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SHAPED CHARGE PENETRATION IN ALUMINA TARGETS

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Summary—Laminated targets consisting of steel/ceramic/steel layers have a high level of protection against shaped charge penetration. However, using very thick ceramic layers the targets loose their protective capability. This implies that different physical effects run contrary enhancing or weakening the shaped charge performance. Possible mechanisms causing this penetration behavior are investigated and discussed. The knowledge of effective protection mechanisms enables one to better design ceramic layers in heavy targets against shaped charge threat.

INTRODUCTION

That ceramics have a high ballistic resistance against KE projectiles is well known. Therefore, ceramics are frequently applied in light armors. Their most important intrinsic material properties are very likely to be the hardness, compressive strength, and crack behavior. However, little is known about the ballistic resistance of targets against shaped-charge jet penetration, if they contain a ceramic component. The use of ceramics would offer the option of reducing the mass of a conventional steel target to two-thirds of the overall mass and still maintain the same protection against a given shaped charge jet impact, provided the penetration of the jet follows hydrodynamic laws [1,2]. Of course, in actual heavy target constructions, steel can be only partially replaced by ceramic material. Hence, the achievable target mass reduction will be less than one third of the overall mass, and the important question arises whether ceramics offer an effective option for heavy targets. Adequate experiments are required to determine possible mass reduction and answer the open question.

This paper describes experiments that were carried out to deal with the above problems and unravel penetration mechanisms in laminated steel/ceramic/steel targets. The difficulty encountered in the experiments was the problem to single out the various effects that might be responsible for these mechanisms, because experimental penetration data usually represent an integral reaction to all the effects. Further, there are only a few experimental techniques available that are capable of measuring time-resolved data which help to elucidate local penetration effects. In order to quantify the influence of a single effect on the penetration behavior of shaped charge jets several assumptions have further to be made.

EXPERIMENTAL

The alumina ceramic material used in the investigated laminated targets had a density of 3.5 g/cm^3. The ceramic consisted of 92 % alumina, 6 % S_iO_2, 1 % M_gO, and 1 % other phases. In the laminated target, a steel plate of 20 mm thickness was positioned in front of the ceramic layer absorbing the non-steady phase at the beginning of penetration. Behind the ceramic layer a number of steel plates, each 50 mm thick, sufficed to consume the entire jet. The ceramic layer con-