A three degrees of freedom foundation model for a non-ideal motor

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Abstract. We present a 3-D-O-F model of the elastic foundation of a non-ideal motor. The Sommerfeld Effect of rotation stagnation at resonance is observed for two available energy levels, as this model has two resonance peaks. Nonlinear motion equations are obtained via Lagrange's Method and numerical simulations are carried out.

Introduction

In rotating-unbalance-machine/structure systems, stable regime equals constant angular. All energy supplied by the motor is consumed by internal friction and energy dissipated by damping of structure. Energy beyond this accelerates the system. Each constant energy level provided by the motor corresponds to stable constant angular speed. In a non-ideal system, with limited power supply, an available motor torque level can intercept the torque curve consumed by friction and the structure at a constant rotation point before or after the resonance peak. If before, is a stable point of capture at resonance (Fig. 1 right). Angular speed no longer increases, stagnating before the peak, not reaching higher rotation regimes. Jumps happens when more energy is supplied to overcome this stagnation. There comes a point the torque curve goes over the peak and intercepts the consumed torque curve further ahead in steady higher angular velocity, no intermediate stable steady states. There is really no difference between ideal and non-ideal systems. Only the available power level. A model considering mutual interaction support-structure/machine, should always be used. In that sense, all systems are non-ideal. In practice, if the motor has enough power, this effect is negligible and we only consider interaction between the motor and the structure but not the reverse, simplifying the model. Literature is available on one DOF support structure models [1-3], with two coupled autonomous equations of motion, one for the structure, the other for the motor. In this paper we present a better representation of a machine foundation moving in horizontal and vertical directions, as in Fig. 1 left, with mass, stiffness and damping in each direction. Thus, we study two possible occurrences of the Sommerfeld Effect in the same model.

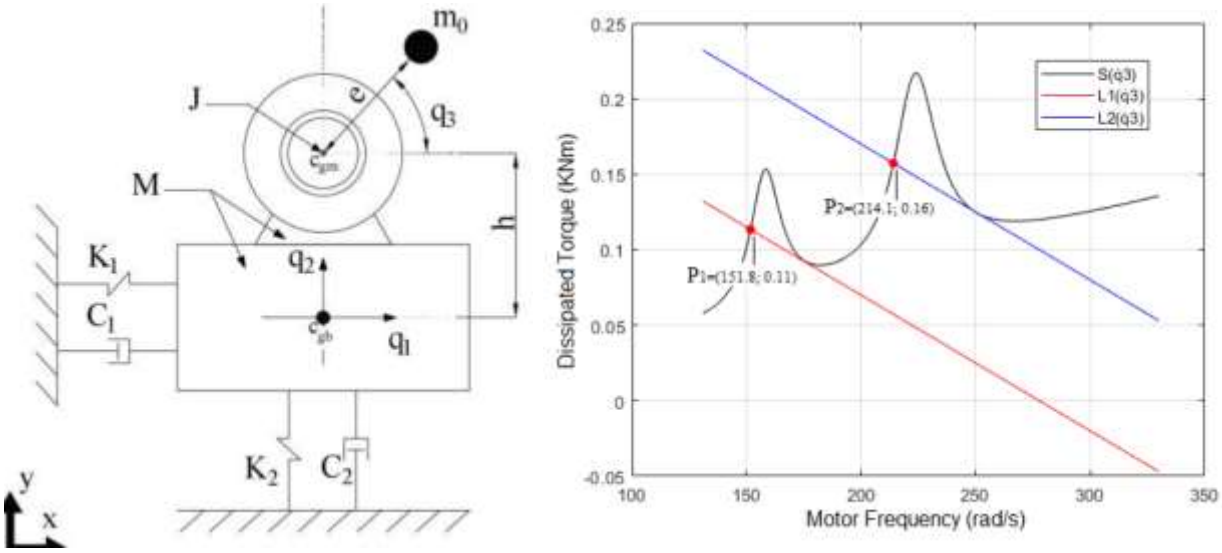

Figure 1: The foundation model and occurrences of the Sommerfeld Effect of frequency stagnations

Results and discussion

A study of non-ideal behaviour of a two degrees of freedom support structure for a limited power unbalanced motor, Fig. 1 left, was carried out. The expected Sommerfeld Effect of rotation frequency stagnation near resonances was observed, as displayed in Fig 1 right. We conclude that all such systems are non-ideal, in the sense that mutual interaction between motor and support structure should always be considered.

References

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