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A Numerical Approach to Evaluate the Seismic Performance of Water Supply Systems Based on Demand and Capacity in the Damaged Network

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The disruption of water supply systems due to an earthquake may cause serious problems to the daily life of people in the stricken area, and medical caring, sanitation, fire-fighting and so forth may be seriously affected, too. Several studies and observations regarding past earthquakes such as Northridge (1994) and Kobe (1995) earthquakes have shown the importance of water supply systems functionality on response and recovery efforts.

The general trend of studies on simulating water supply performance is towards achieving more accurate models to represent the system behavior. Commercial hydraulic models such as EPANET and H2ONET are not able to simulate damaged systems realistically. Seismic performance of a water supply system in the aftermath of an earthquake depends on the available flows and pressures in the damaged system. There are some computer programs for calculating the flows and pressures based hydraulic analysis of the network. However, these programs have been developed for undamaged systems, and when used for damaged systems, they may predict unrealistically high negative pressures. Water distribution systems are not air tight so that their ability to support negative pressures is very limited. Previous models, such as those proposed by Markov [1], Shinozuka et al. [2], Shi and O'Rourke [3], are not completely able to show the actual performance of the water supply systems (Figure 1).

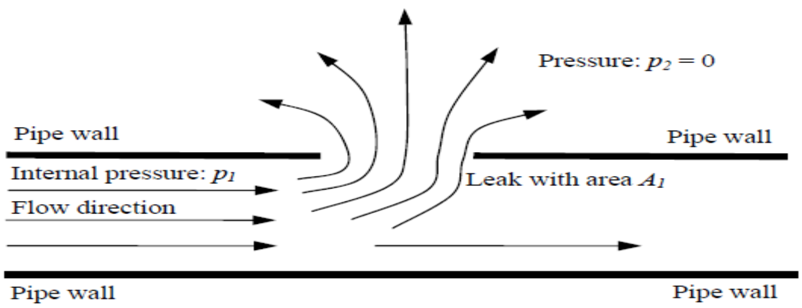

Figure1: Simulation of leakage in damaged systems is one of the most important challenges in water supply systems following earthquakes

Although Mani et al. [4] presented a model based on head-driven simulation method instead of demand driven method to avoid negative pressure, it has some limitations such as discarding the effect of reservoirs on the network, and other seismic parameters such as PGD. This paper describes a comprehensive methodology for numerical simulation of the earthquake performance of water supply systems based on demand and capacity concept to handle some issues which have not been considered in other models. To show the practicability of the proposed approach, it is tried to consider two neighboring and inter-connected sections of the water distribution network of Tehran metropolis, each of which is supported by a reservoir for providing the required hydraulic head are considered. Although the two considered relatively small networks are basically of branch type, to create some level of redundancy they have been linked in some locations, which makes the to neighboring networks inter-connected, and their hydraulic behavior should be studied together. The results of applying the proposed numerical approach to the considered networks are compared to those obtained by other previously suggested approaches to show its higher efficiency, particularly for the case of relatively larger networks.

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