PROACTIVE FIRE TRENDS

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for Asia Pacific Building Industry Professionals

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Second Half, 2003

● New generation of non-combustible mineral bound PROMAXON® boards

New Technology PROMATECT® 250 Protects Structural Steel

Steel is so common that most of us simply take it for granted. From kitchen appliances to mighty bridges, humble paperclips to towering skyscrapers, this exceptionally versatile material continues to have a profound impact on virtually every aspect of modern life. It is difficult indeed to imagine a world without steel and its many derivatives.

Nowhere is the influence of steel more fundamental and more far-reaching than in the construction industry. An overwhelming number of today's modern buildings would not be possible without steel. The fire protection and the fire sciences industries are understandably aware of its influence, too.

In fact, following recent tragic events and the subsequent engineering analysis of structural behaviour of buildings in fire conditions, many in both industries now look at steel and, specifically, steel protection in an entirely new light.

Under certain extreme and adverse conditions, steel can clearly be a strength and a weakness. It is therefore not surprising these days that there is heightened concern about how steel is designed into and used in building construction. The same level of concern is naturally extended to the protection steel is given, especially against fire and fire conditions.

Although there are many different types of steel, High Strength Low Alloy (HSLA) is the steel of choice for most structural applications. Depending on its alloy composition, steel loses it strength at around 550°C.

In standard practice in most parts of the world, structural fire safety is usually determined through a combination of prescriptive code requirements and standard fire test results for different structural assemblies.

Global Recognition, New Advanced Technology, New Fire Rated Boards

Promat is an industry leader. The company enjoys global recognition for its superior products and systems. It has built its reputation over many years on a solid foundation of advanced and continuing Research & Development.

One of the company's latest innovations is PROMATECT® 250, a new generation of non-combustible mineral bound PROMAXON® board designed for the effective fire protection of structural steel.

Thanks to PROMAXON® technology, PROMATECT® 250 has superior fire performance, workability and surface finish when compared to most other fire protection boards.

Developed in Promat's Belgium headquarter factory, the high fire performance of PROMATECT® 250 generally means that boards of lower thickness can be used. This in turn leads to lower weight and reduced costs.

Both PROMATECT® technology and PROMATECT® 250 are tried, tested and proven. Since its well-received launch five years, PROMATECT® 250 has enjoyed substantial sales success in the tough, competitive and demanding markets of Europe.

Continued on page 2

STEELWORK SPECIALS

Point of View

INSPIRATION FROM EVENTS IN THE WORLD AROUND US!

When I look back over the past few months since our last issue – a mere blink of an eye in the continuing development of human history but a lifetime of changes in the complex world of business – I never cease to be surprised!.

On the one hand, we had an unfortunate tragedy in Bali. This was quickly followed by a rather worrying SARS scare. The war in Iraq created yet more uncertainty. Another devastating blast in the crowded capital city of Indonesia did little to halt a downward trend.

On the other, the very real confidence I constantly witness all around me during my frequent business travel through the Asia Pacific region can be as humbling as it is positively inspiring!

Despite the near prevalent litany of doom and gloom, I constantly see people from all walks of life, frequently in conditions considerably less than ideal, working undeterred towards a better tomorrow. They always restore my faith in the best of human nature! Yes, the human spirit is alive and well and resiliently looking forward.

It also reaffirms the steadfast conviction that the world of business has a collective corporate responsibility not just to "enhance shareholder value" but to never settle for less than the best. From ourselves, from our products and services and, perhaps more importantly, from each other. We try to do this at Promat and I am convinced that our message of improving safety and security for the society we serve is definitely a good example for the way ahead.

Speaking of dedication, I am also proud to report that this, our twelfth issue of PFT, is only the third devoted entirely to a single theme, Fire Protection for Steel in this particular case. It is noteworthy that the decision to follow this dedicated editorial path follows the tremendous response we have received for comprehensive information on Fire Rated Applications and related developments.

I am also very proud to announce the launch of two new Promat products, PROMATECT® 250 and PROMAPAINT®. The former is a new generation of non-combustible mineral bound boards incorporating Promat's brilliant PROMAXON®. The latter, you can read it in our special two page centrespread, is a new paint-on intumescent coating for structural steel. Both new products are the result of a huge investment in and continuing dedication to R&D. Both products are also expected to meet very real needs in an increasingly sophisticated and demanding marketplace. We expect both products to help sustain Promat's leadership.

Elsewhere in PFT12, you will be pleased to find on page 3 a thorough overview of steel beams supporting composite floors in our Science & Research department. Page 6 features a story on PROMATECT® Steelwork Cladding from Shanghai, China and from India an article which, quite rightly, equates Fire Safety with Life Insurance, an accurate and rather sensible analogy in my opinion. Page 7 features the usual bilingual text (a summary of news elsewhere in the same issue of PFT) while Specification To Note In Structural Steel on page 8 rounds out our dedicated to steel issue! On balance, PFT12 weighs in with a lot of valuable information for anyone interested in this critical aspect of fire protection.

At the end of the day, it is important that we continue to be inspired by the world around us and not be downhearted. As the Chinese say, every voyage begins with a single, solitary step. In this way, as we go forward we accumulate experience, knowledge and valuable information which will help us realise our dreams for a better tomorrow – as individuals and as a company concerned about the world we all live in.

As we move quickly towards the end of another momentous calendar year, I would like to take this opportunity to extend best wishes and good fortune to all. I look forward to continuing our important work building the future together.

Erik D. van Diffelen
Managing Director

Promat Asia Pacific Organisations

September 2003

PROACTIVE FIRE TRENDS

Volume 6, Number 2 Second Half, 2003

The Promat International Asia Pacific Network spans the region with innovative proactive fire protection products, systems and solutions: Australia, China, Hong Kong, India, Malaysia and Singapore, with distributors in Brunei, Indonesia, Japan, New Zealand, Philippines, South Korea, Taiwan and Thailand.

ProActive Fire Trends is published by Promat (Malaysia) Sdn. Bhd. (PMSB) and Promat Building System Pte. Ltd. (PBS) for professional organisations and/or individuals interested in the fire sciences industry in the Asia Pacific region.

New Technology PROMATECT® 250 Protects Structural Steel

Continued from cover

Spheres of New, Alternative Technology

Promat is no stranger to non-combustible autoclaved calcium silicate boards. These have been used successfully for many years in numerous fire protection applications. Their composition provides exceptional degrees of strength, dimensional stability and stability in fire.

Two such boards from Promat, PROMATECT®-L and PROMATECT®-L500, are long-time market leaders.

Both boards incorporate synthetic hyrdated calcium silicate spheres called PROMAXON® which actually help to hold each board together.

The capacity of PROMAXON® spheres to retain water in fire conditions contributes to the overall fire insulation efficacy of the board.

The company's PROMATECT® 250 also uses PROMAXON® spheres but combines them with a mineral matrix to extend fire insulation even further.

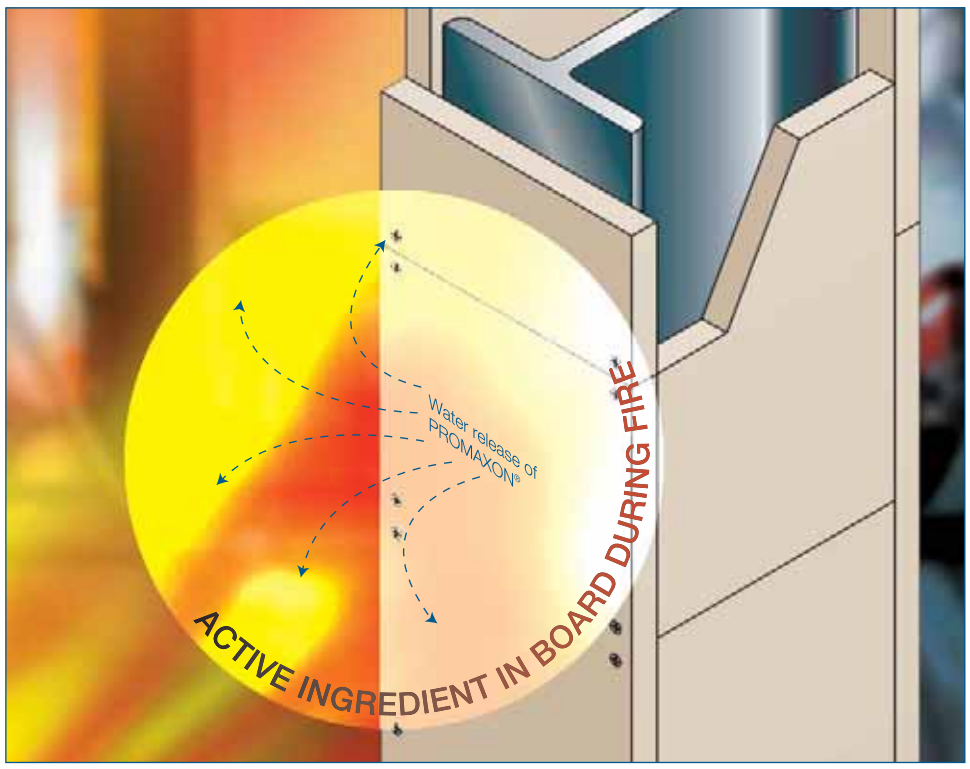
PROMATECT® 250 is a high performance board ideal for steel column and beam encasement. It provides up to 2 hour fire resistance.

All The Benefits of PROMAXON® Technology in One New Board

In general terms, PROMATECT® 250 provides better fire rating, is easy to install and is capable of providing economies of scale on many building sites.

Specifically, the benefits of PROMATECT® 250 include the following:

- Superior fire performance resulting from a double cooling effect
- Improved strength, so it can be used in most areas
- Improved fire insulation, allowing thinner and lighter constructions than other fire boards
- Non-combustible, meets the standards set by National Building Regulations
- Impact resistant, less brittle than other fire boards
- Cost effective, competitive system costs
- Better workability, easier to score, cut and fix
- Improved surface finish



"Thumbs-Up" Approval From Installation Department

We've all heard stories about boards which promise incredible performance despite their heavy weight and unwieldy thickness. Not surprising, where it matters most at on-site level, they invariably fall far short of desirable results in the installation department.

PROMATECT® 250 is definitely not one of those boards!

In fact, PROMATECT® 250 wins "thumbs-up" approval from most installers and contractors for its easy workability and ease of installation.

Here's how:

- Cutting – PROMATECT® 250 can be cut with a sheet saw (using hardened steel teeth), a jig saw or a power saw with a tungsten carbide-tipped blade. PROMATECT® 250 can even be scored and broken over a straight edge.
- Planing and sanding – The edges of a PROMATECT® 250 board can be easily planed and bevelled using rasps and normal on-site tool. Conventional papers and sanding disks are adequate for sanding.
- Drilling – Most boards do not require pre-drilling. However, drilling can be easily done on-site with hand-operated or power drills with high speed drill bits.
- Stapling – PROMATECT® 250 boards can be readily fixed using normal industrial quality, construction industry standard steel wire staples.
- Jointing – Joints between PROMATECT® 250 boards do not have to be filled for fire protection purposes provided that any joint does not exceed 2-3mm. If the board requires paint or plaster, joints can be filled with either PROMAPLAST® or any other standard, industry-approved gypsum joint filler, installed according to the plaster manufacturer's recommendations.
- Painting of PROMATECT® 250 with water-based paints requires at least two coats. The first coat should be slightly diluted. In areas where knocks and scratches are expected, a suitable alkali-resisting primer is recommended. The same alkali-resisting primer should also be applied before oil-based paint.
- PROMATECT® 250 takes skim coating, papering and tiling well but requires some special considerations which can be acquired after brief consultation with the Promat Technical Department.

For information of PROMATECT® 250 fire protection of steelwork, please contact us via page 7 Enquiries Form for a handbook of "PROMATECT® 250 Calcium Silicate Board Steelwork Fire Protection". PFT

● Further study on beam steelwork cladding

by **Jennifer Yii** / *Fire Engineer Consultant*,
Promat International (Asia Pacific) Ltd.

Beams Supporting Composite Floors with Profiled Metal Decking

Assessment of Composite Floor Slabs

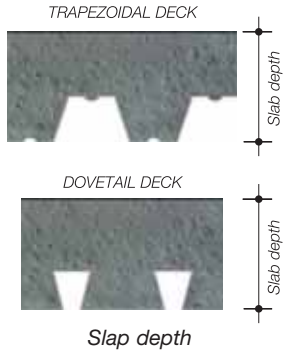
A composite floor slab/beam member with profiled metal decking is designed to act structurally in bending as either a series of simply supported spans or a continuous slab, by means of shear connectors. Strength in fire is ensured by the inclusion of reinforcement. In fire, the reinforcement becomes effective and the floor slab behaves as a reinforced concrete slab with the loads being resisted by the bending action. However, catenary action may develop away from the edges of the floor with the reinforcement then acting in direct tension rather than bending, which consequently will result in the slab failure when the reinforcement yields.

Therefore, methods have been introduced for the design of composite metal deck floors to endure under the fire conditions.

Simple Method & Fire Engineering Method

One of the methods that are available for the design of composite floor with profiled metal decking is called the "Simple Method". The simple method consists of placing a single layer of standard mesh in the concrete. The mesh reinforcement, which is not designed to act structurally under normal conditions, makes a significant contribution to structural continuity in fire.

Fire resistance of composite floor slabs up to 90 minutes (1½ hours) can be achieved using normal A142 mesh reinforcement. This can normally be increased to 120 minutes (2 hours) if heavier mesh is used and the slab depth is increased, as shown in the following ***Tables 1 and 2*** for trapezoidal deck and dovetail deck, respectively.



Slap depth

Lightweight concrete is a better insulator and thus losses strength less rapidly in fire than high density concrete. Therefore, lightweight concrete floors tend to be thinner than normal alternatives.

For other cases outside the limits shown in ***Tables 1 and 2***, these can be evaluated by the "Fire Engineering Method", which is more complicated. For further details on the fire engineering method, please refer to the Steel Construction Institute publication *The Fire Resistance of Composite Floors with Steel Decking*.

Advantages

In practice, the advantages of utilizing the simplified method of mesh reinforcement for the design of composite floor with profiled metal decking are as follows:

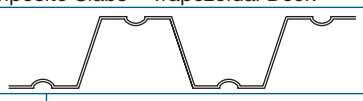
- Standard mesh, without additional reinforcing bars, may be used.
- No fire protection is required on the deck soffit.

Limitations

However, there are some limitations, which should be taken into account when using the simplified method for the design of composite floor with profiled metal decking. These limitations are:

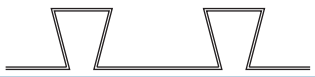
- Applies only to slabs designed to BS 5950: Part 4.
- Mesh overlaps should exceed 50 times bar diameters.
- Mesh bar ductility should exceed 12% elongation in tension (BS 4449).
- Mesh should lie between 20mm and 45 mm from slab upper surface.
- Imposed load should not exceed 6.7kN/m³ (including finishes).

Table 1 Fire Resistant Composite Slabs – Trapezoidal Deck



Maximum span (m)	Fire rating (hour)	Minimum dimensions: Sheet thickness (mm)	Slab depth (mm) NWC [2]	Slab depth (mm) LWC [3]	Mesh size
2.7	1	0.8	130	120	A142
3.0	1	0.9	130	120	A142
	1½	0.9	140	130	A142
	2	0.9	155	140	A193
3.6	1	1.0	130	120	A193
	1½	1.2	140	130	A193
	2	1.2	155	140	A252

Table 2 Fire Resistant Composite Slabs – Dovetail Deck



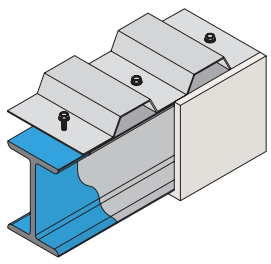
Maximum span (m)	Fire rating (hour)	Minimum dimensions: Sheet thickness (mm)	Slab depth (mm) NWC [2]	Slab depth (mm) LWC [3]	Mesh size
2.5	1	0.8	100	100	A142
	1½	0.8	110	105	A142
3.0	1	0.9	120	110	A142
	1½	0.9	130	120	A142
	2	0.9	140	130	A193
3.6	1	1.0	125	120	A193
	1½	1.2	135	125	A193
	2	1.2	145	130	A252

1. Imposed load not exceeding 5kN/m² (+1.7kN/m² ceiling and services).
2. NWC = Normal weight concrete.
3. LWC = Light weight concrete.

NOTE: Minimum slab depths given in BS 5950: Part 8 are to satisfy the insulation criterion only. Figures given in the tables above incorporate a strength criterion also and thus, may exceed the minimum depth given in the code.

Composite Floor Slabs with Profiled Metal Deck with Unfilled Voids

A series of fire resistance tests, jointly sponsored by ASFP members (including Promat) and others, has shown that filling the voids between the raised parts of the deck profile and the beam top flange in composite construction is not always necessary. The research was intended to demonstrate the circumstances in which void fillers can be omitted, and the "trade-off" in terms of increased protection to the section.


Unfilled void

In a composite beam/slab member, the neutral axis in bending lies, in, or close to the beam top flange. Since the top flange of a composite beam is so close to the plastic neutral axis that it makes little contribution to the bending strength of the member as a whole. Thus, the temperature of the top flange can often be allowed to increase, with a corresponding decrease in its strength, without significantly adversely affecting the capacity of the composite system.

Method

In composite construction, deck voids above the top flange using dovetail profiles can remain unfilled for all fire resistance periods. For the larger deck voids, which occur under trapezoidal profiles, these can be left open in many occasions for fire ratings up to 90 minutes (1½ hours). However, some increase to the thickness of protection may be necessary to be applied to the rest of the beam. Refer to ***Tables 3 and 4*** below for further details on summarized recommendations for decks running normal unfilled voids for composite beams, based on the research that have been published by the Steel Construction Institute.

For decks running parallel to the beams, it is advisable to ensure that the side boards are always abut the underside of the deck.

Advantages

Generally, it is economically significant by allowing the voids created above the steel beam by the profiled decking unfilled. This is because void filling can be a labour intensive and expensive activity. Other advantages or having the voids unfilled are as follows:

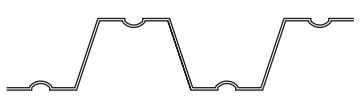
- Saving in time on site.
- It is unnecessary to build up the full thickness of protection on toes of upper flange.
- Void filling is unnecessary when using dovetail deck.

Limitations

However, there are some limitations, in which voids must be filled where:

- Trapezoidal deck is used for fire ratings over 90 minutes (1½ hours).
- In a rare case, trapezoidal deck is used in non-composite construction.
- Any type of beam deck crosses or forms part of a fire separating wall, in order to ensure the integrity of the compartment.

Table 3 Unfilled Voids – Trapezoidal Deck



Construction	Fire protection on beam	Fire resistance: Up to 60 minutes	Fire resistance: Up to 90 minutes	Fire resistance: Over 90 minutes
Composite beams	Board or spray	No increase in thickness.[1] Do not fill void.[2]	Increase thickness [1] by 10% (or use thickness [1] appropriate to beam Hp/A + 15% whichever is less). Do not fill void.[2]	Fill voids [3]
	Intumescent	Increase thickness [1] by 20% (or use thickness [1] appropriate to beam Hp/A + 30% whichever is less). Do not fill void.[2]	Increase thickness [1] by 30% (or use thickness [1] appropriate to beam Hp/A + 50% whichever is less). Do not fill void.[2]	Fill voids [3]
Non composite beams	All types	Fill voids [3]		

Table 4 Unfilled Voids – Dovetail Deck

Construction	Fire protection on beam	Fire resistance (minutes)
Composite of non composite beams	All types	Void may be left unfilled for all fire resistance periods [2]

1. Thickness is the board, spray or intumescent thickness given for 30, 60 or 90 minutes rating in *Fire Protection for Structural Steel in Buildings*, published by ASFP and the Steel Construction Institute.
2. If a fire wall is located beneath the beam, then the voids must be fire-stopped to prevent fire and smoke spreading from one component to another.
3. Voids need not be fully filled (unless they are located above a firewall (2). The top flange of the beam can be protected by securing a horizontal strip of board over the exposed sections of the upper flange, or shaped sections of board can be fitted vertically above each side board. Such voids are often fully filled with Corofil mineral fibre pre-shaped sections, but loose packed mineral wool (rockfibre) is adequate for up to 2 hours.

For further details on the composite floor slabs with profiled metal deck with unfilled voids, contact us via page 7 Enquiries Form for the Steel Construction Institute's report "Joint Industry Sponsored Research: The Fire Resistance of Composite Beams with Unfilled Voids – Document SCI/RT/135 July 1990". PFT

NEW PRODUCT FOR STEELWORK FIRE PROTECTION

● Paint-on protection for mighty steel

Promat Launches New Intumescent Fire-Rate

Paint-and-Protect. It is a deceptively simple concept which, until now, has frequently been bedevilled by a number of shortcomings, particularly as far as fire protection for steel is concerned. Now no more.

Thanks to PROMAPAINT®, the new intumescent fire protection paint from Promat, a worldwide leader in advanced fire science technologies, steel can be fire protected with a range of attractive colour finishes.

Although intumescent coatings have been around for some time, their acceptance has been inhibited to some extent by factors such as cost and difficult on-site application.

New PROMAPAINT® challenges *and* changes these long-held perceptions.

Colourful Fire Protection For Even Exposed Structural Steel

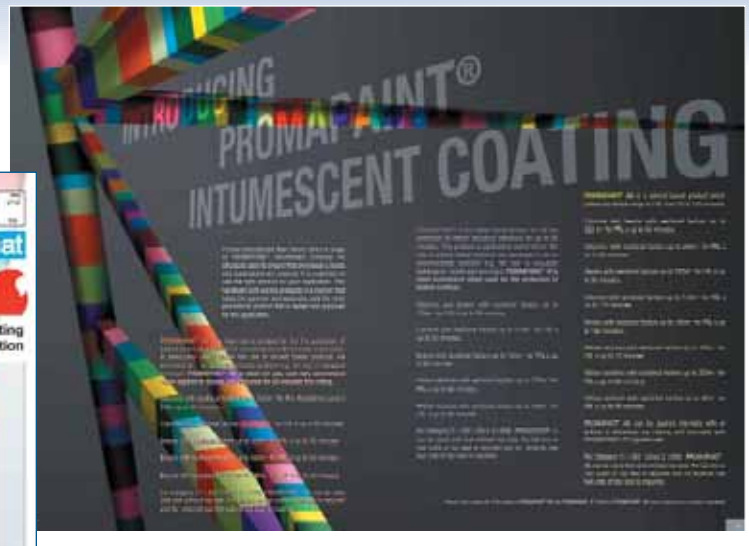
In an architectural age when exposed steel beams and columns are deliberately left exposed by the architect as an integral part of the structure's design aesthetic, an artist's pallette of colours for a fire-rated protective coating will definitely have an impact on the decision making process.

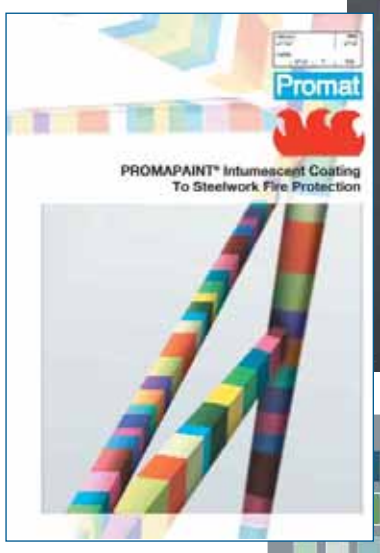
PROMAPAINT® is available in two types, PROMAPAINT® 60 and PROMAPAINT® -H. The numerous benefits also include:

- One-coat application
- Less paint required
- Improved installed price

When PROMAPAINT® is applied to structural steel, all that is required is:

- clean steel
- an initial coat of primer
- followed by a coating of PROMAPAINT® and
- a final topcoat of any painted colour finish.

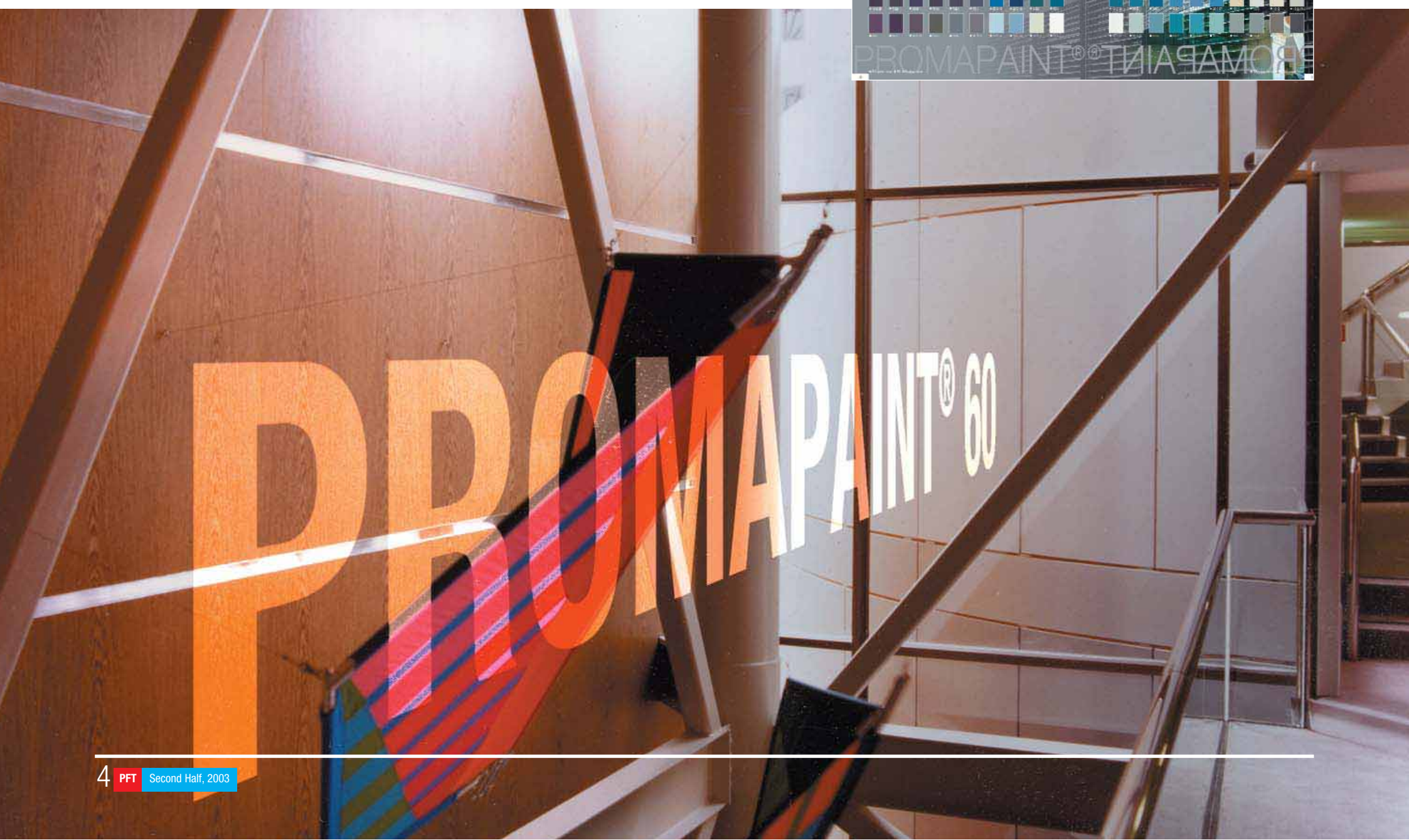




In conjunction with the launch of PROMAPAINT® intumescent fire protection paint, Promat International Asia Pacific has also published a special handbook. Titled "PROMAPAINT® Intumescent Coating To Steelwork Fire Protection", the new product handbook is supplied with a CD which provides comprehensive information on the application and performance of PROMAPAINT®.

Please contact us via page 7 Enquiries Form for this handbook.

Illustrated on this page is the cover and the pages from the colour selector of PROMAPAINT®-AT Top Seal, which is used as an overcoat on PROMAPAINT® 60 and PROMAPAINT® -H.



w PROMAPAINT®
ed Paint

The article on this page is researched and written by

Dr. Ian Bennetts
Centre for Environmental Safety & Risk Engineering,
Victoria University of Technology, Australia
and is used with his kind permission.

In Australia and New Zealand the application of performance-based design has meant that, in some situations, it has been possible to reduce the fire resistance required for some structural members. In some cases it may be possible to use unprotected structural steelwork although such solutions need to be carefully considered. The introduction of performance-based design into countries throughout Asia will raise this possibility for construction in other countries around the region.

Reductions in the prescriptive requirements for fire-resistance levels will mostly favour structural steel construction, the cost of which is dependent on the cost of fire protection. The use of conventional fire protection such as on-site sprayed insulating material can lead to significant additional costs that will be considered by a builder deciding whether to build in structural steel or reinforced concrete. Lower cost materials that can be applied off site will prove to be more attractive.

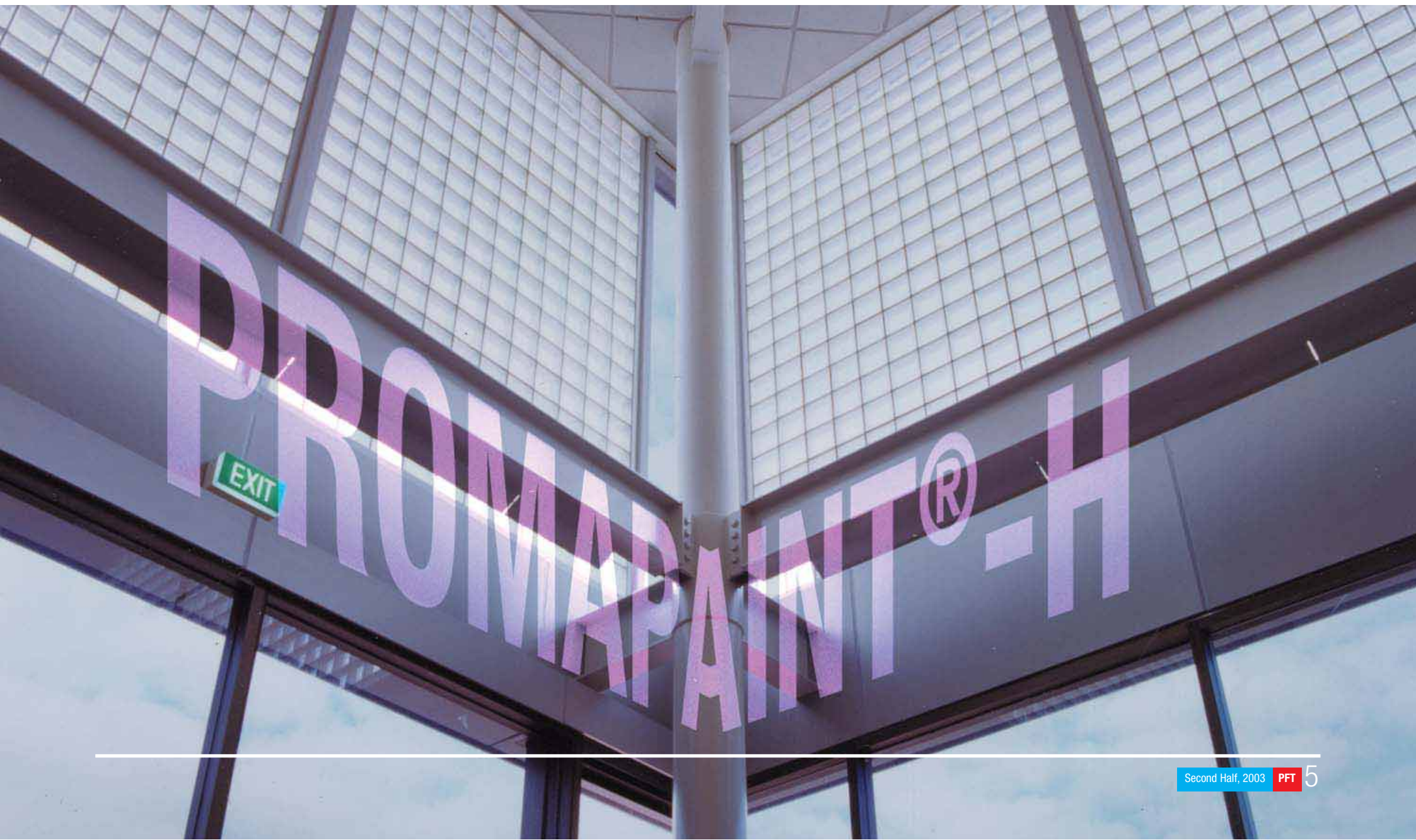
Intumescent coatings have long been available and have been widely used throughout the world. They are particularly suitable for the achievement of fire resistance levels of 30 and 60 minutes, since for longer periods, the thickness of the coating and associated costs can be high. They have also proven to be popular with architects as they allow the shape of the structural steel members to be expressed - a detail that can be important with many steel-framed buildings.

As a general principle, intumescent coating works as follows: Large volumes of gas are emitted during the heating process and this causes the coating to swell to many times it original thickness. The resulting expanded layer acts as an insulating layer. The coating can be applied by brush, roller or spray, but for an acceptable architectural finish only spray is recommended.

In the past, intumescent coatings were applied on-site and this often required screening of the application area. This, and the presence of specialist application staff, has been sometimes viewed as providing a basis for a claim for additional site allowances for workers - at least in some work environments, or even the closure of sites during application. The advent of water borne coatings have eliminated these perceived problems.

Recent development work in the UK, and more recent examples of building construction, have demonstrated that intumescent coatings can be applied off-site at the fabrication shop or steel distributor. There is a range of chemical compositions for these coatings consisting of two-part epoxy mixtures or solvent based products. Other non-solvent based systems are available and achieve lower thickness coatings.

A fire protective coating that would be attractive to the steel and construction industries would be one that is capable of achieving a fire-resistance level of 60 minutes that could be applied on or off-site as a single coat. The marketability of such a coating would also depend on its applied cost. PFT



● Challenging steelwork fire protection in Shangai's First Steel Factory

by **Tony Li**/*General Manager*,
Promat China Ltd.

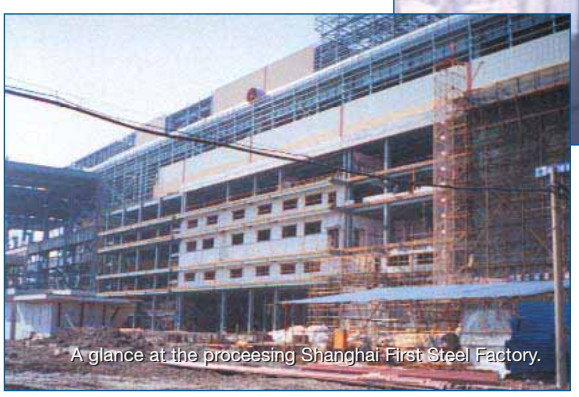
PROMATECT® Steelwork Cladding

Shanghai, an old but modern international city that has gained the world's attention due to its rapid development and the success it has enjoyed in its rapid economic growth.

At present, the Changjiang River delta has been the prime location for international companies wishing to invest in the Shanghai locality, Further more, with some other large cities, such as Nanjing, Hangzhou, Suzhou and Wuxi which also have huge development potential within easy reach of Shanghai, this locality has prime strategic importance.

Entering The Fire Rated Cladding System

Promat China Ltd, as part of the Promat International (Asia Pacific) organisation, has been in the forefront of promoting *ProActive Fire Protection* within this area, Promat China Ltd has been developing their business in China for the past eight years. In this time, Promat has provided its clients with not only technical solutions to the problems of meeting *ProActive Fire Protection* needs, but also has been heavily involved in the development of advanced concepts of passive fire protection in China.



A glance at the proceesing Shanghai First Steel Factory.

The Shanghai First Steel Factory belongs to the Shanghai Baogong Group. As part of technical upgrades and business expansion projects, a multi-functional building with a total construction area of 9000m² was developed in 2002. The building consists of a four story steel frame structure building, meeting class 1 fire resistance level complying with GBJ 16~87 (code for fire protect design of buildings). This means that the steel columns have a requirement to be provided with a three hour fire rating and steel beams for two hours. The building is mainly to be used as offices and is to include important equipment, thus more attention needed to be given to the fire resistance performance of loadbearing elements when considering the high fire load and ensuring the security of this equipment. Through analysing all types of fire protection methods for steel elements, the owner and architect selected the PROMATECT® board cladding system from Promat.

Within this project, the total cladding area for the structural steelwork was some 14000m².

The natural off-white surface of PROMATECT® calcium silicate board is ideal to provide a clean, pleasantly looking result in the finishing of column or beam cladding.

Advantages of PROMATECT® Steelwork Cladding System

- This cladding system has been successfully subject to fire tests to standards such as China standard GB 9978.
- The PROMATECT® product has a long lifetime and is a durable product with more than a 40-years life expectancy.
- Easy to control the on-site quality of installation. PROMATECT® board is produced under ISO 9002 quality control procedures ensuring the cladding thickness is consistent so the level of fire resistance is maintained at all times.
- Easy to decorate. The surface finish of PROMATECT® is easy to paint, it can also accept plaster skim or cement render finish and ceramic tiles can easily be applied.
- Dry installation. In course of installation, no pollution to other parts of the building will occur.
- Excellent impact resistance performance, and the system can also be used in moist environments. PFT

● Steelwork fire protection in India's leading insurance business building

Fire Safety Matters As Much As Your Life Insurance

by **Raman Kapur**/*Business Manager*,
Promat Representative Office, India

The Reliance Group is India's largest business house with total revenues of (USD16.8 billion), and exports of (USD2.5 billion). The group's activities span exploration and production (E&P) of oil and gas, refining and marketing, petrochemicals (polyester, polymers, and intermediates), textiles, financial services and insurance, power, telecom and infocom initiatives. Reliance has emerged as India's Most admired business house, for the second successive year in a TNS-Mode survey for 2002.

With globally competitive capital and operating cost positions, Reliance Industries decided to create, at a single location, the largest Telecommunication centre to serve the Indian market with the latest and state of art telecommunication facilities on the outskirts of Mumbai, the commercial Capital of India.

The design of building was carried out with the view that as a major data centre for telecommunications, Architects and Consultants wanted to ensure the completed construction was safe against the ravages of fire. Thus the choice of passive fire protection systems was restricted to those suppliers who could ensure full technical backup throughout the project, to ensure any problems encountered could be supplied with speedy solutions, suppliers with products and systems who could ensure all solutions were fully backed with compliant test certification.

The Building was designed using a steel structure which was to be provided with a fire resistance of 120 minutes in accordance with Indian National standards. Due to the need to also provide a ceiling construction for aesthetic purposes beneath the protected steel beams, Promat India came up with a solution which combined both requirements into one application, therefore providing time and cost savings to the construction team. The innovative solution was to install 3000m² of a fire resistant ceiling construction below the steel structure, thus utilising the cavity space for heat dissipation and reducing the need to individually clad steel beams. The 12mm PROMATECT®-H ceiling system has been fully tested to ensure compliance with the performance criteria for both ceilings and for the protection of structural steelwork; thereby allowing this combination of systems to offer aesthetics, economies and importantly, fire safe performances. PFT

封面内容

● 为您优美的钢结构披上安全的外衣—防火涂料

保全公司的全新膨胀型防火涂料—PROMAPAINT®开始投放市场

对钢构件进行涂刷以达到某种保护的效果，这是一个石破惊天的事情，但是直到今天，涂料的保护方式却总因有这样那样的缺点而令人压抗，尤其是在进行防火保护的时候

现在您不必再为此担忧了，因为您有了新的选择——"PROMAPAINT"，来自于防火业界巨人 Promat 的全新膨胀型防火涂料，基于他们对火灾科学研究的领先技术，现在用来保护钢结构的薄型防火涂料同样可以轻易地做到色彩纷呈，满足建筑师和客户的美学要求。

尽管膨胀型防火涂料已经存在有相当的历史，但是由于费用高昂或上述施工困难等因素，它们的外观选择一直都受到很大的限制。

今天，新型的 PROMAPAINT® 的出现，势必极大的冲击并将改变这种长期的市场僵局。

在这样一个讲求建筑艺术的时代，许多建筑师都把有意让一些钢柱，钢梁外露，以表现他们的建筑美学设计思想，如果防火涂料具有缤纷色彩可供选择，无疑将极大的支持建筑师的设计决定。

PROMAPAINT® 具有两种型号，PROMAPAINT® 60 和 PROMAPAINT®-H，它们具有的优点主要是：

- 一次到位，兼具防火和装饰效果
- 涂漆耗费少

当 PROMAPAINT® 应用于钢结构防火施工时，只需要以下三步：

- 一层底漆
- 涂刷一层 PROMAPAINT® 涂料
- 最后是一层具有多色彩可选择的面漆

为了配合 PROMAPAINT® 膨胀型防火涂料的投放市场，保全（国际）亚太有限公司特别发行了一本工具书，书名是 *PROMAPAINT® Intumescent Coating To Steelwork Fire Protection*，随书附有一张 CD，其中提供了该涂料的应用信息和技术性能数据。

请通过填写以下的联络表 Enquiries Form，获取这项新手册。

接着以下是原著 Ian Kennetts 博士（Centre for Environmental Safety & Risk Engineering, Victoria University of Technology, Australia）特别研究及专写的文章。

澳大利亚和新西兰都是推行性能化防火设计的国家，这也就意味着，在某些情况下，是可以适当降低对结构构件的耐火性能的，甚至在某些时候还可以使用完全裸露的钢结构而不须做保护措施，尽管这时需要做仔细的计算估计算。这些案例只适用于：有充分证据可表明，在条文性法令规定的要求基础上降低构件耐火性能并不会明显影响建筑物中的人员安全的情况，当然其他的一些消防安全的保护对象也需要进行适当考虑。随着性能化防火设计的理念在亚洲各区的推广，也将使得澳大利亚和新西兰的经验在其他国家的防火行业中得到分享。

构件耐火性能在条文性法令规定基础上的降低，将使得钢结构施工行业最大的受益，因为他们现在很大的花费都出自防火材料。使用传统的防火材料，例如现场施工的厚型喷射膨胀防火涂料，总是导致增加很多的额外成本，这都使得建造者经常犹豫于是采用钢结构还是钢筋混凝土结构的问题中。而采用无须现场涂刷的低成本防火材料，无疑将对业界具有很大的吸引力。

膨胀型防火涂料已经存在有很长的历史，并且也被世界各地所广泛使用，他们尤其适用于 30 分钟和 60 分钟耐火极限的钢构件防火。而用于耐火极限更高的构件保护，则会使得涂料的厚度增加并导致费用攀升。薄型涂料主干能够凸如地表现建筑钢构件的外轮廓，一直深受建筑师的欢迎，被广泛的应用于钢框架的建筑中。

通常来讲，膨胀型防火涂料的工作机理如下：涂料在持续的加热过程中，释放出大量的气体和泡沫，而这将导致涂料的体积膨胀，初始的数倍。而最终形成的膨胀层就构成了很好的隔热层。涂料的施工方式可以是涂刷，滚刷或喷涂，但是对于有建筑装饰要求的防火涂料施工，只允许采用喷涂的方式。

在过去，膨胀型涂料都是在工地现场施工，而这就通常要求先打磨涂刷处的钢构件表面，于是在某些工地环境下，甚至是封闭的工地环境下，要求有特殊培训的工人进行操作，这也就意味着要为这些工人准备特别的津贴补助，从而使的系统造价增加。而水基型的防火涂料的出现则解决了上述问题。

在英国，最近的一些研究成果和实际工程应用都表明：膨胀型防火涂料实际上是可以在装配车间甚至是钢构件生产商处预先涂刷的。这些涂料都是很多种化学成分的产物，主要是由环氧化合物或可溶型基底混合物组成，其他的不溶型成漆系统则相应可以达到更薄的涂层厚度。

一款能够对钢结构施工行业产生巨大吸引力的防火涂料应该是：具有 60 分钟以上的耐火极限，并且以单一涂层的方式，可灵活选择工地现场施工或预先施工。当然，这种涂料的市场推广性同样也取决于其运用成本。PFT

● 全新的钢结构防火保护技术运用于上海一钢厂建设项目

PROMATECT®防火板包覆钢结构

作者　李景东/总经理
Promat China Ltd.

上海一钢集团是上海宝钢集团，为了适应不断增长的钢铁市场需求和增加产品品种，决定在其现有的厂区内新建一条 2300mm 宽厚板生产线，承重梁柱均为钢结构。根据中华人民共和国建筑设计防火规范 GBJ16-87，该建筑的耐火等级为一级，钢柱的耐火极限为 2 小时，钢梁的耐火极限为 1.5 小时。该建筑是集多种用途和多种设备为一体，系统的火灾荷载的性质和重要设备的火灾安全等方面考虑，设计单位建筑结构专业的工程师提出了若干种不同的要求。本项目业主和设计单位通过对各种钢结构防火保护系统的性能和价格综合分析，最终选择了钢梁柱采用防火板包覆系统。在本项目中，典型钢结构的火荷载密度为 400MJ/m²。

采用防火板包覆钢梁柱的优点为减少钢结构施工的总投资，并缩短施工周期及节省：

- 保全钢结构防火包覆系统通过了各种测试，主要有火焰传播试验，如中国标准 GB 9978，国际标准 ISO 834，英国标准 BS 476，澳大利亚标准 AS 1530，美国标准 ASTM E 119 和德国标准 DIN 4102
- 保证安全生产，不会出现，保全板厂内生产，防火保护性能稳定和质量控制完善
- 容易进行质量控制，保全板厂内生产，防火保护性能稳定和质量控制完善
- 施工方便快捷，整个包覆系统可在现场进行施工，施工时间短节省费用
- 干式作业，施工时不会污染建筑物的其他部位
- 保护性能优越，不可燃用于室内和室外。PFT

● Further study on steelwork fire testing method and Hp/A calculation

by **Ian R. Holt**/*Regional Technical Manager*,
Promat International (Asia Pacific) Ltd.

Specifications To Note in Structural Steel

Steel has a high thermal expansion which can lead to thermal movement in other parts of the structure, which in turn may cause loss of integrity and stability. Unprotected structural steel cannot normally achieve practical periods of fire resistance by virtue of the relatively low temperature of 500~550°C (for mild steel) at which it loses 50% of its strength. Failure will occur if the safety factor with respect to ultimate load is 2 (a normal figure in engineering practice). To satisfy the criterion of loadbearing capacity therefore, a loaded steel section generally need to be protected to ensure that this temperature is not attained during the fire resistance period required – due consideration being given to the way in which continuity, restraint, etc may affect this value.

The performance of structural steel depends on the mass of the steel and the surface area exposed to heating. In the past, steel section sizes adopted for fire tests were identical and thus deemed-to-satisfy tables referred to sections of a minimum mass. In order to provide design information for the protection of a range of steel section sizes, the research in conjunction with industry developed a programme of fire resistance tests designed to provide a computational method of assessment for the thickness of protection needed. Methods of affording protection to steel beams and columns by passive encasement systems and by the use of intumescent coatings have been published as the renowned "Yellow Book" by the ASFP (Association of Specialist Fire Protection) and which is now in its third edition.

Fire Testing Methods

1. Building Regulations usually require certain elements of structure to have fire resistance for a specified minimum period of time. The amount of fire protection to achieve this depends on the following:
   - Duration of fire resistance specified
   - Type of protection used
   - Perimeter of the steel section exposed to fire
   - Shape and size of the steel section
2. To determine how these factors affect fire resistance, all products and systems should have to be tested at independently accredited laboratories.
3. Tests should be in accordance with recognised international standards, e.g. for Asia Pacific the two most widely used standards are BS 476:Part 21:1987 and AS1530:4:1997 performed on loaded beams and columns protected with fire protection material. A new standard which will come into prominence in the coming years will be EN13381 Part 4. Steel surface temperatures are monitored with thermocouples to assess the insulation performance of the cladding, and since steel fully stressed in accordance with BS 449 or BS 5950: Part 1, begins to lose its design margin of safety at temperatures around 550°C.
4. A range of loaded and unloaded sections would have been tested to obtain data for calculating analytically, exactly how much protection is needed for the most common steel sections and for providing fire resistance for different time periods.
5. These and other tests have also demonstrated the ability of the cladding to remain in place, commonly termed as the 'stickability' of the material, for the maximum duration for which protection may be required.

Specifications

1. Choose the material to be used.
2. Determine the period of fire protection required. This factor will usually be determined either by reference to national building codes and regulations, or by a fire engineered solution to the particular building.
3. Determine the Hp/A section factor of the steel section **Hp/A Section Factor**.

   In years past, the methods of testing and analysing performance of structural steelwork protection were somewhat basic and limited in scope. There was a time when the application of fire protection was a simple as stating that for 30 minutes use 6mm, for 60 minutes 12mm for 90 minutes 18mm and so on, regardless of the dimensions of the section to which protection was being applied. In some countries this is still the case today. However, it was realised that there is a significant difference in the time at which differing steel sections reach critical temperatures, and thus the one size fits all approach does not ensure fire safe constructions. Thus the regression analysis system used today was born out of scientific research into the behaviour of structural steelwork in fire situations.
4. Using the Hp/A factor and the required fire protection period, determine the board thickness and fixing details.

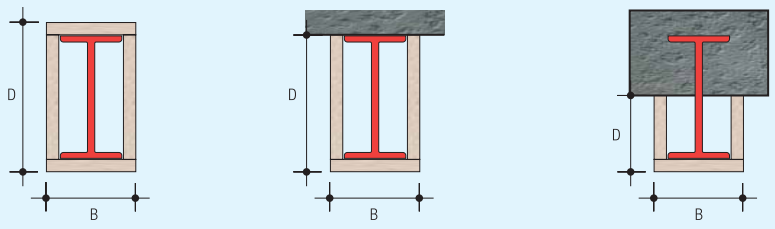
   Using modern methods of providing protection to structural members, it is not acceptable simply to perform one fire test and then use the "one thickness fits all" scenario. After carrying out a set series of fire tests, an analysis of the results is carried out which in turn provides a table of protection thickness to section factor relationships. From this, once you can determine the section factor of any steel section, you can ascertain a material thickness to provide the requisite protection performance.

Hp/A Section Factor

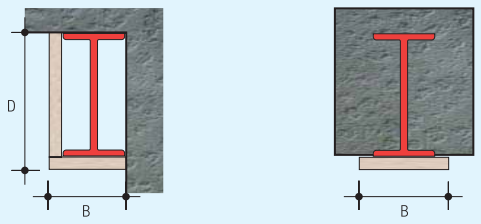
The degree of fire protection depends on the Hp/A section factor for the steel section. The Hp/A factor is a function of the area of the steel exposed to the fire and the mass of the steel section. The higher the Hp/A, the faster the steel section heats up, and so the greater the thickness of fire protection material required. Also of relevance is the steel section itself; a thick section of steel will take longer to heat up than a thinner section. Therefore it follows that where you have two steel sections of identical overall dimensions, but where the flange and web of one section is thicker material than the other, then the thicker section would generally require a lower level of protection in order to provide the same fire resistance period.

Box Protection

1. In the case of box protection, Hp is the sum of the inside dimensions of the smallest possible rectangle or square encasement of the steel section (except for circular hollow sections). See below types of universal beams, columns and joists, and Hp/A section factor for boxed encasements.



2B + 2D | B + 2D | Partially exposed B + 2D



B + D | Partially exposed B

2. Where a steel section abuts, or is built into a fire resisting wall or floor, the surface in contact with, or the surface within the wall or floor, is ignored when calculating Hp. However, the value of A is always the total cross-sectional area of the steel section.
3. The serial size and mass per metre of most steel sections are given in the following steelwork tables, which also give Hp/A values calculated for 3 or 4 sided box protection. Further tables are given in the ASFP publication *Fire Protection of Structural Steel* ("The Yellow Book").

Profile Protection

1. Encasements following the profile of the steel section will generally have a higher Hp/A section factor than a box encasement. One exception is circular hollow sections.
2. Hp/A section for profile encasement will be different and of a higher value than that for a boxed encasement, it thus follows that the required thickness of protection material will be greater for a profile Hp/A than for a box Hp/A.

Calculation of Hp/A Factor & Board Thickness for Non-Standard Situations

1. Floors
   Where beams are wholly within the cavity of a timber floor protected by a fire resistant ceiling then test evidence can show that the cavity air temperature of the floor can be such that the beam will be adequately protected to the same fire resistance by the ceiling that protects the floor. Where the beam is wholly or partly below the line of the ceiling then Hp should be based upon the portion of the steel beam that is below ceiling level. However, as for all constructions, evidence of fire tests carried out on the ceiling with steel beams within the cavity, e.g. BS 476 : Part 23 : 1987 should be sourced.
2. Insulation across wall etc
   When a section is partially exposed to fire, for instance when a column is built into a wall or a beam is embedded into a floor slab, and construction materials such as brick, block or concrete have been used it should be noted that where the steel penetrates both sides of the fire resisting construction as per the drawing, the thickness of the protection may be determined by factors other than the HP/A of the steel section. Such constructions are generally required to ensure that there is no lapse of the insulation requirement of the standard through the wall or floor. As an example consider the drawing to the left, as a steel section passing through a wall or floor slab, different approaches should be followed according to the fire resisting requirements of the wall or floor. Whether it is similar to or less than that of the steel section or zero. Additionally there could be a risk of simultaneous attack from fire on both sides of the wall; all will influence the protection thickness relevant to steel protection and insulation across the wall.

Please contact us via page 7 Enquiries Form for examples of universal steel beam calculation, and more information on Calculation of Hp/A factor and board thickness for non-standard situations. PFT