



Experimental investigation of fire behaviour of different types of façade used in buildings



Joint project by IIT Gandhinagar and Underwriters Laboratories

Use of façade in modern construction

Glass façade are used very commonly in modern construction. In addition to being aesthetically pleasing, they enable better energy management of buildings and hence, have become an integral part of green building design. Almost all modern commercial buildings utilize a façade system either entirely based on glass or a combination of glass and other materials (e.g. aluminium composite panels, ACP, and medium density foam, MDF). For acceptable performance, such systems must be constructed with appropriately rated materials following good installation practices.



Such glass façade systems are typically called curtain walls and are connected to the main structural frame of the building through aluminium-based frames of their own. A gap is always provided between the curtain wall and the deck slab of the building to avoid crashing of glass in case of unwanted vibrations arising from passing of heavy vehicles and/or minor earthquakes and also to mitigate effects of thermal expansion. This gap is filled with appropriate fire stop material (e.g. rockwool). In case of a fire event, the performance of the façade as well as the fire stop material is crucial for the overall performance of the building.

Performance of façade system in fire

While glass façade systems offer excellent energy management advantages, they can easily become vehicles for movement of fire along the building. A number of past fire incidents in buildings indicate the risks associated with using façade system. Images from some notable recent fire shows mechanisms through which fire spreads.



2014 Mumbai Mantralaya



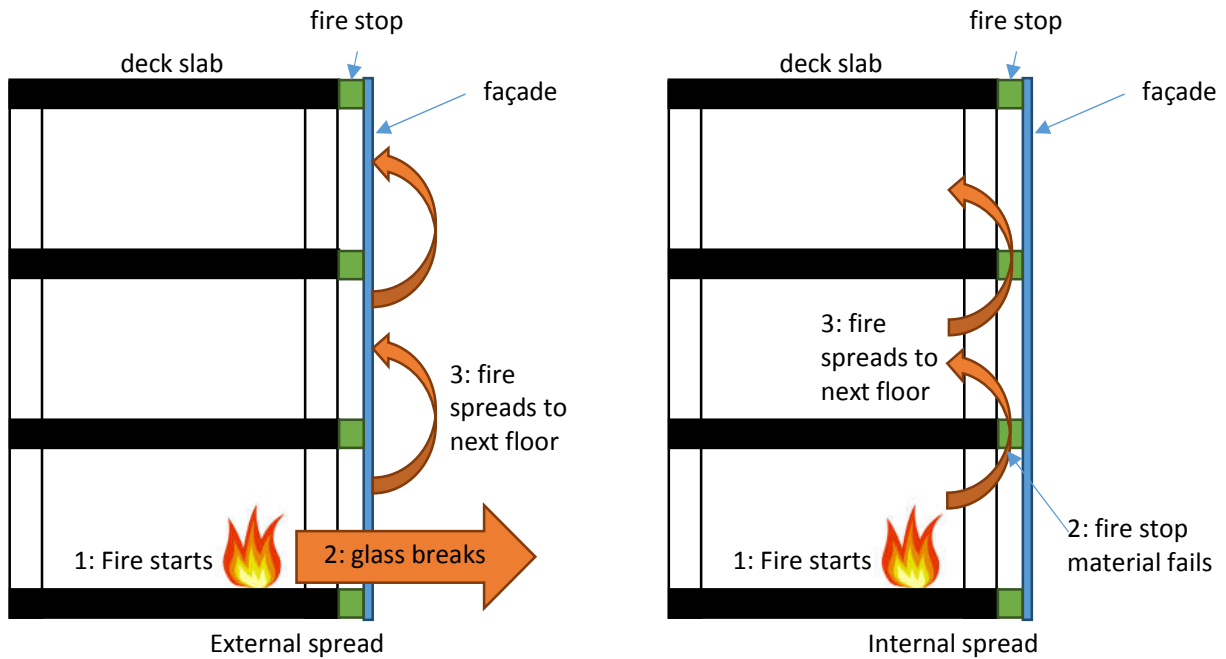
2015 Mumbai skyscraper



2014 Lotus Business Park

The frequency and severity of past fire accidents indicate lack of awareness of the available rating and testing mechanisms in the Indian construction industry and public, in general. This can be due to lack of available provisions and dearth of appropriate testing and certification mechanisms. Thus, it is essential to develop this capacity in the academic and industrial outfits within India, especially in the wake of 100+ smart cities being planned by the Government of India in the next few years. Another issue peculiar to the Indian context is the use of masonry walls as a predominant method of compartmentation and even as main load-bearing members. A good understanding of the behaviour of masonry walls subjected to fire is also important.

Mechanisms of fire spread in façade systems



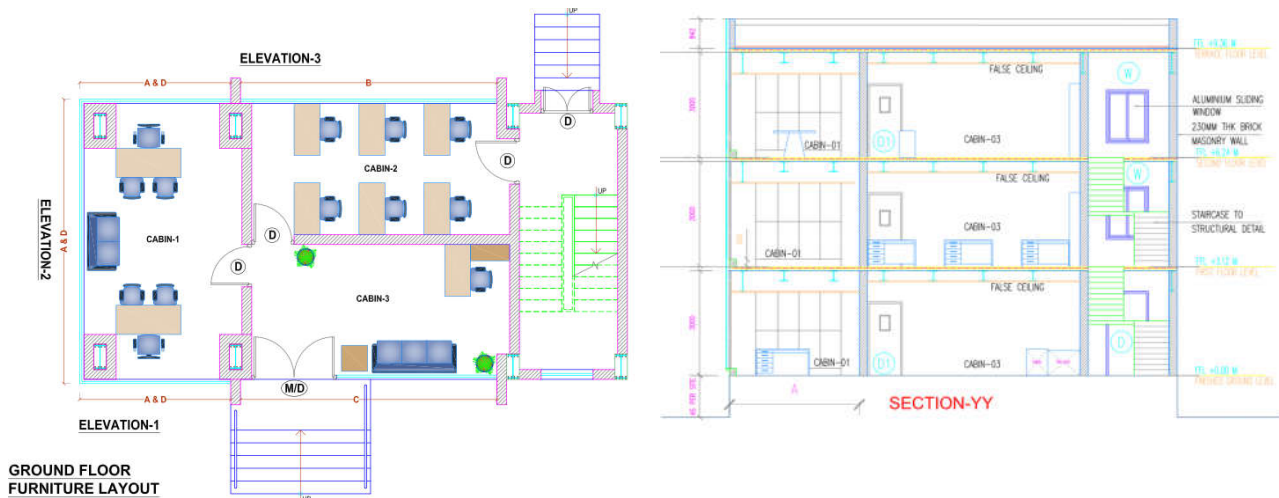
Key objectives of the project

- To study glass-break behaviour in real fire scenario
- To study fire stop material in real fire scenario
- To assess the smoke and obscuration levels
- To study the fire spread behaviour
- To assess fire behaviour with ACP/MDF being used with glass
- To assess utility of existing smoke alarms
- To assess out-of-plane behaviour of masonry wall
- To assess impact of fire spread on structural components (beams, columns)
- To assess performance of locally available fire proofing material (cement boards)
- To assess ambient conditions in adjacent compartments during fire

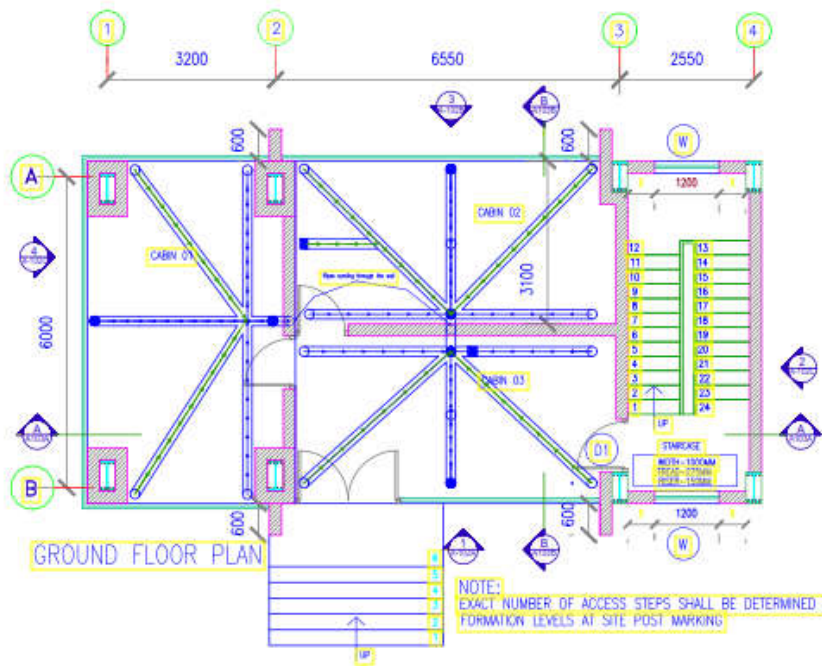
The test facility

- The only facility of its kind in India
- Full-scale G+2 storey structure
- Three compartments in each floor
- Uses locally available/used materials (both for construction and furnishing)
- Steel structural frame
- Masonry partition walls
- Masonry as fire protection for columns
- Plaster boards as fire protection for beams and slab
- Appropriate provision of fire fighter access

Detailed layout plan and elevation of the facility

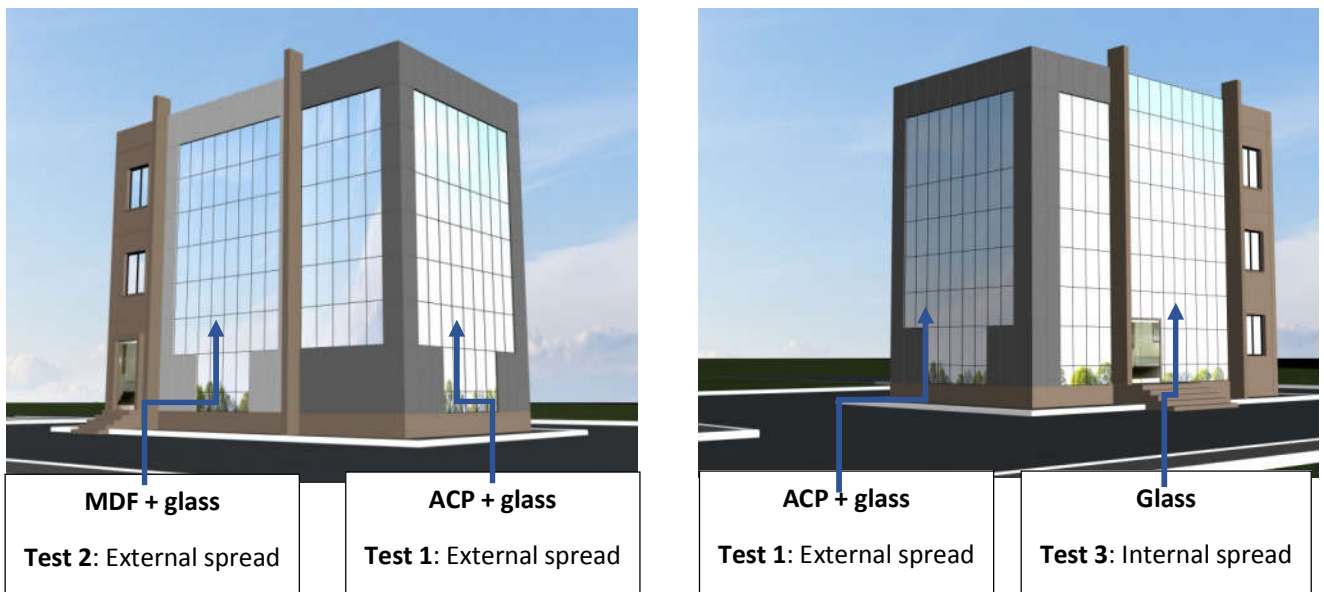


Instrumentation layout



- Thermocouple – temperature measurement
- Strain gauge – response of beams/columns
- LVDT – response of compartment masonry walls
- Video cameras – smoke obscuration levels
- Thermal imaging cameras – surface temperatures
- Drone with HD camera – aerial observations

Planned tests



Expected outcomes

- Better understanding of fire travel in buildings with façade system
- Comparative performance of MDF and ACP used with glass façade
- Effects of fire due to external and internal spread mechanisms
- Strategies for fire fighters to approach buildings with façade under fire
- Assessment of ambient conditions in different compartments at different times during fire
- Inputs for codal provisions and building regulations
- Assessment of structural performance and damage measurements
- Assessment of fire proofing materials

Technical Team <photo to be included on 5th Dec>

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