Piping Subsystem Shake Table Tests

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Task Description/Goals/Outcomes

Task 4D focused on the seismic response of pipeline and gas storage surface infrastructure. An elaborate experiment on a generic representative surface subsystem was conducted at the University of Nevada, Reno, using two tandem shake tables. The experiment confirmed the resiliency of the subsystem and potential vulnerability of pipe supports, and provided a unique dataset for testing and validation of computational models of piping systems.

Introduction

Some components of surface natural gas infrastructure have demonstrated poor seismic performance in past earthquakes. Because of the large variability of subsystems at critical facilities, a generic subsystem, Figure 1, which included selected vulnerable components, was designed and tested at full-scale. The subsystem included 4 in diameter Schedule 80 pipes, 8 in diameter Schedule 40 pipes, elbows, tees, and reducers, bolted flange joints and a scale-model vessel.

Figure 1. Piping subsystem tested at UNR, piping system (top) and system components (bottom).

Setup

The subsystem was fabricated by licensed piping contractors with extensive experience and the welds were made similar to typical field welding. The closed system was air pressurized to 15 psi and was subjected to both synchronous and asynchronous earthquake motions. In the latter case, a relative displacement of 17 inches was induced between the adjacent shake tables.

Results

The subsystem remained linear under synchronous motions up to 200% of the El Centro earthquake. Under asynchronous motions with large relative displacements, progressive yielding was observed in some components (Figure 2). There was no visible damage to the pipes or vessel or loss of pressure in the subsystem. Damage was only observed at one pipe support (Figure 2).

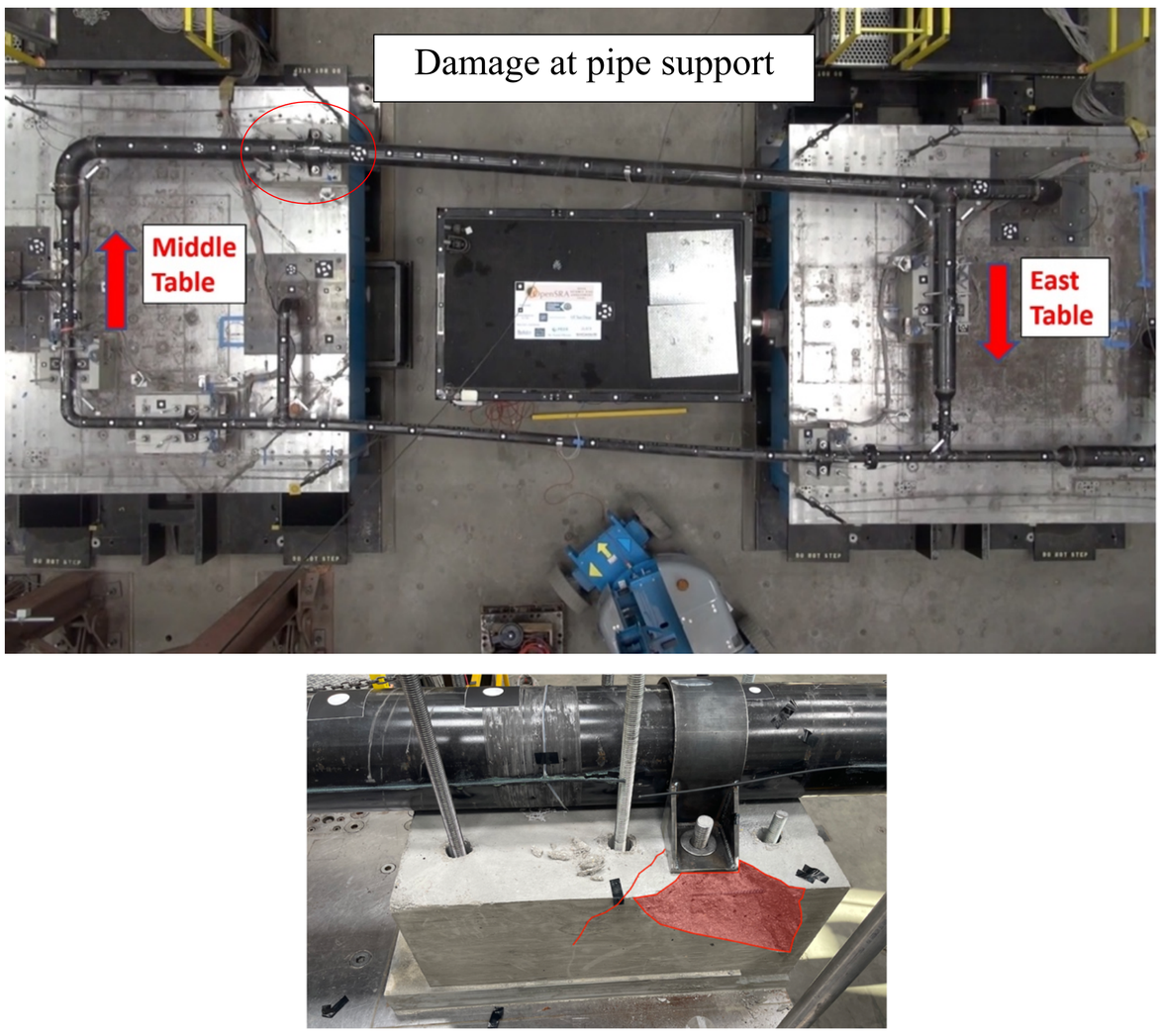

Figure 2. Pipe deformation at 17 inches displacement (top) and observed support damage (bottom).

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