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THE INFLUENCE OF SHED UNBALANCING ON BEAT-UP FORCE ON HIGH SPEED BEAT-UP LOOMS

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Abstract

Experimental results showed that beat-up force (B.U.F.) or weaving resistance (W.R.) is reduced considerably when the shed is unbalanced, thus confirming previous findings. The reduction is maintained at corresponding high speed (up to 700 picks per minute), although B.U.F. tends to increase with increase in loom speed.

The obvious implication of the reduction in W.R. is that the stress on the yarn and the machine parts (i.e. the force on the sley) is reduced and this could permit some reduction in sley mass which is important with increasing loom speed. This should be of interest to loom manufacturers in view of the fact that recent trends in loom development tends toward increase in loom speed.

Introduction

The beat-up action in a weaving process is applied by the reed. The Warp threads, which are under tension, exert pressure on the new pick. The reed must therefore exert some force to push the pick into the fell. The W.R. increases rapidly as the new pick is being pushed into the fell of the fabric. This action forces the reed to bend and thus measurement related to the degree of bending tends to indicate the level of B.U.F. Based on this principle, a fine technique has been developed over the years to measure B.U.F. on shuttle looms [1, 2]. Unfortunately this method cannot be used on modern shuttleless high speed looms with 'cantilevered' reed for beat-up. On such looms, the action of the beat-up process may be different, the action of the reed on the fell is more of an impact than a smoothly applied force. Some experiments on a Sulzer loom which does have a faster beat-up (235 picks per minute) than shuttle looms showed the effect of loom settings on B.U.F. (excess beat-up peak tension substituted for B.U.F.) and this indicates that shed unbalance tends to reduction in W.R. [3]. Although there was nothing to suggest that an unbalanced shed is responsible for this. The experiments on sulzer loom measured beat-up peak tension which though provided adequate information under-represented the actual B.U.F. values [4]. Measuring the actual B.U.F. is important for a proper understanding of the mechanics of beat-up process and dynamic behaviour of high speed looms. Although effort has been going on this, it is faced with difficulties, hence no complete success has been recorded so far [5, 6].

Zhang and Mohamed [7] provided a theoretical prediction of beat-up force and the filling yarn response to the beat-up motion taking place during weaving by setting up a weaving model under static and dynamic conditions. They concluded that the pick-spacing coefficient of friction between the warp and filling, basic warp tensions, and the ratio of tension in the warp sheets, loom speed and shed timing are the key factors affecting the beat-up force and filling motion during beat-up.

Kumpikaite and Milasius [8] carried out an integrated analysis of fabric structure parameters and those of the beat-up process as well as the relation of beat-up process parameters and fabric structure factors. Their findings showed a close correlation exists between beta-up and fabric parameters.

Textile performing operations play a key role in most of the composite manufacturing processes [9]. The basic textile yarn and fabric forming processes have been modified and developed to a significant extent to meet the increasing demand from the composite manufacturing sector.

Dauda and Bandara [10] studied the effect of shed geometry and shed timing on 50:50 cotton/vincel fabric cover, using a shittle loom and a combination of weaving conditions that gives best cover, least stress on loom and warp yarns. They found that the shed unbalancing shows improvement in fabric cover. Shed timing on the other hand, shows variable responses with the so-called 'normal' shed timing, resulting in a fabric of lowest reediness and highest pick density.

Fortunately, a narrow fabric loom which had a variable speed of up to 700 picks per minute was available. Its cantilevered reed was modified by fixing a frame to hold the reed baulks that enabled simulation and use of developed system on slow looms [1]. With this, fixing two re-strained cantilevers on the reed was possible and this allowed the cancellation of inertia effects. Therefore, this arrangement was used to investigate the influence of passive shed unbalancing on the B.U.F. of high speed looms.

Experiments on the Loom

The loom was set at conditions of late timing and balanced shed with the tension set as low as possible to weave a plain fabric (sett 18.5 ends/cm x 12 picks/cm) with 59 tex warp and weft blend of cotton-vincel yarns. This sett gave sufficiently high W.R. to enable significant changes in B.U.F. to be obtained when the loom settings are varied.

A series of experiments were carried out by varying the loom setting such as shed timing 0° (late), 40° (medium); and 75° (early) of crank angle before beat-up, extra-roller positions (0, balance shed; 18 mm above zero position, unbalanced shed) and 100-700 picks per minute at intervals of 100 picks per minute.

The B.U.F. (using reed strain gauge) and dynamic warp peak tensions for the two warp sheets were recorded using Wetzel type gauge on oscilloscope [1].

Results

Table I Effect of Increased Loom Speed On Dynamic Warp Peak Tension (Balanced Shed)

LOOM SPEED PICKS/MIN	WARP PEAK TENSIONS (GF/END) SHED TIMINGS (DEG)		
	0°	75°	40°
100	197	180	179
200	192	200	195
300	202	200	195
400	200	209	202
500	202	215	204
600	214	222	206
700	214	230	206

Table II Influence of Unbalanced Shed On Dynamic Warp Tension Ratio of Increased Loom Speed

LOOM SPEED PICKS/MIN	WARP PEAK TENSIONS RATIO (PTR) SHED TIMING	
	75°	40°
100	0.40	0°61
200	0°47	0°63
300	0.49	0.71
400	0.46	0.69
500	0°47	0.69
600	0°50	0.72
700	0°50	0.72

*PTR = Low/high beat-up peak warp tensions

The effect is not significant at late timing hence not included in the experiments

Discussion of the Results

Tables I and II show that B.U.F. tends to increase with increase in loom speed. The increase in B.U.F. observed agreed with a published paper [6]. According to the paper, increased loom speed causes increase in the speed of weft yarn's shift into the cloth and the frictional effects resulting in increase in B.U.F. and warp tensions. The let-off systems and dynamics of backrail at high speed may account for part of the increased B.U.F. It was observed during weaving that as the loom speed was increased, the fabric contracted widthwise. This could be due to the extra tension in the weft yarn, thus causing it to crimp less easily at the fell and so behave almost as if it were thicker and hence giving rise to increase in W.R.

Previous studies indicated little or no effect of increased speed on B.U.F. on shuttle and water jet looms [6]. The present results tend to support this view, considering the narrow or limited range (a difference of less than 100 rpm) of speeds used (i.e 129-190 rpm and 298-391 rpm for shuttle and waterjet machine, respectively), but do indicate that substantial increase over a wider range (600 rpm) could increase the B.U.F.

It is interesting to note from analysis of the results that at corresponding loom speeds, B.U.F. is still smaller (i.e a reduction in W.R.) when the shed is set unbalanced during weaving. The B.U.F. is higher with balanced shed (zero extra-roller position), the yarns following the same path has a tension ratio of near 1.00. It can be seen that with increase in the speed of beat up the reduction in W.R. is of similar magnitude compared to that at slow speed, under given conditions. In other words, the reductions were maintained as the speed of beat-up was increased from 100 picks per minute (145 gf/end to 107 gf/end) to 500 picks per minute (166 gf/end to 123 gf/end) and similarly at 700 picks per minute (although inertia force cancellation began to fail, analysis of the results indicate it to be still valid). In essence the considerable reduction in W.R. attributable to unbalancing the shed passively were more or less maintained at this speed, although a general increase in W.R. with loom speed was indicated.

The interactions with shed timing of unbalanced shed indicate that advantage of the effects could be taken when beat-up takes place on already crossed shed (i.e nearly open shed).

Observation of the fabrics woven with the two sets of extra-roller positions suggest that the unbalanced shed fabrics possess better 'cover' (closeness or uniformity of thread spacing) as expected. This supports the earlier results that reduction in W.R. facilities for the weaving of highly dense fabrics with reduced reediness which are important in the weaving of quality maximum sett, maximum cover or very heavy fabrics for required end-use performance. Such fabrics could be used for apparel or industrial purposes that may not need application of resin or other treatments and are impermeable to fluids.

Dynamic Warp Tension

Tables I and II also showed that the beat-up tension generally increases with increased loom speed. This varies to almost the same degree as the increase in B.U.F. The beat-up peak value is slightly higher for early timing, and this could be attributable to the increased abrasion, friction on the yarns and crossing effect on beat-up of an already crossed shed. Generally, the warp tension is increased due to increased friction between the warp and weft yarns loom parts and other ways in which shed timing influences the beat-up process such as promoting or opposing slipping of picks from the fabrics. The trend of beat-up peak tension ratio tends to follow the expected pattern that is the lower the peak tension ratio the smaller the force, under given conditions.

CONCLUSION

The results provide evidence that passive shed unbalancing could reduce substantially the W.R. at high speed of beat-up (up to 700 picks per minute and on modern looms, almost to the same degree as at lower loom speeds e.g. 100 picks/min), although increase in B.U.F. with loom speed has also been noted.

One obvious advantage of the reduction in W.R. is that the stress on the yarn and machine parts is reduced i.e. the forces on the sley are reduced and this could allow some reduction in sley mass which is important with increasing loom speed. However, this would not by itself, reduce tension in the tighter warp sheet, and even if it does, the effect will probably be small, but the frequency of such peaks will be halved and it is also likely that with the unbalanced shed the working tension would be set at lower level. These facts should make the influence of shed unbalancing on B.U.F. attractive to loom manufacturers with the recent trend tends towards increasing the loom speeds for higher productivity [3, 4].

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