



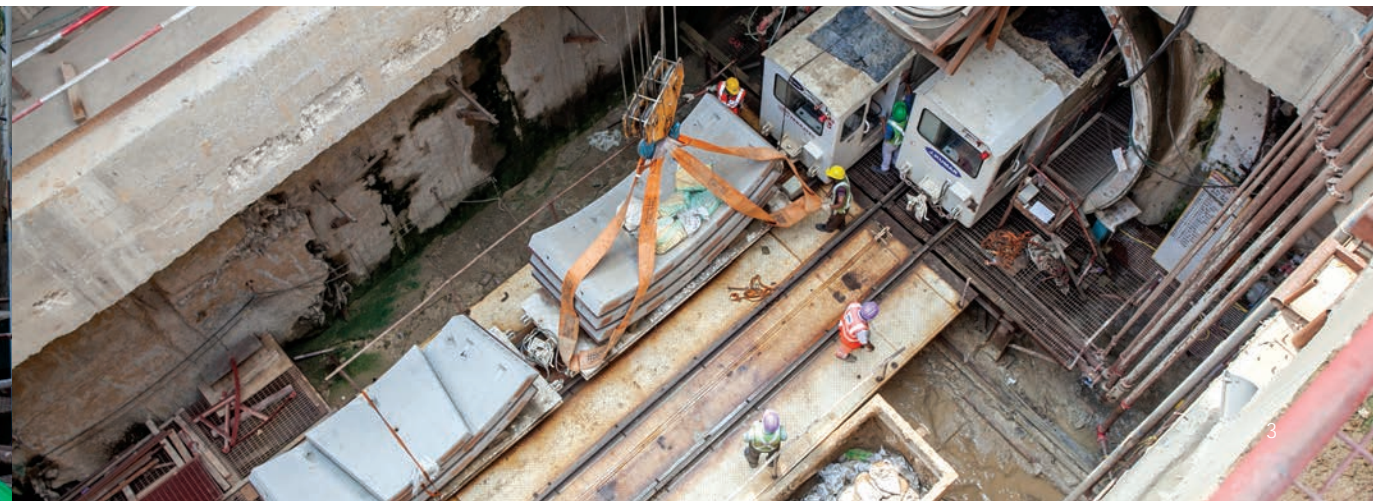
Rail Based Equipment

Locomotives & Rolling Stock

The successful construction of a tunnel not only depends on the most suitable tunnelling machine or tunnelling methodology. The success also requires an efficient system to remove the spoil out of the tunnel and bring in consumable items such as segments, grout, foams and oils. Even if a conveyor system is the primary method of spoil removal, the machine still needs to be supplied with consumable items.

One of the most reliable methods of resupply is using a rail based system.

Since its incorporation in 1990, TERRATEC has been supplying rail based solutions as part of its integrated line of tunnelling equipment. From battery locomotives to segment cars, TERRATEC aims to provide an integrated solution to get the job done efficiently.



Locomotives

TERRATEC battery locomotives are designed to provide the most reliable material handling solution whilst minimizing the environmental impact to the tunnel. TERRATEC battery locomotives are configured with Solid State Digital Controllers.

Solid State Digital Controllers offer a robust control system that are particularly suitable for remote and tandem applications. They have excellent trouble shooting capabilities using handheld diagnostics equipment.

Weight and motor specifications of the locomotive can be customized to match the project requirements. TERRATEC engineers can assist in defining the system requirements. The system can be provided for single units to tandem operated units.

Features of TERRATEC Battery Locomotives:

- Fail Safe Braking System (Dead Man Switches, Service brake, Park brake)
- Regenerative braking system
- Warning light
- CCTV systems
- Sanders

Battery options are available depending on the locomotives' duty cycles. TERRATEC engineers can assist in these calculations to match the project needs. The battery life (amp hours) is carefully calculated to ensure that the locomotives have sufficient capacity to work for a full shift (at the furthest part of the project) before they require a battery change (normally combined with shift change) – the chargers are smart and switches off after the desired charge is reached.



Rolling Stock

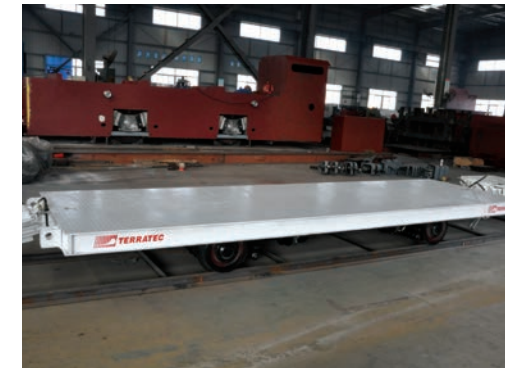
TERRATEC provides all types of rolling stock from flat cars to crane cars, from muck cars to grout cars. TERRATEC can provide the chassis only and the design drawings for muck boxes or flat car decks such that they can be manufactured locally. This reduces shipping costs and time to delivery. The project can also engage and benefit the local communities where fabrication takes place.

TERRATEC manufactures:

- Segment Cars – Fixed table or Turntable (Manual or automatic)
- Grout Cars – With Agitator and Transfer Pump
- Flat Cars – Single axel design or bogie styled, widths as required
- Muck Cars – Lift-Off, Side Dump, 5th Wheel, Rotary Dump and Flip over cars
- Personnel Carriers (Menriders) – Open or closed with emergency exits and stretcher carrying capacity
- Other Equipment such as Muck Dumping Stations, Movable Cross Switches, Car Shifters, etc.

Rolling Stock Construction Information:

- Couplers are cast steel with coupler pins heat treated to BHN 260-300. Available styles of couplers are: Willison style automatic, Willison style automatic with round shank for roll-over applications, Willison style automatic coupler with European style release.
- Wheels are also cast steel (repairable) of a proprietary metallurgy from 152mm (6") diameter to 838mm (33"). Fully heat treated and custom made to accept specified axle and bearing sizes. Axles from 457mm (18") to 1067mm (42").
- Brakes of different styles (disk or tread). Spring applied/air released (fail safe) design if required.
- Brake Shoes made out of TERRATEC proprietary heat dissipating cast iron, tread or tread-and-flange design.
- Frame and body construction is all steel using high quality steel and high grade fasteners.



Case Study: Delhi Metro

Project Name: Delhi Metro Phase III
Contracts: CC-07, CC-20, CC-24
Location: New Delhi, India
Year: 2013 & 2014
Clients: CC-07: Joint Venture of Metrostroy O.S. of Russia and ERA Infra Engineering Ltd. of India
 CC-20 & CC-24: Joint Venture of J.Kumar Infraprojects Ltd. of India and China Railway Third Group (CRTG) of China

Supplying the full rolling stock solution to service 6 TBM's included:

- Locomotive (15ton) x 3 Nos.; Locomotive (25ton) x 3 Nos.
- Locomotive (35ton) x 5 Nos.; Locomotive (45ton) x 4 Nos.
- Charging Stations & Spare Set of Batteries
- Segment Car (15ton) x 23 Nos.
- Flat Car (10ton) x 11 Nos.
- Muck Car (13m³) x 56 Nos.
- Men Rider x 3 Nos.
- Traverser (Car Shifter) for 25ton Loco x 1 No.
- Traverser (Car Shifter) for 45ton Loco x 4 Nos.
- Muck Dumping Station x 6 Nos.
- Cross Switch x 6 Nos.

The locomotives contain different weights due to the grades for each tunnel section (A steeper grade requires more tractive effort and therefore requires a heavier locomotive). The power source for the haulage locomotives is electric (battery powered). By using solid state control systems from Japan, the equipment can account for regenerative braking. The locomotive acts as a dynamo and recharges its own batteries whenever it is being slowed down which extends the time between charges. The locomotives' standard includes 2 sets of battery and a high efficiency battery charger.

The rolling stock solution adapts the tried and tested link and pin system for car connection and quick release couplings for the pneumatic brakes. Wheels are cast steel of a proprietary TERRATEC metallurgy that balances ductility with longevity.



Case Study: Singapore Mrt

Project Name: MRT Downtown Line Stage II
Contract: C921
Location: Singapore
Year: 2011
Client: SsangYong E&C Co. Ltd.

Supplying a compact rolling stock solution:

- Locomotive (25ton) x 2 Nos.
- Charging Station & Spare Set of Batteries
- Segment Car x 2 Nos.
- Flat Car x 1 No.
- Muck Car (12.5m³) x 6 Nos.
- Muck Bucket (6m³) x 3 Nos.
- Traverser (Car Shifter) for 25ton Loco x 1 No.

The site was located in a densely populated area in Singapore. The project faced challenges in mucking out from a congested shaft during the project start-up phase. The tunnel length was short so TERRATEC had to devise a mucking and supply mechanism to work in a limited amount of space.

A twofold solution has been deployed: Small start-up muck cars and a car traverser maximized space efficiency as cars could be traversed from one set of rail tacks to another without the use of a locomotive or crane. Initially, small (6m³) muck boxes were used.

In the later stage, full size (12.5m³) muck boxes were utilized. The segment cars referenced above were simple cars which could serve as multipurpose cars. Battery locomotives minimized air pollutants released to the tunnel's atmosphere. This reduced the amount of fresh air required to flush out the pollutants. Smaller ventilation fans could then be installed to achieve proper ventilation.





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