Yury V. Diomin, Rostislav Yu. Diomin

State Scientific-Research Center of Ukrainian Railway Transport

PROCEDURAL ISSUES ACCEPTANCE
OF ROLLING STOCK GAUGE 1435/1520 mm

The manuscript delivered: April 2013

Abstract: In the paper the results of comparative analysis of the systems for estimation of dynamic qualities of rolling stock of 1520 mm and 1435 mm gauges are presented. Procedures, necessary for confirmation of exploitation possibility of rail vehicles for international transportations on the railways of different standards are considered.

Keywords: rolling stock, integration tests, computer simulation, admission procedure

1. STATEMENT OF THE PROBLEM

Technical conditions of train traffic safety are determined by the design characteristics and technical state of rolling stock running parts track. The corresponding factors acquire more weight to the objective of enhanced quality passenger and cargo traffic. However, the existing normative documents under which the work is done on the design and modernization of the rolling stock of 1520 mm gauge, oriented industrial manufacturers and repair facilities on outdated approaches to quality assurance systems and admission to the operation of rolling stock. Therefore there is a need to accelerate the process of renovation of regulatory documents, which should form the basis for the creation of rolling stock corresponding to the requirements of modern international criteria of traffic safety, strength reliability, ride quality and acceptable impact on the track.

In connection with the formation of the rolling stock to ensure sustainable development of international communication in the directions of "East-West" issues of operational approval of the new generation cars become especially important [1]. In addressing issues relating to the admission to the operation of cars for interoperable transport requirements that apply to the rolling stock of 1520 mm and 1435 mm should be compared. Then, confirmation procedure meeting these requirements to passenger and freight cars for international traffic should be determined.

At present there is no specific system of procedures for admission to the permanent operation on railways of 1520 mm of passenger and freight cars designed for interoperable transport. In addition, the methods and means that are traditionally used in the tests of the
rolling stock in need of revision. Consideration of matters concerning interoperability and technical regulations between the railway systems of 1520 mm and 1435 mm gauges is carried out by the Contact Group OSJD / ERA, initiated by the European Union and the Baltic States.

2. EVALUATION RIDE QUALITY OF THE ROLLING STOCK

Ride quality is the most important characteristic that determines the functional properties of the rolling stock. Indicators of ride quality and traffic safety of cars mainly depend on their dynamic performance. These indicators are evaluated with numerical and experimental methods. In each case the structural features and condition of the track must be taken into account.

From comparisons of regulatory requirements related to the assessment of dynamic qualities and the impact on the track of the rolling stock of 1520 mm gauge [2], on the one hand, and the relevant European standard [3, 4], on the other hand, it can be stated the significant differences in the approaches to settlement cases and to the assessment of rolling stock running characteristics (Table 1).

<table>
<thead>
<tr>
<th>Comparison of the rolling stock dynamic indexes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rail tracks of 1520 mm gauge</td>
</tr>
<tr>
<td>The safety factor of wheel set stability against derailment</td>
</tr>
<tr>
<td>The safety factor of stability against overturning</td>
</tr>
<tr>
<td>Frame forces in the fate of axial load</td>
</tr>
<tr>
<td>Coefficient of vertical dynamics</td>
</tr>
<tr>
<td>Determined</td>
</tr>
<tr>
<td>Determined</td>
</tr>
<tr>
<td>Not determined</td>
</tr>
<tr>
<td>Ride indexes (Wz)</td>
</tr>
</tbody>
</table>

Regarding the differences in regulatory requirements should be noted that, for example, the assessment indicators for safety standards for track 1520 mm is the method which does not reflect the actual conditions that increase the risks of rising locomotives and wagons
derailment because it does not take into account the time factor. Ride comfort is assessed by indexes which are determined using the methodology developed several dozen years ago. During tests of rail vehicles experiments with wheels naturally worn in service are not provided.

2. CONFIRMATION PROCEDURE POSSIBLE EXPLOITATION CARS OF 1520/1435 mm GAUGE

Currently, there are no specific procedures for admission to the operation of rolling stock designed for use on the railways of 1520 mm and 1435 mm. Therefore the matter of admission to the operation of wagons in international traffic is determined by bilateral or multilateral agreements between railway administrations as traffic participants. The following are the basic requirements for the procedural provisions of the admission tasks.

Cars to international transport before being approved for operation must undergo comprehensive tests – stationary, strength, running, brake and train sets. These tests are necessary to determine the degree of car conforming to technical requirements on the criteria of traffic safety, durability, reliability and functionality.

Before the series of tests required to inspect the characteristics of a prototype for compliance with technical requirements and design documents. Also need to check for quality certificates, approvals, acceptance of conclusions for each element and material.

Stationary tests include weighing on the wheels, the determination of resistance to the truck rotation comparatively of the body and resetting wagon with wedges. Weighing the wheels is performed to determine the actual weight of the car and the vertical distribution of the static wheel load.

Test at reset the car off wedges conducted to determine the natural frequencies of the vehicle vibrations on the spring suspension and damping parameters. At carrying out of these tests vibrations bouncing, pitching and rolling of vehicle are caused artificially. According recordings of the acceleration obtained in the process of free oscillations of the vehicle natural frequencies and vibration decrements are established. These characteristics are also determined by dynamic analysis. The calculated data are compared with the results of the tests.

Strength tests include static and dynamic testing, bench testing and tests for the collisions. Static tests include the determination of the stresses in the bearing elements of the running gears of the body weight. Dynamic strength tests are usually conducted during tests on track. At the same time characteristics of the stress-strain state of the tested structure as a whole, as well as of its separate elements are determined.

Running tests are conducted to determine the dynamic parameters of cars and assessment of security conditions of its motion as well as force action on the track. The test track sections, on which the running tests should be statistically representational in design and status, and to plan and profile. Running tests are conducted under two conditions of wheels – without wear and with wear. The values of equivalent conicity must meet the normalized values.
Brake tests are conducted to determine the effectiveness of the brake and consist of stationary and running regimes. At steady-state tests characteristic and condition of the braking equipment are verified. During running tests, which are carried out by method of «throwing» of an experienced car, braking distances are defined in emergency braking.

Trainset tests are conducted to check the level of dynamic forces in the coupling gears at actual operating conditions and to determine the conditions of train formation, mode of traction and braking trains.

According to the results of the comparative analysis of the regulatory requirements on admission procedures for exploitation of rail stock in international transport should be determined by the conditions under which the procedure, which is performed on the railways of 1435 mm gauge, may be offset when deciding on admission of vehicles to the railways of 1520 mm gauge.

3. COMPUTER SIMULATION

The role of mathematical modeling in the preparation and analysis of the test results is difficult to overestimate. Each model that is built with use of modern software, although approximately displays certain characteristics of an object, however, has the properties of universality. Thus, provided the veracity of the parameters, which are used in the calculation, the computer model adequacy to investigated object reaches a level satisfactory for practical use of the simulation results [5, 6].

Therefore, experimental studies to determine the feasibility of admission to operation of the railway vehicle must be accompanied by a dynamic and strength calculations with the use of modern computer simulation. The results of calculation promote to formation of rational software solutions and to expand of information area, complementing the experimental data.

It should be noted that the methods and means of tests which are used to address issues related to the admission of new rolling stock for the modernized vehicles are too costly in terms of time and money. According to the authors admission procedures for operating the modernized carriages can be simplified compared to the procedures that accompany the admission of new rolling stock. In these cases it is recommended the use of computational and experimental method (CEM), which is based on the idea of the expansion restricted experimental data on the dynamic behavior of rolling stock by using of appropriate mathematical models [7]. Fig. 1 shows the scheme of realization of CEM.

Application of CEM-technology to assess the dynamic properties of rolling stock involves performing a number of the following sequential operations:

a) The mathematical model of forced spatial vibrations of the vehicle is created, and then by means of special software it is implemented in a computer model;

b) The tests of rolling stock unit are conducted under the simplified procedure. This can restrict the measurement of the body and bogies accelerations. In particular, these measurements can be carried out under standard operation of rolling stock;
c) The experimental data are used to configure the computer model to a satisfactory convergence of the results of tests and calculations. Thus, there is an adequate simulation of the dynamic processes that accompany the movement of the vehicle;
d) With the help of the corrected computer model full range of output values necessary for a comprehensive assessment of the dynamic characteristics of rolling stock is calculated.

Fig. 1. The scheme of realization of computational and experimental method

4. CONCLUSIONS

1. Due to the absence a coherent system admission to operation of the rolling stock for the direct and cargo connection in direction of East-West is necessary to develop an appropriate regulatory framework based on the harmonization of existing guidance documents on the railways of the different standards.

2. Procedures for admission of rolling stock for interoperable transport should provide their complex tests, including the kinds of tests accepted on the railways as of 1520 mm and 1435 mm gauges. Thus should determine the conditions netting of similar types and modes of tests.

3. To obtain sufficient and reliable assessment of the dynamic properties of the modernized railway vehicles, as well as to reduce the time and cost associated with the work on their admission to operation, it is recommended to use a new approach based on balanced mutual complement of mathematical modeling of the dynamics of railway vehicles and full-scale tests under the simplified schemes.
References

2. Norms for analysis and design of railway wagons MPS 1520 mm (non-self). GosNIIV-VNIIZhT, Moscow, 1996.

ZAGADNIENIA PROCEDURALNE PRZYJĘCIA DO EKSPLOATACJI TABORU KOLEJOWEGO 1435/1520 mm

Streszczenie: W artykule przedstawiono wyniki analizy porównawczej systemów oceny dynamicznych właściwości wagonów na kolejach 1520 mm oraz 1435 mm. Rozpatrywane procedury niezbędne w celu potwierdzenia możliwości eksploatacji dla międzynarodowego transportu kolejowego w różnych standardach.

Słowa kluczowe: tabor kolejowy, testy integracyjne, symulacja komputerowa, procedury przyjmowania