Non-linear dynamics of a new design of a two-tyre flexible coupling

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Abstract. This paper investigates the non-linear dynamics of a new design of a two-tyre flexible coupling via computer modelling and simulation. On the basis of the derived mathematical model, and by assuming ranges of variability of the control parameters, the areas in which chaotic coupling movement takes place are determined. The research mainly focused on identifying coexisting solutions of the formulated phenomenological coupling model. The coupling characteristics were determined on a laboratory stand. The results of model and experimental tests were related to the classical design solution of a flexible coupling with a single tire.

Introduction

In flexible couplings, the nonlinearity of the system is mainly due to the mechanical characteristics of the flexible connector [1]. From a theoretical point of view, the optimum mechanical properties of the flexible coupling to the dedicated drive system should not only be based on the transmitted torque (as in most cases) but also mainly, based on the viscoelastic properties of the flexible connector present in the flexible coupling [2]. These properties are identified based on static or dynamic characteristics recorded under experimental conditions. Laboratory tests were carried out in a system of two induction motors connected by a flexible coupling.

Model and experimental research

Differential equations of motion were derived using a non-classical method - bond graph (Fig.1). In order to carry out the numerical experiments effectively, the derived mathematical model was transformed into a dimensionless form. With regard to model tests, special attention was paid to the coexisting solutions and the possibility of its correction in order to reduce the dynamic loads affecting the fatigue life of the flexible connector. The results of the model tests were presented in the form of multi-colored maps of the largest Lyapunov [3] exponent distribution, through which zones of periodic and chaotic solutions were identified. In addition, the influence of the load characteristics on the evolution of the geometrical structure of the Poincare cross-sections was analyzed. The coexisting solutions were depicted as stable orbits recorded in the phase plane.

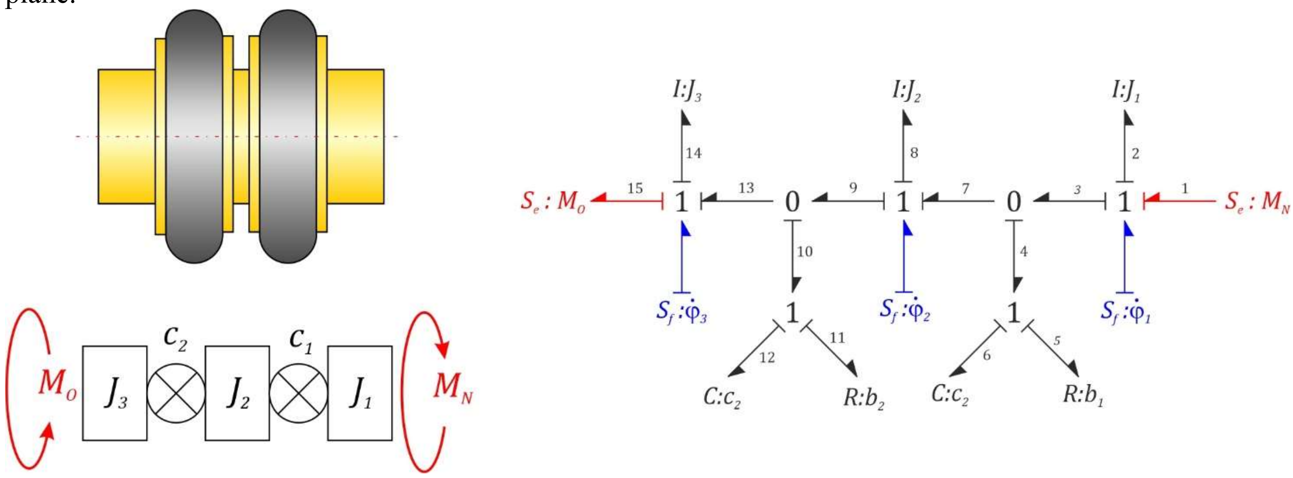

Figure 1: View of the coupling and the model in the form of a bond graph

References

[1] Margielewicz J, Opasiak T, Gąska D, Litak G. Study of flexible couplings non-linear dynamics using bond graphs. Forsch Im Ingenieurwesen/Engineering Res 2019;83. doi:10.1007/s10010-019-00317-w.

[2] Serkies P. Comparison of the control methods of electrical drives with an elastic coupling allowing to limit the torsional torque amplitude. Eksploat i Niezawodn – Maint Reliab 2017;19:203–10. doi:http://dx.doi.org/10.17531/ein.2017.2.7.

[3] Wolf A, Swift JB, Swinney HL, Vastano JA. Determining Lyapunov exponents from a time series. Phys D Nonlinear Phenom 1985;16:285–317. doi:10.1016/0167-2789(85)90011-9.