Structural Safety 1994–96


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IMMEDIATE PRIORITY RECOMMENDATIONS

1: INSPECTION AND APPRAISAL OF MULTI-STOREY CAR PARKS
Owners and operators of existing multi-storey car parks should commission periodic inspections and structural appraisals on the condition of their structures. Such inspections and appraisals should be made by engineers with appropriate experience following the principles adopted by bridge owners. Appraisal should extend beyond any areas of conspicuous deterioration, particularly where water with road salts may have penetrated, and should include a review of resistance to progressive collapse.

2: ADEQUACY OF EDGE BARRIERS IN MULTI-STOREY CAR PARKS
Owners and operators of existing multi-storey car parks should:
- establish whether the strength of edge barriers is adequate to restrain vehicles,
- establish whether the height and design of edge barriers are appropriate to safeguard small children,
- modify, strengthen or replace inadequate edge barriers.

3: GUIDANCE ON ASSESSMENT OF EDGE BARRIERS IN MULTI-STOREY CAR PARKS
The Institutions of Civil and of Structural Engineers should urgently prepare guidance on assessment and strengthening of existing edge barriers in multi-storey car parks.

4: PIN CONNECTIONS IN BRIDGES AND BUILDINGS – REVIEW OF GUIDANCE
The Steel Construction Institute in collaboration with the British Standards Institution should review the guidance on the design, inspection and maintenance of pin connections in bridges and buildings.

5: PIN CONNECTIONS IN BRIDGES AND BUILDINGS – DESIGN
The design of pin connections should be overseen by suitably experienced engineers who are responsible for design, detailing, installation, inspection and maintenance.

6: FATIGUE IN STEEL STRUCTURES
The Institutions of Civil and of Structural Engineers, and the British Standards Institution should undertake a strategic review, from a safety standpoint, of standards and codes of practice relating to design against fatigue in steel structures as a basis for achieving convergence towards a compatible set of fatigue rules, taking into account the commitment to the development of the CEN Structural Eurocodes.

7: DISPROPORTIONATE COLLAPSE
The Institutions of Civil and of Structural Engineers should prepare design guidance for engineers on structural concepts and forms which have a low sensitivity to damage and an appropriate capacity to resist disproportionate collapse.

8: FLOOD DAMAGE TO BRIDGES
A continuing collaboration between highway authorities, Railtrack and other owners of bridges over water, possibly under the aegis of the Institution of Civil Engineers, should be established to keep flood damage to bridges under continuing review and to develop consistent best practice.

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SCOSS is an independent body established by the Institutions of Civil and Structural Engineers to maintain a continuing review of building and civil engineering matters affecting the safety of structures.

A car broke through the edge barrier on the fourth floor of a multi-storey car park in Canterbury in January 1996, seriously injuring the driver. (Photo: Kent Messenger)
**STRENGTH RECOMMENDATIONS**

9: HAZARD IDENTIFICATION AND RISK ASSESSMENT IN DESIGN
Starting at the design stage of projects, designers should apply an explicit risk management process, including the identification of hazards and assessment of risks, with the effort expended and sophistication of the assessment being directly related to the nature, size and importance of the structure.

10: DESIGN AND BUILD: CLIENT-SUPPLIED DATA
Bodies responsible for standard forms of contract for design and build should review their conditions of contract to ensure that the responsibility of the designer for investigation, checking and evaluating ground and other site conditions is clearly stated, and that there is protection against unjustified reliance on or over-optimistic interpretation of client-supplied data.

11: STRUCTURAL CODES OF PRACTICE
The British Standards Institution should give publicity to an overall policy for the development of codes of practice relating to structural design and should aim to achieve a single set of codes through positive coordination and support of their development.

12: AIR-SUPPORTED STRUCTURES – WITHDRAWAL OF BRITISH STANDARD
The British Standards Institution should withdraw BS 6661: 1986 Guide for the design, construction and maintenance of single-skin air-supported structures.

13: GUIDANCE ON AIR-SUPPORTED AND FABRIC STRUCTURES
The Institutes of Civil and of Structural Engineers in collaboration with the industry should prepare guidance on the design, specification, construction and use of air-supported and fabric structures.

**REVIEW OF EVENTS AND TRENDS**

Over the past two years, the Standing Committee (SCOSS) has observed a very good record, with a few exceptions, of structural safety in the United Kingdom. Worldwide there have been structural collapses and failures arising from extreme natural disasters or man-made causes. These events provide a constant challenge for all who are concerned with structures of finding ways to avoid or minimise hazards to structures and offset the risks.

Acceptable standards in structural safety can only be achieved through the constant vigilance of engineers and others who have responsibilities for safety. Effective communication in the construction industry, including the regulatory and standards bodies, professional and educational institutions and research organisations, is a major factor in maintaining vigilance and awareness of adverse trends and events affecting structural safety.

A challenge to effective communication has arisen in recent years from the fragmentation and commercialisation of the construction industry. Some organisations providing advice on good practice no longer exist or their output is diminished or less freely available. SCOSS has considered these and other trends and has noted some compensatory changes which have helped to maintain effective communications as the industry seeks greater competitiveness through innovation and increased efficiency.

**LEGISLATION AND INFORMATION TECHNOLOGY**

Important new legislation, particularly the Construction (Design and Management) Regulations 1994, provides a strong positive stimulus. The growing use of information technology helps to compensate for the effects of the fragmentation of the industry, the dispersion of reservoirs of knowledge and the trends towards lower permanency of employment and greater individual responsibility and mobility of professionals.

There is danger, however, in placing too much reliance on information technology. This can be avoided by education and training and measures to ensure that good quality information reaches the right people. Safeguards are needed to ensure competent use of generated material.

**CODES OF PRACTICE, STANDARDS AND GUIDANCE DOCUMENTS**

These play an important role in communicating information on safe practice. A plethora of such documents exists however making it very difficult for the busy practising engineer...
to keep up to date. The growing portfolio of codes of practice relating to structural design is introducing conflict and inconsistency in available guidance.

Practising engineers would be assisted substantially in ensuring structural safety if more positive action was taken by the Institutions of Civil and Structural Engineers, the British Standards Institution and appropriate Government Departments at an early date to amend or replace out-of-date codes of practice and other guidance documents in line with technological changes and new guidance which becomes operational in Europe.

FEEDBACK OF EXPERIENCE
Systems for the feedback of experience relevant to the maintenance of structural safety are not as well developed in the construction industry as in some other industries.

Feedback of experience, both good and bad, can be a valuable influence towards maintaining structural safety. Feedback concerning hazards and risks in structural safety is not always distributed widely in the construction industry. The technical press plays an important role. Some other industries have confidential reporting systems for safety-related incidents. SC OSS aims to give warning where unacceptable risk is believed to exist.

CHANGES IN NATIONAL CONSTRUCTION-RELATED ORGANISATIONS
Effectiveness in maintaining structural safety may be lost during major organisational changes through, for example, dissipation of in-house experience or loss of records.

The potential loss of effectiveness in maintaining structural safety during major organisational changes is apparently being recognised and countered in some national construction-related organisations.

EDUCATION AND TRAINING
Education and training are perhaps the most important communication processes. The study of recent experience of structural failures has an important role in raising awareness of hazards and risks. Educators have a valuable opportunity to instil a sense of caution and an appreciation of the need to guard against complacency and over-optimistic extrapolation from experience.

Study of failures by students, and also by engineers throughout their careers, can make a valuable contribution towards avoidance of losses of structural safety.

COMMUNICATING RESEARCH FINDINGS
Research provides the basis for the application of innovation and development in structures. Clients are currently demanding substantial improvements in the durability and quality of structures and yet expecting this at no extra cost. Innovation may assist the achievement of this objective. Continuing support for relevant research is needed to ensure that the industry responds to the pressures for improvements maintaining a high level of safety.

SPECIFIC TOPICS
TEMPORARY DEMOUNTABLE STRUCTURES
Further incidents of loss of structural safety of temporary demountable structures have emphasised the need to implement the recently-published Institution of Structural Engineers' Guide Temporary Demountable Structures: Guidance on Procurement, Design and Use.

EXPLOSION DAMAGE TO BUILDINGS
Attempting to protect buildings fully from damage by massive explosions is not realistic, but aiming to achieve robust structures, i.e. structures resistant to disproportionate collapse, may give a degree of explosion resistance. More robust glazing and cladding will reduce the risk of blast penetration.

POST-TENSIONED CONCRETE BRIDGES
A substantial programme of collaborative work by the concrete bridge industry and others has now established the principles for satisfactory construction of post-tensioned concrete bridges, including the improvement of the design concept, development of improved grouting materials, procedures and specifications, and use of the UK Certification Scheme for Reinforcing Steel (CARES) quality assurance system for post-tensioning operations.

BRIDGE ASSESSMENT AND STRENGTHENING
Road (and possibly rail) bridges in the United Kingdom will be required to carry increased loads in the future. Current assessment rules are being reviewed by the Highways Agency against the requirement to maintain safety with the aim of avoiding as far as possible any unnecessary strengthening and repair. For rail bridges, structural assessment should be based on up-to-date standards.

BRIDGE STRIKES
Actions to reduce the risks of accidental impact on bridges in the United Kingdom are progressing but delays in introducing traffic management and other measures at some high-risk sites and in enacting the ‘height-in-cabs’ legislation matter of concern.

CLADDING AND GLAZING
Few reports of unsatisfactory performance of claddings have been received over the past two years. Guidance prepared by the Institution of Structural Engineers should contribute towards a further improving record.

HIDDEN TENSION MEMBERS
Continuing vigilance is needed to ensure that bridges and buildings with hidden tension members are known and remain safe.

WASHWATER SYSTEMS
The questions raised in the Ninth SC OSS Report on the use of super-retarder treatment of washwater in concrete mixers have been satisfactorily answered.
FREESTANDING MASONRY WALLS

Guidance on the design and construction of freestanding masonry walls is now readily available and will encourage safer construction.

SEISMIC RESISTANCE OF STRUCTURES

Structures of modern seismic design have improved seismic resistance but more work is needed to mitigate the effects of earthquakes on communities.

A full-scale post-tensioned concrete bridge beam 60 m long was constructed for growing trials which formed the basis of new guidance. (Photo: Transport Research Laboratory)

FEEDBACK INVITATION

Through SCOS, engineers and others can express concern about trends adverse to structural safety. Confidentiality is a key feature of SCOS activity. Whatever the degree of concern or potential urgency of a structural safety problem, engineers and others are invited to refer it, on a confidential basis if they so wish, to SCOS. Feedback on experiences where structural failure has occurred, or where it has been prevented, i.e. 'near-misses', is specially valuable.

SCOS invites comments on this Bulletin and the Eleventh Report.

For further information contact Dr John Menzies (Secretary), Tel. 01923 675 106, Fax 01923 680 965; or Mr Nick Clarke (Technical Officer), Tel. 0171-235 4035, Fax 0171-235 4294. SCOS, 11 Upper Belgrave Street, London SW1X 8BH, UK. E-mail: istructe.bnl@mail.bogo.co.uk.

THE ELEVENTH SCOS REPORT

The Eleventh SCOS Report, Structural Safety 1994–96: Review and recommendations contains the full text of the findings and recommendations summarised in this Bulletin. The Report has 48 pages, and is published by SETO Ltd, price £25.00, including postage and packing, ISBN 1 874266 31 X. The Report is in seven sections:

1 Introduction
2 Communication
3 Safety concepts, design and control
4 Structures where large numbers of people congregate
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6 Other structures, components and materials
7 Future SCOS programme.

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The Eleventh SCOS Report may be ordered using the order form below, or from:

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