Effect of Weave on Thickness of Fabric for Belting Application

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Abstract— This paper investigates the relation between weave and thickness of the Belting Woven Fabric, which are mainly used for the Industrial purpose. For the evaluation four different weave structures, that is, 1/1 plain, 2/1 (LHT) twill, 4/1 satin weave and Dobby weave as per design were taken as input variables to get the equation for thickness value for any kind of weaves. The study was conducted on Thickness Tester based on ASTM D1777 Standard test Methods. Findings of the study may be helpful in determining appropriate manufacturing specification of woven fabrics to attain nearest actual thickness value that can be given the approximate thickness value for Woven Belting fabric.
Key words: Non-plain woven fabric, Thickness, Weave

I. INTRODUCTION

A Belt consists of one or more layer or material most commonly used are Cotton, Polyester, and Nylon. Generally belting fabric is composed of three main components. Carcass, Skims, Covers. Carcass is woven fabric that is the base of the Conveyor belt. It is conventionally utilized for reinforcement, which found inside of conveyor belt. Profoundly low stretch characteristics of fabric and good trough ability. The importance of this study is mainly for industrial purpose. In industrial application, belting fabric is utilized in which thickness of the belt is paramount parameter for constructing the fabric.

Thickness of fabric were varied by changing the ratio of diameter to spacing (d/p) of yarns [1].Thickness of the fabric is consequential for belting application because of Tensile strength, Absorb impact, Provide bulk and lateral stiffness and provide adequate strength. For industrial purpose, it is intended to study the relation between weaves and thickness of the fabric i.e. How the different weaves affect the thickness of the belting Fabric. Study can avail out to the customers, which requires concrete criterion for the thickness value depends on that end-used requirement.

According to ISO 5084, Thickness is defined as vertical distance between two defined surfaces of the fabric [2].This thickness is totally depending upon fabric weave as well as thread position in the binding repeat and yarn with identical parameters like yarn count and yarn under fill. Fabric thickness is also depending upon yarn diameter, compression in interlacement between the threads and Number of floats in the weave repeat [2].Thickness value is defined by Fabric structure. As the interlacement in the weave repeat are higher, the float decreases gradually.e.g.1 X 1[3]. For Non-plain woven fabric, it is always to be considered weave repeat as whole because of interlacing pattern of individual warp and weft threads to vary within the repeat [4]. For such fabric cover and crimp values also taken as whole or considered to be average values for warp as well as weft sheets based on all threads in repeat [4]. The geometry of the fabric cannot be described by a simple Mathematical forms which is based on basic geometry, but many efforts are needed to idealize geometry of fabric and to represent the configuration of yarn in woven structure. These studies were often based on the assumption of arbitrary geometrical models for the crimp wave and yarn cross-sectional shape [5].So New model have been developed for the non-plain woven fabric for this geometrical model It is needed to manufacture woven fabrics with different thickness by manipulating the yarn count and yarn spacing. The property of Woven fabric has vital effects on the fabrics of mechanical and physical behavior. The study of plain-woven fabric geometry started with pierce who assumed yarns as flexible circular cylinders interwoven in a very often-continual pattern to make fabric. Pierce developed a geometrical model to see numerous fabric parameters [6].

Majority of the studies reported in the literature review has focused on the plain-woven geometry and fabric Structural parameters. However, Studies based on relationship between thickness and weave structure for non-plain weave structure are still rare as there is scarcity of literature on this relationship. The present study was there for taken to investigate the relation between thicknesses and weave for all type of weaves.

II. EXPERIMENTAL SET-UP

A. Sampling

Sampling is done on Dornier Rapier loom with or without Top beam facility shown in "Fig. 2," For Plain, Twill and Satin weave, sampling is done on loom without Top beam and for Dobby weave sampling is done on loom with Top beam Facility. For sampling 100% Cotton and 100% Polyester material for warp as well as for weft were used. Thickness values were changed by changing the weaves of the fabric. The different weaves like Plain, Twill, satin, Dobby weave.
For accurate results 10-Face side & 10-back side Thickness values (t) were taken for each samples. Thickness values (t) of the fabric were tested by Thickness Tester by using ASTM D 1777 Standard test methods which is shown in "Fig. 1,"

Fig. 1: Thickness Tester

Fig. 2: Rapier loom with Top-beam

III. RESULTS AND DISCUSSION

This study focuses to evaluate thickness value for any kind of weaves. For this study, Yarn cross-section shape was considered as circular. Generally, Thickness value is defined for Plain Woven fabric from geometrical model of plain-woven fabric. i.e. t = h + d. For Non-plain Woven fabric, it is considered as Number of interlacement and floats of individual warp and weft taken as average crimp values also taken as average for the weave repeat to define the thickness(t) value of the fabric. The Constructional details of woven fabrics shown in Table 1. The results obtained by these method are shown in Table 2.

Sample No.	Sample Code	Type of Weave	Warp Count (Ne1)	Weft Count (Ne2)	Warp Crimp (C1 %)	Weft Crimp (C2 %)
1	A 1	Plain Weave (1/1)	6/7's OE	6/7's OE	22.5	3.5
2	A 2	Twill Weave (2/1 LHT)	2/24's S Carded	10's OE	13.5	3
3	A 3	Satin Weave (4/1)	10's Carded	10's Carded	10.7	3
4	A 4	Dobby Weave (As per Design)	1000 D = (5.3's)	4/1000D= (1.32's)	8	1

Table 1: Constructional Details of Woven Samples

Table II shows Experimented Thickness values (t) of the fabric for different types of weaves like (1/1) Plain weave, (2/1) Twill weave, (4/1) Satin weave, and Dobby weave-As per design which were taken 10-Face & 10-Back side readings for each samples then Final value taken as average of that values.

NO.OF TEST	THICKNESS (mm)			
	PLAIN WEAVE - A 1		TWILL WEAVE - A 2	
	FACE SIDE	BACK SIDE	FACE SIDE	BACK SIDE
1	1.85	1.92	0.61	0.61
2	1.88	1.89	0.6	0.64
3	1.89	1.84	0.61	0.64
4	1.92	1.85	0.62	0.62
5	1.84	1.88	0.65	0.61
6	1.85	1.89	0.61	0.61
7	1.89	1.9	0.62	0.6
8	1.92	1.87	0.62	0.61
9	1.91	1.87	0.61	0.62
10	1.9	1.86	0.6	0.61
AVERAGE	1.88	1.87	0.62	0.62

NO.OF TEST	THICKNESS (mm)			
	SATIN WEAVE - A 3		DOBBY WEAVE - A 4	
	FACE SIDE	BACK SIDE	FACE SIDE	BACK SIDE
1	1.85	1.92	0.61	0.61
2	1.88	1.89	0.6	0.64
3	1.89	1.84	0.61	0.64
4	1.92	1.85	0.62	0.62
5	1.84	1.88	0.65	0.61
6	1.85	1.89	0.61	0.61
7	1.89	1.9	0.62	0.6
8	1.92	1.87	0.62	0.61
9	1.91	1.87	0.61	0.62
10	1.9	1.86	0.6	0.61
AVERAGE	1.88	1.87	0.62	0.62

Table 2: Thickness Values for the Different Samples

For Non-Plain, woven fabric Thickness value (t) is calculated by following Formula:

$$T\ (mm) = D\ (Avg.)\ [\ 1 + 1.33\ \{\ \sum (\text{Number of floats} + \text{Number of intersection} \times 1.732)\} / (\text{Total Number of Threads} / \text{Repeat})] \times \sqrt{C\ (Avg.)}$$

T = Thickness of Fabric in (mm)
D = Average diameter of Yarn-Warp & Weft (mm)
C = Average Crimp of Yarn-Warp & Weft (%)

This formula represents relationship between Thickness and Weaves of the fabric in the repeat. The formula has Correlation with the formula which is defined for plain-woven fabric but Average value is considered for Non-plain Woven fabric to get the thickness values (t) close nearer to the actual experimented values. One of the sample is taken for the evaluation.

Sample Code A 4:

Dobby Weave A4 as per design shown in "Fig. 3,"

No. of threads/Repeat (R) = 12 x 16, Total No. of Floats (E) = 124, Total No. of Intersection (I) =52

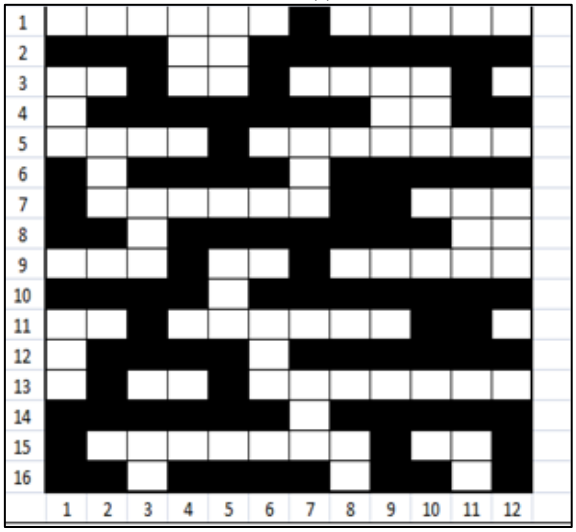

Fig. 3:

As per Formula:
Thickness value (Actual) = 1.65 mm; Thickness value (Theoretical) = 1.90 mm

According to this Testing Method and experimental set- up, study found the relationship between weave (Interlacement of threads) and Thickness of the fabric that is applicable for all Types of weaves (Non-plain Woven fabric) which has been already defined. Fabric thickness values was measured with ASTM standard and compared with the calculated values according to the given equation. It can be observed that after theoretical calculation, Thickness values for Twill and Satin Weaves came nearer to actual experimental values. i.e. +/- 0.05 mm to 0.10mm variation and for Dobby weave, it goes to little higher. i.e. +/- 0.20 mm to 0.25 mm which is acceptable depending upon the criterion as per customer requirement.

IV. CONCLUSION

In the study, Thickness values of the fabrics for different weave structures were measured by theoretical and compared it with by experimental values. It can be observed that the differences in Experimental values and calculated values are in acceptable limit. It is concluded that the thickness Values (t) in mm can be found for all kinds of Weaves (Non-Plain Woven Fabric).An attempt has been made to make the most effective technique for engineering attributes of plain and non-plain weave fabrics as per customers demand. Soft computing technique is employed to solve the geometrical model equation and relationship between thickness (t) in mm and useful fabric parameters like crimp, thread spacing and Number of floats within the weave repeat. The strong potential of pierce geometrical model for plain weave construction already has been exploited by soft computing techniques and so from this successful technique further the constant study is evaluated for the non-plain woven construction. Thus, the study can be given the total idea about the Thickness values (t) for higher derived weaves, which can be accepted as approximation value while constructing the fabric. The findings of the study may be helpful for the industries in deciding appropriate specification for manufacturing of the woven fabrics to attain the Actual Thickness value.

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