

# 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):

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*Recent Developments in Deflection Evaluation of Concrete* Edward G. Nawy,1996      **Structural Engineering, Vibration and Aerospace Engineering** Yun Hae Kim,2013-12-19 Selected peer reviewed papers from the 2013 International Conference on Structural Engineering Vibration and Aerospace Engineering SEVAE 2013 November 23 24 2013 Zhuhai China      3rd fib Congress Washington USA FIB - International Federation for Structural Concrete,2010-06-01 Finite element method. Methods of calculation short terms deflections of reinforced concrete slabs FIB - International Federation for Structural Concrete,1983-06-01      *Proceedings fib Symposium in Stuttgart* FIB - International Federation for Structural Concrete,2008-09-01      *12th International Conference on FRP Composites in Civil Engineering (CICE 2025)* João R. Correia,Susana Cabral-Fonseca, José Gonilha, João Firmo, Mário Garrido,2026-02-09 This book composed of two volumes presents the latest advances innovations and applications in fibre reinforced polymer FRP composites and structures as shared by leading international researchers and engineers at the 12th International Conference on FRP Composites in Civil Engineering CICE held in Lisbon Portugal on July 14 16 2025 The volumes cover a broad spectrum of topics including all FRP structures bond and interfacial behaviour concrete filled FRP tubular members FRP reinforced or pre stressed concrete structures confinement design methodologies and guidelines durability and long term performance fire impact and blast resistance FRP as internal reinforcement hybrid FRP systems with other materials new materials and products seismic retrofitting structural strengthening of concrete steel masonry and timber and experimental testing All contributions underwent an international peer review process ensuring both quality and relevance Together they provide a rich source of ideas that not only advance current understanding but also inspire new research directions and foster multidisciplinary collaboration across the field      *Structural Integrity Assessment* P. Stanley,1992-03-10 The assessment of structural integrity is a vitally important consideration in many fields of engineering which has an influence on the full range of professional activities from conception design and analysis through operation to residual life evaluation and possible life extension In devising satisfactory procedures for this purpose there is      **Finite Element Bibliography** Gerard De Vries,1976-12 Thjs bibliography had its inception in 1967 when the compilers first attempted a comprehensive coverage of the finite element literature using both manual and computer based retrieval Initially the data base was stored on a card index but this was subsequently transferred to punched cards and magnetic tape Computer processing was adopted at an early stage to derive the three index formats from the data base Over the subsequent years several versions of the bibliography were produced with two of these being made available in a report form to other researchers From the widespread interest in these documents it became evident that there was a need for a commercially available comprehensive bibliography in this area A major effort was undertaken to revise update and extend the data base resulting in this present volume The bibliography covers the period 1956 1975 primarily although some earlier publications of historical interest are

included The citations are not restricted to the English language and documents are listed in many languages and from diverse places of origin All publication formats were accepted so that references will be found to books monographs journal papers and articles theses dissertations reports surveys and the like *Time-Dependent Behaviour of Concrete Structures* Raymond Ian Gilbert, Gianluca Ranzi, 2010-09-15 Serviceability failures of concrete structures involving excessive cracking or deflection are relatively common even in structures that comply with code requirements This is often as a result of a failure to adequately account for the time dependent deformations of concrete in the design of the structure The serviceability provisions embodied in *Deflections of Concrete Structures*, 1974 **Proceedings fib Symposium in Copenhagen**

**Denmark** FIB - International Federation for Structural Concrete, 2015-05-01 *ACI Structural Journal*, 2004

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John Gardner, 2003 *Deformation of Concrete Structures* Dan E. Branson, 1976 **Geodex Structural Information Service** Geodex International, 1988 **Journal of the American Concrete Institute** American Concrete Institute, 1986

**Reinforced-concrete Slab-column Structures** Andrzej Ajdukiewicz, Włodzimierz Starosolski, 1990 This book presents a review of the whole field of flat plates and slab column structures also known as beamless structures encompassing their analysis design and detailed construction from both the theoretical and practical aspects Methods of analysis and design for slabs and entire slab column structures are compared and assessed both for elastic and post elastic phases with recommendations for practical use The review and comparison of the techniques of design for joints between slabs and columns together with test results presents the reader with a choice of applications The outline of international construction solutions used in monolithic prefabricated structures including lift slab structures includes examples of real buildings and provides a wealth of information for designers An integral part of the book consists of tables and nomograms for the direct calculation of bending moments deflections and support reactions in slabs locally supported *Civil Engineering Transactions*, 1976

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web an itinerary showcased by the Écrins national park the great tour of the Écrins is a main hiking route that is promoted by the Écrins national park you can find all the information you need to prepare you great tour on

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web sep 2 2022 it is located in one of the eleven french national parks between briançon and grenoble the two hours drive from ceillac is unbelievably gorgeous and i can t believe i ve never been to the ecrins national park as it s pretty close to home i start hiking a bit late around 4pm and i m starting off with a massive and never ending climb

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web jul 25 2023 typically the hike was during a heat wave last week and i hiked and wild camped 100miles through the gr54 trail the gr54 is a truly epic long distance trail of the circuit of the ecrins massif

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web the tour of the ecrins national park is also known as the gr54 it is arguably the best trek in the alps it is an incredible walk of 193km 120 miles around the incomparable ecrins national park in the southern french alps it takes 9 12 days on the way 14 magnificent mountain passes are crossed