Project

Pan Pacific serviced suites at Somerset Road, Singapore

P. H. Lim, S. H. Lee, H. L. Toh and M. S. Leong describe how new buildings were constructed on a brownfield site with extensive rail lines beneath

The development consists of a two-storey podium, a 16 storey tower block and a two basement car-park and is situated within the Railway Safety Zones. Cast *in situ* bored piles were adopted as the foundation system and the locations of these were carefully planned to avoid the existing foundation piles. A cost effective solution comprising contiguous bored piles and grout-mixed piles was used as the earth retaining structure for the basement. A two-way concrete beam and slab system was adopted for the podium due to the variations in levels. A system of precast planks, hollow core slabs, precast columns, cast *in situ* beams and cast *in situ* walls were used for the 16-storey tower block. This system was developed for an optimum balance of speed of construction and cost effectiveness. For the unique U-shaped architectural façade, diagonal struts at the third storey were used to transfer the upper storey loads onto the lower storeys. During the construction stage, changes by the client required the innovative use of a composite steel/concrete secondary slab at the first storey and fibre reinforced polymer system to strengthen the structure. This article presents the challenges faced during the design and construction of this project.

The proposed commercial development comprised a two-storey podium with a 16 storey tower block housing 128 units of serviced apartments and a two-basement car-park (Fig 1). This new development was constructed on the existing UOL building site. At the time when the proposed development was launched, it was one of the newer buildings to be redeveloped along Somerset Road which was originally lined with a series of offices and hotels. The site plan is shown in Fig 2.

The site was located along Somerset Road and within the Railway Safety Zone. At the rear of the development is the 10m wide Stamford Canal and on the flanks of the building, an open Urban Redevelopment Authority (URA) car-park and the new Land Lease development adjacent to the current Somerset Mass Rapid Transit (MRT) station. The building frontage is above the first reserve line. The railway reserve lines are shown in Fig 3.

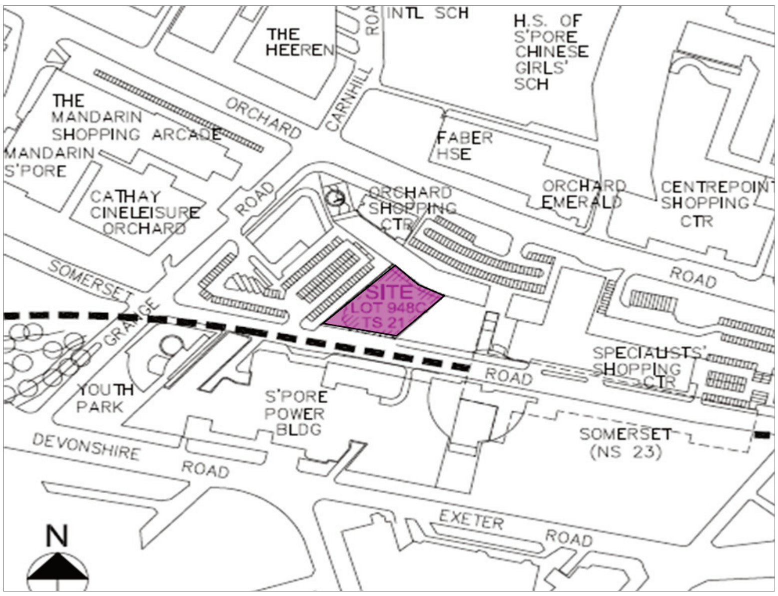
The floor dimensions are 33.6m by 25.2m and consists of two wings connected by a central lift and stair-case core. The height of the building is 95m. The first storey to second storey height is 8.7m, the second to third storey height is 16.6m while the rest of the floor heights are 3.6m. The typical structural floor plan is shown in Fig 4. A section of the building and the proximity to the nearby MRT tunnel is shown in Fig 5.

Foundation and earth retaining system

The proposed building was within the MRT reserve lines and founded over the existing UOL building. This posed design and

1

2



1 Night view of Pan Pacific serviced suites
2 Site plan

construction challenges to the foundation system.

A cast *in situ* bored pile system was used as the foundation for the proposed building. Bored piles were used to withstand the high loads from the floors above. The piles were debonded within the influence zone of the MRT tunnels so that the pile loads will not be transferred to the MRT tunnels. The debonding was done using the double casing method.

The presence of leftover bored piles and pile caps from the existing UOL building posed obstructions to the foundation works. It was originally planned to make use of the existing bored piles for the new development. However, as they had been installed for a long time, there were questions about their integrity. Each of the existing piles would have had to be tested to ensure that they could be used for the new development which would take up too much time. The cost of testing was also prohibitive. Furthermore, there remained possibilities that these existing piles could not be used for the new development even after the extensive testing.

After a series of discussions between the Qualified Person (QP) and the client, it was decided that the existing piles would not be reused but new bored piles would be constructed instead. The existing pile caps ranged from 3m to 4m thick and removal was uneconomical and time consuming. Thus provisions were made for in the design of the new pile groups as well as their locations so as not to hamper the progress of the construction work. Careful planning using as-built drawing during design stage was carried out to minimise the amount of hacking works involved during construction stage.

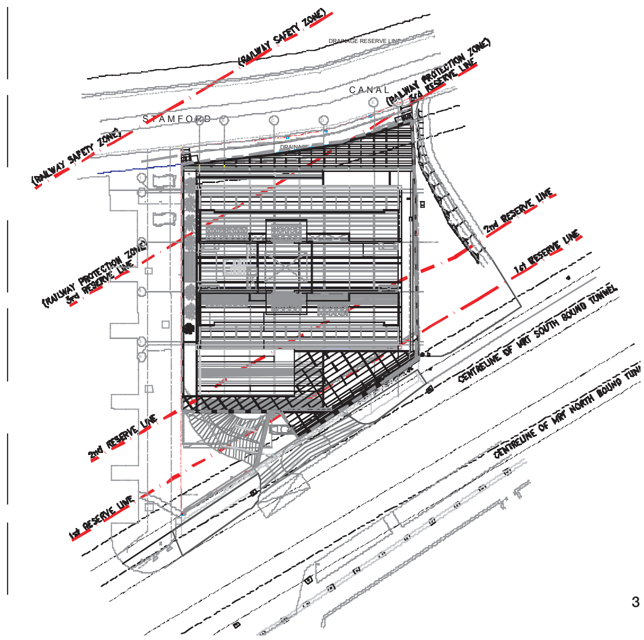
A combination of contiguous bored pile (CBP) and grout-mix pile (GMP) system was used as the earth retaining structure for the basement walls. The GMP was used between the bored piles in the CBP/GMP wall to prevent the ingress of fines and loose soil into the excavation. GMP also helped to ensure water tightness during the basement construction works and the different extents of the two levels of basement to the existing MRT tunnels. A larger size of contiguous bored piles and grout-mix piles was used on the side nearer to the MRT reserve lines to comply with the stringent requirements. This system was a cost-effective solution that was able to meet the multiple requirements of safety, stability, robustness, water tightness and speed of construction. This earth retaining structure was also being used as the permanent wall of the basement, further improving the cost effectiveness. The earth retaining structure is shown in Fig 6.

Structural system

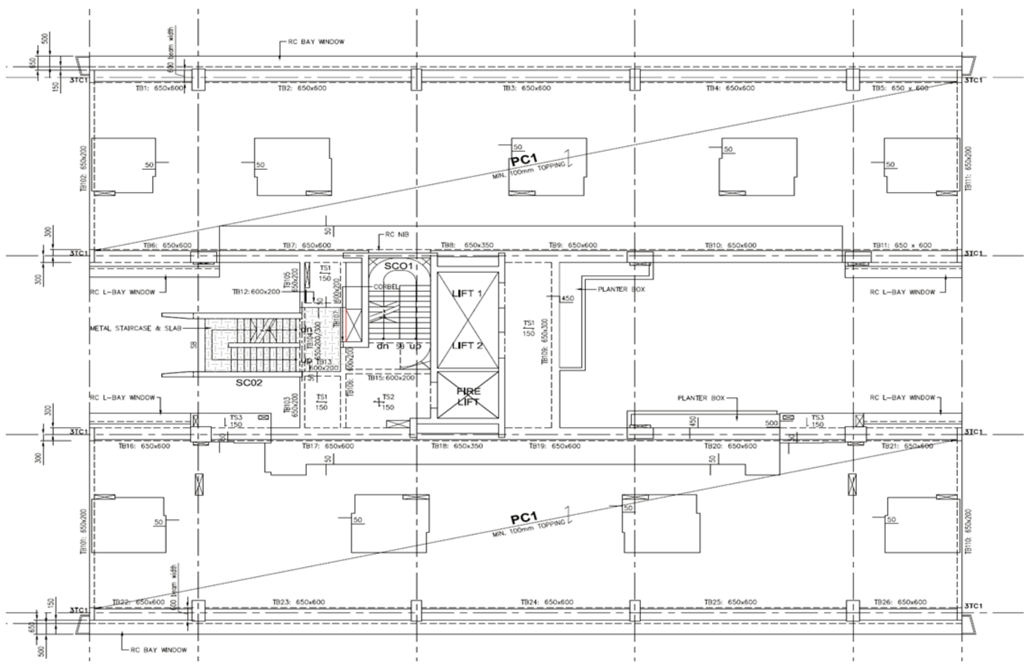
A conventional two-way concrete slab system was adopted for the first and second storey podium levels. This was the most suitable system to cater for the numerous level differences for uses such as swimming pools, roof gardens and spas.

For the tower block, the typical column grid was 8.4m x 8.4m with a 4.2m bay at both ends of the tower. The architectural intent was to cantilever the 4.2m bay to provide unobstructed views from the rooms. This was also to cater for the unique U-shape façade of the building. However, after discussions with the architect, there were concerns that the long-term creep of the cantilever beams may cause unacceptable deflections to the glass windows.

The decision was then taken to provide small transfer columns at the ends of the 4.2m bays. These transfer columns will be supported by a diagonal column that served as a strut between the second upper intermediate storey and third storey. The diagonal column together with the horizontal beam formed a concrete truss to transfer the vertical loads (the roof to the third storey) from the edge columns to the internal columns. The

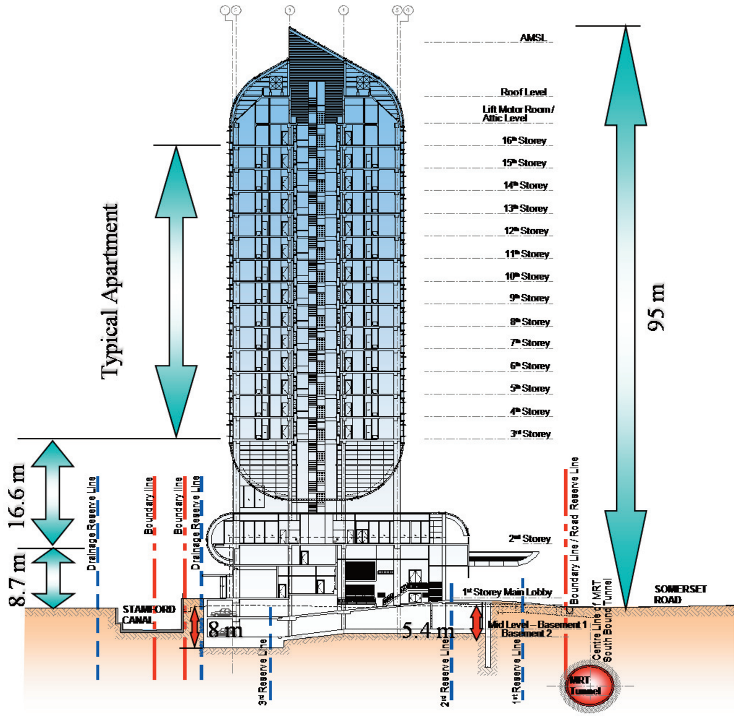


3



4

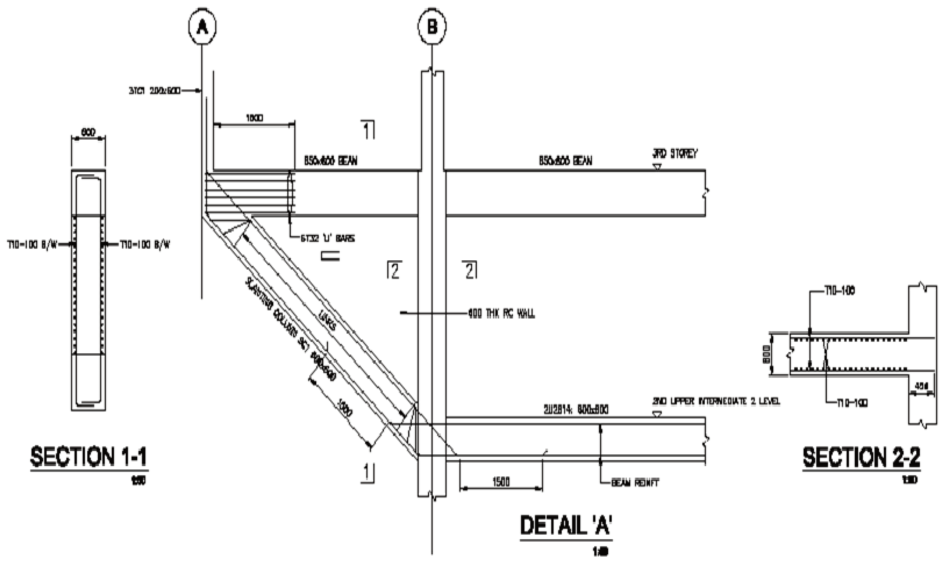
3 Railway reserve lines
4 Typical floor plan



5

6

5 Section of building
6 CBP and grout-mix pile wall
7 Detail of diagonal strut
8 Completed diagonal strut



7

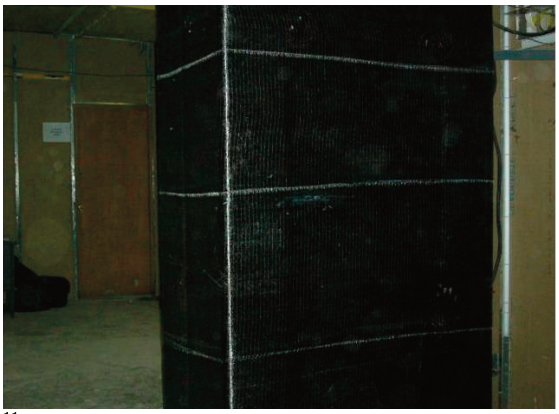
8

implementation of slanted diagonal columns reduced the depth of the beams at the third storey. The slanted columns, the horizontal beams and its connections were also designed to withstand an ultimate load of 34kN/m^2 applied in any one direction. This was in accordance with the key structural element design approach specified in the codes to achieve the required robustness of the structure. Thus, the original architectural intent was preserved and overall structural safety of the building was enhanced. The detail of the diagonal strut is shown in Fig 7. The completed strut is shown in Fig 8.

Close coordination and review between the QP, builder and specialist contractor resulted in a counter-proposal for the upper storey structural system. The initial intent to use post-tensioned slabs posed challenges to the operations on site due to the close proximity of the building line with Somerset Road at the front and Stamford Canal at the rear. Temporary platforms outside the building envelope would have to have been erected to enable


9


10


11


12

9 Two-tier precast columns
10 Lifting of precast planks
11 Completed fibre-wrapped column
12 Steel beams for secondary slab

workers to position themselves for the stressing operations. These platforms would have been next to Somerset Road where pedestrian traffic is high. There remained a risk of failure of the temporary platforms even if they were carefully designed. A failure, there would have had a severe impact on public safety at the adjacent Somerset Road. Furthermore, lifting the heavy stressing machines also posed significant risk to public safety. Accidents could also happen during the stressing operations, such as anchorages giving way and bursting of concrete if the honeycombing occured at the anchorage locations.

Precast prestressed planks and hollow core slabs were thus used in place of post-tensioned slabs to eliminate the risks involved. They also speeded up the construction.

At higher floors, one or two-tier precast columns were also used to speed up operations and increase overall safety. Precast edge columns were installed by workers inside the building envelope. This was in contrast to cast-*in situ* edge columns where workers would have needed to erect formwork from the outside of the building envelope. The risk to both the workers and the public was higher if cast-*in situ* edge columns were used. Furthermore, the time taken to construct cast-*in situ* columns was longer than for precast columns. The longer the construction process, the higher the likelihood of making mistakes and endangering public safety. Figs 9 and 10 show the pre-cast columns and precast planks.

Towards the end of the project, the use of the podium storey was changed. This required the strengthening of the structural members. A polymer-fibre-wrap reinforced system was considered amongst the several options such as enlarging the column sizes and steel plate bonded strengthening systems. It was finally adopted after rounds of technical presentation by the fibre-wrap specialist and discussions with the QP. Usage of fibre-wrap system minimised the need for partial hacking and demolition of already cast RC components that were conventionally needed if one was to enhance the existing structural capacity. This provided a safe working environment and assurance to the contractor and vendors who were in the midst of taking over the respective units within the building, where structural enhancing works were concurrently in progress. The technology being well tested locally and abroad thus provided a good solution and overall safety assurance. The completed strengthening of one column is shown in Fig 11.

The client decided to raise the first storey slab by 1m after the first storey elements were cast. Several options were considered such as hacking the entire first storey slab, mass concreting or infilling with polyfoam to create the required level. The final decision was to use steel beams and Bondek slabs to create a secondary slab that produced the required level. This method of construction resulted in minimum hacking works and strengthening works. Fire proofing to the structural steel members were also not required as the original slab provided sufficient protection to the steel members. The innovative system adopted enabled the construction to be completed as scheduled. Fig 12 shows that construction of this secondary deck.

Conclusion

In densely built-up Singapore, more and more buildings will be constructed on formerly occupied sites. The extensive underground rail network will also grow steadily in the near future. The innovative, original and cost-effective engineering solutions adopted in this project could be considered for use in other projects with similar conditions.

Additions and alterations to buildings are also increasingly common with many owners wanting a facelift to their old buildings. The methods employed here can also be easily adapted to suit similar projects.

The authors work at CPG Consutlants Pte Ltd