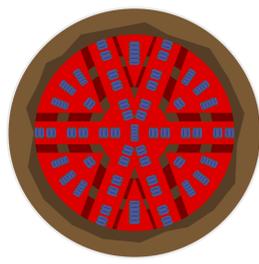
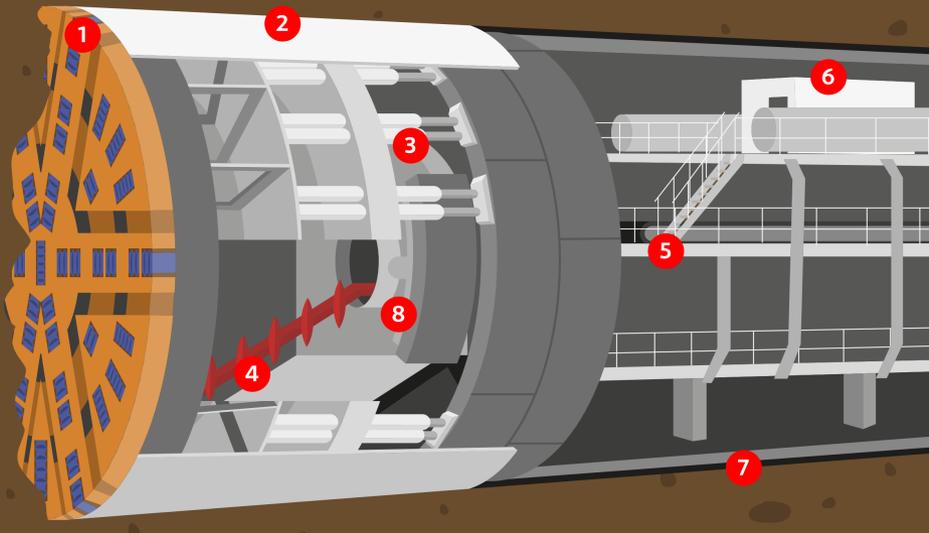


TUNNEL BORING MACHINES: THE GIANTS BUILDING UNDERGROUND WORLDS



TBMs are capable of cutting through the hardest rock, enabling the safe and efficient construction of all types of tunnels.

TBMS ARE SOPHISTICATED PIECES OF EQUIPMENT WEIGHING UP TO 5,000 TONNES



- | | | | |
|--|---|--|--|
| <p>1</p> <p>Cutting head
Equipped with different cutting tools tailored to the surrounding geology.</p> | <p>2</p> <p>Shield
Protects workers until the tunnel lining segments are in place and houses the main systems for excavation, spoil removal, and lining installation.</p> | <p>3</p> <p>Propulsion system
Powers the forward movement of the TBM.</p> | <p>4</p> <p>Screw conveyor
Transfers the excavated material from the cutting face to conveyor belts or other extraction systems.</p> |
| <p>5</p> <p>Conveyor belt
Moves the excavated material from the screw conveyor to a transfer point, where it is loaded onto another belt for removal to the surface.</p> | <p>6</p> <p>Control cabin
The operations hub where guidance, advance rate, injection pressure, and auger speed are monitored and adjusted.</p> | <p>7</p> <p>TBM back-up
A series of trailers towed behind the shield, carrying all auxiliary systems and essential equipment needed for TBM operation.</p> | <p>8</p> <p>Erector
A system used to install segments: precast concrete components that support the excavated tunnel cavity.</p> |

EACH TYPE OF TBM IS DESIGNED FOR SPECIFIC GROUND CONDITIONS

- | | |
|--|---|
| <p></p> <p>Main Beam
<i>(open TBM)</i> Unshielded, ideal for stable and predominantly solid rock formations.</p> | <p></p> <p>Single shield
Suitable for the full range of rock qualities.</p> |
| <p></p> <p>Double shield
Suitable for all rock quality ranges. It can operate in single or double shield mode, allowing tunnel lining to be installed simultaneously with excavation.</p> | <p></p> <p>Earth Pressure Balance
<i>(EPB)</i> Designed for general soil types with some fine materials; maintains face stability in loose or unstable ground.</p> |
| <p></p> <p>Hydroshield
<i>(Slurry TBM)</i> Best suited for granular soils and rock with little or no fine material; operates under high pressure to counteract earth and water loads.</p> | |

FOLLO LINE: HOW ONE OF THE WORLD'S LONGEST RAILWAY TUNNELS WAS BUILT

LOCATION
Norway, between Oslo and Ski

DIAMETER
8.75 m

TBM USED
4 double-shield machines

BENEFITS
Travel time cut from 22 to 11 minutes

LENGTH
Two tunnels, each 18.5 km long