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ADAPTATION OF THE SUPPORT FRAME OF THE COOLING SKIDS SYSTEM FOR USE IN MARITIME TRANSPORT

ABSTRACT

The article presents calculations of the strength of a support frame Skid Cooling units used on oil rigs. The complexity of the equipment does not allow for efficient FEM modeling of such structures. It indicates how to the simplify the model so that the calculations can accepted by the American Bureau of Shipping (ABS).

Key words:

cooling skids, offshores, frame.

INTRODUCTION

The purpose of this article is to present the results of a computer-based simulation of load-bearing structures. A cooling skid was used to carry out the investigations.

A ccooling skid system (fig. 1) can use numerous elements to transfer heat, including hot water, steam, glycol-mix, or hot oils. Most often these systems are used in climates where snow and ice occur. For example, if a hospital has a helipad on the roof for receiving critically ill or injured patients, obviously it needs to be free of ice and snow during the winter so that helicopters can land safely and staff can move a patient into the hospital quickly, without any incidents.

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To deal with challenges faced by many companies appropriate heat transfer systems can be designed. And since a skid-mounted package arrives preassembled it is ready to use as soon as it is delivered and installed. These systems can be customized to fit most spaces whether inside or outside, regardless of weather conditions.

One of the major components of the cooling skid is a support frame. The frame has to comply with the strength requirements to bear the weight of the installed equipment and assumed overload.

The article presents the FEM simulation calculations of the frame strength. Due to the absence of endurance, the structure had to be redesigned in order to meet the strength requirements [1, 2, 3, 4]. All the calculation steps are presented in the article.
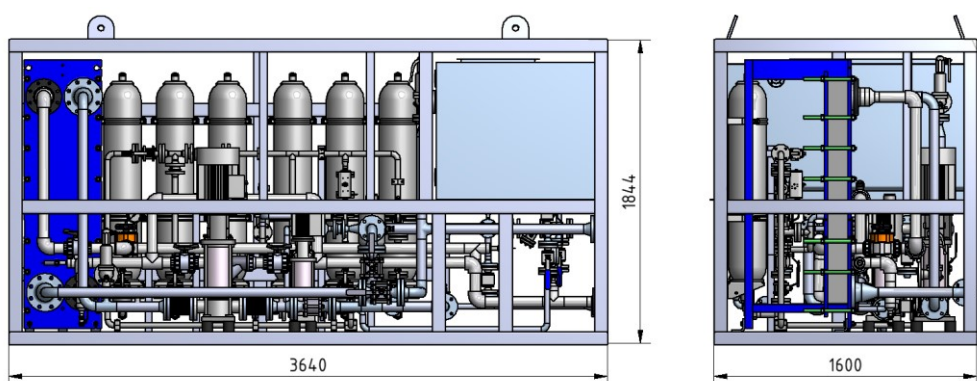

Fig. 1. Main dimensions of the cooling skid unit

THE MAIN FEM CALCULATIONS

Calculations of the cooling unit were made in configuration shown in figure 2. Frames were made of stainless steel AISI 316L. All the main equipment was taken into account in the calculations as an equivalent weight, shown in figure 2. The self--weight frame was taken into account in the calculations. The calculations were performed with regard to the static structural lifting capacity/stack ability of skid frame only.

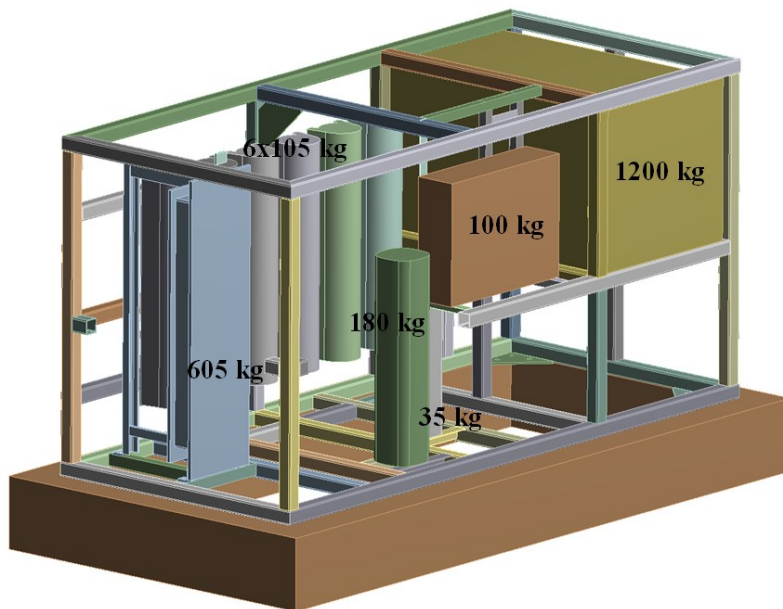The main frame was supported (simulated fitting to a deck) as shown in figure 3.

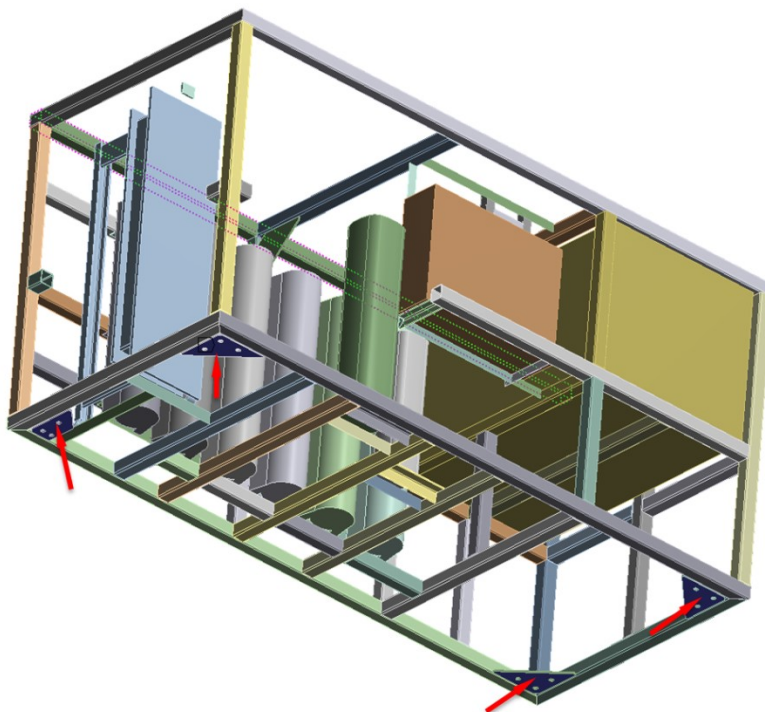Fig. 2. The equivalent weight of the main equipment

Fig. 3. The frame support

THE RESULTS OF THE FEM ANALYSIS

The main result of the calculations are presented in figure 4. The stress, displacement and safety factor (fig. 4–6) were shown as a result of static weight loading. The stress does not exceed the yield strength and its maximum value is 47.1 MPa in the exchanger support region shown in the figure 4. The result displacement (fig. 5) and the average safety factor (fig. 6) are acceptable with regard to the material strength once the exchanger support has been strengthened.

Next calculations were carried out of the frame strength under load acceleration. The results show (fig. 7–9) that the unit was not sufficiently stiff and the frame had to be improved.
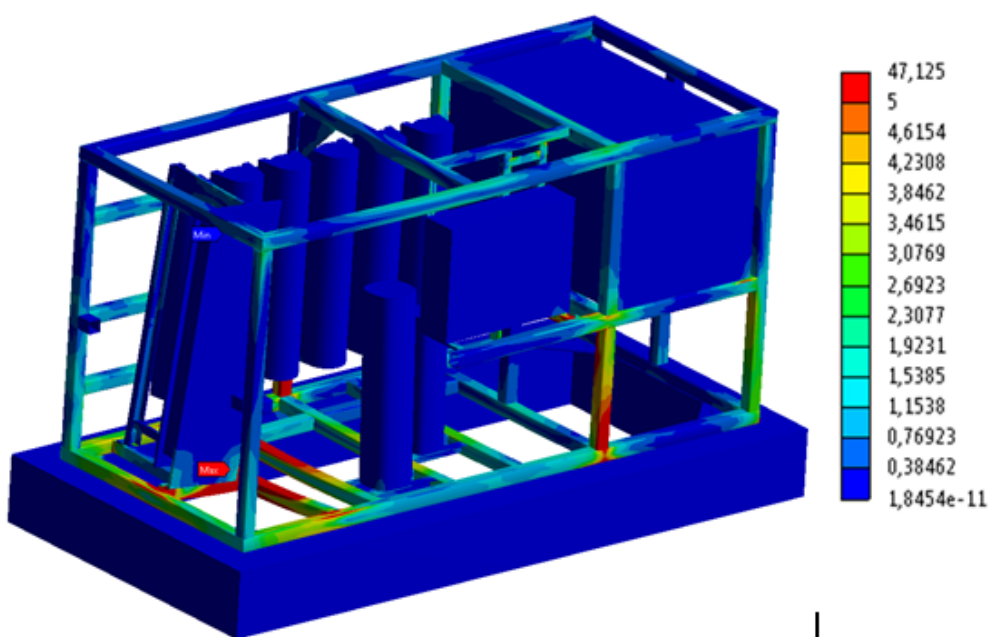

Fig. 4. The equivalent Von Mises stress in MPa which does not exceed the yield strength is equal to 47.1 MPa in the exchanger support region shown in figure as the maximum value — displacement rescaled x 210 times
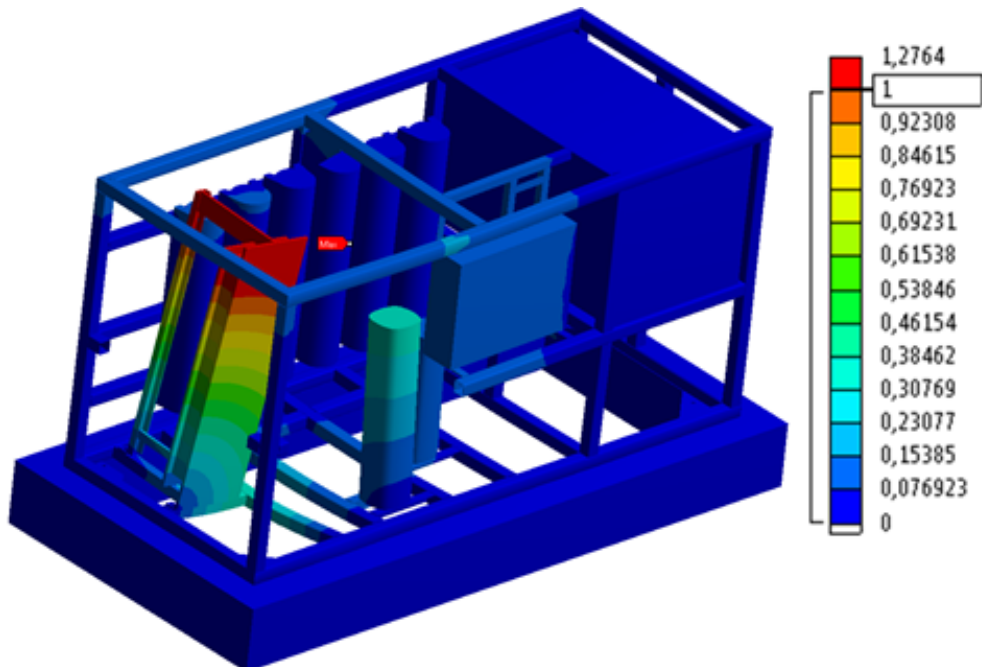
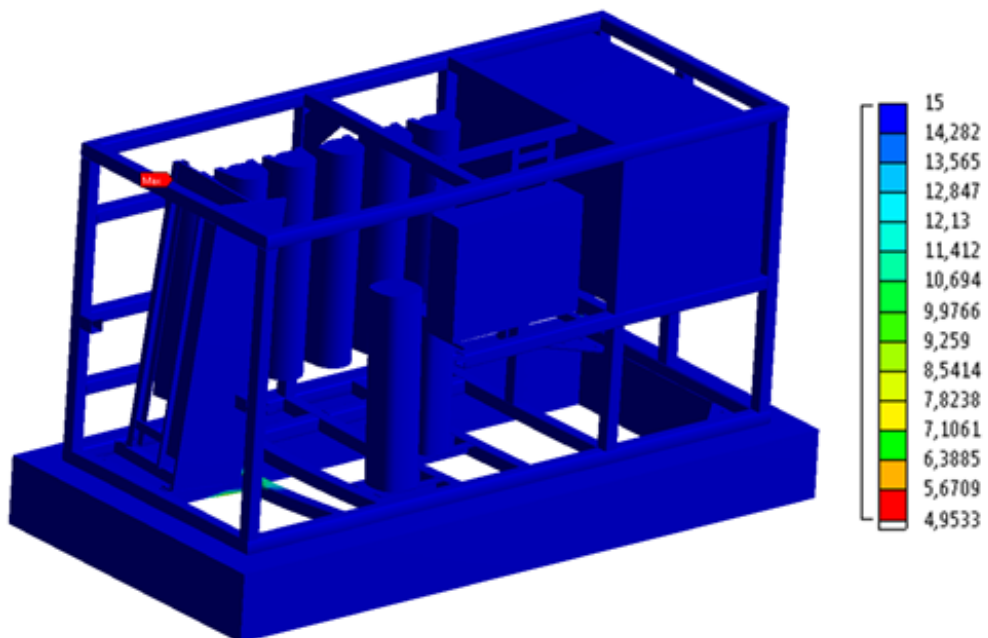Fig. 5. The resultant displacement 1.27 mm — displacement rescaled x 210 times

Fig. 6. The minimum safety factor 2.06; average values between 2–15 and more — displacement rescaled x 210 times
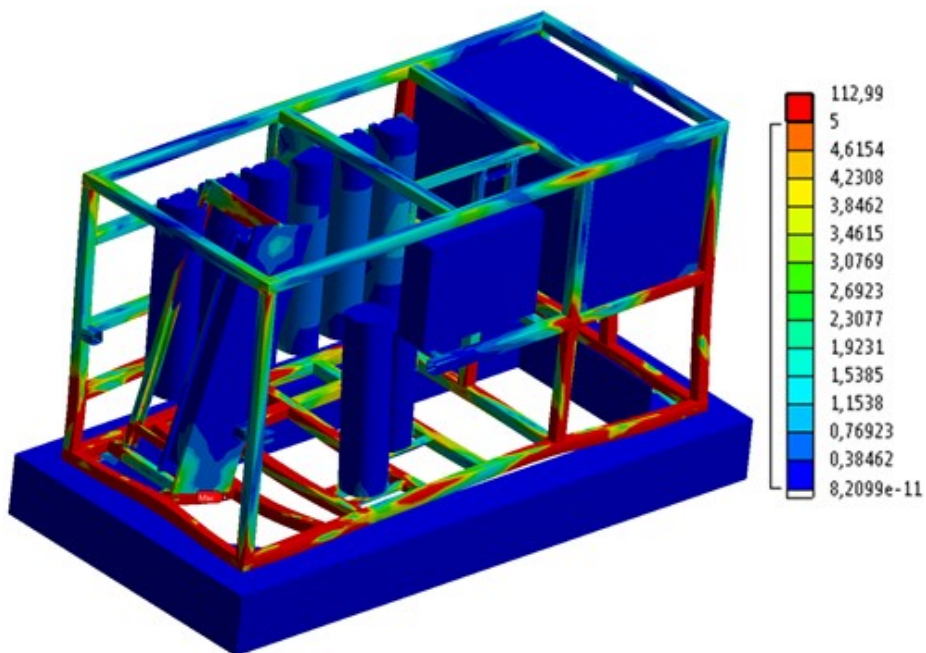
Fig. 7. The equivalent Von Mises stress in MPa; local maximum value 112.99 MPa; the average nominal value less than 5 MPa — displacement rescaled x 210 times
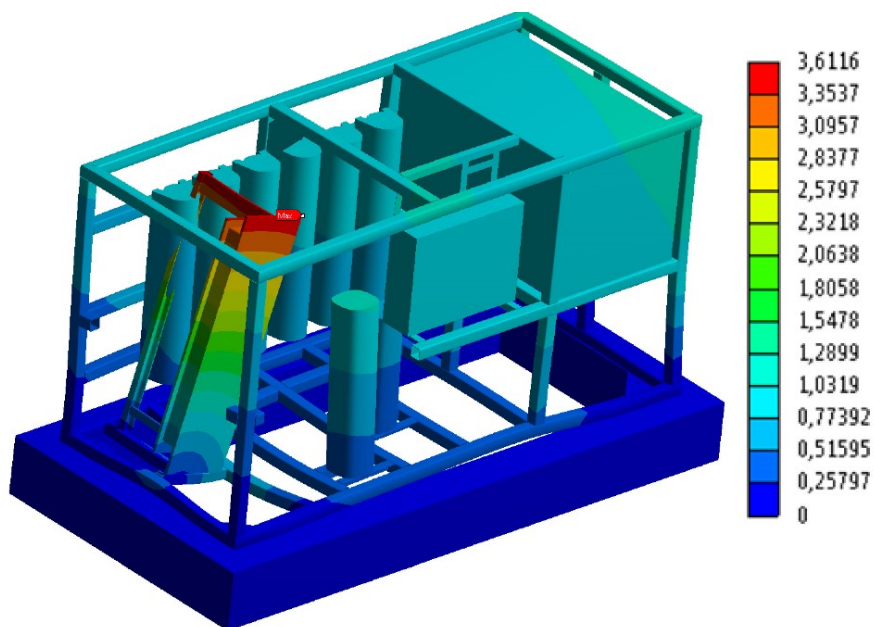

Fig. 8. The resultant displacement 3.6 mm — displacement rescaled x 210 times
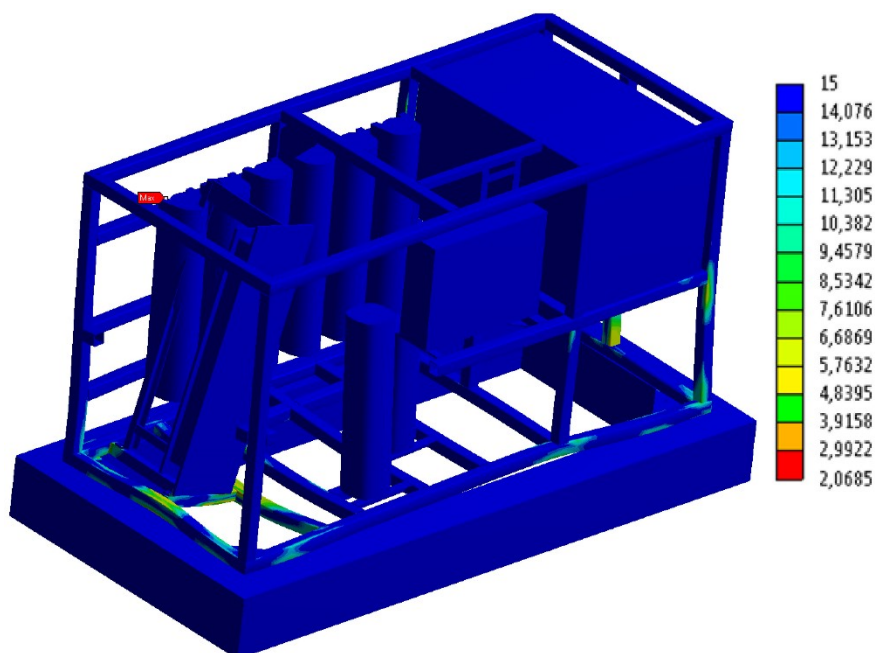
Fig. 9. The minimum safety factor 2.06; average values between 2–15 and more —
displacement rescaled x 210 times

THE IMPROVEMENT IN THE FRAME

The stresses resulting from the static weight of the load and the acceleration show that locally the frame structure was close to the yield limit of the material structure and the frame of the unit had to be improved. Taking into account the conclusions from the previous sections the frame was improved (fig. 10) and the acceleration caused by the vessel movement is given in table 1.

Table 1. The movement condition

Condition	Horizontal acceleration at drill floor level	Have
Survival North Atlantic (100y)	6 m/s^2	4 m/s^2

A lot of variants the new frame unit were calculated. The most appropriate structure is shown in figure 10. In the calculations the acceleration components for the most unfavorable variant shown below in table 2 were taken into account.
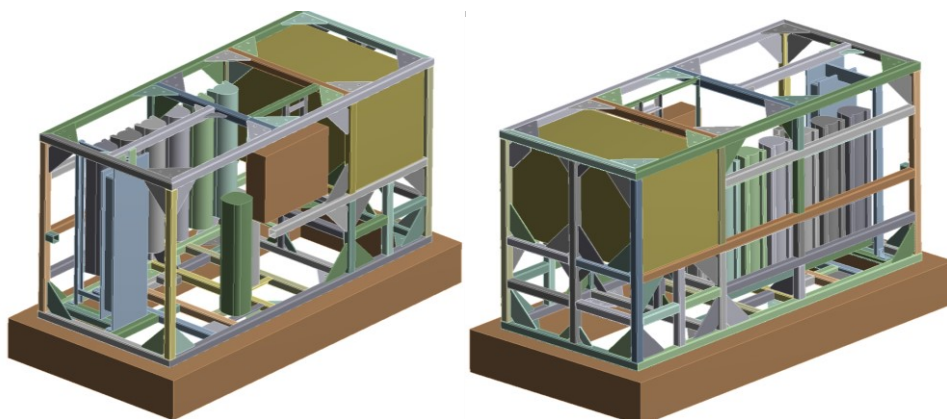
Fig. 10. The isometric view of the final frame

Table 2. The acceleration components used in the calculations

Acceleration components of	X m/s^2	Y m/s^2	Z m/s^2
–	6	–4	6

Like in the section 2 the stresses, displacements and safety factor were cal-culated (fig. 11–13) for the acceleration load and all the results refer to the elastic limit of the material structure.
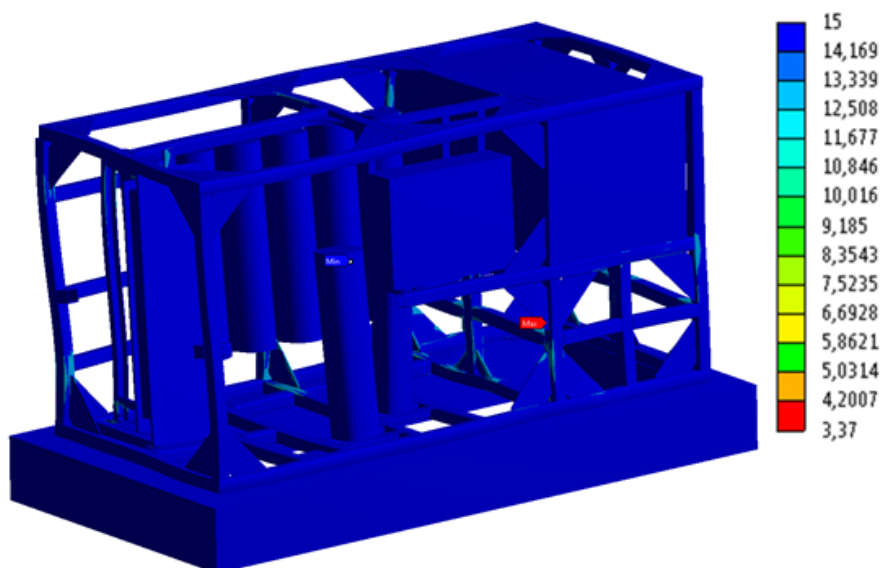

Fig. 11. The equivalent Von Mises stress in MPa; local maximum value 50.446 MPa;
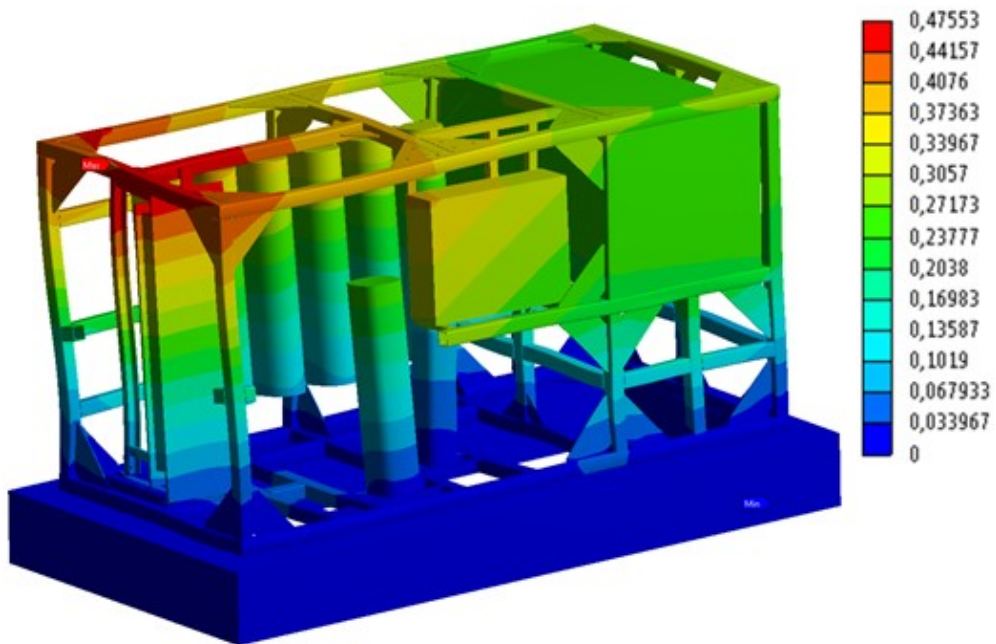the average nominal value 5 MPa — displacement rescaled x 210 times

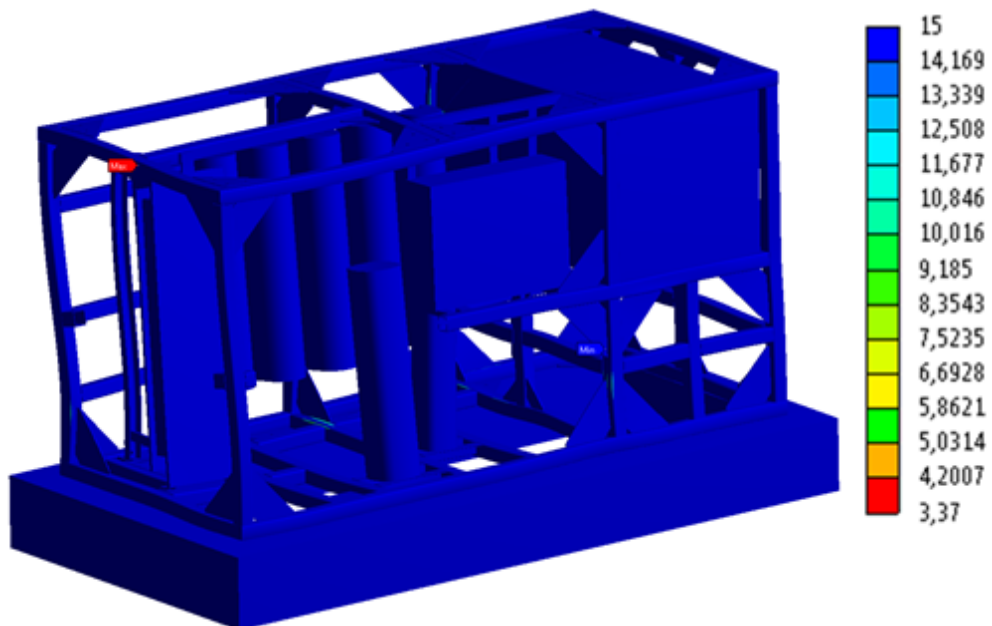Fig. 12. The resultant displacement 0.47 mm — displacement rescaled x 210 times

Fig. 13. The minimum safety factor 3.37; average values between 4–14 and more —
displacement rescaled x 210 times

CONCLUSIONS

The stresses caused by the static weight of the load in the frame represented by the FEM model were within the elastic load of the frame construction material.

The stresses caused the self-weight, mass of the equipment and the acceleration were within elastic limit of the material structure. If the system is considered as a single frame design it can be operated under the conditions shown in table 2.

According the American Bureau of Shipping (ABS) the maximum calculated stress, with all the dead load should not exceed the specified minimum ultimate tensile strength. The improved unit (fig. 10) met all the requirements.

Calculations were carried out at the Academic Computer Centre in Gdańsk.

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ADAPTACJA RAMY NOŚNEJ SYSTEMU CHŁODZĄCEGO DO WYKORZYSTANIA W WARUNKACH TRANSPORTU MORSKIEGO

STRESZCZENIE

W artykule przedstawiono obliczenia wytrzymałościowe ramy nośnej jednostki Cooling Skid wykorzystywanej na platformach wiertniczych. Złożoność urządzenia nie pozwala na efektywne modelowanie MES takich konstrukcji. Wskazano, w jaki sposób można uprościć model, aby obliczenia były przyjęte przez towarzystwo klasyfikacyjne American Bureau of Shipping (ABS).

Słowa kluczowe:

mobilne wymienniki ciepła, platformy wiertnicze, ramy, symulacje komputerowe.