Study on Generation of Knotting Waste in Weaving Cotton Fabric and its Remedial Measures

Dr. S. K. Ghosh[1], Mr. K. R. Gupta [2], Mr. C. Dey [3]
1 Associate Professor, Department of Jute and Fibre Technology, University of Calcutta, 35, Ballygunge Circular Road, Kolkata – 700019, India
2 Assistant Professor, Department of Jute and Fibre Technology, University of Calcutta, 35, Ballygunge Circular Road, Kolkata – 700019, India
3 Junior Research Fellow, Department of Jute and Fibre Technology, University of Calcutta, 35, Ballygunge Circular Road, Kolkata – 700019, India

***Abstract* - Waste control during knotting of warp yarns plays a considerable role in increasing the rate of production of fabric and to maintain its quality criterion. During knotting, a notable length of the warp yarns in the sized beam gets wasted as the quality of those ends get damaged during the previous process. In this study, ways to reduce the knotting waste of the sized beam warp yarns have been examined using cotton yarns of carded and open-end qualities. A small modification of the accessories of the yarn sizing machine along with adoption of some new practices different from the common practices applied for manufacturing of the fabric, have been proposed. This will not only help to reduce the knotting waste of the warp yarns, it is also a time saving process, which will eventually lead to increase in production rate.**

1. INTRODUCTION

The textile industry suffers a great deal of material waste which is inevitable due to the variable natures of fibres, fibre machine interaction and the lack of purity of the raw material. But in some cases the materials get wasted due to deficiency of precision of the common practices which have to be improved in order to get the desired quality and higher rate of production of the finished product [1]. Therefore, the aim of the present researchers is to improve the standard of common practices which are followed in manufacturing the fabric. One of the common causes of generation of waste in the textile industry occurs during the knotting of the warp yarns in the loom shed of weaving section [2]. Knotting is the technique in which new warp ends are tied with the preceding warp ends running across the width of the loom, keeping the parameters of the fabric constant as that of the previously woven fabric. Thread density, total numbers of ends, weave, reed count, reed space, resultant count and drawing pattern are kept constant. A comprehensive practical study has been accomplished to find out the probable causes of the knotting waste [3]. Cotton yarns of carded and open-end qualities have been used in this work to make a comparative analysis of respective waste generations.

2. MATERIAL AND METHODS

In this study, cotton yarns of carded and open-end qualities having 16s, 20s, 30s and 32s count been used.

2.1. Machine and accessories used for knotting process

The machine accessories that have been attached in the loom and employed for the entire knotting process are knotting machine, suitable needles for specific counts of yarn, knotting frame, comb, brush and lease rod (where ever necessary) as shown in the Figs 1, 2, 3, 4 and 5 respectively [4].

Figure 1. Knotting machine

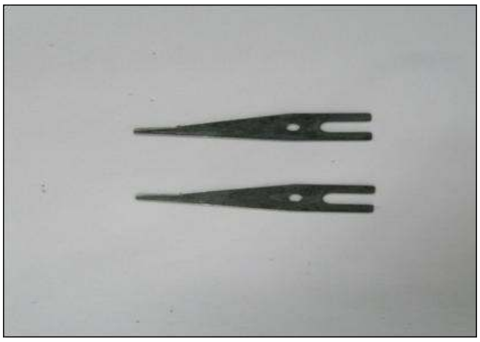


Figure 2. Suitable needle for specific count

Figure 3. Knotting frame

Figure 4. Comb

Figure 5. Brush

2.2. Needle used for knotting of warp yarns

Different types of needles [5, 6, 7] is used according to the count of the warp yarns, which are to be knotted for weaver's knot. Separate needles for coarser and finer yarns have been employed and shown in Table 1 [8].

Table 1. Suitable needle for specific warp count for knotting

SL. No.	Warp count	Needle no.
1	10^{s}	25
2	12^{s}	25
3	14^{s}	20
4	16^{s}	20
5	20^{s}	18
6	30^{s}	16
7	40^{s}	12
8	45^{s}	10
9	50^{s}	10
10	60^{s}	10
11	70^{s}	8

2.3 Method

The experimental work had been started off with cleaning of fluffs from heald frames, reed, drop pins, shedding lever, picking parts of machine and cutter and the former has been collected and removed by a suction trolley(as shown in Figs. 6 and 7 respectively).

Figure 6. Cleaning process

Figure 7. Ground cleaning

This is followed by greasing of weaver beam adapted gear, metal bracket etc. Oiling of heald frame side support is also carried out. The subsequent process is beam fall which is accomplished into two steps. At first, the warp sheet of the beam which needs to be unloaded is cut maintaining a distance of 105-110 cm from the back rest of the loom as shown in Figs. 8 and 9 respectively.

Figure 8. Cutting of warp sheet

Figure 9. Unloading of empty beam

The dressing of the warps, which will be tied with the new beam warps is done manually by frequent brushing in small groups to prevent any crossing of the warp ends (shown in Fig. 10).

Figure 10. Dressing of warp yarns

The new weaver beam is put into the beam adapter (shown in Fig.11).

Figure 11. Loading of the new sized beam

The knotting stand has been attached at the rear side of the weaver beam and the height is adjusted according to the height of the back rest roller as shown in Fig. 12.

Figure 12. Knotting stand is attached with the loom

The new warp yarn sheet is taken out from the full beam and mounted on the knotting stand. The upper most layer of the warp yarns wrapped in the beam has been dragged out as those are damaged as shown in Figs. 13 and 14 respectively.

Figure 13. Warp sheet is pulled out from new beam

Figure 14. Damaged warp yarns is dragged out

This is followed by dressing of the warps of new beam with iron comb having 56 count as shown in Fig. 15. This has been done to avoid the crossing of the yarns and to make them parallel to each other in order to knot all the new warp yarns with the existing warp yarns in the loom successfully.

Figure 15. Dressing of new warp yarns

The warp sheet is then clamped in both sides by clamping bars maintaining a distance of 33 cm between the bars as shown in Fig. 16.

Figure 16. Warp sheet is clamped

The existing warp sheet on the loom is placed above the new warp sheet and dressed with metal brush for about 10 to 20 minutes as shown in Figs. 17 and 18 respectively.

Figure 17. Dressing of loom warp sheet

Figure 18. Clamping of loom warp sheet

Knotting machine has been placed on the knotting machine track for carrying out knotting of warp yarns [10] as shown in Figs.19 and 20 respectively.

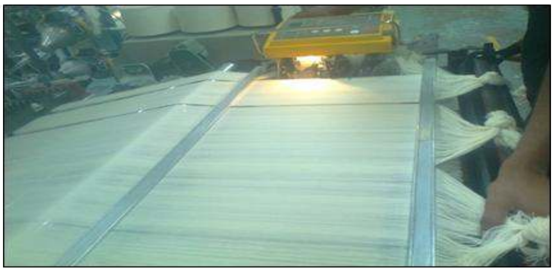


Figure 19. Knotting m/c is fitted on knotting frame

Figure 20. Knotting of warps yarns

Knotted warp yarns are then passed through the drop pins, heald eyes and reed dents as shown in Fig. 21.

Figure 21. Passing of warp threads through warp path

3. RESULTS AND DISCUSSION

In this present study, the knotting waste percentage has been studied on two different counts of carded quality namely 30s and 32s and two different counts of open-end quality namely 16s and 20s of cotton yarns. The results are shown in the Tables 2, 3, 4 and 5 respectively.

Table 2. Knotting waste percentage for cotton yarns of carded quality of 32^s count

Beam No.	No. of ends	Length of warp (m)	Waste (kg)	Total wt. of warp (kg)	Waste %
1	7488	2600	1.5	574.90	0.26%
2		2800	2	619.14	0.32%
3		2560	1.5	566.06	0.26%
4		2800	2	619.14	0.32%
5		2490	2.5	550.60	0.45%
6		2500	1.5	552.80	0.27%
7		2490	2	550.60	0.36%
8		1490	3	329.46	0.91%
9		2500	3	552.80	0.54%
10		1095	2	242.13	0.82%

Average knotting waste percentage of the 32^s carded quality (sort no. -13257/K) = 0.48 %.

Average knotting waste in kg = 2.65 kg.

Table 3. Knotting waste percentage for cotton yarns of carded quality of 30^s count

Beam No.	No. of ends	Length of warp (m)	Waste (kg)	Total wt. of warp (kg)	Waste %
1	8122	2635	2	421.40	0.47%
2		3000	1.5	479.77	0.31%
3		2840	2.5	454.18	0.55%
4		2815	2	450.18	0.44%
5		1200	2.5	490.52	0.50%
6		3000	3	479.77	0.62%
7		3448	2.5	551.41	0.45%
8		2840	2	454.18	0.44%
9		3000	1.5	479.77	0.31%
10		2635	2	421.40	0.47%

Average knotting waste percentage of the 30^s carded quality (sort no. -130N55/K) = 0.46 %.

Average knotting waste in kg = 2.15 kg.

Table 4. Knotting waste percentage for cotton yarns of open-end quality of 20^s count

Average knotting waste percentage of the 20^s open-end quality (sort no. -120H19) = 0.45 %.

Average knotting waste in kg = 2.10 kg.

Beam No.	No. of ends	Length of warp (m)	Waste (kg)	Total wt. of warp (kg)	Waste %
1	10220	2814	2	530.78	0.37%
2		3100	3	584.72	0.51%
3		2778	2.5	523.99	0.47%
4		2933	2.5	553.22	0.45%
5		2610	2	492.30	0.40%
6		2700	3	509.27	0.58%
7		2900	2	546.99	0.36%
8		2800	4.5	528.14	0.85%
9		3145	3	593.21	0.50%
10		3355	2	623.82	0.32%

ISSN: 2278-0181
Vol. 3 Issue 6, June - 2014

Table 5. Knotting waste percentage for cotton yarns of open-end quality of 16^s count

Beam No.	No. of ends	Length of warp (m)	Waste (kg)	Total wt. of warp (kg)	Waste %
1	6096	2500	2	562.50	0.35%
2		2123	2.5	477.68	0.52%
3		2300	1.5	517.51	0.28%
4		2300	1.5	517.51	0.28%
5		2600	1.5	585.01	0.25%
6		1600	1.5	360.01	0.41%
7		2600	2	585.01	0.34%
8		2500	2.5	562.50	0.44%
9		1788	1.5	459.06	0.32%
10		2500	1.5	562.50	0.26%

Average knotting waste percentage of the 16^s open-end quality (sort no. -116414) = 0.35 %.

Average knotting waste in kg = 1.80 kg.

3.1. Effects of different faults on knotting waste

From the test results obtained, considering all of the carded and open-end quality cotton warp yarns having different counts, the knotting waste percentage of the beam no. 8 of the sort no. 13257/K is 0.85 % (4.5 kg in terms of weight), as shown in Table 2, which is higher compared to the average knotting waste percentage of 0.48 % (2.65 kg in terms of weight) of the same quality. Similarly, Table 3 shows the knotting waste percentage of beam no. 6 of the sort no. 130N55/K is 0.62% (3 kg in terms of weight), which is higher than the average knotting waste percentage 0.46 % (2.15 kg in terms of weight) of the carded quality 130N55/K. The knotting waste percentage of the beam no. 8 of open-end quality 120H19 is 0.91 % (3 kg in terms of weight), which is higher compared to the average knotting waste of 0.44 % (2.10 kg in terms of weight) of the same quality. Again, for the open-end quality of sort no. 116414, the knotting waste percentage of beam no.2 is 0.52 % (2.5 kg in terms of weight), which is higher than the average knotting waste of 0.35 % (1.80 kg in terms of weight) of the same quality. The knotting waste percentage observed in the above mention cases is found to be higher due to the presence of various sizing faults like size patch, sticky ends, missing ends, broken ends etc. Moreover, at times, due to inadequate protective covering of the warp beams, unwanted deposition of fluffs takes places on the beam affecting the quality of the upper layers of yarn which may be accounted as one of the reasons for increasing knotting waste percentage. In this study, the high knotting waste percentage that have occurred is mainly due to the cumulative effect of the above mentioned causes. Even the transportation of the sized warp beam from sizing machine to the concerned loom has also found to be contributed to the increase in knotting waste percentage as observed in his study.

3.2. Comparative analysis of knotting waste percentage between cotton warp yarns of carded and open-end qualities

The test results show that the average knotting waste percentage of carded quality warp yarns is 0.47 % (2.4 kg in terms of weight), which is higher compared to that of the warp yarns of open-end quality having 0.40 % (1.95 kg in terms of weight) knotting waste. While analysing the test results of these different varieties and counts of cotton yarns it has been revealed that there are certain factors which cause the variation of knotting waste percentage in those yarns. One of the important reasons is the size pick-up percentage of the yarn. The size pick-up percentage of the carded warp yarns is around 12 to 13 % on the weight of the yarn, which is higher than the size pick-up percentage of 4 to 6 % on the weight of the open-end yarn. This higher size pick-up percentage of the carded yarn is found to be responsible for the generation of higher knotting waste than that in the open-end warp yarn. Fig. 22 shows the graphical representation of average knotting waste in terms of percentage and weight of different qualities warp yarns.

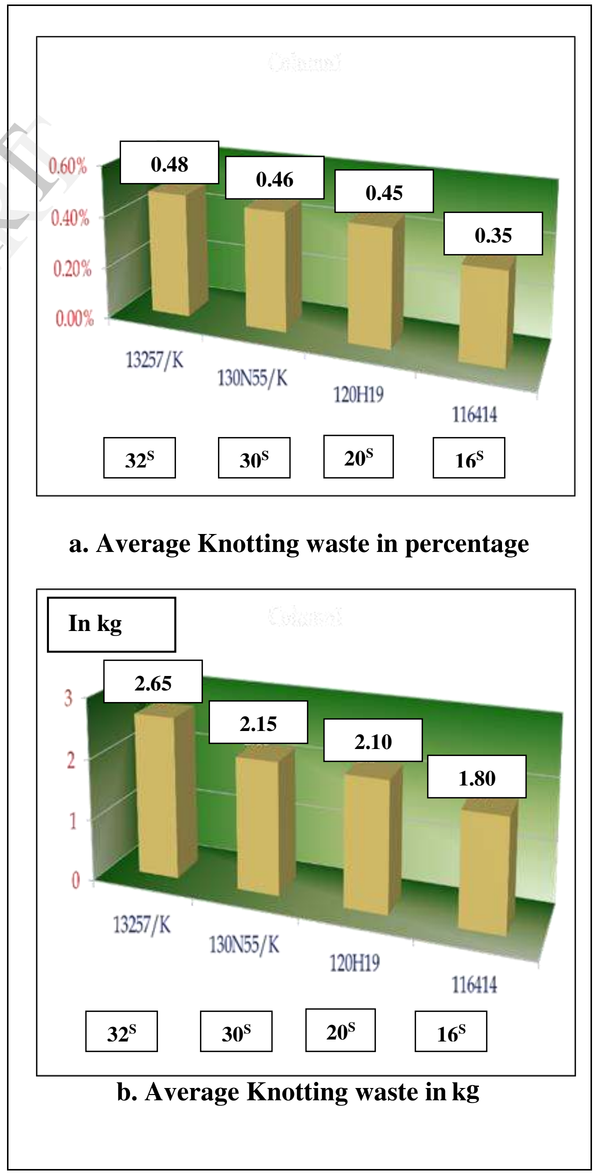


Figure 22. Graphical representation of average knotting waste in terms of percentage and weight of different qualities warp yarns beam

Again, the chances of occurrence of missing ends, during sizing, are more in case of finer quality warp yarns than in the coarser quality warp yarns leading to generation of higher waste in finer quality yarns. The carded yarns is found to have greater number of yarns per unit length than the open-end yarns which gives rise to occurrence of higher number of crossing ends causing higher knotting waste generation. After the process of sizing has been completed the full beam is unloaded from the sizing machine. During this time, it has been observed that on one hand the warps present on the size rolls continue to pick up the size paste and on the other hand the yarns which were on the drying cylinder gets over dried throughout the stoppage time of the sizing machine. This causes a very poor tenacity and elongation of the yarns in the regions of excessive size pick-up and over-dry along with increase in hairiness which ultimately leads to yarn breakage.

3.3. Recommendation for reduction of knotting waste percentage

Analysis of the probable causes of knotting waste generation and examination the subsequent test results reveal that modification of certain practices followed in a commercial textile mill may reduce the occurrence of knotting waste. Fig. 23 shows the condition of the warp beam before the yarns are cut and their quality gets affected.

Figure 23. Condition of the warp beam before the yarns are cut

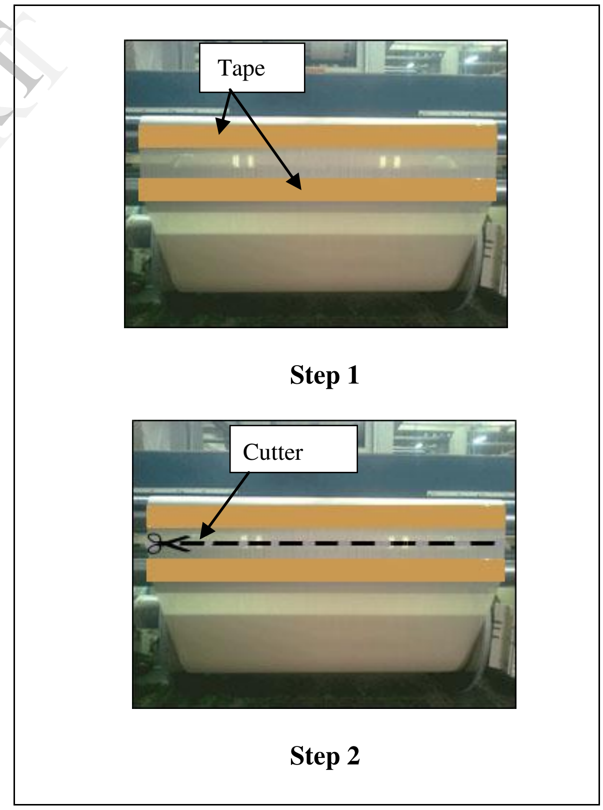
It is a general practice of a textile mill to cut the yarns of a full sized beam and make them crossed as shown in Fig. 24.

Figure 24. Unloading of the sized warp beam from sizing machine

But this process proves detrimental to the quality of the yarn. The affected yarn is taken out of the beam until the layer of the decent quality yarns is obtained for knotting of the warp yarns as shown in the Fig. 25.

Figure 25. Crossing damaged ends are taken out before knotting process

In order to reduce the occurrence of this event, a new improvisation has been recommended. The application of this innovative method is shown schematically in Fig. 26.



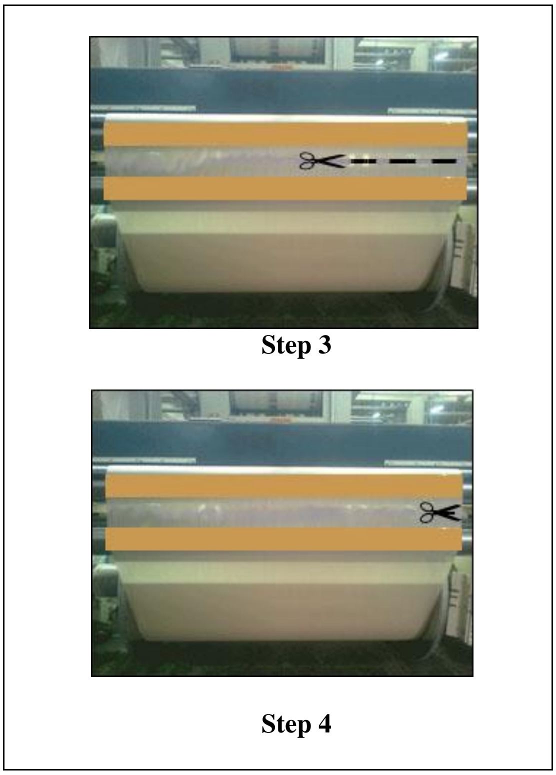


Figure 26. New technique to avoid crossing of the yarns as per the proposed process

Incorporation of a taping material on the warp sheet placed over the guide roller has been accomplished to maintain a parallel alignment of the yarns reducing the tendency of crossing over of the yarns. This process may be termed as taping of the warp yarns. This is followed by the clamping of the yarns and cutting them subsequently. The sized yarns from a full warp beam are dragged into the holes of empty beam tube in the form of bunches to maintain the continuity of the sizing process. But in doing so it has been observed that a considerable length of the yarn gets affected as shown in the Fig. 27.

Figure 27. Starting position of the beam

The damaged warp yarns have to be eliminated as shown in Fig. 28.

Figure 28. Damaged warp yarns are cut

Thorough research has been carried out to obviate this considerable loss of warp yarns. It has been found that the insertion of the taped yarns, as mentioned earlier, through a channel made in the beam tube, instead of the conventional holes, has led to the maintenance of proper alignment of the yarns during their insertion and more importantly has reduced the loss of warps yarns to a considerable extent. Moreover, it has been also observed that if the newly made channel in the beam tube can be covered with a metal piece then this not only helps to maintain proper yarn winding tension but also assists in proper rotational motion of the beam. The entire process sequence is shown in Figs. 29 and 30 respectively.

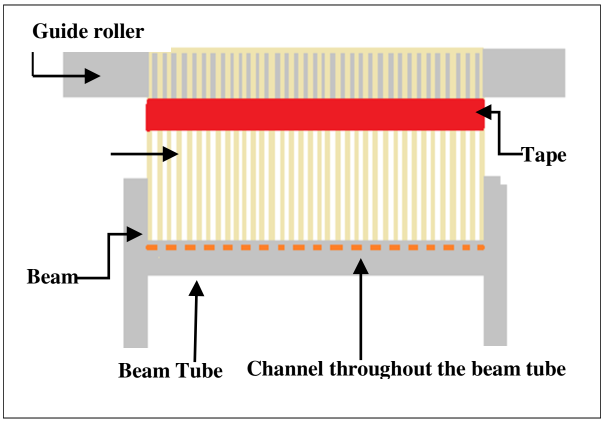
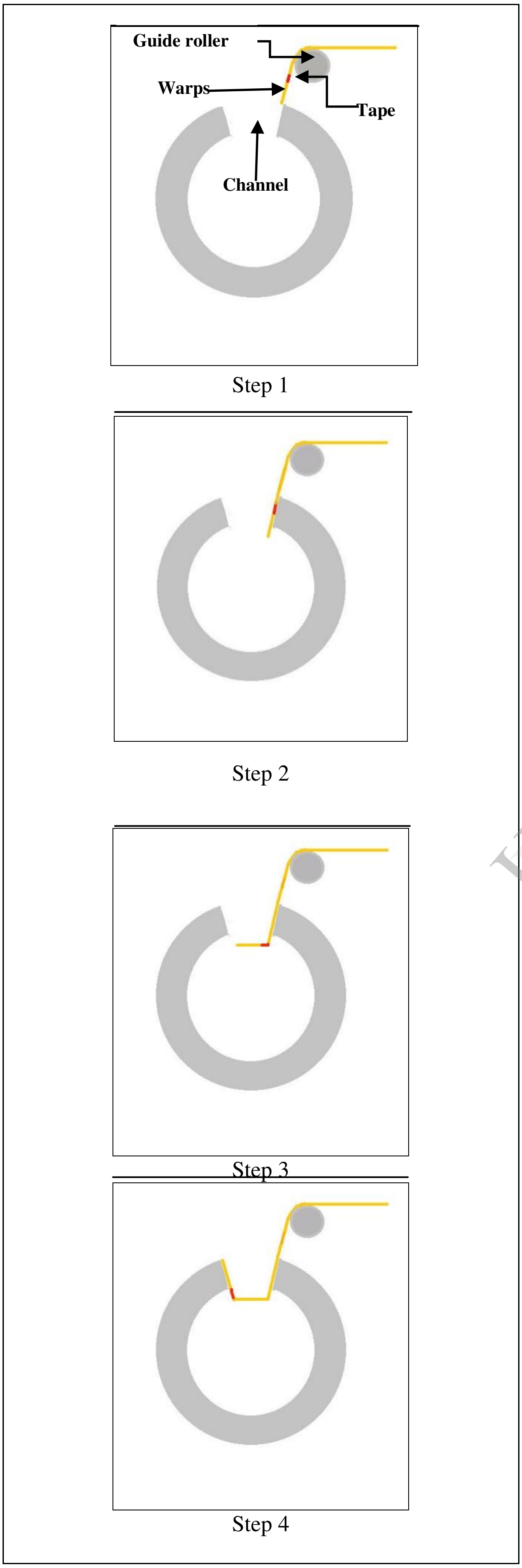


Fig 29 Front view of the beam in the sizing machine according to the proposed technique



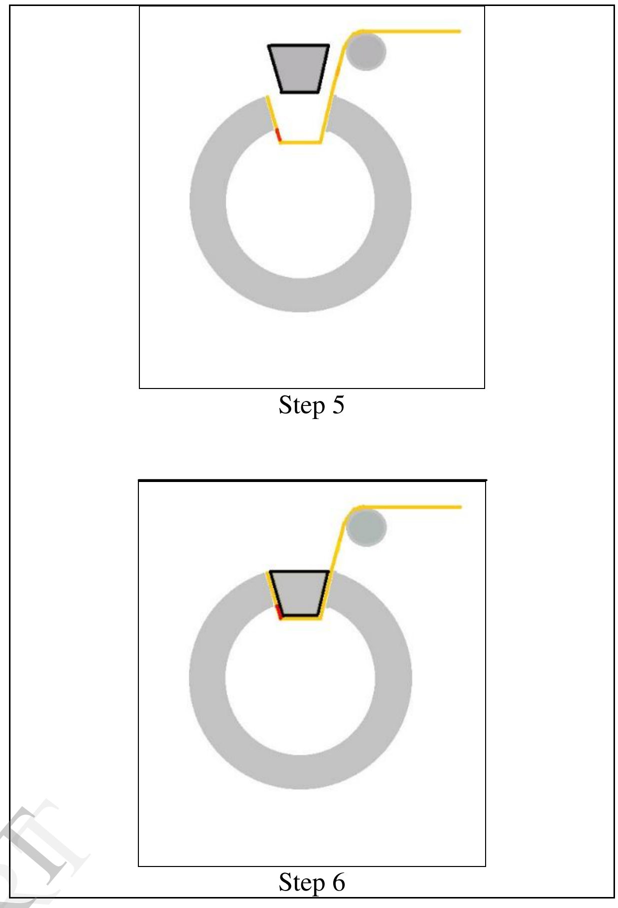


Figure 30. Cross sectional view of the beam tube and the step to be followed according to the proposed technique

4. CONCLUSION

In this study, primarily the objectionable faults which are responsible for generation of knotting waste in commercial production of fabrics in a textile mill have been identified, analysed and tried to be reduced by adoption of certain recommended practices. These proposed techniques have been tried on an experimental basis and the response is quite satisfactory in reducing faults like size patch, sticky ends, missing ends, broken ends etc. Moreover, besides the recommendations to adopt the new techniques, it has been also observed in this study that rectifications of certain common practices followed in textile mills like adequate covering of the full sized beams, prevention of fluffs deposition on the warps, proper handling and transportation of the beams etc. should be maintained which will facilitate smooth manufacturing of fabric, reducing the waste generation and eventually increasing the productivity. It has been seen that the average knotting waste percentage of all type of yarns of different qualities is 0.43% (an average weight of 2.17 kg) which has been reduced to a considerable extent by adopting the recommended technique. Also the time required to drag the affected yarns, followed by taping and subsequent combing is around 10-15 minutes. Taping of the warps has been carried out in the sizing machine following the proposed technique maintaining a parallel alignment of the yarns.

This operation leads to requirement of less number of combing action of the yarns for 2-3 times saving thereby about 5-8 minutes in this process. The study shows that the recommended techniques help in producing good quality fabric and it is also a time saving process by which high production rate can be achieved. Moreover, this proposed process can prove as a cost- effective one for the knotting of dyed yarns.

5. ACKNOWLEDGEMENTS

The authors convey their regards to the Honourable Vice Chancellor and Pro-Vice Chancellor (academic), University of Calcutta, West Bengal, India for their kind consent to allow this review paper for publication in the scholarly journal and valuable guidance to carry out this paper.

6. REFERENCES

[1] S. B. Abdessalem, Tensile and Knot Performance of Polyester Braided Sutures, Textile Research Journal, February 2009 vol. 79 no. 3 247-252.

[2] T. P. Liu, The Weaver's Knot: The Contradictions Of Class Struggle And Family Solidarity In Western France, 1750-1914, published by Cornell University Press 1994. [3] R. Safavieh, G. Z. Zhou and D. Juncker, Microfluidics made of yarns and knots: from fundamental properties to simple networks and operations, DOI: 10.1039/C1LC20336C (Technical Note) Lab Chip, 2011, 11, 2618-2624.

[4] M Topalbekirog˘lu, Kinematic Analysis and Synthesis of the Knotting Mechanisms Can be Used in the Production of Handmade Carpet: A Case Study, Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science September 1, 2005 vol. 219 no. 9 987-1005.

[5] R. K. Garnsworthya, Slippage of The Fisherman's Knot, The Journal of The Textile Institute, Volume 73, Issue 4, 1982, pp 170-176.

[6] R. K. Garnsworthya and D. E. A. Platea, An Evaluation of Selected Knots In Weaving, The Journal of The Textile Institute, Volume 74, Issue 5, 1983, pp 241-248.

[7] M. J. Karamad, M. Latifi, M. Amani-Tehran, Nondestructive Identification of Knot Types in Hand-Made Carpet. Part I: Feature Extraction from Grey Images, Journal of Nondestructive Evaluation, June 2009, Volume 28, Issue 2, pp 55-62.

[8] R. K. Garnsworthya and D. E. A. Platea, AN EVALUATION OF SELECTED KNOTS IN WEAVING, DOI:10.1080/00405008108631580, 01 Dec 2008, pages 26-33.

[9] A. Kireçci, L.C. Dülger, M. Topalbekiroğlu, An analysis on production of electro mechanical Gördes knot in handmade carpet (Gördes düğümlü elektromekanik halı üretiminin analizi). In 10. Nat. Mech. Theory Sym., Univ. of Selcuk, Konya-Turkey, 12-14 Sept. 2001, pp. 68-76.

[10] M. Topalbekiroğlu, A. Kireçci,, L.C. Dülger, A study of weaving 'Turkish Knots' in handmade carpets with an electromechanical system. Proc. IMechE Part:I J. Systems and Control Engineering, Number I5, August 2005, pp. 343-347(5).