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A UNIFIED MACHINE FOR TECHNOLOGICAL ELECTRIC TRANSPORT LOAD-BEARING SYSTEM

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Abstract: The paper presents such a research of one of the most important layout-forming parts of the unified machine for technological electric transport (UMTET), namely the load-bearing system. With all the variety of design criteria set for UMTET, the bearing frame must satisfy the following requirements: to be an installation base for the assumed units, UMTET mechanisms, as well as attached implements; to be technologically advanced and have a low production cost; to withstand operational operational loads with the minimum possible weight, which will allow to maximize the power and duration of UMTET operation without recharging.

1 Introduction

The development of wheeled vehicles for general and specialized purposes requires a complex multi-vector combinatorial approach because of the multifunctionality of the projected facility. A lot of publications are devoted to this problematics [1-3]. At the same time, the search for the most optimal solutions, both for the design in general and for individual units and assemblies, comes to the fore. This determines the scientific and technical relevance of research in the sphere of the unified machine for technological electric transport (UMTET) especially in the application to its load-bearing system, as the main element that perceives workloads, and is the main component installation base.

It should be noted that the development of such a complex product as a load-bearing system is a complex iterative process of finding a solution based on a gradual modification of the design, aimed at step-by-step compliance with design and technological criteria. At the first stage it is necessary to determine the type of the load-bearing system, as a logical base for further design.

Consider the pre-design criteria that have been defined as the main ones for the development of the UMTET load-bearing frame, based on the standard operating modes of the product, design constraints and technological capabilities of the manufacturer:

1. General restrictions on the overall dimensions of the construction: 3400x1300, height 1550, the length of the load platform is not less than 2100 mm.
2. The load-bearing system must have a ladder structure.
3. Elemental composition of the frame structure profiles: channel, I-beam, Taurus, corner, square tube. The basic configuration of the frame is formed by the channel.
4. The choice of profiles material is carried out in accordance with GOST: 8240-97, 8278-83, 26020-83, 7511-73, 8509-72.
5. The load-bearing system should be assembled on a robotic welding system.
6. The possibility of a subsequent modification of the load-bearing system front and rear sections for the installation of hinged plates.

At present, there is a significant variety of wheeled and caterpillar vehicles of various functional purposes and as a result with a different set of workloads perceived by load bearing structures which determine the classification that has been formed to date:

- simple ladder load-bearing system;
- channelshaped load-bearing system;
- Box frame;
- Integral frame-in-body load-bearing system;
- Complex load-bearing system;

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- Backbone frame;
- Combined ladder-backbone frame;

Considering pre-project requirements, the most relevant in terms of UMTET equipment layout are a simple ladder load-bearing system and a combined ladder-backbone frame. We will carry out a comparative analysis of the developed projects of each type in the context of use in UMTSET, assessing their advantages and disadvantages, as well as some strength characteristics.

2 UMTET standard rolled profile ladder load-bearing system

The construction (Figure 1) is a complex space system consisting of a main frame and other load-bearing elements that are designed to provide the basing and assembly of all parts and assemblies, as well as reliable operation of the entire machine.

The advantages of UMTET ladder load-bearing system:

- Providing the required geometric dimensions (width - 1300 mm, length - 2750 mm, height - 397 mm);
- the design is developed from standard steel profiles (St3sp), which significantly reduces the cost of production;
- the possibility of assembly and basing most of the UMTET units and assemblies (Figure 2);
- manufacturability;
- low production cost.

The disadvantages of ladder load-bearing system:

- An additional load-bearing framework of the front attachment is needed;
- the complexity of traction batteries installation and maintenance;
- high load-bearing system mass - 230 kg;
- the necessity to change the entire load-bearing system to upgrade the vehicle.

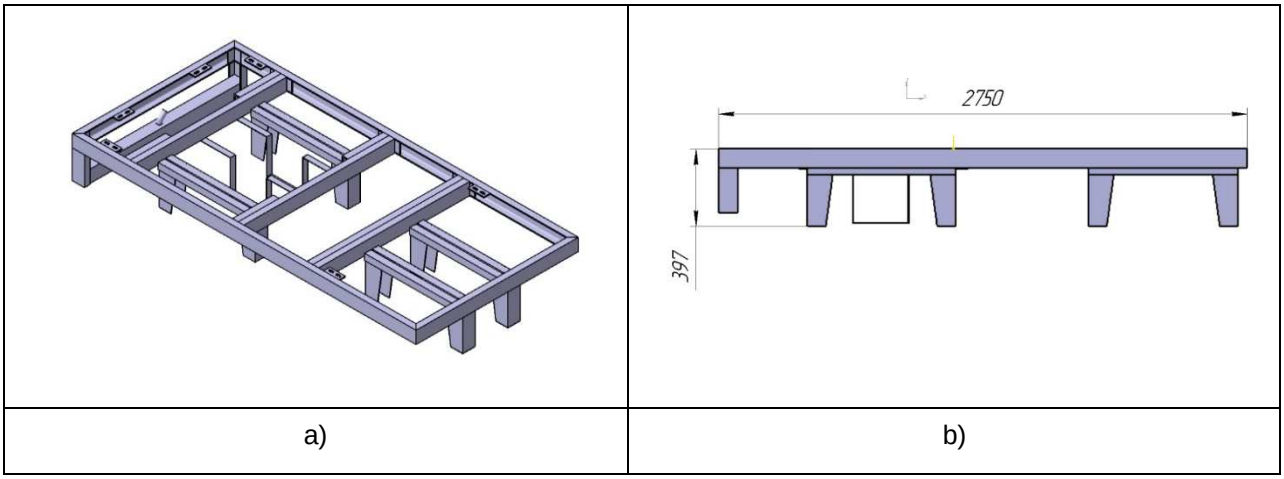

Figure 1 UMTET ladder load-bearing system a) geometric model b) overall dimensions

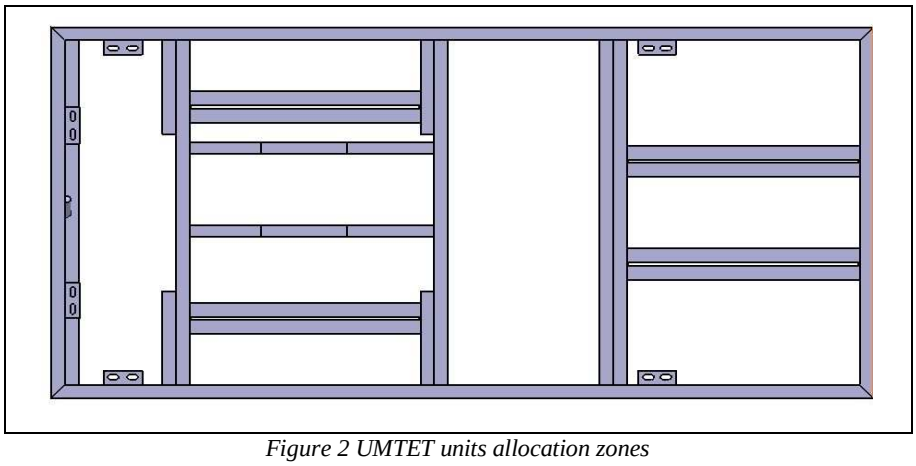

Figure 2 UMTET units allocation zones

3 UMTET Workload Impact Numerical Strength Analysis

The UMTET load-bearing system like any other wheeled vehicle has a whole range of static and dynamic loads during operation [4-10]. The most critical in force is the alternating load with alternating diagonal hanging of the wheels. Therefore, for evaluating the numerical analysis, this particular type of loading was chosen. Figure 3 shows the mounting zones and the scheme for applying the forces of the computational model performed in the CATIA V5 software environment using the standard Generative Structural Analysis module. At the same time, the organization of the scheme for the application of forces is based on the following assumptions:

- Vertical load of 30000 N (nominal load-bearing capacity of UMTET) is applied to the upper surface of the spars and crossmembers in the framework area of the load platform;
- on the mounting zones of the battery in the middle of the load-bearing system, the load is 6500 N (battery weight);
- the load of 3000 N (according to the weight of the cabin) from the cabin, the front attachment framework, the driver, the passenger and the units is applied to the front of the load-bearing system.

Figure 4 shows the results of a numerical analysis from which it is concluded that there are no failure stresses when subjected to specified loads with a maximum frame deformation of 12.7 mm, which indicates the overall operational capability of the structure.

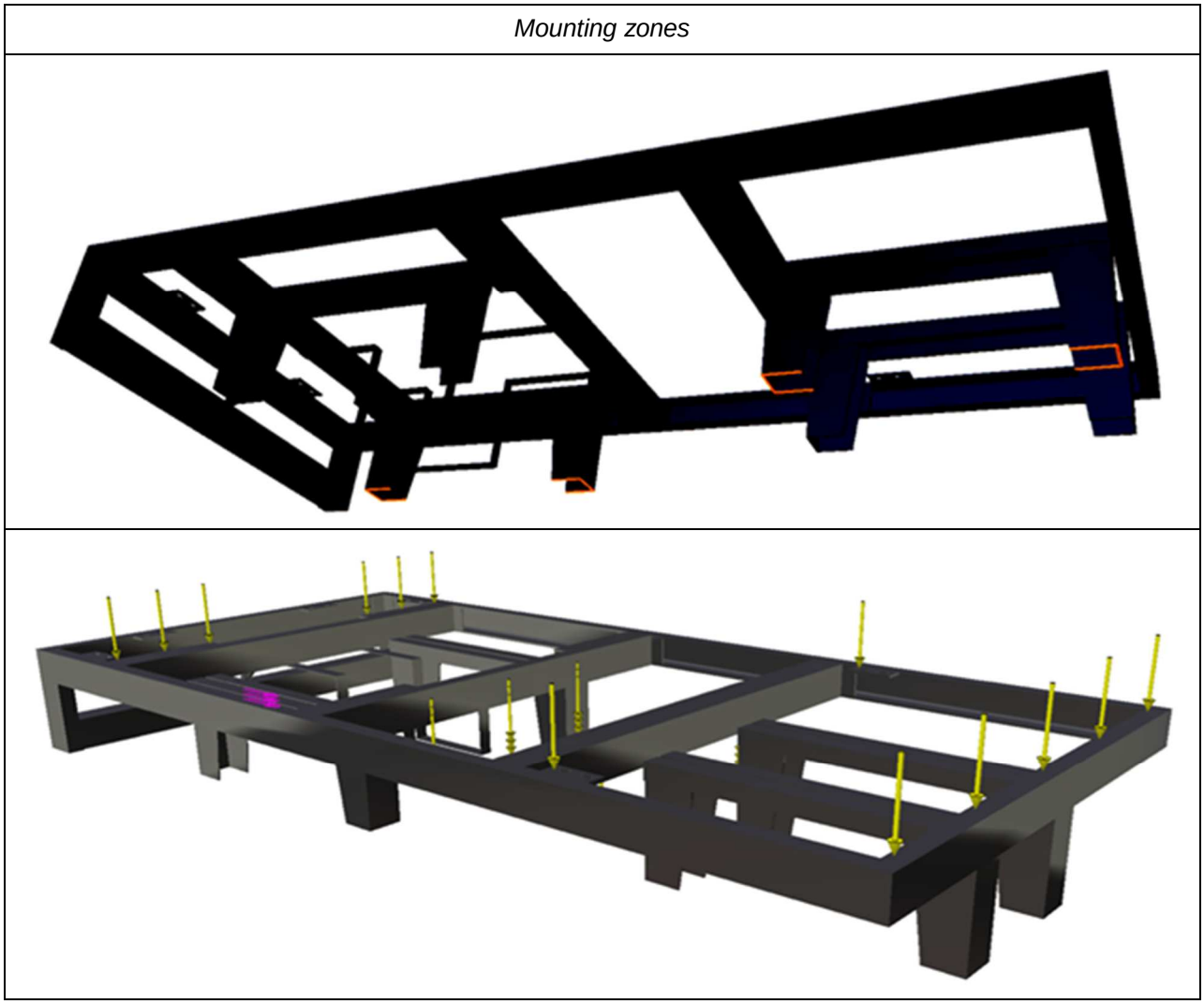

Figure 3UMTET ladder load-bearing system calculated numerical model characteristics

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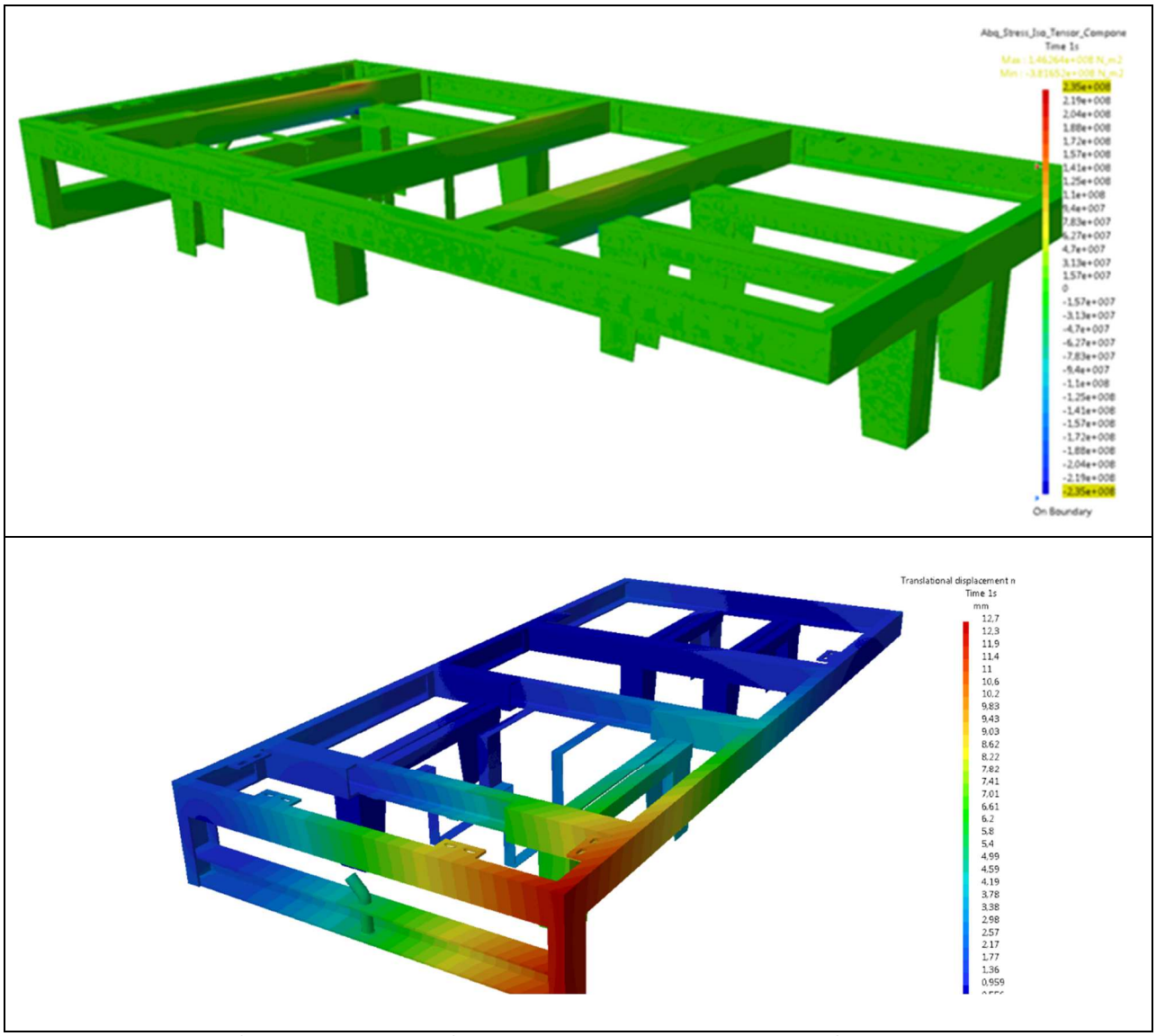

Figure 4 The results of the numerical analysis from which it is concluded that there are no failure stresses when subjected to specified loads with a maximum frame deformation of 12.7 mm

4 Conclusion

Estimating the UMTET ladder scheme of load-bearing system characteristics, the following conclusions should be drawn. Load-bearing system is preferable for a vehicle equipped with an electric motor since with sufficient strength characteristics.

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