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DESIGNING OF ULTRA-LIGHT MOBILE ELEVATING WORKING PLATFORM (MEWP) PROTOTYPE

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ABSTRACT
Designing of ultra-light mobile elevating working platform (MEWP) prototype was based on testing of mechanical properties of high-strength fine-grained steels and on obtained results. The results of stress and deformation analysis of main platform parts are presented in this paper.
Key words: Ultra-light mobile elevating working platform, stress analysis

1. INTRODUCTION

Ultra-light mobile elevating working platforms are used for lifting different types of small loads in workshops, warehouses, power plants, and they are also used for maintenance of glass fronts of buildings, for restoration of frescos in churches, etc.

Ultra-light mobile elevating working platforms can be manually operated, or they can also have hydraulic, electric or combined drive. Maximum operating height is up to 30m, and the platform can be operated either from the ground or from the crane basket. The platform must fulfil some additional criteria in order to be competitive on the market, and these are:

1. small weight (under 3t)
2. min. pressure on the ground
3. use of high-strength fine-grained steels
4. automotive, i.e. self-propelled
5. autonomous, i.e. outer source of energy is unnecessary
6. small dimensions when retracted – in order to pass through narrow passages, i.e. doors
7. special automatic safety (to prevent the upturning of the platform)
8. operating height (15m), operating reach (10m)
9. rotation of the stabilizer (30^o left – right) to enable access at less than 90^o.

2. EXPERIMENT, RESULTS AND DISCUSSION

Certain construction solutions and high-strength fine-grained steels StE 680 and StE 960 were used in order to reduce the weight of the platform.

Based on the testing of mechanical, metallographic, tribological and other properties, and on obtained results, the design of the ultra-light mobile elevating working platform was carried out. The results of stress and movement analysis acquired by using software packages CATIA and Pro-Eng. (based on Finite Element Method) are shown in this paper.

Table 1 shows design criteria and input data which determine the characteristics of the platform. It also shows the way of determining input data which are necessary for calculation and dimensioning of ultra-light mobile elevating working platform elements.

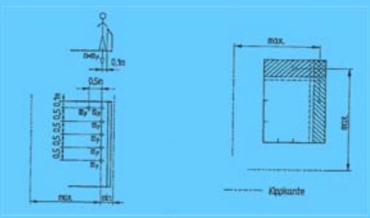
Table 1. Input data for calculation of the ultra-light mobile elevating working platform

Opterećenje dizalice

Sila od jedne osobe	F_p = 800 x 1,1 x 1,25 = 1100 N	
Faktor preopterećenje = 1,25		EN 280 (6.1.4.3)
Faktor dinamičnost = 1,1		EN 280 (6.1.4.4)
Sila od korisnog tereta	F_e = 400 x 1,1 x 1,25 = 550 N	
Bočna sila (2 osobe)	S_x = 400 N	EN 280 (5.2.3.4)
Bočna sila	S_y = 400 N	EN 280 (5.2.3.4)
Tlak vjetra	q = 100 N/m²	EN 280 (5.2.3.3.1)
Tlak vjetra na profile 25x25	c_f = 1,4	EN 280 (5.2.3.3.2)
	$w = c_f x\ q\ x\ d$ = 1,4 x 100 x 0,025 =0,4 N/m	
Tlak vjetra na osobu	A_p = 0,7 m² c = 1,0	EN 280 (5.2.3.3.3.1)
	$W_p = c_f x\ q\ x\ d$ = 1,0 x 100 x 0,7 = 70 N	

Opterećenje ultra - lake dizalice

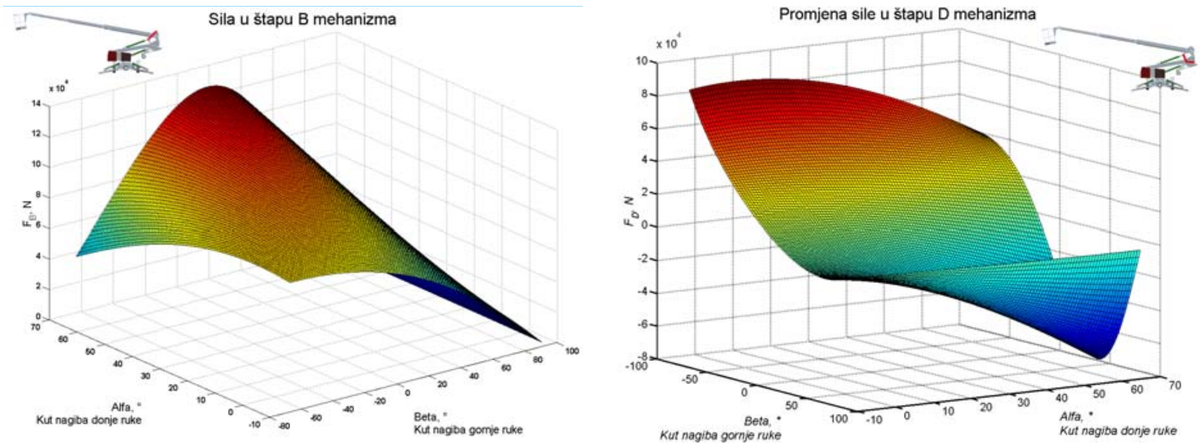
EN 280:2001



Nosivost dizalice

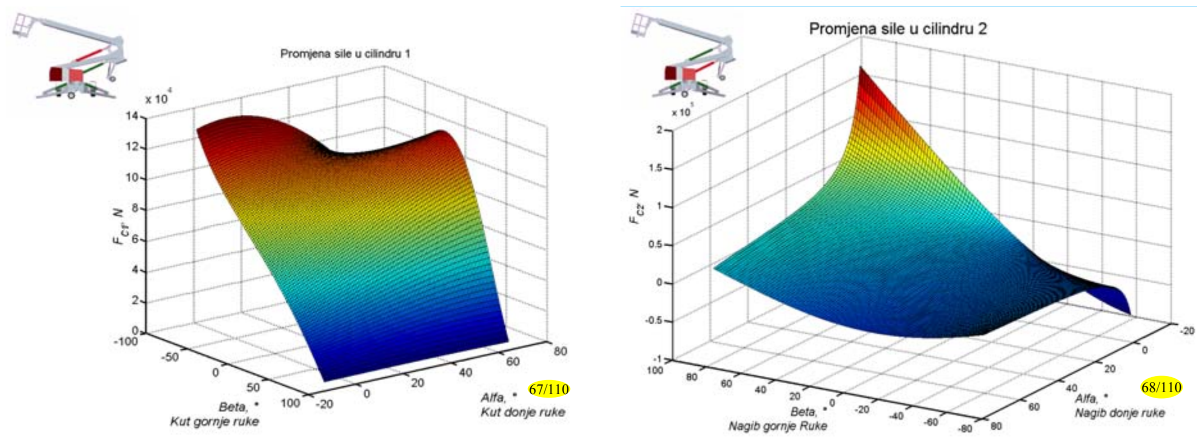
m_p = 80 kg (masa jedne osobe)	EN 280 (5.2.3.1)
$n = 2$ (broj osoba)	EN 280 (5.2.3.1)
m_e = 40 kg (koristan teret)	EN 280 (5.2.3.1)
Nazivna nosivost dizalice	EN 280 (5.2.3.1)
$m = n\ x\ m_p + m_e$ = 2 x 80 + 40 = **200kg**	

Max. forces which act on certain platform elements were determined with respect to the possible angles of the working arms of the platform. Figures 1 and 2 show the results of platform elements analysis.



a) Change of force in the rod of the working arm mechanism *b) Change of force in the rod of the working arm mechanism*

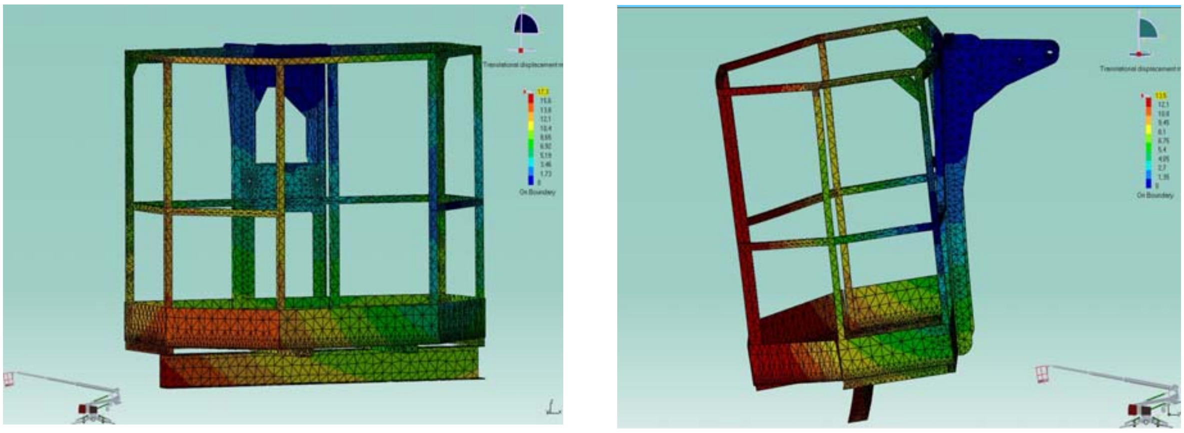
Figure 1. Change of force in the rod of the working arm mechanism



a)Change of force in the cylinder for upper arm rotation *b) Change of force in the cylinder for lower arm rotation*

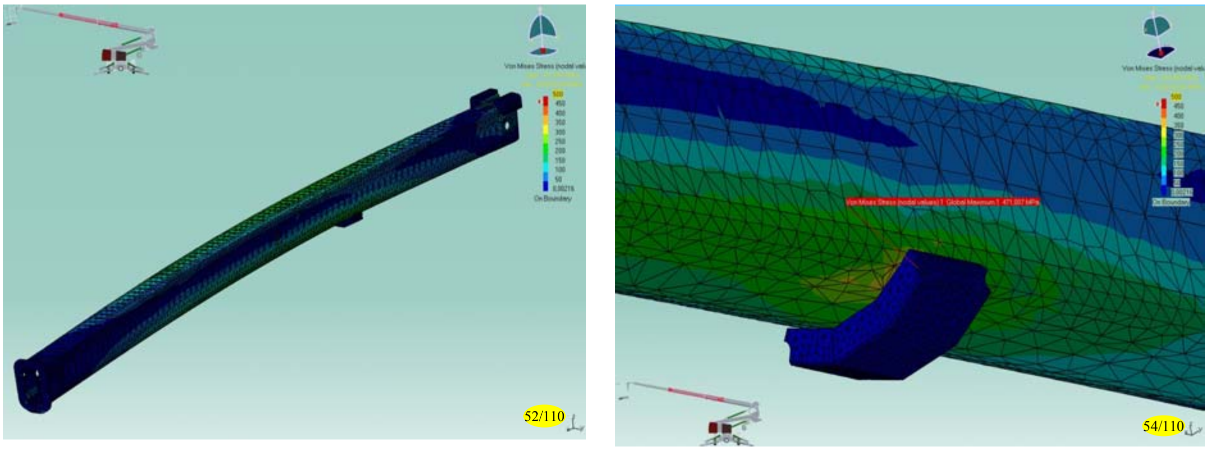
Figure 2. Change of force in the cylinder for upper and lower arm rotation

While using FEM (Finite Element Method) certain problems arose, e.g. how to determine all values necessary for the analysis of the described continuous system by using known elements and known theoretical relations. 10-node iso-parameter tetrahedral 3D elements were used for describing design elements and for generating elements. Figures 3, 4, 5 and 6 show the examples of analysis of some platform elements. Figure 3 shows basket movements at different types of loads. Figures 4 and 5 show stresses and movements of one platform segment. Figure 6 shows the distribution of stresses and deformation of the upper and lower turret of ultra-light mobile elevating working platform.



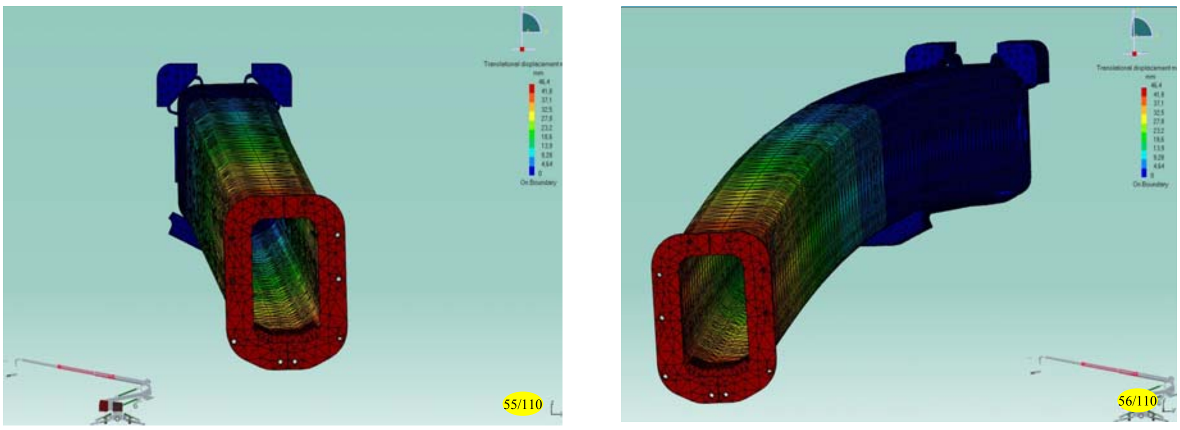
a) Centre of mass in the basket is shifted forward *b) Centre of mass in the basket is shifted towards the middle*

Figure 3. Analysis of the basket movements at external loading



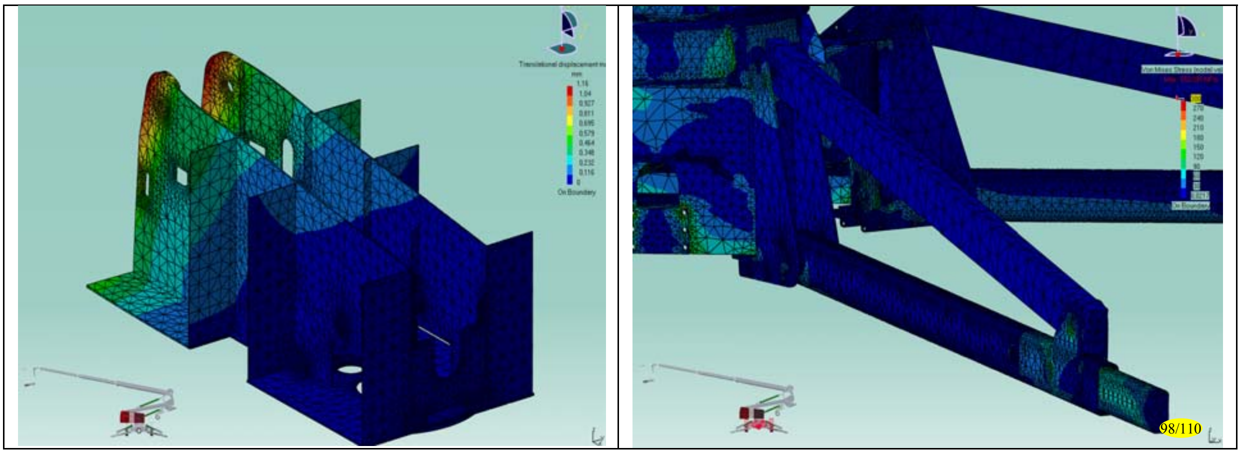
a) Distribution of stresses in one of the segments *b) Distribution of stresses in one of the segments - detail*

Figure 4. Distribution of stresses in one of the segments



a) Distribution of deformations in one of the segments *b) Distribution of stresses in one of the segments*

Figure 5. Distribution of stresses in one of the segments



a)Distribution of deformations (the upper turret) *b) Distribution of stresses (the lower turret and stabilizers)*

Figure 6. Distribution of stresses and deformations (the upper turret, the lower turret, stabilizers)

Figure 7. Manufacturing and testing of the prototype in the workshop

3. CONCLUSION

Development and analysis of ultra-light mobile elevating working platform design are shown in this paper. The main objective was to design a very light platform by using high-strength materials, and also to make a detailed stress analysis of each platform element. Innovative design solutions with optimizing were also used.

4. REFERENCES

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