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Coasting down signal analysis as a tool for detection of proximity of resonances and a case study

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ABSTRACT

Steady state vibration response of a machinery-supporting structure is strongly influenced by resonances closer to its operating speed. The coasting up/down response of the machinery and the corresponding signal may throw light on the proximity of resonances and precautions can be taken to de-tune it away from the operating frequency. The paper presents the theoretical and experimental background of coasting down response characterized by continuous variation of frequencies. A case study is shown for illustration of the phenomenon and how a large vibration problem in a beam supporting the bearing of a turbo-generator is effectively solved using information obtained from the coasting down signals.

1. Introduction

The dynamic excitation onto a structure can be classified into three types, namely,

(a) Steady state excitation involving a single frequency (or its integral multiples) excitation. The example is the dynamic load due to machinery running at constant RPM.
(b) Narrow or broad band random excitations with randomness associated in frequency or amplitude or both. This may be further classified as long duration as in wind or transient as in blast or impact loads.
(c) Excitations with frequencies varying continuously and with amplitudes being constant over the entire range or proportional to the square of the instantaneous frequency as in the case of coasting up/down of the machinery.

This paper will be essentially dealing with type (c) excitations mentioned in the previous paragraph. In the parlance of dynamic testing such an excitation is also termed as 'sweep sine excitation'. Structures supporting rotary machines like coals and iron crushers, compressors and turbines are under-tuned structures ($\omega_{op} > \omega_n$; $n = 1, 2, \ldots$), where ω_{op} is the operating frequency and ω_n is the natural frequency corresponding to the n-th mode of a structure. Any switching on (coasting up) or switching off (coasting down) of these machinery result in exciting modes below the operating frequency to large amplitudes of vibration. For low damped structures, a considerable amount of amplitude build-up is experienced during these transient resonance stages. Customarily, the design practice is to neglect these transient effects and to do the dynamic design for steady state amplitudes only.

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