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Computer Analysis and Design of Masonry Structures

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Preface

Masonry is the term generally used to describe calcium silicate, clay, concrete and stone brick or block units. Masonry construction is widely used for buildings up to four storeys in height and occasionally for over five stories, but then usually as cladding, although it is often used in loadbearing situations and for single structures such as bridges, chimneys and the like.

Masonry can be used for unreinforced masonry structures, reinforced masonry structures or as confined masonry. Unreinforced masonry is used in low seismicity activity areas and for building up to four storeys in height. Reinforced masonry is used in taller buildings while confined masonry is used as panels which act as stiffening to frames to resist lateral loads in compression.

Although there are many design codes on masonry design, in order to maintain competitiveness, ongoing research is required to improve the design of masonry structures. Research is needed into the enhancement of material properties, the use of numerical modelling to improve design accuracy and robustness in resisting seismic forces. This data can then be used to improve the design rules for unreinforced masonry, reinforced masonry and for confined masonry. Considerable research has been carried out into the nonlinear design of masonry, its dynamic and seismic behaviour, masonry testing, strengthening of existing masonry structures, thermal efficiency, resistance to blast loading and even the use of unreinforced masonry in seismic areas. Accordingly, this book is written by chapter authors who have expert experience that covers many of the areas where research is needed and where their work can be incorporated into design codes that will enhance the safe design of masonry structures.

Chapter 1 considers heritage stone arch bridges which carry light traffic. While researchers have examined the nonlinear behaviour of these structures, few have considered their reinforcement and restoration. This chapter studies the nonlinear and limit analysis and a method of reinforcement with FRP materials. A method of reinforcement by using FRP is proposed. Numerical examples are included.

Chapter 2 describes the numerical modelling of industrial masonry chimneys under seismic conditions. In situ experimental results are included to calibrate the numerical model; and alternative strengthening arrangements using FRP are discussed and conclusions drawn.

Chapter 3 compares two numerical approaches for modelling the dynamic behaviour of masonry structures. The constitutive equation of masonry-like materials with bounded compressive strength and the dynamic problem for both three-dimensional bodies and one-dimensional structures are considered. The results stressed the impor-

tance of using accurate constitutive models for masonry.

Chapter 4 reviews design methods for single-leaf wide-spaced reinforced masonry walls, as this wall system is popular in regions dominated by cyclonic wind. Research findings with respect to the in-plane shear response are reviewed and a method that predicts global behaviour of the walling system is presented. Experimental validation of the model is also presented.

In Chapter 5 the understanding of the dynamic and static analysis of existing structures is considered essential. To assist in this purpose material tests, dynamic tests and static collapse tests of existing brick chimneys were carried out. From the experimental tests, numerical models were prepared and the numerical results used to evaluate the seismic performance of the chimneys.

Chapter 6 compares the results of experimental and numerical analyses of concrete block prisms under compression loads, with the object of simulating the nonlinear mechanical response of the prisms using a numerical damage model. An experimental program determined the parameters for the numerical model.

Chapter 7 shows how the thermal efficiency of multi-holed brick walls can be improved by determining the best brick from the thermal point of view. Experimental tests are presented to validate the numerical analysis procedure and to analyse the material conductivity for different compositions of the light concrete. To select the appropriate wall design, detailed instructions are included.

Chapter 8 reviews a simple micro-mechanical model for the homogenised limit analysis of masonry where a linear optimization problem is derived to recover the homogenised failure surface of the brickwork. Relevant structural examples are compared with competing approaches.

Chapter 9 considers the lateral load resistance behaviour for unreinforced masonry buildings subjected to simulated seismic ground motions. It was shown that low-rise brick masonry buildings could resist such ground motions if minimum standards of material, geometry and interconnectivity of the structural elements were maintained.

Chapter 10 presents formulations for the resistance and blast load response of membrane retrofit unreinforced concrete masonry walls. These formulations can be used for the design of high-risk structures to enhance the level of protection provided by new buildings and for the retrofitting of similar walls in existing buildings.

Chapter 11 describes the development and use of a procedure to assess the reliability of concrete masonry unit walls subjected to personnel-delivered blast loads. Reliability, over load frequency-of-occurrence times, is estimated for grouted and un-grouted walls for design blast load levels in terms of wall failure and occupant injury.

I would like to thank the chapter authors for the high quality of their work and also the publishers for their diligence in ensuring the high quality production of this book.

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