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Design and Strength Analysis Methods of RV Gear Reducers

By Prof. Shuting Li

1． Abstract

RV reducers are characterized by their high reduction ratio, high torsional rigidity and high shock resistance, making them commonly used in industrial robot joints and machine tools. In this reducer, a trochoid curve is used as the tooth profile and a pin serves as the tooth of the internal gear; meshing is achieved through the eccentric oscillation of the crank shaft. Mechanically, this reducer differs from those with involute tooth profiles, and currently, it is not possible to accurately calculate the strength of the reducer during the design.

To enable strength calculations for this type of reducer, the author began developing specialized software in 1994 that uses the two-dimensional, finite element method (2D-FEM) to analyze the contact problems of this reducer. Here, we briefly present the tooth surface pressure and the contact pressure on the needle bearing rollers of an RV reducer analyzed using specialized software. For details on this research, please refer to References [1–2].

2． Development of Design Calculation Software for RV Reducer

The design software was developed using standard Visual Basic and AutoCAD VBA, respectively. Figures 1 and 2 show the input and output screens, respectively. As shown in Figures 1 and 2, once the gearing parameters are entered into the software's "Input" section and the "Execute" command is clicked, the calculation is completed immediately, and the mechanical diagrams on the right side of Figures 1 and 2 are generated instantly.

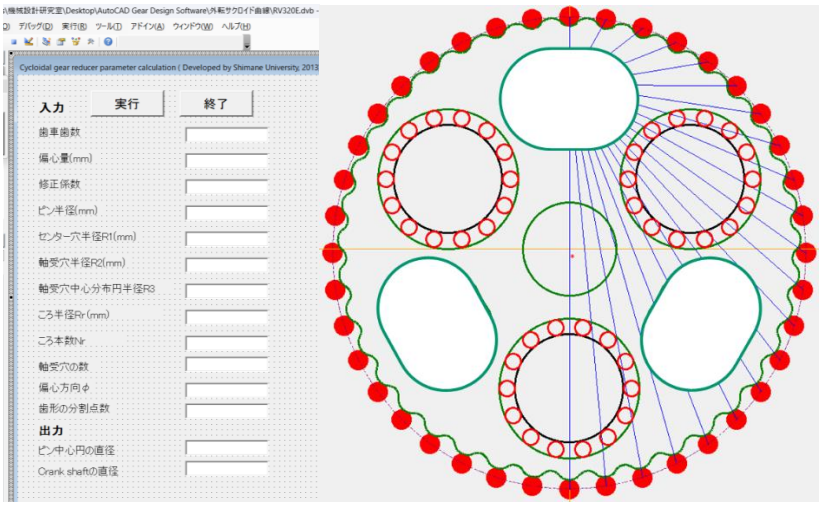

Figure 1: Design calculation software for RV gear reducers using visual basic

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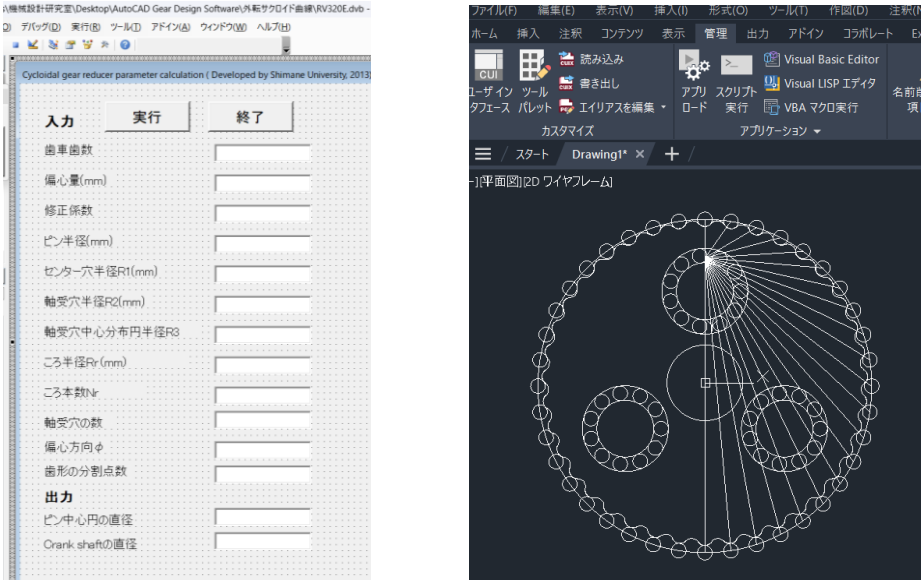

Figure 2: Design calculation software for RV reducers using AutoCAD VBA

3． Contact Strength Analysis of RV Reducer

To analyze the contact strength of RV reducers, the author developed specialized software using the two-dimensional, finite element method in 1994. The results of the strength analysis using this software are presented below. For details on the analysis method, please refer to References [1–2].

Figure 3 shows the FEM model and element mesh for the contact analysis of the RV reducer. Figure 4 shows the tooth surface loads and contact pressures (stresses) of the analyzed RV reducer. Figure 5 shows the loads and contact pressures on the needle bearings arranged in each bore.

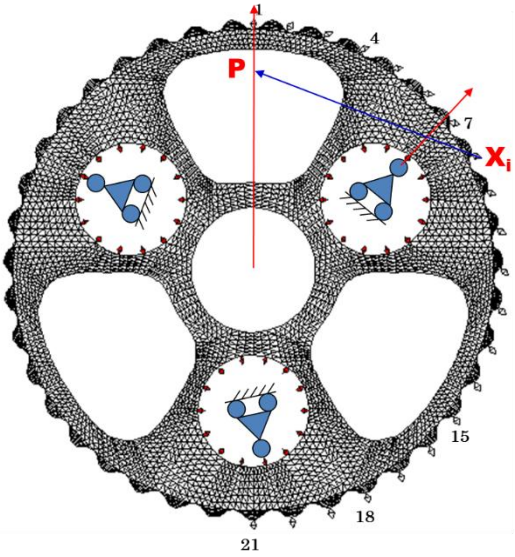

Figure 3: FEM model and element mesh for contact analysis of RV reducer

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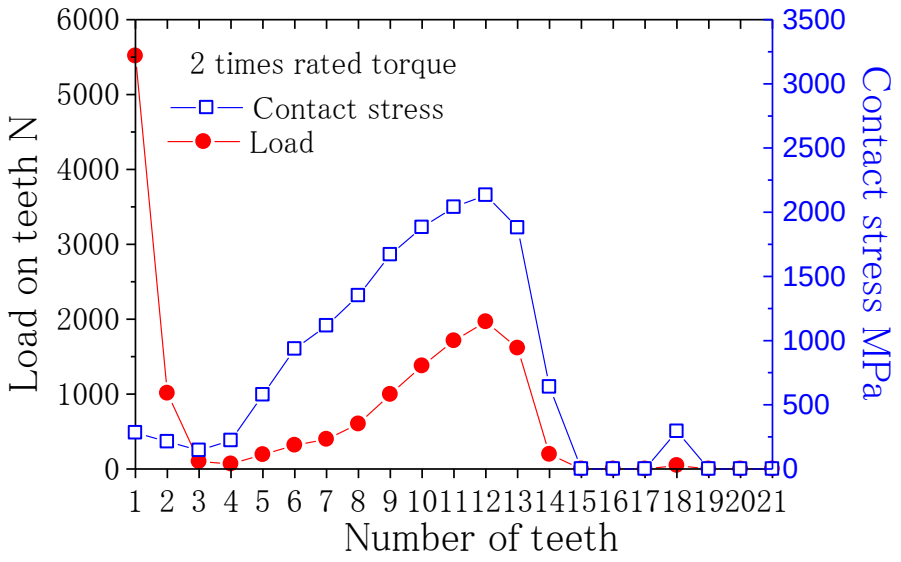

Figure 4: Distribution of tooth load and contact pressure (stress) on an RV gear

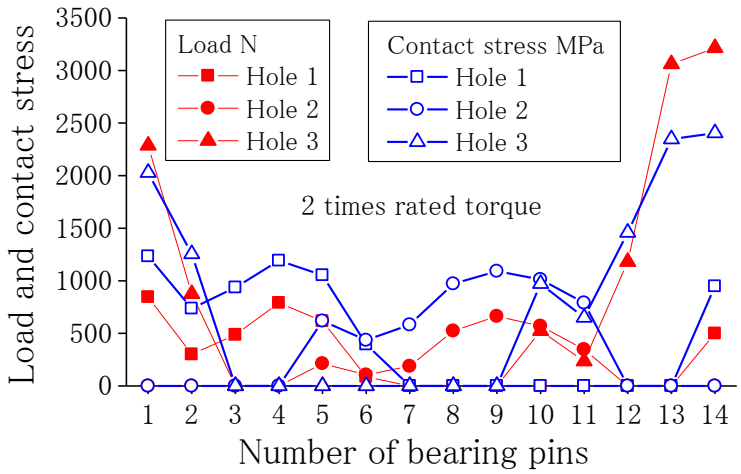

Figure 5: Load and contact pressure on the needle bearing rollers positioned in each hole

References:

(1) Takeshi Ishida, Shuting Li, and 3 others, “Effects of Tooth Width, Gear Size, Machining Tolerances, and Loading Torque on Tooth Load of a Cycloid Gear,” Proceedings of the Yamaguchi Regional Conference of the Chugoku-Shikoku Branch of the Japan Society of Mechanical Engineers, No. 955-2, November 18, 1995, pp. 227–230.

(2) T. Ishida, S. Li, T. Yoshida and T. Hidaka, “Tooth load of thin rim cycloidal gear”, The 7th ASME International Power Transmission and Gearing Conference, DE-VOL.88, SAN DIEGO, CALIFORNIA, pp.565-571, 1996