Bullet Proof Jackets/Shields Finite Element Method Review

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Abstract: Bullet proof shield or jacket is the area where lots of study is going on. Present work focus on the study of finite element simulation tool used to solve the impact of the bullet on the shield or jacket. As they know that the impact of bullet may break the shield which can results in serious injuries or even a human life. In present work a review has been conducted of the earlier work done on the impact of bullet on the shield or jacket. From the review it has been found that the best material suited for bullet proof shield or jacket are Kevlar and Spectra Shield. While material used in the earlier 70s is ballistic nylon. Literature also shows that these jackets are of standard sizes (such as 30 long and 32 short) otherwise they can be custom-made based on the customer's requirements. Results also show that Finite element simulation is a great tool to conduct the pre-manufacturing study of these shields or jackets as one can calculate the impact of the bullet coming at high speed towards the shield or jacket.

I. INTRODUCTION

Present work deals with the review of the earlier work conducted in the field of impact of bullet on the shield or jackets using finite element simulation. Sugandhan and Thirumavalavan in 2017 [1] covered ballistic composite might be utilized as a part of defensive head protectors or with pottery and different materials like fiber fortified polymers (FRP) for defensive body love. It is utilized as a part of a few enterprises, for example, Aviation segment, guard and broadly useful Helmet making ventures. It requires a few high cost gear for the testing and breaking down of the material. While the utilization of PC reenactment programming like ANSYS help scientists to investigate these kinds of issues effectively.

Nagendran et al. [2] in 2107 conducted the numerical recreation and examination of the ballistic effect on the sandwich model of polymer and aluminum. The investigation was directed over a scope of effect speed by 750 m/sec to 950 m/s. Three unique mixes of materials were utilized as a sandwich. The part of polymer assumes a key part in the investigation that it will go about as a flexible segment and retains the greatest vitality from the projectile model. As results vitality plots, push plots and distortion are thought about between three cases. By utilizing the mix of disparate material like polymer (flexible property material) and gentle steel (pliable material) they can without much of a stretch assimilate the vitality applied by the shot.

Rajput et al. [3] in 2017 conducted the finite element simulation of impact on PASGT army helmet. PASGT is personal armour system ground troops made of heat resistant material. Initially they focused their study on the impact of spherical projectile travelling at 205 m/s on the PASGT helmet. They considered KEVLAR 129 as a material of the helmet and ANSYS AUTODYN-3D for finite element simulation. They validated their results of the above mention data with results available in the literature. They also simulated the two standard test for helmet MIL-H-44099A and NIJ-STD-0106.01 type II.

Sujith et al. [4] in 2015 studied the impact analysis of bullet on different bullet proof materials. They targeted their study to find out the best materials suitable for bullet proof jacket when a bullet strike it by analysing the directional deformation, total deformation, shear stress and principal stresses. They utilized ANSYS and CATIA version to conduct the finite element analysis of the problem considered. CATIA is used for drawing the geometry of the bullet while ANSYS is used for meshing and analysis purpose. They conducted their study on three different materials Kevlar149, Spectra900 and Boron. The parameters of the study are bullet diameter, bullet velocity and fibres thickness. The values of these parameters are 9mm, 9950m/s and 9mm respectively. They concluded that Spectra900 is best material compared to boron and Kevlar149. Spectra900 shows least deformation and stress compared to born and Kevlar149 when it is under the same bullet impact speed.

Sikarwar and Velmurugan [5] in 2014 studied the glass/epoxy composite covers which are subjected to stacking and vitality retaining limit of the covers is considered. In the present examination, covers with four unique introductions and thickness esteems are considered. Expository examination is completed in light of vitality strategy and results are contrasted and FE comes about got from ABAQUS/Explicit programming.

Results got from the expository strategies are demonstrating great concurrence with the FE comes about. It is discovered that cross-handle covers are most proficient in ballistic protection when contrasted and the covers of different introductions. It is additionally seen that the vitality engrossing limit is diminishing with increment in speed of the shot for a surrendered lay and thickness esteem. A straightforward diagnostic model has been utilized to foresee the remaining speed and vitality retaining limit. The logical outcomes acquired are contrasted and comes about got from ABAQUS/express for the glass/epoxy covers for various fiber introductions and thickness esteems.

Thiyagarajan et al. [6] in 2014 modelled finite element simulation of Kevlar alloys mechanical properties. In the field of guard and other profoundly secure spots parcel of effect are framed, at the season of the war part of wounds are happened because of the effect of the slug and the firearm shots. At the point when Kevlar material is utilized as a Body Armour for the guard reason and for the wellbeing reason at the season of the war fenced in area, the issue looking here is the point at which the effect is connected at a point the material distortion happens and at a specific point and the avoidance will be high so that human who is wearing Kevlar as the body evidence encounter an overwhelming torment in the Armour.

Luan et al. [7] in 2013 studied the ballistic impact of 3D angle interlock woven composited (3DAWC). Their research was based on the high strain rate constitutive equation of fiber tows. They considered hemispherical rigid projectile penetration and multi-scale geometric model of the 3DAWC. The constitutive conditions of the Twaron fiber tows (poly paraphenylene terepthalamide, PPTA) under high strain rates have been built up to portray the mechanical practices under effect stacking. The Twaron fiber tows were accepted as transversely isotropic viscoelastic material to infer the constitutive conditions. The greatest strain disappointment foundation was embraced for characterizing the disappointment of the PPTA fiber tows. Ramavat et al. [8] in 2012 conducted the study on godrej security solution division has created slug safe arrangements like Bullet safe entryways, Mantraps, Bullet safe screening for banks, and slug safe lodges and so on which are outlined according to the necessities said in different gauges like National foundation of Justice (NIJ), Underwriters Laboratory (UL), and so on. These organizations have set up the execution criteria and arranged it into different security levels. To pick up the trust in these projectile safe arrangements it is chosen to test execution of steel plate for its protection against projectile.

Kosiuczenko et al. [9] in 2011 numerically studied the ceramic steel composites shield subjected to ballistic impact. The issue of rocket affect protection is talked about in detail in numerous articles and standard papers managing body defensive layer. The experience from numerous furnished clashes, be that as it may, might be confirmation that the genuine dangers are identified with a more noteworthy degree to parts than those of shots. It can be demonstrated that the all the more frequently the question is demolished as an outcome high-speed effect of pieces. The paper depicts the aftereffects of numerical reproductions of 22 gauge shot shrapnel puncturing multilayer ballistic shield. Gopalakkrishnan and Senthil [10] in 2011 conducted the ballistic materials study in defence applications for giving assurance against indicated shots. They are utilized as an essential material in the assembling of impenetrable vests and defensively covered battling vehicle. Subsequently, disappointment investigation of these materials under effect stack conditions has progressed toward becoming an essential investigation to qualify them for defence applications. Effect wonder is an extremely convoluted process in which the execution relies upon numerous parameters like term of the effect, active vitality, speed of shot and the properties of target and the shot materials.

Barauskas and Abraitiene in 2007 [11] developed a finite element model of the ballistic test against the multi-layer paraaramid materials bundle structure has been created in LS-DYNA. The projectile has been considered as a deformable body in contact with the texture bundle spoken to by a joined yarn structure. The rearrangements of the model have been accomplished by methods for the "mezzo-mechanical" approach by maintaining a strategic distance from the immediate demonstrating of fibres including the yarns. Rather, yarns have been displayed by utilizing slender shell components the thickness of which speaks to the genuine thickness of yarns as it can be estimated in the weave. Barauskas et al. [12] in 2005 conducted finite element component model of the shooting test against the paraaramyde Twaron multi-layer materials bundle structure has been produced in LSDYNA. The shot has been viewed as a deformable body in contact with the texture bundle exhibited by joined yarn structure. The rearrangements of the model have been accomplished by displaying the multifilament yarns by thin shell components, the thickness of which speaks to the genuine thickness of yarns as it can be estimated in the weave. The zones of the texture remote from the purpose of effect have been displayed as a generally fit uniform thin shell show.

Kevlar has long been the most widely used material in bulletproof vests. To make Kevlar, the polymer solution is first produced. The resulting liquid is then extruded from a spinneret, cooled with water, stretched on rollers, and wound into cloth. A recent competitor to Kevlar is Spectra

Shield. Unlike Kevlar, Spectra Shield is not woven but rather spun into fibers that are then laid parallel to each other. The fibers are coated with resin and layered to form the cloth.

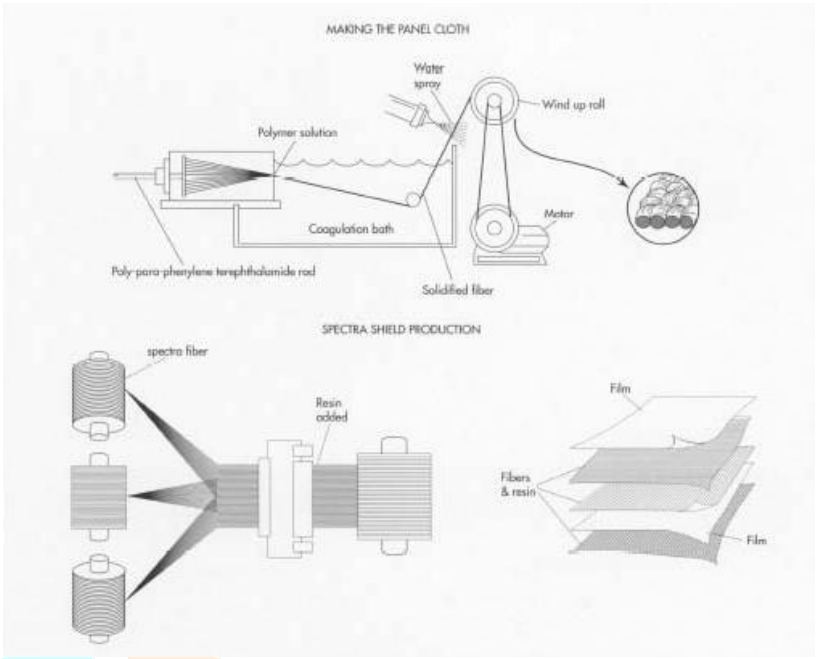

Figure 1 Making of kevlar

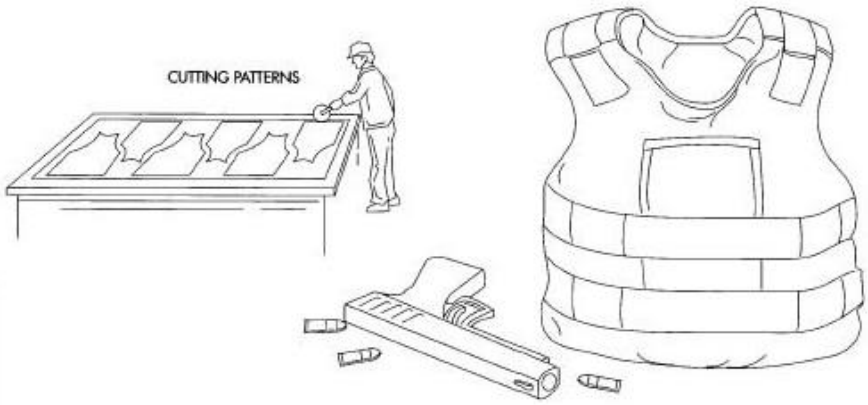

Figure 2 Making of Jacket or shield

Figure 3 .22-250 Remington rifle

Figure 3 shows the bullet considered for finite element analysis. Dimensions of the bullet are, Bullet diameter .224 in (5.7 mm) Neck diameter .254 in (6.5 mm) Shoulder diameter .414 in (10.5 mm) Base diameter .469 in (11.9 mm) Rim diameter .473 in (12.0 mm) Case length 1.912 in (48.6 mm) Overall length 2.35 in (60 mm) Rifling twist 1-12, 1-14 Primer type Large rifle. The .22-250 Remington is a very high-velocity (capable of reaching over 4000 feet per second), short action, .22 caliber rifle cartridge primarily used for varmint hunting and small game hunting, though it finds occasional use on deer. This cartridge is also sometimes known as the 22 Varminter or the 22 Wotkyns Original Swift. Along with the .220 Swift, the .22-250 was one of the high-velocity 22 caliber cartridges that developed a reputation for remote wounding effects known as hydrostatic shock in the late 1930s and early 1940s.

II. CONCLUSION

- Bullet proof jacket and shield is the very interesting area of research.
- Impact analysis of bullet proof using finite element analysis can help in improving the quality.
- Explicit analysis is a tool used for FEA of the impact of bullet.
- Kevlar and spectra are the widely used material for making of the bullet proof jackets.
- Ballistic nylon is the material used in earlier 70s for bullet proof jacket manufacturing

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