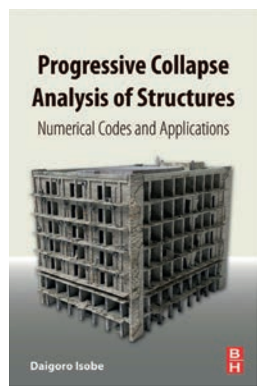
Review

This book presents an interesting – if simplistic – approach for the simulation of progressive collapse of building structures, and may be of interest to researchers and software developers working in this area, concludes Bassam Izzuddin.

Progressive Collapse Analysis of Structures: Numerical Code and Applications



Author: Daigoro Isobe
Publisher: Butterworth-Heinemann
Price: £118.00 (paperback); £141.60 (e-book)
ISBN: 978-0-12-812975-3

This book is concerned with the numerical simulation of the progressive collapse phenomenon in building structures. From this perspective, it is potentially relevant to researchers in computational mechanics and to developers of advanced simulation software. It is not as relevant to structural engineers, even those engaged in the design and assessment of structural robustness, where the primary concern is to ensure that local damage does not lead to conditions which initiate progressive collapse.

The book is organised in 12 chapters and four appendices, principally reporting on the author's work in computational mechanics, as well as applications to actual building structures. After an introductory chapter, Chapters 2 and 3 present the formulation of an elastic-perfectly plastic Timoshenko beam element based on the so-called ASI-Gauss technique, ASI standing for 'adaptively shifted integration'. In this technique, the linear Timoshenko beam element is integrated with a single integration point, which is moved to the critical section for a plastic response and relocated to the original position for an elastic response. The large displacement response is considered using the well-established updated Lagrangian approach. While the presented element is computationally efficient, it has several shortcomings including the neglect of i) the spread of plasticity over the member length and cross-section depth, ii) material strain-hardening, and iii) the complex interactions between the axial force and bending moments in a reinforced concrete cross-section.

Chapter 4 presents the treatment of member fracture and contact considering the previously presented Timoshenko beam element. Member fracture is based on curvatures or the average axial strain exceeding some limiting values, via a simplistic uncoupled approach. This assessment is also not objective with regard to the mesh size, given that the cross-sectional response is considered to be perfectly plastic; hence, the dependence of plastic curvatures on the element length. The conditions of contact activation and release are also presented for the beam element within an efficient approach. However, no consideration is given to issues of energy loss upon impact and spurious energy loss/gain due to the adopted time-integration scheme. Overall, this chapter is rather too simplistic and brief for the complex phenomena purported to be considered.

Chapters 5–11 then present several application studies using the developed techniques, including building impact by an aircraft, fire-induced progressive collapse, blast demolition analysis, seismic collapse analysis and debris impact analysis. While these studies are individually interesting, particularly from the perspective of forensic analysis, the ability of the simplistic methods presented in the book to offer a realistic simulation is highly questionable. Leaving aside uncertainty of the applied actions, the use of one-dimensional stick models is unrealistic for representing the behaviour of floor and wall systems, and even more so in relation to the phenomena of contact and fracture development.

Finally, Chapter 12 provides some concluding remarks on the developed approach and the considered applications, along with suggestions for future work. The source code for the presented element is also given in one of the four appendices, though this code is functionally limited as it does not include the treatments of fracture and contact.

Overall, the book presents an interesting approach for the simulation of progressive collapse of building structures, even if it is too simplistic. Despite the noted shortcomings, the book could be of interest to researchers and software developers working on progressive collapse simulation, for whom the presented approach may offer an alternative treatment for comparison purposes.

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Bassam Izzuddin is Professor of Computational Structural Mechanics at Imperial College London. Over the past 30 years, he has developed advanced non-linear structural analysis methods for structures under extreme loading. He has also engaged in developing simplified assessment methods for structural engineering practice, including a widely recognised design-oriented framework for the assessment of structural robustness.