WHAT'S INSIDE:

PREFAB architecture

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The Court, Condominium and Campus

The recent completion of the New Supreme Court Building has added another fascinating landmark to Singapore's historic civic district. The courthouse for the 21st century is definitely a head-turner with its prominent flying-saucer-like disc on top of the building. Given its short project period of 20 months, the first article shows how the New Supreme Court project draws on the benefits of high levels of prefabrication to accommodate fast-paced construction, and to overcome the tight site constraints and limited site accessibility.

The second article illustrates how the designer redesigns to incorporate precast construction to convey its timeless, sophisticated and high-living theme of the new condominium development The Pier @ Robertson along the Singapore River. The prefabrication efforts included replacing the original cast-in-situ load bearing walls with precast wall components to achieve better quality and foster a safer construction site. To further boost its site productivity, the two-way precast planks were used to construct the flat slab for the basement car park and the conventional pile cap formwork was substituted with precast formwork, saving precious time and manpower.

The ancient Agora of Athens was a place of public assembly for social interaction, congregation and a market place for trade. Adopting the same concept, the last article shows how an Agora is created within the Republic Polytechnic campus to provide a comfortable learning environment where the exchange of information and interaction is multi-lateral. The project demonstrates several benefits of using prefabrication in its design. In recognition of its environment-friendly design, the Republic Polytechnic project was recently awarded the prestigious BCA Green Mark Platinum Award 2006.

By William Lim

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Superb Supreme Court

By Linda Pang
CPG Consultants Pte Ltd

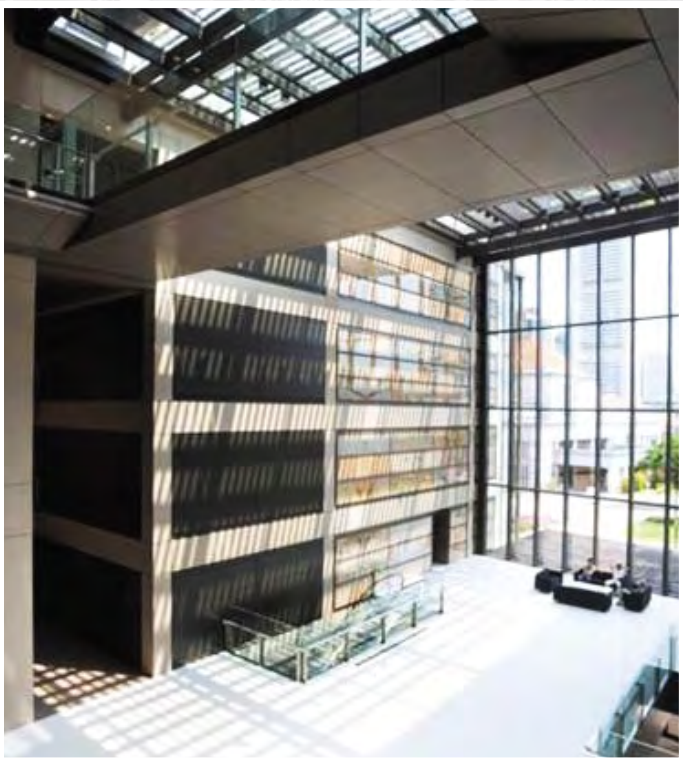
Project Team

Client	Supreme Court, Singapore
Architect	CPG Consultants Pte Ltd
Design Consultant	Foster and Partners
Civil and Structural Engineer	CPG Consultants Pte Ltd
M&E Engineer	CPG Consultants Pte Ltd
Project Manager	PM Link
Main Contractor	IRE-Sato Kogyo Joint Venture
Quantity Surveyor	CPG Consultants Pte Ltd
Façade Consultant	Arup Façade
Interior Designer	TID Associates Pte Ltd
Lighting Consultant	Lighting Planners Associates Inc
Landscape Consultant	Tierra Design Pte Ltd

Interior view of atrium

The Supreme Court Building

Exterior view of the new Supreme Court



Glazed skylights and facade

Located within the historic civic district, the new Supreme Court is the result of a vision to create a courthouse for the 21st century. Designed for long-term flexibility, it incorporates accommodation for future expansion in terms of the number and size of the courtrooms as well as upgrades in electronic systems. The building's architecture conveys the qualities of justice, efficiency, transparency and accessibility in Singapore's legal system. Hence the architectural language is expressed by using steel, glass and translucent stone. Natural light permeates the building during the day while the building emits a warm glow at night.

The building exhibits clarity in its functional and hierarchical expression. The building mass is segmented into distinct blocks using the glazed atria. The atria contain circulation routes lining the interior perimeter with the roof skylights flooding the public spaces with natural daylight. The blocks separately house the high courts, administration offices, the major tenant - Singapore Academy of Law and the appellate courts, and the highest courts in the land, which are symbolically raised in an elevated disc or 'flying saucer'. The disc is a modern iteration of the old Supreme Court's dome and its circular form lends itself the appropriate symbolism of centricity.

Design & construction challenges

From the start, various factors were considered in deciding the most appropriate structural systems for the project. These included the tight urban site constraints, limited accessibility, minimum construction disturbance to neighbours and the fast-paced 20-month construction program.

The bulk of the building design utilised repetitive building grids and floor layouts locked in modular dimensions of 300 mm and 100 mm. Large structural spans were required to cater to the flexibility of the court blocks to expand and reconfigure the internal layouts. High headroom was essential for better quality of space. Another aesthetic consideration was the adoption of the unblemished off-form finish on the columns. Only a thin architectural coating was applied to articulate the purity and slenderness of the structural elements.

The design of the disc structure required the consultants to resolve intricate issues relating to meeting functional and technical requirements while not compromising its aesthetics.

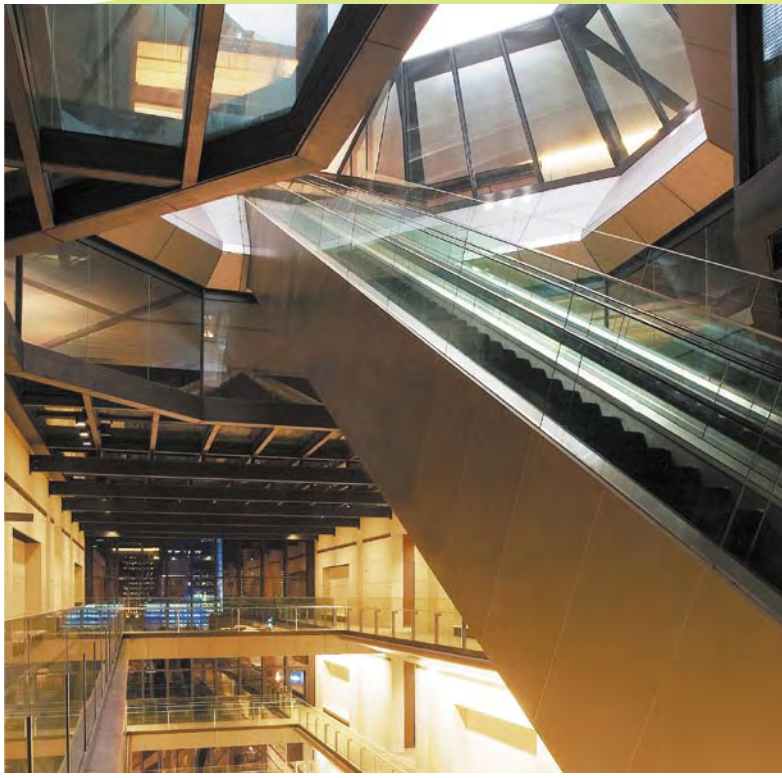
Structural system

Although cast in-situ concrete was used for the basement construction, precast concrete composite steel was chosen as the structural medium for the structure above ground and steel structure for the disc shell roof. Prefabrication was chosen as the most appropriate method to handle the challenges of the project. This chosen method shortened the construction time, minimised noise disturbance, and achieved high construction accuracy and quality.

In order to accommodate the slender column and beam sizes with long structural spans (12 metres and 16 metres in the Court Blocks) with shallow structural space, the building weights had to be designed as light as possible. As such, steel construction with composite steel decks was chosen. To meet the aesthetic requirement of concrete frame with unblemished off-form surface finish, the steel beams and columns were encased in precast concrete. The precast concrete also served to provide fire protection to the steel members.

The disc, undoubtedly an outstanding trademark of the new Supreme Court, comprises a two-storey high and 67-metre diameter circular structure. The structure is framed as a three-dimensional structure using outer and inner virendeel trusses as the primary structural system. The design of the shell roof of the appellate courts is relatively simple despite the long structural span. The main roof structure comprises sixty-four numbers of radial steel spine beams located at the perimeter of the highest floor of the disc. To minimise deflection, an intermediate ring beam near the centre of the floor was installed to support the spine beams before they met at the roof apex. Circular tension ring members were incorporated at the base and at regular intervals along the span of the spine beams to ensure the lateral stability of the roof structure.

The use of prefabrication effectively reduced the weight of the building and lowered the foundation and column costs.

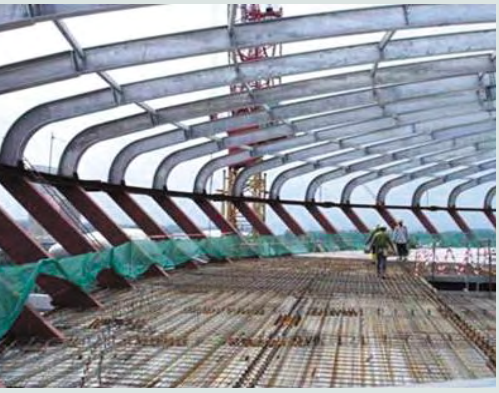


Escalator connects lower podium block to disc

Composite floor construction

Use of prefabricated structural elements

Aerial view of shell roof



Radial spine beams

Prefabricated composite columns and beams

Ring beams

External façade system

The façade cladding is the major architectural expression of the building. The main atrium and side atria are clad in double-glazed and laminated glass set in steel frames. The façade system comprises modular cassettes of the double-glazed stone-glass system set in aluminium frames. The striking feature of the façade is due to the translucent stone - Rosa Aurora Marble. The marble was quarried in Portugal and selected for its translucent property. The marble was sliced into 6 mm thick pieces and laminated with 6 mm thick clear glass. This particular marble accentuates the natural light during the day and the glow of the building at night.

The roof of the disc is clad in aluminium to conceal the underlying layers of thermal and acoustic insulation above the secondary metal deck roof.

A modular sunshade system is integrated at the East and West Elevations to shield the offices from the sun. The sunshade system doubles up as a maintenance catwalk to facilitate the cleaning of the façade.

Sunshade system

Night view of the new Supreme Court

Night view from roof garden

Dry wall system & internal finishes

Dry partitions were used for the internal walls except for the wet areas. Several partitions were also used to form the fire compartments for the courtrooms. They met the stringent acoustic requirements with the mineral wool infill and staggered studs construction. Dry partitions were adopted for their ease of construction, as well as their flexibilities in the future re-layout.

A power float finish was given to the structural concrete of the internal floors to reduce the need for screeding. The raised floor was laid directly above the structural slab. Prefabricated systems were also used for most of the interior finishes. For example, the public corridor walls are lined in aluminium cladding or limestone slabs supported on steel frames. The corridor ceilings are covered with aluminium panels and the raised floor with carpet tiles. The toilet walls are furnished with large panels of floor-to-ceiling height laminated boards, which are dry-laid. The offices are enclosed in system walls comprising horizontal bands of glass set into aluminium frames.

Roof garden

The 'fifth' elevation is an important aspect of the design. Much thought was put into enhancing the external perspective of the new Supreme Court viewed from the neighbouring high-rise buildings. A secondary roof was created to conceal all the mechanical fans and ducts, which pop up from the main roof. The secondary roof was constructed using the steel frames covered with square-shaped precast concrete slabs. Landscaping was integrated to soften the structural grid with Kyoto grass planted in between the square slabs. Trees were also planted along the grid to form a continuous green canopy serving to unify the separate blocks below.

Conclusion

Although being modernistic in its architectural expression, the latest addition to the historic civic district relates well to the scale and dignity of the surrounding civic and colonial buildings. The high levels of prefabrication actualise this project's aesthetics and high quality of finishes befitting of this iconic building.

View of roof garden

Sophisticated living by the Singapore River

By Axis Architects Planners

Project Team

Client	City Developments Limited
Architect:	Axis Architects Planners
Structural Engineer	LSW Consulting Engineers
M&E Engineer	Meinhardt (Singapore) Pte Ltd
Project Manager	City Project & Property Management Pte Ltd
Main Contractor	Sumitomo Mitsui Construction Co., Ltd
Quantity Surveyor	Davis Langdon and Seah Singapore Ltd
Precaster	Fermold Pte Ltd
Landscape Designer	Sitetectonix Pte Ltd
Interior Designer	Axis ID Pte Ltd

Extensive use of full-height windows and doors with sporadic horizontal louvre elements

The Pier @ Robertson

Contemporary & timeless living

Living at The Pier @ Robertson is about sophistication, lifestyle and high living. Offering an unhindered view of the frontage of Singapore River, The Pier entices young professionals and expatriates with its loft home concept and close proximity to the vibrant nightlife along Boat Quay and Clarke Quay.

The single block of 10-storey commercial and residential mixed development consists of 201 apartment units and 13 units of F&B outlets. The apartment units comprise predominantly studio units and other choices of loft-type units and luxurious penthouses with extensive roof terraces. The facilities include an environmental deck with an infinity lap pool, Jacuzzi, rooftop tennis court, a clubhouse as well as basement car parks.

The residential tower, designed in an inverted 'U' shape, resembles the splaying of its two wings to embrace the river view. The Pier's modern architectural language expresses a timeless and yet progressive image, embodied by the clean lines that intersect at multiple planes, creating an effect that is contemporary, dynamic and tropical. Its façade employs generous use of full-height glass doors and windows with sporadic horizontal louvred elements. The beamless flat slab balcony coupled with the glass parapet enhances the outward appearance of the building.

Site constraints

The site for the project was adjoined to a pre-war building at the west boundary and approximately 10 m from the Singapore River along its south most boundaries. The small and tight site had very limited lay-down area and only one entry and exit point for vehicular access. As this did not facilitate an on-site prefabrication yard to be set up, the plan to prefabricate the plank on-site was scrapped due to space constraint.

F&B outlets residing at the ground level

Embracing the Singapore River view

The Pier @ Robertson

Using precast planks to form flat slab

Installation of precast formwork for pile cap

Guiding precast column into position

Substructure construction

The substructure construction involved forming the secant pile retaining wall along the entire basement perimeter. The permanent retaining wall was supported by two pairs of temporary reinforced concrete beams acting as the lateral struts. The struts were carefully spaced to avoid sharing the same location as the precast columns. With the combination of marine clay and sandstone forming the foundation underneath the basement slab, the secant pile retaining wall acted as a very stable soil retaining structure. The free space below the struts allowed obstruction-free manoeuvre of the equipment and the materials. It enabled the easy installation of the precast columns and precast planks during the basement construction. More importantly, the client's objectives of achieving zero time loss due to injury or damage to neighbouring properties were also met.

The secant pile retaining wall also provided very effective water-tightness as the Singapore River is only about 10 metres away from the wall and posed a threat.

Opting for prefabrication

The project team decided to use extensive prefabrication for the structural and architectural components to overcome the site constraints. The precast components used were prefabricated off-site and included the two-tier columns and precast planks which were used for the construction of basement levels, the external facades, the load bearing walls, the balconies, the bay windows, the staircases, the refuse chutes, the planter boxes and the air-con ledges. Precast walls were also installed along the boundary wall next to the existing old buildings to allow safer and faster construction of the feature wall with high quality finish.

Scaffoldless construction site

Northeastern view of The Pier

Precast formwork

In contrast with other conventional projects, the project team for The Pier used precast formwork to speed up the construction of its foundation and the pile caps. The dimensions of the precast formwork used were typically 1 m by 2.8 m in size. Caution was taken to limit the height of the formwork to less than 2 m to avoid damage while handling. Lean concrete was first laid and reinforced with BRC when the basement slab level was reached. This was to stabilise the marine clay foundation. The excavation was subsequently carried out as fast as possible followed by the construction of the pile cap using the precast concrete formwork. The choice of precast formwork was fast, safe, simple to erect and helped to boost the site productivity. The time and manpower savings for the period of the pile cap and basement construction is estimated to be 40 percent.

Close-up view of the suspended precast balcony

Clean lines intersecting at multiple planes

Precast planks

The structural system used for the construction of the basement comprised a flat plate supported by the precast columns. One novel approach adopted for the basement construction was the use of two-way precast planks to construct the flat slab in the car park area. As the practice is not common locally, designing the detailing of the reinforcements to ensure a rigid connection posed an interesting challenge to the engineers. Load tests were carried out to ascertain the adequacy of the design. The use of precast planks reduced the need to strip the slab formwork and enabled easy housekeeping, which kept the construction site clean and safe. It improved the site productivity and allowed the basement one floor and the first floor to be completed earlier by ten weeks.

To facilitate the ease of installation of the vertical components, the connections of the 2-tier precast columns to the base were simplified using bolts. The concept was inspired by the design of the structural steel column with bolted joints at the base. This unique feature allowed the installation operation to be completed within minutes without any propping.

Precast walls with flat slab

The superstructure, however, was constructed using cast in-situ flat plate supported by the precast load bearing walls. The designer had to redesign so as to adopt the precast load bearing walls instead of the original cast-in-situ load bearing walls to achieve better quality and faster construction. The flat slab system combined with the load bearing walls allowed higher headroom for the installation of M&E services. The beamless structural system also gave each unit a clean look.

Stud wall system

A stud wall system was used for the internal walls for its better quality finishes as well as ease of installation. The choice of the dry wall partitions eliminated the labour intensive processes of laying, plastering and skim coating that are common in methods such as brickwall construction. It also improved site productivity and prevented the site from becoming an untidy and unsafe working place that wet trades are often known for.

Conclusion

The project team's vast use of prefabrication improved the site productivity and helped meet its tight schedule. Often in cases where there is limited source of skilful workforce available, this is the obvious and most rewarding solution, as can be seen from the project team's success.

Installation of drywall partitions in living room & bedroom

Republic Poly
gets a campus in the park

by Leo Mauricio and Goh Su-Liang,
DP Architects Pte Ltd

Project Team

Client	Republic Polytechnic
Architect	Maki and Associates (Japan) & DP Architects Pte Ltd
Structural Engineer	Meinhardt (S) Pte Ltd
M&E Engineer	Beca Carter Hollings & Ferner (SE Asia) Pte Ltd
Project Manager	PM Link Pte Ltd
Main Contractor	China Construction (South Pacific) Development Co Pte Ltd – Taisei Corporation Joint Venture
Quantity Surveyor	Davis Langdon & Seah Singapore Pte Ltd
Landscape Designer	Ohtori Consultants Environmental Design Institute (Japan)
Façade Consultants	Meinhardt Façade Technology Pte Ltd
Acoustics Consultants	Nagata Acoustics (Japan) & Acviron Acoustics Consultants Pte Ltd

Prefabricated aluminium cladding at the Republic Polytechnic Centre

Conceptualised as a 'Campus in the Park', the new Republic Polytechnic encompasses a seamless boundary with its adjoining property, the Park and the Woodlands community. It allows harmonious interaction between the residents and has introduced a vibrant feeling to the neighbourhood. This concept is most evident at the western end of the campus adjacent to the park where the campus literally flows into the contours of the parkland.

Creative design

The design called for a large elliptical covered space, known as the Agora, to be located at the centre of the campus. The Agora, common in ancient Greece, is a space created for social interaction and congregation, as well as a market place for trade. A similar design concept was adopted for the Republic Polytechnic campus with the aim of creating a platform to allow social interaction between the staff and students and to enhance the learning process of problem solving.

The Agora measures approximately 4 hectares and comprises a unique roof garden turfed and planted with trees, known as the Lawn. This roof garden blends perfectly into the surrounding greenery and is one of the largest in Singapore. The landscaped roof features thermal insulation shielding occupants below from the tropical sun. There are twelve blocks called Learning Pods housing the educational facilities residing on the Agora.

Practical architectural elements

The main administrative building, also known as the Republic Polytechnic Centre, and the twelve Pods have been designed to incorporate practical architectural elements such as sun shades, fritted glass, precast concrete panels and louvres. These prefabricated elements are arranged on the façade to provide a coherent and unifying overall theme of simplicity and cohesiveness.

The Republic Cultural Centre, located at the south-eastern side of the campus, is characterised by a large pointed and sweeping canopy over the front of the building. The sweeping roof is supported by the prefabricated steel eaves and blends well with the delicate glass facade giving the impression of a very light and airy building.

The Sports Hall has been uniquely constructed with a vaulted prefabricated aluminium roof without any visible joints. It offers a column-free space for housing the indoor courts.

Use of prefabricated aluminium louvres at Republic Polytechnic Centre

Unique prefabricated roof design at the Sports Hall

Use of prefabricated sunshade and external glass façade

Prefabricated recycled concrete road kerbs

Installation of recycled road kerbs leading to the Sports Hall

Environment-friendly practices

A majority of the buildings in the campus are clothed in white or silver paint, with accents of reds at strategic locations. The paints contain low volatile organic compounds, which are environment-friendly as they do not contribute to the depletion of ozone layer. These all-white buildings stand out brilliantly when superimposed against the green forest background. The materials were carefully selected to ensure quality finish and minimal impact to the environment with due economical consideration.

A huge portion of the building products used in the Republic Polytechnic project contained recycled materials. These building materials were manufactured and prefabricated from recycled products, thus extending the sustainability of scarce building resources.

Construction waste and demolition debris such as concrete and brick remains were transformed and recycled into new building product such as road kerbs. Other recycled or recyclable building materials used in the project included the linoleum flooring made from renewable cellulose materials, the carpet tiles containing recycled nylon and the Cemboards, an asbestos-free wood cement board made from recycled wood and Portland cement. The Cemboards were used extensively for the roof of the Sports Hall, the Republic Cultural Centre and Republic Polytechnic Centre.

Prefabricated aluminium cladding at the entrance of Republic Polytechnic Centre

Prefabricated glass, curtain wall and sunshades

Prefabricated glass was widely used for the external façade for the twelve Pods, Republic Polytechnic Centre, Sports Hall and The Republic Cultural Centre. Different glass types were carefully selected to suit their functionalities and locations, depending on the buildings' orientation. Sunshades and louvres were integrated with the external façade of the buildings to reduce the sun's glare and the overall thermal conductivity of the building. This was so as not to compromise the total energy efficiency of the buildings.

Sunshade device

Cross-section of sunshade device

Advantages of prefabrication

Prefabrication, involving mainly the production of building components offsite, offered several inherent advantages, such as increased productivity and the speed of construction, higher buildability, better quality and cost effectiveness. It also helped to improve the overall site safety, allowed better control of the construction programme and encouraged environment friendliness.

The Just-In-Time practice in the delivery of prefabricated components reduced the need for storage space on site. This was useful especially when the space constraints limited the quantity of materials that could be stored on site. Off-site prefabrication also allowed large units of building components to be delivered to site when needed without occupying substantial space.

The stringent production control in the factory ensured that the building components were manufactured with consistent and high standards of quality. This ultimately reduced the number of defects that can be found in conventional cast-in-situ construction. Secondly, achieving zero defects in the prefabricated products was also made possible while tapping on the economy of scale in prefabrication yielded cost savings to the client. Other benefits included faster or shorter construction time, which translated to earlier occupancy of the building.

Prefabrication minimised the number of tradesmen required and the need for scaffolding. The finished components were often delivered to site and lifted from the transporting vehicle into the designated location. This greatly reduced the chances of accidents.

Wastage of raw materials was greatly reduced during the production of prefabricated components under controlled settings. The aim for zero-waste helped to extend the lifespan of non-renewable building materials such as cement, sand and granite.

Innovation using the recycled debris as a new source of raw materials significantly reduced the waste generated from construction-related activities. Prefabrication using recycled materials was also perceived as a manufacturing method, which consumed less energy per unit of production as compared to the use of mined raw materials, such as aluminium.

Conclusion

The Republic Polytechnic clinched the prestigious BCA Green Mark Platinum Award 2006. The project is an exemplary showcase of how the construction industry can contribute to promote an environment-friendly and green environment by using prefabricated recycled building products.

Prefabricated sunshade louvres surrounding the entire façade of the Faculty Centre

INNOVATIVE INTERIOR SOLUTIONS BY BPB

From Guggenheim Museum, Bilboa to Viennese Konzerthaus, Vienna and from Petronas Twin Towers, Kuala Lumpur to One Raffles Quay, Singapore, BPB's portfolio of systems are creating leading edge designs throughout the world. With innovative and quality walls and ceiling solutions, BPB provides fast-track and lightweight solutions, customizable to every need, whether commercial or residential.

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- CasoLine™ Grid Ceiling System

Republic Polytechnic, Singapore

Republic Polytechnic, Singapore

Republic Polytechnic, Singapore

The interior wall of the prestigious Republic Polytechnic has been brought to you by BPB Malaysia Gypsum Sdn Bhd in collaboration with our partners in Singapore, Pacific Interior Supply Pte Ltd and M&F Industrial (S) Pte Ltd. Republic Polytechnic is the fifth and latest polytechnic to be set up in Singapore. Its new 20-hectare Woodland campus is expected to be completed in 2006.

Nottingham Business School, UK

Republic Polytechnic, Singapore

Republic Polytechnic, Singapore

The Sage, UK

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New High Performance Partition Solutions

Lafarge Residential Toughwall and Boral Commercial Impact Wall System

Today's designers no longer need to compromise when considering a lightweight solution which offers fire and high impact resistance. The Lafarge Toughwall and Boral Impact Wall System, comprising of 19mm thick plasterboard sheets mounted on steel framing, is an innovation in the plasterboard lining industry designed to satisfy stringent requirements for severe duty applications in commercial, industrial, institutional and residential projects. The unique feature of these systems is their ability to withstand damage caused by impact from various objects.

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The strength and robustness test (BS 5234), in accordance to SS492:2001, has shown that these systems are suitable for severe duty usage. In addition, these systems also offer a wide range of fire and moisture resistance as well as acoustic ratings to meet designers' requirements.

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- Offers high acoustical and thermal value

These systems have been successfully used and proven in projects such as The Pier, Savannah CondoPark, Coastarina, Butterworth Condo, Mandai Camp, Red Swastika Primary School, Singapore Sports School and Keat Hong Camp.

The Boral Impact Wall System

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