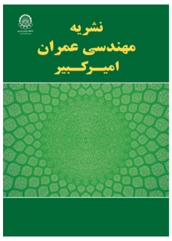

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The effect of Cover, Pressure Strength, and bars corrosion on Cracking of Reinforced Concrete Structures

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ABSTRACT: Reinforced concrete structures usually suffer from damage due to corrosion of the reinforced bars, which may be caused by carbonation and chloride ions ingress. So, predicting the onset of corrosion and the formation of cracks in the concrete cover is important. In this study experimental samples were carried out, cured and then exposed to the accelerated corrosion condition. The results were used to verify a numerical model. The effect of concrete properties such as compression strength, initial pressure and some other parameters investigated on concrete cracks. The results showed that the compressive strength and concrete cover are the main parameters at the start of cracking, and with increasing these two parameters the internal pressure, which is due to products, to start the cracking will increase.

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1- Introduction

Phenomenon of corrosion can be cause of decrease cross sections of bar, cracking, scaling of concrete, reduce bond strength and change of adhesion behavior of slip between concrete and reinforcement that all these cases eventually are lead to poor performance of concrete structures [1]. Many studies by using numerical simulation and some finite element common software have been done in order to evaluate the effects of corrosion of reinforcement in concrete. Here, it can be cited to the study of Berra et al [2]. They modeled the effect of corrosion on the deterioration of adhesion between the concrete and reinforcement, by using ABAQUS software for different levels of confinement. Lundgren used DIANA finite element software for numerical analysis and experimental testing cracking corrosion of reinforcement in the presence of corrosion extraction as well [3]. Besides, Saether and Sand investigated a beam by applying DIANA software, which was the under condition of corrosion and its results were obvious, and then, simultaneous results with experimental samples achieved [4]. In this paper it is tried to build a three dimensional model of a beam by using ABAQUS finite element software. Then, achieved results from developed model has been compared to experimental samples. After verification of the model, the effect of parameters such as concrete cover, diameter of rebar amount of corrosion products and type of concrete evaluated on the propagation of cracks.

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2- Description of the experimental samples, finite element modeling and verification

In order to ensure the accuracy of the outputs of the software, also part of the concrete slab built by Leon Chernin and Dimitri val [6] was selected and the analytical results were compared with numerical model (Figure 1).

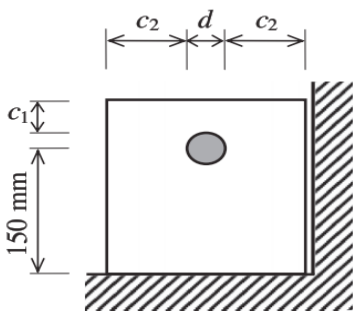

Figure 1: Dimensions of model for testing

In this validation, the comparison between the stress around the reinforcement and parameters of displacement has been done, and these parameters are shown in Figures 2 to 5.

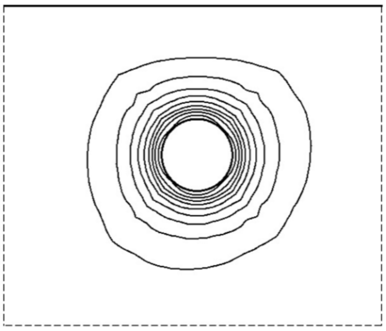

Figure 2: Distribution of radial tension around the reinforcement (TWDC)

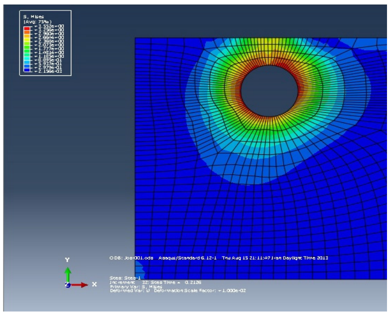

Figure 3: Distribution of radial tension around the reinforcement (numerical model)

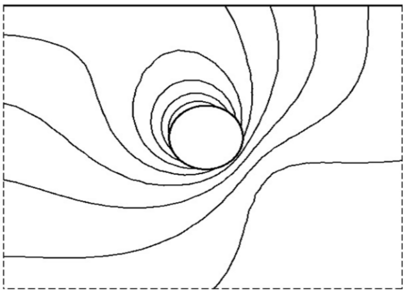

Figure 4: Distribution of radial displacement of the reinforcement (TWDC)

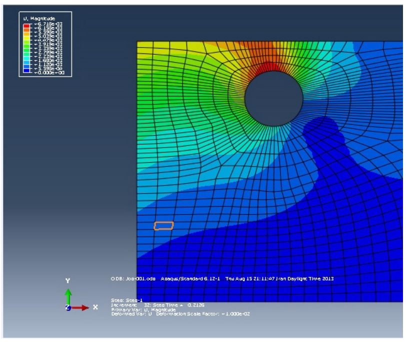

Figure 5: Distribution of radial displacement of the reinforcement (numerical model)

The results of model and analysis of cracking are also compared to experimental results presented by Miri et al [6]. These experimental studies were include cubic samples of 20×20×20 cm3 reinforced concrete with reinforcement at different part of them. The compressive strength of concrete (f'c) was 30 MPa. Samples after 24 hours, from the mold were removed and cured for 28 days in lab condition. To create corrosion by using the wires, maximum DC current of 100 mA/cm2 was applied to the bars. Figure 6 shows an image of the sample after corrosion.

Figure 6: Reinforced samples for verification The result show

The crack position of numerical model for the above mentioned samples have shown in Figure 7.

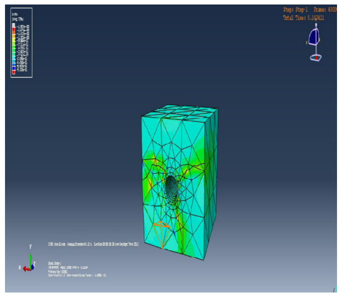

Figure 7: Numerical cracked sample

As can be seen from the modeled sample by software, the direction of development and the path of crack is similar to experimental results and numerical model simulated the behavior of samples very well. After verification of numerical model, it was necessary to evaluate the effect of various parameters on cracking samples. In this paper the effect of compressive strength, cover to bars diameter ratio and inside pressure around the bars due to reinforcement corrosion were studied.

3- Results

3- 1- The effect of c/d

c/d parameter is one of the most important parameters effect on pressure inside the concrete at the start of cracking. In Figure 8, the effect of this parameter on inside pressure and increased diameter of bars are shown. Where Δd is the increased diameter of bar due to corrosion.

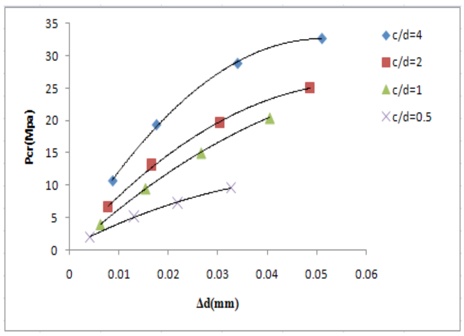

Figure 8: Comparison of stress cracking pressure

As it can be seen in Figure 8, with increasing the parameter of c/d, the beginning cracking pressure will be increased. Also, increasing the cover of reinforcement is an effective factor, and with considering that, the rust layer diameter will increase.

3- 2- The effect of f'_c

The effect of compressive strength of concrete on carjacking pressure presented in Figure 9. The presented results are related to c/d=0.5. As shown in the Figure 9, for smaller compressive strength, smaller cracking pressure resulted in and with increasing f' , pressure at the start of cracking (P_{cr}) will be greater.

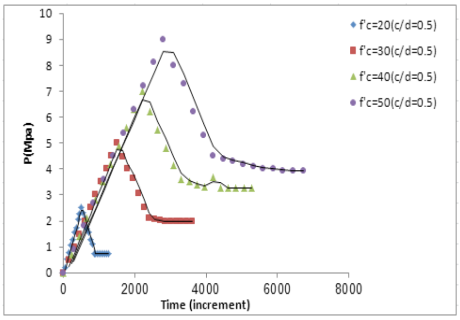

Figure 9: The cracking pressure for different compressive strength of concrete.

4- Conclusion

In this study in order to evaluate the crack occurrence at the result of corrosion of bars in reinforced concrete structures, numerical and experimental models was analyzed. Based on this research, it can be comprehend that using numerical methods for the problems of finite element analysis is a useful way compared to experimental tests, and it can reduce costs and time. Also, by increasing the concrete cover, the diameter of rusty layer around the reinforcement and the time of cracking will sharply increase (almost 4 to 5 times). It causes an increasing at the diameter of corrosion layer. Applied concrete compressive strength is an effective parameter effect on the process of cracking, and it can be observed that for some samples with the same coverage if the compressive strength of the sample is greater, the pressure for the creation of cracks in the sample will increase. (Almost 4 times).

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