

Tunnels: Design and Construction. Substructure

1 Purpose and scope

This chapter describes the requirements for the substructure of tunnels, including the cleaning and frost protection of tunnel beds, construction and drainage.

2 Substructure of tunnels

2.1 Cleaning and frost protection of tunnel beds

2.1.1 Frost zone

- a) The tunnel bed must be cleaned in the frost zone.
- b) Cleaning operations must ensure that the residue of loose particles is no greater than a depth of 50 mm on top of solid rock.
- c) Rock protruding beyond the theoretical blast profile must be removed.

The frost resistance for the relevant substructure must be calculated.

- e) If the bed is higher than the designed frost depth, standing water in hollows must be drained away. Alternatively, the hollow can be filled in.

2.1.2 Frost-free sections

- a) Frost-free sections must be cleaned down to the top of rock nodules.
- b) Standing water in hollows on rock nodules must be drained away, and the hollow filled if necessary.
- c) Rock protruding beyond the theoretical blast profile must be removed.

Tunnel sections where the rock is of poor quality should be cleaned to the same standard as in the frost zone.

2.2 Construction up to formation level (FL)

- a) The materials below the formation level (FL) must have good friction qualities, i.e. they must be well draining and frost proof.
- b) The formation level must be trimmed with a suitable fraction.
- c) Grading must normally be within the region of 20–120 mm.

2.3 Drainage

- a) The drainage system must be designed in accordance with [Underbygning/Prosjektering og bygging/Drenering](#).
- b) The drainage system must be designed so as to ensure that all the water that leaks into a tunnel is fed out of the tunnel in a frost-protected manner. In the frost zone, this is ensured by using insulated ditches on both sides of the tunnel. In the frost-free sections, a continuous ditch at one side of the tunnel is generally sufficient. Wet portions are serviced by double ditches, which feed into a single

full-length ditch by way of transverse ditches.

Closed drainage should be used in tunnels.

In frost-free tunnel sections, the drainage system and cable duct should run along opposite sides of the tunnel.