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Structural Mechanics

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Preface

As a first-year undergraduate or HND student in civil or mechanical engineering or in building, you should be using this book as an aid to consolidating your understanding of the principles and application of structural mechanics.

This is not a standard textbook; it should be used as supporting material to your main course text and/or lecture material. Indeed, it has been written on the assumption that you have already studied, or are currently studying, structural mechanics, and that you now require additional help in applying the principles you have learnt to a range of problems typical of those that you will encounter in your end-of-year examinations. The greatest advantage can therefore be gained from this book by using it together with a main-stream textbook such as *Structural Mechanics* by J. A. Cain and R. Hulse (Macmillan Education, 1990).

Each chapter covers one main topic area that you may have studied on your course. At the beginning of each chapter the essential theory, important facts and relevant equations are presented and summarised in a '*Fact Sheet*'. This is the essential information that you must know and be familiar with. The main part of each chapter is devoted to a series of typical examination questions and worked solutions which will demonstrate the application of the theory to a wide range of typical examination standard problems. At the end of the chapter there are additional problems with answers given so that you can gain further practice in problem solving.

Structural mechanics, as with all mathematically based subjects, can only be completely mastered by attempting and solving problems for yourself. The more problems that you attempt the more confident you will become about the subject itself. Throughout the book you should therefore attempt to answer each problem yourself before looking at, and studying, the given solution. The presentation of the solutions is more detailed than would usually be expected under normal examination conditions. Additional explanation is given to most questions as an aid to understanding; the comments in **bold** type would not be expected to form part of the student's solution to a given problem. However, in an examination you should always attempt to set out the solution neatly, giving sufficient explanation to demonstrate to the examiner that the nature of the problem is fully understood and that the correct application of principles is being made.

In each chapter, immediately following the *Fact Sheet*, a list of the main symbols used throughout that chapter is given. These are generally commonly accepted standard symbols and reference to the list should minimise any difficulties if you have been using different symbols in your own study of structural mechanics. Commonly used units are quoted alongside each symbol although the actual units used in any given problem may differ depending on the nature of the problem and the information given. For example, units of stress

may be quoted as N/mm^2 although in some cases stress may have been calculated in kN/m^2 . In all problems, however, the over-riding consideration is that units must be consistent within any equation. It is important that all equations are dimensionally correct. The sign conventions used throughout the chapter are also quoted. Again, these have been chosen to be consistent with common practice.

In working through the examples and problems you should neither assume that all questions are equally demanding in terms of the time required to complete a solution nor equally valuable in terms of their contribution to the total marks in an examination. The format of the examination papers from which the questions have been selected varies somewhat and some questions are expected to take longer to do than others. In general, most of the questions should be capable of solution within 30–45 minutes. A few of the shorter questions are selected from papers where the solution is expected to be achieved within 15 minutes.

Finally, a comment about accuracy of calculations. The answers to many engineering problems can be slightly sensitive to the extent of numerical ‘rounding off’ used throughout the calculation. With the use of modern calculators it is possible to perform extensive complex calculations in a few calculator operations (or even a single operation). If intermediate calculations are performed and intermediate answers are ‘rounded off’ to, say, two or three decimal places before the result of the calculation is used in subsequent calculations, the final answer may vary slightly from the ‘exact’ answer. For this reason the reader should be prepared to recognise that slight differences between answers may only be an indication of ‘rounding off’ errors, whereas substantial differences will indicate some major source of error.

This book is intended to assist you in successfully passing your examinations and in forming the firm foundations of your further study. If you work your way through the majority of the given examples and problems we believe that both these objectives will be readily met. Good luck!

Coventry, 1990

R.H.
J.C.

Acknowledgements

We are indebted to our academic colleagues from the universities listed below who assisted in the writing of this book by providing us with copies of recent first-year examination papers in structural mechanics and the syllabuses on which these questions were based.

In compiling this text we have endeavoured to select a range of questions from these papers which illustrate as many aspects of the subject as possible and which give a broad coverage of the topics which are most commonly studied in most undergraduate and HND engineering courses.

Except for minor alterations to maintain some uniformity of presentation, the questions are reproduced exactly in the form in which they were provided to us. In a few cases, particularly in earlier chapters, only parts of some questions have been reproduced in order to illustrate specific aspects of structural mechanics. Although we fully acknowledge the origins of the questions it must be stated that the solutions to these questions are entirely our own. While every effort has been made to ensure that the solutions given are accurate we, not the originators of the questions, accept the responsibility for any remaining inconsistencies or inaccuracies in the solutions which the reader may find.

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