Topics

Gear Noise Reduction of a Transmission

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1. Introduction

Recently, it has become necessary to consider the vibration characteristics of structural systems in addition to the analysis of meshing transfer error fluctuation[1].

So far, studies made on the vibration characteristics of structural systems include the effect of gear train structures on the rigidity of meshing points[2], the basic structure of low-vibration cases, and the studies on rib arrangement[3, 4]. Few studies have been made, however, on the process of vibration transfer in the overall structure consisting of gears, shaft, bearings and case.

In this connection, the present study[5] discusses the gear noise generating mechanism. It studies the substitutional index of gear noise and a guide for developing a low-vibration structure based on this index mainly when making design changes to the case.

2. Methodology

We considered indices a, b, c and d in the gear noise generation/transfer mechanism. We reviewed the relationship between gear noise e and index d, and a method for the simple evaluation of index d using indices a, b and c. We carried out the tests by varying the sectional contours of the case. In addition, we conducted experimental identification of the bearing characteristics, etc., to develop an FEM model to quantitatively calculate the substitutional indices of the gear noise. We explored ways to establish a low-vibration guide for the case axis-support surface structure through FEM calculations and shaker tests.

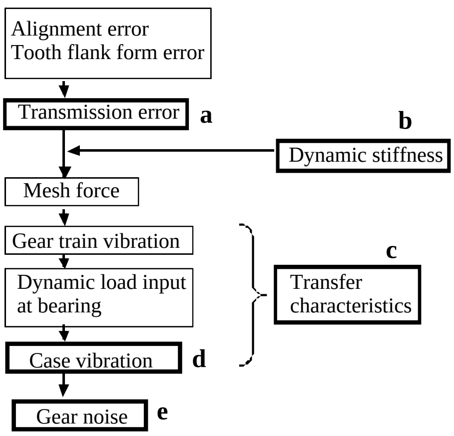

Fig. 1 Mechanism of gear noise generation.

3. Result

(1) As a result of these experiments, we confirmed that principal gear noise e can be substituted by the vibration response at the center of the case surface (**Fig. 1**, index d). Moreover, when the structure of the case becomes the object of the engineering change, it is found that the effect of indices a and b can be regarded as constant. Accordingly, the transfer function (index c) at the center of the case surface to the input of the mesh point is rendered an approximate index.

(2) From the FEM analysis, a guide to the low vibration structure based on the above index c is considered as shown in **Fig. 2**, and the effect of the vibration reduction was clarified through an oscillating test using a prototype (**Fig. 3**).

References

1) Yoshikawa, Tani , et al. : "Measurement of Helical Gear Transmission Error and Improvement of the Analytical Method", Japan Society of Mechanical Engineers, Transaction, Ver. C., 63-609(1997-5), 1775-1782

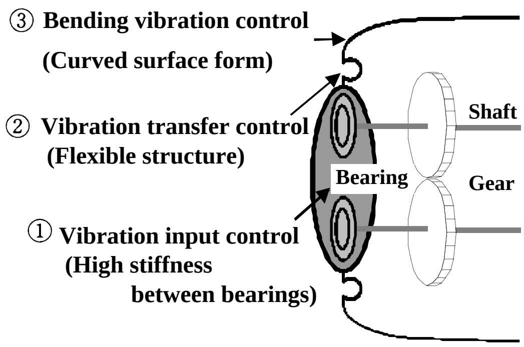

Fig. 2 Low oscillating structure.

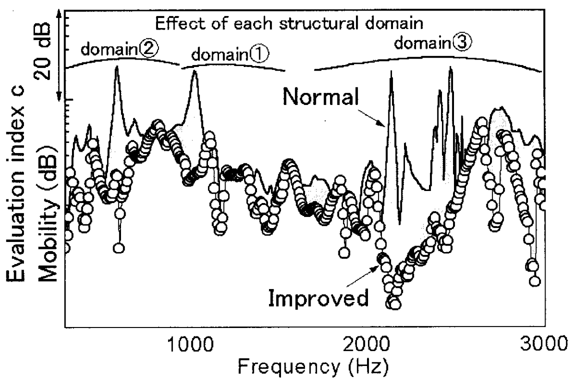

Fig. 3 Experimental confirmation of vibration reduction methods.

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2) Yokoyama, Abe, et al. : "Reduction of Gear Noise by Optimization of the A/T Gear Train", Society of Automobile Engineers Symposium, (1992), 17-21

3) Okamura and Morita : "Study of Low Noise Structures about Transmission Case", Mitsubishi Motor Technical Review, No. 9 (1997), 91-96

4) Morikawa, Maruyama, et al. : "Gear Case Shape and Rib Distribution for Reducing Automobile Transmission Gear Noise", Japan Society of Mechanical Engineerings, Transaction, Ver. C, 64-627 (1998-11), 4361-4366

5) Goto, Tarutani, et al. : "Vibration Analysis of Transmission Structure for Gear Noise Reduction", Fall Convention of the Society of Automobile Engineering, Proc. No. 70-99 (1999), 17-20

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