International Journal of Innovation and Applied Studies
ISSN 2028-9324 Vol. 18 No. 3 Nov. 2016, pp. 760-772

http://www.ijias.issr-journals.org/

Effect of production method variation used to produce three dimensional upholstery fabrics on functional performance

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ABSTRACT: The three dimensional upholstery is considered as one of the fabrics which have distinctive technical and aesthetic values. This effect comes from the presence of projections or wrinkles in the fabric which leads to better aesthetic nature and decorative sense. This in turn enriches the appearance of these types of fabrics. The three dimensional effect can be obtained through several production methods. This research is concerned with the possibility of obtaining projections and heights (three dimensional effects) on the surface of the fabrics through altering the applied production method used in weaving or finishing stages then studying the effect of each applied method on the physical and mechanical properties of the upholstery fabrics. Four fabrics having the same design were produced by different applied methods to achieve three dimensional effect then these fabrics were tested for essential functional properties such as tensile strength, tear strength, stiffness and abrasion resistance. The test results obtained showed that sample which was produced by weft backed cloth method has scored the highest value for tensile strength in warp direction and abrasion resistance.

KEYWORDS: double cloth, backed cloth, warp tension, tensile strength, abrasion resistance, tear strength.

1 INTRODUCTION

Upholstery fabrics are considered as one of the most important kinds of fabrics produced by textile industry for public users, and it obtains a lot of care and interest in its production field where it must be characterized by high quality performance and appearance making it suitable for its usage.

The three dimensional upholstery fabrics have technical and aesthetic distinctive value. This effect comes from the presence of projections or wrinkle in the fabrics, leads to aesthetic nature and decorative sense. This in turn enriches the appearance of these types of fabrics [1].

The three dimensional effect can be abtained througth several methods such as:

1- Different weave structure (tight and loose weaves)
2- Special types of yarns (lycra, bi-shrinkage yarns)
3- Various raw materials (natural or synsthic)
4- Yarns with different twist levels in the same fabrics.
5- Threads with different tension in the same fabric [2], [3].

Each method from these methods has its own physical and mechanical properties, therefore it was necessary to study the properties of each method and determine the best method that achieve the highest functional performance in order to produce good upholstery fabrics able to facing the global textile markets that cannot be penetrated or even to dealt with, but through high quality.

2 EXPERIMENTAL WORK

This research is concerned with the possibility of obtaining projections and heights (three dimensional effect)on the surface of the fabrics through altering the production method used in weaving or finishing stages then studying the effect of each applied method on the physical and mechanical properties of the upholstery fabrics, so four fabrics having the same design were produced by different production methods to achieve the three dimensional effect then these fabrics were tested for some essential functional properties which reflected to their end uses.

2.1 THE PARAMETERS USED FOR PRODUCING THE SAMPLES UNDER STUDY

In this research 4 fabrics were produced according to table (1)all the fabrics have the same design but differ from each other in the production method used to achieve the three dimensional effect

2.1.1 THE FIRST PRODUCTION METHOD: (WEFT BACKED CLOTH)

These method depend on the presence of weft float length at the backside of the fabrics at the ornamentation area (three dimensional area) so two weave structures were used one of them with long float length for the three dimensional area and the other with small float length for the flat area .

2.1.2 THE SECOND PRODUCTION METHOD METHOD (THERMAL FINISHING)

These method depend on the use of two different weft material, one of them used in the face of the fabric and the other in the back side,additional to the usage of long floats at the back side of the fabric .then the fabrics were finished by heat setting at temperature 150°C so as a result the three dimensional effect appears in the face of the fabrics.

2.1.3 THE THIRD PRODUCTION METHOD: (WADDED DOUBLE CLOTH)

These methods depend on using a wadded weft between the two layer of the cloth (face – back). The usage of double weave structure with the presence of thick wadded wefts .this in turns makes the three dimensional effect in these places.

2.1.4 THE FOURTH PRODUCTION METHOD: (WARP TENSION VARIATION)

At this method two warp beams were used, one of them has a high tension (for flat area) and the other one has low tension (for three dimensional area).

Table 1. Parameters used for producing the samples under study

Samples	production method
The first Sample	Weft backed cloth
The second Sample	Thermal finishing
The third Sample	Weft Wadded double cloth
The fourth sample	Warp tension variation

2.2 SPECIFICATIONS (MACHINE AND FABRICS)

2.2.1 THE SPECIFICATION OF THE MACHINE USED IN PRODUCING THE SAMPLES:

1- Loom type: rapier machine.
2- Loom model: super excel.
3- Machine speed: 290 pick/min.
4- reed: 11 dent/cm.
5- Jacquard type: stable cx-880.
6- Jacquard format: 2688

2.2.2 THE SPECIFICATIONS OF THE PRODUCED FABRICS:

1- Material of warp: polyester.
2- Count of the warp ends: 70/1denier.
3- No. of warp ends: 66 end/cm.
4- warp arrangement :1black : 1 light brown.

5- Material of weft: polyester – Polypropylene.
6- No. of picks: 45 pick/cm.
7- Count of weft: 300/1 denier.
8- weft arrangement :1gold polyester :1 gold polypropylene.

2.3 Produced samples

2.3.1 The first sample (weft backed cloth method)

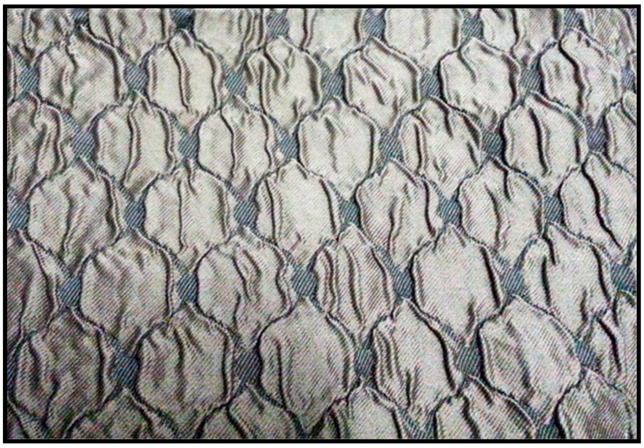

Figure (1) the first sample which produced by weft backed cloth method.

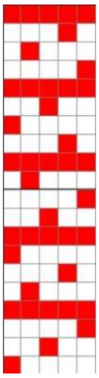

Fig. 2. weave structure for three dimensional areas

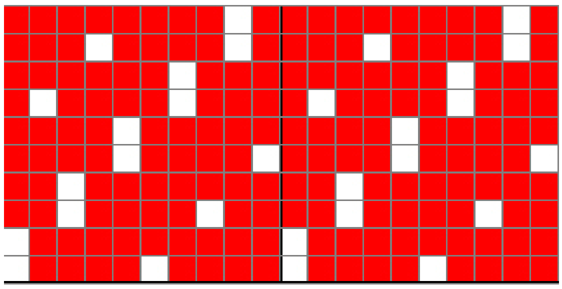

Fig. 3.weave structure for flat area

Figure (2) illustrate the weave structure used in the three dimensional area, it is weft backed cloth consist from sateen 5 for the face and long weft floats at the back of the cloth, the wefts arrangement are 3 face: 1 back .while figure (3) illustrate the weave structure used in flat area, it is warp face weave that are backed with weft, consist from satin 5 for face weave and satin 10 for back weave, the wefts arrangement are 1 face: 1 back.

Fig. 4. Illustrate a portion of the card view for the first sample

2.3.2 THE SECOND SAMPLE (THERMAL FINISHING METHOD)

At this method the double cloth weave used in the three dimensional area while backed cloth weave used in the flat area and it has taken in consideration the usage of polyester in the upper layer of the three dimensional area, whereas the polypropylene used at the lower layer then the thermal finishing is applied at 130°C.this in turns leads to three dimensional effect at the area of the double cloth weave.

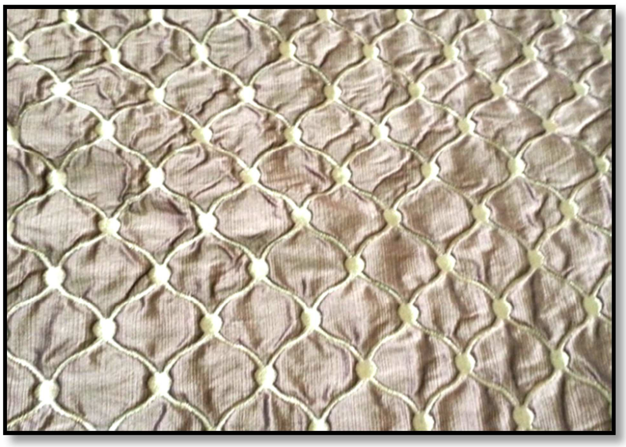

Fig. 5. The second sample which produced by thermal finishing method.

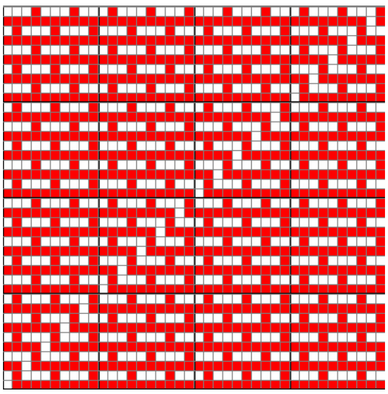

Fig. 6. weave structure for three dimensional area

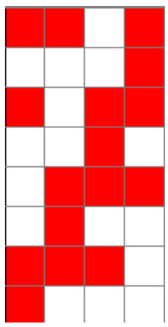

Fig 7.weave structure for flat area

Figure (6) illustrate the weave structure used in the three dimensional area, it is double cloth weave consist from plain 1/1 for the upper layer (face) and twill 19/1 for the lower layer (back). while figure (7) illustrate the weave structure used in flat area, it is weft backed cloth weave which is consist from twill 1/3 for face weave and twill 3/1 for back weave ,the wefts arrangement are 1 face : 1 back.

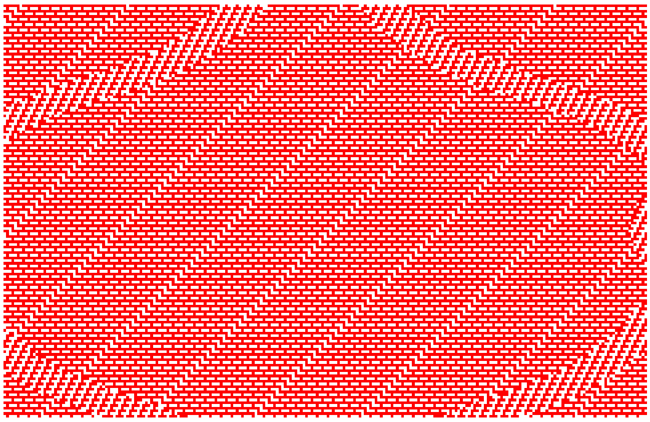

Fig. 8. illustrate a portion of the card view for the second sample.

2.3.3 THE THIRD SAMPLE (WEFT WADDED DOUBLE CLOTH METHOD)

Fig. 9. The third sample which produced by weft wadded double cloth method

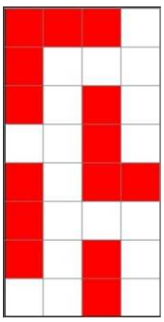

Fig. 10. weave structure for Three dimensional area.

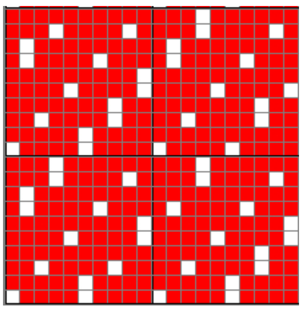

Fig. 11.weave structure for flat area.

Figure (10) illustrate weft wadded double cloth weave used in the three dimensional area, which consist from plain 1/1 for the upper layer and wadded weft inserted between the two layer, the wefts arrangement are 1 face : 1 wadded weft : 1 back. while figure (11) illustrate the warp face weave that backed with a weft which used in the flat area, this weave structure consist from satin 5 for face and satin 10 for back, the wefts arrangement are 1 face : 1 back.

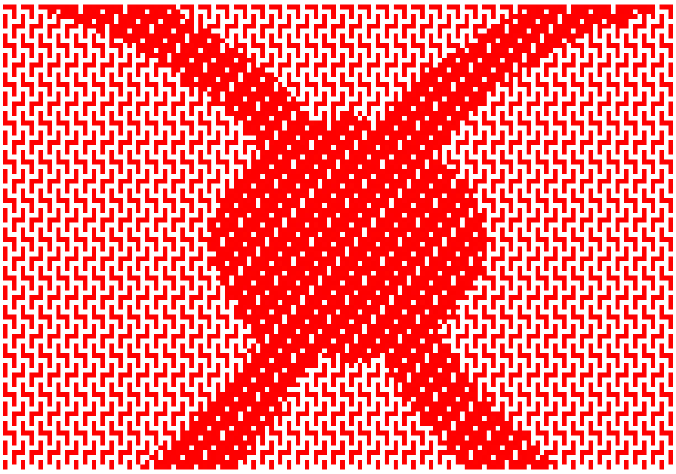

Fig. 12. illustrate a portion of the card view for the third sample.

2.3.4 THE FOURTH SAMPLE (WARP TENSION VARIATION METHOD)

At this method two warp beams were used, one of them has a high tension (for flat area) and the other one has low tension (for three dimensional areas).

Fig. 13. The fourth sample which produced by warp tension variation method.

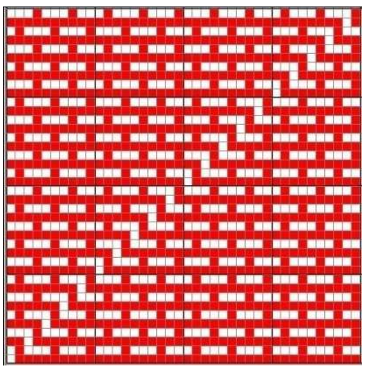

Fig. 14. Weave structure for Three dimensional area.

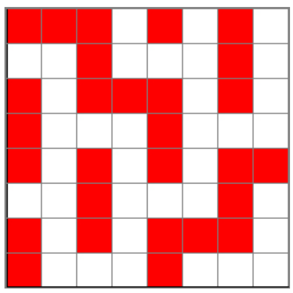

Fig .15. Weave structure for flat area.

Figure (14) illustrate the weave structure used in the three dimensional area, it is double cloth weave consist from plain 1/1 for the upper layer (face) and twill 19/1 for the lower layer (back). while figure (15) illustrate the weave structure used in flat area, it is double cloth weave which is consist from plain1/1 for face weave and sateen 4 for back weave, the warp arrangement is 1 face : 1 back and the wefts arrangement are 1 face : 1 back.

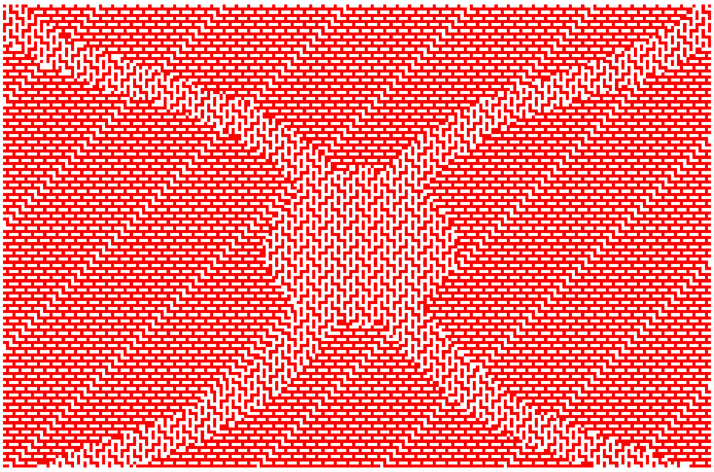

Fig. 16. illustrate a portion of the card view for the fourth sample.

2.4 LABORATORY TESTS APPLIED TO SAMPLES UNDER STUDY

2.4.1 TENSILE STRENGTH TEST

The test was carried out according to American standard specifications of (ASTM-D-5034-90) [4].

2.4.2 FABRIC STIFFNESS TEST

The test was done according to American standard specifications of (ASTM-D-4158-2001) [5].

2.4.3 TEAR STRENGTH TEST

The test was carried out according to American standard specifications of (ASTM-D-2661-71) [6].

2.4.4 ABRASION RESISTANCE TEST

The test was done according to American standard specifications of (ASTM-D-3885-99) [7].

3 RESULT AND DISCUSSION

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

Table 2. Presents the results of the tests of the fabrics.

Samples	Applied method	Properties						
		Warp tensile strength (kg)	Weft tensile strength (kg)	Warp Stiffness (mg/cm)	Weft Stiffness (mg/cm)	Warp tear strength (gm)	Weft tear strength (k.g)	Abrasion resistance (no. turns)
1	Weft backed cloth	106	205	62	192	6.1	7.3	802
2	Thermal finishing	75	229	92	161	8.3	9.1	603
3	Weft Wadded double cloth	94	177	174	369	7.6	5.6	233
4	Warp tension variation	69	214	84	278	9.1	10.6	180

3.1 TENSILE STRENGTH IN WARP DIRECTION

It can be noticed from figure (17) that the first sample which produced by weft backed cloth method has scored the highest value for tensile strength in warp direction, while the fourth sample which produced by warp tension variation method has scored the lowest value for tensile strength in warp direction.

Because the numbers of intersections in the weave structures of the first sample are greater than the other sample so the crimp of warp ends increased leading to increase in elongation as a result the resistance of the fabrics to tensile strength in warp direction increased also. According to these there is a direct relationship between number of intersection and tensile strength in warp direction.

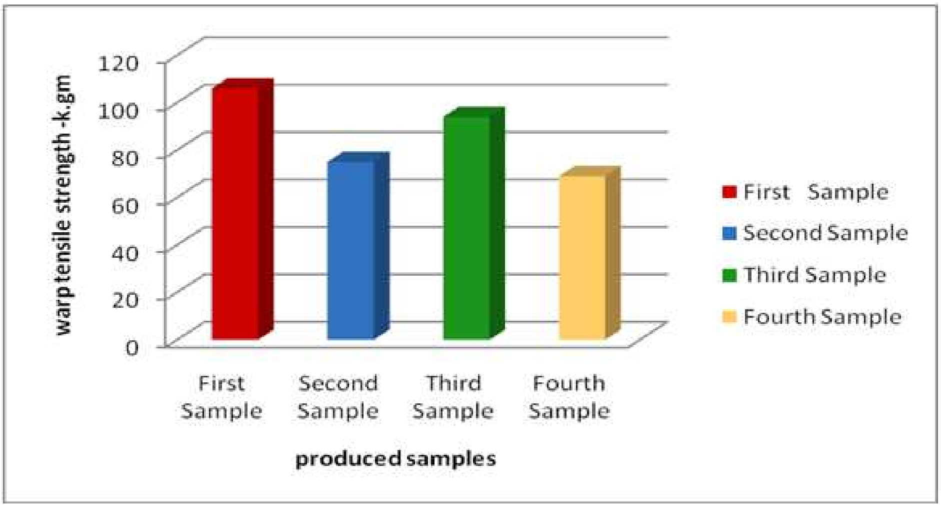

Fig. 17. Effect of production method variation on tensile strength in warp direction

3.2 TENSILE STRENGTH IN WEFT DIRECTION

It is clear from figure (18) that the second sample which produced by the thermal finishing method has recorded the highest value for tensile strength in weft direction. While the third sample which produced by the weft wadded double cloth method has recorded the lowest value. Due to at the second sample the wefts are shrink after the thermal finishing, so the fabrics become more compact as a result the resistance of the fabrics to tensile strength in weft direction increased.

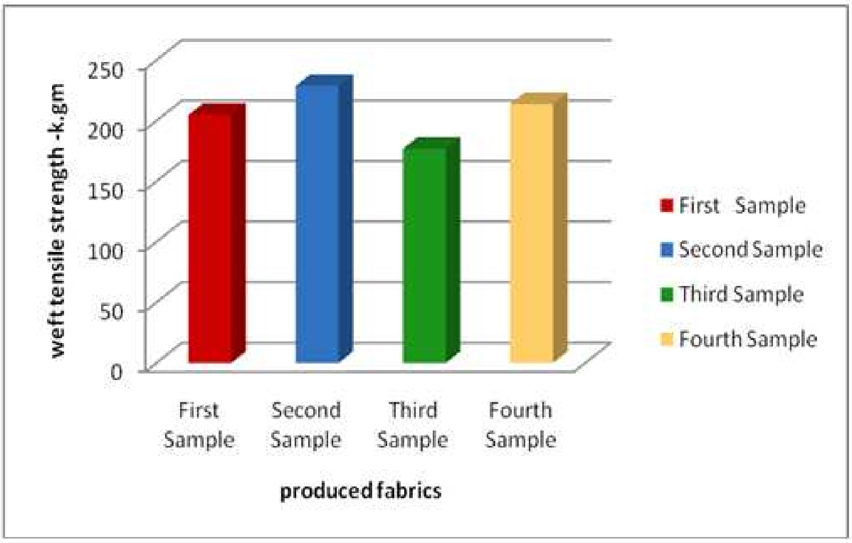

Fig. 18. Effect of production method variation on tensile strength in weft direction

3.3 FABRIC STIFFNESS IN WARP DIRECTION

From figure (19) it can be observed that the third sample which produced by the weft wadded double cloth had scored the highest rates for fabric stiffness in warp direction. Whereas the first sample which produced by weft backed cloth method had scored the lowest rates for fabric stiffness in warp direction. This is most probably due to there is an inverse relationship between warp float length and fabric stiffness in warp direction so as the float length decreases the number of intersection between warp and weft inside the weave structure increases leading to increase in fabric stiffness and vice versa.

The weave structure in the three dimensional area for the third sample is plain 1/1 for face and back as a result the number of intersection increased leading to increase in fabric stiffness in warp direction while the first sample which produced by weft backed cloth has a large float length as a result the number of intersection decreased leading to decrease in fabric stiffness in warp direction.

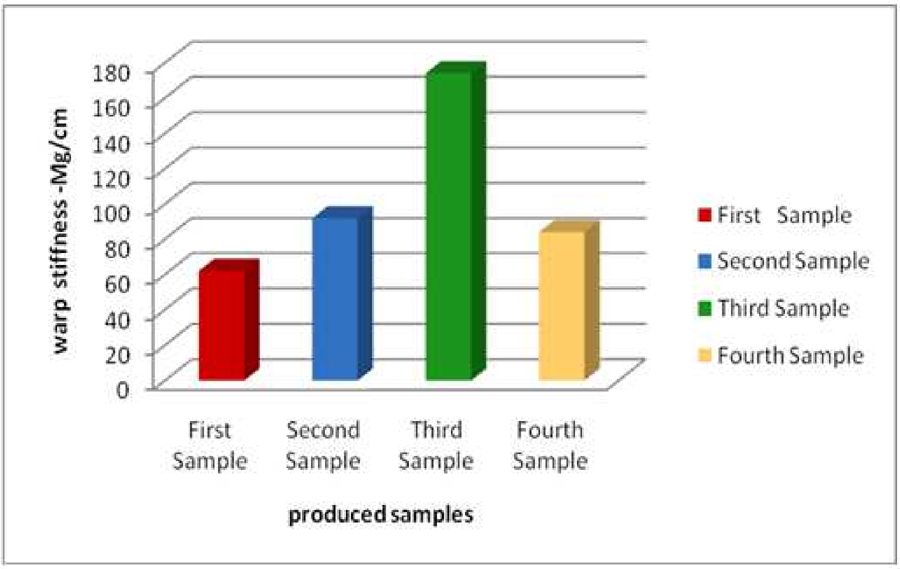

Fig. 19. Effect of production method variation on fabric stiffness in warp direction.

3.4 FABRIC STIFFNESS IN WEFT DIRECTION

From figure (20) it can be noticed that the third sample which produced by the weft wadded double cloth had scored the highest rates for fabric stiffness in weft direction. Whereas the first sample which produced by weft backed cloth method had scored the lowest rates for fabric stiffness in weft direction. This is most probably due to there is an inverse relationship between weft float length and fabric stiffness in weft direction so as the float length decreases the number of intersection between warp and weft inside the weave structure increases leading to increase in fabric stiffness and vice versa .

The weave structure in the three dimensional area for the third sample is plain 1/1 for face and back as a result the number of intersection increased leading to increase in fabric stiffness in weft direction while the first sample which produced by weft backed cloth has a large float length as a result the number of intersection decreased leading to decrease in fabric stiffness in weft direction.

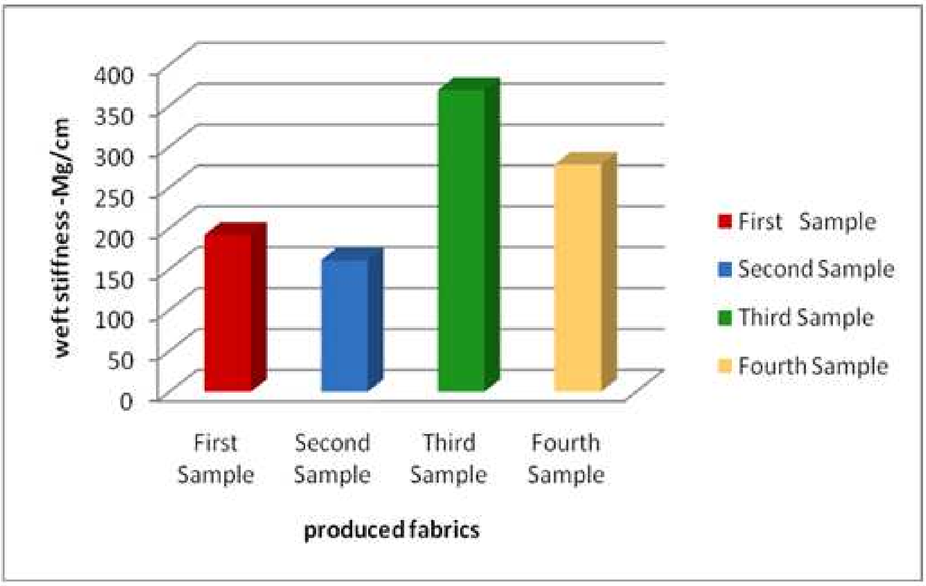

Fig. 20. Effect of production method variation on fabric stiffness in weft direction.

3.5 TEAR STRENGTH IN WARP DIRECTION

From figure (21) it can be seen that, the fourth sample which produced by warp tension variation had scored the highest rates for tear strength in warp direction, while the first sample had scored the lowest rates for tear strength in warp direction .because there is direct relationship between threads float length ,free movement of the threads inside the weave structure and tear strength so as the float length increase the thread inside the weave structure become more free to move and group together presenting bundles facing the tear load as a result the tear strength in warp direction increased which consistent with study of brody [8].

Thus due to the increase of the tension on the warp ends in additional to the double cloth weave makes the threads inside the fabric to be free, in the double cloth weave the warp ends and wefts are distributed in two layers which reduce the number of warp ends and wefts in each layer so the threads become more free to move and also the high tension leads to reduce the crimp and increase the spacing between the threads. All of these make the threads to be more free to move as a result the tear strength in warp direction increased.

While the first sample which produced by weft backed cloth method, all the threads (warp-weft) lies in one layer. Therefore the ability of the yarns to move decreased causing decreasing in tear strength in warp direction.

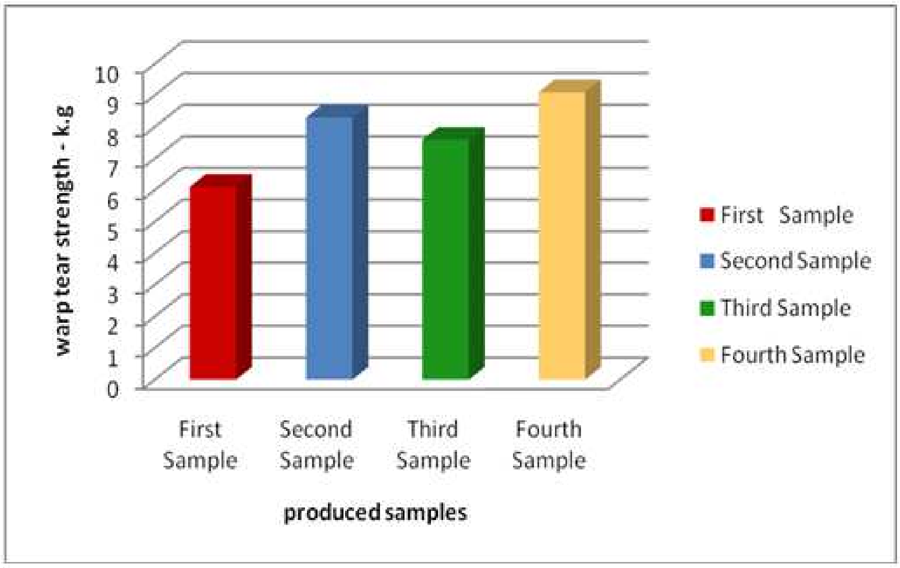

Fig. 21. Effect of production method variation on tear strength in warp direction

3.6 TEAR STRENGTH IN WEFT DIRECTION

It is clear from figure (22) that the fourth sample which produced by warp tension variation had scored the highest rates for tear strength in weft direction, while the first sample had scored the lowest rates for tear strength in weft direction. Thus due to the increase of the tension on the warp ends in additional to the double cloth weave makes the threads inside the fabric to be free, in the double cloth weave the warp ends and wefts are distributed in two layers which reduce the number of warp ends and wefts in each layer so the threads become more free to move and also the high tension leads to reduce the crimp and increase the spacing between the threads. All of these make the threads to be more free to move as a result the tear strength in weft direction increased.

While the first sample which produced by weft backed cloth method, all the threads (warp-weft) lies in one layer. Therefore the ability of the yarns to move decreased causing decreasing in tear strength in weft direction.

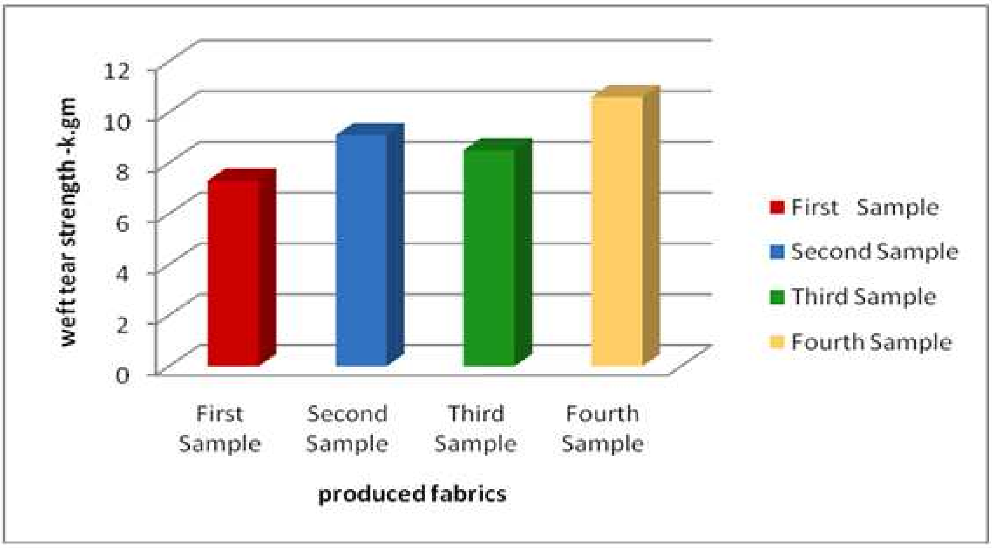

Fig. 22. Effect of production method variation on tear strength in weft direction

3.7 Abrasion resistance

It can be noticed from figure (23) that the first sample which produced by weft backed cloth method has recorded the highest rates for abrasion resistance, whereas the fourth sample which by warp tension variation has recorded the lowest rates for abrasion resistance.

This is most probably due to the long yarn float length and low number of interlacing cause the continuous contact between the yarns and abrading surface thus facilitates the yarn to lose its form more easily and wear. So the long floats in a weave structure are more exposed and abrade faster as a result increasing the mass loss[9], also the more threads per unit area in a fabric are the less force to each individual thread is, therefore the fabrics with a tight structure have higher abrasion resistance than those with a loose structure. However as the threads become jammed together they are the unable to deflect under load and thus absorb the distortion .these was agreed with what mentioned by Saville [10].the fabrics which have lower floats have better abrasion resistance because the yarns are more tightly locked in structure and the wear is spread more evenly over all of the yarns in the fabric [11].

Accordingly the first sample which produced by weft backed cloth has yarns in one layer so the fabric become crowded by yarns (compact) so they are the unable to deflect under load and thus absorb the distortion, as a result the abrasion resistance increased .while at the fourth which produced by warp tension variation the yarns are distributed in two layers because the weave structure of these samples is double cloth causing the density of yarns per unit area decreased as a result the abrasion resistance decreased.

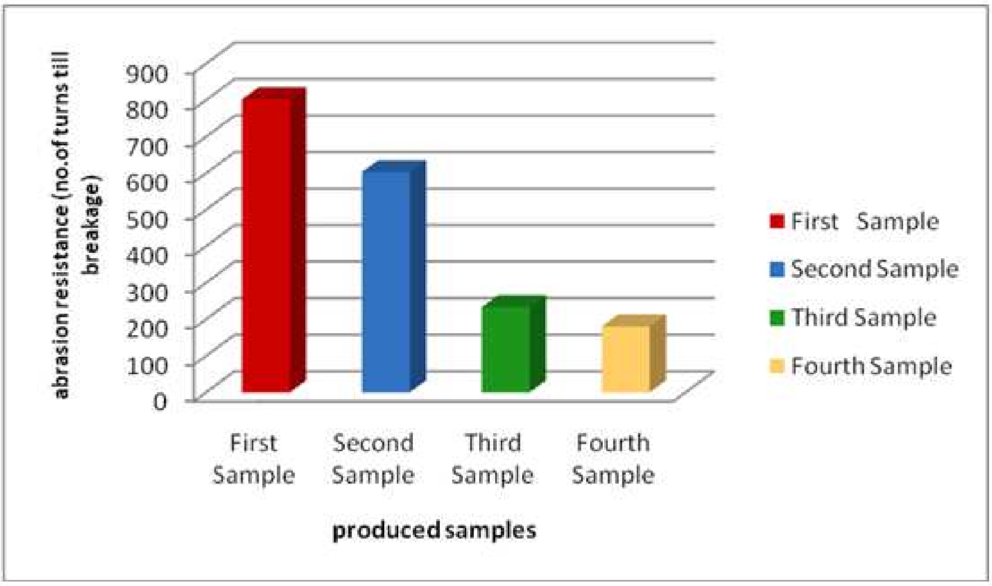

Fig. (23) Effect of production method variation on abrasion resistance

4 Conclusions

From the previous results and discussion concerning some conclusions were achieved benefiting from it in the production of these type fabrics and these could increase the efficiency of the functional performance of those fabrics. These conclusions are:

1- The first sample which produced by weft backed cloth method has scored the highest value for tensile strength in warp direction and abrasion resistance.
2- The second sample which produced by the thermal finishing method has recorded the highest value for tensile strength in weft direction.
3- The third sample which produced by the weft wadded double cloth had scored the highest rates for fabric stiffness in warp and weft direction.
4- The fourth sample which produced by warp tension variation had scored the highest rates for tear strength in warp and weft direction.

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