Chapter Five

Conclusions and Recommendations

5.1 Conclusions

This research is provide and give an overview to effect of corrosion on load carrying capacity of service live in concrete structures and predicting deterioration of a reinforced concrete columns .When the depassivation of reinforcement occurs the deterioration of reinforcement leads to the undesirable event of collapse of the structure. In this research failure are defined: the event which marks the time when the corrosion starts or the event of ULS-Load carrying capacity. From the possible mechanism of deterioration of concrete structures the chloride ingress is the leading mechanism of this study.

Moreover, the reliability assessment of deteriorating reinforced concrete column in which the effect of corrosion of the reinforcing steel has been taken into account with respect to ULS-Load carrying capacity. The results show that only after corrosion has started the reliability of the column decreased slowly. With elapse of time corrosion penetration starts to affect the reliability of the column significantly.

The main uncertainties in the analysis of corroded reinforced column were:

(a)The bond properties when extensive cover cracking or spalling has taken place, and when stirrups have been subjected to corrosion; and (b) the temporal and spatial variability of pitting corrosion. It was found that taking into account only pitting corrosion or uniform corrosion may lead to overestimation of the residual load-carrying capacity of a structure. For better estimation, both of the corrosion effects have to be taken into account.

The main conclusions, that can be drawn based on the analytical studies carried out under this investigation, are the following:

1- The analysis result of model in this research for the shear force and moment redistribution. The ultimate load carrying capacity at the ratio equal to 16% of the corrosion rate of steel area is equal to 1507 KN with no ductility change but the structure is not safe at ratio of 18% corrosion rate. The ultimate load carrying capacity is decreased by increasing corrosion rate and decreasing the ductility.

2- The Reduction in rebar ductility directly influences the stiffness of the structure, the possibility for force and moment redistribution, and limits the load-carrying capacity of structure, its quicken the deteriorate in structure.

3- Concrete normally provides a high degree of protection to the reinforcing steel against corrosion; both chloride and carbon dioxide may destroy the passivating. Thus the quality of concrete has a big influence on the initiation and sustenance of reinforcement corrosion.

4- The main factors that determine the resistivity of the concrete to chloride penetration are the permeability, nature and intensity of cracks, and the cover thickness.

5- Quality Concrete and Concrete Practices the first defense against corrosion of steel in concrete is quality concrete and sufficient concrete cover over the reinforcing bars.

6- Quality concrete has a water-to-cementations material ratio (w/c) that is low enough to slow down the penetration of chloride salts and the development of carbonation. Concretes with low w/c ratios can be produced by;

(1) Increasing the cement content; (2) reducing the water content by using water reducers and super plasticizers; or (3) by using larger amounts of fly ash, slag, or other cementations materials. Additionally, the use of concrete ingredients containing chlorides should be limited. The Building Code provides limits on the maximum amount of soluble chlorides in the concrete mix.

7- Other protection techniques include protective membranes, cathodic protection, epoxy-coated reinforcing bars, and concrete sealers (if reapplied every four to five years).

5.2 Recommendations

In this study it is assume that chloride ingress or Sulphate attack into concrete exhibits considerable scatter due to little data available from inspections in the field. This suggests that relatively more points during the time of exposure should be taken in purpose to achieve reliable predictions of the time of initiation of corrosion.

In addition in the service life calculations performed in this study both events are considered mutually independent. Thus the scatter in the time of initiation has not been considered. In this respect it is recommended a quantification of the scatter in the time of initiation of corrosion. Also a refinement of the probabilistic model presented for the propagation period of corrosion is suggested by including other factors which can affect propagation of corrosion significantly.

5.3 Suggestions for Future Research

1- Based on the literature study, it was found that the ductility of corroded reinforcement can be calculated using practical models in which the residual ductility is confined to empirical correlations of area loss of the corroded reinforcement. However, the reported correlation factor varies widely. Thus, more research is needed to investigate how the ductility is affected by a variety of aggressive conditions. The temporal and spatial variability of uniform and pitting corrosion also needs to be further investigated.
2- Needs to be the probabilistic corrosion model, which takes into account the effect of rust flowing through cracks. First, a detailed study of the phenomenon including the physiochemical properties of rust, the crack through which rust flows, and the flow mechanism involved, is suggested. Next, it is proposed to set up tests in which the volume of flowing rust and its dependence on crack width, corrosion rate, elapsed time, and rust composition, for example, can be measured. Such experimental data would be very useful for further verification and calibration of the model.
3- Little experimental data is available for the bond behaviour of severely corroded reinforcement with cover spalling. Moreover, the majority of experimental results report the bond properties of reinforcement which was corroded artificially with accelerating methods. Therefore, further experimental investigations of the bond properties of corroded reinforcement exposed to a natural aggressive environment is suggested, especially for structures with severe corrosion