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A case study on Light gauge framed steel structure

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Abstract— *Light gauge framed steel structure is based on factory made galvanized steel sections of appropriate size. It is manufactured by using cold-formed steel method at manufacturing plants and assembled as panels on site forming the structural steel framework of the building. The current paper covers various aspects of LGS methodology applied in an expansion project. As light gauge steel structure has advantages like more durability, speed in construction etc. it became absolute solution for existing as well as proposed shed.*

Keywords—*Light gauge framed steel structure, cold-formed steel, light gauge steel*

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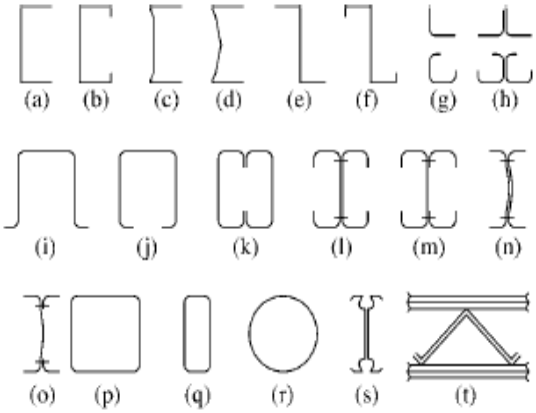
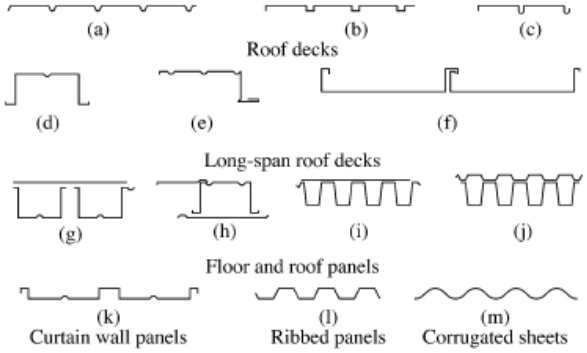
I. Introduction

Light Gauge Framed Steel Structure (LGFSS) is a factory-made galvanized light gauge steel component produced by cold forming method assembled as panels at site forming a steel framework of a building. LGSS can be used without any composition for G+3 building and more than that with the composition of hot rolled structures. The cold formed steel sections are used in LGFS structure. The cold formed steel sections are generally used for columns, beams, wall panels, and siding materials in the building. These sections are cold formed from carbon or low steel sheet, strip, plate or flat bar in cold-rolling machines or by press-brake or bending brake operations. During this case, the heavy hot rolled steel shapes and the cold formed steel sections supplement each other.

Cold formed steel structure is applicable in special features like high compressive strength and lastingness local buckling, high flexural strength, fire resistance, adequate wind, and seismic response using the bracing shear wall, respectively in a very highly competitive and aggressive construction market. As compared to other materials like timber and concrete, cold- formed steel members can give the subsequent advantages like light in weight, high strength and stiffness, easy prefabrication and production, fast and simple erection and installation and economy in transportation and handling. As these cold formed steel sections are light in weight the thickness ranges from 0.378 mm to 6.35mm and some 25.4 mm thick plate and bar can be cold-formed steel becomes structural forms as per our requirements and its strength can increase up to 550MPa.General terms used in LGS framing is cold formed steel, galvanized steel, bottom plate, C-sections, joist, beams, girders, studs, noggins, floor joist, blockings, anchor bolts, X- bracings etc. In this paper our aim is to study recent advances in cold formed steel structure. The present work deals with the construction of light gauge steel structure inside an existing factory shed where they have made their worker's cabin in LGFS system.



a) The above figure shows various structural framing used for LGFS structure.



The above figure shows panels and decks used in LGFS structure [6].

II. Review of Literature

J Michael Davies studied light gauge steel cassette wall construction. Cassettes are C shaped cold formed steel sections also known as structural liner trays. In this paper author concentrated on C shaped cold formed steel sections which were used as primary elements in low rise construction where there behavior in shear is important. The principles explained in this paper were used in more than 20 actual projects and mainly in residential and commercial projects. The author concluded the paper by noting the suitability of cassette wall construction for extreme loading conditions such as earthquake [1]. S.Vignesh kannan reviewed different research articles on light gauge steel structure to understand the properties of LGFS. The author also studied the advantages of LGFS. Cold formed steel sections performing good under finite element analysis were also studied [2].Thanuja Ranavaka carried experimental studies for understanding mechanical properties of light gauge cold-formed steel section at elevated temperature. The mechanical properties of light gauge cold-formed steels at elevated temperatures are not fully understood and appropriate design values are not available to the designers. Tensile coupon tests were undertaken at more than seven different temperature level up to 800^0C.The sections ranging from 0.6 – 1 mm thickness to determine the yield and ultimate strengths, the elasticity modulus and the stress-strain curve. Results showed that the steel grades has an influence on the yield strength of steel however, there is no relation between steel grades and modulus of elasticity [3].

Benjamin J. Schafer studied recent advances, analysis, application and design in cold formed steel structures. Cold formed steel members have definitely evolved to include numerous optimized shapes beyond the conventional cross-sections. Analysis advances in the Finite Strip Method and Generalized Beam Theory provide unique capabilities for modal decomposition and identification of thin-walled members, but important work still remains to provide efficient tools that can be readily integrated with conventional structural analysis [4]. Reynaud L. Serrette studied seismic design of light gauge steel structure. In this paper author mentioned some design issues with the LGFS structure at the time of earthquake and also highlighted some areas in LGS framed design that may be useful to designers. The author suggested use of gypsum wall board for vertical wall shear in wood framed assemblies. The author mentioned the use of flat type X-bracing: strap over strength and proved that 35% more yield strength can be achieved. Also the application of similar sheathing attached to both sides of wall were recommended by author. The author presented issues related to hysteretic behaviour, deformation capacity, over strength, gypsum wall board and sheathing both sides [5]

V Venkatesan and R Ganesan showed many statistical data by taking a case study of LGFS structure. Many advantages of LGFS structure as compared to hot-rolled structure were shown. The most significant advantages are the lack of need to using thermal operations, lack of thermal tensions of residual in sections, the possibility of creating sections in various shapes to achieve the maximum resistive return in section, lightweight, high resistance and rigidity, high accuracy in implementing details, and rapid and easy installation. As the research findings revealed the amount of base cut in the LGSF system compared to the reinforced concrete system is reduced up to 55.5%, and compared to the metal system is reduced to 38.1% [7].

III. Methodology

Cold formed steel structures are manufactured by two methods. 1.) Roll forming and 2.) Brake Forming. In roll forming process steel sections are manufactured using a roll forming mill and rolling the steel plastically to a desired shape. Whereas in brake forming process, by using a machine, cold press break the section and the section will be pressed and broken several times to get the desired section. Various sections for cold-formed steel are as shown below (Images to be added).

In this paper we have taken a case study of an existing factory shed (area to be mentioned) which was first expanded to (area to be mentioned). Later on client had an additional requirement of worker's cabin in the existing production shed for which LGFS system was implemented. The area of LGFS structure is 330 Sqm comprising of G+1 structure with mezzanine slab (Deck slab) of 150mm thick and a staircase in MS. The light framing structure system was manufactured out of high tensile bare-Galvalume (150GSM) cold formed C-sections of 89mm web, 41mm flange and 11mm lip both side comprising 550MPa yield strength. The framing had a provision of 32mm dia hole at standard spacing to accommodate conduits of electrical/plumbing to be fixed in the system. The structure had a provision of framed openings for doors, windows and ventilations. The structure was fixed vertically by 400 mm c/c by means of galvanized steel fasteners. External walls and partition walls were considered for first floor only. Wall cladding for external walls was 10mm thick cement fiber board whereas for internal walls was 12.5 mm thick gypsum board. Wall insulation was of 50mm thick rock wool insulation. Wall cladding and insulation is considered only for 1st floor.

Design loads		
1.	Dead load (Kn/m^2)	0.13 (Kn/m^2)
2	Live Load (Kn/m^2)	0.57 (Kn/m^2)
3	Wind Speed (m/sec)	39 m/sec
4	Seismic Zone	III
5	Design Software	Stadd Pro
6	Design Code	AISC-05/MBMA-06

The various stages of work for LGDS structure includes material assembly within 5 days for 330 sqmt. Area and that to in a running factory. After excavation of PEB columns the erection of columns was done. Then wall erection i.e. LGFS framing, first exterior walls were erected and then interior truss fixing was done. And lastly false ceiling work of gypsum was done.

Material stacking – Stage 1

Column Erection

Deck slab sheet laying for mezzanine floor

Wall framing

Exterior cladding

LGFS structure after completion

IV. Conclusion

With this case study we have come to a conclusion that light gauge steel framed structure has following advantages:

1.) Construction period is less. In this structure it took less than 30 days to erect G+1 structure.

2.) Waste material is less and material used is of improved quality. The material can be reused and is recyclable and also easy to remove.

3.) The structure is designed for seismic loads and high wind forces, hence the structure is safe.

4.) Designs are more flexible, we can have longer spans.

5.) The structure is more durable and requires less maintenance.

6.) The structure can be erected in hilly areas also as the sections and members are light in weight so transportation is easy.

Whereas, in comparison to hot rolled steel cold formed steel has following properties:

1.) The sections are relatively small in comparison to its width unlike hot rolled members. In this case local buckling is the issue which leads to different modes of failure.

2.) For fastening methods, use of mostly screws and bolts are done while in hot roll steel use of welds and bolts are done.

3.) Designing LGFS is more complex than hot rolled structures due to thinness of its member section and unusual section types. Due to thinness of member section local buckling may occur before the section yielding. But if the member is stiffened by another element, it will resist to more loads and will show more strength called post buckling strength.

4.) In case of fire the steel will lose its strength and huge collapse will occur which seems to be the only disadvantage of LGFS structure.

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