

Diaphragm wall Construction

Diaphragm wall is a continuous wall constructed in ground in to facilitate certain construction activities, such as:

- a) As a retaining wall
- b) As a cut-off provision to support deep excavation
- c) As the final wall for basement or other underground structure (e.g. tunnel and shaft)
- c) As a separating structure between major underground facilities
- d) As a form of foundation (barrette pile – rectangular pile)

Diaphragm wall

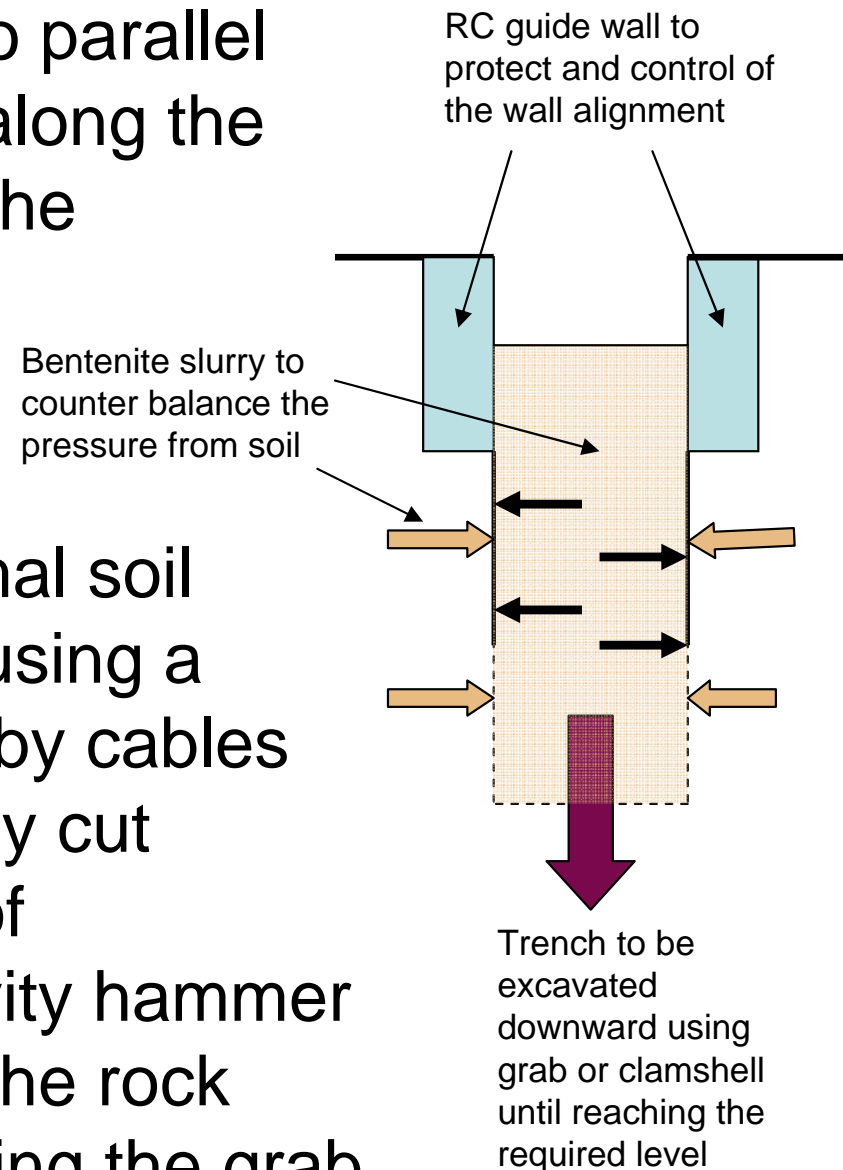
Diaphragm wall is a reinforced concrete structure constructed in-situ panel by panel. The wall is usually designed to reach very great depth, sometimes up to 50m, mechanical excavating method is thus employed. Typical sequence of work includes:

- a) Construct the guide wall
- b) Excavation to form the diaphragm wall trench
- c) Support the trench cutting using bentonite slurry
- d) Insert reinforcement and placing of concrete to form the wall panel

Further explanation on the work sequences

Guide wall – guide wall is two parallel concrete beams constructed along the side of the wall as a guide to the clamshell which is used for the excavation of the diaphragm wall trenches.

Trench excavation – In normal soil condition excavation is done using a clamshell or grab suspended by cables to a crane. The grab can easily cut through soft ground. In case of encountering boulders, a gravity hammer (chisel) will be used to break the rock and then take the spoil out using the grab.

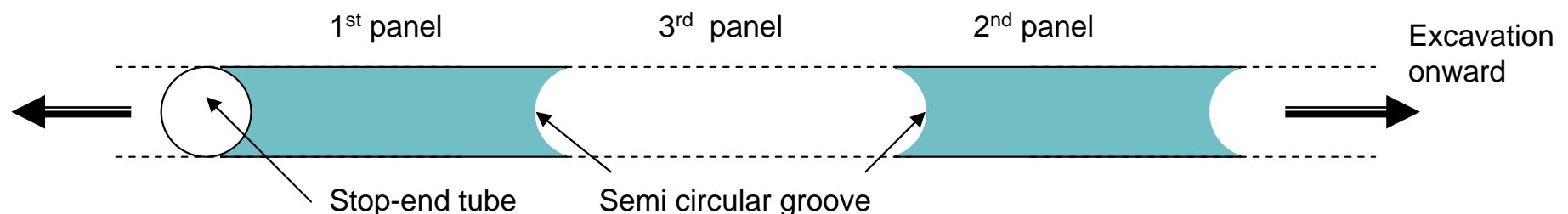


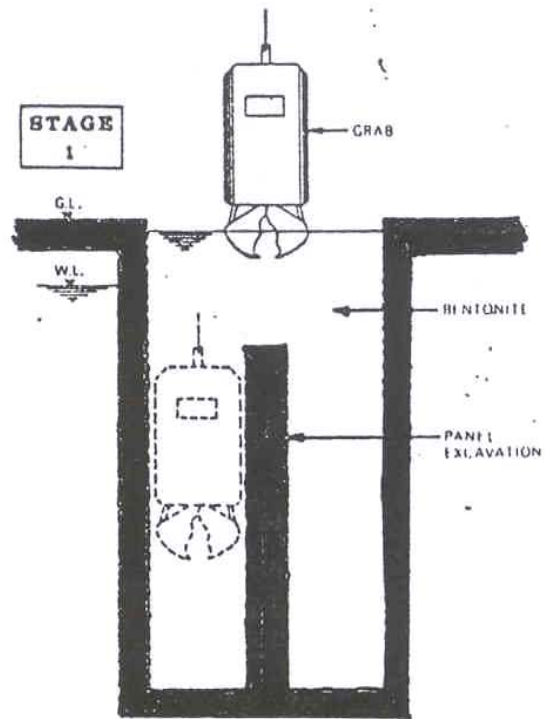
Excavation support – the sides inside the trench cut can collapse easily. Bentonite slurry is used to protect the sides of soil. Bentonite is a specially selected fine clay, when added to water, forms an impervious cake-like slurry with very large viscosity. The slurry will produce a great lateral pressure sufficient enough to retain the vertical soil.

Reinforcement – reinforcement is inserted in the form of a steel cage, but may be required to lap a few sections in order to reach the required length.

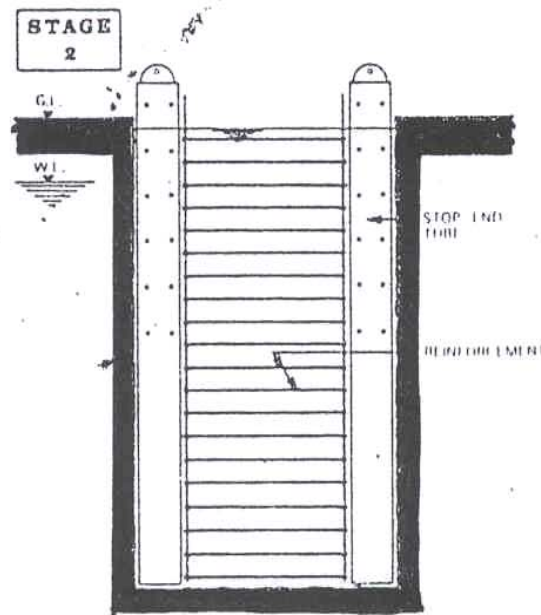
Concreting – placing of concrete is done using tremie pipes to avoid the segregation of concrete. As concrete being poured down, bentonite will be displaced due to its lower density than concrete. Bentonite is then collected and reused.

Joining for the diaphragm wall panel – Diaphragm wall cannot be constructed continually for a very long section due to limitation and size of the mechanical plant. The wall is usually constructed in alternative section. Two stop end tubes will be placed at the ends of the excavated trench before concreting. The tubes are withdrawn at the same time of concreting so that a semi-circular end section is formed. Wall sections are formed alternatively leaving an intermediate section in between. The in-between sections are built similarly afterward but without the end tube. At the end a continual diaphragm wall is constructed with the panel sections tightly joined by the semi-circular groove.

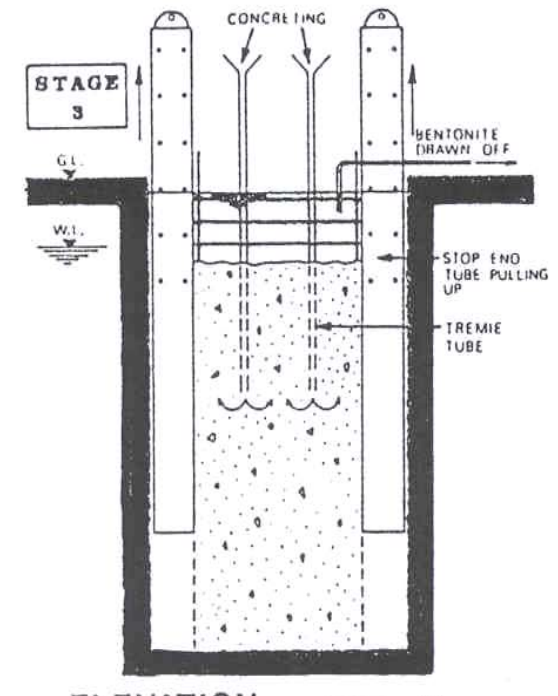




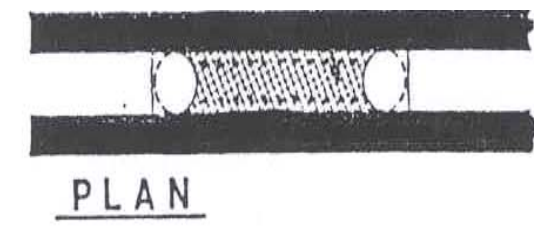
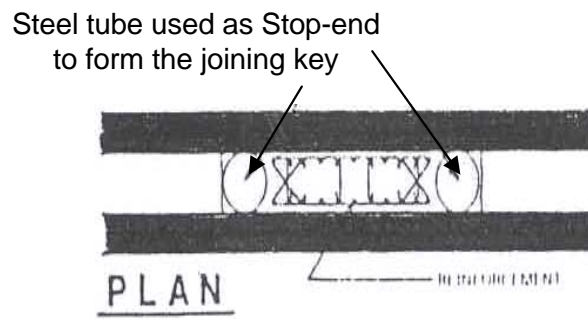
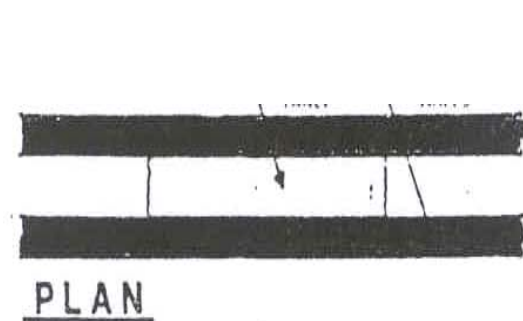
Excavation using grab or clamshell to form trench for the diaphragm wall panel. Bentonite slurry is filled inside the trench to stabilize the side of cut



Placing in of reinforcement bars and stop-end into trench



Placing concrete into the trench using tremie pipe and take-out the stop-end at the same pace



Construction process for a diaphragm wall panel



Forming the guide wall and using it in the trenching operation





Clamshell use to excavate the trench to form a diaphragm wall panel





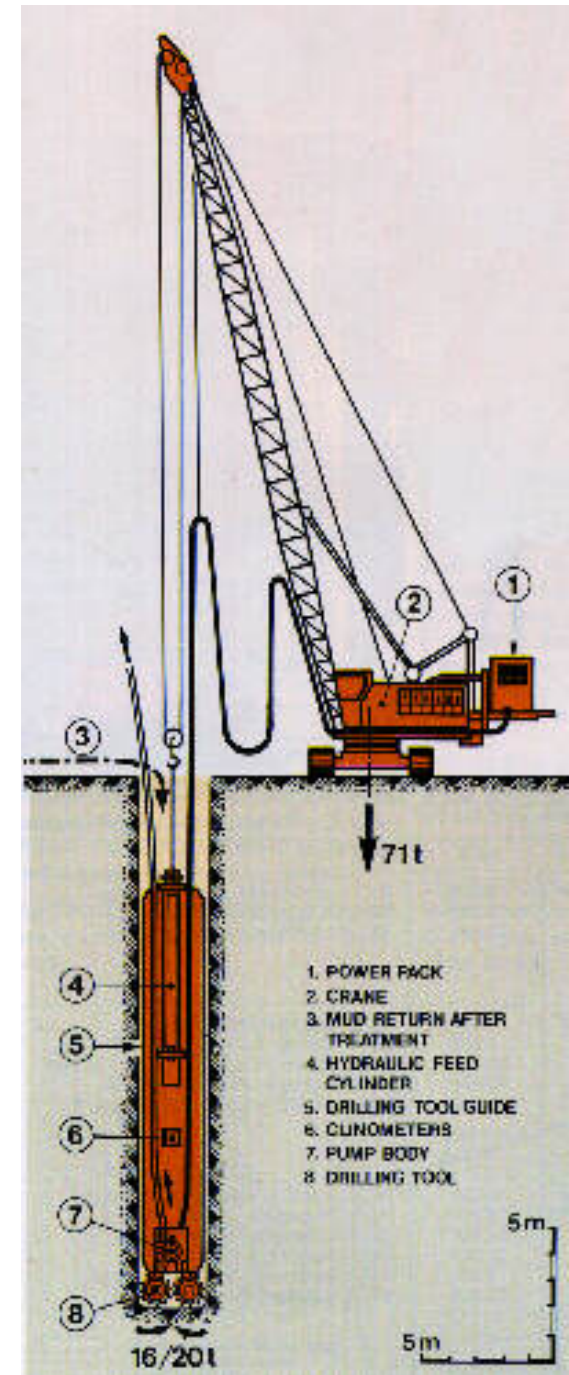
Fixing and placing of reinforcing cage



Using hydrofraise (reverse circulation trench cutter) to form diaphragm wall panel

Bored piles of square section can be installed using the Hydrofraise or similar drilling techniques. The bore hole is stabilised by drilling mud. The "Hydrofraise" is a drilling machine powered by three down-the-hole motors, operating with reverse circulation.

A heavy metal frame, serving as a guide, is fitted at its base with two cutter drums carrying tungsten carbide tipped cutters. These rotate in opposite directions and break up the soil. A pump is placed just above the drums and evacuates the loosened soil, which is carried up to the surface by the drilling mud. The mud with cuttings is continuously filtered (desander unit) and then poured back into the trench.

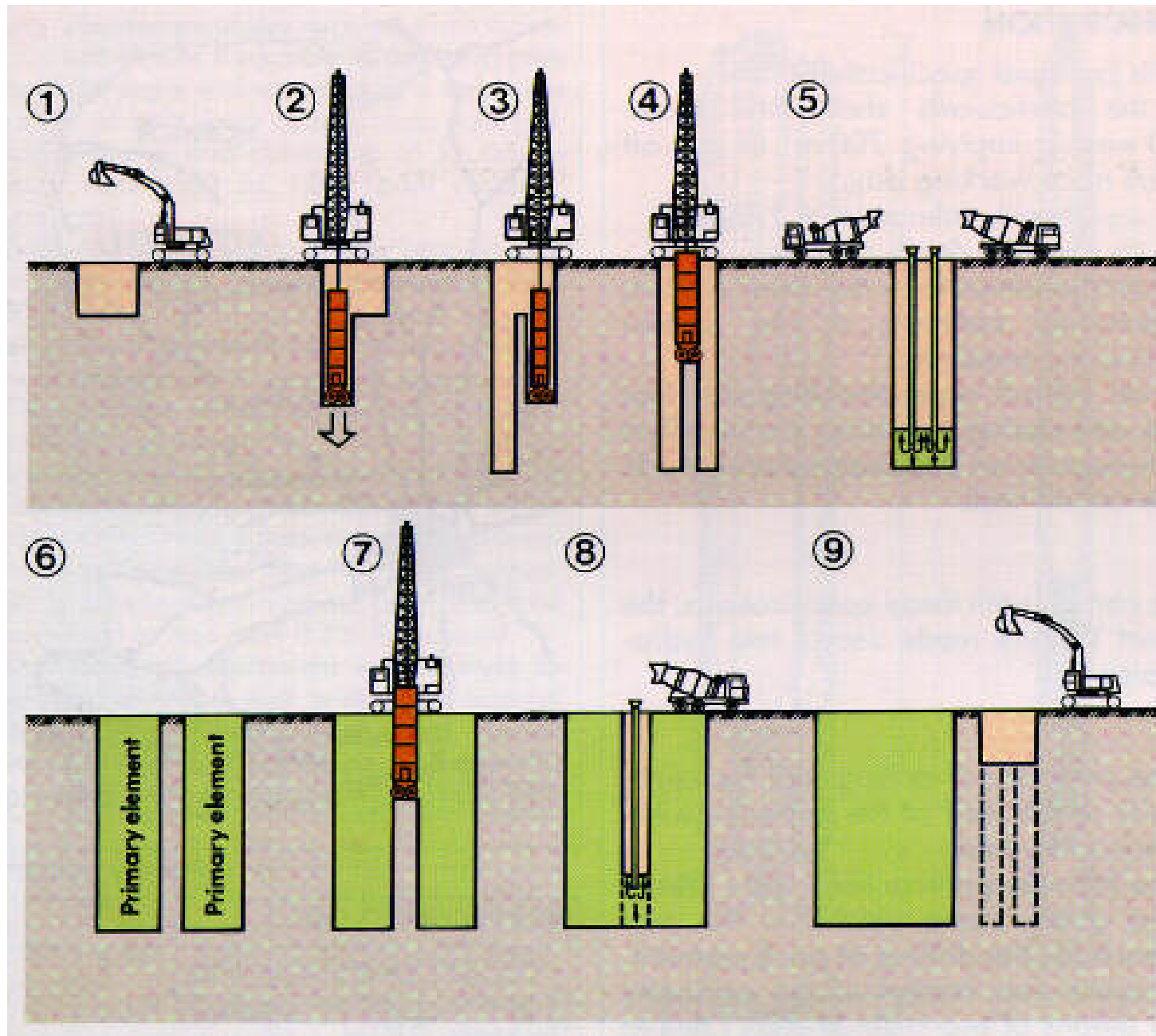


A heavy crawler crane supports and manipulates the machine. It carries the power pack supplying the hydraulic power, which is conveyed through hoses to the three down-the-hole motors, two of them driving the cutter drums and the third driving the pump. The hydraulic cutting device is designed to give the cutter drums a high torque at low speed of rotation.

The guide frame is suspended from the cable-operated crane. A hydraulic feed cylinder is used to achieve a constant rate of advance or to maintain a constant weight on the cutter drums.

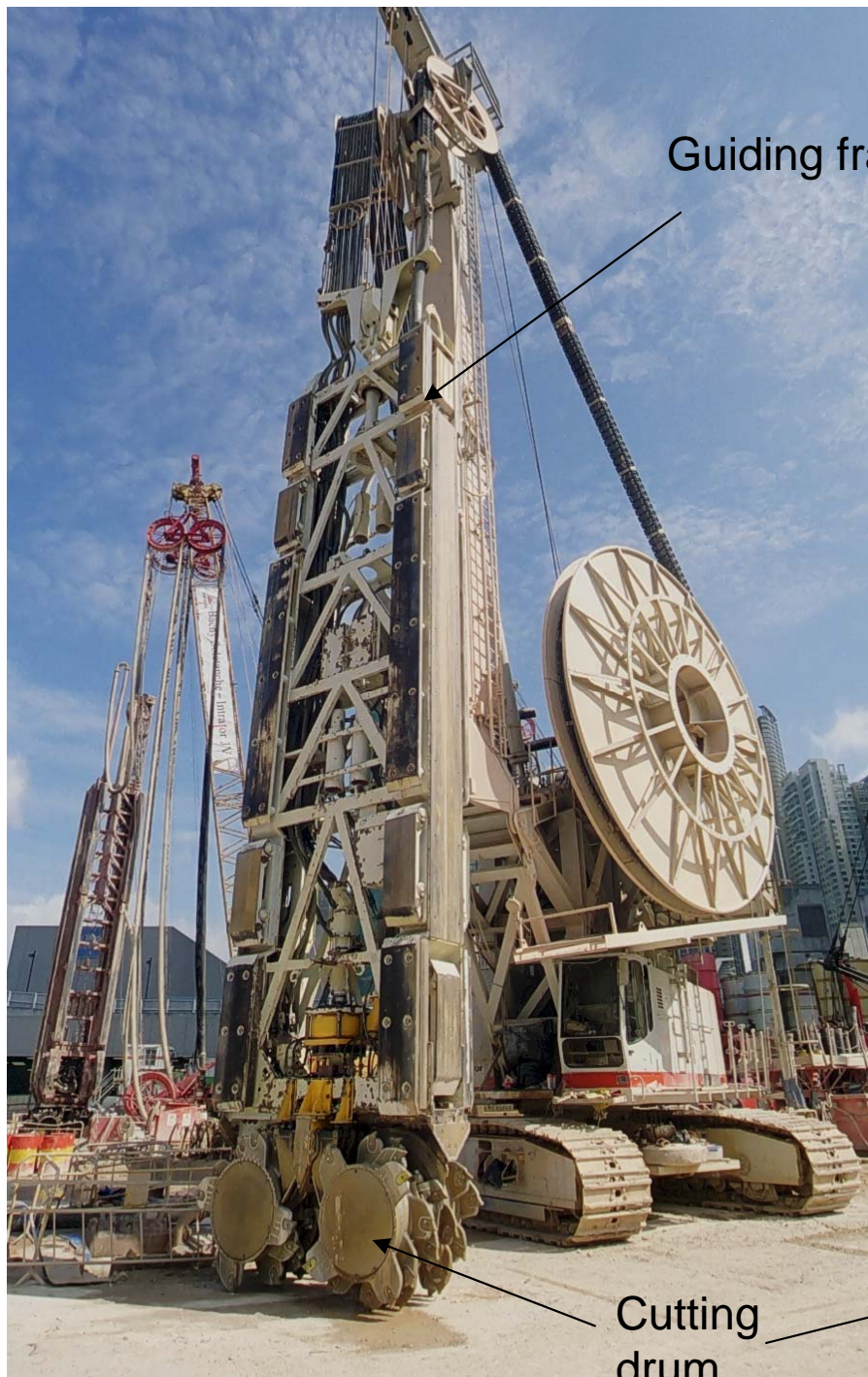
Another important advantage is that the drilling mud is constantly screened and desanded during excavation. Thus the reinforcement can be placed and concreting carried out as soon as the required depth has been reached. This excavation system makes it possible to drill piles panels or diaphragm wall elements in a very wide range of soils, from cohesionless soils to hard rock.

Construction sequences of a Hydrofraise panel





Common hydrofraise equipment with the guiding frame and the cutting drum at the bottom for cutting into various kind of subsoil ranging from clay to hard rock



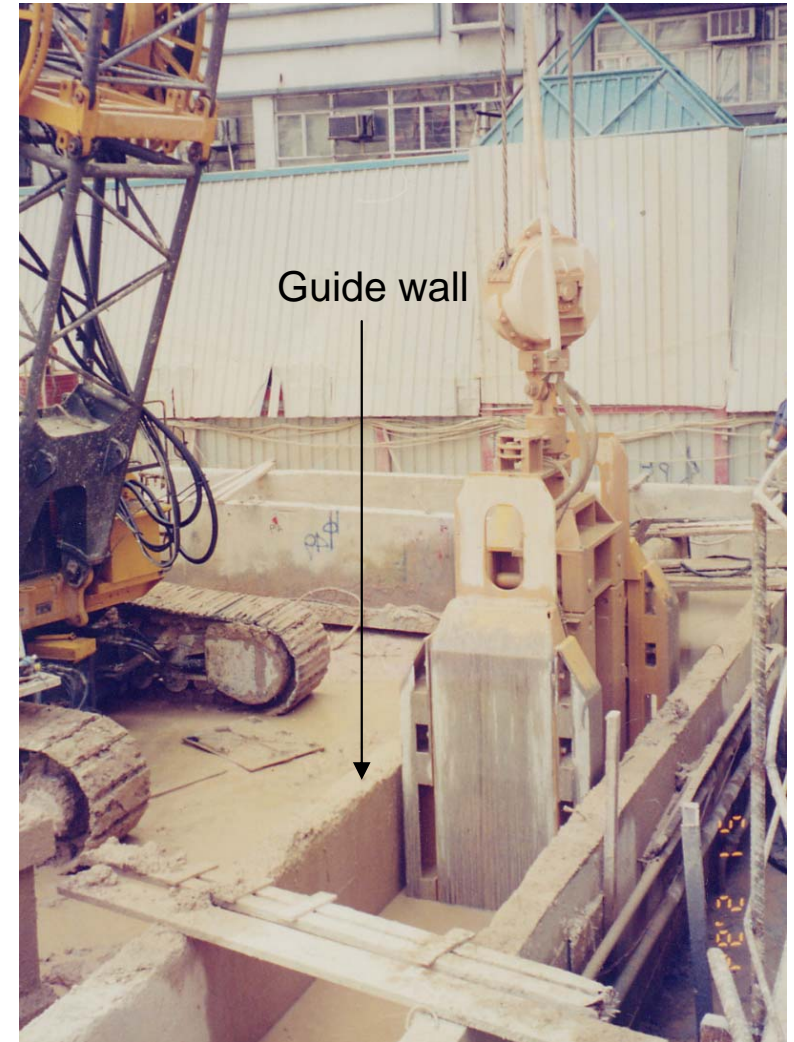


Using hydrofraise (reverse circulation trench cutter) to form the diaphragm wall panel – Festival Walk



Using hydrofraise (reverse circulation trench cutter) to form the diaphragm wall panel – KCRC project





Trench excavation working in bentonite slurry with grab alignment control by guide wall

de-sanding equipment



Debris
storage tank

Debris (sand and gravel) being
filtered from the bentonite slurry
and deposited to the storage tank

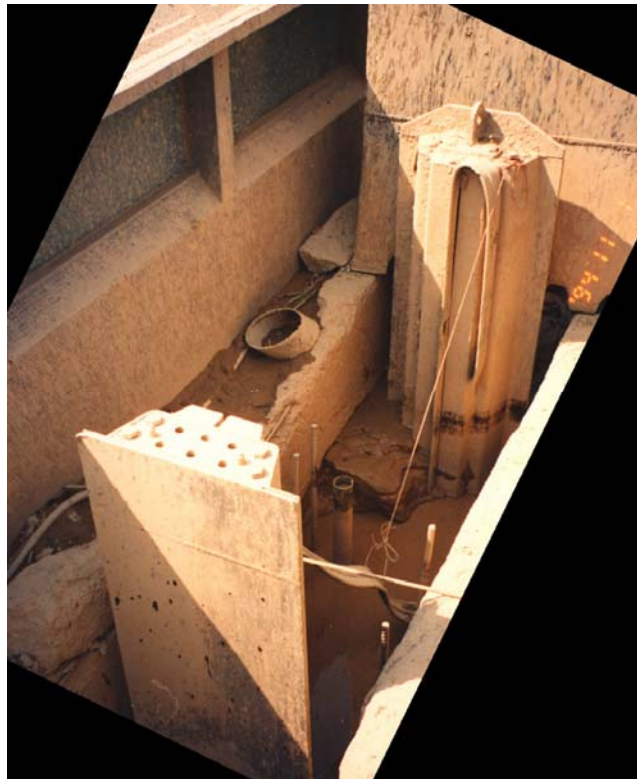


De-sanding equipment – the bentonite slurry carrying the soil and gravel re-circulate to this equipment with the bentonite slurry and the debris being removed. The debris will be collected in the storage tank for disposal later

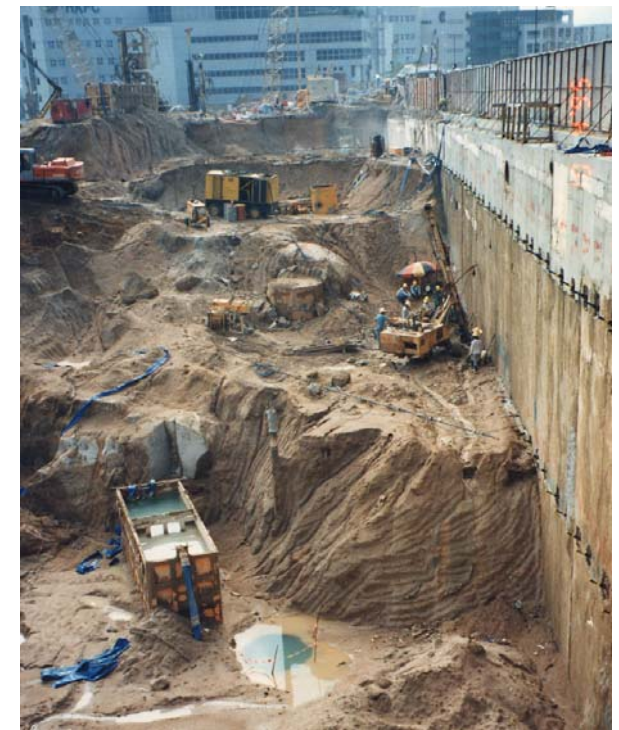


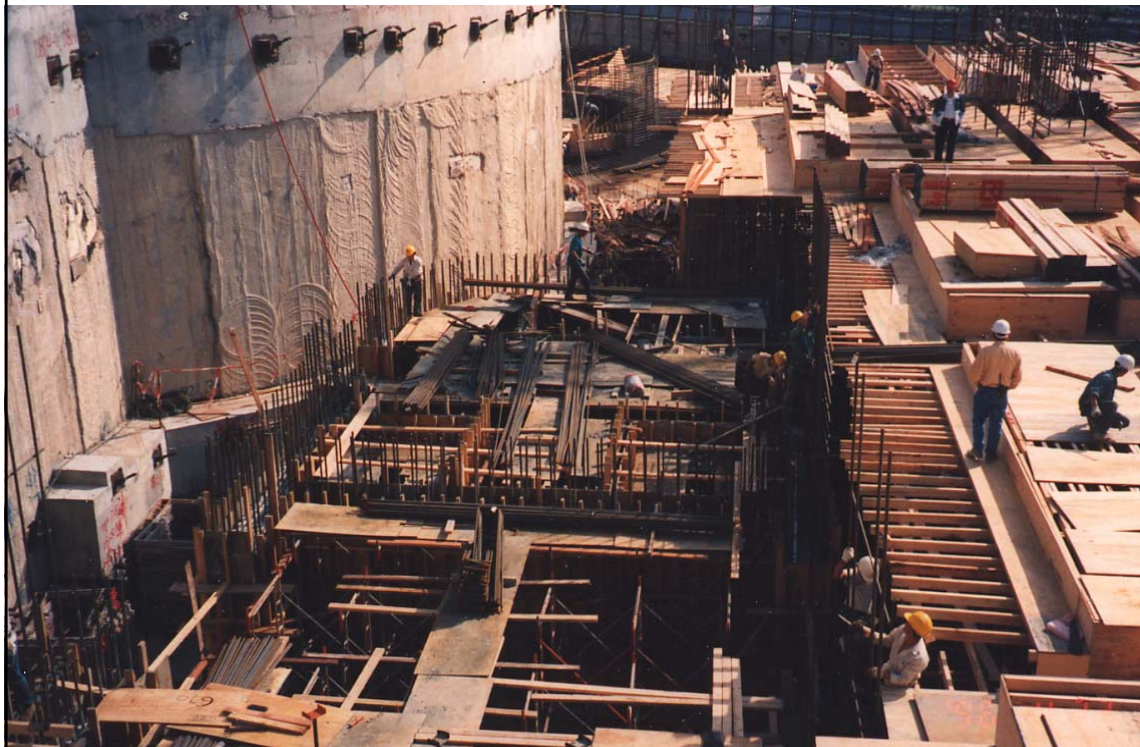
Concrete placing using
hopper and tremie pipe

Tongue and groove type stop-
end to form the joining for two
adjacent diaphragm wall panel



Application of diaphragm wall in construction





Connecting the basement floor onto the diaphragm wall. The diaphragm wall will become the permanent basement wall afterward



Diaphragm wall



As side support for trenching cutting (constructing an underground subway for Central-Wanchai Bypass)



Diaphragm wall

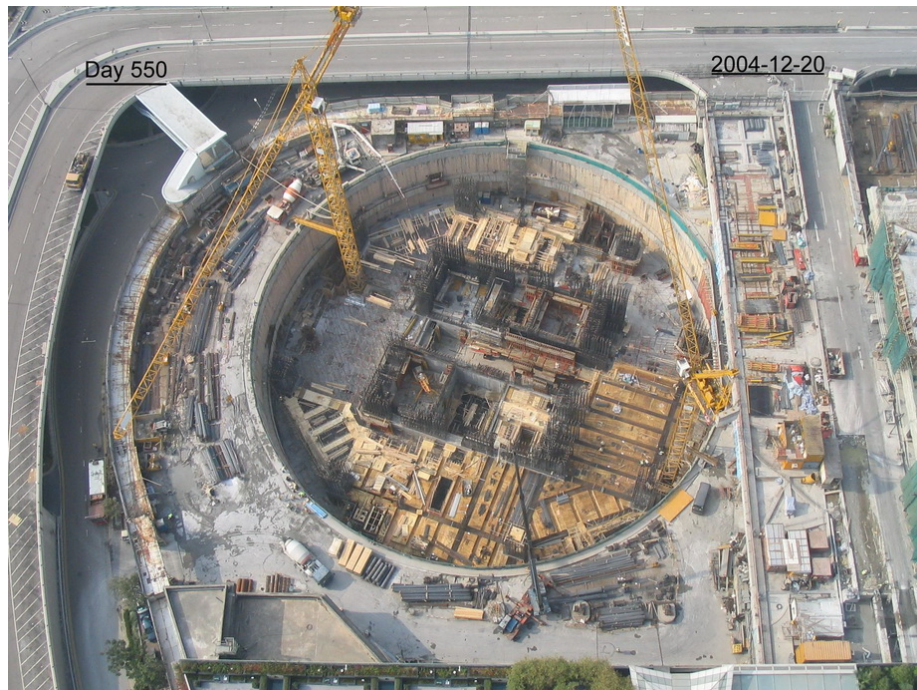
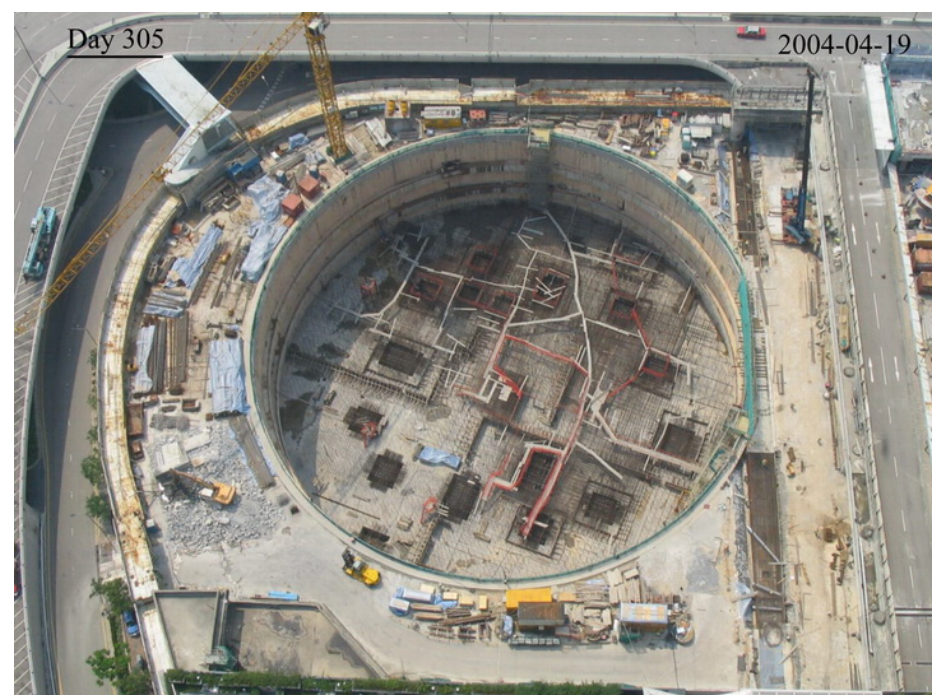


Diaphragm wall



Diaphragm wall

Diaphragm wall to form large
cofferdam for building foundation



Construction of the ICC Tower from a cofferdam formed using diaphragm wall



End of presentation