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STUDY REGARDING THE OPTIMIZATION OF THE JERSEY' S MASS

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Abstract: *Correct setting of the structure parameters and their relative influences is the basis of technological adjustments which should be done when programming a new article but also during the operation as a means of preventive control for quality protection.*
The main defects that appear in the knit jersey are determined by the incorrectness of the setting of technological parameters.
Beside these parameters may also be considered as parameters of the knitting process some of the technical characteristics of knitting machines as knitting speed which can be adjusted according to the nature and fineness of the raw material and the structure of the knit.
The structure of the knit has a direct influence on the appearance, on the dimensional stability, on the rip capacity, on extensibility, weight, thickness and width of the knit. Through a judicious choice of their structure knits can satisfy a number of requirements on physico-mechanical and hygienic functional properties as well as some economic desiderata such as reducing raw material consumption by reducing the mass of the knit (but without affecting quality).
The determinations were made on a knit plated jersey made by yarns 50% cotton and 50% polyester, Nm60/1. The knit samples were made on Terrot S 256 4 track machines
To analyse the influence of the knitting parameters on the mass of the jersey was used a mathematical model that expresses the correlation between the knit mass, in g/m as dependent variable (response) and the vertical density, in courses/10mm and the number of turns, in rot/min as dependent variables.

Key words: *mass, knitting, mathematical model, structure parameters, speed, vertical density.*

1. INTRODUCTION

For this research we used knitted fabric made by yarns Nm60/1, 50% cotton and 50% polyester [1], [2], [3]. The experimental part was conducted under a correlation program with two independent variables, central compose rotable second order program [4]. Mathematics patterning has been realised in Mathcad 8 Professional and it contains 13 experiments from which five parallel experiments has been made at independent parameters central values [5], [6].

2. EXPERIMENTAL PART

To analyse the influence of knitting parameters we chose as independent variable x – the vertical density, in courses/10mm, y - number of turns, in rot/min

The coded values of the independent variables are presented in table no.1. [4],[7],[8],[9],[10]

Table 1: *The variation limits of independent variables*

Independent variables	Coded values				
	- 1,414	**- 1**	**0**	**1**	**1,414**
x	19,5	21,2	20,5	19,62	21,5
y	19	22.42	21	19,58	23

The experimental plan is shown in table no. 2 [11]

Table2: *The experimental plan with two independent variables*

Experience' number	x	y
1.	-1	-1
2.	1	-1
3.	-1	1
4.	1	1
5.	-1.414	0
6.	1,414	0
7.	0	-1,414
8.	0	1,414
9.	0	0
10.	0	0
11.	0	0
12.	0	0
13.	0	0

Experimental matrix and measured values for the response function are presented in table no. 3.

Table 3: *Experimental matrix and the measured values for the response function*

Experience' number	Independent variables				Dependent variable
	x vertical density, in courses/10mm		y number of turns, in rot/min		Z=F(x,y) Mass, in g/m^2
	cod.	real	cod.	real	
1	-1	21,2	-1	22,42	248,3254
2	1	19,62	-1	22,42	270,2145
3	-1	21,2	1	19,58	249,6542
4	1	19,62	1	19,58	271,2354
5	-1,414	19,5	0	21	245,3258
6	1,414	21,5	0	21	276,0275
7	0	20,5	-1,414	19	258,2458
8	0	20,5	1,414	23	261,2154
9	0	20,5	0	21	256,2471
10	0	20,5	0	21	256,2458
11	0	20,5	0	21	256,2654
12	0	20,5	0	21	256,2357
13	0	20,5	0	21	256,2654

The regression equation that describes the evolution of the knit mass is shown in equation no.1:

$$z = 256,3147 + 10,8603\, x + 0,8185\, y + 2,0746\, x^2 + 1,6017\, y^2 - 0,0384\, xy \quad \textbf{(1)}$$

The calculated values of response function coefficients are shown in table no.4.

Table 4: ***The coefficients of the response function***

The coefficients of the response function	The calculate values of the coefficients of the response function
b_0	256,3147
b_1	10,8603
b_2	0,8185
b_{11}	2,0746
b_{22}	1,6017
b_{12}	-0.0384

The significance of the regression equation' coefficients was verified with Student test. The critical value for the test is 2,132 for a significance level α = 0,05 and a number of degrees of freedom ν = n-1 = 4 [4],[7],[8]. As a result of the verification, all coefficients of the regression equation are significant.

The adequacy of the model was verified with Fisher- Snedecor test and with the percentage deviation. [4],[7],[8]. The calculated value with Fisher- Snedecor test Fc=0,0000548 is less that the critical value Fc = 2,69, for a significance level α = 0,05, ν_1 = 12, ν_2 = 12. The percentage deviations are less than 10% that shows the veracity of the model. The values for $c_{alculated}$ and for the veracity of the model are shown in table no.5

Table 5: *The veracity of the model*

No.	z measured (mass, g/m^2)	z calculated (mass, g/m^2)	Veracity A (%)
1	248,3254	248,2738	0,0207
2	270,2145	270,0714	0,0529
3	249,6542	249,988	-0,1336
4	271,2354	271,6316	-0,1460
5	245,3258	245,1064	0,0894
6	276,0275	275,8193	0,0754
7	258,2458	258,3599	-0,0441
8	261,2154	260,6748	0,2069
9	256,2471	256,3147	-0,0263
10	256,2458	256,3147	-0,0269
11	256,2654	256,3147	-0,0192
12	256,2357	256,3147	-0,0308
13	256,2654	256,3147	-0,0192

By analyzing the coefficients of the regression equation result that the two independent variables influence identically the resultative z, the mass, the most important parameter is x, the vertical density. Both vertical density increase and speed increased leads to increase mass increase.

The influence of the vertical density about the mass is 4,23% while the influence of the speed is only 0,3% We can see that the influence of the two parameters selected for experiments is low which leads to the conclusion that the mass is influenced by other factors as: yarn's count, the horizontal density of the jersey, the length of the yarn from one stitch a.s.o.

The existence of second degree terms shows that the answer surface will be well defined. The speed of change of the dependent variable is 0,8% for the vertical density and 0,6% for the speed of the knitting machine.

The interaction of the two parameters represented by the existence of b_{12} coefficient is 0,01% and shows that a concerted growth of the two parameters leads to the decrease of the resultative.

In figure no. 1 is presented the answer surfaceand in figure no.2 are presented the level curves obtained through the intersection of the response plane with parallel planes, at the following z values: 251,47; 258,811; 266,151; 273,492; 280,833; 288,174; 295,514; 302,855.

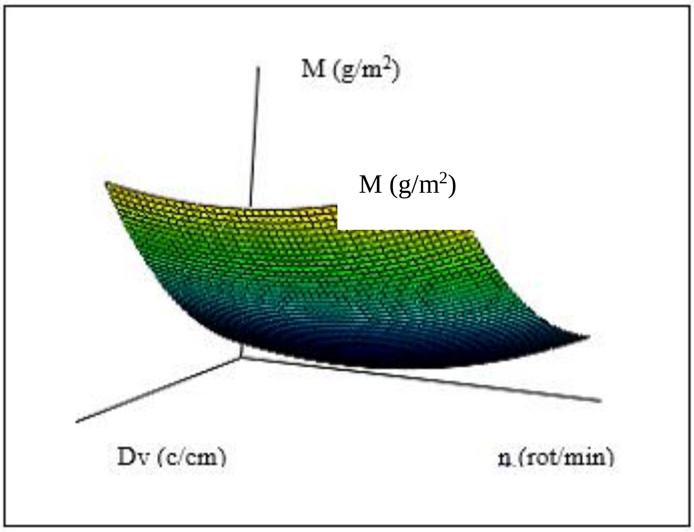

Fig.1: *The response surface*

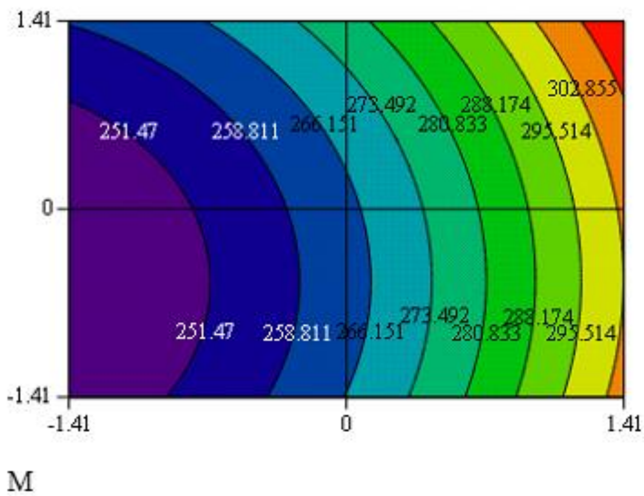

Fig. 2: *The level curves for different values of the mass*

The response surface is a conic with a with a unique center, elliptic paraboloid, and the level curves that generate the response surface, respectively the sections through the response surface for different levels of z, have elliptic shapes. The elliptical shape of the sections through the answer surface results from the calculation of the metric invariants that change the coordinates of the regression equation, resulting S $\neq$0. [4],[7],[8].

The new axis center calculated for optimal function determination is: x = -2,61 and y = -0,28. By calculating the second order partial derivatives of the regression equation results that the new axis center is a minimum point.

In figure no.3 is presented the variation z=f(x) for y=constant.

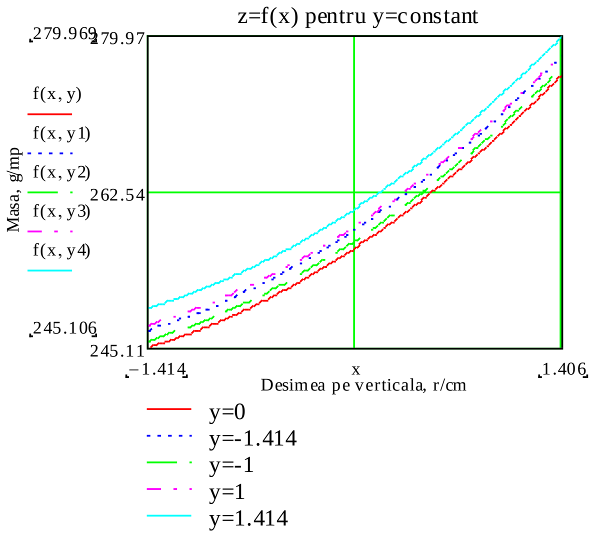

***Fig.3**: The influence of the vertical density about the mass*

3. CONCLUSIONS

For low values of vertical density, about 19,5 stitches/10mm the mass is small, 245,3258 g/m^2, because the variation of the vertical density influence directly proportional the mass size. If the vertical density grows at 20,5 stitches/10mm the mass become 256,2458 g/m^2.

At a bigger value of the vertical density, e.g. 21,5 stitches/10mm the mass become 276,0275 g/m^2. To such a vertical density there is a danger that due to the large agglomeration of stitches to appear pilling phenomenon at wearing the products. There is also the danger that in the knitting process the knit quality is affected by making the stitches forming process more difficult. The bending of the yarn under the action of the stitch forming organs will be difficult. Also, at these values the consumption of raw material is high.

After the mathematical modeling of the knitting process it is recommended to work with vertical density 19,5 stitches/10mm corresponding to -1,414 code values and a speed about 21 rot/min corresponding to 0 code value for that the mass value is 245,3258 g/m^2, very close for the optimum value that is 243,0155 g/m^2. At this value the product is easy to obtain and the raw material consumption is minimal.

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