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Commentary

An Overview of Torsional Vibration

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DESCRIPTION

Torsional vibration is angular vibration of an object — commonly a shaft along its axis of rotation. Torsional vibration is usually a priority in power transmission systems using rotating shafts or couplings where it can cause failures if not controlled. An alternate effect of torsional vibrations applies to passenger cars. Torsional vibrations can cause seat vibrations or noise at certain speeds.

In ideal power generation, or transmission, systems using rotating parts, not only the torques applied or reacted are smooth resulting in constant speeds, but also the rotating plane where the power is generated (or input) and the plane it's taken out (output) are the same. In reality this isn't the case. The torques generated may not be smooth (e.g., internal combustion machines) or the component being driven may not react to the torque smoothly (e.g., reciprocating compressors), and the power generating plane is generally at a long way to the facility begin plane. Also, the components transmitting the torque can generate non-smooth or alternating torques (e.g., elastic drive belts, worn gears, misaligned shafts). Because no material are often infinitely stiff, these alternating torques applied at a long way on a shaft causes twisting vibration about the axis of rotation.

Torsional vibrations in electromechanical drive systems

Torsional vibrations of drive systems usually end in a big fluctuation of the rotational speed of the rotor of the driving motor. Such oscillations of the angular speed superimposed on the typical rotor rotational speed cause more or less severe perturbation of the electromagnetic flux and thus additional oscillations of the electric currents in the motor windings [1]. Then, the generated electromagnetic torque is additionally characterized by additional variable in time components which induce torsional vibrations of the drive system. According to the above, mechanical vibrations of the drive system become including the electrical vibrations of currents within the motor windings. Because of this reason, till present majority of authors won't to simplify the matter regarding mechanical vibrations of drive systems and current vibrations within the motor windings as mutually uncoupled. Then, the mechanical engineers applied the electromagnetic ropes generated by the electric motors as a prior assumed excitation functions of time or of the rotor-to-stator slip, e.g. in paper usually basing on numerous experimental measurements administered for the given motor dynamic behaviours. For this purpose, by means of measurement results, proper approximate formulas are developed, which describe respective electromagnetic external excitations produced by the electrical motor. However, the electricians thoroughly modelled electric current flows [2] in the electric motor windings, but they generally reduced the mechanical drive system to one or infrequently to at most a few rotating rigid bodies. In many cases, such simplifications yield sufficiently useful results for engineering applications, but fairly often they will cause remarkable inaccuracies, since many qualitative dynamic properties of the mechanical systems, e.g. their mass distribution, torsional flexibility and damping effects, are being neglected. Thus, an influence of drive system vibratory behaviour on the electrical machine rotor angular speed fluctuation, and during this way on the electrical current oscillations within the rotor and stator windings, can't be investigated with a satisfactory precision.

Mechanical vibrations and deformations are phenomena related to an operation of majority of railway vehicle drivetrain structures. The knowledge about torsional vibrations in transmission systems of road vehicles is of an excellent significance within the fields dynamics of mechanical systems [3]. In many modern mechanical systems torsional structural deformability plays a crucial role. This approach doesn't allow to analyse self-excited vibrations which have an important influence on the wheel- rail longitudinal interaction [4]. A dynamic modelling of the electrical drive systems including elements of a driven machine or vehicle is especially important when the aim of such modelling is to get an information about the transient phenomena of system operation, sort of a run-up, run-down and loss of adhesion within the wheel- rail zone [5].

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