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Maximum Sett of Woven Fabrics

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أقصى كثافة للخيوط في الأقمشة المنسوجة

ملخص :-

لا يمكن نسج القماش بأى كثافة للخيوط ، فهناك حد أقصى لكثافة الخيوط لا يمكن تجاوزه ، ويعتمد هذا الحد الأقصى على هندسة الخيوط وخواصها، وضبطات ونوع ماكينة النسيج. ويؤدى تجاوز هذا الحد إلى زيادة الإجهادات على أجزاء ماكينة النسيج وإلى التأثير على جودة القماش المنسوج. وقد إجتهد الباحثون لصياغة هذا الحد كدالة فى نوع الخيط ونمرته وكذلك التركيب النسجى، وجاءت نتائج إجتهاداتهم مختلفة وقام بعضهم بتحقيق هذه الصيغ عمليا فوجد أن بعض الصيغ تحتاج إلى تصحيح أو تعديل . ويهتم هذا البحث بإيجاد صيغ رياضية للتعبير عن الحد الأقصى لكثافة الخيوط فى القماش المنسوج كدالة فى التركيب النسجى وأقطار الخيوط بناء على نموذج هندسى للقماش المنسوج ، كما يهتم بإيجاد صيغ رياضية لبعض الكميات المعتمدة على كثافة الخيوط مثل زاوية النسيج ، والبعد بين كل خيطين متجاورين ، ونسبة تشريب الخيوط ، وقيمة النسيج ، ونسبة تغطية الخيوط والقماش ، ويقدم البحث شكلين بيانيين لإستخدامهما فى المصانع بقصد تحديد أقصى كثافة ممكنة للخيوط بتركيب نسجى ما ، ويعطى الشكل الأول أقصى كثافة للخيوط ذات النسيج السادة ١/١ أو النسيج المشيف ، بينما يعطى الشكل الثانى قيمة النسيج الممتد بدلالة نسبة أقطار الخيوط ومتوسط تشييف الخيوط ، ونحصل على أقصى كثافة للخيوط فى النسيج الممتد بضرب كثافة الخيوط فى النسيج السادة المناظر فى قيمة النسيج.

Abstract :

The woven fabric can not be produced with any yarn density as there is a maximum value of yarn sett which can not be exceeded This limit depends on yarn geometry, proprties, adjustments and type of weaving machine . Exceeding this limit causes incressing stresses on parts of the weaving machine and affects the quality of the woven fabric. Researchers tried to find out formulae to express this limit as a function of yarn type, yarn count and weave structure. They reached different formulae. Some researchers verified these formulae experimentally. They found that some formulae need correction . This paper aims to find mathematical formulae to express the maximum sett of yarns in the woven fabric as a function of weave structure and yarn diameters based on a geometrical model of the woven fabric . This paper presents also mathematical formulae of some quantities that depend on yarn sett such as weave angle , yarn spacing, yarn crimp ratio, weave value , yarn cover ratio, and fabric cover ratio. For practical application purposes two graphs are presented to determine maximum yarn density (e.g weft density) .The first graph gives the maximum sett of plain or floated woven fabrics. The second graph gives the weave value of extended weaves in terms of diameter ratio and average yarn float. To obtain the maximum sett in an extended weave, its weave value is multiplied by the maximum sett of the corresponding plain weave.

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I. Introduction :

The maximum number of ends and picks per unit length that can be woven with a given yarn and weave is an important issue for weave designers. Weave designer should be sufficiently familiar with construction limit to avoid difficult and unachievable constructions. With constructions above or near the upper weavability limit, parts of the weaving machine may be overstressd and damaged. For this reasons, the subject of weavability limit for regular - thickness yarns has attracted many researehers. Empirical and theoretical relationships relating maximum warp and filling cover factors for regular yarns have been derived. Theoretical relationships are provided in graphic forms for simple weaves [1].

Plate et el recommended using a full - width temple and early shed timing for weaving tight fabrics [2]. Seyam et al [3] studied the weavability limit of fabrics made from irregular thickness filling yarn. They eoneluded that yarn regularity inereases weavability limit. They [4] also concluded that weavability limit depends on warp and weft yarn counts, fibre packing in the yarn (spinning method), fibre type, weave design (warp and filling spacings), loom type and setting , and yarn uniformity. Snowden [5] states that limits of setts depend on loom construction and weaving conditions. These limits depend on loom type (light or heavy), dobby mechanism (negative or positive), let-off mechanism (negative or positive), and take-up mechanism (negative or positive). Weaving conditions that affect limits of setts are warp tension, shed change timing, and back rest position.

It's concluded from literature that there are so many relations, assumptions, and empirical formulae that determining weavability limit is still difficult. My opinion in this respect is that weavability limit of any fabric on any weaving machine is a value which we don't want to approach but we want to be safely below it. This is because of both difficulty of achieving and side problems arising with respect to machine and fabric. For this I don't want to assume that yarns loose their circular cross-section and become of either elliptical or race-track cross-section .

The object of this work is to deduce simple and safe formulae to determine the weavability limit as a function of weave design and yarn diameters, and to give an idea about the maximum crimp ratios of yarns and cover ratio of fabric. The lower value of weavability limit is more achievable than the higher value especially on modern and faster weaving machines rather than multi - phase weaving machines.

II. Maximum Construction Theories [4] :

1. Ashenhurst's "ends plus intersections" Theory :

This theory states that

$$t = \frac{e}{d(e+i)} \qquad (1),$$

t = max. ends or picks / inch

e = ends or picks / weave repeat

i = intersections / weave repeat

d = yarn diameter in inches

under the following assumptions :

- warp diameter = weft diameter.
- the spaces between threads are equal to their diameter.
- yarns are uniform cylinders.

2- Ashenhurst's General Theory :

This theory states that

$$t_1 = \frac{e_1}{e_1 d_1 + i_1 d_2} \quad (2)$$

and

$$t_2 = \frac{e_2}{e_2 d_2 + i_2 d_1} \quad (3),$$

t_1 = maximum ends / inch

t_2 = maximum picks / inch

e_1 = ends / weave repeat

e_2 = picks / weave repeat

i_1 = warp intersections / weave repeat

i_2 = weft intersections / weave repeat

d_1 = warp yarn diameter in inches

d_2 = weft yarn diameter in inches

3. Curvature Theory :

For square fabric, Ashenhurst corrected his "ends plus intersections" theory by the curvature theory. Accordingly

$$t = \frac{e}{d\ (e + 0.732\, i)} \quad (4)$$

4. Peirce's maximum weavability formula for plain weave cotton fabric [6] :

This formula is as follows :

$$\sqrt{1 - \left[\frac{28}{(1+\beta) k_1}\right]^2} + \sqrt{1 - \left[\frac{28\ \beta}{(1+\beta)\ k_2}\right]^2} = 1 \quad (5),$$

k_1 and k_2 are warp and filling cover factors respectively,

$$K_1 = \frac{28\ d_1}{P_1} \ldots\ldots (6), \quad K_2 = \frac{28\ d_2}{P_2} \ldots\ldots (7), \quad \beta = \frac{d_2}{d_1} \ldots\ldots (8),$$

P_1 and P_2 are warp and filling yarn spacings, respectively, and d_1 and d_2 are warp and filling yarn diameters, respectively.

5. Love completed after Peirce (3,4, and 5 harness) assuming race-track shape of threads under float.

6. Snowden's maximum sett formulae [4]:

- Plain weave sett (ends and picks / cm)

$$S = \frac{135}{\sqrt{T}} \ldots\ldots (9), \text{ T is tex count}$$

- Weave sett (ends and picks / cm for any weave)

$$= V. \text{ plain weave sett}$$

$$= V. \frac{135}{\sqrt{T}} \text{........} (10),$$

V is the weave value

For a 2/2 twill V = 1.31 and for a 3/3 mat weave V = 1.9

III. Maximum Construction Experiments [4] :

1. Experimental Verification of Askenhurst's Theories :

Law tested woven fabrics of maximum sett. His results agreed for short floated twill weaves but they were more for long floated twill weaves. He made corrections in Ashenhurst's theories for different weaves .

2. ***Brierley*** concluded from Ashenhurst's geometry that fabric thickness must be the same whatever its weave. His experiments showed that the float length or (weave) affects fabric thickness. His experimental results agreed with Law's additional allowances.

3. ***Based on experimental evidence, Armitage introduced his empirical formula of the maximum threads / inch as follows [4]:***

where :

$$t = S\,(yN)^{1/2} \quad (11),$$

t = maximum ends or picks / inch,

y = cloth setting constant that depends on yarn numbering system,

N = yarn count in the indirect system, and

S = setting ratio varying with weave.

He determined the cloth constant y for worsted, woolen, and cotton as 6 , 2.56, and 9.56, respectively. Table (1) shows Armitage's cloth setting (S) for different weaves .

Table (1) : Armitage's cloth setting (S) for different weaves :

Weave	Cloth Setting (S)
Regular twills	f + 4
Plain	4.75
2/2 Basket	6.2
3/3 Basket	7.5
4/4 Basket	8.5
4- Harness satin	6.2
5- Harness satin	7.5
6- Harness satin	7 75
8- Harness satin	9.00

4. Brierley derived the following equation for square worsted fabrics [4] :

where :

$$t = f^{m}\,(KN)^{1/2} \quad (12),$$

t = max. ends or picks / inch,

K is a constant depending on yarn type and numbering system,

N = yarn number in an indirect system,

m is weave constant

f = Average float

K = 134 for worsted yarns from 100% wool.

Table (2) shows empirical values of (m).

Table (2) : Empirical Values of m in Brierley's Equation :

Weave	m
Basket weaves	0.45
Twill weaves	0.39
Satin weaves	0.42

If warp and filling are different in count, then N is replaced by the average count.

Brierley worked on unbalanced fabric and derived the follwing empirical relationships :

(a) $P = CE^{-0.67}$ (warp count = filling count) (13)

(b) $P = CE^{-0.67A}$ (filling is thicker than warp) (14)

(c) $P = CE^{-2}$ (warp is thicker than filling) (15),

$A = \frac{N_2}{N_1}$, N_1 and N_2 are warp and filling yarn count in an indirect system, respectively.

P = picks/inch, E = ends/inch, C = cloth structure constant calculated from maximum square construction $t = f^m (KN)^{1/2}$ (16)

i.e. the value of m in the last expression.

5. *Peirce* [6] tested 85 fabrics to check his maximum weavability formula for plain weave cotton fabric. Only one fabric exceeded the limit.

IV. Weavability Limit of Plain Woven Fabric :

Fig. (1) shows geometry of jammed plain woven fabric. From this figure the following expressions could be derived (subscripts 1 and 2 are for warp and filling, respectively) :

(a) Weave angle (θ) :

$$\cos\theta_1 = \frac{d_1}{d_1 + d_2} \quad (17)$$

$$\cos\theta_2 = \frac{d_2}{d_1 + d_2} \quad (18)$$

$$\therefore \cos\theta_1 + \cos\theta_2 = 1 \quad (19),$$

d is yarn diameter.

(b) Yarn spacing (P)

$$P_1 = \sqrt{d_1^2 + 2d_1 d_2} \quad (20)$$

$$P_2 = \sqrt{d_2^2 + 2d_1 d_2} \quad (21)$$

(c) Yarn Crimp Ratio (C) :

$$C_1 = \frac{\pi (d_1 + d_2)}{180\sqrt{d_1^2 + 2d_1 d_2}} \cos^{-1}\frac{d_1}{d_1 + d_2} - 1 \quad (22)$$

$$C_2 = \frac{\pi (d_1 + d_2)}{180\sqrt{d_1^2 + 2d_1 d_2}} \cos^{-1}\frac{d_2}{d_1 + d_2} - 1 \quad (23)$$

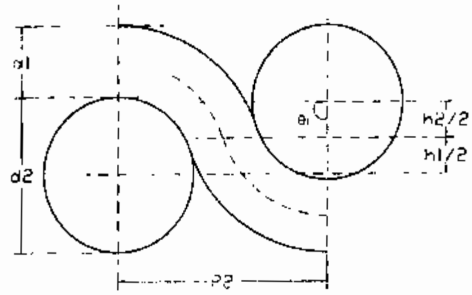

Fig (1) Geometrical Model of Plain Woven Fabric

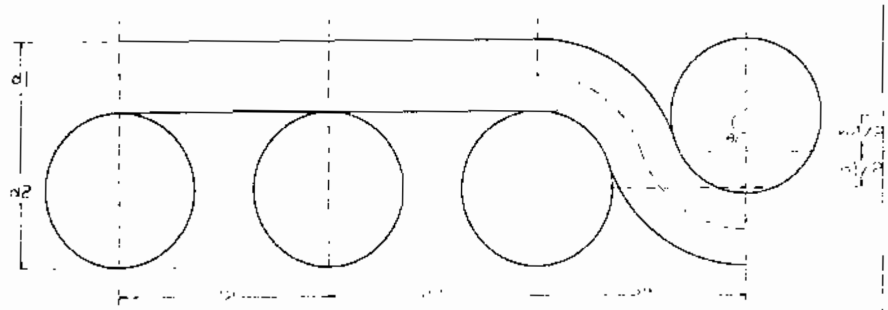

Fig (2) Geometrical Model of Floated Woven Fabric

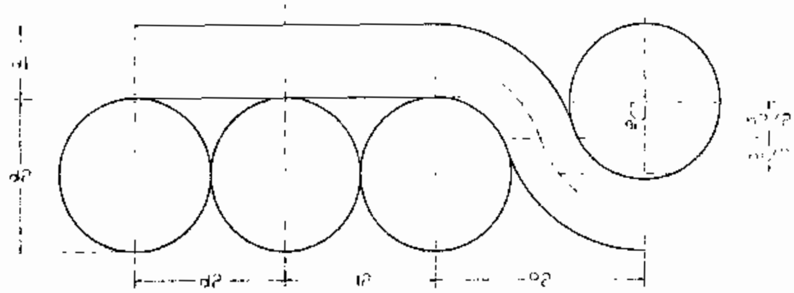

Fig (3) Geometrical Model of Extended Woven Fabric

(d) Yarn Cover Ratio (K) :

$$K_1 = \frac{d_1}{\sqrt{d_1^2 + 2d_1 d_2}} \tag{24}$$

$$K_2 = \frac{d_2}{\sqrt{d_2^2 + 2d_1 d_2}} \tag{25}$$

(e) Cloth Cover Ratio (Kc) :

$$Kc = \frac{d_1}{\sqrt{d_1^2 + 2d_1 d_2}} + \frac{d_2}{\sqrt{d_2^2 + 2d_1 d_2}} - \frac{d_1 d_2}{\sqrt{2d_1^3 d_2 + 5d_1^2 d_2^2 + 2d_1 d_2^3}} \tag{26}$$

(f) Maximum Sett (n) :

$$n_1 = \frac{1}{\sqrt{d_1^2 + 2d_1 d_2}} \tag{27}$$

$$n_2 = \frac{1}{\sqrt{d_2^2 + 2d_1 d_2}} \tag{28}$$

V. Weavability Limit of Floated Woven Fabric :

Fig (2) shows geometry of jammed floated woven fabric. From this geometry the following expressions could be derived (subscripts 1 and 2 are for warp and filling, respectively) .

(a) Weave angle, yarn spacing, yarn cover ratio, cloth cover ratio, and maximum sett have the same expressions as for plain woven fabric .

(b) Yarn Crimp Ratio (C) .

$$C_1 = \frac{1}{F_1}\left[\frac{\pi(d_1 + d_2)}{180\sqrt{d_2^2 + 2d_1 d_2}} \cos^{-1}\frac{d_1}{d_1 + d_2} - 1\right] \tag{29}$$

$$C_2 = \frac{1}{F_2}\left[\frac{\pi(d_1 + d_2)}{180\sqrt{d_1^2 + 2d_1 d_2}} \cos^{-1}\frac{d_2}{d_1 + d_2} - 1\right] \tag{30},$$

F is yarn average float .

It can be concluded that yarn crimp ratio in a floated woven fabric is equal to the value of yarn crimp ratio in the corresponding plain woven fabric divided by yarn average float in the floated fabric. In other words the plain woven fabric is a special case of floated woven fabrics as it has a yarn average float of 1. It can be expressed that the product of yarn average float and yarn crimp ratio is constant for floated fabrics made from warp and filling yarns of the same geometries .

VI. Weavability Limit of Extended Woven Fabrics :

Fig. (3) shows geometry of jammed extended woven fabric From this geometry the following expressions could be derived (subscripts 1 and 2 are for warp and filling, respectively) :

(a) Maximum Sett (n) :

In extended woven fabrics, yarn spacing is not uniform i.e :

- warp yarn spacing is either d_1 (warp ends in contact) or P_1 (warp ends separated by a filling yarn).

- weft yarn spacing is either d_2 (weft yarns in contact) or P_2 (weft yarns separated by a warp yarn).

P is as in plain woven fabric. Therefore yarn sett (n) is expressed as follows .

$$n_1 = \frac{F_2}{\sqrt{d_1^2 + 2d_1d_2} + (F_2 - 1)d_1} \tag{31}$$

$$n_2 = \frac{F_1}{\sqrt{d_2^2 + 2d_1d_2} + (F_1 - 1)d_2} \tag{32}$$

F is yarn average float and n is overall yarn sett

(b) Weave angle is as in plain woven fabric .

(c) Yarn Cover Ratio (K) :

$$K_1 = \frac{F_2 d_1}{\sqrt{d_1^2 + 2d_1d_2} + (F_2 - 1)d_1} \tag{33}$$

$$K_2 = \frac{F_1 d_2}{\sqrt{d_2^2 + 2d_1d_2} + (F_1 - 1)d_2} \tag{34}$$

(d) Cloth Cover Ratio (Ke) :

$$Kc = \frac{F_2 d_1\left[\sqrt{d_2^2 + 2d_1d_2} + (F_1 - 1)d_2\right] + F_1 d_2\left[\sqrt{d_1^2 + 2d_1d_2} + (F_2 - 1)d_1\right] - F_1F_2d_1d_2}{\sqrt{2d_1^3d_2 + 5d_1^2d_2^2 + 2d_1d_2^3} + (F_2 - 1)d_1\sqrt{d_2^2 + 2d_1d_2} + (F_1 - 1)d_2\sqrt{d_1^2 + 2d_1d_2} + (F_1 - 1)(F_2 - 1)d_1d_2} \tag{35}$$

(e) Yarn Crimp Ratio (C) :

$$C_1 = \frac{\frac{\pi}{180}(d_1 + d_2)\cos^{-1}\frac{d_1}{d_1 + d_2} + (F_1 - 1)d_2}{\sqrt{d_2^2 + 2d_1d_2} + (F_1 - 1)d_2} - 1 \tag{36}$$

$$C_2 = \frac{\frac{\pi}{180}(d_1 + d_2)\cos^{-1}\frac{d_2}{d_1 + d_2} + (F_2 - 1)d_1}{\sqrt{d_1^2 + 2d_1d_2} + (F_2 - 1)d_1} - 1 \tag{37}$$

VII. Dimensionless Relations :

Yarn crimp ratio, yarn cover ratio, cloth cover ratio, weave value, and ratio between weft sett and warp sett are dimensionless quantities. They can be expressed as functions of dimensionless quantities by introducing the dimensionless quantity $\beta = \frac{d_2}{d_1}$ Parameter β was termed by peirce [6] as the yarn balance. For convenience I will term $\beta_1 = \frac{d_1}{d_2}$ and $\beta_2 = \frac{d_2}{d_1}$. On this basis the following can be deduced :

(a) Yarn Crimp Ratio (C) :

- For jammed plain woven fabric :

$$C_1 = \frac{\pi(\beta_1 + 1)}{180\sqrt{1 + 2\beta_1}}\cos^{-1}\frac{\beta_1}{\beta_1 + 1} - 1 \tag{38}$$

$$C_2 = \frac{\pi(\beta_2 + 1)}{180\sqrt{1 + 2\beta_2}}\cos^{-1}\frac{\beta_2}{\beta_2 + 1} - 1 \tag{39}$$

- For jammed floated woven fabric :

$$C_1 = \frac{1}{F_1}\left[\frac{\pi(\beta_1 + 1)}{180\sqrt{1 + 2\beta_1}}\cos^{-1}\frac{\beta_1}{\beta_1 + 1} - 1\right] \tag{40}$$

$$C_2 = \frac{1}{F_2}\left[\frac{\pi(\beta_2+1)}{180\sqrt{1+2\beta_2}}\cos^{-1}\frac{\beta_2}{\beta_2+1} - 1\right] \quad (41)$$

- For jammed extended woven fabric .

$$C_1 = \frac{\frac{\pi}{180}(\beta_1+1)\cos^{-1}\frac{\beta_1}{\beta_1+1} + (F_1-1)}{\sqrt{1+2\beta_1} + (F_1-1)} - 1 \quad (42)$$

$$C_2 = \frac{\frac{\pi}{180}(\beta_2+1)\cos^{-1}\frac{\beta_2}{\beta_2+1} + (F_2-1)}{\sqrt{1+2\beta_2} + (F_2-1)} - 1 \quad (43)$$

(b) Yarn Cover Ratio (K) :

- For jammed plain woven fabric :

$$K_1 = \frac{\beta_1}{\sqrt{\beta_1^2 + 2\beta_1}} \quad (44)$$

$$K_2 = \frac{\beta_2}{\sqrt{\beta_2^2 + 2\beta_2}} \quad (45)$$

- For jammed floated woven fabric

The same as for jammed plain woven fabric .

- For jammed extended woven fabric .

$$K_1 = \frac{F_2\beta_1}{\sqrt{\beta_1^2 + 2\beta_1 + (F_2-1)\beta_1}} \quad (46)$$

$$K_2 = \frac{F_1\beta_2}{\sqrt{\beta_2^2 + 2\beta_2 + (F_1-1)\beta_2}} \quad (47)$$

(c) Cloth Cover Ratio (Kc)

- For jammed plain woven fabric

$$K_C = \frac{\sqrt{1+2\beta_1} + \sqrt{1+2\beta_2} - 1}{\sqrt{2\beta_1 + 5 + 2\beta_2}} \quad (48)$$

- For jammed floated woven fabric :

The same as for jammed plain woven fabric .

- For jammed extended woven fabric :

$$Kc2 = \frac{F_2\left[\sqrt{1+2\beta_1} + (F_1-1)\right] + F_1\left[\sqrt{1+2\beta_2} + (F_2-1)\right] - F_1F_2}{\sqrt{2\beta_1 + 5 + 2\beta_2 + (F_2-1)\sqrt{1+2\beta_1} + (F_1-1)\sqrt{1+2\beta_2} + (F_1-1)(F_2-1)}} \quad (49)$$

(d) Weave Value (V) :

It is the ratio of maximum sett in a fabric of a certain weave to maximum sett of the plain woven fabric made from idential yarns .

- For extended woven fabrics

$$V_1 = \frac{F_2\sqrt{1+2\beta_2}}{\sqrt{1+2\beta_2} + (F_2-1)} \quad (50)$$

$$V_2 = \frac{F_1\sqrt{1+2\beta_1}}{\sqrt{1+2\beta_1} + (F_1-1)} \quad (51)$$

- For floated woven fabrics :

$V_1 = 1$

$V_2 = 1$

but the weaving machine operates more efficiently.

(e) Relation between warp sett and weft sett :

- For jammed plain weave .

$$n_1 = \sqrt{\frac{1 + 2\beta_1}{\beta_1^2 + 2\beta_1}}\, n_2 \tag{52}$$

- For jammed floated weave :

as for jammed plain weave .

- For jammed extended weave :

$$n_1 = \frac{F_2 \left\{\sqrt{1 + 2\beta_1} + (F_1 - 1)\right\}}{F_1 \left\{\sqrt{\beta_1^2 + 2\beta_1} + (F_2 - 1)\beta_1\right\}}\, n_2 \tag{53}$$

VIII : Maximum Sett for Fabric Designers in Practice :

In the weaving shed the workers need to determine the maximum sett resulting from weaving certain yarns lest they should exceed it. Table (3) gives maximum sett of weft in terms of yarn diameters in plain or flooted woven fabrics based on equation (28). These results are presented graphically in Fig (4). Weave value of extended weaves is given in Table (4) in terms of yarn diameters ratio and yarn average float based on equation (51) . This is shown in Fig. (5).Maximum sett of extended weave is equal to its weave value multiplied by maximum sett of the corresponding plain or floated weave Maximum yarn density in extended weaves can be directly determined using equation (32). This is shown in Table (5) and Fig. (6).

Table (3) : Maximum Weft Density (yarns /cm) in Plain and Floated Weaves in Terms of Yarn Diameters Based on Equation (28) :

Weft	Warp Yarn Diameter (cm)					
Diameter (cm)	0.02	0.04	0.06	0.08	0.10	0.12
0.02	28.87	22.36	18.90	16.67	15.08	13.87
0.04	17.68	14.43	12.5	11.18	10.21	9.45
0.06	12.91	10.91	9.62	8.70	8.01	7.45
0.08	10.21	8.84	7.91	7.22	6.68	6.25
0.10	8.45	7.45	6.74	6.20	5.77	5.42
0.12	7.22	6.45	5.89	5.46	5.10	4.81
0.14	6.30	5.70	5.24	4.88	4.58	4.34
0.16	5.59	5.10	4.72	4.42	4.17	3.95
0.18	5.03	4.62	4.30	4.04	3.82	3.64
0.20	4.56	4.23	3.95	3.73	3.54	3.37

Table (4) : Weave Value of Weft in Extended Weaves in Terms of $\beta_1 = d_1/d_2$ and Warp Average Float F_1 :

d_1/d_2	Warp Average Float F1					
	1	2	3	4	5	6
0.2	1	1.084	1.115	1.131	1.141	1.148
0.4	1	1.146	1.204	1.236	1.256	1.269
0.6	1	1.195	1.277	1.323	1.353	1.373
0.8	1	1.234	1.339	1.398	1.436	1.463
1.0	1	1.268	1.392	1.464	1.511	1.544
1.2	1	1.297	1.439	1.523	1.578	1.617
1.4	1	1.322	1.481	1.575	1.638	1.683
1.6	1	1.344	1.518	1.623	1.694	1.744
1.8	1	1.364	1.552	1.668	1.745	1.801
2.0	1	1.382	1.584	1.708	1.793	1.854
2.2	1	1.398	1.612	1.746	1.837	1.904
2.4	1	1.413	1.639	1.781	1.879	1.950
2.6	1	1.427	1.664	1.814	1.918	1.995
2.8	1	1.440	1.687	1.845	1.955	2.036
3.0	1	1.451	1.708	1.875	1.991	2.076
3.2	1	1.462	1.729	1.902	2.024	2.114
3.4	1	1.473	1.748	1.928	2.056	2.150
3.6	1	1.482	1.766	1.953	2.086	2.185
3.8	1	1.491	1.784	1.977	2.115	2.218
4.0	1	1.500	1.800	2.000	2.143	2.250

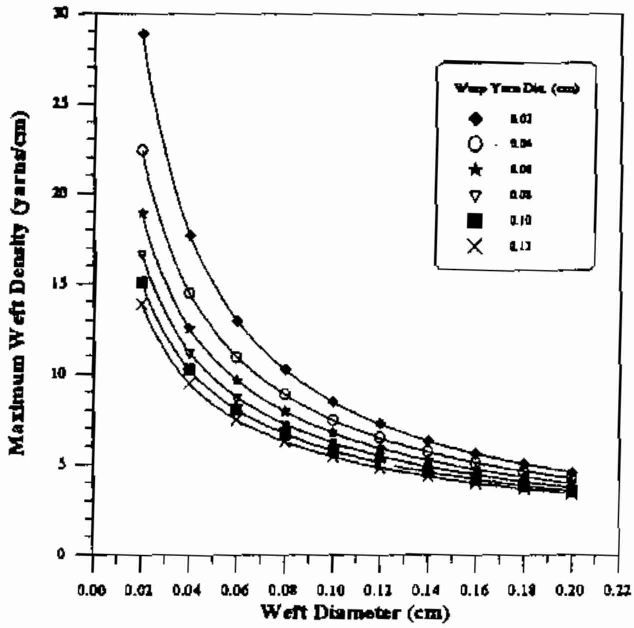

Fig. (4) : Maximum Weft Density (yarns/cm) in Plain and Floated Weaves in Terms of Yarn Diameter

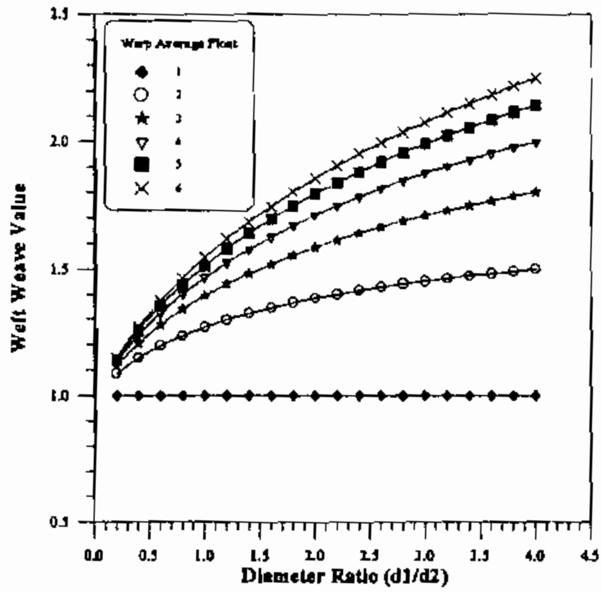

Fig. (5) : Weave Value of Weft in Extended Weaves in Terms of Diameter Ratio $\frac{d_1}{d_2}$ and Warp Average Float F_1

Table (5): Maximum Weft Density of Extended Woven Fabric (yarns/cm) in Terms of Ratio of Yarn Diameters (d1/d2) and Warp Average Float F_1 (Weft Diameter = 0.03cm)

Diameter Ratio	Warp Average Float					
d_1/d_2	1	2	3	4	5	6
0.2	28.17	30.54	31.41	31.87	32.16	32.35
0.4	24.85	28.47	29.93	30.71	31.20	31.54
0.6	22.47	26.85	28.71	29.74	30.40	30.85
0.8	20.67	25.52	27.68	28.91	29.70	30.25
1.0	19.25	24.40	26.79	28.18	29.08	29.71
1.2	18.08	23.44	26.02	27.53	28.52	29.22
1.4	17.10	22.60	25.32	26.94	28.01	28.78
1.6	16.27	21.86	24.70	26.41	27.55	28.37
1.8	15.54	21.20	24.13	25.92	27.12	27.99
2.0	14.91	20.60	23.61	25.46	26.73	27.64
2.2	14.34	20.06	23.13	25.04	26.36	27.31
2.4	13.84	19.56	22.68	24.65	26.01	27.00
2.6	13.39	19.10	22.27	24.29	25.68	26.70
2.8	12.97	18.68	21.89	23.94	25.37	26.42
3.0	12.60	18.29	21.53	23.62	25.08	26.16
3.2	12.25	17.92	21.19	23.31	24.80	25.91
3.4	11.94	17.58	20.86	23.02	24.54	25.66
3.6	11.64	17.26	20.56	22.74	24.28	25.43
3.8	11.37	16.95	20.27	22.47	24.04	25.21
4.0	11.11	16.67	20.00	22.22	23.81	25.00

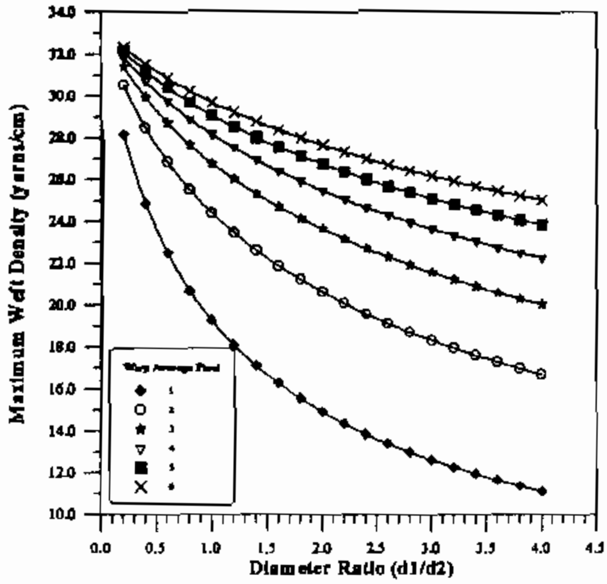

Fig. (6) : Maximum Weft Density (yarns/cm) in Extended Weave in Terms of Diameter Ratio $\frac{d_1}{d_2}$ and Warp Average Float F_1 (Weft Diameter = 0.03 cm)

IX. Conclusion :

Because of the importance of weavability limit many trials have been carried out. Some trials were theoretical and others were experimental. Many expressions were obtained but they were neither accurate nor general. The fabric designer in the weaving shed needs general and easy expressions to determine the maximum yarn density which can be achieved. Three models of weave structure are presented in this paper : plain weave, floated weave , and extended weave. Only yarn diameters are needed to determine maximum yarn density in either plain or flaoted woven fabric. For extended weaves, yarn average float is also needed . Warp maximum sett depends on weft average float, and weft maximum sett depends on warp average float. For extended weave there is a value called weave value. Weave value is the ratio between maximum sett of the extended woven fabric and the maximum sett of the corresponding plain or floated woven fabric. Weave value could be determined for some extended weaves but in this paper weave value can be determined for any extended weave. Many quantities depending on yarn maximum sett could be expressed in terms of yarn diameters and yarn average float

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