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Investigating the Behavior of Manufactured Rocket Propelled Grenade (RPG) Armour Net Screens from Different Types of High Performance Fibers

A.I.H.Fayed[1], Y. A. Abo El Amaim[2], Doaa H. Elgohary[3]*

[1]Mechanical Engineering Branch, Military Technical College, Kobry El Quba, Cairo, Egypt
Email: amr.fayed [at]mtc.edu.eg

[2] Spinning and Weaving Department, Faculty of Applied Arts, Beni Suef University, P.O.62512, Beni Suef, East of the Nile, Egypt
Email: engsamaim2000 [at]hotmail.com

[3]Department of Spinning and Weaving Engineering, Textile Research Division, National Research Centre, 33 El Bohouth st. (Former El Tahrir St.), Dokki, P.O.12622, Giza, Egypt
Email: d_ego44 [at]hotmail.com

Abstract: ***Rocket-propelled grenade nets, is armour net screens from mesh fabrics which is used in protecting vehicles and crew against explosive projectiles. In this paper we show 1) the production of three armour nets from three different materials (Kevlar-polypropylene-polyester), Mechanical properties were done for the produced yarns made for net, while firing tests were performed on produced the net. 2) The effect of shooting RPG7 projectiles on the manufactured nets.***

Keywords: Rocket-propelled Grenade, Nets, Armour, High Performance Fibre

1. Introduction

Protection is an important point for the crew in the military field as it creates safety and security to keep them moving fearlessly in war area with certain effective systems [1]. Armour protection is an effective system which considered as important elements of survivability, for the area of safeness and military [2].

Various types of vehicles used in military conflicts and missions to protect crew, one of these types is the armoured vehicles, as these vehicles must be characterized by its resistance to high mines, IED-detonation and artillery fire, and its ability to work in different conditions [3].

Number of weapons are used in war field; a Rocket-Propelled grenade is one of most weapon system which is a shoulder fixed anti-tank that can launch projectile with an explosive warhead at its end, as it is operative against armour vehicles, according to penetrated projectile type [4], [5]. These systems of weapons including different types, some of these types are reloaded with a new rocket-propelled grenade, while others are disposable used for single-use [4].

One of the most commonly used system for the rocket propelled grenade is the portable anti-tank launcher RPG7, shown in figure (1,2), as it is characterized by its simple design, effectiveness and simple handling that cannot take a long time for training [5].

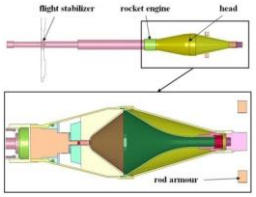


Figure 1: An Intersection of the projectile PG- 7G Head [6]

Net screens (RGP screens) are types of screens used to protect the outer surface of vehicles against the impact of weapons projectiles (RPG armour, High Explosive Anti-tank Warhead) [3,4], it is fixed at distance ranging 30-50 cm from the surface of the vehicle. The function of these screens to prevent the formation of a shaped charge jet, which done by the tasks of exploiting two mechanisms, the task of first mechanism is that the net screen deform the ballistic cap when be closed with the conductive cone, while the second mechanism tasks deformation of the shaped charge liner and explosive in the projectile [5].

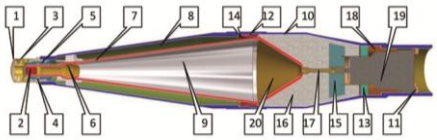


Figure 2: Cross-section of the warhead of PG-7WM Projectile [5]

1- Fuse Cover	2- Piezoelectric element	3- Nut	4- Isolator	5- Fuse body
6- Joint	7- Isolator sleeve	8- Ballistic cap	9- Conductive cone	10- Locking ring
11- Shaped	12- Isolating ring	13- Explosive	14- Warhead	15- Conductor

charge liner			body	
16- Cover	17- Isolator	18- Sleeve	19- Bottom part of the fuse	20- Locking ring

There is an essential point during designing the net screens is to prove the geometrical structure for mesh size in order to increase the probability of projectile neutralization [5]. Three different companies announced the production of RPG screen (Net screens), as shown in figure (3), its task to protect military vehicles and crew against the rocket-propelled grenade projectiles (RPG). First Tarian made by Amsafe Bridport, is a novel product light weight and RPG armour systems, compared to traditional methods which is heavy, metal bar armour RPG protection [7], as shown in figure (4). It works as cage armor, its weight less 50% than aluminum and 1/7 steel weight [8]. The core elements of these screen nets made from extremely strong textile from high tenacity fibres [7].

Second net screens is Q-net made by Qinetiq is a type of nets manufacturing using a high-tech fabrics, this type of net is tough enough to resist tear against rockets [9]. Q-nets characterized by its light weight as it is lighter than armour systems about 50-60 %, can be easily installed and removed without using any tools, also its capability of multi-hits [10].

Third type is SidePro LASSO made by Ruag is a type of mesh with a rhomboid opening and 3-D structure with knotted ends made of 4mm high tensile wires, its tensile strength 1770 N/mm^2. It is characterized by its supercoating that provides a protection against corrosion; it can be available in different frame sizes [11].

(a) (b) (c)

Figure 3: Examples of net protection systems [5]

(a) Tarian® firmy Amsafe Bridport

(b) Q-net made by Qinetiq

(c) SidePro-LASSO made by Ruag (Switzerland)

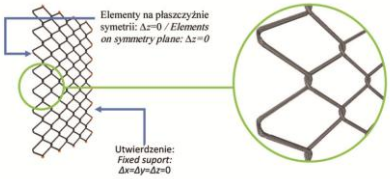


Figure 4: Net made of high-strength steel wire [5]

New generation of high performance fibers were developed to protect against impact projectiles, these developments results in a fiber with high strength, high modulus, lightweight, tough but still maintaining its flexibility, these types of fibers including aramid, high-density polyethylene [6,7].

From the most widely used in high performance fiber for impact proof materials is the Kevlar, as these materials can be used in many industries especially in the production of bulletproof and armour materials, as shown in figure (5) also in wear resistant brakes and aviation materials [14]. This type of fibers combined between different properties which make it first choice for different applications, also its structures affords some properties including high tenacity, high modulus, toughness and thermal stability, reduction of weight, resistance to corrosion [8,9].

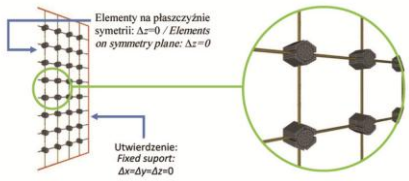


Figure 5: Net of aramid strings [5]

Polyester (PES) acquired an important place as synthetic fibres [10], which have been used over the past 50 years [11]. It considered the most widely used fibres that results from its great features add to the products which including high tenacity combined with its resistance to abrasion, chemicals and stretching also it can resist sunlight and has good thermal resistance, etc) [10–12].

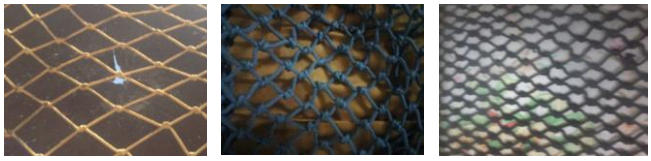
Polypropylene is a widely used polymer [20], which is one of the youngest generations of produced chemical fibres [21] as it considered the fourth largest production quantity after polyesters, nylon and acrylics [20]. These types of fibres characterized by different advantages, including low price, chemical resistance, biological resistance and almost zero water adsorption [13,14].

Literature Survey

In this paper we describe in details the effect of shooting RPG7 rocket on the manufactured armour nets, with different textile materials.

2. Material and Method

This work illustrate the manufacturing of three armour nets from three different materials (Kevlar- polypropylene - polyester), as shown in figure (6), the yarn count for each material is 300 Denier , the yarns was braided as a round braided yarn with 4 strands each strand count 300 Denier. Each braided yarn for each material was manufactured in the form of net (mesh shape), the measure of each void in each net equals 5cm, while number of knots per meter equals 70.



(a) (b) (c)

Figure 6: Three different materials of armor nets

(a) Kevlar **(b)** Polypropylene **(c)** Polyester

2.1. Measurements of net armor

The tests were carried out to measure the properties and efficiency of the manufactured samples:

2.1.1. Textile testing

2.1.1.1. Yarn Tensile Strength & Elongation Test

The test was carried out according to ASTM 2256 Standard Test Method for Tensile Properties of Yarns by the Single-Strand Method [24].

2.1.2. Firing tests

It is a ballistic test, which was performed in one of the Egyptian army shooting range, the shooting done from distance about 70 meter using RPG7 projectile, the net was fixed into instant armour, as it was in front of armor at distance 50cm.

2.1.3. Post firing examination

The examination was performed to examine the behavior of samples after firing. It was carried out after the test directly and the net was damaged for the three samples near by the fixing point with the armor and the penetration happens in the armor.

3. Result and Discussion

Tensile strength test and elongation were performed for the three different braided yarns, which indicated that Kevlar gives the highest value which equals to 1281.39 N and its elongation equals 29.05% followed by polypropylene which recorded 454.63 N and its elongation equals 64.36%, while polyester recorded the lowest value which equals to 426.91 N and its elongation equals 90.5%.

The test performed on fixed armour, which was a very severe condition, in which the net took all the impact energy of the projectile and cannot withstand it. Due to the damage of net, the fuse started the charge even without any divert of the projectile, because the net cannot withstand the kinetic energy of projectile which equals 150*150*8*(1/2).The condition of test will be more realistic if the armour would be moved in order to make some diversion and not face the armour by its noze. The next test will be holding on more strength net rope in order to withstand the impact energy of fire projectile.

4. Conclusion

Three types of net armour were manufactured as mesh samples and tested by fire infield. The three types of mesh do not fulfill its task to prevent the armour from penetration.

5. Future Scope

In future work a stronger material will be used to prevent the projectile from penetration and in this case the net may be withstanding the projectile.

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Author Profiles

A. I. H. Fayed, Associate Professor at Military Technical College, I am an Associate Professor at Military Technical College. I have got Master degree from University of Manchester Institute and Technology, UK, entitled:" Investigation of stress Waves in Barrels due to firing". I have got The Degree of Doctor of Philosophy from University of Manchester Institute and Technology, UK, entitled:" Penetration and ballistic resistance of multi- layered textile, flexible composite materials. Participated in a lot of positions in Military Technical Colleague. Manager Assistant for Undergrad Educational Affairs from 2016-2018. Manager Assistant for Postgrad and Research Affairs, in 2018

Y. A. Abo El Amaim, Lecturer at Faculty of Applied Arts, Beni Suef University, I am a lecturer at Spinning, Weaving and knitting Department; Faculty of Applied Arts, Beni Suef University. I have got Master degree from Spinning, Weaving and Knitting Dept., Faculty of Applied Arts, entitled:" characterization heat transfer through layers of fabrics to improve protection and comfort behaviors". I have got The Degree of Doctor of Philosophy from the Faculty of Applied Arts, entitled: Achieving the best functional properties of technical fabrics for ballistic protection military and civil fields". Participated in strategic plan as Executive Director Assistant - Unit of Strategic Planning - Beni Suef University.

Doaa Elgohary Hanafy, Researcher at National Research Centre, I am a researcher at Spinning and Weaving Engineering Department; National Research Centre. I have got Master degree from Spinning, Weaving and Knitting Dept., Faculty of Applied Arts, entitled:" Comparative Study for Sutures to Determine Their Best Functional Performance Efficiency ", Patent was obtained from the Academy of Scientific Research and Technology, No.27479, Egypt, Entitled "Untwisted Natural Silk Sutures for Animals". I have got The Degree of Doctor of Philosophy from the Faculty of Applied Arts, entitled:" Design and Production of Textile Meshes for Heart Muscle Reinforcement (An Application Study on Animal. A Patent was obtained from the Academy of Scientific Research and Technology, No.29110 Egypt, Entitled "Method for Designing, Forming and Producing of Textile Meshes for Reinforcing Cardiac Hypertrophy for Animals". Participating in the procedure of tests and analyses of laboratory tests for fabrics & yarns, participating in training courses (as a lecturer) at Spinning and Weaving Engineering Department.