

> MAJOR STRUCTURES

# Tunnels and underground spaces

CSTB's multi-disciplinary service  
at all stages of the project

A complete and tailored service for all professionals  
involved in tunnels and underground spaces.  
Exceptional experimental facilities and numerical tools.

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# CSTB support throughout the project lifetime



1

## Design

Studies and modelling of: ventilation, vibration, lighting, acoustics, smoke extraction, aeraulics



2

## Concrete mix selection

Concrete behavior at high temperatures and fire resistance screening tests



3

## Segment manufacturing

Full-scale fire resistance tests under mechanical load (up to 1 000 tons)



4



## Construction

Smoke extraction strategy, in-situ measurements, in-situ tests

5



## Operation

Fire safety, in-situ tests, acoustic and visual comfort of users, indoor air quality, fungal contamination

*People travelling on a subway platform*

*Montreal underground town center*



## Tunnels and underground spaces

- Fire safety engineering (smoke extraction, fire resistance of structures, active protection, fire evacuation plan)
- In-situ measurements: monitoring of vibration level during construction stage, concrete spalling under fire
- Project management assistance
- Design studies (ventilation, acoustics, vibration, lighting, aeraulics)
- Virtual reality
- Modelling and numerical simulation

## Component

- Fire resistance tests under mechanical load
- Thermo-mechanical modelling
- Regulation assessments
- Vibration tests on floating slab or track laying system

## Material

- Mechanical tests at high temperature

## Product

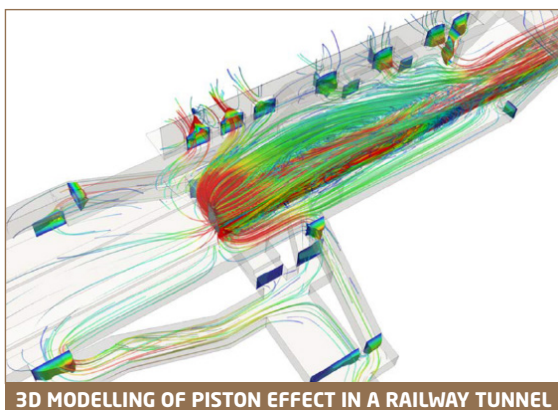
- Fire reaction tests
- Fire resistance tests
- Mechanical tests
- CE marking
- BIM modelling for integration into BIM library



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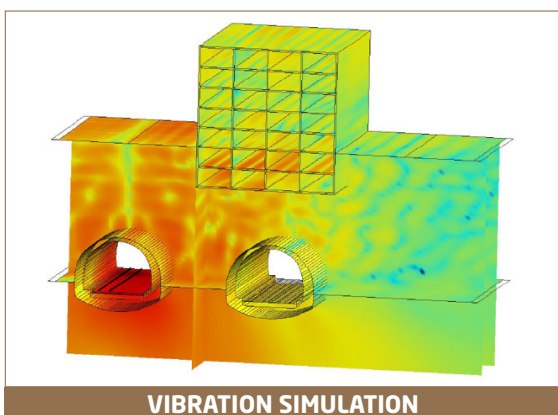




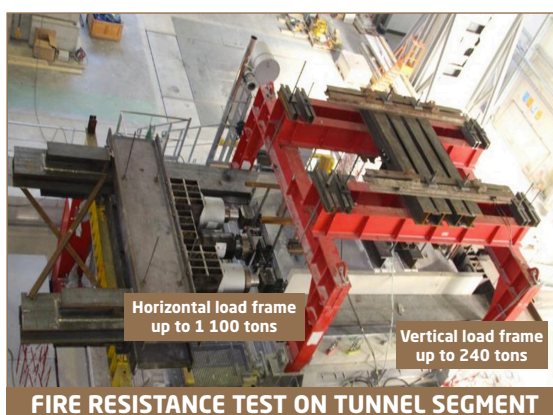
3D MODELLING OF PISTON EFFECT IN A RAILWAY TUNNEL



IN-SITU FIRE RESISTANCE TEST WITH MOBILE FURNACE



VIBRATION SIMULATION



Horizontal load frame  
up to 1 100 tons

Vertical load frame  
up to 240 tons

FIRE RESISTANCE TEST ON TUNNEL SEGMENT

## References in France and around the world

### France

- Cut-and-cover tunnel of the L2 ring road
- Cut-and-cover tunnel of La Parette – Marseille
- Angers cut-and-cover
- La Défense cut-and-cover
- Fréjus tunnel
- Orelle tunnel
- Chamoise tunnel
- Perthus tunnel
- Caluire tunnel
- Nogent tunnel
- Paris area tunnels
- Jenner tunnel
- Lyon-Turin project
- Mont-Blanc tunnel
- A86 tunnel
- Eurotunnel
- Prado tunnel - Marseille
- Grand Paris Station

### Wales

- Tunnel of Conwy

### Qatar

- Subway tunnel of Doha

### Switzerland

- Sargans

### Egypt

- Ismailia and Port Saïd Suez canal tunnels

### Trainings

- Optimising indoor air quality
- Optimising lighting
- Optimising comfort of public spaces in operation
- Fire safety

### Environmental certification



HQE™ infrastructures delivered  
by our subsidiary Cerway

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