

Tunnels: Design and Construction. Tunneling

1 Purpose and scope

The requirements apply to blasted tunnels.

2 Consideration to the surrounding area

2.1 Functional requirements

a) Requirements must be set to ensure that the condition of the surrounding area is safeguarded.

This will normally apply to:

- Noise from drilling, blasting, pneumatic drills, transportation of spoil, ventilation plant, etc.
- Blasting tremors
- Settlement as a result of groundwater lowering
- Water wells draining dry
- Emissions/discharge from the site (drainage water, air from tunnel ventilation, dust, etc.)

b) The maximum vibration level must be determined on the basis of information about the type of building, building material and the ground conditions for buildings or structures in the zone affected by the blasting work, as well as experience of previous blasting work in similar conditions.

c) The vibration requirements must be calculated in accordance with NS 8141-1:2012.

d) Land planning guidelines for noise management must be considered in accordance with T-1442.

2.2 Measurement programme and registrations

a) The tunnel work must be carried out in a way that does not cause unacceptable damage to neighbouring buildings.

b) A risk assessment must be carried out to identify what damage could potentially be caused. On the basis of a survey of the conditions, the following measures must be assessed and organised:

- Extent and need to which buildings must be inspected and registered. This is normally done as close to the time of blasting as is practically possible.
- Programme of tremor measurements.
- Requirement for settlement bolts for subsequent control measurements.
- Requirement for pore pressure measurements.
- Requirement for water infiltration during the construction period.
- Water quality of effluent from the tunnel after planned cleaning operations.

c) An assessment must also establish whether there are any special conditions requiring registration/control measurements.

d) Based on the assessments, a measurement programme must be drawn up. The measurements are included in the ongoing assessment of salvo planning, scale of injection work, etc.

e) The measurements must provide reliable documentation of actual damage for use in any compensation claim cases.

f) The measurements must ensure that the site is not charged for alleged damage that has nothing to do with its work operations.

2.3 Effluent

a) Applications must be submitted for effluent permits for temporary and permanent situations.

2.4 Operating requirements

a) Blasting operations must ensure that a good, even contour is achieved, and that as little damage as possible is caused to the remaining rock, leaving only a small amount of overbreak.

b) Contour blasting must be adapted to suit the rock conditions.

2.5 Probe drilling

Probe drilling can be carried out to test the quality of the rock and assess tunnel water leakage.

a) When probe drilling is performed, drill hole data must be logged automatically.

b) Core drilling, like probe drilling, must be considered if there are special rock conditions.

2.6 Injection

a) The tunnel must be sufficiently watertight against leaks, in terms of:

- The risk of damage through environmental impact
- The tunnel's function and safety

b) Injection must normally take place in the form of pre-injection.

Post-injection is only used in exceptional cases, since this is much more extensive than pre-injection.

c) Pre-injection must be used in the following conditions:

- Where requirements for maximum water leakage have been stipulated, in order to prevent damage to buildings and surroundings as a result of groundwater lowering.
- Where water leakage into a tunnel is so great that it will create problems during both the construction phase and the operational phase.
- When stabilising sections that have poor rock conditions.

d) The rock material's fracture properties and water flow must be assessed, including the direction of flow in the rock material around the tunnel, before injection work can begin. On the basis of this, a plan must be drawn up for the injection work.