Seminar on Pavement Design Systems and Pavement Performance models

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Flexible Pavement Design, Practise in Finland

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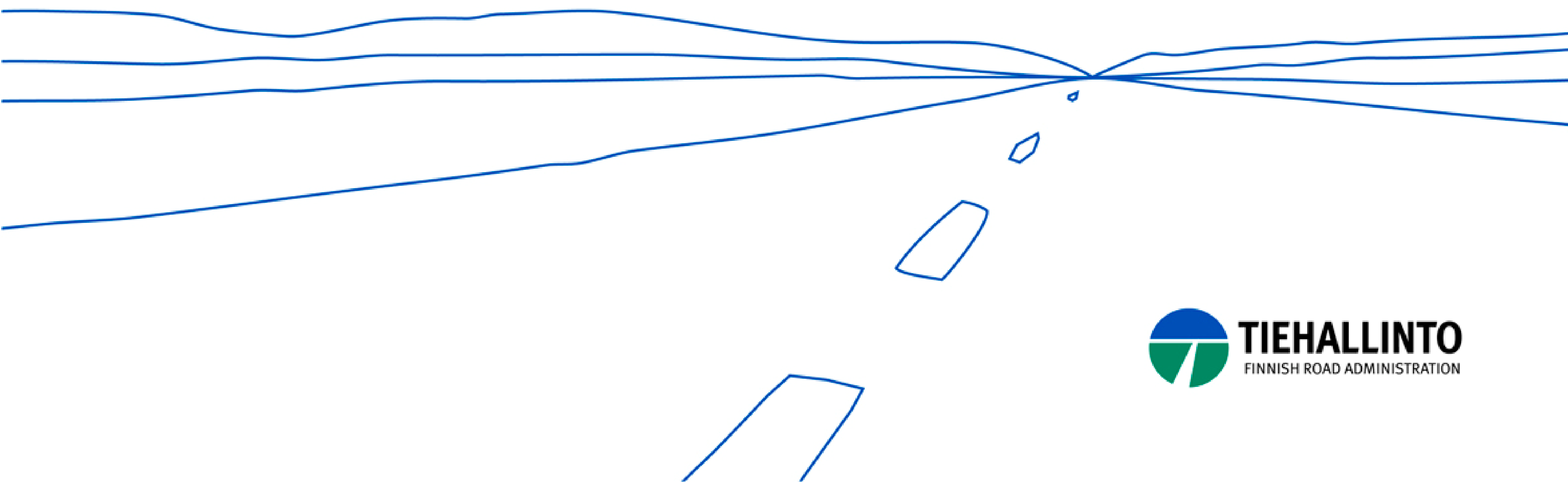
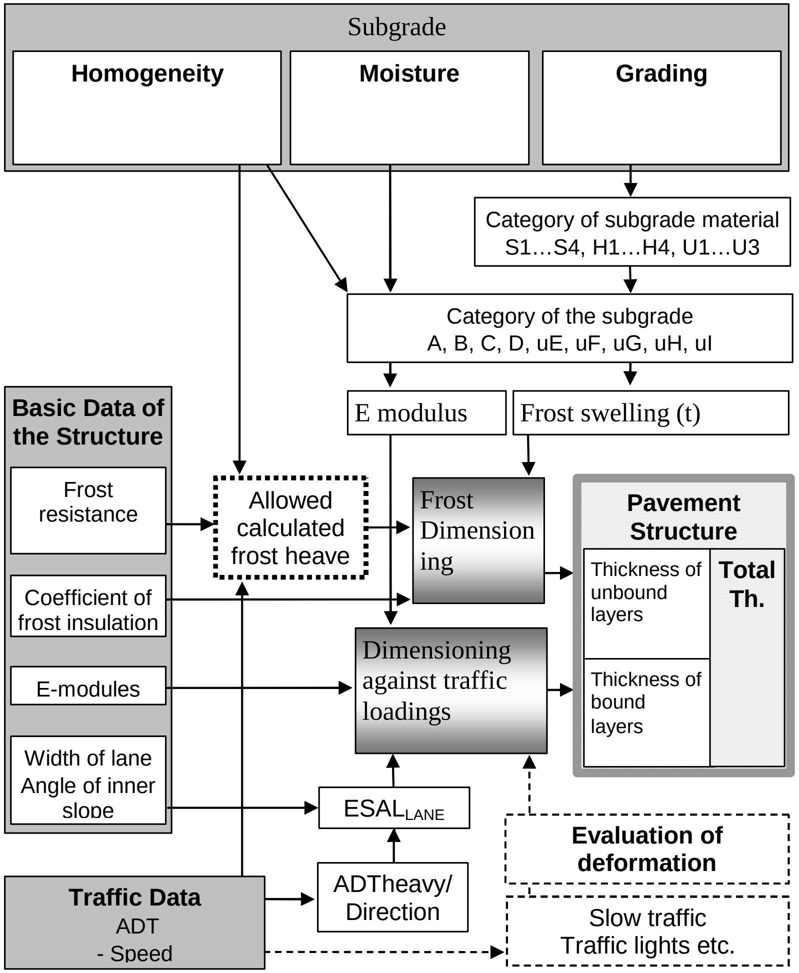


TIEHALLINTO
FINNISH ROAD ADMINISTRATION

Main features of pavement design in Finland



Parts of the Task in Pavement Design

1) Design against fatigue because of traffic loadings
2) Design against frost damages based on the control of calculated frost heave
3) Control of the deformation of subgrade and unbound structural courses
4) Control of the deformation of the bound courses
5) Control of the rutting of the wearing course because of the use of studded tyres
6) Control of the frost cracks

Finnish special features to take account in Pavement design

- frost heave because of cold climate, mostly frost susceptible and inhomogenous subgrades
- frost cracks
- salt water because of antiskid treatments
- softening of subgrade during spring time
- use of thick frost resistant aggregate layers
- use of steel wire nets for repairing frost damages
- use of studded tires
- road strengthening by stabilizing old asphalt and part of unbound base course under it

Dimensioning of the fatigue resistance

The target bearing capacity method

- requirements are the calculated target bearing capacity on the surface and the thickness of asphalt courses based on the number of equivalent 100 kN axels during 20 years
- possible building in stages

analytical pavement design (for example by APAS 3 program)

- based on allowed horizontal tensile strains at the bottom of bound layers and vertical compressive strains on the top surfaces of unbound bearing courses and subgrade

Calculation of ESALs

Based on axle load measurements (1998-1999) and from them analyzed average ESAL-values for type vehicles. formula:

$ESAL_{LANE}$ = L*(2,9*COMB + 0,8*OTHER)*7300 (Formula 1), where

L = Coefficient which depends on the width of (lane + shoulder) according to the table 1.

COMB = Average daily number of truck combinations per lane

OTHER = Average daily number of other trucks per lane

$ESAL_{LANE}$ = 0,2*L*$ADT_{direction}$*7300 (main roads etc.)

$ESAL_{LANE}$ = L*2,2*$Heavy\_vehicles_{direction}$*7300 (not in guideline)

The width coefficient L in ESAL calculations.

Width of lane +shoulder, m	The inner slope inclination	Coefficient L
2,5 - 3,49	1:2...1:2,5	2,8
2,5 - 3,49	1:3...1:4	2,0
3,5 - 5	1:3...1:4	1,4
over 5		1

Target bearing capacities and minimum thicknesses of asphalt concrete layers in final pavement structure depending of ESAL category (Millions of 100 kN standard axels during 20 years)

ESAL	< 0,1	0,1-0,4	0,4-0,8	0,8-2	2-6	6-10	10-25
Bear. cap. MPa	170	170	230	265	360	420	475
Min th. mm	40	40	80	90	140	170	200

Calculating of Bearing capacity with Odemark formula

Bearing capacity is calculated one layer at a time starting from the bearing capacity of the subgrade until the bearing capacity on the surface course.

The bearing capacity and the frost swelling value of the subgrade depend on its grading and moisture conditions. They are presented in the table 3 of the delivered paper.

Some typical E modulus values for used materials are: asphalt concrete 2500 MPa, soft asphalt 1400 MPa, bitumen stabilization 1050 MPa, crushed rock for base course 280 MPa, gravel for subbase 200 MPa and sand for the frost protection layer 70 MPa.

Frost dimensioning

Dimensioning is made determining the total thickness of frost resistant structural courses so that calculated frost heave caused by frost-susceptile subgrade is less than allowed value

In the delivered paper are presented

- Allowed frost heave values
- Dimensioning frost depth (1400…2200 mm, south - north),
- Frost heave calculation
- Frost swelling properties of different subgrades
- Equivalence coefficient regarding frost insulation

Some problems with pavement design in Finland. (1) Bearing capacity method

- With bearing capacity method it is more difficult to take account different fatigue and deformation properties of road materials or subgrade. It works with conventionals structures but with some new solutions you can get early damages although bearing capacity is enough.
- Method does not require special program, but calculations can easily done in excel. Then also keeping up the method is easier if needed

Some problems with Pavement design in Finland. 2. Analytical Methods (APAS 3)

- Analytical methods are not yet trusted and they should be validated and developed further (resources?).
- APAS 3 does not include design of road improvements. It should be added so that use of the program could become more common
- Pavement performance models are based on quite inaccurate measurements and their multiple correlation squared isn't good enough. Better methods for measurements and to get data about affecting factors are developed and they should be used and analyzed
- APAS 3 does not include effective methods to take account that properties of materials are changing for example seasonally, when aging and from place to place

Some problems with Pavement design in Finland. 2. Analytical Methods (APAS 3) to be continued

- APAS 3 does not include the possibility to limit both compressive strain on the top of bearing course and tensile strain at the bottom of it. For example some stabilized materials get there strength so slowly that immediately there surface can deform but after some years they are so rigid that fatigue is possible if bottom is weak. The top or bottom of unbound layer is critical depending how hard or soft layer is under it