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TOWARDS THE BETTER PROTECTION OF THE OPERATOR HANDLING THE MOBILE BUILDING MACHINES

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SUMMARY: The paper presents the method for testing the protective frame of a mobile building machine. The analysis of conditions relevant for certification has been also done in order to meet the conditions which are defined by standards for safe and reliable operation of a building machine. The attention is directed to the work place (cab) of tractor operator, with special reference to tractor roll-over.

KEY WORDS: ROPS, cab, certification, tractor

1. INTRODUCTION

Safe and reliable work place of the operators handling the building and transportation machines is one of the vital conditions for their safety. High level of protection should be achieved without considerable limitations in application of machines in industrial production.
Previous analyses and statistic data point to various risk levels when working with particular types of machines. In order to undertake precautions it is very important to possess thorough information on machines and working conditions. Since the building machines operate on uneven ground (fields with irrigation ditches and the like) the roll-over of machines along with accidents often happen.

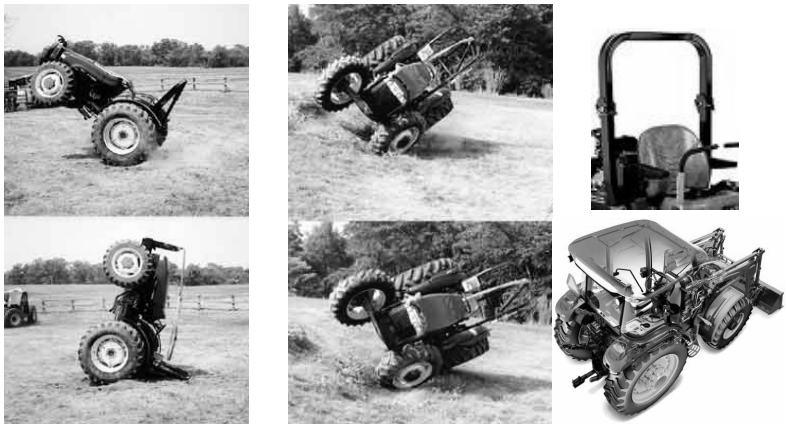

Fig. 1 – Roll-over protective structures (ROPS)

Thus the roll-over protective structures (ROPS) have been introduced. They are included within the standards defining the structures for protection when the machine rolls over.
The rolling over is a very significant problem and it is stated in the Directive for machines no. 98/37/EC of European Union, Annex I, entitled "Main health and safety requirements related to the structure and design of machines and safety components", Section 3 - "Main health and safety requirements for preventing the danger caused by machine movement".

There are three main objectives of protecting the operator in case of roll-over [1]:

- inviolability of necessary cab space;
- to make the contact between the operator and vehicle structure unlikely;

- to make the possible operator's injury be minimal by means of additional elements in the cab.

Figure 2 describes the algorithm of making the machine safe so that it has adequate ROPS. When there is no uniformity, the process has another course, and it becomes less understandable.

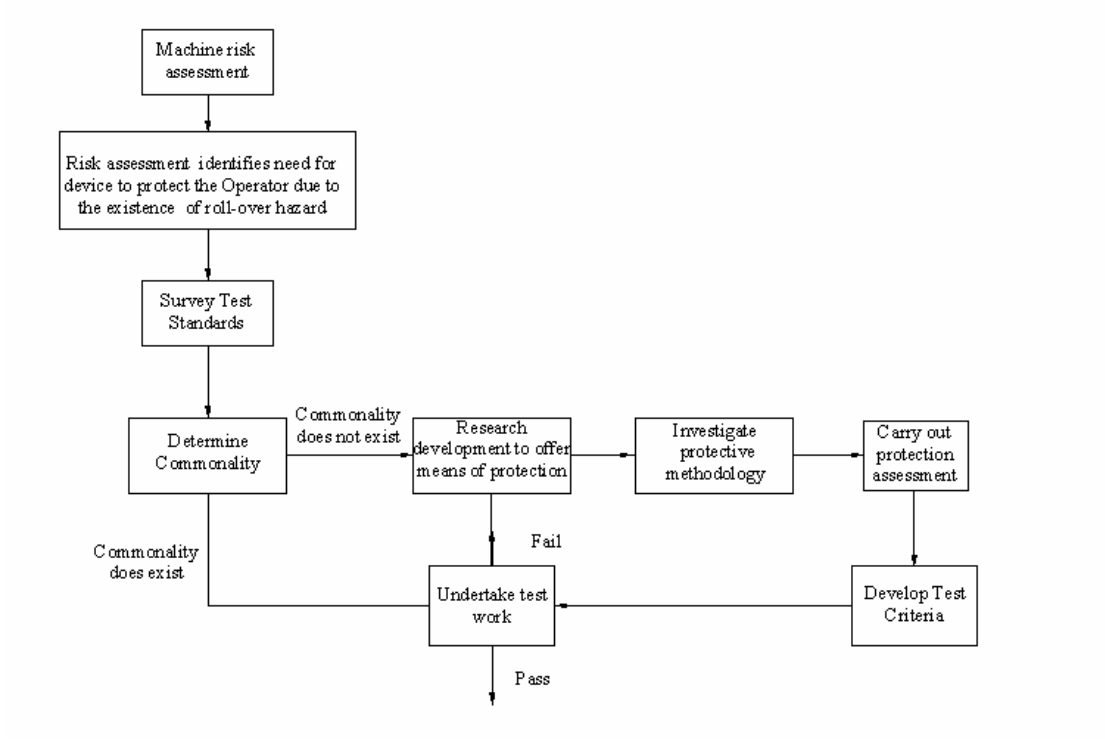

Fig. 2 – Algorithm of ROPS affirmation

2. PROCEDURE AND RESULTS OF TESTING THE PROTECTIVE FRAME OF TRACTOR TYPE UZT-24

The testing has been done according to the requirements prescribed by JUS.M.L1.406 (this standard is in accordance with international standards ISO 5700 and SAE J 1194) which defines the method of statistical testing and conditions for cab safety and protective frames of wheel tractor. Conformably to the mentioned standard, for tractors whose weight ranges from 800 to 15000 kg and whose smallest width of wheel track is higher than 1150 mm, the following has been done:

- **Measurement of maximal horizontal load (figure 3a)**
  – Testing by means of horizontal force F_1 which acts on the front tractor frame. The point of application of the force is located at 170 mm, i.e. 1/6 of total width of protective frame. The condition which must be met by protective frame is to absorb the energy of $E_1=1,4m_{tr}$ =1666 J, while the operator's safety space should be inviolated.
  - Testing by means of horizontal force F_2 which acts laterally on upper part of the frame. When loaded like this, the protective frame must absorb the energy of $E_2=1,75m_{tr}$= 2082 J, while the operator's safety space should be inviolated.

- **Measurement of maximal vertical load (figure 3b)**
  - Testing by means of vertical force acting on front and back frame while the operator's safety space should be inviolated.

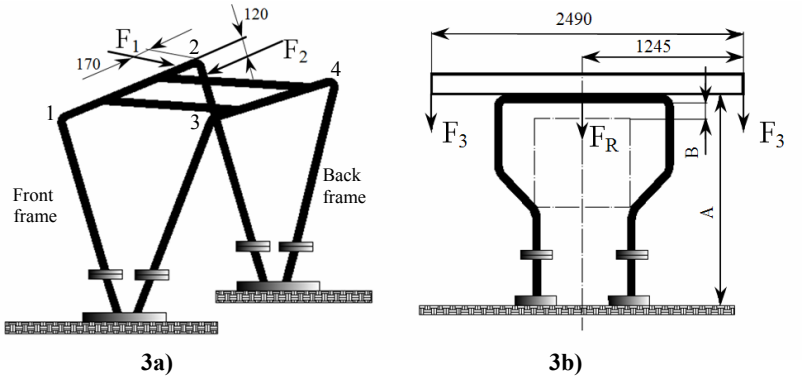

Fig. 3 – Loads of protective frame

To achieve the horizontal force when protective frame is loaded on the front side and when laterally loaded, hydraulic cylinder has been used. The force and cylinder stroke have been measured because it is not possible to directly measure the total energy absorbed. The stroke and force value are placed at X and Y axes, respectively. The area beneath the curve obtained is total energy absorbed which should be equal to or bigger than E_1=1666 J when loaded by horizontal force; when laterally loaded it is equal to or bigger than E_2=2082 J. The points of application of forces F_1 and F_2 are designated in figure 3 as well as the force of vertical load F_3 for which two cylinders have been used. Resultant force acting on protective frame is carried out by hydrocylinder.

Operator's safety space, which must be unharmed during testing, serves as the indicator of good quality of protective frame. Conformably to standards, the safety space for tractor UZT-24 has been made of wire whose diameter is 6mm, and it has been set in the protective frame being tested. Cycle point of the operator's seat serves as competent point for setting the safety space in protective frame.
The results of testing by means of horizontal load acting on front frame and from lateral side to the upper part of front frame are given in Table 1 and in Figure 4.
The testing having been over, the measurement of geometric dimensions of protective frame have been done in order to determine the values of resulting permanent deformations. These values are given in Table 1. The results of testing when the vertical force acts on the front and back frames are given in Figure 4, and the geometric dimensions of protective frame important for determining the values of resulting permanent deformations are presented in Table 2 .

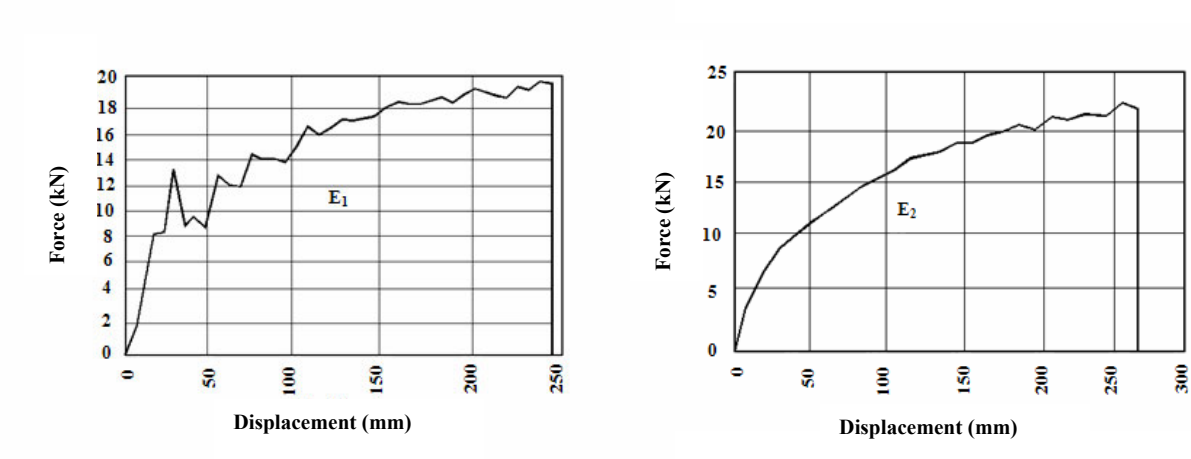

Fig. 4 – Total absorbed energy of protective frame

Tab.1: Results of testing the protective frame by means of horizontal force

Measured values			Measures before testing (mm)	Departure from starting measures after the loading by horizontal force	
				Load along longitudinal axis F_1 (mm)	Lateral load F_2 (mm)
Hight	Front frame	L1	1515	25	-15
		R2	1515	15	-20
	Back frame	L3	1385	-20	-20
		R4	1380	-20	15
Distance from operator's safety space to protective frame B(mm)			80	10	-10

Tab.2: Results of testing the protective frame by means of vertical force

Measured values		Measures before testing (mm)	Departure from starting measures after the loading by maximal vertical force (mm)
Hight A(mm)	Front frame	1573	1558
	Back frame	1430	1420
B (mm)	Front frame	105	90
	Back frame	105	95

3. CONCLUSION

One of the most important conditions for a product to obtain CE mark is that the product should meet the safety conditions in compliance to appropriate directives. Building and transportation machines must meet a series of safety conditions, whereas the most significant one is the safety of the operator in case of rolling over. Therefore, a huge attention is directed to this problem, particularly to the methodology of testing the cabs themselves (ROPS).

It is essential to develop the methods and procedures for certification and to develop required lab capacities in Serbia. The testing would be also significant for stopping the import of machines and devices which do not meet the conditions prescribed by certification. New machines and devices along with certification list would be competitive at the international market, too.

By means of ROPS methodology, the testing done on the protective frame of the tractor UZT-24, made by IMK 14.oktobar, Kruševac, has proved that the conditions related to cab protection, i.e. to operator's safety if rolled-over, have been met.

4. REFERENCE

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