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NEESR-II: Highly Damage Tolerant Slab-Column Frame Systems

Short Title: NEESR-II: Highly Damage Tolerant Slab-Column Frame Systems

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Keywords:

High-Strength_Concrete
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Reinforced_Concrete
Smart_Structure_Technologies
Self-Performance_Monitoring
Multi-Axial_Subassemblage_Testing
Slab_Column_Connection
Lateral_Displacement
Punching_Shear

Description: Structural systems that combine reinforced concrete (RC) slab-column frames with moment resisting frames or shear walls find wide applications in zones of moderate and high seismicity. Due to combination of lateral displacements imposed during earthquakes with gravity loads, slab-column connections are prone to exhibit punching shear failures. Traditionally, the required shear strength of slabcolumn connections is achieved by the use of drop panels or shear stud rails. The work outlined in this proposal is to develop a highly damage tolerant and smart slab-column frame system through the use of high-performance fiber reinforced cement composites (HPFRCCs) and wireless sensing technology. The development of new materials (HPFRCC) and smart structure technologies (computationally rich wireless sensors) have previously occurred in isolated research communities - this proposal is a first of its kind to explore their combination so that an intelligent HPFRCC structure capable of sustaining large drift demands and self-performance monitoring can be derived. The revolutionary features of the NEES infrastructure offer exciting paths of exploration that will lead to a more profound investigation of intelligent HPFRCC slab-column systems. In order to develop the proposed frame system, a series of HPFRCC flat slab specimens will be first tested monotonically at the University of Michigan to optimize the HPFRCC material for this application. A total of six large-scale slab-column sub-assemblages will then be tested under simulated earthquake loading. Four of these sub-assemblages will be bi-directionally loaded using the NEES-MAST facility at the University of Minnesota. The MAST facility is ideally suited to this application as it can be used to load slab-column assemblages in a realistic manner to fully assess the shear capacity of HPFRCC connections. The results of these tests will be used to develop models to predict the seismic behavior of building systems employing these advanced materials and design provisions for the proposed slab-column connections. To further enhance building safety, new technology in wireless sensors will be incorporated into the project to develop instruments that can self-detect and report structural damage due to seismic

events. The high resolution cameras available at the NEES-MAST facility will enable the close correlation of the wireless measurements with the accumulated damage, aiding in the development of a damage index appropriate for this type of connection. An algorithm for the developed

Project Documentation

Type	File Name	Title	NEEScentral Upload Date
Report	Final Report Slab-Column Connections.pdf	*Punching Shear Strength and Deformation Capacity of Fiber Reinforced Concrete Slab-Column Connections Under Earthquake-Type Loading*	8/11/2009

Desc: The main objective of this research was to evaluate the potential of using steel fiber reinforced concrete in slab-column connections for increasing their punching shear strength and deformation capacity when subjected to earthquake-induced lateral displacements. The research was divided in three phases. In the following, a brief description of the scope of each phase and its objectives is provided. In the first stage, a series of slabs with different types of fiber reinforced concretes was tested under monotonically increased concentrated load. A total of five pairs of slabs, four pairs constructed with fiber reinforced concrete and one pair with regular concrete were tested. Two flexural reinforcement ratios were evaluated for each material. The main objectives of this research stage were: 1) to evaluate the potential of various fiber reinforced cement-based materials for increasing punching shear strength and deformation capacity of slab-column connections subjected to monotonically increased concentrated load; 2) to evaluate the influence of flexural reinforcement ratio and rotation on punching shear strength; and 3) to select the best materials for further study under earthquake-type loading. In the second research stage, the behavior of two approximately 1/2-scale slab-column connections constructed with the fiber reinforced concretes that

Experiments

Name	Title	NEEScentral Access	Curation Status	Curation Date
Experiment-1	MAST Specimen SB1	PUBLIC	Complete	8/3/2009
Experiment-2	MAST Experiment SB2	PUBLIC	Complete	8/3/2009
Experiment-3	MAST Experiment SB3	PUBLIC	Complete	8/4/2009