

Windsor Tower Madrid

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The recent fire in Madrid's Windsor Tower building resulted in partial collapse of the building above the 21st floor. Completed in 1978 the building was undergoing substantial renovation when fire broke out. The renovation works consisted of a new facade, a third new escape stairs on the on the South elevation, enlargement of two top floors and an upgrade of the fire protection measures.

The fire initially started in the upper part of the building and spread downwards, probably due to burning embers dropping through service penetrations, slab edge openings and other openings caused by the core wall's expansion. In a preliminary report, Arup engineers suggested that fire had spread rapidly above the 21st floor due primarily to the failure of compartmentation measures between the facade detail and the floor which is intended to prevent vertical fire spread.

The containment failure is attributable to two factors. Firstly, lightweight metal structural elements, such as curtain walling

mullions, can heat up quickly and expand causing bulging away from the slab edge, creating internal flues, if expansion precedes breakage of the facade glazing. In the case of Windsor Tower, the situation was exacerbated by the fact that the new curtain wall system was mounted on top of the original mullions and transoms, effectively creating a double void. Commenting on the Windsor Tower fire, Arup engineers pointed out that by not considering the thermo-mechanical response of the system there are no provisions to prevent damage in building codes worldwide.

The Windsor Tower fire allows for direct comparisons to be made between concrete and steel structural elements. The building had a concrete core throughout with concrete columns up to the 21st floor and steel columns between the 22nd and 30th floors. Despite the intensity of the fire and the fact that it raged for almost 26 hours before burn out, the concrete floors and columns remained intact. In contrast, the

steel supported floors above the 21st floor collapsed leaving the concrete core in place and intact. Structural failure began with the failure of the perimeter steel columns which resulted in the floor slab collapsing when the steel edge support failed. However, despite the intensity and duration of the fire the building remained standing.

An investigation is currently underway involving the Spanish technical agency Intemac, Arup Fire, Edinburgh University and representatives of the concrete industry including Cembureau, BCA and The U.K. Concrete Centre. Preliminary findings suggest that the combination of upper concrete technical floor (an effective concrete barrier on the 20th floor) and the excellent passive fire resistance of the towers concrete columns and core prevented total building collapse. Commenting on the fire, Arup engineers stated that the concrete core performed well and seems to have played a major role in ensuring the stability of the building throughout the incident.

Time	Fire Development	Cross Section
23:00	Fire started at the 21st Floor	
23:05 - 23:20	After receiving a fire signal, the security guards went to the 21st floor and attempted to fight the fire before giving up	
23:21	Fire brigade was called	
23:25	Fire brigade arrived	
23:30	Fire brigade started to fight the fire (news report)	
00:00	All floors above the 21st floor were on fire (news report)	
00:30	Fire brigade retreated and adopted a defensive position, preventing fire spread to adjacent buildings	
02:00	Fire spread below the 17th floor	
02:15	Chunks of facade started falling off (news report)	
03:30	Fire spread below 16th floor, crossing over the upper technical floor	
04:00	Floors at upper level collapsed (news report)	
05:30	Fire spread below the 12th floor (news report)	
08:30	Fire spread below the 4th floor	
13:30	Fire was under control	

Table 2 Estimated time frame of collapses (NILIM 2005)

Time	Collapse Situation
1:29	East face of the 21st floor collapsed
1:37	South middle section of several floors above the 21st floor gradually collapsed
1:50	Parts of floor slab with curtain walls collapsed
2:02	Parts of floor slab with curtain walls collapsed
2:11	Parts of floor slab with curtain walls collapsed
2:13	Floors above about 25th floor collapsed
2:17	Large collapse of middle section at about 20th floor
2:47	Parts of floor slab with curtain walls collapsed
2:51	Southwest corner of 1 - 2 floors below about 20th floor collapsed
3:35	Southeast corner of about 18th - 20th floors collapsed
3:48	Fire broke through the Upper Technical Floor
4:17	Debris on the Upper Technical Floor fell down

