

Outline of Cementaid
Hydrophobic Pore-blocking Ingredient (HPI)
Used in
Singapore Mass Rapid Transit (MRT)

you can **RELY** on Cementaid

CEMENTAID

The Way to Better Concrete

50 Years

The Only Admixture in the World Produced Proven
Corrosion-proof Concrete More Than 50 Years



CEMENTAID INTERNATIONAL GROUP OF COMPANIES



Message from the Founder and Governing Director

Concrete is the most commonly used construction material in the world today. Its low cost and versatility fuel its increasing use throughout the construction industry. At the same time, many structures have also demonstrated the deficiencies of concrete, including shrinkage, low tensile strength, cracking, "dusting" of abrasive cement particles, absorption of deleterious materials and poor durability amongst others.

Cementaid's simple-to-use technical products enable designers and users to reduce and even eliminate such problems, or to enhance certain properties of concrete or mortar. These range from specialised chemical resistance, water-tightness, extreme resistance to abrasion and impact, or any one of a dozen properties where higher performance qualities are desired.

Steel, like concrete, is a general purpose material. The modern steel mill technician selects different admixtures to give his steel special merits for the uses to which it is to be applied. With our proven technical aids, the modern concrete designer can also enhance particular concrete properties to meet the specific needs of his industry.

The Specification Guide gives the concrete designer and user an easy technical reference to the wide range of proven Cementaid products.

What became the Cementaid group of Companies in 1954 was established in Perth, Australia in 1946. As a result of the advanced performance and value of its admixtures and surface impregnations, technical service centres and production plants soon spread throughout Australia and expanded into Asia, then Europe, North America and the Middle East. The Group is dedicated to helping produce better quality concrete, and a number of products now acceptable world-wide had their world origin in our group's research laboratories. We have specialised in original research, development and manufacture of reliable concrete enhancing products, our sole business. Our credo has always been and remains:



For service, advice and information, simply call the Cementaid Technical Service Representative in your area, who will be pleased to help, or email us direct below from the Contact Button.

I would like to take this opportunity on behalf of our dedicated directors and staff to express our appreciation of the great support and encouragement we have had from specifiers, the ready mixed concrete industry and our customers over the past great 50 years. It could not have happened without you, and we look forward to continuing our service to you.

Yours sincerely

Peter N. Aldred D.F.C.

Introduction

Singapore famous Metro System, the Singapore Mass Rapid Transit (MRT) System takes off in 80s. This is part of the city modernization processes and to catch up with the ever growing population and people's expectation of public transport.

Cementaid, at the same time, grows together with Singapore MRT System. Since the first phase of MRT until now, except those stations that built on ground, we have been supplying our waterproofing system to a fair bit of underground MRT stations.

At the moment, there are five MRT lines which are either currently in use or in different construction stages, they are:

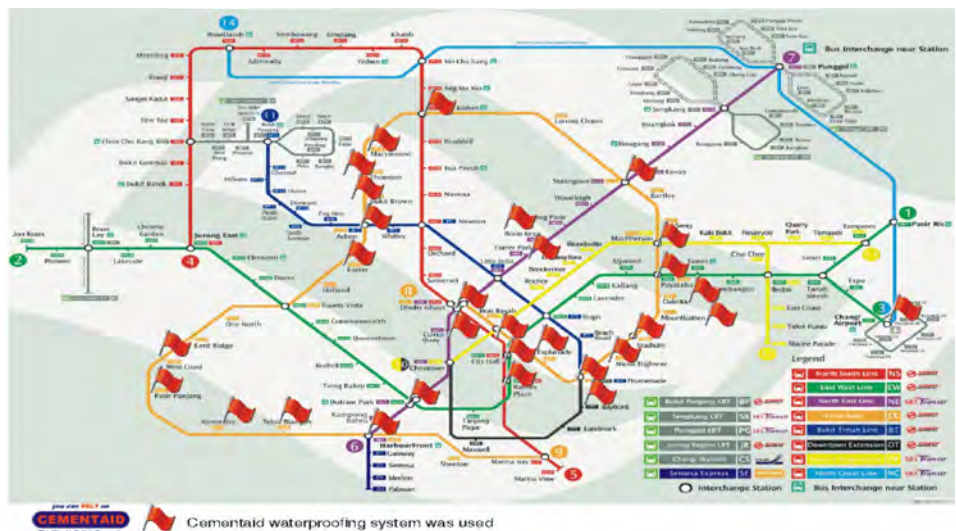
The **North South MRT Line** was the first Mass Rapid Transit (MRT) line in Singapore. The line is currently 44 km long with 25 stations, and is operated by SMRT Corporation. Traveling from one end of this line to the other end takes around 61 minutes, and this line is coloured **red** on the rail map. As the name implies, the line connects central Singapore to both northern and southern parts of the island. The line, basically, connects central Singapore to both northern and southern parts of the island. Cross-platform transfer to the **East West Line** is provided at Jurong East, City Hall and Raffles Place stations while transfer to the North East Line is possible via a linkway at Dhoby Ghaut station. When the Woodlands Extension was opened in 1996, the Branch MRT Line consisting of the route from Jurong East MRT Station to Choa Chu Kang MRT Station was integrated into the main line.

The **North East MRT Line (NEL)** is the third Mass Rapid Transit line in Singapore and the world's first fully-underground, automated and driverless rapid transit line. The line is 20 km long with 16 stations and operated by SBS Transit. Travelling from one end of this line to the other end takes around half an hour. This line is coloured **purple** in the rail map. As the name implies, the line connects central Singapore to the north-eastern part of the island.

The **Circle Line (CCL)** is Singapore's fourth Mass Rapid Transit line. Under construction as of 2008, the fully underground line will be 35.7km long with 31 stations, and will be operated by SMRT Corporation. It will be the World's longest fully automated metro line. The colour to be used for distinguishing the Circle Line from other lines is confirmed to be orange. As the name implies, it will be an orbital line linking all radial lines leading to the city, and also will cover many parts of the Central Area.

The **Downtown Line (DTL)** will be the fifth Mass Rapid Transit line in Singapore, with the first stage of construction commencing on February 12, 2008. When fully completed, the line will be about 40-km long with 33 stations. It will be a fully-automatic and driverless system similar to the North East Line and the Circle Line, and will be fully underground. The line will serve the Bukit Timah area and eastern Singapore and bring commuters to the new downtown area.

Cementaid has been supplying MRT projects through various Contractors with the Company's suitable products. Among all, the Cementaid waterproofing systems namely, THE EVERDURE CALTITE SYSTEM[®], THE 3CC SYSTEM[®] as well as THE 3CC PB SYSTEM[®] are being used in different projects in different stages to solve various site waterproofing problems. Indeed, there are many happy and satisfied customers throughout the years the Company served. The following is a brief summary of Cementaid activities in MRT projects.



MRT PROJECT	CONTRACTOR	LOCATION USED	DURATION
EVERDURE CALITE SYSTEM			
MRT NSL C103 - Bishan Station	Sinbelco	Basement Wall & Slab	1987 – 1989
MRT NSL C107B - Raffles Place Station	Taisei, Shimizu, Marubeni	Basement Slab	1987 – 1989
MRT NEL C704 - Serangoon Station	Wass-Econ-CEH JV	Cross Passages	1999 – 2002
MRT NEL C705 - Kovan Station	KSM JV	Cross Passages	1999 – 2002
MRT NEL C707 - Dhoby Ghaut Station	Obayashi Corporation	Basement Slab	1999 – 2002
MRT NEL C708 - Clarke Quay Station	Nishimatsu-Lum Chang	Basement Slab & Cross Passages	1999 – 2002
MRT NEL C709 - People's Park Station	Gammon-Econ JV	Entrance Slab	1999 – 2002
MRT NEL C710 - Outram Station	SDK JV	Basement Slab	1999 – 2002
MRT NEL C712 - Punggol Station	Sato Kogyo	Tunnel Wall & Collar Joint	2002
MRT CCL C822 Macpherson Station	Econ JV NCC	Cut and cover tunnel, Station base slab	2004 – 2005
MRT CCL C8282 Macpherson Station	Chye Choo	Cut and cover tunnel, Station base slab	2007 – 2008
MRT CCL C823 - Paya Lebar Station Dakota Station Mountbatten Station	Nishimatsu Lum Chang JV	Basement slab, wall (most part) and cut and cover tunnel	2006 – 2009
MRT CCL C824 / C828 - Nicolle Highway Station Stadium Station	Nishimatsu Lum Chang JV	Basement slab and roof (partial at Boulevard Siding)	2006 – 2009
MRT CCL C825- Dhoby Ghaut Station Bras Basah Station Esplanade Station Promenade Station	WH-TEC NCC JV	Basement slab, roof slab, entrances and cut and cover tunnel	2005 – 2009
MRT CCL C852	WH-TEC JV	Cross Passages	2006
MRT CCL C853a Bishan Interchange	Eng Lim Ho Lee JV	Basement slab, wall sections where membrane with no space	2006 – 2009
MRT CCL C853 Marymount Stn	Taisei Corp	Basement slab and roof slab (partial)	2006 – 2009
MRT CCL C854- Thomson Station Bukit Brown Station	Taisei Corp	Basement slab	2006-
MRT CCL C854- Thomson Station Bukit Brown Station Adam Station Farrer Station	Taisei Corp	Cross Passages	2006-

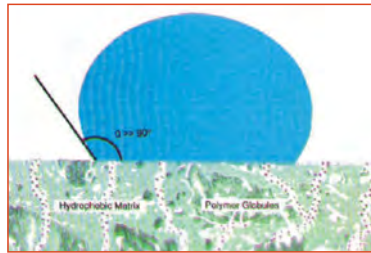
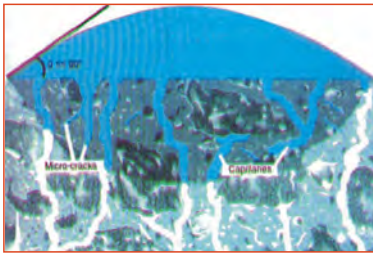
MRT PROJECT	CONTRACTOR	LOCATION USED	DURATION
MRT CCL C856 -West Coast Station Pasir Panjang Station Labador Station Telok Blangah Station Harbour Front Station	Sembawang E&C	Basement Slab	2006
MRT DDL C8402 Tunnel linking to Bayfront Station	Shanghai Tunnel	Basement Slab	2009
MRT DDL C906 Bayfront Station	Sembawang E&C	Piles concrete toppings, partial wall panels and lock out panels	2009
Kallang Paya Lebar Expressway C421	Sembcorp	Basement Slab and roof slab (partial)	2005—2008
Kallang Paya Lebar Expressway C424	Taisei Corp.	Basement Slab and wall (partial)	2005—2008
3CC / 3CC PB SYSTEM			
MRT NSL C107 - Raffles Place Station	Keppel-Kajima JV	Tunnel Ends Abutments	1987—1989
MRT Depot @ Ulu Pandan	Mechtel	Ground Floor	1993—1994
MRT NEL C707 - Dhoby Ghaut Station	Obayashi Corporation	Partial wall in station, entrances and roof under canal	1999—2002
MRT NEL C710 - Outram Station	SDK - JV	Underpass Linked to Cantonment Complex(CID)	1999—2002
MRT CHANGI LINE C504 - Changi Airport Station	Kumagai-Sembcorp JV	Overrun tunnel wall	1999—2002
MRT CCL C823 - Paya Lebar Stn	Lum Chang Bldg Contractors	Skin wall in front of Diaphragm Wall	2006—2009
CALMET II & ROKITE			
SMRT Bishan Depot	Obayashi Corporation	Floor Coating System at Rolling Stock Work Shop of Main Building	2006
CEMENTAID OTHER PRODUCTS IN VARIOUS PROJECTS			
 CALGROUT NO. 7	Cementaid non-shrinkage cementitious material for honey comb repair		
 WELDCRETE	Cementaid latex based bonding agent for honey comb repair		
 CALCURE B	Cementaid curing compound for effective curing		

CEMENTAID waterproofing systems in general

Throughout the years of serving MRT projects, Cementaid is always perceived as a reliable, responsible, resourceful, informative and "never say die" type supplier. With long history of track records in local and throughout the World, since early stage Cementaid waterproofing systems have become one of the approved type waterproofing systems.

Cementaid's waterproofing systems being classified under hydrophobic poreblocking ingredients (HPI) waterproofing system is one of the approval types waterproofing systems to be used in basement slab as stated under section 14 of M/W specification.

As HPI type waterproofing system, once the admixture is incorporated into concrete at the batching plant, the poreblocking ingredients and hydrophobic lining will fill up the capillaries that generated by



bleeding water inside concrete while it is still green. Once hardened, the whole concrete mass becomes hydrophobic, i.e. not absorbing water and thus maintaining dry throughout its service period.

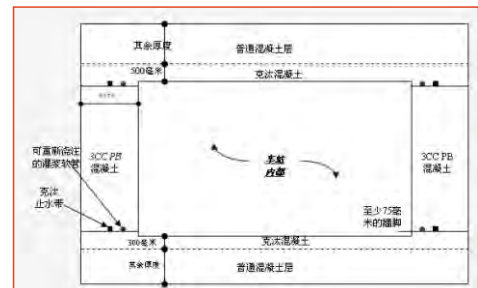
For economic point of view, in a thick raft slab casting, Cementaid HPI waterproofing systems need not to be used in the full thickness. In general, by casting at the top 300mm layer of the raft slab in one single casting, i.e. composite casting, waterproofing to the base slab is suffice.

The two layers, i.e. normal concrete and waterproofing concrete, are placed monolithically and compacted / vibrated together. The Caltite concrete MUST be on the top, upper layer (interior), so that any placement imperfections requiring rectification (voids, honeycomb, shrinkage crack, etc) can be conveniently accessed from inside the finished structure.

As is the case with a normal concrete raft slab, the lower section thickness becomes effectively saturated. This saturation itself ensures long term durability and corrosion-protection of the lower / bottom steel reinforcement, by permanently depriving this zone of sufficient oxygen to fuel any corrosion.

However water is not able to penetrate past, or into, the upper CALTITE concrete layer, permanently protecting embedded reinforcement in this zone against corrosion. Because the HPI concrete remains permanently dry, embedded top steel reinforcement remains DRY and corrosion-protected.

NOTE: The reverse may apply in the case of very thick "composite roof" castings (e.g. underground rail & road tunnels below water table) In this application, the waterproof / corrosion-proof HPI concrete is cast in the lower layer, and the slab "topped-up" to finished thickness using ordinary concrete. Subsequent in-service saturation of the upper, ordinary layer ensures durability and corrosion-protection of steel embedded in this zone, again by depriving the environment of the oxygen required for corrosion. Meanwhile, the dry, hydrophobic matrix of the lower, air-exposed CALTITE concrete layer (accessible from "inside" the completed structure), ensures permanent durability and corrosion-protection of steel embedded in this zone.



Several difficult MRT highlights



It was never be easy for Singapore to start her first very phase of MRT project. In fact, during construction stage, the local soil condition was always the headache problems for Engineers to deal with.

Raffles Place MRT Station is a Mass Rapid Transit (MRT) interchange station on the North South Line and the East West Line in Singapore. It is directly beneath the centre of the financial district of Raffles Place, located in the Downtown Core area, south of the Singapore River. It is one of the more prominent and busier stations within Singapore's transport system, especially being an interchange station located within the Central Area.



The station has a large number of entrances/exits, the two main ones facing the Raffles Gardens, with the building resembling a colonial style. It used to be the largest and deepest MRT station in Singapore, but the record was broken by Dhoby Ghaut in 2003. It will then be broken by Bras Basah in 2009, which is around 35 metres below ground.

The construction of Raffles Place Station during the 1980s was not an easy task at all. Problems included a tunnel section which links

up City Hall MRT station and Raffles Place MRT station and is directly underneath the Singapore River. However, the Singapore River then was not as clean as now, in fact, according to soil investigation conducted, the soil sample indicated a low PH value, i.e. acidic soil.

Engineers was then facing a tough time to determine the right waterproofing system to this tunnel section, whatever waterproofing system they decided at that time, it had to overcome two instant problems; the system must not be affected by the acidic soil condition and should be an effective and fast system to avoid delay due to tidal condition.

Engineers ever considered membrane system. However, all membrane systems are subject to a life span and the acidic soil condition might pose a danger in shortening the overall life span of the membrane. Also, it was extremely difficult to apply membrane properly onto the concrete surface especially when it is working in marine environment. Hence, the best solution was to employ integral waterproofing system. On top of this, a HPI system is on an upper because by ensuring a dry concrete matrix, aggressive ions such as chloride or sulphate inside the water will not be able to permeate into the concrete and thus rebars are protected from corrosion.

Based on the above considerations, eventually Cementaid EVERDURE CALTITE & 3CC PB system were selected as waterproofing systems to the tunnel section as well as the basement slab of the Raffles Place MRT station. The 3CC PB system instead of EVERDURE CATLTIE was used at the two ends of tunnel abutments because of their substantial thickness. By doing so, cost was reduced and this value engineering practice becomes an example for the later MRT projects.





Dhoby Ghaut Station

Dhoby Ghaut MRT Station is located at the eastern end of Orchard Road. Originally it was only a station on the North South Line but as of the opening of the North East Line, it became the interchange station for these two lines. When the Circle Line opens later, this station will be the only MRT station in Singapore to be an interchange station for three lines and would also be the largest MRT station in Singapore. Due to its size, the MRT station is equipped with travellators, and is one of two MRT stations in Singapore with travellators, the other being at Serangoon MRT Station. There is a bomb shelter in the North East Line section of the station. The North South Line section of the station was upgraded in 2002 in the first phase of the station upgrading programme, which was completed in 2006. It is currently the largest and 2nd deepest MRT station (after Bras Basah MRT Station) in Singapore. The deepest point is 28 metres in depth and it is the one of the two stations to have five storeys below ground level.



Current Station Layout

L1	Street Level	Plaza Singapura
B2		Dhoby Xchange, Stamford Canal
B2	Concourse	Faregates, Ticketing Machines, Station Control, Transitlink Counter
B3	Platform A Platform B	NS1 EW24 jurong east towards NS27 Marina Bay
B4	Platform A Platform B	CC29 NE1 harbourfront towards CC29 NE1 HarbourFront
B5	Platform A Platform B	Ne1 CC29 HarbourFront towards NE17 Punggol

Right before the actual construction started, Obayashi Corporation being the awarded Design and Build Contractor of this C707 MRT NEL package, faced several site conditions.

- Right located at down town of Orchard Road, building a huge and deep extension to existing Dhoby Ghaut station would mean that the Contractor had to deal with a very chronic traffic diversion.
- Deep excavation (approx. 28m, the deepest part) would be obstructed by a lot of existing utilities and protecting and stabilizing adjacent buildings was difficult but crucial.
- An existing canal, the Stamford Canal, required temporary diversion and eventually let it flows through the basement by containing it into a new construction box culvert and formed part of the building. In order to ensure a smooth flow of the canal throughout construction, Contractor decided to employ top-down construction method. This, again, increased the difficulty of the project as a whole.
- The new extension was built close to the existing shopping centre, the Plaza Singapura, and many future linkages required.
- Planned as the largest interchange in the MRT planning, many locations required demolition of old Diaphragm Walls of previous phases to form new linkages between the new and old stations.

All the above facts told the Contractor that the waterproofing system chosen for this project must be very user friendly, less affected by site constraints and most importantly effective and yet speedy.

When Cementaid contacted Obayashi Corporation, all of the above constraints were then studied carefully. In order to provide a better solution to the clients, Cementaid joined the Contractor as part of their planning team to work out waterproofing details in different areas.

The Stamford Canal

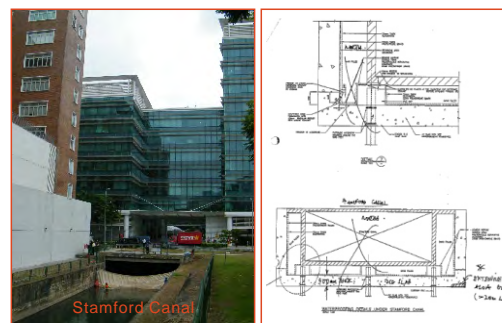
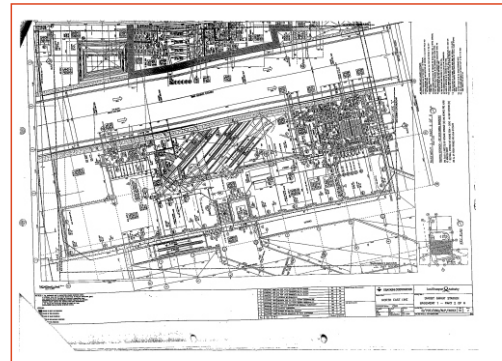
The main problem of this canal to the new extension was that it must be firstly diverted temporary during construction and basement construction started under top down construction method. Once completed, the canal would form part of the station. The canal located at B1 level and is just right on the top of the Concourse platform. Despite that it would be fully enclosed and not shown to the public in the future, it also means that the waterproofing system used there has to be effective or else unwelcomed leaks might cause inconvenience to staff working in a lot of control rooms and commuters who are there to buy their MRT tickets at the concourse level.

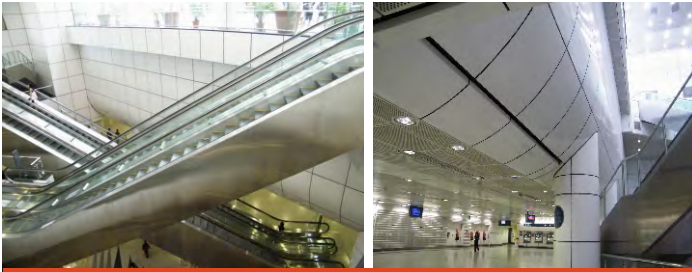
Another challenging problem to the Engineers was the low headroom as low as 600mm allowed between the soffit of the new canal and the future roof slab of this extension. In other words, membrane system might not be a good choice here for the 600mm headroom did not allow any workers of normal adult body size to do a proper installation there.

The best remaining alternative was to employ Cementaid integral waterproofing system. In case like this, Cementaid waterproofing system works totally within the concrete matrix and it also does not require any installation on site. Therefore, the low headroom problem did not vividly jeopardize the overall performance of Cementaid's waterproofing system.

Based on the above consideration, 3CC System was eventually introduced both to the new canal itself as well as the full thickness of the new roof slab of the station extension.

3CC System was proposed mainly because of the roof slab thickness. The only site constraint to Cementaid's waterproofing system in this scenario might probably be the potential inconvenience in executing composite casting by just casting EVERDURE CALTITE concrete to bottom 500mm of the roof slab. As such, since full thickness casting was obviously unavoidable, 3CC System was the best alternative to Contractor.





The two photos shown different angles taken of the enclosed canal within the station compound now.
The enclosed canal is just right on top of the Concourse level where a lot of control rooms are located and commuters are buying tickets for their MRT journey

The various entrances to vicinities

Deep basement construction

Before CCL was designed, Dhoby Ghaut used to be the deepest stations among all the other stations. The deepest part of the basement can be up to 28m below ground. It was literally a tough challenge for Contractor to construct it in such a site full of constraints. Underground water, soil stabilization, maintaining the existing

Stamford Canal etc were somewhat crucial issues to Contractor throughout the whole construction period. In view of this, the choice of waterproofing system to the basement slab (B5 and partial B2) under such depth must be easy to handle, effective and less susceptible to site hindrances. Contractor eventually opted for Cementaid's EVERDURE CALTITE System for the basement slab. By choosing Cementaid HPI waterproofing system, Contractor literally combined the casting program with waterproofing program, this in turn enabled Contractor to have an upper hand in controlling construction period. In fact none of the external barrier waterproofing system could give the Contractor such privilege. Furthermore, since EVERDURE CALTITE System only required top 300mm layer as waterproofing barrier in a thick raft slab and therefore Contractor also saved substantial amount in this item.

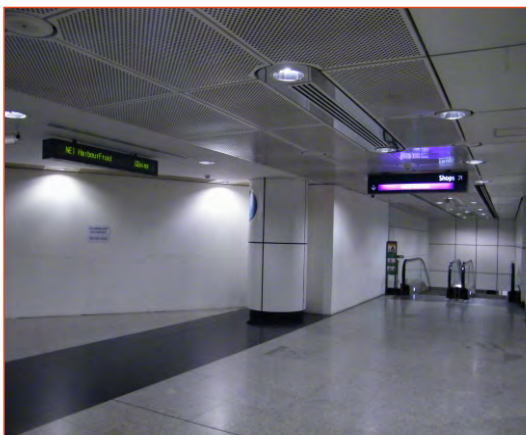


The various entrances to vicinities

This new extension is located right besides Plaza Singapura shopping centre and also the NSL existing MRT station. Architect's idea is to have full and convenient accesses to all different surrounding buildings. As such, a lot of linkages and entrances were planned in this project.

In most cases, in order to gain access or link up with the vicinities, knocking down existing diaphragm wall or old sheet piling were not uncommon. However, the irregularity surface and lack of working space posed a genuine problem for membrane applicator to install external barrier properly. To solve the problem effectively, Cementaid's waterproofing system once again was selected as alternative waterproofing proposal to such locations.

As value engineering, since HPI system was used in wall and cast in full thickness (approx. 2.0m thick), 3CC System was employed.



Typical linkage between old and new station, the old diaphragm wall was knock down to provide such access.



Typical entrance for commuters to enter shopping centre as well as MRT station



Bishan Interchange

Bishan MRT Station is an interchange station along the North South Line and the Circle Line that serves the Bishan community, especially that of Bishan East. The station is located in Central Singapore, along Bishan Road, close to the town centre of Bishan. Some trains from Bishan Depot arrive at platform B of the station to travel southbound towards Marina Bay for evening peak period services. It is one of the five stations on the new Circle MRT Line that opened to the public on 28 May 2009. Commuters will be able to transfer to the line via an underpass that links the Circle Line platform to the two separate platforms at the North South Line.

Like Raffles Place MRT Station, the soil investigation report during the NSL construction shown that the soil condition of this station was somewhat acidic. Again, in other words, the life span of normal external barrier would be at risk and shortened. Therefore, since NSL time, Cementaid EVERDURE CALTITE SYSTEM was used to cast the precast wall blocks at the two sides of the track area.

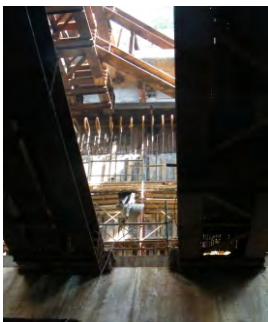
During CCL stage, this ground level station was expanded to be an interchange which provides a changing point for commuters to switch between the NSL and CCL. Under the CCL design, a new underground Bishan Interchange would be built perpendicularly to the existing NSL and also butt with the existing Junction 8

Shopping Centre as well as a huge multi storey carpark with bus interchange.

Therefore, the main challenge in this project was to construct a new underground station with 3 levels basement adjacent to the existing live station and also to ensure that the daily



Precast wall blocks cast with Caltite installed at both sides of track



traffic operation would not be interrupted. Moreover, Contactor had to make sure that the construction would pose no danger to the structural stability of the existing shopping centre and the multi storey carpark with bus interchange.

Eng Lim Ho Lee JV being the Contractor in this project firstly selected Cementaid's EVERDURE CALTITE System for the basement slab

construction in order to speed up the construction process. However, when it came to basement wall construction, basement wall was literally cast butt up with the existing shopping centre.

As a result of this, Contractor realized that it was basically having no working space for any external barrier application. The only solution left was to switch to HPI waterproofing system and eventually Cementaid supplied EVERDURE CALTITE System to the full thickness of almost 90% of the stretch of wall which directly butt with the shopping centre.

In actual fact,with this decision made,Contractor actually spent less time on wall construction and substantial timing was saved in this item.



Photo to show that the new CCL MRT station indicated by yellow arrow is built close to the existing building.



Photo to show wall cast with Cementaid HPI waterproofing system speeded up construction process.

Bras Basah / Esplanade MRT Stations

The above two MRT stations together with another two more stations i.e. Dhoby Ghaut (Ph III) and Promenade are all under one single construction contract awarded to the Contractor, Woh Hup NCC STEC JV.

Among the four stations, Bras Basah and Esplanade stations are highlighted here. The reason is that Cementaid's HPI waterproofing system was extensively used (more than just only for the basement slab) in both of these stations to solve various site difficulties mainly due to their basement depth and extremely time constraint.

Bras Basah MRT Station is an underground Mass Rapid Transit station on the Circle MRT Line in the Museum Planning Area of Singapore. It is located in front of the Singapore Art Museum and is linked to the new Singapore Management University and Plaza by the Park tower at concourse level. The station, is the deepest station of the Mass Rapid Transit system at 35 metres below ground. The platform will be located at basement 5.

Current Station Layout

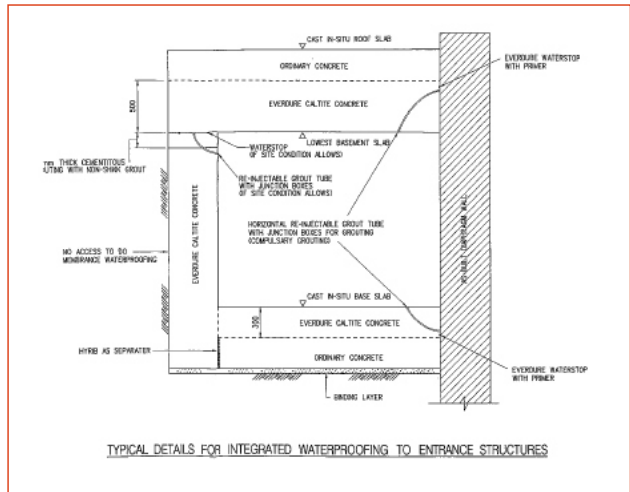
L1	Street Level	Singapore Art Museum, Singapore Management University
B1		
B2		
B3		
B4	Concourse	Faregates, Ticketing Machines, Station Control, Transitlink Counter
B5	Platform A Platform B	CCL towards CC1 NS24 NE6 Dhoby Ghaut (→) CCL towards CC29 NE1 HarbourFront via CC17 Caldecott (←)

As the deepest MRT station and an underground station that links up with Art Museum and Singapore Management University. Contractor had to fight with high water table and to hack a lot of old / existing diaphragm wall in order to provide accesses to all the vicinities.

One concern that Contractor had with regard to waterproofing system in this project was in what way the waterproofing system could be installed effectively and properly. This is crucial to the Contractor especially when a lot of hacking works were involved. External barrier like membrane might not be a good suggestion here as the membrane system could be jeopardized during the hacking process. Reinstatement to membrane system had never been easy as well. On top of this, in order to speed up the construction time, Contractor decided to adopt a top down method (See photos). This, obviously, increased the difficulty of all waterproofing installation.

Diaphragm Wall construction is always commonly employed in deep basement construction, to construct slabs and walls within Diaphragm Wall is always obstructed by many struttings and bracings. Unavoidably many box-outs had to provide on wall panels and sometimes even basement slab for struts to pass through in order to maintain the stability of Diaphragm Wall before the basement is up. Most of the time, once basement is almost constructed, Contractor shall need to reinstate all the left behind box-outs, some of the box-outs sizes could be as big as 2m x 2m!

By using Cementaid's EVERDURE CALTITE SYSTEM in this project, Contractor needed not to worry about the box-outs reinstatement. As Cementaid HPI waterproofing system is incorporated into concrete matrix, therefore hacking and reinstating becomes simple and user friendly. Reinstatement through a simple cementitious grouting mixed with Cementaid HPI admixture is suffice. Most of all, in such case, the performance of waterproofing system is not jeopardized and therefore warranty against watertightness is not affected.





Esplanade MRT Station is also an underground Mass Rapid Transit station on the Circle MRT Line in Singapore. It is located next to the War Memorial Park and Suntec City Convention Centre. It is also link to CityLink Mall and the proposed underground extension link from Raffles City.

On 30 April 2008, the underpass linking CityLink and Suntec City was reopened to the public after five years of closure. It's also the first of the Circle Line stations where the public can have a glimpse of the interior. The underpass had been closed since 2003 to facilitate the construction of the station and pedestrians had to use a temporary covered overhead bridge to cross Raffles Boulevard.

Current Station Layout

L1	Street Level	Suntec City, Suntec Convention Centre
B1		Transfer Link to NS25 EW13 City Hall via CityLink Mall
B2	Concourse	Faregates, Ticketing Machines, Station Control, Transitlink Counter
B4	Platform A Platform B	Circle Line towards CC1 NS24 NE6 Dhoby Ghaut (→) Circle Line towards CC29 NE1 HarbourFront via CC17 Caldecott (←)

Like the rest of the MRT station in this Contract, Contractor was working under tremendous pressure. All the four stations are along down town. Traffic diversion had never been easy. That was why Contractor would like to use top down construction method in order to speed up the overall construction period.

In 2006 Singapore was the country in support of the 61st Annual Meetings of the Boards of Governors of the International Monetary Fund (the IMF) and the World Bank Group. The opening ceremony and plenary sessions for the main meetings took place from 19-20 September 2006 at the Suntec Singapore International Convention and Exhibition Centre (SSICEC) in Marina Centre. The ministers of G8, G10 and G24 concided with the event on 16 September. Registration for event delegates began on 11 September 2006 at City Hall, and the three-day Program of Seminars from 16 September 2006 at the Pan Pacific

Singapore.

The IMF and the World Bank Group meeting directly impacted the whole construction progress of the Esplanade MRT Station. Contractor was reminded by Government body many times that no delay to the event was allowed. Among all, an underground



linkway was part of the crucial structure which the Contractor had to complete it before the event. To Contractor's point of view, to construct an underground linkway which is underneath the main street that links up the Suntec City, City Mall and the Raffles City, the choice of waterproofing system may determine the overall construction time. To avoid unnecessary time waste on installation detailing, Contractor decided to use Cementaid EVERDURE CALTITE System to the whole linkway to catch up time. Eventually, Contractor successfully constructed the linkway before the opening of the event.

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Singapore will not forget the industrial accident that happened in Nicoll Highway while the CCL construction was underway. The collapse of Diaphragm Wall panels along side of the Nicoll Highway not only took away 4 lives but also prompted the Government to implement a much tighter safety regulations as well as all the subsequent structural design practices in Singapore.

In Government's actions, three key changes were made as a result of the Nicoll Highway cave-in incident. First, the Government has instituted key reforms to improve Singapore's occupational safety and health standards. In March this year, the Workplace Safety and Health Act was implemented as part of a new framework aimed at entrenching a safety culture at workplaces.

Second, the Building Control Authority Act is being revised to take into account the role of geotechnical engineering in the management of temporary earth-retaining structures. These changes will bring the design and construction of temporary retaining structures under the ambit of the Building Control Authority Act.

Third, the Singapore Government is working to increase the professionalism of the construction industry at all levels in order to raise the skill levels of the construction workforce, which in turn to go hand in hand with

developing a strong safety culture.

To Nishimatsu Lum Chang JV, being the corresponded Contractor of the Contract which the accident happened, the direct impact was tremendous and disastrous. While it caused an unavoidable long delay in the affected Contract, the other MRT stations which were under the same Contractor carried more or less the same amount of pressure as well. All design calculations had to be reviewed, construction sequencing changed in order to comply with new design criteria, re-arrangement of men resources for the new and balancing works etc were directly pointing to the Contractor that they had to consider a much faster and yet reliable and effective construction method. Among all, waterproofing was one of the crucial path as well.

In Cementaid's MRT projects supply history, the Company was involved to the most in the above stations. The reason was simply that the Contractor needed to make use of Cementaid's user friendly, less hassle and effective waterproofing system to catch up time.

In sum, the following table shows all different Cementaid's HPI Waterproofing System being used in these stations:

Contract	Station Name	Product	Structure Used
C824 before accident and changed to C828 after accident	Boulevard Siding	Everdure Caltite System	Roof slab RC wall Basement slab
	Stadium		Basement slab RC wall (partial)
C823	Dakota	Everdure Caltite System	Basement slab Majority of RC wall
	Mountbatten		
	Paya Lebar	Everdure Caltite System	Basement slab
		3CC PB System	Skin wall in front of Diaphragm Wall. Roof slab (partial)

Stadium MRT

Stadium MRT Station is an underground Mass Rapid Transit station on the Circle MRT Line in Singapore. It serves the future Singapore Sports Hub (which comprises the new National Stadium, new Aquatic Centre and the existing Singapore Indoor Stadium), Kallang Leisure Park and the Tanjong Rhu area. The station is named after the sport centres/stadiums in the vicinity. It is expected to have a high amount of passenger usage when there is a significant event in the Sport centres nearby. After the accident, the design plan of this station had been changed. Part of the previously unaffected tunnel had to link up with new section. To speed up the construction time, Contractor employed Cementaid



EVERDURE CALTITE System to the entire new tunnel section. Meanwhile, there were a lot of lappings with the old existing tunnel sections which were previously waterproofed by using membrane system. By doing so, Contractor avoided the risk of voiding the warranty at the construction joints, since the existing membrane system was damaged during hacking. Once again, Cementaid's services in this portion gave a high comfortable and confident level to both the Contractor and the LTA.

Dakota MRT Station



Dakota MRT Station is an underground Mass Rapid Transit station on the Circle MRT Line in Singapore.

The construction of Dakota Station and the tracks led to the closure of the stretch of Old Airport Road between Cassia Link and Guillemard Camp Road in March 2006. Instead, Jalan Tiga was extended to Guillemard Road, opening up a traffic junction there. In addition, the old Guillemard Camp Road was widened to provide public buses enough space to drive through. Despite the widening of the road, there have been several accidents occurring near the T-junction of Guillemard Road and Guillemard Camp Road. The closed stretch of Old Airport Road has since re-opened on 29 December 2008.



The station will be served by 2 exit and entry points and is expected to be operational by 2010. It was built as part of stage 2 of the Circle Line by the same joint venture responsible for the Nicoll Highway station.

A major decision was made during the construction of both the Dakota and Mountbatten MRT Stations. To catch up the time lost due to a review of calculation in design, despite paying more in cost, the Contractor bite the bullet and employed Cementaid's EVERDURE CALTITE System not only for the basement slab but also for the basement wall in full thickness. The decision caused Contractor to pay more but substantial time saved in installation and also backfilling. By using Cementaid's HPI waterproofing system, the waterproofing function is built-in into the concrete matrix and therefore protective screed and hollow blockings as protection in membranespecification can be omitted. In other words, construction of wall can be faster and backfilling can be faster as well. The above two photos shown the completed track wall.



M&E pipes go through the CALTITE wall at Concourse Level with less disturbance and easy detailings.



Mountbatten MRT

Mountbatten MRT Station is an underground Mass Rapid Transit station on the Circle MRT Line in Singapore. The station will be served by two exit and entry points and is expected to be operational by 2010. The contractor in charge of building this station was Nishimatsu-Lum Chang joint venture, the same joint venture that was in charge of the Nicoll Highway station.

The alignment of the underground Kallang-Paya Lebar Expressway intersects with the alignment of the railway tunnels of the Circle Line between Mountbatten and Stadium. It posed a construction challenge as both were constructed at the same time.

Same as Dakota MRT station, Cementaid EVERDURE CALTITE System was used in wall sections in order to catch up time. In fact, the decision was praised and affirmed by the Authority openly during the stations structural work completion celebration ceremony.



Beautiful basement wall cast with Caltite System only



Both left and right photos shown the underplatform. The base slab of this underplatform was cast with Cementaid EVERDURE CALTITE and topped up with 100mm RC screed.



Paya Lebar MRT

The Paya Lebar MRT Station is a Mass Rapid Transit (MRT) interchange station on the East West Line and on the future Circle Line in Singapore.

Unlike Dakota and Mountbatten MRT stations, Paya Lebar MRT Station was built adjacent to the existing above ground Station of the same name. However, due to the high traffic volume at this junction and the difficulties in building a basement extension just next to the existing station, Contractor once again chosen HPI waterproofing system to save time and to reduce expected difficulties in installation.

The station basement slab was built within the Diaphragm Wall compound. Same as Bras Basah MRT Station, Contractor had to construct the basement slab and wall while maintaining the braces and struts to ensure the stability of the Diaphragm Wall. Box-outs once again were not uncommon in this project. However, by using Cementaid HPI Waterproofing system, all of the above problems were solved and construction could go on seamlessly.

One more special decision was made by the Contractor in this project was to employ Cementaid 3CC PB System to the skin wall (approx. 300-400mm thick) cast directly in front of the Diaphragm Wall. This was new trial but yet effective and successful. Truly, many Cementaid's satisfied customers could be found in this project!





Building a tunnel is not an easy task. Building a tunnel within a live airport compound even pushed the construction difficulties to the climax.

Kumahgai Sembawang JV was the Contractor this C504 Changi MRT Station. The main station itself was built under an open cut environment and therefore the membrane system used in the station was not challenged by so much site constraints. However, at the end part of the station, there

was an overrun tunnel section in this project had to be built underneath of the existing Terminal 2 compound. On top of this, one of the most difficult constraints was that this twin tunnel box built approx. 20m below ground and in-between two sides of Diaphragm Wall had to go underneath of a taxi driveway which was not allowed to have any interruption in operation throughout the whole construction period. With much planning and consideration, Contractor decided to employ Cementaid EVERUDRE CALTITE System to the tunnel's very basement slab and 3CC System for the wall sections of the whole overrun tunnel. With this move, Contractor save substantial construction time in the project and avoided a lot of unnecessary inconvenience.



Normal locations in MRT projects that used Cementaid waterproofing system

Basement slab

Normally track area is at the lowest part of the MRT basement structure and should be part of the basement slab.

Cementaid EVERDURE CALTITE System is normally cast at the top 300mm layer of the raft slab in one single operation. Cementaid termed this as " composite casting " method. It means regardless how thick is the overall thickness of the raft slab, Caltite was only being cast to the top 300mm layer and there is NO cold joint between the Caltite and the normal concrete interfacing.



Cut and Cover tunnel

Cut and cover tunnel can be built within Diaphragm Wall or under open cut condition.

In Diaphragm Wall case, base slab will cast in-between the 2 sides of Diaphragm and same as base slab, Cementaid would propose EVERDURE CALTITE to the top 300mm of the raft slab. Sometimes, a skin wall may be required to mask the Diaphragm Wall, 3CC PB could be a good choice in this situation.

In open cut condition, besides basement slab cast with top 300mm CALTITE, basement wall being normal RC wall construction can also be cast with Cementaid CALTITE or 3CC PB concrete in full thickness.



Cross Passages and cable trenches / sump pits

The construction of cross passages, cable trenches and sump pits is always not easy especially when they are constructed in deep basement condition or between two deep tunnel tubes. Limited working spaces always crippling the progress. To ensure a proper membrane installation here is not practical as well. Therefore, in Cementaid's reference, all cross passages, cable trenches and sump pits that the Company dealt with were cast totally with Cementaid EVERDURE CALTITE SYSTEM. In doing so, enormous time is saved and time is always crucial to Contractors.



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