



LAMPIRAN



PROPERTI TEMPURUNG KELAPA

Tempurung kelapa merupakan bagian *endocarp* dari struktur buah kelapa (*Cocos nucifera*), dengan properti umum sebagai berikut:

Warna	Coklat	
Ketebalan	3,00 – 7,36 mm	
Berat jenis (ASTM D2854)*	420 – 480 kg/m ³	
Temperatur Terbakar(ASTM D3466)*	350 °C	
pH cairan ekstraksi (ASTM D3466)*	10	

*Sumber : Artikel “*Granular Coconut Shell Carbon*”, TGS Aqua Tech. Inc.

❖ Data Ketebalan Tempurung Kelapa

Tanggal : 3 April 2008

Tempat : Laboratorium Mekanika Tanah, Departemen Teknik Sipil FTUI

Alat : Jangka sorong ketelitian 0,05 mm

Berikut data yang diperoleh setelah diurutkan dari 40 sampel yang diambil secara acak:

No.	Tebal (mm)	No.	Tebal (mm)	No.	Tebal (mm)	No.	Tebal (mm)
1	3,00	11	4,11	21	4,55	31	5,00
2	3,10	12	4,11	22	4,59	32	5,47
3	3,10	13	4,14	23	4,60	33	5,50
4	3,11	14	4,15	24	4,61	34	5,55
5	3,30	15	4,19	25	4,63	35	5,85
6	3,30	16	4,20	26	4,82	36	5,90
7	3,64	17	4,28	27	4,85	37	6,32
8	3,66	18	4,36	28	4,91	38	6,65
9	3,70	19	4,40	29	4,96	39	7,21
10	4,00	20	4,50	30	4,96	40	7,36

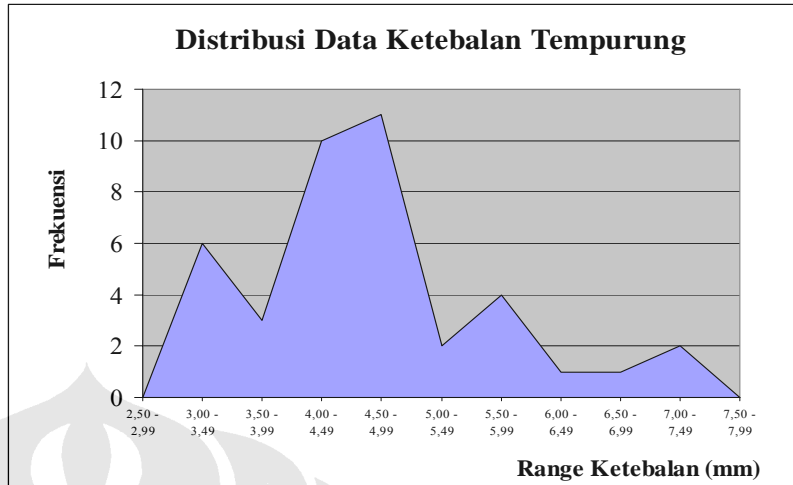
Ketebalan rata-rata = 4,62 mm

Standar deviasi = 1,074



Berikut data distribusi ketebalan tempurung kelapa dengan pengelompokan range panjang kelas 0,5 :

Range	Frekuensi
2,50 - 2,99	0
3,00 - 3,49	6
3,50 - 3,99	3
4,00 - 4,49	10
4,50 - 4,99	11
5,00 - 5,49	2
5,50 - 5,99	4
6,00 - 6,49	1
6,50 - 6,99	1
7,00 - 7,49	2
7,50 - 7,99	0



❖ Data Distribusi Ukuran Agregat Tempurung Kelapa

Tanggal : 3 April 2008

Tempat : Laboratorium Bahan, Departemen Teknik Sipil FTUI

Alat : Mesin Abrasi ASTM D2613, *Motorized Dynamic Sieve Shaker*
(Sieve analisis)

Sampel : 1000 gram tempurung kelapa kondisi kering oven

Berikut data yang diperoleh dari sampel yang dimasukkan mesin abrasi selama ±15 menit, dan dilakukan sieve analisis selama ±8 menit :

Saringan	Ukuran (mm)	Tertahan (gram)	Lolos (gram)	% Lolos
2	50	0	1000	100,00%
1,5	37,5	0	1000	100,00%
1	25	0	1000	100,00%
0,75	19	73	927	92,70%
0,5	12,5	199	728	72,80%
0,375	9,5	211	517	51,70%
No. 4	4,75	217	300	30,00%
No.8	2,36	122	178	17,80%
No.16	1,18	66	112	11,20%
No.30	0,6	33	79	7,90%
No.50	0,3	18	61	6,10%
No.100	0,15	12	49	4,90%
No.200	0,075	19	30	3,00%
PAN		29	1	0,10%

Jumlah 999

PROSES PERSIAPAN UJI CBR



Penghancuran tempurung kelapa menjadi material granular (ukuran ± 2 cm)



Material granular tempurung kelapa (ukuran ± 2 cm)



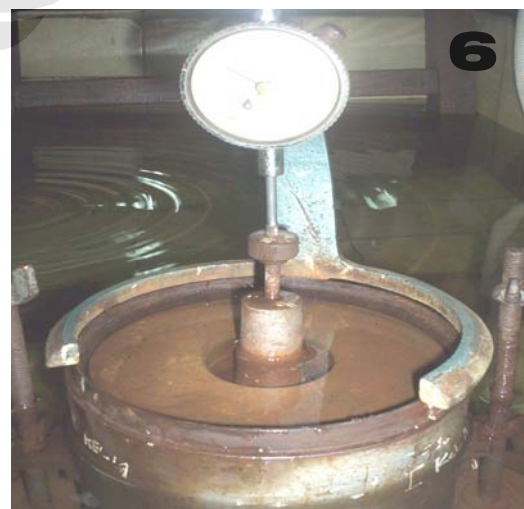
Material granular tempurung kelapa dikondisikan kering oven



Material granular tempurung kelapa dipadatkan dengan meja getar ± 8 menit



Penetrasi uji CBR



Pencatatan *swelling*



DATA PEMADATAN SAMPEL DENGAN MEJA GETAR

Berat mold + sampel = 10,023 kg Diameter mold = 15,23 cm
 Berat mold = 8,762 kg Tinggi = 16,15 cm
 Berat sampel = 1,261 kg

Setelah dipadatkan dengan meja getar selama ±8 menit :

	Tinggi awal (cm)	Penurunan (cm)	Tinggi sampel (cm)	Bulk Density* (gram/cm ³)
Percobaan I	16,15	1,50	14,65	0,472724377
Percobaan II	16,15	1,53	14,62	0,4736944
Percobaan III	16,15	1,48	14,67	0,4720799

*Bulk Density = $\frac{\text{Berat sampel}}{\text{Volume sampel setelah pemadatan}}$

DATA TANAH LEMPUNG DEPOK

Diambil dari praktikum mata kuliah Mekanika Tanah tahun 2007.

Praktikan: Mahasiswa Departemen Teknik Sipil FTUI Angkatan 2005.

Percobaan I : Tanggal 3 Maret 2007.

Percobaan II : Tanggal 10 Maret 2007.

Percobaan III : Tanggal 17 Maret 2007.

Penetrasi (in)	Percobaan I		Percobaan II		Percobaan III		Rata-rata	
	Unsoaked	Soaked	Unsoaked	Soaked	Unsoaked	Soaked	Unsoaked	Soaked
0,000	0	0	0	0	0	0	0	0
0,025	4	2,1	5	3	7	4	5,333	3,033
0,050	5,5	3,2	7	4	12	6	8,167	4,4
0,075	6,5	4,1	8	5	13	8	9,167	5,7
0,100	7,9	5	9	5,5	15	9	10,633	6,5
0,125	8,9	5,5	10	6	15,5	10,5	11,467	7,333
0,150	10,1	6	11	6,5	16,5	11	12,533	7,833
0,175	10,9	6,5	12	7	18	12	13,633	8,5
0,200	11,1	7	14	9	18,5	13	14,533	9,667

(Dipadatkan dengan kadar air optimum sebesar 36%)



Penetrasi (in)	Resisten Penetrasi	
	Unsoaked	Soaked
0,000	0	0
0,025	41,32978	23,50631
0,050	63,28622	34,09707
0,075	71,03556	44,1712
0,100	82,40124	50,37067
0,125	88,85902	56,82844
0,150	97,12498	60,70311
0,175	105,6492	65,86933
0,200	112,6236	74,91022

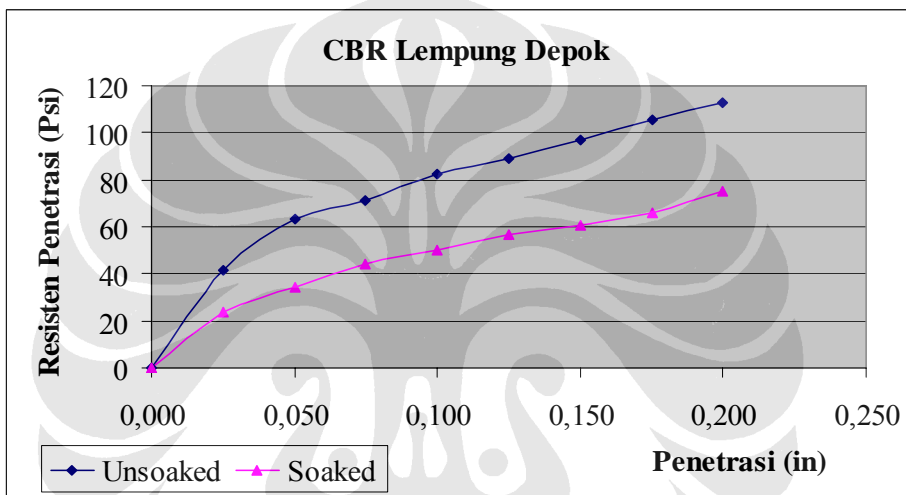
$$\text{Resisten Penetrasi (Psi)} = \frac{M \times LRC}{A}$$

Dimana:

M : Pembacaan Dial

LRC : Faktor kalibrasi alat (lbf/div) = 23,248

A : Luas bidang tekan (3 in²)



Perhitungan nilai CBR:

$$CBR = \frac{M \times LRC}{A \times BS} \times 100 \%$$

❖ **Penetrasi 0,1"**

$$\text{Unsoaked : CBR} = \frac{10,633 \times 23,248}{3 \times 1000} \times 100\% = 8,24 \%$$

$$\text{Soaked : CBR} = \frac{6,5 \times 23,248}{3 \times 1000} \times 100\% = 5,04 \%$$

❖ **Penetrasi 0,2"**

$$\text{Unsoaked : CBR} = \frac{14,533 \times 23,248}{3 \times 1500} \times 100\% = 7,51 \%$$

$$\text{Soaked : CBR} = \frac{9,667 \times 23,248}{3 \times 1500} \times 100\% = 4,99 \%$$



Data *swelling* lempung :

waktu (jam)	Percobaan I	Percobaan II	Percobaan III
0	0	0	0
0,5	0,56	0,46	0,56
1	0,65	0,52	0,7
2	0,67	0,54	0,72
3	0,7	0,63	0,74
48	0,72	0,65	0,76
72	0,74	0,67	0,78
96	0,75	0,72	0,79

$$Swell = \frac{M' \times LRC \times 0,001}{t} \times 100\%$$

$$\text{Percobaan I: } swell = \frac{0,75 \times 2,54 \times 0,001}{11,42} \times 100\% = 0,017\%$$

$$\text{Percobaan II: } swell = \frac{0,72 \times 2,54 \times 0,001}{11,40} \times 100\% = 0,016\%$$

$$\text{Percobaan III: } swell = \frac{0,79 \times 2,54 \times 0,001}{11,41} \times 100\% = 0,018\%$$

Swelling rata-rata = 0,017%

PENGGOLONGAN NILAI CBR

Penggunaan korelasi nilai CBR dapat digolongkan sebagai berikut :

Nilai CBR	Penggunaan untuk	Kategori
0 % ≤ CBR ≤ 3 %,	<i>Subgrade</i>	Sangat buruk
3 % ≤ CBR ≤ 7 %,	<i>Subgrade</i>	Buruk
7 % ≤ CBR ≤ 20 %,	<i>Subbase</i>	Sedang
20 % ≤ CBR ≤ 50 %,	<i>Base / subbase</i>	Baik
CBR ≥ 50 %,	<i>Base</i>	Sangat baik

Sumber: Standar ASTM D1883 – 87

**UNCONFINED COMPRESSIVE STRENGTH
TANAH LEMPUNG**

Nilai UCS untuk tanah lempung :

N – SPT	Konsistensi	Nilai q_u (ton/ft ²)
2	<i>Very soft</i>	0,25
2 – 4	<i>Soft</i>	0,25 – 0,5
4 – 8	<i>Medium</i>	0,5 – 1
8 – 15	<i>Stiff</i>	1 – 2
15 – 30	<i>Very stiff</i>	2 – 4
> 30	<i>Hard</i>	4 – 8

Sumber: Terzaghi dan Peck, *SPT N-Values and Unconfined Compressive Strength in Clayey Soils*, 1953.

**PROSES PERSIAPAN UJI TEKAN
SEMENTASI TEMPURUNG KELAPA**



Keterangan:

1. Pembuatan spesimen, pelepasan cetakan setelah satu hari.
2. Pemberian mortar belerang (*capping*) setelah curing 28 hari.
3. Uji tekan pada spesimen.

Percobaan I : Tanggal 28 Maret 2007, uji tekan Tanggal 25 April 2007.

Percobaan II : Tanggal 2 April 2007, uji tekan Tanggal 30 April 2007.



PROSES PERSIAPAN UJI MODULUS ELASTISITAS SEMENTASI TEMPURUNG KELAPA

Pujian sampel menggunakan silinder ukuran diameter 15 cm, dan tinggi 30 cm.

Proporsi semen-agregat 1:6, w/c rasio 0,6 dengan komposisi sebagai berikut:

Bj semen	:	3150	kg/m ³
Bj Agregat	:	480	kg/m ³
Void	:	0,05	
Volume	:	0,005303571	m ³
Waste	:	0,4	
Vol. Design	:	0,007425	m ³



Kebutuhan masing-masing sampel:

Semen	:	3,077	kg
Agregat tempurung kelapa	:	2,814	kg
Air	:	0,886	liter

Sampel berupa spesimen berpori, kemudian sisi-sisinya ditambal/diperhalus dengan semen supaya dapat dipasang alat/pencatat dial uji modulus elastisitas.

Pengujian I : umur 18 hari, tanggal 14 Juni 2008.

Pengujian II : umur 28 hari, tanggal 24 Juni 2008.



Activated Carbon Data Sheet			
Grade: Microcarb SXO 20 x 50 Carbon			
Grade SXO 20 x 50 is a granular, coconut shell manufactured by steam activation. The material is porous adsorbent with a highly developed internal surface area.			
<ul style="list-style-type: none"> • Excellent hardness. • Optimum adsorption kinetics. 		<ul style="list-style-type: none"> • Highly developed Micropore structure. • Highly developed pore structure. 	
<i>Standard Specifications</i>			
Parameters	Unit	Value	Method
Type	-	Coconut Shell	-
CTC	% min	60	ASTM D3467
Moisture as packed	% max	5	ASTM D2867
Hardness	% min	98	ASTM D3802
Mesh Size US Sieve	-	-	ASTM D2862
+20 (0.85mm)	% max	5	-
20 x 50 (0.85 X 0.30mm)		Balance	-
-50 (0.30mm)	% max	5	-
<i>Typical Properties</i>			
Parameters	Unit	Value	Method
Bulk Density	g cm ³	0.48	ASTM D2854
Density-back washed & drained	g cm ³	0.42	*See note 1
pH Aqueous Extract	-	10	ASTM D3838
Ignition Temperature	Degree C	350	ASTM D3466
Ash	% max	2	ASTM D2866
Surface Area	mg ² g ⁻¹	1,200	BET N ₂
Pore volume	cm ³ g ⁻¹	0.73	-
Pore Size Distribution	-	-	-
Micropores (r<1nm)	cm ³ g ⁻¹	.40	N ₂ Isotherm
Mesopores (r=1-25nm)	cm ³ g ⁻¹	0.12	N ₂ Isotherm
Macropores (r>25nm)	cm ³ g ⁻¹	0.21	Hg Porosimetrty
Dechlorination half life	cm	1.20	DIN 19603
Standard Ref. SXO 2050 DST 2/Rev D - Jan 1991	The information contained herein is provided for consideration and evaluation by technically knowledgeable individuals. No guarantees are implied with use of this information.		
Note 1*: The weight per unit volume on a dry basis of a bed of activated carbon that has been backwashed and drained.			

Sumber : Artikel “Granular Coconut Shell Carbon”, TGS Aqua Tech. Inc



**Bureau of Reclamation values of E' for Iowa formula
(for initial flexible pipe deflection) (Customary units)**

Soil type-pipe bedding material (Unified Classification System) ¹	E' for degree of compaction of bedding (lb/in ²)			
	Dumped	Slight <85% Proctor <40% relative density	Moderate 85-95% Proctor 40-70% relative density	High >95% Proctor >70% relative density
Fine grained soils (LL>50) ² Soils with medium to high plasticity CH, MH, CH-MH	No data available; consult a competent soils engineer; otherwise use E' = 0			
Fine-grained soils (LL<50) Soils with medium to no plasticity CL, ML, ML-CL, with less than 25 percent coarse-grained particles	50	200	400	1000
Fine-grained soils (LL<50) Soils with medium to no plasticity CL, ML, ML-CL, with more than 25 Percent coarse-grained particles	100	400	1000	2000
Coarse-grained soils with fines GM, GC, SM, SC ³ contains more than 12 percent fines				
Coarse-grained soils with little or no fines GW, GP, SW, SP ³ contains less than 12 percent fines	200	1000	2000	3000
Crushed rock	1000		3000	
Accuracy in terms of percent deflection ⁴	±2%	±2%	±1%	±0.5%

¹ ASTM Designation D 2487, USBR Designation E-3.

² LL = liquid limit.

³ Or any borderline soil beginning with one of these symbols (i.e., GM-GC-SC).

⁴ For ± 1 percent accuracy and predicted deflection of 3 percent, actual deflection would be between 2 % and 4 %.

Note:

- A. Values applicable only for fills less than 50 ft.
- B. Table does not include any safety factor.
- C. For use in predicting initial deflections only, appropriate deflection lag factor must be applied for long-term deflections.
- D. If bedding falls on the borderline between two compaction categories, select lower E' value or average the two values.
- E. Percent Proctor based on laboratory maximum dry density from test standards using about 12 - 500 ft-lb/ft³ (ASTM D-698, AASHTO T-99, USBR Designation E-11).

Sumber : Artikel "Modulus of Soil Reaction (E')", Info Brief.

(<http://www.rinkermaterials.com/>)