Dynamic Testing of In-Situ Composite Floors and

Evaluation of Vibration Serviceability Using the Finite Element Method

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(ABSTRACT)

The presented research examined three areas: best practices in high quality dynamic testing of in-situ floor systems, extensive dynamic testing of three bare (non-fit out) in-situ multi-bay steel composite floors to estimate their dynamic parameters/response and to identify trends in dynamic behavior, and development of a set of fundamental finite element (FE) modeling techniques to adequately represent the dynamic response of steel composite floors for the purpose of evaluating vibration serviceability. The measurement, analysis, and computation of a floor's accelerance frequency response function (FRF) is the core premise linking all areas of the presented research.

The burst chirp signal using an electrodynamic shaker is recommended as the most accurate and consistent source of excitation for acquiring high quality measurements suitable for use in parameter estimation, operating deflection shape animation, and calibration/validation of FE models. A reduced mid-bay testing scheme is recommended as a time-saving alternative to modal testing over a full coverage area, provided the only desired estimated parameters are frequencies, damping, and mid-bay acceleration response.

Accelerance FRFs were measured with an electrodynamic shaker located within 23 unique bays on the three tested floors. Dominant frequencies ranged from 4.85 Hz to 9 Hz and measured estimates of damping varied considerably, ranging from 0.44% to 2.4% of critical (0.5%-1.15% was typical). Testing showed several mode shapes were localized to just a few bays and not all modes were adequately excited by forcing at a single location. The quality of the estimated mode shapes was significantly improved using multi-reference modal testing.

FE models for the tested floors were developed based on high quality measured data and were shown to provide adequate representations of measured floor behavior. Fundamental techniques are presented for modeling mass, stiffness, boundary conditions, and performing dynamic analysis. A method of evaluating vibration serviceability was proposed using the FE model's computed accelerance FRF for comparison with a *design accelerance curve* that represents an acceleration response threshold in the frequency domain. An example design accelerance curve is presented based on current serviceability guidelines for acceleration tolerance and effective harmonic forces due to human activities such as walking.

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