Design Guide for Ferrocement

Reported by ACI Committee 549

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This guide provides technical information on physical and mechanical properties, design criteria, and testing of ferrocement. The objectives are to promote the most effective use of ferrocement in terrestrial structures, provide architects and engineers with the necessary tools to specify and use ferrocement, and provide owners or their representatives with a reference document to check the acceptability of a ferrocement alternative in a given application.

Keywords: composite materials; construction materials; ferrocement; fibers; reinforcing materials; structural design; welded wire fabric.

CONTENTS

ACI 549.1R-18 supersedes ACI 549.1R-93 was adopted and published September 2018.

CHAPTER 1—GENERAL

1.1—Scope

This guide is based on technical information assembled from current practice, developments, and advances in the field of ferrocement around the world. It represents a practical supplement to ACI 549R. This guide covers physical and mechanical properties, performance and design criteria, and testing.

The objectives of this guide, in conjunction with ACI 549R, are to promote the effective use of ferrocement in structures, provide architects and engineers with the necessary tools to specify and use ferrocement, and provide owners or their representatives with a reference document to check the acceptability of a ferrocement alternative in a given application. This guide is consistent with ACI 318, except for the special characteristics of ferrocement, such as reinforcement cover and limits on deflection.

Ferrocement is a form of reinforced concrete using closely spaced multiple layers of mesh, small-diameter rods completely infiltrated with mortar, or encapsulated in mortar, or both. The most common type of reinforcement is steel mesh. Other materials such as selected organic, natural, or synthetic fibers may be combined with metallic mesh. This guide addresses only the use of steel reinforcement in a hydraulic cement mortar matrix.

Applications of ferrocement are numerous, especially in structures or structural components where self-help or low levels of skills are required. Besides boats and marine structures, ferrocement is also used for housing units, water tanks, grain silos, flat or corrugated roofing sheets, and irrigation channels (ACI 549R).

1.2—Approval for use in design and construction

Use of ferrocement and the procedures covered in this guide may require approval by the authority or governmental agency having jurisdiction over the project.

CHAPTER 2—NOTATION AND DEFINITIONS

2.1—Notation

A_c = cross-sectional area of ferrocement composite
A_s = total effective cross-sectional area of reinforcement in the direction considered
A_s = $\sum_{i=1}^{N} A_{si} A_s = \sum_{i=1}^{N} A_{si}$
A_{si} = effective cross-sectional area of reinforcement of mesh layer i in the direction considered
b = width of ferrocement section
c = distance from extreme compression fiber to neutral axis
d'' = clear cover of mortar over first layer of mesh
d_b = diameter or equivalent diameter of reinforcement used
d_i = distance from extreme compression fiber to centroid of reinforcing layer i
E_c = elastic modulus of mortar matrix
E_{cr} = elastic modulus of cracked ferrocement in tension (slope of the stress-strain curve in the cracked elastic state)
E_r = effective modulus of the reinforcing system
E_s = elastic modulus of steel reinforcement
f_c' = specified compressive strength of mortar
f_{si} = stress in reinforcing layer i
f_{su} = strength of mesh reinforcement or reinforcing bars
f_y = yield strength of mesh reinforcement or reinforcing bars
h = thickness of ferrocement section
M_n = nominal moment strength
N = number of layers of mesh; nominal resistance
N_n = nominal tensile strength
n_r = modular ratio of reinforcement
S_r = specific surface of reinforcement
S_{rl} = specific surface of reinforcement in the longitudinal direction
S_{rt} = specific surface of reinforcement in the transverse direction
s = mesh opening or size
V_f = volume fraction of reinforcement
V_{fi} = volume fraction of reinforcement for mesh layer i
V_{fl} = volume fraction of reinforcement in the longitudinal direction
V_{ft} = volume fraction of reinforcement in the transverse direction
β_1 = factor defining depth of rectangular stress block
η = global efficiency factor of embedded reinforcement in resisting tension or tensile bending loads
η_l = value of η when the load or stress is applied along the longitudinal direction of the mesh system or rod reinforcement
η_t = value of η when the load or stress is applied along the transverse direction of the mesh reinforcement system or rod reinforcement
η_θ = value of η when the load or stress is applied along a direction forming an angle θ with the longitudinal direction