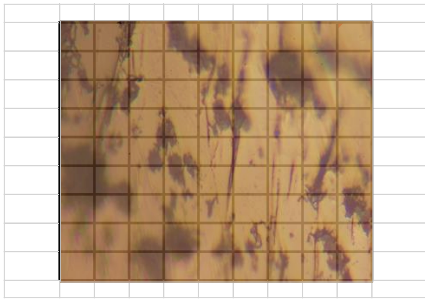


LAMPIRAN

❖ Perhitungan presentase ferrite perlite struktur mikro

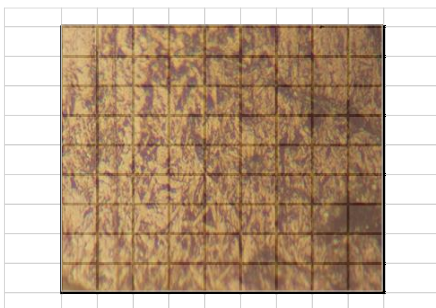
➤ Tanpa preheating



$$\begin{aligned}\text{Presentase perlite} &= \frac{\text{jumlah fasa perlite}}{\text{jumlah titik}} \times 100\% \\ &= \frac{18}{100} \times 100\% = 18\%\end{aligned}$$

$$\begin{aligned}\text{Presentase ferrite} &= 100\% - \text{presentase perlite} \\ &= 100\% - 18\% = 82\%\end{aligned}$$

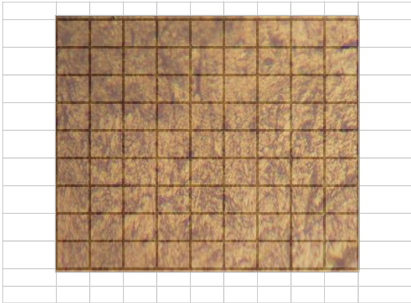
➤ Preheating 160°C waktu tahan 7menit



$$\begin{aligned}\text{Presentase perlite} &= \frac{\text{jumlah fasa perlite}}{\text{jumlah titik}} \times 100\% \\ &= \frac{38}{100} \times 100\% = 38\%\end{aligned}$$

$$\begin{aligned}\text{Presentase ferrite} &= 100\% - \text{presentase perlite} \\ &= 100\% - 38\% = 62\%\end{aligned}$$

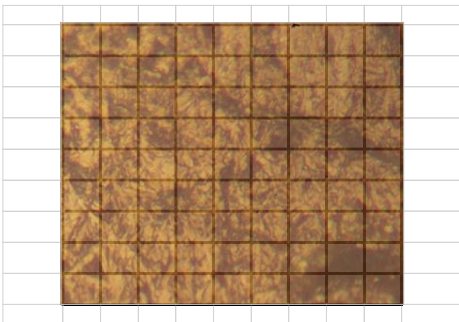
➤ **Preheating 160°C waktu tahan 15menit**



$$\begin{aligned}\text{Presentase perlit} &= \frac{\text{jumlah fasa perlit}}{\text{jumlah titik}} \times 100\% \\ &= \frac{51}{100} \times 100\% = 51\%\end{aligned}$$

$$\begin{aligned}\text{Presentase ferrite} &= 100\% - \text{presentase perlit} \\ &= 100\% - 51\% = 49\%\end{aligned}$$

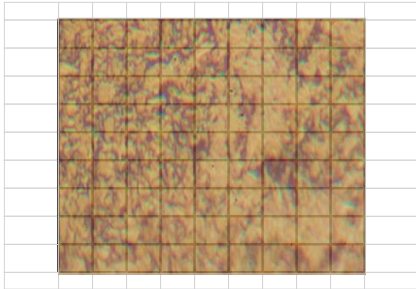
➤ **Preheating 160°C waktu tahan 20menit**



$$\begin{aligned}\text{Presentase perlit} &= \frac{\text{jumlah fasa perlit}}{\text{jumlah titik}} \times 100\% \\ &= \frac{58}{100} \times 100\% = 58\%\end{aligned}$$

$$\begin{aligned}\text{Presentase ferrite} &= 100\% - \text{presentase perlit} \\ &= 100\% - 58\% = 42\%\end{aligned}$$

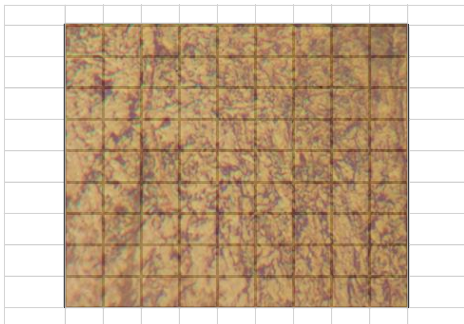
➤ **Preheating 210°C waktu tahan 7menit**



$$\begin{aligned}\text{Presentase perlit} &= \frac{\text{jumlah fasa perlit}}{\text{jumlah titik}} \times 100\% \\ &= \frac{45}{100} \times 100\% = 45\%\end{aligned}$$

$$\begin{aligned}\text{Presentase ferrite} &= 100\% - \text{presentase perlit} \\ &= 100\% - 45\% = 55\%\end{aligned}$$

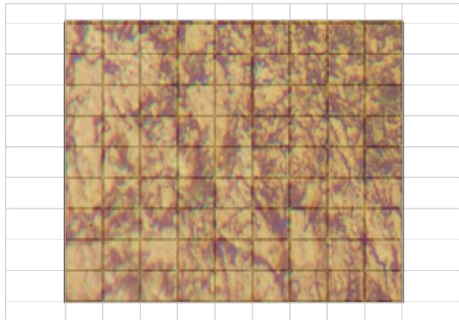
➤ **Preheating 210°C waktu tahan 15menit**



$$\begin{aligned}\text{Presentase perlit} &= \frac{\text{jumlah fasa perlit}}{\text{jumlah titik}} \times 100\% \\ &= \frac{56}{100} \times 100\% = 56\%\end{aligned}$$

$$\begin{aligned}\text{Presentase ferrite} &= 100\% - \text{presentase perlit} \\ &= 100\% - 56\% = 44\%\end{aligned}$$

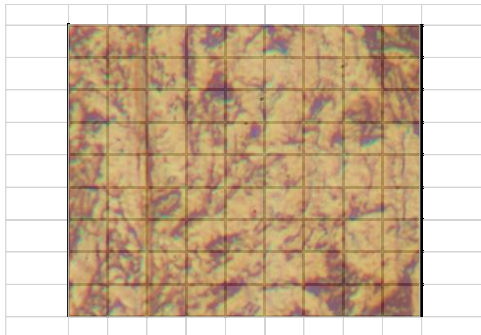
➤ **Preheating 210°C waktu tahan 20menit**



$$\begin{aligned}\text{Presentase perlit} &= \frac{\text{jumlah fasa perlit}}{\text{jumlah titik}} \times 100\% \\ &= \frac{66}{100} \times 100\% = 66\%\end{aligned}$$

$$\begin{aligned}\text{Presentase ferrite} &= 100\% - \text{presentase perlit} \\ &= 100\% - 66\% = 34\%\end{aligned}$$

➤ **Preheating 260°C waktu tahan 7menit**

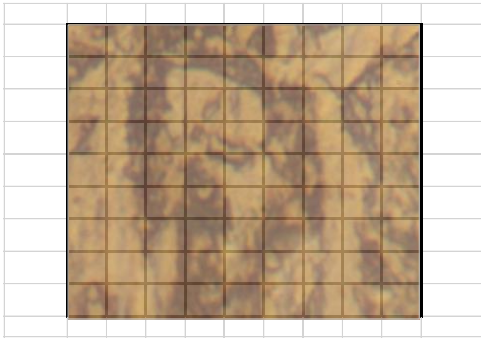


$$\begin{aligned}\text{Presentase perlit} &= \frac{\text{jumlah fasa perlit}}{\text{jumlah titik}} \times 100\% \\ &= \frac{49}{100} \times 100\% = 49\%\end{aligned}$$

$$\text{Presentase ferrite} = 100\% - \text{presentase perlit}$$

$$= 100\% - 49\% = 51\%$$

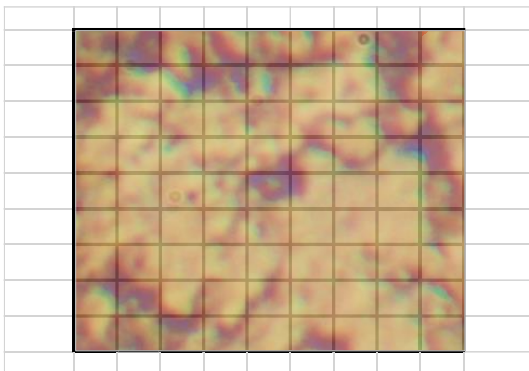
➤ **Preheating 260°C waktu tahan 15menit**



$$\begin{aligned} \text{Presentase perlit} &= \frac{\text{jumlah fasa perlit}}{\text{jumlah titik}} \times 100\% \\ &= \frac{62}{100} \times 100\% = 62\% \end{aligned}$$

$$\begin{aligned} \text{Presentase ferrite} &= 100\% - \text{presentase perlit} \\ &= 100\% - 62\% = 38\% \end{aligned}$$

➤ **Preheating 260°C waktu tahan 20menit**



$$\begin{aligned} \text{Presentase perlit} &= \frac{\text{jumlah fasa perlit}}{\text{jumlah titik}} \times 100\% \\ &= \frac{71}{100} \times 100\% = 71\% \end{aligned}$$

Presentase ferrite = 100% - presentase perlit
= 100% - 71% = 29 %

NO	Keterangan	Spesimen 1	Spesimen 2	Spesimen 3
1	Panjang Awal (L_0), mm	95	95	95
2	Panjang Akhir (L_f), mm	98	97	97
3	Pertambahan Panjang (ΔL_{max}), mm	3	2	2
4	Dimensi awal mula mula (penampang) mm	9,2	9,2	9,2
5	Luas penampang mula mula (A_0) mm^2	66,4	66,4	66,4
6	Beban yield (P_y), Kgf	1854	1200	1100
7	Beban ultimate (P_u), Kgf	1980	1390	1210
8	Beban putus (P_{pts}), Kgf	1915	1131	1147
9	$\Delta L(yield)$, mm	27,9	18	16,5
10	$\Delta L(max/ultimate)$, mm	29,8	20,9	18,2
11	$\Delta L(putus)$, mm	28,8	17	17,2

Tanpa Preheating

- *Tegangan Teknik dan Regangan Teknik Spesimen 1*

$$L_{yield} = L_0 + \Delta L_y = 95 + 27,9 = 122,9 \text{ mm}$$

$$L_{max} = L_0 + \Delta L_u = 95 + 29,8 = 124,8 \text{ mm}$$

$$L_{pts} = L_0 + \Delta L_{pts} = 95 + 28,8 = 123,8 \text{ mm}$$

- *Tegangan Teknik*

$$\sigma_{t(y)} = \frac{P_y}{A_0} = \frac{1854}{66,4} = 27,9 \text{ N/mm}^2$$

$$\sigma_{t(u)} = \frac{P_{max}}{A_0} = \frac{1980}{66,4} = 29,8 \text{ N/mm}^2$$

$$\sigma_{t(pts)} = \frac{P_{ypts}}{A_0} = \frac{1915}{66,4} = 28,8 \text{ N/mm}^2$$

- *Regangan Teknik*

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{122,9 - 95}{95} \times 100\% = 0,29$$

$$\epsilon_y = \frac{L_u - L_0}{L_0} \times 100\% = \frac{124,8 - 95}{95} \times 100\% = 0,31$$

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{123,8 - 95}{95} \times 100\% = 0,30$$

- *Kekuatan Tarik Maksimum (UTS)*

$$S_u = \frac{P_{max}}{A_0} = \frac{1890}{66,4} = 29,8 \text{ N/mm}^2$$

- Batas Luluh

$$S_0 = \frac{P_y}{A_0} = \frac{1854}{66,4} = 27,9 \text{ N/mm}^2$$

- Tegangan Teknik dan Regangan Teknik Spesimen 2

$$L_{yield} = L_0 + \Delta L_y = 95 + 18 = 113 \text{ mm}$$

$$L_{max} = L_0 + \Delta L_u = 95 + 20,9 = 115,9 \text{ mm}$$

$$L_{pts} = L_0 + \Delta L_{pts} = 95 + 17 = 112 \text{ mm}$$

- Tegangan Teknik

$$\sigma_{t(y)} = \frac{P_y}{A_0} = \frac{1200}{66,4} = 18 \text{ N/mm}^2$$

$$\sigma_{t(u)} = \frac{P_{max}}{A_0} = \frac{1390}{66,4} = 20,9 \text{ N/mm}^2$$

$$\sigma_{t(pts)} = \frac{P_{ypts}}{A_0} = \frac{1131}{66,4} = 17 \text{ N/mm}^2$$

- Regangan Teknik

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{113 - 95}{95} \times 100\% = 0,18$$

$$\epsilon_u = \frac{L_u - L_0}{L_0} \times 100\% = \frac{115,9 - 95}{95} \times 100\% = 0,22$$

$$\epsilon_{pts} = \frac{L_{pts} - L_0}{L_0} \times 100\% = \frac{112 - 95}{95} \times 100\% = 0,17$$

- Kekuatan Tarik Maksimum (UTS)

$$S_u = \frac{P_{max}}{A_0} = \frac{1390}{66,4} = 20,9 \text{ N/mm}^2$$

- Batas Luluh

$$S_0 = \frac{P_y}{A_0} = \frac{1200}{66,4} = 18 \text{ N/mm}^2$$

- Tegangan Teknik dan Regangan Teknik Spesimen 3

$$L_{yield} = L_0 + \Delta L_y = 95 + 16,5 = 111,5 \text{ mm}$$

$$L_{max} = L_0 + \Delta L_u = 95 + 18,2 = 113,2 \text{ mm}$$

$$L_{pts} = L_0 + \Delta L_{pts} = 95 + 17,2 = 112,2 \text{ mm}$$

- Tegangan Teknik

$$\sigma_{t(y)} = \frac{P_y}{A_0} = \frac{1100}{66,4} = 16,5 \text{ N/mm}^2$$

$$\sigma_{t(u)} = \frac{P_{max}}{A_0} = \frac{1210}{66,4} = 18,2 \text{ N/mm}^2$$

$$\sigma_{t(pts)} = \frac{P_{ypts}}{A_0} = \frac{1147}{66,4} = 17,2 \text{ N/mm}^2$$

- Regangan Teknik

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{111,5 - 95}{95} \times 100\% = 0,17$$

$$\epsilon_y = \frac{L_u - L_0}{L_0} \times 100\% = \frac{113,2 - 95}{95} \times 100\% = 0,19$$

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{112,2 - 95}{95} \times 100\% = 0,18$$

- Kekuatan Tarik Maksimum (UTS)

$$S_u = \frac{P_{max}}{A_0} = \frac{1210}{66,4} = 18,2 \text{ N/mm}^2$$

- Batas Luluh

$$S_0 = \frac{P_y}{A_0} = \frac{1100}{66,4} = 16,5 \text{ N/mm}^2$$

NO	Tegangan dan Regangan Teknik	Hasil Spesimen 1	Hasil Spesimen 2	Hasil Specimen 3	Nilai Rata-rata
1	egangan Teknik (σ yield), N/mm ²	27,9	18	16,5	20,8
2	egangan Teknik (σ maximum), N/mm ²	29,8	20,9	18,2	22,9
3	egangan Teknik (σ putus), N/mm ²	28,8	17	17,2	21
4	egangan Teknik (ϵ yield),	0,29	0,18	0,17	0,21
5	egangan Teknik (ϵ maximum),	0,31	0,22	0,19	0,24
6	egangan Teknik (ϵ putus),	0,30	0,17	0,18	0,21

1) Suhu 200 , 40 menit

NO	Keterangan	Spesimen 1	Spesimen 2	Spesimen 3
1	Panjang Awal (L ₀), mm	95	95	95
2	Panjang Akhir (L _f), mm	101	101	102
3	Pertambahan Panjang (ΔL _{max}), mm	6	6	7
4	Dimensi awal mula mula (penampang) mm	9,2	9,2	9,2
5	Luas penampang mula mula (A ₀) mm ²	66,4	66,4	66,4
6	Beban yield (P _y), Kgf	2911	2745	2801
7	Beban ultimate (P _u), Kgf	3021	2920	3080
8	Beban putus (P _{pts}), Kgf	2982	2799	2855
9	ΔL(yield), mm	44,9	41,3	42,1
10	ΔL(max/ultimate), mm	45,4	43,9	46,3
11	ΔL(putus), mm	44,9	42,1	42,9

- Tegangan Teknik dan Regangan Teknik Spesimen 1

$$L_{yield} = L_0 + \Delta L_y = 95 + 44,9 = 139,9 \text{ mm}$$

$$L_{max} = L_0 + \Delta L_u = 95 + 45,4 = 140,4 \text{ mm}$$

$$L_{pts} = L_0 + \Delta L_{pts} = 95 + 44,9 = 139,9 \text{ mm}$$

- Tegangan Teknik

$$\sigma_{t(y)} = \frac{P_y}{A_0} = \frac{2911}{66,4} = 43,8 \text{ N/mm}^2$$

$$\sigma_{t(u)} = \frac{P_{max}}{A_0} = \frac{3021}{66,4} = 45,4 \text{ N/mm}^2$$

$$\sigma_{t(pts)} = \frac{P_{ypts}}{A_0} = \frac{2982}{66,4} = 44,9 \text{ N/mm}^2$$

- Regangan Teknik

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{139,9 - 95}{95} \times 100\% = 0,472$$

$$\epsilon_u = \frac{L_u - L_0}{L_0} \times 100\% = \frac{140,4 - 95}{95} \times 100\% = 0,477$$

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{139,9 - 95}{95} \times 100\% = 0,472$$

- Kekuatan Tarik Maksimum (UTS)

$$S_u = \frac{P_{max}}{A_0} = \frac{3021}{66,4} = 45,4 \text{ N/mm}^2$$

- Batas Luluh

$$S_0 = \frac{P_y}{A_0} = \frac{2911}{66,4} = 43,8 \text{ N/mm}^2$$

- Tegangan Teknik dan Regangan Teknik Spesimen 2

$$L_{yield} = L_0 + \Delta L_y = 95 + 41,3 = 136,3 \text{ mm}$$

$$L_{max} = L_0 + \Delta L_u = 95 + 43,9 = 138,9 \text{ mm}$$

$$L_{pts} = L_0 + \Delta L_{pts} = 95 + 42,1 = 137,1 \text{ mm}$$

- Tegangan Teknik

$$\sigma_{t(y)} = \frac{P_y}{A_0} = \frac{2745}{66,4} = 41,3 \text{ N/mm}^2$$

$$\sigma_{t(u)} = \frac{P_{max}}{A_0} = \frac{2920}{66,4} = 43,9 \text{ N/mm}^2$$

$$\sigma_{t(pts)} = \frac{P_{ypts}}{A_0} = \frac{2799}{66,4} = 42,1 \text{ N/mm}^2$$

- Regangan Teknik

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{136,3 - 95}{95} \times 100\% = 0,43$$

$$\epsilon_y = \frac{L_u - L_0}{L_0} \times 100\% = \frac{138,9 - 95}{95} \times 100\% = 0,46$$

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{137,1 - 95}{95} \times 100\% = 0,44$$

- Kekuatan Tarik Maksimum (UTS)

$$S_u = \frac{P_{max}}{A_0} = \frac{2920}{66,4} = 43,9 \text{ N/mm}^2$$

- Batas Luluh

$$S_0 = \frac{P_y}{A_0} = \frac{2745}{66,4} = 41,3 \text{ N/mm}^2$$

- Tegangan Teknik dan Regangan Teknik Spesimen 3

$$L_{yield} = L_0 + \Delta L_y = 95 + 42,1 = 137,1 \text{ mm}$$

$$L_{max} = L_0 + \Delta L_u = 95 + 46,3 = 141,3 \text{ mm}$$

$$L_{pts} = L_0 + \Delta L_{pts} = 95 + 42,9 = 137,9 \text{ mm}$$

- Tegangan Teknik

$$\sigma_{t(y)} = \frac{P_y}{A_0} = \frac{2801}{66,4} = 31,3 \text{ N/mm}^2$$

$$\sigma_{t(u)} = \frac{P_{max}}{A_0} = \frac{3080}{66,4} = 46,3 \text{ N/mm}^2$$

$$\sigma_{t(pts)} = \frac{P_{ypts}}{A_0} = \frac{2855}{66,4} = 42,9 \text{ N/mm}^2$$

- Regangan Teknik

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{137,1 - 95}{95} \times 100\% = 0,44$$

$$\epsilon_y = \frac{L_u - L_0}{L_0} \times 100\% = \frac{141,3 - 95}{95} \times 100\% = 0,48$$

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{137,9 - 95}{95} \times 100\% = 0,45$$

- Kekuatan Tarik Maksimum (UTS)

$$S_u = \frac{P_{max}}{A_0} = \frac{3080}{66,4} = 46,3 \text{ N/mm}^2$$

- Batas Luluh

$$S_0 = \frac{P_y}{A_0} = \frac{2801}{66,4} = 31,3 \text{ N/mm}^2$$

NO	Tegangan dan Regangan Teknik	Hasil Spesimen 1	Hasil Spesimen 2	Hasil Specimen 3	Nilai Rata-rata
1	Tegangan Teknik (σ yield), N/mm ²	43,8	41,3	31,3	38,8
2	Tegangan Teknik (σ maximum), N/mm ²	45,4	43,9	46,3	45,2
3	Tegangan Teknik (σ putus), N/mm ²	44,9	42,1	42,9	43,3
4	Regangan Teknik (ϵ yield),	0,47	0,43	0,44	0,46
5	Regangan Teknik (ϵ maximum),	0,47	0,46	0,48	0,47
6	Regangan Teknik (ϵ putus),	0,47	0,44	0,45	0,45

2) Suhu 300 , 20 menit

NO	Keterangan	Spesimen 1	Spesimen 2	Spesimen 3
1	Panjang Awal (L_0), mm	95	95	95
2	Panjang Akhir (L_f), mm	102	102	102
3	Pertambahan Panjang (ΔL_{max}), mm	7	7	7
4	Dimensi awal mula mula (penampang) mm	9,2	9,2	9,2
5	Luas penampang mula mula (A_0) mm^2	66,4	66,4	66,4
6	Beban yield (P_y), Kgf	2878	2921	2841
7	Beban ultimate (P_u), Kgf	3190	3180	3050
8	Beban putus (P_{pts}), Kgf	3030	2889	2752
9	ΔL (yield), mm	43,3	43,9	42,7
10	ΔL (max/ultimate), mm	48	47,8	45,9
11	ΔL (putus), mm	45,6	43,5	41,4

- Tegangan Teknik dan Regangan Teknik Spesimen 1

$$L_{yield} = L_0 + \Delta L_y = 95 + 43,3 = 138,3 \text{ mm}$$

$$L_{max} = L_0 + \Delta L_u = 95 + 48 = 143 \text{ mm}$$

$$L_{pts} = L_0 + \Delta L_{pts} = 95 + 43,5 = 138,5 \text{ mm}$$

- Tegangan Teknik

$$\sigma_{t(y)} = \frac{P_y}{A_0} = \frac{2878}{66,4} = 43,3 \text{ N/mm}^2$$

$$\sigma_{t(u)} = \frac{P_{max}}{A_0} = \frac{3190}{66,4} = 48 \text{ N/mm}^2$$

$$\sigma_{t(pts)} = \frac{P_{ypts}}{A_0} = \frac{3030}{66,4} = 45,5 \text{ N/mm}^2$$

- Regangan Teknik

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{138,3 - 95}{95} \times 100\% = 0,45$$

$$\epsilon_y = \frac{L_u - L_0}{L_0} \times 100\% = \frac{143 - 95}{95} \times 100\% = 0,50$$

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{138,5 - 95}{95} \times 100\% = 0,0,45$$

- Kekuatan Tarik Maksimum (UTS)

$$S_u = \frac{P_{max}}{A_0} = \frac{3190}{66,4} = 48 \text{ N/mm}^2$$

- Batas Luluh

$$S_0 = \frac{P_y}{A_0} = \frac{2878}{66,4} = 43,3 \text{ N/mm}^2$$

- Tegangan Teknik dan Regangan Teknik Spesimen 2

$$L_{yield} = L_0 + \Delta L_y = 95 + 43,9 = 138,9 \text{ mm}$$

$$L_{max} = L_0 + \Delta L_u = 95 + 47,8 = 142,8 \text{ mm}$$

$$L_{pts} = L_0 + \Delta L_{pts} = 95 + 43,5 = 138,5 \text{ mm}$$

- Tegangan Teknik

$$\sigma_{t(y)} = \frac{P_y}{A_0} = \frac{2921}{66,4} = 43,9 \text{ N/mm}^2$$

$$\sigma_{t(u)} = \frac{P_{max}}{A_0} = \frac{3180}{66,4} = 47,8 \text{ N/mm}^2$$

$$\sigma_{t(pts)} = \frac{P_{ypts}}{A_0} = \frac{2889}{66,4} = 43,5 \text{ N/mm}^2$$

- Regangan Teknik

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{138,9 - 95}{95} \times 100\% = 0,46$$

$$\epsilon_u = \frac{L_u - L_0}{L_0} \times 100\% = \frac{142,8 - 95}{95} \times 100\% = 0,50$$

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{138,5 - 95}{95} \times 100\% = 0,45$$

- Kekuatan Tarik Maksimum (UTS)

$$S_u = \frac{P_{max}}{A_0} = \frac{3180}{66,4} = 47,8 \text{ N/mm}^2$$

- Batas Luluh

$$S_0 = \frac{P_y}{A_0} = \frac{2921}{66,4} = 43,9 \text{ N/mm}^2$$

- Tegangan Teknik dan Regangan Teknik Spesimen 3

$$L_{yield} = L_0 + \Delta L_y = 95 + 42,7 = 137,7 \text{ mm}$$

$$L_{max} = L_0 + \Delta L_u = 95 + 45,9 = 140,9 \text{ mm}$$

$$L_{pts} = L_0 + \Delta L_{pts} = 95 + 41,4 = 136,4 \text{ mm}$$

- Tegangan Teknik

$$\sigma_{t(y)} = \frac{P_y}{A_0} = \frac{2841}{66,4} = 42,7 \text{ N/mm}^2$$

$$\sigma_{t(u)} = \frac{P_{max}}{A_0} = \frac{3050}{66,4} = 45,9 \text{ N/mm}^2$$

$$\sigma_{t(pts)} = \frac{P_{ypts}}{A_0} = \frac{2752}{66,4} = 41,4 \text{ N/mm}^2$$

- Regangan Teknik

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{137,7 - 95}{95} \times 100\% = 0,44$$

$$\epsilon_u = \frac{L_u - L_0}{L_0} \times 100\% = \frac{140,9 - 95}{95} \times 100\% = 0,48$$

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{136,4 - 95}{95} \times 100\% = 0,43$$

- Kekuatan Tarik Maksimum (UTS)

$$S_u = \frac{P_{max}}{A_0} = \frac{3050}{66,4} = 45,9 \text{ N/mm}^2$$

- Batas Luluh

$$S_0 = \frac{P_y}{A_0} = \frac{2841}{66,4} = 42,7 \text{ N/mm}^2$$

NO	Tegangan dan Regangan Teknik	Hasil Spesimen 1	Hasil Spesimen 2	Hasil Specimen 3	Nilai Rata-rata
1	Tegangan Teknik (σ_{yield}), N/mm ²	43,3	43,9	42,7	43,3
2	Tegangan Teknik ($\sigma_{maximum}$), N/mm ²	48	47,8	45,9	47,2
3	Tegangan Teknik (σ_{putus}), N/mm ²	45,5	43,5	41,4	43,4
4	Regangan Teknik (ϵ_{yield}),	0,45	0,46	0,44	0,45
5	Regangan Teknik ($\epsilon_{maximum}$),	0,50	0,50	0,48	0,49
6	Regangan Teknik (ϵ_{putus}),	0,45	0,45	0,43	0,44

3) Suhu 300 , 30 menit

NO	Keterangan	Spesimen 1	Spesimen 2	Spesimen 3
1	Panjang Awal (L ₀), mm	95	95	95
2	Panjang Akhir (L _f), mm	102	102	102
3	Pertambahan Panjang (ΔL _{max}), mm	7	7	7
4	Dimensi awal mula mula (penampang) mm	9,2	9,2	9,2
5	Luas penampang mula mula (A ₀) mm ²	66,4	66,4	66,4
6	Beban yield (P _y), Kgf	3128	2901	2933
7	Beban ultimate (P _u), Kgf	3375	3180	3290
8	Beban putus (P _{pts}), Kgf	3289	2827	2901
9	ΔL(yield), mm	47,1	43,6	44,1
10	ΔL(max/ultimate), mm	50,8	47,8	49,5
11	ΔL(putus), mm	49,5	42,5	43,6

- Tegangan Teknik dan Regangan Teknik Spesimen 1

$$L_{yield} = L_0 + \Delta L_y = 95 + 47,1 = 142,1 \text{ mm}$$

$$L_{max} = L_0 + \Delta L_u = 95 + 50,8 = 145,8 \text{ mm}$$

$$L_{pts} = L_0 + \Delta L_{pts} = 95 + 49,5 = 144,5 \text{ mm}$$

- Tegangan Teknik

$$\sigma_{t(y)} = \frac{P_y}{A_0} = \frac{3128}{66,4} = 47,1 \text{ N/mm}^2$$

$$\sigma_{t(u)} = \frac{P_{max}}{A_0} = \frac{3375}{66,4} = 50,8 \text{ N/mm}^2$$

$$\sigma_{t(pts)} = \frac{P_{ypts}}{A_0} = \frac{3289}{66,4} = 49,5 \text{ N/mm}^2$$

- Regangan Teknik

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{142,1 - 95}{95} \times 100\% = 0,49$$

$$\epsilon_u = \frac{L_u - L_0}{L_0} \times 100\% = \frac{145,8 - 95}{95} \times 100\% = 0,53$$

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{144,5 - 95}{95} \times 100\% = 0,52$$

- Kekuatan Tarik Maksimum (UTS)

$$S_u = \frac{P_{max}}{A_0} = \frac{3375}{66,4} = 50,8 \text{ N/mm}^2$$

- Batas Luluh

$$S_0 = \frac{P_y}{A_0} = \frac{3128}{66,4} = 47,1 \text{ N/mm}^2$$

- Tegangan Teknik dan Regangan Teknik Spesimen 2

$$L_{yield} = L_0 + \Delta L_y = 95 + 43,6 = 138,6 \text{ mm}$$

$$L_{max} = L_0 + \Delta L_u = 95 + 47,8 = 142,8 \text{ mm}$$

$$L_{pts} = L_0 + \Delta L_{pts} = 95 + 42,5 = 137,5 \text{ mm}$$

- Tegangan Teknik

$$\sigma_{t(y)} = \frac{P_y}{A_0} = \frac{2901}{66,4} = 43,6 \text{ N/mm}^2$$

$$\sigma_{t(u)} = \frac{P_{max}}{A_0} = \frac{3180}{66,4} = 47,8 \text{ N/mm}^2$$

$$\sigma_{t(pts)} = \frac{P_{ypts}}{A_0} = \frac{2827}{66,4} = 42,5 \text{ N/mm}^2$$

- Regangan Teknik

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{138,6 - 95}{95} \times 100\% = 0,45$$

$$\epsilon_y = \frac{L_u - L_0}{L_0} \times 100\% = \frac{142,8 - 95}{95} \times 100\% = 0,50$$

$$\epsilon_y = \frac{L_{pts} - L_0}{L_0} \times 100\% = \frac{137,5 - 95}{95} \times 100\% = 0,44$$

- Kekuatan Tarik Maksimum (UTS)

$$S_u = \frac{P_{max}}{A_0} = \frac{3180}{66,4} = 47,8 \text{ N/mm}^2$$

- Batas Luluh

$$S_0 = \frac{P_y}{A_0} = \frac{2901}{66,4} = 43,6 \text{ N/mm}^2$$

- Tegangan Teknik dan Regangan Teknik Spesimen 3

$$L_{yield} = L_0 + \Delta L_y = 95 + 44,1 = 139,1 \text{ mm}$$

$$L_{max} = L_0 + \Delta L_u = 95 + 49,5 = 144,5 \text{ mm}$$

$$L_{pts} = L_0 + \Delta L_{pts} = 95 + 43,6 = 138,6 \text{ mm}$$

- Tegangan Teknik

$$\sigma_{t(y)} = \frac{P_y}{A_0} = \frac{2933}{66,4} = 44,1 \text{ N/mm}^2$$

$$\sigma_{t(u)} = \frac{P_{max}}{A_0} = \frac{3290}{66,4} = 49,5 \text{ N/mm}^2$$

$$\sigma_{t(pts)} = \frac{P_{ypts}}{A_0} = \frac{2901}{66,4} = 43,6 \text{ N/mm}^2$$

- Regangan Teknik

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{139,1 - 95}{95} \times 100\% = 0,46$$

$$\epsilon_y = \frac{L_u - L_0}{L_0} \times 100\% = \frac{144,5 - 95}{95} \times 100\% = 0,52$$

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{138,6 - 95}{95} \times 100\% = 0,45$$

- Kekuatan Tarik Maksimum (UTS)

$$S_u = \frac{P_{max}}{A_0} = \frac{3290}{66,4} = 49,5 \text{ N/mm}^2$$

- Batas Luluh

$$S_0 = \frac{P_y}{A_0} = \frac{2933}{66,4} = 44,1 \text{ N/mm}^2$$

NO	Tegangan dan Regangan Teknik	Hasil Spesimen 1	Hasil Spesimen 2	Hasil Specimen 3	Nilai Rata-rata
1	Tegangan Teknik (σ yield), N/mm ²	47,1	43,6	44,1	44,9
2	Tegangan Teknik (σ maximum), N/mm ²	50,8	47,8	49,5	49,3
3	Tegangan Teknik (σ putus), N/mm ²	49,5	42,5	43,6	45,2
4	Regangan Teknik (ϵ yield),	0,49	0,45	0,46	0,46
5	Regangan Teknik (ϵ maximum),	0,53	0,50	0,52	0,51
6	Regangan Teknik (ϵ putus),	0,42	0,46	0,45	0,42

6) Suhu 300 , 40 menit

NO	Keterangan	Spesimen 1	Spesimen 2	Spesimen 3
1	Panjang Awal (L_0), mm	95	95	95
2	Panjang Akhir (L_f), mm	102	103	102
3	Pertambahan Panjang (ΔL_{max}), mm	7	8	7
4	Dimensi awal mula mula (penampang) mm	9,2	9,2	9,2
5	Luas penampang mula mula (A_0) mm^2	66,4	66,4	66,4
6	Beban yield (P_y), Kgf	3301	3270	3341
7	Beban ultimate (P_u), Kgf	3621	3460	3520
8	Beban putus (P_{pts}), Kgf	3491	3220	3278
9	$\Delta L(yield)$, mm	49,7	49,2	50,3
10	$\Delta L(max/ultimate)$, mm	54,5	52,1	53
11	$\Delta L(putus)$, mm	52,5	48,4	49,3

- Tegangan Teknik dan Regangan Teknik Spesimen 1

$$L_{yield} = L_0 + \Delta L_y = 95 + 49,7 = 144,7 \text{ mm}$$

$$L_{max} = L_0 + \Delta L_u = 95 + 54,5 = 149,5 \text{ mm}$$

$$L_{pts} = L_0 + \Delta L_{pts} = 95 + 52,5 = 147,5 \text{ mm}$$

- Tegangan Teknik

$$\sigma_{t(y)} = \frac{P_y}{A_0} = \frac{3301}{66,4} = 49,7 \text{ N/mm}^2$$

$$\sigma_{t(u)} = \frac{P_{max}}{A_0} = \frac{3621}{66,4} = 54,5 \text{ N/mm}^2$$

$$\sigma_{t(pts)} = \frac{P_{ypts}}{A_0} = \frac{3491}{66,4} = 52,5 \text{ N/mm}^2$$

- Regangan Teknik

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{144,7 - 95}{95} \times 100\% = 0,52$$

$$\epsilon_y = \frac{L_u - L_0}{L_0} \times 100\% = \frac{149,5 - 95}{95} \times 100\% = 0,57$$

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{147,5 - 95}{95} \times 100\% = 0,55$$

- Kekuatan Tarik Maksimum (UTS)

$$S_u = \frac{P_{max}}{A_0} = \frac{3621}{66,4} = 54,5 \text{ N/mm}^2$$

- Batas Luluh

$$S_0 = \frac{P_y}{A_0} = \frac{3301}{66,4} = 49,7 \text{ N/mm}^2$$

- Tegangan Teknik dan Regangan Teknik Spesimen 2

$$L_{yield} = L_0 + \Delta L_y = 95 + 49,2 = 144,2 \text{ mm}$$

$$L_{max} = L_0 + \Delta L_u = 95 + 52,1 = 147,1 \text{ mm}$$

$$L_{pts} = L_0 + \Delta L_{pts} = 95 + 48,4 = 143,4 \text{ mm}$$

- Tegangan Teknik

$$\sigma_{t(y)} = \frac{P_y}{A_0} = \frac{3270}{66,4} = 42,9 \text{ N/mm}^2$$

$$\sigma_{t(u)} = \frac{P_{max}}{A_0} = \frac{3460}{66,4} = 52,1 \text{ N/mm}^2$$

$$\sigma_{t(pts)} = \frac{P_{ypts}}{A_0} = \frac{3220}{66,4} = 48,4 \text{ N/mm}^2$$

- Regangan Teknik

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{144,2 - 95}{95} \times 100\% = 0,51$$

$$\epsilon_y = \frac{L_u - L_0}{L_0} \times 100\% = \frac{147,1 - 95}{95} \times 100\% = 0,54$$

$$\epsilon_y = \frac{L_{pts} - L_0}{L_0} \times 100\% = \frac{143,4 - 95}{95} \times 100\% = 0,50$$

- Kekuatan Tarik Maksimum (UTS)

$$S_u = \frac{P_{max}}{A_0} = \frac{3460}{66,4} = 52,1 \text{ N/mm}^2$$

- Batas Luluh

$$S_0 = \frac{P_y}{A_0} = \frac{3270}{66,4} = 42,9 \text{ N/mm}^2$$

- Tegangan Teknik dan Regangan Teknik Spesimen 3

$$L_{yield} = L_0 + \Delta L_y = 95 + 50,1 = 145,1 \text{ mm}$$

$$L_{max} = L_0 + \Delta L_u = 95 + 53 = 148 \text{ mm}$$

$$L_{pts} = L_0 + \Delta L_{pts} = 95 + 49,3 = 144,3 \text{ mm}$$

- Tegangan Teknik

$$\sigma_{t(y)} = \frac{P_y}{A_0} = \frac{3341}{66,4} = 50,3 \text{ N/mm}^2$$

$$\sigma_{t(u)} = \frac{P_{max}}{A_0} = \frac{3521}{66,4} = 53 \text{ N/mm}^2$$

$$\sigma_{t(pts)} = \frac{P_{ypts}}{A_0} = \frac{3278}{66,4} = 49,3 \text{ N/mm}^2$$

- Regangan Teknik

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{145,1 - 95}{95} \times 100\% = 0,52$$

$$\epsilon_y = \frac{L_u - L_0}{L_0} \times 100\% = \frac{148 - 95}{95} \times 100\% = 0,55$$

$$\epsilon_y = \frac{L_{pts} - L_0}{L_0} \times 100\% = \frac{144,3 - 95}{95} \times 100\% = 0,51$$

- Kekuatan Tarik Maksimum (UTS)

$$S_u = \frac{P_{max}}{A_0} = \frac{3521}{66,4} = 53 \text{ N/mm}^2$$

- Batas Luluh

$$S_0 = \frac{P_y}{A_0} = \frac{3341}{66,4} = 50,3 \text{ N/mm}^2$$

NO	Tegangan dan Regangan Teknik	Hasil Spesimen 1	Hasil Spesimen 2	Hasil Spesimen 3	Nilai Rata-rata
1	Tegangan Teknik (σ yield), N/mm ²	49,7	42,9	50,3	47,6
2	Tegangan Teknik (σ maximum), N/mm ²	54,5	52,1	53	53,2
3	Tegangan Teknik (σ putus), N/mm ²	52,5	48,4	49,3	50,7
4	Regangan Teknik (ϵ yield),	0,52	0,51	0,52	0,51
5	Regangan Teknik (ϵ maximum),	0,57	0,54	0,55	0,55
6	Regangan Teknik (ϵ putus),	0,55	0,50	0,51	0,52

5) Suhu 400 , 20 menit

NO	Keterangan	Spesimen 1	Spesimen 2	Spesimen 3
1	Panjang Awal (L_0), mm	95	95	95
2	Panjang Akhir (L_f), mm	102	103	103
3	Pertambahan Panjang (ΔL_{max}), mm	7	8	8
4	Dimensi awal mula mula (penampang) mm	9,2	9,2	9,2
5	Luas penampang mula mula (A_0) mm^2	66,4	66,4	66,4
6	Beban yield (P_y), Kgf	3399	3498	3527
7	Beban ultimate (P_u), Kgf	3740	3830	3770
8	Beban putus (P_{pts}), Kgf	3553	3522	3488
9	ΔL (yield), mm	51,1	52,6	53,1
10	ΔL (max/ultimate), mm	56,3	57,6	56,7
11	ΔL (putus), mm	53,5	53	52,5

- Tegangan Teknik dan Regangan Teknik Spesimen 1

$$L_{yield} = L_0 + \Delta L_y = 95 + 51,1 = 146,1 \text{ mm}$$

$$L_{max} = L_0 + \Delta L_u = 95 + 56,3 = 151,3 \text{ mm}$$

$$L_{pts} = L_0 + \Delta L_{pts} = 95 + 53,3 = 148,3 \text{ mm}$$

- Tegangan Teknik

$$\sigma_{t(y)} = \frac{P_y}{A_0} = \frac{3399}{66,4} = 51,1 \text{ N/mm}^2 \quad \sigma_{t(y)} = \frac{P_y}{A_0} = \frac{3399}{66,4} = 51,1 \text{ N/mm}^2$$

$$\sigma_{t(u)} = \frac{P_{max}}{A_0} = \frac{3740}{66,4} = 56,3 \text{ N/mm}^2$$

$$\sigma_{t(pts)} = \frac{P_{ypts}}{A_0} = \frac{3553}{66,4} = 53,5 \text{ N/mm}^2$$

- Regangan Teknik

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{146,1 - 95}{95} \times 100\% = 0,53$$

$$\epsilon_y = \frac{L_u - L_0}{L_0} \times 100\% = \frac{151,3 - 95}{95} \times 100\% = 0,59$$

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{148,3 - 95}{95} \times 100\% = 0,56$$

- Kekuatan Tarik Maksimum (UTS)

$$S_u = \frac{P_{max}}{A_0} = \frac{3740}{66,4} = 56,3 \text{ N/mm}^2$$

- Batas Luluh

$$S_0 = \frac{P_y}{A_0} = \frac{3399}{66,4} = 51,1 \text{ N/mm}^2$$

- Tegangan Teknik dan Regangan Teknik Spesimen 2

$$L_{yield} = L_0 + \Delta L_y = 95 + 52,6 = 147,6 \text{ mm}$$

$$L_{max} = L_0 + \Delta L_u = 95 + 57,6 = 152,6 \text{ mm}$$

$$L_{pts} = L_0 + \Delta L_{pts} = 95 + 53 = 148 \text{ mm}$$

- Tegangan Teknik

$$\sigma_{t(y)} = \frac{P_y}{A_0} = \frac{3498}{66,4} = 52,6 \text{ N/mm}^2$$

$$\sigma_{t(u)} = \frac{P_{max}}{A_0} = \frac{3830}{66,4} = 57,6 \text{ N/mm}^2$$

$$\sigma_{t(pts)} = \frac{P_{ypts}}{A_0} = \frac{3522}{66,4} = 53 \text{ N/mm}^2$$

- Regangan Teknik

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{147,6 - 95}{95} \times 100\% = 0,55$$

$$\epsilon_y = \frac{L_u - L_0}{L_0} \times 100\% = \frac{152,6 - 95}{95} \times 100\% = 0,60$$

$$\epsilon_y = \frac{L_{pts} - L_0}{L_0} \times 100\% = \frac{148 - 95}{95} \times 100\% = 0,55$$

- Kekuatan Tarik Maksimum (UTS)

$$S_u = \frac{P_{max}}{A_0} = \frac{P_{max}}{A_0} = \frac{3830}{66,4} = 57,6 \text{ N/mm}^2$$

- Batas Luluh

$$S_0 = \frac{P_y}{A_0} = \frac{3498}{66,4} = 52,6 \text{ N/mm}^2$$

- Tegangan Teknik dan Regangan Teknik Spesimen 3

$$L_{yield} = L_0 + \Delta L_y = 95 + 53,1 = 148,1 \text{ mm}$$

$$L_{max} = L_0 + \Delta L_u = 95 + 56,7 = 151,7 \text{ mm}$$

$$L_{pts} = L_0 + \Delta L_{pts} = 95 + 52,5 = 147,5 \text{ mm}$$

- Tegangan Teknik

$$\sigma_{t(y)} = \frac{P_y}{A_0} = \frac{3527}{66,4} = 53,1 \text{ N/mm}^2$$

$$\sigma_{t(u)} = \frac{P_{max}}{A_0} = \frac{3770}{66,4} = 56,7 \text{ N/mm}^2$$

$$\sigma_{t(pts)} = \frac{P_{ypts}}{A_0} = \frac{3488}{66,4} = 52,5 \text{ N/mm}^2$$

- Regangan Teknik

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{148,1 - 95}{95} \times 100\% = 0,55$$

$$\epsilon_y = \frac{L_u - L_0}{L_0} \times 100\% = \frac{151,7 - 95}{95} \times 100\% = 0,59$$

$$\epsilon_y = \frac{L_{pts} - L_0}{L_0} \times 100\% = \frac{147,5 - 95}{95} \times 100\% = 0,55$$

- Kekuatan Tarik Maksimum (UTS)

$$S_u = \frac{P_{max}}{A_0} = \frac{3770}{66,4} = 56,7 \text{ N/mm}^2$$

- Batas Luluh

$$S_0 = \frac{P_y}{A_0} = \frac{3527}{66,4} = 53,1 \text{ N/mm}^2$$

NO	Tegangan dan Regangan Teknik	Hasil Spesimen 1	Hasil Spesimen 2	Hasil Specimen 3	Nilai Rata-rata
1	Tegangan Teknik (σ yield), N/mm ²	51,1	52,6	53,1	52,2
2	Tegangan Teknik (σ maximum), N/mm ²	56,3	57,6	56,7	56,8
3	Tegangan Teknik (σ putus), N/mm ²	53,5	52	52,5	52,6
4	Regangan Teknik (ϵ yield),	0,53	0,55	0,55	0,54
5	Regangan Teknik (ϵ maximum),	0,59	0,60	0,59	0,59
6	Regangan Teknik (ϵ putus),	0,56	0,55	0,55	0,55

6) Suhu 400 , 30 menit

NO	Keterangan	Spesimen 1	Spesimen 2	Spesimen 3
1	Panjang Awal (L_0), mm	95	95	95
2	Panjang Akhir (L_f), mm	102	102	102
3	Pertambahan Panjang (ΔL_{max}), mm	7	7	7
4	Dimensi awal mula mula (penampang) mm	9,2	9,2	9,2
5	Luas penampang mula mula (A_0) mm^2	66,4	66,4	66,4
6	Beban yield (P_y), Kgf	3982	3648	3811
7	Beban ultimate (P_u), Kgf	4170	3830	4080
8	Beban putus (P_{pts}), Kgf	3921	3505	3780
9	ΔL (yield), mm	59,9	54,9	57,3
10	ΔL (max/ultimate), mm	62,8	57,6	61,4
11	ΔL (putus), mm	59	52,7	56,9

- Tegangan Teknik dan Regangan Teknik Spesimen 1

$$L_{yield} = L_0 + \Delta L_y = 95 + 59,9 = 154,9 \text{ mm}$$

$$L_{max} = L_0 + \Delta L_u = 95 + 62,8 = 157,8 \text{ mm}$$

$$L_{pts} = L_0 + \Delta L_{pts} = 95 + 59 = 154 \text{ mm}$$

- Tegangan Teknik

$$\sigma_{t(y)} = \frac{P_y}{A_0} = \frac{3982}{66,4} = 59,9 \text{ N/mm}^2$$

$$\sigma_{t(u)} = \frac{P_{max}}{A_0} = \frac{4170}{66,4} = 62,8 \text{ N/mm}^2$$

$$\sigma_{t(pts)} = \frac{P_{ypts}}{A_0} = \frac{3921}{66,4} = 59 \text{ N/mm}^2$$

- Regangan Teknik

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{154,9 - 95}{95} \times 100\% = 0,63$$

$$\epsilon_y = \frac{L_u - L_0}{L_0} \times 100\% = \frac{157,8 - 95}{95} \times 100\% = 0,66$$

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{154 - 95}{95} \times 100\% = 0,52$$

- Kekuatan Tarik Maksimum (UTS)

$$S_u = \frac{P_{max}}{A_0} = \frac{4170}{66,4} = 62,8 \text{ N/mm}^2$$

- Batas Luluh

$$S_0 = \frac{P_y}{A_0} = \frac{3982}{66,4} = 59,9 \text{ N/mm}^2$$

- Tegangan Teknik dan Regangan Teknik Spesimen 2

$$L_{yield} = L_0 + \Delta L_y = 95 + 54,9 = 149,9 \text{ mm}$$

$$L_{max} = L_0 + \Delta L_u = 95 + 57,6 = 152,6 \text{ mm}$$

$$L_{pts} = L_0 + \Delta L_{pts} = 95 + 52,7 = 147,7 \text{ mm}$$

- Tegangan Teknik

$$\sigma_{t(y)} = \frac{P_y}{A_0} = \frac{3648}{66,4} = 54,9 \text{ N/mm}^2$$

$$\sigma_{t(u)} = \frac{P_{max}}{A_0} = \frac{3830}{66,4} = 57,6 \text{ N/mm}^2$$

$$\sigma_{t(pts)} = \frac{P_{ypts}}{A_0} = \frac{3505}{66,4} = 52,7 \text{ N/mm}^2$$

- Regangan Teknik

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{149,9 - 95}{95} \times 100\% = 0,57$$

$$\epsilon_u = \frac{L_u - L_0}{L_0} \times 100\% = \frac{152,6 - 95}{95} \times 100\% = 0,60$$

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{147,7 - 95}{95} \times 100\% = 0,55$$

- Kekuatan Tarik Maksimum (UTS)

$$S_u = \frac{P_{max}}{A_0} = \frac{3830}{66,4} = 57,6 \text{ N/mm}^2$$

- Batas Luluh

$$S_0 = \frac{P_y}{A_0} = \frac{3648}{66,4} = 54,9 \text{ N/mm}^2$$

- Tegangan Teknik dan Regangan Teknik Spesimen 3

$$L_{yield} = L_0 + \Delta L_y = 95 + 53,7 = 148,7 \text{ mm}$$

$$L_{max} = L_0 + \Delta L_u = 95 + 61,4 = 156,4 \text{ mm}$$

$$L_{pts} = L_0 + \Delta L_{pts} = 95 + 56,9 = 151,9 \text{ mm}$$

- Tegangan Teknik

$$\sigma_{t(y)} = \frac{P_y}{A_0} = \frac{3811}{66,4} = 57,3 \text{ N/mm}^2$$

$$\sigma_{t(u)} = \frac{P_{max}}{A_0} = \frac{4080}{66,4} = 61,4 \text{ N/mm}^2$$

$$\sigma_{t(pts)} = \frac{P_{ypts}}{A_0} = \frac{3780}{66,4} = 56,9 \text{ N/mm}^2$$

- Regangan Teknik

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{148,7 - 95}{95} \times 100\% = 0,56$$

$$\epsilon_u = \frac{L_u - L_0}{L_0} \times 100\% = \frac{156,4 - 95}{95} \times 100\% = 0,64$$

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{151,9 - 95}{95} \times 100\% = 0,59$$

- Kekuatan Tarik Maksimum (UTS)

$$S_u = \frac{P_{max}}{A_0} = \frac{4080}{66,4} = 61,4 \text{ N/mm}^2$$

- Batas Luluh

$$S_0 = \frac{P_y}{A_0} = \frac{3811}{66,4} = 57,3 \text{ N/mm}^2$$

NO	Tegangan dan Regangan Teknik	Hasil Spesimen 1	Hasil Spesimen 2	Hasil Specimen 3	Nilai Rata-rata
1	Tegangan Teknik (σ yield), N/mm ²	59,9	54,9	57,3	57,3
2	Tegangan Teknik (σ maximum), N/mm ²	62,8	57,6	61,4	60,6
3	Tegangan Teknik (σ putus), N/mm ²	59	52,7	56,9	56,2
4	Regangan Teknik (ϵ yield),	0,63	0,57	0,56	0,58
5	Regangan Teknik (ϵ maximum),	0,66	0,60	0,64	0,63
6	Regangan Teknik (ϵ putus),	0,52	0,55	0,59	0,55

7) Suhu 400 , 40 menit

NO	Keterangan	Spesimen 1	Spesimen 2	Spesimen 3
1	Panjang Awal (L ₀), mm	95	95	95
2	Panjang Akhir (L _f), mm	105	104	104
3	Pertambahan Panjang (ΔL _{max}), mm	10	9	9
4	Dimensi awal mula mula (penampang) mm	9,2	9,2	9,2
5	Luas penampang mula mula (A ₀) mm ²	66,4	66,4	66,4
6	Beban yield (P _y), Kgf	4181	4170	4112
7	Beban ultimate (P _u), Kgf	4400	4360	4390
8	Beban putus (P _{pts}), Kgf	4151	4080	4211
9	ΔL(yield), mm	62,9	62,8	61,9
10	ΔL(max/ultimate), mm	66,2	65,6	66,1
11	ΔL(putus), mm	62,5	61,4	63,4

- Tegangan Teknik dan Regangan Teknik Spesimen 1

$$L_{yield} = L_0 + \Delta L_y = 95 + 62,9 = 157,9 \text{ mm}$$

$$L_{max} = L_0 + \Delta L_u = 95 + 66,2 = 161,2 \text{ mm}$$

$$L_{pts} = L_0 + \Delta L_{pts} = 95 + 62,5 = 157,5 \text{ mm}$$

- Tegangan Teknik

$$\sigma_{t(y)} = \frac{P_y}{A_0} = \frac{4181}{66,4} = 63 \text{ N/mm}^2$$

$$\sigma_{t(u)} = \frac{P_{max}}{A_0} = \frac{4400}{66,4} = 66,2 \text{ N/mm}^2$$

$$\sigma_{t(pts)} = \frac{P_{ypts}}{A_0} = \frac{4151}{66,4} = 62,5 \text{ N/mm}^2$$

- Regangan Teknik

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{157,9 - 95}{95} \times 100\% = 0,66$$

$$\epsilon_u = \frac{L_u - L_0}{L_0} \times 100\% = \frac{161,2 - 95}{95} \times 100\% = 0,69$$

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{157,5 - 95}{95} \times 100\% = 0,65$$

- Kekuatan Tarik Maksimum (UTS)

$$S_u = \frac{P_{max}}{A_0} = \frac{4400}{66,4} = 66,2 \text{ N/mm}^2$$

- Batas Luluh

$$S_0 = \frac{P_y}{A_0} = \frac{4181}{66,4} = 63 \text{ N/mm}^2$$

- Tegangan Teknik dan Regangan Teknik Spesimen 2

$$L_{yield} = L_0 + \Delta L_y = 95 + 62,8 = 157,8 \text{ mm}$$

$$L_{max} = L_0 + \Delta L_u = 95 + 65,6 = 160,6 \text{ mm}$$

$$L_{pts} = L_0 + \Delta L_{pts} = 95 + 61,4 = 156,4 \text{ mm}$$

- Tegangan Teknik

$$\sigma_{t(y)} = \frac{P_y}{A_0} = \frac{4170}{66,4} = 62,8 \text{ N/mm}^2$$

$$\sigma_{t(u)} = \frac{P_{max}}{A_0} = \frac{4360}{66,4} = 65,6 \text{ N/mm}^2$$

$$\sigma_{t(pts)} = \frac{P_{ypts}}{A_0} = \frac{4080}{66,4} = 61,4 \text{ N/mm}^2$$

- Regangan Teknik

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{157,8 - 95}{95} \times 100\% = 0,66$$

$$\epsilon_y = \frac{L_u - L_0}{L_0} \times 100\% = \frac{160,6 - 95}{95} \times 100\% = 0,69$$

$$\epsilon_y = \frac{L_{ypts} - L_0}{L_0} \times 100\% = \frac{156,4 - 95}{95} \times 100\% = 0,64$$

- Kekuatan Tarik Maksimum (UTS)

$$S_u = \frac{P_{max}}{A_0} = \frac{4360}{66,4} = 65,6 \text{ N/mm}^2$$

- Batas Luluh

$$S_0 = \frac{P_y}{A_0} = \frac{4170}{66,4} = 62,8 \text{ N/mm}^2$$

- Tegangan Teknik dan Regangan Teknik Spesimen 3

$$L_{yield} = L_0 + \Delta L_y = 95 + 61,9 = 156,9 \text{ mm}$$

$$L_{max} = L_0 + \Delta L_u = 95 + 66,1 = 161,1 \text{ mm}$$

$$L_{pts} = L_0 + \Delta L_{pts} = 95 + 63,4 = 158,4 \text{ mm}$$

- Tegangan Teknik

$$\sigma_{t(y)} = \frac{P_y}{A_0} = \frac{4112}{66,4} = 61,9 \text{ N/mm}^2$$

$$\sigma_{t(u)} = \frac{P_{max}}{A_0} = \frac{4390}{66,4} = 66,1 \text{ N/mm}^2$$

$$\sigma_{t(pts)} = \frac{P_{ypts}}{A_0} = \frac{4211}{66,4} = 63,4 \text{ N/mm}^2$$

- Regangan Teknik

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{156,9 - 95}{95} \times 100\% = 0,65$$

$$\epsilon_y = \frac{L_u - L_0}{L_0} \times 100\% = \frac{161,1 - 95}{95} \times 100\% = 0,69$$

$$\epsilon_y = \frac{L_y - L_0}{L_0} \times 100\% = \frac{158,4 - 95}{95} \times 100\% = 0,66$$

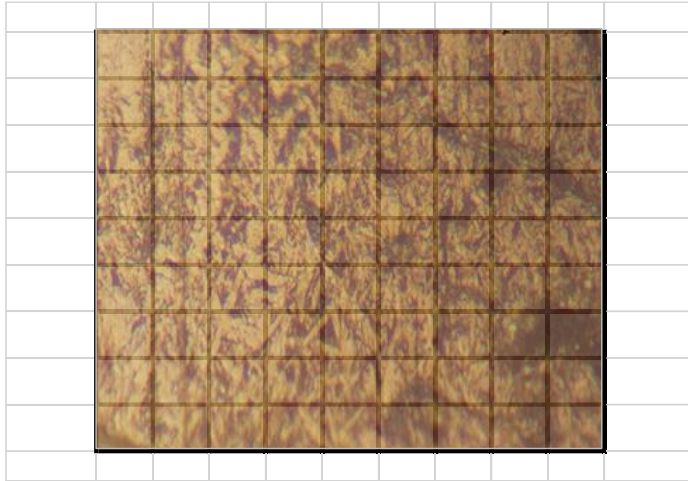
- Kekuatan Tarik Maksimum (UTS)

$$S_u = \frac{P_{max}}{A_0} = \frac{4390}{66,4} = 66,1 \text{ N/mm}^2$$

- Batas Luluh

$$S_0 = \frac{P_y}{A_0} = \frac{4112}{66,4} = 61,9 \text{ N/mm}^2$$

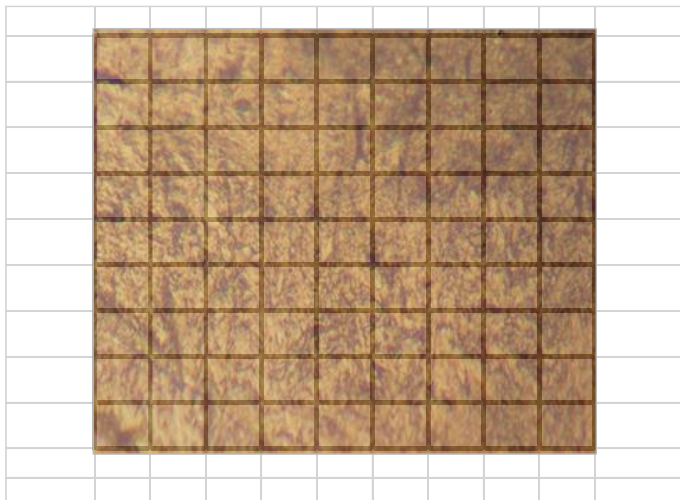
NO	Tegangan dan Regangan Teknik	Hasil Spesimen 1	Hasil Spesimen 2	Hasil Specimen 3	Nilai Rata-rata
1	Tegangan Teknik (σ_{yield}), N/mm ²	63	62,8	61,9	62,5
2	Tegangan Teknik ($\sigma_{maximum}$), N/mm ²	66,2	65,6	66,1	65,9
3	Tegangan Teknik (σ_{putus}), N/mm ²	62,5	61,4	63,4	62,4
4	Regangan Teknik (ϵ_{yield}),	0,66	0,66	0,65	0,65
5	Regangan Teknik ($\epsilon_{maximum}$),	0,69	0,69	0,69	0,69
6	Regangan Teknik (ϵ_{putus}),	0,65	0,64	0,66	0,65



$$\text{Presentase Perlit} = \frac{\text{Jumlah fasa perlit}}{\text{Jumlah titik}} \times 100\%$$

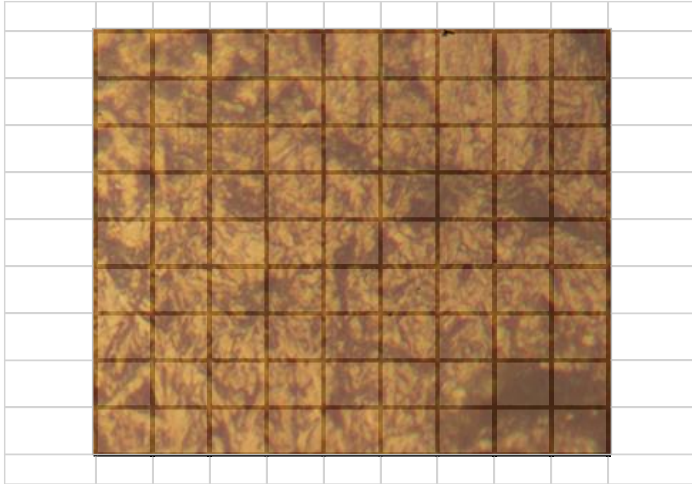
$$= \frac{38}{100} \times 100 = 38\%$$

$$\text{Presentase Ferrite} = 100\% - 38\% = 62\%$$



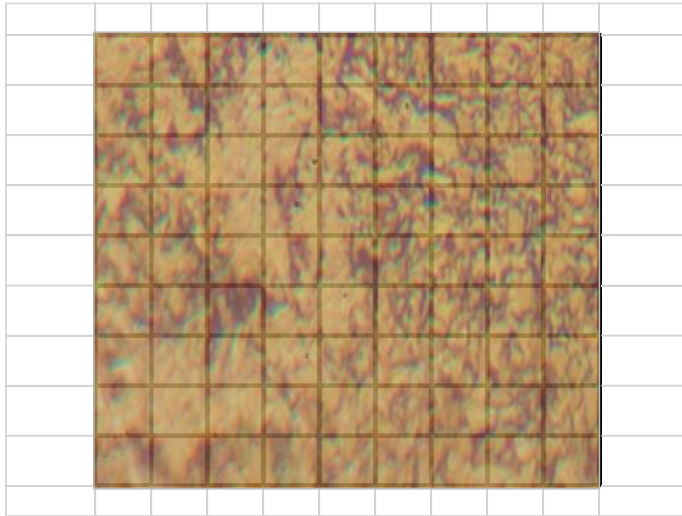
$$\begin{aligned}\text{Presentase Perlit} &= \frac{\text{Jumlah fasa perlit}}{\text{Jumlah titik}} \times 100\% \\ &= \frac{51}{100} \times 100 = 51\%\end{aligned}$$

$$\text{Presentase Ferrite} = 100\% - 51\% = 49\%$$



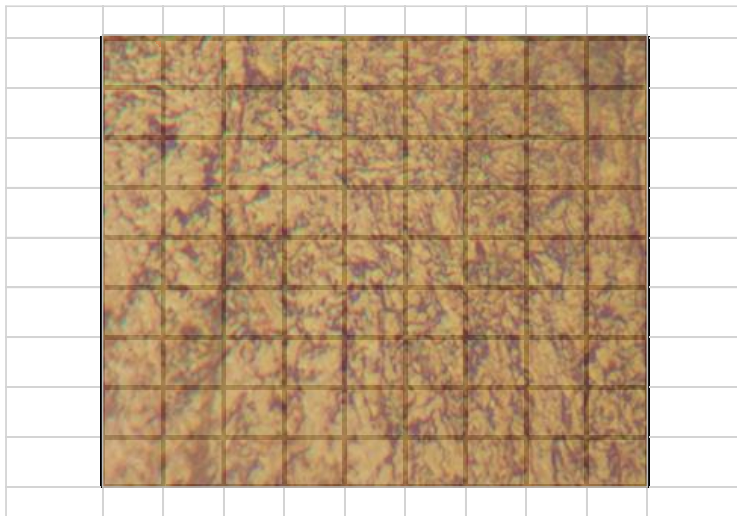
$$\begin{aligned}\text{Presentase Perlit} &= \frac{\text{Jumlah fasa perlit}}{\text{Jumlah titik}} \times 100\% \\ &= \frac{58}{100} \times 100 = 58\%\end{aligned}$$

$$\text{Presentase Ferrite} = 100\% - 58\% = 42\%$$



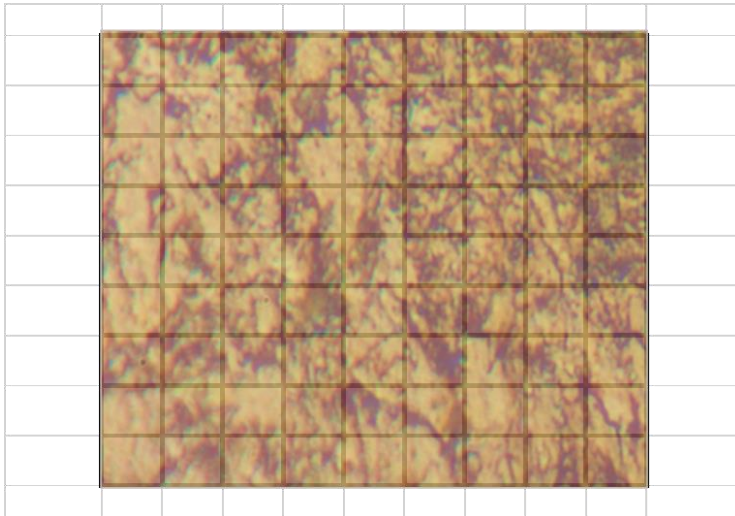
$$\begin{aligned} \text{Presentase Perlit} &= \frac{\text{Jumlah fasa perlit}}{\text{Jumlah titik}} \times 100\% \\ &= \frac{55}{100} \times 100 = 55\% \end{aligned}$$

$$\text{Presentase Ferrite} = 100\% - 55\% = 45\%$$



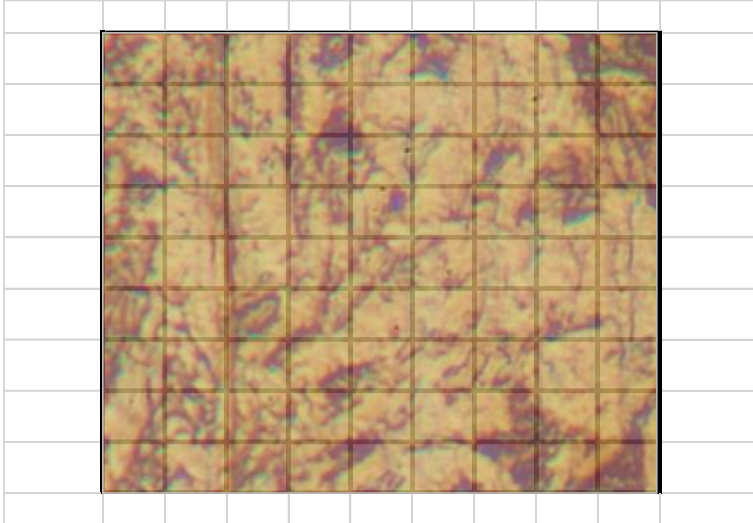
$$\begin{aligned}\text{Presentase Perlit} &= \frac{\text{Jumlah fasa perlit}}{\text{Jumlah titik}} \times 100\% \\ &= \frac{56}{100} \times 100 = 56\%\end{aligned}$$

$$\text{Presentase Ferrite} = 100\% - 56\% = 44\%$$



$$\begin{aligned}\text{Presentase Perlit} &= \frac{\text{Jumlah fasa perlit}}{\text{Jumlah titik}} \times 100\% \\ &= \frac{66}{100} \times 100 = 66\%\end{aligned}$$

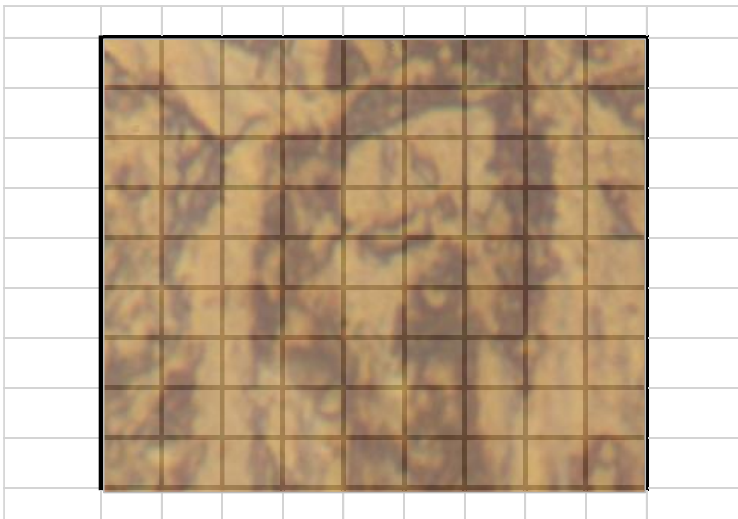
$$\text{Presentase Ferrite} = 100\% - 66\% = 34\%$$



$$\text{Presentase Perlit} = \frac{\text{Jumlah fasa perlit}}{\text{Jumlah titik}} \times 100\%$$

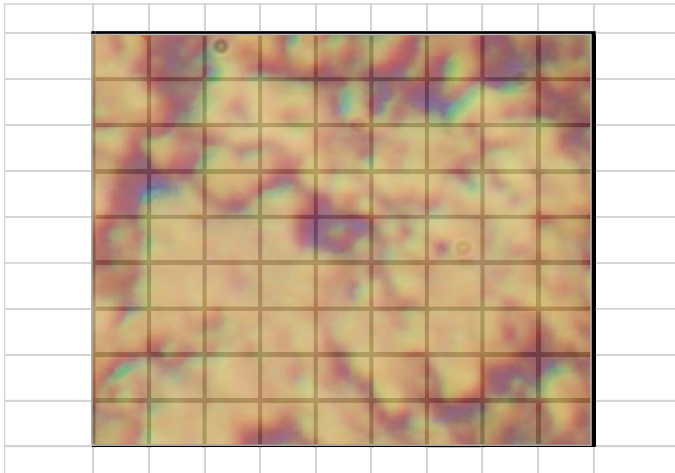
$$= \frac{49}{100} \times 100 = 49\%$$

$$\text{Presentase Ferrite} = 100\% - 49\% = 51\%$$



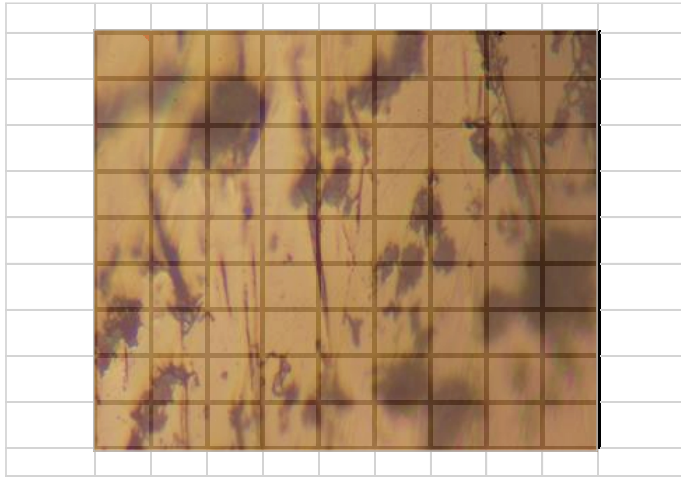
$$\begin{aligned}\text{Presentase Perlit} &= \frac{\text{Jumlah fasa perlit}}{\text{Jumlah titik}} \times 100\% \\ &= \frac{62}{100} \times 100 = 62\%\end{aligned}$$

$$\text{Presentase Ferrite} = 100\% - 62\% = 38\%$$



$$\begin{aligned}\text{Presentase Perlit} &= \frac{\text{Jumlah fasa perlit}}{\text{jumlah titik}} \times 100\% \\ &= \frac{71}{100} \times 100 = 71\%\end{aligned}$$

$$\text{Presentase Ferrite} = 100\% - 71\% = 29\%$$



$$\begin{aligned}\text{Presentase Perlit} &= \frac{\text{Jumlah fasa perlit}}{\text{Jumlah titik}} \times 100\% \\ &= \frac{18}{100} \times 100 = 18\%\end{aligned}$$

$$\text{Presentase Ferrite} = 100\% - 38\% = 82\%$$











