Earthquake Performance and Simulation of San Francisco's Auxiliary Water Supply System

by Thomas O'Rourke

Abstract

This project involved the development, verification, and implementation of an interactive computer program with color graphics to model the Auxiliary Water Supply System (AWSS) of San Francisco. The AWSS was built as a consequence of the 1906 San Francisco earthquake to provide fire protection in coordination with the Municipal Water Supply System. Composed of approximately 200 km of 250 to 500-mm-diameter pipelines, it is the backbone of San Francisco's fire protection and critically important for emergency response after a major earthquake.

The interactive computer program, known as GISALLE, can perform accurate hydraulic analyses of the entire system and for any damage state sustained by the system as a consequence of earthquake effects. It contains a special algorithm to predict, for a given damage state, which portions of the system will be able to supply water at flow rates and pressures necessary for fire fighting. It can also predict which portions of the system will not be able to function effectively, thereby helping to plan for effective protection and restoration strategies. The program can be manipulated interactively by engineers, planners, and fire department personnel to change or add components and evaluate how these modifications affect earthquake performance of the system The computer model was verified by special fire flow tests performed by the San Francisco Fire Department.

The AWSS model was used to show city planners that damage to the buried pipeline network and unacceptable losses of water are likely in a severe earthquake. These simulations played an important role in the City's efforts to obtain a $46.2 million construction bond for improving the AWSS The bond was passed overwhelmingly by 89.2% of the voters After the 1989 Loma Prieta earthquake, the computer simulations of AWSS seismic performance were shown to compare very favorably with the actual earthquake response, and used to understand the full implications of damage sustained as a result of the earthquake.

Various strategies for improving the AWSS have been explored with the model, and communicated to fire fighting personnel and emergency planners. The recommendations resulting from AWSS simulations and the continued use of the model by engineers in San Francisco stand as significant proof that computer graphics modeling of water supply systems provides an effective way of improving both seismic performance and fire protection.

Collaboration

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