FULL SCALE MONITORING OF A LIGHT TOWER UNDER WIND ACTION

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Abstract: This paper presents an ongoing full scale monitoring campaign carried out over a light tower, measuring simultaneous wind induced loading and response. Wind field is supplied by an ultrasonic anemometer installed on the top of the pole. The dynamic response of the structure is recorded by MEMS accelerometers and strain gauges. In parallel, a 3D model of the top and two sectional models of the shaft are investigated in the wind tunnel, with the aim of evaluating the aerodynamic properties of the pole. The analysis of acquired data will be used for the calibration of models of the response to stationary and non-stationary wind events.

Keywords: Full scale measurements, Slender structures, Wind induced response, Thunderstorms.

1. Introduction

The behavior of slender structures subject to wind action is dealt with in a number of scientific papers [1, 2], codes and standards. However, some aspects are still open, such as the response to non-stationary winds [3] and the evaluation of wind induced fatigue. In addition, current calculation models rely only on few measurement campaigns and therefore need to be validated on a richer amount of data. For these reasons, monitoring campaigns over tall and slender structures have been launched in the last years [4]. This paper describes the ongoing experimental activity related to a light tower in Italy. Due to the structural simplicity, this structure is very attractive for a comparison between measured and predicted behavior. The research include a full scale monitoring of wind loadings and structural response and an experimental characterization of the aerodynamic behavior by means of wind tunnel tests.

2. Description of the tower and monitoring equipment

The light tower under investigation is located in the Harbour of La Spezia, Northern Italy. The tower is 16.6 m high (Figure 1a). The shaft is composed by two steel polygonal shafts 5 mm thick, superimposed by slip joints, with base and top diameters equal to 528 mm and 254 mm, respectively. A steel ladder connects the bottom to the top of the pole, with a platform at mid height. At the top of the pole, a squared platform houses the lighting devices. The bottom segment of the pole is embedded in a 2.5 m high concrete block, which constitutes an almost perfect clamped end.

The pole has been equipped with a monitoring system including wind speed and structural response sensors. Positions of the sensors are reported in Figure 1b. A three-axial ultrasonic anemometer is installed on the top platform, recording the three components of wind speed with a sampling frequency of 10 Hz. The structural response is recorded by two biaxial MEMS accelerometers placed at the top and at an intermediate section of the pole, and eight mono-axial strain gauges placed near the base of the tower, characterized by sampling frequencies of 200 Hz and 100 Hz, respectively. Sensors are cable-connected to an acquisition unit placed at the base, recording simultaneously data from sensors with different sampling rate.

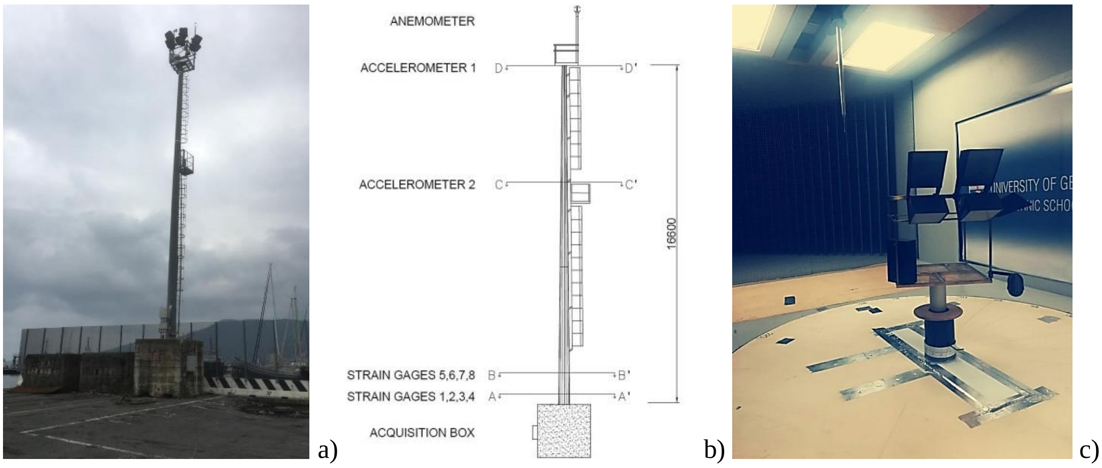

Fig. 1 - The light tower (a); location of sensors and acquisition unit (b); tower top model in the wind tunnel (c).

3. Wind tunnel tests

Two type of models have been realized for the wind tunnel investigation of the aerodynamic properties of the tower: the top platform with the lighting equipment, scaled to 1:5 (Figure 1c), and two sectional models, reproducing the top and bottom segments of the shaft, including the external ladder and the welding details, at 1:8 scale. Static tests were run in order to evaluate the aerodynamic coefficients of the top platform. Static and dynamic tests were carried out to assess the aerodynamic coefficients and the dynamic displacements of the shaft, respectively.

Conclusions

Data from the sensors have been recorded continuously from 01/03/2019 and statistical parameters on 10 minutes time intervals have been computed. Wind velocity records are analyzed in order to identify and separate synoptic and non-synoptic events [5]. The correspondent wind induced response records are analyzed with the aim of calibrating and validating the calculation methods of the response to synoptic and non-synoptic winds.

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