14TH BIENNIAL REPORT FROM SCOSS
The Standing Committee on Structural Safety

July 2003

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CONTENTS

FOREWORD

SUMMARY
Report recommendations

1 INTRODUCTION
The aims of SCOSS
Introduction

2 RISK MANAGEMENT OF STRUCTURES
Introduction
Project Risk management
Legislation
Competency
Responsibility for Buildings (and other facilities) during their lifespan
Temporary Works (a)
Summary

3 GATHERING OF INFORMATION ON MATTERS OF STRUCTURAL SAFETY
Recommendations
References

4 EUROCODES
Introduction
British Standards Institution (BSI)
Timetable
General issues associated with the introduction of Eurocodes

5 EDUCATION
Higher Education Issues

6 ALERTS AND OTHER MATTERS
Alerts issued since the last report
Items discussed since the 13th report

7 REVIEW OF ACTIONS FROM RECOMMENDATIONS IN REPORTS 11-13
Risk Management and Design
Codes and Quality Management
Legislation and Duty of Care
Education and Research

APPENDICES
Appendix A: Recommendations and actions from Reports 11 - 13
Appendix B: List of topics considered by the Committee during 2001 - 2003
Appendix C: Membership of the Committee

Foreword

I am particularly pleased to introduce the 14th Biennial Report - my first as the incoming Chairman, taking over the reins from Lord Lewis of Newnham.

Risk occurs in all walks of life, but for structural engineers in particular, and others involved in, or influencing the delivery of safe facilities, the need to have regard to issues that might adversely affect margins of safety is paramount. As the report mentions, despite the very significant advances in the industry's design procedures and processes, there is still a demonstrable need for vigilance.

The key I believe is to keep a clear vision. If the approach taken is not adding value to a project, it usually means it is not quite right. In most instances, risk management need not be complex and indeed an examination of recent failures demonstrates this fact very forcibly.

The contents of this report illustrate the point that there continue to be many items that warrant attention and control - some of these have been raised by the Committee on previous occasions. I hope that all those engaged in the design or delivery of structural facilities, or their components, will read this document and its recommendations.

It is the Committee's hope that the immediate availability of this report in electronic format on the web, will allow wide dissemination within the industry, and will promote debate and actions on the issues raised.

Kate Priestley
Chairman

Summary

The 14th report draws attention to practical matters which have the potential, directly or indirectly, to adversely affect the margin against failure. It is considered however that the advice which flows from many items, and those relating to risk management in particular, will also have the wider benefit of bringing about a more logical approach to structural design and specification. It is anticipated that this will in turn bring improved commercial benefit.

History tells us that we can never be complacent. Despite the many and varied advances in the design and procurement of facilities, the lessons of the past continue to give us salutary advice. However, the many fine achievements of the industry, summed up by the comment

UK construction at its best is excellent. We applaud the engineering ingenuity and design flair that are renowned both here and overseas(1) ,

should not be forgotten.

Hence although this report tends to dwell on matters of concern, the Committee recognises the substantial investment made by the industry in terms of achieving structural safety, and actions taken that relate to a number of the issues raised in previous reports. In particular,

- The comprehensive advice now available in respect of multi story car parks,
- The likely extension of the Building Regulations requirements against disproportionate collapse, to the majority of buildings,
- Current debate and research in respect of climate change.

The purpose of SCOSS is to collate and consider issues which may have a medium or long term bearing on structural safety, and to suggest actions to be taken by those most able to influence the practices adopted within the construction industry.

In order to assist in the assimilation of the report recommendations, they are directed at ***Influencers***, and at ***Practitioners***.

Influencers are individuals or organisations able to influence or directly bring about change. These will include for example Government Departments and Agencies, Institutions, BSI and Higher Education centres. ***Practitioners*** are all those who practise structural engineering or who manage the process. In some instances however, the recommendations will also be relevant to Owners and Facility Managers. The recommendations for Influencers are in many cases different to the recommendations for Practitioners.

Chapter 2: Risk management of structures

Influencers

2/I1	Institutions and others are encouraged to emphasise the benefit to most structures of application by designers of the broad lessons learnt from the various investigations following the World Trade Center collapse, and specifically as set out in the IStructE Report 'Safety in Tall Buildings' (2). Guidance should be given to this approach by way of practical advice and examples, related to common structural form.

2/I2	Institutions are urged to emphasise to their members the benefits of a whole life risk management approach to facility design and to provide appropriate guidance in this respect. A joint initiative with the Construction Best Practice Programme is suggested as a way forward.
2/I3	The Institutions should determine whether there are lessons to be learnt from other industries in respect of whole life risk management, and which are applicable to the day to day project. A conference might provide a suitable vehicle for this as a starting point.
2/I4	Institutions should actively support the Construction Industry Council (CIC) in their endeavour for a comprehensive review and harmonisation of building legislation (3) in order that it might be better understood, enforced and add value to the process.
2/I5	Institutions should give continuing thought to the benchmarking of skills in order that third parties are able to make appropriate judgements in respect of competencies, and so that standards are maintained.
2/I6	Government (currently via ODPM) is asked to support initiatives aimed at simplifying building legislation, and provide funding to allow this to progress as a means of achieving a greater degree of 'joined up' construction.
2/I7	The Joint Board of Moderators (JBM) should consider the implications of this Chapter on accredited courses.

Practitioners

2/P1	Practitioners should manage risks arising out of their design from an holistic, whole life viewpoint, recognizing the interaction between disciplines and legislative requirements.
2/P2	The report on the Pentagon building collapse (4) is recommended to structural engineers, as an exemplar of forensic engineering.
2/P3	Practitioners are reminded of their obligations to undertake CPD throughout their careers and for it to include in particular updates on best practice methodologies.
2/P4	The use of 'life-care plans' is recommended, whereby the designer may convey to the facility owner the design assumptions in respect of the requisite inspection and maintenance regimes over the facility's life. This is particularly important on certain structures where the design is sensitive to use, the environment or maintenance undertaken.
2/P5	Practitioners are urged to inform the Committee of examples of good practice in respect of risk management that may be used to advise a wider audience.
2/P6	Those practitioners involved in the procurement, design or erection of falsework, should read the SCOSS Topic paper on 'Falsework: Full Circle.' (5)
2/P7	Those practitioners involved in the design of buildings and other facilities are encouraged to read the SCOSS Topic paper on 'Assessment and Inspection of Buildings and Other Facilities' (6)

Chapter 3: Gathering of information on matters of structural safety

Influencers

3/I1	The Institutions are urged to actively seek ways of establishing a pilot scheme for the gathering of information on matters of structural concern, in order that this may progress without undue delay.

Practitioners

3/P1	Practitioners are encouraged to consider how they might assist the wider industry by reporting matters of structural concern generally and specifically so once the pilot has been established. (Until that time matters may be confidentially reported to the SCOSS Committee).

Chapter 4: Eurocodes

Influencers

4/I1	The scale of the structural Eurocode implementation programme makes it essential that a co-ordinated plan of action is compiled between all the major interested parties, in order to ensure a smooth introduction. The Institutions should take a lead in this respect reflecting the outcome of recommendation 4/I2.
4/I2	The ODPM is urged to support the concept and funding of the Standing Advisory Committee, recommended by the Review Body which reported in June 2000. (7). It is considered that this body will provide the essential leadership needed. (See also recommendation 6I/2)
4/I3	BSI is urged to consider the pricing policy for Eurocodes, having particular regard to the smaller practitioner, the availability of English language versions of Annexes relating to other European countries, and the cost of revisions generally.

Practitioners

4/P1	Practitioners should keep abreast of the Eurocode itinerary and its detail in respect of their area of work. Although not all Eurocodes are yet available in their final format, the process of familiarisation should begin now.
4/P2	Design organisations should plan an implementation strategy, which should include their anticipated adoption date of the Eurocodes, together with education and training programmes.

Chapter 5: Education

Influencers

5/I1	The Institutions should convene a forum or working group to review the strategic issues on Education raised in the text, with the specific aspiration of taking the outcome of their deliberations to Government, in conjunction with those sponsoring the Rethinking Construction initiative. This might be in addition to any action they may directly consider through the Joint Board of Moderators (JBM), Engineering Council (EC(UK)) or others.
5/I2	The JBM should consider the issues raised in respect to the University curriculum.

Practitioners

5/P1	Practitioners are encouraged to forge local partnerships with Academia in order to strengthen the accredited courses, to their joint benefit, and to demonstrate to students the attractive and worthwhile nature of the industry.
5/P2	Practitioners should aim to contribute to the debate in respect of curriculum content through University industrial liaison committees, and active participation in Institution affairs.

Chapter 6: Alerts and other matters

Influencers *Reverse Bidding*

6/I1 Institutions are urged to take a lead in the debate on potential risk to safety if using internet reverse bidding by seeking feedback, providing clear guidance to members, and by entering into a dialogue with Government, industry organisations, and major clients.

British Standards

6/I2 Institutions and BSI are urged to review the current method of developing British Standards (or their Eurocode equivalents) given the warnings made by a number of commentators on the issues relating to committee membership.

Practitioners *Alerts*

6/P1 Practitioners should ensure that they are aware of the issues raised in the various Alerts and other advice issued by SCOSS from time to time.

Reverse Bidding

6/P2 Practitioners are encouraged to i) explain to those clients, tempted to utilise internet based reverse bidding, the pitfalls and generally detrimental overall outcome when applied to professional services and construction related procurement. ii) provide feedback to institutions of instances of use in inappropriate situations.

Chapter 7: Review of actions arising from recommendations in Reports 11-13

7/IP1 The Committee urges Influencers and Practitioners alike to review the recommendations made in previous reports, and commented upon in Appendix A.

References

1	*Rethinking Construction* The Report of the Construction Task Force DETR July 1998
2	*Safety of Tall Buildings and other structures of large occupancy* Institution of Structural Engineers 2002
3	*Regulation for Buildings: Harmonisation of Legislation* Construction Industry Council December 2002
4	*The Pentagon Building Performance report* ASCE January 2003
5	*Falsework:* Full Circle. SCOSS Topic paper. www.scoss.org.uk
6	Assessment and Inspection of Buildings and other facilities. SCOSS Topic paper. www.scoss.org.uk
7	*Review of Structural Design Codes in Construction.* Study Group led by Prof Les Clark prepared for the Office of the Deputy Prime Minister et al. June 2000.

Chapter 1: Introduction

The aims of SCOSS

1.1 The formal aims and objectives of SCOSS are set out on the *website.* In brief terms however, the Committee is charged with investigating, and then, if appropriate, disseminating advice to the industry on matters concerning structural safety that are considered of sufficient importance to warrant action. The Committee is concerned with trends and practices rather than one off events. It relies heavily on feedback and input from the industry to identify matters for review. A list of topics considered over the years is to be found in *Appendix B* and the *website* contains pdf files of all previous reports and other documents issued by the Committee.

Introduction

1.2 This is the 14th Biennial Report produced by the Committee, since it was formed in 1976. An innovation, implemented since the last report was published, is to have placed all the reports on the SCOSS web site thus allowing easy access for practitioners, those able to influence the manner of structural engineering, researchers and industry historians.

1.3 The general aim of this report is to summarise subjects discussed by the Committee over the last two years, to draw them together into logical groups where appropriate (Risk Management in Buildings, for example), and to indicate how, in the Committee's view, matters may be improved. Further detail on most of these topics may be found in specific papers on the website.

1.4 A change of emphasis from previous reports is to direct the recommendations specifically at either 'practitioners', anticipated to be the majority readership, or 'influencers' i.e. those who are able to influence the manner in which the industry works. This might be by through contribution to Institution or Government deliberations, or by bringing influence to bear in a more general way via experience or standing.

1.5 SCOSS has, over the years, been effective in raising awareness of issues, resulting in the establishment of guidance and best practice methodologies, changes to standards, and other benefits to the industry.

1.6 However, those who take some time to review past concerns and matters of discussion will soon identify that there is much yet to be done. Many of the points raised by the Committee over the years recur; either in a slightly different format, or because no action has been taken. This Report includes an analysis of the recommendations made over the last three reports, a span of some 6 years, which concludes that, whilst welcome advances have been made, relatively few of the recommendations have been comprehensively tackled.

1.7 The report considers a number of matters considered by the Committee to be key to the continued maintenance of adequate levels of structural safety. In this respect:

Chapter 2 considers the risk management of buildings (although the principles are applicable to

other structures), and the need for an holistic approach to risk management that takes account of whole life needs. Specific lessons are drawn from the World Trade Center disaster and shortcomings in Falsework. Comments are also made on Insurance, Competency and Legislative matters within this context.

Chapter 3 outlines the Committee's endeavours to establish a pilot 'information gathering' scheme in respect of matters concerned with structural safety. It is argued that the industry lacks an accessible means of encouraging feedback on matters of structural concern and that as a consequence this hinders our ability to learn from mistakes, to identify shortcomings, and to make improvements.

Eurocodes are likely to dominate the industry for some years to come. *Chapter 4* recognises that the introduction of these new codes will be an event of major implication and highlights some of the key actions that should be taken in order that the transition proceeds smoothly. The Committee questions whether the industry is sufficiently aware of the ramifications of the structural Eurocode suite, and associated material codes.

Chapter 5 identifies a number of serious concerns in respect of Higher Education. The Committee believes that if an adequate supply of structural engineers is to be assured, steps have to be taken now in order to counter the several identified issues that pervade the higher education sector.

Chapter 6 takes the opportunity to summarise various Alerts and Other advice issued over the last two years, all of which remain pertinent.

The Report concludes (in *Chapter 7*) with an analysis of the actions taken by various bodies in respect of the recommendations from the last three reports (Numbers 11-13). These 47 recommendations have been set out in four logical groups. The analysis shows that most of the recommendations made remain valid and some significant actions have been taken. However the majority remain to be tackled.

1.8 The Committee recommend this 14th Report to all structural engineers. As the paper(1) on gathering of information states:

Despite the very real advances in technology and management techniques made over recent times, the profession needs to remain vigilant in respect of the control and management of those risks giving rise to a reduction in structural safety. It is not difficult to find examples to support this thesis - the SCOSS Reports have set out a number of areas of concern. (para 4.1)

1.9 History tells us that we forget the lessons of the past at our peril. The pressures on the industry for continuing change and 'improvement' demand our continuing attention.

1.10 The 14th Report is also recommended to those who may be able to influence the manner in which the art and science of structural engineering is practised. The Committee urges this widespread group, from all sectors of the industry, to consider the points made and consciously decide whether and how action should be taken.

References

1	*Gathering of Information on Matters of Structural Safety.* SCOSS, June 2001 (internal briefing paper)

Chapter 2: Risk Management of Structures

Introduction

2.1 Although the need to avoid, mitigate and control structural risk at the time of design, over the lifespan of a structure, has been a requirement for many years(1, 2, 3), it is often not well done. We only have to look around at the UK's infrastructure to see examples of deterioration or misuse, and cause for concern. SCOSS has commented and raised such concerns on various aspects of this subject on previous occasions.(4,5) Further examples are given in this Chapter.

2.2 All these concerns relate to the management of risk, and should be considered therefore within an appropriate risk management framework, commencing at the initial design stage. Although the responsibilities of those who control risk (clients, designers and contractors for example) extend to all types of risk, SCOSS' interest lies in structural 'safety' risk. It is likely however that a well managed project or facility from the perspective of structural risk, will also have the effect of mitigating other risks, and bringing additional benefits stemming from the well ordered process; it is for this reason that holistic consideration of risk is important.

2.3 Examples of concern regarding management of risk, expressed by SCOSS over many years in this field, include those relating to multi storey car parks, stadia with large spans, post tensioned bridges, and cladding. Section 7 comments on the recommendations made previously on this topic.

2.4 Industry is not short on advice as to how to manage risk.(8, 9) However much of it is aimed at the large or complex project, or does not relate readily to every day work experience. It is also thought to be the case that the general level of understanding of risk, and its management, in a practical sense, is not well understood, or communicated.

2.5 Structural engineers need to ensure they are at the centre of things in respect of assessing and managing risk. Often other professions take the lead in respect of project risk, and the importance of a whole life risk approach to structural safety is not fully appreciated or realised.

2.6 For structures of established behaviour and robustness, this risk management approach will be a relatively short and familiar exercise. For the larger or more complex structures however it will encompass the wider issues of, for example, possible deterioration scenarios, fire strategy, risk associated with the degree of redundancy, decommissioning and possibly extreme events.

2.7 This section of the report gathers together items raised, commented upon or otherwise considered by the Committee since the publication of Report 13, in respect of this topic. It is hoped that by bringing several threads together, a stronger and clearer case will emerge for an holistic approach to risk management of structures, no matter what their use or size.

Project Risk management

Tall Buildings

2.8 The tragic events of September 11th 2001 (now commonly referred to as 9/11) have led to an unprecedented review of the design and management of tall and large buildings, primarily from the viewpoint of structural safety.(10, 11, 12, 13, 14) The main thrust of this work was, and still is,

directed at the special category of tall or large buildings, and some even more specifically at the World Trade Center and Pentagon buildings themselves, in the understandable quest to discover the precise failure mechanisms. Many of the interim conclusions and recommendations drawn may be considered applicable to other buildings or structures generally. The substantial knowledge arising from this event is therefore of potential interest to all designers.

2.9 The Institution of Structural Engineers (IStructE) convened a working group shortly after the World Trade Center attack, to provide guidance and advice on the implications that followed the collapse; they reported in July 2002.(11)

2.10 Although the report concentrated on tall buildings, or those with large occupancy, it was notable that, as indicated above, many of the recommendations were equally applicable to structures of all sizes, i.e.:

i. there may be buildings not considered to be above the trigger points of large and tall, but which are nonetheless susceptible to extreme events by virtue of use, occupancy, or proximity to other structures of larger size,
ii. other 'structures' may be equally susceptible to extreme events particularly those with minimal redundancy e.g. grandstands.
iii. many of the principles that the report outlines in terms of robustness, means of escape etc make good engineering sense for any building, even in the absence of extreme events, and hence there is merit, and opportunity, to encourage decision makers on all buildings, to assess the consequences of their design through a structured risk management process.

2.11 As is the case with risk management, the particular circumstances would determine the relevant events to be assessed and for many structures the list of risks would rapidly reduce to 'commonplace' eventualities. The key message is that the need to consider risk holistically applies to all structures, and that this exercise will bring general benefit to facility owners and operators, as well as enhanced safety.

2.12 The Committee supports the identified need for further development and research work, subject to there being tangible benefit. Despite the terrible event of 9/11, it must be ensured that any action taken has a logical, cost effective base. ODPM have commissioned a scoping study on the lessons learnt, as a first step towards considering potential implications for the Building Regulations.

2.13 The report(13) on the collapse of the Pentagon building is an excellent example of forensic engineering, illustrating a number of prime structural essentials, e.g. ductility, resistance to disproportionate collapse, mechanisms of fire resistance, as they relate to that particular form of construction. It is recommended to all structural engineers and to graduates in particular.

Insurance

2.14 Expectation of a greater level of active enforcement by the regulatory bodies in respect of structural safety matters is likely to be unrealistic owing to constraints on budgets and resources. There are opportunities perhaps to link construction and operational preparedness with insurance premiums as an alternative incentive for industry to improve and be benchmarked. The connection between compliance and adoption of best practice, and the level of insurance premium is one of the points arising from the HSE Discussion Document published in September 2002(15). It is known that others are also looking at this subject, for example through Action Point 5* of the Revitalising Health and Safety Strategy Statement (16). The Committee would like to see this explored more generally as it has the benefit of promoting best practice, rewarding success and bringing greater financial security to both insurer and insured. The recent exposure of difficulties relating to Employers Public Liability Insurance illustrates the need to reconsider how improvements might be made. The Committee note with interest the Code of Practice in the process of being agreed with insurers and the tunnelling industry for use on the procurement, design and construction of tunnels in

the UK.

**this talks of looking to see how the insurance industry might be involved more closely in the work of the Health and Safety Commission.*

Legislation

2.15 Legislation relating to building regulation has grown over many years in a piecemeal fashion and appears in a number of often uncoordinated statutes. This subject has been reviewed by the Committee as a matter of concern with specific reference to structural safety(17) and is commented on further in the sub section below entitled *'Responsibility for Buildings…'*. The Committee is pleased to note that others are also reviewing this topic from a broader standpoint.(18) The need for an overhaul of legislation and enforcement is essential if Government is to deliver on its support for 'joined up construction' and the aspirations of *Accelerating Change*(19).

2.16 The key issue in respect of structural safety relates to the need for consistent and clear emphasis on the statutory need for designers to consider the whole life span of a facility at the time of design (including the need for a planned inspection, assessment and maintenance programme for this period), and clarity as to who is responsible for the structure at all times without recourse to complex case law and interpretation of specific terms.

Competency

2.17 The Committee's attention has been drawn to this subject by a number of people and from evidence of independent reports (20, 21). These have included mention of:

- Building submissions proposing fundamentally unsafe structures
- Designs of timber trusses that fail to recognise practical reality
- Failure to appreciate structural actions and behaviour in falsework (see sub section below)
- Use of software without appropriate safeguards

2.18 Competency is derived from two sources- that of the corporate organisation and that of the individual. The obligation to operate in a competent manner, at either level, derives in turn from professional duty of care, codes of conduct (if a member of a recognised institution or trade body), a contractual obligation and, always, from a statutory duty.

2.19 A number of the causes of incompetent actions are outlined in the Committee's *Topic Paper* entitled Falsework: Full Circle(22) (discussed later in this Chapter) but these are in fact equally applicable in other situations. The demand for structural engineers who are able to demonstrate competence by some recognised test or experience is growing. In Scotland, structural certificates must be signed off by a 'chartered engineer', the inspection of most UK dams and reservoirs must be carried out by a 'Panel Engineer' and the IStructE has called for structural design of certain structures to be restricted to 'structural engineers'(23) as is the case in Hong Kong and some other countries overseas. This concept appears to have merit, particularly when taken in conjunction with mandatory continuing professional development. Both ICE and IStructE, in a joint consultation paper(24), have proposed an 'Approved Persons' register, as a means of licensing individuals to certify compliance with structural requirements under the Building Act. The ICE has also discussed the concept of licensing and already administers a number of skill based registers of approved persons.

2.20 The issue of competency and the associated subject of licensing were discussed in the *13th Report.* It appears to the Committee that the pressure is growing for transparent accountability in respect of competence. In the short term, structural engineers need to ensure that they comply with their institution code of conduct in respect of CPD and scope of work undertaken. In the longer term it is likely that some form of licensing may apply as a means of demonstrating to others that minimum standards are met and maintained.

Responsibility for Buildings (and other facilities) during their lifespan

2.21 The Committee has produced a *Topic Paper* (17) on this subject as a result of a number of concerns relating to the overall manner in which many facilities are maintained during their lifespan. The key points stemming from this Paper are summarised in the following paragraphs.

2.22 Designers have a professional duty of care to consider the implications of their design decisions as they relate to the lifespan of the facility. This duty is supplemented by parallel statutory responsibilities arising from the Management of Health and Safety at Work Regulations, the Workplace Regulations, and the CDM Regulations.

2.23 The new Eurocode EN 1990-Basis of Structural Design(6) sets out some critical assumptions, applicable to all structures designed within its remit viz:

- Adequate supervision and quality control during construction
- Use of construction materials and products that comply with Eurocode requirements
- That the structure is adequately maintained
- That the structure is used in accordance with design assumptions.

2.24 The code goes on to specify that the quality management measures shall consist of:

- Definition of the reliability requirements
- Organisational measures and
- Controls at the stages of design, execution, **use and maintenance***

*Committee's emphasis

Current codes contain similar, but less emphatic assumptions.

2.25 The Committee is of the view that the need for a 'whole life' approach may be achieved, reasonably and efficiently, by rationalising existing legislation and regulatory resource, and by designers adopting a best practice approach to identify necessary inspection, repair and refurbishment regimes. The conclusion of such an analysis should feature within a 'life care plan' which might feature in conjunction with the health and safety file. *('Life care plans' are described in Reference 3, Chapter 7)*

2.26 Designers should adopt the approach outlined above, at the time of design, on the basis that the aim is to achieve minimum whole life cost consistent with an adequate safety margin, as well as achieving compliance with the law. The approach adopted by the Eurocodes requires such an explicit analysis to be made. It also sits comfortably with sustainable design philosophy. The provision of some examples might assist designers in this respect.

2.27 Designers are reminded of the need for special consideration on those structures that:

i. have minimal redundancy
ii. attract large numbers of people
iii. are tall
iv. use innovative design or materials
v. exist in an aggressive environment
vi. were designed to now out dated codes
vii. fall outside the scope of verified code methodologies.

2.28 It is understood that work is on going to improve the interface between local authority building control and HSE, particularly in respect of structures not showing clear signs of danger, i.e. where at present the Building Act is ineffective. The responsibility of owners, or others for buildings which are unoccupied, or otherwise not a place of work, could also be usefully clarified. In the meantime, an HSE Information Sheet, also expected in Autumn 2003, will give interim guidance to the inclusion of 'stability and solidity' requirements of the Workplace Regulations(3).

2.29 Current design codes of practice, and indeed the Eurocodes also, assume that the facility in question will not deteriorate during its lifespan. This assumption makes it imperative for designers to inform their Clients of an appropriate assessment and inspection framework. Structures which do deteriorate in an uncontrolled fashion often pose a significant hazard.

Temporary Works (a)

(a) *(The Committee prefers the all encompassing term 'temporary works' to the rather confusing demarcation between 'falsework' and 'formwork').*

2.30 Following a request from HSE, the Committee reviewed the research report produced by Birmingham University on certain aspects of falsework (20) which was published in 2001.

2.31 It was felt that there were sufficient points of concern, both from within the report and from a consideration of the wider issues, to justify further consideration and wider publicity. Details of the Committee's views and recommendations are given in the *Topic Paper* (22) which may be found on the SCOSS website.

2.32 The findings of the research should be of great concern to the industry. They show that:

- There is a lack of understanding of the fundamentals of stability of falsework and the basic principles involved. This shortfall occurs at all levels.
- Wind load is rarely considered.
- There is a lack of clarity in terms of design brief and coverage of key aspects such as ground conditions.
- The lateral restraint assumptions made by designers were often ignored/misunderstood by those on site.
- There is a lack of adequate checking and a worrying lack of design expertise.
- Erection accuracy leaves much to be desired.

2.33 These failings illustrate both contractual and statutory shortcomings. The Committee believes that there is a need to carefully consider the means by which falsework is currently procured, designed, constructed and supervised. Judging from the evidence mentioned above it is only a matter of time before a serious event occurs (although some might argue that it has already happened (25))

Summary

2.34 The various concerns outlined in the above paragraphs illustrate the need for an holistic approach to facility risk management, and adequate competency to undertake the task in order that adequate margins against failure may be maintained.

2.35 It is essential that those specifying or designing structural elements realise the importance, and relevant statutory need to consider whole life risks to structural safety, and the commercial benefits that will accrue by doing so. The construction industry should learn also from other industries with more established track records.

2.36 Recommendations

Influencers

2/I1	Institutions and others are encouraged to emphasise the benefit to most structures of application by designers of the broad lessons learnt from the various investigations following the World Trade Center collapse, and in particular as set out in the IStructE Report 'Safety in Tall Buildings'. Guidance should be given to this approach by way of practical advice and examples, related to common structural form.
2/I2	Institutions are urged to emphasise to their members the benefits of a whole life risk management approach to facility design and to provide appropriate guidance in this respect. A joint initiative with the Construction Best Practice Programme is suggested as a way forward.
2/I3	The Institutions should determine whether there are lessons to be learnt from other industries in respect of whole life risk management, and which are applicable to the day to day project. A conference might provide a suitable vehicle for this as a starting point.
2/I4	Institutions should actively support the CIC in their endeavour for a comprehensive review and harmonisation of building legislation in order that it might be better understood, enforced and add value to the process.
2/I5	Institutions should give continuing thought to the benchmarking of skills in order that third parties are able to make appropriate judgements in respect of competencies, and so that standards are maintained.
2/I6	Government (currently via ODPM) is asked to support initiatives aimed at simplifying building legislation, and provide funding to allow this to progress as a means of achieving a greater degree of 'joined up' construction.
2/I7	The Joint Board of Moderators (JBM) should consider the implications of this Chapter on accredited courses.

Practitioners

2/P1	Practitioners should manage risks arising out of their design from an holistic, whole life viewpoint, recognizing the interaction between disciplines and legislative requirements.
2/P2	The report on the Pentagon building collapse is recommended to structural engineers, as an exemplar of forensic engineering.
2/P3	Practitioners are reminded of their obligations to undertake CPD throughout their

careers and for it to include in particular updates on best practice methodologies.

2/P4 The use of 'life-care plans' is recommended, whereby the designer may convey to the facility owner the design assumptions in respect of the requisite inspection and maintenance regimes over the facility's life. This is particularly important on certain structures where the design is sensitive to use, the environment or maintenance undertaken.

2/P5 Practitioners are urged to inform the Committee of examples of good practice in respect of risk management that may be used to advise a wider audience.

2/P6 Those practitioners involved in the procurement, design or erection of falsework, should read the SCOSS Topic paper on 'Falsework: Full Circle.'

2/P7 Those practitioners involved in the design of buildings and other facilities are encouraged to read the SCOSS Topic paper on 'Assessment and Inspection of Buildings and Other Facilities'.

References

1	Health and Safety at Work etc Act 1974
2	Construction (Design and Management) Regulations 1994
3	Workplace Regulations 1992, as amended 2002.
4	*Multi Storey Car Parks.* SCOSS 12th Report section 3.1
5	*Inspection of Cladding.* SCOSS 12th Report section 3.3
6	Eurocode EN 1990:2002 Basis of Structural Design
7	Health and Safety (Miscellaneous Amendments) Regulations 2002
8	*Risk Analysis of Major Projects(RAMP)* Thomas Telford 1998
9	*Reducing Risk; Protecting People.* HSE Books
10	*World Trade Center Building Performance Study.* Federal Emergency Management Agency, USA. May 2002
11	*Safety of Tall Buildings and other buildings of large occupancy* Institution of Structural Engineers July 2002
12	*'Tall Buildings'* House of Commons report HC 482-I September 2002
13	*The Pentagon Building Performance* report ASCE January 2003
14	*World Trade Center Building Code Task Force Findings and Recommendations.* New York City Department of Buildings. February 2003
15	*Revitalising Health and Safety in Construction;* Discussion Document HSE Books 2001
16	*Revitalising Health and Safety Strategy Statement* DETR June 2000
17	*'Assessment and Inspection of Buildings and other Facilities'* SCOSS Topic Paper February 2003. www.scoss.org.uk
18	*Regulation for Buildings: Harmonisation of Legislation* Construction Industry Council. December 2002
19	*Accelerating Change.* The Strategic Forum Rethinking Construction September 2001

20	*Investigation into aspects of falsework* HSE Research report 394/2001
21	Gross errors fear in timber design SCOSS Alert January 2002 www.scoss.org.uk
22	*'Falsework: Full Circle'* SCOSS Topic Paper. www.scoss.org.uk
23	The Institution: who cares? President's Address. The Structural Engineer 15 October 2002 p25.
24	*A scheme for Approved Persons certifying compliance with the structural requirements of the Building Regulations.* Institution of Structural Engineers and Institution of Civil Engineers December 2002
25	Site Safe News May 2003 p1

Chapter 3: Gathering of Information on Matters of Stuctural Safety

3.1 The effective distribution of information is key to any industry; this is particularly so when the information relates to experiences of safety related issues, be they actual events such as failures, or 'near misses' where, but for a degree of good luck, a serious event could have arisen or may arise in the future, or concern relates to procedures which create or allow unacceptable risk potential.

3.2 Despite the very real advances in technology and management techniques made over recent times, the profession needs to remain vigilant in respect of the control and management of those risks giving rise to a reduction in structural safety. It is not difficult to find examples to support this thesis.(1)

3.3 These incidents are of course a risk to life and limb (the most important of all the associated issues), but are also a risk to the image, profitability, and integrity of the construction industry. ie its sustainability. We cannot afford to overlook these aspects when we are also suffering a skill shortage, and competing in a world market.

3.4 The diversity of the construction industry is both its strength and weakness. The strength is that it encourages independent action and thinking; the weakness is that the essential feedback of information, not just on safety issues, but also on best practice, is problematic. Information becomes lost amongst the plethora of interested parties. This is exacerbated by the fact that there is no well-developed history of data dissemination throughout either the design or construction elements of the industry. (if one excludes the offshore industry which does have an established history of information exchange(5))

3.5 There are examples in a number of other industries (2, 3, 4, 5) where confidential reporting schemes are well established and seen as an integral part of the process of improvement and learning from mistakes.

3.6 The argument for establishing a construction industry scheme is that:

i. those established in other industries appear to have been a success, (see 3.7 below)
ii. recent serious incidents or reported shortcomings (see 3.8 below) have demonstrated the potential for benefits arising from a ready forum to report concerns,
iii. it would operate independently from Institutions, Employers, HSE and Government (i.e. the establishment in all its forms)
iv. it would allow data to be collected that could then be fed back into the industry, thus not only alerting others, but also allowing procedures, materials, or products to be changed for the better.
v. it has the potential for unlocking the data arising from Professional Indemnity claims, currently kept confidential to the parties.
vi. it will allow rapid dissemination of data.

3.7 A representative from CIRAS (the railways reporting scheme) has reported scheme benefits to include new information, improved ability to predict issues arising from near miss data and improved safety awareness and perception. Interviews with respondents have also allowed an insight into the management of unsafe situations. v 3.8 In relation to recent issues addressed by SCOSS, a confidential information gathering scheme would be most useful as illustrated in the following examples; much more could be done to tackle concerns in other areas with such a system in place.

i. multi-story car parks so as to allow collection of data on inspection and maintenance regimes.
ii. falsework design, to establish and highlight the extent of deficiencies highlighted by the HSE Report (See Chapter 2)
iii. timber design, to determine the extent of design shortcomings such as those highlighted in Chapter 6 (Section 6.3).

3.9 The Committee produced a discussion paper(6) on this topic in June 2002 which was issued to the Sponsors of SCOSS. This paper proposed a pilot scheme to run for a period of 12 months, in order to gauge the take-up and benefits, before committing to significant expenditure. At the time of writing (May 2003), the ICE and IStructE have given their support in principle to the proposals. Discussions are now in hand to determine a source of funding for the pilot scheme.

3.10 It is important to note that this proposal is designed to enable confidential reporting of matters of concern; it is not intended to be a 'whistle blowing' scheme.

3.11 **Recommendations**

Influencers

3/I1	The Institutions are urged to actively seek ways of establishing a pilot scheme for the gathering of information on matters of structural concern, in order that this may progress without undue delay.

Practitioners

3/P1	Practitioners are encouraged to consider how they might assist the wider industry by reporting matters of structural concern generally and specifically so once the pilot has been established. (Until that time matters may be confidentially reported to the SCOSS Committee).

References

1	*The collapse of NATM tunnels at Heathrow Airport.* HSE Books
2	Marine Accident Reporting Scheme (MARS)
3	Confidential Incident & Reporting & Analysis System (CIRAS) for the railways
4	United Kingdom Confidential Reporting System (CHIRP) (for the airlines)
5	Safety Alert Database and Information Exchange (SADIE) (for the off shore industry)
6	*Gathering of Information on Matters of Structural safety.* SCOSS, June 2001 (internal briefing paper)

Chapter 4: Eurocodes

Introduction

4.1 In some respects the forthcoming introduction of structural Eurocodes will represent the greatest change to the manner in which UK engineers go about the business of specification and design, ever experienced by the construction industry. CP110 (introduced in 1972), was the first Code of Practice to introduce limit state design for buildings. The adoption of this new code (now developed as BS8110) was nowhere near as demanding a challenge as will be the case with the new Eurocodes. The new code in 1972 was but one document of modest proportions, covering concrete alone and was introduced in the days of scale fees and in the absence of today's commercial pressures. Bridge designers had already adopted this methodology some years earlier following the Merrison report(1); limit state design for building steelwork did not appear until 1985 with the first edition of BS5950. Permissible stress design codes remain acceptable in many cases and continue to be used.

4.2 The final versions of the structural Eurocodes, denoted by the prefix EN (Euronorm), of which some are already available, should be published by 2006. This represents a major milestone in a project that began in 1975, and represents professional consensus between some 19 countries. Although existing British Standards will remain available for some years to come there are a number of important issues to note in respect of their concurrency as noted below.

4.3 In addition to new 'design' codes, many of the associated 'materials' codes are also changing, introducing new concepts and terminology. The specification of concrete for example, currently covered by BS 5328, will, from December of 2003, be replaced by BS EN 206-1 and the complementary BS 8500, relating to concrete specification, performance, production and conformity.

4.4 There is a myriad of papers and other documents explaining the rationale of Eurocodes. The reader is recommended to obtain a copy of the ICE Proceedings (2) for a comprehensive and succinct overview of the entire structural Eurocode suite and the helpful publication relating to the use of Eurocodes.(3) published by the Office of the Deputy Prime Minister (ODPM). There are also useful websites available.(4)

4.5 It is important to realise that the utilisation of Eurocode principles will be mandatory for most public sector work and are likely to become the adopted standard for all work. Although the Eurocodes wish to encourage innovation, and thus allow alternative approaches to design, the user will have to demonstrate that these are of equal standing to the Eurocode methodology. This will be a major task and hence for most projects the Eurocodes will be, de facto, the codes to adopt.

4.6 The Committee believes that the introduction of Eurocodes requires clear and strong leadership from the industry in order to ensure a smooth and effective change from current standards. It will be necessary also to ensure that clients are aware of the implications of Eurocodes from their perspective.

British Standards Institute (BSI)

4.7 The BSI is the UK's National Standards Body (NSB) and is charged with the representation of the UK on CEN (Comité European de Normalisation) which is responsible for the structural Eurocode programme. It is a condition of the Eurocode implementation protocol that once a package of Eurocodes has been released, and after a period of co existence with existing national documents, any British Standard (BS) that contradicts the Eurocode philosophy, must be withdrawn. Although they will in fact remain available (and will be needed for historical assessments for example) they will, in due course, cease to be maintained by BSI and in time therefore will become out of date and unreliable, effectively making them unusable for contemporary design.

4.8 The Committee wish to remind the industry that:

- Even now, some 7 years before the final cessation of 'maintenance', standards are in some cases only being updated or amended in respect of items that have a specific safety consideration. Updating to reflect new technology, to cover aspects originally omitted, to reflect the experience of use, or otherwise to keep the document at the forefront of knowledge, is not generally occurring.
- Despite the national standing of BSs, designers have a responsibility to ensure that the design guidance they are using is adequate and appropriate for the task. (see also Appendix A, recommendation 12/1)

Timeline

4.9 At the time of writing this Report (May 2003), it is anticipated that all Eurocodes will be complete by mid 2005 (i.e. released by CEN for BSI to commence the preparation of the National Annex). Many however will be available prior to that date, and as noted above, some have already been published Thus the final period of issue has commenced and stretches ahead over the next 26 months. (Reference 4 is expected to maintain a current listing of dates of availability). Despite the period of co-existence, which follows publication, it is clear that we are now in a critical phase in respect of the actions and preparation necessary to fully integrate the codes into the industry.

General issues associated with the introduction of Eurocodes

The need for action

4.10 There is no reason why the industry should not accommodate this significant change, without disruption to their work, or a lowering of structural safety standards. However, in order to achieve this aim, there is much to do in preparation and there are some underlying concerns that need to be tackled in order to realise the significant potential. It is the concern of the Committee that, with the exception of some specific organisations, industry at large has not yet woken up to the challenge. It is considered that there is scope for risk to structural safety if users lack the requisite competence when needed.

4.11 Although the stipulated period of co-existence means that BSs may continue to be used for some years to come the Committee believe that greater benefit to all will result in early adoption of the new Eurocode approach. This is because:

- Universities can only realistically teach design methodology in accordance with one code; clearly this must reflect the most up to date needs of tomorrow's graduates. They cannot work to some vague aspiration that within some undefined period over the next five years or so,

there will be need to change from BS design to Eurocodes. The inference is that Universities need to prepare themselves to deliver the necessary education early in the process of Eurocode implementation. Notwithstanding, a number of Universities already teach to the Eurocode principles, rather than to current BSs. A strategy is needed however as shortly, aspiring engineers will increasingly graduate who have only been educated in aspects of design relating to Eurocodes. This point alone has the potential for significant disruption if design offices are not running to the same timetable.

- The development of training provisions for industry takes time and investment. Those able to deliver such courses may be reluctant to invest in preparation whilst there is uncertainty as to take up

- Many of the industry's software and other support packages will require to be rewritten. Those undertaking this task will have similar concerns to training providers.

- There is a concern that too much reliance is being placed on voluntary input. (see also Chapter 6 - BSI Committee Membership)

4.12 Concern has already been raised by some commentators at the potential cost of purchasing Eurocodes. Generally many more standards will be required for a typical design portfolio than at present in view of the overall structure of the Eurocode suite. This potential increase in cost is of particular concern in respect of smaller practices, which predominate within industry, and also Colleges and Universities.

4.13 The Study Group set up in 2000 by the then DETR recommended the formation of a Standing Advisory Committee to provide guidance on the introduction of the structural Eurocodes.(5) The Committee is concerned to note that at the time of writing no action has been taken on this point. The Committee believes that given the nature of this change, there needs to be a co-ordinated strategy that recognises the need for education in the Eurocode concepts.

4.14 Hence in view of the importance of the smooth implementation of structural Eurocodes into UK's structural design offices, the Committee would be keen to see other avenues explored to allow this initiative to move ahead. Time is of the essence however as it is already almost three years since the recommendation was made (see also recommendation 12/1 in Appendix A).

4.15 Recommendations

Influencers

4/I1	The scale of the structural Eurocode implementation programme makes it essential that a co-ordinated plan of action is compiled between all the major interested parties, in order to ensure a smooth introduction. The Institutions should take a lead in this respect reflecting the outcome of recommendation 4/I2.
4/I2	The ODPM is urged to support the concept and funding of the Standing Advisory Committee, recommended by the Review Body which reported in June 2000. It is considered that this body will provide the essential leadership needed. (See also recommendation 6I/2)
4/I3	BSI is urged to consider the pricing policy for Eurocodes, having particular regard to the smaller practitioner, the availability of English language versions of Annexes relating to other European countries, and the cost of revisions generally.

Practitioners

Practitioners should keep abreast of the Eurocode itinerary and its detail in respect of

4/P1	their area of work. Although not all Eurocodes are yet available in their final format, the process of familiarisation should begin now.
4/P2	Design organisations should plan an implementation strategy, which should include their anticipated adoption date of the Eurocodes, together with education and training programmes.

References

1	*Inquiry into the basis of design and method of erection of steel box girder bridges.* HMSO 1973
2	Civil Engineering Institution of Civil Engineers November 2001 (Special Edition on Eurocodes)
3	*Implementation of Structural Eurocodes in the UK* Office of the Deputy Prime Minister February 2003
4	www.eurocodes.co.uk
5	*Review of Structural Design Codes in Construction.* Study Group led by Prof Les Clarke prepared for the Office of the Deputy Prime Minister et al. June 2000

Chapter 5: Education

Higher Education Issues

Background

5.1 The Industry has arrived at a crucial juncture in respect of the higher education of tomorrow's engineers. Recent reports (1, 2) spell out in simple, if bleak terms, the current warning signs viz:

- 45% decline in applicants for building and construction courses between1994-2000
- A decline in the academic standard of applicants
- A decline in the number of graduates entering and staying in construction
- A reducing number of academic staff

5.2 This is particularly crucial in respect of ensuring an adequate supply of structural engineers in years to come as, in addition to these general concerns, the on going debate over mathematics provision (3), and the structural engineering sector's likely inability to utilise graduates with arts or humanities degrees, as has been done in other engineering fields (4), reduces room for manoeuvre and places further pressures on the system.

5.3 It is perhaps ironic that this should be an issue coming to a head at this time when structural engineering has had arguably the highest profile for many years. The 'Greatest Briton' series on BBC television (2002), giving I. K. Brunel a deserved profile; the prominence of the Falkirk boat lift, the Millennium wheel, the Stirling prize winning Gateshead footbridge, the Eden project and the Downland Gridshell, as examples, have all illustrated structural engineering as a true synergy between expressive art and engineering.

5.4 The UK is not alone in experiencing these challenges. The USA has similar problems (5) for example.

5.5 It is a matter of regret that in some respects, the industry is not doing more to attract larger numbers of capable young people. This is, in part, why the Rethinking Construction 'respect for people' initiative (6) is so important. The CIC has also addressed this issue through their video 'Building Visions - Creative Careers in the Construction Professions'(7) designed to encourage the 14-18 age range to consider the construction industry as a future career. The Committee has also noted the very positive contribution made by the Royal Academy of Engineers 'Visiting Professors' scheme in bringing together industry and academia, and its effect in promoting research.

5.6 The political background, in respect of the likely imposition of student funded costs related to a University education, and recent estimates of graduate indebtedness, has created doubts generally, and specifically surrounding the future viability of 4 year MEng courses. This will cause dismay amongst academia which has spent much effort creating these courses to satisfy SARTOR3 (8) requirements.

5.7 Many aspiring engineers face a daunting and confused period of education compared to other professions. For those taking an MEng, apart from the points made previously, the route is currently clear cut. However for those considering a BEng, which will require a so-called 'matching section' in order to provide the necessary supplementary education for CEng status, industry is largely ill prepared. As if this was not confusing enough, the Engineering Council(UK), is currently redrafting the current rules (to become SARTOR4).

5.8 It is worth noting in passing that the broader picture in respect of higher education is considered by many to present similar challenges. The Institute of Directors (IoD) has produced a comprehensive analysis which provides an interesting insight into its current difficulties.(9) The recent White Paper(10) will, if translated into action, also have a profound effect.

Challenges for Academia
5.9 The difficulty of attracting students of the appropriate calibre, and retaining them within the industry, is only part of the problem. Academia itself is struggling with a number of serious issues. These accrue from a combination of:

- The changing profile of entrants' capabilities, which results in some benefits, but also in Universities having to spend time bringing students up to an acceptable level of learning in mathematics and mechanics.
- Engineering courses being the second most expensive to run (after Medicine)
- Uncompetitive salaries, acting as a disincentive for many to apply, or remain as lecturers or researchers,
- The RAE (Research Assessment Exercise) system whereby the funding of departments is geared to research status, stated by some Universities to militate against the employment of good practitioners, creating a significant loss of potential
- The ageing profile of staff in many departments, as a consequence of the above, creating an experience gap. It is not unusual to find that some established staff last had direct industry experience some 10-15 years ago.

5.10 These points of concern exist now. Immediate action is required as, whatever is adopted, will take time to filter through into the system.

Course Content Issues
5.11 The contents of all accredited courses are dictated in overall terms by the accreditation bodies. In the case of UK structural engineering degrees this is the Joint Board of Moderators (JBM).(11) The JBM is composed of senior representatives of both academia and industry, and is managed by the institutions, on behalf of the Engineering Council, working within the remit of SARTOR3.

5.12 University course directors are under constant pressure to include ever more material, all deemed by their sponsors as vital to the ethos and future success of engineering. This widening from the traditional core engineering subjects began with the so called 'soft' management topics; more recent examples would include environment and health and safety risk management and sustainability issues. It is axiomatic of course that the more that is included, the shallower the depth of study overall.

5.13 The Committee has discussed some specific issues associated with course content, including the following:

Dynamics	This is believed to be a relevant component of structural engineering courses in view of the growing prevalence of relatively lightweight structures where dynamic effects may represent a critical limit state. (see also Appendix A, Recommendation 13/12). The Committee's views have been referred to the JBM
Risk	The Committee would encourage the teaching of 'health and safety' within a risk management framework and as part of overall project risk management. In this manner it becomes apparent how it may bring wide benefit, and fit logically with other strands of risk management, rather than simply reducing

management	the number of accidents or incidents of ill health. Risk management issues are discussed elsewhere in this report; the principles espoused are relevant to undergraduate teaching.
Timber design	Few courses offer timber design as part of the curriculum. Whilst timber is not as dominant as steel or concrete, as a construction medium, it remains an important material with some key specialist aspects. He Committee acknowledge however the difficulties of including all materials within the curriculum.This is also discussed in Chapter 6

Matching Industry Needs
5.14 The CITB and 'Rethinking Construction' held a conference in November 2002 on the subject of Rethinking Construction Education in recognition of the need to take some positive action and produce an action plan to be put to Government. The need to build better contact between industry and academia was recognised.(1) This document will, it is understood, now act as a platform for future action.

5.15 The 'sandwich' course is a long-standing UK degree format. The Committee strongly supports the concept as the knowledge, experience and confidence gained by students during their year out in industry, benefits not only themselves, but also their fellow students. The industrial period (or shorter placements in some cases) also provides an excellent opportunity for employers to forge advantageous links with future employees

Concluding Comments
5.16 The Committee does not suggest that it has all the answers to the wide ranging issues outlined above. It does suggest however that a major effort, in a coordinated manner, needs to be taken to improve matters whilst at least some time is left before the serious skill shortages become irretrievable. In this endeavour, industry must play a leading role

5.17 Recommendations

Influencers

5/I1	The Institutions should convene a forum or working group to review the strategic issues on Education raised in the text, with the specific aspiration of taking the outcome of their deliberations to Government, in conjunction with those sponsoring the Rethinking Construction initiative. This might be in addition to any action they may directly consider through the Joint Board of Moderators (JBM), Engineering Council (EC(UK)) or others.
5/I2	The JBM should consider the issues raised in respect to the University curriculum.

Practitioners

5/P1	Practitioners are encouraged to forge local partnerships with Academia in order to strengthen the accredited courses, to their joint benefit, and to demonstrate to students the attractive and worthwhile nature of the industry.
5/P2	Practitioners should aim to contribute to the debate in respect of curriculum content through University industrial liaison committees, and active participation in Institution affairs.

References

1	*Accelerating Change in Built Environment Education*Construction Industry Council January 2003
2	*Academic Staff: trends and projections* HEFCE 2002
3	*ICE Council to debate A level maths proposals* New Civil Engineer 6. March 2003 p33
4	*Arts graduates to plug transport skills gap* New Civil Engineer 27.March 2003 p14
5	*Schools seek new ways to retain a most valuable asset-students* Engineering News Record 21.October 2002 p6
6	*A Commitment to People 'Our Biggest Asset'* Rethinking Construction November 2000
7	*Building Visions-Creative careers in the Construction Professions* Construction Industry Council Video 2002
8	*Standards and Routes Towards Registration* (SARTOR) 3rd Edition 1997Engineering Council
9	*Education and Training. A business blueprint for reform* Institute of Directors Policy Paper June 2002
10	*The Future of Higher Education* HMSO January 2003
11	*Guidelines for MEng and BEng (Hons) degrees in Civil, Structural and Building Services Engineering* Joint Board of Moderators, August 1998 as amended. www.jbm.org.uk

Chapter 6: Alerts and Other Matters

Alerts issued since the last report

6.1 The Committee has issued a number of Alerts and other advice since the publication of Report 13 in May 2001. Alerts are issued when there is a subject that the Committee believes requires more immediate attention than would be achieved via an occasional publication such as the Bulletin or Biennial Report. The full text of all the Alerts and other commentaries may be found on the web site. Those issued since the last report relate to:

Concrete System Buildings *(December 2001)*
6.2 Precast concrete systems were quite widely used in the 1950s to 1970s for the construction of schools, offices and other buildings. Many incorporated elements utilising pre or post tensioned concrete. Investigations at the time, following concern in respect of their integrity, concluded that the periodic inspection by an experienced engineer was the best available means of obtaining indications of the condition of these structures, and thus substantially reducing the risk of unexpected failure. This advice holds good today and hence building owners and their professional advisors are reminded of the continuing need for periodic inspection.

Design of Timber *(January 2002)*
6.3 This Alert arose as a result of concern that the standard of structural timber design achieved by many designers falls far short of that needed to give adequate assurance of safety. A number of instances were quoted to the Committee to support this belief. It was also noted that many of these shortcomings were not picked up by Building Control during the building regulation submission process.

6.4 The Committee has identified a number of other areas where lack of design competence is an issue (See for example Chapter 2 - Falsework). Timber design in particular however does seem to suffer from a lack of expertise on the part of designers. This appears to be due to a number of factors including the general omission of timber as a design subject within most University curricula, that it largely remains in the shadow of other construction materials, and that historically it was a material fashioned at site level rather than being formally designed. It has to be said also that there is a tendency for some designers to push design responsibility down the supply chain. This has the potential for increasing risk if not managed in a controlled fashion. As the Alert illustrates, a lack of appreciation of site realities can lead to some very concerning situations. Scottish Enterprise and the timber industry have recently funded a chair of Structural Timber design at Napier University in direct response to this overall concern.

6.5 In addition to the above, an Alert was included as an article within Bulletin 5, relating to *Unregulated Use of Plywood* (July 2002). This concerned the use of unregulated plywood in instances where the design calls for structural grade material.

6.6 As the article mentioned this appears to be a failing of quality control measures rather than a design deficiency, but it is nonetheless an example of where structural engineers specifically, but also others such as Architects and Building Control Inspectors, need to be alert to the dangers of incorrect material being used, inadvertently or otherwise, and may bring a positive influence.

Cast Iron Beams *(December 2002)*
6.7 A published commentary was made on aspects of Cast iron beams following the collapse of a cast iron beam member in a house within a London terrace. Although on balance the Committee did not believe that an 'Alert' was justified, the collapse quoted in the New Civil Engineer magazine, was

thought worthy of a reminder to owners and professionals of concerns that may arise when CI beams:

- Are subjected to unregulated increases in load
- Suffer from prolonged water ingress
- Are initially designed with high stress levels (possibly as a result of being sized by eye rather than calculation)

6.8 The Committee draws this to the attention of owners of buildings of this era (typically 1830s-1850s) and type of construction.

Items discussed since the 13th report

Temporary Access Gantries
6.9 Following the collapse of the temporary access gantry at Avonmouth bridge in 1999 the Committee reviewed a discussion document produced by the HSE on 'The Use of Temporary Bridge Access Gantries in the UK'. The primary recommendation of the Committee was that the existing IStructE guide 'The operation and maintenance of bridge access gantries and runways' be updated to include in particular the use of temporary access gantries. The IStructE is intending to produce a supplement in this respect.

Reverse Internet Bidding
6.10 Reverse bidding, or 'dutch auction' as it is often known, is not new to the construction industry. It has been most prevalent in sub-contracting where, having received tenders as requested, the main (or employing) contractor will then make the lowest tender known and ask if any of the tendering group will better it.(1)

6.11 Recently however a new form of reverse bidding has emerged whereby this process occurs on the internet, over a short period of time (usually a couple of hours). The press have reported some significant clients utilising this technique.

6.12 Although to date most instances have been related to the acquisition of products, there is a very real concern that quality and safety may suffer and, crucially, that this approach may spread to services (despite current denials). The Confederation of Construction Clients suggested that for standard design (a utility office block for example) there was no reason why it should not be used for acquisition of design services. Their approach was that if designers didn't like it, they should decline to take part.

6.13 It should be noted that the Consolidated Procurement Directive, on its way through the legislative approval process, will, if passed, permit this technique in the public sector.

6.14 If this approach to bidding is allowed to develop and gain a foothold there is a very real danger of the hard won gains achieved by the 'Rethinking Construction' ethos unravelling. Any tightening of the economic climate will increase this risk.

6.15 The Committee's concern stems from the probable reduction in attention to structural safety if margins are diminished below sustainable levels. We believe that this will also be a subject of concern to the Institutions and ask that some debate and action be encouraged whilst time remains to exert an influence.

Membership of BSI Committees

6.16 The traditional manner of formulating new standards via BSI committees, the membership of which represents the broad interests and expertise of UK industry, is an established and important aspect to our business success, and in particular our standing in world markets. The introduction of Eurocodes and other Directives from the EU, which will eventually come to be the adopted standards for UK construction business, emphasises this importance. If we want a say in the manner in which these are derived, we must ensure we are properly represented- not just in number, but also in expertise.

6.17 There has been concern expressed over a number of years at the increasing difficulty in obtaining adequate representation on BSI technical committees. The report Review of Structural design Codes in Construction(2) stated,

There is widespread concern that there is a declining representation from practising engineers on code committees. There is also reduced input from Government Departments and their Agencies… It is emphasised that no prospect is seen for reversal of the decline of representation from consultants and Government without positive action. (Section 2.3)

6.18 The Committee regrets that, approaching some three years since the recommendation was made, no action appears to have been taken.

6.19
Recommendations

Influencers

Reverse Bidding

6/I1	Institutions are urged to take a lead in the debate on potential risk to safety if using internet reverse bidding by seeking feedback, providing clear guidance to members, and by entering into a dialogue with Government, industry organisations, and major clients.

British Standards

6/I2	Institutions and BSI are urged to review the current method of developing British Standards (or their Eurocode equivalents) given the warnings made by a number of commentators on the issues relating to committee membership.

Practitioners

Alerts

6/P1	Practitioners should ensure that they are aware of the issues raised in the various Alerts and other advice issued by SCOSS from time to time.

Reverse Bidding

6/P2	Practitioners are encouraged to i) explain to those clients, tempted to utilise internet based reverse bidding, the pitfalls and generally detrimental overall outcome when applied to professional services and construction related procurement. ii) provide feedback to Institutions of instances of use in inappropriate situations.

References

1	*'Reverse Bidding Error'* Letters NCE 6 February 2003 p14
2	*Review of Structural Design Codes in Construction* Study Group led by Prof Les Clarke prepared for the Office of Deputy Prime Minister et al. June 2000

Chapter 7: Review of Actions from Recommendations in Reports 11-13

7.1 SCOSS Reports 11-13 cover the Committee's deliberations over the period from 1996 through to 2001. The Reports are freely available on the SCOSS website and remain germane reading for all those involved in the built environment. Each report made a number of recommendations, relating to the various topics discussed and reviewed at the time. These recommendations have been recently researched to see what, if any, action has been implemented since their original publication. The results of this research may be seen in *Appendix A*.

7.2 47 individual recommendations were made within the three quoted reports, which, when allowing for commonalities and other similarities over the time span involved, consolidate on a qualitative basis to approximately 34 issues. Of these, 21 were directed at formal organisations such as BSI, Institutions or Government Departments. The balance of recommendations was aimed at facility owners or industry professionals generally.

7.3 It is estimated that some 15% of the recommendations have been considered by the relevant party, with appropriate action taken, or in hand. It is interesting to note that these all relate to actions directed at specific bodies.

7.4 The most comprehensive of the considered items is the publication of several reports and guidance relating to the procurement, design, and maintenance of multi storey car parks (1, 2, 3) stemming from recommendations in Reports 11 and 12 (and first raised in fact in Report 10). The Committee believe that these reports represent a major achievement. Other recommendations that have been actioned, or are in hand, include a (likely) change to the Disproportionate Collapse requirements of the Building Regulations and the withdrawal of BS6661

7.5 Approximately 35% of all recommendations have had no action taken. We are not in a position to know definitively whether the balance of recommendations (some 50%) has been taken up or not - as they apply to industry generally-but anecdotal evidence suggests that take up has been variable and poor.

7.6 The various consolidated recommendations may be conveniently grouped under four broad heads:

Risk Management and Design
Codes and Quality Management
Legislation and Duty of Care
Education and Research.

7.7 A summary sheet at the beginning of *Appendix A* indicates how the various recommendations have been categorised in this fashion.

7.8 A number of these outstanding issues are considered again within other sections of this report. Selected comments are made below however on some of the key outstanding recommendations using the groupings given above and illustrated in *Appendix A*.

Risk Management and Design

7.9 This is the largest of the four chosen categories. A significant proportion of the recommendations relate to actions by industry at large where the Committee is unaware whether action has been taken. As mentioned above however anecdotal evidence suggests that little has been done.

7.10 With regard to those recommendations directed at specific bodies (for example Government Department or the Institutions) implementation has been varied. There is much that is either moving at a slow pace (bridge strikes: recommendation 12/15) or where no action has been taken.(control of risk: recommendation12/2)

7.11 It is interesting and useful perhaps to take an overview of these recommendations, now that they are laid out for us to consider as a whole. This demonstrates that this group may be further categorised into themes i.e. the need for:

- clarity of regulatory material
- planned periodic inspections and reviews, and the
- benefit of whole life, 'holistic' risk assessment undertaken at the time of design.

7.12 These themes are discussed in more detail in Section 2, the need for which is a reminder of the failure of industry generally to have adopted the recommendations, made over a period of some years. Whereas the first theme may only be tackled by formal bodies, it is noted that the other two themes are able to be implemented by individuals within organisations.

We offer the following comments on three specific issues:

Inspections and reviews (Various Recommendations)
7.13 The subject of appropriate inspections of facilities arose in respect of buildings generally (recommendation 12/8), sports stadia (recommendation 12/13) and cladding (recommendation 12/14). Although the detail is very different in regard to each of these, the underlying philosophy of need and approach is the same. The recent reports(1, 3) on car parks place significant emphasis on this aspect the principles of which are applicable to all facilities.

Disproportionate Collapse (Recommendation 11/7)
7.14 A longstanding concern of the Committee relates to disproportionate collapse. SCOSS has argued, over a period of many years, for Requirement A3 of the Approved Document to be amended to include the stipulation for all buildings to be designed against disproportionate collapse. The Office for the Deputy Prime Minister (ODPM) consulted on this, and other matters relating to Part A, in 2001(4) and the outcome is awaited (expected in October 2003) but the Committee was pleased to note that the consultation draft as submitted extended the requirement for positive design against disproportionate collapse to all structures except those in 'Category 0'- broadly single occupancy housing up to 3 stories in height and some warehousing. The Committee looks forward to these proposals being implemented as soon as possible but, notwithstanding the requirements of the Building Regulations, designers need to consider the likelihood of disproportionate collapse as part of an holistic risk assessment approach (as advocated in Section 2) and in consideration of the requirements of the EU 'solidity and stability' requirements expressed via the Workplace Regulations (5).

Climate Change (Recommendations 13/13 and 13/14)
7.15 The 13th Report devoted a Chapter to the growing importance of this subject. It is true to say that further research and analysis is required in order to present the data in a manner in which practitioners may readily assess its relevance to a particular project. Nonetheless, in the spirit of

whole life risk management which is espoused throughout this report, designers need to be aware of the background and influences which may be relevant to their design briefs. As was noted in The Structural Engineer(6):

'Thus the message for structural engineers should be one of readiness, far less certainty that 'more of the same' will suffice and a greater chance of some more extreme climate events but not to the extent of taking an alarmist view'

Codes and Quality Management

Codes
7.16 The industry is entering a critical period in respect of structural design codes, the like of which has probably never been experienced before, as the suite of Eurocodes becomes ever closer to agreement and issue for implementation by industry. Individual Euronorms (ENs) are now available, although their equivalent British Standards will not be withdrawn for some years. This topic remains a significant concern, and is discussed further in Section 4.

Legislation and Duty of Care

Continuing structural safety: the regulatory regime (Recommendation 12/9)
7.17 Concern was expressed at the potential 'gap' in the regulatory regime between Building Control and HSE. The desire for better co-ordinated use of statutory authorities has been promoted elsewhere as part of the general drive to improve health and safety standards.(7, 8, 9)

7.18 In line with the desirability of considering projects, of all types, from a whole life point of view, it is important that the regulatory framework is designed to be compatible, and of practical effectiveness, to promote this approach. At the present time it consists of a number of Acts and Regulations most of which have arrived on the statute book without sufficient regard for effective interaction. Thus we have the situation where there is overlap, or gaps between regulatory authorities and resources are not used to maximum benefit.

7.19 The Committee is supportive of the current work being undertaken by ODPM and others to review this subject and looks forward to an early outcome. The Committee has also reviewed the subject and this is discussed in Section 2.

Reporting of Unexpected Behaviour (Recommendation 13/11)
7.20 All industries need to learn from their mistakes and innovations. The construction industry, partly because it is project driven, is not good at this and has never had a comprehensive framework to allow feedback in a manner that will allow benefit to the wider audience. There are few examples where effort has been made to inform others (10) or circumstance has allowed scrutiny (11, 12). A fundamental tenet of the 'rethinking construction' agenda is the sharing of information to the benefit of industry as a whole but this has not yet been adopted as the norm of behaviour.

7.21 SCOSS is proposing a confidential reporting system, which is described in Section 3, but notwithstanding, members of the industry are encouraged to assist in the distribution of information through such channels as Verulam (The Structural Engineer), the SCOSS Committee, or papers in institution journals.

Education and Research

Use of Computers (Recommendation 12/5)
7.22 The inappropriate use of computers (or more strictly, software), or use by those without the appropriate experience, remains a concern in an industry that sees ever-increasing, and almost exponential, sophistication of software, and unrelenting commercial pressure to reduce costs.

7.23 As the schedule in Appendix A indicates there is adequate advice available on this subject. It is the Committee's view that it is the responsibility of academia to first alert students to the risks associated with inappropriate use of software, and that of industry to continue this education, supplemented by training, and to operate within risk managed frameworks (13) in order to maintain adequate margins against error. Precautionary measures against mis-use are part of the holistic risk management approach advocated throughout this report.

Climate Change (Recommendation 13/15)
7.24 Much useful work has already been done in this field and this has had the beneficial effect of raising awareness within the industry. The Committee believe it is important however that this momentum is maintained and co-ordinated given the widespread implications for the UK of adverse changes. It is pleased to note that research is on going.

Summary

7.25 The relatively low rate of implementation of previous SCOSS recommendations should be of concern as it is believed that the rationale for first raising these matters generally still applies.

7.26 Although a few knowledgeable owners (project sponsors)/operators may be aware of these recommendations, in the main they will depend upon their professional advisors to alert them to good practice and necessary actions.

7.27
Recommendations

7/IP1 The Committee urges Influencers and Practitioners alike to review the recommendations made in previous reports, and commented upon in Appendix A.

References

1	*Design recommendations for multi storey and underground car parks*, Institution of Structural Engineers 2002
2	*Enhancement and whole life performance of existing and future car parks*, Mott McDonald 2002. (ODPM PII project)
3	*Recommendations for the Inspection, Maintenance and Management of Car Park Structures*, Institution of Civil Engineers 2002
4	*Proposals for Amending Part A- Structure.* Office of the Deputy Prime Minister August 2001
5	Health and Safety (Miscellaneous Amendments) Regulations 2002
	Climate Change: the structural engineers' response.

6	Prof D. A. Nethercot The Structural Engineer 7 January 2003 p24.
7	*Revitalising Health and Safety in Construction* HSE Discussion Document Sept 2002.
8	*Regulation for Buildings: Harmonisation of Legislation* Construction Industry Council (CIC) January 2003
9	*'Inspection and Assessment of Buildings'* SCOSS Topic paper: www.scoss.org.uk
10	*The London Millennium Footbridge* P. Dallard et al The Structural Engineer 20 November 2001 p20
11	*The Collapse of the Ramsgate walkway* Structural Engineer 6 January 1998 p1
12	*Collapse of NATM tunnels at Heathrow Airport.* HSE Books
13	*Reflections on Structural Safety.* The Structural Engineer 16 April 02 p12.

Appendicies

Appendix A

CATEGORISATION OF PREVIOUS REPORT RECOMMENDATIONS (Reports 11-13)

Refer to Chapter 7 for a commentary on the categorisation process.

Theme	Subject (brief description)	Report Number and recommendation
Risk Management and Design	Multi-Storey Car Parks	11.1, 11.2
	Pins, integrity of	11.5
	Flood damage	11.8
	Risk management	11.9
	Contract forms	11.10
	Control of risk in design	12.2
	Regulatory control of risk	12.3
	Disproportionate collapse	12.6
	Inspections of structures	12.8
	Safety management of bridges	12.10
	Use of Health & Safety File	12.11
	Inspection of stadia	12.13
	Inspection of cladding	12.14
	Bridge strikes	12.15
	Reinforced autoclaved aerated concrete	12.16
	Lighting columns	12.17
	Control of Risk	13.1
	Competence	13.3
	Dynamic behaviour	13.10
	Climate assessment	13.14
	Disproportionate collapse	11.7

Codes and Quality Management	Multi-Storey Car Parks	11.3, 12.12
	Pins, design of	11.4
	Fatigue	11.6
	Coordination of codes	11.11
	Air supported structures	11.12, 11.13
	Standing Advisory Committee	12.1
	QA Systems	12.4
	Guidance on Robustness	12.7
	Updating of codes	13.2
	Use of BS9001	13.4
	Certification	13.5, 13.6, 13.7, 13.8
Legislation/Duty of Care	Legislative roles	12.9
	Reporting of unexpected behaviour	13.11
	Duty to warn	13.16
Education/Research	Use of Computers	12.5
	Research for dynamic behaviour	13.9
	Knowledge of dynamics	13.12
	Climate assessment	13.13, 13.15

RECOMMENDATIONS AND ACTIONS FROM REPORTS 11-13 (1997 TO 2001)

REPORT 11 (1997)

	Item	Action/Progression
-	**Inspection and appraisal of existing multi-storey car parks**	-
11/1	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 extent 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.	This subject has now been comprehensively covered in ICE's report 'Recommendations for the inspection, maintenance and management of car park structures' 2002. See also 12/12 It appears, however, from anecdotal evidence that owners have not yet taken on board this recommendation. It is hoped that the publicity surrounding the launch of the report, and the clear signal that this represents the benchmark of acceptable management, will act as a catalyst.
-	**Adequacy of edge barriers in multi-storey car parks**	-
11/2	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	This subject is comprehensively covered in the reports mentioned in 11/3 below. See also 12/12. As far as implementation is concerned it is suspected that the comment made above in 11/1 applies.
-	**Guidance on assessment of barriers in multi-storey car parks**	-
11/3	The Institutions of Civil and Structural Engineers should urgently prepare guidance on assessment and strengthening of existing edge barriers in multi-storey car parks.	The subject is covered in the IStructE Report (see 12/12)ODPM has also published two reports: - *Edge protection in MSCPs- Assessment method for installed restraint systems- Final report* - *Edge protection in MSCPs- design specification and compliance testing-Final report.*
-	**Pin connections in bridges and buildings - review of guidance**	-
11/4	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.	This point relates specifically to design against fatigue, and pins being disengaged. In addition guidance was thought to be necessary in respect of maintenance issues. The Highways Agency (HA) has written a procedural note on this topic but it has not yet been issued. The SCI and BSI have not yet actioned this point. Actions in relation to this recommendation are outstanding
-	**Pin connections in bridges and buildings - design**	-
11/5	The design of pin connections should be overseen by suitably experienced engineers who are responsible for design, detailing, installation and maintenance.	It is hoped that following the extensive publicity surrounding the Port of Ramsgate walkway collapse, the CIRIA guidance (*Safety in Ports*, C518) for marine structures, the implications of the CDM regulations and the comments made against item 13/1, that this point is sufficiently actioned.
-	**Fatigue in steel structures**	-
11/6	The Institutions of Civil and 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.	This issue in respect of fatigue is dealt with in the forthcoming Eurocodes (EN1993-1-9 Fatigue Strength) which provides design rules independent of use or application. This is due for publication in 2004. No other action has been taken in respect of current British Standards or other guidance. Given the time yet to run before BSs are withdrawn, this recommendation is considered to remain relevant
-	**Disproportionate collapse**	-

11/7	The Institutions of Civil and 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.	No action has been taken, but see 12/6
	Flood damage to bridges	
11/8	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 review and to develop consistent best practice. *now Network Rail	IStructE produced a report entitled *'Guide to Inspection of Underwater Structures'* in Oct 01. CIRIA have produced C551 'Manual on Scour at Bridges' May 02 Highways Agency (HA) advises that flood damage is dealt with at a local level. They are developing advice on scour assessment and are reviewing implementation needs. Technical Note BD59/94 (*The design of highway bridges for hydraulic action*) covers scour action Network Rail have a set of procedures in place to assess the risk of scour, (trigger levels for action, flood warnings) but the approach taken reflects the number of structures in the portfolio. All structures receive an underwater inspection at regular intervals.
	Hazard identification and risk assessment in design	
11/9	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.	The Committee believes this is a fundamental need. The philosophy of holistic risk management applied to all projects is not yet accepted as an essential part of project management. The Institutions could play a valuable role in this respect. See also 12/.2
	Design and Build: client-supplied data	
11/10	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.	No action has been taken on this point. However- -Clarity of responsibilities should be a pre requisite of any contract. -All designers have a general duty of care, and, in respect of structural safety, a statutory duty to ensure risks are avoided or mitigated.
	Structural codes of practice	
11/11	The British Standards Institution should give publicity to the overall policy for 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.	The point being made here was the need for clarity and simplicity. Clarity in that common topics should be consistency dealt with in differing codes e.g. fatigue between bridges, cranes and other structures. Simplicity in that efforts should be made to minimise the number of documents that practicing engineers have to review and comply with, particularly when they may be out of date or inaccurate. The introduction of Eurocodes, and the necessary revisions to existing BSs as a consequence, will, it is hoped go some way to satisfying this point, although it will take a number of years to achieve. See also 12/1
	Air-supported structures - withdrawal of British Standard	
11/12	*The British Standards Institution should withdraw BS 6661: 1986 Guide for the design, construction and maintenance of single skin air-supported structures.*	This BS has now been withdrawn; it is reported by BSI that there is no industry support to revise and re issue this standard.
	Guidance on air-supported structures	
11/13	The Institutions of Civil and Structural Engineers in collaboration with industry should prepare guidance on the design and specification and use of air-supported and fabric structures.	As noted above there are no plans for a new BS. There is however guidance from ASCE 17-96: *Guidelines for air supported structures and IStructE has published conference proceedings 'Design of air supported structures'* July 1984

REPORT 12 (1999)

	Item	Action/Progression
-	**Codes of practice for structural design**	-
12/1	The Institutions of Civil and Structural Engineers and the British Standards Institution should review the whole production and writing process of codes, including the Structural Eurocodes, and define and vigorously implement a strong policy, agreed and actively supported by industry and government, addressing the following issues: • The growing portfolio of codes of practice in structural engineering and the inadequacies and confusions within them. • The need to converge as far as possible to a single set of codes that clearly distinguishes between performance requirements, principles and rules. • The need to keep codes reasonably in line with technological advance and to withdraw codes that are obsolete. • The need for positive strategic management of the process of code development in the UK.	The report *'Review of Structural Design Codes in Construction'* sponsored by IStructE, ICE, BSI, and ODPM recommended the formation of a Standing Advisory Committee. At the time of writing (May 03) ODPM has not decided whether to support such a Committee. It is hoped that the Institutions will determine how this committee might be established and the report recommendations implemented. This is rated as a key action. See also 11/11
-	**Control of risk through design**	-
12/2	The Institutions of Civil and Structural Engineers should prepare a guidance on procedures for assessment of hazards and risks affecting structural safety that should be followed as part of an explicit risk management process starting at the design stage of projects. The procedures should include the definition and prioritisation of critical situations relating to hazards to the structure during its life, and the determination of the need for, and adequacy of, safeguarding measures.	The need to consider risk has been given a much higher profile than hitherto by virtue of the CDM Regulations. However these do not cover all stages in a facility's life (i.e. they exclude operational risks). There is no lack of publications on risk management (e.g. RAMP) but they often suffer from being pitched at the wrong level for day to day projects, or are not well known. Notwithstanding these publications, and CDM, the understanding of risk management principles is not as good as it ought to be. The rationale for an explicit holistic risk management process on all projects, crossing all discipline boundaries, is not yet accepted by the majority and is a subject that needs further emphasis. The debate and actions arising from the 'Tall Buildings' analysis may offer such an opportunity. The Institutions of Civil and Structural Engineers are in a position to lead on this and are urged to do so.
12/3	The regulatory requirements for risk management should be clarified by the relevant government departments.	This recommendation stemmed from the Ramsgate case where the statutory duty to perform risk assessment by virtue of the HASWA was reinforced. Notwithstanding the CDM Regulations, this all encompassing need is not well understood or spelt out- relying on case law interpretation is not a good way forward in practice. The situation remains that some simple guidance and illustration from ODPM and HSE would be very useful.
-	**Quality management systems and design**	-
12/4	Managers of quality assurance systems relating to structural design should ensure that they are explicitly based on a direct response to the specification clauses of ISO 9001. In particular design management controls for verification and review should be based on ISO 9001 Clause 4.4.	The latest issue of this BS is 9001: 2000 which has been re ordered from the 1994 version on which the recommendation was based. Clause 4.4.1 (mentioned in the text of the SCOSS Report) no longer exists. It appears that 'products' (which may include services typical of designers) that are specified to BS 9001: 2000 will have the necessary controls.
-	**Use of computers**	-
12/5	Those responsible in universities, professional engineering institutions and government for the education of engineers and their continuing professional development should	IStructE has published *'Guidelines for the use of computers for engineering calculations'*, as a first step. There has also been a number of relevant papers published in the Structural

	provide more guidance on understanding structural behaviour and its modelling for computer analysis, and on avoiding uncritical reliance on computer-generated results.	Engineer e.g. *- 'Powerful analysis software needs skilled users'* *- A training agenda for new technology* Anecdotal evidence suggests that this is an on going concern. It is recommended that the Joint Board of Moderators (JBM) consider this topic and pursue as necessary.
	Resistance to disproportionate collapse	
12/6	The Department of the Environment, Transport and the Regions* should continue consideration of the SCOSS recommendation that resistance to disproportionate damage (robustness) should be required by regulation for all structures, especially those where large numbers of people may congregate. *now the Office of the Deputy Prime Minister(ODPM)	The consultation period for Part A3 of the Building Regulations ended in November 01. The ODPM are currently reviewing the responses and are also taking account of the parallel development of the related Eurocode 1991-1-7 'Accidental actions due to impact and explosion'. ODPM advise that the proposed Part A will be published at the end of 2003. The work may also be influenced in due course by further research stemming from 9/11 investigations.
12/7	The Department of the Environment, Transport and the Regions* should issue Approved Document guidance on the design of structures for robustness and provision against accidental actions including advice on identification of hazards and analysis of critical situations. *now ODPM	This is allied to the progress and issues highlighted above.
	Periodic structural inspection	
12/8	Owners and operators of buildings and other structures should arrange for periodic inspections and structural appraisals to ensure that their safety is adequate as they continue in use; this process is particularly important for structures where large numbers of people may congregate.	Anecdotal evidence would suggest that no comprehensive action has been taken. The ICE Structures and Building Board have called for regular inspections of buildings (ICE Press Release March 02), and the SCOSS Committee is currently reviewing the subject again. The subject is also covered to some degree by the on going review of legislation in respect of control/responsibility of buildings, and the recommendations made by IStructE and ICE regarding car park management are relevant(See 11/1 and 12/12, and 12/13). Reviews are also being undertaken by CIC, HSE and others. It is to be hoped that clarity in terms of timetable and intent will be forthcoming in the near future. In the meantime, designers are reminded of their obligations to inform clients of the appropriate frequency and type of inspection and appraisal of facilities designed by them. The Committee has written further on this subject in the Topic Paper *'Assessment and Inspection of Buildings and other facilities'* , to be found on the SCOSS website.
	Continuing structural safety: the regulatory regime	
12/9	The review in progress by the Department of the Environment, Transport and the Regions and the Health and Safely Executive of the respective roles and responsibilities of the Health and Safety Executive and Building Control Authorities for the continuing safety of permanent and short-life structures should be completed to determine an adequate regulatory and enforcement regime.	Discussions are continuing, but no outcome as yet. This now ties in with the work of others and is considered to be key research.
	Safety management of bridges	
12/10	Responsibilities for enforcement of the requirement for safety of highway bridges should be independent and completely separated from those for maintenance, operation and use.	No action has been taken on this point. It is considered that this is particularly relevant and essential for Local Authority and privately owned structures used by the public.
12/11	The owners of rail underbridges should consider adopting a safety file approach as a framework for managing the safety of each bridge.	Network Rail do not have a formalised individual safety file as such for each structure; they operate instead on a framework which allows judgements to be made as to appropriate actions. These trigger specific actions should certain parameters not be met.

	Multi-storey car parks and edge barriers - technical issues	
12/12	The Institution of Structural Engineers should expedite the preparation of up-to-date guidance on the structural design and assessment of multi-storey car parks including edge barriers.	The IStructE issued its guide *'Design recommendations for multi storey and underground car parks'* in June 02; ODPM also issued a report *'Enhancement and whole life performance of existing and future car parks'*. The ICE published their guide *'Recommendations for the inspection, maintenance and management of car park structures'* in December 02. Although these have no statutory status they represent the view of industry, HSE and Government, and should therefore carry some significant weight. They also carry messages applicable to building stock generally.
	Stadia structures	
12/13	Owners of stadia should arrange a detailed structural inspection and appraisal of the structures periodically by a competent person to ensure their safety is adequate in the light of current circumstances and use.	The point being made here was that although all designated sports grounds are required to have a safety certificate under the Safety of Sports Grounds Act 1975, and that this would normally include the requirement for a report from a competent person that the structural elements have been inspected and found to be adequate, it was felt that more attention needed to be given to the definition of competence in this case. *It is the Committee's view that this recommendation could now be amended to: Those undertaking inspections on behalf of stadia owners need to ensure that the brief is so worded as to allow the necessary inspection, and testing if needs be; that the brief is derived from a risk assessment of the facilities, and that those undertaking the work have the contemporary competence to undertake the task.* In addition, the health and safety file should contain a design philosophy statement in respect of future inspection needs. It is considered that the methodology for dealing with safety critical structures does need to receive more guidance in a readily accessible format; it is a specific case of the more generalised need to formalise inspection of structures over their working lives. See 12/8
	Periodic inspection of cladding	
12/14	Owners of buildings should arrange for periodic inspection of claddings to check safety. The requirement for checking should be defined in the CDM health and safety file.	No regulatory action taken but see item 12/8 and 9 The Committee has written to Association of Planning Supervisors, ICE Safety Board, IOSH Construction Specialist Group and others of similar status, in respect of the H&S File recommendation. This is tied up with the wider issue of maintenance inspection of buildings. See 12/8
	Bridge strikes	
12/15	The Bridge Strikes Prevention Group, regulatory authorities and industry should more vigorously seek and implement measures for the prevention and mitigation of bridge strikes and their effects.	The BSPG continues to meet and implement trials and research on new methodologies, but, at its own admission, has no powers to implement. The HA report that strikes are dealt with in accordance with a report by the BSPG (*A Strategy for the reduction of Bridge Bashing* July 88) which lists actions dependent upon various risk assessment ratings. The Highways Agency also works to BD 60/94. Network Rail uses a variety of approaches depending upon the history of strikes at a bridge location, and their potential seriousness. Notwithstanding the work of the BSPG, hauliers and others need to appreciate their responsibilities; this could be emphasised by a more emphatic prosecution policy although it appears that gathering evidence is problematical.
	Reinforced autoclaved aerated concrete	
12/16	Owners of both school and non-school buildings that have pre-1980 RAAC plank roofs should arrange for these roofs to be inspected if this has not been done since 1994, although generally the deterioration of RAAC planks may not jeopardise structural safety.	No further action on behalf of SCOSS considered necessary in view of low risk identified in the research done by others.
	Lighting columns	
12/17	Owners of existing lighting columns should arrange for them to be inspected periodically giving greatest priority to those that are likely to be most vulnerable due to position, age, environment, detailing and quality.	Lighting Columns are now designed to BD26/99 which was revised to take on board concerns in respect of fatigue. A risk management strategy is now in place and contained in ILE Technical Report ILE22 Second edition.

REPORT 13 (2001)

	Item	Action/Progression
	The control of risks to structural safety	
13/1	Structural safety can be placed at risk by active errors by designers, site personnel and the like and by latent errors introduced through inadequate procurement procedures, codes, standards and regulations.	Confirms importance of the *Rethinking Construction* Agenda (promoting best practice and integrated teams), and a proper understanding of risk. Solutions to this lie over a wide area and with many parties, and are covered in the main by actions relating to other items. This relates to an on going need for caution; it is not new. No further action is proposed by the Committee on the basis that the profession is aware of its importance.
13/2	Codes and standards provide a core means of controlling risks to structural safety. Identified shortcomings should be addressed with urgency. It must be recognized that there may be gaps in codes and they may not cover recent innovation.	The timely implementation of UK specific codes to pick up aspects not covered by Eurocodes will become increasingly important. It is necessary however to highlight current anomalies which may not be corrected through the Eurocode route by virtue of time or subject matter. This remains a concern. The changing nature of code production, in its commercialisation, increased difficulty in obtaining industrial participation, and the pending implementation of the new Eurocode suites, suggests a period of vigilance is required. This action is considered particularly important as we commence a period when Eurocodes are available, but BS are not yet withdrawn. See also 11/11.
13/3	The control of risks to structural safety depends primarily on the competence and integrity of individuals and organisations. The possibility that individuals or organisations might not be competent, or that their competence might be affected by commercial or other pressures is a risk to structural safety and needs to be controlled.	This relates in part to item 12/2. The Committee is currently considering the issue of competence but this topic raises the question as to whether some form of more general licensing may be beneficial as has been introduced in limited areas already e.g. (Reservoir) Panel Engineers
13/4	Supervision and management systems used to control risks to structural safety should include appropriately independent arrangements for checking safety-critical elements. There is doubt as to whether systems conforming with ISO 9000 are adequate for this purpose.	This concern remains and relates to a perceived trend away from independence in certifying non proprietary materials and components. The growing emphasis on 'one stop' procurement routes means that it is even more essential to have a risk managed process for certification that will be robust enough to withstand both intentional and unintentional abuse.
13/5	The certification of structural safety-related work should be entrusted only to appropriately qualified and experienced engineers.	See 13/3 In Scotland this already happens in respect of independent certification when building design has to be signed off by a chartered engineer. Report 13 sets out some suggestions as to how certification might operate. IStructE and ICE have recently published 'A scheme for Approved Persons certifying compliance with the structural requirements of the Building Regulations' which would allow appropriate persons to certify the work of others (and themselves in limited circumstances)
13/6	Certification by the work originator of the design and construction of structures whose failure would not have high consequences can give adequate assurance of structural safety provided there are appropriate systems in place for ensuring competence.	See 13/3
13/7	For safety-critical aspects of design and construction of structures whose failure would have high consequences, third party independent certification is needed to give adequate assurance of structural safety.	With regard to 'design', SCOSS has proposed that the scheme mentioned under recommendation 13/5 should incorporate third party independent certification for those structures where failure would have high consequences. No specific action has been taken in respect of 'construction'.
13/8	For structures whose failure would have high consequences and for structures that are innovative or unfamiliar in relation to the experience of the project team, an explicit process of risk management should be used. The process should include the systematic identification of hazards and assessment of risks to	See Item 12/2 and items discussed above.

	structural safety, followed by the selection of critical situations for design.	
13/9	Specifically targeted research is needed to evaluate the uncertainties in the structural design of cantilever seating decks for dynamic effects and to assist the IStructE/DETR/DCMS Working Group.	The Working Group having published *'Dynamic performance requirements for permanent grandstands subject to crowd action'* and the subsequent *'Dynamic testing of grandstands and seating'* in 2002, recognise the need for further research and it is understood that this is in hand.
	Dynamic response of structures	
13/10	There may be many bridges that have only experienced moderate pedestrian traffic and have performed well but which, if subject to greater pedestrian density, could suffer strong lateral vibrations.	This has received world wide publicity as a consequence of the London Millennium Bridge problems. The IStructE has published guidance to enable designers to determine whether a bridge is susceptible to this phenomenon
13/11	Where previously unknown structural behaviour is observed, whether failure has occurred or not, it is incumbent upon professional engineers to report the observations in the technical literature, if possible, so that others are alerted to potential risks to safety.	This is an on going responsibility of all professionals and needs to be kept in the foreground, in order that the profession may learn from mistakes and other unforeseen events. SCOSS has produced a report on a scheme for the gathering of information on matters of structural safety; this is being considered by the ICE and IStructE.
13/12	The identification of dynamically sensitive structures and the visualisation and understanding of structural behaviour at the design stage may not be sufficiently well covered in the education and formation of civil and structural engineers.	The Committee wrote to the Chairman of the Joint Board of Moderators (JBM) in June 02 in respect of this issue. A response was received in September 02 indicating that JBM would be considering this topic.
	Naturally-occurring environmental hazards to structures, including climate change	
13/13	The consequences for structural safety of climate change should be regarded as a national and international issue. Consequences should be assessed taking account of the uncertainties existing in the predictions of climate change. Changes should be quantified by continuous monitoring and analysis of the climate.	This is a long term issue. Oxford University(through the UK Climate Impacts Prgramme)are undertaking research into climatic conditions. ICE structures and Building Board and IStructE Codes Committee are also interested in this subject. Dti (see 13/15 below) has published a report on Construction sector strategy for Sustainability. The Committee is advised that matters of this type are not as high on HSE's agenda as other more immediate shortfalls.
13/14	A prudent minimum approach for maintaining structural safety as climate change occurs would be to update design and assessment criteria as change is confirmed. Anticipating climate change in design and assessment may be justified in some cases, particularly if evidence is found that a significant change is taking place over a short time scale relative to the life of structures, say 50-200 years.	It is hoped that this will be picked up through regular (5 year) reviews of BSs, or Eurocode National Annexes. See also D. Nethercot's paper *'Climate Change: the structural engineer's response'*. The Structural Engineer 7 January 2003.
13/15	Research is needed into the sensitivity of structures to climate change to determine thresholds at which the updating of design values and the strengthening of existing structures may be necessary to maintain acceptable structural safety.	There are signs that this is being taken seriously; the Engineering & Physical Sciences Research Council and the UK Climate Impacts Programme have produced a report *'Building Knowledge for a changing climate'*
	Duties to warn and heed warnings	
13/16	Giving and heeding warnings are essential parts of ensuring structural safety. In difficult situations, the Royal Academy of Engineering Draft Guidelines for Warnings of Preventable Disasters is commended to engineers.	The IStructE and ICE Presidents have agreed that implementation of the Guidelines is a good idea and the ICE formally adopted these in September 02. The Engineering Council incorporates them, in part at least, into their publication 'Guidelines on Risk Issues' which sets out the obligations of all registered engineers.
13/17	Views would be welcomed by the Committee on whether the establishment of a system for confidential reporting on matters affecting structural safety, or safety in construction generally, is needed and would be used.	IStructE and ICE are interested in pursuing this and a pilot scheme is under consideration.

Appendix B

List of Topics considered by the Committee during 2001-2003

The Committee has monitored and discussed developments relating to earlier recommendations in its published Reports and recent trends and changes that potentially may give rise to a concern for structural safety. The topics discussed during 2001-2003 included:

1. Ageing Infrastructure
2. Approved Persons
3. CI Beams
4. Competencies
5. Confidential reporting
6. Education
7. Eurocodes
8. Falsework
9. Fires in Tunnels
10. Inspection of Buildings
11. Lessons from the attack on the World Trade Centre
12. Management of Records
13. Resolution of Previous recommendations (Reports 11-13)
14. Reverse bidding
15. Revisions to Part A of the Building Regulations
16. Timber design
17. Timber Joist Hangers
18. Tower cranes
19. Unregulated Plywood
20. Welded fixings

Appendix C

Membership of the Committee 2001-2003

Chairman
Kate Priestley MBA CQSW HFIHEEM FRSA. Chief Executive of Inventures. [since October 2002]

The Lord Lewis of Newnham Kt. FRS FRSC. Former Warden Robinson College, University of Cambridge. [until September 2002]

Members
John Barber MA LLB CEng MICE MHKIE FCIArb. Consulting Engineer. [until September 2001]

Professor David Blockley FREng BEng PhD DSc CEng FIStructE FICE. Professor of Civil Engineering and Head of Department of Civil Engineering at Bristol University. President: Institution of Structural Engineers, 2001-02. [since November 2002]

John Collins MSc CEng MIStructE MICE. Head of Bridges for the Transport Directorate at the Welsh Assembly Government. [since February 2001]

David Cornes BSc(Eng) AKC CEng FICE FCIArb. Founding Partner of Winward Fearon Solicitors specialising in construction. [since October 2001]

Professor Parag Das OBE PhD CEng FICE. Project Director, Bridge Management, The Highways Agency. Visiting Professor: University of Surrey. [until February 2002]

Dr David Fowler BSc DPhil FIMarE MICE CEng FIStructE. Independent Consultant. [until January 2003]

Martin Holden BSc MSc CEng MIStructE MICE ACIArb MCIWEM. H.M. Principal Specialist Inspector at the Health and Safety Executive. [since October 2001]

John Lane BSc CEng MICE. Department Head of Infrastructure Division at TRL Limited. [since October 2002]

Joe Locke MBE FREng MSc CEng FIStructE FWeldI. Director at William Hare & Co. [since October 2002]

David Mackenzie BEng MS CEng MASCE FIStructE MHKIE. Partner at Flint & Neill Partnership. [since October 2001]

Rod McClelland CEng MICE MIHT. Senior Engineer, Alfred McAlpine Civil Engineering. [until September 2002]

Dr Gordon Millington OBE FIAE FIStructE FICE FIEI FIHT Hon FICE Eur Eng. MASCE SMCSME. Retired Senior Partner of Kirk McClure Morton, Consulting Engineers. [since June 1997]

Alec Moir Hon DSc CEng Hon FIStructE FIMechE FCIBSE FCIWEM. Retired Chairman Oscar Faber - consulting engineers. Past President CIBSE. Vice Chairman Construction Industry Council 1997-99 [until September 2002]

Brian Neale AGCT CEng FIStructE MICE FIDE. Health and Safety Executive, Technology Division. [until September 2001]

Professor David Nethercot BSc(Eng) PhD DSc FREng FIStructE FICE FCGI. Head: Department of Civil and Environmental Engineering, Imperial College, Vice President: Institution of Structural Engineers. [until September 2001]

Professor Brian Rofe MA(Cantab) FREng FICE FCIWEM. Consultant. [since October 2002]

John Rushton BEng (Hons) MSc CEng MIStructE MICE. Partner at Peter Brett Associates. [since October 2001]

Brian Simpson OBE CEng FIStructE FRSA. Independent Consultant, formerly Director Husband & Co. and Mott MacDonald Civil Ltd. President: Institution of Structural Engineers, 1995-96. [until September 2002]

Helen Stone OBE BSc FREng FICE. Independent Consultant, formerly Managing Director of WS Atkins Structural Engineering. [since June 1997]

Dr Howard Taylor BScTech PhD FREng FIStructE FICE. Technical Director, Tarmac Precast Concrete Ltd. President: Institution of Structural Engineers, 1993-94. [until September 2001]

Dr Sam Thorburn OBE DSc FREng FIStructE FICE. President: Institution of Structural Engineers, 1997-98. [until September 2002]

Anthony Umney BSc CEng FICE. Group Director Tunnels at FaberMaunsell. [since October 2002]

Faith Wainwright BA(Hons) CEng FICE FIStructE. Director at Arup. [since February 2001]

Secretary
John Carpenter CEng FIStructE FICE MIOSH, Consultant, formerly Director of Health and Safety at Symonds Group. [since April 2002]

Dr John Menzies BSc(Eng) PhD FREng FIStructE. Independent Engineering Consultant, formerly Director: Geotechnics and Structures Group, Building Research Establishment. [until May 2002]

Technical Officer
John Fenn CEng FIStructE. [until November 2001]