# MONITORING OF TEMPERATURE VARIATIONS IN THE TAGUS RIVER SUSPENSION BRIDGE

Jorge Rodrigues[a], Maíra Ledesma[a]

[a] *LNEC, Structures Department*

## ABSTRACT

The structural behavior of the Tagus river suspension bridge in Lisbon is monitored by a structural health monitoring system that is being developed and implemented by LNEC. That system includes several temperature sensors that are being used to measure the temperature variations to which the structure is subjected. By presenting some of the results obtained recently, this paper highlights the importance of the environmental load of temperature variations in the structural behavior of a large civil engineering structure like the Tagus river suspension bridge.

KEYWORDS: environmental loads, temperature variations, structural health monitoring, steel structures, suspension bridges.

## 1 INTRODUCTION

The Tagus river suspension bridge, in Lisbon, is a steel structure with a main suspended span of 1013 m, two suspended side spans with 483 m and three backstay spans of 100 m, 100 m and 99 m, summing up to a total length of 2278 m between anchorages. The bridge was completed to carry four lanes of roadway traffic in 1966 and in the end of the nineties was subjected to construction works in order to add two railway tracks at the lower level of the stiffening truss and to widen the upper roadway deck to six lanes. The strengthening construction works were concluded in 1999 and included the addition of a secondary suspension cable with respective new suspenders in order to support the additional loads.

During the lifetime of the Tagus river suspension bridge there were several occasions in which LNEC was involved in the monitoring of its structural behavior, namely: during the first phase of the construction works in the sixties; in the reception load tests performed in 1966 before the opening of the bridge to the traffic; in the monitoring of the structural behavior with a system developed in the sixties, which remained operational during about a decade; in the reception load tests performed in 1999 after the railway deck addition; and, more recently, in the development and implementation of a new structural health monitoring (SHM) system.

The structural behavior of the Tagus river suspension bridge in Lisbon is, therefore, being monitored by a SHM system, which includes several temperature sensors that are being used to measure the temperature variations to which the structure is subjected.

## 2 MONITORING OF TEMPERATURE IN THE BRIDGE

The temperature is being measured with negative temperature coefficient (NTC) thermistors, connected to adequate conditioning and data acquisition equipment. Those sensors are currently installed in three sections of the deck, located at the mid-span of the three suspended spans. In the south side tower (P3), the NTC thermistors were also already installed, but the collection of data with them hasn't started yet. So the results that were collected and analyzed, so far, were obtained in the referred three sections of the deck. In each of these sections there are eight NTC sensors, placed on both exterior vertical faces of the structural elements of the upper and bottom chords of the stiffening truss.

Due to compatibility with the remaining measurements, which include accelerations, the temperature data is, currently, being collected with the high sampling rate of 500 Hz and later it is pre-processed with outlier removal, filtering and smoothing procedures and finally decimated to time series corresponding to an average value per each 10 minutes. The temperature data thus obtained is later processed in order to evaluate the uniform and differential components of the temperature variations, first at a level of each instrumented element of the stiffening truss chords and finally at a level of each instrumented cross section of the deck.

## 3 CONCLUSIONS

The temperature values recorded in the stiffening truss of the Tagus river suspension bridge allowed to evaluate the variations of temperature in its uniform and differential components. It was observed that the daily amplitudes of temperature variation can be significant, emphasizing the effects that this environmental load can have in the structural behavior of the bridge. It is also interesting to note that the differential temperature variation is more significant in the horizontal direction than in the vertical direction, this is mainly due to the specific alignment of the longitudinal axis of the bridge, which follows a north-south orientation.