Effect of Textile Architecture on the Ballistic Impact Resistance of Woven Fabrics

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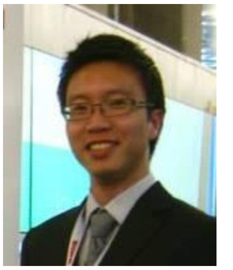


Abstract: Textile composites made from high-performance fibres such as Kevlar® and Dyneema® possess high flexibility, high strength-to-weight ratio, and outstanding energy absorption capacity for offering protection against ballistic impact. Among the various mechanisms influencing the impact resistance of fabrics, textile structure has been identified as one of the major factors capable of significantly influencing the mechanical performance as well as energy absorption capacity (EAC) of woven fabrics. This study aims at investigating the effect of fabric structures towards its ballistic resistance through both meso-scale FE modeling and experiments. FE models simulating ballistic impact on Plain, Satin, Twill, and Basket woven fabrics were constructed and verified using experimental data. Simulation results have revealed the evolution of energy components as well as stresses /strain distributions during impact for different weaving structures.

Experimental Studies:

Ballistic impact experiments were carried out using a Gas-Gun assembly with 0.33 caliber bullets weighted 7.5*g*, impacting Kevlar® 29 plain woven fabric target with four edge clamped as shown in **Fig.1**. Results in **Table 1** suggest an increase in EAC with higher projectile impact. speed.

Table 1. Kevlar® 29 Ballistic Test Results (m/s)

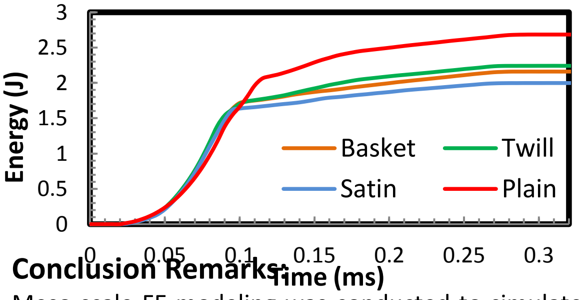
K® 29	V_ini	V_res	ΔV	%ΔV
Test 1	83.5	73.2	10.3	12.3%
Test 2	90.0	80.5	9.5	10.6%
Test 3	99.2	81.3	17.9	18.0%
Test 4	105.3	84.8	20.5	19.5%

Numerical Modeling:

Geometry and mechanical properties of Kevlar® 29 fabrics were imported into LSDYNA to construct plain, basket, twill and satin woven FE model, where simulation results in **Fig.2 & 3** exhibited good agreement with test observations. Detail modeling on kinetic/strain/friction energy was then carried out in order to simulate the evolution of energy absorption and distribution within the fabrics during impact as shown in **Fig.4**.

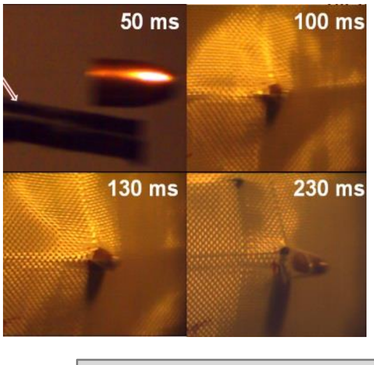
Data Analysis:

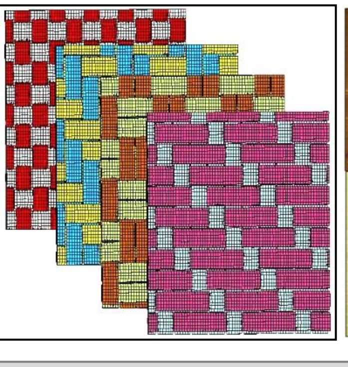
Evolution of energy from the four models illustrated below shows a steep raise in energy absorption from the moment of impact, and immediately eased As the bullet begins to puncture through. The gradient of the curve was then gradually relieved as the bullet passes through and eventually left the fabric. Among all structures modelled, plain weave exhibits outstanding EAC when compared to the remaining weaves.

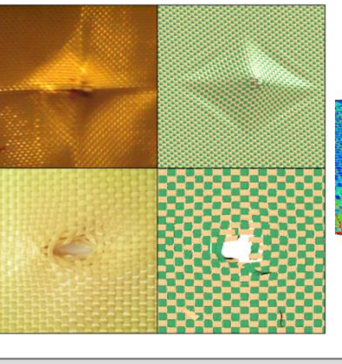


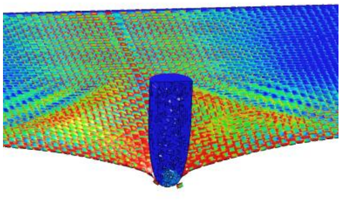
Conclusion Remarks:

Meso-scale FE modeling was conducted to simulate the ballistic impact of woven fabrics with various structures.









2013 Infrastructure Engineering Postgraduate Conference