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[Akter * *et al.*, 7(3): March, 2018]
IC™ Value: 3.00

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

IJESRT
INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

CORRELATION BETWEEN TOTAL FRACTIONAL COVER AND WARP BREAKAGE

Shilpi Akter*[1], IsratSharminMerin[2], Md. RakibulIslam[3], Taskin Rahman[4] & Dewan Murshed Ahmed[5]

[1, 5] Assistant Professor, Department of Fabric Engineering, Bangladesh University of Textiles,
[2, 3&4]B.Sc. in Textile Engineering, Department of Fabric Engineering, Bangladesh University of Textiles

DOI: 10.5281/zenodo.1207016

ABSTRACT

In this study, the influence of total fractional cover on warp breakage during weaving is investigated by weaving plain and $\frac{1}{3}$twill structure with finer cotton yarns. For this purpose, we have taken cotton yarns of three different count and determined the total fractional cover for the constant value of EPI and varying the PPI for the same count of warp and weft yarn. The PPI is increased for the same EPI until frequent warp breakage occurred during weaving. While the value of total fractional cover increased by the value of PPI, the warp breakage increased with higher total fractional cover value. It was also found that higher fractional cover was attained with $\frac{1}{3}$twill structure without frequent warp breakage compared to the plain structure. This study shows too high total fractional cover disrupts weaving performance with frequent warp breakage.

Keywords: Total fractional cover, Warp breakage, Weaving performance, Fabric Structure.

I. INTRODUCTION

The fractional cloth cover is the numerical value indicating the fraction of the total fabric area covered by the component yarns (Peirce, Frederick Thomas, 1937). The parameters required to calculate the total fractional cover are warp yarn diameter, weft yarn diameter, EPI and PPI (Booth, John E., 1968). In this study, we have woven three different fabrics with the same count of weft and warp yarn. Fractional cover was measured by multiplying the no of threads in unit length with yarn diameter. Previous studies showed that weaving performance was affected by a too high cover factor(Haque Md. Mahbubul, 2009). But in this study, we have shown a correlation between the total fractional cover and warp breakage. Although we couldn't ascertain the result for varying value of EPI, which is a limitation of this study. Our aim of the study is to observe the influence of total fractional cover on warp breakage. Moreover, this study also showed the influence of yarn count and fabric structure on the total fractional cover and warp breakage.

Total fractional cover is a significant parameter in woven fabric properties. This study shows that higher value of total fractional coverwithout frequent warp breakage was achieved with finer yarn rather than the coarser yarns. However, the fabric structure exhibits a prime role in this regard.Higher fractional cover can be achieved for twill structure than plain structure before frequent warp breakage which conforms well to previous study regarding weavability(Akter, Murshed, Sharmin, Islam, & Rahman, 2018). The reasons behind this phenomena is discussed in the paper. We believe this study will be helpful in generating a better understanding of the weaving process from both theoretical and practical point of view.

II. MATERIALS AND METHODOLOGY

We have taken 100% cotton yarns of three different count – 60 Ne, 72 Ne, 80 Ne.

For sizing one shot ready-mix sizing chemical was used with heavy sizing (40% sizing chemical).As part of the preparatory process of weaving, CCI TECH INC Sizing and Warping Unit were used.

We conducted the experiment on CCI Sample loom.
Loom specification – CCI Tech Inc, Model – Evergreen 500, Origin – Taiwan

Here, the shedding and beat-up mechanism is done by pneumatic pressure and picking is done by a single rigid rapier system. The required pneumatic Pressure for this loom was 6KPa (kg/cm^2). The loom speed was 60 ppm, which is the highest for this particular loom and was kept constant for this experiment. As we conducted the experiment with lower loom speed, the results may vary with higher loom speed.

Ends per inch: 100
Total number of warp ends: 2000
Reed Count: 100
Fabric Width: 20 inch

To observe the warp breakage in both compact and relatively loose structure, plain and $\frac{1}{3}$twillwere used.

III. RESULT AND DISCUSSION

In this study EPI was kept constant at 100 for each fabric construction. (Peirce, Frederick Thomas, 1937) & (Booth, John E., 1968) determined the total fractional cover by the following equation,

Total Fractional Cover = $C_1 + C_2 - C_1 \times C_2$
Where, C_1 = Warp fractional cover = $d_1 \times n_1$
C_2 = Weft fractional cover = $d_2 \times n_2$
d= diameter, n = threads / unit length
$d = \frac{1}{28 \times \sqrt{Ne}}$ inch

Table 1: Total Fractional Cover at different PPI for plain structure

60 Ne			72 Ne			80 Ne		
PPI	Total Fractional Cover	Warp Breakage	PPI	Total Fractional Cover	Warp Breakage	PPI	Total Fractional Cover	Warp Breakage
40	0.56	0	40	0.52	0	40	0.49	0
45	0.57	1	50	0.54	0	50	0.51	0
50	0.58	1	60	0.57	0	60	0.53	0
55	0.59	5	70	0.59	0	70	0.55	0
			80	0.61	0	80	0.58	0
			85	0.63	0	90	0.60	0
			90	0.64	1	100	0.63	1
			95	0.65	6	105	0.64	4

The result clearly indicates that with the increase in PPI the total fractional cover value also increases. Up to a certain value no warp breakage occurs. But with too high total fractional cover value frequent warp breakage is observed. The frequency of warp breakage increased with higher total fractional cover value. It was also observed that warp breakage occurred at higher total fractional cover value with finer yarn compared to coarser yarn. For example, frequent warp breakage occurs at 0.59 total fractional cover value with 60 Ne yarn, whereas, for 80 Ne, the value is 0.64. From the above equation of Pierce formula, it is clear that the finer the count, the lower the diameter of the yarn cross-section. As the EPI was kept at 100 for each yarn count& coarser yarns have a higher yarn diameter, it exhibits more friction between the warp yarns compared to finer yarns with less yarn diameter

Table 2: Total Fractional Cover at different PPI for 1/(3)twill structure

60 Ne			72 Ne			80 Ne		
PPI	Total Fractional Cover	Warp Breakage	PPI	Total Fractional Cover	Warp Breakage	PPI	Total Fractional Cover	Warp Breakage
40	0.56	0	40	0.52	0	40	0.49	0
50	0.58	0	50	0.54	0	50	0.51	0
60	0.61	0	60	0.57	0	60	0.53	0
70	0.63	0	70	0.59	0	70	0.55	0
80	0.66	0	80	0.62	0	80	0.58	0

ISSN: 2277-9655
Impact Factor: 5.164
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85	0.67	1	90	0.64	0	90	0.60	0
90	0.68	2	100	0.66	0	100	0.63	0
95	0.70	7	110	0.69	0	105	0.64	0
			130	0.74	0	110	0.65	0
			140	0.76	0	120	0.68	0
			145	0.77	1	130	0.70	0
			150	0.79	7	140	0.72	0
						145	0.74	0
						150	0.75	1
						155	0.76	2
						160	0.77	9

When we conducted the experiment with twill structure, significant deviations is noticed. The value of total fractional cover remains same in case of both plain and twill structure. However, higher total fractional cover value is achieved with twill structure withoutany frequent warp breakage. This phenomenon is observed for each count of yarns, although the correlation of total fractional cover with warp breakage remained similar. It is also observed that warp breakage occurs at higher total fractional cover value with finer yarn compared to the coarser yarn. For example, frequent warp breakage occurs at 0.70 total fractional cover for 60 Ne yarn, while for 80 Ne yarn, frequent warp breakage occurs at 0.77 total fractional cover value. The reason is already explained in the previous paragraph

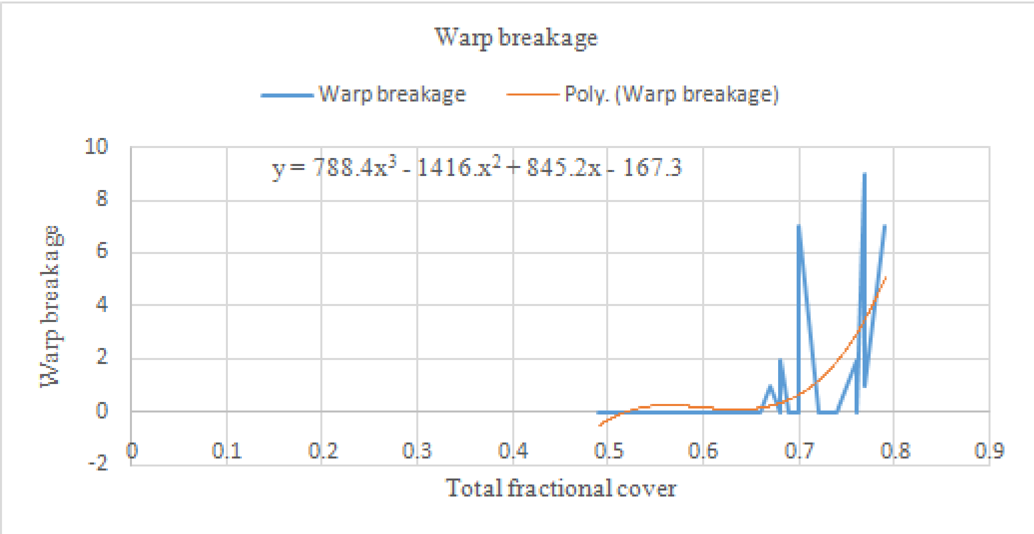

Figure 1: Correlation of total fractional cover with warp breakage in case of plain structure

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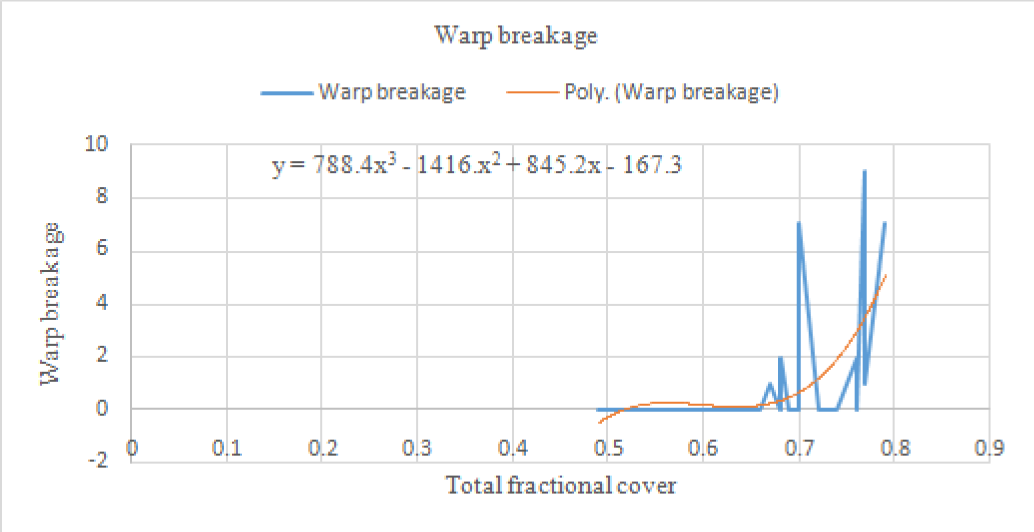

Figure 2: Correlation of total fractional cover with warp breakage in case of twill structure

The correlation of total fractional cover with warp breakage can be expressed with this graph. Here both the graph for both plain and twill structure shows similarity. With the increase of the value of total fractional cover, the warp breakage increases.

But in case of plain structure warp breakage rate differs rapidly from twill structure. The reason is the interlacement point between warp and weft yarns. In plain structure, there are two interlacement points with 2×2 repeat number, and in twill structure, there are two interlacement points with 4×4 repeat number. A geometrical analysis is given to explain why more PPI can be obtained with twill structure.

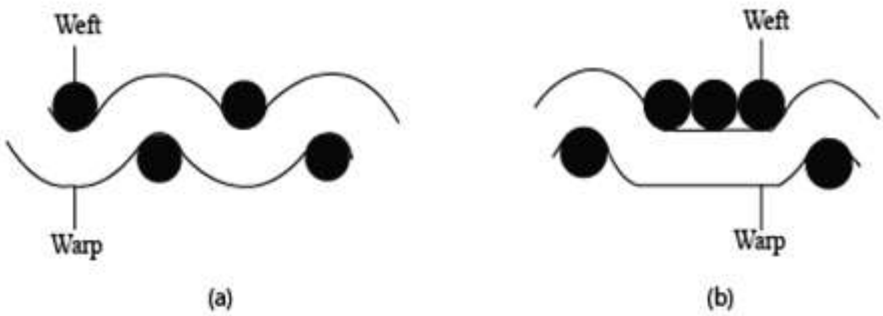

Figure 3: Diagram of weave structure: (a) Plain weave, (b) Twill ($\frac{1}{3}$) weave

It can be clearly understood that the interlacing points of plain are much more than $\frac{1}{3}$twill structure. In plain weave, there are two interlacement points between two consecutive yarns whereas in case of twill weave, there are two interlacement points in between four yarns. Here, three weft yarns lie together side by side without interlacement. As a result, the average space between two consecutive weft yarns is more in plain compared to twill weave. In other words, the less space consumed by the weft yarns in twill weave leads to more weft density that can be imparted in case of twill weave.

IV. CONCLUSION

The total fractional cover is a significant parameter for weaving performance. It can be concluded that with the higher value of total fractional cover, higher warp breakages occur. However, with finer yarns, higher value of total fractional cover can be achieved before frequent breakage which means higher thread density can be obtained with finer yarn compared to coarser yarns before frequent breakage occurs on the loom. We can also achieve higher total fractional cover value with twill structure in comparison with the plain structure.

ISSN: 2277-9655
Impact Factor: 5.164
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Furthermore, too high value of total fractional cover disrupts weaving performance. With a given fabric construction the difficulties in weaving could be evaluated with the data presented in the paper.

In future studies, experiments can be conducted by varying the EPI and with higher loom speed, which is not done in this study. Different fabric structures and count variations can be analyzed in near future. However, we would be able to draw a more precise conclusionif different materials with varying sizing conditions were used. These factors should be included in later studies

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Akter, S., Merin, I. S., R., Md, Taskin, T., & Ahmed, D. M. (n.d.). CORRELATION BETWEEN TOTAL FRACTIONAL COVER AND WARP BREAKAGE. *INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY*, *7*(3), 648-652.