BAUER Diaphragm and Cut-off Walls
High degree of leak tightness – great depths
Diaphragm and cut-off walls are specialist foundation engineering methods with many advantages for dam sealing, securing of deep excavation, and the retaining of medium and large excavation pits of great depths. They can serve as a temporary or permanent part of the structural design and take on a sealing and/or load-bearing function. Diaphragm and cut-off walls are created by sequencing individual diaphragm wall elements. The successful application of this technique requires special knowledge of calculation, design, concrete technology, formation of joints and construction.
Diaphragm walls

Barrette foundations of tall buildings

Shangri-La Hotel, Istanbul, Turkey
The five-star Shangri-La Hotel in Istanbul was built overlooking the Bosphorus strait. Bauer Lebanon was awarded the contract for the excavation pit retaining structure. The design included diaphragm walls and bored piles with rock socketing up to a depth of 45 m.

Foundation element

Airport Link, Brisbane, Australia
The city of Brisbane is getting a 6.7 km-long freeway from the city center to the airport. Bauer Foundations Australia carried out extensive specialist foundation engineering work, including a 1,000 mm to 1,200 mm thick diaphragm wall.
**Areas of application**

**Excavation pit retaining structure with base**

**El Amiria waste water system, Egypt**

Bauer Egypt was awarded the contract to carry out the diaphragm wall work for connecting and extending the El Amiria waste water system. This project involved the construction of 52 panels with a size of 1,200 mm by 2,800 mm and a depth of 60 m. A grout curtain with a thickness of 9 m was also constructed on the shaft bottom.

**Quayside wall**

**Lock Zerben, Germany**

In addition to the existing lock, a new larger lock basin with a total length of 265 m is under construction. The altogether 10,000 m³ diaphragm wall with depths up to 21 m was created with a Bauer hydraulic diaphragm wall grab on an MC 64 crane.

**Excavation pit retaining structure integrated in natural dam reservoir**

**Üsküdar Station, Istanbul, Turkey**

For the Istanbul subway under the Bosphorus strait, Bauer Lebanon built the Üsküdar Station excavation pit on the Asian side with a 27,300 m² diaphragm wall which is 1.5 m thick and up to 55 m deep, as well as an HPI base strutting at a depth of 38 m to 48 m.
**Cut-off walls**

### Sealing block for tunneling

**N5 bypass Biel, Switzerland**

For the Biel bypass of the national road N5, Bauer Spezialtiefbau Schweiz was awarded the contract by the executing consortium to construct diaphragm walls and bored pile walls at the Bözigenfeld portal, the Orpund portal as well as the Brüggmoos portal.

### Dam sealing

**Sylvenstein Dam, Germany**

To seal the dam core, Bauer Spezialtiefbau built a 10,000 m² plastic concrete diaphragm wall with a length of 170 m and depths of up to 70 m. An MC 128 cutter unit with a BC 40 and two MC 64 rigs for the excavating and concreting work were used.
Retaining wall for contaminated area

Shell Albian Sands, Canada
Shell is extracting oil from oil sands in Alberta. To protect a river, Bauer Foundations Canada constructed an approximately 2.6 km-long cut-off wall with a depth of up to 50 m. The 900 mm thick wall cuts off the ground water.

Retaining wall for opencast mine

Diavik, Canada
In order to be able to recover diamonds in an opencast mine with a depth of up to 300 m near the Arctic Circle, the dams around the volcanic vent were sealed with diaphragm walls in the rocks to partition off the lake.

Cut-off wall (static load-bearing) with embedded sheet pile wall

Mannheim Q6/Q7, Germany
Bauer Spezialtiefbau constructed a 16 m-deep excavation pit on an area of 18,700 m² under the protection of a multilayered anchored cut-off wall with embedded sheet pile wall and a secant pile wall.
The construction of a 1-phase-wall comprises the following steps. The first step involves excavation work, optionally with a grab or cutter, whereby the stabilizing slurry consists of a self-hardening bentonite-cement slurry. Subsequently, sheet pile walls or beams can be installed as static element in the not yet hardened slurry.
Construction methods

Positioning the sheet pile wall elements

Work sequence for 1-phase-cut-off wall with sheet pile walls or beams

1. Excavation of a panel
2. Installation of sheet pile walls and/or beams as static element in the self-hardening slurry
3. Excavation of another panel, followed by installation of sheet pile walls and/or beams

Guide wall

Bentonite-cement-slurry
2-phase-method

The construction of a 2-phase-wall always comprises the following steps. The first step involves excavating a defined sub area (panel) using suitable excavation equipment such as a grab or cutter under stabilizing bentonite slurry. This is followed by the regeneration of the stabilizing bentonite slurry and the installation of the reinforcement (for diaphragm walls) and the selected joint element. These can be made from concrete as temporary stop end planks or permanent stop end plates or prefabricated elements. The final step involves concreting using the tremie pipe.

Work sequence for 2-phase-cut-off wall
1. Excavation of the primary panel
2. Regeneration of the slurry
3. Concreting using the tremie pipe
4. Excavation of the secondary panel

Excavation tools – cutter wheels and hydraulic grab
Construction methods

Temporary stop end plank system – Bauer
Joint plate with joint tape
Prefabricated element with suspension

Work sequence for 2-phase-diaaphragm wall
1. Excavation of a panel
2. Regeneration of the slurry / installing joint elements / installing reinforcement
3. Concreting using the tremie pipe
4. Excavation of another panel

Bentonite slurry
Permanent or temporary joint element
Concrete
Tremie pipe with hopper
Guide wall

1 3 4 2

11
The mixture of soil material and slurry is pumped through permanently installed lines to the desanding plant. There, the soil material is separated from the slurry by means of vibrating screens and cyclones. The cleaned slurry is then returned to the excavation trench. During concreting, the stabilizing slurry displaced from the trench is also pumped out and cleaned.

**Slurry circulation**

- Excavating the trench with grab
- Pumping the mixture of soil material and slurry through permanently installed lines to the desanding plant
- The soil material and slurry enter the desanding plant
- The stabilized slurry is pumped out, cleaned, and returned to the excavation trench

**Slurry separation**

- Gradual separation of slurry contaminants

**Screening technology**
- Intake
- Soil particles
- Outflow
- Soil components > 5 mm

**Cyclone technology**
- Intake
- Soil particles
- Cyclone > 20 - 60 μm

**Centrifugal technology**
- Intake
- Soil particles
- Decanter 10 - 20 μm
- Cleaned slurry
Grab and cutter

Bauer trench cutters and Bauer hydraulic grabs are typically the lead equipment for the panel excavation for the execution of concrete diaphragm and cut-off walls. The centrepiece of the Bauer trench cutter system consists of a steel frame with two gearboxes attached at its base, which rotate in opposite direction around a horizontal axis. Cutter wheels suitable for the prevailing ground conditions are mounted on the gearboxes. Selecting the most suitable type of cutter wheels (standard cutter wheel, round shank chisel-cutter wheel or roller bit-cutter wheel) is essential for cutter progress which mainly depends on the soil conditions (particle size, density, abrasiveness, compressive strength, etc.). The accurate determination on the trench cutter for your project depends on ground conditions, the required trench width and wall depth. The ideal base machines for Bauer trench cutter and mechanical or hydraulic grab equipment are BAUER foundation cranes MC 64, MC 96 and MC 128. The entire hydraulic power supply of the attached cutter/hydraulic grab is provided by the hydraulic systems of the MC crawler cranes which have been specially designed for those applications.

Slurry provision

The provision of slurry is based on the volumes simultaneously excavated and is determined for each construction project on the basis of the planned construction process. Stacked tanks, liquid storage silos or lined ground basins are available for storing the slurry.
Diaphragm and cut-off walls require an increased level of quality assurance and control measures during construction. Compliance with the quality requirements is checked and documented in the construction site’s own laboratory. With the examination of the stabilizing and sealing slurry, the rheological properties of the slurry used during the excavation phase through to final inspection are checked and consequently documented upon completion of a cut-off or diaphragm wall element. Verticality and excavation depth are constantly visualized by the operator through integrated inclinometer and depth gauges in the rigs and these are included in the production report following the completion of the excavation. When constructing diaphragm walls, the quality of the concrete used is also continuously controlled and the professional concreting process is documented, which constitutes one of the main quality characteristics. Diaphragm and cut-off walls are advancing into ever greater depths. Requirements to comply with the verticality criteria are thereby increasing. There are various systems available for controlling and monitoring the verticality (B-Tronic, Steering plate, 3D visualization, Ultrasonic measuring instrument).

**B-Tronic**

The inclinometers installed in the body of the cutters and grabs continuously record the verticality of the trench. The visualization is done in real time on the screen of the base carrier unit by means of the B-Tronic.

**Steering plate**

To counteract deviations in verticality, steering plates attached to the body of the cutters and grabs can be actively used for correction. The effect can be tracked directly by means of the B-Tronic.

**3D visualization**

It can create a 3D model by reading the implemented verticality measurements. The visualization provides users with a simple way to display and control the specified overlap of the panels.

**Ultrasonic measuring instrument**

An ultrasonic measuring probe hanging on a cable is lowered into the excavated panel which is filled with stabilizing slurry. In the process, orthogonal waves are continuously emitted and reflected on the wall. In doing so the vertical deviation of the trench and panel excesses are recorded. The return flow duration and the wave velocity are used to calculate the distance to the wall.
Steadily and rapidly advancing globalization is posing new challenges in terms of occupational safety and environmental and health protection.

As a globally active company, the BAUER Group sends a large number of German employees on overseas assignments on a regular basis.

In order to achieve this goal, we have established worldwide standards in the field of Health, Safety & Environment (HSE).

**Occupational safety**

Safety on the construction site is the foundation stone for highly concentrated work. Bauer Spezialtiefbau employees are highly qualified, undergo regular training, and use properly maintained equipment.

**Quality management**

On a global and group-wide basis, the BAUER Group’s certified quality management system provides clearly defined and equally flexible processes from the acceptance of an order through to its execution and beyond.

**Ethics management**

As a founding member of the EMB Wertemanagement Bau e.V., BAUER Spezialtiefbau GmbH expects its employees to meet the highest standards of ethical conduct.

**Environmental management**

The construction industry is inevitably impacting the environment. All construction companies must make it their goal to minimize this impact as much as possible. BAUER Spezialtiefbau GmbH has an EMAS-certified environmental management system and participates in environmental audits. Furthermore, Bauer Spezialtiefbau is establishing a partnership-efficient and thus resource-saving project execution.