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Passive film formation and corrosion initiation in lightweight concrete structures as compared to self compacting and ordinary concrete structures at elevated temperature in chloride rich marine environment

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HIGHLIGHTS

- Corrosion of RC structures is one of the most critical durability concerns.
- Passive film formation and corrosion in OC, SSC and LWC concrete types.
- Samples analysed with 5% and 3% chloride kept at 30, 40 and 50 °C.

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ABSTRACT

Corrosion of reinforced concrete is one of the most critical durability concerns in the construction field. Researchers and engineers are examining and determining the performance of various types of reinforced concrete in saline and under various environmental conditions. This research is also a contribution to such corrosion studies and it aims at investigating passive film formation and the corresponding corrosion and its extent in the ordinary (OC), self-compacting (SSC) and lightweight concrete (LWC) structures at normal and elevated temperature. For this purpose total of 18 specimen including 6 specimens of each OC, SCC and LWC were prepared with 5% and 3% total chloride, respectively and kept in environmental chambers at 30, 40 and 50 °C. After six months of corrosion observations i.e., corrosion potentials, currents and gravimetric mass loss, interesting and novel results were obtained on comparing the corrosion observations of all the above types of concrete.

1. Introduction

In modern construction due to its workability and lightweight emphasis and preference is given to the lightweight aggregate concrete (LWC) nowadays [1–5]. Moreover its workability; LWC is reported as very economical and environmental friendly concrete [6,7]. The production of structural high-strength lightweight concrete (HSLWC) has now become easy with the current advancements in concrete technology [8,9]. The lightweight aggregate can be natural aggregate such as pumice, scoria and all of those of volcanic origin and the artificial aggregate such as expanded blast-furnace slag, silica fume, vermiculite and clinker aggregate. Besides its natural occurrence, lightweight aggregates have been successfully manufactured from fly ash since the 1960s [10].

High strength lightweight concrete (HSLWC) for structural applications has been prepared with the combination of lightweight aggregate with silica fume and/or fly ash [11]. Due to its ease of application, HSLWC became popular in off-shore structures [10,12], where it was susceptible to corrosion due to chloride rich marine environment. However, one study has shown that LWC is more resistive to ordinary concrete due its dense matrix, which is believed to restrict continuous pores that may carry chloride ions [13]. But, still there is more research needed to establish facts

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Table 1
LWC mix-materials and their weights.

Materials	Weight (kg)
Cement	168.75
Silica fume	27.5
Water	90
Light weight coarse aggregate	160
Light weight fine aggregate	142
Red silica sand	85.25
Conplast SP 430	3.125
Total	676.625

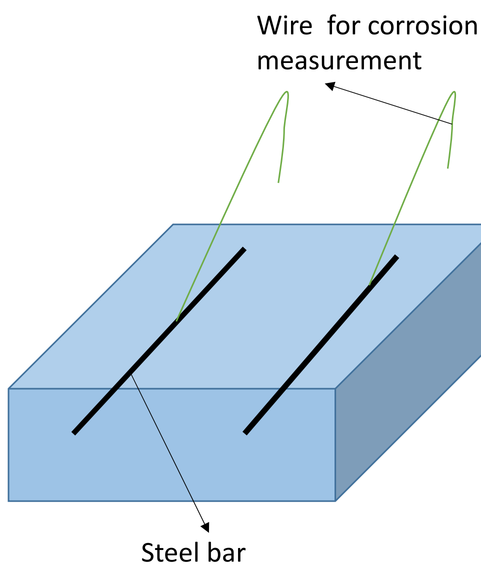

Fig. 1. Schematic representation of identical 3% Cl and 5% Cl test specimens.

Fig. 3. GECOR 8 for corrosion measurements (I_{corr} and E_{corr}).

about the corrosion resistance of LWC and its limitations under particular environmental conditions.

Researchers and engineers working in the construction field are very concerned about corrosion of reinforced concrete structures. The author of this research paper has also conducted several research studies related to corrosion behaviour of OC and SCC structures in the past [14–17]. There is a considerable research data available in literature related to passive film formation and corrosion initiation of OC and SCC. However, the research related to the effect of temperature on passive film formation and corrosion behaviour of LWC is very limited and leads to the basis of this research. The exploration of the extent of corrosion behaviour of OC, SCC and LWC is the other main objective of this research.

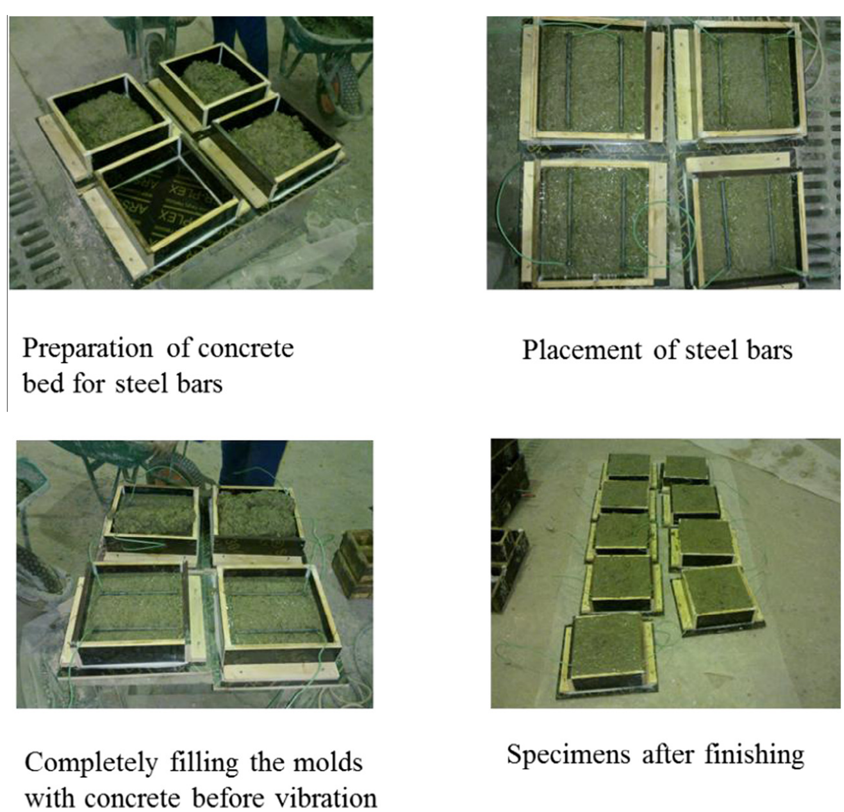

Fig. 2. Specimens' preparation methodology.