STRUCTURAL HEALTH MONITORING IN THE CATHEDRAL OF THE ASSUMPTION OF CHILPANCINGO, MEXICO; BY A GEODETIC-TOPOGRAPHIC-PHOTOGRAMMETRIC RECORD AND ENVIRONMENTAL VIBRATION. A METHODOLOGICAL PROPOSAL

Sulpicio Sánchez Tizapa*, Rodolfo Aurelio Felicito†, René Vázquez Jiménez†, José Luis Carranza Bello† and Roberto Arroyo Matus†

* † Facultad de Ingeniería
Universidad Autónoma de Guerrero (UAGro)
Av. Lázaro Cárdenas s/n, Ciudad Universitaria, 39070 Chilpancingo, Guerrero
e-mail: sstizapa@uagro.mx, web page: http://www.posgradoingenieria.uagro.mx

ABSTRACT

In this paper, we present a review of state of the art about the structural health monitoring of historic structures, using three inspection techniques and the methodological proposal for a particular case. The proposed techniques are a) the use of Unmanned Aerial Vehicles (UAV), which is a reliable system for data acquisition in photogrammetric inspection and surveillance work due to its secure handling and its accessibility to risk areas for humans. b) Global Positioning System (GPS), which offers the capability of static or dynamic monitoring, using real-time satellite kinetic navigation (RTK), and precise point positioning (PPP). c) Environmental Vibration (EV), which consists of a test performed by an accelerometer in order to determine the structural dynamic properties of any structure, and whose values indicate the structural health.

The case study corresponds to the Cathedral of the Assumption of Chilpancingo (Mexico), Mexico, which represents a great historical value because it was the seat of the First Congress of Anahuac of the Mexican Independence movement in 1813. The current construction began after the Acapulco earthquake of 1902. During the San Marcos earthquake in 1957, its north tower partially collapsed. Later, great damage was observed on the south tower during the Michoacan 1985 earthquake. Both towers were repaired after the occurrence of both events. As a consequence of the Zumpango 2011 earthquake (Mw=6.5), there were cracks in the basements and the arches of the two bell towers, as well as serious damage to its north tower; and moderate damage for the south one.

The proposed methodology consists of three stages, the first one is the establishment of a Geodetic azimuthal control line by applying the static GPS method, and post-processing performance, which will be supported and related to the National Geographic and Statistics Institute (INEGI) Active National Geodetic Network (ANGN). Then, by applying the topographic trilateration method and using a total station equipment, will be determined with high precision Ground Control Points (GCP) and with the radiation method, will be obtained the coordinates of Structure Control Points (SCP). In a second stage, an Unmanned Aerial Vehicle (UAV) will be used to acquire images, generating a georeferenced orthoimage with the GCP previously determined, and in which the SCP will be located. The result of the first two stages is a high precision geodetic-topographic-photogrammetric record. Finally, with a "Sequoia" accelerometer equipment, the translational and torsional periods of the structure will be obtained and registered. The expected results are a matrix of distances between SCP, high precision ortho images, and structural dynamic properties. According to the architectural and structural characteristics, the location, importance factor and the use of this building, a monitoring process at least every six months or after earthquakes with a seismic magnitude greater than 6, as well as epicentre distances from this structure up to 60 km, it is suggested that it be performed. The comparison of the measured parameters will be used to evaluate the structural health of this building.

REFERENCES

[1] M. A. Akbar, U. Qidwai, and M. R. Jahanshahi, "An evaluation of image-based structural health monitoring using integrated unmanned aerial vehicle platform," Structural Control Health Monitoring., Vol. 26(1), pp. 1-20, (2019).

[2] M. Gul and F. N. Catbas, "Ambient Vibration Data Analysis for Structural Identification and Global Condition Assessment" J. Eng. Mech., vol. 134(8), pp. 650–662, (2008).