Substructure: Design and construction. Snow

1 Purpose and scope

This chapter includes snow protection and measures to prevent operational disruption due to snow.

Blowing snow, drifting snow and avalanches can all result in considerable operational disruption. In the worst cases, drifting snow and avalanches or a high avalanche risk may result in the closure of sections of line, despite extensive snow removal operations. Measures to mitigate this tend to be snow fences and snow sheds, and occasionally altering the natural terrain to make the line less vulnerable to snow deposits.

2 Snow fences

Snow fences tend to be made from timber, aluminium, steel or plastic, or a combination of these materials. Plastic has so far proved to be ineffective. Traditional wooden fences with round wooden supports and horizontal slats (5/4" x 5") are almost universally used. Snow fences are constructed either as collector fences or deflector fences.

Collector fences must be as perpendicular as possible to the prevailing wind direction.

The fence reduces the wind speed so that most of the drifting snow is deposited before it reaches the track. The length of the drift behind the fence depends on how open the slats are. Slats that are closer together produce snowdrifts that are shorter and higher. The distance from the collector fence to the track should be 10–15 times the height of the fence. The lower part of the fence (0.5–1.5 m) must always be open. This increases the wind speed under the fence, and thereby prevents the fence from becoming covered in snow.

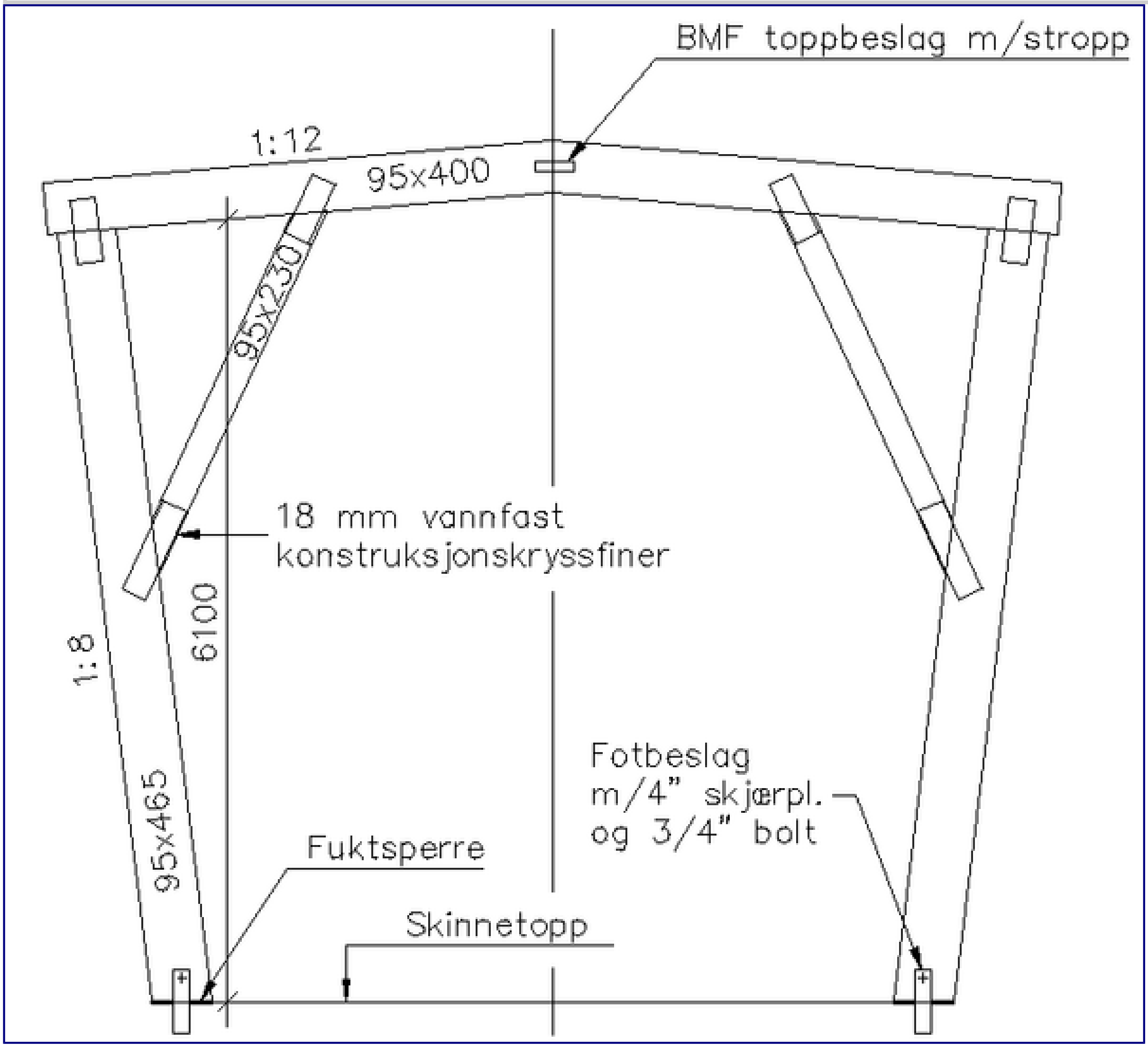
Deflector fences must deflect the wind so as to prevent snowdrifts from reaching the track. They are therefore erected at a sharp angle (25–30°) to the prevailing wind direction.

The slats on a deflector fence must be relatively close together, to make the fence more windproof. This type of fence will also act as a collector fence to varying degrees; correspondingly, a collector fence will have a deflecting effect if the wind blows against it from an oblique angle.

If possible, fences should be located on elevations in the terrain. This makes it less likely for them to become covered in snow. The fences can then function throughout the winter, and are not vulnerable to settling snow. Closer slats also mean that there is less risk that the fence will become buried, due to the increased wind speed under the fence. If there is a possibility that the fence will become covered in snow, it must be designed for the additional loads that will occur. Otherwise, fences must be designed for wind loads in accordance with NS-EN 1991 'Laster på konstruksjoner'. A fence must be at least as high as the depths of snow expected to occur locally. Permanent fences are the norm; removable fences are not used.-

3 Snow sheds

The most common type of snow shed is a timber-framed structure of laminated wood, with longitudinal wooden nailing strips and aluminium sheet cladding. Se Figur 1. The roof angle is shallow, so that as much snow as possible will blow off. The walls slope outwards, so that snow will slide off the wall when it begins to thaw and is at its heaviest. The structure is normally built on a continuous concrete foundation wall, the top of the foundation being on the same level as the top of the rail.



Figur 1: Timber-framed snow shed of laminated wood

Specially designed concrete structures are used in locations where particularly heavy snow loads are expected. Steel snow sheds are used to a lesser degree.

These may be fitted with hatches to give passengers a view. The hatches may be opened in summer. Windows are another possible solution.

4 Altering the natural terrain

The aim of new installations must be to make lines as self-clearing as possible, by choosing the most appropriate route and altering the natural terrain. Simple and relatively inexpensive methods may often remove the cause of snowdrift formation on a line. These include:

- extending cuttings
- removing protruding slabs of soil/rock
- reducing the gradient of slopes
- raising the track
- lowering the terrain

In order to prevent drifts from forming when the gradient of a slope is reduced, the slope should be no steeper than 1:6.

5 Avalanche protection

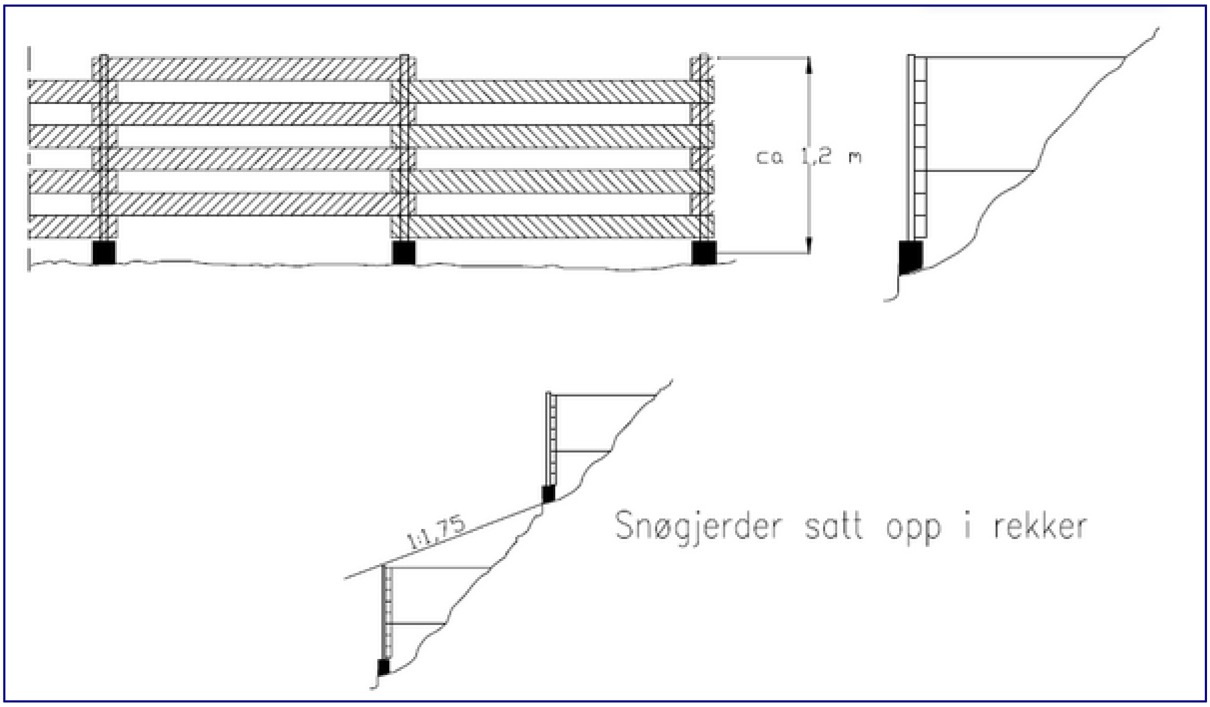
There are two types of avalanche: loose snow avalanches and slab avalanches. A slab avalanche often carries a large volume of snow, and occurs on shallower slopes than loose snow avalanches. Several options may be used to protect the line from the major adverse effects of avalanches:

- prevent snow from breaking loose
- redirect the course of avalanches
- stop or slow the avalanche
- build a secure superstructure over the track
- trigger avalanches artificially

5.1 Prevent snow from breaking loose

Several methods may be used. Transverse barriers such as walls or snow fences may be erected in open terrain. Fence design and construction is shown in Figure 2. The snow fences should be erected in rows along the slope, across the entire critical area.

Ideally, it should be possible to achieve an incline of 1:1.75. The distance between rows must therefore take this into account. (Refer to Figure 1). The fences must have strong foundations.



Figur 2: Fence design and construction

In locations where avalanches occur as a result of blowing snow that accumulates as snowdrifts on steep slopes or as overhanging slabs at the top of slopes, collector fences may be erected on the plateau in front of the slope.

5.2 Redirect the course of avalanches

In order to redirect avalanches so that they cause as little damage as possible, deflector walls or deflector mounds may be constructed, so as to force the avalanche to one side. These structures must be sufficiently high, and must be erected at a sharp angle to the original course of the avalanche.

5.3 Stop or slow the avalanche

In order to stop, slow or reduce the avalanche, catching dams or braking mounds may be erected across the course of the avalanche.