UDC 629.463.001.63

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VALUE ANALYSIS OF CARRYING STRUCTURE OF GONDOLAS

There is presented the procedure of the functional cost analysis for load-bearing structures of freight cars. It's also included the mathematical description of the determination of the total cost and cost components of block designs, based on structural and functional models. Moreover in the publication are proposed the evaluation method excessive structural margin. As an example of how to apply the presented procedure of functional cost analysis it is implemented in its study of one of the current basic frame designs wall socket most mass type of modern rolling stock - universal gondola. Following procedure of functional cost analysis should be used in carrying out the design and cost estimates, works and other means of rail transport.

У роботі подано процедуру проведення функціонально-вартісного аналізу для несучих конструкцій вантажних вагонів. Зокрема висвітлено розроблені математичні описання визначення загальної собівартості та собівартостей складових блоків конструкцій, на основі структурно-функціональних моделей. Також в публікації наведено запропонований метод оцінювання надлишкових конструкційних запасів міцності. Як приклад застосування поданої процедури функціонально-вартісного аналізу її реалізовано при відповідному дослідженні одного із базових нинішніх виконань каркасу стін торцевих найбільш масового типу сучасного рухомого складу – універсальних напіввагонів. Наведену процедуру функціонально-вартісного аналізу доцільно використовувати при здійсненні проектувальних та вартісно-оцінювальних робіт і для інших засобів залізничного транспорту.

В работе представлена процедура проведения функционально-стоимостного анализа для несущих конструкций грузовых вагонов. В том числе отражены разработанные математические описания определения общей себестоимости и себестоимости составных блоков конструкций, на основе структурно-функциональных моделей. Также в публикации приведен предложенный метод оценивания избыточных конструкционных запасов прочности. В качестве примера применения представленной процедуры функционально-стоимостного анализа ее реализовано при соответствующем исследовании одного из базовых нынешних выполнений каркаса стен торцевых, наиболее массового типа современного подвижного состава – универсальных полувагонов. Приведенную процедуру функционально-стоимостного анализа целесообразно использовать при осуществлении проектировочных и стоимостно-оценочных работ и для других средств железнодорожного транспорта.

Keywords: freight car, load-bearing structures, value analysis, frame wall face freight gondolas.

The problematic and analyze of the results of last researches

In the market economy, competition from other modes parties and foreign railway companies with domestic rail there is a problem with the implementation and operation of high-performance networks in their own rolling stock. The vast majority of freight rolling stock consists from gondolas. But now more than 80% of Ukraine's Railway freight park formed from obsolete models of freight cars (gondolas), which operated on the edge of the designated service life [1]. This situation caused the importance and urgency to update the national park by highly competitive truck models. The above is confirmed by the basic provisions of the Transport Strategy of Ukraine till 2020, which was approved by the Cabinet of Ministers of Ukraine on 20 October 2010 and the Comprehensive Program update rolling stock of Ukraine on 2008-2020 years, which was approved by the Cabinet of Ministers of Ukraine dated by October 14, 2008 №1259.

A special role in improving the efficiency of domestic cargo park assigned to the development and operational use of new designs of explosives, which would provide significantly better feasibility and operational performance - establishment and use of explosive new generation. Practical steps in this direction are complicated by the fact that gondolas observed a high degree of complexity, as unite as functional elements below the structural hierarchy of hardware (modules, chassis, couplers and so on. [2]), are appropriately placed and interconnected in space (deployed in space), and operate in real time (deployed in time). Moreover gondolas and their components must meet a wide range of complex operational conditions and requirements [2] formed by parts of their life cycle.

An important component of research and development work to create a new generation of explosives is a cost-directed design of structures and components. Nowadays the design and structural studies of explosives aimed at reducing the cost of using traditional objective approach where looking for ways to reduce the cost of their concrete implementation. However, the advanced world experience in designing technical systems (TS) demonstrated the feasibility of such cases in the functional approach, which is based on a Value Analysis (VA) [3]. This approach analyzes the abstract function TS. That does not take into account the real implementation of the TS design, and examines the need for it executable functions and their quantitative characteristics, identifies ways to reduce the cost function being performed. The application of VA (Activity Based Costing, ABC) system for the study of explosives and their components will enable scientific finding a reasonable balance between their cost and utility. However, the results of a study related to the investigated issues of information sources pointed to the lack of appropriate materials for explosives.

The goal of the article and the main material

The aim of the article is to present the features of the proposed procedures for conducting functional cost analysis for load-bearing structures of freight cars. It covers the mathematical description of the formation of the total cost of construction of explosives and cost of its constituent elements that are at lower hierarchical levels, based on structural-functional model. Also, the publication presents a method of evaluation of structural surplus margin. As an example, the application presented VA its procedures implemented in its study of one of the current basic frame designs wall socket most mass type of modern rolling stock – universal gondola.

VA is based on the assertion – functions transform the resource into product. It means for freight wagon that unused portion of their designs is constantly moved resource (extra ballast) and not useful item. VA concept allows characterizing the performance of excellence bearing elements of freight cars (FC) in financial form (in monetary terms). The above is due to physical mapping functions of individual components of the structure, the level of resources functions, as well as research into the causes from which these resources are used. Results of VA are sound basis for decision-making with respect to upgrades or alterations (both structural and functional) bearing FC system.

Information from VA shows as possible to redistribute resources from the maximum strategic benefit, reveals the possibility of the key factors (strength and operational reliability), and determine the best options of resource investment.

The main benefits of VA for freight wagons are its consistency, for instance a systematic approach in identifying possible all excess costs (complexity, cost of materials and energy, etc.) in existing or designing models, the systematic use of methods of engineering creativity in finding new technical solutions with lower cost, accurate representation processes of perception pressures and their impact on cost, not on the basis of direct costs or keeping the total volume of manufactured products.

In general we can identify the following parts of VA:

1) A technical description of the research;

2) Identify and define the functions of the elements of the object;

3) The allocation of «extra» (unnecessary) features and functions of the excess costs of implementation, through the implementation of each valuation function (often in the form of cash expenditures is also possible in the form of cost of material, energy, etc.);

4) Exclusion of items with unnecessary features and choosing the most sustainable solutions to elements of excessive expenditure;

5) Implementation in VA results.

Above work plan of VA includes five interrelated stages, each of which consists of several separate stages. In this sequence, given the work plan is mandatory. More advanced work plan of VA for supporting structures explosives and their components can be described by the following works:

1) the preparatory phase, which elected the object of study (total supporting structure or its individual component) and its purpose, created technical description;

2) information-analytical phase, which collects information on the design and engineering solutions, costs, operating conditions and disadvantages of the object. It further identifies the components and their functions subject to. The next important step is to construct a structural and functional model of the object [4], which is often represented as a proper scheme. The solution of the present complex scientific and technical task necessitates solving a number of problems, among which are: the creation of a structural description and definition of the functions of modules/components/assemblies/basic structural elements corresponding to specific conditions and limitations under which execute functions. Here is [2] presented a new approach to formalizing the description of the structural designs of explosives, developed on the basis of the principles of hierarchy and decomposition (blocking). Using the principle of hierarchy involves structuring the description of the construction of explosives in the degree of detail with the release of certain hierarchical levels. Application of the principle of decomposition provides a description of the design division of explosives at each hierarchical level corresponding to the number of blocks (structural units) with separate options for design and research. The above principles are

fully reflected in the block-hierarchical model freight cars on which aspects of using are described in [4] is formed structural-functional model; the third stage of feature analysis and classification defined and formalized in the structural and functional model functions. Identified and described the function elements can be separated [3] into four groups: main, main, auxiliary and unnecessary. The main functions are the main elements. The main functions relate to items that directly support the work of the main elements; to the exclusion of any basic function key functions in principle can't be implemented. Auxiliary functions related to the elements that make the implementation of the main or principal functions more efficient, more acceptable or attractive to consumers and etc.; to the exclusion of any auxiliary function performance object remains, however, some worse quality. Unnecessary functions relate to items that do not play a significant (or any) role in the smooth running of the facility or improving its quality. So when you turn off unnecessary features and elements related quality indicators do not deteriorate, and some may even improve. Then determined and compared the cost functions. There are two basic methods for determining the value of the function is: a direct calculation of the exact and approximate methods of expert comparisons. The first method is based on determining the value of the evaluation function as the calculation of production costs (including the cost of materials and supplies, labor costs, energy costs, overheads). The second method is based on the relative subjective assessment, where a table of data to be evaluated elements and their money accrues points that are calculated allows conclusions regarding the usefulness and relative cost elements. It is proposed to determine the production cost function elements on the basis of structural and functional description of the object under study (FC or its component), which may be represented by the following mathematical relationships arranged in ascending hierarchy:

$$C_{ijlkm} = C_{ijlkm}^{\text{Ì (Î)}} + C_{ijlkm}^{\text{Ì (Ä,²)}} + C_{ijlkm}^{\text{Ò}} + C_{ijlkm}^{\text{Å}} + C_{ijlkm}^{\text{Í}}; \qquad (1)$$

where C_{ijlkm} «the» cost of the m-th basic element (I, j, l, k, m – level-positional indices, corresponding to the cipher block-studied component of hierarchy scheme (I – corresponds to number of investigational option carriage; j – corresponds to the positional number of the module formalized description, which includes a component to be tested; l – number corresponds to the positional component of the formal description, which includes an element to be tested; k – corresponds to number of node in the respective component; m – corresponds to number of basic elements included of the corresponding node).

$C_{ijlkm}^{\text{Ì (Î)}}$ – The total cost of basic materials, which include: metal, parts and components, which are made from m-th basic element;

$C_{ijlkm}^{\text{Ì (Ä,²)}}$ – The total cost of ancillary and other materials, which include: fasteners, screws, rivets, welding wire, paint, oxygen, carbon dioxide, etc., which are made from m-th basic element;

$C_{ijlkm}^{\text{Ò}}$ – Total labor costs for manufacturing the m-th basic element;

$C_{ijlkm}^{\text{Å}}$ – Total energy consumption (electricity, compressed air, etc.) For production of m-th basic element;

$C_{ijlkm}^{\text{Í}}$ – Total overhead of making m-th basic element. Depending on what is the end product of the enterprise or organizational structure imposed, overhead, administrative or other costs [5].

$$C_{ijlk} = \sum_{m=1}^{a} C_{ijlkm} + C_{ijlk}^{\text{Ì (Ä,²)}} + C_{ijlk}^{\text{Ò}} + C_{ijlk}^{\text{Å}} + C_{ijlk}^{\text{Í}}; \tag{2}$$

C_{ijlk} – The cost of the *k*-th node;

$\sum_{m=1}^{a} C_{ijlkm}$ – The total cost of the basic elements that make up the *k*-th node;

$C_{ijlk}^{\text{Ì (Ä,²)}}$ – The total cost of ancillary and other materials from which made the *k* node;

$C_{ijlk}^{\text{Ò}}$ – Total labor costs for manufacturing the *k* node;

$C_{ijlk}^{\text{Å}}$ – Total energy consumption for manufacturing the *k* node;

$C_{ijlk}^{\text{Í}}$ – Total manufacturing overhead of *k* node.

$$C_{ijl} = \sum_{k=1}^{b} C_{ijlk} + C_{ijl}^{\text{Ì (Ä,²)}} + C_{ijl}^{\text{Ò}} + C_{ijl}^{\text{Å}} + C_{ijl}^{\text{Í}}; \tag{3}$$

C_{ijl} – The cost of l component;

$\sum_{k=1}^{b} C_{ijlk}$ – The total value of units that are part of the l component;

$C_{ijl}^{\text{Ì (Ä,²)}}$ – The total cost of ancillary and other materials that are made from l component;

$C_{ijl}^{\text{Ò}}$ – Total labor costs for manufacturing l component;

$C_{ijl}^{\text{Å}}$ – Total energy consumption for production l component;

$C_{ijl}^{\text{Í}}$ – Total manufacturing overhead of l component.

$$C_{ij} = \sum_{l=1}^{d} C_{ijl} + C_{ij}^{\text{Ì (Ä,²)}} + C_{ij}^{\text{Ò}} + C_{ij}^{\text{Å}} + C_{ij}^{\text{Í}}; \tag{4}$$

C_{ij} – The cost of the j module;

$\sum_{l=1}^{d} C_{ijl}$ – The total value of the components that make up the j module;

$C_{ij}^{\text{Ì (Ä,²)}}$ – The total cost of ancillary and other materials from which made the j module;

$C_{ij}^{\text{Ò}}$ – Total labor costs for manufacturing the j module;

$C_{ij}^{\text{Å}}$ – Total energy consumption for production of j module;

$C_{ij}^{\text{Í}}$ – Total overhead of making the j module.

$$C_{i} = \sum_{j=1}^{n} C_{ij} + C_{i}^{\text{Ì (Ä,²)}} + C_{i}^{\text{Ò}} + C_{i}^{\text{Å}} + C_{i}^{\text{Í}}; \tag{5}$$

C_{i} – The cost of the i freight car;

$\sum_{j=1}^{n} C_{ij}$ – The total cost of modules that participate in the i freight car;

$C_{i}^{\text{Ì (Ä,²)}}$ – The total cost of ancillary and other materials used in the general assembly and the first freight car;

C_i^{∂} – Total labor used in the general assembly and the first freight car;

C_i^{A} – Total energy consumption for production used in the general assembly and the first freight car;

C_i^{f} – Total overhead costs of production and the first freight car.

Future work can be described as specific bearing FC system, because they are devoted to the definition and evaluation of excess margin. So on the basis of theoretical and experimental studies, using the procedure described in [6], the model selected gondola determined excess margin. In general, the procedure for determining the strength of excess inventory includes the following steps. Originally defined (theoretically and experimentally) the maximum values of stresses in the elements according to the 1, 2, 3 calculated modes and mode collisions according to the design standards of explosives. After this initial set minimum safety factor by each settlement regime based on comparing the obtained values with acceptable and shall be elected by the least of them. It further identifies the minimum acceptable basic features - points of resistance sections. The next step is setting the resistance moment of sections studied profiles at the end of the designated period of service (for example, to gondola over 22 years), performed using the developed mathematical relationships by modeling the geometrical parameters of cross sections based on the corrosion rate. And then by comparing allowable value points resistances sections of their performance at the end of the designated term of service is determined by the extra margin of safety.

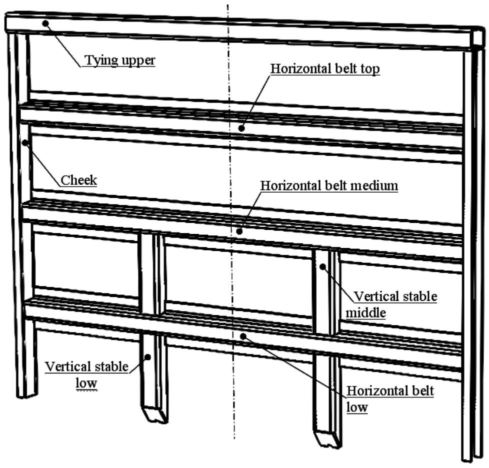
After determining the values of the functional elements are the most functional areas of concentration cost object. The problem of finding a more rational and optimal design and technological solutions;

4) search and exploratory stage. As part of the work carried out at this stage: search for improved technical solutions of mathematical modeling, the search for optimal parameters settings and technical solutions, Experimental study;

5) development and implementation of VA results.

As an example of application of the proposed procedures are presented below VA its use for a study frame wall socket body the most common and sought after type of explosives - a universal gondola.

As part of these works among modern gondola wagon models of the CIS, including the considered model: JSC "SPC" Uralvagonzavod ", JSC" Kryukov Railcar Plant ", JSC" AzovMash ", JSC" Stakhanov Wagon Works ", JSC" Dneprvahonmash ", OJSC" Altayvahon "PJSC" DMZ ", JSC" Diesel plant ", JSC" SPC "Transmash" redeveloped VRZ UZ (Kiev VRZ, SE "Ukrspetsvagon" Popasnaja VRZ and Stryiskyi VRZ) and others, one of the most common set of basic structural framework of walls face (Figure 1). Frame investigated wall face (Figure 1) consists of: Strapping upper (bent profile rectangular size 140h110h7mm by TU 27.3-00190319-1316-2004 welded on section in the boxes), side racks (channels 12P ISO 3436), the upper horizontal zone, middle zone, horizontal, bottom horizontal belt (with profile carriage rack (GOST 5267.6-90)), intermediate and lower racks (racks – bent channel 130h80h8mm).



Pic. 1. **The frame chosen for the study of end wall gondola**

The main function of frameworks of mechanical gondola is their work as part of the overall carriage carrying system on the perception of stress that occur in operation, without residual deformation. As the main types of stress are the following: a useful static load (weight of goods transported) and containers (net weight gondola); interaction forces between wagons for movement of trains or when shunting; forces arising during braking of the train; inertial forces, which are caused by fluctuations in the acceleration of inequality track and change the speed of the car; forces that arise when writing their car into curves and transitional areas of track; thrust force and other loose bulk cargoes; forces arising mechanized unloading. In addition, elements of the frame wall socket gondola should effectively counter the actions of the weather conditions throughout the designed service life (22 years).

Basic requirements for the general frame of the wall face and its elements are corresponded with the requirements for supporting systems gondola [2]. As the main criteria for further evolution frameworks of face include: cost reduction, reduction of material consumption, improvement of operational reliability.

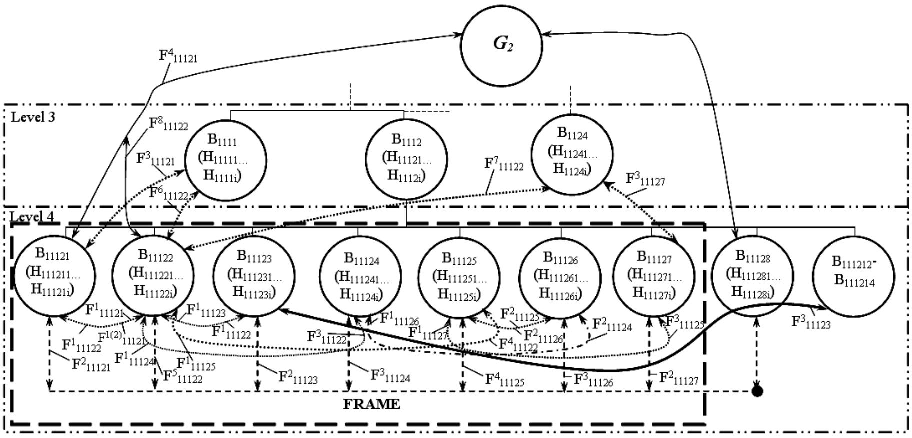
As the terms of reference frameworks of VA end gondola can determine the following points: 1) VA should be done for the entire frame wall face; 2) The first goal seeks to reduce the cost of manufacturing frameworks of face in complying with the durability and serviceability.

The following Table 1 shows the basic functions of a skeleton chosen for the study of end wall gondola, based on the presented in [4] materials. The information contained in the table. 1, was developed by major structural and functional model of the frame, which is shown in Figure 2 as the corresponding graph. The vertices of the graph shown in Figure 2 are: basic components and design elements, as well as the object of G2. Structural connections (in the form of edges of the graph) between the elements shown by solid straight lines. Features elements are represented as edges of the graph curved lines. They come from nodes - elements that have the function and belong to nodes - elements that are intended effect of this function. Designation of vertices elements, vertices and edges of objects on the graph corresponds to and listed in Table. 1. As to the essential complexity of the scheme (picture 2) and a significant concentration of information, support functions (see below), which, by their direction consistent with the basic functions are not shown in Picture 2.

Table 1. **Analysis of the functions of the basic elements of the framework chosen for the study wall socket gondola**

№ з/п	Main element: The object the action directed for	The function of a basic element given the special circumstances and constraints H
1	2	3
1	B_{11121} – Upper strapping: B_{11122}; B_{11128} – lath; B_{1111} – lateral wall; G_2 – load.	F_{111121}- interaction on the perception of stress B_{11122}; $F^{1(2)}_{11121}$- ensure airtight ceiling B_{11122}; F^{2}_{11121}- interaction on the perception of stress B_{11128}; F^{3}_{11121}- nteraction on the perception of stress B_{1111}; F^{4}_{11121}- interaction with G_2 when loading the body, and when shipping which is fully loaded body. In compliance with the relevant conditions $H_{111211}\ldots H_{11121r}$.
2	B_{11122} - cheek: B_{11121}; B_{11123}; B_{11124}; B_{11125}; B_{1111}; B_{1124} - final beam; G_2 - load.	F^{1}_{11122}- interaction on the perception of stress B_{11121}; F^{2}_{11122}- interaction on the perception of stress B_{11123}; $F^{2(2)}_{11122}$ tight overlap B_{11123}; F^{3}_{11122}- interaction on the perception of stress B_{11124}; $F^{3(2)}_{11122}$ - tight overlap B_{11124}; F^{4}_{11122} - interaction B11125; $F^{4(2)}_{11122}$ - tight overlap B_{11125}; F^{5}_{11122}- interaction on the perception of stress B_{11128}; F^{6}_{11122}- tight unity and cooperation in the perception of stress B_{1111}; F^{7}_{11122}- interaction with B_{1124}; F^{8}_{11122} - interaction with G_2 in compliance with the relevant conditions $H_{111221}\ldots H_{11122r}$.
3	B_{11123} - horizontal belt top: B_{11122}; B_{11128}; B_{111212}-B_{111214} – connected items.	F^{1}_{11123} - interaction on the perception of stress B_{11122}; F^{2}_{11123} - interaction on the perception of stress B_{11128}; F^{3}_{11123} - interaction with B_{111212}- B_{111214} through B_{11128}, in compliance with the relevant conditions $H_{111231}\ldots H_{11123r}$.
4	B_{11124} – horizontal belt middle: B_{11122}; B_{11126}; B_{11128};	F^{1}_{11124} - interaction on the perception of stress B_{11122}; F^{2}_{11124} - interaction on the perception of stress B_{11126}; $F^{2(2)}_{11124}$ B_{11126}-tight overlap; F^{3}_{11124} - interact in the perception of stress when performing B_{11128} appropriate conditions $H_{111241}\ldots H_{11124r}$.
5	B_{11125} – horizontal belt low: B_{11122}; B_{11126}; B_{11127};B_{11128};	F^{1}_{11125} - interaction on the perception of stress B_{11122}; F^{2}_{11125} - interaction on the perception of stress B_{11126}; $F^{2(2)}_{11125}$-tight overlap B_{11126}; F^{3}_{11125} - interaction on the perception of stress B_{11127}; $F^{3(2)}_{11125}$ Tight overlap B_{11127}; F^{4}_{11125} - interact in the perception of stress when performing B_{11128} appropriate conditions $H_{111251}\ldots H_{11125r}$.
6	B_{11126} – vertical rack average B_{11124}; B_{11125}; B_{11128}.	F^{1}_{11126}- interaction on the perception of stress B_{11124}; F^{2}_{11126}- interaction on the perception of stress B_{11125}; F^{3}_{11126} - interaction on the perception of stress when performing B_{11128} appropriate conditions $H_{111261}\ldots H_{11126r}$.
7	B_{11127} – vertical bottom rack: B_{11125}; B_{11128}; B_{1124}.	F^{1}_{11127}– interactions in the perception of stress B_{11125}; F^{2}_{11127} - interaction on the perception of stress B_{11128}; F^{3}_{11127} - interaction on the perception of stress B_{1124} in compliance with the relevant conditions $H_{111271}\ldots H_{11127r}$.

After analyzing the functions of a skeleton wall socket they can be divided as follows: the main function (the cargo in the car at work) takes the frame together obshyvoyu, as the main features can be distinguished: F^{1}_{11121}, F^{2}_{11121}, F^{3}_{11121}, F^{1}_{11122}, F^{2}_{11122}, F^{3}_{11122}, F^{4}_{11122}, F^{5}_{11122}, F^{6}_{11122}, F^{1}_{11123}, F^{2}_{11123}, F^{1}_{11124}, F^{2}_{11124}, F^{3}_{11124}, F^{1}_{1112}, F^{2}_{11125}, F^{3}_{11125}, F^{4}_{11125}, F^{1}_{11126}, F^{2}_{11126}, F^{3}_{11126}, F^{1}_{11127}, F^{2}_{11127}. In turn, the subsidiary can be described functions: : $F^{1(2)}_{11121}$, F^{4}_{11121}, $F^{2(2)}_{11122}$, $F^{3(2)}_{11122}$, $F^{4(2)}_{11122}$, F^{7}_{11122}, F^{8}_{11122}, F^{3}_{11123}, $F^{2(2)}_{11124}$, $F^{2(2)}_{11125}$, $F^{3(2)}_{11125}$, F^{3}_{11127}. Unnecessary features are missing, due to a significant evolution (over a century) designs frames chotyryvisnyh gondola.



Pic. 2. **Structural and functional model frame wall face of the module body hypothetical universal modern gondola**

Next, the cost averaged 2013 on the basis of the proposed procedure and vyschep-redstavlenoyi formation costs (formula 1-5) by the maximum (existing) and minimum (defined on the basis of promising options) cost elements frameworks of face. The data included in the Table 2.

From Table 2 we can see that the zone of highest concentrations expenses include section and an upper zone of horizontal strapping. This can be explained by the fact that these basic elements are made of a special metal rolling wagon and as a result have a higher price. Then, based on the above presented procedure for determination of surplus stocks of strength by the relative costs and the fate of excess costs (product of surplus stocks with relative strength costs). Results of above works presented in Table 3.

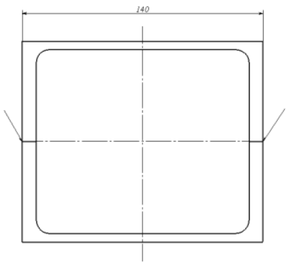
Table 2. **Summary of the cost functional elements**

№	Functions	Elements	Cost, hrn		The relative difference%	cost 1 kg component in the design, UAH / kg
			min	max		
1	2	3	4	5	6	7
1	F^1_{11121}; F^2_{11121}; F^3_{11121}; F^4_{11121}.	Tying Upper (B_{11121})	411	544	24,4	7,37
2	F^1_{11122}; F^2_{11122}; F^3_{11122}; F^4_{11122}; F^5_{11122}; F^6_{11122}; F^7_{11122}; F^8_{11122}.	Cheek (B_{11122})	121	128	5,5	2,92
3	F^1_{11123}; F^2_{11123}; F^3_{11123}.	Horizontal belt top (B_{11123})	428	656	34,8	7,88
4	F^1_{11124}; F^2_{11124}; F^3_{11124}.	Horizontal belt medium (B_{11124})	428	656	34,8	7,88
5	F^1_{11125}; F^2_{11125}; F^3_{11125}; F^4_{11125}.	Horizontal belt low (B_{11125})	428	656	34,8	7,88
6	F^1_{11126}; F^2_{11126}; F^3_{11126}.	Vertical stable middle (B_{11126})	37	42	11,9	2,82
7	F^1_{11127}; F^2_{11127}; F^3_{11127}.	Vertical stable low (B_{11127})	40	46	13,0	2,90

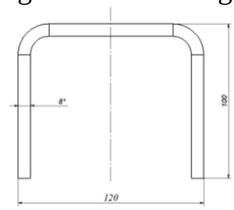
Table 3. **Fate of excess cost elements**

№	Functions	elements	Excess margin,%	Relative costs,%	The fate of excess expenditure,%
1	F^1_{11121}; F^2_{11121}; F^3_{11121}; F^4_{11121}.	Tying Upper (B_{11121})	16,2	21,7	35,1
2	F^1_{11122}; F^2_{11122}; F^3_{11122}; F^4_{11122}; F^5_{11122}; F^6_{11122}; F^7_{11122}; F^8_{11122}.	Cheek (B_{11122})	48,8	6,4	31,2
3	F^1_{11123}; F^2_{11123}; F^3_{11123}.	Horizontal belt top (B_{11123})	52,1	22,6	117,8
4	F^1_{11124}; F^2_{11124}; F^3_{11124}.	Horizontal belt middle (B_{11124})	39,1	22,6	88,3
5	F^1_{11125}; F^2_{11125}; F^3_{11125}; F^4_{11125}.	Horizontal belt low (B_{11125})	30,3	22,6	68,6
6	F^1_{11126}; F^2_{11126}; F^3_{11126}.	Vertical stable middle (B_{11126})	54,4	2,0	10,6
7	F^1_{11127}; F^2_{11127}; F^3_{11127}.	Vertical stable low (B_{11127})	61,1	2,1	12,9

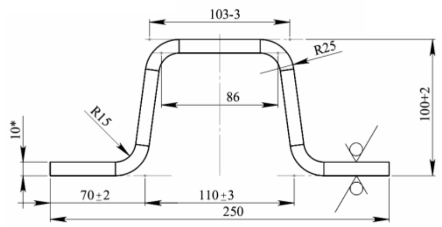
From Table 3 we can see the functional area of greatest concentration of overspending is a group of horizontal zones wall socket and binding top that indicates a need for improvement. With that said, and based on numerous exploratory studies were asked to perform the binding of Upper welding interconnected channels (pic. 3a), the upper horizontal wall face are as bent channel (pic. 3b), and the middle and lower horizontal belt as bent analog sectional carriage rack (pic. 3c).



a– execution binding the top of the channels



b – implementation of horizontal belt lower



c – implementation of horizontal zones of the middle and lower

Pic. 3. **Prospective implementation of a skeleton wall socket**

Proposed solutions have allowed significantly (about 2500 UAH) to reduce the cost of manufacturing gondola.

As a result of VA framework of one of the basic designs wall socket modern gondola revealed that their structural and functional diagram contains no superfluous elements. Also determined that the functional area of greatest concentration cost object is horizontal zones (top (pic.1), middle and bottom) and the binding overhead, which today are made of rolled sections. Thus as a result of cost comparisons of existing and future performances defined substantial economic reserves to reduce the cost gondola. The economic development potential of the area gondola design is quite large considering the mass of the park. So for example, reducing the cost of a gondola only 1 thousand UAH. thus achieving a significant reduction in production costs in terms of their production even at 100 units per month.

Conclusions and recommendations for future use. Reproduced in the article a Value approach to cost-oriented design work to improve existing or develop new designs of explosives is an effective and workable, it is advisable to apply during the relevant research. On the above results demonstrate that using the proposed procedure VA when developing frameworks of mechanical gondola. Practical implementation of the results obtained will significantly (about 2500 USD) to reduce production cost gondola selected for the study.

As a further development of the proposed area of research supporting systems of explosives can be distinguished work aimed at the development of object-oriented banks or directories/databases, where researcher/designer would be able to quickly find a ready assessment of costs related to the required function and appropriate technical solutions.

VA following procedure should be used in carrying out the design and cost estimates, works and other means of rail transport.

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