# MODELLING OF DAMAGES IN RC STRUCTURES

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# Abstract

Reinforced concrete is a very versatile and durable building material. Reinforced concrete efficiently combines the best properties of concrete and reinforcing steel into a strong structural element. As a result of this, nowadays, we have vast number of reinforced concrete structures all over the world. At the same time, the deterioration of reinforced concrete structures has become a problem. Deterioration of concrete can take the form of corrosion of the internal reinforcing or degradation of the exposed surface of the material. Even though, the high alkalinity of concrete helps to protect the embedded steel from corrosion initially, this will occur with the degradation of the exposed surface of the material which causes excessive cracking. Despite of these deteriorations which reduce the structural performances, reinforced concrete structures are subjected to an abrupt usage during service lives. Quite often, this includes changing floor usage (Often increasing loads) and reusing abandoned structures. Also, both monumental as well as water retaining concrete structures which have long history of surviving should be assessed regularly to check safety against progressive weakening. Therefore, both cracking of exposed concrete surface and steel corrosion result to unpredictable behaviours of reinforced concrete members under loading and this may cause significantly for both capacity reduction of reinforced concrete members as well as loss of serviceability requirements.

The use of finite element technique to look at the effect of concrete cracking and steel corrosion to ultimate load carrying capacities and serviceability requirements of reinforced concrete members has been well accepted because of capability of simulating concrete cracking and concrete-steel bond deterioration due to steel corrosion with other non linearities. Nowadays, there are advanced finite element packages that can be used for this type of modelling. But, unfortunately, the use of those in developing countries like. Sri Lanka has been avoided since they are quite expensive. Therefore, this study aims to develop a finite element procedure in which concrete cracking and steel corrosion are simulated using available and relatively cheap computer package named "ANSYS".

The study deals with the non linear finite element analysis of reinforced concrete members. Concrete and reinforcing steel are represented by separate material models and steel reinforcements are introduced in to the models by both discrete as well as smeared approaches. Both concrete and steel are treated as inelastic materials in which stress states continue beyond the initial elastic limit up to the final failure point and the modelling are done in the commercial package called "ANSYS". The behaviour of cracked concrete is described by a system of orthogonal cracks, which follow the principal strain directions and are thus rotating during the load history. Crushing or cracking of concrete takes place when the strains lie outside the ultimate surface in the biaxial strain space. The finite element simulations are done for both damaged and undamaged reinforced concrete members. Damages include concrete flexural cracking and corrosion of steel reinforcements.

Finally, correlation studies between analytical and experimental results and several parameter studies are conducted with the objective to investigate both crack initiations and propagations in reinforced concrete members under applied loads as well as effect of damages to the load carrying capacities and serviceability conditions of reinforced concrete members. Experiments on non corroded members are done while the experimental results on corroded reinforced concrete members are collected from the literature.

These studies show that the finite element models created in ANSYS could produce good agreements to the experimental results in terms of stiffuess, initial cracking load, yield load, failure load, strain in reinforcement and yield line pattern etc. The normalized values of deflections determined using experimental data show that actual reinforced concrete members are undergoing expected behaviours. The deflections in both actual and finite element model slabs are increased by more than 50 % after introducing the damage due to flexural cracking by an initial loading. Also, developed ,finite element model was able to simulate high localized corrosion in reinforced concrete members and produced a good agreement to the experimental results. The finite element results prove that the corrosion of reinforcement below approximately 2 % of area loss doesn't affect seriously on the load carrying capacities of reinforced concrete members whereas the corrosion beyond that reduces the. Interface bonding which results to a sudden capacity loss.