

FACTORS AFFECTING THE SHAPE OF WRINKLES IN GARMENT FABRICS

العوامل المؤثرة على شكل التجعدات في اقمشة الملابس

By

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خلاصة : في هذا البحث تم تعديل التركيب الانشائي لاجد اصناف الاقمشة المصنوعة من خليط الصوف والثيريلين والمستخدمه في صناعة البدل وذلك لتحسين شكلها الخارجى . هذا التعديل امكن تحقيقه لمعززة العوامل المثاليه المؤثره على مظهره قماش البدل وهى نسبة الصوف في خيوط اللحمة ، نعرة خيط اللحمة ، كثافة اللحمت في وحدة الطول ، قطر زراع الانسان ، نسبة قطر الزراع الي قطر كم البدله ، عدد دورات شى الزراع وزمن الشى وزمن التهيج . الحساوى الهندسيه التى درست ولها علاقه قويه بشكل او مظهر قماش البدل هى سعة الموجه ، طول الموجه وعدد الموحات في وحدة الطول وقد امكن التوصل الى موديلات رياضيه للتنبؤ بشكل الملابس بكل سهوله بالاناهه الى تحديد امثل العوامل المختلفه المؤثرة على الشكل الخارجى للملبس ومراعاة ذلك عند اختيار وتصميم البدل في مصانع الملابس الجاهزة .

ABSTRACT:

In this paper an attempt has been made to modify the construction of one style of wool/terylene fabrics which are used to make suit clothes in order to improve its form. This modification could be achieved to determine the optimum studied factors such as wool percent in weft yarns, weft yarn linear density, pick density, the diameter of arm, the ratio of arm diameter to the sleeve diameter, number of creasing (crushing) cycles, creasing (crushing) time and relaxation time. The investigated geometrical properties that correlated with the form of suit cloth are amplitude of wave, wave length and number of waves per unit length. Mathematical models describing the form of clothes are presented in a form can be easily predicted. In addition, the optimum factors affecting the formability could be determined to improve the appearance of cloths.

1. INTRODUCTION

Although wool/terylene fabrics are widely used in winter suit cloths, no work has yet been carried out to design or modify these fabrics in order to improve the outer form of suits. The form of cloth profile is expressed by three fundamental parameters such as the amplitude of wave, the wave length and the number of waves per unit length. These geometric properties are correlated to a large extent by the type of material, yarn count, pick density, sleeve diameter, the arm-to-sleeve diameter ratio, number of creasing (crushing) cycles, creasing time and relaxation time.

This paper deals with investigating the parameters influencing the form of cloth and determining the optimum values of these parameters.

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2. EXPERIMENTAL PROCEDURE

2.1 Joint For Representing Human Arm :

The joint used for this investigation is made of wood with different diameters (4,5 and 6 cm). It consists of two levers connected with each other, one of them is fixed vertically and the other can be swung handly around a pivot until 135° angle in clockwise direction. The tested specimen in a cylindrical shape 145 mm height is fixed around the joint at the bottom with a clamp as shown in Fig. (1).

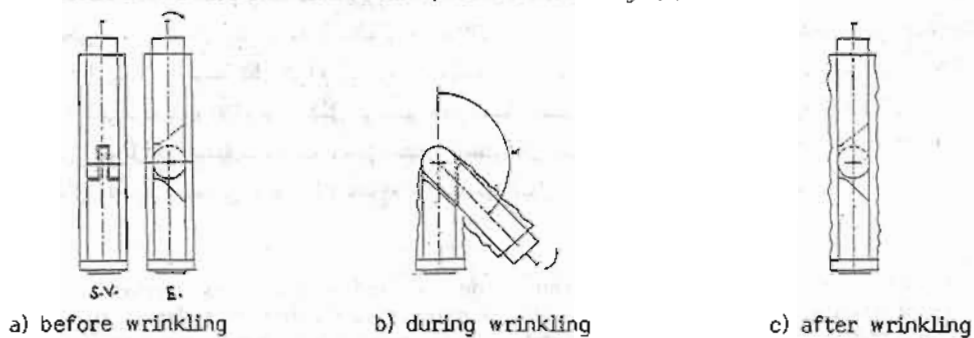


FIG. (1) : DIFFERENT POSITIONS OF JOINT

2.2 Test Method :

A cylindrical specimens of cloth of 145 mm height and with different diameters are fixed vertically. By moving the upper lever handly from the vertical position until 135° angle causing its wrinkling or creasing for a certain time. After that the specimen is allowed to recover from the crease or wrinkling. At the end of the time allowed for recovery, the average height of the cylindrical specimen after crushing is measured. Then wrinkle resistance (Kn) can be determined [5]. In this case, the image of the crushed cylindrical cloth profile is formed and is drawn on a millimetric square scale.

Measurements of the profile radius along the two outer outside edges of the cylinder were determined at constant intervals of about 5 mm. Several measurements of the wave amplitude, wave length and number of waves of the same length of cylindrical cloth were performed accurately.

The wave amplitude of the cloth after wrinkling is calculated by the following equation :

$$A = \left[\left(\sum_{i=1}^n r_i^2 \right) / n \right]^{1/2} \quad \dots (1)$$

where (r_i) is the profile radius or the distance between each point of the profile and the original outside edges of the cylinder before crushing and (n) is the number of points

Thus the wave amplitude can characterize only one aspect of the geometric shape of a cloth profile and an additional geometrical independent term is necessary for describing this shape. However, the wave length can be used as the second term. But it is impossible to measure directly the wave length of a cloth profile.

Although it could be possible to use these two measures (wave amplitude and wave length) for characterizing the shape of the cloth profile, it is possible to deduce from these two measures the number of waves per unit length assuming the specimen shape after crushing follows the sine profile, zig-zag profile and trapezoid profile.

At a known value of wrinkle resistance (Kn) , the value of (A/h) can be determined from tables 1,2,3 [5]. After calculating the wave amplitude (A) from Eq.(1) the wave length (h) would be calculated. And number of waves (N) can be calculated by the ratio of the initial height of the cylindrical cloth (145 mm) to the curve length of one wave (L) calculated from the following equations :

a) For sine profile ; (Fig. 2)

$$L = 4.A. E(m) / m \quad \dots (2)$$

where $E(m)$ is the complete elliptic integral of the second kind.

b) For zig-zag profile ; (Fig.3)

$$L = 4 \left[(A)^2 + (h/4)^2 \right]^{1/2} \quad \dots (3)$$

c) For trapezoid profile ; (Fig. 4)

$$L = 2 a + 4 A \sqrt{1 + \tan^2(\theta)} \quad \dots (4)$$

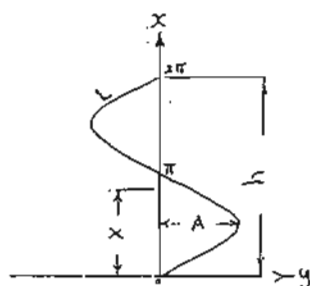


Fig. (2)
Sine profile

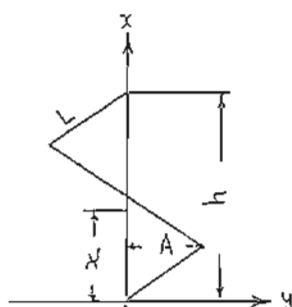


Fig. (3)
Zig-zag profile

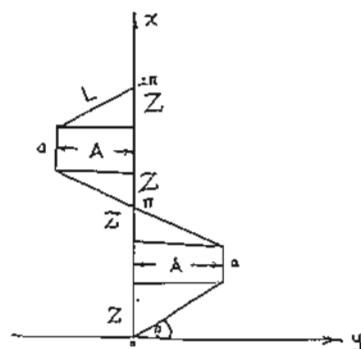


Fig. (4)
Trapezoid profile

3. EXPERIMENTAL DESIGN

The experiments were planned as orthogonal plan of eight variables design [1-4]. The variables were X_1 , wool percent, X_2 , yarn count, X_3 , pick density, X_4 , arm diameter, X_5 , the arm-to-sleeve diameter ratio, X_6 , number of creasing cycles at creasing angle equal to 135° , X_7 , creasing time and X_8 , relaxation time. The range of variation of these factors in weft direction is given in Table (1) and the experimental plan is given in Table (2).

Table 1 : Range of Variation for Studied Factors

| Factor | Level | Minimum Value (-1) | Centre Point (0) | Maximum Value (+1) |
|-----------------------------------|-------|--------------------|------------------|--------------------|
| X_1 - wool /terylene(%) | | 30/70 | 50/50 | 70 /30 |
| X_2 - weft count (Nm) | | 36/2 | 43/2 | 50/2 |
| X_3 - picks /inch | | 40 | 45 | 50 |
| X_4 - arm diameter (cm) | | 4 | 5 | 6 |
| X_5 - arm to sleeve dia. ratio | | 0.50 | 0.65 | 0.80 |
| X_6 - number of creasing cycles | | 5 | 10 | 15 |
| X_7 - creasing time, min | | 5 | 10 | 15 |
| X_8 - relaxation time, min | | 1 | 3 | 5 |

Table 2 : Experimental Plan For Studied Factors

| Experimental No. | Values of factors | | | | | | | |
|---------------------|-------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| | X ₁ | X ₂ | X ₃ | X ₄ | X ₅ | X ₆ | X ₇ | X ₈ |
| 1 | 30 | 36/2 | 40 | 4 | 0.8 | 15 | 15 | 5 |
| 2 | 70 | 36/2 | 40 | 4 | 0.5 | 5 | 15 | 5 |
| 3 | 30 | 50/2 | 40 | 4 | 0.5 | 15 | 5 | 5 |
| 4 | 70 | 50/2 | 40 | 4 | 0.8 | 5 | 5 | 5 |
| 5 | 30 | 36/2 | 50 | 4 | 0.8 | 5 | 15 | 1 |
| 6 | 70 | 36/2 | 50 | 4 | 0.5 | 15 | 15 | 1 |
| 7 | 30 | 50/2 | 50 | 4 | 0.5 | 5 | 5 | 1 |
| 8 | 70 | 50/2 | 50 | 4 | 0.8 | 15 | 5 | 1 |
| 9 | 30 | 36/2 | 40 | 6 | 0.8 | 15 | 5 | 1 |
| 10 | 70 | 36/2 | 40 | 6 | 0.5 | 5 | 5 | 1 |
| 11 | 30 | 50/2 | 40 | 6 | 0.5 | 15 | 15 | 1 |
| 12 | 70 | 50/2 | 40 | 6 | 0.8 | 5 | 15 | 1 |
| 13 | 30 | 36/2 | 50 | 6 | 0.8 | 5 | 5 | 5 |
| 14 | 70 | 36/2 | 50 | 6 | 0.5 | 15 | 5 | 5 |
| 15 | 30 | 50/2 | 50 | 6 | 0.5 | 5 | 15 | 5 |
| 16 | 70 | 50/2 | 50 | 6 | 0.8 | 15 | 15 | 5 |

4.RESULTS AND DISCUSSIONS

4.1 Experimental Analysis:

The results obtained for wave amplitude, wave length and number of waves per unit length were fed to computer and regression coefficients were determined. The coefficients were tested for significance at the 95% significance level. The response-surface equations for the various fabric characteristics are given in Table 3 with the correlation coefficients between the experimental and the calculated values. The response surface agrees fairly with the experimental data especially for the sine shape, as can be seen from the high correlation coefficients. The values of wave amplitude (A), wave length (h) and frequency (number of waves per unit length) (N) for the different profiles are listed in Table (4) using the experimental and theoretical representation of the wrinkle profile in garments shown in reference [5].

4.1.1 - Wave Amplitude :

From analysis the mathematical model of wave amplitude, it could be observed that when changing the factors within the chosen interval, the factor (X5) has a great influence afterwards the factors X4, X8, X1, X3 and X2 respectively. Wave amplitude decreases with using the level -1 of X2, X3 and X4 and with an increase of the variables X1, X5 and X8 as shown from Figures (5-9).

Figures (5-9) show the effect of arm to sleeve dia. ratio on both wool (%), Weft count (Nm), picks/inch, arm diameter and relaxation time on wave amplitude. There is a large increase in wave amplitude when wool (%), weft count (Nm), picks/inch, arm diameter and relaxation time at the highest level. Also with decreasing the arm to sleeve dia. ratio wave amplitude gradually increases. This is may be due to decreasing the radius of curvature of these fabrics and the tightness of suit sleeve with respect to human arm and consequently the higher strains of fabrics.

4.1.2 - Wave Length :

For the mathematical model of wave length, it could be noticed that with an increase of the factors X2, X3 and X4 and with using the level -1 of X5, X6 and X8 wave length increases as shown in Figures (10 - 14) .

Figures(10-14) show the effect of weft count (Nm), Picks/inch, arm diameter, number of creasing cycles, relaxation time and arm to sleeve dia. ratio on wave length. The maximum value of wave length is occurred when increasing weft count, picks/inch, arm diameter and when decreasing number of creasing cycles, relaxation time and arm to sleeve dia. ratio. This is mainly due to the lower strains to which the fibres are subjected during bending.

4.1.3 - Number of Waves Per Unit Length :

But for the mathematical model of number of waves per unit length, it could be observed that it reduces with using the level -1 of X5 and X8 and with an increase of the variables X2, X4 as shown in Figures (15 -17) .

Figures (15-17) show the effect of weft count (Nm), arm diameter, relaxation time and arm to sleeve dia. ratio on number of waves per unit length. Any decrease in arm to sleeve dia. ratio and any increase in both weft count (Nm) and arm diameter

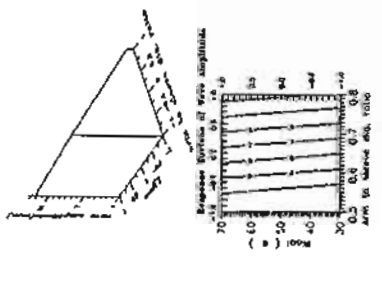


FIG. (1) EFFECT OF ARM TO SLERVE DIA. RATIO AND WAVELENGTH ON WAVE AMPLITUDE

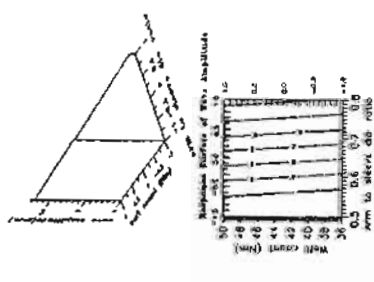


FIG. (2) EFFECT OF ARM TO SLERVE DIA. RATIO AND MESH COUNT ON WAVE AMPLITUDE

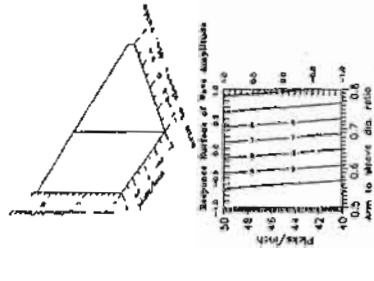


FIG. (3) EFFECT OF ARM TO SLERVE DIA. RATIO AND PLATE THICKNESS ON WAVE AMPLITUDE

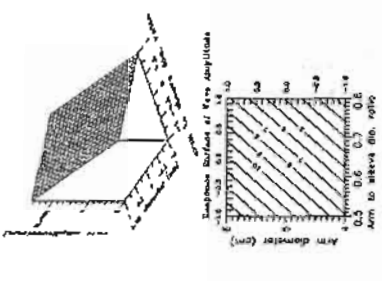


FIG. (4) EFFECT OF ARM TO SLERVE DIA. RATIO AND ARM DIAMETER ON WAVE AMPLITUDE

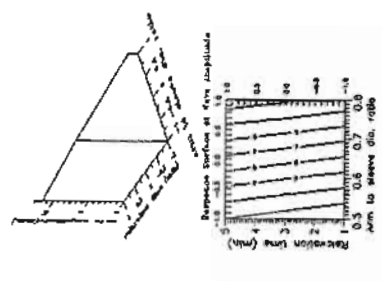


FIG. (5) EFFECT OF ARM TO SLERVE DIA. RATIO AND RETENTION TIME ON WAVE AMPLITUDE

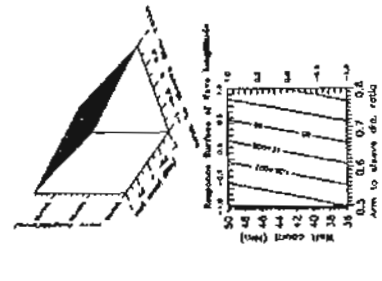


FIG. (6) EFFECT OF ARM TO SLERVE DIA. RATIO AND MESH COUNT ON WAVE LENGTH

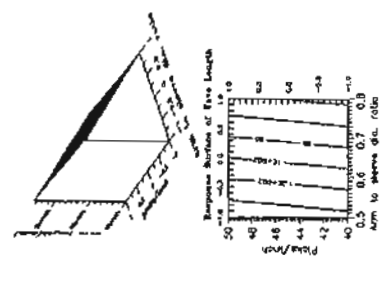


FIG. (7) EFFECT OF ARM TO SLERVE DIA. RATIO AND PLATE THICKNESS ON WAVE LENGTH

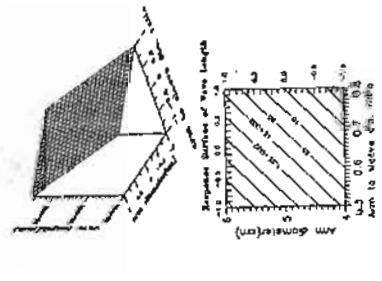


FIG. (8) EFFECT OF ARM TO SLERVE DIA. RATIO AND ARM DIAMETER ON WAVE LENGTH

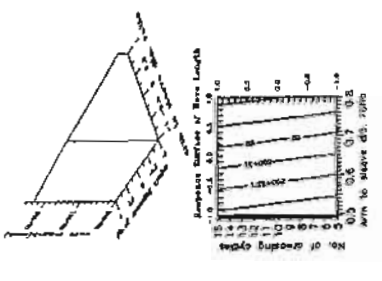


FIG. (9) EFFECT OF ARM TO SLERVE DIA. RATIO AND RETENTION TIME ON WAVE LENGTH

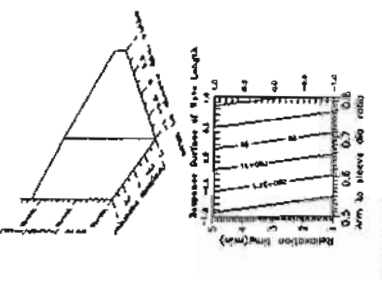


FIG. (10) EFFECT OF ARM TO SLERVE DIA. RATIO AND RETENTION TIME ON WAVE LENGTH

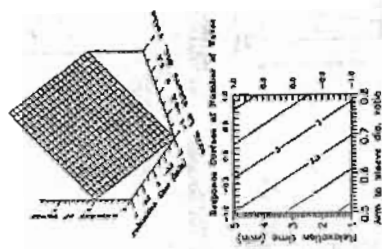


FIG.17) EFFECT OF ARM TO SLEEVE DIA. RATIO AND REINFORCEMENT TIME ON NUMBER OF WAVES

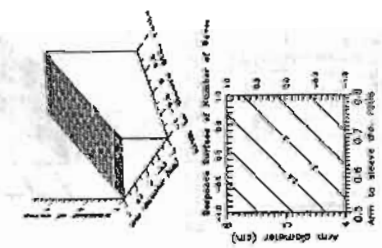


FIG.18) EFFECT OF ARM TO SLEEVE DIA. RATIO AND ARM DIAMETER ON NUMBER OF WAVES

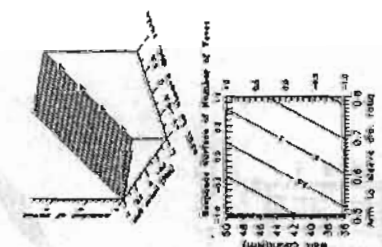


FIG.19) EFFECT OF ARM TO SLEEVE DIA. RATIO AND WAVE COUNT ON NUMBER OF WAVES

result in decreasing number of waves per unit length during use and improving the appearance of the garment sleeve. This is may be due to the lower strain of the specimen and the loose space between the human arm and suit sleeve.

4.2 - Graphical Solution :

Figures (8,12,16) are contour plots of each property on two or three dimensions represent the two important variables (arm to sleeve dia. ratio and arm dia.) when X_1, X_2, X_3, X_6, X_7 and $X_8 = 0$. The plots show how the studied properties behave within the the limitation of the tested materials.

The problem of improving the wrinkle properties of outer wear clothes could be solved by overlaying the graphs (Figures 12 and 16) of the response - surfaces together as shown in Fig. (18). Because when X_1, X_2, X_3, X_6, X_7 and $X_8 = 0$, the best wrinkle properties can be achieved. In Fig. (18) if the value of wave length was equal to 170 mm and upward and number of waves is less than 1.5, then the desired constructional factors would be found in point (A) which $X_1 = +1$ (70/30 wool/terylene), $X_2 = +1$ (50/2 Nm), $X_3 = +1$ (50 picks/ inch) and $X_4 = +1$ (6 cm arm diameter) and $X_5 = -1$ (arm to sleeve dia. ratio = 0.5). Thus Fig. (18) shows the graphical solution which represents all the investigated properties.

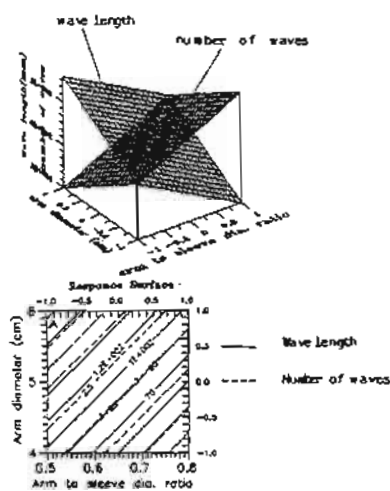


FIG.(18):EFFECT OF ARM TO SLEEVE DIA. RATIO AND ARM DIAMETER ON NUMBER OF WAVES AND WAVE LENGTH

5. CONCLUSION

The study reported in this paper with respect to both wool percent, weft count, pick density, arm diameter, arm to sleeve diameter ratio, number of creasing cycles, creasing time and relaxation time led to the determination of the values of these variables that permit the highest quality to be attained for one style of suit cloth.

Thus, in this paper, it could be deduced that the optimum values of the studied factors are wool percent, 70% , yarn count, 50 /2 Nm, pick density, 50 threads/inch, arm diameter, 6 cm, arm-to-sleeve diameter ratio, 0.5, maximum number of creasing cycles, 5, maximum creasing time, 6 min, and minimum relaxation time, 1 min.

These optimum factors are very important for designing a new fabric, with a higher quality, fits the suit cloth.

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