

Lampiran 1.



PT.H.P.METALS INDONESIA **122804**

Method: AI-ADC-12 11/10/2015 10:45:10 AM  
 Comment: AI-Base ADC-12 Element Concentration  
 Sample No.: Sample ID:

	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti
	%	%	%	%	%	%	%	%
1	0.469	0.369	0.0899	0.0534	9.77	0.0113	0.0687	0.0109
2	0.457	0.365	0.0875	0.0532	9.57	0.0112	0.0663	0.0120
3	0.424	0.361	0.0829	0.0531	9.30	0.0112	0.0596	0.0120

	Na	Ca	Ni	Pb	P	Sn	Sb	Sr
	%	%	%	%	%	%	%	%
1	< 0.00005	0.00087	0.0066	0.0088	< 0.00050	0.0035	< 0.00040	< 0.00010
2	< 0.00005	0.0013	0.0065	0.0082	< 0.00050	0.0032	< 0.00040	< 0.00010
3	< 0.00005	0.0010	0.0060	0.0073	< 0.00050	0.0026	< 0.00040	< 0.00010

	Be	Zr	Bi	Cd	Al			
	%	%	%	%	%			
1	0.00006	0.0012	0.00048	0.00067	89.1			
2	0.00006	0.0012	< 0.00030	0.00064	89.4			
3	0.00006	0.0011	0.00033	0.00066	89.7			



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 Comment: AI-Base ADC-12 Element Concentration  
 Sample No.: Sample ID:

	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti
	%	%	%	%	%	%	%	%
Ø (3)	0.450	0.365	0.0868	0.0532	9.55	0.0112	0.0649	0.0116

	Na	Ca	Ni	Pb	P	Sn	Sb	Sr
	%	%	%	%	%	%	%	%
Ø (3)	< 0.00005	0.0011	0.0064	0.0081	< 0.00050	0.0031	< 0.00040	< 0.00010

	Be	Zr	Bi	Cd	Al			
	%	%	%	%	%			
Ø (3)	0.00006	0.0011	0.00037	0.00066	89.4			

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PT.H.P.METALS INDONESIA

122804

Method: AI-ADC-12  
 Comment: AI-Base ADC-12  
 Sample No.: 2  
 Sample ID: 2  
 Element Concentration  
 11/10/2015 10:41:57 AM

	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti
	%	%	%	%	%	%	%	%
1	0.529	0.411	0.119	0.0568	9.75	0.0118	0.0809	0.0125
2	0.538	0.391	0.108	0.0566	9.76	0.0117	0.0769	0.0123
3	0.550	0.418	0.117	0.0570	9.89	0.0119	0.0806	0.0124

	Na	Ca	Ni	Pb	P	Sn	Sb	Sr
	%	%	%	%	%	%	%	%
1	< 0.00005	0.0018	0.0075	0.0092	< 0.00050	0.0038	< 0.00040	< 0.00010
2	< 0.00005	0.0016	0.0062	0.0089	< 0.00050	0.0036	< 0.00040	< 0.00010
3	< 0.00005	0.0018	0.0073	0.0100	< 0.00050	0.0042	< 0.00040	< 0.00010

	Be	Zr	Bi	Cd	Al			
	%	%	%	%	%			
1	0.00006	0.0011	< 0.00030	0.00066	89.0			
2	0.00006	0.0012	0.00039	0.00070	89.0			
3	0.00006	0.0012	0.00032	0.00061	88.8			



PT.H.P.METALS INDONESIA

122804

Method: AI-ADC-12  
 Comment: AI-Base ADC-12  
 Sample No.: Ø (3)  
 Sample ID: Ø (3)  
 Element Concentration  
 11/10/2015 10:41:57 AM

	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti
	%	%	%	%	%	%	%	%
Ø (3)	0.539	0.406	0.114	0.0568	9.80	0.0118	0.0795	0.0124

	Na	Ca	Ni	Pb	P	Sn	Sb	Sr
	%	%	%	%	%	%	%	%
Ø (3)	< 0.00005	0.0017	0.0070	0.0094	< 0.00050	0.0039	< 0.00040	< 0.00010

	Be	Zr	Bi	Cd	Al			
	%	%	%	%	%			
Ø (3)	0.00006	0.0012	0.00034	0.00066	89.0			

10/11/2015





PT.H.P.METALS INDONESIA

122804

Method: AI-ADC-12  
 Comment: AI-Base ADC-12  
 Sample No.: 3  
 Element Concentration  
 Sample ID:  
 11/10/2015 10:37:22 AM

	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti
	%	%	%	%	%	%	%	%
1	0.564	0.435	0.107	0.0545	8.72	0.0121	0.0699	0.0128
2	0.567	0.436	0.105	0.0545	8.84	0.0122	0.0692	0.0130
3	0.544	0.419	0.106	0.0542	8.70	0.0119	0.0691	0.0127

	Na	Ca	Ni	Pb	P	Sn	Sb	Sr
	%	%	%	%	%	%	%	%
1	< 0.00005	0.0015	0.0082	0.0083	< 0.00050	0.0036	< 0.00040	< 0.00010
2	< 0.00005	0.0015	0.0081	0.0085	< 0.00050	0.0037	< 0.00040	< 0.00010
3	< 0.00005	0.0015	0.0080	0.0079	< 0.00050	0.0033	< 0.00040	< 0.00010

	Be	Zr	Bi	Cd	Al			
	%	%	%	%	%			
1	0.00006	0.0011	< 0.00030	0.00057	90.0			
2	0.00006	0.0012	< 0.00030	0.00060	89.9			
3	0.00006	0.00094	< 0.00030	0.00059	90.1			



PT.H.P.METALS INDONESIA

122804

Method: AI-ADC-12  
 Comment: AI-Base ADC-12  
 Sample No.: 3  
 Element Concentration  
 Sample ID:  
 11/10/2015 10:37:22 AM

	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti
	%	%	%	%	%	%	%	%
Ø (3)	0.558	0.430	0.106	0.0544	8.75	0.0121	0.0694	0.0128

	Na	Ca	Ni	Pb	P	Sn	Sb	Sr
	%	%	%	%	%	%	%	%
Ø (3)	< 0.00005	0.0015	0.0081	0.0083	< 0.00050	0.0035	< 0.00040	< 0.00010

	Be	Zr	Bi	Cd	Al			
	%	%	%	%	%			
Ø (3)	0.00006	0.0011	< 0.00030	0.00059	90.0			

10/11/2015





**PT.H.P.METALS INDONESIA**

**122804**

Method: AI-ADC-12 11/10/2015 10:59:15 AM  
 Comment: AI-Base ADC-12 Element Concentration  
 Sample No.: **4** Sample ID:

	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti
	%	%	%	%	%	%	%	%
1	0.475	0.398	0.0903	0.0549	9.93	0.0109	0.0712	0.0100
2	0.480	0.391	0.0899	0.0548	10.05	0.0109	0.0701	0.0088
3	0.464	0.395	0.0878	0.0548	9.77	0.0111	0.0638	0.0102

	Na	Ca	Ni	Pb	P	Sn	Sb	Sr
	%	%	%	%	%	%	%	%
1	< 0.00005	0.00078	0.0069	0.0090	< 0.00050	0.0037	< 0.00040	< 0.00010
2	< 0.00005	0.00078	0.0067	0.0084	< 0.00050	0.0034	< 0.00040	< 0.00010
3	< 0.00005	0.00078	0.0068	0.0088	< 0.00050	0.0038	< 0.00040	< 0.00010

	Be	Zr	Bi	Cd	Al			
	%	%	%	%	%			
1	0.00006	0.0011	< 0.00030	0.00060	88.9			
2	0.00006	0.0010	0.00041	0.00068	88.8			
3	0.00006	0.0012	0.00059	0.00056	89.1			



**PT.H.P.METALS INDONESIA**

**122804**

Method: AI-ADC-12 11/10/2015 10:59:15 AM  
 Comment: AI-Base ADC-12 Element Concentration  
 Sample No.: **4** Sample ID:

	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti
	%	%	%	%	%	%	%	%
∅ (3)	0.473	0.395	0.0893	0.0548	9.91	0.0110	0.0684	0.0097

	Na	Ca	Ni	Pb	P	Sn	Sb	Sr
	%	%	%	%	%	%	%	%
∅ (3)	< 0.00005	0.00078	0.0068	0.0087	< 0.00050	0.0036	< 0.00040	< 0.00010

	Be	Zr	Bi	Cd	Al			
	%	%	%	%	%			
∅ (3)	0.00006	0.0011	0.00044	0.00061	89.0			

*10/11/2015*



## Lampiran 2.



Jl. Teluk Mendar, Arjosari, Tromol Pos 5 Malang  
Telp. ( 0341 ) 491239 – 495849, Fax ( 0341 ) 491342  
e – mail : vedcmalang@vedcmilg.or.id

### SURAT KETERANGAN

Nomer. 005/J/UK/45/X/2016

Yang bertanda tangan dibawah ini adalah Kepala Program Keahlian Teknik Permesinan Departemen Mesin dan CNC PPPPTK BOE Malang, menerangkan bahwa mahasiswa :

Nama : HARYO RIDHONOTO MUKTIAJI  
NIM : 125060 20 71 11 026  
Jurusan : Teknik Mesin, Fakultas Teknik - Universitas Brawijaya  
Waktu Pelaksanaan : 12 – 14 Oktober 2016

Telah melaksanakan penelitian pengukuran kekerasan Brinell pada Material Aluminium, menggunakan Hardness Tester Model KW 06-213. Judul skripsi "**Pengaruh Tingkat *Recycling* Aluminium Al-Mg-Si terhadap Kekuatan *Impact* dan Kekerasan**" di Bengkel Metrologi Departemen Mesin dan CNC PPPPTK BOE Malang.

Demikian Surat Keterangan ini dibuat dengan sesungguhnya, agar dapat dipergunakan sebagaimana mestinya.

Malang, 14 Oktober 2016

Ka Program Keahlian  
Teknik Permesinan



*Art Firdausi Ananda, M.Pd*  
NIP. 197402232005011003

## TEST REPORT

NAMA : HARYO RIDHONOTO MUHTIAJI  
NIM : 125060 20 71 11 026  
JURUSAN : FT – MESIN BRAWIJAYA  
TANGGAL PENGUJIAN : 3 Oktober 2016  
KEPERLUAN : Mengetahui Kekerasan pada Aluminium  
BAHAN : Aluminium Cor

1 2 3 4 5

SPEKIMEN	Titik 1 (HB)	Titik 2 (HB)	Titik 3 (HB)	Titik 4 (HB)	Titik 5 (HB)
1.1	98	111	89	85	93
1.2	102	99	100	102	103
1.3	102	107	109	112	89
2.1	102	129	111	111	117
2.2	106	124	121	115	113
2.3	131	101	99	119	107
3.1	94	103	119	111	118
3.2	131	113	116	101	133
3.3	125	151	139	133	120
4.1	107	98	111	93	102
4.2	85	135	152	158	140
4.3	108	114	99	113	115



Kaprodi Pemesinan

Ani Firdausi Ananda, M.Pd.

### Lampiran 3.

#### Overview a material of aluminium alloy casting

Categories: [Metal](#): [Nonferrous Metal](#): [Aluminum Alloy](#): [Aluminum Casting Alloy](#)

**Material Notes:** This property data is a summary of similar materials in the MatWeb database for the category "Aluminum Casting Alloy". Each property range of values reported is minimum and maximum values of appropriate MatWeb entries. The comments report the average value, and number of data points used to calculate the average. The values are not necessarily typical of any specific grade, especially less common values and those that can be most affected by additives or processing methods.

**Vendors:** No vendors are listed for this material. Please [click here](#) if you are a supplier and would like information on how to add your listing to this material.

Physical Properties	Metric	English	Comments
Density	2.57 - 2.95 g/cc	0.0928 - 0.107 lb/in <sup>3</sup>	Average value: 2.74 g/cc Grade Count:189
Mechanical Properties	Metric	English	Comments
Hardness, Brinell	25.0 - 170	25.0 - 170	Average value: 84.6 Grade Count:152
Hardness, Knoop	73.0 - 191	73.0 - 191	Average value: 114 Grade Count:118
Hardness, Rockwell A	36.0 - 54.0	36.0 - 54.0	Average value: 42.0 Grade Count:62
Hardness, Rockwell B	45.0 - 87.0	45.0 - 87.0	Average value: 62.5 Grade Count:75
Hardness, Vickers	70.0 - 175	70.0 - 175	Average value: 103 Grade Count:113
Tensile Strength, Ultimate	82.7 - 565 MPa	12000 - 81900 psi	Average value: 243 MPa Grade Count:182
Tensile Strength, Yield	27.6 - 525 MPa	4000 - 76100 psi	Average value: 180 MPa Grade Count:144
Elongation at Break	0.500 - 28.0 %	0.500 - 28.0 %	Average value: 4.62 % Grade Count:162
Modulus of Elasticity	66.0 - 81.4 GPa	9570 - 11800 ksi	Average value: 72.0 GPa Grade Count:163
Compressive Yield Strength	75.0 - 925 MPa	10900 - 134000 psi	Average value: 205 MPa Grade Count:49
Compressive Modulus	74.5 - 82.8 GPa	10800 - 12000 ksi	Average value: 82.2 GPa Grade Count:13
Poissons Ratio	0.330	0.330	Average value: 0.330 Grade Count:133
Fatigue Strength	48.0 - 435 MPa	6960 - 63100 psi	Average value: 115 MPa Grade Count:66
Machinability	10.0 - 90.0 %	10.0 - 90.0 %	Average value: 57.9 % Grade Count:149
Shear Modulus	23.0 - 30.0 GPa	3340 - 4350 ksi	Average value: 26.6 GPa Grade Count:132
Shear Strength	75.0 - 290 MPa	10900 - 42100 psi	Average value: 165 MPa Grade Count:145
Charpy Impact	3.30 - 21.7 J	2.43 - 16.0 ft-lb	Average value: 6.52 J Grade Count:15
Charpy Impact, Unnotched	16.3 - 77.0 J	12.0 - 56.8 ft-lb	Average value: 48.4 J Grade Count:6

## Lampiran 4.

*Approximate equivalent hardness numbers for wrought aluminum products ASM Handbook*

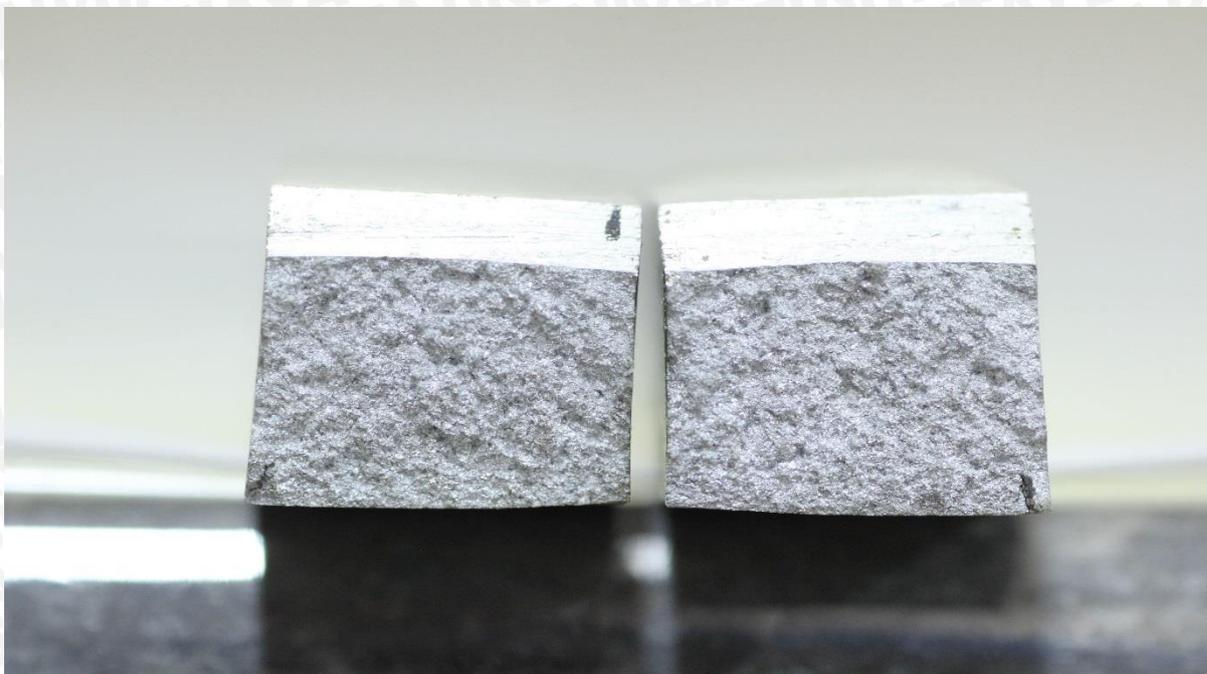
Brinell hardness No., 500 kgf, 1 0 mm ball, HBS	Vickers hardness No., 15 kgf, HV	Rockwell hardness No.			Rockwell superficial hardness No.		
		B scale, 100 kgf, $\frac{1}{16}$ in. ball, HRB	E scale, 100 kgf, $\frac{1}{8}$ in. ball, HRE	H scale, 60 kgf, $\frac{1}{8}$ in. ball, HRH	15T scale, 15 kgf, $\frac{1}{16}$ in. ball, HR15T	30T scale, 30 kgf, $\frac{1}{16}$ in. ball, HR30T	15W scale, 15 kgf, $\frac{1}{8}$ in. ball, HR15W
160	189	91	...	...	89	77	95
155	183	90	...	...	89	76	95
150	177	89	...	...	89	75	94
145	171	87	...	...	88	74	94
140	165	86	...	...	88	73	94
135	159	84	...	...	87	71	93
130	153	81	...	...	87	70	93
125	147	79	...	...	86	68	92
120	141	76	101	...	86	67	92
115	135	72	100	...	86	65	91
110	129	69	99	...	85	63	91
105	123	65	98	...	84	61	91
100	117	60	...	...	83	59	90
95	111	56	96	...	82	57	90
90	105	51	94	108	81	54	89
85	98	46	91	107	80	52	89
80	92	40	88	106	78	50	88
75	86	34	84	104	76	47	87
70	80	28	80	102	74	44	86
65	74	...	75	100	72	...	85
60	68	...	70	97	70	...	83
55	62	...	65	94	67	...	82
50	56	...	59	91	64	...	80
45	50	...	53	87	62	...	79
40	44	...	46	83	59	...	77



Lampiran 5.



Lampiran 6.



*Recycling 1*



*Recycling 2*



*Recycling 3*



*Recycling 4*



### Lampiran 7.

$$\begin{aligned} E_{\text{serap}} &= \text{energi awal} - \text{energi yang tersisa} \\ &= m \cdot g \cdot h_1 - m \cdot g \cdot h_2 \\ &= m \cdot g \cdot L (\cos \alpha - \cos \beta) \end{aligned}$$

Keterangan :

$E_{\text{serap}}$  = energi serap (J)

$m$  = berat pendulum (kg)

$g$  = percepatan gravitasi ( $\text{m/s}^2$ )

$L$  = panjang lengan (m)

$\alpha$  = sudut ayunan pendulum mematahkan spesimen ( $^\circ$ )

$\beta$  = sudut pendulum sebelum diayunkan ( $^\circ$ )

Contoh perhitungan pengujian impak diambil salah satu untuk mewakili perhitungan seluruh pengujian, yaitu pada *recycling* pertama :

Diketahui :

$\alpha$  = sudut akhir – sudut awal

$$= 168^\circ - 90^\circ$$

$$= 78^\circ$$

$\beta = 90^\circ$

$m = 8 \text{ kg}$

$g = 9.81 \text{ m/s}^2$

$L = 45 \text{ cm} = 0.45 \text{ m}$

Sehingga

$$E_{\text{serap}} (\text{ideal}) = m \cdot g \cdot L (\cos \alpha - \cos \beta)$$

$$= 8 \text{ kg} \times 9.81 \text{ m/s}^2 \times 0.45 \text{ m} (\cos 78^\circ - \cos 90^\circ)$$

$$= 35.316 \text{ kgm}^2/\text{s}^2 (0.207 - 0)$$

$$= 7335.12 \text{ kgm}^2/\text{s}^2 = 7335.12 \text{ J}$$

Kerugian alat =  $m \cdot g \cdot L ((\cos 90^\circ - \alpha) - \cos \beta)$

$$= 8 \text{ kg} \times 9.81 \text{ m/s}^2 \times 0.45 \text{ m} (\cos 85^\circ - \cos 90^\circ)$$

$$= 35.316 \text{ kgm}^2/\text{s}^2 (0.283 - 0)$$

$$= 3074.85 \text{ kgm}^2/\text{s}^2 = 3074.85 \text{ J}$$

$$E_{\text{serap}} (\text{aktual}) = E_{\text{serap}} (\text{ideal}) - \text{Kerugian alat}$$

$$= 7335.12 \text{ J} - 3074.85 \text{ J}$$

$$= 4260.27 \text{ J}$$

Maka harga kekuatan impaknya :

$$HI = \frac{E_{\text{serap}}}{A}$$

Keterangan :

A = luas penampang spesimen ( $\text{mm}^2$ )

= panjang x lebar

= 55 mm x 10 mm

= 550  $\text{mm}^2$

$$HI = \frac{E_{\text{serap}}}{A}$$

$$= \frac{4260.27 \text{ J}}{550 \text{ mm}^2}$$

$$= 6.28 \text{ J/mm}^2$$



UNIVERSITAS BRAWIJAYA

# LAMPIRAN

