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OVERVIEW OF SELECTED HYDRAULIC DEVICES SUPPORTING ROAD RESCUE OPERATIONS

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Abstract:

The intense human activity determines the continuous development of systems and means of transport, which contributes to the intensification of existing road traffic risks and the emergence of new ones. Reduction in the number of fatalities of road accidents is dependent on investment in transport infrastructure, the development of safety systems for means of transport and the care for the technical condition of vehicles. Furthermore, the human factor is manifested in the growing awareness of hazards and improving skills of vehicle drivers. The article presents the construction, operating principles and technical capabilities of the most commonly used hydraulic rescue tools. All this was presented against the background of selected problems occurring during rescue operations while releasing victims caught in car wrecks.

Keywords:

road traffic safety, rescue operations, hydraulic rescue tools

INTRODUCTION

Systematically growing human activity entails the continuous development of systems and means of transport, which contributes to the emergence and intensification of various existing threats. Poland is a case in point, where in recent years the increase in the number of vehicles has not been supported by sufficient improvement of the exist-

ing road infrastructure. This results in, despite the steady decline in the amount of traffic events, the highest number of fatalities in this branch of transport. Preventing casualties of road accidents depends not only on investments to improve the technical condition of transport means and infrastructure or raising vehicle drivers' awareness and skills, but also on the efficiency of emergency services involved in rescue actions [2-5]. This is essential to meet the objective of the IV EU's Road Safety Action Program, which is to halve the number of road fatalities in the next decade [10].

Rescue operations at the scene of the event require the coordination of many entities statutorily established for this purpose [1]. The effective rapid response ability of emergency services such as [4]: fire brigade, ambulance, police, roadside assistance, etc., in the event of a road accident depends on the use of specialized equipment. This equipment should meet a variety of specific requirements, including reliability, functionality, ergonomics and safety [7]. Therefore, the attention is paid to them during the design process of specialist rescue devices.

The present paper outlines the construction, operating principles and capabilities of the most commonly used hydraulic rescue tools. All this was presented against the background of selected problems encountered during rescue operations in the release of victims trapped in motor vehicles.

1. HYDRAULIC RESCUE TOOLS

Hydraulic rescue tools are the basic equipment used to recover survivors from vehicle wrecks after a collision. This group of rescue devices is used to cut, move and extend the structural components of vehicles in order to release victims of road accidents. In addition, hydraulic tools are used to remove the effects of construction and technological catastrophes, e.g. for cutting steel and concrete elements. Hydraulic tools can be divided into the following types [9]:

- arm spreaders;
- cutters;
- spreading cylinders;
- combi devices (cutter – spreader).

Figure 1 shows the Lukas hydraulic rescue kit.

In accordance with the Regulation [11] all hydraulic rescue tools are subject to authorization processing. From the point of view of the approval process the determination of parameters such as the class of cutting capacity of cutters, the force of compression and expansion for arm spreaders and the expansion force and stroke of the piston rods for spreading cylinders are relevant [7]. In addition, a durability test consisting of a cyclic 150 times opening and closing of the tool at the 80% nominal load on the test bench is performed in order to determine the strength of the tool. The test is considered positive if, after its completion, the device is functioning properly in the absence of any leaks or leakage [11].

The arm tips of hydraulic tools are tooth-shaped and then they are wear-resistant and prevent the tool from slipping during operation. Equipment of this type incorporates

modern materials and surface-improving technologies to reduce the weight of such tools by about 20-25 kg, thus making them more comfortable to use and rescuers become less tired during rescue operations. These aspects are extremely important in life saving situations, where every second counts. Figure 2 shows the CORE SP 3260+ arm spreader with a description of the main components.

Fig. 1. Exemplary hydraulic rescue kit manufactured by the Lukas company

Source: [13]

The operating principle for hydraulic tools is based on the use of hydraulic units with working fluid pressures of from 630 to 720 bars [8]. Such pressure values are needed to obtain high pressing forces ranging from several to several tens of tons. Figure 3 shows the use of a hydraulic spreader during rescue operations.

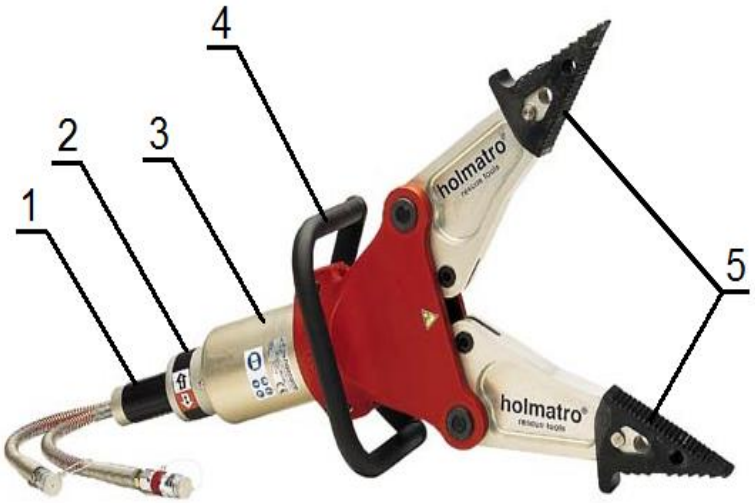

Fig. 2. Basic hydraulic tools on the example of CORE SP 3260+ arm spreader, 1- arm spreader handle with connector, 2 -3 - cylinder of hydraulic servomotor, 4 – hand-grip, 5 - spreading and compressing arms

Source: Own study

Fig. 3. Example of using a hydraulic spreader during rescue operations

Source: [6]

The most commonly used spreaders are mid-range ones operating under the working load of up to 5 tons on the tips of the arm's ends, i.e. in the area of the least force acting on the spreader. Arm spreaders have their own – specified by manufacturers - characteristic, which is measured for several points of application in relation to the opening of the spreader arms [9]. It is important to have a suitable point of application of the tool when performing rescue operations. If its optimum position is maintained and the working load is 8 ÷ 10 tons, the cut element should not be an obstacle, however, the tools sometimes get damaged.

Nowadays, rescuers increasingly have more than one set of such devices.

Another rescue device are hydraulic cutters. They are shown as examples in Figures 4 and 5.

Fig. 4. Example of using a hydraulic cutter to cut a B door pillar in a vehicle

Source: [15]

Fig. 5. Example of using a hydraulic cutter to cut an A door pillar in a vehicle

Source: [6]

They are used in situations where cutting of the vehicle's supporting structure (e.g. pillars, a roof, etc.) is required in order to reach victims as quickly as possible and release them, for example, with a rescue board. The construction of hydraulic cutters is very close to the construction of arm spreaders. The basic elements include: a handle with hose coupler, a control mechanism, a cylinder of hydraulic servomotor, a handgrip and cutter blades. Due to the fact that modern vehicles are made from very different construction materials: steel of varying strength, aluminum alloys and composites, rescuers must be equipped appropriately. To this end, the manufacturers of hydraulic devices use replaceable blade cores made from special metal alloys to cut the strengthened bodywork and hardened parts. Cores are also characterized by extended life span, which makes the blades wear out much slower and retain their high performance at all times [6].

The cutter- spreader is a combination of two rescue devices that work well where priority is given to saving space and weight of rescue equipment. They are employed by units that perform lighter rescue tasks, or as a supplement to heavy rescue kits. The cutter- spreader drive is usually a compact hydraulic unit designed to supply a single tool [6].

Another group of devices are columnar spreading cylinders that are used to widen and stabilize the door surface of a vehicle and dents in the load-bearing structure. Spreading cylinders can be divided into:

- those with one-sided pull-out pistons;
- those with double-sided pull-out pistons;
- telescopic ones.

Available solutions regarding cylinders have a rated carrying capacity of over 10 tons. In the case of two-stage cylinders their carrying capacity is up to 20 tons. Telescopic spreaders are characterized by the most favorable weight ratio in relation to the spreading force and length, and therefore rescuers often choose them. Spreading cyl-

inders often have additional equipment consisting of replaceable working tips mounted to the base and at the end of the retracted piston rod [12]. The use of tips allows these devices to extend the range and capabilities of the spreading cylinders during rescue operations. Figure 6 presents the exemplary tips of the spreading cylinder assembly.

Fig. 6. Exemplary shapes of working tips of spreading cylinders

Source: [12]

Figure 7 shows the example of the use of a flat bracket in co-operation with a spreading cylinder with a one-sided pull-out piston.

Fig. 7. Example of using a spreading cylinder with one-sided pull-out piston

Source: [14]

Hydraulic power units and pumps are used to supply hydraulic equipment. Two types of aggregates can be distinguished: powering one tool and powering several hydraulic tools. The first one is a small compact unit designed for the operation with a single hydraulic unit. The second solution is designed for two or more hydraulic units supplied from one pump-unit, such as a spreader and a cutter or a spreading cylinder during rescue operations. It must have the performance required to power several hydraulic devices connected at the same time. The working pressure of such power units

is up to 720 bars. Units can be powered by the 230V electric motor with power up to 2 kW or the spark-ignition or compression-ignition combustion engine of 1 to 4 kW. Hydraulic generators may have additional devices such as cable reels. Winding devices are very useful since the standard length of hydraulic hose lines is 20 meters.

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CONCLUSIONS

Undesired events such as traffic accidents constantly occur in vehicle transport. This is a problem that cannot be completely eliminated either in Poland or in the so-called 'Old Union'. Therefore, specialist rescue services play a very important role in the protection of human life. In order to make the rescue operations proceed smoothly, these services must be equipped with appropriate hydraulic devices and trained for various variants of their use. On the basis of the review of such devices made in the present paper, it should be noted that the units of the State Fire Brigade have access to the state-of-the-art rescue equipment of leading manufacturers.

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