Climate and Transportation project in Norway:

Pavement performance in a changed climate

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Climate & Transportation

R&D program

**Main objective:** Improve design, construction and maintenance of the road network in order to adapt to climate changes.
Estimated change in mean year temperature 1961-1990 → 2071-2100 (CICERO)

2.4 - 2.8 °C
Estimated change in yearly precipitation 1961-1990 → 2071-2100 (CICERO)
Effect on bearing capacity

Temperature increase:
decreased pavement stiffness affects load distribution, less frost, changed frequency of freeze-thaw cycles

Precipitation increase:
higher ground water level, higher infiltration of rain water
Consequences of increased precipitation

- Increased water content in unbound materials
- Reduced bearing capacity (deformation properties and load distribution)
- Increased deterioration (rutting and roughness)

Moist pavement surface

Increased wear of asphalt
NEGATIVE consequences of increased temperature

- Material properties of asphalt are closely dependent on temperature due to reduced stiffness with increased temperature.
  - Reduced deformation properties
  - Reduced load distribution
  - Increased loading on sub-layers
- A frozen road is very strong, and a reduced frozen period can lead to increased deterioration
- The number of freeze-thaw cycles will increase in some areas
  - Several spring-thaw weakening periods during one single winter
    → Melting of the upper part of the pavement → reduced bearing capacity
- Reduced frost index, but more critical where in the construction the ice lenses form
POSITIVE consequences of increased temperature

- The number of freeze-thaw cycles will be less in some areas.
- Less frost heave and less spring thaw weakening in some regions.
- Reduced "studded season" → reduced rutting caused by studs.
Climatic zones and road structure data

Climatic zones

Road network

Representative weather station
Example of complexity of road structure data

Ev 136 Møre og Romsdal, oppgravingsdata

HP - km

Tykkelse

Betong  Ma/Og  Asfalt  Pp  T 1  Isol  T2  T3
Climatic change

- Measured climatic data from the period of 2000 - 2008 where modified to be representative for the climate in the period of 2070-2100 (based on the report):
  - Precipitation is given a %-increase.
  - Temperature is modified using linear regression.

- A big part of the climatic change described in the report has already happened!
Climatic data used in the calculations

Mean year temperature

Frost index

Freeze-thaw cycles

Mean year precipitation
Working procedure

Climatic station

Climatic station

Road network

Typical road construction

Daily climatic data 5 yr
- Precipitation
- Max/min temp
- Wind
- Solar radiation

Modified climatic data → year 2100

Calibration sections

Rutting/IRI data 2000 - 2008

Calibration of ME-PDG

Norwegian traffic
FHWA classes

AASHTO 2002 Design Guide ME-PDG

Processing of data

Evaluation conclusion
Results for main roads

Fig. 3: Results from the calculations. The figure does not show the differences between the different regions because other parameters like traffic, road structure materials etc. within the different regions are included in the input data.

There are still some uncertainness linked to the calibration, lack and/or quality of road structure data and the importance of the ground water level.
Conclusions

- The climate itself in interaction with the road structure has a great impact on the pavement performance.
- ....but the anticipated changes in climate is of less importance compared to the other deterioration factors.
- The anticipated development of ruts will be about 0.2 mm/year less in the future because of the climatic changes.
- This is similar to 13-16 % longer pavement life time.
- The positive effect of less frost and spring-thaw weakening problems is bigger than the negative effect of more precipitation.
- Climate adaption advices:
  - Use of stiffer binders for future pavement maintenance.
  - Increased focus on rehabilitation of the drainage systems.
  - Upgrading of gravel base course’s independent of climatic change (which do not even cope with today’s traffic and climate).
Gravel roads

- LCC analysis: increase in maintenance costs of about 20% because of a changed climate.

- The drainage system and the base and surface accumulated maintenance backlog are major limiting factors.

- It will be cost efficient to do drainage and strengthening upgrading of the gravel road network to reduce the excessive maintenance costs due to climate change.
Reports

http://www.vegvesen.no/Klimaogtransport