 ICCES, vol.20, no.1, pp.11-12

Sonic-Shearography for Nondestructive Inspection of Bonding Integrity Between Tiles and Building Wall

Michael Y. Y. Hung

Summary

Aging of tall buildings has serious safety concerns. One of the potential hazards is loosened tiles (or external finishing) falling off the external wall of buildings. This can be life-threatening to passers-by. A major cause for this is inadequate bonding during tiling, or degradation of the bonded interface due to aging. It is therefore important to be able to detect and identify areas where the tiles are likely to detach from the external walls and take preventive measures. Current inspection methods primarily rely on human inspectors to tap every piece of tile, and listen for hollow echoes generated by the debond. This method is not only laborious and time consuming but also prone to inconsistent human judgment and, hence, diagnostic errors. This presentation reports a novel optical technique which combines shearography and sonic excitation for more efficient and reliable inspection of tiles-wall bonding integrity. Another merit of this technique is that it yields quantitative results.

Shearography is an interferometric technique for full-field and non-contact measurement of object deformation. It was invented by the author to overcome several limitations of holography by eliminating the requirement of a reference beam. Consequently, the technique enjoys the advantages of simplified and robust setup, reduced laser coherence length requirement, and less demanding in environmental stability. It is employable in industrial settings and has received wide industrial acceptance, particularly for NDT. Currently the rubber industry routinely uses shearography for evaluating tire quality, and the aerospace industry has adopted it for nondestructive testing of aircraft structures. FAA has endorsed the technique for inspecting aircraft tires. Since the adoption, aircraft accidents due to tire failures have been virtually eliminated.

In NDT, shearography reveals defects by identifying defect-induced deformation anomalies. Hence, the applicability of shearography for NDT applications relies on the development of a practical means of stressing which can reveal defects. Sonic shearography employs acoustical stressing and shearography as a full-field sensor. In the testing, the object surface is illuminated by an expanded laser beam and imaged by a digital image-shearing camera. The inspection process involves continuously recording the shearographic images of the laser-illuminated test area when it is acoustically "excited" through a broad spectrum of frequencies. A debonded area has a specific natural frequency, and resonance occurs when the frequency of excitation coincides with the natural frequency. With broadband sonic excitation, all

debonded areas of different resonance frequencies within the frequency band will be in resonance. Since a resonant debonded area vibrates with relatively large deformation, it can be detected by shearography. A peak-phase acquisition algorithm is developed for shearography to capture this resonant deformation, thus revealing the debond. At present, sonic shearography is capable of inspecting an area of one square meter in less than one second with a digital camera of 480x640 pixels. It is possible to inspect a larger area by employing a higher resolution (or multiple) camera. More importantly, it yields quantitative results (location, size and shape of the debonded area).

The test equipment includes a digital shearographic camera equipped with diode laser illumination, a computer-controlled powerful loudspeaker (to acoustically "excite" the test area with broadband excitation frequencies), and a portable computer (to digitally store and process the acquired images). The equipment is compact and portable, and the testing process is automated. It permits in-situ whole-field visualization and quantification of the actual size, shape and location of debonds. Being quantitative in nature, this technique allows debond criticality to be assessed, hence enhancing the efficacy of maintenance strategies for early prevention against falling tiles.