明治大学学術フロンティア
信頼性データバンク疲労データシート

Meiji University Academic Frontier
Reliability Data Bank Fatigue Data Sheet

ローラガイドの寿命試験特性データシート

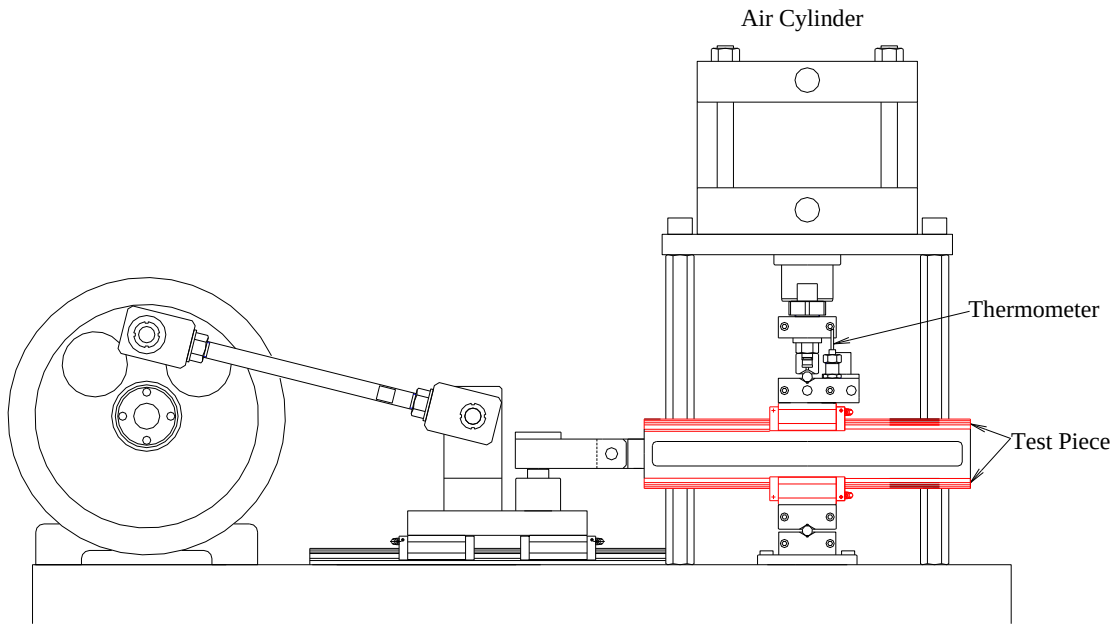
Data Sheet on Rolling Fatigue Life test of Roller Guide

Project of Meiji University Academic Frontier

2010 年 4 月 27 日（火）

Roller Guide LIFE TEST RIG

Machine type	Crank driven 8-Roller Guide life test rig
Motor	ϕ 3-8p-3.7kw
Frequency	0~80Hz



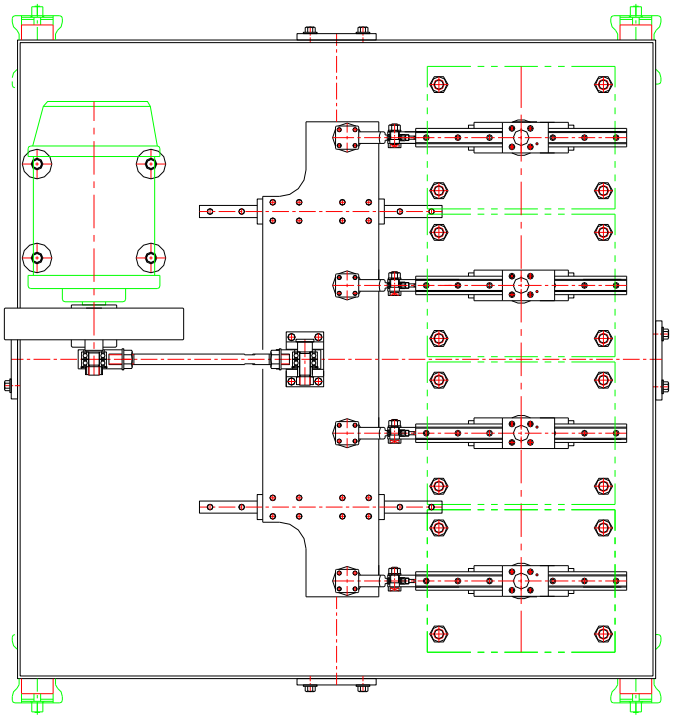


Table 1 Dimension of Test roller guide(R Crowning)

Carriage raceway length, mm	l_t = 65.5
Roller pitch, mm	t_w = 2.88
Stroke, mm	S_t = 200
Initial contact angle, °	γ =45
Roller diameter, mm	D_w = 2.5
Factor of effective length, mm	f_L= 3.2/3.8
Effective length of roller, mm	L_{we} = 3.2
Length of roller, mm	L_w = 3.8
Crowning width, mm	X_r = 12.0
Crowning depth, mm	λ_e= 0.02

Table 2 Dimension of Test roller guide(R Crowning ver.2)

Carriage raceway length, mm	l_t = 65.5
Roller pitch, mm	t_w = 2.88
Stroke, mm	S_t = 200
Initial contact angle, °	γ =45
Roller diameter, mm	D_w = 2.5
Factor of effective length, mm	f_L= 3.2/3.8
Effective length of roller, mm	L_{we} = 3.2
Length of roller, mm	L_w = 3.8
Crowning width, mm	X_r = 8.0
Crowning depth, mm	λ_e= 0.01

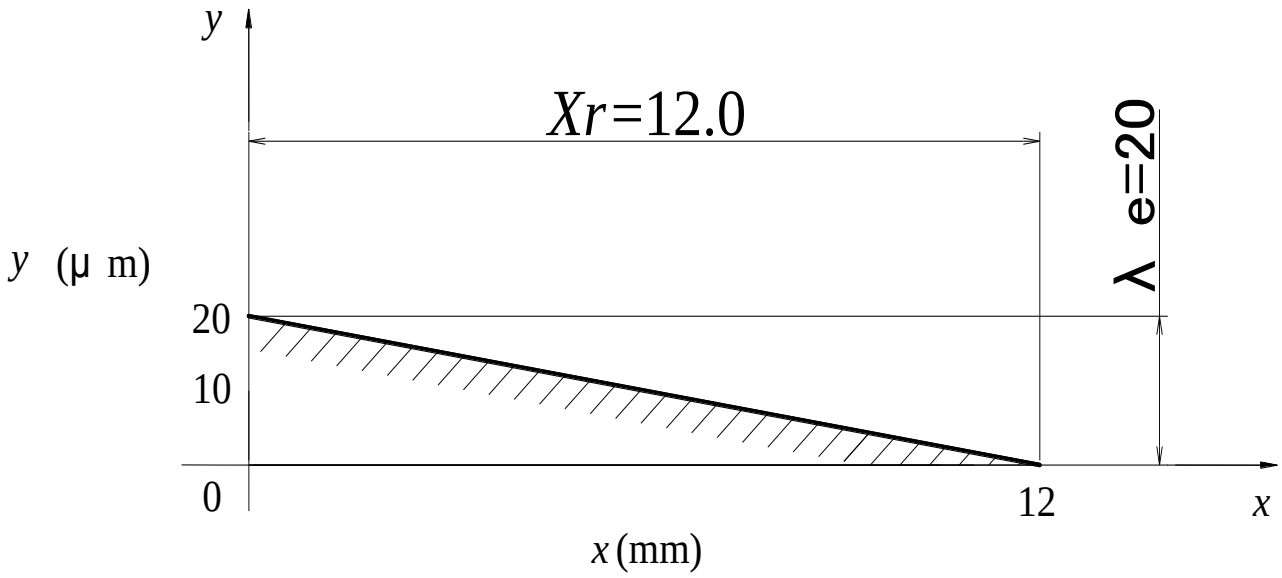
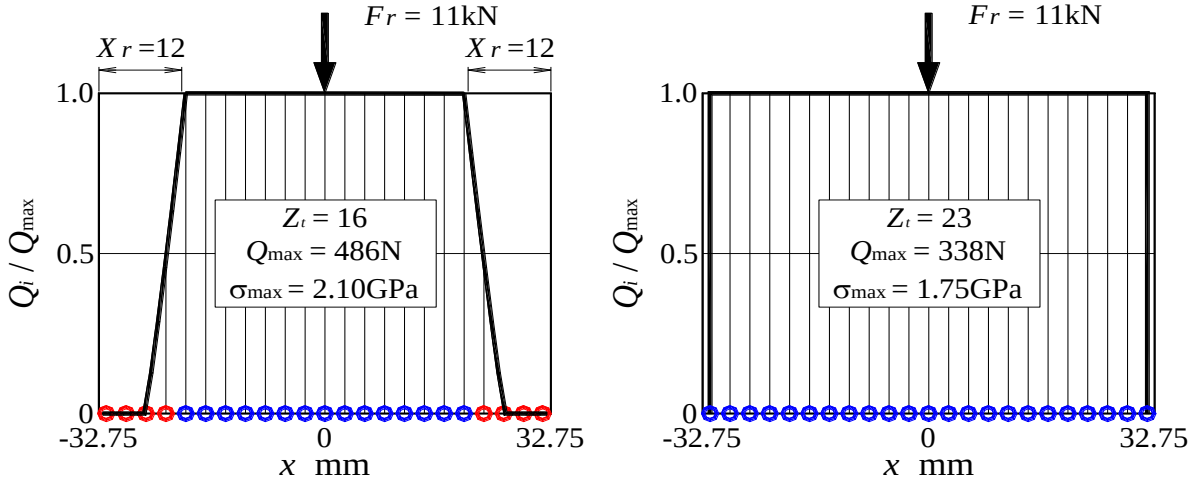


Fig.1 Configuration of Step crowning



(a) With crowning (b) Without crowning

Fig.2 Load distribution in roller guide with and without crowning for Step crowning

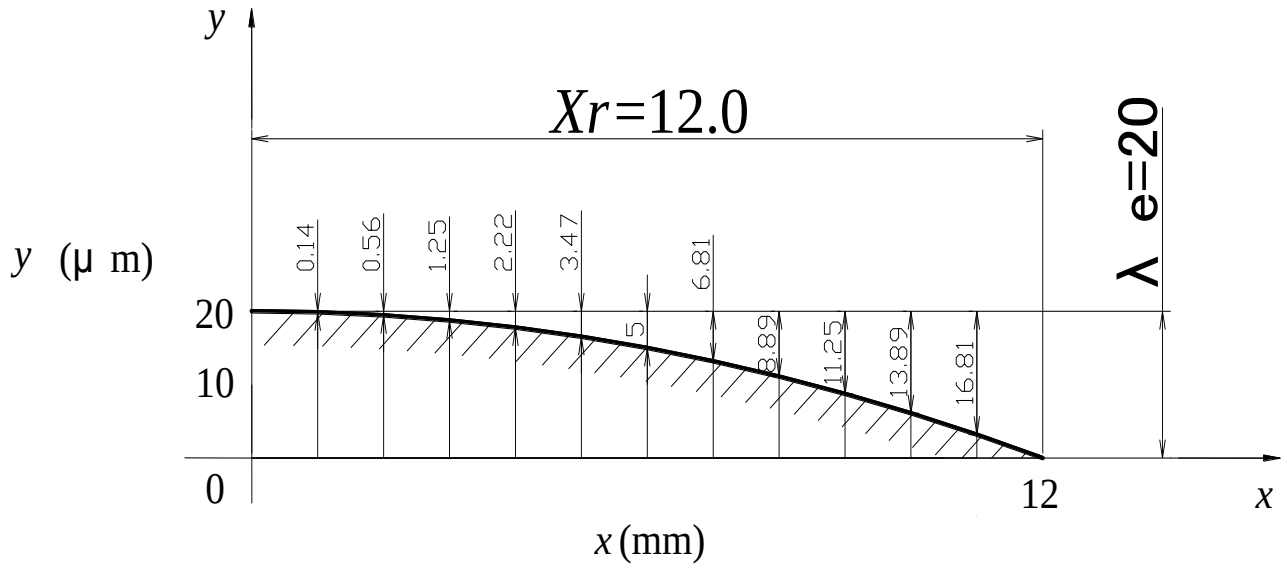
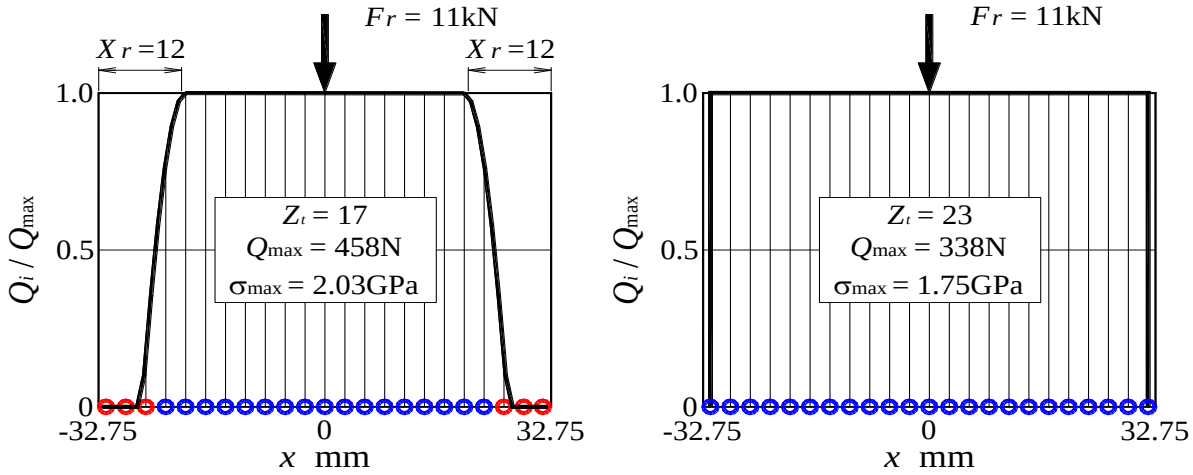


Fig.3 Configuration of R crowning



(a) With crowning (b) Without crowning

Fig.4 Load distribution in roller guide with and without crowning for R crowning

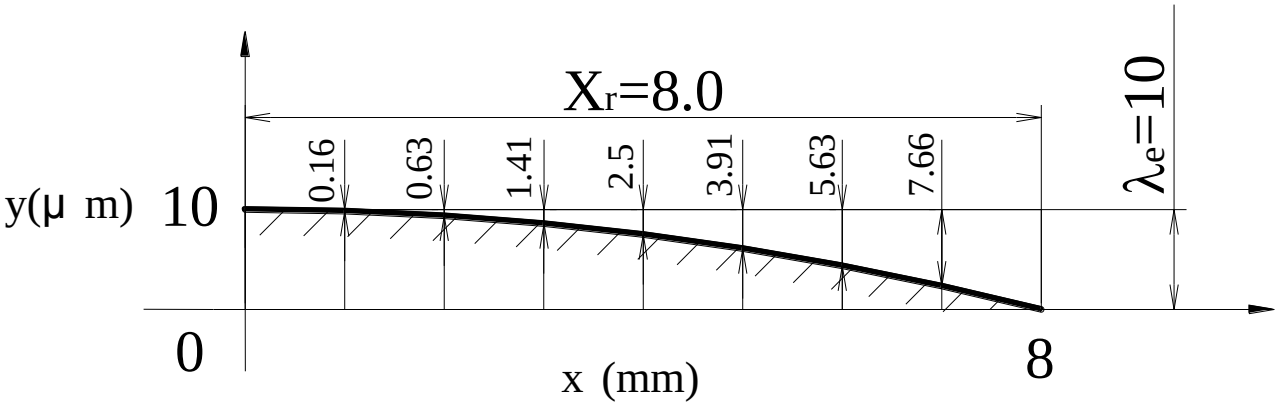
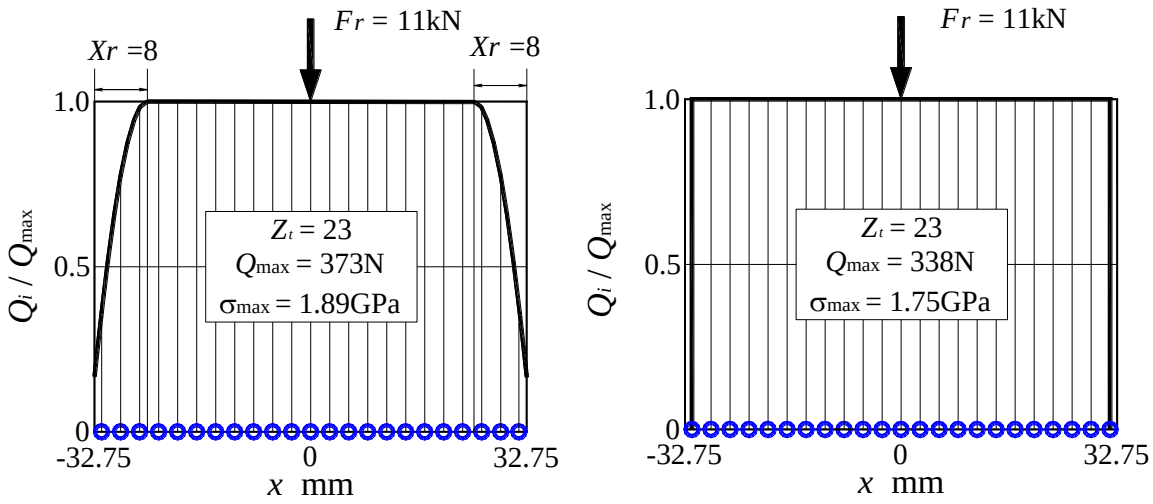


Fig.5 Configuration of R crowning ver.2



(a) With crowning (b) Without crowning

Fig.6 Load distribution in roller guide with and without crowning for R crowning ver.2

Table 3 Test condition

Test load , kN	17 (Step Crowning)	11 (Step crowning)	11 (R crowning)	11 (R crowning ver.2)
Test speed, m/min	48.0(Max)		15.0 (Mean)	
Stroke, mm	200			
TotalNumber of rollers	60			
Grease	AFB-LF Grease			

Table 4 Estimation parameters by log-normal distribution function

Load, kN	17 (Step Crowning)	11 (Step Crowning)	11 (R Crowning)	11 (R Crowning ver.2)
μ	6.05	7.12	7.40	7.79
σ	0.43	0.41	0.38	0.24
σ/μ	0.07	0.06	0.05	0.03

Table 5 Estimation parameters by two-parameter Weibull distribution function

Load, kN	17 (Step Crowning)	11 (Step Crowning)	11 (R Crowning)	11 (R Crowning ver.2)
m	2.81	2.99	3.15	5.09
η	5.21	13.69	19.26	27.0

Table 6 Estimation parameters by three-parameter Weibull distribution function

Load, kN	17 (Step Crowning)		11 (Step Crowning)		11 (R Crowning)		11 (R Crowning ver.2)	
m	9/8	27/20	9/8	27/20	9/8	27/20	9/8	27/20
η	2.99	3.12	5.97	6.40	8.90	9.39	9.24	10.3
γ	1.98	1.85	6.13	5.70	8.74	8.12	17.3	16.2

Table 7 Travel distance to failure of Roller Guide

(*F*=17 kN, Step crowning)

No	*Load*=17kN	*No*	*Load*=17kN	*No*	*Load*=17kN	*No*	*Load*=17kN	*No*	*Load*=17kN	*No*	*Load*=17kN
1	191.771	11	295.824	21	378.678	31	462.482	41	535.933	51	892.637
2	210.188	12	296.001	22	388.688	32	466.530	42	594.860	52	983.104
3	217.575	13	309.389	23	388.688	33	467.917	43	629.946	53	997.934
4	230.976	14	315.928	24	399.663	34	480.308	44	657.454	54	
5	237.252	15	331.021	25	410.128	35	480.308	45	665.932	55	
6	237.252	16	331.021	26	413.319	36	480.501	46	673.070	56	
7	254.448	17	338.693	27	413.319	37	487.858	47	731.104	57	
8	255.738	18	346.491	28	414.952	38	503.326	48	832.330	58	
9	267.747	19	366.541	29	415.756	39	505.580	49	832.860	59	
10	292.231	20	374.262	30	454.820	40	510.030	50	839.679	60	

Table 8 Travel distance to failure of Roller Guide
(*F*=11 kN, Step crowning)

No	*Load*=11kN	*No*	*Load*=11kN	*No*	*Load*=11kN
1	633.934	11	1000.520	21	1606.741
2	645.199	12	1045.144	22	1657.416
3	749.959	13	1099.166	23	1709.199
4	755.114	14	1134.559	24	1818.901
5	775.081	15	1228.538	25	1878.497
6	805.081	16	1228.538	26	1878.497
7	895.487	17	1346.676	27	1942.470
8	900.726	18	1394.801	28	2057.964
9	965.665	19	1476.312	29	2252.049
10	977.507	20	1505.572	30	2492.933

Table 9 Travel distance to failure of Roller Guide

(*F*=11 kN, R crowning)

No	*Load*=11kN	*No*	*Load*=11kN	*No*	*Load*=11kN
1	869.134	11	1365.494	21	2091.704
2	900.863	12	1390.692	22	2146.343
3	969.571	13	1401.226	23	2225.519
4	1008.087	14	1490.279	24	2291.091
5	1050.420	15	1544.761	25	2345.172
6	1144.752	16	1642.470	26	2497.235
7	1183.477	17	1652.175	27	2632.734
8	1204.194	18	1752.175	28	2762.463
9	1257.007	19	1883.169	29	2802.760
10	1308.939	20	1988.974	30	3064.135

Table 10 Travel distance to failure of Roller Guide (*F*=11 kN, R crowning ver.2)

No	*Load*=11kN	*No*	*Load*=11kN	*No*	*Load*=11kN
1	1308.4064	11	2599.1048	21	3146.7420
2	1604.9940	12	2599.2388	22	
3	1746.4892	13	2623.3888	23	
4	1980.7220	14	2644.3504	24	
5	2077.8220	15	2807.9784	25	
6	2132.9040	16	2850.7736	26	
7	2184.8440	17	2850.7736	27	
8	2324.6908	18	2958.4392	28	
9	2348.3820	19	3007.3740	29	
10	2410.7680	20	3033.2692	30	

Table 11 Dimension of Crowning

Crowning type	Step Crowning	R Crowning	R Crowning ver.2
Crowning width, mm	X_r = 12.0		X_r = 8.0
Crowning depth, mm	λ_e= 0.02		λ_e= 0.01
Effective number of roller	Z_t = 16	Z_t = 17	Z_t = 23
Rolling element load, N	Q_{max}= 486	Q_{max}= 458	Q_{max}= 373
Stress, GPa	σ_{max}= 2.10	σ_{max}= 1.75	σ_{max}= 1.89

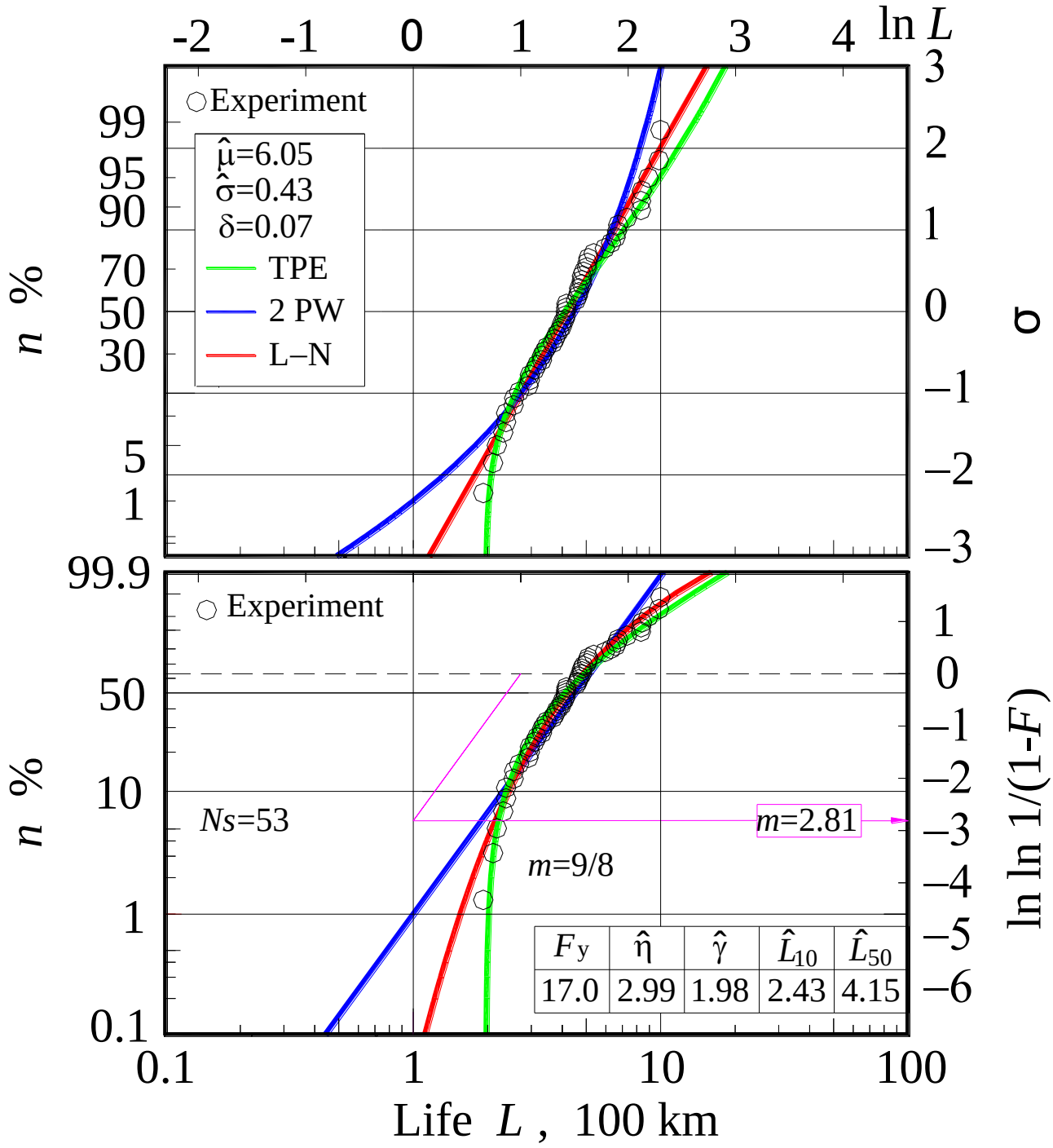


Fig. 7 Weibull and log-normal plot for LMRG component life data by method of two-point estimation (*F*=17 kN, N_s=53, *m*=9/8, Step crowning)

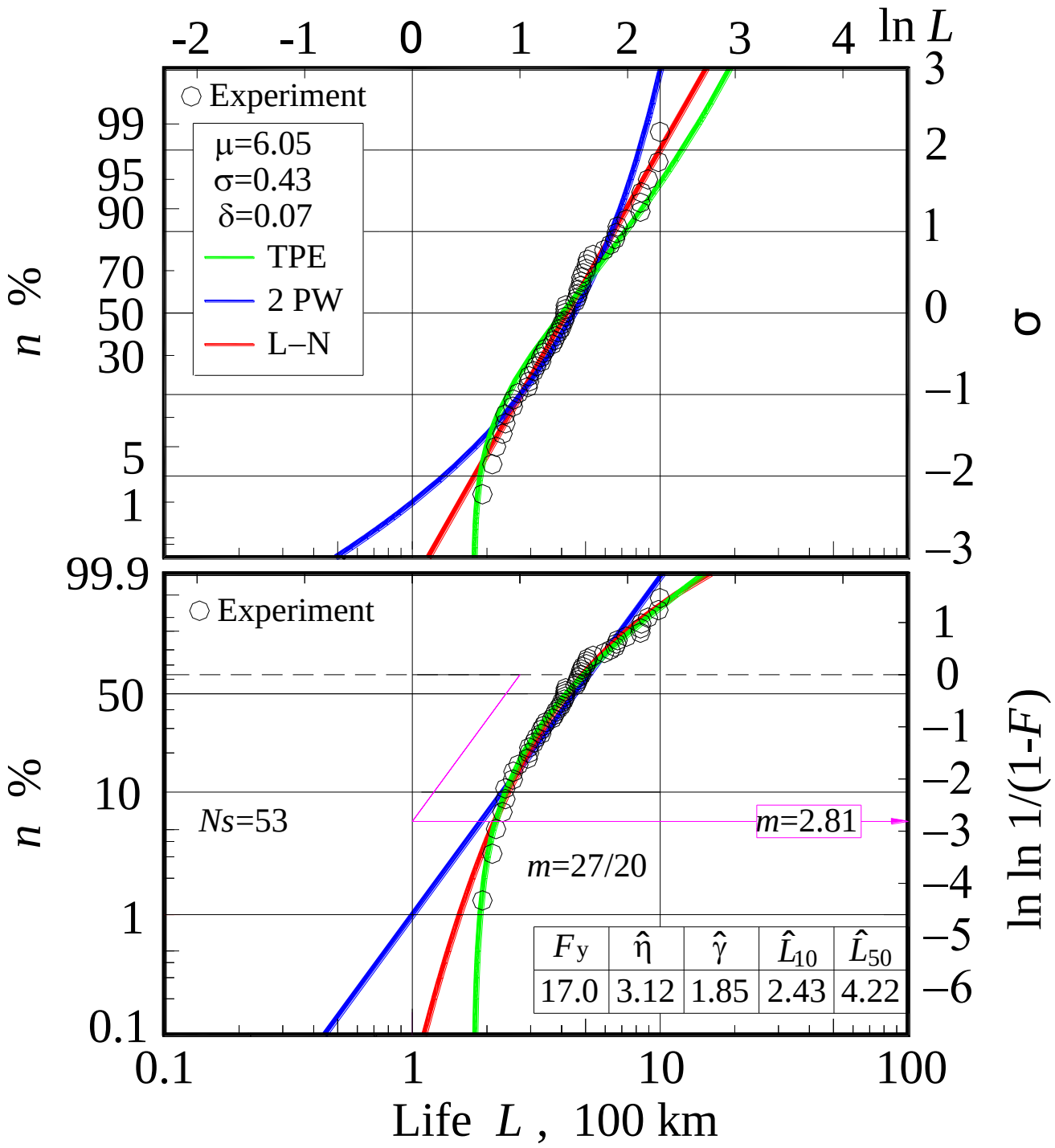


Fig. 8 Weibull and log-normal plot for LMRG component life data by method of two-point estimation (*F*=17 kN, N_s=53, *m*=27/20, Step crowning)

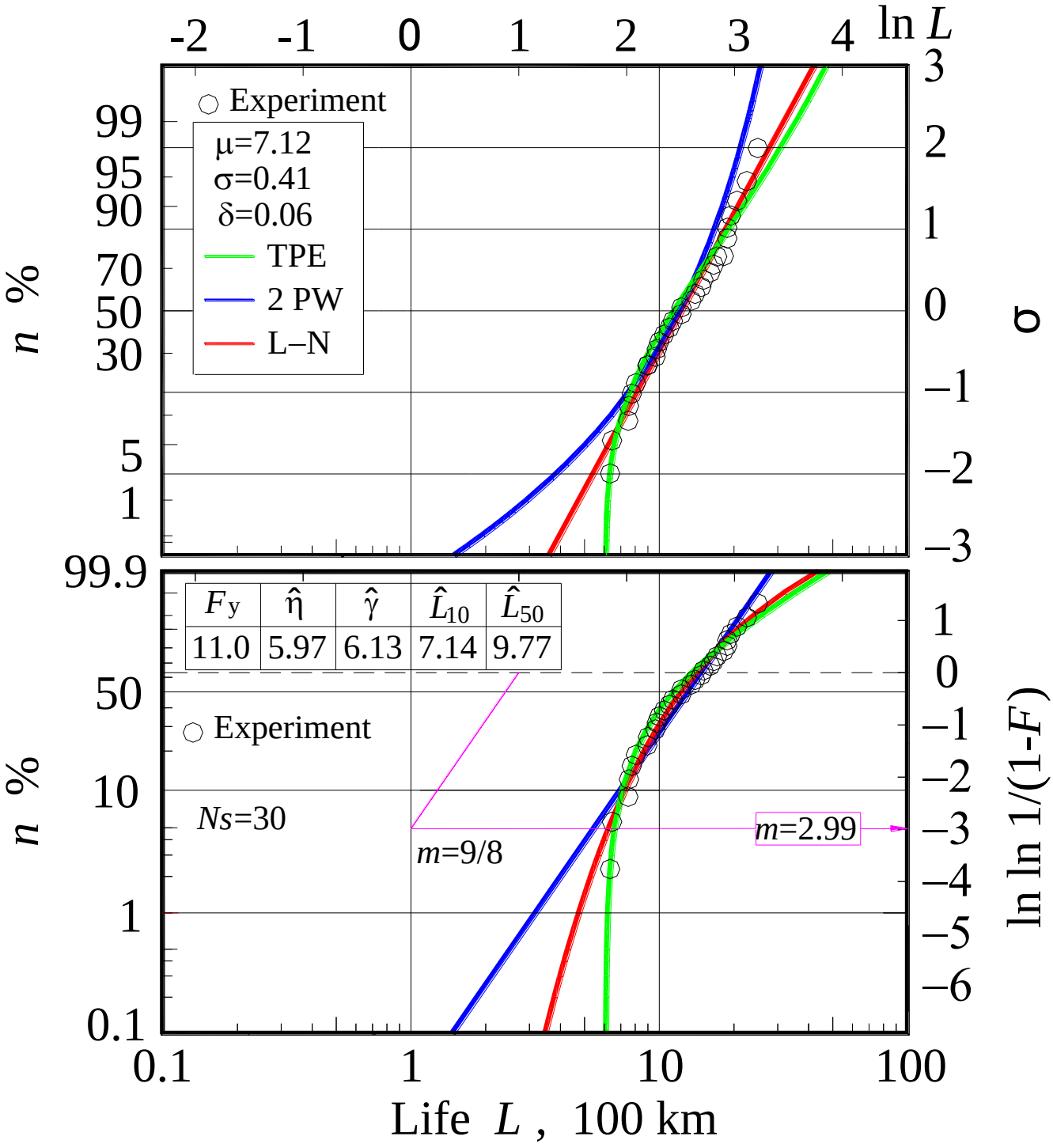


Fig. 9 Weibull and log-normal plot for LMRG component life data by method of two-point estimation (*F*=11 kN, N_s=30, *m*=9/8, Step crowning)

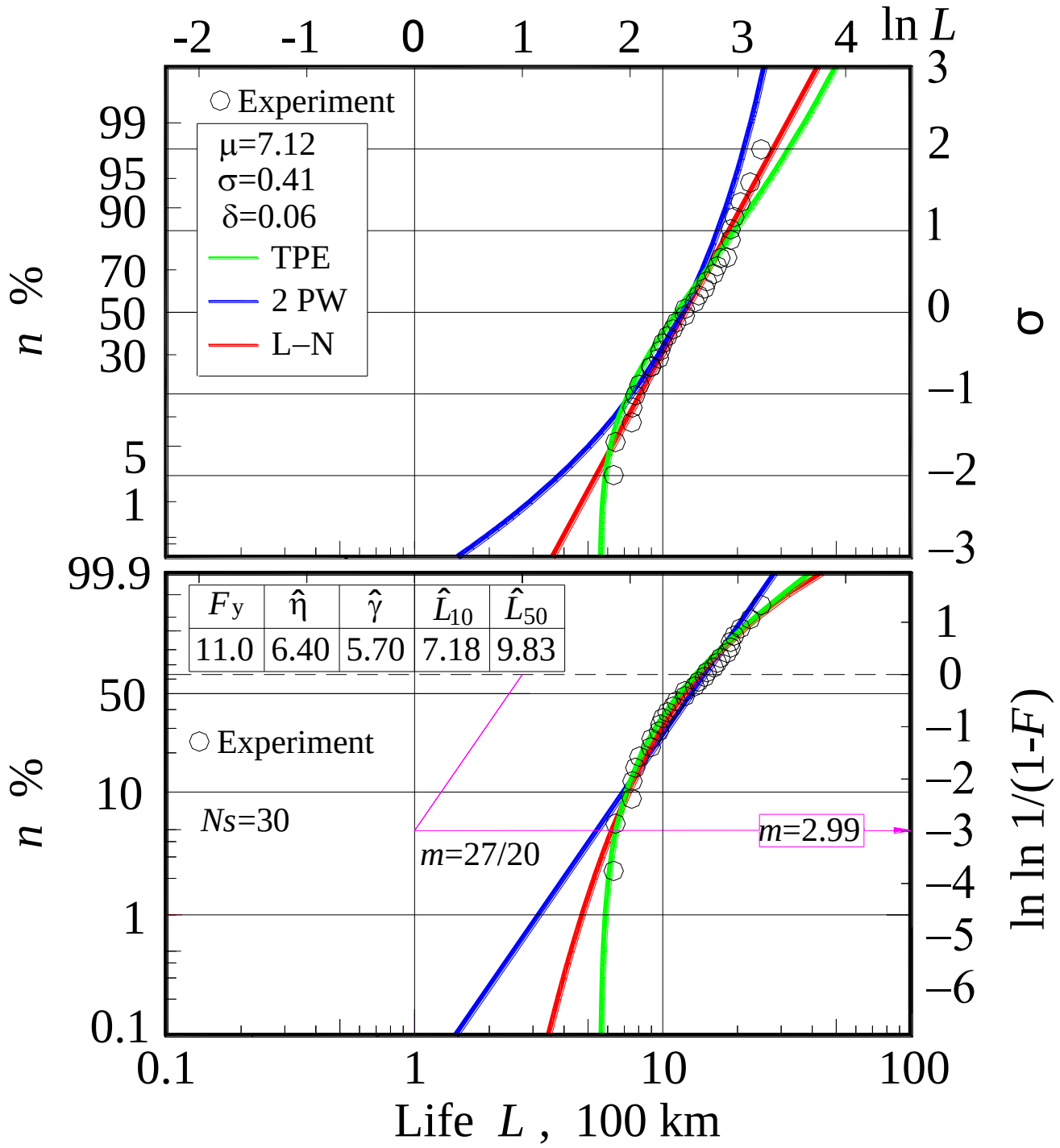


Fig. 10 Weibull and log-normal plot for LMRG component life data by method of two-point estimation (*F*=11 kN, N_s=30, *m*=27/20, Step crowning)

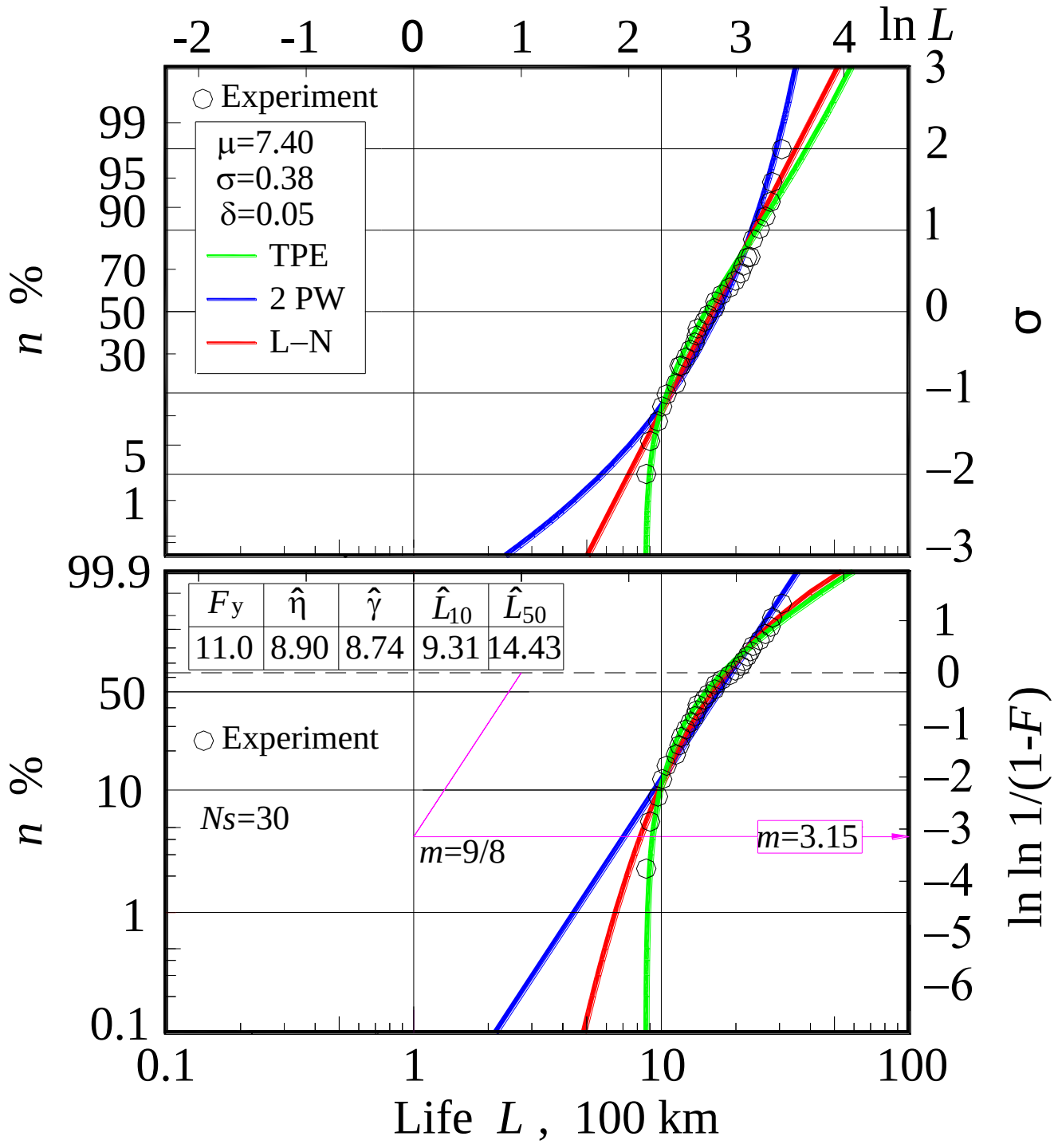


Fig. 11 Weibull and log-normal plot for LMRG component life data by method of two-point estimation (*F*=11 kN, N_s=30, *m*=9/8, R crowning)

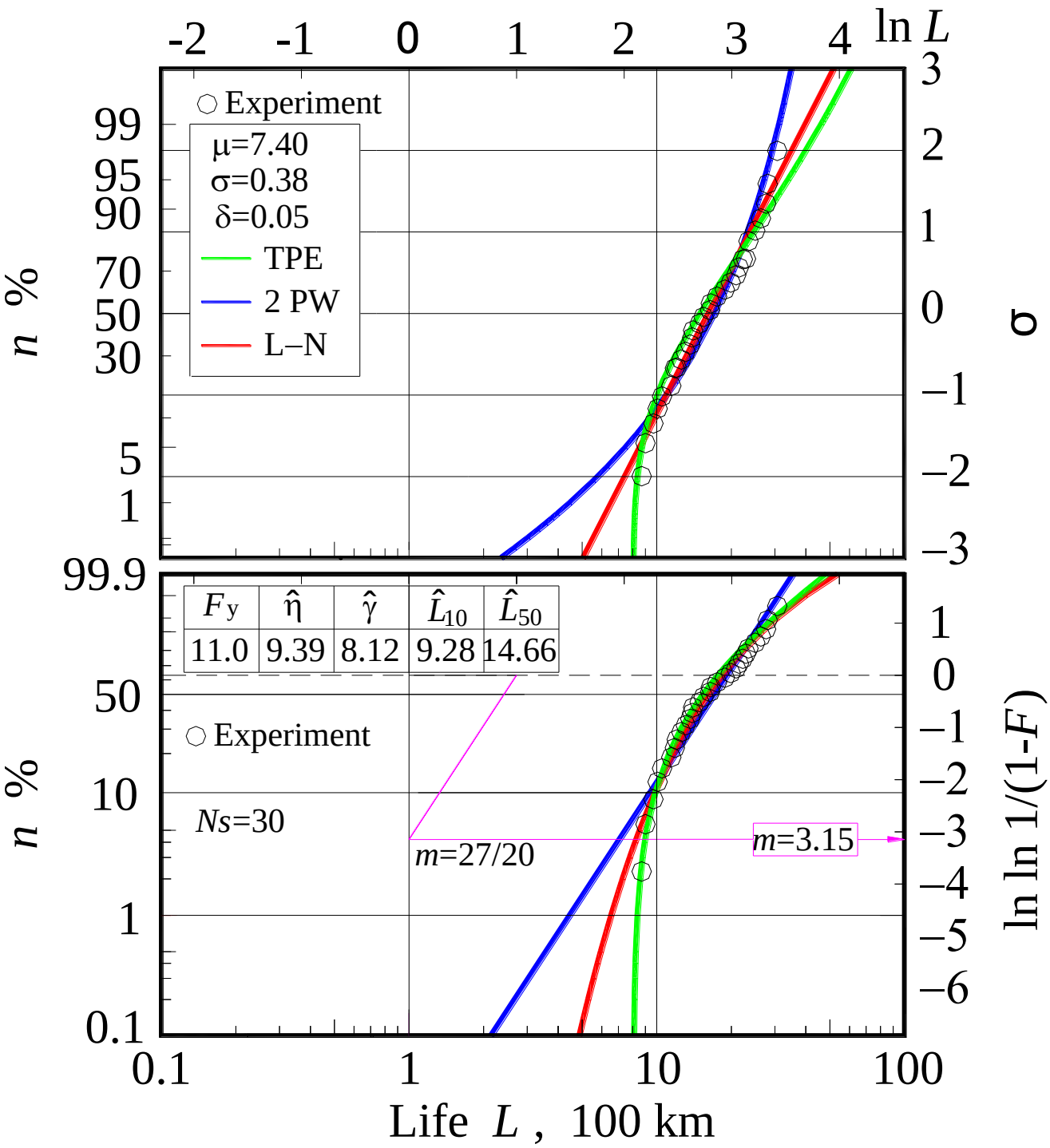
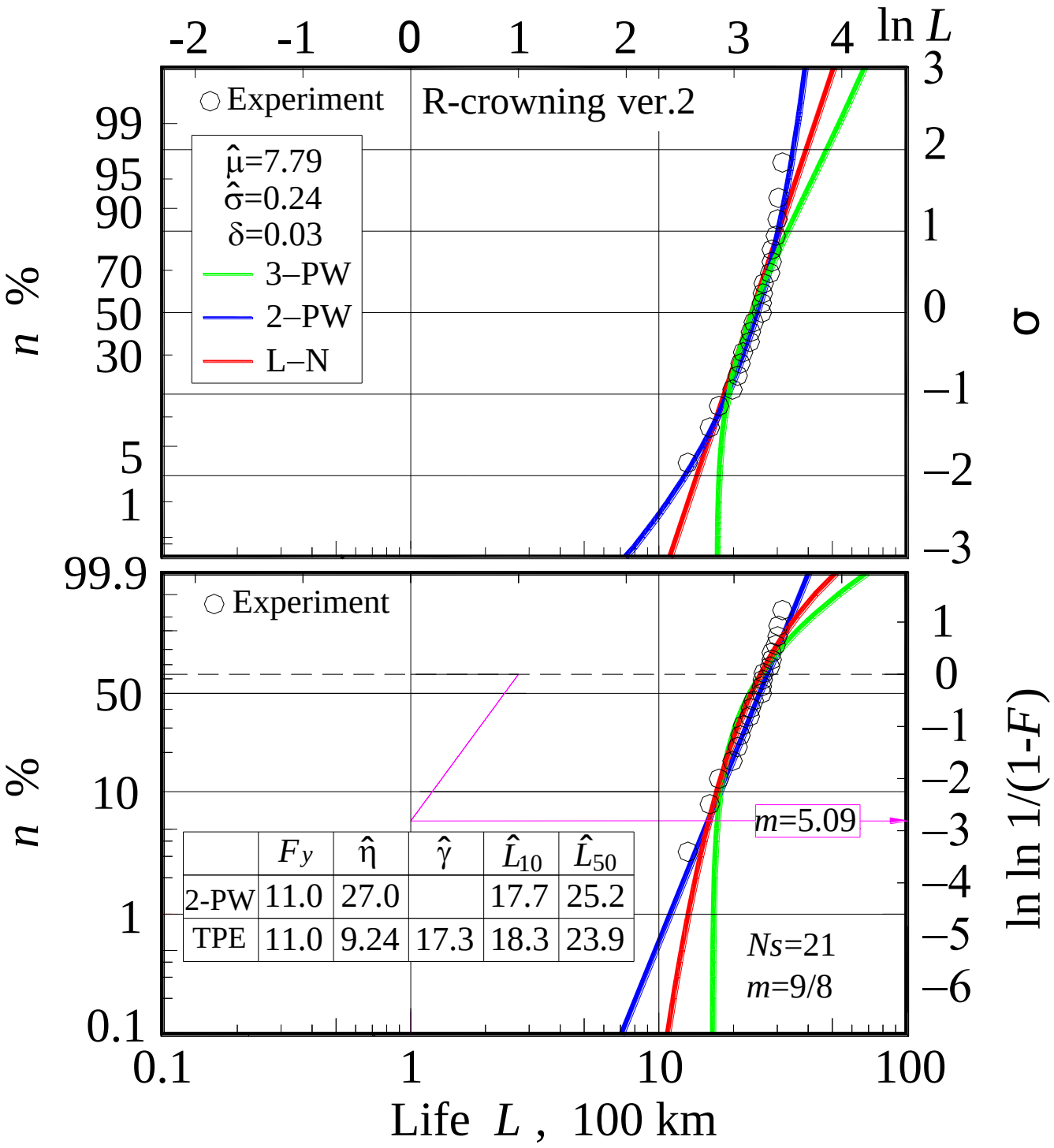
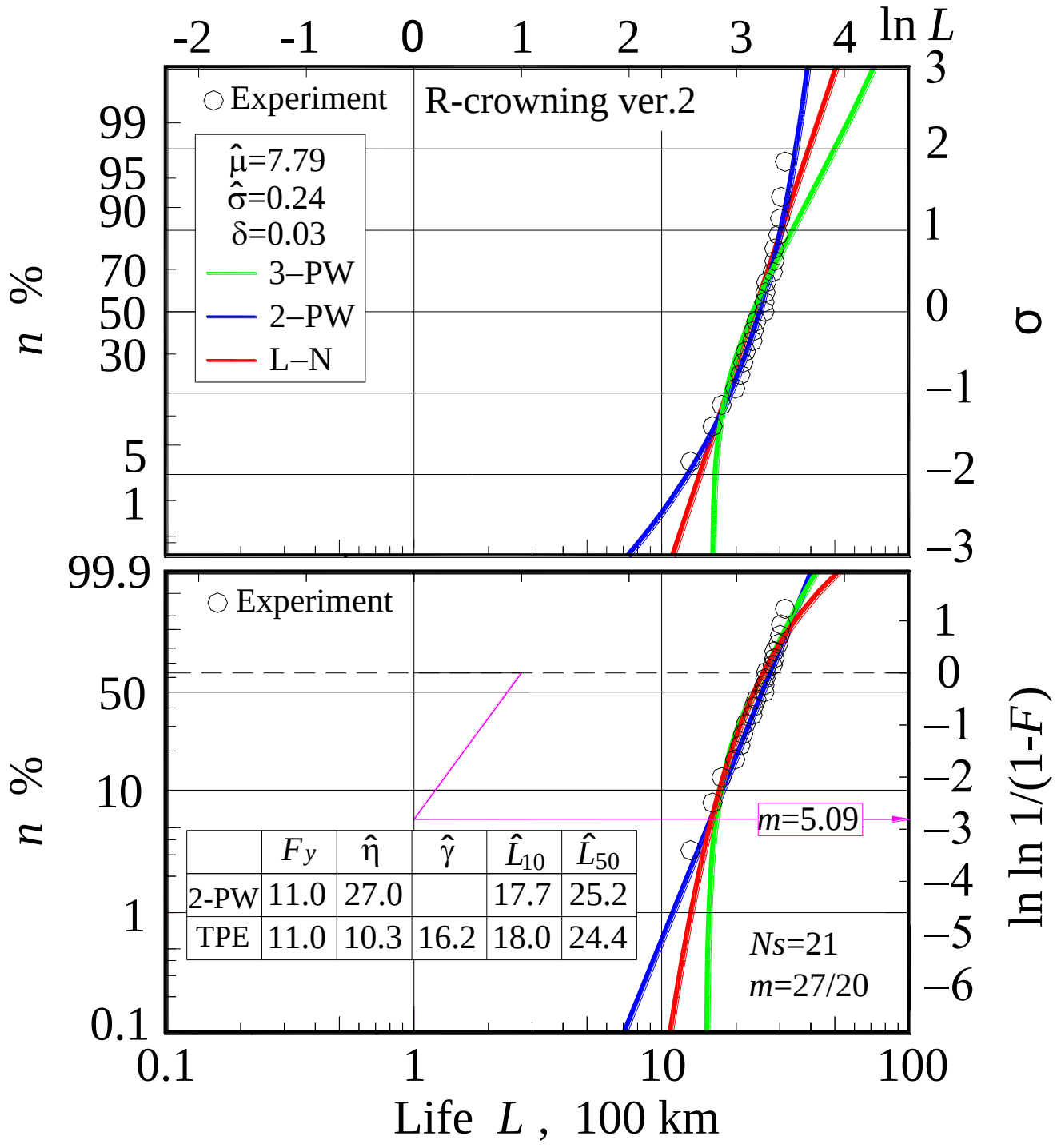


Fig. 12 Weibull and log-normal plot for LMRG component life data by method of two-point estimation (*F*=11 kN, N_s=30, *m*=27/20, R crowning)



	F_y	$\hat{\eta}$	$\hat{\gamma}$	$\hat{L}_{10}$	$\hat{L}_{50}$
2-PW	11.0	27.0		17.7	25.2
TPE	11.0	9.24	17.3	18.3	23.9

Fig. 13 Weibull and log-normal plot for LMRG component life data by method of two-point estimation (*F*=11 kN, N_s=21, *m*=9/8, R crowning ver.2)



	F_y	$\hat{\eta}$	$\hat{\gamma}$	$\hat{L}_{10}$	$\hat{L}_{50}$
2-PW	11.0	27.0		17.7	25.2
TPE	11.0	10.3	16.2	18.0	24.4

Fig. 14 Weibull and log-normal plot for LMRG component life data by method of two-point estimation (*F*=11 kN, N_s=21, *m*=27/20, R crowning ver.2)

Table 12 Estimation of *C* from life distribution

(*F*=17 kN, *m*=9/8, Step crowning)

	3-PW	2-PW	Log-normal
$C_{ex(\gamma)}$ kN	13.92	—	—
$C_{ex(\gamma=0)}$ kN	21.23	21.09	21.35
C_{th} kN	19.96	19.96	19.96
$C_{ex(\gamma)} / C_{th}$	0.70	—	—
$C_{ex(\gamma=0)} / C_{th}$	—	1.06	1.07

Table 13 Estimation of *C* from life distribution (*F*=17 kN, *m*=27/20, Step crowning)

	3-PW	2-PW	Log-normal
$C_{ex(\gamma)}$ kN	14.44	—	—
$C_{ex(\gamma=0)}$ kN	22.19	22.02	22.35
C_{th} kN	17.73	17.73	17.73
$C_{ex(\gamma)} / C_{th}$	0.81	—	—
$C_{ex(\gamma=0)} / C_{th}$	—	1.24	1.26

Table 14 Estimation of *C* from life distribution (*F*=11 kN, *m*=9/8, Step crowning)

	3-PW	2-PW	Log-normal
$C_{ex(\gamma)}$ kN	11.00	—	—
$C_{ex(\gamma=0)}$ kN	17.97	17.90	18.10
C_{th} kN	19.96	19.96	19.96
$C_{ex(\gamma)} / C_{th}$	0.55	—	—
$C_{ex(\gamma=0)} / C_{th}$	—	0.90	0.91

Table 15 Estimation of *C* from life distribution (*F*=11 kN, *m*=27/20, Step crowning)

	3-PW	2-PW	Log-normal
$C_{ex(\gamma)}$ kN	12.37	—	—
$C_{ex(\gamma=0)}$ kN	19.87	19.73	20.00
C_{th} kN	17.73	17.73	17.73
$C_{ex(\gamma)} / C_{th}$	0.70	—	—
$C_{ex(\gamma=0)} / C_{th}$	—	1.11	1.13

Table 16 Estimation of *C* from life distribution (*F*=11 kN, *m*=9/8, R crowning)

	3-PW	2-PW	Log-normal
$C_{ex(\gamma)}$ kN	9.56	—	—
$C_{ex(\gamma=0)}$ kN	19.21	19.13	19.20
C_{th} kN	19.96	19.96	19.96
$C_{ex(\gamma)} / C_{th}$	0.48	—	—
$C_{ex(\gamma=0)} / C_{th}$	—	0.96	0.96

Table 17 Estimation of *C* from life distribution

(*F*=11 kN, *m*=27/20, R crowning)

	3-PW	2-PW	Log-noormal
$C_{ex(\gamma)}$ kN	11.50	—	—
$C_{ex(\gamma=0)}$ kN	21.46	21.37	21.46
C_{th} kN	17.73	17.73	17.73
$C_{ex(\gamma)} / C_{th}$	0.65	—	—
$C_{ex(\gamma=0)} / C_{th}$	—	1.21	1.21

Table 18 Estimation of *C* from life distribution (*F*=11 kN, *m*=9/8, R crowning ver.2)

	3-PW	2-PW	Log-noormal
$C_{ex(\gamma)}$ kN	11.00	—	—
$C_{ex(\gamma=0)}$ kN	22.75	22.56	22.94
C_{th} kN	20.64	20.64	20.64
$C_{ex(\gamma)} / C_{th}$	0.53	—	—
$C_{ex(\gamma=0)} / C_{th}$	—	1.09	1.11

Table 19 Estimation of *C* from life distribution (*F*=11 kN, *m*=27/20, R crowning ver.2)

	3-PW	2-PW	Log-noormal
$C_{ex(\gamma)}$ kN	13.12	—	—
$C_{ex(\gamma=0)}$ kN	26.18	26.05	26.57
C_{th} kN	18.29	18.29	18.29
$C_{ex(\gamma)} / C_{th}$	0.72	—	—
$C_{ex(\gamma=0)} / C_{th}$	—	1.42	1.45

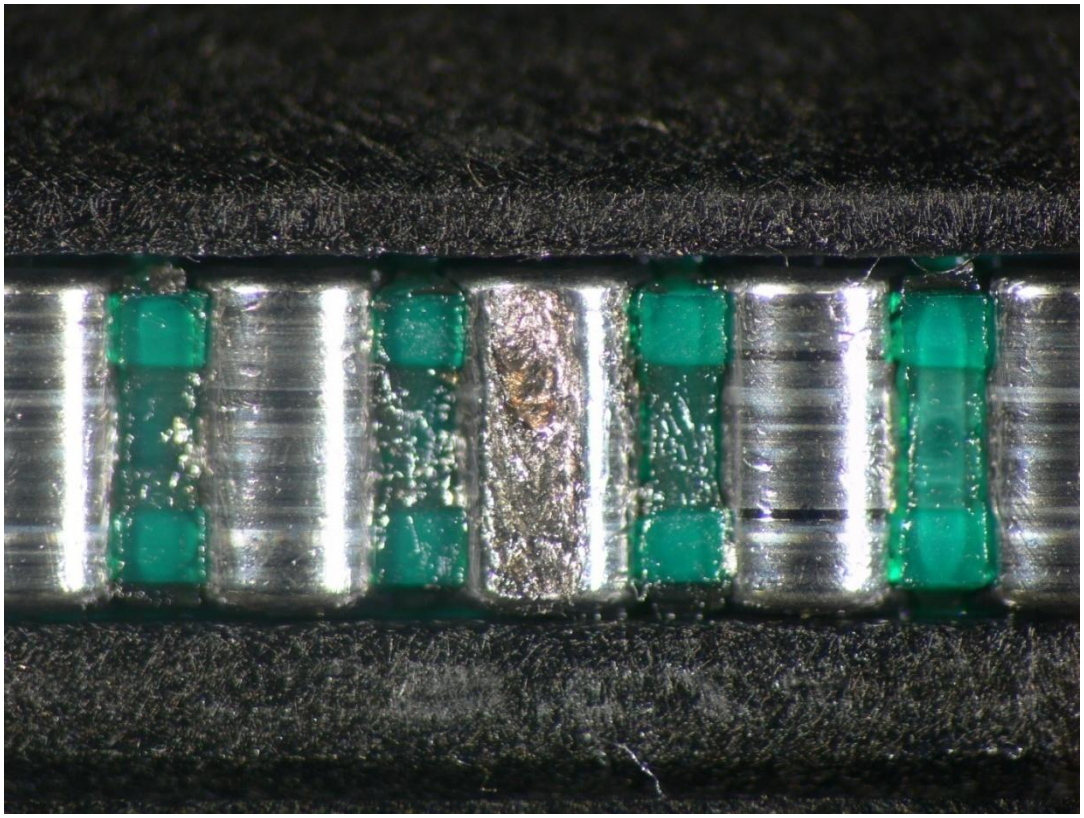


Fig.15 Spalling of roller (346 km　17 kN)

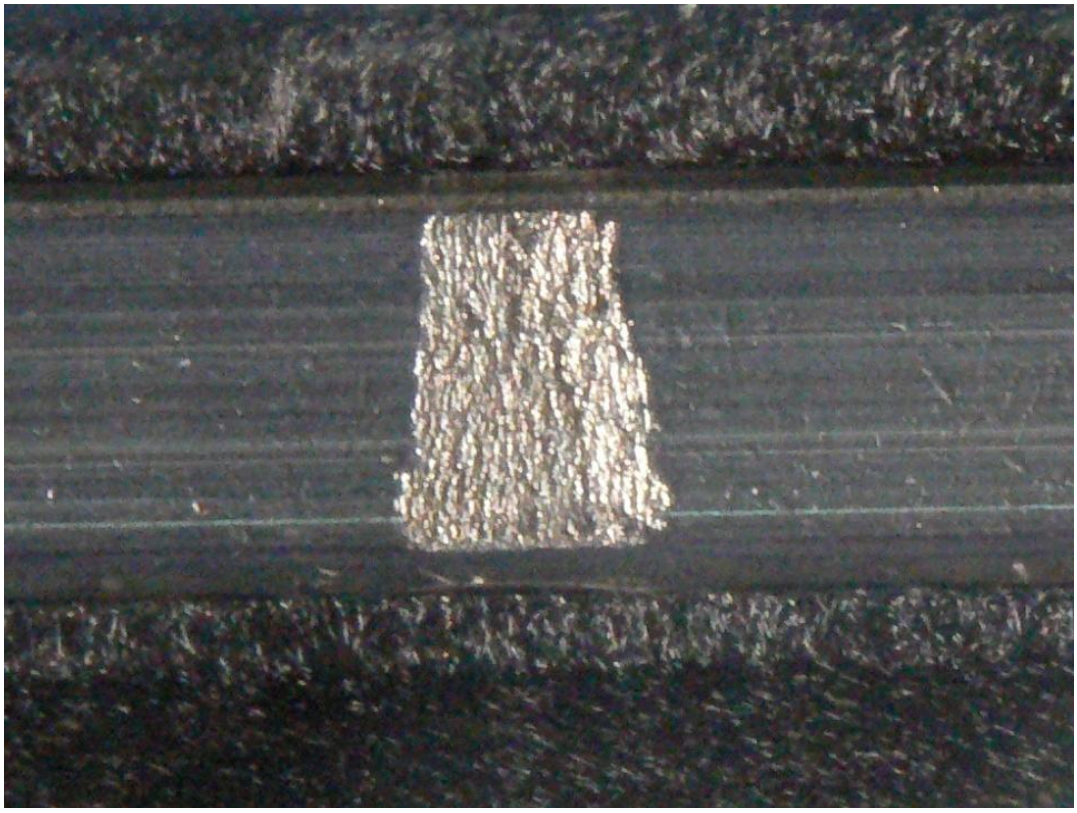


Fig.16 Spalling of carriage raceway surface (1878 km　11 kN)

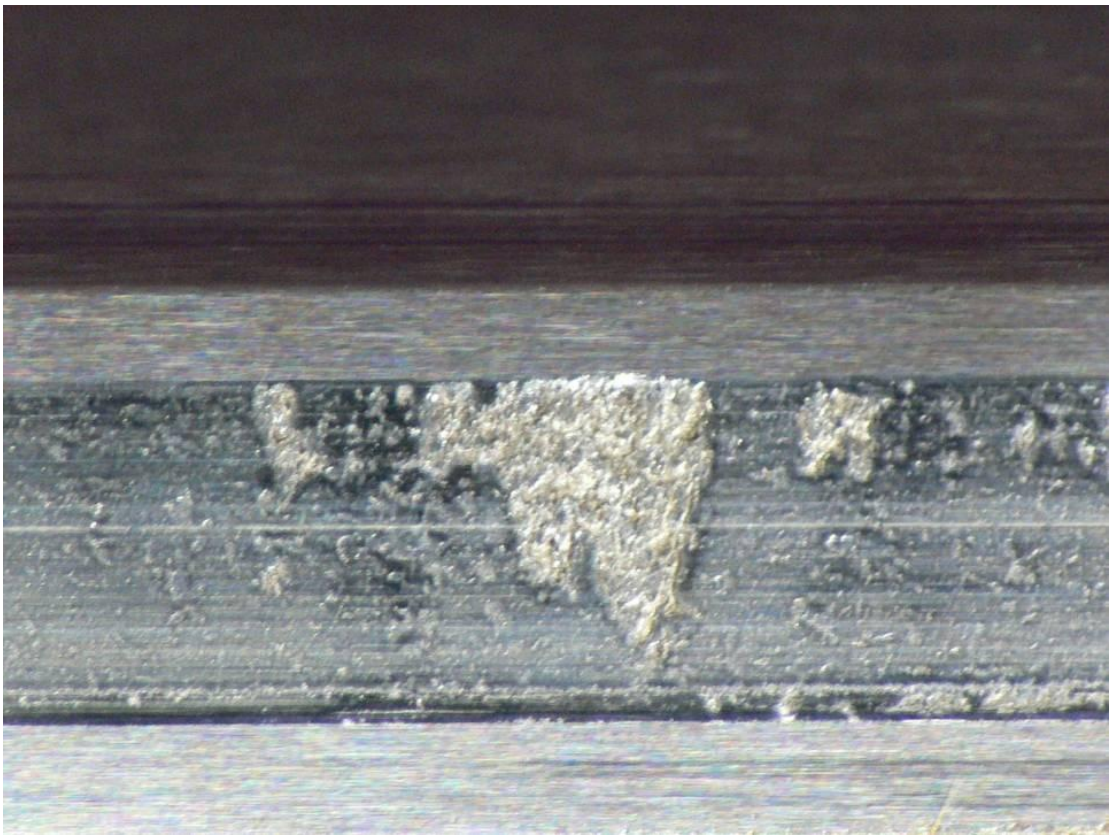


Fig.17 Spalling of rail (645 km　11 kN)

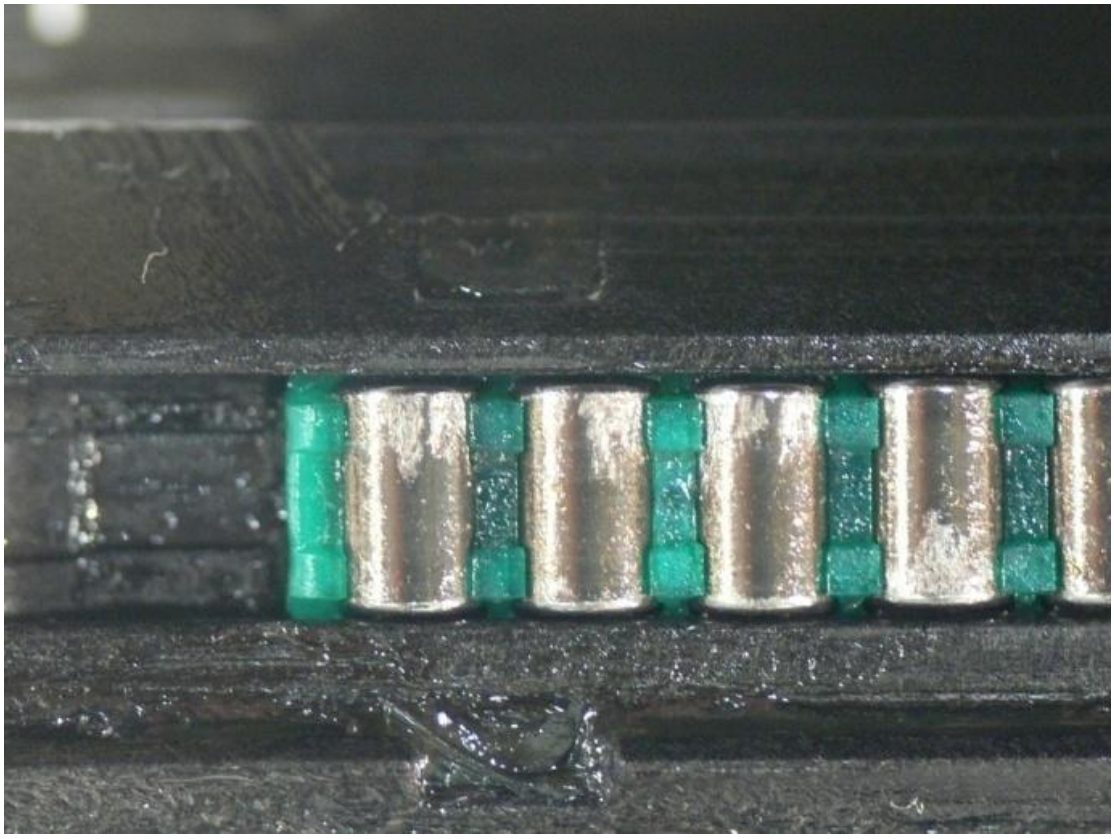


Fig.18 Spalling of roller (2958 km　11 kN)

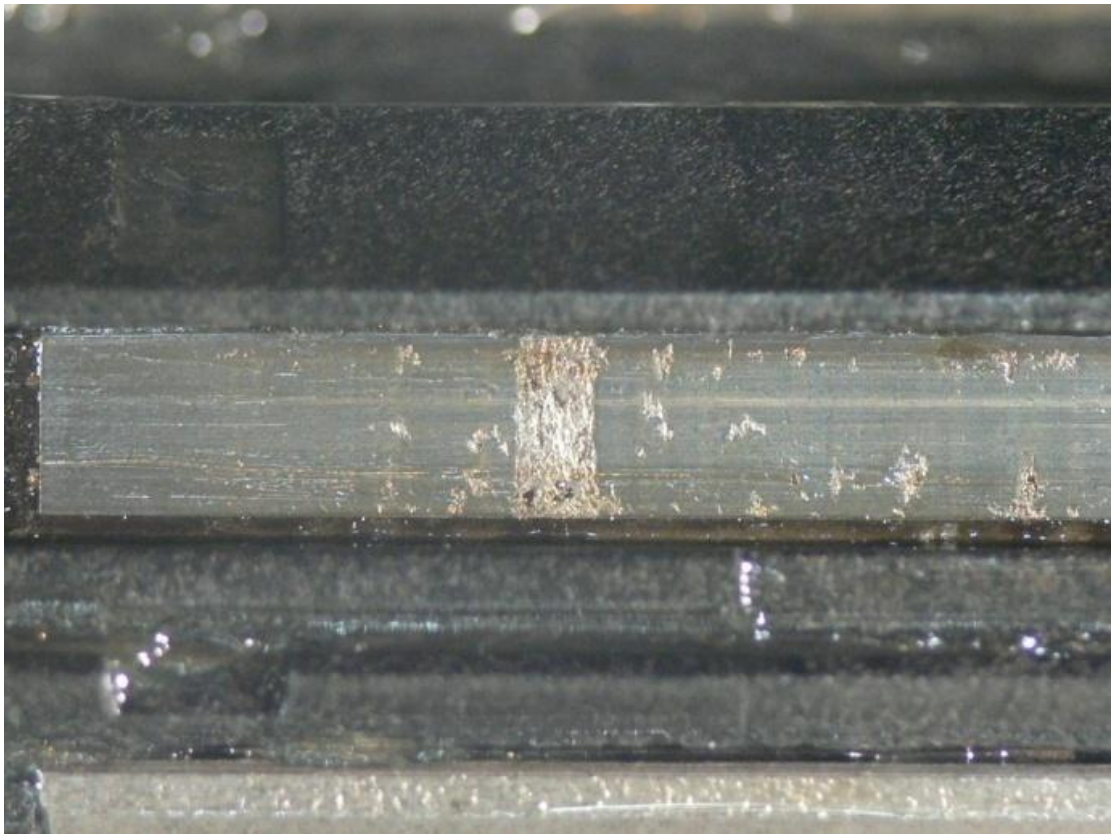


Fig.19 Spalling of carriage raceway surface (2348 km　11 kN)