International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878, Volume-8 Issue-5, January 2020

Development of the Design and Conditions of Operation of Containers for Transportation of Fruit and Vegetable Products

Matluba A. Khadjimukhametova, Avaz M. Merganov

Abstract*: The article deals with the need for the development and commissioning of specialized containers for transporting fruits and vegetables. The requirements for the design of the new container are given and a previously unknown (developed) container design for transporting fruits and vegetables is proposed for consideration. Corresponding studies on the stress-strain state for the developed container design have been carried out. Container operating conditions are summarized.

Keywords*: container, fruits and vegetables, finite element model, load during operation, stress-strain state, transportation, ventilation, small size, stack.

I. INTRODUCTION

The quality of fresh fruits and vegetables delivered to the consumer is a complex economic problem. It depends on the chemical composition of the sown area, on the timeliness of agrochemical and agrotechnical measures during the cultivation of crops, etc. An important place in this chain is given to the country's transport system, which delivers cargo from production areas to consumption areas.

Transportation of fruits and vegetables in Uzbekistan is carried out by road and rail. Aviation transportation is not reasonably excluded from participation in the transportation of fruits and vegetables due to the high cost of transportation.

To carry fruits and vegetables, refrigerated wagons and cars, covered railway rolling stock, and universal containers are used. Moreover, a covered wagon and a universal container are used only during the transition period (autumn-winter and winter-spring), when the ambient temperature and in the cargo area of the wagon vary by 7-8 degrees. At present, fruits and vegetables are transported by domestic and foreign automobile transport of private individuals, since the primordial specialized automobile enterprises have exhausted their technical resources of the vehicle fleet and are therefore not allowed in foreign countries (do not comply with international exhaust gas standards).

Last year, refrigerated railroad cars passed and continue to pass certification at Russian plants, which significantly reduces the ability of the Uzbek Railways to organize the transportation of this cargo.

Transportation of fruits and vegetables in refrigerated containers in the republic is not used due to the fact that there are no specialized container platforms in the republic, the regulatory and legal framework for these transportations has not been created, etc.

At the same time, a large fleet of universal containers remains unclaimed and not involved in the transportation process. In this regard, it is necessary to take measures to increase the efficiency of these containers during transportation of fruits and vegetables.

II. MAIN PART.

Over the past years, the development of agriculture in the Republic of Uzbekistan has been phased in, which will help ensure the country's food security. Various kinds of projects for the development of the horticulture sector take place in the country and are aimed at helping to increase productivity and income farmers in the fruit and vegetable sector. At the same time, projects of this kind will contribute to increasing overall well-being, while supporting the development and increase of small and medium enterprises in rural areas, creating the largest number of jobs in the processing industry, trade and export sectors of the agricultural industry, and increasing the added value of the agricultural sector.

Today, the republic pays a lot of attention to expanding and expanding farms and dehkan farms. According to statistics, it is established that more than 17.5 million tons of fruits and vegetables are annually grown and consumed. A lot of work has been done to ensure uninterrupted supply of foodstuffs to the population, to fully satisfy consumer needs through the cultivation of fruits and vegetables, melons, potatoes and grapes in the country. In connection with the systemic measures being taken, the export potential of the industry is increasing.

Manuscript published on January 30, 2020.
* Correspondence Author
Matluba A. Khadjimukhametova, Head of Department, Tashkent Railway Engineering Institute, Tashkent, Uzbekistan (E-mail: matluba_78@mail.ru)
Avaz M. Merganov*, Head of Research, Innovation and Training of Scientific and Pedagogical Staff Tashkent Railway Engineering Institute, Tashkent, Uzbekistan (E-mail: meravaz@gmail.com)

In recent years, Uzbekistan has become a major exporter of high quality fruits and vegetables, which in turn is competitive in the world market. To ensure the population, as well as the development of export of fruits and vegetables, year-round special attention is paid to specific issues of its processing, storage and transportation. Gradually, the geography of export of fruits and vegetables and grapes is expanding.

Previously, the republic exported it mainly to the Russian Federation, Kazakhstan and other CIS countries, and today products from Uzbekistan are sent to markets in more than 100 countries of the world.

Almost all types of transport are developed in the Republic of Uzbekistan railway, automobile, aviation, pipeline and river. The main transport, which transports more than 60% of the total cargo turnover in the international direction.

The railways of Uzbekistan are in good condition and suitable for the operation of freight trains at a speed of 90 km / h, and the reconstructed sections of the railways allow reaching speeds of more than 100 km / h.

Along with the ongoing processes for updating and reconstructing the state of railways, it is necessary to take appropriate measures to improve the entire chain of organization and management of freight transportation Competent experts note that the solution to this issue may be, firstly, the widespread use of containers, and secondly, the modernization of infrastructure facilities, both of the locomotive fleet and the fleet of freight (passenger) wagons of Uzbekistan Temir Yollari JSC [1 - 3]. The dispatch of fruit and vegetable products in small batches and its variety determines the operation of containers of such a design, where it is possible to create conditions for ensuring the preservation of the initial quality of the product, taking into account its biochemical composition, as well as microbiological contamination of the products for the organization of related, road and rail transportation.

Transportation of fruits and vegetables in covered wagons and universal containers is associated with the problem of removing moisture from the cargo area. Covered wagons have small hatches in the side walls through which the cargo room is ventilated. Universal containers do not have such hatches. In the laboratory of the Tashkent Institute of Railway Engineers, studies were conducted on the organization of the transportation of fruits and vegetables in universal containers, where hatches were made.

Based on the results of research in the laboratory of the Tashkent Institute of Railway Engineers, using modern engineering computer programs, a 3D model of the design of the container with hatches (Fig. 1) for the transportation of fruits and vegetables was developed. This container design was developed on the basis of 20 and 40 foot universal containers, which have proven themselves well when transporting fresh fruits and vegetables during the transition period.

Fruits and vegetables are a living organism where a complex biochemical process takes place. As a result of these processes, complex organic substances undergo hydrolysis, decompose and, as a result, various gases and liquid vapors are formed, which already leave this fruit in the form of vapor. These vapors condense and settle on the surface of the transported fruits inside the container, which is a favorable environment for the development of microorganisms on this surface. To avoid this situation, ventilation is used, which is provided inside the container by opening the vents on the sides (Fig. 1).

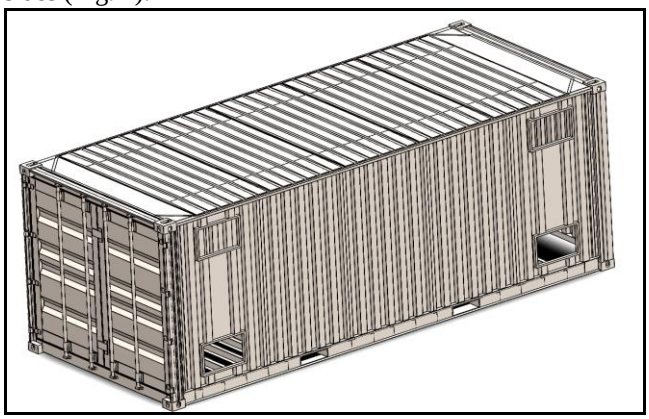

Fig. 1. General view of the developed 3D model of the design of a new container for transportation

When the container moves, the air coming from these air vents moves inside the container, thereby providing air ventilation and not allowing particles of vapors and microorganisms to settle on the surface of the fruit. The movement of air inside the container was verified by aerodynamic research using engineering programs. According to the results of the studies, it was found that the air penetrating from the upper and lower vents circulates inside the container between stacked stacks and leaves the upper and lower vents at the end of the opposite side, thereby providing the necessary environment inside the container, removing moisture and essential oils. In this case, it is necessary to improve the design of the container, which would allow the ventilation of its cargo area during the transport of fruits and vegetables that meets the established requirements.

Employees of the Tashkent Institute of Railway Engineers conducted relevant studies on the creation of containers for transporting fruits and vegetables.

Studies of the design of these containers were carried out based on conceptual approaches, subject to the following requirements:

- the implementation of mechanization of loading and unloading products from containers;
- production of loading and unloading operations using cranes and forklifts;
- stacking of containers in two and three tiers at warehouses and container sites;
- maintaining absolute stability on rolling stock;
- ensuring moisture tightness for goods that are “afraid” of atmospheric effects.

The type and main parameters, as well as the dimensions of specialized containers, intended for the transportation of bulk, piece and liquid goods, perishable and food products without containers, in containers and in lightweight packaging, on platforms and in gondola cars of railways, cars, road trains, river and sea vessels and for temporary storage at storage sites are installed taking into account the requirements of the international standard [4].

The structural elements of a specialized container for transporting fruits and vegetables are made of steel grade "09G2S GOST 19281-89", the permissible stresses of which are 295 MPa [5].

Two side walls of the proposed container design were equipped with hatches with dimensions of 550 × 400 mm for natural ventilation of goods. Along the perimeter of the holes for the hatches, reinforcement by the stringers of the angular profile is provided for strength. To achieve natural ventilation in the design of the new container, it is recommended to position the hatches in the side walls in four angular sides, while observing the corresponding distances shown in Fig. 2.

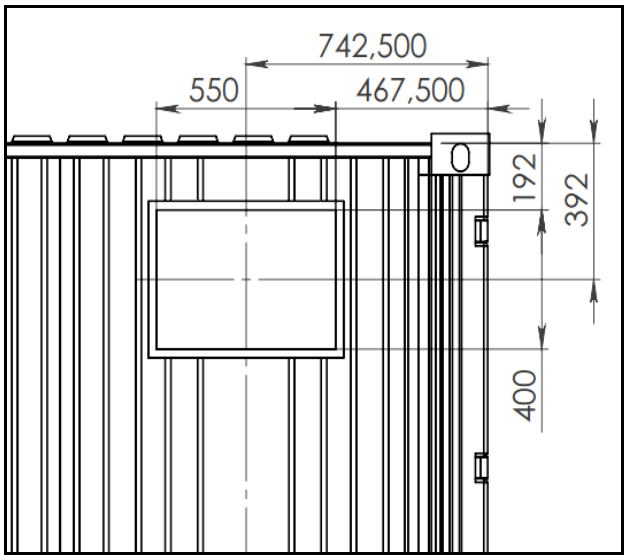

Fig. 2. Dimensions and location of the hatch of the new container for transporting fruits and vegetables

Studies to verify the stress-strain state of the developed and proposed container design for transporting fruits and vegetables under the influence of operational loads are carried out using industrial software that implements the finite element method (FEM). The essence of the method and examples of its use for various calculations are described in detail in a large number of literature [6-8].

In order to ensure that the design scheme of the container for transporting fruits and vegetables, as closely as possible corresponds to the actual performance and nature of the work, lamellar-rod end elements were used to check the container elements. Elements contain six degrees of freedom in each node: movements in the direction of the X, Y, Z axes of the nodal coordinate system and rotations around the X, Y, Z axes of the nodal coordinate system. Elements of the mass type were connected to the elements of the frame using absolutely rigid connections. The calculation model of the design of the container for transportation of fruits and vegetables is shown in Fig. 1a with a finite element grid is shown in Fig. 3.

The calculated plate-rod finite element model of the developed container for transporting fruits and vegetables includes 208,393 finite elements and 71,957 nodes.

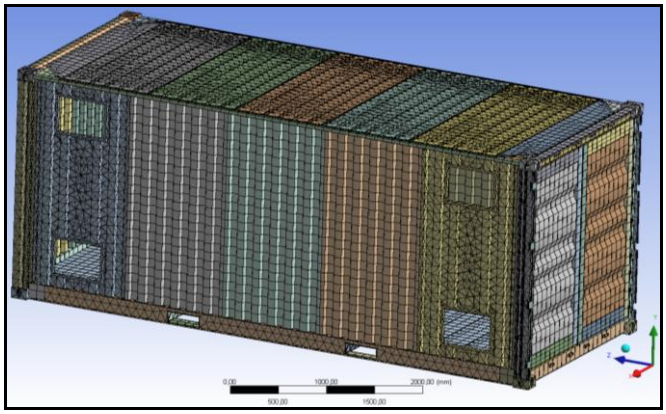

Fig. 3. View of the finite element model of a container for transporting fruits and vegetables

The loads acting on the container elements in the process of transportation, transport, reloading and storage operations are described in detail in many sources [9 - 10].

During the modeling process, the maximum permissible stresses of the container elements were adopted in accordance with the standards [5]. For all steels, the elastic modulus was taken to be 2.1 • 105 MPa, and the Poisson's ratio was 0.3.

Selected results of the equivalent stress distribution fields in the container elements are shown in Fig. 4a in fig. Figure 5 shows the results of the distribution fields of equivalent movements in the elements of the container for transporting fruits and vegetables.

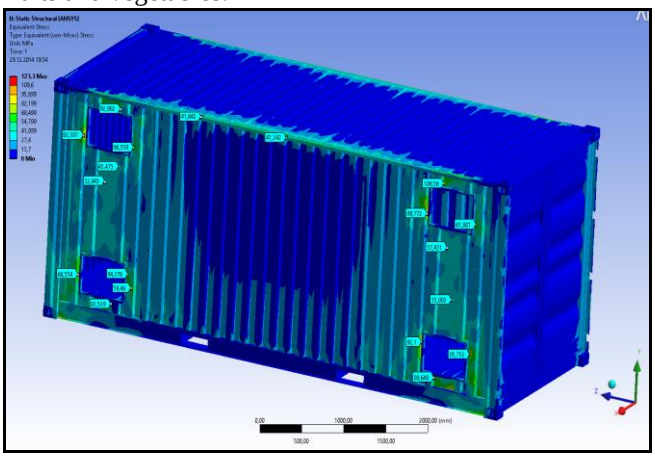

Fig. 4. Fields of distribution stresses in the elements of the container for transporting fruits and vegetables, MPa

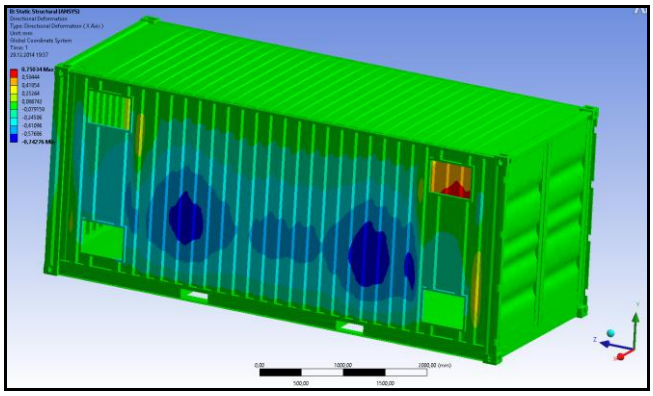

Fig. 5. Fields of distribution of equivalent movements in the elements of the container for transporting fruits and vegetables, mm

According to the results of theoretical studies of the strength of the proposed container for transporting fruits and vegetables, it was found that the maximum rated stresses in the structural elements of the container do not exceed the permissible norms (123.3 MPa <295 MPa). Thus, the selected container design for strength meets the requirements for all combinations of operational loads and, moreover, has proven itself in testing. The conditions for high-quality transportation of goods are different when using refrigerated and non-refrigerated containers. When transporting fruits and vegetables on refrigerated containers, the cargo stack is formed either solid (if the cargo is pre-cooled), or using gaskets, under the lower tier and between the tiers of the cargo. Gaskets between tiers must be laid parallel to the movement of air.

In addition to horizontal, vertical gaskets are also used, which are installed through each row of boxes. When forming a stack between its surface and the ceiling, a free space of at least 15 cm is provided. When transporting fruits in trays, the cargo area is filled sequentially, stacking trays in vertical rows from bulkheads to the center of the container. In the center of the container there is free space filled with wooden struts that prevent the load from moving during the transition.

When transporting fruits and vegetables without refrigeration, which is implied in the container under development, the nomenclature of the cargo is limited and the permissible transit time is specified (up to 30 days - potatoes, beets, carrots, onions, garlic; up to 15 days - citrus fruits (except tangerines), watermelons, melons; up to 10 days - bananas, tangerines, pears, cabbage; up to 5 days - plums, apricots, peaches, grapes). The cargo is stacked in a container, departing from the sides and bulkheads by 15–20 cm. The stacking height of boxes with apples, pears, citrus fruits is 6 tiers, half boxes with pineapples and plums are 17 tiers, and fruit trays are 15 tiers. When forming a stack to create better ventilation conditions, gaskets are installed through each tier of cargo.

In practice, the operation of universal containers requires the allocation of container sites where the storage and transshipment of containers is carried out. In container platforms it is recommended to use tower, block, trailer, transverse and longitudinal-transverse container stacking schemes.

Tower stacking scheme of containers is used when using forklifts with side grip for laying containers. Containers are stacked in two rows (side by side, end to end) of 8-12 pcs. The adjustable width of the driveways between the rows is determined by the width of the loader and the clearance; total size can be up to 4000 mm. The height is laid in two tiers; in every third stack pile, the top seat remains free so that containers can be rearranged and any of them removed. The tower scheme is used for relatively small flows of cargo in different directions and more often with an incoming stream of containers. Containers are stacked in separate stacks for rail or road shipping. In a block storage scheme, containers are stacked side by side, end to end in dense rows of any available width and length of 3 tiers, empty - in 5 tiers with appropriate fastening; only fire passages are provided. The block diagram is designed for the use of gantry cranes or loaders with side grip. It provides significant savings in storage space and is used in cases where a large number of containers should go to one destination, as well as for laying empty containers.

The trailer scheme is used to install trailer platforms with containers and other wheeled vehicles, immersed in a horizontal way. The placement of units in a stack ensures its free export from anywhere.

The cross-sectional scheme is advisable with significant unevenness of the outgoing flows of the containers.

The longitudinal-transverse layout of containers is used for regular movement of trains and cars, and, accordingly, with uniform incoming and outgoing traffic flows. Export and import blocks alternate in the longitudinal rows, which allows for uniform simultaneous loading and unloading of containers from rolling stock. At the same time, it is possible to ship import containers to container trains and accept export from the train to exempt export blocks.

III. RESULT

However, the nomenclature of cargo is limited and the allowable duration of cargo delivery is stipulated, and it is also necessary to observe the difference in temperature fluctuations from the outside and inside the container within 7-8 degrees.

IV. CONCLUSION

Based on the studies, technological technological solutions of the developed container for transportation of fruits and vegetables were adopted. Operating conditions are close to those of conventional containers or boxcars.

ACKNOWLEDGMENT

The study was supported by the grant of Ministry of Innovative Development of the Republic of Uzbekistan «Development of a methodology for organizing package transportation of piece cargo» (project No. YoBV-Atex-2018-223)

REFERENCES

1. Decree of the President of the Republic of Uzbekistan dated December 21, 2010 No. PP-1446. *On accelerating the development of infrastructure, transport and communication construction in 2011-2015*.
2. Decree of the President of the Republic of Uzbekistan dated January 5, 2012 No. PP-1676 "*On measures to implement the project" Electrification of the Marokand-Karshi railway section with the participation of the Asian Development Bank*".
3. Decree of the President of the Republic of Uzbekistan dated February 21, 2012 No. PP-1712 "*On measures to implement the investment project" Electrification of the Karshi-Termez railway section using a loan from the Japan International Cooperation Agency*".
4. GOST R 53350-2009 (ISO 668: 1995) Containers cargo series 1. Classification, dimensions and weight. Series 1 freight containers. Classification, dimensions and ratings
5. Standards for the calculation and design of new and modernized railroad cars of the Ministry of Railways of 1520 mm gauge (non-self-propelled).– M.: GosNIIV-VNIIZHT, 1996. – 317 pp.
6. Zenkevich O., Morgan K. Finite elements and approximation. - M .: Mir, 1986.- 318 pp.
7. Biryukov D.B., Postoev V.S. The finite element method in stresses. - SPb .: AOOT NPO CKTI, 1999. - 187 pp.

8. Alyamovsky A.A. SolidWorks / COSMOSWorks. Finite Element Engineering Analysis. - M.: Design, 2004. - 432 pp., Ill.
9. Lokshin H.A., Sotsky N.V. Containers - M .: Transport, 1976. 126 pp.
10. Container transport system / L.A. Kogan, Yu.T. Kozlov, M.D. Sitnik and others; Ed. L.A. Kogana. 2nd ed., Prerab. and add. - M.: Transport, 1991 .- 254 pp.
11. Merganov A.M. Method of consolidation of freight transport units. Part II / A.M. Merganov // *Solloquium-journal*. - 2019 - Issue. 6. - № 30. - pp. 33-37
12. Merganov A.M. Method of consolidation of freight transport units. Part I / A.M. Merganov // *Solloquium-journal*. - 2019 - Issue. 6. - № 30. - pp. 27-33
13. Ilesaliyev, D.I. Increase in the mass of the consignment of goods due to a rational choice of transport packaging / D.I. Ilesaliyev // *Scientific and Technical Bulletin of Bryansk State University*. - 2018. - № 1. - pp. 97-104