Project datasheet: Railways

Project Name: Railway cut & cover tunnel design

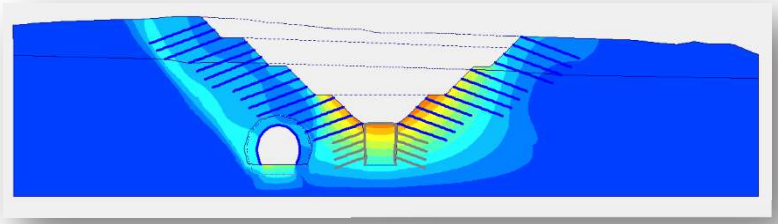
Location: Itu, SP, Brazil

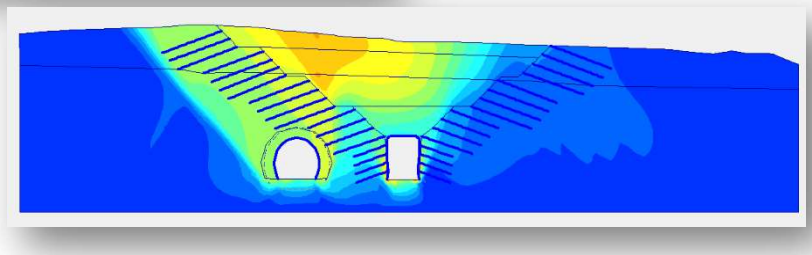
Client: Rumo Railways

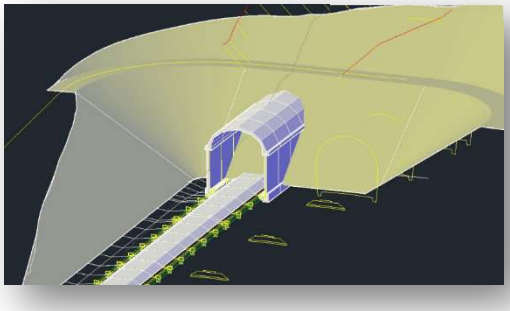
Description: Terratek designed a 500 m *cut & cover* single line tunnel close to an existing tunnel built some one hundred years ago. The geotechnical profile was residual soils at the top followed by sandstone. Preliminary studies pointed out that a cut & cover solution was more economical than a NATM tunnel, as the rocks could be excavated with a vertical slope.
A design challenge was to avoid damage to the existing tunnel. An advanced numerical model has shown the need to reinforce the excavated slopes to avoid displacements to the old tunnel.

Terratek carried out:

- Preliminary design;
- Trade-off analyses and comparison with conventional solutions;
- Plaxis 2D and Plaxis LE analyses;
- Structural, drainage and pavement design design
- BIM design







Project datasheet: **Railways**

Project Name: Railway underpass with box jacking

Location: Campinas and São Carlos, SP, Brazil

Client: Rumo Railways

Description: Terratek designed two railway underpasses employing jacking box technology. It consists of casting a concrete caisson box and then hydraulics jacking into position under the railway lines, while an excavator operates at the box front to remove the soils ahead. Terratek also designed a track suspension system to avoid track deformation and ensure line operation safety during jacking.

Terratek carried out:

- Preliminary design;
- Trade-off analyses and comparison with conventional solutions;
- Detailed design including structural, drainage, pavement and geotechnical design.

Project datasheet: Railways

Project Name: Integrity assessment of bridges and abutments

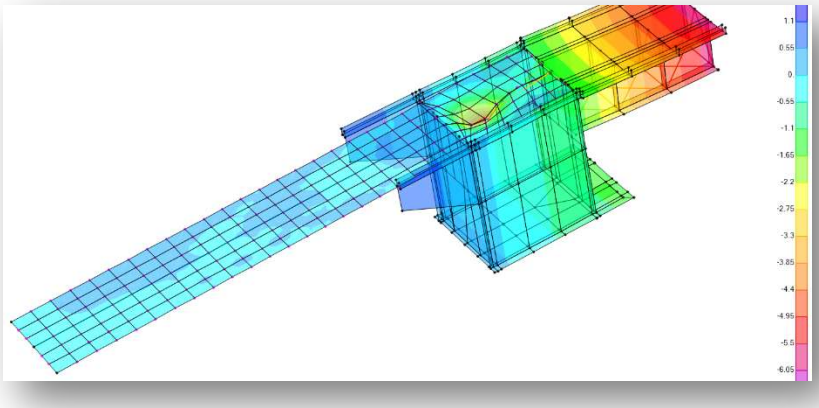
Location: Amazon, Brazil

Client: Vale

Description: Buriticupu Bridge is part of Vale's Carajás Railway stretching over 1000 km from the Amazon iron ore mines to the São Luís Harbour. Vale built the first concrete bridge in the '80s. Duplication took place in 2016 and the new steel beam bridge showed problems in one abutment. Vale awarded Terratek a contract to carry out a monitoring programme and geotechnical and structural integrity assessments of both bridges.

Terratek carried out:

- Site investigation programme and PMT tests;
- Geotechnical analyses using Plaxis 2D;
- Dynamic monitoring of both structures;
- Numerical modelling of both bridges;
- Data interpretation, analyses and recommendations.



Project datasheet: **Railways**

Project Name: Jointed rock slopes stabilisation design

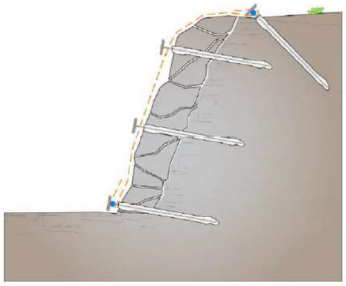
Location: Bahia, Brazil

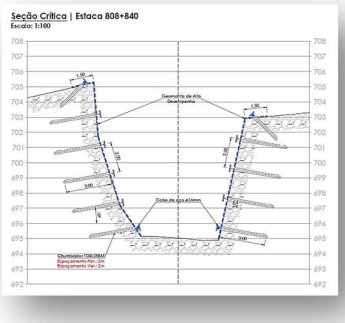
Client: VLI Railway

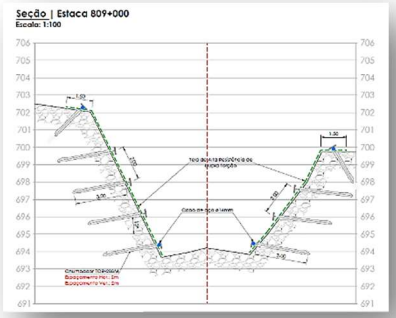
Description: A Terratek elaborou em 2018 projetos de estabilização de 13 taludes em rocha fraturada em trecho da VLI na Bahia onde ocorriam frequentemente quedas de blocos, interrompendo o tráfego.

Terratek realizou os seguintes serviços:

- Inspeção;
- Topografia
- Mapeamento geológico superficial
- Projetos de contenção empregando ancoragens, grampos e tela metálica







Project datasheet: **Railways**

Project name: Duplication of Vale's Carajás Railway

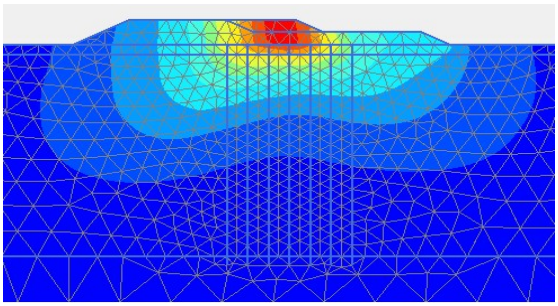
Location: Maranhão, Brazil

Client: Vale Mining

Description: This was a huge 1000 km long railway line stretching from the Amazon to São Luis Harbour. The first single railway line was built back in 1980, was enlarged to support the new one. One main challenge of this project is to cross 30 km long, 8 to 17 m deep very soft marine clay. The old single line was placed on an embankment with lateral berms. Vale designed this new line 16 m apart, far from the existing embankment. Based on a comprehensive site investigation, Terratek carried out consolidation analyses through Plaxis 2D and found out that the effect of the new line on the old one was minimal. Therefore, Terratek proposed to change the design and to build the new line only 5 m apart from the old one without the need for any ground improvement. This solution led to a savings of US $ 50 M.

Services provided by Terratek:

- Site investigation;
- Geotechnical consultancy;
- Plaxis 2D consolidation numerical analysis;
- Instrumentation and monitoring.



Project datasheet: **Railways**

Project name: Mosquito Bridge

Location: Maranhão, Brazil

Client: Vale Railway

Description: Mosquito Bridge was built in the early ’70s and by 2006 already presented structural damage.

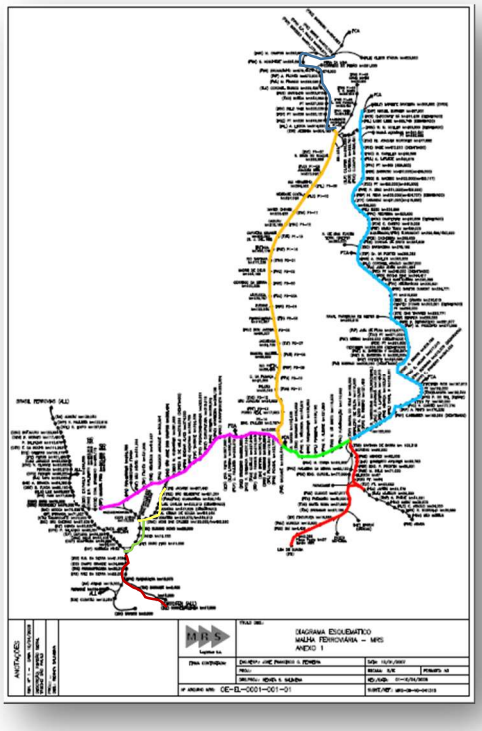
Services provided by Terratek

- Bridge inspection;
- Concrete damage assessment
- Structural monitoring through high precision accelerometers
- Mode extraction and spectrum analysis
- Mathematical modelling
- Damage detection
- Integrity assessment
- Structural rehabilitation design

Project Datasheet **Railways**

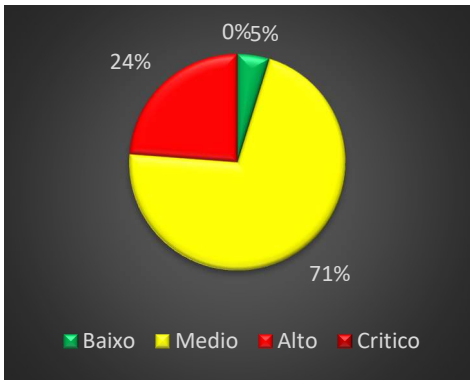
Project Name: Risk management of slopes

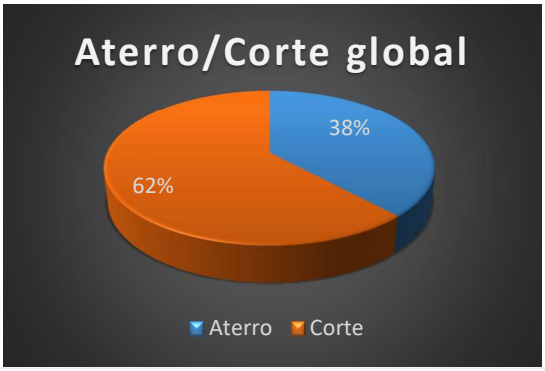
Client: MRS Railways

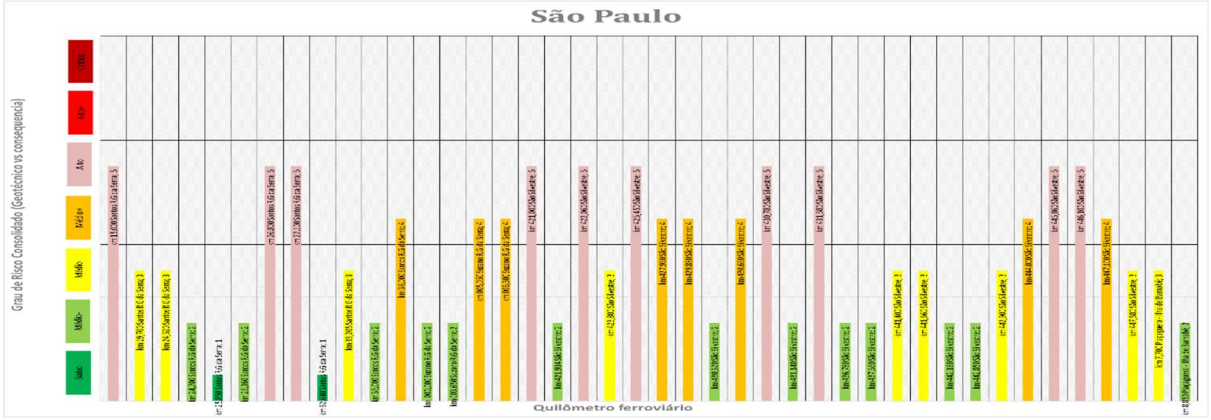


Project description: In 2012 MRS Railways hired Terratek to carry out a Slope Risk Assessment programme along their 1622 km of railway lines. The work that lasted for one year, employed two field inspection crews that included one geologist, one technician and a surveying team.

Terratek devised a method to classify slope risk into four categories which were tested along a 50 km railway length, before applying to the remaining railway. Once approved, Terratek office-based team received and processed field data using advanced software. Also, for risky slopes which fell into two more risky categories, Terratek proposed a stabilisation solution and a preliminary budget to stabilise it.







Project Datasheet **Railways**

Project Name: CSN 2 Car dumper

Location: Sepetiba Harbour, Brazil

Client: Paranasa Contractor

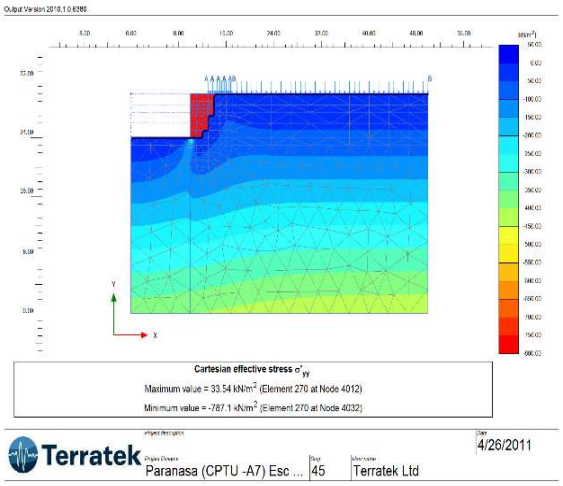
Description: CSN (National Steel Co.) decided in 2009 to install a new car dumper which required a 22 m deep excavation through a top sandy or clayey layer overlying hard rocks.

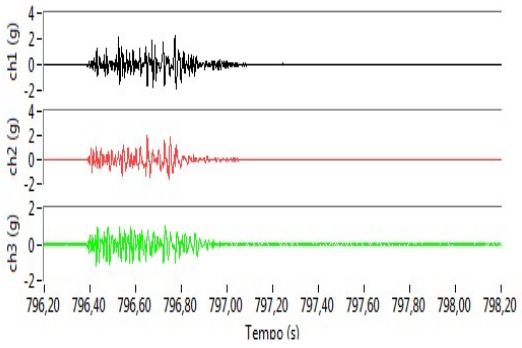
Terratek designed a top jet grouting (JG) secant column wall with the first line pinned into the rock utilizing a steel reinforcement tube.

The rocks were excavated by drilling and blasting.

Terratek carried out:

- Site investigation and CPTU testing
- JG wall design
- Plaxis 2D numerical modelling
- Instrumentation and monitoring
- Vibration monitoring during blasting





Project Datasheet **Railways**

Project Name: CSN 1 Car dumper

Location: Sepetiba Harbour, Brazil

Client: Paranasa Contractor

Description: CSN (National Steel Co.) decided in 2007 to install a new car dumper at Sepetiba Harbour. This included a 22 m deep excavation supported by a 400 mm thick diaphragm wall. Soil conditions were 8 m thick soft clays followed by compacted sands.

Terratek carried out

- Design review and tieback support optimization;
- External dewatering system in the sand layers;
- PMT testing;
- Plaxis 2D numerical modelling;