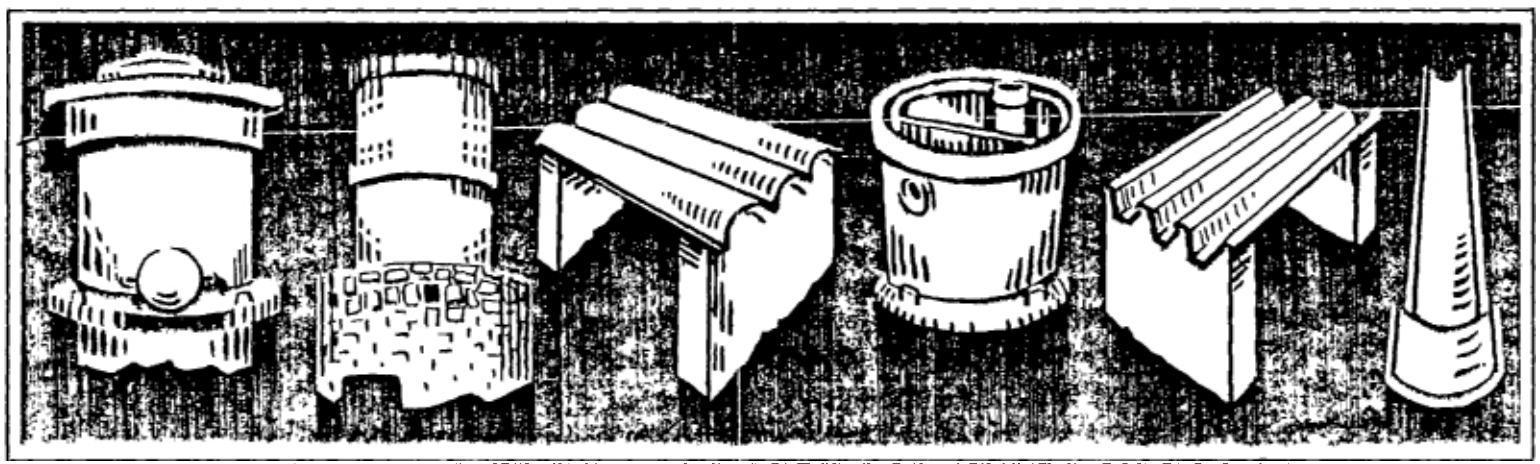
FERROCEMENT APPLICATIONS

DEVELOPED AT
STRUCTURAL ENGINEERING RESEARCH CENTRE
(COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH)
GHAZIABAD-201001, U.P., INDIA



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(Council of Scientific & Industrial Research)
Sector 19, Kamla Nehru Nagar,
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INTRODUCTION

There is a crying need for cheap bins and tanks for the safe and hygienic storage of grain and water especially at the village level. Likewise there are several other needs – drainage, sewage disposal, pucca roofs, low cost digesters for biogas plants etc., which must be urgently met. Further, the technology involved should be such that village level craftsman may be trained to use it and it must not be capital intensive.

While studying some of these problems at SERC(G), it was found that 'ferro-cement' was a material filling this bill.

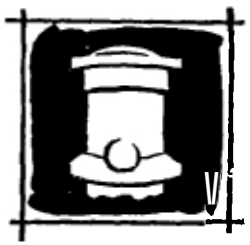
A start was made with bins and water tanks. These caught on very well both in rural and urban surroundings. The use of the material was then extended to other items like roofing units, septic tanks, manhole covers and irrigation cum drainage channels. All these were found to meet the felt need.

Later the material was used for another common malaise – leaky overhead water tanks. Such tanks in distress or abandonment represent a huge national waste. It was demonstrated that using ferrocement, even an abandoned leaky tank could be put back into service with an investment of a small fraction of the cost of a new one.

This brochure illustrates some of these applications and is prepared with a hope that the technology developed would contribute to a modest extent in curbing waste and improving the quality of life, particularly in rural areas.

GHAZIABAD, U.P.
JANUARY 1990

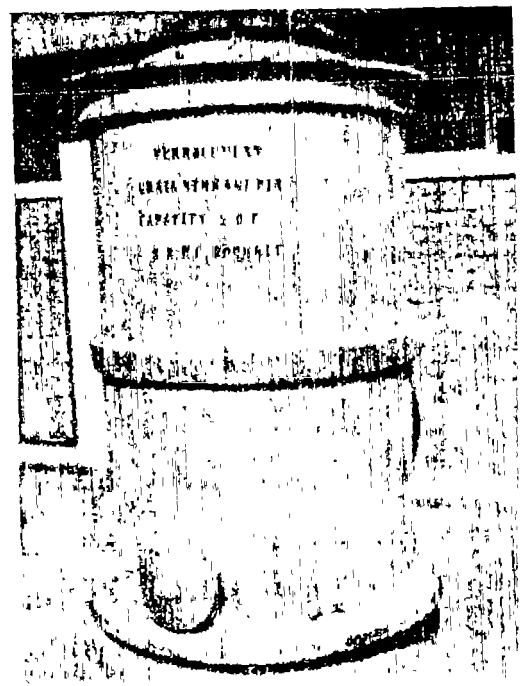
S.P. SHARMA
Director



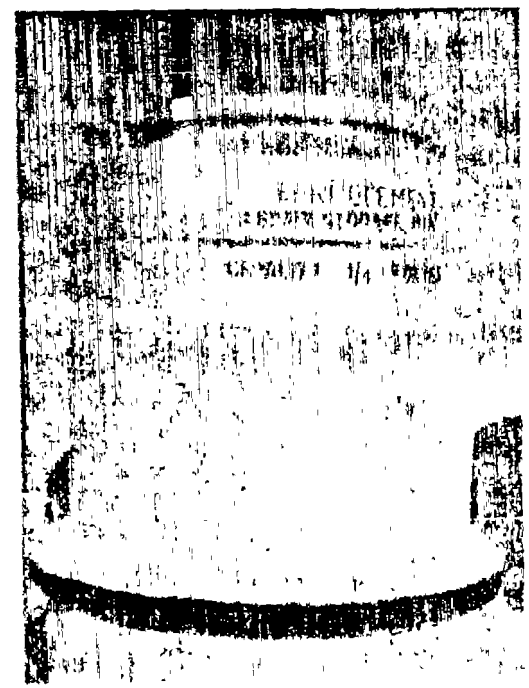
FERROCEMENT BINS FOR STORAGE OF FOODGRAIN AND OIL SEEDS

The answer to the problem of the colossal loss of foodgrain during storage lies in the development and promotion of scientific and inexpensive methods of storage at rural level. Keeping this in view the SERC, has developed ferrocement bins of ¼, ½, 1, 2, 3, 4, 8 and 16 tonnes capacity (in terms of wheat). A process has been developed for producing ferrocement bins which can also be used for casting several other ferrocement items such as tanks, septic tanks, Biogas Plant digesters etc. These units are cast by a simple semi-mechanised process calling for only rural level skills.

The ferrocement bins developed at the Centre are cylindrical in shape and are assembled using prefabricated components, viz, base slab, wall unit, dome shaped roofs unit and lid. Bins of various capacities may be assembled by erecting one, two or three wall units, one over the other and filling up the joints. A manhole is provided in the roof unit for loading and an outlet is provided in the bottom wall unit for unloading the grain. Gaskets are provided on the inlet and outlet openings to make the bins air-tight. Locking arrangements are also provided. The external surface of bin is painted with bituminous aluminium paint. The sizes of the various components of the bins are such that these units can be handled and erected by 4 persons. Depending upon the size, the wall units are cast using the semi-mechanised



Ferrocement grain storage bin capacity 2 t (wheat)



Ferrocement grain storage bin capacity ¼ t (wheat)

process in one single unit. Walls for Bins of 8 & 16 t capacity are cast in vertical segments and joined in place for ease in transportation & erection.

These bins are also useful in storing oilseeds. The bin must be dry at the time of use for storing grains or oil seeds. The infill also must be dry to a level of recommended moisture.

Advantage of Ferrocement bins

i) Cheaper compared to steel, reinforced concrete, aluminium and plastic bins.

ii) Lighter compared to conventional reinforced concrete bins or masonary bins.

iii) Require little or no maintenance.

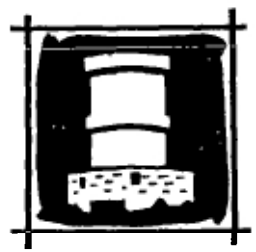
iv) The condensation and moisture migration problems in the foodgrains stored in Ferrocement bins are much less than in foodgrain stored in steel bins.

v) Ferrocement bins are rodent proof, fire proof, damp proof and can be easily made air-tight by sealing the inlet and outlet openings.

vi) Any structural damage can be easily repaired.

vii) Can be easily fabricated at the rural level. The fabrication technology is simple and can be easily learnt by the rural artisans.

Bins developed at SERC have been tested by Central Food & Technological Research Institute, Mysore and Punjab Agriculture University, Ludhiana and have been declared safe for storing food grains.



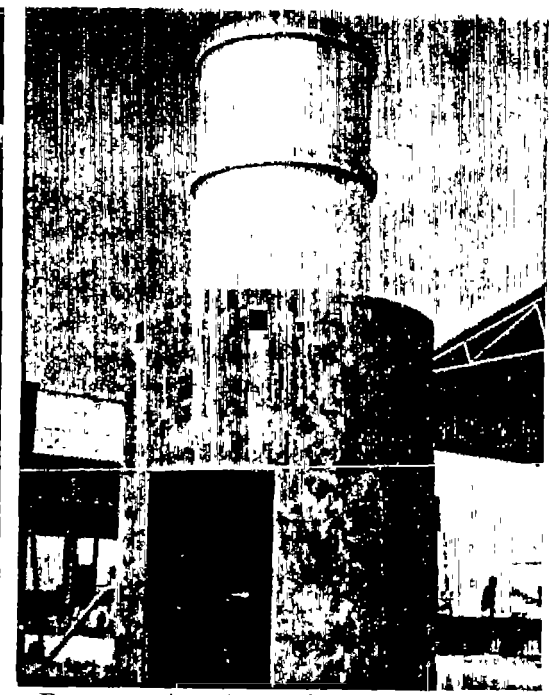
FERROCEMENT WATER STORAGE TANKS

The prefabricated components produced using SERC Process viz, base, wall, roof and Lid units are used for assembling water tanks of 300,600,1250 & 2500 litre capacity. These units, with suitable provisions of sockets for inlet, outlet scouring and over flow pipes and with the inside surface painted with drinking water tank paint, can be used to meet the demands for hygienic water supply in rural areas. Water tanks of 250 litre to 20000 litre capacity can be produced and erected for use as overhead and underground tanks in cities and for rural water supply schemes. Tanks, above 2500 litre capacity, are assembled using SERC segmental shell units. Units cast over simple masonary/soil deposit moulds are transported to site and jointed to adjacent unit by overlapping the projected wire mesh reinforcement and plastering the joint areas. F.C. Segmental shell units can be safely transported for long distances.

Large number of F.C. tanks developed by the centre have been produced and installed by firms Licenced by NRDC of India.

These tanks are being adopted for rain water harvesting schemes under National Mission on drinking water.

Ferrocement water tank - capacity 20000 litre, constructed using SERC segmental technique.



Ferrocement water tank - capacity 2500 litre used as overhead tank in a pipe factory in NOIDA. Produced with SERC semi-mechanised process.

Advantages of Ferrocement Water Tanks

i) Unlike steel water tanks F.C. tanks are free from effect of corrosion.

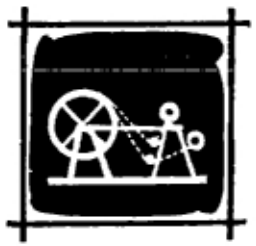
ii) These are lighter than reinforced concrete water tanks and consume less cement and steel.

iii) These are cheaper than steel, concrete, masonary and plastic tanks.

iv) In case of any accidental damage these can be easily repaired.

v) These do not leave any residue in water due to rise in temp. of water in summer.

vi) Require little or no maintenance.



SEMI-MECHANISED PROCESS FOR PRODUCING FERROCEMENT CYLINDRICAL UNITS

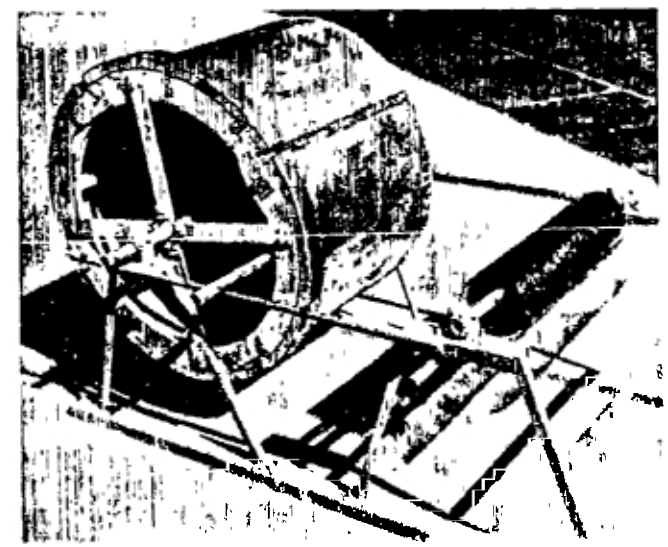
In most countries ferrocement cylindrical units are produced using the traditional hand plastering technique in which a separate cage is fabricated with steel wires/ bars and meshes and the mortar is applied over the cage surface manually. The system has many disadvantages like non-uniform thickness and non-compaction of mortar. The minimum thickness achieved in this type of casting method comes to about 25 mm.

S.E.R.C.(G), has developed a semi-mechanised process for producing ferroment cylindrical units used as walls for grain storage bins, water tanks, septic tanks, biogas digesters, tree guards etc. In the casting process, a continuous winding of wiremesh from a wiremesh roll on to a cylindrical mould and simultaneous application of cement mortar on the wiremesh as and when it is wound on the mould is achieved. This permit a high degree of compaction of mortar and good control over thickness.

The process is simple, labour intensive and does not require electric power, fuel, expensive machinery or highly skilled technical manpower. The equipment could be fabricated in a small workshop having welding, cutting, drilling and grinding facilities.

Ferrocement cylindrical units as thin as 1 cm and as thick as desired with various types of reinforcement layouts can be cast with this process.

The process has been patented and released to more than 50 licencees (up to Jan '89) through the National Research Development Corporation, New Delhi.

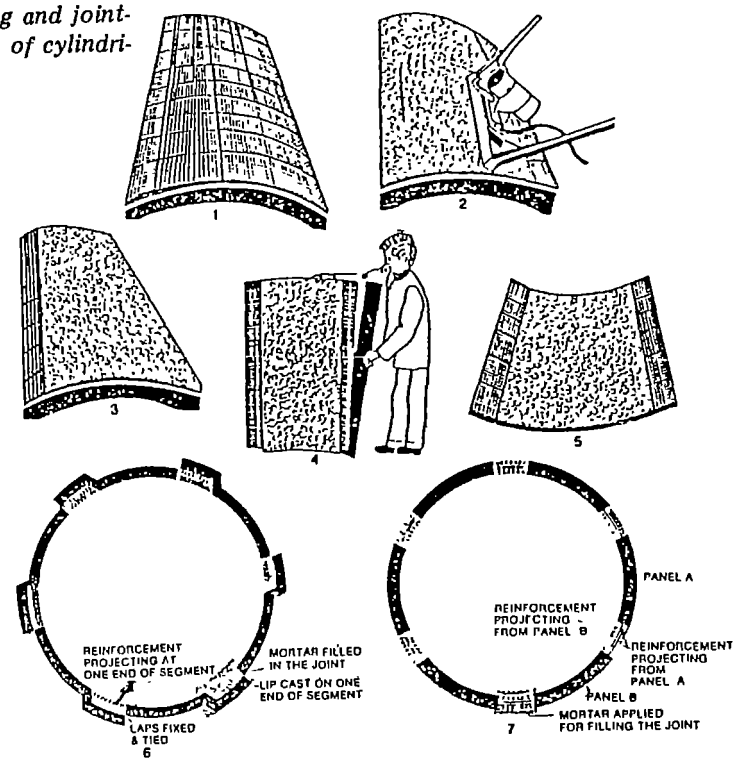


Semi-mechanised process for producing cylindrical ferrocement units (Patented) - Costing equipment.

PRECAST FERROCEMENT SEGMENTAL SHELL CASTING AND ASSEMBLING TECHNIQUE FOR CYLINDRICAL STRUCTURE

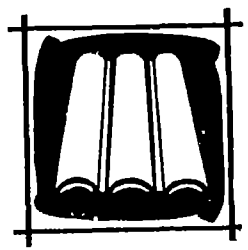
During field demonstrations and transportation tests it was observed that transportation and handling of Ferrocement cylindrical units, larger than 1.2 m. in dia., for water tanks, bins, septic tanks and digesters etc. on rural road Pose Problems. A system of casting the cylindrical units in vertical segments was developed at SERC(G) for solving this problem. Ferrocement Segments are cast over masonary/soil deposit or wooden moulds in horizontal position. The wire mesh and cross reinforcement (rings in pieces) projects out on both the sides of the segments. As the units are cast in horizontal position modified surface vibrators can be used for compaction of the surface. Vertical ribs and circular bands can be easily cast while precasting the segments. The segments can be transported to place of erection in bullock carts, cycle rickshaws or manually depending upon local conditions. The base concrete for the tank is placed and segments are placed in vertical position over a marked inner dia, tank line with joint positions marked. The projecting mesh and reinforcement is lapped and tied and mortar is applied over the joint areas, vertical ribs and circumferencial bands are cast. The inner surface is finished and a C.C. triangular band is cast at the joint of the wall and base.

Various steps in casting and jointing of segmental shells of cylindrical structure.



The roofing unit for these tanks can be cast over masonary moulds in one piece or in 4 to 8 segments. If needed the base unit can be also cast partly in 4 to 8 segments.

Transportation for long distances have been tried out by SERC and segments cast at Ghaziabad could be safely transported to Bhopal (800 km. in Jan 88) and Gulbarga via Bangalore (2800 km. in Dec. 1988) by fast moving mini-trucks in unpacked condition. No damage was observed. 5000 litre tanks have been assembled using these segments at both the places and no damage or leakage has been observed.



FERROCEMENT ROOFING UNITS

Two types of ferrocement roofing units have been developed at the Centre:

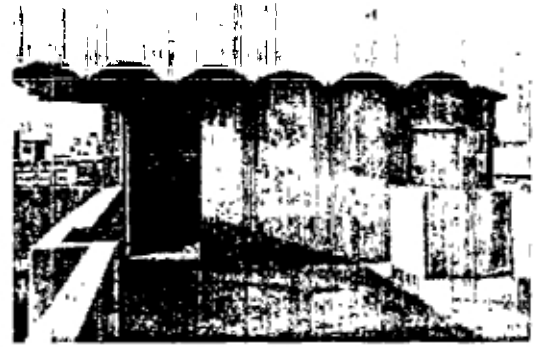
(a) Ferrocement Folded Plates

Trough shaped folded plate units of upto 5.0 m span have been developed and tested in the laboratory. Thickness of 3.0 m span roof is only 15 mm and it can be used for temporary and permanent structures. A few demonstration roofs were cast and erected at IITF, NTF, CHOGRM-2 at New Delhi and at SERC, for studying the difficultics in transportation, erection and handling. The roof does not require any maintenance. F.C. folded plate roofing is economically comparable to G.I./ A.C. sheet roof supported over standard wooden/steel structures. Such F.C. roofs cost about Rs.125/- per m^2 and do not require any bolting or site jointing. If needed, these units could be removed and shifted to any other site without any problem.

(b) Segmental Shell Roof

This type of roof is assembled using precast segmental shell--elements developed at SERC(G). Cost of such roof installed at one floor level comes to about Rs.130/- per m^2 which is quite competitive with A.C/G.I. sheet roof supported over steel structure. Architecturally, such a roof provides an elegant structure. Such roofs

Ferrocement trough shaped precast roofing units for span upto 5.0 m - cast using SERC mechanised process.



Precast ferrocement segmental shell roof of a house in Ghaziabad.

have been used for several structures including a cycle shed in Parliament Complex, New Delhi, roofs for staircase blocks for houses for UPSEB at Annapara Thermal Power Project, factories in Meerut and Ghaziabad etc. and are in use since last several year.

The Centre has developed a mechanised process for producing F.C. roofing and wall elements. Use of this system improves the quality of the product and reduces production time. Laboratory investigations have shown a strength improvement by 25% in units cast with this system when compared with hand cast (plastered) units.

FERROCEMENT BIOGAS PLANT DIGESTERS & GASHOLDERS

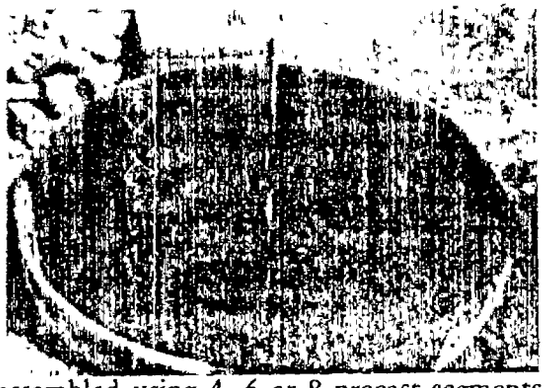
Ferrocement Biogas Holder

In the conventional biogas plants gas holders made of steel sheets are used. These gas holders account for nearly 40-50 per cent of the total cost of the plant. Furthermore, it has a low life and needs expensive maintenance, as it is highly susceptible to corrosion.

The ferrocement (cement mortar reinforced with steel wiremesh layers) gas holder designed for biogas plants of 2 to 6 cu.m capacity gas production per day has been found 40-50 per cent cheaper than the steel gas holders. Besides, it needs much less maintenance and has a much longer life. It can be fabricated in rural areas without expensive equipment but require very good quality control during production and careful handling during transportation and installation for preventing mechanical damages.

Ferrocement Biogas Plant Digester

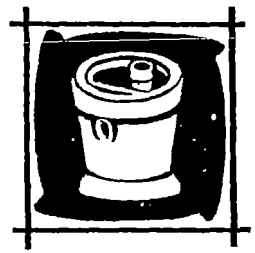
A system using ferrocement precast segmental shell units for constructing digesters for biogas plants (producing 2.0 to 10.0 m^3 gas per day) has been developed and



Ferrocement biogas plant digester for biogas plant upto 10 m^3 Cap., assembled with segmental shell element units.

tested at SERC,(G). The digesters are assembled using 4, 6 or 8 precast segments which are 15 to 18 mm thick. The wiremesh and wire reinforcement projecting out on sides is used for connecting these segments when placed in vertical position. The mesh laps form the joint ribs and also accommodate inlet and outlet pipe junction with the digester wall. Rich cement sand mortar is applied over the mesh joint areas and ribs are formed. Extra reinforcement could be provided in the joints and external radial bands are provided at top, middle and bottom positions.

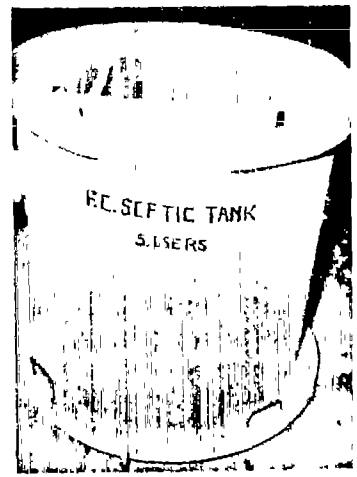
In further improved method developed at SERC a joint lip is cast at one side of the precast ferrocement panel and this facilitate the mortar application only from inside. Adoption of this technique for construction of digesters in areas where good bricks are not available or where mass scale construction of biogas plants is to be taken up, will save considerable expenditure and construction time.



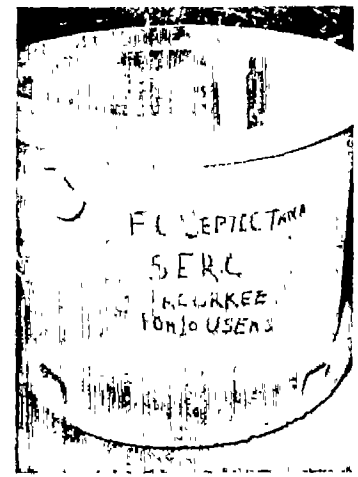
FERROCEMENT SEPTIC TANKS

Septic tanks provide the most effective system for disposal of human excreta for the population that cannot afford the high cost sewerage system. Moreover, for most rural areas septic tanks are the only possibility. Generally the septic tanks constructed at present are rectangular in shape. Circular septic tanks have been found to be equally efficient. In circular tanks greater economy could be achieved by reducing the consumption of materials. The circular or rectangular septic tanks constructed using brick masonry are (i) not 100% water tight, (ii) require large area, (iii) effluent quality deteriorates with time.

Use of ferrocement as construction material for septic tanks ensures impervious ness. SERC has developed production techniques for production of F.C. septic tanks using functional designs developed by a group of U.P. Jal Nigam experts which ensures a much compacted unit needing less space and better effluent quality throughout. These septic tanks are made of two precast units, (i) the sludge digestion chamber and (ii) a desludging pit. Walls for both units are produced using SERC semi-mechanised process or segmental system. The units including inlet, outlet tee and ferrocement baffle wall etc. for sizes of 5, 10 and 25 users can be produced in a factory in fully precast form. The desludging pit and digestion chambers are connected at the site with a desludging pipe. Units for 50 and 100 users are assembled using SERC's multipurpose segmental shell element units at site.



Cylindrical vertical ferrocement septic tank (capacity 5 users).



Ferrocement vertical ferrocement septic tank (capacity 10 users).

These septic tanks are slighly cheaper than brick work septic tanks but these are more competitive due to following advantages (1) availability of good quality manure from desludging pit, (2) no need for closing down for sludge removal, (3) fully water tight construction, (4) possibility of mass production in factory and quick installation and (5) minimum chances of choking due to sludge depositing.

These septic tanks are ideally suited for use in rural areas in plains and hills and in areas where good quality bricks are not available.

IRRIGATION CUM DRAINAGE CHANNEL

For rapid laying of irrigation and drainage lines, the Centre has developed semi-circular and trough shaped ferrocement irrigation/drainage units with built-in-jointing collar at one end for jointing. A simple process for pre-casting of these units has been developed. The process of casting involves a masonry mould make to fit exactly the inner surface of the channel unit and a mortar vibration cum compaction device made with a mild steel frame and a medium frequency form-vibrator.

The reinforcement cage for the channel unit, which is made of steel wires and wire meshes, is placed over the oiled masonry mould over which a layer of old newspaper sheet is spread. Rich cement: sand mortar (1:2) is applied over the re-inforcement cage and compacted with the vibration-cum-compaction device which also shapes the unit to a uniform shape.

These units are lighter in weight as compared to reinforced concrete water channels of semi-circular shape and cheaper than 9" brick work irrigation/drain-age channels. These could be repaired easily in case of any accidental damage. In areas where electricity is not available the units could be also cast by hand applica-tion of mortar.

Ferrocement irrigation cum drainage unit.

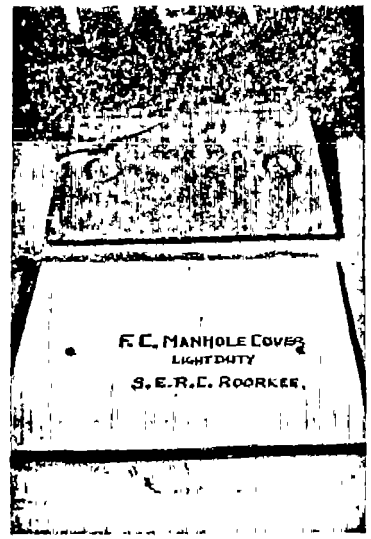
FERROCEMENT MANHOLE COVERS

Cast iron manhole covers used at present for covering manholes in the sewer lines, water lines and covered drainage lines are pilfered in large numbers while open manholes are liable to cause accidents. During handling or while in position large number of C.I. covers crack and there is no method by which these could be repeaired.

Considering these, facts, the Centre has developed light-duty, medium-duty and heavy duty ferrocement manhole covers. The tests conducted on these covers have shown that ferrocement manhole covers can take the loads specified for cast iron manhole covers in Indian Standards Code I.S. 1726.

The covers developed at the Centre have been provided with mild steel flat edging all round for preventing the edges from breaking. The skeletal steel bars are directly welded to edge frame. Centre has developed a method and equipment needed for the production and testing of these covers. The covers are vibrated under pressure using electrically operated equipment.

Ferrocement manhole covers are 15 to 25% cheaper than cast iron manhole covers and are free from problems of theft or cracking. Also, production of cast iron covers requires large quantity of fuel (coal) and power which is not required in case of ferrocement covers.

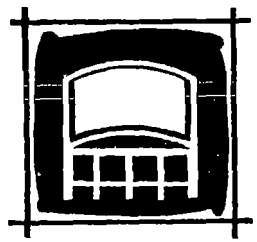


Ferrocement manhole cover and damaged cast iron cover.

Ferrocement medium duty manhole cover.

Ferrocement support frames for these covers and their casting process has also been developed at the centre.

The process for F.C. Covers is being released to entrepreneurs through N.R.D.C., New Delhi.



FERROCEMENT LEAK PROOF TREATMENT FOR TANKS AND ROOFS

Leakage of water through the wall and base of reinforced concrete and masonry tanks or building roofs, is a problem which is faced by field engineers quite frequently. The usual methods of repairing such leaky structures are epoxy patching/lining, silicate mixed mortar application or guniting etc.

SERC (G) has developed a method of lining leaky structures using ferrocement, a material known for its high impermeability and ease in application. Behaviour of several tanks and roofs treated in 1976-77 at Ahmedabad has been reported to be satisfactory. A badly leaking reinforced concrete overhead water tank of 50000 gallon capacity was treated in 1982. This tank situated in Roorkee Cantt and belonging to Military Engineering Services, was abandoned soon after its construction due to heavy leakage. The tank was recommissioned after ferrocement treatment in October 1982 and is in continuous service without any leakage.

Ferrocement treatment over a roof assembled with precast unit.

Ferrocement leak proofing treatment over the leaking RCC shell - Hotel Dron, Dehradun.

ENQUIRIES FROM INDIVIDUALS AND ORGANISATIONS ARE WELCOME

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