Construction trends – impacts, challenges and opportunities through research

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Trend in fire deaths in the UK since 1981

Figure 1.4: Fatalities from fires, Great Britain, 2000/01 – 2011/12

- Fire related deaths

p = provisional
Some regulatory changes

- Smoke alarms (1992)
  - 8% in 1988
  - 74% in 1994
  - 86% in 2008

- Furniture and furnishings fire safety regulations introduced in 1988
  - Match resistance
  - Cigarette resistance

- Reduced ignition propensity cigarettes
  - Mandatory in EU countries from November 2011
  - Impact not yet clear

- Construction Products Regulation
  - Mandatory CE marking for all construction products placed on the market in EU countries from 1st July 2013
Our world is continuing to change

- Most significant changes in building technology have been occurring over the last 20 years
- Moved from traditional construction (e.g. masonry, heavy) to more lightweight, easier and faster to construct
- Driven by needs to;
  - Reduce energy consumption during use
  - Reduce waste during construction and use
  - Reduce end of building life environmental impact by consideration and focus reduction of hazardous materials, recycling and re-use
New construction technologies
Some issues we face

- No historical database available to assess performance of new systems, construction methods
- Possibility of systematic faults/poor quality of installation
- Use of new materials (in particular increasing use of highly insulating combustible materials to reduce energy demand)
- New methods for testing and benchmarking fire performance of products and systems
- New requirements for air tightness in buildings
- Levels of safety and property protection unknown
- Possibility of disproportionate damage
Impact of insulation on compartment temperatures
(U values 0.8 to 3 W/m²/°C)

Research opportunities

- To assess impacts, support innovation and resolve challenges
- Maintain or improve safety levels
- Reduce fire losses from property damage and business interruption

The following is an example of a recent research study that we have undertaken to determine whether it is cost effective to install and maintain fire sprinklers in warehouses in England and Wales

- First detailed study that considers the sustainability aspects within the analysis i.e. environmental, societal and economic impacts
Sprinklers in warehouses

- The first part of the project was a “cradle to site” assessment of an ‘average’ warehouse fire, considering both the environmental impacts and the monetary costs.

- The second, larger phase of our research, which was the primary focus of the study, looked at a whole-life cost benefit analysis for the installation of sprinklers, for three ranges of warehouse sizes.
Life cycle stages using BRE Methodology to calculate Ecopoints

- Production
- Construction
- Use
- End of life
Contents specification for the case study warehouse

50% class II commodity (non-combustible contents in heavy carton) and 50% standard plastic (combustible plastic contents). The content loading was assumed to be 75% of the total warehouse capacity.
Ecopoints results

15,000 m² GIA Case Study Warehouse

Ecopoints per m²

- Warehouse without sprinkler
- Warehouse with sprinkler
Whole life cost benefit analysis

- Generic warehouse buildings were categorised in three size ranges:
  - small, 0 to 2,000m²,
  - medium, 2,000m² to 10,000m² and
  - large, greater than 10,000 m².
- The frequency of fires per (building.year) were estimated from the statistics for the number of buildings of a given type, the estimated proportion with sprinklers, and the number of fires observed.
- Consequences expressed in terms of:
  - Fire and smoke damage
  - Deaths and injuries
  - Carbon dioxide emissions or embodied carbon dioxide
  - Water usage
  - Unemployment
- Monte Carlo calculation method was developed and applied to this problem
### Results – Breakdown of average costs considered

<table>
<thead>
<tr>
<th>Quantity</th>
<th>“Small” warehouse (&lt; 2,000 m²)</th>
<th>“Medium” warehouse (2-10,000 m²)</th>
<th>“Large” warehouse (&gt; 10,000 m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No sprinkler</td>
<td>Sprinkler</td>
<td>No sprinkler</td>
</tr>
<tr>
<td>Cost of total area damaged</td>
<td>£116,427</td>
<td>£37,540</td>
<td>£1,511,289</td>
</tr>
<tr>
<td>Cost of injuries</td>
<td>£658</td>
<td>£1,692</td>
<td>£2,217</td>
</tr>
<tr>
<td>Cost of fatalities</td>
<td>£6,602</td>
<td>£17,665</td>
<td>£23,228</td>
</tr>
<tr>
<td>Cost of CO₂ released in fire</td>
<td>£202</td>
<td>£20</td>
<td>£2,661</td>
</tr>
<tr>
<td>Cost of CO₂ embodied in replacement</td>
<td>£537</td>
<td>£52</td>
<td>£7,081</td>
</tr>
<tr>
<td>Cost of water used in firefighting</td>
<td>£5,017</td>
<td>£3,609</td>
<td>£8,376</td>
</tr>
<tr>
<td>Cost of CO₂ embodied in rebuild</td>
<td>£106</td>
<td>£13</td>
<td>£866</td>
</tr>
<tr>
<td>Cost of unemployment</td>
<td>£15,818</td>
<td>£1,822</td>
<td>£196,268</td>
</tr>
<tr>
<td><strong>Total costs</strong></td>
<td>£145,364</td>
<td>£62,410</td>
<td>£1,751,983</td>
</tr>
</tbody>
</table>

(Values quoted in 2010 prices, and based on best estimates of fire and smoke damage costs)
## Results – Average whole life costs (warehouse buildings)

(Values quoted in 2010 prices, and based on best estimates of fire and smoke damage costs)

<table>
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<tr>
<th>Quantity</th>
<th>“Small” warehouse (&lt; 2,000 m²)</th>
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<th>“Large” warehouse (&gt; 10,000 m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No sprinkler</td>
<td>Sprinkler</td>
<td>No sprinkler</td>
</tr>
<tr>
<td>Total cost of fire</td>
<td>£21,895</td>
<td>£16,059</td>
<td>£845,065</td>
</tr>
<tr>
<td>Cost of insurance over lifetime</td>
<td>£32,630</td>
<td>£16,315</td>
<td>£139,604</td>
</tr>
<tr>
<td>Total cost of sprinklers</td>
<td></td>
<td>£66,349</td>
<td></td>
</tr>
<tr>
<td>Total Whole Life Costs</td>
<td>£54,525</td>
<td>£98,722</td>
<td>£984,669</td>
</tr>
</tbody>
</table>
Conclusions 1

- For warehouses larger than 10,000m$^2$, the average whole life costs for buildings with sprinklers are between 2 and 5 times smaller than the corresponding average costs for buildings without sprinklers. A similar level of cost-effectiveness was found for warehouses between 2,000 and 10,000m$^2$ in area.

- Sprinklers were, on average, not cost-effective in warehouses with an area below 2,000 m$^2$. The lifetime referred to is that of the sprinkler system, which is on average, 45 years.
Conclusions 2

– There is an overall net environmental benefit to installing sprinklers including a reduction in CO₂ emissions from fire, reduced size of fire, reduced quantities of water used to fight fire and resultant embodied CO₂ savings from contents replacement and warehouse rebuild.

– It is estimated that 20% of warehouses between 2,000 and 10,000m² in area are fitted with sprinklers. For warehouses above 10,000m² in area, the estimated fraction with sprinklers is 67%. In a hypothetical scenario where all warehouses above 2,000m² in area are fitted with sprinklers, the study indicates that the annual saving in the UK could be between £60m and £210m.

– Full version of final report available at:

Finally….

– Investing in solving fire protection problems through research and collaboration
  – In 2003, the first BRE University Centre of Excellence was set up here at Edinburgh – BRE Centre for Fire Safety Engineering
  – Through education and research, the BRE Trust (a charity) promotes and supports excellence and innovation in the built environment for the benefit of all
    • Funding has been provided to support
      – Chair of Fire Safety Engineering (Prof. Jose Torero and now Prof. Albert Simeoni)
      – 12 PhDs – the next generation of leaders in the field
Thank you for listening

– Any questions?

– Acknowledgements to colleagues at BRE;
  – Richard Chitty
  – Jeremy Fraser-Mitchell
  – Owen Abbe
  – Corinne Williams