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Vibrations as a Parameter to Technical Condition of System; Notions and Criteria for Evaluation of Vibrations in a Vehicle

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***Abstract*— Vibration is an important part in systems of mechanical analyses that can appear in every engineering problem in vehicles. It is clear that in order to have better control over problems in mechanical systems, analyses of vibrations is useful in order to resolve precisely reduction of vibrations and forces.**

***Index Terms*— System, vibrations, motion**

I. INTRODUCTION

Vibrations in their simpliest form can be considered as a motion or movement of bodies which are repeated around in an equilibrum position. Equilibrum position is a position in which the body remains out of influence of external forces. Such a type of vibration is called "entire body motion/movement, meaning that all parts of a body move together (at once) at the same direction, at the same course and at the same time [1].

II. CRITERIA FOR EVALUATION OF VIBRATIONS IN A MACHINE

Every measuring of vibrations has as an aim understanding or considering the dynamic condition of a machine. Calm operation of a machine and intensity of vibrations depend from: load in the machine and space around which is linked to intensity of actions/operations, safety of machine operation and equipment depend on the level of vibrations; safety of department/section/ward depending on the level of vibrations, especially when the resonance is in question. Within ISO standard there is an ISO/TC 108 technical committee who deals with vibrations, whose duties are excitation of actions in objects aiming review of the same, diminishmet, elimination and limitation of vibrations through balancing, insulation and amortization, development of criteria in connection with effect of vibrations in people, as well as determination of limit values of machines and systems, development of research methods and coorporation with other ISO commettees on mastering terminology of this field. Many interntional standards have offered their concrete recommendations on evaluation of vibrations, such as VDI 2056 Recommendations, Normative in accordance with DIN 45665, 45666, ISO standards 2372, 2373, 1971, English standards BS 4675, 1971, French norms E 90 E 100. In accordance with provisions, amplitude and effective speed of vibrations are fundamental magnitudes based on which the technical condition of machine, when the vibrations are in question, are determined. Effective speed of vibration is [1]:

$$v_{ef} = \sqrt{\frac{\int_0^T V^2(t)dt}{T}} \tag{1}$$

Equivalent speed of vibrations:

$$v_{eq} = \sqrt{2}\,\frac{v_{ef}}{\omega_r} = \frac{\sqrt{2}v_{ef}}{2\pi\, rf} \tag{2}$$

Equivalent amplitude of vibrations:

$$A_{eq} = \sqrt{2}\,\frac{v_{ef}}{\omega_r} = \frac{\sqrt{2v_{ef}}}{2\pi fr} \tag{3}$$

III. DYNAMIC ANALYSES OF VEHICLES WITH LOAD

In general, there are two types of approaches regarding dynamic analyses of a car. The first approach relies in experimental analyses and tests in the field; the second approach is computeric simulation in order to complete numeric analyses. The application of the first approach is not as extended as the second approach; [2, 3] the first approach is known for its high cost and in addition the needed equipments for experimenations are extremely expensive.

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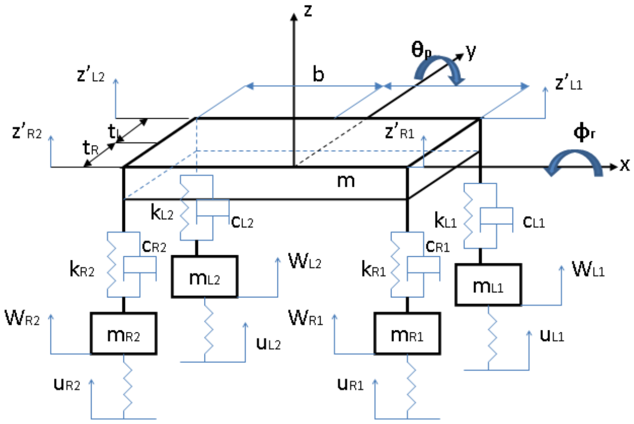

Figure 1. Model of vibrations of vehicles/cars

Unlike the first approach, the second one is more popular, because of its low cost and the flexibility of testing various scenarios in a model. Depending model of the vehicle, dynamic response of every position in vehicle can be brought closer only numerically. A diagram indicating vibrations in every vehicle is shown in figure 1. General equation of every vibration model in a certain vehicle may be determined as follows [4]:

$$[M]\{\ddot{X}\} + [C]\{\dot{X}\} + [K]\{X\} = \{P\} \qquad (4)$$

where [M] is massive matrix, [C] is matrix of softening/mitigation coefficient, [K] is matrix of hardness/solidity/rigidity/rigidness, while {P} is determined as a force imposed to a vehicle by the road.

IV. COMPLETION OF MEASURING

Measuring of vibrations was completed through the equipment for measuring of vibrations in “Beissbarth Screen Lane SN600” vehicles, production of Beissbarth GmbH Company in Renault Megane cars.

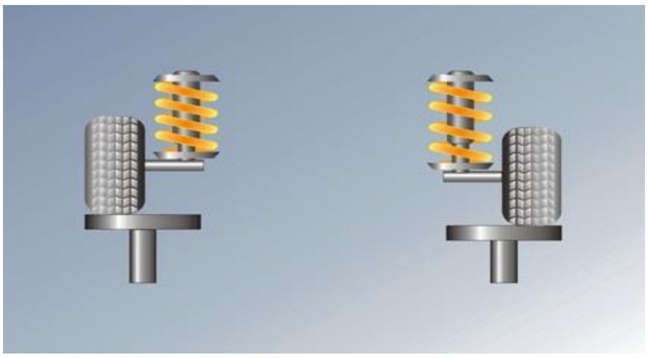

Figure 2. Software of Beissbarth Screen Lane SN600 equipment for measuring vibration in vehicles

The process of measuring was completed in order to certify magnitude of resultant frequency, difference or change in vibratios between two amortisators of two shafts, weight of vehicle wheels, weight of shafts, obtaining needed curves which indicate magnitude of vibrations. The results obtained during the measuring of vibrations in the vehicle/car are shown in the Figure 3 and Table 1, as well as in the diagrams and curves present the obtained results.

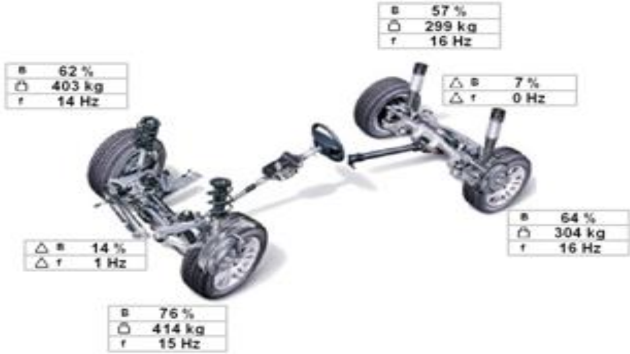

Figure 3. Measured parameters and results obtained

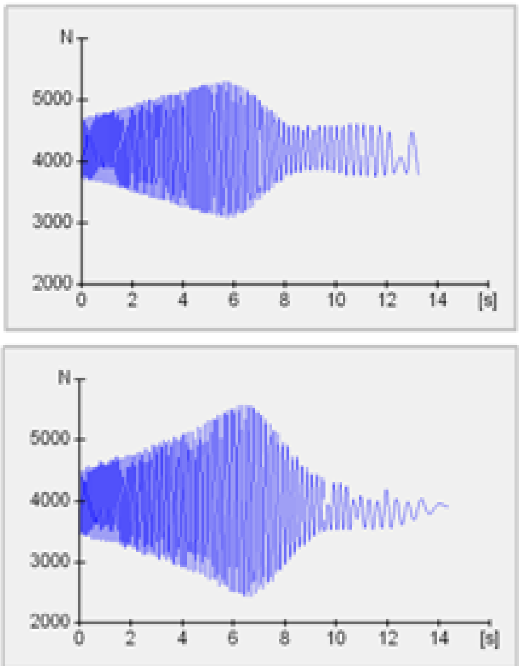

Figure 4. Resultant frequency of front shaft for the left and the right wheel

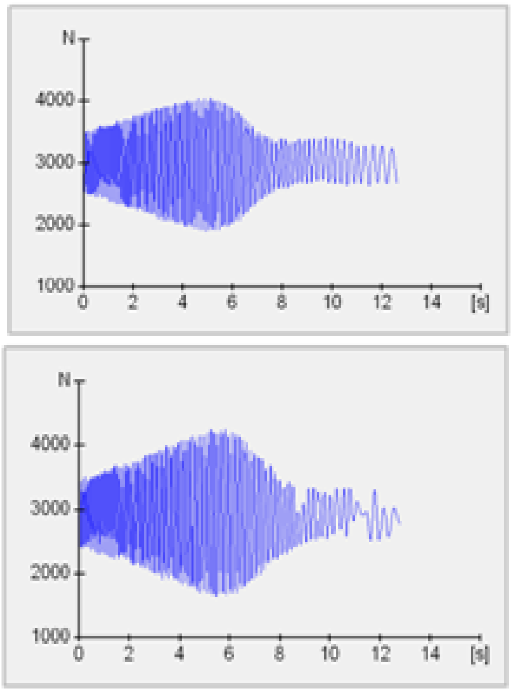

Figure 5. Resultant frequency of front shaft for the left and the right wheel

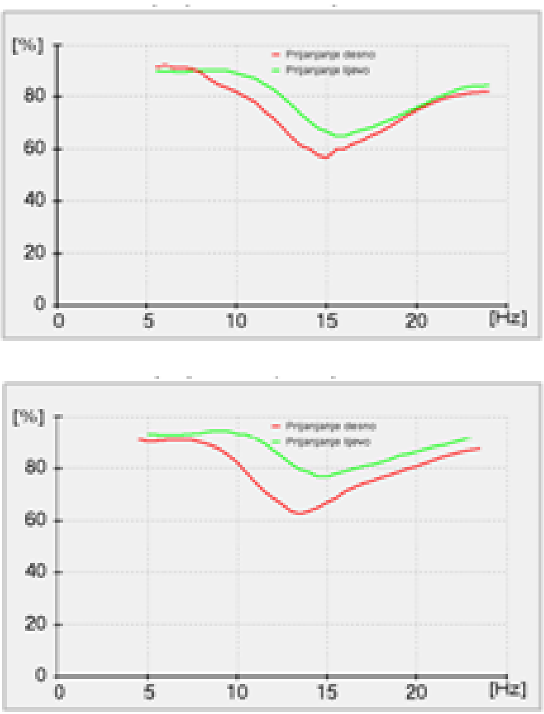

Figure 6. Difference between the left and the right wheel for the front shaft and the back shaft

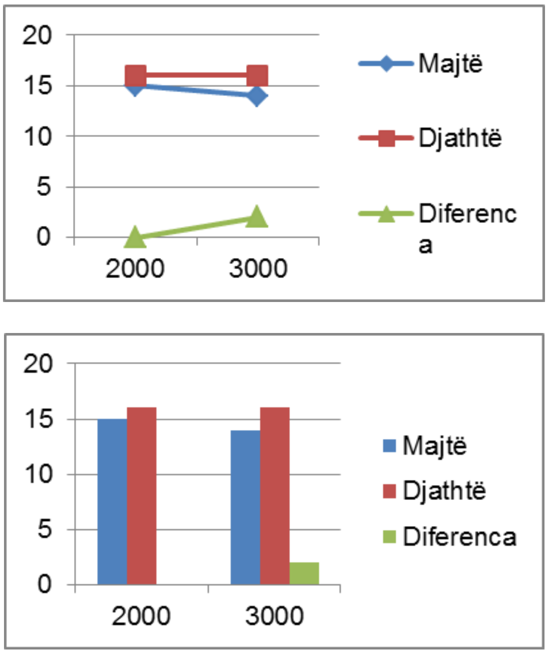

Figure 7. Difference between the left and the right wheel in the front shift and in the back shift

Table 1. Presentation of the results obtained

Nr.	Measured parameters	Front shaft			Back shaft		
		left	difference	right	left	difference	right
1	Resultant frequency	15 Hz	1 Hz	14 Hz	16Hz	0 Hz	16Hz
2	Difference	76%	14%	62%	57%	7%	64%
3	Weight in wheels	414 kg	-	403 kg	304 kg	-	299 kg
4	Weight in shafts	817 kg			603 kg		
5	Time duration of measuring process	25 min					

V. CONCLUSION

Force of vibrations is the main factor regarding dynamic analyses in vehicles, bacause the forces that appear in the entire chassis/framework in the road cause trembles/vibrations. Springs (push buttons, fasteners) and amortisers in a car have an important role in reducing trembles/vibrations in a vehicle. Because of binding between wheels and chassis, that is every force imposed in wheels from holes in roads will be transferred in the chassis. This fact shows that lower part of the vehicle (springs, push buttons, fasteners and amortisers) make an important part in the process of analyses of vibrations in vehicles. Because of binding between wheels and chassis, that is every force imposed in wheels from holes in roads will be transferred in the chassis. This fact shows that lower part of the vehicle (springs, push buttons, fasteners and amortisers) make an important part in the process of analyses of vibrations in vehicles

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