



Statens vegvesen
Norwegian Public Roads
Administration

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Frost design for culverts on low volume roads

WS 1: Pavement Design in Cold Regions



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INTRODUCTION

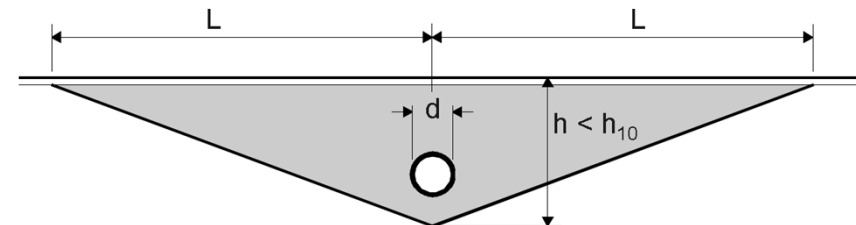
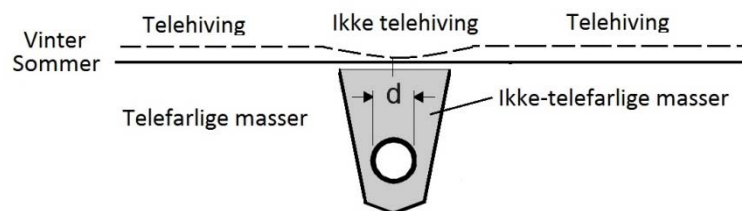
- Design of new roads and rehabilitation/strengthening of low volume roads without frost protection of the pavement needs special attention when it comes to frost protection of culverts and transition wedges to ensure that no unacceptable uneven frost heaves occurs.
- In addition to design, the workmanship of the entrepreneur and quality control is of great importance when it comes to the quality and function of these structures.



Frost design for culverts on low volume roads

CASE/PROBLEM

- Many low volume roads only designed for bearing capacity.
- Unacceptable uneven frost heave over culverts can occur due to:
 - Soil replacement with non-frost susceptible materials around the culvert
 - Frost penetration through the culvert it selves
- Traditional a high quality aggregate is placed in a narrow trench, just wide enough to place the culvert.
- In winter the road lifts while culvert and new aggregate remains in place creating a sudden sharp recession over the culvert.
- Traffic safety issue, reduced ride quality and increases dynamic loads
- In some cases also bearing capacity problems related to the end of the wedge.





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Construction of a wedge.



Wedge with insufficient inclining causing unacceptable uneven frost heave.



Area outside the wedge where asphalt has been removed and bearing capacity problems often occurs

Wedge



The same place as on the picture above. An uneven frost heave or damage due to bearing capacity problems can be seen in the end of the wedge the first winter after paving.

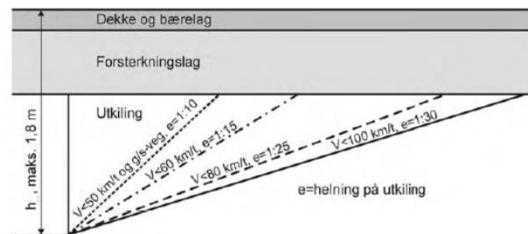




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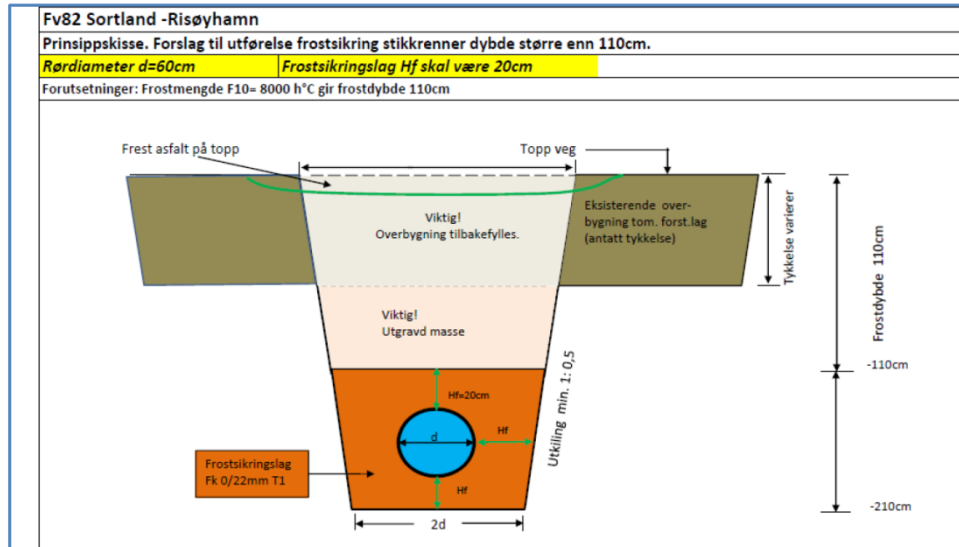
CASE/PROBLEM

- Main solution: Transition wedge when replacing culverts.
- Criterion in Hb018 design manual: inclining of 1:15 at 60 km/h and 1:25 at 80 km/h.
- Wedges represent major parts of the costs for rehabilitation → reduced lengths/steeper inclining.
- Improper craftsmanship is also often causing faults in the wedges.

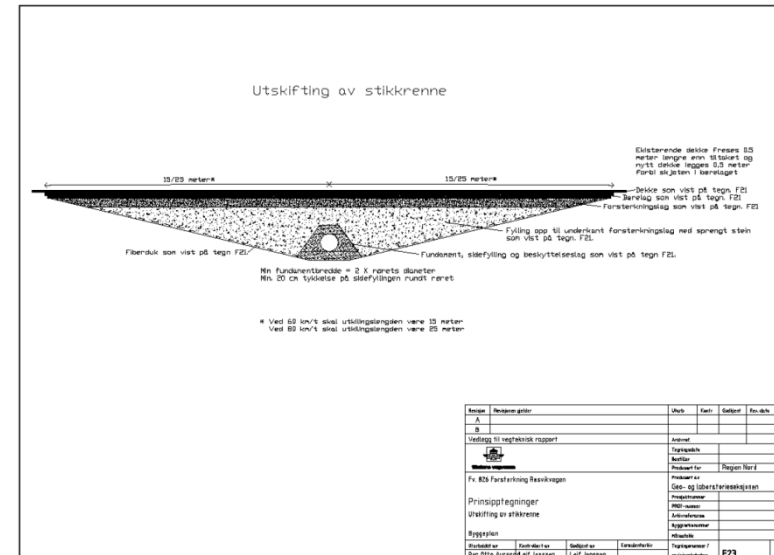


Figur 512.13. Helning på utkilingen (jfr. figur 512.12)

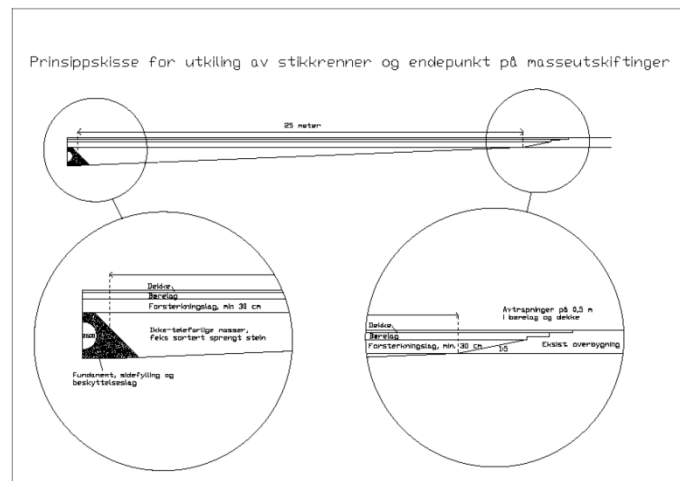
- Alternative construction is needed. These methods could be:
 - Placing the culvert deeper than the frost depth. Includes frost insulation of the culvert (if diameter is more than 600mm).
 - Full mass exchange between culverts (if culverts are close and wedges are interfering each other)
 - Raising the grade line to increase depth to culvert.
 - Excavate a narrow trench but using the existing subgrade material for backfilling.



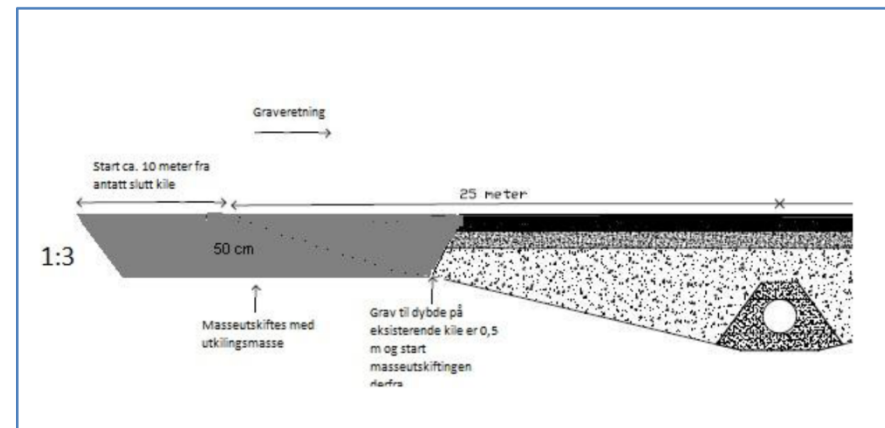
Culvert without wedge (placed under frost depth (F10) and insulated).



Culvert with 25 or 15 m wedge



Culvert with wedge and details of the design near the end of the wedges



Sketch over an "emergency" solution to prevent bearing capacity failure near the end of the wedge.



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CONCLUSIONS AND RECOMMENDATION

- Transition wedges should be constructed if culvert is placed within the frost depth (F10).
- When lowering the culvert or raising the grade line the wedges can be reduced or skipped.
- Alternative methods should be considered to reduce costs and ensure good quality.



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ITEMS TO BE DISCUSSED

- Different proposals for solutions for new and existing roads.
- Inclining/lengths of wedges.
- Details of the design near the end of the wedges.
- Use of new high quality aggregate contra existing materials.
- Depth to culverts.
- Frost insulation around culverts.