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INTERNATIONAL EXPERIENCE IN ORGANISING REGULAR PIGGYBACK SERVICE

The economic crisis being overcome by the Russian economy, on the one hand, combined with the inevitable globalisation processes, on the other hand, brings to the forefront the economic efficiency of technical processes associated with environmental safety and the possibility of introduction into the world system. One example of effective use of innovative technologies in the interaction of transport systems in the world is the piggyback transportation.

Aim: The author has conducted the analysis of international experience of the organisation of the piggyback transportation in order to identify technological solutions suitable for efficient use in the Russian market of intermodal transportation.

Methods: To assess the efficiency of different technological systems, the author uses comparative analysis methods, inductive reasoning, system approach method. The author has also synthesised the world experience in the organisation of the piggyback transportation.

Result: The results of the analysis have revealed that the current economic situation in Russia allows the evaluation of innovative transport systems in the first place in terms of the possibility of rapid return, which draws attention to the most economical technologies. In this regard, the use of the rolling highway and Lift-on – Lift-off (Lo-Lo) piggyback systems seems to be the most rational at this stage.

Conclusion: Since 1990s Russia has made a number of attempts to organise regular piggyback service on certain routes. However, due to the lack of demand for this type of services in the Russian market at the moment, investing in the development of piggyback technology involves high risks. The experience of other countries shows that regardless of the chosen technology, stimulating the demand for innovative "green technologies" is not possible without the participation of governmental bodies. At the same time, the creation of the necessary methodological framework for the organisation of piggyback transportation in Russia is possible by virtue studying the multifaceted world practice of piggyback technology operation in the world.

Keywords: transport system, logistic solutions, combined (intermodal) transportation, piggyback, piggyback technology.

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ЗАРУБЕЖНЫЙ ОПЫТ ОРГАНИЗАЦИИ РЕГУЛЯРНОГО КОНТРЕЙЛЕРНОГО СООБЩЕНИЯ

Кризис российской экономики, вписанный в глобализационные процессы, выдвигает на первый план экономическую эффективность технических процессов, сопряженную с экологической безопасностью и с возможностью внедрения в мировую систему. Один из примеров эффективного использования инновационных технологий при взаимодействии транспортных систем в мире – контрейлерные перевозки.

Цель: Проанализировать зарубежный опыт организации контрейлерного сообщения, выявить технологические решения, пригодные для эффективного использования на российском рынке интермодальных перевозок.

Методы: Для оценки эффективности различных технологических систем авторами используются методы сравнительного анализа, индукции, системного подхода. Также обобщен мировой опыт организации контрейлерного сообщения.

Результаты: По результатам анализа выявлено, что современная экономическая ситуация в России позволяет оценивать инновационные транспортные системы, в первую очередь, с точки зрения быстрой экономической окупаемости, обращая внимание на наиболее экономичные технологии. На данном этапе представляется наиболее рациональным использование контрейлерных систем «бегущее шоссе» и Lift-on – Lift-off (Lo-Lo).

Заключение: С 1990-х годов в России на определенных маршрутах пытаются организовать регулярное контрейлерное сообщение, однако в связи с отсутствием спроса на данный вид услуг на российском рынке инвестиции в контрейлерные технологии сопряжены с высокими рисками. Опыт других стран показывает, что независимо от выбранной технологии стимулирование спроса на инновационные «зеленые технологии» невозможно без участия органов государственной власти. Необходимый методологический фундамент организации контрейлерных перевозок на территории России можно создать, изучая мировую практику эксплуатации контрейлерных технологий.

Ключевые слова: транспортная система, логистическое решение, комбинированные (интермодальные) перевозки, контрейлерная перевозка, контрейлерная технология.

Introduction

The economic downturn which is being overcome by Russia’s economy on the one hand, combined with inevitable globalisation processes on the other, brings economic efficiency of technical processes integrated with environmental security and possibility of the implementation into the world system to the forefront.

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From the point of view of the economic efficiency and environmental security, the most efficient way of transporting freight is the seaborne transportation. However, the range of its application is quite limited. In any case, at a certain stage of transportation the application of car transport is expected, since it is the only means of transport with door-to-door service. Railway transport is an efficiently and economically optimal option for carrying freight at large distance or in complicated weather or geographical conditions. However, railway lines in their turn are limited by the possibility to transport freight only between stations. Thus, it is logical to conclude that we should search for an answer to the issue of reducing transport expenses in the relation and transfer of freight between car transport and other means of transport.

Already in XX century in other countries, the innovative systems of combined interrelation of railway and car transport, namely transportation of trailers, semi-trailers and low-loaders by flat wagons, saw rapid development. This type of transportation was named the piggyback transportation.

The USA's experience in the organisation of piggyback transportation

The father of the piggyback transportation may be considered the USA, where trailers and truck trailers started their operation in the end of 19th century. Despite this, the piggyback transportation services were long distrusted, and only in 1926, an American railway company North Shore Line presented a new service to their clients, that consisted in transportation of truck trailers by railway transport. The technology of loading of that time was quite primitive and consisted in sending the flat wagon to the dead end siding, which was located on the same level, and passing each truck trailer along the entire train up to the anchorage place. At the same time, the tractors were transported with the trailers, which was commercially less profitable than transporting only the truck trailer.

In 1950s on the USA government initiative the unified concept of development of piggyback transportation in the country. The concept was based upon the idea of the organisation of swift delivery of freight for long distances in containers and semi-trailers by trains operating between piggyback-container ports along the country's entire railway network.

In order to encourage the introduction of piggyback transportation system, the railway companies in the USA were granted legal and economic privileges and exemptions, which would boost development of these services and transfer the load from the overloaded car transport to the railway transport.

The creation of standardised fleet of railway flat wagons in the USA was carried out with the participation of Trailer Train (currently TTX Company), which provides investors with flat wagons. This would facilitate avoiding the empty run on their way back, which was impossible if a client's platforms were used [1].

In 1960s, to load the truck trailers on the flat wagon, the cranes began to be used, and the model of the first rotating deck for lateral loading with the mechanical rotation of the central part.

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By 1970, more than 1 million truck trailers had been transported on the USA's railways [1].

The modernisation of flat wagons for piggyback transportation continued. In 1970–1980, the 22 900 mm long rolling stock was developed, that could carry two 10700 mm long semi-trailers at one time. The length of the flat wagons did not exceed the length of the passenger wagon, giving no ground for the issue of fitting into the railway curve radius to rise.

In 1980s, as the car's dimensions grew, the 27 100 mm long flat wagons were developed which enabled carrying two 13 700 mm long semi-trailers.

Further increase of the length of the truck exhausted the potential for efficient use of 27 metres long flat wagons. Consequently, the carriers began testing different schemes of loading which enabled them to locate one of the trailers above the coupling of the wagons. Also, during this period a unique solution was elaborated to dismantle the middle part of the deck floor, in order to reduce the tare weight and the axle load.

Today, just like in XX century, in the USA's terminals, as a rule, the standardised equipment is used for transferring truck trailers and high-capacity containers – gantry cranes, reach stackers [2]. This kind of loading and unloading of transport is called Lift-on/lift-off (Lo-Lo), which means performing the loading vertically (fig. 1).

The application of the universal freight handling equipment enables the standardisation of the mixed structure of the freight flow, since cars and containers are transported together. Apart from saving money for construction of the terminal, this technology also accelerates the time for the accumulation of the wagons for dispatch.

Fig. 1. Loading the semi-trailer by the reach stacker

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Besides, owing to absence of electrification on the USA's railways, there is no such issue as the loading gauge. Due to this, the majority of transportation volume there is carried out on standard railway flat wagons. There are even technologies being developed there to transport containers and contrailers piled up on special platforms (fig. 2).

Fig. 2. Double-stack transportation on the platform with the depressed floor on the USA railways

In 1950, in the USA the alternative technology of piggyback transportation was developed – Roadrailer. The point of this technology was to carry trailers without the use of flat wagons, but with the help of the integrated wheelsets, which were lifted up during the highway mode and lowered during the rail one (fig. 3). This system was operated by C&O, Union Pacific и Contrail companies [3]. The main disadvantage of the technology was that apart from high costs of such trailers, equipping them with railway wheelsets would highly contribute to the weight, resulting in decreasing productivity of transportation and limiting the possibility to drive on certain roads.

The terminal of this technology is equipped with rails attached to the parking lot, and with tractors for pulling lorries. Beginning from the end of the train, one by one trailers are attached to the bogie, with the lorries lifting by virtue of their own electric traction. After all the roadrailers are connected together, the bogie is installed in front of the stock which is links the entire system with the locomotive. Since there is no flat wagon, the rolling stock is much lighter than the conventional one. At the destination point, the system is easily disassembled, with the trailers placed in the parking place to be collected by tractor units.

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Fig. 3. Roadrailer bogie system

Today, the roadrailer technology in the USA's railway transportation market is actively used by Triple Crown. The roadrailers are manufactured by a number of companies: Deluxe, Bowser, Santa Fe, Amtrak. Sometimes, groups of roadrailers are connected to passenger and freight trains [3].

The roadrailers can carry 12 % more fright load than conventional piggy-back trains do.

Currently, the piggyback transportation is experiencing the second rise in the USA, which is explained environmentally aware population and toughening up the ecology and noise control norms. Today, the USA's railway transport fleet possesses more than 300 thousand designated flat wagons for operating piggyback. More than 100 national-scale terminals were constructed, where basic transport modes meet and railway lines cross. Also, more than 500 terminals for all modes of transport and several thousands of hubs were erected [4].

Almost all big US railway operators (BNFS, Union Pacific, CSX, Amtrak) offer piggyback transportation services.

Thus, today in the USA all freight for the distance of up to 800 km is transported, as a rule, directly by cars, and over 800 km – by combined on-the-road and over-the-rail transportation [4].

The rolling stock for piggyback operation in the USA is owned both by the state and the shipper. Yet, the most successful experience is considered when the piggyback transportation is forwarded by a car transport enterprise, which is fully responsible for the organisation of the entire cycle of the transportation by road and railway and performs all calculation with railway operators and clients by its own.

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Organisation of piggyback transportation in Europe

It was far later when the piggyback transportation appeared in Europe. The works related to the organisation of piggyback transportation in the western countries began in 1960s. Generally, the development of piggyback transportation was connected with the difficulty for the car transport to cross the natural geographical obstacle − the Alps.

However, the current volume of piggyback transportation of all the railway transportation in the European Union makes approximately 30 % [5]. This situation became possible due to certain pressing conditions, as from the point of view of economic efficiency piggyback transportation does not appear to be an attractive mode of transporting freight. The prerequisites for a widespread use of this type of intermodal transportation in Europe became the following factors:

- complicated geographical and natural conditions (the bulk of piggyback transportation in Europe is concentrated in transport corridors which run on transalpine routes);
- the presence of the unified European piggyback terminals represented by more than 300 terminals in 29 states (initially, the erection of the terminals was supported by the state) [4];
- the presence of special railway tariff for transporting containers;
- legislative limitations for freight transport traffic. For instance, Germany, Austria, France, Italy, Switzerland, Slovakia, Slovenia and the Czech Republic have traffic restrictions for freight transport of more 7,5 tonnes in the daytime during the holidays and the weekend. In Switzerland and Austria – in the nighttime on the permanent basis [4].

The restrictions do not apply to combined freight transport drivers with relatively low road transport involvement.

For instance, after arriving at the terminal station, the trailer hauled by the train, may go to the destination point by itself provided that it is located within a 65 km radius, whereby the above-mentioned restrictions will have no effect on it [5].

Studying the international experience of the organisation of piggyback transportation, one can see several successful, totally different piggyback systems.

Generally, the international technologies of piggyback transportation employ a specially designed rolling stock and relative terminals equipment.

The search for non-standard solutions and the development of innovative technologies for European countries are the forced measure, which can be explained, unlike the USA, by a strict structural clearance of 4300 mm (the European railways are electrified, therefore safe distance to the catenary network should be observed). This limitation causes the platforms with depressed floors or special platforms with a smaller wheel diameter to be used.

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The system of carrying trailer trains and lorries “Rolling highway”

The rolling highway (originally from Austria) is a method of carrying transport units by loading them horizontally on the railway flat wagons with the lowered deck.

In this technology, the trailer train maneuvers onto the flat wagon with the tractor unit on its own. The process of loading is carried out via high ramps. Embarking on and disembarking from the flat wagon is carried out at the rear of the special platform, with the lorries driving along the entire train.

The loading of the rolling highway train consisting of 30 trailer trains takes 30 minutes.

The expense for terminal infrastructure at this method of transportation is minimal. The terminal consists of an even railway track with the length equal to that of the train’s, and an endloading ramp. The gaps between the wagons are covered by drop-back shields for unhindered passage of the trailer trains to the end of the rolling stock. Using this shield enables loading another trailer unit between the platforms which makes the entire trailer train longer than the platform (the standard length of the flat wagon by the deck is 13 300 mm).

The rolling highway technology is referred to as the accompanied combined transport. During the transportation (basically conducted in the nighttime in Europe) the lorry drivers travel by the same train in the passenger wagon, to carry on with the door-to-door delivery.

In 1970s, in Europe the special wagons for carrying trailer trains by the rolling highway were developed. One of the Austrian companies developed a platform with a maximum low level of loading surface of 410 mm, which creates the minimum requirements for the height of the transport unit.

In 1980, the German company Talbot developed an improved construction of the wagon with two four-axle bogies. The length of the wagon by its buffers was 19 900 mm with the maximum capacity of 40 tonnes and the wheel diameter of 380 mm.

Currently, the two-axle platforms are widely used, the maximum axle load of which is increased to 22,5 tonnes [6].

In rolling highway transportation, a small diameter of wheels of the platform for carrying trailer trains (a lorry with a semi-trailer) imposes speed limitations on the train traffic and its passing switch yards, and explains an increased wear of the wheelsets (fig. 4).

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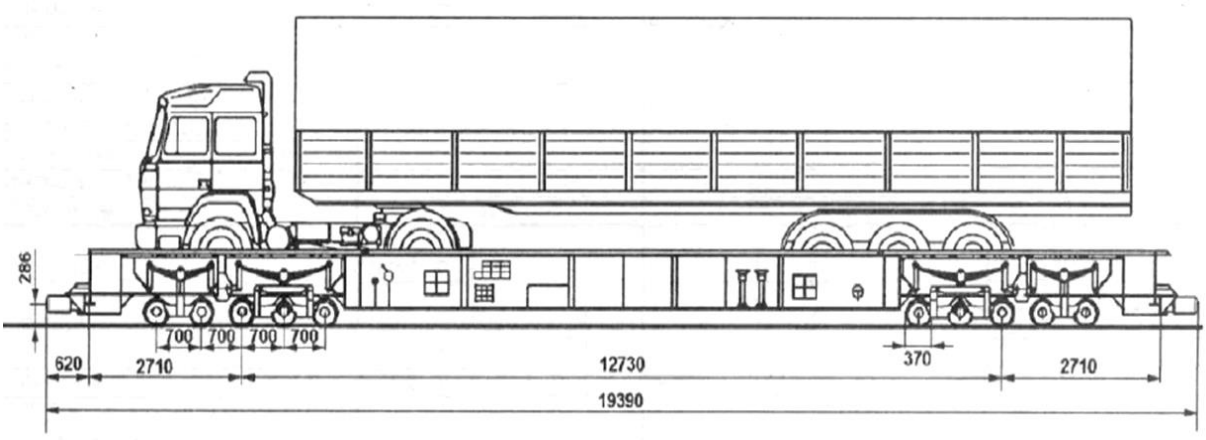

Fig. 4. The scheme of the platform with a small diameter of wheels

The main advantages of the rolling highway technology are:

- the absence of necessity to use cranes;
- maximised simplicity of the organisation of loading and unloading activities;
- minimised volume of investments for buying loading and unloading equipment of the terminal;
- a higher level of safety during loading and unloading works does not require special equipment (apart from weighing equipment), since the terminal is an area for location of the equipment for driving on and off and an external parking area for lorries waiting for loading.

The main disadvantages of the rolling highway technology are:

- a small diameter of wheels of 370 mm which results in limited axle loads (not more than 7 tonnes), increased wear of the wheels due to high rotation frequency (up to 1500 r/min);
- transportation of fully loaded trains only;
- speed limitations to 100 km/h;
- dimension limitations require buying high-tech expensive wagons;
- constant expense for transportation and drivers' wages, irrational use of tractor units;
- the ratio between the gross weight of the transported road train and the net weight of the freight itself.

Piggyback transportation "Modalohr"

A more advanced technology "Modalohr" (France) differs from a conventional rolling highway by the possibility to use standard wheels, which removes the speed limitations and enables cutting operational costs. However, the wagons used in this technology are technically sophisticated and expensive.

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The innovative piggyback technology “Modalohr” developed by the French LOHR Industries, a well-known European manufacturer of transport units. The controlling stake (51 %) is held by SNCF, the National Society of French Railways, and 49 % − by LOHR Industries, which develops and provides technical solutions for carrying passengers and freight. The system was launched in November 2003 between the French Aiton and the Italian Turin.

The “Modalohr” wagon for carrying freight lorries and semi-trailers is designed in accordance with the strict technical regulations, that envisage:

- low floor of the wagon that enables the transport units up to 4 m high to fit into the rolling stock loading gauge;
- the application of standard bogies and wheelsets to keep the cost of the technical maintenance and repairs on the same level;
- horizontal loading and unloading with lateral pockets for simultaneous and swift processing of several lorries;
- simple and reliable mechanical system for coupling and blocking of transport units to ensure safety and low operational costs.

The wagon of the system “Modalohr” has a movable deck which swings 30 degrees and is fixed on the ground level upon arrival at the terminal (fig. 5). The road train then maneuvers on to the platform itself, the trailer is fixed on the platform, the tractor unit is unfastened, the hydraulic mechanism lifts and swings the deck. The platform returns to its initial position.

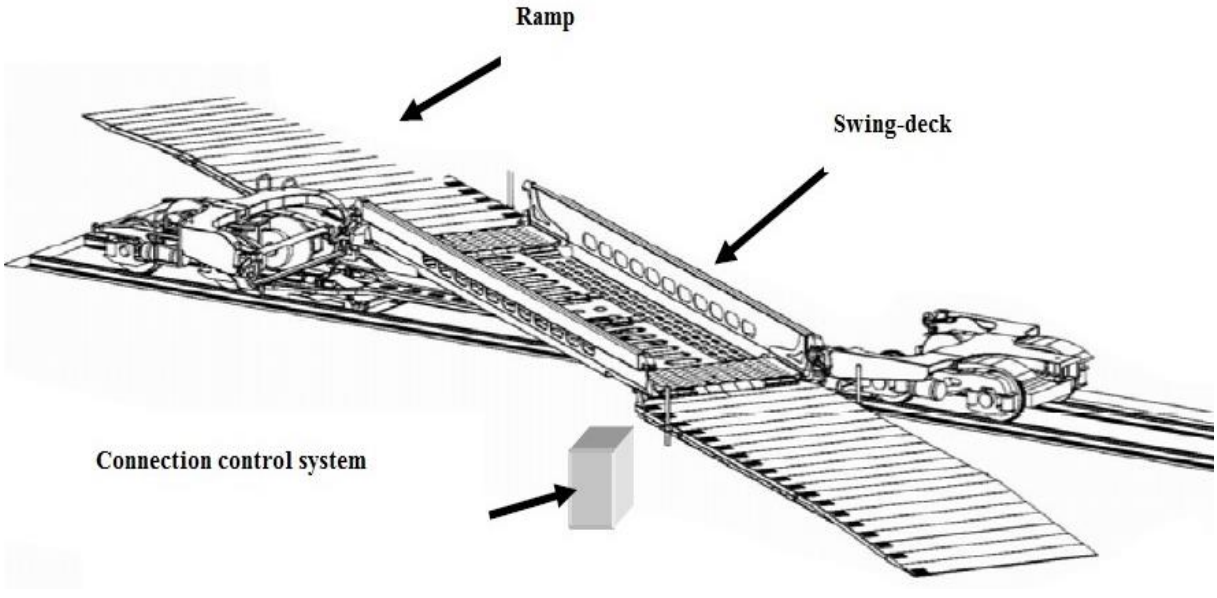

Fig. 5. The Modalohr piggyback platform

The special equipment of the wagon consists of stabilising pneumatic supporters fixed on the bogies and resting on the ground, and of a pneumatic gear whereon the semi-trailer is fixed [7].

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The Modalohr terminal consists of an even area and does not require high costs for equipment (fig. 6). The rails are embedded in the road surface, the ramps ensure loading and unloading of transport from both sides of the track. Before loading and unloading operations, hydraulic opening system drives rollers and jacks which lift the movable deck to the level of the floor of the wagon and swing it.

Fig. 6. The Modalohr system terminal

The only complexity of loading and unloading procedures is to position the train within 30 cm at the terminal.

The tractor unit and the semi-trailer of the road train are transported in an unfastened state due to limitations of radius curves. Their positioning between the bogies is also impossible due to the length limit of the platform. Consequently, the conceptual principle of the system is that each wagon can carry one lorry, one semi-trailer, or two tractor units.

The intermediate flat wagons rest on the same bogie, the end ones in their turn – on two. Thus, a train of n wagons has $n + 1$ bogies.

The equipment that secures the loading deck is of special importance. The safety of traffic is ensured by four locks in the platform. They can be unblocked only in the stations during loading and unloading.

The loading cycle of a 750 m train is completed within 45 minutes. The drivers do not participate in the process. The operation is performed by the terminal's personnel. The terminals where drivers can leave their trailers are open 24 hours a day.

Currently, the Modalohr piggyback trains operate on two routes:

- the Alpine rolling highway between the Aiton (Chambry, France) and Orbassano (Turin, Italy) terminals, which runs through the Frejus Rail Tunnel for 175 km;
- the North – South route between the Bettembourg (Luxembourg) and the Le Boulou (Perpignan, France) terminals – more than 1000 km [8].

The Modalohr trains run irrespective of fullness, in accordance to the strict schedules, like the passenger trains do. The alpine line has four trains running at both directions each day. The fullness of trains varies depending upon

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the time: in the morning the train, as a rule, is loaded by half of its volume, in the noon the fullness makes approximately 30%, in the second half of the day – approximately 70%. In the evening the trains run fully loaded [5]. The interest towards this service is dependent upon the season and the traffic situation.

Currently the bulk of the freight transported by this technology is trailers without tractor units (approximately 80 %) [8]. The trucking companies offer their own tractor units in order to load and unload trailers. To carry trailers with tractor units there is a passenger wagon in the train for transporting derivers.

The cost of construction of the specialised terminal makes 3 million euros, the cost of the specialised platform is 355 000 euros [5].

The advantages of the Modalohr technology are:

- the possibility of the rolling stock to carry high-tonnage containers (40 and 45 ft.);
- the possibility of being used both in accompanied and unaccompanied transportations;
- the possibility to perform loading and unloading simultaneously;
- the absence of necessity to employ cranes;
- the possibility to use twin and triple section wagons (fig. 7). The efficiency of this measure is in benefiting from the weight at the expense of employing fewer bogies and expanded loading surface (table).

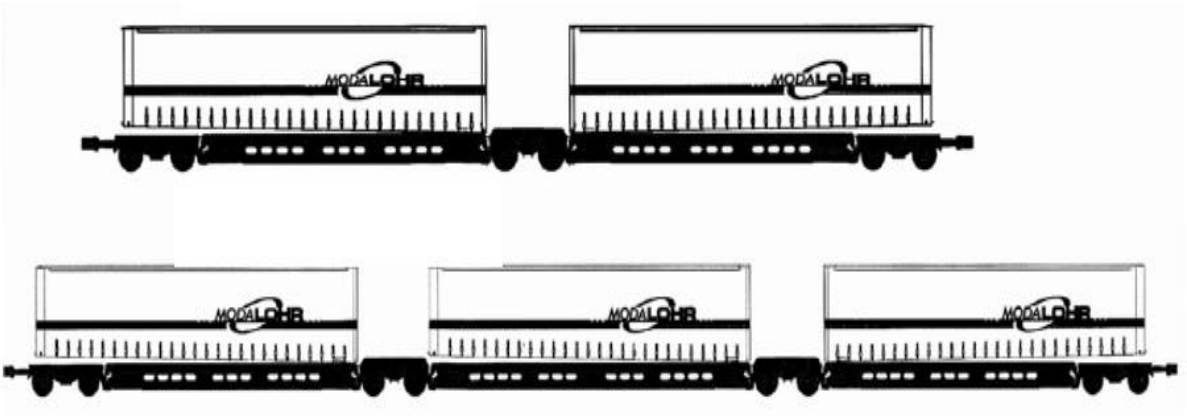

Fig. 7. Variants of twin and triple section wagons train of the Modalohr system

Technical data of twin and triple section wagons

Technical data	Twin section wagon	Triple section wagon
Total length	32,48 m	48,68 m
Weight of the wagon	35,7 tonnes	52,3 tonnes
Maximum speed when fully loaded	120 km/h	120 km/h
Maximum length of the tractor unit with the trailer	16,5 m	16,5 m
Maximum length of the trailer without the cooling unit	13,7 m	13,7 m
Maximum length of the trailer with the cooling unit	14,0 m	14,0 m
Maximum weight of the tractor unit with the trailer	40,0 tonnes	40,0 tonnes
Maximum length of the train (in Europe)	750 m	750 m

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According to this data, the full train carries 26 tractor units with the trailers. Additional increase of capacity is possible if only trailers are transported.

Among the disadvantages of the technology Modalohr there are:

- the necessity of precise positioning of the train at the terminal;
- high-tech processing at the loading area;
- big investments into the rolling stock and the terminals;
- demand in high capacity of the terminals.

Today Modalohr successfully operates in France where there is a number of special terminals and a park of swing-decks.

Piggyback technology “Flexiwaggon”

The Swedish Flexiwaggon is a system of unaccompanied transportation. The owner and the founder of the system is Flexiwaggon AB. The scope of the company includes research and development in the field of design, construction and repair of rolling stock, as well as the provision of logistics services. Flexiwaggon AB puts the environmental friendliness of piggyback transportation as the main advantage over road transport.

This technology does not require erection of terminals for loading and unloading of transport units, and is focused on the application of the specialised platform which enables loading and unloading operations almost in every place.

The special construction of the wagon-platform and the system of its hydraulic jack and the special rotating mechanism ensure rotation of the wagon, thus creating a ramp for the transport to be loaded on to the wagon without any hindrance. The loading and unloading operations can be carried out at any side of the platform, therefore there is no necessity for the train to move backwards during the loading and unloading operations (fig. 8) [9].

Fig. 8. Swing-deck of the system Flexiwaggon

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The entire procedure takes maximum 10 minutes. Besides, the simplicity of the operation of the system enables the drivers to perform loading and unloading without extra personnel, which results in additional savings. The system can carry both the entire road train and the trailer separately.

In addition, a specialised wagon is equipped with a device for connecting the trailer or the car engine to the power supply. Especially this service is in demand in the cold season, as well as for refrigerated trailers. The structural load capacity of the wagon is 50 tonnes, the maximum operating speed is up to 120 km/h.

The European states' authorities pay much attention to ecology and climate change issues, therefore the government of Sweden and the Swedish Energy Agency fully support the project Flexiwaggon. According to the specialists the Swedish Energy Agency, the active application of piggyback transportation may significantly influence the ecologic problem and reduce CO_2 emission in freight transportation by 75 %, and reduce the amount of road traffic, which would positively affect the situation with traffic congestion and the general state of the roads.

The cost of the wagon-platform of the Flexiwaggon system is 175 000 euros [5].

The piggyback technology "Megaswing"

The new technology "Megaswing" is a competitor of "Flexiwaggon" in the Swedish market.

The "Megaswing" technology was developed by one of Northern Europe's premier manufacturer of freight wagons and freight forwarder of the company Kockums Industrie.

The technology means that owing to the special wagon-platform for carrying trailers the loading and unloading operations can take place outside the terminal (fig. 9).

The Megaswing platform is equipped with a sliding mechanism which enables rotation to allow the trailers to be loaded and unloaded (fig. 10) [10].

Special hydraulic supporters pivot and lower the pocket section for the trailer wheels at the angle of the axis of the terminal to ensure that transport unit loads and unloads on its own (fig. 11).

Owing to the depressed floor, the Megaswing can carry semi-trailers of any height, unlike the rolling highway technology.

The loading time is 5 minutes. Considering the simultaneous two-side loading and unloading, the train's standing time does not exceed 30 minutes.

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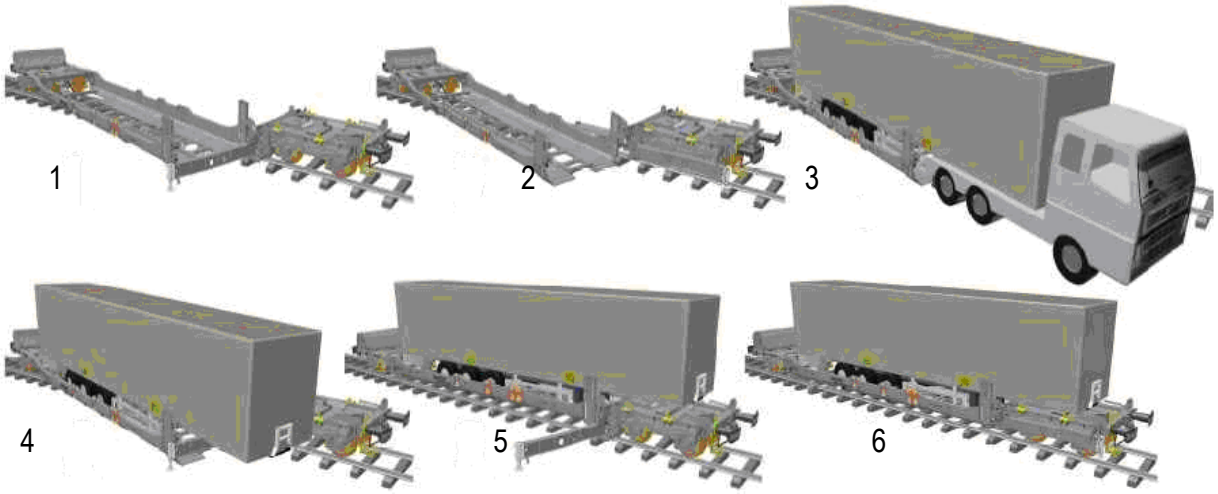

Fig. 9. The scheme of performance of the technology Megaswing

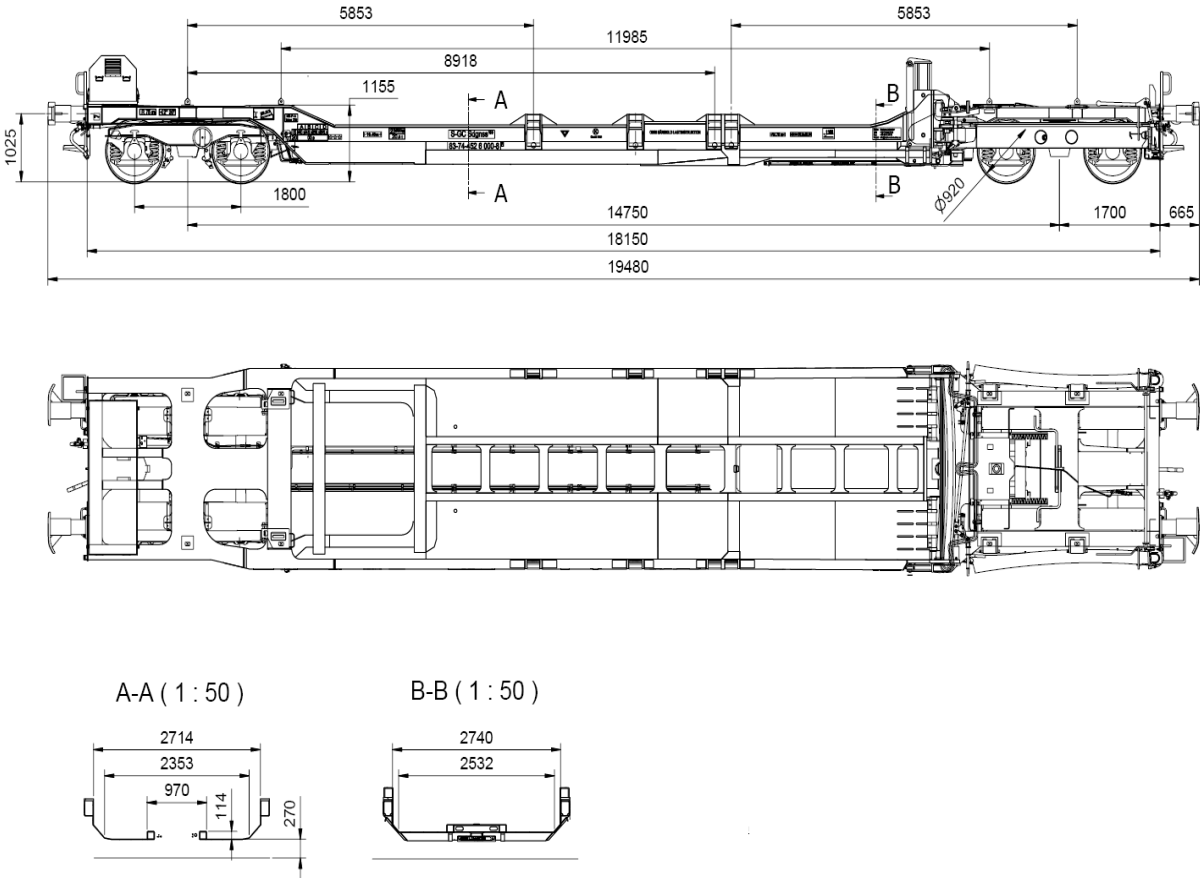

Fig. 10. The scheme of the Megaswing platform

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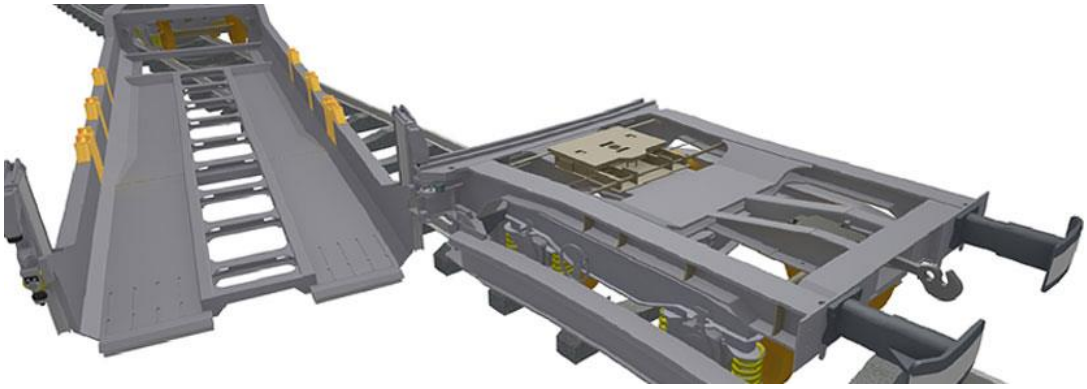

Fig. 11. The profile of the technology Megaswing

The cost of the platform is estimated approximately 270 000 euros.

The main advantages of the technologies “Megaswing” and “Flexiwaggon” are:

- the possibility to carry road trains, semi-trailers and containers on the same platform;
- the speed is up to 120 km/h;
- the application of standard wheels with the diameter of 920 mm;
- the absence of the necessity to construct special terminals, the possibility conduct loading and unloading in own railway warehouse, not at the container terminal;
- simple operation;
- the absence of necessity to position wagons along the loading and unloading area;
- the possibility to swiftly load and unload the entire rolling stock;
- high capacity.

The main disadvantage of these technologies is a high cost of special swing-decks.

The piggyback technology “CargoSpeed”

The system CargoSpeed (Great Britain) fundamentally differs from the earlier mentioned technologies.

The British piggyback system “CargoSpeed” was developed already in the beginning of 1990s under the support of the European Commission for Research and Innovation.

The realisation of this project cost 1,8 million euros.

The work to implement the system “CargoSpeed” was begun in January 2001, with the first ride taking place only in June 2004. The demonstration of the test sample, which was conducted at Barrow Hill, the Centre for Railway Research at the University of Newcastle, Chesterfield, failed. The unsuccessful

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test ride and interruption in the development of the technology gave some advantage to the system Modalohr being developed at that time.

The three basic elements of the system are the specially designed wagon, movable platform and a hydraulic lift (fig. 12).

The technology means that there is a T-shaped hydraulic mechanism between the tracks, which lifts up the platform of the wagon. The mechanism lifts the deck of the platform to the ground level and pivots it so that there is a possibility to conduct loading on it. Thus, the trailer's loading and unloading operations take place.

Fig. 12. Elements of the piggyback system CargoSpeed

The technology allows to make up to 750 thousand handling operations per year. The time of direct loading or unloading of the entire train at a specialised terminal takes from 8 to 30 minutes. As an additional advantage, it should be noted that the system is capable of operating in different directions, that is, taking the trains regardless of the direction of their movement, which increases the operational flexibility of this system.

The cost of erection of the specialised terminal is 2,3 million euros, the price of the CargoSpeed platform is 120 thousand euros.

The advantages of the technology CargoSpeed are:

- relatively low cost of the terminal equipment and specialised platforms;
- the absence of the necessity to employ cranes;

High loading speed.

Among the disadvantages of the technology "CargoSpeed" there are:

- the necessity to erect special terminals;
- the system does not allow transporting the tractor unit and does not envisage carrying a driver;
- complexity of operation due to electronic systems and hydraulic equipment.

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The piggyback system “CargoBeamer”

The German technology “CargoBeamer” also fundamentally differs from other piggyback systems.

This technology was developed in Germany by the company CargoBeamer AG, which works in three main areas: intermodal transportation, design and maintenance of rolling stock, and operation and construction of terminal facilities.

The essence of the technology “CargoBeamer” is that the trailer is placed on a specially designed pallet, which is electrically drawn on the platform along the special guides. In parallel, the arrived trailer is loaded on to the opposite side [11].

The "CargoBeamer" system consists of a reloading terminal where the semi-trailer is removed from the wagon and installed on a wagon pallet, which by means of a transverse shift moves the load onto a specialised railway platform (fig. 13).

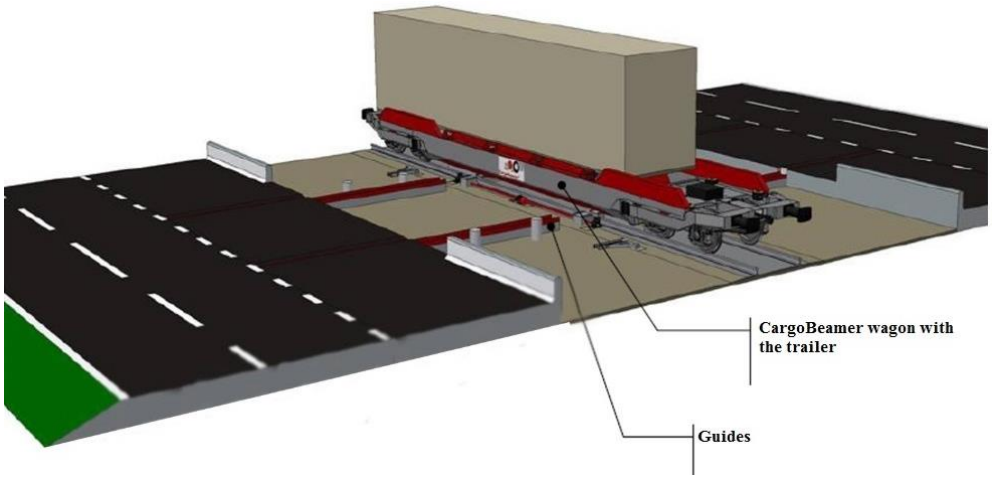

Fig. 13. The loading pallet CargoBeamer

During the loading operation, the tractor unit hauls the trailer on to the special movable pallet, which is located along the rolling stock, and parks it. The trailer is fixed firmly on the pallet, and the tractor unit uncouples and leaves the pallet. Then, the pallet is set on the platform and fixed (fig. 14).

The terminal of this system is equipped with the electronic systems for connection of platforms (fig. 15).

The train with 36 wagons is loaded at the terminal within 15 minutes.

Besides, a large advantage of this system is an automated rail gauge switching from the Standard gauge to the 1520 gauge and back, including in the electrified sections.

The advantages of the technology “CargoBeamer” are:

- the application of standard wheels with the diameter 920 mm;
- the speed is up to 120 km/h;
- the possibility to quickly load and unload the entire train;

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- the possibility to carry road trains, semi-trailers and containers.

Among the disadvantages of the technology there are:

- high cost of the terminal equipment and platforms;
- complexity of operation due to hydraulic equipment, traction mechanisms for platforms, and electronic systems;
- the necessity to position the wagons along the loading and unloading area.

Fig. 14. The technology scheme of the loading
of the trailer on the the CargoBeamer platform

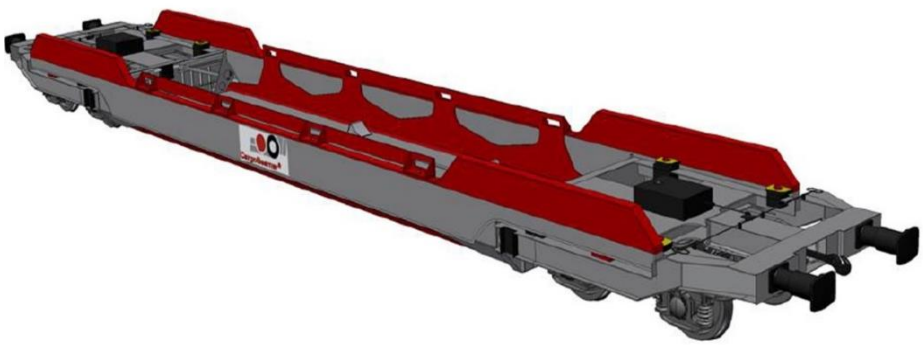

Fig. 15. The CargoBeamer platform

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The system was widely supported by the European Union. Система получила широкую поддержку Европейского союза. Namely, the Project is financed within the programme “Marco Polo − II”, one of the points of which is “Efficient Semi-Trailer Transport on Rail Baltica (the project of the standard gauge railway that is intended to connect Eastern Poland, Baltic states and Western Europe)”.

Currently, this technology had a few successful test rides from Leipzig (Germany) to Calais (France), where the construction of the second terminal of this technology is underway [11].

The total amount of investment in the French project is 22,5 million euros. The planned processing capacity of the terminal is 800 trailers per day. The terminal will serve two routes: the East – West route from Central to Eastern Europe via Germany, and the North – South route via Italy, Switzerland, Germany and France. Apart from the French port of Calais, CargoBeamer AG has plans to erect 70 terminals, among which there are ones in Polish Legnica, German Hagen, and Lithuanian Mockava.

Final chapter

On the basis of the analysis of different piggyback transportation system one can conclude that the world experience of combining road and railway transport on the basis of the piggyback transportation is very variable. All the mentioned technologies have their advantages and disadvantages. Each of them developed in different countries with different economic, geographic and technological conditions and demands.

The most primitive and the least expensive technologies for processing trailers and road trains are rolling highway and the Lo-Lo systems.

The organisation of test piggyback transportations in Russia was conducted using these technologies only.

In modern Europe, due to the consistently high demand for transportation of transport units by railway, these technologies are not at all competitive. High-tech systems, operating sophisticated specialised equipment, allow making the procedure of loading and unloading the fastest and safest.

However, the Russian conditions dictate that the innovative transport systems should be evaluated from the point of view of the fastest economic return, which results in choosing the most economical technologies. In this respect, using the Lo-Lo and the rolling highway technologies at this stage seem to be the most rational.

Besides, these technologies can be successfully employed on the existing JSC “RZD” infrastructure with the minimum of investment as compared to the specialised systems.

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Since 1990s Russia has made a number of attempts to organise regular piggyback service on certain routes. Basically, the main initiative belonged to JSC "RZD". However, due to the lack of demand for this type of services in the Russian market at the moment, investing in the development of piggyback technology involves high risks. The experience of other countries shows that regardless of the chosen technology, stimulating the demand for innovative "green technologies" is not possible without the participation of governmental bodies. It also seems obvious, that the development of technological systems of the piggyback transportation should not run chaotically. The geographical and climatic conditions of Russia, without any doubt, require operation of the unified technology in the territory in order to unify the rolling stock and the terminal facilities. In the light of this, the involvement of the Ministry of Transport, the Federal Agency for Railway Transport and other related bodies of legislative and executive power in the process of elaboration of the normative framework and encouragement of demand for the piggyback transportation, becomes unprecedented.

At the same time, the establishment of the necessary methodological framework for the organisation of piggyback transportation in Russia is possible by virtue studying the multifaceted world practice of piggyback technology operation in the world.

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