

## Wave Propagation Approach for Structural Vibration

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The author defines the two primary objectives for the book. The first objective is to introduce structural vibration analysis using a wave propagation approach (WPA). The second objective is to describe and encourage the use of raft technology to control vibration transmission from vehicles. The two objectives are merged toward the end of the books by developing a raft model of a submarine and then analyzing the model using a WPA.

Based on fourth-order differential equations, the WPA utilizes time-domain spatial exponential functions in the equation derivations and reconstructs to create a unified framework for analyzing structural vibration. The advantage of the WPA is to establish a direct correlation between structural waves and control parameters. This book aims to make WPA become a mechanism analysis tool that designers can master and use structural waves to establish logical relationships among the target control parameters, structural vibration, and sound radiation.

Raft technology is regarded as a revolutionary technology for submarine vibration and noise reduction. The application of raft technology is vital for vehicles with high acoustic requirements. Raft models are structural, multi-stage isolation systems using tuned mass dampers to minimize the structural vibration transmission into the surrounding fluids. However, the author poses this question, "Why is raft technology so rarely used or not used in general industries now that it is so useful?"

**Chapter 1.** Before introducing the WPA, the author presents the basic theory of structural vibration including basic parameters such as wave number, wavelength, and lateral displacement. The examination of continuous systems such as the bending vibration of a beam and a plate is the focus of Sec. 1.1 and 1.2. Modes and mode shapes are calculated and graphed. In Sec. 1.3 and 1.4, the author expands to discuss the sound pressure, sound power, volume velocity, and sound radiation efficiency for simple structures.

**Chapter 2.** The author discusses and compares the classical analytical methods, the numerical methods, and

the WPA. The advantage of the WPA is to establish a direct correlation between structural waves and control parameters. From the perspective of the structural wave, the author describes the input, propagation, and reflection of structural vibration energy and analyzes the waveform conversion. In Sec. 2.2, the WPA mathematics formulations and boundary conditions are developed. The WPA of analyses for simple structures is presented in Sec. 2.3.

**Chapter 3.** Analysis of plate structures using WPA is investigated to a greater depth in this chapter. Responses with various boundary conditions and input forces are solved and evaluated.

**Chapter 4.** This chapter is dedicated to analyzing complex beam structures. Elastic coupled beams are addressed in Sec. 4.2; in Sec. 4.3 and 4.4, the WPA was focused on multi-supported elastic beams; periodic structures are analyzed in Sec. 4.5; and transmission loss is studied in Section 4.6.

**Chapter 5.** Using WPA to analyze hybrid dynamic systems is shown on this chapter. In Sec. 5.2, continuous elastic beams with lumped mass are studied; analysis of the dynamic characteristics for multi-supported beams with vibration absorbers is presented in Sec. 5.3; and an analysis of retrofitting a mast by a tuned mass damper is demonstrated in Sec. 5.4.

**Chapter 6.** The formulation and procedure for applying WPA to calculating response under distributed force excitation are presented in this chapter.

**Chapter 7.** The focus of this chapter is to analyze structures with discrete, distributed tuned mass dampers. Comparison of the tuned mass damper versus multiple tuned mass dampers is discussed in Section 7.4. Also, under/over tuned states and mass ratio are discussed.

**Chapter 8.** A thorough analysis of rafts using WPA is conducted in this chapter. A raft is a revolutionary form of technology that facilitates the mechanical noise control of submarines. Sec. 8.1 starts with single-stage and double-stage vibration isolation to ensure systematic analysis. A raft vibration isolation system using WPA is developed and analyzed in Sec. 8.2 to 8.4. Analyses of the effects of mass, mixing, and tuning are included in Sec. 8.5 to 8.7.

**Chapter 9.** The vibration power flow and experimental investigation are addressed in this chapter. In Sec. 9.1 and 9.2, the author formulated the basic theory of vibration power flow and then draws a complementary procedure for testing. Testing, measurement, and measurement accuracy are covered in Sec. 9.3 and 9.4.

Wave propagation approach is a supplementary analytical method. The readers include undergraduate students, graduate students, and engineering designers who wish to deepen their studies on structure-borne noise, power flow theory, or fine control of vibration noise. The book is

intended for researchers, graduate students, and engineers in the fields of structure-borne sound.

The organization of the book's material content follows a relaxed pace and a logical progression. The nomenclature and formulations are easy to follow. The figures are understandable and pertinent to the topic at the adjacent text. In general, the book was very well researched and written. Only time

will tell if the work in the book will catalyze a broader use of the WPA and raft technology.

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