# UNDERGROUND INFRASTRUCTURE

Diaphragm walls and retaining structures

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### TAILOR-MADE SOLUTIONS FOR COMPLEX INFRASTRUCTURE PROJECTS

Today's underground infrastructure schemes have an unprecedented level of complexity. Construction projects are often carried out in close proximity to existing structures and under densely populated areas. As a result, they have to cope with restrictions on noise and vibrations, take place in locations with low headroom and meet accelerated schedules. Complex geological profiles and ever greater excavation depths bring additional challenges to many major projects.

Intrafor has taken part in a number of international infrastructure schemes and has developed a wide range of solutions to tackle the challenges of building the most demanding underground structures, whether they are road or railway tunnels or stations.

Our expertise extends from the early stages of a project, including design and optimisation, right through to verification testing once work is complete. We apply both our experience and our innovations - especially in terms of methods and equipment - to develop new technology and deliver high-quality solutions.

# ADVANTAGES

### A LARGE RANGE OF TECHNIQUES

Various types of retaining structures can be built to cope with the needs of different infrastructure projects and ground conditions. We have mastered specialist areas of construction, such as:

- Diaphragm walls for cut-offs, earth retaining structures (slurry, concrete and reinforced concrete walls)
- Deep foundations such as barrettes and piles
- Cutter Soil Mixing (CSM)

### ANY TYPE OF GEOLOGY

Retaining structures might need to be built in areas with complex geological conditions. If the soil is loose or soft, pre-treatment may be necessary, which involves choosing the most appropriate technique. If the area is characterised by the presence of hard rock, the project might require the use of specialist equipment (such as hydraulic grabs or cutters) and the optimisation of the structure's design.

### BUILDING IN BUSY URBAN AREAS

Leveraging our expertise, we can build retaining structures in close proximity to - or even within or underneath - existing buildings or infrastructure, such as stations or viaducts. The construction sequence is optimised in order to minimise the impact on traffic and the need for utility diversions. The existing foundations may be integrated into the design of the new structure or removed using specialist equipment.

# APPLICATIONS

- Road and rail tunnels: retaining structures are extensively used in tunnelling projects. When a tunnel is built with the cut & cover method, a diaphragm wall can be constructed to support the trench during excavation. The retaining walls used during excavation can be kept as permanent structural elements of the tunnel.
  The top-down construction method can also be an advantageous solution for tunnelling projects. In this case, part or all of the structural slabs are built as the excavation proceeds. This enables, for example, the restoration of traffic on the surface while the work continues underneath, as the ground movements in the surrounding areas are minimised.
- ▼ TBM launching and retrieval shafts: shafts formed using diaphragm walls or CSM (only for temporary retaining structures) are employed for the assembly, launching, retrieval and dismantling of tunnel boring machines (TBMs). Reinforcing part of the wall with GFRP (fibreglass) panels instead of steel allows the TBM to break through the concrete wall.
- ▼ Cut-off walls: these structures help create a watertight barrier around the perimeter of an excavation and prevent groundwater from flowing into the working area. They are usually embedded in strata of rock or soil with a low permeability.
- ▼ Station boxes: temporary or permanent retaining walls are also employed for the construction of underground stations. With ever-increasing tunnel diameters, the free span of the structure necessary to accommodate a major TBM is also getting larger. This issue can be addressed by using circular or multi-cell diaphragm wall solutions (see illustration on the next page).



### CUT AND COVER TUNNELS

When there are no constraints at the surface, the cut & cover method is often more cost-effective than other tunnelling techniques.



#### IN-HOUSE DESIGN CAPABILITIES

By leveraging its extensive knowledge and internal expertise in 3D modelling, Intrafor is able to support its clients' design teams or provide a full design package including reinforced concrete and strutting design, movement and settlement calculations and water inflow assessment.



### MULTI-CELL SHAFTS

Circular or multi-cell diaphragm walls are self-retaining structures used to create the shaft without additional supports (struts, tie-backs etc.).

### MULTI-CELL DIAPHRAGM WALL

### MAIN FEATURES



Our machines are fitted with state-of-the-art verticality control systems in order meet the highest of tolerance requirements and enable safe excavation of the wall.

### **KEY CAPABILITIES**



#### BUILDING IN LOW-HEADROOM CONDITIONS

Intrafor has the equipment and the expertise to build retaining structures with a height clearance as low as 5.3m. Our plant pool includes low-headroom trench cutters and short-boom excavation rigs equipped with short grabs, able to work in restricted areas.



#### DEEP SHAFTS

Intrafor has built shafts up to 90m deep. The use of circular or multi-cell, strut-free diaphragm wall shafts offers high stiffness, thereby minimising ground movements in the surrounding areas. Our patented soft-milled joints technique for the formation of wall joints provides a watertight solution combined with excellent verticality control, as it guarantees continuity of the concrete hoop.



### TURNKEY APPROACH

We are able to assist our clients from the early stages of a project to its completion. Our services encompass the full range of tasks from ground investigation, preliminary design, optimisation and ground improvement through to verification testing and guality control.

### INTERNATIONAL PROJECTS

Through the years, Intrafor has brought its expertise to many countries, participating in major international infrastructure projects such as:

- Cairo Metro Line 3, Phase 1, Egypt
- Gautrain Rail Link, South Africa
- New Metrorail City Project Package F, Australia
- Chinatown Station Project C909, Singapore
- Shatin to Central Link, Hong Kong
- Dubai Metro, United Arab Emirates

# SPECIALIST EXPERTISE & EQUIPMENT

In-house design capabilities, experienced production teams and state-of-the-art equipment are key to achieving high performance on projects.

Our equipment pool is continuously renewed to comply with the most stringent international standards – **both in terms of safety and sustainability** – and to reduce fuel consumption, vibration and noise on site. The machines are always operated and maintained by well-trained staff.

#### Our specialist equipment includes:

- Trench cutters capable of excavating to depths of up to 120m
- Hydraulic and mechanical grabs fitted with an advanced control system to ensure verticality
- Equipment designed for sites with low headroom restrictions
- Cutter Soil Mixing equipment able to work to a depth of up to 40m
- Slurry treatment plants to support the work

### **GROUND ENGINEERING SPECIALIST**

Intrafor is a world-renowned foundation and ground engineering specialist, aiming to provide cost-effective solutions that meet technicallydemanding specifications.

The company performs a wide range of activities for buildings and civil infrastructure – including geotechnical investigations, ground improvement and the construction of special foundations such as deep diaphragm walls. Intrafor is a subsidiary of VSL International, a company belonging to the Civil Works Division of Bouygues Construction (BYCN) whose 50,000 employees and operations in 80 countries make it one of the main players in the international construction industry.

Being part of this extensive international network means that we are able to carry out operations all over the world.





#### Contact Us

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