ANNALS OF FACULTY ENGINEERING HUNEDOARA
– International Journal of Engineering
Tome XI (Year 2013) – FASCICULE 3 (ISSN 1584 – 2673)

[1.] Dana-Mirela COSTEA, [2.] Mugurel-Nicolae GĂMAN, [3.] George DUMITRU

THE HUNTING OSCILLATIONS OF ELECTRIC LOCOMOTIVE BR 185 SERIES ON MOVEMENT SPEED BETWEEN 70 AND 220 km/h

[1.] UPB, ROMANIAN RAILWAY AUTHORITY – AFER, ROMANIA
[2-3.] ROMANIAN RAILWAY AUTHORITY – AFER, ROMANIA

ABSTRACT: In the case of locomotives intended to carry passengers traffic (as the case locomotive of the series BR 185), engine vehicle is subjected to high dynamic loads. One of these dynamic phenomena is known in the literature, the phenomenon of hunting. By hunting means coupling the lateral oscillations of hunting. Hunting oscillations occur when a vehicle maintained and increasing lateral oscillations develop due to sub-assemblies, ie the reactions of the resultant forces that interact with the machine running and the axle drive system engine and the suspension and damping floors. One of the significant features of the hunting phenomenon lies in the fact that it is composed oscillations occur even in the case of perfect track.
KEYWORDS: hunting, field waveform, Dirac signal, modes of vibration, resonance. lateral oscillations

INTRODUCTION

The present paper is subject to the synthesis of results obtained from a study of vibrating character, drive systems characteristic of axles of railway traction vehicles for high-speed traffic. Measurements were performed in Germany and Austria, with electric locomotives (Figure 1.a & 1.b) BR 185 of the series (with axle formula Bo Bo) with 10 wagons and locomotive subsequently rotation and in Romania, the tests were conducted both with train isolated and dual traction. The comparison results (both experimental speed up to 220 km / h in Germany and analytically by successive simulations in Romania) with the results of existing studies in the literature, the conclusions drawn are not intended to be only an addition on the light of improving the performance of indicators of efficiency, quality and reliability, in terms of passenger trains on high-speed rail.

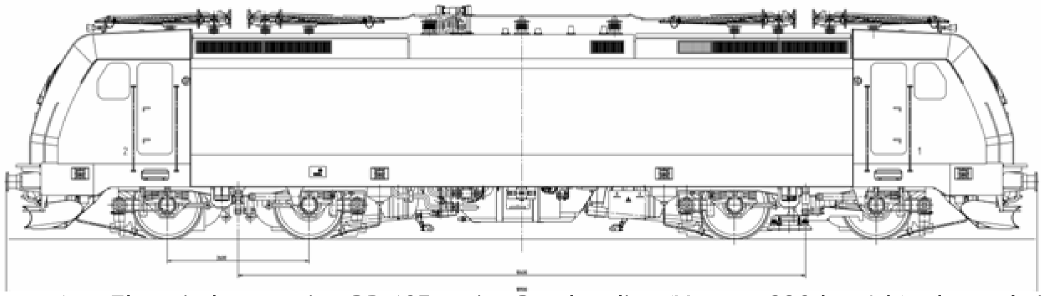


Figure 1.a. Electric locomotive BR 185 series Bombardier (Vmax = 220 km / h) - lateral side

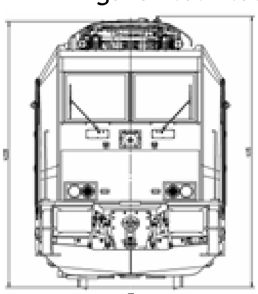


Figure 1.b. Electric locomotive BR 185 series Bombardier (Vmax = 220 km / h) - front side

The study of vibration in high-speed movement of trains is necessary because it involves directly the environmental damage by its noise and vibration propagation through structure that destroy the resistance of the buildings in the vicinity of railway lines. Vibrations concerned mainly propagates as a wave field (as if noise occurred when trains pass through neighboring buildings), thus affecting the occupants. The rapid expansion of high-speed rail network across Europe manifested simultaneously with the initiation of numerous studies to reduce vibrations and their effects, especially the sound.

The measurements made and the experimental results were then subjected to laboratory analysis comparison of the phenomenon of contact and the vibration occurring or [2]. These measurements have been processed and the data found in tabular form in the present paper. This has been possible by applying the quasi-static excitation with the variable parameters, frequency transient excitation due to the reactions found in the joints and suspension *from contact wheel - rail roughness induced excitation in conjunction with treads. Second was considered constituted the whole vehicle dynamic model - running track [3]. In this context, the path was considered subassembly defined and constituted the bed of the ballast or prism the rolling track.*

The railway 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 effective analysis and taking the necessary measures for improving or, if possible, eliminate them, it is important to better understanding the relationship between noise exposure and to other types of vibration present in rail traffic, or on how they affect human health. All this is done taking into account the development of rail transport capacity and the intensification of high-speed train traffic or heavy freight trains.

The analytical processing and comparing the experimental data obtained, as well as the results of the proposed indicators submitted to have been possible in view of the basic theory is the essence of research carried out in the course of time, on the whole vibration phenomena, in particular the phenomenon of hunt, which means coupling the lateral oscillations of hunting [7], such that it maintains.

In general, all studies show that the discomfort of rail traffic is higher in areas with simultaneous vibration. The discomfort caused by vibration was more pronounced at low noise levels and a high level achieved in other situations of discomfort was influenced by vibration amplitudes and / or high frequencies and high noise levels. One possible explanation of the results of the latter is that "masking" noise reduced vibration perception.

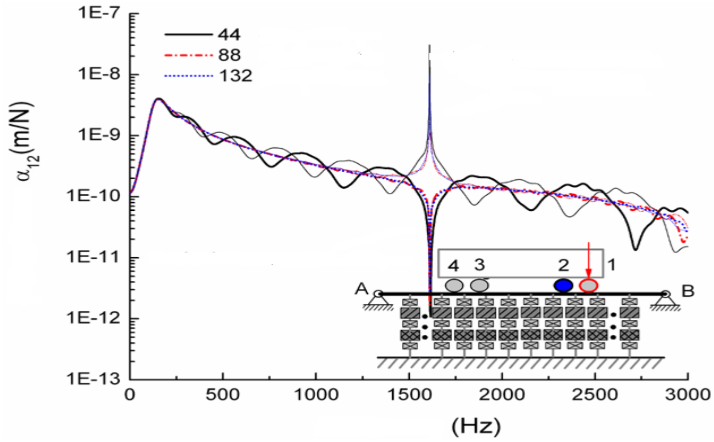


Figure 2. Excitation diagram of a point on the tread wheel locomotive BR 185 and propagated vibration spectrum

In the calculations was taken consideration the variation of amplitudes. This was considered as high-speed trains can travel at constant speed (for example, at 200 km / h), but also speed variations between the values of 70 and 220 km / h A full description of the analyzed data and measurements made with the locomotive BR 185, subject to various tensile test to identify and the vibration stabilization regime can be found in tabular form in the following pages. Modeling dynamical systems mentioned above, assume in advance and conducting preliminary research. In particular, the study of mechanical wave propagation in soil takes into account the dynamic nature of the interaction forces and the soil structure. Finally, it takes into consideration aspects of wave propagation saturation field (multilayer), which may influence or part of the ground.

An important role in determining the oscillating system rigidity wheel - rail is dynamic calculation of basic functions for multilayer media as raceway or of the ballast bed (prism path). This is possible by using Green's function determined analytically. Subsequently used semi phases response factor of a multilayer environment for three-dimensional boundary element. This is possible with the Dirac method using a single pulse. Reaction that is the Dirac function response signal can be calculated from a two-dimensional system of equations whose solutions are obtained by a transformation homograph [4].

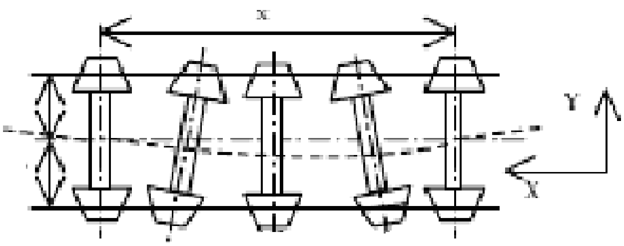


Figure 3. Simulated hunting phenomenon of axle locomotive BR 185

It should be noted is the fact that the initial solution is a solution to limit the problem of placing, in this case, only the actual finished a solution, which can be achieved by processing successive full independent variables [3] the system dimensional equations mentioned above. Layer and the semi phases, described above, are elements which are obtained from the use of solutions which are used as matrix analysis of partial differential equations and second-order equations derived from two-dimensional system. For full transformations are used to limit the initial conditions, the problem can be solved in the case of a domain (system) with coordinates transposed by quadrature [7] adapted to the shape of the Green equation.

From the point of view of the spectral analysis of surface waves, the intensity variation of induced vibration is an environmental problem as already shown. Discomfort reported by the residents of neighboring homes railroad lines may be caused by malfunctioning equipment and rolling stock assemblies [7].

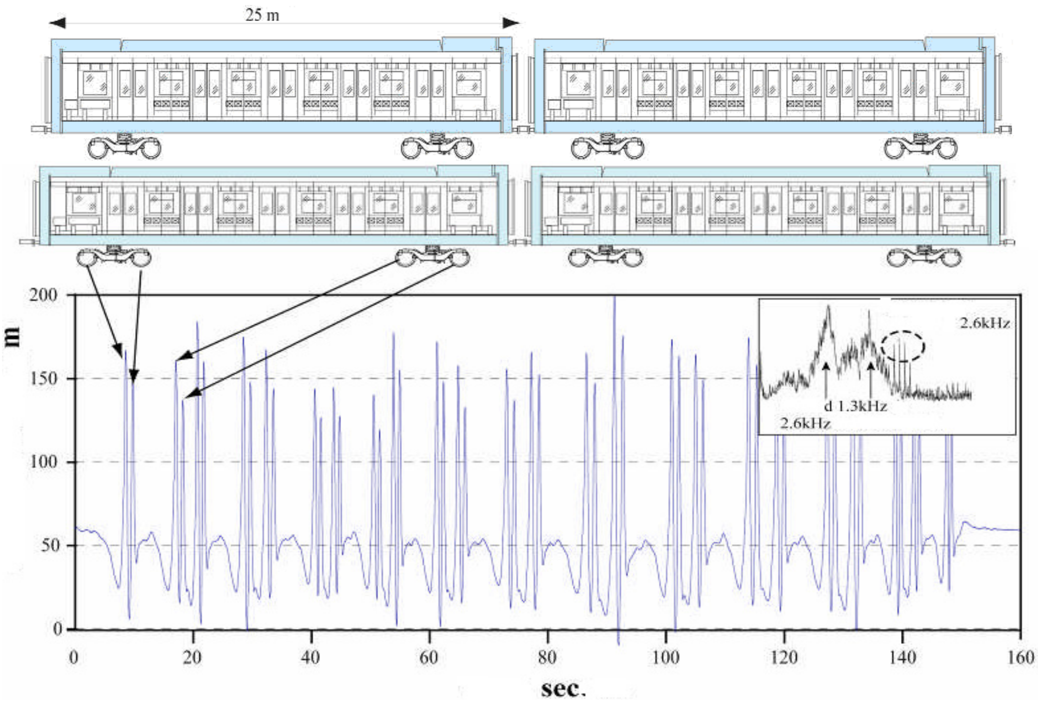


Figure 4. The variation of the vibrations frequency spectrum produced by the high-speed circulation of passenger trains

All of these aspects can even lead to damage by damaging buildings they counting medium that induces vibrations in railway traffic. This is due, in particular rail freight traffic, where the design elastic and damping elements have a degree inferior compared to that for passenger traffic (Figure 4). One of the consequences arising immediately involves research on the numerical model, which is able to determine response to vibration due to railway traffic. The analysis is suitable in this case to two different phases. The first step is to calculate the interaction forces and dynamic overloads propagated in the bed of ballast and prism the rolling track after passage of rolling stock. In the this case, the railway vehicle is approximated and modeled as a set of tables linked to each other by hinges and suspension and shock [7]. The second step involves the determination of the vibration due to the movement of the vehicle in the vicinity of the rolling track. Subsequently calculation is dynamic rigidities through a system of equations in matrix form, the vertical dynamic forces occurring when after passing the vehicle, taking account of the viscous - elastic soil. This solution is rigorous in terms of determining the frequency spectrum of vibration induced. In this way, the system can be effective in combination with the method of calculation for finite element modeling and ground vehicle using Green's function.

During the high speed movements, oscillations due to the rolling track irregularities, wheel prints through engaged (respectively the ring gear and pinion gear) motor rotor shaft vibration disruptive electric traction, although attenuated vibration damping systems through and vibration absorption, are likely to cause premature wear of the teeth of the gear wheels wheelset drive system [6]. Determining the shape and character of these vibrations random subject of this study aimed to identify their modes of vibration to determine fundamental harmonic oscillations hunting, technical procedures that identify mitigation or elimination.

The present study of the vibration retrieved at the level primary storey of the locomotive suspension class BR 185, in the electric traction motor rotor (fully suspended from the chassis of the box) and the box locomotive was made considering random deformation path rolling can be approximated by a sinusoidal function [1], the resultant decomposed disruptive forces caused by oscillations printed by jump oscillations in railway path, for which the wavelength is that the length of the rail segment that was considered the manifestation of the phenomenon proposed for study.

For the determination of the size and tolerance limits used in the studying the influence of the vibrations it is preferable to identify the sinusoidal vibration modes [10] for the simplified calculation with two degrees of freedom, extending to more complex models operating only presenting some difficulties if increasing the number of equations and parameters characterizing the equations of motion. From the point of view of at the level box meet the comfort of the vehicle, must be considered in designing the own frequencies of vibration of the box to a low enough value [9] in relation to the frequencies of oscillation of the bogie.

CONCLUSIONS

The interaction between the rolling stock and the road surface excitation results in a dynamic vibration generating sound waves, and also mechanical vibrations, which propagates in the soil. There *were clashes with the composite thereof which, although it has a dissipative nature, yet enables the propagation of acoustic waves and mechanical field by of the subassemblies residential buildings and structures in the vicinity of the track. After mitigation field level foundation, the vertical component of the vibrations can be amplified by the resonance frequency of the different floors building structure.*

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

The hunting phenomenon is one of the most important emerging high speed the movement of locomotives, which means coupling the lateral oscillations of sub-assemblies hunting vehicle, this happens especially when a railway vehicle lateral oscillations developed and maintained escalation of the sub-assemblies, regardless of the roadway (the defending hunting even under conditions of perfect rails).

REFERENCES

[1] DUMITRU, G. Considerații asupra unor aspecte legate de dinamica vehiculelor motoare de cale ferată (Considerations on some aspects of railway vehicle dynamics engine), Revista MID-CF (MID-CF Gazette), no. 1/2008.

[2] DUMITRU, G. & others: “Dynamics Of The Vehicle Running Track Interraction”, in RailwayPRO Science & Technology - Official Magazine For Club Feroviar Conferences & Technical Colloquia, ISSN 2284 - 7057, pp. 10 – 20, Sibiu, March 28 - 29, 2012.

[3] HEUMANN, H., Grundzüge der Führung der Schienenfahrzeuge, Olandenburg - Verlag, 1954.

[4] KALKER, J. J., "Book of Tables for the Hertzian Creep - Force Law", in Report of the Faculty of Technical Mathematics and Informatics No. 96-61, Delft University of Technology, Netherland, 1996.

[5] KUNIEDA, M.: “Theory and Experiment on Vertical Vibration of Rolling Stock Equipped with Air Spring“, in Railway Technical Research Report, no. 6, RTRI (Railway Technical Research Institute) JNR, Apr. 1958, Japan.

[6] MATSUDAIRA, T. & others: “Problems on Hunting of Railway Vehicle on Test Stand. T mas“, in A.S.M.E. Journal of Engineering in Industry, Vol. 91, Ser. B, no. 3, pp. 879 - 885, 1969.

[7] MAUZIN, A., “Contribution a l’□tude du confort transversal de vehicules”, Revue Generale Des Chemins De Fer, Oct. 1965.

[8] PRUD’HOMME, A., Les problems que pase, pour la voie, la circulation des rames a grande vitesse", Revue Generale des Chemins de Fer, Nov. 1976.

[9] SEBEŞAN, I., MAZILU, T.: “Vibrațiile vehiculelor de cale ferată” (The Vibrations Of Railway Vehicles), Editura “MatrixRom“ Bucureşti, 2009.

[10] SIRETEANU, T. & others: “Improving The Hunting Motion Stability By Using The Nonlinear Dissipation Device In Wheelset With Elastic Joints System“ in Tehnomus XV 15-th International Conferences Proceeding, pp. 81-86, ISSN-1224-029X, Suceava, 2009.

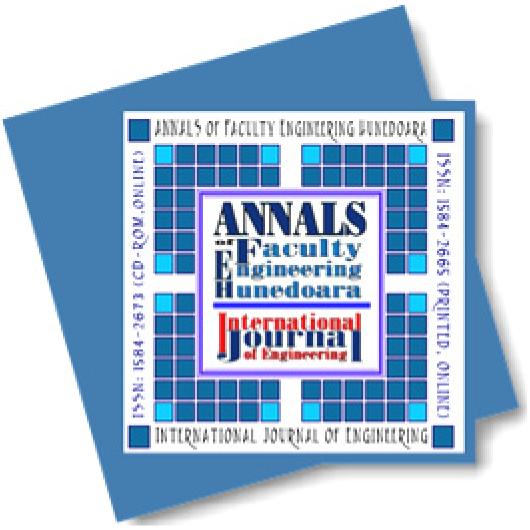
[11] VAN BOMMEL, P., STASSEN, H. G., "Determination de quelques caracteristiques stochastiques des deviations des files des rails", En vue de l’etude du mouvement de lacet, Report ORE, Utrecht, 1996.

[12] VOINEA, R., VOICULESCU, D., CEAUŞU, V.: “Mecanică“, Editura Didactică și Pedagogică, București 1975.

[13] Journal of Dynamic Sistems: march 2003

[14] Nonlinear Dynamics: no. 13 / 2007

[15] Quarterly of Applied Mathematics: april 2008



ANNALS of Faculty Engineering Hunedoara

– International Journal of Engineering