"The effect of certain geometrical construction elements on flame resistance property of velvet fabrics"

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Abstract:
Velvet fabrics are luxurious, expensive and currently enjoying a renewed popularity. It is not only a famous in upholstery fabric but also are gaining importance in other textile and uses such as apparel, foot wear, toys and accessories.
Flammability testing is arguably one of the most important testing procedures within the textile industry because it has crucial safety implications in the event of a fire. It has been statistically shown that the
Major cause of fatalities in fire can be directly attributed to the accidental ignition of upholstery and textiles, so it is only sensible that proper flammability standards should be in place. Flammability performance can be improved by the fabric manufacturer at the design stage to ensure a safer interior environment.
Owing to this it is very important to study the effect of some geometrical construction elements such as pile weave - pile height on fire resistance property of velvet fabrics, to enriching it and also improving its properties so that to meet the functional purpose it is produced for.
So we produced 9 fabrics treated with the same fire retardant substance but differ from each other in the pile weave and pile height then these fabrics were tested for fire resistance to determine which fabric resist the fire greater than the others.
That the pile structure 1/2V has scored high rates in flame resistance followed by pile structure 2/4U and pile structure 3/6W respectively.

Keywords:
- ***geometrical construction***
- ***flame resistance property***
- ***velvet fabrics***

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1: Introduction:
Fabric flammability is an important issue to consider, especially for drapery that will be used in a public space such as a school, theatre or special event venue, since federal regulations require that drapery fabrics used in such spaces be certified as fire retardant. Although all fabric will burn, some are naturally more resistant to fire than others. Those that are more flammable can have their fire resistance drastically improved by treatment with flame retardant chemicals.
Certain synthetic fibers are extremely flame resistant, including glass fibers and mod acrylic. Other synthetics including certain polyesters, are slow to ignite and May even self-extinguish. However, once synthetic fabrics ignite, they will melt rather than flame. The resulting substance can lead to severe burns if it comes into contact with the skin.
Natural fibers typically do not melt. Wool and silk burn slowly, are difficult to ignite, and may self-extinguish. With other untreated natural fabrics, such as cotton and linen, the fabric can ignite quickly, resulting in a fast moving flame spread. Fabrics that include a combination of natural and synthetic fibers, such as polyester-cotton blends, can be particularly troublesome, as they combine the fast ignition and flame spread of the natural fiber with the melting aspect of the synthetic fiber. [1, 2]

Face-to-face weaving principle:
In this kind of double pile fabric textile structures consisting of overlapping three systems of yarns are:
1- Group of pile warp yarns.
2- Group of ground warp yarns
3- Group of weft yarns [3].

Face-to-face weaving represents an alternative method of manufacture of the cut warp pile fabrics in which two cloths are woven simultaneously. Two separate ground fabrics with a space between them, each with its own warp and weft, are woven on the unstitched double-cloth principle, while the pile warp threads interlace alternately with the picks of both fabrics and thus are common to both. [4]
The distance between the ground fabrics is regulated according to the required length of the

pile and as the textures pass forward the pile threads extending between them are cut by means of a transversely reciprocating knife during the weaving process. Two cloths are thus formed the bottom cloth with the pile facing up, and the top cloth with a similar pile facing down, as shown in Fig. (1). the cloths pass in contact with separate take-up rollers and are wound on two cloth rollers.

Fig. (1): Face to face weaving principle

The delivery of the pile yarn ranges from five to ten times or more the length of the ground yarn. [5,6]

The main function of the ground yarn is to support the structure and create a base which meets tensile and seam fatigue requirements. However, any stretch requirements would be a function of ground yarn and structure and would have to be approached in the way described for flat woven although there would be much less opportunity to influence yarn crimp. The pile yarn is the main feature and must meet aesthetic design, color and the main technical requirements such as light fastness, abrasion, crease resistance, tuft adhesion. [7]

Pile fabric constructions:

Velvet weaves structure consists of two weaves, one for the ground and the other for the pile. The famous weaves for the ground are plain 1/1 and warp rib 2/1 or 2/2. [8]

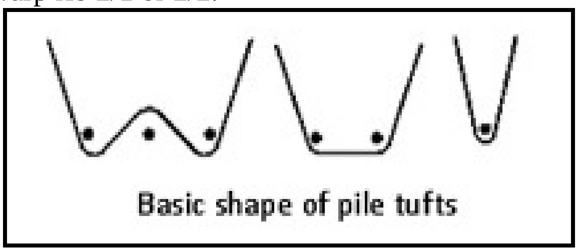

Fig. (2): The basic shape of pile tufts

There are many different weave structures associated with the pile particularly in relation of interlacing of the pile yarns and often velvets (pile tufts) are referred to as (v), (u), or (w) shaped. This refers to the individual tuft formation is illustrated in Fig. (2). It is immediately apparent from this that the densest pile will be formed form (v) shape but it will also have the lowest tuft adhesion since each tuft is only anchored by one weft (u) shape has a lower pile density, and (w) shape has a low density but a high tuft adhesion since it is anchored by three weft. [7]

V-shaped is written as v-1/2. This means that the pile loop extends over one filling and the loop forming path is repeated after two fillings. W-shaped is written as w-3/6. This means that the pile loop extends over three fillings, and the loop forming path is repeated after six fillings, U shaped is written as U-2/4 as shown in Fig. (3). [9] [10]

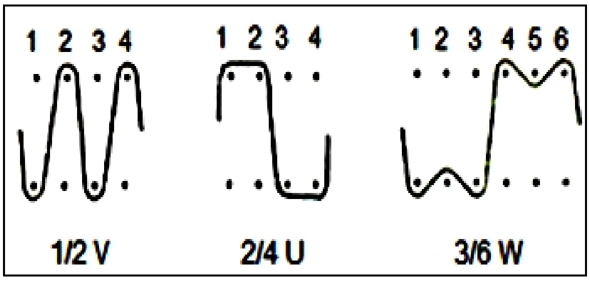

Fig. (3): Pile structure (1/2V, 2/4U, 3/6W)

C-Velvet finishing:

Finishing is a vital part of velvet cloth development. After weaving the cloth is cropped to even out the pile surface and "tiered" or vigorously brushed on the pile surface to burst the yarn filaments, cropped again to create a standard "pile height" specification and may be heated and brushed again to thermally set the pile at a specific angle. Totally vertical pile looks good but is not favored since in use it does not present a uniform appearance when individual filaments crush in different directions. A slight angle to the pile causes the filaments to crush in a similar direction presenting a more even light reflection and appearance in use. [7]

2: Experimental work:

This research concern with studding the effect of some geometrical construction elements such as pile structure - pile height on flame fire resistance property of velvet fabrics, to enriching it and also improving its properties so that to meet the functional purpose it is produced for.

In this research 9 fabrics produced which are treated with the same fire retardant substance (flocavon H12/10 - 400g/l) but differ from each other in the pile structure and pile height then these fabrics were tested for flame resistance to determine which fabric resist the fire greater than the other.

1-The parameters used for producing the samples under study.

Pile height,

this parameter consists from three levels:

A-Pile height (1):

In this level the pile height 2mm

B-Pile height (2):

In this level the pile height 4mm

C-Pile height (3):
In this level the pile height 6mm

Pile structure, this parameter contains 3 levels.

a-Pile structure (1): In this level pile structure is 1/2V which is repeated on 2 wefts(means pile tuft formed every 2picks)

b-Pile structure (2): In this level pile structure is 2/4U which is repeated on 4 wefts(means pile tuft formed every 4picks)

c-Pile structure (3): In this level pile structure is 3/6W which is repeated on 6 wefts(means pile tuft formed every 6picks)

Table (1): Parameters of the samples.

Samples	Parameters	
	Pile structure	Pile height
. 1	(1)	(1)
. 2	(1)	(2)
. 3	(1)	(3)
. 4	(2)	(1)
. 5	(2)	(2)
. 6	(2)	(3)
. 7	(3)	(1)
. 8	(3)	(2)
. 9	(3)	(3)

2-The specifications:

Table (2) Specifications of the samples

No.	Property	Specification
1	Machine	Face-to-face. Double rapier.
2	Machine type	GÜSKEN Veloromat GMV-90
3	Shedding system	Dobby
4	Dobby type	Stäubli 1230 DE 92
5	No. of shafts	16 shaft
6	Machine speed	230 pick / min
7	Reed count (dents / cm)	6 dents /cm
8	Denting system	6 ends/ Dent (2 for pile – 2 for upper ground – 2 for lower ground)

Table (3) the specifications of the produced samples under study:-

No.	Property	Specification
1	Warp ground ends material	Cotton
2	Warp ground ends count	24/2 Ne
3	No. of warp ground ends	16 end/cm
4	Warp pile ends material	Acrylic
5	Warp pile ends count	24/2 Nm
6	No. of warp pile ends	16 end/cm
7	Weft yarn material	Cotton
8	Weft yarn count	10/1 Ne
9	No of picks / cm	16 pick/cm
10	Ground weaves structure	Plain 1/1

3-Laboratory tests applied to samples under study:

A- Fabric weight test:
The test was carried out according to the American standard specification of (ASTM -D-3776-79). [10]

B –flame resistance:
The test was carried out according to the American standard specification of (ASTM –D626-55). [11]

3: Result and Discussion:

The produced fabrics in this research were tested for some essential functional properties which reflected to their end uses.

Table (4): The results of the tests to the produced fabrics.

S. No.	Pile structure	Pile height	weave structure for pile	Pile height mm	Fire area Cm^2	Total weight g/m^2
1	Pile structure(1)	Pile height (1)	1/2V	2	1.496	626
2	Pile structure(1)	Pile height (2)	1/2V	4	1.274	660
3	Pile structure(1)	Pile height (3)	1/2V	6	1.096	681
4	Pile structure(2)	Pile height (1)	2/4U	2	5.634	410
5	Pile structure(2)	Pile height (2)	2/4U	4	5.424	445
6	Pile structure(2)	Pile repeat (3)	2/4U	6	4.804	510
7	Pile structure(3)	Pile repeat (1)	3/6W	2	6.622	365
8	Pile structure(3)	Pile repeat (2)	3/6W	4	6.098	371
9	Pile structure(3)	Pile repeat (3)	3/6W	6	5.704	387

1- Fabric weight:

A-Effect of pile structure on Fabric weight.

It can be noticed from Figures (4, 5, and 6) that using pile structure 1/2V has recorded the highest rate for fabric weight followed by pile structure 2/4U and pile structure 3/6W respectively. Because at pile structure 1/2V the pile tuft formed every 2picks so as a result the number of tufts per unit is greater than number of tufts at pile structure 2/4U(one tuft formed every 4 picks and at pile structure3/6W (one tuft formed every 6 picks)

B-Effect of pile height on Fabric weight.

From the table (4) and Figures (4, 5, and 6) it is clear that, there is a direct relationship between the fabric weight and the pile length, so that the increase in the pile length causes increase in the fabric weight and vice versa.

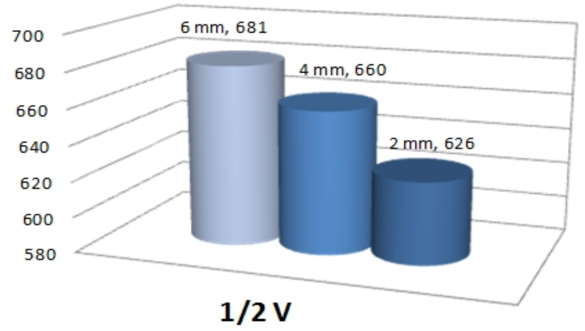

Fig. (4): The relationship between the Pile height mm & Fabric Weight g/m2 at constant of Weave Structure of Pile (1/2 V)

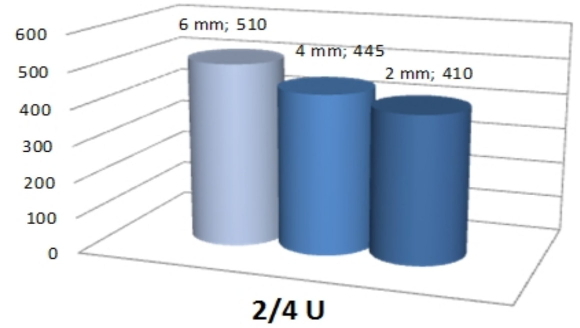

Fig. (5): The relationship between the Pile height mm & Fabric Weight g/m2 at constant of Weave Structure of Pile (2/4 U)

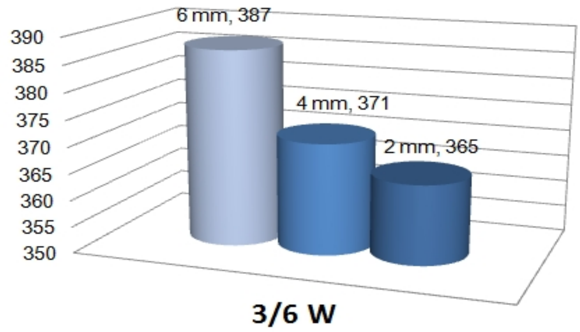

Fig. (6): The relationship between the Pile height mm & Fabric Weight g/m2 at constant of Weave Structure of Pile (3/6 W)

2- Flame resistance.

A-Effect of pile structure on flame resistance.

From Figures (7, 8, and 9) it can be observed that the pile structure 1/2V has scored high rates in flame resistance followed by pile structure 2/4U and pile structure 3/6W respectively. This is due to pile structure 1/2V gives heavier fabrics than other pile structures as explained previously in fabric weight test. So the heavy fabrics resist the ignition more than the light fabrics because During ignition the chemical (fire retardant substance) reacts with the gases and tars generated naturally by the fabric, converting the gases and tars to carbon crust, which is non-flammable thus drastically slowing the fabric's burning rate.

B-Effect of pile height on flame resistance.

From Figures (7, 8, and 9) it is clear that, there is a direct relationship between pile height and flame resistance so as the pile height increase the flame resistance increase and vice versa. This is due to as the height increase the weight increase so the fiber trapping the flame and converted to carbon curst which is a non-flammable thus drastically slowing the fabric's burning rate. Hence, as the pile height decreases the fabrics become more light and contains air space which tie up the fiber to resist the flame so as a result the fabric ignite quickly.

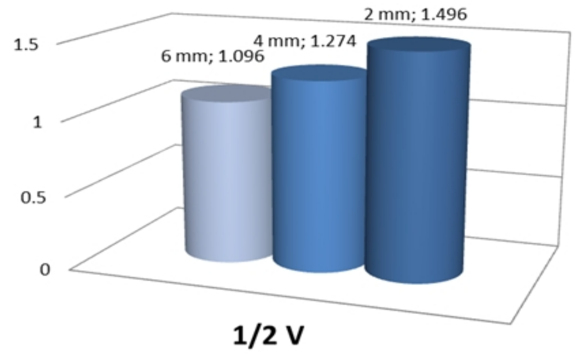

Fig. (7): The relationship between the Pile height mm & Fire Area cm2 at constant of Weave Structure of Pile (1/2 V)

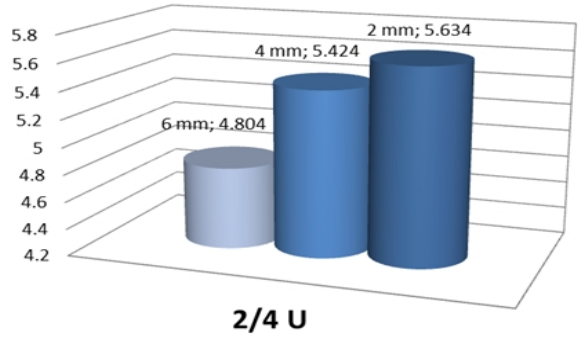

Fig. (8): The relationship between the Pile height mm & Fire Area cm^2 at constant of Weave Structure of Pile (2/4 U)

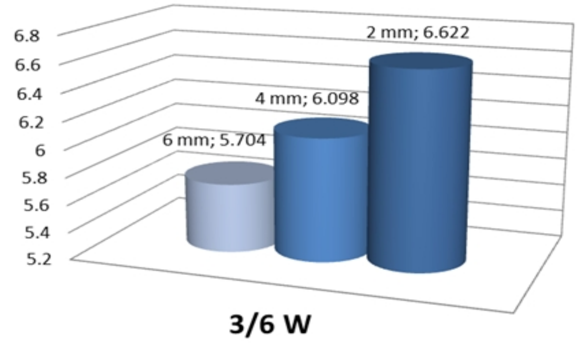

Fig. (9): The relationship between the Pile height mm & Fire Area cm^2 at constant of Weave Structure of Pile (3/6 W)

Conclusions:

From the previous results and discussion concerning with flame resistance for velvet fabrics. Some conclusions were achieved benefiting from it in the production of velvet fabrics and these could increase the efficiency of the functional performance of those fabrics. These conclusions are:

1-The pile structure 1/2V has scored high rates in flame resistance followed by pile structure 2/4U and pile structure 3/6W respectively.

2-There is a direct relationship between pile height and flame resistance.

3- Heavier fabrics resist the ignition more than Lightweight fabrics

4- Tight weaves structure resist the ignition more than loose weaves structure.

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