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Seminar: Assessment of existing structures

Codes and Recommendations

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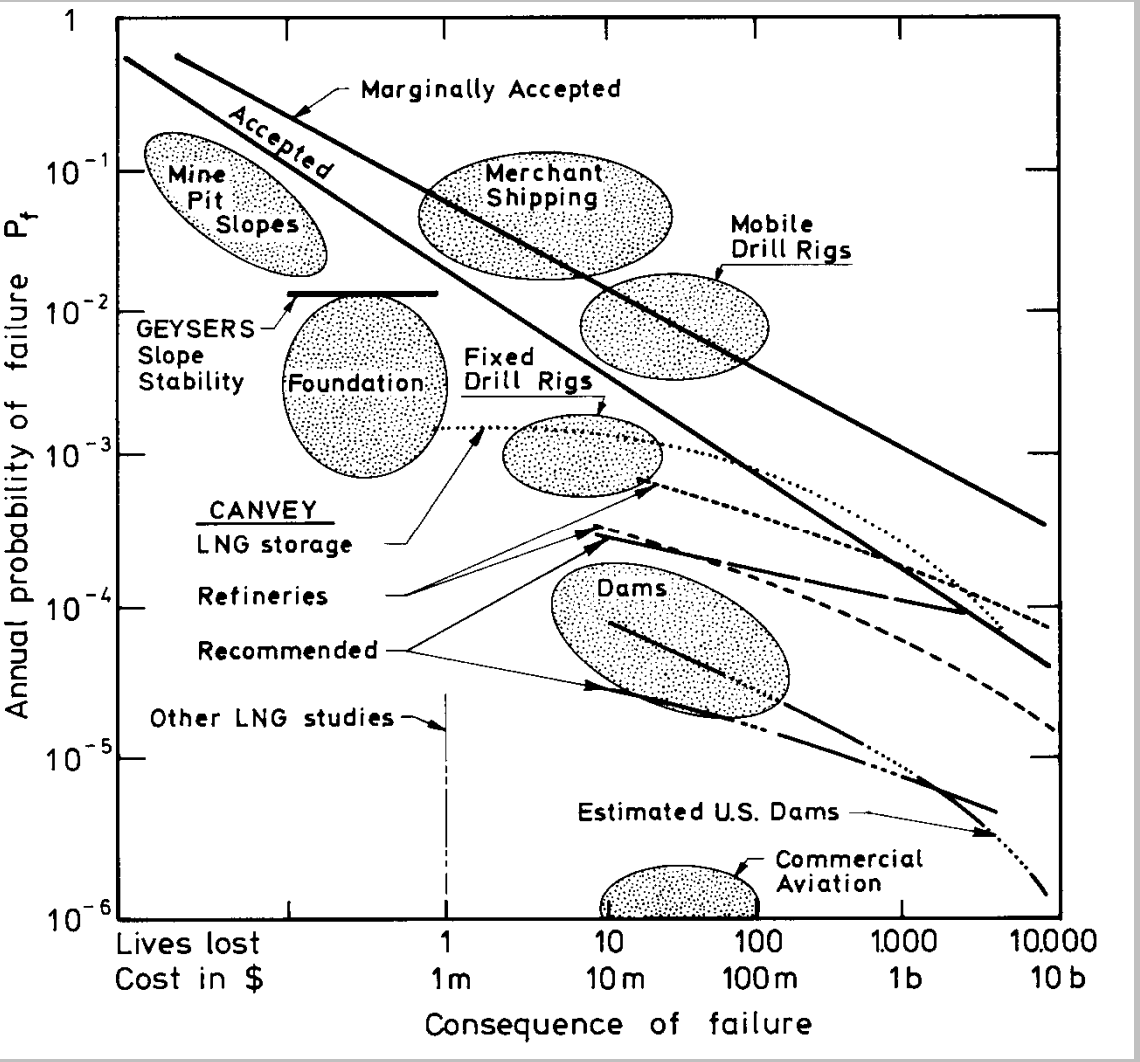
Earthquake damage, Istanbul 1999

Ice-stadium Bad Reichenhall, January 2006

Cracks in buildings

Structural failures experience



Requirements for a code on existing structures

- **Applicability**: the code should be applicable to typical assessment cases.
- **Compatibility to codes for new structures**: the code should use the same philosophy as current codes for new structures.
- **Flexibility**: the code should be flexible to include additional information gained by inspection.
- **Ease of use**: the code should be understandable to engineers and easy to use in practice.

Use of codes for new structures?

- Under what conditions?
- Possible relaxations/safety measures?
- Required performance level?
- Uncovered aspects (inspections etc.)?

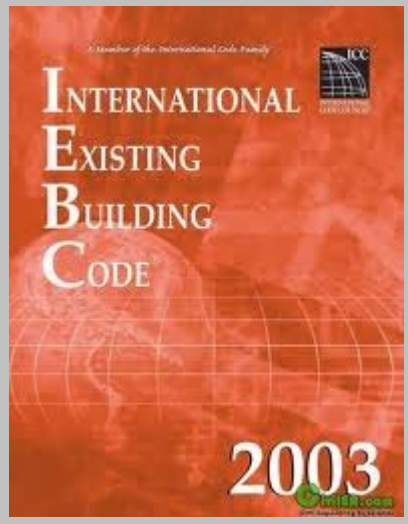
Regulatory tools for existing structures

- **What topics are covered?**
- **What type of buildings are dealt with?**
- **Under which circumstances?**
- **Used methodologies (prescriptive or risk based)**
- **Specified performance level**

Example: Building Code

- 1997 UBC: 2 pages
- 2000 IBC: 14 pages
- 2003 International Existing Building Code:

  67 pages +214 pages Annexes
- 2012 new version 290 pages



Why reassess an existing structure?

- **Deviations from original design**
- **Doubts about safety**
- **Adverse inspection results**
- **Change of use**
- **Lifetime prolongation**
- **Inadequate serviceability**

Typical questions

- What type of inspections are necessary?
- What type of measurements shall be taken?
- What analyses shall be performed?
- What is the future risk in using the structure?

How to find the Answers

- **No classical code approach**
- **New information becomes available**
- **New techniques can be implemented**
- **New material technologies can be used**
- **New decision criteria under new uncertainties**

Prenormative and regulatory tools

- **ISO 13822, 2003**
- **ICC Existing Buildings Code, 2009**
- **SIA 462 (Switzerland), 1994**
- **Danish Technical Research Council**
- **ASCE Seismic Evaluation, 2003**
- **ACI 437R -03, 2003**
- **JCSS Recommendations, 2001**

ISO 13822

- **General Framework of Assessment**
- **Data for assessment**
- **Structural Analysis**
- **Verification (Limit State)**
- **Assessment based on satisfactory past performance**
- **Interventions**
- **Report**
- **Judgement and Decisions**

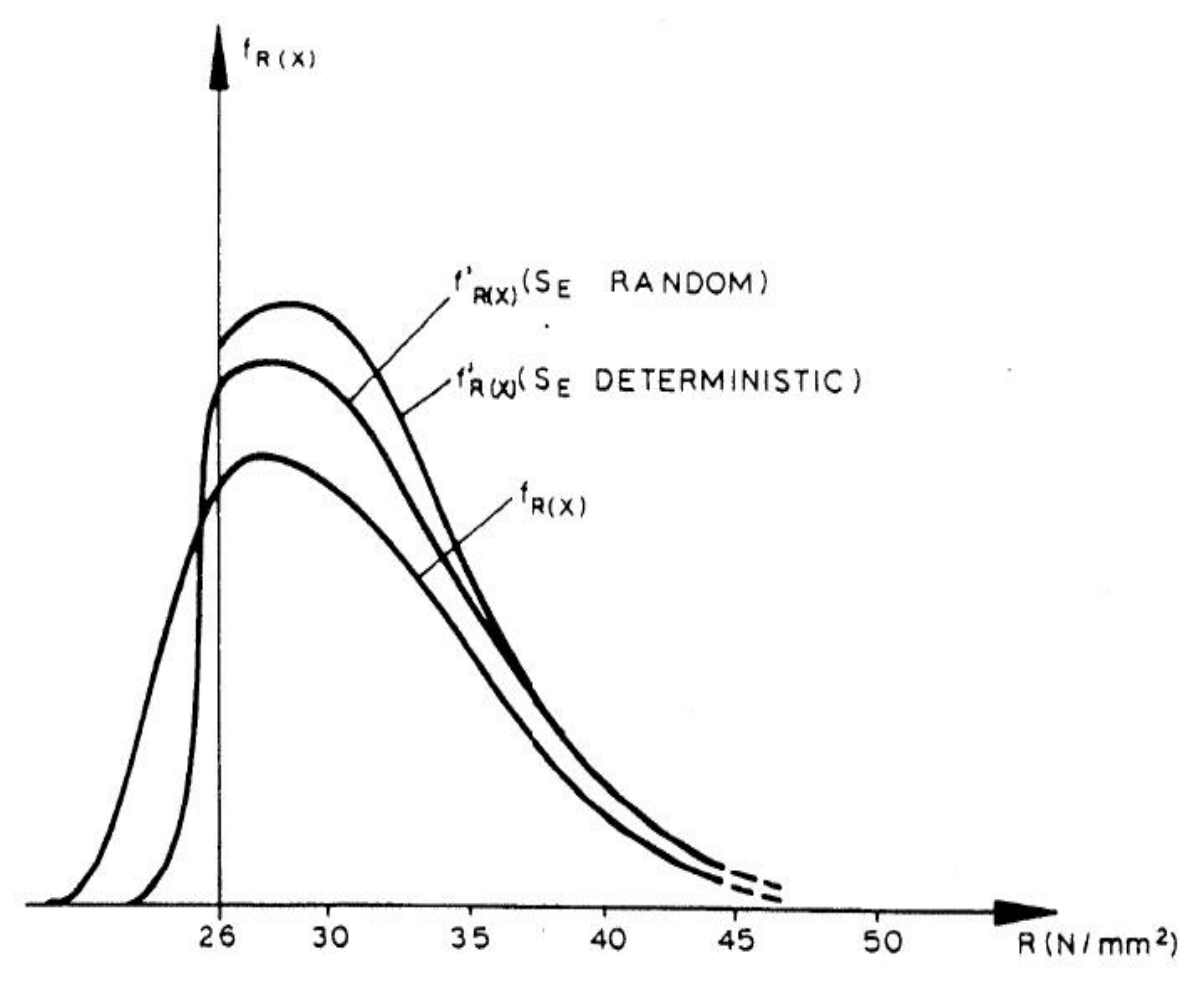
New Information (Updating)

A) Proof loading

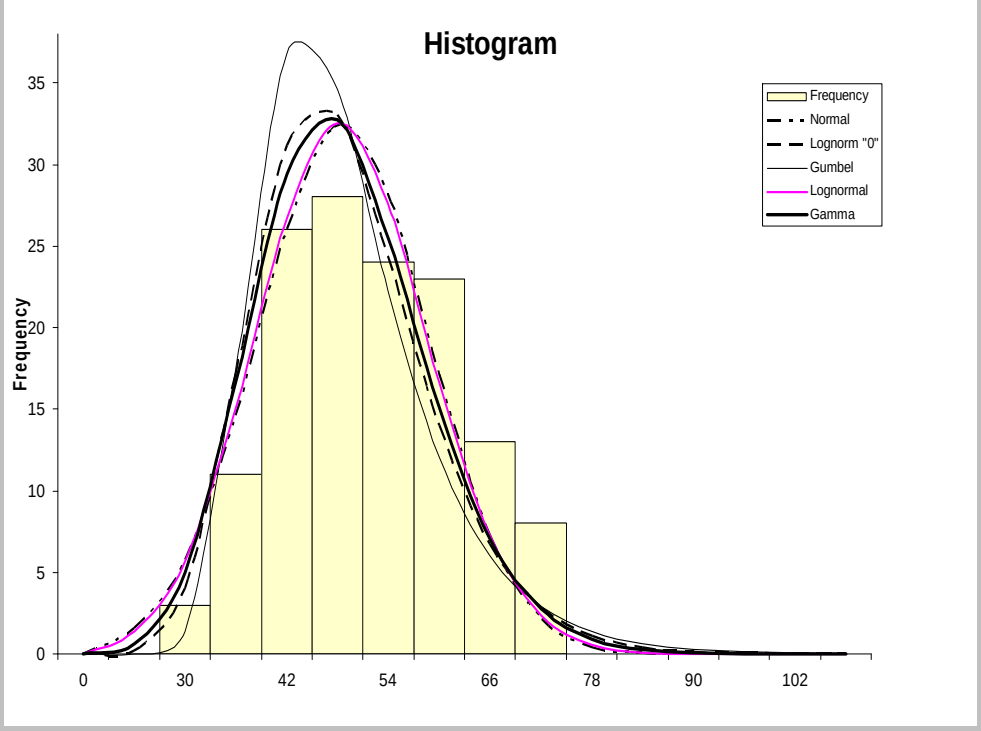
B) Variables (concrete strength)

A) Example: Proof Loading (Survival of a load)

> Updating of resistance



B) Example: Concrete strength data



JCSS Recommendations for Existing Structures

- **Preface**
- **Part 1: General (Guidelines, Codification)**
- **Part 2: Reliability Updating**
- **Part 3: Acceptability Criteria**
- **Part 4: Examples and case studies**
- **Annex:Reliability Analysis Principles**

Safety Acceptance Criteria

- **European Experience (limit state verification)**
- **New practice in the US (performance based design)**
- **Optimisation based on LQI**
- **Judgement**

Methodology

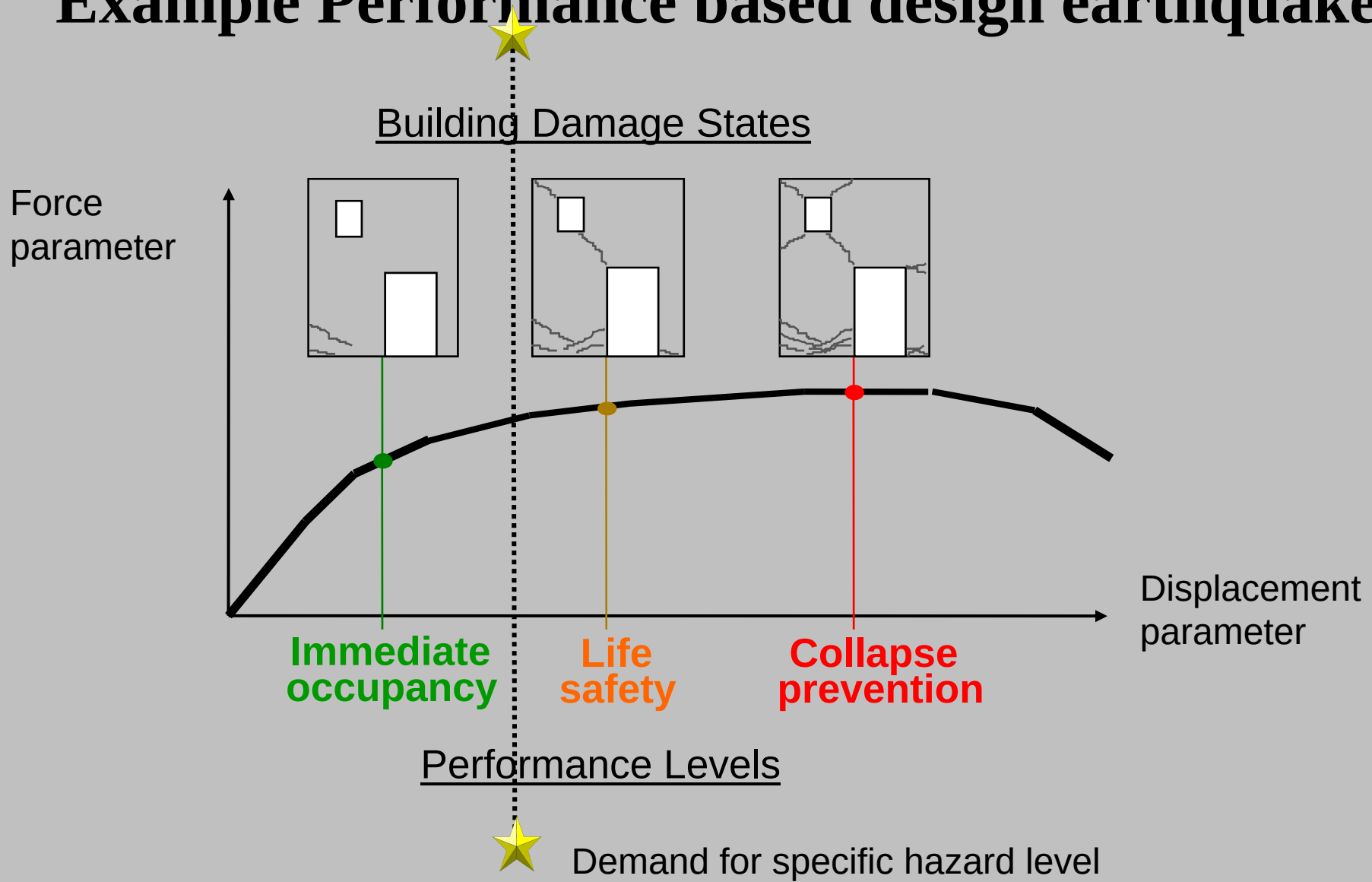
Prescriptive rules

(limit state verification by use of safety factors)

Performance based design

(global check)

Example Performance based design earthquake



PBD criteria

$$p_E \cdot p_{NP|E} < p_A$$

p_E : propability of event

$p_{NP|E}$: conditional probability of no performance given event

p_A : acceptable probability

PBD criteria (new structure)

$$p_E \cdot p_{NP|E} < p_A$$

p_E : 2% in 50 years

$p_{NP|E}$: 10%

p_A : 4×10^{-5} per year

PBD criteria (old structure)

$$p_E \cdot p_{NP|E} < p_A$$

p_E : 4% in 50 years

$p_{NP|E}$: 25%

p_A : 2×10^{-4} per year (5 times larger)

Conclusions regarding targets

- **A lower safety level compared to a new structure is acceptable**
- **Various criteria have been proposed**
- **Acceptance criteria depend on cost of safety, consequences of failure, desired residual lifetime**
- **An increase of acceptable p_F by a factor of 2 to 10 is recommended**