FBG based strain monitoring system to assess load distribution and differential settlements in a 33-story building: The constructive life cycle behavior

Esteban Paniagua-García[*,a], Javier E. Penagos-Congóte[b], Carlos A. Blandón-Uribe[b], Carlos A. Riveros-Jeréz[c], Jorge Aristizabal[d] and Julián Sierra-Pérez[a],

[*,a] Grupo de Investigación en Ingeniería Aeroespacial, Escuela de Ingenierías
Universidad Pontificia Bolivariana
Medellín, Antioquia, Colombia
e-mail: esteban.paniaguag@upb.edu.co,

[b] Departamento de Ingeniería Civil, Universidad EIA
Envigado, Antioquia, Colombia,

[c] Facultad de Ingeniería, Universidad de Antioquia
Medellín, Antioquia, Colombia

[d] Área Ingenieros Consultores
Medellín, Antioquia, Colombia

Key Words: FBG sensor, Differential settlements, Civil structure, Reinforced concrete building

ABSTRACT

Civil structures are prone to axial shortening, overloads, differential settlements, structural damage, and some other events that make the structure to behave different than expected. Those conditions need to be assessed to maintain the building safe, nevertheless, there are not affordable and reliable technologies to evaluate the structure integrity at any moment. In this work, a low-cost monitoring system for strain, loads, and differential settlements is implemented in a 33-story building structure, aiming to get knowledge on its behavior over the construction and operational life cycle. The work is addressed from the FBG-based sensor conception and its experimental and numerical validation, as well as it is discussed the installation method in the real construction environment. The sensor is mechanically and thermally sensitive, hence, it allows to account for strain variations from both thermal and mechanic sources. It is embedded in all 32 building columns before concrete pouring, and connected in a fiber optics network to a common acquisition site. The data collection during the construction period were carried with some minor interruptions. Data analysis techniques are used to evaluate each individual column and the whole structure. Load distributions and trends are identified and compared with the construction binnacle during that period, associating column strains with concrete pouring of any particular structural element and its location, as well as pointing changes not associated with any constructive load. The monitoring system presented some damages due to heavy constructive activities, however, it still allows to constantly monitor the structural behavior, which makes the building reliable in future events that may require structural analysis.