

Young Researchers Seminar 2009

Torino, Italy, 3 to 5 June 2009

Structural Evaluation of Flexible Pavements Using Non Destructive Tests

Simona Fontul

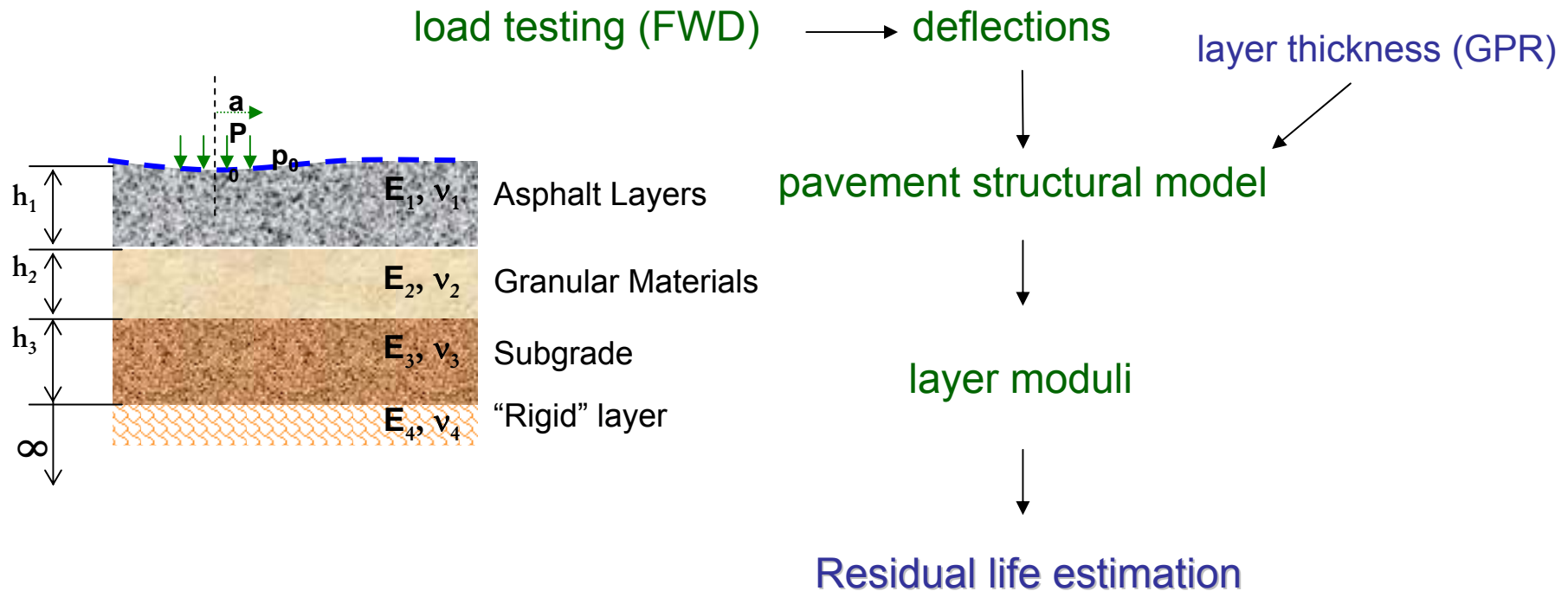


Outline of the paper

1. Introduction
2. Improved Method for Pavement Evaluation
 - 2.1. Non Destructive Tests
 - 2.2. Interpretation of Results
 - 2.3. Artificial Neural Networks
3. Case Study
 - 3.1. General Presentation
 - 3.2. Data Analysis
4. Final Remarks

Introduction

Pavement structural design process



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Improved Method for Pavement Evaluation

Non Destructive Tests (NDT)



Falling Weight Deflectometer (FWD)



Structural Evaluation of Pavements using NDT

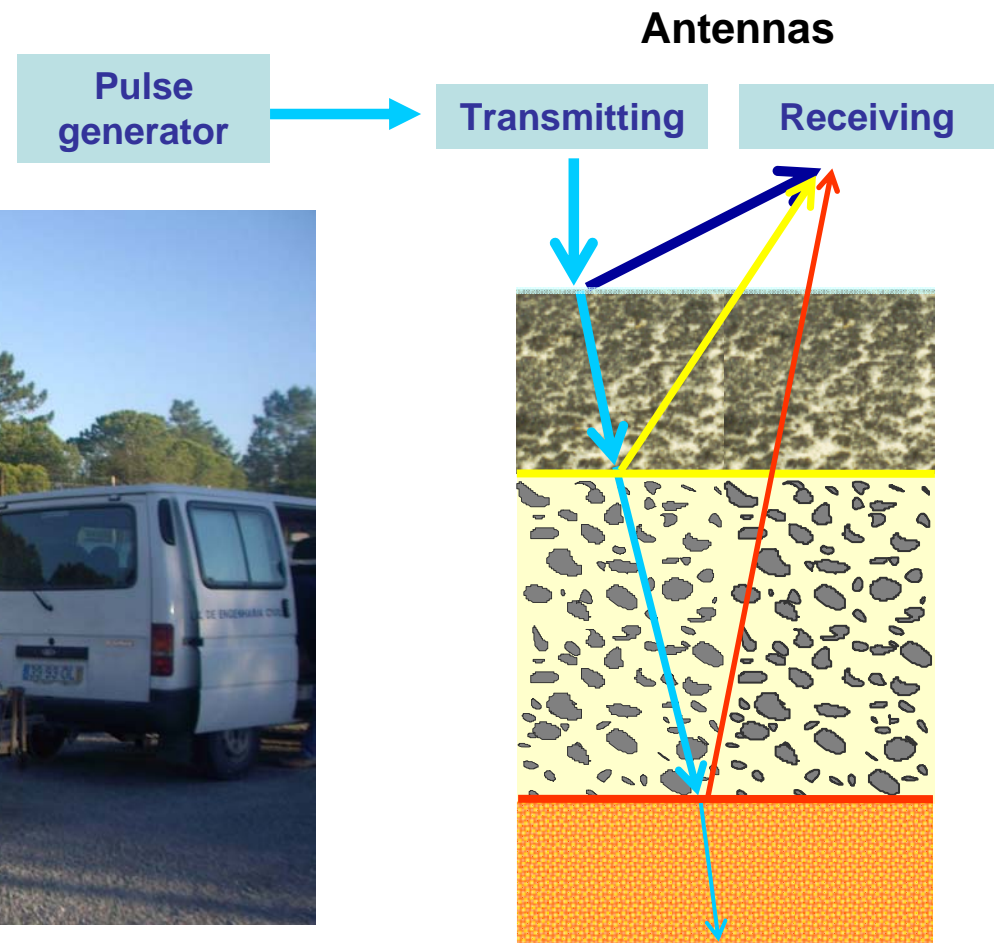
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Improved Method for Pavement Evaluation

Non Destructive Tests (NDT)

Ground Penetrating Radar (GPR)



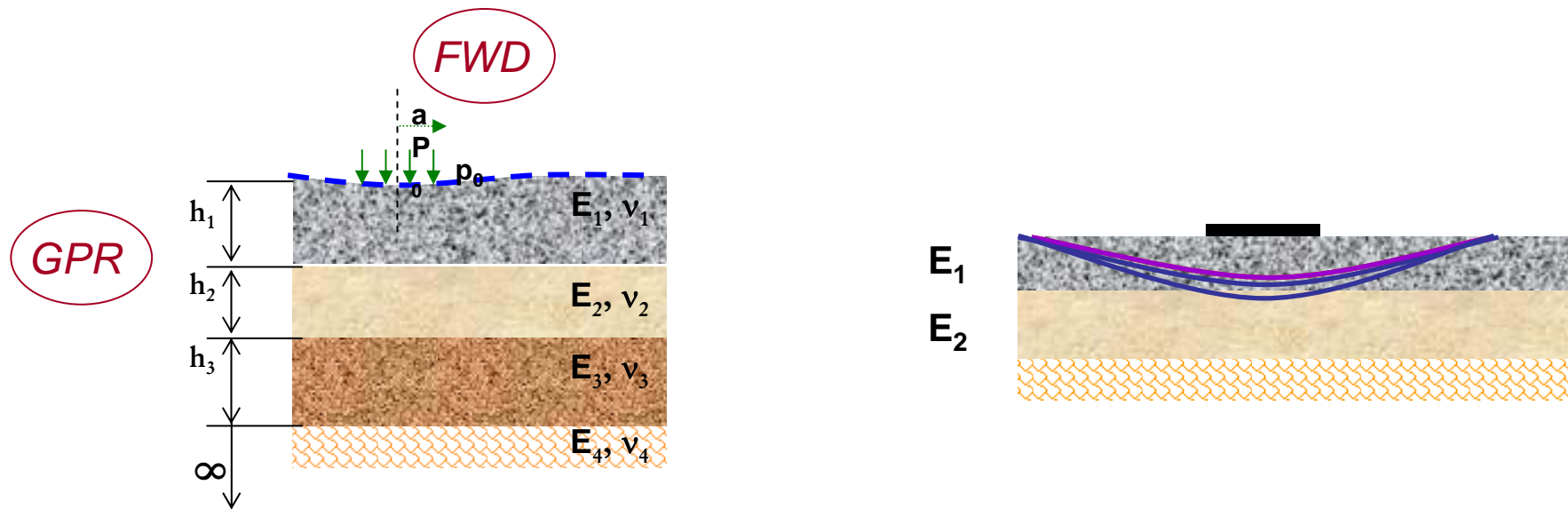
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Improved Method for Pavement Evaluation

Interpretation of results

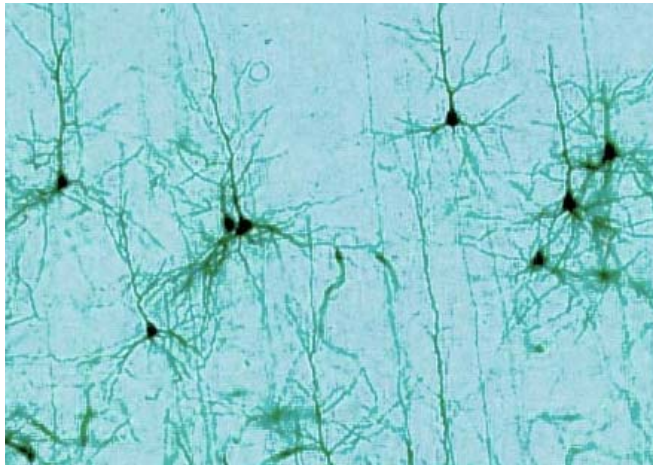


pavement structural model

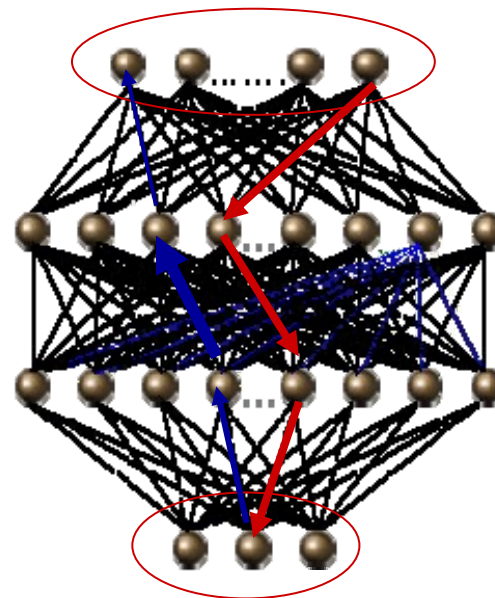
Improved Method for Pavement Evaluation

Artificial Neural Networks (ANN)

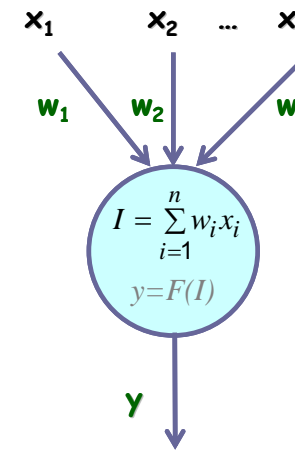
General presentation



biological neurons



ANN structure



artificial neuron

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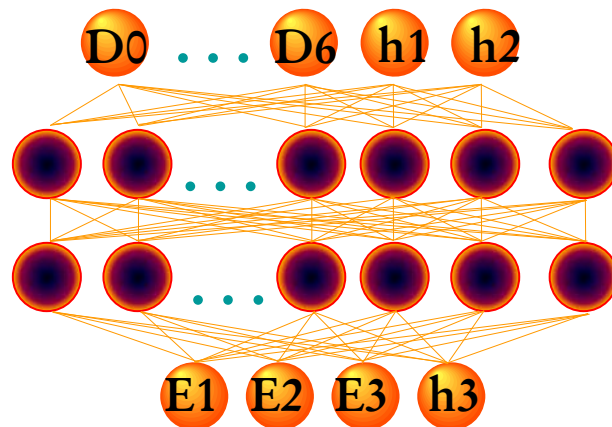
Improved Method for Pavement Evaluation

Artificial Neural Networks (ANN)

Inputs

Deflections: D_0 to D_6 (FWD)

Layer thickness: h_1, h_2 (GPR)

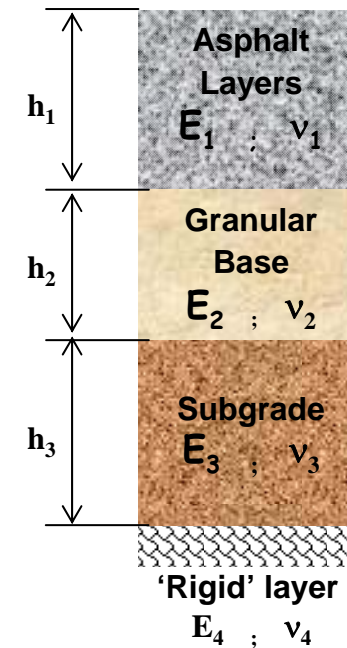


Outputs

Layer Elastic Modulus: E_1, E_2 and E_3

Layer thickness: h_3

Application of ANN for Interpretation of NDT Results



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Case Study

General Presentation

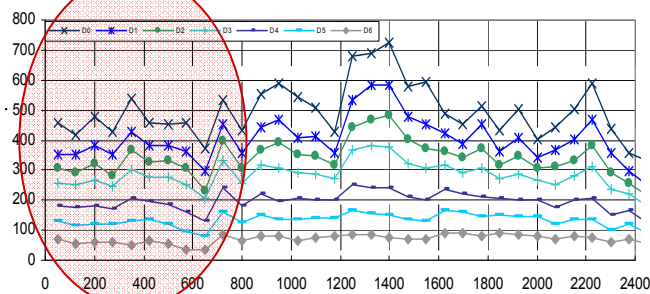
Airport pavement bearing capacity evaluation

- built in 1965, then extended and reinforced in 1980 and 1990
- 2400 m long
- 45 m wide

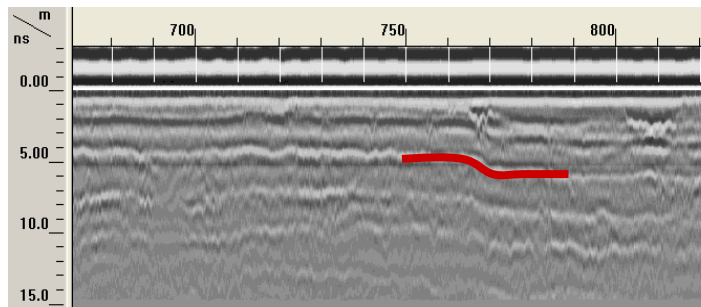
Pavement structure



Tests performed



FWD



GPR



Cores

Structural Evaluation of Pavements using NDT

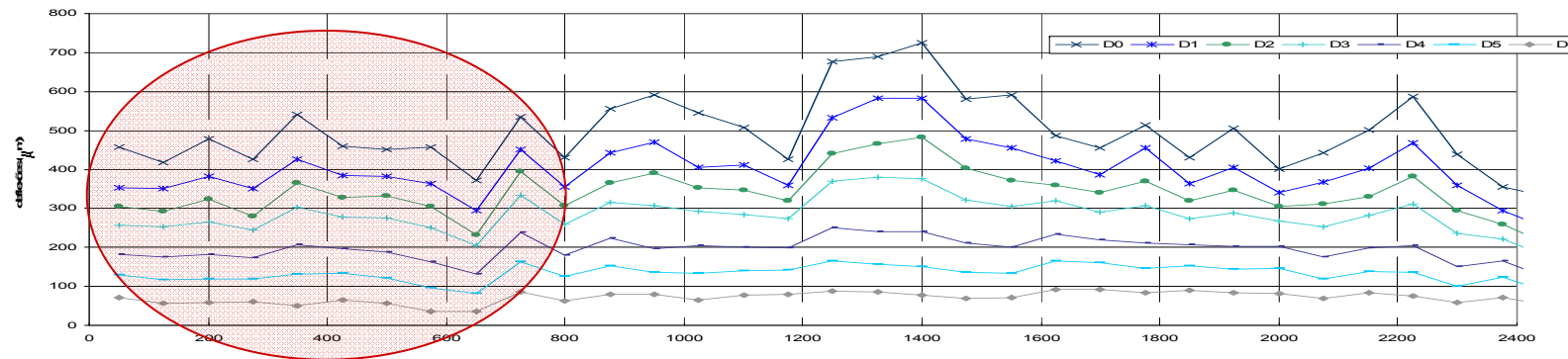
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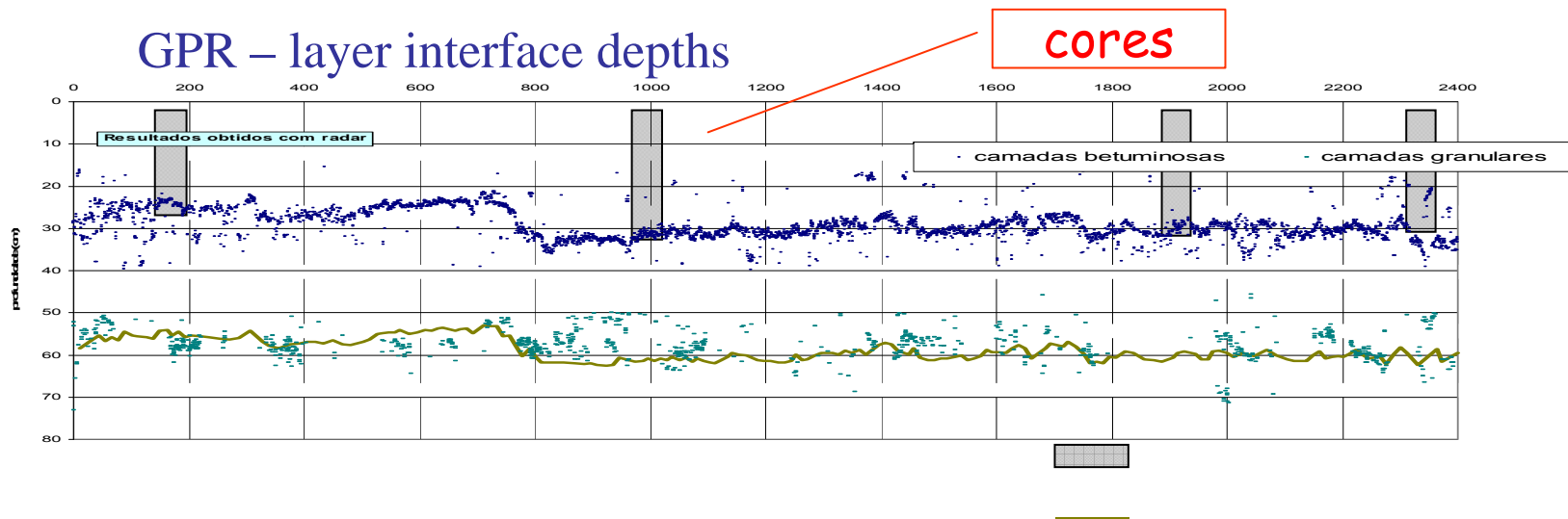
Case Study

General Presentation

FWD - deflections



GPR - layer interface depths



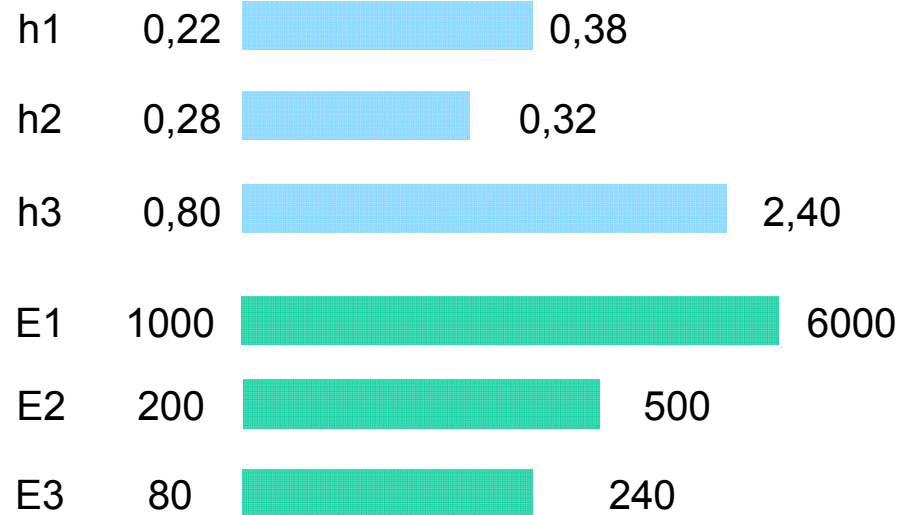
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Case Study

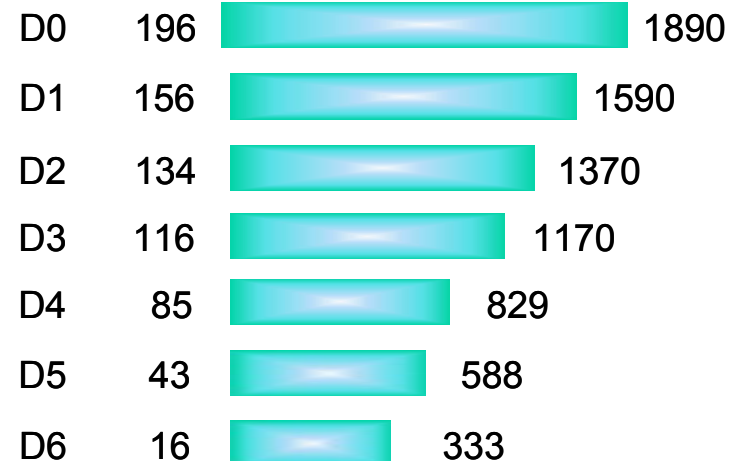
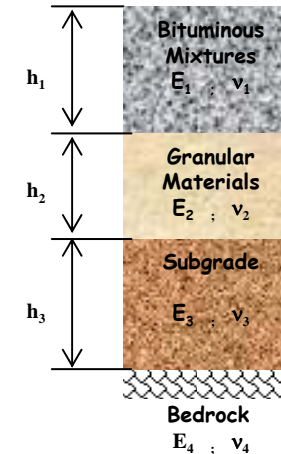
Data Analysis



Elastic layer model



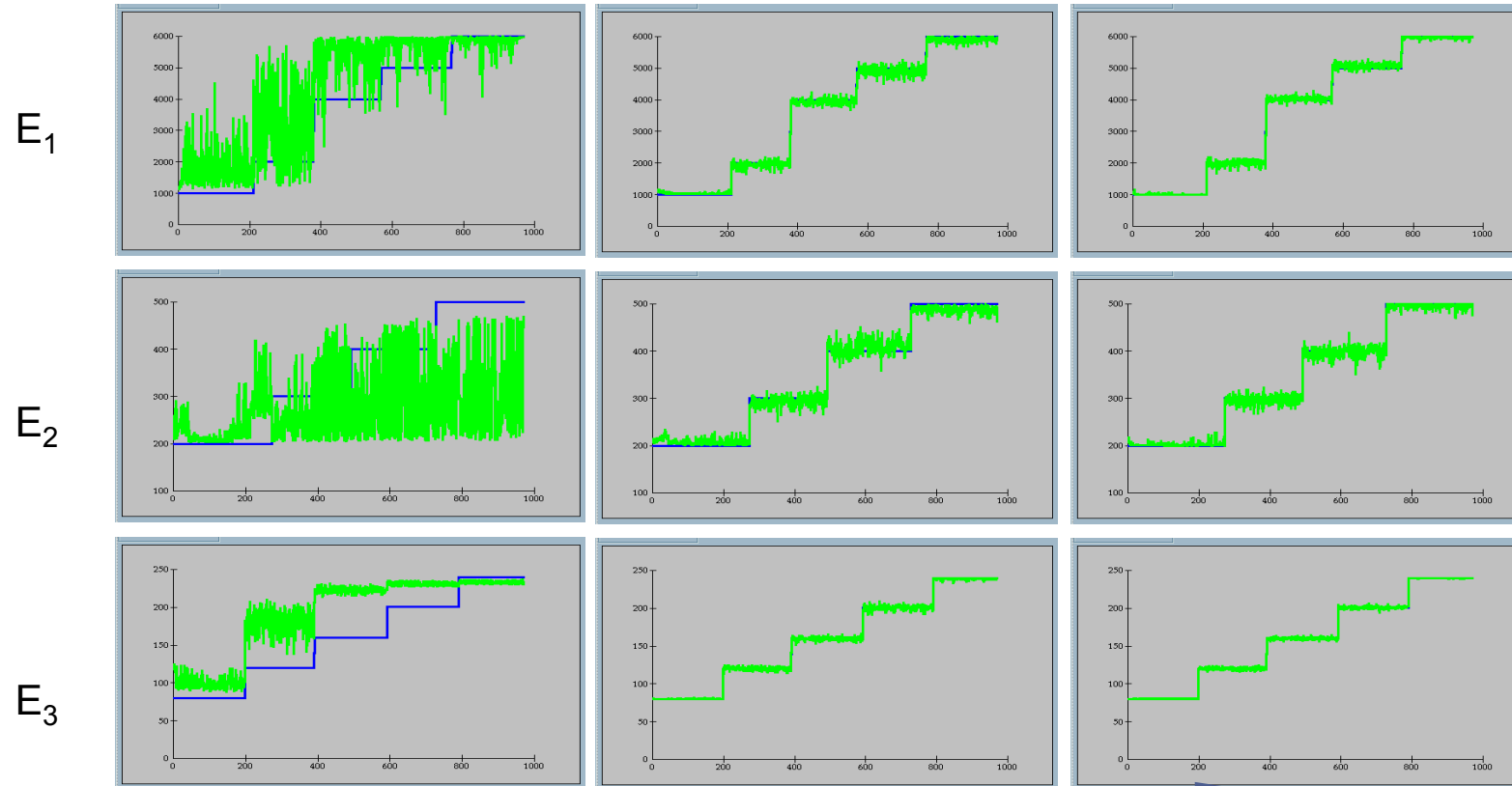
ANN training



Case Study

Data Analysis

ANN training



Structural Evaluation of Pavements using NDT

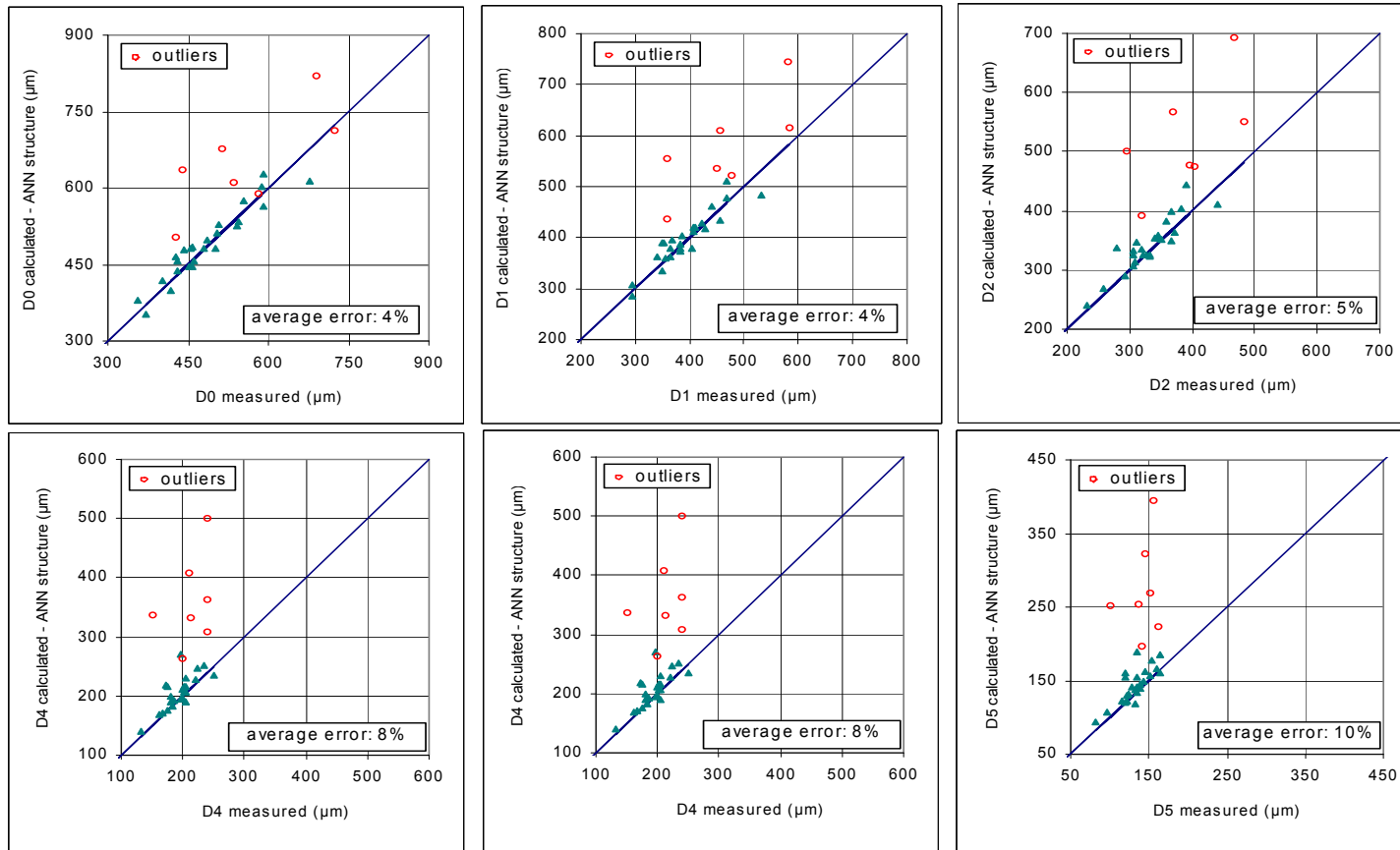
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Case Study

Data Analysis

ANN training



Structural Evaluation of Pavements using NDT

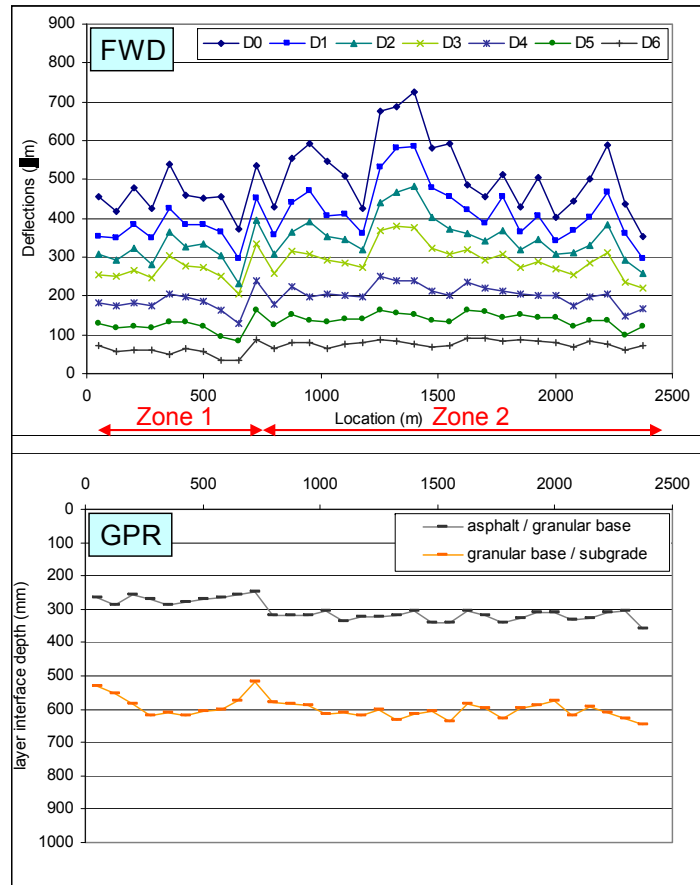
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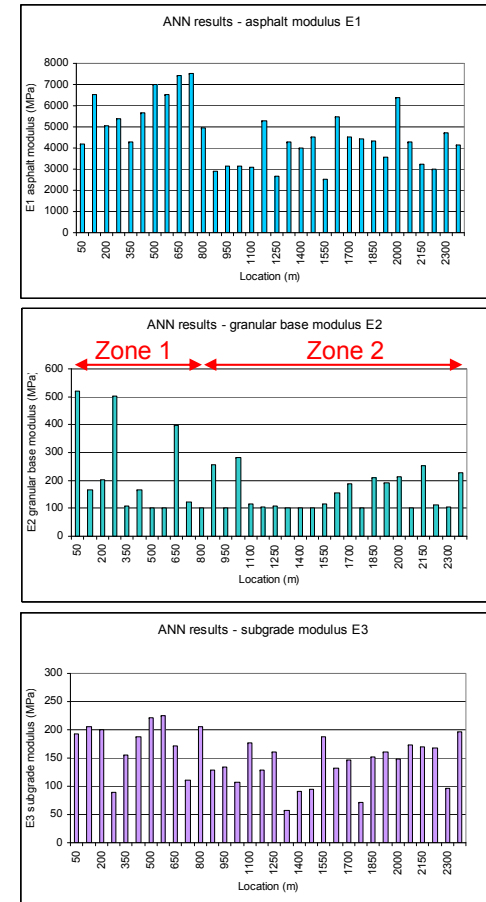
Case Study

Data Analysis

Inputs



Outputs



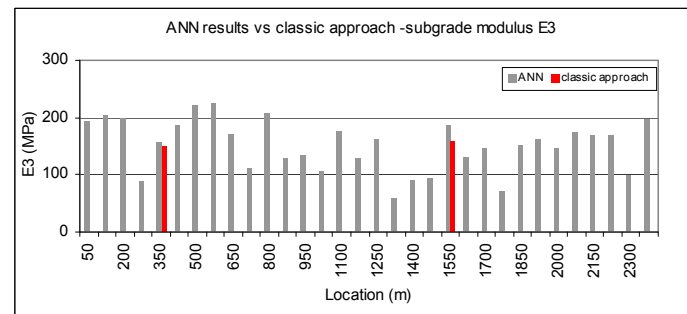
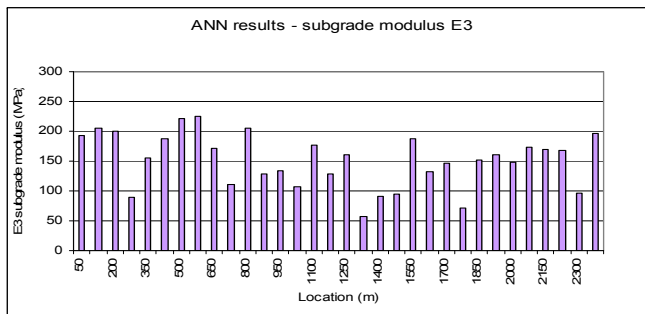
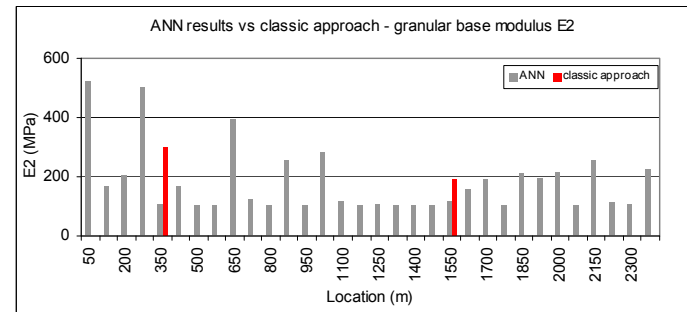
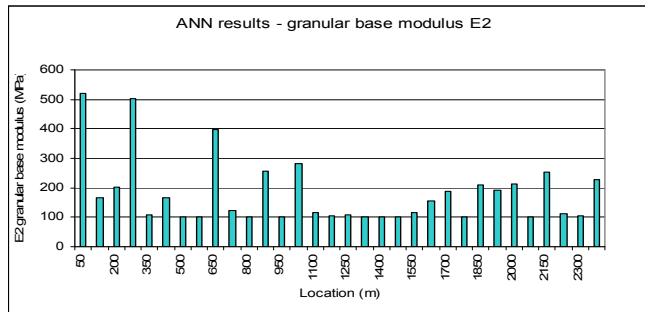
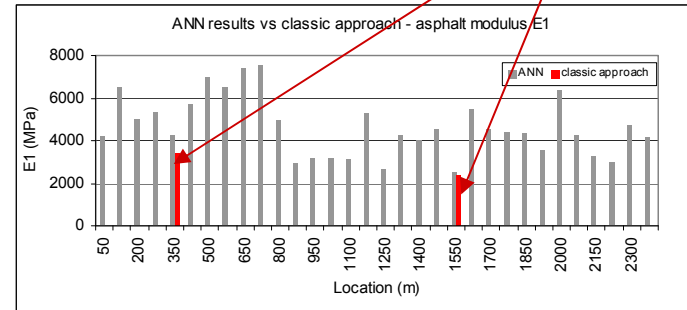
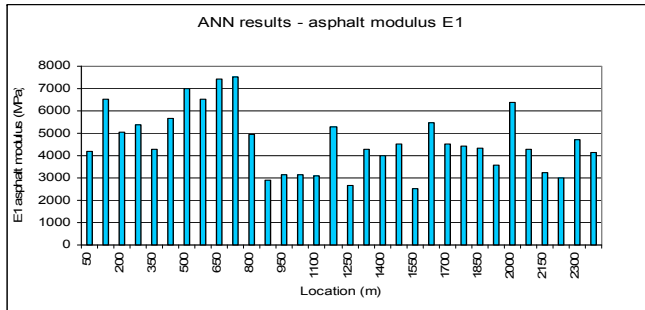
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Case Study

Data Analysis



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Final Remarks

- GPR provides continuous information on layer thickness, for the bound and also the unbound layers. Consequently all the FWD test points can be used for backcalculation.
- The results obtained using ANN are realistic and similar to the one obtained through classic approach.
- It is possible to reduce the computation time and to include some engineering judgment in the process by limiting the range of pavement structure parameters used in the training process.

Future developments

- Use ANN for pavement residual life estimation directly from deflections.
- Application to other type of pavements (rigid or composite).
- Use of more sophisticated pavement models (visco-elastic, non-linear response).



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