16th World Conference on Earthquake Engineering, 16WCEE 2017
Santiago Chile, January 9th to 13th 2017
Paper N° 4989
Registration Code: S-A1464482589

PERFORMANCE OF WATER AND ELECTRIC SYSTEMS IN THE 2016 KUMAMOTO EARTHQUAKE

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Abstract

The April 14 2016 Mw 6.0 (foreshock) and April 16 2016 Mw 7.0 (main shock) earthquakes occurred near the City of Kumamoto, Japan. This presentation covers the performance of water and power systems only.

Water system. The City of Kumamoto and outlying towns' potable water supply comes from nearly 200 wells, and is distributed to the population by a network of 4,470 km of pipelines. The main shock was the most damaging, resulting in nearly 460,000 customers (1 customer = 1 billing account) outages.

The primary reasons for the outages was “semi-artificial” due to regulatory requirements for water quality; plus outages due to broken water pipelines. There was damage to prestressed concrete water tanks and water wells. The “semi-artificial” issue is that all wells recorded a sudden increase in NTU level, and thus automatically-shut themselves down. This resulted in a city-wide water outage. There was never any health impact of any sort due to adverse water quality. There were more than 6,000 customer complaints to the water company. Water outages occurred due to breakage of underground water pipes, of which there were about 231 repairs made. Over the past decade or so, the local water companies were aggressively replacing old fragile pipe with new seismic-resistant pipe, primarily using Kubota’s earthquake-resistant ductile iron pipe (DIP), which at the time of the earthquake, totaled 518 km of the total 4,470 km. The damage rate for the seismic resistant DIP was about 0.002 per km (1 minor leak). The damage rate for other types of pipe was about 13 times higher (about 30 times higher when including damage to appurtenances). There was also widespread damage to service laterals.

Water pipeline damage was concentrated in areas that sustained liquefaction, landslide and surface faulting. There were 16 fire ignitions. There was no wind at the time of either earthquake, and there was no fire spread.

Electric System. The main shock caused considerable damage to the electric system. Customer power outages peaked at nearly 477,000 customers, lasting about 6 hours, then decreased to nearly zero within 4.5 days of the main shock. The repair of the power system to pre-earthquake conditions will take many months of work. The damage included 60 kV to 220 kV equipment at 10 high voltage substations due to inertial shaking; landslides that required replacement of 30 high voltage transmission towers and poles; landslides to flumes and penstocks at 9 hydroelectric power plants; collapse and various damage of distribution poles and feeders. In one rural area, complete failure of the transmission system left customer without any source of power, which was temporarily addressed using169 portable generators to re-energize otherwise undamaged distribution.

Lessons learned.

The replacement of older water pipes with new earthquake-resistant water pipes substantially reduced the duration of water outages in Kumamoto area. The regulatory-requirement to turn off wells that show sudden increases in NTU, is possibly an unsuitable strategy for post-earthquake service. The strategy to have many emergency generators greatly reduced the duration of power outages to customers.

Keywords: Kumamoto, Water, Power