Prospective Construction Systems for Mass Housing

No.
8/2014

TECHNOLOGY PROFILE

Light Gauge Steel Framed Structures (LGSF)

Building Materials & Technology Promotion Council
Ministry of Housing & Urban Poverty Alleviation
Government of India
New Delhi

System in Brief

Light Gauge Steel Framed Structures (LGSF) is based on factory made galvanized light gauge steel components, designed as per codal requirements, produced by cold forming method and assembled as panels at site forming structural steel framework of a building of varying sizes of wall and floor.

The basic building elements of light gauge steel framing are cold formed sections which can be prefabricated on site using various methods of connection. The assembly is done using special types of screws and bolts.

Cold formed sections are widely used in construction including residential floors, industrial buildings, commercial buildings, hotels and are gaining greater acceptance in the residential sector. LGSF is already well established in residential construction in North America, Australia and Japan and is gaining ground in India.

LGSF is typically ideal for one to three storey high buildings, especially in residential homes, apartments and commercial buildings. Due to its flexibility fast construction and durability, this technology has great potential for counties like India.

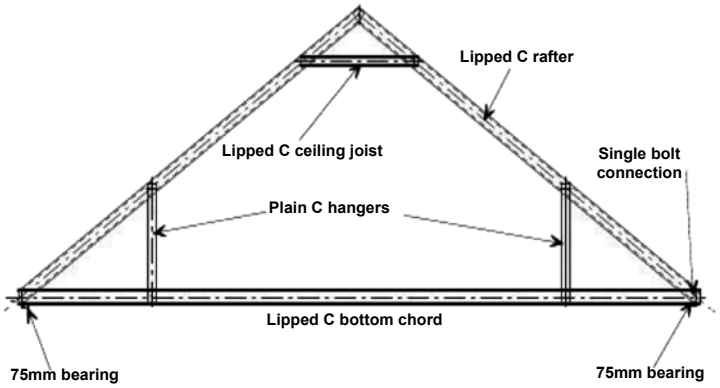
LGSF can be combined with composite steel / concrete deck resting on light steel framing stud walls. Apart from having potential for mass housing, modular buildings can be used for long term temporary or permanent structures such as schools and classroom, military and civil housing needs, post – disaster relief structures and industrial buildings. Advisable span for LGSF buildings should be 7.5 m.

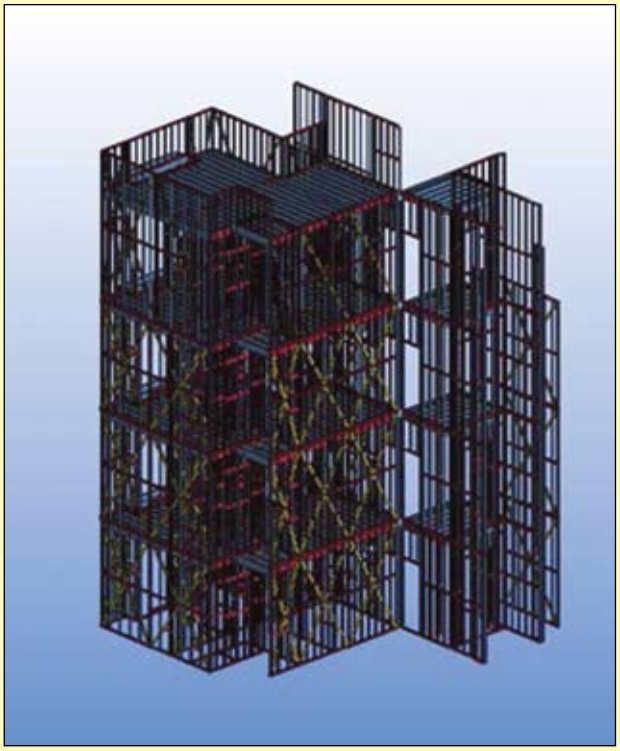
Specifications for the System

Structural Section	**Main Section are Studs & Track.** **Studs** serve as a general all purpose framing component used in a variety of applications including external curtain walls, load bearing walls, headers floors & roof joists, soffits and frame components. **Track** is used as closure to stud and joists end as well as head and sill conditions. It is also used for blocking and bridging conditions. Load bearing steel framing members shall be cold – formed to shape from structural quality sheet steel complying with the requirements of one of the following: i) ASTM A 653 / A 653 M -13 Grade 33, 37, 40 & 50 (Class 1 and 3) or ii) ASTM A 792 / A 792 M -13 Grade 33, 37, 40 & 50; or iii) ASTM A 875 / A 875 M – 13 Grade 33, 37, 40 & 50; or iv) Sheets, that comply with ASTM A 653 except for tensile and elongation with requirements, shall be permitted, provided, the ratio of tensile strength to yield point is at least 108 and the total elongation is at least 10 percent for a 5 mm gauge length or 7 percent for a 20 mm gauge length.

Wall frame	Consists of top track (U shape configuration) with a depth compatible with that of the studs of the same nominal size. Minimum height of track flanges shall be 19 mm. **Load Bearing Walls** C section studs with depth of 90 and 200 mm and thickness between 2.7 mm and 2.0 mm shall be provided at a distance of 300 mm / 400 mm / 610 mm to ensure the efficient use of cladding material. Multiple studs are used at heavily loaded application such as adjacent to openings or in braced panels. C section with 94 x 50 mm is used for noggins. Alternation shall be required for the local details at the head & the base of the wall to ensure that loads are adequately transferred without local deformation of the joists & studs. **Non Load Bearing Walls** It is similar to that of load bearing walls except that noggins and diagonal bracing are not required to stabilize the studs. **Deflection Limit of Walls** Suggested deflection limit for external walls subject to wind loading are as follow: Full height glazing — Height / 600 Masonry wall — Height / 500 Board / reduced finish — Height / 360 Steel cladding — Height / 250 Other flexible Cladding — Height / 360
Wall cladding	Wall cladding shall be designed to resist wind load. Sheet has to be screwed to the joist / purlin with maximum spacing of 300 mm c/c. All the joints of sheet in longitudinal direction require a minimum lap of 150 mm in order to make them leak proof. Following materials are generally used on wall cladding: • Gypsum board conforming to IS 2095 (Pt. 1): 2011 • Heavy duty cement particle board conforming to IS 14862:2000.
Bracing	Bracing and bridging shall have configuration and steel thickness to provide secondary support for the studs in accordance with the relevant specification for the design of Cold – formed steel structure of members.

Floor frame	For speed of construction, floor joist may be pre-assembled to form floor cassettes. This works well for regular floor places but care shall be taken when the geometry of the building requires the cassettes to vary in size with location or when non – right angel corners are required. Resistant may be provided to the top flange of the joists by the flooring board. The floor should be designed for the combined effect of dead and imposed load. The construction of a suspended floor comprising cold formed steel floor joists is similar to that for a floor using timber joists. The strength to weight ratio of light steel joist is higher than that of other material. Steel joists are stable and do not suffer, the long term problems of drying out, creep and Shrinkage. Joists are generally positioned at 300, 400 & 600 mm centres, depending on the spacing capabilities of the floor materials used.
Roof frame	Flat roof is made up of joists. Where steel decking form a flat roof, a minimum fall of 1:4 should be introduced to ensure that any moisture runs off. To avoid local ponding to rain water, the pitch may need to be increased to overcome the effective reduction in roof angle caused by the deflection of long span roof purlin or decking.
Roof truss	Use of Light Steel roof truss is very economical for larger span building, an attic or open roof truss creates usable roof space, uses fewer components than Fink truss and provides an economical solution, since it utilizes the high strength of the steel members. The trusses are placed at 600 mm maximum spacing and are battened and tiled in a conventional manner.





Screws	Screws as per the details given below shall be used: • Panel Assembly – Low profile screws • LGS-LGS Wall panel to roof cassette – 12-14x15mm • LGS to concrete – Tapcon screw 14-12x60mm Hex head • Wire mesh = EPS board – SDS Hex head with Ceresin without washer • HRS-LGS – Hex heat • CP board 6mm – WT 8 CSK Phillips • Gypsum board – Flat heat self-driven type • Deck sheet/Wire mesh – SDS WT, CSK, Flat head
Extended Polystyrene Panel	Shall be of minimum density – 15 kg/m^3.
Wire Mesh	Shall be made of 4 mm dia wire of UTs 480 MPa with spacing 150 mm x 150 mm or 1.4 m dia of spacing 40 mm x 40 mm.
Shortcrete	Shortcrete when used shall be of minimum grade M 25.
Design	
	The LGSS is designed based on provision of the following standards: • Indian Standard IS 801: 1975 Code of Practices for use of cold formed and welded section and light gauge steel structural members in general building construction. • British Standard BS 5950 (Part 5):1998 – Structural use of steel in Building Part 5 – Code of Practice for design of cold formed thin gauge structure. • British Standard BS 5950 (Part 1): 2000 Structure use of steel work in Building Part 1 with loading requirement as per IS 875 (Part 1) • Indian Standard IS 875 : 1987 Code of Practice for design loads Part 1 - Dead Loads - Unit Weights of Building Material and Stored Materials Part 2 - Imposed Loads Part 3 - Wind Loads • IS 1893 (Part 1):2002 Criteria for Earthquake Resistant Design of Structures - Part 1 : General Provisions and Buildings
Manufacturing	
	The sectional are manufactured using a Centrally Numerical Control (CNC) automatic four Pinnacle Roll Forming machine having production speed of 450-900 m/h with very high precision.

Construction

Foundations for light steel framing are essentially the same as for any form of construction, although dead loads applied by the light steel frame will be much lower than in the concrete or masonry construction.

Construction phases of steel buildings resembles the phases of conventional reinforced concrete buildings. The sections, manufactured as per design are numbered properly. The profiles are sent to site either as profile or panellized parts, considering the distance of the construction site and transportation conditions. Profiles are assembled by trained assembly team at the construction site in line with the architectural plan. Only special studs are used during assembly, no welding is done. Once the assembly is done, the frame is filled with insulation materials (fibreglass, rockwool etc). Walls are then covered with standard boards or similar approved materials.

The sequence of erection is foundation laying, fixing of tracks, fixing of wall panels with bracings as required, fixing of floor panels, fixing of roof panels, decking sheet, fixing of electrical & plumbing services and finally fixing of insulation material & walling panels.

Electrical Gas and plumbing, services are installed through pre-punched service holes in the web of the steel forms. Plastic grommets and silicon seals are used to fasten and protect wiring and pipes from corrosion and damage arising from vibrations

Electrical cables running within floor insulation layer in the separating floor construction should be protected with cartridge fuses or mini circuit breaker.

Wall panels are generally made by using heavy duty Cement Particle Board and Gypsum board. It can also be made using high density extended polystyrene core plastered from outside using wire mesh and chicken mesh. Galvolume sheet of appropriate thickness can also be used as cladding. This technology is being evaluated by BMTPC under PACS.

Advantage

LGSF is based on established system of light gauge steel structures and designed as per codal provisions with loading requirements as per Indian Standards.

High Precision

- Fully integrated computerised system with CNC machine provides very high accuracy upto 1 mm.

Structural

- High strength to weight ratio. Earthquake force generation is less due to light weight. Chance of progressive collapse are marginal due to highly ductile and load carrying nature of closely spaced studs/joists.

Speed in Construction

- Construction speed is very high. A typical four storeyed building can be constructed within one month.

Saving in foundation

- Structure being light, does not require heavy foundation.

Mobility

- Structural element can be transported any place including hilly places to remote places easily and structure can be erected fast.
- Structure can be shifted from one location to other without wastage of materials.

Environment friendly

- Steel used can be recycled when required.

Other Referred Standard :

IS 2095 (Part 1) : 2011	Specification for Gypsum Plaster Boards - Part 1 Plain Gypsum Plaster Boards
IS 14862 : 2000	Specification for Fibre Cement Flat Sheets
ASTM – A653/ A 653 M -13	Specification for steel sheet, zinc coated (galvanized) on zinc – iron alloy coated by hot dip process.
ASTM – A 792/792 M -13	Specification for steel sheet, 55% aluminium zinc alloy coated by hot dip process
ASTM – A 875/875 M -13	Specification for steel sheet, zinc 5% aluminium alloy coated by hot dip process.

About BMTPC

Set up in 1990, Building Materials & Technology Promotion Council (BMTPC) an autonomous organisation under the Ministry of Housing & Urban Poverty Alleviation strives to bridge the gap between laboratory research and field level application in the area of building materials & construction technologies.

Vision
"BMTPC to be world class knowledge and demonstration hub for providing solutions to all with special focus on common man in the area of sustainable building materials, appropriate construction technologies & systems including disaster resistant construction."

Mission
"To work towards a comprehensive and integrated approach for promotion and transfer of potential, cost-effective, environment-friendly, disaster resistant building materials and technologies including locally available materials from lab to land for sustainable development of housing."

For more information, kindly contact:

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