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## DECORATIVE FERROCEMENT ELEMENTS

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**ABSTRACT:** Ferrocement has the versatility that can be 'sculptured' or shaped into numerous fascinating structures and objects for very wide applications. The exposure of this technology to engineers in general is rather minimal in Romania and many are skeptical about it. The potential is not exploited for it being unconventional in nature. Its ability to compete or use as a cheaper alternative and yet a promising technology in ensuring improved living standard and environmental quality must not be neglected. The paper discusses about the applicability of ferrocement in the Romanian scene with respect to recreation and home use. The ferrocement elements can be used for outside or inside exposure, thanks to ferrocement's durability, resistance to impact and resistance to fire.

**KEYWORDS:** outdoor ferrocement furniture, silos, water tank, indoor ferrocement furniture

### INTRODUCTION TO FERROCEMENT

Ferro-cement composite is a rich cement mortar matrix of 10 to 100 mm thickness with reinforcement volume of five to eight per cent in the form of one or more layers of very thin wire mesh and a skeleton reinforcement consisting of either welded mesh or mild steel thin bars. (Figure1) The proportions in terms of sand-cement ratio are normally 1:1,5 or 1:2. The water cement ratio may vary between 0.4 and 0.5. Admixtures can be added for achieving improved workability, reduced permeability and increased durability. The presence of small diameter steel wires closely and uniformly spaced in the volume of cement mortar improves many properties like ductility, toughness and crack resistance as compared to conventional reinforced concrete.



Figure 1. Ferrocement element

Joseph Monier, a gardener in Boulogne, is considered to be the first to introduce steel into concrete in 1849 to build sturdy flowerpots and garden furniture, and his version was patented in France in 1867. However two years earlier in 1847 another Frenchman, Joseph-Louis Lambot had already introduced reinforcement in cement to build boats at his estate near Brignoles. Lambot called his invention 'ferciment' and described the technique as 'construction formed of metal mesh plastered and

joined together with cement'. Lambot made his invention public only in 1855 when he showed one of the boats at an International Exhibition in Paris.

According to Romauldi, "the technology of that period could not accommodate the time and effort needed to make mesh of thousands of wires. Instead, large rods were used to make what is now called standard reinforced concrete, and the concept of ferrocement was almost forgotten for a hundred years. [1] For civil buildings Pier Luigi Nervi was the first one to use the ferrocement for structural elements. Even though ferrocement has recently found a wide range of applications particularly in developing countries, unfortunately ferrocement remains generally underutilized in mainstream architecture.

### FERROCEMENT NON STRUCTURAL ELEMENTS FOR EXTERNAL USE

During the opening of the second day of the International Symposium on Ferrocement FERRO 10 held between 12-17 October 2012 in Cuba, the president of the organizing committee, engineer Hugo Wainshtok Rivas presented dozens of examples of the durability of this technology after decades of application. In 1982 Baconao Park in Santiago de Cuba was opened with more than 100 large pieces (Figure 2) by sculptor Dagoberto Moreno.



Figure 2. Ferrocements sculptures in Baconao Park Santiago de Cuba

At present all are kept in good condition. When we are talking about elements for external use we are talking about elements exposed to weather conditions, marine environments or different kind of chemicals.

Ferrocement's durability is the reason to be chosen for different kind of sculptures, facade elements, decorations, street furniture, drains, gutters, food and water storage. To prove it's applicability in Romania few examples are presented in this article with the hope that production of ferrocement elements will begin.

**Ferrocement statues**

The flexibility of meshes gives so much versatility for this material and can be molded almost in any shape. Amusement parks use it when big dimensions statues are built. Figure 3 shows the steel meshes fixed on rods taking the shape of a tree. The micro concrete is applied on the meshes having different admixtures to obtain a white concrete that can be easily painted.



Figure 3. Statue of a tree in a park



**Ferrocement facade elements**

Non-structural elements of a building are not part of the main load-resisting system and the design does not follow the design standards. They are considered decorative elements and the durability in time is one of the concerns. Ferrocement elements are used for balconies (Figure 4) being light weight and easy to construct and install. They need zero maintenance and are easy repairable. Meticulous building precision is crucial to the successful completion of ferrocement projects especially with respect to the cementitious composition and the way in which it is applied in and on the framework, and how or if the framework has been treated to resist corrosion. An example of facade elements is presented in Figure 5 an architectural artwork created by architect Renzo Piano for the museum Menil Collection in Houston, USA, where the ferrocement "leaves" concentrate the light only the sculptures inside.



Figure 4. Ferrocement for balconies



Figure 5. Menil Collection, Houston, Texas, ferrocement leaves

**Urban sculptures**

Wood and steel are materials most used to build benches, bus stations, tables in cities but ferrocement is more reliable because of its resistance to impact, to fire [3] and damage can be fixed locally very easy. Figure 6-10 show this examples.



Figure 6. Ferrocement bench



Figure 7. Ferrocement bench

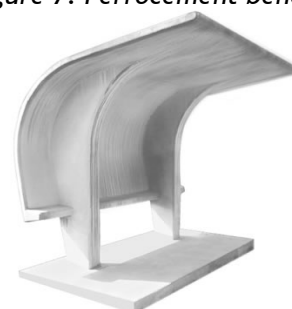


Figure 8. Ferrocement Bus Shelter





Figure 9. Ferrocement Table



Figure 10. Ferrocement Table

**Food and water facilities**

Ferrocement water tanks for rainwater collection in rural communities as a user-built can be an alternative to store-bought plastic tanks that can be difficult to transport for some areas or too expensive. At the moment there are many websites with all the information how to build a ferrocement water tank. (Figure 11)



Figure 11. Ferrocement Rain Water Tank

The problem of food storage in the developing countries is emerging as a major subject of attention from technical assistance organizations. Increasing supplies of food grains, such as rice, wheat, and maize, resulting from the intensive production have caused an unprecedented need for grain storage in developing countries, yet most production areas are still unprepared to store this new abundance adequately. The production is lost to inadequate harvest and inadequate storage facilities and practices. In addition to grain storage, facilities are urgently needed to protect all products sensitive to temperature, humidity, rain, wind, pest animals, bacteria, or fungi. Other typical products requiring storage are peas, beans, oil crops such as soybeans, salt and other nonfood items such as fertilizers, pesticides, and cement. Major needs are small scale silos, particularly for on farm storage. [2] Figure 12. A particular advantage of ferrocement in building food storage facilities in developing countries is its adaptability to an almost unlimited range of curved shapes and local conditions. Ferrocement silos require little maintenance, and they offer protection against rodents, birds, insects, water, and weather. [2] Ferrocement silos could be built in a factory, but they are particularly adaptable to on-site

construction, an important consideration in remote areas without vehicle access. As with other applications, silos require only simple artisan skills, performed by local labor with minimal supervision. [2]



Figure 12. Ferrocement Silo

**Ferrocement gutting**

Ferrocement applications are free-form and can be limited only by one's imagination. It provides easy mould ability and can take any form. To produce rain gutter a half pipe is used as a mold. (Figure 13)

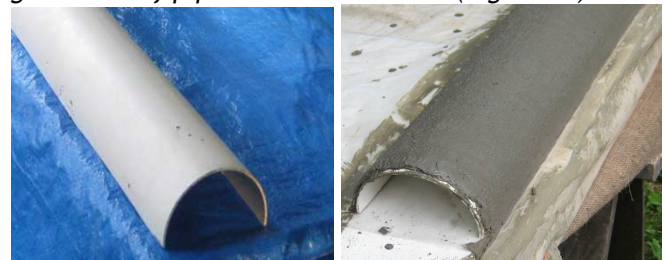


Figure 13. Ferrocement Gutting

**FERROCEMENT NON STRUCTURAL ELEMENTS FOR INTERNAL USE**

The versatility of ferrocement has led to its appearance in numerous non-traditional formats such as furniture, sculpture and art. Due to improved setting and molding techniques, it is now possible to create more sophisticated shaped furniture using concrete. The added durability of concrete means they can be placed indoor or outdoor, in local parks and community areas. Concrete furniture design is evolving rapidly and cement furniture is making an appearance inside the contemporary home. Cast concrete counters in the kitchen are one thing but furniture designers are bringing the material into the home in a very modern way.



Figure 14. Ferrocement Furniture

Concrete furniture has a bad reputation because most people have never seat in a well designed concrete chair. With new technologies it is possible to design pieces that conform to the body and add an amazing solution to the furniture needs.



Figure 15. Ferrocement Chair

Ferrocement applications are free-form and can be limited only by one's imagination. It provides easy mould ability and can take any form. It can be used for manufacturing precast building components that can be easily transported. Some popular uses are for making tables (Figure 16) doors, tubs (Figure 17), flower pots etc.



Figure 16. Ferrocement Table



Figure 17. Ferrocement Tub

#### FERROCEMENT'S ADVANTAGES

- Easy to construct and install, little new training is required.
- Ferrocement may be fabricated into almost any conceivable form to meet the particular requirements of the user.
- Labor intensive technology creates more jobs for the rural community.
- Earth quake resistant design.
- The basic raw materials for the construction of ferrocement-sand, cement, and reinforcing mesh-are readily available in most countries.
- Durability.
- Zero maintenance and very easy reparability.
- Good resistance to fire [3]
- Low cost applications are lighter on the pocket.

#### FERROCEMENT'S DISADVANTAGES

- Labor intensive nature of it, which makes it expensive for industrial application in the western world.
- Degradation (rust) of the steel components is a possibility if air voids are left in the original construction, due to too dry a mixture of the concrete being applied.

#### CONCLUSIONS

In this paper were presented objectes made by ferrocement thin sections. Any person that worked with concrete before can use ferrocement with little training and by combining the fine meshes with the micro concrete any shape can be achived. This independence by comercial products can lower the prices and the use of local work and materials recomands ferrocement for a sustainable economy. Objects for the house (chairs, benches, tubs, gutting or water tanks) with a long working life can be made and all the disadvantages of steel or wood can be avoided.

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