ABSTRACT

On September 28, 2018, a 7.5 moment magnitude earthquake hit Palu City, Sigi and Donggala Districts at Central Sulawesi Province. It triggered liquefaction which was followed by flow-slide. Gumbasa Irrigation Area was one of the affected public infrastructures that was suspected to have a role in liquefaction and flow-slide. Restoring it to operate as before required a reconstruction plan considering potential damage caused by the earthquake and liquefaction. The objective of this study was to identify the effect of Gumbasa Irrigation Area to liquefaction phenomena. In addition, this study assesses the performance of the mitigation plan applied on Gumbasa Irrigation Area (canal and rice field).

Begin with liquefaction potential assessment in the Gumbasa Irrigation Area around Jono Oge was determined by reviewing several factors that trigger liquefaction, i.e., (1) Geological and geotechnical condition; (2) Groundwater condition; and (3) Seismic condition. Gumbasa Irrigation's influence on liquefaction potential was examined using the Idris and Boulanger simplified method. It was simulated with several scenarios: (1) Groundwater table simulated the Gumbasa Irrigation Area non-operating condition (2) Groundwater table simulated the Gumbasa Irrigation Area on-operating condition. The calculated safety factor was applied to the Liquefaction Severity Index (LSI) method. The liquefaction potential analysis is used as a consideration for selecting the mitigation method. Two mitigation plans to be applied in the Gumbasa Irrigation Canal are evaluated, i.e., (1) implementing impermeable lining and geogrid; (2) applying impermeable lining and steel-sheet pile with drain. Each mitigation plan was compared using the finite element method in Plaxis 2D v8.6 to examine the stability and displacement mechanism.

The liquefaction potential assessment on several factors that trigger liquefaction concluded that the Gumbasa Irrigation Area still has liquefaction potential. It wass confirmed by *LSI* value ranges from 0 - 36.451 and classified as no-liquefied to moderate. The role of groundwater level was related to the liquefaction potential, and it occurred when the Gumbasa Irrigation Area was either on or off operating conditions. The first mitigation plan was identified as more effective to reduce displacement caused by earthquake and liquefaction potential. Applying impermeable lining and geogrid resulted the deformation during the maximum considered earthquake geometric mean only 242 mm. The lowering groundwater method was applied on Jono Oge rice fields area by maintaining the recommended groundwater level obtained from the simulation of groundwater level using the simplified method. Concluded that mitigation plans on irrigation canal by applying impermeable lining and geogrid and by lowering groundwater on the rice fields area were the best mitigation plan for Gumbasa Irrigation Area.

Keywords: Liquefaction, irrigation area, simplified method, mitigation plan, finite element method

INTISARI

Pada tanggal 28 September 2018, gempa berkekuatan magnitudo 7.5 mengguncang Kota Palu, Kabupaten Sigi dan Donggala di Provinsi Sulawesi Tengah. Hal tersebut memicu terjadinya likuefaksi yang diikuti oleh longsoran aliran. Daerah Irigasi Gumbasa merupakan salah satu infrastruktur publik yang terkena dampak. Untuk mengembalikan Daerah Irigasi Gumbasa agar dapat beroperasi seperti semula diperlukan rencana rekonstruksi yang mempertimbangkan potensi kerusakan akibat gempa dan likuefaksi. Penelitian ini bertujuan untuk mengidentifikasi pengaruh Daerah Irigasi Gumbasa terhadap fenomena likuefaksi. Selain itu, studi ini menilai kinerja rencana mitigasi yang diterapkan di Daerah Irigasi Gumbasa (saluran dan area persawahan).

Dimulai dengan penilaian potensi likuefaksi di Daerah Irigasi Gumbasa di sekitar Jono Oge ditentukan dengan meninjau beberapa faktor pemicu likuefaksi, yaitu (1) Kondisi geologi dan geoteknik; (2) Kondisi air tanah; dan (3) Kondisi seismik. Pengaruh Irigasi Gumbasa terhadap potensi likuefaksi diperiksa dengan menggunakan metode sederhana Idris dan Boulanger. Simulasi ini dilakukan dengan beberapa skenario: (1) simulasi muka air tanah Daerah Irigasi Gumbasa kondisi non-operasional (2) Mutasi muka air tanah simulasi Daerah Irigasi Gumbasa kondisi operasi. Perhitungan faktor keamanan diterapkan pada metode Liquefaction Severity Index *(LSI). Analisis potensi likuefaksi digunakan sebagai pertimbangan untuk memilih metode mitigasi. Dua rencana mitigasi yang akan diterapkan di Saluran Irigasi Gumbasa dievaluasi, yaitu, (1) penerapan lapisan kedap air dan geogrid; (2) menerapkan lapisan kedap air dan* steel-sheet pile *dengan saluran pembuangan. Setiap rencana mitigasi dibandingkan menggunakan metode elemen hingga di Plaxis 2D v8.6 untuk menguji stabilitas dan mekanisme perpindahan.*

Kajian potensi likuefaksi terhadap beberapa faktor pemicu likuefaksi menyimpulkan bahwa Daerah Irigasi Gumbasa masih memiliki potensi likuefaksi. Hal ini dibuktikan dengan nilai LSI yang berkisar antara 0 - 36,451 dan tergolong tidak-likuefaksi hingga sedang. Peran muka airtanah berkaitan dengan potensi likuefaksi, dan terjadi pada saat Daerah Irigasi Gumbasa dalam kondisi beroperasi maupun tidak beroperasi. Rencana mitigasi pertama diidentifikasi lebih efektif untuk mengurangi displacement akibat potensi gempa dan likuefaksi. Penerapan lapisan kedap air dan geogrid menghasilkan deformasi akibat gempa maksimum yang dipertimbangkan rata-rata geometrik sebesar 242 mm. Metode penurunan muka air tanah diterapkan pada areal persawahan Jono Oge dengan mempertahankan muka air tanah yang direkomendasikan, elevasi tersebut diperoleh dari simulasi muka air tanah menggunakan simplified method. *Disimpulkan bahwa rencana mitigasi pada saluran irigasi dengan menerapkan lapisan kedap air dan geogrid dan dengan menurunkan air tanah di area persawahan merupakan rencana mitigasi terbaik untuk Daerah Irigasi Gumbasa.*

Kata kunci: likuefaksi, area irigasi, simplified method*, rencana mitigasi, metode elemen hingga*