

Check analysis of horizontal stresses in road transport

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Abstract :

No matter the activity sector, industrials product goods which have to be packaged and conveyed across the world. Goods are usually palletized. Goods transportation generated much kind of constraints. Usually, vertical vibratory constraints are the main subject of studies. They are composed of vibrations, shocks and shakes. The new industrial preoccupations focus more and more on horizontal constraints. They want to study their pallets behaviors when they endure horizontal constraints.

These horizontal constraints are obviously vibrations dues to the truck displacement but not only. Indeed, it exists some other kind of horizontal constraints rarely studied and qualified of "quasi-statics". These long and slow events are almost continuous and generated during the braking or the acceleration of the truck. These goods transitory transportation phases induce displacements and deformations of palletized packs. We find these constraints type during road bend or on roundabout. The French road network is particularly well equipped of roundabout mostly around industrial areas and more and more on national roads. In this work, we will record these horizontal phenomena on truck. We will propose to collect the different profiles of constraints regarding their origin and we will class them (right turn, left turn, acceleration, truck speed...). Dynamic and "static" acceleration sensors, incline sensors and deformations measurements will be used. After watching horizontal phenomena in the field, laboratory simulations will be considered.

Material :



Angle tilt (°)

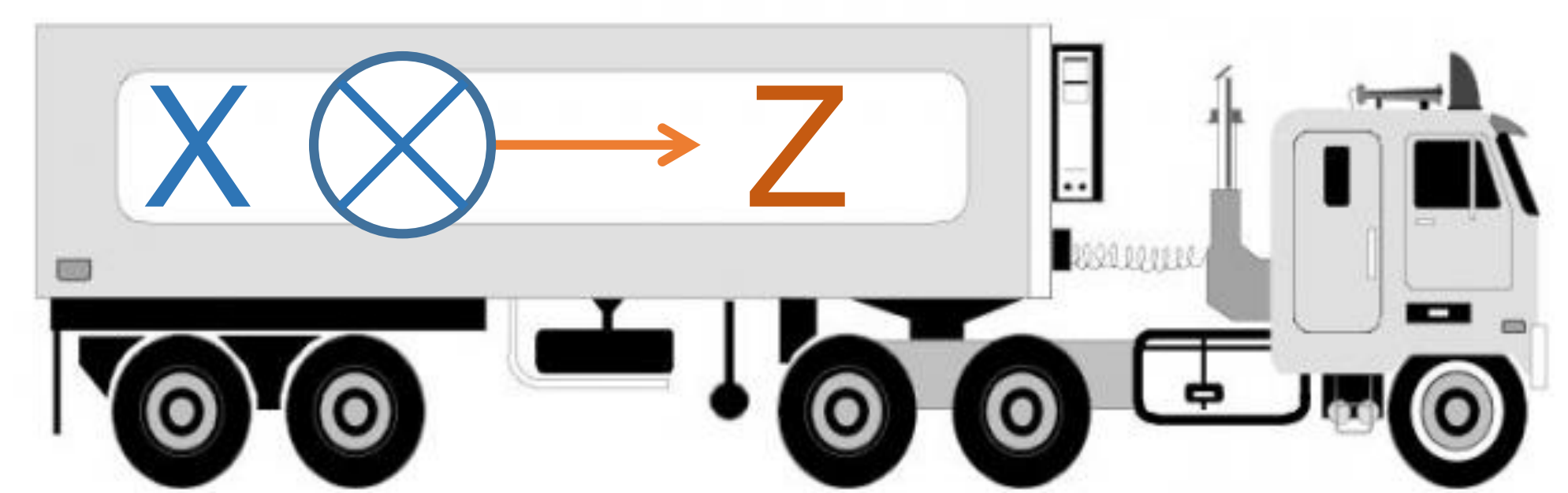


Horizontal acceleration (g)

An inclination sensor is screwed onto a pallet. Another acceleration sensor (DC response measurement capability) is screwed to the pallet. We will focus on left - right & front - back inclinations and accelerations. The measurement is performed continuously. The pallet is placed on a truck next to another pallet. The truck is making a journey in a French industrial city. During his distribution cycle the truck must make turns, take traffic circles, brake and start to run. The data below show the strongest results.



Angle tilt (°)



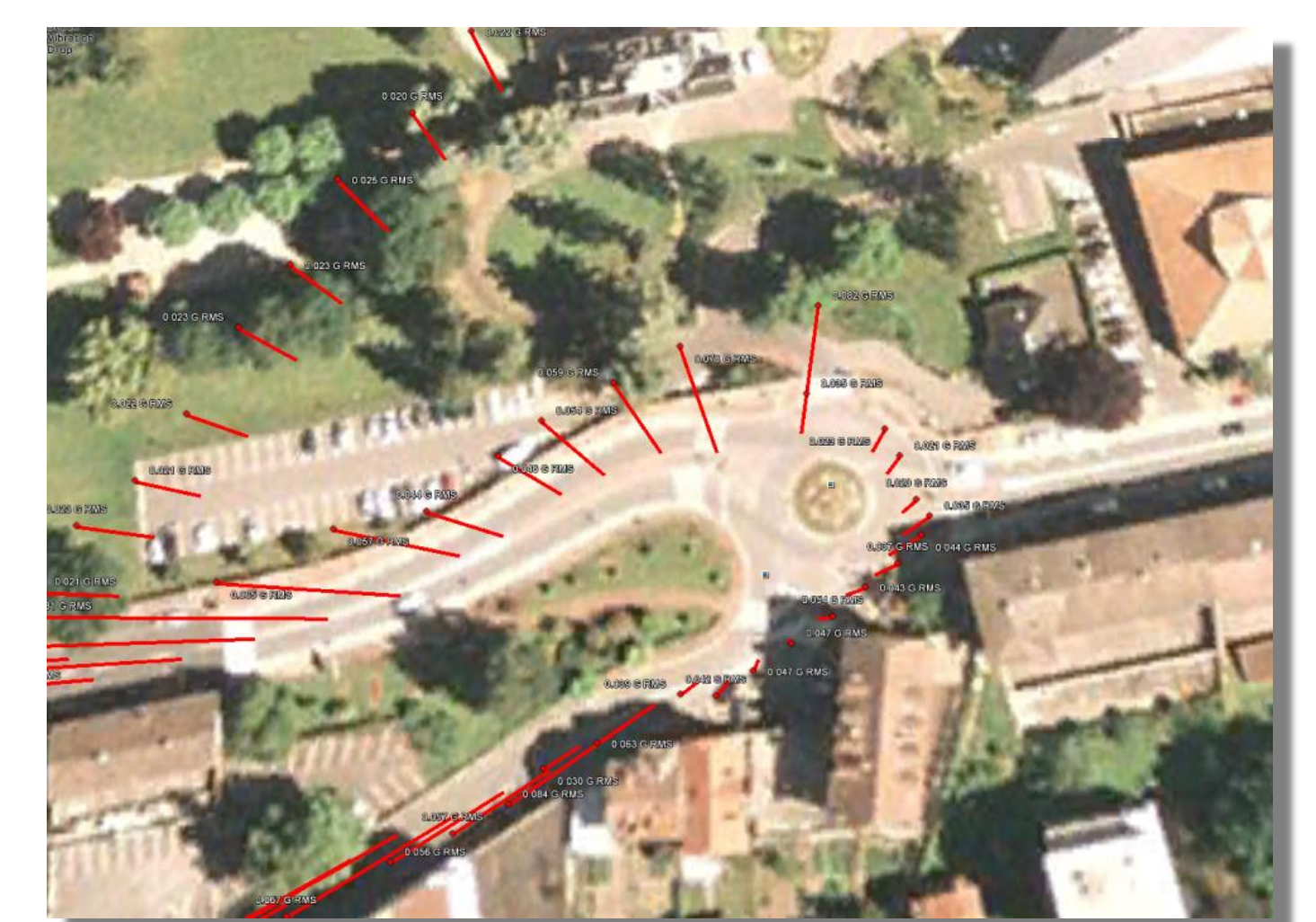
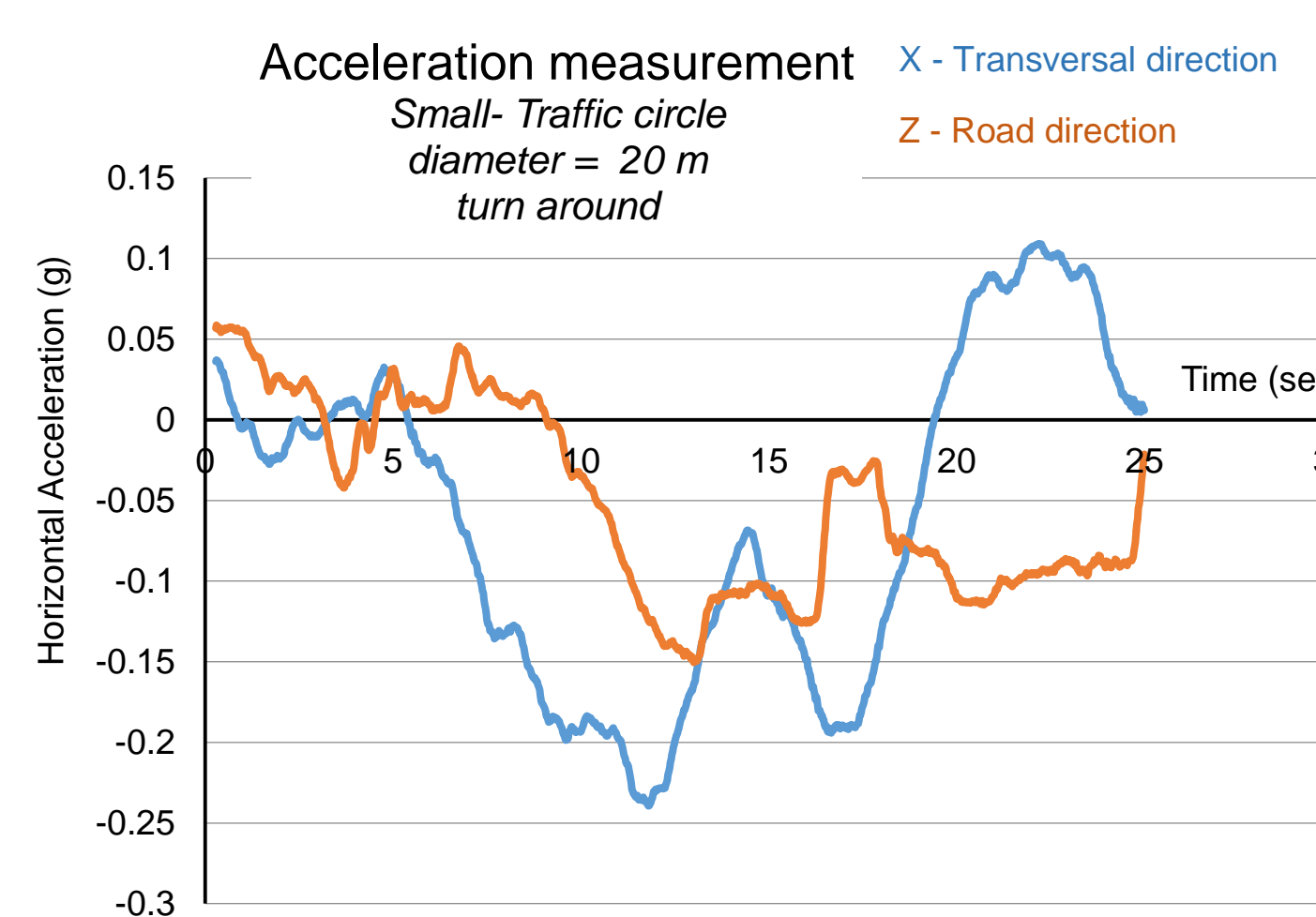
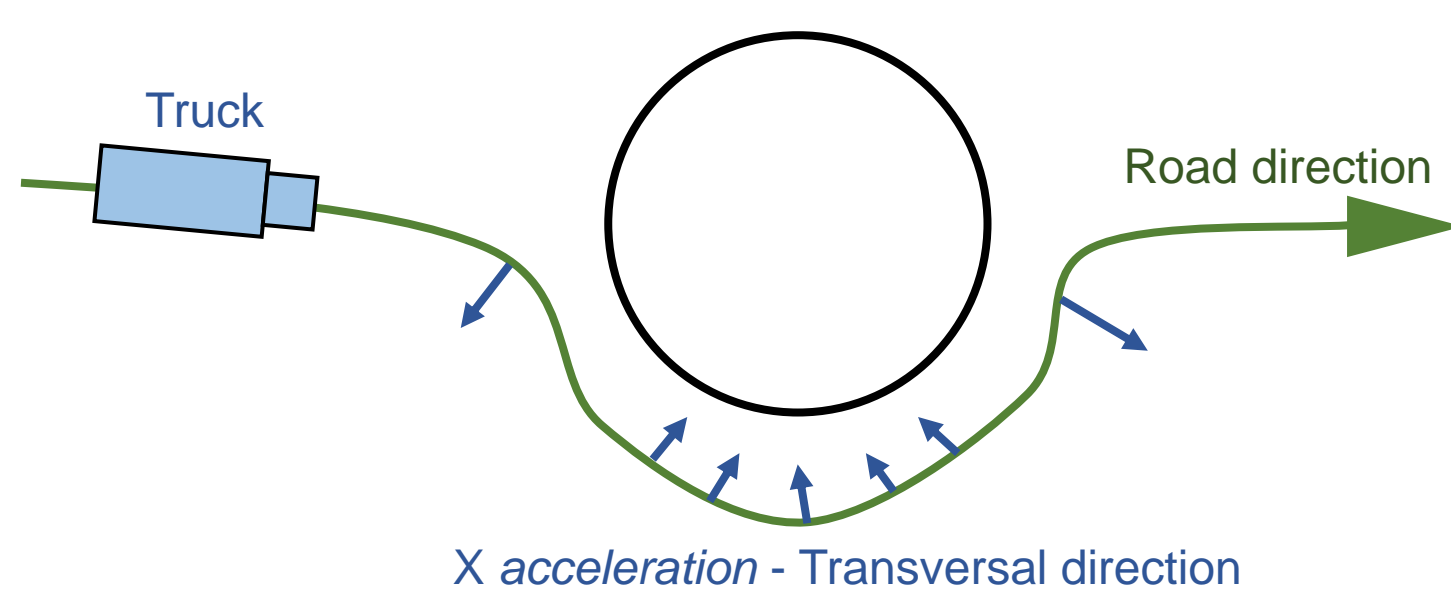
Material	Companie	Type
Accelartion recorder	LANSMONT	3D15
Attitude and Heading Reference System (AHRS)	SBG System	IG-500A
Sample Rate setting	50 Hz	200 Hz
Resolution	0.01 g	0.2 °

Results :

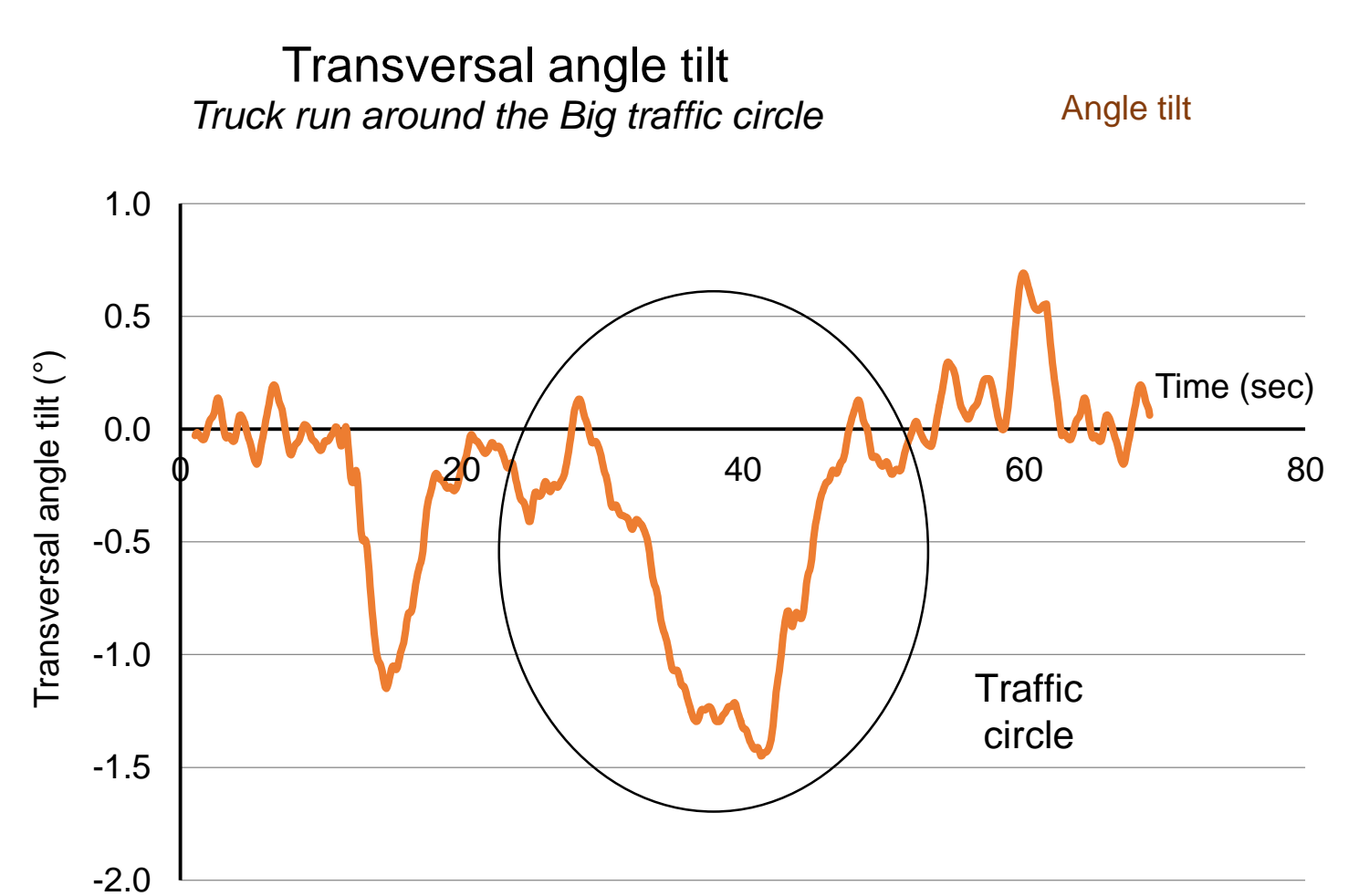
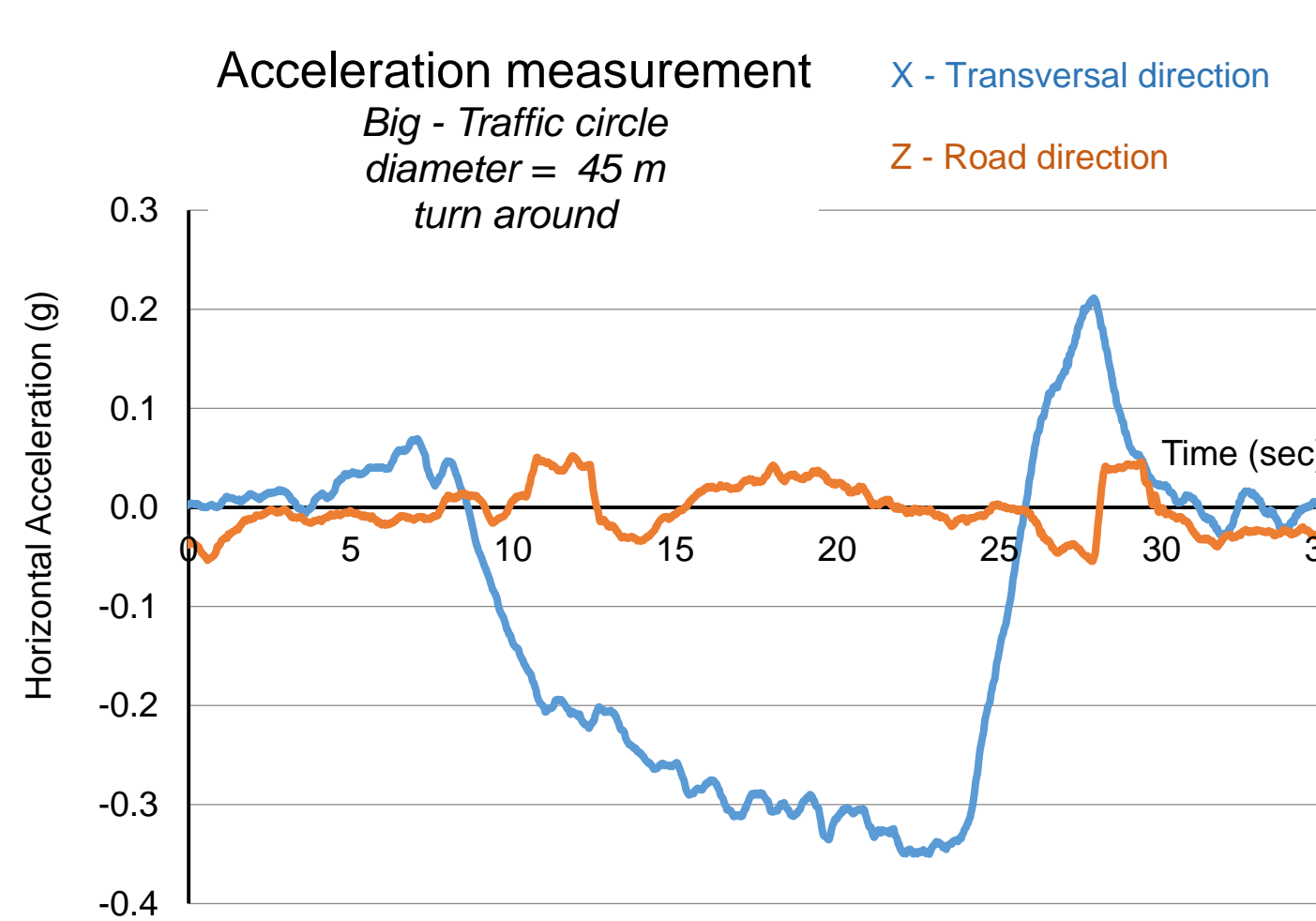
When the truck arrives at a roundabout, he made a right turn, then a long left turn, and leave the roundabout with another right turn. In the following graphs, are shown the temporal representation of the recorded horizontal acceleration and inclination signal. The table shows that :

- the applied transversal acceleration increase progressively to reach a maximal acceleration of 0.5 G.
- This transition duration can vary from 1 to 7 seconds.
- This constraint can be held during 16 seconds.

The roll angles (Transversal = right - left) reach +/- 1.5°. The pitch angles (road direction = front - back) are usually low except in hard truck stop cases. We measure 3°.



Road event	Transversal acceleration (g)	Transition duration (sec)	Angle tilt road direction (°)	Angle tilt transversal direction (°)	Truck speed (km/h)
Small - Traffic circle diameter = 20 m turn around	- 0.25	7	< 0.2	+/- 1.5	14
Medium - Traffic circle diameter = 36 m straight	0.2 arrival - 0.4 turn around 0.5 exit	3 4 seconds dwell 4	< 0.2	+/- 1.5	32
Big - Traffic circle diameter = 45 m turn around	0.1 arrival - 0.35 turn around 0.5 exit	3 16 seconds dwell 3	< 0.2	+ 1.5 - 0.6	arrival = 18 exit = 37
Right turn lane diameter = 69 m	- 0.25	15 seconds dwell	< 0.2	1.5	40
Truck start moving	0.15	2	-1	< 0.2	start = 0 end = 12
Braking - Hard truck stop	0.25 max	1	3	< 0.2	start = 7 end = 0



Conclusion :

The horizontal stresses are present during a distribution cycle. Today there are devices that can approach these constraints. They are able to reproduce these horizontal accelerations (Test device figure - 1). However, during these periods, the constraint duration is too short.

About angles, there magnitudes are low. The truck bed incline slightly. However, the goods on the top of the pallet can move highly. To test these inclinations, devices can be used (Figure - 2). It is possible to switch the pallet with the desired angle and maintain this action for the required time.

To faithfully reproduce these constraints (angle, acceleration, transition duration & dwell duration) there is no existing equipment's yet. Despite these challenges, we can find in the ISTA 3 E rotational edge drop test protocol a good alternative. The long horizontal accelerations can be simulated by exerting a pull on the load with a strap (Figure - 3).

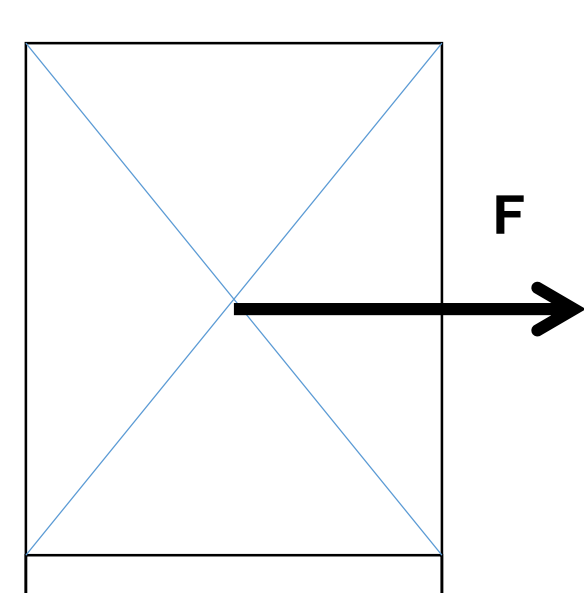
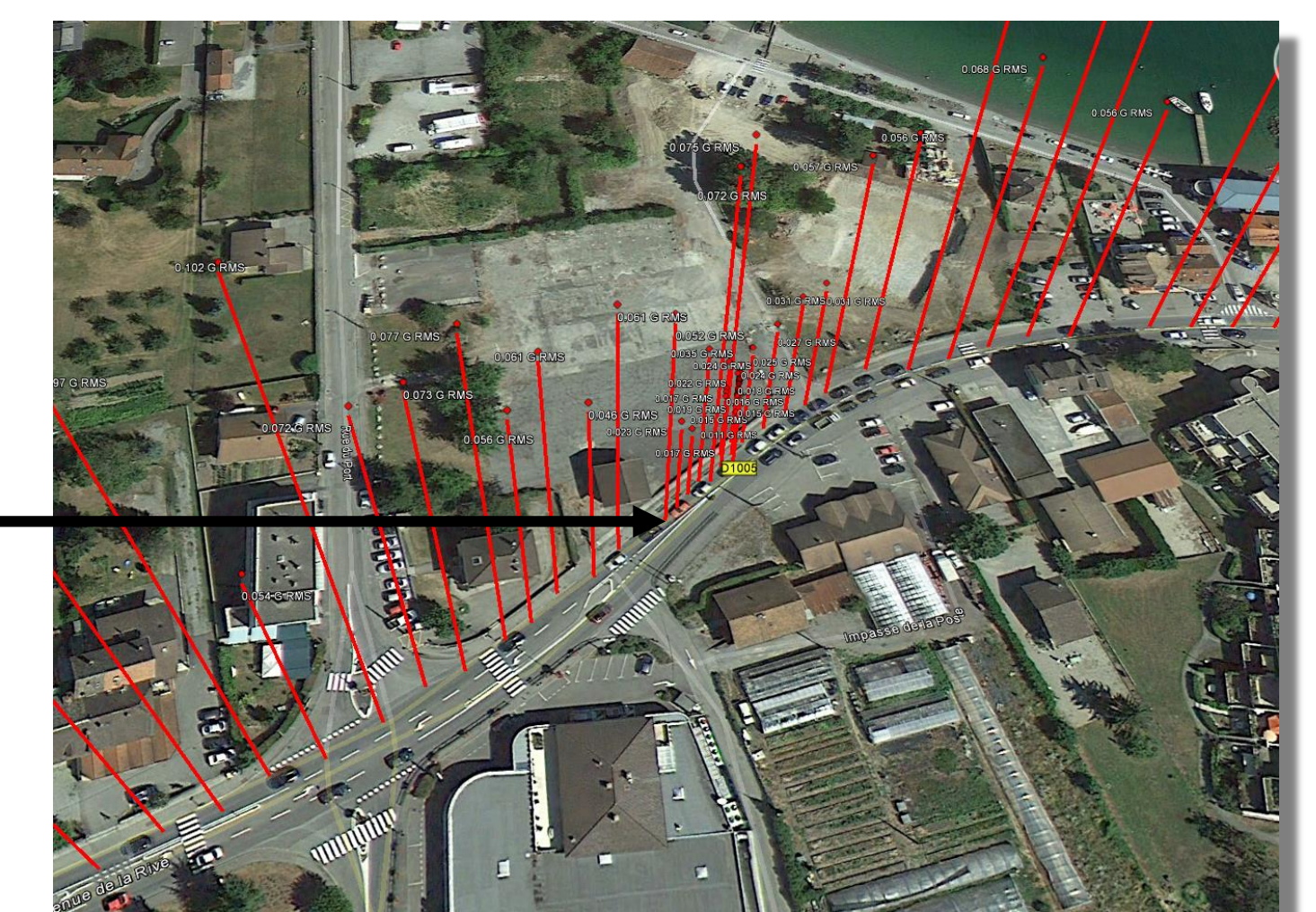
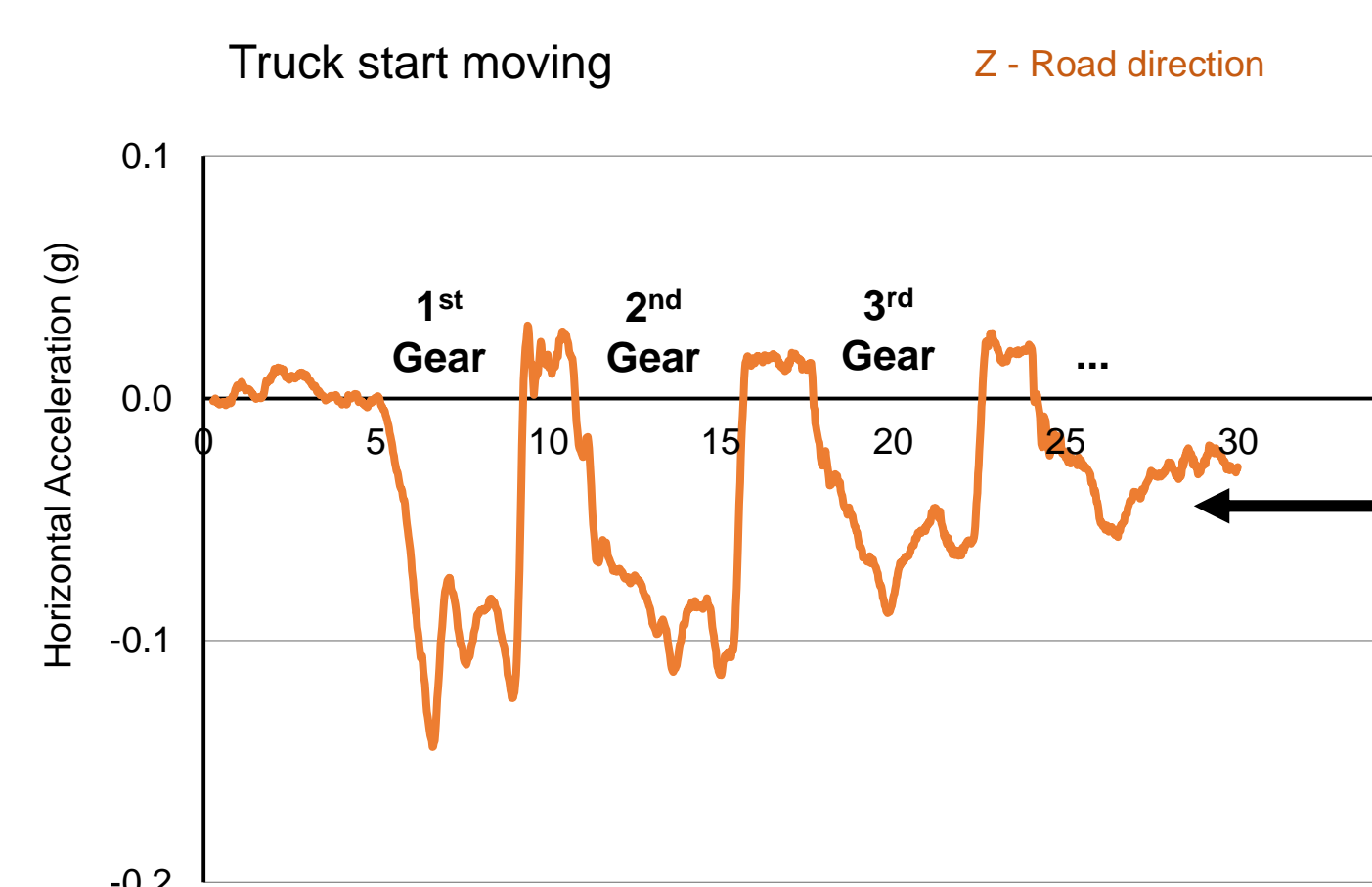


Figure - 3



Figure - 1
ITENE device



Figure - 2

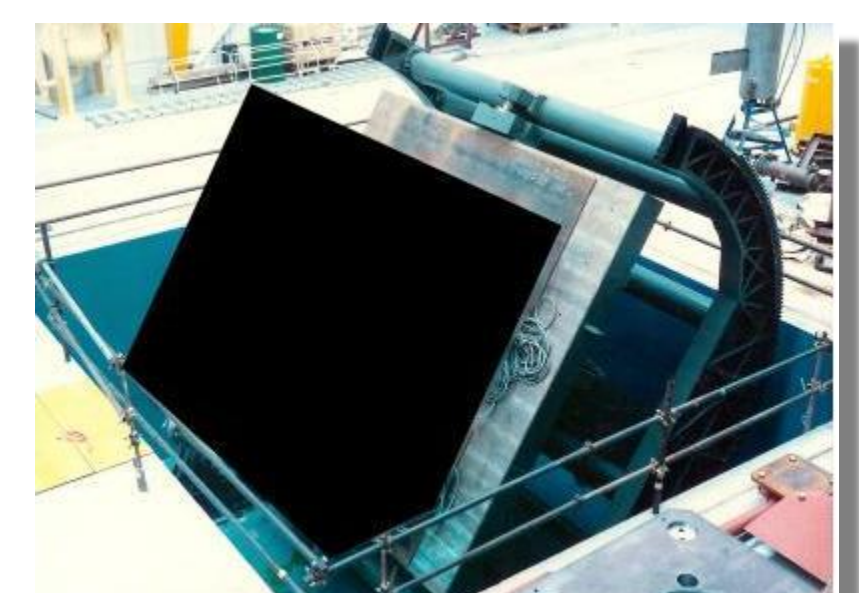


Figure - 2
SEREME device