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Light Gauge Steel Framing
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Boosting Production and Quality

Longevity and Performance of
Hardened Concrete

Light Gauge Steel Framing in India For Sustainable Steel Housing

Light Gauge Steel Framing is an advanced alternative to the prevailing design methods and building materials in India due to its faster construction time, higher durability of structures, and better environmental sustainability.

Nibedita Dey, Senior Manager (Civil & Structural), Institute for Steel Development and Growth (INSDAG)

Structural Steel is used in heavy industrial structures, railways, bridges, metros, etc, besides high- and medium-rise commercial buildings. Structural steel is also becoming very popular for its use in Pre-Engineered Buildings (PEB), industrial buildings, and in prefab structures. Hot-Rolled or fabricated steel sections are being commonly used in industrial and building construction.

Light Gauge Steel Framing

Another technology called Light Gauge Steel Framing (LGSF) is also becoming popular in India in low to medium-rise housing, in industrial buildings, warehouses, storages, and similar structures.

Assembly of components, primarily made of Cold Formed Steel (CFS) sections, assembled as panels or full truss systems at site, forming a structural steel framework, is called LGSF. This structural system uses CFS, not only as secondary members, but also as primary beams, columns and frames.

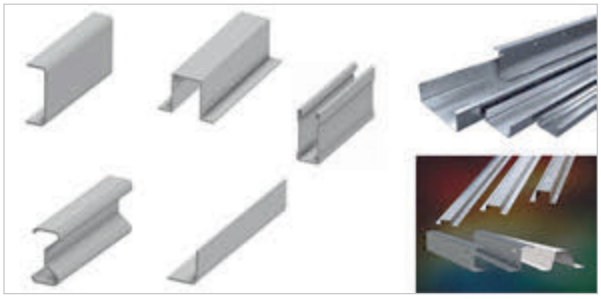
There are three basic forms of Light Gauge Steel Framing for Buildings

- Individual members assembled onsite to form a structural frame
- Prefabricated wall, roof and floor panels or sub-frames
- Volumetric systems, where buildings or major units are delivered in modules.

Cold-Formed Steel

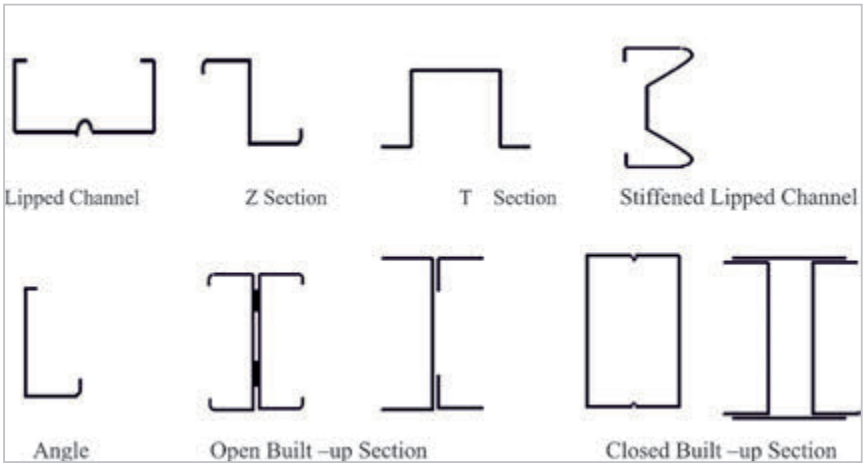
Cold-formed steel sections are structural components made from thin sheets of steel that are bent or rolled into desired shapes at room temperatures. Cold forming or cold working is any metal working process in which metal is shaped below its recrystallization temperature, usually at the ambient temperature. This is achieved by using rolling or pressing techniques, unlike traditional hot-rolled steel which is formed at high temperatures. These are shaped from steel sheets, plate or strip materials of uniform thickness, hence the name Light Gauge Steel. The thickness of steel sheet used in cold formed construction is usually 1 to 3 mm.

As the metal sheet of CFS is shaped at lower temperatures, the steel's hardness, resistance against tension breaking, and resistance against deformation are all increased due to the hardening. Cold working involves twisting or drawing the hot rolled sheets or bars at room temperature. The cold formed steel is harder and stronger than hot formed for the same chemical grade without additional heat treatments. Due to cold forming, the material is easily workable; it could be deformed into many possible shapes. Even a small change in the geometry creates significant changes in the strength characteristics of the section.



Cold Formed Sections Manufactured/formed from Steel Sheets

Various Types of Cold Formed Sections Used in Light Gauge Steel Framing



Advantages of Cold Formed Sections

Converting the LGSF system an advanced technology of Steel Framed Housing

Cold forming process causes the strain-hardening in the metal steel bar used and increases the yield strength of steel section formed.

Some of the main advantages of cold rolled sections, as compared with their hot-rolled counterparts are as follows:

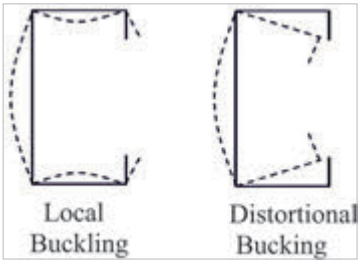
- Cross sectional shapes are formed to close tolerances and these can be consistently repeated for as long as required.
- Cold forming –forges metal sheets at near room temperatures and a low-energy process and more sustainable.
- Cold forming can be employed to produce almost any desired shape to any desired length.
- Pre-galvanised or pre-coated metals can be formed, so that high resistance to corrosion, besides an attractive surface finish, can be achieved.
- All conventional jointing methods, (i.e. bolting, welding and adhesives) can be employed. But Bolt and screws are mostly used in LGSF system. Easy and faster connection.
- High strength to weight ratio is achieved in cold-rolled products.

Due to lesser thickness of any cross section, they are usually light weight, making it easy to transport and erect.

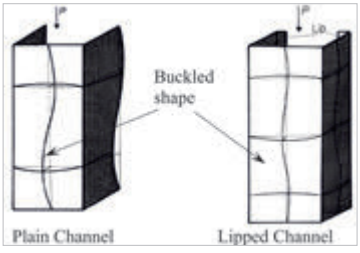
Issues Faced With Cold Formed Sections

Light Gauge Steel Framing Brings Solution to the Buckling Issues in CFS

Along with many advantages, these thin-walled sections also encounter buckling problems: local and distortional, due to very thin thickness. It is also critical in flexural torsional buckling due to very low torsional rigidity. The behaviour of the buckling depends on the section's geometry, support conditions, and other factors. Due to more strain hardening, cold formed steel section possesses low ductility and cannot dissipate energy in seismic resistant structure as compared to hot rolled section, but still these sections can be used for seismic resistant structures due to their reduced weight compared to hot rolled section. Buckling issues are resisted to the extent possible in structural faming (LGSF) with the arrangement of wall panels, use of sheathings in walls, use of proper bracing and stiffening in the individual CFS members and in many other ways.

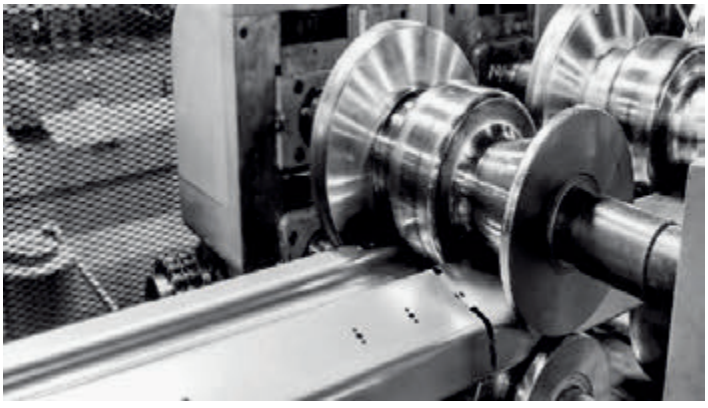


Various Buckling Modes Cold formed lipped channel



Effect of Lip/Stiffener to resist Buckling

Buckling in Individual Steel Sections

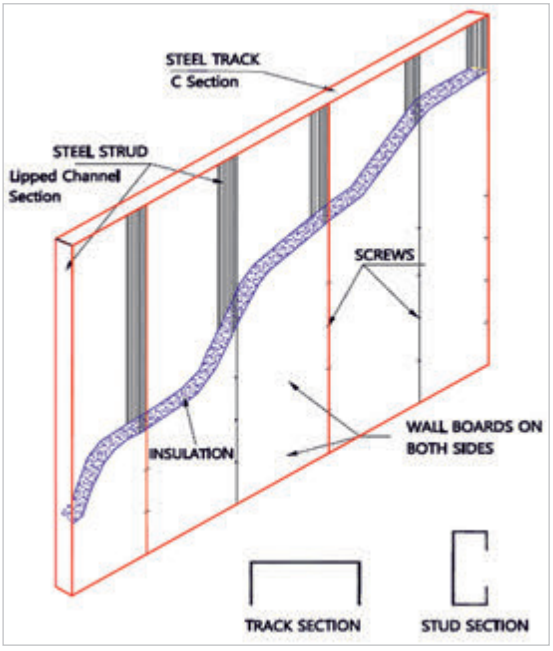


Cold forming process

Press Brake Forming

a) Buckling Issues in CFS

Solution by Sheathings in cold-formed steel (CFS) wall panel



Wall Panel with components

Sheathing Board in Wall Panel

- Provide stability against buckling,
- Resist lateral forces due to wind and other sources
- Increases fire performance in case of elevated temperature.

Types of Sheathing: Gypsum board, Plywood, Galvalume sheet, Heavy duty Cement Particle Board

Insulation: Rockwool, Polystyrene, Fibreglass etc.

b) Load bearing Wall Panel

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.

Roof Trusses with Cold Formed Sections

Provides easy handling of service lines

Easy Connection with Floor deck and with bolts and Screws

Closely spaced CFS Channels as Floor Joists - Open Web Joists

Opening of web and service holes to accommodate mechanical and plumbing services

c) Easy Connection and Installation of wall panels with sheathing

Steel Sheet in Sheathing in Shear Wall Panel
Ref. Thin Walled Structures, Research Paper, Elsevier Journal, Volume 75, February 2014.

Light Gauge Steel in Mass Housing – Sheathing used in Wall Panel
Ref. ASCE Library

d) Roof & Floor system in LGSF

Application Areas of LGSF Construction

Light Gauge Steel Framing can be used for roof systems, wall systems, floor systems, roof panels, decks and also for the entire building. Some of the applications of such structures are:

- Low to mid-rise house construction
- Multi-unit buildings: residential housing, dormitories
- Hotels, resorts, hospitals, relief housing
- Warehouses, storage sheds, garages
- Solar Panel Mounting
- Commercial buildings like supermarkets, poultry sheds, and also high-rises along with hot rolled steel sections.

Temporary Site Office Building with LGSF Technology
Constructed by Akash Engimech India Pvt Ltd

G+1 Hostel complex for Indian Oil Corporation Ltd. at Paradip, Odisha
By Nest-In - A Tata Steel Construction Solution

Warehouses- Storage Sheds with LGSF

Housing in LGSF wall panel
with Hot Rolled Steel in Framing

Mounting Frame in Cold Formed Section
for Solar Panel Arrangements
Ref. FrameCAD Website

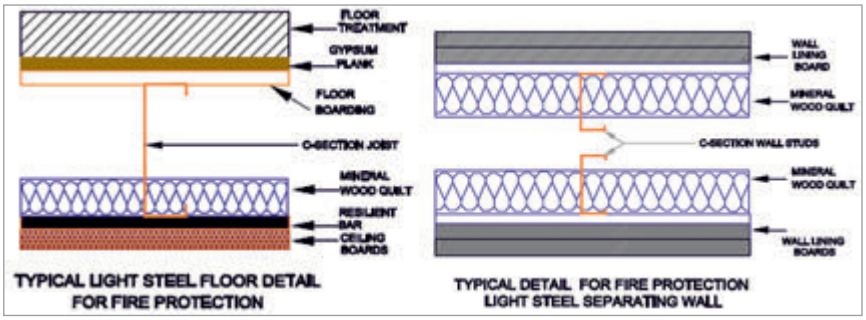
Fire Protection of CFS and LGSF

Like hot rolled steel, intumescent coating, sprayed cementations or gypsum-based coatings which all provides fire protection, does not work good in galvanised cold-formed steel sections. We can see that use of combustible material in a light steel-framed building is generally lower compared to some other forms of construction. Beams section with CFS can be concealed behind a suspended false ceiling for protection against fire. Fire resistance period of 30 minutes is usually achievable by using one layer of special fire-retardant plasterboard covering the load bearing panel walls in LGSF buildings. As plasterboard material has low shrinkage and high integrity property in case of fire, with proper thick (9 to 12 mm) plasterboard in doubled layer or higher thick like 15mm in single layer can also extent the fire rating time to upto 1 hour.

In light gauge steel framing, gypsum board depending on the quality, covering of walls and floors can protect the steel against fire for more than 90 minutes even upto up to 120 minutes, depending on the board material and the number of boards. The choice of insulation material, mineral wool or rock wool is also crucial to fire strength.

Box protection of individual cold-formed steel sections used as beams and columns is provided in much the same way as with hot-rolled sections.

Non-load bearing members require less fire protection, as they only have to satisfy the "insulation" criterion in fire conditions. Ordinary plasterboard may be used in such cases.



[Ref: Technical Information Sheet ED 016, SCI, UK]

Corrosion Protection of LGSF With CFS

Layers of corrosion protection coating can be applied to the steel strip/sheet during manufacture and before roll forming. Cold-formed steel is protected from corrosion by coating it with zinc or zinc-aluminium alloy through a process called hot-dip galvanizing. Galvanised strip can be passed through the rolls and requires no further treatment. Steel sheets are cleaned and immersed in a bath of molten zinc at a temperature of around 450 °C (842 °F). The zinc reacts with the iron in the steel to form a zinc-iron alloy layer.

Galvanized Steel sheet

Galvanized steel profile sheet

The galvanising layer is sufficient to protect the steel profiles against corrosion during the entire life of a building, if constructed in the correct manner. The most severe effects of corrosion on the steel occur during transport and outdoors storage. When making holes in hot dip galvanised steel framing members, normally no treatment is needed afterwards since the zinc layer possesses a healing effect, i.e. transfers to unprotected surfaces.

Sustainability in LGSF Steel Construction

Sustainability is one of the greatest challenges of the modern world. Sustainability includes environmental, economic and social aspects, all contributing to a durable development of

the society. The building industry plays an important role both in national economies and in the sustainable development of the world in general.

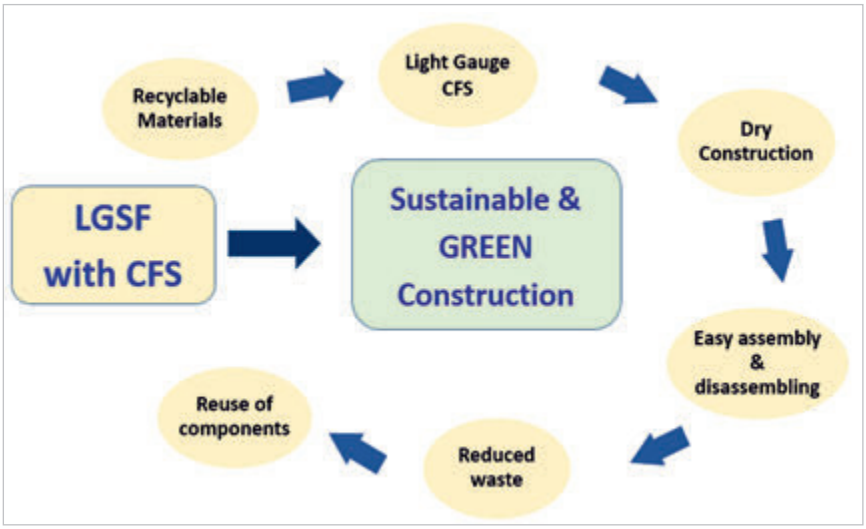
Sustainable construction can be regarded as a subset of sustainable development and contains a wide range of issue, i.e.: re-use of existing built assets, design for minimum waste, reduction of resources and energy consumption and of pollution.

Light gauge steel framed houses are usually built by using different solutions for interior and exterior cladding.

LGSF can be chosen for housing from an environmental and economic point of view:

- Dry construction system without organic materials significantly reduces the risk of moisture problems.
- Every material used in light gauge steel framing (steel, gypsum and mineral wool) can be recycled to 100%.
- Easy assemble and disassemble of CFS members make the construction FASTER with lesser waste material and the building components can be re-used.
- Connection of all the parts of a building can be done with bolts and screws, welding can be avoided, hence greener environment.
- Mostly prefabricated offsite, wall panels, floor assembly all connected through bolts and screws easily transported to site in truck.
- Consumes lesser energy during production than equivalent housing with a framework of in-situ concrete.
- Less waste means a cleaner work site and a low dead weight of building components ensures lesser seismic load and reduced transportation cost. Lower foundation cost.

It could be stated that houses with cold-formed light gauge steel structural elements represents a good alternative to masonry and low and mid rises RCC framed houses, not only with respect to structural requirements but also in considering the environmental effect.



Codes & Standards used for Design with Cold Form Section

Cold Formed Steel is being used in many foreign countries since long. Light gauge steel framing is now widely used in European countries, America, Canada, China, Japan, and Australia, etc. In India also, many low rise (1 or 2 storied) buildings and few Light house projects of G+3 storied buildings, warehouses and prefabricated buildings are now constructed with these thin gauges galvanized cold formed sections using the LGSF technology.

In India, for design of building with Cold Form Steel Section, the code of practice used was an older version and based on allowable stress design. IS:801-1987: Code of practice general construction in steel (Bureau of Indian Standards).

IS 811-1987: Specifications for Cold Formed Light Gauge Structural Steel Sections

At present IS: 801 it is undergoing revision for Limit State Method (LSM) of design. In the absence of design methods in LSM, the structural designer uses many foreign codes. The following codes are mostly used in India by the manufactures and suppliers of buildings and structures in LGSF technology:-

- EN 1993-1-3 Eurocode 3 - Design of steel structures - Part 1-3: General rules – supplementary rules for cold-formed members and sheeting, European Committee for Standardization.
- BS EN 10346: 2015 – continuously hot-dip coated steel flat products for cold forming - technical delivery conditions. It includes the requirement for chemical composition, mechanical properties, coatings and surface finish.
- AISI S100-16 - North American Specification for the Design of Cold-Formed Steel Structural Members - 2016 Edition, American Iron and Steel Institute. Different ASTM grade of steel depending on specified elongation of >10%, 3-10% and <3% are used as specified in AISI S100-16.
- AS/NZS 4600:2018 'Cold-formed steel structures' - Australian/ New Zealand Standard sets out minimum requirements for the design of structural members cold-formed to shape from carbon or low-alloy steel sheet, strip, plate or bar not more than 25 mm in thickness and used for load-carrying purposes in buildings.

Manufacturerer/Provider of Steel Sheet or COILS /CFS/LGSF

Manufacturer of Galvanized Steel sheets/ coils:

- JSW Steel – 0.3 mm to 1.45 mm thick and width up to 1.87 m available
- Tata Steel – 0.45 mm to 2 mm thick & 1.0 to 1.52 m width
- AM/NS (0.25 to 3 mm thick - 0.9 to 1.25 m width - with varying width and thickness) are the major manufacturers of galvanized steel sheets/ coils in India.

Tata BlueScope Steel, Kirby System, Tata Nest-In, INTERARCH, EPACK Prefab, Akash Engimeh, and many other companies are providing complete LGSF houses and integrated solutions to customers.

Conclusion

LGSF: A Rising Housing Technology In India

Cold-formed steel technology is gaining recognition as a key solution in the future of construction, particularly as part of India's "Global Housing Technology Challenge" (GHTC). The government has identified LGSF as one of the six cutting-edge technologies capable of revolutionizing the housing sector by promoting faster, affordable, and sustainable construction practices. With the capacity to reduce construction time by up to 50% compared to conventional methods, LGSF is ideal for mass housing projects. It is also lightweight, earthquake-resistant, and minimizes waste, aligning with global sustainability goals. Government plans such as the "Pradhan Mantri Awas Yojana" (PMAY), aim to leverage LGSF technology to meet the target of building 11 million urban housing units by 2022, showcasing the strategic role of this technology in addressing housing shortage efficiently.

This technology is expanding in India as more construction professionals and property owners recognize the benefits. Many prefab construction companies in India are now either supplying wall and floor systems with CFS or total building solutions in LGSF technology. To make this modern technology adopted by the housing sector, the initial high cost has to be also explained with all the long-term benefits of a more sustainable and greener future, and more workers will need to be skilled for installing LGSF houses.

Examples of LGSF in India

Easy installation at site
Wall Panel assembly erected at one go.

Prefabricated Sections from Factory
Ref: BMTPC website

Wall Panel with Cold formed steel sections

Building using LGSF Wall Panels with Pre-Engineered Steel Structural System

Light House Project in Agartala, Tripura under Global Housing Technology accepted by Building Material & Technology Promotion Council (BMTPC) under Ministry of Housing & Urban Affairs (MoHUA), GoI, Ref: BMTPC website

Habi Nest - LGSF construction solution by Tata Steel Nest-In

LGSF house
Ref. ODF Group Calicut- Prefab, Kerala