Review paper of behavior of ferrocement encased RC column under concentric loading

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ABSTRACT

In recent years, composite materials have gained significant attention for upgrading and rehabilitating concrete structures. Among the various strengthening methods, ferrocement jacketing has emerged as an effective solution for improving the performance of reinforced concrete columns. Since columns are the primary load-carrying elements in framed structures, any failure in these members can seriously affect the overall stability of the building and may even result in structural collapse. The present research examines the effectiveness of ferrocement jacketing in enhancing the strength of both square and circular reinforced concrete columns.

For square columns, two strengthening strategies were investigated. The first method involved providing reinforcement at all column corners, while the second focused on minimizing stress concentration by converting sharp edges into rounded corners. These approaches were further studied using two different jacketing configurations: (i) ferrocement jackets consisting of three wire mesh layers and (ii) jackets with a single mesh layer supplemented by two additional mesh layers at the corners.

For circular columns, the study evaluated the influence of varying confinement levels through the use of different numbers of galvanized iron wire mesh layers. The specimens were wrapped with single-layer, double-layer, and triple-layer ferrocement jackets to assess their effect on compressive strength enhancement.

A total of 27 specimens were prepared for the experimental program, including 15 square columns and 12 circular columns. After an initial curing period of seven days, the columns were retrofitted with ferrocement jackets and then cured for an additional 28 days. Once curing was completed, all specimens were subjected to concentric axial compression testing to determine their load-carrying capacities.

The experimental findings demonstrated a considerable improvement in structural performance due to ferrocement confinement. Square columns with rounded corners and three-layer ferrocement jacketing exhibited the highest enhancement, achieving an increase in load capacity of up to 82.29%. Likewise, the strengthened specimens identified as RFCS, RFCSC, and RFCRCC showed increases in capacity of 68.01%, 53.13%, and 58.20%, respectively. In the case of circular columns, the specimens CC1, CC2, and CC3 recorded improvements of 46.50%, 73.66%, and 132.51%, respectively, indicating that greater confinement through additional mesh layers significantly enhanced compressive strength.

(iv)

Overall, the study confirms that ferrocement jacketing is an efficient and economical technique for strengthening reinforced concrete columns, particularly when proper corner treatment and adequate mesh confinement are provided.

INTRODUCTION

1.1 GENERAL

Reinforced concrete structures show excellent performance in terms of structural behavior and durability except for those zones that are exposed to severe environmental influences and high mechanical loading. Reinforced concrete is a commonly used construction material. RCC as a construction material has come into use for the last one century. In India RCC has been used extensively in the last 50 to 60 years. During this period we have created large number of infrastructural assets in terms of buildings, sport stadium, and bridges etc., which are lifeline for civilized society. These have been constructed with huge investment of resources. We can never dream of recreating such assets out of some degree of national resources. So it is essential to maintain them in functional condition.

The structures are constructed based on the specifications given in standard codes to meet the service life. As with time the codes are upgraded for different reasons, the structures which were constructed on the bases of old codes may have some deficiencies according to the upgraded codes. Change in use or higher loads and performance demands require modifications and strengthening of structural elements. Similarly a large stock of existing structures are deteriorated with use and time and might have passed their design life and require retrofitting and rehabilitation. The structures are also susceptible to earthquake, flood, cyclone, environmental pollution, chloride attack, carbonation, inadequate design and faulty construction. The environmental stresses like humidity, air and water pollutants also cause corrosion and develop cracks leading to the failure of structural element. Replacement of damaged structural elements is difficult and cost intensive task and replacement of a particular structural element may lead to the integrity of the connecting members. Retrofitting of a damaged structural element is one of the best solutions instead of replacing it. Retrofitting is a process by which the strength or load carrying capacity of a structure or structural member is increased to a significant range.

Retrofitting may be carried out on a global basis by adding extra load resisting elements or it can be done on a local basis by retrofitting the existing structural elements. Global retrofitting of a RC structure can be done by the following methods:

a. Adding shear walls
b. Adding infill walls
c. Adding bracings
d. Adding wing walls
e. Wall thickening
f. Base isolation
g. Mass dampers

Local retrofitting is a technique in which an element of a structure is retrofitted and this can be carried out by following methods:

a. Jacketing of columns
b. Jacketing of beams
c. Jacketing of beam column joint
d. Strengthening of individual footing

From all above global and local retrofitting techniques, jacketing is most preferred method of retrofitting that can be applied by the following techniques:

1. Confinement with external steel caging techniques
2. Confinement with ferrocement
3. Confinement with fibre reinforced polymers such as carbon fibres, glass fibre polymer etc.

Retrofitting with ferrocement confinement is the oldest and economical technique of retrofitting. Lots of research work has done on ferrocement confinement and it is found an effective technique to use ferrocement confinement for retrofitting of structural elements. The unique properties of ferrocement such as water proof, fire resistance, low self weight, durability and crack resistance makes it an ideal material for wider applications. Due to low cost and less skilled labour requirement in ferrocement construction, it is preferred in various rehabilitation projects.

a) Steel reinforcing mesh

Ferrocement uses layers of continuous small diameter steel wire weld mesh netting (metallic or non-metallic) as reinforcement with high volume fraction of reinforcement (2 to 8%) and the specific surface of reinforcement is considerably higher for ferrocement than for RCC. Also, the reinforcing steel wire mesh has openings large enough for adequate bonding; the closer distribution and uniform dispersion of reinforcement, transform the otherwise brittle mortar into a high performance material distinctly different from reinforced concrete. Skeletal steel rods/wires/strands are used as spacer material and to form the skeleton of the shape of the structure to be built, around which the mesh layers are later attached (Naaman, 2000). The type of wire mesh available in market are square, expanded, hexagonal mesh as shown in fig. 1.1.

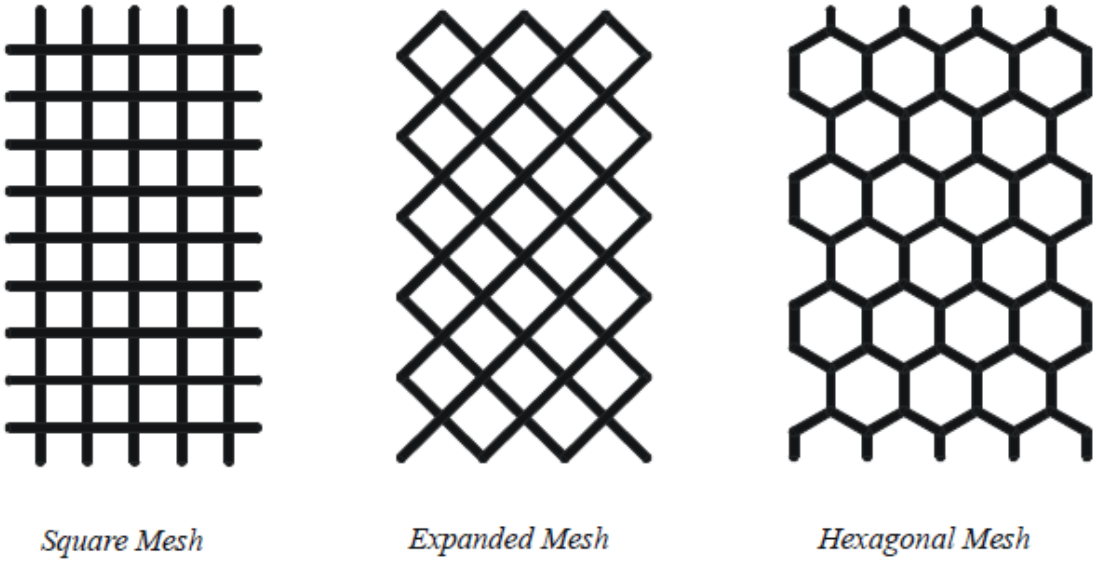

Fig. 1.1 Types of Wire Mesh

b) Cement

Portland cement is generally used in ferrocement. The type of cement should be selected according to the need or environment in which the structure is constructed. Mineral admixtures, such as flyash, blast furnace slag, or silica fumes, may be used to maintain a high volume fraction of fine filler material as well as to enhance the properties at wet and hardened state.

c) Aggregate

Only fine aggregate is used in ferrocement. Normally, the aggregate consists of well graded fine aggregate (sand) that passes a 2.34 mm sieve; and since salt-free source is recommended, sand should preferably be selected from river-beds and be free from organic or other deleterious matter. Good amount of consistency and compatibility is achieved by using a well-graded, rounded, natural sand having a maximum top size about one-third of the small opening in the reinforcing mesh to ensure proper penetration. The moisture content of the aggregate should be considered in the calculation of required water (Naaman, 2000).

d) Water

In ferrocement, the water used for mixing cement mortar should be fresh, clean and fit for construction purposes; the water of pH equal or greater than 7 and free from organic matter silt, oil, sugar, chloride and acidic material

e) Admixtures

To enhance the strength of ferrocement mortar matrix, polymers can be added to concrete in green stage and after construction, surface coatings like polymer based waterproofing coatings, cement based paint coating can be done.

Structural applications of ferrocement

Ferrocement can be used in various structural members subjected to different type of stresses. As a compression member, hollow columns with horizontal stiffners can be cast in ferrocement. Columns or walls in concrete, RCC, stone or brickwork can be encased in ferrocement to increase their strength due to confinement. Members subjected to membrane stresses like shells, domes, pyramids can be cast in ferrocement very easily; and being a homogenous material, full section of member is utilized in resisting the membrane stresses. A greater use could be made of ferrocement in water-retaining constructions. Because of its very small crack widths under service load and it superior extensibility, ferrocement provides excellent leakage characteristics for applications in water tanks.