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RESEARCH AND APPLICATION OF TESTING METHOD FOR PROTECTIVE FRAME OF TRACTORS

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Summary. *The paper presents the research and application of testing method for the protective frame of the tractor type UZT-24, made by IMK 14.oktobar. The analysis of prescribed conditions has also been done for safe and reliable operation of tractors. The attention is directed to the work place (cab) of tractor operator with special reference to tractor roll-over protection.*

Key words: *ROPS, cab, protection, tractor.*

Introduction

Previous observation of risks points to various dangers occurring 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 tractors operate on uneven ground (fields with irrigation ditches and the like) the roll-over of machines along with accidents often happen.

Thus the roll-over protective structures (ROPS) have been introduced. ROPS is defined by the standards relating to the protective structures when the machine rolls over.

In accordance with these standards as well as to European Union's Directives for machines there are three main objectives of protecting the operator in case of roll-over:

– inviolability of necessary cab space;
– to provide the operator with necessary space and to make the contact between the operator and vehicle structure unlikely;
– the elements inside the cab should cause minimal operator's injury (if the contact is likely to happen).

Figure 1 describes the process of making the machine safe so that it has adequate ROPS.

Procedure and results of testing the protective frame of tractor type UZT-24

The testing has been done according to the requirements prescribed by international standards ISO 5700 and SAE J 1194 which define the method for static testing and conditions for cab safety and protective frames of wheeled tractors.

Conformably to the mentioned standards the following measurements have been done for tractors whose weight ranges from 800 to 15000 kg and whose smallest width of wheel track is higher than 1150 mm.

Measurement of maximal horizontal load:
– 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} =1666J, 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:

– testing by means of vertical force acting on front and back frame while the operator's safety space should be inviolated.

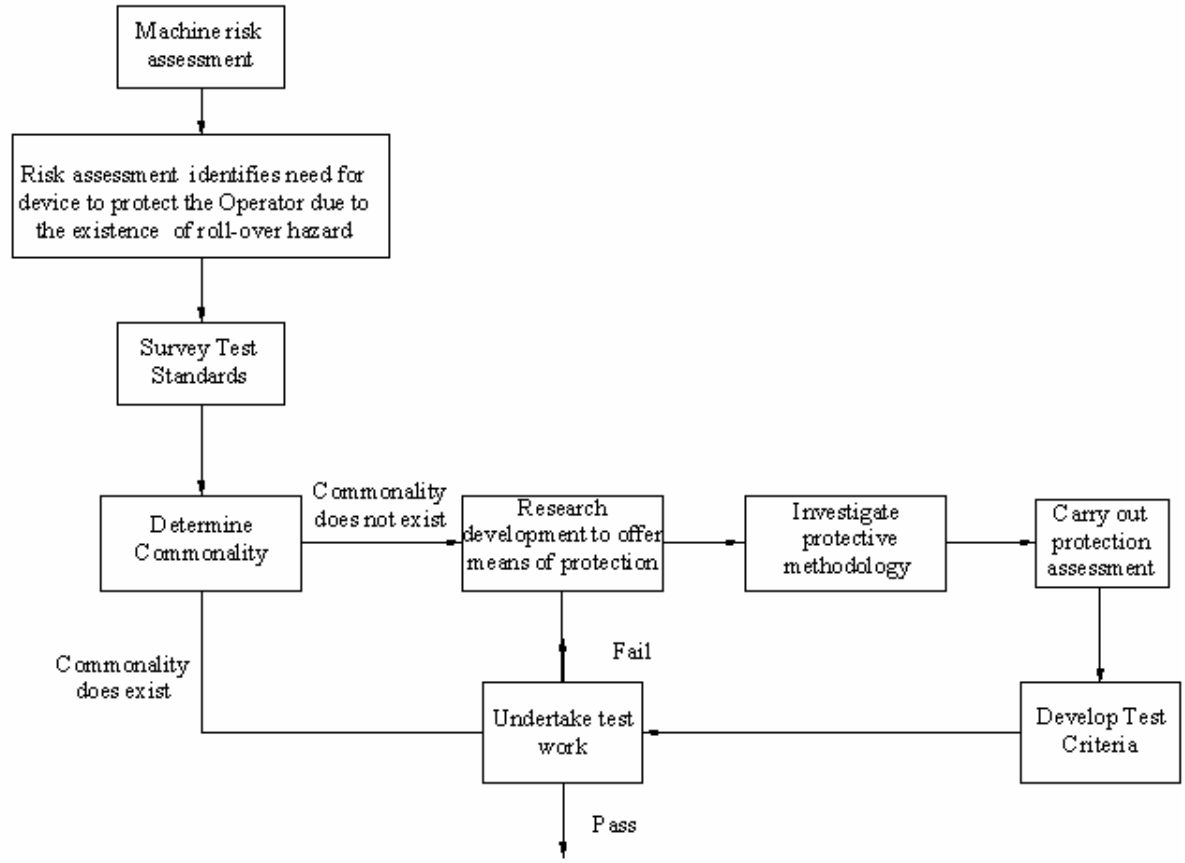

Fig. 1. Process of ROPS affirmation

To achieve the horizontal force when protective frame is loaded on the front side and when laterally loaded, hydraulic cylinder, whose piston diameter is 200 mm, 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 sum of areas beneath the curve 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 F_R=2F_3=23800N.

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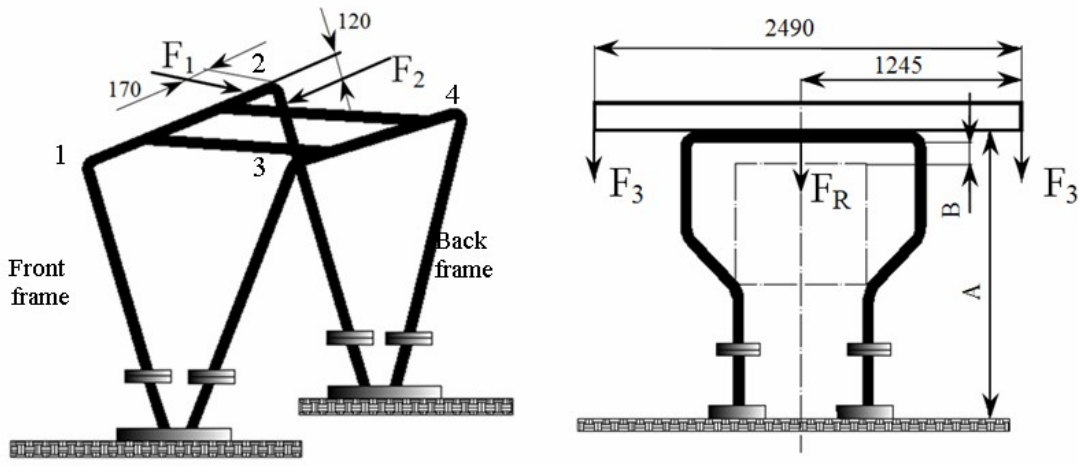

Fig. 2. Loads of protective frame

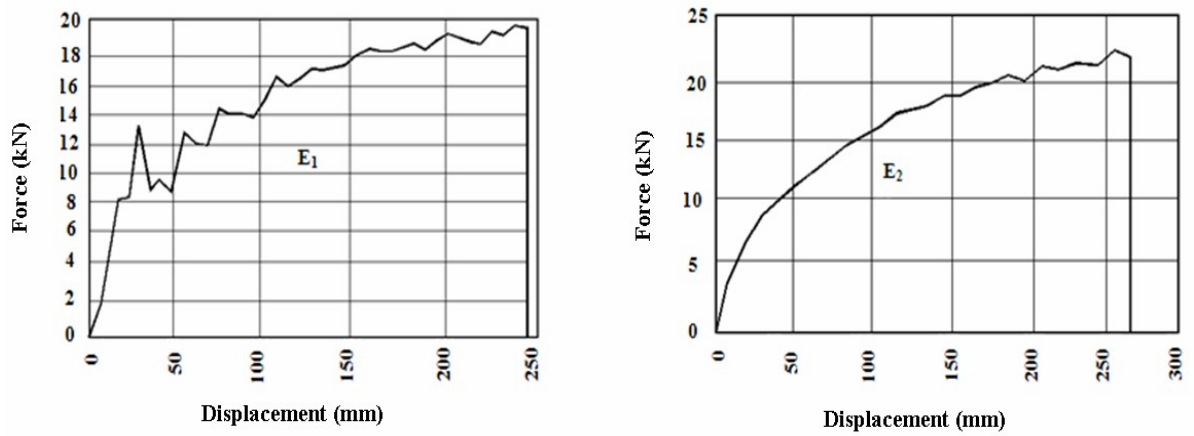

Fig. 3. Total absorbed energy of protective frame

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. The cycle point of the operator's seat serves as competent point for setting the safety space in protective frame.

The results of testing under horizontal load are given in Figure 3a and Table 1.

Table 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 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

Table 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 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

The testing having been over, the measurement of geometric dimensions of protective frame were done in order to determine the values of resulting permanent deformations.

These values are given in Table 1. The results of testing under the vertical force are presented in Figure 3b and Table 2.

Conclusion

By means of ROPS methodology, the research and testing done on the protective frame of the tractor UZT-24, made by IMK 14 oktobar, Kruševac, have proved that the conditions defined by standards related to cab protection, i.e. to operator's safety if rolled-over, have been met. The laboratory plant has been also made in order to estimate and check the functions of protective frames of bigger tractors with bigger power.

Reference

1. Official journal of European Union, Directives
2. Gašić M., Savković M., Marković G.: Application of the methods which are relevant for certification of building and conveying machines, MHCL'06, Belgrade 2006, session B, pages 145-148.

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