1 Passive structural fire protection

One key constituent of modern, passive structural fire protection are fire protection coatings. Whether steel, wood, or concrete components, special coating systems always come into play when fire protection requirements must be fulfilled without detriment to visual appeal.

Fire protection coatings are materials whose surfaces are barely distinguishable from paints. This holds true whether they are applied with brushes, rollers, or airless sprayers. In the event of fire, fire protection coatings protect not only steel, but also wood constructions and concrete components from structural failure. Also cables and cable trays are protected against combustion and malfunction. In combination with a joint sealing compound, they also serve as seals in walls and floors.

The fire protection effect is provided by a robust, heat-resistant carbon foam layer that forms at temperatures over 200 °C, protecting the coated components against overheating, combustion, and loss of their structural properties for a period defined in the product approvals. This period of time can be used to rescue persons and retrieve material assets from the structures treated with fire protection coatings.

Owing to their relevance to safety, fire protection coatings must comply with stringent market approval criteria. Training courses held on the manufacturer's premises familiarise customers with the products and their use, and certificates are issued.

Inadequately treated and incorrectly designed components can cause considerable damage in the event of a fire, hinder the rescue of persons and animals, and prevent effective firefighting. Every year, fires break out in 70,000 buildings in Germany, and every ten minutes there is a house fire. The lamentable tally is 450 deaths and 8,000 grievously injured. The corresponding fire protection requirements have been set down with legal force in § 4 of the MBO and in other ordinances, directives, and official decisions.

2 Steel fire protection

Steel and glass are the building materials of spectacular architectural achievements and so enjoy high demand for major building projects. In fulfilling the safety requirements for structural fire prevention, building projects must also preserve the aesthetic points of the design plans, so fire protection coating systems for steel are the first choice.

Although it does not burn, steel does lose its structural integrity at temperatures over 500 °C. Fire protection coatings applied to the profiles of sectional steel safeguard heat resistance for a defined period and hence the structural integrity of both open and hollow steel components.

Fire protection systems for steel are available as water- and solvent-based products for indoor and outdoor applications on open and hollow, corrosion proofed, and / or galvanised sections. They cover the DIN 4102 fire resistance classes F30 to F90 and the classes R15 to R150 under DIN EN 13501.

The foam insulant forms under the action of fire. This foam retards the passage of heat defined for each of the fire resistance classes. The products for the coating set-up are the primer (corrosion inhibitor), the fire protection coating (foam insulant), and the top coat, which must be applied as specified in the approval.

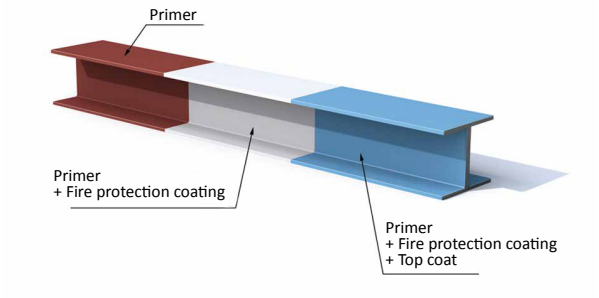
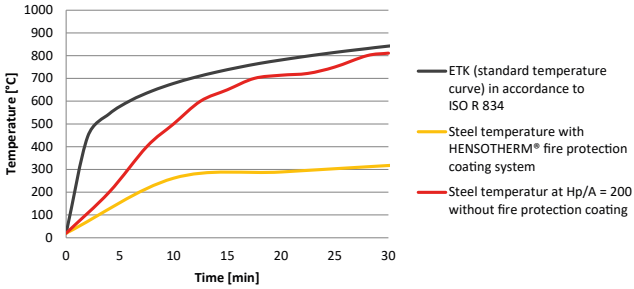


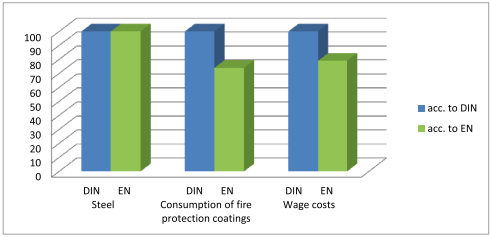
Figure depicts: Coating set-up on Sa 2.5 blasted steel

EN approvals for potential savings

Formerly, the testing directives and approval principles were based exclusively on national standards. In Germany, these included DIN 4102. For fire protection coating systems, this standard defined a limited number of section types together with their Hp/A value that are tested for a maximum fire resistance duration of 90 minutes (e.g. F30 max. 300 m^{-1}). The standard treated the fire behaviour solely at a critical design temperature of 500 °C. The testing furnaces were fired according to the standard temperature curve (ISO R 834). Once the thermocouples register the critical temperature on the test specimen, the achieved time is attested as a fire resistance duration for the applied dry thickness of the tested coating system, and the national technical approval abZ issued.

The tests under the European standard DIN EN 13381-8 for fire protection coatings and the classification into European Technical Assessments (ETA) under DIN EN 13501-2 now give rise to a virtually limitless potential for visually appealing steel components that enhance architectural detail and wealth, yet also fulfil the requirements of passive structural fire protection. The procedure described in the European test directive is far more differentiated than specified in the DIBt approval principles. Although conducted according to the **standard temperature curve (ISO R 834),** the material tests can be applied to a great many steel sections and record the results for design temperatures from 350 °C to 750 °C and various fire resistance durations.





The Figure depicts the potential savings as a comparison of **DIN** and **EN** approvals on an example open section with Hp/A = 127 m^{-1}

Advantages of **EN products R 60:**

- Reduction of the **coating quantity** of at least **– 45 %**
- Reduction of the **labour costs** (operations / handling) of at least **– 25 %**
- **Hp/A values > 400** for open sections: Beams (H/I sections) and columns

Advantages of **EN products R 90:**

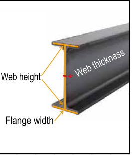
- Reduction of the **coating quantity** of at least **– 25 %**
- Reduction of the **labour costs** (operations / handling) of at least **– 20 %**
- **Hp/A values > 400** for open sections: Beams (H/I sections) and columns

The most important criteria affecting the decision on which structural fire protection system to use for a building project are ultimately cost effectiveness, design aspects, and, in an increasing number of cases, the issue of sustainability. Smaller steel sections, less applied quantities, and fewer operations save material costs and time. The heavier sway of costs makes HENSOTHERM® 421 KS an economical solution even for steel structures, when these do not have to be visible in the architecture. The EN tested coating system HENSOTHERM® 421 KS enhances the Hp/A value of beams (H/I sections), columns, and even hollow sections to 185 m^{-1} for fire resistance class R 90, and to 390 m^{-1} for fire resistance class R 60.

Sections – Section measurements

IPN Web thickness	t	5,9	6,8	7,7	8,6	9,5	10,4	11,3	12,2	13,1	14,1	15,2	16,2	17,3	18,3	19,5	20,5	21,6	23,0	24,3	25,6	27,0	30,0	32,4
IPN Flange width	w	42	50	58	66	74	82	90	98	106	113	119	125	131	137	143	149	155	163	170	178	185	200	215
IPN Web height	h	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400	425	450	475	500	550	600
Profile IPN		**80**	**100**	**120**	**140**	**160**	**180**	**200**	**220**	**240**	**260**	**280**	**300**	**320**	**340**	**360**	**380**	**400**	**425**	**450**	**475**	**500**	**550**	**600**
Hp/A (4-sided)		**402**	**349**	**309**	**276**	**252**	**229**	**212**	**196**	**183**	**170**	**158**	**149**	**140**	**133**	**125**	**119**	**113**	**107**	**101**	**95**	**91**	**85**	**76**

IPE Web thickness	t	5,2	5,7	6,3	6,9	7,4	8,0	8,5	9,2	9,8	10,2	10,7	11,5	12,7	13,5	14,6	16,0	17,2	19,0
IPE Flange width	w	46	55	64	73	82	91	100	110	120	135	150	160	170	180	190	200	210	220
IPE Web height	h	80	100	120	140	160	180	200	220	240	270	300	330	360	400	450	500	550	600
Profile IPE		**80**	**100**	**120**	**140**	**160**	**180**	**200**	**220**	**240**	**270**	**300**	**330**	**360**	**400**	**450**	**500**	**550**	**600**
Hp/A (4-sided)		**429**	**388**	**360**	**336**	**310**	**292**	**269**	**254**	**236**	**227**	**215**	**200**	**186**	**174**	**162**	**150**	**140**	**129**



HE-A Web thickness	t	8,0	8,0	8,5	9,0	9,5	10,0	11,0	12,0	12,5	13,0	14,0	15,5	16,5	17,5	19,0	21,0	23,0	24,0	25,0	26,0	27,0	28,0	30,0	31,0
HE-A Flange width	w	100	120	140	160	180	200	220	240	260	280	300	300	300	300	300	300	300	300	300	300	300	300	300	300
HE-A Web height	h	96	114	133	152	171	190	210	230	250	270	290	310	330	350	390	440	490	540	590	640	690	790	890	990
Profile HE-A (IPBI)		**100**	**120**	**140**	**160**	**180**	**200**	**220**	**240**	**260**	**280**	**300**	**320**	**340**	**360**	**400**	**450**	**500**	**550**	**600**	**650**	**700**	**800**	**900**	**1000**
Hp/A (4-sided)		**265**	**264**	**253**	**234**	**225**	**212**	**196**	**178**	**171**	**164**	**154**	**142**	**135**	**128**	**120**	**113**	**107**	**104**	**102**	**100**	**96**	**94**	**91**	**89**

HE-B Web thickness	t	10,0	11,0	12,0	13,0	14,0	15,0	16,0	17,0	17,5	18,0	19,0	20,5	21,5	22,5	24,0	26,0	28,0	29,0	30,0	31,0	32,0	33,0	35,0	36,0
HE-B Flange width	w	100	120	140	160	180	200	220	240	260	280	300	300	300	300	300	300	300	300	300	300	300	300	300	300
HE-B Web height	h	100	120	140	160	180	200	220	240	260	280	300	320	340	360	400	450	500	550	600	650	700	800	900	1000
Profile HE-B (IPB)		**100**	**120**	**140**	**160**	**180**	**200**	**220**	**240**	**260**	**280**	**300**	**320**	**340**	**360**	**400**	**450**	**500**	**550**	**600**	**650**	**700**	**800**	**900**	**1000**
Hp/A (4-sided)		**218**	**202**	**187**	**169**	**159**	**147**	**140**	**130**	**127**	**124**	**116**	**110**	**106**	**102**	**97**	**93**	**89**	**87**	**86**	**85**	**82**	**81**	**78**	**78**

HE-M Web thickness	t	20,0	21,0	22,0	23,0	24,0	25,0	26,0	32,0	32,5	33,0	39,0	29,0	40,0	40,0	40,0	40,0	40,0	40,0	40,0	40,0	40,0	40,0	40,0	40,0	40,0
HE-M Flange width	w	106	126	146	166	186	206	226	248	268	288	310	305	309	309	308	307	307	306	306	305	305	304	303	302	302
HE-M Web height	h	120	140	160	180	200	220	240	270	290	310	340	320	359	377	395	432	478	524	572	620	668	716	814	910	1008
Profile HE-M (IPBv)		**100**	**120**	**140**	**160**	**180**	**200**	**220**	**240**	**260**	**280**	**300**	**320/305**	**320**	**340**	**360**	**400**	**450**	**500**	**550**	**600**	**650**	**700**	**800**	**900**	**1000**
Hp/A (4-sided)		**116**	**111**	**106**	**100**	**96**	**92**	**89**	**73**	**71**	**70**	**60**	**79**	**60**	**60**	**61**	**61**	**63**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**