A Review Of Parametric Comparison Of Conventional And Ferrocement Soil Retaining Structure

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Abstract- *The conventional RCC soil retaining structure has got its certain drawbacks of being too heavy and costly. This paper deals with use of ferrocement as an alternative to conventional RCC soil retaining structure. An analytical study is carried out using Ansys 17.0 software to compare ferrocement soil retaining structure with geometrically identical Conventional RCC soil retaining structure. Ferrocement is advantageously used for its less thickness and flexibility to mould in required shapes. We can use full sectional strength of ferrocement in analysis of structure using optimum geometrical configuration. In the research work, Conventional RCC structure is also compared with rectangular and arch shaped ferrocement soil retaining structure of 50 mm thickness and 5m height, with a retaining soil density of 18kN/m3. The results showed that in arch shaped face and base wall structure, deflection and stresses are very less and within permissible limits. Due to reduced thickness of members, requirement of material is less and thus found to be more cost-effective than RCC soil retaining structure.*

I. INTRODUCTION

1.1 General

Walls built for backing granular solid materials like soil, earth, loose stone, sand coarse aggregate, coal, grains etc. are called Retaining walls. Loads of these materials when piled together will not remain in a vertical face. They have tendency to slide down and repose themselves to a particular inclination. Soils in cutting or embankment have got the same tendency of sliding down. When such embankments and cutting or loads of granular materials are to be kept in vertical position, there should be supporting structure to keep the material from falling into an inclined repose formation. The conventional type of retaining wall are made of brick, stone masonry and RCC cantilever and counterfort retaining walls are constructed depending upon vertical heights of retaining material to be supported. These retaining wall having heavy, bulky foundation, also required more time for construction. Therefore, alternative material as ferrocement is came as good alternative in which time for construction, weight of the structure and cost can be reduced as compared to RCC cantilever and counterfort retaining wall. Ferrocement is basically composed of reinforcement and mortar, one is naturally desirous to compare it with reinforced concrete. RCC is a heterogeneous composite. After first crack, steel and concrete share the load separately and the design is based on concrete taking compression and steel taking tension. In ferrocement due to strong bond between wire meshes and mortar, even after the first crack steel and mortar act together as homogeneous material.

Up to the yield of steel wires, strains in steel and mortars are same.

Fig.1.1 Ferrocement Wall

Ferrocement can replace all types of construction material. It is thin walled and continuity and placement of equal mesh reinforcement in both directions make it possible to achieve high equal strength in both the direction. It can be moulded in any shape and size. Its strength to weight ratio in tension and compression is very low. There is various advantage of this material which make it best alternative of RCC. In this project work comparison of conventional RCC retaining wall is done with ferrocement retaining wall, for comparing some common data is adopted like height of wall is considered as 5m, soil retained by wall having density 18kN/m^3 backfill supported by the wall is on counterfort side depth of surcharge is considered equal to height of stem and backfill is assumed to be horizontal. By considering all this data for various geometrical configuration, optimal geometrical configuration needs to be find out and after that parametric study on optimal section is done.

The conventional RCC soil retaining structure has got its certain drawbacks of being too heavy and costly. For solution over drawback ferrocement is chosen as an alternative to conventional RCC soil retaining structure. There are various structure like water tanks, dams, pipe, domes, roof slabs, shells, etc where ferrocement is used widely. ferrocement structures can be shaped in such a way that the full section of the member and the full strength of material can be utilized, so its stem is shaped as an arch to use higher compressive strength of mortar and full cross section of arch sharing the load, due to reduced thickness requires material will be less. Therefore taking this advantage of ferrocement its application for soil retaining structure needs to be find out

II. LITERATURE REVIEW

2.1 Review of Literatures

Before choosing ferrocement as an alternative material, the past study regarding its properties and about its application is carried out as under:

1. **Bhargav Y Desai, Jaldipkumar J Patel.** The study has been carried out to the effect of testing level of ferrocement boards stimulated with various number of steel wire meshes. The target of this study is to know the effect of various number of mesh layer on flexural quality of level ferrocement boards. Number of section boards of size 900mm x 200mm with the thickness varying as 25mm, 50mm and 75mm is casted. The mortar is in proportion of 1: 2 and boards are reinforced with welded square mesh boards are prepared and kept for 28 days of curing. After that two-point loading test is conducted on ferrocement boards. The author concluded that by increasing number of layers of mesh reinforcement, flexural strength increases the section having more thickness has capacity to resist more loads. The average value of modulus of elasticity of 25mm thick boards was found to be more as compared to 50mm and 75mm thick boards.
2. **Sunil kumar M.V., N. Jayaramappa.** In this experimental work nine number of slab panels of size 600mm x 600mm and six number of panels of 250mm x 250mm with the same thickness of 40 mm these slabs are reinforced with two, three and four layers of meshes.to determine the modulus of elasticity flexural and tension test is conducted the flexural test is carried out using manually operated jack and there results are in the form of in load verses deflection. To calculate deflection strain gauges are attached below slab panels and all these slabs are then compared with RCC slab panel. Author concluded that reinforced concrete slab is having only 1.7% of more load caring capacity than four mesh layered ferrocement slab. As the number of mesh layer increases deflection in slab decreases.
3. **Girish P. Dhotre** author has done experimental analysis over arch shape counterfort retaining wall and cost comparison of RCC cantilever, counterfort and ferrocement arch shape counterfort retaining wall was done. Ferrocement arch shape base and heel counterfort retaining wall of height 1.5 m, arch rise of 0.2m and thickness of 0.04m is casted and deflections at various points were calculated using strain gauges for different loading condition. Loads are provided using concrete blocks in six to nine layers such that surcharge loading of 18.30 kN/m2 to 27.5 kN/m2 comes over the structure. He concluded that in ferrocement arched shaped counterfort retaining wall maximum deflection is observed at middle heights of counterfort and ferrocement retaining wall found to be more economical than RCC cantilever and counterfort retaining wall.
4. **Hamis Eskandari and Amir Hossein Madad**. Their study provides an experimental analysis of ferrocement channel of span 4.5m and width 70cm and finite element analysis of channel for different support systems and beam spans. Analysis is done by applying surface loading and author concludes that fixed support is the best support by proving arch shape material can resist more compressive loads, value of deflection also found to be reduced.
5. **Prakash Desayi, N. Nanda Kumar.** An experimental study on the shear strength of ferrocement was carried out. Tests was conducted on 155 simply supported rectangular ferrocement specimens. Specimens are tested under four-point loading. Author has considered number of parameter for studding such as number of layers of wire mesh, two mesh layouts, strength of the mortar and shear span-to-depth ratio. flexure-shear and web-shear, are the two types of shear cracking and failure were noticed. Test results indicate that for both of the mesh layouts considered, the shear strengths of ferrocement at cracking and at failure due to flexure-shear and web-shear increase as the shear span-to-depth ratio is decreased, and the volume fraction of mesh wires is increased. The shear stresses at which the web-shear crack and web- shear failure occurred were higher than the shear stresses at which the flexure-shear crack and flexure- shear failure occurred. Best-fit equations and characteristic strength equations are proposed for the shear strength of ferrocement in flexure- shear cracking, webshear cracking, flexure- shear failure and web-shear failure.
6. **Gray F. Moita, Estevam B. de Las Casas, Edgar V. Mantilla Carras.** The purpose of study was to find the application of ferrocement in large water tank structures for this experimental and analytical study on water tanks were carried out. Experimental model of diameter 20 m with height of 2.86 m and thickness of 8 cm is prepared using different percentage of reinforcement. Strain measurements were performed at 40 different points while loading the water tank. Using Finite element analysis analytical study of models were done. Author concluded that properties of water tank depend upon the

skilled work how worker works. It varies if thickness is not proportional and also due to low quality work , working conditions on site etc. author also concluded that finite element analysis is the best suited for study of different model.

7. **Vatong Greepala, Pichai Nimityongskul.** The experimental study has been carried out to know the performance of ferrocement under fire. Slab panel of size 200mm x 240mm x 25mm were casted and tested for temperature above 1060^0C. Two variables were considered one is percentage of mesh reinforcement and another is mortar cover. Author concludes that increase in percentage mesh reinforcement increases mechanical properties of ferrocement section under normal condition and content of mesh reinforcement had no significant change under fire condition. Mortar cover does not have any influence of improvement in mechanical properties of ferrocement element under both normal and fire condition. More damage is observed with the element having less mortar cover.
8. **Y. B. I. Shaheen, B. Eltaly and M. Kameel.** This study has been done to analyse the application of ferrocement for water supply pipe. To achieve the objectives comparison between ferrocement and reinforced concrete under static loading was done. Finite elements models were prepared for analysis of water supply pipes up to failure using ANSYS. Four models were prepared and its experimental and analytical results are compared and found to be similar. Ferrocement pipes are found to be better than reinforced concrete pipe. Pipe with welded wire mesh has capacity to carry more load. Ferrocement pipes are found to be 25% more economical than reinforced cement concrete.
9. **N. Jayaramappa, Dr. H. Sharada Bai.** Number of slab panel were casted of size 500mm x 500mm x 30mm for flexural strength and slab panel of 100mm x 500mm x 30mm for tension test. Mesh reinforcement in one, two, three, four layers were provided. As a reinforcement hexagonal mesh and skeleton reinforcement were used. Mortar of 1:3 mix proportion was used. Author concludes that the ultimate load, ultimate deformation, modulus of elasticity and ductility of FC elements under flexure and tension increase with increase in volume fraction. The ductility of FC elements under flexure is higher than that under tension. The average value of modulus of elasticity per unit volume fraction of FC elements under flexure and tension are almost equal varying by only 6.16 %,
10. **Hiralal Pawar.** To study the effect of the reinforcement in ferrocement structure column were casted and tested under compressive loads. Number of columns casted with different positions of reinforcement in both vertical and horizontal direction from the analysis author concluded that by using welded mesh under column increases the density as well as strength of column. Welded mesh of layers placed In centre of the column it get increase strength up to 12% as compare to three different positions of mesh in the columns. Density increases same 2% in the ferrocement column. If changes location and position of welded mesh I ferrocement column strength also changes.
11. **M. A. Saleem and M. Ashra A.** In his paper gives the idea of the behaviour of ferrocement structure under the earthquake. The earthquake resulted in a great loss of life and property. This work is mainly focused on developing a design of small size, low cost and earthquake resistant house. Ferrocement panels are recommended as the main structural elements with lightweight truss roofing system. Earthquake resistance is ensured by analysing the structure on ETABS for a seismic activity of zone 4. The behaviour of structure is found satisfactory under the earthquake loading. An estimate of cost is also presented which shows that it is an economical solution.
12. **Ar. Laxmi Salgia, Ar. Aparna Panganti.** In this study author compares construction cost of RCC construction work and ferrocement work. Author has studied various case studies and provided a review over advantages of ferrocement application of ferrocement method of construction of ferrocement structure. Also prepared wall panel of ferrocement and RCC and tested under flexural test. Compression is prepared between material and labours involved for construction and he concluded that Areas where there is labor shortage, complicated shapes and material shortage it is always cost effective to replace RCC with Ferro cement.

III. CONCLUSIONS

General

In RCC structure under the loading after first crack concrete and steel behaves separately while in ferrocement, steel meshes used as reinforcing material is dispersed throughout the structure due to strong bond between wire meshes and mortar even after first crack steel and mortar act together as a homogeneous material. This shows ductile properties of material. Hence deflection limit under limit state of collapse is considered which allows 20mm deflection and as we are using grade of mortar M20 its permissible limit of direct stress is 5MPa from IS 456-2000. From above results following conclusions are observed:

1. In rectangular shape counterfort retaining wall maximum deflection is observed at h/3 distance on

stem while in arch shape counterfort retaining wall maximum deflection is observed at top surface of stem.

2. Direct stresses are maximum at middle height of counterfort from inside in all the types of retaining wall.
3. Shear stresses are maximum at middle height of counterfort from outside in all the types of retaining wall.
4. Values of deflection and stresses of ferrocement rectangular retaining wall with same dimensions as RCC is more than conventional RCC retaining wall.
5. Very large deflections and maximum direct stress values are observed in rectangular shaped ferrocement counterfort retaining wall with 50mm thickness, hence application of rectangular shaped ferrocement retaining wall with less thickness is unsafe.
6. Values of deflection and stresses ferrocement arch stem and base retaining wall is less that ferrocement arch stem and rectangular base retaining wall
7. Direct stress values in stem at various heights of ferrocement arch stem and base retaining wall is 3.5% more in comparison with conventional RCC retaining wall and values are within permissible limits.
8. Shear stress values in counterforts at various heights of ferrocement arch stem and base retaining wall is 1.5% more in comparison with conventional RCC retaining wall and values are within permissible limits.
9. Deflection values of stem in arch stem and base ferrocement counterfort retaining wall is found to be very less.
10. Deflection values of counterforts in arch stem and base ferrocement counterfort retaining wall is found to be very less.
11. Deflection at base in all the types of retaining wall is found to be zero.
12. In parametric analysis considering height variation deflection of structure increases twice for small heights and for larger heights slight increase in deflection value.
13. For semi-circular section the values of deflection and stresses are found out very less but in semi-circular section arc length increases which increases size and cost of structure.
14. For different percentage volume reinforcement, increase in soil density of surcharge increases deflection of structure by 15%.
15. **15.** Quantity of concrete required in ferrocement construction is found to be very less than conventional RCC counterfort retaining wall therefore found to be economical.

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