Scientific Journal of Silesian University of Technology. Series Transport
Zeszyty Naukowe Politechniki Śląskiej. Seria Transport

Volume 115 **2022**

p-ISSN: 0209-3324

e-ISSN: 2450-1549

DOI: https://DOI:.org/10.20858/sjsutst.2022.115.14

Journal homepage: http://sjsutst.polsl.pl

Article citation information:
Warczek, J., Wójak, R. Good practices in the cargo preparation process in intermodal transport. *Scientific Journal of Silesian University of Technology. Series Transport*. 2022, **115**, 193-210. ISSN: 0209-3324. DOI: https://DOI:.org/10.20858/sjsutst.2022.115.14.

Jan WARCZEK[1], Rafał WÓJAK[2]

GOOD PRACTICES IN THE CARGO PREPARATION PROCESS IN INTERMODAL TRANSPORT

Summary. Increasing exports of goods between countries over long distances and increasing amounts of cargo generated by ports and transported on roads and railways require the organization of cargo transportation using several modes of transport, forcing the construction of places (container terminals) where it is possible to reload them to other means of transportation. An important aspect of cargo transportation by intermodal transport is its proper securing with the use of properly selected packaging and a loading unit. This article shows how to properly prepare cargo for transport. It also presents a diagram of the correct calculations of the permissible masses that may be in the container during transport to prevent overloading of the container and evenly distribute the load so that the reloading devices located in container terminals are not damaged during reloading to another mode of transport. Therefore, appropriate securing of the load against its displacement and damage was also selected.

Keywords: intermodal transport, container, packing

---

[1] Faculty of Transport and Aviation Engineering, The Silesian University of Technology, Krasińskiego 8 Street, 40-019 Katowice, Poland. Email: jan.warczek@polsl.pl. ORCID: 0000-0002-4767-5588
[2] Faculty of Transport and Aviation Engineering, The Silesian University of Technology, Krasińskiego 8 Street, 40-019 Katowice, Poland. Email: r.wojak@interia.pl. ORCID: 0000-0002-2769-1732

1. INTRODUCTION

Transport is one of the most important economic sectors [12, 13]. Since the implementation of container transport technology, a steady increase in the demand for this type of transport has been observed [4, 9]. This is supported by the several benefits related to both the organization of transport and the reduction of the negative impact of transport on the environment. One of the key issues of container transport is the correct selection of the container to the specification of the transported cargo. This is because, in the organization of container transport, the price of this service depends directly on the container used. An additional factor influencing the importance of this issue is the significant increase in freight costs in container transport observed in the transport markets, resulting from high demand in the phase of the market reconstruction after the pandemic. This work aims to analyze the case of selecting a container for a transport task for cargo preparation toward maximizing the use of cargo space. This task seems trivial; however, according to the authors, a properly prepared container use plan allows for reduced transport costs, not only directly but also considering the scale of transport, their overall impact on the external environment as well. The analyzed example is related to the authors' research on trade between Poland and Russia.

Intermodal transport is the transport of a specific load by at least two different modes of transport without changing the load unit [10, 11, 15].

Currently, trade and transport of various products are carried out not only between neighboring countries but also between continents (especially intermodal transport). Thanks to packaging, effective trade is possible. Packaging ensures proper storage of products at every stage of their transport, protecting them from the effects of degradation factors.

The modern logistics system (intermodal transport) should ensure the appropriate implementation of logistics processes, the features of which are easy to configure, and the diversity of its networks and supply chains. The variety of transport solutions should be based on multi-branch transport infrastructure and efficient technical (line and point) and ICT infrastructure. In addition, the development of intermodal transport should be based on the simplification of customs procedures between countries by changing the law and promoting it by the state as the best long-distance transport [8, 13, 16, 18].

2. PACKING IN INTERMODAL TRANSPORT

Each cargo intended for transport has specific physical, chemical and biological characteristics. Knowledge of the characteristics of the transported cargo allows for the selection of appropriate packaging [2, 20].

The correct selection of packaging is one of the important elements in the supply chain. Given the variety of products sold and transported, packaging can be divided into:

- unit,
- collective (indirect),
- transport.

The unit packaging ensures proper seating of a product during its transport and attracts consumers' attention toward buying it at the final stage, for example, a case [7].

Collective packaging allows for easy sorting, storage, and order completion. Its purpose is to place multiples of a given product in one place [7]. The most common types of collective packaging are cardboard boxes.

Transport packaging, in turn, is designed to facilitate the entire transport of the order to a specific place and is a specific element of the distribution system, which enables an efficient and quick flow of goods [6, 14, 17].

When carrying out transport of large quantities of loads, it is advisable to use load units suited to the types of packaging used. The container is the most popular loading unit in intermodal transport. It is a durable structure that enables multiple use. The container loading unit has design solutions for the transport of goods by multiple means of transport without the need to reload the goods in the container. One of the design solutions is handling grooves. They are located in the lower part of the container and enable reloading in container terminals to other modes of transport using, for example, a gantry car.

The construction of containers enables easy, quick and efficient filling and emptying of the transported goods. Additionally, containers are equipped with elements that ensure efficient handling during reloading from one means of transport to another [1, 17].

2.1. Functions of packaging in intermodal transport

The basic functions of transport packaging include:

- protective function - enables protection of the product against external factors,
- logistic function - affects the efficiency of handling activities in container terminals,
- information function - informs about the weight, capacity or use of the container,
- economic function - shows the costs of producing the packaging,
- ecological - meets the environmental needs of transport packaging [14].

The above functions can also be applied to unit packages and collective packages. However, in intermodal transport, they are less important than transport packaging because the load is placed in the transport packaging and is not reloaded, and only the loading unit is transferred to another mode of transport.

3. METHOD OF PACKING AND PREPARATION FOR TRANSPORT OF A SELECTED CARGO

The appropriate packaging should be selected with the correct specification for the product being transported. The appropriate method of packaging should protect the goods against damage and will protect them against external factors, for example, excessive sunlight.

3.1. Product selection

The product of choice is bar soap. The product was selected based on research conducted by the authors and published in the article “Analysis of the potential of intermodal transport in trade between Poland and Russia”, where the export of the above product between Poland and Russia is one of the largest regarding loading weight.

Fig. 1. Bars of soap - side view

The soap bars provided by the manufacturer were wrapped in a protective foil and contain 12 pieces of soap in one package (Figure 1).

3.2. Getting to know the card of the transported product

After choosing the product to be transported, in this case, the bar soap, it is indicated in the product card. The product sheet is a collection of all the information about a given product. It contains, among others, information on the chemical composition of the product and identifies the risks that the product poses to human health and life or the environment. It is issued by the manufacturer.

Based on the product sheet, the following information is read and established:

- chemical composition of the product,
- whether it poses a threat to humans and the environment,
- emergency first aid,
- product handling and its storage conditions,
- any contraindications regarding its transport by selected modes of transport (the information mainly concerns intermodal transport).

Bar soap is a product with no contraindications for transport by various modes of transport and is harmless to humans and the environment in the event of an accident. However, the product must be transported at a low constant temperature and not be exposed to direct sunlight.

3.3. Selection of collective packaging

A cardboard box with the following specification was selected as the collective packaging:

- external dimensions: 400x400x400 [mm],
- internal dimensions: 398x398x398 [mm],
- cardboard weight: 465 [g],
- cardboard thickness: 2 [mm].

To load the goods into the collective packaging, its measurements must be taken. Subsequently, the following dimensions were established:

- length (after pressing the protective foil): 198 [mm],
- width (after pressing the protective foil): 78 [mm],
- height (after pressing the protective foil): 78 [mm].

Figures 2 and 3 below show the dimensions obtained.

Fig. 2. Front view of the soap packet

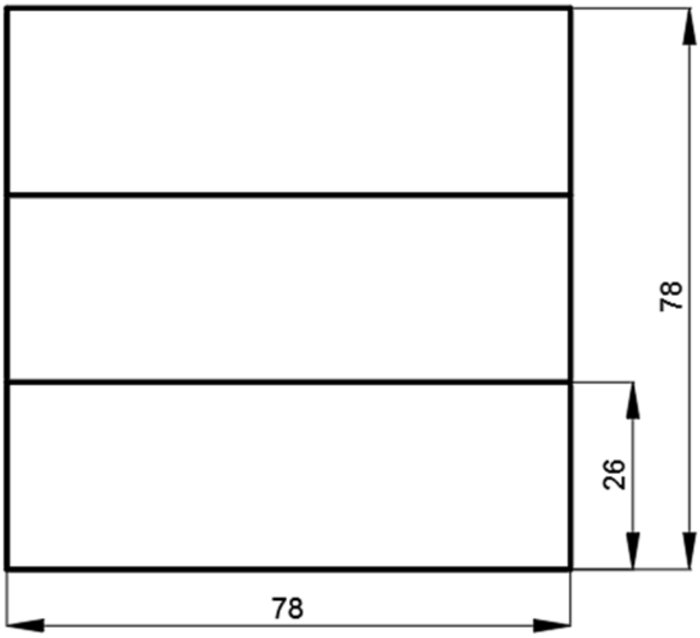

Fig. 3. Right side view of the soap packet

The calculations considered the weight of a single soap bar package when packing the goods. The weight of a single bar of soap is 90 grams.

$$p = k * m \tag{1}$$

where: k - number of pieces of soap in a single package [-], m - mass of a single bar of soap [g].

Based on formula 1, it was found that the weight of a single soap package is 1080 grams, that is, 1,08 kg.

The soap packets will be packed in a carton with the specifications shown in subsection 3.1 above, which is about the external dimensions: 400x400x400 [mm].

The number of soap packages a single carton could hold was determined based on the formulas below.

Number of soap packages in a single carton:

$$pk = a * b \tag{2}$$

where: a - number of soap packets in a single layer [-], b - the number of levels of soap packets contained in a carton [-].

After calculations, it was found that a single carton is capable of holding 50 soap packages. Visualizations of the packed cardboard are shown in Figures 4 and 5.

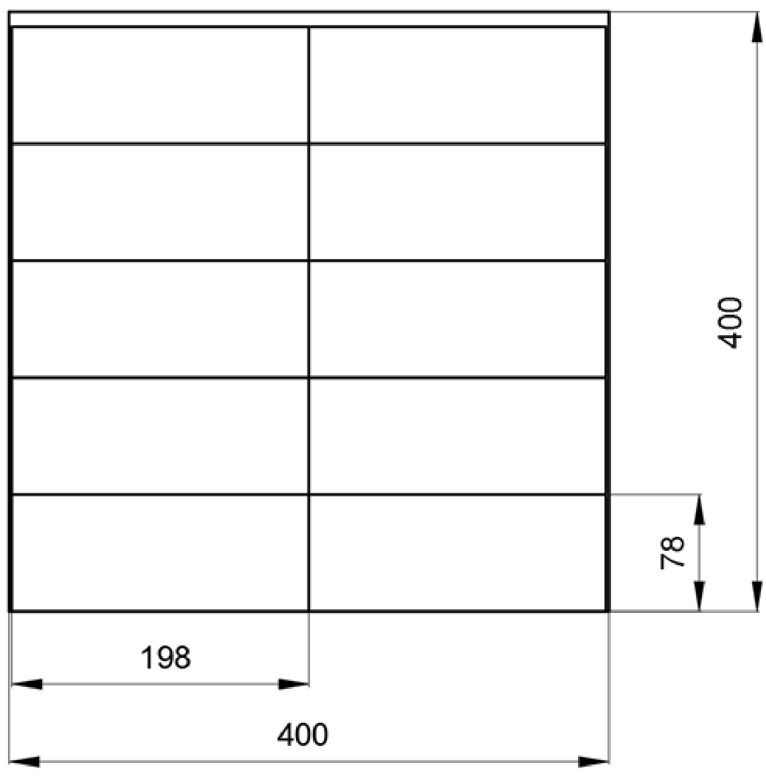

Fig. 4. Front view of the packed cardboard

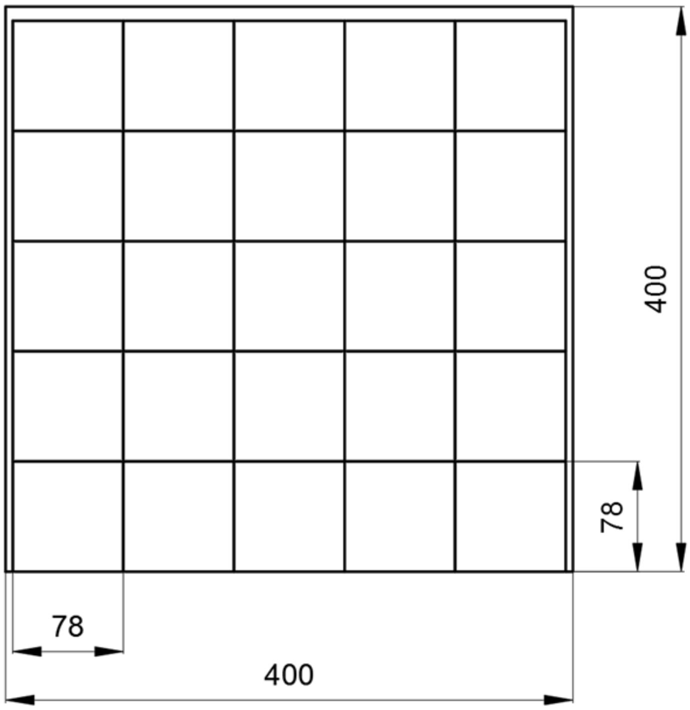

Fig. 5. Right view of the packed cardboard box

In addition, 10 and 5 mm handling clearance on each side of the carton was considered for the cardboard cover. This allows the load a little freedom and the possibility of movement during transport or reloading of the load unit. The collective packaging in which handling clearance is not kept may lead to its tearing, and consequently, damage to the cargo.

The next calculations are made based on the following formulas 3, 4 and 5 to determine the gross weight of a single carton to be able to form it on the transport packaging.

Formula 3 allows the calculation of the number of individual pieces of soap contained in a carton:

$$i = k * pk \tag{3}$$

where: k - number of pieces of soap in a single package [-], pk - number of soap packages contained in a single carton [-].

Based on formula 3, it was found that the number of pieces of soap in a single carton is 600.

Formula 4 allows calculating the weight of the soap packages in the carton. While, formula 5 summarizes the final gross weight of the collective packaging, that is, the cardboard box with the load.

$$n = p * pk \tag{4}$$

where: p - weight of a single package [g], pk - number of soap packages contained in a single carton [-].

Based on formula 4 above, it was found that the weight of the soap packages in a single carton is 54 kg.

$$b = n + t \tag{5}$$

where: n - mass of soap packets contained in a single carton [kg], t - weight of an empty cardboard box [kg].

After making calculations based on formula 5, it was found that the gross weight of a single box is 54,465 kg. However, due to health and safety regulations, it is not possible to manually move the boxes and place them on transport packaging. Therefore, attention should be given to solutions for the automation of work.

This article focuses mainly on the best use of the selected collective packaging.

3.4. Selection of transport packaging

The selected transport packaging is the EUR pallet. It is a universal logistic carrier with standard dimensions, characterized by universal access and is used for transporting various loads, including collective packaging. The standard dimensions of the EUR pallet are shown in Figure 6 below.

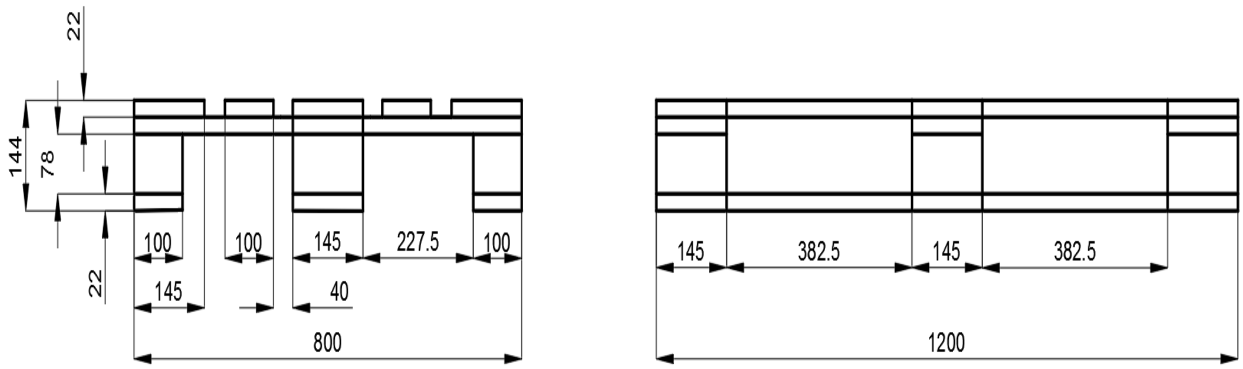

Fig. 6. EUR pallet – dimensions

The weight of a single empty EUR pallet is 25 kg. Its permissible load is 1000 kg in the case of uneven load distribution. However, in the case of even load distribution, its permissible load may be 1500 kg.

The first layer contains six cartons, and each pallet has two levels of cartons, so there will be 12 cartons on each pallet. Calculations of the gross weight of a single EUR pallet are presented based on formulas 6 and 7. An important aspect to consider when making calculations is not exceeding the permissible load capacity of the loading unit.

$$e = l * b \tag{6}$$

where: l - the number of all cartons on the pallet [-], b - gross weight of a single carton [kg].

$$bp = e + w \tag{7}$$

where: e - gross weight of all cartons on a single EUR pallet [kg], w - weight of a single pallet [kg].

Based on formulas 6 and 7, it was found that the gross weight of the pallet with load is 678,58 kg. The calculation of this mass will be used to verify the selection of an appropriate loading unit.

Figure 7 below presents a diagram summarizing stage 1 regarding the choice of cargo and the method of its packaging.

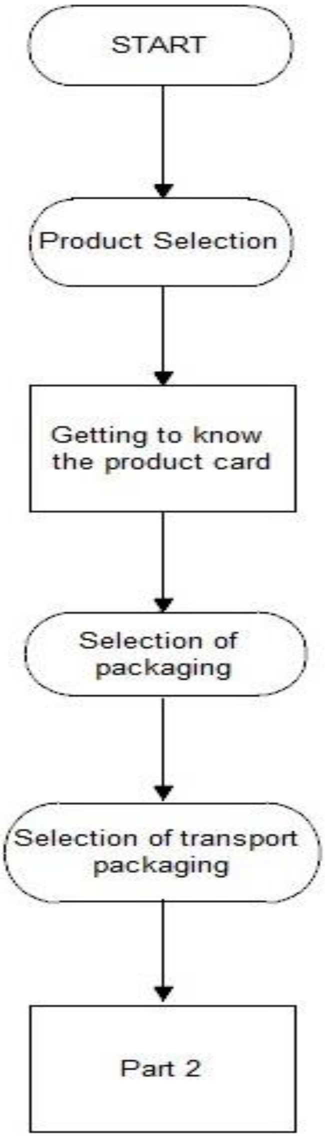

Fig. 7. The process for selecting the load and how it is packaged (part 1)

4. SELECTION OF THE LOADING UNIT

A properly selected loading unit should protect the cargo against damage due to the transport of cargo by various modes of transport and reloading at container terminals. The most popular loading unit in intermodal transport, that is, a container, was selected for the transport of the soap bars.

Bar soap is a product that does not endanger human life, health and the environment. Therefore, the container does not need to have additional ADR type markings, and its transport is possible by all modes of transport. When selecting a container, it is necessary to determine which group of loads the transported goods belong to - whether they are general cargo or bulk cargo. Groupage loads include goods on pallets, and bulk cargo can be called sand. In this case, it is a general cargo.

It is also necessary to determine the size of the container to fill it to the best percentage possible and determine whether the container does not need additional aggregates that will maintain a constant temperature inside it for the transported cargo.

For soap bars, due to the need to maintain a constantly low temperature during transport and non-exposure of the product to sunlight, a refrigerated container with special units for maintaining a constant temperature inside was selected.

Next, a calculation is made to obtain the best possible use of the container percentage of transport potential. The choice will be made based on four container sizes, that is, 10 ', 20', 40 'and 40' HC (elevated container) by MT CONTAINER. Their characteristics are presented below (Table 1).

Tab. 1

Container specification

Specifications	Parameters	Container 10’	Container 20’	Container 40’	Container 40’ HC
External dimensions [mm]	Length	3050	6058	12192	12192
	Width	2438	2438	2436	2438
	Height	2591	2591	2591	2896
Internal dimensions [mm]	Length	2383	5456	11577	11550
	Width	2190	2294	2294	2290
	Height	2291	2263	2110	2545
Weight [kg]	Curb weight	2250	2900	3900	4660
	Capacity	7910	27600	28600	29340
	Total mass	10160	30480	32500	34000
Volume [m^3]		12	28,4	59,8	67,5
Group type code		RT	RT	RT	RT
Type code		R1	R1	R1	R1

The amount of a given cargo in the container can be selected using mathematical formulas relating to the stowage factor of the cargo and the stowage factor of the container. After making these calculations, the rule of selecting the container, whether its load-bearing capacity or capacity of the container is used. However, this rule can only apply to loads where the stowage loss is known [19].

The stowage loss is the free space (handling clearances) that should be used during the transported goods. However, the stevedoring loss, in this case, is unknown. Therefore, in the calculations, it should be assumed that each item of cargo is treated as a cuboid, and the way of positioning the cargo in the container along the length of the container and its width should be checked. Formula 8 shows the dependence of the load orientation along the length of the container, while formula 9 shows the relationship of load orientation along the width of the container.

$$N_1 = \left[\frac{L}{l}\right] * \left[\frac{B}{b}\right] * \left[\frac{H}{h}\right] \tag{8}$$

where: L - internal length of the container [m], l - cargo length [m], B - internal width of the container [m], b - cargo width [m], H - container height [m], h - load height [m].

$$N_2 = \left[\frac{L}{b}\right] * \left[\frac{B}{l}\right] * \left[\frac{H}{h}\right] \tag{9}$$

where: L - internal length of the container [m], l - cargo length [m], B - internal width of the container [m], b - cargo width [m], H - container height [m], h - load height [m].

When making calculations, each obtained quotient is rounded up to a whole number, always down. The number of possible items of cargo for transport after completion is presented in Table 2.

Tab. 2

Calculation results for the maximum number of pallets in the containers

Container size	N1 [szt.]	N2 [szt.]
10’	4	4
20’	16	12
40’	36	28
40 HC	36	28

Based on the above calculations, it was found that the 40 'container and the 40' HC container can accommodate the largest amount of cargo. Both containers obtained identical results. The load should be placed along their length. However, it is also worth paying attention to whether it is possible to use a mixed setting or not, that is, some pallets will be placed along the length of the container, and some along its width. With the mixed setting, the 40' and 40' HC container can accommodate 46 EUR pallets.

Additionally, when selecting the appropriate amount of cargo in the container, calculations should be made regarding the gross weight of the transported cargo so as not to exceed the load capacity of the container and the degree of its filling. The container for the transport of a given load is selected based on the highest degree of filling.

Exceeding the permissible load capacity of a container has serious consequences. This phenomenon should be counteracted at the initial stage, that is, before loading. Therefore, appropriate cargo calculations need to be made, and the results must be compared with the permissible load capacity of the container.

An overloaded container may cause:

- damage to fixed or mobile handling equipment,
- damage to the reloading equipment, for example, slings,
- damage to means of transport during transportation.

Following the above, the container that has been reloaded should be put in a safe place and should not be handled or transported until it is reformed. In intermodal transport, it is of great importance due to reloading at the container terminals and the transport of containers through various means of transport.

Usually, reloading of containers takes place because of an incorrect reading of the information on the cargo or the container door. In intermodal transport, the weight information is given in kg and Ibs units. Incorrect reading of the appropriate unit causes overloading of containers in terminals. Therefore, one should always make sure of the unit type the weight of the load is given and the units of weight related to the container.

Transport of 46 EUR pallets placed in two layers will not be possible due to the exceeded load capacity of both containers. Therefore, the 40 'container will be able to accommodate 42 EUR pallets, and the 40' HC container will be able to accommodate 43 EUR pallets.

Further, if the pallets are properly positioned in the 20 'container, it will be possible to transport 18 EUR pallets arranged in two layers.

To make the above calculations, the following formulas and relationships should be used. Formula 10 and relationship 11 concern calculations related to the permissible gross weight of the cargo, formula 12 calculates the internal volume of the container, formula 13 calculates the volume of a single EUR pallet of cargo, and formula 14 calculates the volume of all the pallets in the container. However, the degree of filling the container is calculated from the proportion, that is, the ratio of the total internal volume of the container to the volume of all the pallets in the container.

$$k = d * bp \tag{10}$$

where: d - number of pallets in the container during transport [-], bp - gross weight of a single EUR pallet [kg].

$$k < M \tag{11}$$

where: gross weight of all the pallets in the container [kg], M - container load capacity [kg].

$$V_k = L * B * H \tag{12}$$

where: L - internal length of the container [m], B - internal width of the container [m], H - internal height of the container [m].

$$V_p = l * b * h \tag{13}$$

where: l - length of the pallet with load [m], b - width of the pallet with load [m], h - height of the pallet with load [m].

$$V_c = V_p * d \tag{14}$$

where: Vp - volume of a single EUR pallet with cargo [m^3], d - number of pallets during transport [-].

Table 3 presents the collective results for all types of containers.

Tab 3.

Calculation of the degree of filling of the containers

Container size	Number of possible pallets to be loaded [szt.]	Gross weight of the transported cargo [kg]	The volume of a single pallet in a container [m^3]	Volume of all the pallets [m^3]	The degree of filling [%]
10’	4	2147,32	0,90	3,62	30,21
20’	18	12214,44	0,90	16,31	57,44
40’	42	28500,36	0,90	38,06	67,93
40’ HC	43	29178,94	0,90	38,97	57,73

Based on Table 3, it was found that the 40' container has the highest degree of filling and, therefore, the best for the soap load being transported. Figure 9 below shows the arrangement of the pallets in the container.

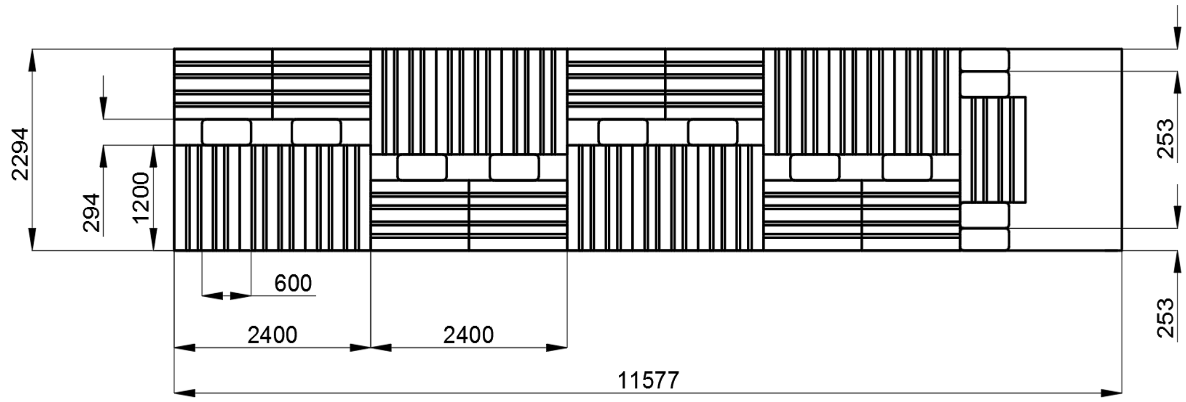

Fig. 8. Pallet arrangement in a 40' container with stevedoring material

Figure 8 also includes dunnage material, which is to prevent the cargo from shifting during transport. Dunnage cushions with the following dimensions were selected as the stowage material:

- 90x294 mm; liczba sztuk: 10,
- 90x253 mm; liczba sztuk: 2.

The following Figure 9 presents a summary in the form of a diagram, the selection of the loading unit and the sequence of calculations related to it.

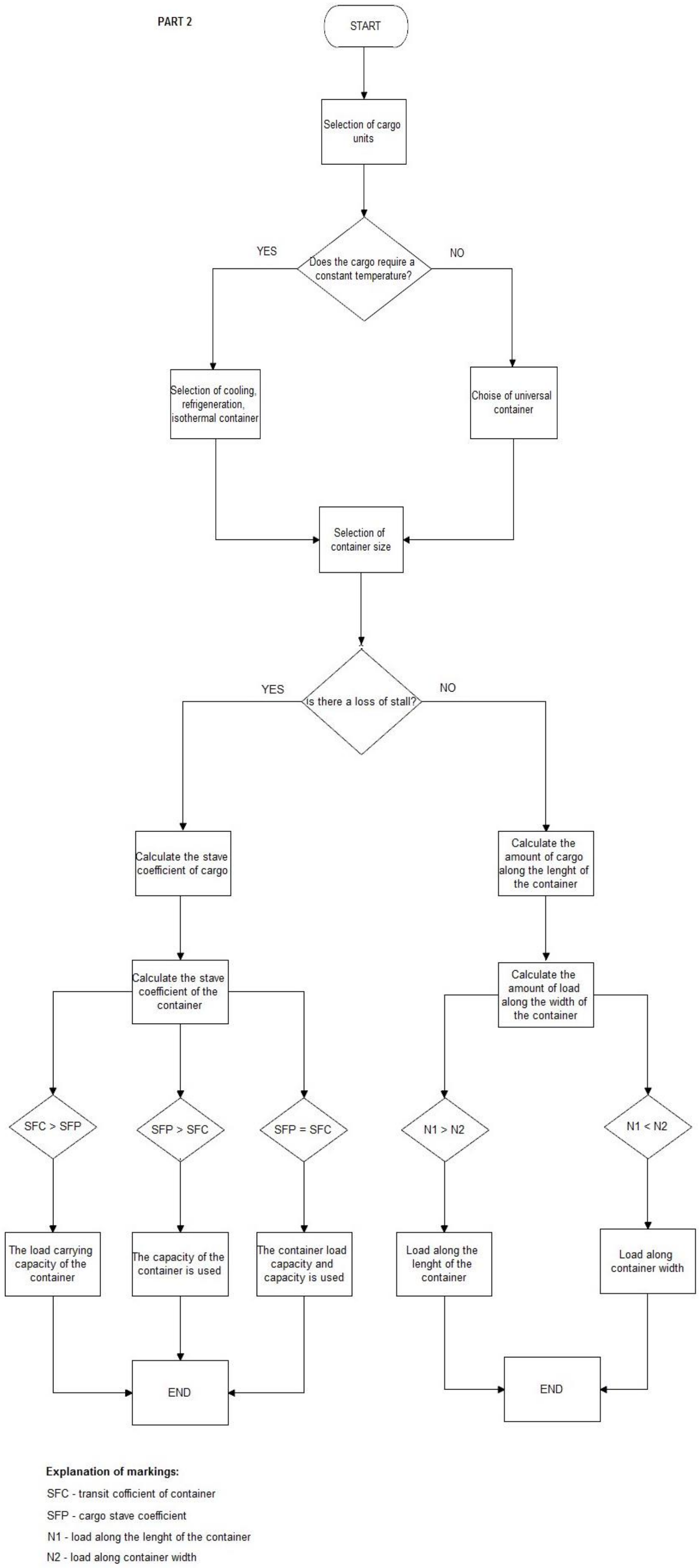

Fig. 9. Selection of the loading unit (part 2)

Figure 10 presents a summary diagram, starting from the choice of cargo, through the proper selection of packaging and loading units, to its arrangement in the container.

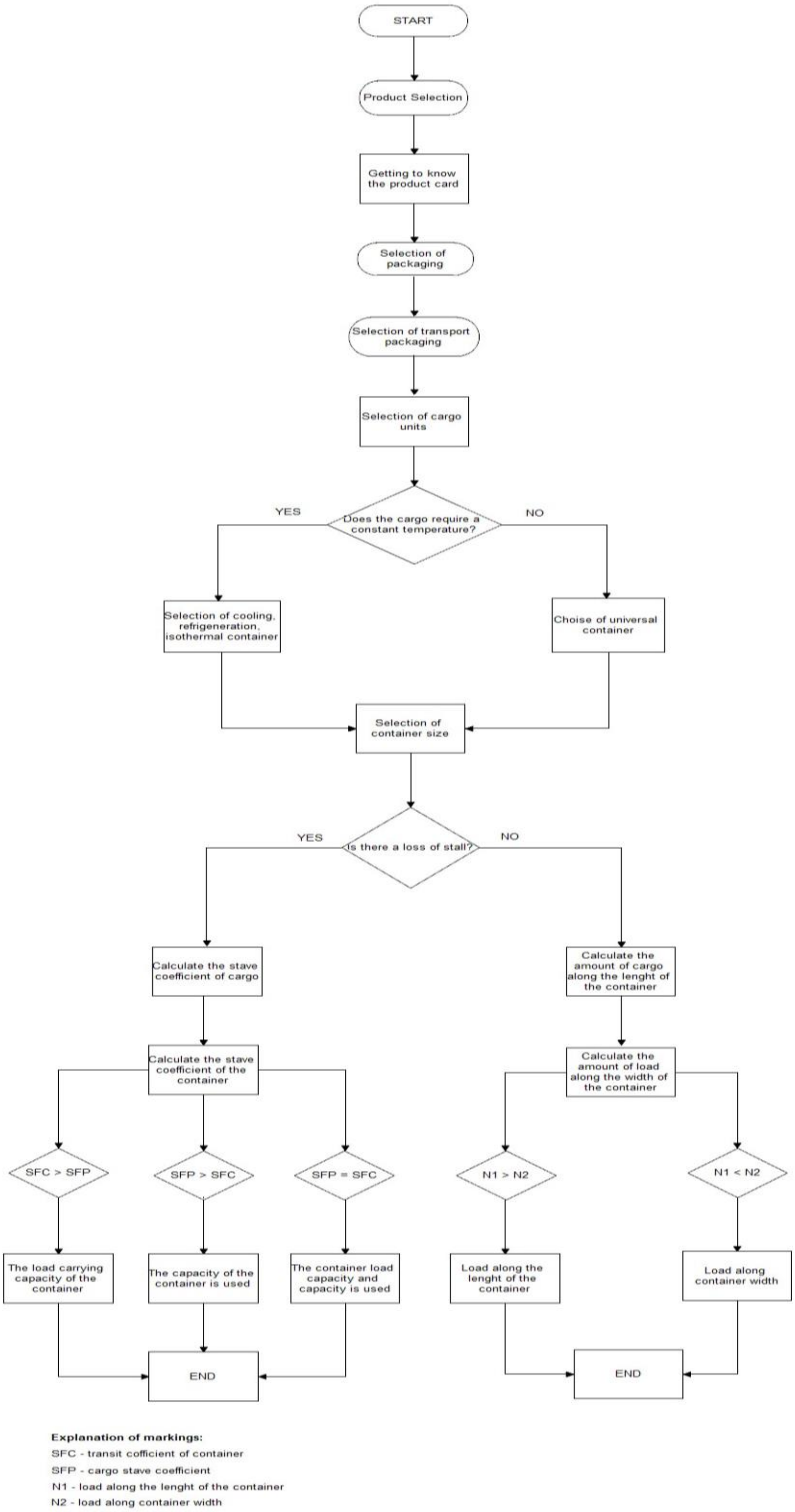

Fig. 10. Summary of the container selection process

5. CONCLUSION

Transport packaging is an important element of the distribution system, which determines the efficient and quick flow of goods from the producer to the recipient.

To facilitate the reloading of loading units such as containers, they have been standardized and adapted to increase the efficiency of the transport process while minimizing the transport time during the activities related to the reloading of integrated loading units.

The selection of the container requires knowledge of the properties of the transported cargo. The product sheet provided by the manufacturer helps in this. It contains recommendations and restrictions related to its storage and transport with the use of various modes of transport. In addition, it should be used to determine the type of container to be used during transport. An isothermal container was used when organizing the transport of an exemplary load due to the information in the product sheet on the conditions of storage at a temperature below 30°C and avoiding sunlight.

The rule for selecting the size of the container is based on the calculation of the cargo stowage coefficient and the stowage coefficient of the container. Their values should be equal then the load capacity and capacity of the container are used at the same time. In this work, the stevedoring loss was not known; therefore, it was necessary to make calculations related to the maximum number of pallets that could be placed in the container. After making the appropriate calculations and receiving their results, it was found that the selected 40' container, when properly arranged, can accommodate 46 pallets with cargo. However, the maximum load capacity of the container was exceeded; therefore, 4 EUR pallets had to be subtracted from the contents of the container.

An important element when forming the container is the use of dunnage material, which is designed to fill empty surfaces and ensure the safety of the cargo so that it does not shift during transport. Dunnage bags were used in the container when the soap bars were transported. The dimensions of the bags and the degree of their safety to the allowable pressure that may exist in them must be adapted to intermodal transport. Their application is to ensure safety during reloading operations related to the container at the container terminal.

When filling the container with pallets, it is advised that the load on the pallet be properly secured, for example, with the use of tapes and heat-shrinkable foil. Moreover, when two rows of pallets are formed, a free cargo space inside the container should be left. On the other hand, the stacking of pallets depends on their dimensions and the permissible load on the pallet in the first layer. Due to the height of the container used, the pallets were loaded in two layers.

References

1. Araújo Eliseu Junio, Antonio Augusto Chaves, Luiz Leduino de Salles Neto, Anibal Tavares de Azevedo. 2016. “Pareto clustering search applied for 3D container ship loading plan problem”. *Expert Systems With Applications* 44: 50-57.
2. Araya I., M.-C. Riff. 2014. “A beam search approach to the container loading problem”. *Computers & Operations Research* 43: 100-107.
3. Bortfeldt Andreas, Hermann Gehring. 2001. “A hybrid genetic algorithm for the container loading problem”. *European Journal of Operational Research* 131: 143-161.
4. Bozzo Riccardo, Alfredo Traverso, Marco Galaverna, Annalisa Delfino. 2000. “Innovative cargo unit for vehicles transport: tecnical and economic considerations”. European Transport / Trasporti Europei 16: 29-33.

5. Choong Sook Tying, Michael H. Cole, Erhan Kutanoglu. 2002. “Empty container management for intermodal transportation networks”. *Transportation Research Part E* 38: 423-438.
6. Egeblad Jens, Claudio Garavelli, Stefano Lisi, David Pisinger. 2010. “Heuristics for container loading of furniture”. *European Journal of Operational Research* 200: 881-892.
7. Emblem Anne, Henry Emblem. 2014. *Packaging technique. Basics, materials, manufacturing processes*. Warsaw: Polish Scientific Publishers PWN SA. ISBN: 978-83-01-17845-1.
8. Fechner Ireneusz. 2010. “Logistics centers and their role in the cargo flow processes in the Polish logistics system”. *Scientific Papers of the Warsaw University of Technology* 76: 20-32. ISSN: 1230-9265.
9. Gattuso Domenico, Giuseppe Musolino. 2000. “Container traffic flow through Gioia Tauro port in the international and Italian context”. European Transport / Trasporti Europei 16: 46-52.
10. Gnap Józef, Jaroslava Kubáňová. “Selected Options for Modelling of Transport Processes Particularly in Relation to Intermodal Transport”. In: *18th International Scientific Conference - LOGI 2017*: 1-8. MATEC Web Conf. 8 November 2017. DOI: 10.1051/matecconf/201713400015.
11. Ishfaq Rafay, Charles R. Sox. 2010. “Intermodal logistics: The interplay of financial operational and service issues”. *Transportation Research Part E* 46: 926-949.
12. Jacyna M. 1998. “Some aspects of multicriteria evaluation of traffic flow distribution in a multimodal transport corridor”. *Archives of Transport* 10(1-2): 37-52.
13. Jacyna M., M. Wasiak, K. Lewczuk, M. Kłodawski. 2014. “Simulation model of transport system of Poland as a tool for developing sustainable transport”. *Archives of Transport* 31(3): 23-35.
14. Kwaśniowski Stanisław, Tomasz Nowakowski, Mateusz Zając. 2008. “Intermodal transport in logistics networks”. Wrocław: Publishing House of the Wrocław University of Technology. ISSN: 1425-0993.
15. Racunica Illia, Laura Wynter. 2005. “Optimal location of intermodal freight hubs”. *Transportation Research Part B* 39: 453-477.
16. Šakalys Algirdas, Ramūnas Palšaitis. 2006. “Development of intermodal transport in new European union states”. *Transport* XXI(2): 148-153. ISSN: 1648-3480. Taylor & Francis.
17. Warczek Jan, Rafał Wójak. 2021. “Analysis of the potential of intermodal transport in trade between Poland and Russia”. In: *XIII International Conference Transport Problems*: 809-819. Faculty of Transport, Silesian University of Technology, Katowice, Poland. 28-30 June 2021, Katowice, Poland. ISBN: 978-83-959742-1-2.
18. Winebrake James J., James J. Corbett, Aaron Falzarano, J. Scott Hawker, Karl Korfmacher, Sai Ketha, Steve Zilora. 2008. “Assessing Energy, Environmental, and Economic Tradeoffs in Intermodal Freight Transportation”. *Journal of the Air & Waste Management Association*: 1003-1013. DOI: https://doi.org/10.3155/1047-3289.58.8.1004.
19. Wiśnicki Bogusz. 2006. *Vademecum of Containerization. Forming a load unit*. Szczecin: Link I Maciej Wędziński. ISBN: 83-909749-9-1.
20. Wronka Jerzy. 2010. “Transport susceptibility of cargo: a forgotten economic category?”. *Scientific Journals of the University of Szczecin. Economic Problems of services* 60: 484-496. ISSN: 2450-8330.

Received 07.01.2022; accepted in revised form 29.03.2022