Travelling Fire Spread and Realistic Fire Spread Rates

Where fires occur in large open-plan compartments (>300m2) the fires rarely burn uniformly across the entire floor plate at one time. This fact has been observed by firefighters for several decades where in such cases, fire will not generally demonstrate rapid horizontal fire spread across an entire space, akin to a flashover, but more likely spread at a steady growth rate. Although flashover may appear to occur on a more localised basis, researchers have suggested that such fires will demonstrate ‘near field’ (at the peak fire area) and ‘far field’ fire conditions (behind, in front of, or surrounding the current area of burning). This type of fire spread has been termed ‘travelling fires’ by some researchers, or ‘progressive burning’ or ‘fire migration’ by others. The temperature distribution across zones will equally be spread over a wide range, with temperatures sometimes exceeding 1000 deg. C in the early stages at the fire (near field), reducing below 800 deg. C in the far fields. This effect has major implications for firefighting tactics, structural stability and the quantities of firefighting water required to extinguish a fire, or reduce the heat in the gas layers at any particular location.

Travelling fire methodology (TFM) assumes a uniform fuel load distribution along the fire path and a constant fire spread rate, which is measured at the leading edge of the fire. The fire travel at peak intensity will be determined by variables according mainly to floor geometry, ceiling height, fuel load distribution and ventilation. As the peak rate of burning advances, it leaves behind a fire load in decay, but not entirely consumed. In fact, there may be a reducing level of fire intensity (fire decay) for quite long periods in the area behind the fire's moving front. The travelling fire is directly measured according to its rate of spread. The exposures to structural elements are in front, directly at, and behind the travelling fire. A travelling fire in a large compartment may still be in decay (not totally consumed) for a lengthy period after the travelling part of the fire (peak rate of heat release) has reached the end of the compartment. The speed of the travelling fire is determined by two variables: the constant fire spread rate, which determines the front edge location of the travelling fire; and the proposed 'burnout time', which determines the back-edge location of the travelling fire.

In EuroFirefighter 2 (2017) I describe several office fires I have attended and studied over previous decades where *office fire spread rates* **(m^2/min or mm/s)** have shown that real fire data is far removed from those being used by academic researchers. This is important because real fires do appear to spread across floor plates at a much greater rate than those observed in research, where wood cribs are often used. The academic research by Rein, Law, Stern-Gottfried, Rackauskaite, Clifton, Xu Dai, Welch and Usmani (amongst several others) frequently reference one particular fire (amongst others) that shows how 'real' fires supposedly spread at a particular rate.

The fire at the Interstate Bank in Los Angeles (1988) was one fire scene that I personally attended some months after as a member of the London Fire Brigade, to research and interview LAFD senior fire chiefs who were in command. After reviewing the LAFD fire data, on-scene videos, plans and witness statements I was able to analyse how quickly this particular fire spread. In fact, the **14.5mm/s** repeatedly referred to by academic researchers into a 'Travelling Fire' at the Interstate Bank has no sound basis and although two fire reports are commonly cited in the literature, there is no reference in these actual reports in relation to how quickly the fire spread to fully involve the 12th floor. This fire eventually headed upwards to involve four additional floors above. It was the actual case that this fire's *leading edge* travelled at an average of **48.2mm/s**, which saw the fire entirely wrapping around the entire open-plan section on the 12th floor core within 65 minutes from origin. One must also consider that there were hundreds of litres of water being applied to this fire at one point and this may well have slowed the spread rate down further still. Note: On p269 of EuroFirefighter 2, the 12^{th} floor dimensions were incorrectly entered and <u>should be amended</u> to 56m length and 38m width. On p105 the correctly entered 4-zoned fire model shows a 47m long quadrant of floor space of 7.5m width (this totals to the correct 188m distance for all four quarters of floor space and a 1,410 m^2 total floor area). With a fire that eventually met its tail as it wrapped the entire open-plan area of the 12^{th} floor in 65 minutes, it is straightforward to simply calculate the average speed of the leading edge of fire spread at **22m^2/min** or **48.2mm/s** (0.048m/s).

The importance here is that although the research to date is extremely useful and may innovate future structural design, without referencing and calculating more accurate 'real' fire spread rates, which appear much faster than those in research fires, the outcomes of far-field and near field temperature exposures on critical primary and secondary beams and columns may not be most accurately represented.

The reader is recommended to search for articles and academic papers on ‘travelling fires’ for further information.

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