Trailers for the transport of dangerous goods carried out within the project TIRAMISU

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Abstract

The issue of the first part of work will be transport and storage of hazardous materials of various nature, including mines, unexploded ordnance, IEDs, ammunition and explosives. The proposed work will describe the issues related to hardware problems and the latest proposals of technical solutions related to the storage and transport of munitions. In the section on structural solutions will present information and ideas proposed recent work related to the project TIRAMISU: trailer for temporary storage and transport of explosives and munitions. In the second part of work will cover both the destruction (by trawling) hazardous materials. Paper will present information and ideas proposed recent work related to the project TIRAMISU: modular demining machine, working by pressure, connected to a remote-controlled mobile support platform - for example: tractor of PIERRE.

1. Trailer for temporary storage and transport of explosives and munitions

Currently, many kinds of explosion-containment vessels are manufactured worldwide. The weight of the explosives they can contain varies from several hundred grams to a few dozen kilograms. All these containers are mounted onto a dollies, platforms or transport trailers. Such containers are to provide protection to the persons transporting the explosive and also to those in the vicinity of the transport vehicle, should such unexpected (accidental) detonation take place. This means that the container should preclude the mine/ERW fragments, resulting from the explosion and destruction of e.g. the anti-personnel mine casing, from spreading and also properly direct the release of detonation by-product in the form of hot blast gasses. Most of the analyzed vessel constructions are characterized by unfavourable ratio of their mass to the mass of the explosive transported. In many cases the containers are relatively heavy, and the blast energy absorbing material in not very effective. Often complicated lid opening and closing mechanisms are employed, in spite of the fact that some regulations (including those in Poland) specify that the vessel no longer be used after it had contained one explosion

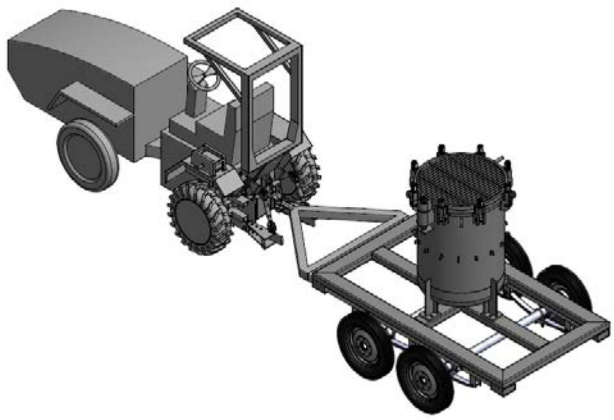

Fig.1. Trailer for temporary storage and transport of explosives and munitions – second version

This is due to the fact that a slightly damaged structure of the container (following a single explosion) may not withstand another explosion and the elaborate container constructions, especially lid lifting and lowering mechanisms (often using hydraulics) lead to unnecessary increased production costs. Furthermore, it is assumed that the structure of the vessel should direct the blast gas vertically through properly designed channels, valves and the like. This is a fully legitimate guideline, however in several types of containers the gasses are discharged horizontally, through the side walls of the vessel, and it is extremely dangerous for the persons transporting the explosive, in particular when they are to travel through urban terrain (in cities and villages)

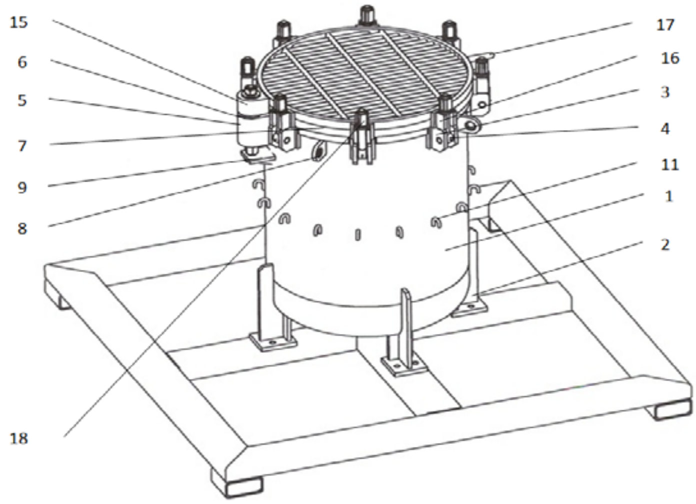

Fig.2. Blast containment vessel for temporary storage and transport of ERW (explosive remnants of war) produced by WITI

a) b)

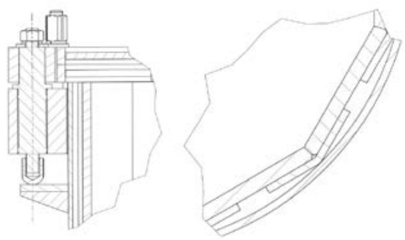

Fig.3. Blast containment vessel actuators produced by WITI:
a – safety grip, b – cross wall of the container

1 – body; 2 – supports; 3 – clamps; 4 – eye bolts; 5 – lower casing; 6 – rotation axis; 7 – lid; 8 – transport lugs; 9 – support; 10 – bolt; 11 – hooks; 15 – upper casing; 16 – supports; 17 – handle; 18 – nut.

The body (1) of the container is a cylinder with supports (2) attached to its lower casing. The supports mount the vessel onto the transport trailer. The upper part of the body includes: clams (3) with eye bolts (4) being seated in them; lower casing (5); rotational axis (6), lids (7) and transport lugs (8). Under the lower casing (5), a support (9) is mounted upon which the (6) screw of the rotational axis (10) of the lid (7) is leaning – Fig. 2. The central part of vessels' body (1) is equipped with hooks (11) for the protective cover line. The lid (7) of the vessel comprises two rings – the lower one (12) and the upper one (13) with bars (14) placed in an alternating manner. Upper casing (15), rotational axis (6), supports (16) and a handle (17) Are attached to the cover (7). The cover (7) is held down to the body (1) with the aid of eye bolts (4) and nuts (18). Inside the vessel's body (1) (Figs. 2 and 3) there are elements which absorb blast energy: wooden boards (19) are located on the circumference of the vessel and they are conjoined with a rubber tapes (20), while a wooden floor (21) can be found in the lower region of the vessel, supporting rubber lining (22). In the mid region there is an insert (23) made of expanded polystyrene with a cavity (24) inside. This cavity is sealed with an inner lid (25) made of rubber. It is in this cavity (24) that the explosive items (26) can be stored in.

Should an unforeseen explosion occur, the blast containment vessel should preclude:

- the blast fragments from spreading directly in horizontal plane;
- 0.1 atm blast wave from propagating further then 6.5m away from the vessel.

The above assumptions will be test during a field test. 11 directional explosive charges will be prepared for the test. The number of steel bearing balls with diameter of 6 mm will amount to 2500. There will also be an explosive charge in a casing made of steal . Overall, the explosive charges combined will weigh 1.0kg.

A vital parameter to be considered when analysing the impact of pressure impulse of the hull underside is the maximal pressure value at the wavefront.

$$\Delta P_2 = \varphi_{(k)} \cdot E/L_3$$

where:

ΔP2 – maximal positive pressure at the blast wave front;
R – distance between the explosive and the walls of the containment vessel,
E – average explosion energy per unit of mass of an explosive;
k – vapour/gas isentropic exponent in the area affected by the blast wave;
φ(k) = 0.1038 – for strong explosion in the air.

The model of blast-containment vessel used for the calculations is presented in Fig. 4.

Data for the calculation:

a) mass of an explosive M = 1.0 kg TNT;

b) average energy released with TNT explosion E = 4.2 • 106 J/kg.

c) L_1 = 0.4 m;

d) L_2 = 0.55 m;

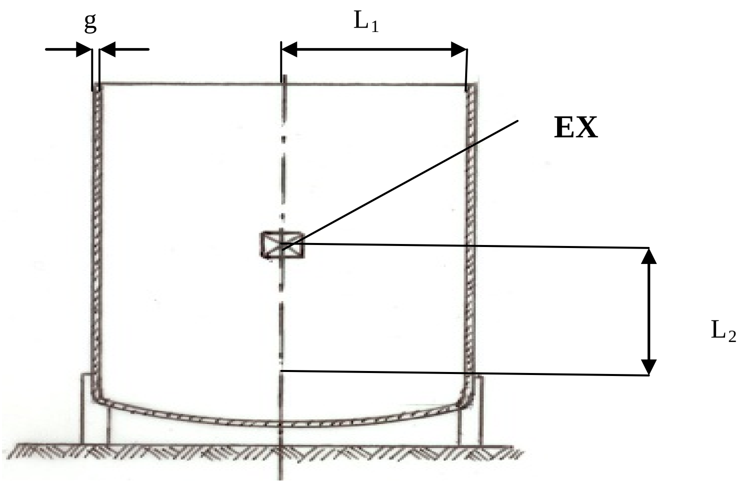

Fig.4 Schematic of a containment vessel assumed for strength calculations.

impact of positive pressure on the bottom of the vessel ΔP_2 = 2619952 N/m^2;

time of positive pressure impact on the bottom of the vessel t_1 = 0.00075 s.

impact of positive pressure on the side surface of the vessel ΔP_2 = 6811875 N/m^2;

time of positive pressure impact on the side surface of the vessel t_1 = 0.00063 s.

The body of the vessel was manufactured out of high strength alloy steel sheet (steel grade 18G2A) whose thickness equaled g = 10mm and for this steel:

tensile strength R_m (R_r) = 520÷640 MPa;

admissible tensile stress k_r = 260 ÷ 320 MPa

where factor of safety x = 2.

circumferential stress of the explosion containment vessel body $\sigma_{1\ max}$= 295.4 MPa

What can be seen here is that when $\sigma_{1\ max}$ and k_r are compared, it is visible that $\sigma_{1\ max}$ value lies between the upper and lower limits of k_r . This means that it is slightly higher than the lower limit of k_r, and lower than its upper limit.

In reality circumferential stress $\sigma_{1\ max}$ should be slightly lower than the ones calculated due to partial dissipation of the explosion energy by structural elements inside the vessels' body (wood, rubber, expanded polystyrene), inertia of the body (side surface) of the vessel and short time t_1 of the impact of positive pressure on the bottom of the vessel $\Delta P_{2.}$

2. The modular demining machine

The Project is aimed at developing a state-of-the-art demining machine based on a roller principle, continuing the Polish national program, called SHIBA. The modular mine roller, will be connected to a remote-controlled mobile support platform, for example: tractor by PIERRE trattori.
Width of the device will be correlated with the dimensions of the vehicle.

The modular demining machine – Fig. 5, 6 – contains:

- protection kit (1, 2);
- mounting arrangement for vehicle (3);
- boom (4, 5);
- working tool (6).

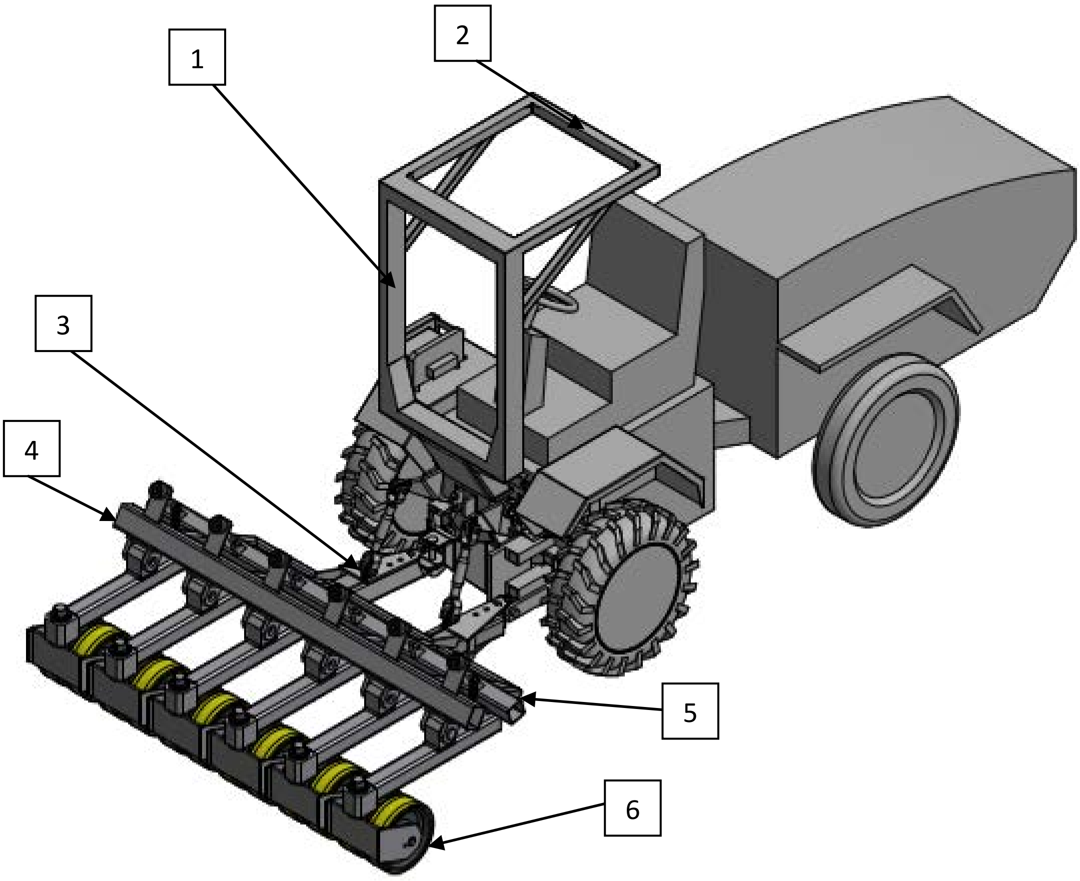

Fig.5. Light modular demining machine (mine roller) attached to a tractor – in working position

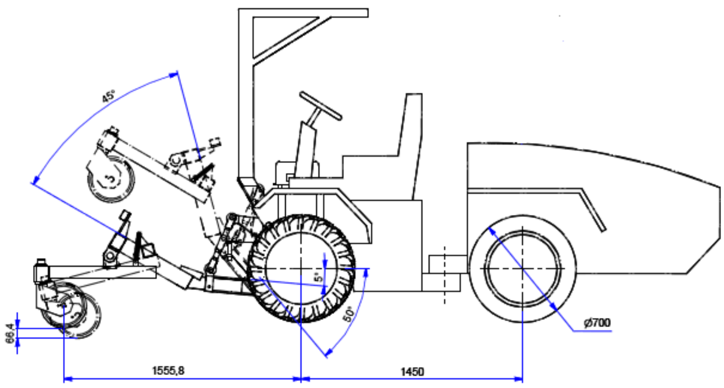

Fig.6. Diagram of a light modular demining machine with a tractor

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