Thursday 23rd & Friday 24th April 2009 CIB W14 Commission Meeting - Lund, Sweden



NIST Recommendations & Continuing WTC Health Studies A Delayed Evolution in Fire Engineering ?

www.fireox-international.eu/fire/structdesfire.htm





WTC Complex, New York

11 September 2001

Catastrophic Failure in All Practices & Procedures ...

- Architectural / Conventional ('Ambient') Engineering / Fire Engineering ;
- Building Management ;
- Emergency Responders / Firefighters / Rescue Teams ;
- Control Organizations Having Authority (AHJ's) or Jurisdiction ;
- Fire Safety Objectives in Building Legislation, Codes & Standards.



Fire Engineering After 9-11

 NIST(USA) 2005 Final Report on 9-11 WTC 1 & 2 Tower Collapses Introduced a New Benchmark for International Fire Engineering ... 30 Important Recommendations (1-30) contained in Chapter 9

3R's - 'Reality' - 'Reliability' - 'Redundancy' **Evacuation Way Finding** - 'Intuitive & Obvious'

NIST(USA) 2008 Final Report on 9-11 WTC 7 Collapse Confirmed this New Benchmark ...

> 12 Recommendations (A, C-M) reinforce earlier 2005 Recommendations and 1 New Important Recommendation (B) contained in Chapter 5

Structural Fire Engineering

 NYC-ATSDR World Trade Center Health Registry (est. 2002)
 Long-Term Monitoring of Health Status ... People directly exposed to the WTC 9-11 Incident ... Regular Reporting ... 20 Years ...





Building Evacuees Requiring Assistance / All Building Types, excluding Health Facilities

Buildings Must Remain Serviceable =

- While people are waiting in 'Areas of Rescue Assistance' ;
- Until all of these people can be rescued by Firefighters and can reach a 'Place of Safety'. (with an assurance of individual health, safety & welfare)



World Trade Center Complex, New York - Tuesday Morning, 11 September 2001 (9-11)

Staircases too steep & too narrow; Steps have projecting nosings; Handrails on only one side / not continuous; Assisted Evacuation not possible; Contraflow of firefighters not possible; Evacuation Routes disjointed; Lift/Elevator Use not permitted; Building Design not suitable for fire evacuation, etc., etc.

'Reality' of Fire Evacuation Must Apply 'Accessibility-for-All' Design Criteria !



'Reliability' of Fire Protection

Coherent Fire Engineering Design, Competent Installation & Servicing, Informed Management



Will a Fire Protection Measure Perform, as Expected, during a 'Real' Fire Incident? ... at Any Time in the Building's Life Cycle ??



'Redundancy' of Structure & Systems

'Lean Construction' is an outdated 'Green' Concept - Not a Concept related to 'Sustainability' !



Empire State Building (NY), 79th Floor

After B-25 Plane Crash, 28 July 1945



Fire-Induced Progressive Collapse

The sequential growth and intensification of distortion, displacement and failure of elements of construction in a building - during a fire and the 'cooling phase' afterwards - which, if unchecked, will result in disproportionate damage, and may lead to total building collapse.

Progressive Collapse can commence before any breach occurs in the 'integrity' of a **Fire Compartment** (?) ... **Sustainable Design** (!)

[Building Types: High-Rise + Iconic + Critical Function + Innovative Design]

Disproportionate Damage

The failure of a building's structural system ... (i) remote from the scene of an isolated overloading action ; and (ii) to an extent which is not in reasonable proportion to that action.



Structural Reliability

[ISO 2394 : 1986 + Addendum 1 : 1988]

The ability of a structural system to fulfil its design purpose, for a specified time, under the actual environmental conditions encountered in a building.

In structural design for fire, the concern must be that the structure will fulfil its purpose, both during the fire - and for a minimum period afterwards, during the 'cooling phase'.

Limit State Design ... (Ultimate Limit State &) Fire Serviceability Limit States

Structural Fire Engineering

Those aspects of fire engineering concerned with structural design for fire, and the complex architectural interaction between a building's structure and fabric, i.e. non-structure, under conditions of fire and its aftermath.



Safer Structural Forms for Tall Buildings



www.fireox-international.eu

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m C}$ Sustainable Design International Ltd. 1995-2009

Fire Resistance

The inherent capability of a building assembly, or an 'element of construction', to resist the passage of heat, smoke and flame for a specified time during a fire.

Footnotes:

- (i) ... a simple, easy-to-understand, generic language which clearly explains the concept ;
 - (ii) ... one term one concept.



NIST 2005 Final Report on 9-11 WTC 1 & 2 Tower Collapses

Footnote 26 states that a Maximum Credible Fire Scenario includes conditions which are severe, but reasonable to anticipate ... related to building construction, occupancy, fire loads, ignition sources, compartment geometry, fire control methods ... and adverse, but reasonable to anticipate, operating conditions.

Maximum Credible User Scenario

Represents user conditions which are also severe but reasonable to anticipate ...

- The Number of People Using a Building increases, on occasions which cannot be specified, to 120% of calculated maximum building capacity; and
- 10% of People Using the Building (occupants, visitors & other users) have an Impairment (visual or hearing, physical function, mental or cognitive, psychological, with some impairments not being identifiable).

[On 9-11 ... Approximately 8% of WTC building occupants were 'people with disabilities'.] [2005 U.S. Census Figures on 'Disability' ... 'people with activity limitations'.]







Accessible Routes to 'Places of Safety' ?





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Building Users / Fire Incident / No Explosion Hazard *

Place of Safety:

Any location beyond a perimeter which is [100] metres from the fire building or a distance of [10] times the height of such building, whichever is the greater and

where necessary and effective medical care and attention can be provided, or organized, within one hour of injury

and

where people can be identified.

* Where there is a Risk of Explosion ... multiply the numbers in square brackets above by 4 !



- Visuo-Spatial Learning ?
- Proprioception ?
- Cognitive Psychology ?
- Intuitive & Obvious' Design ?

Firefighter Safety ?
 e.g. disorientation



Building Design for Evacuation ?





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Design Professional in Responsible Charge

Following the WTC 9-11 Incident, fire engineering and conventional ('ambient') structural engineering must be seamlessly integrated.

NIST WTC 1 & 2 Final Report - Recommendation 28 NIST recommends that the role of **Design Professional in Responsible Charge** be clarified.

Footnote 49 states that the **Design Professional in Responsible Charge** ensures that All Members of the Building Design Team use consistent design data and assumptions, co-ordinates overlapping specifications, and serves as the liaison between all parties involved in the project, including enforcement and review officials, and the client or client organization.

The Fire Engineer as an Effective Member of Design & Construction Teams ?

Fire Engineers - Design & Construction Competence ?



Fire Engineering & Ethics ?

Good Fire Engineering Practice involves much more than 'cost-effective' compliance with the minimum performance criteria established in Building Codes & Regulations.

Issues such as ...

- Sufficient Care and Attention to vulnerable building users in 'situations of risk' -Article 11 of 2006 UN Disability Rights Convention ;
- Resistance to Fire-Induced Progressive Collapse & Disproportionate Damage ;
- Safety of Firefighters / Rescue Teams ;
- Adequate Protection of Property & the Natural Environment ;
- Sustainable Human & Social Development ;

... should be referenced in a Fire Engineering Code of Ethics ... using as a basis ...

World Federation of Engineering Organizations (WFEO) 2001 Model Code of Ethics



Proposal for CIB W14

Publication / CIB Report / Collaborative Essay(s) ...

 Mapping the Path Forward A Pre-Normative Response to the Recommendations of NIST NCSTAR 1(2005) & 1A(2008)
 & Continuing WTC Health Monitoring Studies '

... Multi-Disciplinary Group

