Limit state theory for reinforced concrete design

SI Units (Second edition)

B. P. Hughes

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A Pitman International Text.
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This is the second edition of Professor Hughes' book on limit state design. Parts of it have been extensively rewritten and improved, notably the chapters dealing with serviceability.

By comparison with many recent books on reinforced concrete, this one is fairly long, running to nearly 700 pages. This is not necessarily a fault, as it is an exceptionally comprehensive book. It covers all aspects of reinforced concrete structural design according to CP110 and BS 5337.

As it is basically intended for students, Professor Hughes very wisely avoids controversial matters such as whether particular Code clauses are right or wrong, or how well they fit experimental data. Where Code clauses are dealt with, he simply explains, in a generally concise manner, what the Code proposes, what the particular provisions are intended to achieve and how, in practice, they may best be applied.

As well as dealing specifically with Code provisions, the book includes a great deal of general information on the behaviour of reinforced concrete.

Notable features of the book are the extensive set of Appendixes (there are 180 pages of them), which contain a concise summary of CP110 and BS 5337, and extensive design aids.

Possibly one area which could have usefully been given less attention than it has received in the book is the elastic analysis and design of sections, which takes up two chapters. This, however, remains a minor criticism of what is generally a very good undergraduate textbook.

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Concrete shell roofs

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The book concentrates on shells of practical interest, and presents the theory of symmetric and north-light cylindrical shell roofs in Part 1, and the structural analysis of hyperbolic paraboloid shell roofs in Part 2. The extensive design tables form the second half of the book.

There are four chapters in Part 1, the first giving notes on the tables for north-light shells. Three-bay roofs have been analysed, and the resulting tables give values of forces and moments considered applicable for any number of bays. The span range is from 20 to 90 ft by increments of 2 ft; longer spans would require prestressed edge beams, and this is outside the scope of the book. Three widths are treated for each span less than 60 ft, and several widths for each span greater than 60 ft. Glazing inclinations of 60° and 90° to the horizontal are assumed. The shell thickness is taken as 2½ in., and an adjustment factor is given for use with other thicknesses. The superimposed load considered is 15 lb/ft², with an adjustment factor for a snow load of 30 lb/ft². The theory of R. S. Jenkins has been used in the analysis.

The design tables give values of forces and moments which are sufficiently close to one another to allow linear interpolation. The units used are Imperial, but the use of SI units is facilitated by this ability to interpolate for the fractional values arising on conversion to Imperial units.

Chapter 2 gives notes on the tables for ordinary shells. For multi-bay structures, it is assumed that an analysis is required only for one external half-shell and one internal half-shell. Spans considered range from 20 to 100 ft by increments of 2 ft; again, for greater spans, prestressed edge beams would be required. For each span, three widths are considered for a shell without valley beams, and several widths for one with valley beams. The values of thickness and superimposed load are those used in Chapter 1, and Jenkins' theory is again the basis.

Chapter 3 provides an explanation of the tables. The 81 tables covering cylindrical north-light shell roofs give full information on the geometry of and forces and moments in the two external shells and one internal shell of the three-bay system. In addition,

dimensions of and forces and moments in the external and internal beams are given. Only those forces needed for design of the shells are listed, as others have been found to be insignificant on checking. All internal shells and beams can be given identical reinforcement. For ordinary cylindrical shell roofs, there are 96 tables on roofs without internal valley beams, and 168 on those with such beams. Analyses are performed for external and internal half-shells, and for external and internal edge beams.

An example of the design of a five-bay north-light shell roof is given in Chapter 4. The shell reinforcement is designed by CP 114 (1957). A check is made for buckling, and recommendations are given for longitudinal reinforcement to resist shrinkage and temperature stresses. In addition, the reinforcement in the beams and glazing posts is designed. A list of four references ends Part 1.

Part 2 contains three chapters, and begins with an introduction to hyperbolic paraboloid shells in Chapter 5, followed by the bending theory of these shells in Chapter 6. The analysis is applicable to thin, shallow shells, and a criterion is stated for deciding whether the shell is shallow or not. Chapter 7 presents the analysis of the inverted umbrella type of shell, rectangular or square in plan, subjected to uniformity distributed load, with negligible flexural rigidity and supported on a central column. Shells with and without edge and valley beams are considered.

Appendix I gives the roots of an eighth-degree polynomial equation, and Appendixes II and III list Atlas Autocode programs for the two types of shell analysed in Chapter 7. There is a selected bibliography of 81 references, and the tables then follow.

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