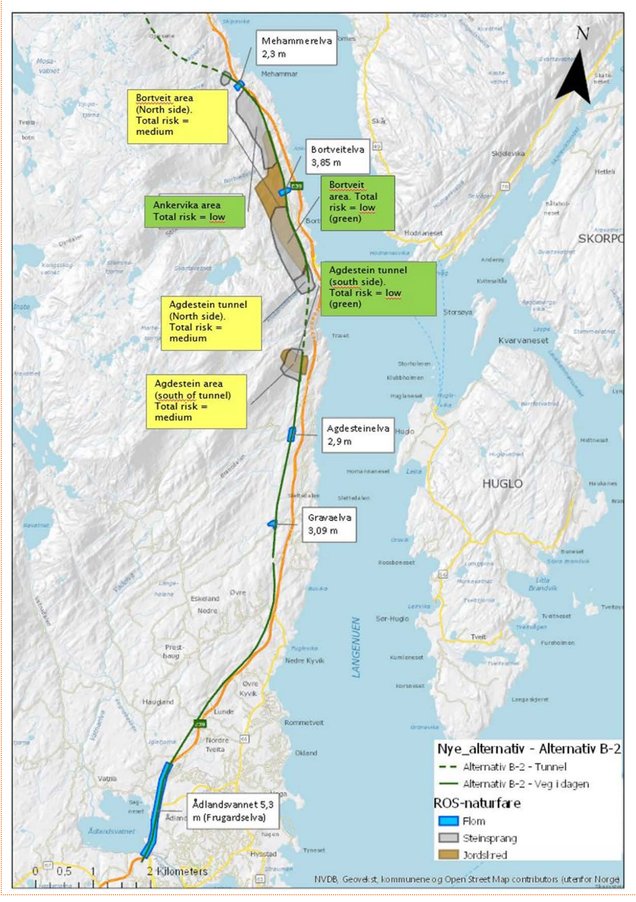
Statens vegvesen
Norwegian Public Roads Administration

Amendments to rules for design and practice to incorporate climate change



The NPRA have a series of manuals, containing requirements and recommendations for planning, design, maintaining roads. They are based on standards, but include interpretations and specifications for roads or road transport. One of the main products of the NPRA's work on adaptation to climate change are the amendments to these manuals. They are done successively – whenever a manual is reviewed, points regarding climate change are included.

Including risks from natural hazards in road planning



Risk and susceptibility analyses are a compulsory part of road planning, according to the Norwegian Planning and Building Act. The requirement to perform risk- and susceptibility analyses in the planning phase of a project has been added to the NPRA's manual for impact assessment.

However, natural hazards have up until now not been sufficiently taken care of. Amendments are made to ensure that geology, hydrology and geotechnics are included in future impact assessments.

The new standard is to provide vulnerability maps for each of the road alignment alternatives under consideration.

Erosion protection

The design load for erosion protection is the 200-year return period of water flow.

This is a requirement for slope protection, also included in the bridge manual.

In addition, bridge free height over water is to be calculated based on the 200-year return period of water level (sea or fresh water).

Costal roads need higher protection from wave erosion, and sea level rise has to be included:

Design high-water is a combination of:

- 200-year storm surge level
- sea level rise by year 2100
- 200-year significant wave height

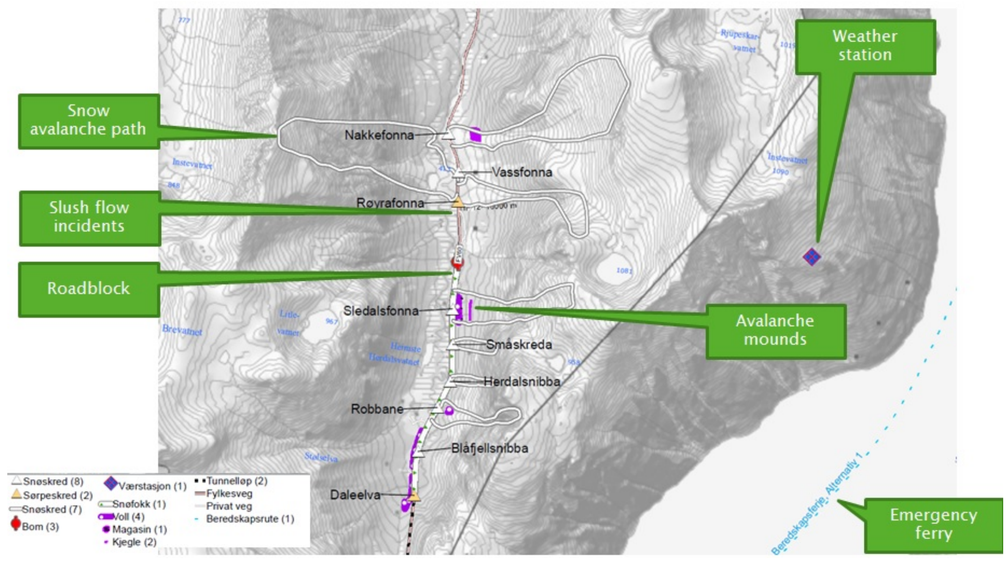
Requirements are set to the geometry of the erosion protection layers and stone size.


Photo: Ove Strømme

Vulnerability maps as a basis for operation contracts

A new standard is set for the contents and quality of information provided by the NPRA for the contractor. The vulnerability maps include:

- Information about the area's climate (present) and weather situations that typically cause natural hazards
- Information about the area's terrain; including landslide and avalanche susceptibility and flooding susceptibility
- Point locations of all previous events (landslides, avalanches, floods, bad visibility, coastal erosion, high winds, etc.)



The basis for adaptation work in Norway is provided by the Norwegian Centre for Climate Services (NCCS). The Centre gives access to regional projections of climate parameters, changes in flood levels, snow season and growth season, etc.
Inn addition, regional climate "profiles" are established, describing the expected changes in risks and uncertainties. Practical climate safety factors are recommended for design purposes. www.klimaservicesenter.no

Ensuring flood-proof elevation

The manual for road design of 2013 included for the first time a requirement for elevation of roads. The minimum elevation is to determined from the 200-year flood level, increased by a safety margin recommended by CSS and in collaboration with the Norwegian Water Resources and Energy Directorate.

The 2018 edition includes a requirement for alignment for coastal roads, calculated from:

200 year storm surge level
+ sea level rise by 2100
+ safety margin recommended by NCCS.


Foto: Norfilm

Ensuring sufficient drainage capacity

The manual for road construction adopted in 2011 new provisions for design return period of precipitation used for calculating water flow. The range is from 50 years for drainage along the road and good redundancy, to 200 for transversal drainage and low redundancy. The 2011-edition introduced a climate factor, k_f, added to the rational formula for calculating water flow Q in small catchments.

The revised design guidelines of 2018 introduced a number of changes.

- The uncertainty is compensated for by two safety factors: a climate factor (incorporating projected changes) and a general safety factor (compensating for uncertainties in the calculation method and data quality):

  $$Q_{dim} = Q \times F_k \times F_u$$

  The climate factor follows recommendations from NCCS, whereas the uncertainty factor is chosen for predefined safety classes.
- The design water flow, Q, should be calculated by several methods, in order to reduce the uncertainty. The choice is dependent i.a. on the catchment area and shape.
- Hydraulic calculations are to be adapted to the water management solution.

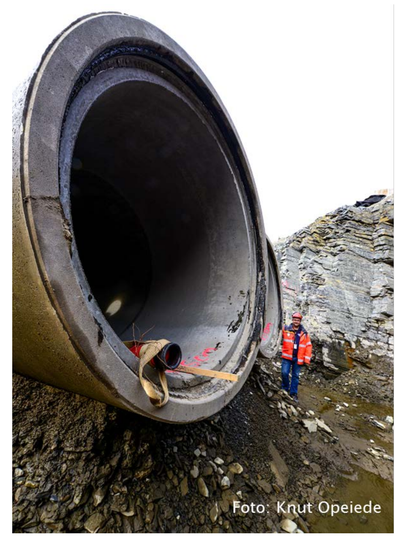


Foto: Knut Opeiede

Regular risk assessment on the road network

Vulnerability assessment of the roads is performed annually on all national and regional roads. This work in its original edition focused on road closure due to accidents, security issues. Adaptation to climate change required changes.
The risk from natural hazards is now included in the analyses. In order to incorporate trends in climate change, climate data for year 2050 are used as basis for the analyses. The process teams includes staff with knowledge of natural hazards and climate change impact.

In that way, the usual system for risk assessment includes climate vulnerability as well. For assets requiring closer risk analyses, a procedure is developed.

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