Cold Region Road Design Dilemma – Example from Swedish Road Design Code.

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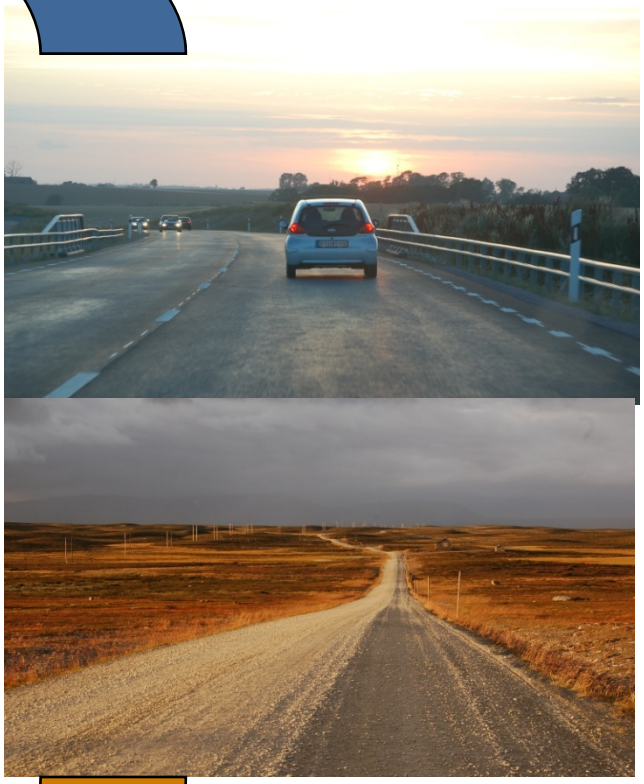
By Carl Lenngren for the pavement design in cold regions workshop in Trondheim, June 2013

Outline

- Brief review of design principles
- Some examples
- Comparison of construction effort per axle load

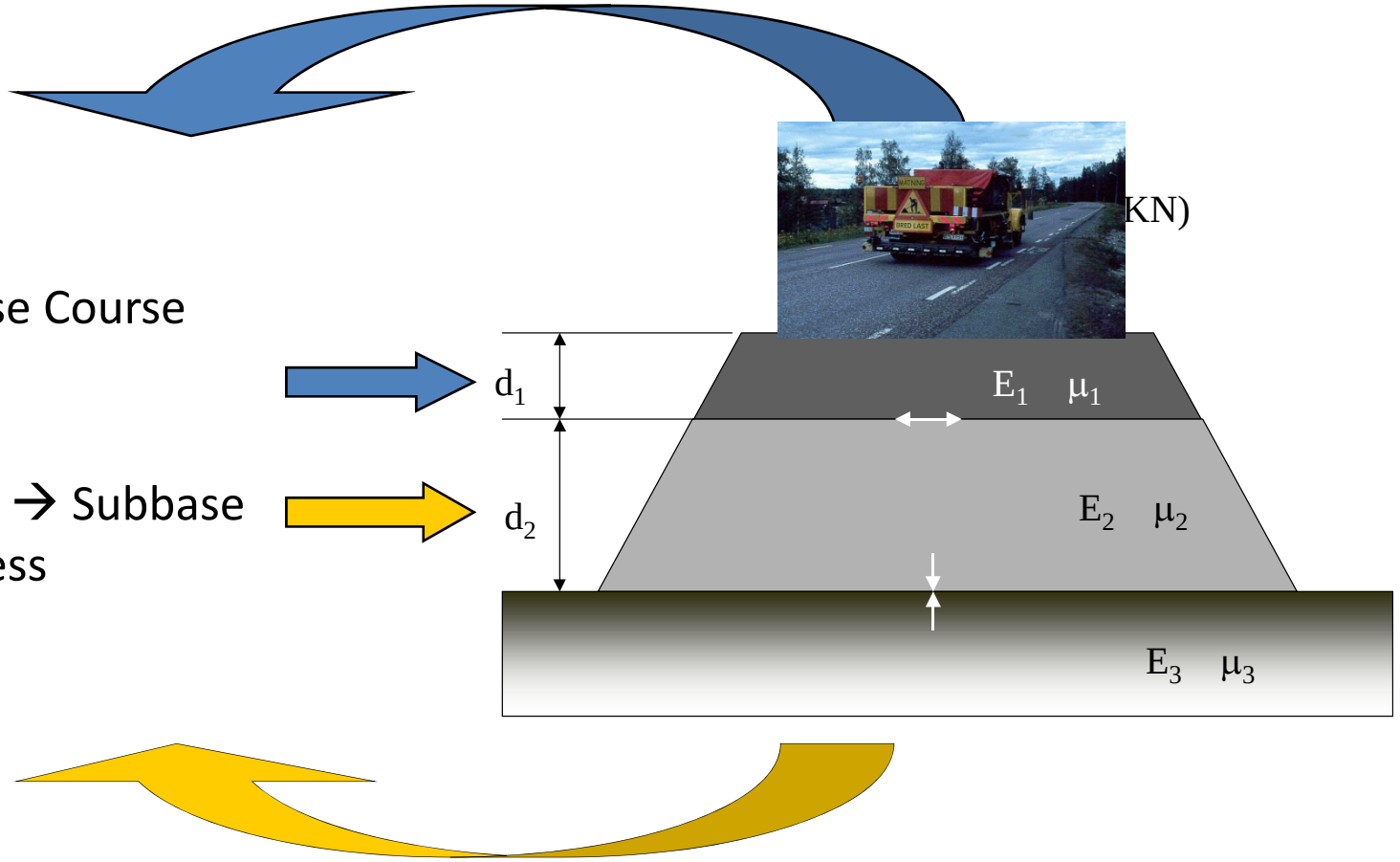
Road Design History
1968 input?

- Traffic
- Environment
  - Climate
  - Subgrade



“Classic” Design

- Traffic –> Base Course Thickness
- Environment → Subbase Layer thickness

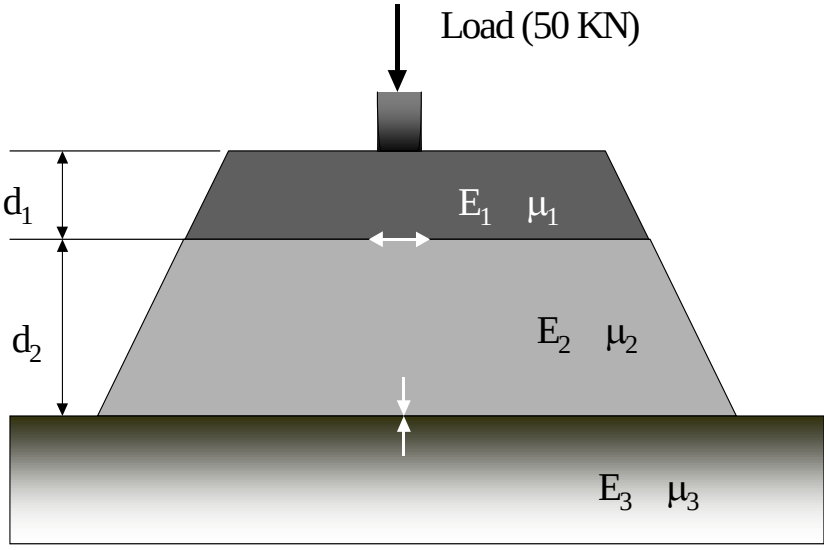


By mid 1980:ies

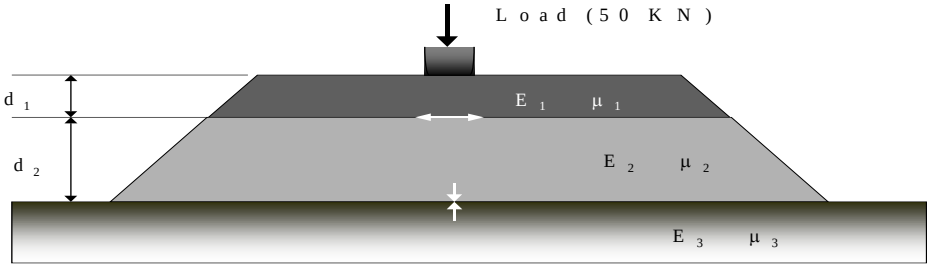
- Tougher Criteria for unbound base and subbase materials.
- 1984 Protective Layer introduced. (Usually old type of subbase layer).

Frost Heave Design

- It pays off to use a heavy design.

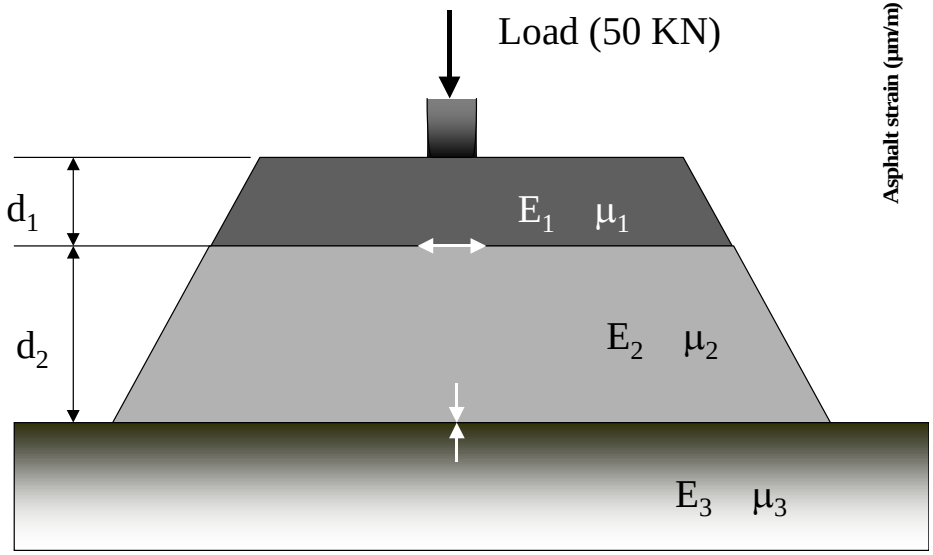


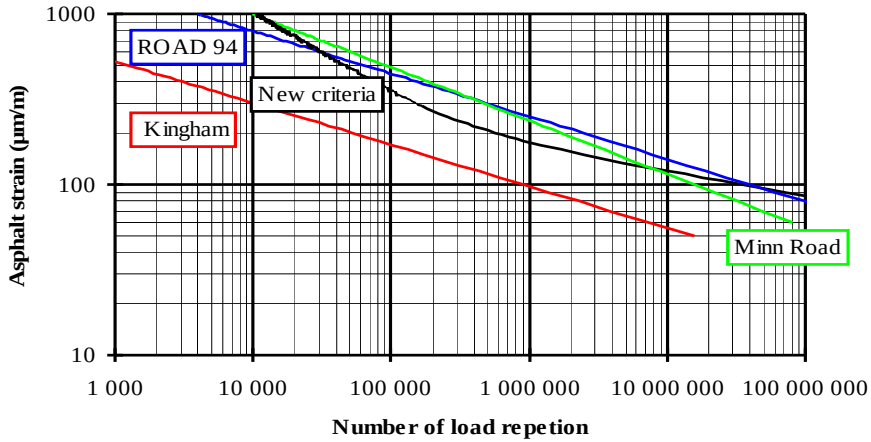
- E.g. thick layer of unbound materials better than bound or stabilized layers.



By 1994

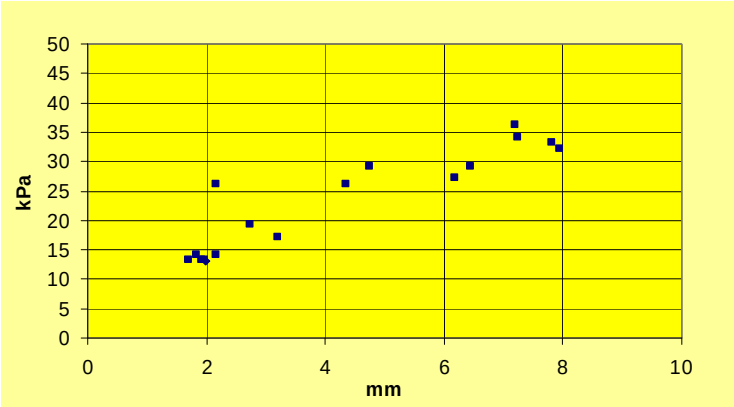
- Design governed by strain criteria





Criteria

- Bound Layers' strain criterion – Miner-Palmgren Fatigue
- Top of subgrade stran criterion. - Deterioration regression criterion.



Rutting vs. Stress

Rutting is the prime distress parameter!

Frost Heave Design

Uneven Frost Heave usually causes roughness from which user costs may be calculated.

Weight Counteracts the Heave.

Frost Heave Design

Input:

Freezing Index

Soil Type Frost Susceptability

Water Abundance

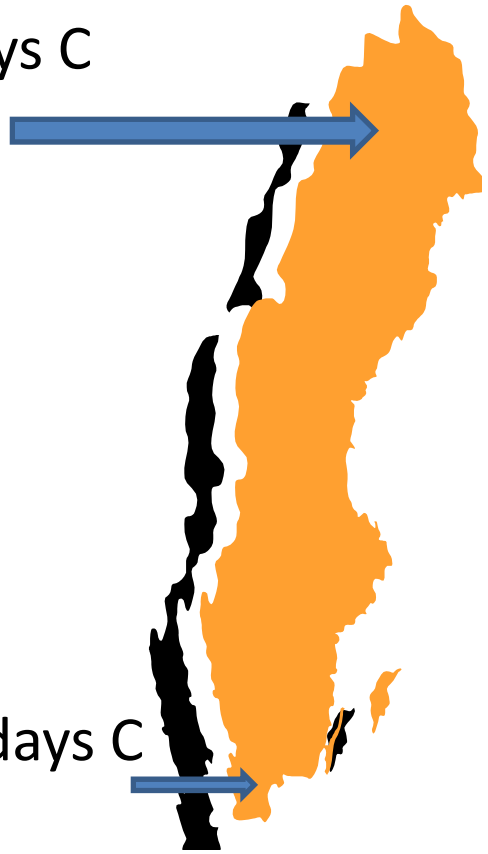
Road Category Desired IRI as Design

Output:

Frost Protective Layer (if needed)

Examples
Southern Sweden vs Northern Sweden

Climate Zone 6: 2000 degree days C



Climate Zone 1: 50-100 degree days C

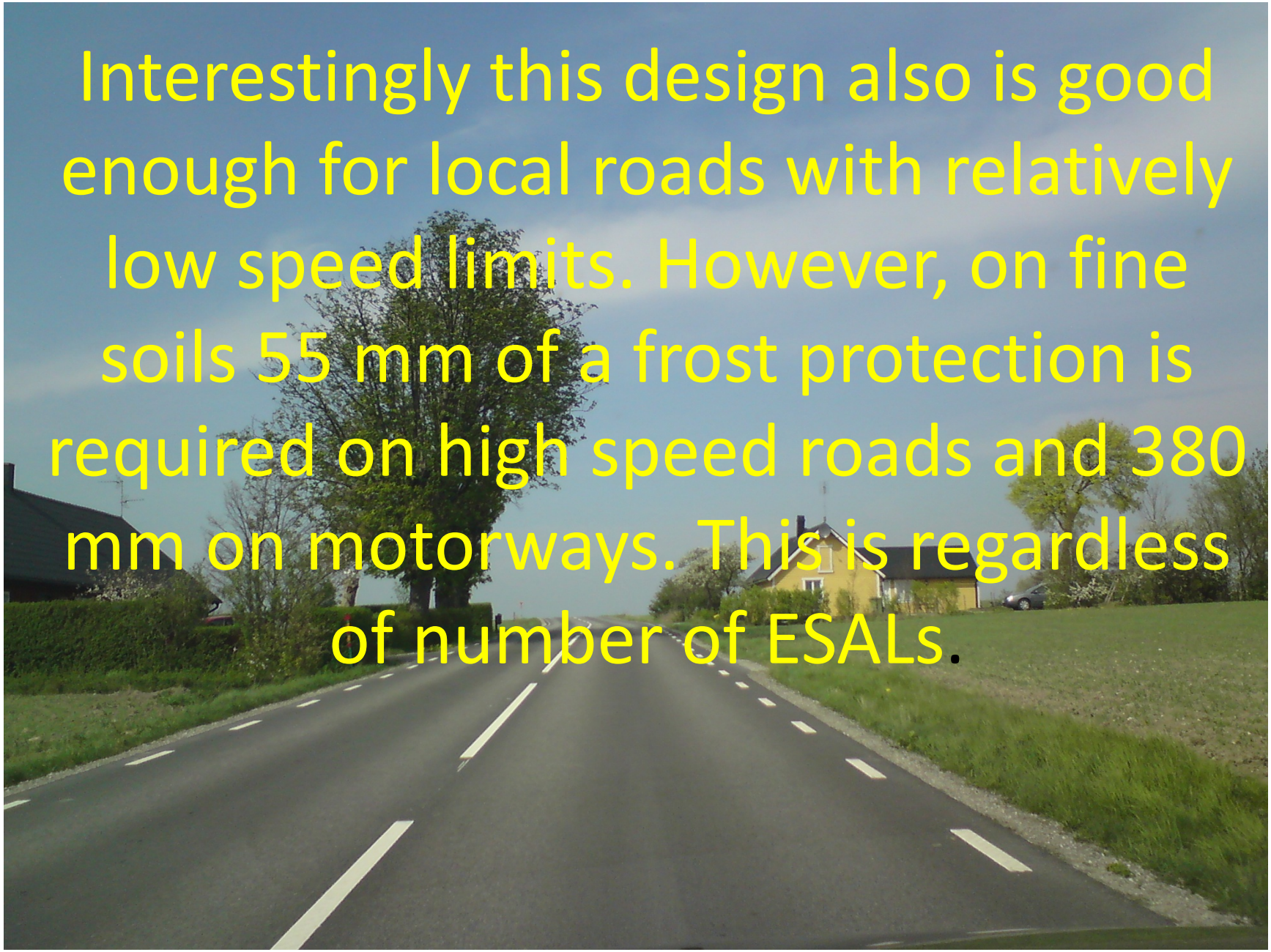
High Volume Examples
Layer Thickness [mm]

	Wearing course	Bound layers	Unbound base	Subbase	Frost protection
Zone 1 High volume High Soil support	40	170	80	420	
Zone 6 High volume Low Soil support	40	190	80	420	1750

Low Volume Examples

	Wearing course	Bound layers	Unbound base	Subbase	Frost protection
Zone 1 Low volume Low Soil support	45		80	420	380 (5) 55 (4) 0 (3)
Zone 6 Low volume Low Soil support	45	-	80	420	2355 (5) 1455 (4) 1005 (3) 605 (2) 355 (1)

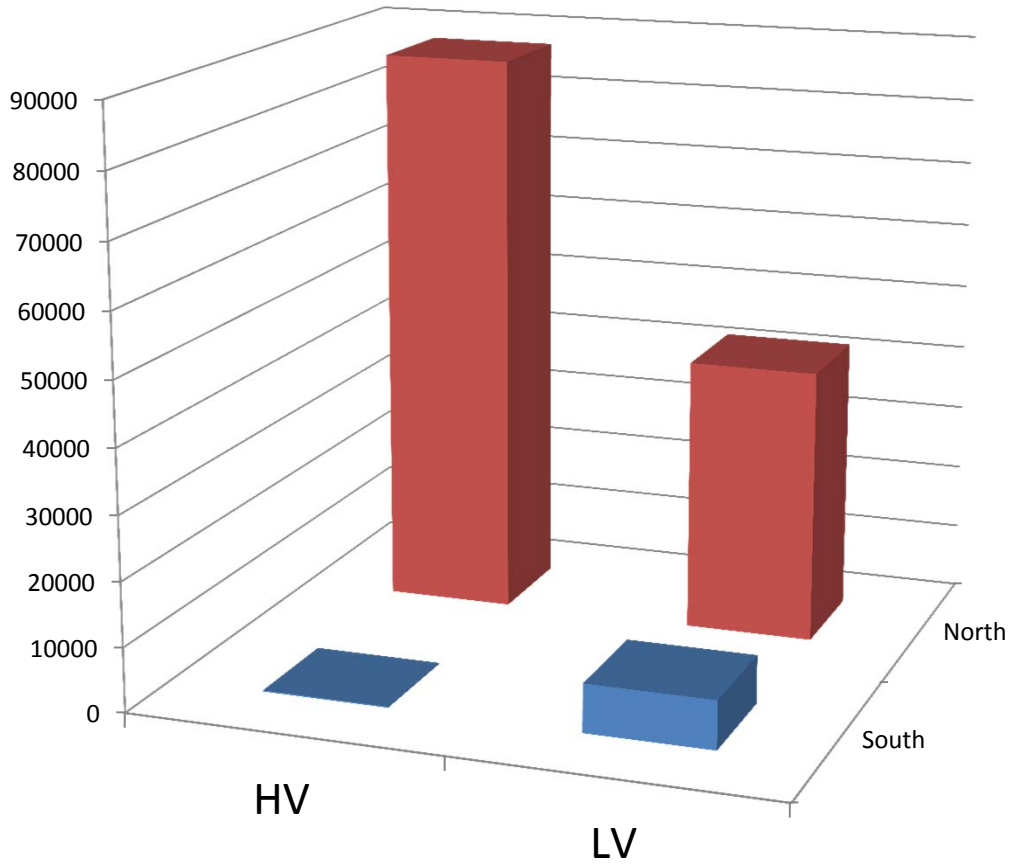
A high volume road in the south requires 210 mm of bound materials and 500 mm of unbound materials on soils providing a good support.

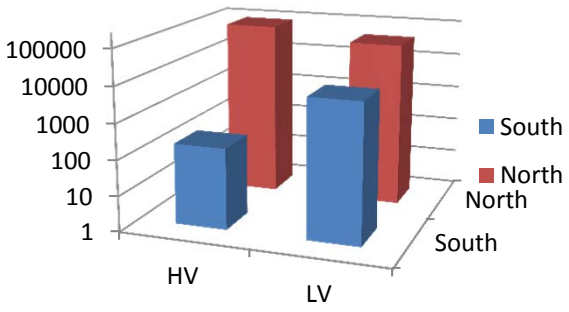

Interestingly this design also is good enough for local roads with relatively low speed limits. However, on fine soils 55 mm of a frost protection is required on high speed roads and 380 mm on motorways. This is regardless of number of ESALs.

Now, it is interesting to see what this means investment-wise. The 380 mm means 189 weight units per million axle loads.

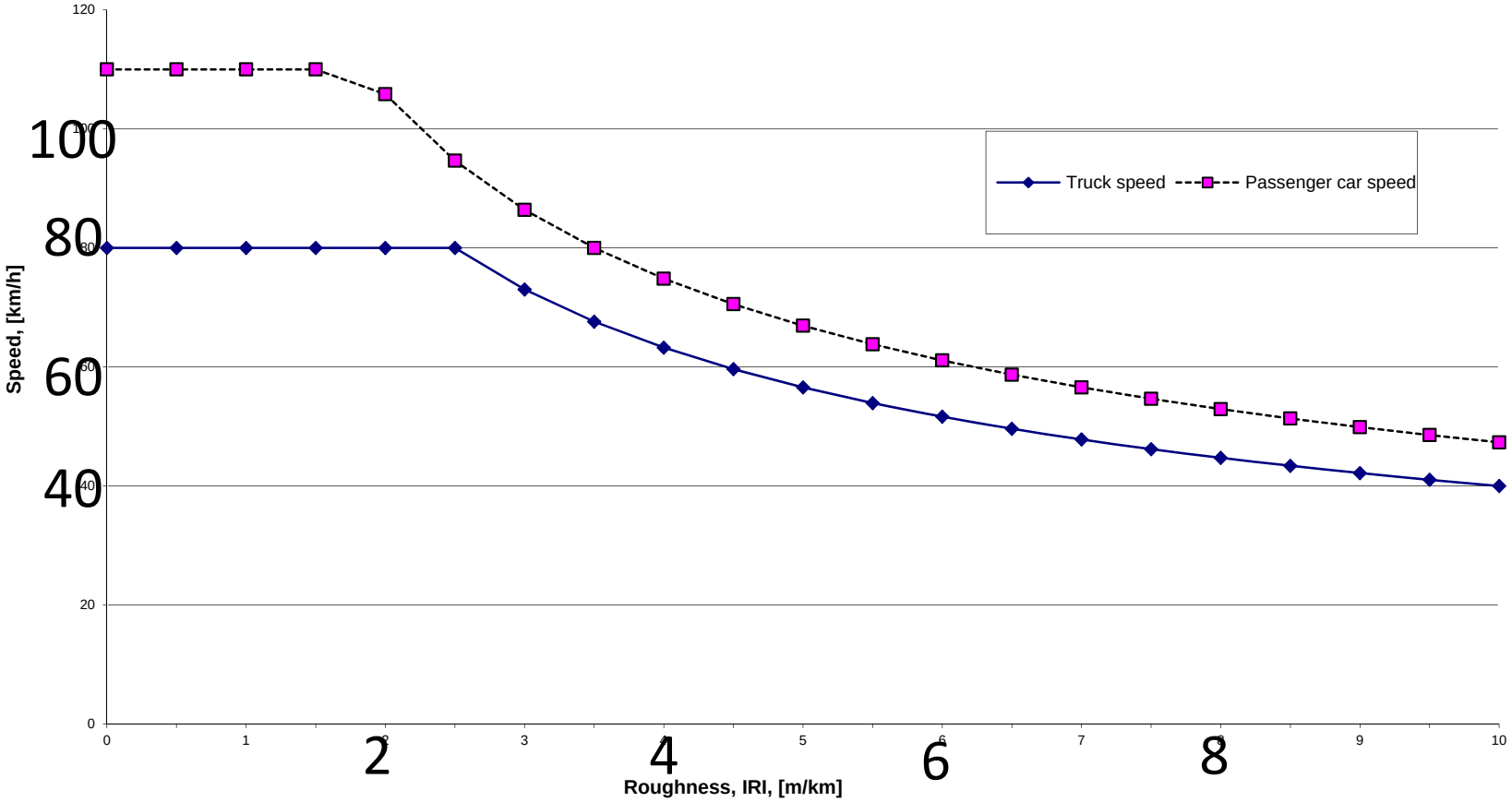
For a low-volume road with 500 000 ESALs the figure jumps to 7541 or forty times higher. A road in a cold climate would require 1455 mm or 42637. A motorway (if such would be built) a whopping 87700 tons per million axle loads.

Construction Effort Mass units per Million ESALs





Roughness vs Speed



Is it Worth it?


Här slutar
allmän väg