



STEEL INDUSTRY  
GUIDANCE NOTES

# Steel in fire

Steel is the most comprehensively fire tested of all structural framing materials. Over the past twenty years, the steel construction sector has carried out over a hundred individual fire tests. These include large-scale tests, which have demonstrated the behaviour of fire in real buildings.

## 1. Building Regulations

The Building Regulation requirement for fire is stated as: "The building shall be designed and constructed so that, in the event of a fire, its stability will be maintained for a reasonable period."

In England & Wales, an Approved Document approach is used to satisfy this requirement. The relevant Approved Document is B in which a combination of building occupancy and height determine the required fire resistance. This can vary from 15 to 120 minutes but the dominant period by far is 60 minutes.

## 2. What does 60 minutes fire resistance mean?

When a building has 60 minutes fire resistance, it doesn't mean that it will necessarily collapse after 60 minutes if there is a fire in the building. It means that, if the fully loaded structural elements are subjected to a standard fire test, outlined in BS476, it will fail after that time. However, very few fires are as severe as the standard fire and this fact, combined with additional capability due to the structural continuity and robustness to be found in most multi-storey buildings, means that there is considerable conservatism in most of our fire precautions.

## 3. The Inherent Fire Resistance of Steel Sections

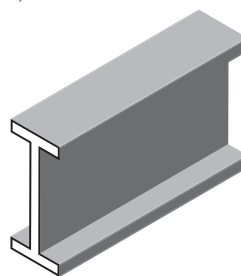
Fire resistance is expressed in units of time so one of the contributory factors to fire resistance is the heating rate of the member; this governs the time taken to reach its failure (or limiting) temperature and varies according to the dimensions of the section. Clearly, a heavy, massive section will heat up more slowly (and thus have a higher fire resistance) than will a light, slender section. (see figure in next column)

For unprotected hot rolled steel beams and columns the inherent fire resistance varies between 10 and 45 minutes.

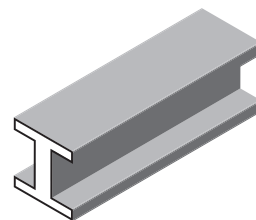
### Hp/A concept

The heating rate of a steel section in a fire depends upon

- The perimeter of the steel exposed to flames - Hp
- The cross sectional area of the section - A



High Hp / Low A = Fast heating



Low HP / High A = Slow heating

## 4. Building in Fire Resistance

Some forms of steel construction have fire resistance built-in and may require no added fire protection. The most popular methods are Slimdek and concrete filled tubes both of which can have 60 minutes inherent fire resistance. Fire resistance built into the structure in this way can never be compromised.

## 5. Passive Fire Protection

Passive fire protection materials insulate steel structures from the effects of the high temperatures that may be generated in fire. They can be divided into two types, non-reactive, of which the most common types are boards and sprays, and reactive, of which intumescent coatings are the best example.

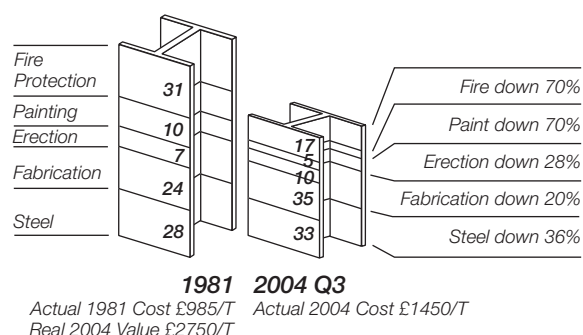
Intumescent coatings now dominate the market for structural fire protection. They are generally thin film, paint like coatings which are inert at low temperatures but which provide insulation by swelling to provide a charred layer of low conductivity materials at temperatures of approximately 200-250°C.

Improvements in technology in recent years have reduced coating thicknesses considerably and intumescent are increasingly cost competitive for up to 90 minutes fire resistance. Intumescent can also be applied off-site in factory conditions before the steel is erected. Steel manufacturer Corus estimates that some 75,000 tonnes of structural steelwork was given fire protection during factory based operations in 2005. That represents some 35% of the total market for intumescent fire protection.

After intumescent coatings, boards dominate the remainder of the structural fire protection market.

## 6. The Cost of Fire Protection

Fire protection for structural steelwork used to be a cost factor that could sometimes swing projects towards other materials. But over the past 20 years the cost of protection has fallen by some 70% in real terms.



## 7. Advanced Design Methods for Fire

At the same time as costs have been falling, fundamental research into the nature of real fires in buildings, allied to advances in structural engineering, have led to the development of design methods which allow secondary beams in composite metal deck construction to be left unprotected.

## 8. Fire Safety Engineering

The increasing use of fire safety engineering has resulted in the fire ratings of many tall and/or complex buildings being reduced without compromising the safety of the building or its occupants. This has resulted in a significant reduction in the numbers of buildings in the UK requiring the maximum, 120 minute, fire rating.

## 9. Reinstatement

Where a fire does occur in a steel framed building, reinstatement may be simple and straightforward. After a fire in Broadgate in 1990, the structural repair was less than 5% of the overall cost. This should be seen as a marked contrast to the concrete frame of the Windsor Torre Fire, which is being torn down after its recent fire due to concerns with the structural integrity of the reinforced concrete after the fire.

## Key Points

- Fire Resistance Periods
  - When a building has one hours fire resistance, it doesn't mean that it will necessarily collapse after 60 minutes if there is a fire. There is a great deal of inbuilt conservatism in fire precautions.
- The Inherent Fire Resistance of Steel Sections
  - The inherent fire resistance of unprotected hot rolled steel beams and columns varies between 10 and 45 minutes.
  - This figure can be rapidly improved by utilising the built in protection offered by systems such as Slimdek
- Passive Fire Protection
  - can be divided into two types, non-reactive, of which the most common types are boards and sprays, and reactive, of which intumescent coatings are the best example.
- The Cost of Fire Protection
  - Over the past 20 years the cost of fire protection has fallen by some 70% in real terms.
- Designing for Fire
  - The use of Fire Engineering techniques can
    - reduce the fire period of complex buildings
    - remove the need for fire protection of secondary steelwork
- Reinstatement
  - For a steel framed building, reinstatement after a fire is normally simple and straightforward.

## Further sources of Information

[www.corusconstruction.com/structuralsteel](http://www.corusconstruction.com/structuralsteel)  
[www.structuralfiresafety.org](http://www.structuralfiresafety.org)