

# Deflection Calculation of RC Beams: Finite Element Software Versus Design Code Methods

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## Summary

The paper investigates accuracy of deflection predictions made by the finite element package ATENA and design code methods ACI and EC2. Deflections have been calculated for a large number of experimental reinforced concrete beams reported by three investigators. Statistical parameters have been established for each of the technique at different load levels, separately for the beams with small and moderate reinforcement ratio.

## 1 Introduction

Civil engineers for analysis of reinforced concrete structures can choose between traditional design code methods and numerical techniques. Although design code methods ensure safe design, they do not reveal the actual stress-strain state of cracked structures and often lack physical interpretation. Numerical methods which were rapidly progressing within last decades are based on universal principles and can include all possible effects such as material nonlinearities, concrete cracking, creep and shrinkage, reinforcement slip, etc, being responsible for complexity of this material. In order to choose a particular calculation method, engineers should be aware of accuracy of different techniques.

This paper investigates accuracy of deflection predictions made by the finite element package ATENA and the design code methods ACI and EC2. Deflections have been calculated for a large number of experimental reinforced concrete beams reported by three investigators. Statistical parameters have been established for each of the technique at different load levels, separately for the beams with small and moderate reinforcement ratio.

## 2 Deflection calculation methods of design codes

In this section, two design code deflection calculation techniques, i.e. the ACI (ACI Committee 318 1989) and the EC2 (ENV 1992-1-1 1992) methods are briefly described.

### 2.1 Deflection analysis by ACI method

The curvature of a reinforced concrete member is determined by the classical expression  $\kappa = M/E_s I$  where  $E_s I$  is the flexural stiffness. Constant modulus of elasticity of concrete,  $E_c$ , was offered for all loading stages, but moment of inertia,  $I$ , is varying (Banson 1977). Thus, for the elastic stage,  $I_e$  is written as for the gross concrete section ignoring reinforcement and for the load corresponding to the steel yielding  $I_c$  is calculated as for the cracked section. For loading points between the concrete cracking and yielding of the steel, the following equation was derived to express the transition from  $I_e$  to  $I_c$ , that was observed in experimental data (Banson 1977):

# Deflection Calculation Of Rc Beams Finite Element

**Lauren Gardner**



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