

Dissipation of energy in stacking layer of bullet proof vest



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Dissipation of energy in stacking layer of bullet proof vest

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In

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By

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Dedication

“I humbly thank **Allah** Almighty, the Merciful and the Beneficent, who gave me health, thoughts and co-operative people to enable me achieve this goal.”

I dedicate my dissertation work to my family and many friends. Special feelings of gratitude to my loving parents and friends their words of encouragement and push for tenacity ring in my ears I also dedicate this dissertation to my friends who supported me throughout the process. There is no doubt in my mind that without their continued support and counsel. I could not have completed this process.

May Allah bless them with good health, success & happiness of life.

(Ameen)

,

Statement of Submission

This is to certify that **Miss Ayesha Ghazanfar ID No. 091420-132** and **Miss Ayesha Azhar ID No. 091420-316** have successfully completed the final year project named as “**impact of bullet on stacking layer of fabric**” with the support of School of Textile and Design, University of Management and Technology
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(Signed)

.....

(Ayesha Ghazanfar)

(Signed)

.....

(Ayesha Azhar)

Dated: 28/09/2013

Abstract

In This project we are discussing the dissipation of energy in stacking layers of bullet proof vest. We use the three fabrics (Kevlar, Nomex and Dyneema) for making the stacking of fiber then find the impact of the bullet on the stacking layer of fiber. For this purpose we find the momentum, and velocity of the bullet. We use the TexGen and ABAQUS software for modeling of fiber and the stress strain curve of the fiber

Keywords: Textile, Bullet Proof Vest, Stacking layer, Kevlar, Nomex, Dyneema

Table of Contents

DEDICATION	III
STATEMENT OF SUBMISSION	IV
ABSTRACT	VI
TABLE OF CONTENTS.....	VII
LIST OF TABLES.....	XI
LIST OF FIGURES.....	XII
CHAPTER 1: INTRODUCTION	13
1.1 TECHNICAL TEXTILE:.....	14
1.2 APPLICATION OF TECHNICAL TEXTILE:	14
1.2.1 <i>Agro tech</i> :.....	14
1.2.2 <i>Build tech</i> :.....	14
1.2.3 <i>Cloth tech</i> :	15
1.2.4 <i>Geo tech</i> :	15
1.2.5 <i>Home tech</i> :	15
1.2.6 <i>Indu tech</i> :	15
1.2.7 <i>Med tech</i> :	15
1.2.8 <i>Mobiltech</i> :	16
1.2.9 <i>Oeko tech</i> :	16
1.2.10 <i>Packtech</i> :.....	16
1.2.11 <i>Protech</i> :.....	16
1.2.12 <i>Sportech</i> :	17
1.3 CLASSIFICATION OF PROTECT (PROTECTIVE TEXTILE) ^[13] :	17
1.3.1 <i>Fire Protection</i> :	17
1.3.2 <i>Heat Protection</i> :.....	17
1.3.3 <i>Cold Protection</i> :	18
1.3.4 <i>Chemical Protection</i> :.....	18
1.3.5 <i>Mechanical Impact Protection</i> :.....	18
1.3.5.a <i>Ballistic Protection</i> :.....	18
1.3.5.b <i>Biological Protection</i> :.....	18
1.3.5.c <i>Radiation Protection</i> :	19
1.3.6 <i>Electrical Protection</i> :	19
1.3.6.a <i>Electromagnetic protection</i> :.....	19
1.3.6.b <i>Electrostatic protection</i> :	19
1.4 FIBERS USED IN TECHNICAL TEXTILES:.....	20
1.5 PRESENT SCENARIO OF TECHNICAL TEXTILE:	20
CHAPTER 2: HISTORY OF BULLET PROOF VEST	ERROR! BOOKMARK NOT DEFINED.
2.1 BACKGROUND OF BULLET PROOF VEST:	ERROR! BOOKMARK NOT DEFINED.
CHAPTER: 3 FIBERS IN BULLET PROOF VEST	ERROR! BOOKMARK NOT DEFINED.
3.1 NOMEX [®] FIBER:	ERROR! BOOKMARK NOT DEFINED.
3.2 GRADES OF NOMEX [®] FIBER ^[6] :.....	ERROR! BOOKMARK NOT DEFINED.
3.2.1 <i>Type 430 Nomex[®]</i> :	Error! Bookmark not defined.
3.2.2 <i>Type 462 Nomex[®]</i> :	Error! Bookmark not defined.
3.2.3 <i>Type 455Nomex[®]</i> :.....	Error! Bookmark not defined.
3.2.4 <i>Type 450 Nomex[®]</i> :	Error! Bookmark not defined.
3.2.5 <i>Type N102Nomex[®] Texturized Filament Yarn</i> :.....	Error! Bookmark not defined.
3.2.6 <i>Type N104Nomex[®]Dyeable filament yarn</i> :.....	Error! Bookmark not defined.

3.2.7 Type N300 and N101 Nomex® Producer Colored Fibers:.....	Error! Bookmark not defined.
3.2.8 Nomex CGF® and Nomex thermacolor®	Error! Bookmark not defined.
3.2.9 Nomex Omega®:.....	Error! Bookmark not defined.
3.2.10 Nomex Spunlaced Fabrics:.....	Error! Bookmark not defined.
3.3 PROPERTIES OF NOMEX® FIBER ^[8]	ERROR! BOOKMARK NOT DEFINED.
3.4 DYNEEMA FIBER ^[13]	ERROR! BOOKMARK NOT DEFINED.
3.5 KEVLAR®:.....	ERROR! BOOKMARK NOT DEFINED.
3.6 GRADES OF KEVLAR® FIBER:	ERROR! BOOKMARK NOT DEFINED.
3.6.1 Kevlar NTF:	Error! Bookmark not defined.
3.6.2 KEVLAR MTP:.....	Error! Bookmark not defined.
3.6.3 Kevlar MTP system:.....	Error! Bookmark not defined.
3.6.4 DuPont Kevlar correctional TM:.....	Error! Bookmark not defined.
3.6.5 Kevlar COMFORT:	Error! Bookmark not defined.
3.6.5a: Kevlar COMFORT AS (anti-stab):.....	Error! Bookmark not defined.
3.6 PROPERTIES OF KEVLAR™ FIBER	ERROR! BOOKMARK NOT DEFINED.
CHAPTER: 4 BULLET	ERROR! BOOKMARK NOT DEFINED.
4.1 DEFINITION:	ERROR! BOOKMARK NOT DEFINED.
4.2 SHAPES OF BULLETS:	ERROR! BOOKMARK NOT DEFINED.
4.2.1 Round nose bullet:	Error! Bookmark not defined.
4.2.2 Hollow round bullet:.....	Error! Bookmark not defined.
4.2.3 Wadd cutter:	Error! Bookmark not defined.
4.3 BULLETS TYPES ENERGIES, VELOCITIES AND MOMENTUM:.....	ERROR! BOOKMARK NOT DEFINED.
CHAPTER: 5 ARMOR CLASSIFICATION	ERROR! BOOKMARK NOT DEFINED.
5.1 ARMOR TYPE:.....	ERROR! BOOKMARK NOT DEFINED.
5.1.1 Type I:.....	Error! Bookmark not defined.
5.1.2 Type II-A:.....	Error! Bookmark not defined.
5.1.3 Type II-B:	Error! Bookmark not defined.
5.1.4 Type III-A:.....	Error! Bookmark not defined.
5.1.5 Type III-B:	Error! Bookmark not defined.
5.1.6 Type IV:	Error! Bookmark not defined.
CHAPTER: 6 BALLISTIC TESTS	ERROR! BOOKMARK NOT DEFINED.
6.1 EXPERIMENT:	ERROR! BOOKMARK NOT DEFINED.
6.2 FAIR HIT	ERROR! BOOKMARK NOT DEFINED.
6.3 ANGLE OF INCIDENCE	ERROR! BOOKMARK NOT DEFINED.
6.3.1 Armor Carrier.....	Error! Bookmark not defined.
6.3.2 Armor Panel.....	Error! Bookmark not defined.
6.3.3 Armor Sample.....	Error! Bookmark not defined.
6.4 BACK FACE SIGNATURE (BFS).....	ERROR! BOOKMARK NOT DEFINED.
6.4.1 Backing Material.....	Error! Bookmark not defined.
6.4.2 Backing Material Fixture	Error! Bookmark not defined.
6.4.3 Baseline Ballistic Limit.....	Error! Bookmark not defined.
6.5 BALLISTIC PANEL.....	ERROR! BOOKMARK NOT DEFINED.
6.6 BALLISTIC PENETRATION AND BACK FACE SIGNATURE TEST (P-BFS):.....	ERROR! BOOKMARK NOT DEFINED.
6.7 HAND LOADS:	ERROR! BOOKMARK NOT DEFINED.
6.8 TEST WEAPONS:	ERROR! BOOKMARK NOT DEFINED.
6.9 TEST WEAPON FIXTURES:.....	ERROR! BOOKMARK NOT DEFINED.
6.10 V50 TEST METHOD:	ERROR! BOOKMARK NOT DEFINED.
6.10.1 Benefits of using V50 test method:	Error! Bookmark not defined.
6.10.2 Types I, IIA, II, and IIIA:	Error! Bookmark not defined.

6.10.3 Type III.....	Error! Bookmark not defined.
6.10.4 Type IV.....	Error! Bookmark not defined.
6.11 FLEXIBILITY AND THICKNESS TESTS	ERROR! BOOKMARK NOT DEFINED.
6.11.1 Flexibility and thickness test results.....	Error! Bookmark not defined.
6.11.2 Flexibility and thickness for pure Kevlar and STF impregnated Kevlar	Error! Bookmark not defined.
6.12 YARN PULLOUT METHOD AND DISSIPATION OF ENERGY.....	ERROR! BOOKMARK NOT DEFINED.
6.13 BEHAVIORS OF YARN PULLOUT FROM WOVEN FABRICS: THEORETICAL AND EXPERIMENTAL.....	ERROR! BOOKMARK NOT DEFINED.
6.14 THEORETICAL ASPECTS:	ERROR! BOOKMARK NOT DEFINED.
CHAPTER: 7 MATHEMATICAL CALCULATIONS:	ERROR! BOOKMARK NOT DEFINED.
7.1 FOR 0.25 CALIBER GLASER SAFETY BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.2 FOR 0.25 AUTOMATIC EXPANDING POINTS:.....	ERROR! BOOKMARK NOT DEFINED.
7.3 FOR 0.25 AUTOMATIC FULL METAL JACKET:	ERROR! BOOKMARK NOT DEFINED.
7.4 FOR 0.30 LUGER (7.65MM) FULL METAL JACKET BULLET TYPE:.....	ERROR! BOOKMARK NOT DEFINED.
7.5 FOR .30 CARBINES HOLLOW SOFT POINT BULLET TYPE:.....	ERROR! BOOKMARK NOT DEFINED.
7.6 FOR .32 SMITH & WESSON LEAD-ROUND NOSE BULLET TYPE:.....	ERROR! BOOKMARK NOT DEFINED.
7.7 FOR .32 SMITH & WESSON LONG LEAD-ROUND NOSE BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.8 FOR .32 SHORT COLT LEAD-ROUND NOSE BULLET TYPE:.....	ERROR! BOOKMARK NOT DEFINED.
7.9 FOR .32 AUTOMATIC GLASER SAFETY SLUG BULLET TYPE:.....	ERROR! BOOKMARK NOT DEFINED.
7.10 FOR .32 AUTOMATIC HOLLOW POINT BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.11 FOR .32 AUTOMATIC FULL METAL JACKET BULLET TYPE:.....	ERROR! BOOKMARK NOT DEFINED.
7.12 FOR .38 SMITH & WESSON LEAD-ROUND NOSE BULLET TYPE:.....	ERROR! BOOKMARK NOT DEFINED.
7.13 FOR .380 AUTOMATIC GLASER SAFETY SLUG BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.14 FOR .38 SPECIAL GLASER SAFETY SLUG BULLET TYPE:.....	ERROR! BOOKMARK NOT DEFINED.
7.15 FOR .38 SPECIAL JACKETED HOLLOW POINT BULLET TYPE:.....	ERROR! BOOKMARK NOT DEFINED.
7.16 FOR .38 SPECIAL LEAD-ROUND NOSE BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.17 FOR .38 SPECIAL LEAD-SEMI WAD CUTTER BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.18 FOR .38 SPECIAL + P GLASER SAFETY SLUG BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.19 FOR .38 SPECIAL + P JACKETED HOLLOW POINT BULLET TYPE:.....	ERROR! BOOKMARK NOT DEFINED.
7.20 FOR .38 SPECIAL + P JACKETED HOLLOW POINT BULLET TYPE:.....	ERROR! BOOKMARK NOT DEFINED.
7.21 FOR .38 SPECIAL + P JACKETED HOLLOW POINT BULLET TYPE:.....	ERROR! BOOKMARK NOT DEFINED.
7.22 FOR .38 SPECIAL + P LEAD-SEMI WAD CUTTER BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.23 FOR 9MM MAKAROV GLASER SAFETY SLUG BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.24 FOR 9MM LUGER FULL METAL JACKET BULLET TYPE:.....	ERROR! BOOKMARK NOT DEFINED.
7.25 FOR 9MM LUGER JACKETED HOLLOW POINT BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.26 FOR 9MM LUGER JACKETED HOLLOW POINT BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.27 FOR 9MM LUGER +P GLASER SAFETY SLUG BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.28 FOR .38 SUPER AUTOMATIC GLASER SAFETY SLUG BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.29 FOR .38 SUPER AUTOMATIC +P JACKETED HOLLOW POINT BULLET TYPE:.....	ERROR! BOOKMARK NOT DEFINED.
7.30 FOR .38 SUPER AUTOMATIC+P FULL METAL JACKET BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.31 FOR .357 MAGNUM GLASER SAFETY SLUG BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.32 FOR .357 MAGNUM JACKETED HOLLOW POINT BULLET TYPE:.....	ERROR! BOOKMARK NOT DEFINED.
7.33 FOR .357 MAGNUM JACKETED HOLLOW POINT BULLET TYPE:.....	ERROR! BOOKMARK NOT DEFINED.
7.34 FOR .357 MAGNUM JACKETED HOLLOW POINT BULLET TYPE:.....	ERROR! BOOKMARK NOT DEFINED.
7.35 FOR .357 MAGNUM LEAD-SEMI WAD CUTTER BULLET TYPE:.....	ERROR! BOOKMARK NOT DEFINED.
7.36 FOR .357 MAGNUM JACKETED SOFT POINT BULLET TYPE:.....	ERROR! BOOKMARK NOT DEFINED.
7.37 FOR .357 SIG GLASER SAFETY SLUG BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.38 FOR 40 SMITH & WESSON GLASER SAFETY SLUG BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.

7.39 FOR 40 SMITH & WESSON JACKETED HOLLOW POINT BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.40 FOR 10MM AUTOMATIC GLASER SAFETY SLUG BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.41 FOR 400 COR-BON GLASER SAFETY SLUG BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.42 FOR .41 REMINGTON MAGNUM JACKETED HOLLOW POINT BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.43 FOR .41 REMINGTON MAGNUM JACKETED HOLLOW POINT BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.44 FOR .44 SMITH & WESSON SPECIAL GLASER SAFETY SLUG BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.45 FOR .44 SMITH & WESSON SPECIAL JACKETED HOLLOW POINT BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.46 FOR .44 SMITH & WESSON SPECIAL LEAD-ROUND NOSE BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.47 FOR .44 REMINGTON MAGNUM GLASER SAFETY SLUG BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.48 FOR .44 REMINGTON MAGNUM JACKETED HOLLOW POINT BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.49 FOR .44 REMINGTON MAGNUM HOLLOW SOFT POINT BULLET TYPE:.....	ERROR! BOOKMARK NOT DEFINED.
7.50 FOR .45 AUTOMATIC JACKETED HOLLOW POINT BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.51 FOR .45 AUTOMATIC FULL METAL JACKET-BULLET TYPES:	ERROR! BOOKMARK NOT DEFINED.
7.52 FOR .45 AUTOMATIC FULL METAL JACKET BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.53 FOR .45 AUTOMATIC +P GLASER SAFETY SLUG BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.54 FOR .45 G.A.P. JACKETED HOLLOW POINT BULLET TYPE:.....	ERROR! BOOKMARK NOT DEFINED.
7.55 FOR .45 COLT GLASER SAFETY SLUG BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.56 FOR .45 COLT JACKETED LEAD-ROUND NOSE BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
7.57 FOR .45 WINCHESTER MAGNUM JACKETED SOFT POINT BULLET TYPE:.....	ERROR! BOOKMARK NOT DEFINED.
7.58 FOR .454 CASULL JACKET FLAT POINT BULLET TYPE:	ERROR! BOOKMARK NOT DEFINED.
CHAPTER: 8 TEXGEN MODELING OF FIBER	ERROR! BOOKMARK NOT DEFINED.
CHAPTER: 9 CONCLUSION:	ERROR! BOOKMARK NOT DEFINED.
REFERENCES:.....	ERROR! BOOKMARK NOT DEFINED.

List of Tables

TABLE 1: PRESENT SCENARIO OF TEXTILES ^[13]	21
TABLE 2: HISTORY OF BULLET PROOF VEST	ERROR! BOOKMARK NOT DEFINED.
TABLE 3: PROPERTIES OF NOMEX FIBER.....	ERROR! BOOKMARK NOT DEFINED.
TABLE 4: PROPERTIES OF HPPE FILAMENT YARN ^[13]	ERROR! BOOKMARK NOT DEFINED.
TABLE 5: GRADES OF KEVLAR	ERROR! BOOKMARK NOT DEFINED.
TABLE 6: GRADES OF ARAMID	ERROR! BOOKMARK NOT DEFINED.
TABLE 7: PROPERTIES OF KEVLAR FABRIC	ERROR! BOOKMARK NOT DEFINED.
TABLE 8: BULLET TYPE, VELOCITY AND MOMENTUM	ERROR! BOOKMARK NOT DEFINED.
TABLE 9: ARMOR CLASSIFICATION TYPE I	ERROR! BOOKMARK NOT DEFINED.
TABLE 10: ARMOR CLASSIFICATION TYPE II-A.....	ERROR! BOOKMARK NOT DEFINED.
TABLE 11: ARMOR CLASSIFICATION TYPE II-B.....	ERROR! BOOKMARK NOT DEFINED.
TABLE 12: ARMOR CLASSIFICATION TYPE III-A.....	ERROR! BOOKMARK NOT DEFINED.
TABLE 13: ARMOR CLASSIFICATION TYPE III-B.....	ERROR! BOOKMARK NOT DEFINED.
TABLE 14: ARMOR CLASSIFICATION TYPE- IV.....	ERROR! BOOKMARK NOT DEFINED.
TABLE 15: NIJ STANDARD	ERROR! BOOKMARK NOT DEFINED.
TABLE 16: FLEXIBILITY AND THICKNESS TEST	ERROR! BOOKMARK NOT DEFINED.
TABLE 17: FLEXIBILITY AND THICKNESS TEST RESULT OF PURE AND IMPREGNATES KEVLAR	ERROR! BOOKMARK NOT DEFINED.
TABLE 18: TABLE OF STRENGTH PROPERTIES OF VARIOUS FIBERS	ERROR! BOOKMARK NOT DEFINED.

List of Figures

FIGURE 1: FIBER USED IN TECHNICAL TEXTILE	20
FIGURE 2: 1-2 GRAPH ^[4]	21
FIGURE 3: FORMULA OF NOMEX	ERROR! BOOKMARK NOT DEFINED.
FIGURE 4: GRAPH OF STRENGTH BASED ON WEIGHT VS. STRENGTH BASED ON VOLUME OF FIBERS ^[13]	ERROR! BOOKMARK NOT DEFINED.
FIGURE 5: GRAPH OF SPECIFIC STRESS VS. ELONGATION OF VARIOUS FIBERS ^[13]	ERROR! BOOKMARK NOT DEFINED.
FIGURE 6: FORMULA OF KEVLAR	ERROR! BOOKMARK NOT DEFINED.
FIGURE 7: GRAPH SHOWING STRENGTH PROPERTIES OF VARIOUS FIBERS ^[14]	ERROR! BOOKMARK NOT DEFINED.
FIGURE 8: STRUCTURE OF A BULLET	ERROR! BOOKMARK NOT DEFINED.
FIGURE 9: ROUND NOSE BULLET	ERROR! BOOKMARK NOT DEFINED.
FIGURE 10: HOLLOW BULLET	ERROR! BOOKMARK NOT DEFINED.
FIGURE 11: WADD CUTTER BULLET	ERROR! BOOKMARK NOT DEFINED.
FIGURE 12: BALLISTIC TESTS	ERROR! BOOKMARK NOT DEFINED.
FIGURE 13: ANGLE OF INCIDENCE	ERROR! BOOKMARK NOT DEFINED.
FIGURE 14: YARN PULLOUT TEST METHOD	ERROR! BOOKMARK NOT DEFINED.
FIGURE 15: YARN PULL OUT AND DISSIPATION OF ENERGY	ERROR! BOOKMARK NOT DEFINED.
FIGURE 16: GRAPH OF YARN PULL OUT	ERROR! BOOKMARK NOT DEFINED.
FIGURE 17: WOVEN STRUCTURE	ERROR! BOOKMARK NOT DEFINED.
FIGURE 18: GEOMETRY OF WOVEN FABRIC	ERROR! BOOKMARK NOT DEFINED.
FIGURE 19: GRAPH OF RATIO OF MODULUS AND WIDTH TO THICKNESS RATIO VS. EFFICIENCY FACTOR	ERROR! BOOKMARK NOT DEFINED.
FIGURE 20: RELATION OF RELATIVE PULL OUT STRESS GRAPH	ERROR! BOOKMARK NOT DEFINED.
FIGURE 21: RELATION OF RELATIVE PULL OUT STRESS	ERROR! BOOKMARK NOT DEFINED.

Chapter 1: Introduction

1.1 Technical Textile:

The term technical textile is defined as the ‘textile materials and products manufactured primarily for their technical or performance rather than the aesthetic or decorative properties^[3]. Other terms used for defining technical textiles include industrial textiles, functional textiles, performance textiles, engineering textiles, smart textiles and Hi-tech Textiles^[2].

Technical textiles are used as a component or a part of a product in order to enhance its functional and performance properties. Technical textiles sectors are developing their market segment around the world. Technical textile are used as both as functional or performance perspectives for e.g.in health and safety, cost effectiveness, durability, high strength, light weight, versatility, customization, user friendliness, eco friendliness, logistical convenience etc.^[2].

Technical textile has never been a single coherent industry sector and market segment. It is developing in many different directions with varying speeds and levels of success. The growing market of technical textiles, has classified technical textiles into twelve groups from the application point of view^[3].

1.2 Application of Technical textile:

Technical textiles are reported to be the fastest growing sector and account for almost 19% (10 million tons) of the total world fiber consumption. Technical textile products are used in 12 main areas which are as follows.

1.2.1 Agro tech:

It is used in agriculture, aquaculture, horticulture and forestry for example the nets use in the aquaculture for sea bream farming is manufactured from DSM Dyneema by Dutch company which consist of high molecular weight polyethylene fiber. The unique properties of Dyneema fiber, like high strength with low weight, high-strength, High Modulus, durability and excellent bite resistance, make it extremely suitable for use in sea bream farming^{[24][25]}.

1.2.2 Build tech:

It is used in a building and construction. Large pieces of precast concrete are manufactured from Carbon fiber which is high in strength, light weight and corrosion resistance form it an

ideal for use in concrete reinforcing materials. Group of precast concrete manufacturers “Altis Group members use Chomarat’s C-GRID®, as the carbon fiber epoxy based reinforcing in several precast building system products to enhance the strength and reduce the weight of precast concrete”^[16].

1.2.3 Cloth tech:

It is used in a technical component of footwear and clothing like swing threads, interlining etc. Anecord® Nylon is manufactured by American & Efird Company. It is made up of nylon fiber and consists of a monochord twisted filament nylon sewing thread. It have exceptional abrasion resistance, good seam strength and superior sew ability which make it suitable for used in sewing a wide variety of products such as in Automotive, Furniture’s, Medical and orthopedic devices etc.^[17].

1.2.4 Geo tech:

It is used in geo textiles and civil engineering like construction of bridges, railway tracks etc. Kevlar a para-aramid is developed by DuPont. This high performance fiber utilizes in the construction of buildings as they have high strength and high modulus at low weight, low elongation to break and high chemical resistance^[18].

1.2.5 Home tech:

It is used in technical components of furniture, household textiles and floor coverings. For example STAINMASTER® is made by Invista™ and it is use in floor covering. Fiber use in STAINMASTER® is **Nylon 6, 6 is used** in a set of rugs because it hold greater strength, resiliency and durability^[19].

1.2.6 Indu tech:

It is used in filtration, conveying, cleaning of gases and overflow liquids and other industrial uses. Lyocell which is used in conveyer belt is manufactured by Lenzing AG of Lenzing, Austria in the brand name of Lyocell by Lenzing and Tencel which is made from dissolving cellulosic pulp. It shares properties like they are soft, absorbent and very strong^[20].

1.2.7 Med tech:

It is used as an extracorporeal devices, non-implantable materials, and plantable materials and in hygiene and medical. For example Polytetrafluoroethylene (PTFE) fiber which is a synthetic fluoropolymer of tetrafluoroethylene therefore it is used in the manufacturing of vascular grafts as a plantable material for replacing thick arteries and veins. The brand name of PTFE is Teflon by DuPont^[21].

1.2.8 Mobiltech:

It is used in automobiles, shipping, railways and aerospace and also used textiles in seat covers, seat belts, car carpets etc. The fiber used in seat covers of cars or in automobiles is made up of Neoprene or polychloroprene is a family of synthetic rubbers that are formed by polymerization of chloroprene. Neoprene possesses a property of good chemical stability, and maintains flexibility over an extensive range of temperature^[22].

1.2.9 Oeko tech:

Some textiles are used in environmental protection. They do not create pollution in the environment. For example polyester and bamboo fiber are the recyclable fibers and do not create pollution into the environment.

1.2.10 Packtech:

Textiles used in packaging of food items, wrapping of textiles bales and carpets packing. Textile fiber use in a Tea bags made of polylactide (PLA) which is a bioplastic material or thermoplastic aliphatic polyester which is derived from renewable resources. The main producer of PLA (bioplastic) was nature work in the United States. They were using two main monomers lactic acid, and the cyclic di-ester lactide^[23].

1.2.11 Protech:

It is used for protection from heat, flames, chemicals, and from all the kinds of toxic gases. For protection against flame and heat a special clothing system is designed in which highly flame retardant textile material are utilized. Thus DUPONT manufacturer fiber Nomex (Meta Aramid) made from the solution of meta-phenylenediamine and isophthaloyl chloride in an amide solvent. Nomex fibers have the property of high heat and flame resistant, low elongation to break and high chemical resistance. Chemical structure of Nomex fiber is given below^[6].

1.2.12 Sportech:

Textile materials are used in sports as a sports active wears and leisure. SUPPLEX[®] fabric is made by the combination of nylon and Lycra fiber. It is engineered by the scientists of DuPont and Investa. SUPPLEX[®] fabric is highly breathable takes sweat away from the skin so they have high wicking property. Due to this property make them suitable for use in sportswear^{[3][26]}.

1.3 Classification of Protect (protective textile) [13]:

Protections of the individual are necessary especially in the industrial areas or when the environment condition is unsociable. Thus Personal protective textiles are further classifying into different types of protection this depends upon their end usage of their application such as thermal (cold) protection, flame protection, chemical protection, mechanical impact protection, radiation protection, biological protection, and electrical protection.

1.3.1 Fire Protection:

It has been impossible to stay alive for humans in the early age without the use of fire. Though, fire could be treacherous. Fire disasters occur more rapidly or frequently resulting in non-fatal and fatal casualties like skin burns. The most often ignited materials are the textiles, like upholstery and furnishings use in Hometech. It should yet be noted that the main cause of fatal , non-fatal and death casualties in a fire accident is not because of direct burning but it is due to the suffocation caused by the toxic gases released during burning, hence it is compulsory to use of non or low toxic burning materials is very important for fire protection. So a special type of protective clothing is designed which have must have two function, i.e., be flame resistant and form a fire and flame barrier. Kevlar and Nomex fiber are the inherently flame retardant material used in the protective clothing garment

1.3.2 Heat Protection:

There are three modes of transferring heat is either from convective, conductive, radiant and combination of all these modes. There must be protection are required from these kinds of heat transferring. Convective is the transferring of heat when air passess by the skin. If the temperature of the inward bound air is colder than the skin temperature, the air takes some

heat away during its channel along the skin. So for the protection from the convective heat, flame retardent property in the fabric must be required.

Similarly conductive is the transferring of heat between two surfaces at different temperature due to contact. Thus for the protection from convective heat tranfering high density or more fiber thickness fabric are required hence air trapped between the fiber are precieved to low thermal conductivity. In the same way protection for the radiative or electromagnetic haet transported metallized fabric or alluminizaed fabric are preffered.

1.3.3 Cold Protection:

It is important to protect human fom the cold environment in which larger human body heat loss is expected to the environment. Speciall clothing system is designed which is used in extreme cold environment. So the thermoregulating or temperature adaptable fabric like phase change materials (PCM) are working well in cold situation.

1.3.4 Chemical Protection:

In industries during manufacturing process surplus use of chemicals take place. If proper chemical handling are not doing it can cause many hazordous casualities like damaging nerve tissues, causing skin cancer and many others. Therefore in order to avoid from these types of casualities a chemical protective clothing is designed which protect the wearer from the strong chemicals.

1.3.5 Mechanical Impact Protection:

1.3.5.a Ballistic Protection:

Ballistic protections mostly required by the people who are soldiers in military, policmens, and other security officers. It protects wearer from bullets shot from handguns, rifles, machine guns, from fragmenting projectiles and other improvised weapons. consequently a special type fibers such as kevlar, tawron, spectra and dyneema are used while giving a ballistic protection to the wearer.

1.3.5.b Biological Protection:

Textile is designed for biological protection that could protect the wearer from the attack of bacteria, fungi, moulds, and other pathogenic germs or microorganisms.

The antimicrobial property present in the silk is used in different types of medical products like in sponges and gauzes similarly many type of antibacterial or antimicrobial finishes are applied onto the surface of textile in order to prevent these kinds of attack.

1.3.5.c Radiation Protection:

Special clothing is manufactured to prevent nuclear radiation, UV radiation and electromagnetic radiation. Nuclear radiations have three modes Alpha-Beta-Gamma rays. It is necessary to protect the peoples working in radioactive environment. If precautions are not taken than these high frequency radiations make a way into skin and cause diseases like skin cancer, lead to acute and chronic reactions, burning of the skin, in the same way many kinds of other injuries which is related to ageing of the skin.

1.3.6 Electrical Protection:

1.3.6.a Electromagnetic protection:

Peoples who are working in power plants, in power grids and who are using electrical equipment are necessary to protect them from the high voltage sources. From protection against higher voltages or electromagnetic sources a clothing system is used which is usually made up of different types of fibers combination such as “fabrics made of 25% stainless steel fiber with 75% wool blends or 25% stainless steel fibers with 75% aramid fiber” blends are used for the protection of the wearer from electromagnetic fields generated by high voltage.

1.3.6.b Electrostatic protection:

It is the protection of the wearer from electrostatic charges which can be easily accumulated in any textile materials. When there is a friction between fiber to fiber or yarn to yarn are there especially in the dry condition. Whenever charges are accumulated it would difficult to dissipate it.

The dissipation of the electrostatic charges results in sparks and shocks thus producing heat and flame in the industry. In order to prevent from these situations anti electrostatic finishes are applied onto the textile materials or to maintain level of humidity particularly in dry conditions.

1.4 Fibers Used in Technical Textiles:

There are many types of the fibers which are utilize in the technical textile area are belong to not only to high functional fibers but also included natural fiber and common man-made fibers, which is shown below in the given graph and in a given table .^[5]

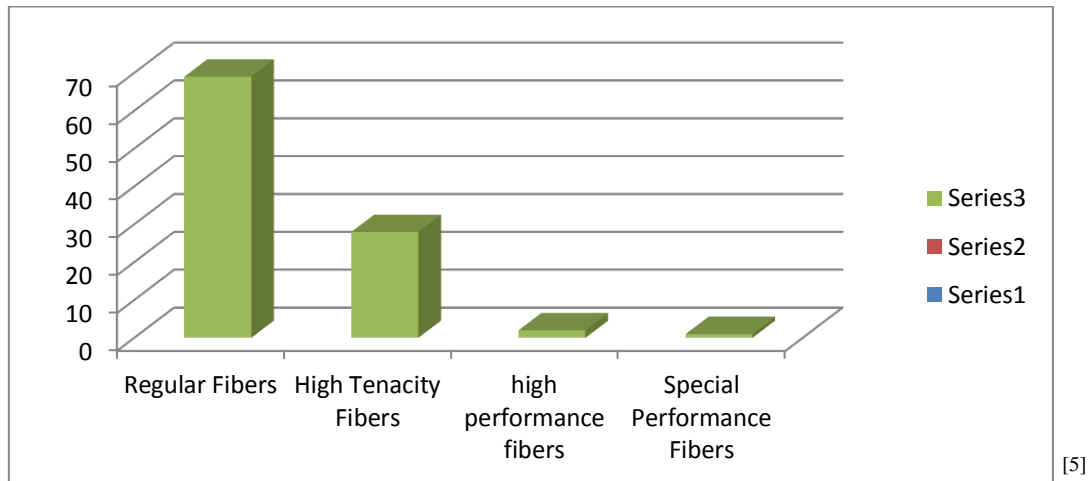


Figure 1: Fiber used in technical textile

1.5 Present Scenario of Technical textile:

Technical textile has become a fastest growing sector of the textile industrial sector. In 1997 almost 19% (10 million tons) fibers are consumed in the applications of technical textile. But now this figure is increased to 14 million tons by the year 2005. Technical textiles are estimated to account for well over 40% of the total textile production in many developed countries and in the year 2000 account for almost 20% of all textile manufacturing in China (Byrne 1997). The current volume of the market worldwide for technical textiles is more than \$60 billion. The average annual growth rate of technical textiles worldwide is expected to be around 3.8% for the period 2000 to 2005^[3].

The present market growth of Technical Textiles gives a new ways and opportunity to the textile industry to keep on progressing and provides a new direction for advancement of the industry. The field of technical textiles has not received adequate importance in most of the countries e.g. Pakistan, India, Bangladesh etc. but in some countries it shows remarkably positive results e.g. china, Japan America. The field of technical textile and the application of the technical textile have been increased globally and domestically. The below table which depict the present scenario of the market of technical textiles^{[4][5]}

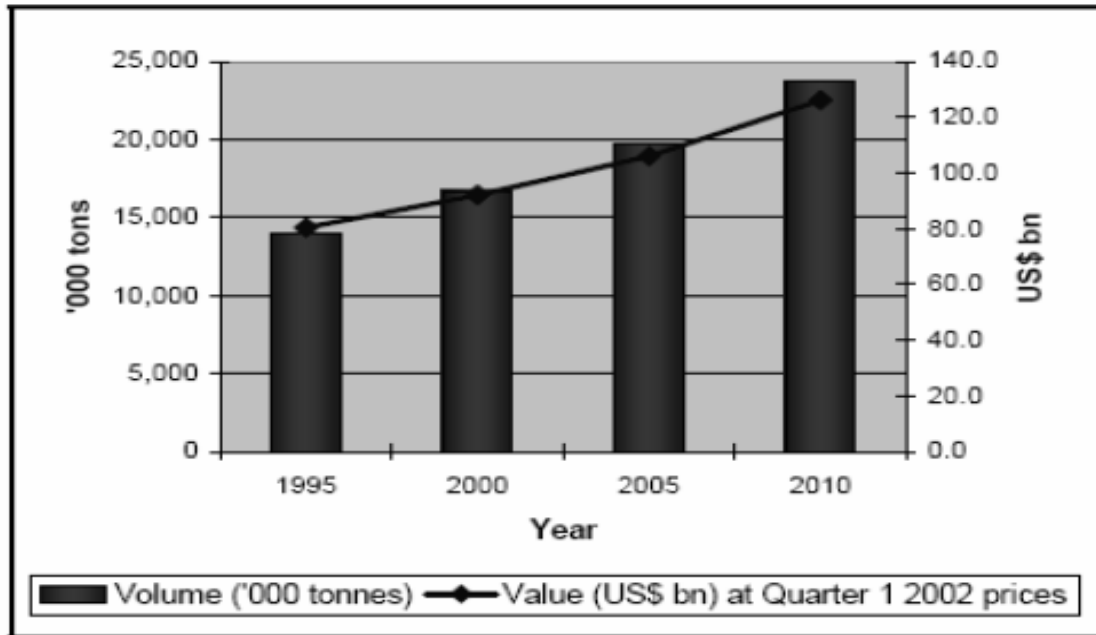


Figure 2: 1-2 graph ^[4]

Table 1: Present Scenario of Textiles ^[13]

Region/ Country	2000		2005		2010		CAGR % (vol.)	
	Volume '000 Tons	Value US\$ mn.	Volume '000 Tons	Value US\$ mn.	Volume '000 tons	Value US\$ mn.	00-05	05-10
Europe (West)	3,614	19,394	4,107	23,968	4,760	21,047	2.6	3.0
Europe (East)	548	4,043	666	4,583	817	5,225	4.0	4.2
America (North)	4,184	21,318	4,774	23,710	5,591	27,564	2.7	3.2
America(South)	847	5,723	1,004	6,348	1,230	7,255	3.5	4.1
Asia	6,604	39,970	8091	48,401	10,156	65,156	4.7	5.0
India	1,204	3,633	1,573	4,905	2,075	6,774	5.4	5.8
Oceania	99	484	116	578	141	712	3.2	3.9
Total	16,714	92,881	19,683	106,899	23,774	127,287	3.3	3.8

In this table, it may be observed that in terms of volume, overall technical textile consumption is expected to grow from 19.7 million tons to 23.8 million tons, with a CAGR of 3.8 %, during the period from 2005 to 2010. The developed countries viz., N. America and W. Europe have been forecast to have a decelerating growth while S. America, E. Europe and Asia are expected to grow well during the same period. As highlighted, the Indian market for technical textiles is expected to expand for technical textiles ^[4].

This table shows the consumption of the fiber in the field of technical textile in the world market. It also shows the increase in the percentage rate of the usage of the technical textile product and the appreciation of the field of technical textile in the global market.