



Full-face TBM CSM Bessac

Earth pressure balance or slurry shield

Tunnel boring machines which can excavate full face in difficult terrains, under heavy hydrostatic pressure.



CSM BESSAC develops and uses a range of TBM's designed to excavate in all type of geological conditions, from highly-permeable terrains to the hardest rock, under heavy water pressure.

Fast progress thanks to full face excavation enables us to carry out projects several kilometres in length in the shortest time.

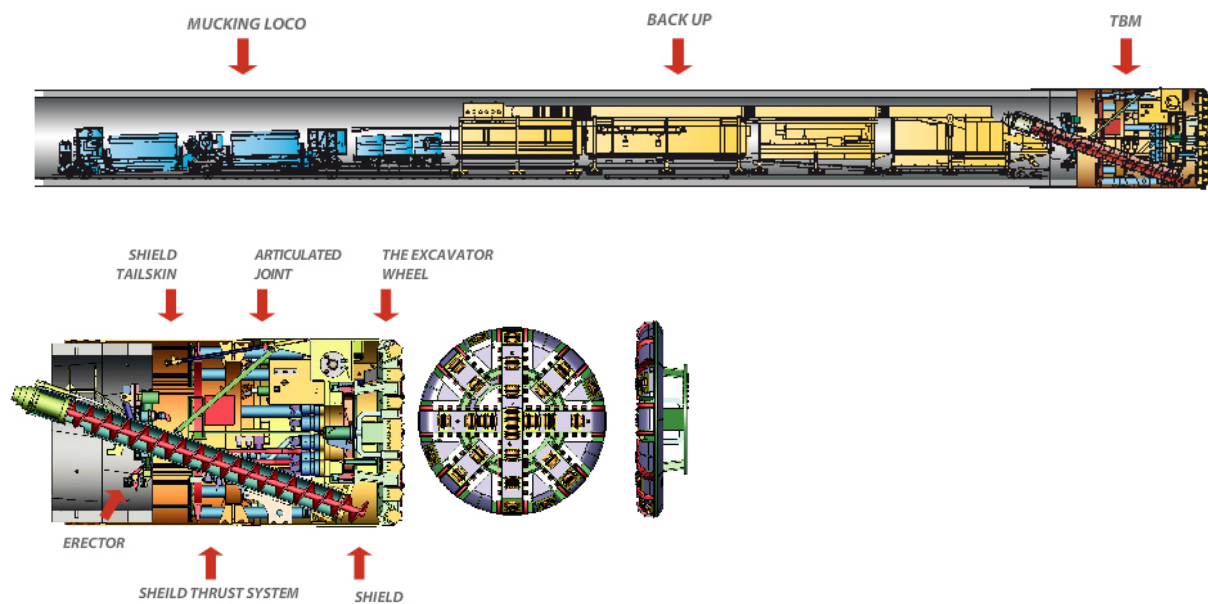
CSM BESSAC tunnel boring machines retain their special characteristics particularly suited to drainage works, water supply or service tunnel projects. Compact machines capable of working in very curvy alignments, adapted to suit small pits and tight working spaces.

- **Earth pressure balance**



The working principle of earth pressure balance tunnel boring machines consists of ensuring the stability of the face by pressurizing the excavated spoil contained in the excavating chamber in order to balance both the pressure of the ground and the water table. The spoil is transformed into a paste, if necessary, using additives injected from nozzles on the excavating head and the bulkhead. Extraction is by screw conveyor. The pressure of the excavated spoil is maintained in the excavating chamber by regulating the extraction of spoil according to the thrust of the TBM. In order to achieve perfect manoeuvring, compressed air might be added in order to improve pressure regulation in the upper part of the chamber.

Diagram of boom-type heading machine



THE BOOM-TYPE HEADING MACHINE WITH EARTH PRESSURE BALANCE

The TBM uses an excavator wheel to excavate terrain: provides temporary support thus enabling the permanent lining of the tunnel to be put in place. Spoil is transferred from the excavating chamber to the removal area via the extractor screw and the trailing support mechanism conveyor belt.

MUCKING LOCO

- Electric tractor/truck with hydraulic transmission
- One or more side-tipping muck skips
- Mortar lorry with mixer and mortar pump
- Lining segment car with automatic segment handling system

BACK UP

The shield itself is equipped with all the items needed for its operation, and only simple back-up is needed.

It simply fulfils the function of interfacing between the shield and the mucking train. It is joined to the shield and comprises:

- A belt conveyor collecting spoil from the screw conveyor and discharging it into the muck skips
- A lining segment transporter which unloads, stores and transfers the segments
- A segment feeder passing segments from the transporter to the erector
- Lubrication system which continuously lubricates the shield machinery and a tailskin seal sealant injection system.

SHIELD TAILSKIN

The tailskin, behind and connected to the shield, is a space used for assembling the lining rings. There is a complex seal system between the tailskin and the previously installed lining. In pipe jacking operations, it interfaces between the first pipe jacked and the tunnelling machine.

ARTICULATED JOINT

The junction between the shield and tailskin is engineered to allow relative movements between the two parts. This is the articulated joint by which the machine can be steered around curves. The joint has an adjustable seal, excluding water when working in saturated ground.

THE EXCAVATOR WHEEL

The design of the excavator wheel depends on the type of terrain to be excavated. Likewise, its tools are adapted to suit either to rock excavation (excavator wheel) or loose terrain (scraper). It is possible to enter the excavating chamber under compressed air, via an air lock. In this way, tools may be replaced during work when worn.

TBM

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SHIELD THRUST SYSTEM

The thrust system consists of hydraulic rams arranged around the tailskin periphery. The rams are attached at the front end to the shield ring beam. They take their reaction against the last lining ring installed, bearing on protective pads. The shield advances as excavation is proceeding.

ERECTOR

The segments are assembled inside the tailskin by means of an erector which picks them off the back-up train.

It consists of a swivelling hydraulic arm mounted on the screw conveyor. The combination of a 6DOF segment gripping system and proportional control on all six motions allows the segments to be positioned accurately and smoothly.

SHIELD

The shield at the front carries most of the components of the machine. Towards the middle, there is an airtight pressure bulkhead which carries the excavator boom and separates the working chamber from the rear section.

There is a cutting edge at top front. Thrust cylinders force the shield and cutting edge into the soil, supporting the working face and preventing overcutting outside the design lines.

▪ Slurry shield



The balance of the excavating chamber is ensured by pressurized bentonite slurry.

The slurry is transported in conduits from the surface, and mixed with spoil excavated by the cutting wheel in the excavating chamber. Then the spoil/slurry mix is pumped up to the surface. The slurry is filtered to separate the spoil, and then reinjected into the circuit. (removal circuit).

▪ Geology



Full face excavation (cutting wheel) enables work to be carried out in all types of geological conditions, ranging from highly-permeable loose soil to all types of rock, full face. The design of excavator wheels and the kind of cutting tools will be specific to each type of grounds.

Slurry shield TBM's are best suited to sandy gravel grounds under high hydrostatic pressure. The hydrostatic pressures withstood by these TBM's are 3.5 bars for earth pressure balance machines and 7 bars for slurry shield TBM's.

▪ Lining



- Reinforced concrete arches
- Pipes installed by horizontal sinking
- Primary linings by shoring and centering

Hard rock tunnel boring machine

Tunnel boring machines designed for excavating rocky terrain.



Excavation is carried out using cutting wheel with disc cutters. The pressure exerted on the disc cutters by the TBM, coupled with the rotation of the cutting wheel, destroys the rock. The tunnel boring machine is equipped to support the rock as the machine advances, using anchors, steel ribs and shotcrete. Grippers enable the machine to advance, by gripping the sides of the tunnel.