The study on ultra-light chair assigned to passengers conveyance

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Abstract. The work provides the analysis of ultra-light chair applied in transport of passengers. With regard to a minimization of weight of whole chair, it was used multilayer composite material with high strength properties and aluminum alloy for load carrying parts. The structure has been designed and prototyped to satisfy requirements of the Regulation ECT 14. It was analyzed different thicknesses of thin-walled carbon-fiber composite material with number layers amounting to 5. The arrangements of main directions of orthotropy was following: 0°/90°/0°/90°/0°. To assess a load-capacity of aluminum and steel parts, Huber-Mises yield criterion was applied, while for parts made of composite material Maximum Stress, Tsai-Wu or Tsai-Hill failure criterion was used.

1. INTRODUCTION

The application of ultra-light material with high strength in engineering structures becomes every time the challenge because final price of product should be taken into account simultaneously satisfying the adequate safety regulations during conveyance [1]. One of the most effective solutions is an application of composite material because of very high load-capacity to weight ratio of structural elements made of such materials [2].

2. THE OBJECT OF STUDY

The range of presented paper includes the modeling and investigations of structure of seats assigned to transport the passengers in special vehicles. The whole frame of seat comprise of aluminum elements, steel reinforcements and multilayer composite parts of the main frame carrying the load. The present paper shows exemplary results of parametric study of the structural members mentioned above. The seat design was developed to achieve the minimum of weight, simultaneously fulfilling strength demands included in Regulation ECT 14 [3]. The problem was solved on the basis of finite element method using **MIDAX NFX** software. Properties of analyzed materials are shown in Table 1. The numerical model of chair with boundary condition is presented in Fig. 1.

TABLE 1. Properties of considered materials

Material	Aluminum	Steel	Composite
Young Modulus in 1-direction (0°) [GPa]	72	210	175
Young Modulus in 2-direction (90°)[GPa]	72	210	8
Poisson's ratio [-]	0.33	0.3	0.3
Shear Modulus [GPa]	27.07	80.77	5
Tensile strength in 1,2-direction (0°, 90°) [MPa]	280, 280	400, 400	1000, 40
Compressive strength in 1,2-direction (0°, 90°) [MPa]	280	400	800, 200

Shear Strength [MPa]	n/d	n/d	60

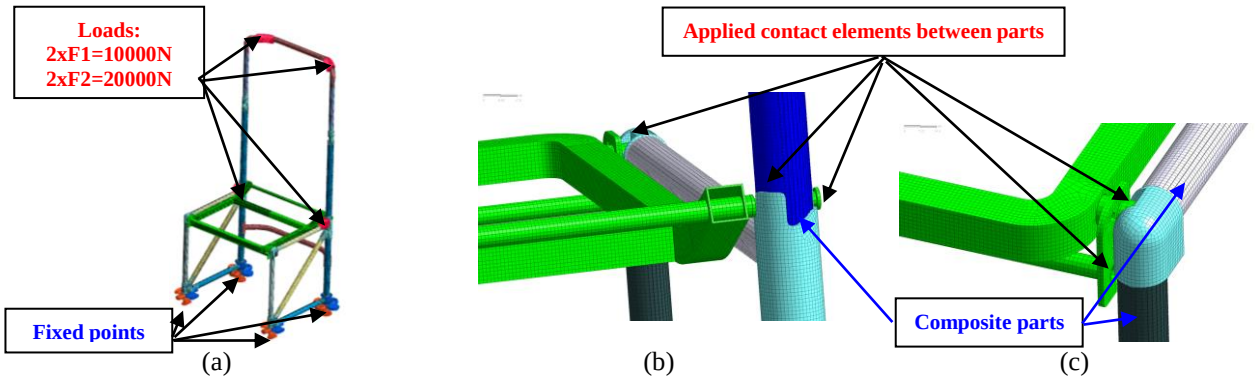

FIGURE 1. Exemplary numerical model with boundary conditions prepared to calculations (a) , view of partition 1 (b), view of partition 2 (c).

3. THE RESULTS OF CALCULATIONS

Fig. 2. shows the exemplary results of calculation, the maps of displacements, equivalent von Mises stresses and limit state map due to Tsai-Wu failure criterion.

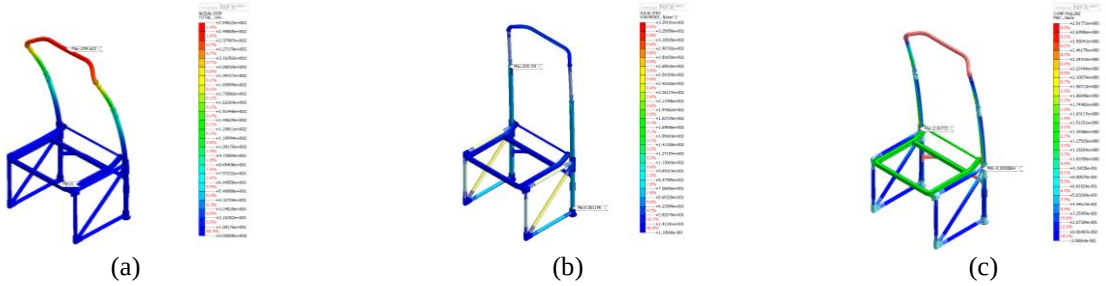

FIGURE 2. Exemplary maps of nodal quantities: displacements (a), equivalent Huber-Mises stresses (b), limit state of material due to Tsai-Wu failure criterion (c).

4. SUMMARY

The work concerned the analysis of ultra-light structure of seat subjected to loads corresponding to regulation R66. To evaluate the stress state occurring in the chair frame, several analyses for different variants of design solutions were performed. On the basis of calculations it was stated, that (for the design variant shown in Fig.1) the thickness of composite beams should be in range of 1.5mm up to 3 mm with regard to location.

5. ACKNOWLEDGMENTS

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6. REFERENCES

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