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On the line self-contact deformation of a clamped rod under combined edge thrust and twist

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We study the deformation of a clamped-clamped rod under combined edge thrust and twist, with emphasis on the final deformation pattern involving line self-contact. Two types of loading combinations are considered, i.e., twist-shortening and shortening-twist. In twist-shortening, the rod is pre-rotated a specified angle and then the two ends are brought closer quasi-statically. Shortening-twist is the other way around. Continuation scheme based on shooting method is employed to study the rod deformation as the end twist and shortening vary. We first examine the deformation sequence when the two ends are brought to one half of the initial distance and then the twist angle is increased quasi-statically. The deformation jumps from free-of-contact to one-point contact, then jumps again to two-point, then evolves smoothly to three-point and then to point-line-point writhing. In the case of twist-shortening, a typical deformation sequence also includes free of self-contact, one-point, two-point, three-point, and point-line-point contact. The final stage of deformation when the two ends approach each other depends on the pre-rotation. For instance, when the rod is pre-rotated 7π and beyond, the final deformation as the two ends approach each other is point-line-point self-contact. For pre-rotations 6π , 5π , and 4π , the final deformations are three-point, two-point, and one-point self-contacts, respectively.

Keywords: elastica, self-contact, shooting method

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