Software for Operational Modal Analysis

ARTeMIS

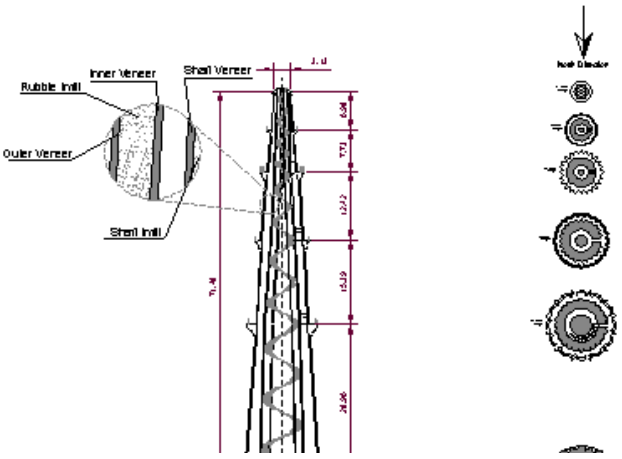
Dynamic Identification of the Qutub Minar, New Delhi, India

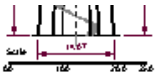
The results presented are made available by research assistant Luis Ramos, M.Sc. Department of Civil Engineering, University of Minho, Portuga carried out with the support of the European-Indian Economic Cross Cultural Program, under contract ALA/95/23/2003/077-122, "Improving th Cultural Heritage Buildings".

The Qutub Minar is the highest monument of India and on of the tallest stone masonry towers in the world. An interior circular staircase, with 3 to the balconies, where the muezzin called to the prayer. This minaret is also symbolic, which glorifies the victory of Islam against idolatry. The during the reign of Qutb-ud-din around 1202 but only the first story of the tower was constructed. The next ruler, Iltutmish, added the next thre damaged by lightning in 1326 and again in 1368. In 1503, Sikandar Lodi carried out some restoration and enlargement of the upper storey's.

The minaret is circular in plan, with a base of 14.0 m diameter and it tapers to a diameter of 3.0 m at the top along a height of 72.5 m. The stai central masonry shaft, and is made by Delhi quartzite stone. Each storey has a balcony, which is supported by a system of stalactite bracketing, storey finishes with a platform.

The tower is mainly composed by an external shell built with a masonry wall with three leaves and a cylindered central core. These two element helicoidally stairs and, locally and randomly, by 27 bracing beams composed by stone units with an average cross section of 0.4 times 0.4 m2.

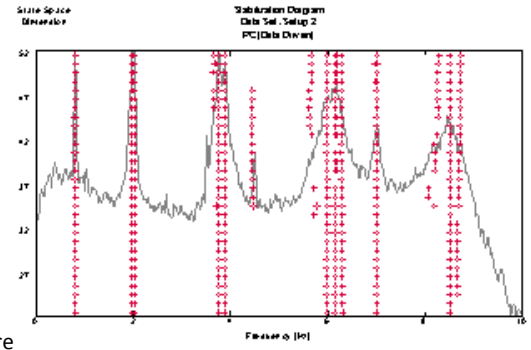


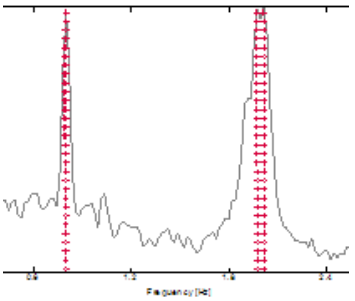


The modal identification was made under the Euro-Indian Research Project Improving the Seismic Resistance of Cultural Heritage Buildings, cor 077-122, with the main issue to study the seismic resistance of the monument.

For the response, measurements of 20 points in four levels of the structure were selected to measure the accelerations caused by ambient vibra series acquired at 100 Hz were then processed by a decimation of 5 (Nyquist frequency of 10 Hz), with segment length of 516 points with 66.67 projection channels for the subspace identification.

For the stochastic estimation of the models, 20 structural modes and 30 noise modes were considered. Pairs of narrow frequencies could be see for the first two modes, as can be observed in the following figure. This fact and the complexity of the structure increase the difficulty on the est modes.





Picture

Below you can download AVI movies of some of the modes. The modes have been estimated with the Principal Component Stochastic Subspace available in the ARTeMIS Extractor Pro version.

Mode - 3.746 Hz
Mode - 3.87 Hz
Mode - 6.967 Hz

Hint: To get the maximum out of the downloaded AVI movie, please set your AVI movie player to "Repeat Forever".

Related Information

The Masonry and Historical Constructions Group of Department of Civil Engineering of the University of Minho (www.civil.uminho.pt/masonry) t related to masonry and historical constructions, including inspection, advanced testing and modelling, assessment and strengthening, and comb specialized consultancy and product development for the industry.

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