



FUNCTIONAL DAMAGE AND RESTORATION PROCESSES OF UTILITY LIFELINES IN THE 2016 KUMAMOTO EARTHQUAKE IN COMPARATIVE PERSPECTIVE

N. Nojima⁽¹⁾, Y. Maruyama⁽²⁾

⁽¹⁾ Professor, Department of Civil Engineering, Gifu University, Japan, nojima@gifu-u.ac.jp

⁽²⁾ Associate Professor, Department of Urban Environment Systems, Chiba University, Japan, ymaruyam@faculty.chiba-u.jp

Abstract

Functional damage and restoration processes of electric power, water and city gas supply systems are compared among three major earthquakes in Japan. Aiming at deepening objective understanding of the 2016 Kumamoto Earthquake, similarities and unique features of utility lifeline damage and restoration processes in the three events are discussed.

Keywords: The 2016 Kumamoto Earthquake, the 1995 Great Hanshin-Awaji Earthquake Disaster, the 2011 Great East Japan Earthquake Disaster, utility lifelines, functional damage, initial outage, restoration process, organizational efforts

1. Introduction

The 2016 Kumamoto Earthquake (April 14 and 16, 2016, $M_{JMA}=6.5$ and 7.3 , respectively) caused severe damage to lifeline facilities and resultant disruption of lifeline service. In this paper, key data related to functional damage and restoration of utility lifelines in the 2016 Kumamoto Earthquake are compared with those in the 1995 Great Hanshin-Awaji Earthquake Disaster and the 2011 Great East Japan Earthquake Disaster. The former was caused by the 1995 Hyogoken-Nambu Earthquake, Japan (inland crustal earthquake, $M_{JMA}=7.3$). The latter was caused by the 2011 off the Pacific Coast of Tohoku Earthquake, Japan (off-shore mega-thrust earthquake, $M_w=9.0$). Following abbreviations are used: electric power supply (E), water supply (W), city gas supply (G).

2. Comparison of initial outage and population exposure

Figure 1 compares initial outages in terms of the number of customers or households without lifeline service. It is commonly seen that the scale of initial outage is in the order of E , W and G . The 2016 event gives the least values among the three. Figure 2 compares population exposure (PEX) to various levels of JMA seismic intensity. By examining the relationships between PEX and initial outage, it has been found that initial outages are roughly in proportion to PEX to different levels of seismic intensity, implying the differences in functional fragility relationships. Figure 3 shows an example of E . Initial outage is approximately a half to one third of $PEX(I_{JMA}=5U+)$. As for W and G , $PEX(I_{JMA}=6L+)$ and $PEX(I_{JMA}=6U+)$ show good linearity, respectively.

3. Comparison of restoration process

For the 2016 event, Figure 4 shows the decreasing processes of disrupted number of customers or households, and Figure 5 shows restoration ratio representing the percent restored. Restoration ratios among three earthquake are compiled in Figure 6. Relative configurations of restoration curves are similar in the three events. It is commonly seen that the rapidness of service recoveries is in the order of E , W and G . However, restoration processes in the 2016 event were much more rapid than the other two events.

4. Comparison of organizational efforts for disaster response

Organizational efforts for disaster response were compared in the light of restoration works and emergency supply. Considering the scale of disaster, much efforts were devoted aiming at rapid functional recovery in the 2016 event. Such tendency can be markedly seen in deployment of restoration personnel and emergency supply measures in E and G .

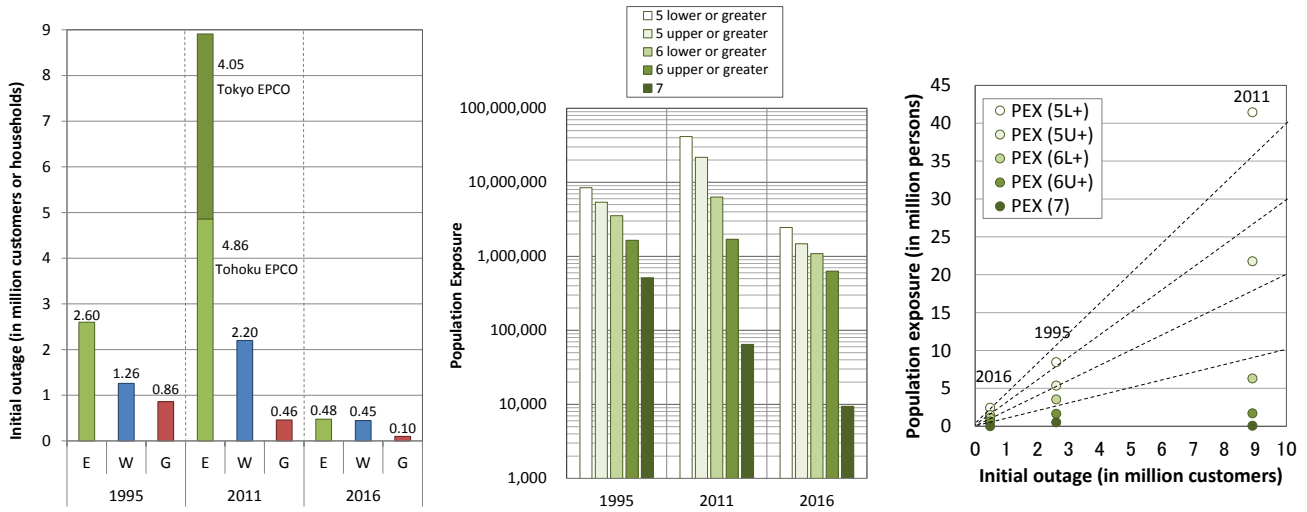


Fig. 1 – Initial outage Fig. 2 – Population exposure to seismic intensity Fig. 3 – PEX vs. power outage

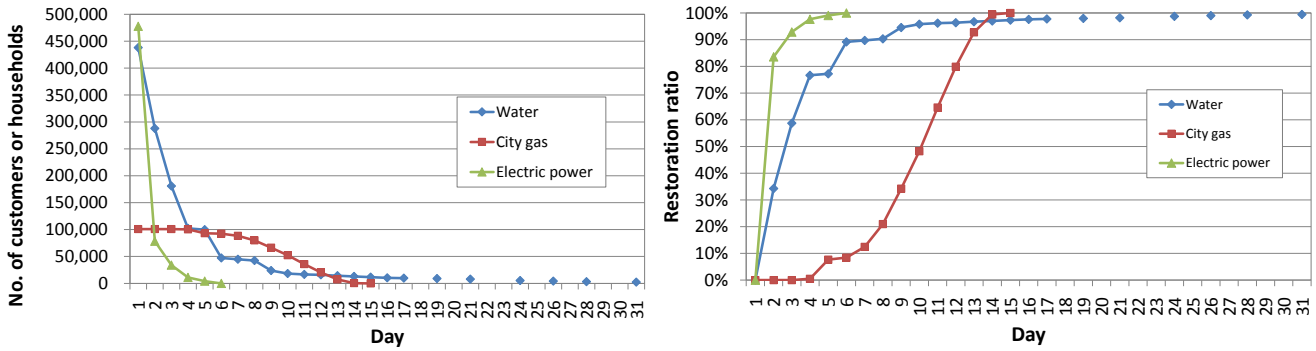


Fig. 4 – Number of customers or households without service Fig. 5 – Restoration ratio (1st day: April 16, 2016)

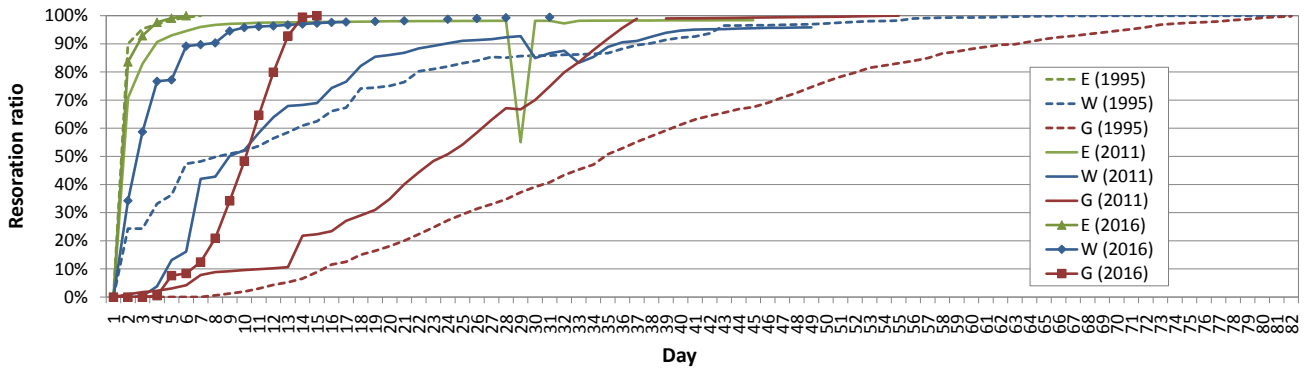


Fig. 6 – Restoration ratio in the three events (The first day is set to the day of occurrence of each earthquake.)

5. References

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