BAB 5
KESIMPULAN DAN SARAN

5.1 Kesimpulan

Berdasarkan analisis dan penelitian yang telah dilakukan terhadap pergerakan tanah di Desa Sibalaya, Kecamatan Tanambulava, Kabupaten Sigi, Sulawesi Tengah, Indonesia, maka dapat disimpulkan beberapa hal sebagai berikut :

1. Parameter karakteristik tanah di Desa Sibalaya pada sampel S1 memiliki berat jenis tanah (G_s) 2,63.
2. Parameter reologi tanah di Desa Sibalaya memiliki nilai viskositas (η) dan *yield stress* (τ_y) sebesar 0,067 Pa●s dan 2 kPa.
3. Arah dari *flowslides* pada analisis pergerakan tanah meggunakan program FLO-2D cenderung ke barat dan barat laut.
4. Daerah terdampak pergerakan tanah *flowslides* berdarkan analisis menggunakan program FLO-2D adalah sebesar 68,75 ha.
5. Aliran bergerak dengan rentang interval kecepatan (0,3 – 2) m/s atau (1,08 - 7,2) km/jam dengan rentang interval ketebalan pada daerah deposisi 0.01 m - 0,6 m.
6. *Flowslides* menyebabkan terjadinya pergeseran bangunan-bangunan di Desa Sibalaya yaitu pada rentang 250 m – 425 m.
7. Tindakan preventif dan mitigasi untuk mengurangi potensi resiko *flowslides* di masa mendatang yaitu dengan melakukan *mapping* daerah yang rawan dan beresiko terhadap terjadinya *flowslides* dan atau likuifaksi. Tidak menggunakan lahan tersebut sebagai tempat yang dihuni manusia karena dapat membahayakan, dibutuhkan relokasi untuk meminimalisir dampak apabila terjadi kembali *flowslides* dan atau likuifaksi di masa mendatang.

5.2 Saran

Berdasarkan analisis yang telah dilakukan, berikut ini merupakan beberapa hal yang disarankan penulis mengacu pada penelitian terhadap pergerakan tanah di Desa Sibalaya :

1. Penelitian lebih lanjut terhadap tanah di Desa Sibalaya agar dapat memprediksi pergerakan tanah yang mungkin terjadi di masa mendatang, sehingga dapat dilakukan antisipasi terlebih dahulu.
2. Diperlukan *mapping* daerah-daerah rawan *flowslides* dan atau likuifaksi di Sibalaya dan sekitarnya, guna mengurangi dampak yang akan terjadi apabila di masa mendatang kembali terjadi gempa bumi yang memicu terjadinya *flowslides* dan atau likuifaksi.
3. Perlu dilakukan evaluasi tata guna lahan terutama pada daerah zona rentan *flowslides*.
4. Perlu dilakukan peringatan dan penyuluhan terhadap masyarakat sekitar jika terjadi tanda-tanda pergerakan tanah

DAFTAR PUSTAKA

Atkinson, J. (1993). Stability of Slope. *An Introduction to the Mechanics of Soils and Foundations through Critical State Soil Mechanics*, 256-274.

Bartlett, S. F., dan Youd, T. L. (1992). *Empirical Analysis of Horizontal Ground Displacment Generated by Liquefaction-induced Lateral Spreads.* Buffalo: Technical Report NCEER-92-0021, National Center for Earthquake Engineeering Research, State University of New York.

Bird, P. (2003). An Updated Digital Model of Plate Boundaries. *Geochemisry, Geophysics, Geosystems*.

Bishop, A. W., Hutchinson, J. N., Penman, A. D., & Evans, H. E. (1969). *Geotechnical Investigations into the Causes and Circumstances of the Disaster of 21st October 1966.* London: HMSO.

Chigira, M., dan Yagi, H. (2005). *Geological and Geomorphological Characteristics of Landslides Triggered by the 2004 Niigata-ken Chuetsu Earthquake in Japan.* 82,202-221: Engineering Geology.

Cruden, D. M., dan Varnes, D. J. (1996). *Landslide Types and Processes, Special Report, Transportation Research Board.* National Academy of Sciences.

D'Agostino, V., dan Tecca, P. R. (2006). Some Considerations on The Application of The FLO-2D Model For Debris Flow Hazard Assessment. *Monitoring, Simulation, Prevention and Remediation of Dense and Debris Flow*, (hal. 160-170).

FLO-2D. (2007). *Data Input Manual*.

FLO-2D. (2007). *GDS Manual*.

FLO-2D. (2007). *Mapper Manual*.

FLO-2D. (2007). *Users Manual*.

Hungr, O., Evans, S., Bovis, M. J., & Hutchinson, J. N. (2001). A Review of the Classification of Landslides of the Flow Type. *Environmental Engineering Geoscience VII*, (pp. 221-238).

Hutchinson, J. R., dan Bhandari, R. K. (1971). Undrained Loading, a Fundamental Mechanism of Mudflows and Other Mass Movements. *Geotechnique*, vol.21,353-358.

Ishihara, K. (1966). Soil Behaviour in Earthquake Geotechnics. *Oxford University Press Inc*, New York, USA.

Ishihara, K. (1985). Stability of Natural Deposits During Earthquakes. *Proceedings, International Conference on Soil Mechanics and Foundation Engineering.* San Fransisco.

Kaharuddin, M. S., Hutagalung, R., & Nurhamdan. (2011). Perkembangan Tektonik dan Implikasinya terhadap Potensi Gempa dan Tsunami di Kawasan Pulau Sulawesi. *JCM Makassar 2011, 1 - 10.* Makassar: The 36th HAGI and 40th IAGI Annual Convention Exhibition, 26 - 29 September 2011.

Keefer, D. F. (1999). Earthquake-induced Landslides and Their Effects on Alluvial Fans. *Journal of Sedimentary Research*.

Keefer, D. K. (1984). Landslides caused by Earthquake. *Geological Society of America Bulletin*, 406-421.

Keefer, D. K. (2002). *Investigating Landslides caused by Earthquakes-A Historical Review.* USA: U.S. Geological Survey.

Keefer, D. K., dan Johnson, A. M. (1983). *Earth Flows-Morphology, Mobilization and Movement.* U.S: Geological Survey Proffesional Paper 1264.

Khazai, B., dan Sitar, N. (2003). *Evaluation of Factors Controlling Earthquake-Induced Landslides caused by Chi-Chi Earthquake Comparison with the Northridge and Loma Prieta Events.* UC Berkeley, USA: Department of Civil and Environmental Engineering.

Kokusho, T. (1999). Water Film in Liquefied Sand and Its Effect on Lateral Spread. *Journal of Geotechnical and Geoenvironmental Engineering*.

Koppejan, A. W., Wamelen, B. M., & Weinberg, L. J. (1948). Coastal Flow Slides in the Dutch Province of Zeland. *2 Proc. II ICSMFE,* (hal. Vol.5,89-96). Rotterdam,Holland.

Kramer , S. L. (1996). Geotechnical Earthquake Engineering. *Prentice-Hall*, New Jersey, USA.

Kramer, S. L., dan Seed, H. B. (1988). Initiation of Soil Liquefaction Under Static Loading Conditions. *Journal of Geotech Engineering*, vol.114, 412-430.

Krizek, R. J. (2004). *Slurries in Geotechnical Engineering 12th Spencer J.Buchanan Lecture.* Texas: Texas A&M University.

Kutter, B. L., dan Fiegel , G. L. (1991). Mechanism of Sand Boil Formation in Layered Soils as Observed in Centrifuge Tests. *Proceedings from the Third Japan-U.S. Workshop on Earthquake Resistant Design of Lifeline Facilities and Countermeasures for Soil Liquefaction* (hal. pp.279-292). Technical Report NCEER-91-0001.

Lin, H. S., Kogelmann, W., Walker, C., & Bruns , M. A. (2006). *Soil Moisture Patterns in a Forested Catchment: A hydropedological Perspective.* Geoderma.

Liu, H., dan Qiau, T. (1984). Liquefaction Potential of Saturated Sand Deposits Underlying Foundation of Structure. 199-206.

Lunne , T., Robertson , P. K., & Powel, J. J. (1997). *Cone Penetromeeter Testing in Geotechnical Practice.* London: Blackie Academic & Proffesional.

Milsom, J., Masson, D., Nichols, G., Sikumbang, N., Dwiyanto, B., Parson, L., & Kallagher, H. (1992). The Manokwari Trough and the Western End of the New Guinea Trench. *Tectonics 11 (1)*, 145-153.

National, R. C. (1985). Liquefaction of Soils during Earthquakes. *National Academy Press.* Washington, D.C.

Parise, M., dan Jibson, R. W. (2000). *A Seismic Landslide Suscpetibility Rating of Geologic Units Based on Analysis of Characteristics of Landslides Triggered by 17 January, 1994 Northridge, California Earthquake.* Engineering Geology.

Picarelli, L., Olivares, L., Comegna, L., & Damiano, E. (2008). Mechanical Aspects of Flow-like Movements in Granular and Fine-Grained Soils.

Rodriguez, C. E., Bommer, J. J., & Chandler, R. J. (1999). Earthquake-induced Landslides: 1980-1997. *Soil Dynamics and Earthquake Engineering 18*, 325-346.

Seed, H. B. (1987). The Liquefaction of Sands, a Collapse Surface Approach. *Journal of Geotechnical Engineering*.

Seed, H., dan Idriss, M. (1982). Ground Motions and Soil Liquefaction during Earthquakes. *Earthquake Engineering Research Institute,* Berkeley, USA.

Shroder, J. F. (1971). Landslide of Utah: Salt Lake City. *University of Utah, Utah Geological and Mineral Survey Bulletin*.

Sladen, J. A., D'HOLLANDER, R. D., & KRAHN, J. (1985). The Liquefaction of Sands, a Collapse Surface Approach. *Canadian Geotechnical Journal,22*.

Supartoyo, dan Surono. (2008). *Katalog Gempa Bumi Merusak di Indonesia Tahun 1629 - 2007.* Bandung: Pusat Vulkanologi dan Mitigasi Bencana Geologi.

Terzaghi, K., dan Peck, R. B. (1967). *Soil Mechanics in Engineering Practice,1st Ed.* Ney York: Wiley.

Tsuchida, H. (1970). Prediction and Countermeasure against Liqiuefaction in Sand Deposits. *Seminar of the Port and Harbour Research Institute, Ministry of Transport,* (hal. 3.1-3.3). Yokosuka,Japan.

USGS. (2004). *United States Geological Survey Facr Sheet 2004-3072*. Diambil kembali dari geology.com/usgs/landslides

Varnes, D. J. (1978). *Slope Movement Types and Processes.* Washington, D.C: Schuster RL, Krizek RJ (eds) Landslides, Analysis and Control, Special Report 176: Transportation Research Board, National Academy of Sciences.

Whitman, R. V. (1985). On Liquefaction. *Proceedings, 11th International Conference on Soil Mechanics and Foundation Engineering*, (hal. vol.4,pp.1923-1926).

Widjaja, B. (2017). *Perilaku Longsoran dan Mudflow Studi Kasus di Indonesia: Pendekatan Reologi.* Solo: Simposium Nasional RAPI XVI-2017 FT UMS.

Widjaja, B., dan Lee, S. H. (2013). Flow Box Test for Viscosity of Soil in Plastic and Viscous Liquid State. *Soils and Foundation*, 35-45.

Wikipedia. (2019, Mei 30). Diambil kembali dari https://en.wikipedia.org/wiki/Bingham_plastic

Woo, G. (1999). *The Mathematics of Natural Catastrophes.* London: Imperial College Press.

Youd, T. L. (1973). Liquefaction flow, and Associated Ground Failure. *U.S. Geological Survey Circular*.

Youd, T. L. (1978). Major cause of Earthquake Damage is Ground Failure. *Civil Engineering*.

Youd, T. L. (1984). Recurrences of Liquefaction at Same Site. *Proc., 8th World Conf. on Earthquake Engineering*, (hal. 231-238). San Fransisco.