المؤتمر الدولي الرابع لكلية الفنون التطبيقية
الفنون التطبيقية
(ابداع - تصميم - انتاج - تنافسية)
٢٨-٢٩ فبراير ٢٠١٦
مجلة التصميم الدولية

DEVELOPING NEW TREND IN HONEYCOMB WOVEN METHOD TO BENEFIT IT IN CREATIVE DESIGN FOR DECORATIVE CURTAINS USING DOUBLE FACE FABRICS

MOSTAFA EL GAMAL
Professor Of Textile Design
Faculty of Applied Arts.
Helwan University. Cairo. Egypt

MOHAMED. M .AMER*
Professor Of Textile Design
Faculty of Applied Arts.
Helwan University. Cairo. Egypt

Abstract

The curtains woven fabric of various types are considered the most important textile products; they play a functional and aesthetic important role in the place that resides in it; therefore are received considerable attention of the consumer and the product in a permanent and continuous attempt to promote this kind of fabrics, and add all that is new and sophisticated in order to improve its performance career, and add a new aesthetic values. So must the designers of this quality textile products design and development tools and Applied employed in achieving relative new aesthetic features.
The article has been Attempted to develop practical method for fabrication of Honeycomb; through the re-employment of some design tools and methods applied in the design of jacquard woven fabrics with functional and aesthetic new values. When we take into account the achievement of mechanical properties and compositions of the textile and the functional requirements that must be meet in curtain fabrics, this method will give new trend in the textile production area.
In order to achieve the aim of the research followed the following procedural steps :
•Design and production a number 6 trials; two experiments with weaving specification on mechanic jacquard loom; and four experiments with weaving specification different on Electronic jacquard loom; in trying to develop practical method for Honeycomb woven fabrics and that has been integrated with a backed cloth structure from warp and weft for striped curtains, jacquard fabrics can be used on the same duplex Functionality.
•The practical side of the study results scientifically has been in the article discussed. Furthermore, the study has been reached several results by previous studies that we have done. This article shows that the honeycomb woven fabrics

Keywords: Curtain woven Fabrics - Functional and aesthetical values - Technical methods - Honeycomb structure - backed cloth structures - woven specifications – Fabric double face.

*corresponding author: Mohamed MitwallyAmer
Address: Faculty of Applied Arts, HelwanUniversity , Cairo , Egypt
E-mail address: mohamed_mitwally@yahoo.com

1. Introduction

The curtains woven fabric one of an importunate textile design and product, that must has been functional and aesthetical values by high efficiency that it has been roles on the interior design, so it has been interested a fabrics producers and customers, through add all the modern form and renew technical methods to improve its function and aesthetic values.
The paper has attempted to development honeycomb as woven technical's method (Xueliang Xiao, Tao Hua, 2015) through reusing some of design tools and applied methods to design jacquard woven fabric have new functional and aesthetical values, that has been design and produce six experiments with two weave specifications as attempt to develop a honeycomb – weave methods that it has been compounded with a backed cloth methods to obtain a woven fabric patterns has a new functional and aesthetical values and can be used as a double faces byhigh efficiency (Elizabeth Austin2009, William Watson 1975) , and has been discussed the results in order to achieve the aim of paper.

2. Aim of paper

1- The aim of paper has developed honeycomb woven fabric technical's through has been applied it with a warp threads that has been arranged as a thread color (A) : color (B) and weft threadscolor (C) : color (D) to obtain honeycomb weave fabric from warp &from weft and combination from warp and weft.

2- The Honeycomb Weave structures has been applied after developed it with backed cloth structure for jacquard curtain fabrics design to use it double faces by high efficiency and has a new functional and aesthetical values.

3. Previous studies

3.1 Honeycomb Woven Fabric

The honeycomb woven fabric that has been warp and weft threads has formed cavities like textures honeycomb structure that the structures has a long floats from warp, weft or together and interlace with plain structure 1/1at the center and edges of the Honeycomb Woven Fabric (William Watson1975, Xueliang Xiao2015) .
The cavities form has been more appearance that like diamonds after the honeycomb fabric finished.
The normal of using honeycomb structure woven fabrics as a kitchen and table towels, beds and tables covers some kinds of man and women cloths .but up normal has been used as a curtain fabrics(Xiaogang Chen,Ying Sun,and Xiaozhou Gong 2008).
The technical's of honeycomb structure as follow up :

1- Honeycomb – weaves
2- Leno
3 - Mock leno

3.2 The methods of honeycomb structures

3.2.1 The first method

The first method consists of opposite of twill weave structures direction from warp and weft to give diamonds shapes with plain structures 1/1 between (William Watson1975, Xueliang Xiao2015). As shown at Fig (1).

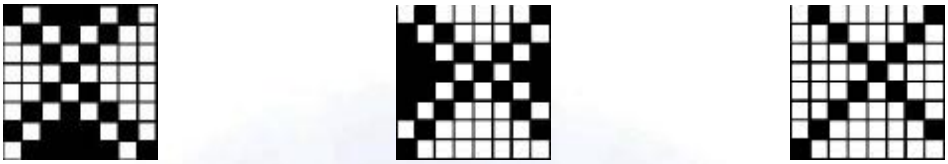


Fig1: The first method of Honeycomb weaves

3.2.2 The second method

The first method consists of opposite of twill weave structures direction from warp and weft with left one pick to give diamonds different shapes and more size with plain structures 1/1 between it Xueliang Xiao, Tao Hua, Li Li and Jinchun Wang 2015). As shownat Fig .2

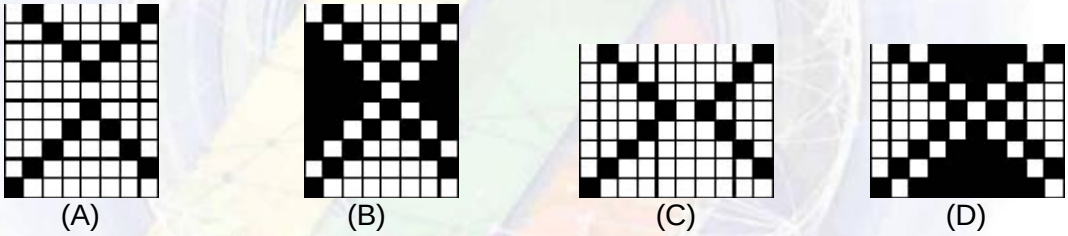


Fig 2 : The second method of Honeycomb weaves

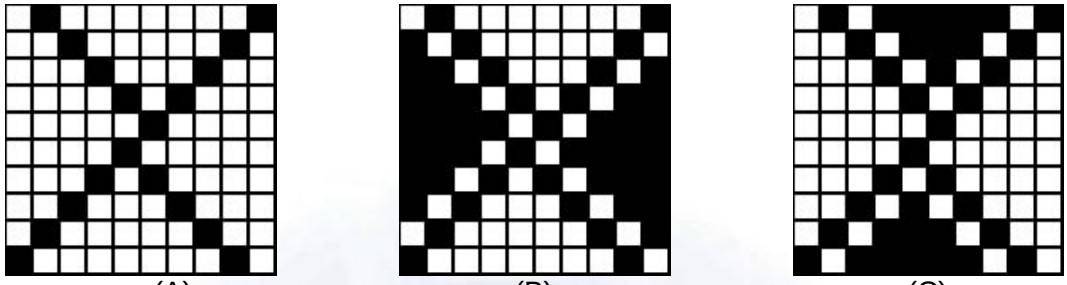
3.2.3 The third method

Using participant twill weave structures on big size diamonds to lose the long floats (William Watson; F.T.I . 1975). As shown at Fig(3).

Fig 3 : The third method of Honeycomb weaves

3.2.4 The fourth method :

Using opposites twill weave directions from warp and weft to obtain diamonds different shapes (Xiaogang Chen,Ying Sun,and Xiaozhou Gong 2008, S.T. Peters 1998). As shown at Fig(4) .

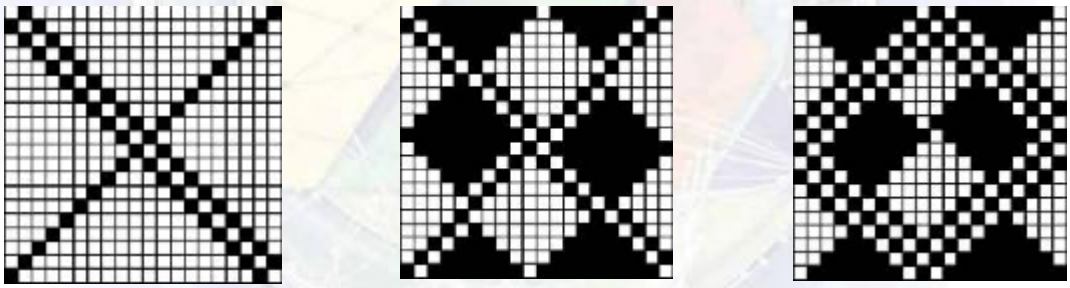


(A) (B) (C)

The fourth method of Honeycomb weaves**Fig 4 :**

3.2.5 The fifth method :

Using twill structure lines on right direction and two lines on left direction or opposite and divide all the big diamonds shape to four small diamonds different sizes with the big diamonds ratio (Xiaogang Chen,Ying Sun,and Xiaozhou Gong 2008.William Watson; F.T.I . 1975). As shown at Fig(5).



(A) (B) (C)

The fifth method of Honeycomb weaves**Fig 5 :**

4. Experimental work :

4.1 The first weaving specifications for the experimental work

The first and second experiments were produced at the weave specifications follow up:

4.1.1 Type of Jacquard machine

1- Mechanical Jacquard machine.
Number of hooks in machine 650.2-
3- Number of hooks in use machine 604
4- Repeat width 15 cm

4.1.2 The specification of warp

1- Warp material: polyester yarn
2- Warp Ne: 40/2 cotton
3- Warp colors: two colors (A:B) are arranged one Golden color : one Red color
4- 40 threads / cm
5- Reed 10 dent / cm.
6- 4 threads / dent.

4.1.4 The specification of weft

1- Weft Ne 40/2 cotton
2- 40 picks / cm
3- Weft colors: two colors (C : D) are arranged one (C) color : one (D) color as a pattern colors

4.1.5 The First Experimental by the first weaving specifications

3.1.5.1 Design a strips decorative repeat for jacquard curtain fabric has been accurate with the weave specifications and techniques method which has been selected for the first experimental. illustrate Fig (6)

Fig 6

4.1.5.2 Designing a new groups of Honeycomb weave structures has been repeated at 20 warp threads and 20 picks .as shown at Fig (7) , (8) , (9) , (10) , (11) , (12) .

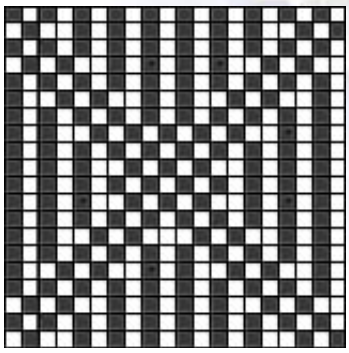


Fig 7: Anew honeycomb weave structure from warp on two faces with two colors

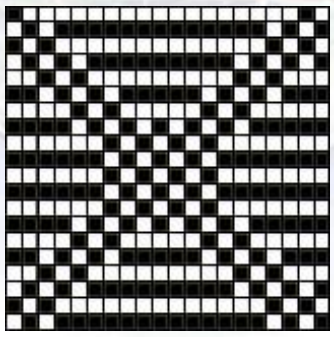


Fig 8: Anew honeycomb weave structure from weft on two faces with two colors

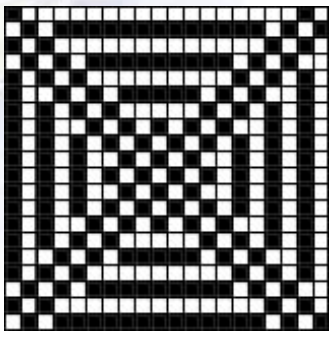


Fig 9: Anew honeycomb weave structure from warp and weft on two faces with two colors

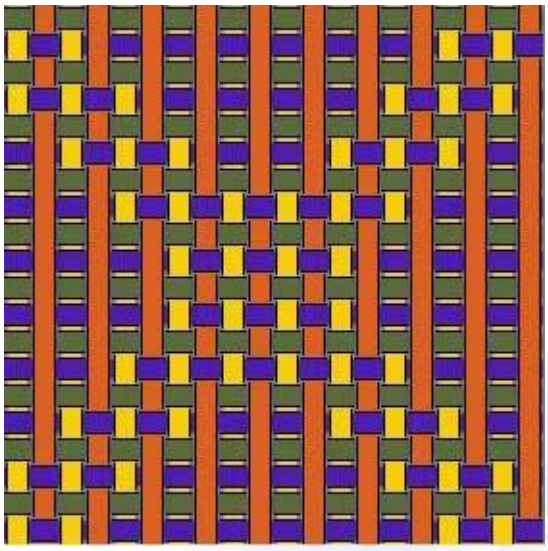


Fig 10:surfaces weft and warp floats A new honeycomb weave structure from warp on two faces with two colors **(Fig.7)**

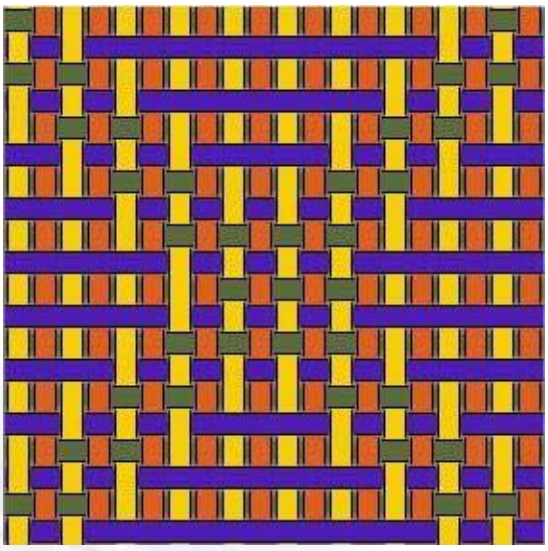


Fig 11:surfaces weft and weft floats A new honeycomb weave structure from weft on two faces with two colors **(Fig.8)**

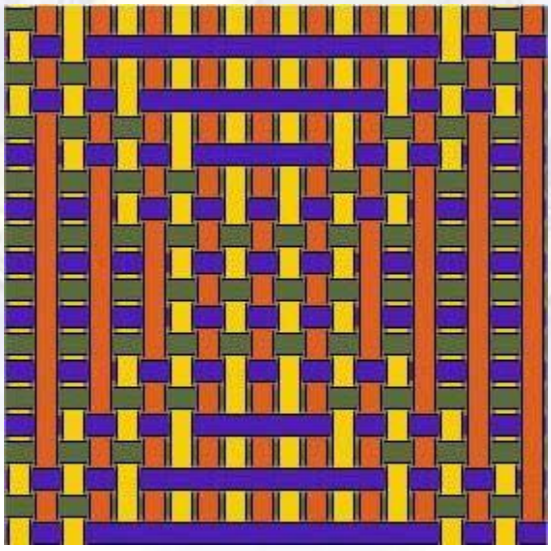


Fig 12:surfaces weft and warp and weft floats Anew honeycomb weave structure from warp and weft t on two faces with two colors **(Fig.9)**

4.1.5.2 Designing a groups of backed cloth structures has been repeated at 20 warp threads and 20 picks .as shown at Fig (7) , (8) , (9) , (10) , (11) , (12) .

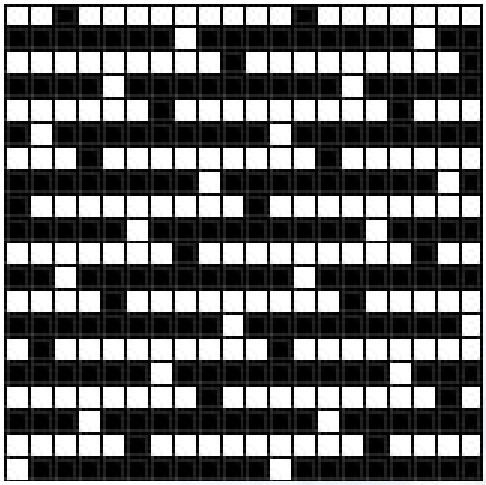


Fig 13: A backed cloth structure from weft on two faces with two colors

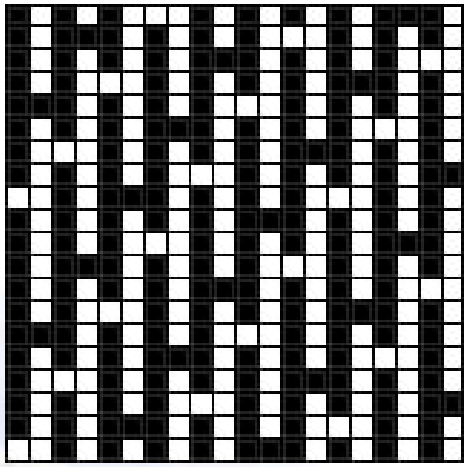


Fig 14: A backed cloth structure from warp on two faces with two colors.

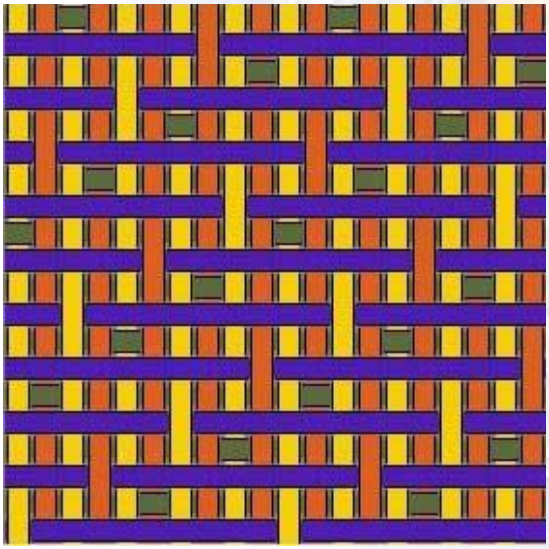


Fig 15:surfaces weft and warp and weft floats A backed cloth structure from weft on two faces with two colors **(Fig.13)**

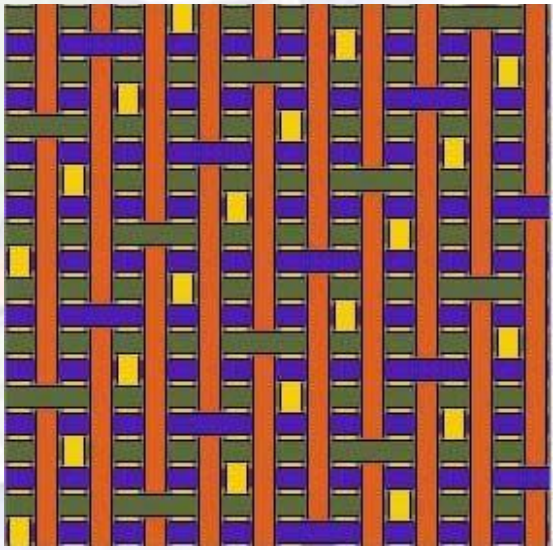


Fig 16:surfaces weft and warp and weft floats A backed cloth structure from warp on two faces with two colors **(Fig.14)**

4.1.5.3 The weave structures has been distributed at the design colors. As shown at Fig (17)

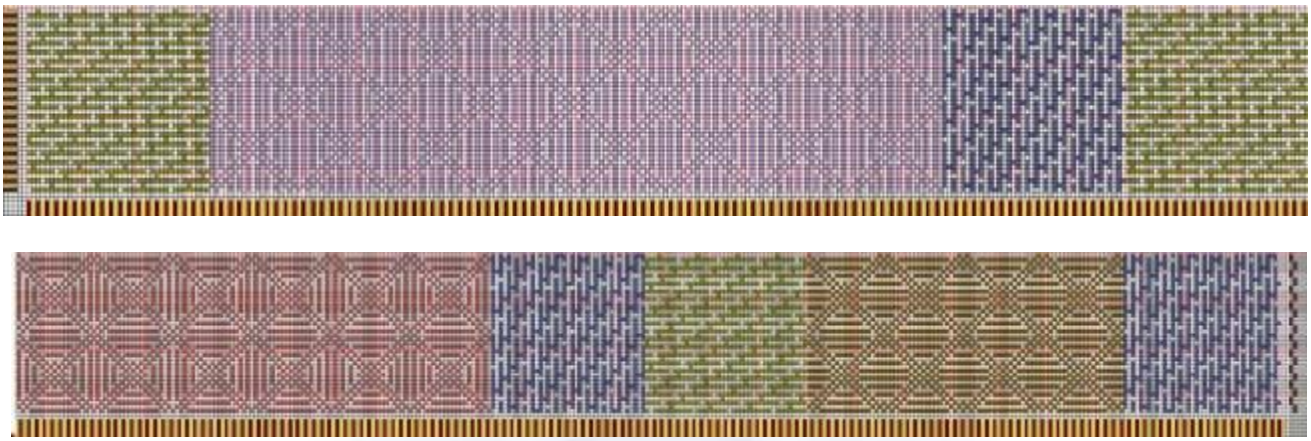


Fig : 17

4.1.5.4 Fabric samples of the first experimentby the first weaving specifications

Many fabric samples were produced for the first experiment accordant with the first experiment specifications follow up:

4.1.5.4.1 The first fabric samples of the first experimentby the first weaving specifications

Warp colors = one red : one gold yellow
Weft colors = one navy : one dark green .
As shown at Fig (18), (19) .

Fig 18 : Face of the first fabric sample of the first experiment by the first weaving specifications

Fig 19 : Back of the first fabric sample of the first experimentby the first weaving specifications

4.1.5.4.2 The second fabric sample of the first experimentby the first weaving specifications

Warp colors = one red : one gold yellow
Weft colors = one navy : one silver .
As shown at Fig (20), (21) .

Fig 20 : Face of the second fabric sample of the first experiment by the first weaving specifications

Fig 21 : Back of the second fabric sample of the first experiment by the first weaving specifications

4.1.5.4.3 The third fabric sample of the first experimentby the first weaving specifications

Warp colors = one red : one gold yellow
Weft colors = one dark green : one navy
As shown at Fig (22), (23) .

Fig 22 : Face of the third fabric sample of the first experimentby the first weaving specifications

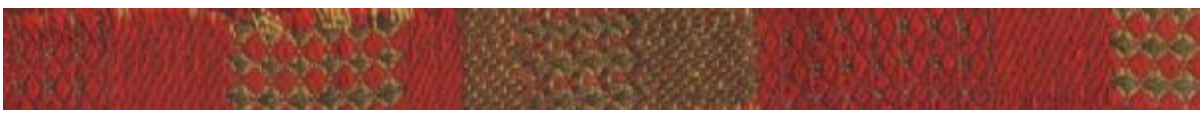


Fig 22 : Face of the third fabric sample of the first experiment by the first weaving specifications

4.1.5.4.4 The fourthfabric sample of the first experimentby the first

weaving specifications

Warp colors = one red : one gold yellow
Weft colors = one navy : one dark green .
As shown at Fig (24), (25).

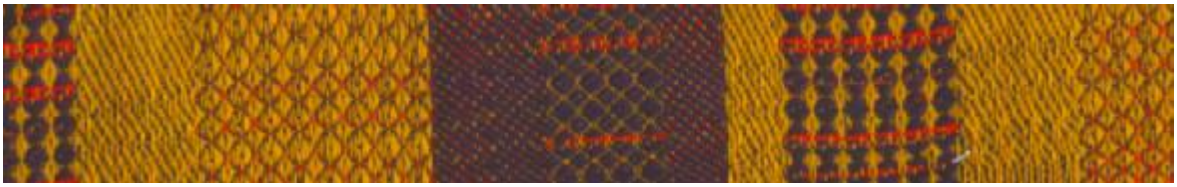


Fig 24 : Face of the fourth fabric samples of the first experiment by the first weaving specifications

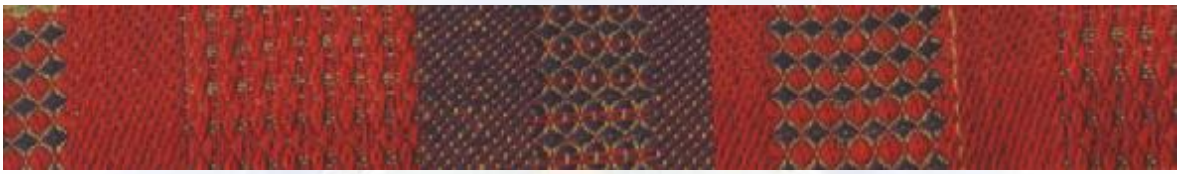


Fig 25 : Back of the fourth fabric sample of the first experiment by the first weaving specifications

4.1.5.5Fabric samples of the second experimentby the first weaving specifications

4.1.5.5.1 Designing a new groups of honeycomb - weave structures has been repeated at 20 warp threads and 20 picks, with lessening
the plain structure 1/1 at the center of Honeycomb - weave structures .as shown at Fig (26) , (27) , (28) , (29) , (30) , (31)
3- The second experiment fabric samples has been produced at the same jacquard machine and weave specifications for the first experiment

4.1.5.5.2 The new Honeycomb – weave structures group after modification for the second experiment

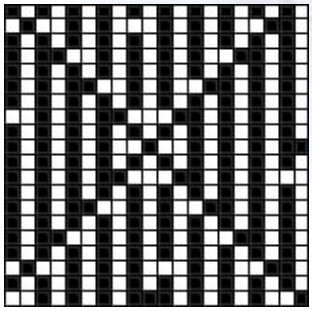


Fig 26: the new honeycomb – weave structure from warp on two faces with two colors for the second experiment

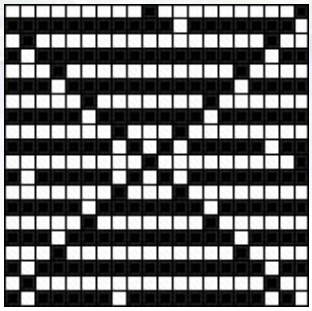


Fig 27: the new honeycomb – weave structure from weft on two faces with two colors for the second experiment

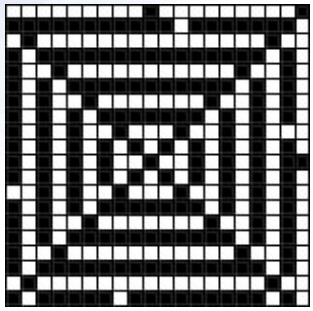


Fig 28: the new honeycomb – weave structure from warp and weft on two faces with two colors for the second experiment

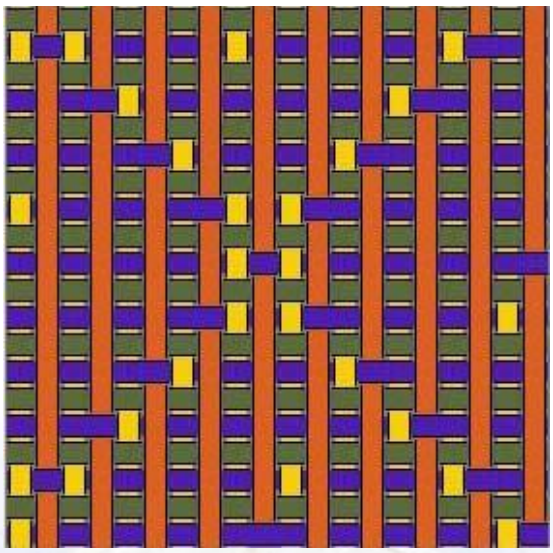


Fig 29:surfaces weft and warp floats A new honeycomb weave structure from warp on two faces with two colors for the second experiment **(Fig.26)**

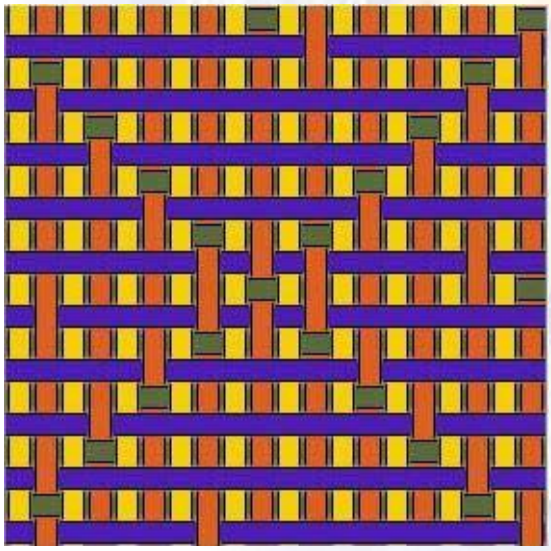


Fig 30:surfaces weft and weft floats Anew honeycomb weave structure from weft on two faces with two colors for the second experiment **(Fig.27)**

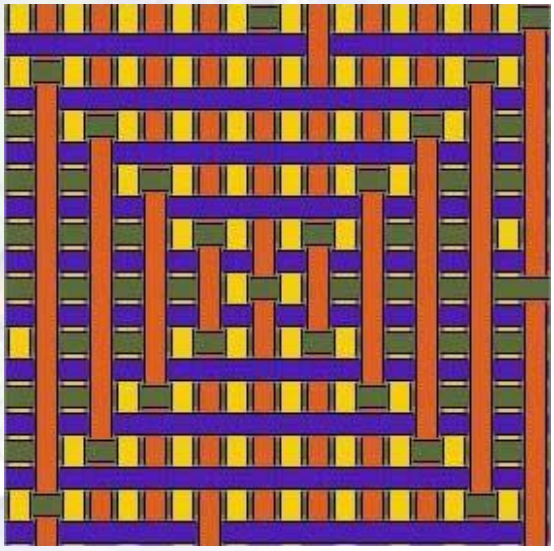


Fig 31:surfaces weft and warp and weft floats Anew honeycomb weave structure from warp and weft on two faces with two colors for the second experiment **(Fig.28)**

4.1.5.5.3 Using a backed cloth structures group that same the first experiment; asshown at Fig (32), (33

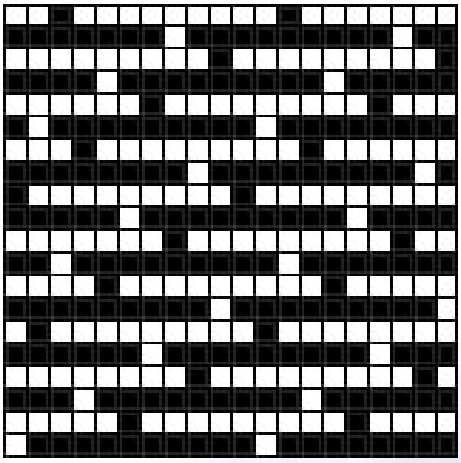


Fig 32: A backed cloth structure from weft on two faces with two colors for the second experiment

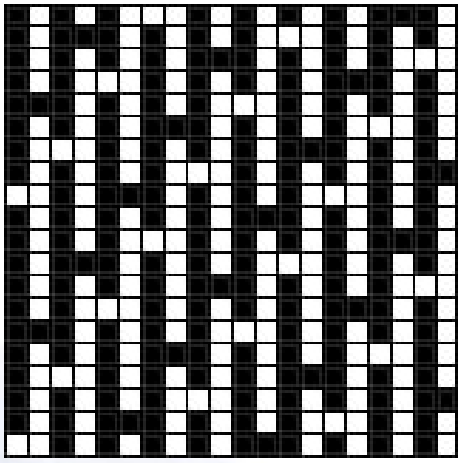


Fig 33: A backed cloth structure from warp on two faces with two colors for the second experiment

4.1.5.5.4 Designing a strips decorative repeat for jacquard curtain fabrichas been accurate with the weave specifications and techniques method which has been selected for the second experimentalby the firstweaving specifications. Illustrate Fig (34)

Fig 34

4.1.5.5.5 The weave structures has been distributed at the design colors. As shown at Fig (35)

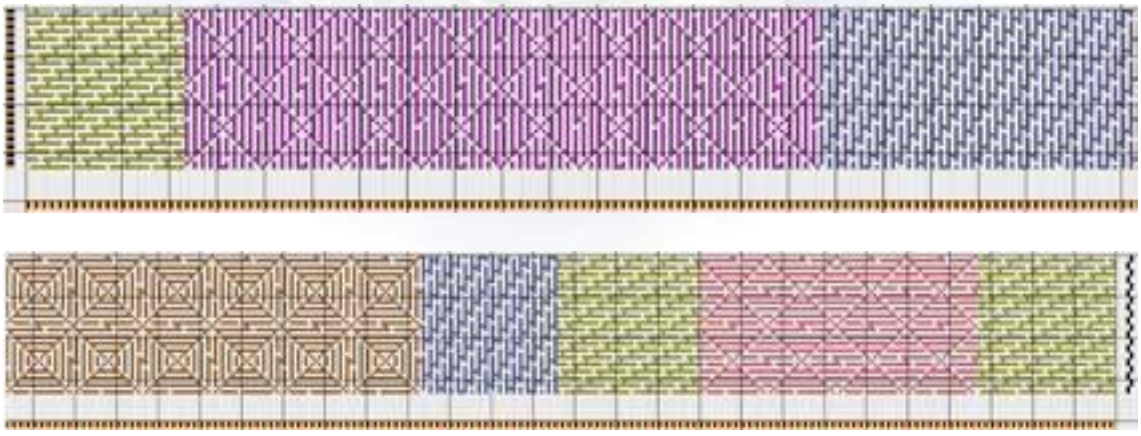


Fig 35

Many fabric samples were produced for the second experiment accordant with the second experiment specificationsby the first weaving specifications follow up:

4.1.5.5.6 The first fabric sample of the second experimentby the first weaving specifications

Warp colors = one red : one gold yellow
Weft colors = one navy : one dark green
As shown at Fig (36), (37) .

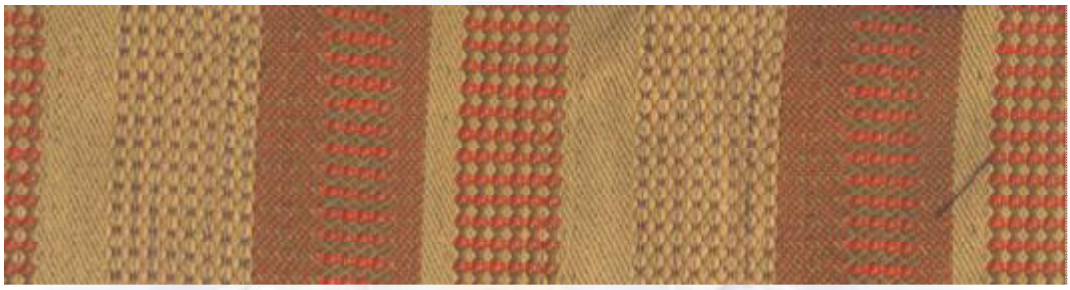


Fig 36 : Face of the first fabric samples of the second experiment by the first weaving specifications

Fig 37 : Back of the first fabric samples of the second experiment by the first weaving specifications

4.1.5.5.7 The secondfabric sample of the second experimentby the first weaving specifications

Warp colors = one red : one gold yellow
Weft colors = one dark green : one navy .
As shown at Fig (38), (39) .

Fig 38 : Face of the second fabric sample of the second experiment by the first weaving specifications

Fig 39 : Back of the second fabric sample of the second experiment by the first weaving specifications

4.2 The second weaving specifications for the experimental work

The third, fourth, fifth and sixth experiments were produced by the weavingSpecifications follow up

4.2.1 Type of machine

1- Electronic Jacquard machine.
Number of hooks in machine 3072. 2-
3- Number of hooks in use machine 2560
4- Repeat width 35.5 cm

4.2.2 The specification of warp:

1- Warp material: polyester yarn
2- Warp Nu .150/1 denier
3- Warp colors: two colors (A: B) are arranged one silver color : one Black color
3- 72 threads / cm
4- Reed 9 dent / cm.
5- 8 threads / dent.

4.2.2 The specification of weft

1- Weft Ne 30/2 cotton
2- 36 picks / cm
3- Weft colors: two colors (D: C) are arranged one (D) color: one (C) color as pattern colors

4.2.3 The fabric samples ofthe third experimentby the second weavingspecifications

The third experiment fabric samples were run with the same weave structures for the second experiment. As shown at fig .(40, 41, 42, 43, 44).

4.2.3.1 The new Honeycomb weave structures groups after modification for the third experiment

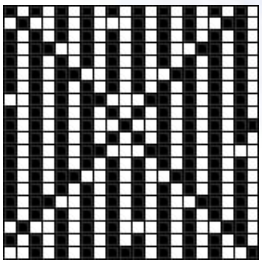


Fig 40: The new honeycomb weave structure from warp on two faces with two colors for the third experiment

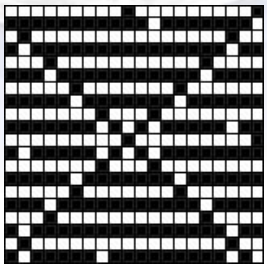


Fig 41: The new honeycomb weave structure from weft on two faces with two colors for the third experiment

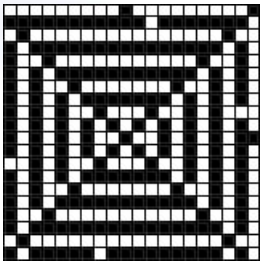


Fig 42: The new honeycomb weave structure from warp and weft on two faces with two colors for the third experiment

4.2.3.2 Using a backed cloth structures group that same the first experiment. as shown at Fig (43, 44) .

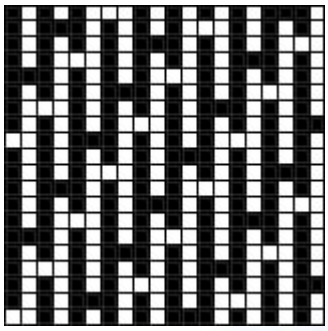


Fig 43: A backed cloth structure from warp on two faces with two colors for the third experiment

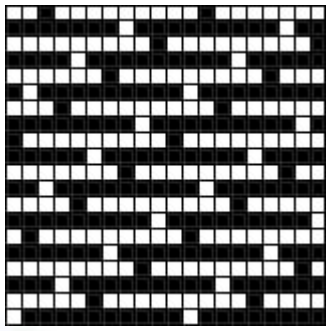


Fig 44: A backed cloth structure from weft on two faces with two colors for the third experiment

4.2.3.3 The fabric sampleof the third experiment by the second weavingspecifications

Warp colors = one silver : one black
Weft colors = one gray : one orang
As shown at Fig (45), (46)

Fig 45 : Face of the fabric sample of the third experiment by the second weaving specification

Fig 46 : Back of the fabric sample of the third experiment by the second weaving specification

4.2.4 Thefabric sample of fourth experiment by the second weavingspecifications

The study had done some modifications at the Honeycomb weave structures groups to less the horizontal floats that has been appearance at the patterns of pervious experiments with retain the same backed cloth structures group , hence evaluate the results of the fourth experiment fabric samples. As shown at Fig (47), (48) (49), (50), (51).

4.2.4.1 The new Honeycomb weave structures group after modification for the fourth experiment

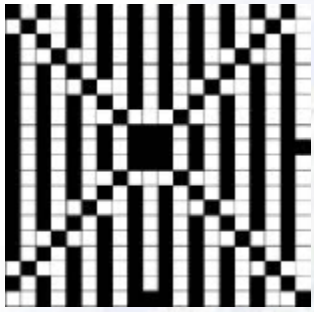


Fig 47: the new honeycomb – weave structure from warp on two faces with two colors for the fourth experiment

Fig 48: the new honeycomb – weave structure from weft on two faces with two colors for the fourth experiment

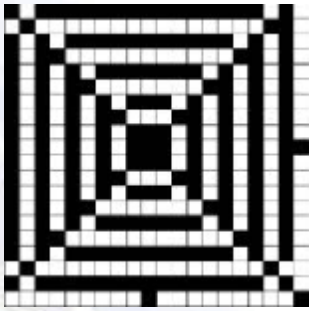


Fig 49: the new honeycomb – weave structure from warp and weft on two faces with two colors for the fourth experiment

4.2.4.2 Using a backed cloth structures group that same the first experiment. as shown at Fig (50, 51) .

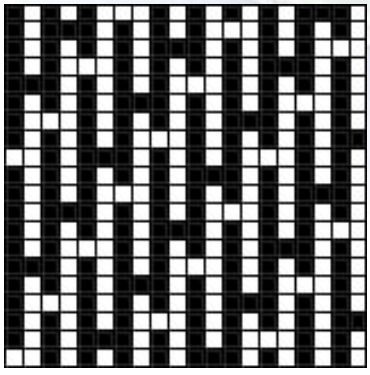


Fig 50: A backed cloth structure from warp on two faces with two colors for the fourth experiment

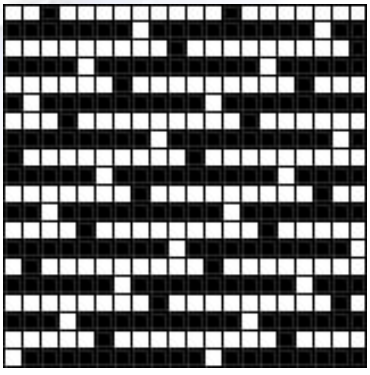


Fig 51: A backed cloth structure from weft on two faces with two colors for the fourth experiment

4.2.4.3The fabric sampleof the fourth experiment by the second weavingspecifications

Warp colors = one silver : one black
Weft colors = one orange : one gray
As shown at Fig (52), (53) .

Fig 52 : Face of fabric sample of the fourth experiment by the second weaving specifications

Fig 53 : Back of fabric sample of the fourth experiment by the second weaving specifications

4.2.5 Thefabric sample of fifth experiment by the second weavingspecifications

Thestudy had done some modifications at the Honeycomb – weave structures groups to less the horizontal floats that has been appearance at the patterns of pervious experiments with retain the same backed cloth structures group , hence evaluate the results of the fifth experiment fabric samples. As shown at Fig (54), (55) (56), (57), (58).

4.2.5.1 The new Honeycomb – weave structures groups after modification for the fifth experiment

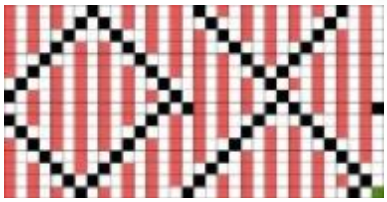


Fig 54:the new honeycomb weave structure from warp on two faces with two colors for the fifth experiment

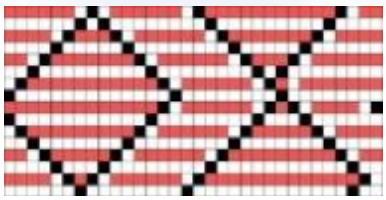


Fig 55: the new honeycomb weave structure from weft on two faces with two colors for the fifth experiment

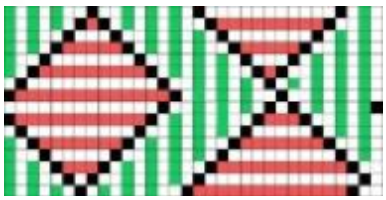


Fig 56: the new honeycomb weave structure from warp and weft on two faces with two colors for the fifth experiment

4.2.5.2 Using a backed cloth structures group that same the first experiment. as shown at Fig (57, 58)

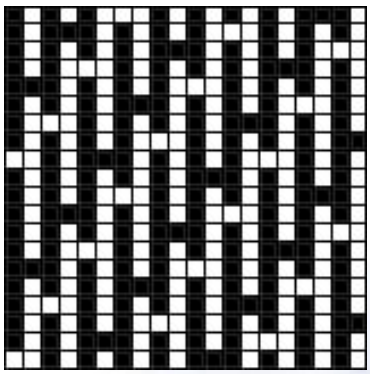


Fig 57: A backed cloth structure from warp on two faces with two colors for the fifth experiment

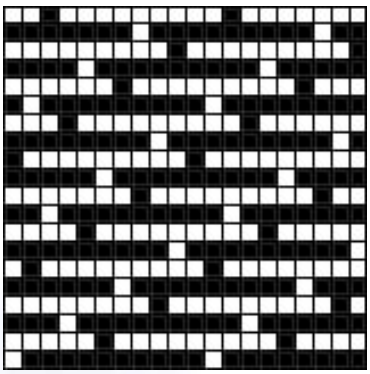


Fig 58: A backed cloth structure from weft on two faces with two colors for the fifth experiment

4.2.5.3 The fabric sampleof the fifth experiment by the second weavingspecifications

Warp colors = one silver : one black
Weft colors = one red : one green
As shown at Fig (59), (60

Fig 59 : Face of fabric sample of the fifth experiment by the second weaving specifications

Fig 60 : Backof fabric sample of the fifth experiment by the second weaving specifications

4.2.6 The fabric sample of sixth experiment by the second weaving specifications

The study had done some modifications at the Honeycomb weave structures groups to less the horizontal floats that has been appearance at the patterns of pervious experiments with retain the same backed cloth structures group , hence evaluate the results of the fourth experiment fabric samples. As shown at Fig (61), (62) (63), (64), (65).

4.2.6 .1 The new Honeycomb – weave structures groups after modification for the sixth experiment

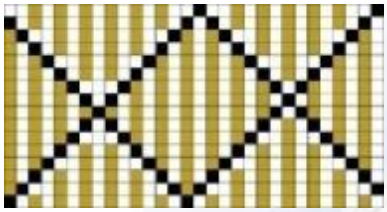


Fig 61: the new honeycomb weave structure from warp on two faces with two colors for the sixth experiment

Fig 62: the new honeycomb weave structure from weft on two faces with two colors for the sixth experiment

Fig 63: the new honeycomb weave structure from warp and weft on two faces with two colors for the sixth experiment

4.2.6 .2 Using a backed cloth structures group that same the first experiment. as shown at Fig (64, 65)

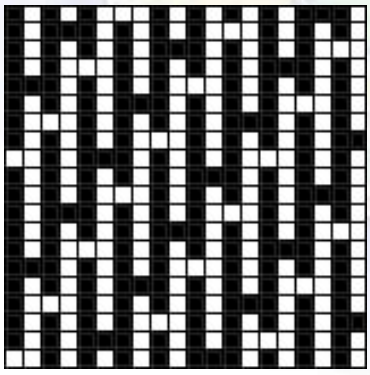


Fig 64: A backed cloth structure from warp on two faces with two colors for the sixth experiment

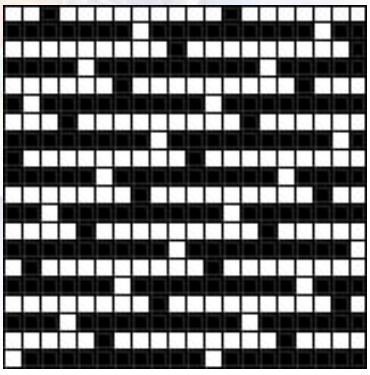


Fig 65: A backed cloth structure from weft on two faces with two colors for the sixth experiment

4.2.6.3 The fabric sampleof the sixth experiment by the second weavingspecifications

Warp colors = one silver : one black
Weft colors = one Navy : Dark green
As shown at Fig (66), (67) .

Fig 66 : Face of fabric sample of the sixth experiment by the second weaving specifications

Fig 67 : Back of fabric sample of the sixth experiment by the second weaving specifications

5. Results and discussions

5.1 The first experiment

Some of problems had been done through producing the fabric samples at the jacquard machine that had been treated at the second experiment as that follow up :
(A) - The target of pick numbers per/cm hasn't been accepted through producing it because the plain weave structures 1/1 areas were more than the Honeycomb – weave and backed cloth structures. As shown at Fig.(7,8,9,10,11,12, 13, 14, 15, 16).

(B) - The decorative color and Honeycomb - weave structure areas hadn't clear enough because The target of pick numbers per/cm hasn't been accepted through producing it because the plain weave structures 1/1 areas were more than the Honeycomb - weave and backed cloth structures. As shown at Fig.(18, 19, 20, 21, 22, 23, 24, 25).

5.2 The second experiment

1- The honeycomb – weave structures interlace had been least than the first experiment to try solving the first experiment defects. As shown at Fig. (26, 27, 28)
2- The second experiment fabric samples were more success and could obtained many patterns with new textures and new aesthetical values. As shown at Fig (36, 37, 38, 39)

5.3 The third experiment

1- The modifications of weave specifications are improved the fabric samples but did not 100% percentage. As shown at Fig. (40, 41, 42)
2- The fabric samples color appearance and building structure had been improved but did not 100% percentage. As shown at Fig. (45,46)

5.4 The fourth experiment

1- The modifications of weave specifications and honeycomb – weave structures are improved the fabric samples but did not 100% percentage. As shown at Fig. (47, 48, 49)

2- The fabric samples color appearance and building structure had been improved but did not 100% percentage. As shown at Fig. (52, 53)

5.5 The fifth experiment

1- The modifications of weave specifications and Honeycomb – weave structures are improved the fabric samples. As shown at Fig. (54, 55, 56)

2- The fabric samples color appearance and building structure had been improved. As shown at Fig. (59, 60)

5.6 The sixth experiment

1- The modifications of weave specifications and Honeycomb – weave structures are improved the fabric samples. As shown at Fig. (61, 62, 63)

2- The fabric samples color appearance and building structure had been improved. As shown at Fig. (66, 67)

6. Conclusion

1-we can use of the physical and aesthetical Honeycomb – weave structure properties to design a jacquard curtain fabric has a new functional and aesthetical values has been used it as a double faces by the high efficiency

2- The Honeycomb – weave structures method can be improved through a jacquard curtain fabric patterns that has been obtained by various colors and textures can be used at the two faces by high efficiency

3- merging between backed cloth structures from weft & warp and both with-honeycomb – weave structures has helped us to increase a jacquard curtain fabric function and aesthetic values.

4- Arranging warp colors as one color (A): one color (B) , and weft colors one color (C) : one color (D) method of he weave structures selection and distributing it at the decorative design helped us to obtain a fabric patterns has a new f function and aesthetic values and can be used at the two faces by high efficiency.

5- According between weave specifications and weave structures helped us to obtain a fabric patterns has a new function and aesthetic values and can be used at the two faces by high efficiency.

7. References

[1]. Edita Malčiauskienė,Žaneta Rukuižienė,Rimvydas Milašius (2009): "Investigation of Linen Honeycomb Weave Fabric Shrinkage After Laundering in Pure Water" 10th International Cotton Conference Natural Fibers - Their Attractiveness in Multi-Directional Applications September 3 - 4, 2009 Gdynia, Poland .
[2]. Elizabeth Austin.(2009): " Fine Linens &Interiors" Holland,Michigan.2009 .
[3]. Peacock Alley. (2005): "Standard Fabric Terms" Dallas,Texas.
[4]. Phyllis G. Tortora, Ingrid Johnson "The Fairchild Books Dictionary of Textiles" Fairchild Books An Imprint Bloomsbury Publishing Inc. New York, Ny
[5]. Phyllis G. Tortora, Ingrid Johnson "The Fairchild Books Dictionary of Textiles" Fairchild Books An Imprint Bloomsbury Publishing Inc. New York, Ny .
[6]. S.T. Peters process Research, Mountin View California, USA (1998) : "Handbook of Composites" Thomson Science is a division of International Thomson Publishing, Green Gate Publishing Services,Tonbridge, England 262:272
[7]. Xueliang Xiao, Tao Hua, Li Li and Jinchun Wang(2015): " Geometrical modeling of honeycomb woven fabric architecture "Textile Research Journal 2015, Vol. 85(16), Reprints and permissions:sagepub.co.uk/journalsPermissions.nav .
[8]. Xueliang Xiao1, Tao Hua1, Jinchun Wang1, Li Li1 and (2015): " Transfer and mechanical behavior of three-dimensional honeycomb fabric" Textile Research Journal July 2015vol. 85 no. 12 1281-1292
[9]. Xiaogang Chen, Ying Sun, and Xiaozhou Gong (2008): " Design, Manufacture, and Experimental Analysis of 3D Honeycomb Textile Composites Part I: Design and Manufacture"Textile Research Journal, September 2008; vol. 78, 9: pp. 771-781.
[10]. Xiaogang Chen,Ying Sun,and Xiaozhou Gong(2008): "Design, Manufacture, and Experimental Analysis of 3D Honeycomb Textile Composites, Part II: Experimental Analysis"Textile Research Journal, November 2008; vol. 78, 11: pp. 1011-1021.
[11]. William Watson; F.T.I . (1975): "Textiles Design and Colour " London.