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Measurement of dynamic parameters of composite columns

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Abstract: The paper presents the results of measurements of dynamic parameters of composite lighting columns in the laboratory. The subject of the research were two types of composite poles 9.0 m high. The poles were made of GFRP (Glass Fiber Reinforced Polymer) or G/BFRP (Glass/Basalt Fiber Reinforced Polymer) composites.

Keywords: modal analysis, composites, lighting columns

1. Introduction

Nowadays, the use of composite materials is more and more common in all types of industries. Starting from the aviation industry, through shipbuilding, automotive industry, and ending with civil engineering [1]. Designing and applying composites as an element of construction requires verification of their mechanical properties. From the point of view of resistance to dynamic loads (vibrations, shocks), it is important to determine their real dynamic parameters (resonance frequencies, damping, vibration modes). Most often, experimental modal analysis [2] is used for the estimation of modal models. This knowledge can be used to validate their numerical models.

2. Results

The tested poles were designed and manufactured by Alumast S.A. The experimental tests of the poles were carried out at the Faculty Research Laboratory of Structures. Three columns were tested for each type, six columns in total. The composite part of round columns was with variable stiffness along the height. The research was carried out using the modal analysis system with impulse and kinematic excitation. The analysis was performed for the frequency band 0.5-160.0 Hz. The following were used for the measurements:

- multi-channel recorders Scadas-LMS,
- acceleration sensors,
- modal hammer PCB 086D20 (soft tip),
- shaker TIRA TV59389,
- software LMS TEST.LAB v.16A.

For the excitations of the tested elements were used modal hammer and white noise. The response to the excitations was recorded in the 0.5-204.0 Hz band with a resolution of 0.05 Hz. The arrangement of measurement accelerometers (P1-P7) on the tested elements and the place of impulse excitations (PHx, PHy) are shown in Fig. 1. The reference (Ref) and control (Pk) accelerometers were used to control the shaker excitation.

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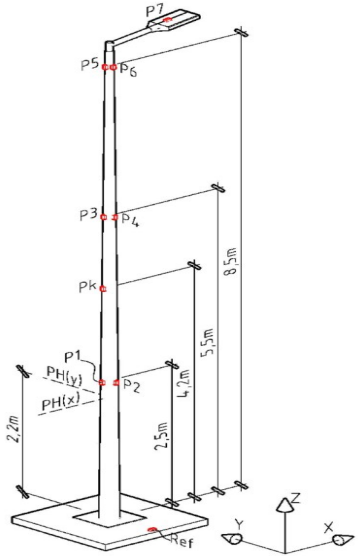

Fig. 1. Distribution of acquisition points on the tested elements

During the tests, 16 vibration modes were identified in the range up to 120 Hz. Their resonant frequency values and damping coefficients were determined. The Table 1. shows the eight resonance frequencies of the tested composite elements. Lower frequencies were measured for columns made of G/BFRP composite.

Table 1. Comparison of measurement results

	f_1[Hz]	f_2[Hz]	f_3[Hz]	f_4[Hz]	f_5[Hz]	f_6[Hz]	f_7[Hz]	f_8[Hz]
GFRP	1.15	1.17	3.75	4.33	8.75	9.67	22.45	23.38
G/BFRP	1.00	1.04	3.38	4.04	7.62	7.82	18.13	19.32

3. Concluding Remarks

The measurement of dynamic parameters allowed to establish modal models of the tested elements. The obtained measurement results were used to build numerical models for analyses taking into account wind and seismic loads.

References

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