Construction of a Semi-Buried Building – A Super-sized Shopping Mall:

The Festival Walk

Presented by
Raymond Wong Wai Man,
Division of Building Science & Technology,
City University of Hong Kong
General Information

- Site area – 21000 sq m (overall measure 290m x 80m)
- geological features
  - Tat Chee Avenue (+35m) on one longitudinal sides and the Kowloon Canton Railway (+20m) on the other, a level diff. of about 15m exist.
  - rockhead range between +25m to -35m.
  - Mass Transit Railway tunnels cutting across site at +8m
  - deepest basement down to -3m (36m below Tat Chee Av.)
Block Plan

Site

25m roadway (Tat Chee Avenue)

Railway track
Diaphragm Wall
Typical Section cutting through MTR tunnels

Raymond Wong
Site Formation and Diaphragm Wall Construction

- Sub-divided into 7 stages from level +35m down to +20m.
- Diaphragm wall and bored pile foundation construction work at the same time.
- Two rows of temporary ground anchor were installed at Diap. Wall along Tat Chee Avenue Av as lateral support to cut during site formation excavation.
Boring Machine
Diaphragm Wall
Temporary Ramp

Preliminary Site Formation
Raymond Wong
Row of anchor as lateral retrain to diaphragm wall
Site at the up-hill portion had been formed down to +20m (level to the KCR Rail track level)

Raymond Wong
Site formation close to its completion

Raymond Wong
Site Formation and Diaphragm (cont.)

- 2m thick Diap. Wall constructed using traditional grab/chisel and reverse circulation trench cutting (hydrofraise) methods, both using bentonite slurry as a stabilizing agent.
- Removal of soil maintained at 2 exit-points arrangement as far as possible.
- Later stage of site formation merged with the main contract.
Using a trench cutting machine (hydrofraise) to form the diaphragm wall panel
Detail of the cutting drums of the hydrofraise (trench cutting machine)
Forming the diaphragm wall panel using grabs (clamshell)
Bored Pile Foundation

- Total about 165 piles ranging from 1.8, 2.65 and 3.25m dia.
- 3.25m dia piles were done by hand-dug method.
- Excavation done by steel grab/chisel and reverse circulation drilling method, both using steel casing as excavation support.
- With steel stanchion anchored into the pile as support to basement structure constructed in top-down arrangement.
MTR Kwun Tong Line Tunnels

Bored Piles Layout

Raymond Wong
Forming the bored pile using grab

Protective steel casing
Forming the bored pile using Reversed Circulation Drill
Stages of construction
Stages of construction – from site formation to completion of superstructure

Excavation start at this point
Diaphragm wall
MTR Tunnels

Ground anchor to serve as lateral support during excavation

2.5m dia bored pile

Site formation stages
Commencement of Top-down Basement Construction

- Basement excavation below the ground slab
- Upper floor slab and basement excavation and construction work at the same time
- Excavation to form the vehicular ramp
Completed vehicular ramp in advance to facilitate the removal of excavated spoil.

Superstructure

Basement excavation and construction
Atrium space
Topping out of the entire structure
Construction of Basement

- 4-level full basement and 3-level semi-basement.
- Full basement constructed in top-down method.
- Construction generally arranged in a 6-phased manner, each with appropriate sub-sectioning depending to local layout.

Spoil removal:

1\textsuperscript{st} stage, maintain a exit point to road level on the down-slope side of site;

2\textsuperscript{nd} stage, use the newly constructed vehicle ramp (permanent structure) at the up-slope side.
Steel stanchions to be inserted into bores piles as temporary support during the top-down construction of the basement structure (encased to become column later)
Connecting the stanchion to the basement slab

Anchor plate at head of stanchion

Floor slab formwork for basement at +22m
Provision of temporary ramp to exit point at down-slope location

Raymond Wong
Basement underneath to be formed by top-down method

Vehicular ramp leading to basement carpark used as temporary access for removal of spoil during site formation and basement excavation
Forming an entrance into the basement for carrying out of excavation
Progressing stage of superstructure & basement construction (1)

Raymond Wong
Progressing stage of superstructure & basement construction (2)
Progressing stage of superstructure & basement construction (3)
Progressing stage of superstructure & basement construction (4)

Raymond Wong
Progressing stage of superstructure & basement construction (5)
Principle of top-down method:

- Construct the ground slab first (in this case slab between full and semi-basement at +20m).
- Provide an entrance to the basement to facilitate downward excavation (between portion 2 & 3 at the first start).
- Excavate downward until the proceeding slab being cast.
- Repeat the excavation and basement slab casting horizontally and vertically until the entire basement finished.
- Cast/encase other vertical elements (staircase, ramps or columns) at time appropriate.
Forming the first basement slab at +20m
Steel columns erected in the bored pile helps to support the ground slab at the beginning of the top-down basement construction.
Excavation in progress

Formwork for the lower basement slab being erected

Upper basement slab already cast

Excavation and casting the basement slab in a top-down manner
Steel columns support the ground slab at the beginning stage.
Excavation along Tat Chee Avenue where rockhead located close to ground.
Rock cutting carried out under the steel shore
The Main Structure

- Traditional timber panel formwork was used.
- Majority of structure in span ranging from 8.5m to 16m, some post-tensioned beams up to 35m and 48m.
- Strength of concrete in 40 (in-situ) and 45 (post-tensioned).
- Phasing and sectioning arrangement somewhat similar to basement construction, but more complicated due to the layout of the shopping mall.
Construction of the superstructure in complicated phases

Raymond Wong
Superstructure constructed using traditional manual timber formwork.
Construction of the superstructure at its final stage (observe the complicated sectioning arrangement of formwork)
Steel fixing for the superstructure structure
Elevation along Tat Chee Avenue

Office block

Skating rink below

48m span post-tensioned girder beams
Main Structure: Other features

- existence of large volume atrium spaces (120m x 35m high, 80m x 40)
- ice skating ring measures 46m (span) x 70m x 30m high)
- fully glazed sky light (180m x 22m for mall, 30m x 35m for office)
- Glass wall total 3500 sq m.
Isolated “Island” sub-divided by the “River” & “canyon”

Complicated spacing arrangement within the superstructure

Raymond Wong
Raymond Wong 54

The “River” taking shape

Escalator spanning below two levels of the shopping mall
Steel frame that formed the skeleton of the skylight of “River” and “Canyon”.
Installing the glazing panels for the skylight
Isometric view of the Festival Walk superstructure
Glass wall that form the “Canyon”

Raymond Wong
Forming the glass wall at end-side of Canyon
Cladding the glass wall of the “Canyon”
GI grille (A/C compressors behind)
Powder coated metal panels
Marble slab
Difficulties encountered in the project

- Very large scale of works – site formation, volume of excavation, large layout, huge amount of formwork and concrete, interior space that fitting out works required etc.
- Very deep excavation and the required support.
- Works in close proximity with MTR facilities and tunnels.
- Difficult phasing and sectioning arrangement.
- Relatively tight schedule.
- Very high headroom and difficult accessible interior spaces sub-divided by the atrium.
Complicated teething arrangement between interface of phased sections (1)

Steel stanchion to support basement slab

1.2m thick slab (MTR tunnel tubes below)
Complicated teething arrangement between interface of phased sections (2)
Working close to the MTR pedestrian facilities – in-situ bored piles were constructed to protect during excavation.
Steel strut supporting pedestrian shaft to partially completed basement structure

Protecting the MTR pedestrian facilities
Raymond Wong 68

MTR pedestrian and ventilation shaft

Structural steel strut frame to stabilize the shaft

Squeezing difficultly into the ground to form the basement structure when working close to the MTR facilities.
Cut into rockhead to extend diaphragm wall further downward

Underpinning to extend diaphragm wall panels further down into the rockhead
Vast volume within the atrium add difficulty in the carrying out of superstructure and interior works.
Finishing the atrium formed within the “River”
The “River” and the skylight
The 48m-span interior space at the skating rink and food-stall area
Finishing the skating rink
Finishing the 20m-high, 48m-span Skating Ring

Raymond Wong
Construction of a series of linking bridge in structural steel within the atrium space of the Skating Rink.
The vast interior space within the long-span atrium area (skating rink)
End of presentation