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400 mm base Extensometer for measurement of structural deformations

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ABSTRACT: Recent developments in Structural Health Monitoring (SHM) made available technology to continuously monitor bridges' condition. Deformation measurements at specific points on the structure are of great importance to evaluate its behaviour during load test and during structure's lifespan. Several solutions have been proposed and used but some drawbacks were found. An innovative solution of an extensometer for deformation measurement is presented. The instrument is able to measure linear relative displacements between two points 400 mm apart (measurement base) in a range of ±500 μm/m. The instrument works on the principle of measuring the deformation of four steel strips, previously pre-stressed, with a total of four strain gages that constitute a full Wheatstone bridge. With this electrical arrangement temperature effects are diminished. Handling and easy installation were also aspects accounted in the design. This paper describes the instrument, presents the mathematical formulation and shows some results of experimental tests used to validate the proposed solution.

1 INTRODUCTION

The design, construction and use of a structure, like a bridge, a viaduct or a main building, are always of great interest due to human use. The observation of these structures during and after construction add to the knowledge of its real behaviour, provides the evaluation of its performance and contributes to guaranty that safety conditions are achieved. One of the responsibilities of the National Laboratory for Civil Engineering (LNEC - Laboratório Nacional de Engenharia Civil) is the instrumentation, monitoring and safety control of bridges and special structures One of LNEC's first interventions was on Rio Sousa Bridge and dates from 1948; Rocha et al. (1955). Afterwards several other works have been instrumented and observed by LNEC. Nowadays the structural observation activity is being integrated in the Structural Health Monitoring (SHM) systems. SHM is defined as the process of implementing a structural behaviour evaluation strategy by using measured data acquired over time in a way to identify the presence of structural damage, which being present will be localized and quantified by specific analysis methods. With this technology it is possible to remotely monitor the structure continuously and thus assess its state at specific points in time; Farrar and Worden (2007).

The field observation of structures (bridges and viaducts) can be divided into three stages: 1) measurement during construction; 2) load tests; 3) long term observation; Santos (2002). The load tests in particular intend to observe the structure's behaviour in situ in order to validate behaviour theories, the structural models and to characterize the initial state of the structure which will be used as reference. During those tests several quantities are measured according to a predetermined observation plan which is the result of the simulations performed using the mathematical model of the structure. Two types of tests are performed: 1) **static load tests**,