# Deflection prediction of reinforced concrete structures

Autor(en): **Mickleborough, Neil / Chan, Chun-Man / Ning, Feng**

Objekttyp: **Article**

Zeitschrift: **IABSE reports = Rapports AIPC = IVBH Berichte**

Band (Jahr): **83 (1999)**

PDF erstellt am: **01.05.2024**

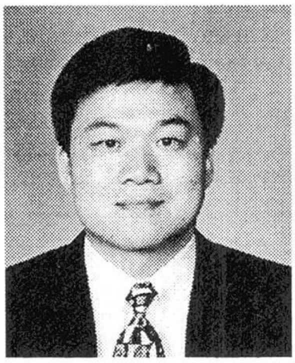
Persistenter Link: https://doi.org/10.5169/seals-62877

# Deflection Prediction of Reinforced Concrete Structures

**Neil MICKLEBOROUGH**
Assoc. Prof.
Univ. of Science & Techn.
Kowloon, Hong Kong

**Chun-Man CHAN**
Assist. Prof.
Univ. of Science and Techn.
Kowloon, Hong Kong

**Feng NING**
Research Assoc.
HKUST
Kowloon, Hong, Kong



## Abstract

The serviceability design criteria for tall structural concrete buildings is to restrict the level of movement due to lateral loading so that it is acceptable to the occupants and the general functioning for the intended purpose of the structure. Current code guidelines give various values, based both on analytical and experimental results, to determine the ***EI*** of the structural members for use in sidesway calculations. To improve the prediction of lateral deflection, and hence optimise structural size and layout, a more accurate method to predict the effective stiffness of components and sub-assemblages, which accounts for the factors which influence the structural response, is required.

The factors that influence the overall response of reinforced concrete structures can be categorised into three classes, external causes, internal causes and effects. The external causes include loading types and boundary conditions, the internal causes involve material and section properties, and the effects include various cracking patterns and tension stiffening. The philosophy in solving for the cracking effects is that it is a result of the interaction both the external and internal causes.

To make this improvement in evaluating the effective stiffness, a method has been developed based on the above philosophy and the probability of crack formation in reinforced concrete components. The most significant feature of the proposed model is its extensive applicability to the members subjected to various loading types. This method considers the ratio of the area of the moment diagram segment of a member in which the working moment exceeds the cracking moment, to the total area of the moment diagram. The probability of the occurrence of cracking is then used to calculate the effective stiffness of the structural component at member level. The stiffness of each component can be combined to produce the overall stiffness of the structure under given loading conditions. A design orientated analysis system has been established by integrating the proposed stiffness reduction model, iterative algorithms and commercial packages of linear finite element analysis. This model forms part of a design orientated integrated analysis system to quantitatively account for the cracking effects on the lateral deflection and stiffness characteristics of tall reinforced concrete buildings with loading in the serviceability range.

A comprehensive comparison with available test data as well as an experimental test program, to determine the accuracy and limitations of the above method, has been conducted. The experimental program comprised the testing of beams and a large-scale frame incorporating these structural components. The structural response of the flexural beams, and frame test incorporating beams and columns, are reported in this paper.

Nine reinforced concrete beams with dimensions of 300mm x 450mm and 3m clear span and with varying reinforcement ratios, were subjected to midspan concentrated loading, two-point concentrated loading and uniformly distributed loading. The two-storey reinforced concrete test frame had a center-to-center span of 3000 mm and an inter-storey height of 2000 mm. The beams of the frame had dimensions of 250 mm by 375 mm deep and columns with dimensions of 250 mm by 375 mm. Sidesway testing of the frame involved the application of lateral loads at the level of the second floor beam. A vertical load of 200 kN was applied at the top of each column to simulate gravity load through the structure.

From the available published data, and from the test series forming part of this work, the probability based analytical model provides improved accuracy over conventional methods for the prediction of effective stiffness of flexural reinforced concrete members under service loads. The model has been integrated into a linear finite element package to account for cracking and an iterative procedure presented to calculate the nonlinear lateral deflection of reinforced concrete structures with cracking under service load. The procedure can be used to calculate the load-deflection history as well as calculate the deflection under any desired working load stage.

In the serviceability range, the flexural stiffness reduction due to cracking is a dominant component resulting in the nonlinear load-deformation response of reinforced concrete structures. The analytical results and experimental observations indicate that the cracks occurring in the beams are responsible for the first abrupt reduction in overall lateral stiffness at a low load level, approximately 15% of ultimate load. The stiffness of beams generally reduce to around 50% of the gross moment of inertia at 50% ultimate lateral load, with further reduction as the lateral load reaches 70% of ultimate.

The proposed method is a valuable tool in the design of tall structural concrete buildings.