EQUIPMENT FOR TESTING STABLE FLOOD DEFENSES

L. Ševčík

Technical university in Liberec, Liberec, Czech Republic

Abstract
Issues of the impactor testing flood defenses in this contribution. By impactor will be tested stationary and mobile barriers. They are mechanical deformation test. Standard is a log impactor - weighing 400 kg, a diameter 400 mm and approximately 4 m long. Log alludes by force 2 m/s to the flood barrier. Impact must not lead to instability barriers. The aim is to propose smaller device with the same effects.

Key words: velocity, pneumatic piston, devices, flow rate.

INTRODUCTION

The following figure shows the arrangement of the experiment. The cylinder piston impactor was fitted with a load cell resistance to water immersion. Furthermore, among the wooden headboard of the impactor and the fixed bracket cable was stretched the distance measurement. Pressure compressor air was 0.6 MPa.

Due to the detection of real properties of the air motor was carried out measuring the speed of ejection of the piston rod of the engine and its force effect on a floating log (APPROVAL STANDARD FOR FLOOD ABATEMENT EQUIPMENT, 2013).

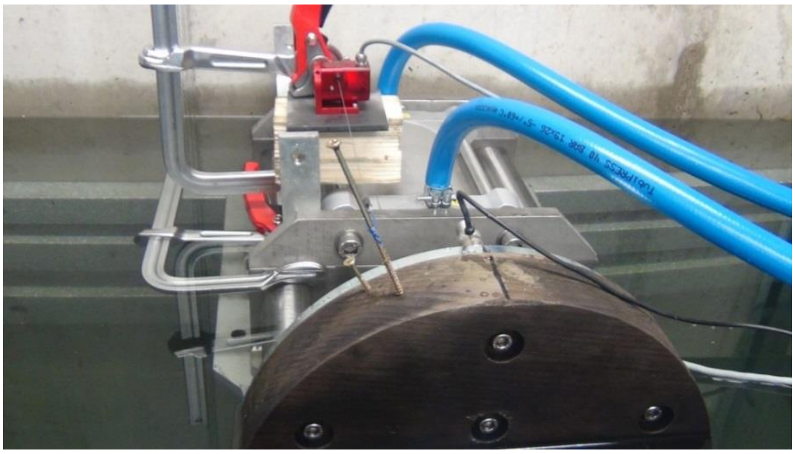


Fig. 1. – Front view of the experiment

Used sensors are in Fig. 1:
- Wire position sensor for sensing position of a piston engine.
- Force transducer to the piston engine to determine the forces acting on the piston log.

The calculations:
- Real time was calculated velocity of the piston engine logs and the derivative signals from the sensors to their position (calculated speed signals exhibit noise generated by a mathematical derivative transaction on real measured signal) (MUTTRAY, OUMERACI, 2005).

Measuring the speed of eject impactor

The air pressure was vented to air cylinder impactor. Impactor was ejected against a flood inhibition. Measurements were carried out forces, piston extension and the calculated energy, see Fig. 2.

Measured values:
- Ejecting piston speed 0.25 m/s.
- Maximum force 25 kN.
- The maximum amount of deformation flood defenses.

If we start from the equality impact energy timber in standing water, we arrive at the value of the strain energy:

$$E = \frac{1}{2} m v^2 \text{ given} \tfrac{1}{2}\ 400\ kg\ 2\ m/s2 \text{ get } 800J. \qquad (1)$$

Energy of cylinder:

$$E_{cylinder} = \frac{1}{4}\pi d^2 \int_0^{E\max} p(z)dz \text{ given} \qquad (2)$$

diameter 200x200x3,14 / 4 of 1 MPa (max. Pressure) = 0.125 maximum stroke 3925 J.

So that, in terms of energy it is enough and it can reduce by the pressure. If we neglect the effect of speed on the deformation, so we could cylinder attached to the wall, shoot the strength and track and stop when we reach 800 J (MALCANGIO ET AL., 2011). In conclusion, the piston is of sufficient strength, but does not have the necessary speed.

The measurement result was insufficient velocity impactor, 10 times less than required. The speed can be increase by next possibilities- by changing the pneumatic diagram or by different mechanism.

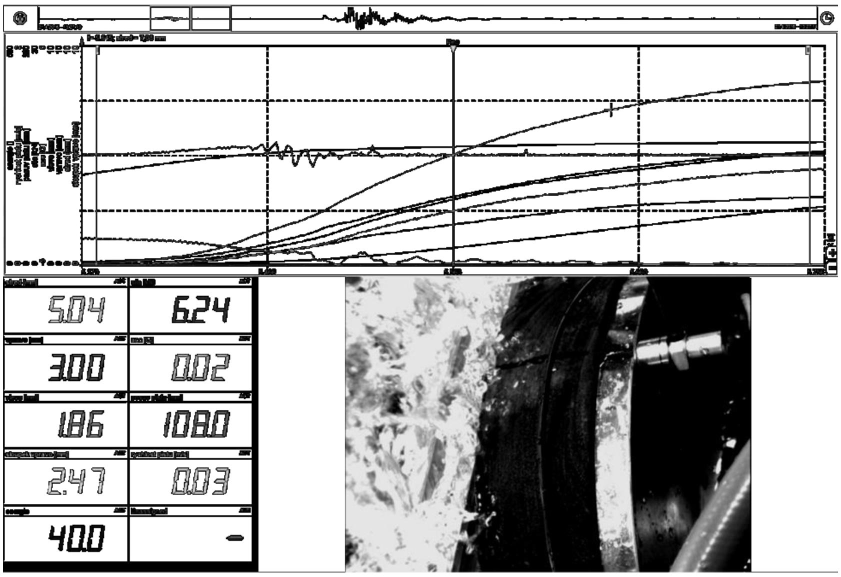
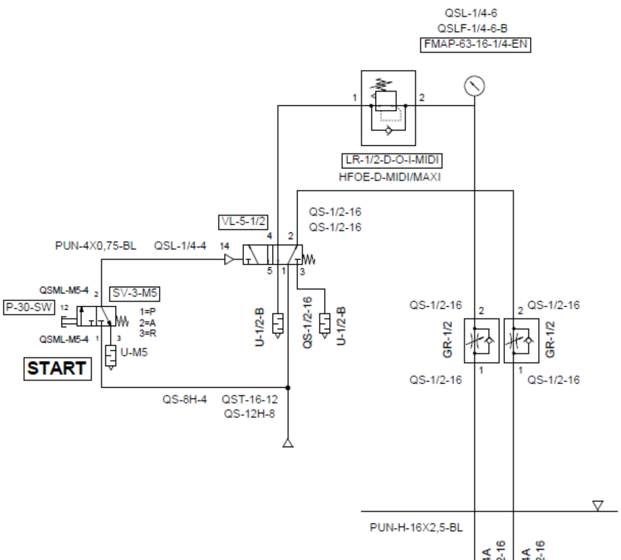


Fig. 2. – Measurement results

Optimization of pneumatic schema

Was designed pneumatics schematic diagram of impactor see. Fig. 3. Small the flow of air caused inadequate speed ejection piston.



ks	číslo dílu	typ	označení výrobku	obj. kód 1
2	3588	D-1/2I-3/4A	redukce	
2	153096	QSLV-1/2-16	L-šroubení s nástrčnou koncovkou	
1	2344936	DSBG-...-200- -N3		DSBG-200-500-PA-N3R3
2	3720	GR-1/2	jednosměrný škrticí ventil	
7	153011	QS-1/2-16	nástrčné šroubení	
2	6844	U-1/2-B	tlumič hluku	
1	197388	PUN-H-16X2,5-BL	hadice z plastu	
1	159593	HFOE-D-MIDI/MAXI	upevňovací úhelník	
1	161131	FMAP-63-16-1/4-EN	přesný přírubový manometr	

Fig. 3. – Pneumatic schema of impactor

Given the small space in the canal was a cylinder -200-500 impactor DSBG indicated in the diagram changed to cylinder-DSBG 200-125, with smaller stroke. From the measurement showed that the pressure in the cylinder is only 0,08 MPa and in the reservoir of the compressor was 0.6 MPa, 7.5 times smaller. The pneumatic cylinder is designed to 1 MPa, a pressure in the cylinder could 12.5x increase the. The result is insufficiently oversized and intake air into the cylinder. To reduce air resistance was eliminated throttle valve, truncated tube 16 mm minimum. The result - the rate unchanged, has been calculated feed rate of the piston rod. For the simulation was used valve MFH-3-3 / 4 (thread ¾ ")

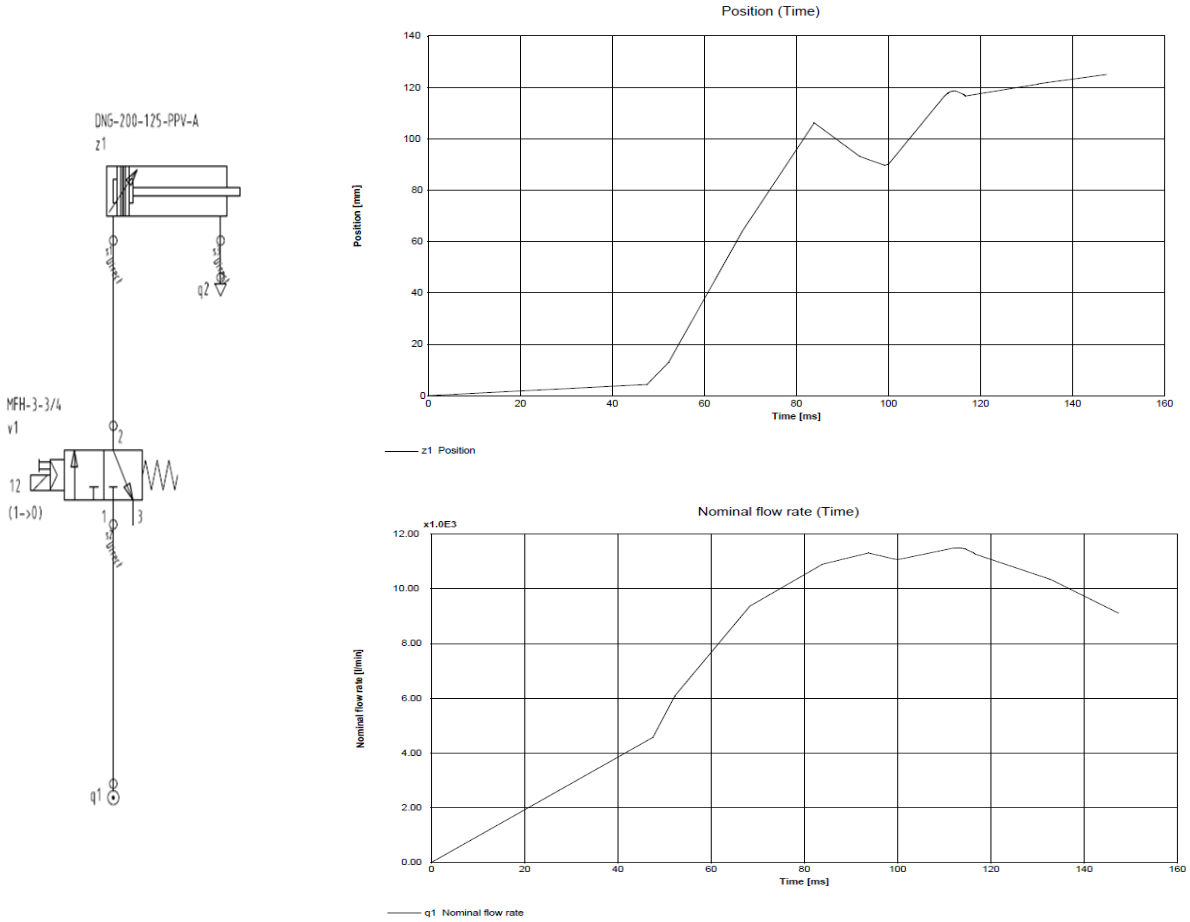


Fig. 4. – Pneumatic scheme without air tank, position of piston, nominal flow rate

VL-5-15 To reach 2 m/s and a stroke of 125 mm will need to get to time moving from one extreme position to the other in 62,5 ms at a constant speed 2 m/s. Unfortunately, even with this valve resulting value (total time crossing) is based on 150 ms.

Simulations are two, without an air tank (see Fig. 4) and without air tank (see Fig. 5). But theresults are the same, the total time is 150 ms. There is still instability, starting at the stroke traveled about 90 mm. The speed is so great that it cannot roll vented and leads to bounce back. The flow rates are enormous, 12 tis nl / min. (Norm liter). NB. Calculation counts load 10 kg.

A calculated 12000 norm liter per minute is the value of the required volume of air (at atmospheric pressure) per minute. The equations (P * V) / T = const. (Pressure 0 absolute value, a pressure of 6 bar - we calculate 7 bar), T - the temperature is neglected because it is still the same. The cylinder is 200 mm diameter, 125 mm stroke, about 4 liters need for filling (6-bar pressure!) 7bar * 4 l = 1 bar * V (standard liters) V = 28 nl

This value is required for the cylinder.

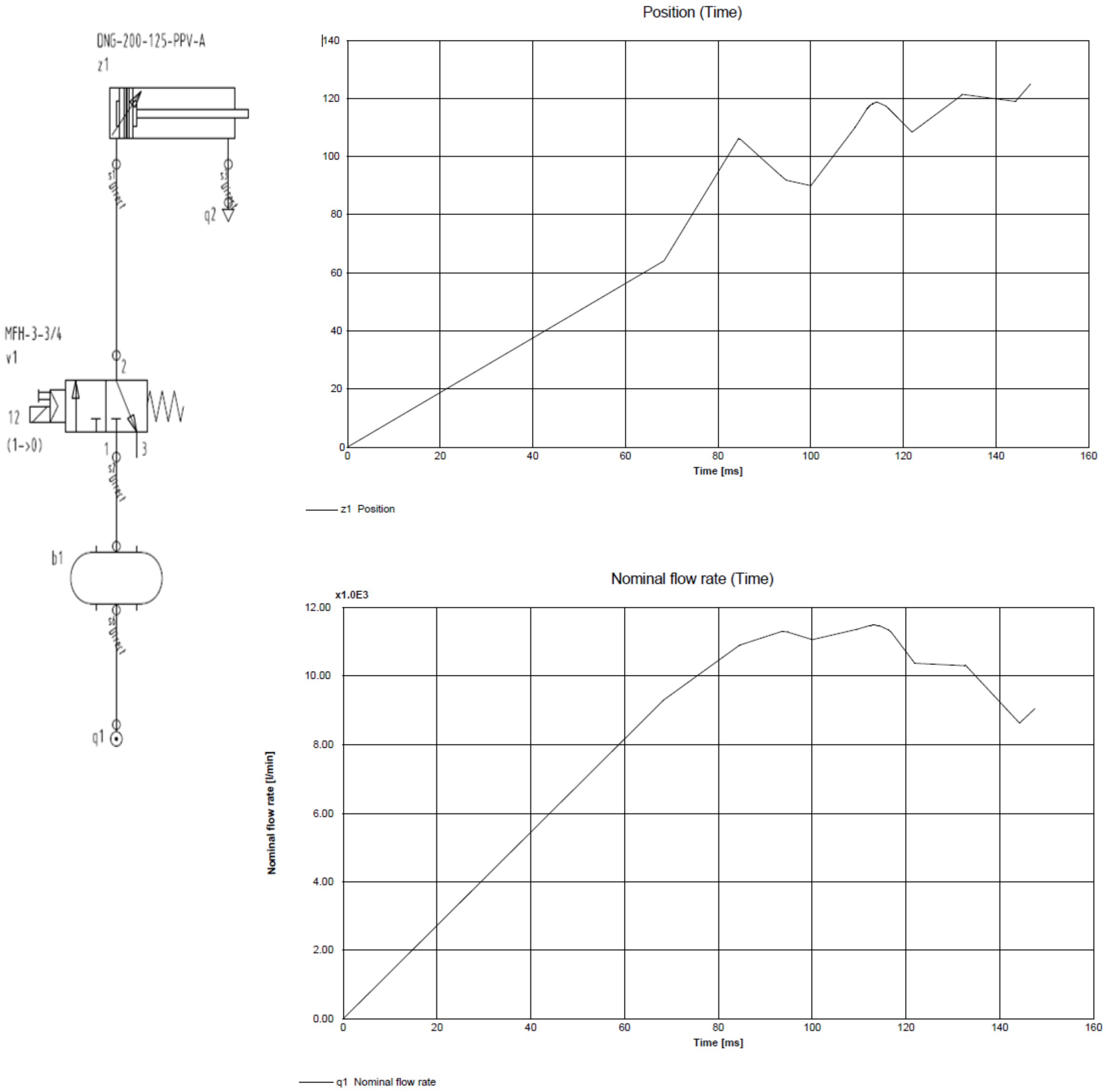


Fig. 5. – Pneumatic scheme with air tank, position of piston, nominal flow rate

Now it depends for what time I need him to fill. The required time, thus 62,5 ms, then the corresponding flow rate:

28 nl / 0.0625 s = 448 nl / s = approx. 26,9 tis nl/min.

As a control I can take the needed time from the graph, i.e. 150 ms. Then it comes out there about 12000 nl / min as a simulation.

Practically, it would be good to use a pressure tank. It should have a greater capacity. We need four liters of pressurized air. From a small pressure vessels would quickly "escaped air" and would dramatically reduce the pressure cylinder would rapidly "fade".

It can conclude that in these conditions it is not possible to achieve the speed of 2 m/s by available pneumatic elements.

Ejection mechanism

Detention brake pressurizing and releasing causes certain effects "air gun" (see Fig. 6 left). Certainly it will be more dynamic than the classic start valve. Bounce-back is prevented, while ensuring adequate exhaust from the second chamber at the price enlarges the hole in the cylinder cover.

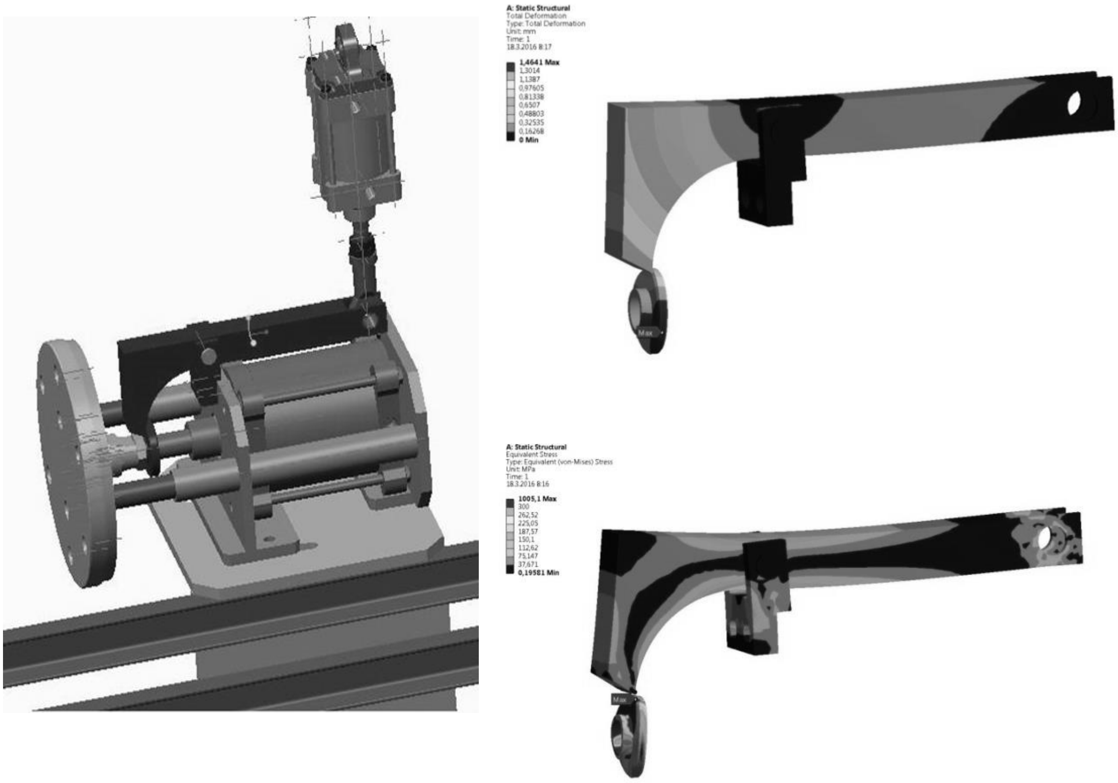


Fig. 6. – 3D model, stress and deformation ejection mechanism

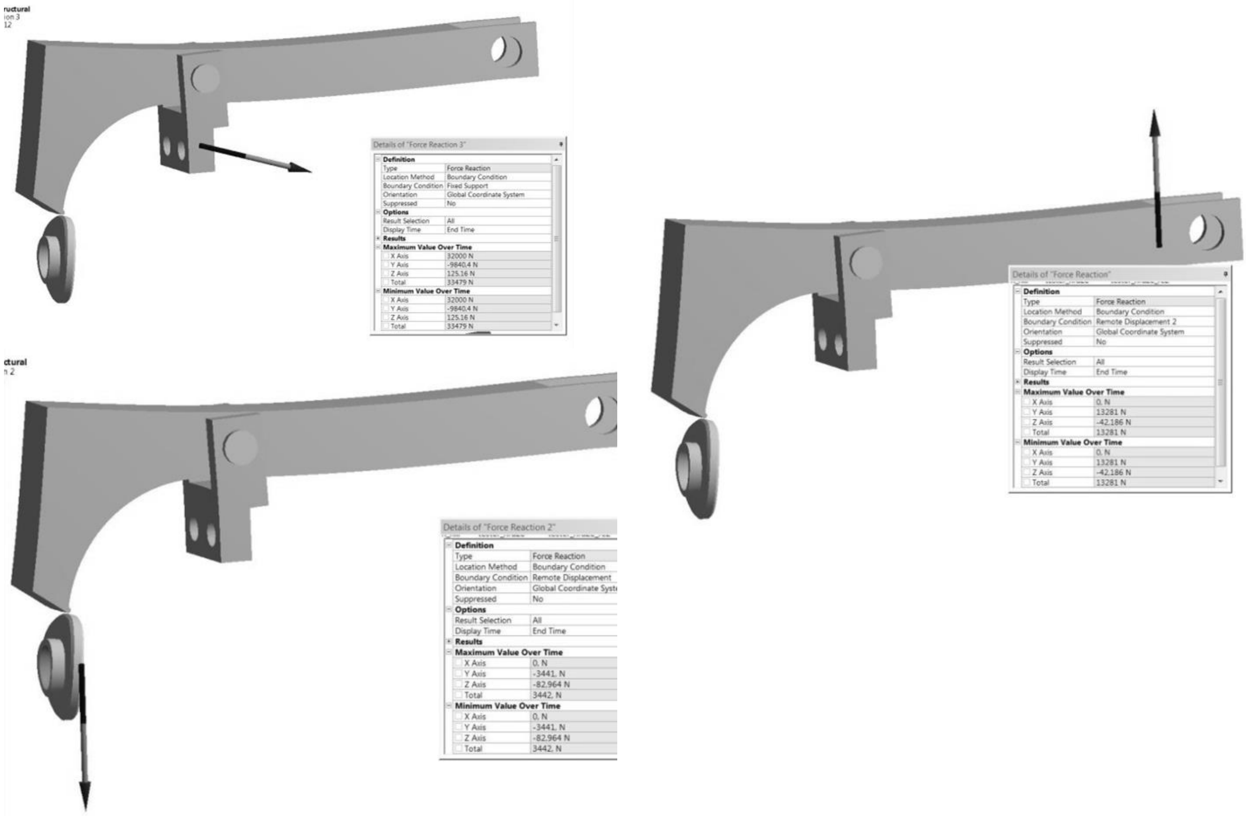


Fig. 7. – Strength for unlocking, power saving in the frame, the contact force between the lever and the ring disarming

The piston rod of the main pneumatic cylinder impactor is attached with special ring. The ring is hooked with armed release lever. At the other end of this lever is unlocking pneumatic cylinder. In the case of pushed back will be shut before the pressurized piston. The aim was to design this mechanism. Calculation of stress and strain (see Fig. 6 left) was made in ANSYS. Deformation of the lever reaches value 1.4 mm, and contact stress of about 1000 MPa. A calculation of the contact forces see. Fig. 7. Forces were derived from FEM analysis.

It was calculated to force unlocking mechanism with a friction coefficient of 0.2. Further reactions in storage and contact force, force vectors refer to Fig. 7.

CONCLUSIONS

Proposal was made of impact testing equipment for stationary and mobile flood barriers. Due to the layout of the channel was designed pneumatic cylinder of diameter 200 mm and a stroke 125. When the pressure is 10 bar the impactor has 3 times more energy than is required in the tests. But impactor does not have required speed. In this contribution was optimized pneumatic schema. The optimization is only three-time increase impact speed. And therefore was designed ejection mechanism. Its properties must be verified in practice yet.

ACKNOWLEDGEMENTS

The results of this project VI20152018005 were obtained with co-funding from the Ministry of the Interior of the Czech republic as part of targeted support from the project "Vývoj proti povodňových systémů pro zvýšení ochrany obyvatelstva a infrastruktury".

REFERENCES

1. FM GLOBAL: Approval Standard for Flood Abatement Equipment, Class Number 2510, FM APPROVALS LLC. 2013: Available at: . [https://www.fmglobal.com/assets/pdf/fmapprovals/2510.pdf].
2. MUTTRAY, M., OUMERACI, H.: Theoretical and experimental study on wave damping inside a rubble mound break water. Coast. Eng. 52 (8), 2005: p. 709–725.
3. D. MALCANGIO, M., TORRESI, G., PASCAZIO AND PETRILLO, A.F.: Numerical Simulations of Water Wave Propagation by Volume of Fluid Approach, 34th IAHR World Congress - Balance and Uncertainty 26 June - 1 July 2011, Brisbane, Australia.

Corresponding author:
Ladislav Ševčík, Technical University in Liberec, Czech Republic, Studentská 2, Liberec 46117