carried out. The body considering as a beam with exact geometry and load, which value was solved in the previous step.

After defining the cross-section dimensions by analytical calculation, it is possible to build a 3D model of the hydraulic arm in CAD software. In Fig. 7 the three-dimensional model of the middle part of the hydraulic arm is shown.

The whole arm consists of three parts and to simplify the problem, numerical analysis of each part of the arm is made separately.

Further as an example, analytical calculation of the middle part of the hydraulic arm is indicated (Fig. 8). In this section the analytic calculation of the middle part of a hydraulic arm is described. Firstly, it is necessary to perform initial analytical calculation of the hydraulic arm structure. In this point we determine strain behaviour in the middle part of the hydraulic arm. Based on them the required dimensions will be it will be defined. The safety coefficient was chosen k = 1.5 [-].

Fig. 7 *3D model of the middle part of the hydraulic arm*

Calculation of the bending moment as a dominant loading is carried out by method of virtual cut. The beam is cut as many times as it is divided by outer loading, inner loading and by geometry, i.e. three times (Fig. 8).

In critical section, besides bending stress also tensile stress from normal force F_N = 5 824 N acts. The total stress then is (1):

$$\sigma_c = \frac{M_{omax}}{W_o} + \frac{F_N}{S} \qquad (1)$$

$$\sigma_c = \frac{M_{o\,max}}{W_o} + \frac{F_N}{S} \qquad (2)$$

By solving the equation (1), we get a value of total stress σ_c = 73.8 MPa. Force from the hydro motor F_{V1} then loads the critical section through holder by shear stress parallel with the length of the construction and force from the hydro motor F_{V2} loads the critical section through the holder also by shear stress, but perpendicular to the length of the construction.

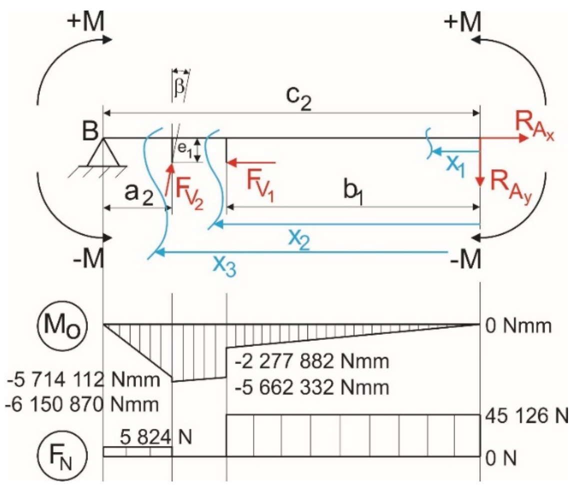

Fig. 8 *Pick-up platform for mounting the designed hydraulic arm*

Value of the resultant shear stress is found out from the equation (2):

$$\tau_s = \sqrt{\tau_{s//}{}^2 + \tau_{s\perp}{}^2} \qquad (3)$$

The resultant shear stress in the critical section then is τ_s = 9 MPa. Effective stress in the critical section is calculated according to HMH hypothesis (3):

$$\sigma_{RED} = \sqrt{\sigma_c{}^2 + 3.\tau_s^2} \qquad (4)$$

Value of the effective stress in a weld reaches by analytical method of calculation σ_{RED} = 75,5 MPa. However, value of the resultant stress will grow because of non-considering of.

3. Analysis of the hydraulic arm using Finite Element Method

In this chapter, the analysis of the hydraulic arm is carried out using the FEM software.

In the programme, there was input material properties to it (elasticity modulus E = 2.1 x 10^{11} Pa, density 7 850 kg.m^{-3}, Poisson's ratio 0.3). Input boundary conditions and meshed shell construction is shown in Fig. 9. Four nodes tetrahedron elements with density of mesh 4 mm were used at meshing.

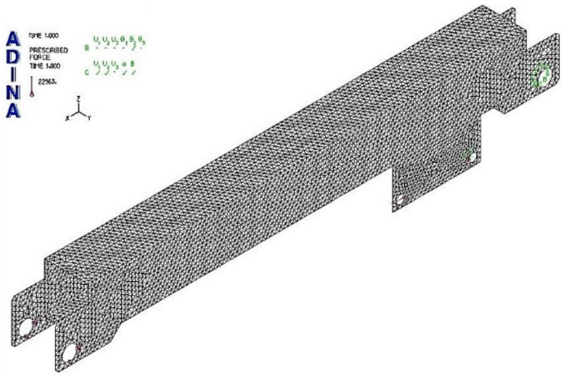

Fig. 9 *Mesh and boundary conditions in the middle part of the hydraulic arm*

After triggering of the solver it is possible to show results in the post-processor and so von Mises's stress in the first part and in the middle part of the hydraulic arm (Fig. 10, Fig. 11, Fig. 12, Fig. 13).

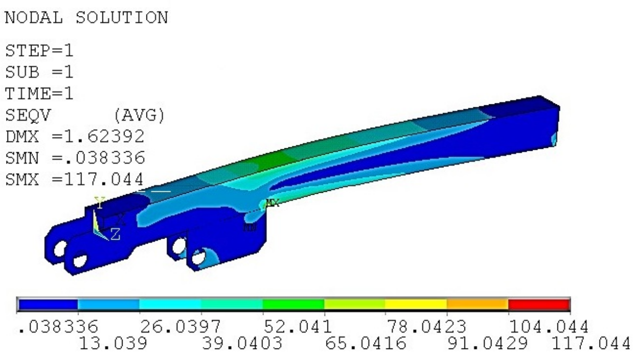

Fig. 10 *Distribution of* effective von Mises's stress in the first part

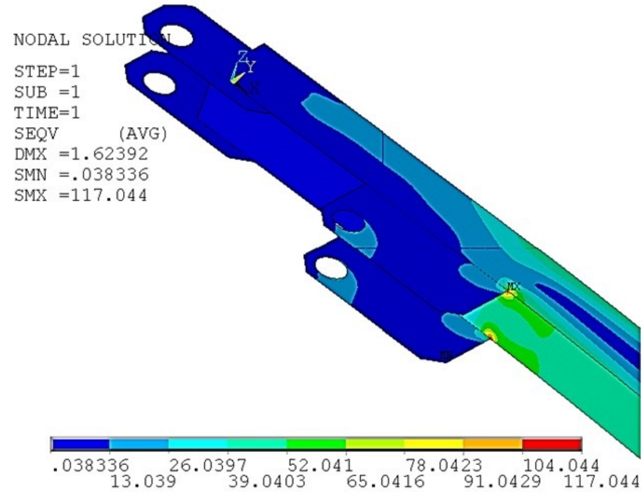

Fig. 11 *Detail of the critical section in the first part*

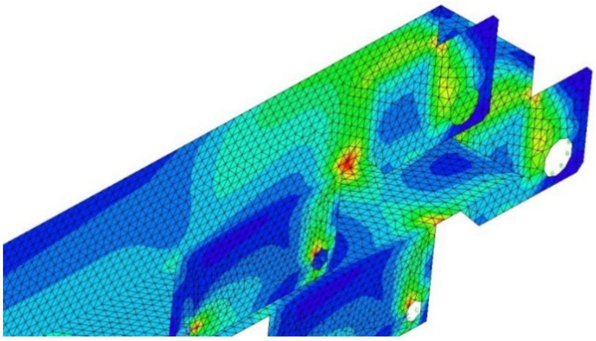

Fig. 12 Effective von Mises's stress in the middle part of the hydraulic part

Values as well as place of the maximal stress detected by FEM programme are practically identical with those achieved by analytical calculation. Values of the stress in the critical section may be determined in FEM programme in interval 80 – 86 MPa in comparison with 75.5 MPa from analytical calculation. A detail of the critical section with distribution of the effective stress is shown in fig. 7.

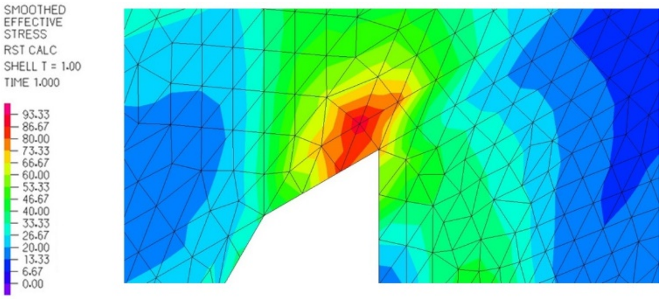

Fig. 13 *Detail of distribution of the effective stress in the critical section*

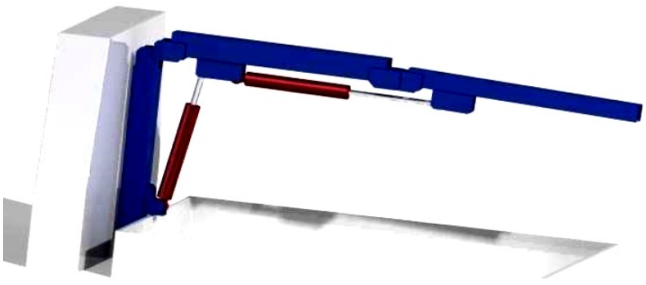

Fig. 14 *Lifting pivot arm with pick-up bed*

Conclusion

In the presented paper was performed design, analysis and calculation of the hydraulic arm, which was designed for mounting on a light goods vehicle. As a suitable platform for installation this arm the chassis of the off-road vehicle can be used. This equipment of a vehicle improves it operability, makes easier manipulation with loads and reduces the operational time. Although the designed structure causes decreasing the vehicle payload, still the vehicle load is enough.

As the every structure as this hydraulic arm has to be submitted analytical calculation and analyses. Well-defined force effects in the proposed mechanism is a necessary precondition for the safe operation of this device. The next step of the performing of this task is an analytical calculation of the cross-sectional dimension of each arms by using of conventional methods of elasticity and strength of material.

After designing of all dimensions creation of the 3D model was possible in a CAD software (Fig. 14). And then, the CAD model was imported into a FEM software. In this way, we could obtain adequate results of the structure strength, etc. Comparison of these two methods allows to find the overall accuracy of the solution. If unsatisfactory results had been identified, the task we could optimize before the expensive production, which in turn will contribute to the cost saving in the production of this mechanism.

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