# FAST*TRACER* NEWS

## Evaluation of vibration inside a car under different road types


The vibrations produced by the contact between a car tire and the road must be monitored to evaluate both the comfort of the people inside the car and the health condition of the road. The vibration must be measured on the car base and actually they depend on many different factors:

- The car velocity
- The car tire
- The car wheel (dimension and type of alloy wheel)
- The road roughness.

The report evidences the difference among different road types, by using a unique car, with a nearly constant velocity.

## THE TESTS

The tests have been conducted inside a car, placing the FastTracer below the passenger seat, on a metallic part which is directly fixed on the car base. Three types of roads have been travelled:

1. Asphalted road
2. Setts-paved road
3. Dirt road

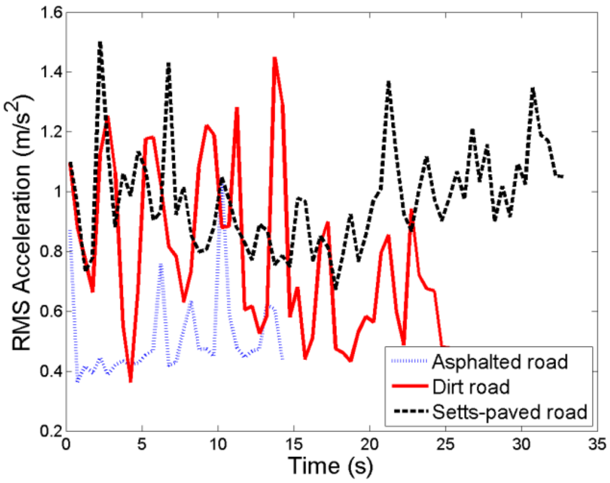
In every test, the velocity of the car was maintained around 30 km/h, corresponding to around 8 m/s. The tests last from 10 to 20 seconds.

## DATA ANALYSIS

The data analysis is subdivided in two parts:

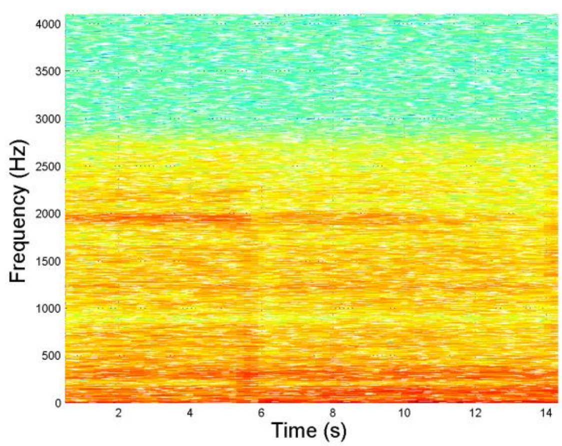
1. the analysis of the time histories, with the extraction of the maximum value reached and the RMS value calculated every 0.5 s;
2. the frequency analysis, expressed both by the Power Spectral Density and the spectrogram.

In the following figure, the RMS of three signals recorded on the different road types is depicted.

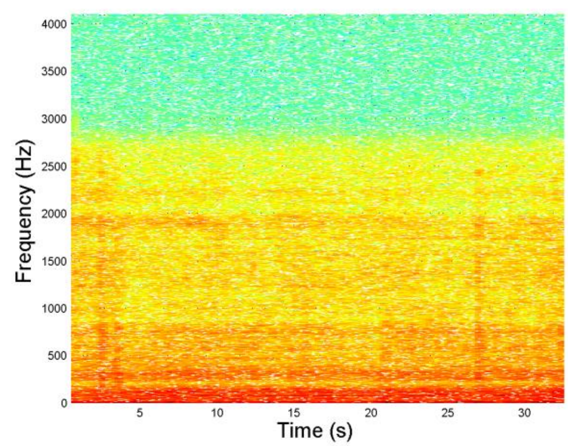



The asphalted road has low values of RMS acceleration, while the setts-paved road has values significantly higher, due to the impact with the setts. The dirt road, due to the more irregular ground, has a higher variance of the RMS accelerations, from low values comparable to those of the asphalted road to high values comparable to those of the setts-paved road.

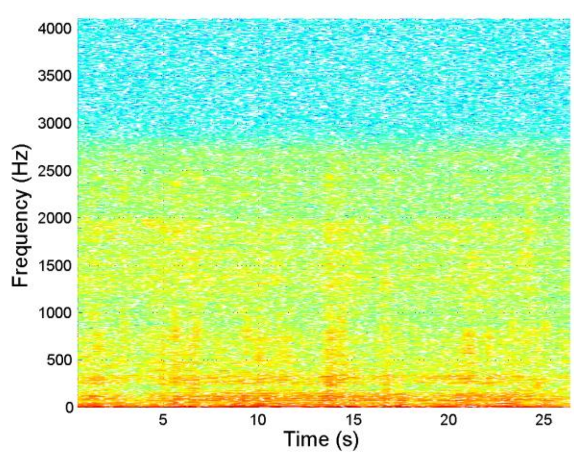
In the following figures, the spectrograms of the three road types are shown: a) asphalted road, b) setts-paved road, c) dirt road.




a)

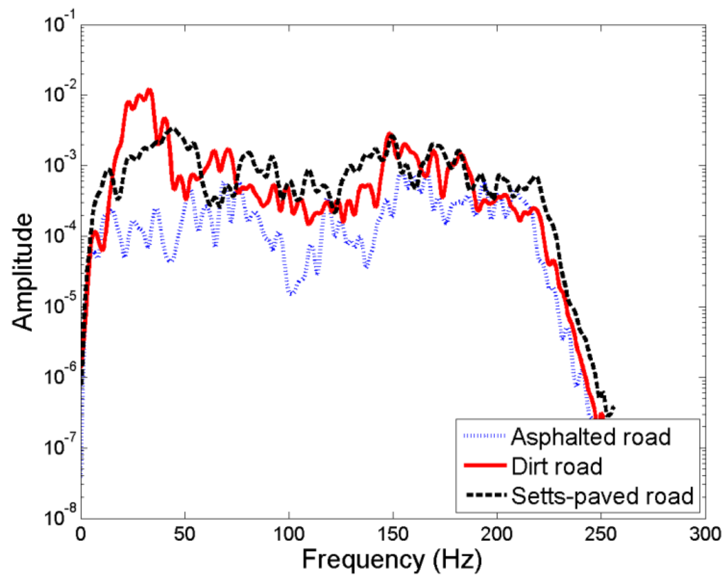



b)




c)

In the spectrograms, there is an evident frequency content between 1900 and 2000 Hz. This is probably the main frequency of the metallic piece on which the FastTracer has been mounted. The frequency content referred to the roads can be seen in the low frequencies. Since there is not a significant time-variability, the different cases can be compared by means of the Power Spectral Density:




The signal recorded in presence of the asphalted road does not have significant peaks at low frequencies. Contrarily, the setts-paved road shows a peak around $f = 45 - 50$ Hz, which corresponds exactly to the inverse of the time $T$ between two successive setts:

$$f = \frac{1}{T} = \frac{v}{L}$$

where $v = 8$ m/s is the car velocity and $L = 0.15$ m is the sett length. The dirt road is an intermediate case: the frequency is not constant because the irregularities are always different, but the spaces between two successive of them are always bigger than $L$: this is the reason because the most important frequencies are lower respect to the setts-paved road.

## CONCLUSIONS

The vibration analysis conducted inside a car allows identifying the differences among various types of roads, in terms of RMS accelerations and frequencies. This technique can be used to evaluate the degradation of a road, by repeating the test in successive moments, but using the same car, tires and velocity.