Construction proposal of shipping bulk container

R Poklemba, J Zajac, D Goldyniak, I Olexa and M Dlýová
Technical University of Kosice, Faculty of Manufacturing Technologies Department of Industrial Engineering and Informatics, Bayerova 1, 08001 Presov, Slovak Republic

E-mail: robert.poklemba@tuke.sk

Abstract. The presented paper is focused on proposal of folding container that would minimize this problem and reduce transportation costs. Transportation has been an important part of everyday life in the past. Crates of various shapes and sizes were used to transport various goods, the main task of which was to protect the material from adverse atmospheric influences. As a result of technology development, people have tried to simplify the way they transport different materials or products. Containerisation has arisen for the need to transport more goods over longer distances, even between continents. The work also contains descriptions of individual graphic systems through which it is possible to implement the container proposal before its production. In the last part there is a comparison of the classic folding container in terms of its transport and description of its construction.

1. Introduction
Transportation has been an important part of everyday life in the past. Crates of various shapes and sizes were used to transport various goods, the main task of which was to protect the material from adverse atmospheric influences. As a result of technology development, people have tried to simplify the way they transport different materials or products. Containerisation has arisen for the need to transport more goods over longer distances, even between continents. For better transport compatibility, container dimensions have been unified by a multinational ISO company. At present, container transport is the most used for the transport of goods. Currently, around 20 million containers are in circulation around the world, with about 3 million new ones each year. The biggest problem with this type of transport is the transport of empty containers, 40 % of the total number of containers transported by land is empty [1, 2].

The main aim of this paper is to propose a folding container that would minimize this problem and reduce transportation costs. The work also contains descriptions of individual graphic systems through which it is possible to implement the container proposal before its production. In the last part there is a comparison of the classic folding container in terms of its transport and description of its construction [1, 2].

2. Construction proposal of folding bulk container
Nowadays, shipping containers are used to transport various materials that are used in almost every industry. Construction of the shipping container have to be adjusted for stacking, it means storing several containers on top of each other. ISO 1496-3 norm specifies that a maximum of 9 containers can be stored in one column, while a fully loaded container can’t be weighing more than 30 000 kg.
This norm also determines the distribution of containers into 3 basic series (table 1) according to the load capacity and dimensions [3, 4].

| Series  | ISO container series [3]                                                                 |
|---------|------------------------------------------------------------------------------------------|
| Series 1| Shipping containers weighing between 10 and 30 tonnes                                      |
| Series 2| Shipping containers weighing between 5 and 7 tonnes                                        |
| Series 3| Shipping containers weighing between 10 and 30 tonnes                                      |

The individual series further describes the exact container parameters its length, height and width. Containers of series 1 are nowadays used most frequently in intermodal transport due to their capacity. ISO norm also describe shipping containers according to the usage: universal container, open top container, coal transport container, bulk container, tank container, termic container and platform container [5, 6].

We worked with inventor program for the shipping container proposal. In the production of container construction will be used current production technologies: cutting, forming, welding and grinding technologies [7]. Cutting technology uses band sawing and cutting. After the container has been made, a surface treatment is applied in which two layers of paint are applied, namely the base paint and the surface paint. For this proposal, it would be best to cut the profiles with usage of band saw. Cutting technology will be used for splitting the side walls, the roof of the container, as well as the back wall and door panels. Considering to the material used for girder, MAG welding technology is most suitable. After completing the container, a protective coating will be applied to the surface. The primer used is a primer based on alkyd resin with zinc phosphate admixture, which is suitable for steel structures exposed to weathering, with a spray thickness of about 60 µm. The same type of coating is also applied to the inner part of the container. As a second layer of outer coating, a low solvent-based polyurethane-based topcoat is used which is UV and abrasion resistant. The spray thickness of this layer is approximately 120 µm. The most suitable material for construction of girder part of container is proposed the low alloy steel S235 JRG (table 2), which is suitable for statically stressed structures and has good weldability and suitable mechanical properties, seems to be the most suitable material for the main girder container [5, 8, 9].

| Steel type | Yield strength $R_p$ (MPa) | Tensile strength $R_m$ (MPa) | Elongation $A_5$ (%) | Impact test KCU (J) |
|------------|----------------------------|------------------------------|----------------------|---------------------|
| S235 JRG   | 235                        | 340-470                      | 24                   | 27                  |

3. Describing of folding container construction

Floor (figure 1), the main floor frame is made of IPE type profile with height of 160 mm. In the corners of the floor there are standardized casted corner cubes for handling and fixing containers. The front and back transverse part of the floor construction is a thin-walled profile of 120×70 mm with a wall thickness of 5mm. One more IPE 160 profile is inserted in the middle along the entire structure for higher floor strength. The cross stiffeners consist of a profile of 40×40 mm and a wall thickness of 3 mm. Tunnels are placed across the frame to manipulate the container with a forklift. All parts of the floor are welded together with a corner weld with a wall height of 3 mm. A steel sheet of 3 mm thickness is used on the floor and is fixed to the transverse reinforcements by spot welds. Hinges are still placed on the floor to attach the side walls to the floor.
The lower part of the perimeter structure (figure 2) is an L-profile with dimensions 38×38 mm with a wall thickness of 3 mm, into which a steel rod with an outer diameter of 35 mm is inserted with an internal hole of 20 mm diameter which serves to attach the side wall to the floor. On the sides there is a strip steel 38 mm wide and 35 mm thick. The upper part of the frame is made of an L-profile with dimensions 38×38 and a thickness of 3 mm, into which holes ø 10 are used to connect the wall to the roof. The side wall panel is made of a trapezoidal sheet of 1.5 mm thickness and 35 mm width.

The back wall is made of two thin-walled profiles with dimensions 150×130 mm and wall thickness 5 mm. At the top of each profile (figure 3) are L-profiles 50×50 mm and 5 mm thick are welded in the corner sections, which are inserted into the roof profiles to reinforce the folded structure. At the bottom, these profiles are cut to a height of 60 mm at an angle of 45° to avoid collision with folded side walls. Special-shaped hinges (figure 4) are located on the outside part of the main profile for exact accommodation of back wall when folding the container.
The front wall construction (figure 5) is almost identical to the back wall structure, with the difference that the trapezoidal sheet is replaced by double-leaf doors. The perimeter structure of the door is a thin-walled 35×35 mm profile with a wall thickness of 3 mm. A 5 mm thick steel sheet is used for the door panel.

![Figure 5. Front wall with double doors.](image1)

![Figure 6. Roof.](image2)

As with the floor, there are standardised cubes are placed in the corners. The longitudinal parts of the main structure are L-profiles 220×90. There are square profiles with dimensions 120×120 and wall thickness 5 mm placed on the transverse parts. Thin-walled profiles with a length of 520 mm and dimensions 150×130 mm are located in the corner parts. The roof (figure 6) is covered with the same type of trapezoidal sheet as used on other parts of the container. The trapezoidal sheet is inserted into the back of the roof and is fixed to the side profiles by the L-profile from the bottom. This L-profile is used to connect the back wall and roof with screw connections.

4. Description of container composition
The first step in the storage container is to remove the retaining plates (figure 7), which prevent the top and bottom of the container from being disengaged when unfolded. These boards are mounted on the pins on the profiles and are fastened with 4 screws DIN 438 with M10 thread.

![Figure 7. Safety plate.](image3)
The roof is lifted with a crane or manipulator, and the side walls (figure 8) which are located on the hinges are folded. In order to allow a collision-free composition, one wall is lower and is mounted on a thin-walled profile that is welded to the floor, thereby allowing one panel to be folded over the other. The next step is to assemble the front and rear panels. These panels are fixed to the floor with DIN 427 adjusting screws, which have only a half-length thread and can be rotated. After tilting these panels, a roof is placed on the contact surfaces. In order to ensure that the folded container is not detached during transport and during handling, the same safety plates (figure 9) serve to ensure the strength of the folded container.

![Figure 8. Olded side walls.](image1)

![Figure 9. Front clutch.](image2)

5. Technical parameters of folding container

Table 3 presents the basic information about folding container.

| Length (mm) | Width (mm) | Height (mm) | Height of folded container (mm) |
|-------------|------------|-------------|-------------------------------|
| 6053        | 2438       | 2591        | 660                           |

| Weight (kg) | Internal volume (m³) | Material   | Internal hole dimension (mm) |
|-------------|----------------------|------------|------------------------------|
| approximately 2700 | 30 | C 235 JRG | 2233×2308                   |

6. Economical comparison of folding and classic

To compare the price of transport, the route Presov (SK) - Salzburg (AU) was chosen. The total length of the route is approximately 784 km. The price for 1 km of truck transport is approximately € 1.20 per km depending on the carrier. On a standard 12 meters trailer, only two classic containers can be transported on one route (figure 10). The cost of transporting two containers would cost € 940, so the cost of transporting one container would be € 470.

When using a folding container, a total of up to 8 empty containers could be stored on the semi-trailer (figure 11) which means that for the same route length, the price of transporting one container would be only € 117.5 which reduces the manufacturer's shipping costs products.
7. Conclusion

The paper deals with the design of a folding container to reduce shipping costs, which would ultimately save not only financial costs but also transport time. Economical recalculation of folding container containers compared to folding proves that the company can save shipping costs. Even from an environmental point of view, this type of transport will have a positive impact on the reduction of emissions generated by the means of transport.

8. References

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