Test report: **Machinery capability investigation from industry screwdriver**

C. & E. FEIN GmbH
Schwäbisch Gmünd
Hans-Fein-Str. 81, D-73529 Schwäbisch Gmünd-Bargau

Maschine typ	Angle head screwdriver	**Date**	30.05.2017
Model variant	ASW 18-12 / PC		
Manufactorer	C.&E. Fein GmbH		
Development No.	7021		
Stage of development	Series		
MCI - Typ	Homologation		
Number of steps	1-step	**Test bench - ID**	100021008

Screw connection class	2
Fitting tolerance	10,0%

1	**2**	3	4	5	6
5,0%	**10,0%**	12,0%	15,0%	20,0%	25,0%

Torque range	M_{min} =	3,00	Nm		M_{max} =	12,00	Nm
Idle speed	n =	430	min^{-1}	**Weight incl. Battery**	m =	1,45	kg
Battery voltage	U =	18,0	V	**Sound pressure level**	L_{pA} =	<81	dB(A)
Battery capacity	Q =	2500	mAh	**Undervoltage detection**		☑	

Torque range investigation : **Testing maschine :** 3 **Stück**

	30%	→ M30%	= Mmin + 30% x (Mmax -Mmin) =	5,70	Nm
	80%	→ M80%	= Mmin + 80% x (Mmax -Mmin) =	10,20	Nm
Mmax =	100%	→ M100%	= Mmin + 100% x (Mmax -Mmin) =	12,00	Nm

Information on all 3 test items

Load level		30%		80%		100%	
Test torque	M_d =	5,70		10,20		12,00	
Joints		hard	soft	hard	soft	hard	soft
		30°	360°	30°	360°	30°	360°
$c_{m\,min}$ =		2,923	3,800	3,036	3,119	2,740	3,306
$c_{mk\,min}$ =		2,590	3,327	2,553	2,847	2,518	2,954

		Name :	**Date :**
Carried out by	:	Mück	30.05.2017
Test report prepared by	:	Mück	04.07.2017

Appendix documentation and presentation of data

30.05.2017

A1 General information on the test item 1

Manufactorer :	**C.&E. Fein GmbH**	**Model:**	**18-12 / PC**	**Ident-No. :**	**2017-05.014387**
Modell variant:	**ASW**	**begin:**	09:00	**Serial-No. :**	**7021**
		end:	11:00		

Torque range from M_{min} =	3,00	Nm		to M_{max} =	12,00	Nm
Weight incl. Battery :	1,450	kg	Sound pressure level :		<81	dB(A)
Battery voltage :	18,00	V	Undervoltage detection :		☑	
Battery capacity :	2500	mAh	Idle speed :		430	min^{-1}

Number of screwed connections with battery at 100% rated power		
Turn rate low (soft) :	560	LC
Turn rate high (hard) :	1005	LC

Temperature measurement for power tools at 80% rated power 360° soft joint				
	beginn:		end:	
On the handle :	27,2	°C	35,1	°C

A2 General information test equipment and test conditions

Description of test equipment, design and function:

Schatz cerTest 2.5 5413-5392/303

Brake 10 Nm	Brake 50 Nm	3
ASM firmly and positively clamped		
2 sec. wait between two load changes		

Measurability test	No.:	V-49199	Date: 04.04.2017
Certificate according to VDI/VDE 2646		V-49200	Date: 04.04.2017

A3.1 Data per test item

Torque-range	from M_{min} =	3,00	Nm	to M_{max} =	12,00	Nm
Test torque 30%	$M_{30\%}$ =	5,70	Nm			
Test torque 80%	$M_{80\%}$ =	10,20	Nm			
Test torque 100%	$M_{100\%}$ =	12,00	Nm			
Fitting tolerance 2	in % ±	10,0%				

Load level		30%		80%		100%		
Test torque	M_d =	5,70		10,20		12,00		Nm
Joints		hard 30°	soft 360°	hard 30°	soft 360°	hard 30°	soft 360°	
Tolerance : Upper limit :	$M_{zul\ max}$ =	6,27		11,22		13,20		Nm
Tolerance : Lower limit :	$M_{zul\ min}$ =	5,13		9,18		10,80		Nm
Medium torque :	M_q =	5,72	5,63	10,15	10,11	12,10	11,87	Nm
Standard deviation :	s =	0,06	0,05	0,11	0,11	0,15	0,11	Nm
6s torque scattering :	$6s/M_q$ =	6,19%	5,33%	6,62%	6,47%	7,24%	5,66%	
Ability index :	c_m =	3,22	3,80	3,04	3,12	2,74	3,57	
Ability index :	c_{mk} =	3,11	3,33	2,90	2,85	2,52	3,19	
Mean speed :	n =	423	441	383	383	374	382	min^{-1}

Appendix documentation and presentation of data

30.05.2017

A1 General information on the test item 2

Manufactorer :	**C.&E. Fein GmbH**	**Model:**	**18-12 / PC**	**Ident-No. :**	**2017-05.014394**
Modell variant:	**ASW**	**begin:**	11:00	**Serial-No. :**	**7021**
		end:	13:00		

Torque range from M_{min} =	3,00	Nm		to M_{max} =	12,00	Nm
Weight incl. Battery :	1,450	kg	Sound pressure level :		<81	dB(A)
Battery voltage :	18,00	V	Undervoltage detection :		☑	
Battery capacity :	2500	mAh	Idle speed :		430	min^{-1}

Number of screwed connections with battery at 100% rated power		
Turn rate low (soft) :	560	LC
Turn rate high (hard) :	1005	LC

Temperature measurement for power tools at 80% rated power 360° soft joint				
	beginn:		end:	
On the handle :	27,2	°C	35,1	°C

A2 General information test equipment and test conditions

Description of test equipment, design and function:

Schatz cerTest 2.5 5413-5392/303

Brake 10 Nm	Brake 50 Nm
ASM firmly and positively clamped	
2 sec. wait between two load changes	

Measurability test	No.:	V-49199	Date: 04.04.2017
Certificate according to VDI/VDE 2646		V-49200	Date: 04.04.2017

A3.1 Data per test item

Torque-range	from M_{min} =	3,00	Nm	to M_{max} =	12,00	Nm
Test torque 30%	$M_{30\%}$ =	5,70	Nm			
Test torque 80%	$M_{80\%}$ =	10,20	Nm			
Test torque 100%	$M_{100\%}$ =	12,00	Nm			
Fitting tolerance 2	in % ±	10,0%				

Load level		30%		80%		100%		
Test torque	M_d =	5,70		10,20		12,00		Nm
Joints		hard 30°	soft 360°	hard 30°	soft 360°	hard 30°	soft 360°	
Tolerance : Upper limit :	$M_{zul\ max}$ =	6,27		11,22		13,20		Nm
Tolerance : Lower limit :	$M_{zul\ min}$ =	5,13		9,18		10,80		Nm
Medium torque :	M_q =	5,72	5,67	10,30	10,11	12,16	11,90	Nm
Standard deviation :	s =	0,06	0,04	0,11	0,10	0,13	0,12	Nm
6s torque scattering :	$6s/M_q$ =	5,77%	4,65%	6,24%	5,76%	6,22%	6,10%	
Ability index :	c_m =	3,45	4,32	3,18	3,51	3,17	3,18	
Ability index :	c_{mk} =	3,36	4,11	2,88	3,19	2,74	3,53	
Mean speed :	n =	408	410	380	379	377	375	min^{-1}

Appendix documentation and presentation of data

30.05.2017

A1 General information on the test item 3

Manufactorer :	**C.&E. Fein GmbH**	**Model:**	**18-12 / PC**	**Ident-No. :**	**2017-05.014385**
Modell variant:	**ASW**	**begin:**	13:00	**Serial-No. :**	**7021**
		end:	16:00		

Torque range from M_{min} =	3,00	Nm		to M_{max} =	12,00	Nm
Weight incl. Battery :	1,450	kg	Sound pressure level :		<81	dB(A)
Battery voltage :	18,00	V	Undervoltage detection :		☑	
Battery capacity :	2500	mAh	Idle speed :		430	min^{-1}

Number of screwed connections with battery at 100% rated power		
Turn rate low (soft) :	560	LC
Turn rate high (hard) :	1005	LC

Temperature measurement for power tools at 80% rated power 360° soft joint				
	beginn:		end:	
On the handle :	27,2	°C	35,1	°C

A2 General information test equipment and test conditions

Description of test equipment, design and function:

Schatz cerTest 2.5 5413-5392/303

Brake 10 Nm	Brake 50 Nm
ASM firmly and positively clamped	
2 sec. wait between two load changes	

Measurability test	No.:	V-49199	Date: 04.04.2017
Certificate according to VDI/VDE 2646		V-49200	Date: 04.04.2017

A3.1 Data per test item

Torque-range	from M_{min} =	3,00	Nm	to M_{max} =	12,00	Nm
Test torque 30%	$M_{30\%}$ =	5,70	Nm			
Test torque 80%	$M_{80\%}$ =	10,20	Nm			
Test torque 100%	$M_{100\%}$ =	12,00	Nm			
Fitting tolerance 2	in % ±	10,0%				

Load level		30%		80%		100%		
Test torque	M_d =	5,70		10,20		12,00		Nm
Joints		hard 30°	soft 360°	hard 30°	soft 360°	hard 30°	soft 360°	
Tolerance : Upper limit :	$M_{zul\ max}$ =	6,27		11,22		13,20		Nm
Tolerance : Lower limit :	$M_{zul\ min}$ =	5,13		9,18		10,80		Nm
Medium torque :	M_q =	5,77	5,61	10,37	10,06	12,00	11,84	Nm
Standard deviation :	s =	0,07	0,05	0,11	0,09	0,12	0,12	Nm
6s torque scattering :	$6s/M_q$ =	6,76%	4,82%	6,42%	5,19%	5,95%	5,93%	
Ability index :	c_m =	2,92	4,22	3,06	3,91	3,36	3,42	
Ability index :	c_{mk} =	2,59	3,53	2,55	3,37	3,35	2,95	
Mean speed :	n =	429	442	381	379	378	384	min^{-1}

Testbench Measuring

MCS for FEIN-Project : 7021 | **Homologation** | Date: 30.05.2017

f_{mess} = 300 Hz | M_{min} | M_{max}

ASW 18-12 / PC | ScrewdriverType ASW | Accuracy-Class 10,0% | Class : 2 | M_{range} = 3,00 up to 12,00 Nm

Variant : 18-12 / PC | n_{given} = 430 rpm | U = 18,00 V

cycles: 100

MCSs	M_d [Nm]	Angle [°]	M_q [Nm]	$\Delta M_{q\,1/2}$ [Nm]	s [Nm]	c_m [1]	c_{mk} [1]	n [min^{-1}]			Remarks
1	5,70	360°	5,629	0,090	0,050	3,800	3,327	441	2017-05.014387	30%	
1	5,70	30°	5,719		0,059	3,220	3,113	423			
1	10,20	360°	10,111	0,042	0,109	3,119	2,847	383		80%	
1	10,20	30°	10,153		0,112	3,036	2,896	383			
1	12,00	360°	11,872	0,225	0,112	3,571	3,190	382		100%	
1	12,00	30°	12,097		0,146	2,740	2,518	374			
2	5,70	360°	5,672	0,044	0,044	4,318	4,106	410	2017-05.014394	30%	
2	5,70	30°	5,716		0,055	3,455	3,358	408			
2	10,20	360°	10,107	0,188	0,097	3,505	3,186	379		80%	
2	10,20	30°	10,295		0,107	3,178	2,882	380			
2	12,00	360°	11,896	0,268	0,121	3,306	3,019	375		100%	
2	12,00	30°	12,164		0,126	3,175	2,741	377			
3	5,70	360°	5,607	0,158	0,045	4,222	3,533	442	2017-05.014385	30%	
3	5,70	30°	5,765		0,065	2,923	2,590	429			
3	10,20	360°	10,060	0,310	0,087	3,908	3,372	379		80%	
3	10,20	30°	10,370		0,111	3,063	2,553	381			
3	12,00	360°	11,837	0,159	0,117	3,419	2,954	384		100%	
3	12,00	30°	11,996		0,119	3,361	3,350	378			

Start of measurement: 09:00

End of measurement: 16:00

Homologation : 3 Machines out of a series, each 30%, 80% and 100% the torque-ranges.
Waitingtime between Load changes 2 sec.
Series of measurement per machine, Nominal Torque and Screwinghardness each 100 Load changes (LW).

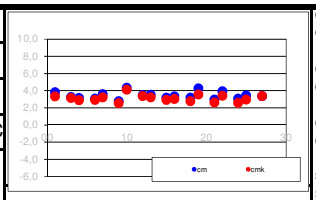
Measurment based on VDI 2647 February 2013

$c_{m\ min}$ = 2,740	$c_{m\ q}$ = 3,407	$c_{m\ max}$ = 4,318	s_{cm} = 0,416
$c_{mk\,min}$ = 2,518	$c_{mk\ q}$ = 3,085	$c_{mk\ max}$ = 4,106	n_{MFU} = 18

Name: Mück | Project: 7021 : ASW 18-12 / PC

C. & E. FEIN GmbH
Schwäbisch Gmünd

Stage of Development : Series



$c_{m\ min}$ = c_m - Minimum Value
$c_{mk\ min}$ = c_m - Minimum Value
c_m - Minimum Value
$c_{m\ q}$ = c_m - Mid Value
$c_{mk\ q}$ = c_m - Mid Value
c_m - Mid Value
$c_{m\ max}$ = c_m - Maximum Value
$c_{mk\ max}$ = c_m - Maximum Value
c_m - Maximum Value
s_{cm} = c_m - Standard deviation
s_{cmk} = c_{mk} - Standard deviation
n_{MCS} = No. of Machine Capability Study (MCS)
c = correktion Value

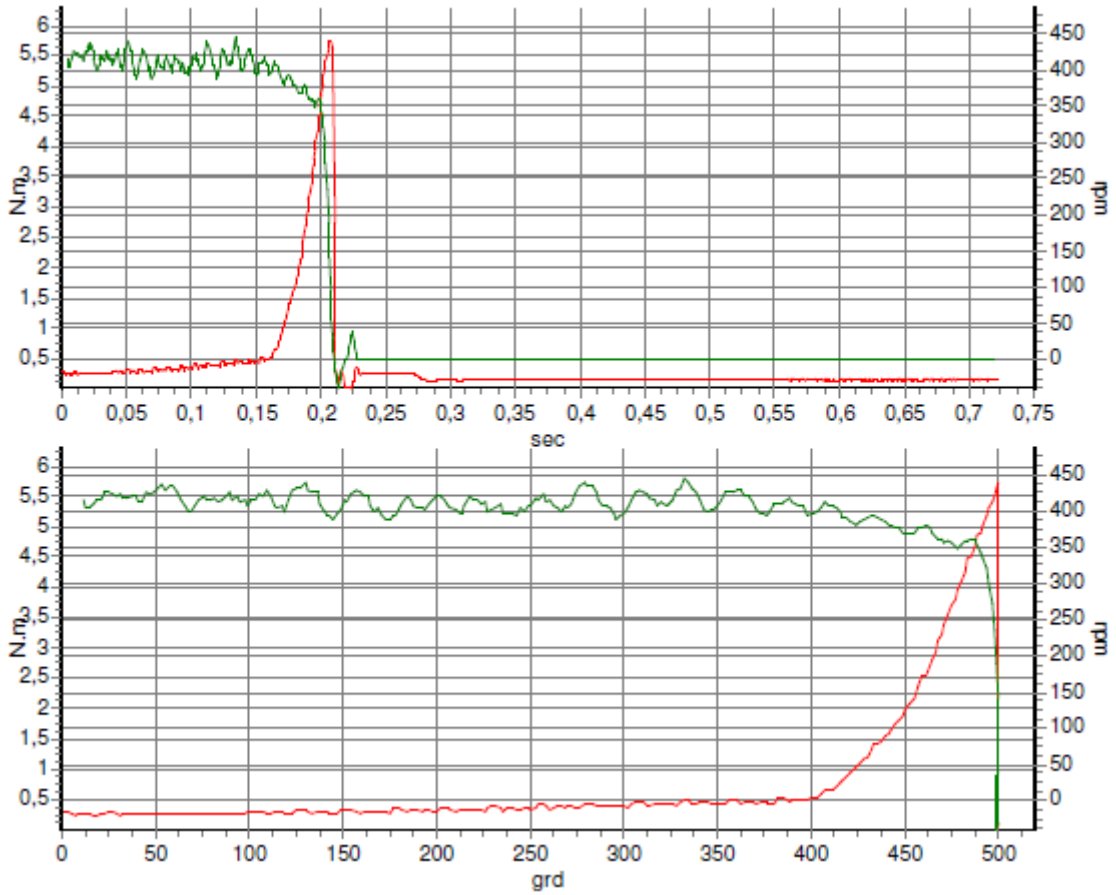


Illustration 1: 30° hard joint 5,7 Nm before load change machine 2017-05.014387

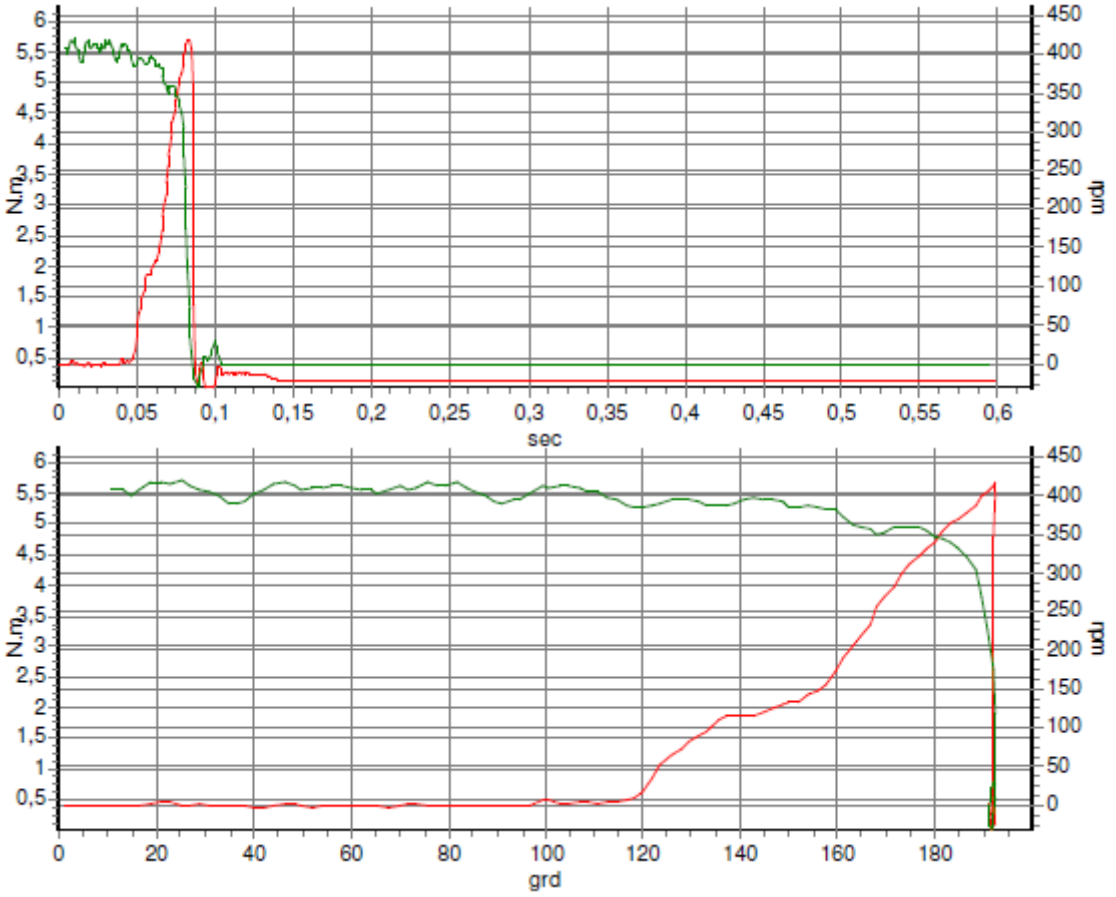


Illustration 2: 30° hard joint 5,7 Nm after load change machine 2017-05.014387

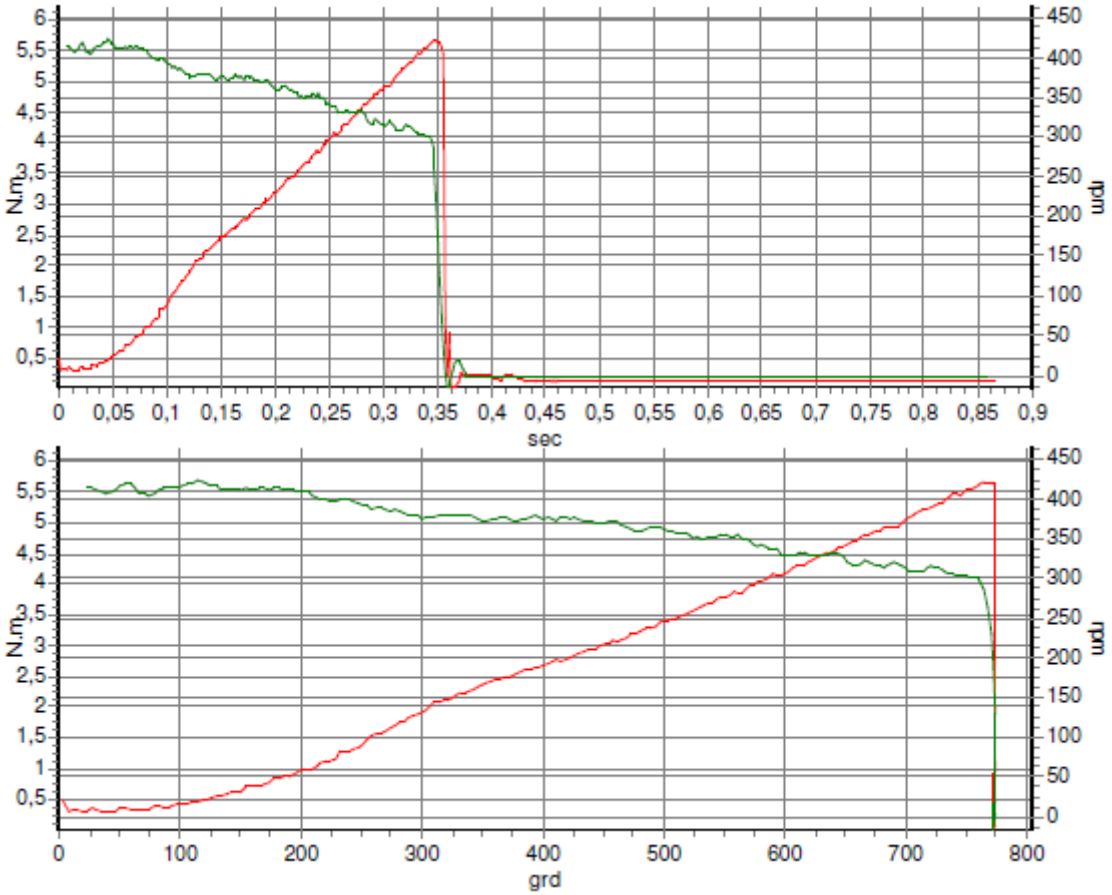


Illustration 3: 360° soft joint 5,7 Nm before load change machine 2017-05.014387

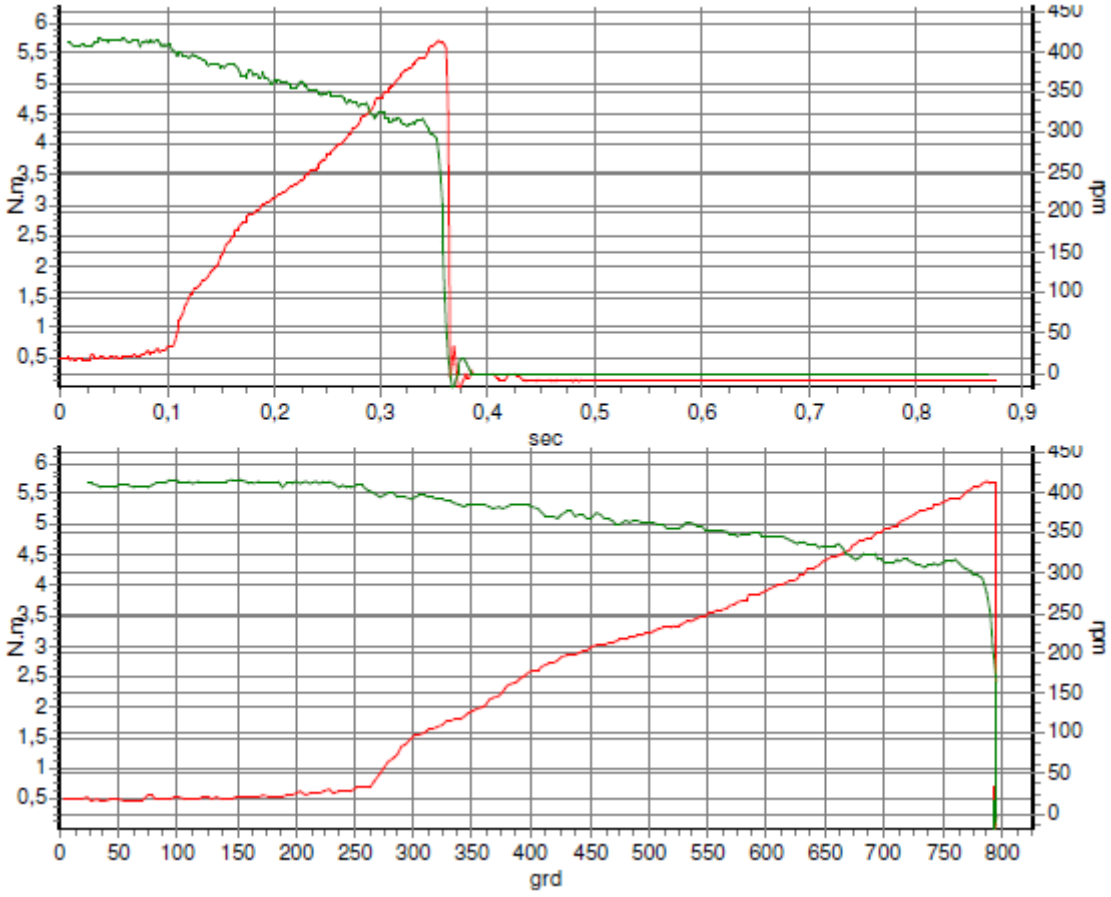


Illustration 4: 360° soft joint 5,7 Nm after Load change Machine 2017-05.014387

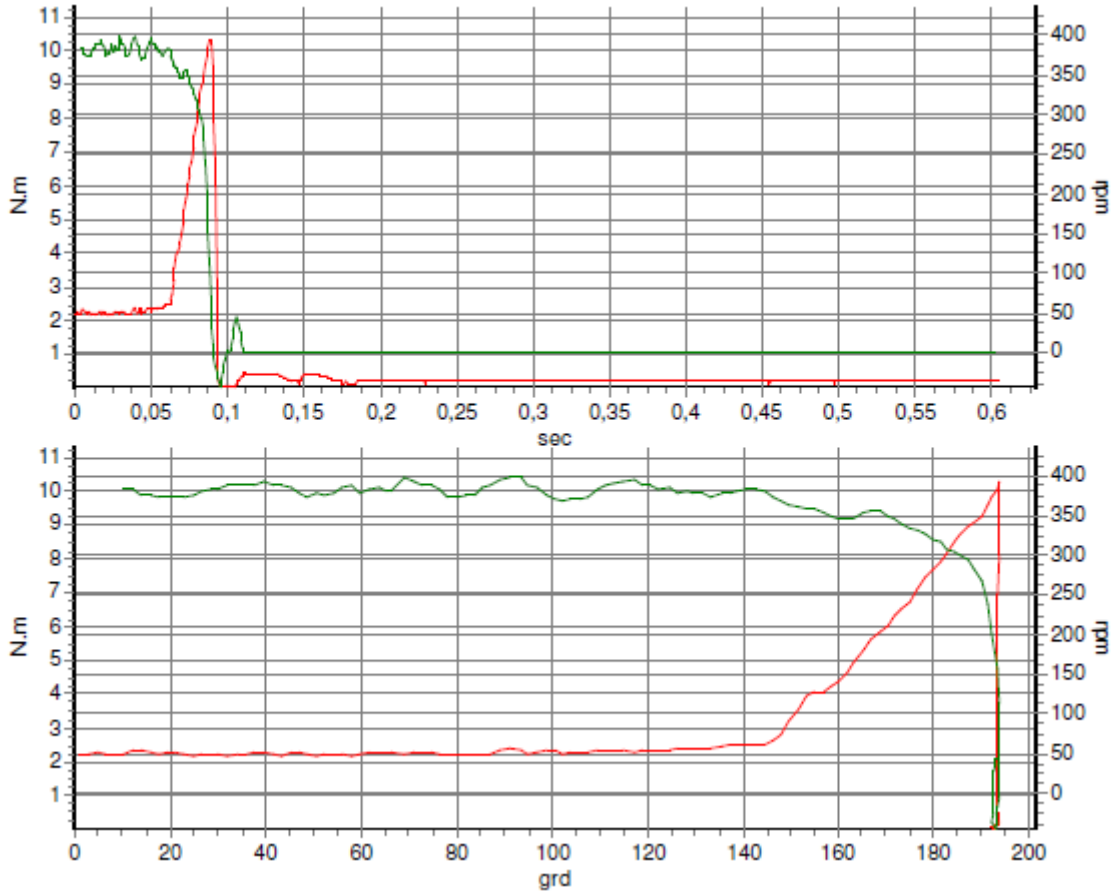


Illustration 5: 30° hard joint 10,2 Nm before Load change Machine 2017-05.014387

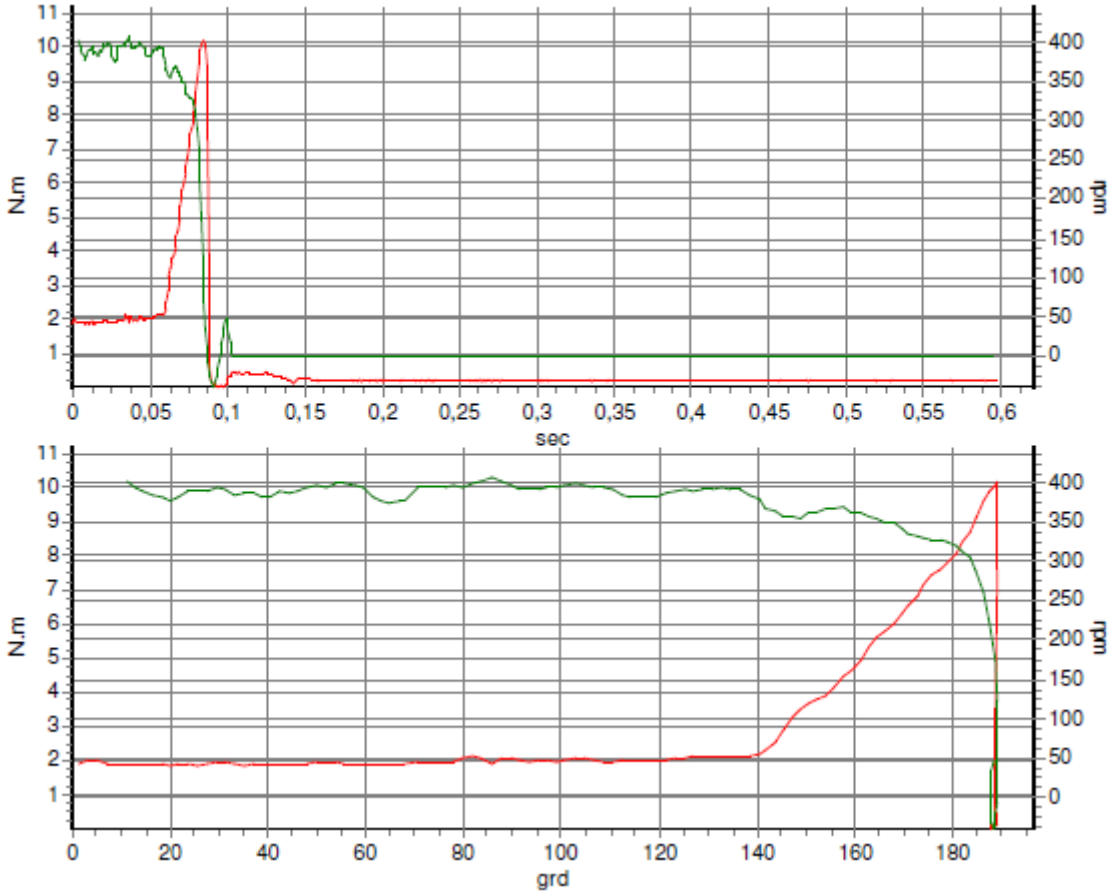


Illustration 6: 30° hard joint 10,2 Nm after Load change Machine 2017-05.014387

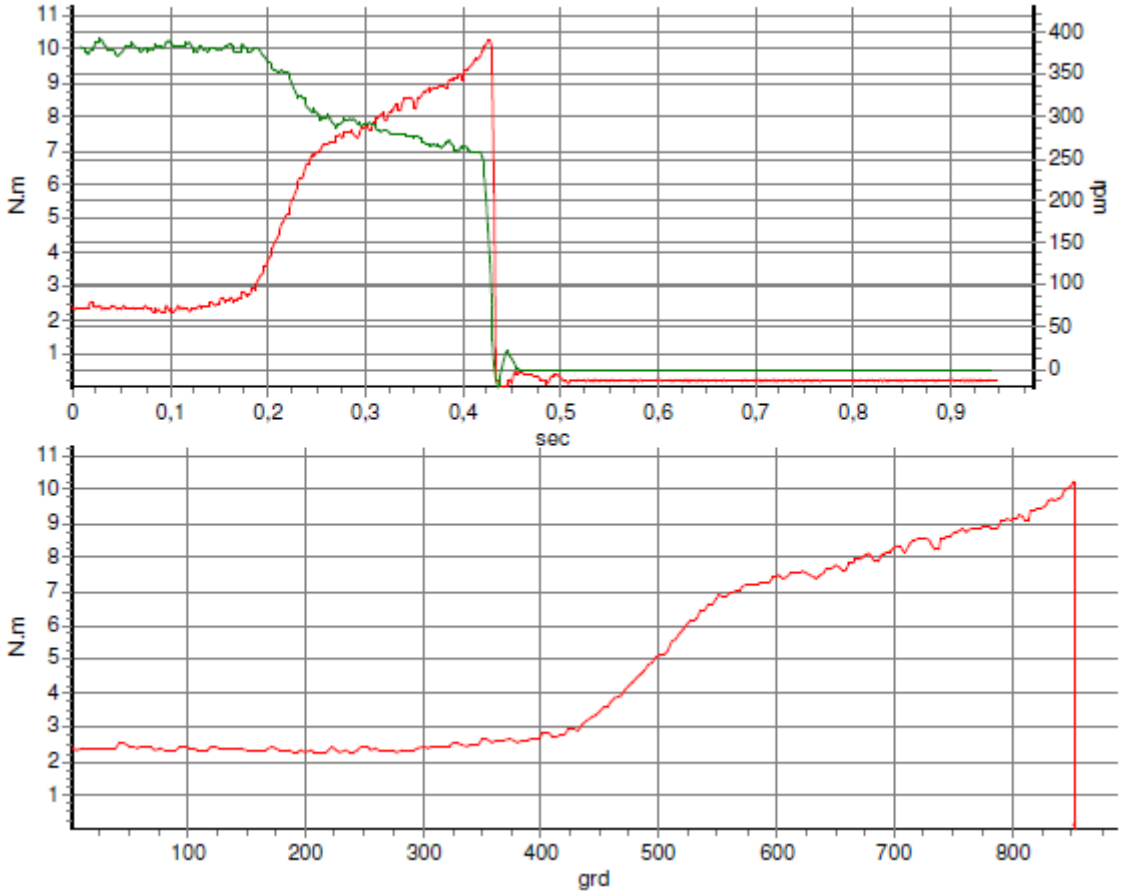


Illustration 7: 360° soft joint 10,2Nm before Load change Machine 2017-05.014387

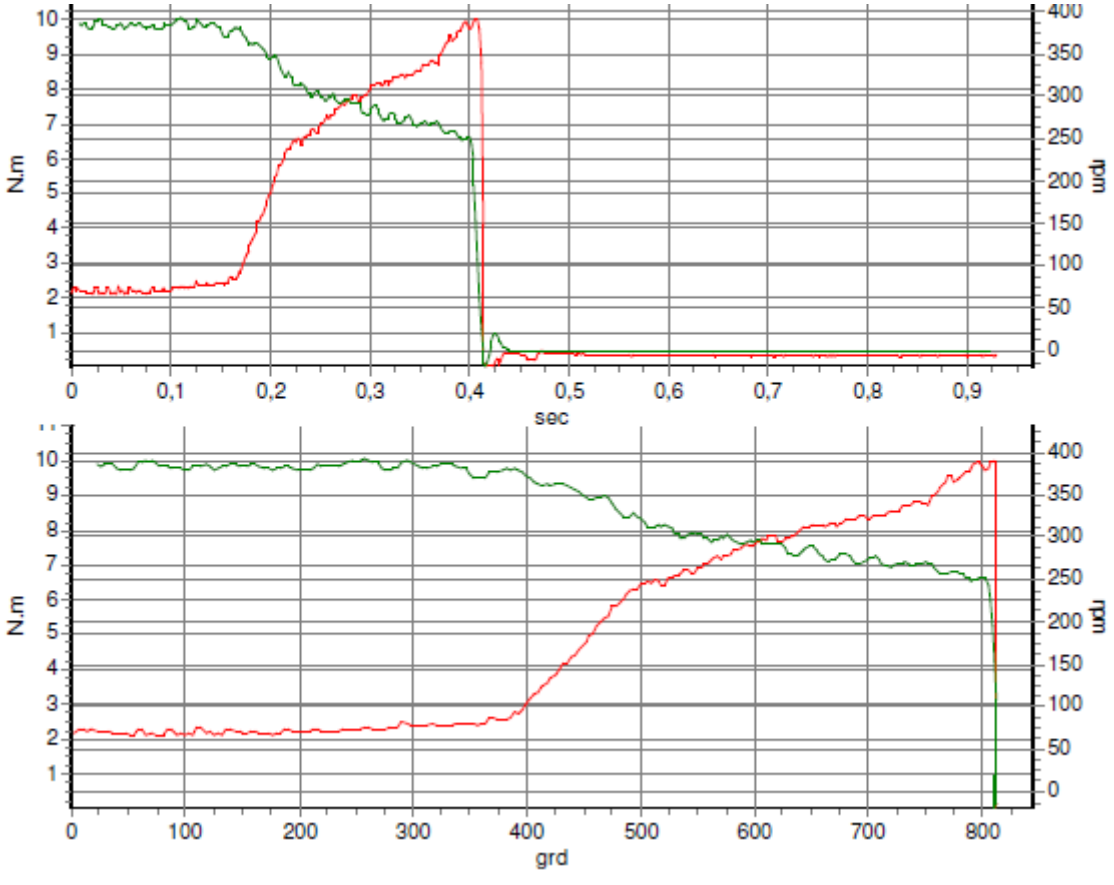


Illustration 8: 360° soft joint 10,2Nm after Load change Machine 2017-05.014387

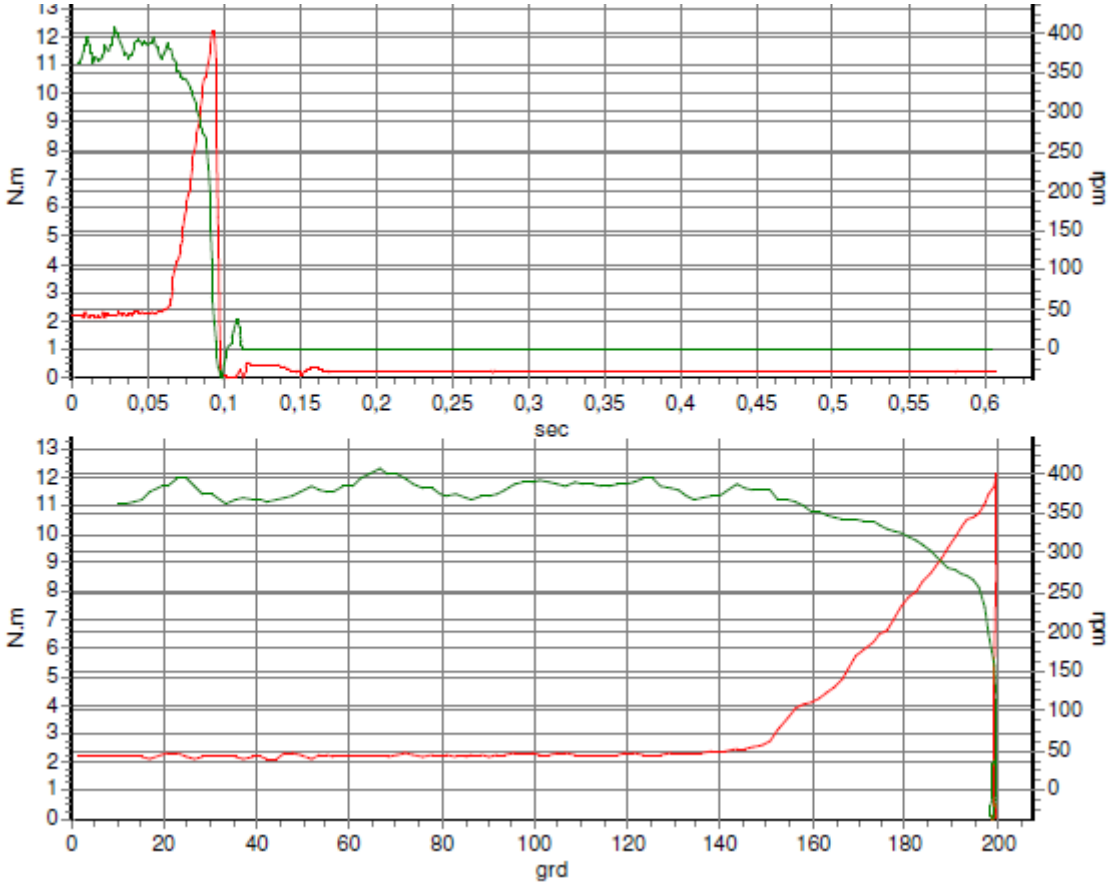


Illustration 9: 30° hard joint 12,0 Nm before Load change Machine 2017-05.014387

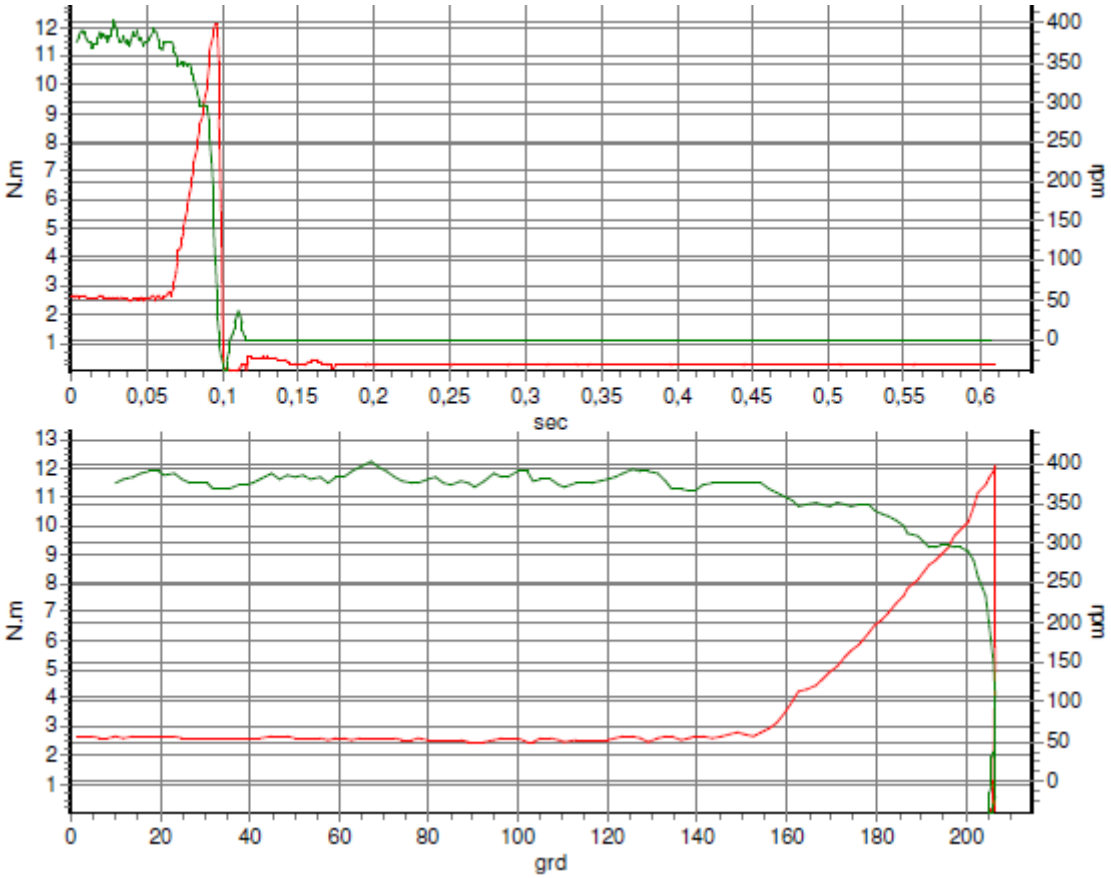


Illustration 10: 30° hard joint 12,0 Nm after Load change Machine 2017-05.014387

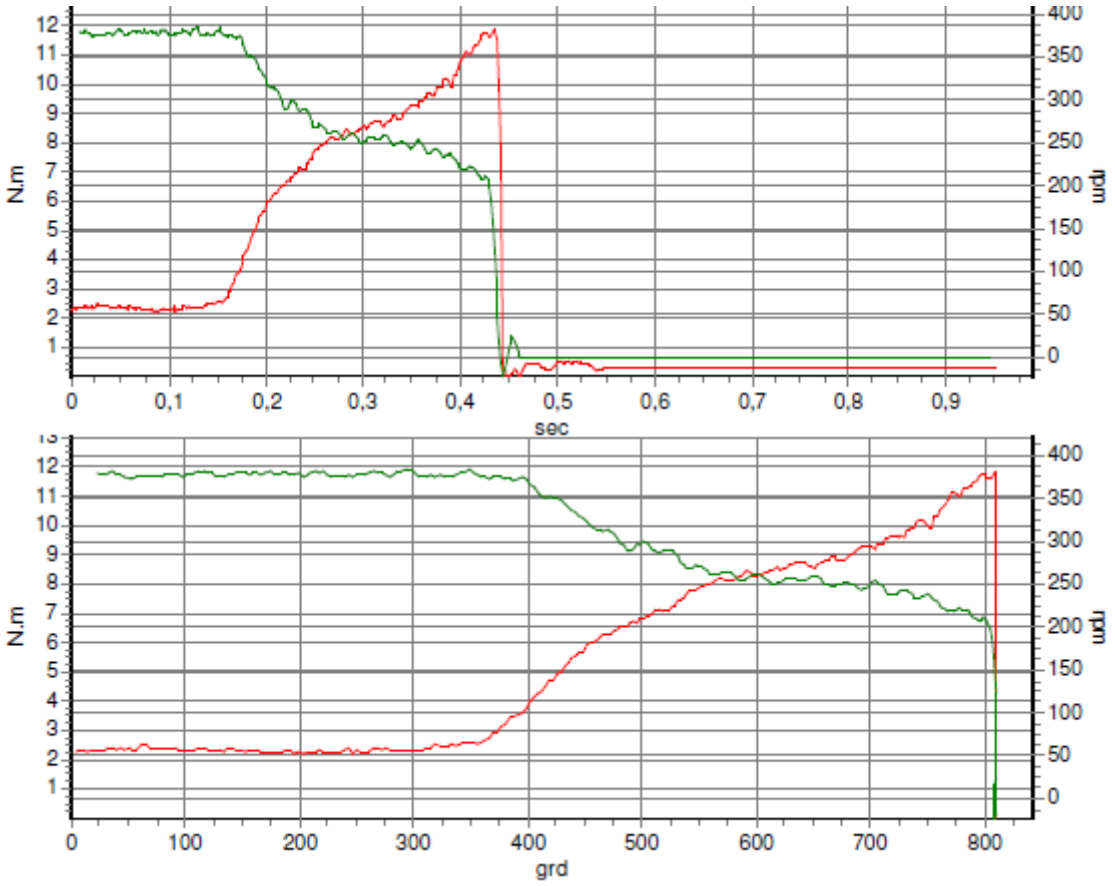


Illustration 11: 360° soft joint 12,0 Nm before Load change Machine 2017-05.014387

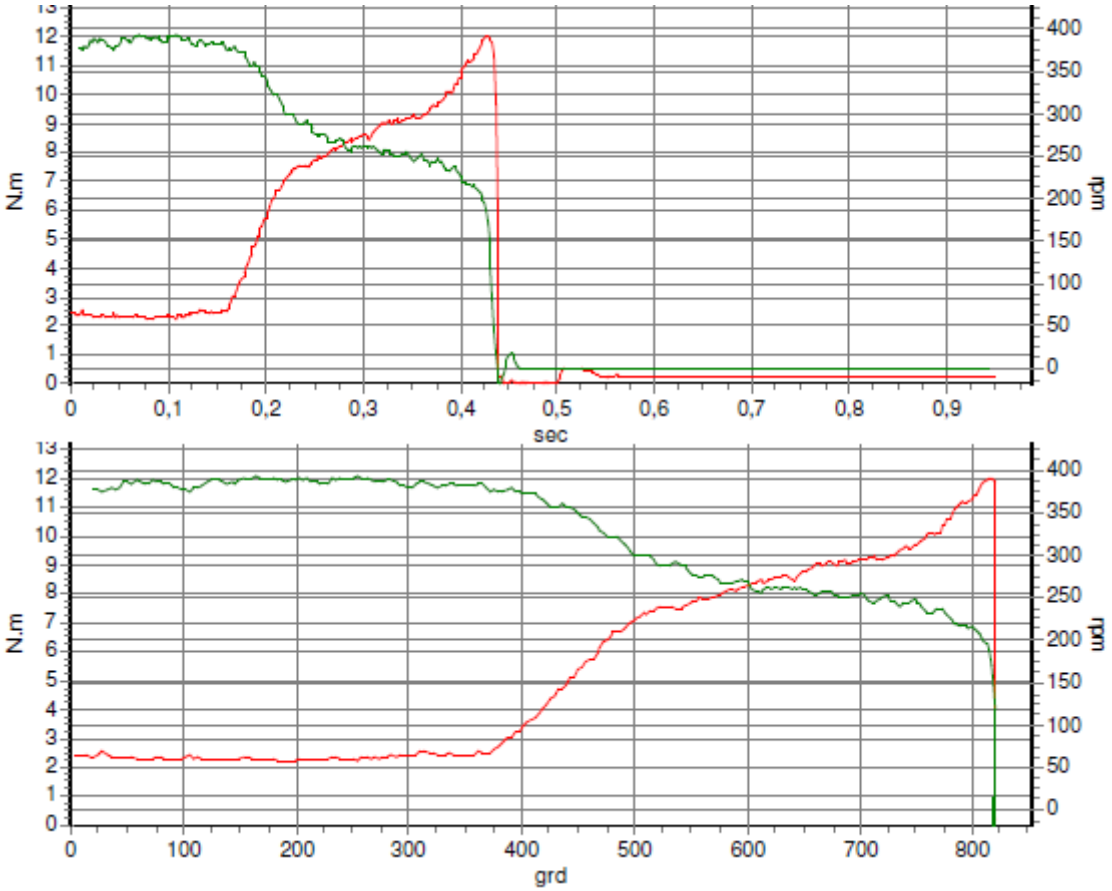


Illustration 12: 360° soft joint 12,0 Nm after load change machine 2017-05.014387

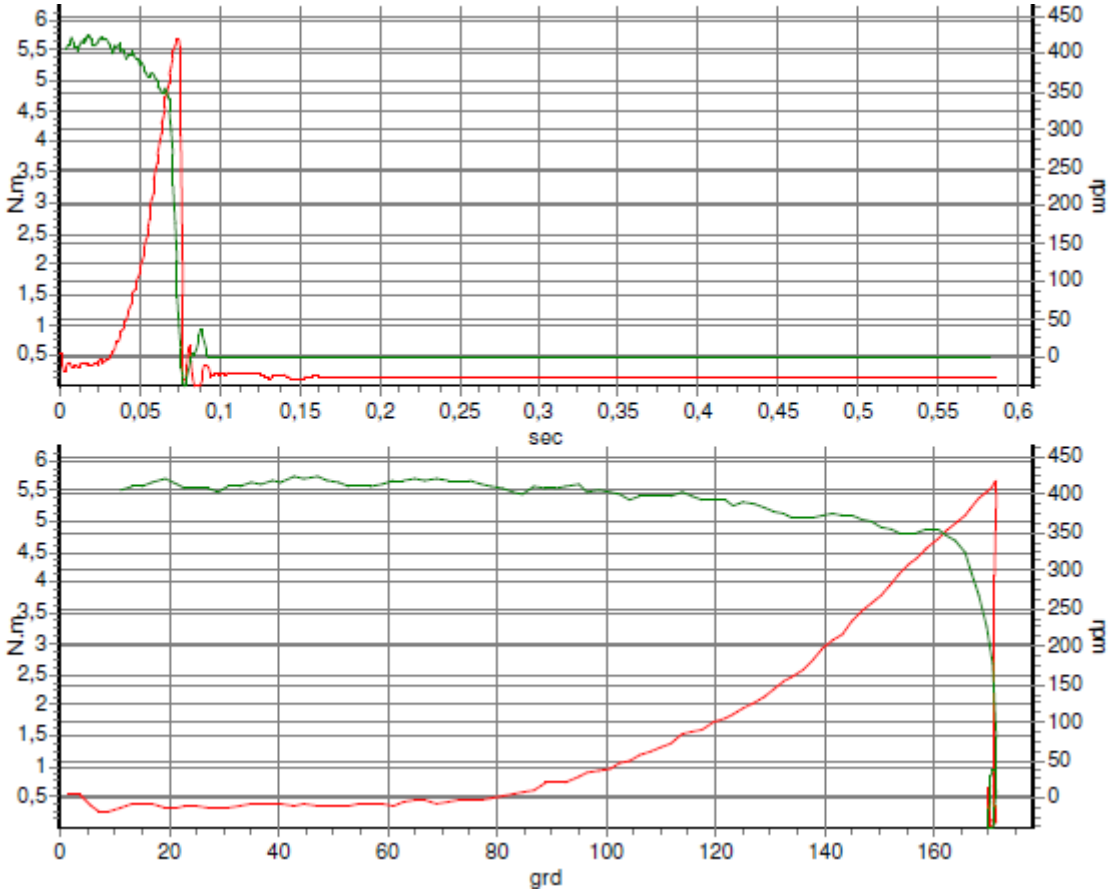


Illustration 13: 30° hard joint 5,7 Nm before load change machine 2017-05.014394

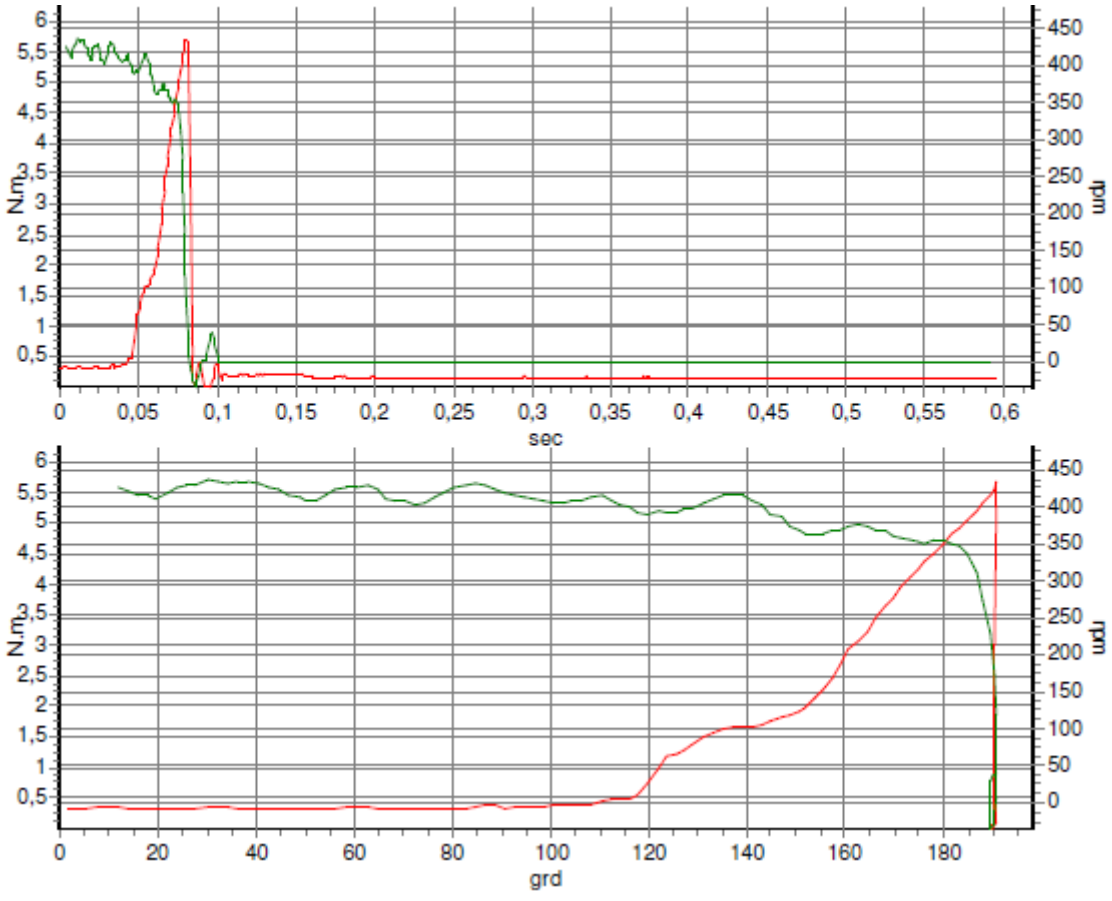


Illustration 14: 30° hard joint 5,7 Nm after load change machine 2017-05.014394

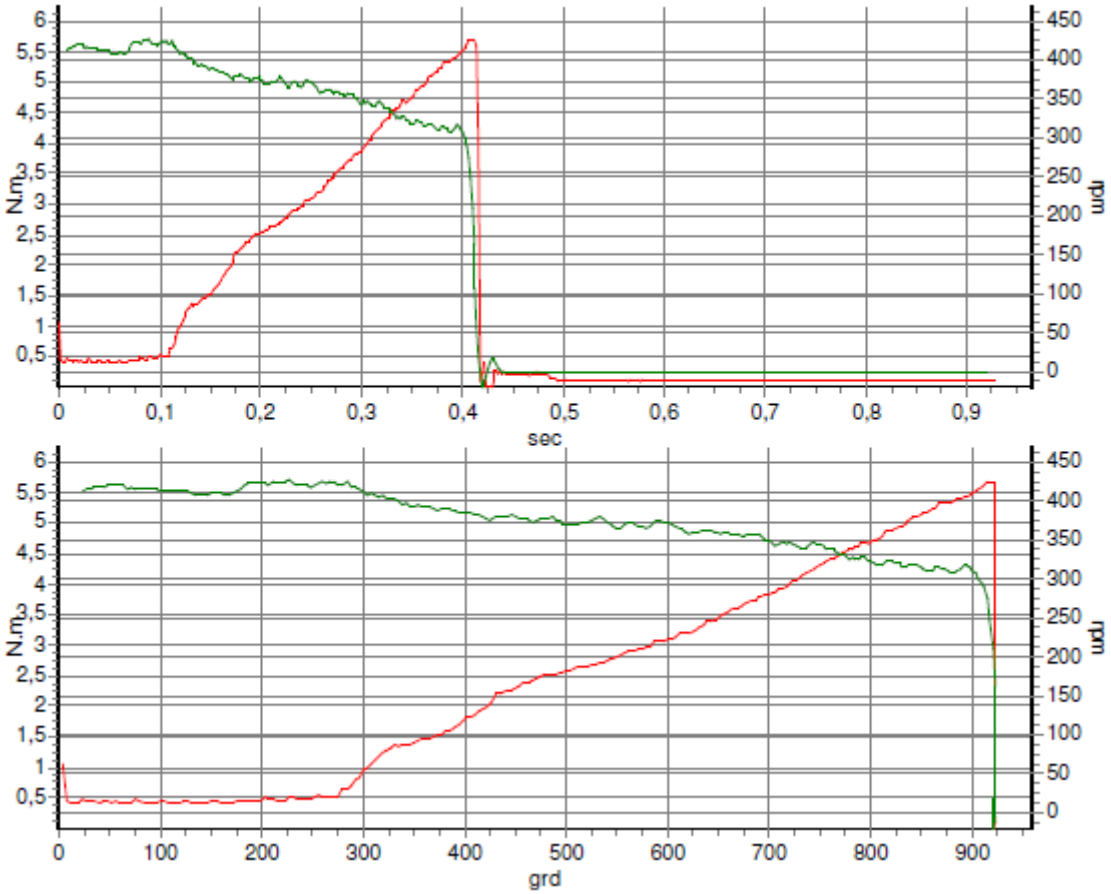


Illustration 15: 360° soft joint 5,7 Nm before load change machine 2017-05.014394

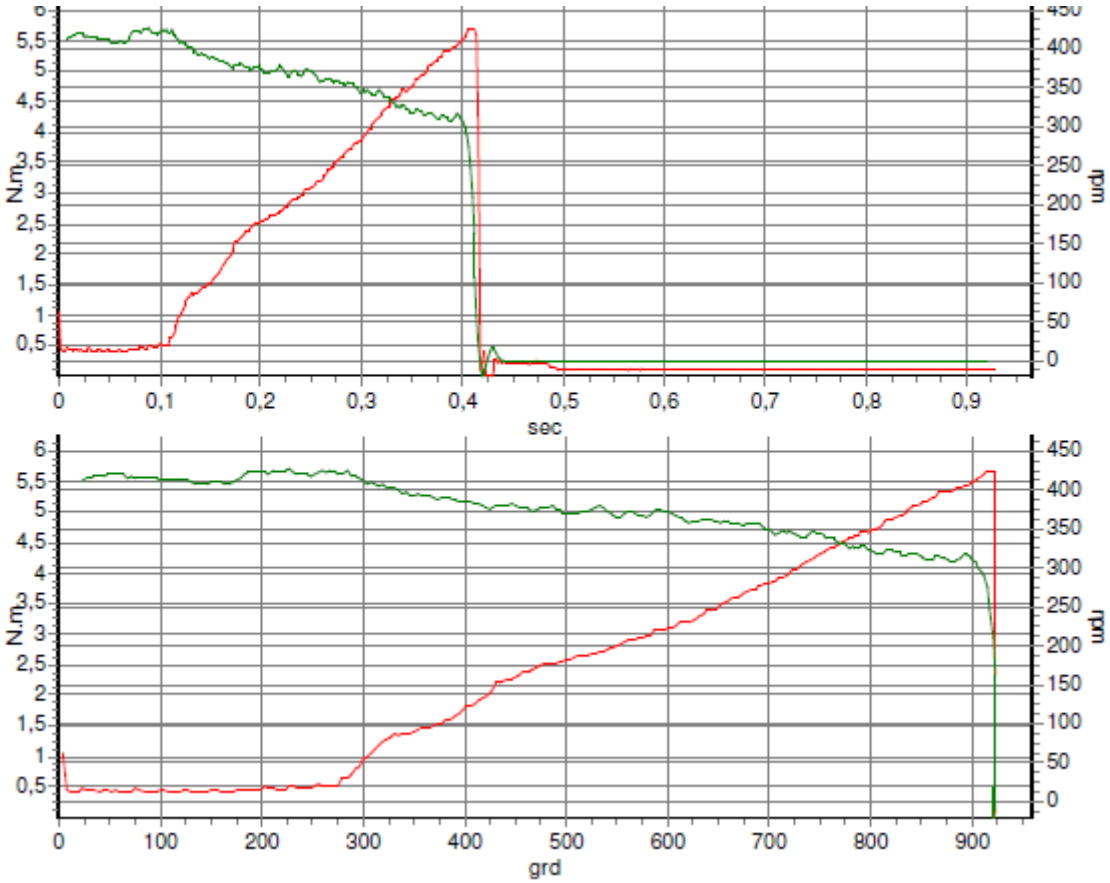


Illustration 16: 360° soft joint 5,7 Nm after load change machine 2017-05.014394

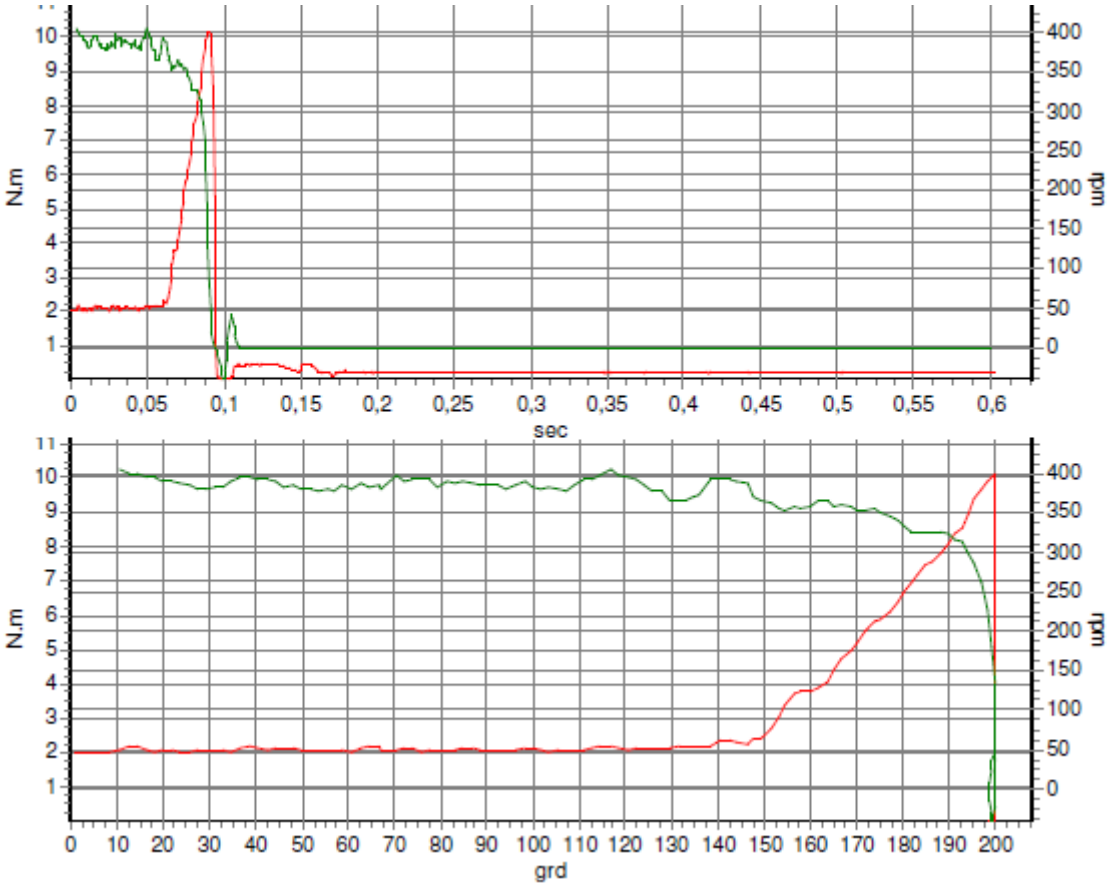


Illustration 17: 30° hard joint 10,2 Nm before load change machine 2017-05.014394

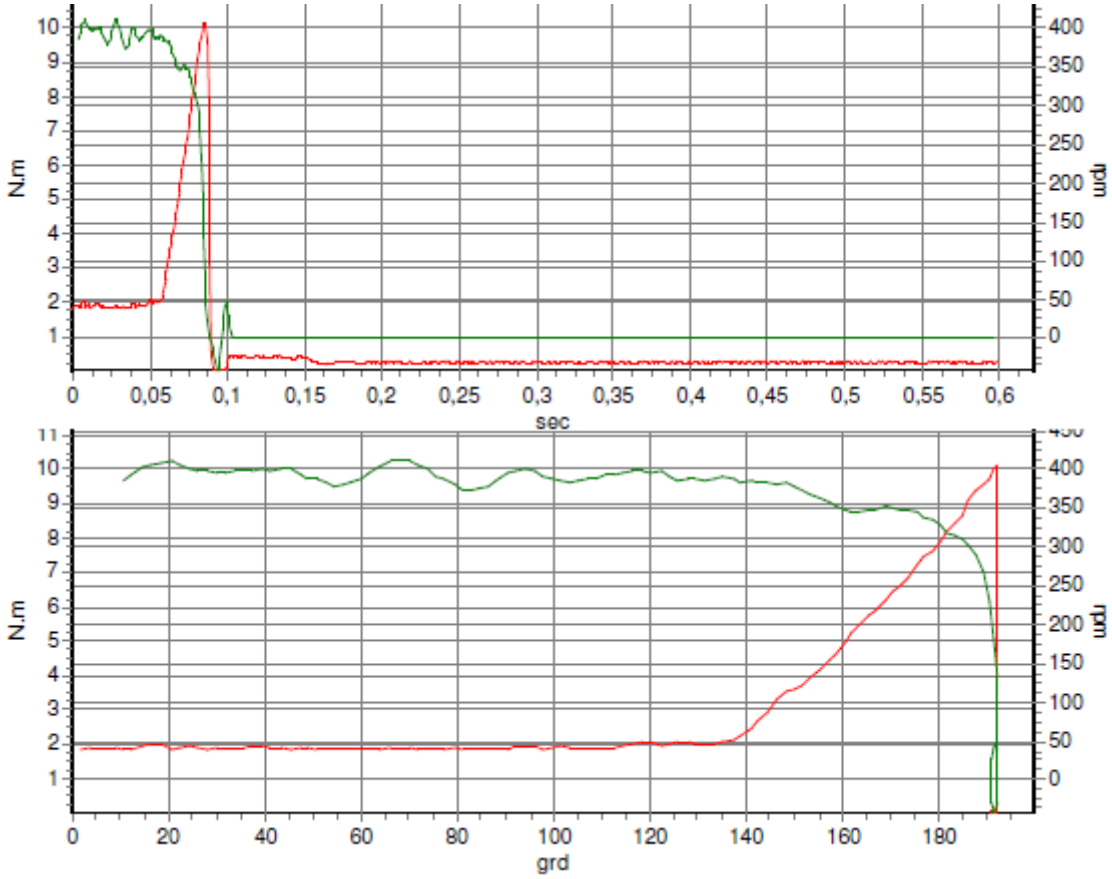


Illustration 18: 30° hard joint 10,2 Nm after load change machine 2017-05.014394

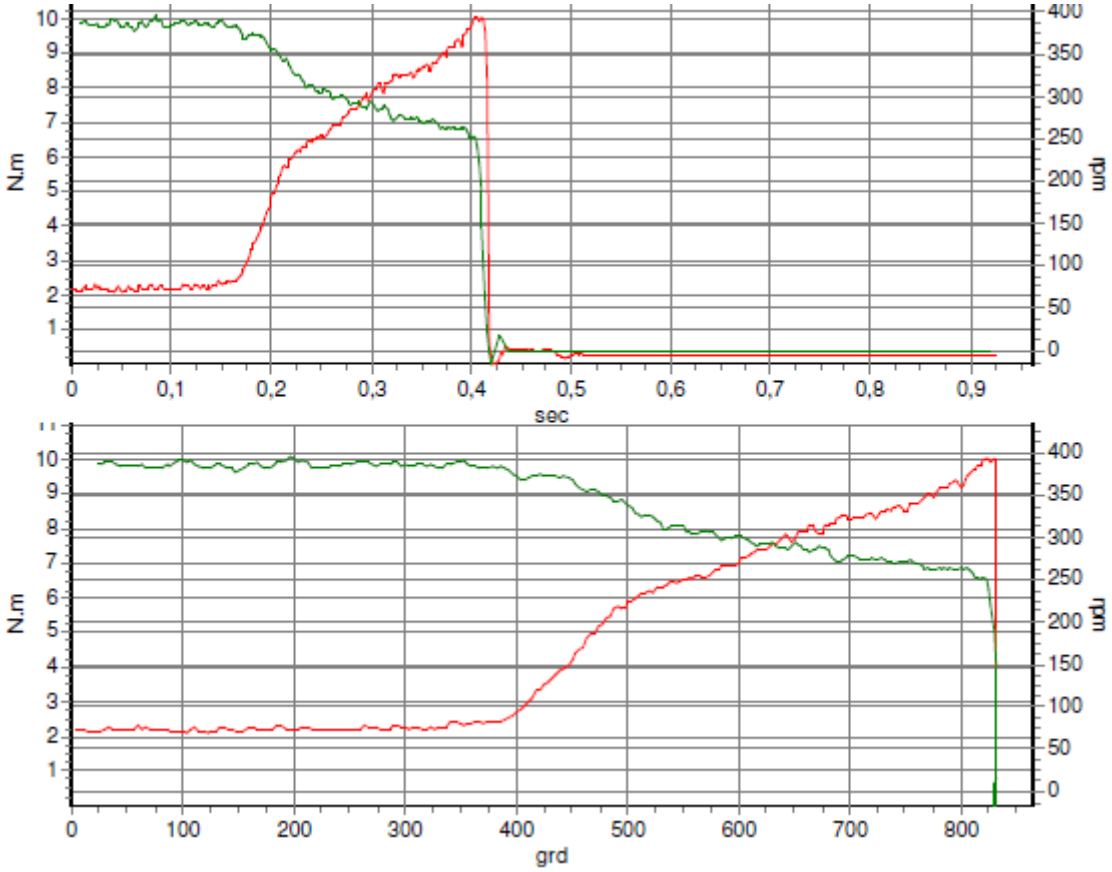


Illustration 19: 360° soft joint 10,2 Nm before load change machine 2017-05.014394

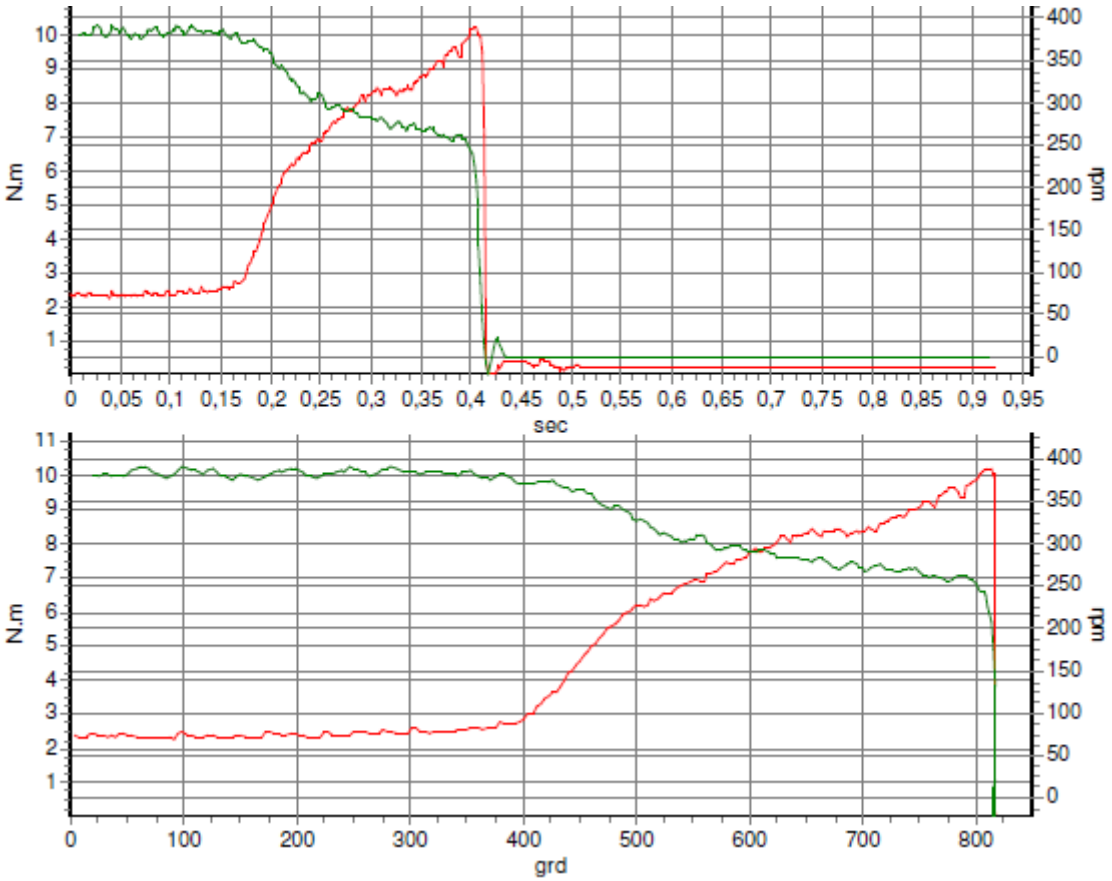


Illustration 20: 360° soft joint 10,2 Nm after load change machine 2017-05.014394

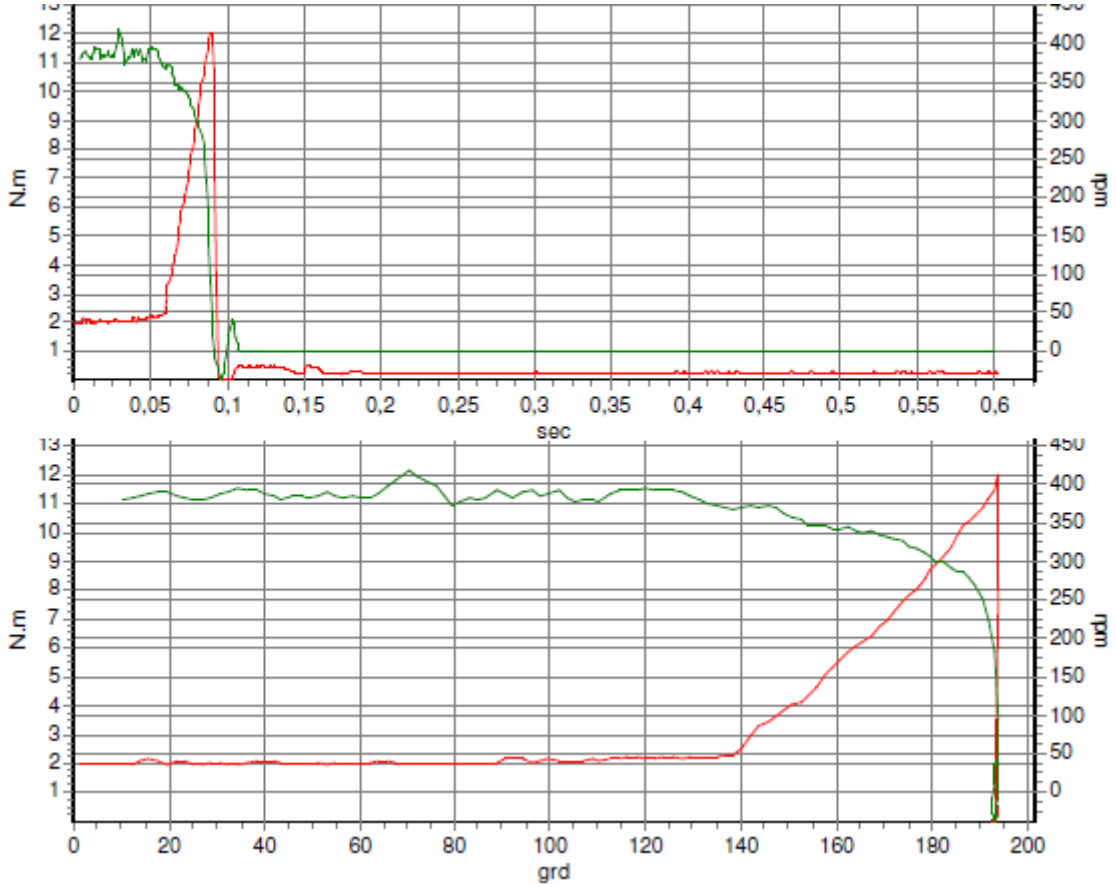


Illustration 21: 30° hard joint 12,0 Nm before load change machine 2017-05.014394

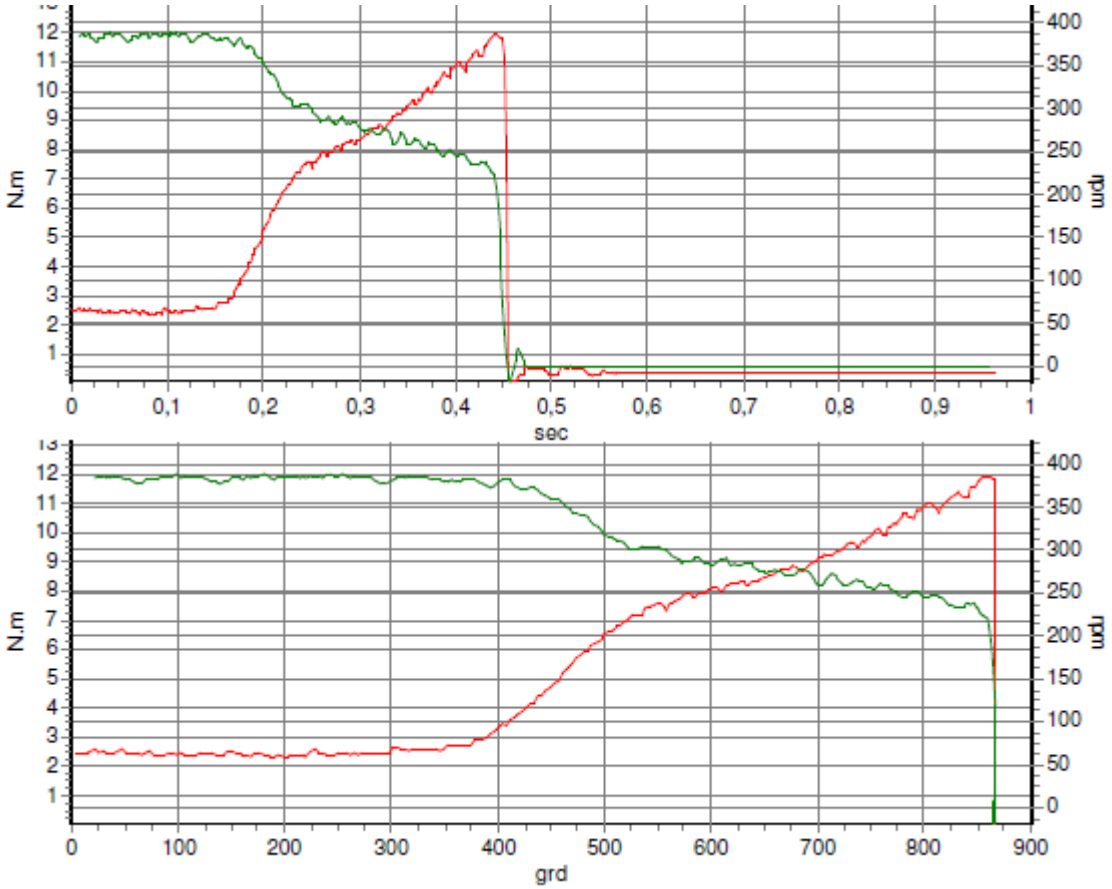


Illustration 22: 30° hard joint 12,0 Nm after load change machine 2017-05.014394

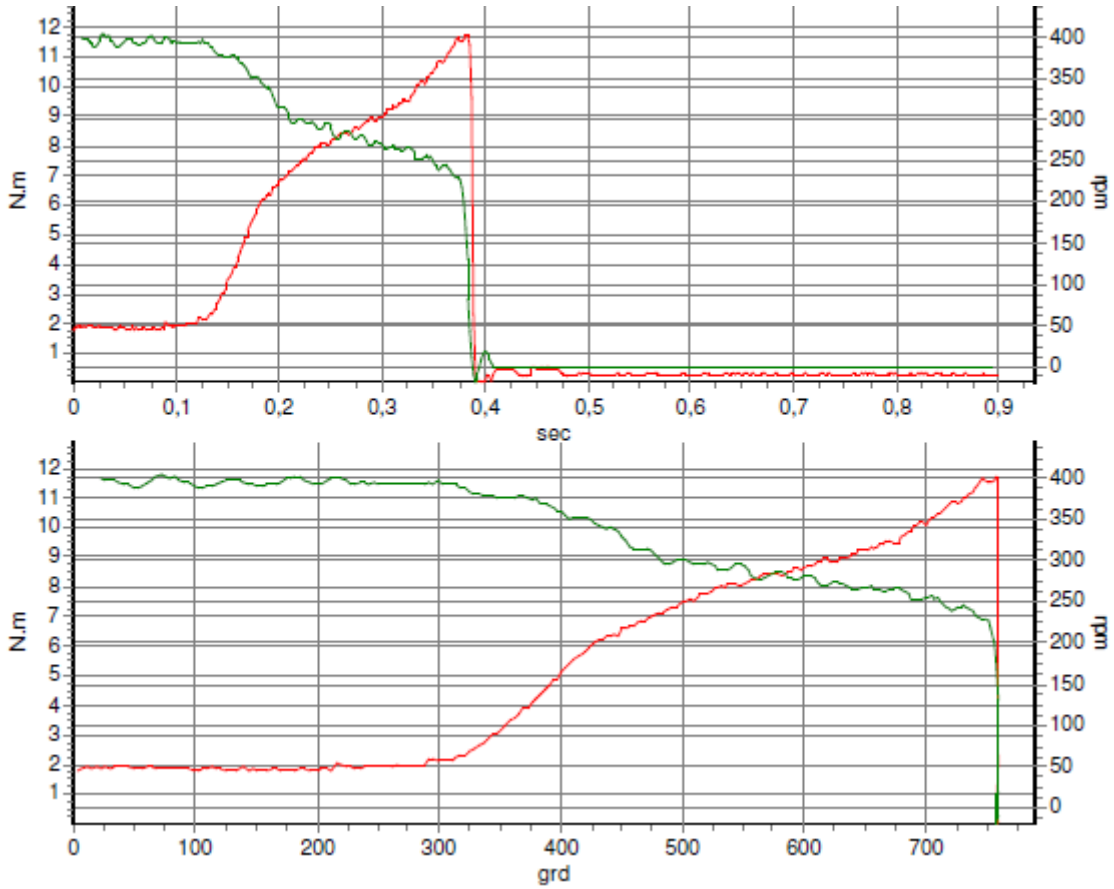


Illustration 23: 360° soft joint 12,0 Nm before load change machine 2017-05.014394

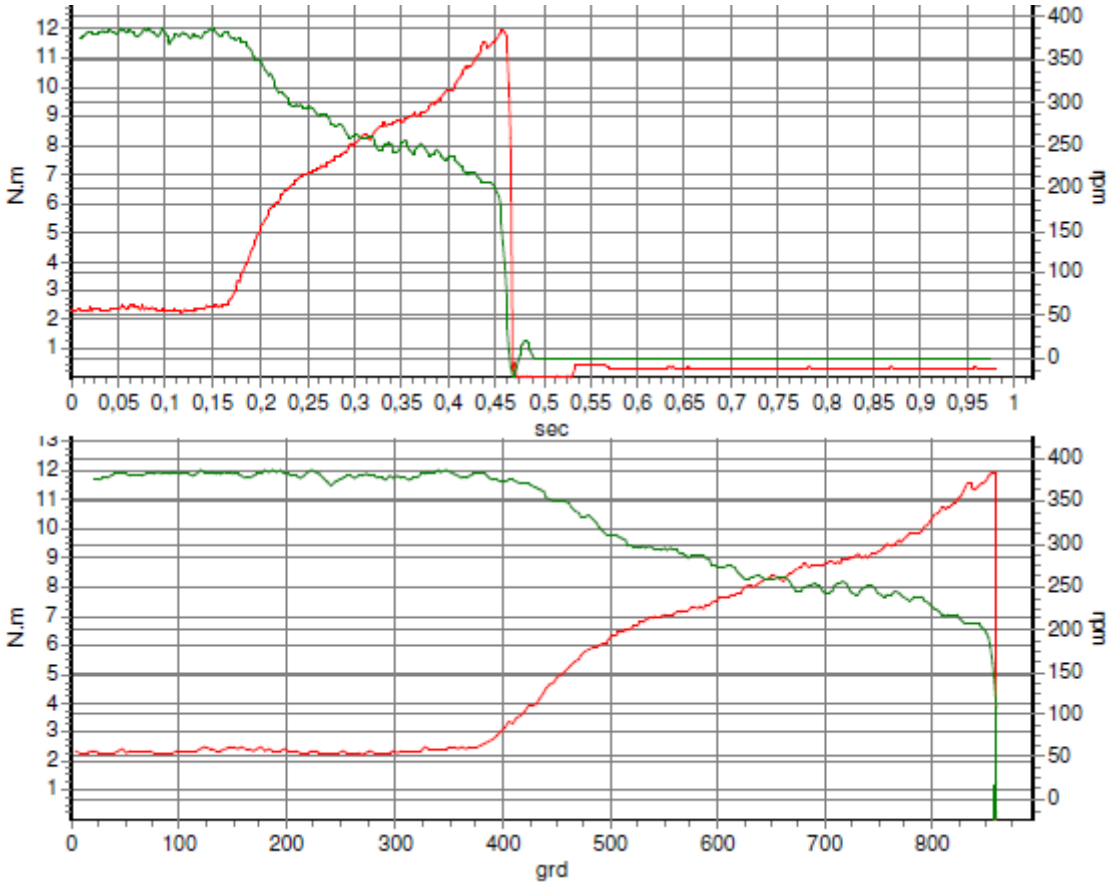


Illustration 24: 360° soft joint 12,0 Nm after load change machine 2017-05.014394

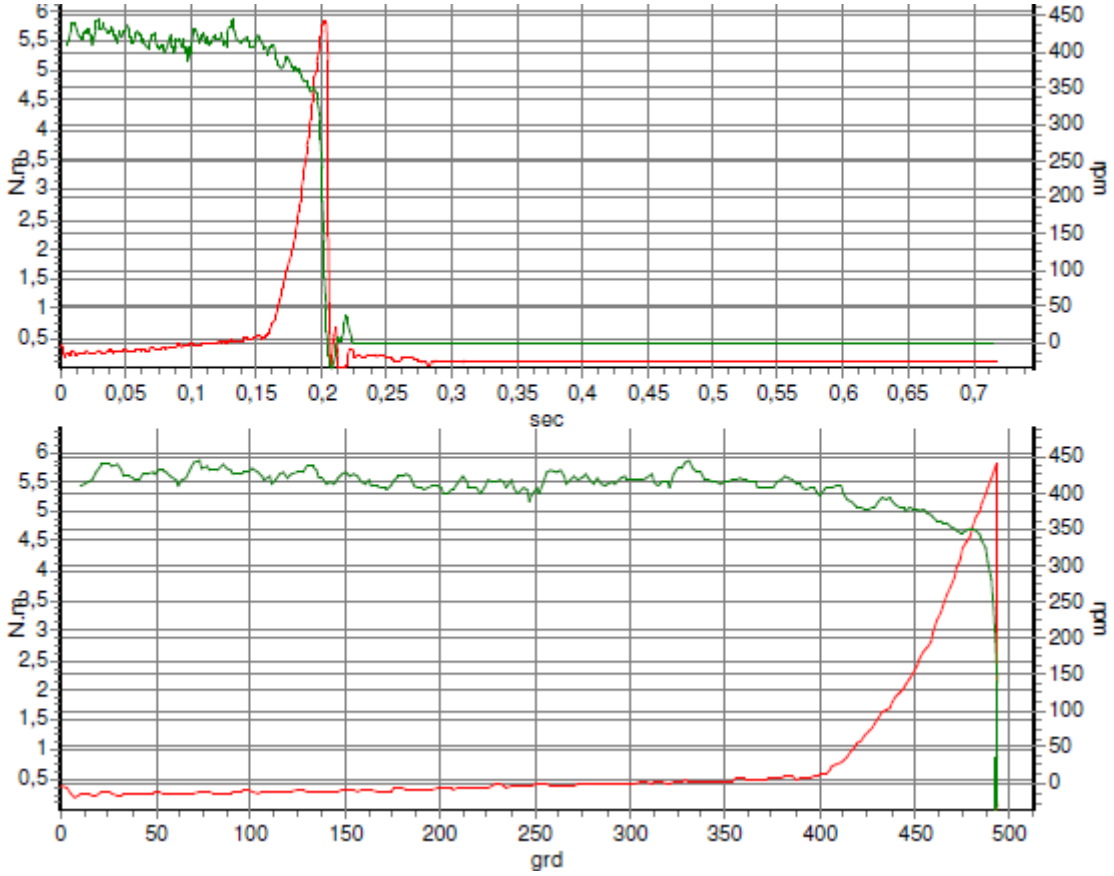


Illustration 25: 30° hard joint 5,7 Nm before load change machine 2017-05.014385

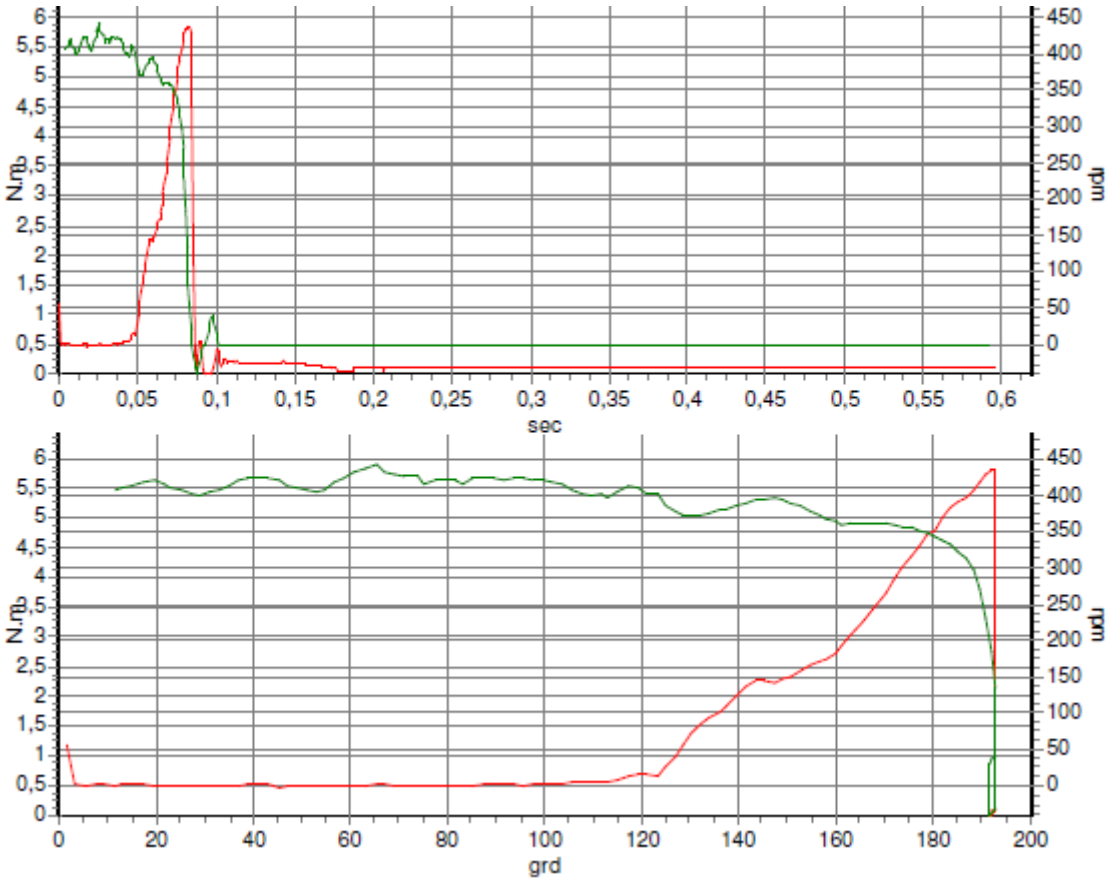


Illustration 26: 30° hard joint 5,7 Nm after load change machine 2017-05.014385

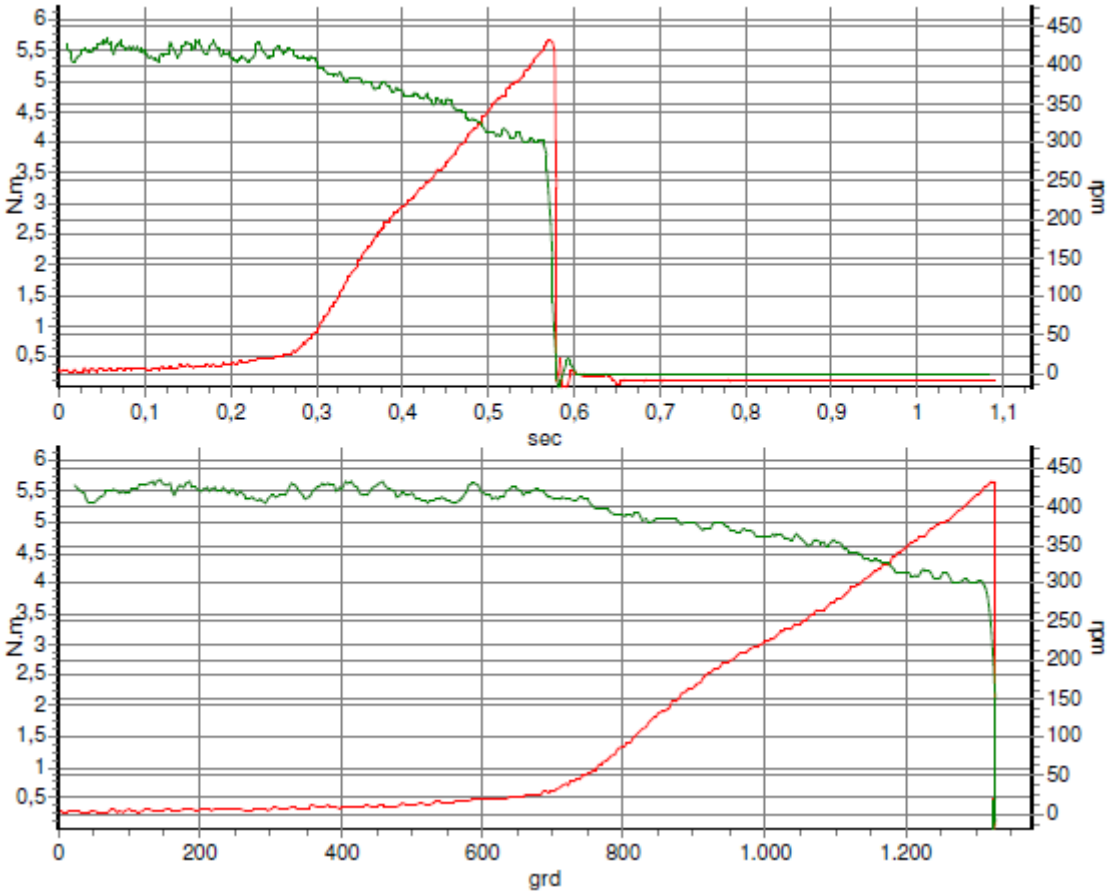


Illustration 27: 360° soft joint 5,7 Nm before load change machine 2017-05.014385

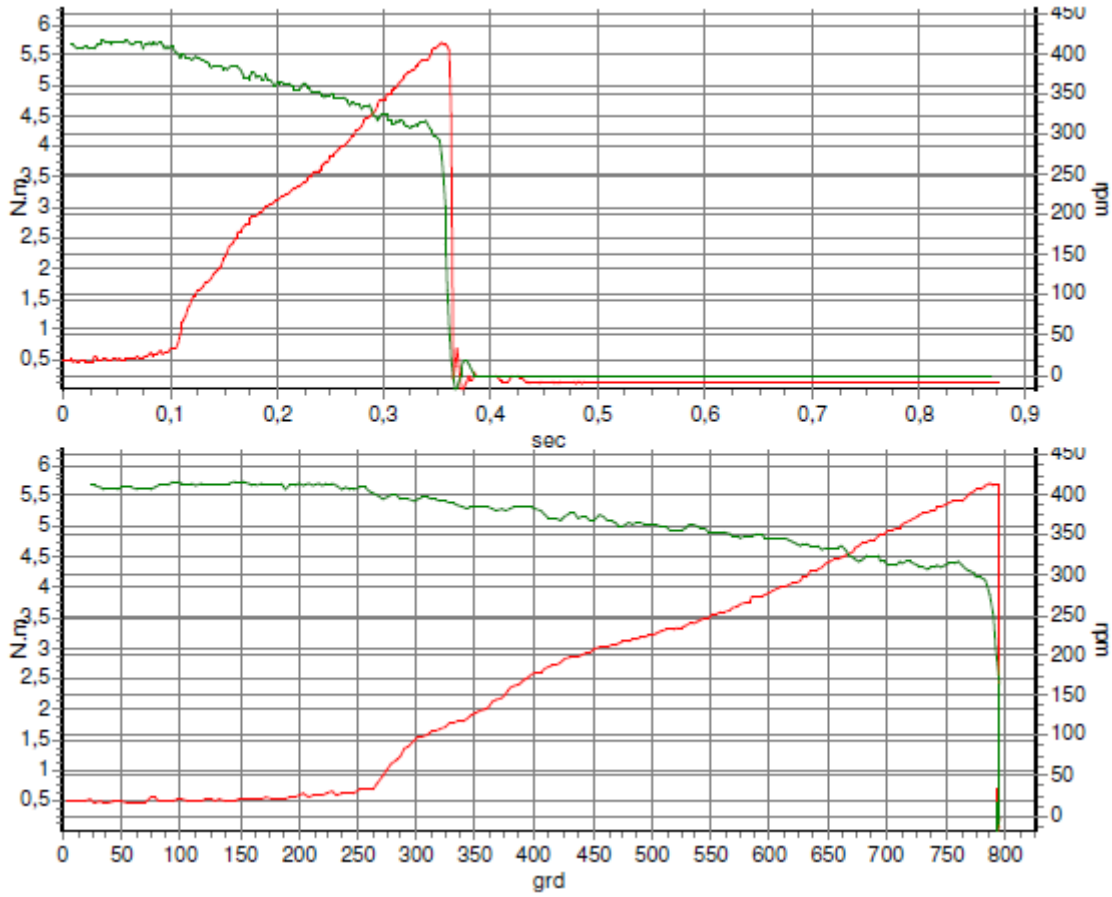


Illustration 28: 360° soft joint 5,7 Nm after load change machine 2017-05.014385

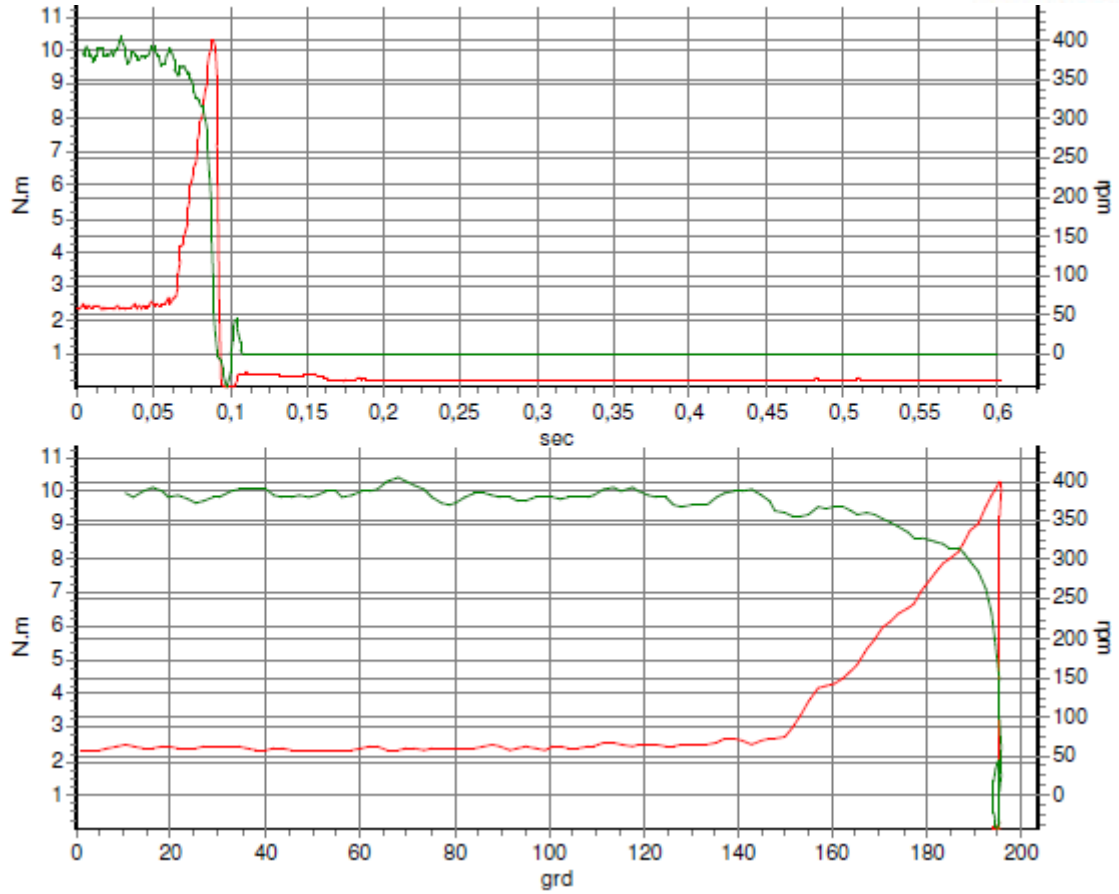


Illustration 29: 30° hard joint 10,2 Nm before load change machine 2017-05.014385

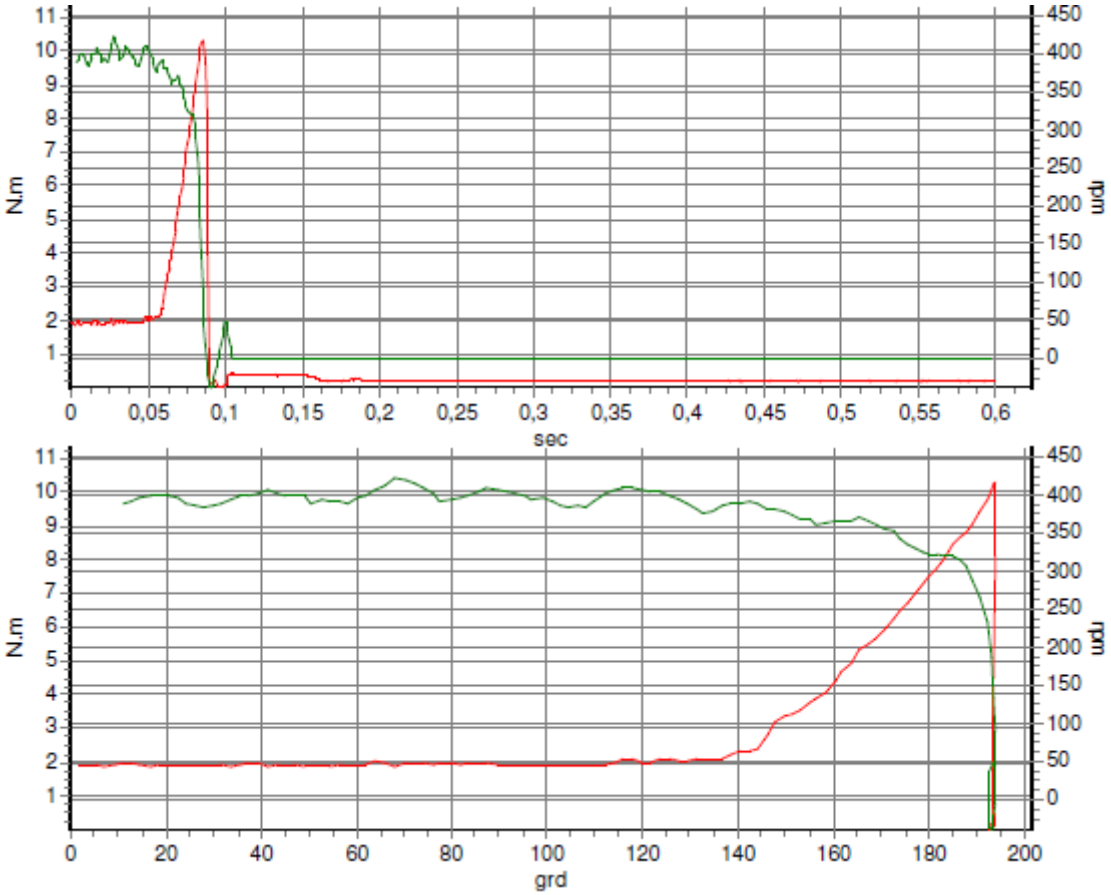


Illustration 30: 30° hard joint 10,2 Nm after load change machine 2017-05.014385

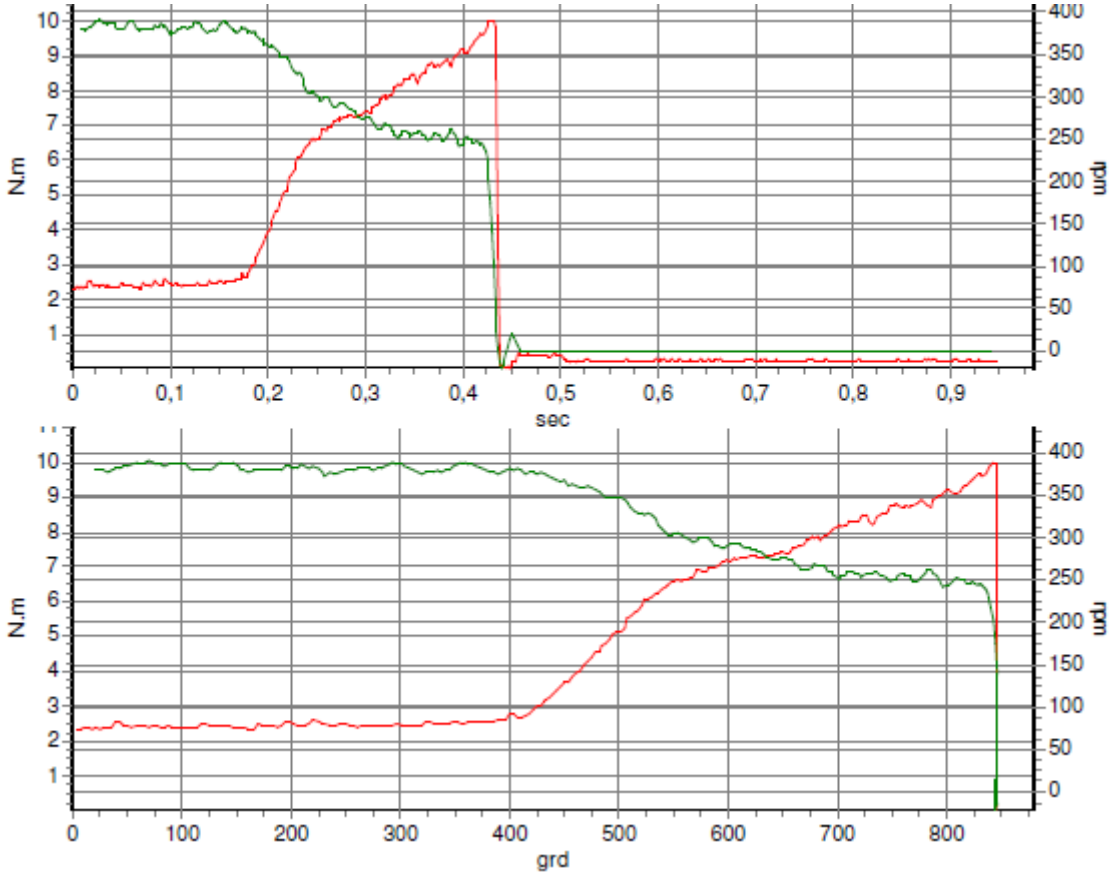


Illustration 31: 360° soft joint 10,2 Nm before load change machine 2017-05.014385

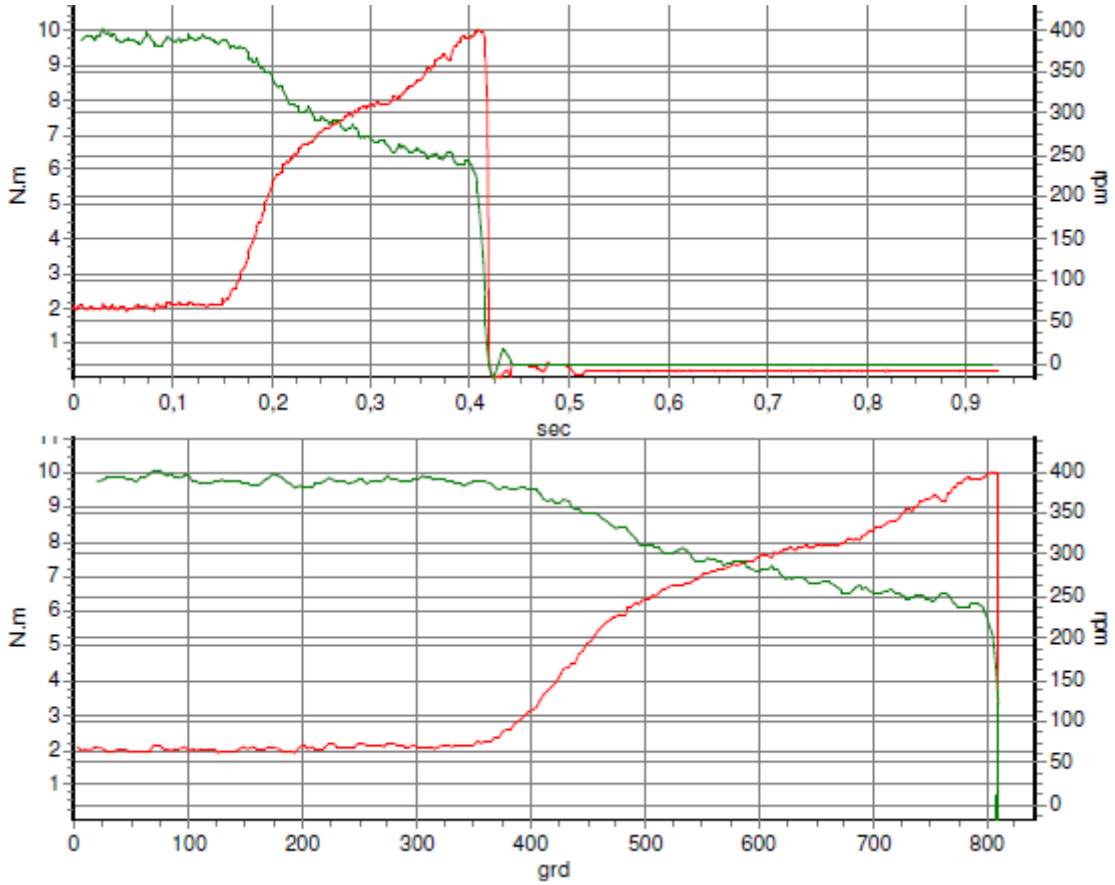


Illustration 32: 360° soft joint 10,2 Nm after load change machine 2017-05.014385

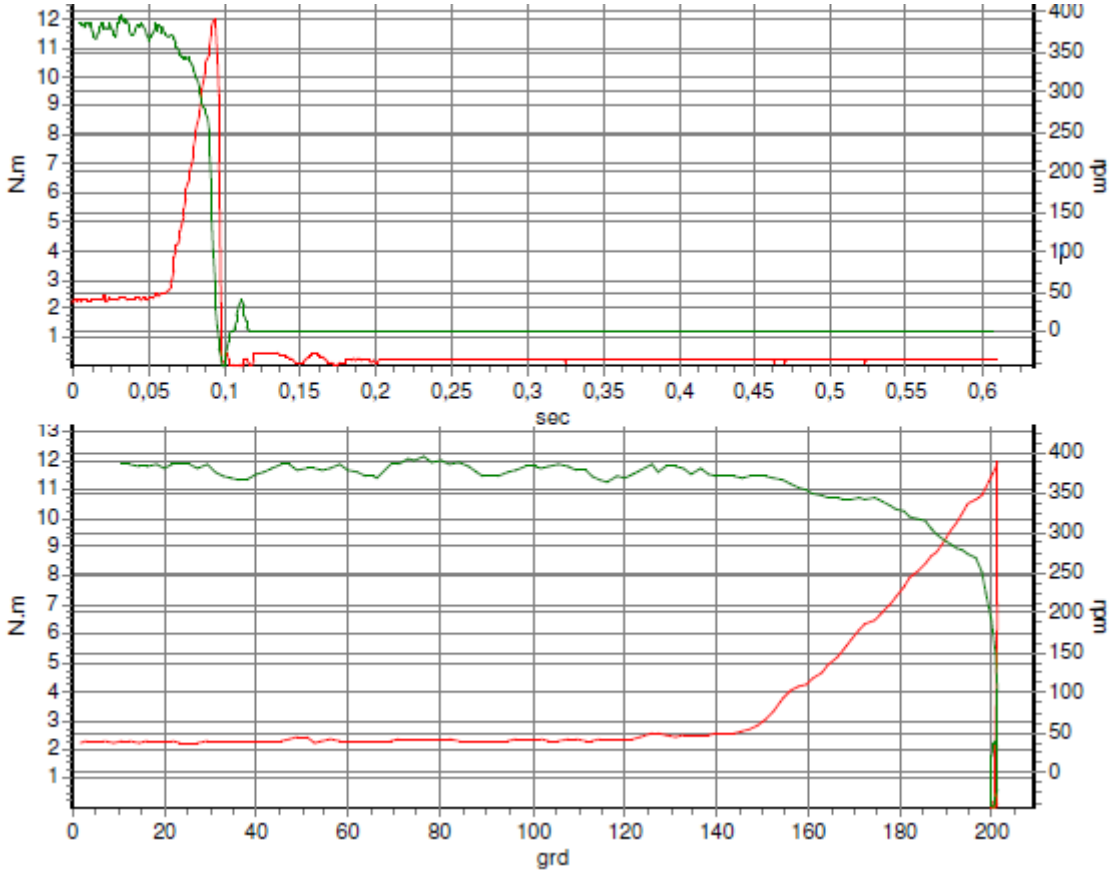


Illustration 33: 30° hard joint 12,0 Nm before load change machine 2017-05.014385

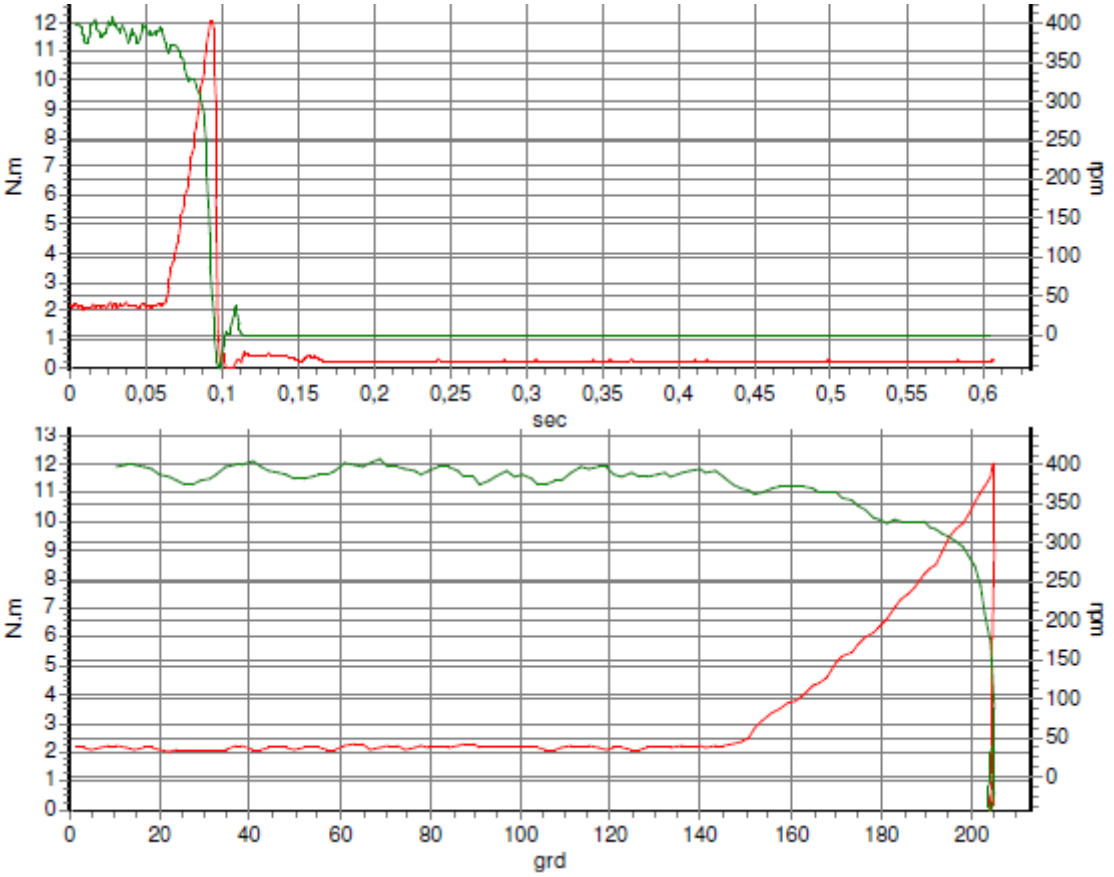


Illustration 34: 30° hard joint 12,0 Nm after load change machine 2017-05.014385

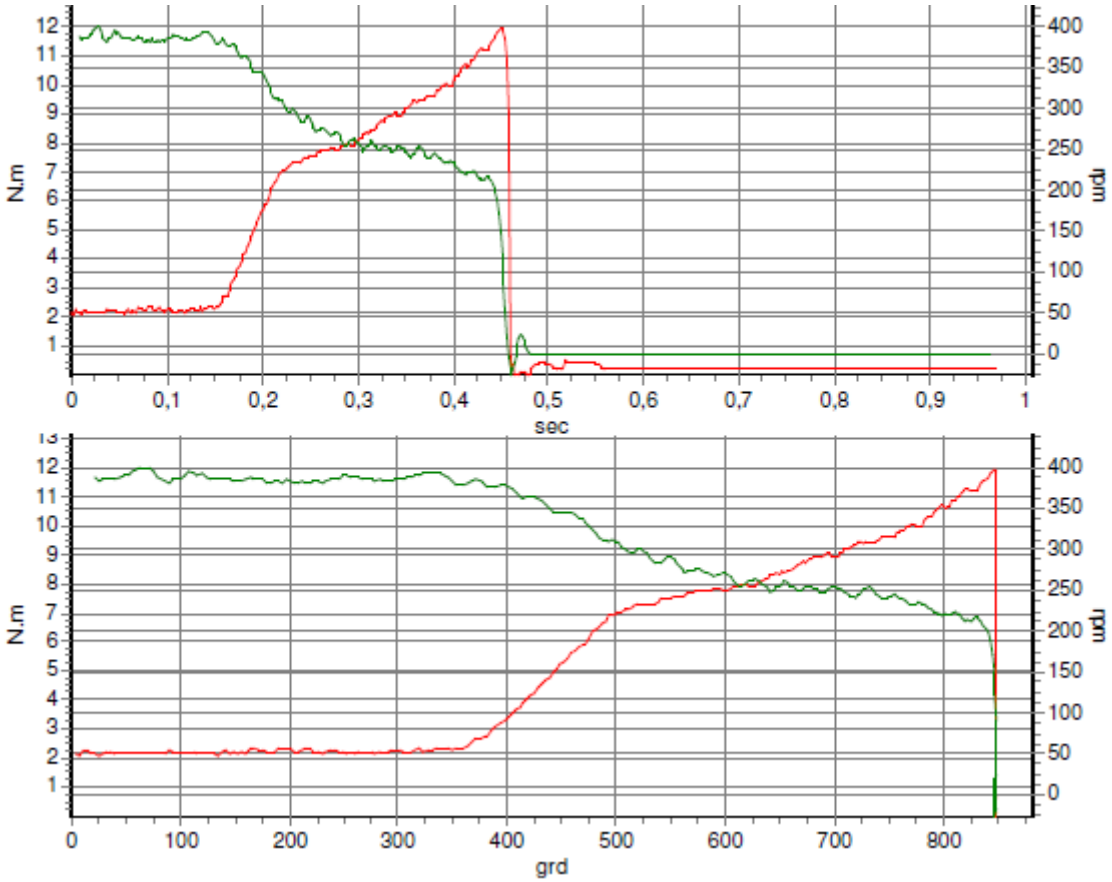


Illustration 35: 360° soft joint 12,0 Nm before load change machine 2017-05.014385

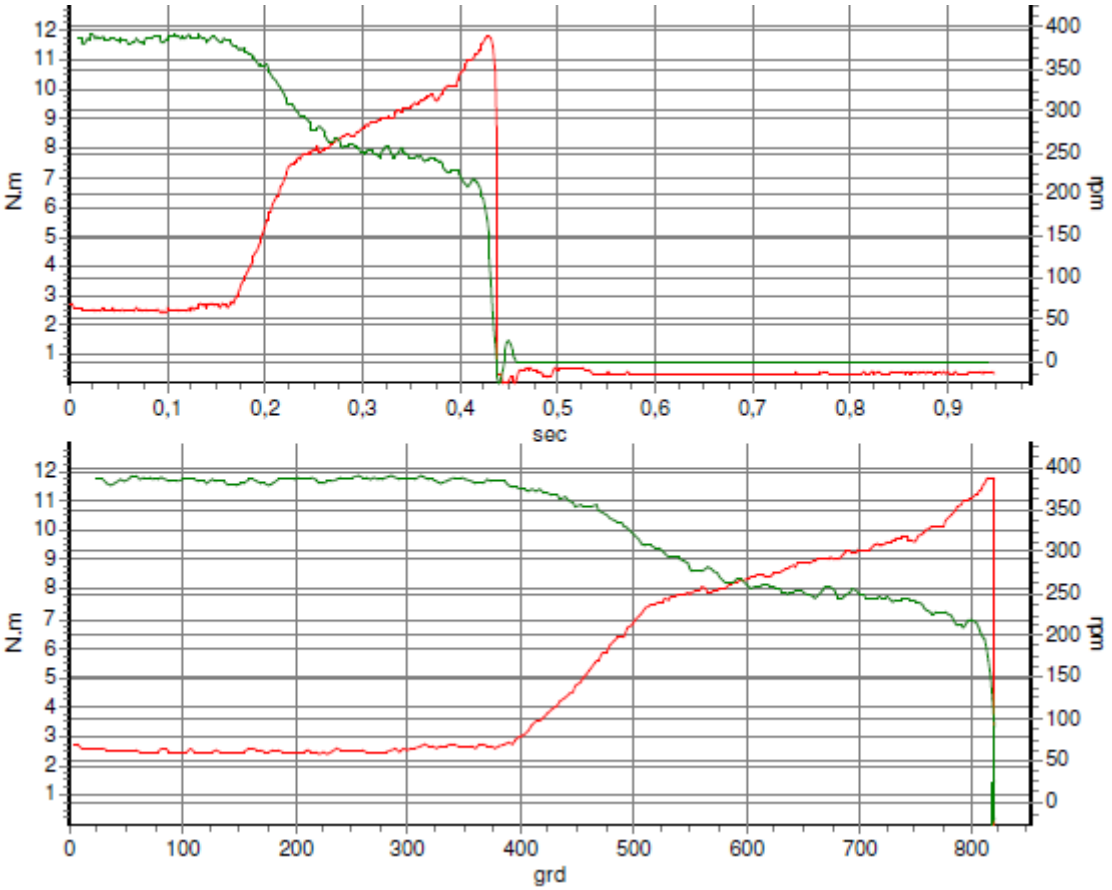


Illustration 36: 360° soft joint 12,0 Nm after load change machine 2017-05.014385