BALLISTIC PENDULUM FOR BLAST WAVE IMPULSE MEASUREMENT - ANALYSIS AND OPTIMIZATION

B. Reck[1], M.O. Sturtzer[1], R. Allen[2], D. Eckenfels[1]

[1]*ISL, French-German Research Institute of Saint Louis,*
5 rue du General Cassagnou, BP 70034, F-68301 SAINT LOUIS CECEX, France
[2]*MoD, Porton Down,*
Building 17t, Porton Down, SALISBURY, Wiltshire, SP4 0JQ, United Kingdom

ABSTRACT

The pendulum presented in this study has been designed to withstand the effects of explosive charges up to 2 kg of TNT at a minimum distance of 50 cm. It consists of a square load impact area and two vertically hanging I-beam arms that are attached to an axle. An angle gauge is positioned on the axle to record the pendulum rotation.
In this paper we focus on the dynamic blast load and its effect on the pendulum structure. This effect depends on both the nature of the blast wave and on the pendulum geometry. Thus, the specific impulse obtained from the pendulum movement is significantly different from the specific impulse which is calculated by the time integration of the pressure of an undisturbed blast wave.
The basic formulas for the determination of the impulse of this pendulum concept are developed and used to evaluate the current design. They allow guidelines for the optimization of the pendulum to be established. Some of the main issues are:

- the blast load on the pendulum arms should be taken into account, depending on the geometry of the pendulum arms and on the position of the explosive charge;
- the heavy rotating steel axle weighs over 50% of the total mass, but its rotational inertia can be neglected;
- the distance between the load impact area and the rotating axis can be optimized in order to increase lifetime of the bearings in the axle.

The study is supported by numerical simulation. A 3D-simulation model was created with the dynamic nonlinear software AUTODYN and validated by a test series using spherical 1-kg TNT charges. The results obtained from the numerical simulation are in good agreement with the experimental data.