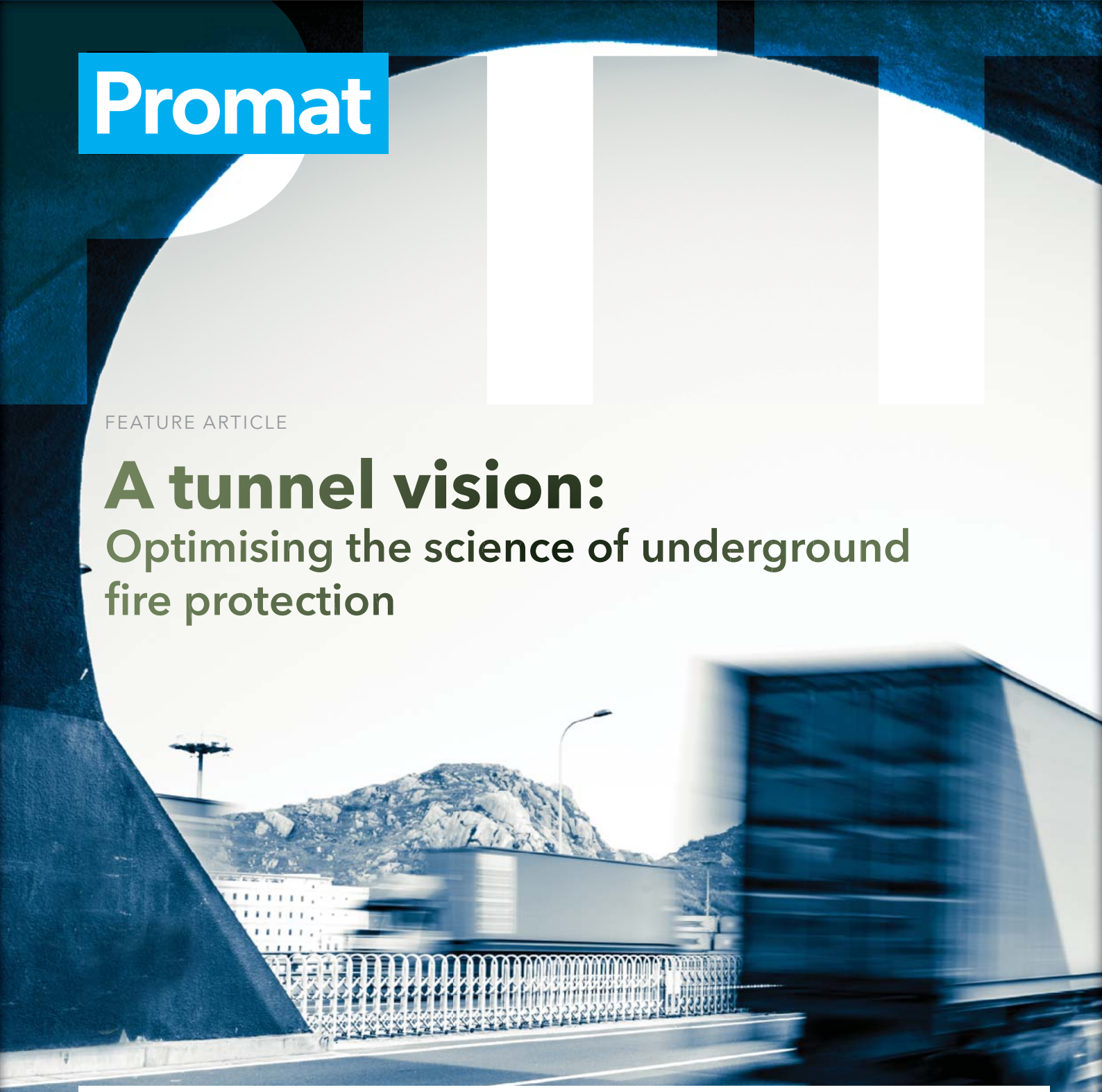
Promat

FEATURE ARTICLE

# A tunnel vision:

## Optimising the science of underground fire protection



# Promat Technology Trends Newsletter

Issue n° 11 | 2016 | For building fire protection professionals in Asia Pacific

# TEST STANDARDS & TUNNELS

Dear Business Friends,

In this 11th edition of Promat Technology Trends (PTT), we spotlight the widespread and increasingly popular usage of Promat fire and safety systems in applications as diverse as airports and leisure arenas, with a particular focus on the company's extensive tunnel expertise. First, we review the Hong Kong-Zhuhai-Macau Bridge (HZMB) and tunnel project and secondly provide readers with an important awareness-building overview of testing trends for fire protection in tunnels.

HZMB is certainly one of the most challenging civil engineering projects in the world today. Promat is extremely proud that its proven fire security systems are employed in the HZMB tunnel, at 6.7km it is one of the planet's longest fully-immersed structures.

Similarly, it is encouraging – and indeed better for safety standards generally – that tunnel owners, operators and consultants in the Asia Pacific region are increasingly concerned with and willing to adapt to effective fire protection standards for all underground structures. These benchmarks are widely observed throughout Europe.

To promote tunnels and tunnel safety around the region, Promat uses its own hard-earned and widely recognised empirical evidence in conjunction with the extensive, published research findings of international laboratories, government organisations and not-for-profit professional associations. It is important to note that fire protection is best not limited to concrete but should also include holistic, system-wide integration of cable protection, movement joints and fire-rated ducts, as well as other tested and proven applications.

The regional trend towards accepting EN (European Norms) fire testing standards for the building market is generally a good sign as EN standards are more comprehensive, particularly in defining specific types of fire applications and the appropriateness of testing methodology. This is most obvious when compared to the existing British Standard BS 476: Parts 20-24 observed regionally for more than two decades but without real improvement of fire testing methods adapting to changes in building design dynamics. Promat encourages the market to adopt more EN tested systems, especially for applications not well-defined in BS tests simply because the EN way appears to ensure deployment of the most appropriate safety system. It is worth noting that this is overall a long-term objective in a regional building market still preoccupied with the easiest way to achieve "basic" fire test results that fulfil minimum statutory requirements.

Elsewhere in this 11th edition of PTT we present articles on Promat systems hard at work in Penang's booming built environment, in the world famous and recently refurbished Adelaide Convention Centre, and at Terminal 4 of Singapore's award-winning Changi International Airport. It's a reassuring read of some of the basic building blocks that help all of us build confidence and optimism in Promat's continuing success and innovative future.

Enjoy!

Samson Ho
*Managing Director*
Promat Asia Pacific organisation

# A tunnel vision:
## Optimising the science of underground fire protection

There are thousands of sophisticated, modern tunnels engineered and in daily operation all over the world. They solve problems in transportation, space management, time and congestion. Despite numerous commonalities, no two tunnels are alike. Their geometry, by the nature of local topography and the problems the tunnels aim to resolve, is invariably different.

Tunnel owners/operators and indeed users expect nothing less than the quality of proven design, integrating strategies known to ensure optimum fire safety. From an architectural, engineering and structural point of view, tunnels are without exception designed to tried and tested international building codes, standards or are based on a systems engineering approach.

They usually function efficiently and safely in extreme, mostly hostile environments. Given the ever increasing number of users, tunnels are by and large remarkably safe. Nevertheless, accidents still occur and the devastating impact of fire in tunnels is always a potential hazard.

The much publicised Channel and Mt Blanc Tunnels are good examples, and they illustrate all too clearly and tragically what can and will happen despite the best of intentions, and many layers of real safety built into tunnel security systems. It is worth noting that these tunnels did not have passive structural protection as an integral part of their fire and life safety systems.

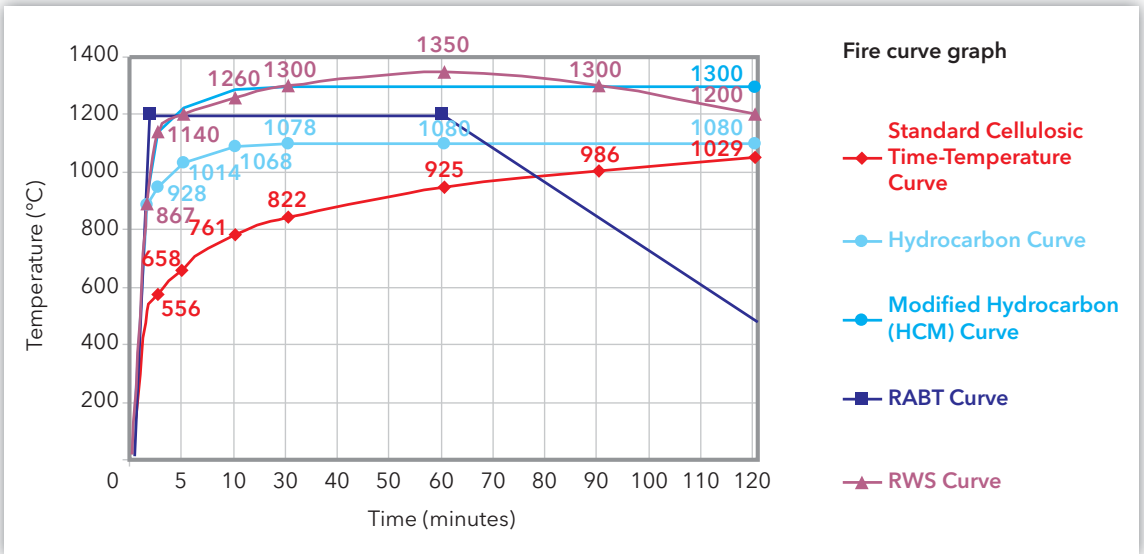
Significant structural damage to the actual tunnel is also common. Direct and indirect collateral damage to surrounding economies is usually longer lasting and even more costly.

Vehicular tunnels are strategically important investments that need to be protected and kept safe for all road, rail and metro users. Life safety is paramount but protection of the concrete structure (the asset) should also be considered a top priority. In all cases when exposed to a high intensity fire, the tunnel and its numerous support systems must be inspected, repaired and returned to normal service without incurring additional economic burden to the community. Unprotected concrete typically faces large repair costs after a fire event, and the time required to make those repairs adds further to the cost of "return to service".

## Proven fire science strategies improve tunnel safety

A number of internationally recognised safety standards benchmark the design and operation of tunnels and other underground structures. These include Australian, British, EU and American fire safety codes.

In most instances of structural protection, tunnels will use the Rijkswaterstaat (RWS)*, the modified hydrocarbon curve (the French version of RWS) or the RABT tests developed in Germany.




Above fire curve graph outlines the extreme heat at a very fast heating rate these tunnels are designed to resist when tested to the above standards.

*Rijkswaterstaat (RWS) is part of the Dutch Ministry of Infrastructure and the Environment, the former Ministry of Transport, Public Works and Water Management.

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Australia has developed the standard AS 4825-2011 as a guidance document now widely used in the building and use of tunnels. It details the process that should be followed when designing optimum fire safety in tunnels.

The American NFPA 502–2017 also states that protection from the effects of the RWS fire curve and thus Efectis–2008–R0695 is the test method now required to be used when protecting against this particular design fire.

This test method, adopted by NFPA, was developed by RWS and Efectis in the Netherlands and is now widely used for road tunnels throughout the world.

## Effective fire protection technologies

Generally speaking, efficacious fire protection plans in tunnels are typically built around two parallel and often integrated systems:

- Passive fire science technologies, and
- Active or fixed firefighting systems (FFFS).

Promat is a leading and much imitated developer of so-called passive technologies, offering proven board, cementitious spray and accessory systems to a demanding market for more than five decades.

FFFS on the other hand include deluge or watermist systems but these are subject to some reasonable questions from industry professionals.

One such organisation is the much respected PIARC*, the World Road Association. In one of its recent publications *Fixed Fire Fighting Systems In Road Tunnels: Current Practices and Recommendations – 2016*, the organisation opines that:

- The effects of FFFS on the production of toxic chemicals such as carbon monoxide (CO) or more smoke production are not clearly understood.
- Tests and computational analysis demonstrate that activation of FFFS creates a downward force which transfers smoke from the upper areas of the tunnels down to the lower areas where people may be in the process of evacuation, creating a reduction in visibility which is potentially life threatening for evacuees.
- To provide effective protection in the event of a fire, FFFS must be adequately maintained and regularly tested throughout the life of the system. If this cannot be assured, then the benefits of FFFS will be considerably diminished in a fire event, if not negated altogether. There are generally significant restraints on when these activities can take place; for example, closures may be possible only at night to minimise disruption to traffic.
- It is recognised that passive measures are normally considered to be the most reliable.
- It should be noted that FFFS will disrupt the smoke layer and will affect the smoke extraction system.
- Shielding effects tend to be a particular concern when dealing with vehicle fires. If there is a fire within a vehicle (and this is often the case), the fire is shielded from the FFFS and will continue to grow.
- Where FFFS is adopted, it is essential that it be designed, installed, integrated, commissioned, maintained, tested and operated with a high level of reliability. If this cannot be guaranteed, then the efficacy of the system cannot be guaranteed and the owners will have wasted their money.

The PIARC article concludes by stating that "certainly, the consequences of failure of the FFFS to operate on demand must be considered".

* Excerpts above are quoted from one of the PIARC's recent publications *Fixed Fire Fighting Systems In Road Tunnels: Current Practices and Recommendations – 2016*. PIARC is a worldwide body dedicated to the transfer of technology in all matters related to improved road, transportation and tunnel networks.

**SPALLING TESTS**

In a recent Tunnel Academy 2016 presentation in Kuala Lumpur, Mr Rick Fox, Tunnel Manager, Promat Asia Pacific highlighted a number of interesting facts about spalling tests, as outlined in the Efectis–2008–R0695 benchmark. These include:

- There are two types of tests, i.e. a) spalling test, and b) thermal insulation test.
- Spalling tests should replicate type of concrete used at installation site, i.e. concrete mix, compressive load, conditioning (typically 90 days) and appropriate fire protection system.
- Two identical samples must be tested.
- Spalling cannot be predicted!

A severe example of concrete spalling after actual fire

## Concrete spalling and thermal barriers

While concrete is a non combustible product and not a contributor to fire spread or fuel load, it is still vulnerable to the impact of fire. With the application of an additional thermal barrier, the concrete can be made safe and inhibit spalling of the concrete when subject to the extreme temperatures typical of tunnel fires.

Full scale fire testing shows that the intense temperatures of many tunnel fires can easily and rapidly reach 1,350°C.

When concrete is exposed to elevated temperatures during a tunnel fire, it is exposed to extreme heat and in some cases extremely fast rate of rise of temperature. This in turn creates thermal shock to the concrete which has the potential to induce concrete spalling.

Spalling is the phenomenon of parts of the concrete structure breaking away from its underlying support and the potential exposing of reinforcement bars (rebar) which can affect the structural integrity of the tunnel.

A simple, but effective method to "eliminate" spalling is to install a thermal barrier.

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# A TUNNEL VISION: OPTIMISING THE SCIENCE OF UNDERGROUND FIRE PROTECTION

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A thermal barrier to spalling can be provided by two types of Promat system – boards or spray – that are measured effectively against the severe RWS fire test benchmarks. Typically these thermal barriers are employed with PROMATECT®-H and PROMATECT®-T boards, or Cafco FENDOLITE® MII spray.

Polypropylene fibres (PPF) are another form of mitigation of concrete spalling.

However, recent research indicates that, regardless of the type or dose of PPF, there will always be some form of spalling of the concrete.

While PPF may reduce the likelihood of collapse, the concrete will still be subject to the thermal shock of high intensity fires typical of tunnel incidents. The concrete will be damaged by high temperature exposure. Not only will the concrete be damaged by spalling at the face of the fire, it will also be affected by cracking on both the fire side and the cold side.

This will greatly affect the future durability of the concrete due to carbonisation and chloride attack on the concrete/reinforcement bars. In other words, a detrimental impact on the durability of the overall tunnel structure is likely.

The provision of a thermal lining to the concrete has shown to completely "eliminate" the likelihood of spalling when the lining is designed to the correct thickness. This professional service is provided by Promat, and is particularly reassuring when there is a performance-based specification to be met.

## Tunnels worldwide employ Promat systems

Over the years, Promat has developed a reputation both as a leading innovator of international benchmark fire science technologies and as a global fire protection specialist for tunnels.

Over the past half century, the company has been involved in more than 200 projects protecting underground/undersea structures, mostly employing PROMATECT®-H and/or PROMATECT®-T board systems.

Adding even further depth to the company's accumulated subterranean expertise is the manufacture and supply of Cafco FENDOLITE® MII, a cementitious spray material now protecting more than 1.5m² million of tunnel linings.

Promat takes a holistic approach to fire protection and an excellent example of the company's "in depth" approach to problem solving and the application of proven fire science technologies is the on-going Hong Kong-Zuhai-Macao Bridge (HZMB) and tunnel system.

First proposed in 1983, actual construction began 2009. At 6.7km, the HZMB tunnel is one of the world's longest fully-immersed vehicular traffic undersea structures. The entire HZMB tunnel and highway system is one of the most technically challenging civil engineering projects anywhere (please see pages 8 and 9 for a complete review).

Promat systems are hard at work in many underground structures elsewhere.

## Legacy Way Tunnel
**Brisbane, Australia**

Legacy Way is an inner city tolled road tunnel comprised of twin two-lane tunnels 4.6km in length. The primary underground structure runs between tunnel portals located at the western and eastern ends of the tunnel.

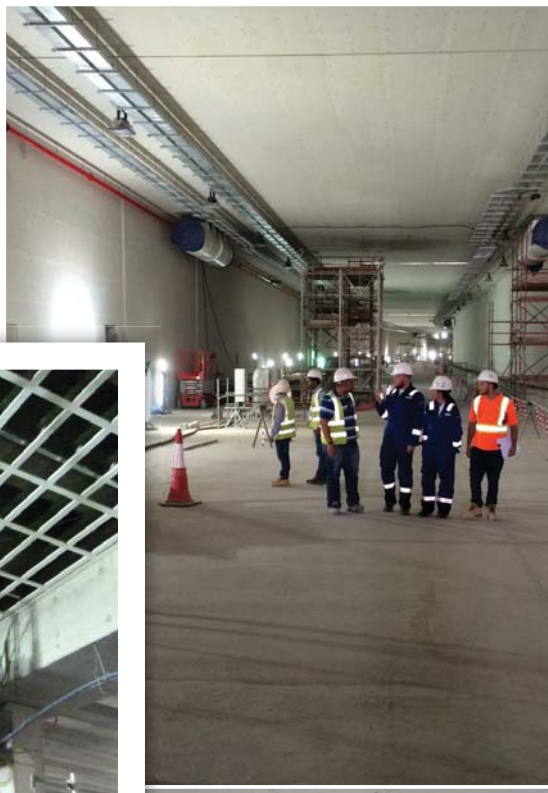
Legacy Way solves connection problems and dramatically reduces commuter travel times.

Promat's partnership with the tunnel owners, designers and contractors – from March 2011 to project completion – is typical of Promat's focus of providing globally recognised expertise and a wide range of integrated fire protection systems.

Large ceilings at portals and the provision of structural protection to cut and cover areas of the Legacy Way tunnel utilise PROMATECT®-H. This is typically affixed to a stainless steel structural horizontal frame suspended from the slab above, spanning from one side of the tunnel to the other. Design fire is to HCM classification.

Concrete substations are also protected with PROMATECT®-H while concrete piles and headstocks are protected with Cafco FENDOLITE® MII.

Fitting out and trial runs were satisfactorily completed in June 2015. The Legacy Way tunnel and 45km long highway network is now fully operational.



## Dukhan Highway Central Tunnel
**Doha, Qatar**

Dukhan Highway Central, part of the Dukhan Highway, involves the construction of 66km of new dual four-lane highway stretching from the existing Thani bin Jassim junction in the west of Doha to the existing Zirkreet interchange near the Dukhan industrial area.

Some 60,000m² of PROMATECT®-H will be installed in to the tunnel wall and soffit in this project.

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# Bluewaters Integrated Complex

## Dubai Marina, United Arab Emirates

Located off the Jumeirah Beach Residence coastline, Bluewaters will feature demarcated retail, residential, healthcare facility and entertainment zones.

The underground tunnel that connects the island to its car park is protected by 65,000m² of PROMATECT®-H for 120 minute fire resistance as prescribed by the required RWS fire curve specifications.



PROMATECT®-H board lining at the entry ramp wall area of the Bluewaters tunnel

# Wakrah Bypass Road

## Doha, Qatar

PROMATECT®-H lost form work is installed in the Wakrah bypass road tunnel. The scope of work covers 50,000m² of wall and soffit fire protection.

Located to the west of Al Wakra and connecting Mesaieed to Doha City, the main Al Wakra bypass road provides five traffic lanes in each direction. It also acts as the main link between Al Shamal and Mesaieed, connecting Mesaieed and Wakra City directly to the centre of Doha without the need to travel though Al Wakra City.

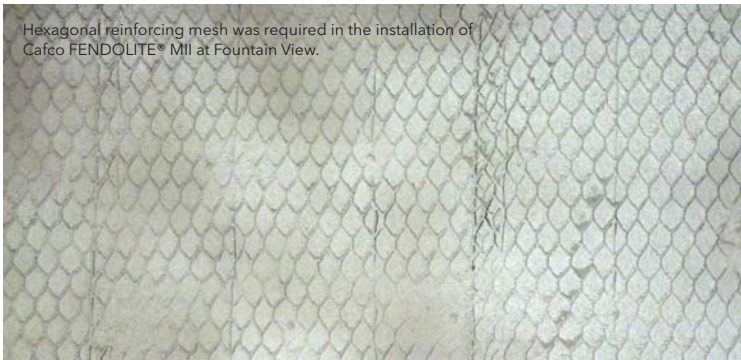
The Wakrah Bypass also provides extra traffic capacity during the construction of Al Wakra Main Road which is also an integral and important part of Ashghal's Expressway Programme.

# Fountain View Residential Complex

## Dubai, United Arab Emirates

Located in downtown Dubai, Emaar's Fountain View project includes four high-rise towers. Three of the towers will comprise a ground floor and 59 additional floors each, while the fourth tower will have 58 storeys.

The infrastructure and road works include an underground tunnel for residential access. This underground feature is protected by Cafco FENDOLITE® MII to RWS fire curve specifications that meet Dubai's RTA and DCD requirements.



Hexagonal reinforcing mesh was required in the installation of Cafco FENDOLITE® MII at Fountain View.

# A TUNNEL VISION: OPTIMISING THE SCIENCE OF UNDERGROUND FIRE PROTECTION

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## AMETI
### Auckland, New Zealand

The Auckland Manukau Eastern Transport Initiative (AMETI) helps to integrate bus, rail and vehicular transportation in the east of New Zealand's biggest city.

Auckland is New Zealand's largest urban area and the focal point of the country's demographic and economic growth. When fully complete, AMETI will deliver numerous benefits to the city's residents.

To mitigate progressive structural collapse, the load bearing columns and beams were also protected with PROMATECT®-H.

Promat Australia proposed tunnel specifications for the protection of the concrete "Supa T" concrete beams that span the roadway as well as other structural elements, including concrete columns. Local code expectations observe the onerous RWS curve.

Approximately 8,000m² of tunnel grade PROMATECT®-H are employed in the AMETI tunnel, along with small amounts of PROMATECT®-T compound.



## Airport Link Tunnel
### Brisbane, Australia

Promat Australia worked with all the major structural stakeholders, contributing the global fire protection leader's usual high levels of professional expertise and dedication. The AMETI tunnel and network system is now fully operational.

The Airport Link integrates a twin 5.1 km road tunnel and toll road system in the northern suburbs of Queensland's state capital. It connects the city's central business district and the Clem Jones Tunnel to the East–West Arterial Road which leads to the Brisbane Airport. It is used by about 60,000 vehicles daily.

Much of the tunnelling was performed by the two largest tunnel boring machines to operate in Australia. The tunnels are 12.48 metres in diameter and as they went the machines secreted a full circle concrete tunnel lining behind them.

This tunnel was submitted to a detailed fire engineering analysis and Promat Australia was involved with the design and specification of the Airport Link tunnel from the very beginning, providing expert advice and direction to a multitude of project engineers and through all phases of the concept and design process over a four year time line.

The protective system of choice Cafco FENDOLITE® MII up to a maximum thickness of 26mm, applied to all entry and exit portals, cut and cover areas, concrete piles, corbels, concrete slabs and vent ducts. Unlike other systems, the spray application is monolithic and was installed without any mechanical reinforcement.

The Airport Link Tunnel was completed in June 2012.

# Fire resistant tunnel systems at Hong Kong-Zhuhai-Macau Bridge


The Hong Kong-Zuhai-Macau Bridge (HZMB) and tunnel system is one of the world's largest and most challenging civil engineering projects.

First proposed in 1983, actual construction began 2009. It is expected to be fully operational by 2020. HZMB includes the world's longest undersea vehicular tunnel.

HZMB is located over busy sea lanes and deep below the choppy estuarial waters of the Pearl River Delta. It links the Hong Kong Special Administrative Region (HKSAR), Zhuhai city of Guangdong province and the Macao Special Administrative Region.

The province of Guangdong is one of China's most important engines of economic growth. When complete, the HZMB network will not only cut travel times significantly but also help accelerate development of the vicinity and its immediate hinterland with a combined population of 80 million people.

## Many tough environmental challenges

HZMB is considered China's most important infrastructure project, both technically and politically. With 33 immersed structural elements submerged at depths more than 40 metres below sea level, HZMB pushes the boundaries of what is technically possible. It also includes numerous long span suspension bridges and the creation of artificial islands.

The 6.7km long tunnel component, the world's longest immersed tunnel for vehicular road traffic, is constructed on a soft seabed which required soil improvement to prevent the elements from settling.


*Inset group picture above (from left)* Jeff Tang (Technical Manager, Promat China Ltd), Tony Li (General Manager, Promat China Ltd), staff of China Communications Construction Company Ltd, Samson Ho (Managing Director, Promat Asia Pacific group), staff of China Communications Construction Company Ltd, Rick Fox (Regional Tunnel Manager, Promat Asia Pacific group) and Paul Sparrow (Global Support Manager, Tunnel Business Segment, Promat International NV)

**HZMB FAST FACTS**

- Hopewell Holdings founder and then Managing Director Gordon Wu originally proposed the idea of the bridge in 1983.
- A study by the National Development & Reform Commission and the Hong Kong government indicates that this new bridge-tunnel-highway network will provide significant macro socio-economic benefits for all in the Pearl River Delta regions. The study is the result of an HKSAR Government proposal to improve linkages between the three places under the "one country, two systems" policy.
- HZMB Advance Work Coordination Group was established in 2003 to coordinate the project.
- Lok Ma Chau cross-border checkpoint operates 24 hours daily for both road vehicle and passenger traffic en route between Hong Kong to Shenzhen.
- The bridge was due for completion in late 2016 but has been delayed to the end of 2017.

Other considerations factored into the exceptionally tough construction process include constant sea traffic navigating some of the world's busiest shipping lanes, an unpredictable annual typhoon season, and many concerns for the threatened China White Dolphin, sometimes know as the Pink Dolphin, whose home range is the Pearl River delta.

## One of largest contracts in Promat tunnel history

The Promat team – comprised of personnel from Promat China and the Promat Asia Pacific Regional Tunnel Manager – have been working on the HZMB project for a number of years.

For quite some time it was a challenge to see how Promat could compete with many less expensive systems available on the market. However, in the final analysis, dogged persistence, legendary Promat professionalism, technical excellence and proven solutions provided the competitive edge required to win this important contract.

The designers chose the RABT curve up to maximum 1200°C. After the fire test it was determined that 25mm thick PROMATECT®-H was required to be fixed directly to concrete in accordance with the design and regulatory specifications.

Approximately 290,000m² of PROMATECT®-H and 8,000 tubes of 600ml PROMASEAL®-A Acrylic Sealant are employed in the HZMB tunnel making it one of the largest fire resistant board construction jobs for the tunnel segment business of Promat worldwide.

A substantial amount of PROMASEAL® FyreStrip is used to seal various movement joints within the concrete.

The Promat team is working closely with the installer to ensure that they have immediate access to solutions for any potential issues as and when they occur.

Actual board installation commenced in early April 2016.

**WHAT**
Direct fixed tunnel lining

**WHERE**
Tunnel of the Hong Kong-Zhuhai-Macau Bridge 港珠澳大桥 (HZMB) in the Pearl River Estuary between Hong Kong and Zhuhai of Guangdong province, China mainland

**WHEN**
Completion scheduled for end 2017

**MAIN CONTRACTOR**
China Communications Construction Company Ltd
中国交通建设股份有限公司

**INSTALLER**
Shenzhen Baoying Construction Group Co, Ltd

**PRODUCTS & USAGE**
PROMATECT®-H
25mm thick x approx. 290,000m²
PROMASEAL®-A Acrylic Sealant
600ml x 8,000 foil tubes
PROMASEAL® FyreStrip

**FIRE PROTECTION PERFORMANCE**
Maximum 1,200°C for RABT fire curve

# Talk of the town –
## steelwork fire protection at Penang's new SPICE project

Strategically located at the northern gateway of the Straits of Malacca, one of the world's busiest waterways, the Malaysian island of Penang is always amongst the first to identify and feel the impact of international trade trends.

In the early 1800s it was a key port in the lucrative Spice Island Trade. Today Penang remains a premier business location, a renowned centre for industry and high tech manufacturing, and a very popular multicultural and heritage-rich destination for regional, global and domestic tourism. Malaysia's Tourism & Culture Ministry noted that Penang received in excess of 5 million tourists during the Malaysia Year of Festivals (MyFest) 2015.

To meet a diversity of modern demands, the physical dimensions of Penang's modern built environment continue to change too. International standard skyscrapers, prestige office blocks, global quality hotels, condominiums, factories and business centres are a common and eye-catching feature of the real estate of Penang and its Sebrang Prai districts on the neighbouring mainland.

*SPICE in the map of Penang island ('Pulau Pinang'), Peninsular Malaysia*


A very good example of these developments is the new and upcoming RM350 million Subterranean Penang International Convention & Exhibition Centre (SPICE) project in Bayan Baru, near Penang's Bayan Lepas International Airport.

Among the project's structural components already finished are the SPICE Aquatic Club (project value estimated at MYR16 million, about EUR3.52 million), SPICE Canopy comprised of F&B retail outlets (MYR28/ EUR6.17 million) and the upgraded SPICE Arena (MYR22/EUR4.85 million). The latter was formerly known as Penang International Sports Arena.

Still under construction are a 2.8ha public rooftop park, a modern convention hall (see picture on this page), function rooms and exhibition areas. All in all, these add a further MYR284/EUR62.57 million to the project's estimated build value.

The basement and lower ground structural works, the multi-storey car park and installation of steel trusses for the green roof are complete.

### The steel trusses employ Cafco MANDOLITE® CP2 fire protection spray coating system

Riang Ceria Enterprise (RCE), the certified installer of Promat Malaysia, commenced Cafco MANDOLITE® CP2 application in April 2016. Installation was completed on time and on budget in mid June 2016.

According to developer SP Setia and its subsidiary Eco Meridian Sdn Bhd, SPICE will be a place for family outings, recreational and sporting activities, and when fully on stream, a highly desirable state-of-the-art destination for professional MICE industry (meetings, incentives, conference and exhibition) events.

Eco Meridian was awarded by the Penang State Government a 30 year concession to develop and manage the SPICE project. SP Setia is one of Malaysia's leading property developers.

When fully complete in 2018, the SPICE project will integrate a world-class convention centre, a hotel, a competitive aquatic facility and a diversified portfolio of international standard retail outlets.

The 25 storey hotel alone adds 453 much-needed business class rooms to Penang's highly diversified and very competitive hospitality industry.

Promat

*All pictures on this page*
Spray application areas of the main roof steel structures adjacent to the iconic roof at the exhibition hall.

**WHAT**
Fire protection for the structural steel trusses in the main roof and operable wall areas, including three dimentional trusses and horizontal section beams

**WHERE**
Subterranean Penang International Convention & Exhibition Centre (SPICE) in the Bayan Baru township of Penang island, Peninsular Malaysia

**WHEN**
Completed in May 2016

**BUILDER / DEVELOPER**
Eco Meridian Sdn Bhd

**PROJECT MANAGEMENT**
SP Setia Bhd Group

**CONTRACTOR**
Sediabena Sdn Bhd

**ARCHITECT**
BYG Architecture Sdn Bhd

**ENGINEERS**
Arup Jururunding Sdn Bhd
GH Consultants Sdn Bhd
GH TAG Consultancy

**INSTALLER**
Riang Ceria Enterprise (RCE)

**PRODUCT & USAGE**
Cafco MANDOLITE® CP2
20–25mm thick coating x approx. 18,844m²

**FRL PERFORMANCE**
120/-/-

# Robust floors and platforms at Changi Airport Terminal 4

The main challenge was to design a slim but robust floor capable of providing 120 minutes of fire resistance and loading capacity of 20kN/mm², while also incorporating the moveable platform structural design.

Changi International Airport is a major air transport hub in the Asia Pacific region, constantly upgrading to meet changing and ever-increasing demand. In 2015 alone, it handled about 346,500 aircraft departures/arrivals and more than 55 million passenger movements through its three existing terminals.

That's a lot of people but even more baggage has to be processed, moved, coded and thoroughly checked before it is precisely reassigned – safe and secure – to departing aircraft and arriving passengers.

This highly sophisticated aeropolis – a purpose-built but also a major lifestyle destination set within a very busy island city state republic – employs a workforce of some 55,000. The new Terminal 4, its major external structure and livery already complete and glinting in the equatorial sun, is slated to be fully operational by late 2017.

Promat Building System Pte Ltd, working closely with master contractor Takenaka Corporation and the project architects, recently oversaw the installation of DURASTEEL® systems as loadbearing floors in the Terminal 4 baggage handling area.

These rooms are designed tough in order to cope with routine maintenance and servicing of the very large x-ray machines that are employed in the security processing of incoming and outgoing baggage and palletised air cargo.

The x-ray machines are located at different levels of the terminal. The floors of the machine service room therefore feature moveable platforms that raise and lower the large and heavy x-ray machines.

The floors and the moveable platforms have to resist the consistent forces of heavy duty wear-and-tear and the repeated shock of the fully loaded platforms constantly raising up and down.

A major concern was the interface of the DURASTEEL® moveable platforms with the DURASTEEL® fixed floor. The gaps could not compromise fire integrity while maintaining functionality and workability of the floor-platform system.

Although some initial reluctance was encountered, mainly due to cost factor perceptions, the Promat sales team convinced the contractor, the architect and the Changi Airport Group that tough, durable 9.5mm thick DURASTEEL® was the right system for the right application.

Promat ensured on-time delivery of five containers of DURASTEEL® from the Blackburn factory. All panels were cut to size and worked on site for professional installation, on time and on budget... meeting present and future safety and security expectations.

DURASTEEL® is marketed by Intumex Asia Pacific in some Asia Pacific regions.

Promat

There are four moveable platforms in this flooring area alone

Moveable platform with up to 20kN/mm² of loading capacity

Installation work

**WHAT**
Loadbearing floor incorporating moveable platforms for the baggage handling area

**WHERE**
Singapore Changi International Airport, Terminal 4

**WHEN**
Completed in July 2016

**MAIN CONTRACTOR**
Takenaka Corporation

**ARCHITECT**
SAA Architects Pte Ltd

**INSTALLER**
Ah Yap Renovation Contractor Pte Ltd

**PRODUCT & USAGE**
DURASTEEL®
9.5mm thick x 3,000m²

**FRL PERFORMANCE**
120/120/120

**LOADING CAPACITY**
20kN/mm²

# A new face lift and re-engineered

View from Torrens footbridge of Adelaide Convention Centre extension work

**WHAT**
Fire protection for structural steel columns in parking area, primary and transfer beams in two levels of the building

**WHERE**
Adelaide Convention Centre, South Australia

**WHEN**
Completed in September 2016

**BUILDER**
Government of South Australia

**BUILDING CERTIFIERS**
Katnich Dodd

**MAIN CONTRACTOR**
Lendlease

**ARCHITECT**
Woods Bagot

**INSTALLER**
LPH Painting Co Pty Ltd

**FIRE & STRUCTURAL ENGINEER**
Aurecon

**PRODUCT & USAGE**
Cafco SPRAYFILM® WB3
25kg x 1,000 pails (25 tons)

**FRL PERFORMANCE**
From 60/-/- to 120/-/-

Adelaide, the state capital of South Australia, has a track record of creating and sustaining some remarkable trends, despite its relative size.

The world-renowned Adelaide Festival of Art, now an annual event, always attracts headline acts, rave reviews and sell-out crowds. The nearby Barossa, McLaren Vale, Clare Valley and Coonawarra wine regions continue to win global accolades from vigneron, gourmet and consumer alike.

The built environment of the city itself is synonymous with excellent quality of life benchmarks that always rate highly in surveys for the "world's most livable city".

The Adelaide Convention Centre is Australia's first purpose-built convention centre. It opened its doors for business in 1987.

After nearly three decades of successful operation – including a number of extensions and refurbishment programmes – city authorities recently decided that a fresh approach to building extension work was necessary. It is noteworthy that the Convention Centre always remained profitable, despite the changes.

Their objective? To ensure that South Australia sustains and expands the economic benefit of the state's annual slice of the current AUD17 billion conference and exhibition industry in Australia.

It's worth noting that the total value of Australia's very competitive business events sector was reckoned to be AUD24 billion in 2012, a bottomline that is forecast by most industry observers to rise to AUD31 billion by 2020.

## New extension timeline scheduled over two stages

Stage one included a 4,300m² multi-purpose exhibition and conference space, meeting spaces and a 600 seat -1,000 stand-up space ballroom that was built by extending the site over existing railway tracks.

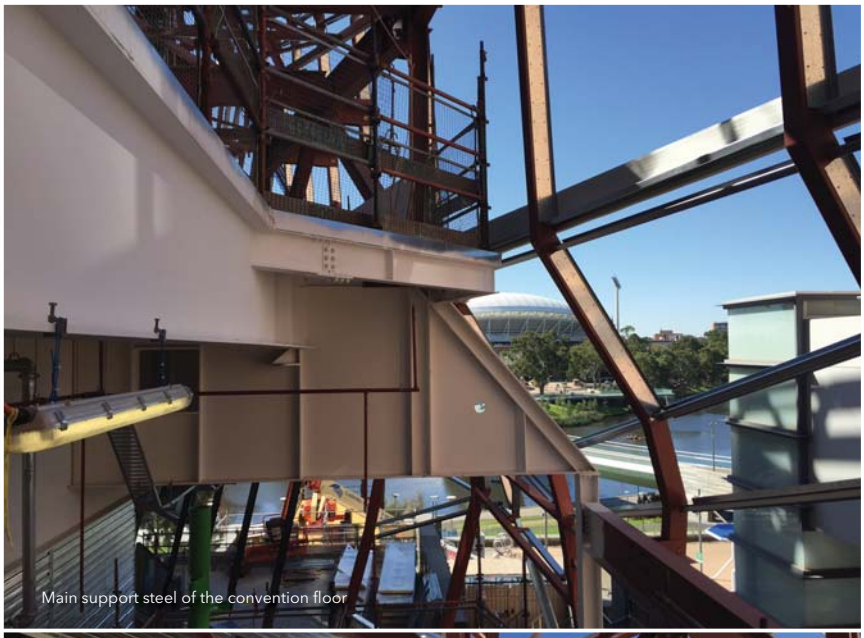
With the first stage complete, the original building was demolished to make way for the second stage construction which commenced in early 2015.

Stage two includes a 3,500 seat plenary building or 3,000m² of flat area for exhibitions. This is achieved in the same area by the innovative use of seating that can be raised, lowered and reconfigured depending on the characteristics of particular events.

The building super structure is built from steel with extra steelwork added to the existing carpark levels below the building to provide additional seismic performance.

The Building Code of Australia's (BCA) deemed to satisfy requirements stipulated all steelwork to have a fire resistance up to 120 minutes.


View into future plenary area


Main support steel of the convention floor


Supports for theater seating area

## Structural fire engineering report points the way ahead

As fire protection of all structural steel in the project to the deemed to satisfy requirements was not considered to be cost effective, Aurecon was commissioned to complete a structural fire engineering report to assess individual rating requirements.

Aurecon examined the use, geometry and fire risk of the building as well as other active fire protection measures used through the structure, such as sprinklers. Aurecon also modelled a number of fire scenarios through the use of Computational Fluid Dynamics (CFD). The modeling system used Fire Dynamics Simulator 5 software.

From such CFD computations, likely temperatures that steel in the building would reach in different fire scenarios were determined. Similarly, assessment of the limiting steel temperature required – and how the structure would spread and transfer its load in the event of failure of beams or columns in certain location – was also calculated.

The data determined what FRL various structural steel members would require.

The report provide clear indications that columns in the carpark areas, along with the primary and transfer beams on levels 4 and 5, required an FRL of either 60/-/- or 120/-/-, depending on their location. Most secondary beams and some of the primary beams in the upper levels were left unprotected.

Through the tenacity of Promat Australia's technical knowledge and the company's recognised applicator, the team clearly demonstrated that Cafco SPRAYFILM® WB3 spray meets all essential requirements of the fire engineers.

## Appropriate fire protection with spray coating application

The green credentials of Cafco SPRAYFILM® WB3 and its low VOC content also weighed significantly on the eventual "product approved for use" decision making process.

Installation at the Adelaide Convention Centre of approximately 25 tons of the Cafco SPRAYFILM® WB3 spray coating system was achieved over an eight month timeline.

Both installer and builder devised an effective quality control system, and the Promat technical team made a number of site visits to ensure the appropriate thickness of the applied product on all structural steelwork.

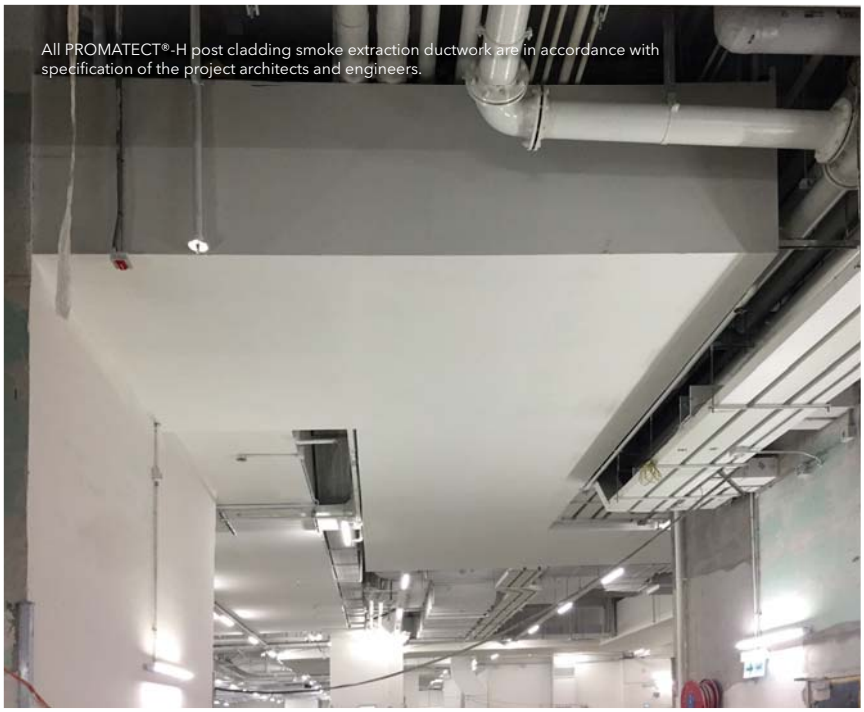
The reconfigured structure of the Adelaide Convention Centre is slated to re-open to international acclaim in mid 2017.

*Goldin Financial Global Centre redefines Grade A building standards and has been awarded by LEED and BEAM for its sustainable design – a reflection of pursuit in design excellence and quality.*

# Prestigious, green and safe

The Goldin Financial Global Centre is part of the continuing redevelopment of the former Kai Tak Airport site. It is easy to reach and market-positioned as a practical and prestigious alternative to Central, the costly and congested business district directly across Victoria Harbour on Hong Kong island.

The innovative building is the headquarters of the Goldin Financial Group, a global enterprise specialising in the operation of vineyards, trading in wine, property investment and management, and integrated factoring services.



All PROMATECT®-H post cladding smoke extraction ductwork are in accordance with specification of the project architects and engineers.

When fully on stream in mid 2017, the Goldin Financial Global Centre will offer 27 floors and three levels of basements, for a total of 79,200m² (852,509 ft²) of space.

Goldin's impressive architectural design features building façades that are in fact articulated textured curtain walls. On the south side of the structure, glazing is angled towards the ground in order to shade the façade. On the north face, however, glazing is tilted skywards to optimise interior lighting. Cantilevered cubes at the summit of the building feature built-in LEDs in the form of a media wall, all in all creating a bold and unique structural identity visible across most of Hong Kong.

Some 3,000m² of 12mm thick PROMATECT®-H and 600m² of 20mm thick PROMATECT®-H are installed for the M&E services enclosure system throughout the project.

It's noteworthy that, thanks to solid, time-tested relationships with contractors, PROMATECT®-H post cladding smoke extraction duct and M&E services enclosure systems were submitted to the project consultants and were quick to achieve approval.

Other advantages for PROMATECT®-H post cladding smoke extraction ductwork include ease of on-site installation, particularly when compared directly with sprayed duct systems.

Strong technical support and access to detailed construction drawings also means that contractors are very familiar with above PROMATECT®-H systems…saving time and money.

Befitting a world class structure set to make a striking statement on this intensely urbanised skyline, the architects and engineers for the Goldin Financial Global Centre specified products and systems to optimise fire safety and security, and to easily meet full compliance with local building and fire code requirements.

**WHAT**
Post cladding smoke extraction duct system and M&E services enclosure for 27 floors and 3 basement levels of the headquarters building

**WHERE**
Goldin Financial Global Centre, Kowloon Bay, Hong Kong

**WHEN**
Completed in August 2016

**MAIN CONTRACTOR**
Hip Hing Construction Co, Ltd

**ARCHITECT**
Ronald Lu & Partners

**STRUCTURAL ENGINEER**
Ove Arup & Partners Hong Kong Ltd

**M&E ENGINEER**
Meinhardt (M&E) Ltd

**PRODUCT & USAGE**
PROMATECT®-H

15mm and 25mm thick x 7,800m² for the ductwork

12mm and 20mm thick x 3,600m² for the M&E services enclosure

**FRL PERFORMANCE**
Up to 240/240/240 for the ductwork

Up to -/240/240 for the M&E services enclosure

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Etex is a Belgian industrial group that specialises and markets high quality building materials and systems. Founded since 1905 and headquartered in Brussels, Belgium, Etex currently operates in 123 factories and 116 subsidiaries across 44 countries, employs more than 18,000 people and is one of the largest fibre cement producers in the world.

Through its subsidiaries, the group offers an extensive range of products: small and large roofing materials, cladding and building boards, passive fire protection systems and ceramic tiles.

Etex aims to be a professional, solid partner for all kinds of building projects.