

GRISPE

Guidelines and Recommendations for Integrating Specific Profiled steel sheets in the Eurocodes (**GRISPE**)

Test report of steel trapezoidal sheeting with and without embossments and outward stiffeners

Annex

31.10.2014

Deliverable D 1.3
(Rev03. 29. June 2015)

**Guidelines and Recommendations for Integrating Specific Profiled Steels sheets in the Eurocodes
(GRISPE)**

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1 Annex A: Object of testing

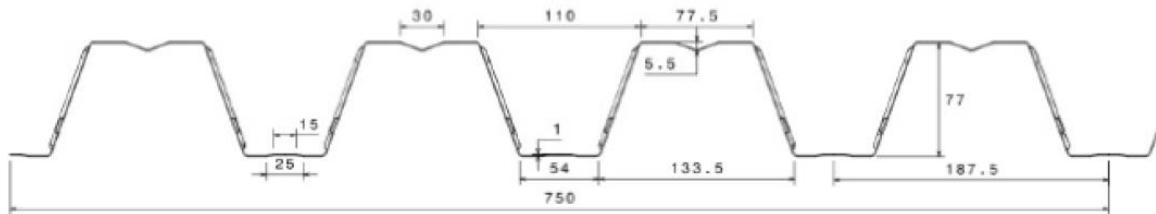


Figure A.1: Cross-section of PCB 80

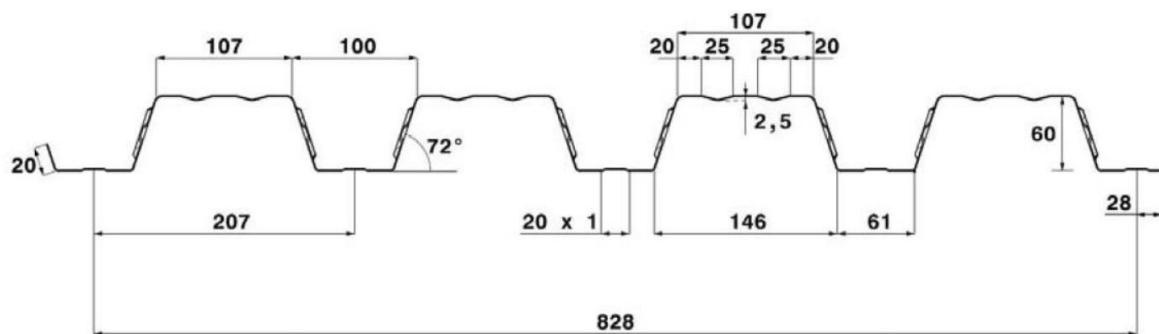


Figure A.2: Cross-section of PCB 60

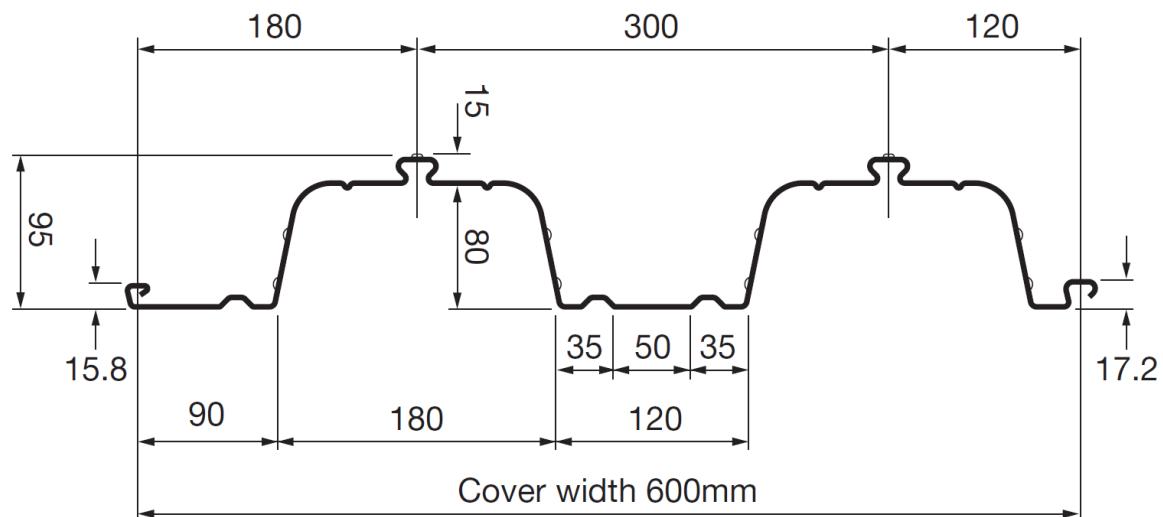


Figure A.3: Cross-section of ComFlor 80

2 Annex B: Single span positive bending tests

Tests set-up:

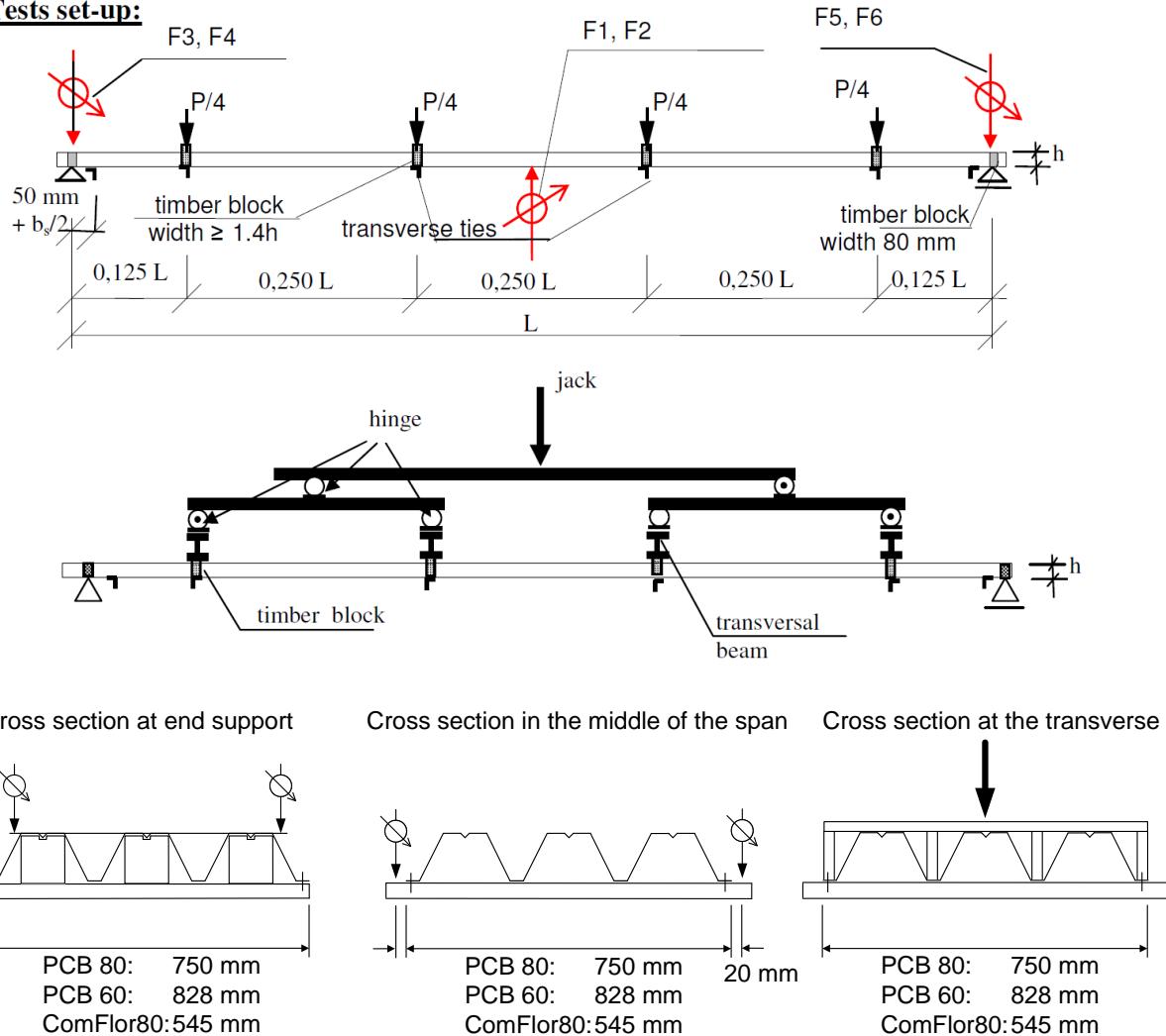


Figure B.1: Schematic test setup



Figure B.2: Test setup (exemplary for PCB 80, $t_N = 1.00$ mm without embossments)



Figure B.3: Test setup (exemplary for PCB 80, $t_N = 1.00$ mm without embossments)



Figure B.4: Test setup (exemplary for ComFlor80, $t_N = 0.90$ with outward stiffeners)



Figure B.5: Failure mode (PCB 80 $t_N = 0.75$ mm without embossments)



Figure B.6: Failure mode (PCB 80, $t_N = 0.75$ mm with embossments)

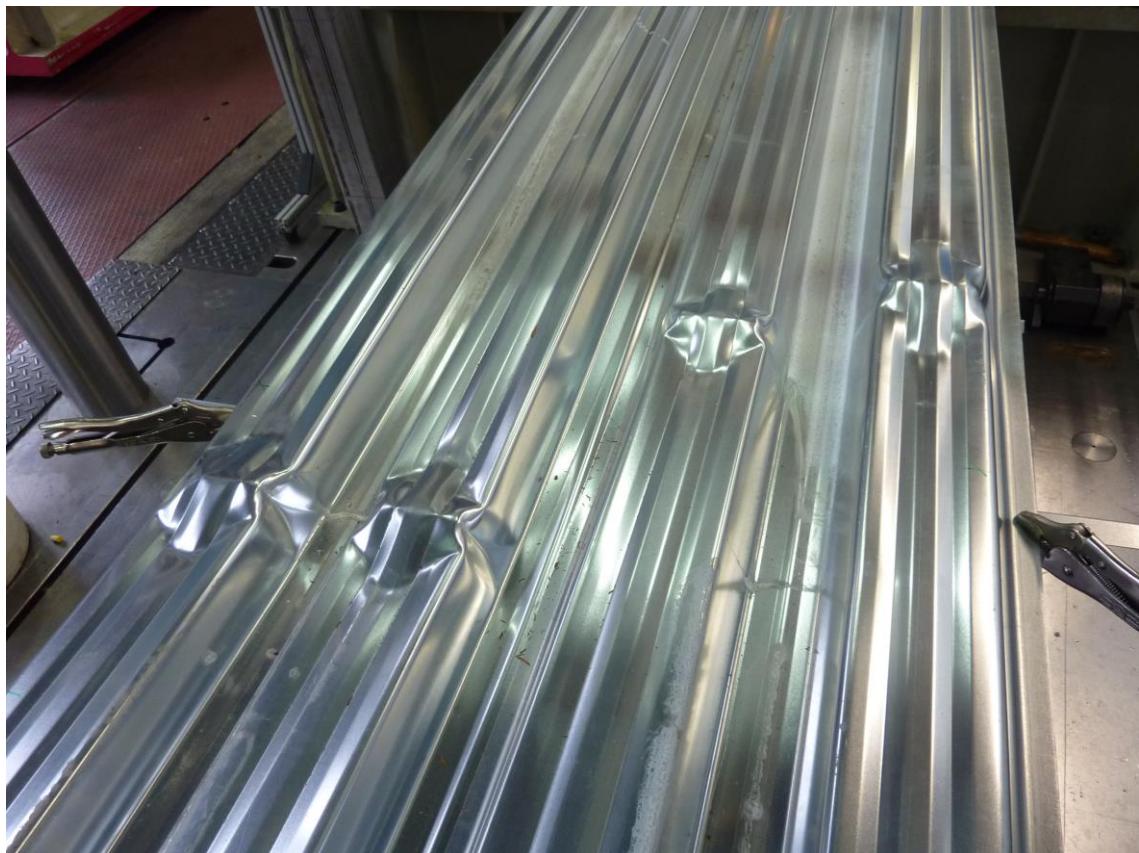


Figure B.7: Failure mode (PCB 60, $t_N = 0.75$ mm without embossments)

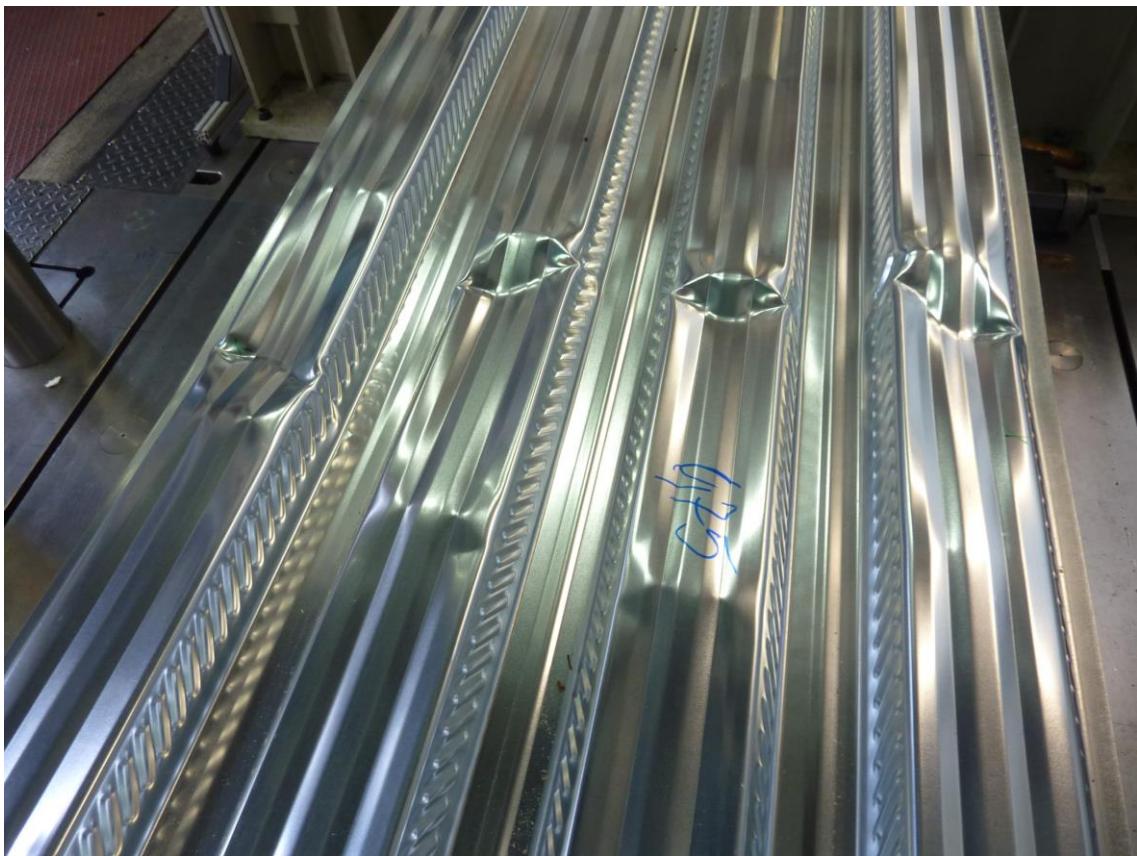
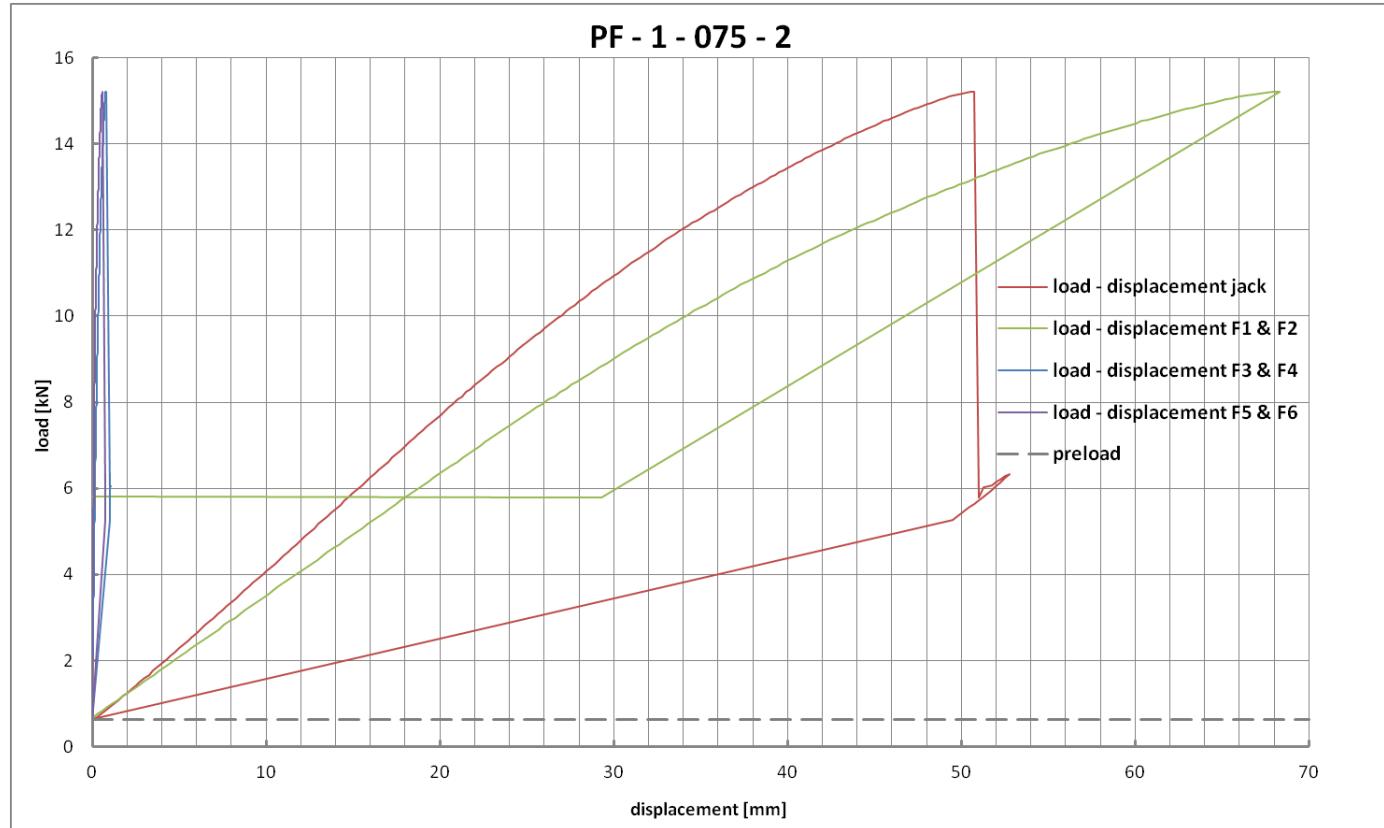
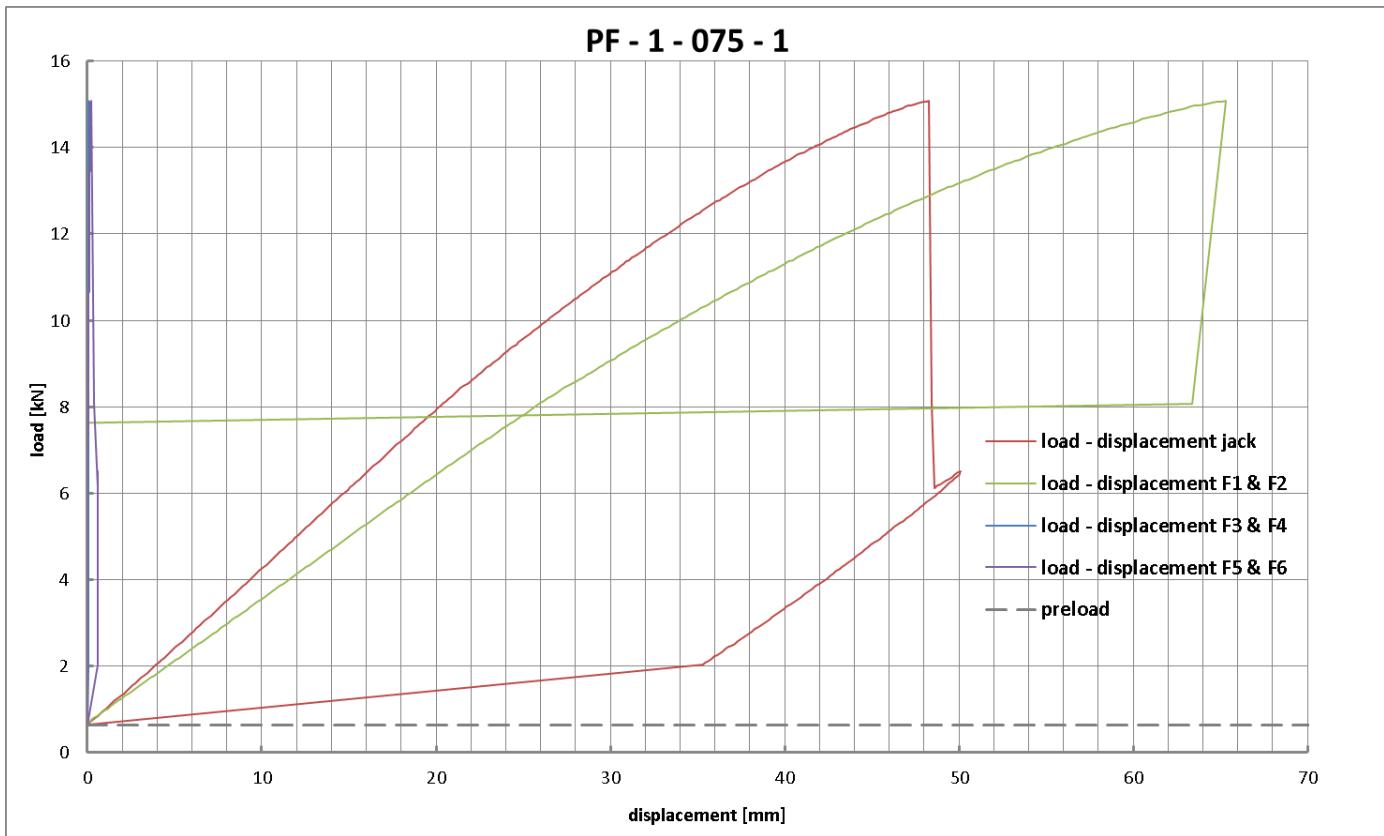


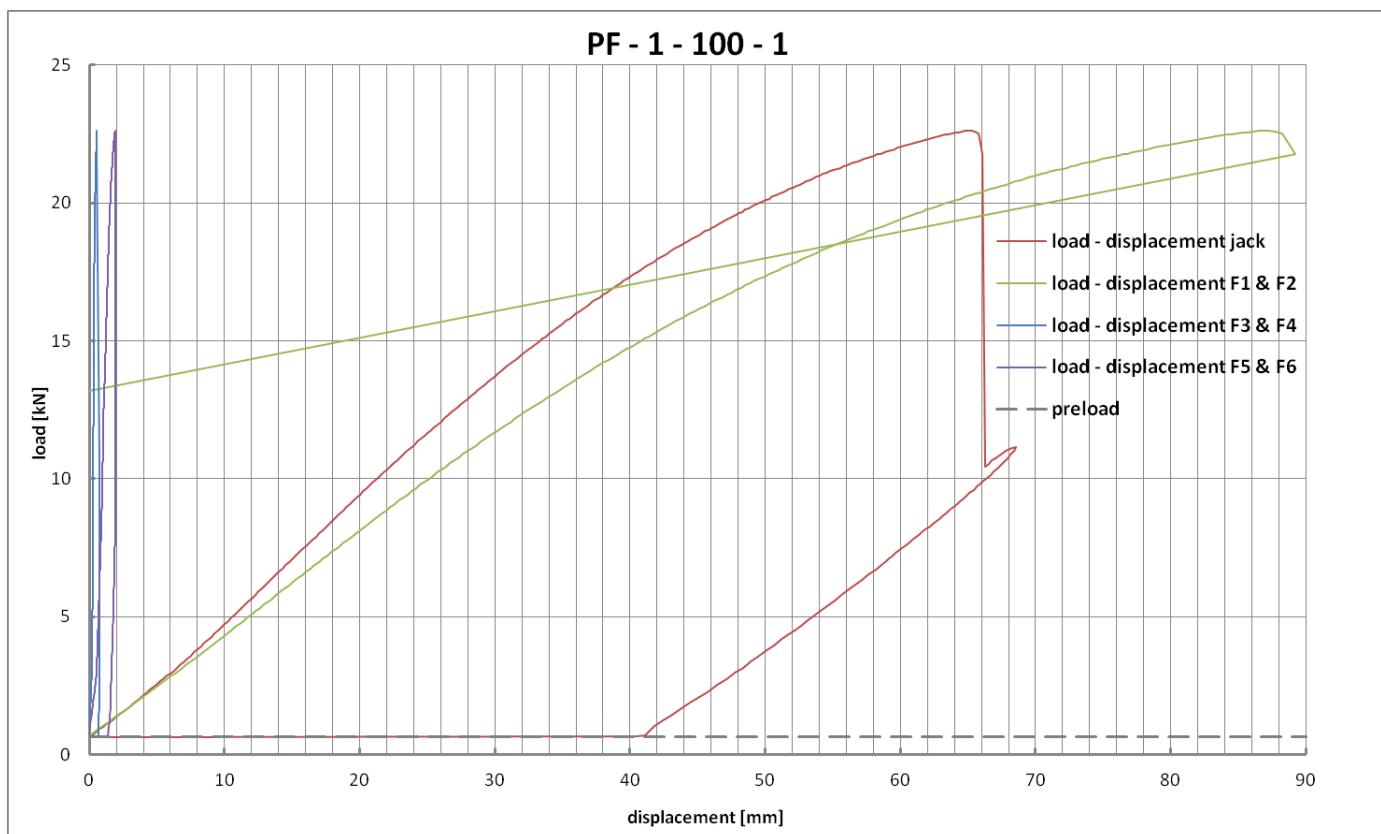
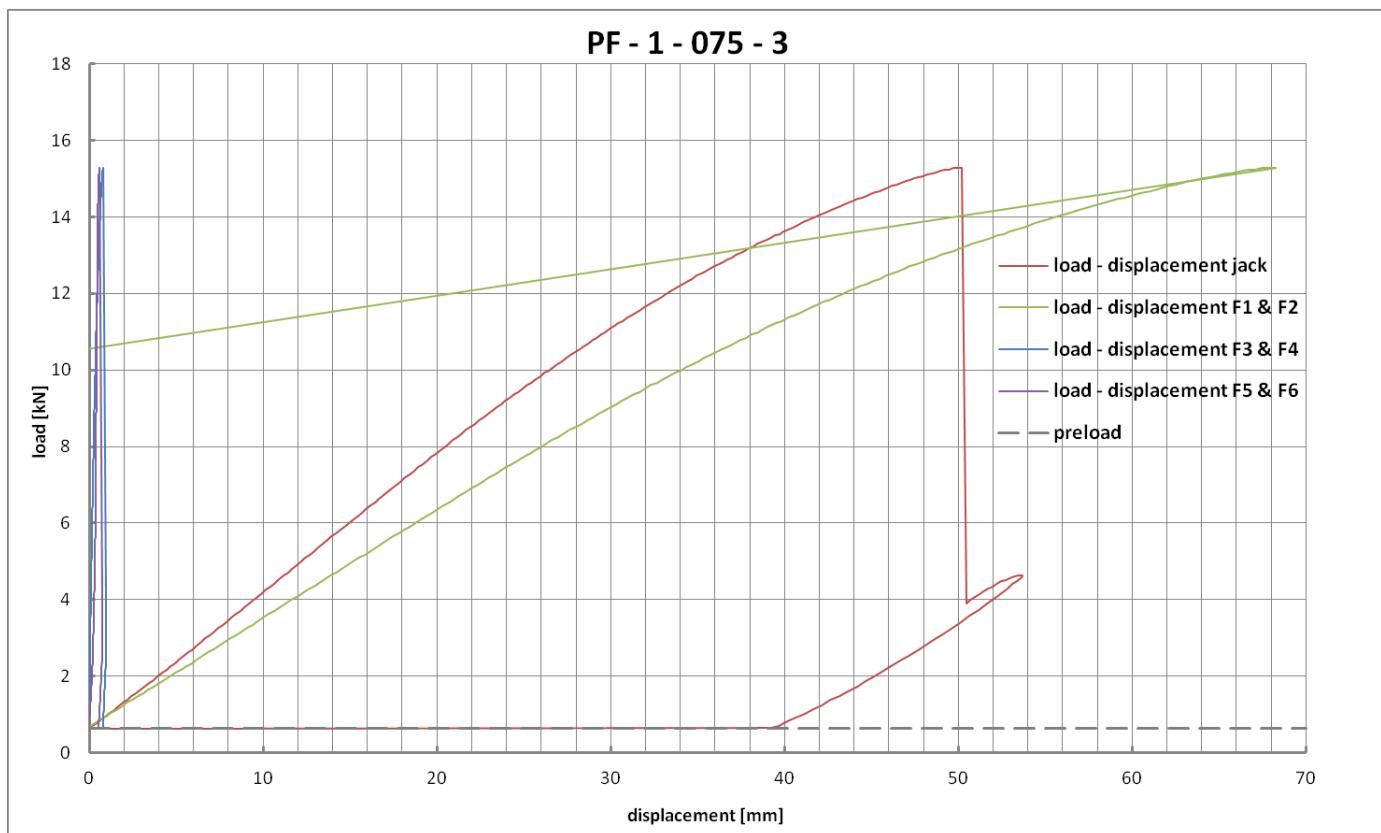
Figure B.8: Failure mode (PCB 60, $t_N = 0.75$ mm with embossments)

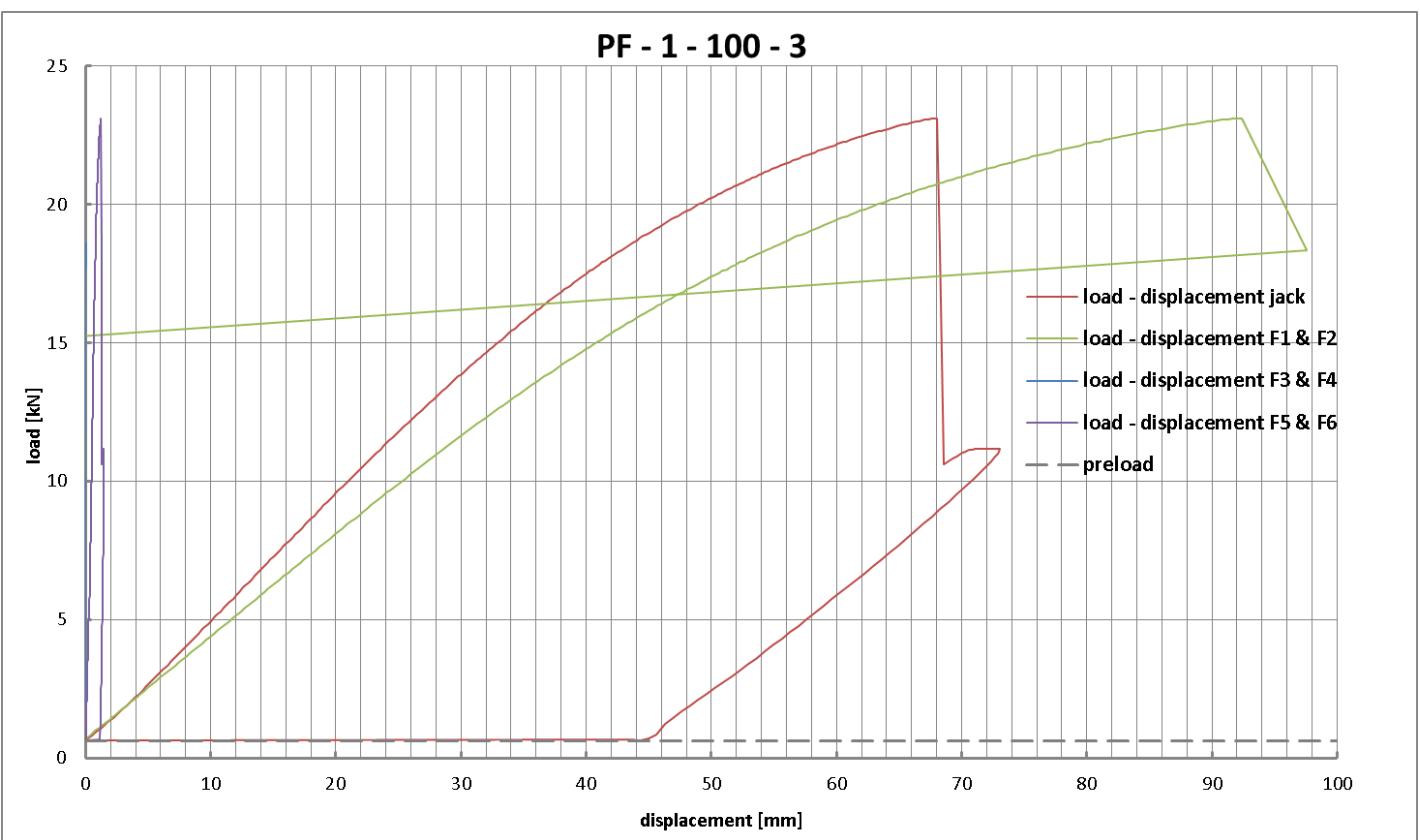
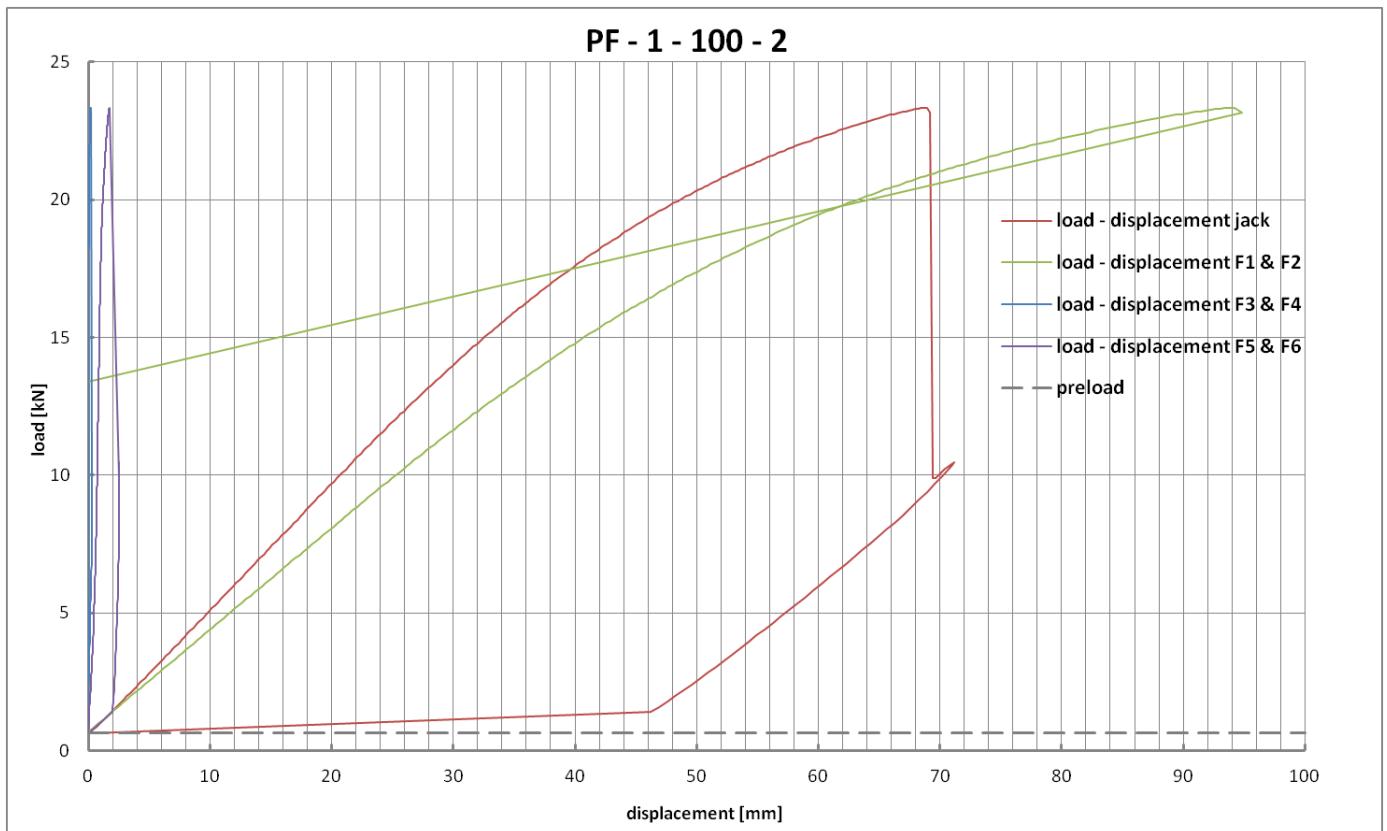


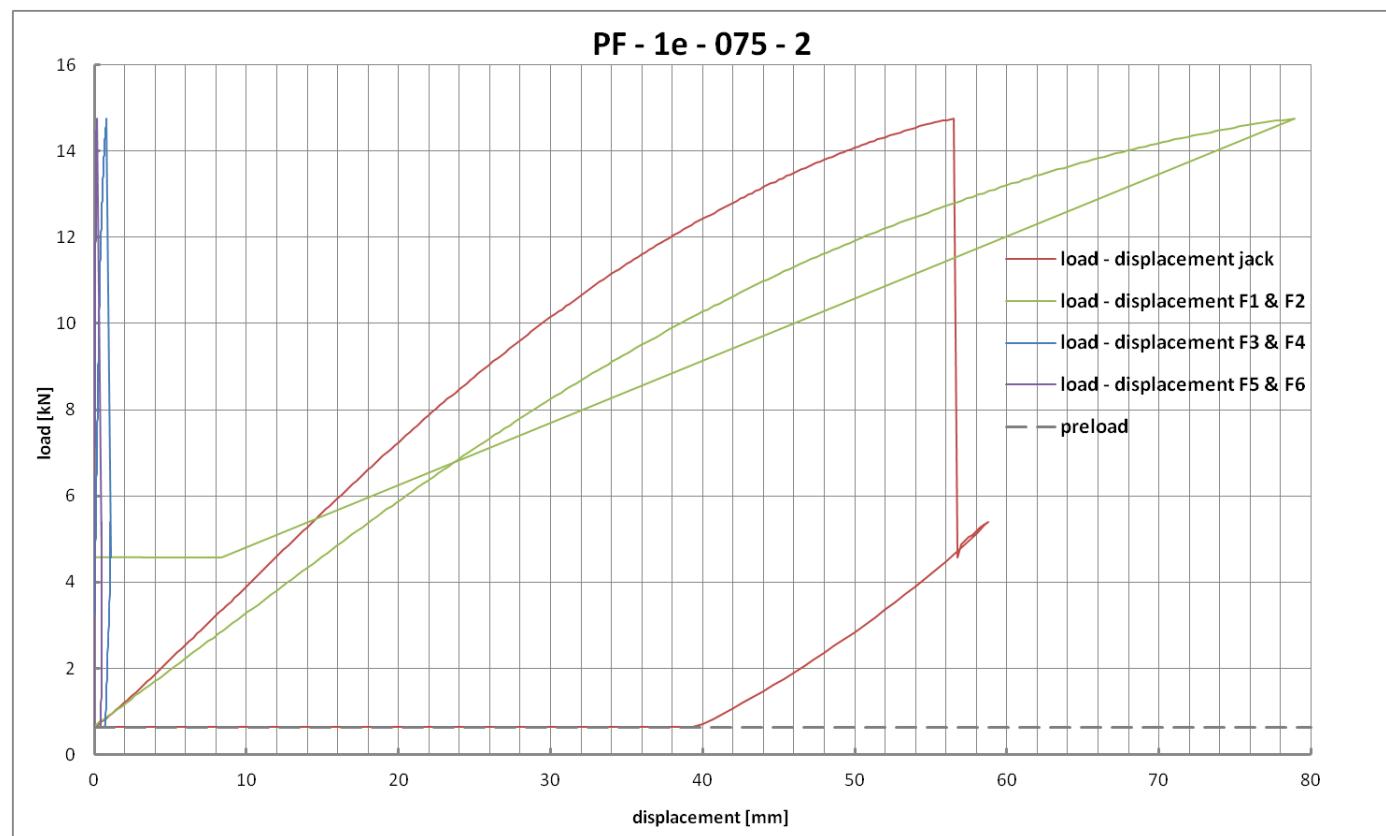
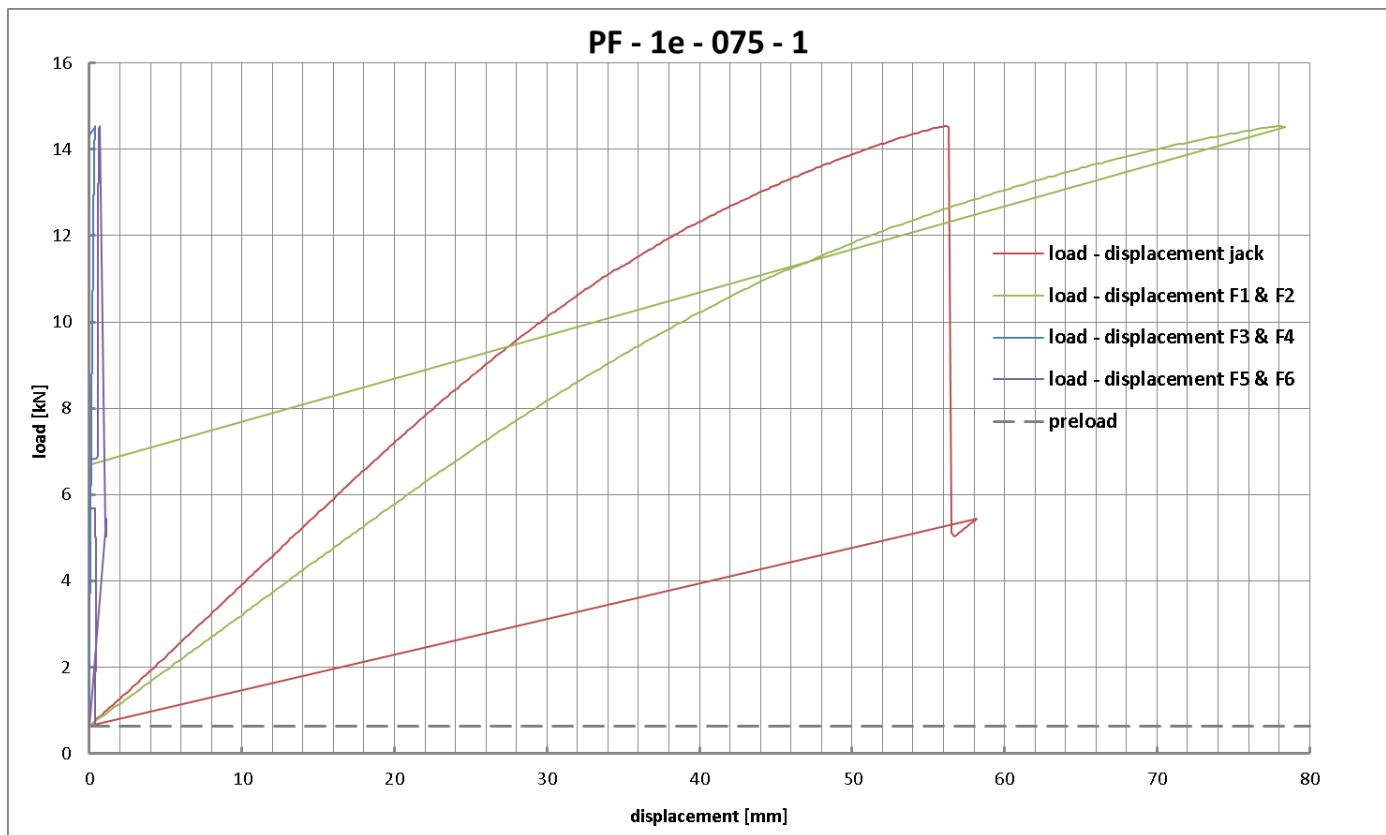
Figure B.9: Failure mode (ComFlor 80, $t_N = 0.90$ mm with outward stiffeners)

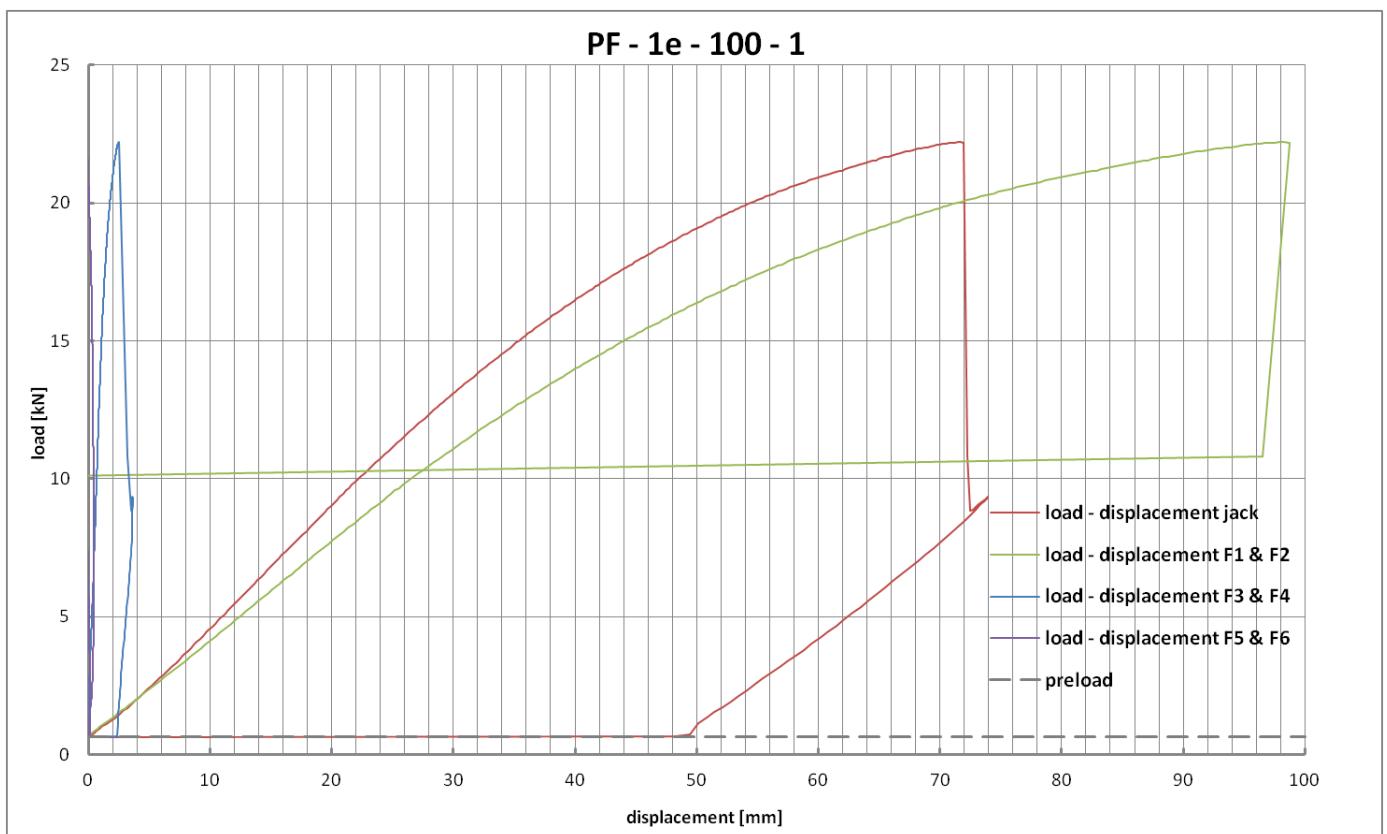
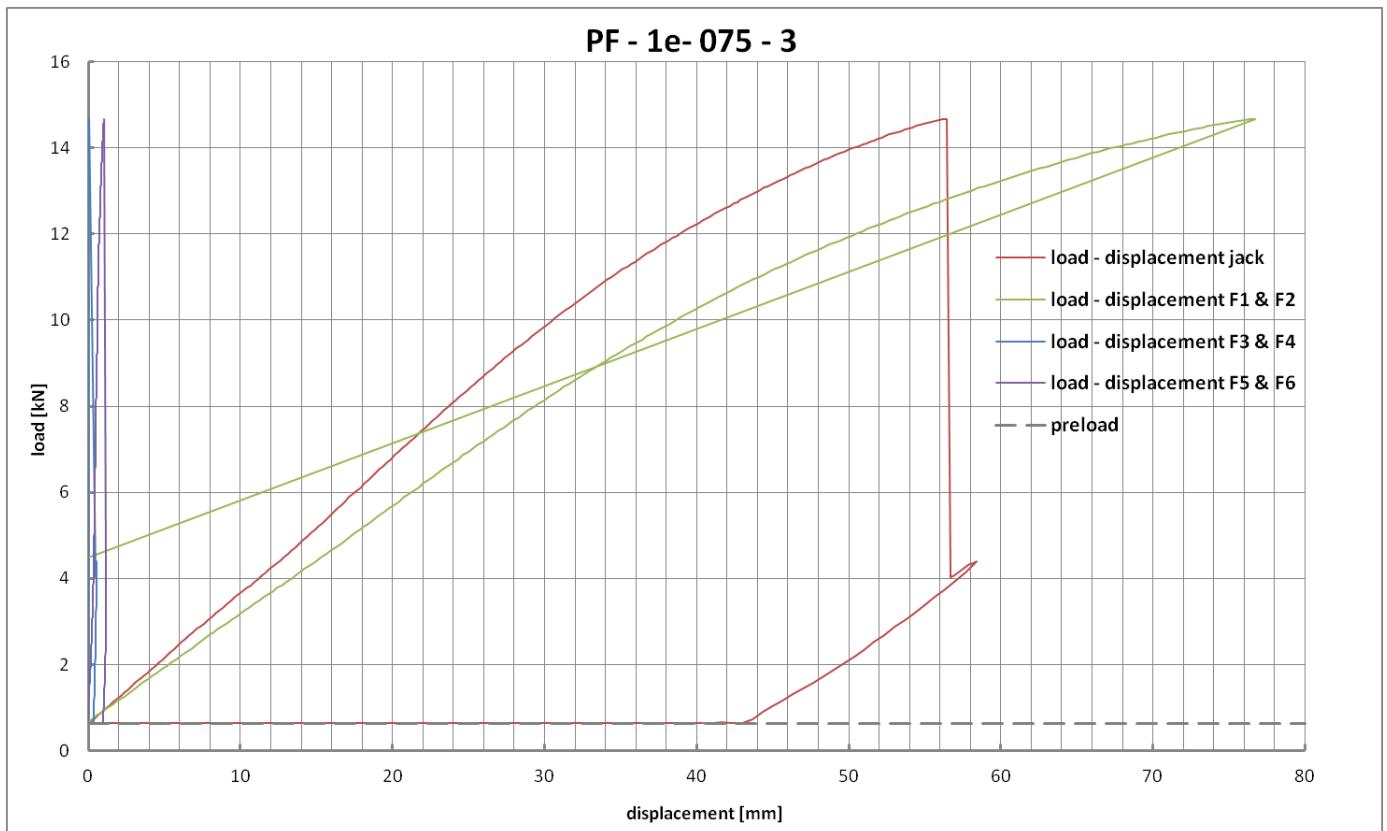
Load-deflection curves:

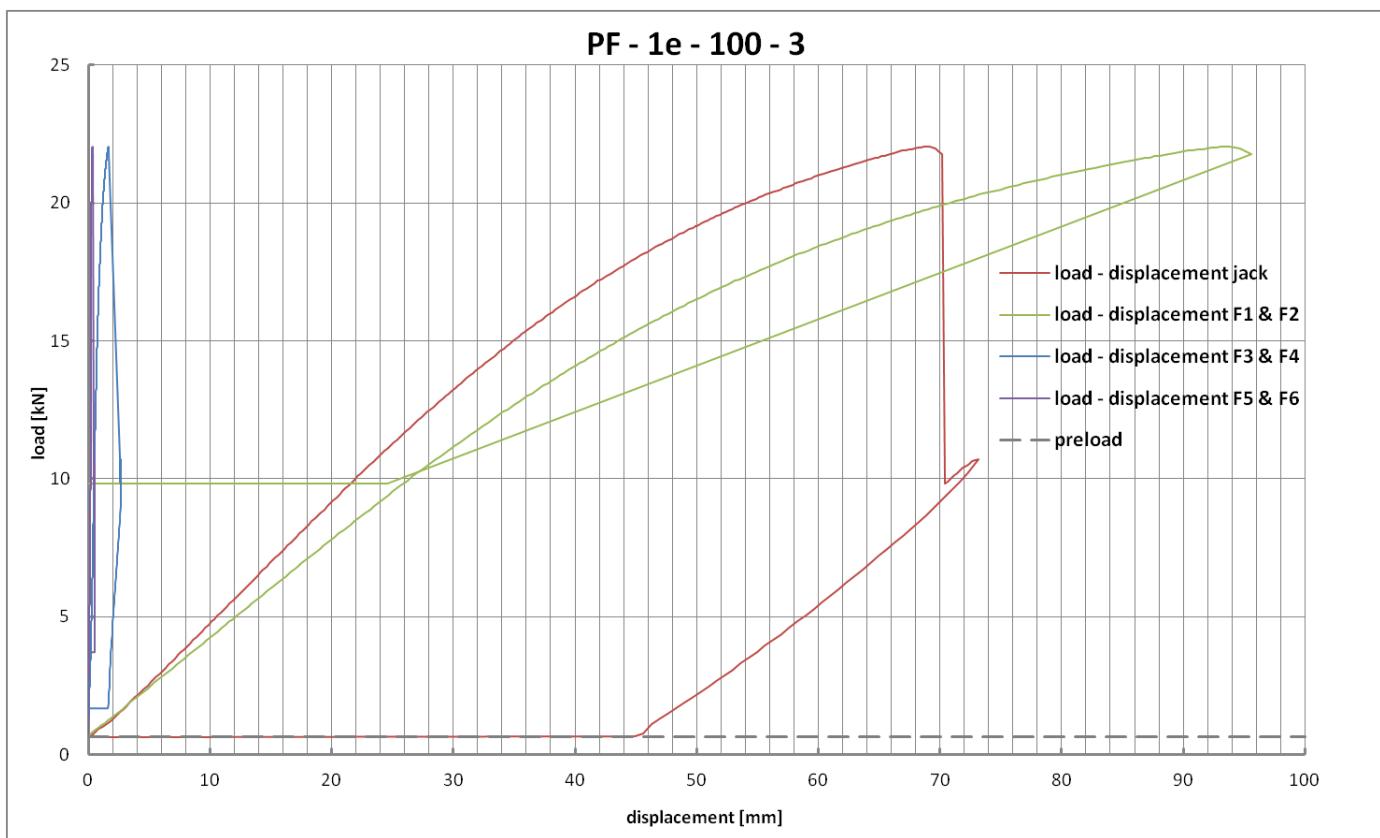
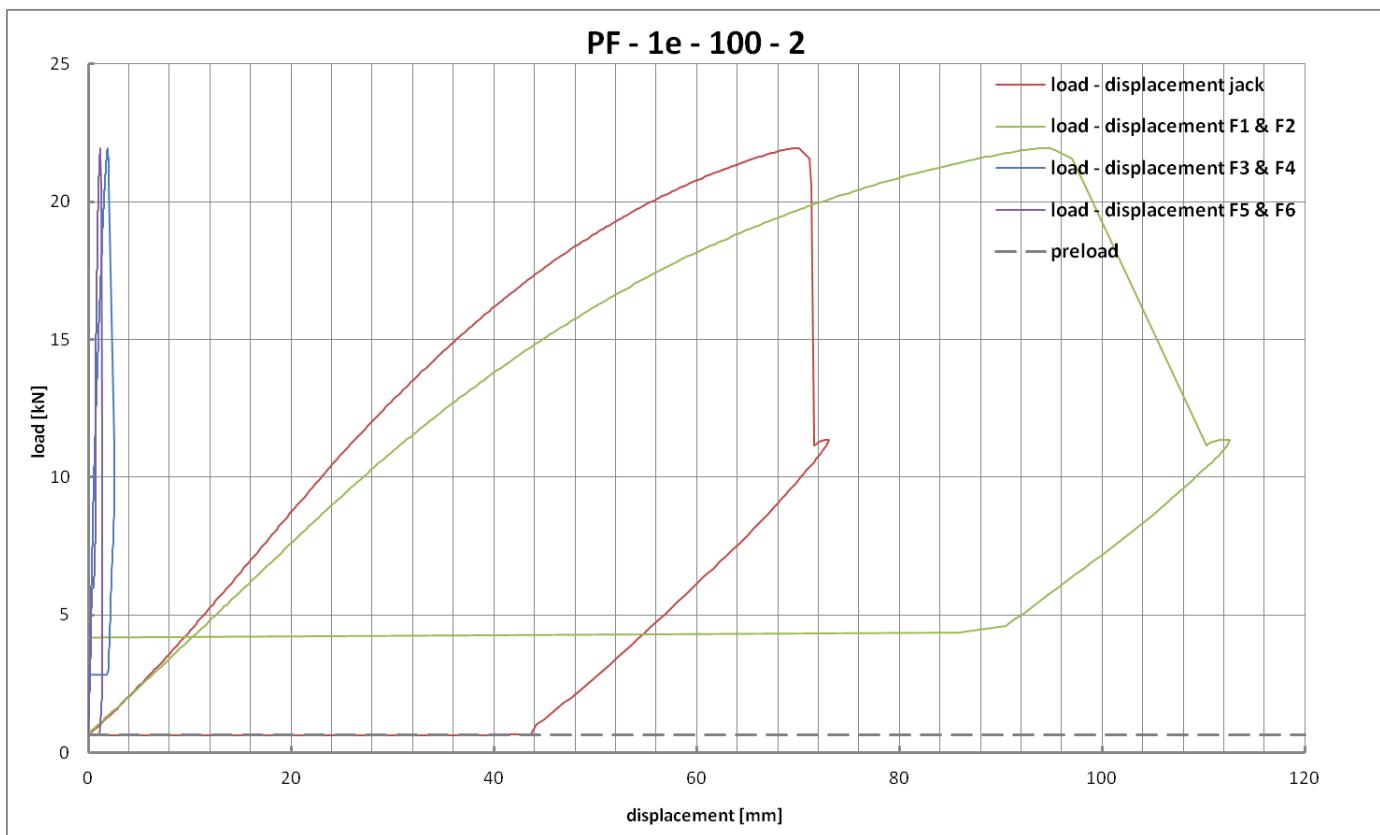


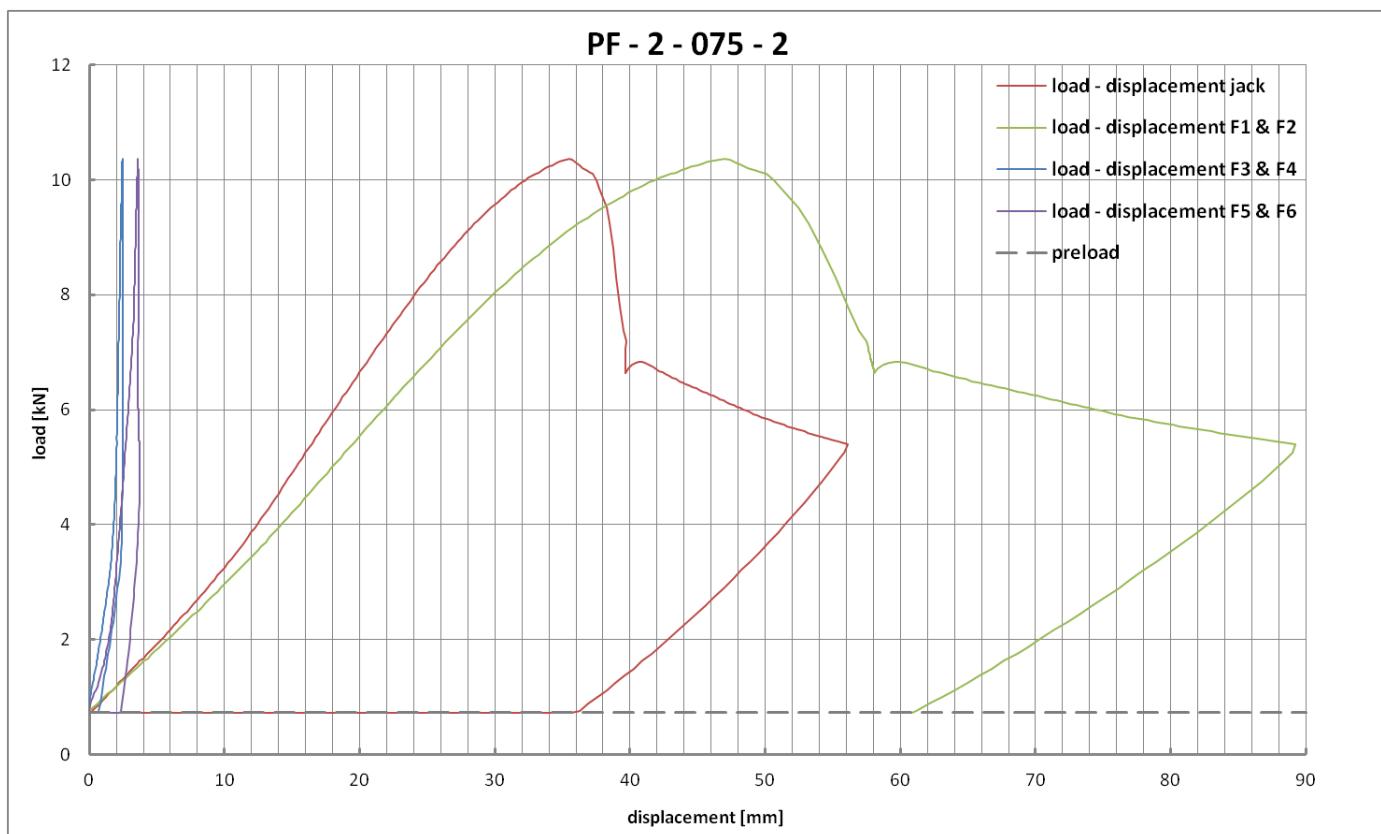
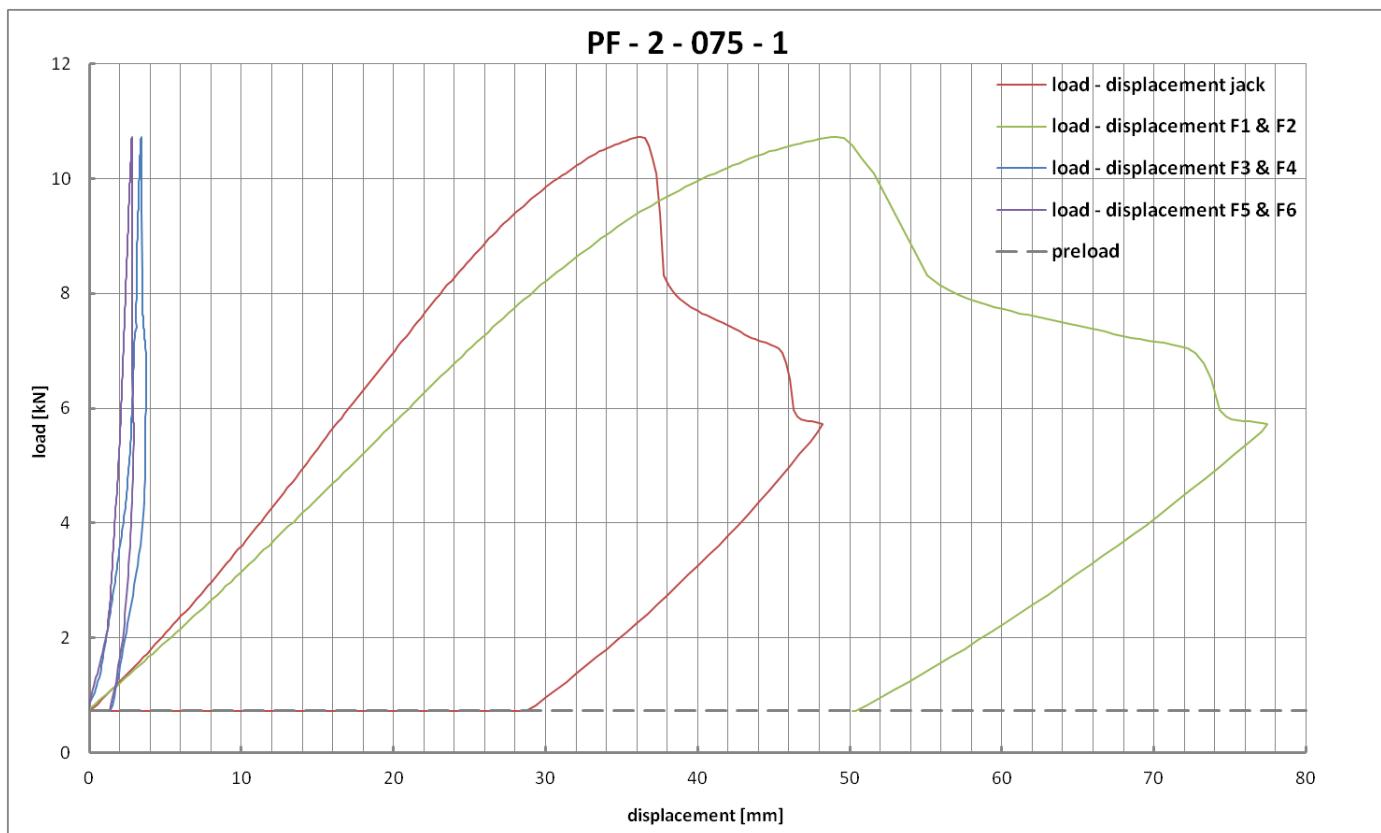


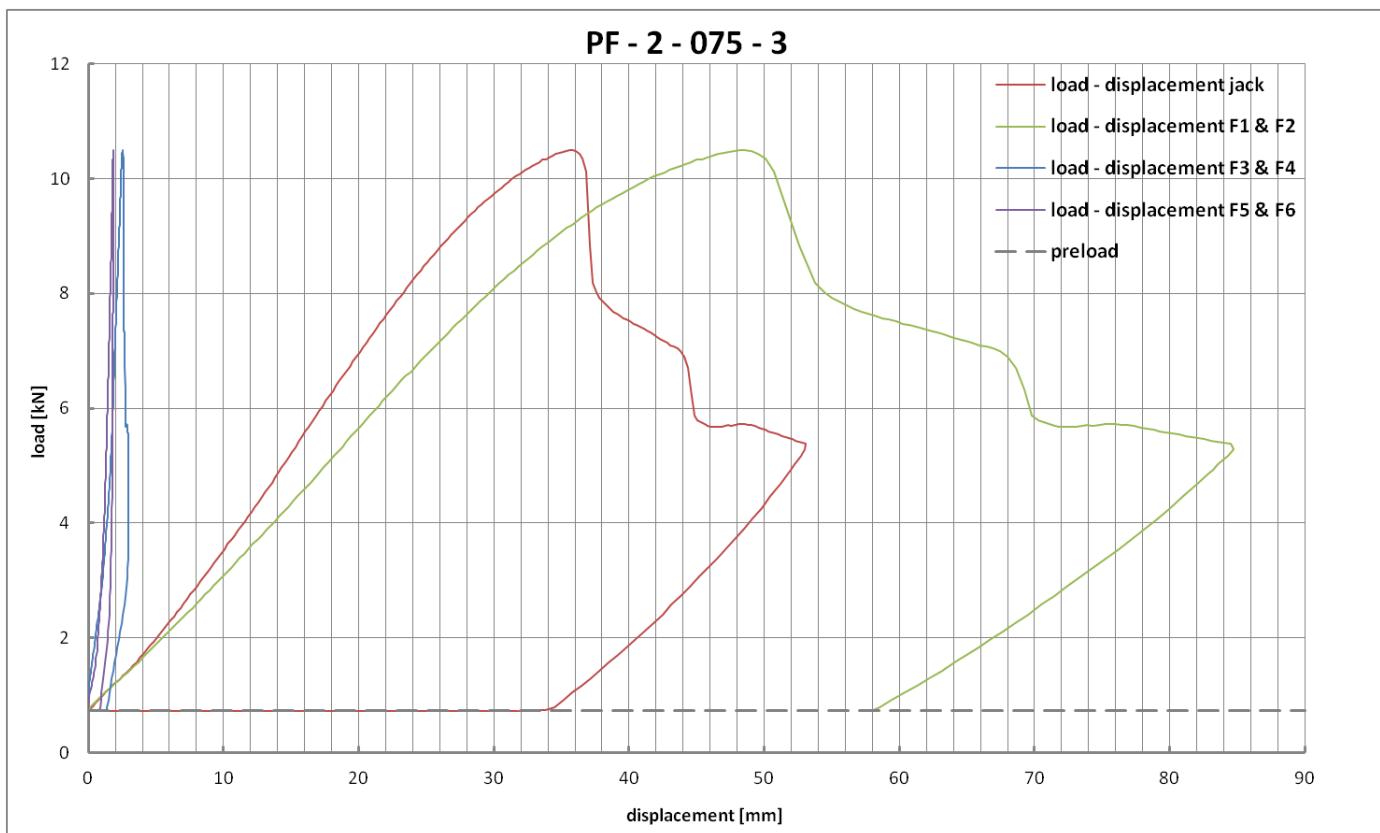




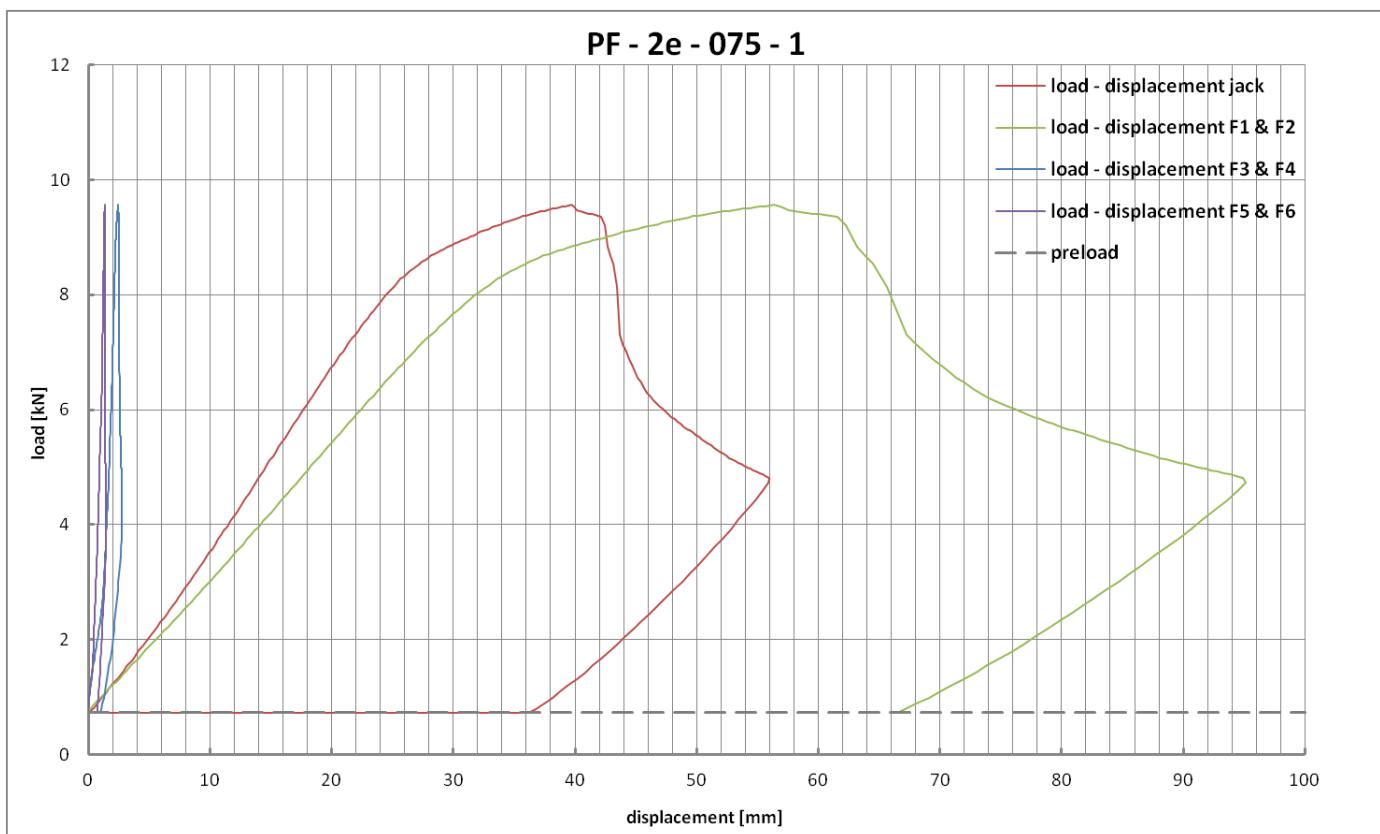
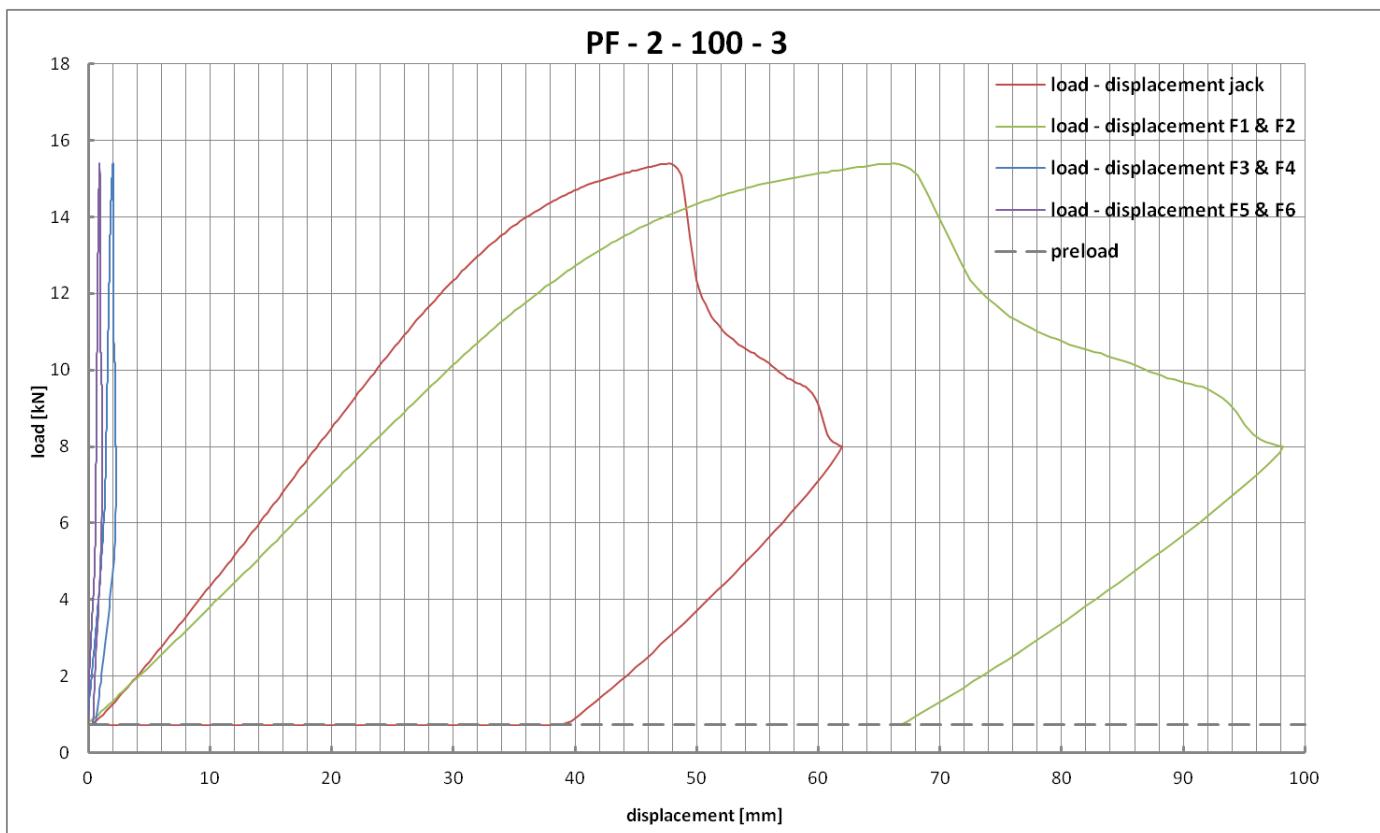


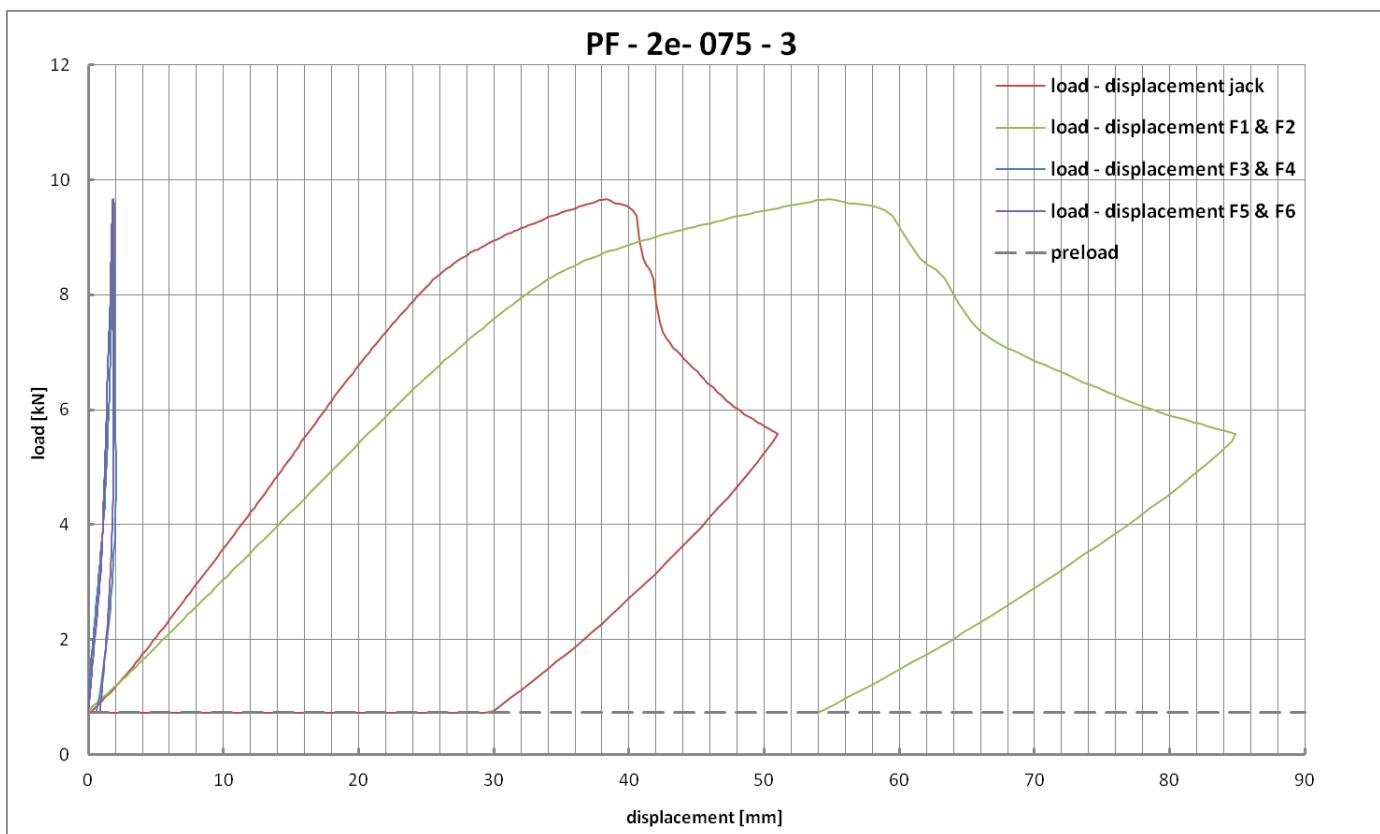
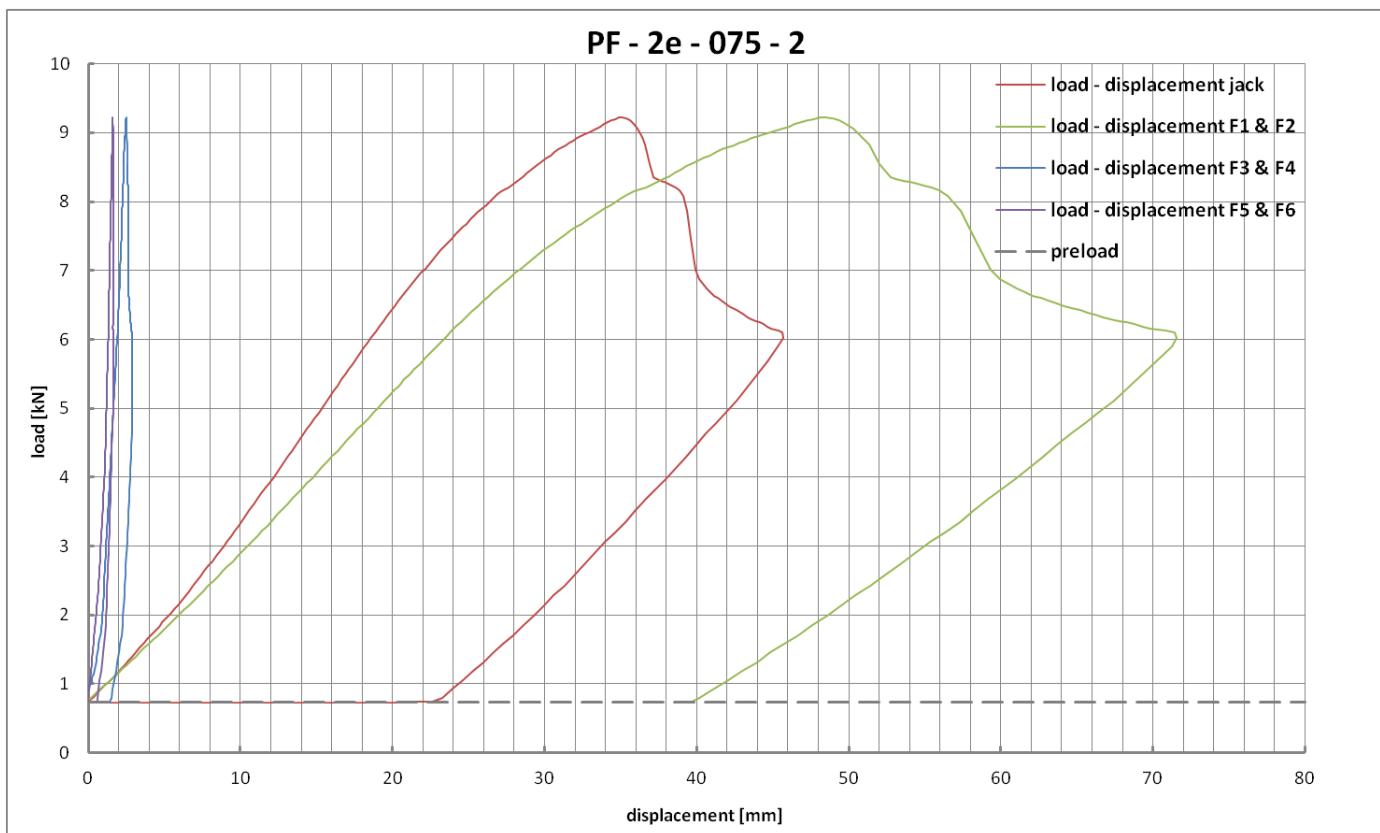


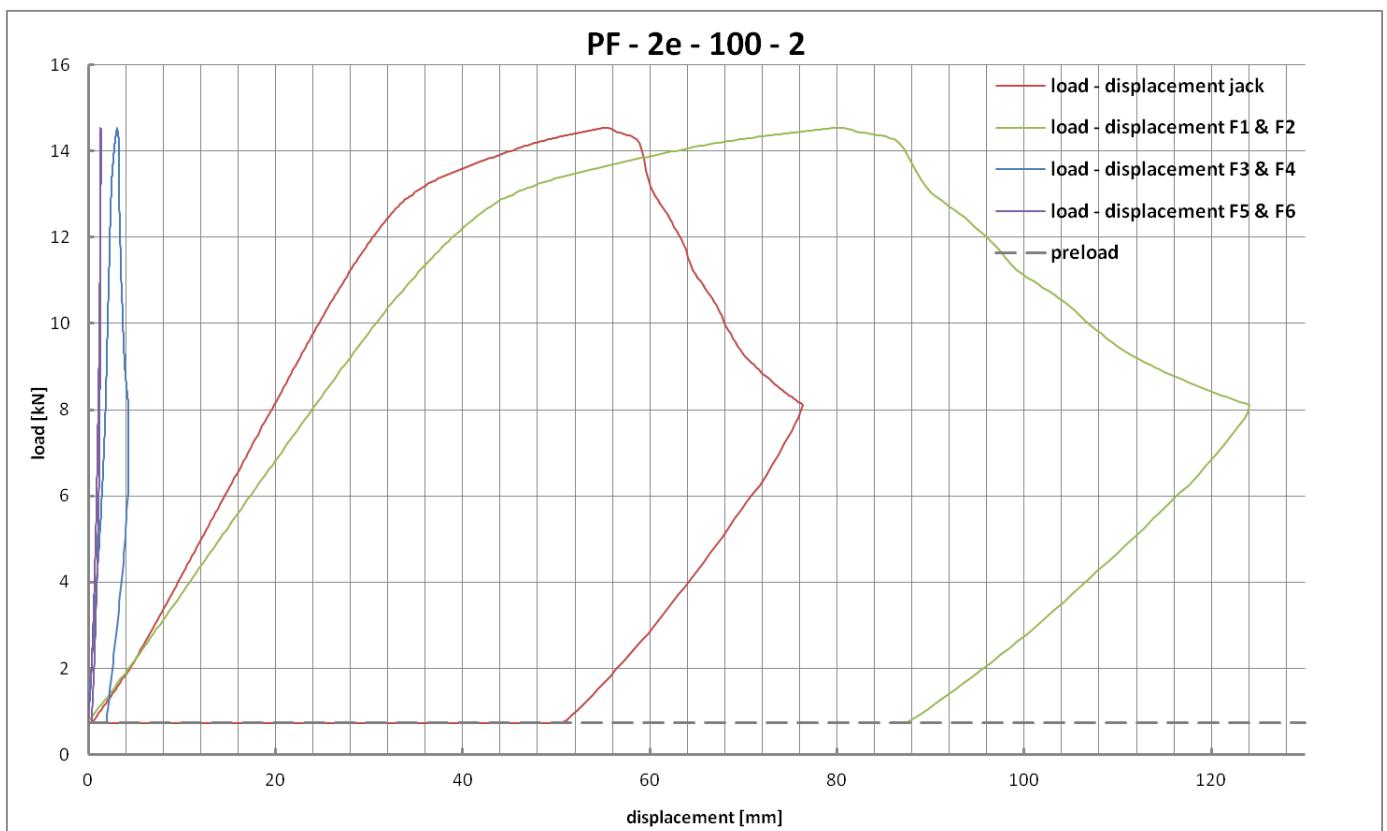
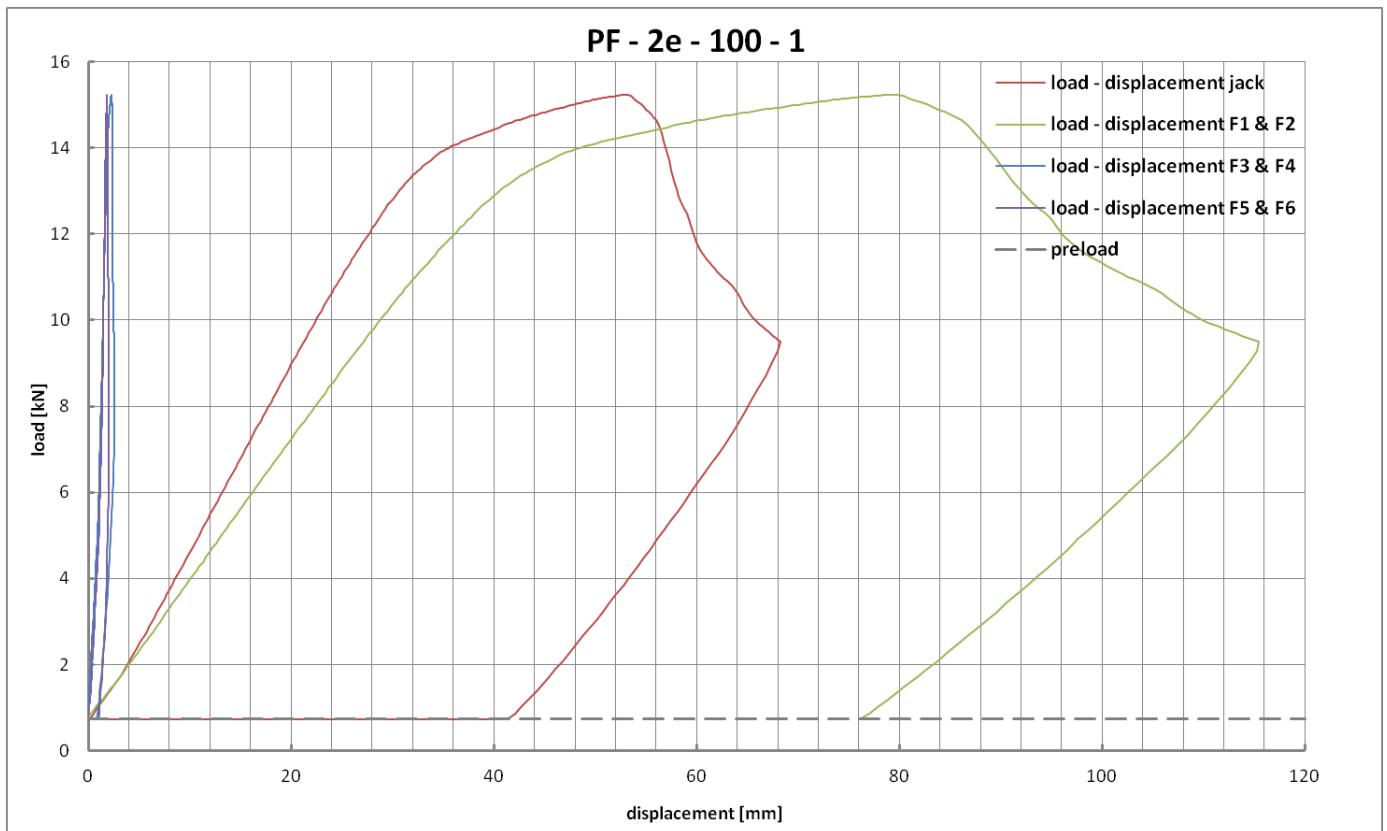


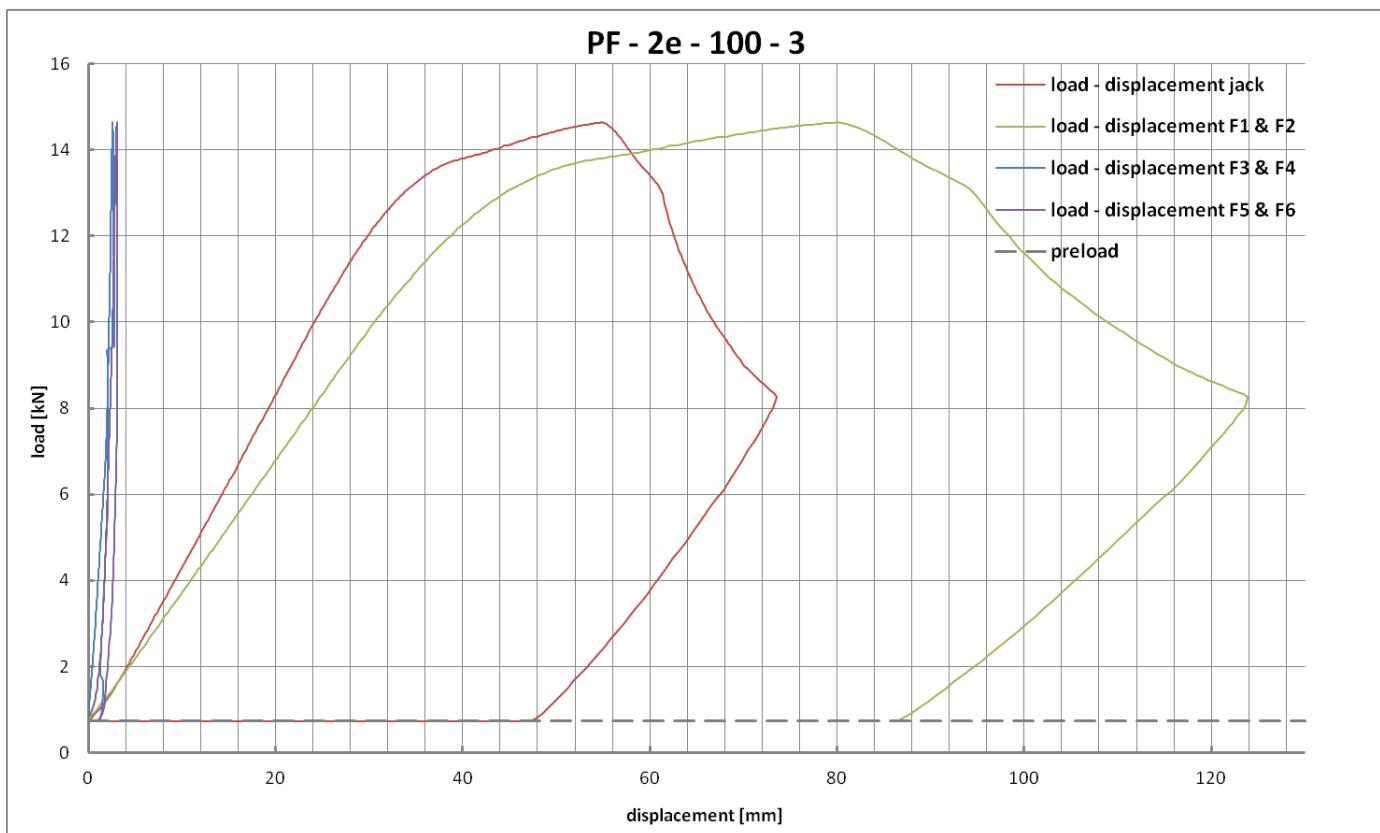


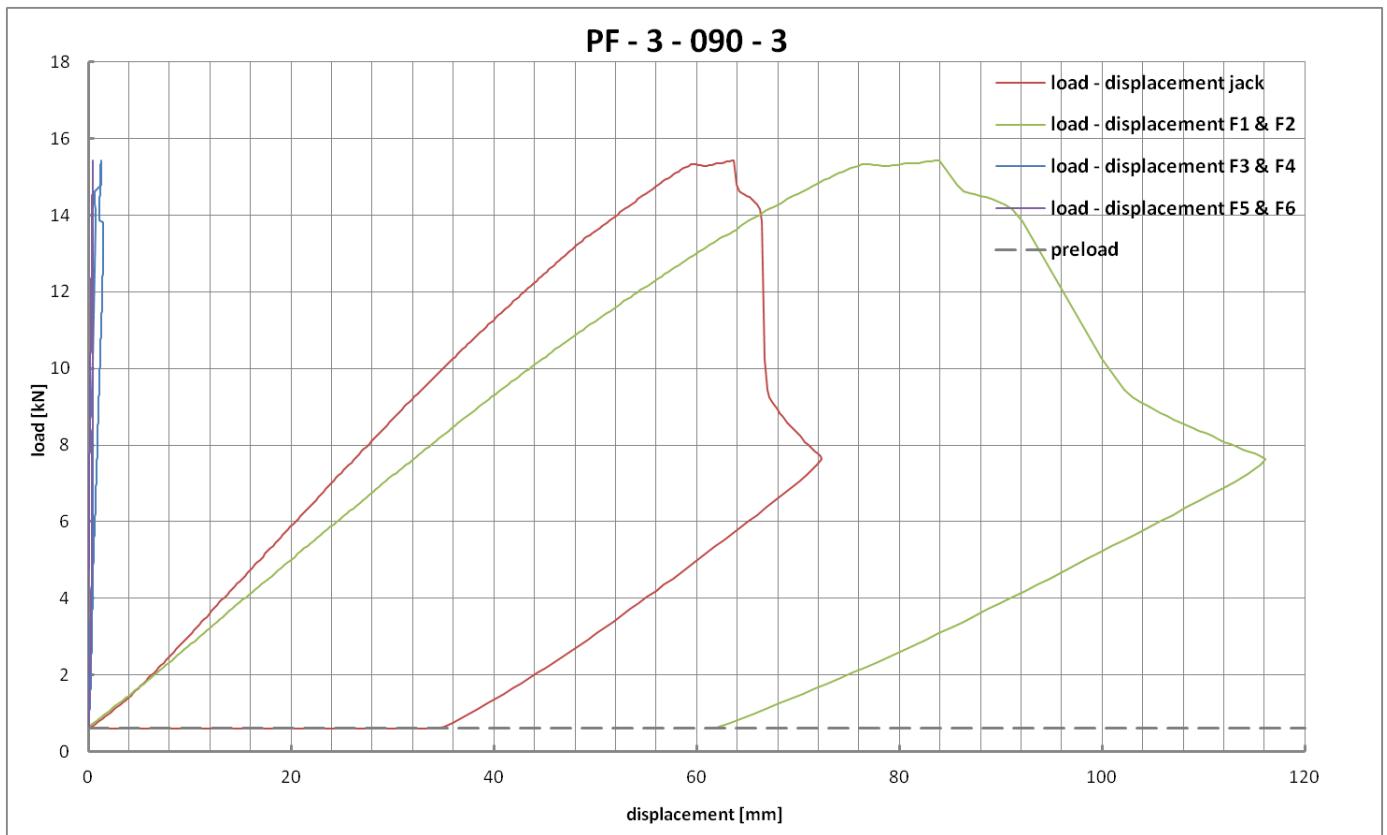
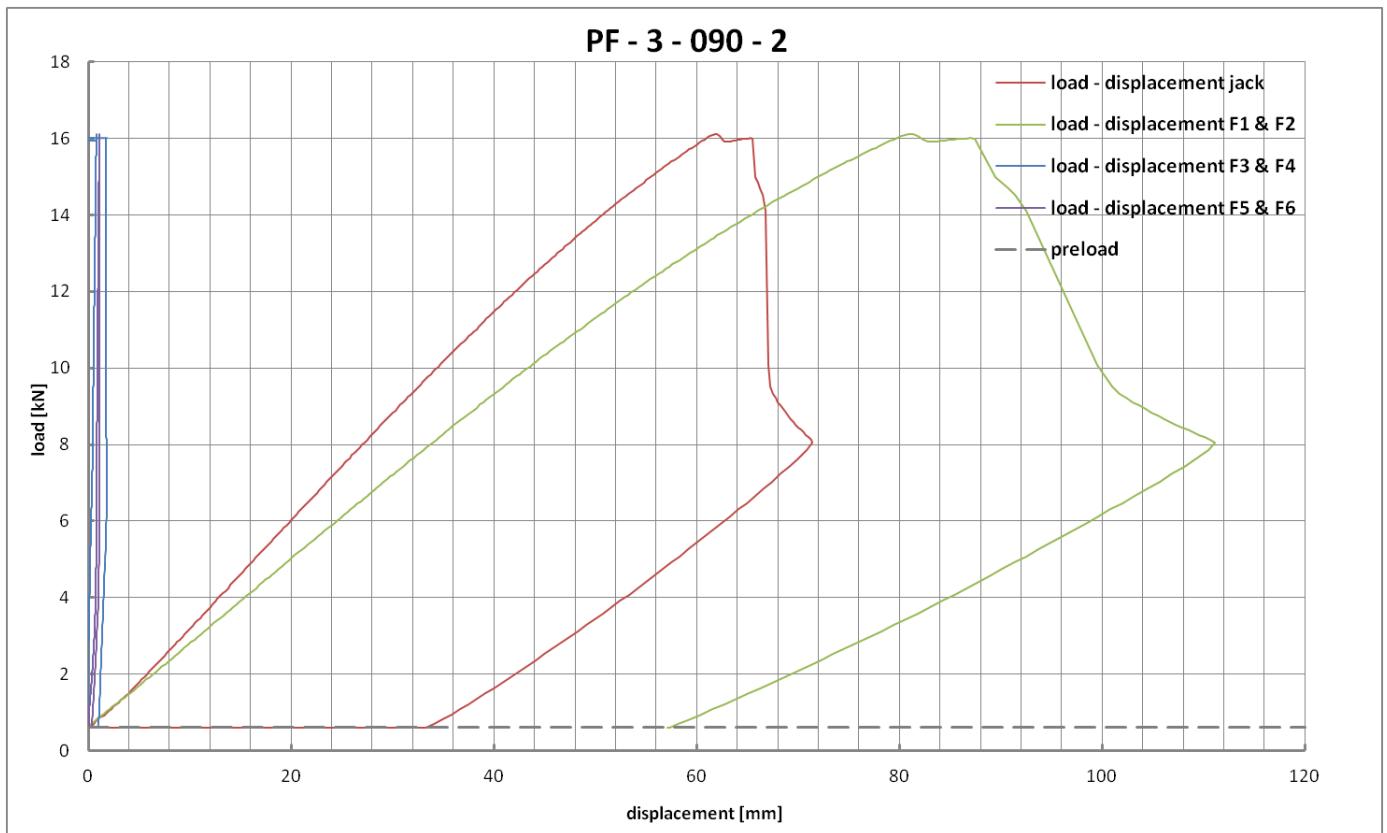
PF-2-100-2: error in data storage (see annex E for a copy of the load-deflection curve)

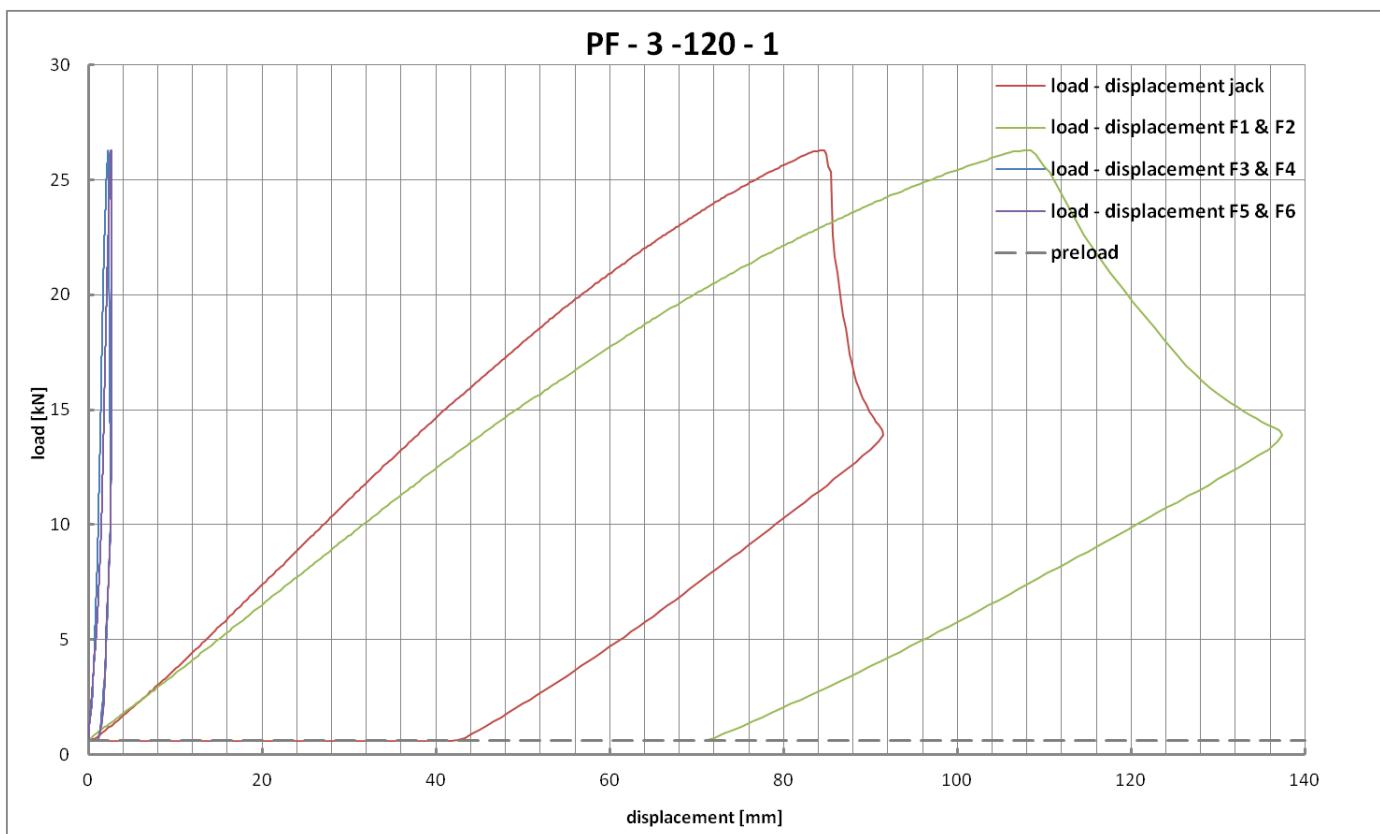
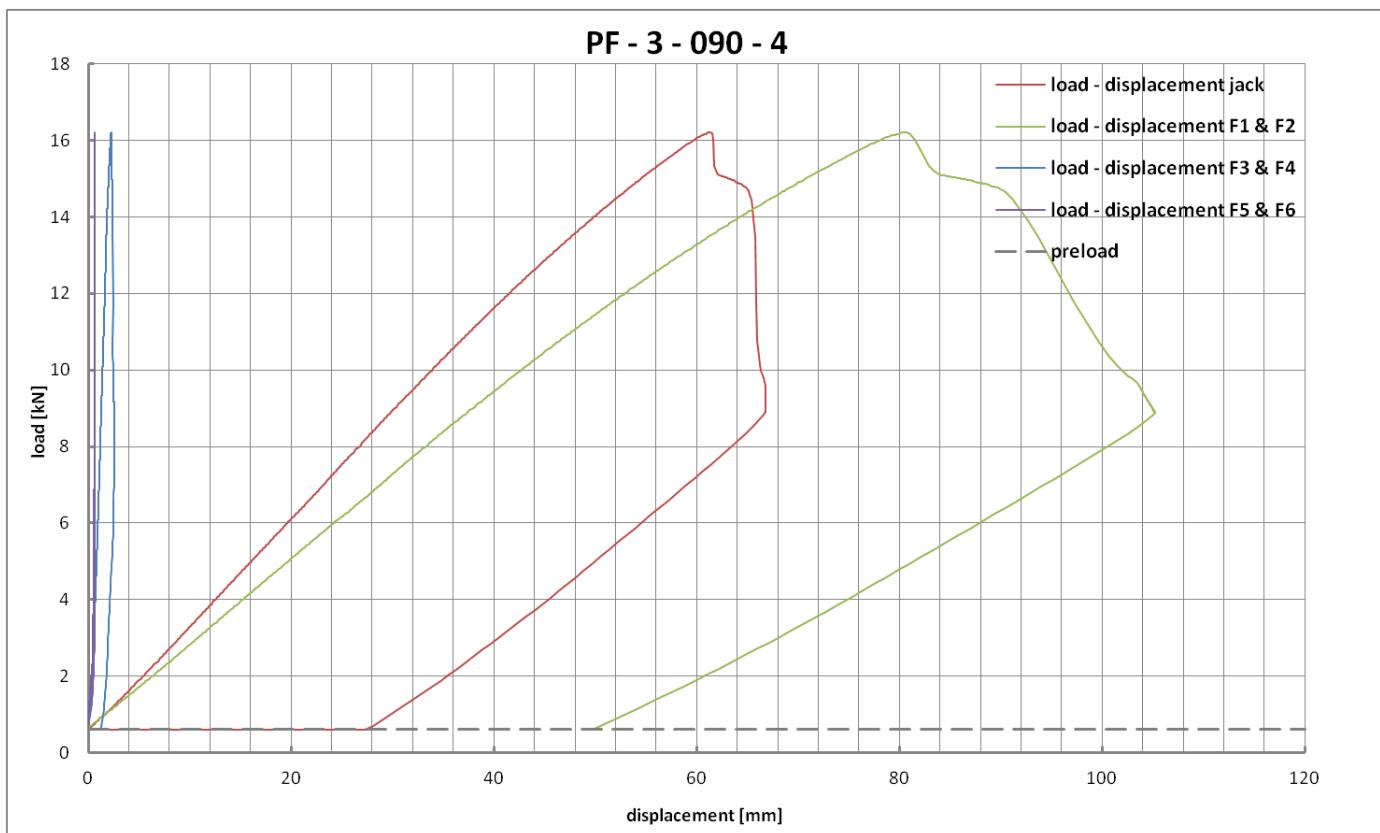


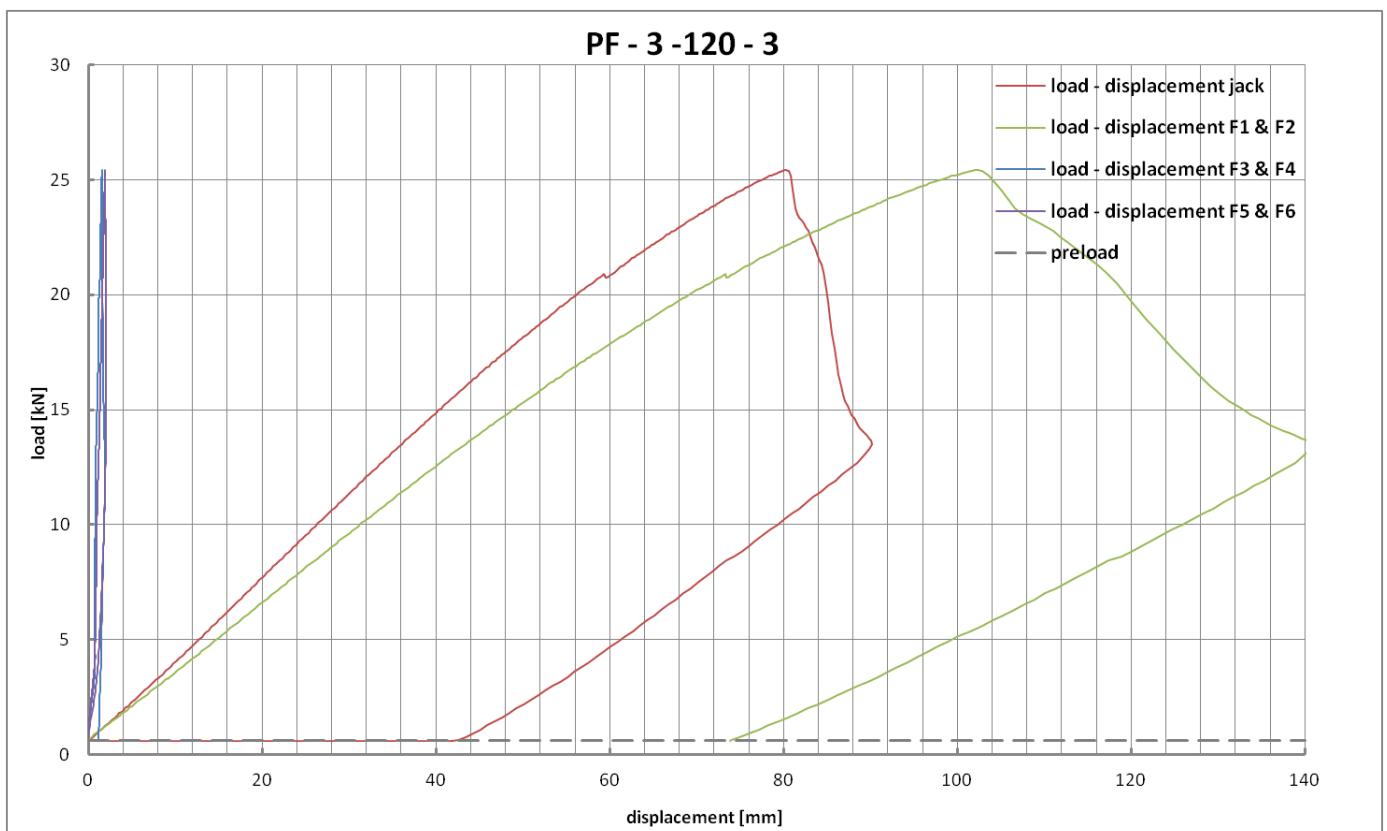
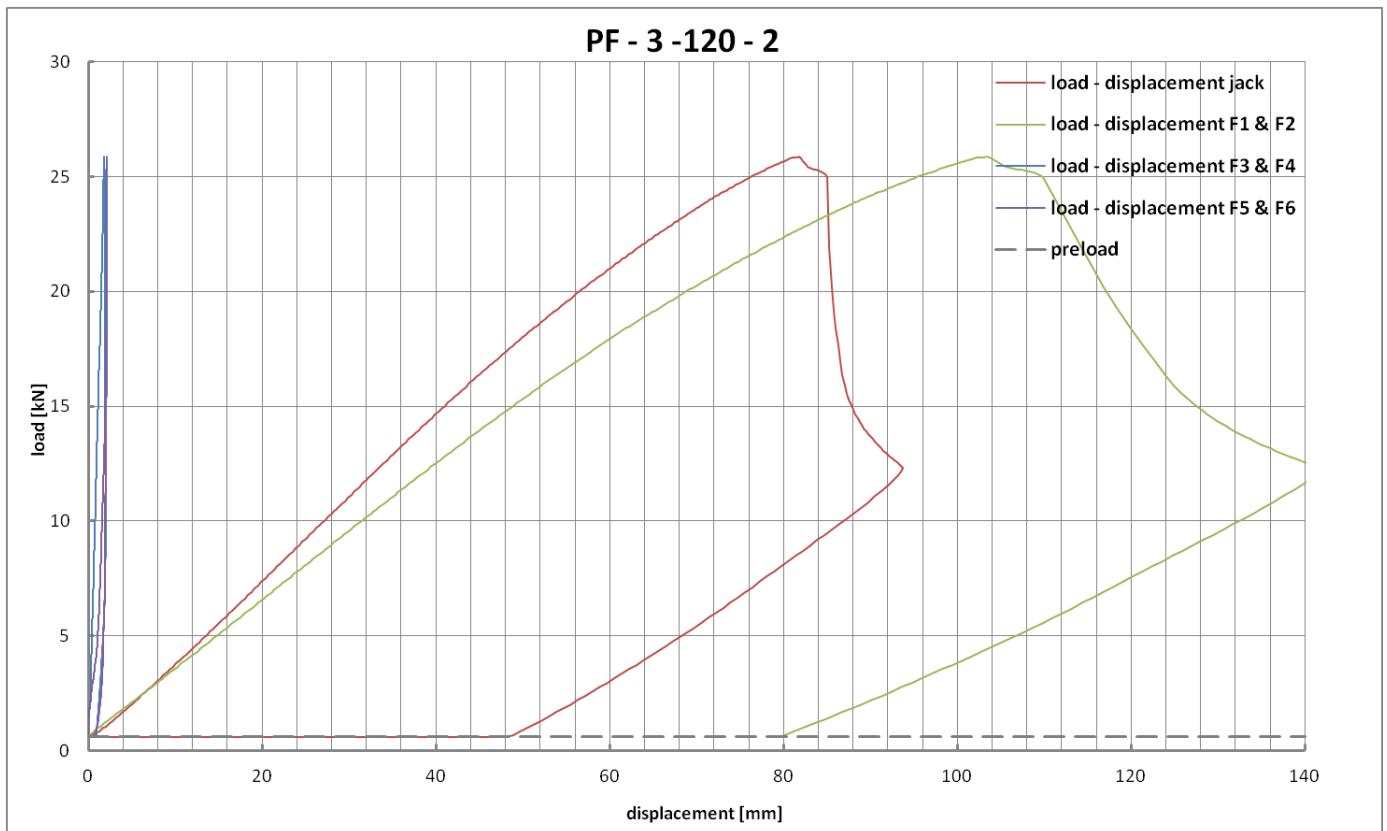


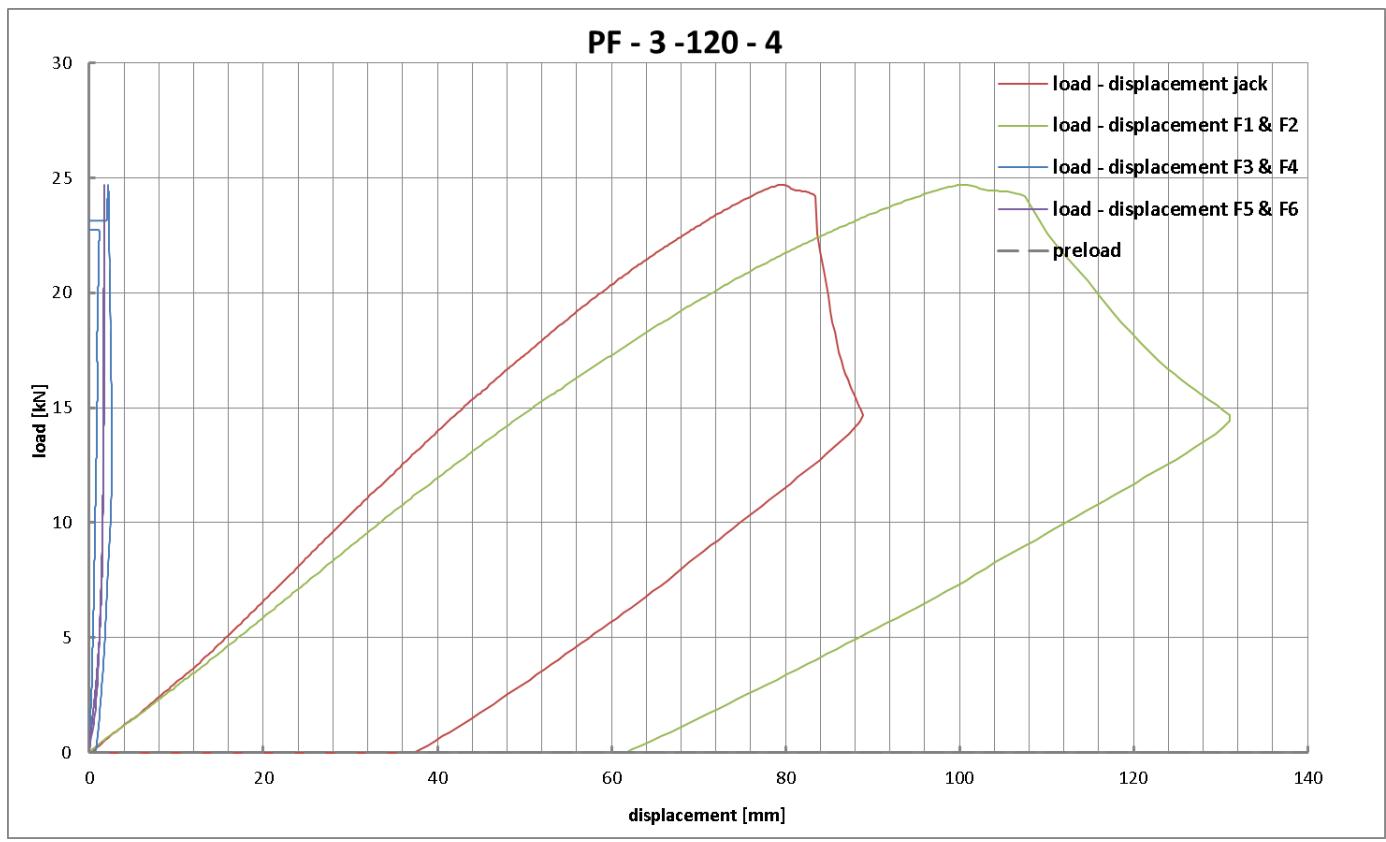












3 Annex C: Intermediate support test with downward load

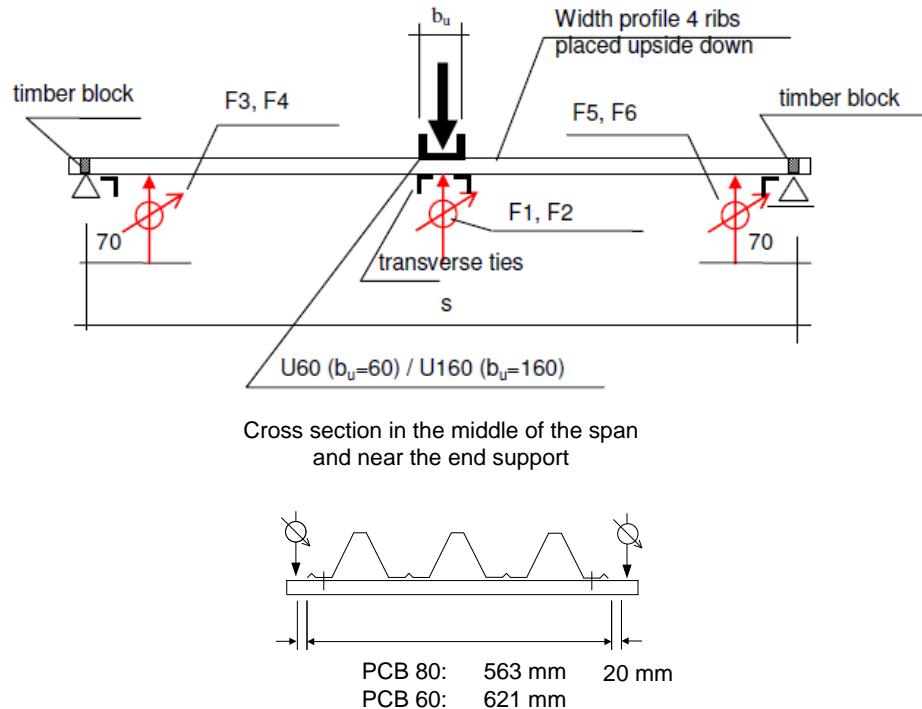


Figure C.1: Schematic test setup



Figure C.2: Test setup (exemplary for PCB 80, $b_u = 60$ mm, $t_N = 0.75$ mm without embossments)



Figure C.3: Test setup (exemplary for PCB 60, $b_u = 60$ mm, $t_N = 0.75$ mm without embossments)



Figure C.4: Failure mode (exemplary for PCB 80, $b_u = 60$ mm, $t_N = 0.75$ without embossments)

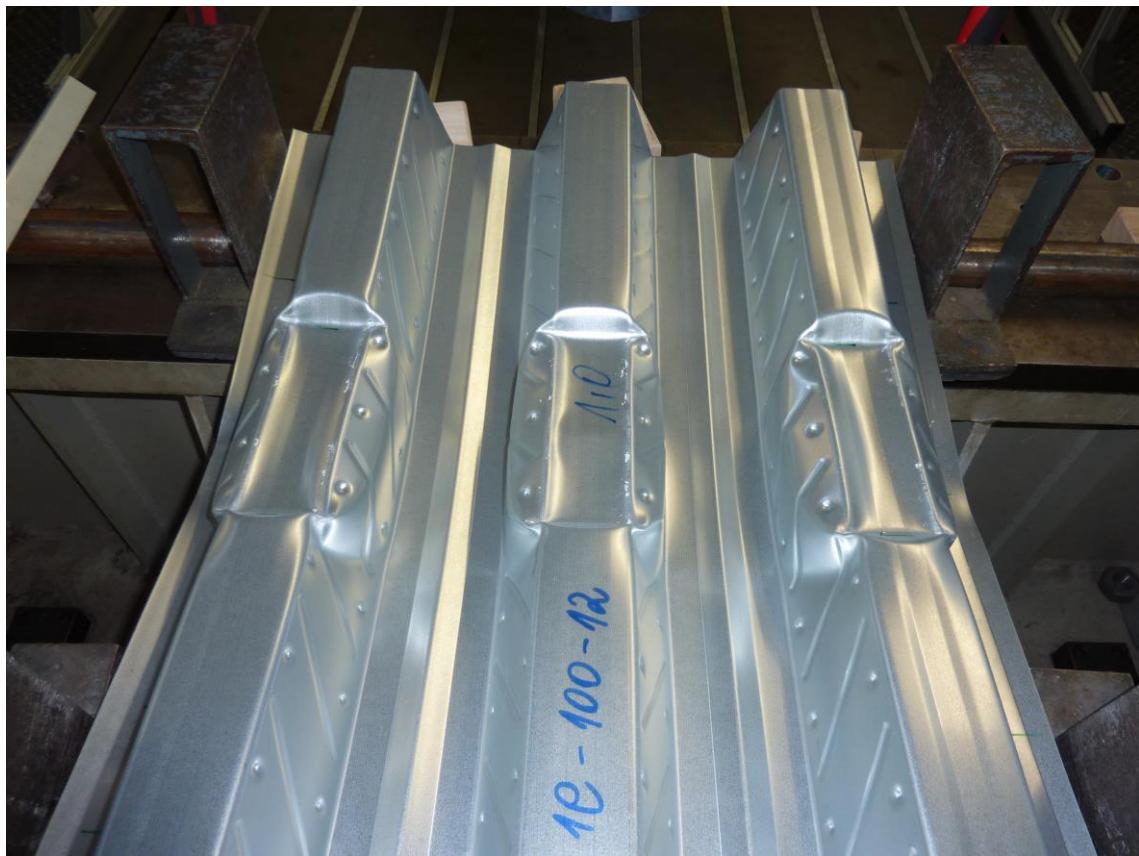


Figure C.5: Failure mode (exemplary for PCB 80, $b_u = 160$ mm, $t_N = 1.00$ with embossments)

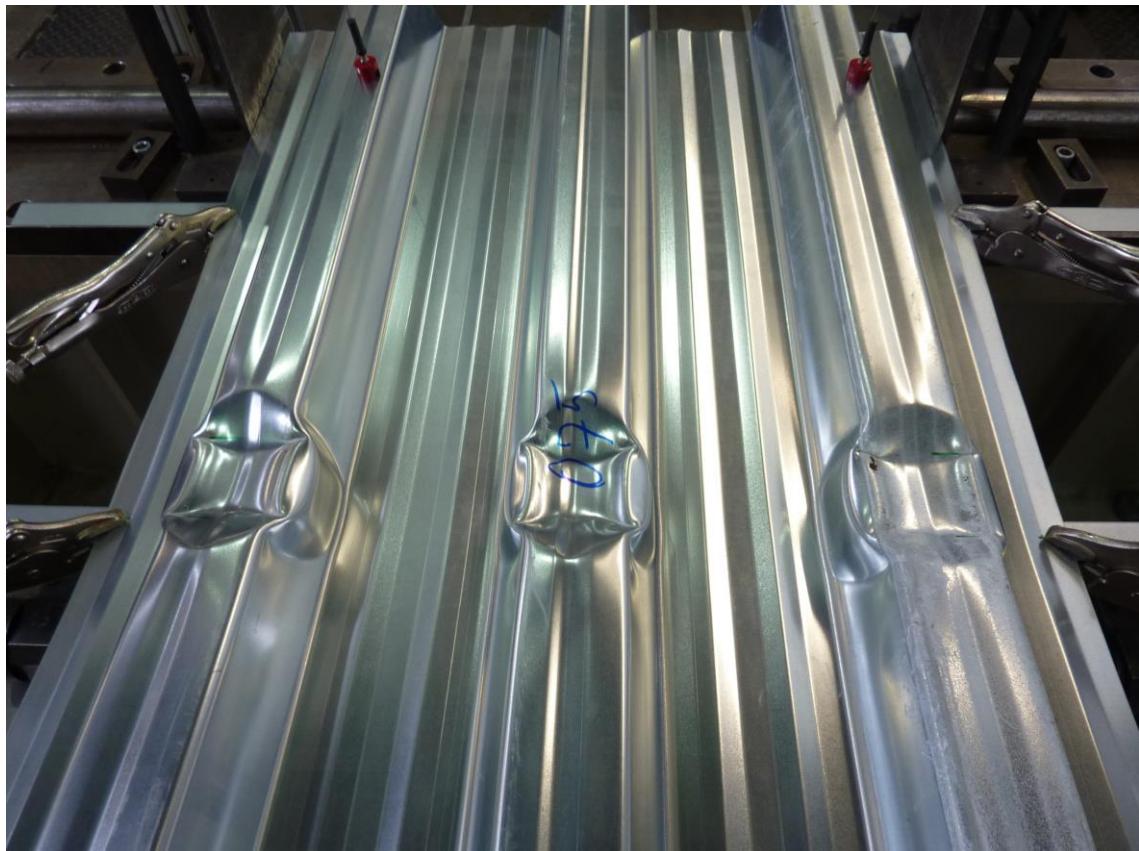


Figure C.6: Failure mode (exemplary for PCB 60, $b_u = 60$ mm, $t_N = 0.75$ without embossments)

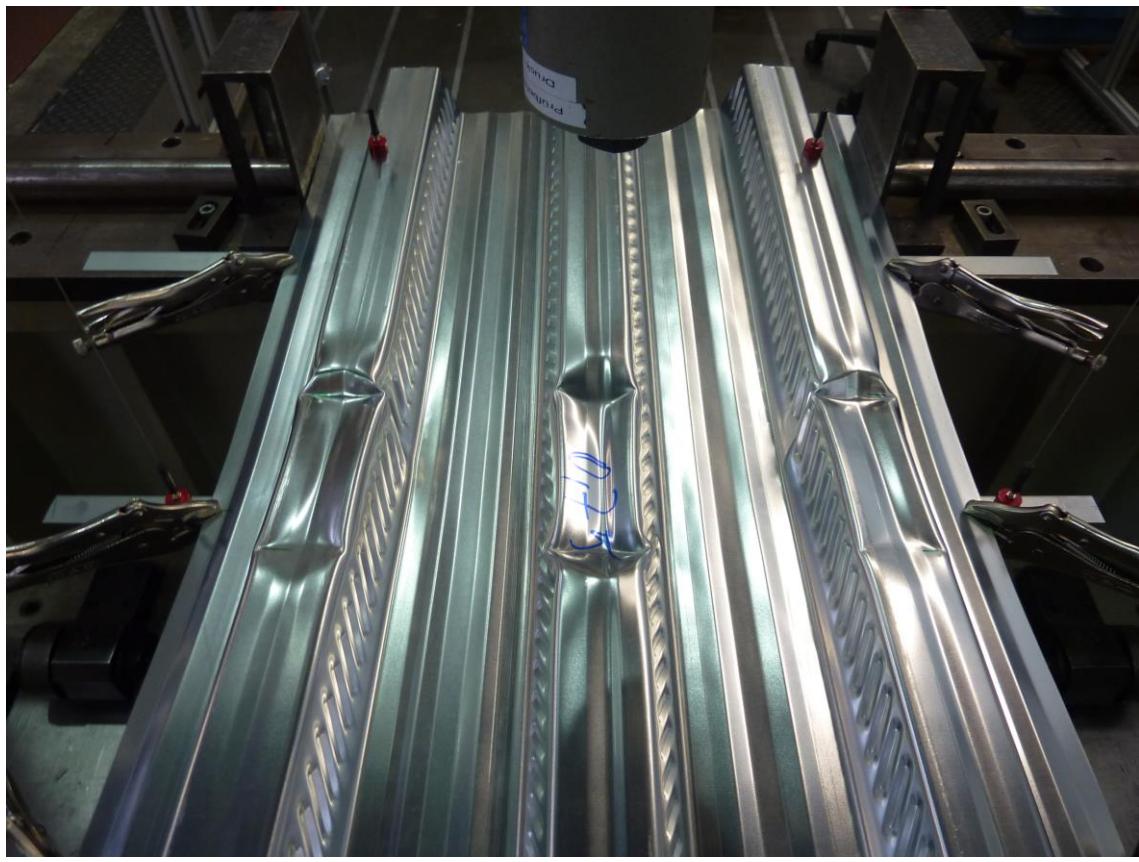
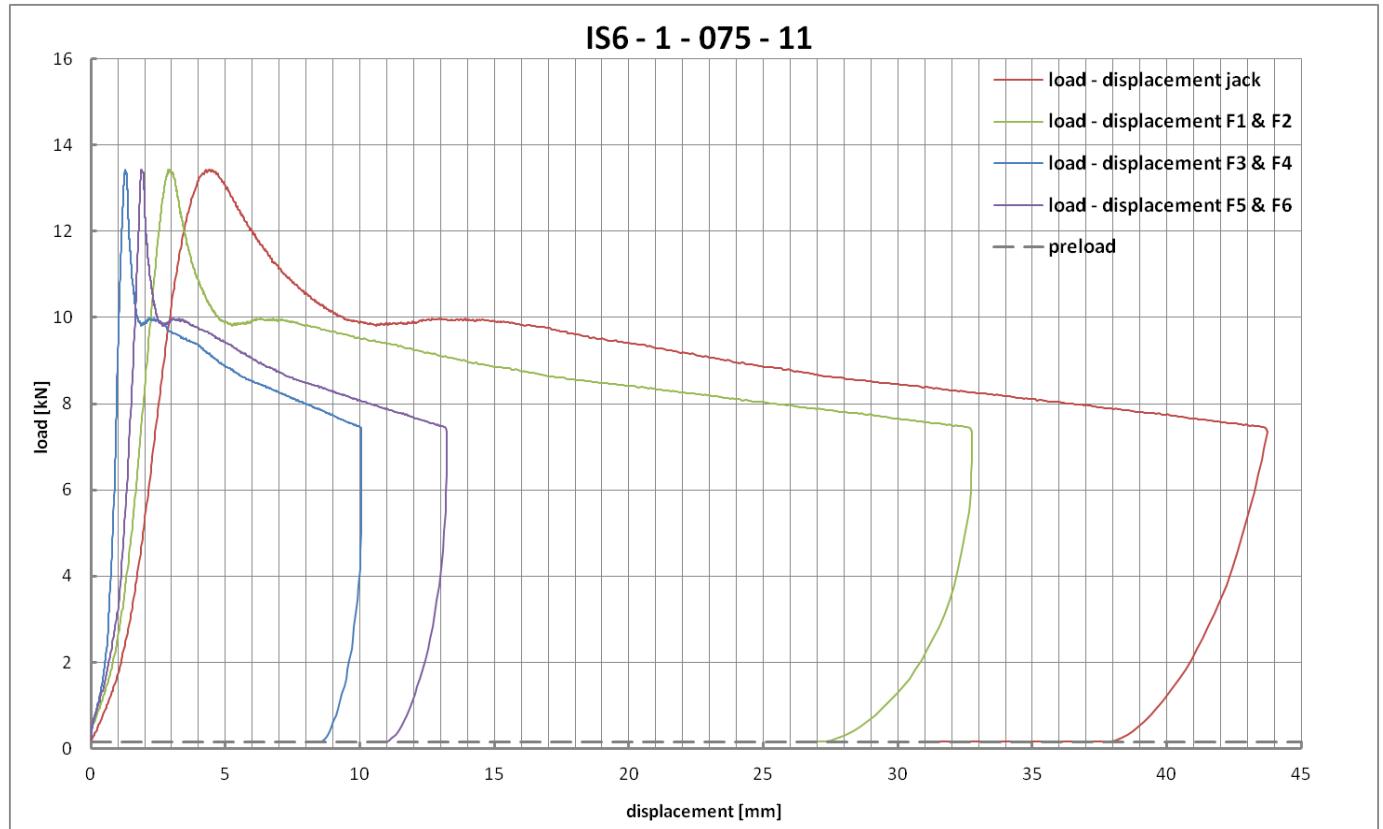
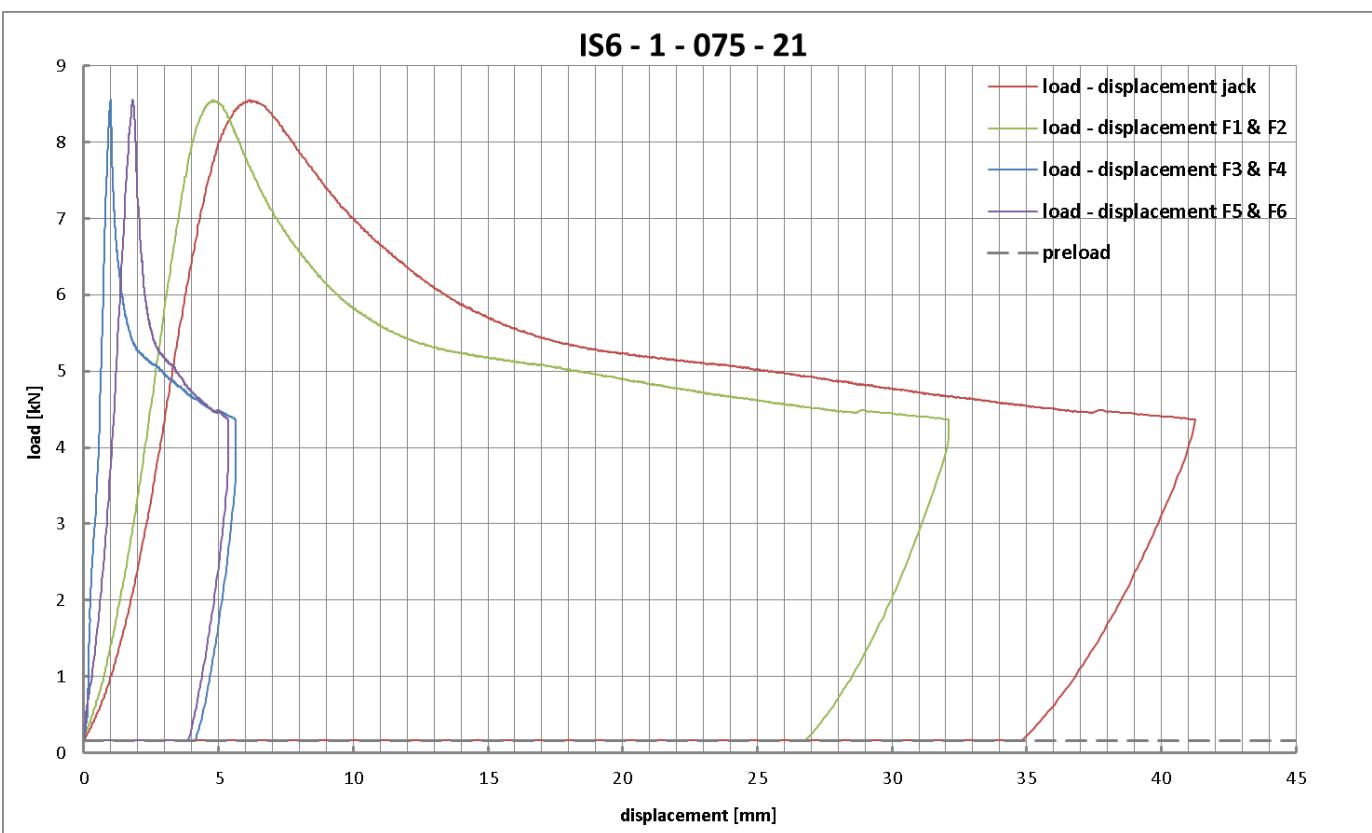
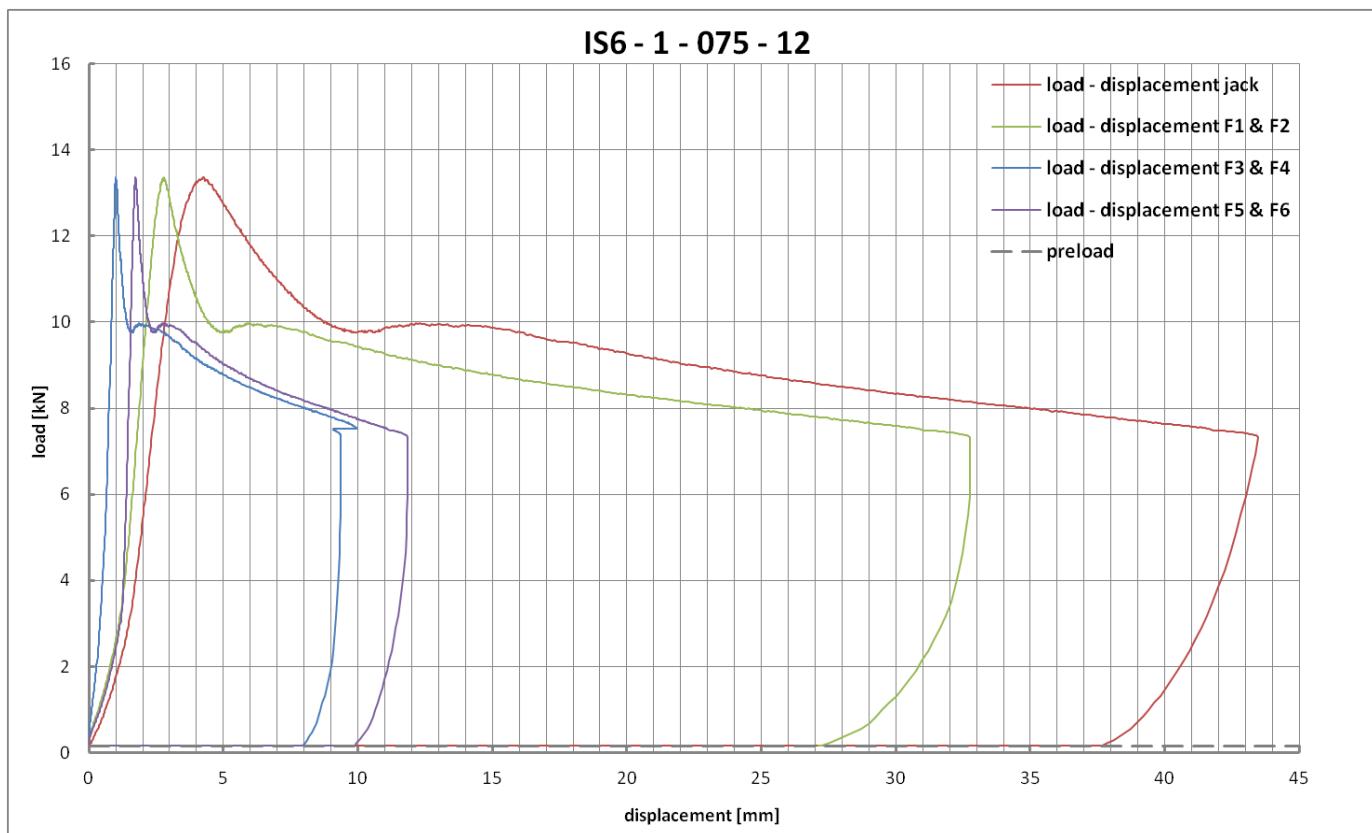
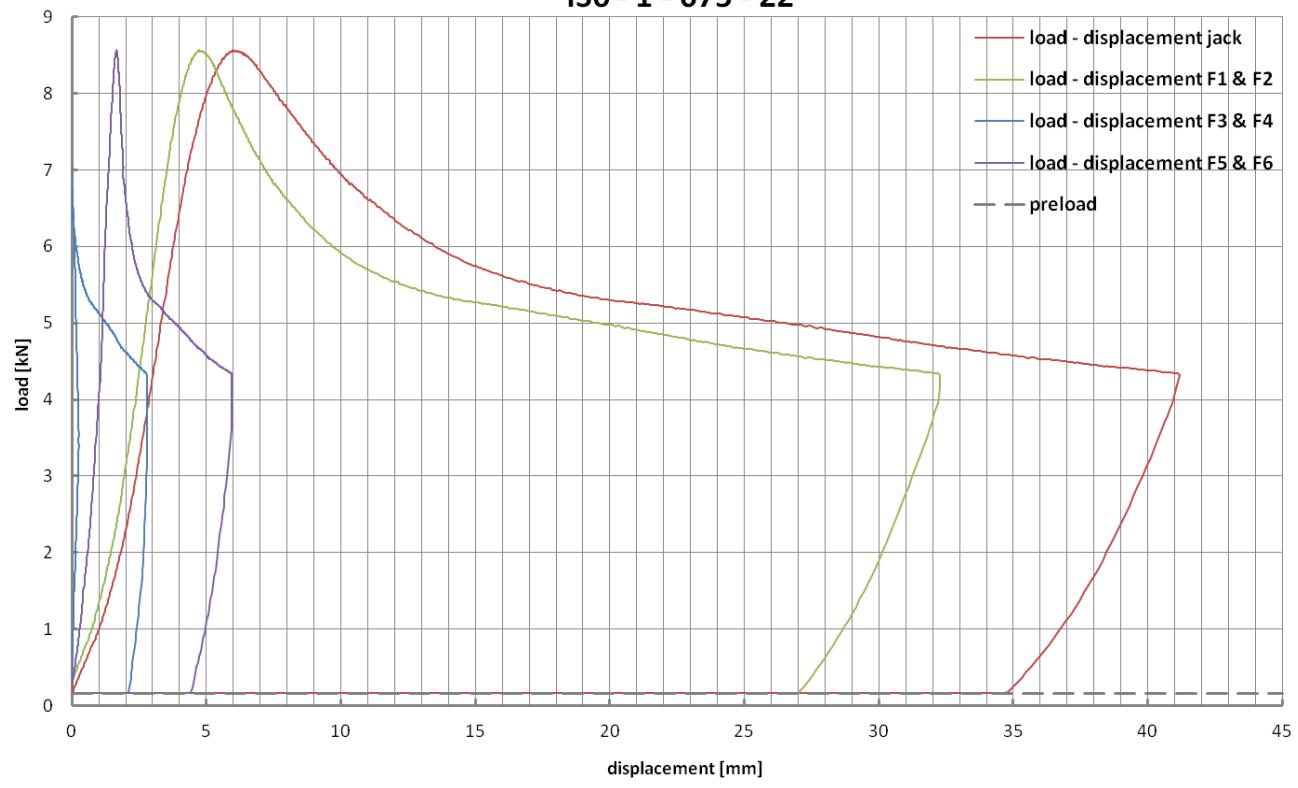
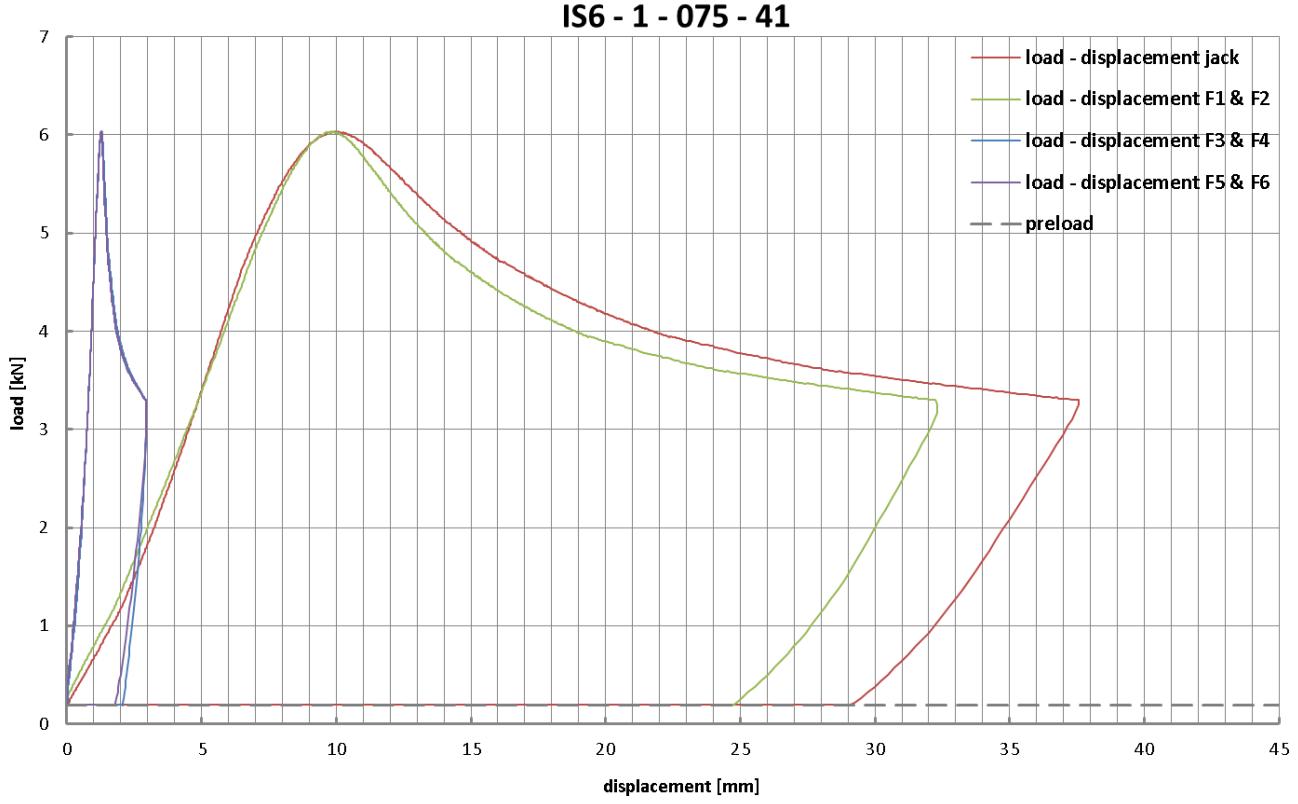


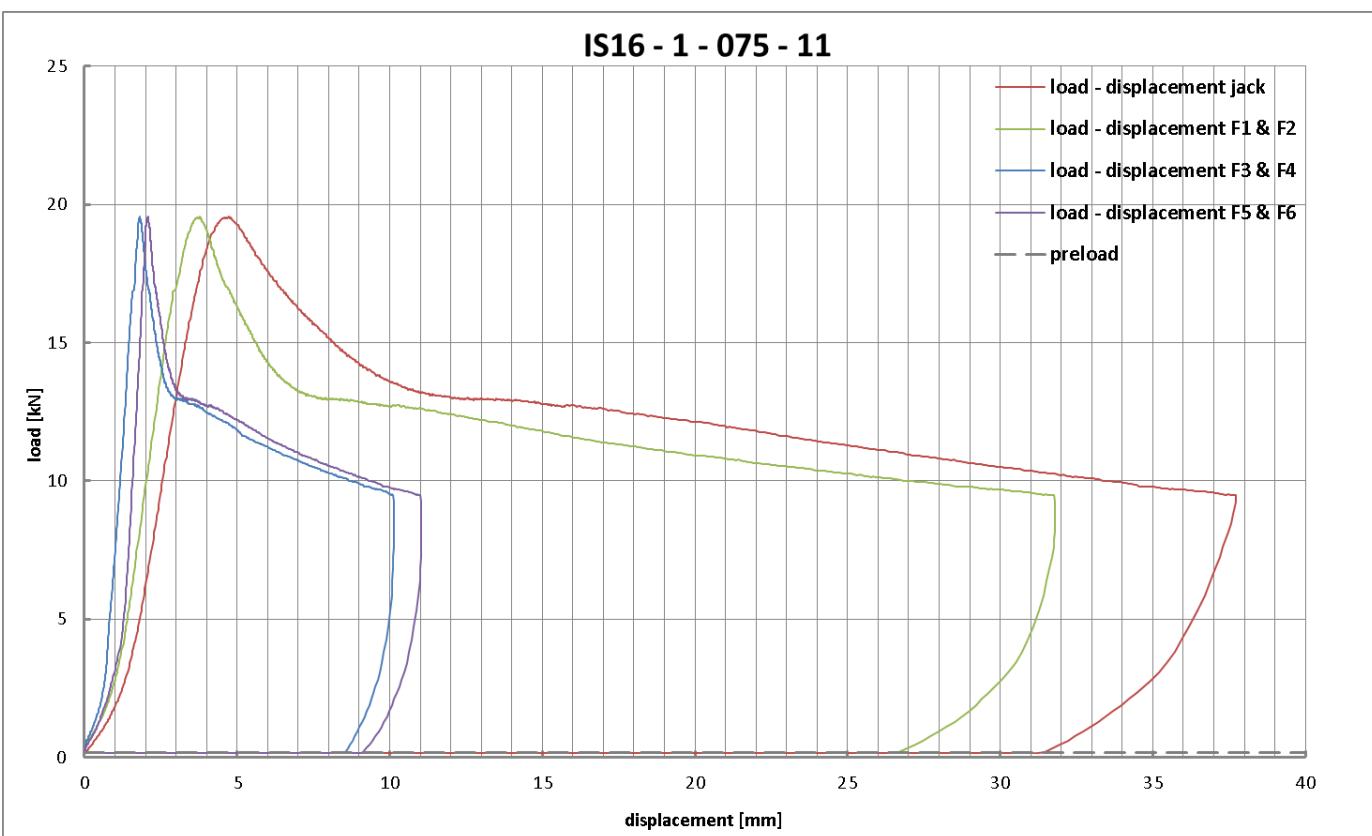
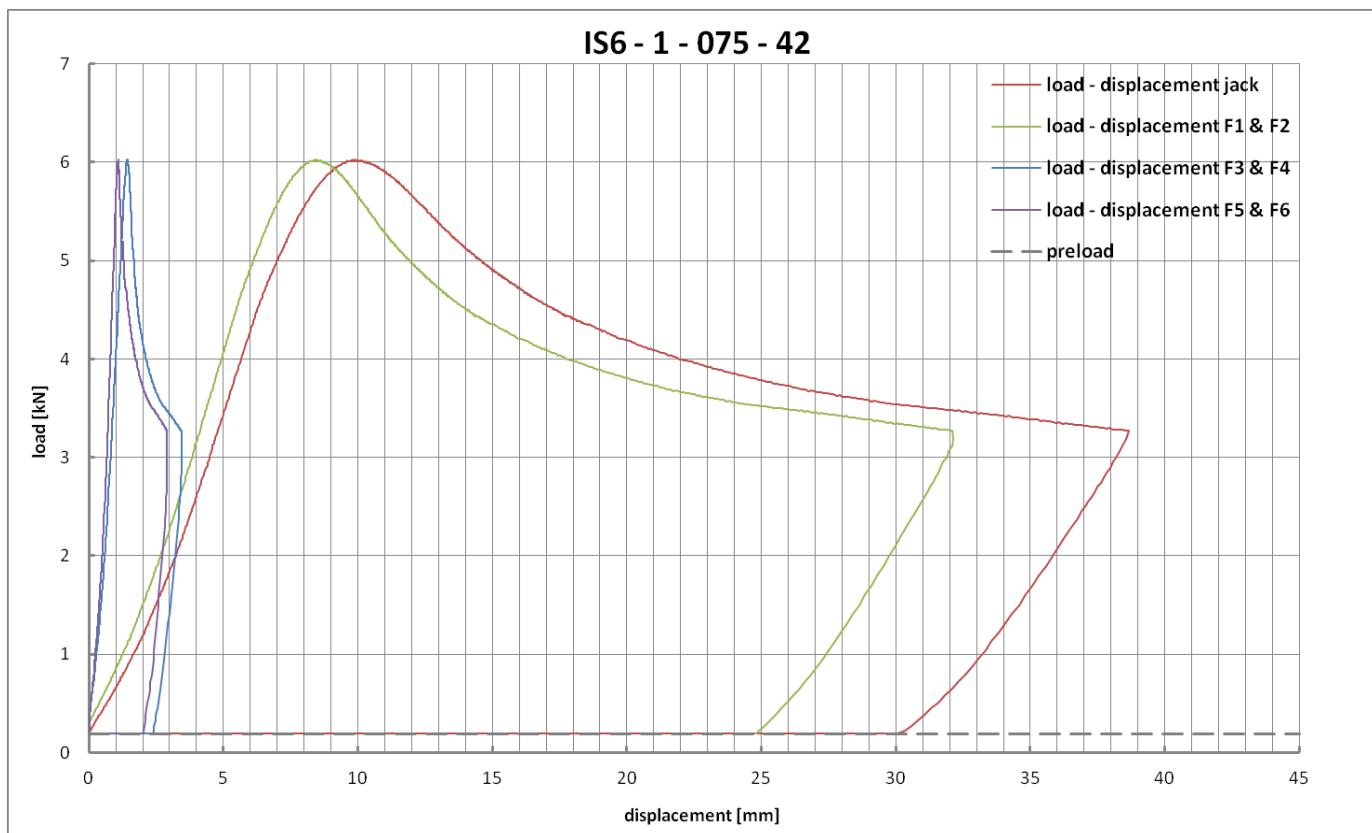
Figure C.7: Failure mode (exemplary for PCB 60, $b_u = 160$ mm, $t_N = 0.75$ with embossments)

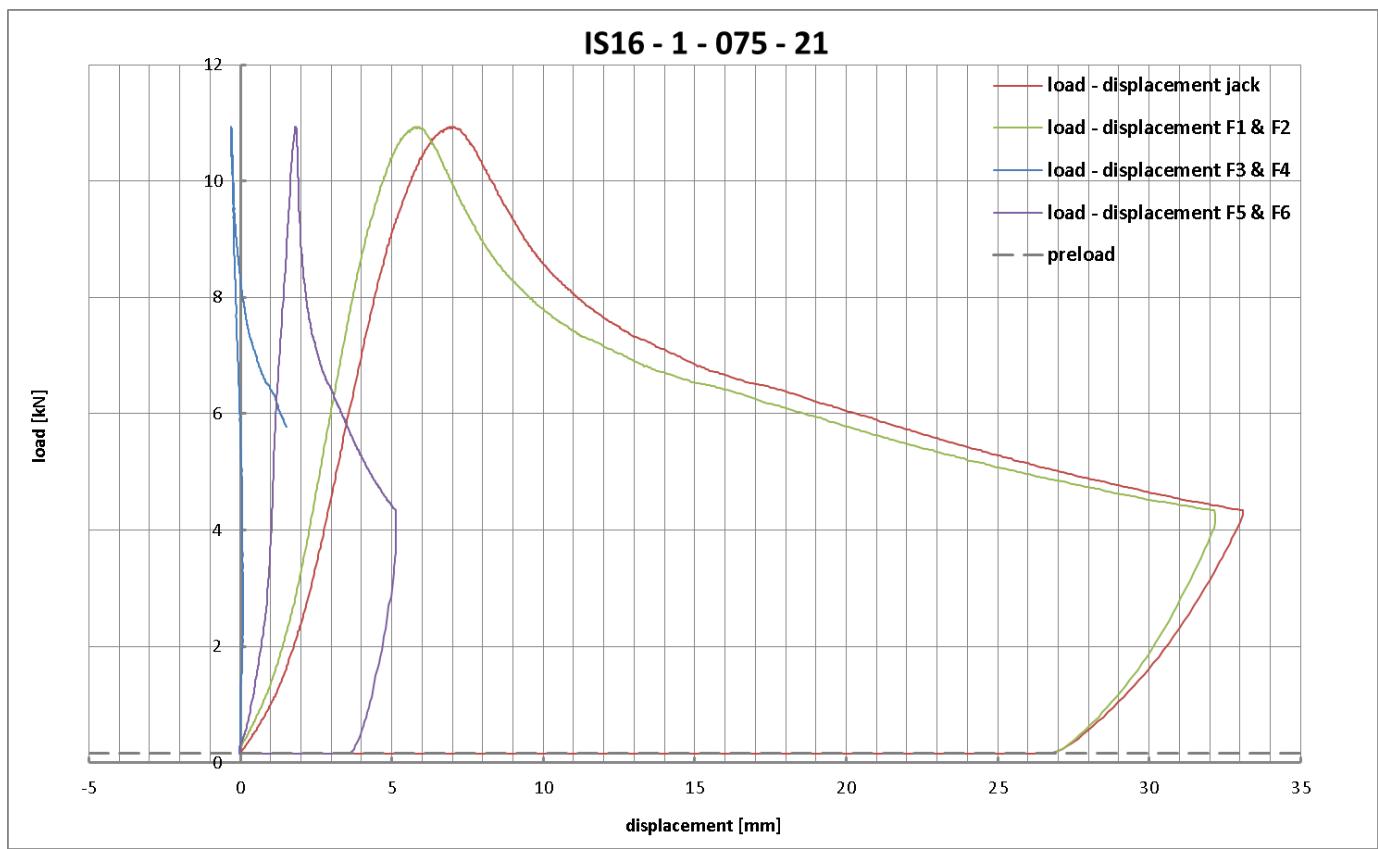
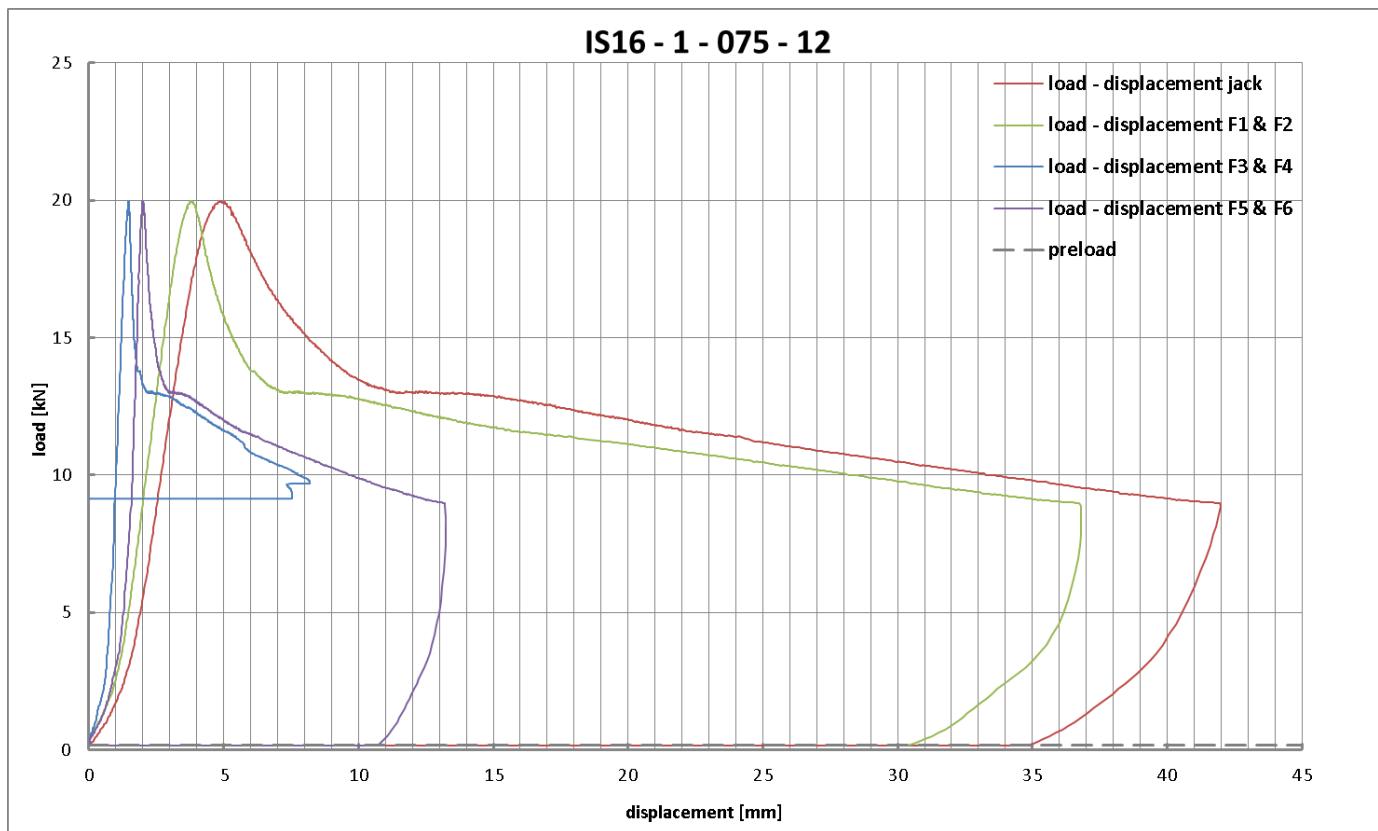
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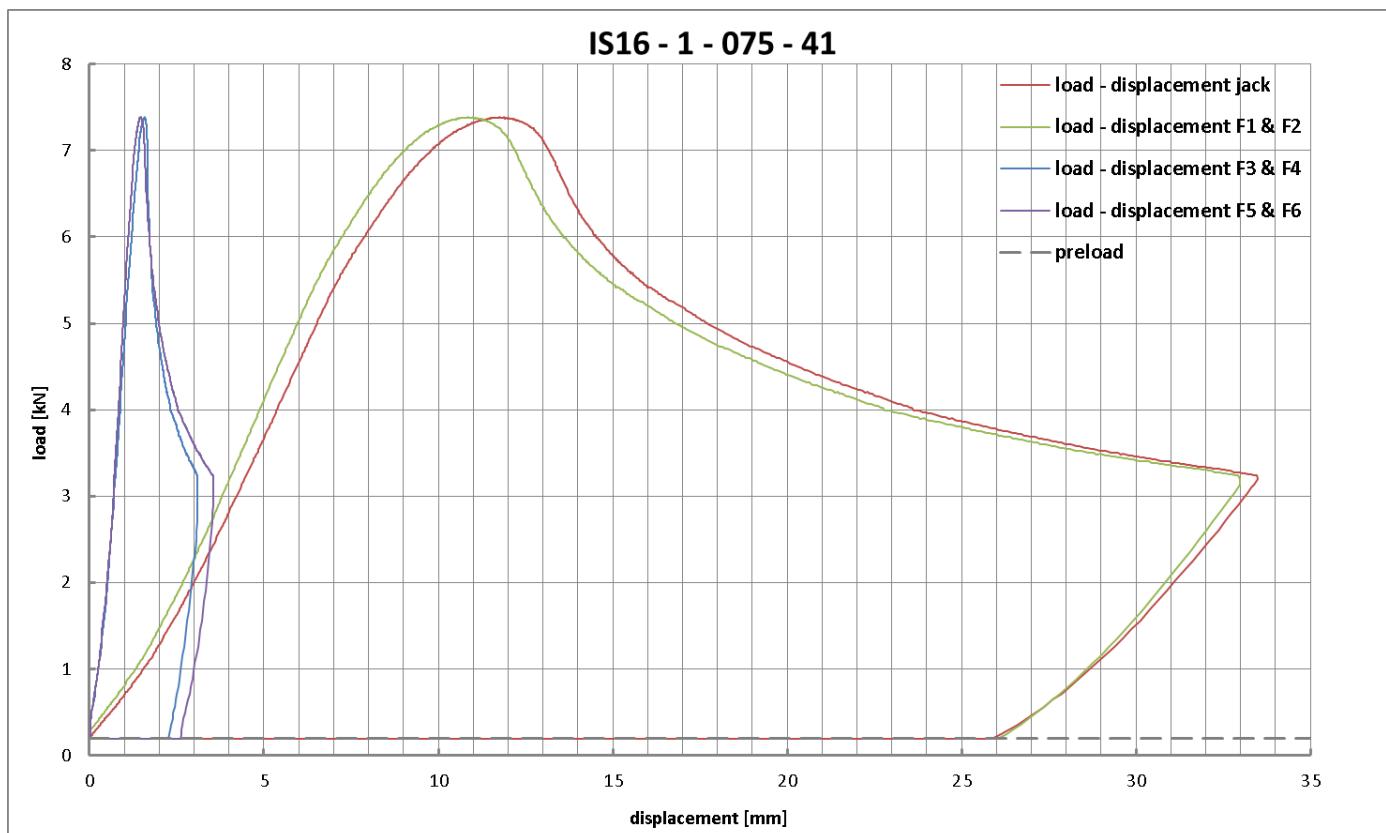
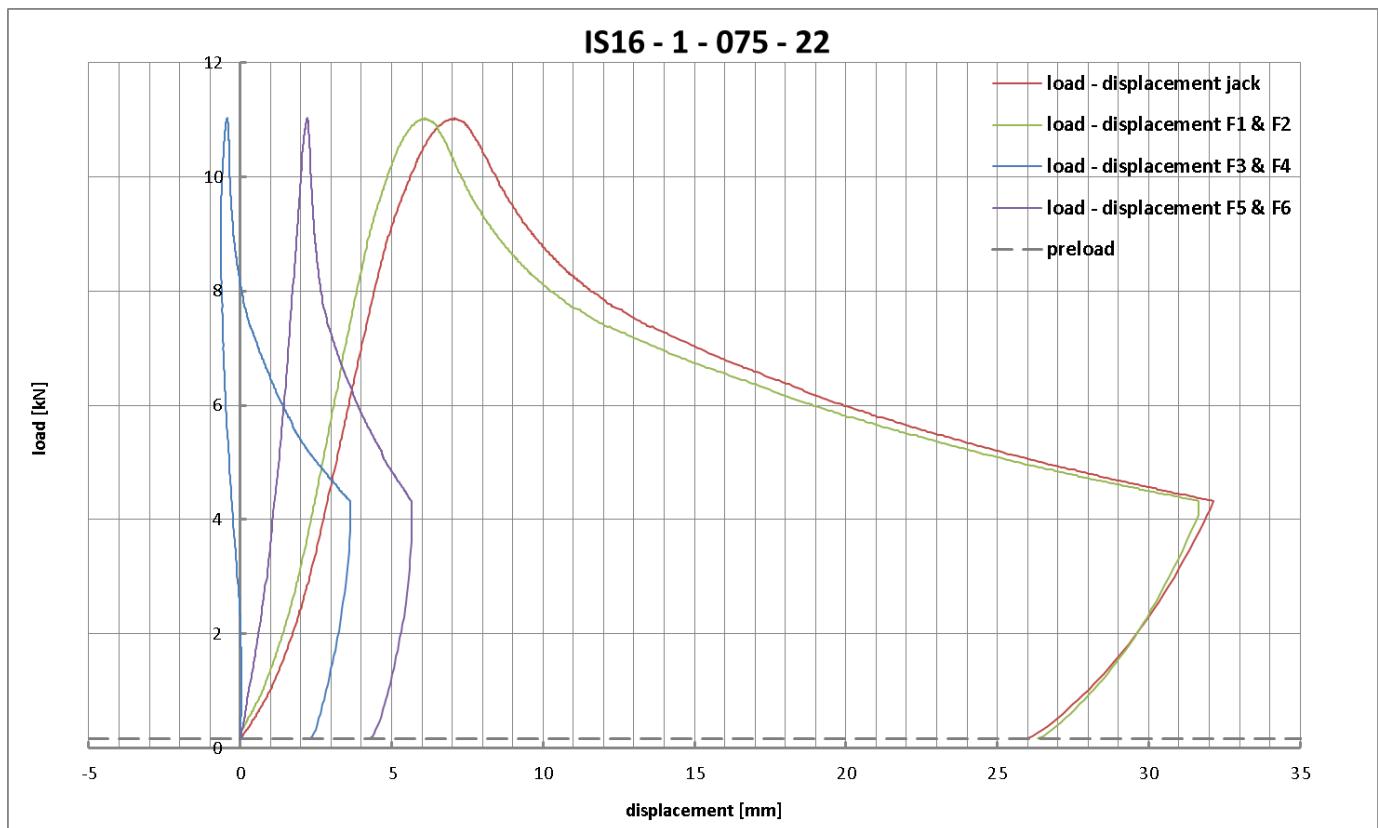


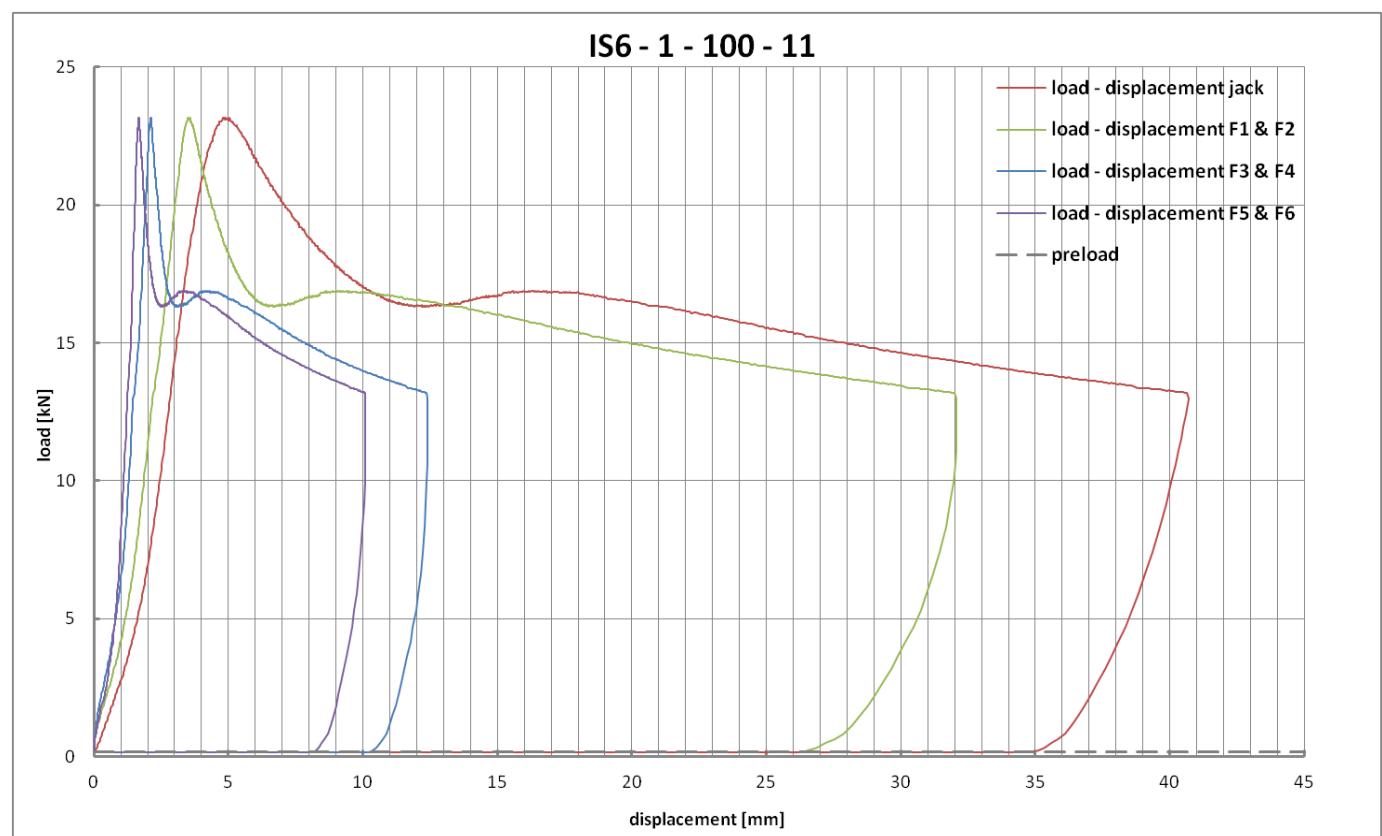
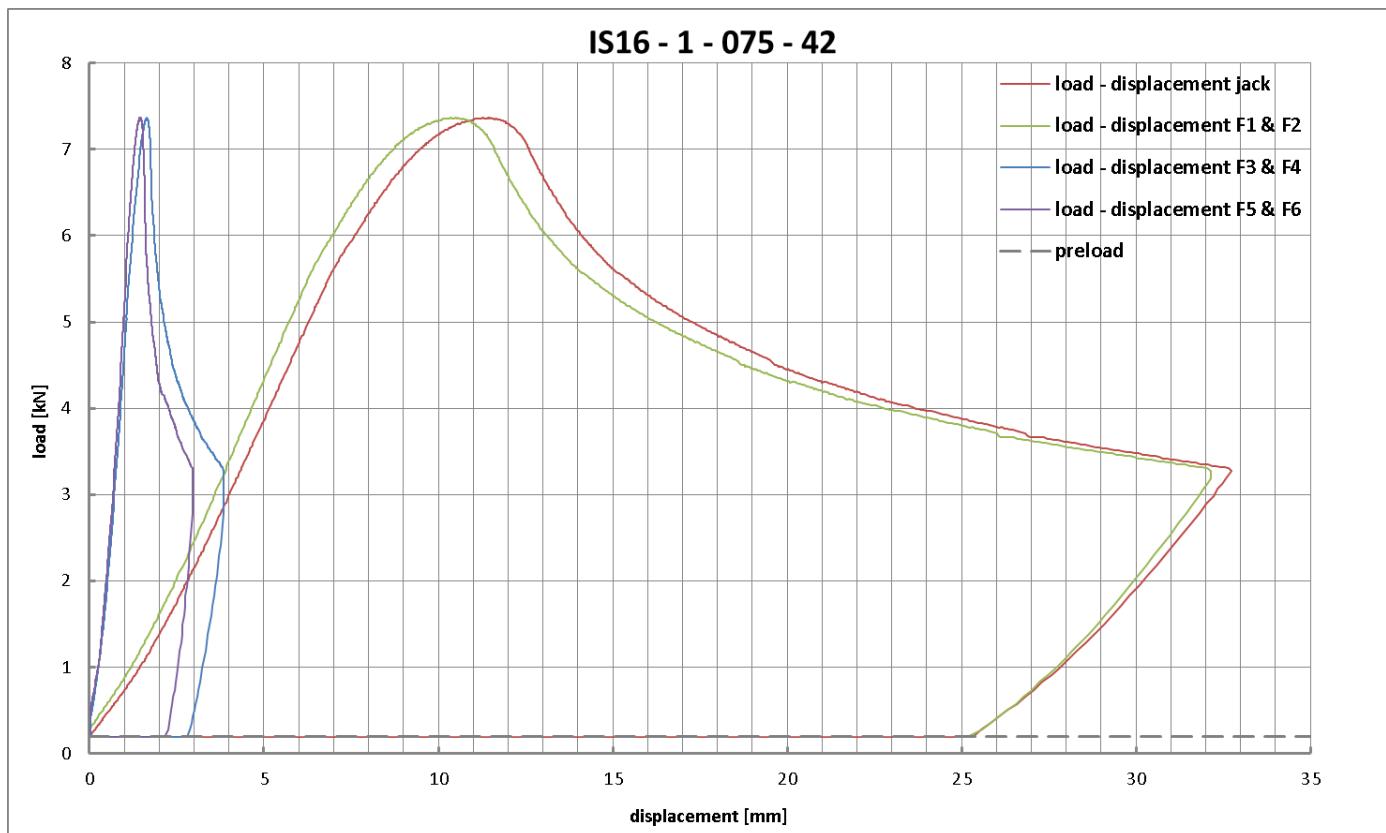


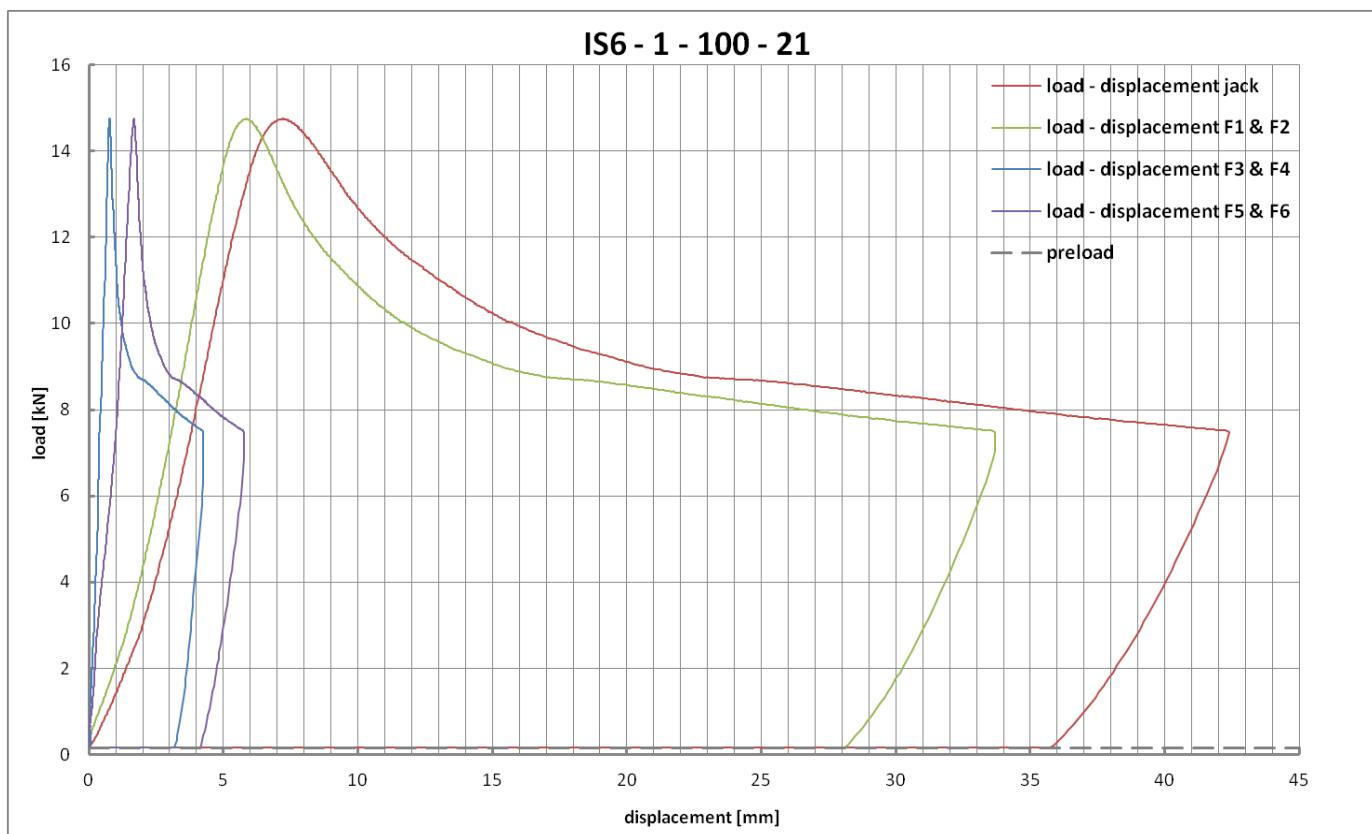
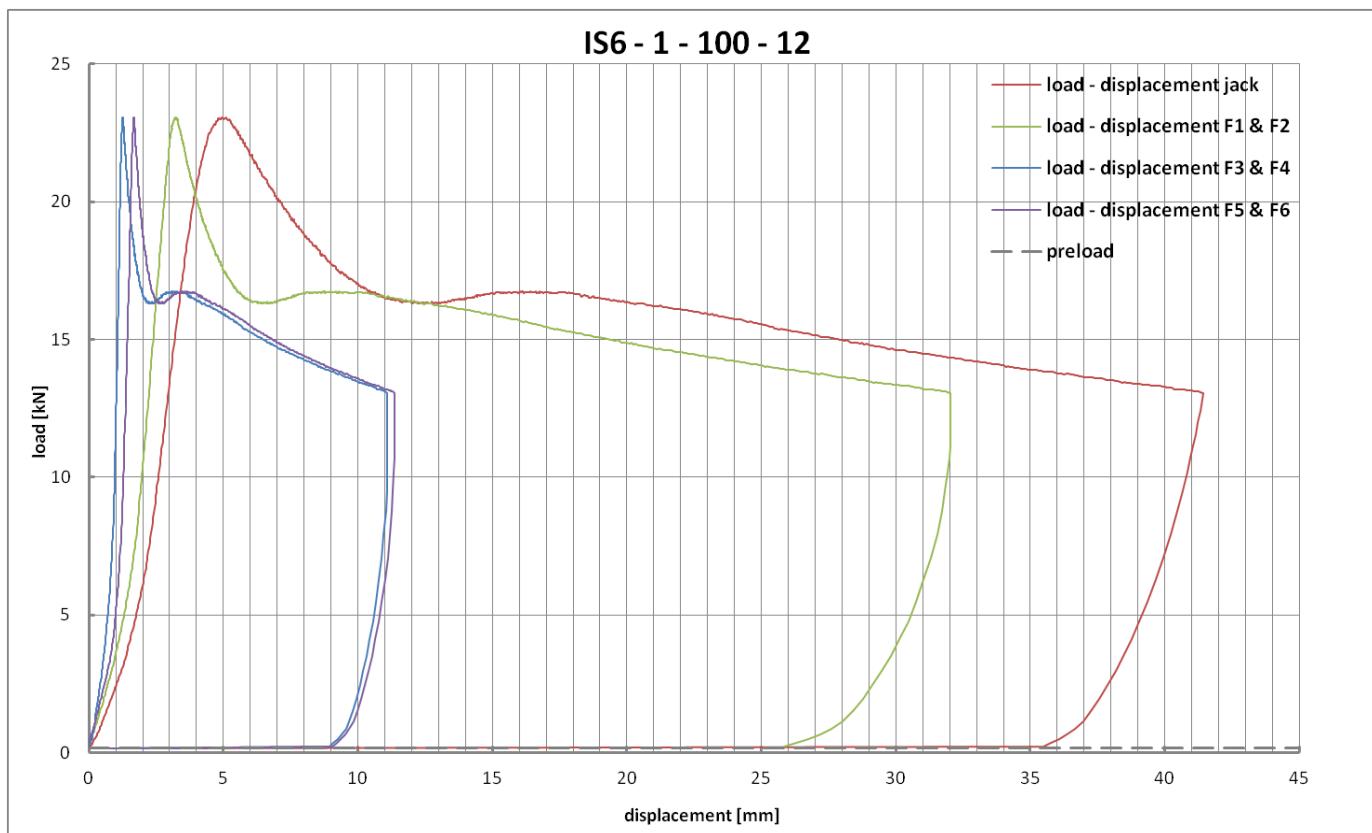
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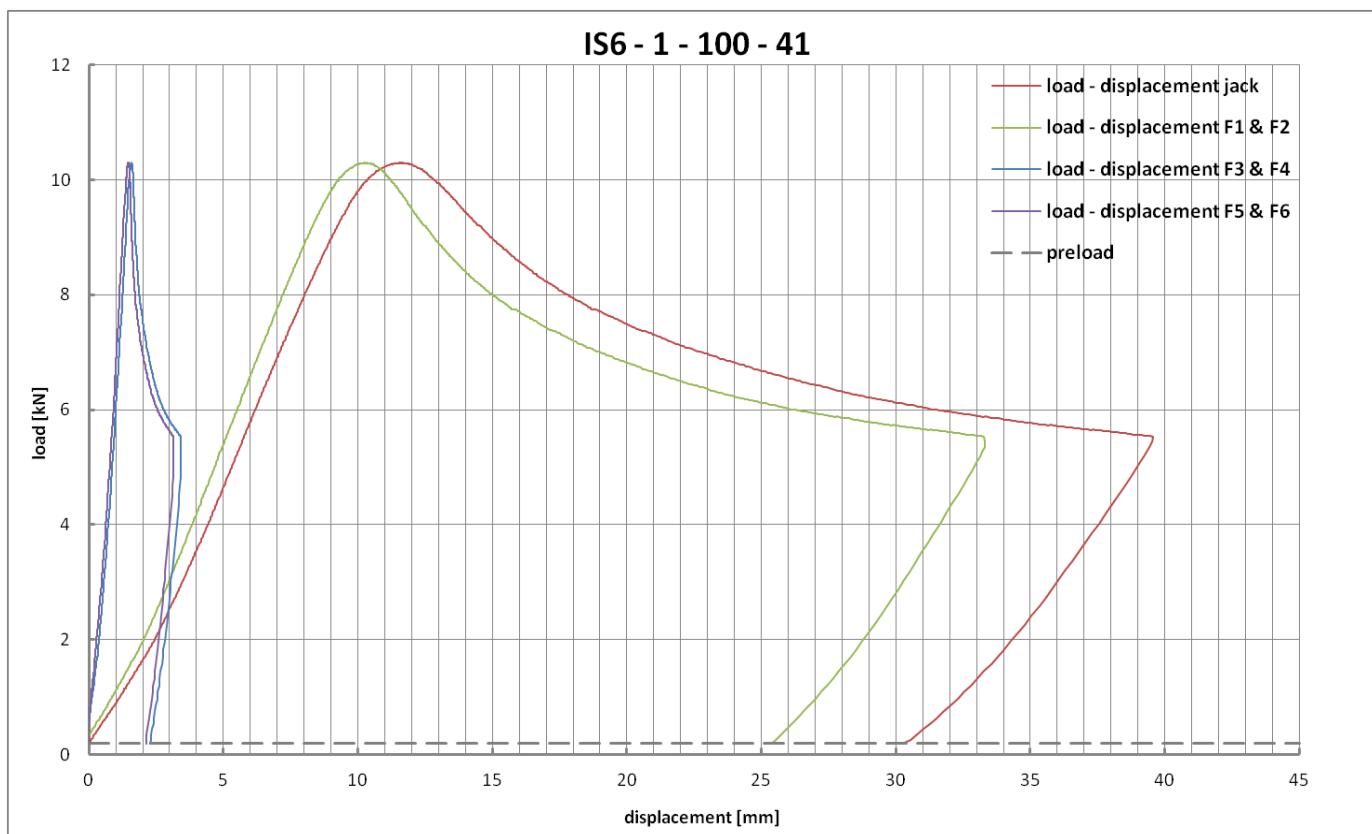
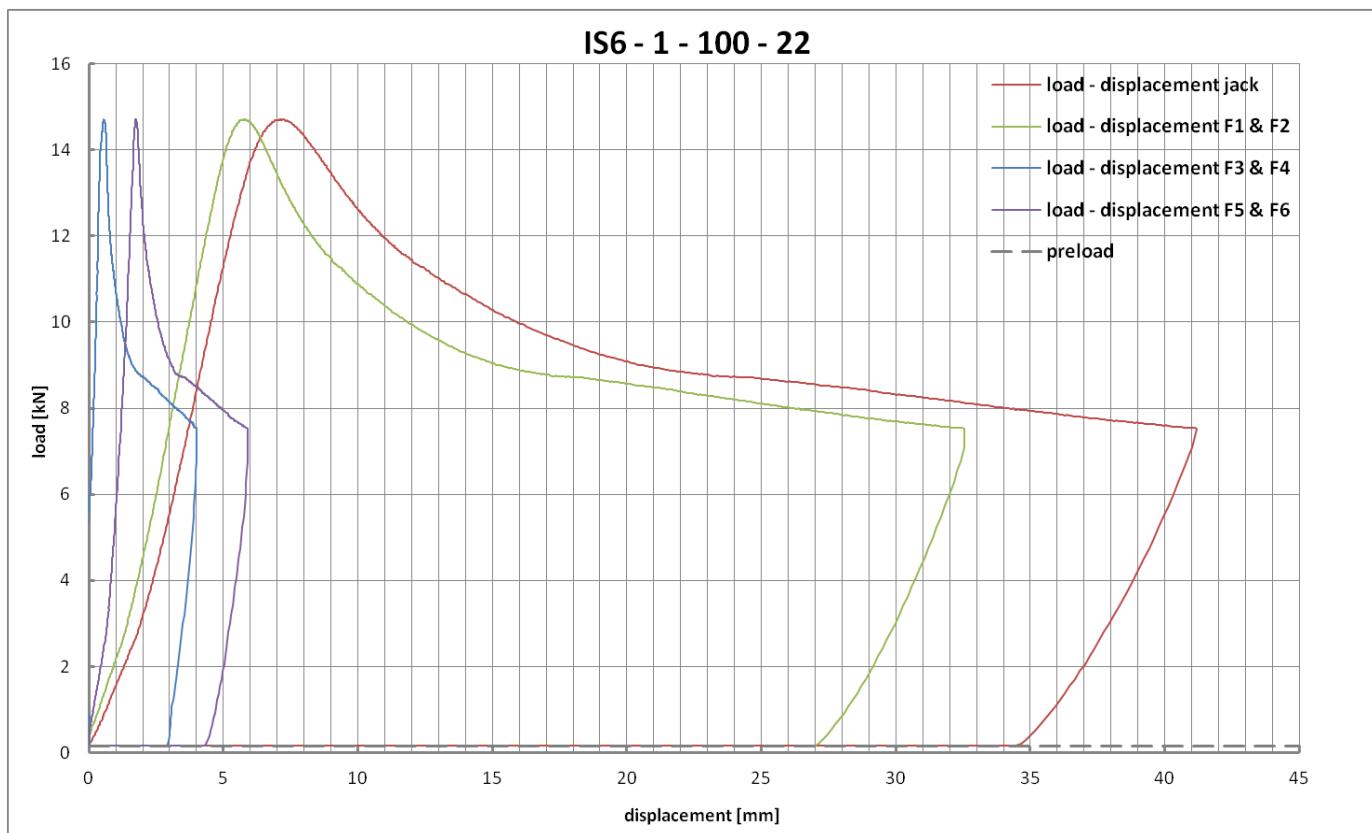


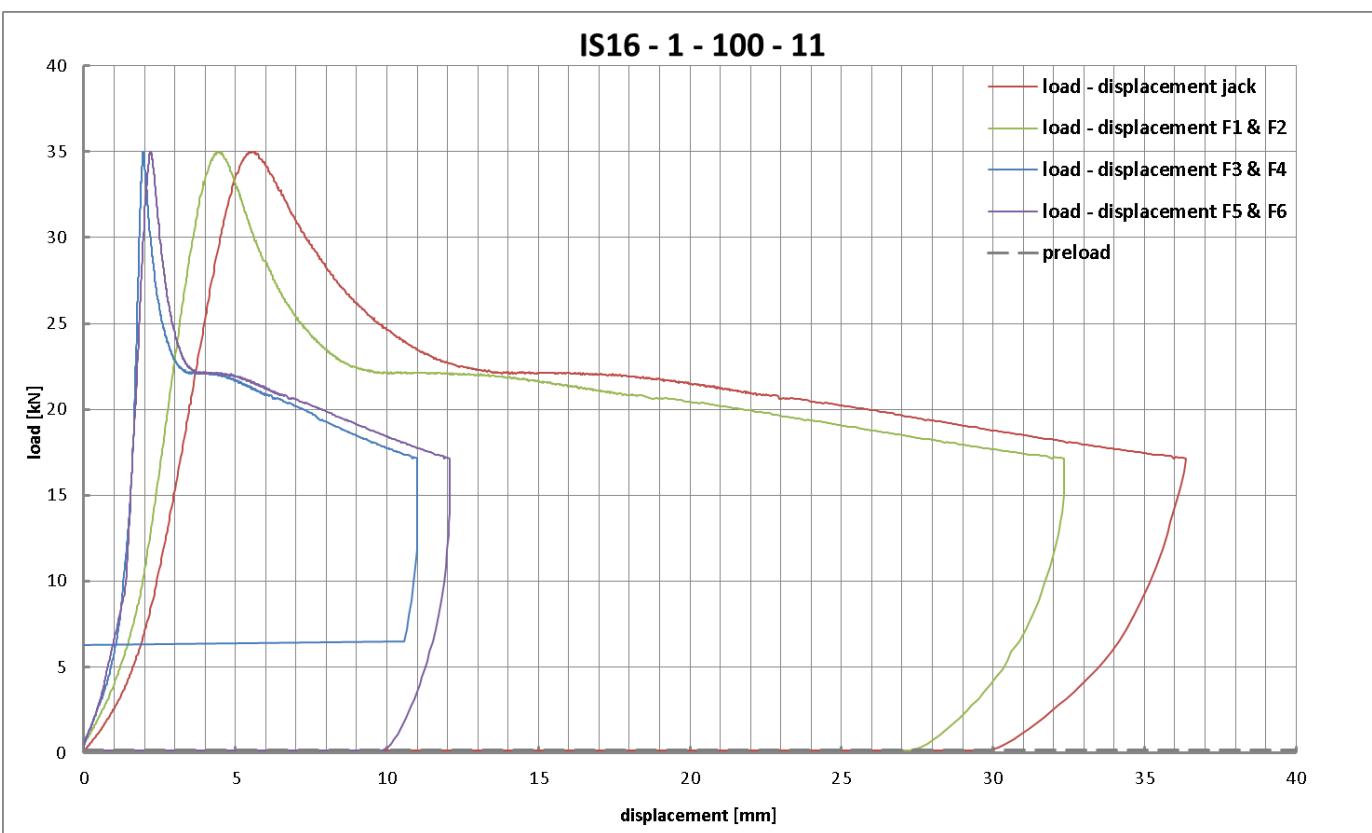
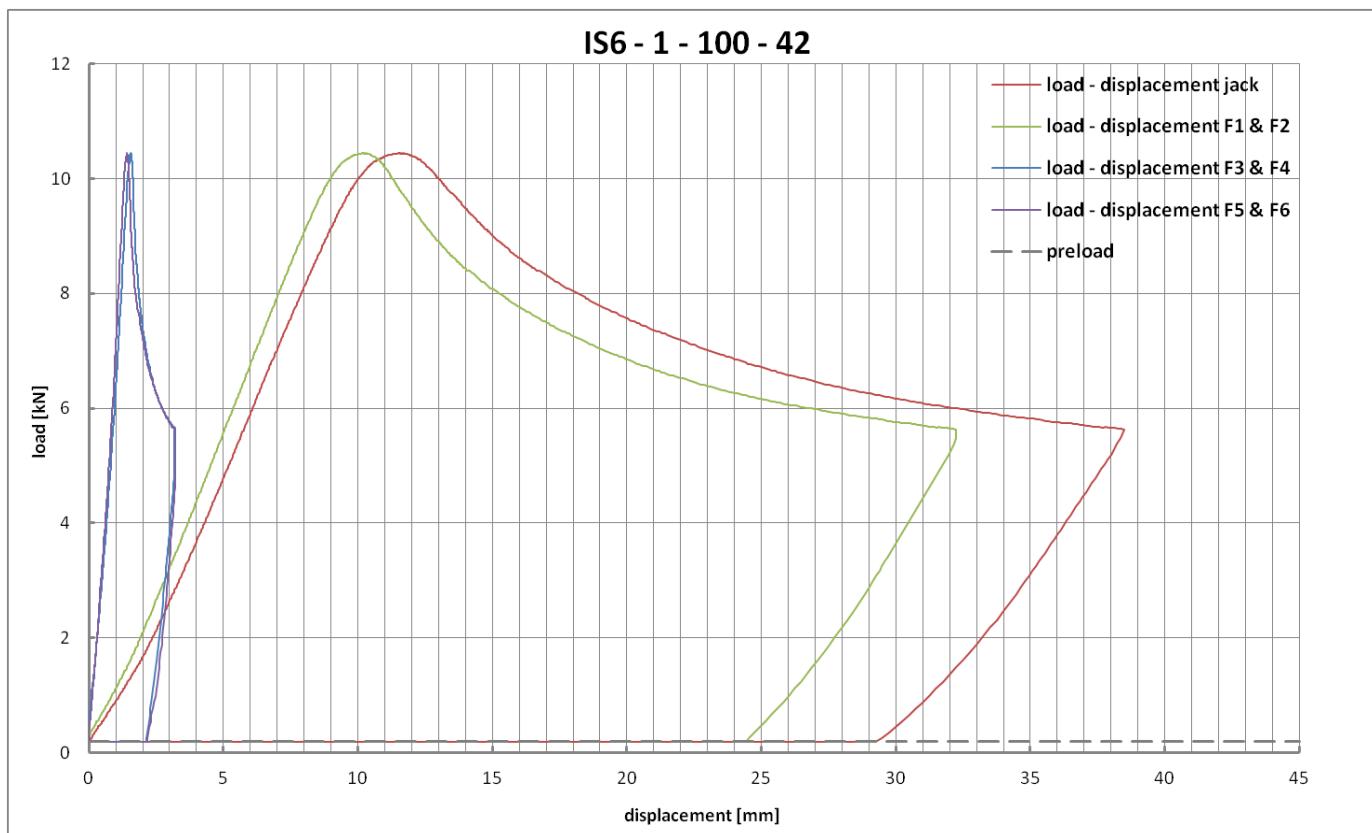


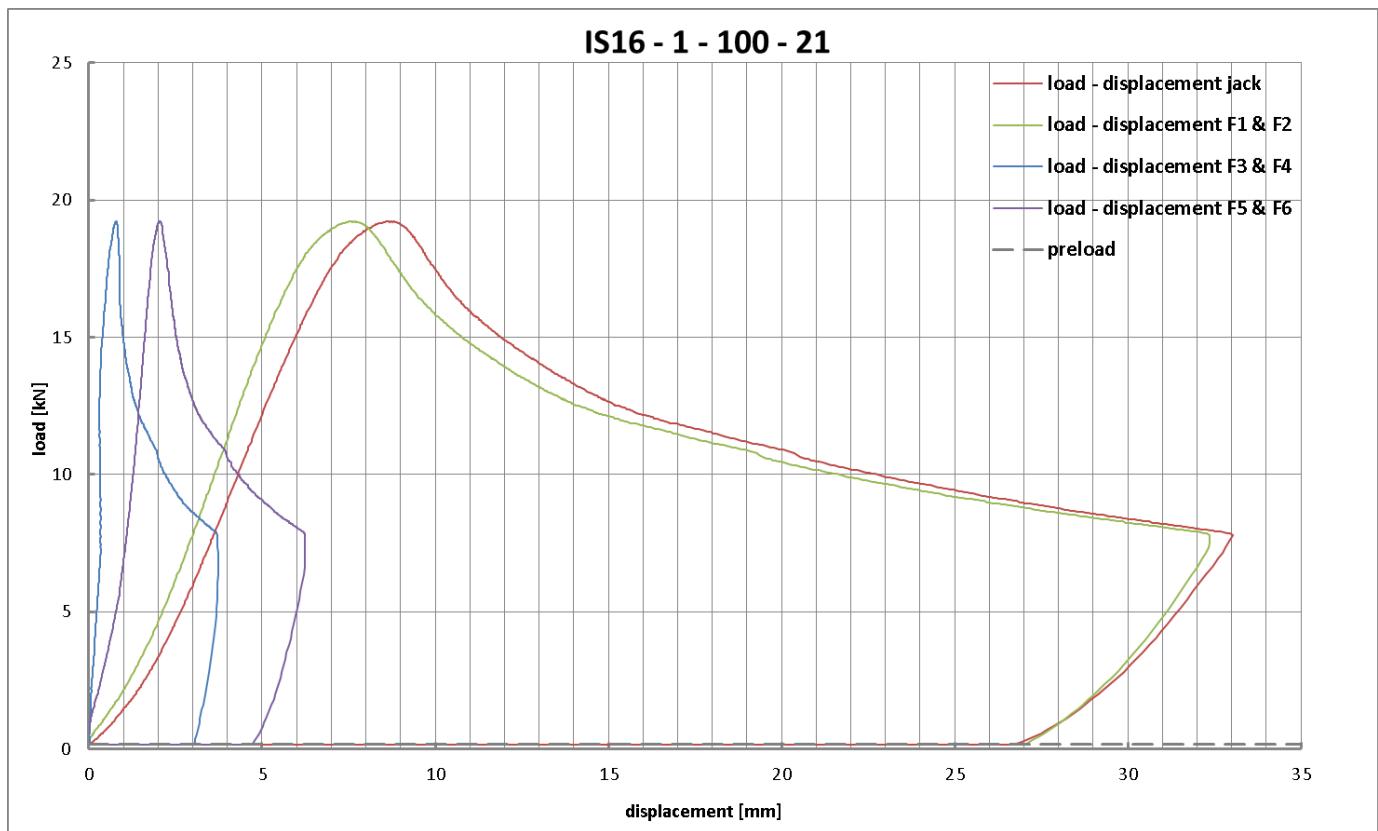
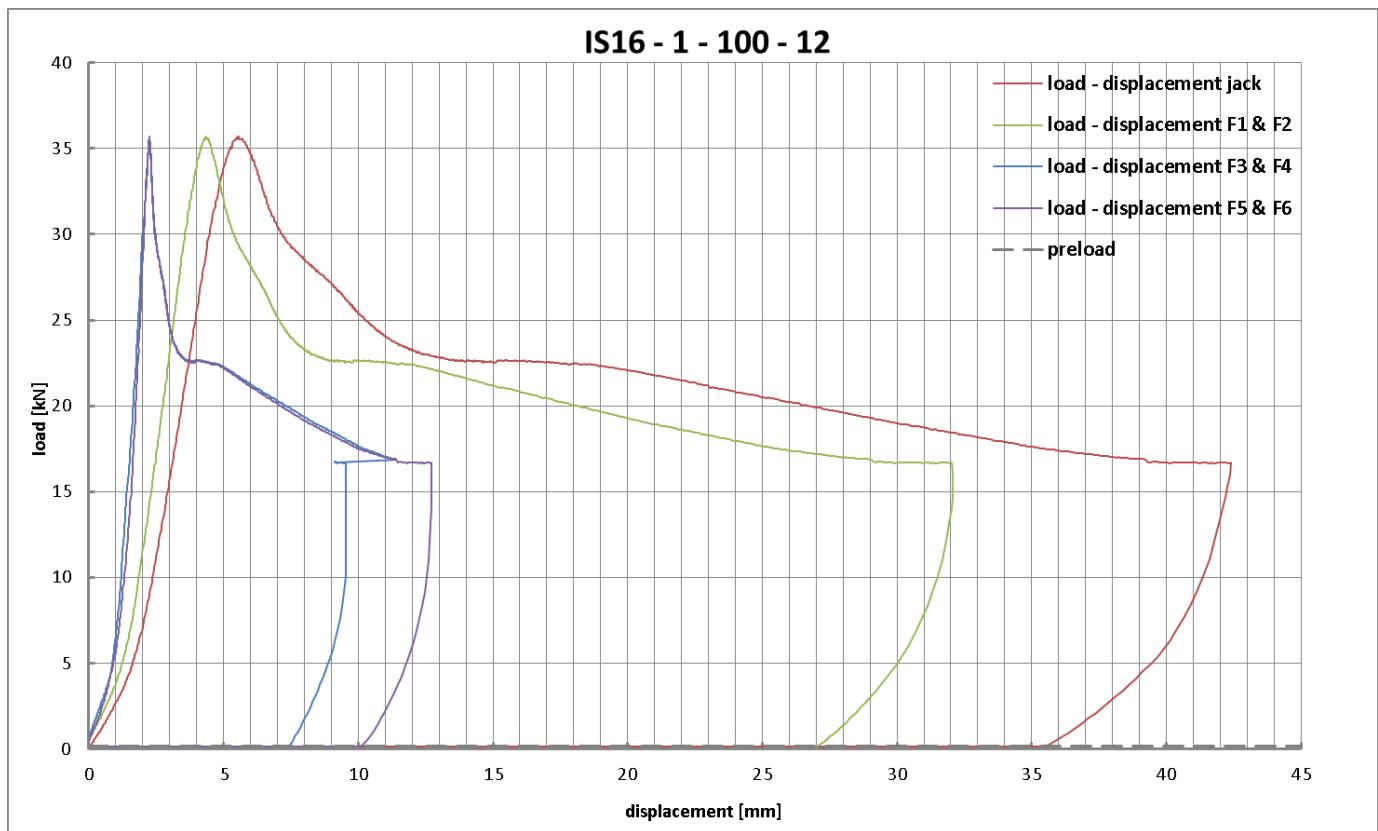


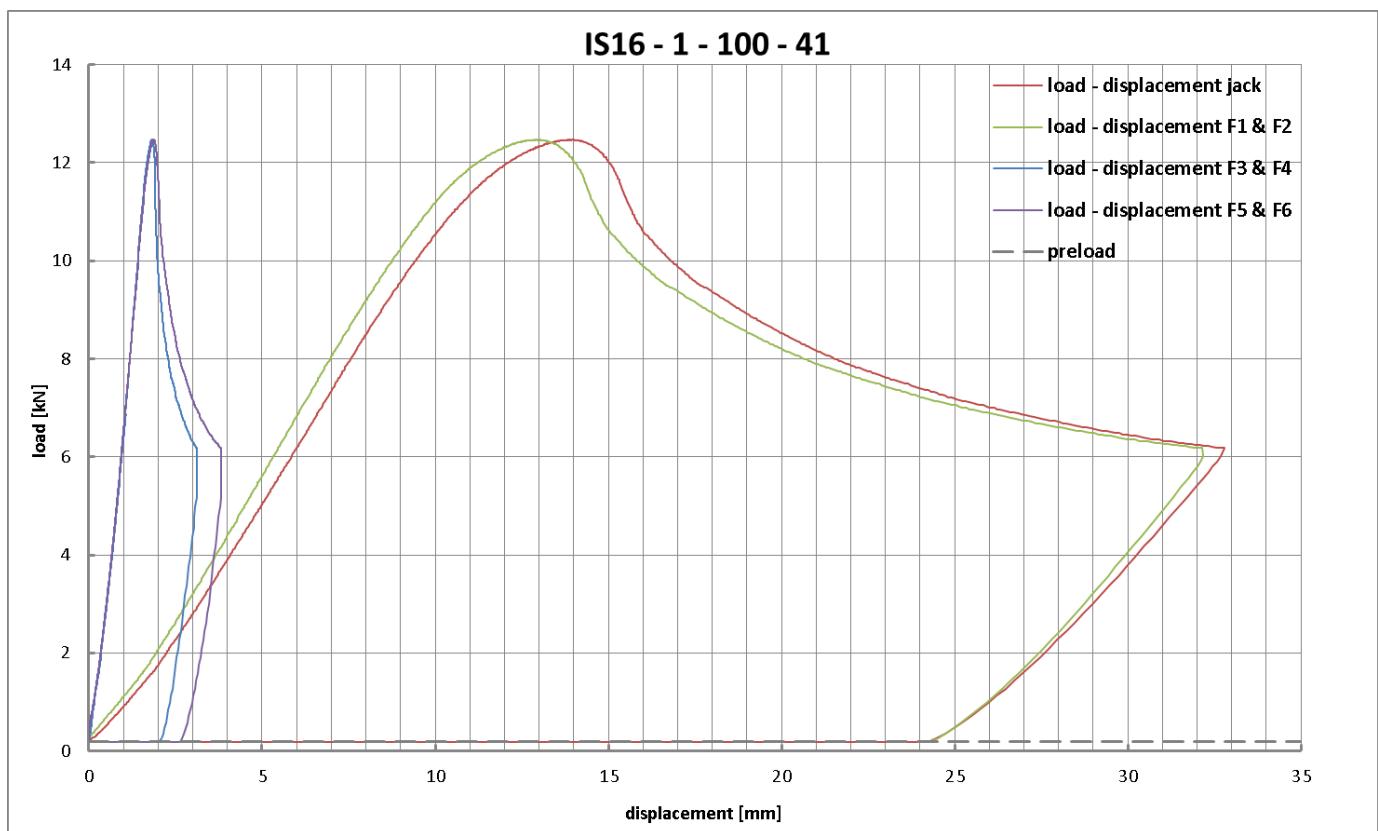
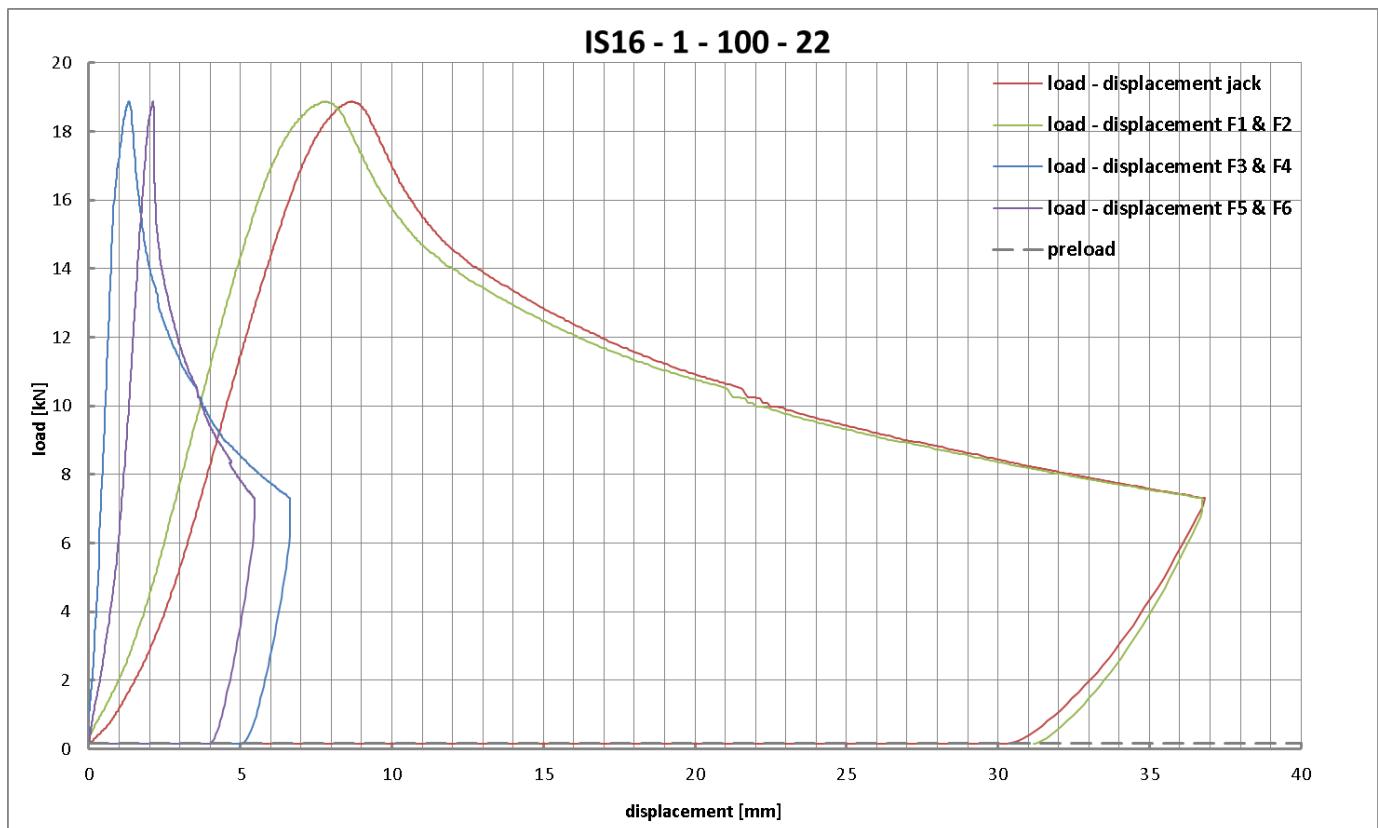


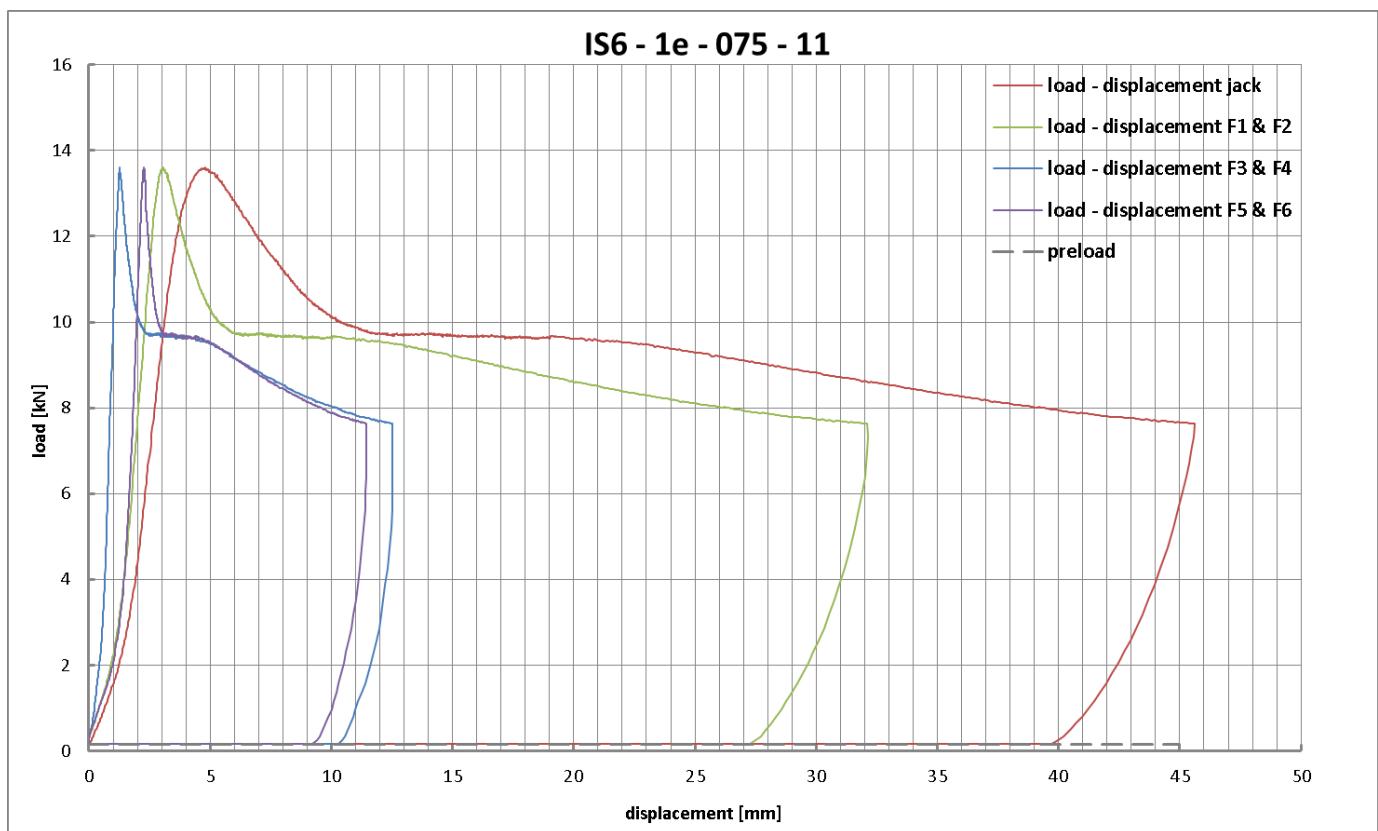
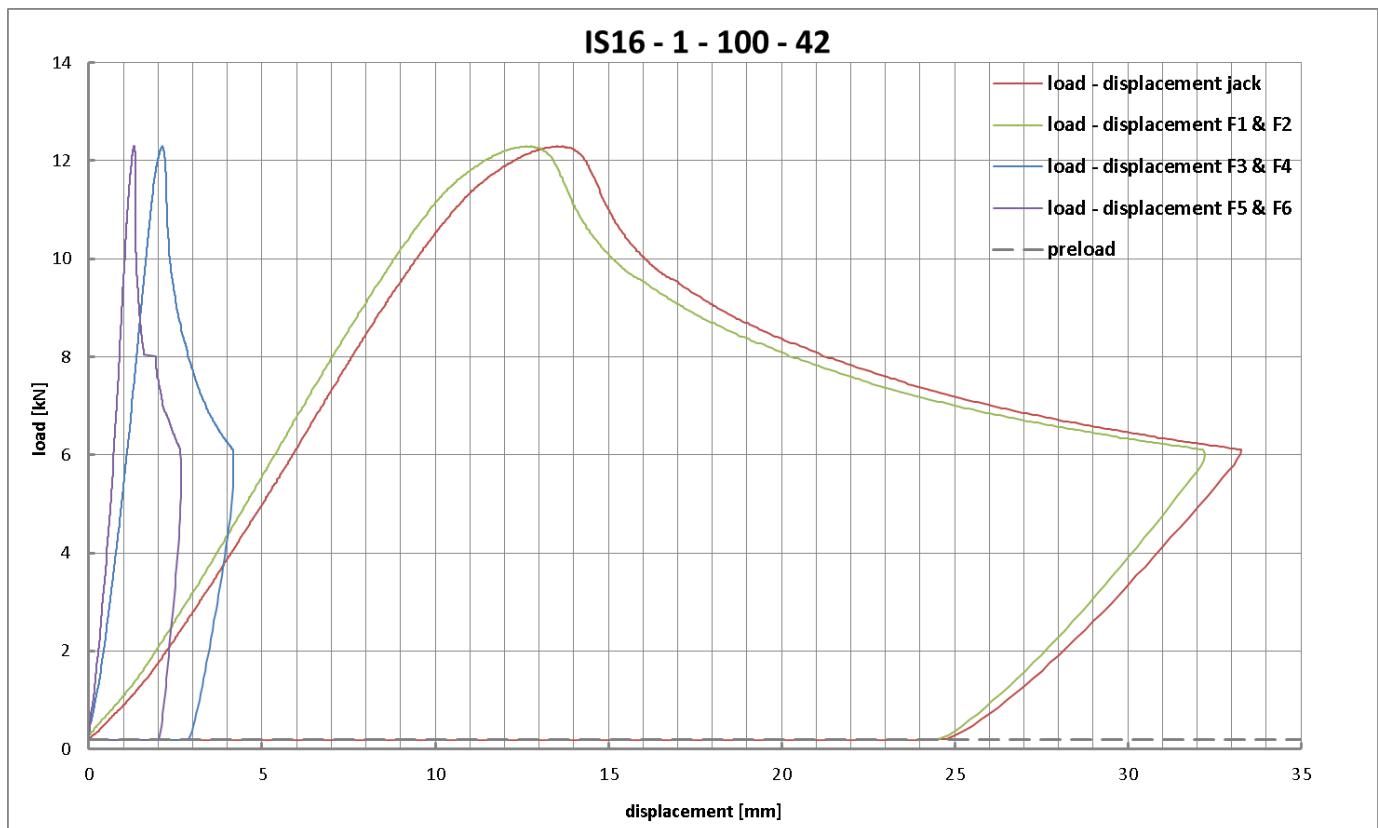


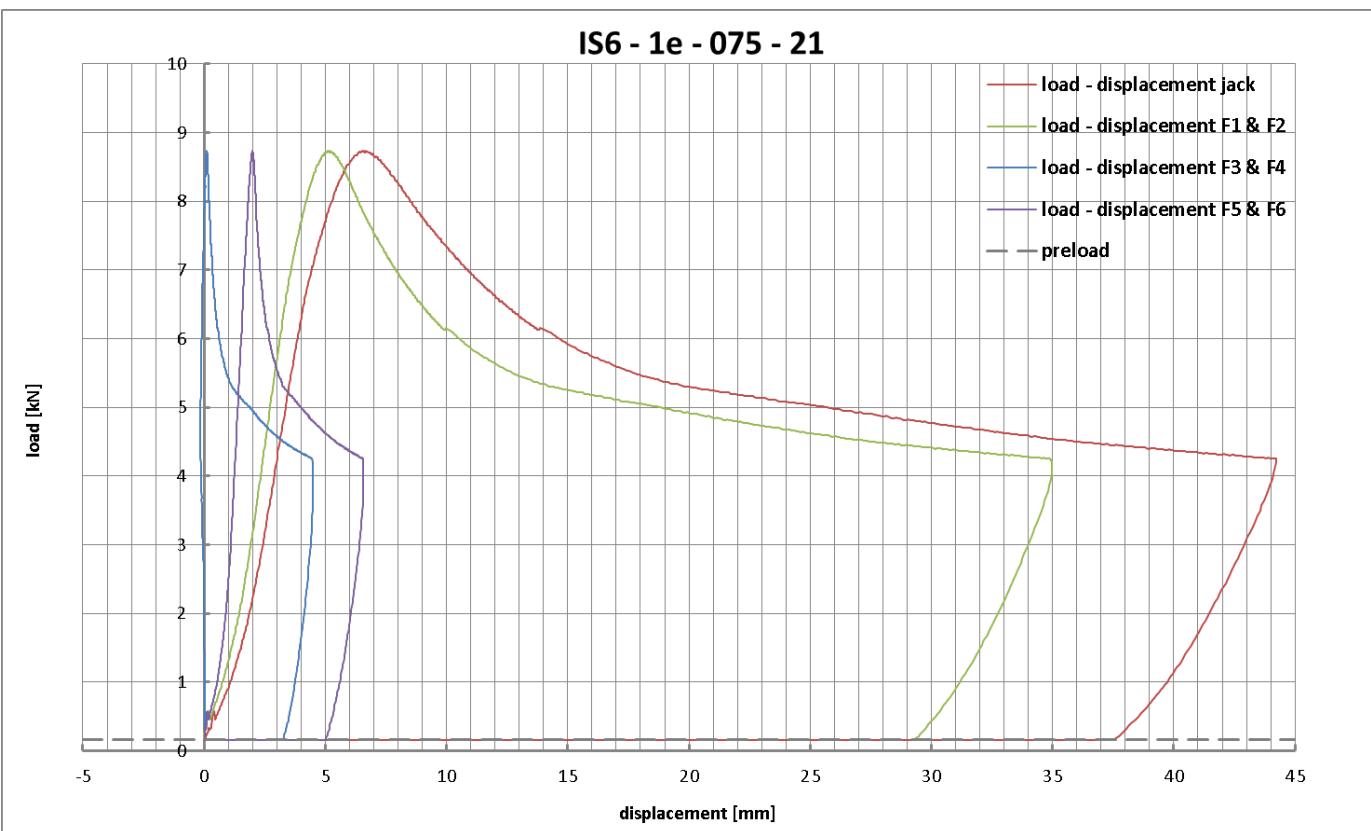
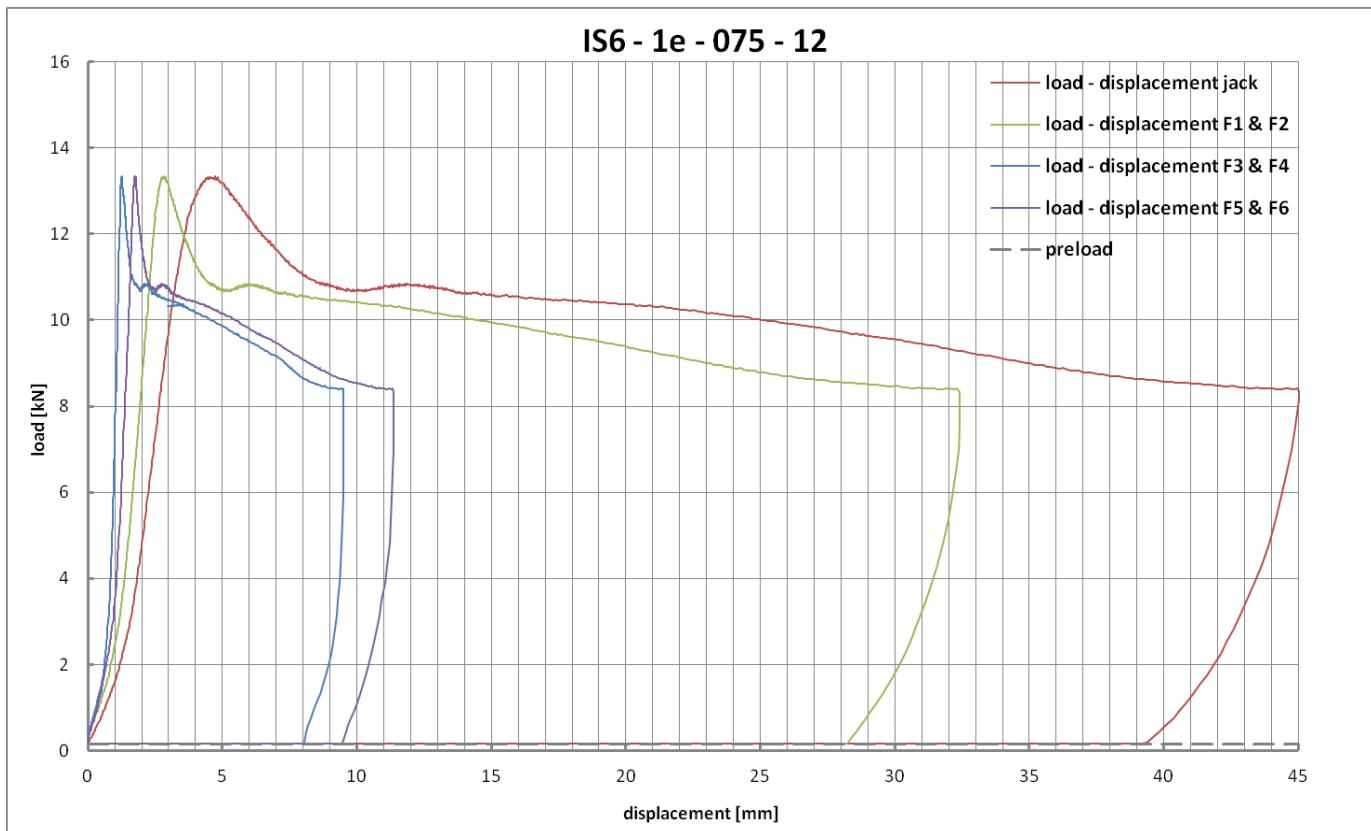


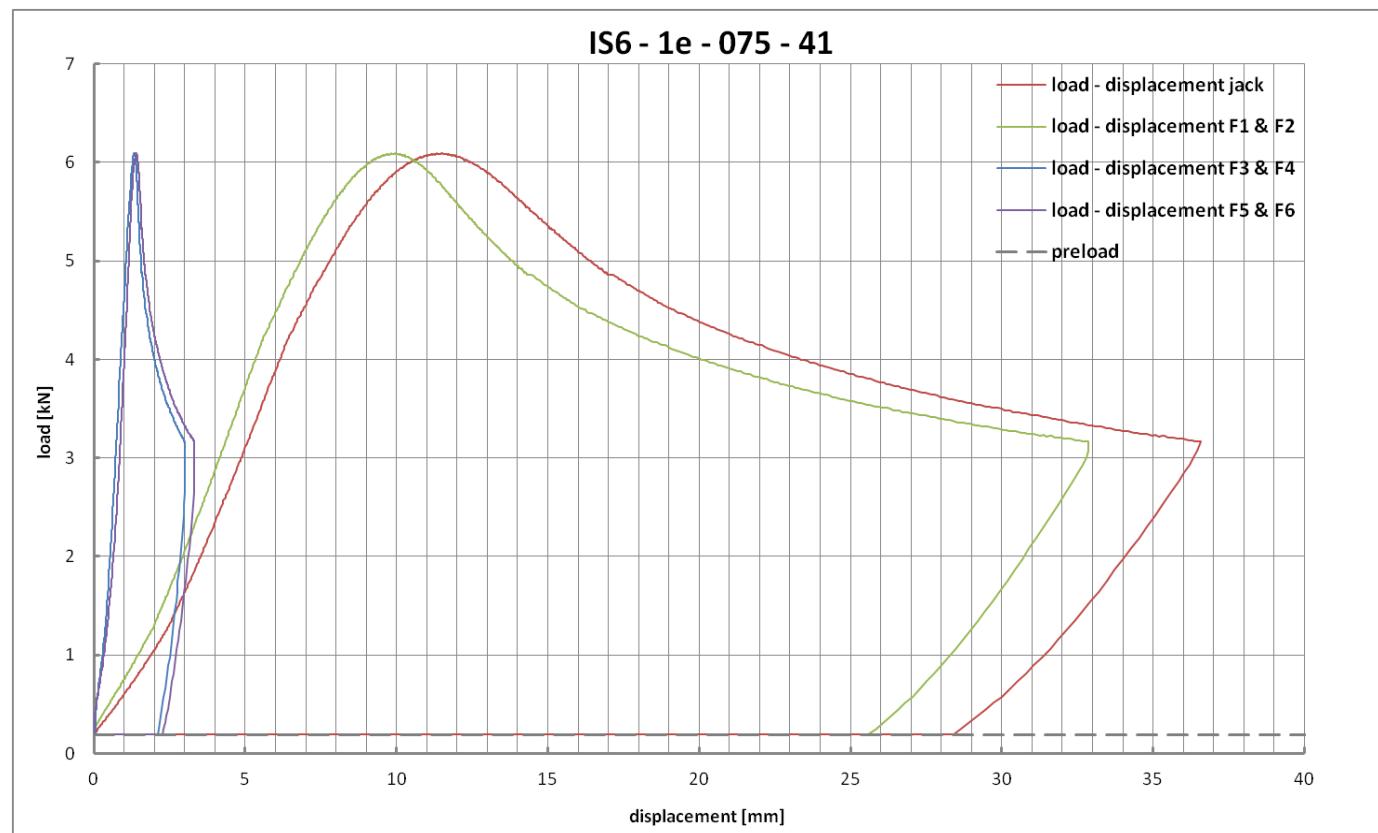
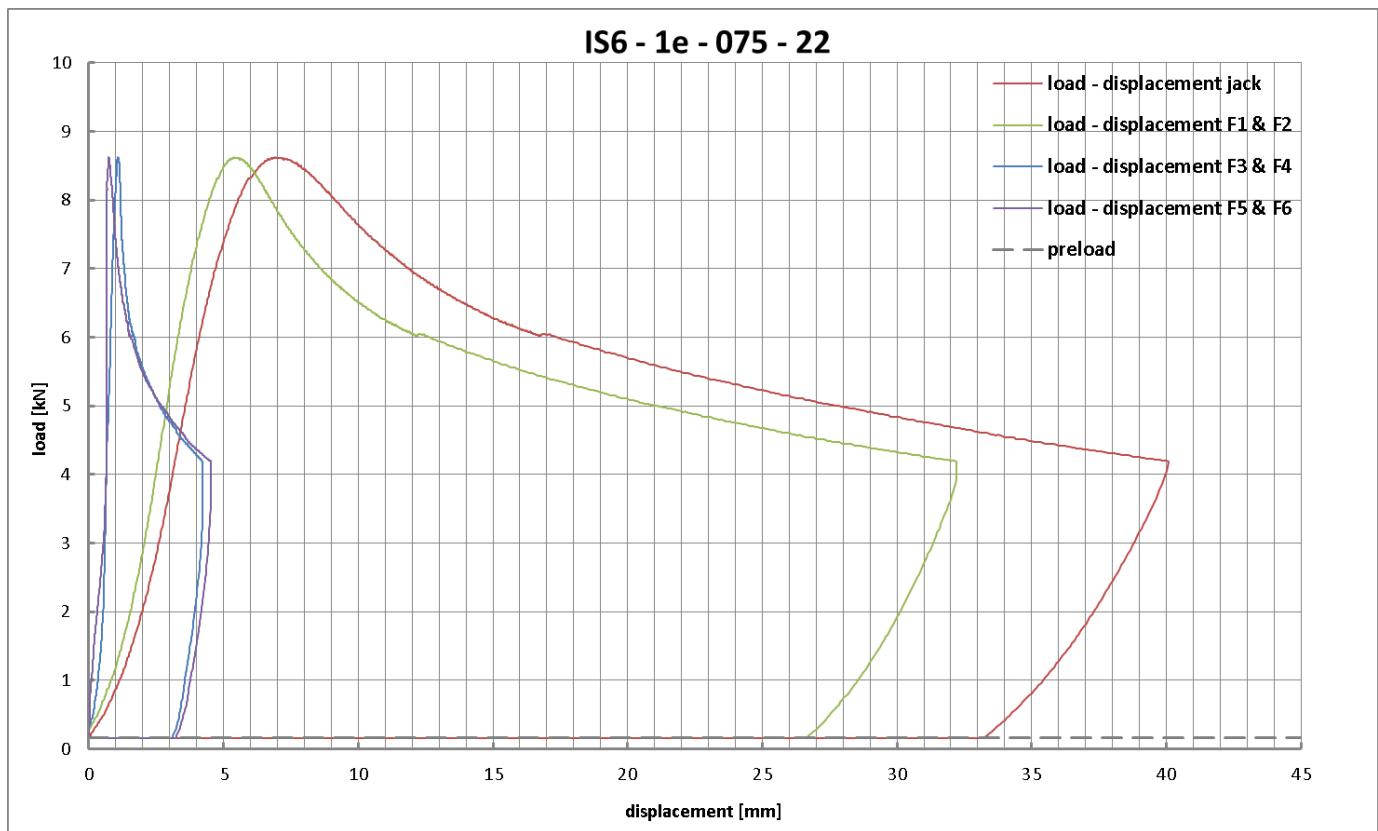


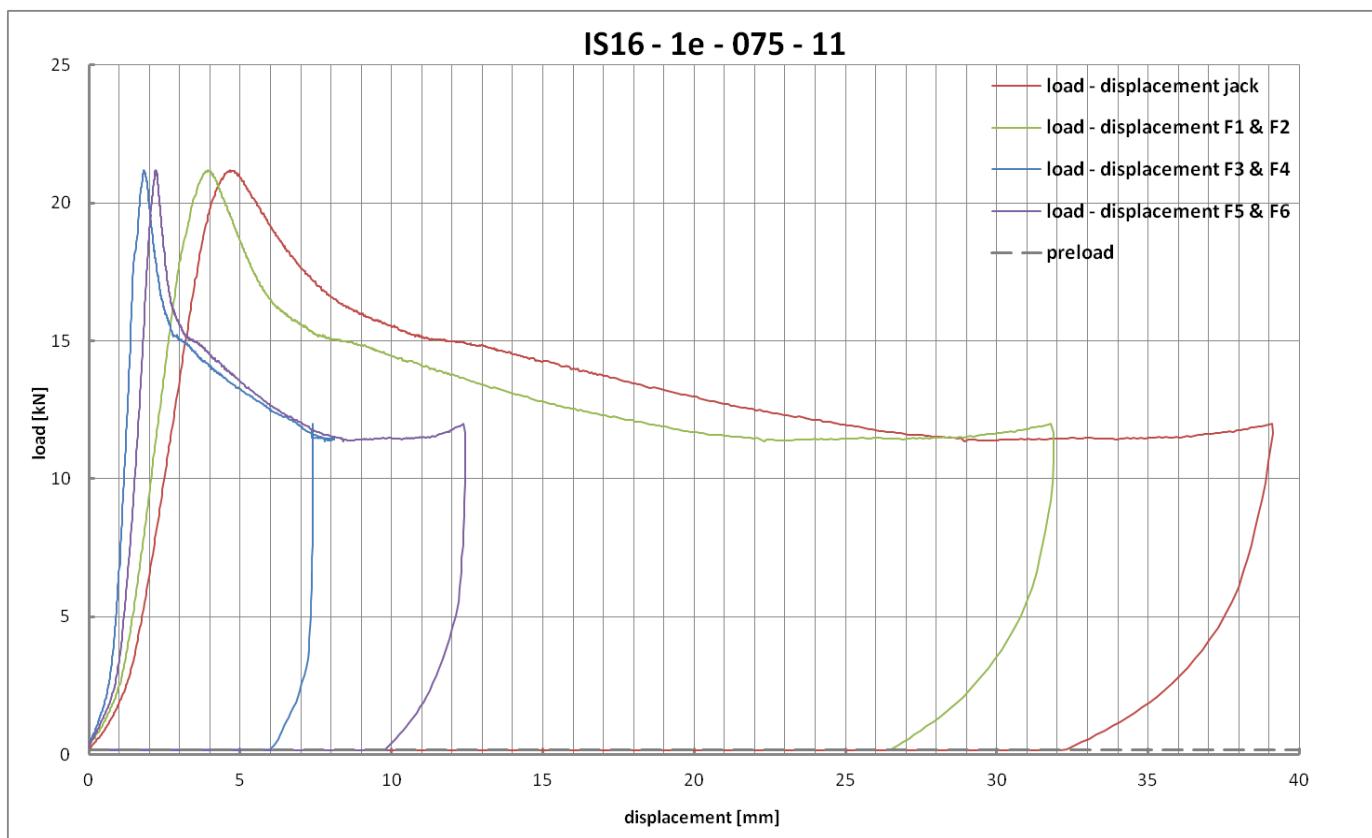
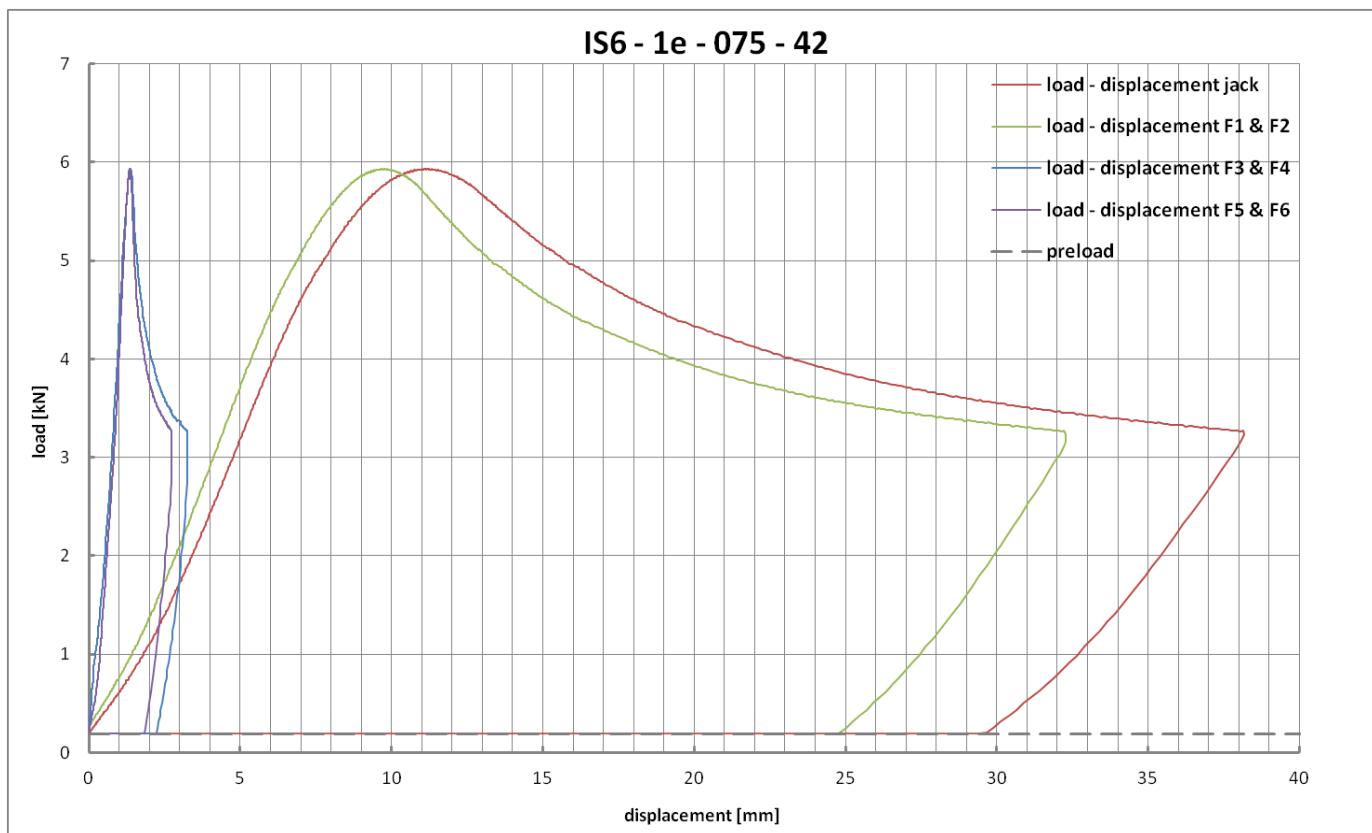


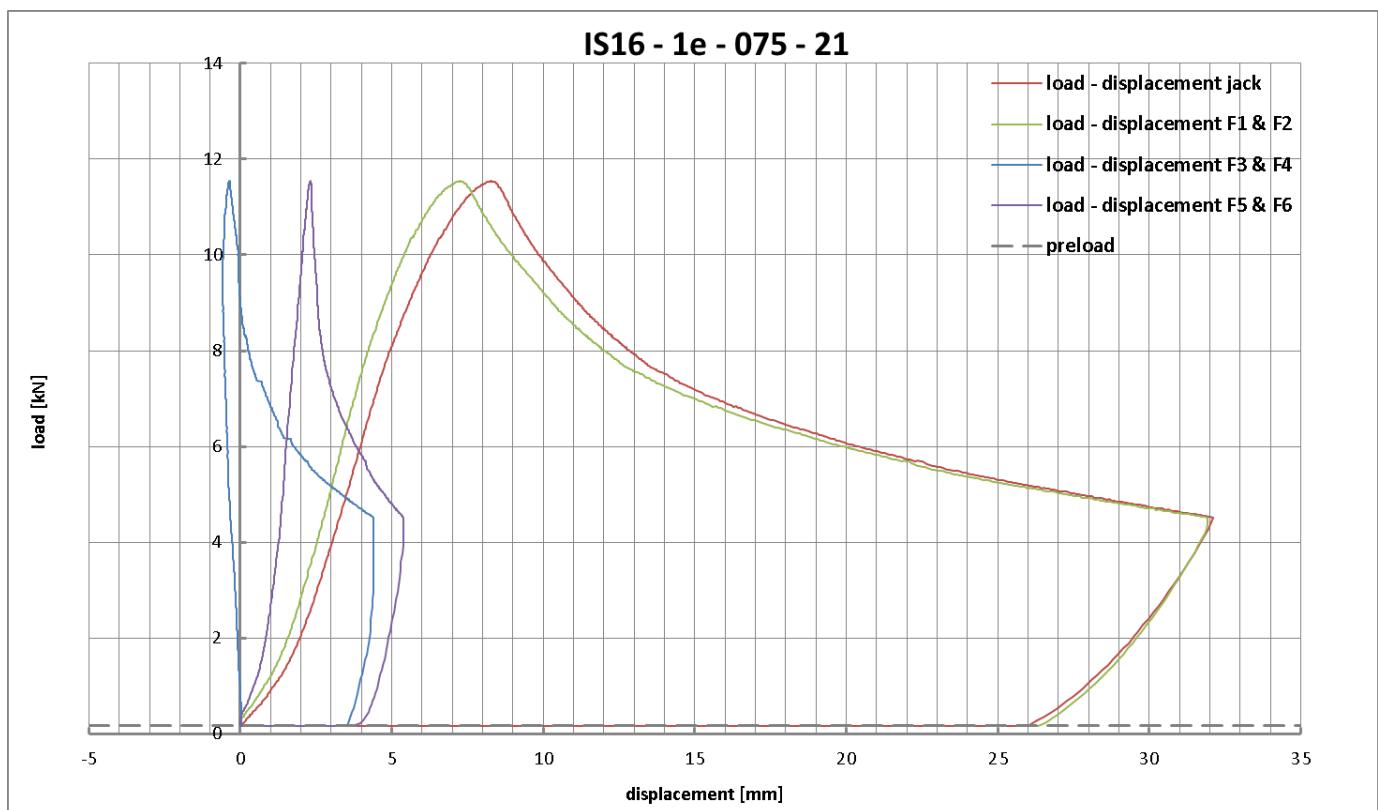
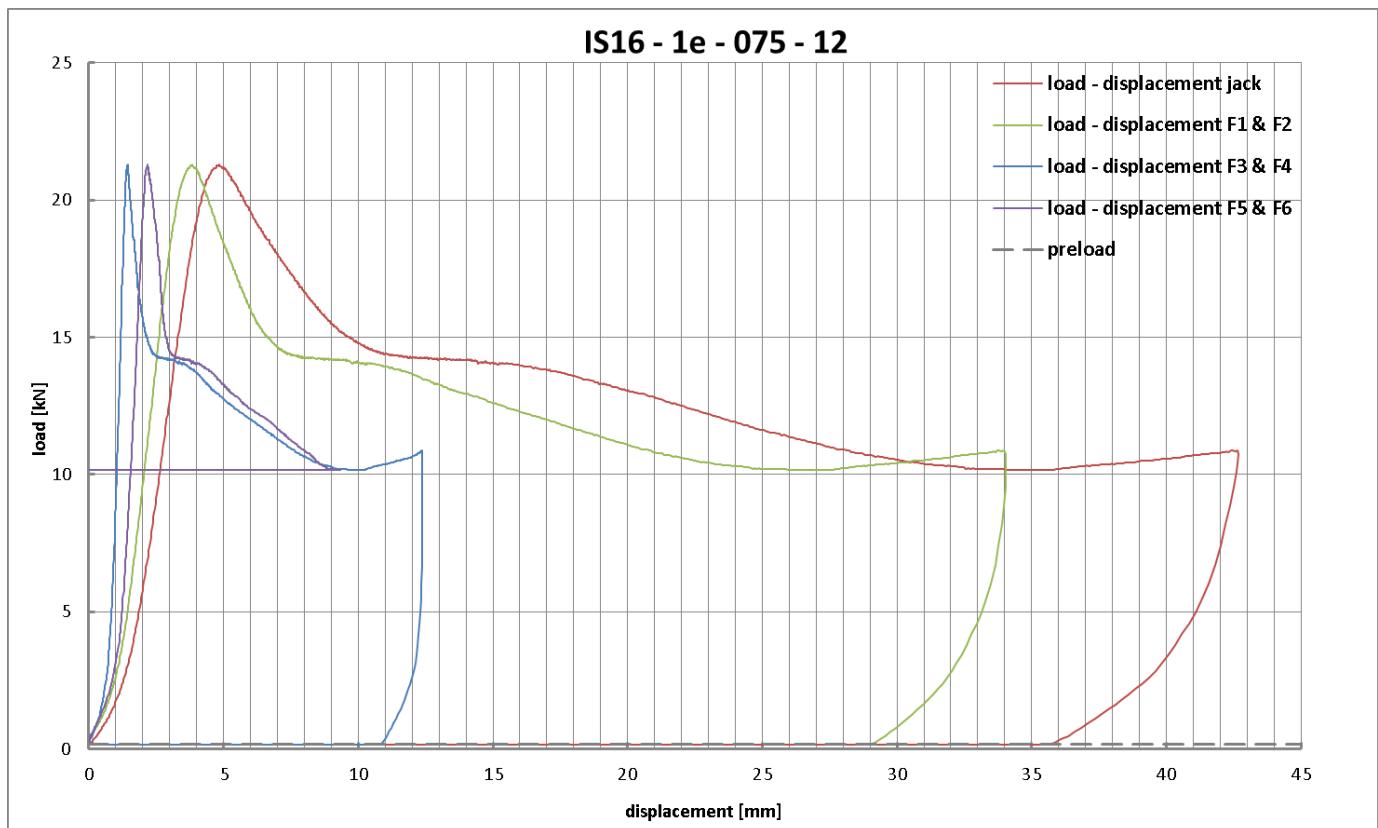


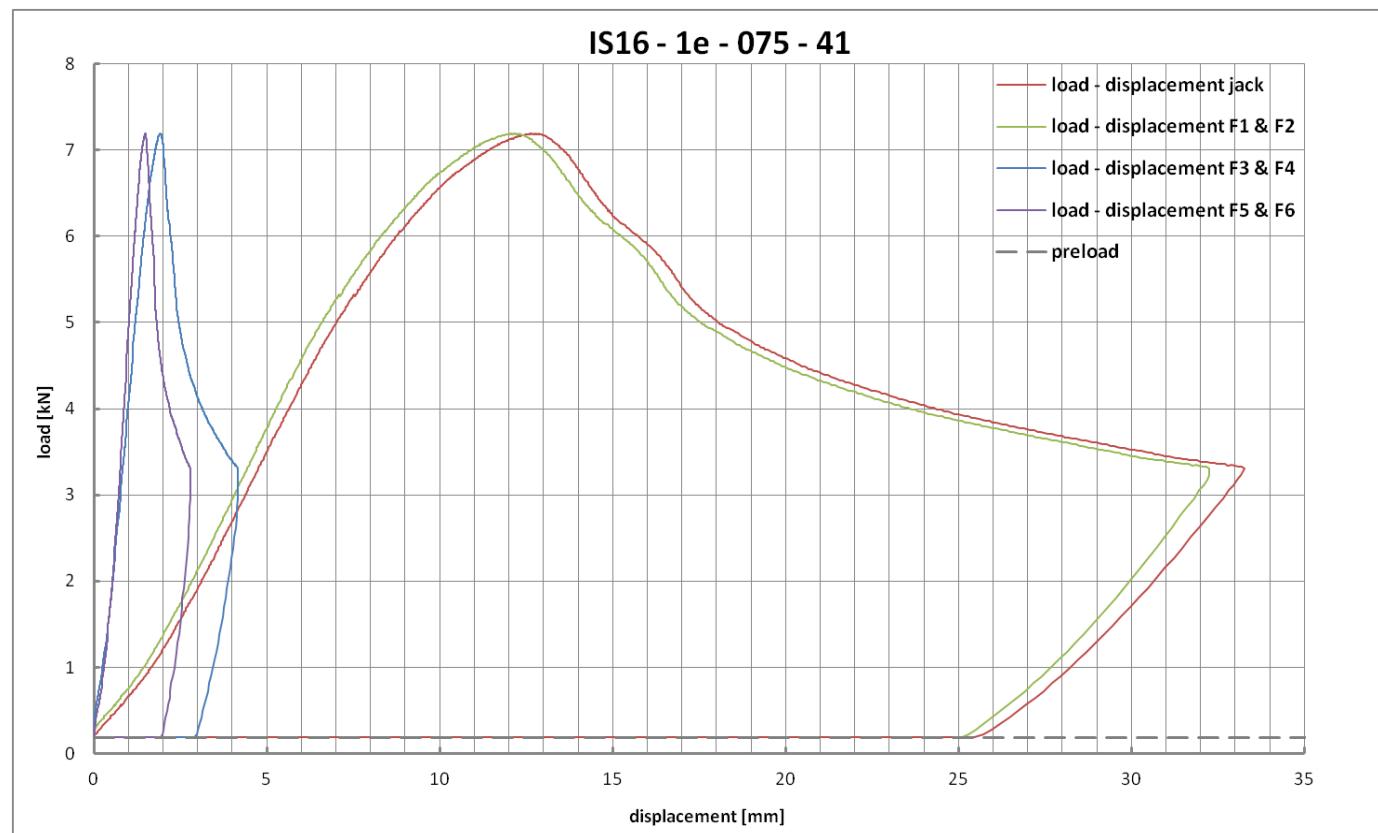
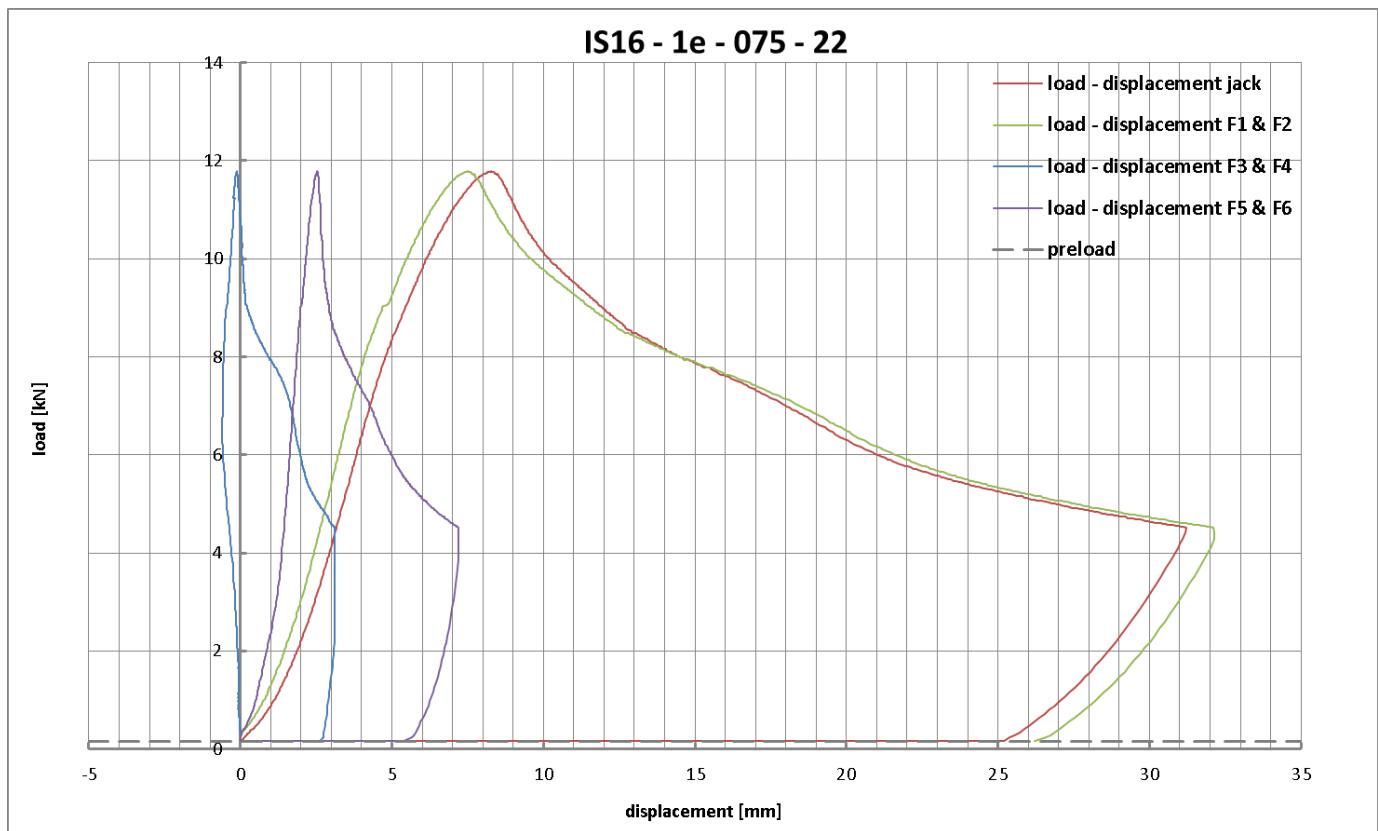


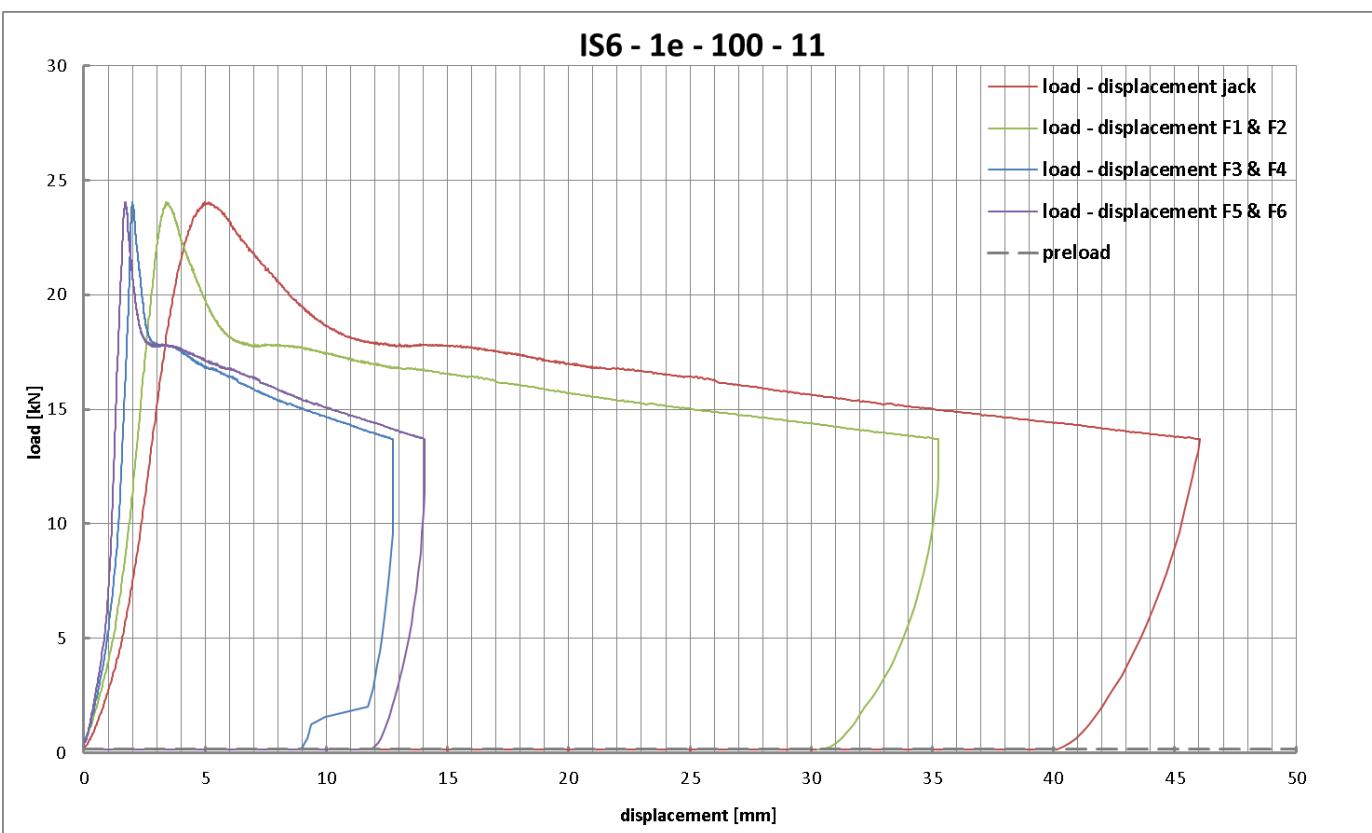
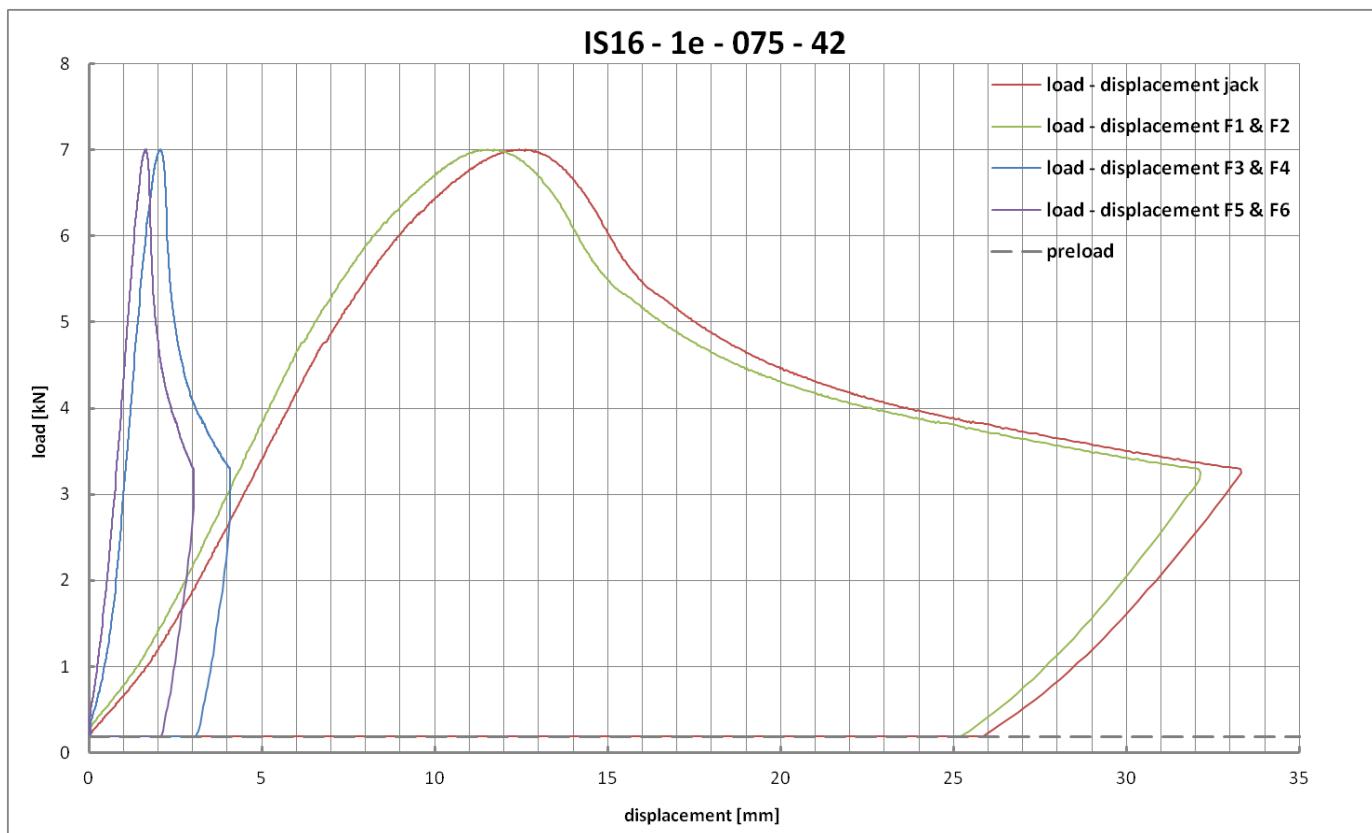


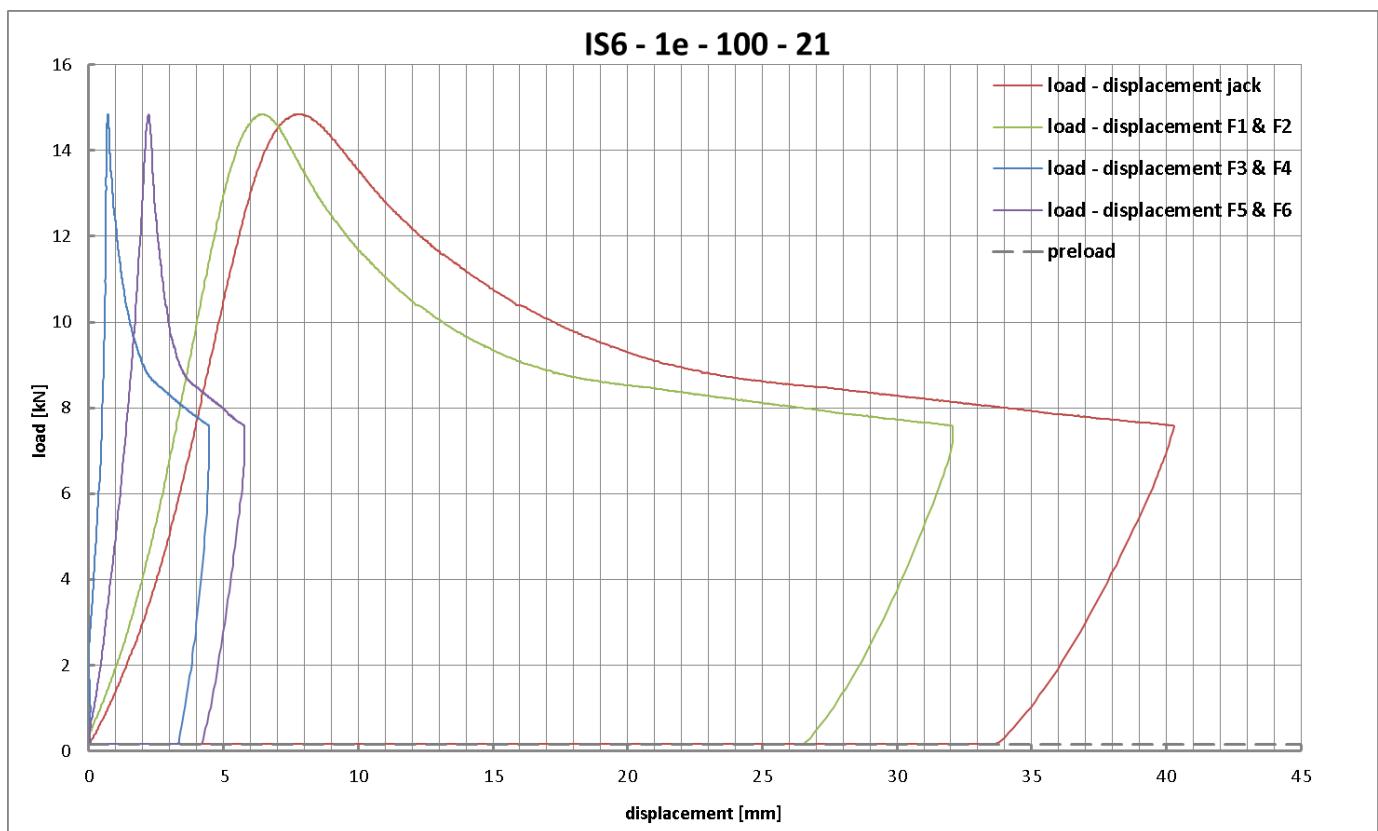
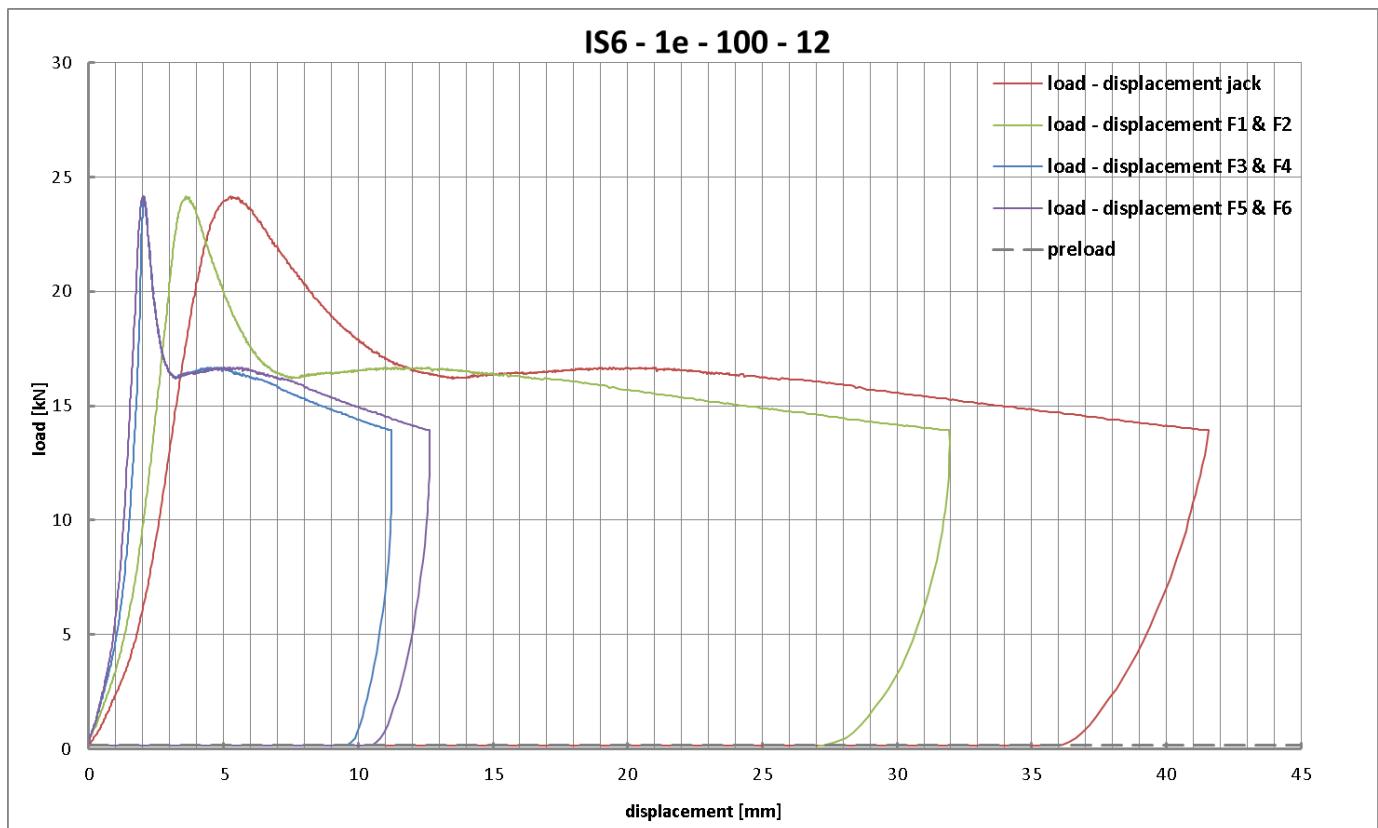


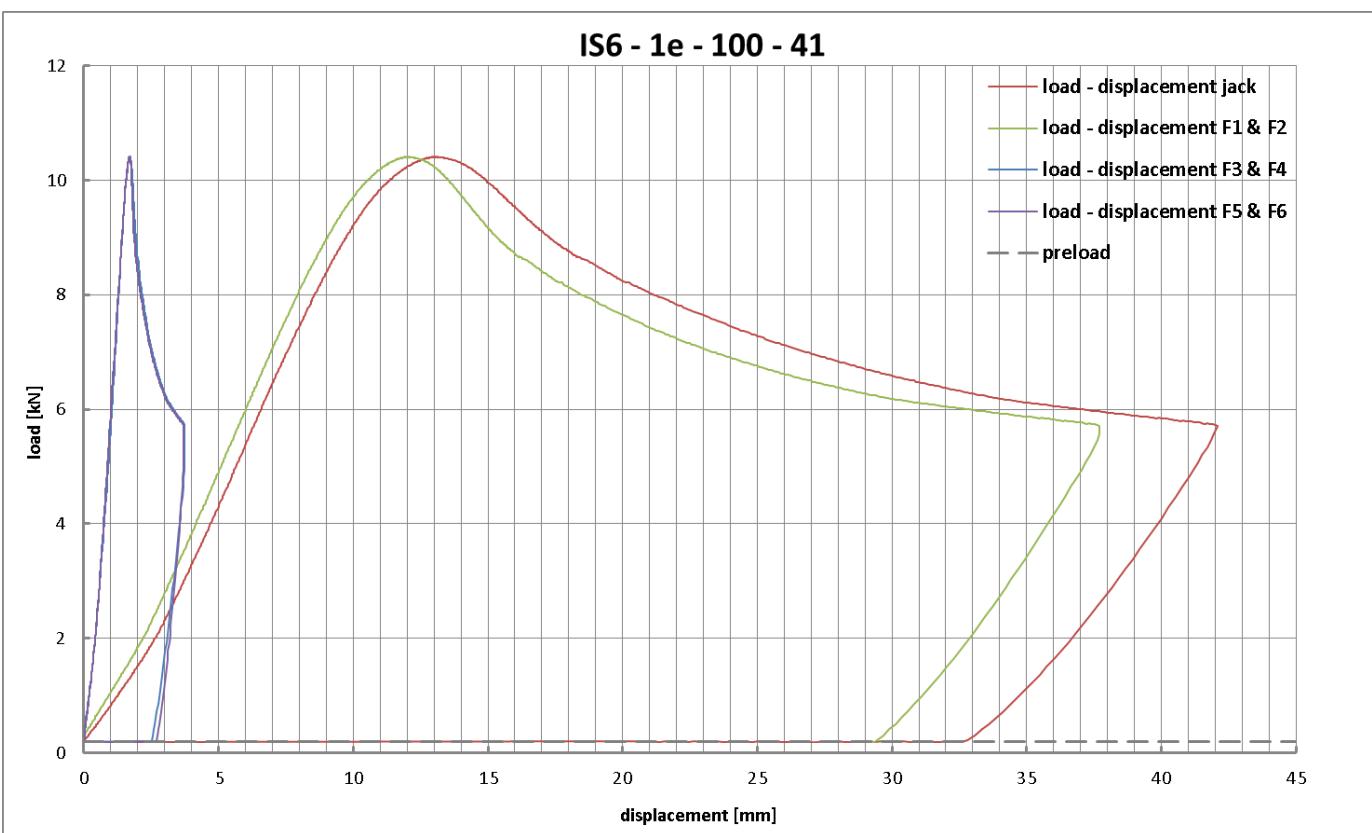
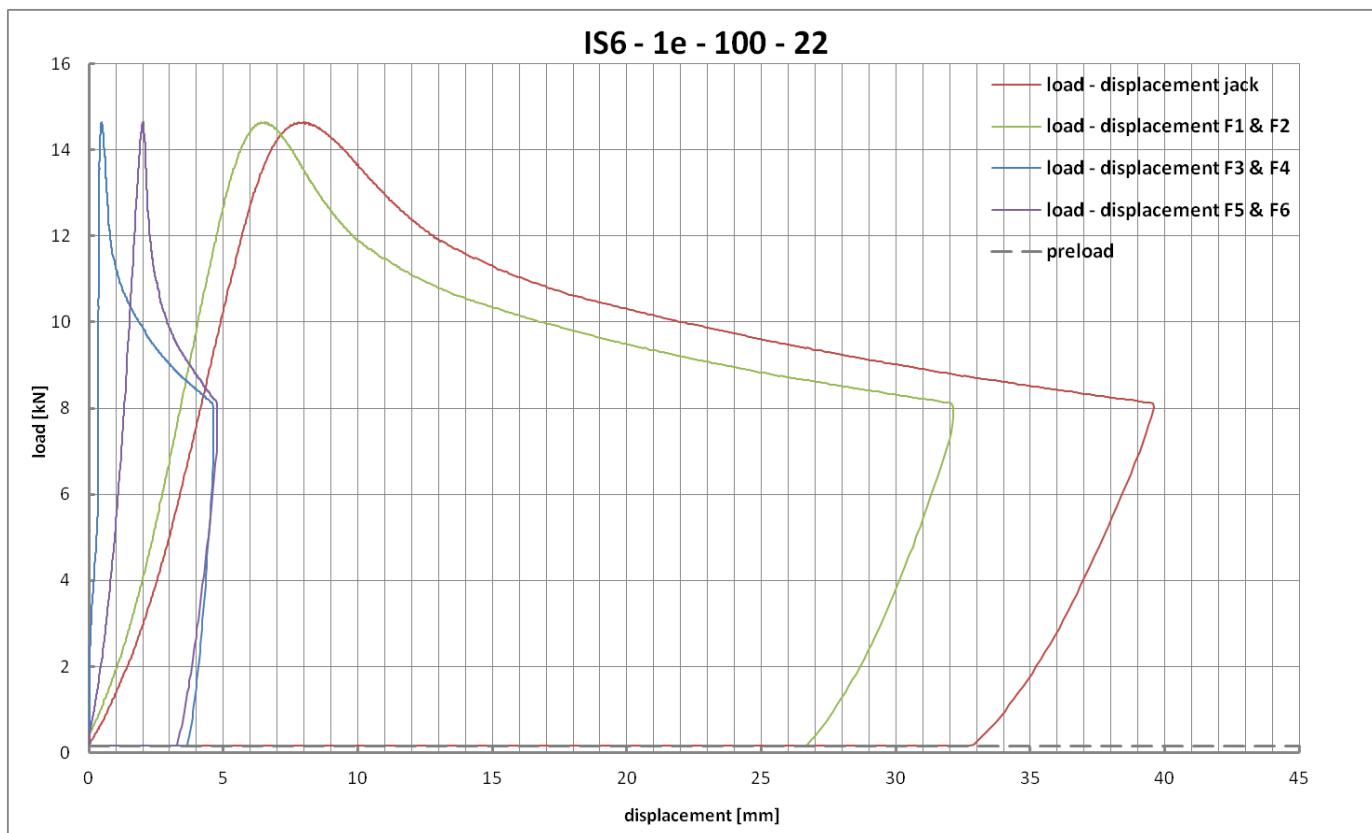


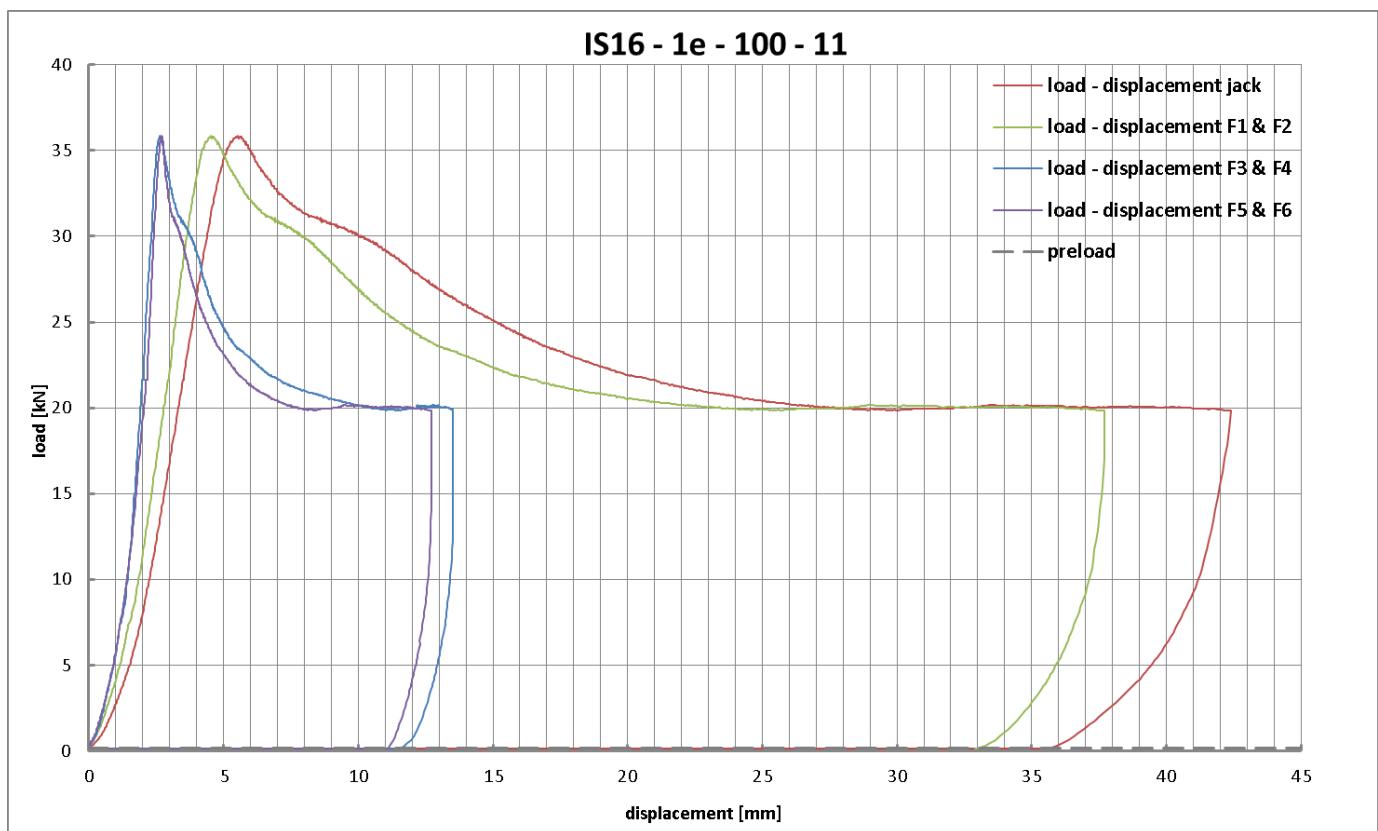
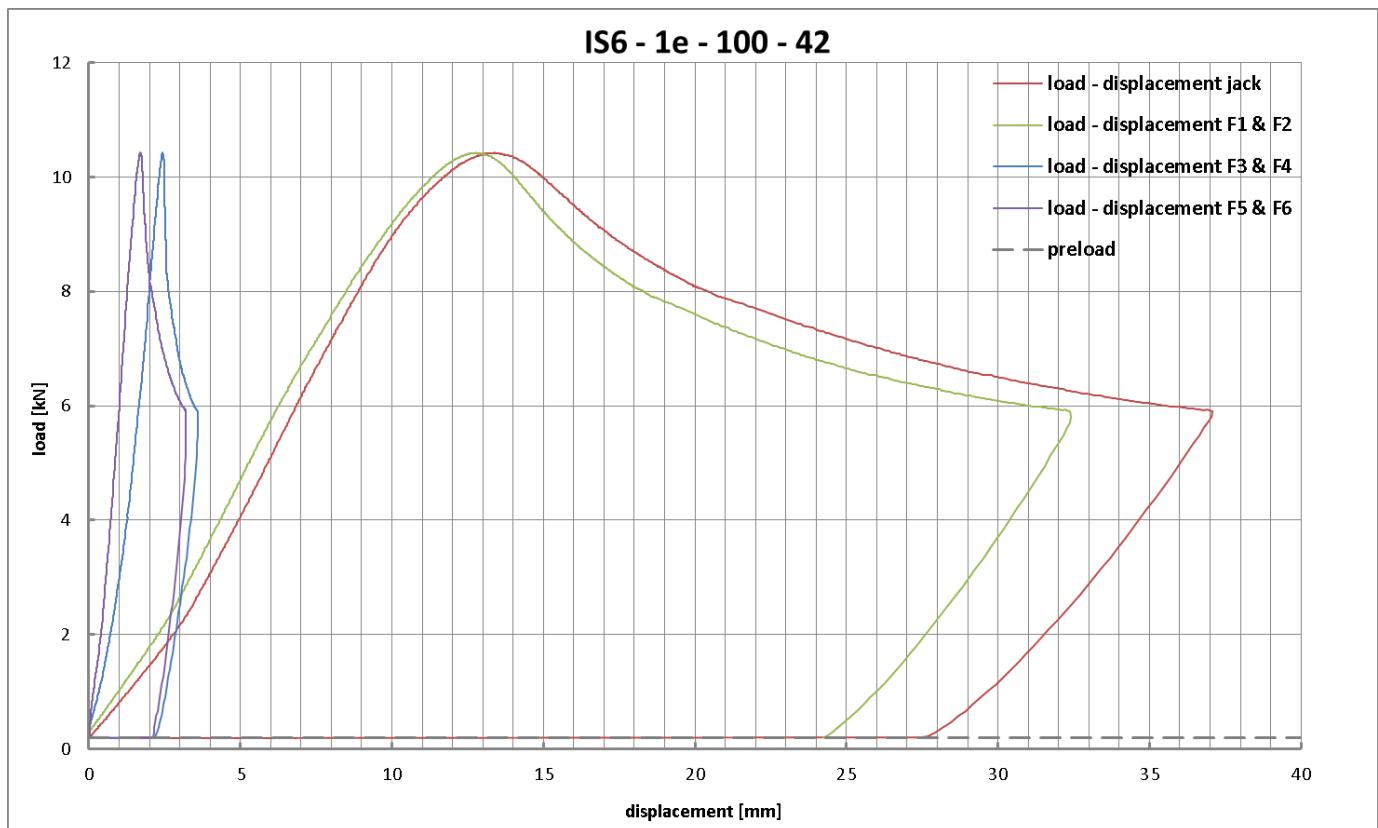


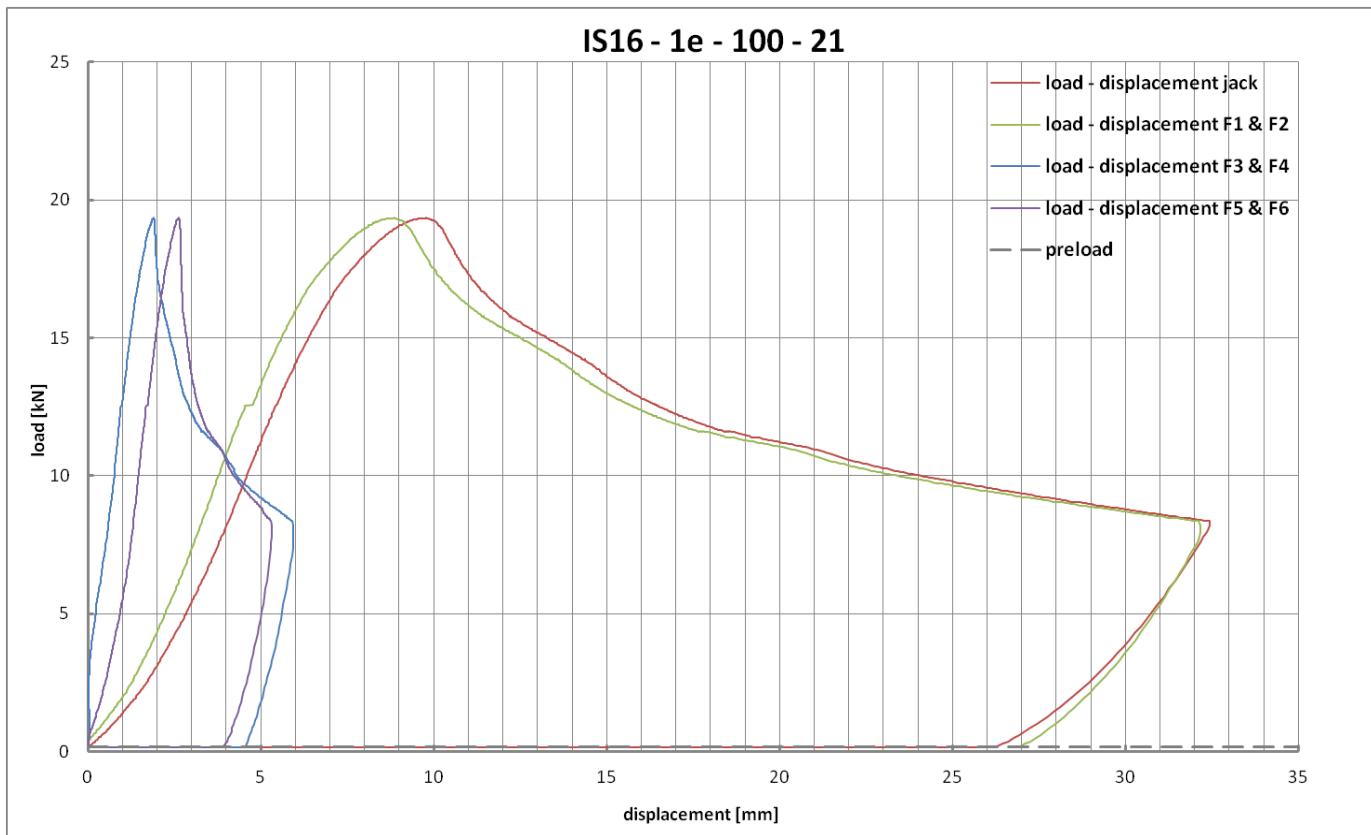
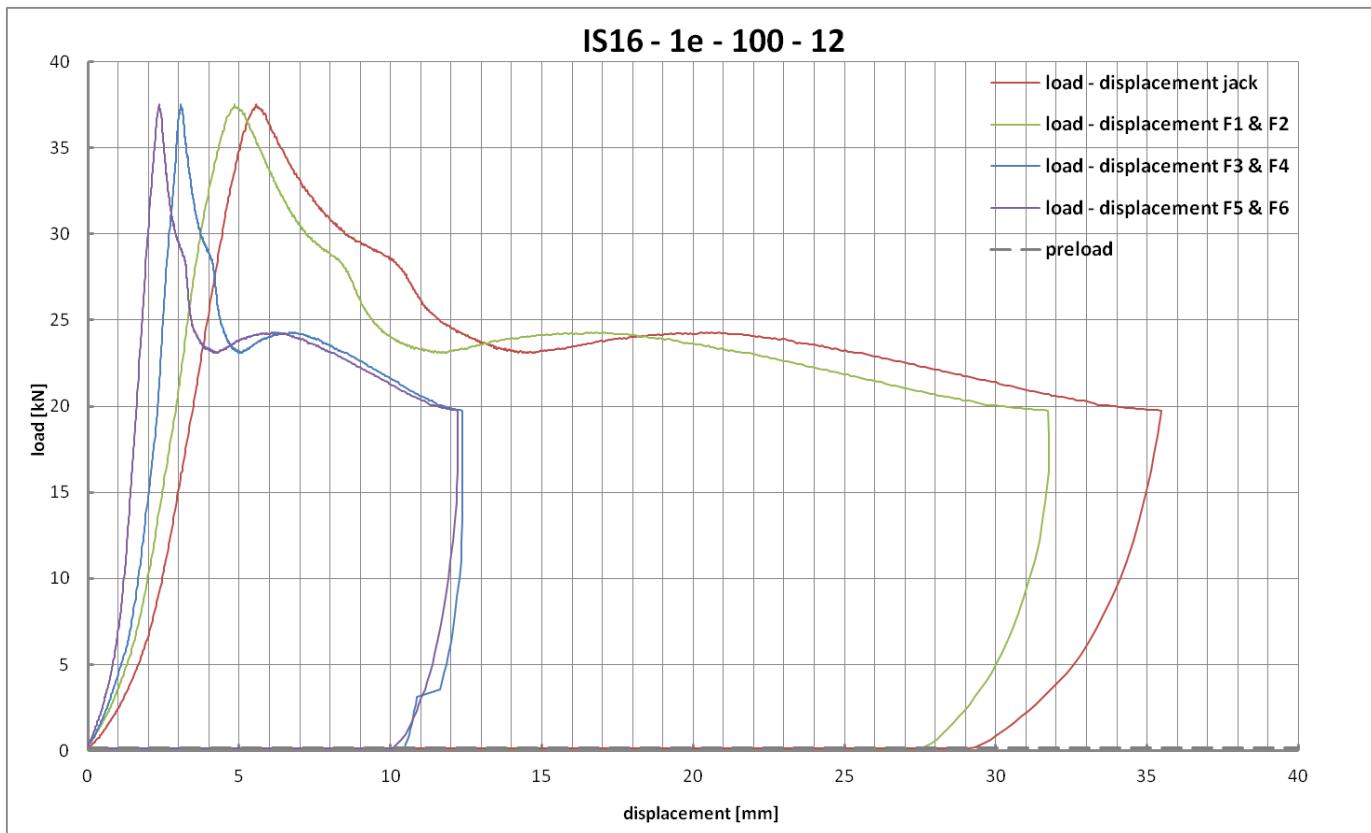


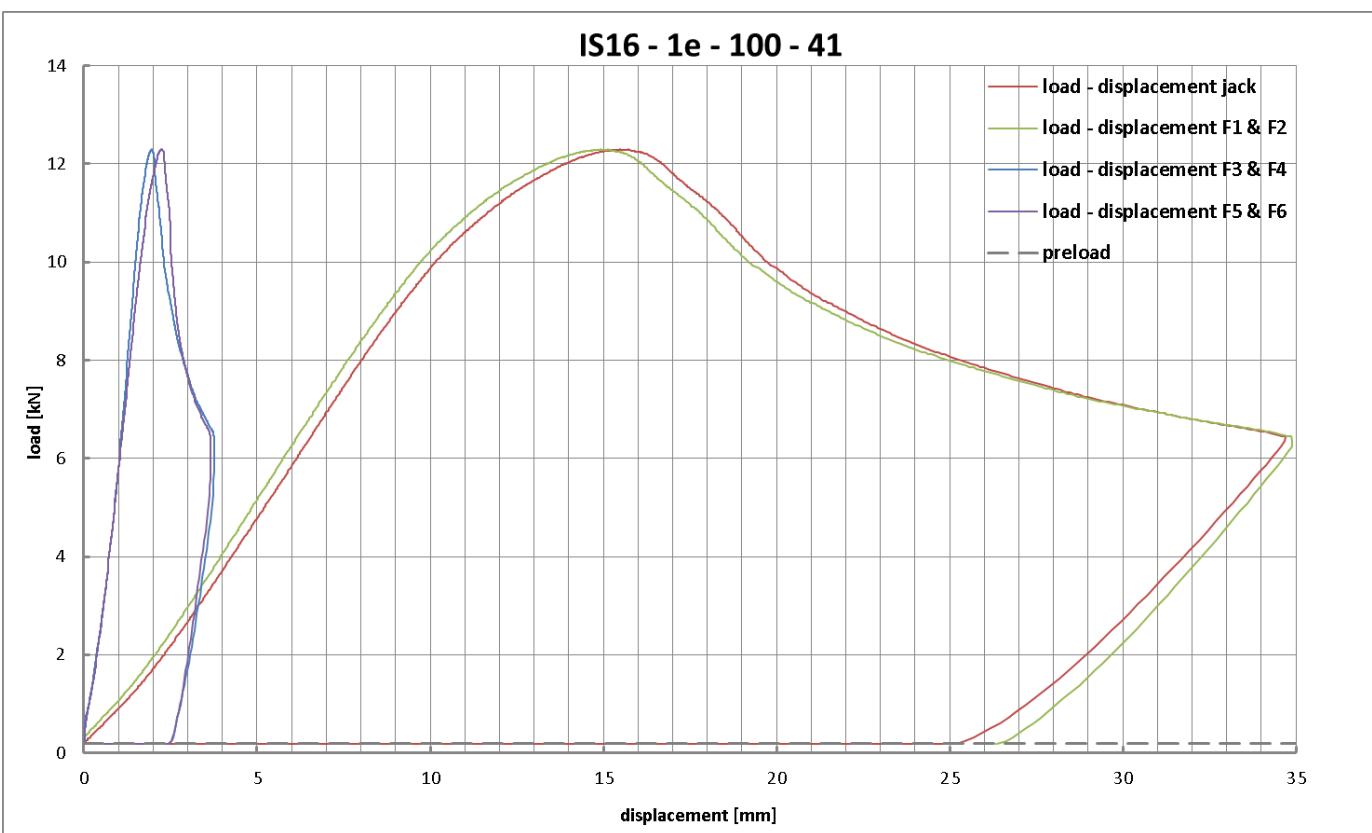
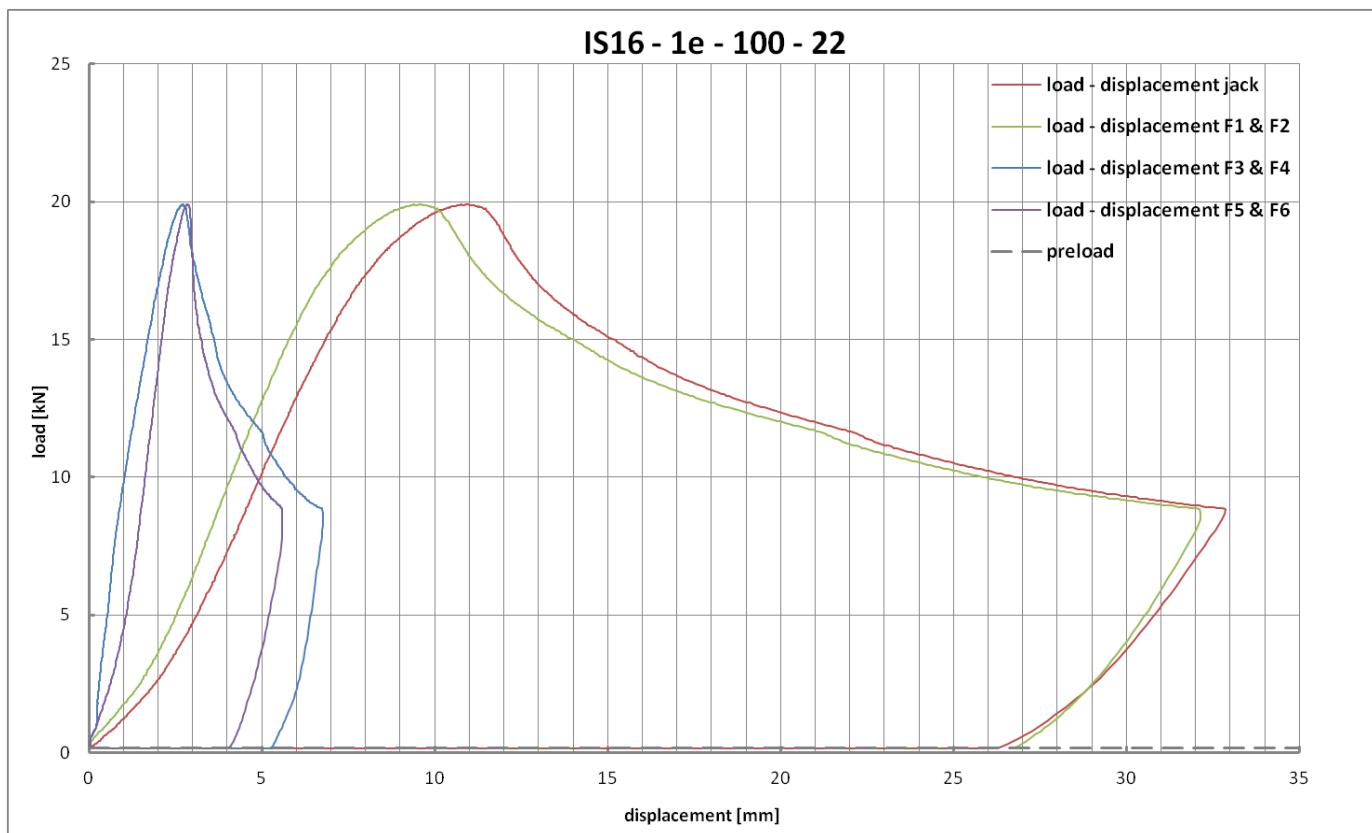


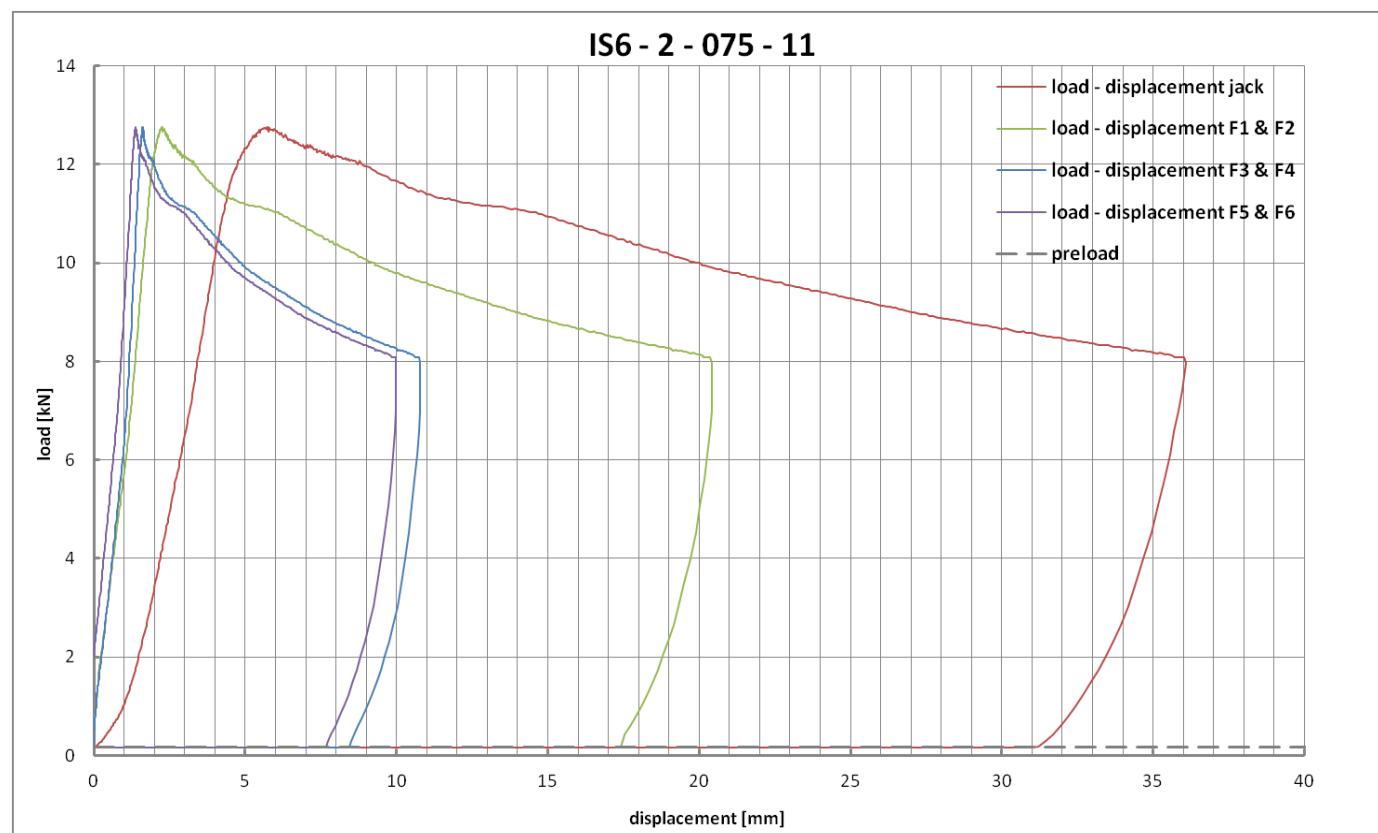
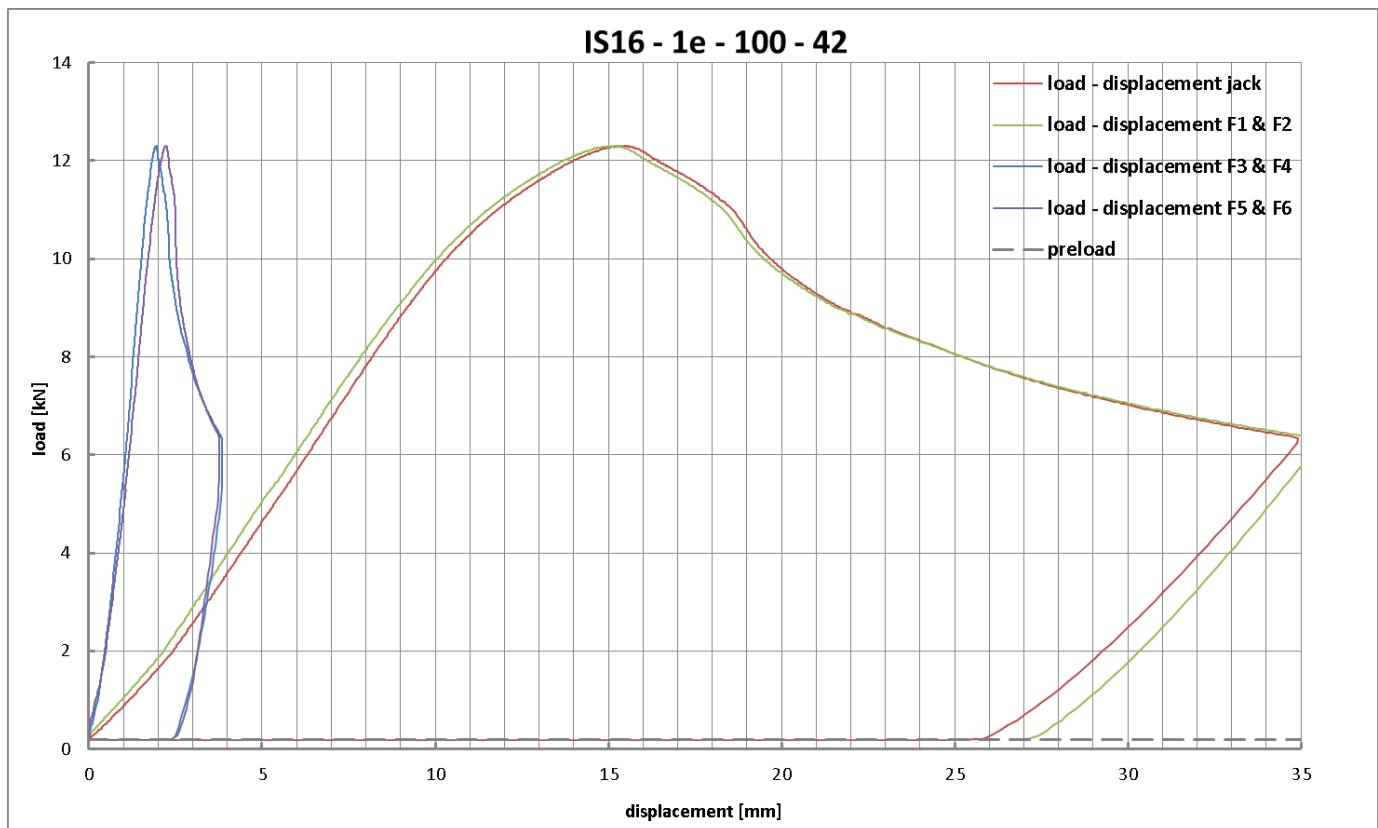


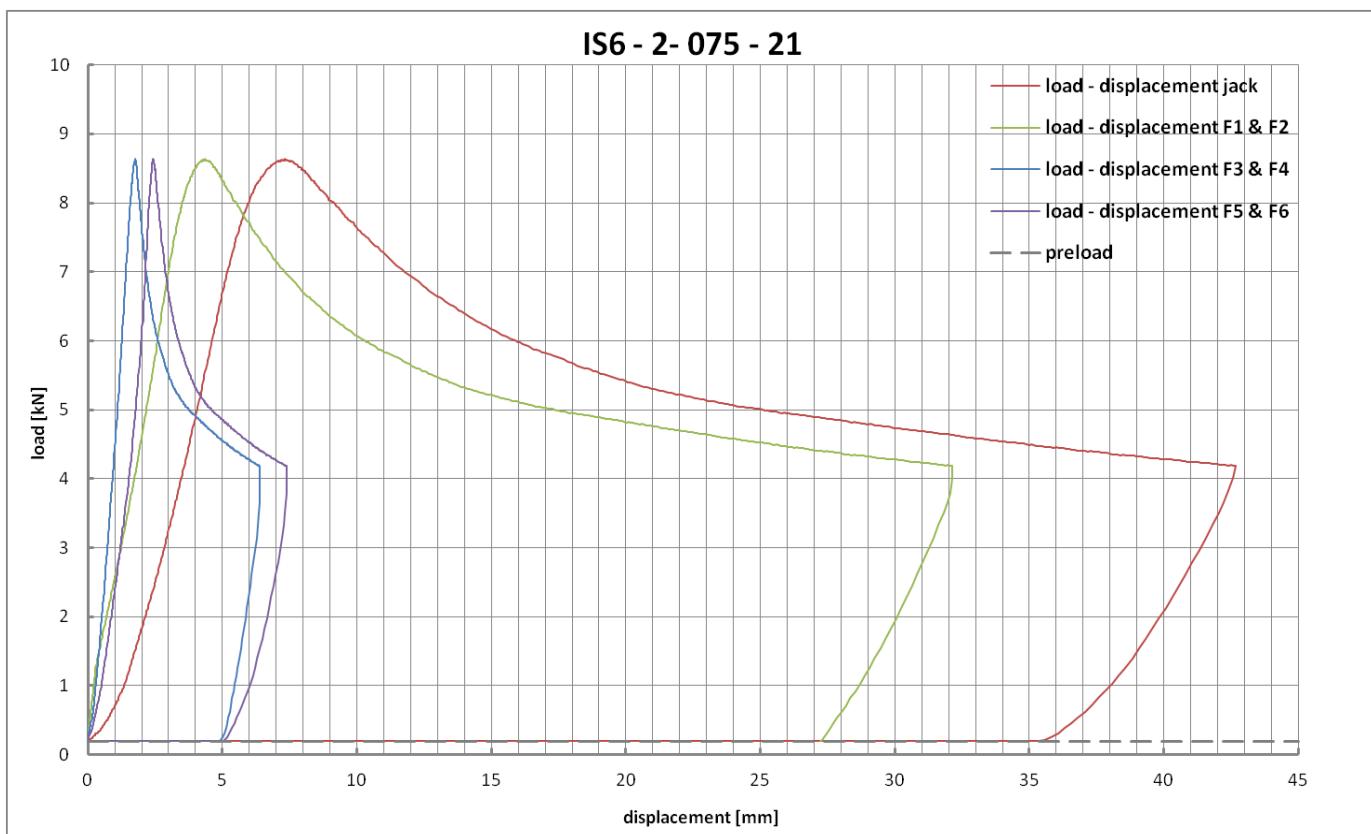
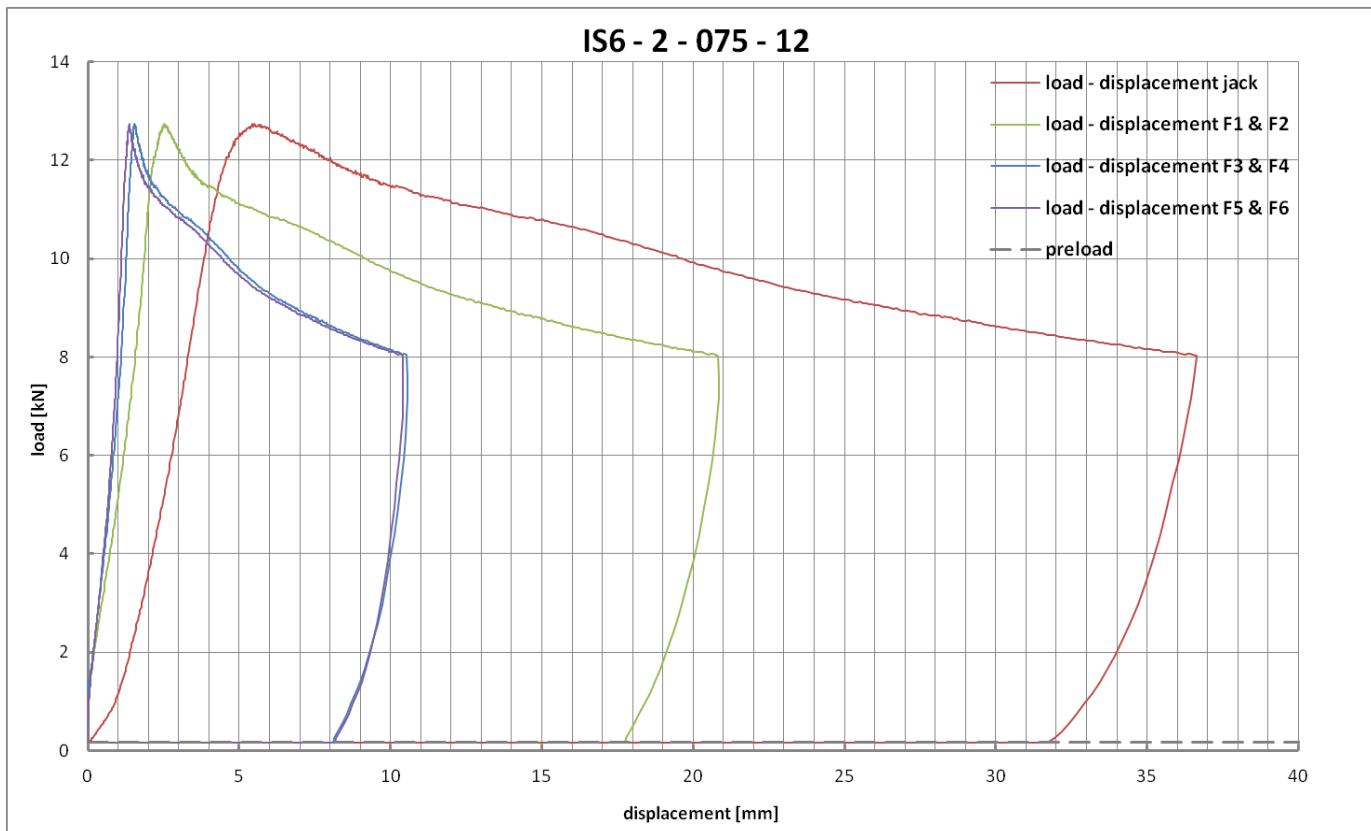


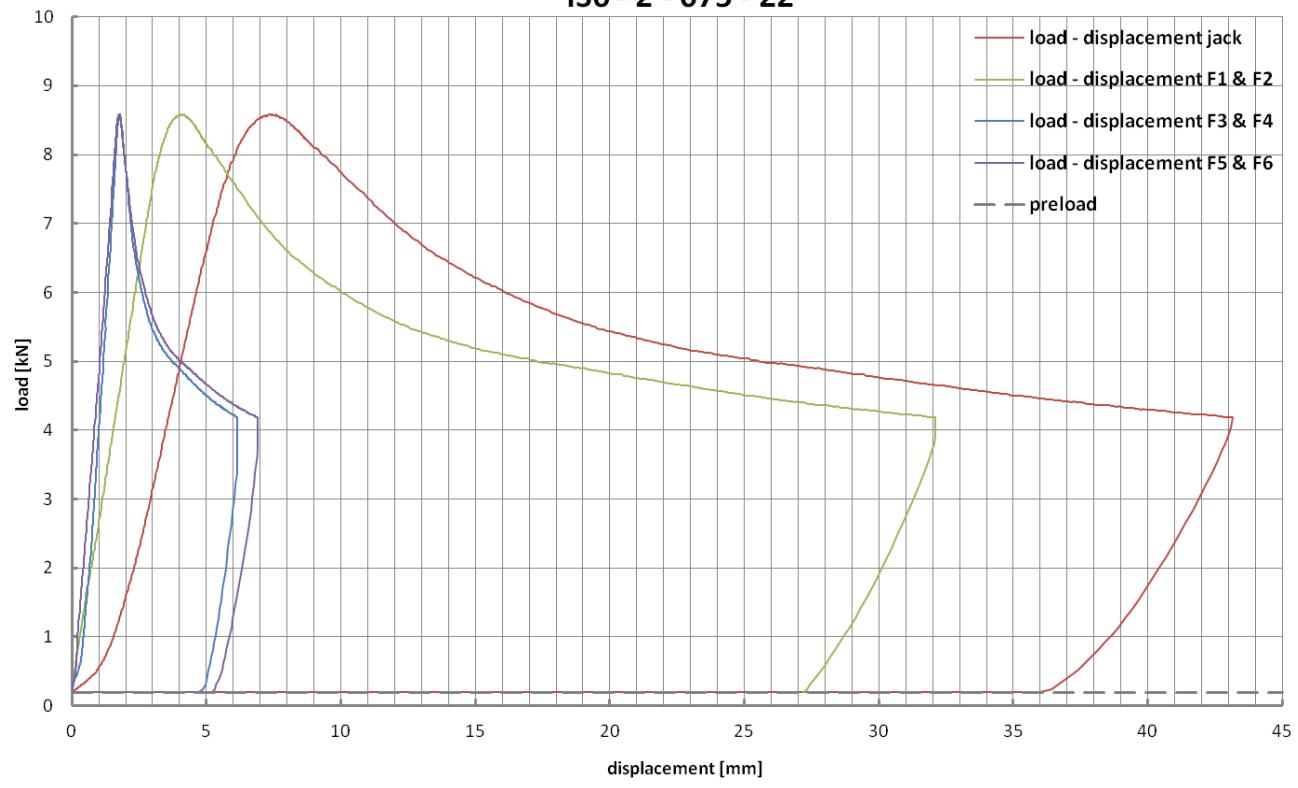
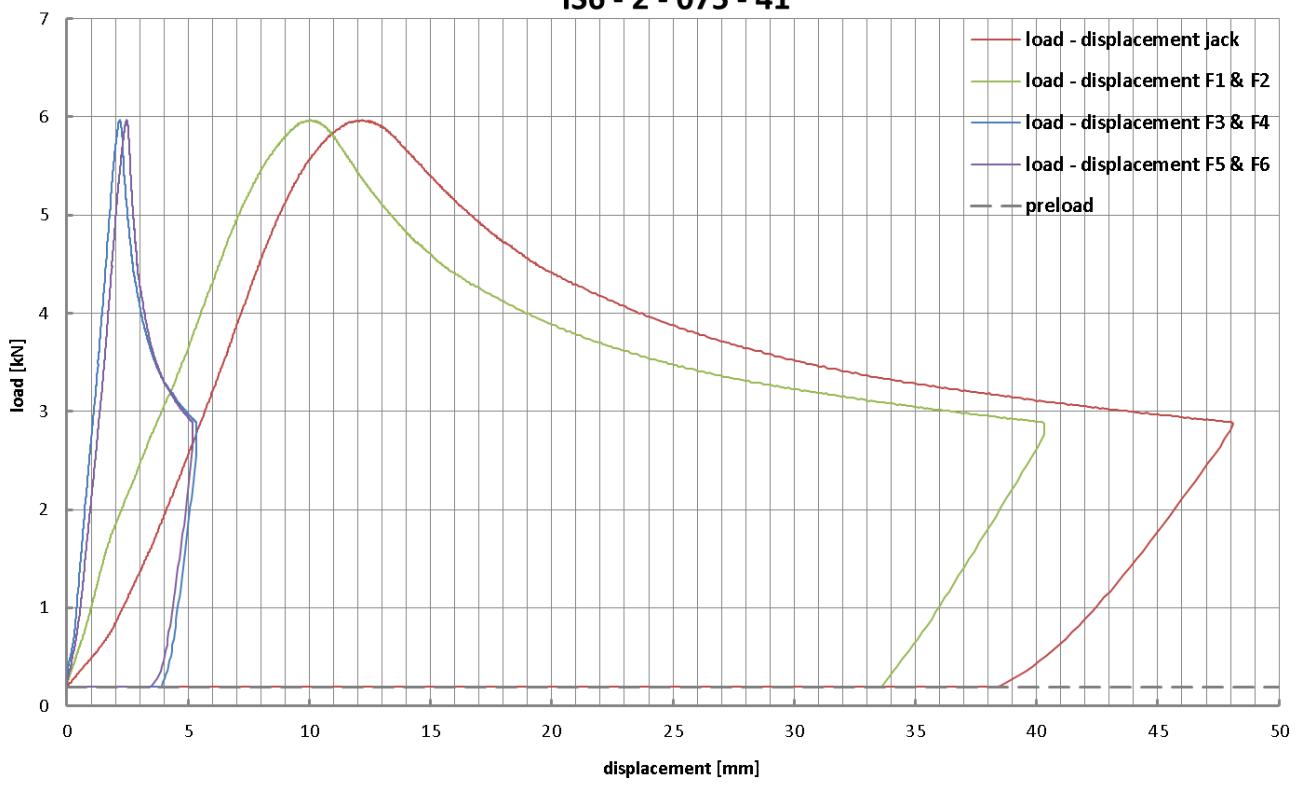


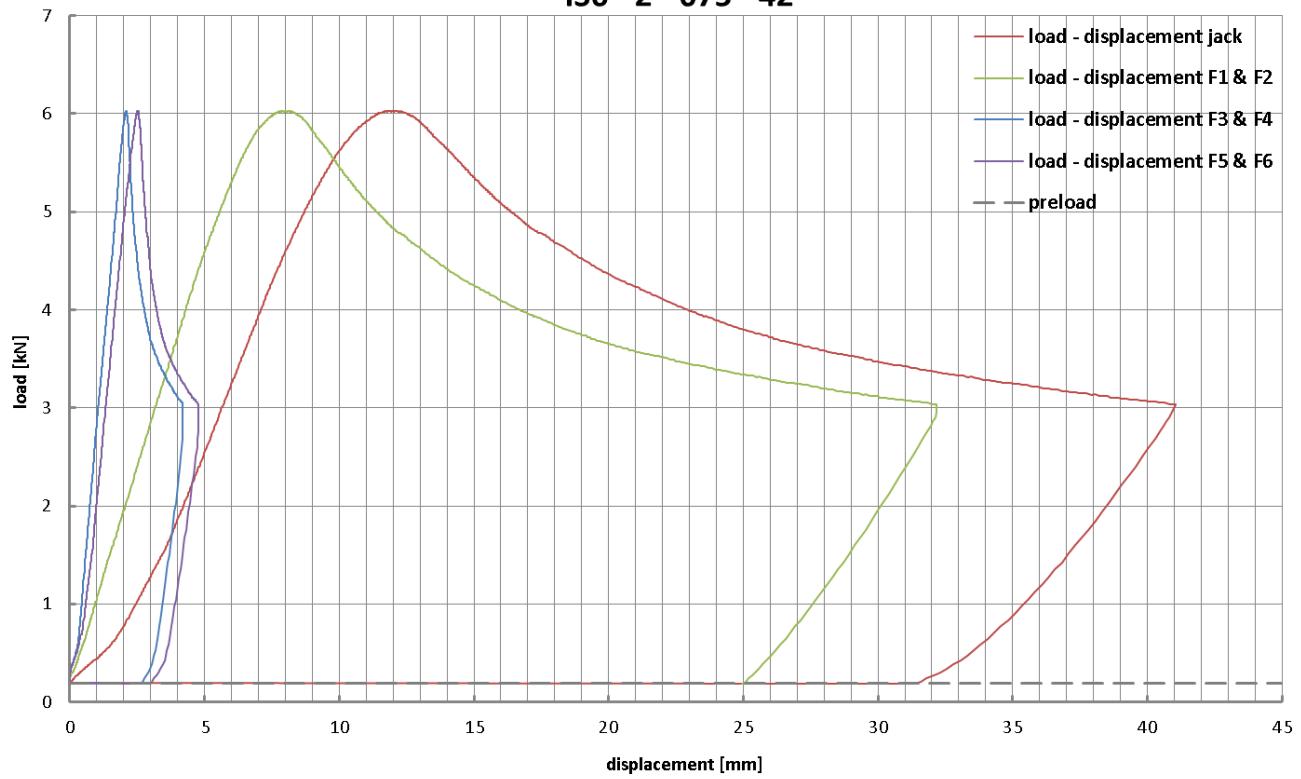
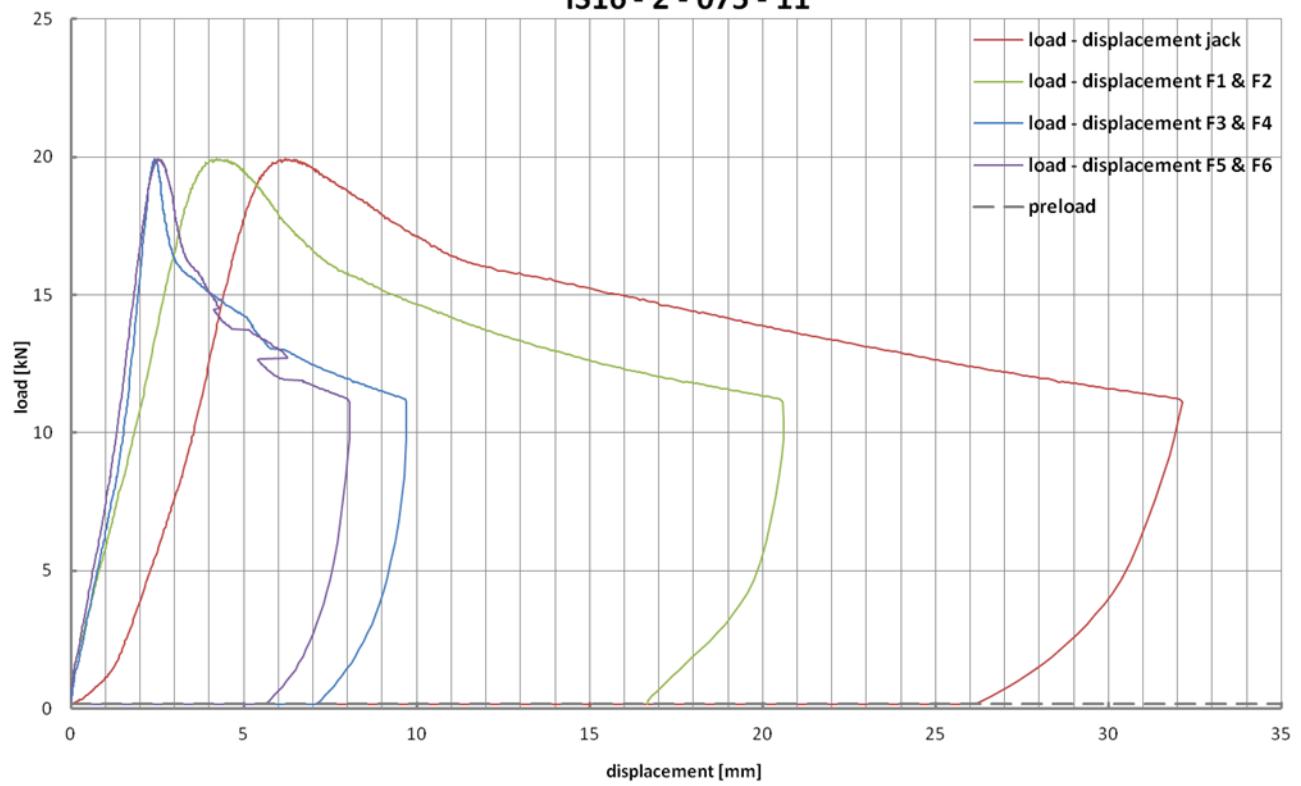


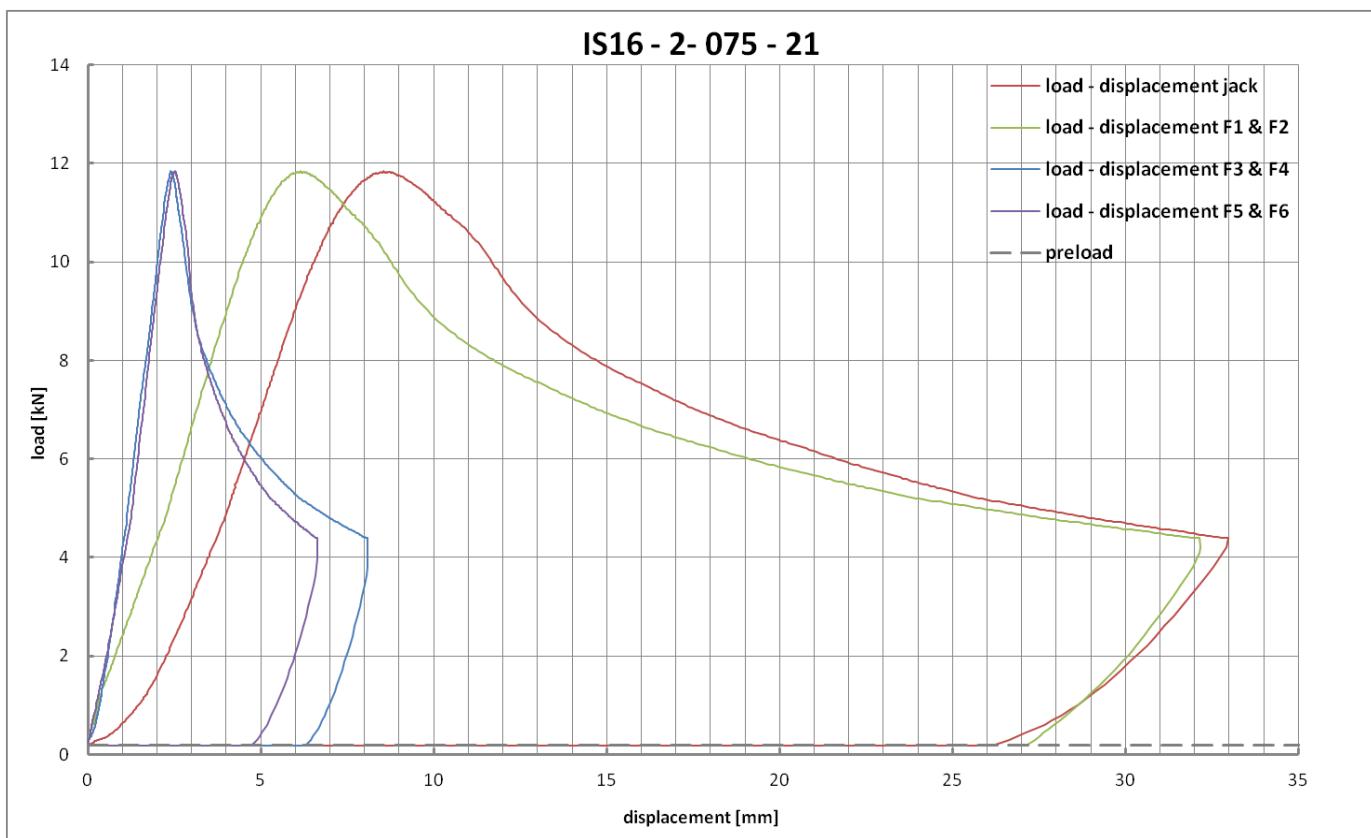
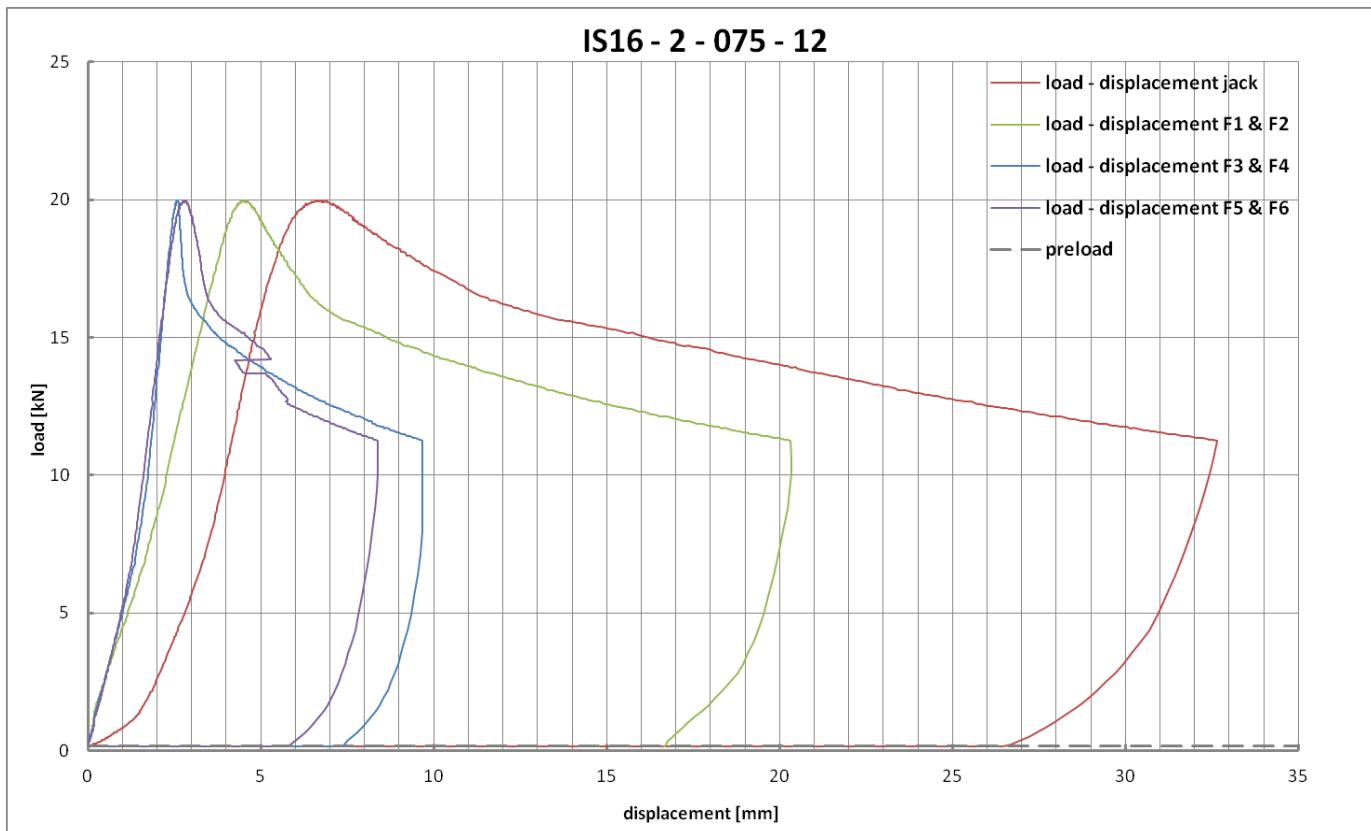


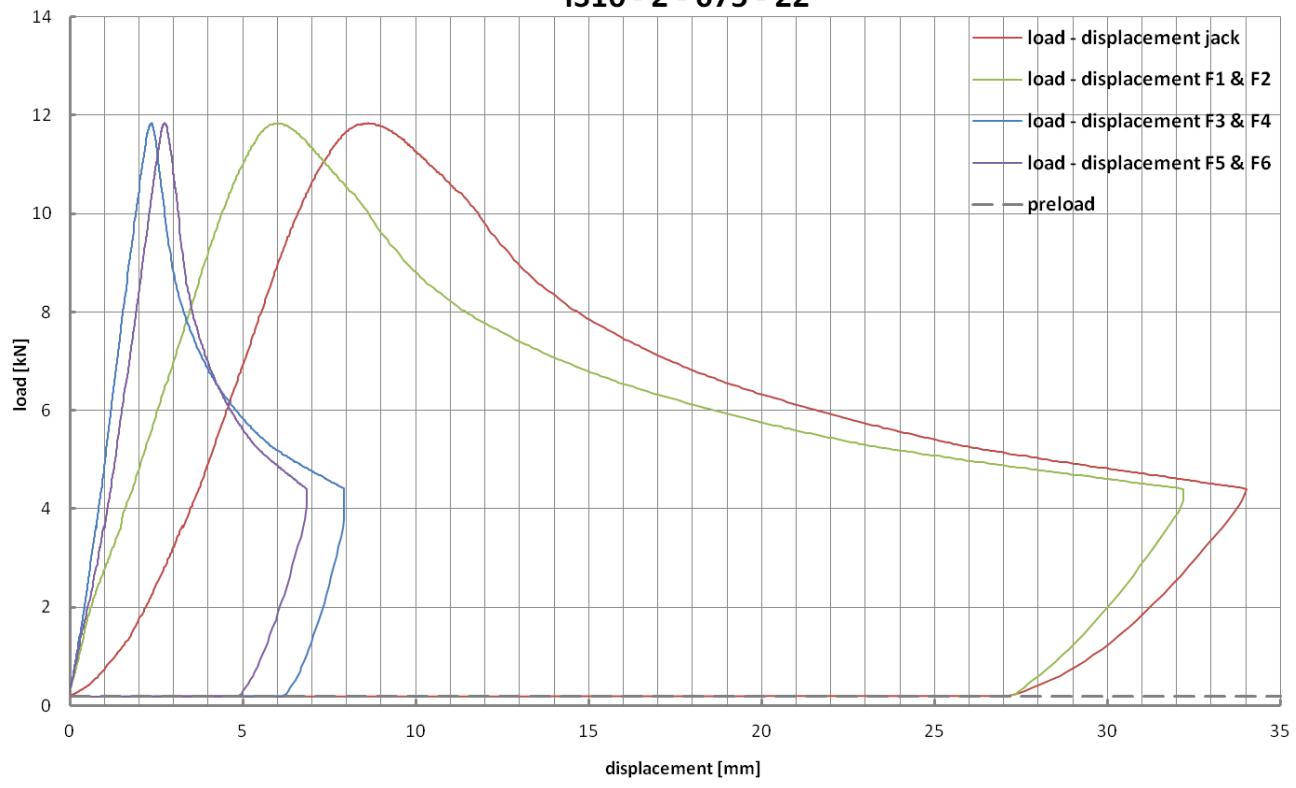
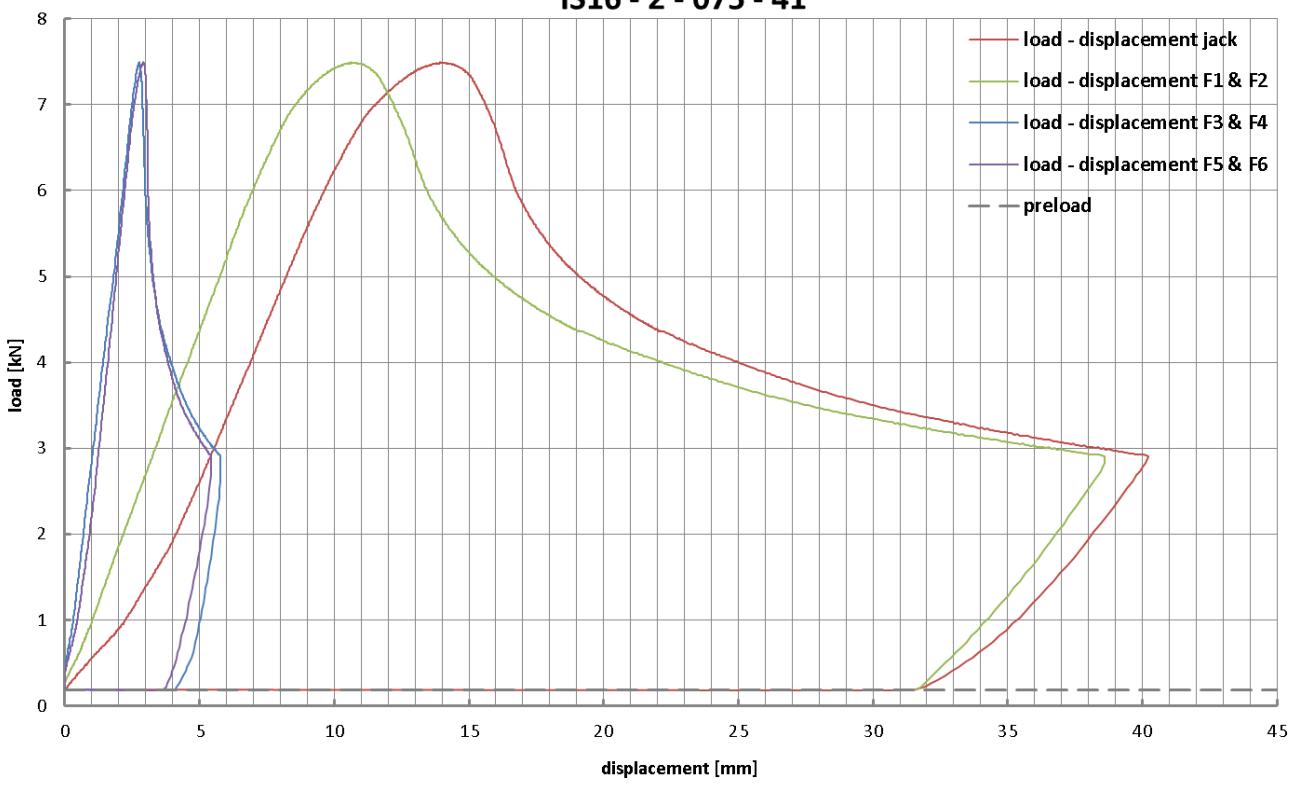


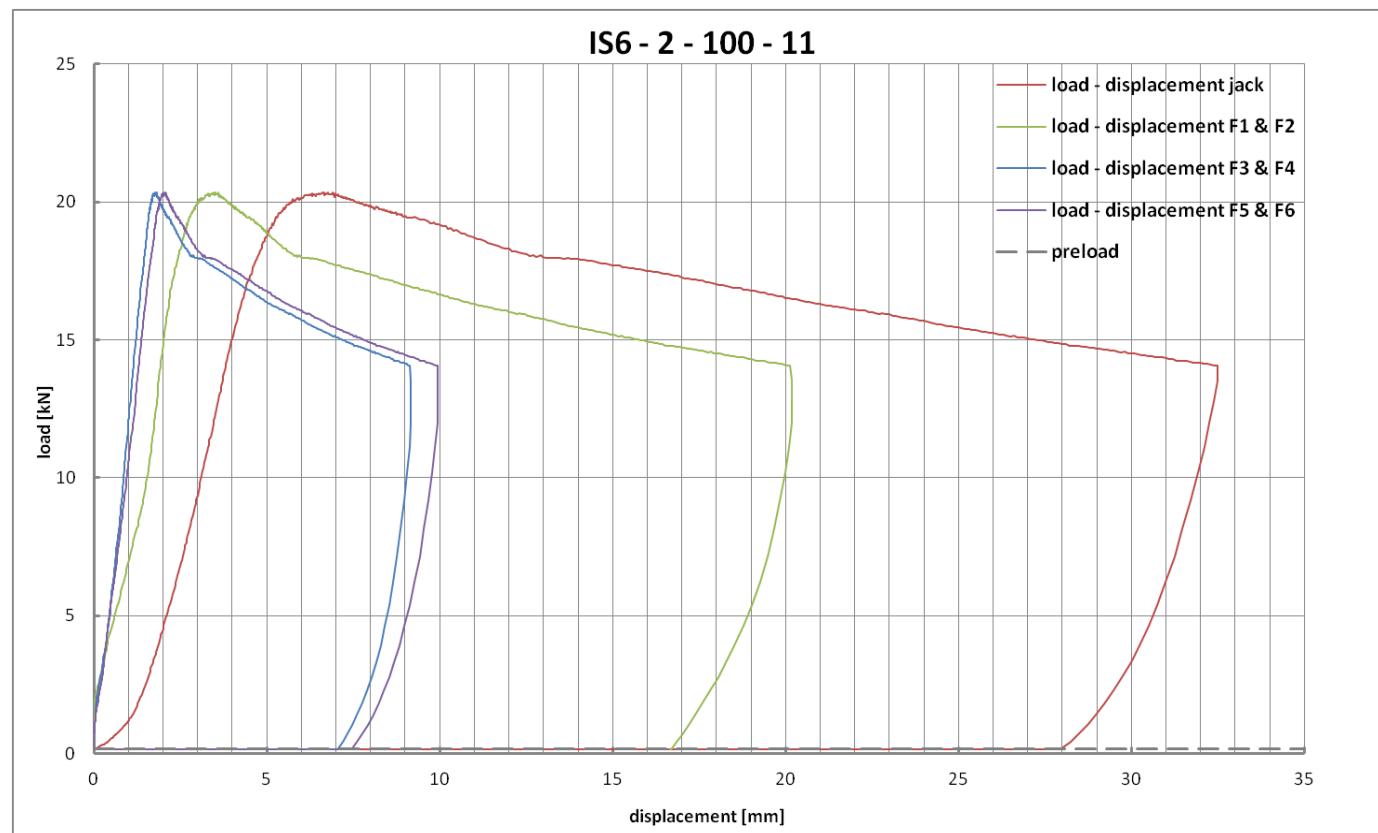
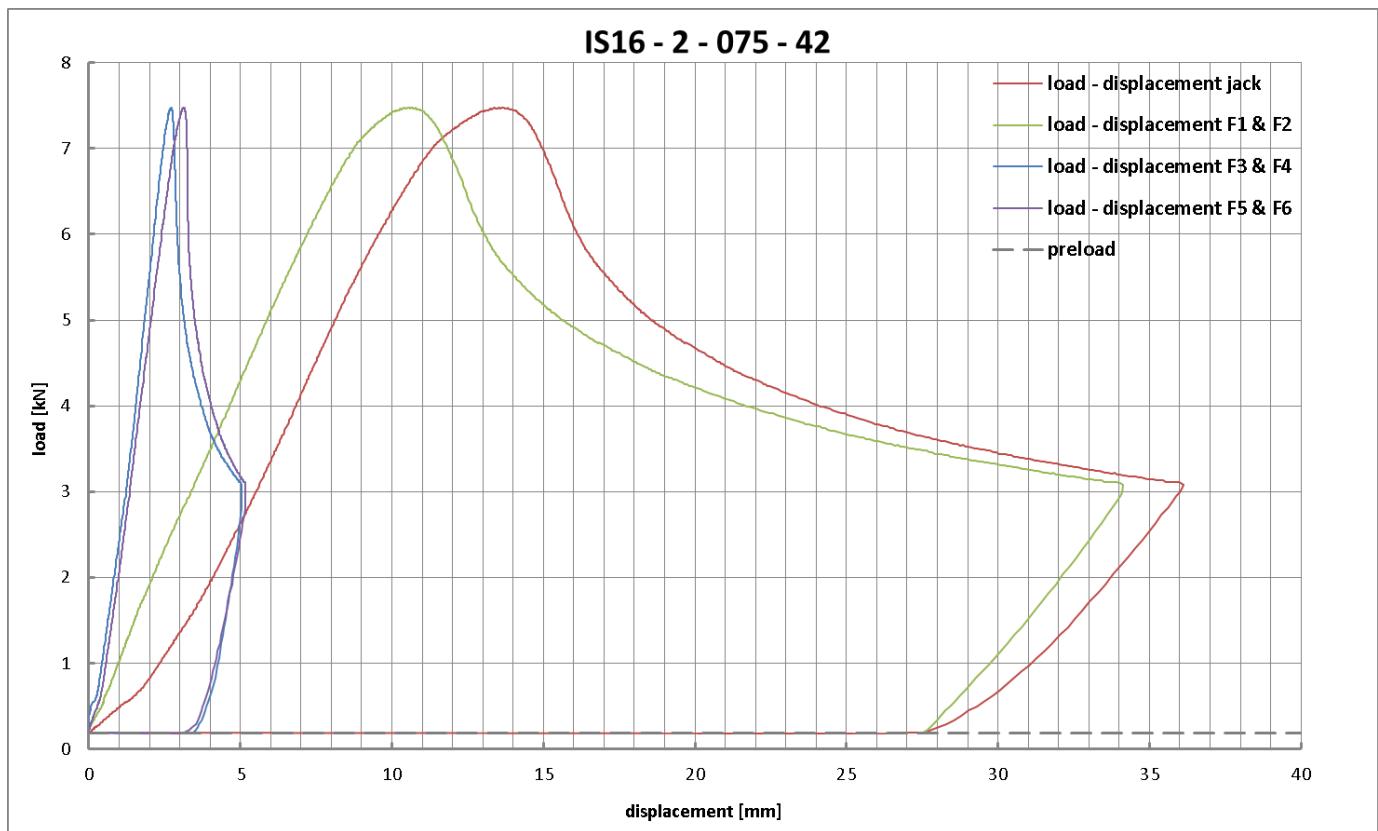


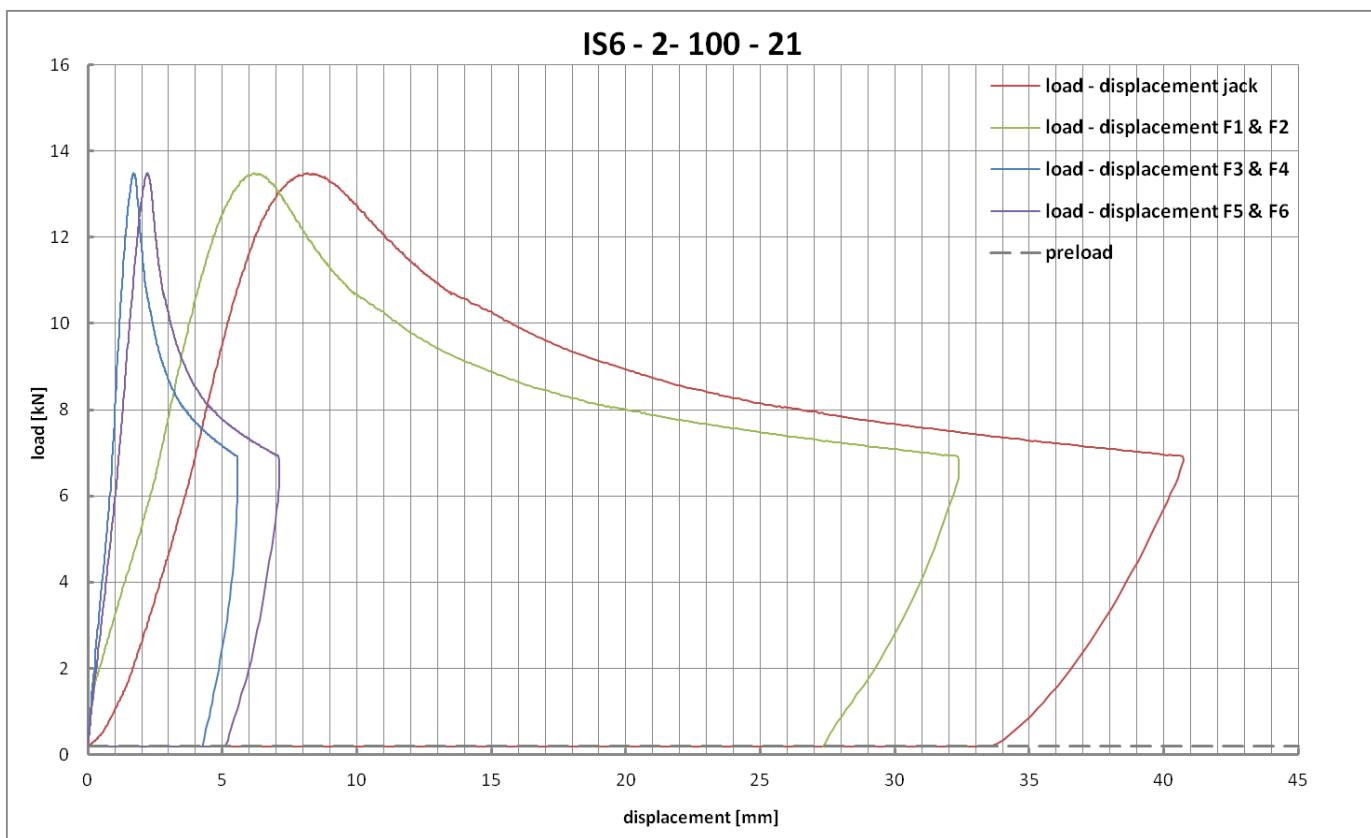
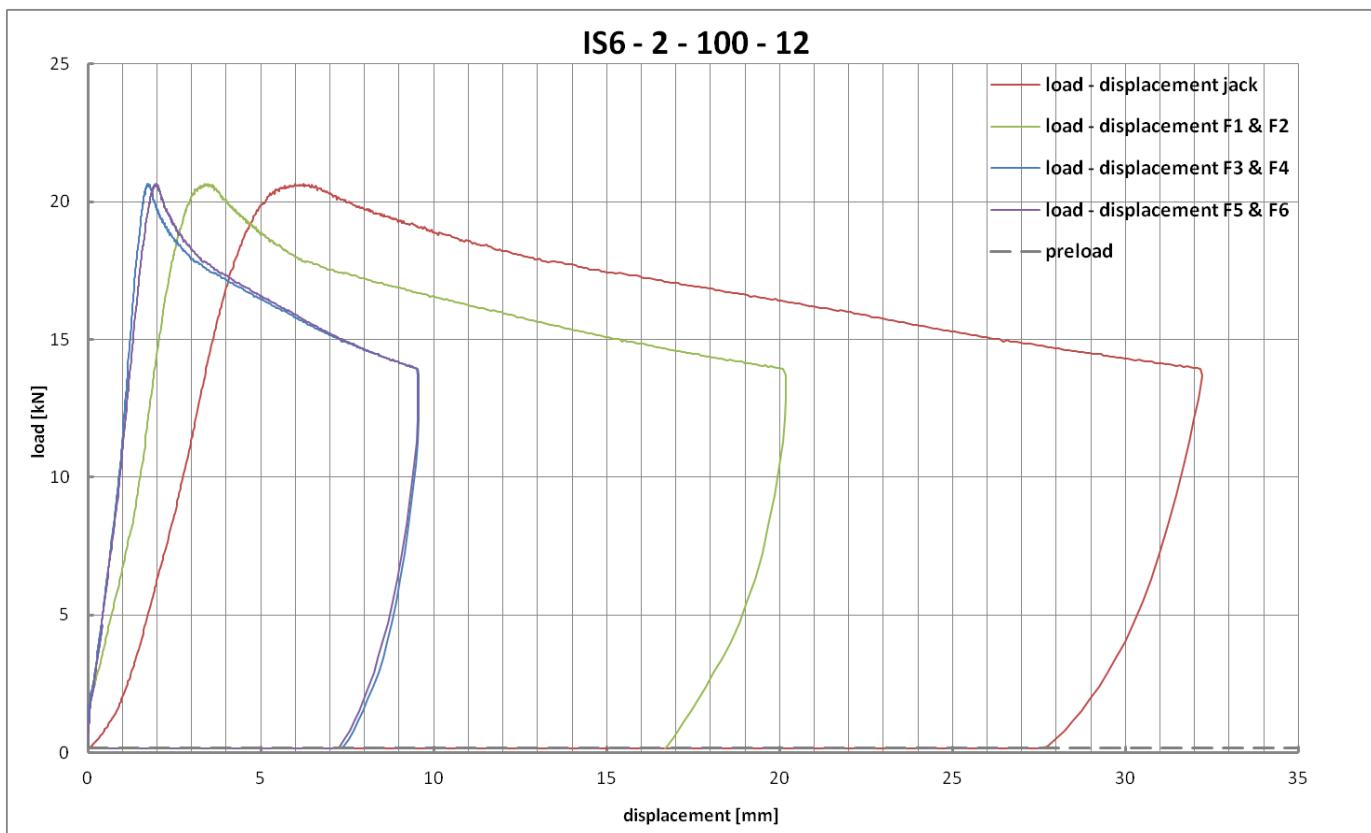
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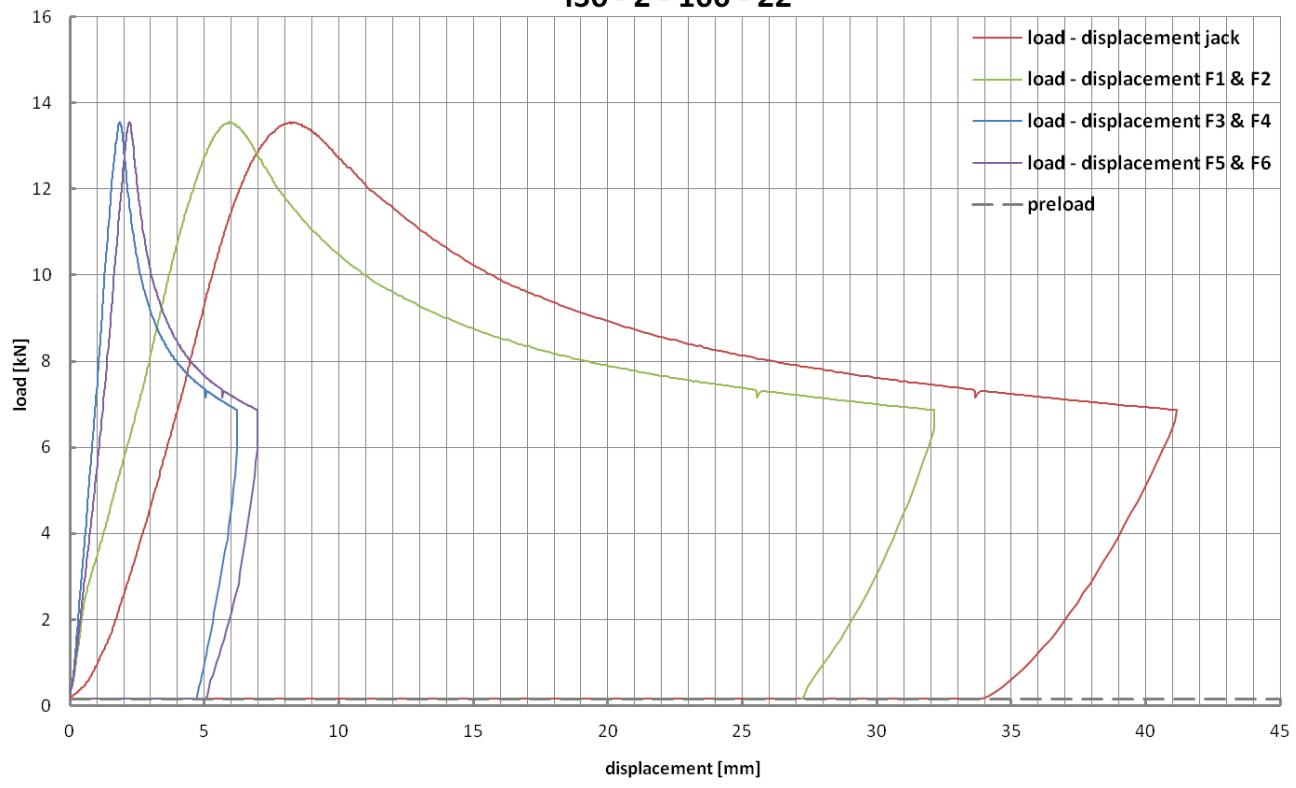
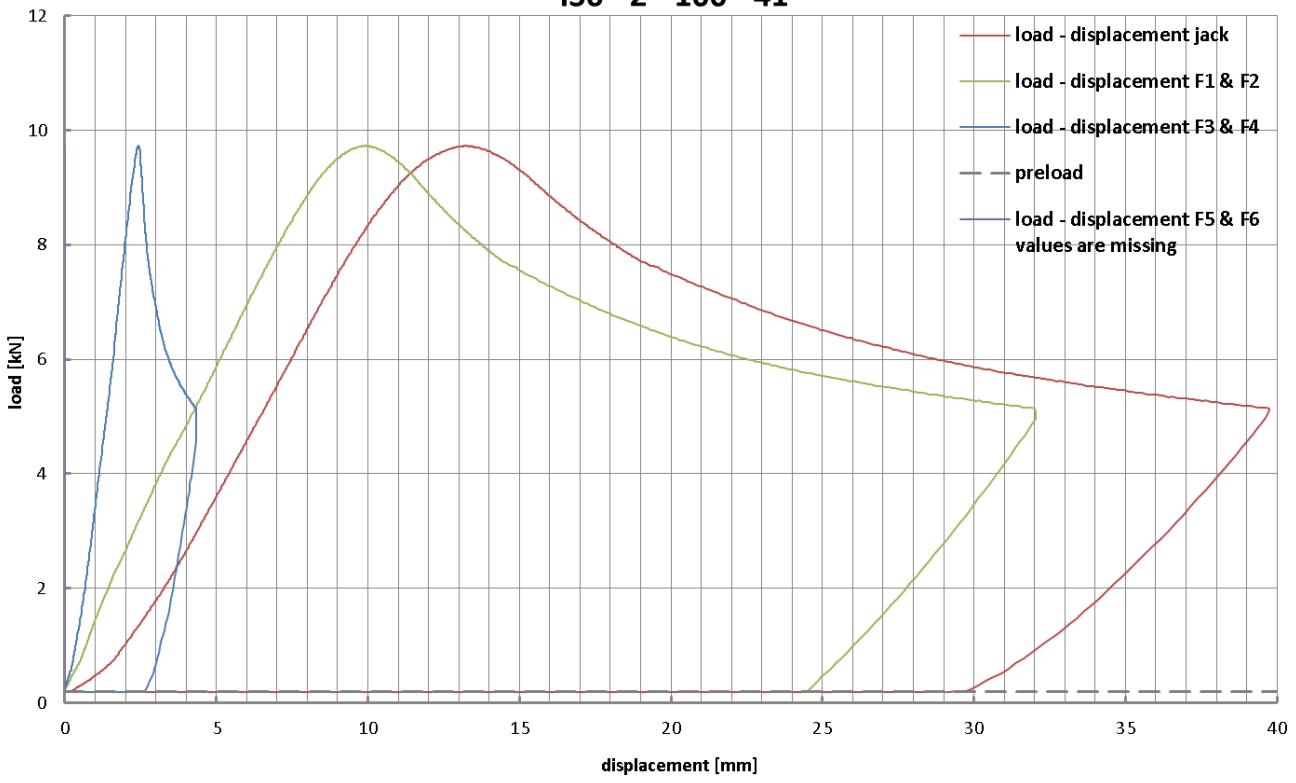
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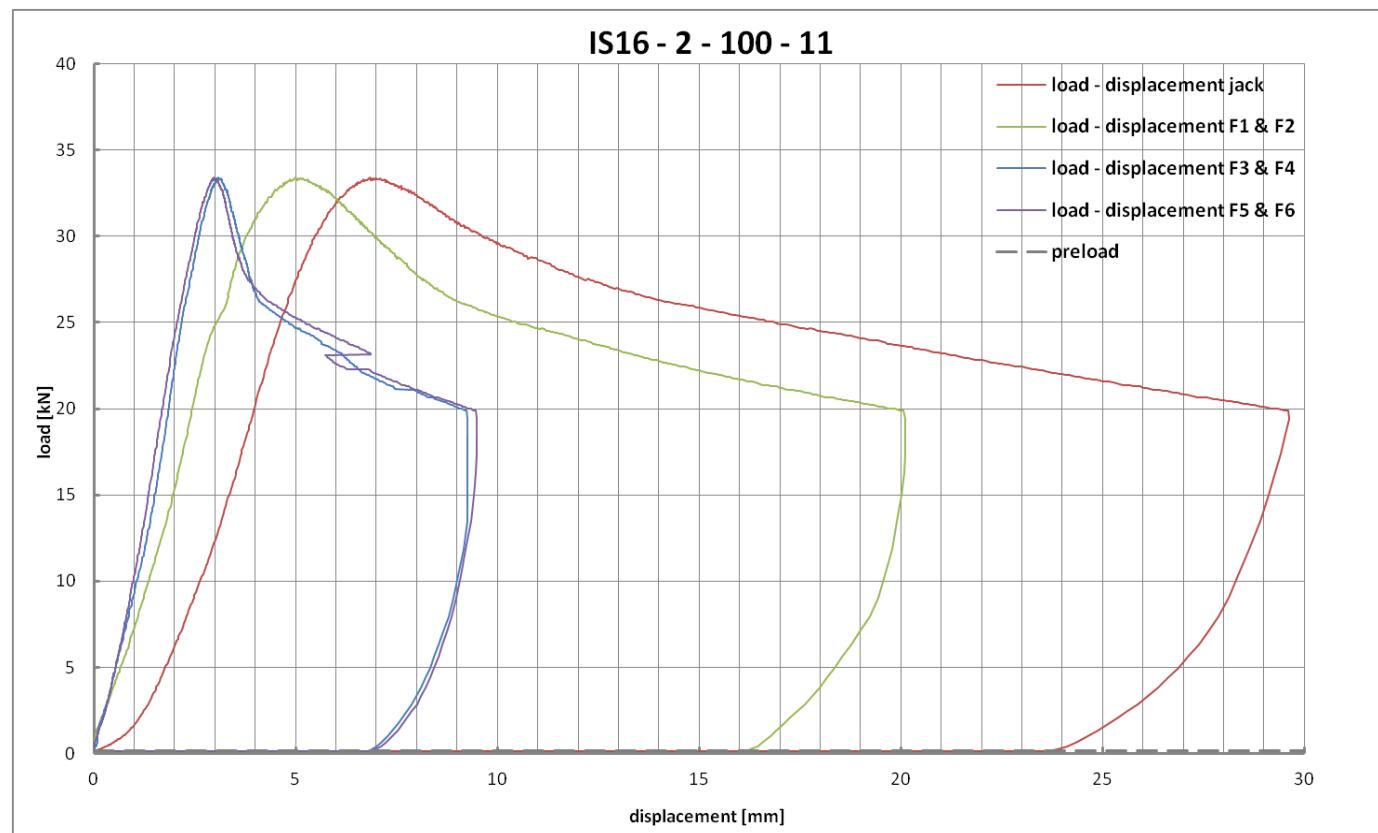
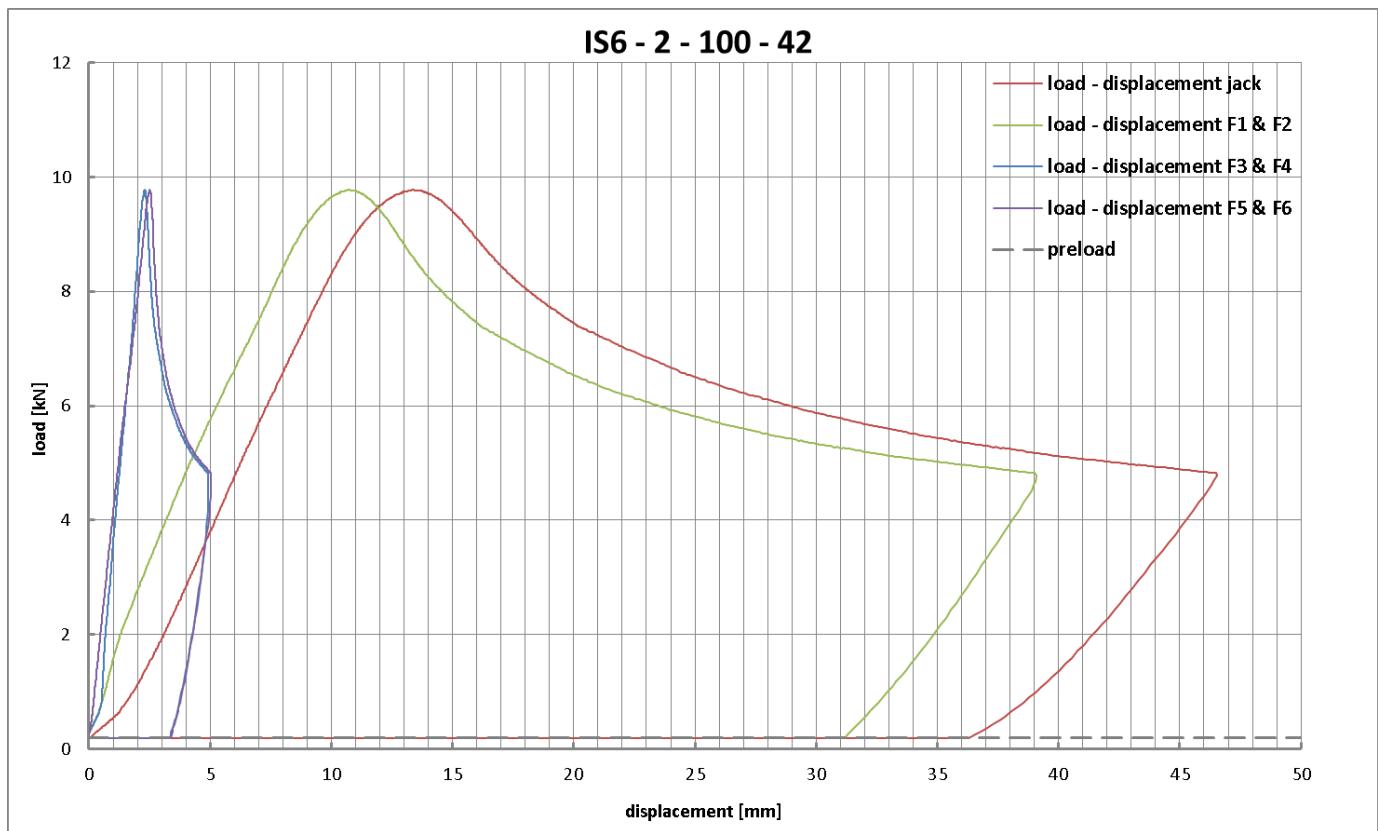


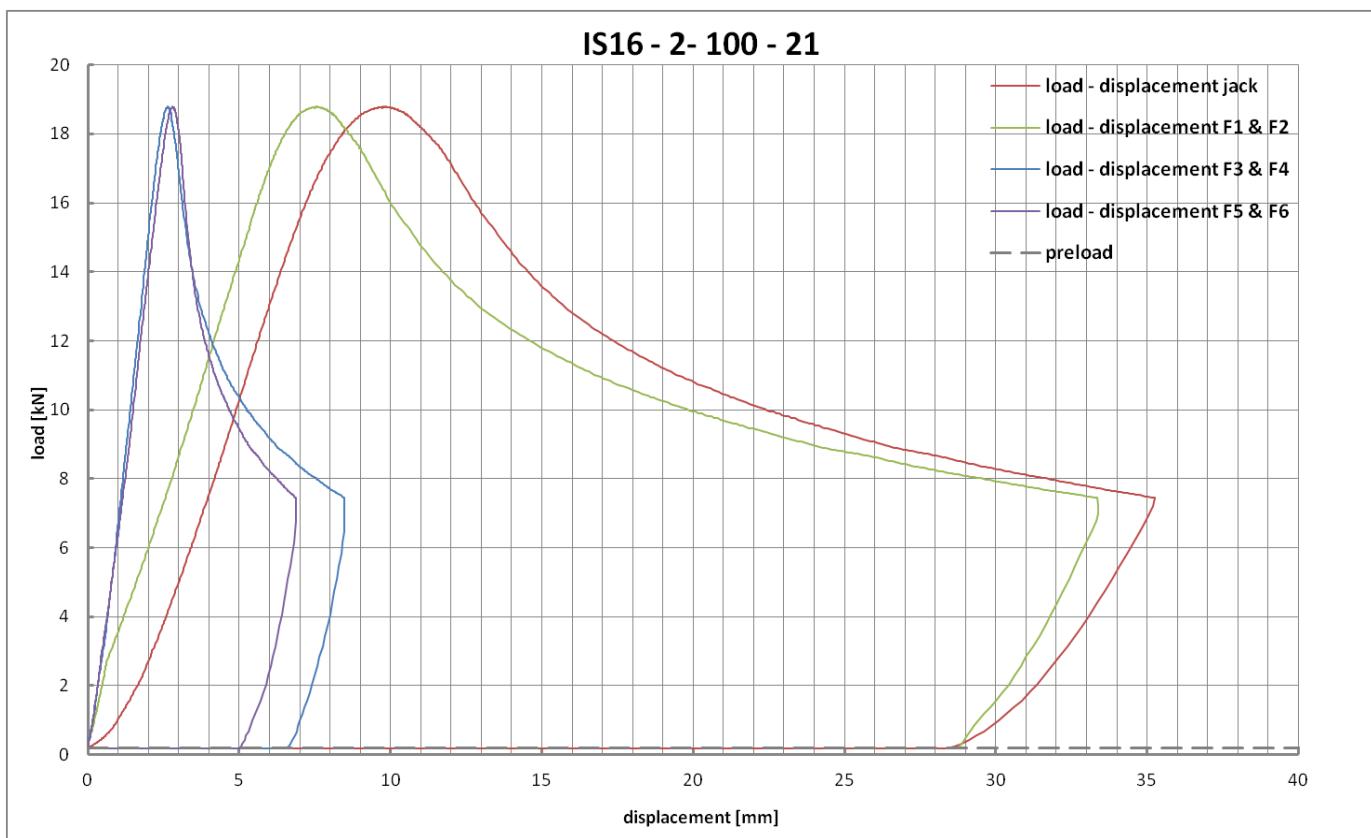
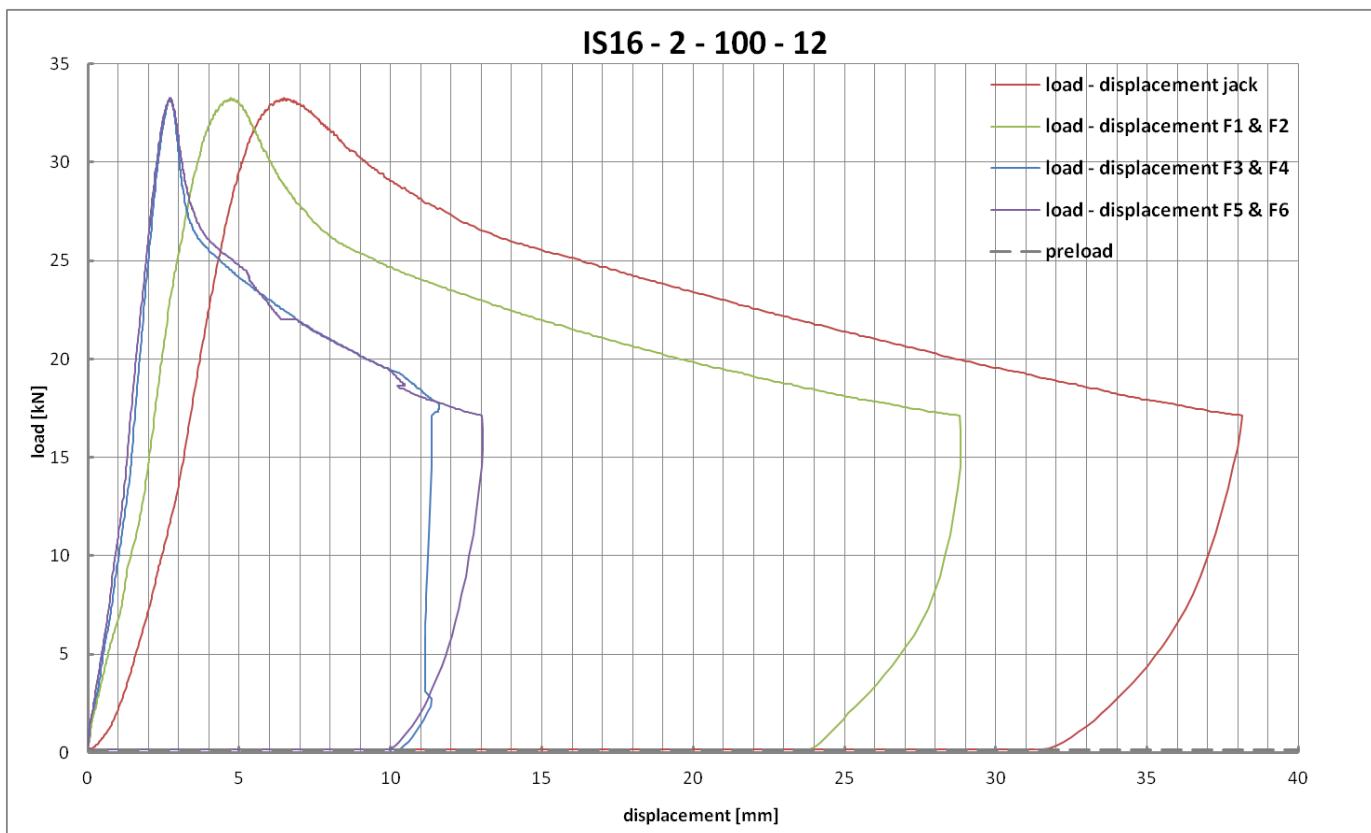
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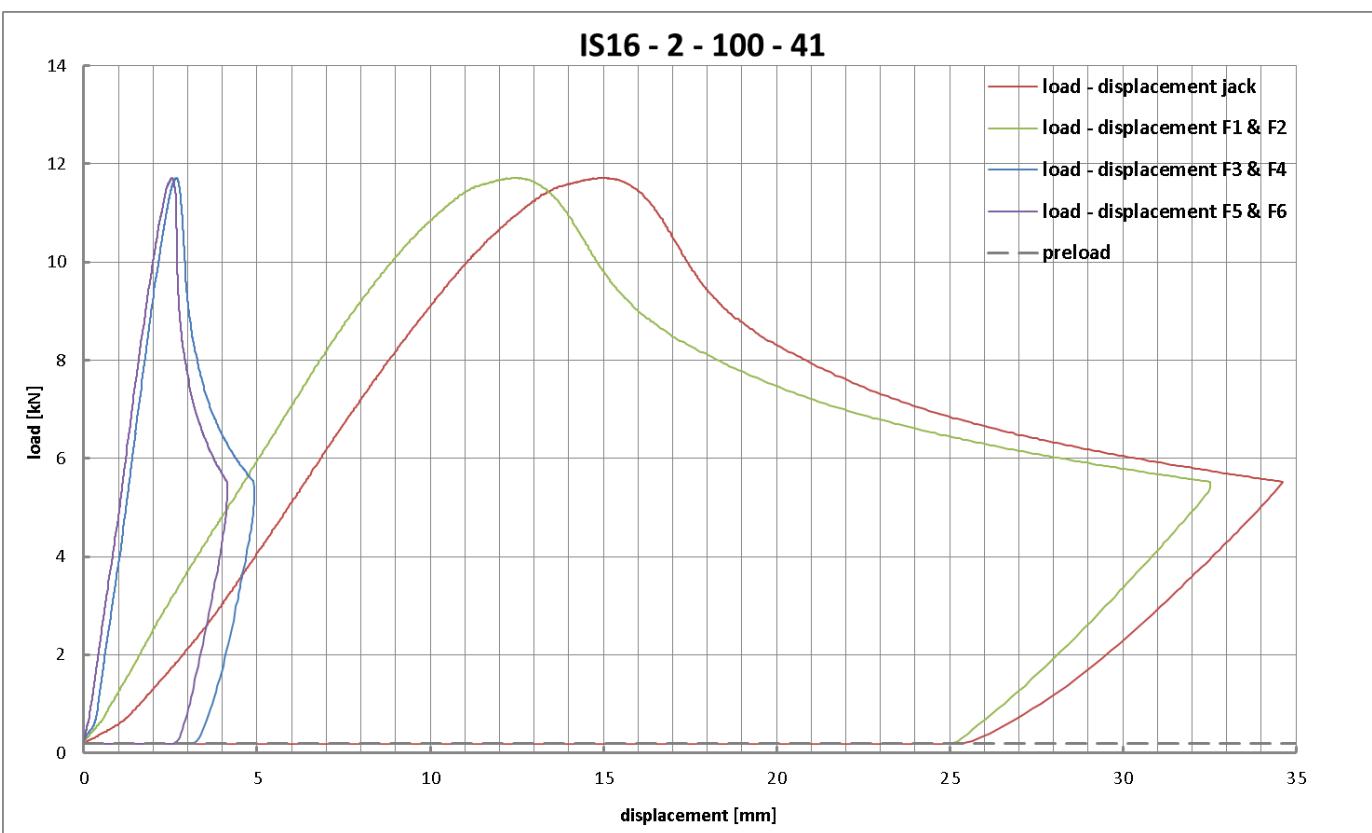
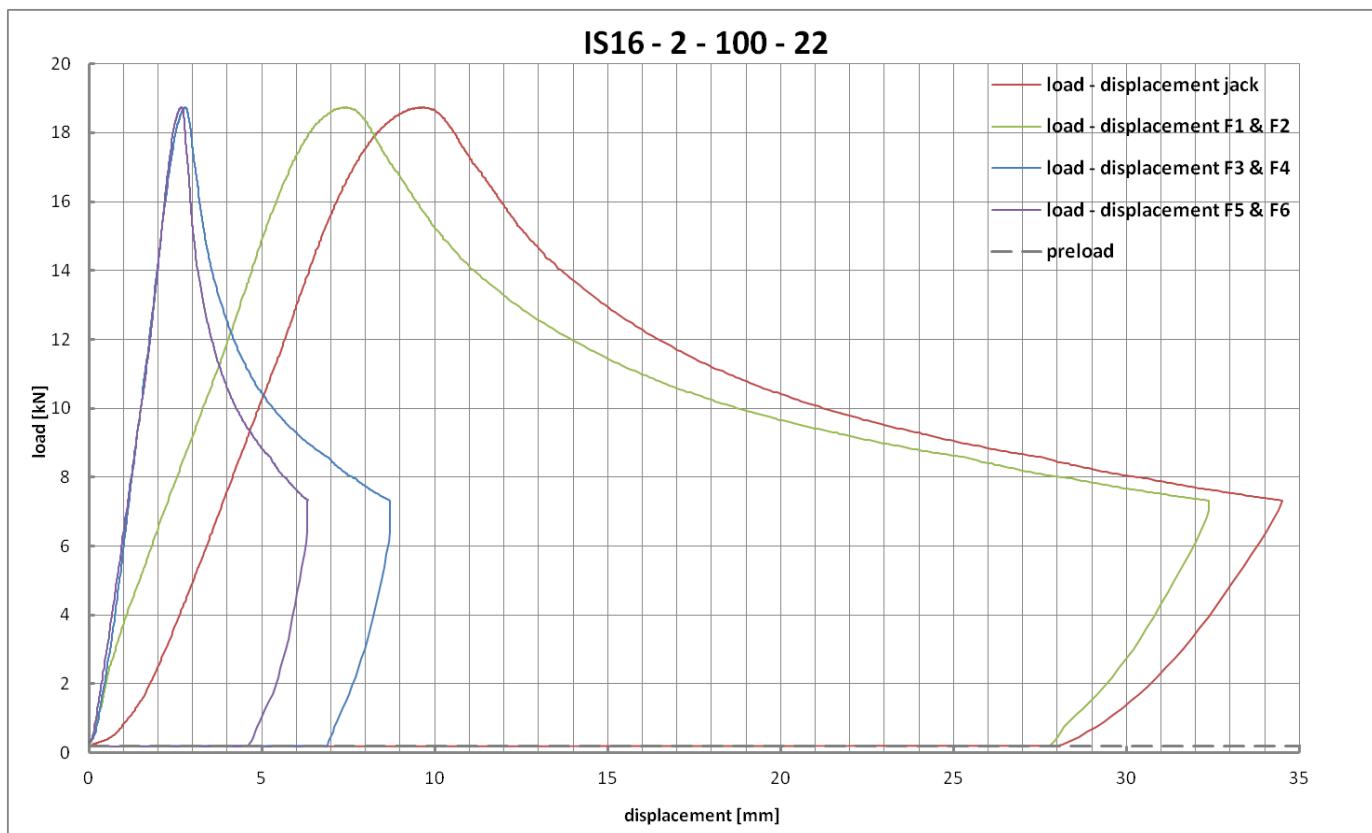


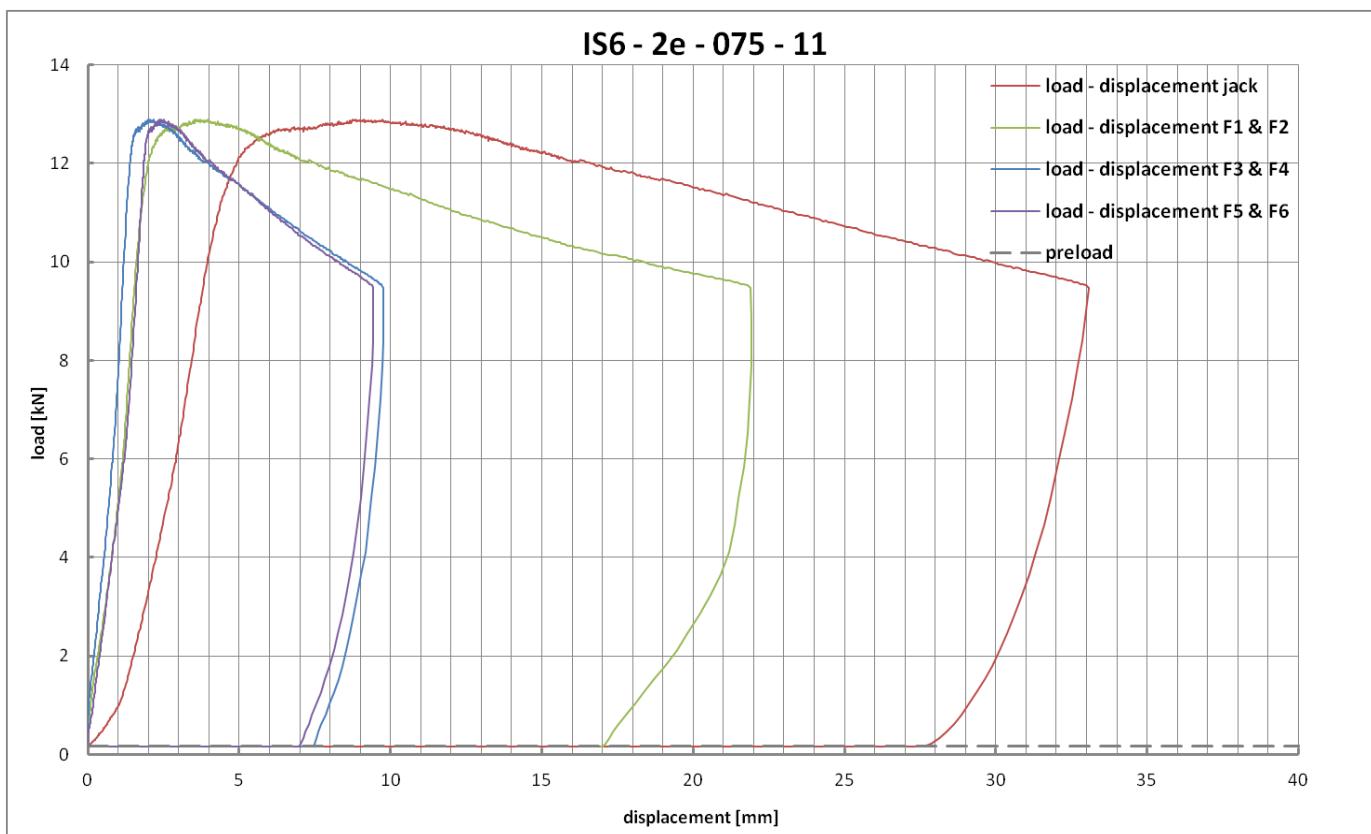
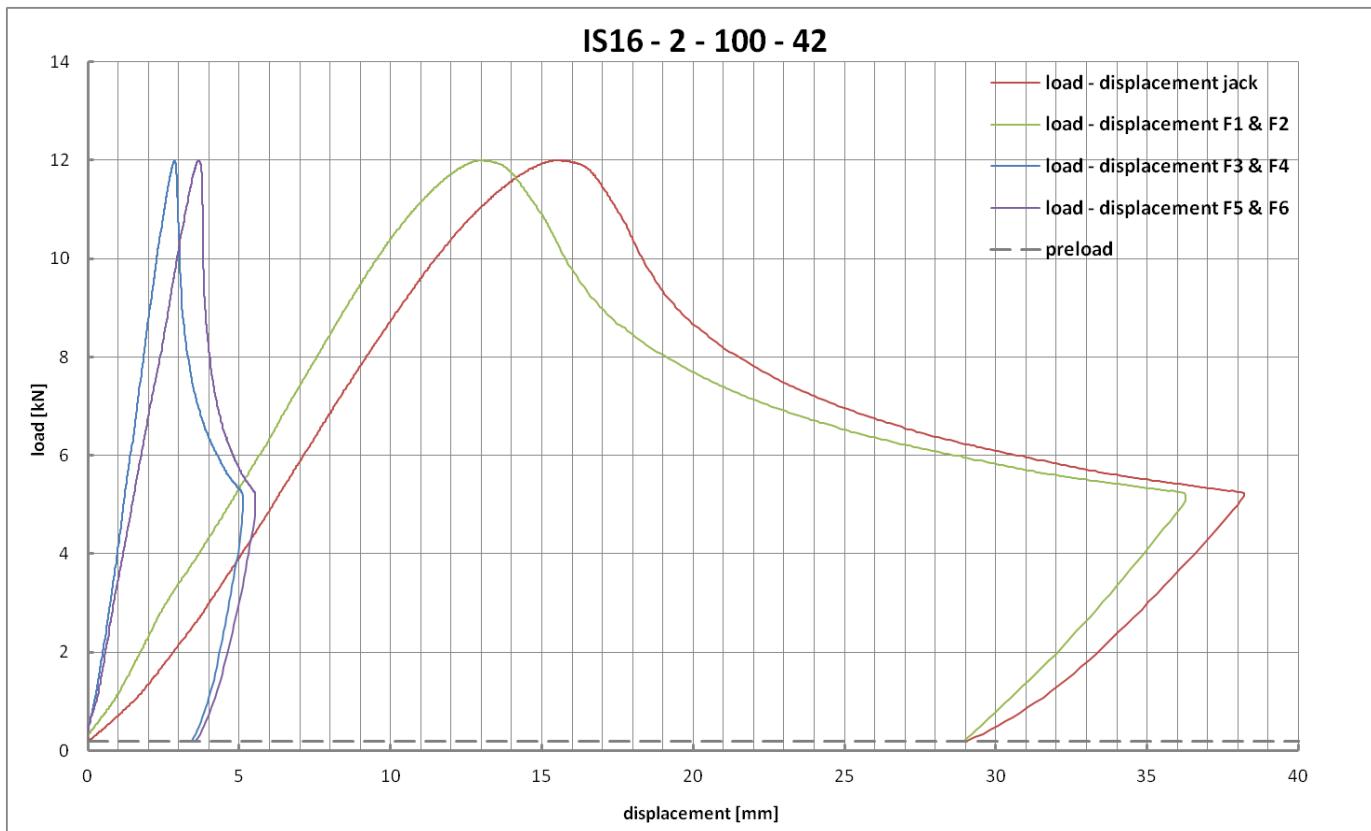


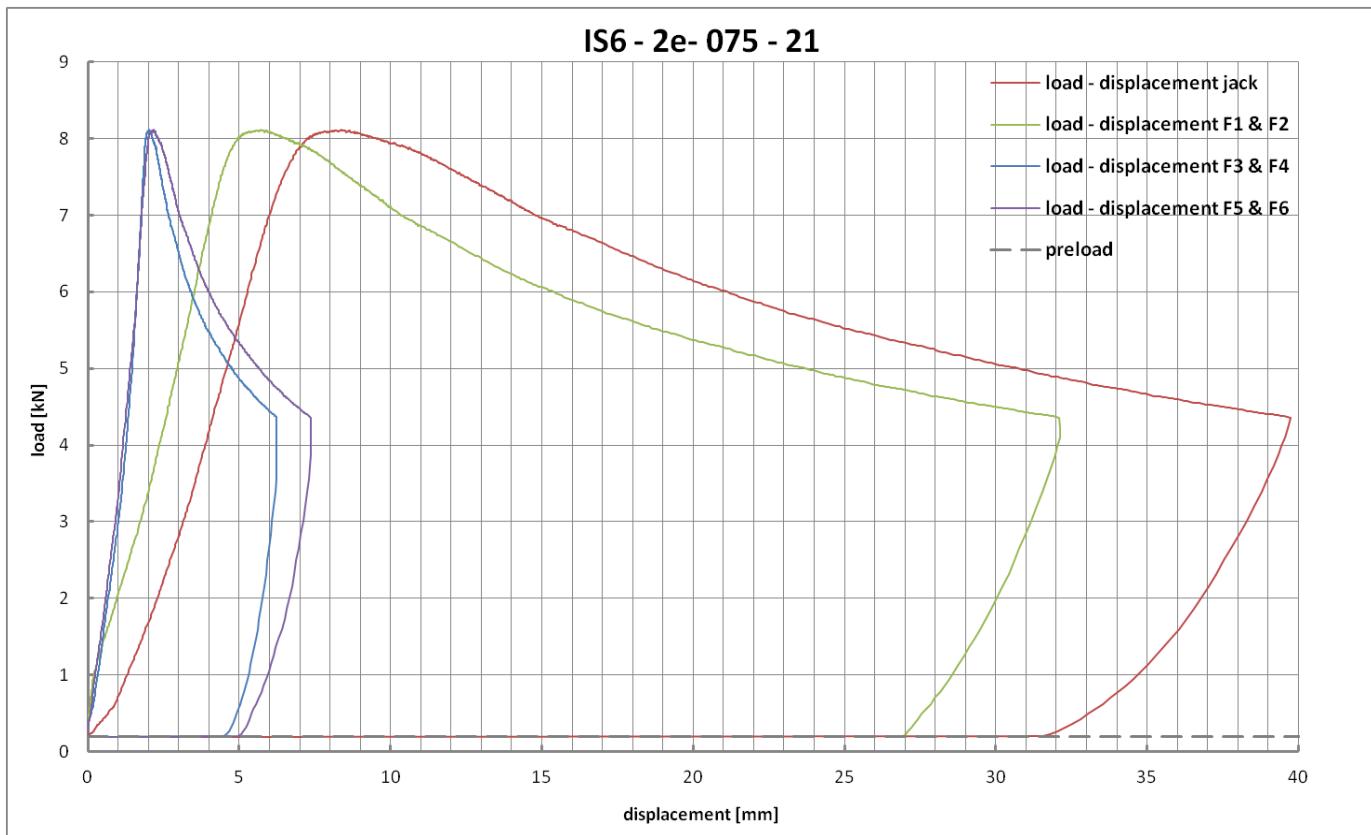
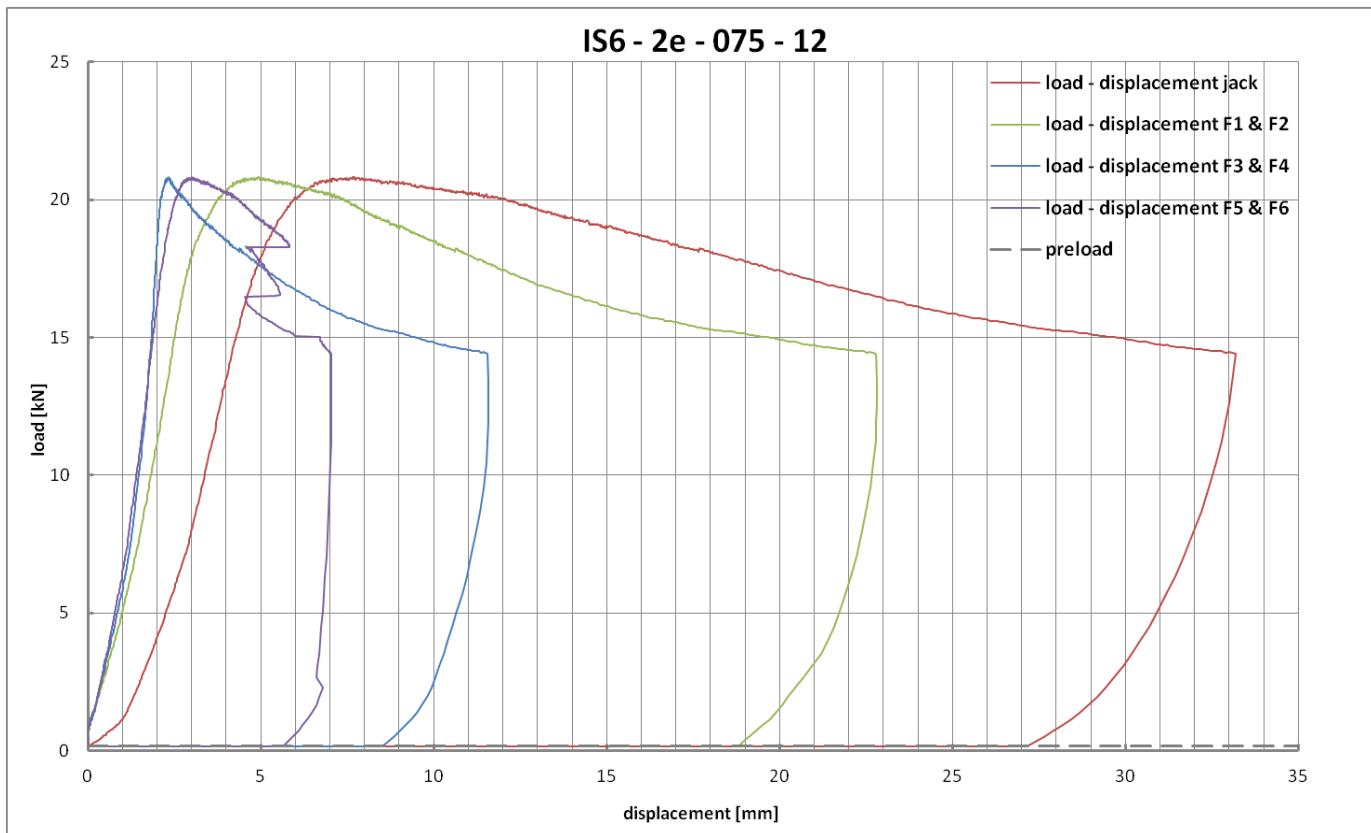
IS6 - 2 - 100 - 22**IS6 - 2 - 100 - 41**

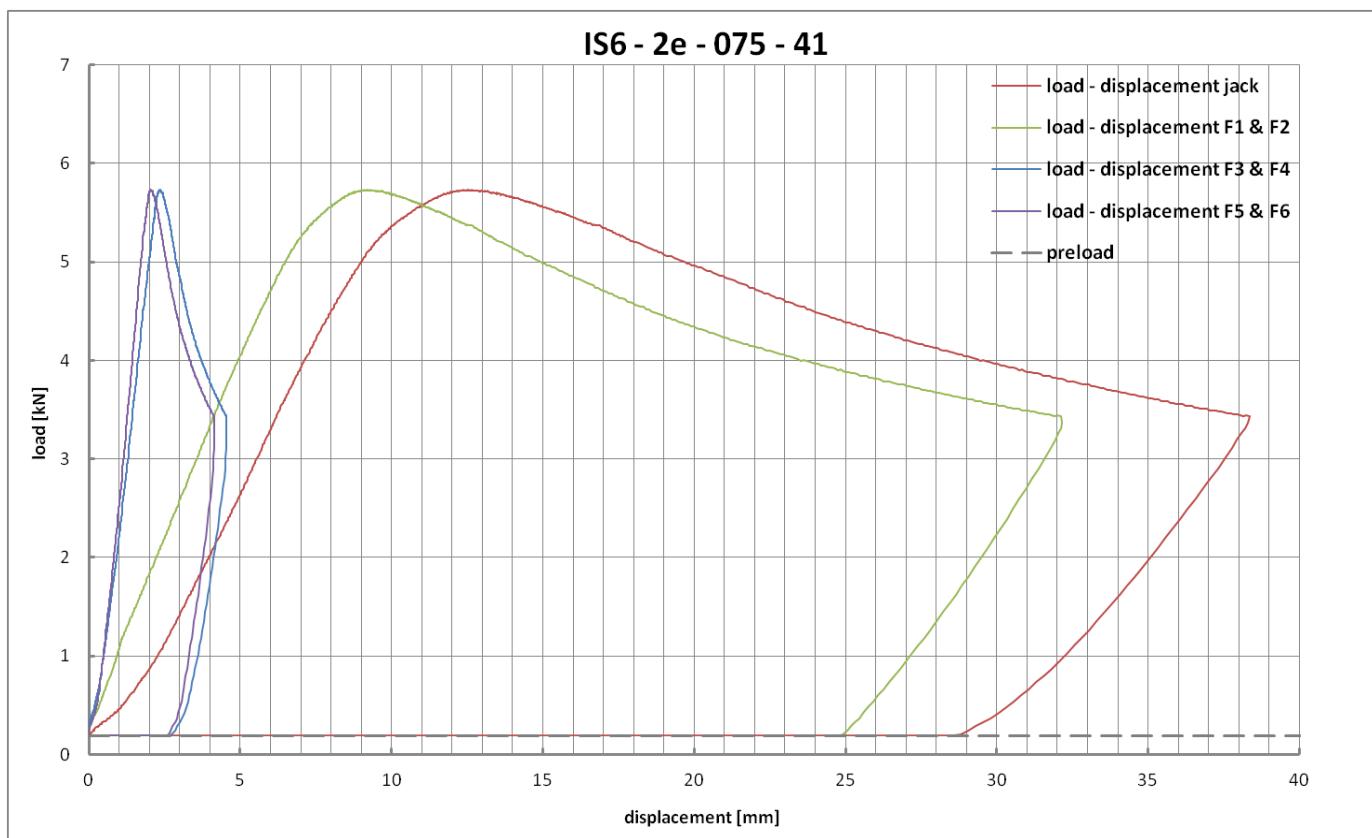
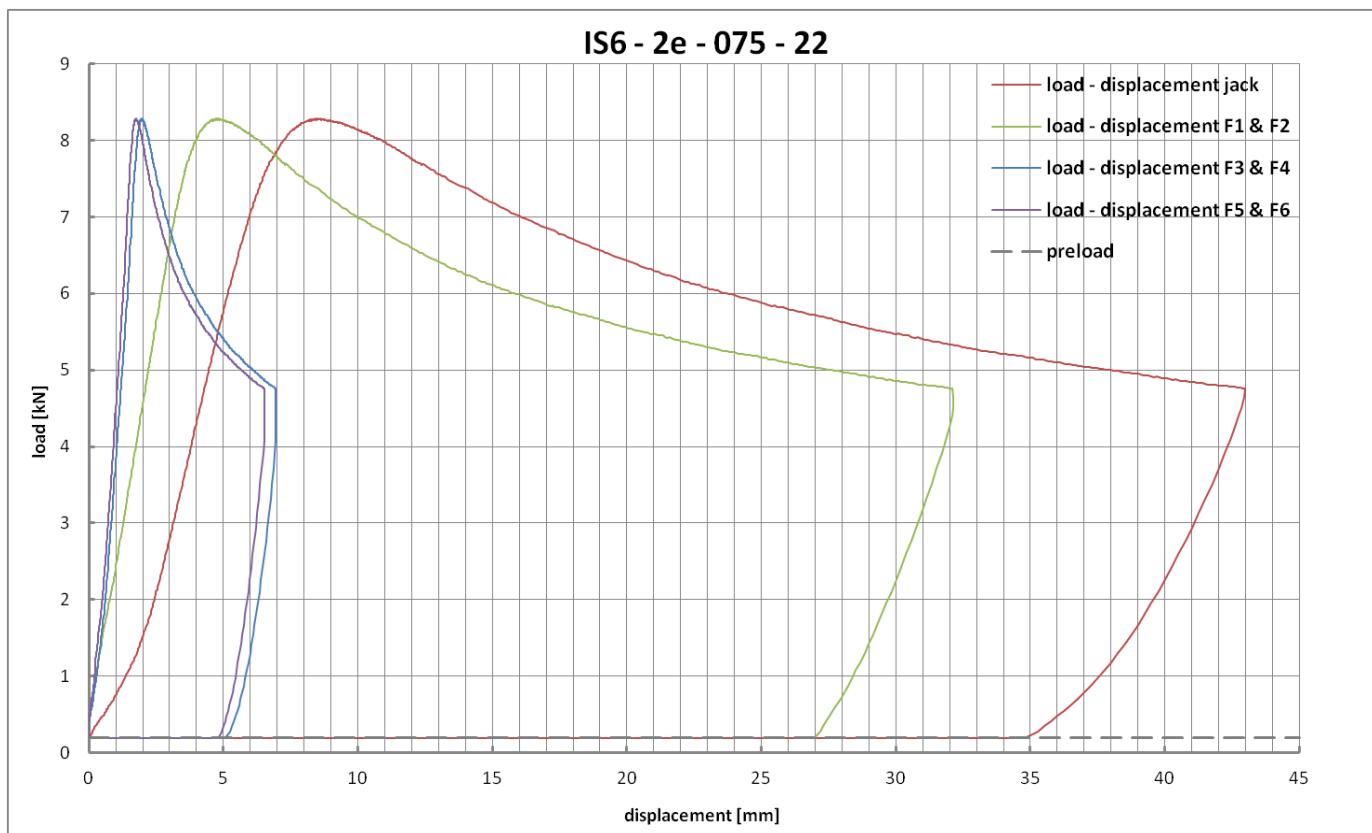


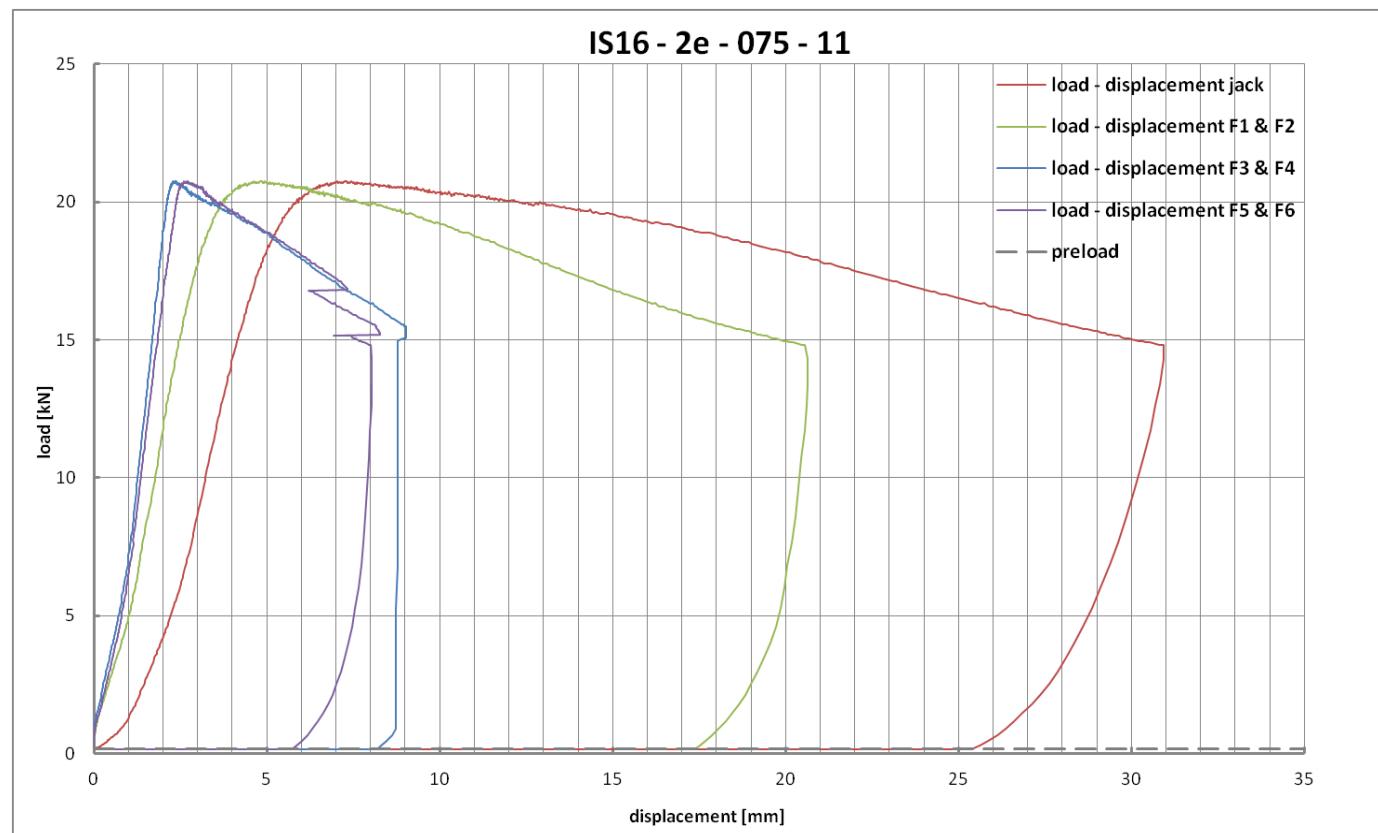
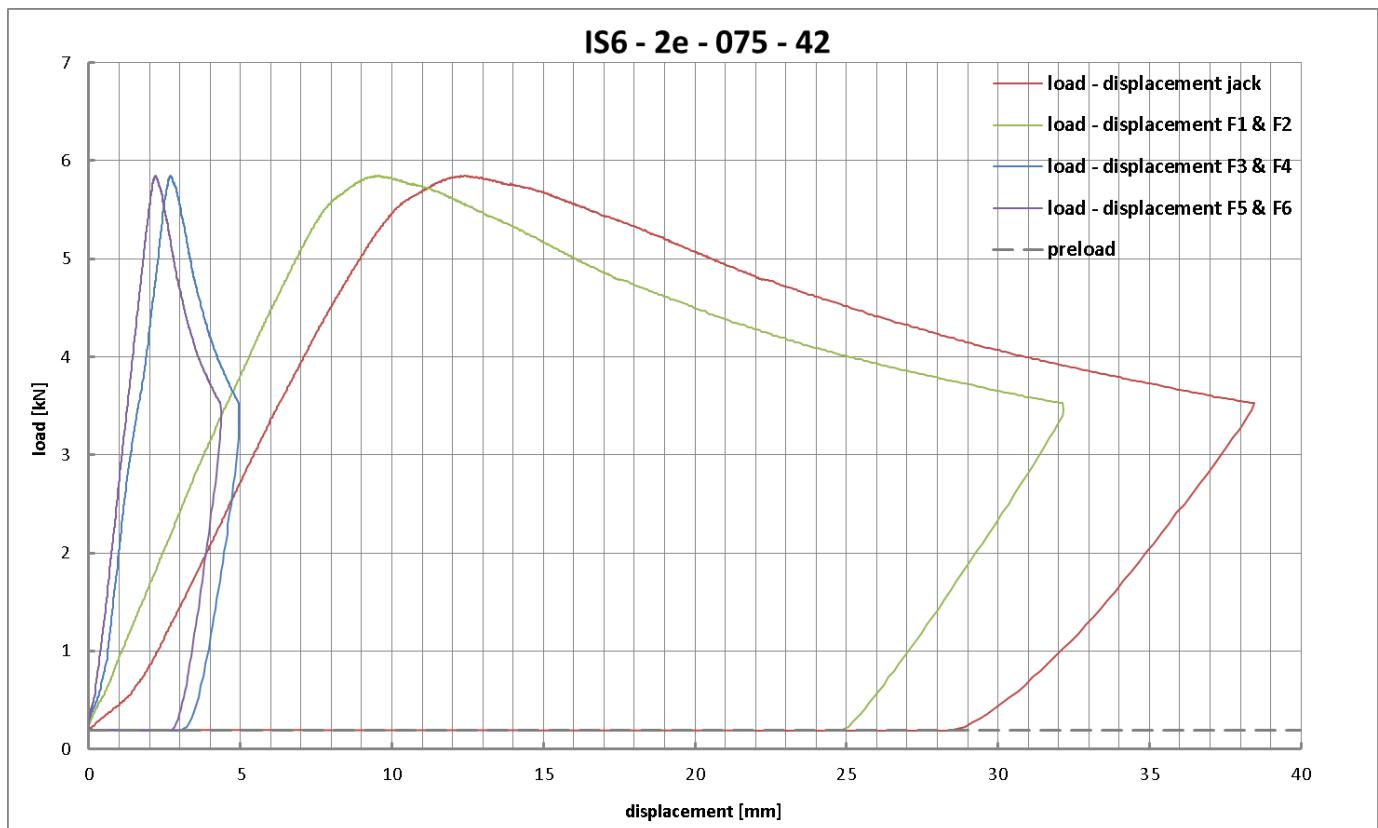




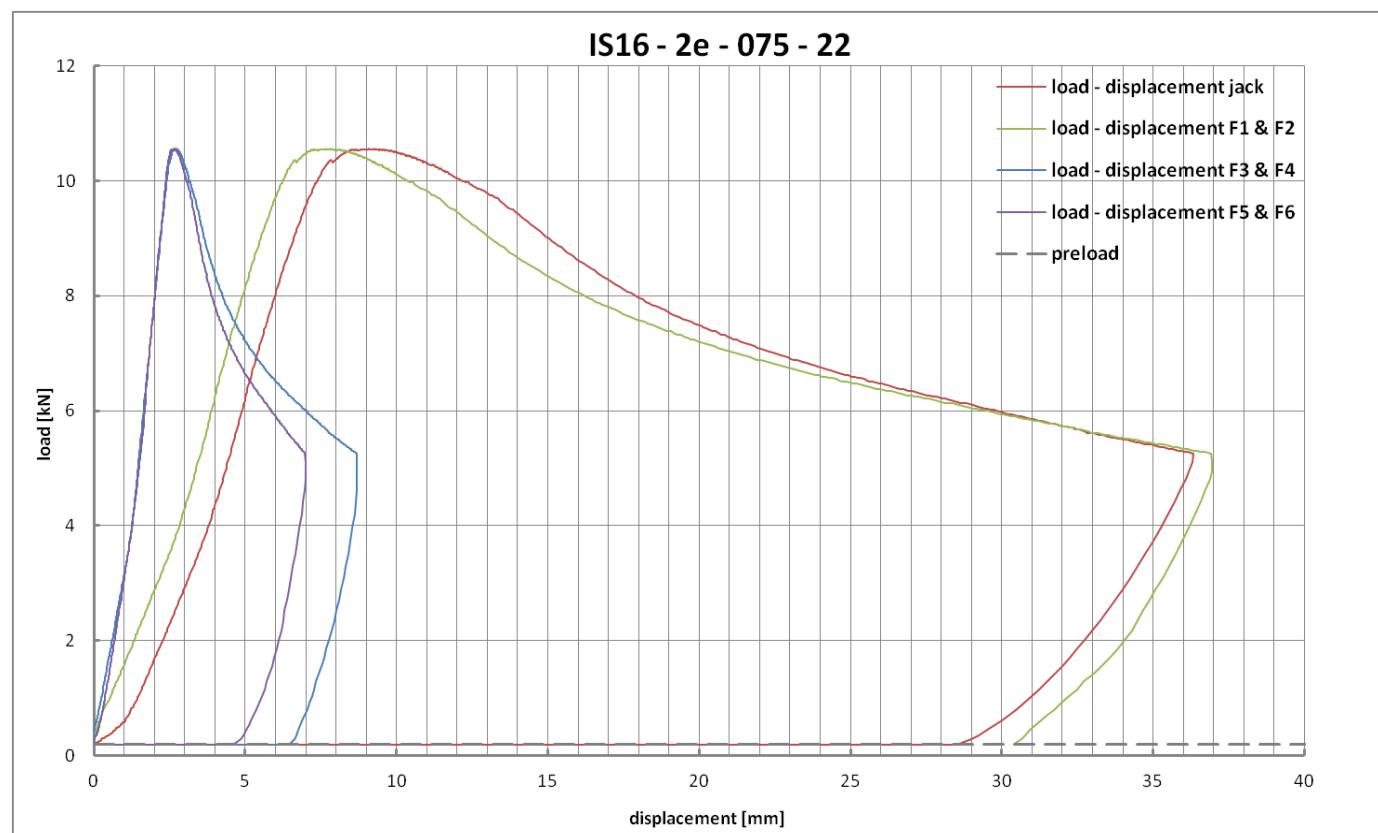
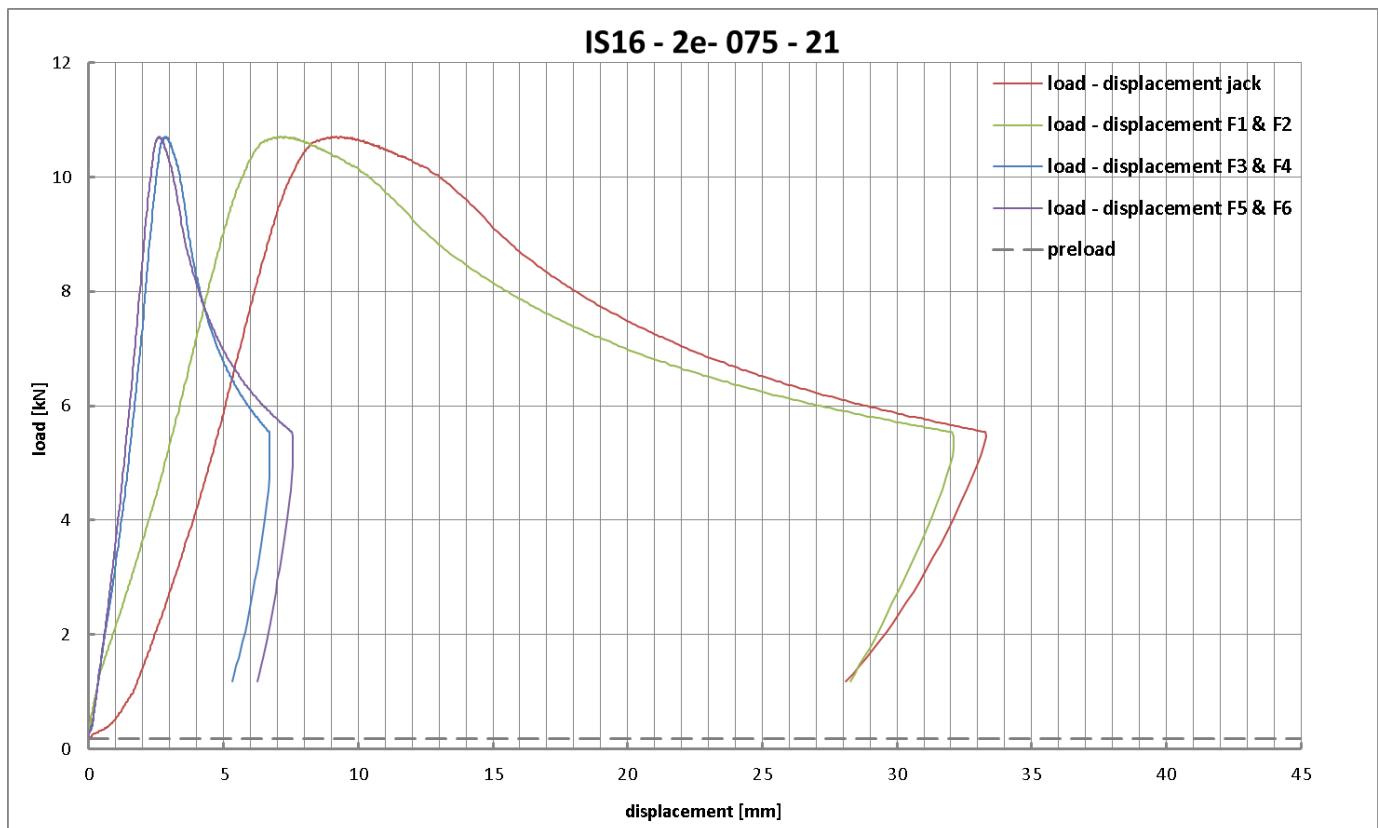


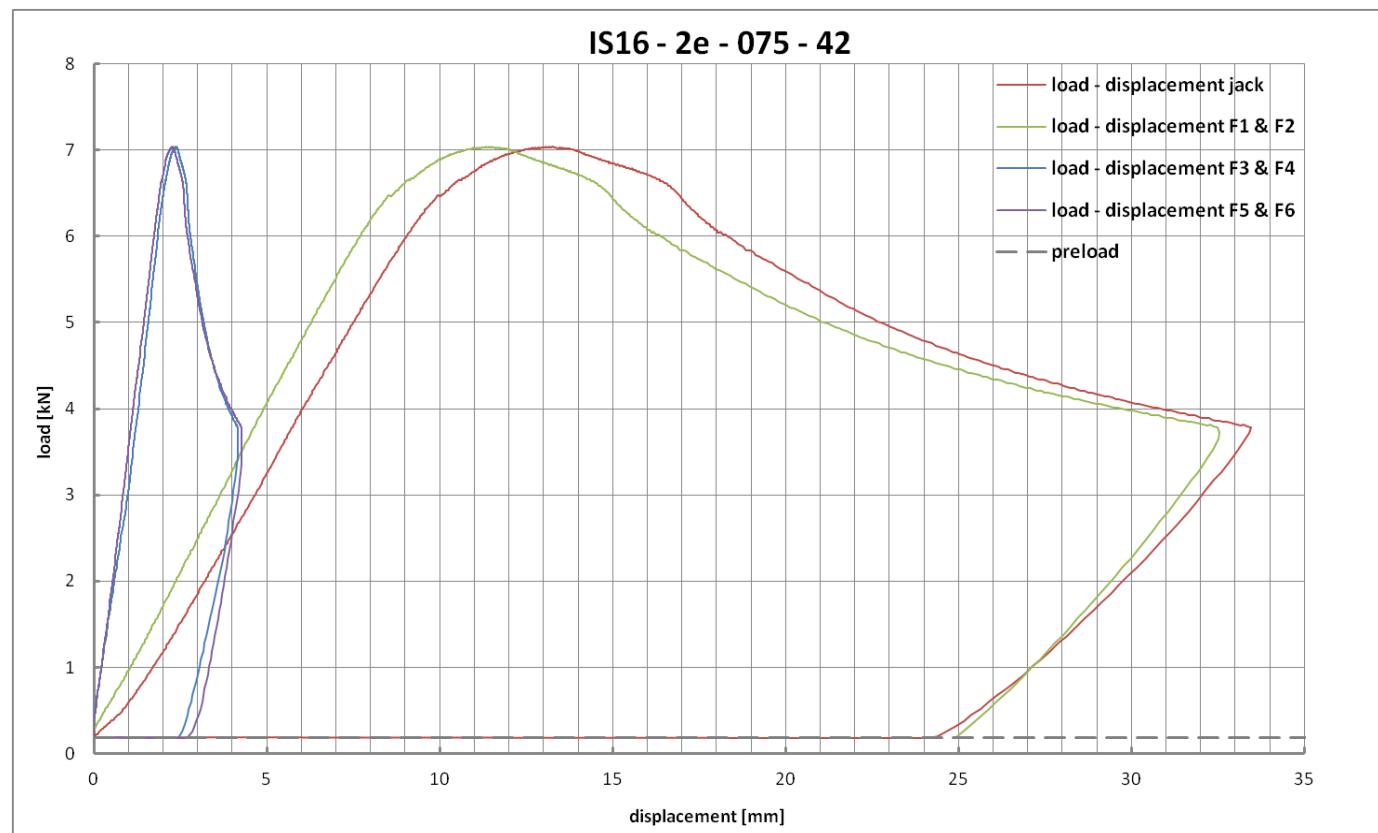
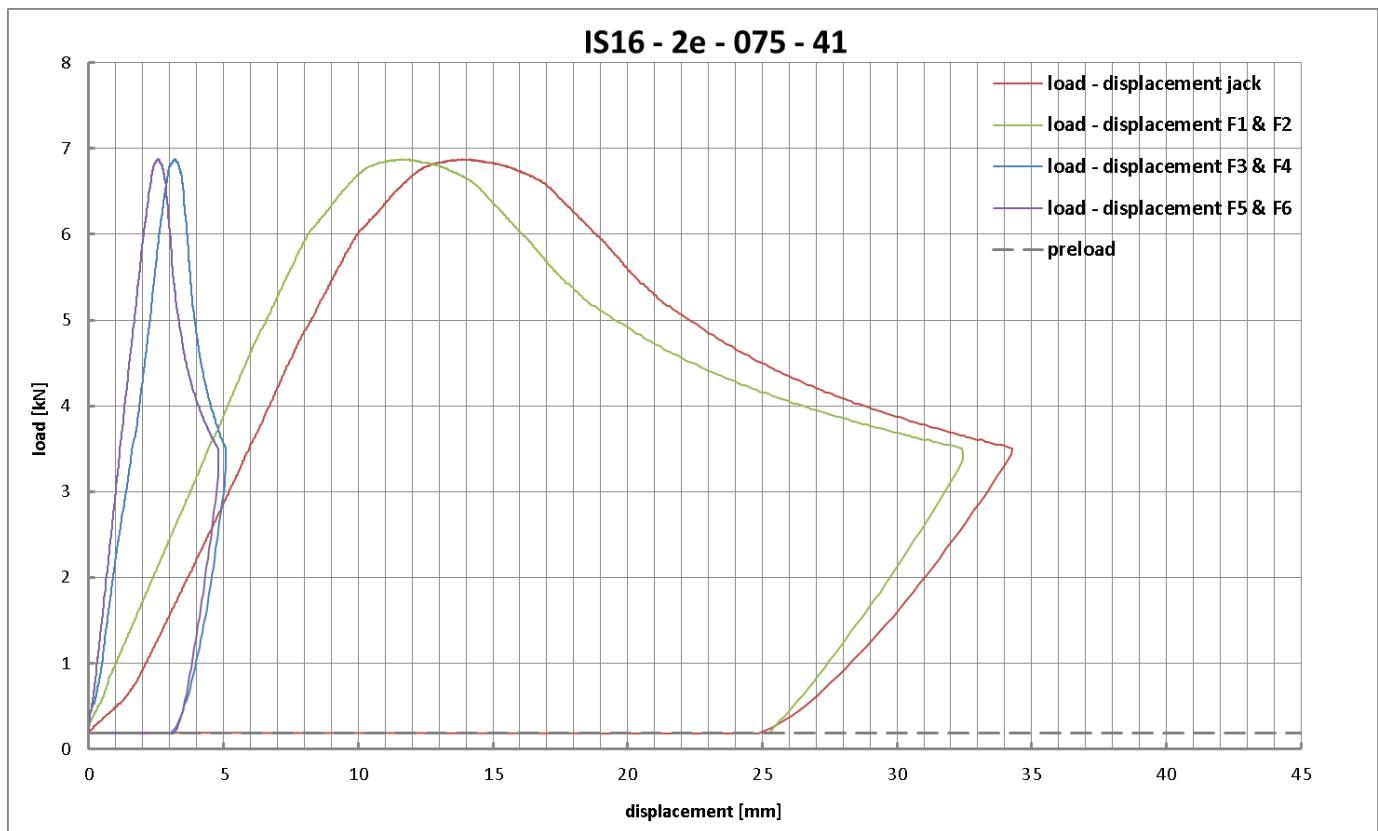


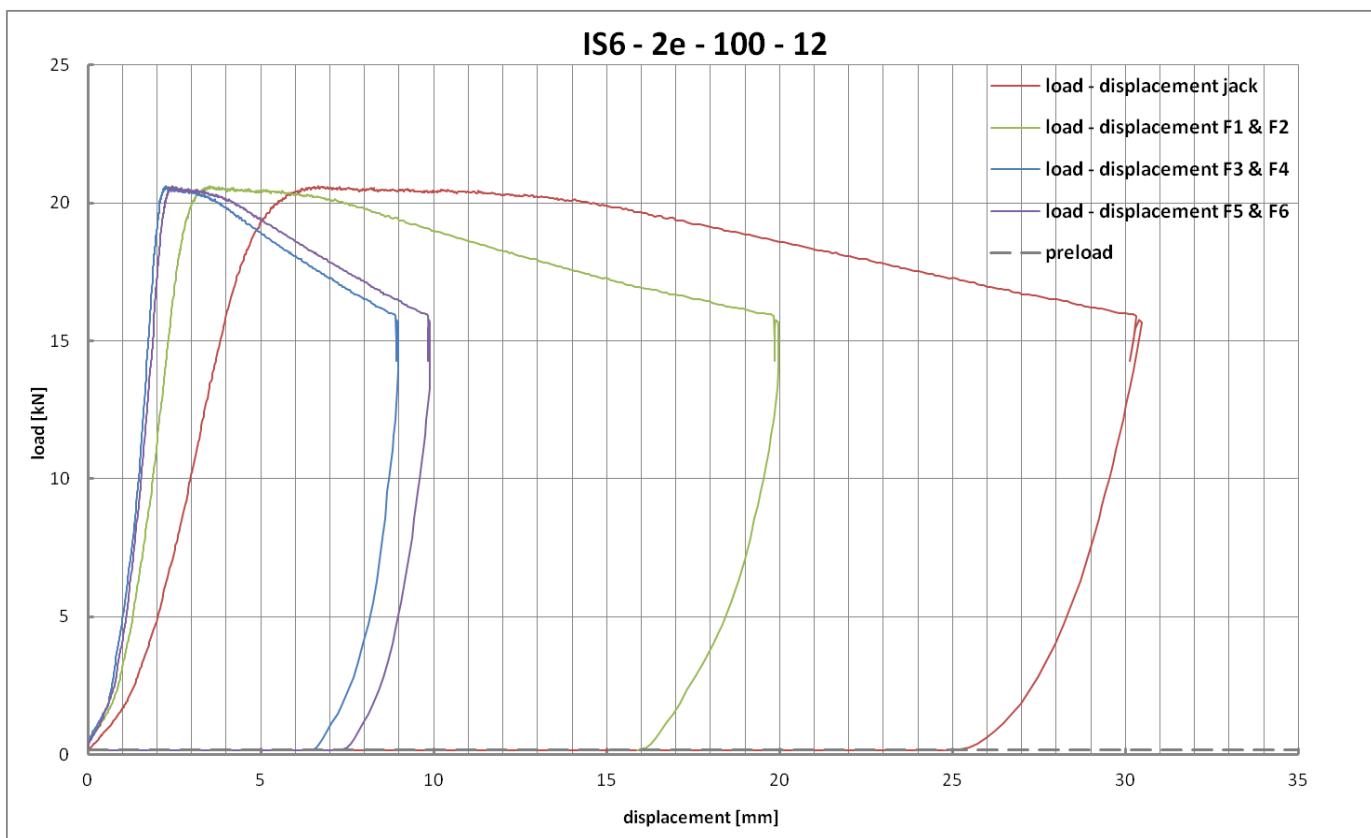
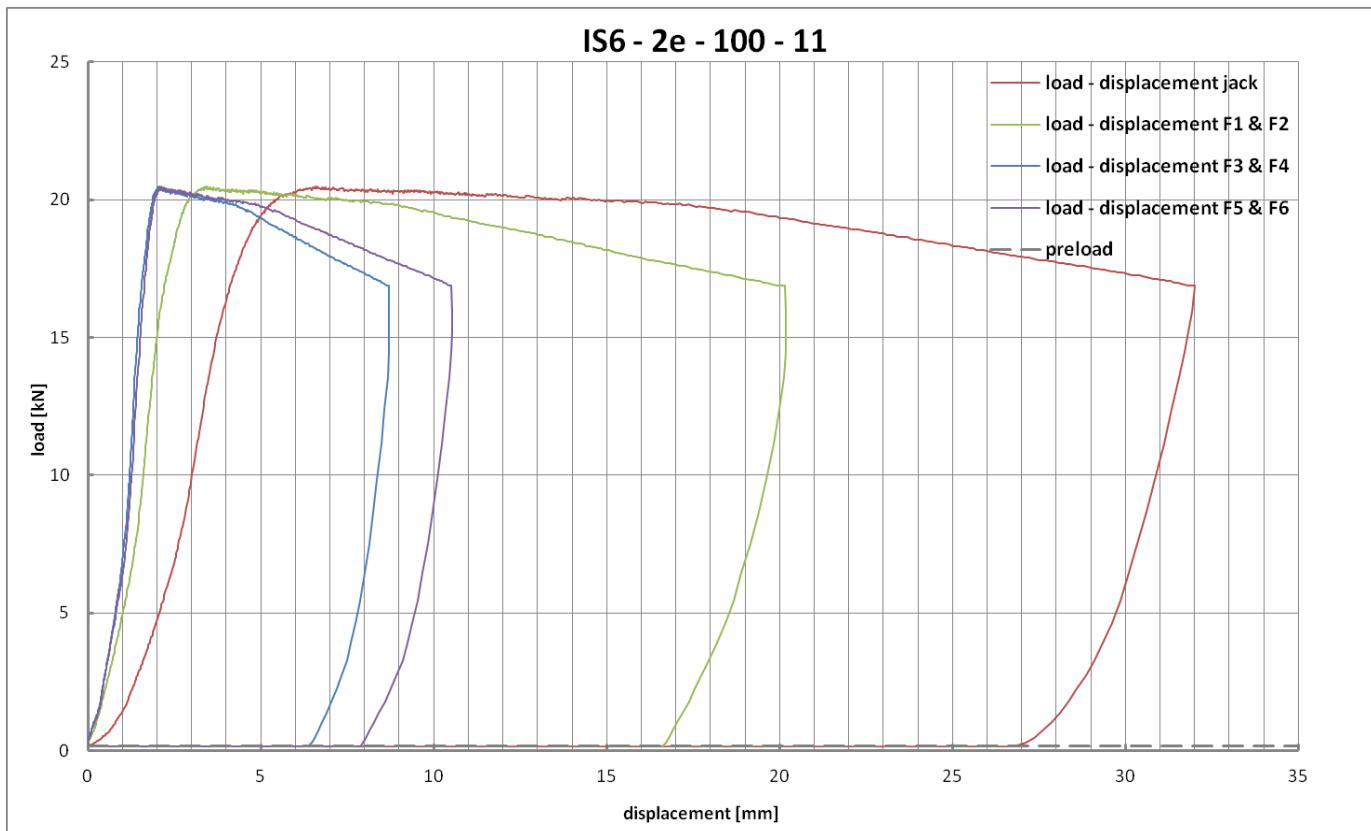


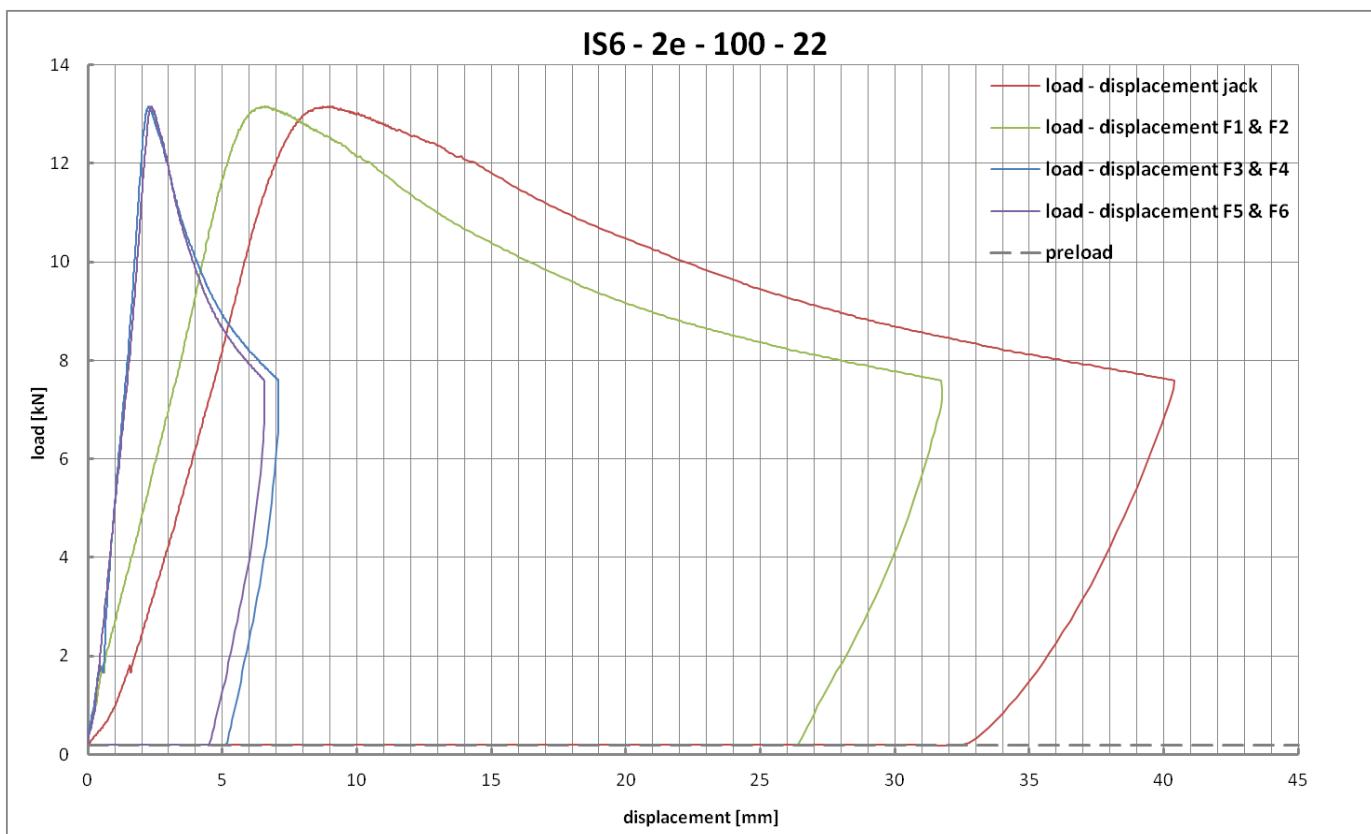
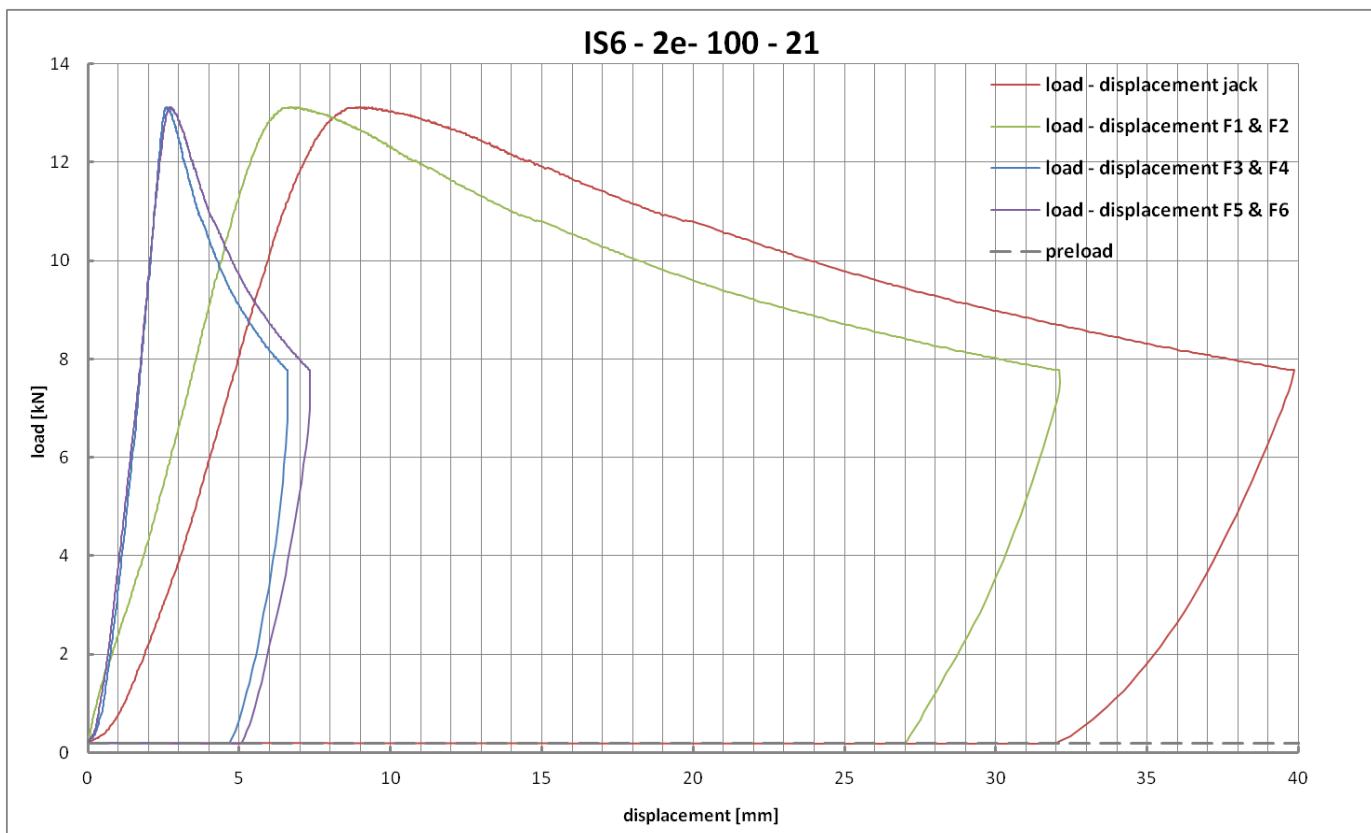


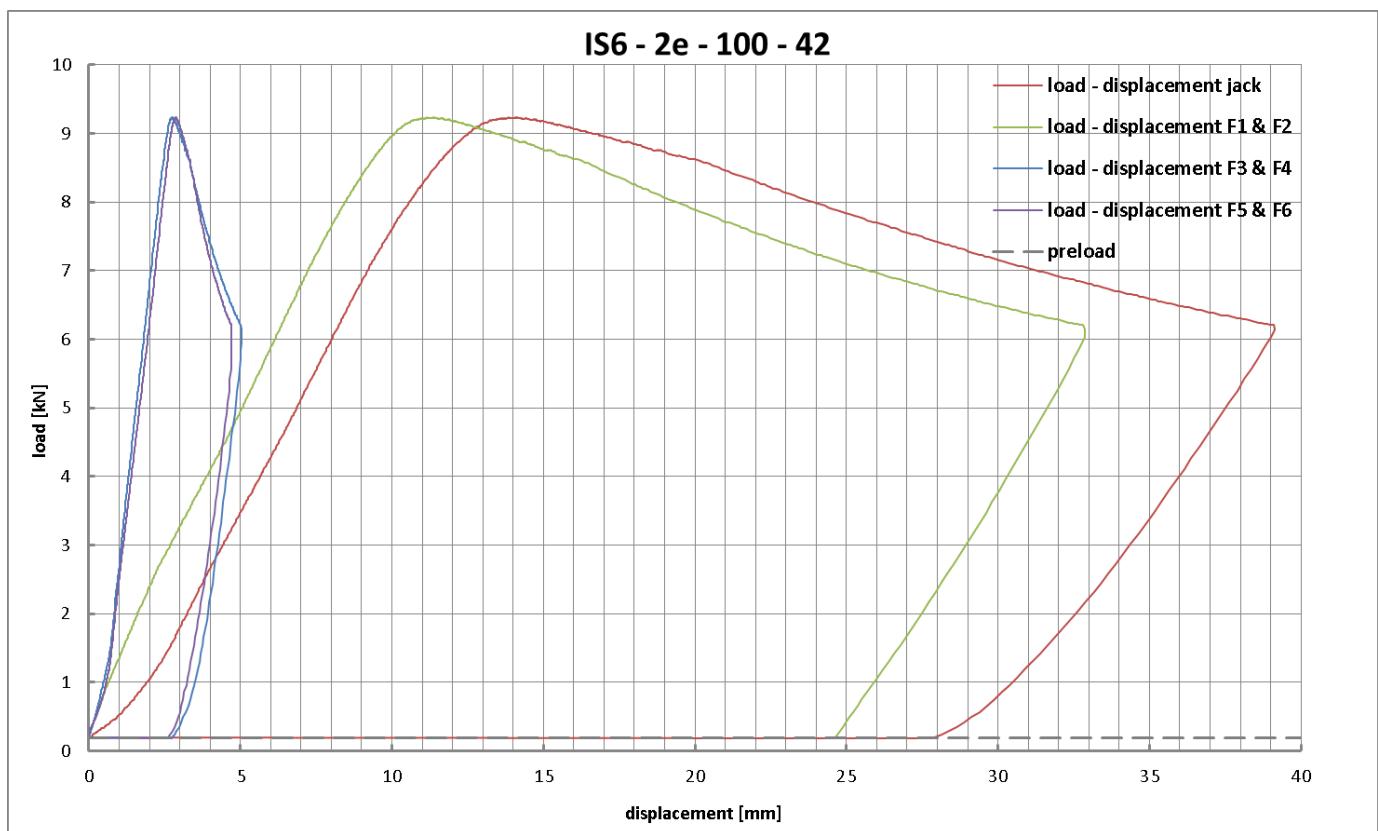
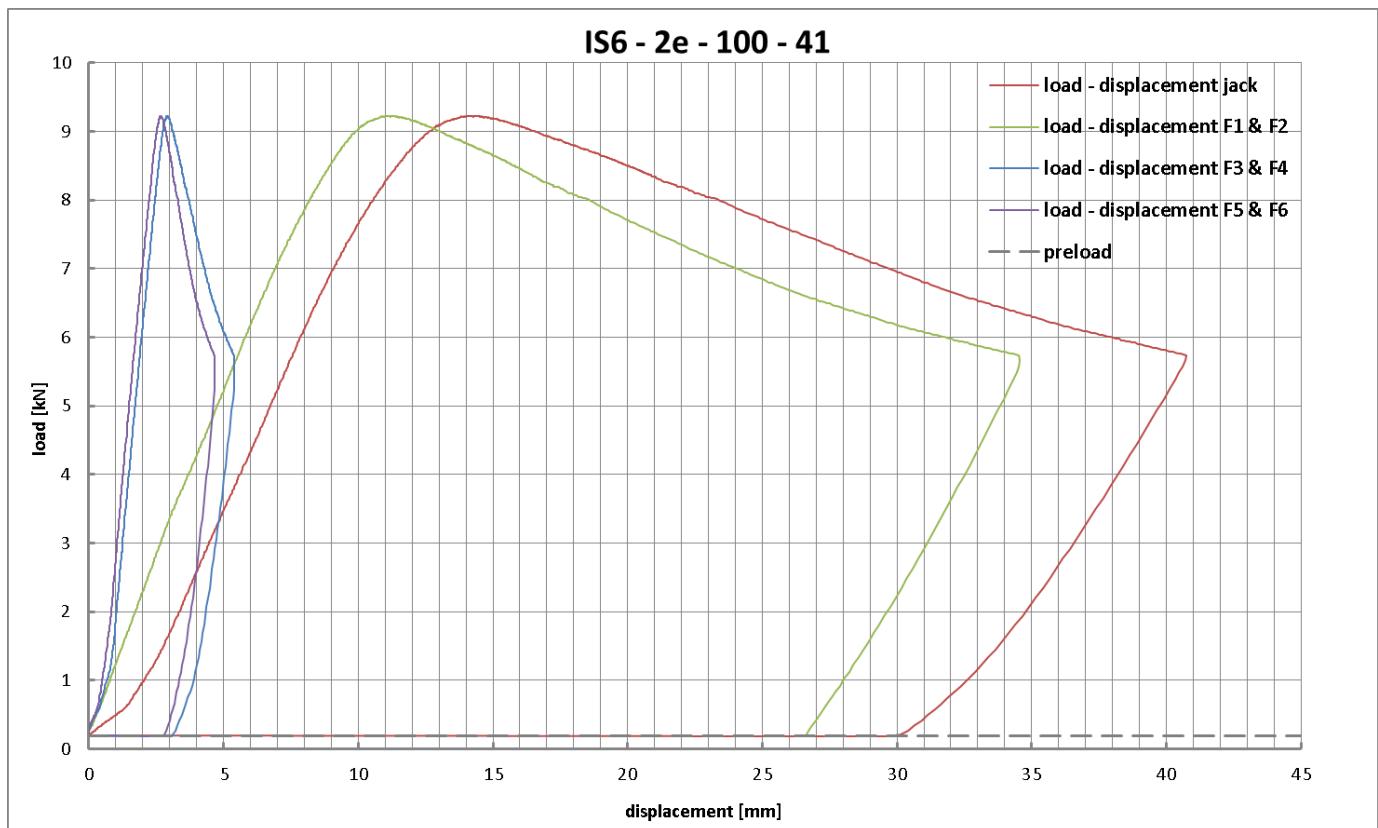
IS16-2e-075-12: error in data storage (see annex E for a copy of the load-deflection curve)

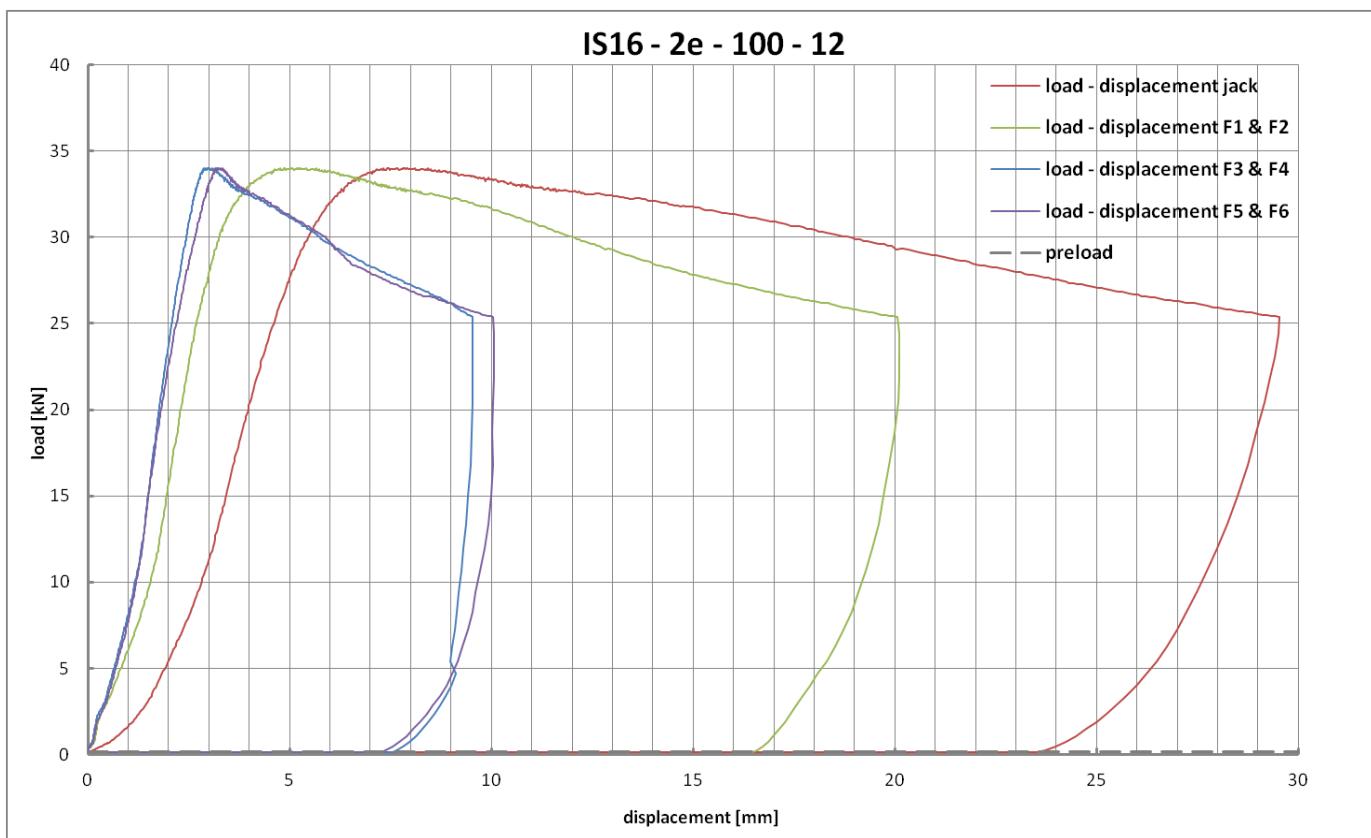
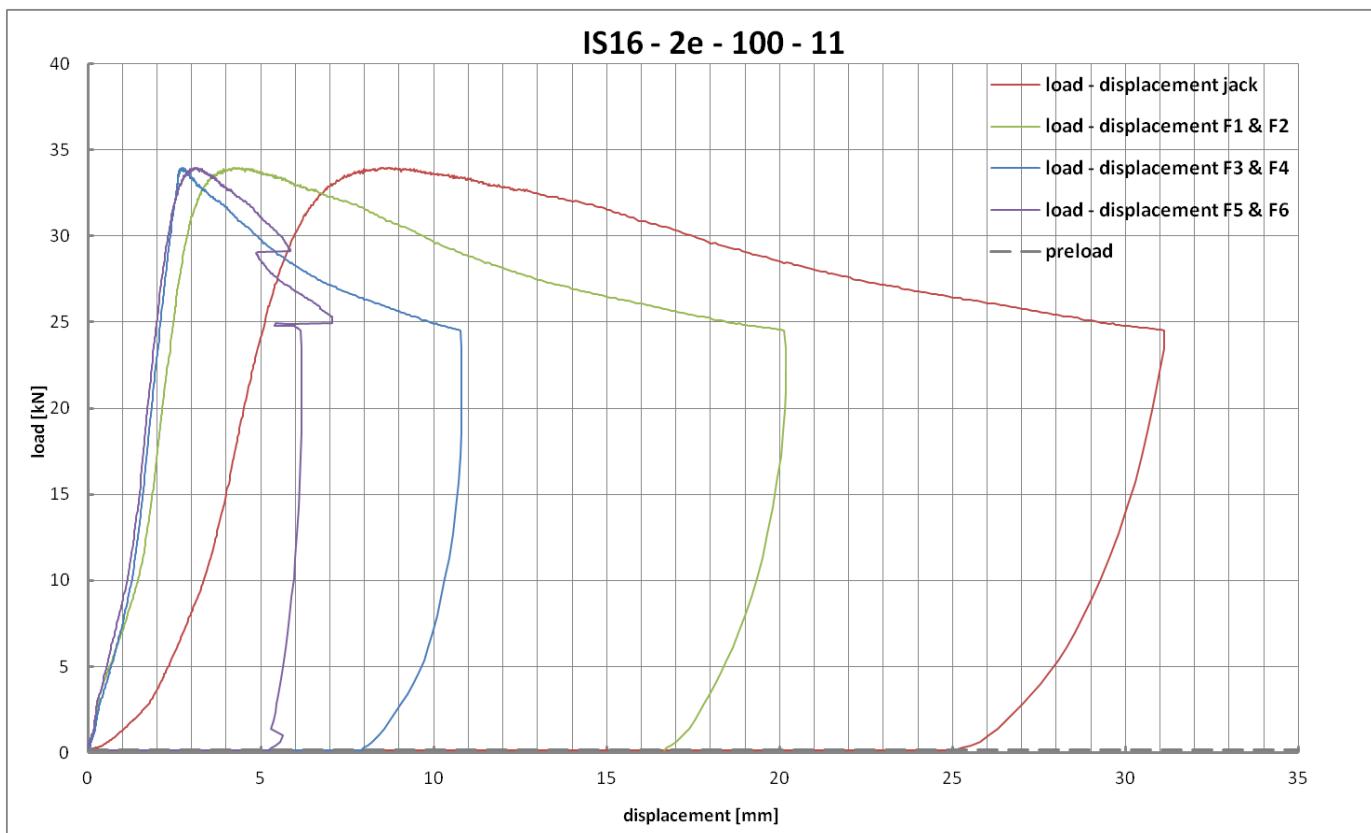


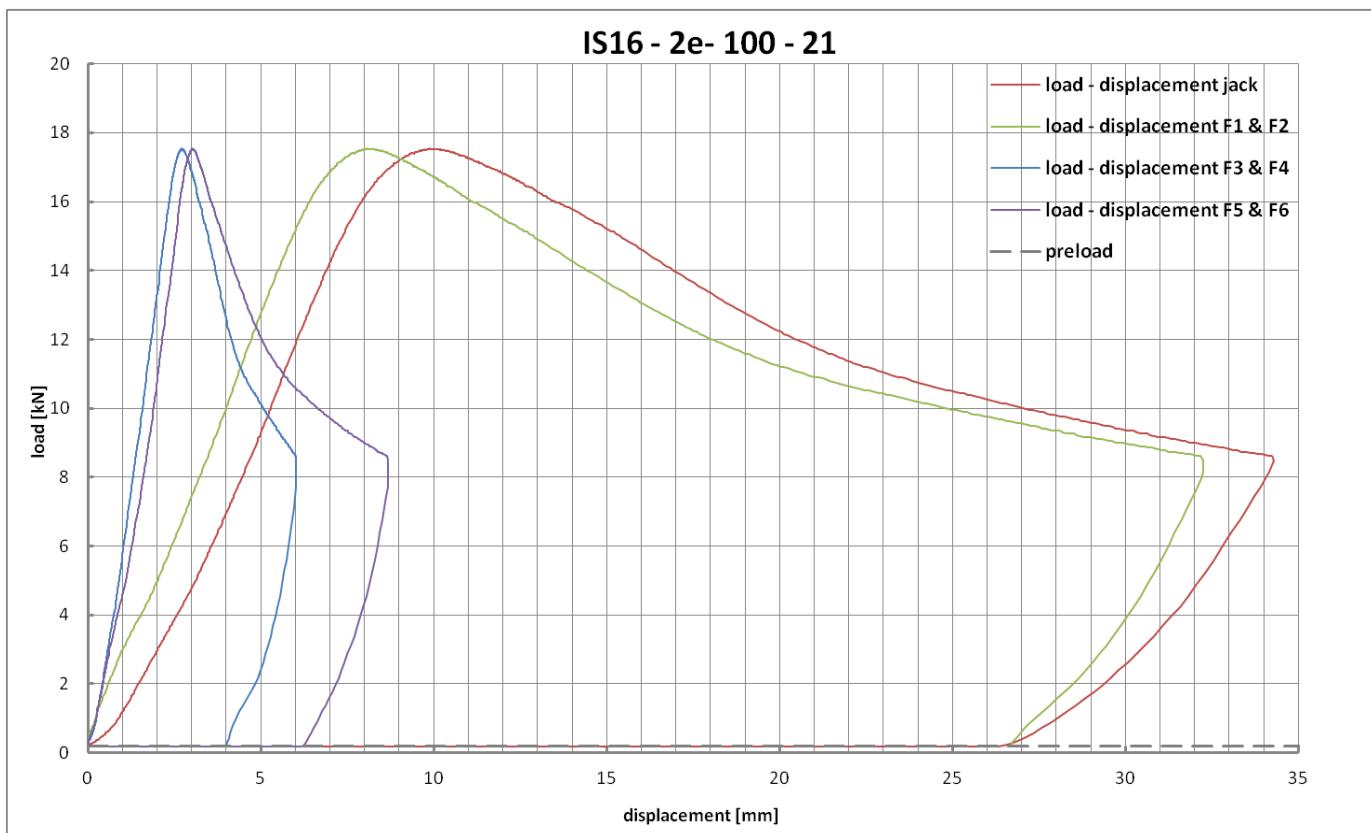


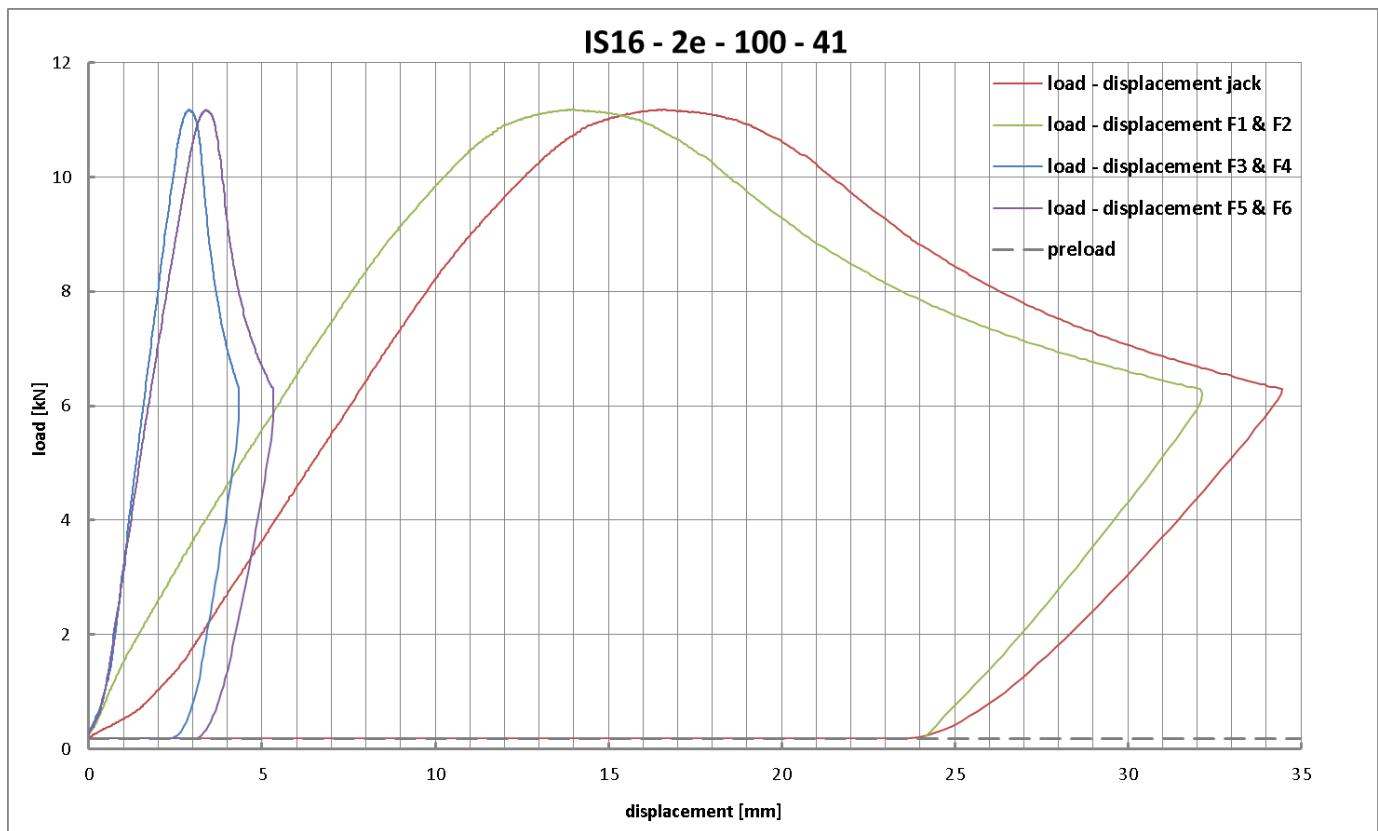












4 Annex D: End support test with downward load

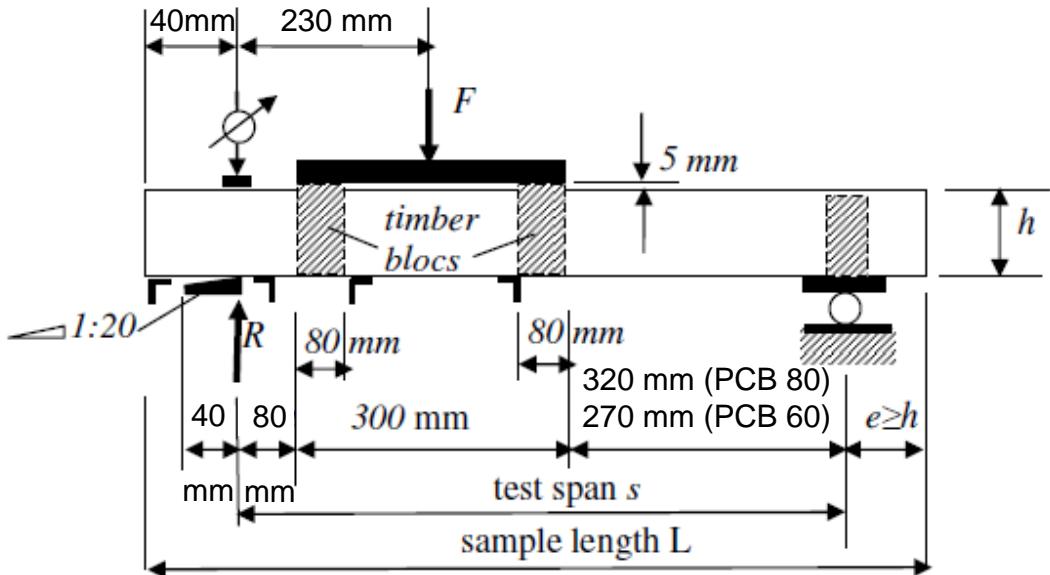


Figure D.1: Schematic test setup

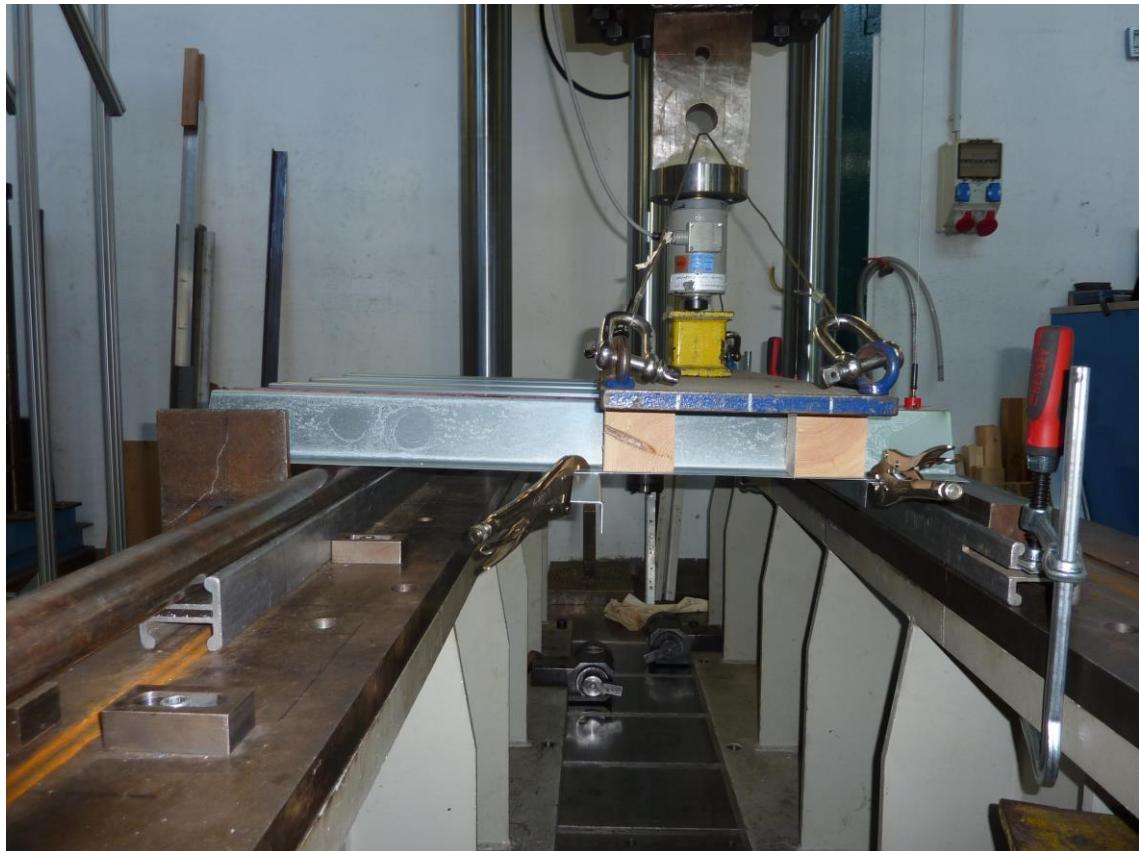


Figure D.2: Side view of the test setup (exemplary for PCB 80, $t_N = 0.75$ mm without embossments)

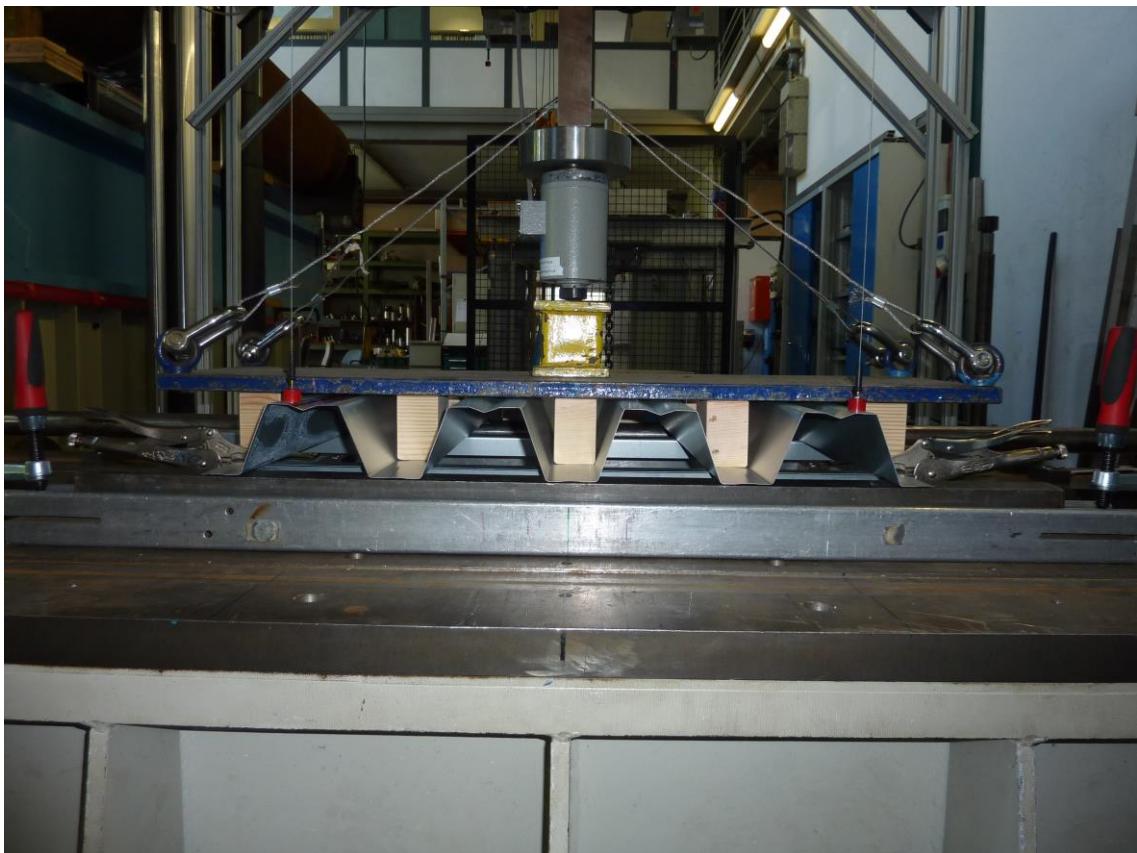


Figure D.3: View of the test setup (exemplary for PCB 80, $t_N = 0.75$ mm without embossments)



Figure D.4: Web-crippling (PCB 80 $t_N = 0.75$ mm without embossments)

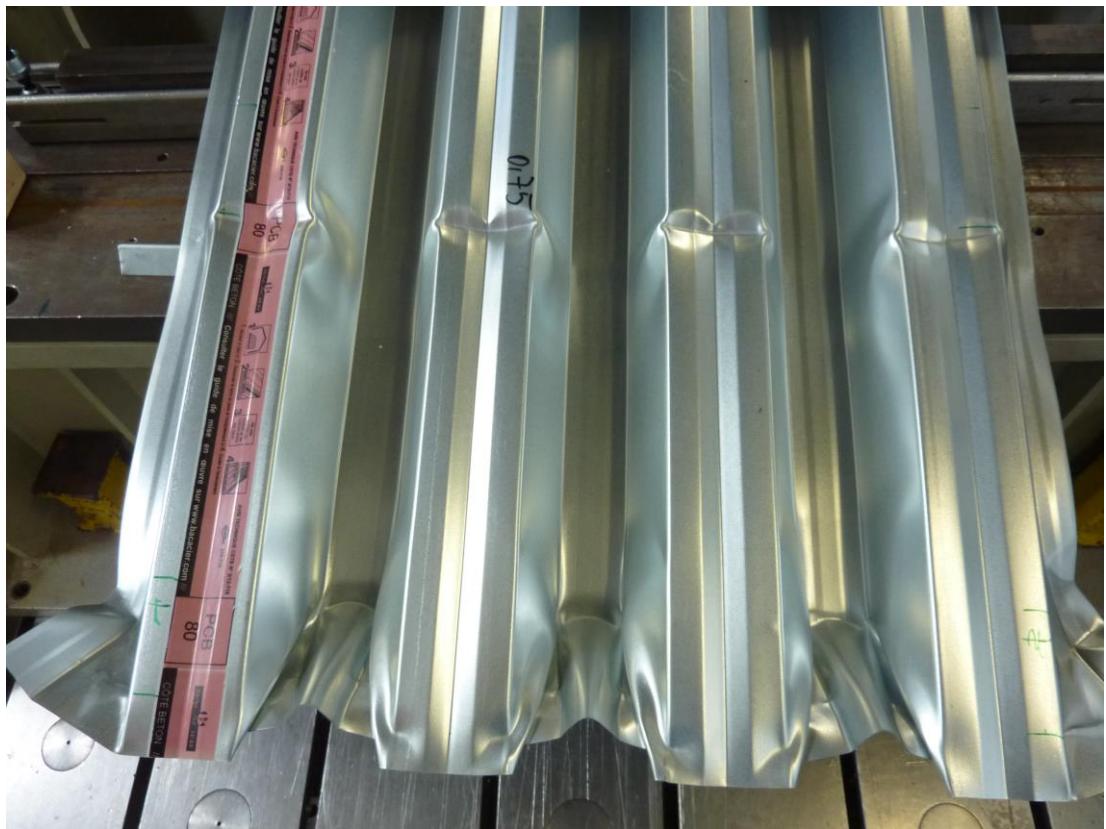


Figure D.5: Deformation of the profile after the test (PCB 80 $t_N = 0.75$ mm without embossments)



Figure D.6: Web-crippling (PCB 80 $t_N = 0.75$ mm with embossments)

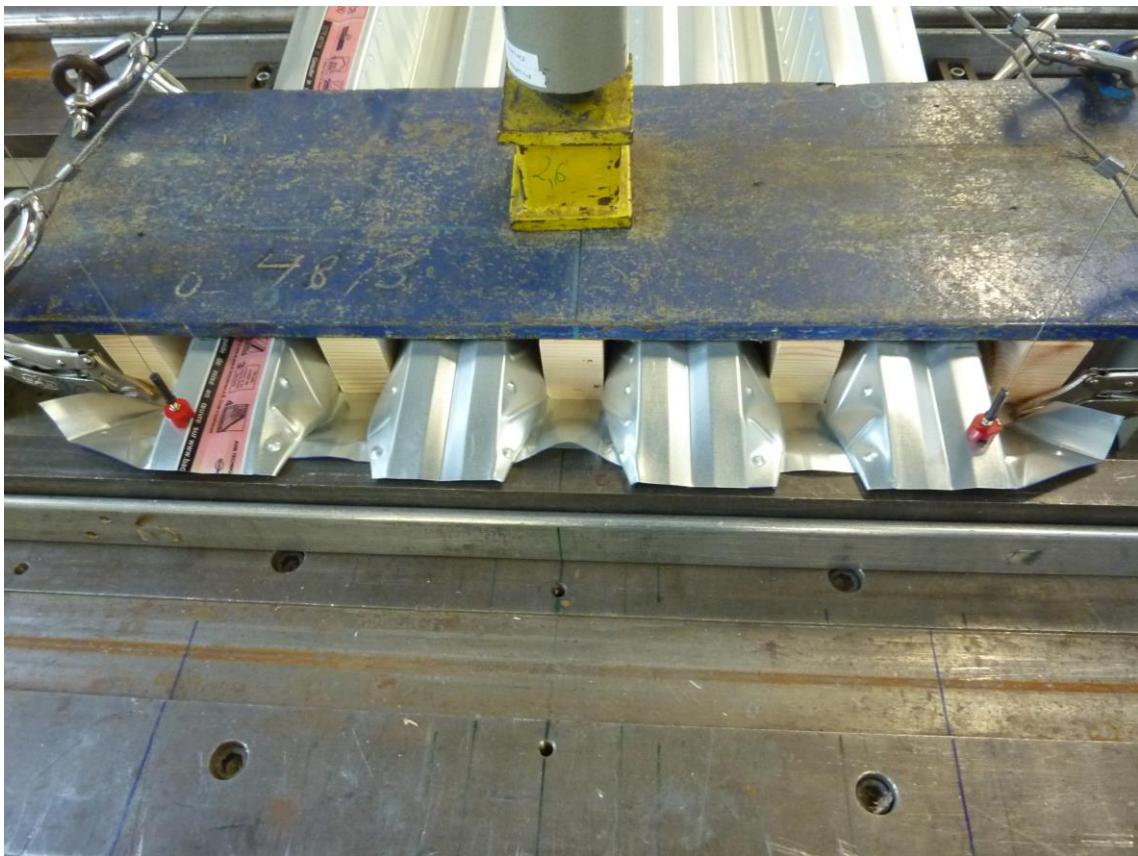


Figure D.7: Deformation of the webs during the load increase after the first peak (PCB 80, $t_N = 0.75$ mm with embossments)



Figure D.8: Buckling of the upper flanges (PCB 80, $t_N = 0.75$ mm with embossments)



Figure D.9: Deformation at the end of the test (PCB 80, $t_N = 0.75$ mm with embossments)

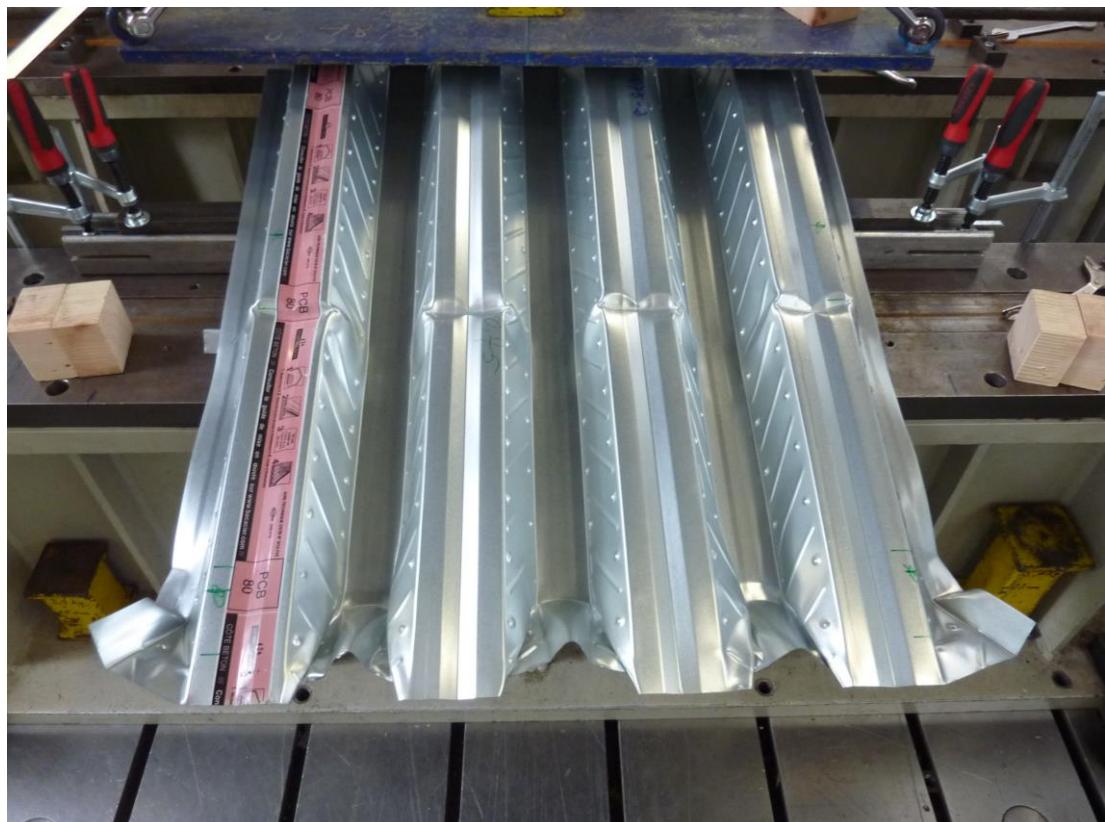


Figure D.10: Deformation of the profile after the test (PCB 80 $t_N = 0.75$ mm with embossments)

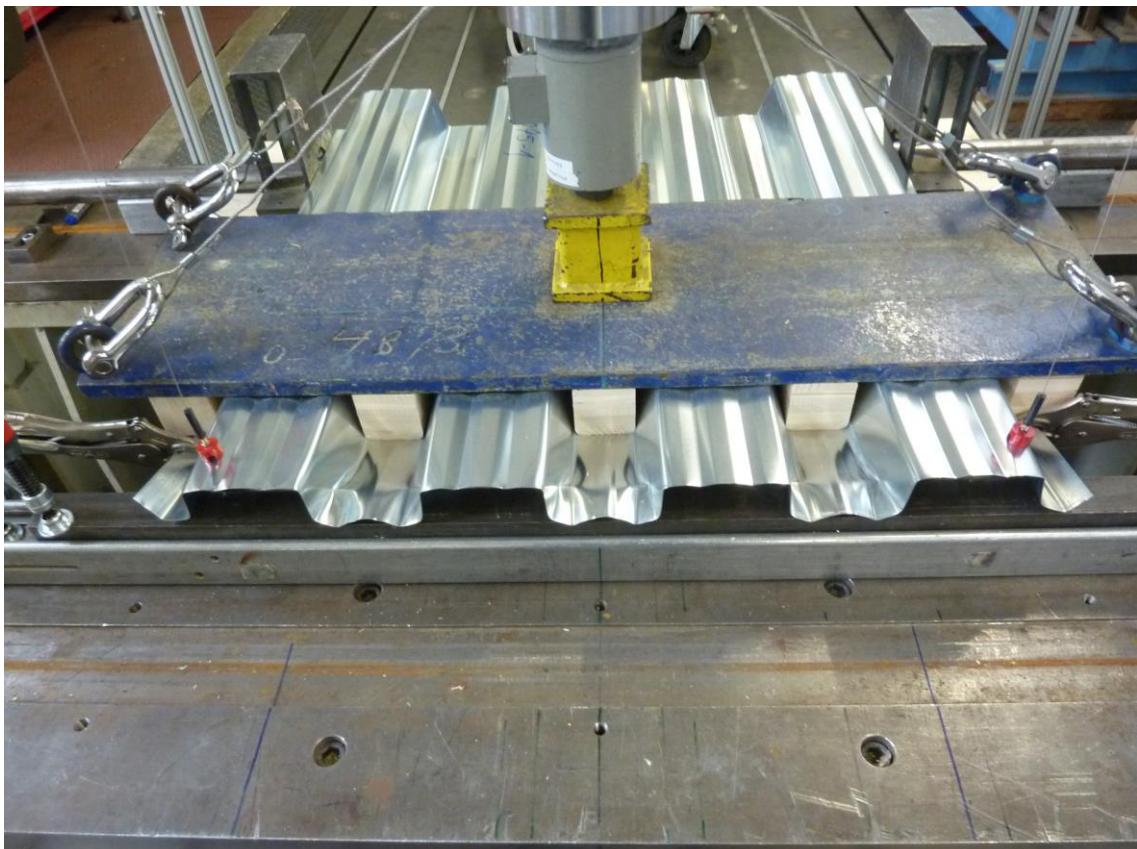


Figure D.11: Web-crippling (PCB 60 $t_N = 0.75$ mm without embossments)



Figure D.12: Buckling of the upper flanges (PCB 60, $t_N = 0.75$ mm without embossments)



Figure D.13: Web-crippling (PCB 60 $t_N = 1.00$ mm without embossments)

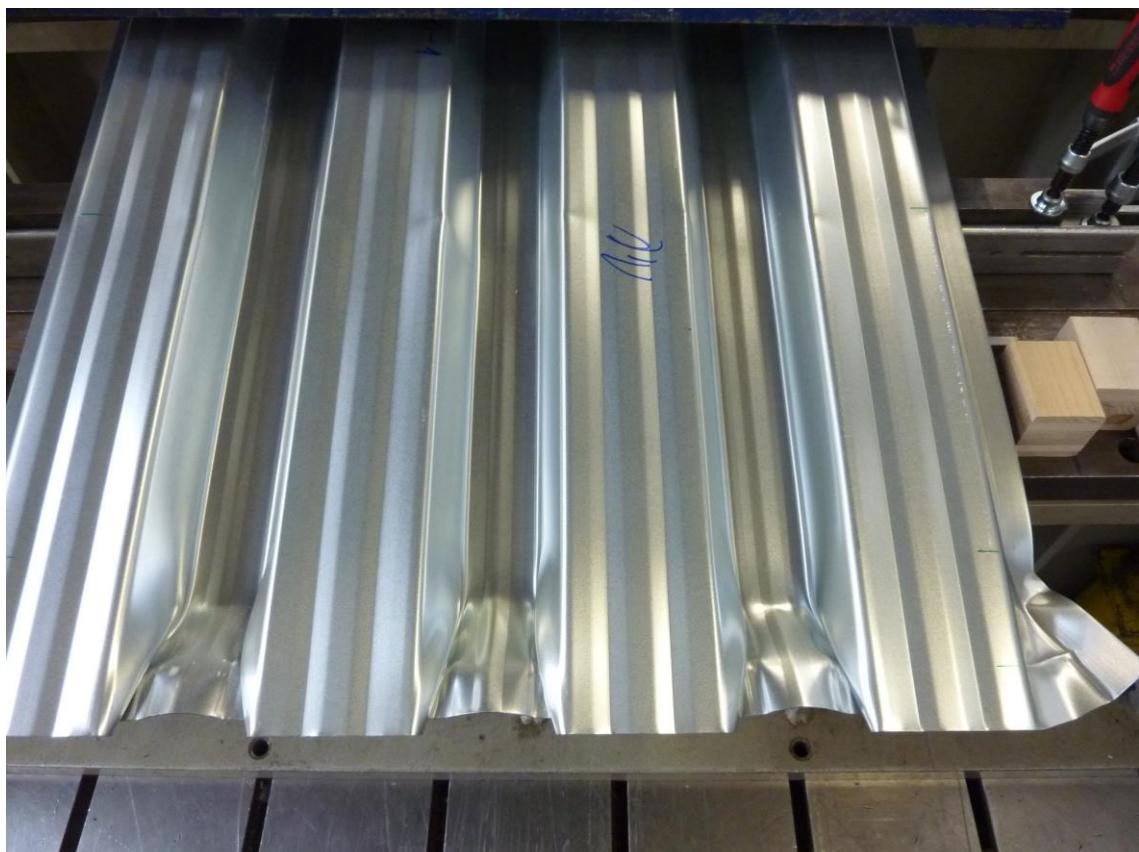


Figure D.14: No buckling of the upper flanges (PCB 60, $t_N = 1.00$ mm without embossments, test 1 and test 2)



Figure D.15: Buckling of the upper flanges (PCB 60, $t_N = 1.00$ mm without embossments, test 3)

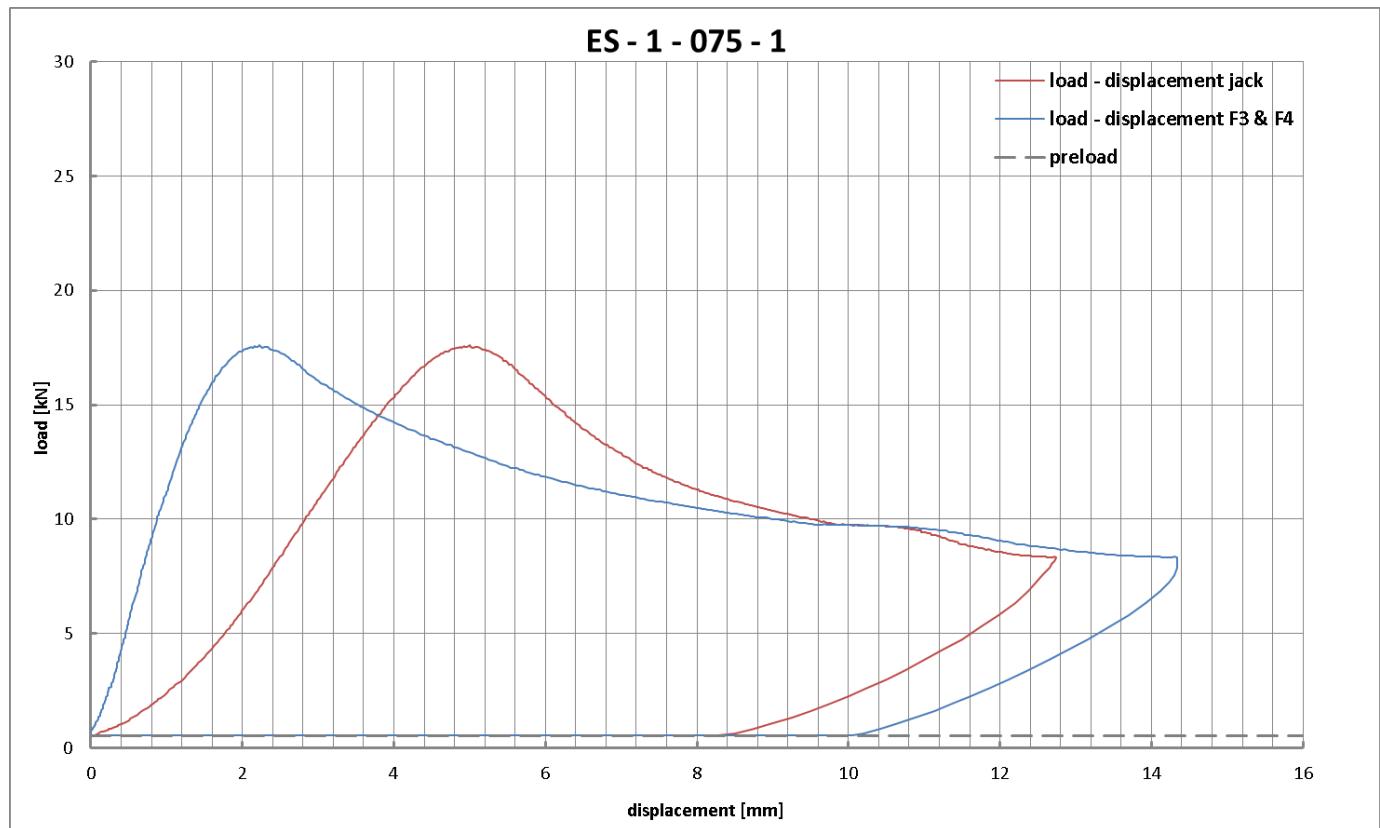


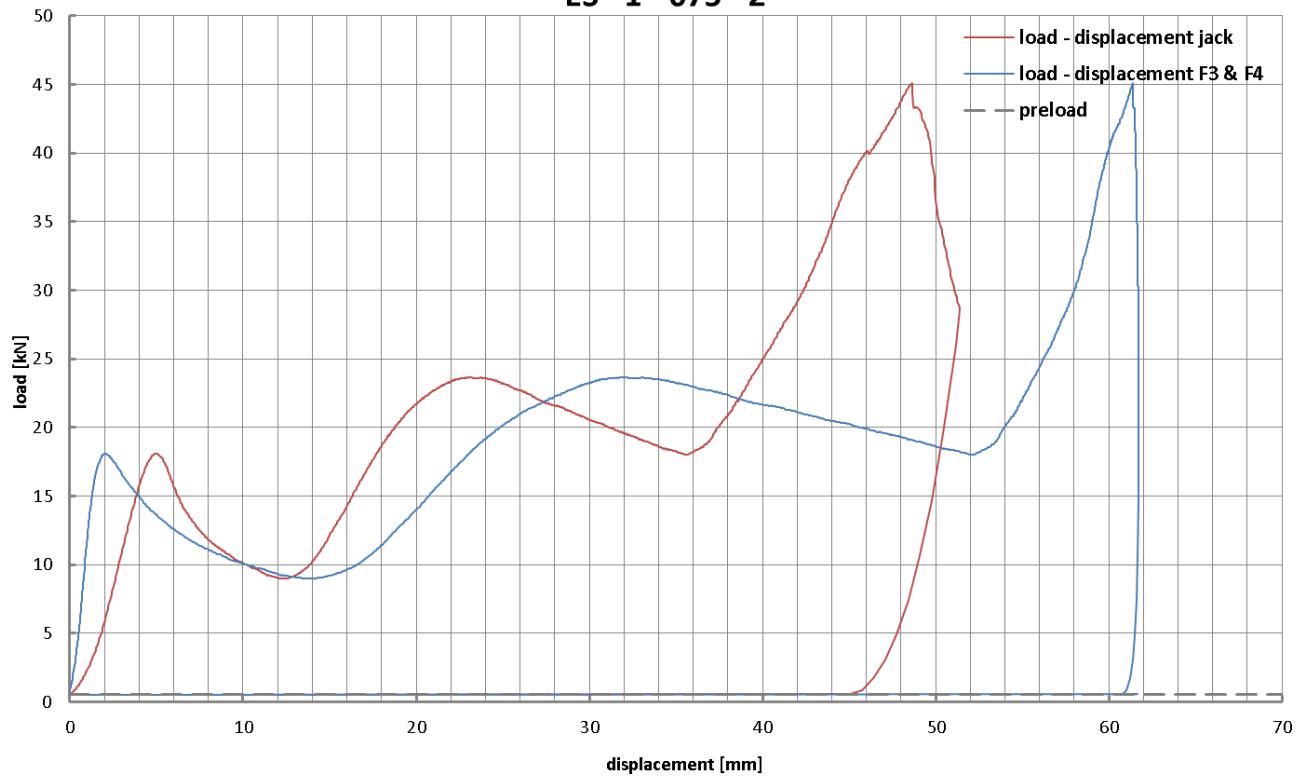
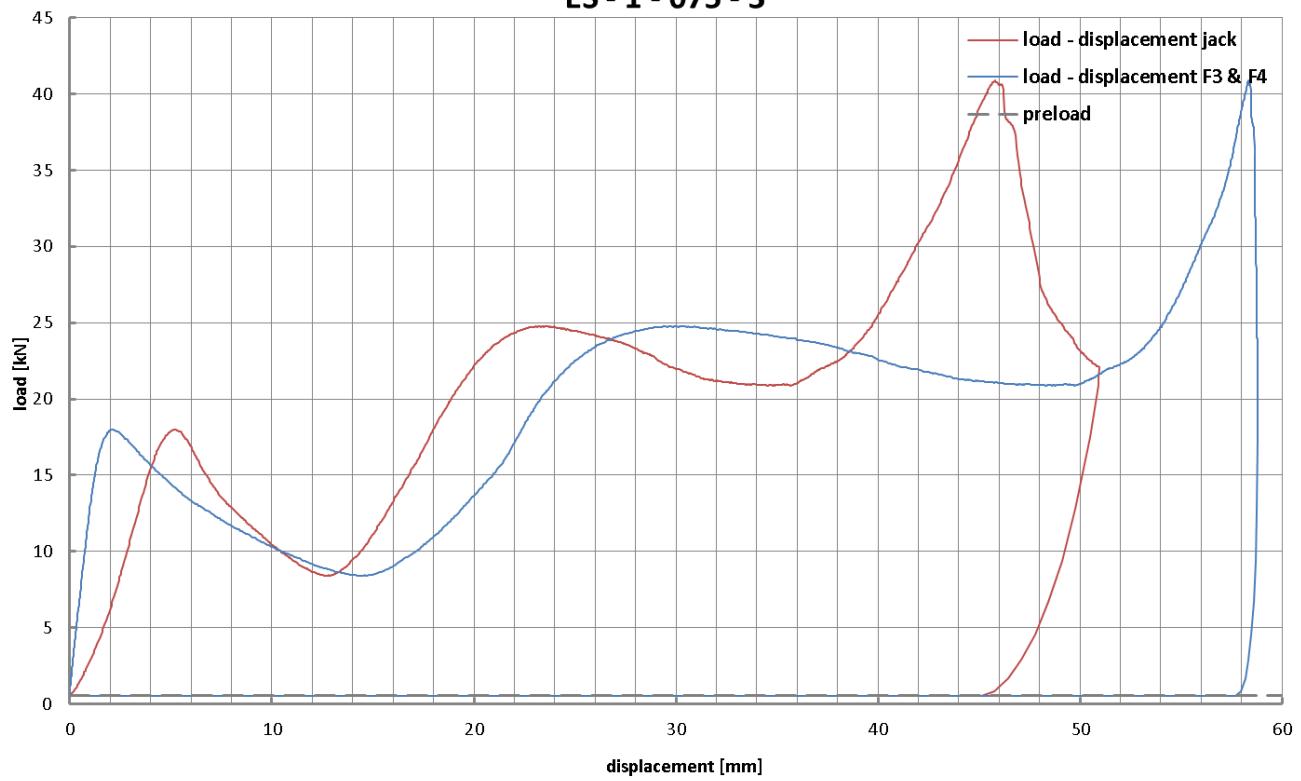
Figure D.16: Web-crippling (PCB 60 $t_N = 0.75$ mm with embossments)

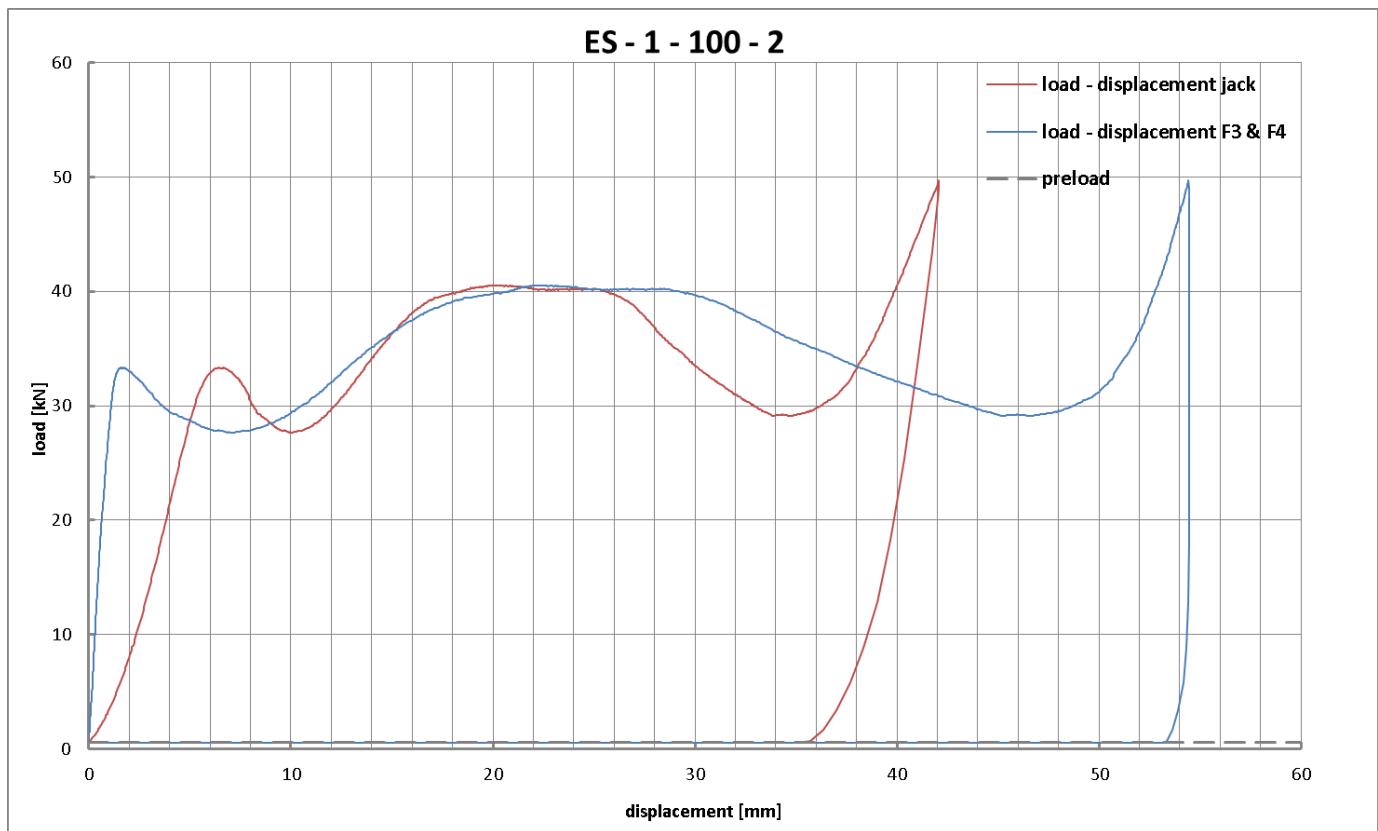
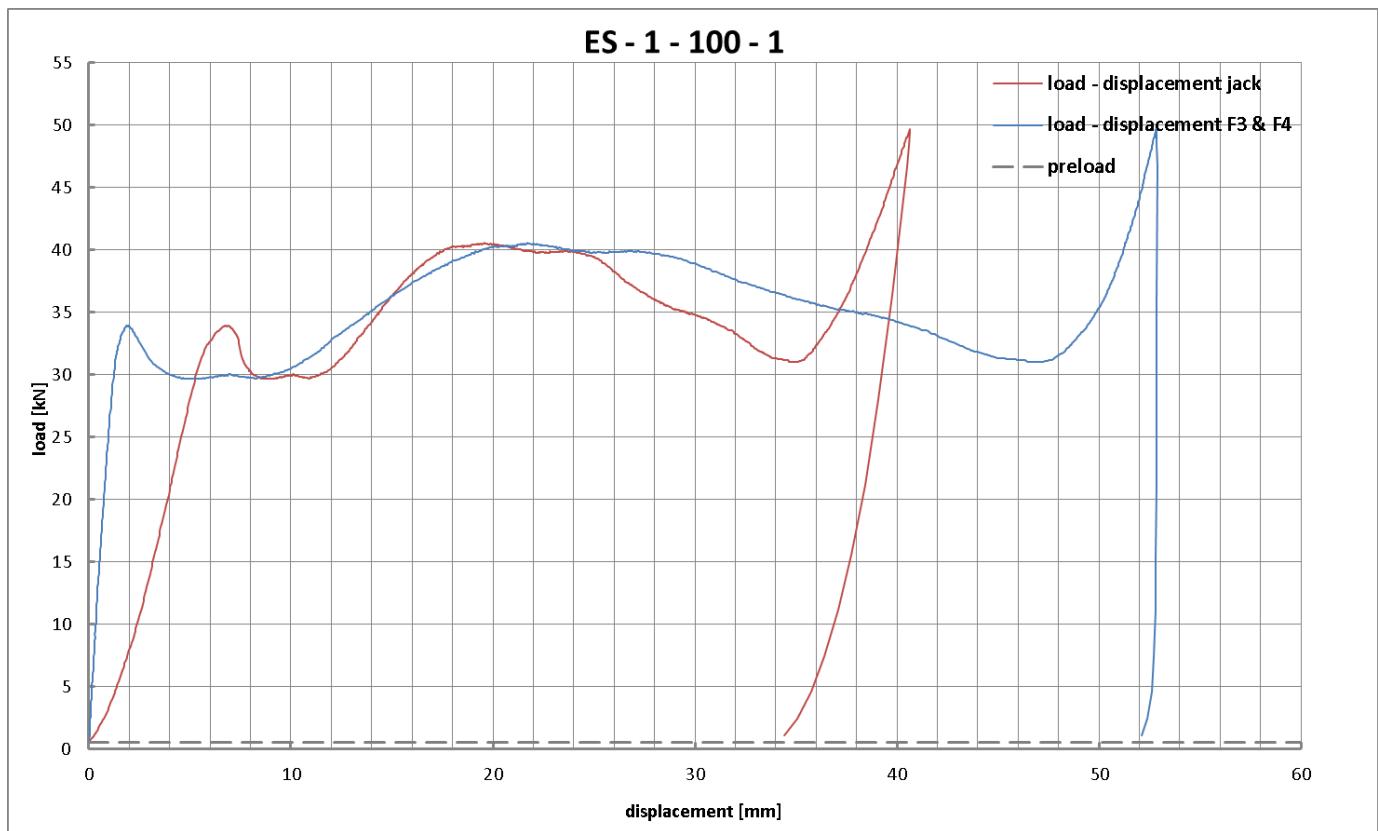


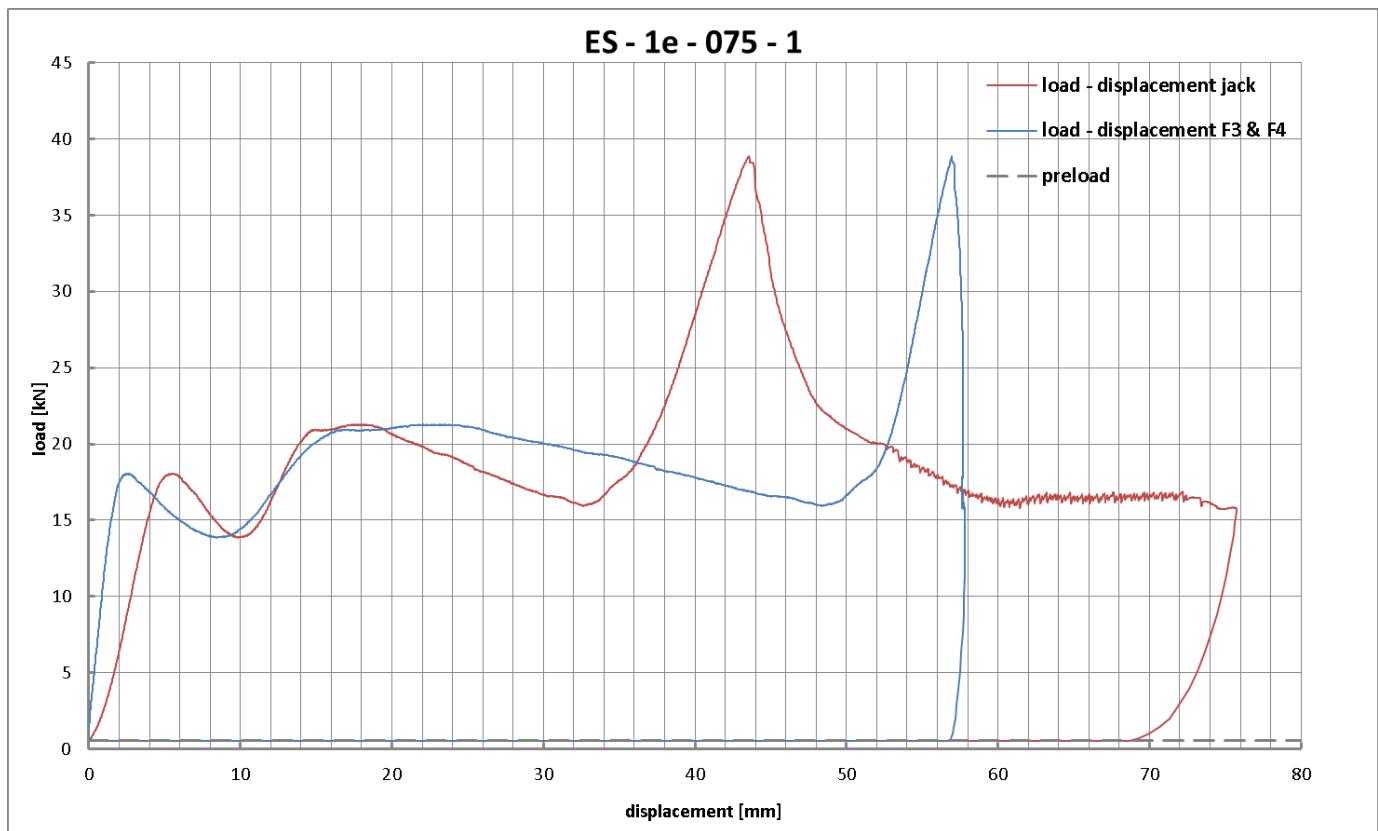
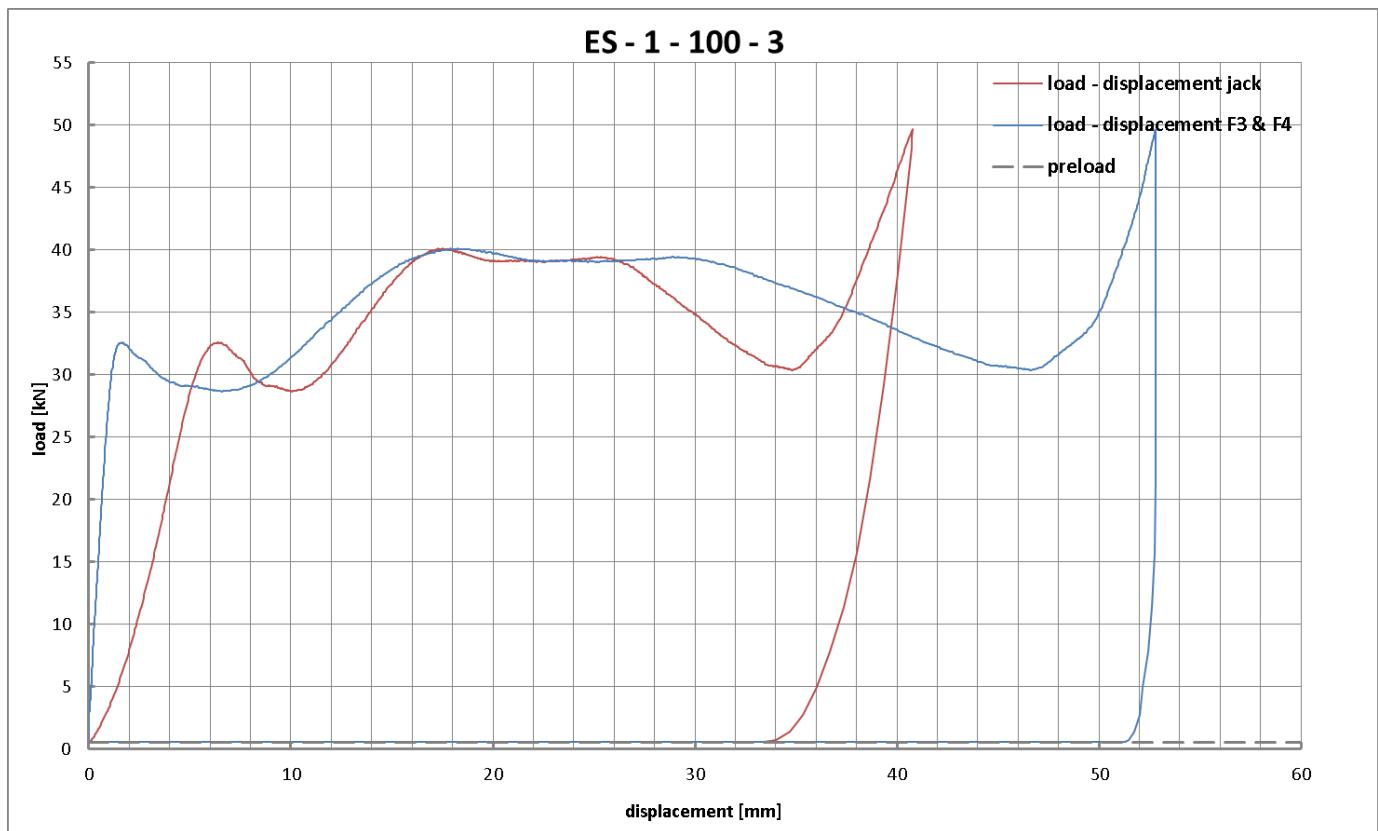
Figure D.17: Buckling of the upper flanges (PCB 60, $t_N = 0.75$ mm with embossments)

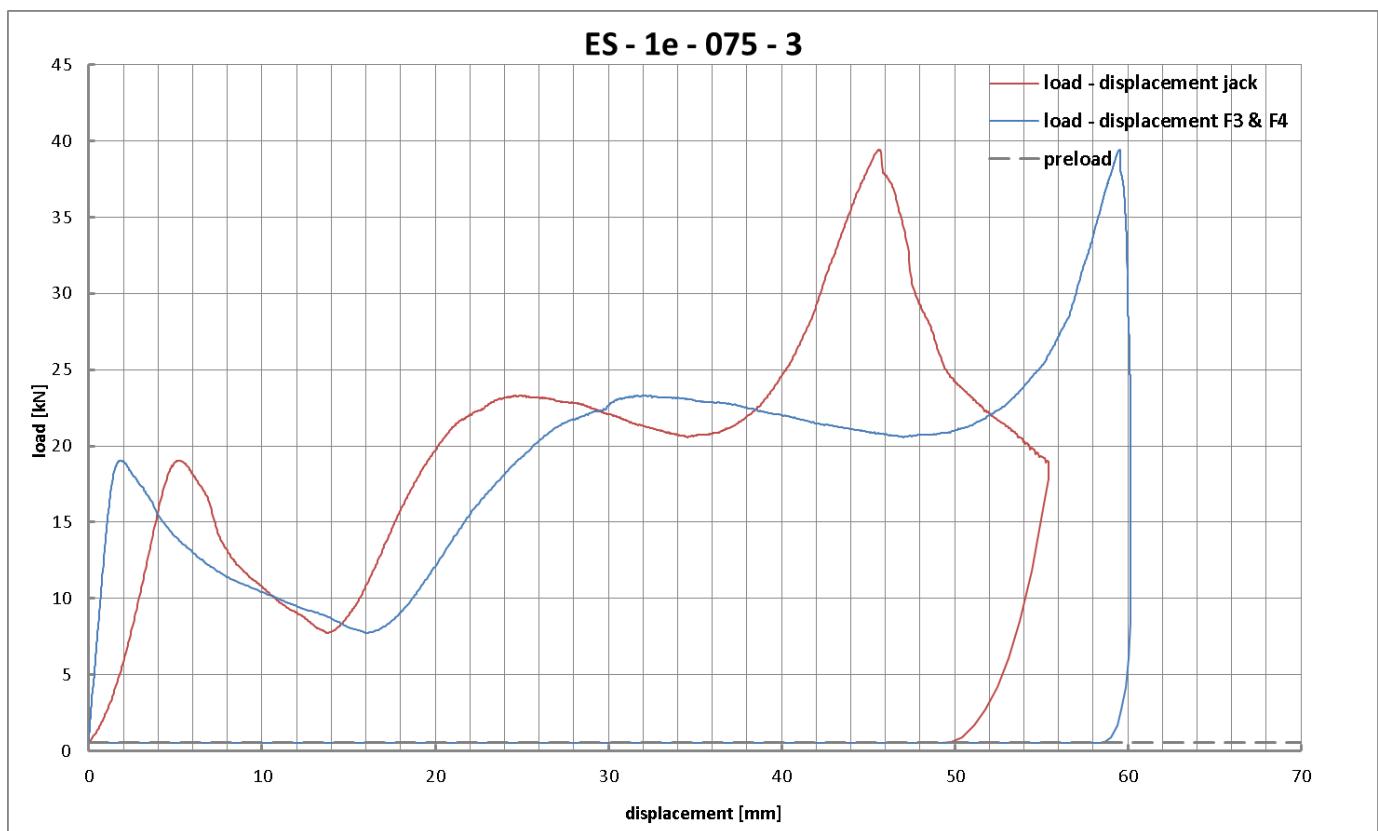
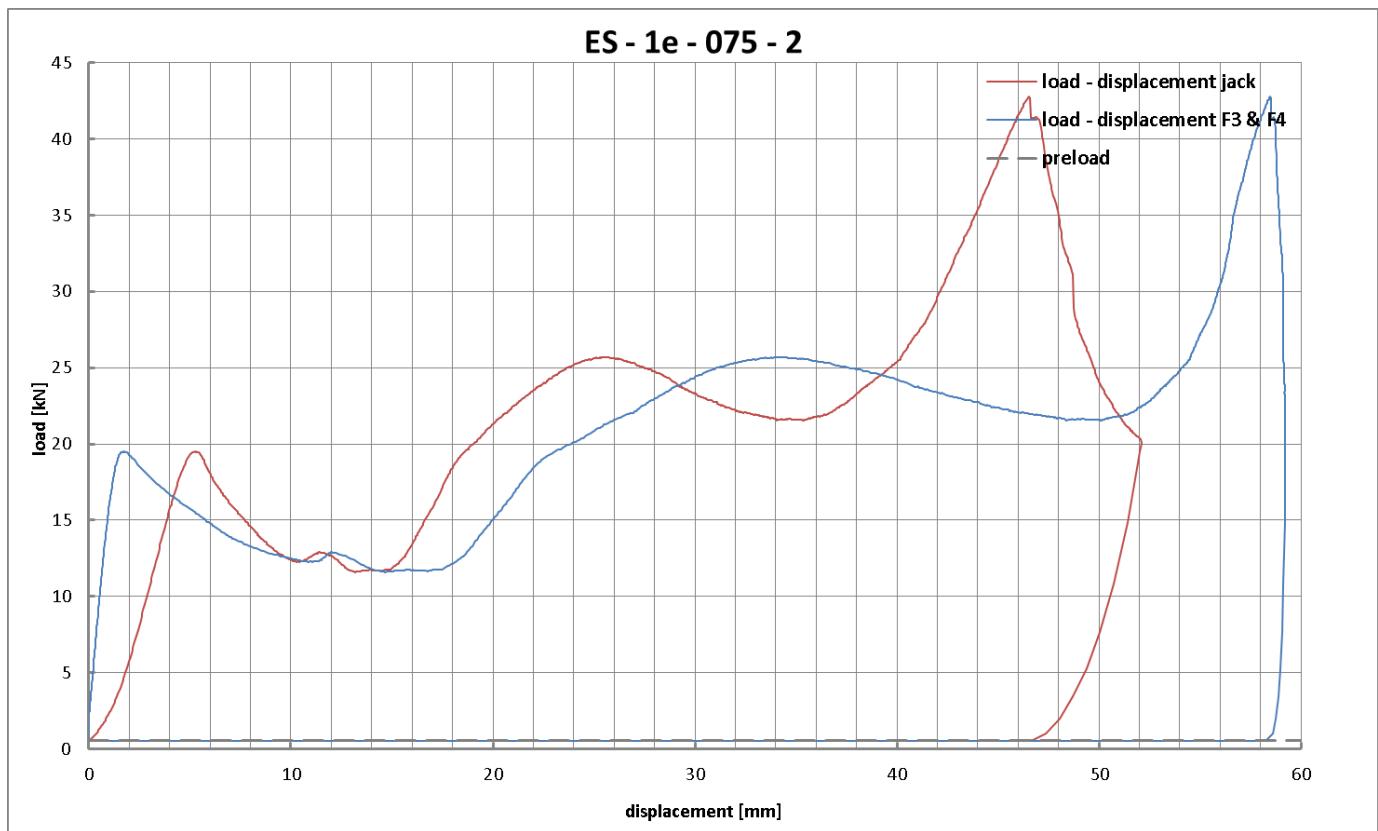
Load-deflection curves:

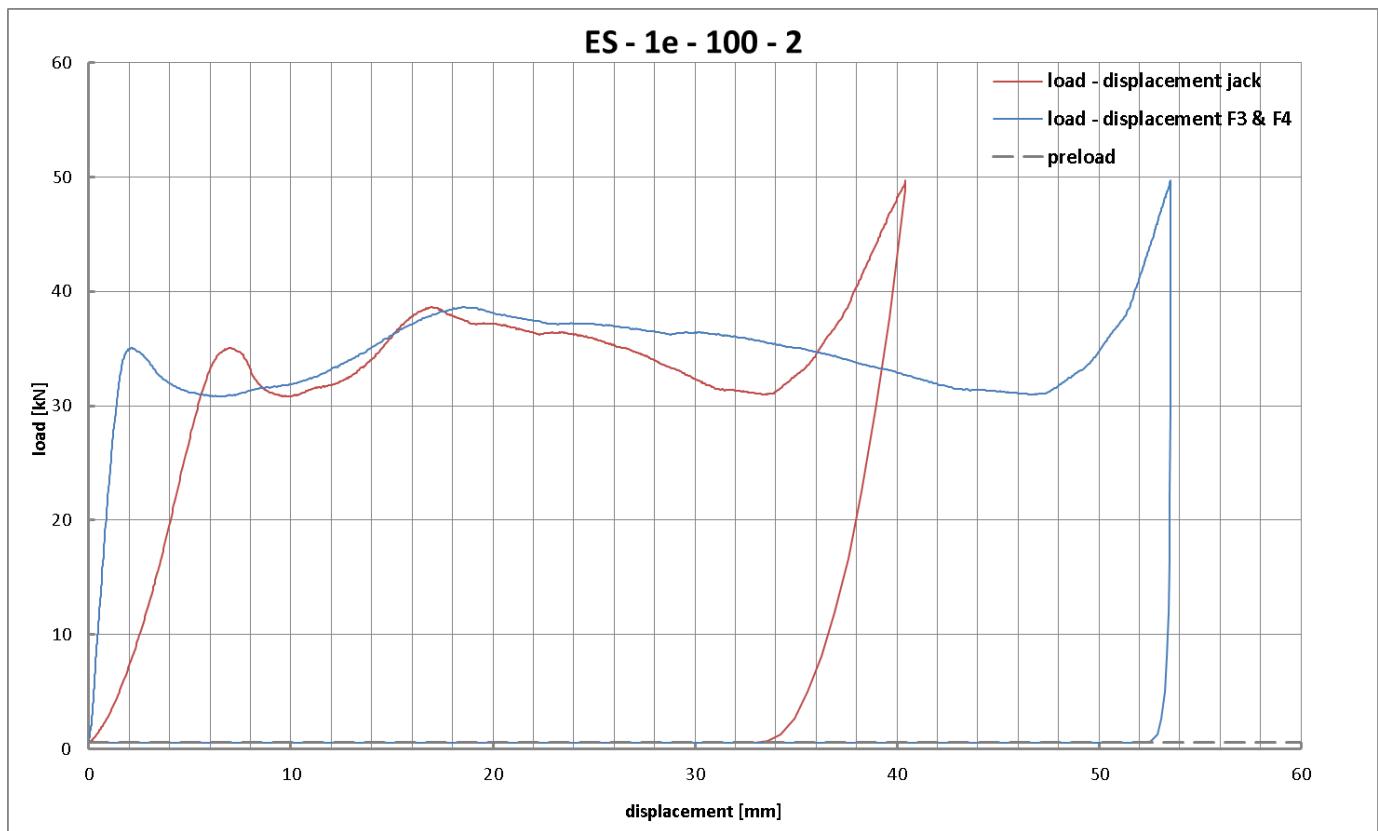
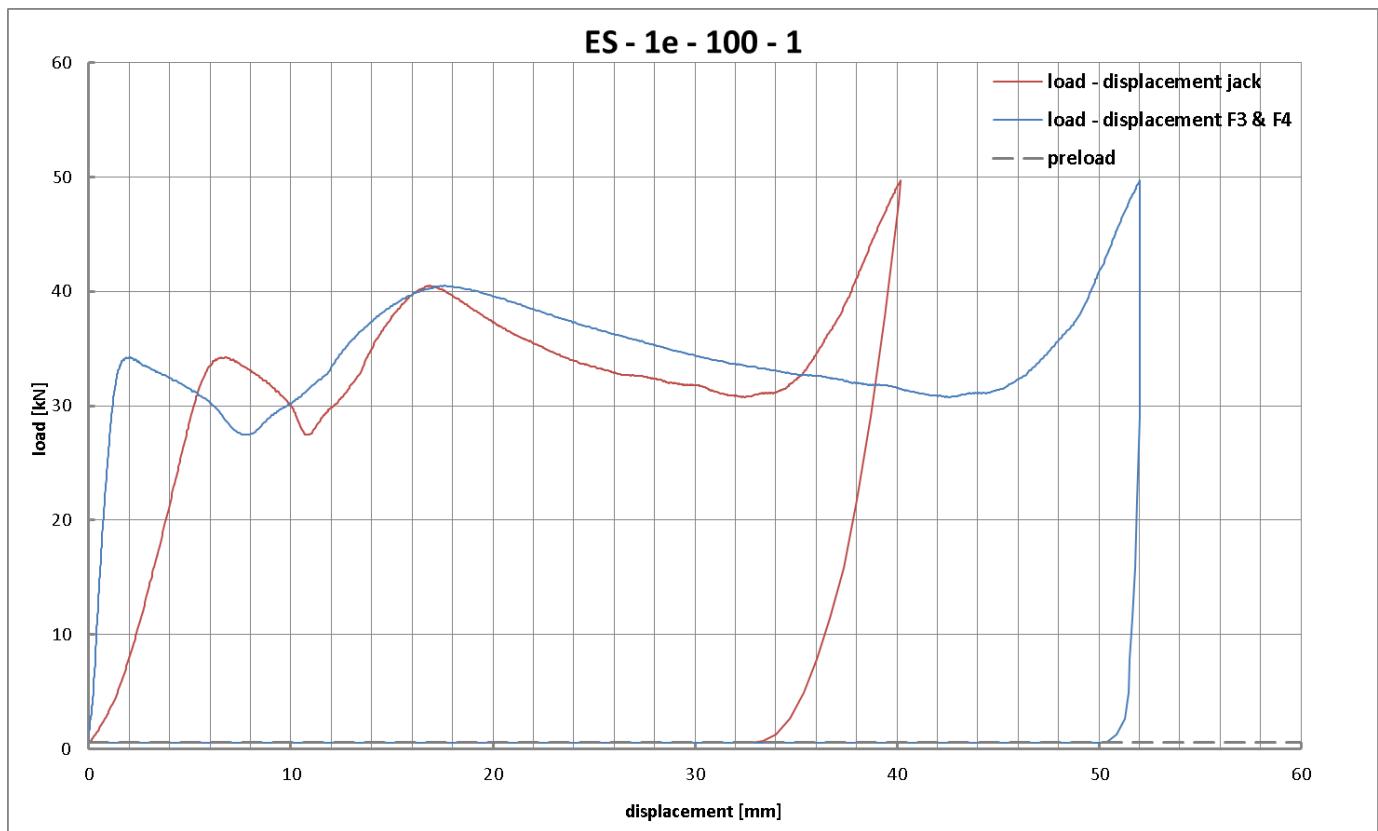


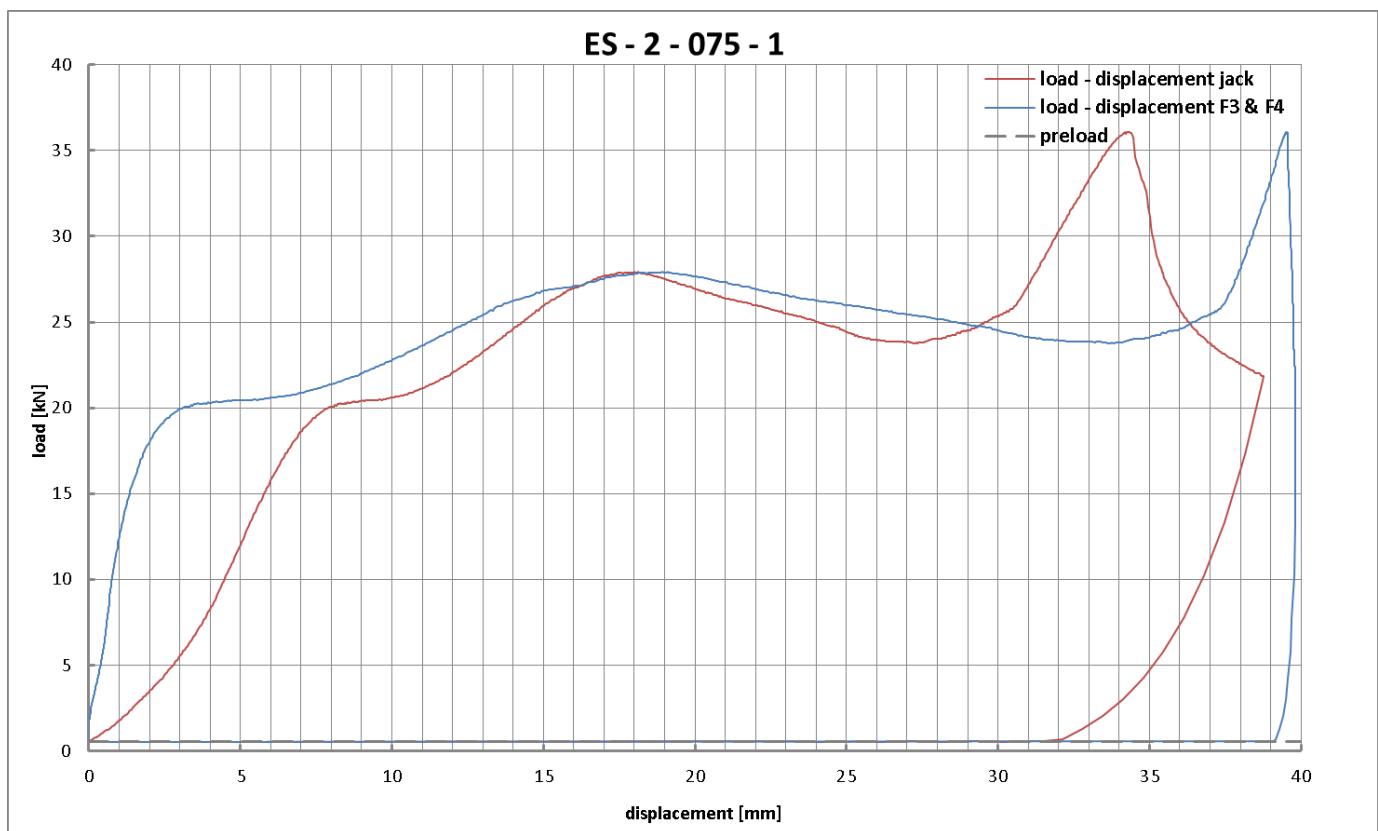
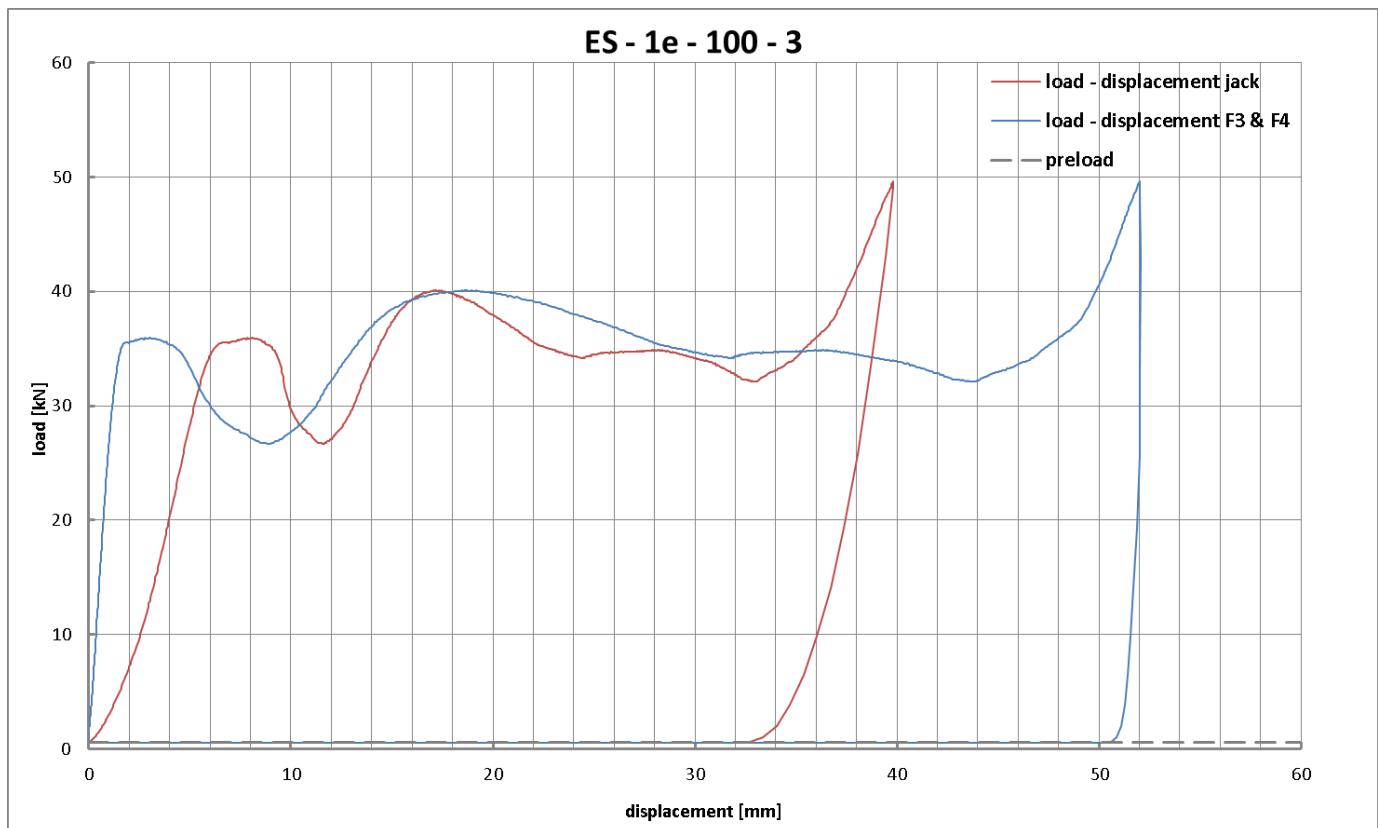
ES - 1 - 075 - 2**ES - 1 - 075 - 3**

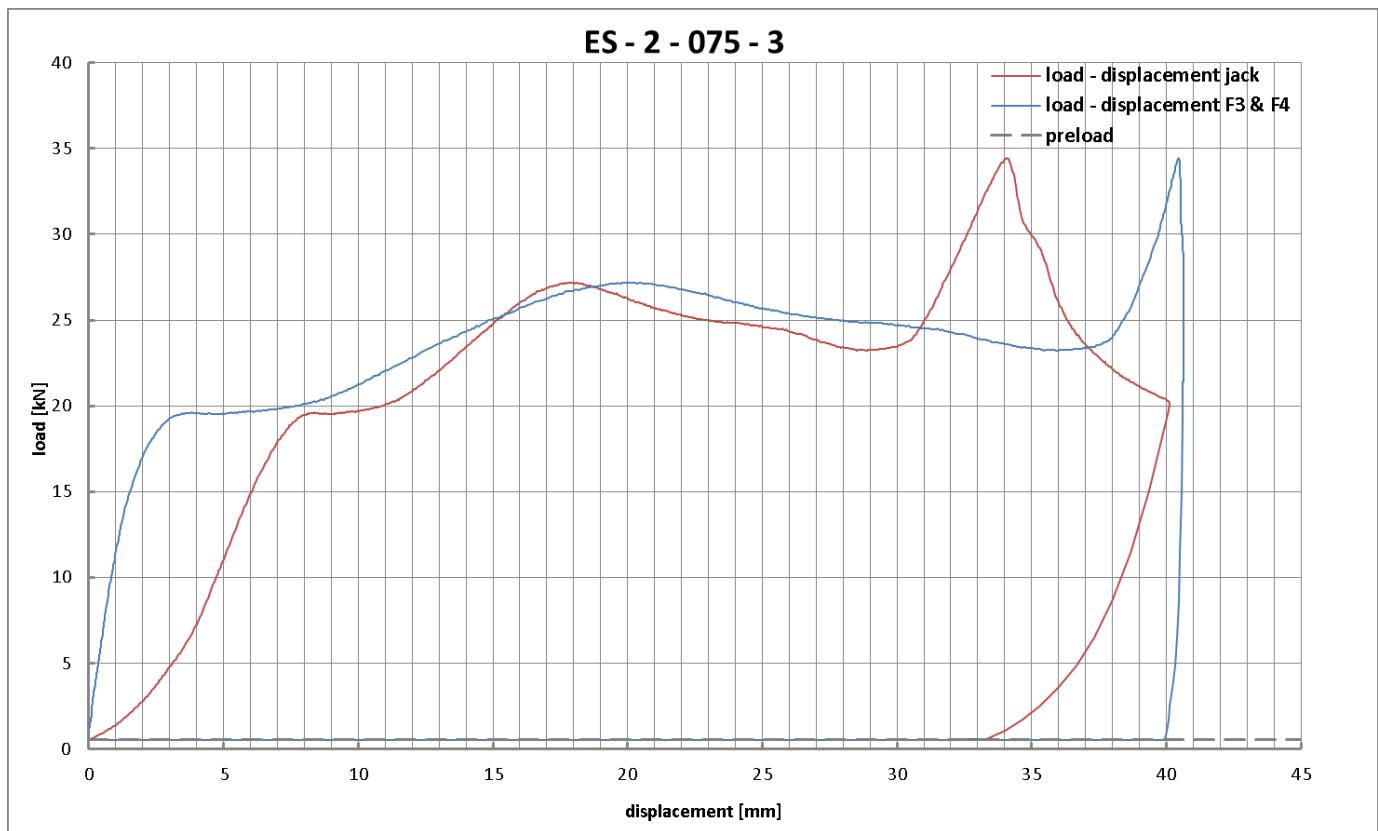
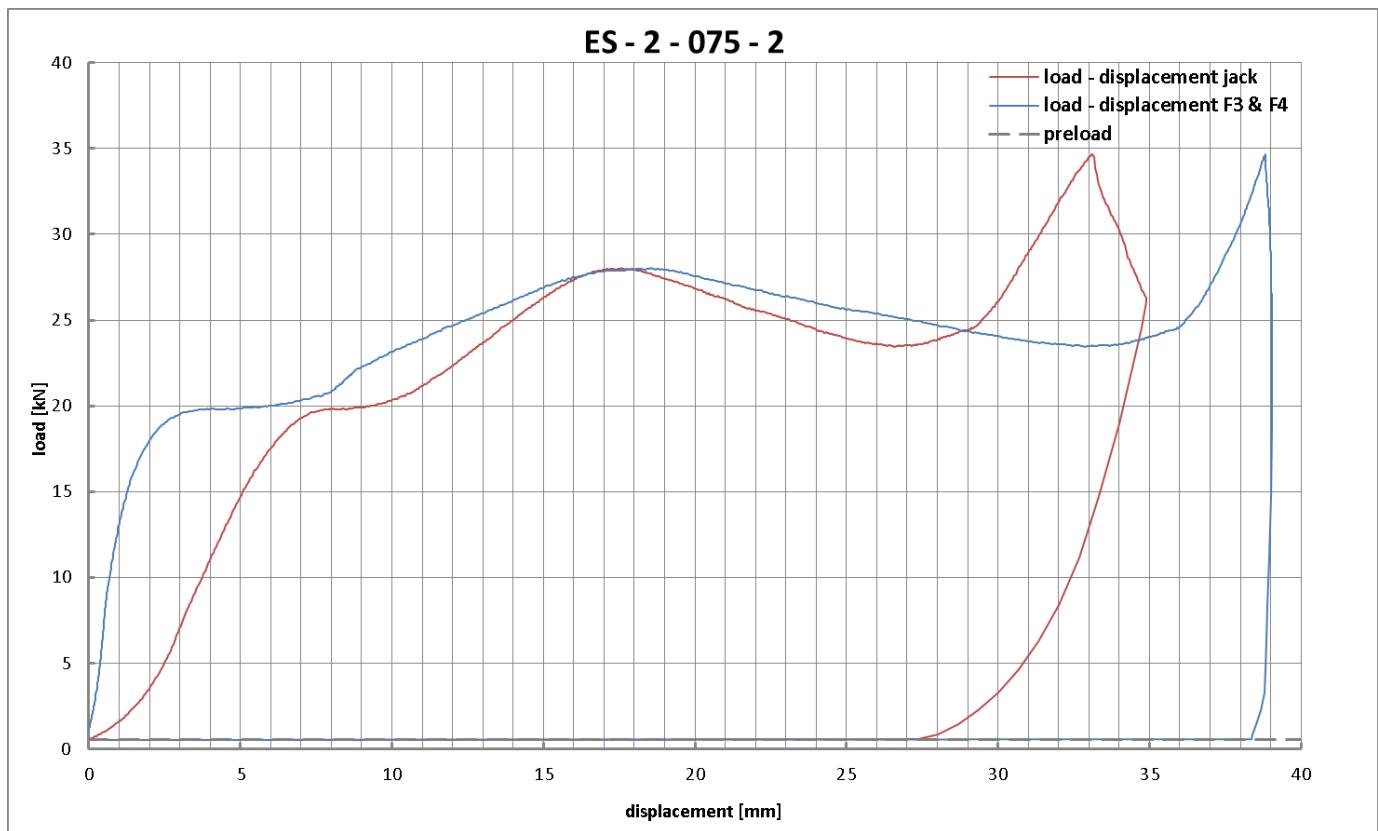


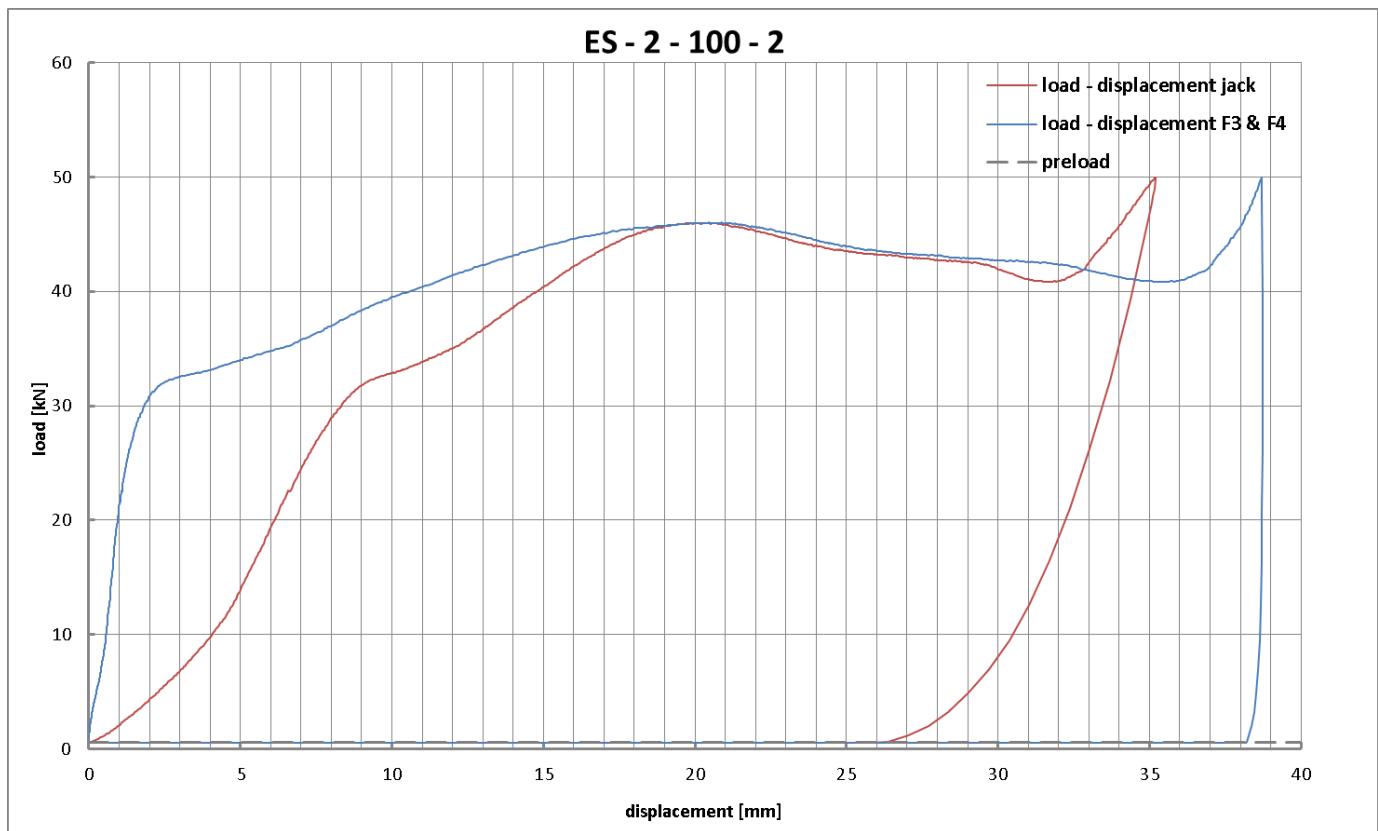
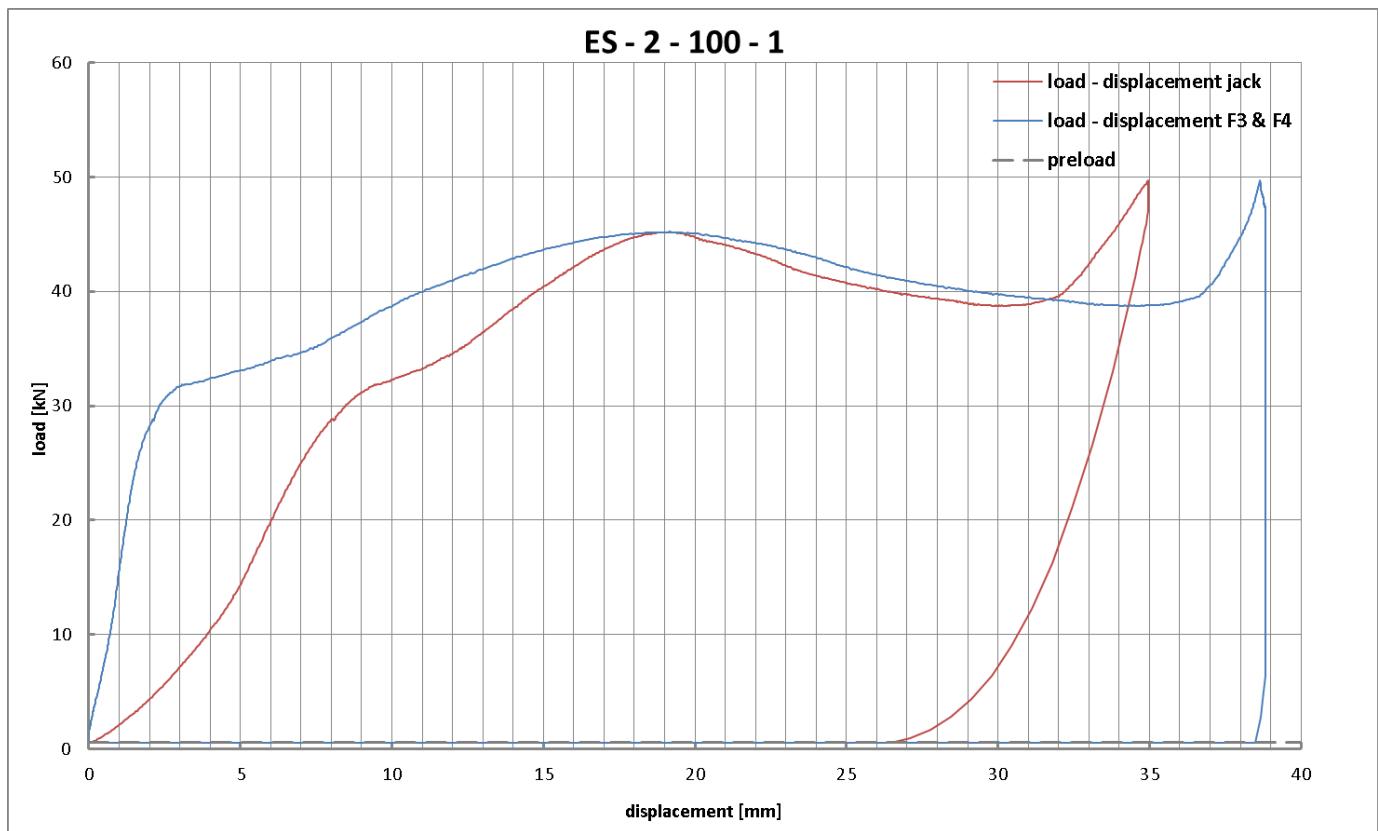


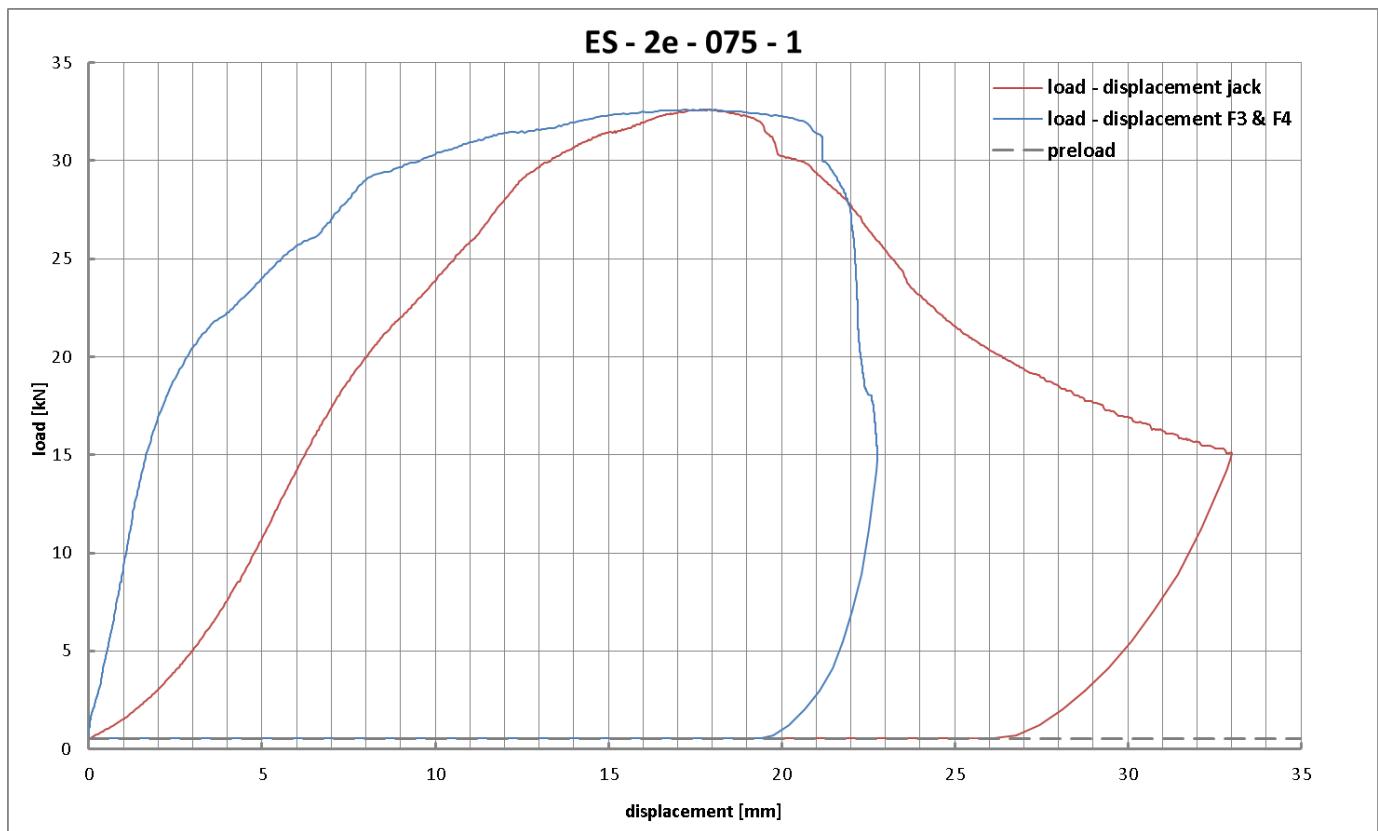
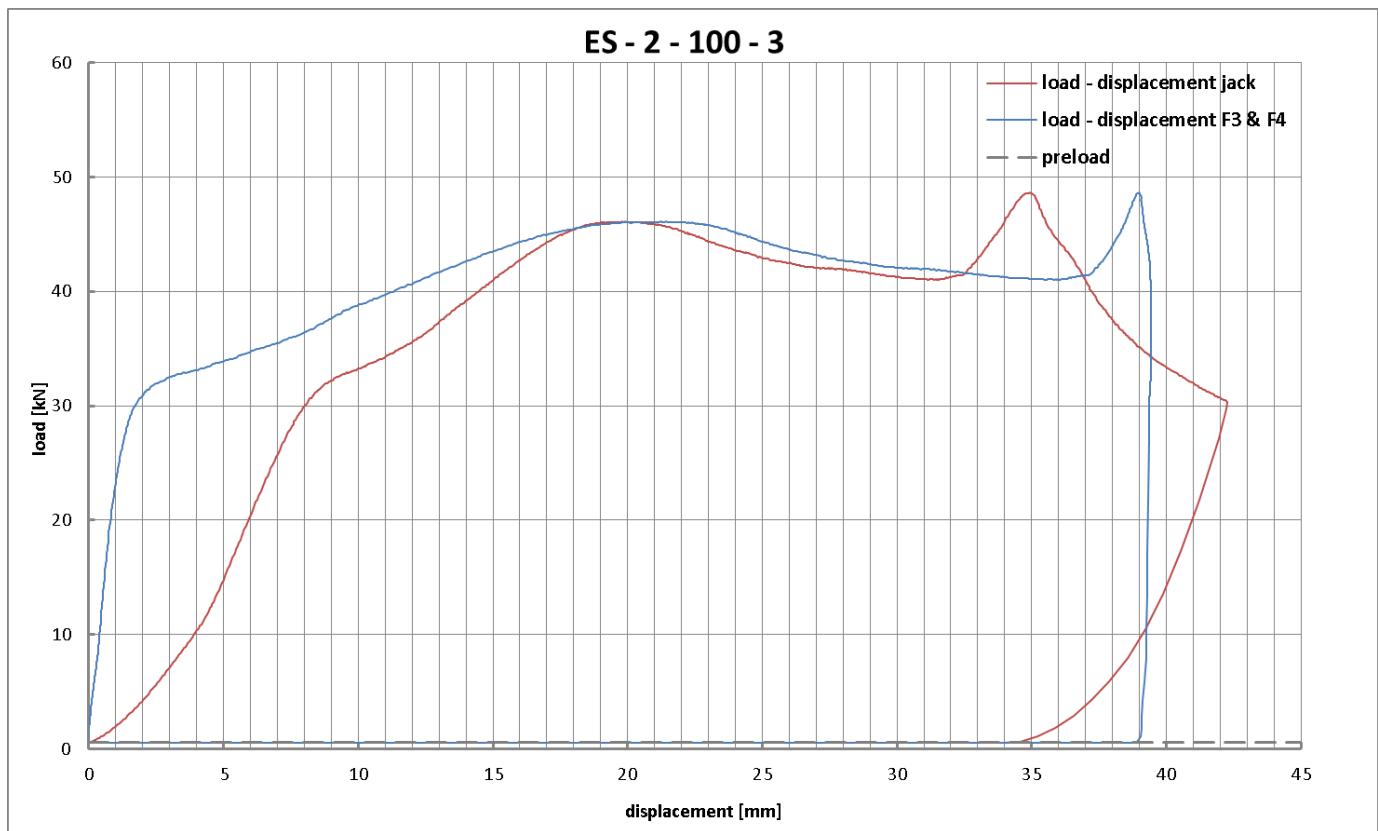


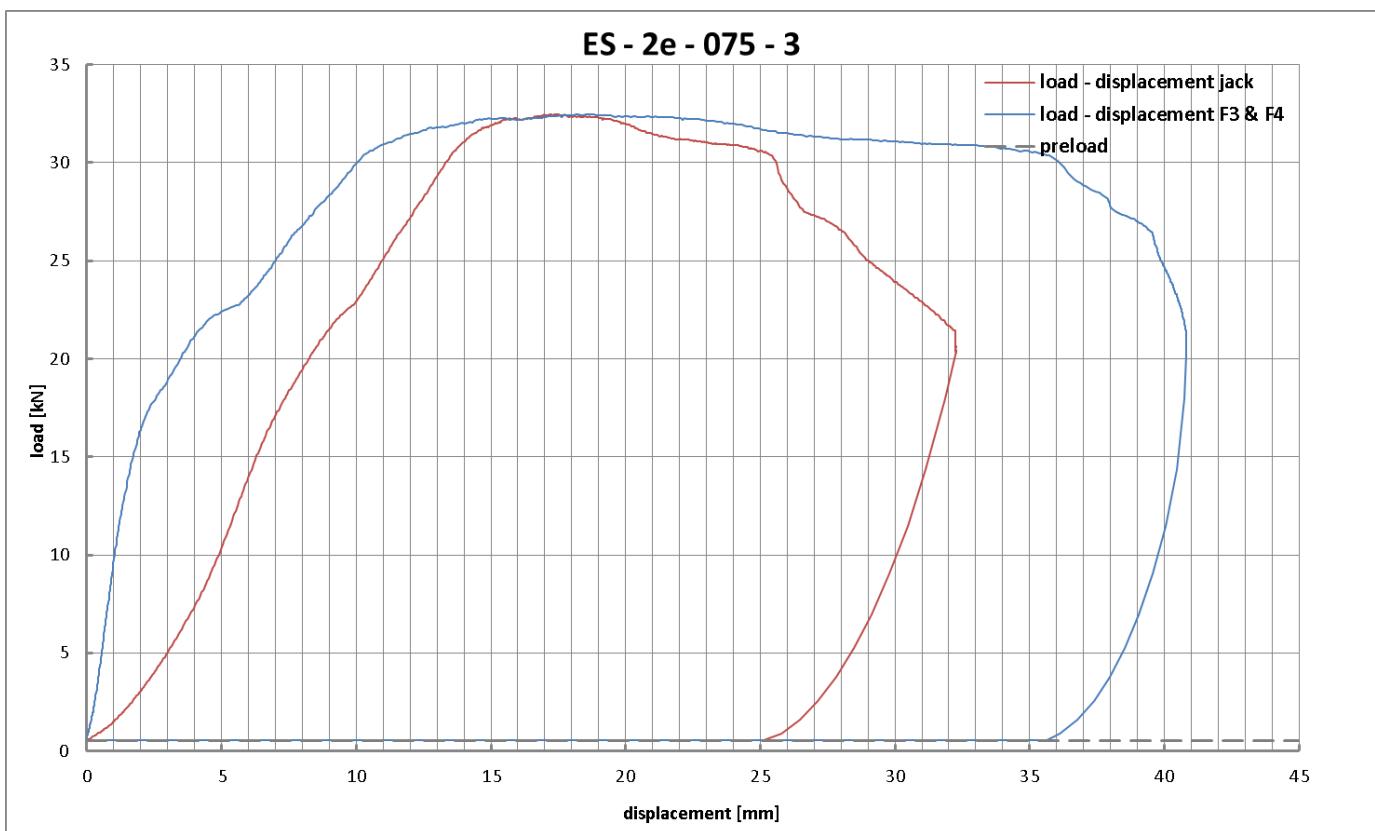
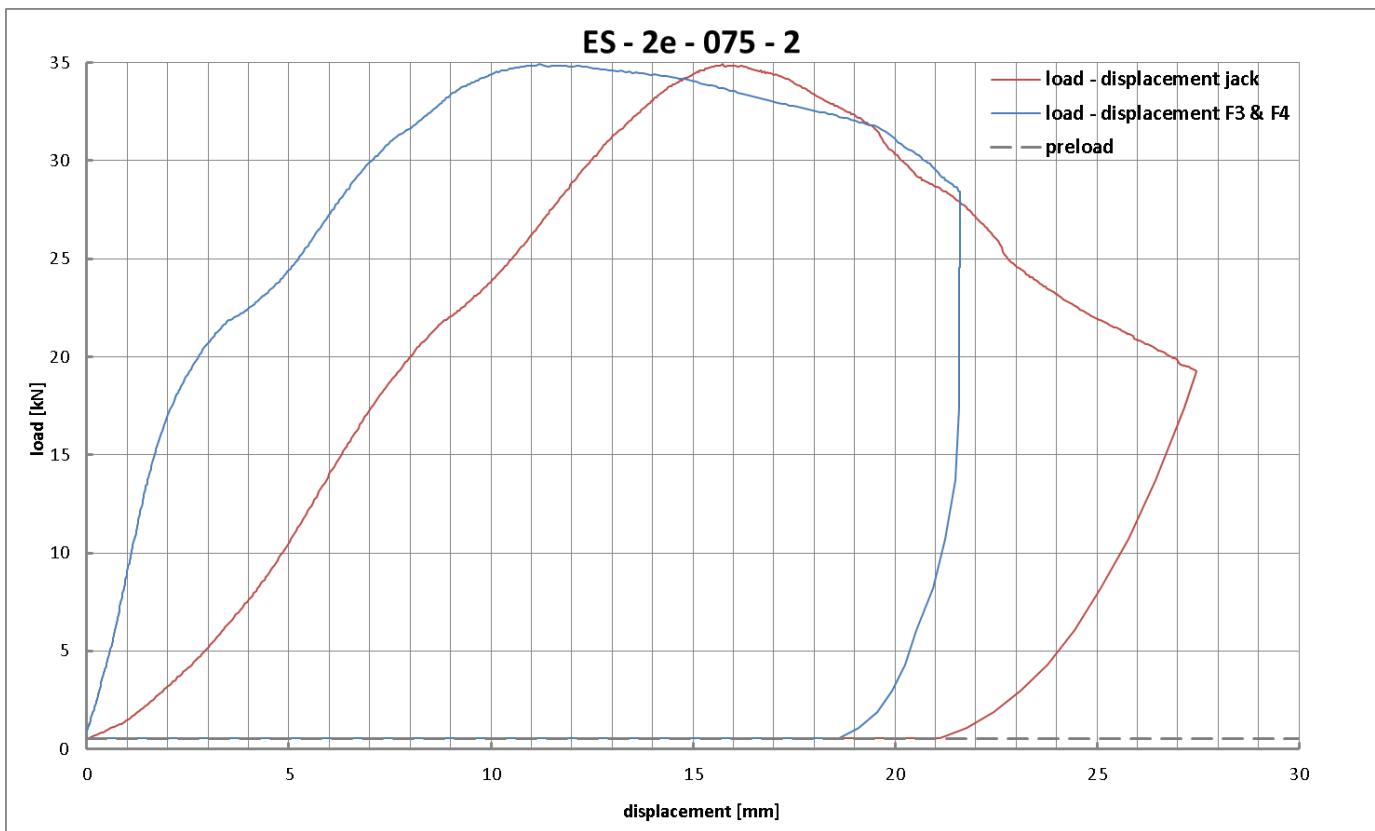


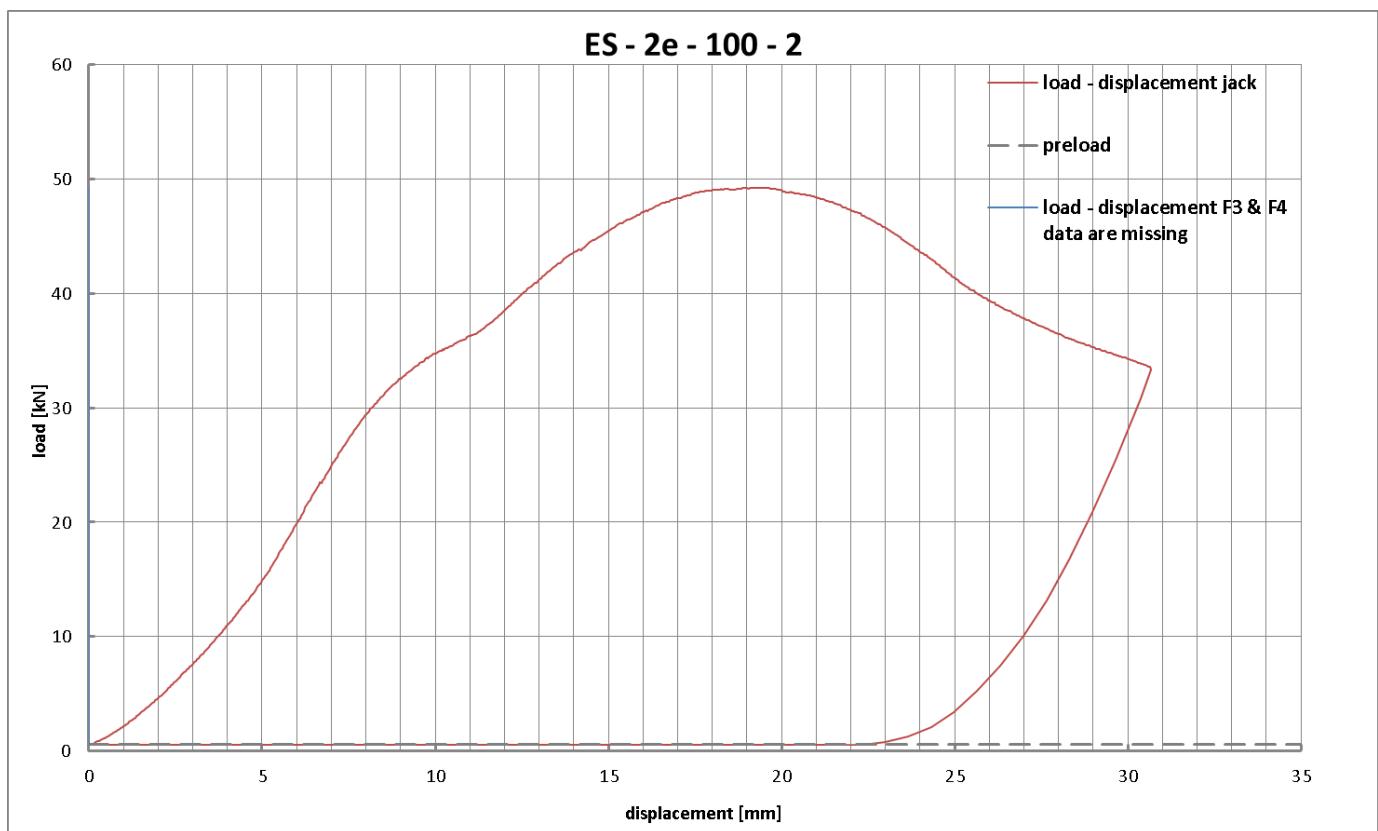
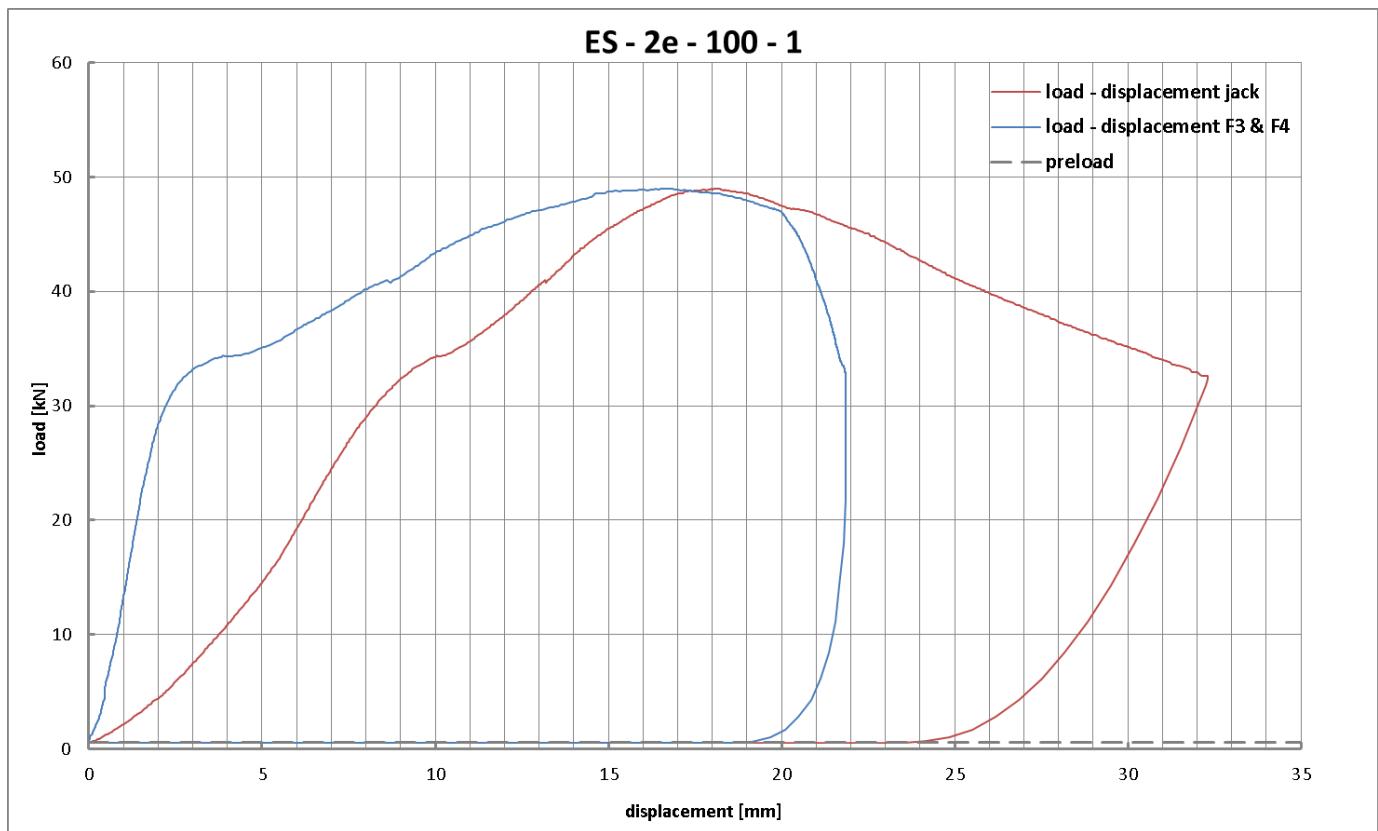


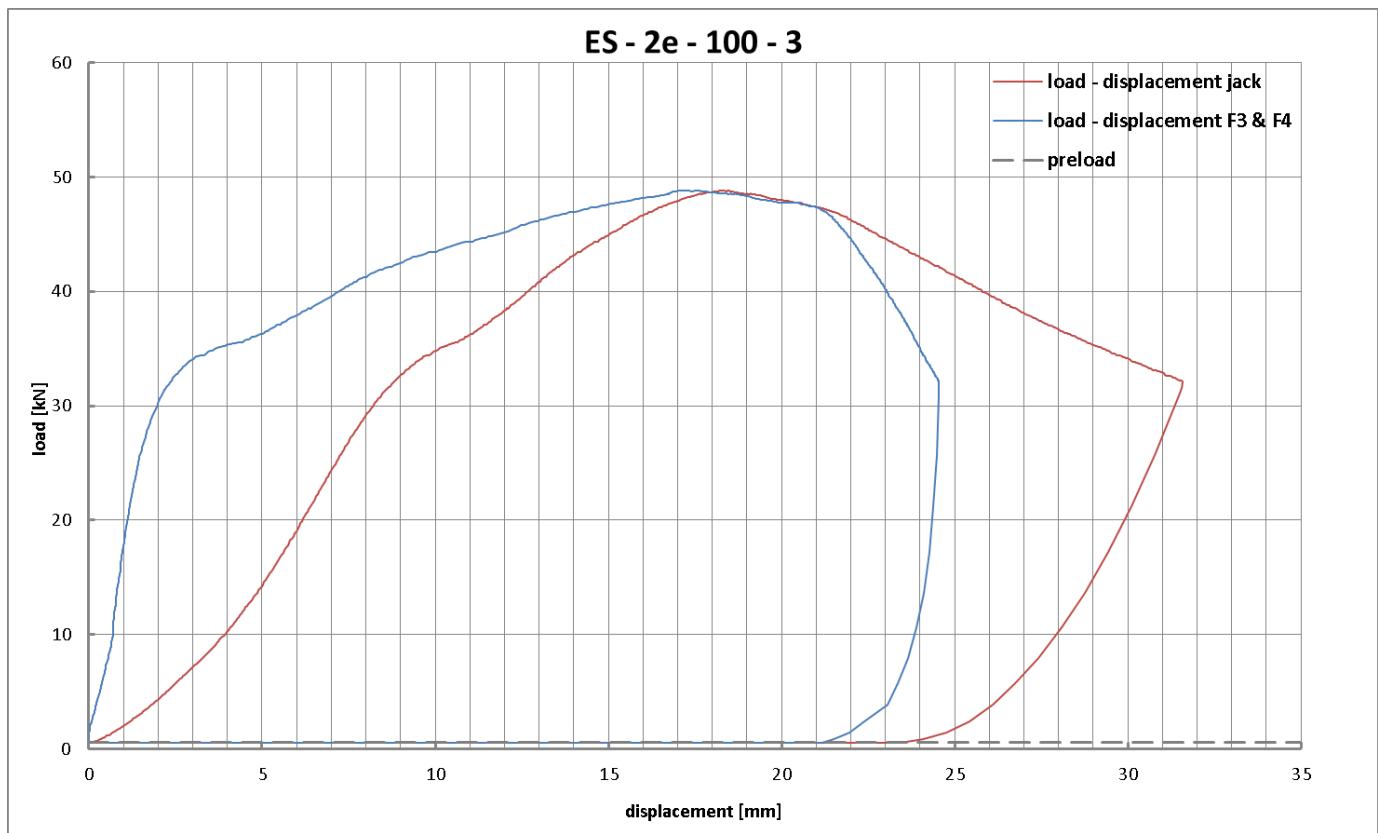




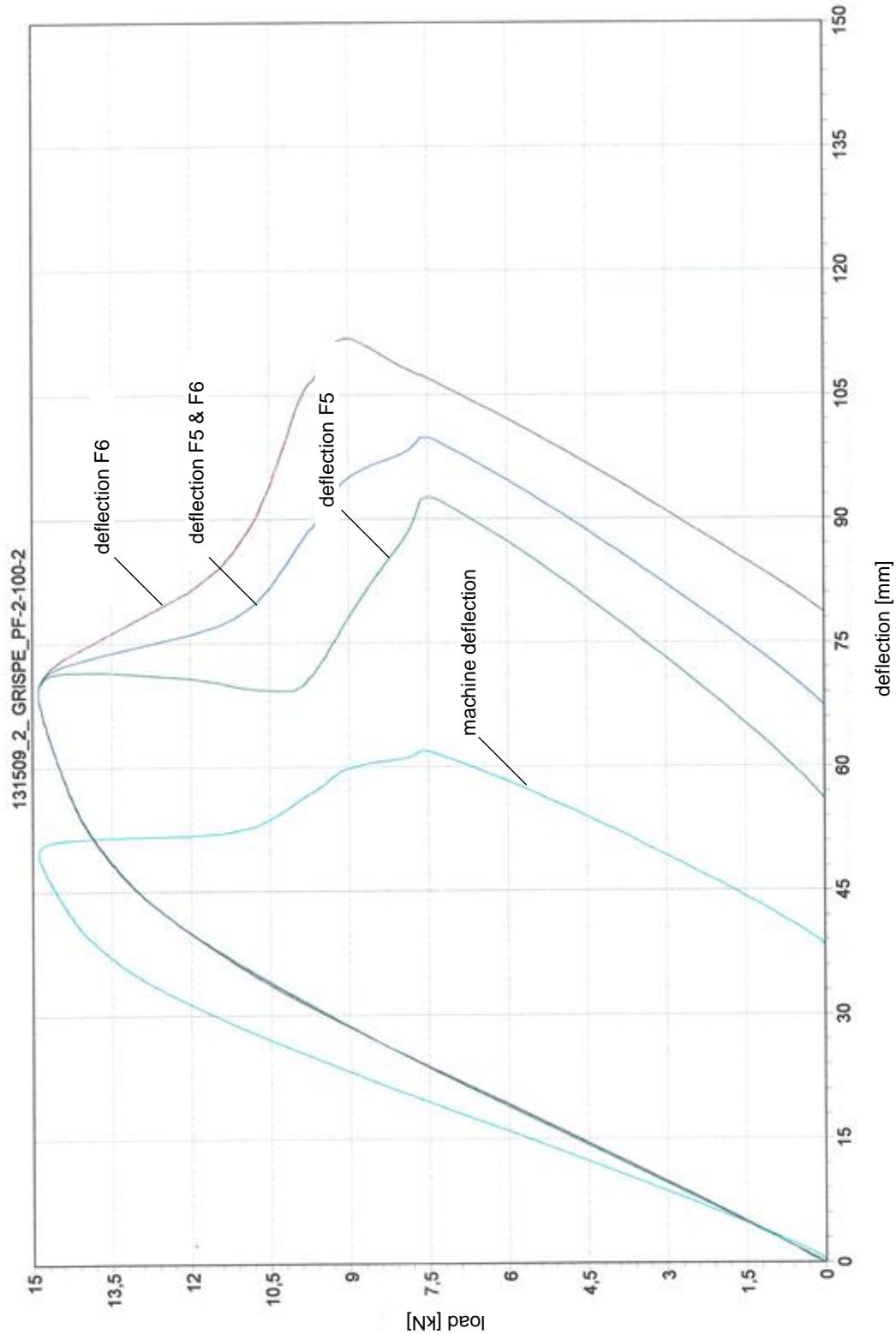


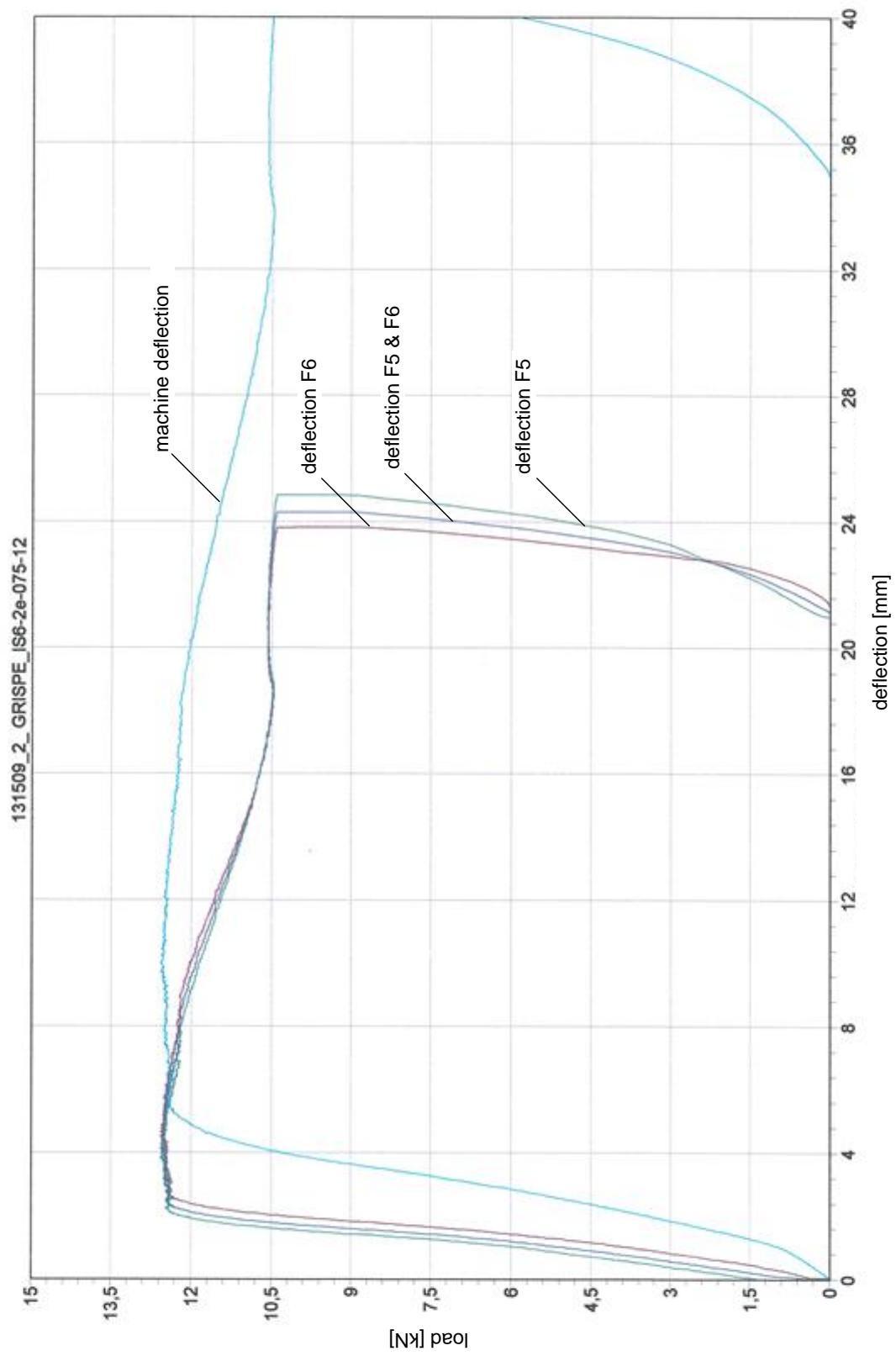


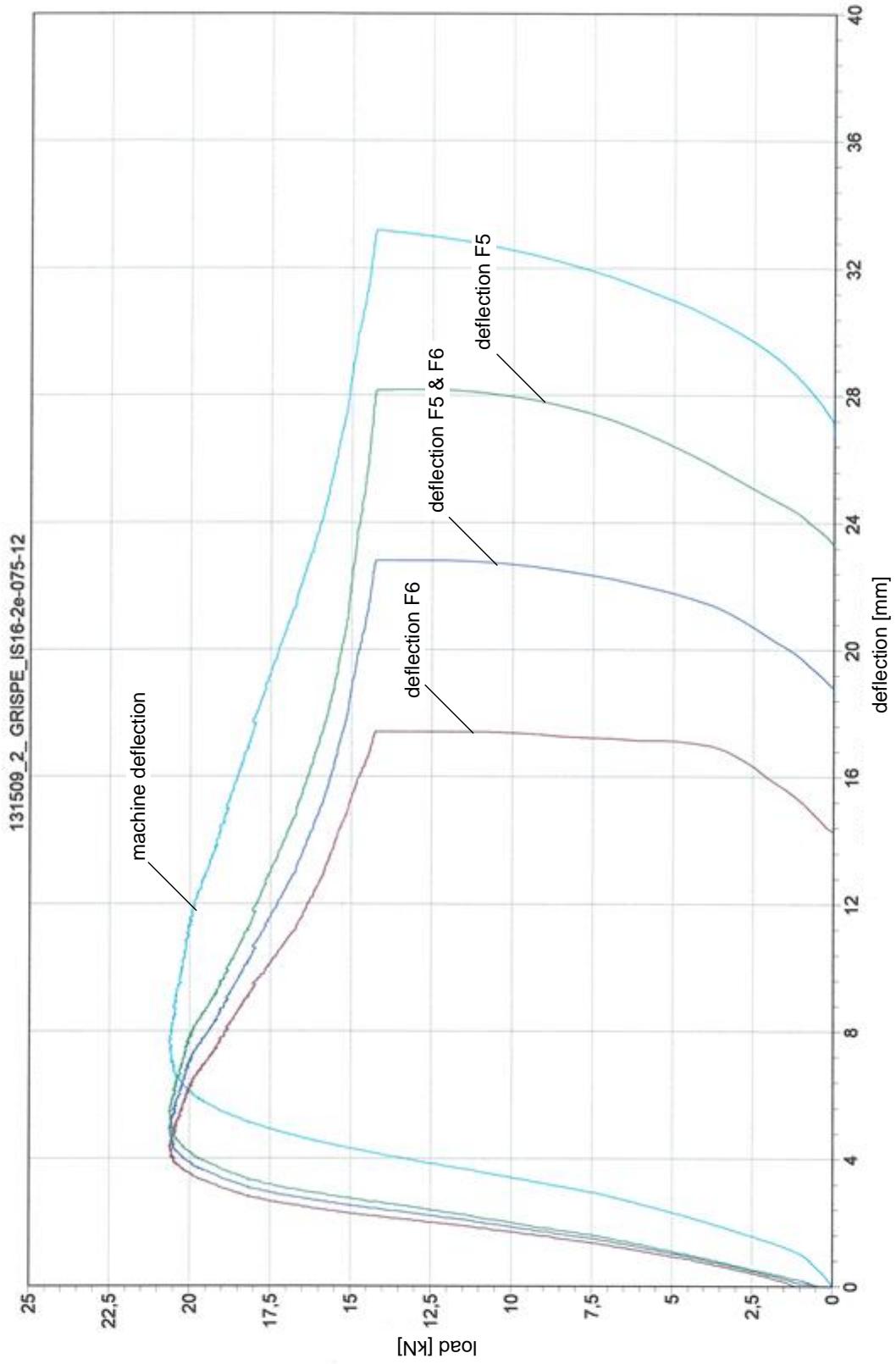




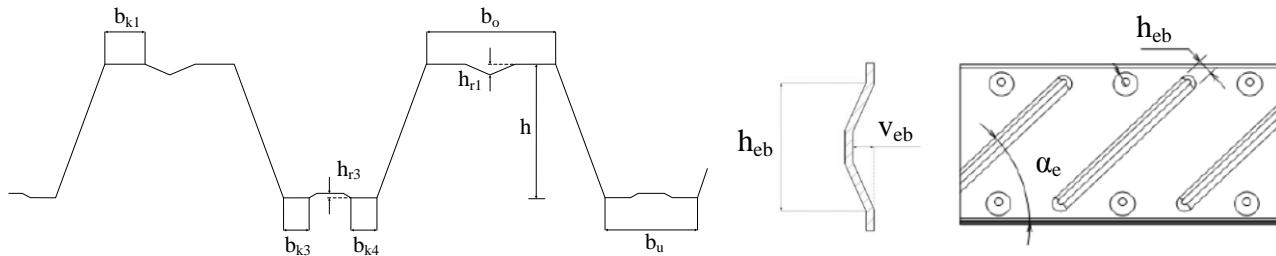
5 Annex E: Copies of the load-deflection curves





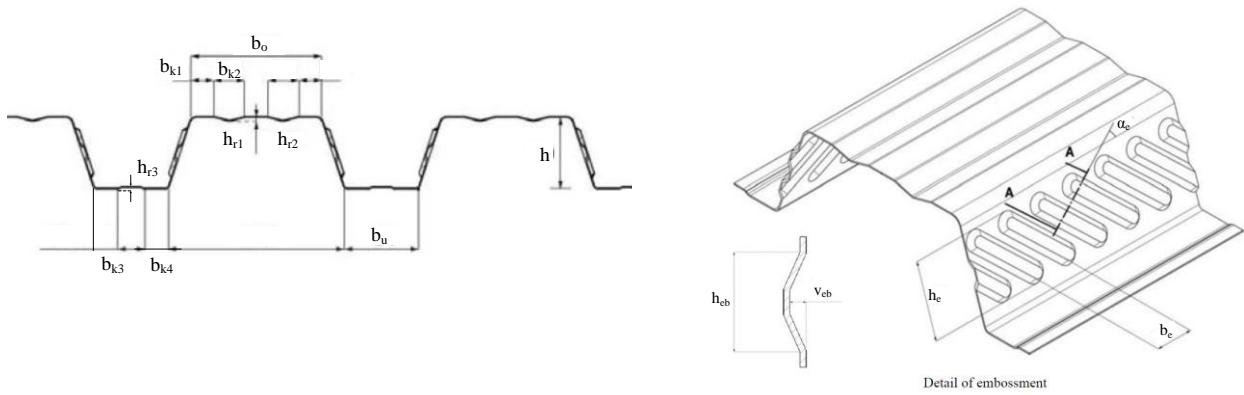


6 Annex F: Measurement of the profile geometry



	PCB 80 $t_N = 0.75$					
	1st Rib	2nd Rib	3rd Rib	1st Rib	2nd Rib	3rd Rib
Thickness t_N	0,74	0,74	0,74	0,77	0,78	0,76
Depth of profile h	77,8	77,0	78,1	77,3	78,1	77,0
Depth of stiff. valley h_{r3}/h_{r4}	1,7	-	0,2	-	1,6	-
Depth of stiff. crown h_{r1}/h_{r2}	6,2	-	6,7	-	6,7	-
Widths of crown b_o	78,0	77,0	78,0	78,5	78,0	78,0
Position of stiff. crown b_{k1}/b_{k2}	23,5	-	24,0	-	23,5	-
Position of stiff. valley b_{k3}/b_{k4}	17,5	17,5	17,5	17,5	14,0	14,5
Widths of valley b_u	55,0	54,0	55,0	55,0	54,5	54,5
Radius of bends r_o	2,5	3,0	Radius of bends r_u		3,0/3,5	3,0
Angle of embossment α_e	-	-	-	45,0	45,0	45,0
Widths of embossment h_{eb}	-	-	-	8,1	7,9	8,0
Depth of embossment v_{eb}	-	-	-	1,8	1,7	1,9

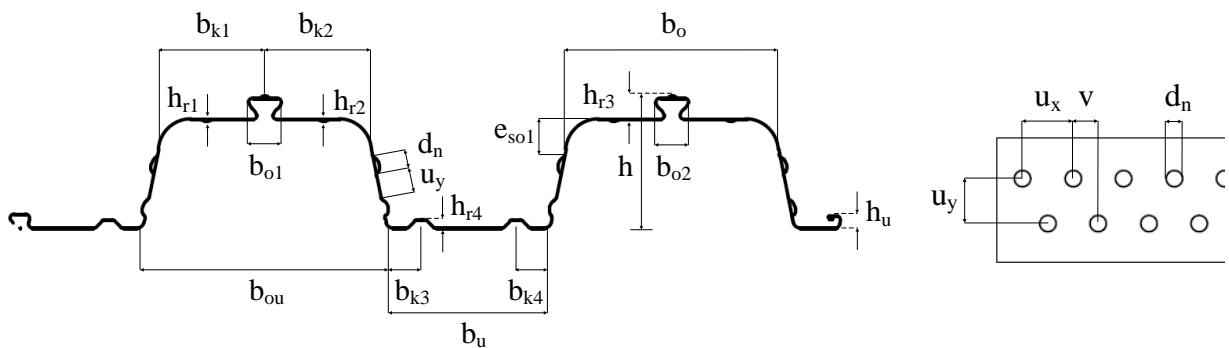
	PCB 80 $t_N = 1.00$					
	1st Rib	2nd Rib	3rd Rib	1st Rib	2nd Rib	3rd Rib
Thickness t_N	0,98	0,98	0,98	0,97	0,99	1,00
Depth of profile h	78,2	78,0	78,0	77,2	77,7	77,6
Depth of stiff. valley h_{r3}/h_{r4}	1,3	-	0,1	-	1,4	-
Depth of stiff. crown h_{r1}/h_{r2}	5,2	-	5,2	-	5,4	-
Widths of crown b_o	78,0	77,5	78,0	79,5	78,0	79,0
Position of stiff. crown b_{k1}/b_{k2}	23,0	-	22,5	-	23,0	-
Position of stiff. valley b_{k3}/b_{k4}	15,5	14,5	15,0	14,5	15,5	14,5
Widths of valley b_u	55,0	55,0	54,0	55,0	55,0	54,5
Radius of bends r_o	3,0	2,5	Radius of bends r_u		3,0	3,0/3,5
Angle of embossment α_e	-	-	-	44,0	46,0	46,0
Widths of embossment h_{eb}	-	-	-	7,7	8,0	7,9
Depth of embossment v_{eb}	-	-	-	1,8	1,7	1,9



Detail of embossment

	PCB 60 $t_N = 0.75$											
	1st Rib		2nd Rib		3rd Rib		1st Rib		2nd Rib		3rd Rib	
Thickness t_N	0,72		0,73		0,73		0,76		0,74		0,74	
Depth of profile h	60,2		58,3		59,6		60,1		58,7		60,6	
Depth of stiff. valley h_{r3}/h_{r4}	1,1	-	1,3	-	0,7	-	0,6	-	1,4	-	1,4	-
Depth of stiff. crown h_{r1}/h_{r2}	1,7	2,8	2,0	2,5	2,3	2,3	2,5	2,3	2,6	2,1	-	-
Widths of crown b_o	107,0		107,0		107,0		106,0		106,0		-	
Position of stiff. crown b_{k1}/b_{k2}	21,5	26,0	20,0	25,0	20,0	25,0	21,0	25,5	20,0	25,5	-	-
Position of stiff. valley b_{k3}/b_{k4}	25,0	15,5	21,0	18,5	25,0	15,5	20,0		21,0		24,5	17,5
Widths of valley b_u	61,0		60,0		60,5		61,0		60,5		61,5	
Radius of bends r_o	5,5/6,0		5,0		Radius of bends r_u		6,0		5,5			
Angle of embossment α_e	-		-		-		45,0		45,0		45,0	
Widths of embossment h_{eb}	-		-		-		12,8		12,9		13,1	
Depth of embossment v_{eb}	-		-		-		1,9		2,0		2,1	
height of embossment h_e	-		-		-		42,0		42,4		42,3	
distance of the embossments b_e	-		-		-		22,2		22,6		22,8	

	PCB 60 $t_N = 1.00$											
	1st Rib		2nd Rib		3rd Rib		1st Rib		2nd Rib		3rd Rib	
Thickness t_N	0,97		0,96		0,96		1		0,98		0,97	
Depth of profile h	60,2		58,7		60,5		58,8		59,1		59,8	
Depth of stiff. valley h_{r3}/h_{r4}	0,7	-	1,1	-	1,2	-	1,4	-	1,2	-	1,4	-
Depth of stiff. crown h_{r1}/h_{r2}	2,2	2,3	2,6	2,0	-	-	-	-	1,9	2,6	2,4	2,1
Widths of crown b_o	107,0		107,0		-		-		105,0		106,0	
Position of stiff. crown b_{k1}/b_{k2}	-	-	21,0	24,0	21,5	23,5	-	-	19,5	26,0	20,0	24,5
Position of stiff. valley b_{k3}/b_{k4}	19,0	21,0	18,0	23,0	16,0	25,0	-	-	-	-	-	-
Widths of valley b_u	61,0		60,5		61,0		61,5		61,0		62,0	
Radius of bends r_o	6,0/6,5		6,0/6,5		Radius of bends r_u		5,5/6,0		5,5			
Angle of embossment α_e	-		-		-		44,0		44,0		44,0	
Widths of embossment h_{eb}	-		-		-		12,8		12,9		13,1	
Depth of embossment v_{eb}	-		-		-		2,0		1,7		2,0	
height of embossment h_e	-		-		-		42,0		42,2		42,3	
distance of the embossments b_e	-		-		-		22,2		22,6		22,8	



	ComFlor 80 $t_N = 0.90 \text{ mm}$				ComFlor 80 $t_N = 1.20 \text{ mm}$							
	1st Rib		2nd Rib		1st Rib		2nd Rib					
Thickness t_N	0,93				0,94							
Depth of profile h	96,2				98,7							
Depth of stiffeners h_{r1}/h_{r2}	3,9	2,9	2,7	2,9	3,1	2,9	2,7	2,6				
Widths of crown b_o	142,0		141,5		142,0		143,0					
Position of stiffeners b_{k1}/b_{k2}	70,0	72,5	66,0	72,5	72,0	69,0	72,0	70,5				
Position of stiffeners b_{k3}/b_{k4}	-	-	24,0	26,5	-	-	24,0	26,0				
Width of crown stiffeners b_{o1}/b_{o2}	13,9	13,6	13,7	13,8	13,9	13,9	13,8	13,7				
embossment diameter d_n	14,1	14,6	13,8	13,3	13,2	14,6	14,1	14,6				
embossment pitch u_x	35,3	34,7	35,5	35,1	35,2	35,7	34,8	35,1				
Offset v	18,0	17,5	16,9	19,4	18,9	20,2	18,3	18,6				
Row spacing u_y	29,3	29,7	29,2	29,5	30,4	30,9	30,0	30,2				
Edge spacing e_{so1}/e_{so1}	25,5	28,1	28,2	24,8	32,0	27,0	29,0	26,5				
numbers of rows (transv.)	2,0				2,0							
numbers of rows/m (long.)	28,0				28,0							
Widths of valley b_u	120,0				120,5							
Depth of stiffeners h_{r3}/h_{r4}	15,5	8,1	16,0	-	14,2	8,3	16,4	-				
Long. edge upstand h_u	17,5				17,5							
width of crown b_{ou}	186,0		184,0		184,5		189,0					
Radius of bends r_u	25,0	25,0	Radius of bends r_u		5,5	4,5						

7 Annex G: Coupon tests with embossments

