

Review



'Well worth the read', says **Michael Dickson** of this accessible, well-illustrated book on both the fundamentals and greater complexities of structural performance.

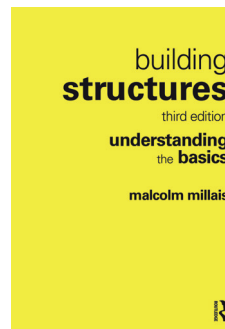
Building structures – understanding the basics (3rd ed.)

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The third edition of this book includes the material of the successful second edition largely unchanged, but now extends to cover engineering in the ground, robustness against progressive collapse, dynamic response, structural appraisal and some mathematical approaches upon which structural mechanics are based. Its 500 pages and 1100 clear hand-drawn diagrams provide a complete qualitative explanation of the behaviour of many structural forms and their individual elements. It convincingly illustrates the visual evidence behind the mathematics of structural mechanics.

The introduction reviews briefly the advances in the understanding of structural performance from Greek and Roman times through to the contributions of Hooke, École Nationale des Ponts et Chaussées, Navier, Stephenson *et al.*, upon which much current structural design is founded. Early chapters build on the fundamentals of elemental structural behaviour, method of calculation of action and resistance through load paths to foundations. The concept of equilibrium is clearly illustrated.

Axial, bending, shear and torsional stresses and their patterns of stress are illustrated for a range of elemental cross-sections. Diagrams show the path of principal stresses in 2D and 3D structures, elastic stress patterns in beams, the actions of reinforcement and prestressing tendons in a concrete member, and also explain rolling shear and shear connectors in steel beams. Later, a useful chapter includes calculations of forces on beams, columns, frames and trusses and

examines the effects of external loads on internal forces and of stresses on strain and resulting deflection.

Following chapters distinguish between elastic and plastic behaviour in materials; discuss the behaviour of a simple building and, in language that is easily understandable, the concepts of safe structures, failure and collapse in the context of statistics. Bending moment diagrams, yield lines in plates, as well as local and overall buckling, are clearly illustrated alongside deflected shapes in portals. A later chapter contains a more extensive discussion on robustness and progressive collapse.

The significance of geometry on the ability of frames, trusses and shells to resist loads upon them is examined alongside the funicularity of arches and the disrupting effects of asymmetric loads on the geometry of cables. New chapters set out the importance of secure foundations and illustrate soil structure interaction beneath footings, rafts and piled solutions and the path of forces in cathedrals, shells, multistorey frames and tall towers. Resulting stress patterns within elements and connections are also judiciously illustrated.

The difference of philosophy and method between structural design of a new structure to that of investigation, appraisal and remediation of an existing building is explained in an easily understandable way. New text also discusses advanced finite-element analysis of large structures of complex form, and the basis for the stiffness method of complex computer analysis is included for the more

mathematically inclined reader. Aptly, the reader is reminded of the need for a degree of scepticism towards the outputs from these multi-degree of freedom models and to check against the fundamentals of earlier chapters.

New material on the dynamic behaviour of structures explains clearly the concepts of forcing function and soil structure interaction as part of the dynamic response in terms of stiffness, damping, acceleration and of any resonant frequencies.

The differences of action between the structural forms of domes, skeletal structures and concrete frames are also clearly explained. This leads to a philosophical discussion of the differing roles of architect and engineer in modern buildings and on the role, useful or otherwise, of what the author describes as 'engineering as fantasy'.

In this interesting, perhaps controversial chapter, Arup/Utzon's Sydney Opera House, Tsuboi/Tange's Tokyo swimming pool, Arup/Piano-Rogers' Centre Pompidou, SOM/Gehry's Guggenheim Museum Bilbao and BuroHappold/Cullinan's Downland Gridshell are among examples ruthlessly dissected for their engineering worth.

This perspective is extended in the final chapter to a discussion on what should be considered a 'successful structure' and whether the 'Keep it Simple Stupid' approach (KISS) favoured by many engineers, perhaps rightly from the ethical view of conservation of resources, should be a necessary restraint to much 'starchitecture' of the 21st century.

To conclude, I would recommend students and professional colleagues to read this accessible, well-illustrated book on both the fundamentals and greater complexities of structural performance. The text rightly concludes that building structures need to be both strong and stiff enough to be fit for purpose. Interestingly, it also endeavours to place structural endeavour in an ethical context. Well worth the read!

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