

A SCHEMATIC DESIGN AND CONSTRUCTION OF SUPER INSULATED SHELL HOUSE USING FERRO CEMENT

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ABSTRACT

The advancement and development of lightweight pre-created sandwich auxiliary components in building development is a developing pattern in development industry everywhere throughout the world because of its high quality to-weight proportion, diminished weight, and great warm protection attributes. Sandwich development component comprises of thin face sheets or encasement of elite material and a thick, lightweight and low quality material as center. Ferro concrete is viewed as exceedingly flexible thin material having predominant properties which can't be coordinated by other ordinary thin materials. Circulated air through cement is a cell lightweight material which shows moderately higher quality than the regular center materials, for example, froth. Also, sandwich development manages the issue of delamination of face sheets prompting their untimely disappointment. This can be stayed away from by giving encasement over the center. This investigation was centered around the improvement of Ferro bond encased circulated air through solid sandwich divider components, where Ferro concrete thin box encases a thick center of lightweight circulated air through cement. The investigation was led in two stages. In the first place stage included the improvement of high workability and superior slag-bond based mortar blend to cast proposed Ferro concrete encasement. The created mortar was planned to supplant the customary manual strategy for putting the wire work by a motorized throwing technique. The

execution of mortar was explored as far as compressive quality, quality advancement, unit weight, impact of curing administration, and incomplete supplanting of concrete by weight with half and 60% of slag. The second period of the examination set out on the advancement and examination of the qualities of Ferro bond encased lightweight circulated air through solid sandwich divider components. To accomplish the goal, around 600 examples including vast size divider components were thrown and tried. Ferro concrete encasement was kept up at 12mm all through the examination. The parameters examined were compressive quality, flexural quality, disappointment mode, stack avoidance conduct, stack twisting conduct, stack strain conduct, unit weight, water ingestion, introductory surface assimilation consistency, and part of sort and layers of the wire networks. The outcomes uncovered the potential utilization of Ferro bond encasement of lightweight circulated air through cement to deliver lightweight basic components which leads towards the industrialization of building framework. At long last, two numerical models were created to foresee compressive quality of high workability slag-bond based mortars and the Extreme heap of Ferro bond encased circulated air through solid sandwich divider components. The qualities anticipated from the scientific models were 95%-100% exact to the exploratory outcomes.

Keywords: *Lightweight, pre-manufactured, circulated air through solid sandwich Ferro bond.*

1.0 INTRODUCTION

Among the design hull materials in use for shipbuilding, a specific place is occupied by Ferro-concrete and one of its variants, i.e., and reinforced concrete. The substantial savings in metal (by two-three times) realized the construction of the hulls of floating structures of reinforced concrete, at a simultaneous substitution of expensive and scarce sheet and profile rolled iron, with reinforced rod steel, establishes that unvarying interest which is expressed in Ferro-concrete in shipbuilding. Just as much interest in the floating facilities with Ferro-concrete hulls is also manifested by the operating organizations, since in distinction from the structures with steel hulls, the designs with Ferro-concrete hulls do not require layovers in dock for painting the hulls and for the periodic replacement of rusted plates of sheathing and elements of a set, which saves considerable resources. In spite of the circumstances noted above, confirmed by the construction experience and the subsequent operation of the Ferro-concrete floating facilities, as a whole for the Ferro-concrete shipbuilding for the past 50 years, we have typically had both periods of abrupt increases, and periods of equally abrupt declines, including the complete shutdown of this type of floating facilities. Such an instability in the development of the Ferro-concrete shipbuilding, in addition to the purely subjective factors (and in a number of cases, of outright prejudice), has been established mainly by the absence of the necessary objective conditions for the regular construction of Ferro-concrete hull reliable in operation. The seemingly simple organization of construction, the simplicity of the production processes under the possible utilization of specialists with relatively low skills have inevitably involved the appearance of super flours Ly overheavy, over-reinforced hulls with a low quality of concrete, cracking under the

effect of atmospheric moisture, - fluctuations in temperature and in sea water. A time was required sufficient In r that the basic conditions, determining the reliable operation of the marine Ferro-concrete hulls, were revealed, understood and strictly regulated. Beginning from 1955, as a result of the accomplishment of a series of scientific-research, planning and testing-design activities, the necessary scientific base was created for developing the plan of Ferro-concrete ships and for the selection of the most effective engineering processes for their building. The systematic studies which were conducted established the necessary extents of reinforcing the main and secondary design elements, the principles of efficient design configuration; standard documents were developed Z:r all types of work in the assembly and concrete reinforcing both of the individual sections, and of the entire hull as a whole; the specific requirpznnts were determined and delineated on monittrirq the qualities of the 'Finished products.

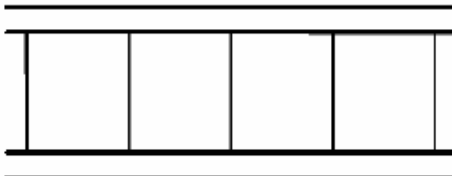
As a result of the rsearch activities, it was demonstrated that the conditions of wavering on concrete, reinforced hills, situated in sea water under constantly changing loads (in ueotnt and suIn), the requirnwnts of resistance to freezing, complete airtightness end relate resistance to the aggressive effect of see water basically! Distinguish' the floating river and naval faro-concrete facilities from any civil installations, including the hydrates :uncial ones. The book brought to the attention of the readers contained a brief discussion of the basic results of the activities and studies conducted by the shipbuilding scientific-research organizations, the design bull 'us and the shipyards engaged in reinforced concrete shipbuilding, with the development of design criteria and engineering processes necessary . 'nine and bulimia,-g the hulls of floating facilities made of reinforced conches.

SANDWICH STRUCTURAL ELEMENTS/MEMBERS:

A sandwich panel is a three-layer element, comprising two thin, flat facing plates of high-strength material and between which a thick lightweight core of low average strength is attached. Figure 1.1 presents a few types of sandwich panel elements. Such sandwich structures have gained widespread acceptance within the aerospace, naval/marine, automotive and general transportation industries as an excellent way to obtain extremely lightweight components and structures with very high bending stiffness, high strength and high buckling resistance.



(a) FOAM CORE SAND WITCH



(B) HONEY COMB SAND WITCH
AIM AND OBJECTIVES OF THE STUDY:

The main aim of this research investigation is to manufacture and study the behavior and properties of Ferro cement encased aerated concrete sandwich wall elements.

Towards achieving the above mentioned aim, the related objectives associated were identified as follows:

1. To investigate the minimum flow value (flow table) of cement mortar capable to be poured during the casting of thin Ferro cement encasement.
2. To establish the optimum high workability and high performance mortar with slag and super plasticizer.

This pertained to the compressive strength, strength development, unit weight, curing regime, water absorption and ISAT (permeability) as parameters of study

3. To study the behavior of Ferro cement encased aerated concrete sandwich specimens. This part of study was focused on, to optimize the various variables; in compression as principal testing and in flexure as additional

testing.. The variables investigated were, type and number of wire mesh layers, overall unit weight, core dimensions (core-encasement volumetric ratio) to achieve lightweight sandwich, and the encasement direction (parallel or perpendicular to the loading direction) effective in terms of compressive strength. Water absorption and ISAT tests were also included in this part of study. A variety of specimens of standard size; cubes, blocks and prism beams were cast and tested.

4. To investigate the behavior of Ferro cement encased lightweight aerated concrete wall elements of relatively large size particularly in compression with additional flexural and ultrasonic pulse velocity (UPV) tests.

5. To develop mathematical models.

LITARATURE REVIEW

[1] Perumal & Sundararajan (2005) investigated the performance of M110 Grade of high performance concrete trial mixes having different replacement levels of cement with SF. The strength and durability characteristics of these mixes are compared with the mixes without SF. Compressive strength of 110 MPa and 54.65MPa at 28 days is obtained by using 10% and 0% replacement of cement with SF. The results showed that the SF concrete possesses superior durability properties.

[2] Parichatprecha et al (2006) conducted a experimental investigation on the influence of using different pozzolanic materials, cement content, and water to binder ratios on the durability of concrete by measuring the charge passed of concrete in accordance with ASTM C 1202-97. Two types of pozzolanic material were used namely pulverized fly ash and condensed silica fume. The cementations

materials were varied from 400-550 kg/m³ with w/b ratio ranging from 0.3 to 0.4. It was found that the increase in cement content of concrete resulted in higher charge passed. The optimum cement content for producing high strength and durable concrete was found to be 450 kg/m³. It was noticed that the lower the w/b, the lower the charge passed of the corresponding concrete, which agrees with the general concepts of concrete.

[3] Selcuk tu rkel & yigit altuntas (2009) compared the effect of limestone powder (LP) on the properties of Supplementary Cementations Replacing Materials (SCRM) with other mineral additives such as silica fume (SF) and fly ash (FA) and their combination effects. Fresh properties, flexural and compressive strengths and water absorption properties of mortars were determined. The use of SF in mortars significantly increased the dosage of super plasticizer (SP). At the same constant SP dosage (0.8%) and mineral additives content (30%), LP can better improve the workability than that of control and FA mixtures by 19% and 27%. However, the results of this study suggested that certain FA, SF and LP combinations can improve the workability of SCRMs, more than FA, SF and LP alone. LP can have a positive influence on the mechanical performance at early strength development while SF improved aggregate-matrix bond resulting from the formation of a less porous transition zone in mortar. SF can better reduce the effect on total water absorption while FA and LP would not have the same effect, at 28 days.

[4] Rathish kumar (2010) conducted an experimental program to study the functional efficacy of an Sulphonated Naphthalene Formaldehyde condensate (SNF) condensate used as a water reducing super plasticizer. The compressive strength and flow characteristics of the mortars were determined to decide their suitability for Ferro cement works. The parameters included the mix proportions, the grade of

cement, age of curing and the dosage of super plasticizer. It was concluded from the study that the addition of an optimum dosage of super plasticizer improved the workability and strength characteristics of silica fume mortars.

[5] Yilmaz kocak (2010) determined the mutual influence of fly ash and silica fume with Portland cement. For this purpose physical, chemical, X-ray Diffraction Analysis (XRD) and particle size analysis were applied to these raw materials. The results indicated that fly ash and silica fume had shown different surface features compared to Portland cement. The variations in surface features affected on compressive strength of mortar samples. The ternary use of fly ash and silica fume provided the optimum results, when the compressive strength properties of the cement mortars were taken into account.

METHODOLOGY

This chapter presents the methodology and implementation of structural shell modeling. The three house case studies are built using this system and also presented. The goal of the system is to make the design and structural analysis as quick and easy as possible. To this extend, various software solutions are explored. It's unavoidable that some complexity exists, for example in scripting, but the overhead of learning and using the tools should be as small as possible. The designer should be able to convert hand sketches, rough dimensions and ideas into a functional model with a few hours' worth of work.

3.1 EXPERIMENTAL PROGRAMME OF STUDY

the main aim of the study was to investigate the characteristics of Ferro cement encased aerated concrete sandwich wall element. in order to achieve the aim and the related objectives mentioned in chapter one, a two-phase experimental study; each comprised of stepwise strategy was adopted. Following are the details of

the two phases, stepwise research methodology adopted.

3.2 FUNCTIONALITY:

The scope of features desired in the modeling system is: 3D geometry The entire house shell must be modeled as a solid, with discrete reinforcing bars. Other reinforcement, such as welded wire and meshes are best modeled as shells onset from the rebar's. Ease of use of the CAD software is important, as is adorability to the designer/builder.

Change management Changes in 3D geometry need to be easy to incorporate without manually changing surface points. This includes enlarging spaces, recon_guring rooms, recon_goring penetrations, changing shell shape and others. This is critical to successful exploration in the design phase and optimizing the structure for loads.

2D drawings The 3D model must be able to export 2D drawings of any desired parts of the geometry. This includes cross sections with dimensions. Every rebar's dimensions and shape can be exported separately to aid in shop bending. **FEA link** The relevant geometry must be cleanly exported to the FEA software such that additional tweaking isn't necessary. This includes assemblies and material types. Relevant geometry is the structural framework and doesn't need to include non-structural details. **Scripting and automation** The entire design and analysis process must ultimately be represented in macros and scripts. This is critical for automating routine tasks in creating geometry and performing the structural analysis.

There needs to be a template for any project, where the user concentrates only on the structure's features and has the remaining worked automated. Common textiles should include all inputs such as material properties and loads. Text _les should also be used where possible for transferring information between different

software packages and debugging. The scripting language should be easy for the user to learn.

POST-PROCESSING:

All tasks such as generating standard views, key drawings, analysis results and reports need to be automatically done for the user. Material quantity estimates for steel, concrete and insulation need to be available. It's also important to clarify the limits to the scope. Building Information Modeling (BIM), which involves all building elements is not the focus of this project even if the 3D model is a sign cant contribution in that direction. Likewise, utilities such as electrical conduits and wiring, water pipes, HVAC and lighting are not considered

SOFTWARE IMPLEMENTATION:

The software worked is shown in Fig. 3.1. It is an iterative process, where the geometry is changed based on structural analysis results. Automation through scripting is used heavily in each program to allow for experimenting with various shapes and concrete composites. The details of the software selection process are in Appendix C, including the plugins that are required.

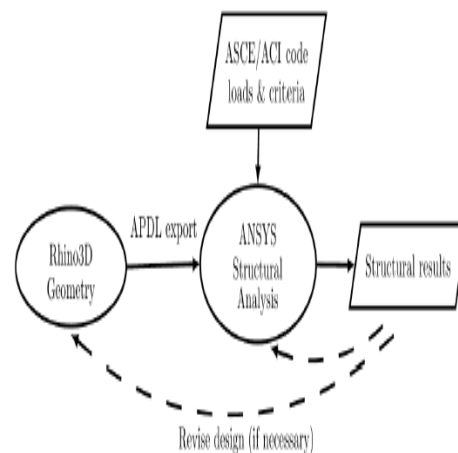
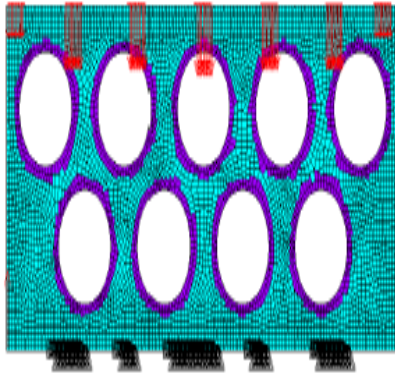


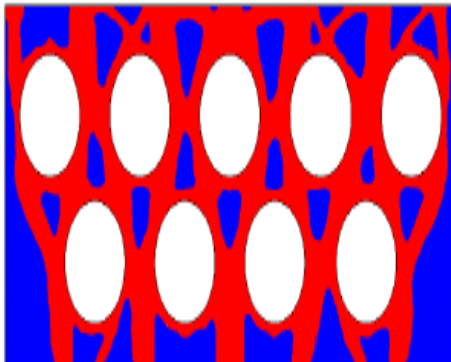
FIGURE 3.1 MODELING FLOW SHAPE OPTIMIZING:

Where a complex design detail is used as a structural support, such as a tree-like internal wall, it is convenient to use a shape optimization tool. Such a tool takes as input a generic grid with loads applied

as they are in reality. The program determines which elements in the grid are the most critical to stones, such that the "dead" material can be cut out. The amount of material to remove is species by the user.



ELEMENTS AND LOADS



RESULTING OPTIMIZATION SANDWICH WALL ELEMENTS :

Finally ferrocement encased aerated concrete sandwich wall elements of relatively large size were tested. The details are as follows:

(a) Dimensions of wall elements

Wall elements 700 x 300 x 100 mm (Figure 3.10)

Wall elements 700 x 400 x 100 mm (Figure 3.11)

Wall elements 1400 x 400 x 100 mm (Figure 3.12)

(b) Variables

Mesh layers: Optimum number of wire mesh obtained from previous step

Curing regime: Water moist Age of Wall element: 28 days.

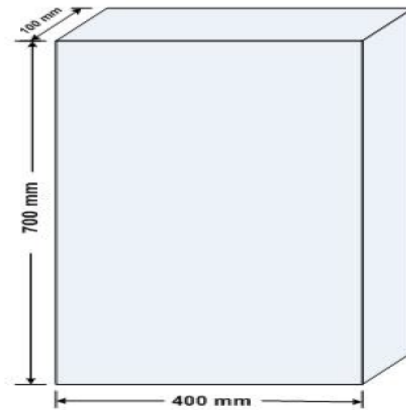


Figure shows Dimensions of wall elements (700 mm x 400 mm x 100 mm)

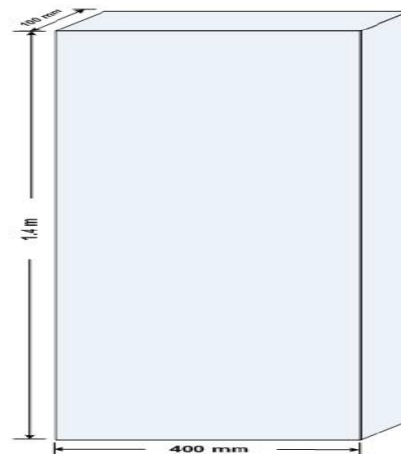


Figure shows Dimensions of wall element (1400 mm x 400 mm x 100 mm)

RESULTS

Representative displacement plots for two load cases are shown in Fig. 4.1, showing a roof sag in the 1:4D load combination and a wall bulge in the 1:2D+E_{north} combination. Specie notes for each load combination are discussed here:

1.4D Roof sags by 5 mm. Tension due to bending is highest on the roof's inside surface and requires another layer of mesh reinforcement.

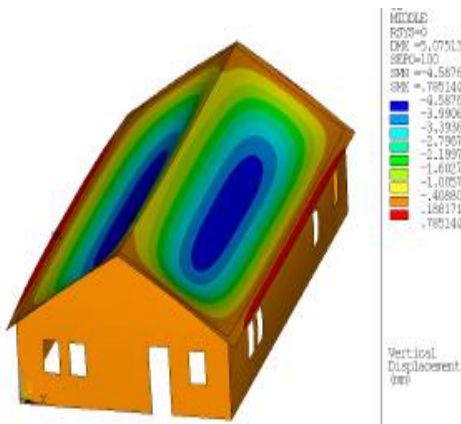
Seismic The walls bulge out a little due to horizontal acceleration. The maximum of 2 mm occurs on the southern wall during the 1:2D + E_{north} load combination. Generally the 1:2D combinations yield higher displacements and stresses than the 0:9D combinations.

Roof sag increases to 6 mm for E_{west} and E_{east}. The largest tension occurs on the roof ridge, in the middle of each roof section and in the corners of window and door openings. No crushing issues.

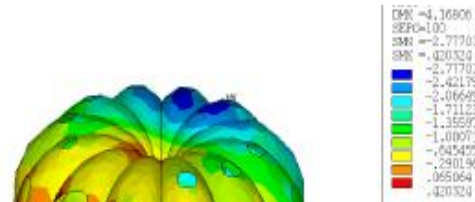
Wind loads stress the structure less than seismic. Maximum wall bulge is 4 mm on the north and south walls. The north and south walls exhibit more bulging than the east and west walls, even in cross winds. Roof uplift is maximum for 0:9D + W_{east}=E_{west} combinations, but is under 2 mm. No crushing issues.

layers of 150 x 150 x 5 mm mesh are stacked on the exterior. Concreting begins by plastering the lath, which becomes formwork for shot Crete on the other side. The composite is 40 mm

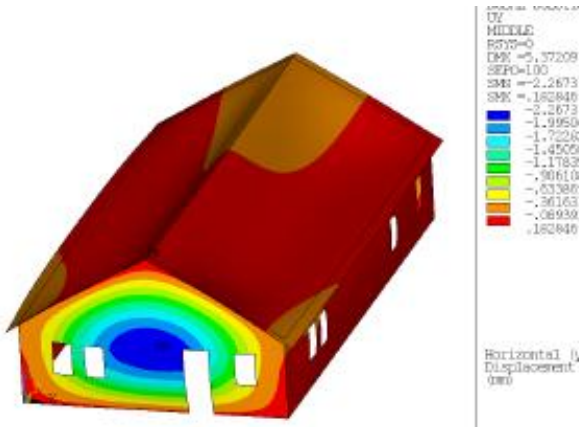
Creating the armature and concreting the lower half of the shell _rst, including the second story oor, would reduce scolding for completing the upper half. Insulation is attached to the outside of the shell. Spray foam is the most convenient solution, but also expensive. It would be more economical to use foam as only a glue that holds EPS blocks together and seals gaps. The exterior of the insulation may be smoothed and painted as is done with Mesolithic's domes. Otherwise, a thin concrete shell can be built with either the laminated technique. The mass of the shell consists of 51.8 tons of concrete and 4.5 tons of steel.



VERTICAL DISPLACEMENT FOR 1:4D

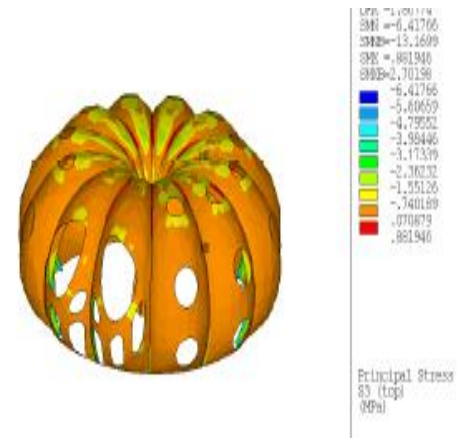


Vertical displacement for 1:2D + E east



HORIZONTAL Y DISPLACEMENT FOR 1:2D + ENORTH CONSTRUCTION NOTES:

The proposed construction technique is similar to classic Ferro cement. A rebar armature of the Whole structure is erected. Expanded metal lath is attached on the interior of the shell. Two

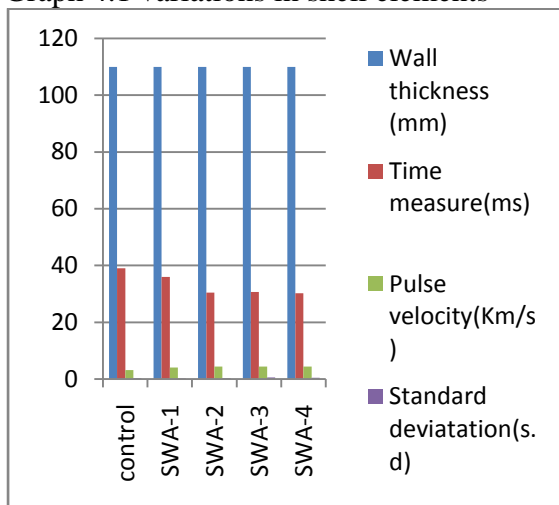


Surface_3 for 1:4D



Shell house inside construction

Graph 4.1 variations in shell elements



CONCLUSIONS

Ferro cement construction is an exciting alternative to conventional wooden and masonry methods. In the context of sustainable housing, aspects such as strength, durability, architectural freedom, occupant comfort, adorability and energy efficiency align well with Ferro cement's qualities. This project explores its rich history and structure types, including water tanks, houses, boats and large public areas. Various options are explored to reduce construction labor costs, which is the biggest reason for its low adoption in today's buildings. There are many modern improvements possible, including new materials, innovative fabric forming methods, computer modeling and analysis, among others. Traditional Ferro cement's large labor requirements can be

reduced. Computer-generated, projected layouts allow for shop fabrication of rebar armature, which is only assembled on-site. Innate fabric, spray foam insulation and the laminated Ferro cement technique can drastically reduce armature work. The use of flexible, non-metallic materials such as basalt increases durability and makes the mesh easier to handle and shape. Mortar composition can be improved with y ash for quicker shot create application. Modern CAD tools allow for quick exploration of ideas and sophisticated form finding. The combination of Rhino3D with the Kangaroo physics plugin is one of a few powerful options available to a designer today. These tools allow an amateur to create shapes that in the past required complex physical models.

The prefabricated houses made of ferro cement have a good seismic behavior.

- Houses in Ferro cement can easily sustain in earthquake up to scale 7.5-8.
- Technique can be used for watertight structures and retrofitting of water structures
- The Ferro cement layers will substitute as shear reinforcement in the joint region. Hence the use of Ferro cement layers in strengthening joints without shear reinforcement will enhance the
- behavior of these joints and will reduce the vulnerability of these joints to be excessively damaged when subjected to seismic loading.

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