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Road and Rail Infrastructure IV

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PROTOTYPE RAILWAY WAGON WITH ROTATABLE LOADING PLATFORM AND CONCEPT OF INNOVATIVE INTERMODAL SYSTEM USAGE

Tadeusz Niezgodą, Wiesław Krason
Military University of Technology, Poland

Abstract

An innovative system proposed in the paper is based on a special railway wagon with a rotatable, low and flat loading floor. It can be used for transporting various types of vehicles, for example, tractors, trucks, trailers, semitrailers, cargo containers. The railway system using special wagons allows quick and convenient self loading and unloading of vehicles and containers (no cranes needed); no platform infrastructure is required, but hardened, flat, surface; no need for hubs, terminals or special logistics; each wagon can be operated separately. The selected aspects of the idea and a project of a special wagon for intermodal transport were discussed in authors' earlier papers. A prototype version of the wagon with a rotatable load platform is presented shortly in the paper. The idea of an intermodal system based on the innovative railway wagons and the constructional solutions used for it is presented in the paper as well. A technology presented in the paper allows elimination of expensive terminal loading devices from the utilization. In relation to a presently utilized construction of such a type (e.g. Moda Lohr and other), the advantages of the presented system are as follows: applying of repeatable wagons-platforms with an automatic rotating body for fast easy and safe loading and unloading of trucks without additional crane devices, constructional dimensions of the wagon with the load in the form of a semitrailer up to 4 m meet requirements of GB1 gauge, relatively simple and cheap infrastructure of the proposed system enabling cheap, ecological and safe transport of truck tractors with a semitrailer with a total length of 17 m, a weight up to 40 tons and low exploitation costs of such a system.

Keywords: intermodal transport, special railway wagon, rotatable platform, rail-road system, semitrailers transport

1 Introduction

In European railway transport, in recent years, there have been implemented intermodal systems based on horizontal or vertical reloading or others [1]. These systems require developed reloading terminals equipped with, for example, vertical reloading devices of accurate load capacity or other expensive and complicated devices enabling loading and unloading activities. The latest solution is the system of transportation of TIR type trucks with the use of railway developed by French company Moda Lohr [2] and Megaswing wagon built by Swedish company Kockums Industrier [3]. Figure 1 presents new intermodal systems developed by the above mentioned companies. Moda Lohr system requires extended infrastructure, especially, railway platforms as well as proper maintenance of the platform devices. Megaswing wagon is equipped with a low-loader rotating platform, which is rotated in respect to an asymmetrically located rotating junction, placed at the rear part of the wagon over its 'over-bogie' part.



Figure 1 Wagons for trucks semitrailers transportation: a) developed by French company Moda Lohr [2], b) Megaswing developed by Swedish company Kockums Industrier [3].

The idea of an intermodal system based on the innovative railway wagons and the constructional solutions used for it is presented in the paper. The system is based on a special railway wagon with a rotatable, low and flat loading floor. It can be used for transporting various types of vehicles. A technology presented in the paper allows elimination of expensive terminal loading devices from the utilization. A rail-road system for the semitrailers transport adjusted to the present condition of the existing railway infrastructure in Poland is developed.

2 Construction of the wagon in a prototype version

A prototype railway wagon with a rotatable platform for an intermodal system is developed in the Laboratory of Materials Strength of the Department of Mechanics and Applied Computer Science, Military University of Technology [4, 5]. Due to constructional assumptions in which transport of standard semitrailers of height of up to 4 m and standard biaxial rail bogies of Y25 type has been expected, maintenance of a gauge is possible by dint of lowering the wagon floor with maintaining the minimum distance of 130 mm from the frame bottom to the head of the rail and application of a special construction of the frame with the thickness of less than 70 mm in the central part of the wagon. A considered wagon consists of the following elements: chassis with biaxial standard Y25 bogies, frame, platform body, pneumatic systems, buffer devices, other external devices, electric equipment and hydraulic systems. A general view of a prototype version wagon prepared for transport and with a loading platform rotated to the loading-unloading position is presented in Figure 2.

According to this solution (Fig. 2), a wagon has been equipped with a low located frame of the chassis (1) meeting the requirements of gauge GB1 and a rotatable platform of the body wagon (2) with a strengthened construction of tailboards equipped with rotatable rolls located under the end edges of the platform. The platform is rotated in respect to a chassis and a loading/unloading platform owing to application of a rotating junction located in the central part of the wagon. Moreover, the wagon is equipped with an over-bogie part of the frame (1) located over standard bogies (3) on the both ends of the chassis. Additionally, the wagon can be equipped

with stabilizers in the form of additional hydraulic supporters (5) fixed – two on each side of the frame – under a lowered plate of the chassis and adjusted for lifting the wagon on the rails during loading and unloading. The rotatable movement of the loading part of the body (2) is extorted by mechanisms (6) located on the both sides of the over-bogie part of the wagon (Fig. 2 and 3). It consists of a plate with a fixed toothed bar (8), hydraulic engine (9) driving the mechanism of rotation, toothed wheel cooperating with toothed bar and holder (10).

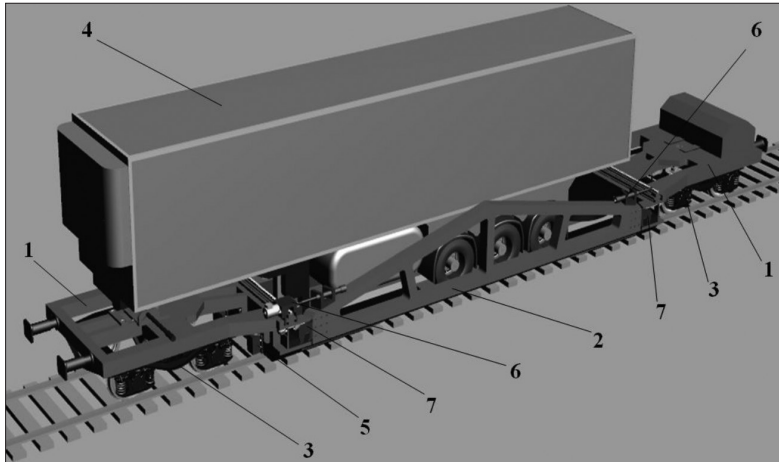


Figure 2 A view of a prototype wagon with a loading platform after loading/unloading process (in transport position): 1 – frame of the chassis (over-bogie parts), 2 – rotatable platform, 3 – Y25 bogies, 4 – semitrailer with load, 5 – hydraulic supporter, 6 – mechanism of the load platform rotation, 7 – tailboard locks.

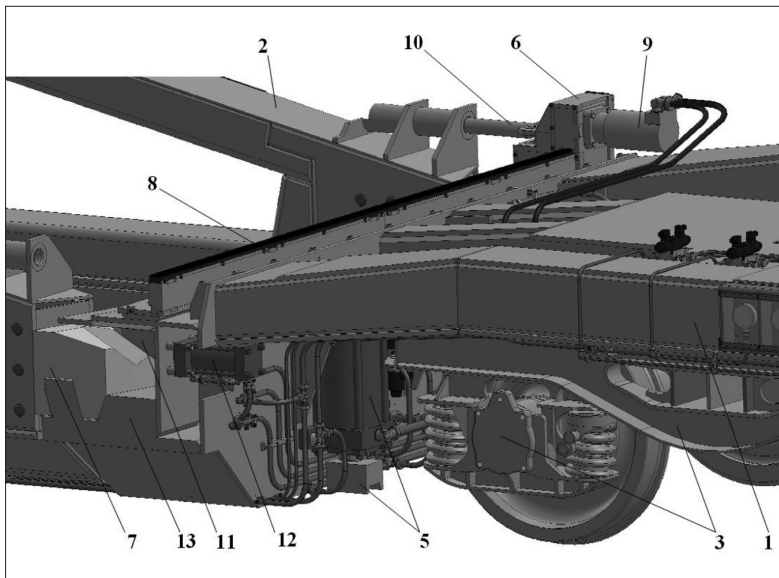


Figure 3 A view of an over-bogie part with: 5 – stabilizing supports, 6 -mechanism rotating the wagon loading platform, 7 – tailboard hook – locks, 8 – toothed bar cooperating with toothed wheel, 9 – hydraulic engine driving the mechanism of rotation (6), 10 – holder, 11 – wedge blocking of hook-locks, 12 – hydraulic actuator, 13 – raceways on which the hooks move.

A mechanism blocking rotation of a rotatable platform during transport of the load (a semi-trailer – 4 in Fig. 2) is very important from a functionality and strength point of view of the considered system of the constructional wagon. Construction of such a lock (7) – Fig. 3 allows only transmission of longitudinal load, therefore it does not block rotation of the platform and its movement in a transverse direction. This function is performed by a wedge (11) which is pressed to a lock-hook (7) and blocked with the use of a hydraulic actuator (12). The moving platform, while rotating, is supported on the central rotatable node in the centre of the wagon and on two raceways (13) on which the hooks move.

3 Cooperation of a special wagon with loading ramp – idea of the special wagon operation in kinematic simulations

A detailed geometrical model of the railway wagon with a rotatable platform has been built. The model served also to prepare kinematic simulations of the real cooperation of wagon subsystems with the rotatable platform of the body. These analyses enabled estimating the fluency of motions of the cooperating wagon mechanisms, and made it possible to detect potential cuts and initial identification of critical states concerning the run of loading/unloading operations and a proper transport phase from a constructional-operating point of view. The discussed model is used in the paper to demonstrate the principle of operations and to visualize basic functions of the railway wagon for transport of trucks.

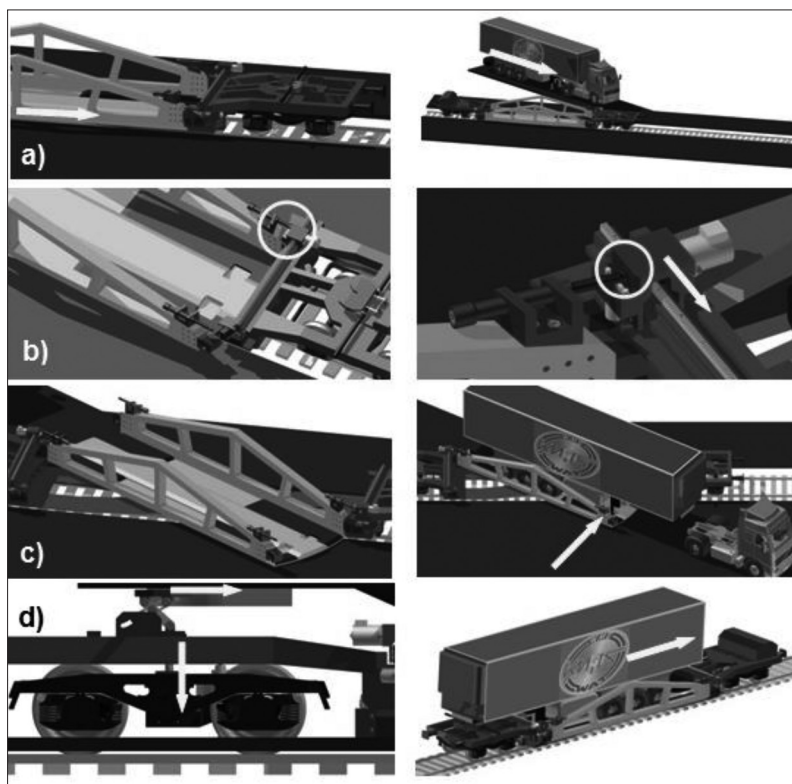


Figure 4 A view of selected operations during loading process: a) onset of an empty wagon onto the railway ramp, b) preparation for rotation of the loading platform, c) rotation of the loading platform in respect to the wagon frame and tractor's downhill drive from the railway ramp, d) preparation of the wagon with semitrailer to departure.

Fig. 4 presents visualization of cooperation of moving wagon parts and the wagon–tractor with a semitrailer system during loading/unloading operations. Numerical methods are used to simulate realization of individual sequences of the following operations:

- a) onset of an empty wagon onto the loading-unloading ramp,
- b) preparation for rotation of the loading platform, i.e., supporting the chassis on the heads of rails with the use of stabilizing supports and unfastening of tailboards locks,
- c) rotation of the loading platform in respect to the wagon frame and the loading/unloading ramp, onset of a tractor with a semitrailer onto the loading/unloading ramp,
- d) driving the tractor-semitrailer set onto the loading platform and unfastening the tractor,
- e) tractor’s downhill drive from the railway ramp,
- f) rotation of the loading platform of the wagon along with a semitrailer to the transport position,
- g) preparation of the wagon to departure, i.e., fastening the tailboards locks blocking the rotatable movement of the platform in respect to the wagon during the travel with the load and raising the supports stabilizing the wagon through resting the frame on the rails,
- h) onset of the wagon with a semitrailer onto the loading/unloading ramp.

4 Intermodal system

4.1 Idea of the intermodal system based on the innovative wagon

An idea of the intermodal system and simulations of basic functions and loading/unloading operations with innovative railway wagons and the used constructional solutions are presented in the paper.

The main part of the proposed intermodal system is a train consisting of a locomotive and a set of innovative wagons with the rotatable platform – Fig. 5. The wagon construction, optimized through application of modern design methods [6, 7, 8, 9], allowed achievement of suitable strength and considerable stiffness during the transport of the semitrailer with the load of total weight up to 40 tones. A characteristic property of the described solution is high resistance to loads assured through application of accurately stiff locks-joints fixing the moving loading platform to the over-bogies part of the frame in the configuration of the wagon ready for transport [10].

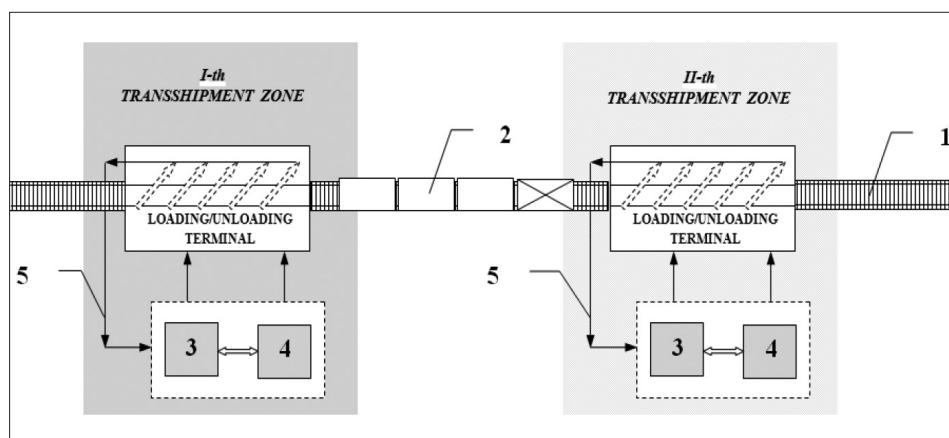


Figure 5 Proposal of the intermodal system with a train consisting of a locomotive and a set of innovative wagons with the rotatable platform: 1 – terminal railway track, 2 – train consisting of a locomotive and a set of innovative wagons, 3 – car park for tractors, 4 – warehouse/car park for semitrailers, 5 – access and maneuvering roads.

An important part of each intermodal system is a railway station that allows execution of loading or unloading of semitrailers. To load and unload such sets, there are needed final railway stations or intermediate railway stations with an access to a track (one or more) and a ramp with suitable dimensions enabling loading-unloading operations [1, 10]. Therefore, the innovative system for intermodal transport with the use of wagons with rotatable loading platform additionally consists of loading-unloading terminals – Fig. 6.

It is assumed that tractors serving for loading and unloading of semitrailers would operate in direct neighbouring of loading-unloading terminals. Special railway wagons can be operated simultaneously during a loading/unloading process. One or more tractors may be used. Their purpose would be delivering the semitrailers with freight intended for transportation to the designated terminal with a waiting set of special wagons and then loading the semitrailers with a freight on the wagons. After the semitrailer is detached and left on the wagon, the tractor can be reused for transport and loading the semitrailer waiting on the parking lot. If a greater number of tractors is used (simultaneous loading-unloading operation – Fig. 6), the time needed to stop the train at the terminal is reduced proportionally.

Loading-unloading terminals can be located in convenient border points having standard railway lines well communicated with junction stations in a particular country with a special attention paid to transshipment border stations on the main west-east and north-south directions for servicing intermodal transports over long distances.

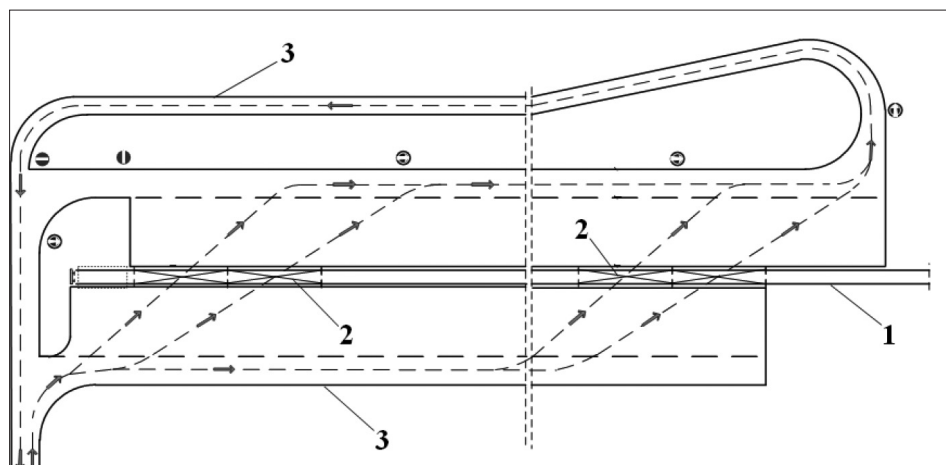


Figure 6 Terminal and traffic organization during loading of the set with special wagons: 1 – terminal railway track, 2 – special wagon with semitrailer, 3 – access and maneuvering roads.

5 Conclusions

The subject of consideration is a rail-road transport system adjusted to the present condition of the existing railway infrastructure in Poland. A developed technology allows elimination of expensive terminal loading devices from the utilization. Such a solution enables shortening the loading time and lowering the direct costs of loading terminal operations. An important advantage of the proposed solution is a possibility of trains production by national companies. Introduction of an innovative system of truck sets developed at Military University of Technology will results in the following profits:

- lowering the social costs of transport through its safety improvement as well as lowering the negative interaction of the road transport on the natural environment,

- improvement of the railway infrastructure condition through competent usage of the European Union's structural funds,
- reduction of expenditures for road infrastructure maintenance through limitation of degradation of routes resulting from limitation of road sets,
- improving the quality and extending the range of railway transport services,
- an increase in competition of national transporters within the framework of liberalization of the European Union's transport policy.

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