Modeling of a Fragmented Composite for Shielding Applications

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***Abstract*—The paper deals with the numerical modeling of a fragmented composite applied to a low-frequency shielding application. The considered composite is made of a steel layer placed between two aluminum layers, and is obtained by cold roll bonding. A first numerical homogenization process is proposed to obtain a homogeneous material with effective properties. As this material has still to be discretized with a fine mesh to be considered in the numerical model, a second step based on the AMSL approach is then used to work with a one-layer mesh for the composite screen.**

***Index Terms*— Cold Roll Bonding, Finite Element Method, Homogenization, Shielding Effectiveness.**

I. Introduction

Composite materials are nowadays an interesting solution for shielding applications. In this paper, a composite trilayer made of Al/Steel/Al is considered. Previous studies have shown that an interesting trade-off between shielding effectiveness and Al/Steel interfaces adherence can be obtained when the steel layer presents a small quantity of fragmentations, with the welding of the 2 Al layers [1]. Nevertheless, the simulation of shielding applications with the consideration of such heterogeneous material requires huge computation resources. Artificial Material Single-Layer (AMSL) approach gives the possibility to work with a one-layer mesh for a multilayer barrier [2], but the layers have to be plane, and with isotropic material properties, conditions that are not present for the considered trilayer.

II. Modeling approach and results

The composite is obtained by cold roll bonding, as shown in Fig.1.

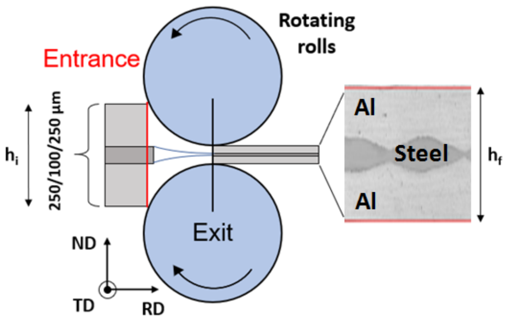

Fig. 1. Cold roll bonding of Al/Steel/Al composite

Due to the fragmented non-plane steel layer, here with a 4% rate, the AMSL method cannot be directly used to get the global material properties. As a first step, a numerical homogenization is then added, see Fig. 2. For this homogenization, a representative part of the steel layer obtained experimentally after the rolling process, including the fragmentations, has been scanned and integrated into finite element simulations with the "actual" material.

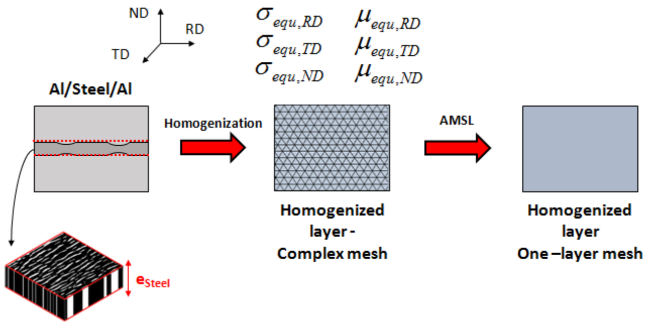

Fig. 2. Modeling approach

Magnetostatic and electrostatic simulations have then been performed with imposed boundary conditions, so as to get the effective material properties of the equivalent layer from energy equivalence. Due to the initial trilayer structure, the obtained fictive material presents anisotropic properties. In order to apply the AMSL approach, only the influential material parameter is retained, i.e. RD component of the conductivity and permeability, leading to a new isotropic fictive material. Considering this last fictive material, Table I gives some results of simulated shielding effectiveness (2D axi FEM model, shielding barrier with one-layer mesh AMSL2), compared to the ones obtained with a 6-layer mesh with the first anisotropic fictive material and with our experimental approach, showing good agreement.

Table I
Result comparison for shielding effectiveness (dB)

	10 Hz	1 kHz	5 kHz	10 kHz
Experimental	2.2	2.3	3.4	5.7
6-layer mesh & anisotropic	2.18	2.28	4.24	7.70
1-layer mesh & isotropic	2.08	2.19	4.18	7.67

References

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