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FACTORS AFFECTING THE SHAPE OF WRINKLES IN GARMENT FABRICS

العوامل المؤثرة على شكل التجعدات فى اقمشة الملابس

By

Prof. Dr. M. A. SULTAN * and Assoc. Prof. Dr. H. A. ABOU-TALEB **

خلاصة : فى هذا البحث تم تعديل التركيب الانشائى لاحد اصناف الاقمشه المصنوعه من خليط الصوف والتيرلين
والمستخدمه فى صناعه البدل وذلك لتحسين شكلها الخارجى . هذا التعديل امكن تحقيقه لمعرفة العوامل المثاليه المؤثره
على مظهريه قماش البدل وهى نسبه الصوف فى خيوط اللحمه ، نمرة خيط اللحمه ، كثافة اللحمات فى وحدة الطول ،
قطر زراع الانسان ، نسبة قطر الزراع الى قطر كم البدله ، عدد دورات ثنى الزراع وزمن الثنى وزمن التهيج . الخواص
الهندسيه التى درست ولها علاقه قويه بشكل او مظهر قماش البدل هى سعة الموجه ، طول الموجه وعدد الموجات فى وحدة الطول
وقد امكن التوصل الى موديلات رياضيه للتنبؤ بشكل الملبس بكل سهوله بالاضافه الى تحديد امثل العوامل المختلفه المؤثرة
على الشكل الخارجى للملبس ومراعاة ذلك عند اختيار وتصميم البدل فى 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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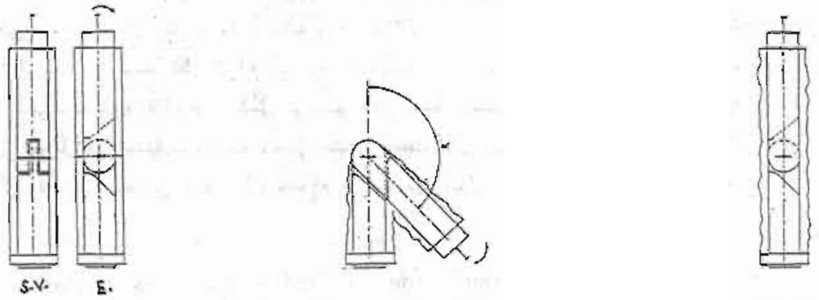
2. EXPERIMENTAL PROCEDURE

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 cylinderical shape 145 mm height is fixed around the joint at the bottom with a clamp as shown in Fig. (1).



a) before wrinkling b) during wrinkling c) after wrinkling

FIG. (1) : DIFFERENT POSITIONS OF JOINT

2.2 Test Method :

A cylinderical 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 cylinderical specimen after crushing is measured. Then wrinkle resistance (Kn) can be determined [5]. In this case, the image of the crushed cylinderical 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 cylinderical cloth were performed accurately.

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

$$A = [(\sum_{i-1}^{n} ri^2) / n]^{1/2} \quad \ldots (1)$$

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

Thus the wave amplitude can characterize only one aspect of the geometric shape of a cloth profile and an additional geometrical independent term is necessa for describing this chape. However, the wave length can be used as the second tern 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 an wave length) for characterizing the shape of the cloth profile, it is possible to deduc from these two measures the number of waves per unit length assuming the specime 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 determin from tables 1,2,3 [5] . After calculating the wave amplitude (A) from Eq.(1) the wav length (h) would be calculated. And number of waves (N) can be calculated by the rati of the initial height of the cylinderical cloth (145 mm) to the curve length of one wav (L) calculated from the following equations :

a) For sine profile ; (Fig. 2)

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

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

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

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

c) For trapezoid profile ; (Fig. 4)

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

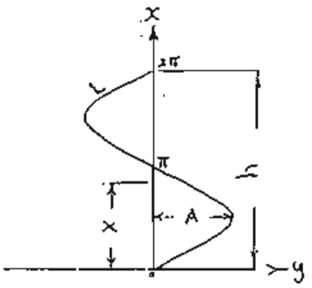


Fig. (2)
Sine profile

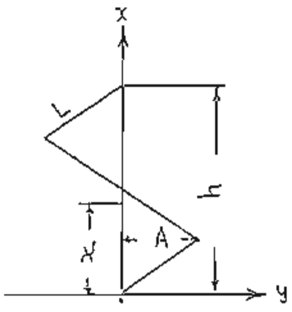


Fig. (3)
Zig-zag profile

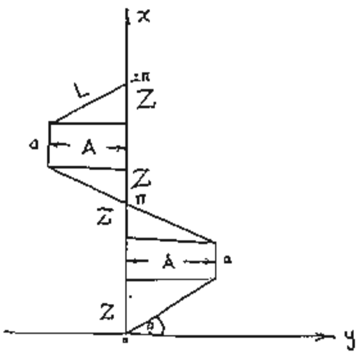


Fig. (4)
Trapezoid profile

3 . EXPERIMENTAL DESIGN

The experiments were planned as arthogonal 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

Level / Factor	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 theoritical rperesentation 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/inck, 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 tightiness 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

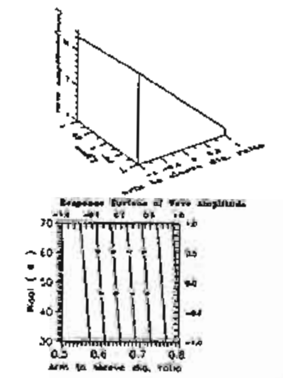


FIG.(5):EFFECT OF ARM TO SLEEVE DIA. RATIO AND WOOL(%) ON WAVE AMPLITUDE

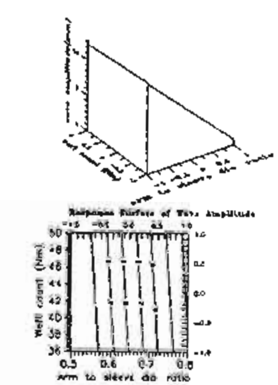


FIG.(6):EFFECT OF ARM TO SLEEVE DIA. RATIO AND WEFT COUNT ON WAVE AMPLITUDE

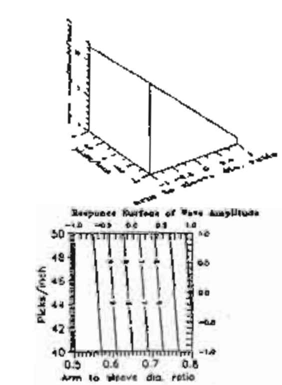


FIG.(7):EFFECT OF ARM TO SLEEVE DIA. RATIO AND PICKS/INCH ON WAVE AMPLITUDE

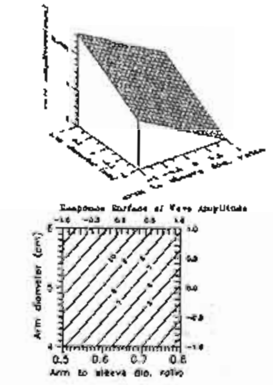


FIG.(8):EFFECT OF ARM TO SLEEVE DIA. RATIO AND ARM DIAMETER ON WAVE AMPLITUDE

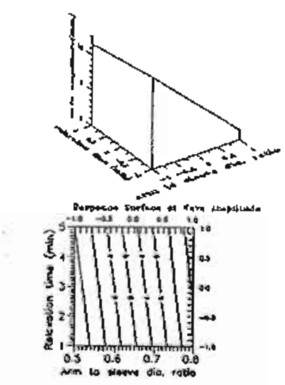


FIG.(9):EFFECT OF ARM TO SLEEVE DIA. RATIO AND RELAXATION TIME ON WAVE AMPLITUDE

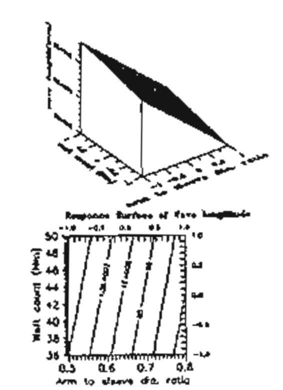


FIG.(10):EFFECT OF ARM TO SLEEVE DIA. RATIO AND WEFT COUNT ON WAVE LENGTH

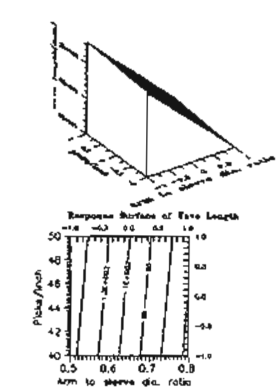


FIG.(11):EFFECT OF ARM TO SLEEVE DIA. RATIO AND PICKS/INCH ON WAVE LENGTH

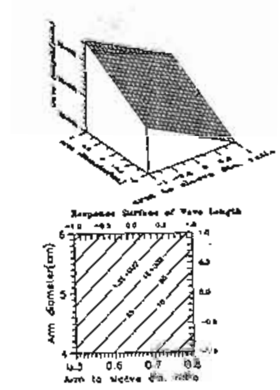


FIG.(12):EFFECT OF ARM TO SLEEVE DIA. RATIO AND ARM DIAMETER ON WAVE LENGTH

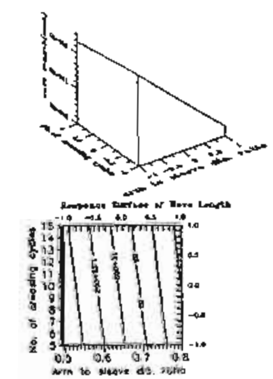


FIG.(13):EFFECT OF ARM TO SLEEVE DIA. RATIO AND CREASING CYCLES ON WAVE LENGTH

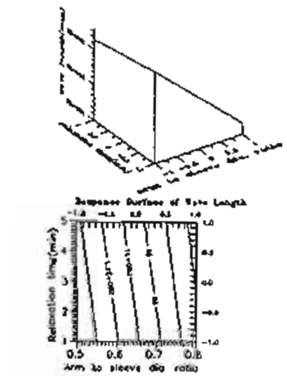


FIG.(14):EFFECT OF ARM TO SLEEVE DIA.RATIO AND RELAXATION TIME ON WAVE LENGTH

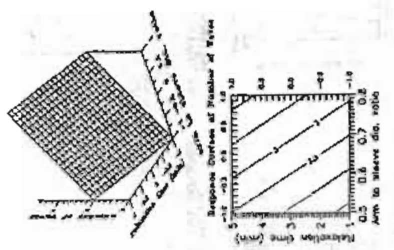


FIG.(17):EFFECT OF ARM TO SLEEVE DIA. RATIO AND RELAXATION TIME ON NUMBER OF WAVES

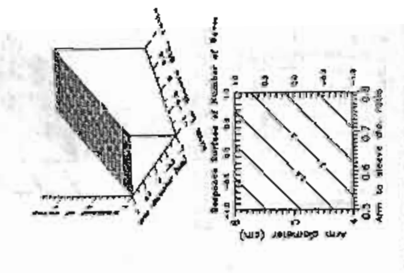


FIG.(16):EFFECT OF ARM TO SLEEVE DIA. RATIO AND ARM DIAMETER ON NUMBER OF WAVES

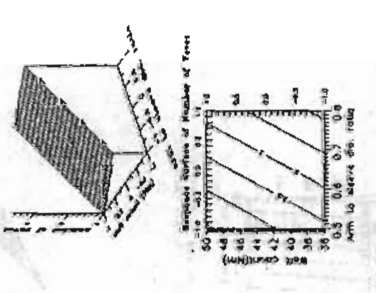


FIG.(15):EFFECT OF ARM TO SLEEVE DIA. RATIO AND WEFT COUNT ON NUMBER OF WAVES result in decreasing number of waves per unit length during use and improving the appearance of the garment sleeve. This is may be due to the lower strain of the specimen and the loose space between the human arm and suit sleeve.

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 X1, X2, X3, X6, X7 and X8 = 0. The plots show how the studied properties behave within the the limition 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 X1, X2, X3, X6, X7 and X8 = 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 contructional factors would be found in point (A) which X1 = +1 (70/30 wool/terylene), X 2 = +1 (50/2 Nm), X3 = +1 (50 picks/ inch) and X4 = +1 (6 cm arm diameter) and X5 = -1 (arm to sleeve dia. ratio = 0.5). Thus Fig. (18)shows the graphical solution which represents all the investigated properties.

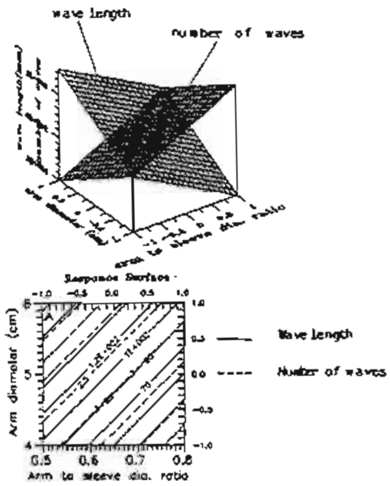


FIG.(18):EFFECT OF ARM TO SLEEVE DIA. RATIO AND ARM DIAMETER ON NUMBER OF WAVES AND WAVE LENGTH

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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