Fast Screening of Jointed Concrete Pavements for Weak Joint Detection with a Traffic Speed Deflectometer

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Motivation:

Detect and flag weak transverse joints and cracks on jointed concrete pavements at corridor- or network-level (1)

Why?

Locate and allocate repairs for structural weakness before distress sets on!

TSDs for JPCP surveying:

•TSDs are suitable for testing concrete pavements (1, 2, 3)

•In most jointed pavements, joints can be "seen" as pulses in 1-m resolution data (2, 4)

·Newest TSDs can report v_y data at 2-inch [5-cm] resolution

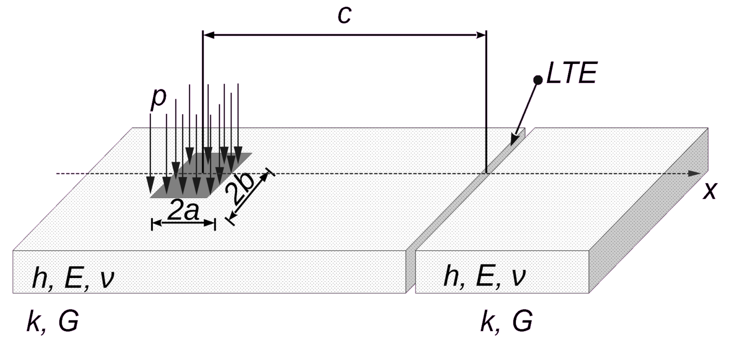
·On JPCPs, TSD can record the joint's response to rolling load!

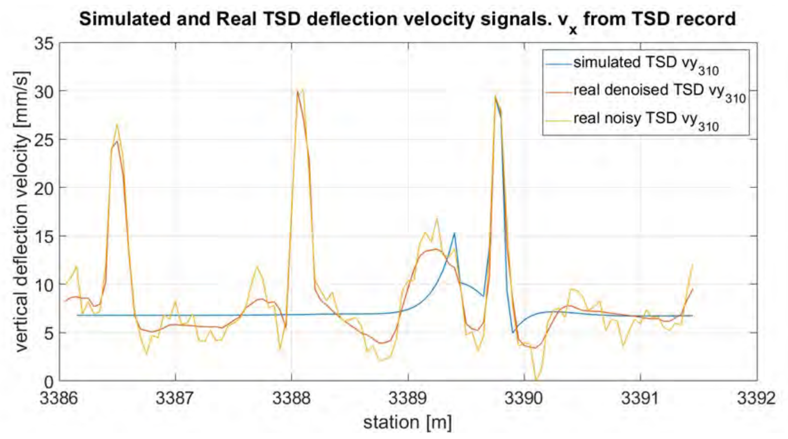
Current state of the art:

•Deflection basin slope cannot be estimated from TSD v_y when near a joint (4)

•Linear elastic slab-on-ground model can simulate TSD load on JPCP (4,5,6)

•We can back-calculate LTE of JPCP joints from TSD v_y (4,6)

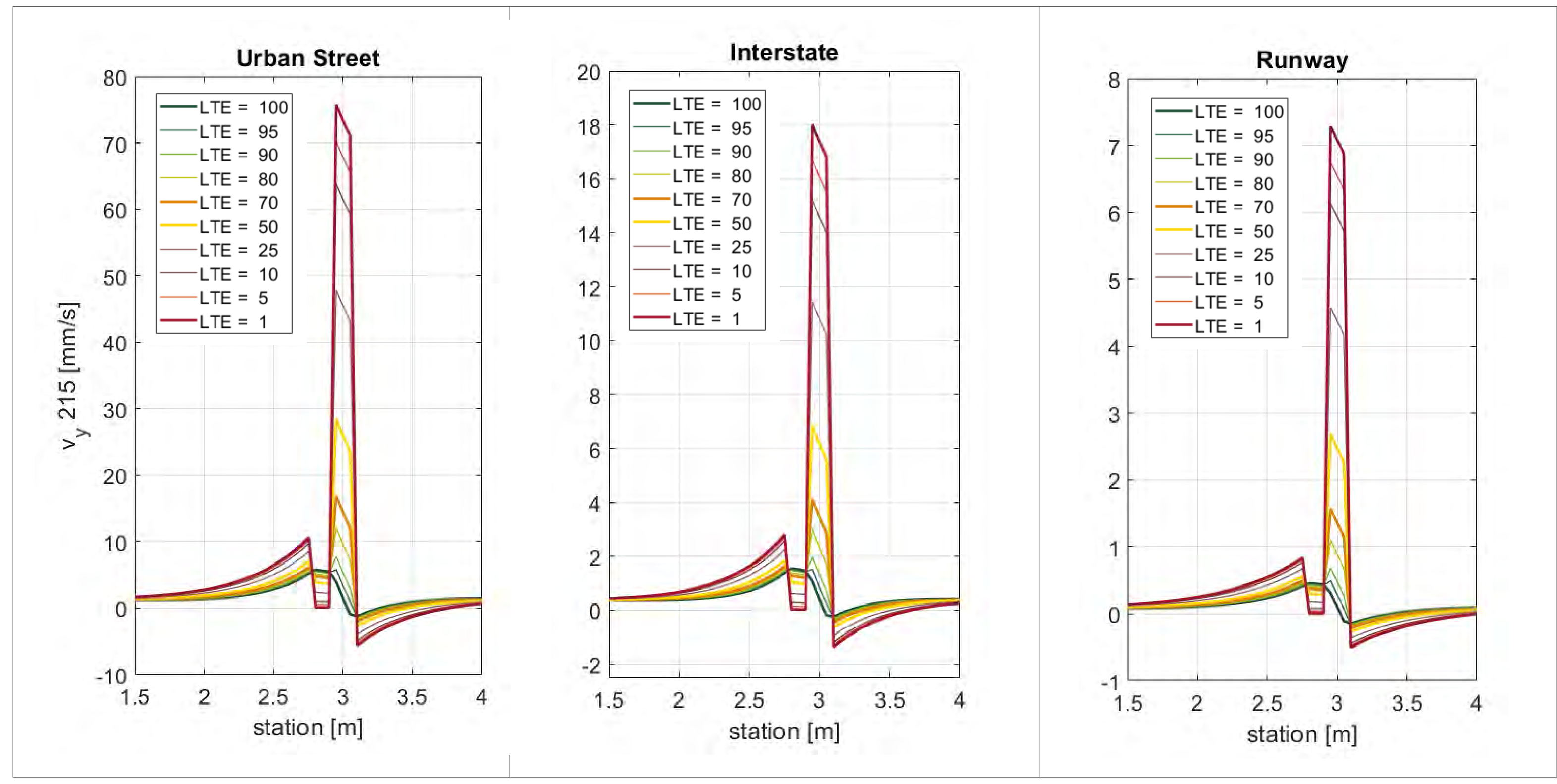




**But back-calculation is
DEMANDING AND VERY TIME CONSUMING!
Is there a faster way to get LTE?**

ABM_x: A TSD-based metric for LTE estimation:

•Simulated v_y signals from TSD sensors from different 'typical' JPCP pavements



Model Parameters:

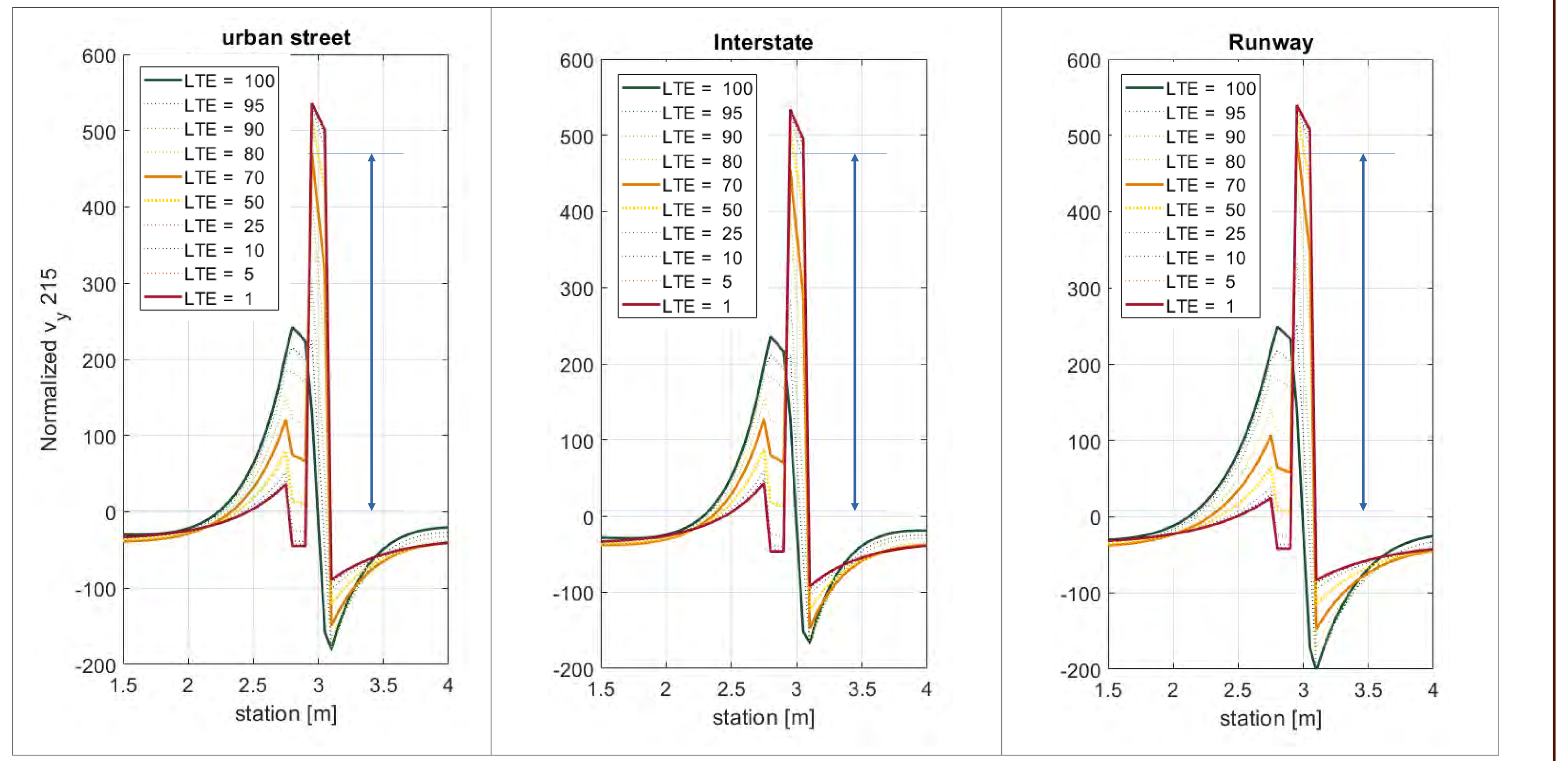
Urban street:
k-value= 40MPa/m, h=0.20m

Interstate Highway:
k-value = 200MPa/m, h=0.30m;

Runway:
k-value = 300MPa/m, h=0.50m;

All:
E = 30 GPa, G = 0 N/m;
ν = 0.17; v_x = 20 m/sec;
Load=49kN; pressure=700kPa;
load area dims. 0.50×0.14m²

Normalization



·All normalized v_ys reduce to a single set of *shapes* that vary with LTE, **regardless of the pavement and subgrade stiffness**

•New metric: The maximum normalized v_y data [ABM_x] can be related to LTE

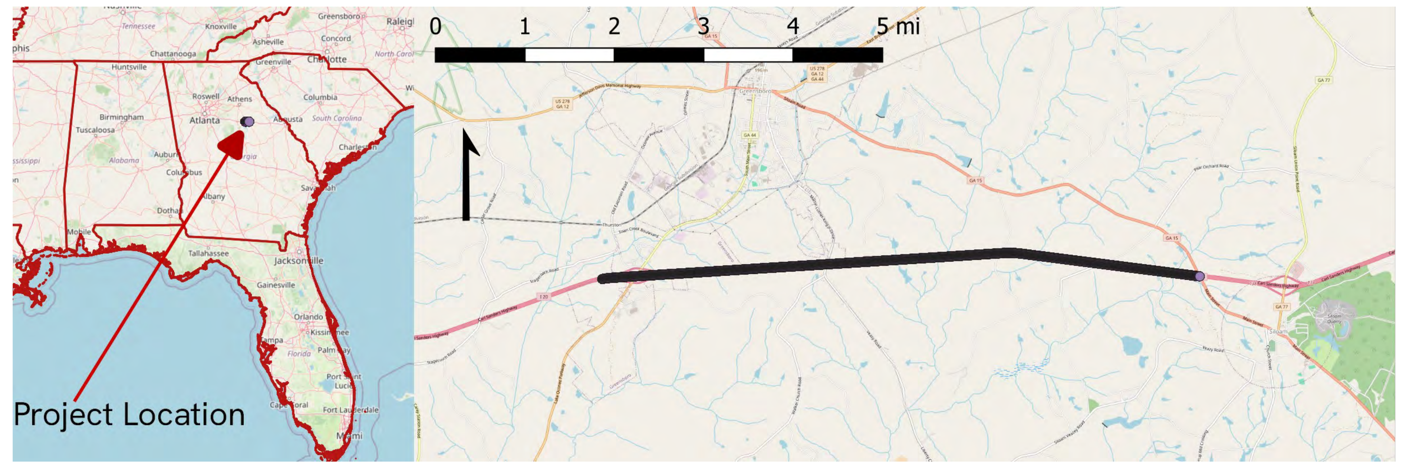
ABM_x -based joint classification

ABM Thresholds for different LTEs

TSD sensor[mm]	130	215	300	450	600	900
LTE = 100%	303	217	160	107	76	36
LTE = 70%	523	454	387	300	237	149
LTE = 1%	572	562	549	526	499	437

Good: $ABM_x < ABM_{100}$
Fair: $ABM_{100} < ABM_x < ABM_{70}$
Weak: $ABM_{70} < ABM_x < ABM_1$
Very Weak: $ABM_x > ABM_1$

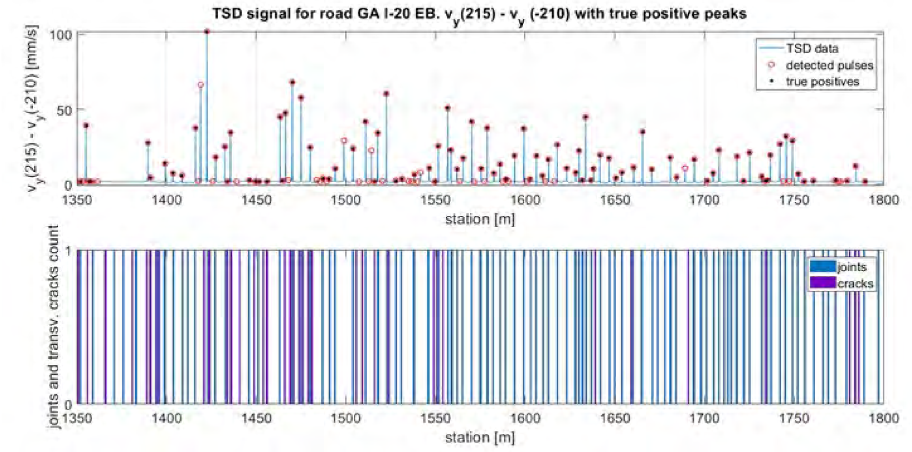
Application: I-20 Eastbound [Georgia]:



Length: 12km [7.5mi]
Surveyed with iPAVe
October 2022
TSD & ACD data available [joints/cracks]

•1133 pulses from TSD data
•3394 joints & cracks counted by ACD

rating	LTE	count	percentage
Strong (no v_y pulse)	100%	1010	55%
Good	100%	251	14%
Fair	70%-100%	320	17%
Weak	0%-70%	97	5%
Very weak / failed	0%	171	9%



Weak joints mapped!

Proc. Time: 90 sec!

Conclusion:

Procedure to detect and classify weak joints/cracks on JPCP corridors **FAST!**
Simple enough to implement in GIS or PMS apps – **no back-calculation needed!**

Future work:

Extend methodology to composite pavements
•Deflection model exists
•V_y pulses can't always be validated with ACD (transverse joints are overlaid!)

References: