study emphasizes optimizing the structural integrity and cost-efficiency of circular roof designs for swimming pools. It explores innovative design approaches, considering geometric intricacies and load distributions specific to circular configurations, while adhering to industry standards and safety regulations.

Findings from the comparative analysis offer valuable insights into the strengths and limitations of both cold-formed and hot-rolled steel sections in constructing circular swimming pool roofs. The study facilitates informed decision-making for engineers, architects, and stakeholders involved in selecting the most suitable construction method based on project requirements, budget constraints, and structural performance expectations.

The research underscores the significance of a comparative approach in assessing construction methods, promoting sustainable and optimized designs for circular roof structures in swimming pool applications, fostering advancements in structural engineering practices.

Index Terms— Circular Roofs, Cold-Formed Steel Sections, Hot-Rolled Steel Sections, Structural Analysis,

INTRODUCTION

Steel is an alloy of iron which is hard, strong, and greyish in color. The use of steel structure has been increasing day by day due to its higher strength, ductility and durability. Steel is mainly of two types: cold-formed steel and hot-rolled steel. Hot rolled steel are rolled above steel's recrystallization temperature and these steel can be easily changed into any desired shapes and sizes. Generally hot-rolled sections are of higher thickness as compared to cold-formed steel which are mainly used in railway track, heavy beams and columns, and other different steel section which are need not be precise in shape and size as that of the cold form steel. Cold formed steel are also known as light gauge steel structures which are extensively used in industrial structures, roof sheeting's, floor decking, or as a prefabricated frames or panels. The thickness of cold formed steel are generally thinner and ranges normally from 0.4mm to 6.4mm. Cold form sections are more sensitive to local buckling than hot rolled sections. The primary concern for everyone is to choose the best, safe structure. Truss is the structure which comprises of one or more triangular units and members are connected through bolting or welding or riveting. The total external forces acting on the structure comes at the nodes but due to

the truss structure's formation, it allows dispersion of all the external loads in the form of tensile or compressive forces. Trusses are most commonly used in bridges, roofs and towers. Mainly trusses are used to:

- ➢ Achieve long span
- ➢ Reduce the self-weight of the structure
- ➢ Able to withstand higher loads and stresses
- ➢ Lesser deflection

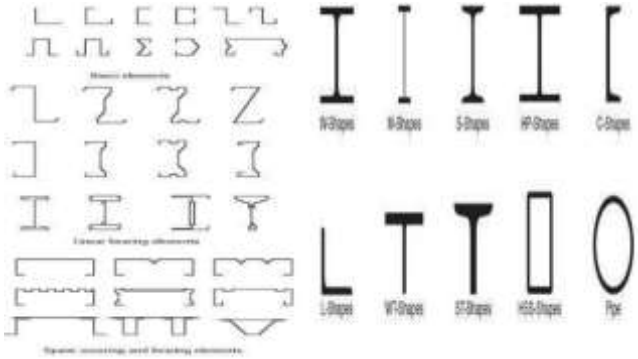

Fig 1: Cold Formed and Hot Rolled Steel Sections

There is lots of disparities between cold-formed steel and hot-rolled steel mainly in material properties, geometrical configurations, residual stress, material response as well as general structural behavior, load carrying capacity and cost. In this paper, truss element is taken for the experimental and analytical study made of cold and hot rolled steel and compared their behavior.

Table No 1: Details of Specimen

Type of Truss	Warren Truss
Length	1.2 m
Height	0.3 m

II. DESCRIPTION OF THE MODEL

Here for the analytical and experimental study truss of cold formed steel and hot-rolled steel are made separately; which has the following details:

The cold formed truss comprises of square tube of 50x50x2 mm as a member and connected via welded connection. Similarly, hot rolled truss consists of 50x50x5 mm section square tube and connected via welded connection of 3 mm thickness

III. ANALYTICAL STUDY

For the analytical study, STAAD Pro. Software was used and the economical sections were selected for the experimental study.

Here both the samples made of cold-formed and hot-rolled steel were done separately and their behavior was studied.

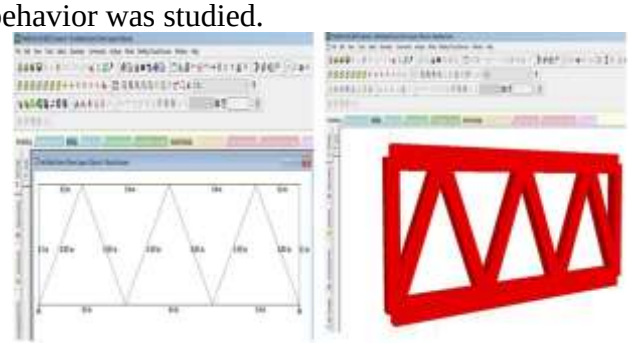

Figure No: 2 Modelled 2-D and 3-D View of Truss

a. LOAD AND LOAD COMBINATIONS For analysis purpose, dead load and live loads of the

structure were taken into account. DL and LL were only taken into account so as to match the loads that will be applied during the experiment too. The load combinations considered during analysis in STAAD Pro. are:

1.5 (DL+LL)
1.2 (DL+LL)
1.5 DL
1.2 DL 0.9DL

b. CODES USED The code books followed are: IS 800:2007 (General Steel), IS808:1989 (Hot Rolled Steel), IS 801 (Cold Formed Steel)

IV. EXPERIMENTAL STUDY

The testing of both cold formed truss and hot rolled truss sample were tested in Universal Testing Machine and different parameters were like deflection, load carrying capacity, residual stresses, etc. were tabulated.

Figure No 3: Failure of Cold Form Steel and Hot Rolled Steel

V. RESULTS AND DISCUSSION

Different parameters of steel like physical properties, weight of the structure, Deflection, residual stress and cost are discussed briefly.

A. COMPARISON OF PHYSICAL PROPERTIES

All the types of steel are passed through two or more number of rolls. The rolls squeeze the steel and apply the pressure to change into desired shapes and sizes, which in-turn changes the physical properties of the steel. Hot rolled steel have scaly grey finish, rounded and less precise corners than the cold formed steel. This makes the use of hot rolled section more where the product are not needed in precise size, shape and finishing also smoother. The scaly finish can be more preferred mainly in the metalworking.

B. COMPARISON OF WEIGHT

The weight of the hot rolled steel is generally higher as their section are of higher thickness compared to cold form steel, even though the same size of specimen are made. Here in this research work 5mm hot rolled steel and 2 mm cold form steel is also taken for the experiment. Here the weight of cold formed steel along with infilled wood is lesser than that of the hot rolled sample taken.

C. DEFLECTION AND LOAD CARRYING CAPACITY

From the above graph, it is clear that the load carrying capacity of both forms of steel are same even though the thickness of hot rolled is higher than that of the cold form steel. The ultimate load carrying capacity of hot rolled is nearly 120 KN, on the other hand cold formed steel is 115 KN. The cold form steel has resisted more load due to the presence of wooden member which helped in taking the compressive loads acting on the steel member and making it stiffer.

D. RESIDUAL STRESS

Stresses in steel which are present prior to the application of stress is called residual stress. Residual stresses in welded joints develop due to heating, peak temperature and cooling at any moment during welding. Residual stress can be measured by destructive and non-destructive techniques like deep hole drilling, ring core, ultrasonic, neutron diffraction method, etc. Thicker the section higher will be the residual stress, hence hot rolled steel mainly have higher value of residual stress than the cold form steel.

E. COST

Table shows the cost analysis of two different forms of steel. Here the cost analysis includes only the cost of the steel available in the market. The cost of cold form steel is slightly higher than that of the hot rolled steel, but due to the less weight of the cold formed steel, the overall cost of the steel is reduced.

CONCLUSION

Cold formed steel members have more advantages over the hot rolled steel, but the cold formed are more vulnerable to various buckling modes. Cold formed steel can go more deformations before failure and they can resist almost the same load as the hot rolled section if there can be infilled with some compressive members like wood (which is carried out in this experiment). The weight of hot rolled sections is higher slightly than the cold form members. The stress distribution of hot rolled section is uniform throughout the section while the cold formed steel shows distinct variation in the stress distribution. The software analysis results done by STAAD Pro. Software are nearer to the experimental results. While comparing the load carrying capacity, hot rolled steel members are failing in bending while cold formed steel members are failing due to distortional local buckling failure. Hence, for low rise structures like roof sheeting, floor decking, trusses, industrial sheds, prefabricated frames and panels. Similarly, hot rolled section can be used high rise structures, railway tracks, etc., where the loads are expected to be higher.

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