

Lampiran 1 Hasil Pengujian Kekuatan Tarik



LABORATORIUM STRUKTUR
JURUSAN TEKNIK SIPIL
FAKULTAS TEKNIK UNIVERSITAS NEGERI MALANG
Gedung D9 Lt. 1 Kampus UM jl. Semarang No. 5 Malang Telp / Fax (0341)
587 082

HASIL PENGUJIAN KEKUATAN TARIK

Spesimen diterima : 2 Februari 2018

Spesimen diuji : 7 Februari 2018

Nama spesimen : Hasil *Friction Stir Welding* Pada Aluminium 6061

Nama : Faizal Novantani Abdillah

No	Spesimen FSW Dengan Gaya Tekan (N)	Pembebanan (kN)	Ultimate Tansile Strength (Mpa)
1	13000 N	2	93
		2,4	112
		3	140
2	14000 N	1,7	80
		2,8	131
		3	140
3	15000 N	3,4	159
		2,2	104
		1,7	80



Lampiran 2 Surat Keterangan Pengujian Kekuatan Tarik



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Gedung D9 Lt 1 Kampus U.M.Jl. Semarang No. 5 Malang Telp/Fax: (0341) 587 082

SURAT KETERANGAN

No. 19e.03.2018

Yang bertandatangan di bawah ini Laboran / Teknisi Laboratorium Jurusan Teknik Sipil Fakultas Teknik Universitas Negeri Malang, menerangkan bahwa,

Nama : Faizal Novantani Abdillah

NIM : 135060201111062

Instansi : Jurusan Teknik Mesin - Fakultas Teknik - Universitas Brawijaya

Telah melakukan pengujian kuat tarik terhadap material A6061 pada proses hasil *friction stir welding* sebanyak 9 benda uji pada tanggal 7 Februari 2018 di Laboratorium Struktur - Teknik Sipil - FT - UM.

Demikian keterangan ini dibuat untuk dipergunakan sebagaimana mestinya.

Mengetahui,
Kepala Laboratorium
Teknik Sipil - FT - UM



Dr. Karyadi, M.P., M.T
NIP. 19610312 198703 1 001

Malang, 19 Maret 2018
Koordinator Uji
Laboratorium Struktur - FT - UM

Lusti Mustikasari, Amd
NITK. 19900511 20160548

Lampiran 3 Hasil Pengujian Komposisi Kimia Aluminium 6061



UNIVERSITAS NEGERI MALANG
FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM
LABORATORIUM MINERAL DAN MATERIAL MAJU (LABORATORIUM SENTRAL)

Jalan Semarang 5, Malang 65145
Telp. 0341-551312 (psw 200) 574895/ 085106001088
E-mail : laboratoriumsentralum@yahoo.co.id
Website : central-laboratory.um.ac.id

LAPORAN HASIL UJI No. LSUM.LHU.E.00208.2018

Nomor Pengujian : LSUM.P.00200.2018
Nomor Sampel : Aluminium (E 191)
Nama Pelanggan : Faizal Novantani A.
Instansi Pelanggan : UB
Jenis Karakterisasi : XRF
Sampel Diterima Tanggal : 12 Maret 2018

Hasil

No filter			Helium		
Compound	Conc (%)	Metode	Compound	Conc (%)	Metode
Al	91,1	XRF	Mg	0,2	XRF
Si	5,1		Al	69,2	
P	1,2		Si	4,03	
Ca	0,811		P	0,96	
Ti	0,044		Ca	1,17	
V	0,01		Mn	5,4	
Cr	0,033		Br	15	
Mn	0,10		Zr	0,67	
Fe	1,19		Ba	1,1	
Ni	0,01		Pr	2,8	
Cu	0,18				
Ga	0,045				
Ba	0,07				
Pr	0,05				
Yb	0,06				
Os	0,04				

Keterangan :

1. Hasil analisa hanya berlaku untuk sampel yang diuji
2. Dilarang menggandakan sebagian laporan hasil pengujian tanpa persetujuan tertulis dari Laboratorium Mineral dan Material Maju.

Malang, 15 Maret 2018
a.n Dekan
Kepala Lab. Mineral dan Material Maju

Dr. Abdulloh Fuad, M.Si
NIP. 196302221988121002

Lampiran 4 Komposisi Kimia Baja HQ 760

MACHINERY STEEL

TRADE NAME	DIN	AISI	CHEMICAL ANALYSIS (%)										TECHNOLOGY	MECHANICAL PROPERTIES					CHARACTERISTIC	APPLICATION
			C	Cr	Ni	Mo	Mn	Si	S	P	UTS-tens	Rp 0.2%		Elong.	HAZARD (MAGN.)					
												Min				Max	Min	Max		
HQ 705	AISI 4140	4140	0.30-0.50	1.30-1.70	1.20-1.70	0.18-0.30	0.18-0.30	0.08-0.30	0.035-0.050	0.005-0.008	0.005-0.008	800-1000	900	600	100-150	100-150	min 20%	100-150	Good hardenability, strength, ductility. High strength parts for high speed equipment, crankshafts, shafts and gears, etc.	High strength Machinery parts - Shafts, crankshafts, gears, connecting rods, pistons, valves, etc.
HQ 706	AISI 4140	4140	0.30-0.45	0.80-1.20		0.15-0.30	0.04-0.09	0.15-0.30	0.005-0.008	0.005-0.008	800-1000	1000	600	100-150	100-150	min 20%	100-150	Good hardenability, strength, ductility, and impact resistance.	High strength Machinery parts - Medium and large machinery parts requiring high tensile strength, crankshafts, shafts and gears, etc.	
HQ 7210	AISI 4140	4140	0.34-0.50	1.40-1.70	1.40-1.70	0.18-0.30	0.18-0.30				800-1200	900-1000	600	100-150	max 20%			Excellent strength, good hardenability, ductility and impact resistance. Good strength in case carburizing.	Case hardening steel with high core strength. Wear resistance and high strength parts - e.g. gears and bearings.	
HQ 760	C-70	AISI 7040	0.42-0.50	0.80-1.20	0.80-1.20	0.18-0.30	0.18-0.30	0.18-0.30	0.040-0.045	0.040-0.045	800-1000	900-1000	600	100-150	100-150	min 20%	100-150	Classification of high toughness and ductility. Excellent strength, ductility and impact resistance. Heat treatment flame and induction hardening are not recommended for carburizing.	Medium to high strength machinery parts - Shafts, connecting rods, pistons, valves, etc. Requires moderate strength and wear resistance, etc.	
HQ 708	AISI 4140	4140	0.28-0.33	0.80-1.20	0.80-1.20	0.18-0.30	0.18-0.30	0.11-0.40	0.005-0.008	0.005-0.008	800-1000	1000	600	100-150	100-150	min 20%	100-150	As follows: heat treatment can obtain a broad range of strength and ductility, good wear resistance and ductility.	High strength mechanical parts, shafts and gears, rod and other machinery parts.	
HQ 805	SAE 52100	AISI 52100	0.30-0.38	1.30-1.70	1.30-1.70	0.15-0.30	0.04-0.09	0.04-0.30	0.005-0.008	0.005-0.008	800-1000	1000	600	100-150	100-150	min 20%	100-150	High strength, good hardenability, ductility and impact resistance.	High strength Machinery parts - Shafts, connecting rods, pistons, valves, etc. Requires moderate strength and wear resistance, etc.	
HQ 806	AISI 52100	AISI 52100	0.30-0.40	0.80-1.20		0.15-0.30	0.04-0.09	0.15-0.30	0.005-0.008	0.005-0.008	800-1000	1000	600	100-150	100-150	min 20%	100-150	As follows: heat treatment can obtain a broad range of strength and ductility, good wear resistance and ductility.	High strength Machinery parts - Shafts, connecting rods, pistons, valves, etc. Requires moderate strength and wear resistance, etc.	

HQ series 7

Steel in accordance with European standard EN 10083 / EN 10084 unlike similar product in the market, HQ 705 and HQ 709 are hardened and tempered so that they can be used directly after machining without going through any heat treatment. Its combine high strength with best toughness. HQ 7210 is an alloyed case hardening steel with high core strength. It is used for application requiring a hard, wear resistant surface and a tough core, e.g. gear

Product Application



HQ series 8

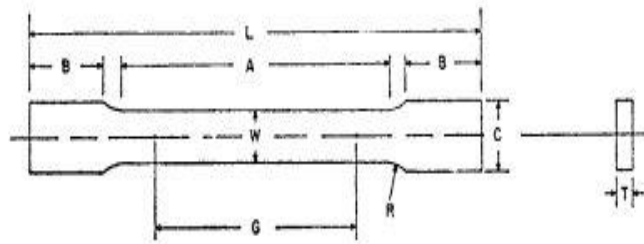
This series offering excellent fatigue, straightness guarantee and mechanical properties compare to HQ 7 Series. Steel are melted followed by ladle metallurgy operation vacuum degassing. Resulting in excellent cleanliness and very low level of dissolved gas. Steel also pelled condition, resulting free from rolling defect, and decarburizing scale. As standard HQ 8 Series supplied ultrasonic testing satisfactory that guarantees there are no surface and internal crack which could lead to the part being rejected during operation.



TARA STEEL


Lampiran 5 Dimensi Spesimen Uji Tarik Dengan Standar ASTM E8

ASTM E8/E8M - 13a



	Dimensions		
	Standard Specimens		Subsize Specimen
	Plate-Type, 40 mm [1.500 in.] Wide	Sheet-Type, 12.5 mm [0.500 in.] Wide	6 mm [0.250 in.] Wide
	mm [in.]	mm [in.]	mm [in.]
G—Gauge length (Note 1 and Note 2)	200.0 ± 0.2 [8.00 ± 0.01]	50.0 ± 0.1 [2.000 ± 0.005]	25.0 ± 0.1 [1.000 ± 0.003]
W—Width (Note 3 and Note 4)	40.0 ± 2.0 [1.500 ± 0.125, -0.250]	12.5 ± 0.2 [0.500 ± 0.010] thickness of material	6.0 ± 0.1 [0.250 ± 0.005]
T—Thickness (Note 5)		12.5 [0.500]	6 [0.250]
R—Radius of fillet, min (Note 6)	25 [1]	200 [8]	100 [4]
L—Overall length, min (Note 2, Note 7, and Note 8)	450 [18]	57 [2.25]	32 [1.25]
A—Length of reduced section, min	225 [9]	50 [2]	30 [1.25]
B—Length of grip section, min (Note 9)	75 [3]	20 [0.750]	10 [0.375]
C—Width of grip section, approximate (Note 4 and Note 9)	50 [2]		


Lampiran 6 Sertifikat Kalibrasi Alat Uji Tarik



PT. GLOBAL QUALITY INDONESIA
SNI ISO/IEC 17025:2005

PT. GLOBAL QUALITY INDONESIA

CALIBRATION, INSTRUMENTATION, TRAINING, QUALITY CONSULTANT,
INSPECTION, SUPPLY, CERTIFICATE PERSONAL, MAINTENANCE & REPAIR



Komite Akreditasi Nasional
Laboratorium Kalibrasi
IA 027-02A

CALIBRATION CERTIFICATE

Certificate Number: 0706-0201-Sert05/17
Page: 1 of 1

Order Number: 031 0517-177
Received Date: 03 May 2017
Equipment Name: Universal Testing Machine
Manufacturer: Kai Wei
Model/Type: D88
Serial Number: D88
Capacity/Graduation: 1000 kN / 0.1 kN
Technician ID: AMNE
Typewriter ID: AMNE

Client: Lab. Struktur Jurusan Teknik Sipil Universitas
Sragen Malang
Address: Jl. Semarang No. 5, Sumberan
Kec. Lendah, Widy. Kota Malang
Calibration Location: Lab. Struktur
Calibration Date: 03 May 2017
Calibration Method: K-G 01 ref. IS 8172:2008
Environmental Condition: T before = 26.6 °C RH before = 75 %
T after = 25.7 °C RH after = 70 %

Calibration Report

Standard Indication (kN)	Instrument Indication (kN)		Correction (kN)	Error of Force (%)
	Before Setting	After Setting		
0	17.3	13.4	-13.4	0.0
100	151.0	112.4	-12.4	12.4
200	285.5	212.6	-12.6	6.3
300	420.3	313.4	-13.4	4.5
400	556.5	413.2	-13.2	3.3
500	692.3	514.1	-14.1	2.8
600	828.2	615.1	-15.1	2.5
700	915.3	714.4	-14.4	2.1

Uncertainty $U_{95\%} = 0.7 \%$

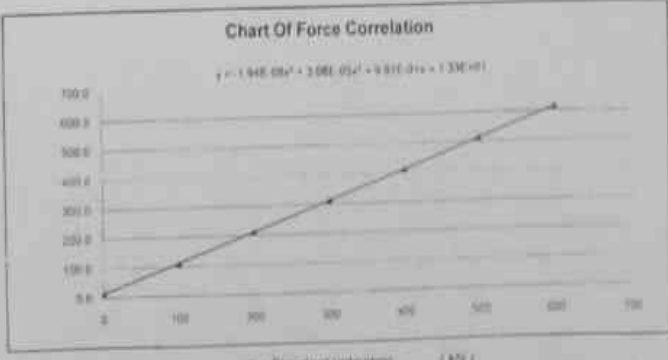


Chart Of Force Correlation

$y = 1.94E-05x^2 + 3.08E-05x^2 + 9.81E-01x + 1.33E+01$

x = Standard Indication (kN)

y = Instrument Indication (kN)

The Uncertainty is taken at a Confidence Level 95 % and Coverage Factor (k) = 2


Standard used

Name: Load Cell

Mark/Type: MKT/ST

Serial Number: 15784

Traceable to SI through: K-013-IDN



PT. GLOBAL QUALITY INDONESIA

Attention: 1. This calibration result is valid only for the equipment concerned.
2. It is not permitted to reproduce this certificate without permission from PT. Global Quality Indonesia.
3. The Original Calibration Certificate of PT. Global Quality Indonesia uses a Barcode Mark.

Lampiran 7 Koefisien Gesek Aluminium Dan Baja

NILA KOEFISIEN GESEK ANTAR DUA MATERIAL

Friction Couple	Conditions	Static Coefficient	Kinetic Coefficient
aluminum / aluminum	oxidizing environment	1,9	
aluminum / steel		0,61	0,47
automotive brake pad / cast iron	humid environment		0.2 - 0.5
brick / brick		0,65	
carbon composite / carbon composite	inert environment		0.5 - 1.2
carbon composite / carbon composite	humid environment		0.1 - 0.5
copper / copper	inert environment	4	
copper / copper	oxidizing environment	1,6	
copper / steel		0,53	0,36
cortical bone / cancellous bone	saline lubrication	0,61	
diamond / diamond	clean	0,1	
diamond / diamond	lubricated	0.05 - 0.1	
glass / glass	clean	0,94	0,4
glass / glass	lubricated	0.2 - 0.3	
glass / metal	clean	0.5 - 0.7	
gold / gold	inert environment	4	
gold / gold	humid environment	2,5	
ice / ice		0.1 0	0,03
iron / iron	oxidizing or humid environ	1,2	
leather / metal		0,55	
metal / metal	lubricated	0,15	0,05
mica / mica	clean, fresh cleave	1	
mica / mica		0.2 - 0.4	
nickel / nickel	inert environment	5	
nickel / nickel	oxidizing environment	3	
nickel / nickel	humid environment	1,6	
nylon / nylon	clean	0,2	
rubber / concrete	varying	1.00 - 4.00	0,8
sapphire / sapphire	non-lubricated	0,2	
sapphire / steel	non-lubricated	0,15	
Silver / Silver	oxidizing or humid environ	1,5	
steel / steel		0,74	0,57
synovial joints (humans)		0,01	0,003
teflon / teflon		0,04	0,04
tungsten carbide / graphite		0,62	
wood / stone		0,4	
wood / wood		0.25 - 0.5	0,2

Lampiran 8 Perhitungan Gaya Tekan, Heat Input dan UTS

Perhitungan

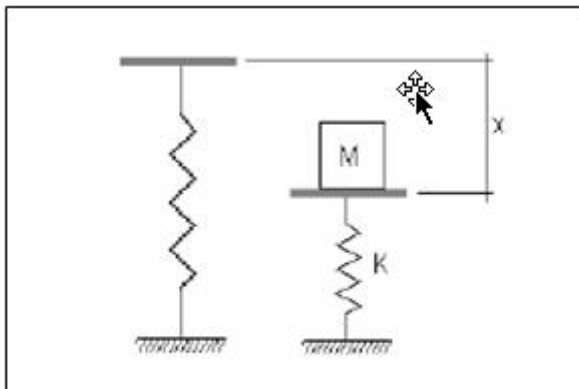
1. Heat Input

$$\begin{aligned} Q &= \frac{1}{2} \mu F_N (R_i + R_o) \omega \\ &= \frac{1}{2} 0,47 13000 (7 + 15) 1095 \\ &= 73,59 \text{ J/mm} \end{aligned}$$

$$\begin{aligned} Q &= \frac{1}{2} \mu F_N (R_i + R_o) \omega \\ &= \frac{1}{2} 0,47 14000 (7 + 15) 1095 \\ &= 79,25 \text{ J/mm} \end{aligned}$$

$$\begin{aligned} Q &= \frac{1}{2} \mu F_N (R_i + R_o) \omega \\ &= \frac{1}{2} 0,47 15000 (7 + 15) 1095 \\ &= 84,91 \text{ J/mm} \end{aligned}$$

2. Gaya Tekan



Gambar C.1 :Harga kekakuan pegas

$$F = k \cdot \Delta x$$

$$k = \frac{F}{\Delta x} = \frac{m \cdot g}{\Delta x} = \frac{100 \cdot 10}{0,01} = 100.000 \text{ N/m}$$

$$\begin{aligned} F &= k \cdot \Delta x \\ &= 100.000 \cdot 0,13 \\ &= 13000 \text{ N} \end{aligned}$$

$$\begin{aligned} F &= k \cdot \Delta x \\ &= 100.000 \cdot 0,14 \\ &= 14000 \text{ N} \end{aligned}$$

$$\begin{aligned} F &= k \cdot \Delta x \\ &= 100.000 \cdot 0,15 \\ &= 15000 \text{ N} \end{aligned}$$

3. Ultimate Tansile Strength

$$\sigma = \frac{F}{A}$$

$$\sigma = \frac{F}{A} = \frac{2}{213} = 93 \text{ MPa}$$

$$\sigma = \frac{F}{A} = \frac{2,4}{213} = 112 \text{ MPa}$$

$$\sigma = \frac{F}{A} = \frac{3}{213} = 140 \text{ MPa}$$

$$\sigma = \frac{F}{A} = \frac{1,7}{213} = 80 \text{ MPa}$$

$$\sigma = \frac{F}{A} = \frac{2,8}{213} = 131 \text{ MPa}$$

$$\sigma = \frac{F}{A} = \frac{3}{213} = 140 \text{ MPa}$$

$$\sigma = \frac{F}{A} = \frac{3,4}{213} = 159 \text{ MPa}$$

$$\sigma = \frac{F}{A} = \frac{2,2}{213} = 104 \text{ MPa}$$

$$\sigma = \frac{F}{A} = \frac{1,7}{213} = 80 \text{ MPa}$$