The JCSS Guidance Document on Robustness of Structures

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CONTENTS

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1. The Joint Committee on Structural Safety (JCSS)

- An international committee of structural safety experts
- Formed by civil and structural engineering associations such as
  - IABSE
  - CIB
  - fib
  - RILEM
  - ECCS
  - CEB

- President: Prof Michael Faber, ETH, Zurich
- Secretariat: ETH, Zurich.

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- JCSS's concern: Structural Safety
- It developed most safety concepts in Eurocodes and ISOs

- Current Initiatives:
  - Probabilistic Model Code
  - Guidance Document on Robustness of Structures
  - Guidance Document on Risk Assessment

  Organises dissemination activities such as seminars, workshops,...

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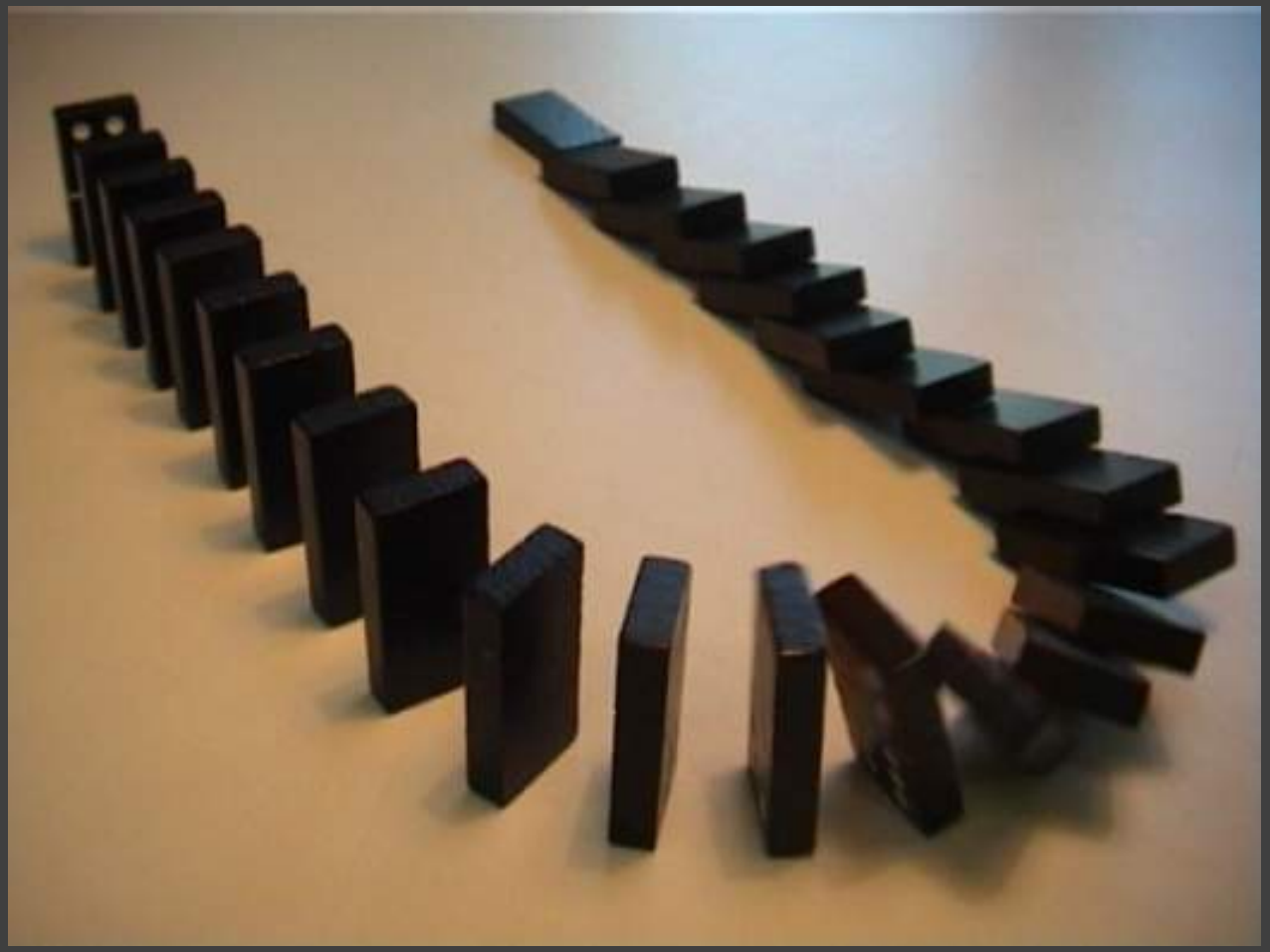
2. Robustness/Disproportionate Collapse



Picture: by courtesy of Michael Faber, ETH, Zurich

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World Trade Centre (2001)

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- 1968
- Ronan Point
- Gas Explosion

In the UK and Europe,

- Design Robust Structures
- Eliminate Disproportionate Collapse

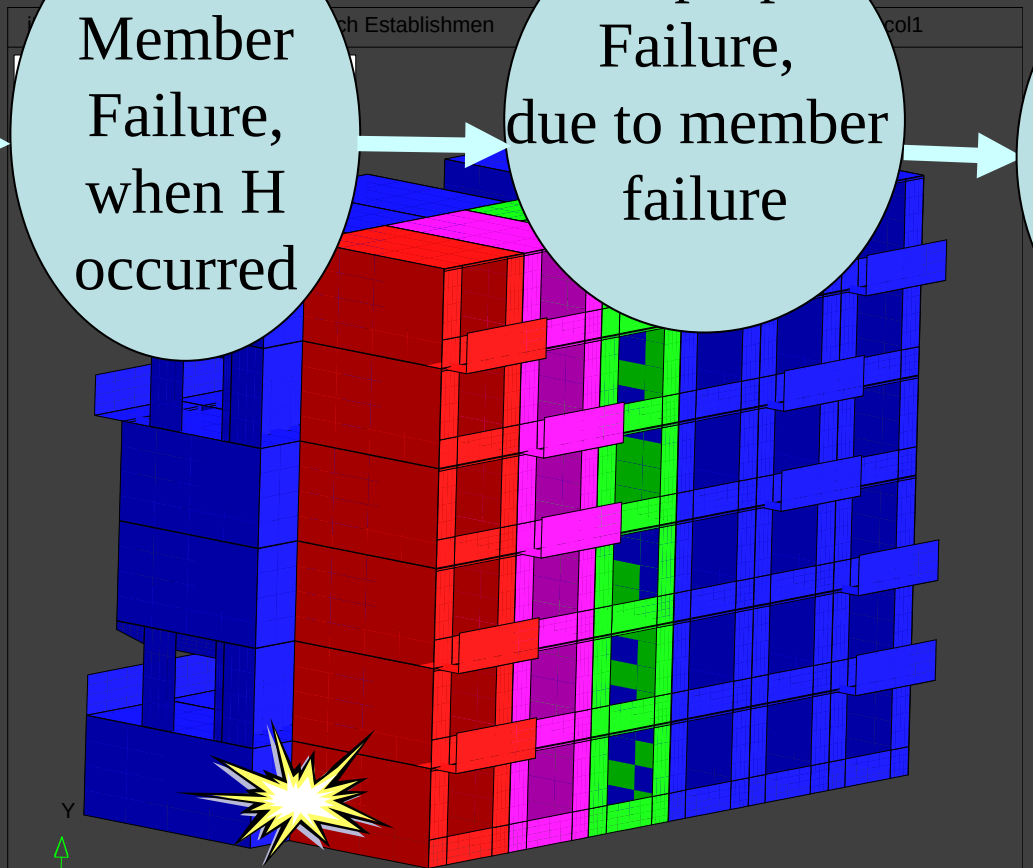
- Progressive Collapse only a mode of failure.

Consider a ‘SYSTEM’

A chain of events lead to undesirable results

Hazard (*H*)

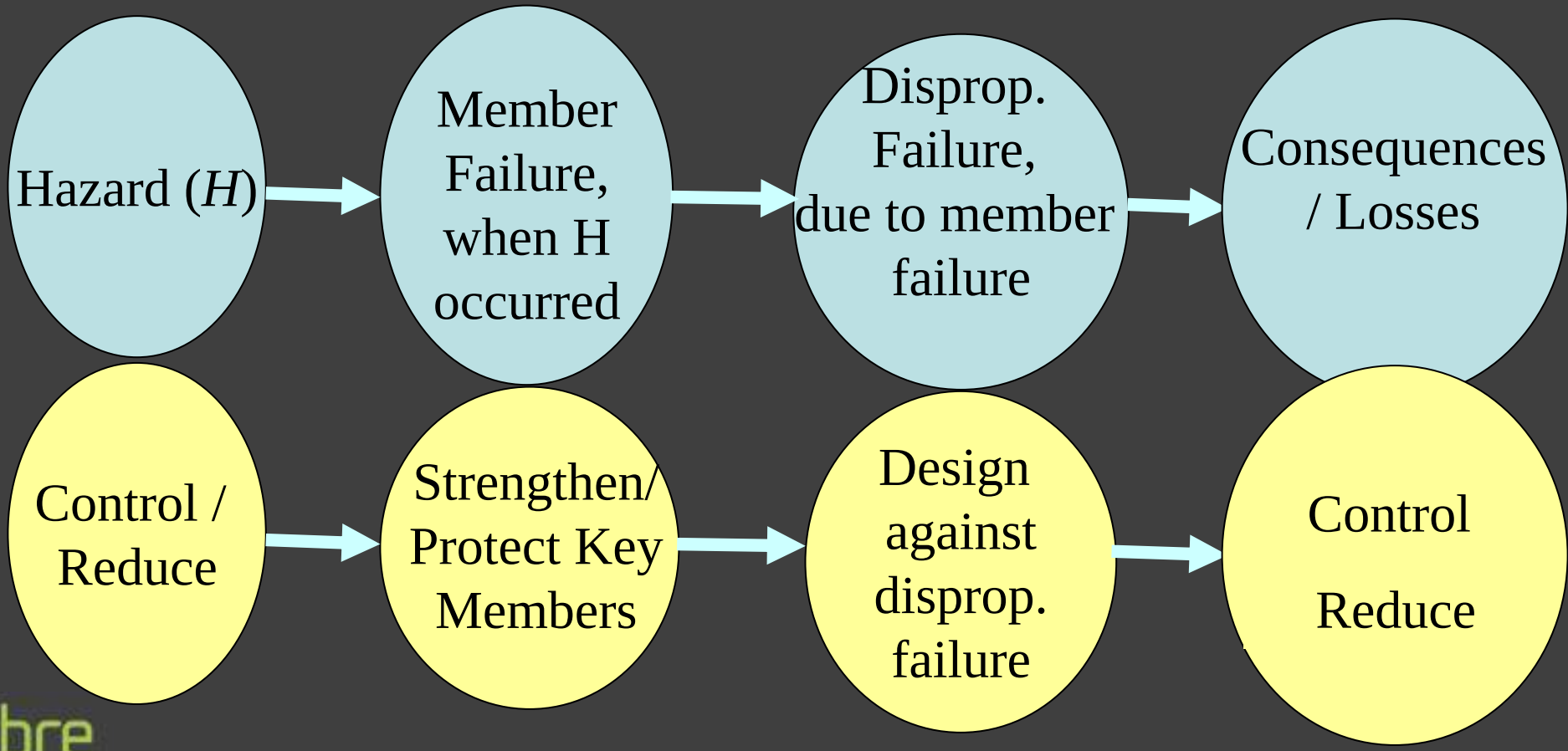
Member Failure, when H occurred



Disprop. Failure, due to member failure

Consequences / Losses

Achieve Robust Structural Systems



3. The JCSS Robustness Initiative

- An outcome of
  - JCSS/IABSE International Workshop on Robustness
  - 28-29 November, 2005 at BRE
- TG formed on 25 April 2006
- Develop International Guidelines Related to Robustness of Structures (Target July 2008)

4. JCSS Expert Task Group - Members

- Dr T.D. Gerard Canisius (BRE). Chairman
- Prof. Michael Faber (ETH, Zurich)
- Prof. John Sorensen (University of Aalborg, Denmark)
- Mr Geoff Harding (formerly of ODPM/CLG, UK)
- Prof. A. Vrouwenwelder (TNO, The Netherlands)
- Prof. Bruce Ellingwood (Georgia Tech, USA)
- Prof. Thomas Vogel (ETH, Zurich)
- Dr John Menzies (Private Consultant, ex BRE, UK)
- Dr Fahim Sadek (NIST, USA)
- Dr Finn Sorensen (Denmark)
- Dr Jack Baker (Stanford University, USA)
- Prof. Milan Holicky (Klockner Institute, Czech Rep.)
- A. Maitra (Faber-Maunsell, UK)
- R. Shipman (CLG, UK)

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- Observers
  - Prof. Haig Gulvanessian (BRE)
  - Mr Richard Shipman (DCLG)
  - Prof. Carmen Andrade (IETCC, Spain)
  - Dr Inger Kroon (COWI, Denmark)
  - Prof. A. Scherer (Univ. of Dresden, Germany)

- First Meeting – 5th July 2006 (BRE)
- Second Meeting – 23rd November 2006 (Munich)

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5. The JCSS Guidance Document:

'Provision and Assessment of Structural Robustness'

- The objective:
  - To provide international state-of-the-art guidance on robustness issues.

    Cover methods of quantifying, assessing and providing robustness incorporating latest international thinking and knowledge.

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- A document directed more at
  - Regulators
  - Code Developers
  - Research and Development personnel

  - Can be used by practising engineers

- Scope
  - On-shore and near-shore structures, but not off-shore structures
  - Common structures (common rules & methods) & special structures.
  - Includes robustness during erection (execution).

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Would Deal With ...

- The structural safety basis for current robustness considerations.
- Adequacy of current ‘deemed to satisfy’ rules for providing various levels of ties to a building in situation where multiple load-bearing members can be lost.
- Issues arising from ‘too much’ tying of a structure, especially under ‘deemed to satisfy’ rules – for example, non-confinement of collapse and ‘drag down’ of a structure.

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- Methods of quantifying robustness of a building when risk is defined in terms of damage, fatalities or economical costs.

- The importance of non-structural consequences, e.g. economical consequences and public morale, in assessing risks. The relation to consequence classes in EN1991-1-7.

- Decision making in relation to robustness issues. Determination of best (optimum) solutions, including by incorporating hazard elimination (reduction) measures.

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- Quality control during execution (construction) and provision of maintenance regimes as means for providing and assuring robustness.

- How EC1 consequence classes, which relate to potential fatalities, can be used in situations where economic consequences and public morale are important.

- ‘Over-strength’ materials and components that can modify structural behaviour (robustness) determined based on characteristic strength.

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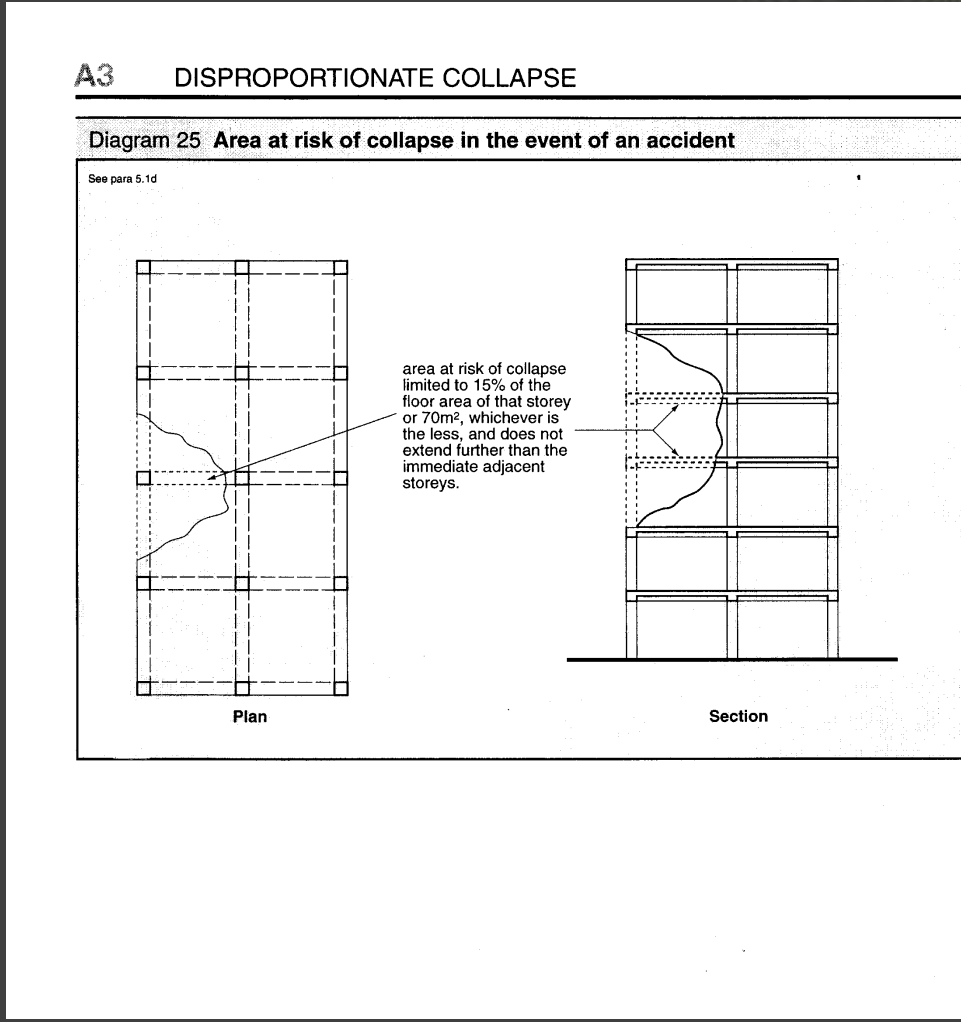
Contents - 14 Chapters

- Chapter 1: Introduction

- Chapter 2: Philosophy and Principles of Robustness
  - A preamble giving historic approaches
  - Stakeholder requirements, especially in terms of existing practice and regulations



- Chapter 3: Public perception of issues related to robustness
  - Nature of structural safety
  - ‘tolerable risks’
  - risk communication
  - risk acceptance
  - stakeholder participation in decision making

- Chapter 4: Hazards
  - those considered by Regulations and codes
  - those not considered (including terrorist attacks)

- Chapter 5: Consequences
  - methods of quantifying consequences (human, structural, economical, political)
  - methods of expressing risks
  - proportionate consequences

- Chapter 6: Definition of structural systems
  - from components to complete structures
  - inclusion of hazard and consequences in a system
  - sub-systems

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- Chapter 7: Quantification of robustness
  - what is robustness?
  - can we give a number, like reliability index?
  - how can we compare two structures or solutions?

- Chapter 8: Methods of providing robustness
  - How to make a system robust
    - *Control of hazards*
    - *Good structural forms (topology) and properties (energy absorption)*
    - *Redundancy, stronger components*
    - *Inspection and maintenance*

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- Chapter 9: Decision making
  - Strengthening costs vs accepting risks
  - Regulations
  - Optimisation
  - Legal issues
  - Dealing with public perception issues

- Chapter 10: Designing for Robustness
  - Framework for designing for robustness, considering
    - *Hazards (prevent, control, compartmentalise)*
    - *Structure (strength, redundancy, energy absorption, maintenance)*
    - *Consequences (escape time & routes, contingency plans, emergency services)*
    - *Risks (Control/Minimise, Acceptable risk, Constraints)*

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- Chapter 11: Robustness during construction
  - The vulnerability of structures during construction
  - Special hazards and temporary structural conditions
  - Prevention of disproportionate failure

- Chapter 12: Effects of quality control and deterioration on robustness
  - Gross Errors
  - Material quality and fabrication errors.
  - Importance of maintenance.
  - Prevention.

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- 13: Other issues
  - Existing structures Situations of Changing Risk
  - Deliberate attacks – with prior weakening of structures, when full occupied
  - Demolition

  (Not in detail – as generally same principles apply)

- Chapter 14: Recommendations

- Annexes

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Conclusion

- The JCSS has formed an Expert Task Group on Robustness of Structures.
- The TG will produce a Guidance Document *Provision and Assessment of Structural Robustness*
- The document will be a major step forward, especially by dealing with issues such as
  - consideration of systems
  - quantification of robustness
  - robustness during construction
- The document is currently being developed.

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Thank you.

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