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FRICTION ANALYSIS BETWEEN SKIN AND FABRIC

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Abstract: Friction plays a critical role in the interaction of skin and fabric. Increasing skin wetness impact on the skin and fabric, resulting in discomfort or skin infections. In this study, fabric will be examined by comparison of the woven fabric, crimp and knitted fabric. Knitted fabric has a non-uniform rough surface compared to other fabrics. Friction and sheer forces acting on the skin under increased moisture and temperature level in sportswear. As the study, result show that knitted fabric are suitable for sportswear according to the performance of the athlectics. After the all research, may be experimenting with another different fabric at another stages of performance for the better future relevant.

Index Terms **–** Fricttion, Adhesion, Deformations, Coefficient, Comfortability

I. INTRODUCTION

Friction is a force that resist the motion of one object against another. Friction occurs in human skin when repeatedly rubs against fabric , seams , tight clothing . When body skin start feeling rough , uneven , poor moisturizing then it's affect in players performance and comfortness. Human skin having extended contact while playing the games , it's all depend on the clothing material. The presence of friction is the adhesion between sportswear and body , the resulting in poor performance, discomfort, body reaction, skin diseases : eg - socks causing friction while running, skin irritation from tight athletics wear . Sportswear intimate healthcare products are inevitably under moist conditions. The selection of clothing material becomes important to ensures excercise performance and wear comfort and textiles which minimize stickness sensation seem to be an appropriate choice[4]. Properties of the fabric plays measure role in the friction it's affect the appearance of sports wear , which further complicate to handle during the performance.

In this research, we study about the comparison between fabric like knitted fabric test done by the Eular formula:-

$Q2 = ef\varphi\ (Q0 + p0S) = Q1\ ef\varphi$.[5]

In crimp fabric , done by Coulomb's friction:-

$$f\mathrm{t} = \mu\mathrm{N}.^{[6]}$$

In non woven fabric, friction test have been applied on specimen produced with different weighted polypropylene based spunbond technique[7].

In this study , friction test apply between the woven , non woven and crimp fabric to examine the which one fabric will better for the athletics performance.

II. LITERATURE REVIEW

Analysis of inter yarn friction in plain fabric with varied thread densities

This study is about the role of inter yarn friction in plain fabric with varying thread densities. The main point is that how inter fabric friction is a crucial role in reserve yarn ability to dissipate energy . The friction characteristics of yarn mostly define by the friction coefficient. The expanded inclusion of increasing auxiliary yarns which could be a coordinated with positive results as yarn - to - yarn friction.The part of friction isn't alll about to upgrade through frictional sliding but through expanded yarn kinetic energy as well as through yarn strain progressed . Its concluded that the increase of energy absorption is highly sensitive to the compare of low range friction even with a slight increase in friction coefficient, the energy absorption increased directly.

Tactile perception of textile fabric based on friction and brain activation

Tactile perception plays a role in the interaction of humans and environment. The coefficient of friction increase with the normal load , indicating that the skin deformation mechanism are related with friction of skin against fabrics . The feature of coefficient of friction have a strong correlation with perceived fineness , slipperiness and prickliness of fabric due to low surface roughness. In that adhesive friction is proportional to Ar and u increases with the decreasing normal load . From that adhesive friction was too small. As the weave construction of fabric , fiber friction also influenced the friction . This study is meaning for evaluating the tactile stimulation of textile fabric and understanding the cognitive mechanism in the tactile perception of textile fabric.

Biomechanical Monitoring in Athletics Performance

Human movement involves complex interactions between neurological control and environmental factors. These systems provide extraordinary detail about joint angles , ground reaction force and movement cordination .These device enable field based monitoring during actual training and competition, sustainability improving practical utility. Wearable alternatives emerged using accelerometer and gyroscope attached to athletes bodies or embedded in footwear . Biomechanical analysis makes these invisible patterns visible , enabling targeted intervention that enhance performance and prevent injuries . Early system faced challenges with data interpretation to extract meaningful biomechanical parameters.

Assessing the accumulated stickiness magnitude from fabric - skin friction: effect of wetness level of various fabric

Human skin having extended contact with textile from sleeping, working , walking condition of clothing material. Increasing skin weakness tends to increase fabric -skin adhesion and friction, resulting in wear discomfort or skin injuries . This study suggests us the way to predict perceived stickiness in fabrics with different wetness levels which is useful for application like sportswear . In this research for testing the fabric , seven fabric types were wetted by putting onto wet skin surface and dried for different duration to achieve different wetness levels , results showed that the relationship between magnitude estimate of stickiness and amount of water present in fabric demonstrated a power function. The result show that thin cotton fabric in particular give sticker feeling . This study also suggest that magnitude estimation can be used to investigate other sensorial comfort factor for sportswear.

Study of friction in the " textile - human" system for the ergonomic design of sustainable function clothing

Friction is one of the key factor affecting the tactile sensation form the sportswear which and athletes experience during the training process. This study investigated the frictional interaction of textile samples with prototypes of human body surface segment made of solid polymer base and medical purpose silicon . The obtained data have a wide application range in the scope of tight fitting sportswear and medical clothing production . Its develop and manufactured a pilot plant for the study of the frictional interaction between clothing and the surface of the human body . This phenomenon can be

explained by the above - mentioned mechanism of friction force , based on the simultaneous action of forces aimed at overcoming the elements that caused frictional interaction and the forces of molecular attraction of the contiguous partical.

Investigation on friction behaviour uni and bidirectional non crimp fabric.

The friction behavior of engineering textiles directly affects the forming quality during composite molding processes. In forming tests of dry engineering textiles large relative slip between plies and the tools is observed. The characterization of friction is commonly conducted via relative motion between a fabric ply and either another fabric ply (ply-ply) or a tool (tool-ply) under controlled transverse pressure.The results of this study allow a better understanding of the relevant factors influencing the friction behavior of both investigated non-crimp fabrics. They can be used in forming simulation models to analyze the impact on the resulting slippage between individual plies and between plies and tools.

Effect of Weight and Apllied Force on The Friction Coefficient of The Spunbond Nonwoven Fabrics.

Friction experiments have been performed by designed and manufactured two different systems which work as a horizontal platform and inclined plane. It has tried to investigate friction properties of polypropylene (pp) nonwoven fabric samples which are produced by spunbond methods (filament laid and thermal bonding) with different weight. The purpose of this study is to obtain results which can be understood and applied and repeated in uniformity by everyone so as to determine surface and handle properties of fabrics based on various methods. It is believed that obtained test results and devices which are designed and manufactured provide an important database for all researchers and industrialists who want to determine the frictional properties of fabrics, as well as supporting further research in this area.

Plantar pressure and foot biomechanics

The foot serves as the body's primary interface with the ground, managing impact forces during activities like running that can exceed three times body weight . Recent advances in textile pressure sensors use conductive fabric that change resistance when compressed. Capacity sensors measure pressure through changes in electrical capacitance when conductive layers compress together. Resistive sensors employ material whose electrical resistance changes under mechanical load . Both approaches face challenges with durability, temperature sensitivity and pressure reading that depend on loading history rather than instantaneous force alone . However, textile sensors electrical properties vary with moisture, temperature and fabric from electrical signals to absolute pressure values.

Design and development of smart textile technology for athletics performance

This research develop an innovative smart sock technology integrating miniaturized sensors directly into structure. Athletics performance optimization increased depend on precise biomechanical data collection during training and competition. This study is about the growing demand for unobtrusive wearable technology that provides real time performance without disturbance of athletics performance . The research contributes to both academic understanding of smart textile development and practical implementation of wearable athletics monitoring system . This system integrates pressure, temperature, motion tracking into comfortable, durable with repeated washing and intense use of sock.User acceptance testing confirmed that athletes found the technology comfortable, usable and valuable.

Acute effects of footwear and surface condition on sport specific performance in athletes.

This study examined the acute effects of minimalist shoes, standard sport shoes, and barefoot conditions on sports-specific performance in forty-eight team and racket sport athletes across three testing sessions. Biomechanical laboratory assessments included 90° cutting maneuvers (90°COD) and jump tests. Linear (LS) and multidirectional sprint (MS) performances were evaluated in a second session on an indoor sports floor.Additionally, there was an indication of sex-specific responses to the shoe change in the MS. These findings suggest that the effects of minimalist footwear are context-dependent and should not be generalized without considering specific surfaces, movements, and individual factors.

III. METHODOLOGY

Friction analysis between skin and fabric :-
It is usually to describe the coefficient of friction of skin
F = kWn
u = kWn−1

where F is the friction force, W is the normal load, u is coefficient of friction k is a load-dependent coefficientof friction, and n is the load index.
Because of the viscoelastic properties, the frictionof human skin depends on the normal load, effectivecontact area, and elastic modulus. The friction forcecomes from the adhesive friction Fadh and deformation friction Fdef between the skin and material surface . As shown ,for all fabric samples u increased with the increasing W, indicating that the skin deformation mechanisms are relevant for the friction of skin against fabrics. Friction force mainly comes from deformation friction between the skin and fabric surfaces, and the adhesion friction was relatively small. Meanwhile given by the hairiness and weave construction of fabric, fiber friction also influenced the friction[3].

Study related to knitted fabric
The tension measurements of the samples of knitted fabrics were carried out using a piezoresistive pressure sensor. For this purpose, we calibrated the device, then we obtained the calibration curve and the corresponding functional dependence:
y = 484.54x-1.2313

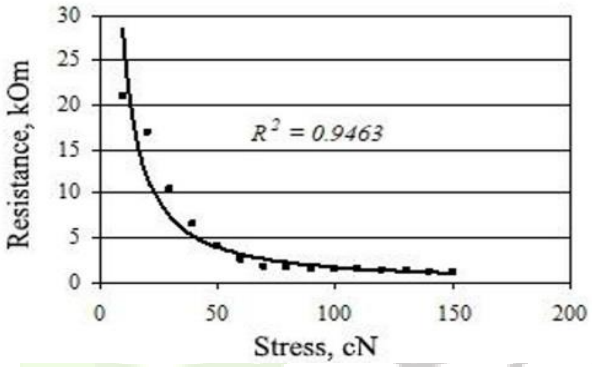

Figure 1

This table is explaining by the I.N .tyurin in their previous paper then I carried out an analysis of possible movements of the rotational type in the "man-fabric shell" system, then we determined a range of rotation frequencies and a list of wrap angles of the bearing surface by the knitted fabric. Knittedfabrics have a non-uniform rough surface, which can be represented as alternating protuberances and cavities, depending on the structural characteristics of the weave, as wellas non-alternating (random) formations in the form of pills, fibre particles, etc. When theknitted fabric is in contact with other surfaces, at the points of convergence occurs the forces the contact areas experience compression deformations, the energy transfer according to the principles of dissemination of acoustic waves and subsequent slip of the common contact areas in the direction of greater forces[5].

Study related to crimp fabric
The final fiber orientation in components manufactured from liquid composite molding processes is significantly influenced is relative slip between individual fabric layer as well as the tools. The relative movement results in tangential friction, which induces in-plane stresses and impacts me the fabric's deformation. This influences the material draw-in and can potentially result in defects such as gapping or ruptures of the textile .Non-crimp fabrics (NCFs) have straight fibers compared to woven fabrics with undulated fibers and therefore provide a higher lightweight potential. However, they are more susceptible to defects due to the low stiffness and strength of the stitching.
In this work, the tangential friction behavior at interfaces between ply and tooling and between plies of a unidirectional and a bidirectional non-crimp fabric are investigated in sled pull-over-tests [6].

Study related to non woven fabric

In this study, friction tests have been applied on nonwoven fabric specimens produced with different weighted polypropylene based spunbond technique with testing devices that work on two different principles. As a result of this study, it has been observed that fabric weight and the force applied on fabric are two effective parameters on fabric-fabric friction coefficient of the nonwoven fabrics.

For the purpose of this study, frictional properties of nonwoven fabrics have been tested by using two different working principle devices. These devices are named as Horizontal Platform Experiment Device and Inclined Plane Experiment Device".For the purpose of this study, frictional properties of nonwoven fabrics have been tested by using two different working principle devices. All tests have been conducted in a controlled environment with a temperature of 20±2 °C and relative humidity of % 65±5. Test results show that, as weight increases, nonwoven fabrics with more stable structure have lower friction coefficient.[7]

Comparison study between different fabric

Table 1

	CRIMP FABRIC	**kNITTED FABRIC**	**NON-WOVEN FABRIC**
Structure	Textured yarn	Interlocked loops	Bonded fiber
Moisture	Very good due to air trapping	Excellent rapid wicking	Varies often hydrophobic
Stretchability	Higher	Excellent	Lower
Fiction	Medium range	Low range	High range
Breathability	Moderate to high	Higher level	Lower level
Comfort	High (bulky)	Very high (soft)	Low (stiffer)
Performances	Provide soft cozy hand feel including bulk	Offer highest flexibility , allowing atheletes maximum range of motion	Weaker than knitted and crimp fabric , they are very cost – efficient to produce and versatile

fabric code	fabric type	fabric structure	fibre content	yarn count (tex)[a]	weight (g m^{-2})	thickness (mm)	porosity	water absorption time (s)[b]	water absorption capacity (WAC) (mg cm^{-2})[c]	surface friction (MIU)[d]	surface roughness (SMD)[e]
KD1	knitted	single jersey	60% polyester, 40% cotton	18.4	144.6	0.56	0.8224	15.5	37.17	0.191	1.68
KD2	knitted	single jersey	95% rayon, 5% spandex	18.4	259.0	0.86	0.8022	0.7	61.54	0.211	2.26
WD1	woven	plain	cotton	7.4	56.6	0.37	0.9002	31.8	14.62	0.177	3.44
WD3	woven	plain	cotton	14.8	156.9	0.42	0.7598	13.0	18.26	0.181	2.89
W3M[f]	woven	plain	96% polyester, 4% spandex	6.6	89.1	0.28	0.7685	>60	16.46	0.210	2.36
SIL	woven	plain	silk	5.9	57.9	0.16	0.7299	>60	12.40	0.139	1.89
PET2	woven	satin	polyester	4.5	66.8	0.12	0.6024	>60	7.27	0.132	1.68

Figure 2

IV. RESULT

The increase of inter yarn to participate in the process of energy absorption in the fabric . As the study , friction analysis between skin and fabric is important for foot health and comfort. During walking and running, friction and sheer forces acting on the skin under increase the moisture and temperature levels within sports shoes are main reason of foot blisters. It should be noted that , knitted fabric have a non uniform rough surfaces, which can be represented as alternative cavities, depending on the structural characteristics weave, as well as non alternative formation in fiber particle [5] . The result about crimp fabric allow understanding of the relevant factor influencing friction behaviour of both investigated non crimp fabric [6] . The performance are good but not better that then knitted fabric , As a result of the non woven fabric, it has been observed that fabric weight and the force applied on fabric are two effective parameter on the fabric-fabric friction coefficiency of the nonwovenfabrics[7].

Overall study of the results are knitted fabric are suitable for Sportswear according to other fabric performance including breathability, moisture, friction , etc.

V. CONCLUSION

Analysis of obtain data indicates the friction between skin and different types of fabric. After preparing the fabric at different level in moisture,breathability, friction, comfort, overall conclusion come in favour of knitted fabric for the sportswear. After the all research, may be experimenting with another different fabric at another stages of performance and comfortability to better result of the sportswear without any other effect in government for future relevant.

This is study suggested that comparison between another fabric with method of coefficiency of friction tactile perception of fabric,critical bulking, force of parameters in quantitatively characteristic of fabric.

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