BAB 8

KESIMPULAN DAN SARAN

8.1 Kesimpulan

Simpulan yang dapat diperoleh dari penilitian ini antara lain adalah:

1. Nilai *specific gravity* pada tanah volkanik dapat memberikan informasi awal perihal keberadaan *light mineral*.
2. Kajian indeks properti pada tanah volkanik berdasarkan nilai *specific gravity* akan semakin dikuatkan oleh hasil uji XRD dan XRF.
3. Batas-batas Atterberg tanah volkanik akan mengalami perubahan jika dilakukan pada kondisi preparasi atau kondisi awal/*initial state* (saat kadar air natural dan *air dried*) yang berbeda untuk kondisi uji kompaksi di laboratorium maupun pada saat uji kompaksi di lapangan.
4. Kondisi inisial pada kadar air tanah volkanik terkompaksi akan berpengaruh terhadap perubahan nilai *unconfined compression strength*.
5. Perubahan struktur terjadi pada tanah volkanik terkompaksi di lapangan untuk setiap jumlah gilasan *compactor*/mesin gilas (*number of roller passes*).
6. Terdapat kondisi anisotropi untuk tanah volkanik terkompaksi di lapangan. Kondisi anisotropi tersebut dinyatakan pada adanya perbedaan nilai modulus terkekang (*oedometric modulus*) pada kondisi arah cetak sample vertikal dan horizontal untuk uji konsolidasi/oedometer.
7. Struktur tanah volkanik terkompaksi akan hancur pada kondisi uji kompaksi di laboratorium dengan metoda dinamik *standard* Proctor.

8. Struktur tanah volkanik terkompaksi di laboratorium menyerupai struktur tanah terkompaksi di lapangan.
9. Kompaksi statik di laboratorium akan menghasilkan Kurva Energi - *Dry Density*, dimana kurva ini dapat digunakan untuk melakukan pendekatan energi yang akan digunakan di lapangan (jumlah lintasan *compactor*).
10. Kurva Energi – *Dry Density* untuk tanah volkanik terkompaksi yang diperoleh dari hasil uji kompaksi statik di laboratorium berada di bawah kurva yang diperoleh dari hasil uji kompaksi (pemadatan) di lapangan. Hal ini tersebut menunjukkan kecenderungan adanya *scale factor* (faktor skala) yang terjadi saat pemodelan kompaksi statik di laboratorium.
11. *Dry density* tanah volkanik tidak akan meningkat lagi jika energi pemadatan telah mencapai energi optimal.
12. Metoda atau prosedur uji kompaksi statik di laboratorium lebih prospektif untuk uji kompaksi di laboratorium untuk tanah volkanik karena lebih mendekati kondisi aktual uji pemadatan di lapangan jika dibandingkan dengan penggunaan metode atau prosedur uji kompaksi dinamik di laboratorium.

8.2 Saran

Saran untuk penelitian selanjutnya antara lain adalah:

1. Melakukan uji kompaksi statik di laboratorium dan uji pemadatan di lapangan untuk kondisi tanah volkanik dengan kandungan mineral dan batas-batas Aterrberg yang berbeda.
2. Melakukan kajian terhadap pebaikan tanah secara kimiawi untuk tanah volkanik.

3. Melakukan kajian terhadap energi terukur di laboratorium dengan padanannya pada beban untuk kelas jalan.
4. Kajian terhadap hukum konstitutif untuk tanah volkanik terkompaksi.
5. Kajian terhadap penentuan *yield stress* tanah volkanik terkompaksi.
6. Pengintegrasian data akuisisi ke PC saat uji kompaksi statik di laboratorium untuk *data record* dan *data processing.*

UNIVERSITAS KATOLIK
PARAHYANGAN
BAKUNING HYANG MRIH GUNA
SANTYAYA BHAKTI

DAFTAR PUSTAKA

Alonso, E.E., Pinyol, N.M. and Gens, A., (2013), *Compacted soil behaviour: intial state, structure and constitutive modeling*, Geotechnique 63, No. 6, pp. 463-478.

Altschaeffl, A.G., and Lovell, J.W. Jr., (1969), *Compaction variables and compaction specification*, Proc. 54th Annual Road School, Engineering Bulletin, Extension Series No. 131, Purdue University, pp. 116-133.

ASTM C 136, *Standard Test Methods for Sieve Analysis of Fine and Coarse Aggregates*, Annual Book of ASTM Standards.

ASTM C 837-09, *Standard Test Methods for Methylene Blue Index of Clay*, Annual Book of ASTM Standards.

ASTM D 1556-00, *Standard Test Methods for Density and Unit Weight of Soil in Place by the Sand-Cone Method*, Annual Book of ASTM Standards.

ASTM D 1557-02, *Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort*, Annual Book of ASTM Standards.

ASTM D 1883-99, *Standard Test Methods for CBR (California Bearing Ratio) of Laboratory-Compacted Soils*, Annual Book of ASTM Standards.

ASTM D 2166-00, *Standard Test Methods for Unconfined Compressive Strength of Cohesive Soils*, Annual Book of ASTM Standards.

ASTM D 2216-98, *Standard Test Methods for Laboratory Determination of Water (Moisture Content) of Soil and Rock by Mass*, Annual Book of ASTM Standards.

ASTM D 2435-03, *Standard Test Methods for One-Dimensional Consolidation Properties of Soils Using Incremental Loading*, Annual Book of ASTM Standards.

ASTM D 2487-00, *Standard Practice for Classification of soils for Engineering Purposes (Unified Soil Classificication System)*, Annual Book of ASTM Standards.

ASTM D 2850-03, *Standard Test Methods for Unconsolidated-Undrained Triaxial Compresion Test on Cohesive Soils*, Annual Book of ASTM Standards.

ASTM D 422-02, *Standard Test Methods for Particel Size Analysis of Soils*, Annual Book of ASTM Standards.

ASTM D 4318-10, *Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils*, Annual Book of ASTM Standards.

ASTM D 4643-00, *Standard Test Methods for Determination of Water (Moisture) Content os Soil by the Microwave Oven Heating*, Annual Book of ASTM Standards.

ASTM D 4767-02, *Standard Test Methods for Consolidated Undrained Triaxial Test for Cohesive Soils*, Annual Book of ASTM Standards.

ASTM D 4944-98, *Standard Test Methods for Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester Method*, Annual Book of ASTM Standards.

ASTM D 5298-03, *Standard Test Methods for Measurement of Soil Potential (Suction) Using Filter Paper*, Annual Book of ASTM Standards.

ASTM D 5856-02, *Standard Test Methods for Measurement of Hydraulic Conductivity of Porous Material Using Rigid-Wall, Compaction-Mold Permeameter*, Annual Book of ASTM Standards.

ASTM D 6951-09, *Standard Test Methods for Use of the Dynamic Cone Penetrometer in Shallow Pavement Application*, Annual Book of ASTM Standards.

ASTM D 698-00, *Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort*, Annual Book of ASTM Standards.

Blight, G.E. and Leong, E.C., (2012), *Mechanics of Residual Soils*, 2nd Ed., CRC Press, Taylor & Francis Group, Boca Raton.

Briaud, J.L., (2013), *Geotechnical Engineering: Unsaturated and Saturated Soils*, John Wiley and Sons, Hoboken, New Jersey.

Budhu, M, (2011), *Soil Mechanics and Foundations*, 3rd Ed., John Wiley & Sons, Hoboken, New Jersey.

Bulletin 151, (2017), *Tropical Residual Soils as Dam Foundation and Fill Material, International Commission on Large Dams*, CIGB, Paris.

Cokca E., (1991), *Swelling potential of expansive soils with a critical appraisal of the identification of swelling of Ankara soils by methylene blue tests,* PhD. Thesis, Department of Civil Engineering, Middle East Technical University, Ankara, Turkey, p. 246.

Das, B.M., Shoban, K, (2012), *Principles of Geotechnical Engineering*, 8th Ed., Cengage Learning, Standford, USA.

Echlin, P., (2009), *Handbook of Sample Preparation for Scanning Electron Microscopy and X-Ray Microanalysis*, Springer, UK.

Effendi, A.C., Kusnama, dan Hermanto, B., (1998), *Peta Geologi Lembar Bogor, Jawa*, Pusat Penelitian dan Pengembangan Geologi.

Eswaran, H., and Sys, C., (1970), *An Evaluation of The Free Iron in Tropical Basaltic Soils*, Pedologie 20, pp. 62-85.

Fredlund, D.G., Rahardjo, H., and Fredlund, M/D., (2012), *Unsaturated Soil Mechanics in Engineering Practice*, John Wiley & Sons, Hoboken, New Jesey.

Gurtug, Y., and Sridharan, A., (2004), *Compaction Behaviour and Prediction of Its Characteristics of Fine Grained Soils with Particular Reference to Compaction Energy*, Soil and Foundation – Japanese Geotechnical Society, Vol. 44, No. 5, pp. 27-36.

Hafez, M. A., Doris Asmani, M. Y., and Nurbaya, S., (2011), Static Laboratory Compaction Methods, EJGE, Vol. 16, pp. 1583–1593.

Hanif, M., (2021), *Simulasi Pemadatan Tanah di Lapangan dengan Uji Kompaksi Statis Laboratorium*, Skripsi, Program Studi Teknik Sipil, Universitas Katolik Parahyangan.

Hogentogler, C.A., (1937), *Engineering Properties of Soil*, McGraw-Hill Book Company, Inc., New York.

Holtz, R.D., Kovacs, W.D., and Sheahan, T.C., (1981), *An Introduction to Geotechnical Engineering*, 2nd Ed., Prentice Hall, New Jersey, USA.

Horpibulsuk, S., Suddeepong, A., Chamket, P., and Chinkulkijniwat, A., (2013), *Compaction behavior of fine-grained soils, lateritic soils and crushed rocks*, Soils and Foundations ;53(1), pp.166–172.

Huat, B.B.K, Toll, D.G and Prasad, A., (2013), *Hand Book of Tropical Residual Soils Engineering*, CRC Press, Taylor & Francis Group, Boca Raton.

Johnson, A.W., and Sallberg, J.R., (1960), *Factor that Influence Field Compaction of Soils*, Bulletin 272, Highway Research Board, pp. 206.

Kaech, A., (2013), *An Introduction to Electron Microscopy Instrumentation, Imaging and Preparation*, Center for Microscopy and Image Analysis, University of Zurich.

Karlinasari, R., (2009), *Penelitian Karakteristik Tanah Residual Tropik Vulkanik Formasi Hasil Gunung Api Tua (Qob) Jawa Barat*, Disertasi, Program Pasca Sarjana Doktor Ilmu Teknik Sipil, Universitas Katolik Parahyangan.

Kusuma, R.D., (2021), *Studi Laboratorium Uji Kompresibiltas dan Kuat Geser Hasil Penggilasan di Lapangan Tanah Lempung Daerah Lagadar Kota Cimahi*, Skripsi, Program Studi Teknik Sipil, Universitas Katolik Parahyangan.

Lambe, T.W., (1951), *Soil Testing for Engineers*, 2nd Ed., John Wiley & Sons, New York, USA.

Meshab, A., Morel, J. C., and Olivier, M., (1999), *Clayey Soil Behavior Under Static Compaction Test*, Mater. Struct., Vol. 32, No. 9, pp. 687–694.

Mitchell, J.K. and Soga, K., (2005), *Fundamentals of Soil Behaviour*, 3rd Ed., John Wiley & Sons, Hoboken, New Jersey.

Mueno, H.U., (2004), *Penentuan Nilai In-Situ Stress pada Tanah Residual Vulkanik Tropis dengan Alat Uji Flat Plate Dilamtometer dan Unpar Dual Dilatometer*, Disertasi, Program Pasca Sarjana Doktor Ilmu Teknik Sipil, Universitas Katolik Parahyangan.

Mueno, H.U., (2011), *Penentuan Parameter Geoteknik Tanah Residual Tropis Melalui Pengujian Dilatometer*, Jurnal Teknik Sipil, Jurnal Teoretis dan Terapan Bidang Rekayasa Sipil, Vol. 18, No.1, pp. 91 -102.

Munsell Soil Color Charts, (1975), Baltimore, Maryland.

Nagaraj, H.B., Reesha, B., Sravan, M.V., Suresh, M.R., (2015), *Correlation of Compaction Characteristics of Natural Soils with Modified Plastic Limit*, Transportation Geotechnics 2, pp. 65-77.

NCHRP Synthesis 456, (2014), Non-Nuclear Methods for Compaction Control of Unbound Materials, A Synthesis of highway Practice, Transportation Research Board, Ohio.

NF EN 933-9, (1999), *Part 9: Assesment of Fines – Metyhelene Blue Test*, AFNOT, France.

NF P 94-068, (1999), *Determination de la valuer de blue de methylene d'un sol ou d'un materiau rocheux*, ARVOR Geotechnique, Ingenierie des sols et des fondations.

Pandian, N.S., Nagaraj, T.S., and Sivakumar Babu, G.L., (1993), *Tropical Clays, I: Index Properties and Microstructural Aspects*, Journal of Geotechnical Engineering, Vol. 119, No. 5, May, pp. 826-839.

Pickens, G.A., (1980), *Alternative compaction specifications for non-uniform fill materials,* Proc. Third Australia-New Zealand Conf. on Geomechanics, Wellington, Vol. 1, pp. 231–235.

Prasetyo, D., (2021), *Simulasi Pemadatan Lapangan dengan Metode Statik*, Skripsi, Program Studi Teknik Sipil, Universitas Katolik Parahyangan.

Proviteq *Catalogue General Saison 4*, Materiel De Laboratorie Pour Le Genie Civil

Rahardjo, P.P., dan Santosa, T.M., (2002), *Karakteristik Tanah Ekspansif di Daerah Cikarang, Jawa Barat*, GEC, Bandung.

Reddy Venkatarama, B. V. and Jagadish, K. S., (1993), *The Static Compaction of Soils, Ge´otechnique*, Vol. 43, No. 2, pp. 337–341.

Reddy, K., (2002), *Experiment 7: Atterberg Limits*, Engineering Properties of Soils Based on Laboratory Testing, pp. 60-72.

Rinaldi, H.A., (2021), *Kajian Nilai CBR pada Model Uji Penggilasan di Lapangan Menggunakan Dynamic Cone Penetrometer*, Skripsi, Program Studi Teknik Sipil, Universitas Katolik Parahyangan.

Rodrigues, A.R., del Castillo, H., Sowers, G.F., (1988), *Soil Mechanics in Highway Engineering*, 7th Ed., Trans Tech Publication, Clausthal-Zellerfeld, Germany.

Sharma, B., Deka, A., (2016), *Static Compaction Test and Determination of Equivalent Static Pressure,* Indian Geotechnical Conference IGC2016.

Sharma, B., Sridharan, A., Talukdar, P., (2016), *Static Method to Determine Compaction Characteristics of Fine-Grained Soils,* Geotechnical Testing Journal, doi:10.1520/GTJ20150221.

Shoji, S., Nanzyo, M., and Dahlgren, R.A., (1993), *Volcanic Ash Soils*, Elsevier, Tokyo.

Silitonga, P. H., (1973), *Peta Geologi Lembar Bandung, Jawa*, Pusat Penelitian dan Pengembangan Geologi.

Sridharan, A. and Nagaraj, H.B., (2005), *Plastic Limit and Compaction Characteristics of Finegrained Soils,* Ground Improvement 9, No. 1, Pp. 17–22.

Sudjatmiko, (1972), *Peta Geologi Lembar Cianjur, Jawa*, Pusat Penelitian dan Pengembangan Geologi.

Sulastri, Y., (2020), *Kajian Karakteristik Anisotropy Tanah Vulkanik Bogor*, Tesis, Program Magister Teknik Sipil, Program Pascasarjana, Universitas Katolik Parahyangan.

Suryanarayana, C., and Grant Norton, M., (1998), *X-Ray Diffraction A Pratical Approach*, Springer Science+Business Media, LLC, New York.

Talukdar, P., Sharma, B., (2014), *Determination of Compaction Characteristics of Soil by Static Compaction Method*, NES-Geocongress 2014, IIT-Guwahati.

Tatsuoka, F., Fujishiro, K., Tateyama, K., Kawabe, S., and Kikuchi, Y., (2015), *Properties of Compacted Soil as A Function of Dry Density and The Degree of Saturation*, Japanese Geotechnical Society Special Publication, Vol. 2, Issue 4, pp. 247-252.

Tatsuoka, F and Correia, A.G., (2016), *Importance of Controlling the Degree of Saturation in Soil Compaction*, Procedia Engineering, Vol.143, pp. 556–565.

Toms, T, Philip, J.G., (2013), *Prediction of Compaction Characteristics from Atterberg Limits and Specific Gravity for Kuttanad Soil,* International Journal of Science and Research, Vol. 5, Issue 8, pp. 1146-1149.

Turkos, M. and Tosun, H., (2011), *The use of methylene blue test for predicting swell parameters of natural clay soils*, Scientific Research and Essays, Vol. 6(8), pp. 1780-1792.

Wesley, L., (2009), *Behaviour and Geotechnical Properties of Residual Soils and Allophane Clays*, Obras y Proyectors 6.

Wesley, L.D., (1973), *Some Basic Engineering Properties Of Halloysite and Allophane Clays In Java,Indonesia*, Geotehnique, 23, No. 4, pp. 471-494.

Wesley, L.D., (1977), *Cluster Hypothesis and The Shear Strength of a Tropical Red Clay,* The Institution of Civil Engineers, London, pp. 109-113.

Wesley, L.D., (1977), *Shear Strength Properties of Halloysite and Allophane Clays in Java, Indonesia*, Geotehnique, 27, No. 2, pp. 125-136.

Wesley, L.D., (2010), *Fundamentals of Soil Mecahnics for Sedimentary and Residual Soils*, John Wiley & Sons, New Jersey.

Wesley, L.D., (2010), *Geotechnical Engineering in Residual Soils*, John Wiley & Sons, Hoboken, New Jersey.

Wibowo, Y.S., (2011), *Perilaku Sifat Fisik dan Keteknikan Tanah Residual Batuan Volkanik Kuarter di Daerah Cikijing, Majalengka, Jawa Barat*, Riset Geologi dan Pertambangan, Vol. 21, No. 2, pp. 131-139.

Wibowo, Y.S., Sugiarti, K, and Soebowo, E., (2017), *Characteristic and Engineering Properties of Residual Soil of Volcanic Deposit*, Global Colloquium on GeoSciences and Engineering, pp. 1-6.

XP CEN ISO/TS 17892-3, (2005), *Laboratory Testing of Soil-Part 3: Determination of Particle Density – Pycnometer Method*, French Standardizaation, Geotechnical Investigation and Testing.

Yaghoubi, E., M. M. Disfani, A. Arulrajah, and Kodikara, J., (2017), *Impact of compaction method on mechanical characteristics of unbound granular recycled materials*, Road Materials and Pavement Design, DOI: 10.1080/14680629.2017.1283354.

Yusoff, S.A., Bakar, I., Wijeyesekera, D.C., Zainorabidin, A., M. Azmi, and Ramli, H., (2017), *The Effects of Different Compaction Energy On Geotechnical Properties Of Kaolin And Laterite*, AIP Conference Proceedings 1875, pp. 030009-4–030009-7.

Zhemchuzhnikov A., Gavami, K dan Casagrande, M.D.T., (2015), *Static Compaction of Soils with Varying Clay Content*, Key Engineering Materials, Vol. 668, pp. 238-246.