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Construction Of Roof Truss System Using Ferrocement

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ABSTRACT : The main principle of design of truss by using Ferro-cement is economy and safety. In this investigation a ferrocement roof truss has been designed which are of low in cost, light in weight and easy to maintain. The first step of design involves the calculation of dead load using IS 875 (part-1) and wind load using IS 875 (part-3)-1987. The next step involves the calculation of tension and compression in each individual member of the truss. Sections of the truss are designed using the value of highest tension or compression. After designing all the sections, the truss is constructed. A 6-mm diameter circular coil is used as reinforcing material for construction and angles of desired shape are made to hold the sections in position. Hexagonal wire mesh or chicken mess is cut into required sizes and are placed over the reinforced skeleton of the section. Conventional mortar of cement sand ratio of 1:2 is prepared. The mixture is laid on the truss and the structure is allowed to stand for 28 days. Connection plates, nuts and bolts are used to connect the members and to hold them firmly in position.

Keywords : Ferrocement; Truss; Prefebricated; Chicken mesh

1. INTRODUCTION

FERRO cement which is also known as Ferro concrete, is generally applied to a mixture of Portland cement and sand , applied over layers of woven or expanded steel mesh and closely spaced small-diameter steel rods rebar. It is used to form relatively thin, compound curved sheets to make hulls for boats, shell roofs, water tanks and many civil engineering structures.It is necessary to seek for structural building elements, which have the structural characteristics of prefabricated elements which are easy to handle, light in weight, maintenance is minimum and are of low cost. With these in mind, structural elements are made from ferrocement. There are many advantages in the use of ferrocement in pre-fabricated buildings in terms of light weight, ease of handling, low labour cost (skilled and non- skilled) in its production and a durable material which requires little maintenance. Due to these reasons ferrocement has gained advantage over other reinforced concrete and steel structures. The main characteristics of ferrocement is the use of fine diameter mesh reinforcement of diameter (ø), 0.5 ≤ ø ≤1.5mm and mesh size (S), 6 ≤ S ≤ 25mm. The surface area per unit volume of mortar is ten times that of conventional reinforced concrete. For balanced, bidirectional meshes the volume fraction of reinforcement normally lays between 2% ≤ Vf ≤ 8%. Generally sand-cement ratios of 1:2 and water-cement ratios of 0.35 to 0.45 are used in mortars in case of ferrocement. In order to achieve a stiff reinforcing cage regular reinforcing bars in a skeletal form are often added to thin wire meshes.

2 SPECIFICATIONS OF TRUSS GEOMETRY

The specifications of the ferrocement roof truss are tabulated in the Table 1. The geometry of the roof truss is shown in the Fig. 1.

TABLE 1
Specification Of Roof Truss

Class of building	General life of 50 years
Height of eve-level	7 m
Span of truss	4 m
Slope	30 degree
Sheeting	AC sheets
Spacing of purlins	1 m
Spacing of truss	3 m
Terrain category	2 (IS 875-1987, Part 3)

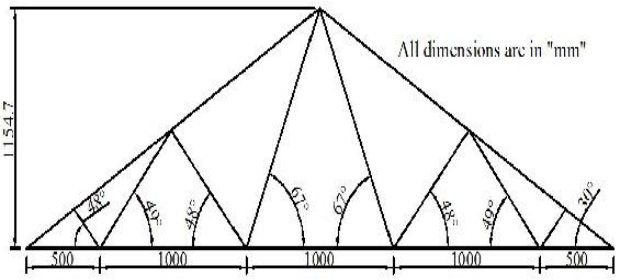

Fig. 1. *Geometry of roof truss*

3 SPECIFICATIONS OF MATERIALS

3.1 Hexagonal Wire Mesh

Hexagonal wire mesh with diameter of 0.7 mm is used for all the elements. It is also known as chicken wire mesh. Mesh openings is 25 mm.

3.2 Mild Steel Bar

A mild steel bar with diameter of 6 mm is used as reinforcement material

3.3 Cement

Ordinary Portland cement of 43 grade conforming to IS 8112: 2013 is used.

3.4 Fine Aggregate

Zone-II sand is used for the entire experiment as per IS 383:1970 specifications.

3.4 Water

Portable water for drinking purpose was used for the Experiment.The mix proportion of sand and cement used in casting the model is 2:1 by weight with water-cement ratio of 0.40.

4 DESIGN AND CONSTRUCTION OF ROOF TRUSS

The truss members are designed as pin joint plane determinate structure. Wind load is calculated as per IS 375:1987, Part 3. The size of the angle of the truss are 75 mm x 75mm x 12.5 mm. The construction of the truss is discussed below. The channels are used ase purlin of size 50 mm x 30 mm x 12.5 mm

4.1 Laying of Reinforcement
Laying of reinforcement involves a serious of steps. Firstly, a 6 mm diameter circular coil is cut into its desired calculated lengths. After cutting of circular coil is done, it is straightened with a hammer manually. Now, angles of L and U shape are used to hold the reinforcement in purlins member. The chicken mesh is cut into its desired size and the mess is wrapped around the reinforcement
.

4.2 Making of Angles
L shaped angles are used for roof truss angle members and U shaped angles are used for purlin sections.

4.3 Cutting of Reinforcement
The 6mm dia coil is cut in the required dimensions.

4.4 Straightening of Reinforcement
The bars which are cut in the required dimension are straightened with the help of hammer.

4.5 Making of Angle Members
Angles are made with the help of a die and a wood block in which nails are driven at suitable spacing.

4.6 Making of Frame Members
The sections of the frame members are made by tying the straight members and the angle members, with the help of black wire. The truss members are shown in the Fig. 2.

Fig.2. *Truss members*

4.7 Wrapping of Chicken Mesh
The chicken mesh is cut in the required dimension with the help of a cutter and wrapped around the members as shown in the Fig. 3.

Fig.3. *Members fitted with chicken mess*

4.8 Joining the Sections
The sections are joint and one truss is divided into three parts, so that it can be easily moved.

Fig.4. *Truss section*

4.9 Laying of Mortar
A mortar of cement-sand ratio 1:2 is prepared manually and carefully laid on the skeleton member by making appropriate formwork. It requires a skilled workmanship. After the mortar is laid, it is allowed to set for 28 days and curing is done. Once it is set, the formworks are removed and the surfaced is smoothened and the truss is ready. Connection plates are also made with ferrocement. Nuts and bolts are used to connect the section in position firmly.

4.10 Putting of Cement Sand Mortar
The mortar is placed in appropriate shape by using wood plans as formwork as shown in the Fig. 5.

Fig.5. *Laying of cement mortar*

4.11 Setting and Curing
The truss members are allowed to set and curing is done for 28 days.

4.12 Connection Plates
The connection plates are also made of ferrocement and suitable size of holes are provided for fixing nuts and bolts.

Fig.6. *Connection plates*

4.13 Fixing the Members

The members are fixed with bolts, to form the roof truss system. The finished roof trus system thus constructed is shown in the Fig. 7.

Fig.7. *Finished roof truss system*

5 Conclusion

Ferrocement is a versetile, cheap and light weight material. The roof truss and purlins are comparatively light weight resulting less earthquake shear lateral loads. Further the ferrocement purlins can be drilled easily resulting easy fixation of roofing material such as asbestors sheets and corrugated galvenised iron sheet. The procedure developed here of fixing truss member with gusset plate can be a prefabricated work of factory.

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