

## Ferro-Cement



The main supporting superstructure of my submarine is a ferro-cement structure. Ferro-cement construction is a method of constructing a steel matrix of varying gage wire into a structural fabric which is then cemented with an approximate thickness of one inch of cement. Once this combination of steel and cement cures a incredibly strong and flexible structure is achieved. Unlike a concrete dam or large concrete building, the steel matrix is actually flexible to some degree. This method of construction has been utilized primarily in sailboats. This type of construction has many advantages. The strength is one factor, another is corrosion resistance. If done correctly, that is, if absolutely no steel is exposed after the cementing process is complete, the steel reinforcement will not be subject to rusting. After the curing process (2 months) to ensure a complete seal of the concrete an epoxy coating compatible with cement is applied to all exposed areas of the boat.



In the evolution of the design of the ferro superstructure a major dilemma presented itself. One of the main purposes of the superstructure, in addition to supporting all of the necessary components of the sub (including the pressure hull), is its function as a soft ballast tank. That is to say that the entire structure has an interior air chamber which, in the surface condition is completely filled with air. In the submerged state the chamber is flooded. The term "soft ballast" refers to the air chamber having an always open port located underneath the boat. No pressure is ever present in this air chamber because water can freely flow in and out. Early in the design stage it came apparent that cementing the inside of this air chamber was going to present a problem. The air chamber itself is not large enough for a person to crawl into. To solve this problem I decided to make the boat into two separate halves and construct each half separately. Once the two halves are finished they will be sealed and bolted together.



After the completion the ferro structure and after the cementing process has completely cured all of the necessary connecting hardware will be bolted on. It is critical that this is done after the curing of the cement. After the cementing process it is important that no steel is protruding out of the cement and that no hardware is in direct contact with the steel matrix, this is to prevent any corrosion from occurring to the steel. Once the curing is complete only then can holes be drilled though and hardware attached. A system of epoxy will be used when bolting hardware to the boat. The epoxy will isolate the hardware from the steel reinforcement.



The framing spacing is approximately 18" apart on the boat. This is a bit of overkill possibly but no harm done and extra strength will be achieved. This system of construction was pioneered by the Hartley - Brooks company of New Zealand where they have had over 30 years of experience with this type of construction. Though my application is a bit different the basic concepts will be the same. Hartley - Brooks discovered that by utilizing this framing technique a more integral structure was possible. Also through experience, the isolation of the steel matrix was found to prohibit any corrosion from occurring to the steel reinforcement.



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