NEW BLAST RESISTANT COMPOSITE/METALLIC ARMOURING SOLUTIONS FOR VEHICLES

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Abstract:
Armored land transport vehicles are primarily protected against blast threats by reinforced metal structures. However, these solutions reduce the payload of the vehicle and for some lighter vehicles they cannot be used due to low payload. To overcome this weight problem, the use of composite materials as additional armor for the vehicle can be an innovative and lightweight solution. To date, different configurations have been subjected to the blast effect and analyzed to understand their dynamic behavior. The first fibrous reinforcements used, based on stacked layers of E-glass fabric, were able to withstand dynamic blast loads. However, these reinforcements tend to have the same performance as the all-steel solution for the same areal weight [1]. Therefore, an investigation has been carried out to introduce 3D woven fiber reinforcements based on E-glass yarn and use them in composite materials for better dynamic performance under blast effect.

Several authors have highlighted their various advantages as soft and hard protection solutions [2]. As pointed out by Tong et al. [3], it is also confirmed that high performance fibers can be integrated into these multilayer woven structures without major degradation and more easily as weft and/or warp reinforcing yarns to increase the strength in both directions of the 3D warp interlock fabric. The same authors also point out the ease of implementation of a composite material with 3D fiber reinforcement [3], mainly due to its monolithic, compact and integrated architecture [4][5].

In 3D warp-interlock fabrics, the layers are bonded by warp yarns, thus providing a stronger cohesion, which allows the production of a thick reinforcement directly [6], instead of a set of thin reinforcements that must be assembled subsequently [7], while maintaining the ability to pass more resin than in 2D fabrics of equivalent thickness [8].

All of these targets were tested against the same blast threat in a free field configuration. The distance between the charge and the targets was kept constant (except for the 3D woven composite full thickness + steel 2). Dynamic deformation was measured using a metallic honeycomb cell placed on the back of the steel element. During the blast effect, the dynamic deformation was recorded in the thickness direction and a comparison of the different targets is shown in Figure 1.

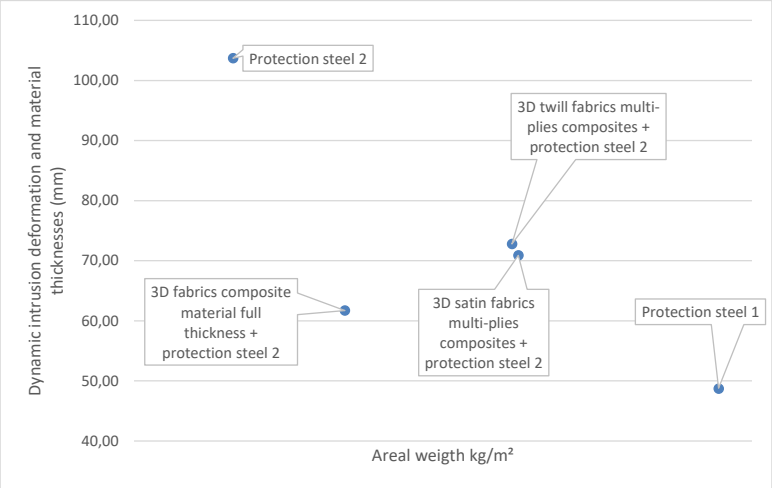

Figure 1. Comparison of different solutions submitted to explosion

According to the resulting dynamic deformation under the impact of the blast, a better performance of the full thickness 3D woven composite material matched with the protective steel plate was revealed.

Conclusion

This study shows that a hybrid composite/steel solution based on a 3D warp interlock fabric can significantly reduce the maximum dynamic deformation compared to the same mass solution made of protection steel. Further studies are needed to confirm this trend.

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