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SELECTED FUNCTIONAL AND UTILITY APPLICATIONS OF A PLATFORM-CONTAINER IN INTERMODAL TRANSPORT

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Abstract

The set of two interconnected base modules 10' (length of up to 3m) of the platform is the equivalent of a 20' container with a length of up to 6m. Such a set consists of: two frames connected with mandrel joints, two rotating transverse walls placed vertically at both ends of the frame set and two sets of stanchions with load straps. The multiplatform set with the log load can be reloaded many times. Four different types of loading and unloading techniques most often used in the transport of logs can be used for this purpose, They concern reloading from trucks, road tractors to various types of railway wagons and vice versa without the need to empty the set of platforms. It is possible to transfer the platform, e.g. with a load of logs, using various means of handling, various types of loading and unloading techniques, from delivery vehicles to various types of railway wagons and vice versa without the need to empty the set from the load. For this purpose, the following solution can be used: typical rope slings and lifting with a self-propelled or stationary crane, overhead crane, etc., trolleys and forklifts of various classes, as well as standard lifting / hook loading by pulling on the vehicle. Empty sets can be delivered to the loading site in an appropriate number in a folded state, i.e. the basic modules, after folding the transverse wall, disassembling the stanchions, can be arranged horizontally in stacks - 'one on top of another'. Platform sets configured this way require less space for transport and storage. Then, after appropriate reconfiguration, depending on the intended use, the platforms filled with logs and other assortment of transported goods can wait for loading and delivery by rail, road or other transport.

Keywords: metal and wood logs, rail and road transport, set of platform-container

1 Introduction

Moving wooden or metal logs is a complex logistic and transport problem, most often organised between the producer and the recipient. The process of transporting wooden logs usually begins in the forest, in places of logging, and then is organised by means of various wheeled trucks and tractors, runs along unpaved and public forest roads to railway stations, where the logs are reloaded on appropriate railway wagons intended for the transport of logs. A similar part of the transport procedure takes place in the reverse order on the recipient's side and most often includes: the stage of unloading railway wagons with logs at the receiving station, loading them on trucks and delivering to the recipient. The described transport chains of wooden logs are very similar in the case of metal logs or e.g. various types of transfer pipes or palletised goods and have numerous transport stages, most often carried out by wheeled vehicles and railway transport. The described transport chains of logs include numerous loading and unloading operations which, due to the transported range of wooden and metal logs, are a serious logistic challenge themselves, especially as they

have to be organised many times in unimpeded terrain (at the place of logging, etc.). The described transport chains of logs are also characterised by the dispersion of transport routes, variety of means of road and railway transport as well as variety of loading and unloading means and methods of reloading. Scientific papers in the field of logistics and transport [1, 2] analyse supply chains of various types of wood, including logs. The focus is placed on two-stage chains consisting of road transport – most often starting and ending the chains of such wood supply: e.g. export from the forest, transport to the storage site, transport to a sawmill or a processing plant. The second stage of the said supply chains concerns railway transport, which is the cheapest way of transporting timber over long distances. The mentioned papers also characterised the individual stages in the chains of the timber transport unit, including the principles of organising various methods of loading, transport, reloading and unloading in different conditions, the use of specialised equipment and devices supporting this type of elements of transport chains.

According to [1, 2], there is a division in intermodal transport resulting from the method of reloading the above-mentioned load units, which is as follows: horizontal reloading, vertical reloading and mixed reloading. Such a division of reloading operations results usually from the terminal conditions in which they are carried out. Horizontal reloading and related technologies consist in moving goods between one means of transport to another (usually road and railway transport) with a slight lifting of the loading unit. Movement during horizontal reloading can take place in the inclined, parallel and perpendicular axis to the axis of the wagon. Vertical reloading and related technologies force top access to the railway means of transport at the terminal. The direction of vertical reloading is usually in the axis perpendicular to the axis of the wagon.

There are various technologies of reloading works in intermodal transport, such as with the use of different container sliders, container trucks with booms, container forklifts, terminal truck tractors, container grabs, ACTS system, reloading devices of various companies and many other devices and accessories [2-4]. Stationary cranes are often used for lifting containers or truck semi-trailers on ropes but in most cases, e.g. for log reloading, especially in the field, those are mobile reloading cranes. Examples of selected, above-mentioned specialised reloading techniques are shown in Figure 1.

Problems related to transport, also the transport of logs, make it possible to clearly identify the area of potential demand for a cheap device which, at the same time, will be universal in terms of configuration possibility (e.g. the size of the transported load) and easy to adapt to picking up, loading and unloading various goods (mainly large-size, including logs) in different logistic conditions, with the use of various means of reloading (overhead cranes, other lifting devices, forklifts, hook devices, etc.). The solution to most of these problems can be a multi-platform container [5] presented in this paper.

Figure 1 a) Mast forklift truck for moving containers [2]; b) Reloading of a container using a mobile crane [3], 1c) Reloading of a container using the ACTS system with the hook-type equipment [4]

2 The object of research – set of innovative platform-containers

The object of research is constituted by the sets of platform-containers [5] of various dimensions corresponding to 10' (length of up to 3 m), 20' (length of up to 6 m), 30' (length of up to 9 m) and 40' (length of up to 12 m) containers. The innovative platform-container multi-set supporting the transport of wooden and metal logs, including pipes, palletised goods but also loose goods (e.g. sawdust) and other goods transported in closed containers, responds to the above-mentioned problems of this type of goods transported by combined means (tractors, motor vehicles and various types of railway wagons). The proposed multi-set is built of identical modules which constitute single 10-foot platform-containers (Figure 2).

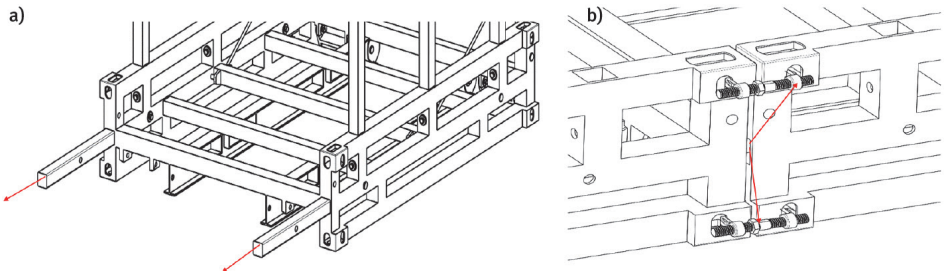

Figure 2 a) Single 10' base module with protruding bolt joints for connecting it into sets; b) Set of two 10' modules connected by bolt joints – a multi-platform corresponding to a 20' container with distinguished screw locks, securing the set against unscrewing of the modules

Module frames with joints to connect the set, foldable (front, rear) end carriages and removable stanchions constitute an essential part of each multi-set. The load of logs intended for transport is placed on the frame. There are movable bolt connectors (Figure 2a) in the sides of the frame, which are used to connect two or more single 10' base modules into multi-sets. Therefore, the set has a modular structure. It is possible to increase the length of the set by folding and connecting two or three (n = 2 or n = 3) basic modules arranged in series one after another, using the above-mentioned special connectors (Figure 2b). Each basic module has external dimensions corresponding to the dimensions of a 10' container and the sets of two, three and four modules connected with side joints (Figure 2) correspond to the dimensions of containers with the following dimensions: 20', 30' and 40'.

3 Methods of loading/unloading the platform-container of the multi-platform set

Due to the original design solutions used, each 10' basic module enables various ways of loading logs in professionally prepared loading and unloading terminals, but also in unimpeded terrain (unpaved roads enabling the entry of lighter trucks, e.g. in forest conditions):
Method I – lifting the module with the load of logs using ropes – a traditional sling for stationary lifting devices (e.g. overhead cranes) and mobile lifting devices (e.g. in unimpeded terrain with access of wheeled vehicles). Each frame of the platform module has two longer sides with sling eyes welded at the top, which are used to lift the frame load together with logs using standard hook-rope sets and the above-mentioned mobile cranes. Both longer sides of the frame are equipped with lower skids constituting the support/base of the frame for setting the frame on ground surfaces (forest areas), reloading stations, terminals or platform surfaces of various types of road vehicles and also, thanks to the container holders mounted in the frame's side skids, for fastening the set with the load of logs on the platform of wagons and road trucks.

Method II – lateral lifting of the module with the load of logs using forklifts of various classes, depending on the weight of the load and possibilities of operation. For this purpose, appropriately profiled holes in the lower part of the sides are used (similar to standard pallets). Figure 3 shows the schematic visualisation of the method of lifting the platform using any class of forklifts and other forklift devices.

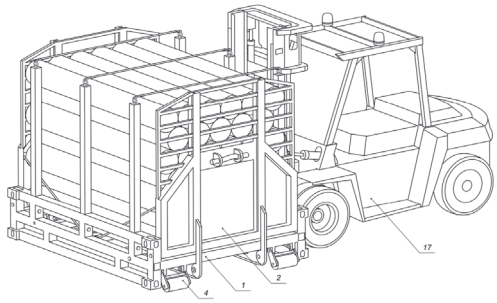

Figure 3 Visualisation of lifting the platform with a forklift [5]

Method III – lifting the module with the load of logs using standardised hook devices. The standard hook lift is designed on the end carriage side and the rollers are attached to the bottom of the frame with standard rails. Figure 4 shows the schematic visualisation of the method of lifting a 10' platform-container using a typical hook device.
The innovative solution for the installation of the hook device rollers in the platform- container is shown in the schematics in Figure 5 [5].

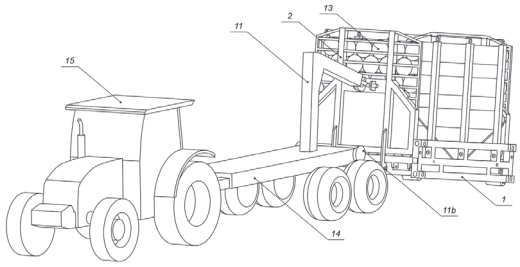

Figure 4 Visualisation of lifting the platform with a typical hook device [5]

It is an automatic, gravity-positioned solution of the mechanism for self-repositioning and blocking the rollers between the working position (hook lifting operation – frame inclination) and the transport position of the platform (horizontal position of the frame). Selected positions of the mechanism from a) to e) are marked in Figure 5, with the distinction of characteristic locations, with red arrows.
The sets built on the basis of the basic modules of the platform-container with the above-presented structure and intended use correspond to the initial version of the structure protected in Poland and abroad by patent applications [5].

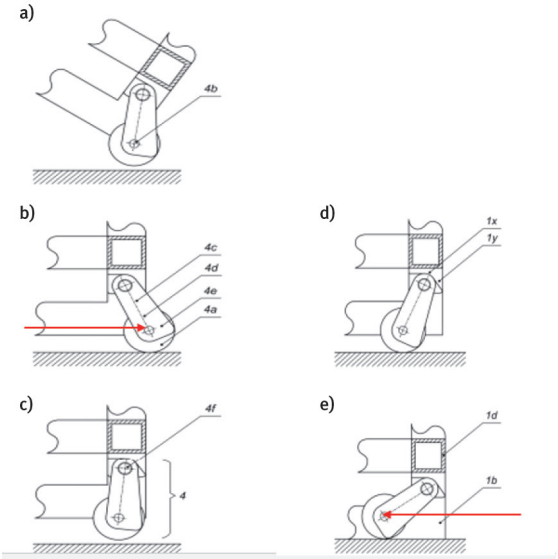

Figure 5 Visualisation of the solution for the installation of the hook device rollers in the platform-container and the principles of their gravitational positioning depending on the configuration and position of the platform

This concept, especially the 20' set, similarly to the 10' basic module, is the subject matter of design tests and it requires thorough strength tests and formulating answers to a number of design questions, so that, on the basis of the collected results and data describing the strength of such a device in specific applications, an initial structural design of a single module of the platform-container can be developed.

4 Selected application issues of platform-containers

Due to the modular structure, the platform for transporting logs can be configured in terms of the length of the load. The shortest wooden and metal logs, with the length of approx. 3 m, can be transported on a single 10' platform. Logs with larger longitudinal dimensions can be transported using a set of multi-platforms obtained by assembling the n number of individual basic modules of a 10' platform. This way, the carrier is able to independently select, easily configure and adjust the dimensions of the platform depending on the range of logs, type of road transport vehicles, type of railway wagons used and any form of loading/unloading operations. Figure 6 shows the visualisation of the use of the sets of two 20' multi-platforms with the load of wooden logs on a truck and a railway wagon (3×20' sets).

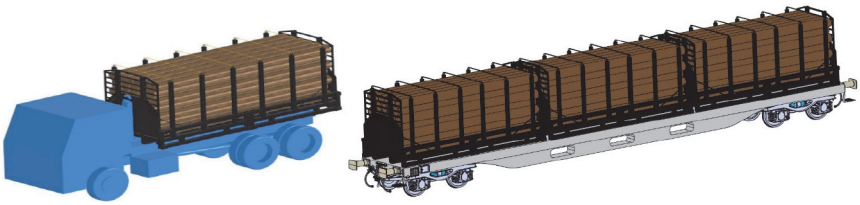

Figure 6 Visualisation of the use of the sets of two 20' multi-platforms with the load of wooden logs on a truck and a railway wagon

Thanks to the modular structure and freedom of configuration, the platform can be used not only for the transport of logs. Due to the market demand, the possibility of using platform-containers for transporting metal sheets in coils and paper bales was checked.
On the basis of data from potential platform recipients, preliminary analyses of the possibility to extend the range of transported goods were performed. Selected results of such analyses are presented in this chapter. Figure 7 shows the manner of stacking paper bales on the 20' platform-container (2×10' platforms connected with bolts). Table 1 presents the data and results of the preliminary analysis of the possibility to extend the range of transported goods using platform-containers on the example of paper bales.
The platform with side walls can also be successfully used for the transport of loose goods in the form of raw materials to various industries, such as sawdust in the wood industry and many others.

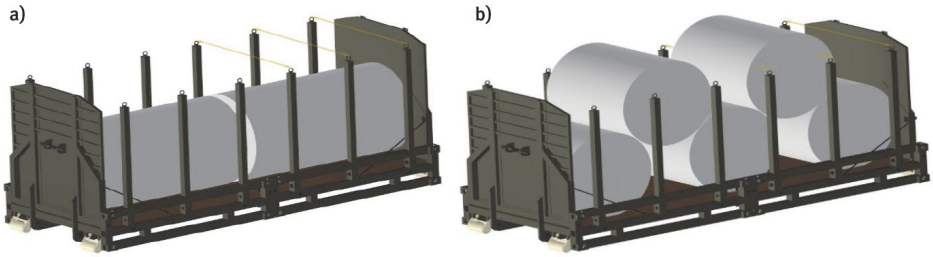

Figure 7 Selected results of the analysis of the possibility to extend the range of transported goods on the example of paper bales: a) Variant I; b) Variant II

Table 1 Selected results of the analysis: Variant I and Variant II

Analysis variant	Load data	Results
I	- diameter of 1 bale = 1,500 mm, - length of 1 bale = 2,800 mm, - weight of 1 bale = 3,300 kg	- weight of 1 complete 20' set with the above-mentioned load = 6,600 + approx. 4,000 kg = approx. 10,500 kg; - weight of 2×20' sets (i.e. 40' set– for one railway wagon) = 21,000 kg; - acceptable variants
II	- diameter of 1 bale = 1,500 mm, - length of 1 bale = 1,600 mm, - weight of 1 bale = 2,800 kg	- weight of complete 20' set with the above-mentioned load – 3×bales = 8,400 + approx. 4,000 kg = approx. 12,400 kg; - weight of complete 20' set with the above-mentioned load – 5×bales = 14,000 + approx. 4,000 kg = 18,000 kg; - unacceptable variant– stacking bales "one on top of another"

The separate frame of the basic module (after removing the end carriage with stanchions) and the set frames obtained after connecting them with joints can serve as pallets for temporary/ad hoc storage of logs with various longitudinal dimensions, for example in difficult terrain: in wet storage sites or areas periodically flooded with rainwater, etc.

5 Conclusions

The basic module and the multi-platform sets, obtained by combining basic modules with dimensions corresponding to typical railway containers: 10' (length of up to 3m), 20' or larger, can be used to support the intermodal transport of various goods, including logs and other loads with non-standard dimensions.
Single set of connected two basic platform modules is the equivalent of a 20' (length of up to 6 m) container. Such a set consists of: two frames connected with bolt joints, two rotating end carriages placed vertically at both ends of the frame set and two sets of stanchions with ties for the load.
The supporting set with the log load can be repeatedly reloaded (using four different types of loading and unloading techniques most commonly used in the transport of logs) from delivery vans to various types of railway wagons and vice versa without the need to empty the set.
The high mobility of a single platform is ensured by various methods of loading/unloading the platform. It is possible to move the platform, e.g. with the load of logs, using various means of close transport, various types of loading and unloading techniques, from delivery vans to different types of railway wagons and vice versa without the need to empty the set from the load. For this purpose, the following solutions can be used: typical rope slings and lifting with a self-propelled or stationary crane, overhead crane etc., forklifts and forklift devices of different class and standard hook lifting.
The freedom to create sets of various lengths, the selection of equipment configurations, i.e. end carriages, removable stanchions and side walls with a roof, ensure high mobility and functional flexibility of the platform-container. The set is also characterised by easy assembly/disassembly of movable/demountable components for the time of transport to obtain the desired transport configuration and in the process opposite to the storage configuration. Empty sets can be delivered to the loading site in an appropriate number in the folded state (basic modules after folding the end carriage, disassembling the stanchions and stacking horizontally – "one on top of another" take up much less space for transport and storage) and then, after their configuration depending on the intended use, they can be filled with logs and other transported goods, can wait for loading and delivery or can be moved with a very limited space, respectively for storage and transport.
Acknowledgements
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