

Mesoscale simulation of effect of multi directional rebar arrangement on corrosion cracking pattern in concrete panel using 3D RBSM

Suhas S Joshi^{*a}, Kumar Avadh^a, Vikas Singh Kuntal^b and Kohei Nagai^b

^aDepartment of Civil Engineering, The University of Tokyo, Japan

^bInstitute of Industrial Science, The University of Tokyo, Japan

* corresponding author: suhas@iis.u-tokyo.ac.jp

Abstract:

Corrosion of reinforced concrete is one of the main problems related to deterioration of infrastructure, due to which the designed service life and performance of the structure gets reduced. Ingress of chloride ions into concrete is one of the main sources of corrosion and this problem is more susceptible in structural components with thinner cover depths and structures located in aggressive environments, where there is rich supply of chloride ions. As a result of corrosion, residual capacity of the structure reduces due to decrease in effective steel area. The expansive corrosion product formed around the rebar generates circumferential stress, which induces cracking in the concrete. This cracking behavior is very difficult to understand in real scenarios where the rebar arrangement is complex, for example: slabs, tunnels, concrete walls etc.

In the present study a discrete analysis method, 3D rigid body spring model (RBSM) is used to analyze the corrosion cracking behavior of reinforced concrete panels. 3D-RBSM tool allows visualization of the state of stress and its distribution inside the concrete specimen. There were two types of panels considered in this study, type-1 with unidirectional rebar arrangements with 30 mm concrete cover and type-2 with multidirectional rebar arrangements with 50mm cover. The corrosion profile of the rebar obtained from the experiments¹ is used as input for the model to generate non-uniform corrosion along the rebar. Width of surface cracks and internal (horizontal) cracks are measured at different steps in the simulation are in good agreement with that of experimental results. In the case of unidirectional rebar arrangements, less confined outer rebars underwent higher degree of corrosion and exhibited relatively higher surface crack widths as compared to other rebars. Confinement here is mainly due to rebar arrangement and concrete. In the later case with multidirectional rebars, additional confinement compared to type-1 is provided by the transverse rebars. The tensile stresses generated due to corrosion is effectively transferred to transverse rebars and then to the specimen. Changes in local stress condition due to confinement can be clearly observed in 3D-RBSM simulation. Providing additional confinement in type-2 as compared to type-1 arrangement, increases the effective area of concrete resisting the tensile stress.

¹Hafiza Fatima Zahid (2020). *Investigation of the effect of multiple and multi-directional reinforcement on the corrosion-induced concrete cracking pattern. Master's thesis, The University of Tokyo*