Genossenschaftliche FinanzGruppe Volksbanken Raiffeisenbanken

Wiesbaden, 18.05.2022, Bianca Jung

# High rise, high risk?

# Cladding fires like Grenfell – A one-off occurrence?

R+V RE

Ihr kooperativer Rückversicherer.

# Agenda

# The Grenfell Tragedy
## Review

https://youtu.be/KczK1kGhp1I

# Agenda

# High Rise Buildings
## Definition

› Germany
  – Buildings above 22 meter.

› U.S.A.
  – Buildings above 23 meters, or about 7 floors

UAE
  – Buildings and structures having total height of inhabitable space of more than 23 meters.

UK
  – Any building with a storey at least 18m above ground level and which contains one or more dwellings; an institution; or a room for residential purposes

› China
  – Residence buildings with more than 10 floors, and other buildings above 24 meters.

# High Rise Buildings
## Development

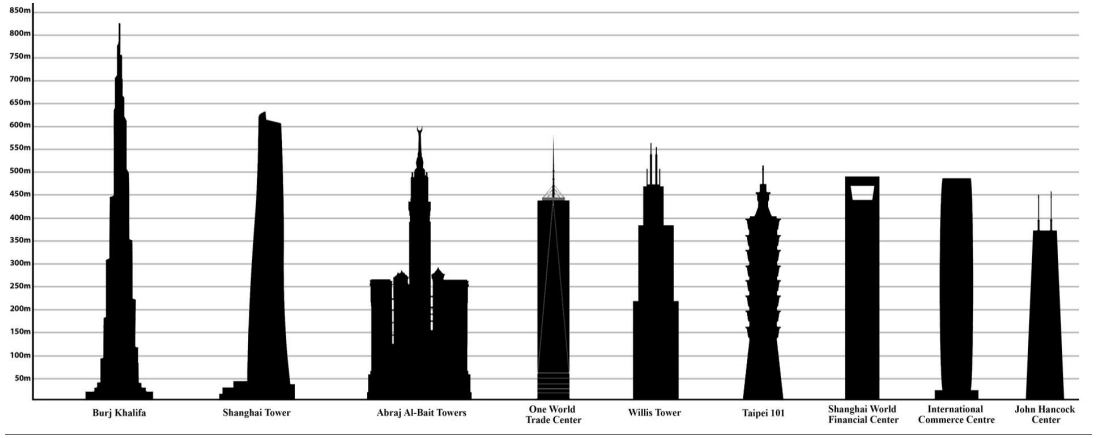
› Building heights have risen dramatically in the last 45 years.

› Tall buildings are becoming taller and build faster than ever before

› New, modern construction methods enable new building heights all around the world

› More than half of the world's 100 tallest buildings have been built in the past four years alone

› The Burj Kalifa still holds the titel with a total height of 828m.

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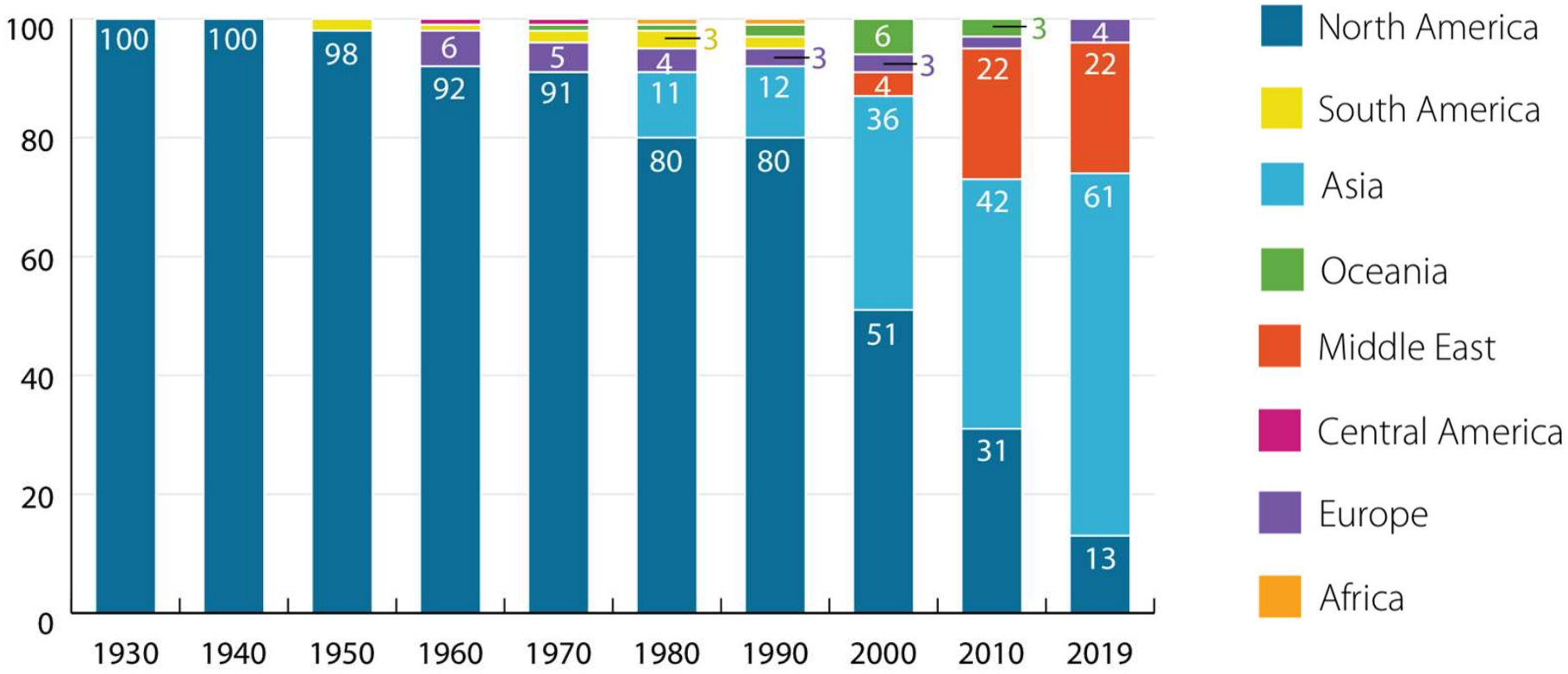
# High Rise Buildings
## Development

100 Tallest Buildings Worldwide



# High Rise Buildings
## Development

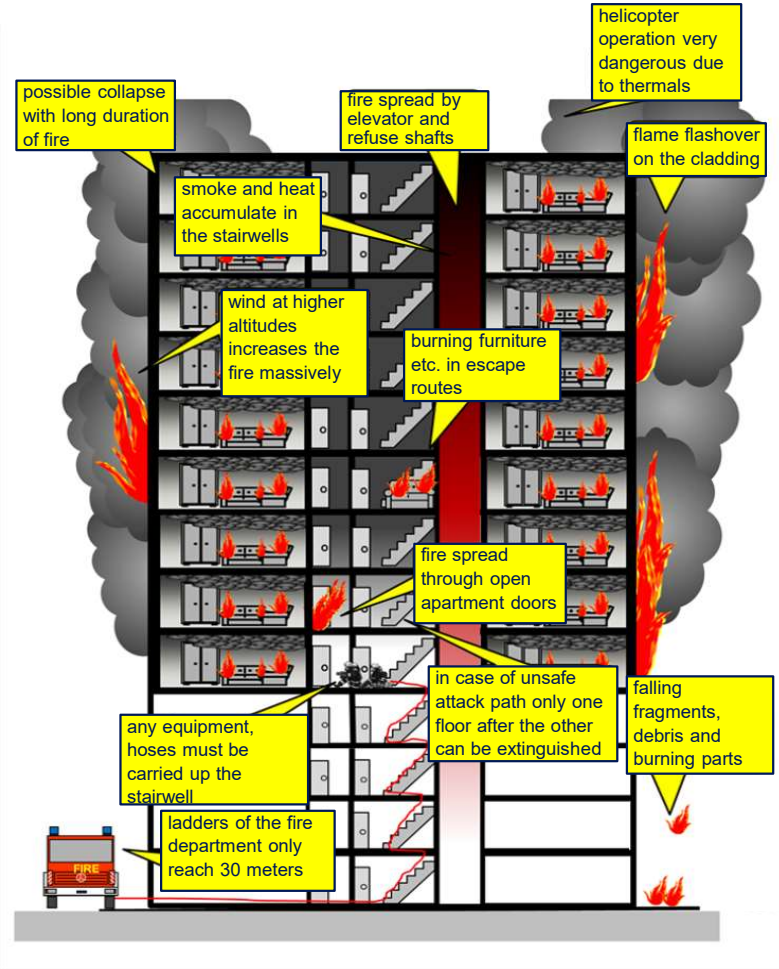
› The trend started in the1930s in USA followed by Middle East and Asia from the 1980s

› Reasons for high-rise buildings:

- Growing populations
- Growing urbanization
- Limited landressources
- Reflection of high technology in construction industry
- Reflection of modern city status
- Urban regeneration (e.g. One Canada Square former Docklands)
- Demonstration of economic and political power

Source: CTBUH

# High Rise Buildings
## Special Characteristics of Fires



# High Rise Buildings
## Firefighting Concept

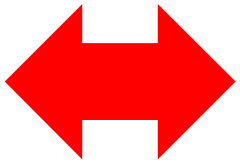
### Compartmentation

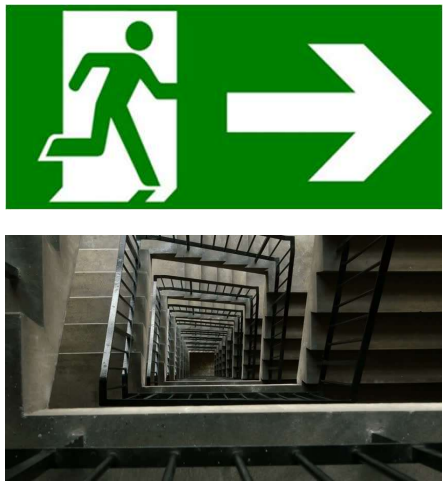
Is the concept of delivering a sector that is expected to fully contain a fire. The sector is therefore generally termed a compartment. A compartment is protected by fire resistant barriers (ex. walls, floor slabs, doors, etc.) and is designed to prevent a fire from spreading to any adjacent compartment.

Characteristics:

› 30 min fire resistance
› Maintains building structure
› Allows sufficient time for escape
› Minimizes destruction
› Assists firefighting
› Prevents fire, heat and smoke from spreading beyond locations of origin

# High Rise Buildings
## Firefighting Concept



- During a single flat fire occupants of that flat evacuate
- All other occupants are safe if they remain where they are
- Relies on containment of fire
- Supported by layers of active and passive protection

- **A**vailable **S**afe **E**gress **T**ime may be ≠ **R**equired **S**afe **E**gress **T**ime
- Risk of panic
- Congestion in staircases

# Agenda

# Façades in High Rise Buildings
## Definitions

### Façade

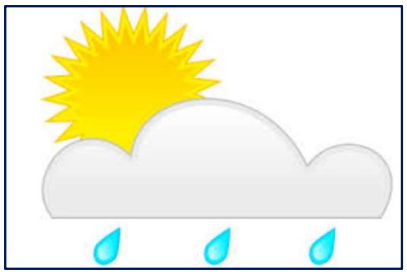
› The assembly of framing and materials used to envelope a building.
› A load bearing exterior wall or nonloadbearing exterior wall (NFPA5000)
› A façade is generally one exterior side of a building, usually but not always the front (Wikipedia)

### Cladding

› Application of one material over another to provide a skin or layer (Wikipedia)
› Covering of tiles, wooden boards or other material that is fixed to the outside of a building to protect it against bad weather or to make it more attractive (Colllins)
› Components that are attached to the primary structure of a building to form non-structural, external surfaces (designingbuildings.co.uk)

Concepts like **cladding, curtain walls, exterior wall assemblies, insulated metal panels, metal composite material, rain screens, wall covering, finishing layer** and more can refer to the same components and assemblies, or to different ones, or to various components

# Façades in High Rise Buildings
## Motivation for Application





Weather resistance

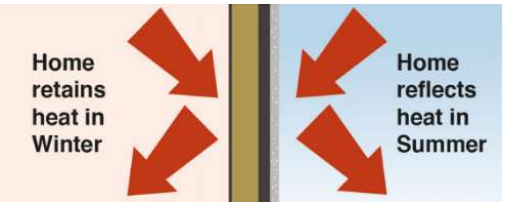
+

Increasing Energy Consump-tion

+

Aestetic Design

→ Façades



# Façades in High-Rise Buildings
## Typologies

**Façade types**:

- Curtain wall
- Built-up wall facade systems with cavities
- Built-up wall facade systems without cavities
- Rainscreen
- Masonry facades
- EIFS: External Insulation Finishing System:
- ETICS: External Thermal Insulation Composite Systems
- Precast Concrete Panels
- Insulated Metal Panels

# Façades in High-Rise Buildings
## Typologies

### Insulation materials

› PUR: Polyurethane

› PIR: Polyisocyanurates

› EPS: Expanded Polystyrene

› EXP: Extruded Polystyrol

### Cladding materials

› MCM: Metal Composite Material

› ACP: Aluminium Composite Panels = MCM faced with aluminium

› HPL: High Pressure Laminates

› GRP: Glass Reinforced Polymer

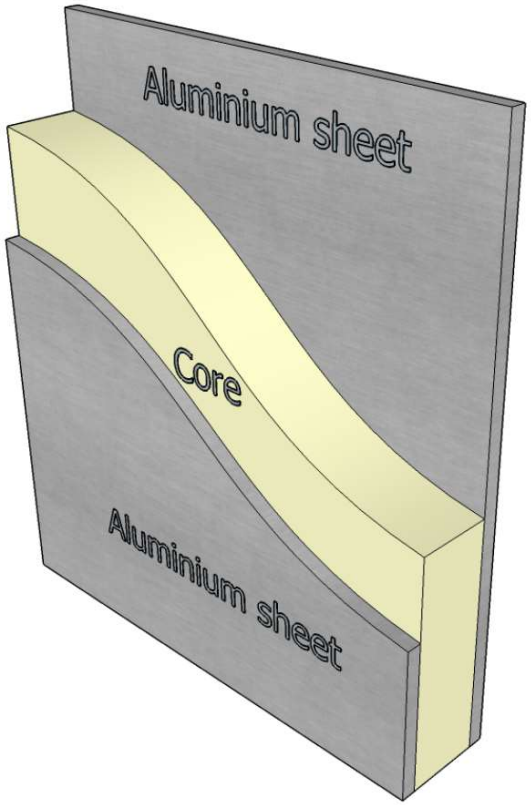
› Timber

› Polycarbonate

# Façades in High Rise Buildings
## Metal Composite Claddings

Metal Composite Material (MCM)

- can be used for façade panels.
- commonly faced with aluminium and known as **ACP: Aluminium Composite Panels.**
- provide a very flat visual appearance.
- Two sheets of 0.5-0.7mm aluminium are bonded to a core material.
- total thickness is typically 4-6mm
- Core is typically extruded thermoplastic
- cost effective
- leightweight
- easy to install

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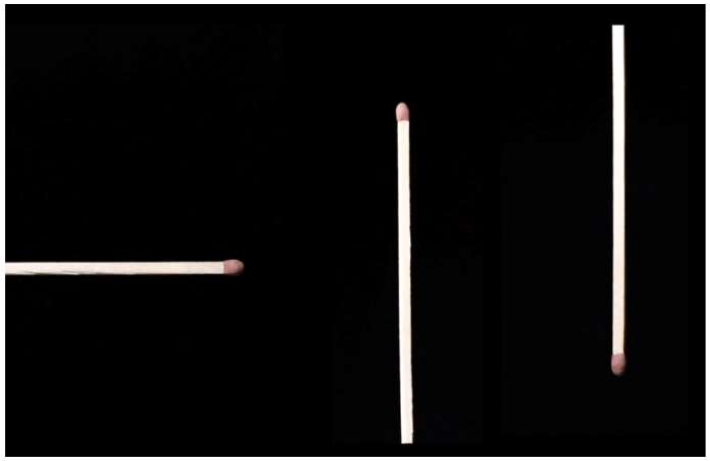
# Agenda

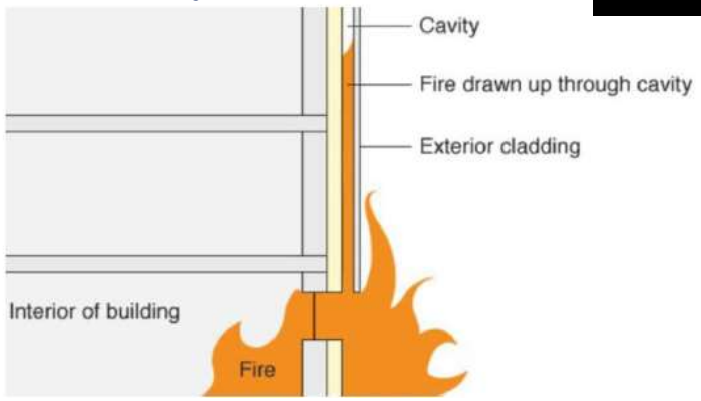
# Mechanisms of Fire Spread
## Vertical vs. Lateral Fire Spread

Vertical vs. Lateral fire spread



Vertical fire spread (upward and downward


Chimney effect



# Façade Fires
## Scenarios for Façade Fires

There are **three typical scenarios of fire spread over façades:**

1. Spread of the external fire onto combustible façade by radiation from the neighboring, separate building,
2. Spread of the external fire onto combustible façade from the source of fire located next to the façade (litter on the balcony, parked cars, waste bins) with the consequence of radiation or direct exposure to fire
3. An internal fire that has started in a space inside a building spreads through openings in the façade (windows,doorsetc.) onto higher or lower floors

# Agenda

# Façade Fires
## Incidents involving Exterior Façade Systems

| Building | Location | Year | Occupancy |
|---|---|---|---|
| 7 storey apartment building | Berlin, Germany | 2005 | Residential |
| Torre Windsor | Spain | 2005 | under construction |
| Jumeirah Lakes Towers / Fortune tower | Dubai, UAE | 2007 | Residential/Commercial |
| Water Club Tower At The Borgata Casino Hotel | Atlantic City, USA | 2007 | under construction |
| MGM Monte Carlo | Las Vegas, USA | 2008 | Hotel |
| Television Cultural Centre /Mandarin Oriental | Bejing, China | 2009 | Hotel/Commercial |
| Lakanal House | London, UK | 2009 | Residential |
| 11 storey building | Miscolc, Hungary | 2009 | Residential |
| Wadell Court / The Gorbals | Glasgow | 2009 | Residential |
| 28 storey buildung | Shanghai, China | 2010 | Residential |
| 9 storey hostel | Dijon, France | 2010 | Residential |
| Wooshin Golden Suites | Busan, South Korea | 2010 | Residential/Commercial |
| Dynasty Wanxin Hotel | Shenyang, China | 2011 | Hotel |
| Tamweel Tower | Dubai, UAE | 2012 | Residential |
| Al Baker Tower | Sharjah, UAE | 2012 | Residential |
| Saif Belhasa Building | Dubai, UAE | 2012 | Residential |
| Mermoz Tower | Roubaix, France | 2012 | Residential |
| Al Tayer Tower | Sharjah, UAE | 2012 | Residential |
| Polat Tower | Istanbul, Turkey | 2012 | Residential |
| Fico Building | Bangkok, Thaiand | 2012 | Commercial |
| Adickessalee 63-65 | Frankfurt, Germany | 2012 | under construction |
| Grozny City Complex | Grozny, Chechnya | 2013 | Hotel/ Commercial |
| Al Hafeet Tower | Sharjah, UAE | 2013 | Residential |
| Lacrosse Building | Melbourne, Australia | 2014 | Residential |
| Nova Vysota | Krasnoyarsk, Russia | 2014 | Residential |
| 16 storey Apartment building | Baku, Azerbaijan | 2015 | Residential |
| Charles Street/ Springburn | Glasgow, UK | 2015 | Residential |

# Façade Fires
## Incidents involving Exterior Façade Systems

| Building | Location | Year | Occupancy |
|---|---|---|---|
| Nasser Tower | Sharjah, UAE | 2015 | Residential |
| Margo City Mall | Depok, Indonesia | 2015 | Commercial |
| Marina Torch | Dubai, UAE | 2015 and 2017 | Residential |
| The Address Downtown Dubai | Dubai, UAE | 2016 | Hotel / Residential |
| Sulafa Tower | Dubai, UAE | 2016 | Residential |
| Ajman One / Tower 8 and 6 | Sharjah, UAE | 2016 | Residential |
| 15 storey building | Ramat gan, Israel | 2016 | Residential |
| Shepherd's Bush | London, UK | 2016 | Residential |
| Al Bandary Twin Towers | Dubai, UAE | 2016 | Residential |
| Neo-Soho Apartment | Jakarta, Indonesia | 2016 | Residential |
| Marina Torch | Dubai, UAE | 2017 | Residential |
| Grenfell Tower | London, UK | 2017 | Residential |
| Taksim Educational & Reasearch Hospital | Istanbul, Turkey | 2018 | Hospital |
| Zen Tower | Dubai, UAE | 2018 | Residential |
| EPF Building | Selangor, Malaysia | 2018 | Commercial |
| 25 storey building | Shenyang, China | 2019 | Residential |
| De Pass Gardens | Barking, UK | 2019 | Residential |
| 10 storey building | Warsaw, Poland | 2019 | Residential |
| The Cube | Bolton, UK | 2019 | Residential |
| 30 storey building | Chongqing, China | 2020 | Residential |
| Abbco Tower | Sharjah, UAE | 2020 | Residential |
| Via Tower | Ankara, Turkey | 2020 | Residential |
| Torre Ambar | Madrid , Spain | 2020 | Residential |
| Samwhan Art-Nouveau | Ulsan, South Korea | 2020 | Residential |
| Zhongxin Building | Shijiazhuang, China | 2021 | Residential |
| New Providence Wharf | London, UK | 2021 | Residential |
| Torre dei Moro | Milano, Italy | 2021 | Residential |

# Agenda

# The Grenfell Blaze

## Key Facts about Grenfell Tower

- Completed 1974
- Social housing
- Renovated in 2015/2016 by Rydon Construction Ltd
- Owner: Royal Borough of Kensington and Chelsea (RBKC)
- Managed by RBKC Tenant Management Organisation (TMO)
- 25 floors (24 above ground) /127 flats
- Height  67m
- approx. 350 inhabitants
- Fire incident in 14.06.2017
- Apartment Fire started in a defected fridge-freezer
- Fire spread to the façade
- Fire reached the roof in **20 min**
- 200 fire fighters / 40 fire engines / 100 paramedics
- **72** deaths / **74** injuries
- **223** residents escaped , **65** rescued

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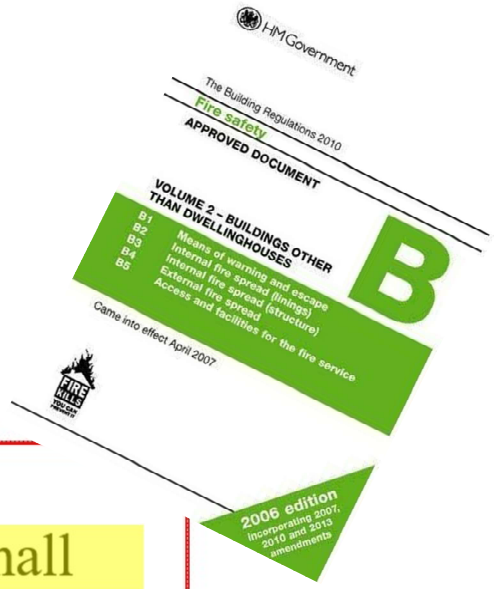
# The Grenfell Blaze
## Original Construction

- Grenfell tower was built between 1972 and 1974.
- The original external wall consisted of exposed concrete surfaces and glazing.
- The perimeter beams were solid concrete.
- The windows fully filled the space vertically between the top of one perimeter beam and the underside of the next beam.
- The external wall was therefore entirely non combustible and there was no void or space concealed within that external wall..
- Reinforced concrete cross walls and floors separated each flat from level 4 to level 23.
- Therefore each flat was enclosed in fire-resisting construction.
- This is known as compartmentation.
- The lobby which provided access to the residential lifts and the central staircase, the only means of escape, was a separate  compartment to the flats and enclosed within its own concrete walls.
- Grenfell Tower had a 'stay put' fire policy

# The Grenfell Blaze
## Building regulation

UK Building Regulations 2010
Regulation B4




**External fire spread**

**B4.** (1) The external walls of the building shall adequately resist the spread of fire over the walls and from one building to another, having regard to the height, use and position of the building.

# Possible Reason for Rapid Fire Spread
## Fire Performance of ACP

- Installation of ACP rainscreen cladding in refurbishment 2016 to improve energy effeciency and visual appearance
- ACP cladding delaminates and the core material melts in case of fire
- Architectural crown consisting of ACP was added and contributed to lateral fire spread
- Unprotected voids in column tips drew flames up and allowed burning material to flow downwards

# The Grenfell Blaze
## What led to the Catastrophe ?

**Politics:**
› Deregulation of the building regulations (performance based)

**Construction:**
› The ACM contained highly combustible polyethylene filler which melts, drips and flows,
› Vertical cavities within the cladding structure played a role in the spread of the fire,
› Installation of cladding left unprotected gaps and exposed polyethylene cores,
› Cavity barriers around the windows and at head of the wall were omitted,
› Combustible material used at and around windows (uPVC window boards)
› Instead of special vertical cavity barriers on the columns (only on 10 of 14) the horizontal cavity barrier material was cut and rotated,
› Lifts not upgraded to applicable fire fighting standard during refurbishment of lift system in 2005 (permits also evacuation),
› Violation of compartmentation through fire door replacement in 2011, installation of main gas supply through protected stair wall,
› Installation of a dry fire main instead of required wet fire main,

# The Grenfell Blaze
## What led to the Catastrophe ?

**Fire brigade:**

› Commanders and senior officers attending the fire had no training in the dangers of combustible cladding

› Data in the operational risk database (ORD) for buildings in London was outdated and incomplete

› Incident commanders were not prepared for such a situation

› Delayed decision to evacuate (more than 1 hour was lost)

› Flaws in communication and information between control room and incident commanders at the scene

# The Grenfell Blaze
## What led to the Catastrophe ?

**Fire safety:**

› No building wide Emergency Warning and Intercommunication System (EWIS)

› Only one central escape route,

› Deficient compartmentation due to apartment doors (fire resistance < 30 min.),

› Smoke ventilation system did not work properly,

› Mistaken stay-put policy,

› Late evacuation

› No sprinkler system

# Agenda

# Lessons learned
## Can Grenfell happen again?

Yes, because of:

› Technology evolves faster than regulations
› “Grandfathering” (regulations apply to new buildings only)
› Lower protection requirements and combustible materials allowed for lower than high-rise
› Use of the ambiguity of regulations and guidance to game the system
› Builders and facility managers who circumvented or otherwise ignored building regulations in recent years either by mistake or intentionally to cut costs
› Missing standards and clear terminology
› Changes to the original design in course of renovations/upgrades that compromise the safety concept

# Lessons learned:
## Conclusion

- **A fire in a tall building must be confined to a single storey**
  - Fire barriers should be installed (correctly) in each floor
  - In general only non-combustible building materials should be allowed
  - General requirement for sprinklers
- **Harmonization of international standards and terminology is required**
- **Strong inspection regimes and consequences have to be implemented**
- **Risk needs to be reviewed when circumstances change**
- **Critical Information has to be made available**
- **Cooperation of all involved parties is necessary**


**Complex systems need a holistic approach !**