

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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Table of Contents Deflection Calculation Of Rc Beams Finite Element

1. Understanding the eBook Deflection Calculation Of Rc Beams Finite Element
 - The Rise of Digital Reading Deflection Calculation Of Rc Beams Finite Element
 - Advantages of eBooks Over Traditional Books
2. Identifying Deflection Calculation Of Rc Beams Finite Element
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Deflection Calculation Of Rc Beams Finite Element
 - User-Friendly Interface
4. Exploring eBook Recommendations from Deflection Calculation Of Rc Beams Finite Element

- Personalized Recommendations
 - Deflection Calculation Of Rc Beams Finite Element User Reviews and Ratings
 - Deflection Calculation Of Rc Beams Finite Element and Bestseller Lists
5. Accessing Deflection Calculation Of Rc Beams Finite Element Free and Paid eBooks
 - Deflection Calculation Of Rc Beams Finite Element Public Domain eBooks
 - Deflection Calculation Of Rc Beams Finite Element eBook Subscription Services
 - Deflection Calculation Of Rc Beams Finite Element Budget-Friendly Options
 6. Navigating Deflection Calculation Of Rc Beams Finite Element eBook Formats
 - ePub, PDF, MOBI, and More
 - Deflection Calculation Of Rc Beams Finite Element Compatibility with Devices
 - Deflection Calculation Of Rc Beams Finite Element Enhanced eBook Features
 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Deflection Calculation Of Rc Beams Finite Element
 - Highlighting and Note-Taking Deflection Calculation Of Rc Beams Finite Element
 - Interactive Elements Deflection Calculation Of Rc Beams Finite Element
 8. Staying Engaged with Deflection Calculation Of Rc Beams Finite Element
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Deflection Calculation Of Rc Beams Finite Element
 9. Balancing eBooks and Physical Books Deflection Calculation Of Rc Beams Finite Element
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Deflection Calculation Of Rc Beams Finite Element
 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
 11. Cultivating a Reading Routine Deflection Calculation Of Rc Beams Finite Element
 - Setting Reading Goals Deflection Calculation Of Rc Beams Finite Element
 - Carving Out Dedicated Reading Time
 12. Sourcing Reliable Information of Deflection Calculation Of Rc Beams Finite Element

- Fact-Checking eBook Content of Deflection Calculation Of Rc Beams Finite Element
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning
- Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
- Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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