CIB W14 : Fire
Pre-Normative Innovation & Research Project 2010-2013

Working Group IV:
Structural Reliability & Fire-Induced Progressive Collapse

Group Leader: C.J. Walsh (FireOx International - Ireland)
Group Members: J. Kruppa (CTICM - France), with additional members to be named from the following organizations: NIST-USA*, NRC-Canada*, TFRI-China*.

Everyone is welcome to join the Working Group, and a very necessary trans-disciplinary approach will be encouraged and fostered.
S.I. Units of Measure will be used throughout.

1. Introduction

The unacceptably long delay in incorporating the **Recommendations** of the **2005 & 2008 NIST Reports on the WTC 9-11 Building Collapses (WTC 1, 2 & 7)** into building and fire codes/regulations, standards and administrative provisions at international, global regional and national levels ... can partly be explained by institutional inertia and by the resistance of vested interests in the Construction Sector. To be fair, however, although both NIST Reports made extensive reference to 'Fire-Induced Progressive Collapse' ... the structural concept was not well defined or elaborated in either document. This was not a task for NIST.

It should be of major concern to the International Fire Research Community that **Building Designers** continue to work, since 12th September 2001 (the day after 9-11), in a vacuum ... without adequate practical design and construction guidance.

2. Project Priority

To define and elaborate the structural concept of 'Fire-Induced Progressive Collapse' ... along with practical principles and general guidance ... for application in new building design and the revision of codes/regulations and standards. The following building types are a priority:

- **High-Rise Buildings** ;
- **Iconic Buildings** ;
- **Buildings of Innovative Design** ;
- **Buildings having a Critical Function**.

And further ... is there a rational reason why such an approach should not be applied in the case of all new buildings ?

3. Project Scope & Concerns

Further to our discussions at the CIB W14 Meeting in Lund (Sweden), on 23rd April 2009, the following definitions are presented:

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.

[Note - Progressive Collapse can commence before any breach occurs in the 'integrity' of a Fire Compartment. That is, if the building is even designed to be compartmented ... refer to Sustainable Buildings !]

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 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.

Within the mainstream context of 'Structural Reliability' ... can the concepts of 'Fire-Induced Progressive Collapse' and 'Fire Serviceability Limit States' be elaborated in a language which is readily assimilated by Architects, (Ambient) Structural Engineers and Fire Engineers ? How are these concepts related to and distinguishable from 'Disproportionate Damage' ? What about 'Structural Robustness' ? And, what are the implications flowing from the answers to those questions ?

Is it possible to assess/appraise/evaluate the likely resistance performance of existing buildings, particularly post 1960-70's non-robust buildings, to 'Fire-Induced Progressive Collapse' in a 'real' fire incident ? If found to be necessary, can anything be done by way of retrofit works to improve this performance ... rather than de-construct and re-build ? Is there a reasonable chance that retrofit works will be effective ... and cost-efficient (in that order) ?

4. Proposed Project Timescale

	WG IV Tasks	2010	2011	2012	2013
1	Finalize WG & Project Description. Draft **Initial Discussion Document** (for circulation in June 2010)	X			
2a	**Literature Review** - Structural Fire Engineering Concepts in #3 above (to be completed before 2011 CIB W14 Meeting)		X		
2b	Hold **1-Day Workshop** prior to 2011 CIB W14 Meeting		X		
2c	Disseminate Discussion Document & Workshop Proceedings - Involve wider fire research, testing, academic and practice communities		X		
3	**Research, Testing & Academic Programme** (to start late 2011)		X	X	X
4	**Final Report** (final draft for circulation late 2013)				X

5. Some Relevant Background ...

WTC Complex in New York - 11th September 2001

5.1 As organizer for the **Dublin International Fire Conference: Fire, Access & Safety in Residential Buildings** in **1987**, I requested that the following Paper be presented ...

> **'Design against Progressive Collapse in Fire'** by Dr. W. Crowe.
> [Link: http://www.fireox-international.eu/fire/dublinfire.htm]

I also contributed to the drafting of the Paper.

5.2 During the late 1980's and early 1990's, working as Research & Technical Officer in the Building Control Section of Dublin City, I was responsible for that local authority's operation of the **1988 Local Government (Multi-Storey Buildings) Act**, which resulted from the total collapse of the multi-storey apartment block 'Raglan House', in January 1987, due to a gas explosion.

5.3 For approximately 12 years from the mid-1980's, I was a Member of the National Masonry Panel - the National Standards Authority of Ireland (NSAI) Masonry Standards Advisory Committee. A substantial text on Fire-Induced Progressive Collapse in Buildings was included, by me, in the following standard ...

> **Irish Standard 325: Code of Practice for Use in Masonry - Part 2: Masonry Construction. 1995.**
> Appendix A - Determination of movement in masonry
> A.3 - Thermal movement

5.4 Since the time that I visited the scene of the 9-11 Incident in mid-October 2001, **FireOx International** (the Fire Engineering Division of Sustainable Design International) has kept the following Page on our WebSite under continuous review and development ...

> **World Trade Center Incident (9-11) & Fire Serviceability Limit States**
> [Link: http://www.fireox-international.eu/fire/structdesfire.htm]