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AN OVERVIEW OF INVESTIGATING THE NEW STRUCTURAL SYSTEAM(LSF)

UNA RESUMEN DE LA INVESTIGACIÓN DEL NUEVO SISTEMA ESTRUCTURAL (LSF)

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HIGHLIGHTS

- "Efficient LSF Construction: Speed, Quality, Resilience"
- "LSF: A Sustainable Solution for Urban Development"
- "Precision and Speed: Advantages of Light Steel Structures"
- Light steel structures (LSF) provide rapid construction, high quality, and earthquake resistance.

RESUMEN

La construcción de estructuras ligeras de acero (LSF) es uno de los métodos constructivos más eficientes actualmente en uso. Debido a la rápida velocidad de este sistema, la calidad superior de la construcción y la adecuada resistencia a los terremotos desde la década de 1950, ahora incluye países como Japón, Estados Unidos y Canadá. Las secciones de acero con paredes delgadas son el componente principal de las estructuras de acero ligeras (LSF). Debido a las características de los perfiles utilizados en este sistema, como la laminación en frío del acero y la ausencia de tensiones residuales en los perfiles, la capacidad de crear perfiles con diversas formas y con alta resistencia y dureza, y precisión y rapidez en la ejecución e instalación de la estructura en comparación con los métodos convencionales. En comparación con los edificios convencionales, la construcción se ejecutó e instaló con mayor precisión y rapidez, al menor costo posible. El empleo de este enfoque de construcción es un método industrial alternativo en proyectos de construcción, así como en viviendas masivas, para disminuir y prevenir el desperdicio de recursos y materiales típicamente presentes en las construcciones tradicionales. En general, el uso de esta estructura es apropiado en todos los sentidos y se ha logrado el objetivo de desarrollo urbano sostenible.

Palabras clave: *Edificación, Construcción, LSF, Estructura, Acero.*

ABSTRACT

The construction of light steel structures (LSF) is one of the most efficient construction methods currently in use. Due to this system's fast speed, superior building quality, and adequate earthquake resilience since the 1950s, it now includes countries like Japan, America, and Canada. Steel sections with thin walls are the primary component of light steel structures (LSF). Due to the features of the sections used in this system, such as cold rolling of the steel and the absence of residual stresses in the sections. The ability to create sections with various shapes and with high resistance and hardness, and accuracy and speed in the execution and installation of the structure compared to conventional methods. Compared to typical buildings, the construction was executed and installed with greater precision and speed, at the lowest possible cost. The employment of this construction approach is an alternative industrial method in construction projects as well as mass housing to lessen and prevent the waste of resources and materials typically present in traditional building. this structure's use is appropriate in every way, and the goal of sustainable urban development has been accomplished.

Keywords: *Building, Construction, LSF, Structure, Steel.*

1.INVESTIGATING THE NEW STRUCTURAL SYSTEAM (LSF)

In recent years, the usage of the LSF system has acquired a great deal of favor in many nations of the globe due to benefits such as the speed and high quality of construction and the performance of appropriate vibrations. 1946 saw the introduction of the LSF system, composed of steel members with CFS sections, into the building sector [1].

Due to the lack of economic viability, it was not extensively employed until 1990, when the necessity for quick and large manufacturing necessitated its adoption. For houses, the demand for the prefab building system increased. Due to the rising cost of wood, its

limited supply sources, and environmental concerns, the LSF method was extensively employed. As a result, this approach is now extensively employed in Japan, Canada, the United States, and many other industrialized nations in the construction industry and for low- and medium-rise commercial and residential structures [2].

In Europe, the usage of light steel buildings is spreading, so diverse structures are being constructed for varied purposes [3].

By investigating the stability of light steel structures, it was determined that if these structures are executed correctly, they may be utilized for various purposes [5].

Despite the correct structure design in most conventional structures, their execution could be better. In other words, the actual behaviour of the structure during operation deviates from the intended behaviour. thorough monitoring of the execution quality and adherence to the estimated details is necessary. The factory's prefabricated structures will function correctly in service owing to the quality control and manufacturing methods that adhere to the calculation plans.

Meanwhile, light steel frames (LSF) with factory-built quality and simple, dependable, robust, and quick connections are particularly relevant. Owing to two unique characteristics, namely prefabricated structural components, and adequate thermal insulation, this structural system has been extensively adopted in the industrialized nations of the globe to construct residential homes. Because the design of connections needs to be adequately addressed in the typical seismic design of these buildings, the connections are regarded as the primary weak spot of these structures during severe earthquakes.

This is owing to prefabrication and simplicity of implementation. No concerns are noted with steel structures, and the execution of the intended structure is, in reality, more congruent with the software design. This technique may lower the structure's weight by fifty percent, the most significant benefit against earthquakes (6)

2. HISTORY OF LIGHT STEEL FRAME SYSTEM (LSF)

This technology was first used to produce bridges, aircraft, and vehicles by bending thin, cold sheets. Before 1920, it was still shrouded in an atmosphere of secrecy in the construction industry. In 1933, during the International Exposition of the Century of Progress in Chicago, the architect and administrator of this design was dubbed "Howard Fisher." In recent years, the LSF system has achieved significant popularity in many nations across the globe because of its many benefits, including rapid construction, excellent quality, and adequate seismic performance.

1946 saw the introduction of the LSF method into the building sector. Is seen 1990, many factors, including the increase in the price of wood and the limited sources of its supply, have caused widespread problems, so this system is now widely used in the construction of low-rise commercial and residential buildings [7].

in the United States, Canada, Australia, Japan, and many other nations. Using cold-formed steel sheets (CFS), the light steel frame construction system (LSF) has become one of the most famous building systems in both industrialized and developing nations over the last decade. The primary components of the building system are the cold-formed steel sheet LSF light steel frame [8].

This system, which is very similar to timber building construction techniques, is based on the usage of master (or wader) and track (or runner) components, and the basic framework of the building is composed of cold-rolled galvanized steel profiles. The components used in this system are C, U, and Z, which are typically joined using cold joints. This system may be finished with various construction boards, including cement board, wood, gypsum board, or building materials, such as pottery. Then, let the celebration begin.

Fig 1: *Lsf implemented structure (source:6)*

3. INTRODUCTION LSF

The LSF system, a summary of the light steel structure, is one of the current construction techniques used to raise the number of floors in buildings with restricted floors (1 to 5) to more than five stories utilizing the LSF system. Several systems are in use. Civil engineers in industrialized and contemporary nations endorse this method. This technique decreases the structure's weight by fifty percent, the most significant benefit against earthquakes (9).

The LSF construction system is composed of three kinds of building materials:

1- Steel cold formed

2- Gypsum panels

3- The formation of glass wool or rock wool.

By linking the components above, the LSF building system is constructed. The masters and runners of the LSF building system's load-bearing and non-load-bearing walls transmit vertical and lateral loads to the support in panel form. Load-bearing walls support the exterior face of the structure and absorb lateral stresses, such as wind and earthquakes, while non-load-bearing walls are often employed to divide the inner sections of the building.

Steel masters are often drilled in advance to pass electrical and mechanical installations, and these masters are typically linked from above and below and from the bottom to the runners (main horizontal elements).

Typically, dividing walls of units in multi-unit structures and separating walls of rooms (non-load-bearing walls) have distinct uses. These Kind of walls may be built on the ground and then erected in the appropriate position as part of the building's components. Another way is to establish the upper and lower runners and position the masters inside them (in situ wall construction) (10).

4. IMPLEMENTATION STEPS OF LSF STYLE STRUCTURES

The steps for implementing LSF-style structures are

4.1 The first stage foundation

The foundation of buildings constructed using the LSF method is exceptionally light, and due to the lightness of this structure, it has a unique simplicity. According to the design of the accounting engineers, strip or radius foundations can be used, and in this type of foundation, the ability to withstand earthquakes is also preserved. The installation of earth wells,

sewage pipelines, and other instances has been seen.

4.2 The second stage - the building skeleton (light steel structures (LSF):

These buildings are manufactured using the roll-forming technique (cold rolling or pressing of cut sheets).

4.3 The third stage - external and internal coverings of the roof - wall:

Roof covering possibilities include sandwich panels - galvanized sheets in various colors - colored sand fiber, roof tile, Akra, and others (11).

4.4 The fourth stage - electrical and mechanical facilities:

Wiring, switches, outlets, switchboards, earth wells, telephone lines, and television cables are readily accessible in these types of structures (12).

4.5 The fifth stage - doors and windows:

UPVC-HDF-MDF doors and windows are used together with fire-resistant and anti-theft aluminum (the door frame is made of steel with wood).

4.6 The sixth stage - flooring - painting and painting:

This type of system uses all types of ceramics and tiles, including laminate, parquet, mosaic, and cement floors.

5. HOW TO IMPLEMENT THE LSF SYSTEM IN DIFFERENT PARTS OF THE BUILDING, INCLUDING (SLATS, WALLS, ROOFS AND FACADES)

5.1 Foundation

To install the walls and build the LSF system, a strip foundation 40 to 50 cm deep is constructed. 40 or 60 cm lengths are established inside the foundation to install the horizontal runners and the strip foundation of anchor bolts (13).

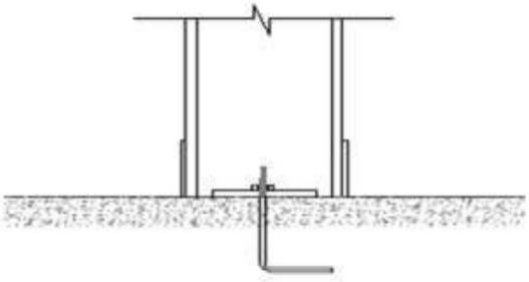

Fig 2: *Section of the foundation (source :14)*

5.2 Wall

The building system's load-bearing and non-load-bearing walls are composed of runners and masters, which transmit lateral and vertical loads as panels to the abutment. Wind and earthquakes influence buildings, and although non-load-bearing walls are often employed to divide interior areas, steel studs are typically drilled to pass through the facilities, and these studs are typically attached to the bottom and top of the runners.

In this building method, walls are often constructed by joining steel masters to steel runners and putting plaster panels in panel form. This building approach is ideal for resisting lateral forces, such as wind and

earthquake loads, when two wind braces are included (15).

Fig 4: *Gypsum panels (source:16)*

Fig 5: *Master and runner connection for runner installation (source:17)*

6. LSF SYSTEM IN VIEWS

6.1 LSF system in the modified traditional view

This design uses metal belts to attach the façade to the structure rather than only mortar, which is how it differs from the conventional brick facade system. However, when they fall from the roof to the floor, the materials are still stacked one on top of the other by gravity. The software used to model this façade is separated into four sections: the brick facade, the mortar linking the facade to the structure, the metal belt, and the LSF structure (18).

6.2 In the modern view of the Lsf system

The modern view of the LSF system introduces a dry construction method, a departure from earlier techniques that heavily relied on mortar. This approach involves placing a horizontal piece on the facade at each floor level, supporting and absorbing that floor's gravity load. This element is distinct from other levels by filler materials. Similar to the previous method, the lateral load is transferred to the structure in this system via metal belts. The model is divided into four parts: the brick facade, the facade support foundation, the metal belt, and the LSF framework (18).

6.3 LSF system in the traditional view

Ordinary constructions often use a mortar or glue-based technique to attach the brick and stone facade components to the building's wall and each other. With this technique, the facade is maintained without needing mortar by stacking the components on top of one another by gravity from the roof to the ground. To model this façade LSF, the program separates and defines three components: the brick facade, the mortar attaching the facade to the structure, and the LSF structure.

7. LSF SYSTEM IN VIEWS

The life system employs a variety of implementation techniques for roofs and rooftops. They allow for applying any roof, including cross roofs with varying slopes and straightforward flat forms. The two most popular roof-building techniques are as follows: - Mostly front-to-back covering roof trusses for the structure. They employ a flat beam system, often divided between supports or load-bearing walls, to construct flat roofs.

Most of the beams in the LSF system are placed along the walls while constructing the middle levels (often with a distance between 400 and 600 mm). The carrying capacity and size of the plaster panels that cover the walls and ceilings were considered while designing and implementing these distances. Moreover,

these components are often implemented as C or Z (19).

Fig 6: Truss roof consisting of sections (*source*:16)

Fig 7: Beams in a flat roof (source:17)

Fig 8: Implementation of concrete slab on Ro fix and beams in flat roof (source:17)

8. TYPES OF CONNECTIONS AND LATERAL BRACING OF LSF CONSTRUCTION SYSTEM

The joints in this approach consist of many execution activities. The majority of the joints are of the dry type, and they are constructed using bolts and nuts, self-tapping screws, and simple fasteners that do not need pre-drilling, pre-drilling, or short nails. While the use of welding joints is uncommon on the job site, and its implementation relies on compliance with the applicable laws and regulations.

it is employed in the two instances when the component is produced in a prefabricated form (panel or box) in the factory. Cold rolling is used to join the members. Corner pieces may reinforce connections, while wind braces, walls, steel shears, and their combinations are utilized for braces (20).

Fig 9: Connections using screws (source:16)

Fig 10: Connections using screws (source:16)

9. ESTABLISHMENTS

As previously stated, two lengths of the member with holes along them are utilized to pass the installation of the facilities in the portions employed as ceiling beams or wall masters. With PVC and Superpipe, the installation pipes' base is squeezed. They are more durable and flexible than metal and cast-iron pipes.

According to the employer, you may also use a package or a central ventilation system for the air conditioning system, and plastic pipes from the top of the fake ceiling to the center can be used for electrical installations. Using specialized supports, the vacant wall space is

drawn to the locations of the cans placed there (21).

10. SYSTEM LSF AND THE ADVANTAGES OF USING THE LSF

• It increases the amount of usable interior space, decreases the building's weight and seismic force, makes it possible to transport materials over long distances (due to lightness), lowers the construction cost, and expedites the building's construction and installation.

• It reduces the need for labor, makes it easier to develop skilled and knowledgeable human resources, makes it simple to create space and install apertures in the walls, and allows for flexibility in the execution of facility designs.

• By international energy consumption criteria and standards, this type of building has a much lower percentage of energy transfer than concrete structures, gradually reducing the building's heating and cooling costs. This is because the walls in the LSF system are adequately insulated. Moreover, it has been constructed.

• Most of the materials can be recycled and replaced by using recycling and replacement technologies, which helps to preserve the environment and increase the productivity of natural resources. Thanks to the paging mechanism used to implement them, almost 70% of the materials used in the LSF system's structural and non-structural components may be readily changed and recycled [1].

• The potential for adding up to 5 and 8 stories to the building

• The buildings constructed using this method have good resistance against corrosion and humidity and have a longer useful life in the north and south of the country's environmental conditions because all sections are galvanized.

• Appropriate resistance in various weather conditions.

• Thermal and acoustic insulation;

• Simplicity of adding different apertures and adjusting the structure's height.

• Because the components of this system are manufactured, cut, and assembled in a factory before being assembled by technical technicians, the final product has a much higher quality than traditional construction. This system also significantly reduces costs, material waste, and national wealth. It also allows for high volume and capacity storage.

• It just needs a small amount of workshop space but has more extraordinary safety precautions.

• CFS portions with no lingering thermal stresses: CFS (Composite Fiber Reinforced Steel) sections are permanent without thermal stresses, that is, they have the ability to maintain their structure and performance when exposed to various thermal conditions.

• It lessens the earthquake's impact on the building [1].

• As the material of the building is galvanized and cannot rot, metal components are not affected by dampness, and their nature does not alter in any way.

• Because of the robust connections, there is extremely little chance that a storm can cause harm.

• The metal skeleton's load-bearing components carry greater weight and can withstand earthquakes.

• Protection from cold, heat, sound, and moisture (21).

11. DISADVANTAGES OF USING THE LSF SYSTEM AND SOLUTIONS

11.1 It has low resistance against heat

It should be noted that proper precautions and threats against fire should be implemented by adding a vapor barrier layer between the thermal insulation and the inside wall. Despite its resilience under earthquake circumstances against the side load of the wind, it suffers from a significant weakness when dealing with the wind's strength (owing to the building's lightness). Unless otherwise specified. We are only permitted to have a maximum of 5 levels due to Iran's restrictions on the number of building floors and apertures. There are places with minimal seismic risk; however, we can employ composite sections and reinforced sections with high bearing capacities. We can eliminate this restriction if we utilize it specifically in the instructors' area. As a result, it should be protected with fences, or the first floor should be implemented with a concrete frame and the continuation using LSF. We will look more closely at each of them as we pay attention to the weaknesses in thickness and side resistance, and due to accidents, such as car collisions, they cannot have the required resistance.

11.2 being weak against heat

Generally, no construction is immune to heat and fire; even concrete structures lack this quality. However, steel structures are far more prone to these problems. The portions of the LSF construction are also exceptionally resistant to heat and fire since they are less thick. Because steel softens fast, its resistance will suffer a significant reduction. They swiftly give up the fight. All of these buildings must resist heat and fire for a certain amount of time to allow for rescue operations; as a result, the necessary precautions should be taken. Thus, in order to prolong the fire resistance, high-strength or high-thickness boards are required. Alternatively, adhere to the insulating layer composition suggested by the rules that provide adequate safety.

11.3 Weaknesses in temperature transfer through heat transfer bridges

LSF insulation with thermal insulation cannot be employed since it serves as a heat transfer bridge. So, efforts should be focused on stopping the temperature transmission, such as adequately insulating the profile or lengthening the temperature transfer. This flaw may be fixed by introducing additional depreciation [18].

11.4 Weakness in vibration and dealing with side loads

With the small weight of the steel frame construction, you would feel much vibration if it is not installed correctly at a high altitude. This will result in a loss of comfort and security. Hence, you must raise the weight or reinforce the side beam components. While the structure's lateral stiffness increased, it should not lose its light state due to this effort. The kind and thickness of the covering materials will significantly influence the ultimate lateral resistance and hardness of the shear wall panels. Also, the coating materials—among the elements influencing the lateral behavior of shear wall panels—impact the plasticity and ultimate shape change of this system. Considering the following factors may result in a better design. Shortening the distance between the columns enhances the system's ultimate lateral resistance with little impact on the initial stiffness. The hardness and lateral strength of

the wall are significantly influenced by the distance between the peripheral screws holding the cover plates to the frame. However, the stiffness and lateral resistance of the system are only slightly affected by the distance of the center connection screws. By ignoring the friction between the connecting plates and taking into account the equation of anchor balance around the geometric center, it can be said that each connection screw supports the anchor [18]. This is because most connection screws experience lateral resistance compared to middle screws because of their greater distance from the center of the connection (the geometric center of the screw) (h).

11.5 Compatibility with new technologies

There is a problem with using renewable energy today to reduce the usage of fossil fuels and avoid air pollution. That is significant. Solar energy is one of these clean sources due to the required slope of the construction roofs. Solar cells may be quickly and readily put in LSF buildings. Moreover, to enable additional usage, The structure should be shorter to spread across a more extensive area, and the building should have solar energy. One of the finest possibilities is the short LSF system (22).

12. CONCLUSION

In the interim, the LSF system may be implemented because of the many benefits discussed in these articles, such as the growing demand to develop essential structures with varied functions that are resistant and of high quality. It may be used in various applications to carry out quick constructions without incurring delays.

The country's construction sector should pay particular attention to this system and its numerous potentials since industrializing construction will minimize the consumption of building materials and energy. This could be accomplished by promoting construction using contemporary construction methods. Use it to react to the technologies needed for effective functioning. The ease of production of these sections without the need for heat treatment, the absence of residual thermal stresses in the sections, and the ability to create sections with various and desired shapes to achieve the highest resistance efficiency are some of the most significant benefits of using cold-rolled steel sections. highlighted the section's light weight, high resistance, hardness, and high level of detailed execution and rapid and straightforward installation.

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