**ISSN**: 1231-4005
**e-ISSN:** 2354-0133
**DOI:** 10.5604/12314005.1138639

# EXPERIMENTAL INVESTIGATION OF IED INTERROGATION ARM DURING NORMAL OPERATION

**Wiesław Barnat**

**Paweł Gotowicki**

**Andrzej Kiczko**

**Paweł Dybcio**

*Military University of Technology*
*Department of Mechanics and Applied Computer Science*
*Gen. Sylwestra Kaliskiego Street 2, 00-908 Warsaw, Poland*
*tel.: +48 22 6837201, +48 22 6839941, +48 22 6837221, fax: +48 22 6839355*
*e-mail: wbarnat@wat.edu.pl, pgotowicki@wat.edu.pl, akiczko@wat.edu.pl, pdybcio@wat.edu.pl*

**Marcin Szczepaniak**

**Wiesław Jasiński**

*Military Institute of Engineer Technology*
*Obornicka Street 136, 50-961 Wrocław, Poland*
*tel.: +48 71 3474440, fax +48 71 3474404*
*e-mail: szczepaniak@witi.wroc.pl, jasinski@witi.wroc.pl*

***Abstract***

*The paper presents experimental static tests of IED interrogation arm for Shiba special vehicle. The test was performed by Military University of Technology and Military Institute of Engineer Technology. A number of strain gauges and camera markers were placed on the arm to allow recording strains and movements of specific construction points. The arm's motion was recorded using high speed camera. The equipment used were Vishay EA 06 120LZ 120 strain gauges with ESAM Traveller bridge. The sampling rate was 1000 Hz. The test was to pick up maximum design weight, move it to maximum overhang and then drop it on the ground. During the test, signal from gauges and video capture was recorded. The data was then processed using Thema 3D software to obtain markers displacements and angular changes of both arm parts. Afterwards, the test was repeated for different weight. The analysis showed, that maximum stresses in examined construction parts did not exceed yield stress of material. As well as that, in-depth motion analysis of the arm was conducted. Further works are twofold. Firstly, there will be tests concerning arm under dynamic load occurring during normal maintenance During this test only strains in specific construction parts will be recorded. Secondly, numerical model of an arm will be developed and validated using data obtained during both tests. This will help visualize stress distribution in each arm's part.*

***Keywords:*** *IED, improvised explosive device, interrogation arm*

## 1. Introduction

Modern warefare and peacekeeping missions served by Polish Army troops shown great need to design and develop, currently unused, types of armament. Such equipment is vehicle with IED interrogation arm. Improvised Explosive Devices are the most deadly threats. The paper presents part of broader work on prototype of Shiba special vehicle with interrogation arm to neutralise IED threats. Experimental research was proceeded by a number of design and construction analyzes.

Such investigations were carried out using modern CAD/CAM/CAE software such as MSC Patran and LS-DYNA software with explicit and implicit solvers. Presented cases of study depict selected loads during normal operation on the battlefield.

## 2. Aim of the research

The aim of presented research were experimental measurements of strains in selected construction parts of IED (Improvised Explosive Device) interrogation arm of Shiba special vehicle during normal operations. For the purpose of the research electroresistance method is used. The equipment consisted of Vishay EA-06-060LZ-120 linear strain gauges with ESAM Traveller CF Signal Conditioner Amplifier System with CF-Card data Storage – presented in Fig. 1.

Linear strain gauges were positioned in order to measure strains normal to the profile axis. As a result, strain versus time plots were obtained. Sampling rate used was 50 Hz. Fig. 2 shows examined arm with specific dimensions measured with 1 mm precision and angles definitions. Fig. 3 presents test points and their placement at the construction.

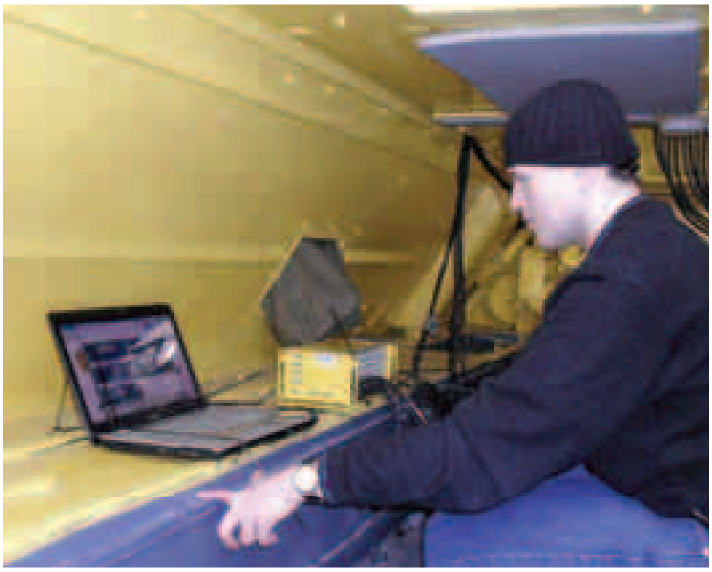


*Fig. 1. Apparatus mounted inside the vehicle*

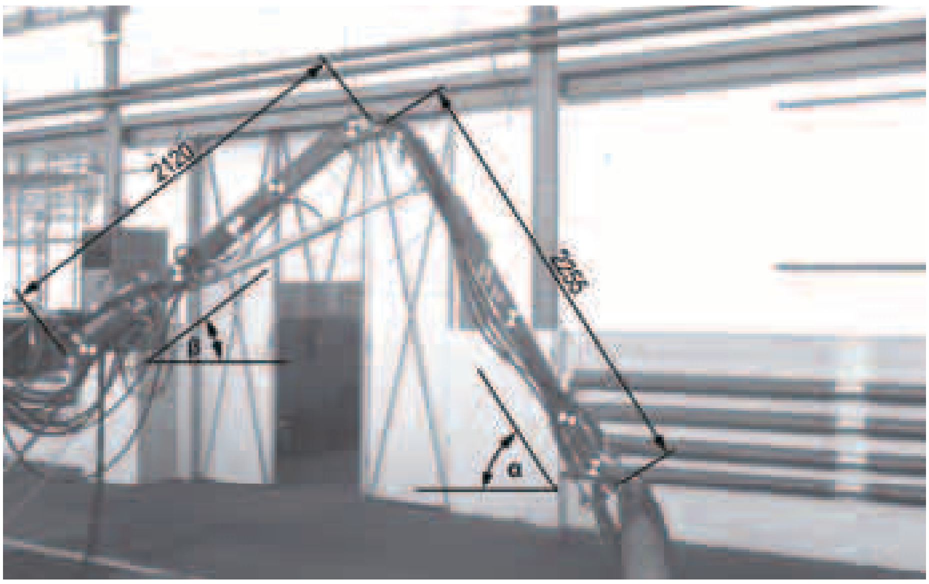



*Fig. 2. Interrogation arm with specific dimensions and angle definitions*

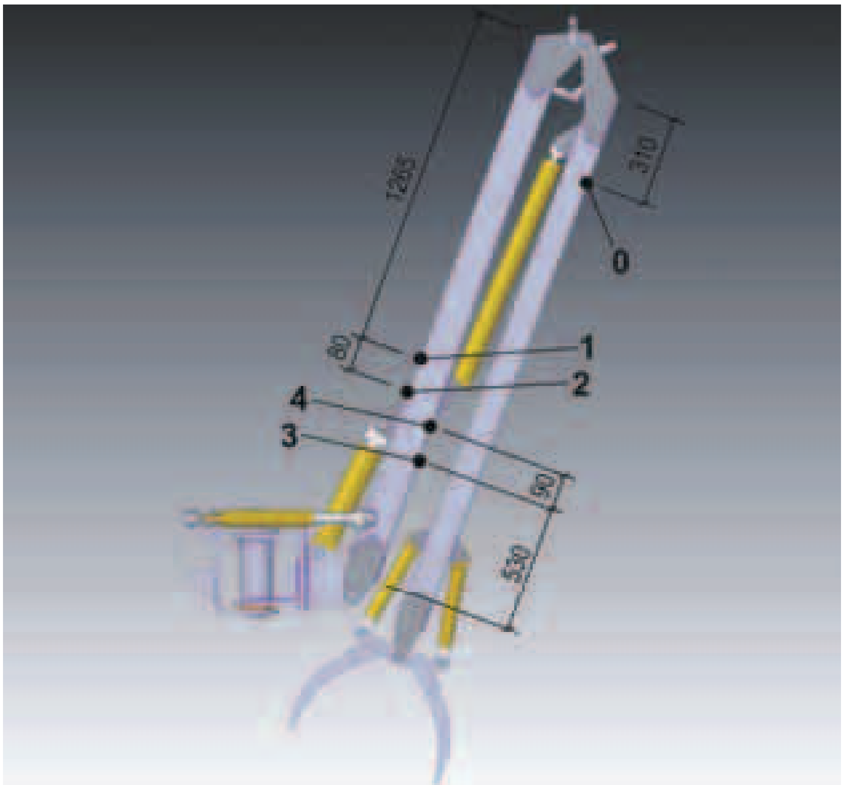



*Fig. 3. Strain gauges placement*

## 2. Experimental tests

The programme included measurements of specific construction points of IED interrogation arm during normal operation – picking up and putting down test load. The load was a 2700 mm long pipe with diameter of 220 mm and 10 mm wall thickness. The weight was taken at the middle.

Interrogation arm for IED threats was mounted on mobile test stand. To manipulate the arm special hydraulic control system produced by Parker also mounted inside the vehicle (Fig. 4).

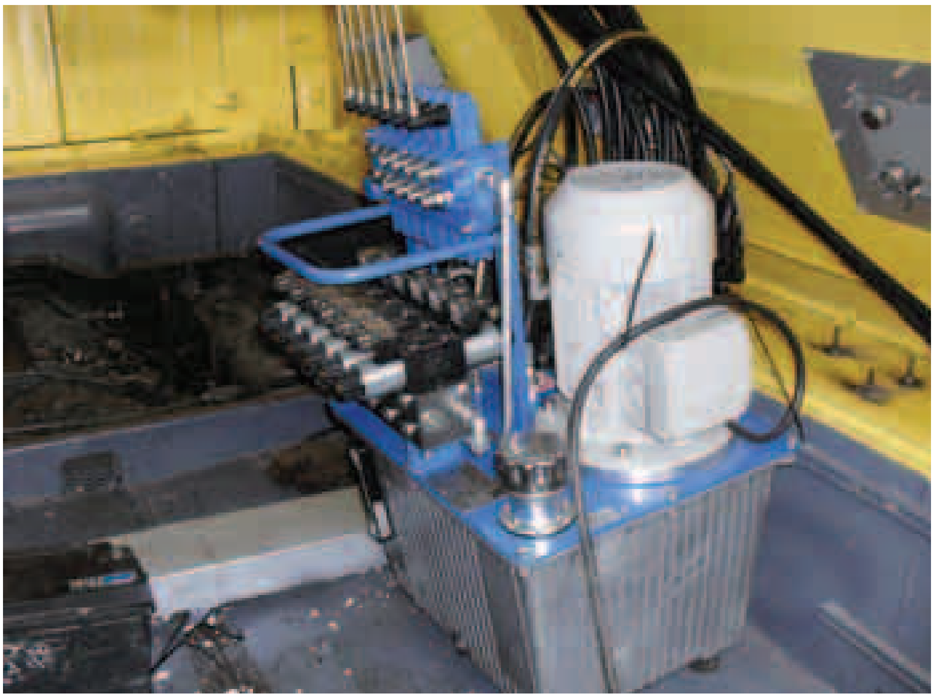
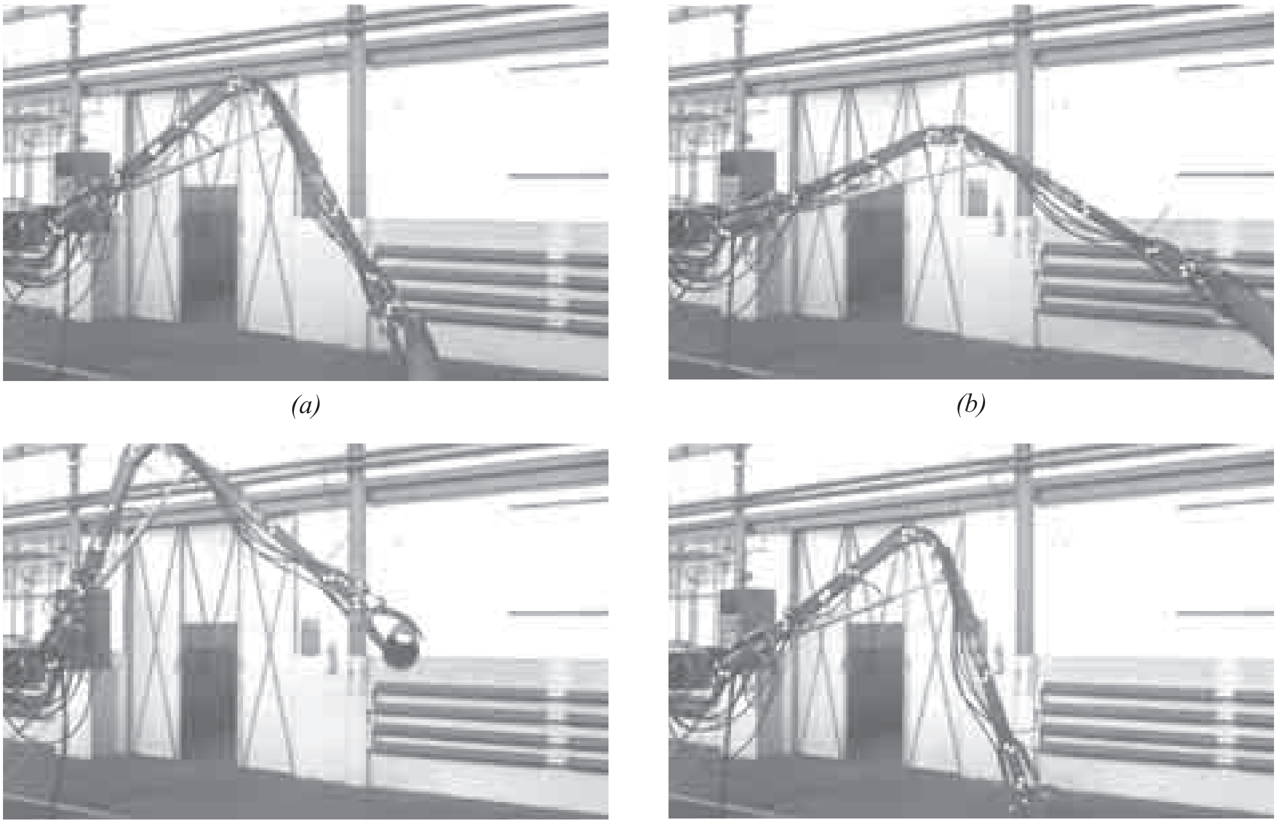


*Fig. 4. Hydraulic pump mounted inside the vehicle*

## 3. Summary

Presented results are a part of work done in Department of Mechanics and Applied Computer Science concerning mine resistance and IED threats. Use of electroeresistance method of measurements of strains will be used to verify and validate numerical models of interrogation arm. Authors know that experimental results can be different than those obtained from numerical simulations. In further papers the experimental results will be compared with numerical simulation. The interrogation arm will be used by troops on the battlefield to neutralize IED threats.

Measurement equipment was balanced when the interrogation arm was placed on the ground. On plots, strains were in microstrains (10-6 m/m) versus time. Using TEMA software specific markers placed on the construction were followed and therefore angles of each arm parts to the horizontal level versus time were obtained: $\alpha$ – arm 2, $\beta$ – arm 1. Fig. 5 shows both arms for different time moments.



*(a)* *(b)* *(c)* *(d)*

*Fig. 5. Arm positions for time: 31 s (a), 42 s (b), 56 s (c), 104 s (d)*

Figure 6 shows strain plots vs. time for 5 test points. Fig. 7 presents angles between arms and horizontal level.

## References


[1] Ochelski, S., Gotowicki, P., *Experimental Assessment of Energy Absorption Capability of Carbon-Epoxy and Glass-Epoxy Composites*, Composite Structures, Vol. 87, No. 3, pp. 215-224, 2008.

[2] Ochelski, S., *Metody doświadczalne mechaniki kompozytów konstrukcyjnych*, WNT, Warszawa 2004.

[3] Boczkowska, A., et al., *Composites* [*Kompozyty*], Warsaw University of Technology Press, Warsaw 2000.

[4] Miracle, D. B, Donaldson, S. L., *ASM Handbook, Vol. 21, Composites*, ASM International, 2001.
[5] Śleziona, J., *Podstawy technologii kompozytów*, Wyd. Politechniki Śląskiej, Gliwice 1998.
[6] Wilczyński, A. P., *Polimerowe kompozyty włókniste*, WNT, Warszawa 1996.

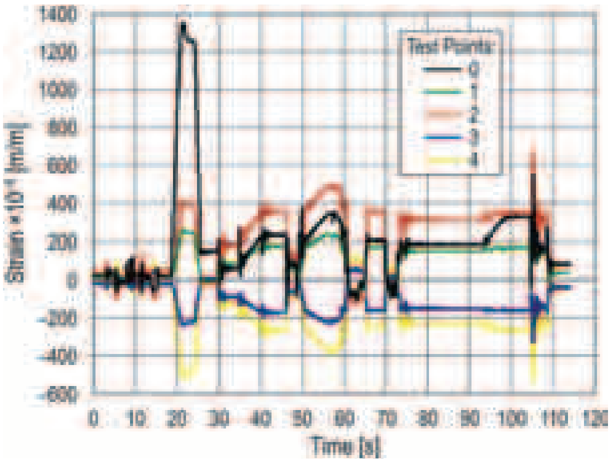



*Fig. 6. Plots of the ε–t for test points 0–4*

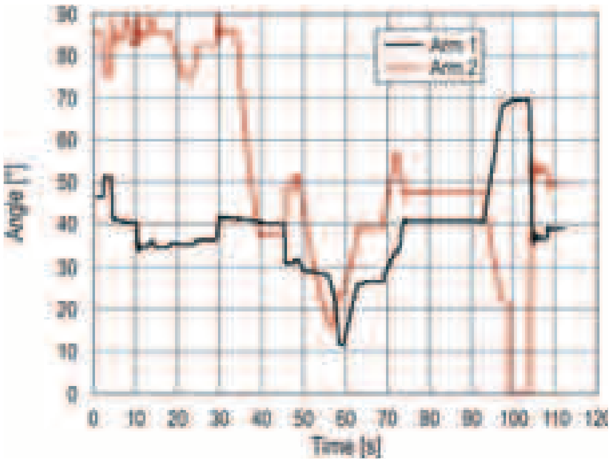



*Fig. 7. Arm 1 and 2 angle to the vertical level versus time*