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Lecture 03



Keynote Lecture - IABSE Conference - Budapest 2006


**STRUCTURAL DESIGN CODES:
THE BRIDGE BETWEEN RESEARCH AND PRACTICE**

by: Prof. Dr. Ing. Ted Galambos

**STRUCTURAL DESIGN CODES:
THE BRIDGE BETWEEN
RESEARCH AND PRACTICE**

Ted Galambos
University of Minnesota, USA
IABSE Symposium

“Responding to tomorrow’s
challenges in structural
engineering”




Keynote Lecture
Theodore V.
Galambos



IABSE 2006
Annual Meetings and Symposium
Budapest, Hungary

THE STORY OF MY LIFE



• **AISC**

• **AISI**

• **AASHTO**

• **SJI**

• **ASCE7**

• **ASCE8**

• **AASHTO**

• **CE**

**FORTY YEARS!
HOW AWFUL!**

*For those of you who don't know Mr. Ing. Galambos
he's our institutional memory.*

Cartoon from New Yorker Magazine

THEME OF THIS PRESENTATION

- How academic research has affected the evolution of structural design standards in the past 50 years in North America
- Future trends of research to lead to new paradigms in the next generation of design codes

EVOLUTION OF SPECIFICATIONS IN USA

- Experience and judgment of individual builders →
- “In-house” standards →
- Codes of professional and industrial associations →
- Formalized legal codes

CURRENT STANDARDS MAINTENANCE PROCESS

- Example: American Institute of Steel Construction
- Committee on specification originates changes and maintains content
- Strict rules on consensus
- Strict distribution of membership:
- 1/3 producers, 1/3 users, 1/3 researchers

CURRENT STANDARDS MAINTENANCE PROCESS

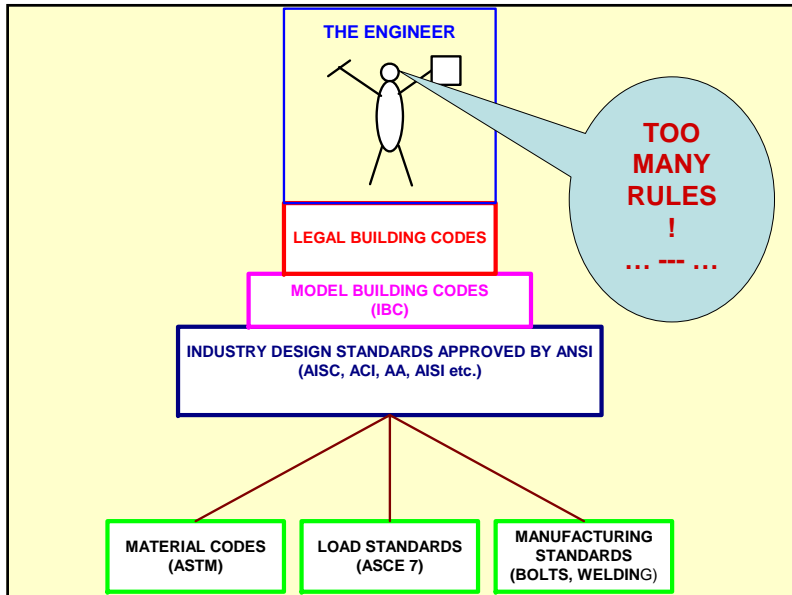
- Strict rules on language
- “Codespeak”
- Never use the word “**may**”, always use “**shall**”
- “...may be equal to...”
NONONONONO!!!!
- Replace by “...shall be permitted to equal...”
- Result: awkward language

VERBOTEN!
TILOS!

CURRENT STANDARDS MAINTENANCE PROCESS

- Committee on specification prepares draft
- Public review of draft
- Resolution of negatives
- Submission to and approval by American National Standards Association (ANSI)
- Adoption by “model codes” (IBC)
- Adoption as legal building code by governments

RESEARCH



HISTORY OF AISC SPEC.

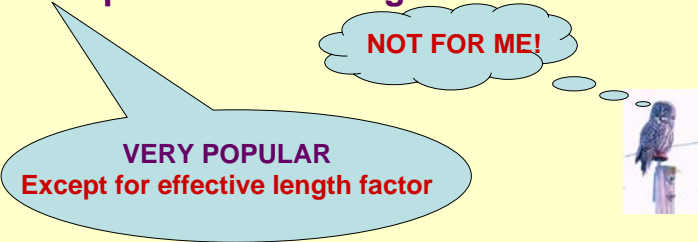
- 1st edition 1923 → experience of past successful design, Allowable Stress Design (ASD)
- Major revisions → significant inputs from research
- 1963: Limit States Design (LSD) **disguised as ASD**
- 1986: LSD (Load and Resistance Factor Design, LRFD)
- 2005: LSD **served up as LRFD or ASD**

RESEARCH AT LEHIGH FOR 1963 AISC SPEC.

- Sponsorship by AISC, (Higgins)
- Late 1940s: visit to Cambridge by Beedle
- 1950s: Work on many aspects of Plastic Design
- Thurlimann at Brown U., Ketter at Cambridge U.
- Translation of DIN 4114 Stability
- 1956 Plastic Design Conference

RESEARCH AT LEHIGH FOR 1963 AISC SPEC.

- Researchers desired full LSD standard, with multiple load factors
- AISC Specification committee approved **ASD plus Plastic Design**



THE 1986 LRFD SPECIFICATION

- Sponsors: AISI, AISC
- Parallel research: Load Factor research at National Bureau of Standards (NBS), sponsored by National Science Foundation (NSF), NBS
- Probability-based load and resistance factors
- Researchers and professors loved it
- Practitioners despised it

THE 2005 SPECIFICATION

- Based on LSD
- Designer can choose between LRFD and ASD ← GOOD or BAD?
- New: Direct Analysis Method for steel frames
- Revolutionary (for AISC):
- Performance-Based Design for design against fire

AISC DEFINITION OF PERFORMANCE-BASED DESIGN

- *“An engineering approach to structural design that is based on agreed-upon performance goals and objectives, engineering analysis and quantitative assessment of alternatives against those design goals and objectives using accepted engineering tools, methodologies and performance criteria.”*

AISC DEFINITION OF PRESCRIPTIVE DESIGN



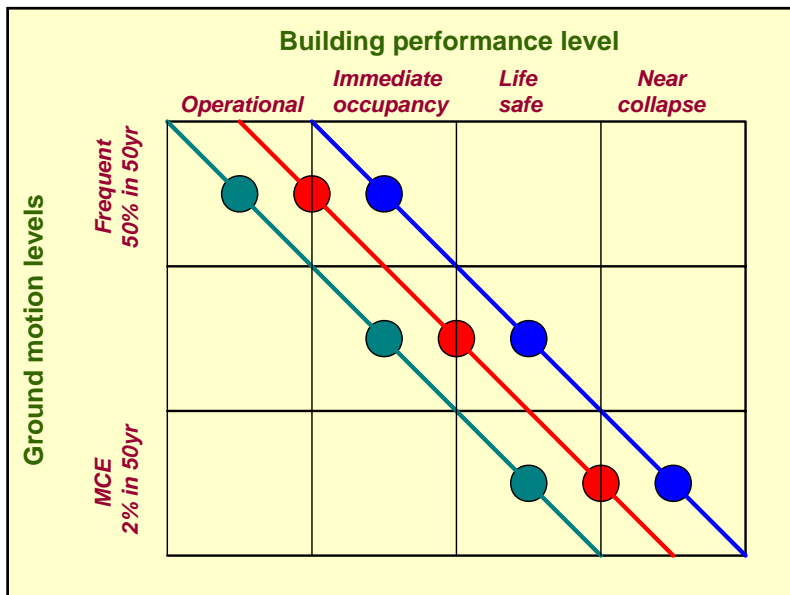
- *“A design method that documents compliance with general criteria established in a building code.”*

AISC PERFORMANCE OBJECTIVE

- “Structural components, members and building frame systems shall be designed so as to maintain their load-bearing function during the design-basis fire and to satisfy other performance requirements specified for the building occupancy.”

PERFORMANCE-BASED DESIGN IN EARTHQUAKE ENGINEERING

- EXAMPLE:
- “Recommended Seismic Design Criteria For New Steel Moment-Frame Buildings.”
- FEMA 350, July 2000

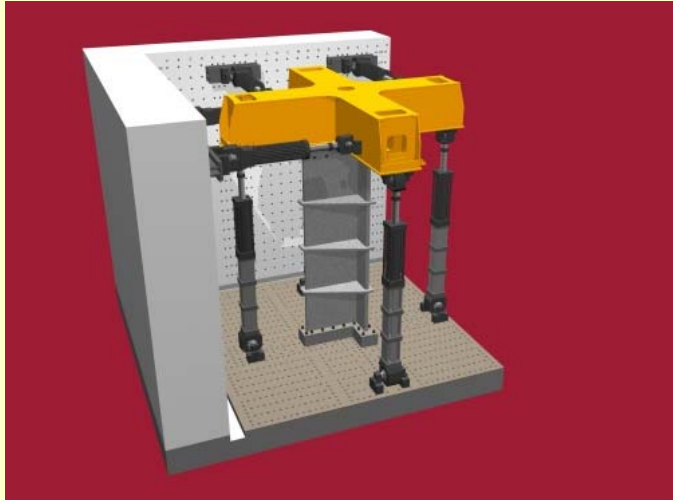


POST EARTHQUAKE STRUCTURAL PERFORMANCE LEVEL DEFINITIONS

- Collapse Prevention:
- Structure is on the verge of partial or total collapse. Must carry gravity load demands.
- Immediate Occupancy:
- Only limited structural damage has occurred.

WHAT NEXT FOR THE RESEARCHERS?

- Are we still needed, or must we fade into the nano-nirvana?
- No, No, Never
- The human, intellectual and physical infrastructure for structural engineering research has never been more robust



THE FUTURE OF STRUCTURAL ENGINEERING RESEARCH

- Maintain, update, improve current standards
- Codes for new materials, new applications, new systems
- Standards for recycling, redesign, reuse, retrofit, rehabilitation, etc.
- **We must not continue the custom of discarding and building new structures!**

NEW PARADIGMS

- “Sustainability” of resources
- “Green” construction
- Rapid reaction to natural and man-made catastrophes
- “Rational” design against future catastrophes. No pyramids!
- There is plenty of work here for standardization

NEW METHODS OF APPROACH

- “Real” and “virtual” experiments to develop new standards
- Rapid dissemination of research results to those who need it in the design office
- Testing, analysis, synthesis by teams whose members are in different sites
- **Close the chasm between academia and the design office!**

THE **BIG** ASSIGNMENTS

- How to formulate design codes for Performance-Based Design?
- How to energize intellectual knowledge (reliability, fuzzy logic, systems science, sociology, psychology, etc.) for better structural engineering?
- **The answers: Pay attention in the next three days!!!!**

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