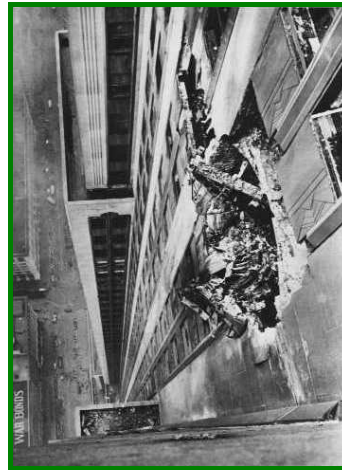


Thursday, 8<sup>th</sup> February 2007 ~ Le Royal Meridien Chennai

## Fire & Safety Association of India (FSAI) National Seminar



Empire State Building, 79th Floor, New York City

Scene After B-25 Plane Crash, 1945-07-28 T 09:40

### 'Green' Buildings

Everything You Always Wanted To Know About  
Sustainable Fire Engineering ... But Were Afraid To Ask



# SDI WebSite Navigation & Content

 <p><a href="http://www.sustainable-fireengineering.com">www.sustainable-fireengineering.com</a> [homepage]</p>	 <p><a href="http://www.fireox-international.eu">www.fireox-international.eu</a> Fire Engineering Division</p>	 <p><a href="http://www.sustainable-design.ie/sustain">www.sustainable-design.ie/sustain</a> [sustainability]</p>
<p>For the purpose of WebSite Location Authentication, <a href="http://www.sustainable-design.ie">www.sustainable-design.ie</a> is the Foundation Domain Name for every part of the SDI WebSite .... '<a href="http://www.sustainable-design.ie">.ie</a>' is the National Domain for Ireland.</p>		
<p>For the purpose of WebSite Content Authentication, we continue to refer to .... COM(2002) 667 final - Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee &amp; the Committee of the Regions <b><a href="#">e-Europe 2002: Quality Criteria for Health-Related WebSites</a></b></p>		



# What is Sustainable Development ?

World Commission on Environment & Development  
1987 Report: 'Our Common Future' - Chapter 2, Paragraph 1

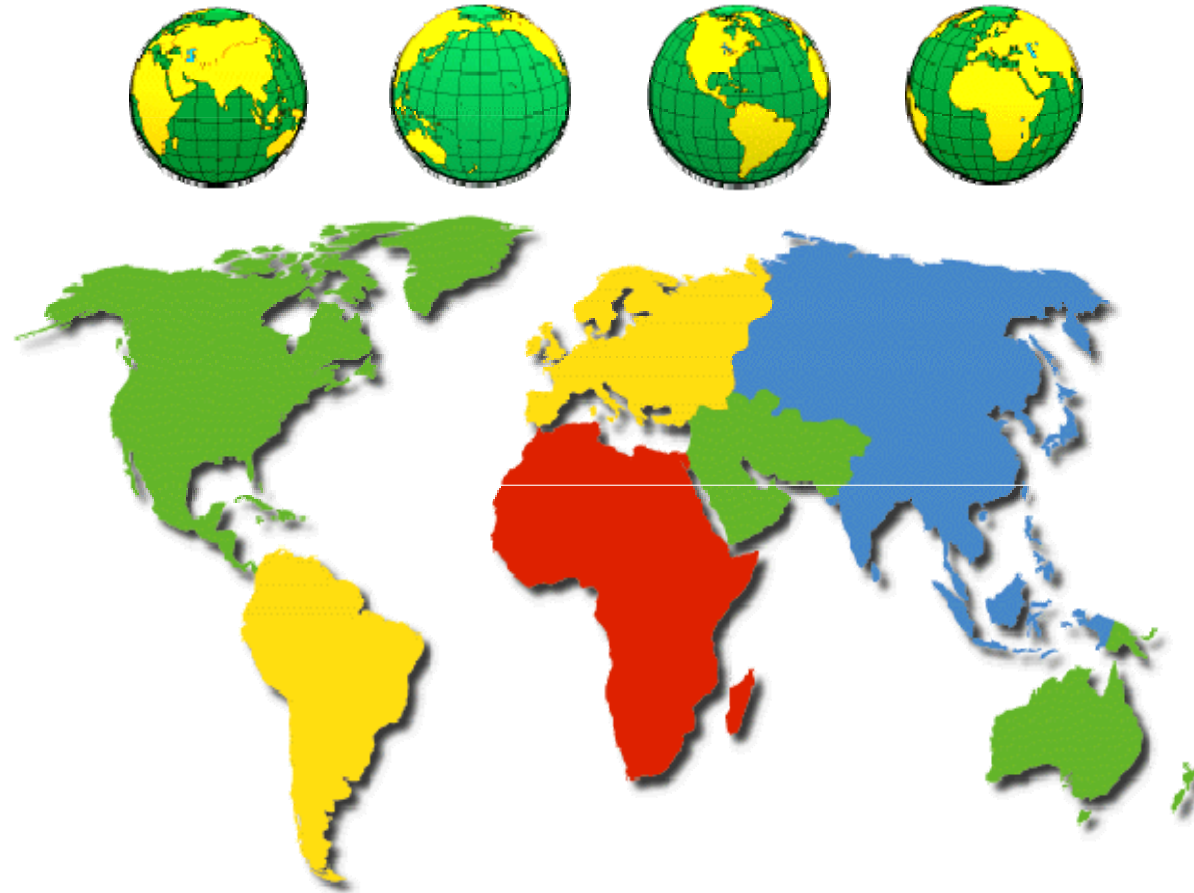
**Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.**

It contains within it two key concepts :

- the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given ; and
- the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.

**1992 UN Rio Declaration on Environment & Development**  
**[1972 UN Stockholm Declaration on the Human Environment]**





[www.sustainable-design.ie/sustain/actionprogramme.htm](http://www.sustainable-design.ie/sustain/actionprogramme.htm)



# **Sustainable Human & Social Development**

Sustainable Design International

2004 Rio de Janeiro Declaration on Sustainable Social Development, Disability & Ageing

**Development which meets the responsible needs, i.e. the Human & Social Rights\*, of this generation - without stealing the life and living resources from future generations, especially our children .... and their children.**

**\*As defined in the 1948 Universal Declaration of Human Rights**

[download at [www.sustainable-design.ie/links/index.htm#udhr](http://www.sustainable-design.ie/links/index.htm#udhr)]

Our Ultimate Goal must be to achieve a dynamic and harmonious balance between a sustainable 'human' environment and a flourishing, not just a surviving, 'natural' environment .... with the Overall Aim of attaining Social Wellbeing-for-All.

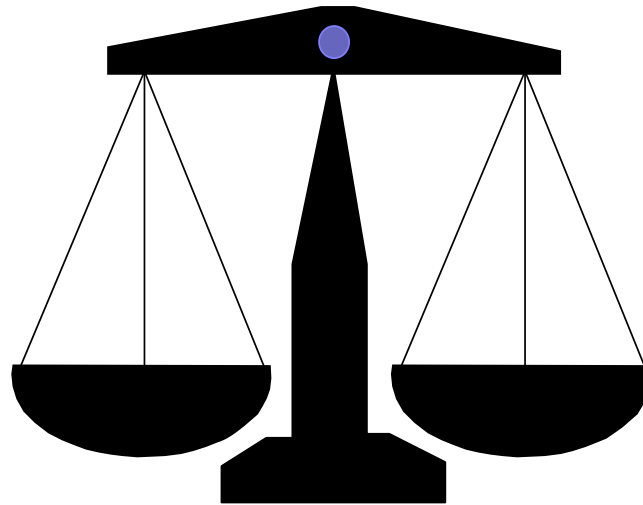
## **Sustainable Design**

**The ethical design response, in built form, to the concept of Sustainable Human & Social Development**



# Sustainable Human & Social Development

**Different Aspects:** 'Social' + 'Environmental' + 'Institutional' +  
'Economic' (UN) + 'Political' + 'Legal' (EU) + 'Judicial' ....  
in a context of 'Lasting Peace' & 'International Law'.



**Balanced & Equitable Implementation is Fundamental !**




## 'SEED'\* Domestic Building Package

\* **S**ustainable, **E**nvironment-friendly, **E**nergy-efficient, **D**evelopment (SDI, 1995)

**Sustainable Design Solutions** are appropriate to local geography, social need, climate, economy and culture .... and are 'person-centred' and 'reliability-based'.

Commercial, Practical & Affordable Implementation (Non-Research)

minimum life cycle of 100 years		'fit for intended use'
electronically mature (incorporating remote access to building management system, with fire & security)		super insulated
		super energy-efficient
domestic sprinkler system		
renewable energy & heat and recycling technologies		
high indoor air quality (including protection from radon)		
'flexible' - 'adaptable' - 'accessible' (for people with activity limitations)		
set in sustainable landscaping - relationship between interior and exterior spaces		

Competently Built, Reliably Completed to Project Programme & Cost Estimate

**'Real' Performance-in-Use Tested**



# 11 Times Square, New York City : 2009

**Eleven Times Square** will be an extraordinary, environmentally responsible modern office building befitting its marquee location at 8<sup>th</sup> Avenue and 42<sup>nd</sup> Street. The design features a sculptural composition of forms sheathed in combinations of sheer glass curtain wall and unique silk-glass spandrel panels. The most dramatic of these forms is an outwardly sloped glass-clad crystal, crowned with a chiselled profile. Private roof terraces with glass windscreens will be included on several of the building setbacks. Exterior sunshades will animate the portions of the southern and western facades while improving thermal comfort and reducing glare and helping this green building achieve **LEED Certification** from the **U.S. Green Building Council**. The Class A corporate tenant space will rise from the 3<sup>rd</sup> floor to the 38<sup>th</sup>. A major retail component will occupy the lower floors. The building entrance is marked by the expressed truss vaulting over monumentally-scaled all-glass walls, promoting a sense of light and grandeur within the lobby.

**FXFOWLE Architecture, Planning & Interior Design**

## Sustainable Design Guidelines for Commercial Development : 2001

The Sustainable Design Guidelines for Commercial Development provide both required and suggested strategies for increasing the **environmental sustainability** of future development. To attempt to **increase energy-efficiency by 40%**, the guidelines require new commercial construction to integrate **photovoltaic panels** and use **fuel cell power**. To conserve water, the guidelines call for structures to **reduce overall water use by 20%**, by requiring all building setbacks to **collect** re-usable **rainwater** and to use reclaimed water for non-potable purposes.





## South-South Fire Engineering Challenges

- ◆ **'Low-Cost' Sustainable Housing**
  - **Severe Shortages of Building Materials in Developing Parts of the World ....**  
Large-scale local production, from local resources, of products improving environmental protection, energy conservation, and employment generation in low-income settlements.
- ◆ **'High-Tech' Sustainable Buildings**
  - **LEED-India & CII Green Business Centre (also China, Mexico, Brazil, UAE) ....**
  - **2006 Indian Energy Conservation Building Code ....**
  - **Innovative, High Performance Building Products & Systems (Imported ?) ....**  
Innovative fire engineering strategies / systems ? Flexibility of fire codes & standards ?
- ◆ **UN Convention on the Rights of Persons with Disabilities (2006)**
  - **Article 11:** "States Parties shall take .... all necessary measures to ensure the protection and safety of persons with disabilities in situations of risk, .... "
- ◆ **UNFCCC Kyoto II Protocol & Other International Instruments**
  - **WMO-UNEP Intergovernmental Panel on Climate Change ....**  
Will the fire engineering community become proactive .... or wait, and be pushed ?



[India NBC 2005 : Part 4 / Page 8 'fire-resistive' ?!]

## 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.**

Particularly in Sustainable Building Design, fire resistance must not only be extended to consider a **complementary relationship with 'active' fire protection measures**, but be stretched to embrace the concept of **'non-construction' ....**

## Building Sterile Space (Fire)

**An open space of sufficient and appropriate extent which is designed to retain an exceptionally low level of fire hazard and risk, and is 'intelligently' fitted with a suitable fire suppression system - in order to resist and control, for a specified time during a fire, the advance of heat, smoke and flame.**





World Trade Center Complex, New York

Tuesday Morning, 11<sup>th</sup> September, 2001

## Catastrophic Failure in Common Practices & Procedures ....

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



**USA NIST NCSTAR 1 - September 2005**

Federal Building & Fire Safety Investigation of the World Trade Center Disaster

**Final Report of the National Construction Safety Team on the  
Collapses of the World Trade Center Towers  
[WTC 1 & WTC 2]**

On 26<sup>th</sup> October 2005 .... Presented to the Committee on Science  
House of Representatives, United States Congress

By William Jeffrey, Director  
National Institute of Standards and Technology (NIST)  
Technology Administration, United States Department of Commerce

**Executive Summary & Chapter 9 - Recommendations**

[Full Report: 10,000 Pages approx.]



**In Our Opinion** .... There is a surprising strength and directness of language in the Recommendations of the NIST Final Report on the WTC 1 & 2 Collapses. And while older minds may still remember the 3 R's of a Good Education, these Recommendations will also be remembered for their 3 R's :

**'Reality' - 'Reliability' - 'Redundancy'**

## **Technical Control**

NIST urges state and local agencies **to rigorously enforce** building codes and standards since such enforcement is critical to ensure the expected level of safety. Unless they are complied with, the best codes and standards cannot protect occupants, emergency responders, or buildings.

[Last Paragraph, Executive Summary, NIST Final Report on WTC 1 & 2 Collapses]



## National, Regional & Local Governmental Authorities

NIST recommends that such entities be encouraged to provide **a level of safety that equals or exceeds** the level of safety that would be provided by **strict compliance** with the code requirements of an appropriate governmental jurisdiction.

To gain broad public confidence .... NIST further recommends that **as-designed and as-built safety** be certified by a qualified third party, independent of the building owner(s). The process should **not use self-approval** for code enforcement in areas including interpretation of code provisions, design approval, product acceptance, certification of the final construction, and post-occupancy inspections over the life of the buildings.

[NIST Final Report on WTC 1 & 2 Collapses - Recommendation 25]



## Design Professional in Responsible Charge

Following the WTC 9-11 Incident in New York, all design disciplines must be seamlessly integrated - and the Fire Engineer must be fully integrated, as an equal member, into Project Design & Construction Teams.

NIST recommends that the role of '**Design Professional in Responsible Charge**' be clarified .... (to ensure the above).

[NIST Final report on WTC 1 & 2 Collapses - Recommendation 28]

NIST 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.







## 'Protecting Health' vs. 'Mitigating Risk to Safety'

**Health:** A state of complete physical, mental and social wellbeing, and not merely the absence of disease and infirmity. (WHO)





## Maximum Credible User Scenario (Fire)

In parallel with the concept of '**Maximum Credible Fire Scenario**' (NIST) .... we strongly advise the introduction of the concept **Maximum Credible User Scenario**, representing 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 and other users) have an **Impairment** (visual or hearing, physical function, mental or cognitive, with some not being or not wanting to be identified).

[On 9-11 in New York - Approximately **8% of WTC Building Occupants** were people with disabilities.]



## Ethical Fire Engineering Practice

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

### Issues such as ....

- Sustainable Human & Social Development ;
- Proper Protection of Property ('Built' Environment) & the 'Natural' Environment ;
- Resistance to Progressive Collapse and Disproportionate Damage ;
- Particular attention being paid to the protection of people with activity limitations from fire - because of their greater difficulties during and after evacuation ;
- Safety of Emergency Responders / Firefighters / Rescue Teams ;

.... should all be incorporated in an effective **Fire Engineering Code of Ethics** ....  
using as a basis ....

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

[download at [www.fireox-international.eu/fire/index.htm#ethics-fire](http://www.fireox-international.eu/fire/index.htm#ethics-fire)]



# Fire Engineering Design Objectives

*" to properly protect society's interests  
and the interests of the client or client organization"*

1. **Protection of the health of all building users**, including people with activity limitations, visitors to the building who may be unfamiliar with its layout, and including contractors or product / service suppliers temporarily engaged in work or other business transactions ;
2. **Protection of property**, including the building, its contents, and adjoining or adjacent properties, from fire loss or damage ;
3. Protection of the safety of emergency responders / firefighters / rescue teams ;
4. **Buildability of necessary re-construction after a fire ;**
5. **Protection of the 'natural' environment from adverse or harmful impacts ;**
6. **Sustainability of the 'built' environment - including the proper selection, and life cycle assessment (ISO 14040) / costing, of fire engineering related materials, products, components, systems, etc., fixed, installed or otherwise incorporated in the building.**



Not Everybody Gets Out



## Buildings Must Remain Structurally Reliable :

- 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' ;
- by robustly resisting 'progressive collapse' & 'disproportionate damage'.





**This is 'Escape' ~ NOT 'Evacuation' !**

[www.evacuation-for-all.eu](http://www.evacuation-for-all.eu)





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

and

where people can be identified.





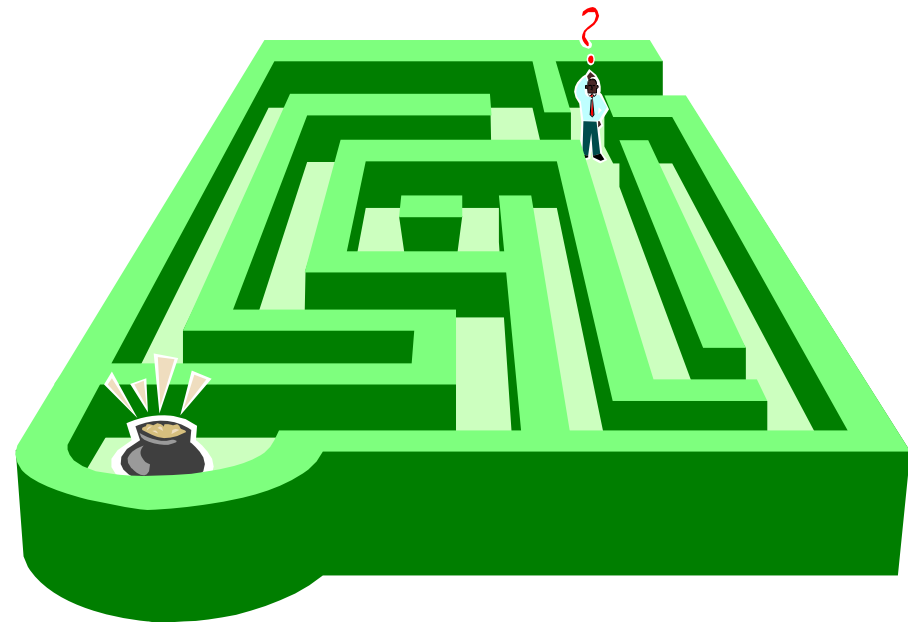
## People Are Different & React Differently to Incidents :

- they must be '**Skilled**' for evacuation to a '**Place of Safety**' ;
- warnings must be timely, informative, and be understandable ;
- **Panic** exists !      **Standard Movement Times** do not exist !!

[NIST Final Report on WTC 1 & 2 Collapses / Footnote 39. NIST found that the average surviving occupant in the WTC Towers descended stairwells at about half the slowest speed previously measured for non-emergency evacuations.]



- ◆ Building 'Understandability' ?
- ◆ Personal Orientation ?
- ◆ Relationship with Exterior ?
- ◆ Clear, Standard Signage ?
- ◆ Use of Elevators/Lifts in Fire ?
- ◆ Use of Escalators/Travelators ?
- ◆ Safe Evacuation Staircases ?



"where is the final exit ?"

## Building Design for Evacuation

[NIST Final Report on WTC 1 & 2 Collapses / Recommendation 18(3). NIST recommends that **evacuation routes** should have consistent layouts, and be 'intuitive and obvious' for all building users, including visitors, during evacuations.]



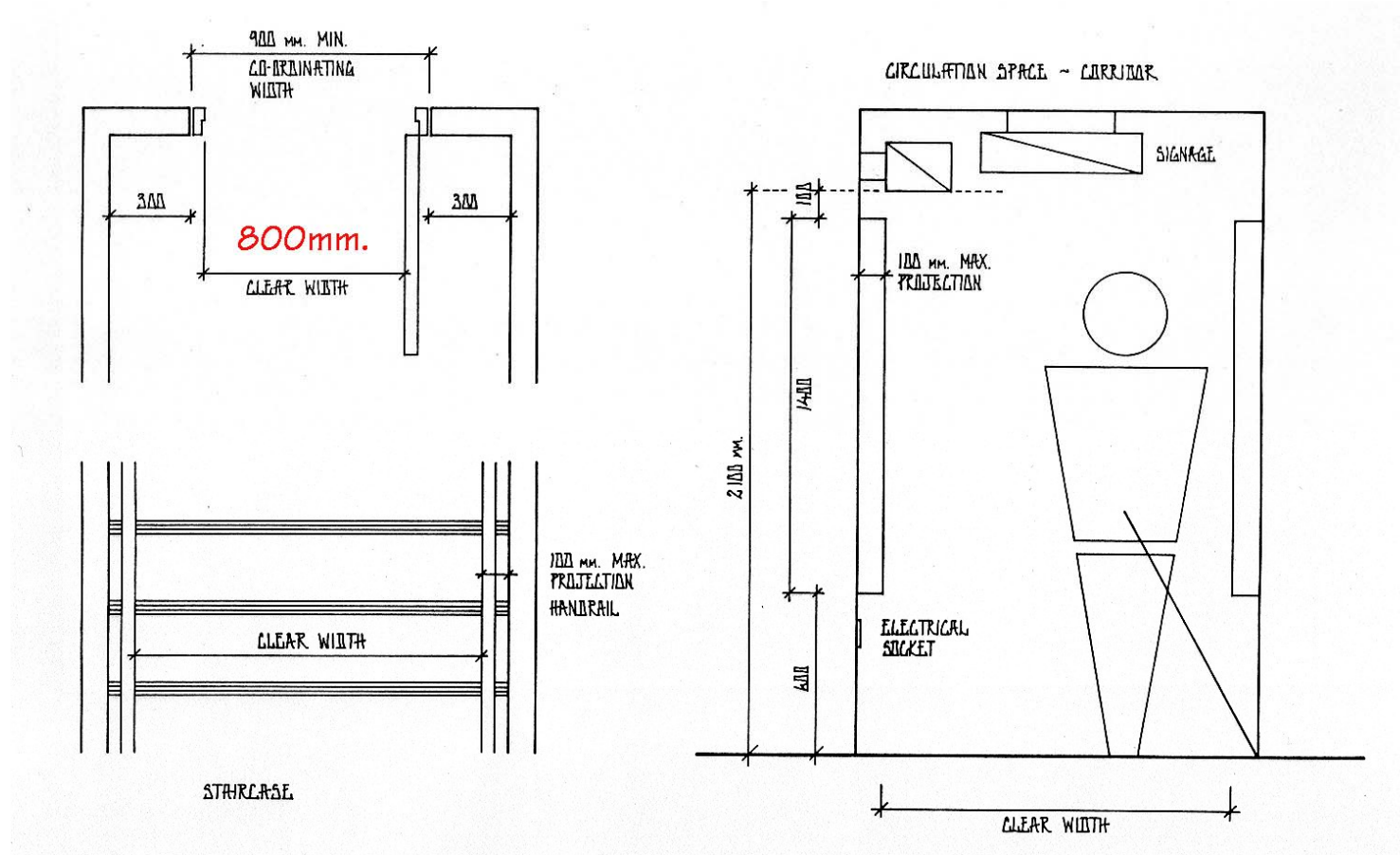




## Evacuation Route Design Must Be Improved :

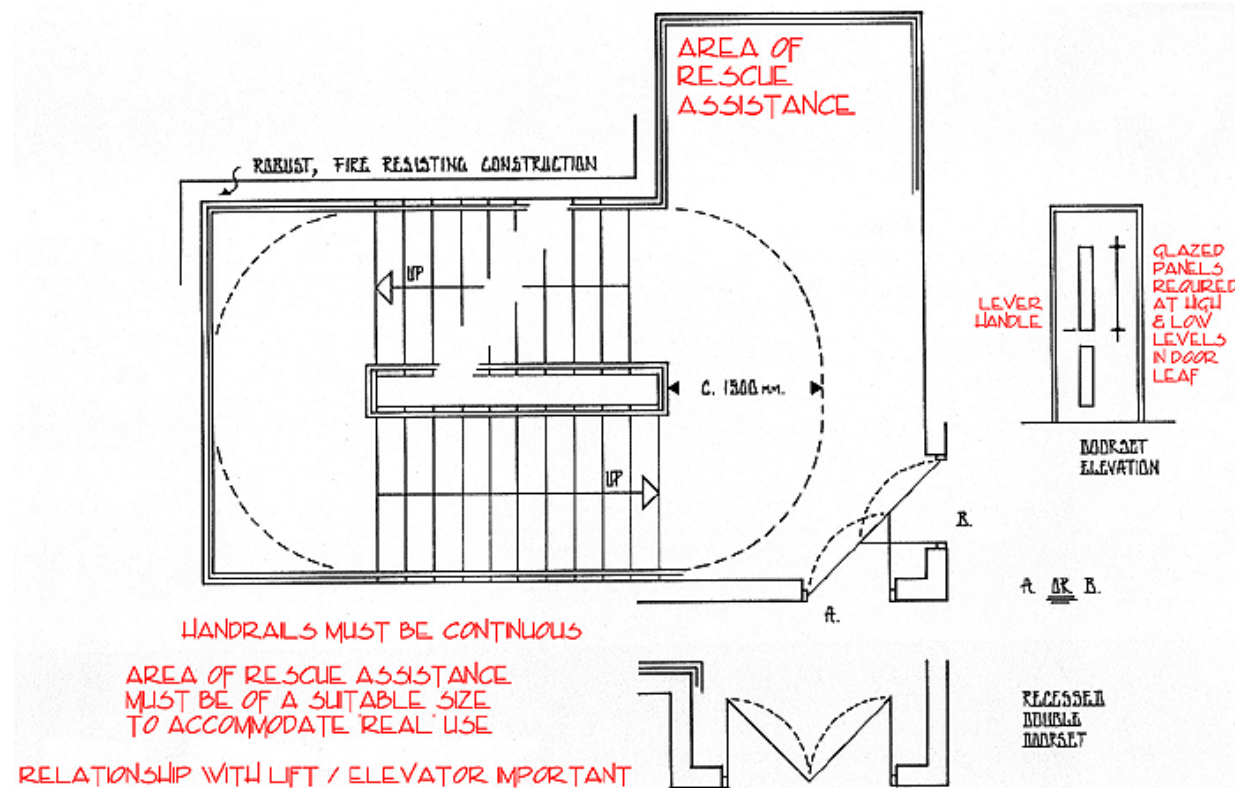
- min. '**Clear Width**' required - to facilitate building user evacuation - assisted, if necessary and contraflow for firefighter access ;
- max. gradient for safety - handrails both sides & no projecting nosings ;
- attach an '**Area of Rescue Assistance**' to each staircase - at every floor, which is of suitable size & in proper relationship to elevators/lifts ;
- all robustly fire protected - fire resistance (heat / smoke / flame) plus resistance to mechanical damage .... hardcore construction is a must ! [ramps ?]





## Harmonization of 'Clear Width' Essential






## Staircase for Assisted Evacuation & Contraflow

[NIST Final Report on WTC 1 & 2 Collapses / Recommendation 17. NIST recommends that stairwell capacity and stair discharge door width should be adequate to accommodate **contraflow** due to emergency access by responders/firefighters/rescue teams.]



## Area of Rescue Assistance

(also known as a 'refuge', or a 'refuge area' )

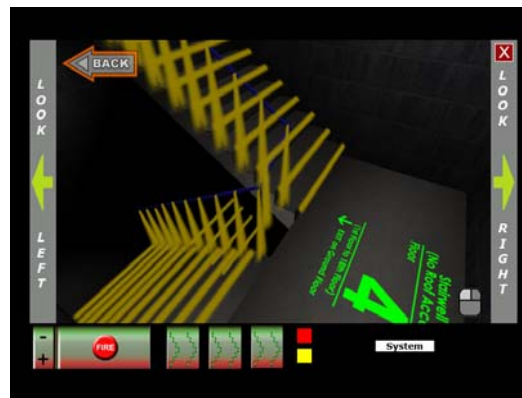
A building space directly adjoining, and visible from, a main vertical evacuation route - robustly and reliably protected from heat, smoke and flame during and after a fire - where people may temporarily wait *with confidence* for further information, instructions, and/or rescue assistance, without obstructing or interfering with the evacuation travel of other building users.

An **Area of Rescue Assistance** is a '**Place of Relative Safety**' ;  
it is not a '**Place of Safety**'.





# 'Intelligent' People Management I



'Real' Time Evacuation Information on Correct Routes & Areas of Rescue Assistance

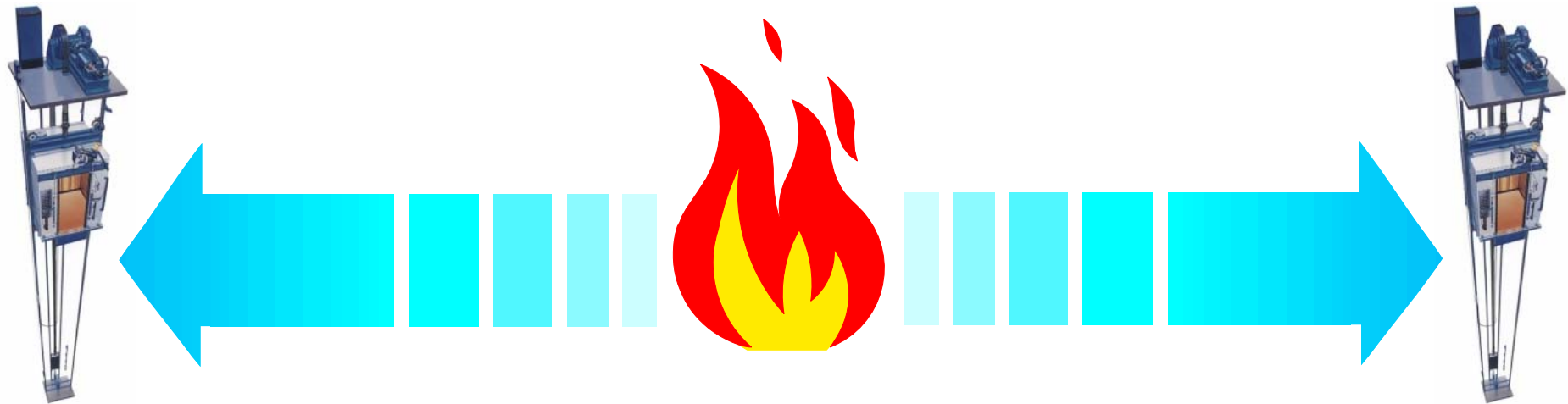




## Building Design for Firefighter Safety ?



## Clear & Alternative



## Means of Evacuation

(for All, including people with activity limitations)

**[ Alternative & Protected Means of Attack for Firefighters ]**



## 'Intelligent' People Management II



Also 'Real Time Firefighter Information on People in Areas of Rescue Assistance & Correct Routes





# 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 architectural 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**

WTC 9-11: [www.fireox-international.eu/fire/structdesfire.htm](http://www.fireox-international.eu/fire/structdesfire.htm)



[Resistance to ....]

## 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 a breach in the 'integrity' of a fire compartment.**

## Disproportionate Damage

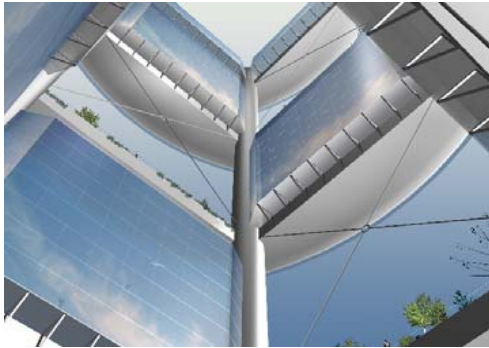
**The failure of a building's structural system ....**

- (i) remote from the scene of an isolated overloading action ; and**
- (ii) to an extent which is not in reasonable proportion to that action.**

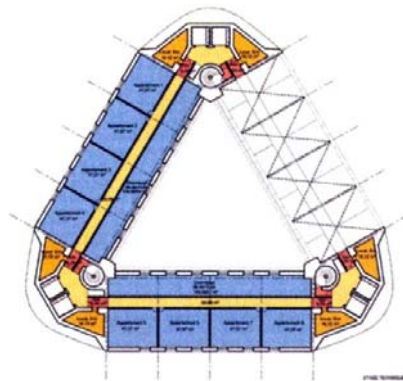
**If portion of a building is removed, will the fire engineering systems remain operational ?**



# Safer Structural Forms for Tall Buildings



Multi-Core Design



Super Tall

Buildings



Denis Sloan, architecte; Peter Terrell et Geoff Rooke, ingénieurs structures; et Claude Delalande, ingénieur sécurité (ex-Officier BSPP, Paris-Expo) - France.



## Conclusion

India's per-capita energy consumption is approximately 4 - 5% of per-capita energy consumption in the United States of America.

What does it mean, therefore, to have a 'Platinum' LEED Rated Building in Chennai ? Will people with disabilities be able to access and work in it ?

**In the event of fire, will everybody get out ?**

**Sustainable Design Solutions** are appropriate to local geography, social need, climate, economy & culture .... and are 'person-centred' and 'reliability-based'.

Within the context of stronger South-South Co-Operation,  
**Sustainable Fire Engineering** may provide a richer design language to meet your Local Fire Engineering Challenges.

**"We Ourselves"**

