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EFFECT OF SOME CONSTRUCTION ELEMENTS ON THE FUNCTIONAL PROPERTIES OF CAR SEAT FABRICS

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ABSTRACT

Textiles in transportation are classed as technical because of the very high performance specifications and special properties required.. The seat is probably the most important item in the car interior. It is the first thing the customer sees when the car door is opened and he or she will probably instinctively touch it; there is only one opportunity to make the most of this first impression. The seat is also the main interface of man and machine and seat comfort is of paramount importance.

The objective of this study is investigating the impact of some geometrical construction elements on the functional properties of car seat fabrics, five chenille yarns were produced with different pile lengths and different pile materials. chenille yarns were used for producing chenille fabrics (fifteen) samples with two different weave structures ,in addition to the usage of two different materials for the auxiliary weft.

Keyword***: car seats, technical textile, mobiltech, Chenille yarn, Abrasion resistance, tensile strength, phase change materials (PCMs).***

I. INTRODUCTION

Textiles provide a means of decoration and a warm soft touch to surfaces that are necessary features for human well being and comfort, but textiles are also essential components of the more functional parts of all road vehicles, trains, aircraft and sea vessels[1].

Along with the growth in the number of vehicles worldwide, the amount of textile materials used in motor vehicles has increased [2]. As can be seen in Fig (1), the second largest area of technical textile application is mobiltech.

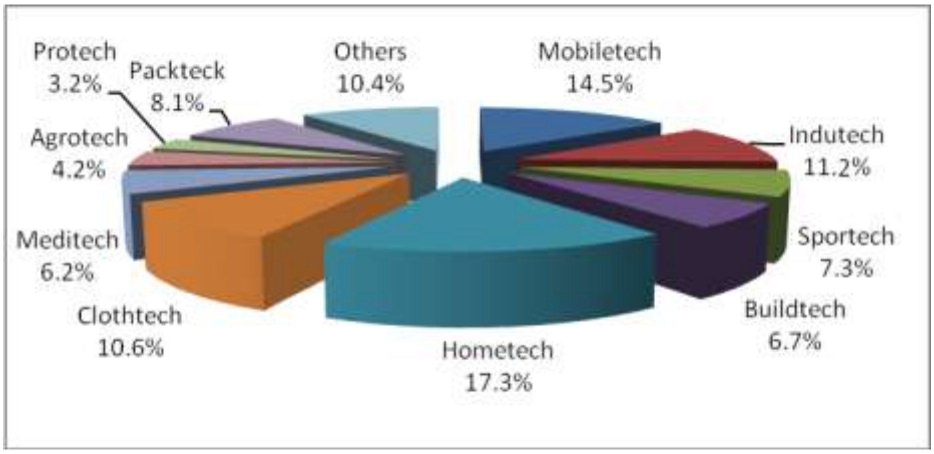

Fig (1) World end- use consumption of technical textiles in terms of application area, 2011 [3].

I CAR SEAT FABRICS (REQUIREMENT & DESIGN)

Although textiles have been used in some car seats since the invention of the car, widespread use has only occurred since the mid-1970s. The technology and manufacturing methods are still on the 'learning curve' compared to other sectors of the textile industry[1].

1-1: Car seat covering requirement

For seat coverings the main technical requirements are resistance to sunlight (both colour fading and fabric degradation by UV), abrasion resistance and, for public transport vehicles, reduced flammability. Table (1) shows a summary of the requirements for car seat classification, taking into account their relative importance. As shown, the most important physical requirements are abrasion and pilling resistance.

Table (1) Requirements on cover materials for car seat

("+"means important and "++"very important) [4]

Seat requirement	+	++
Optic/Aesthetic		
- Touch		■
- Color		■
- Brightness/Dullness		■
Price		■
Resistant to wear and load		
- Light fastness		■
- Abrasion resistance		■
- Pilling resistance		■
- Fastness		■
- Tenacity-elongation	■	
- Dimensional stability		■
Resistant to ageing		
- Light resistant		■
- Temperature resistant		■
Industrial Production (flexibility)	■	
Soil resistant-easy to clean		
- soil resistance	■	
-cleaning ability	■	
Seat comfort		
- Surface softness	■	
- Humidity absorption	■	
- Humidity transport	■	
- Static charge	■	
Recycling		■

1-1-1: Abrasion resistance

Seating fabric needs to be of the highest standard of abrasion resistance. Only polyester, nylon and polypropylene are generally acceptable, although wool is used in some more expensive vehicles because of its aesthetics and comfort. Fabric abrasion is influenced by yarn thickness, texture, cross-section and whether spun or continuous filament. Those factors that result in larger surface area or provide points of frictional stress reduce abrasion resistance. Fabric construction and weight have an effect on abrasion[5].

1-2: Car seats fabric design process

The textile designer must be able to produce innovative interior appearances which reflect or even set current fashion trends, social and economic moods and customer lifestyles. Whilst at the same time being compatible with the exterior colour and car shape. The textile designer must be able to select of: fibre types, yarn types and fabric structures.

1-2-1 Fiber selection

The two most important factors governing the selection of fabrics for car seat covers are resistance to light (UV radiation) and abrasion. These factors have resulted in polyester emerging as the predominant fibre now accounting for about 90% of all textile seat covers worldwide [6].

1-2-2 Yarn types

Fabrics are generally produced from bulked continuous filament (BCF) textured polyester yarns; false twist, knit de knit and air texturising are common, although the latter method is the most used [1].

1-2-2-1 Chenille yarn.

Chenille yarns are fancy yarns with beautiful, soft and fuzzy surfaces. They have become the choice of designers for many items, they used in both woven and knit constrictions and are popular for use in apparel (sweater, out wears, blankets), home textile (upholstery, curtains, bed-spread-rugs) and automotive (decorative fabrics, seats fabrics) [7].There are existing different methods of the chenille yarn production as follows: weaving, knitting, flocking and twisting methods. The latter method used greater than the previous methods [8].

1-2-3 Fabric structure.

The main car seat fabric types with typical weight ranges are: [9]

flat woven fabric (200– 400g/m2) ,flat woven velvet (360–450g/m2) ,warp knit tricot (generally pile surface,160–340 g/m2), raschel double needle bar knitted (pile surface, 280–370 g/m2) , Circular knits (generally pile surface, 160–230 g/m2) , Fabrics in nylon tend to be towards the lower weight range.

II. Materials and Methods.

2-1 Specification of produced chenille yarns.

Chenille yarns (five samples) were produced by using two parameters:

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1. **Pile materials:** Outlast® Polyester 80/36 denier Filament Yarn,Pcm (**OLPF**) , Outlast® viscose polyester 36/1 Ne spun yarn, Pcm (**OLV,p**) and polyester 75/36 denier Filament Yarn (**without pcm, control sample**)
2. **Pile length:** Two pile lengths (1mm & 3 mm) were used in the research for producing the chenille yarns.

2-2: Specification of produced chenille fabrics.

The five chenille yarns were used for producing the chenille fabrics (15 samples) with two different weave structures (depending on the arrangement between chenille weft and auxiliary weft). . Addition to use two different materials for auxiliary weft.

2-2-1: The weave structure of the chenille fabrics.

Two different weave structures were used for producing the chenille fabrics both of them follow double-cloth construction, the arrangement of warp (three ends back to one end face):

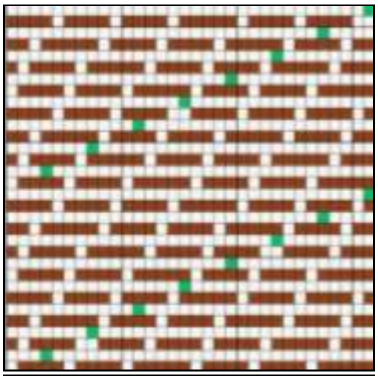

Fig. (2): the first structure (A) the arrangement of the weft (one auxiliary to one chenille)

Pick for auxiliary weft

Pick for chenille weft

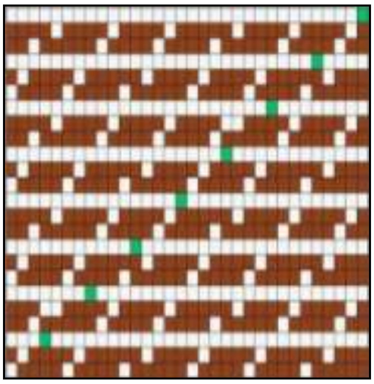

Fig. (3): the second structure (B) the arrangement of the weft (two auxiliary to one chenille)

2-2-2: chenille fabrics Specification.

The below table (2) shows the operational specifications of the produced samples

Table (2) The operational specifications of the produced samples

Sample Number	Chenille weft material	Chenille pile length	Auxiliary weft material	Fabric structure	Picks/cm
1	**Core**: 2*polyester 80/36 pcm* **Pile**: 4* polyester 80/36 pcm	1mm	1* polyester 80/36 denier pcm	A	45
2	**Core**: 2*polyester 80/36 pcm **Pile**: 4* polyester 80/36 pcm	3mm	1* polyester 80/36 denier pcm	A	42
3	**Core**: 2*polyester 80/36 pcm	1mm	1* polyester 80/36 denier	A	42

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	Pile: 4*viscose/polyester 36/1 Ne. Pcm		pcm		
4	**Core**: 2*polyester 80/36 pcm **Pile**: 4*viscose/polyester 36/1 Ne. Pcm	3mm	1* polyester 80/36 denier pcm	A	40
5	**Core**: 2*polyester 80/36 pcm **Pile**: 4* polyester 80/36 pcm	1mm	1*viscose/polyester 36/1 Ne. Pcm	A	45
6	**Core**: 2*polyester 80/36 pcm **Pile**: 4* polyester 80/36 pcm	3mm	1*viscose/polyester 36/1 Ne. Pcm	A	42
7	**Core**: 2*polyester 80/36 pcm **Pile**: 4*viscose/polyester 36/1 Ne. Pcm	1mm	1*viscose/polyester 36/1 Ne. Pcm	A	42
8	**Core**: 2*polyester 80/36 pcm **Pile**: 4*viscose/polyester 36/1 Ne. Pcm	3mm	1*viscose/polyester 36/1 Ne. Pcm	A	40
9	**Core**: 2*polyester 80/36 pcm **Pile**: 4* polyester 80/36 pcm	1mm	2* polyester 80/36 denier pcm	B	55
10	**Core**: 2*polyester 80/36 pcm **Pile**: 4* polyester 80/36 pcm	3mm	2* polyester 80/36 denier pcm	B	48
11	**Core**: 2*polyester 80/36 pcm **Pile**: 4*viscose/polyester 36/1 Ne. Pcm	1mm	2*viscose/polyester 36/1 Ne. Pcm	B	48
12	**Core**: 2*polyester 80/36 pcm **Pile**: 4*viscose/polyester 36/1 Ne. Pcm	3mm	2*viscose/polyester 36/1 Ne. Pcm	B	42
13	**Core**: 2*polyester 80/36 pcm **Pile**: 4* polyester 80/36 pcm	1mm	2*viscose/polyester 36/1 Ne. Pcm	B	55
14	**Core**: 2*polyester 80/36 pcm **Pile**: 4* polyester 80/36 pcm	3mm	2*viscose/polyester 36/1 Ne. Pcm	B	48
15 Control **Without pcm**	**Core**: 2*polyester 75/36 denier **Pile**: 4* polyester 75/36 denier	1mm	1* polyester 70/36 denier	A	45

*Pcm [10].

2.3 Laboratory Test

2-3-1 tensile strength test (Grab method)

This test was carried out by using (SDL ATLAS tester) according to the American Standard Specification of (ASTM D5034 -09 (2013)) [11].

2-3-2 Fabric stiffness test

This test was carried out by using (Digital Pneumatic Stiffness Tester) as shown in figure (2-11) according to the American Standard Specification of (ASTM D4032-08)[12].

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2-3-3 Fabric abrasion resistance test. (mass loss)

This test was carried out by using (Martindale Abrasion Tester) according to the American Standard Specification of (ASTM D4966 – 10) [13].

III. RESULT AND DISCUSSION

Table (3) produced chenille fabrics testing results
*** Control sample (without pcm)**

	Structure A								Structure B						Control*
	Polyester Auxiliary				Viscose Auxiliary				Polyester Auxiliary		Viscose Auxiliary				polyester
	Polyester pile		Viscose pile		Polyester pile		Viscose pile		Polyester pile		Viscose pile		Polyester pile		polyester
	1mm	3mm	1mm	3mm	1mm	3mm	1mm	3mm	1mm	3mm	1mm	3mm	1mm	3mm	1mm
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Weight (g/m^2)	673	818	1086	1315	679	937	1095	1330	596	685	850	1021	623	884	597
Tensile strength (warp)(N)	1367	1380	1386	1400	1375	1420	1430	1445.6	1361	1375.6	1392	1415	1370	1401.8	1296.6
Tensile strength (weft) (N)	716.8	719.8	661.4	657	604.6	604.2	556.4	555.8	775.4	760.4	450.4	440	630	635	793.2
Stiffness (N)	53.36	109.38	138.46	256.94	55.44	150	165	274.69	39.92	55.2	68.08	107.35	46.68	89.33	58.89
Abrasion resistance (%)	2.5	2	3.15	2.65	1.48	0.74	1.6	1.51	3	2.75	4.5	3.5	2.5	1.75	6.5

3-1 Tensile strength in warp direction

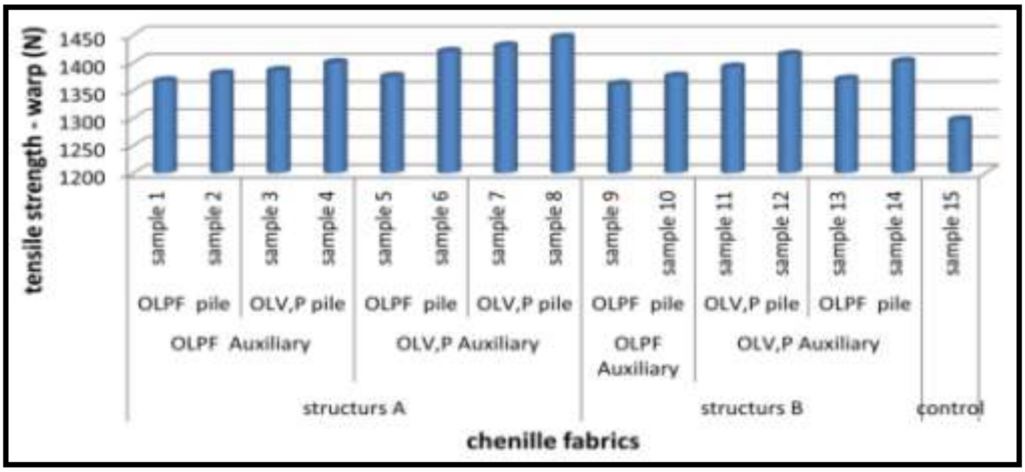

Fig.(4) results of produced chenille fabrics tensile strength in warp direction.

3-1-1 Effect of Chenille's pile yarn material on tensile strength in warp direction.

figure (4) show that the fabrics produced from (Viscose, pcm) have recorded the highest rates of tensile strength in warp direction followed by (polyester, pcm). This is owing to the increase in chenille yarn count increasing warp crimp as a result, the resistance of fabrics to tensile strength in warp direction increased.

* Sample one (Polyester, pcm) has recorded high rates to fabric tensile strength in warp direction compared to sample fifteen (Polyester, without pcm)

3-1-2 Effect of Chenille's pile length on tensile strength in warp direction.

From figure (4) it can be noticed that, there is a direct relation between the tensile strength in warp direction and Chenille's pile length, so as the pile length increase the tensile strength in the warp direction increases and vice versa. This is because of the increase in the pile length which leads to an increase in the warp crimp, as a result the fabric tensile strength in warp direction increased.

3-1-3 Effect of weave structure on fabric tensile strength in warp direction.

From figure (4) it can be seen that, (Structure A) has recorded higher rates of fabric tensile strength in warp direction followed by (Structure B). This is due to the increase in chenille yarn percentage in the weave structure that lead to an increase in the warp crimp, as a result the fabric tensile strength in warp direction increased.

3-1-4 Effect of auxiliary weft materials on fabric tensile strength in warp direction.

From figure (4) it is clear that, the auxiliary weft produced from (Viscose, pcm) has recorded the highest rates of fabric tensile strength in warp direction followed by (polyester, pcm), this is due to (viscose, pcm) count is thicker than (polyester, pcm) which leads to an increase in warp crimp *(more length)*. So as a result the usage of (Viscose, pcm) as an auxiliary weft leads to an increase in fabric tensile strength in warp direction and vice versa.

3-2 Tensile strength in weft direction.

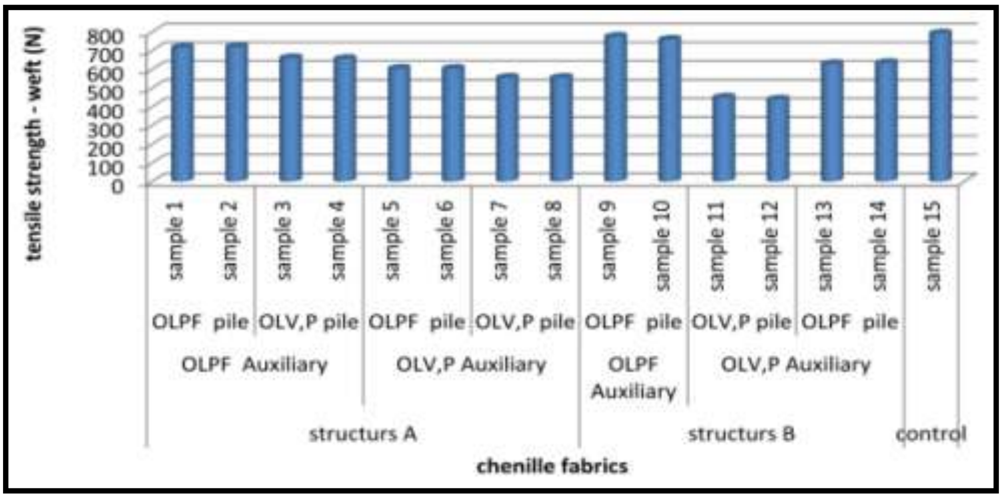

Fig.(5) results of produced chenille fabrics tensile strength in weft direction.

3-2-1 Effect of Chenille's pile yarn material on tensile strength in weft direction.

from figure (5) it is obvious that (polyester, pcm) yarns have recorded the highest rates of tensile strength in weft direction followed by (viscose, pcm). This is due to that Polyester fibers have a higher tenacity compared to other materials, this is mainly due to their extremely crystalline polymer system, which prevents the Polyester polymers from yielding readily when the filament fiber is bent or flexed. [14].

* sample fifteen (Polyester, without pcm) has recorded high rates of tensile strength in weft direction compared to Sample one (Polyester, pcm).

3-2-2 Effect of Chenille's pile length on tensile strength in weft direction.

It can be noticed from figure (5) that the pile length of chenille yarns do not represent any significant effect on the fabric tensile strength in weft direction.

3-2-3 Effect of weave structure on fabric tensile strength in weft direction.

From figure (5) it can be seen that, (Structure B) has recorded higher rates of fabric tensile strength in weft direction followed by (Structure A), mostly when it uses (polyester, pcm) as a chenille weft. This is owing to the increase in weft density per centimeter in weave structure, increasing the number of the yarns under the jaws of tensile testing machine, which leads to an increase in the tensile strength in the weft direction. As a result (Structure B, more picks / cm) reveals higher tensile strength in the weft direction than (Structure A).

3-2-4 Effect of auxiliary weft materials on fabric tensile strength in weft direction.

From figure (5) it can be observed that, (polyester, without pcm) auxiliary yarns have recorded the highest rates of tensile strength in weft direction followed by (polyester, pcm),(Viscose, pcm) respectively. This is due to (polyester, without pcm) has a high tenacity, *37.12 CN/Tex* compared to (polyester, pcm) which has a tenacity, *26.43 CN/Tex* and (Viscose, pcm) which has a low level of tenacity, *13.9 CN/Tex*.

3-3 Stiffness

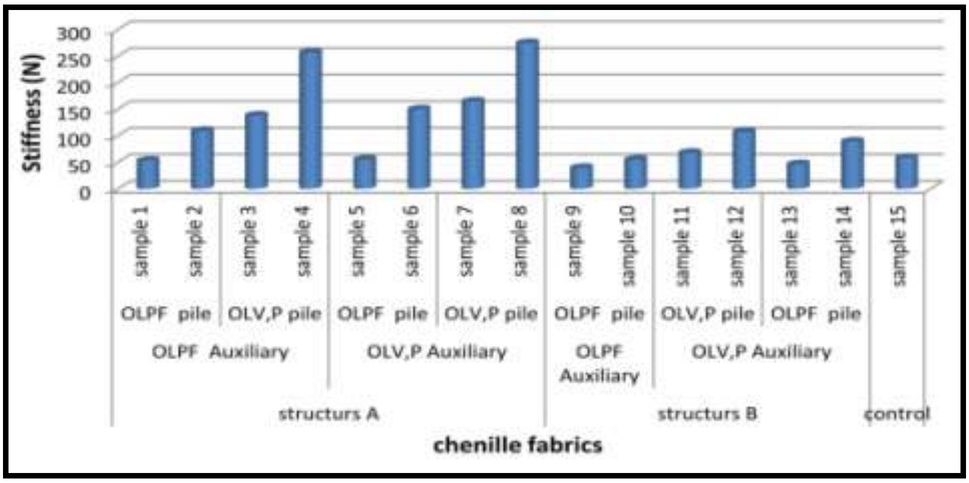

Fig.(6) results of produced chenille fabrics stiffness

3-3-1 Effect of Chenille's pile yarn material on stiffness.

From figure (6), it can be observed that, chenille fabrics produced from (Viscose, pcm) have recorded the highest rates of fabric stiffness followed by (Polyester, pcm). This is due to the increase in yarn diameter leads to an increase in the bending resistance of fabrics. So as a result uses chenille yarn produced from (Viscose, pcm) (low yarn count in Indirect system counts) increases chenille fabrics stiffness.

* Sample one (Polyester, pcm) has recorded insignificant value of fabric stiffness compared with sample fifteen (Polyester, without pcm)

3-3-2 Effect of Chenille's pile length on stiffness.

From figure (6) it is obvious that, there is direct correlation between the fabric stiffness and pile length, this is due to increase of the yarn pile length increase the chenille yarn diameter and increase the thickness of produced fabrics. So as a result the thicker fabrics are stiffer than others. [15].

3-3-3 Effect of weave structure on stiffness.

From figure (6) it can be seen that, (Structure A) has recorded the high rates of fabric stiffness followed by (Structure B). This is because of the fact that the increases in chenille yarn weft percentage in weave structure leads to an increase in the stiffness of fabrics and vice verse.

3-3-4 Effect of auxiliary weft materials on stiffness.

From figure (6) it is clear that, there is a direct relationship between the fabric stiffness and the usage of (Viscose, pcm) as an auxiliary weft, this is due to (viscose, pcm) count is thicker than (polyester, pcm). So as a result usage (Viscose, pcm) as an auxiliary weft leads to an increase in the fabric bending resistance and vice verse

3-4 Abrasion Resistance

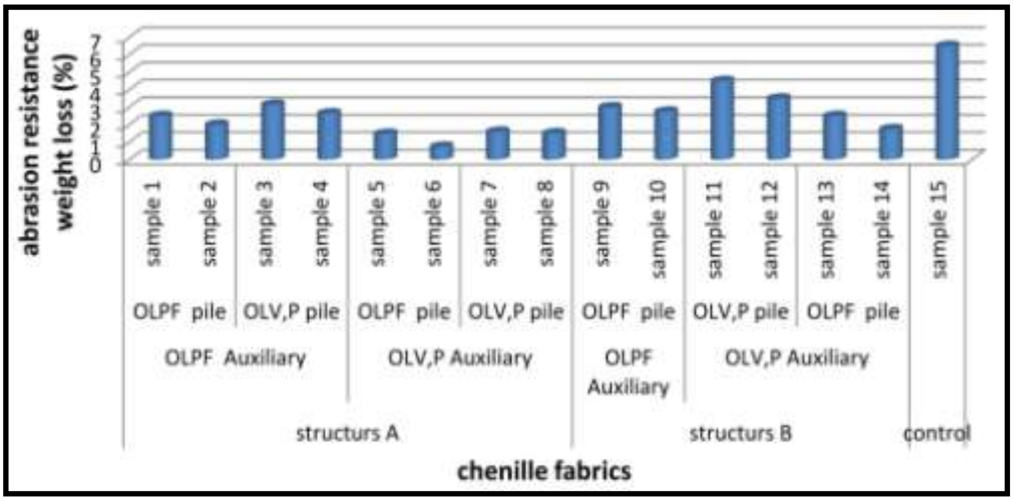

Fig.(7) results of produced chenille fabrics abrasion resistance

3-4-1 Effect of Chenille's pile yarn material on fabric abrasion resistance.

figure (7) the chenille fabrics produced from (polyester, pcm) have recorded the highest rates of fabric abrasion resistance followed by (Viscose, pcm). Because of the Polyester fiber has a high tenacity compared to viscose fiber, which leads to an increase in the fabric abrasion resistance.

* sample fifteen (Polyester, without pcm) has recorded high rates of fabric stiffness compared with Sample one (Polyester, pcm)

3-4-2 Effect of Chenille's pile length on fabric abrasion resistance.

It can be noticed from figure (7) that, there is a direct relationship between the fabric abrasion resistance and the pile length of produced chenille yarns. This is due to the long pile length will offer greater resistance to being pulled out from the fabric and will also take longer time to abrade, that leading to an increase in fabrics abrasion resistance.

3-4-3 Effect of weave structure on fabric abrasion resistance.

From figure (7) it can be seen that, (Structure A*)* has recorded the high rates of fabric abrasion resistance followed by (Structure B). This is because of increases the percentage of chenille yarn in weave structure leads to an increase in the number of chenille yarn on the surface of the fabric which facing the abrading fabric so as a result the fabric abrasion resistance increase.

3-4-4 Effect of auxiliary weft materials on fabric abrasion resistance.

From figure (7) it can be observed that, (polyester, without pcm) auxiliary yarns have recorded the highest rates of abrasion resistance followed by (Viscose, pcm) , (polyester, pcm) respectively. Because of the Polyester fiber has a high tenacity compared to viscose fiber, which leads to an increase in the fabric abrasion resistance.

IV. CONCLUSIONS

1. The ***polyester (Pcm)*** fabrics have recorded highest rates of tensile strength in weft direction. Whilst the ***viscose (Pcm)*** fabrics have recorded highest rates of fabric tensile strength in warp direction and stiffness.
2. It was concluding that, the pile length has a direct relation with fabric tensile strength in warp direction, stiffness and abrasion resistance. Pile length of chenille yarns do not represent any significant effect on the fabric tensile strength in weft direction.
3. As far as the effect of fabric structure on tensile strength in warp and fabric stiffness is concerned, it has been found that tensile strength in warp and fabric stiffness are affected by the change in fabric structure where the **Structure A** showed the high rates of that tensile strength in warp and fabric stiffness .
4. The ***viscose*** auxiliary yarns have recorded the highest rates of fabric tensile strength in warp, stiffness and abrasion resistance. Whilst the ***polyester*** auxiliary yarns have recorded the highest rates of tensile strength in weft direction
5. This result is consistent with [7], in which it was pointed out that the fabrics made from viscose yarns have less abrasion resistance than those made from polyester
6. Based on the results, we also conclude that pile length is one of the properties of chenille yarn which affect the abrasion resistance of car seat fabrics. It is hard to remove longer fibers incorporated into the twists of the chenille yarns than short fibers.
7. As far as the effect of fabric structure on abrasion resistance is concerned, it has been found that abrasion resistance is affected by the change in fabric structure where the **Structure A** showed the best abrasion resistance as per the weight loss results.

Acknowledgements

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