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Forced and Damped Motions: Analysis of vibrations Civil Engineering Structures

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1 Introduction

Civil engineers constantly deal with projects of the most diverse structures. In an equilibrium perspective, those structures can be divided into isostatic, hyperstatic and hypostatic systems, and are constantly subject to several external actions forces like loads of people and vehicles, actions of the winds, earthquakes, explosions and others [1, 2]. A suitable understanding of the response to external excitations is a fundamental way to optimize the civil construction processes as well as to improve the safety factors associated with each component of the structure.

The objective of this work is to determine relations between the physical properties of the materials used in the civil construction and the response of the structure to the action of an external loads. Considering a water box supported by four reinforced concrete pillars with rectangular cross-section of 30×40 cm, moment of inertia $I = 0.0016$ m^4 and height $l = 7$ m. The Young's modulus and the damping factor are, respectively, 30 GPa and 0.007. An ilustration of such system is showed in Figure 1, we analyze the response of the system to an external excitation $F_e(t)$ with different behaviors: periodic, pulsed and random.

In a simplified mathematical model, we can consider a damping coefficient c and an effective elastic constant $k_e = 4k$ such that $k = \frac{3EI}{l^3}$. In this case, the Newton's second law is given by

$$m\ddot{x}(t) + c\dot{x}(t) + k_e x(t) = F_e(t) \tag{1}$$

2 Final Remarks

The numerical integrations performed for this system show which initial conditions provide the different behaviors as beats, resonance with amplitude increase and aperiodic

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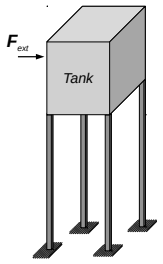

Figura 1: Water tank subject to external force action $F_e(t)$.

motion for this structure (Figure 2) to a periodic external force. The study was carried out for pillars composed by different types of concrete and with different dimensions. The results allow to determine, for structures with a degree of freedom, the most suitable configuration to obtain the required mechanical resistance with the lowest possible cost to each project.

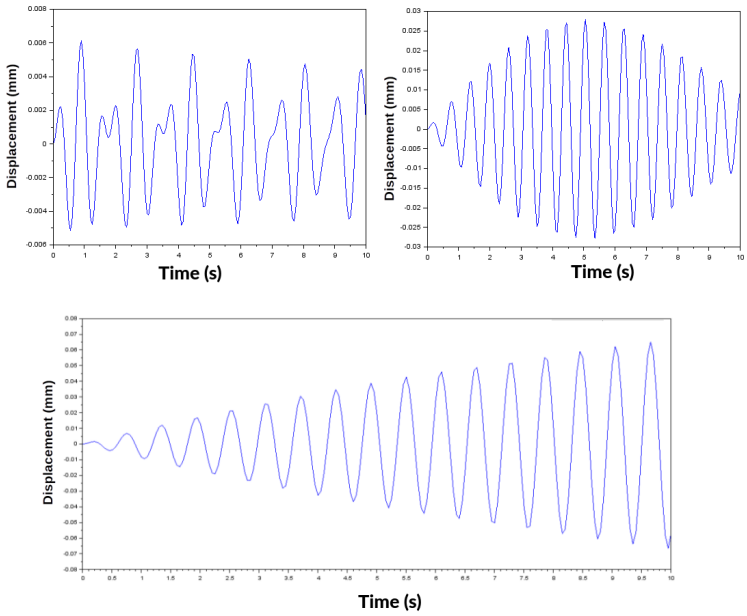

Figura 2: Examples of different behaviors obtained for the structure response.

Referências

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