

Uncovering some hidden dangers behind common methods of protecting steel from fire

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SUMMARY

Several of the products and techniques currently used in the construction industry to provide passive fire protection for steelwork have certain weaknesses that can prevent them from working properly and sustaining the period of fire protection as stipulated by law.

This paper highlights the principal problems that can arise with different forms of conventional insulation—and appeals to all those parties involved in the specification and installation process to apprise themselves of the relevant facts and findings.

The author also examines epoxy intumescent as a medium that possesses the potential of overcoming many of these drawbacks.

KEY WORDS: thin-film intumescent; overcladding; secondary cladding; concrete-filling; slurry-filled columns; test criteria BS476 (parts 20 & 21); epoxy intumescent

DISCUSSION

There is an increasing need for all specifiers and installers of passive fire protection treatments and systems to ensure they comply with existing legislative requirements. The principal considerations covering this area are laid down in Appendix A of Approved Document B to the Building Regulations (for England and Wales) or Technical Standards, Part D (for Scotland).

Recently, question marks have been raised over the true efficacy of certain techniques commonplace in the construction industry. The ASFP, for example, have recently issued an advisory notice concerning ‘the overcladding of thin-film intumescent on steel sections’. It is important that all such concerns are brought to the attention of all parties involved in both the specification and installation of fire protection products—architects, structural engineers, contractors and sub-contractors alike.

The key concern is to establish what flaws might exist that could compromise the integrity of a particular system and prevent it from providing full and functional fire protection.

First, let us look at a couple of traditional ways of treating circular columns to assist fire protection.

‘Concrete-filling’ is one such method. This may have the benefit of reducing the fire protection requirement of the steel surface (and so maximize the usable space in a building) but the process is hardly straightforward. For a start, structural engineers need to be consulted to determine the stress and load on the column or beam. It may also be necessary to add reinforcing bars within the steel tube and, dependent on the structural requirements, these may need to be pre-stressed.

In addition, the concrete must be vibrated to release the air to achieve the correct density (circa 41 Nm.) This limits the size at which concrete filling can be used, as the vibration unit needs to be placed all the way down the centre of the column. Corus have produced an instructive software package for this application.

The purpose of the concrete filling is to replace the steel section when it has lost its structural strength through heat. Corus advise that serious consideration be made to any construction less than 219 mm diameter.

A 20 mm hole, drilled through the steel into the hollow section is required at the base and just underneath the start of the floor above—or at 4 m intervals—whichever is the lesser distance. The bottom hole is to allow the drainage of excess water. The upper hole is to allow steam to escape during the heating process in a fire that could otherwise rupture the steel section prematurely.

The alternative method of ‘slurry-filled’ columns is also well used. But this system has not apparently been subjected to test in accordance with BS476. The method in question is only assumed to work! Specifiers should ask themselves

how the column would survive, bearing in mind that concrete filling is compacted to achieve circa 41 Nm. All fire protection systems should be tested to BS476 (parts 20 & 21) and data for load testing is given in BS490.

Arguably, the most popular procedure for fire protection currently utilized is that of applying a thin-film intumescent coating to the steel prior to over-cladding it with a conventional board system.

On the face of it, this sounds like a thorough enough solution. It is certainly simple. However, there are some potentially critical drawbacks to take into account.

Intumescent coatings act by swelling up under fire conditions to form an insulating char. The expansion of thin-film intumescent is quoted at generally 50 – 75 times thicker than the original coating. This means that cladding systems fixed too close to the coated steel may inhibit the swelling characteristics of the thin-film intumescent—and so reduce or negate its fire protective properties (see figure 1). The thickness of the activated intumescent material is crucial to the protection it provides. Likewise, whilst cladding systems may be designed to fall away in the event of a fire, if this does not occur before the commencement of the thin-film intumescent swelling process, it may also inhibit the performance of the fire protection.

Moreover, cladding systems often require fixings to be fastened to the steel and such fixings may again inhibit the swelling process of the thin-film intumescent and render the protection inadequate.

The crux of the problem is that all too often the raw material manufacturer fails to recommend sufficient space to be allowed between the surface of its thin-film intumescent and the inside of the secondary cladding. In fairness, this could be due to insufficient information given by the enquirer to the manufacturer. Little wonder, then, that the integrity of such a system can be easily breached.

Neither is this scenario confined to purely commercial buildings. Many modern private developments incorporate circular hollow sections in open-plan spaces such as large kitchen/dining areas. The usual method of fire protection here is to use thin-film intumescent on the column to provide the required insulation.

The trouble is that the final occupant is unlikely to know what maintenance and repairs are needed to keep the protection intact. Failure, for example, to keep the top seal in good order will mean the thin-film intumescent beneath the decorative coating will break down over time and the integrity of the system therefore seriously compromised. And after damage or degradation has occurred, would the occupier know to reinstate the protective coating properly?

Similarly, the integrity of a fire tested board system (a commonly used and economical method of protection to structural steel) is again dependent on the board not being damaged over time. A cracked board needs to be replaced. And what reduction in performance will result from damage to corners that have not been reinforced? The replacement can be expensive, particularly if the material is used for a feature column that has also been plastered.

Owners or tenants need to be made aware that any warranty is dependent on regular maintenance checks—and that insurance cover in the event of a fire could be badly jeopardized if fire protection is not properly maintained.

Mistakenly, many believe thin-film intumescent or fireboard to be one of the cheapest methods too. However, over the lifetime of a building, regular maintenance and repair costs can exceed by a substantial degree the initial cost of a more robust and durable system.

So, what can be done to prevent all these potential pitfalls and possible malfunction of the fire protection properties of such systems?

An obvious answer is to use a medium that is sufficiently robust, but also flexible enough in application to overcome the limitations of ordinary thin-film intumescent and other conventional ways of fire protecting hollow (and other steel) sections.

One material that fits the bill is epoxy intumescent, originally developed for use on offshore oil rigs. In this environment, the formulation proved quite capable of withstanding chemical attack, abrasion, corrosion, and major impact. Significantly, this material is not dependent on the top decorative coat for the system to work over time.

The benefits of using epoxy intumescent in a commercial fire protection environment are pronounced: superior longevity, durability and flexibility of finish.

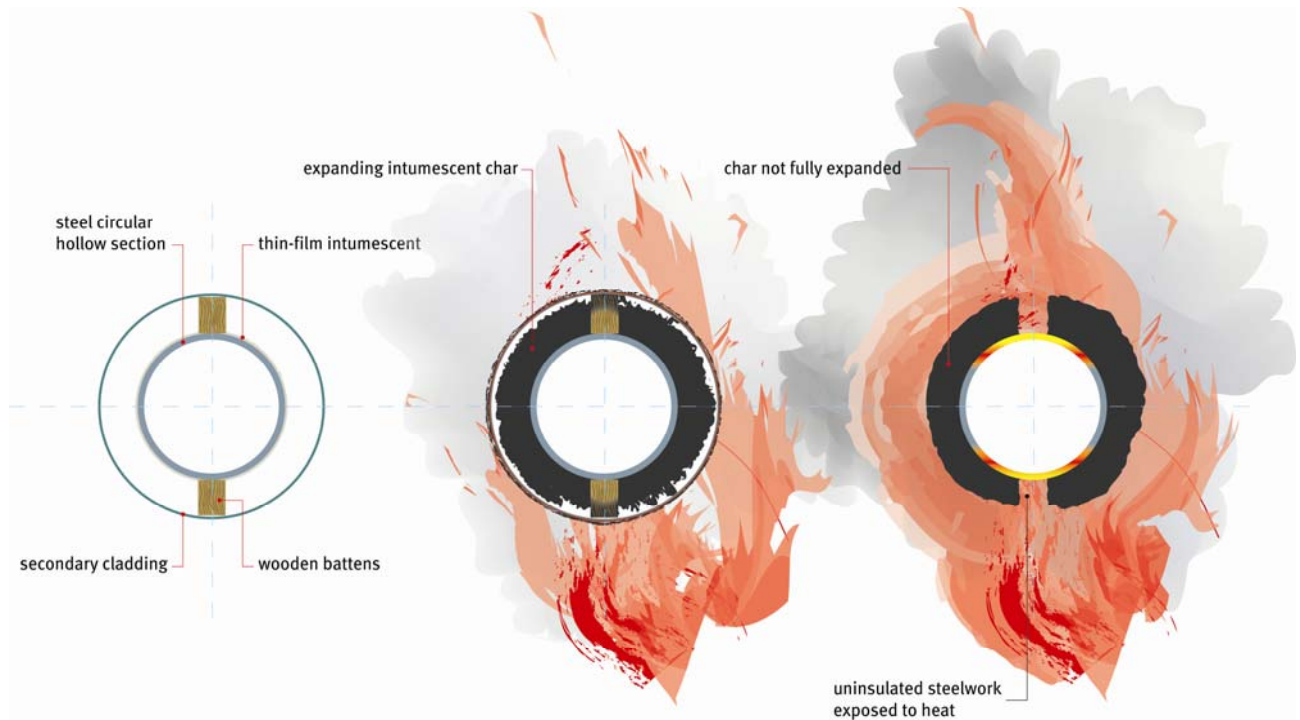
Typical key data and substantiations for epoxy intumescent, are as follows:

- tested to BS476 (parts 20 & 21)
- tested in both cellulosic and hydrocarbon conditions (up to 4 hours)
- certificate of approval from Lloyd's
- supported by Warrington Fire Research

- jet fire test by SINTAF (Norway)
- blast test by Building Research Establishment (Cardington)

Given all these stringent test performances and certifications, it is clear how the basic material of epoxy intumescent can be deployed as a top quality fire protection medium in the construction industry.

If architects and other specifiers are going to be able to recommend a method of fire protection that is relatively easy to apply and guaranteed to deliver an optimum level of efficacy over the lifetime of a structure, then epoxy intumescent must surely feature in such systems in the future.



Bearing in mind the expansion of thin-film intumescent is something like 50 – 70 times thicker than the original coating, insufficient space is allowed here between the surface of the intumescent and the inside of the secondary cladding. Also, wooden battens are used to attach the cladding to the steelwork.

In the event of a fire, the thin-film intumescent fails to reach its full insulation value as the battens and the proximity of the cladding prevent it from fully expanding. The thickness of the activated intumescent is crucial to the protection it provides.

As the battens fall away, the steelwork is left uninsulated and fully exposed to the heat. This results in critical temperature levels being attained in substantially less time than the designed fire protection period.

Figure 1. Example performance of the thin-film intumescent passive fire protection on a secondary-clad circular hollow section in the event of a fire.

CONCLUSIONS

Architects, structural engineers, contractors and sub-contractors all need to be aware of the pitfalls of conventional passive fire protection techniques—and fully realize the possible liability ramifications in the event of the operational failure of any of these systems.

Approval bodies too ought to be mindful of such eventualities and the problems that can arise during construction if the wrong method of protection is specified.

All parties should consider the particular qualities of epoxy intumescent and its potential application as a medium for fire protection in the future.

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FAGUS Fire Safety Consultancy was established to provide a comprehensive range of fire safety services to commerce and industry.

FAGUS's sensitive, client-based approach is suited to large and small companies, whatever their needs. They help companies meet the increasing burden and difficulties that fire safety legislation can impose on business.

FAGUS is able to draw upon the experience and expertise of a number of established fire safety professionals, and so is able to offer a complete service. FAGUS can offer web-based fire risk assessment reports and fire safety management systems, so essential for those with large property portfolios; FAGUS can support the building design process to help cut costs or reduce the impact of compliance requirements; FAGUS will assist in fire policy development and train senior managers in their responsibilities.