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STUDY OF POSSIBILITIES OF UNIFICATION OF SEMI-TRAILER MODULES FOR TRUCKS

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ABSTRACT

The possibility of using a unified approach when creating modular frames and the use of unified modular elements are discussed in the paper. The aim of the work is to simplify production and, as a result, improve the quality, increaser liability and speed of production of frames for various types of trailers and semi-trailers. Depending on the required carrying capacity of the vehicle, the number of unified modules is changed with the help of universal fastening elements, which make it possible to assemble cargo platforms for various purposes from a small set of parts. The use of such unified modules makes it possible to assemble the frame for trailers or semi-trailers of various lengths and carrying capacities.

Keywords: Central tubular frame module, modular ladder frame, Modular structural element.

1. INTRODUCTION

Unification is used to minimize and optimize the technical and economic component of the variety of sets and assembly units, as well as the processes of maintenance and repair of road transport. Technological processes, labor skills and technical documentation are also being unified. The introduction of unification improves the quality and simplicity of the applied actions in the processes of production, operation, maintenance and repair of the product in general and individual units in particular. Unification extends the life cycle of a product, increases the speed and mobility of maintenance and repair, reduces the cost of spare parts due to the use of the same parts for different products[1], including through cooperation between manufacturers.

Unification allows increasing the production of the number of parts by increasing demand and reducing the nomenclature. An increase in the quantity allows the use of modern progressive methods [2], for example, robotic complexes, which will lead to an increase in the quality and a decrease in the cost of production.

There are two types of unification - design and technological ones. The first involves the unification of units, assemblies, parts, fasteners, and operating fluids. The second presupposes the unification of technologies [3], standards, regulatory documents, and the qualifications of specialists.

An example of unification in the modern automotive industry is the application of a modular approach to the creation of motor vehicles.

The modular platform makes it possible to manufacture cars of different classes and purposes by various combinations of the same unified units.

The platform consists of the following modules:

- engine;
- transmission;
- suspension;
- steering system;
- electrical equipment.

Further, the modules are combined with each other [4]. There may be several options for each module in order to obtain a result with the specified characteristics and indicators. The final stage is the installation of the resulting set on a frame or in a body with individual characteristics.

2. MATERIALS AND METHODS

Prerequisites for the implementation of a system for unification of semi-trailer frames.

Reducing labor intensity and time during loading and unloading [5], as well as improving the safety of cargo are factors that stimulate the specialization of general road transport. Specialized road transport is a significant factor in the mechanization of production in all sectors of the economy.

The use of different trailers and semi-trailers reveals a number of advantages of their operation in comparison with vehicles of the same carrying capacity [6] having one cargo platform.

Among these advantages, let's highlight the following:

- reduction of axle loading at the same carrying capacity;
- rational use of the power train torque reserve;
- increase of productivity up to 2 times despite a slight decrease in speed;
- reduction of fuel consumption per ton of transported cargo;
- reduction of the transportation cost;
- reduction in the cost of rolling stock.

The efficiency ranges from 10 to 30% by various items.

Nowadays, trailers and semi-trailers with ladder-type frames of various standardsizes, which somehow satisfy the needs of carriers, are widely used.

The main disadvantage in the manufacture of trailers and semi-trailers is a wide variety of standard sizes. The production of each one requires a separate

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technological process [7], which significantly affects the labor intensity, production time and the final price of the product.

The application of a unified approach to the creation of modular frames [8], the use of unified modular elements for all standard sizes will simplify production and, as a result, improve the quality, increase reliability and speed of production of frames for various types of trailers and semi-trailers.

3. DETERMINATION OF AREAS FOR CONFIGURING UNIFICATION SCHEMES

Historically, trailers and semi-trailers have a frame structure. The frame is the basis for placing the cargo platform. The frame of a trailer or semi-trailer [9], as a rule, is of a ladder type, consists of parallel, horizontally arranged side rails. They are interconnected by crossbars. The frame experiences the whole range of alternating loads during movement. Therefore, its design and manufacturing materials play a special role. Nowadays, there are two main production methods, such as welding and riveting. Both methods have advantages and disadvantages. The welding method has the most durable construction and a more affordable price. Welding technology allows the use of robots, which affects productivity and production costs. The main disadvantage of welding technology is the weakening of strength in the welding places, the creation of stress zones that negatively affect the integral strength at high alternating loads. The use of riveting technology increases the maintainability of products, but at the same time, with prolonged loosening of the joints, creates excessive flexibility of the structure.
The development of a universal module of a unified frame consisted in generalizing the above experience for the implementation of technologically detachable joints that withstand the load in the same way as sealed frames.

In the early stages [10], it was envisaged to create a modular ladder frame from a set of channels of various sizes. A technology was predicted in which a channel of a smaller width would be connected to a channel of a larger width using a technological overlap of length at the junction and would be fixed with rivets.

However, strength calculations revealed that this structure Figure-1 is poorly resistant to torsional deformations, which leads to rapid breaks at the joints.

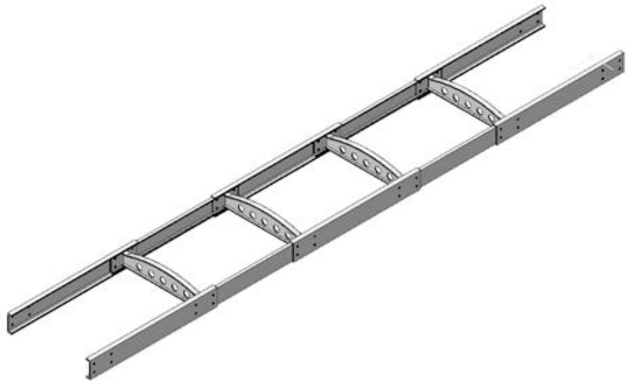

Figure-1. Experimental design of a modular ladder frame.

Thus, the development of the traditional technological solution in the area of modular unification was rejected.

The use of the backbone frame as a unified modular solution was a logical development of the chosen concept.

Many years of experience in operating Tatra vehicles [11] with backbone frames has revealed their main advantage, which is high torsional rigidity.

A tubular spar with a diameter of 300 mm and a wall thickness of 10 mm is taken as a basis Figure-2. A flange with a diameter of 450 mm and a thickness of 30 mm is located at the ends of the pipe. There are 20 holes on the flanges through which the modules are connected to each other.

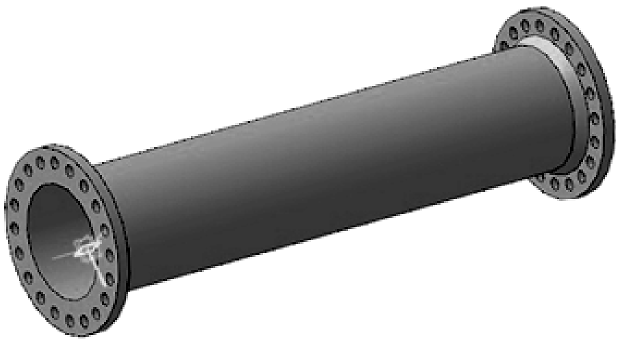

Figure-2. Central tubular frame module.

Besides, two sheet metal crossbars are used Figure-3, to which the semi-trailer axle brackets are attached.

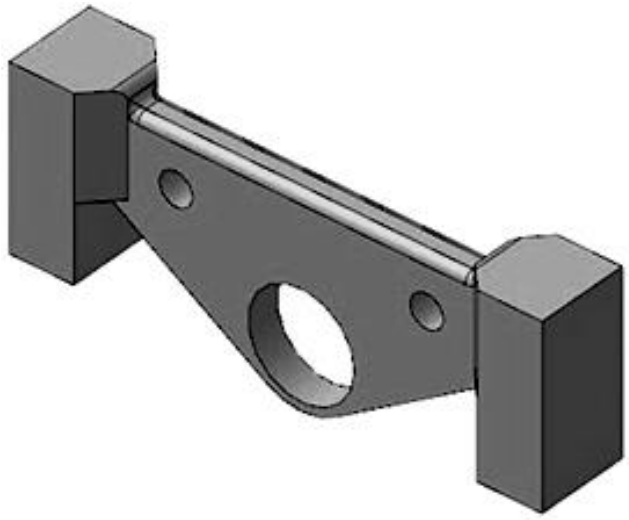

Figure-3. Crossbar of the frame module.

Using the method of electric resistance welding of the spar and crossbars, we obtain the module of the unified frame Figure-4.

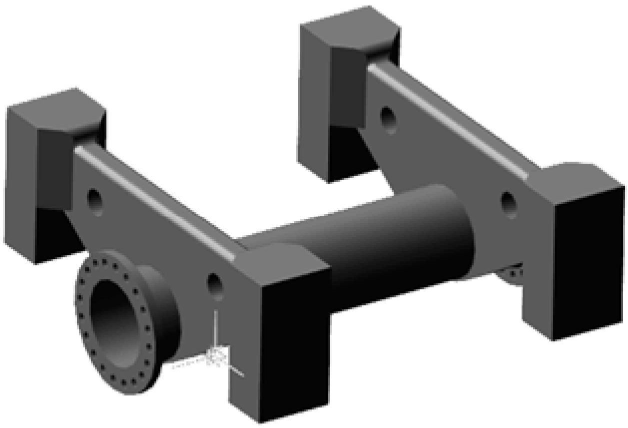

Figure-4. Unified frame module.

The connection of unified modules is carried out with the help of spikes on one side of the crossbar and a slot on the other side Figure-5. The centering of the modules is carried out using a lock Figure-6.

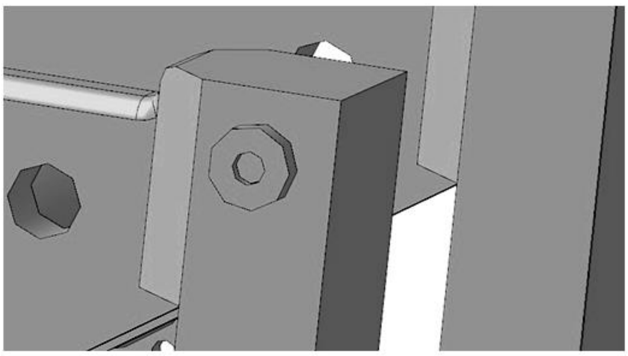

Figure-5. Modular structural element-slot.

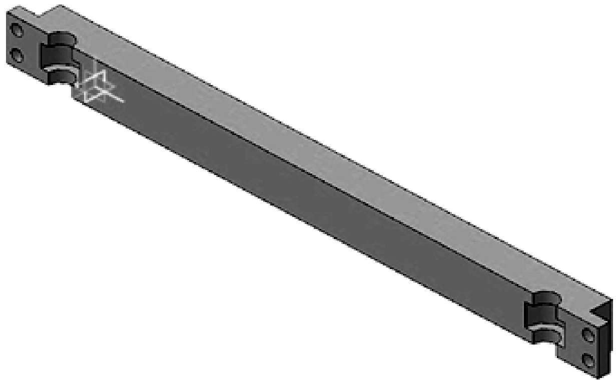

Figure-6. Modular structural element - lock.

The lock is installed in the slots on the crossbars and bolted, creating an additional connection between the modules Figure-7.

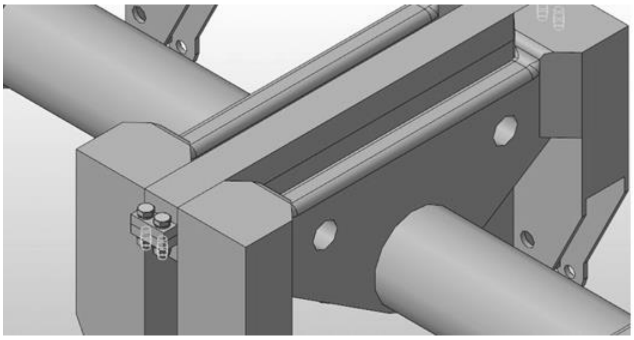

Figure-7. Technology of fastening modules.

The use of such unified modules makes it possible to arrange the frame for trailers or semi-trailers of various lengths and carrying capacities Figures 8, 9.

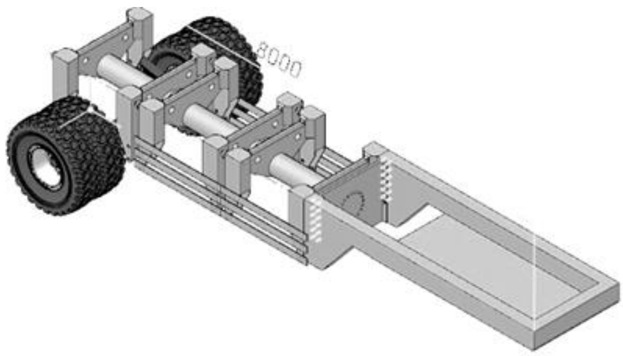

Figure-8. 8 meters long frame of a single-axle semi-trailer.

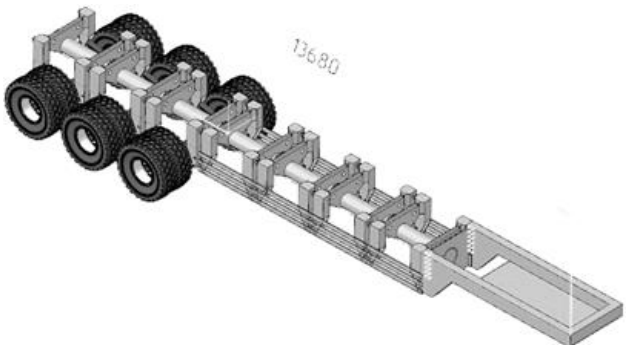

Figure-9. 13.6 meters long frame of a three-axle semi-trailer.

A length of 13.6 meters is obtained bythe use of 7 unified modules.

4. CONCLUSIONS

The estimated strength calculations show a significant design margin for the main indicators. This paper did not consider specific suspension elements. It is assumed that these can be either torsion bars or air springs, based on their compactness and reliability.

In the long term, when solving legal issues, it is possible to change the length of a modular structure based on the needs of a motor transport company.

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