SELECTION OF A SUITABLE INTERMODAL TRANSPORT UNIT IN RAIL TRANSPORT

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Abstract

In Europe, intermodal transport is an indispensable element of transport policy, mainly because of the reduction of the negative effects of road transport on the environment, fuel and energy consumption, highway and road maintenance costs, land take and road safety. The geographic location of the Slovak Republic predetermines and accentuates the importance of transit transport in the west-east and north-south directions. Intermodal transport in the Slovak Republic has very good conditions in the road-rail system, because the Slovak Republic has a well-developed rail and road network within its transport infrastructure. The aim of the article will be the comparison of different types of intermodal transport units transported by rail freight transport together with the selected type of goods.

Keywords: Intermodal transport, railway, intermodal transport unit

INTRODUCTION

News, data and analysis of the various factors that are driving the continued expansion of intermodal shipping activity around the globe. Steady growth in the number of road freight carriers leads to greater traffic congestion and costly delays in delivering goods to end-users in business and consumer markets. Governments and regulatory bodies are introducing costly, stringent regulations to reduce vehicle emissions. Intermodal infrastructures are improving, along with other advances in technology for managing complex supply chains that operate across various modes of transportation. All of those factors are compelling many companies to use an intermodal combination of sea, road and railways to transport their goods on longer routes, rather than depend on a single mode of transportation. The cost-reduction benefits are significant for shippers, buyers, freight forwarders and other stakeholders in the supply chain.

1. COMPARISON OF INTERMODAL TRANSPORT UNITS

In Europe, intermodal transport is an indispensable element of transport policy, mainly because of the reduction of the negative effects of road transport on the environment, fuel and energy consumption, highway and road maintenance costs, land take and road safety [1]. From the user's point of view, intermodal transport is an uninterrupted process of transport and mechanisation complex, ensuring the transport of goods by one and the same transport unit from the consignor to the consignee, using a combination of rail, road, water or air transport throughout the transport [2,3].

Intermodal means of transport are used to facilitate and simplify the handling of goods during their transport. The selection of suitable transport means significantly reduces the risk of damage to goods during transport and during loading operations. In intermodal transport, the means of transport are intermodal transport units, namely: large containers, swap bodies, road trailers and combination vehicles [4].

1.1. Containers

Large containers are the most widely used intermodal transport units. They are standardised worldwide and special equipment is used for their handling, which is equipped with a hanging frame. A large container has either one door located on the front wall or two additional side doors. These containers can be stacked in several layers, however, depending on the handling prostired. The handling means grasps the container by the upper corner elements by means of a hanging frame. After turning the locks on the frame, the handling means can safely stack the container [5,2]. They are designed for the transport and short-term storage of a wide range of packaged and unpackaged piece materials. Goods can be on pallets, loose or in bundles. Large containers can be divided into general-purpose and special-purpose containers according to their purpose and use. Large special containers include the following types: open containers, tipping containers, bulk containers, flatbed containers, tank containers, etc. Special large containers are designed for the transport and also temporary storage of only a certain type of material or materials of a certain group, e.g. liquid, bulk, powder, long. These containers are also suitable for materials that require special conditions during transport, storage and loading operations. For the transport and short-term storage of bulk bulk substrates that do not need to be protected from the weather, open tipping containers are suitable. A flatbed container is designed for the transport of larger machinery units, products with a higher weight, or long lump materials not requiring protection from weather conditions [6]. For the transport of various liquid substrates, liquids, oils, it is most suitable to use a tank container. The desire of intermodal transport operators to transport as many goods as possible in one intermodal transport unit has resulted in large volume containers, so called High Cube containers. In the ACTS system, special containers are used, which are transported on special rail wagons or on car carriers

1.2. Interchangeable superstructures

They were originally designed as a flooded truck bed built on the bottom frame of a container so that it could be transferred from wagon to car and vice versa. The swap body is a unified and detachable cabinet from the vehicle. The basic dimensions, total weight, fixing and retaining elements are unified. Interchangeable bodies have become widespread, especially in European countries, where they have also reached their greatest development [7]. Interchangeable superstructures eliminate some of the disadvantages of large containers:

- the loading area of the swap body is derived from the dimensions of the euro pallet, thus achieving a more efficient use of the loading area; up to 17-euro pallets can be loaded in a single tier in a C-type swap body,
- the swap body can be folded and loaded onto a road vehicle at the end points of transport without the aid of a handling device.

The disadvantage of swap bodies is that they cannot be handled with the same gripping equipment as large containers. Another disadvantage is that they generally cannot be stacked. This problem can be solved by using a hanging device on which there are hinged arms that can be part of the hanging frame. Interchangeable superstructures are available in a larger length range than large containers. There are also a variety of designs, ranging from full-walled enclosed, to the sidewall, to tarpaulin covered, to tank-type, and with the possibility of special equipment for transporting different types of goods [9,10].

1.3. Road semi-trailer

Road semi-trailers are considered as means of transport in direct road transport, but in intermodal transport systems they can also be considered as a means of transport. They serve as an intermodal transport unit in which the goods are transported and the whole transport unit is transferred to another means of transport. Road semi-trailers used as intermodal transport units can be divided into three basic groups: standard construction road semi-trailers, special construction road semi-trailers, double road semi-trailers [11]. A conventional road semi-trailer is a trailer designed to be coupled to a semi-trailer tractor, with part of its total weight being transferred to the semi-trailer tractor. The semi-trailer is designed for the transport of goods and may be a flatbed, tipper, box, special, etc. By rail, these road semi-trailers of conventional construction are transported in basket railway wagons.10 road semi-trailers of special construction do not differ visually from conventional road semi-trailers of conventional construction. However, they are structurally adapted for vertical transshipment [10,11]. In contrast to conventional road trailers, special purpose road trailers have several disadvantages:

- they have to be structurally reinforced for vertical handling and transport on special railway wagons, which makes them more expensive to manufacture and therefore more expensive to buy,
- they have a greater dead weight and therefore a lower load weight [12].

Double-deck semi-trailers are similar to conventional road trailers, but are of more robust construction and also differ in special structural modifications. The semi-trailers have a reinforced and structurally modified frame so that they are capable of running on the railway. The main disadvantage of these semi-trailers is again its increased dead weight [13,14] .

1.4. Retenpal 2.0

Pallets, like other means of transport, are an important rationalisation element in material handling. They enable the transported goods to be combined into larger handling units. These are so-called palletising units, which facilitate and simplify the handling process. Retention pallets were originally intended as a storage solution to prevent spillage of spilled liquids on the warehouse floor. It was soon realised that the pallets could be customised for transport to suit the needs of logistics operators. Importantly, Retenpal 2.0 can have Schoeller Allibert's RFID or SmartLink® sensor technology for completely transparent, safe and secure asset management. Retenpal 2.0 are hygienic, retractable and ideal for transporting shellfish and fish crates and will prevent wet floors. They are the next generation of sustainable spill control solutions. Food safe, robust and built to withstand extreme temperatures from -20°C to +40°C, they are the perfect choice for industries including food processing, retail, industrial manufacturing, pharmaceuticals, cosmetics, chemicals and pooling. Easy storage and transport of goods thanks to a great 45% retract ratio, optimising loading, reducing the number of trucks and their rotations while maintaining product quality [15,16].

Food safe and built to withstand extreme temperatures from -20°C to +40°C, each pallet of Retenpal 2.0 can hold up to 700kg and ensure any leaked liquid is contained. The unique pallet is specially designed with 56 retention cells and provides a retention capacity of up to 37 litres, limiting ripple effects during transport and therefore preventing truck fouling. Retenpal 2.0 guarantees strength and rigidity as it is made from a single piece of medium density food-grade polyethylene with reinforced board and feet [16,17]. It has no hard-to-reach areas, making it easy to clean and meeting the strictest hygiene requirements. The pallet comes in two basic versions, either with or without RFID, with standard dimensions and standardized fork pockets. Four large areas for marking offer the possibility of engraving and stamping on both long and short sides. This enhanced identification allows for better pallet fleet management. With new tracking and tracing capabilities only available for Retenpal 2.0, this pallet solution enables any logistics operator to easily manage their asset pool and responds to consumer and supplier demand for full traceability [17,18].

2. TRANSPORTING CEMENT USING 3 DIFFERENT INTERMODAL UNITS

This chapter contains an analysis of the selection of a suitable means of transport and rail vehicle in intermodal transport. We have selected cement, which is stored in bags, as the commodity to be transported and analyzed for this paper, an example is shown in **Figure 1**.

Figure 1 Cement in bags [19]

The pallet is an elevated platform as a transport means with loading and supporting floor for forked mechanized handling, it is adapted for stacking. Pallets of standardised dimensions 1 000 mm x 1 200 mm x 100 mm (ISO) or 800 mm x 1 200 mm x 144 mm (EUR) up to a weight of 25 kg and a load capacity of 1 500 kg are most commonly used. Pallets enable the formation of intermodal load units (larger handling units), better utilisation of the loading space of the means of transport, speed up and economise loading operations, increase safety and enable mechanised cargo handling. The weight of cement in bags for transport is 350 tonne, while the weight of one bag of cement is 20 kg. We will use Europallet to transport the cement in sacks.

2.1. Transportation of cement in bags by road semi-trailer

As a first option, we chose to put the bags of cement on pallets and load them into a road trailer. We then determine a suitable wagon to transport this intermodal transport unit. The total quantity of cement in bags is 350 tonne. A total of 17,500 bags of cement will be transported. There will be 6 bags loaded on a single layer on a pallet, since the content area of the pallet is 0.96m2 and the area of one bag of cement is 0.135m2. The weight of one layer loaded on the pallet is 120 kg. In total, 8 layers of bags of cement are loaded on the pallet, which makes 960 kg of bags of cement loaded on one pallet. In total we will need 365 pallets for this transport. The weight of one loaded pallet is 985 kg of which 25 kg is the weight of the pallet. The total weight of the consignment is therefore 359,125 kg for the bags of cement and the pallets together.

Figure 2 Road trailer-Safe Curtain trailer [20]

We have selected the Safe Curtain Trailer, a manipulable road trailer, as the intermodal transport vehicle, shown in **Figure 2**. The internal length is 13.62 meters, the internal width is 2.48 meters and the internal height is 3 meters and the dead weight of the road trailer is 6.6 tons. The floor can accommodate 34 Euro pallets and the maximum loading weight is 29 tonne [20].

29 Euro pallets can be loaded into one road semi-trailer. The full capacity of the semi-trailer cannot be used due to the maximum load weight of the vehicle. A total of 13 road semi-trailer trailers are needed to transport 350 tonne bags of cement.

The semi-trailers will be partially loaded on a Sdggmrss series wagon. This wagon series is a modern solution for transporting road semi-trailer trailers. The wagon series can also be used for the transport of swap bodies and various types of containers that are suitable for transport by rail. It is possible to load 2 road semi-trailers on the rail wagon. In this first case, 7 rail freight wagons will be needed to transport 130-tonne bags of cement.

2.2. Transportation of cement in bags by means of an exchangeable superstructure

For the second option, we chose to transport the cement in sacks by means of exchangeable superstructures and subsequent loading onto a railway freight wagon. The basic characteristics of the transported goods remain the same as in the first variant. The type of swap body is C715. It is a swap body with a double-sided ejection tarpaulin. The total load capacity of the superstructure is 16000 kg. Based on the limiting factor of the maximum load weight, 16 pallets can be loaded into one swap body. A total of 23 swap bodies are required. In view of the choice of swap bodies, the Sgnss series wagon was chosen for rail transport. The technical characteristics of this type of wagon correspond to the transport of 2 swap bodies. All limiting parameters such as the loading weight of the wagon and also the axle load are met. Due to the higher number of swap bodies, 12 Sgnss freight wagons are required.

2.3. Transportation of cement in bags in containers

In this third and last variety, the calculation of the number of containers when transporting cement in bags is made. The basic characteristics of the transported goods remain the same as in the first variant and the second variant. For this variant, a 20-foot container with a loading weight of 28,200 kg was chosen. A total of 13 Euro pallets will fit into this type of container. Based on the calculations, it was found that 29 containers would be needed to transport 350 tonne of cement stored in bags. For the transport of containers by rail, a 4-axle wagon of the Sgnss series has been designated, which is suitable for the transport of ISO containers. Three 20-foot containers can be loaded on this type of wagon, and of course, the loading weight of the wagon must not be exceeded. In this case, the maximum permissible load weight of the wagon will not be exceeded either. For the Sgnss series, 10 railcars will be required to transport 350 tons of cement.

3. CONCLUSION

Climate change and environmental degradation pose an existential threat to Europe and the world. To address these threats, the European Green Deal will transform Europe into a modern, competitive and resource-efficient economy. With transport accounting for around 5% of EU GDP and employing more than 10 million people in Europe, the transport system is vital for European businesses and global supply chains. At the same time, our society pays a high price: greenhouse gas and pollutant emissions, noise, traffic accidents and congestion. Emissions from transport now account for around 25% of the EU's total greenhouse gas emissions and have been increasing in recent years. Intermodal transport must therefore be brought to the fore and its strengths exploited. The paper compares the number of intermodal transport units needed with the number of rail freight wagons needed. In terms of the lowest number of rail wagons, the first option is the first one, using road semi-trailer trainsets with 13 and only 7 rail wagons. Intermodal transport is one of the most optimal options for transporting goods over long distances. The article therefore concludes that it is essential to highlight the need for immediate support for European legislative processes in helping individual states to promote intermodal transport. The article clearly pointed out the variety of means of transport used for the different modes of transport. Another contribution of the article is that it is desirable to consider which type of means of transport will be chosen on the basis of criteria, i.e. the type of consignment, the type of road trailer or other type of transport unit being transported. It is necessary to continue this research and focus further on the saved emissions discharged into the environment or noise savings and the lightening of road traffic and increased road safety.

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