Derive SN curve from test data

Given the fatigue test data in Table 1, derive an SN curve that fits the data. The data comes from axial fatigue testing of smooth specimens in GRP500 ductile cast iron [1]. The tests were carried out under constant amplitude loading at a high mean stress of $\sigma_m = 260$MPa.

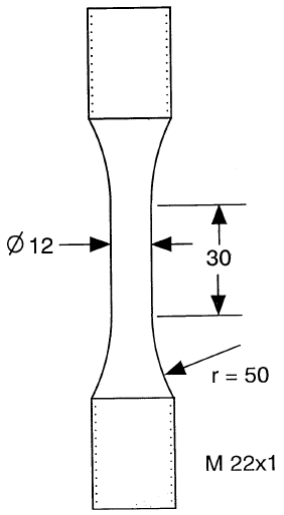

Figure 1: Specimen geometry [1].

1) Plot the data on double logarithmic axes
2) Visually determine when the knee point appear (N_D)
3) Exclude run-outs and data points after N_D in the following, but keep them in the plot
4) Determine the slope m by linear regression
5) Calculate the mean fatigue strength $\sigma_{R,D,50\%}$ at N_D and plot the mean SN curve
6) Determine the design fatigue strength $\sigma_{R,D,97\%}$ at N_D and plot the design SN curve
7) Estimate the design life of a component subjected to a stress amplitude of $\sigma_a = 150MPa$
8) If the required life of a component is $N_{req} = 2 \cdot 10^5$ cycles, what is the allowed stress amplitude?

References

[1] G. Marquis & J. Solin, “Long-life fatigue design of GRP500 nodular cast iron components”, VTT Research notes, Espoo, Finland, 2000. link

Table 1: Fatigue test data [1].

Specimen ID	Mean stress σ_m [MPa]	Stress amplitude σ_a [MPa]	Life N [cycles]	Comment
1.2.6	260	130	518,000	
1.2.28	260	130	265,000	
1.3.5	260	130	448,000	
1.3.9	260	130	647,000	
1.3.20	260	130	431,000	
1.3.22	260	130	232,000	
1.3.25	260	130	277,000	
1.3.27	260	130	298,000	
1.3.28	260	130	378,000	
1.3.23	260	130	261,000	
1.4.8	260	130	437,400	
1.3.8	260	170	198,000	
1.3.11	260	170	168,000	
1.3.12	260	240	26,000	
1.3.13	260	240	13,300	
1.3.19	260	240	15,000	
1.3.24	260	240	12,200	
1.3.26	260	240	19,000	
1.3.29	260	240	10,300	
1.3.30	260	240	12,000	
1.3.31	260	240	19,400	
1.3.32	260	260	13,700	
1.2.18	260	110	845,000	
1.2.25	260	110	566,000	
1.3.7	260	110	2,630,000	
1.3.18	260	110	1,132,000	
1.2.3	260	110	1,501,000	
1.2.21	260	110	1,106,000	
1.3.10	260	110	10,000,000	run-out
1.3.15	260	110	532,000	
1.3.17	260	110	10,000,000	run-out
1.5.20	260	110	659,000	
1.1.6	260	126	589,000	
1.1.22	260	117	359,000	
1.1.23	260	109	1,332,000	
1.1.24	260	100	10,000,000	run-out
1.1.25	260	109	501,000	
1.1.26	260	100	11,000,000	run-out
1.1.27	260	109	705,000	
1.1.28	260	100	1,719,000	
1.1.29	260	92	10,000,000	run-out
1.1.30	260	100	12,000,000	run-out
1.1.31	260	109	1,106,000	
1.1.1*	260	100	13,000,000	run-out
1.1.1*	260	109	10,000,000	run-out
1.1.1*	260	117	10,000,000	run-out
1.1.1*	260	126	867,000	
1.1.2*	260	109	10,000,000	run-out
1.1.2*	260	117	2,457,000	

* indicates re-testing of a previous non-failed specimen.

The data is also available in Excel and Matlab format.