EXPERIMENTAL AND THEORETIC INVESTIGATIONS ON THE EFFECTIVE YOUNG’S MODULUS IN THE TWIST STRUCTURES

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ABSTRACT
In this paper, we present a direct measurement on the effective Young’s modulus on the three strands twist structure, which were made by pure Cu material with the diameter from 0.8 - 2.0 mm. A theoretic model according to the geometrical structure is also presented, which quantitatively agrees with the experimental results very well.

Keywords: effective Young’s modulus, twist structure

INTRODUCTION
Twisted structures, Figs. 1 and 2, including single and multi-stages have been widely applied to dragline, electrical cable, cable-in conduit conductors (CICC), and electrical communication technology. For these applications, there is a key problem to calculate the effective Young’s modulus, which is related to the design consideration and safety limit. Zhai et al (2008) and Li et al /2014) analyzed the spring model which only calculates the deformations of bending and distortion when the twisted strands were axial stretched, and this leads to a lower predication of the effective Young’s modulus. Thin rod theory has been used to investigate the effective Young’s modulus in the twisted structures (Nemov, 2010), and the results are larger than these values obtained by experiments. In this letter, the effective Young’s moduli in the twisted structures with three pure Cu (99.99%) strands have been studied by using axial tension. A model based on the geometric properties of the twisted structure has been proposed, which quantitatively agrees with the experimental results very well.

RESULTS AND CONCLUSIONS

Fig. 1- Triplet-wire structure

Fig. 2 - Normalized Young’s modulus versus pitch angle
Fig. 3 - Comparison between the experimental and theoretic results including the thin rod model and spring model.

In summary, the effective Young’s moduli of the single twisted structures by using pure Cu strands with different diameters were investigated experimentally. There is a size effect in the effective Young’s modulus, which has not been observed in the single Cu strands tension process. Consider the geometrical properties of the twisted structure, a theoretic model has been proposed. During the mathematic derivations, a size factor is introduced which can be used to interpret the observed size effect. Moreover, the theoretic model agrees well with the experimental results (Fig. 3), which can’t be interpreted by the spring model and thin rod model.

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