Establishing the Basis for Using Transient Stress Waves for Nondestructive Evaluation of Masonry

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Abstract:

In a recently completed study, reliability methods were used to assess the feasibility of using transient stress waves and more specifically, the impact-echo method, for nondestructive evaluation of masonry structures. The impact-echo method was developed in the mid-1980s as a nondestructive flaw detection test for concrete. The use of lower frequency stress waves generated by the elastic impact of small steel spheres on concrete allowed the concrete to be treated as a homogeneous material. Small air voids, microcracks, and other natural inhomogeneities in concrete did not have a significant effect on the results.

For the case of masonry structure, the effect on the propagating stress waves caused by the many interfaces between areas of differing materials, such as brick and mortar in a brick wall, had to be determined. The key to determining the significance of these interfaces was in determining the magnitude of the effect caused by the relative differences in acoustic impedance between the various materials in a masonry structure. Because of material property variability in masonry structures, reliability analyses were performed using statistical distributions of the properties to determine the probability that impact-echo could be used to evaluate a masonry wall. The reliability analyses employed included Monte Carlo simulation, the first order reliability method, and Taylor series approximations.

Results of studies presented in this paper demonstrate that transient stress waves can be used for evaluation of masonry structures in about 70 to 85% of all cases. These studies were carried out in conjunction with numerical (finite element) and laboratory studies to establish the basis for using impact-echo method for nondestructive evaluation of masonry.

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