



**HAL**  
open science

# ML-based Model for the Estimation of Pavement Elastic Modulus from Deflection Velocity Measurement

Abdelgader Abdelmuhsen, Jean-Michel Simonin, Franziska Schmidt, Amine Ihamouten

► **To cite this version:**

Abdelgader Abdelmuhsen, Jean-Michel Simonin, Franziska Schmidt, Amine Ihamouten. ML-based Model for the Estimation of Pavement Elastic Modulus from Deflection Velocity Measurement. Transport Research Arena (TRA) 2024, Apr 2024, Dublin, Ireland. , 2024, Lecture Notes in Mobility. hal-04733418

**HAL Id: hal-04733418**

**<https://univ-eiffel.hal.science/hal-04733418v1>**

Submitted on 12 Oct 2024

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

# ML-based Model for the Estimation of Pavement Elastic Modulus from Deflection Velocity Measurement \*

A. ABDELMUHMEN<sup>1</sup>, J-M. SIMONIN<sup>1</sup>, F. SCHMIDT<sup>2</sup>,  
A. IHAMOUTEN<sup>1</sup>

<sup>1</sup>MAST-LAMES, <sup>2</sup>MAST-EMGCU - Université Gustave Eiffel



## 1 Challenges: EU's Road infrastructure

Deteriorating roads, limited budgets, insufficient data for maintenance planning & investment strategies



- 2022, France spent + 300 B € on road transport
- Efficient road infrastructure management needs automated assessments and reliable indicators

## 2 TSDDs: Network-level of PMS

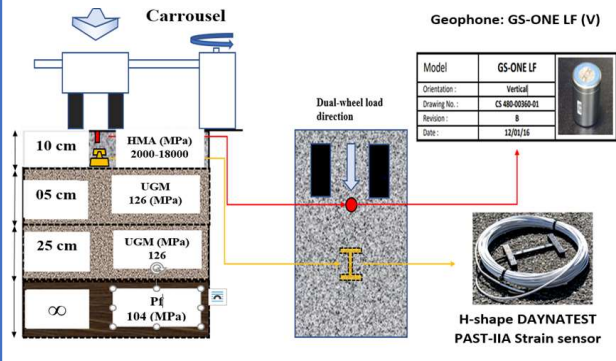
TSD overcomes FWD limitations, but current measurement interpretations prove impractical

- Continuous bearing capacity Assessment
- Measurement at traffic speed (80 km/h)
- Secure with no traffic disruption
- Cost-effective for projects and networks

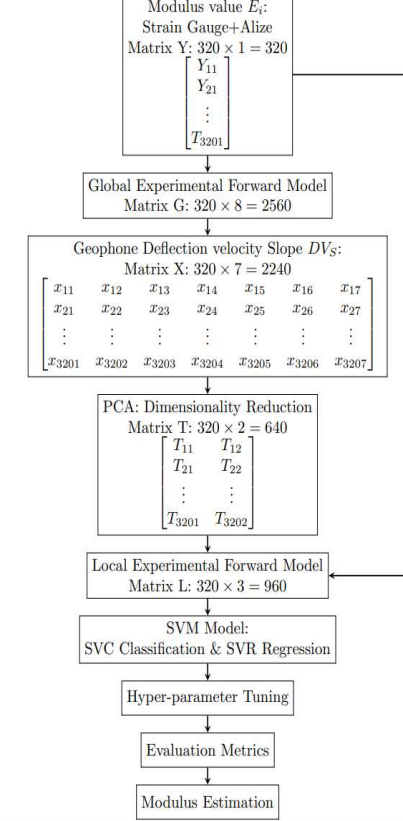


## 3 Objective: ML + TSD = E<sub>i</sub>

Development and Implementation of (ML + TSD) model to estimate pavement elastic modulus from deflection velocity measurement

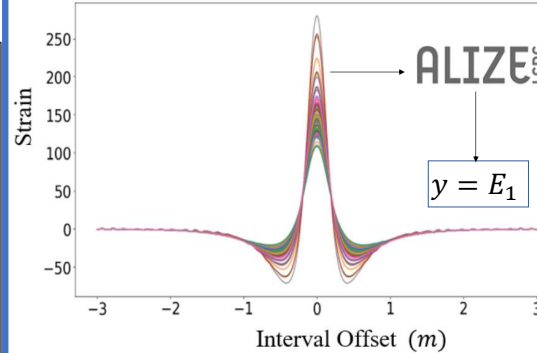


## 4 Methodology: Forward to inverse Model

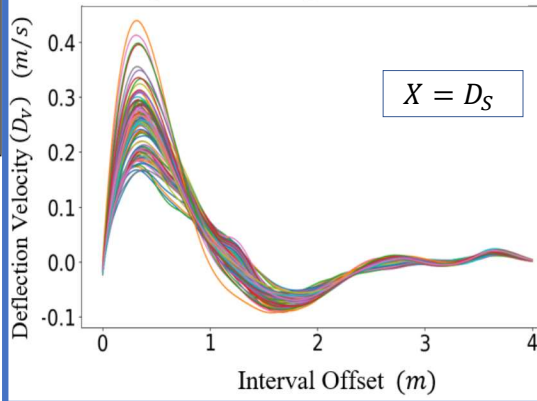


## 5 Forward Model construction Experimental Database

a. Experimental Strain Gauge Measurement

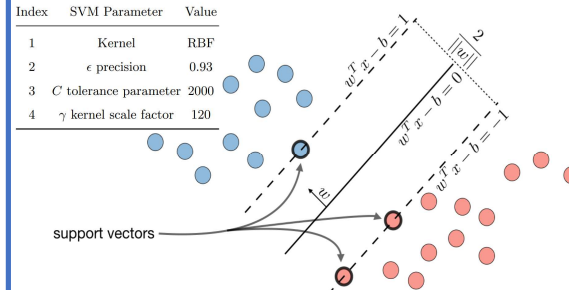


b. Experimental Geophone Measurement

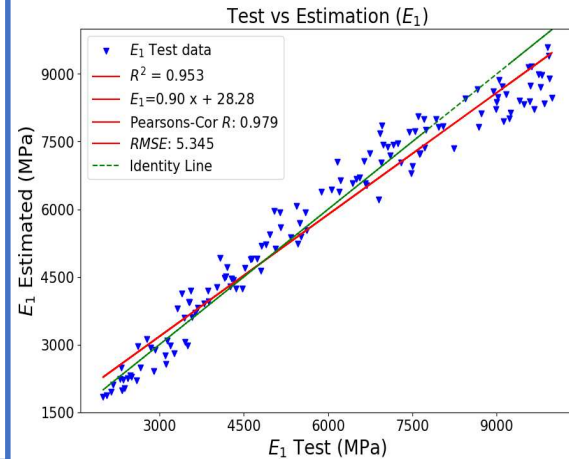


## 6 ML Model: SVM

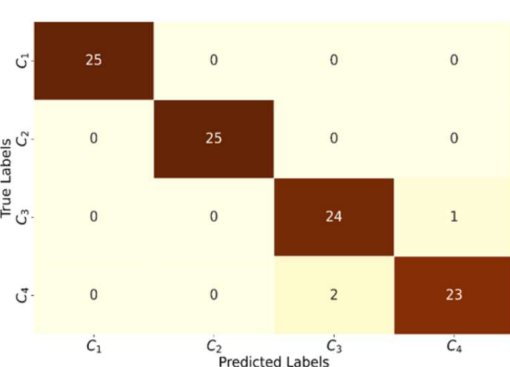
Unlike conventional methods, ML models provide superior accuracy, computational efficiency, and generalization



## 7 Regression Analysis



## 8 Classification Analysis



## 9 Evaluation Metrics

Accuracy = 97.00%

$\hat{C}_1$	0.991	0.994	0.992	0.989	25.000
$\hat{C}_2$	0.962	0.983	0.970	0.968	
$\hat{C}_3$	0.945	0.963	0.951	0.938	
$\hat{C}_4$	0.930	0.922	0.927	0.929	
	Precision	Recall	F-score	Dice score	Support

## 10 Conclusion & Perspectives

- This research among the studies that have been developed to showcase AI/ML Efficiency in estimating pavement structural conditions using deflection velocity data (TSD)
- Sensitivity analysis has accounted for factors such as measurement noise, temperature, data-size, other layers (E) value uncertainty...
- For generalizability, future research should incorporate Raptor measurement data from France territory as the model could be applicable it

\*A. ABDELMUHMEN, J-M. SIMONIN, F. SCHMIDT, D. LIÈVRE, A. COTHENET, A. IHAMOUTEN, On the variants of SVM method for the estimation of soil elastic modulus from TSD model: Numerical parametric study, Transportation Engineering, Volume 13, 2023, 100187, ISSN 2666-691X, <https://doi.org/10.1016/j.treng.2023.100187>.

