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Dynamic analysis of plates made of composite materials.

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The growing search for materials that provide greater resistance and weight reduction means that composite materials are increasingly used in several productive sectors. [4]. In Engineering, it is often extremely important to analyze the natural frequencies of the components involved so that they are outside the system's rotation range, avoiding resonance phenomena [2]. Based on this idea, the work consists of developing a mathematical model to perform the simulation of a discretized plate from the application of the Finite Element Method, analyzing the dynamic behavior of the system, especially the natural frequencies [3]. For this, three different composite materials (Carbon Fiber, Epoxy Resin and Glass Fiber E) and 1040 steel were used.

Figure 1 presents a representation of the system used to realize the simulations, considering three degrees of freedom per node (one vertical displacement and two rotations).

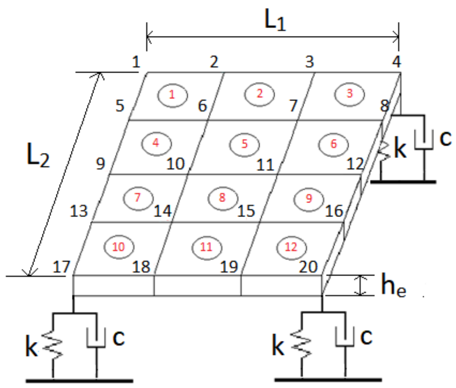

Figure 1: System discretized by the Finite Element Method.

The simulation was performed using the MATLAB software. The values adopted for the plate were: $L_1 = 1$ m, $L_2 = 0.6$ m, $h_e = 0.01$ m, k = 1500 N/m and c = 150 N.s/m. In addition, the presence of a concentrated mass in node 10 of the structure, equal to 50 kg, was considered. The theoretical values of the properties of the materials were taken from the literature [1] [2]. To determine the responses over time, a force described by $F = 20sin(2t)$ was used to excite the structure at node 11. The simulations show that the Carbon Fiber plate has the highest natural frequencies in relation to the other materials, with the main reason being the high modulus of elasticity. Similarly, the lowest frequencies are noted for the Epoxy Resin, which has the smallest modulus of elasticity. Table 1 presents the first three natural frequencies for both.

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Table 1: Natural frequencies of composites.

Composite	First Frequency (Hz)	Second Frequency (Hz)	Third Frequency (Hz)
Carbon Fiber	19,6	200,2	331,7
Epoxy Resin	11,5	47,5	82,1

The responses over time obtained for 1040 steel, Carbon Fiber and E Glass were relatively similar and had small ranges of motion, a fact that can be explained due to the dimensioning of the plates and the applied force. However, for the Epoxy Resin plate, it is noted the existence of greater ranges of motion (practically twice as much). This indicates that the parameters used may not be very suitable to simulate the structure of this material. The responses over time for 1040 steel and Epoxy Resin plates are found in Figure 2. In addition, the mentioned force was replaced by an unbalanced force described by $F = moe\omega^2 sin(\omega t)$, with $moe = 10$ kg.m and $\omega = 2$ rad/s. The result obtained followed the same behavior mentioned for the first force, but with the presence of a greater range of motion.

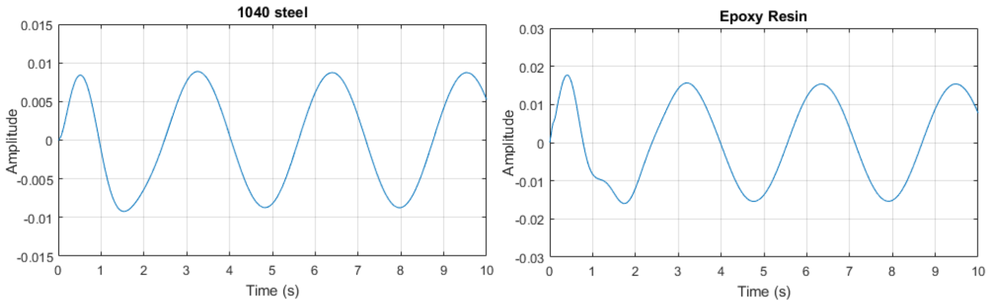

Figure 2: Time responses due to sinusoidal excitation force.

Therefore, it is concluded that it is very important to perform an evaluation of the system so that the natural frequencies do not coincide with the excitation frequencies, that is, with the rotation ranges of the system.

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