A COMPOSITE CONSTRUCTION TECHNIQUE USING LGSF AND FERROCEMENT FOR AFFORDABLE HOUSING

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Abstract : Affordable housing scenario in India has been studied along with the existing technique for affordable housing. There is an immediate need to address the issue of affordable housing. The LGSF and ferrocement construction techniques are discussed in detail and a composite technique using LGSF and ferrocement has been proposed. The advantages of this composite construction technique are discussed.

***Key Words*:** LGSF, ferrocement, affordable

1. Introduction

Housing is one of the basic requirements of any individual next to food and clothing. All of us dream for owning a suitable house in our life span. Light Gauge Steel Frames (LGSF) can be used to replace the traditional brick and concrete construction. The light gauge steel frame is hot dipped galvanized, high tensile steel cold formed to customized sigma profile for various studs and framing tracks along with purlins, joists and trusses. This process enables steel manufacturers to produce light-weight but high tensile steel sheets.The sheet surface is coated with a zinc alloy. This results in buildings that are more solid, rigid, stronger, durable and easier to build. Ferrocement is a composite material composed of a mortar reinforced with steel mesh used to form thin sections. Multiple layers can be used to achieve the required density of steel. A stiff mortar is then applied to both sides of reinforcement. The ferrocement technique is very labour intensive and cost effective. Ferrocement is also used in the construction of boats, silos, tanks, roofs and bridge decks. Compared with reinforced concrete, ferrocement is cheaper, requires no formwork, is lighter, and has a ten times greater specific surface of reinforcement, achieving much higher crack resistance. Considering the advantages of LGSF and ferrocement, a new construction technique involving LGSF and ferrocement has been studied and proposed in this paper.

2. Affordable housing scenario in India

Government of India has recognized the need to fill the gap in urban housing. Large-scale housing projects that are affordable are sure to help. So, the government announced an ambitious project. It seeks to provide 'Housing for All by 2020'. It has taken many initiatives to make this a reality.

2.1 Overview on Indian scenario for affordable housing

It is a key to nation's development, to provide proper shelter to its citizens. India is a populous country where approximately 70% of the people reside in rural areas. [1] According to the 2011 census, the housing stock in India stood at 78.48 million urban households. Though the gap between household and housing stock is narrowing, actual shortage is high due to a certain part of a currnt stock being dilapidated and people leaving in congested dwellings.[2] Cost-effective housing is a key problem in all developing countries, but India definitely presents a remarkable case study. While India's constantly expanding population is the bed rock of its economic promise, it is also the source of any number of issues – not least of all housing deficit. The growing concentration of people in urban areas has led to problems of land shortage, housing shortfall and congested transit and has also severely stressed the existing basic amenities such as water, power and open spaces of the towns and cities. The country's population is likely to be in the neighborhood of 600 million by the year 2030. There is a huge existing and future requirement for affordable homes.

2.2 Need of affordable housing:

1. It is a key to nations development, to provide proper shelter to its citizens.
4. Shortage of affordable and decent housing particularly for the low income earners.
5. Prevalence of slums and informal settlements that account for more than 60% of the households.

2.3 Important factors to be consider for housing

Minimum volume of habitation, provision of basic amenities, cost of the house, location of the house [2]

2.4 Existing techniques of affordable housing

Following are some existing methodologies which can be adopted to cut the construction cost without compromising the strength of the structure.

1. Selection of Load Bearing or Framed Structures
2. Hollow Concrete Block Load Bearing Walls
3. Precast Staircase System
4.Prefabrication of Structural Elements

3. Precast ferrocement panels

The idea of ferrocement is not new to us. It is as old as reinforced cement concrete. Ferrocement is a composite material used to form thin section, it is composed of a mortar, reinforcement include light steel fabrics and meshes[3]. Ferrocement is an excellent construction material due to its mechanical properties, and low cost, and it is considered to possess high cracking strengths.[4]. The ferrocement firstly was constructed by Joseph Louis Lambton in 1847. He built ferrocement concept when he observed that wire mesh and cement mortar produced a material possessing characterization of an approximately homogeneous material and capable of resisting impact. Further ferrocement was flexible. The Ferrocement wall panels are exhibited more ductile behaviour[5]. Elastic and exceptionally strong. Precast Components are 85% recyclable, have low carbon dioxide generation and are

energy efficient. They are ecofriendly, cost effective and easy to install. With use of precast components, wastes during operations are minimal, curing is not required, and structures are waterproof due to less water cement ratio, plastering is not required from the inner side of slabs and the components are corrosion proof[6].

3.1 Advantages of ferrocement

The main advantages of ferrocement is low cost, the low level of skills required for hull construction, and reduced maintenance with increased resistance to rot and corrosion when compared to wood and steel.[7]The materials required to produce ferrocement are readily available in most countries. It can take almost any shape and is adaptable to almost any traditional design. Where timber is scarce and expensive, ferrocement is a useful substitute. The manufacture of ferrocement components requires no special equipment, is labour intensive and easily learnt by unskilled workers. Compared with reinforced concrete, ferrocement is cheaper, requires no formwork and it is lighter than conventional concrete.

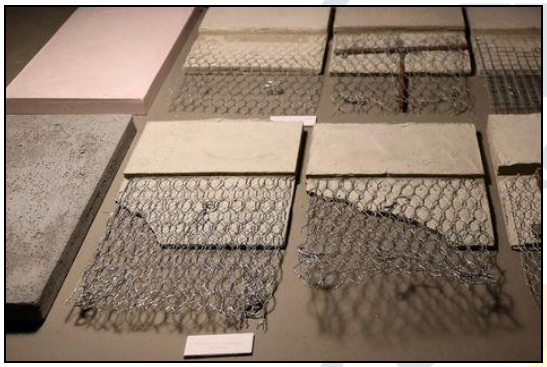

Figure 1 Ferrocement panels
(source: www.pinterest.ca)

4. Light gauge steel frame structure

Light gauge steel construction is very similar to wood framed construction in principle - the wooden framing members are replaced with thin steel sections. The steel sections used here are called cold formed sections, meaning that the sections are formed, or given shape at room temperature. Galvanized light-gauge steel shapes hereinafter referred to as shapes those are produced by cold-forming galvanized steel sheets 1.6 mm or under in thickness. Different from conventional light-gauge steel shapes 1.6 mm or over in thickness conforming to JIS G 3350 ‘‘Light Gauge Steels for General Structures’’. These shapes are thinner in thickness and lighter in weight.[8]. This is in contrast to thicker hot rolled sections, that are shaped while the steel is molten hot. Cold formed steel is shaped by guiding thin sheets of steel through a series of rollers, each roller changing the shape very slightly, with the net result of converting a flat sheet of steel into a C or S-shaped section. This technology offers many benefits to constructors starting with the most valued, being a 1/3 reduction in construction time. This reduction in time itself results in many benefits such as a reduction of cost, more timely deliveries of projects enabling the constructors to take on more projects in a specific period of time, to name a few. In the case of lighter structures, the technology saves on foundation cost as less material is required for construction. Light-gauge cold-formed steel (CFS) is often used as a construction material in low-rise buildings or as non-structural walls in mid-rise and high-rise buildings.[9]

Figure 2 LGS framing before the sheeting has been done
(Source: www.understandconstruction.com)

Designing innovative steel light gauge components through cold forming challenges the ingenuity of the designer. The light weight brings about new problems as regard acoustics but it reduces the load on the foundations. Thin-walled steel members are currently cold-formed to shape from steel strip coil. Compared to components made on the site, the industrially manufactured products have lower cost, better accuracy in dimensions, more uniformity in quality and strength. [10] Locations which are affected by bad weather and difficult terrain can rely on this technology as unlike concrete, steel is less affected by bad weather. The construction through light gauge steel structures will help the buildings to be built in less than half time and be as strong in strength as concrete business which takes years to build. These structures, also perform better in seismic conditions due to its relative strength and much lighter overall building structure weight making buildings not only last longer but also more prone to natural disasters. The technology uses galvanized steel which is rust proof, mold resistant and waterproof and the steel carries 50 years (extendible) warranty against any form of corrosion.

5. Composite technique using LGSF and ferrocement wall panels

The conventional (RCC) technique or LGSF with RCC wall panels increases the cost as well as weight of the structure whereas in composite technique RCC wall panels can be replaced by precast ferrocement wall panels in LGSF for speedy as well as economical construction. Also ferrocement wall panels are easy to install and reduces the dead load of the structure. The ferrocement wall panels are assembled with the help of bolts in the LGSF frames. The LGSF frames can be easily dismantle and the material is reusable for future work. Both LGSF and ferrocement are durable and the composite technique have longer life span.

5.1. Advantages of LGSF + ferrocement technique

Structural steel’s low cost, strength, durability, design flexibility, adaptability and recyclability make it the material of choice for a growing number of construction-related businesses. With factory made accurate steel frame components, construction is quick thereby optimizing labour requirement. Steel won’t ignite or burn and termites can’t eat it. Floors and walls are not susceptible to moisture build-up. Steel framing is fastened to the floor structure through the bottom plate after all ferrocement wall panels have been correctly aligned and plumbed. Ferrocement is a

very co-operative material that goes will with other constructional materials such as bricks, stones, steel etc. Much of the steel used to make light gauge steel framing is recycled. When a steel frame building is demolished, the steel can be recycled. When steel buildings are no longer required in their current location, they can be dismantled and re-erected elsewhere.

6. CONCLUSIONS

There is immediate need to address the affordable housing issue. An innovative technique can be solution meeting the huge requirement of affordable housing in India. The advantages of ferrocement and LGS can be combined effectively and a composite construction technique can be used effectively for affordable housing.

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