ABSTRACT

Huber, Devin, H. Ph.D., Purdue University, December, 2008. The Development and Validation of Long Span Floor Systems for Multi Story Residential Structures. Major Professor: Amit Varma.

Typical steel deck-concrete slab floor systems used in multi-story steel construction require intermediate filler or support beams (14 in. or deeper) and are limited to span of 8-12 ft depending on deck depth. The goal of the research was to develop and validate innovative long span floor systems capable of spanning up to 30 ft with total depths up to 12 in. or less. Several long-span floor systems were conceived and considered. These floor systems were evaluated based on their ability to achieve certain performance objectives. To accomplish these objectives, the project has been conducted in four tasks. The first task focused on conducting a literature review and survey of existing long-span slab systems. This task was conducted to determine the state-of-art for existing floor systems in steel construction. It helped in identifying existing solutions that have been proposed or implemented in steel construction. The second task of the research focused on conceptual development and design of long span floor systems. A suite of different floor system types were developed and proposed. The systems were ranked by the researchers and an oversight committee based on their technical merit and potential to achieve the prescribed performance objectives. The systems were analyzed and designed using analytical tools and methods including the finite element method (FEM), numerical analysis, and existing design codes. Based on the rankings, floor systems were selected for further development and experimental validation. The third task for the research project focused on the experimental validation of the floor system candidates.

The testing focused on three different aspects for the floor systems. The aspects included strength and serviceability characteristics at ambient temperature levels, the fundamental heat transfer of certain specimen, and the effects of combined mechanical and thermal loading. The fourth task focused on numerical investigations and analytical parametric studies of the long-span floor system candidates. Analysis methods were developed and used for structural evaluation and evaluation for floor vibrations. Three different systems were found to present merit as potential long span systems. Two used 7.5 in. deep steel decks acting composite with either a 2.5 in. or 3 in. concrete slab on top to achieve 30 ft spans with a 10 or 11 in. depth. The other modified existing steel deck-concrete slab systems with new type of self-shoring system to achieve 30 ft spans with a 12.5 in. depth.