THE MEASURING OF THE HUNTING OSCILLATIONS AMPLITUDE FOR ELECTRIC LOCOMOTIVE 060 EA TO SPEEDS BETWEEN 120 AND 210 KM/H

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Abstract: *When being moved with the high speed engines vehicle is undergone high dynamic loads stress. Each of these dynamic phenomena is well known in scientific literature, the phenomenon of hunting. Through the hunting shall mean the coupling of the lateral oscillations of flexuosity. Hunting oscillations arise when a vehicle properly maintained and increasing lateral oscillations develop due to component subassemblies, the resultant reaction forces concerned interacting at the level of the forces that rolling the device as well as the engine drive system of the wheelsets, but also at the level of floors suspension systems and damping. One of the significant meaningful features of the phenomenon of hunting is the fact that which it is composed oscillations appearing even in the case of perfect rails track.*

Key words: *hunting, wave field, Dirac signals, frequency spectrum, normal modes of vibration, winding flexuosity, resonance sounding, oscillations swings lateral side*

1. Introduction

This work is subject to synthesis of results obtained from a study on the vibrational character, characteristic of the wheelsets drive systems for traction motors of railway vehicles for high speed main. Measurements were made in Romania, with the EA 060 series locomotives (axle formula with Co Co) on the thoroughfare line 300 in with the two wagons, the 800 thoroughfare line and the polygon with 10 wagons from Făurei, with the a carriage.

After comparing the results obtained (both experimentally up to speed 210 km / h and analytically by successive simulations to speed 243 km / h) with the results of existing studies in scientific literature, the conclusions drawn are not intended to be only a supplement, on terms to obtain the performance indicators of efficiency, quality and reliability, in terms of rail transport at high speed.

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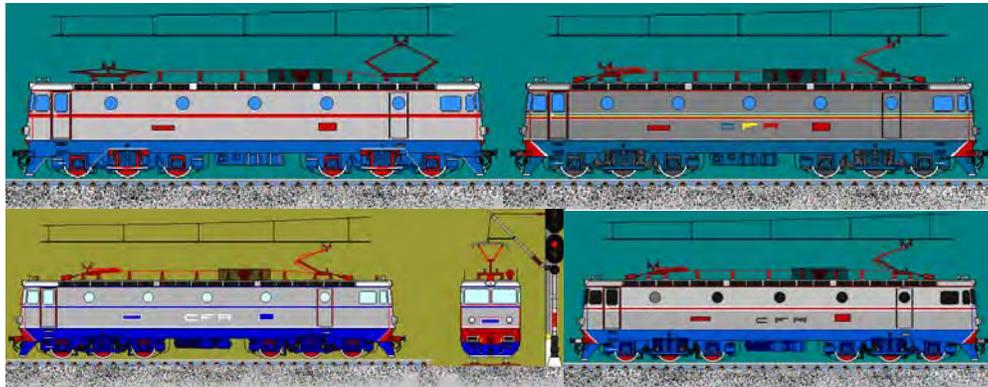[3] SNTFM "CFR Marfă" SA - The Intermodal Center Bucharest, Ploieşti Depot

Fig. 1. *The CFR electric locomotive EA2 060 series, class 42 (V$_{max}$=220 km / h), Co Co*

2. Measurements and experimental results

Measurements and experimental results were subjected to further comparison with the laboratory analysis of contact phenomena, respectively, the vibration have occurred. This was made possible by quasi-static method with the variable parameters of excitation, frequency transient excitation due to reaction forces found in the joints and suspension from contact wheel-rail roughness-induced excitation in conjunction with the tread. The second is the dynamic model set up the whole vehicle - running path (defined by the bed of ballast and light path).

Analytical processing and comparison with the experimental data obtained and the proposed indicators and the results submitted to, have been possible given the basic theories that are the essence of research conducted over time, on vibration phenomena in general, especially the phenomenon of hunting, which shall mean the coupling of the lateral oscillations of winding nature to maintain.

Vibration study of traffic at high speed is necessary because the trains directly involved in the environmental damage, through its noise. Vibration that spreads mainly as a field of light, as if the noise

occurred when trains pass through the vicinity of buildings, thus affecting the occupants. The rapid expansion high-speed rail network across Europe manifested simultaneously with the initiation of numerous studies on vibration and its effects, especially the sound.
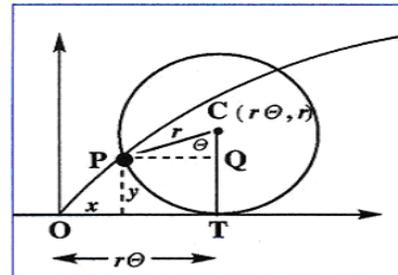

Fig. 2. *The excitation diagram of a point on the tread wheel electric locomotive 060 EA, Co Co*

Rail traffic is a source of vibration which covers a very wide range of frequencies and amplitudes, some of the most significant being the sound generically known under the name of noise. For an effective analysis and taking measures necessary to improve or, if possible, eliminate them, is important to better understanding of the relationship between exposure to noise as well as vibration present in other types of rail traffic,

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concerned on how they affect human health. All this is done taking into account the development of rail transport capacity as well as the intensification of high-speed train traffic or heavy goods trains.
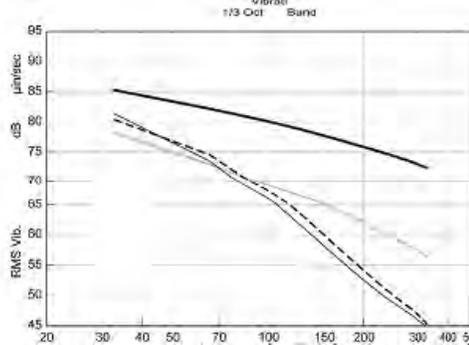

Fig. 3. *The variation diagram of the vibration spectrum of trains produced by numerical*

Overall, all studies show that the discomfort of railway traffic is greater in areas with the simultaneous vibration. The discomfort which caused by vibration was more pronounced at low noise levels and high levels achieved in other situations of distress was influenced by the vibration amplitude and / or high frequency and high noise levels. A possible explanation of the results of the latter is that "masking" noise reduced vibration perception.
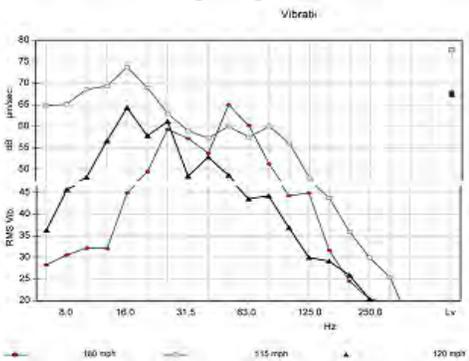

Fig. 4. *The variation of oscillation amplitude characteristic vibration of high speed trains*

In the calculations took into account and amplitude variation. This was considered as high-speed trains can travel at constant speed (eg 200 km / h), but with speed variations between values of 160 and 230 km / h. Modelling dynamic systems mentioned above, I assume, in advance, and make preliminary research [2].

Especially, the study of mechanical wave propagation in soil is given the dynamic nature of interaction forces as well as soil structure. Last but not least, taking into consideration aspects of propagation of the wave field saturation (multilayered), which may affect all or part of the soil, depending on the poro-elastic nature of its structure and composition.
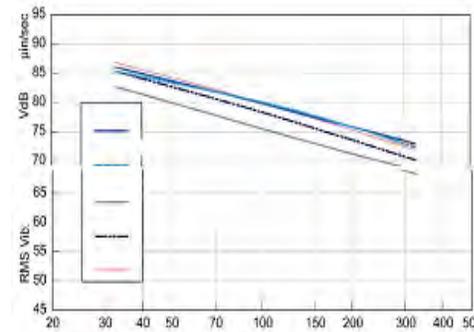

Fig. 5. *The variation of sound vibrations spectrum (headings of frequency) propagated*

All the research is done in advance because the soil is considered as a porous medium consisting of an assembly of solid particles and interstitial space, inter-granular density and distribution of which is taken into account in the calculations are defined three categories namely soil pore space defined by the amount that can be filled with air (dry), who can be filled with a liquid (if media saturation) or one that is characterized by a fluid artificially introduced and a small amount of air (as if unsaturated environment).

Composing dimensional Green functions

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in multilayered poro-elastic medium. An important role in determining the rigidity of the system lies in the dynamic calculation of basic functions for multilayered poro-elastic media. This is possible with the Green function are known analytically, then used a three-dimensional boundary element response factor of a semi-phase multilayered environment. This is possible by Dirac method, using a single pulse. The reaction, concerned Dirac signal response function can be calculated from two-dimensional system of equations whose solutions are delivered through of an omograph transformation [2]. To note there is the fact that the initial solution is a solution to the limit problem is asking, in this case, only a solution finite and real, which can be obtained by successive integral transformations of independent variables mentioned two-dimensional system of equations previous. The layer stratum and semi-stage phase, described above, are elements which are obtained from the use of solutions which are used as matrix analysis of partial differential equations of order I and II derived from two-dimensional system of equations. For the full transformations are used to limit the initial conditions, the problem can be solved and if a field (system) with the quadrature coordinates transposed form equation adapted from Green.

In terms of spectral analysis of surface waves, vibrations induced intensity variation, is an environmental issue as it was shown. The discomfort, reported by the residents with homes in the vicinity of railway lines, can be caused by malfunctioning equipment and rolling stock subassemblies. All of these aspects may even lead to damage by damaging buildings, they counting medium term railway traffic induced vibrations. This is due, in particular rail freight traffic, where the design and elastic damping elements

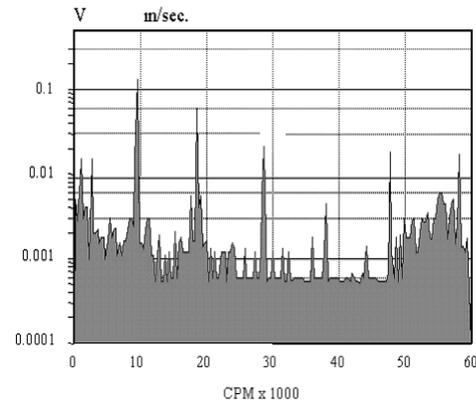have a lower grade quality, compared to that for passenger traffic.

Fig. 6. *The variation of the pulsation signals frequencies of vibrations described by the evolution speed locomotive*

Consequences arising immediately on the research involve a numerical model that is able to determine the response to vibrations due to railway traffic. The analysis in this case lends itself to two distinct phases.

The first step is to calculate the interaction forces and dynamic overloads propagated in bed ballast and tread light after passing rolling stock. In this situation, railway vehicle is approximated and modeled as a set of masses, connected by joints, suspension and shock absorbers.

The second step involves determining the level of vibration due to vehicle movement close to tread.

Subsequent thereafter the calculation is made dynamic rigidities through a system of equations in matrix form for the case of vertical dynamic forces arising from passing vehicle, taking into account the visco-elastic nature of the ground.

This workaround solution is rigorous in terms of determining the frequency spectrum of vibrations induced. In this way the system can be effective in combination with the calculation method for finite

element modeling of vehicle and ground by Green function.

During high speed main, oscillations due to tread irregularities, printed by engaging wheels (i.e. the crown gear and pinion gear) rotor shaft vibrations disturbance of electric traction, although the vibrations are attenuated by damping systems and vibration absorption, are likely to cause premature wear of tooth gears in the wheelsets drive system.

Determining the shape and character of these vibrations randomly covered by this study aimed to identify modes of vibrations in order to establish the fundamental harmonics, namely the identification of technical methods mitigate or eliminate.

This study of vibration, found at the level of floor side of the locomotive suspension EA 060, Co Co, in the electric traction motor rotor (fully suspended from the chassis of the box), was considering random tread deformation can be approximated by a sinusoidal function, where the decomposed resultant disruptive forces of lift oscillations caused by tread prints, for which the wavelength is l_s concerned segment of track length that was considered the manifestation of the phenomenon proposed for study.

To determine the sizes and tolerances used in the study of the influence of vibration is better identification of sinusoidal vibration modes, simplified calculation for systems with two degrees of freedom, extending to more complex models presenting some operating difficulties only if increasing equations and parameters characterizing the equations of motion.

In terms of satisfying comfort at the box vehicle, should be considered in design as their frequencies of oscillation of the box to a value low enough relative to the bogie oscillation frequencies.

3. Conclusions

Interaction between rolling stock and cause a dynamic path of the excitation oscillation generating sound waves, but also by mechanical vibrations, which propagate in the soil. There were clashes with its composite environment which, although has a dissipative character, yet enables the field of acoustic wave propagation and the mechanical by building structures and buildings in the vicinity of the track assemblies. After mitigation at the foundation field, the vertical component of vibration can be amplified by the resonance frequency at the level of different floors of building structure.

In the case the loss of lateral stability (depending on the speed of movement of the vehicle, taper wheel tire, wheel diameter, gauge track, wheelbase bogies and vehicle forces and pseudo-slip characteristics of suspension elements), the hunting oscillations increase the speed of movement the vehicle to which the phenomenon itself, the critical velocity can be increased operating outside of the locomotive, by selecting design parameters such as: taper bandage, features suspension components, runway geometry and vehicle weight.

The hunting phenomenon is one of the most important movements that occur when high-speed locomotives, which shall mean the coupling of the lateral oscillations of the vehicle sub-assemblies flexuosity, this happens mostly when a rail vehicle lateral oscillations developed and maintained increasing, component sub-assemblies, regardless of the tread (the defending hunting even in conditions of perfect rails).

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