Approaches to parametric element constructions and dynamic analyses of spur/helical gears including modifications and undercutting

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Abstract

This paper presents approaches to element constructions and dynamic analyses for involute spur/helical gears, including cylindrical and conical categories. High quality elements for gear dynamics can be generated automatically and parametrically. Many design parameters are incorporated such as pressure angle and correction factor for examples. Besides, crucial influential factors including tip relief, crowning modification, and undercutting are also included. At first, the equations of involutes, fillets, and other curves for teeth are derived after applying coordinate transformation and gear principles to transverse cross section profiles of a rack cutter. Accordingly, tooth profiles of wide types of gears with abundant design considerations can be incorporated. The coordinates of intersection point among nonlinear tooth profiles are obtained, using the Newton-Raphson method. Then, no CAD geometric model required, meshed elements are constructed directly, using the profile equations of the gears via a C code. After that, elements of several gears are created to demonstrate the effectiveness of the presented method. Finally, dynamic responses of spur and helical gear pairs are calculated by LS-DYNA. The dynamic fillet stress of the spur gear pair is compared with an experimental result. It is expected that the proposed approach by the general purpose finite element software can be applied in gear dynamics, incorporating wide design and manufacturing considerations

Keyword：Finite element; Helical gear; Dynamic analysis; Gear modification; Crowning; Undercutting