Time Dependent Flexural Analysis of Reinforced Concrete Members

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ABSTRACT

Concrete is one of the most widely used building materials in the construction industry in the world. Time dependent behaviour of concrete is the major concern for the structural engineers due to its significant effect in the long term serviceability and durability. Reinforced concrete (RC) members are prone to the effect of time dependent deformations that are known as shrinkage and creep, can produce substantial deformations and deflections to the structure.

The mechanics of quantifying the serviceability deflection of RC beams is complex due to flexural cracking and the associated partial interaction (PI) behaviour of slip between the reinforcement and adjacent concrete. Add the additional complexity of time dependent concrete shrinkage to this partial-interaction (PI) behaviour and the problem becomes very complex.

Current design and analysis techniques to quantify serviceability deflection of reinforced concrete (RC) members are generally built on two major principles which are full interaction (FI) through the use of moment curvature approaches; and a uniform longitudinal shrinkage strain ε_{sh} within the member to simplify the analysis technique. Both of the premises are gross approximations and with regard to the first premise, RC beams are subject to flexural cracking and the associated partial interaction (PI) behaviour of slip between the reinforcement and adjacent concrete. Furthermore with regard to the second premise, numerous tests have shown that ε_{sh} varies along both the depth and width of the beam and which is far from uniform. Hence there are two major sources of error in the quantification of serviceability deflections of RC beams for design and which are due to the PI mechanisms that occur in practice; and that due to the time dependent material properties of creep and shrinkage.

This thesis deals with the development of PI numerical mechanics models with non-linear shrinkage strain variations achieved from a moisture diffusion model developed in this study and that is required to simulate the PI behaviour of RC beams in order to considerably reduce the source of error occurred due to the application of numerical mechanics model. Hence this new mechanics model will allow: the development of better design mechanics rules for serviceability deflection; and also assist in the better quantification of non-linear shrinkage and creep by removing or considerably reducing

the existing mechanics source of error. Importantly, this research provides mechanics solutions for all the facets that control the serviceability time dependent behaviour of RC beams and it is envisaged that these numerical mechanics solutions can provide researchers with the tools to develop simple design procedures as they simulate the major mechanisms influencing cracking and tension stiffening in reinforced concrete beams.

Current shrinkage test methodology is having some limitations that are all surfaces are exposed to the environment and they are small scaled which leads to a uniformity of shrinkage strain and which are not present in real size RC beams. Therefore in this thesis, a new form of experimental setup for shrinkage have been proposed to better quantify the shrinkage variations along both the width and depth of RC members with varying the sizes and surface boundary conditions.

STATEMENT OF ORIGINALITY

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List of Publication

Based on the research work one journal paper has been submitted for publication in Proceedings of the Institution of Civil Engineers – Structures and Buildings.

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