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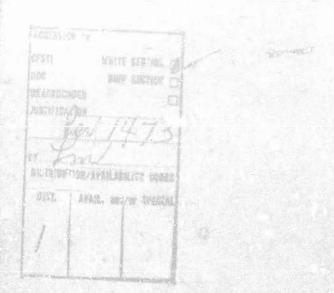
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TECHNICAL REPORT 67-20-CM

1965

DESIGN TABLES FOR TEXTILE FABRICS:
TABLES OF SOLUTIONS OF EQUATIONS FOR MAXIMUM
WEAVABILITY FABRICS MADE FROM SINGLE FIBER
SPECIES AND BLENDS

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FOREWORD

The U.S. Army Natick Laboratories, as part of its research mission in the field of Textiles, has extended the pioneering work of F.T. Peirce on fabric geometry to develop equations, graphs, and tables which can be used in the design of practical textile structures. The studies initiated and supported by the Department of the Army since 1952 have translated initial, rather theoretical, concepts of fabric geometry into easily useable engineering design data.

In 1952, E.V. Fainter developed a system for the graphical analysis of plain weave fabrics based on a plot of the basic Peircean equations for the plain weave.

In 1957, D.F. Adams, E.R. Schwarz, and S. Backer developed a nomographic solution of the geometric relationships in the plain weave.

The first attempt to extend the work of Peirce to fabrics other than the plain weave was accomplished in 1955 by L. Love, who derived the equations for maximum weavable cotton fabrics and plotted graphs which could be used in design.

In 1964, L.T. Weiner and J.E. Johnston, Jr., making use of a GE 225 Computer, tabled the equations for maximum weavable cotton fabrics, covering a practical range of variables for the plain, 3-, 4-, and 5-harness, and the oxford weaves.

In the present report the generalized solutions of the maximum weavable equations are derived and tabled for a broad spectrum of yarn bulk densities; this now permits the design of fabrics made from any of the textile fiber species in use today and any blend of them.

In making these tables available, we hope to assist the textile fabric designer in the rather difficult problem of designing maximum weavable textile structures, and also to encourage further studies of the relationship between fabric geometry and fabric performance. We wish to acknowledge the contributions made to the Army studies of fabric geometry by the above-named individuals and contributions of many others in this country and abroad who have worked toward the simplification of a rather complex textile geometry. Appreciation is expressed to the Data Analysis Office of the U.S. Army Natick Laboratories for the use of their computer and to Mr. David Gracia of the Data Analysis Office for writing the program for solutions to the equations.

ATC COMME

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ABSTRACT

This report contains in tabular form the solutions of the maximum weavability equations for the plain, oxford, 3- and 4-harness twills, and 5-harness sateen in terms of warp and filling cover factors and yarn number ratio (beta) for fabrics made from any fiber species and from blends. The tables are set up for yarn bulk densities ranging from 0.54 to 4.6; this includes fibers as light as polyethylene and as heavy as stainless steel. Supplementary tables are provided giving yarn bulk densities (assuming a standard packing coefficient of 0.59) for all of the commercial fibers and for blends of the most important commercial fibers in increments of 5% ranging from 5% to 95% blend composition.

TABLES OF SOLUTIONS OF EQUATIONS FOR MAXIMUM WEAVABILITY FABRICS MADE FROM SINGLE FIBER SPECIES AND BLENDS

1. Purpose and Scope

a. Purpose

The tables in this report are presented to facilitate the designing of high-texture or maximum-weavable fabrics. Maximum-weavable fabrics are the largest class of functional fabrics used by industry and the military. Among many weaves they include: ducks, poplins, wind-resistant twills and sateens, airplane and balloon cloths, and linings. In designing maximum-weavable fabrics it is always of concern to the designer to know whether his fabric is practical in terms of the capacity of the loom to put in the necessary picks.

The purpose of these tables is to eliminate the need for direct computation or for graphical techniques previously used for obtaining the solution of maximum weavability problems. For the first time, the tables provide the solutions to the maximum weavability equations for fabrics made from any type of fiber or from blends. These tables augment those published in Textile Series Report No. 128 (1), which can be used only for cotton fabrics.

b. Scope

This report contains in tabular form the solution of the equations for maximum weavability fabrics for the plain, oxford, 3- and 4-harness twills, and 5-harness sateen for yarn bulk densities equivalent to polyethylene on the low side and to stainless steel on the high side and including all the commercial textile fibers and blends of the most common textile fibers in increments of 5% from 5% to 95% blend composition.

The maximum weavability tables (Table III) in this report provide solutions over a warp cover factor range of from 8 to 62 inclusive (on a sliding scale depending upon yarn bulk density), at intervals of 1, and over a beta factor range of from 0.5 to 2.0 at intervals of 0.1, where design data are given in terms of yarns per inch and warp or filling yarn number, cover factors and beta factors may be obtained from tables in Textile Series Report No. 128 (1) or computed from equations (4), (5), or (6) given in 3c below.

In addition, two tables are presented which provide a means of obtaining the yarn bulk density when this information is not otherwise available. One of these tables (Table I) gives the standard fiber density for every commercial textile fiber and the equivalent yarn bulk density computed on the assumption of a standard packing coefficient of 0.59. Table I may also be used for any experimental fiber having a fiber density equivalent to that of a given commercial fiber. The second of these tables (Table II) gives the yarn bulk densities of blends of the most important of the commercial fibers. The blends are tabled in 5% increments from 5% to 95% blend composition.

2. Theoretical Background and Previous Techniques

The findings of Peirce have been considered basic in the design and development of fabric structures. The equations of Peirce (2) for the plain weave were published in graphical form by Painter (3), and also in nomographic form, by Backer, Adams and Schwarz (4). Finally, Love (5) extended Peirce's equations to weaves other than the plain, and developed a series of graphs to simplify the prediction of construction parameters of maximum weavability fabrics. Weiner and Johnston (1) solved and tabled the Love equations for a range of cover factors from 10 to 32 and over a beta factor range from 0.5 to 2.0.

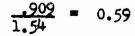
3. Computation and Organization of the Tables

a. Yarn bulk density table for fibers (Table I)

Ideally it would be desirable to know the exact bulk density of yarns comprising textile fabrics, in order to obtain the maximum design accuracy from the maximum weavability tables in this report. It is difficult, but not impossible to obtain a fair approximation of yarn bulk density. The weight of a given length of yarn may be obtained with considerable precision, as can the length of yarn itself. However, because of the inherent compressibility and "hairiness" of many yarns, it is difficult to obtain a realistic measurement of yarn diameter (or yarn area) which is needed to compute the bulk density. Despite the difficulties, many methods have been used with reasonable success to obtain such measurements, including microscopic, seriplane, thickness gauge and Peirce's roving twist technique.

Most workers (5, 6) conventionally follow Peirce's recommendations for cotton fabrics of .909 gm/cm³ as a standard yarn bulk density for design work.

Since the density of cotton fiber is 1.54, the degree of "packing" can be considered to be the ratio of the yarn bulk density to the fiber density, or:



This value of 0.59 which is called the <u>packing factor</u> or packing coefficient has been standardized (6) for fibers other than cotton and on this basis may be used to compute the yarn bulk density from the fiber density of any fiber.

Thus: fiber density x packing coefficient = yarn bulk density or

For mylon (Der of 1.14), for example, if we assume a packing coefficient of 0.59 we get as the yearn bulk density:

$$1.14 \times .59 = .67$$

The yarn bulk density table was prepared in this manner. Thus, the first step to take in designing a maximum weavable fabric, from say, Acrilan, in the absence of experimental data on yarn bulk density, would be to look up its bulk density in Table I.

b. Yarn bulk density table for blends (Table II)

Table II provides for blends of the most common fibers the same information contained in Table I for single fiber yarns. Blend proportions are from 5% to 95% in 5% increments.

The values in Table II were obtained from the solution of the equation:

Dey
$$\frac{0.59}{A}$$
 (Yarn bulk density of blends for (2)
$$\frac{De_{1}}{De_{1}}$$
 Def2

Where De = the bulk density of the blended yarn

Defl = fiber density of fiber #1

Def2 = fiber density of fiber #2

A = percentage of blended fiber #1 expressed as a decimal

A sample calculation for a blend of 25% mylon and 75% cotton would be as follows:

$$De_y = \frac{0.59}{.25 + (1-.25)} = .84$$

In Table II the fiber density of one of the component fibers is given at the nead of the first column with the percentage of that fiber (from 5% to 95%) given below it. The headings of the following seven columns give the fiber densities of the ther component fibers, and the values in the body of the table are yarn bulk densities. For the problem solved above by Equation (2) turn to section of Table II showing fiber density of 1.14 (for nylon) in first column: drop down to 25 (the percentage of nylon in blend) in first column, go across this row (25) to value under column headed 1.54 (fiber density of cotton); this will give bulk density of 0.84.

If necessary, linear interpolation may be used for other blend percentages or fiber densities.

c. Maximum weavability table (Table III)

Table III ("Maximum filling con r factor in terms of warp cover factor and Beta factor") shows the maximum filling cover factor (K₂) that is theoretically obtainable for a given combination of warp cover factor and beta factor. The filling cover factors for the various yarn bulk densities and weaves were obtained by the solutions of the following equations, the derivation of which is given in the Appendix.

PLAIN WEAVE
$$M = 1$$
 $\sqrt{1 - \left[\frac{29.2\sqrt{De}}{(1+\beta)K_1}\right]^2} + \sqrt{1 - \left[\frac{29.2\sqrt{De}}{(1+\beta)K_2}\right]^2} = 1$

THREE HARNESS WEAVES $M = 1.5$ $\sqrt{1 - \left[\frac{M\left(\frac{31.4\sqrt{De}}{K_1} - 1\right) + 1.08}{1.08(1+\beta)}\right]^2} + \sqrt{1 - \left[\frac{M\left(\frac{31.4\sqrt{De}}{K_2} - 1\right) + 1.08}{1.08(1+\beta)}\right]^2} = 1$

FOUR HARNESS WEAVES $M = 2.0$ $\sqrt{1 - \left[\frac{M\left(\frac{32.7\sqrt{De}}{K_1} - 1\right) + 1.12}{1.12(1+\beta)}\right]^2} + \sqrt{1 - \left[\frac{M\left(\frac{32.7\sqrt{De}}{K_2} - 1\right) + 1.12}{1.12(1+\beta)}\right]^2} = 1$

FIVE HARNESS WEAVES $M = 2.5$ $\sqrt{1 - \left[\frac{M\left(\frac{33.6\sqrt{De}}{K_1} - 1\right) + 1.15}{1.15(1+\beta)}\right]^2} + \sqrt{1 - \left[\frac{M\left(\frac{33.6\sqrt{De}}{K_2} - 1\right) + 1.15}{1.15(1+\beta)}\right]^2} = 1$

OXFORD WEAVE $M_1 = 2.0$ $M_2 = 1.0$ $\sqrt{1 - \left[\frac{M_1\left(\frac{32.7\sqrt{De}}{K_1} - 1\right) + 1.12}{1.12(1+\beta)}\right]^2} + \sqrt{1 - \left[\frac{29.2\sqrt{De}}{(1+\beta)K_2}\right]^2} = 1$

where M = Number of yarns per repeat of weave Number of interlacings per repeat of weave

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Cover factors or beta factor may be computed from the following equations:

$$K_1 = \frac{n_1}{\sqrt{N_1}}$$
 [Warp cover factor equation] (4)

where K₁ is warp cover factor

nl is warp texture or yarns per inch
Nl is warp yarn number or "count"

$$K_2 = \frac{n_2}{\sqrt{N_2}}$$
 [Filling cover factor equation] (5)

where K₂ is filling cover factor

n₂ is filling texture or yarns per inch
N₂ is filling yarn number or "count"

$$B = \sqrt{\frac{N_1}{N_2}} \qquad \qquad \text{[Beta factor equation]} \qquad (6)$$

where B is Beta factor or yarn balance N₁ is warp yarn number N₂ is filling yarn number

^{*}Throughout this report subscript 1 refers to warp and subscript 2 refers to filling.

If yarns are numbered in systems other than the "cotton" system, they should be converted to the cotton system in order to use Table III.

In Table III warp cover factors range from 8 to 62 (depending on yarn density), and beta factors from 0.5 to 2.0. In order to simplify the programming and print-out, non-valid values (because of K_1 being too low) are indicated by zeros ("0") in the table. This does not mean that the numerical value of K_2 is zero. The zero should be read as a blank space.

For each of the yarn bulk densities, ranging from .54 to 4.6, there is a section for each of the five weave types. The maximum filling cover factor values are given to one decimal place, which is quite adequate precision for textile design work. Interpolation may be used for fractional values of warp cover factor.

4. Use of Tables I and II

Tables I and II merely provide the essential value of yarn bulk density which indicates the correct location in Table III to enter (each page of Table III has yarn bulk density at the top) to obtain the solution appropriate to the fiber type or blend of which the fabric is composed.

5. How to Use Table III

Table III is the one from which the usefulness of this report derives. Table III is presented primarily as the solution of the equation for filling cover factor (see paragraph 3c) when warp cover factor, beta factor and yarn bulk density are known. (It can also be read for a solution when <u>any three</u> elements are given or required, to find the fourth.)

Perhaps the easiest way to visualize the relationship of these four elements of Table III and how they are obtained is by considering this tabulation:



Element of Table III	Obtainable from	If you have	
Yarn Bulk Density (De)	1. Actual physical measurement		
	2. Table I (for single fiber)	Fiber name or fiber density	
	3. Table II (for blends)	Blend composition	
Warp Cover Factor (K1)	1. Equation 4 $(n_1/\sqrt{N_1})$ or 2. TSR #128 (Table I)*	W yarn number and W texture	
Filling Cover Factor (K ₂)	1. Equation 5 $(n_2/\sqrt{N_2})$ or 2. TSR #128 (Table I)*	F yarn number and F texture	
Beta Factor (B)	1. Equation 6 $(\sqrt{N_1/N_2})$ or 2. TSR #128 (Table II)*	W yarn number and F yarn number	

is chame.

Knowledge of any three of the four "elements" listed above will provide the necessary information for obtaining the fourth from Table III. However, in the conventional design of fabrics the yarn bulk density, warp cover factor, and Beta factor are usually known first or computed and the filling cover factor is the unknown factor which is usually sought.

Text...e Series Report No. 128 [reference (1)] provides the solution of the cover factor equations (4) and (5) and the Beta factor equation (6) for a wide range of yarn numbers and textures.

The textile designer normally has access to the information in the far right column above; this enables him to make the preliminary calculations or to check in Tables I and II to obtain the yarn bulk density to enter Table III. Thus, if he is looking for the greatest number of filling yarns of a given size which car be used for a given weave type, he will know:

- (1) the fiber density or blend composition which will then give him the yarn bulk density
- (2) the warp yarn number and warp texture which will provide the warp cover factor
- (3) the filling yarn number, which with the warp yarn number will provide the beta factor

Using the above three items, he can secure from Table III the maximum filling cover factor.

The maximum filling texture can be obtained by solution of the following equation:

$$n_2 = K_2 \sqrt{N_2}$$
 [Maximum filling texture equation] (7)

where n₂ is filling texture, or yarns per inch
K₂ is filling cover factor

N2 is filling yarn number

Maximum filling texture can also be obtained from TSR No. 128

In addition to thus obtaining the requirements for maximum weavable constructions, it is possible to find what percentage of maximum weavability any construction is. That is, divide the actual filling cover factor by the theoretical filling cover factor. This percentage may be expressed on the basis of either filling cover factor or filling texture.

Also, given a particular construction, the textile designer can determine its <u>practicality</u>. That is, he can determine from the table whether or not it is weavable, without trial weavings.

Given a particular construction, the fabric designer can, by using Table III, determine whether it can be tightened to any extent.

Finally, given certain filling parameters, such as yarn size and texture, it is possible to project certain <u>combinations</u> of warp sizes and textures.

6. Examples of Use of Tables

Since Tables I and II are incidental to the use of Table III, they will not be discussed separately but as an integral part of the discussion of each problem presented in this section. However, it may be well to provide some general information on the role of yarn bulk density before proceeding with specific examples.

Ideally, it would be desirable to know the exact yarn bulk density of the yarns going into the fabric, by means of microscopic or some other type of objective measurement rather than using the approximations of Tables I and II. Where a given yarn is used in many different constructions it may be advisable to go through the mechanics of measuring the actual yarn density. It is recognized that measuring errors may in some instances be as large as estimating errors because of the difficulty in getting a realistic indication of yarn diameter. However, it is important to be aware of differences if they do exist, in the event that actual loom experience yields results that differ somewhat from the predictions of Table III.

Despite the advantages that may accrue from actual yarn density measurements, the busy designer will probably rely more on Tables I and II to obtain the necessary values for entering Table III; the problems below will be based upon this assumption.

a. Design of fabrics made from one type of fiber only

Problems of this type involve the design of a maximum weavable fabric which is made wholly from one type of fiber, such as Arnel or Orlon.

Given: fiber type, filling yarn number, warp yarn number, texture and weave

To find: number of picks for maximum weavable construction

Problem: What are the maximum number of picks of yarn number 19/1 cotton count Orlon that can be woven into a poplin having 106 ends of 40/2 Orlon.

Solution:

Step 1. Find the yarn bulk density of Orlon in Table I; it is 0.67.

Step 2. Find warp cover factor for the 106 ends of 40/2 yarn. First convert 40/2 to 20/1 (cover factor

Step 2. cont'd.

computation is based upon singles equivalents). Obtain warp cover factor using equation (4) where $K_1 = n_1/\sqrt{N_1}$, substituting: $106/\sqrt{20} = 23.702$. Or look it up on page 94 of TSR No. 128.

- Step 3. Find Beta factor for yarns, using equation (6) Beta = $\sqrt{N_1/N_2}$ = $\sqrt{20/19}$ = 1.026. Or look it up on page 138 of TSR No. 128.
- Step 4. Find maximum filling cover factor.

 Turn to Table III for plain weave fabrics (poplin is a plain weave) and yarn bulk densities of 0.67.

 The intersection of "beta factor" (top column) of 1.0 (closest value to 1.026) and row 24 "warp cover factor" (far left) gives "maximum filling cover factor" of 12.1.
- Step 5. Compute maximum filling texture using equation (7): $n_2 = K_2 \sqrt{N_2}$, substituting: 12.1 $\sqrt{19} = 53$. Or look it up on page 95 of TSR No. 128.

b. Design of fabrics made from a blend of two fibers

This problem concerns the design of maximum weavable fabrics made from an intimate blend of two fibers such as nylon and cotton or polyester and cotton.

Given: fiber types, blend composition, filling yarn number, warp yarn number, warp texture and weave.

To find: number of picks for maximum weavable construction

*If it is desired to obtain increased precision, interpolation may be used with the fractional beta factor and the fractional cover factor obtained from the computations in Steps 2 and 3, respectively. In this particular problem, the interpolation would be of no value with respect to warp cover factor, since the equivalent filling cover factor is identical for warp cover factors of 23 and 24. Interpolation for the beta value of 1.026 would increase the maximum filling cover factor to 12.23 or 12.2 in three significant figures. Accordingly, it is suggested that interpolation be ignored for first approximations.

Problem: How many picks/inch must be used in a fabric having 150 ends of 36° yarn to obtain maximum weavability. Solve for both 36° and 25° filling yarns; and for plain and 3-harness weaves. Assume yarns are blended and contain 25% of nylon and 75% of cotton.

24/5/90

- Step 1: Determine density of blended yarn from Table II. Go down column one (headed "fib. den. = 1.14," i.e., fiber density of nylon) to row 25 (% of nylon in yarn). Move across row to value under column headed 1.54 (density of cotton); this gives 0.84. Thus, the yarn density of the blended yarn is .84.
- Step 2: Compute cover factor of warp, using Equation (4).

$$K_1 = m_1 / \sqrt{N_1} = 150 / \sqrt{36} = 25$$

Or look it up in TSR No. 128.

Step 3: Compute Beta factor for both yarn combinations, using Equation (6)

$$B = \sqrt{N_1 / N_2} = \sqrt{36 / 36} = 1$$
$$= \sqrt{36 / 25} = 1.2$$

Or look it up in TSR No. 128.

- Step 4: Go to section of Table III covering Plain Weaves and yarn bulk density of .84

 For Warp cover factor of 25 and Beta of 1, the maximum filling cover factor is 13.5.

 For Warp cover factor of 25 and Beta of 1.2, the maximum filling cover factor is 14.7.
- Step 5: Go to section of Table III covering 3-harness weaves and yarn bulk density of .84.

 For Warp cover factor of 25 and Beta of 1,

the maximum filling cover factor is 17.0. For Warp cover factor of 25 and Beta of 1.2. the maximum filling cover factor is 18.2.

Step 6: Compute maximum filling texture (picks per inch) from cover factor, using equation (7), $n_2 = K_2 \sqrt{N_2}$ Or look it up in TSR No. 128.

Values of no are given in the following tabulation:

	Plain Weavo	3-Harness Weave		
36 ⁸	$n_2 = 13.5 \sqrt{36}$	$n_2 = 17.0\sqrt{36}$		
	= 81	= 102		
25 8	$n_2 = 14.7 \sqrt{25}$	$n_2 = 18.2 \sqrt{25}$		
	= 74	= 91		

Thus, for the plain weave, as we go to the coarser filling yarn (36s to 25s) there are fewer picks that can be woven into the fabric for maximum weavability (81 vs. 74). The same holds true for the 3-harness weave. We can weave 102 picks of the 36s yarn, but only 91 of the 25s yarn.

However, in going from the plain weave to the 3-harness weave it takes more picks to fill the weave. Thus for the 36^S yarn we must increase the number of picks from 81 to 102; and for the 25^S yarn we must increase the number of picks from 74 to 91.

c. To determine percentage of maximum weavability

Problem:

- (1) A Type III wind-resistant <u>all-cotton</u> oxford has a specified texture of 136 by 46. If a 40/2 warp yarn is available, what percent of maximum weavability will be obtained if we use a 12/1 filling?
- (2) If we use the same "size" warp and filling yarns, but made of a <u>blend</u> of 50% Dacron and 50% cotton, what will be the percent of maximum weavability?

(1) Solution

For all-cotton fabric:

First convert 40/2 to 20/1

Step 1: Find yarn bulk density of cotton in Table 1 as .91.

Sel Same

- Step 2: Find warp cover factor by using equation (4) or from TSR No. 128; it is 30.4,
- Step 3: Find filling cover factor by using equation (5) or from TSR No. 128; it is 13.3.
- Step 4: Compute Beta factor, using equation (6) or obtain from TSR No. 128; it is 1.3.
- Step 5: Find maximum possible filling cover factor in Table III for oxford weaves and yarn bulk densities of .91. This value is 15.9.
- Step 6: To obtain percent maximum weavability:

Divide actual filling cover factor (13.3) by computed maximum filling cover factor (15.9) to obtain 83.6 as percent of maximum weavability.

(2) Solution

For Dacron-cotton blend:

- Step 1: Find yarn bulk density of a 50% Pacron 50% cotton blend from Table II as .86.
- Step 2: Find warp cover factor of 30.4 as above.
- Step 3: Find filling cover factor of 13.3 as above.
- Step 4: Find Beta factor of 1.3 as above.
- Step 5: Find maximum possible filling cover factor in Table III for oxford weaves and yarn bulk densities of .86. This value is 15.4.
- Step 6: To obtain percent maximum weavability:

Divide actual filling cover factor (13.3) by computed maximum filling cover factor (15.4) to obtain 86.4 as percent of maximum weavability.

Thus, even though the cotton yarns and the Dacron/cotton blended yarns used in this example were both the same "size" in terms of yarn number (which is a measure of linear density), actually the blended yarn has a larger diameter because of the lower density of the Dacron constitutent. Thus, keeping yarn numbers and textures constant, the blended yarns will produce a fabric with a higher percentage of maximum weavability.

d. To determine weavability or practicality of a given loom construction

Problem: Is a sateen fabric weavable if it has 129 ends of 31/1 polypropylene yarn in the warp and 94 picks of 14/1 polypropylene yarn in the filling?

Solution:

- Step 1: Find warp and filling cover factors: 23.2 and 25.1 respectively.
- Step 2: Find Beta factor: 1.5.
- Step 3: Find Maximum Filling Cover factor in section of Table III for 5-harness weaves and for polypropylene yarn bulk density of .54. This is 19.0.

Since the cover factor desired (25) is <u>larger</u> than the theoretical maximum (19), this fabric would not be weavable. It is interesting to note that a fabric with the same construction characteristics as this could be woven from cotton yarns. Thus, it is erroneous to anticipate that the fiber composition of a fabric can always be changed without also changing the texture and/or the yarn sizes.

7. Basic Assumptions and Limitations of the Tables

Three assumptions were made in developing the equations that led to the formulation of these tables:

- a. The yarn compression in a fabric woven to maximum tightness produces a change in the shape of the yarn section but does not alter the fiber packing density.
- b. Complete flattening takes place in that half of the yarn that is in contact with a neighboring yarn under a single float (see Appendix).
- c. The packing coefficient of yarns made from all fibers and blends is 0.59.

If yarns are numbered in systems other than the "cotton" system, they should be converted to the cotton system in order to use these tables.

For all practical purposes, these assumptions produce only minimal errors and thus the tables are suitable for first-order approximations in fabric design. For designers who work with a few types of fibers or blends it might be useful to check the yarn bulk densities of the yarns they work with, since twist and other factors may alter the yarn bulk density values given in Tables I and II. If actual yarn bulk density values are available, then the only important limitations on the validity of these tables and the equations from which they were derived are the first two assumptions (a and b) listed above.

8. References

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APPENDIX*

DERIVATION OF THE GENERAL MAXIMUM WEAVABILITY EQUATIONS FOR THE PLAIN, TWILL AND SATEEN WEAVES FOR YARNS OF VARYING BULK TENSITIES

^{*}Originally published as:

Material Examination Reports No. 8316 (9 Sept 1965) and No. 8320 (10 March 1966), by Louis I. Weiner, U.S. Army Natick Laboratories, Natick, Mass.

DERIVATION OF THE GENERAL MAXIMUM WEAVABILITY EQUATIONS FOR THE PLAIN, TWILL AND SATEEN WEAVES FOR YARNS OF VARYING BULK DENSITIES

INTRODUCTION

The steps leading to the derivation of the general maximum weavability equations are presented in five sections of this report titled as follows:

- I Derivation of K_0 (procedure of Ball¹).
- II Derivation of the maximum weavability equation for the plain weave (procedure of Peirce²).
- III Derivation of the equations for local spacing in twills and sateens.
 - IV Derivation of K_g (max) and maximum weavability equations for other weave types (procedure of Love³).
 - V Derivation of the generalized maximum weavability equations for all fiber species and blends.

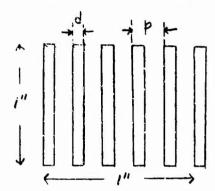
I. DERIVATION OF Ko

It is customary for textile designers to express the "cover" of a woven textile fabric by means of a computed "cover factor" which is

designated by the letter "K". K is derived from fractional coverage as follows:

Fractional coverage $(\frac{d}{p})$:

The cover of a fabric can be expressed as "fractional coverage" which is the ratio of the area "covered" by yarns to the total area of the fabric. For a given fabric direction (warp or filling), fractional coverage may be visualized as the projected area divided by the total area as shown below:



- d = diameter of each
 yarn in inches.
- p = inches/yarn (this
 is called the "spacing"
 and includes a "space"
 and a "yarn diameter")
- n = yarns/inch

For 1 in 2 of fabric, the fractional coverage of either the warp or filling is:

fractional coverage =
$$\frac{yarns/inch \times d'' \times l''}{1 \text{ in}^2} = \frac{nd \times l}{l}$$

numerically fractional coverage = yarns/inch x d" = nd

yarns/inch =
$$\frac{1}{\text{inches/yarn}}$$
 or n = $\frac{1}{p}$ (1)

therefore nd
$$\frac{d}{p}$$
 (2)

The conventional expression for fractional coverage is
$$\frac{d}{p}$$
 (3)

Because of the difficulties encountered in measuring the diameter of yarns it has become customary for textile technologists to use yarn number (N)*, which is easily calculable, in expressions where yarn diameter (d) is normally required.

^{*} N = number of 840 yard hanks per pound or N = $\frac{1}{840w}$

Cover factor (K):

Yarn diameter (d) varies as the reciprocal of the square root of yarn number (N) for the indirect system (which is the system used almost exclusively in this country for staple yarns).

Thus
$$d \propto \frac{1}{\sqrt{N}}$$
 (4)

therefore
$$\frac{d}{p} \propto \frac{\frac{1}{\sqrt{N}}}{p}$$
 (5)

From Equation (1)

$$p = \frac{1}{n}$$
 where $n = yarns/inch$

therefore fractional coverage = (constant)
$$\frac{n}{\sqrt{N}}$$
 (6)

and
$$\frac{\text{fractional coverage}}{(\text{constant})} = \frac{n}{\sqrt{N}}$$
 (7)

The ratio on the left above is designated as cover factor or K, and thus:

$$K = \sqrt{\frac{n}{N}}$$
 (8)

The maximum value of " (designated as K_0) is obtained when d/p = 1, in other words when the projected area of the yarns in the fabric equals the total area. However, as will be seen later in the derivation of the equations for maximum weavability, when compression of the yarns under the float takes place in tightly woven structures, it is possible to get values of K exceeding K_0 . The development of the maximum weavability equations is based on values of K which exceed K_0 . The larger value is designated as K_0 (max). At this stage of our development, however, K_0 can be considered to be the maximum practical cover factor and much valuable design and development work is done utilizing K_0 as a threshold value against which a computed K may be compared.

Yarn diameter (d):

The value of K_0 will vary depending upon the specific volume or density of the yarns for which it is used. Therefore, it is necessary to derive the relationship between diameter (d) and yarn Number (N) as a basis of computing a range of K_0 values. An assumption which has been made in working with this relationship is that cotton yarns have a specific volume of 1.1. If this assumption is accepted, then values of K_0 for a wide variety of fiber types and blends may be computed, if the packing factor or packing coefficient for yarns made from these fibers is considered as identical to that of cotton yarn. More will be said about this later.

. The Chro

The relationship between diameter and yarn number may be deduced as follows:

Consider a textile yarn as an incompressible cylinder of length "L" and diameter "d"

The volume of this cylinder =
$$\frac{d^2 \mathcal{L}}{4}$$
 (9)

The weight of the cylinder =
$$\frac{\pi d^2 De}{l_1}$$
 Where De is density (10) of yarn

In the metric system the weight in grams of the yarn would be

$$W = \frac{1}{4} \frac{2De}{4} \qquad \qquad \int_{De} \frac{\ln cm}{cm/cm^3} \qquad (11)$$

Keeping De in the metric system, which is conventional, but converting W, L, and d to pounds, yards and inches respectively, which are conventional for textile yarns, the following results:

gm =
$$\frac{7 \text{ cm}^2 \text{ cm De}}{4}$$
 lbs x 454.6 = gms
in² x 2.54² = cm²
gm = .785 cm² cm De yds x 36 x 2.54 = cm

11.3 x 454.6 = .785
$$\sin^2 x \ 2.54^2 \ x \ yds \ x \ 36 \ x \ 2.54 De$$
 (12)

$$W = 1.0189 d^2 \cancel{L} De$$
 (14)

$$d^2 = \frac{W}{1.0189 2 \text{ De}}$$
 (15)

$$d = \sqrt{\frac{W}{1.0189 \text{ p be}}}$$
 (16)

Divide top and bottom of fraction by W

$$d = \sqrt{\frac{1}{1.0189 \text{ g/W De}}}$$
 (17)

By definition, in the cotton numbering system where \mathcal{L} is in yds. and W in pounds and N = Yarn Number

$$\mathcal{L}/W = 840 \text{ N}$$
 (18)

$$d = \sqrt{\frac{1}{840 \times 1.0189 \text{ N De}}}$$
 (19)

d
$$=\sqrt{\frac{.001168L}{N De}}$$
 (20)

$$d \sim \sqrt{\frac{.0342}{N \text{ De}}}$$
 (21)

Relationship between K and d/p:

If we find the general relationship between K and d/p, then K_0 can be determined as the value of K when d/p = 1, in other words, when the fractional coverage is unity or the projected area of the yarns equals the total fabric area.

Recall from equation (8) that: $K = \frac{n}{\sqrt{N}}$

and from equation (1) that: $n = \frac{1}{p}$

therefore $K = \frac{1}{p\sqrt{N}}$ (22)

and $p = \frac{1}{K\sqrt{N}}$ (23)

From equation (21)

d • .0342

therefore $\frac{\frac{.0342}{\sqrt{N} \quad De}}{\frac{1}{K \sqrt{N}}}$

thus $\frac{d}{p} = \frac{.0342 \text{ K}}{\sqrt{D_{\bullet}}} \tag{25}$

Calculation of Ko:

By definition when d/p = 1 $K = K_0$ or $\frac{d/p}{1} = \frac{k}{K_0}$ (26)

 $1 = \frac{.03 42 \text{ K}_0}{\sqrt{\text{De}}} \tag{27}$

 $K_0 = \sqrt{\frac{De}{.0342}}$ or $K_0 = 29.2 \sqrt{De}$ (28)

Thus for any yarn, regardless of fiber composition or structure, if we know the yarn density (bulk density) we can compute Ko, i.e., the "maximum" cover factor corresponding to d/p = 1. The problem of determining yarn density is a difficult one and much fabric design as practiced today for cotton fabrics is based upon Peirce's selection of .909 as the bulk density of cotton yarn (.909 is the reciprocal of the specific volume value of 1.1).

For cotton then:
$$K_0 = 29.2 \sqrt{.909} = 27.8$$
 (29)

Some workers round this figure off to 28.0

Packing factor:

It is convenient to relate the density of cotton yarn to the density of cotton fiber. This relationship, expressed as a ratio, is termed the packing coefficient or packing factor.

$$PC = \frac{De (yarn)}{De (fiber)}$$
 (30)

For cotton:
$$PC = \frac{.909}{1.54} = .59$$
 (31)

It has become conventional for designers working with fibers other than cotton to assume that the packing factor of yarns made from these other fibers is constant at .59. With this assumption it becomes simple to compute the densities of yarns, made from a wide variety of fibers, using equation (30).

$$De(yarn) = PC \times De(fiber)$$
 (32)

Substituting this relationship in equation (28), the following is obtained:

$$K_0 = 29.2 \sqrt{\text{De (yarn)}}$$
 (34)

$$K_0 = 29.2 \sqrt{PC \times De \text{ (fiber)}}$$
 (35)

$$K_0 = 29.2 \sqrt{.59De (fiber)}$$
 (36)

$$K_{O} = 22.4 \sqrt{\text{De (fiber)}}$$
 (37)

K values for some typical fiber species are ; iven in the following table:

Fiber	Density of fiber	VDe (fiber)	К _о
Nylon	1.14	1.067	24.0
Wool	1.32	1.149	25.8
Dacron	1.37	1.170	26.3
Cotton	1.5կ	1.241	27.8
Glass	2.54	1.594	35.8

II DERIVATION OF THE HAXIMUM WEAVABILITY EQUATION FOR THE PLAIN WEAVE

In order to reduce the number of variables required in the solution of the geometry of the plain weave, Peirce introduced the parameter "E" which is the sum of the diameters of the warp and filling yerns.

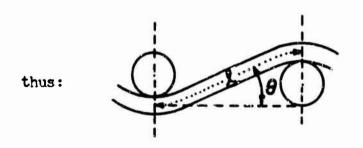
Thus
$$D = d_1 + d_2$$
 where (38)

subscripts 1 and 2 apply to warp and filling respectively. Other symbols used by Peirce are:

h = maximum displacement of yarn axis measured normal to the cloth as follows:



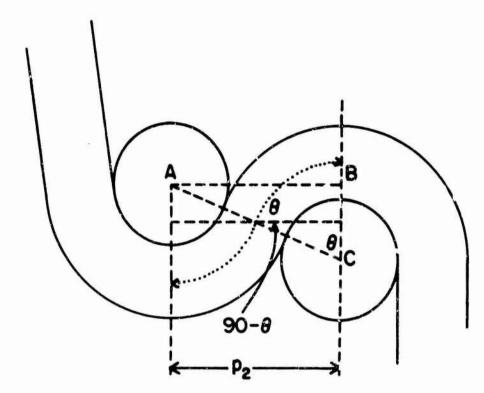
length of yern in a unit cell



θ = angle between yarn axis and plane of clothp, n, and d are as used previously in this report

In tight fabric constructions the yarn systems are considered to be jammed. When the warp yarn is jammed, for example, there is no straight portion in the warp yarn and a line joining the centers of the filling yarns is perpendicular to the warp yarn axis at the point of intersection. When this condition prevails, as shown below, both the filling yarn spacing p₂ and the filling yarn displacement h₂ are functions of the angle (0) between the warp yarn axis and the plane of the cloth.*

^{*} No yarn compression is assumed in these preliminary derivations.



Construction for Filling Yarn Spacing

p₂ is the spacing of the filling yarns and thus is equal to the distance between the vertical lines above: AB

D is the sum of the diameters of the warp and filling yarns which is the length of the diagonal line above: AC

From the geometry of the triangle ABC:

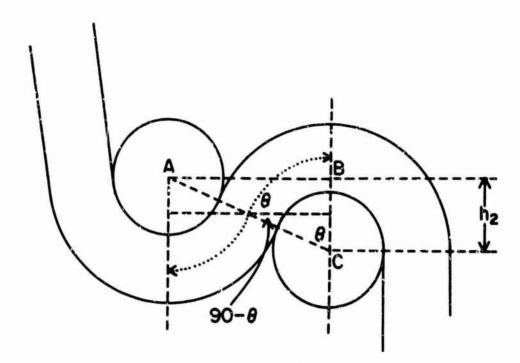
$$\sin \theta = \frac{AB}{AC} = \frac{p_2}{D} \tag{39}$$

and
$$p_2 = L \sin\theta$$
 (40)

For filling yarn displacement:

 h_2 is the displacement of the filling yarns, which is the distance BC below.

D is the sum of the diameters: AC below.



Construction for Filling Yarn Displacement

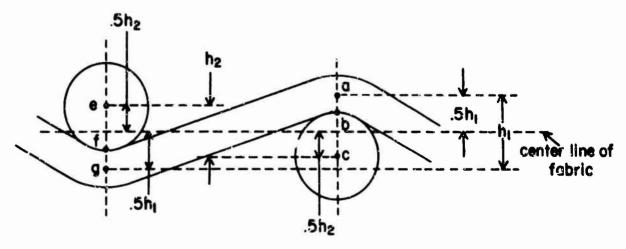
From the geometry of the triangle ABC:

$$\cos \theta = \frac{BC}{AC} = \frac{h2}{D} \tag{41}$$

and
$$h_2 = D \cos \theta$$
 (42)

It can also be shown that for any yarn configuration

$$h_1 + h_2 = D \tag{43}$$



$$.5h_1 + .5h_2 = ef + fg$$
 $.5h_1 + .5h_2 = ab + bc$

$$h_1 + h_2 = ab + bc + ef + fg$$

ab = r₁ (radius of warp yarn)

bc = r2 (radius of filling yarn)

ef r₂

 $fg = r_1$

$$h_1 + h_2 = r_1 + r_2 + r_1 + r_2$$

 $h_1 + h_2 = 2(r_1 + r_2) = d_1 + d_2 = D$

therefore $h_1 + h_2 = D$

Summarizing: When the warp is jammed, then from equation (42)

h₂ = D cos 3₁

When the filling yarn is jammed it can be shown in an analogous fashion that:

$$h_1 = D \cos \theta_2$$
 (44)

Since
$$h_1 + h_2 = D$$
 (45)

then D cos
$$\theta_1$$
 + D cos θ_2 = D (46)

and
$$\cos \theta_1 + \cos \theta_2 = 1$$
 (L7)

Since
$$\cos^2\theta + \sin^2\theta = 1$$
 (48)

$$\cos \theta_1 = \sqrt{1 - \sin^2 \theta_1} \tag{49}$$

and
$$\cos \theta_2 = \sqrt{1 - \sin^2 \theta_2}$$
 (50)

Therefore
$$\sqrt{1 - \sin^2\theta_1} + \sqrt{1 - \sin^2\theta_2} = 1$$
 (51)

Recall from equation (40) that
$$p_2 = D \sin \theta_1$$
 (52)
then $\sin \theta_1 = \frac{p_2}{D}$

analogously
$$p_1 = D \sin \theta_2$$
 and $\sin \theta_2 = \frac{p_1}{D}$ (53)

Therefore
$$\sqrt{1-\left(\frac{p_2}{\overline{D}}\right)^2}+\sqrt{1-\left(\frac{p_1}{\overline{D}}\right)^2}=1$$
 (54)

Equation (54) is the basis of the widely used equations for maximum weavable fabrics. To make it more generally applicable to the design problems of the textile engineer, it has been customary to introduce the cover factor (K) into the relationship and also to use the Peta (B) factor instead of D.

Beta (B) is defined as the ratio of the filling yarm diameter to the warp yarm diameter. It is also numerically equal to the ratio of the square root of the warp yarm number to the square root of the filling yarm number, for the indirect yarm numbering system.

Thus

$$B = \frac{d_2}{d_1}$$
 and $d_2 = Bd_1$ (55)

or
$$B = \sqrt{\frac{N_1}{N_2}} \tag{56}$$

Since D =
$$d_1 + d_2$$
 it follows from (55) that

D = $d_1 + B d_1$ and D = $d_1 (1 + B)$ (57)

also
$$D = \frac{d_2}{B} + d_2$$
 $D = \frac{d_2(1 + B)}{B}$ (58)

Therefore
$$\frac{p_1}{\overline{D}} = \frac{p_1}{d_1 (1 + B)}$$
 (59)

$$\frac{p_2}{D} = \frac{p_2 - B}{d_2 - (1 + B)} \tag{60}$$

Recall from (26) that
$$\frac{d}{p} = \frac{K}{K_0}$$
 (61)

Also from (29) for yarns numbered in the cotton system and having a bulk density of .909 (the value selected by Peirce):

$$K_0 = 27.8$$
 (62)

Then
$$\frac{d}{p} = \frac{K}{27.8}$$
 or $\frac{p}{d} = \frac{27.8}{K}$ (63)

Thus from (57)
$$\frac{p_1}{D} = \frac{27.8}{K_1(1 + B)}$$
 (614)

and from (58)
$$\frac{p_2}{D} = \frac{27.8B}{K_2 (1 + B)}$$
 (65)

Therefore:
$$\sqrt{1-\left(\frac{27.8}{K_1} \frac{2}{(1+B)}\right)} + \sqrt{1-\left(\frac{27.8B}{K_2} \frac{2}{(1+B)}\right)} = 1$$
 (66)

This is the equation for the plain weave, from which the supplementary equations for the twill and sateen weaves have been derived. Before going into the derivation of these other equations it might be well to briefly review the manner in which the above equation is used. Observe that there are variables K_1 , K_2 , and B. These three are not completely independent. The warp yarn number N₁ is a component of K₁, the filling yarn number N₂ is a component of K_2 and the ratio of these two yarn numbers determines E. For a given B and K₁ however, it is possible to obtain the corresponding K₂ required to make the fabric a maximum weavable construction and conversely for a given B and K2 it is possible to obtain the corresponding K1 required to make a maximum weavable construction. In Textile Series Report No. 1284 this equation was solved for a wide range of cover factors (K) and Beta factors (B). For example, on page 149 of report No. 128 it may be observed that for a fabric having a warp cover factor (K1) of 20 and a Beta factor (B) of 1.4, the maximum possible filling cover factor (K2) is 16.6.

From the practical point of view, the textile designer would tentatively select a warp texture (n) and a warp yarn number (N) to obtain the warp cover factor. Then for a given filling yarn number, which would provide the Beta (B), he would obtain the maximum possible filling cover factor and finally for the given filling yarn number he would find in the tables in Report No. 1284 the maximum number of filling yarns (n) which could be woven into the given structure. Depending upon which constructional factors are known, a spectrum of the unknowns in the design of the plain weave fabric can thus be obtained.

III DERIVATION OF THE EQUATIONS FOR LOCAL SPACING IN TWILLS AND SATEENS

Peirce did not extend his geometry of jammed plain weave fabrics to other weave types. This was done by Love in 1955. Two additional assumptions must be made regarding the geometry of the yarns in long float weaves, such as the twills and the sateens, before a model can be formulated for analysis. The first assumption is that the yarns under a long float move toward each other under the stress of weaving until they touch. The second assumption goes beyond the touch stage and postulates that complete flattening takes place in that half of the yarn which contacts a neighboring yarn under the float, i.e., that the original simicircle of the yarn half section becomes a rectangle after compression; and that this compression does not alter the fiber packing density (packing factor). Actual observation of yarns in many tight constructions confirms the fact that these assumptions have a valid basis.



In this section of the report two equations are derived which provide solutions for local spacing (p) in terms of weave factor (M), average spacing (p_R) and either original average yearn diameter (d_{OR}) which pertains to the situation where the yearns move toward and touch each other but are not compressed (designated as Aspect I) or (M), (p_R) , (d_{OR}) and compressed average yearn diameter (d_{CR}) which pertains to the situation where compression of the yearns takes place in that half of the yearn which contacts a neighboring yearn under the float (designated as Aspect II).

The following terms are defined:

- M = weave factor = Number of yarns per repeat of weave
 Number of interlacings per repeat of weave
- p = local spacing = distance between yarn centers of warp or filling at interlacings.
- pa = average spacing = numerical average of "local spacings" and spacing at points of no interlacing,
- doa = original average lateral diameter = the numerical
 average of the yarn diameters assuming no compression
 has taken place (Aspect (I)).
- d_o = original lateral diameter = same value as d_{oa} for an individual yarn.
- d_{C2} = compressed average lateral diameter = the numerical
 average of the compressed and uncompressed lateral
 diameters of the yarns (Aspect (II)).
- d_o = compressed lateral diameter = lateral diameter of compressed yarn only.
 - 1 = subscript l as in pl, pal, doal, etc. --- indicates
 warp yarn.

Aspect I

First examine the situation of Aspect I where the yarns under the floats are assumed to be in contact but not compressed. This can be illustrated diagramatically for a 3, 4, and 5-harness weave as follows:

3 Harmess
$$M = 1.5$$

$$P_{i} \rightarrow d\sigma_{i} \qquad k-P_{i} \rightarrow d\sigma_$$

5 Harness M = 2.5

Warp Yarn Arrangement in Twill Weaves (No Compression)

As shown above, p_1 is the local spacing, which is defined as the distance between centers of the warp yarns (for this case) at the interlacing. And d_{01} is the uncompressed diameter of the warp yarn. In these illustrations d_{01} also represents the spacing at points of <u>no</u> interlacing under the floats.

Now the average warp spacing (pa1) for each of the three weaves is:

3-harness -
$$p_{a1} = \frac{2p_1 + d_{o1}}{3}$$

4-harness -
$$p_{a1} = \frac{2p_1 + 2d_{o1}}{4}$$

5-harness -
$$p_{a1} = \frac{2p_1 + 3d_{o1}}{5}$$

Solving each of the above for p1 we obtain:

3-harness:
$$3p_{a1} = 2p_1 + d_{o1}$$
 $p_1 = 3/2 p_{a1} - 1/2 d_{o1}$

4-harness:
$$4p_{a1} = 2p_1 + 2d_{o1}$$
 $p_1 = 4/2 p_{a1} - 2/2 d_{o1}$

5-harness:
$$5p_{a1} = 2p_1 + 3d_{o1}$$
 $p_1 = 5/2 p_{a1} - 3/2 d_{o1}$

Note that for all of these simple weaves the number of interlacings is two and the number of yarns per repeat is equal to the number of harnesses of the weave. Thus, the weave factor is numerically equal to half the number of harnesses. In the above equations the coefficient of $p_{8.1}$ is always equal to the number of harresses divided by the number of interlacings—which is the weave factor "H". Likewise, the coefficient of $d_{0.1}$ is equal to the weave factor less one or "M-1".

Thus for uncompressed yarrs:

$$p_1 = Mp_{a1} - (M_{-1}) d_{o1}$$

Since for uncompressed yarns doi = doa1

then

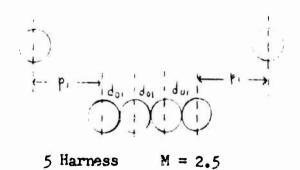
$$p_1 = Mp_{a1} - (M-1) d_{oa1}$$
 Aspect (I) (67)

Aspect II

Now examine Aspect (II) in which compression takes place in the warp

Aspect I

First examine the situation of Aspect I where the yarns under the fleats are assumed to be in contact but not compressed. This can be illustrated diagramatically for a 3, 4, and 5-harness weave as follows:



Warp Yarn Arrangement in Twill Weaves (No Compression)

As shown above, p_1 is the local spacing, which is defined as the distance between centers of the warp yarns (for this case) at the interlacing. And d_{01} is the uncompressed diameter of the warp yarn. In these illustrations d_{01} also represents the spacing at points of $\underline{n}\underline{c}$ interlacing under the floats.

Now the average warp spacing (pa1) for each of the three weaves is:

3-harness -
$$p_{a1} = \frac{2p_1 + d_{o1}}{3}$$

4-harness -
$$p_{a1} = \frac{2p_1 + 2d_{o1}}{4}$$

5-harness -
$$p_{a1} = \frac{2p_1 + 3d_{o1}}{5}$$

Solving each of the above for p1 we obtain:

3-harness:
$$3p_{a1} = 2p_1 + d_{o1}$$
 $p_1 = 3/2 p_{a1} - 1/2 d_{o1}$

4-harness:
$$4p_{a1} = 2p_1 + 2d_{o1}$$
 $p_1 = 4/2 p_{a1} - 2/2 d_{o1}$

5-harness:
$$5p_{a1} = 2p_1 + 3d_{o1}$$
 $p_1 = 5/2 p_{a1} - 3/2 d_{o1}$

Note that for all of these simple weaves the number of interlacings is two and the number of yarns per repeat is equal to the number of harnesses of the weave. Thus, the weave factor is numerically equal to half the number of harnesses. In the above equations the coefficient of p_{a1} is always equal to the number of harnesses divided by the number of interlacings——which is the weave factor "M". Likewise, the coefficient of d_{o1} is equal to the weave factor less one or "M-1".

Thus for uncompressed yarns:

$$p_1 = Mp_{a1} - (M-1) d_{o1}$$

Since for uncompressed yarns $d_{01} = d_{001}$

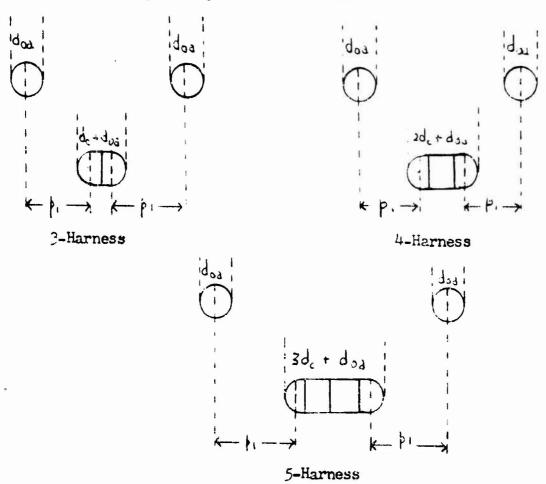
then

$$p_1 = Mp_{a1} - (M-1) d_{oa1}$$
 Aspect (I) (67)

Aspect II

Now examine Aspect (II) in which compression takes place in the warp

yarns under the float. Recall that compression occurs in that half of the yarn which contacts a neighboring yarn under the float. For the three weaves this may be represented as follows:



Warp Yarn Arrangement in Twill wgaves (Compressed Situation)

The average compressed and average yarn diameter (dcal) and the compressed yarn diameter (dcl) for the three weaves is then:

The average spacing (pal) for each of the three weaves is:

3-harness:
$$p_{al} = \frac{2p_1 + d_{cl}}{3} = \frac{2p_1 + 3d_{cal} - 2d_{oal}}{3}$$

4-harness:
$$p_{al} = \frac{2p_1 + 2d_{cl}}{4} = \frac{2p_1 + 2\left(\frac{4d_{cal}}{4} - \frac{2d_{cal}}{4}\right)}{4}$$

5-harmess:
$$p_{al} = \frac{2p_1 + 3d_{cl}}{5} = \frac{2p_1 + 3\left(\frac{5d_{cal} - 2d_{oal}}{3}\right)}{5}$$

Solving each of the above for pl we obtain:

3-harness:
$$3p_{al} = 2p_l + 3d_{cal} - 2d_{oal}$$
 $p_l = 3/2 p_{al} - 3/2 d_{cal} + d_{oal}$ $= 3/2 (p_{al} - d_{cal}) + d_{oal}$

4-harness:
$$4p_{al} = 2p_l + 4d_{cal} - 2d_{cal}$$
 $p_l = 4/2 p_{al} - 4/2 d_{cal} + d_{cal}$ $= 4/2 (p_{al} - d_{cal}) + d_{cal}$

5-harness:
$$5p_{al} = 2p_l + 5d_{cal} - 2d_{oal}$$
 $p_l = 5/2 p_{al} - 5/2 d_{cal} + d_{oal}$ $= 5/2 (p_{al} - d_{cal}) + d_{cal}$

Here, the coefficient of $(p_{al} - d_{cal}) = M$ for each of the weaves. Thus for compressed yarns:

$$\frac{p_1 = M(p_{al} - d_{cal}) + d_{oal}}{Aspect (II)}$$
 (68)

IV DERIVATION OF Ka (max) AND MAXIMUM WEAVABILITY EQUATIONS FOR OTHER WEAVE TYPES

Equation (68) provides a means of determining the local spacing (n) in the warp and filling directions for twill and sateen fabrics in which the assumed movement and compression of the yarns under the float takes place. This provides the numerator of the ratio p/D which is the essential expression in the formulation of the equation for maximum weavability. Now we must find the appropriate value of D (sum of diameters of warp and filling yarms) which will take into consideration the assumed yarn movement and compression. It is understood that compression takes place only in the plane of the fabric and that accordingly the vertical dimension of the yarn (that direction perpendicular to the plane of the fabric) does not change during compression. In addition, fiber packing density does not change.

We can now visualize the dimensional arrangement of the yarns in situations where there are 2, 3, and 4 yarns under the float, representing 3, 4, and 5-harness weaves and can compute the average compressed diameter (d_{Ca}) of the yarns.

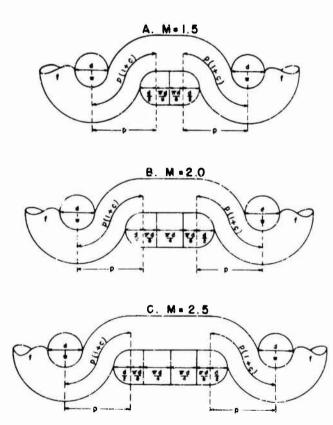


DIAGRAM: YARN COMPRESSION BETWEEN THE FLOAT

We assumed that complete flattening takes place in the half of the yarn which contacts a neighboring yarn under the float and that the original semicircle of the yarn half section became a rectangle after compression. Since the vertical dimension of this compressed half section does not change from the original uncompressed yarn, all of the compression must take place in the horizontal direction. But since the fiber packing density remains constant, the area of the compressed half section must equal that of the uncompressed half section. This means that the product of the compressed horizontal dimension (width) multiplied by the uncompressed vertical dimension (height) must equal the area of the uncompressed semi-circular yarn section. In other words,

$$\frac{\pi d^2}{8} = d \times (Compressed width)$$
 (69)

Compressed width
$$=\frac{\pi d}{8}$$
 (70)

In the situation shown in the diagram "Yarn Compression Between the Float," for M = 1.5 (where three yarns constitute a repeat of weave), the original (before compression) lateral diameter of the three yarns in the repeat is:

$$d \times 3 = 3d \tag{73}$$

After compression has taken place the lateral diameters of the three yarns in the repeat is:

$$d + d + .79 d = 2.79 d$$
 (74)

The compressed average lateral diameter is then

$$d_{ca} = \frac{2.79 \text{ d}}{3} \tag{75}$$

Or putting this in terms of the standard symbols:

$$d_{ca} = .93 d_{oa}$$
 (for M = 1.5) (76)

By following the same reasoning we find that the relationships between d_{ca} and d_{oa} for the weaves with M = 2 and M = 2.5 are:

$$d_{ca} = .89d_{oa}$$
 (For M = 2.0)

$$d_{ca} = .87d_{oa}$$
 (For M = 2.5)

Computation of Ka (max):

Since the average compressed lateral diameters of the yerns are less than the average original lateral diameters of the yerns, it is obvious that more compressed yerns can be squeezed into the same space than would be predicted from the value of K_0 which was previously computed, since K_0 represents the maximum cover factor for yerns assumed to be completely cylindrical. Therefore, in dealing with the 3-, 4-, and 5-harness weaves where migration and compression of the yerns under the float take place, it is necessary to develop a new K_0 to take into consideration the additional number of yerns it is possible to squeeze into the structure. This new K_0 is designated as K_a (max.)

Recall from equation (25) that:

$$\frac{d}{p} = \sqrt{\frac{0.342K}{De}}$$
 (77)

Since for cotton De = .909

then
$$\frac{d}{p} = .0359K$$
 (78)

and
$$K = \frac{27.8d}{p}$$
 (80)

The maximum cover factor or K_a (max) will occur when adjacent yarns are in contact. When this situation prevails the average spacing equals the average compressed diameters or



$$p_{\mathbf{a}} = d_{\mathbf{c}\mathbf{a}} \tag{21}$$

therefore
$$K_a (max) = \frac{27.8 d_{0a}}{d_{ca}}$$
 (82)

And since from (76) for M = 1.5

$$d_{ca} = .93 d_{oa}$$
 (83)

We have
$$K_a$$
 (max) = $\frac{27.8 \text{ dos}}{.93 \text{ dos}}$ = 29.9 (84)

The factor 28.0 has been used in the past in lieu of 27.8. In this case for 28.0 we have:

$$K_a \text{ (max)} = \frac{28.0 \text{ dos}}{.93 \text{ dos}} = 30.2$$
 (85)

Now express d_{oa} in terms of D using equations (55) to (58).

$$B = \frac{d_{oa2}}{d_{oa1}} \qquad D = d_{oa1} + d_{oa1}B$$

..
$$p = d_{oal} (1 + B)$$
 (87)

Since from (76)
$$d_{cal} = .93 d_{cal}$$
 (88)

$$d_{oal} = 1.08 d_{cal}$$
 (89)

therefore:
$$D = 1.08 d_{cal} (1 + B)$$
 (90)

and using equation (68) for local spacing

$$p_1 = M(p_{al} - d_{cal}) + d_{oal}$$
 (91)

Subscripts 1 and 2 refer to warp and filling respectively.

We obtain
$$\frac{p_1}{D} = \frac{M(p_{al} - d_{cal}) + d_{cal}}{1.08 d_{cal} (1 + B)}$$
 (92)

From equation (80) using the value 28.0, we get:

$$K_{al} = \frac{28 \text{ d}_{cal}}{P_{al}} = \frac{30.2 \text{ d}_{cal}}{P_{al}}$$
 (93)

and
$$p_{al} = 30.2 d_{cal}$$
 (94)

therefore
$$\frac{p_{1}}{\overline{D}} = \frac{1.5 \left(\frac{30.2 \, d_{cal}}{K_{al}} - d_{cal}\right) + d_{cal}}{1.08 \, d_{cal} \, (1 + B)} \tag{95}$$

$$\frac{p_1}{D} = \frac{1.5 d_{cal} \left(\frac{30.2}{K_{al}} - 1\right) + d_{oal}}{1.08 d_{cal} (1 + B)}$$
(96)

$$\frac{p_1}{\mathbf{D}} = \frac{1.5 \, d_{cal} \left(\frac{30.2}{K_{al}} - 1\right) + 1.08 \, d_{cal}}{1.08 \, d_{cal} \, (1 + B)}$$
 (97)

$$\frac{P_1}{D} = \frac{1.5 \left(\frac{30.2}{K_{a1}} - 1\right) + 1.08}{1.08 (1 + B)}$$
 (98)

Recall from (55) that
$$B = \frac{doa2}{doal}$$
 doal $\frac{doa2}{B}$ (79)

And
$$D = d_{oal} + d_{oa2}$$
 (100)

therefore
$$D = \frac{d_{Oa2}}{B} + d_{Oa2}$$
 (101)

$$D = \frac{d_{0a2} + d_{0a2} B}{B}$$
 (102)

$$D = \frac{d_{0a2} (1 + B)}{B}$$
 (103)

And from (89)
$$d_{0a2} = 1.08 d_{ca2}$$
 (104)

therefore
$$D = \frac{1.08 \text{ d}_{\text{ca2}} (1 + B)}{B} \text{ (for M = 1.5)}$$
 (105)

And from (68) for local spacing

$$p_2 = M (p_{a2} - d_{ca2}) + d_{oa2}$$
 (106)

therefore
$$\frac{p_2}{D} = \frac{M(p_{a2} - d_{ca2}) + d_{oa2}}{\frac{1.08 d_{ca2} (1 + B)}{B}}$$
 (107)*

And
$$\frac{p_2}{D} = \frac{\left[M \left(p_{a2} - d_{ca2}\right) + d_{oa2}\right] B}{1.08 i_{ca2} (1 + B)}$$
 (108)

And from (94)
$$p_{a2} = \frac{30.2 \text{ d}_{ca2}}{K_{a2}}$$
 (109)

^{*} M = 1.5 for equations 107 to 115 inclusive

therefore

$$\frac{P_2}{D} = \frac{\left[M\left(\frac{30.2 \text{ d}_{ca2}}{K_{a2}} - \text{ d}_{ca2}\right) + \text{ d}_{oa2}\right]_B}{1.08 \text{ d}_{ca2} (1 + B)}$$
(110)

$$\frac{P_2}{D} = \frac{\left[\frac{M_{dca2}\left(\frac{30.2}{K_{a2}} - 1\right) + d_{oa2}}{1.08 d_{ca2} (1 + B)}\right]}{1.08 d_{ca2} (1 + B)}$$
(111)

$$\frac{p_2}{D} = \frac{\left[\frac{M_{dea2}}{K_{a2}} - 1\right] + 1.08 d_{ea2}}{1.08 d_{ea2} (1 + B)}$$
(112)

$$\frac{P_2}{D} = \frac{\left[\frac{M}{K_{a2}} - 1\right] + 1.08 B}{1.08 (1 + B)}$$
(113)

And since from (54)

$$\sqrt{1 - \left(\frac{p_1}{D}\right)^2} + \sqrt{1 - \left(\frac{p_2}{D}\right)^2} = 1$$
 (114)

We have
$$\sqrt{1 - \left[\frac{M \left(\frac{30.2}{K_{al}} - 1 \right) + 1.08}{1.08 (1 + B)} \right]^{2}} + \sqrt{1 - \left[\frac{M \left(\frac{30.2}{k_{a2}} - 1 \right) + 1.08}{1.08 (1 + B)} \right]^{2}} = 1$$
(115)

This is the specific maximum weavability equation of a three harness weave for cotton fabrics numbered in the cotton system and using a $K_{\rm O}$ of 28.0.

V. DERIVATION OF THE GENERALIZED MAXIMUM WEAVABILITY EQUATIONS FOR ALL FIBER SPECIES AND BLENDS

We shall now derive the general equation for a 3-harness weave made from any type of fiber but also numbered in the cotton system.

Recall from (77) that
$$\frac{d}{p} = \frac{.0342 \text{ K}}{\sqrt{\text{De}}}$$
 (116)

Where De is the bulk density of the yarn

and
$$\frac{d}{p} = \frac{K}{29 \cdot 2 \sqrt{De}}$$
 (117)

Thus, recalling equation (79), whenever we use the factors 27.8 or 28.0 in the derivation of Equation (115) above, we may now substitute 29.2 / De

For example, for the three harness weave, Equation (85)

$$K_a \text{ (max)} = \frac{29.2 \text{ VDe}}{.93 \text{ d}_{oa}} = 31.4 \text{ VDe}$$
 (118)

Thus the general equation for the 3-Harness Weave is: (119)
$$1.5 \left(\frac{31.4 \sqrt{\text{De}}}{\text{K}_{81}} - 1\right) + 1.08\right)^{2} + \sqrt{1 - \left[\frac{1.5 \left(\frac{31.4 \sqrt{\text{De}}}{\text{K}_{82}} - 1\right) + 1.08}{1.08 (1 + B)}\right]^{2}} + \sqrt{1 - \left[\frac{1.5 \left(\frac{31.4 \sqrt{\text{De}}}{\text{K}_{82}} - 1\right) + 1.08}{1.08 (1 + B)}\right]^{2}} + 1$$

For the four harness weave (M = 2) d_{cal} = 357 $d_{oal}/4$ = .89 d_{oal}

And
$$d_{cal} = 1.12 d_{cal}$$
 (121)

$$K_{al} = \frac{28 \text{ doal}}{p_{al}} = \frac{28 \times 1.12 \text{ doal}}{p_{al}} = \frac{31.4 \text{ doal}}{p_{al}}$$
 (122)

For the general case of the 4-Harness Weave, we use

$$K_{al} = \frac{29.2\sqrt{De} \times 1.12 d_{cal}}{P_{al}} = \frac{32.7\sqrt{De} d_{cal}}{P_{al}}$$
 (123)

And the general equation for the 4-Harness Weave is: (124)
$$\sqrt{1 - \left[2 \frac{32.7 \text{ VDe}}{K_{al}} - 2\right] + 1.12} + 1.12 + 1.12 \frac{2}{K_{a2}} + 1.12 \frac{2}{K_{a2}} - 1 + 1.12 \frac{2}{K_{a2}} + 1.1$$

For the Five Harness Weave (M = 2.5)

1

$$d_{cal} = .87 d_{cal}$$
 (125)

$$d_{oel} = 1.15 d_{cel}$$
 (126)

For the general case of the 5-Harness Weave we use

$$K_{al} = \frac{29.2 \sqrt{De} (1.15) d_{cal}}{p_{al}} = 33.6$$
 (127)

And thus the general equation for the 5-Harness Weave is:

$$\sqrt{1 - \left[\frac{2.5 \left(33.6 \sqrt{De} - 1\right) + 1.15}{1.15 (1 + B)}\right]^2 + \sqrt{1 - \left[\frac{2.5 \left(33.6 \sqrt{De} - 1\right) + 1.15}{1.15 (1 + B)}\right]^2} = 1$$
(128)

For the Oxford Weave the warp portion of the equation is identical to that for the 4-Harness Weave (M = 2.0) and the filling portion of the equation is identical to that for the Plain (2-Harness Weave).

The general equation for the Oxford is therefore:

$$\sqrt{1 - \left[\frac{2.0 \left(\frac{32.7 \sqrt{De}}{K_{al}} - 1\right) + 1.12}{1.12 (1 + B)}\right]^{2}} + \sqrt{1 - \left[\frac{29.2 \sqrt{De}}{(1 + B) K_{a2}}\right]^{2}} = 1$$
(129)

These general equations are now in practically the same form as the original equations for cotton which were derived in Textile Series Report No. 90°, and solved and tabled in Textile Series Report No. 128°. One new variable appears, namely, De, the bulk density of the yarn. In the tabulations which appear in TSR 128°, one table is required to encompass the solutions of the maximum weavability equation for each weave type, or a total of five tables are necessary for the five basic weave types: the plain, 3-harness, 4-harness, 5-harness, and oxford. To establish a series of tables of solutions for the new general equations it will be necessary to have a group of five tables (representing the five weaves) for each of the yarn bulk densities which are selected.

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TABLE I

BULK DENSITIES OF YARNS, COMPUTED FROM FIBER DENSITIES

This table lists the fiber densities of the natural and man-made fibers in use today. Corresponding to each fiber density, the yarn bulk density of a theoretical yarn spun from this fiber is given, assuming that the packing coefficient of the yarn is 0.59. The range of densities includes fibers as light as polypropylene and as heavy as stainless steel. The additional fiber densities provide for the development of fibers which differ in density from existing fiber species.

TABLE I

BULK DENSITIES OF YARNS, COMPUTED FROM FIBER DENSITIES*

(Listed in order of fiber density)

Fiber Designation	Fiber Density	Yarn Bulk Density gm/cm3
Folypropylene	•91	•54
Folyethylene (Low Density)	•92	•54
Polyethylene (High Density)	•95	•56
	•98	•58
	1.10	.65
	1.12	•66
Mylon	1.14	.67
Orlon	1.14	.67
	1.15	•68
Acrilan	1.17	.69
Creslan	1.18	.70
Nytril	1.18	.70
Zefrag	1.19	.70
	1.20	•71
Kodel	1.22	.72
	1.24	•73
Silk (Boiled-off)	1.25	•74
Az? on	1.25	.74
Vinal	1.26	•74

^{*}Yarn bulk density = fiber density x 0.59 (standardized "packing confficient"); see Equation (1)

TABLE I (Cont'd)

Fiber Designation	Fiber Density	Yarn Bulk Density gm/cm3
	1.27	•75
	1.29	.76
Dynel	1.30	•77
Arnel	1.30	•77
Ardil	1.30	•77
wool	1.32	•78
Lohair	1.32	. 78
Acetate	1.32	.7 8
	1.34	•79
Vinyon	1.35	.80
Vyeron	1.36	.80
Verel	1.37	.81
Dacron	3 8	.81
Fortrel	1.38	.81
	1.39	.82
	1.41	.83
	1,42	.84
	1.44	. 85
	1.46	.86

TABLE I (Cont'd)

Fiber Designation	Fiber Density	Yarn Bulk Density
Hemp	1.48	.87
Jute	1.48	.87
	1.49	.88
avril	1.50	.89
Flax (Linen)	1.50	.89
Ramie	1.51	.89
Zantrel	1.51	.89
Viscose Rayon	1.52	•90
Cuprammonium	1.52	•90
Fortisan	1,52	•90
Cotton	1.54	.91
	1.56	•92
	1.58	•93
	1.59	•94
Saran	1.70	1.00
Alginate	1.70	1.00
Teflon	2.30	1.36
Asbestos	2.50	1.48
Fiberglas	2.54	1.50

TABLE I (Cont'd)

Fiber Designation	Fiber Density	Yarn Bulk Density
	3.00	1.7?
	4.00	2.36
	5.00	2.95
	6.00	3.54
	7.00	4.13
Stainless Steel	7.80	4.60

TABLE II

YARN BULK DENSITIES OF BLENDS OF THE IMPORTANT COMMERCIAL FIBERS

Fiber Density	Fiber Designation
1.14	Nylon, Orlon
1.17	Acrilan
1.22	Kodel
1.30	Dynel, Arnel
1.32	Wool, mohair, acetate
1.38	Dacron, Fortrell
1.52	Viscose rayon, cuprammonium, Fortisan
1.54	Cotton

The fiber density of one of the component fibers is given at the top of the first column, with the percentage of that fiber (from 5% to 95%) given below it.

The <u>headings</u> of the following seven columns give the fiber densities of the <u>other</u> component fibers, and the values in the body of the table are yarn bulk densities.

For example: Given a blend of 25% nylon, 75% cotton. Turn to page of table with "Fib. den = 1.14" above first column (fiber density of nylon is 1.14). Drop down to 25 in this column (the percentage of nylon in the blend). Go across this row (25) to the column headed 1.54 (this is the fiber density of cotton). This will give the bulk density of a blend of 25% nylon and 75% cotton as .84.

TABLE II

YARN BULK DENSITIES OF BLENDS OF THE IMPORTANT COMMERCIAL FIBERS

(FIR. DEN. = 1.14)	1.17	1.22	1.30	1.32	1.38	1,52	1.54
(%)	0.69	0.72	n.76	0.77	0.81	0.83	0.89
1 0	0.69	0.71	0,76	0.77	0.80	1.87	0.88
15	0.69	0.71	0.75	0.76	0.79	0.85	0.86
5 u	0.69	0.71	0.75	0.75	r./8	H . H 4).HD
25	0-69	0.71	0.74	0.75	0.77	0.83	0.84
30	0.68	0.70	0.74	0.74	0.77	0.82	0.82
35	0.68	0.70	0.73	0.74	0.76	0.80	18.0
4 0	0.68	0.70	0.73	0.73	٥.75	1,19	J.40
4 h	0.68	0.76	0.72	0.73	Λ.74	0.78	0.73
5 n	0.68	0.70	0.72	0.72	0.74	0.77	0.77
55	0.68	n.69	0.71	0.72	0.73	0.76	0.76
60	0.68	0.69	0.71	0.71	0.72	0.75	0.75
65	0.68	0.69	0,70	0.71	0.72	0.74	0.74
70	0.68	0.69	0.70	0.70	0.71	0,73	0.73
75	0.68	0.68	0,69	0.70	0.70	0.72	0.72
90	0.68	0.68	0.69	0.69	0.70	0.71	0.71
85	0.68	0.68	0.69	0.69	0.69	0,70	0.70
90	0.67	0.68	0.68	0.68	1.68	0.69	0.69
95	n.67	0.67	0.68	0.68	0,48	0.68	0.68
	•						

TABLE II

YARN BULK DENSITIES OF BLENDS OF THE IMPORTANT COMMERCIAL FIBERS

[FIB. DEN. = 1.17]	1.14	1.22	1.30	1.32	1.38	1,52	1.54
(%)							
5	0.67	0.72	0.76	0.77	0.81	0.88	0.89
10	0.67	0.72	0.76	0.77	0.80	0.87	0.88
15	0.68	0.72	0.75	0.76	0.79	0.86	0.87
50	0.68	0.71	0.75	0.76	0.79	0.85	0.85
25	0.68	0.71	0.75	0.75	0.78	0.83	0.84
30	0.68	0.71	0.74	0.75	0.77	0.82	0.83
35	0.68	0.71	0.74	0.75	0.77	0.81	0.82
40	0.68	0.71	0,73	0.74	0.76	0.80	0.81
45	0.68	0.71	0.73	0.74	0.75	0,79	0.80
50	0.68	0.70	0,73	0.73	0.75	0.78	0.78
55	0.68	0.70	0.72	0.73	0.74	0.77	0.77
60	0.68	0.70	0.72	0.72	0.74	0.76	0.75
65	0.68	0.70	0.72	0.72	0.73	0.75	0.75
70	0.68	0.70	0.71	G.71	0.72	0.74	0.74
75	0.69	0.70	0.71	0.71	0.72	0.73	0.73
80	0.65	0.70	0.70	0.71	0.71	0.72	6.73
85	0.69	0.69	0.70	0.70	0.71	0.71	0.72
90	0.69	0.69	0.70	0.70	0.70	0.71	0.71
95	0.69	0.69	0.69	0.69	0.70	0.70	0.70

TABLE II

YARN BULK DENSITIES OF BLENDS OF THE IMPORTANT COMMERCIAL FIBERS

(FIR. DEN. = 1.22)	1.14	1.17	1.30	1.32	1.38	1,52	1.54
5	0.67	0.69	0.76	0.78	0.81	0.89	0.90
10	0.68	0.69	0.76	0.77	0.80	0.88	0.89
15	0.68	0.69	0.76	0.77	0.80	0,86	0.87
20	0.68	0.70	0.76	0.77	0.79	0.85	0.86
25	0.06	0.70	0.75	0.76	0.79	0.54	0.85
30	0.69	0.70	0.75	0.76	n.78	0.84	0.84
35	0.69	0.70	0.75	0.76	0.78	9.83	0.83
4 0	0.69	0.70	0.75	0.75	0.77	0.82	0.82
45	0.69	0.70	0.75	0.75	0.77	0.81	0.81
50	0.70	0.70	0.74	0.75	0.76	0.80	0.80
55	0.70	0.71	0.74	0.75	n.76	0.79	0.79
60	0.70	0.71	0.74	0.74	0.75	0.78	0.79
65	0.70	0.71	0.74	0.74	0.75	0.77	0.78
70	0.70	0.71	0,73	0.74	0.75	0.77	0.77
75	0.71	0.71	0.73	0.73	0.74	0.76	0.76
A 0	0.71	0.71	0.73	0.73	0.74	C.75	0.75
85	0.71	0.72	0.73	0.73	0.73	0.74	0.74
\$ n	0.71	0.72	C,72	0.73	0.73	0.73	0.74
95	0.72	0.72	U.72	0.72	0.72	0.73	0.73

TABLE II
YARN BULK DENSITIES OF BLENDS OF THE IMPORTANT COMMERCIAL FIBERS

(FIB. DEN. = 1.30)	1.14	1.17	1.22	1.32	1.38	1.52	1.54
5	0.68	0.69	0.72	0.78	0.81	0.89	0.96
10	0.68	0.70	0.72	0.78	0.81	0.88	0.89
15	0.69	0.70	0.73	0.78	0.81	0.87	0.88
50	0.69	0.70	0.73	0.78	0.80	0.87	0.88
25	0.69	0.71	0.73	0.78	0.80	0.86	0.87
30	0.70	0.71	0.73	0.78	0.80	0 - 85	0.86
35	0.70	0.72	0.74	0.77	0.80	0.85	0.85
40	0.71	n.72	0.74	0.77	0.79	0.84	0.85
45	0.71	0.72	0.74	0.77	6.79	0,83	0.84
50	0.72	0.73	0.74	0.77	0.79	0,83	0.83
55	0.72	0.73	0.75	0.77	0,79	0.82	0.82
60	0.73	0.73	0.75	0.77	0.79	0.81	0.82
65	0.73	0.74	0.75	0.77	0.78	0.81	0.81
70	0.74	0.74	0,75	0.77	0.78	0.80	0.80
75	0.74	0.75	0.75	0.77	0.78	0.80	0.80
A O	0.75	0.75	0.76	0.77	0.78	0.79	0.79
85	0.75	0.75	0.76	J.77	0.77	0.78	0.79
90	0.76	0.76	0.76	0.77	0.77	0.78	0.78
95	0.76	0.76	0.76	0.77	0.77	0.77	0.77

YARN BULK DENSITIES OF BLENDS OF THE IMPORTANT COMMERCIAL FIBERS

(FIR. DEN. = 1.32)	1.14	1.17	1.22	1.30	1.38	1.52	1.54
5	0.59	0.69	0.72	0.77	0.81	0.89	0.90
10	0.68	0.70	0.73	0.77	0.81	0.88	0.89
15	0.69	0.70	0.73	0.77	0.81	88,6	0.89
20	0 69	0.71	0.73	0.77	0.81	0.87	0.88
25	0.70	0.71	0.73	0.77	0.81	0.86	0.87
30	0.70	0.71	0.74	0.77	0.80	0.86	0.87
35	0.71	0.72	0.74	0.77	0.80	0.85	0.86
4 0	0.71	0.72	0.74	0.77	0,89	0.85	0.85
45	0.72	0.73	0.75	0.77	0.80	0.84	0.85
50	0.72	0.73	0.75	0.77	n.eo	0.83	0.84
55	0.73	0.74	0.75	0.77	0.79	0.83	0.83
60	n.73	0.74	0.75	0.77	0.79	0.82	0.83
65	0.74	0.75	0.76	0.77	0.79	0.82	0.82
70	0.74	0.75	0.76	0.78	0.79	0.81	0.81
75	0.75	0.75	0.76	0.78	0.79	0.81	0.81
80	0.75	0.76	0.77	0.78	0.79	0.80	0.80
85	0.76	0.76	0.77	0.78	0.78	0.79	0.80
90	0.77	0.77	0.77	0.78	0.78	0.79	0.79
95	0.77	0.77	0.78	0.78	0.78	G.78	0.78

YARN BULK DENSITIES OF BLENDS OF THE IMPORTANT COMMERCIAL FIBERS

(FIB. DFN. = 1.38)	1.14	1.17	1.22	1.30	1.32	1.52	1.54
5	0.68	0.70	0.72	0.77	0.78	0,89	0.90
10	0.68	0.70	0.73	0.77	0.78	0,89	0.90
15	0.69	0.71	0,73	0.77	0.78	0.88	0.89
5.0	0.70	0.71	0.74	0.78	0.79	0.88	0.89
25	0.70	J.72	0.74	0.78	0.79	0.87	0.88
30	9.71	0.72	0.75	0.78	0.79	0.87	0.88
35	0.72	0.73	0,75	0.78	0.79	0,87	0.87
40	0.72	0.74	0.75	0.79	o.79	0.86	0.87
45	0.73	0.74	0.76	0.79	0.79	0,86	0.86
50	0.74	0.75	0.76	0.79	0.80	0.85	0.86
55	0.74	0.75	0.77	0.79	0.80	0.85	0.85
60	0.75	0.76	0.77	0.79	0.80	0.85	0.85
65	0.76	0.77	0.78	0.80	0.80	0.84	0.84
70	0.77	0.77	0.78	0.80	0.80	0.84	0.84
75	0.77	0.78	0.79	0.80	0.81	0.83	0.84
A 0	0.78	0.79	0.79	0.80	0.81	0,83	0.83
85	0.79	0.79	0.80	0.61	0.81	0.83	0.83
90	0.80	0.80	0.80	0.81	0.81	0.82	0.82
95	0.81	0.81	0.81	0.81	0.81	0.82	0.82

YARN BULK DENSITIES OF BLENDS OF THE IMPORTANT COMMERCIAL FIBERS

(FIB. DEN. = 1.52)	1.14	1.17	1.22	1.30	1.32	1,38	1.54
(%) 5	0.68	0.70	0,73	0.77	0.78	0.82	0.91
10	0.69	0.71	0.73	0.78	0.79	0.82	0.91
15	0.70	0.71	0.74	0.78	0.79	0.83	0.91
20	0.71	0.72	0.75	0.79	0.80	0.83	0.91
25	0.72	0.73	0,76	0.80	0.81	0,83	0.91
30	0.73	0.74	0.77	0.80	0.81	0,84	0.91
35	0.74	0.75	0,77	0.81	0.82	0.84	0.90
4 ()	0.75	0.76	0.78	0.81	0.82	0.85	0.90
45	0.76	0.77	0,79	0.82	0.83	0,85	0.90
50	0.77	0.78	0.80	0.83	0.83	0.85	0.90
55	0.78	0.79	0.81	0.83	0.84	0.86	0.90
60	0.79	0.80	0.82	0.84	0.85	0.86	0.90
65	0.80	0.81	0,83	0.85	0.85	0.87	0.90
70	0.82	0.82	0.84	0.85	0.86	0.87	0.90
75	0.83	0.83	0.84	0.86	0.86	0.87	0.90
8.0	0.84	0.85	0.85	0.87	0.87	0,88	0.50
85	0.85	0.86	0.86	0.87	0.88	0.88	0.90
90	0.87	0.87	0.88	0.88	0.88	0.89	0.90
95	0.88	0.88	0,89	0.89	0.89	0.89	0.90

TABLE II

YARN BULK DENSITIES OF BLENDS OF THE IMPORTANT COMMERCIAL FIBERS

(5)	1.14	1.17	1.22	1.30	1.32	1,38	1.52
5	0.68	0.70	0.73	0.77	0.78	0.82	0.90
10	0.69	0.71	0.74	0.78	0.79	0.82	0.90
15	0.70	0.72	0.74	0.79	0.80	0.83	0.90
20	0.71	0.73	0,75	0.79	0.80	0,83	0.90
25	0.72	0.73	0.76	0.80	0.81	0.84	0.90
30	0.73	0.74	0.77	0.80	0.81	0.84	0.90
35	0.74	0.75	0.78	0.81	0.82	0,84	0.90
4 0	0.75	n.76	0.79	0.82	0.83	0,85	0.90
45	0.76	0.77	0.79	0.82	0.83	0,85	0.90
50	0.77	0.78	0.80	0.83	0.84	0,86	0.90
55	0.78	0.80	0.81	0.84	0.85	0,86	0.90
60	0.80	0.81	0.82	0.85	0.85	0,87	0.90
65	0.81	0.82	0.83	0.85	0.86	0,87	0.90
70	0.82	0.83	0.84	0.86	0.67	0,88	0.91
75	0.84	0.84	0.85	0.87	0.87	0,88	0.91
80	0.85	0.85	0.86	0.88	0.88	0.89	0.91
85	0.86	0.87	0.87	0.88	0.89	0.89	0.91
90	0.88	0.88	0.89	0.89	0.89	0,90	0.91
95	0.89	0.89	0.90	0.90	0.90	0.90	0.91



MAXIMUM WEAVABILITY TABLE

TABLE III. MAXIMUM FILLING COVER FACTOR IN TERMS OF WARP COVER FACTOR, BETA FACTOR, AND YARN BULK DENSITY

This table provides solutions for the maxim: weavability equations (3c) for:

- A. Plain weaves, 2-harness B. Twills, 3-harness
- C. Twills and crowfoot, 4-harness
- D. Sateens, 5-harmess
- E. Oxford weave

For each yarn bulk density value listed below there is a section of Table III for each of the above weave types on the page indicated below:

Yarn Bulk Density	Plain Weave	Three Harn.	Four Harn.	Five Harn.	Orford
•54 •55	65	112	161	215 216	277
•55 •57	66	113	162	217 218	278
.58	67	114	163	219	279
•59 •60				220 221	
.61 .62		¢		222	
.63				223 2 2 4	
.64 .65	68	115	164	225 226	280
.66	69	116	165	227	281
.65 .66 .67 .68	70 71	117	166 167	228 229	282 283
.69	72	119	168	230	284
.70 .71	7 3 74	120 121	169 170	2 31 2 32	285 28ර
.72	75	122	171	233	287
•73	76	123	172	234	288
.74	77	124	173	235	289
•75 •76	78 79	125 126	174 175	2 3 6 2 3 7	290 291
.77	80	127	176	238	292
.78	81	128	177	239	2 93
•79	82	129	178	240	294
.80 .81	83 84	130 131	179 180	241 242	295 296

Yarn Bulk Density	Plain <u>Weave</u>	Three Harn.	Four <u>Harn</u> .	Five <u>Harn</u> .	Oxford
.82	85	132	181	243	297
.83	86	133	182	244	298
.84	87	134	183	245	299
.85	88	135	184	246	300
.86	89	136	185	247	301
.87	90	137	186	248	302
.88	91	138	187	249	303
.89	92	139	188	250	304
.90	93	140	189	251	305
.91	94	141	190	252	306
.92	95	142	191	253	307
.93	96	143	192	254	308
.94 .95 .96 .97 .98	97	744	193 194 195 196 197	255 256 257 258 259	309 310 311 312 313
.99 1.00 1.36 1.48 1.50	98 99	145 146 147 148	198 199 200 201 202	260 261 262 263 264	314 315 316 317 318
1.77	100	149	203	265	319
2.00	101	150	204	266	320
2.36	102	151	205	267	321
2.50	103	152	206	268	322
2.75	104	153	207	269	323
2.95	105	154	208	270	324
3.25	106	155	209	271	325
3.54	107	156	210	272	326
3.75	108	157	211	273	327
4.00	109	158	212	2 7 4	328
4.13	111	159	213	275	329
4.60		160	214	276	330

The overall range of warp cover factors is from 8 to 62. However, depending upon the yarn bulk density and/or the weave type the range may be less than this.

Beta factors range from 0.5 to 2.0

See Sections in the body of the report for:

Computation and organization of Table III (3c)

How to use Table III (5)

Examples of use of Table III (6)

Basic assumptions and limitations of tables (7)



PLAIN WEAVE

MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.54

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60	0	.0	0	i) ·		9		0		. 0	0	**	19.	17,	17	8
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	•	•	13.6	11.9	11.8	11.9	12.2	12.4	12.7	13.0	13.3	13.6	13.8	14.1	14.3	·	
	0		0	•	1	-	•	2	N		•	•	9	•	*	₽ •1	•
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	8	•	•	0	0	-	-	ö	2	°	•	5	63	3	54.	4	
	•	•	•	0		14.0	11.5	11.9	12.3	12.7	13.0	13.3	13.6	13.9	14.1		
	•	•	•	•	0	0	-	+	2	2	2	3		3	14.	14	
	7.6		9.1					1	Ċ.	2	07)	m	10	m	44.	4	17)
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	•	•	•	•	0	0	+	+	2	2	~	, ,	m	2	14.	14	
	•	8.2	0.6	9.7	10.3	10.8	11.3	11.8	12.5	12.6	12.9	13.2	13.5	13.8	4	+ +	1 70
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	•	•			10.2	10.8	11.3	11.7	12.1	12.5	12.9	13.5	13.5	13.8	14.1	14.	-
	7.2	8.1	8.0	9.6	•	0	• •4	+	ċ	2	8	M	n	m	14.	14	m
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36	7.2	8.1	8.9	9.6	10.2	10.7	11.3	11.7	12.1	12.5	12.9	13.2	13.5	13.8	1.4.1	+	m
	•	•	•	•	0		-1	+	5	2	~	5	, 10	3	14.	4	



MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.56

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3

MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF MARP COVER FACTOR AND BETA

YARN BULK BENSITY #0.58

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.65

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WARP

HAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.66

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.67

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.63

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.70

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF MARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.71

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.72

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YARN BULK DENSITY #0.73

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YARN BULK DENSITY #0.74

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YARN BULK DENSITY = 0.75

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YARN BULK DENSITY #0.76

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.78

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HAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.79

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK BENSITY #0.80

MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BEFA

YARN BULK DENSITY #0.81

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.82

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.83

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.84

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =0.85

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.86

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF MARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.87

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YARN BULK DENSITY =0.88

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.89

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.90

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF MARP COVER FACTOR AND BETA

YARN BULK BENSITY #0.91

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.92

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.93

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #1.00

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

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4.0



MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #1.77

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K13	0.5	9.0		, GC	0.9		1.1	1.2	\$ 000 \$ 000 \$ 000	1.4	6.4	1.6	1.7	. 40 1 40	1	6	0
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	13.5	15.0		17.6	18.7	6	20.5	21.3	22.1	22.8	23.4	24.0		25.0	25.	5 26	0

YARN BULK DENSITY = 2.00

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YARN BULK DENSITY = 2.36

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FACTOR [K1]	0.5	9.0	0.7	0.8	0.0	1.0	-	1.2	1 PO 1	4	1.5	1.6	1.7	1.8	1.9	2.0
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YARN BULK DENSITY =2.50

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =2.75

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #2,95

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YARN BULK DENSITY =3.25

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #3.54

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #3.75

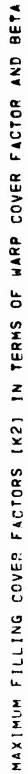
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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =4.00

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TARN BULK DENSITY #4.13

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #4.60

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF MARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.54

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(Starting on page 112)

MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.56

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COYER FACTOR AND BETA

YARN BULK DENSITY #6.58

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.65

THREE-HARNESS WEAVE FABRICS

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.66

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =0.67

THREE-HARNESS WEAVE FABRICS

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.68

THREE-HARNESS WEAVE FABRICS

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MAXIMUM FILLING COVER FACTURS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.69

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HAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.70

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31	10.9	12.0	13.0	13.9	14.6	15.3	15.9	16.4	16.9	17.4	17.8	18.1	18.5	18.8	19.1	19.	17 3
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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WAR? COVER FACTOR AND BETA

YARN BULK DENSITY #0.71

THREE-HARNESS WEAVE FABRICS

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.72

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.73

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #6.74

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HAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.75

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.76

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.77

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.78

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK BENSITY #0.79

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.80

THREE-HARNESS WEAVE FABRICS

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	11.9	13.0	14.1	15.0	15.8	16.5	17.1	17.6	18.1	18.5	19.0	19.4	19.8	20.1	20.4	20.7	
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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.81

THREE-HARNESS WEAVE FABRICS

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.82

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	12.0	13.2	14.3	15.2	16.0	16.7	17.3	17.9	18.4	18.8	19.3	19.7	20.0	20.3	20.7	20.9
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31	11.8	13.1	14.1	15.1	15.9	16.6	17.2	17.8	18.3	18.8	19.2	19.6	20.0	20.3	20.6	20.9
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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.83

THREE-HARNESS WEAVE FABRICS

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARD COVER FACTOR AND BETA

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.85

THREE . HARNESS WEAVE FABRICS

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.86

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.87

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.88

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.89

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.90

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.91

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =0.92

THREE-HARNESS WEAVE FABRICS

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.93

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #6.94

MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =1.00



MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =1.36

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #1.48

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

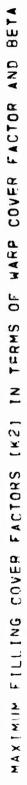
YARN BULK DENSITY =1.50

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #1.77

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =2.36

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BILK DENSITY =2.50

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #2.75

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MAXIM MA FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =2.95

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 3.25

MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =3.54

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =3.75

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46	34.9	32.8	33.4	34.5	35.7	36.9	38.0	39.0	40.0	40.8	41.7	45.4	43.1	43.8	4.4	45.0
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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

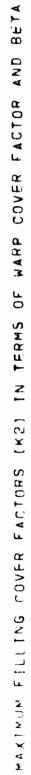
YARN BULK DENSITY =4.00

THREE-HARNESS WEAVE FABRICS

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YARN BULK DENSITY =4.13

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YARN BULK DENSITY =4.60

THREE-HARNESS WEAVE FABRICS

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4-HARNESS

MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =0.54

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.56

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BEFA

YARN BULK DENSITY =0.58

COVER FACTOR [K1]		9	1	1 00 1	0	101	1 +1	BETA	ю Н	1 4	- F	9		1 60 i	6	2
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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.65

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.66

FOUR-HARNESS WEAVE FABRICS



MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =0.67

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.68

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.69

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.70

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MAXIMUM FILLING COVER FACTORS [KZ] IN TERMS C. WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.71

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.72

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BILK DENSITY #0.73

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.74

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.75

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.76

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY 20.77

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.78

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.79

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

1.32 (.52 3.52 2.17 2.14 3.14

YARN BULK DENSITY = 0.80

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 5.83

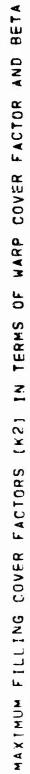
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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSTTY #0.84

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YARN BULK DENSITY = 0.85

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.87

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.88

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =0.89

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1	00 1	0	0 0	7.00	5.0	4. T.	(V	24.0	3.0	3.8	3.7	23.7	3.6	3.6	3.6	3.6	3.6	3.6	3.6	23.5	5	3.5	23.5	3.5	3.5
	-	0	0	26.6 56.5	3	4	4	23.8	٠ •	3	*2	23.4	3	ر ا	3	.	س	(M	3	23.5	3	3	23.5	M	3
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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.90

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(K1)	0.5	9.0	-	60	(C)	1.0		1 ent 1	1.3	1.4	1.5	1.6	1.7	1.8		2.0
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								27.7	5	4	+	4	4	4	+	Š
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				•	9	3	m	3	3	3	3	3	3	4	•	
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		C	2	+	-	+	-	2	2	8	1 20	3	(م)	5	4	*
	0.	20.4	19.7	•		20.8	-	+	2	2	~	23.3	23.6	3	4	24.4
	ac.	00	60	0		ی	•	-	•	2	2	2	P)	6 0	4	*
	_	17.6	18.3	19.1	19.8	0	21.0	21.5	22.0	22.4	22.8	23.1	3	23,8	24.1	4
	.0	7	80	ď	0	0	•	+	+	2	~	₩)	2	3	4	4
	5.	¢	~	œ	6	0	0	-	-	~	~	3	3	3	4	4
		•	7	æ	6	0	0	÷	+	5	2	3		3	4	24.3
30	r.	•	7	60	6	•	0	÷	+4	Ś	2	(س	8	3	4	4
	15.0	16.4	17.5	18.4	19.3	•	20.7	21.2	21.8	22.2	22.6	23.0	23.4	23.7	24.0	
	4	9	7	6	6	0	0	+	+	2	~	3	3	3.	*	*
	4	9	7	60	6	0		+	***	ò	2،	نا. •	3	3	•	4
	4	ċ	7	8	•	19.9	0	+	-1	٥.	<u>٠</u>	3	•	3	4	-
	4	· C	7	æ.	o	6	ċ	•	**	8	~	2	P 5	3	•	4
	4	ċ	7.	80	6	•	c.	+	-	2	2	3	m	3	*	4
3.7	14.7	16.1	17.5	18.3	19.2	19.9	20.6	21.2	21.7	22.2	22.6	23.0	23.3	23.7	24.0	24.5
	4	ċ	7.	oc:	6	•	ċ	+	;	~	2	٠ د	5	٠ س	•	4



MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.91

FOUR-HARNESS WEAVE FABRICS

								BET	1	1	•	!	1		•	1
X	0.5	9.0	0.7	0.8	0.0	1.0	4.1	1.2	1.3	7	1.5	₩ 1	1	→ 1	9 1	
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										0	œ	8	7	•	•	ç
				<u>.</u>				0	•	8	26.6	S	S.	25.5	25.5	Ŋ
i 9	0	c	. 0	u·	0.	0.	. 0	28.8	26.0	25.2	•	•	24.8	•	r.	25.1
					C	5	r.	4	4	4	ৰ	4	4	4	4	4
				;	,	4	~	~	~	~	-	~	4	4	4	4
	•	: c		7 4 7		•		30.00			24.6	7 20	10	0.40	24.4	24.7
			•	•	•			•		•	:		•	•	•	•
		·	0			•		•	2	Š	٠,	·	3	4	•	•
		21.1	0.0	•		21.0	-	1.		C	٠ ا	m	m)	4	.	4
	6	α	6	•	0	ŧ.	.	-	2	CJ	5	•	M	4	4	4
	7	7	00	6	0	0	+	+	ς.	8	~	3	3	3	+	4
	9	7.	œ	19.0	٠ •	0	•	+	ò		22.9	3	٠. س	23.9	•	*
	5		7	œ	0	0	0	***	?	2	<. ⋅	3	3	3	4	4
	15.5	16.7	17.8	•	19.5	20.5	50.9	71.4	21.9	2		3	•	64	4	24.4
30	Ś	ć	7.	<i>عن</i> •	6	c	C	-	+	0	~	3	(M)	3	*	4
	ů.	·	7	œ	6	0	0	1.	·	2	2	M	8	3	4	4
		•	1	18.5		0	Ċ	+	-	N	•	3	•	3	*	4
	v.	9	7.	œ	•	0	0	+	+	~	2	الما •	3	, M	4	4
		16.3	17.5	•	_	20.1	20.7	21,3	21.8		0	23.1	3	23.8	24.1	24.4
	<;·	ς.	7	æ	0	0	0	-	- -1	2	~	w.	8	8	4	4
	4	\$	7.	80	6	0		+	+	2	?	3	m	, M)	4	4
37	14.8	16.2	17.4	18.4	19.3	20.0	20.7	21.3	21.8	22.3	22.7	23.1	23.5	73.B	24.1	24.4
	4.	Ġ	7	œ	•		0	-	÷	2	~	12	3	3	4	4

MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.92

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4 ≈ 1	0	9 . 6	6.7	0 .8	0	-	-	1.2	1 1	4	7.1	1.6	1.7	1.8	6.1	2.	
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	- -	Û.	0	0	c)	0	0	0	0			0	0	31.0	-	•	
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										S.	E	Ś	5.	S.	K U	3	_
						0	•	4	-	4	4	-	4	4	*	5	
		0	0.		0.	4	23.6	23.4	23.5	23.6	23.8	24.0	24.3	*			_
			•	5	3	ċ	ċ	3	3	3	, 10	m	4	*	*	4	_
			3		4	4	5	2	·	3	m	3	3	4	*	*	
	0.	21.9	•	·	•		7	÷	cv.	~	m	3	3			4	
25	0	6	_	19.7	0	20,9	•	÷		22.7	10	M	100	4	•	4	. **
	/	17.9		9	0	0	+	21.7	-	ci	M		23.7	4		4	
	•	7	ď	6	6	0	;	1.	2	5	, m	3	m	4	4	4	
	5	7.	8	8	6	0	÷	1:	2	2	m	رم رم	3	*	*	+	
	15.6	•	7	60	19.6	0	-	1.	2	2	•	3	, M	24.0	4	•	
	10	¢	~	80	6	0	0	+	5	2	~	₹	m	4	4	4	
	15.2	16.6	17.7	18.7	19.5	20.5	50.9	21.5	22.0	22.5	22.9	23.3	23.6	24.0	24.3	24.5	
	3	9	7.	90	•	0	<u>.</u>	*	5	0	~	3	n M	4	4	4	
	50		7	8	6	0	ċ	-	5	2	2	۲)	3	, m	4	4	
4	•	ç	7	œ	·	0	c		ò	2	ĉ	m	2	F)	+	4	
_	4	é	7	ac.	6	0	0	**	ć	2	n	*	3	M)	4	4	
36	14.9	16.3	17.5	18.5	19.4	20.1	20.8	21.4	21.9	22.4	22.9	23.2	23.6	23.9	24.5	24.5	
	4	9	-1	8	0	0	0	1.	7	2	~	3	H)	3	*	4	
	4	÷	7	œ	6	ċ	<u> </u>	7	• پسن	5	~	י כיה	.	w)	4	4	

MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.9.

								BET			!	1	!		•	•
A T	0 .	. 6	0.7	0	0	1.0		1	• 🗝 •	1 44 1	5 . 5	1.6	1.7	41	4,9	2
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_													•	0	0	•
-												0	0	3	6	8
17	. ი	G.	0	0	0.	0	0	0	0	0	<u>.</u>	30.7	28.5	27.3	26.8	26.6
_								0	Ö			9	9	5	5	3
19	0		0							3	5	5	5	r.	S.	5
						C	*	u)	4	4	4	4	4	4	10	5
	0	0	0.	0	•	5.	23.9	23.6	23.7	23.8	24.0	24.2	24.4	24.6	24.8	25.1
			0	7.	3	2	2	2	3	~	3	4	4	4	4	+
			4	2	, -i	-	2	3	2	3	3	'n	4	4	4	+
	0					21.3	-	8	ò	m	۲)	1	4	4	*	4
(((c	,		c	c	C	•	.4	۲			4
	4 ~	1.0.0 1.0.0	, a	, 0				21.0	20.7	20.00	23.0	0 K	23.9	2.40	24.5	
	9	. ~	α	. 0	. 0		• •	•	, N	2	m	, m	3	4	+	4
	9	1	8	6	6	0	•	·	2	2	3	3	3	4	4	4
	15.7	7.	•	Ċ		0	21.1	-1	8	o,	3.	نما •	m	•	4	4
3.0	3.	•	7.	œ	ò	0	÷	+	ć	8	m	8	8	4	4	4
	15.3	16.7	17.8	18.8	19.6	20.4	21.0	21.6	22.1	25.6	23.0	23,4	23.8	24.1	24.4	24.7
	S	•	7.	œ	6	0	+	+	5	8	M	3	3	4	4	4
	'n		7.	æ	•	0	•	+	٠ د	2	3	3	M	4	4	4
	5.	9	7.	80	6	0	•	•	0	0	PC:	نم •	3	4	4	4
	'n.	ż	7	œ	•	0	0	-	8	8	3	3	*	4	4	4
36	15.0	16.4	17.6	18.6	19.5	20.3	20.9	21.5	22.1	22.5	23.0	23.4	23.7	24.1	24.4	24.6
	3.	÷	7.	œ	6	•	ċ	-	ò	2	3		3	4	4	4
	3	ç	7.	œ	6	0	0	*	8	C1	3	m	M	4	4	4

MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.94

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OVER					,	:		BET		1	! :	ļ		•	1		
T X 1 0 X	0.5	9.0	0.7	0		1.0	1.1	1.2	וכוו		1.5	1.6	1.7	4-1 00	4.9	2	
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												0		0			r.
16	0	0	0	0	0.	0	0.	0,	0	0	•	•	0	33.6	29.8		10
										Ġ	9	-1	8	7	7	9	60
								0	0			•		•	•	•	-4
19										8	R.	ري. د	1 0	1 0	1 0	Š	•
20						•	•	3	•	4	4	*	4	Š	10	Š	4
21		0				ĸ.	4	3	3	4	4	4	*	4	5	5	~
5.5				0	3	3	3	3	, M	3	₩)	4	4	•	4	5	-
23	0	·	9	22.4	22.0	22.0	22.3	22.6	23.0	23.3	23.5	23.9	24.2	24.5	24.8		0
24				0.	1.	+	1.	8	5	m	2	3	4	•	4	5	0
ر بر	7	0	0	0	0	•	-	2	2	M	1	6	4	4	4	4	•
		18.4	19.0	19.7	20.3	20.9	21.5	22.0	22.5	22.9	23.3	23.7	24.0	24.3	24.6	24.	•
	9	7	œ	6	0	0	+	-	0	2	3	3	4	4	4	4	0
	•	7	œ	6	0	0	+	-	ò	3	5	3	3	4	4	4	60
66		7.	8	0	6		1.	+	5	0	m	3	3	4	4	4	6 0
	5	•	8	0	•	0	-4	+	ò		3	3	س	4	4	4	30
31	15.4	16.8	17.9	18.9	19.7	20.5	21.1	21.7	25.2	-	23.2	23.5	23.9	24.2	24.5	24.6	6 0
	3.	ç	<u>٠</u>	æ	6	0		+	8	°	, M	3	3	4	4	+	60
	5	3	7.	œ	6	0	+	-	Ĉ	'n	m	m)	3	4	•	4	œ
3.4	5	•	7.	œ	6	0		+	ċ	8	S		3	4	4	+	6 0
	5.	·c	7.	œ	0.	0	-	4-4	8	2	2	8	100	4	+	4	80
36	15.1	16.5	17.7	18.7	19.4	20.4	21.0	21.6	25.2	22.7	23.1	23.5	23.9	24.2	24.5	24.8	60
	5	ċ	7.	8	·	с С		+	<u>٠</u>	2		٠ ا	m	4		4	യ
38	5.	é	7.	8	•	0	-	•	<u>،</u>	3	P)	·	יי רא	4	4	4	6 0



MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.95

A P P P P P P P P P P P P P P P P P P P								₽- U									
FACTOR [K1]	0			1 00	0	1.0	1 44	1.2	; ·	1.4	1.5	1 0	1.7	1.8	1 6	2.0	
1 4 -					.0	0	0	0	0	0				0.	9 •	•	
			c											0		•	
								. 0	0		. 0	0		35.9		80	
			<u>.</u>						0	0	0		•	8		•	
									0	4	•	7	9	•	•	\$	
19	0.			. 0						•	5	S.	5	S.	r.	is.	
						O	0	•	r.	4	4	4	5	2	Š	Š	
						•	4	ष	4	4	4	4	4	4	5	3.	
				0	4	P)	2	23.3	23.5	3	24.0	24.3	24.5	24.8	25.0	•	
			0	2	2	3	2	2	3	ы.	3	4	4	+	4	S.	
	ũ.	26.9	21.5	21.1	21.3	21.7	22.1	\sim	2	23.3	3	4	4	•	4	ľ.	
25	v	·	0	(C)	0	+	• •	\sim	2	M	1 0	M	4	4	*	5	
	T)	α¢	6	6	0	-	-	2	2	M	~ 2	3	4	4	*	5	
	-	17.9	18.7	19.5	20.2		-	22.0	22.5	23.0	23.4	23.8	24.1	24.4	24.7	25.0	
	9	7	00	•	0	0	+	2	2	cv.	M	м М	4	4	+	r.	
	16.0	7.	8	•	0.			1.	5	2	₩.	8	4	4	4	5	
	3	7	œ	6	6	0	,	-1	N	2	™)	3	4	4	4	4	
34	:5:5	16.9	18.0	19.0	19.F	20.6	21.3	21.8	22.4	22.8	23.3	23.7	24.0	24.4	24.7	24.9	
	50	ç	7	œ	٠.	C	+	7	5	~	3	∾.	4	4	4.	4	
	3.	Ś	7	œ	5	0	-	1.	2	2	3	· ·	4	4	.	4	
	5	ċ	7	60	6	0	÷	1	2	2	19	٠ س	4	4	-3 ▼	4	
	5,	ζ.	7	oc	0	c	4	•	~	2	P)	3	4	4	4	*	
(M) (O)	15.2	16.6	17.8	18.8	19.7	20.5	21.2	21.8	22.3	22.8	23.2	23.6	24.0	24.3	24.6	24.9	
	5	9	7	100	6	0	+	+	2	2	+3	3	*	4	4	4	
	Š.	•	/	σC.	6	0	+ 1	+	8	6	M)	M	4	4	•	4	

MAXIMUM FILLING COVER FACTO S (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =0.96

x > 0 x m t	1					1		BET				1				
K11	0.5	0.6	n.7	0.8	6,0	1.0	1.1	1.2	1.3	1.4	1.5	1.6)	1.8	1.9	
4 	•	•	•			8	•	•	0	0	0	. 0	0	0	1	9
														0	0	•
		0			0	0				0	.0	0	0	40.6	31.2	6
	0.									•	0			a)	7	7
									0	•		7.	ø.	9		•
19	0	0.	0	0	0	0	0	0	29.5	•		ic.	5	R.	5	
20	0				0.	0	÷	•	ď.	5	NO.	5	'n.	50	2	5
	0					7	S.	4	*	4	4	4	+	5	5	Š
		0	0	0	5	٠.	23.4	23.5		3	24.2	24.4	4	4		'n
				3	0	2	å	3	3	(~)	3	4	4	*		5
	0	35.7	21.9	21.4	•		5	2	3	23.4	3	•	•	24.7	25.0	•
25		ċ	Û.	0	0		~	ri	2	3	3	4	4	4	4	Š
	6	8	ó	-	0	-1	÷	2	ċ	M)	, 10	م	4	•	4	ů.
		18.0	18.9	19.7	20.4	-	•	25.2	22.7	M	_	23.9	24.2	24.6	24.8	
	6.	7.	80		0	0	•	5	2	~)	M	∾.	4	•	4	5
		7	œ	0	0	0	21.5	5	·	•		ريا •	•	•	4	5
	S	7	œ	6	0	ū.	+	8	2	3	30	₩)	4	4	4	S
	٦.		œ.	6	0	0		2	2	٠ س	3	19	4	4	•	5
	15.5	16.9	18.1	19.1	19.9	20.7	21.3	21.9	25.5	23.0	23.4	23.8	24.1	24.5	24.8	25.1
	۲.	9	30	6	0.	0	-	•	?	å	3	3	4	4	4	S.
46	•	\$	8	•	6	•	+	+	ò	8		3	4	4	4	ŗ.
_	5	¢	7.	œ	•	0	1	+	ò	2	M	3	4	4	+	Š
	'n	ċ	7	80	6	0	-	-	iv	å	3	3	4	4	4	ď\
37	15.2	16.7	17.9	18.9	19.R	20.6	21.3	21.9	22.4	22.9	23.3	23.7	24.1	24.4	24.8	25.0
_	5	\$	7	0	٠.	0	•	-	2	6	2	3.	4	4	4	r.



MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =0.97

								8ET					1			6
X	6 - 5	0.6	0.7	0.8		1.0		1.2	1.4	4.	1.5	1.6	1.7	60	6.4	2
4-1								•	•	. 0		0		6	0	
															0	0
												0	0	0	~	•
			0			0	0	0	0	0	0	45.2	30.6	28.8	28.0	27.6
									0	•		8	7	9	9	÷
	0	c.	0	0	0			0			•	•	•	•	•	. 9
20	0					0	5	7	נו	r.	5	Ŋ.	5	5	K ,	5
						80	5	4	4	4	4	4	5	R.	3	Š
					50	4	3	M	3	24.1	4	4	24.8	5	25.3	25.5
			0	3	2	2	~	3	3	~	4	4	4	4	5	5
	0.	c	22.4	21.6	21.7	22.0	22.4	22.8		3	23.9	•	4	24.8	5	5
		c	c	C	•	4	C	C	, M	M		4	4	4	2	r.
	0	. 0	. 0							M.	, M	4	4	4		3
			19.0	40.6	. 0	• •	4 +4	22.3	22.8	23.2	23.6	24.0	24.4	24.7	25.0	
	9		တ	0	0	-	•	S	2	3	3	4	4	4	5	5
				6	20.5	C	•	8	~	ريا •	m	4	4	*	4	5
30	9	7	œ.	9	0	0	÷	5	2	3	10	3	4	4	4	5
	S	17.1	-	19.2	0	•		22.1	22.6	23.1	23.5	23.9	24.3	24.6	24.9	25.5
	Š	۲,	œ	6	0	с С	-	Ci.	2	3	50	3	4	4	4	'n.
	5	6	ac.	6	9	0	+	2	ċ	5		3		*	*	Š
	5.	•		0	20.0	0	+	5	è	М.	3	3	4	4	4	5
SC.	•	ć	œ	6	0		•	2	2	3	*	3	4	4	4	5
	ر <u>ت</u> .	\$	00	0	0	0		2	2	3	10	2	4	4	4	5
	5		18.0	19.0	19.9	20.7	21.4	22.0	22.5	23.0	23.5	23.9	24.5	54.6	24.9	S
	5.		•	•	0	0	-	8	~	3	•	•	4	•	*	

MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.98

A 50								4	_								
FACTOR	0.5	0.6	0.7	0.8	0.0	1.0	1.1	1.2	1	1.4	1.5	1 -	1.7	1 00	4.9	2.0	•
1 4	1	1	0.0		0.	0.	0.	0.	•	0	6	0	0 .	-	0		î
															0	0	
		·		ů	0.	0	0	0		0	9	0	0	•	33.1	30.3	
											9	0	-1	•	8		
									0	0	•	•	~	•		•	
19	Ú,	0	0		0			0	31.6		9	•	•	•	•	•	
						0	•	7	•	5	5	5	2	5	8	40	
	0	-	0		0.	6	-	25.0	4	4	4	5	5	5	2	5	
					9	4	P)	3	4	4	4	4	5.	5	5	5	
			C	4	3	2	3	3	P)	∾	4	4	4	5	50	S	
0	0	0.		21.9	21.9	25.2		2	23.3	23.7	24.0	24.4	24.7	25.0	25.2	25.5	
~ 25			ċ	ċ	÷		0	0	P.	•	-	4	4	4		ď	
	0	19.3	0	0	0		2	2	M	5	, P	4	4	*	. '0	, R	
	7	œ.	6	6	0		-	2	5	₩.	P)	4	4	4	5	5.	
	9	7	8	6	0	+	-4	2	5	3	2	*	4	4	5	Ŋ.	
		1	*	19.5	•	21.1	21.7	22.3	28		23.7	24.1	24.4	24.8	25.1	25.3	
U *	ν.	7	α	0	c	•	•	C	0	~	,	4	4	4	~	ir.	
	5	, '	00	6	0	0		2		2	, m	4		4	2		
	5	17.1	18,3		20.1	0		•	8	8	1	+	4	4	5	S LO	
	S	7	œ	0	0	0	+	è	2	m	L	4	4	4	80	5	
46	15.5	7.	c c		•	20.8	21.5	22.1	22.7	23.2	23.6	24.0	24.4	24.7	25.0	25.3	
-	S.	·	80	φ.	0	0	•	~	~	•	1	4	4	4	5	5	
	3.	ć	α.	6	0	0	-	~	5	3	3	4	4	*	5	5	
37	15.4	16.8	18.1	19.1	20.0	20.8	21.5	22.1	22.7	23.1	23.6	24.0	24.4	24.7	25.0	25.3	
	r.	ť	œ	•	0	0	•	5	3	3	3	4	4	**	5	ż.	

MAXIMUM FILLING COVER FICTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.99

30 - 1		1 4 1 .	\ C C	6.00	6.0	F C	11.10	101	1.3	4	21.0	1.5	1.7	14:0	1.9	2.0
								• •		• •	• •			•	. 0	
											00	0.0	20.	0 6	4 00	
		 c c				00			33.5	28.4	32.0	28.9	27.8	27.4	27.1	27.1 25.5
			· ·		• •	00	C 43	28.5	26.6	24.9	25.7	S	25.8 25.4	25.9	26.0	26.2
				C U		4 4	24.2	4 4	4 4	4 4	4 4	4 4	₹. 4	ro r	25.	r, r
							5 0	. n	מו מ		4	4	4	. 10) (C)	
	00	22.2 19.6	20.9	21.1	21.5		22.4	22.8	23.3	23.6	24.1	24.4	24.7	25.0	25.3	25.6
		α α	0 0	00	0 0	+ -	٠ ٠	25	M W	w) w)	W W	4 4	4 4	₩. 4	25.	. n
1 +-1			• • •	. 0	0	1:		· ·	8	, m	M	4	4	4	25.	3
	·	7.	oc.	6	0		1.	0	8	3	3	4	4	4	25.	5
	ċ.	7.	ac 0	0 (0	٠,	• •	· ·	· ·	m ,	m 1	4 .	4.	4 .	200	ر ا
		17.2	1 X 4 . 4 . 4 . 4 . 4 . 4 . 4 . 4 . 4 . 4	40.4	20.0	21.0	21.7	200	22.8	20.00	23.7	24.7	24.5	2.4.0	25.2	25.4
	3	7	00	6	Ċ.	+		·	8	3	P)	4	4	4	25.	Ę,
<u>بر</u> ب	υυ 	17.0	18.2	19.3	20.1	20.9	21.6	22.2	22.8	23.3	23.7	24.1	24.5	4 4	25.1	25. 25. 4.
	· ·	ċ.	oc 0	0	<u> </u>	0	•	20	o o	3.	m 1	4.	4 .	4	25,	5
	'n	ċ	α α	o.	0	O		5	$\dot{\sim}$	٠,	(A)	4	4	4	25.	ζ.

MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #1.00

A C																
OVER	1				1	1	 	BET	1	1	1	ı	ı		1	- 1
	0.5	9.0	0.7	0.8	0.0	1	1.1	1.2	וייו	1.4		1.6	1.7	₩ .		2.0
14		0.0			. 0	0.		0		, , ,	ı	0 .	0		1	.0
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						0.	е •	0.		0	0	0	0.	0	36.3	+
											ċ	0			•	•
									0	0			80	7	7	7
	0.		0	C	0			0	37.2		7	9	•	•	9	•
		<u>۔</u>				•	•	6	1	•	9	rU.	•	9	9	•
					0	60	6	5	r,	5	5	5	r.	5	5	•
				•	•	5.	24.5		4	24.6	24.8	5	5	5	6	•
			0	9	3	3	ارا •	3	3	4	•	4	5	5	5	5
	0		24.5	22.5	22.4	25.6	2		•	4	4	24.7	25.0	•	25.5	25.8
25	0	m)	•	-	•	~	~	m	3	3	4	4	4	5	5	ņ
	•	0	\subset	0	+	• •-4	22.3	22.8	23.3	23.7	24.1		•	25.1	25.4	
	a .	oc.	•	ċ	0	4	2	5	3	3	4	4	4	5.	S.	3
		60	6	ċ	0	, ,,,	2	2	3	~	4	4	4	د	ν.	5
	\$	7.	18.9	19.8		21.5	-	8	3	3	3	4	24.7	in	3	
	16.3	•	œ	6	-	, ,-1	+	2	₩.	143	3	4	4	5	5	5
	9	7.	œ	0.	0	+	21.8	22.4	23.0	23.5	23.9			5	-	5
	5.	7.	σc	6	0	+	+	ò	5	3	PF)	4	4	5	5	5
	5	7	œ	6	ċ		-	ċ	ċ	3.	3	4	4	5	S	r.
	5	1		19.4	0	21.1	-	ċ	•	~	3		4			•
	S				C	-	-	8	•	~	(A)	4	4	5	5	5
	5.	۲.	œ.	0	0	+	-	?	1	3	٠,	4.	4	5	5	5
	·.	7.		5	0	21.0	21.7	22.3	22.9	23.4	23.8	24.5	24.6	25.0	25.3	25.6
	ľ.	7	œ	6	0		.	ς.	3	3		4	4	رم د	IL.	5.



MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #1.36

KARP COVER FACTOR	1 1 1	1	1 1	1	1	!	1	98 1	1	; !	1 6 1	1	1	1	b 1	1	i
X	: : ::	6.1	1.1		0	1.0	F	1.2	1.3	1.4	ert 1	1.6	1.7	1.8	1.9	2.0	i
98	•					•	. 0	. 0	. 0	0	0	0	0.	0	0	56.	
1 6							•		•	•	•	•	0	7	•	5	
00										0	c	0	7	4	m	2	
21						0	· c	0	0	0	38.9	34.3	32.8	32.2	31,9	31.8	
25							0	C	0	4		4	•	7	4	-	
23										4-4	0	0	0	0	0	0	
4 6			0				4	;	0	0	6	0	0	0	0	•	
25		ċ	· =		0	å	0	6	00	6	0	6	0	6		C	
26				0	0.	60	œ	80	00	80	œ	φ.	0	٠ د	0	0	
23			0	8	7	7	7.	7	7	60	ac	œ	6	6	6	0	
28		Ċ	œ	9	9		9	7	7	28.0	ac :	8	0,	29.4	•	ċ	
62	0		5	4	5	25.8	26.3	26.8	27.3	1	•	28.6	29.62	0	29.7	30.0	
30	0	w.	23.7		24.8	ĸ	€.	•	7	7	Œ	60	œ	0	•	0	
7.1	2	2	3	M	4	5	25.9		27.1	27.6	•	Ø	28.9	29.3	_		
32	0	•	5	8	4	'n.	5.	9	7	7.	œ	8	œ	6	•	6	
33	6		2	*	4	4	٦.	6.	\$	7	æ	æ	.	٠ 6	•	•	
4	19.4	·	· ·	×.	4	24.8	5	9	9	1	7	28.4	œ	0		0	
iC.	•		•	5	M	4	i.	•		7	7	80	00	6	•	6	
36	æ	٠	•	2	3	4	ŗ.	•	\$	7	-	8	ж Э	6	0	6	
37	3 0	ċ	•	5	3	4	25,4	26.1	26.8	27.3	27.9	28.3	28.	29.1	29.5	•	
38	œ	-	-	ċ	3	4.	5	•	9	7.		ω,	αC	•	•	φ.	
39	OC	c=	-	22.6	8	24.6	2	9	•		7	ю Э	œ	6	0	0	
4 0	œ	·		2	3	4	5	÷	¢	7		00	90	0	6	•	
41	\mathfrak{X}		21.4	25.6	23.6		25.3	26.1	26.7	27.3	27.8	28.3	28.7	29.1	29.5	29.8	
42	•	0		~	•	4	٦.	÷	9	7	7.	œ	8	6	6	6	

YARN BULK DENSITY =1.48

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3 ¥2 □	0.5	9.0	7.0	0	6.0	1.0	+ 1	1.2		1.4	4.5	1.6	1.7	₩ I	4.9	
1 8 T			•	0	•	. 0	•	0.0	•	•		. 0	0		0	. 0
	• 0	·		0				•				•		•	•	•
20												•	0	ы.	7	9
21									0.		0	5.	7.	5	4.	+
22										0	٠.	ت	4.	ы	ю •	ъ.
23	0	0	٠		0		0	0	01	35.9	33.7	32.9	32.6	32.4	32.4	32.5
24						0				2	2		1.	,	'n	ċ
25				c	Ċ		ý	ζ,	÷	,	•	-	<u>, </u>	•	-	•
, ° C	· .		• •	. 0	ò	34.5	31.2	30.4	30.2	30.7	30.5	30.7	30.9	31.2	31.4	31.7
27					•		6	6	Ġ.	6	0	0		#	-	•
5 8				•	Ø	œ)	æ	8	6	6	•		0	0	ij	÷
56			31.4		7.	7.	7.	80	œ	6	•	0.	0	0	÷	
30		·	ç	9	•	7.	7	80	φ.	6	6	6	0		+	-
31	0.	25.5	25.0	25.4	26.0	26.7	27.3	27.9	28.4	28.9	29.4	29.8	30.2	30.6	30.9	31.3
32	4	8	4	4	5.	•	7	7	8	8	٠.	6	0		•	$\ddot{\cdot}$
33	\sim	÷	M	4		•	•	7	æ	œ	•	٠ •	•	0	0	÷
46	•	÷	m	4	v.	ý	.	7.	60	ω	•	6	0	0	•	:
35	6	•	ь.	4	Ŋ.	-₽.	é	7	€	80	6	•		0		+
36	•	<u>.</u>	?	4	5.	ů.	•	,	œ	80	•	٥.	0	。	•	;
37		21.3	22.7	23.8	24.9		26.6	27.3	28.0	28.6	29.1	29.6	30.0	30.4	30.8	31.1
38	<u>,</u>	•	5	×.	4	ņ.	ç	7.		æ	Ġ.	6	<u>.</u>	0	•	;
39		÷	2	ъ.	4	ŗ.	ċ	7.	7	œ	•	6	0	•		;
	·	<u>.</u>	2	κ.	4	5.	•	7	7.	ဆ်	•	ò	0	0	e.	÷
41	19.2	9. ŋ.	22.3	23.6	24.7	25.6	24.5	27.2	27.9	28.5	20.0	29.5	30.0	30.4	30.8	31.1
	٠. د	ċ	÷	8	4	5.	÷	7.	7	œ	•	6	0		6	÷



MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =1.50

								BET		1	1		1				-
X	0.5	9.0	0.7	0 . 0	0.0	1.0	1.1	1.2	1.3			1.6	1.7	8 1	4.9	2.0	1
181		•	0	0	. 0		0	0.		0	0	0	0.	0.	0	0.	
		0	ċ	0	0				•		•			•		•	
	٠.												0	0	•	9	
		c	0			0	ů	0	0.	0	c	0	39.3	36.3	35.1	34.5	
	.0				0.					0	e eri	9	4	M	P)	3	
								•	0				M	2	ċ	ċ	
	0	c C	0		0		0.			m	2	٥.	5	2	8	2	
	0					0	0	100	•		-	-	•	-		2	
						9	+	0	0	0	0	0		-	-	-	
					ď.	0	0.	6	6	0	6	0	0	•	÷	;	
	0	٠.	0	34.2	29.6	28.9	28.8	29.0	29.4	29:7	30.1	30.4	30.7	31.1	31.4	31.7	
				•	7.	7	œ	œ	6	6	0	0	0	÷	+		
		4	7	,	ç	7	7	00	60	6	0	0	0	0	**	+	
	0	26.3	25.5	25.8	26.3	56.9	27.5	28.1	28.6	29.1	29.6	30.0	30.4	30.8	31.2	31.5	
	3.	4	4	n,	5	9	7	7.	8	6	•	O	Ċ.	0	-	+	
	\mathbf{c}	~	3	4	r.	9	7	1	œ	60	6	6	0	0	+		
34	•	· .	8	4	5.	•	7.	7.	œ	œ	6	6	0	0	+	+	
	0	~	M)	4	5.	•	¢	7	œ	80	0	0	0	0			
	0.	*	3	4	ς.	ć	Ġ	-	œ	œ	6	ó	0	0.	+	÷	
	5	-	2	4	50	9	è	7	8	80	0	ъ.	0	0	1.	+	
	19.7	21.3	22.7	23.9	25.0	55.9	26.7	27.5	28.1	28.7	29.3	29.8	30.5	30.6	31.0		
39	•	•	0.		4	5	ċ	7.	80	œ	0	6	0	0			
	3		~	K	4	7	•	7	80	න න	6	0	0	0	-0	4-4	
4 1		21.0	22.5	23.8	24.9	25.8	26.7	27.4	28.1	28.7	20.5	29.7	30.2	30.6	31.0	31.3	
		•	N	*	4	ĸ.	ć	7	8	œ	0	6	0	0	*	+	

YARN BULK DENSITY =1.77

FABRICS	
WEAVE	
FOUR-HARNESS	

A F B								BET			1		1	1	1		
FACTOR [K1]	0.5	9.0	0.7	0 • 8	6.0	1.0	1.1	1.2	1.3	1 + 1 1 • 1	1.5	1.6	1.7	1.8	1.9	2.0	! !
1	1	•	ł	l i I	1	! ! !	1 1 1 1	f 5 F \$! !	! !]) 	
20					0			•	0								
21					0									0	0	4	
20					0.								0	'n	0	6	
, C					0.		0		0.	0.	9	54.8	41.1	38.8	37.7	37.2	
4.5	0		<u>-</u>	0	0.	0.	0.	0				8	7.	9	•	9	
,	•	,						c		c	-	•	ĸ	Ľ	ĸ	ĸ	
25					•		•		•	•	•	• •	•	•	•	·	
56		0			•	0	ċ	ċ	. ·	ø,	'n,		64.0	7.4.	55,1		
27						0	ò	è.	3	4	₹.	4.	4	4	4	*	
28		-			0.0	9	5	8	3	3	₩.	ъ.	δ.	4.	4	4	
000	• •		. 0	0	7.5	34.4	32.9	32.6	32.6	32.8	33.1	ъ.	ю М	4.	4.		
,																	
20					5	+	+	+	?	2	٠.	33.1	33.5	33.8	•	•	
) r				2			ċ	;	÷	2	~	ŝ	3	, M	4	4	
			2	6	6			0	÷	-	۲.	2	δ.	3	3	4	
) M		ς.	8	80	8	6	c	ö	+	;	ò	ς.	3	М.	m	4	
) ki	50.1	27.6	27.3	27.8	28.4	29.1	29.8	30.4	31.0	31.6	32.1	2	3	ъ	m	4	
•						,	(,		c	•			•	
35	\$	5.	Ġ	7	8	æ	6	0	•	;	2	,	;	• •	·	•	
36	4	4	5.	•	7.	8	٠ د	0	0	;	۶.	٥,	ċ	.	·	4	
37	×;	4	5.	9	7	æ	6	0	0	4		32.4	32.9	33.3	33.7	34.1	
80	~	~	5	Š	7	6	6	•	0	+	+	۲,	<u>۰</u>	, M	M	4	
6 6	22.0	23.6	25.0	26.2	27.3	28.3	29.2	59.9	30.6	31.3	34.8	۲,	۲.	ъ.	8	*	
•																	
4 0	1.	5	4	•	7.	8	6	6	ċ	Η.		5	2	m 1	m 1	4	
41		۳.	4.	ç		æ	Ġ.	6	•	.	+	٠. د	٠.	٠ •	, ,	4	
42	۲.	*	4.	.	7.	8	6	•	0	;		۲.	<u>٠</u>	٠,	,	4	
43	_	۴,	24.5		27.1	28.1	29.0	8.66	30.5	31.2	31.8	32.3	32.B	33.2	33.6	34.0	
4	21.0	65.2	•	5.	7.	œ	6	ċ	•		•	۲.	۶.	8	8	4	

MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =2.00

OVER								BET		1		1	((
X - 1		9 1	0.7	60	6.0	0 1	₩ .		1.3	4 1	4.5	1.6	1.7	60 I	1.9	2.0	
		1		 () (c	•	c	c	c	C	ć	
		•		=	•												
				.	0											ت	
				<u>-</u>	0										0	5	
				_	0								0	0	•	42.7	
24	c c	٠,	U	0	0.		0	0.	0.	0.	6	0.	48.6	43,0	-	0	
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		•								> ı	•	ř	• -i (•		
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					0		0	4	6	7		9	. 9	7.	7.	7	
	0	٠	<u>.</u>	0	0	0	43.4	37.9	35.6	36.2	36.1	36.2	36.4	36.6	36.8	37.1	
						è	•	Ŋ.		5.	K)	5	Š	, D	•	· o	
				•	, M		4	4	4	4	v	3	ي.	0	. 9	1	
				c,	5	3	3	8	_		4	5	5	35.9	8	ò	
				4	2	2	?	3	3	4	4	5	3	'n	•		
	.	·	34.3	31.8	31.6	31.9	32.3	32.9			•	34.9	35.3	5		36.4	
ŭ		u	c	c	c		c	c	۲	~	4	4	LC.	u	×	(
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4	22.7	24.6	26.2	27.6	28.8	56.6	30.9	31.7	32.5	33.2	33.8	34.4	34.9	35.3	35.8	36.2	

MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =2.36

FOUR-HARNESS WEAVE FABRICS

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =2.50

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46	26.3	JA . 2	8.62	31.2	32.5	33.7	34.7	35.6	36.4	37.2	37.9	38.5	39.0	39.6	40.0	40.5

MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #2.75

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94	20.0	30.4	31.0	33.2	34.4	35.6	36.6	37.5	38.3	39.1	39.8	40.4	41.0	41.6	42.0	42.5



MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =2.95

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =3.25

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =3.54

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #3.75

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #4.00

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #4.13

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MAXIMUM FILLING COVER FACTORS (KZ) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #4.60

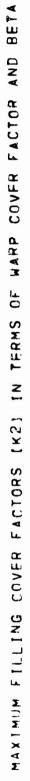
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5-HARNESS

MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.54

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YARN BULK DENSITY = 0.55

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.56

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335	13.1 13.1 13.1	4 4 4 6 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	5.50	16.0 16.0	16.6 16.6	17.2 17.2 17.2	17.7 17.7 17.7	18.2	118 118 18 18 6	18.9 18.9	6 6 6 4 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6	19.5 19.5 19.5	19.8 19.8	20.0	20.2	200.4



MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.57

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.58

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		14.7	15.6	16.4	17.0	~	18.1	18.6	18.9	19.3	19.6	19.9	20.5	20.4	20.6	20.8	
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36	13.3	14.5	15.4	16.2	16.9	17.5	18.0	18.5	18.9	19.3	19.6	56.63	23.1	20.4	20.5	23.8	
	30)	4	S.	ċ	•	/	&	60	60	•	6	0	0	0	0	0	

MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.59

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	1.6		27.3 22.2 21.2 20.7	200.2 200.2 200.1	200.1 200.1 200.1	200.0	20.0
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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.60

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		18.2	17.7	17.9	8	18.6	18.9		19.6	19.9	20.2	20.4		20.9	21.1	21.	
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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.61

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32	13.7	14.9	15.9	16.7	17.4	00	18.5	19.0	19.4	19.8	20.1	20.4	20.7	50.8	21.1		
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36	1.5.7	14.9	15.8	16.7	17.4	18.0	18.5	19.0	19.4	19.8	20.1	20.4	20.7	50.0	21.1	21.3	
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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.62

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YAHN BILK DENSITY = 0.63

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	15.0		•	17.4	18.0	18.5		o.	19.8	0	ċ	о С	•	÷	-	-
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	4	15.4	16.4	17.1	•	an)	α.	10.4	•	20.1	24.5	0	+	21.3	-1	
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MAXIMUM FILLING COVER FACTORS [K2] IN THRMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.64

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25	14.7	15.8	9		00	9.8	0	19.6	0	0	0		-	21.5	÷	
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32	4	15.3	16.3	17.1	•	16.4	19.0	19.4	19.9	20.5	20.6	50.9	21.2	21.4	21,6	21.9
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4	14.0	5	•	7		00	6	0	6	0	c	0		+	-	
35	4	r.	•	7	7	90	6	3	•	0	0	0	•	+	-	+
36	14.0	15.2	16.5	17.1	17.A	18.4	10.0	19.4	19.9	20.5	50.6	50.9	21.2	21.4	21.6	51.9
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MAXIMIM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

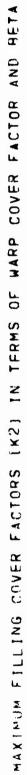
YARN HILK DENSITY = 0.65

								BET							į	,
<u>ب</u> په	5.5	9	n. 7	00	6.0	1.0	1.1	1.2		1.4	1.5	1.0	1.7	1.8	6 . 1	
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33	V		16.4	17.2	7.	Œ	19.1	10.6	20.0	20.4	20.7	21.0	21.3	21.6	21.8	22.0
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36						œ	19.1	19.6	20.0	20.4	20.7	21.0	21.3	21.6	21.8	22.0
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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.66

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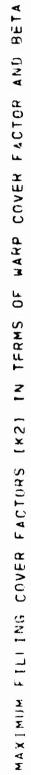
YARN BULK DENSITY = 0.67

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.68

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YARN BULK DENSITY = 0.69

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.70

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YAHN BULK DENSITY = 0.71

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.72

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND RETA

YARN RULK DENSITY = 0.73

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =0.74

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	٦.	·	7	80	on	0	0	0	-		~	2	~	м.	~	m	
	3.	·	7	ď	6	о·	j	0	+	+	~	d	3	3	10	m	
37	15.1	16.4	17.5	18.4	19.1	19.8	20.4	50.9	21.4	21.8	22.1	25.5	22.8	23.0	23.3	23.5	
	ζ.	÷	·.	ά	6	6	0	0	$\dot{\cdot}$	7	?	5	2	3	3	3	
		ç	7	œ	6	φ.	ċ	ċ	√-I	+	٠.	8	ċ	m	3	m	



MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

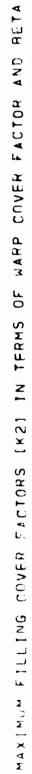
YARN BULK DENSITY = 0.75

								BET					I	1.0	1	1
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				= 4				:	•	•	:	•		0 5	•	•
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						0	4	3	2	3	1 00	3	M	8	3	4
	0				4	2	2	22.5		22.8	•		ь.	23.6	23.8	24.0
				~	+	-	÷	2	2	2	2	₩.	3	5	₩	, M
		M:	ċ	-	0	0		*	0	2	~	5	3	3	1	3
	20.6	19.1	19.5	19.6	20.1	20.6	21.0	-		2	25.5	5		'n	3	3
25	7	7	Œ	5	6		Ċ	•	•	e.	~	٥.	6 0	m		3
	9	7	α	6	0	0			-	ς.	~	2	(M	3	2	~
	_	17.1	18.0	18.8	19.5	0	20.7	21.2	21.6	22.0	22.4	22.7	23.0	23.2	23.5	23.7
	5.	ć	7.	ď	0.	0	0	+	•	ò	0	?	?	3	P	3
	_	•	7	•	6	20.0	0	7	*	2	~	5	2	3	3	3
30	3.	•	7	œ	6	0	c	-	-	-	6	~	~	3	₩.	3
	15.3	16.6	17.7	18.6	19.3	20.0	20.6	21.1	21.5	21.9	22.3	25.6	22.9	23.2	23.4	23.7
	5	9	7	æ	6	0	0	.	-	.	~	2	?	3	3	M
	'n	ç	7	8	6	0	0	+	-	;	5	٠ ن	2	٠,	3	3
4 &	5.	•	7	œ	6	·	0	•	+	÷	5	2	0	M	1 20	3
		v.	7	or.	6	6	ċ	٠	-	Ţ,	٠.	N.	~	1	~)	M
	ζ.	· ·	7	α	·	σ.	0	-	•	4-1	?	2	~	3	3	8
2.83	15.2	16.5	17.0	18.5	19.3	19.9	20.5	21.0	21.5	21.9	22.3	22.6	22.9	23.2	23.4	23.7
	$\dot{\mathbf{r}}$	·	·	œ.	6	•	Ċ	1.	+		?	ò	<u>.</u>	.	3	3
	v.	ċ	7	x	•	6	∵	÷	+		·	ì	Ċ	m	*	ريا •

MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.76

MARP COVER FACTOR		0 0 1 1	 		1 1 1	!		BET		1		ļ	!	!	•		
- X -	0.5	9.6	D . 7	1	0.0		1.1	1.2	1. E. I	4	1.5	1.6	1.7	1.8	1.9	2.0	
1 1 U	1	! !		 	•	 - c	i i i C	! ! ! c	! ! c			! C	 		•	, c	
	•											,) (•	•	• • •	
	.							•				0	0	·	D 1		
	0	0						•		0	0	;	7	ŝ	·	5	
6 0	<u>-</u>	· -	C	<u>-</u>	0	0	c C		0	29.8	26.5	25.5	25.1	25.0	24.9	24.9	
-		· C							25.7	4	4	4	4	4	4	4	
						0	5	4	3	m	100	3	10	4	4	4	
					S.	M)	~	2	2	m	2	ω.	3	3	*	4	
	° ⊃			, m	22.0	•	2	22.2	22.4	22.7	22.9	23.2	23.4	23.6	23.8	4	
		æ	1.	0	0		•	+	3	å	~	3	۲)	3	12	4	
4.5	22.5	19.5	19.5	•	•	20.8	21.2	-	ö	2	0	m	3	3	M	•	
	r	o	C	c	c	c		•	-	0	C	C	۲	~	~	~	
~	•	0 1		. (•		•	•	•		• u (, 0	·	•	•) r	,) ~	
9 1	10.7	17.0	1 C	7.61	× • • • • • • • • • • • • • • • • • • •		4.00	* * *	0 · T · C	20.00	0.00	2000	1.02	200	7.50	200	
	• • •	•	C (•					•	•	, v (• > r	, P) r	
	ζ,		00	1 0	•	·	•			v (*		· ·	·	。 つ	0 1	
56	Š	ċ	7.	œ.	6		C	+	•	~		\sim	8	8	3	'n	
	ir.	v.	7	ω	o'	0	0	.	•	2	~	2	8	3	m	3	
	'n	\$		α	0	0	C	÷	•	2	S	å	3	3	P	3	
	'n	· ·c	7	9	0	0	0	+	+	2		2	, M)	™	3	3	
	'n	16.7	17.7	18.7	19.4	20.1	20.7	21.2	21.7	22.1	22.4	22.8	23.1	23.3	23.6	23.8	
4		ç	7	œ	6	•	ċ	₹-1	**	•	\sim	5	M)	M	M	M	
	ď	4	7	ox,	6	-	<u></u>			~	0	~	Μ,	P)	M	~	
	15		. 1		0	· c	C			0			, p	~	**		
		. 4	17.7	8 6 6	7.61	20.1	20.7	21.2	21.6	22.1	22.4	22.8	23.1	23.5	23.6	23.8	
	3	ċ	7.	œ	6	0	c	• •	•	2	~	2	8	8		3	
3.9	ζ.	ć	7.	œ	6	ů.	0	+4	• •	à	0	5	~	3	m	3	



YARN BULK DENSITY = 0.77

COVER FACTOR (K1)	- C	· ·	0.7	6	6.0	10.0	1 - 1	BETA	1 . 3	1.4	1 .5	1.6	1.7	1 60	1.9	2.0
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								0		0	.	7.	œ	9	•	5
	7	c	· C	Ċ.		0		C		33.1	27.2	26.0	25.5	25.5	25.1	25.1
19	0					0.	°	41.5	26.4	5	4	4	4	4	4	4
c							4	4	4	*	M.	.~;	4	4	4	4
					• • a		·		مم	, ,) M	, ,~	~	~	4	4
	•			• = 1		·	, (•	• o c) P) M	• •	• •		4
		• =	•	×	6.77	. ,	2.77	1.00	0.77	,,,,,,	1.00	200	24.0	7 7 7		2 4 6
	-	C	4-4	• - :	-		•	·	· ·	·	~	٠ ١	•	٠ د د	· ·	·
4	28.5	20.0	•	•	0	21.0		+	ò	2	٠.	٠,	رم •	3	2	• •
	x	ac	0	6	Ċ	0	•		•	8	~	3	10	٠ س	100	4
. C	4.	_	α	0	_	c	•	-	0	2	2	3	۲,	P)	3	4
		, ,	<u>a</u>	10.1			21.0			~	22.7	23.0	M)	23.5	23.8	4
	9	, ~	oc.	6	0	0			-	2	3	3	5	m	3	4
60	15.8	17.0	•	•		20.3	•		21.9		è	5	23.2	3.	3	24.0
ŭ.	ζ.	4	ď	CIL	5	-	c		•	2	~	2	, M	3	,	4
	2		7	σ.	0		· -		•	~	~	2	2	12	3	4
	3	· ·	1	00	0	0	C	-		2		d	3	3	2	4
		16.8	17.9	A . B	19.6	0	20.8	21.3	21.8	22.2	22.6	22.9	23.2	23.5	23.7	4
a.		\$	7	œ	0	20.5	C	-	+	2	ζ.	cu	3.	3	5	24.0
	7	4	7	α	ď	c	·			\sim		ÇU	M)	3	*	4
	· d						•		١,	C	C	·		-	~	4
	'n.	ċ	•	x (· (•	- (v			0 1	,	0 6	•
3.7	15.4	14.7	17.8	18.7	19.5	20.5	20.8	21.3	21 · R	20.00	25.6	20.00	23.2	2.5. C. 10.	63.1	24.0
	ζ.	ċ	7	٠ رر	·	0	c			· ·	٠,	~	٠,	2 1	٠	• •
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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 9.78

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- X	0.5	, v	0.7	1 & 1 C	0	1.0		1.2	F . 1	1.4	٠. ت	1.6	1.7	1.8	1.9	2.0	
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													0	-	·	œ	
											0	0	6	7.	•	9	
	0	c	c	0	c)	0	0	0	0	•	28.0	26.4	25.8	25.5	25.4	25.3	
19						0		.0	27.3	25.6	E)	4	4	4	•	4	
						C	7	Š	4	4	4	4	4	4	4	4	
					7	4		. ~		M.	. 1	~	P.	4	4	4	
				ır		0			, ,	M7	, M		M.	4	4	4	
			~	•		, , , , ,	. +	2	2	CU	, M)	· ~	, m		24.1	4	
4	-	2n.6	20.1	20.3	20.7	21,2	21.6	22.0	22.3	22.7	23.0		23.6		4		
	a	o	c	q	c	c	•	•	C	C	C	~	**	M	4	4	
` '	0 1	• C: (•		•	•		•	, (, () r	•			
	1/.7	- LOS	5 6	7.61	2007	· 02	7:12	61.1	22.1	20.00	22.9	2.50	۲۰۲۶	7.00	24.0	7, 4, 0	
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	Ċ	•	c	•		•		-		•		·	0	٠ ٢٠	٠ ١٠	•	
56	٦.	7	œ	6	6	Ċ	+	•	2	CV	Ċ	~	·	~	יי	4	
0 10	3	7	ac	6	6	0	•	•	2	2	~	8	M	W	3	4	
	٠.	7	ď	0	6	0	-	7-1	?	2	°.	8	3	(א	3	4	
	37	5	Œ	œ.	0	0		-	8	2	2	3	8	3	, M	4	
	15.4	16.9	18.0	18.0	13.7	0	21.0	21.5	21.9	22.4	22.7	23.1	23.4	23.6	23,9	24.1	
4	ζ.	Ġ	о <u>с</u>	œ.	6	20.4	0	+	**	5	,	3	3	m	3	4	
	r.	·	7	œ	6	0	Ċ	·		2	2	8	100	М.	80	4	
	J.	4	7	α	6	<u>_</u>	_			2	5	~7	M.	~	~	4	
			_	or,			· c	• •		2		٠ *	, m	· M	8	4	
33	15.4	٦٤.٩	17.9	18.9	19.4	20.3	20.9	21.5	21.9	22.3	22.7	23.1	23.4	23.6	23.9	24.1	
	•	ζ.	7.	ď.	6	0	0		+	~	·	,	ب	8	*	4	



MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.79

•	2.0	.0	·	•	n	ŗ.	24.9	4	4	4	4	4	7	4 · 4 · 4	4	•	4	4	4	4	•	24.3	4	4	24.3	4	4
1	1.9		5.0	0 4	0.0	5.0	24.7	. J	4	4.5	4.2	4	•	1.40	. 4	•	•	4.1	4.1	4.1	24.1	4.1	4.0	0.4	24.0	4.0	4.0
• •	1.8		ċ	27.9	v 1	'n	24.6	4	4	4	4	100	. ~	200	•) M) 1	٠ د	8	3	₩.	23.8	3	8	~	23.8	3	3
	1.7	. 0	Ġ	30.5	•	N.	•	4,	M	∵ >	<u>س</u>	~		0.5.0 A	• > M	9	3	m)	M)	3	23.5	3	w.		23.5	*	M
•	1.6	. 0		٠		٠.		۲,	۵.	_	m	H7		0. K) M	? !	8	₩.	8	~)·	23.2	₩.	w)	~	23.2	₩,	<i>ۍ</i>
1 1 1	34		•		•			۳,	3			P.		0.50		•	C	0	2	~	22.9	~	ζ.	c.	22.9	~	~
1	1.4	· · · · · · · · · · · · · · · · · · ·		0	0		•	∾.	۵.	M	5	C		, , , ,	, c		cv.	2	2	5	22.5	0	2	S	22.5	~	·
	بنة دما			0	•	හ	4	3	~ ~	22.7	2	C	J (ָ מַנְ מַנְ		,	5	~	è	5	22.1	ò	2	C	22.1	Š	2
8 I	1.2	0					5.	ان	ċ	•	0	c	• J •	21.0	• - ; •	+	•	•	•	-	21.6		•	,	21.6	•	-4
	1.1	0.0					0	~	5	i	•		•	4.12		;	~	÷	•	<u>.</u>	•	•			21.1		-
1	1.0	0					c	ħ.	°.	•	21.5		•	200	D (•	0	0	0	_	20.5	ċ	0	_	00.00	· c	0
! ! !	0.0					0.		٠	3	•	0	с с	•	= c	,	0	0	6	0	0	6	19.8	9	0	۵.	6	•
1	0.8	0				· C	. :	C.	7.	***		c	•	40.0	•	·	·	0	0	5			0	0	0 0	0.	6
•	0.7			· c					Ċ	~	20.4	O	•	4.00 5.4		œ	œ	œ	30	ď	œ	18.1	œ	α	18.0	. ac	œ.
•	c			<u>.</u>		ć				•	21.5	c	•			7.	7	7	,	7	17.0	7	7	4	0.4	ć	·T.
1 3	0.5	==				0	с •				9	3	• !		• 0	ċ	9		5	r.	v.		ι.	٠,	1, c	<i>'</i> .	τ.
	, ,	15																					3.5				

MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR IND BETA

YARN BULK DENSITY = 0.80

SYTE C						1	1	90 EE		1	(1	1	1	1
- AC - CX	ا . د		0.7	0.0	6.0	1.0	1.1	1.2	1.3	4.1	1.5	1.6	1.7	60	4.9	2.0
! ! ! ४	: <u>=</u> 1					 		 			 					. 0
												•	0	0		0
											c	0	~	0	7.	•
	0	· c	0	0	0.				0	0	30.4	27.5	26.5	26.1	55.9	25.8
19			о С	• 0				0.	30.1	26.7	r.	S.	5	5	5	5
20						0	3	÷	ů.	4	4	4	4	4	4	T)
	0		0	ت د	0	26.2	24.4	23.9	23.8	23.9	24.0	24,1	24.3	24.5	24.7	24.8
			C	5	M;	~	2	₩)	3	3	m)	8	4	4	4	4
						ċ	~	0	ċ	Š	3	3	4	4	4	4
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25	0	•	0	-	0		+	8	2	\sim	10	M	₩	4	4	4
	17.7	18.4	19.1	19.8	20.5		21.5	22.0	22.4	22.8	23.5	23.5	23.8	24.0	24.3	24.5
	ċ	7	œ	•	0	-		H	5	2	3	3	3	4	4	4
	\$	7	œ	4	0	0	;	+	5	٥.		٠ <u>٠</u>	3	4	*	4
	•	7	60	6	0.	o.	•	+	ò	Ci	M	3	3	4	4	4
3.0	•	7	œ	0		0	7	+-4	5	5	M3	8	3	4	4	4
	3	7.	œ	6	င်	ů.	•	,	÷	?	·	· ·	, ,	4	4	4
	15.8	17.2	18.5	19.5	20.0	20.6	21.5	21.8	22.2	22.7	23.0	23.4	23.7	24.0	24.2	
	ŗ.	<u>.</u>	œ	·	6	0	•	+	2	2	ς,	٠.	٠,	٠ •	4	4
	s.	7.	60	0	0		1.	-	Ċ.	2	~	•	M	5	4	
	5.	7	α.	•	0	0	•	+	8	2	ارمة •	٠×.	3	2	4	4
	3.	7	œ	6	6	0	•		5	٠ ا		3	3	٤,	4	4
	· v	7	œ	Ġ	о О	0	;	÷.	÷	~	M) (رم د	٠ ا	י נא	÷ .	4 .
00 C	15.7	17.0	18.2		9 0	0.02	21.2	21.7	22.2	22.6	23.0	23.3	23.7	23.9	24.2	4.40
	•	•	c C	•	•	•	•	•	v	·	•	"	•	•	•	•



MAXIMIM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.81

FIVE-HARNESS WEAVE FABRICS

307 424 1207 12		0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6	0 0 0 0 0 0 4 5 5 5 5 5 5 5 5 5 5 5 5 5	74 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	141 CCCC C4W00	m - 00000 04 W W C C	4	4 0000 N N N N N N N N N N N N N N N N N	-	4 4 4 4 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	800 0000 11 0000 4444	0000 0000 0000 0000 000 0000 000 0000	0000 00000 41 0000 04444	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 00000 BEERE ESERE 4 100000 04004 100000		\rightarrow \bigcirc					· · · · · · · · · · · · · · · · · · ·						 १ वक्षक विवयंत्र विवयं		. 44444 44444 44444

MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.82

		! ! !	 		1	! !	 	BET				1 1	1	1	;	1	1
4 m 1		, v, i	0.7	C	6.0	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	1
5	•							0	ت			0			0		
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		C.				0	6	~	5	5,	*	ις,	5	N.	r.	5	
						Ġ	5	4	4	4	4	4	4	4	5	5	
	0	c	0	0	رn .	•	23.5	23.5	23.6	23.8	24.0	24.2	24.5	24.7	24.9	25.0	
		c.				c,	?	*	8	٠,	3	4	4	4	4	3	
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MAXIMUM FILLING COVER FACTORS (42) IN TERMS OF WARP COVER FACTOR AND BETA

YARN RILK DENSITY = 0.83

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.84

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3.8	16.1	17.5	18.6	19.6	20.4	21.1	-	22.3	22.8	23.2	23.6		24.5	24.5	24.8	•
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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.85

FIVE HARNESS WEAVE FABRICS

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.86

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.87

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.88

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.89

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.93

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.91

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.92

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MIXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.93

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.94



MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =0.95

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MAXIMUM FILLING COVER FACTORS 1K2! IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.96

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK BENSITY = 0.97

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.98

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.99

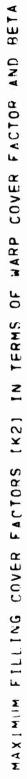
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	17.4	10.0		21.3	22.2	22.9	23.6	24.5	24.7	25.5	25.6	26.0	26.3	26.5	56.9	27.2	
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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =1.00

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J								1								
			•	1		25.3	25.3	25.5	8.52	26.1	26.4	56.6	56.9	27.1	27.4	27.6
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YARN BULK DENSITY = 1.36

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MAXIMUM FILLING COVER FACTOPS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =1.48

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	23.5	24.7	25.8	9.96	27.7	28.5	29.5	6.66	30.5	31.0	31.5	31.8	32.3	32.7	33.0	33.3	
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43	21.6	4.57	24.9	26.1	27.2	28.1	28.0	9.62	30.2	30.8	31.3	31,8	32.2	32.6	32.9	33.3	
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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

VARN BULK DENSITY =1.50

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 1.77

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	•				31.3	•	32.5	33.1	33.7	4	34.7	35.1	35.5	35.9	36.	36.5
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36	26.0	27.2			0	31.2	5	2	3.		4	4	50	5	•	ô
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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 2.00

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =2.36

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =2.50

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 2.75

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	о С	C	.	•	43.6	42.5	45.4	42.6	43.0	43.4	43.8	44.2	44.7	45.1	45.4	45.8
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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =2.95

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =3.25

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

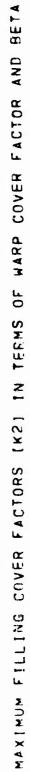
YARN BULK DENSITY =3.54

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =3.75

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YARN BULK DENSITY =4.00

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =4.13

FIVE-HARNESS WEAVE FABRICS

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =4.60

FIVE-HARNESS WEAVE FABRICS

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OXFORD

* 1977.7v

MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.54

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.56

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31	7.3	8.2	0.6	6.7	10.4	10.9	11.5	11.9	12.4	12.8	13.1	13.5	13.8	14.1	14.3	14.6
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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.58

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

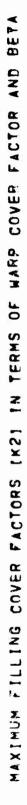
YARN BULK BENSITY = 0.65

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =0.65

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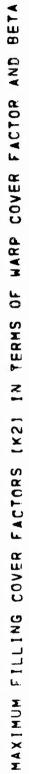
YARN BULK DENSITY = 0.67

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.68

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YARN BULK DENSITY #0.69

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY #0.70

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(K1)	0.5	9.0	0.7		6.0	4.0	1.1	1.2	1.3	4.4	4.5	1.6	1.7	1.8	6.	2.0
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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

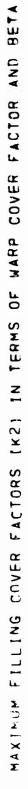
YARN BULK DENSITY #0.71

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK BENSITY = 0.72

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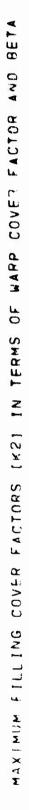
YARN BULK DENSITY = 0.73



MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.74

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YARN BULK DENSITY = 0.75

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.76

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.77

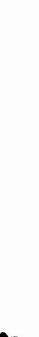
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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.78

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.79

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YARN BULK DENSITY = 0.80

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY *0.81

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YARN BULK DENSITY = 0.82

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

VARN BULK DENSITY = 0.83

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.84

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

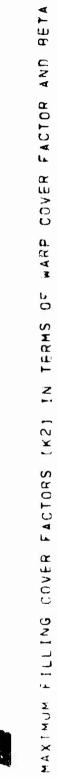
YARN BULK DENSITY =0.85

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.86

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YARN BULK DENSITY = 0.87.

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND RETA

YARN BULK DENSITY #0.88

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

OXTORD FABRICS

VARN BULK DENSITY = 0.89

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =0.90

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MAXIMUM FILLING COVER (ACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =0.91

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.92

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.93

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MANAMENT AND COURT BACK OF THE TO COURT IN TOTAL CONTRACT PART FACTOR AND DRIVE

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MAXIMUM FILLING COVER FACTORS (KZ) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.95

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YARN BULK DENSITY = 0.96

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN RULK DENSITY = 0.97

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MAXIMIM FILLING COVER FACTORS [KZ] IN TERMS OF WARP JOVER FACTOR AND BETA

YARN BULK DENSITY = 0.98

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MAZIMUM FILLING COVER FACTORS [KZ] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 0.99

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF JAMP COVER FACTOR AND BETA

YARN BULK DENSITY = 1,00

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARF COVER FACTOR AND BETA

YARN BULK DENSITY =1.36

MAXIMUM FILLING COVER FACTORS (KZ) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 1.48

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY = 1.50

OXFORD FABRICS

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =2.00

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YARN BULK DENSITY =2,36

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =2.95

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =3.25

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =3.75

MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARG COVER FACTOR AND BETA

YARN BULK DENS:TY =4.00

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MAXIMUM FILLING COVER FACTORS (K2) IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =4.13

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MAXIMUM FILLING COVER FACTORS [K2] IN TERMS OF WARP COVER FACTOR AND BETA

YARN BULK DENSITY =4.60

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This report contains in tabular form the solutions of the maximum weavability equations for the plain, exford, 3- and 4-harness twills, and 5-harness sateen in terms of warp and filling cover factors and yarn number ratio (Beta) for fabrics made from any fiber species and from blends. The tables are set up for yarn bulk densities ranging from 0.54 to 4.6; this includes fibers as light as polyethylene and as heavy as stainless steel. Supplementary tables are provided giving yarn bulk densities (assuming a standard packing coefficient of 0.59) for all of the commercial fibers and for blends of the most important commercial. Tibers in increments of 5% ranging from 5% to 95% blend composition.

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