IGSB-INFO 1

FIRE PROTECTION COATINGS IN STEEL CONSTRUCTION

IGSB
ASSOCIATION FOR FIRE PROTECTION COATINGS

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Editorial

The IGSB is an association of renowned companies in the field of fire protection coatings. It has set itself the goal of providing information about modern intumescent coating systems (which foam up in case of fire), promoting their use, and serves as a center of expertise for all questions related to passive fire protection of steel and other construction materials.

For more than 10 years, its members have been exchanging information on current topics during regular meetings and bundling information that is helpful for the use of fire protection coatings in steel construction. This includes current trends, testing methods, research projects, and regulatory issues - both in Germany and internationally. The IGSB maintains close contact with architects, designers, steel and coating manufacturers, authorities, and testing institutes.

There is knowledge that is only relevant for very specific target groups. The IGSB, as an industry association, makes this expert knowledge available by connecting specialists from different areas of intumescent coatings. A quick and simple exchange of information and the bundling of expertise, as well as innovations as a driving force, are essential for success, including in steel construction and coating technology.

Fire protection through intumescent coatings is extremely popular among planners and architects due to the fulfillment of the highest aesthetic requirements and maximum flexibility. With this technology, design-defining structures can be preserved while simultaneously ensuring compliance with all fire protection regulations.

In case of fire, the function of load-bearing steel elements can be maintained for up to more than two hours. This gained time serves to save lives.

In this brochure, we provide an overview of the current technical state of the field of steel fire protection coatings. The advantages, structure, and mode of operation of intumescence are explained, and possible areas of application are discussed in more detail.

For further detailed information, visit our website at www.igsb.eu and learn about numerous projects where steel fire protection materials have been successfully used. Here you will also find the opportunity to contact us directly as well as our current FAQs with tips and assistance on questions related to fire protection.

IGSB – Because every second counts!

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Introduction

What are fire protection coatings?

The case “fire” presents a special challenge for the supporting structure of a building. To counteract the negative effects of a fire, a fire protection concept specifically tailored to the building’s use must be created.

Steel itself is not combustible and does not emit harmful gases when exposed to fire. It therefore does not contribute to the fire load of a building; however, the load-bearing capacity of steel components can decrease in case of fire. If the time until the critical temperature of the component is reached does not correspond to the fire resistance duration required by building regulations, protective measures are necessary.

Intumescent coatings, more specifically intumescent fire protection paints, are among the passive fire protection measures. They ensure that steel structures are protected in case of fire by extending the time until the critical temperature (Tcrit) is reached. Depending on the type and load of the components, this critical temperature is approximately 500 to 750 °C.

Historical Development

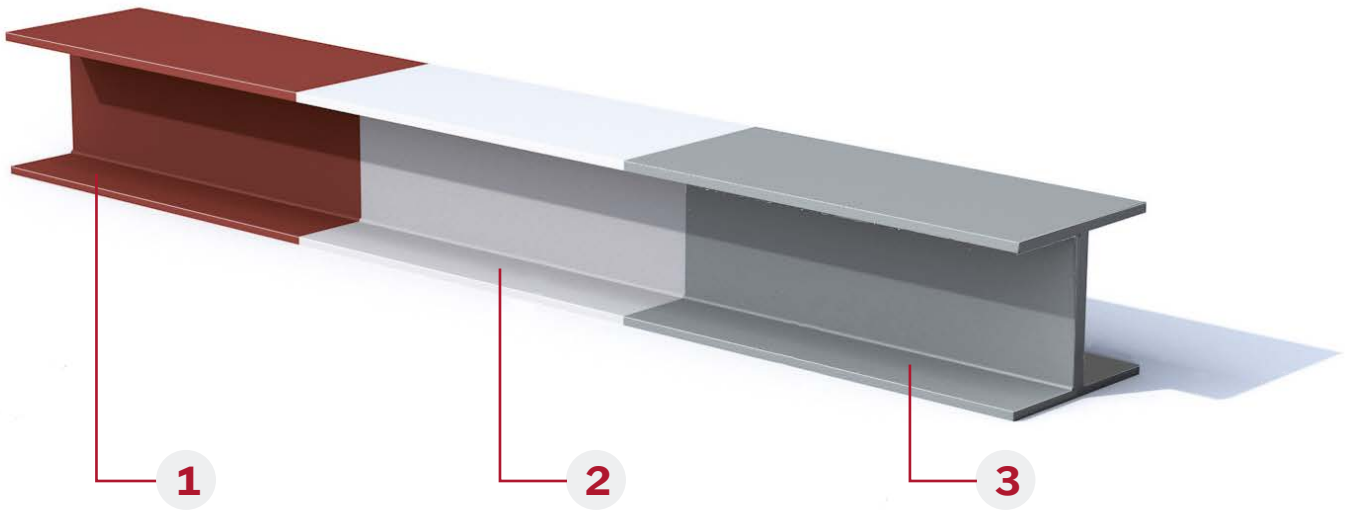
Foaming (intumescent) coatings have been used for over fifty years to protect steel structures from excessive heat exposure. Since then, they have been and continue to be consistently developed further to meet the highest design, visual, technical, as well as health and environmental requirements.

A water-based fire protection coating protects the steel structure of the building “Berliner Bogen”, completed in 2001, an eight-story office building with 43,000 m² gross floor area.

Multiple layers for perfect protection

Depending on the system, a fire protection coating consists of up to three perfectly coordinated layers. The products forming a fire protection system are specified in the respective approval or authorization. In a three-layer structure, the individual products fulfill different tasks (see box).

A three-layer fire protection coating consists of a primer, the intumescent coating, and a topcoat.



Basecoat
The base coating primarily serves as corrosion protection and as an adhesive base for the intumescent layer. Some intumescent coatings also act simultaneously as corrosion protection, so that with these intumescent coatings, the base coating can sometimes be omitted.

Intumescent coating
The intumescent coating represents the core of the coating system. In case of fire, the applied layer ensures the long-term load-bearing capacity of the component. The necessary coating thickness depends on the type and utilization of the components and on the required fire resistance time.

Topcoat
The final topcoat serves for coloration and protection of the intumescent coating against weathering and mechanical influences. If desired, the topcoat can be omitted in interior spaces.

Ingredients

Fire protection coatings are solvent-free, solvent-based, or water-based coating materials.
The latter are primarily used in interior spaces with increased requirements for indoor air quality. Organic systems are used as binders - usually based on vinyl acetates, acrylates, or epoxides. Active substances are added to these, which react in case of fire to form an insulating "carbon foam" (see Fig. 6). The coloration, especially of the top coat, is achieved through added pigments.

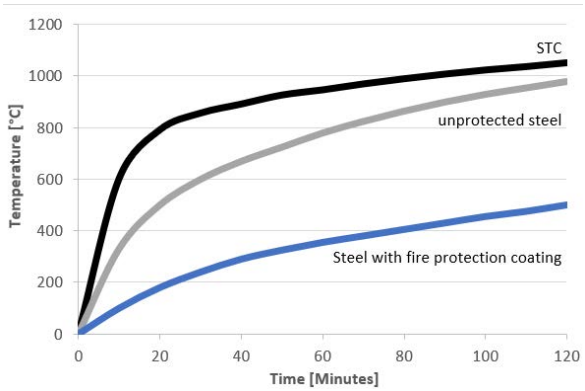
Ammonium polyphosphates, which are harmless to health, are used, among other things, as the basis for intumescent fire protection coatings.

In case of fire, fire protection coatings form an insulating carbon foam that delays the heating of the steel component.

Mode of Action

Structure of a protective intumescence layert
In case of fire, when a temperature of about 120 to 200 °C is reached, the intumescent coating foams up with a large increase in volume and forms a stable, fine-porous carbon foam. This process is also referred to as intumescence. Due to its very low thermal conductivity, the carbon foam insulates the component, causing it to heat up more slowly and extending the period until the critical temperature (Tcrit) of about 500 to 750 °C is reached.

As a main product, an inorganic layer of titanium pyrophosphates is formed due to the temperature exposure, which also has a very low thermal conductivity. Carbon dioxide and water are produced as by-products. Additionally, minimal amounts of ammonia, carbon monoxide, and nitrogen oxides are released in case of fire. However, due to their very low concentration, these can be neglected compared to the reaction products of the actual fire loads and do not pose an environmental or health hazard. To ensure that the intumescent coating can develop its full effectiveness in an emergency, adjacent components must not impede the foaming process. To prevent heat transfer, adjacent steel structures without fire resistance class must also be coated over a length specified in DIN 4102 (min. 30 cm).



The intumescent fire protection coating delays the heating of the steel component (schematic representation).

Advantages at a Glance

Design Freedom

- The profile-following coatings, only a few millimeters thick, **emphasize the filigree constructions of steel construction**.
- Thanks to their smooth surface, fire protection coatings do not differ from conventional coatings.
- The architect has no color limitations in planning. Topcoats are available **in all RAL or NCS colors, and special accents can be created using micaceous iron oxide DB colors.**

Flexibility and Versatility

- Depending on the system, a subsequent increase in the fire resistance class is possible, for example when building in existing structures.
- **Fire protection coatings can be applied in almost any environment,** even with particularly high requirements such as swimming pools or power plants**.**
- There are coating systems that can also be applied to cast iron or galvanized steel components.

The fire protection coatings, applied following the profile and only a few millimeters thick, emphasize the filigree constructions of steel construction

Technical and Economic Quality

- The quickly drying, impact-resistant coatings **combine corrosion and fire protection with long fire resistance durations of up to three hours (R180).**
- The cost-effective intumescent coatings contribute significantly to maintaining a building's value.
- A coating can be applied on-site or in the workshop. Workshop coating allows for particularly short, weather-independent installation.
- **Fire protection coatings are virtually maintenance-free throughout their long service life.**
- Due to their low weight, fire protection coatings do not need to be considered in structural calculations.

Good for People, Good for the Environment

- **The variety of protection systems allows for targeted selection based on health and ecological criteria.**
- For coating in interior spaces, there are particularly low-emission systems that also meet the high requirements of sustainability and building certifications.
- The thin coating layers avoid protection measures that require extensive materials or resources.
- Fire protection coatings help to gain time and thus save lives!

Planning Principles

Application Requirements

Fire protection coatings are excellently suited for making both simple and complex steel structures fire-safe. There are hardly any limits to their application.

Many coating systems are suitable for areas with high requirements, such as hospitals, kindergartens, or food processing facilities. Appropriate products are also available for highly demanding areas such as power plants, petrochemical facilities, or indoor swimming pools.

Fire protection coatings can also be used in existing structures. If necessary, prior cleaning of steel or cast iron components by sand or dry ice blasting may be required. With appropriate product selection and preparation, existing fire protection classes can even be upgraded retroactively.

Approvals and Consent in Individual Cases

In the approvals and authorizations, for which the coating systems for use in occupied rooms undergo environmental and health testing, the scope of application of the fire protection coatings is clearly defined.

Some areas of application are not regulated by general approvals and authorizations. Up-to-date information on this is always available on the website www.igsb.eu.

The ten-story "Deichtor Center" building, constructed in 2002 in Hamburg's HafenCity, is protected by an F30 fire protection coating.

Economic Efficiency

Production costs

The following guideline prices were determined based on typical buildings with medium fire load and can serve as an initial orientation. Since many factors (e.g., accessibility, coating thicknesses, and application method) need to be considered in cost determination, manufacturers should be consulted for precise calculations.

Life cycle costs

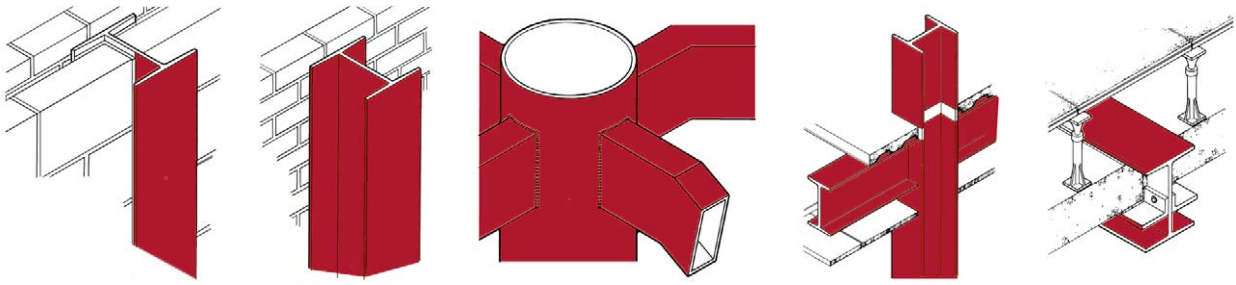
Thanks to their durability, the virtually maintenance-free coatings have low life cycle costs. Over the assumed service life of the building, therefore, no or only very minor additional costs are to be expected.

Passive fire protection in €/m²	Target fire resistance class		
	R30	R60	R90
Shop application	23–36	55–78	91–130
Site application	19–32	49–71	84–123

Guideline prices for fire protection coatings in €/m² of steel surface to be coated (Source: bauforumstahl e.V. "Costs in Steel Construction 2024"))

Surface area calculation

For cost determination, only the surfaces to be coated are considered. Components that are not exposed to fire, for example due to integration into a reinforced concrete ceiling or masonry, do not need to be coated. The adjacent figures show some examples.



For cost determination, only the coated surfaces (red) are to be considered.

Product Selection and Coating Thicknesses

The right system for every application
Which fire protection systems are suitable for the specific application and how thick the individual layers need to be depends on several factors. Therefore, the framework conditions must first be determined, for example based on the following questions.

1. Indoor or outdoor application??
While a topcoat can often be omitted for indoor applications, unless desired for design reasons, such a coat frequently needs to be applied in outdoor areas.

2. Which fire resistance class is required?
Fire protection coatings can achieve fire resistance classes from R15 to R180. Typically, protection classes in the range of R30 to R120 are required. (Note: The German designations F30, F60, etc. are being replaced by the designations R30, R60, etc. as part of European standardization.)

3. Are there corrosion protection requirements?
Fire protection coatings can provide corrosion protection and achieve all corrosion protection classes according to DIN EN ISO 12944.

4. What substrate properties are present?
If the component is galvanized, already coated, or made of special material (stainless steel, cast iron), the suitability of the fire protection system must be considered.

5. What type of profile is it?
Since thin and closed profiles heat up more quickly, they require a greater coating thickness than thick open profiles. The coating thickness required for each component is determined based on the profile factor (U/A value).

The required coating thickness is determined, among other things, by the profile factor (U/A value): Thin or closed steel components heat up more quickly and therefore require a somewhat thicker protective coating than thick open profiles.

6. Coating in the factory or on-site?
Factory coating offers many advantages: It is weather-independent, can be carried out parallel to construction, and is generally more cost-effective than on-site application. Thanks to particularly impact-, shock-, and abrasion-resistant products, transport damage requiring subsequent repairs is minimized.

7. What color should the component be?
The color-giving topcoat is available in all RAL, NCS, and DB color shades, thus offering the greatest possible design freedom.

All RAL and NCS color shades can be chosen for color design. In addition, special accents can be created with DB color shades containing micaceous iron oxide.

8. Is building certification planned??
Modern sustainability certificates also place high demands on indoor air quality, among other things. The certification system of the DGNB. (German Sustainable Building Council), for example, rates low-emission products that enable particularly high indoor air quality very positively in the quality levels. Low-emission, VOC- and halogen-free fire protection coatings help to meet these high requirements.

Support from Manufacturers

The coating thicknesses to be applied depend on the product and are specified in the respective approvals or data sheets from the manufacturers.

Some manufacturers provide free computer programs for initial calculations of the required coating thicknesses.

In addition, manufacturers and coating companies also offer comprehensive project-related consulting services. For example, they calculate U/A values not specified in the respective profile tables and determine the required coating thicknesses based on drawings or parts lists.

For complex constructions, the member companies of the IGSB are happy to assist with product selection and determining the required coating thicknesses.

Application and Maintenance

Application and Quality Assurance

Execution/Application

As a rule, particularly smooth and economical coatings can be achieved using the airless spray method. Alternatively, the coating can also be applied by brushing or rolling, for example on small surfaces.

The application of the coating system can be carried out in the factory or on the construction site: If the components are coated at the factory, they must be protected from damage during transport and storage. Fasteners must be painted over with a brush after complete assembly. When coating on site, care must be taken to ensure that the components are protected from weather influences until all layers are completed and that adequate ventilation is ensured.

Since the application properties always depend on the product, more detailed information can be found in the corresponding data sheets from the manufacturers.

Quality assurance

Fire protection coatings must function reliably in an emergency. Therefore, optimal product quality is already ensured through demanding approval and authorization procedures as well as through regular internal and external monitoring of the manufacturers.

The application of the coating system may only be carried out by companies that have been instructed in the product and certified, using trained, expert personnel. The coating applicator ensures, among other things, compliance with the prescribed climate conditions and measures and documents the applied coating thicknesses at regular intervals using a wet film thickness comb.

After curing, the dry film thickness of each of the two or three layers is checked using electromagnetic measuring instruments. After completion of all work, the coating applicator confirms that the intumescent coating has been applied in accordance with the approval.

The airless spray method ensures fast, uniform, and economical coating. It can be used both in the factory and on site.

The non-destructive measurement of the dry film thickness is carried out using electromagnetic measuring instruments.

Cleaning, Maintenance and Repair

Cleaning

Fire protection coatings are very easy to clean. Loose dust and other dirt can be removed manually or mechanically by blowing off, vacuuming, or light brushing.

Oily or greasy contaminants should be removed with a sponge or light water jet. Household cleaners can also be used and rinsed off with clean water. Depending on the product, cleaning with high-pressure cleaners is even possible. However, it is essential to consult the manufacturer or read the maintenance instructions beforehand. In any case, care must be taken not to damage the coating during cleaning.

Dirty fire protection coatings can be cleaned by blowing off, vacuuming, or light brushing. Some coatings can even be cleaned with a high-pressure cleaner.

Inspection and maintenance

Intumescent coatings are resistant to aging and can easily withstand minor mechanical stresses, such as normal deflection or temperature expansion. With professional application, their service life is therefore almost unlimited. However, care must be taken to provide appropriate protection against mechanical damage, for example from stored goods or vehicles.

To ensure fire safety, the owner is obligated to have the coated components, which are usually marked with stickers or in fire protection plans, visually inspected at regular intervals. Depending on the level of stress, this should be done at intervals of 1 year (e.g., industrial facilities) to 5 years (e.g., museums).

Note: Components that are not visible must be accessible for inspection and maintenance work. If this is not structurally possible, the procedure should be discussed with the responsible fire protection expert. Alternative solutions include installing inspection hatches or placing coated sample plates in exposed locations.

Damage the size of a 2-euro coin or larger should be professionally repaired without delay. When making repairs, care must be taken to select a product that matches the system. Smaller damages, however, do not pose a danger in case of fire.

Interessengemeinschaft Brandschutz-Beschichtungen e. V. (IGSB) sees itself as a competence center for all questions related to intumescent coatings and actively participates in important topics of standardization and related public discussions in order to inform IGSB members in a timely and current manner. At the same time, it also provides advisory support to all interested market participants on the topic of fire protection coatings.

IGSB

- advises building owners, planners, steel constructors, processors, etc. on questions related to technologies and products
- promotes the use of fire protection coatings
- provides support for planning and execution
- promotes and accompanies scientific collaborations
- builds an extensive range of information on the topic of "fire protection coatings in steel construction" on its website www.igsb.eu.

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