Book review

DESIGN FOR ROBUSTNESS

F. Knoll and T. Vogel. IABSE, 2009, ISBN 978-3-85748-120-8, £46, 96 pp.

The importance of robustness has increasingly been recognised. It has been a part of UK regulations and codes for nearly 40 years and is now mentioned in the Eurocodes and other requirements (e.g. US General Services Administration). However, some of the requirements are quite general and guidance is needed. This small book provides some general background and descriptions that are intended to help engineers deal with the question.

The book is divided into three parts; first there is a general description of robustness. This is followed by looking at applications in certain situations and finally a few project examples.

After the introduction in chapter 1, the next chapter (The foreseeable/unforeseen) is a reminder of why robustness is needed. It is noted that in forensic investigations following accidents they are often attributed to something which was not anticipated at the time and hence could not have been considered by a mere amplification of safety factors. Human error is often cited as the origin of flaws and will continue to happen. It is noted that sometimes we have to rely on experience and the authors include a quote 'One bolt is no bolt' as an example of the need to avoid relying on single elements.

The third chapter explains that the design of a robust structural system must be adapted to the particular situation. In the fourth chapter the authors point out that hazards may be due to internal flaws (including gross human error) or external causes. They include earthquakes as a possible external cause and, although obviously connected to robustness, seismic performance may be considered by many to be a separate design situation.

In the fifth chapter the authors point out that robust structures are those that develop less catastrophic failure modes first. They include a very small section on risk analysis before noting that this will not be used partly because of the need to include human error and also the fact that many aspects such as probabilities and numbers of events will be unknown.

The sixth chapter describes various elements of robustness, for

example strength, multiple load paths, capacity design and fuse elements ductility and monitoring. These are divided into different functions; that is, monitoring is part of event control, strength is a direct approach, ductility is an indirect approach and capacity design and fuse elements are part of reducing the consequences.

Chapter 7 reminds us that older structures cannot be considered to be robust even if they have survived for a long time as, owing to alterations and/or deterioration, the original system may no longer be intact.

The second part of the book looks at application of robustness to particular situations. These range from high-rise buildings and high-strength concrete to structural glass. Façades and curtain walls, are also included as a reminder that the idea of disproportionate collapse does not need to be limited to complete buildings.

In the discussion of the assembly of steel structures there are useful points about avoiding the need for special skills and/or quality control and the section on falsework also emphasises the importance of control, or more importantly the need to recognise where it will be lacking. However, many concerns are raised about the use of unbonded prestress without mentioning the difficulties that have occurred with bonded solutions. Also in the discussion of space truss supports there are some simple calculations that do not appear to be consistent and do not recognise the reduced loads for the accidental situation.

The examples are the rehabilitation of a historic building including establishing structural integrity, design of a tunnel to allow for the collapse of caverns causing craters, an avalanche gallery subject to train impact, design of a station building for loss of a column, a cable-stayed bridge that suffered failure of three hangers and the domino-style failure of a power line.

The book makes some contributions to the discussion of robustness and includes some useful points to be considered in design, although some people may not agree with them all. It does not have much information on how much robustness needs to be included or how to apply it. It also does not mention at all the tying requirements that have been the basis of the UK response and are now in the Eurocode.

MIKE BANFI