



Use of WIM sensors and geophones to increase the accuracy of weighing systems

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Introduction



- The effectiveness and durability of WIM technology on pavement depend on the pavement structure.
- WIM technology enables the correlation of pavement stresses and strains, predicting the lifespan of road infrastructure when combined with pavement instrumentation

This paper presents the instrumentation design and results of the first test with known vehicles, providing a general analysis of instrument response to three vehicles tested under different conditions of speed, lateral positioning, and pavement temperature.

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Introduction

- Approaching the WIM sensor, the forces transmitted to the pavement vary according to dynamic acceleration at each instant t .
- The resulting vertical force $F(t)$ on the sensor is proportional to:
 - The equivalent static force (mass under the effect of constant gravity acceleration)

$$F_s = m \cdot g$$

- Combined with the dynamic force in a given instant (mass under the effect of the resulting dynamic acceleration at instant t):

$$F_d(t) = m \cdot a(t)$$

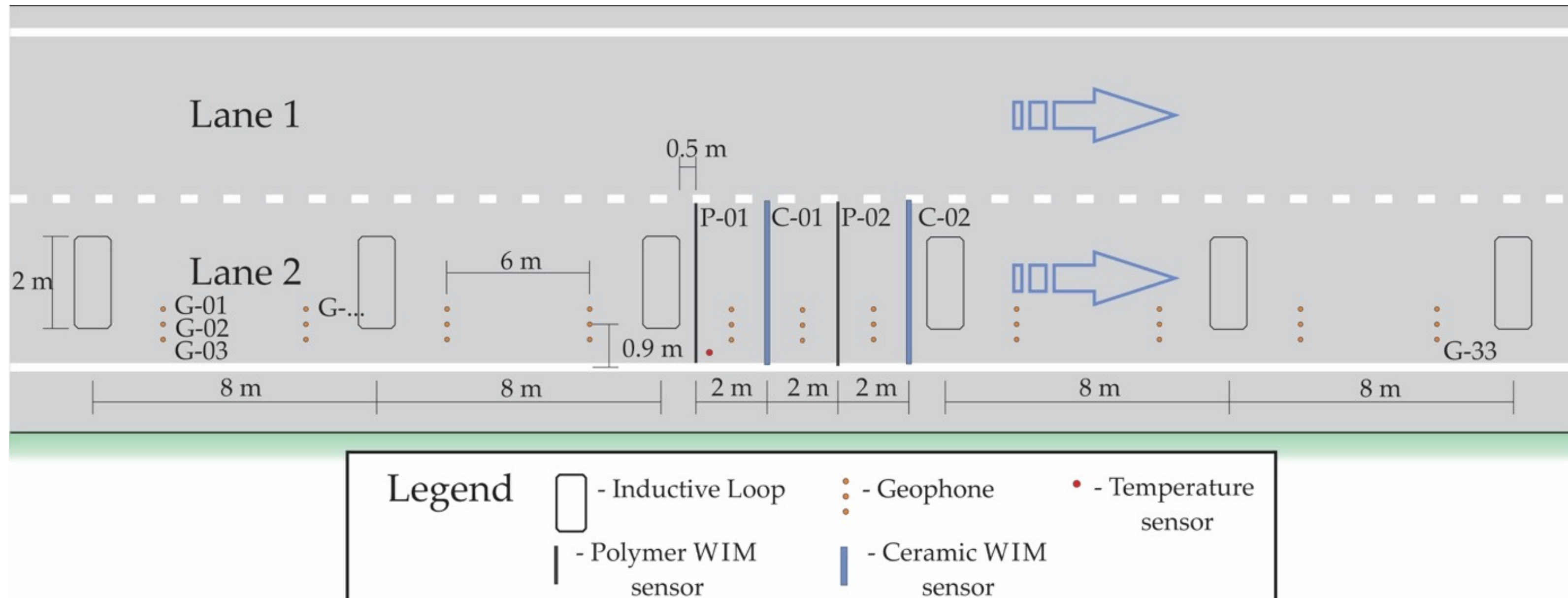
- Therefore, the force transmitted to the pavement is proportional to

$$F(t) = F_s + F_d(t)$$

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Experimental site and the instrumentation



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Test campaign



- Three reference vehicles with different configurations and classes, including:
 - One six-axle articulated vehicle (class 3S3),
 - One five-axle articulated vehicle (class 2S3),
 - One three-axle non-articulated vehicle (class 3C).
- The testing protocol included:
 - multiple runs
 - various speed and
 - lateral position conditions.

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Test campaign



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Vehicle	Axle 1 (kN)	Axle 2 (kN)	Axle 3 (kN)	Axle 4 (kN)	Axle 5 (kN)	Axle 6 (kN)
3 axles	53.710	97.048	76.995	–	–	–
5 axles	56.774	102.881	95.054	81.008	67.235	–
6 axles	51.456	90.810	68.190	78.408	81.309	64.286

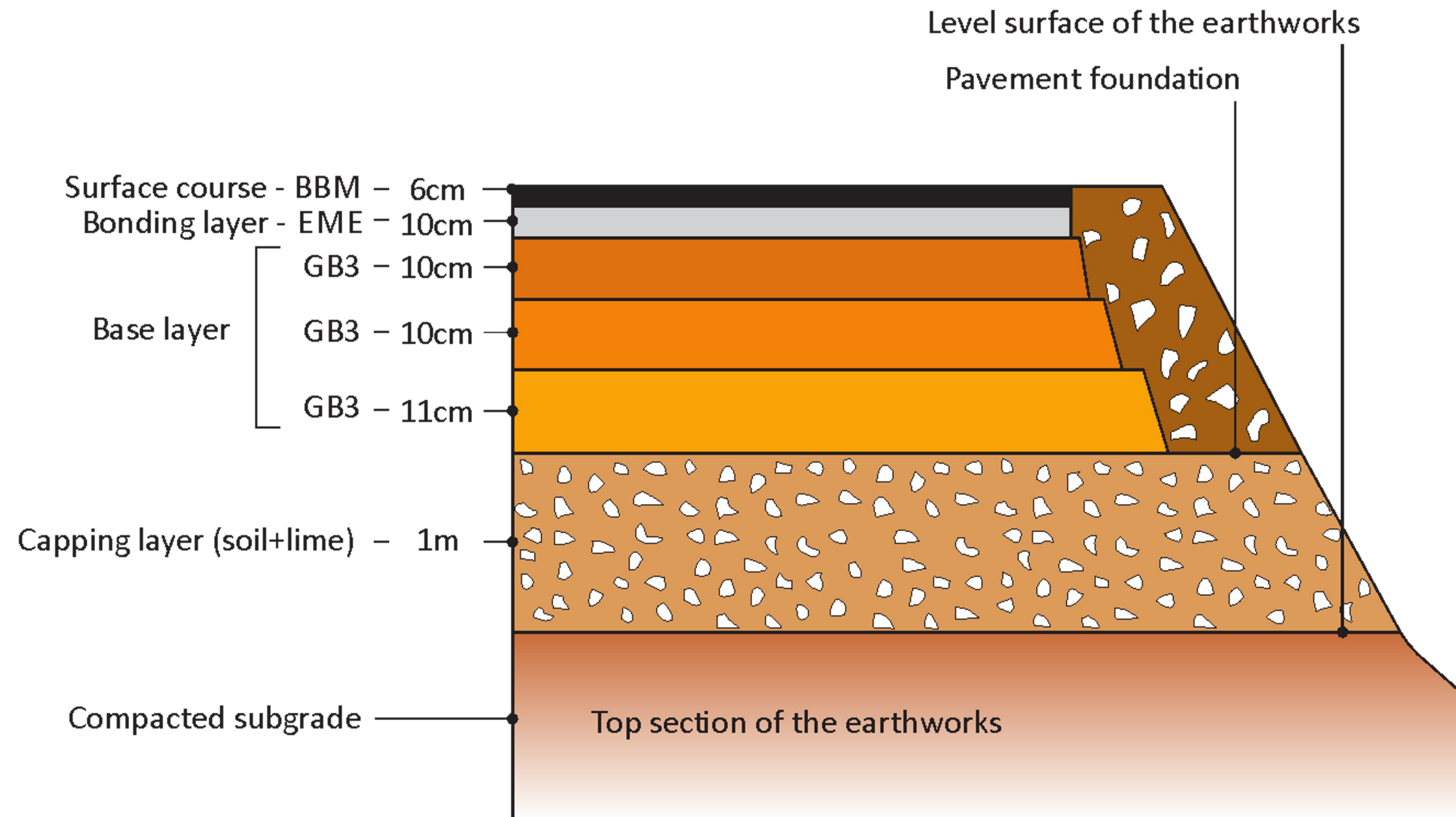
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Pavement structure



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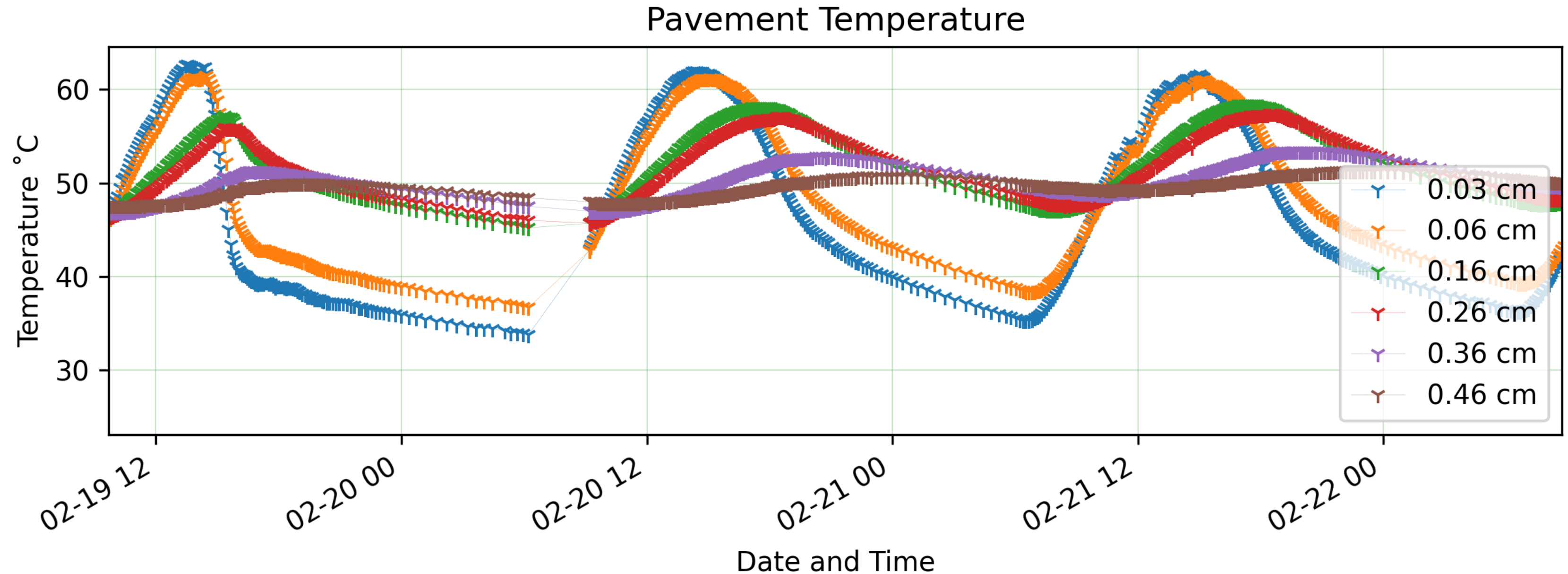
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Temperature variation on the pavement structure



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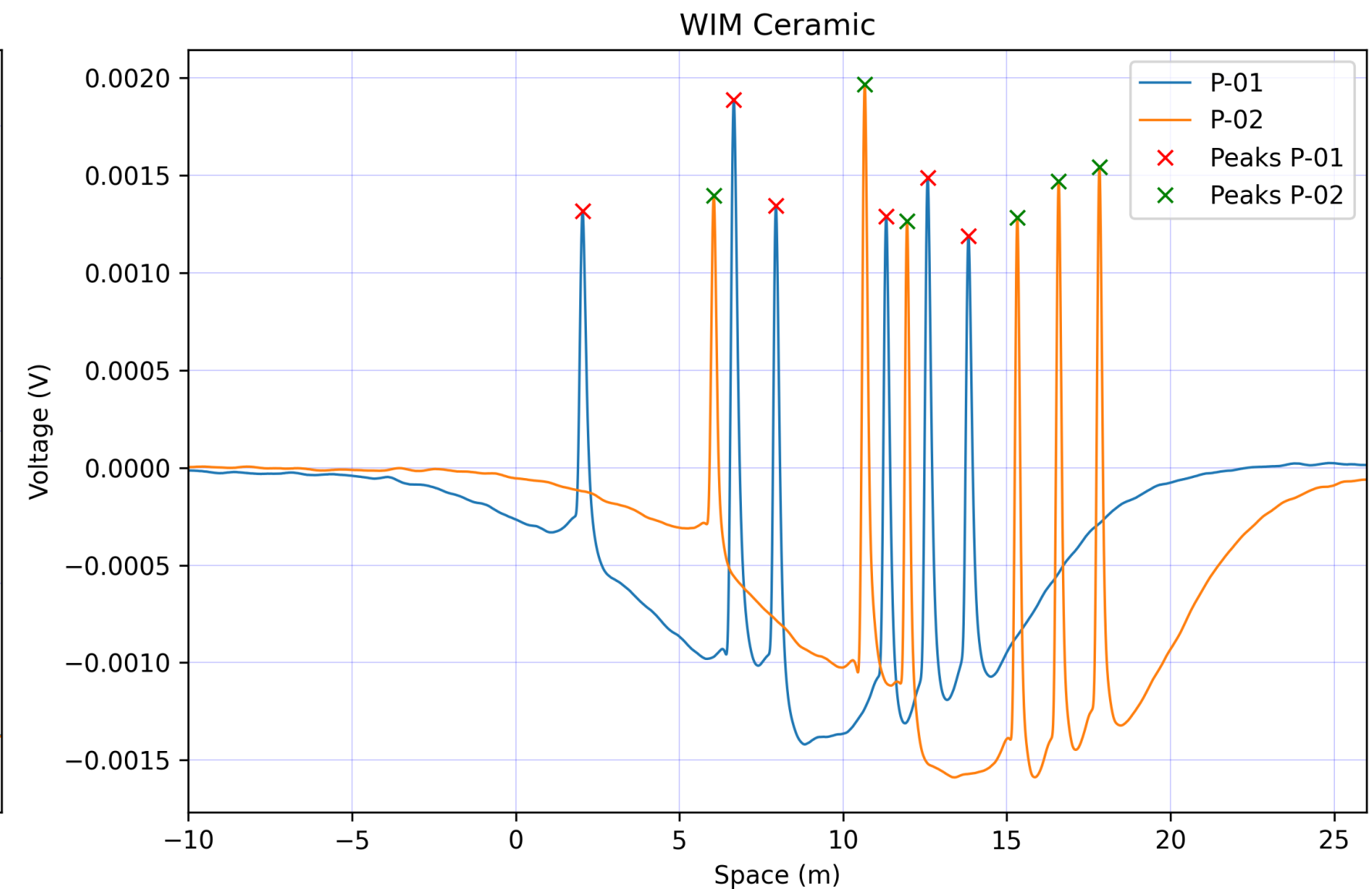
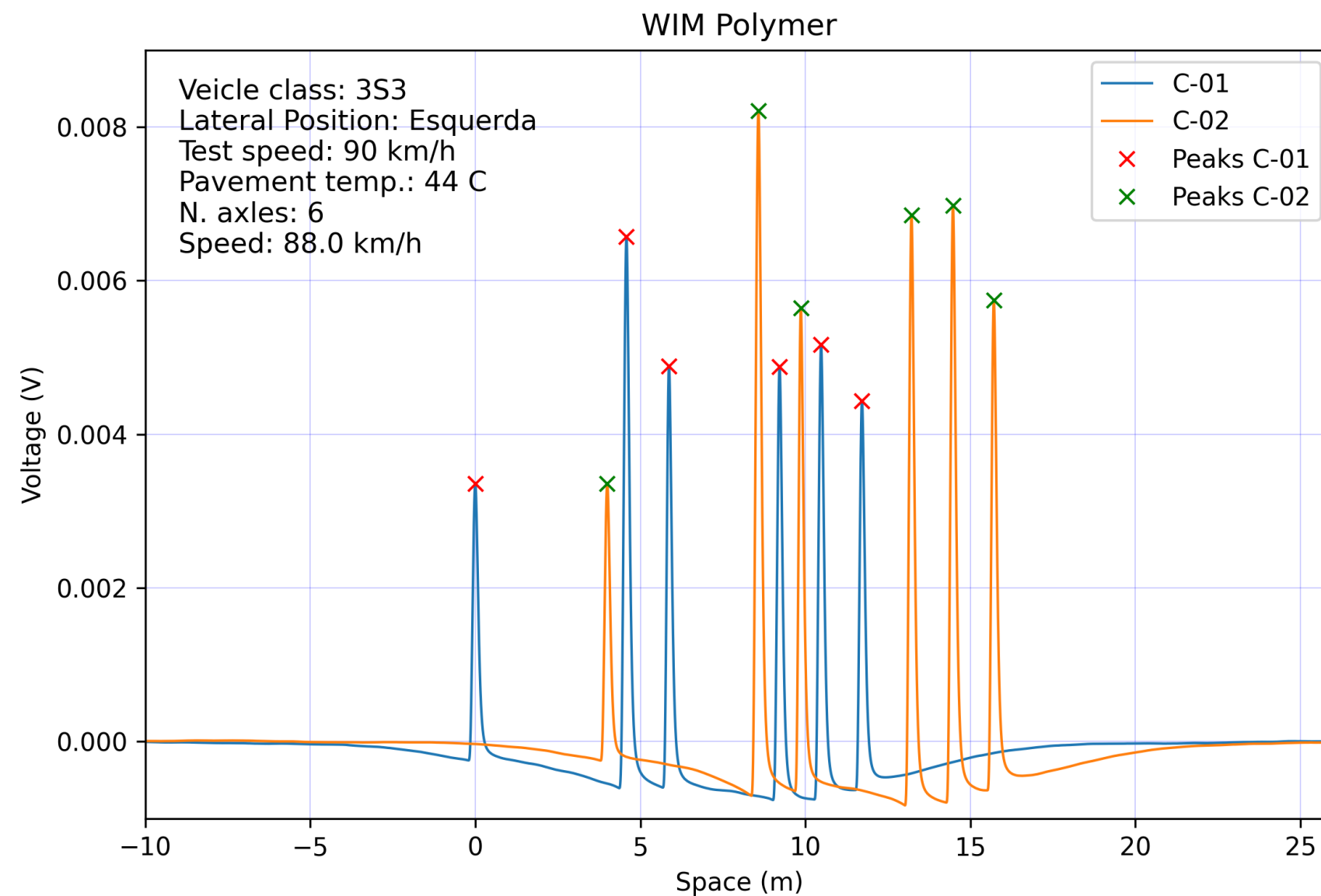
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WIM sensor electrical response of the 6 axles vehicle



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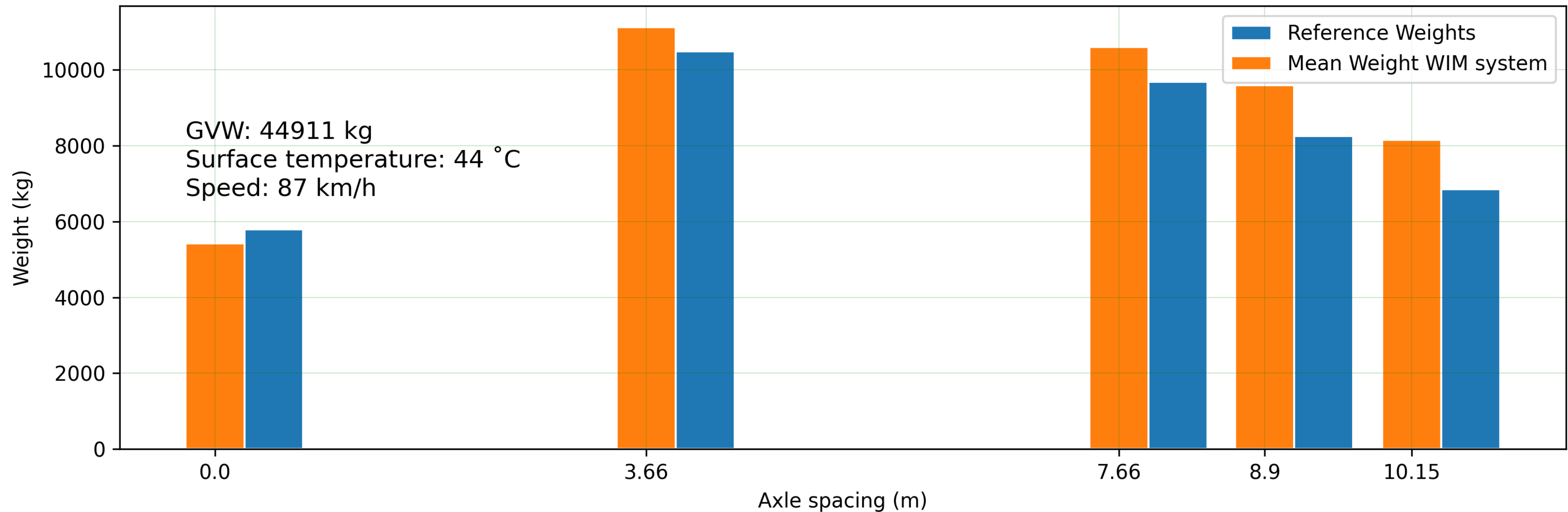
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Results form the mutiple WIM sensors



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Axle weight - Tecnology WIM system



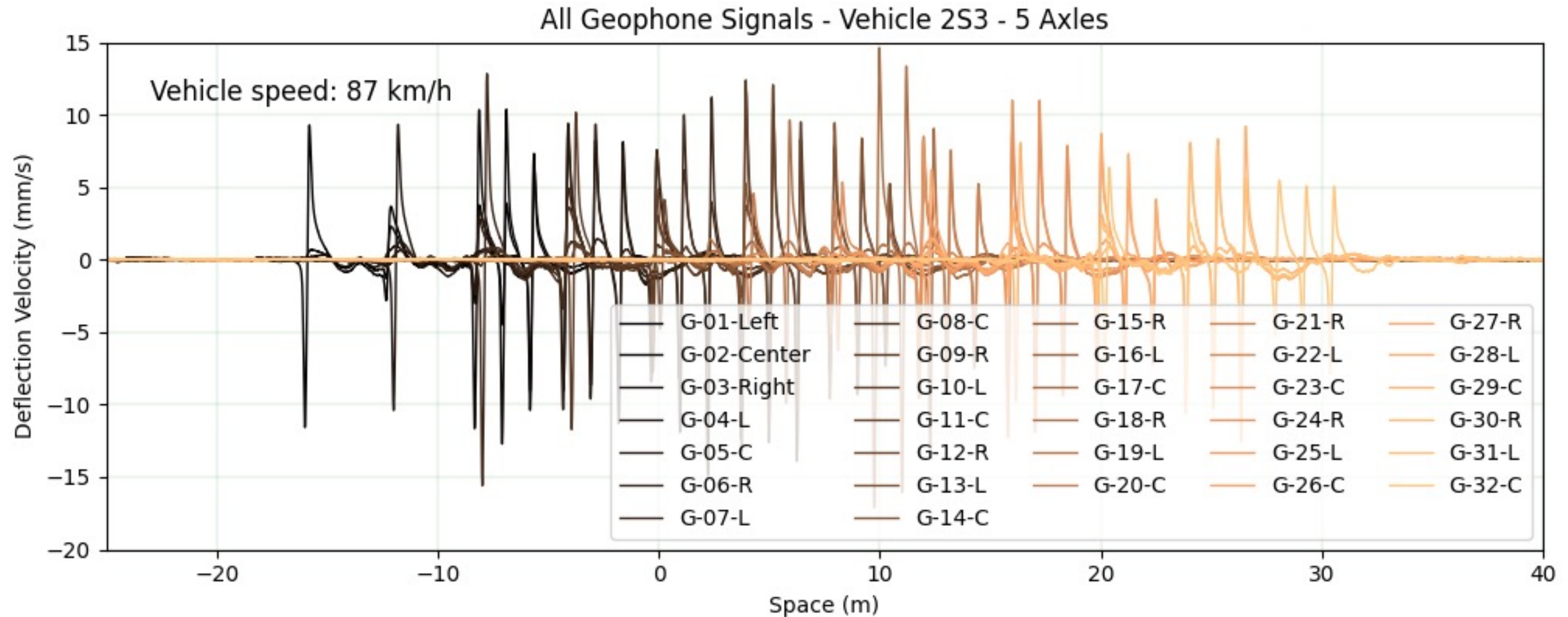
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Singnals from all geophone sensors: 5 axles vehicle



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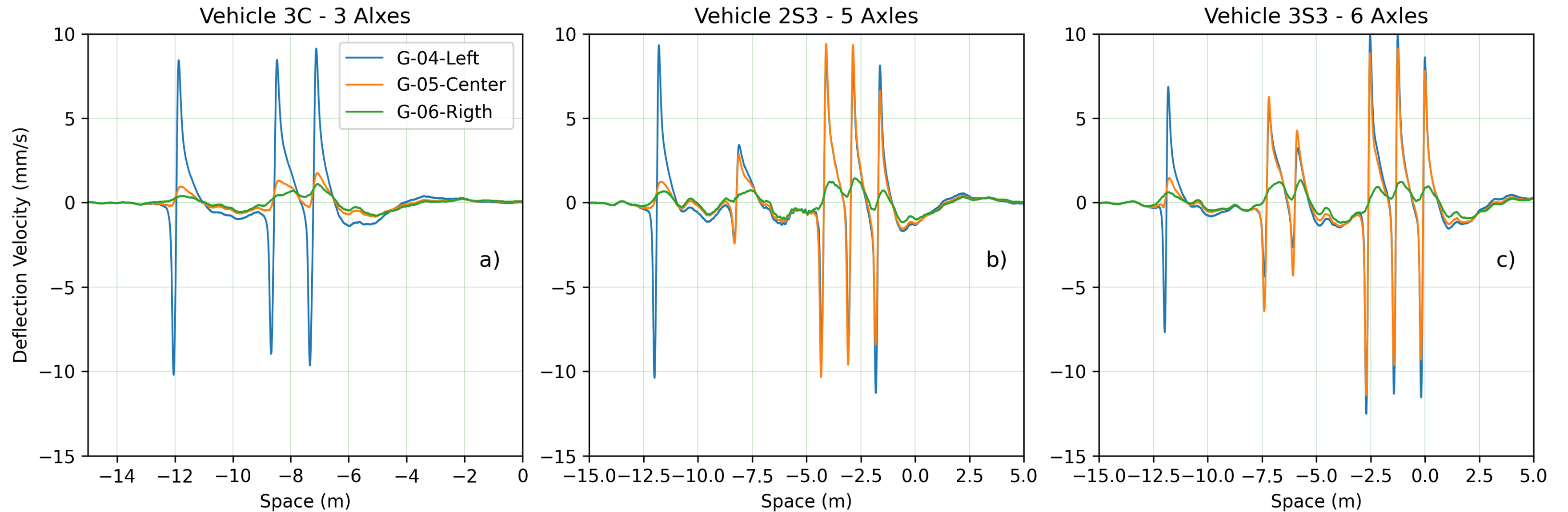
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Geophone signals



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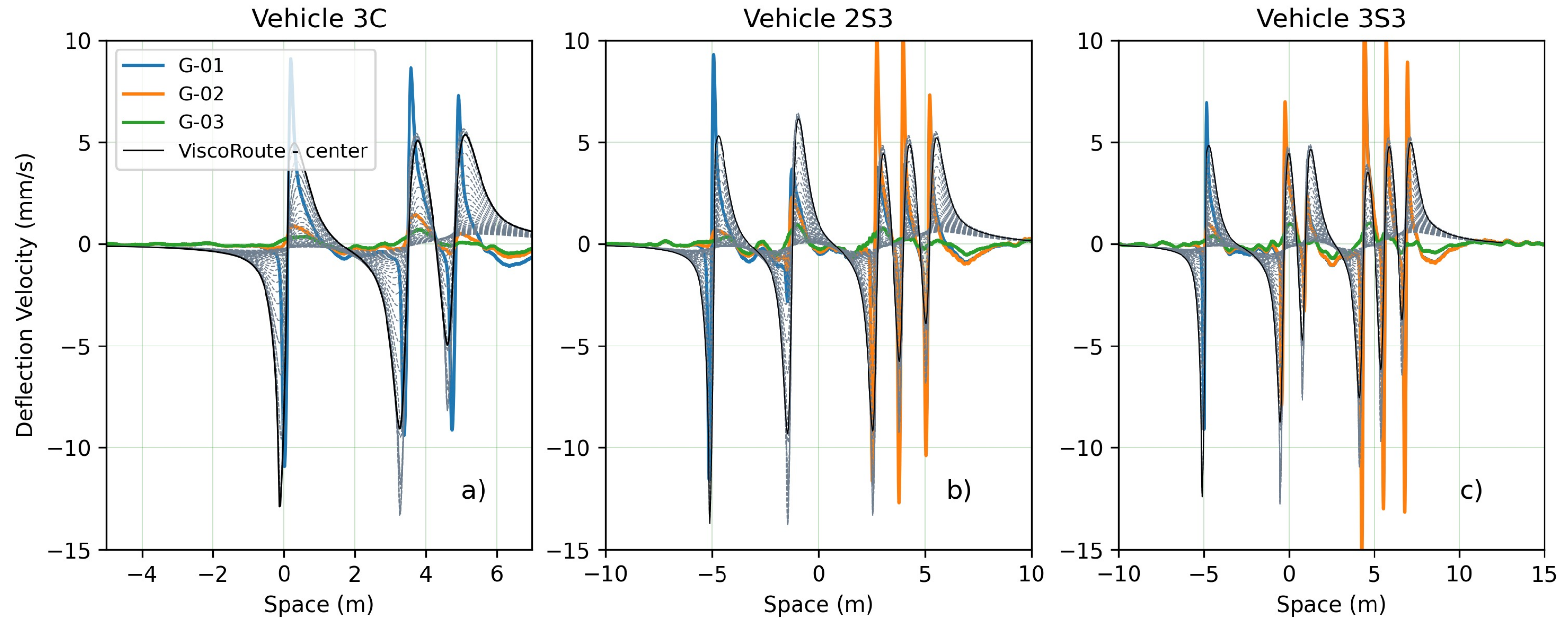
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Geofone singlas and ViscoRoute model



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Conclusions



- Geophones allow a good correlation of pavement behavior as a function of a moving load.
- By applying the principles of backcalculation, the displacement velocity signals obtained from geophone sensors can be transformed into corresponding dynamic load values.
- With dynamic load capture along the geophone sensor grid, it is possible to predict dynamic forces along the installation site, and therefore correct dynamic loads when vehicle axles pass over WIM sensors.

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Thank you!

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