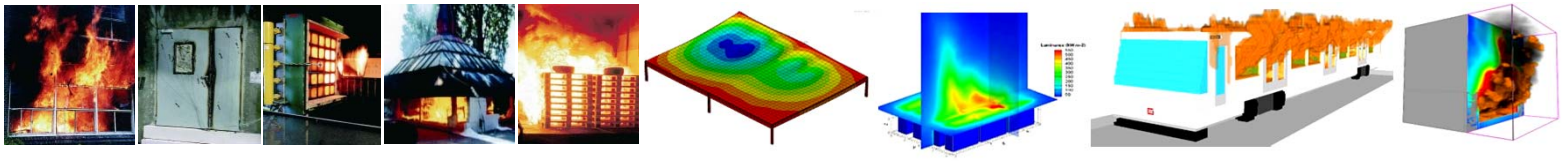


FIRE SAFETY CONCEPT IN HIGH RISE BUILDINGS

İLKER İBİK

WHO IS EFECTIS?

- **Efectis** is an independent and private 'third party', active in the safety of buildings, constructions and people inside them.

- **TNO** (the Dutch national research center) and **CTICM** (the French scientific and technical center dedicated to steel construction), two governmental bodies, decided in 2005 to merge their respective **fire related activities** (more than **110 years of combined experience**) in **one single company, Efectis.**

- Efectis is a **Global Expert in Fire Science**, recognized partner for testing, engineering, design and modeling, risk and fire hazards analysis, forensic fire investigation, training, inspection and certification.

- Whether to optimize safety performance, achieve regulatory compliance, lower insurance premiums or reduce building costs; our **ability to virtually model and physically test** provides an extensive understanding of fire behavior as it interacts with various materials in complex environments.

PRESENTATION - İLKER İBİK

Aeronautical Engineer – İstanbul Teknik Üniversitesi (1995)

Founder of ERA Company Group (2003),

- Set up the first Accredited EUROCLASS REACTION TO FIRE LAB OF TÜRKİYE(2008),

EFECTIS ERA Avrasya A.Ş./İstanbul in partnership with EFECTIS HOLDING (2011),

- Set up the first Accredited FIRE RESISTANCE LAB OF TÜRKİYE (2011),

- Management Board Member of EFECTIS Holding, in charge of Türkiye, Middle-East, CIS and Balkan Regions.
- TK-3 Fire Technical Committe Chair of TUCSA, Fire Technical Committe Chair of IMSAD, TC-3 Fire Technical Committe Member of ECCS, Management Board Member of UDDER, Management Board Member of TUYAK, Member of ONKUR

FIRE SAFETY
IN HIGH RISE BUILDINGS

HISTORY- FRENCH REGULATION

- First French fire regulations from Henri the 4th, King of France:
  - Royal decree in 1607 which limits the construction over the streets (geometry), in order to avoid the spread of fire through the city of Paris.
  - Reinforcement of this Royal decree in 1667, following the big fire of the city of London in 1666, with the demand to cover wood construction with gypsum.


DECLARATION
DU ROY :
PORTANT QUE CEUX DE
LA R. P. R. NE POURRONT
ESTRE RECEUS AVOCATS.

HIGH RISE VS. VERY HIGH RISE?

- French Regulation revision in December 2011 took into consideration the latest risk associated with the so-called « Very High Rise Buildings », meaning those exceeding **200 m**, where as high rise buildings (HRB) are described as more than **50 m.** for housings, more than **28 m.** for the other buildings.

- Turkish Regulation revision in July 2015 defines moderate high rise building as over **28,5 m**. and high rise buildings as **52,5 m.**

GENERAL FIRE SAFETY CONCEPTS IN USE

- How fast can occupants egress ?

- How quick can the fire brigade extinguish a fire ?

- How can we avoid the fire spread in the surrounding ?

CONSEQUENCES OF SUCH AN APPROACH

- **Panic**

- **Accidents**

- **Collateral damages**

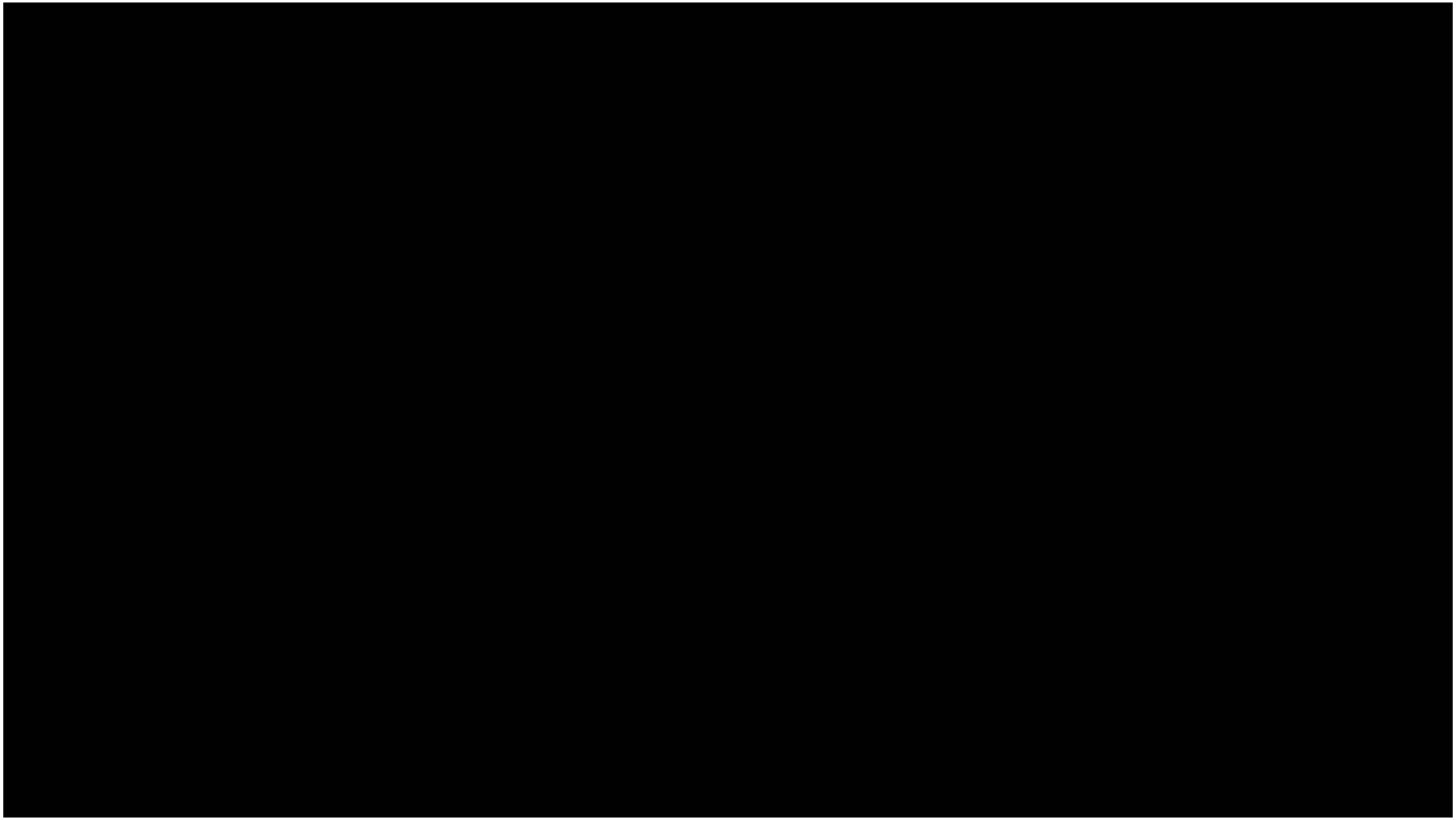
STRATEGY FOR HIGH RISE BUILDINGS

- Maintain people as much as possible where they are

- Only egress people from the directly affected area

…To the closest safe location

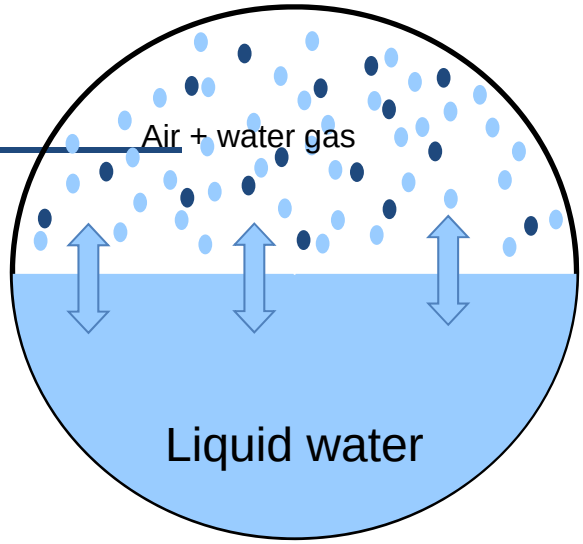
THEN..WHAT REALLY HAPPENS IN FIRE TO BUILDING STRUCTURES?



BUT…BUT… CONCRETE DOESN'T BURN!!!

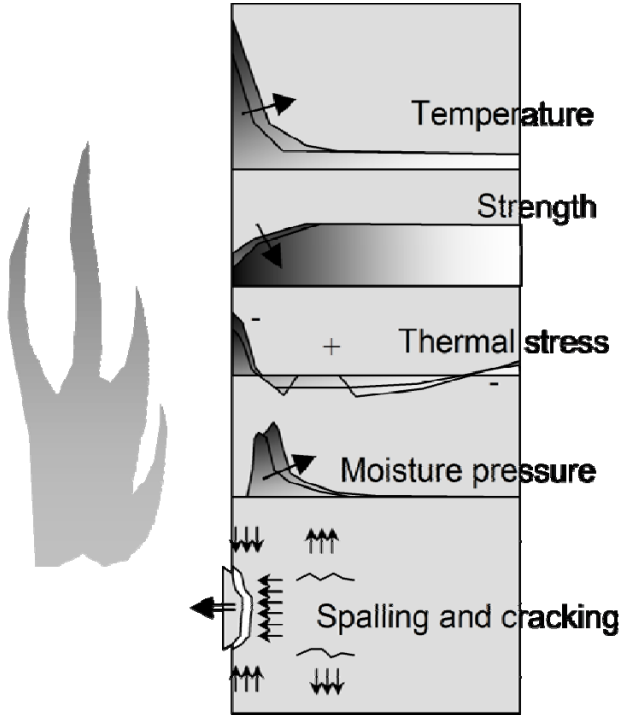
- **EXPLOSIVE SPALLING!**

CONCRETE SPALLING



Concrete spalls in fire due to a combination of;

- Pore pressure rises due to evaporating water when the temperature rises;
- Compression of the heated surface and tension in the cold concrete due to a thermal gradient in the cross section;
- Internal cracking due to difference in thermal expansion between aggregate and cement paste[2];
- Cracking due to difference in thermal expansion/deformation between concrete and reinforcement bars;
- Strength loss due to chemical transitions during heating.



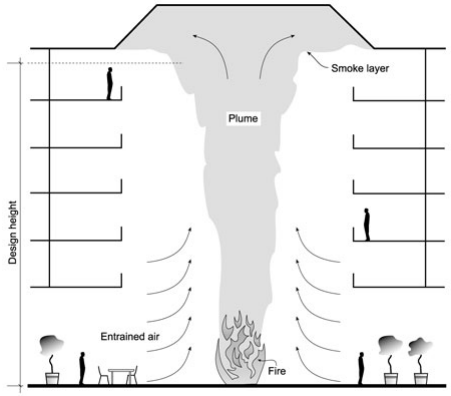
WHAT ARE THE ISSUES TO ADDRESS

- To establish trust

- To be able to communicate

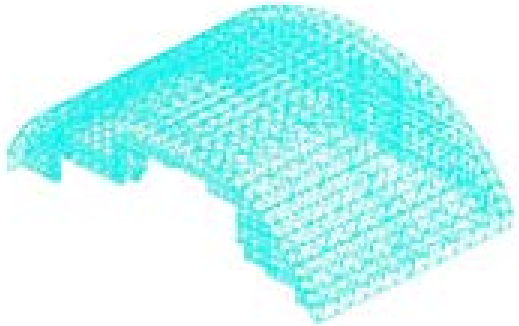
- To avoid structural collapse

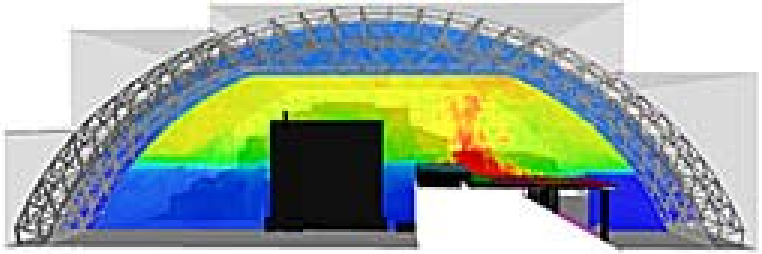
- To manage the heat and smoke



WHICH TOOL TO COMBINE THOSE CONCEPTS INTO A STRATEGY ?

- Fire Safety Engineering





DESIGN PHASE

- The base of the reference codes and regulations are **always prescriptive** and mainly based on rather standard situations.
- It results into non tailor made solutions, or in other words, **non-optimized solutions**.
- As a consequence, the building effort to improve the building safety is **prescriptive regulation driven** and no longer **safety driven**.
- This approach is not well fitted for specific buildings, like for example *high rise buildings*…

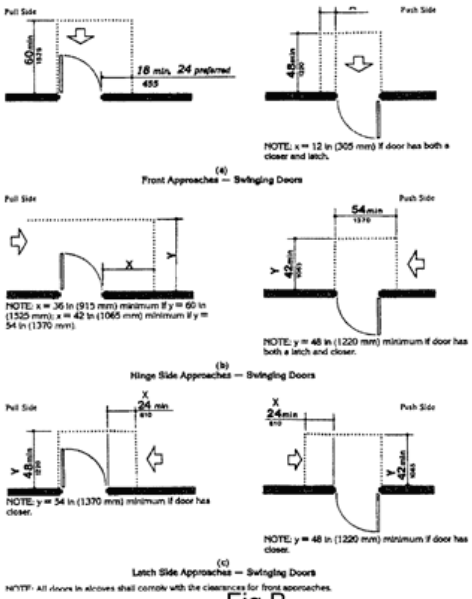


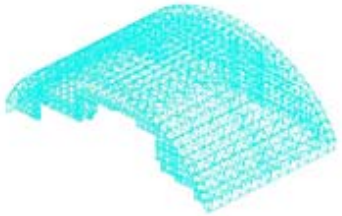
Fig B
Maneuvering clearances at doors

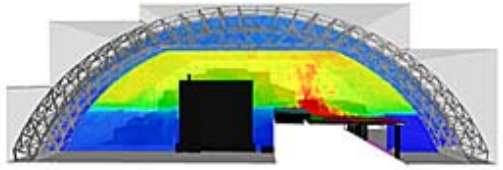
DESIGN PHASE

- The other approach is to use *performance based code..* or in other words, **Fire Safety Engineering**.

- The use of fire safety engineering has several advantages:
  - The designer performs a *risk assessment*
  - The risk assessment is *approved by local authorities*
  - It enables to *increase* the global fire *safety* level of a building
  - It additionally enables some *cost savings* (up to 3% in design and building expenses)

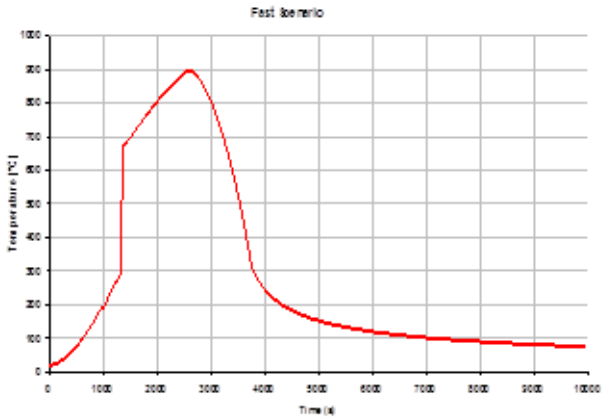
- And major drawback;
  - *Complexity*

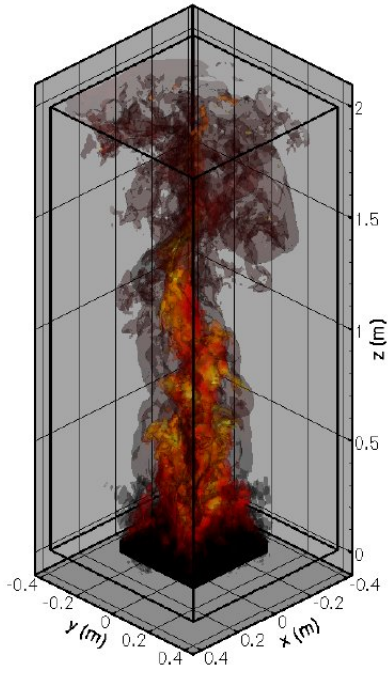




DESIGN PHASE – FSE – FIRE DEVELOPMENT

- Fire safety engineering enables to assess:
  - Fire development (heat and smoke)



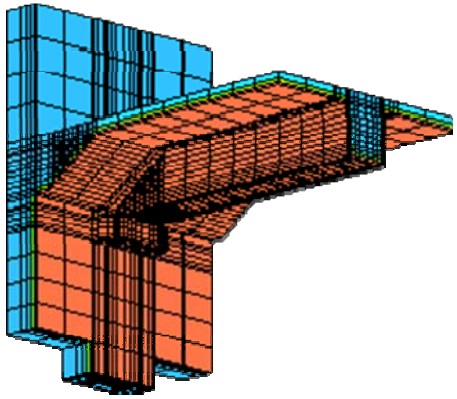


  - Based on the agreed fire scenario (worst case), the fire development is assessed through a CFD (Computational Fluid Dynamics, eg. CAMATT, STREAMAGE, C-FAST, OZONE, FDS softwares)

DESIGN PHASE – FSE – HEAT TRANSFER

- Heat transfer

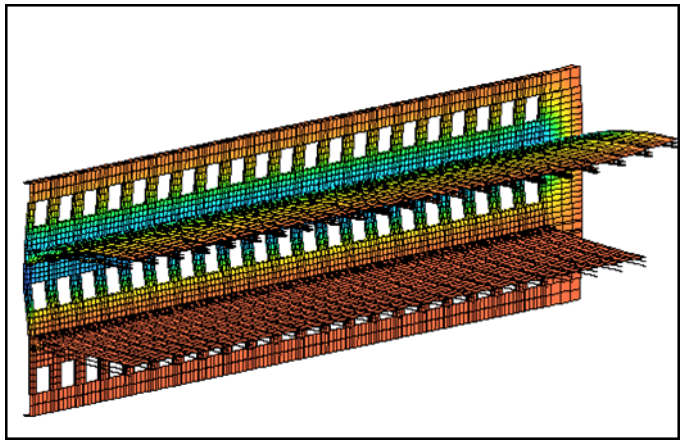
  - The time temperature curve is applied to the structure in order to define the temperature of the structure (example ANSYS, TASEF, SISMEF, SAFIR, DIANA thermal analysis softwares)



DESIGN PHASE – FSE - STRUCTURAL BEHAVIOUR

- Structural behavior

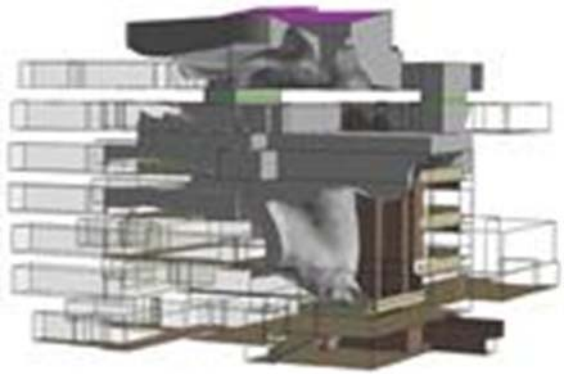
  - The temperature of the structure is then used to determine the structure behavior based on the material thermo-mechanical characteristics (example ANSYS, DIANA non-linear mechanical analysis)



DESIGN PHASE – FSE – SMOKE MANAGEMENT

- Smoke management and ventilation

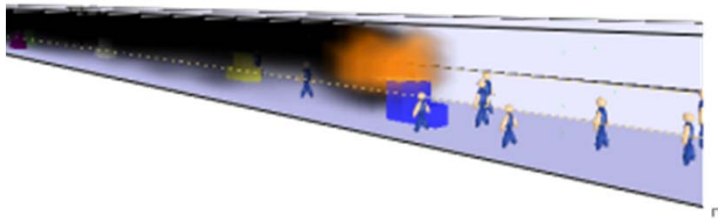
  - The smoke spread is assessed through a CFD program (example FDS) and enables to adapt the equipments (passive and active).
  - The main principle is to avoid the smoke to leave the fire compartment and to bring fresh air in the safe compartment and escape ways, like stairs.
  - In this objective, a controlled pressure difference is maintained between the evacuation stairs, the transfer areas, and the horizontal circulation areas. This enables not only the other occupants to remain safely at their level, but also to the fire brigades to identify and to reach easily the fire sources. The smoke management is handled from a specific control room.



DESIGN PHASE – FSE - EGRESS

- Egress management

  - Simulation of people egress using software like FDS-EVAC, PATHFINDER EXODUS



  - Egress will most often be limited to the evacuation of one or a few fire compartments. But for other reasons, like possible terrorism attacks, the egress of the full building has also to be assessed.

DESIGN PHASE – FSE - COMBINATION

- A combination of these tools enables to assess the level of risk and to optimize the safety level, putting the effort where necessary.

  - Identification of Worst Case Scenario(s)

    +

  - Fire and Smoke Development Model

    +

  - Heat Transfer Model

    +

  - Structural Behavior Model and Assessment

    +

  - Egress Model

    =

  VALIDATION / APPROVAL OF THE FIRE STRATEGY DESIGN

CONSTRUCTION PHASE

- After all these studies are conducted and the design is approved, we enter in the second phase, the construction itself.

- This phase is *CRUCIAL* for safety of building occupants in case of fire.

CONSTRUCTION PHASE

- Even the best product **fails to perform** up to its design performance, **unless** it is **properly manufactured and assembled** in the manufacturing plant and **correctly installed** in its final location on site.

- *Economical and time pressure, lack of training and lack of understanding of the essentials in the product installation often lead to underperforming products.*

CONSTRUCTION PHASE

- Most of the time, the building owner, and even the technical control offices are not able to identify important mistakes. And when we speak about **structural resistance**, as well as partitioning, the idea is really to avoid the "*hole in the shell*".

- At this stage, assistance to building owner through **third party inspection and certification** is a very effective mean to ensure that the money spent for fire safety will reach its aim. Combined with the prescription of **fire certified products**, it will lead to a building «**built as designed**», thus delivering the expected performance in term of safety

LIFETIME PHASE

- During the engineering of the building, some assumptions have been made regarding the final destination, the maximum calorific potential, the number of occupants, etc…

- As well, the installed equipments have been checked to ensure their functionality.

LIFETIME PHASE

- But then, the lifetime of the building starts and it will have to adapt to new demand from users: *It will age*.

- And its occupants will need to be *trained* in order to adopt the right attitude *in case of fire* (alarm, fire-fighting, doors and windows management, use of lift landing, first level egress or total egress exercises …)

LIFETIME PHASE

- A recognized specialized *third party inspection*, **training and certification** is again a must and will provide the building owner, building manager, and building occupant with an invaluable add-on: **Safety and Peace of Mind..**

- This will not substitute the building owner's responsibility, but will provide him with all the **required information and guidance** for the corrective actions, if any.

- He will be able to act in full **consciousness**, no longer only hoping that he is doing the right things.

CONCLUSION

A high rise building can be a correct solution to enable high density of population / workplaces.

The third dimension is, in some specific areas of the city, the only way to grow.

The level of risk associated with such a concentration of people, where both egress and firefighting are complex, still reveals to be manageable.

But we cannot forget the following aspects:

- **Design phase**
- **Construction phase**

CONCLUSION

And at least as important as the former ones is;

- **Lifetime phase**

If each phase is dealt with adequate know-how and expertise,
and if the owner understands in full his level of responsibility,
he will then ensure not only to comply with the regulation,
but moreover, to shift expectations at a reduced cost through fire safety engineering,
and to meet the safety objectives by implementing at each phase
the appropriate level of third party approval / certification.