DYNAMICS OF THE RAILWAY VEHICLES

(Romanian title: Dinamica vehiculelor feroviare)

TREATISE

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REVIEW

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As a fundamental subject of the rolling stock engineering field and aimed to develop the knowledge of the specific issues concerning the vehicle-track interaction, the ***Dynamics of the railway vehicles*** evolved worldwide as the trains became heavier and faster. The scientific analysis took the place of the technical intuition and empiricism and thus, the subject based on knowledge from the theoretical mechanics, vibrations and tribology provides the technical conditions for the safe track guidance and running stability, which are necessary mainly for the design of the rolling apparatus and the vehicle's suspension system.

Given the safety of the track guidance (which has to prevail in railway transportation), the results of the theoretical and experimental research are put into practice only after a severe (and usually very long) testing. As a result, many of the outcomes from the research are published in specialized works very late, when several specialists are already aware of them. Thus, the elaboration of this book - which deals systematically with fundamental issues of the dynamics of the railway vehicles and includes the latest knowledge in this field - became necessary.

Considering the importance of the aspects concerning the wheel-rail contact, this work presents some contact geometry issues and the newest approaches regarding the tribology of the rolling and guiding surfaces, with a special attention paid for the wear profiles.

The issues concerning the kinematics of the axle sets are developed in a generalized form, which allows the determination of the slipping speeds in the contact points, for both cases of running in curves or alignment. The equations for slipping speeds in the particular situations of the axle (free, braking and traction regime) are presented. Also, the author describes the spatial orientation of the slipping speeds in the contact points of the wheels on the rails. The new knowledge concerning the pivot effect was also introduced.

The problems of vehicle kinematics were elaborated in order to limit the speeds and accelerations in circular curves and acceleration variations on connection tracks, taking into account the vehicle's suppleness coefficient (which is determined using some general formulae that may be customized for all types of vehicles).

The stresses in the wheel-rail area are determined using Hertz's theory and the pseudo-slip coefficients are calculated using Kalker's theory, which is the most

important in this matter.

The safety against derailment is presented not only through the well-known Y/Q ratio, but also by analyzing the influences of the forces outside the axle (according to latest researches).

The torsion capacity of the bogies and the vehicles is approached according to the newest knowledge concerning the non-linear regression law of the track torsion gradient.

The issue of determining the main driving forces that occur when running in curved lines is tackled considering the hypothesis of the existence of the wheel-rail pseudo-slip coefficient. A special attention was paid for the new self-steering bogies, which have the so-called capability to *"negotiate"* the curvature radius.

The conditions that need to be fulfilled in order for the "*attack-shock*" to occur when running in curved and jointed lines are also presented, with the calculus of the dynamic shock force and the conditions for derailment.

A distinct attention was granted to the suspension of the vehicles, as this particular element has the crucial role of vibration isolator. The flexibility and damping characteristics for metal, rubber and pneumatic components are presented as well, together with the specific issues for urban rail vehicles (e.g. elastic wheel as a suspension element).

The study of the vibrations is oriented towards particular issues of the railway vehicles, as these are influenced mainly by the interactions with the track. A special place is granted for the hunting movement, which is dealt with the newest analysis methods (by integrating the wheel-rail contact phenomena).

In order to analyze the comfort level of the railway vehicles, the running quality indexes according to Sperling's theory are presented along with the evaluation of the time-span for fatigue occurrence among the passengers.

The main issue concerning the stick-slip phenomena that occurs at the motor vehicles is presented as well. The analysis provides some constructive conditions for the axle drive system, so that the dynamical stresses of this phenomenon may be reduced. The theory of the stick-slip occurrence to an axle drive system of a locomotive is an outstanding personal contribution of the author of this treatise, which brings a significant and valuable input for the progress of science. Through a comprehensive and systematic presentation, the author brings his contribution to the elucidation of some problems highlighted by specialists since late 19th century and the particularities of the modern high-speed trains.

Because the scientific knowledge is developing in a fast manner, the author looked that the whole phenomenology of the dynamic behaviour of the railway vehicles might be developed so that the reader could think himself, helping him thus to form his scientific based conception and to open further perspectives fully adaptable to future discoveries.

A state-of-the art vehicle which has a perfect dynamic behaviour performs a maximum reduction of the effects caused by external disturbances and interaction forces with the track. As anyone knows today, the trend is to increase the train speeds in alignment and curved lines as well. The factors that limit the top speeds in railway

transportation and the particular aspects of the manufacturing of high-speed trains are also depicted in this work.

The actual form is, in fact, a rewritten and highly improved version of the 1995 and 1996 previous editions. Thus, one may notice a series of new aspects, like the influence of the wheel-rail contact conditions, the variation of axle loads for locomotives, the extended presentation of the main characteristics and performances of the suspension systems, elastic wheels, contact phenomena between the pantograph and the catenaries, a series of examples concerning the modern vehicles and some of the author's personal works.

Professor Dr. Ioan Sebesan oriented his entire scientific activity mainly towards his speciality, the dynamics of the railway vehicles, publishing a series of original books of a great scientific value.

The researches performed by *professor Sebesan* (from which a substantial part is included in the present work) contribute to the extension of this scientific field and, nevertheless, to the development of the Romanian school dedicated to the railway vehicles (faculty, master programs and doctoral studies). Under the direct advice of professor Sebesan a significant number of field specialists graduated their doctoral studies, the most part of the subjects covering the issues related to the dynamics of the railway vehicles.

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