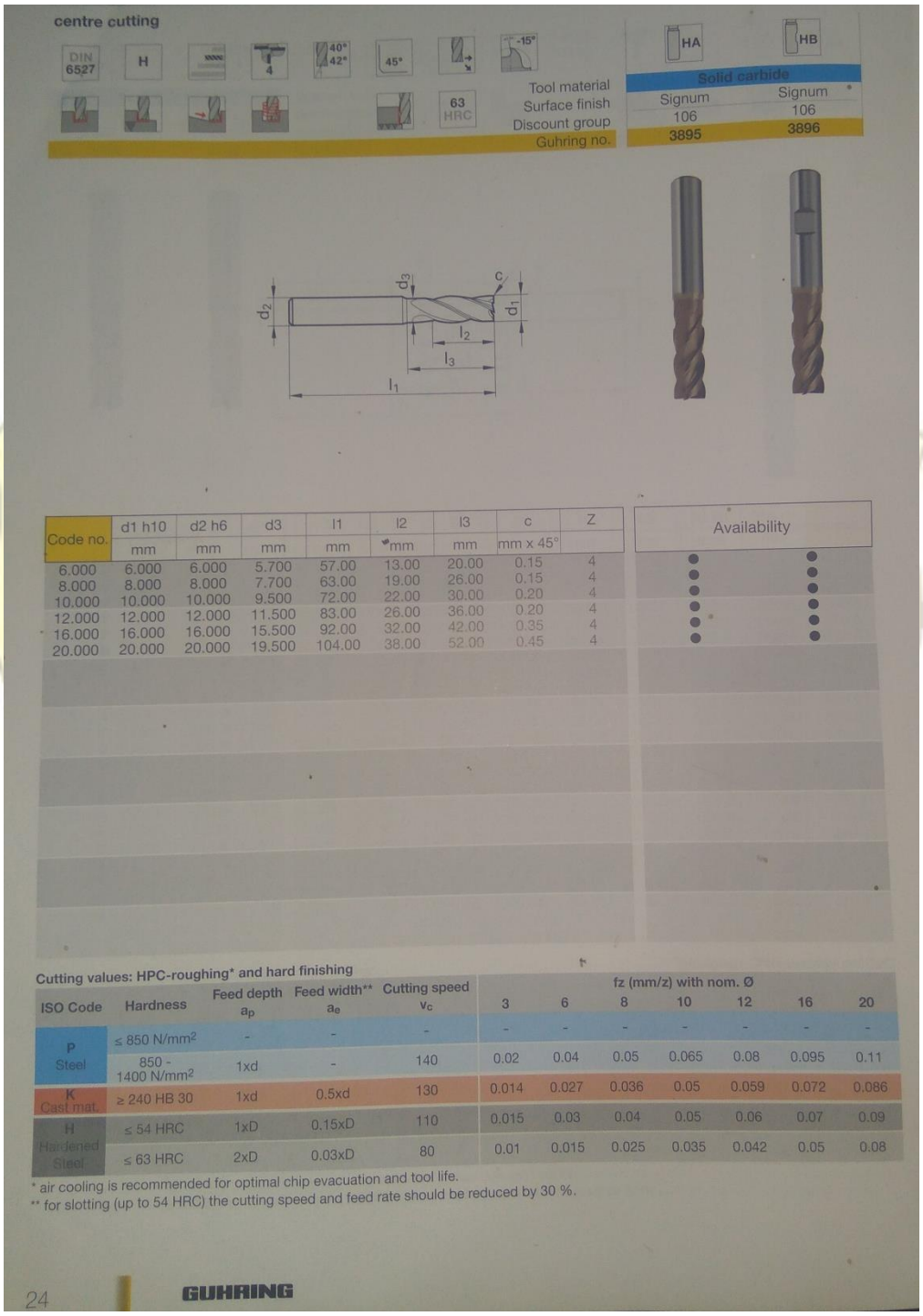
# LAMPIRAN A
# SPESIFIKASI ALAT POTONG

A.1. Spesifikasi *End mill guhring solid carbide* no. 3895 dia 12 mm



centre cutting

DIN 6527 | H | 4 | 40° 42° | 45° | -15°

63 HRC

| | HA | HB |
|---|---|---|
| Tool material | Solid carbide | |
| Surface finish | Signum | Signum |
| Discount group | 106 | 106 |
| Guhring no. | 3895 | 3896 |

| Code no. | d1 h10 | d2 h6 | d3 | l1 | l2 | l3 | c | Z | Availability | |
|---|---|---|---|---|---|---|---|---|---|---|
| | mm | mm | mm | mm | mm | mm | mm x 45° | | | |
| 6.000 | 6.000 | 6.000 | 5.700 | 57.00 | 13.00 | 20.00 | 0.15 | 4 | ● | ● |
| 8.000 | 8.000 | 8.000 | 7.700 | 63.00 | 19.00 | 26.00 | 0.15 | 4 | ● | ● |
| 10.000 | 10.000 | 10.000 | 9.500 | 72.00 | 22.00 | 30.00 | 0.20 | 4 | ● | ● |
| 12.000 | 12.000 | 12.000 | 11.500 | 83.00 | 26.00 | 36.00 | 0.20 | 4 | ● | ● |
| 16.000 | 16.000 | 16.000 | 15.500 | 92.00 | 32.00 | 42.00 | 0.35 | 4 | ● | ● |
| 20.000 | 20.000 | 20.000 | 19.500 | 104.00 | 38.00 | 52.00 | 0.45 | 4 | ● | ● |

Cutting values: HPC-roughing* and hard finishing

| ISO Code | Hardness | Feed depth $a_p$ | Feed width** $a_e$ | Cutting speed $v_c$ | fz (mm/z) with nom. Ø 3 | 6 | 8 | 10 | 12 | 16 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| P Steel | ≤ 850 N/mm² | - | - | - | - | - | - | - | - | - | - |
| | 850 - 1400 N/mm² | 1xd | - | 140 | 0.02 | 0.04 | 0.05 | 0.065 | 0.08 | 0.095 | 0.11 |
| K Cast mat. | ≥ 240 HB 30 | 1xd | 0.5xd | 130 | 0.014 | 0.027 | 0.036 | 0.05 | 0.059 | 0.072 | 0.086 |
| H Hardened Steel | ≤ 54 HRC | 1xD | 0.15xD | 110 | 0.015 | 0.03 | 0.04 | 0.05 | 0.06 | 0.07 | 0.09 |
| | ≤ 63 HRC | 2xD | 0.03xD | 80 | 0.01 | 0.015 | 0.025 | 0.035 | 0.042 | 0.05 | 0.08 |

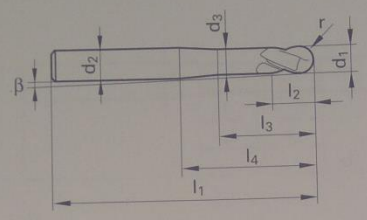
* air cooling is recommended for optimal chip evacuation and tool life.
** for slotting (up to 54 HRC) the cutting speed and feed rate should be reduced by 30 %.

24 GUHRING

A.2. Spesifikasi *Ballnose Solid Carbide* nomer 3359 diameter 8 mm

centre cutting

| | |
|---|---|
| Tool material | Solid carbide |
| Surface finish | Signum |
| Discount group | 106 |
| Guhring no. | 3359 |



| Code no. | d1 h8 | d2 h6 | d3 | l1 | l2 | l3 | l4 | r | β | Z | Availability |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | mm | mm | mm | mm | mm | mm | mm | mm | ° | | |
| 0.500 | 0.500 | 3.000 | 0.400 | 38.00 | 0.75 | 2.60 | 10.00 | 0.25 | 7.40 | 2 | ● |
| 0.800 | 0.800 | 3.000 | 0.700 | 38.00 | 1.20 | 3.50 | 10.00 | 0.40 | 6.60 | 2 | ● |
| 1.000 | 1.000 | 3.000 | 0.900 | 38.00 | 1.50 | 4.00 | 10.00 | 0.50 | 6.10 | 2 | ● |
| 1.500 | 1.500 | 3.000 | 1.400 | 38.00 | 2.25 | 5.50 | 10.00 | 0.75 | 4.70 | 2 | ● |
| 2.000 | 2.000 | 6.000 | 1.900 | 57.00 | 3.00 | 9.40 | 21.00 | 1.00 | 5.80 | 2 | ● |
| 3.000 | 3.000 | 6.000 | 2.700 | 57.00 | 5.00 | 11.60 | 21.00 | 1.50 | 4.40 | 2 | ● |
| 4.000 | 4.000 | 6.000 | 3.700 | 57.00 | 6.00 | 14.50 | 21.00 | 2.00 | 3.10 | 2 | ● |
| 5.000 | 5.000 | 6.000 | 4.700 | 57.00 | 8.00 | 17.30 | 21.00 | 2.50 | 1.60 | 2 | ● |
| 6.000 | 6.000 | 6.000 | 5.700 | 57.00 | 9.00 | 20.00 | 21.00 | 3.00 | - | 2 | ● |
| 8.000 | 8.000 | 8.000 | 7.700 | 63.00 | 12.00 | 26.00 | 27.00 | 4.00 | - | 2 | ● |
| 10.000 | 10.000 | 10.000 | 9.500 | 72.00 | 15.00 | 30.00 | 32.00 | 5.00 | - | 2 | ● |
| 12.000 | 12.000 | 12.000 | 11.500 | 83.00 | 18.00 | 36.00 | 38.00 | 6.00 | - | 2 | ● |
| 16.000 | 16.000 | 16.000 | 15.500 | 92.00 | 24.00 | 42.00 | 44.00 | 8.00 | - | 2 | ● |

Cutting values: HSC copy milling*

| ISO Code | Hardness | Feed depth $a_p$ | Feed width** $a_e$ | Cutting speed $v_c$ | fz (mm/z) with nom. Ø 2 | 3 | 4 | 6 | 8 | 10 | 12 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P Steel | ≤ 850 N/mm² | - | - | - | - | - | - | - | - | - | - | - |
| | 850 - 1400 N/mm² | 0.1xd | 0.1xd | 200 | 0.03 | 0.04 | 0.045 | 0.05 | 0.07 | 0.1 | 0.12 | 0.15 |
| K Cast mat. | ≥ 240 HB 30 | 0.1xd | 0.1xd | 200 | 0.03 | 0.04 | 0.045 | 0.05 | 0.07 | 0.1 | 0.12 | 0.15 |
| H Hardened Steel | ≤ 54 HRC | 0.05xd | 0.1xd | 140 | 0.02 | 0.03 | 0.035 | 0.04 | 0.05 | 0.07 | 0.08 | 0.1 |
| | ≤ 63 HRC | 0.02xd | 0.1xd | 80 | 0.02 | 0.03 | 0.035 | 0.04 | 0.05 | 0.07 | 0.08 | 0.1 |

* Dry machining with air cooling is recommended for optimal chip evacuation and tool life.
** for HSC-finishing with $a_e$ = 0.02xd the cutting speed $v_c$ can be increased by 50 %

52 GUHRING

# LAMPIRAN B
# SPESIFIKASI ALAT UKUR

B.1. Spesifikasi TR 100 *Surface Roughness Tester*

TIME

ISO 9001

## SURFACE ROUGHNESS TESTER TR100/110

**Features:**

- Pocket-size & economical price
- Large measuring range suitable for most materials
- Measures flat, outer cylinder and sloping surface
- Both Ra and Rz parameters in one instrument
- Features external calibration at keyboard
- Standard conform to ISO and DIN
- Rechargeable batteries, work while charging
- TR110 is equipped with Li-ion battery and backlight

### Technical Specification

| | TR100 | TR110 |
|---|---|---|
| Roughness parameter | Ra, Rz | |
| Tracing length | 6mm | |
| Tracing speed | 1.0mm/sec | |
| Cut-off lengths | 0.25mm/0.8mm/2.5mm | |
| Evaluation length | 1.25mm/4.0mm/5.0mm | |
| Measuring range | Ra: 0.05-10.0µm Rz: 0.1-50µm | |
| Tolerance | ≤± 15% | |
| Repeatability | <12% | |
| Filter | RC analogue | |
| Pick-up | Piezoelectric | |
| Radius and angle of the stylus point | Diamond, Radius : 10 ± 2.5µm<br>Angle: 90° (+5° or -10°) | |
| Operating temperature | 0-40℃ | |
| Humidity | <80% | |
| Storing temperature | -25℃~60℃ | |
| Verification | Grade 3 | |
| Power supply | 3.6V/2 × NiMh-batteries | 3.6V Li-ion battery |
| Backlight | No | Yes |
| Charger | DC 9V, 8 - 12 hours (recharging time) | DC6V, 3 hours (recharging time) |
| Dimensions (L × W × H) | 125 × 73 × 26mm | 110 × 70 × 24mm |
| Weight | 200g | 160g |

### Standard Delivery

- Main unit 1
- Protection cover for pickup 1
- Specimen Ra 1
- Charger 1
- TIME certificate 1
- Instruction manual 1
- Warranty card 1

### Optional accessories

- Various Ra specimen with Ra values: 0.1µm, 0.2µm, 0.4µm, 0.8µm, 3.2µm

B.2. Sertifikat Kalibrasi TR 100 *Surface Roughness Tester*

**WAGNER INSTRUMENTS**
POST OFFICE BOX 1217
GREENWICH, CT 06836-1217 U.S.A ☎(203) 698-9681

# CERTIFICATE OF CALIBRATION

**DESCRIPTION:** Wagner Force Ten™ Digital Force Gage

**ACCURACY:** ± 0.3% of Full Scale ± Least Significant Digit

**CERTIFICATION DATE:** December 22, 2010

| | MODEL | CAPACITY | SERIAL NUMBER |
|---|---|---|---|
| **FORCE GAGE** | **FDX 100** | **100 x 0.1 lbf / 50 x 0.05 kgf** | **10716** |

THIS IS TO CERTIFY THAT THE INSTRUMENT IDENTIFIED ABOVE HAS BEEN TESTED, AND IS GUARANTEED WITHIN THE SPECIFIED ACCURACY AT THE TIME OF TESTING. THE CALIBRATION STANDARDS USED TO TEST THE INSTRUMENT ARE PERIODICALLY INSPECTED AND ARE TRACEABLE TO THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST).

THE CALIBRATION STANDARDS USED ARE TRACEABLE TO NIST BY THE FOLLOWING REPORTS:

| | |
|---|---|
| MASSACHUSETTS TEST NUMBER | 1011-F001 |
| STATE OF MASSACHUSETTS WORKING STANDARDS TRACEABLE TO NIST TEST NUMBER | 822/272801-06 & 822/274081-06 |
| THROUGH RICE LAKE WEIGHING SYSTEMS CERTIFICATE NUMBER | 1483863A |
| STATE OF CONNECTICUT CERTIFICATION DATE | 10-22-2010 |

Calibration performed at 75 (±10) Degrees Fahrenheit and 60 (±20%) Relative Humidity.

BY: _____ DATE: December 22, 2010
Pierrette Wagner

# LAMPIRAN C
# HASIL PENGUJIAN SPESIMEN MATERIAL FC25

## C.1. Hasil uji tarik material FC25

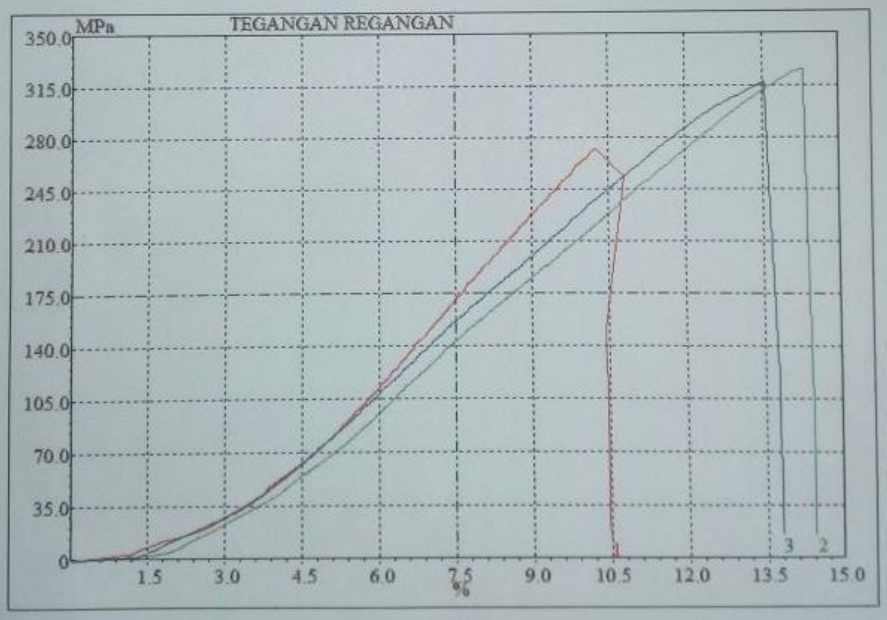
Laboratorium Material Teknik
JURUSAN TEKNIK MESIN FAKULTAS TEKNIK
UNIVERSITAS WAHID HASYIM

Nama : Narno
Instansi : unwahas

Bahan : Cor
Standard : ASTM E8/E8M - 11

**HASIL PENGUJIAN TARIK**

| No | Material | Area | Yield Point | Yield Stress | Max. Load | Max. Stress | Break | Break | Extension | Elongation |
|---|---|---|---|---|---|---|---|---|---|---|
| | | mm² | N | MPa | N | MPa | N | MPa | mm | % |
| 1 | cor | 63.617 | 15761.627 | 247.757 | 17347.127 | 272.680 | 867.243 | 13.632 | 4.188 | 10.469 |
| 2 | Cor | 63.617 | 18782.133 | 295.236 | 20713.680 | 325.598 | 1006.417 | 15.820 | 5.775 | 14.438 |
| 3 | Cor | 63.617 | 18252.892 | 286.917 | 20231.536 | 318.020 | 1001.930 | 15.749 | 5.513 | 13.781 |




Semarang, 10-10-2017
Kepala Laboratorium

Helmy Purwanto, ST , MT
NPP. 05.01.1.0060

Tested By : Nur Kholis, ST
NPP. 02.14.0.0303

Gedung O. Fakultas Teknik
Jl. Menoreh Tengah X/22 Sampangan Semarang 50236
Telp. +62 24 8505680 (ext. 160), Fax. +62 24 8505681, www.teknik.unwahas.ac.id

C.2. Hasil uji komposisi material FC25

4/7/2018 1:54:53 PM

**PT. TRI SINAR PURNAMA**

Sample Identification

SampleNo smpl-besi cor-07-04-2018 Operator wasian

| | C | Si | Mn | P | S | Cr | Mo | Ni | Cu | Al |
|---|---|---|---|---|---|---|---|---|---|---|
| | % | % | % | % | % | % | % | % | % | % |
| 1. | >5.400 | 2.561 | 0.628 | 0.037 | 0.698 | 0.052 | 0.011 | 0.036 | 0.056 | 0.017 |
| 2. | >5.400 | 2.657 | 0.651 | 0.038 | ~0.775 | 0.050 | 0.011 | 0.033 | 0.053 | 0.020 |
| 3. | >5.400 | 2.569 | 0.607 | 0.038 | 0.587 | 0.049 | <0.010 | 0.031 | 0.055 | 0.017 |
| 4. | >5.400 | 2.618 | 0.668 | 0.036 | 0.568 | 0.047 | <0.010 | 0.029 | 0.056 | 0.013 |
| 5. | ~5.218 | 2.434 | 0.658 | 0.042 | 0.567 | 0.054 | <0.010 | 0.031 | 0.057 | 0.013 |
| ∅ | **~5.364** | **2.568** | **0.642** | **0.038** | **0.639** | **0.050** | **<0.010** | **0.032** | **0.055** | **0.016** |
| σ | 0.081 | 0.084 | 0.025 | 0.0023 | 0.093 | 0.0027 | 0.00071 | 0.0026 | 0.0016 | 0.0030 |
| υ | 1.510 | 3.271 | 3.894 | 6.053 | 14.55 | 5.400 | 7.100 | 8.125 | 2.909 | 18.75 |

| | As | B | Bi | Ce | Co | Mg | Nb | Pb | Sb | Sn |
|---|---|---|---|---|---|---|---|---|---|---|
| | % | % | % | % | % | % | % | % | % | % |
| 1. | 0.018 | 0.0046 | 0.028 | 0.016 | 0.0065 | 0.022 | 0.0028 | 0.031 | 0.020 | 0.012 |
| 2. | 0.020 | 0.0045 | 0.024 | 0.017 | 0.0070 | 0.026 | 0.0030 | 0.035 | 0.020 | 0.014 |
| 3. | 0.017 | 0.0042 | 0.022 | 0.0095 | 0.0056 | 0.016 | <0.0010 | 0.018 | 0.013 | 0.011 |
| 4. | 0.015 | 0.0033 | 0.021 | <0.0050 | 0.0056 | 0.013 | <0.0010 | 0.015 | <0.010 | 0.010 |
| 5. | 0.018 | 0.0038 | 0.032 | 0.0080 | 0.0065 | 0.011 | 0.0019 | 0.015 | 0.015 | 0.012 |
| ∅ | **0.018** | **0.0041** | **0.025** | **0.011** | **0.0062** | **0.018** | **0.0019** | **0.023** | **0.016** | **0.012** |
| σ | 0.0019 | 0.00054 | 0.0046 | 0.0052 | 0.00062 | 0.0063 | 0.00095 | 0.0095 | 0.0044 | 0.0015 |
| υ | 10.56 | 13.17 | 18.40 | 47.27 | 10.00 | 35.00 | 50.00 | 41.30 | 27.50 | 12.50 |

| | Ta | La | Ti | V | W | Zn | Zr | Se | Fe |
|---|---|---|---|---|---|---|---|---|---|
| | % | % | % | % | % | % | % | % | % |
| 1. | <0.030 | 0.0036 | 0.010 | 0.0054 | <0.010 | 0.017 | <0.0020 | <0.0050 | 90.26 |
| 2. | <0.030 | 0.0027 | 0.010 | 0.0058 | <0.010 | 0.020 | <0.0020 | <0.0050 | 90.06 |
| 3. | <0.030 | <0.0020 | 0.0092 | <0.0050 | <0.010 | 0.018 | <0.0020 | <0.0050 | 90.44 |
| 4. | <0.030 | <0.0020 | 0.0080 | <0.0050 | <0.010 | 0.012 | <0.0020 | <0.0050 | 90.38 |
| 5. | <0.030 | 0.0030 | 0.0092 | 0.0055 | <0.010 | 0.013 | <0.0020 | <0.0050 | 90.72 |
| ∅ | **<0.030** | **0.0027** | **0.0093** | **0.0053** | **<0.010** | **0.016** | **<0.0020** | **<0.0050** | **90.37** |
| σ | | 0.00069 | 0.00082 | 0.00035 | | 0.0034 | | | 0.243 |
| υ | | 25.56 | 8.817 | 6.604 | | 21.25 | | | 0.269 |

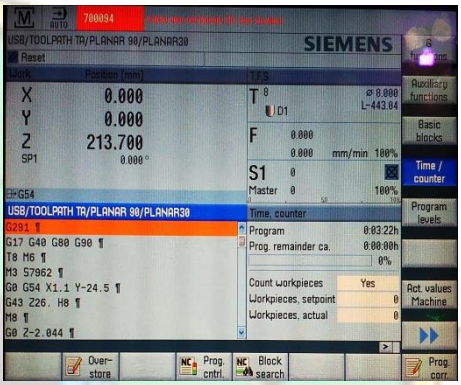
Fe100
Bruker Elemental

Concentrations
1/1

# LAMPIRAN D
# HASIL WAKTU PROSES MESIN CNC, SIMULASI WAKTU CAM DAN HASIL KEKASARAN PERMUKAAN

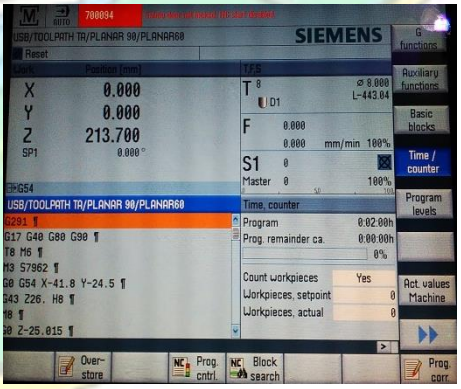
D.1. Hasil waktu proses mesin CNC arah *planar* dan sudut permukaan bidang kerja

Waktu arah *planar* 90$^{o}$
pada sudut benda kerja 0$^{o}$

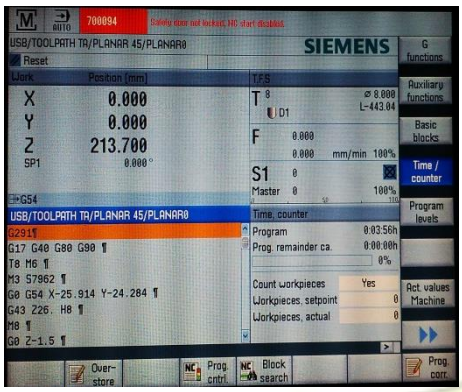



Waktu arah *planar* 90$^{o}$
pada sudut benda kerja 30$^{o}$

Waktu arah planar 90$^{o}$
pada sudut benda kerja 45$^{o}$

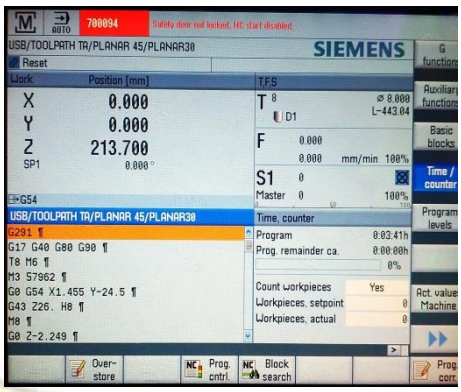



Waktu arah *planar* 90$^{o}$
pada sudut benda kerja 60$^{o}$



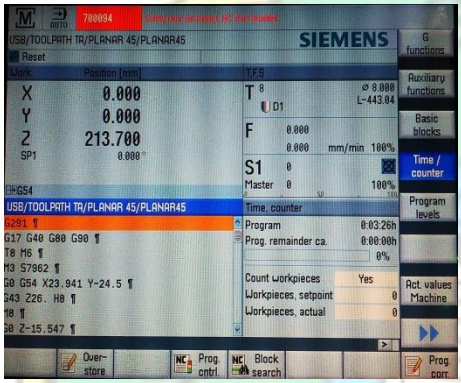

Waktu arah planar 45$^{o}$

pada sudut benda kerja 0$^{o}$



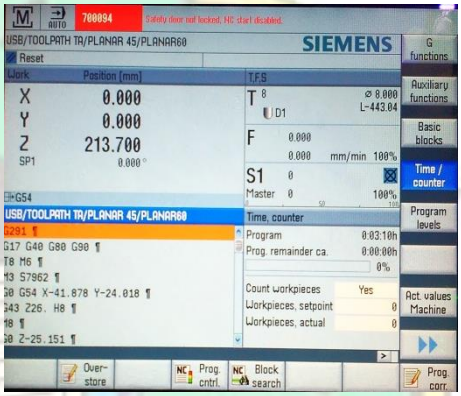

Waktu arah planar 45$^{o}$

pada sudut benda kerja 30$^{o}$



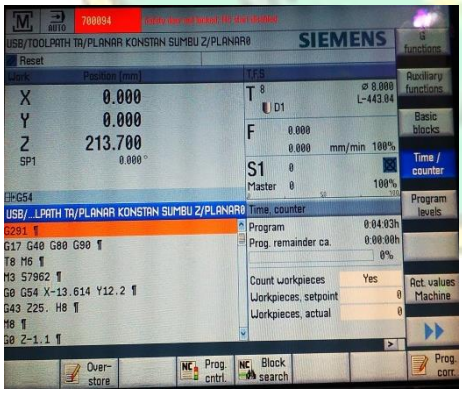

Waktu arah planar 45$^{o}$

pada sudut benda kerja 45$^{o}$



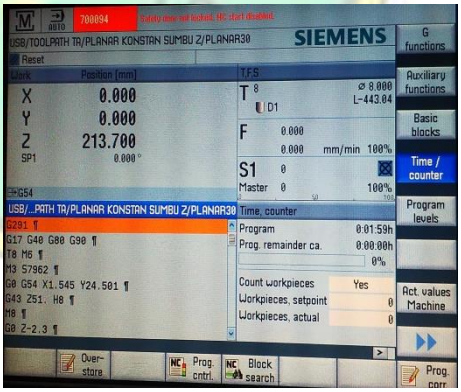

Waktu arah planar 45$^{o}$

pada sudut benda kerja 60$^{o}$



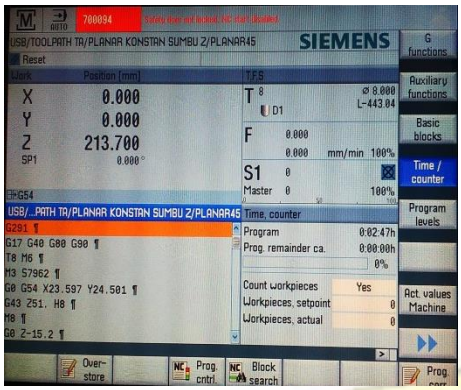

Waktu arah *planar* berputar konstan

sumbu Z pada sudut benda kerja 0$^{o}$

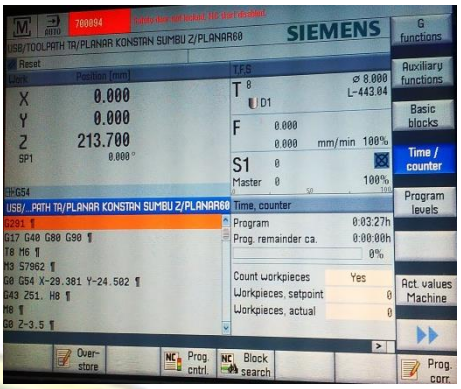



Waktu arah *planar* berputar konstan

sumbu Z pada sudut benda kerja 30$^{o}$

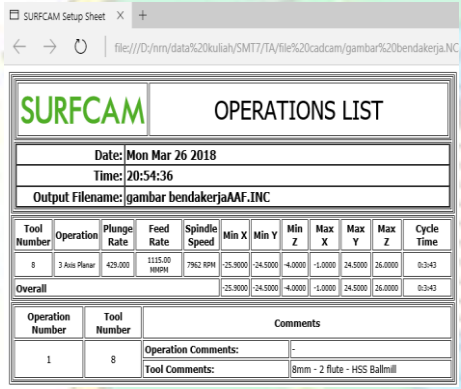



Waktu arah planar berputar konstan sumbu Z pada sudut benda kerja 45$^{o}$




Waktu arah *planar* berputar konstan sumbu Z pada sudut benda kerja 60$^{o}$

D.2. Hasil waktu simulasi CAM arah *planar* dan sudut permukaan bidang kerja



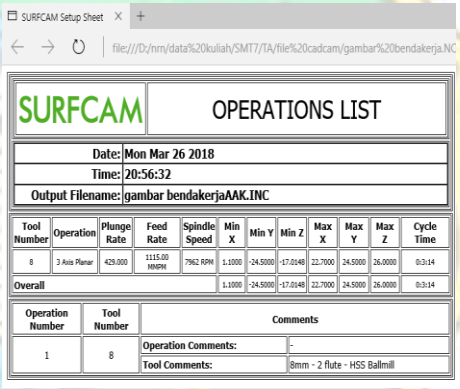
SURFCAM OPERATIONS LIST

Date: Mon Mar 26 2018
Time: 20:54:36
Output Filename: gambar bendakerjaAAF.INC

| Tool Number | Operation | Plunge Rate | Feed Rate | Spindle Speed | Min X | Min Y | Min Z | Max X | Max Y | Max Z | Cycle Time |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | 3 Axis Planar | 429.000 | 1115.00 MMPM | 7962 RPM | -25.9000 | -24.5000 | -4.0000 | -1.0000 | 24.5000 | 26.0000 | 0:3:43 |
| Overall | | | | | -25.9000 | -24.5000 | -4.0000 | -1.0000 | 24.5000 | 26.0000 | 0:3:43 |

| Operation Number | Tool Number | Comments | |
|---|---|---|---|
| 1 | 8 | Operation Comments: | - |
| | | Tool Comments: | 8mm - 2 flute - HSS Ballmill |

Waktu arah planar 90$^{o}$ pada sudut benda kerja 0$^{o}$



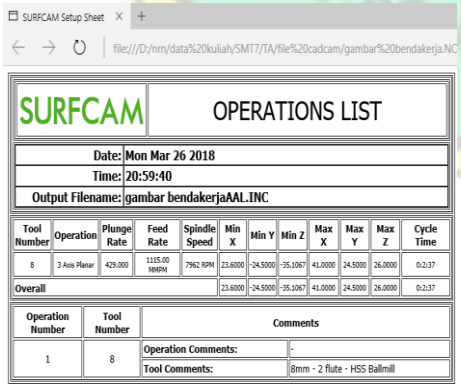
SURFCAM OPERATIONS LIST

Date: Mon Mar 26 2018
Time: 20:56:32
Output Filename: gambar bendakerjaAAK.INC

| Tool Number | Operation | Plunge Rate | Feed Rate | Spindle Speed | Min X | Min Y | Min Z | Max X | Max Y | Max Z | Cycle Time |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | 3 Axis Planar | 429.000 | 1115.00 MMPM | 7962 RPM | 1.1000 | -24.5000 | -17.0148 | 22.7000 | 24.5000 | 26.0000 | 0:3:14 |
| Overall | | | | | 1.1000 | -24.5000 | -17.0148 | 22.7000 | 24.5000 | 26.0000 | 0:3:14 |

| Operation Number | Tool Number | Comments | |
|---|---|---|---|
| 1 | 8 | Operation Comments: | - |
| | | Tool Comments: | 8mm - 2 flute - HSS Ballmill |

Waktu arah *planar* 90$^{o}$ pada sudut benda kerja 30$^{o}$



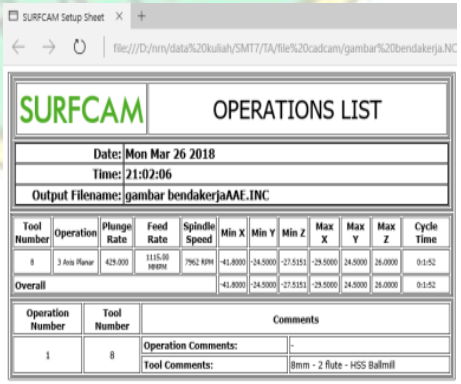
SURFCAM OPERATIONS LIST

Date: Mon Mar 26 2018
Time: 20:59:40
Output Filename: gambar bendakerjaAAL.INC

| Tool Number | Operation | Plunge Rate | Feed Rate | Spindle Speed | Min X | Min Y | Min Z | Max X | Max Y | Max Z | Cycle Time |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | 3 Axis Planar | 429.000 | 1115.00 MMPM | 7962 RPM | 23.6000 | -24.5000 | -35.1067 | 41.0000 | 24.5000 | 26.0000 | 0:2:37 |
| Overall | | | | | 23.6000 | -24.5000 | -35.1067 | 41.0000 | 24.5000 | 26.0000 | 0:2:37 |

| Operation Number | Tool Number | Comments | |
|---|---|---|---|
| 1 | 8 | Operation Comments: | - |
| | | Tool Comments: | 8mm - 2 flute - HSS Ballmill |

Waktu arah planar 90$^{o}$ pada sudut benda kerja 45$^{o}$



SURFCAM OPERATIONS LIST

Date: Mon Mar 26 2018
Time: 21:02:06
Output Filename: gambar bendakerjaAAE.INC

| Tool Number | Operation | Plunge Rate | Feed Rate | Spindle Speed | Min X | Min Y | Min Z | Max X | Max Y | Max Z | Cycle Time |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | 3 Axis Planar | 429.000 | 1115.00 MMPM | 7962 RPM | -41.8000 | -24.5000 | -27.5151 | -29.5000 | 24.5000 | 26.0000 | 0:1:52 |
| Overall | | | | | -41.8000 | -24.5000 | -27.5151 | -29.5000 | 24.5000 | 26.0000 | 0:1:52 |

| Operation Number | Tool Number | Comments | |
|---|---|---|---|
| 1 | 8 | Operation Comments: | - |
| | | Tool Comments: | 8mm - 2 flute - HSS Ballmill |

Waktu arah *planar* 90$^{o}$ pada sudut benda kerja 60$^{o}$

SURFCAM Setup Sheet

SURFCAM — OPERATIONS LIST

Date: Mon Mar 26 2018
Time: 21:04:40
Output Filename: gambar bendakerjaAAZ.INC

| Tool Number | Operation | Plunge Rate | Feed Rate | Spindle Speed | Min X | Min Y | Min Z | Max X | Max Y | Max Z | Cycle Time |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | 3 Axis Planar | 429.000 | 1115.00 MMPM | 7962 RPM | -25.9142 | -24.5000 | -4.0000 | -0.9142 | 24.5000 | 26.0000 | 0:3:44 |
| Overall | | | | | -25.9142 | -24.5000 | -4.0000 | -0.9142 | 24.5000 | 26.0000 | 0:3:44 |

| Operation Number | Tool Number | Comments | |
|---|---|---|---|
| 1 | 8 | Operation Comments: | - |
| | | Tool Comments: | 8mm - 2 flute - HSS Ballmill |

Waktu arah planar 45$^{o}$
pada sudut benda kerja 0$^{o}$

SURFCAM Setup Sheet

SURFCAM — OPERATIONS LIST

Date: Mon Mar 26 2018
Time: 21:07:38
Output Filename: gambar bendakerjaABA.INC

| Tool Number | Operation | Plunge Rate | Feed Rate | Spindle Speed | Min X | Min Y | Min Z | Max X | Max Y | Max Z | Cycle Time |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | 3 Axis Planar | 429.000 | 1115.00 MMPM | 7962 RPM | 1.0858 | -24.5000 | -17.0359 | 22.7365 | 24.5000 | 26.0000 | 0:3:30 |
| Overall | | | | | 1.0858 | -24.5000 | -17.0359 | 22.7365 | 24.5000 | 26.0000 | 0:3:30 |

| Operation Number | Tool Number | Comments | |
|---|---|---|---|
| 1 | 8 | Operation Comments: | - |
| | | Tool Comments: | 8mm - 2 flute - HSS Ballmill |

Waktu arah planar 45$^{o}$
pada sudut benda kerja 30$^{o}$

SURFCAM Setup Sheet

SURFCAM — OPERATIONS LIST

Date: Mon Mar 26 2018
Time: 21:17:15
Output Filename: gambar bendakerjaABB.INC

| Tool Number | Operation | Plunge Rate | Feed Rate | Spindle Speed | Min X | Min Y | Min Z | Max X | Max Y | Max Z | Cycle Time |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | 3 Axis Planar | 429.000 | 1115.00 MMPM | 7962 RPM | 23.5649 | -24.5000 | -35.3492 | 41.2426 | 24.5000 | 26.0000 | 0:3:15 |
| Overall | | | | | 23.5649 | -24.5000 | -35.3492 | 41.2426 | 24.5000 | 26.0000 | 0:3:15 |

| Operation Number | Tool Number | Comments | |
|---|---|---|---|
| 1 | 8 | Operation Comments: | - |
| | | Tool Comments: | 8mm - 2 flute - HSS Ballmill |

Waktu arah planar 45$^{o}$
pada sudut benda kerja 45$^{o}$

SURFCAM Setup Sheet

SURFCAM — OPERATIONS LIST

Date: Mon Mar 26 2018
Time: 21:17:21
Output Filename: gambar bendakerjaAAY.INC

| Tool Number | Operation | Plunge Rate | Feed Rate | Spindle Speed | Min X | Min Y | Min Z | Max X | Max Y | Max Z | Cycle Time |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | 3 Axis Planar | 429.000 | 1115.00 MMPM | 7962 RPM | -41.8783 | -24.5000 | -27.6506 | -29.3783 | 24.5000 | 26.0000 | 0:2:58 |
| Overall | | | | | -41.8783 | -24.5000 | -27.6506 | -29.3783 | 24.5000 | 26.0000 | 0:2:58 |

| Operation Number | Tool Number | Comments | |
|---|---|---|---|
| 1 | 8 | Operation Comments: | - |
| | | Tool Comments: | 8mm - 2 flute - HSS Ballmill |

Waktu arah planar 45$^{o}$
pada sudut benda kerja 60$^{o}$

SURFCAM Setup Sheet

SURFCAM — OPERATIONS LIST

Date: Mon Mar 26 2018
Time: 21:21:14
Output Filename: gambar bendakerjaABD.INC

| Tool Number | Operation | Plunge Rate | Feed Rate | Spindle Speed | Min X | Min Y | Min Z | Max X | Max Y | Max Z | Cycle Time |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | 2 Axis Pocket | 429.000 | 1115.00 MMPM | 7962 RPM | -25.9142 | -24.5000 | -4.0000 | -0.9142 | 24.5000 | 25.0000 | 0:3:52 |
| Overall | | | | | -25.9142 | -24.5000 | -4.0000 | -0.9142 | 24.5000 | 25.0000 | 0:3:52 |

| Operation Number | Tool Number | Comments | |
|---|---|---|---|
| 1 | 8 | Operation Comments: | - |
| | | Tool Comments: | 8mm - 4 flute - HSS Ballmill |

Waktu arah planar berputar konstan
sumbu Z pada sudut benda kerja 0$^{o}$

SURFCAM Setup Sheet

SURFCAM — OPERATIONS LIST

Date: Mon Mar 26 2018
Time: 21:23:25
Output Filename: gambar bendakerjaABE.INC

| Tool Number | Operation | Plunge Rate | Feed Rate | Spindle Speed | Min X | Min Y | Min Z | Max X | Max Y | Max Z | Cycle Time |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | 3 Axis Z Finish | 429.000 | 1115.00 MMPM | 7962 RPM | 1.5450 | -24.5003 | -16.8000 | 22.3489 | 24.5029 | 51.0000 | 0:1:52 |
| Overall | | | | | 1.5450 | -24.5003 | -16.8000 | 22.3489 | 24.5029 | 51.0000 | 0:1:52 |

| Operation Number | Tool Number | Comments | |
|---|---|---|---|
| 1 | 8 | Operation Comments: | - |
| | | Tool Comments: | 8mm - 2 flute - HSS Ballmill |

Waktu arah *planar* berputar konstan
sumbu Z pada sudut benda kerja 30$^{o}$

SURFCAM Setup Sheet

file:///D:/nrn/data%20kuliah/SMT7/TA/file%20cadcam/gambar%20bendakerja.NC

SURFCAM OPERATIONS LIST

| | |
|---|---|
| Date: | Mon Mar 26 2018 |
| Time: | 21:25:31 |
| Output Filename: | gambar bendakerjaABF.INC |

| Tool Number | Operation | Plunge Rate | Feed Rate | Spindle Speed | Min X | Min Y | Min Z | Max X | Max Y | Max Z | Cycle Time |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | 3 Axis Z Finish | 429.000 | 1115.00 MMPM | 7962 RPM | 23.5972 | -24.5003 | -35.1000 | 41.0096 | 24.5029 | 51.0000 | 0:2:40 |
| Overall | | | | | 23.5972 | -24.5003 | -35.1000 | 41.0096 | 24.5029 | 51.0000 | 0:2:40 |

| Operation Number | Tool Number | Comments | |
|---|---|---|---|
| 1 | 8 | Operation Comments: | - |
| | | Tool Comments: | 8mm - 2 flute - HSS Ballmill |

Waktu arah planar berputar konstan sumbu Z pada sudut benda kerja 45$^{o}$

SURFCAM Setup Sheet

file:///D:/nrn/data%20kuliah/SMT7/TA/file%20cadcam/gambar%20bendakerja.NC

SURFCAM OPERATIONS LIST

| | |
|---|---|
| Date: | Mon Mar 26 2018 |
| Time: | 21:26:45 |
| Output Filename: | gambar bendakerjaABC.INC |

| Tool Number | Operation | Plunge Rate | Feed Rate | Spindle Speed | Min X | Min Y | Min Z | Max X | Max Y | Max Z | Cycle Time |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | 3 Axis Z Finish | 429.000 | 1115.00 MMPM | 7962 RPM | -41.8618 | -24.5018 | -27.6000 | -29.3807 | 24.5013 | 51.0000 | 0:3:17 |
| Overall | | | | | -41.8618 | -24.5018 | -27.6000 | -29.3807 | 24.5013 | 51.0000 | 0:3:17 |

| Operation Number | Tool Number | Comments | |
|---|---|---|---|
| 1 | 8 | Operation Comments: | - |
| | | Tool Comments: | 8mm - 2 flute - HSS Ballmill |

Waktu arah *planar* berputar konstan sumbu Z pada sudut benda kerja 60$^{o}$

D.3. Hasil kekasaran permukaan bidang kerja

**LABORATORUM PERANCANGAN**
**JURUSAN TEKNIK MESIN FAKULTAS TEKNIK**
**UNIVERSITAS WAHID HASYIM SEMARANG**
Jl. Menoreh Tengah X / 22. Sampangan. Jawa Tengah Telp. (024) 8505680

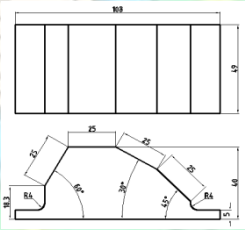
**PENGUJIAN KEKASARAN PERMUKAAN ARAH PLANAR 90$^{O}$**

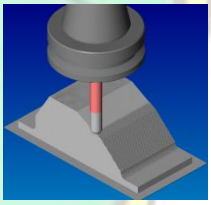
**Informasi Spesimen**

Tanggal Pembuatan : 20 Maret 2018
Material : FC25
Dimensi : 108 mm x 49 mm x 40 mm
Jumlah spesimen : 1
Tanggal pengukuran : 28 Maret 2018
Alat Ukur : TR100 Surface Rougness Tester
Mesin CNC *Milling* : Bridgeport GXV 1000
Alat Potong : Guhring *Ballnose Solid Carbide* nomer 3359 diameter 8 mm

Hasil pengukuran kekasaran permukaan.

| Pengukuran ke | Nilai Ra pada sudut bidang datar (µm) | | | |
|---|---|---|---|---|
| | 0 | 30 | 45 | 60 |
| 1 | 0,70 | 1,38 | 1,40 | 2,93 |
| 2 | 0,68 | 1,32 | 1,82 | 3,22 |
| 3 | 0,74 | 1,63 | 1,43 | 3,29 |
| 4 | 0,80 | 1,22 | 1,42 | 3,03 |
| 5 | 0,67 | 1,33 | 1,43 | 3,29 |
| 6 | 0,82 | 1,56 | 1,64 | 3,52 |
| **Rata-Rata** | 0,74 | 1,41 | 1,52 | 3,21 |





**Cutting Condition**

Arah Planar : 90$^{o}$
Dia Cutter : 8 mm
Jumlah Flute : 2
Material Cutter : Solid Carbide
Put. Spindel : 7962 rpm
Feed Rate : 1115 mm/mnt
Increment : 0,3 mm

Mengetahui,
Kepala Laboratorium

Imam Syafa'at, S.T., M.T

Semarang, 28 Maret 2018
Pengambil Data

Sunarno

**LABORATORUM PERANCANGAN**
**JURUSAN TEKNIK MESIN FAKULTAS TEKNIK**
**UNIVERSITAS WAHID HASYIM SEMARANG**
Jl. Menoreh Tengah X / 22. Sampangan. Jawa Tengah Telp. (024) 8505680

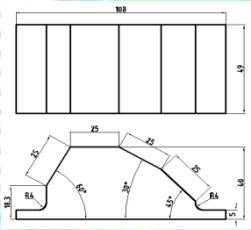
## PENGUJIAN KEKASARAN PERMUKAAN ARAH PLANAR 45$^{O}$

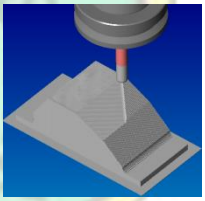
**Informasi Spesimen**

Tanggal Pembuatan : 20 Maret 2018
Material : FC25
Dimensi : 108 mm x 49 mm x 40 mm
Jumlah spesimen : 1
Tanggal pengukuran : 28 Maret 2018
Alat Ukur : TR100 Surface Rougness Tester
Mesin CNC *Milling* : Bridgeport GXV 1000
Alat Potong : Guhring *Ballnose Solid Carbide* nomer 3359 diameter 8 mm

Hasil pengukuran kekasaran permukaan.

| Pengukuran ke | Nilai Ra pada sudut bidang datar (µm) | | | |
|---|---|---|---|---|
| | 0 | 30 | 45 | 60 |
| 1 | 0,60 | 1,12 | 1,15 | 1,63 |
| 2 | 0,80 | 1,20 | 1,03 | 1,58 |
| 3 | 1,04 | 1,22 | 1,43 | 1,63 |
| 4 | 0,72 | 1,08 | 1,09 | 1,74 |
| 5 | 0,72 | 1,42 | 1,45 | 1,76 |
| 6 | 0,68 | 1,17 | 1,38 | 1,32 |
| **Rata-Rata** | 0,76 | 1,20 | 1,26 | 1,61 |





**Cutting Condition**

Arah Planar : 45$^{o}$
Dia Cutter : 8 mm
Jumlah Flute : 2
Material Cutter : Solid Carbide
Put. Spindel : 7962 rpm
Feed Rate : 1115 mm/mnt
Increment : 0,3 mm

Mengetahui,
Kepala Laboratorium

Imam Syafa'at, S.T., M.T

Semarang, 28 Maret 2018
Pengambil Data

Sunarno

**LABORATORUM PERANCANGAN**
**JURUSAN TEKNIK MESIN FAKULTAS TEKNIK**
**UNIVERSITAS WAHID HASYIM SEMARANG**
Jl. Menoreh Tengah X / 22. Sampangan. Jawa Tengah Telp. (024) 8505680

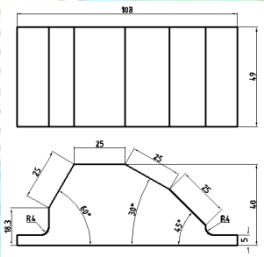
## PENGUJIAN KEKASARAN PERMUKAAN ARAH PLANAR KONSTAN SUMBU Z

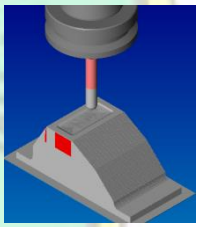
**Informasi Spesimen**

Tanggal Pembuatan : 20 Maret 2018
Material : FC25
Dimensi : 108 mm x 49 mm x 40 mm
Jumlah spesimen : 1
Tanggal pengukuran : 28 Maret 2018
Alat Ukur : TR100 Surface Rougness Tester
Mesin CNC *Milling* : Bridgeport GXV 1000
Alat Potong : Guhring *Ballnose Solid Carbide* nomer 3359 diameter 8 mm

Hasil pengukuran kekasaran permukaan.

| Pengukuran ke | Nilai Ra pada sudut bidang datar (µm) | | | |
|---|---|---|---|---|
| | 0 | 30 | 45 | 60 |
| 1 | 1,30 | 2,28 | 1,16 | 1,20 |
| 2 | 1,09 | 2,59 | 0,98 | 1,09 |
| 3 | 1,25 | 2,54 | 1,19 | 1,17 |
| 4 | 1,14 | 2,78 | 1,14 | 1,09 |
| 5 | 1,30 | 2,28 | 1,22 | 1,04 |
| 6 | 1,20 | 2,80 | 1,17 | 1,17 |
| **Rata-Rata** | 1,21 | 2,55 | 1,14 | 1,13 |





**Cutting Condition**

Arah Planar : Konstan Sumbu Z
Dia Cutter : 8 mm
Jumlah Flute : 2
Material Cutter : Solid Carbide
Put. Spindel : 7962 rpm
Feed Rate : 1115 mm/mnt
Increment : 0,3 mm

Mengetahui,
Kepala Laboratorium

Imam Syafa'at, S.T., M.T

Semarang, 28 Maret 2018
Pengambil Data

Sunarno

# LAMPIRAN E
# PROGRAM CNC

E.1. Program CNC

| | | | | | | |
|---|---|---|---|---|---|---|
| O001 | X-25. | Y-24.5 | X-16.9 | Y24.5 | X-8.8 | Y-24.5 |
| G17 | Y24.5 | X-20.8 | Y-24.5 | X-12.7 | Y24.5 | X-4.6 |
| G40 | X-24.7 | Y24.5 | X-16.6 | Y-24.5 | X-8.5 | Y24.5 |
| G80 | Y-24.5 | X-20.5 | Y24.5 | X-12.4 | Y-24.5 | X-4.3 |
| G90 | X-24.4 | Y-24.5 | X-16.3 | Y24.5 | X-8.2 | Y-24.5 |
| T8 M6 | Y24.5 | X-20.2 | Y-24.5 | X-12.1 | Y24.5 | X-4. |
| M3 | X-24.1 | Y24.5 | X-16. | Y-24.5 | X-7.9 | Y24.5 |
| S7962 | Y-24.5 | X-19.9 | Y24.5 | X-11.8 | Y-24.5 | X-3.7 |
| G0 | X-23.8 | Y-24.5 | X-15.7 | Y24.5 | X-7.6 | Y-24.5 |
| G54 | Y24.5 | X-19.6 | Y-24.5 | X-11.5 | Y24.5 | X-3.4 |
| X-25.9 | X-23.5 | Y24.5 | X-15.4 | Y-24.5 | X-7.3 | Y24.5 |
| Y24.5 | Y-24.5 | X-19.3 | Y24.5 | X-11.2 | Y-24.5 | X-3.1 |
| G43 | X-23.2 | Y-24.5 | X-15.1 | Y24.5 | X-7. | Y-24.5 |
| Z26. | Y24.5 | X-19. | Y-24.5 | X-10.9 | Y24.5 | X-2.8 |
| H8 | X-22.9 | Y24.5 | X-14.8 | Y-24.5 | X-6.7 | Y24.5 |
| M8 | Y-24.5 | X-18.7 | Y24.5 | X-10.6 | Y-24.5 | X-2.5 |
| G0 Z- | X-22.6 | Y-24.5 | X-14.5 | Y24.5 | X-6.4 | Y-24.5 |
| 1.5 | Y24.5 | X-18.4 | Y-24.5 | X-10.3 | Y24.5 | X-2.2 |
| G1 Z- | X-22.3 | Y24.5 | X-14.2 | Y-24.5 | X-6.1 | Y24.5 |
| 4. | Y-24.5 | X-18.1 | Y24.5 | X-10. | Y-24.5 | X-1.9 |
| F429. | X-22. | Y-24.5 | X-13.9 | Y24.5 | X-5.8 | Y-24.5 |
| Y-24.5 | Y24.5 | X-17.8 | Y-24.5 | X-9.7 | Y24.5 | X-1.6 |
| F1115. | X-21.7 | Y24.5 | X-13.6 | Y-24.5 | X-5.5 | Y24.5 |
| X-25.6 | Y-24.5 | X-17.5 | Y24.5 | X-9.4 | Y-24.5 | X-1.3 |
| Y24.5 | X-21.4 | Y-24.5 | X-13.3 | Y24.5 | X-5.2 | Y-24.5 |
| X-25.3 | Y24.5 | X-17.2 | Y-24.5 | X-9.1 | Y24.5 | X-1. |
| Y-24.5 | X-21.1 | Y24.5 | X-13. | Y-24.5 | X-4.9 | Y24.5 |

| | | | | | | |
|---|---|---|---|---|---|---|
| G0 | X2.9 | X5.3 | Y-24.5 | Y-24.5 | Y-24.5 | X14.6 |
| Z26. | Z- | Z- | X7.7 | X10.1 | X12.5 | Z- |
| X1.1 | 5.583 | 6.969 | Z- | Z-9.74 | Z- | 12.338 |
| Y-24.5 | Y24.5 | Y24.5 | 8.355 | Y24.5 | 11.126 | Y-24.5 |
| Z- | X3.2 | X5.6 | Y24.5 | X10.4 | Y24.5 | X14.9 |
| 2.044 | Z- | Z- | X8. Z- | Z- | X12.8 | Z- |
| G1 Z- | 5.756 | 7.142 | 8.528 | 9.913 | Z- | 12.511 |
| 4.544 | Y-24.5 | Y-24.5 | Y-24.5 | Y-24.5 | 11.299 | Y24.5 |
| F429. | X3.5 | X5.9 | X8.3 | X10.7 | Y-24.5 | X15.2 |
| Y24.5 | Z-5.93 | Z- | Z- | Z- | X13.1 | Z- |
| F1115. | Y24.5 | 7.315 | 8.701 | 10.087 | Z- | 12.685 |
| X1.4 | X3.8 | Y24.5 | Y24.5 | Y24.5 | 11.472 | Y-24.5 |
| Z- | Z- | X6.2 | X8.6 | X11. | Y24.5 | X15.5 |
| 4.717 | 6.103 | Z- | Z- | Z- | X13.4 | Z- |
| Y-24.5 | Y-24.5 | 7.489 | 8.874 | 10.26 | Z- | 12.858 |
| X1.7 | X4.1 | Y-24.5 | Y-24.5 | Y-24.5 | 11.646 | Y24.5 |
| Z- | Z- | X6.5 | X8.9 | X11.3 | Y-24.5 | X15.8 |
| 4.891 | 6.276 | Z- | Z- | Z- | X13.7 | Z- |
| Y24.5 | Y24.5 | 7.662 | 9.047 | 10.433 | Z- | 13.031 |
| X2. Z- | X4.4 | Y24.5 | Y24.5 | Y24.5 | 11.819 | Y-24.5 |
| 5.064 | Z- | X6.8 | X9.2 | X11.6 | Y24.5 | X16.1 |
| Y-24.5 | 6.449 | Z- | Z- | Z- | X14. | Z- |
| X2.3 | Y-24.5 | 7.835 | 9.221 | 10.606 | Z- | 13.204 |
| Z- | X4.7 | Y-24.5 | Y-24.5 | Y-24.5 | 11.992 | Y24.5 |
| 5.237 | Z- | X7.1 | X9.5 | X11.9 | Y-24.5 | X16.4 |
| Y24.5 | 6.623 | Z- | Z- | Z- | X14.3 | Z- |
| X2.6 | Y24.5 | 8.008 | 9.394 | 10.78 | Z- | 13.378 |
| Z-5.41 | X5. Z- | Y24.5 | Y24.5 | Y24.5 | 12.165 | Y-24.5 |
| Y-24.5 | 6.796 | X7.4 | X9.8 | X12.2 | Y24.5 | X16.7 |
| | Y-24.5 | Z- | Z- | Z- | | Z- |
| | | 8.181 | 9.567 | 10.953 | | 13.551 |

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|---|---|---|---|---|---|---|
| Y24.5 | X19.1 | Y-24.5 | X23.9 | Y-24.5 | X28.4 | Y24.5 |
| X17. | Z- | X21.5 | Z- | X26.3 | Z- | X30.8 |
| Z- | 14.936 | Z- | 18.007 | Z- | 22.507 | Z- |
| 13.724 | Y24.5 | 16.322 | Y24.5 | 20.407 | Y-24.5 | 24.907 |
| Y-24.5 | X19.4 | Y24.5 | X24.2 | Y24.5 | X28.7 | Y-24.5 |
| X17.3 | Z- | X21.8 | Z- | X26.6 | Z- | X31.1 |
| Z- | 15.11 | Z- | 18.307 | Z- | 22.807 | Z- |
| 13.897 | Y-24.5 | 16.495 | Y-24.5 | 20.707 | Y24.5 | 25.207 |
| Y24.5 | X19.7 | Y-24.5 | X24.5 | Y-24.5 | X29. | Y24.5 |
| X17.6 | Z- | X22.1 | Z- | X26.9 | Z- | X31.4 |
| Z- | 15.283 | Z- | 18.607 | Z- | 23.107 | Z- |
| 14.07 | Y24.5 | 16.668 | Y24.5 | 21.007 | Y-24.5 | 25.507 |
| Y-24.5 | X20. | Y24.5 | X24.8 | Y24.5 | X29.3 | Y-24.5 |
| X17.9 | Z- | X22.4 | Z- | X27.2 | Z- | X31.7 |
| Z- | 15.456 | Z- | 18.907 | Z- | 23.407 | Z- |
| 14.244 | Y-24.5 | 16.842 | Y-24.5 | 21.307 | Y24.5 | 25.807 |
| Y24.5 | X20.3 | Y-24.5 | X25.1 | Y-24.5 | X29.6 | Y24.5 |
| X18.2 | Z- | X22.7 | Z- | X27.5 | Z- | X32. |
| Z- | 15.629 | Z- | 19.207 | Z- | 23.707 | Z- |
| 14.417 | Y24.5 | 17.015 | Y24.5 | 21.607 | Y-24.5 | 26.107 |
| Y-24.5 | X20.6 | Y24.5 | X25.4 | Y24.5 | X29.9 | Y-24.5 |
| X18.5 | Z- | G0 | Z- | X27.8 | Z- | X32.3 |
| Z- | 15.802 | Z26. | 19.507 | Z- | 24.007 | Z- |
| 14.59 | Y-24.5 | X23.6 | Y-24.5 | 21.907 | Y24.5 | 26.407 |
| Y24.5 | X20.9 | Z- | X25.7 | Y-24.5 | X30.2 | Y24.5 |
| X18.8 | Z- | 15.207 | Z- | X28.1 | Z- | X32.6 |
| Z- | 15.976 | G1 Z- | 19.807 | Z- | 24.307 | Z- |
| 14.763 | Y24.5 | 17.707 | Y24.5 | 22.207 | Y-24.5 | 26.707 |
| Y-24.5 | X21.2 | F429. | X26. | Y24.5 | X30.5 | Y-24.5 |
| | Z- | Y-24.5 | Z- | | Z- | |
| | 16.149 | F1115. | 20.107 | | 24.607 | |

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|---|---|---|---|---|---|---|
| X32.9 | Y-24.5 | X37.4 | Y24.5 | X-41.5 | Y24.5 | X-37. |
| Z- | X35.3 | Z- | X39.8 | Z- | X-39.1 | Z- |
| 27.007 | Z- | 31.507 | Z- | 26.995 | Z- | 19.201 |
| Y24.5 | 29.407 | Y-24.5 | 33.907 | Y-24.5 | 22.839 | Y24.5 |
| X33.2 | Y24.5 | X37.7 | Y-24.5 | X-41.2 | Y-24.5 | X-36.7 |
| Z- | X35.6 | Z- | X40.1 | Z- | X-38.8 | Z- |
| 27.307 | Z- | 31.807 | Z- | 26.476 | Z- | 18.682 |
| Y-24.5 | 29.707 | Y24.5 | 34.207 | Y24.5 | 22.319 | Y-24.5 |
| X33.5 | Y-24.5 | X38. | Y24.5 | X-40.9 | Y24.5 | X-36.4 |
| Z- | X35.9 | Z- | X40.4 | Z- | X-38.5 | Z- |
| 27.607 | Z- | 32.107 | Z- | 25.956 | Z- | 18.162 |
| Y24.5 | 30.007 | Y-24.5 | 34.507 | Y-24.5 | 21.799 | Y24.5 |
| X33.8 | Y24.5 | X38.3 | Y-24.5 | X-40.6 | Y-24.5 | X-36.1 |
| Z- | X36.2 | Z- | X40.7 | Z- | X-38.2 | Z- |
| 27.907 | Z- | 32.407 | Z- | 25.437 | Z- | 17.642 |
| Y-24.5 | 30.307 | Y24.5 | 34.807 | Y24.5 | 21.28 | Y-24.5 |
| X34.1 | Y-24.5 | X38.6 | Y24.5 | X-40.3 | Y24.5 | X-35.8 |
| Z- | X36.5 | Z- | X41. | Z- | X-37.9 | Z- |
| 28.207 | Z- | 32.707 | Z- | 24.917 | Z- | 17.123 |
| Y24.5 | 30.607 | Y-24.5 | 35.107 | Y-24.5 | 20.76 | Y24.5 |
| X34.4 | Y24.5 | X38.9 | Y-24.5 | X-40. | Y-24.5 | X-35.5 |
| Z- | X36.8 | Z- | G0 | Z- | X-37.6 | Z- |
| 28.507 | Z- | 33.007 | Z26. | 24.397 | Z- | 16.603 |
| Y-24.5 | 30.907 | Y24.5 | X-41.8 | Y24.5 | 20.241 | Y-24.5 |
| X34.7 | Y-24.5 | X39.2 | Z- | X-39.7 | Y24.5 | X-35.2 |
| Z- | X37.1 | Z- | 25.015 | Z- | X-37.3 | Z- |
| 28.807 | Z- | 33.307 | G1 Z- | 23.878 | Z- | 16.084 |
| Y24.5 | 31.207 | Y-24.5 | 27.515 | Y-24.5 | 19.721 | Y24.5 |
| X35. | Y24.5 | X39.5 | F429. | X-39.4 | Y-24.5 | X-34.9 |
| Z- | | Z- | Y24.5 | Z- | | Z- |
| 29.107 | | 33.607 | F1115. | 23.358 | | 15.564 |

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|---|---|---|---|---|---|---|
| Y-24.5 | Y24.5 | Y-24.5 | Y24.5 | Y-24.5 | X-30.1 | G0 |
| X-34.6 | X-33.7 | X-32.8 | X-31.9 | X-31. | Z-7.25 | Z26. |
| Z- | Z- | Z- | Z- | Z- | Y-24.5 | M9 |
| 15.044 | 13.486 | 11.927 | 10.368 | 8.809 | X-29.8 | G90 |
| Y24.5 | Y-24.5 | Y24.5 | Y-24.5 | Y24.5 | Z- | G0 |
| X-34.3 | X-33.4 | X-32.5 | X-31.6 | X-30.7 | 6.731 | G49 |
| Z- | Z- | Z- | Z- | Z- | Y24.5 | Z0 M5 |
| 14.525 | 12.966 | 11.407 | 9.848 | 8.289 | X-29.5 | T8 M6 |
| Y-24.5 | Y24.5 | Y-24.5 | Y24.5 | Y-24.5 | Z- | X0 Y0 |
| X-34. | X-33.1 | X-32.2 | X-31.3 | X-30.4 | 6.211 | M30 |
| Z- | Z- | Z- | Z- | Z-7.77 | Y-24.5 | % |
| 14.005 | 12.446 | 10.887 | 9.329 | Y24.5 | | |

E.2. Program kode G Pada Mesin CNC

| NO | Kode | Penjelasan |
|---|---|---|
| 1 | G00 | Pengeposisian bebas |
| 2 | G01 | Interpolasi Lurus (gerak pemakanan) |
| 3 | G02 | Interpolasi melingkar searah jarum jam (CW) |
| 4 | G03 | Interpolasi melingkar berlawanan arah jarum jam (CCW) |
| 5 | G04 | Program berhenti pada waktu tertentu |
| 6 | G10 | Data program dapat di-input |
| 7 | G15 | Pembatalan perintah koordinat polar |
| 8 | G16 | Perintah koordinat polar |
| 9 | G17 | Interpolasi helical |
| 10 | G20 | Konversi satuan inchi (british) |
| 11 | G21 | Konversi satuan mm (metric) |
| 12 | G28 | Pengembalian posisi referensi |
| 13 | G31 | perintah skip (melangkahi) |
| 14 | G33 | Pembuatan ulir (Threading cutting) |
| 15 | G40 | Cancel kompensasi cutter |
| 16 | G43, G44 | Kompensasi panjang *tool* positif(G43), Negatif (G44) |
| 17 | G45 | Menaikkan offset *tool* |
| 18 | G46 | Menurunkan offset *tool* |
| 19 | G47 | Menaikkan ganda offset *tool* |
| 20 | G48 | Menurunkan ganda offset *tool* |
| 21 | G49 | Pembatalan kompensasi panjang *tool* |
| 22 | G52 | Penyatuan system koordinat local |
| 23 | G54, G55 | Sistem koordinat workpiece |
| 24 | G60 | Pengeposisian arah tunggal |
| 25 | G63 | Pengerjalaan Tapping (ulir dalam) |
| 26 | G64 | Pengerjaan pemotongan |
| 27 | G74 | Menghitung putaran Tapping |
| 28 | G76 | Pengerjaan proses canned cycle |

| NO | Kode | Penjelasan |
|---|---|---|
| 29 | G80 | Pembatalan pengerjaan siklus |
| 30 | G81 | Pengoperasian eksernal atau putaran drilling |
| 31 | G82 | Keliling counter boring |
| 32 | G83 | Peck drilling cycle |
| 33 | G84 | Pengerjaan keliling Tapping |
| 34 | G85 | Pengerjaan keliling boring |
| 35 | G90 | Perintah system koordinat absolute |
| 36 | G91 | Perintah system koordinat incremental |
| 37 | G94 | Penentuan asutan pemakanan dalam (inchi/menit) |
| 38 | G95 | Penentuan asutan pemakanan dalam (inchi/putaran) |
| 39 | G96 | Kecepatan potong permukaan konstan |
| 40 | G98 | Kembali ke titik initial di sebuah siklus |
| 41 | G99 | Kembali ke titik R di sebuah siklus |

E.3. Program kode M Pada Mesin CNC

| NO | Kode | Penjelasan |
|---|---|---|
| 1 | M00 | Berhenti antar program. |
| 2 | M01 | Usulan program stop |
| 3 | M02 | Akhir program, program berhenti, lampu alarm hidup |
| 4 | M03 | Putaran spindel searah jarum jam |
| 5 | M04 | Putaran spindel berlawanan arah jarum jam |
| 6 | M05 | Spindel berhenti berputar tetapi kode lainnya masih jalan |
| 7 | M06 | Pergantian *tool* di magazine |
| 8 | M07 | Coolant (pendingin) mengeluarkan angin |
| 9 | M08 | Coolant ON |
| 10 | M09 | Coolant OFF |
| 11 | M10 | Rem ke-4 sumbu ON untuk menghentikan jalan |
| 12 | M11 | Rem ke-4 sumbu OFF untuk menjalankan |

| NO | Kode | Penjelasan |
|---|---|---|
| 13 | M19 | Spindel berhenti pada yang diorientasikan secara tepat |
| 14 | M23 | Koveyor bergerak berlawanan jarum jam |
| 15 | M24 | Konveyor bergerak searah jarum jam |
| 16 | M29 | Khusus system fanuc, spindel yg sedang menjepit *tool* tidak bisa diganti langsung tetapi harus gunakan perintah S |
| 17 | M30 | Akhir program, program berhenti |
| 18 | M48 | Pembatalan (cancel) hidupnya OVERRIDE |
| 19 | M50 | Coolant untuk pengeboran dalam perintah |
| 20 | M52 | Kode bayangan sumbu X keluar |
| 21 | M53 | Kode bayangan sumbu Y keluar |
| 22 | M54 | Kode bayangan sumbu X,Y dan keempat arah gerakan ditutup |
| 23 | M80 | Diperintahkan *tool* buka klem |
| 24 | M81 | Diperintahkan *tool* menjepit klem |
| 25 | M90 | Memerintahkan posisi ATC kedepan untuk menjepit *tool* |
| 26 | M91 | Memerintahkan posisi ATC kebelakang (kembali) untuk menjepit *tool* |
| 27 | M98 | Untuk memanggil program pembantu (sub-program) |
| 28 | M99 | Untuk keluar dari program pembantu dan kembali ke program utama. |