

# Modern requirements to carrying systems of railway general-purpose gondola cars



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### Abstract

One of the priority development fields of native railways is the creation by own engineering capacity of gondola cars, which will meet the modern needs. Analysis results of professional inquiry desk and special technical literature testified the absence of executing and lighting the results of the work concerning determination and combination of the data about present requirements to the body structure (combine modules of body and frame) of general-purpose gondola cars. The article shows modern requirements, which are necessary to be considered during designing of new constructions or updating of already existing constructions of carrying systems of railway general-purpose gondola cars.

Key words: DESIGN OF GONDOLA CAR BODIES, REQUIREMENTS TO THE CONSTRUCTIONS.

### **Problem statement and analysis of results of latest researches.**

Railway transport is one of the most important element constituent, which provides life-sustaining activity of multi-branch economy of Ukraine. Running efficiency of railroads depends greatly on the following: structure of rolling stock; technical-and-economic and performance criteria of cars (TEPC); technical condition of rolling stock (most part of it accounts for general-purpose gondola car stock). In this connection the renewal of native gondola car stock by their native patterns with modern level of TEPC is planned by the Government program "Ukrainian car". Furthermore the program determines the necessity of development of native models of gondola cars,

which will successfully compete with foreign analogues on the external-economic transport market. For solution of these tasks, there developed research-and-development activities concerning working out of new and heavy upgrade of basic native models of gondola cars.

During carrying out of suggested works it is necessary to follow up-to-date requirements to their constructions, which may be nominally divided [1] into the following modules: body, frame, autodraft equipment, running gear and brake equipment. Herein the analysis of information and technology-specific materials showed the absence of execution and lighting of the results concerning determination and fusion of information about modern requirements to the

body structure (join modules of body and frame) of general-purpose gondola cars.

### **The aim of the article and statement of base material.**

The article represents modern requirements to the new bodies of general-purpose gondola cars and the ones which are being modernized.

In general case during design works there are the following requirements to the construction of the bodies of gondola cars, which are being developed:

- Cutting down of maintenance charges;
- Reduction of empty weight-to-carrying capacity ratio;
- Increase of capacity;
- Increase of interrepair cycles;
- Increase of service life;
- Cutting down of the factory labour hours for bodies, also by means of development of process structure of minor components, decrease of their nomenclature, amount and cost of repair work.

One may refer to the up-to-date requirements the following:

- The construction should be “clean” during patent search;
- The construction should be adapted for the exploitation without restriction along railway system of Ukraine, CIS countries, Latvia, Lithuania and Estonia of the track 1520 mm, and also along the railways of European countries of the track 1435 mm (upon the condition of cars move) and meet the criteria of GOST 9238 and [2 ... 7];
- Gondola car body should be full metal, of welding structure and fitted with fourteen unloading gates. Side walls should have top and bottom side sills, vertical struts and sheathing. End walls should have top side sill, crossed intermediate belts and sheathing;
- Bodies should be fitted with devices excluding fall on the way of all gimbal-mounted pieces of brake equipment;
- Corbelled out pieces of body structure of gondola car should not have sharp edges and angles, which may hurt operating personnel;
- Gondola car body must be developed taking into account the maximum usage of standard, unitized and borrowed assembly components and pieces. The construction should conform to conditions of interchangeability of normalized, standard

units and pieces from the range of element base of the branch.

- External shape of the body should correspond the requirements to the design, which determine the composition entirety, informative and artistic expression, efficiency of the form and correspond to functional purpose according to the DSTU 3943 and DSTU 3944;
- Body structure should correspond to the anthropometric and operational characteristics of operating personnel from the point of view of servicing ease of gondola cars, routine repairs, control of running gear of underfloor equipment and brake system in respect with processing equipment of car-maintenance companies;
- Gondola car body should provide unloading of loose goods at the overhead crossings on both sides relatively the railway track through the openings, located at the bottom and car dumpers or another means of unloading according to the GOST 22235.

Together with the other components of gondola car construction, there advanced the following quality control requirements: 85% of life until discarded – 22 years; 90% of life cycle – 12 years or 850 000 km; 95% of life until the first roundhouse servicing – 3 years or 210 000 km.

Stiffness of construction of gondola cars to the external climatic effects (fluctuation of temperature, moisture, air pressure, solar radiation, meteorological precipitation, salt fog, dust, water, etc) should correspond to the norms of GOST 15150 for the pieces of climatic category boreal climate, category of location I, with maintainability engineering within the range of air temperatures from  $-60^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$ .

Construction of gondola car should foresee mutual decision of structural and process tasks, directed on the increase of labor productivity, reduction of labour costs, saving in material resources consumption, time cutting for production and repair at set performance index, conditions of production and exploitation. The body according to processability: manufacturing, exploitation and repair should satisfy the requirements of GOST 14.201. Manufacturing technology should correspond the modern requirements of automated manufacturing and consider its technological fitting.

Body workpieces, made of rolled stock by means of National institute of standardization and control (NISC) of die forging and cold cut, should

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not have cracks and raptures. Cracks and raptures (with the depth not more than 0.5mm of rolled stock thickness, length not more than 100 mm) on the pieces, produced by forging, NISC and cold cutting, should be eliminated before assembling by welding and cleaning. Pieces with cracks and raptures, where the values of parameters in depth and length are bigger than mentioned, are refused and not used in wage design. Guide marks should be grinded and sharp edge should be blunted on the pieces made by means of cutting and die forging. Forgings and pressed parts should meet the requirements of GOST 7505 and GOST 8479.

Pieces of fixing joints (bolts, screws, slices, splints) should correspond to the standards, drawings, herein the screw should correspond to GOST 8724, GOST 9150, GOST 24705. Mount of railing and step plate should exclude self-unscrewing of nuts, bolts, etc. In joints, which do not have safety nuts, check plates and splints to avoid self-unscrewing of nuts, it is necessary to center-punch the first fillet of screw from the nut three times or to slug with blunt hack iron at a single location. Herewith the nuts should not screw loosely. Mounting of the equipment with bolt joints should be fulfilled by normalized fastening torque with addition to safety nuts of high fastening torque. Bolt ends should sit proud the nut not less than two screws and not more than the size of bolt. Screw in pieces should be smooth, without plough defects and fashes and other defects, influencing its hardness. There allowed local defects, which do not prevent bolting, according to GOST 1759.2, GOST 1759.3. Form and surface arrangement deviations according to GOST 1759.1.

Welded constructions, weld preparation, welding works should meet the requirements of OST 24.050.34.

Sizes of structural members of welded seams should meet the following requirements: for manual arc welding according to GOST 8713; for arc welding in protective gas according to GOST 14771; for pipeline weld according to GOST 16037; for electric resistance welding according to GOST15878; for welded point contacts according to GOST 14776; sub-standard seams according to the drawings of information developer.

For convenience of fulfillment and control of intermittent welds there set the following limit deviations:

- $T \pm 0.1$  t - deviation of pitch of a seam;
- $L \pm 0.2$  l – deviation of the length of welded area.

There allowed double increase of final seam and also replacement of interrupted welds by full ones. Welded seams must be cleaned from slag and splashes.

Quality of riveted joints should meet the requirements of OST 24.050.35. Workpieces, which enter riveted joints, should be close pulled to each other. There allowed local leakage between superimposed plane of joinable pieces up to 1.5 mm. There is 0.5 mm feeler in the area of rivet head; it should not come to its core between surfaces of joint pieces.

During fitting of the splints on the bolts, nuts, which have safety nut, and also one nut between splint and nut, there is acceptable 5 mm gap. To regulate the gap it is admissible to fit one slice under the nut. After fitting of splints, both branches of each splint should be separated against each other according to OST 1 39502.

Module of gondola car frame should consist of centre girder, made of zed bar according to GOST 5267.3, with set in it front and back blocks according to SUC MIP (Standard of Ukrainian Companies Ministry of industrial policy) 45.060-331 and OST 24.152.01, shaped center plate according to SUC MIP 45.040-069 and OST 24.052.05, pivoted, intermediate, frontal bars made of rolled stock. There should be provided jacking points with ridge surface, which prevents frictional sliding, on the frame of gondola cars.

Module of gondola car body should be fitted with:

- External and internal stairs;
- Wooded cramps for installation of wood stands;
- Railing and continuous foot board according to OST 24.050.67;
- Motor noses for installation of train markers;
- Motor noses for drag of gondola car during shunt of loading, unloading and repair operations;
- Tools, which exclude opening of doors hinged crosswise during tippler unloading;
- Mechanisms, which simplify door lifting;
- Tie down devices inside the body for load security.

Bearing elements of the frame should stand design loads without damages within all exploitation period under the condition of compliance with the requirements of GOST 22235. Body elements should provide computed strength during operational loading, including the loads arising during loading and discharging operations with application of special-purpose machinery and

interrupters without damages within service life if set exploitation terms are observed.

Construction of gondola car bodies should provide the possibility of body lifting by jack, both in empty and load conditions, according to the acting standard "Norm" [4,5]. Strength of tie down devices should provide transmission of forces: upper and middle 25 kN (2.5 tf), lower - 70 kN (7 tf). Devices located in the upper area of the body of gondola car from the internal side for load framing are meant for the load 30 kN (3.0 tf).

Bearing elements of gondola car body should be made of high-strength steels according to GOST 19281, with guarantee of welding:

Centre girder should be made of zed bar according to GOST 5267.3 of steel grades 09G2S, 10F2B или 10G2BD GOST 19281 or 12G2FD according to TR 14-1-5391, strength class not lower than 390, welding class not lower than 14; The other bearing elements of the frame (double-T iron, centre bearer, crossbars) and side end walls (stands, bars, upper and lower sills, sheathing) should be made of steel grades 09G2, 09G2D, 09G2S, 09G2SD, 10ChNDP according to GOST 19281 or 12G2FD, strength class not lower than 390, welding class not lower than 14. There allowed to use steels with strength class not lower than 345 before metallurgical plants will acquire rolled metal products of strength class not lower than 390.

To produce minor parts it is allowed to use carbon and structural steel according to DSTU 2651/GOST 380, with carbon content not more than 0.23%. Herewith for the pieces subjected to welding, it is necessary to apply steel with guarantee of welding.

Material of cast parts of gondola cars body should meet the requirements of GOST 977, TR 24.05.486, OST 32.183, OST 24.153.08, herein carbon content in the pieces, subjected to welding, should not exceed 0.23%. Castings should be cleaned from moulding sand, metal penetration, scale and rust.

The usage of above mentioned requirements during design and production of new gondola cars and updating of already existing ones will allow the manufacturer to compete on the car-building market and also will stimulate the demand, both native and foreign.

In the existing situation on the market competitive struggle for consumer will develop in the direction "qualitative competition". In this connection in accordance with general trends of development of requirements to the constructions of cargo will be intensified, that is why during

design of new samples of freight car it is reasonable to include technical solutions and requirements, promoting the improvement of TEPC.

### Conclusions and recommendations.

Modern requirements to the new bodies of gondola cars and those, which are being updated are determined and represented in the article. This is the base for research-and-development activity in corresponding directions and may be used for makeup of engineering problems.

Requirements to the constructions of bodies of the other types of freight cars are not significantly differ from the mentioned ones, and that is why during their design, one may use the material given in the article.

### References

1. Fomin, O.V. Optimizatsiyne proektuvannya elementiv kuzoviv zaliznichnikh napivvagoniv ta organizatsiya ikh virobnitstva: monografiya [Optimization design of the elements of gondola car bodies and organization of their manufacturing]. Donets'k, DonIZT UkrDAZT, 2013, p.
2. GOST 22235-76. Vagony gruzovye magistral'nykh zheleznykh dorog kolei 1520 mm. Obshchie trebovaniya po obespecheniyu sokhrannosti pri proizvodstve pogruzochno-razgruzochnykh i manevrovnykh rabot [Freight cars of main-line railways of the track 1520 mm. General requirements concerning protection during loading and unloading and shunting operations]. Moscow, 1976.
3. GOST 26725-97 Poluvagony chetyrekhosnye universal'nye magistral'nykh zheleznykh dorog kolei 1520mm. Obshchie tekhnicheskie usloviya [Eight-wheeled versatile cars of main-line railway of the track 1520mm]. Gosstandart Ukrainy, Kiev, 1999.
4. Norms of calculation of design of railway cars of Ministry of Railways of the track 1520 mm (non-self-propelled). Moscow. GosNIIV-VNIIZhT, 1996, 354p.
5. Norms of calculation of design of new and updating railway cars of Ministry of Railways of the track 1520 (non-self-propelled). Moscow. GosNIIV-VNIIZhT, 1983, 260p.
6. NB ZhT TsV 01-98 «Vagony gruzovye zheleznodorozhnye. Normy bezopasnosti» [Rail freight car. Safety standards].

## Machine building

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Ministry of Railways , Russia, Moscow, VNI-IV-VNIIZhT, 1998.

7. OST 24.050.34-84. Proektirovanie i izgotovlenie stal'nykh svarnykh konstruksiy vagonov. Tekhnicheskie

trebovaniya [Design and fabrication of steel welded constructions of cars. Technical requirements]. Ministerstvo tyazhelogo i transportnogo mashinostroeniya. Moskva. 1984.