

For the adjustment of the first two items, friction times of warp in a steady motion need to be considered, which will be subject to yarn quality. Therefore the first two items should not be considered as ways of adjusting the frequency. Because these factors can influence warp vibration frequency, the first two items should be considered in determining loom parameters. For the third item, it should be considered in the loom's let-off system design, and it is worth to popularize in particular application. The tension fluctuation might be influenced by the following factors when the loom rotates in a cycle: take-up speed, let-off speed, shed motion curve and beat-up curve. The beat-up and shed are the major factors in tension variation per period. Thus the two ways which adjust warp tension rapidly and reduce the warp tension peak can decrease the vibration of the warp. The methods that reduce the warp's tension fluctuation may be used in the following two ways:

- 1) Adding a let-off lever, which can reduce the tension variation peak within one revolution through back rest active moments.
- 2) Adopting an electronic let-off system with high speed response. The let-up speed is adjusted two times in one revolution, with high speed in the opening shed and low speed in the closing shed. Thus the tension will remain stable.

■ Conclusions

Based on the dynamic model of the warp moving process, through nonlinear perturbation analysis and numerical analysis, we get the following conclusions:

- 1) In the warp transverse vibration might take place, belonging to nonlinear parameter vibration.
- 2) The vibration will diffuse in the unsteady area, but an unsteady area cannot appear in the actual condition.
- 3) In certain warp material, the vibration frequency in the steady area is connected to the absolute warp speed, warp length and tension fluctuation amplitude.
- 4) Quick adjustment of warp tension is necessary to reduce warp vibration.

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