THE EFFECT OF TWIST MULTIPLER EXPONENT
ON YARN TENACITY CHARACTERISTIC AND YARN DIAMETER CALCULATION

BY

S. Ibrahim*

ABSTRACT:

Exact description of yarn structure using mathematical formulation leads to complete identification of yarn properties and hence projection of fabric properties.
The present work is an attempt trial to study the yarn geometry to find a suitable exponent of twist factor. The logic of analysis is based on the well - known helical model of yarn introducing the variability of raw material and production technology.

Different cotton yarns were used to justify the results of the theoretical analysis. The effect of the suggested and other known exponents on the behaviour of the strength - twist multiplier curves were compared. Also the values of the constant (K) used in determination of yarn diameter is discussed according to the suggested exponent.

1- INTRODUCTION:

The basic assumptions of the coaxial helical model of yarn may be summerized as follows:

1) The yarn have cylinderical cross ...tion.
2) The yarn is built up of huge nu... ...bres in the form of concentrated cyliner ... ...radia.
3) The position of each fibre ir ... ...u- lar helical path around the ... the distance from yarn axi... tant.
4) The helex angle increase...

* Lecturer, Textile Engineerin... El-Mansoura University, El-...
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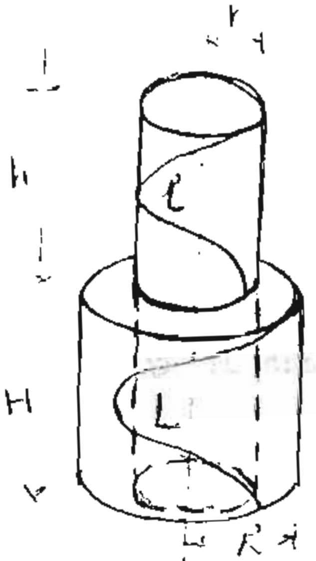
fibre increases in the direction outside of yarn axis. The twist per unit length is considered constant for all layers of the yarn.

5) The density of the fibres in the yarn is considered constant.

Assuming that two different yarns having the same inclination of the perforated fibres



Then $B_1 = B_2$

$$\therefore \tan B_1 = \tan B_2$$

$$\frac{2\pi R_1}{h_1} = \frac{2\pi R_2}{h_2}$$

$$\therefore \frac{d_1}{d_2} = \frac{Z_2}{Z_1}$$

Using the metric count instead of diameters, we obtain

$$\therefore \left(\frac{N_{m\,2}}{N_{m\,1}}\right)^{½} = \frac{Z_2}{Z_1}, \text{ where } N_m = \frac{L}{M \cdot \delta \cdot 10^3} \qquad .....(1.1)$$

L = yarn length m

M = Mass of yarn Kg

δ = Linear density of yarn.

The well known KÖCHLIN twist factor is derived from of equation (1) using $N_{m\,1} = 1$ and $Z_1 = \alpha$ i.e. Köchlin twist factor α½ is written as written as:

$$\alpha_{0.5} = Z \quad N_m^{-0.5} \qquad .....(1.2)$$

or

$$Z = \alpha_{0.5} \cdot N_m^{0.5}$$

/1/ made a correction for Kochlin equation using the formula:

$$Z = \alpha_S \cdot \; N_m^{0.6} \qquad .....(1.3)$$

JAHANSEN/1/ added another correction in staub equation

$$Z = \alpha_S \cdot N_e^{0.5} = \alpha_e \cdot N_e^{0.6} \qquad .....(1.4)$$

α_s : twist factor according to staub

α_e : twist factor according to Köchlin in english system

The correction of Jahansen leads to deviation from the general definition

$$Z = \alpha_q \cdot N^q \qquad .....(1.5)$$

PHRIX used another exponent $q = \frac{2}{3}$, and equation (1.5) becomes /2/:

$$Z = \alpha_{\frac{2}{3}} \cdot N^{2/3} \qquad .....(1.6)$$

REDENBACHER introduced the mean fibre length in Köchlin formula which take the form:

$$Z = C_z \sqrt{\frac{N_m}{l}} \qquad .....(1.7)$$

where

C_z: is the constant equavilant to twist factor.

and l : is the fibre length.

From the previous studies, it is seen that the only equation for determining the twist in the yarn according to physical basis is Köchlin equation, other equations are only imprical forms.

2- THEORTICAL ANALYSIS:

The diameter of yarn could be defined as the diameter of smallest cylinder, where the mass of the main port of the yarn is concentrated /3/. Exact definition in the physical sence does not exist.

Then Eq.(2.7) becomes:

$$D = \frac{1}{\sqrt{N_m \cdot m_t}} \cdot \frac{2}{\sqrt{\pi \cdot \gamma}}$$

and

$$\tan B = \frac{2\ \pi\ .\ \alpha_{0.5}}{\sqrt{\gamma_f} \cdot \sqrt{m_t}}$$

$$= 2.894\ \frac{\alpha_{0.5}}{\sqrt{m_t}} \qquad .....(2.8)$$

According to the principle definition of yarn twisting, tan B has to be constant for different counts with the same intensity of twist, i.e.

$$\frac{\alpha_{0.5}}{\sqrt{m_t}} = \text{constant} = \frac{Z}{\sqrt{N_m \cdot m_t}} \qquad .....(2.9)$$

This formula may be rewritten using the general definition of twist Z defined on the exponent q, then.

$$\frac{\alpha_q \cdot N_m^{q-0.5}}{\sqrt{m_t}} = \text{constant}$$

or

$$\frac{\alpha_q \cdot N_m^{q-0.5}}{\sqrt{f\ (\alpha_q,\ N_m)}} = \text{constant} \qquad .....(2.10)$$

If tan B is constant, then there exists an exponent "q" which makes α_q to be constant and the left hand side of the Equation is a function of α_q only as follow /3/.

$$f(\alpha_q,\ N_m) = m_t = N_m^{2q-1}\ .\ f(\alpha_q) \qquad .....(2.11)$$

Solving equation (2.10) and (2.11) simultanuously gives

$$\frac{\alpha_q}{\sqrt{f(\alpha_q)}} = \text{constant} \quad .....(2.12)$$

and from Equ. (2.9) and Equ. (2.12) we get

$$\frac{m_t \cdot N_m}{Z^2} = \frac{f(\alpha_q)}{\alpha^2_q} \quad .....(2.13)$$

Since the relation between m_t and twist factors have the shape of general prabola in the form of A $(\alpha_q)^B$ then

$$\frac{f(\alpha_q)}{\alpha^2_q} = A \cdot (\alpha_q)^B = \frac{m_t \cdot N_m}{Z^2} \quad .....(2.14)$$

where, B is exponent

In Equ. (2.14) the terms in the right side experimentlly determined. The correct exponent is found if the correlation between $\left(\frac{m_t \cdot N_m}{Z^2}\right)$ and α_q equals unity. Any other values of q would decrease the correlation.

The following results show the correlation coefficients which were found for the exponent (q) of Kachlin, staub and phrix, respectively:

$q = 0.6$ $\quad$ $r = -0.964$

$q = \frac{2}{3}$ $\quad$ $r = -0.9384$

$q = \frac{1}{2}$ $\quad$ $r = -0.9317$

However, for this study suggested exponent is

$q = 0.57$ $\quad$ $r = -0.9841$

Accordingly, the value of the constant A is 0.042 and for

B = -1.5765, Equation (2.14) will be:

$$f(\alpha_{0.57}) = 0.042 \cdot \alpha^{0.4235} \quad .....(2.15)$$

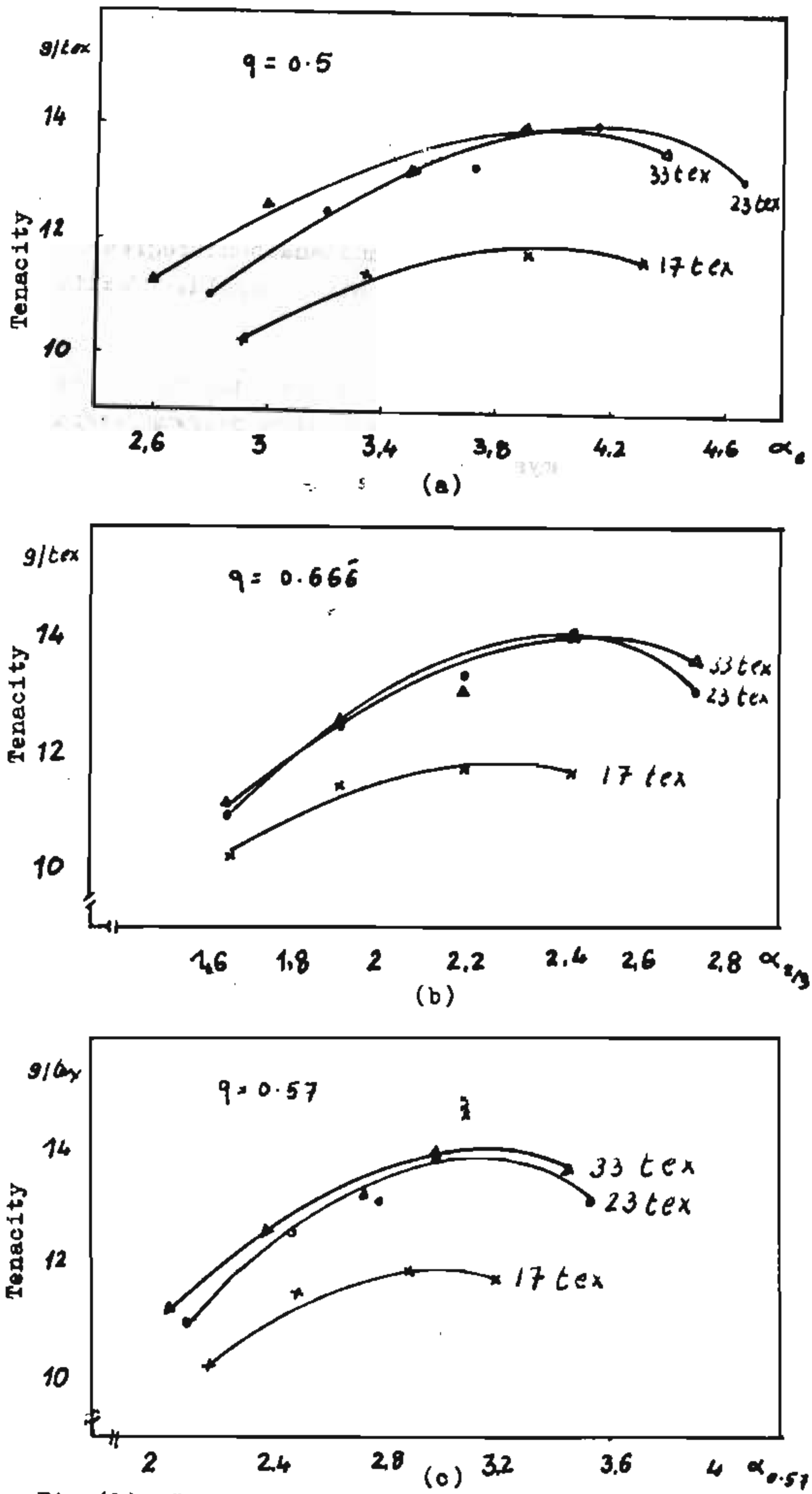


Fig.(1): Tenacity - twist multiplier curve according to Kochlin, phrix and the suggested exponent.

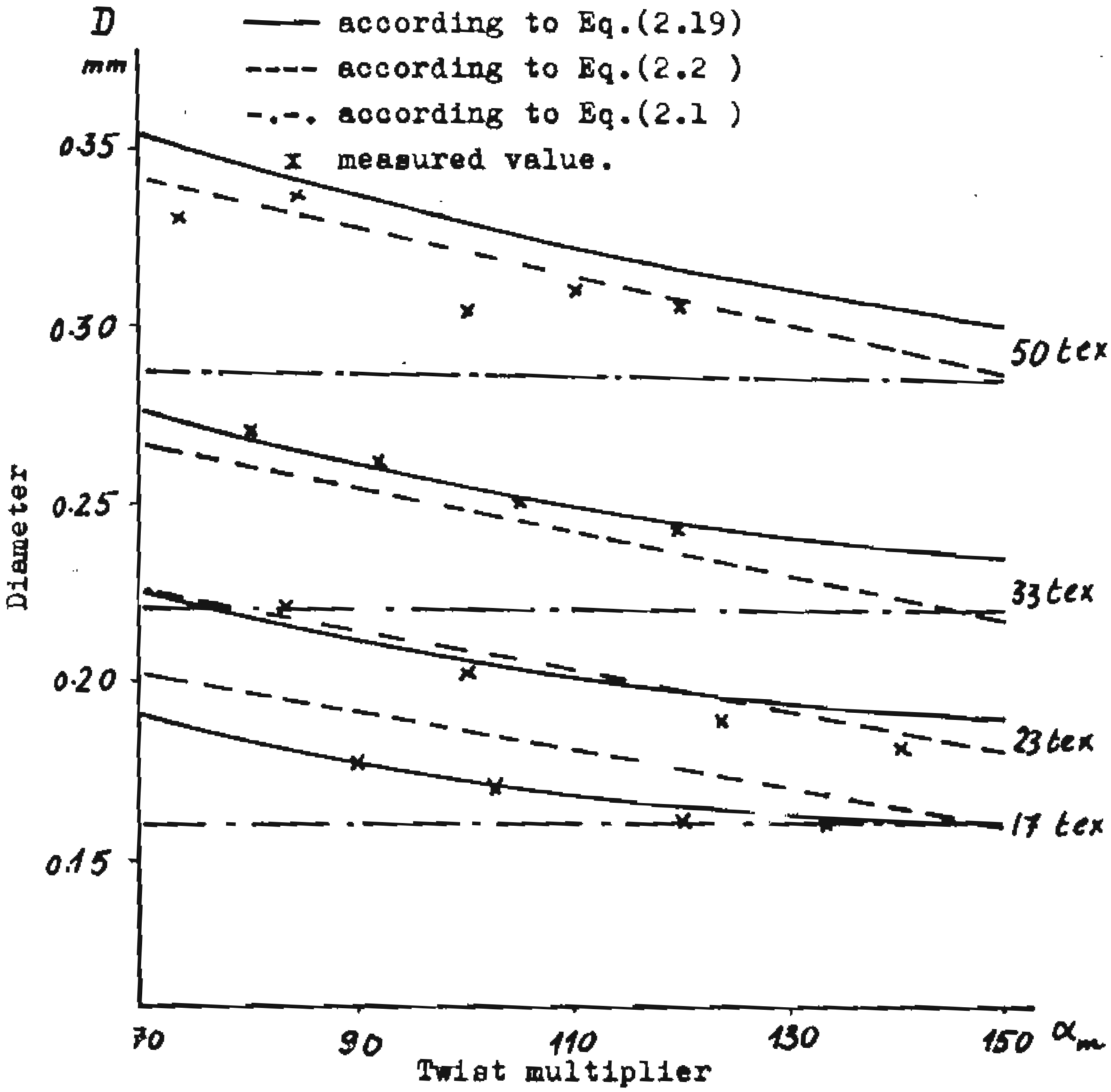


Fig.(2): The relationship between yarn diameter and metric twist multiplier for different yarn cohts.

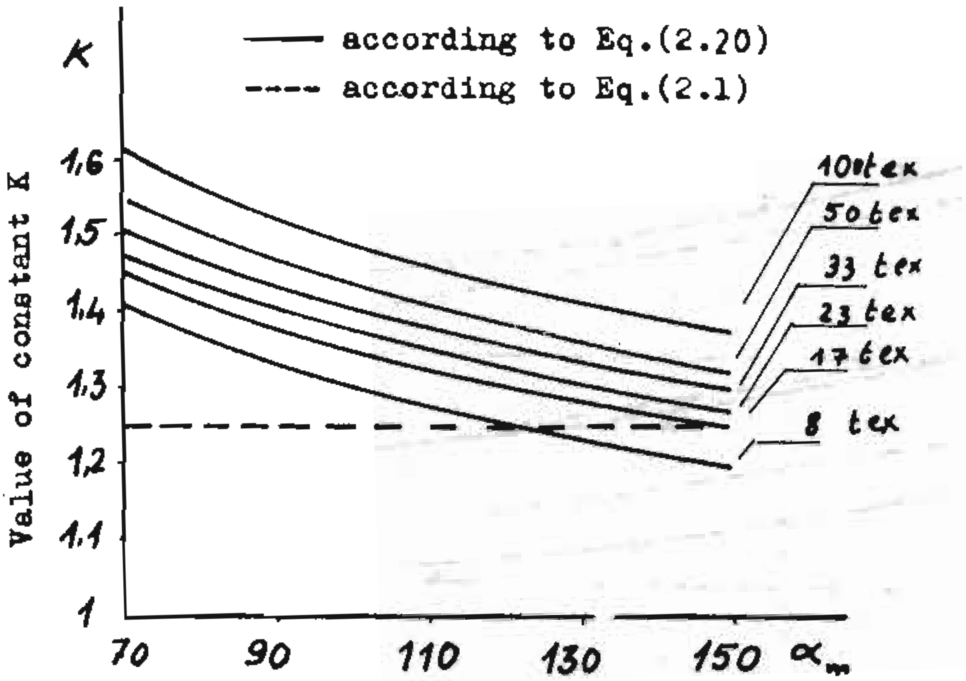


Fig.(3): The value of the constant K in relation to twist multiplier.

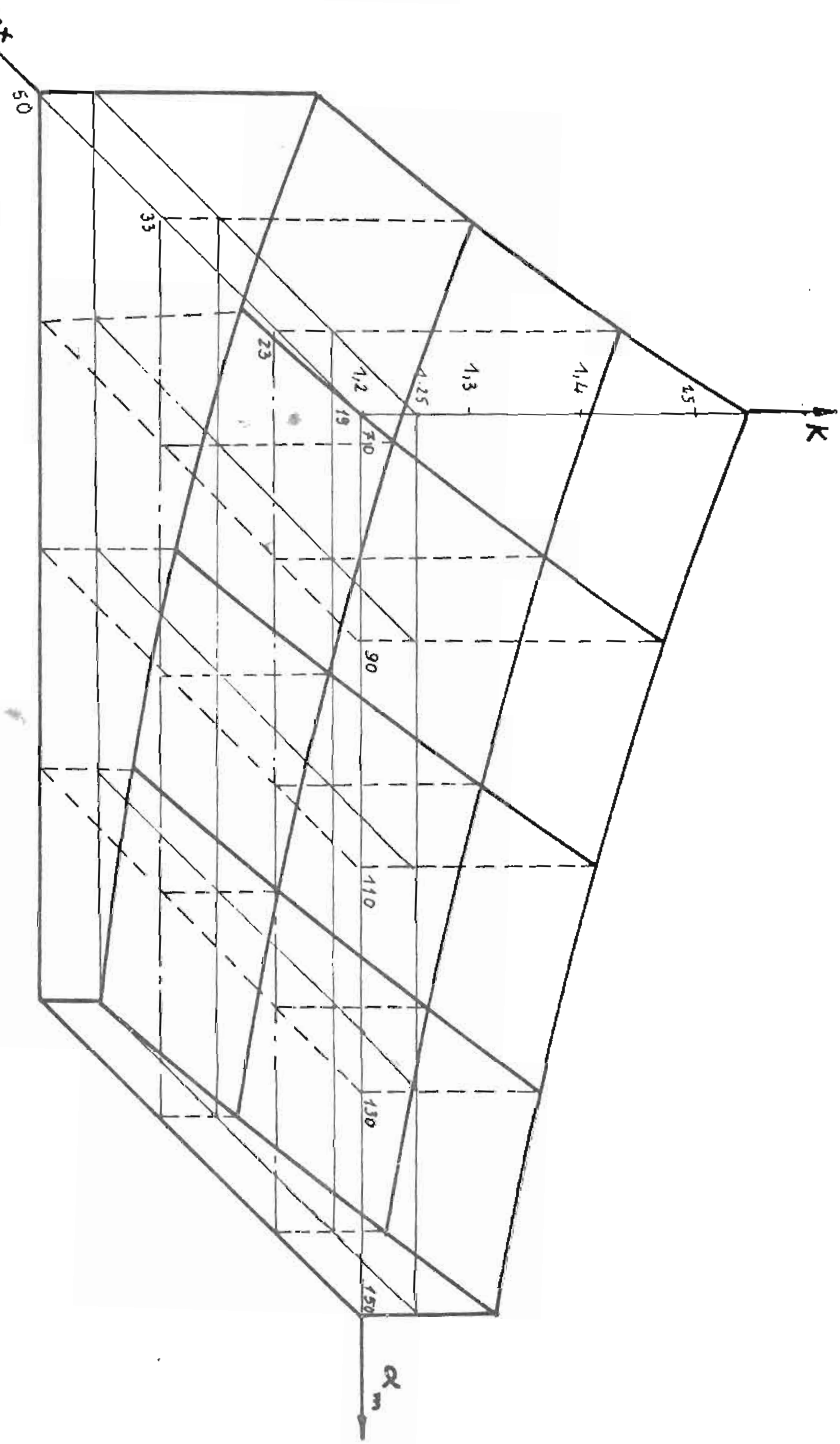


Fig.(4): The relationship between the constant K, twist multiplier α_m and yarn linear density(tex).