# DAFTAR PUSTAKA


Budiman, 2013. *Pengaruh Penambahan Abu Ampas Tebu Terhadap Sifat Fisik dan Sifat Mekanik Tanah Lempung Ekspansif*. Universitas Udayana. Denpasar.

Damanhuri, Enri dan Tri Padmi. 2010. *Diktat Kuliah Pengelolaan Sampah*. Bandung: ITB.

Darwis. 2017. *Dasar-Dasar Teknik Perbaikan Tanah.* Penerbit Pustaka AQ: Yogyakarta

E. Sutarman (2013). *Konsep dan Aplikasi Mekanika Tanah*, Edisi ke I, Penerbit Andi: Yogyakarta.

Fatoni, Mochamad. 2014. *Tinjauan Kuat Tekan Bebas dan Permeabilitas terhadap Tanah Lempung yang Distabilisasi dengan Kapur dan Abu Ampas Tebu.* Universitas Muhammadiyah Surakarta.

Google Earth. 2018. Peta Citra, Sungai Jene'berang Desa Sokkolia Kecamatam Bontomarannu Kabupaten Gowa.

Hafiz, M Imam, Dkk. 2019. Stabilisasi Tanah Lempung Menggunakan Bahan Tambahan Abu Ampas Tebu. Politeknik Negeri Sriwijaya. Palembang.

Hardiyatmo, H.C. 2001. Prinsip-prinsip Mekanika Tanah dan Soal Penyelesaian I (1st ed). Yogyakarta: Beta Offset.

Hardiyatmo, H.C. 2002. Mekanika Tanah I (3rded). Yogyakarta : Gadjah Mada University Press. Teknologi Bandung.

Jin, T, dkk. 2011. *Ethanol separation from ethanol aqueous solution by pervaporationusing hydrophobic mesoporous silica membrane.* journal of Ceramic Society of Japan. 119 (7).

Jun He, dkk. 2015. *Modified Sewage Sludge As Temporary Landfill Cover Material.* Universitas Teknologi Hubei, Wuhan.

Kementrian ESDM. 2006. *Peraturan Mentri Energi dan Sumber Daya Mineral* No. 045 Tahun 2006. Tentang Pengelolaan Lumpur Bor, Limbah Lumpur dan Serbuk Bor Pada Kegiatan Pengeboran Minyak dan Gas Bumi.

L.D.Wesley (2017). *Mekanika Tanah.* Edisi ke II, Penerbit Andi: Yogyakarta.

L.D.Wesley (2012). *Mekanika Tanah, untuk Tanah Endapan dan Residu.* Edisi ke I, Penerbit Andi: Yogyakarta.

Nurdin, Sukiman. 2016. *Kinerja Tanah Lunak Stabilisasi Fly Ash dengan Perkuatan Serat Alami sebagai Lapis Penutup Landfill*. Universitas Hasanuddin: Makassar

Qian, X.D., Shi, J.Y., Liu, X.D., 2010. *Modern Sanitary Landfill Design and Construction*. China Construction Industry Press, Beijing (in Chinese).

SNI Nomor 19-2425:2002. Tentang Tata Cara Teknik Operasional Pengelolaan Persampahan Perkotaan.

Susianto, Tiyongko Adi. 2017. *Studi Perencanaan Tempat Pemrosesan Akhir Sampah Sanitary Landfill Lempeni Kabupaten Lumajang.* Universitas Muhammadiyah Malang.

Tchobanoglous, G., et al. (1993). *Integrated Solid Waste Management*. McGrawHill. New York.

Undang-undang Republik Indonesia Nomor 18 Tahun 2008 Tentang Pengelolaan Sampah. Jakarta: Sekretariat Negara.

US. EPA. 1994. Clean Water Act, sec. 503. (U.S. Environmental Protection Agency Washingtion, D.C.). 58(32).

US. EPA. *Guidance Note on Daily and Intermediate Cover at Landfills*, Environmental Protection Agency, Wexford, Ireland, 2014.

Vigneswaran. 2019. *Water And Wastewater Treatment Technologies*. University of Technology, Sydney.

Wisnumurti, dkk. 2007. *Pengaruh Penggunaan Akselerator Megaset Merah di Bawah Dosis Optimal Terhadap Kuat Tekan Beton dengan berbagai Variasi Umur Beton.* Universitas Brawijaya Malang.

Xihun Fan, dkk. 2019. *Increasing the Hydraulic Conductivity of Solidified Sewage sSludge for Use as Temporary Landfill Cover.* Universitas Hohai. China.

# LAMPIRAN

## PERHITUNGAN PERMEABILITAS LUMPUR LIMBAH

| **Permeabilitas Lumpur Limbah** | |
|---|---|
| *Volume of Specimen, V* | 384,17 |
| *Specific Gravity of Soil Solids, $G_s$* | 2.158 |
| *Mass of specimen tube with fittings, $W_1$ (g)* | 1320.77 |
| *Mass of tube with fittings and specimen, $W_2$ (g)* | 1785.76 |
| *Dry density of specimen,* $\rho_{dry}$ | 7.79 |
| *Void ratio of specimen, e* | 0.15 |

| **Test No.** | **1** | **2** | **3** |
|---|---|---|---|
| *Average flow, Q* | 690 | 785 | 865 |
| *Time of collection, t* | 60 | 60 | 60 |
| *Temperature of water, T* | 28 | 28 | 28 |
| *Head difference, h* | 50 | 60 | 70 |
| *Diameter of specimen, D* | 6.44 | 6.44 | 6.44 |
| *Length of Specimen, L* | 11.80 | 11.80 | 11.80 |
| *Area of specimen, A* | 32.56 | 32.56 | 32.56 |
| $k = \frac{Q\ L}{A\ h\ t}$ *(cm/s)* | 0.0834 | 0.0790 | 0.0746 |
| *Average k* | 0,0790 | | |

## PERHITUNGAN PERMEABILITAS TANAH

| **Permeabilitas Tanah** | |
|---|---|
| *Volume of Specimen, V* | 384,17 |
| *Specific Gravity of Soil Solids, $G_s$* | 2.158 |
| *Mass of specimen tube with fittings, $W_1$ (g)* | 1320.77 |
| *Mass of tube with fittings and specimen, $W_2$ (g)* | 1785.76 |
| *Dry density of specimen,* $\rho_{dry}$ | 7.79 |
| *Void ratio of specimen, e* | 0.15 |

| **Test No.** | **1** | **2** | **3** |
|---|---|---|---|
| *Average flow, Q* | 690 | 785 | 865 |
| *Time of collection, t* | 60 | 60 | 60 |
| *Temperature of water, T* | 28 | 28 | 28 |
| *Head difference, h* | 50 | 60 | 70 |
| *Diameter of specimen, D* | 6.44 | 6.44 | 6.44 |
| *Length of Specimen, L* | 11.80 | 11.80 | 11.80 |
| *Area of specimen, A* | 32.56 | 32.56 | 32.56 |
| $k = \frac{Q\ L}{A\ h\ t}$ *(cm/s)* | 0.0834 | 0.0790 | 0.0746 |
| *Average k* | 0,0790 | | |

**PERHITUNGAN PERMEABILITAS CAMPURAN LUMPUR LIMBAH, ABU AMPAS TEBU DAN TANAH**

**Pengujian menggunakan air**

| **Permeabilitas Variasi 0% Abu Ampas Tebu (Abu Ketel)** | |
|---|---|
| *Volume of Specimen, V* | 302.7780168 |
| *Specific Gravity of Soil Solids, $G_s$* | 2.661 |
| *Mass of specimen tube with fittings, $W_1$ (g)* | 1191 |
| *Mass of tube with fittings and specimen, $W_2$ (g)* | 1622 |
| *Dry density of specimen,* | 1.42 |
| *Void ratio of specimen, e* | 1.166854492 |

| **Test No.** | **1** | **2** |
|---|---|---|
| *Diameter of specimen, D* | 6.44 | 6.44 |
| *Length of Specimen, L* | 9.30 | 9.30 |
| *Area of specimen, A* | 32.56 | 32.56 |
| *Beginning Head difference, $h_1$* | 35 | 30 |
| *Ending head difference, $h_2$* | 20 | 20 |
| *Time of collection, t* | 6662.33 | 4762.18 |
| *volume of water flow through the specimen, Vw* | 8.9 | 6.5 |
| $k = 2{,}303\frac{V_w\, L}{(h_1 - h_2)\, A\, t} \log\frac{h_1}{h_2}$ *(cm/s)* | 0.000014 | 0.000016 |
| *Average k* | 0.000015 | |

| **Permeabilitas Variasi 5% Abu Ampas Tebu (Abu Ketel)** | |
|---|---|
| *Volume of Specimen, V* | 302.7780168 |
| *Specific Gravity of Soil Solids, $G_s$* | 2.647 |
| *Mass of specimen tube with fittings, $W_1$ (g)* | 1191 |
| *Mass of tube with fittings and specimen, $W_2$ (g)* | 1644 |
| *Dry density of specimen,* | 1.50 |
| *Void ratio of specimen, e* | 1.098403951 |

| **Test No.** | **1** | **2** |
|---|---|---|
| *Diameter of specimen, D* | 6.44 | 6.44 |
| *Length of Specimen, L* | 9.30 | 9.30 |
| *Area of specimen, A* | 32.56 | 32.56 |
| *Beginning Head difference, $h_1$* | 35 | 30 |
| *Ending head difference, $h_2$* | 20 | 20 |
| *Time of collection, t* | 7192.17 | 6113.31 |
| *volume of water flow through the specimen, Vw* | 10.0 | 7.0 |
| $k = 2{,}303\frac{V_w\, L}{(h_1 - h_2)\, A\, t} \log\frac{h_1}{h_2}$ *(cm/s)* | 0.000015 | 0.000013 |
| *Average k* | 0.000014 | |

| **Permeabilitas Variasi 10% Abu Ampas Tebu (Abu Ketel)** | |
|---|---|
| *Volume of Specimen, V* | 302.7780168 |
| *Specific Gravity of Soil Solids, $G_s$* | 2.646 |
| *Mass of specimen tube with fittings, $W_1$ (g)* | 1195 |
| *Mass of tube with fittings and specimen, $W_2$ (g)* | 1663 |
| *Dry density of specimen,* | 1.546 |
| *Void ratio of specimen, e* | 1.065 |

| **Test No.** | **1** | **2** |
|---|---|---|
| *Diameter of specimen, D* | 6.44 | 6.44 |
| *Length of Specimen, L* | 9.30 | 9.30 |
| *Area of specimen, A* | 32.56 | 32.56 |
| *Beginning Head difference, $h_1$* | 45 | 40 |
| *Ending head difference, $h_2$* | 20 | 20 |
| *Time of collection, t* | 19271.42 | 17146.01 |
| *volume of water flow through the specimen, Vw* | 25.0 | 21.0 |
| $k = 2{,}303 \frac{V_w L}{(h_1 - h_2) A t} \log \frac{h_1}{h_2}$ *(cm/s)* | 0.000012 | 0.00001213 |
| *Average k* | 0.00001207 | |

| **Permeabilitas Variasi 20% Abu Ampas Tebu (Abu Ketel)** | |
|---|---|
| *Volume of Specimen, V* | 302.7780168 |
| *Specific Gravity of Soil Solids, $G_s$* | 2.635 |
| *Mass of specimen tube with fittings, $W_1$ (g)* | 1191 |
| *Mass of tube with fittings and specimen, $W_2$ (g)* | 1640 |
| *Dry density of specimen,* | 1.483 |
| *Void ratio of specimen, e* | 1.103 |

| **Test No.** | **1** | **2** |
|---|---|---|
| *Diameter of specimen, D* | 6.44 | 6.44 |
| *Length of Specimen, L* | 9.30 | 9.30 |
| *Area of specimen, A* | 32.56 | 32.56 |
| *Beginning Head difference, $h_1$* | 35 | 30 |
| *Ending head difference, $h_2$* | 20 | 20 |
| *Time of collection, t* | 3753.42 | 2535.31 |
| *volume of water flow through the specimen, Vw* | 5.10 | 3.5 |
| $k = 2{,}303 \frac{V_w L}{(h_1 - h_2) A t} \log \frac{h_1}{h_2}$ *(cm/s)* | 0.000014 | 0.00001599 |
| *Average k* | 0.00001524 | |

| **Permeabilitas Variasi 30% Abu Ampas Tebu (Abu Ketel)** | |
|---|---|
| *Volume of Specimen, V* | 302.7780168 |
| *Specific Gravity of Soil Solids, $G_s$* | 2.631 |
| *Mass of specimen tube with fittings, $W_1$ (g)* | 1192 |
| *Mass of tube with fittings and specimen, $W_2$ (g)* | 1641 |
| *Dry density of specimen,* | 1.483 |
| *Void ratio of specimen, e* | 1.100 |

| **Test No.** | **1** | **2** |
|---|---|---|
| *Diameter of specimen, D* | 6.44 | 6.44 |
| *Length of Specimen, L* | 9.30 | 9.30 |
| *Area of specimen, A* | 32.56 | 32.56 |
| *Beginning Head difference, $h_1$* | 35 | 30 |
| *Ending head difference, $h_2$* | 20 | 20 |
| *Time of collection, t* | 3569.27 | 2618.84 |
| *volume of water flow through the specimen, Vw* | 5.4 | 4.2 |
| $k = 2{,}303 \frac{V_w L}{(h_1 - h_2) A t} \log \frac{h_1}{h_2}$ *(cm/s)* | 0.000016 | 0.00001858 |
| *Average k* | 0.00001735 | |

| **Permeabilitas Variasi 40% Abu Ampas Tebu (Abu Ketel)** | |
|---|---|
| *Volume of Specimen, V* | 302.7780168 |
| *Specific Gravity of Soil Solids, $G_s$* | 2.629 |
| *Mass of specimen tube with fittings, $W_1$ (g)* | 1192 |
| *Mass of tube with fittings and specimen, $W_2$ (g)* | 1626 |
| *Dry density of specimen,* | 1.433 |
| *Void ratio of specimen, e* | 1.136 |

| **Test No.** | **1** | **2** |
|---|---|---|
| *Diameter of specimen, D* | 6.44 | 6.44 |
| *Length of Specimen, L* | 9.30 | 9.30 |
| *Area of specimen, A* | 32.56 | 32.56 |
| *Beginning Head difference, $h_1$* | 35 | 30 |
| *Ending head difference, $h_2$* | 20 | 20 |
| *Time of collection, t* | 7406.19 | 5429.47 |
| *volume of water flow through the specimen, Vw* | 13.0 | 10.0 |
| $k = 2{,}303 \frac{V_w L}{(h_1 - h_2) A t} \log \frac{h_1}{h_2}$ *(cm/s)* | 0.000019 | 0.00002134 |
| *Average k* | 0.00002002 | |

**Pengujian menggunakan larutan etanol**

| **Permeabilitas Variasi 0% Abu Ampas Tebu (Abu Ketel)** | |
|---|---|
| *Volume of Specimen, V* | 302.7780168 |
| *Specific Gravity of Soil Solids, $G_s$* | 2.661 |
| *Mass of specimen tube with fittings, $W_1$ (g)* | 1193 |
| *Mass of tube with fittings and specimen, $W_2$ (g)* | 1610 |
| *Dry density of specimen,* | 1.38 |
| *Void ratio of specimen, e* | 1.206029463 |

| **Test No.** | **1** | **2** |
|---|---|---|
| *Diameter of specimen, D* | 6.44 | 6.44 |
| *Length of Specimen, L* | 9.30 | 9.30 |
| *Area of specimen, A* | 32.56 | 32.56 |
| *Beginning Head difference, $h_1$* | 35 | 30 |
| *Ending head difference, $h_2$* | 20 | 20 |
| *Time of collection, t* | 3374.37 | 2754.66 |
| *volume of water flow through the specimen, Vw* | 12.0 | 10.0 |
| $k = 2{,}303 \frac{V_w L}{(h_1 - h_2) A t} \log \frac{h_1}{h_2}$ *(cm/s)* | 0.000038 | 0.000042 |
| *Average k* | 0.000040 | |

| **Permeabilitas Variasi 5% Abu Ampas Tebu (Abu Ketel)** | |
|---|---|
| *Volume of Specimen, V* | 302.7780168 |
| *Specific Gravity of Soil Solids, $G_s$* | 2.647 |
| *Mass of specimen tube with fittings, $W_1$ (g)* | 1192 |
| *Mass of tube with fittings and specimen, $W_2$ (g)* | 1635 |
| *Dry density of specimen,* | 1.46 |
| *Void ratio of specimen, e* | 1.12567809 |

| **Test No.** | **1** | **2** |
|---|---|---|
| *Diameter of specimen, D* | 6.44 | 6.44 |
| *Length of Specimen, L* | 9.30 | 9.30 |
| *Area of specimen, A* | 32.56 | 32.56 |
| *Beginning Head difference, $h_1$* | 35 | 30 |
| *Ending head difference, $h_2$* | 20 | 20 |
| *Time of collection, t* | 6480.00 | 5107.45 |
| *volume of water flow through the specimen, Vw* | 15.0 | 10.0 |
| $k = 2{,}303 \frac{V_w L}{(h_1 - h_2) A t} \log \frac{h_1}{h_2}$ *(cm/s)* | 0.000025 | 0.000023 |
| *Average k* | 0.0000237 | |

| Permeabilitas Variasi 10% Abu Ampas Tebu (Abu Ketel) | |
|---|---|
| *Volume of Specimen, V* | 302.7780168 |
| *Specific Gravity of Soil Solids, $G_s$* | 2.646 |
| *Mass of specimen tube with fittings, $W_1$ (g)* | 1192 |
| *Mass of tube with fittings and specimen, $W_2$ (g)* | 1635 |
| *Dry density of specimen,* | 1.463 |
| *Void ratio of specimen, e* | 1.125 |

| **Test No.** | **1** | **2** |
|---|---|---|
| *Diameter of specimen, D* | 6.44 | 6.44 |
| *Length of Specimen, L* | 9.30 | 9.30 |
| *Area of specimen, A* | 32.56 | 32.56 |
| *Beginning Head difference, $h_1$* | 35 | 30 |
| *Ending head difference, $h_2$* | 20 | 20 |
| *Time of collection, t* | 5329.40 | 3661.71 |
| *volume of water flow through the specimen, Vw* | 10.0 | 5.8 |
| $k = 2{,}303 \frac{V_w L}{(h_1 - h_2) A t} \log \frac{h_1}{h_2}$ *(cm/s)* | 0.000020 | 0.00001829 |
| *Average k* | 0.00001914 | |

## Pengujian menggunakan larutan $CaCl_2$

| Permeabilitas Variasi 0% Abu Ampas Tebu (Abu Ketel) | |
|---|---|
| *Volume of Specimen, V* | 302.7780168 |
| *Specific Gravity of Soil Solids, $G_s$* | 2.661 |
| *Mass of specimen tube with fittings, $W_1$ (g)* | 1192 |
| *Mass of tube with fittings and specimen, $W_2$ (g)* | 1535 |
| *Dry density of specimen,* | 1.13 |
| *Void ratio of specimen, e* | 1.466222408 |

| **Test No.** | **1** | **2** |
|---|---|---|
| *Diameter of specimen, D* | 6.44 | 6.44 |
| *Length of Specimen, L* | 9.30 | 9.30 |
| *Area of specimen, A* | 32.56 | 32.56 |
| *Beginning Head difference, $h_1$* | 35 | 30 |
| *Ending head difference, $h_2$* | 20 | 20 |
| *Time of collection, t* | 1517.18 | 1182.10 |
| *volume of water flow through the specimen, Vw* | 15.0 | 10.0 |
| $k = 2{,}303 \frac{V_w L}{(h_1 - h_2) A t} \log \frac{h_1}{h_2}$ *(cm/s)* | 0.000105 | 0.000098 |
| *Average k* | 0.000102 | |

| **Permeabilitas Variasi 5% Abu Ampas Tebu (Abu Ketel)** | |
|---|---|
| *Volume of Specimen, V* | 302.7780168 |
| *Specific Gravity of Soil Solids, $G_s$* | 2.647 |
| *Mass of specimen tube with fittings, $W_1$ (g)* | 1192 |
| *Mass of tube with fittings and specimen, $W_2$ (g)* | 1590 |
| *Dry density of specimen,* | 1.31 |
| *Void ratio of specimen, e* | 1.25295325 |

| **Test No.** | **1** | **2** |
|---|---|---|
| *Diameter of specimen, D* | 6.44 | 6.44 |
| *Length of Specimen, L* | 9.30 | 9.30 |
| *Area of specimen, A* | 32.56 | 32.56 |
| *Beginning Head difference, $h_1$* | 35 | 30 |
| *Ending head difference, $h_2$* | 20 | 20 |
| *Time of collection, t* | 4552.17 | 3413.31 |
| *volume of water flow through the specimen, Vw* | 15.0 | 10.0 |
| $k = 2{,}303 \frac{V_w L}{(h_1 - h_2) A t} \log \frac{h_1}{h_2}$ *(cm/s)* | 0.000035 | 0.000034 |
| *Average k* | 0.0000345 | |

| **Permeabilitas Variasi 0% Abu Ampas Tebu (Abu Ketel)** | |
|---|---|
| *Volume of Specimen, V* | 302.7780168 |
| *Specific Gravity of Soil Solids, $G_s$* | 2.646 |
| *Mass of specimen tube with fittings, $W_1$ (g)* | 1192 |
| *Mass of tube with fittings and specimen, $W_2$ (g)* | 1639 |
| *Dry density of specimen,* | 1.476 |
| *Void ratio of specimen, e* | 1.115 |

| **Test No.** | **1** | **2** |
|---|---|---|
| *Diameter of specimen, D* | 6.44 | 6.44 |
| *Length of Specimen, L* | 9.30 | 9.30 |
| *Area of specimen, A* | 32.56 | 32.56 |
| *Beginning Head difference, $h_1$* | 35 | 30 |
| *Ending head difference, $h_2$* | 20 | 20 |
| *Time of collection, t* | 4757.46 | 4376.19 |
| *volume of water flow through the specimen, Vw* | 14.2 | 6.7 |
| $k = 2{,}303 \frac{V_w L}{(h_1 - h_2) A t} \log \frac{h_1}{h_2}$ *(cm/s)* | 0.000032 | 0.00001763 |
| *Average k* | 0.00002469 | |

## DOKUMENTASI PENGAMBILAN DATA DI LABORATORIUM

### A. Dokumentasi Pengujian Karakteristik Sampel Lumpur Limbah, Tanah dan Abu Ampas Tebu (Abu Ketel)

1. Pengujian Basic Propertis

   a. Pengujian berat jenis


   b. Pengujian batas-batas Atterberg


c. Pengujian Analisa saringan dan Hidrometer

Pengujian Analisa saringan


Pengujian Hidrometer


2. Dokumentasi Pengujian Sifat Mekanik

a. Kompaksi


b. Permebilitas


## B. Dokumentasi Pengujian Campuran Lumpur Limbah, Tanah dan Abu Ampas Tebu

a. Kompaksi

b. Permeabilitas