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Test documentation 2020-108

Experimental examination on the load bearing capacity of a seam clamp for the roof covering Craft.Lock of the manufacturer Clotan Steel

Customer:

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1. General information

Subject of the present test report are experimental investigations to determine the load bearing capacity of specific seam clamps for the industrially produced roof covering of the manufacturer Clotan steel with the product name Craft-Lock. The profile is a concealed fix roofing deck with a specific width of 385 mm, which is fixed in the longitudinal joints by fasteners on the supporting structure of the roof (purlins or battens) or on the roof boarding. The profile manufactured by roll forming has different top chord geometries in the middle of the profile and at the longitudinal joints. Since the upper chord does not have a back slope in the middle of the profile, a clamp fastening is not possible. As a result, a seam clamp can only be fixed on the longitudinal joints.

Fig. 1 schematic display of the profile cross section

Fig. 2 isometric display of the seam clamp

Fig. 2 shows the seam clamp for the specific geometry of the Craft.Lock profile. This clamp has two legs, one of which encloses the overlapping area of the profiles and the other one fixing the clamp to the profile joint with the screw tightening, thus creating a force and form locking. Tensile and pressure forces are thus introduced directly into the profile.

Shear forces parallel to the upper chords of the sheet metal resulting from the slope downforce of the solar generator are transmitted by friction. It is thus essential that the screw is tightened with a defined torque of 15 Nm.

2. Experimental Sequence

The testing program for the determination of the load-bearing capacities required for the structural safety verification consists of three test sequences

2.1 Examination of shear force

2.2 Examination of tensile force

2.3 Examination of pressure force

The tests were carried out with a servo-hydraulic testing machine of the manufacturer Zwick Roell with a controlled path feed. The test loads and the corresponding deformations were recorded.

2.1. Examination of shear force

The test arrangement for the shear tests is shown in Fig. 3. The clamp was fixed at a roof section with a torque of 15 Nm. In the testing procedure the seam clamp was pushed parallel to the crown directly above the crown to exclude favorable effects from bending.

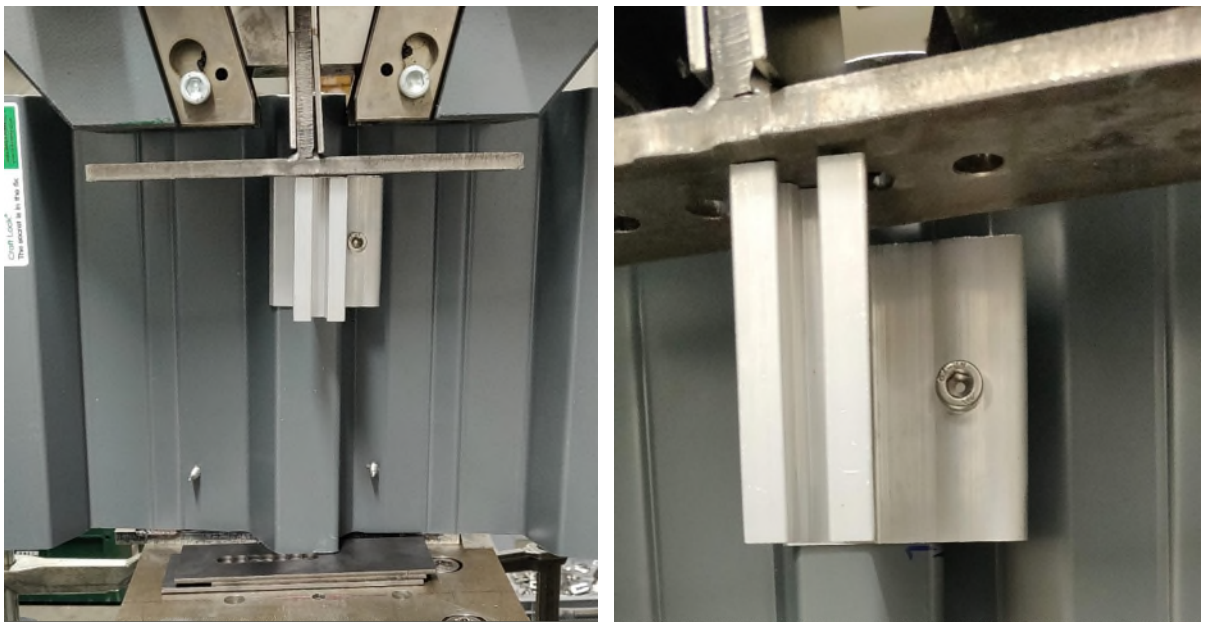
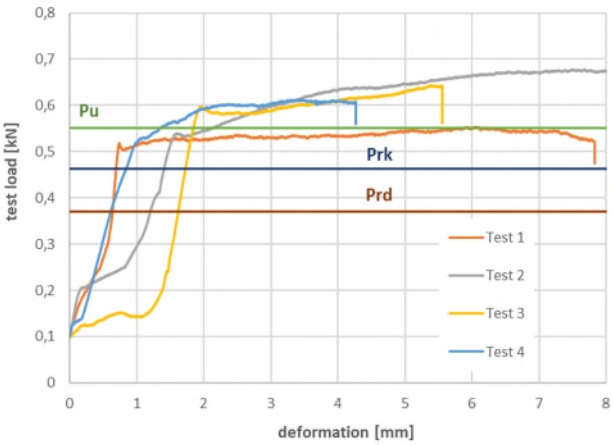


Fig.3 Test set-up for the shear tests

Fig. 4 shows the test records and the results of the statistical evaluation to determine the characteristic load-bearing capacity and the rated value of the load-bearing capacity.



Statistical evaluation according to DIN EN 1990 annex D

		x_i		$\ln x_i$	
S_1	=	0,52	kN	-0,66	0,00390741
S_2	=	0,56	kN	-0,58	0,00019063
S_3	=	0,60	kN	-0,51	0,00746108
S_4	=	0,53	kN	-0,63	0,00141941
average value		**0,55**	**kN**	**sum**	**0,01297853**

m_y	=	-0,60	number of tests	
s_y	=	0,06577367	4	
k_n	=	2,63	α_r	0,800
			β_s	4,700
P_{Rk}	**=**	0,46292607	k	1,645
			v_y	0,066
P_{Rd}	=	0,37034086	γ_M	1,250

Fig. 4 Test records and statistical evaluation of design values of the shear capacity

The measuring curves show a linear increase of the load deformation curves up to the point where the static friction is exceeded. With further feed the process passes into sliding friction, with only a small load increase being possible. The initial shiftings for the tests 2 and 3 result from settlements of the test setup and are not decisive for the test evaluation. The perceptible excess of static friction was selected as evaluation level. The mean value resulting from the 5 tests is P_u = 0,55 kN. Based on a statistical evaluation, the charateristic value of the load bearing capacity P_{Rk} = 0,46 kN was determined. This value represents the 5% fractile. For the verification of the structural safety, a partial safety factor on the resistance side γ_M = 1,25 must be considered. The rated value for the shear strength is derived from the following equation:

$V_{Rd} = V_{Rk} / \gamma_M = 0,46 / 1,25 = 0,37$ kN

2.2. Examination of tensile force

As the tensile strength typically shows significantly less variation than the shear strength, only two tensile tests were carried out to determine the values. Fig. 5 shows the test setup and failure mode and Fig. 6 shows the measuring records. The failure was always due to plastic deformation of the roof profiles in the longitudinal joint.

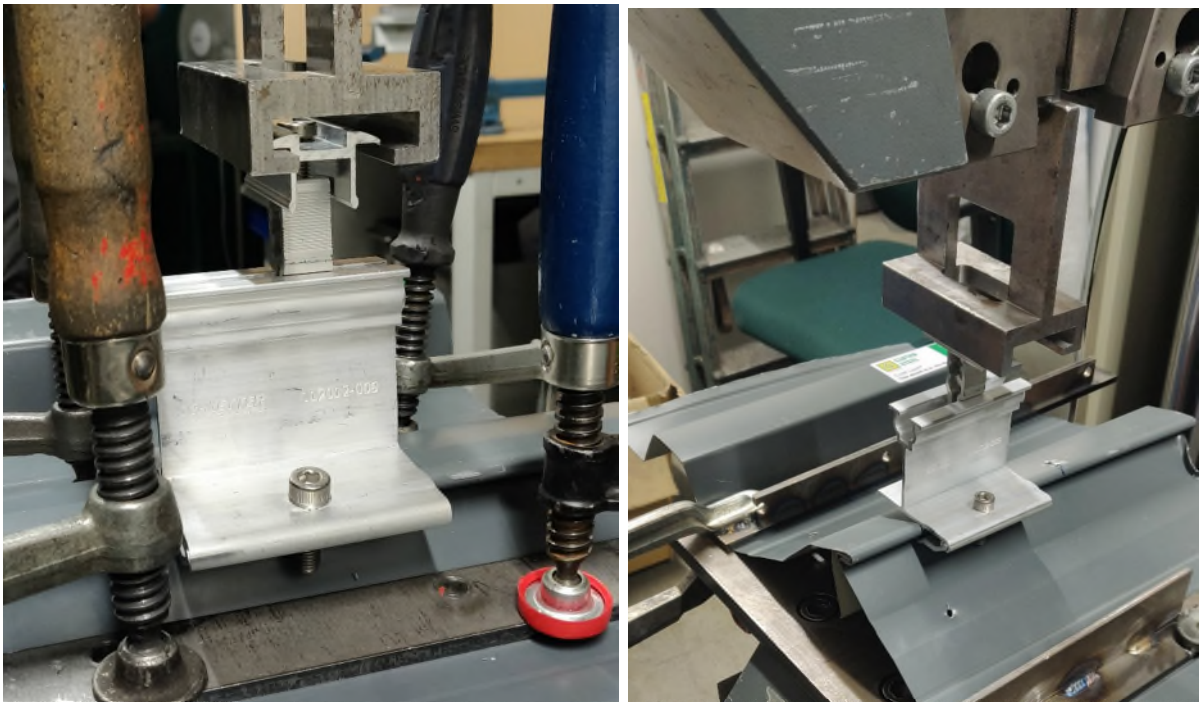
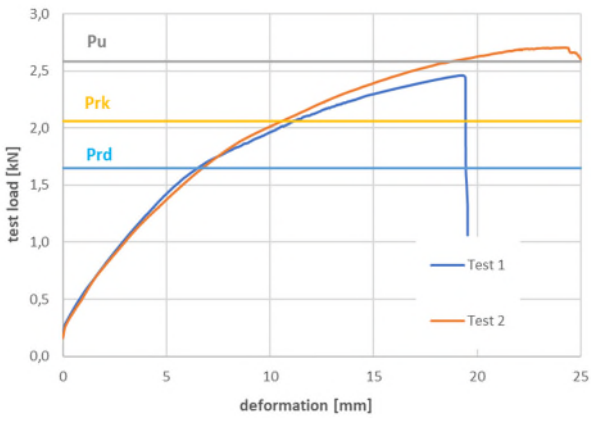


Fig. 5 Test arrangement for the pulling tests and failure mode



Statistical evaluation according to DIN EN 1990 annex D

		x_i		$\ln x_i$	
S_1	=	2,46	kN	0,90	0,00222393
S_2	=	2,70	kN	0,99	0,00222393
average value		**2,58 kN**		**sum**	**0,00444786**

m_y	=	0,95	number of tests		
s_y	=	0,06669226	2		
k_n	=	3,37	α_r	0,800	
			β_s	4,700	
P_{Rk}	**=**	2,06057695	k	1,645	
			v_y	0,067	
P_{Rd}	=	1,64846156	γ_M	1,250	

Fig. 6 Test records and statistical evaluation of design values of the tensile capacity

The average ultimate load was P_u = 2,58 kN. The statistical evaluation with a fractile factor k_n = 3,37, which takes into account the small number of tests, provides a characteristic value for the tensile strength $F_{t,Rk}$ = 1,27 kN. With the partial safety factor γ_M = 1,25 the rated value for the tensile strength is:

$V_{Rd} = V_{Rk} / \gamma_M = 2,06 / 1,25 = 1,65$ kN

2.3 Examination of pressure force

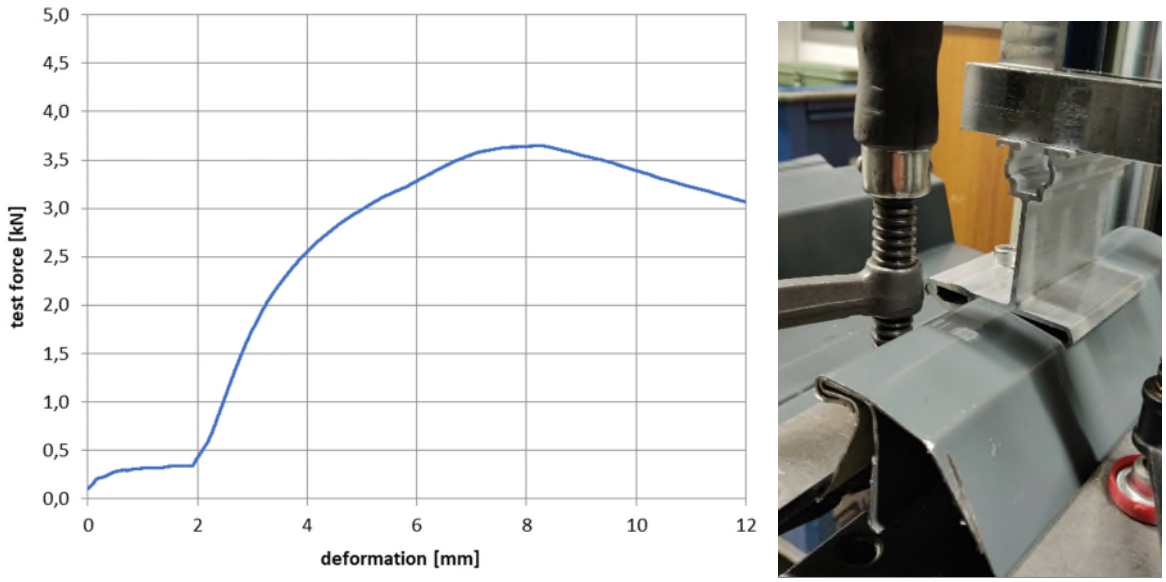


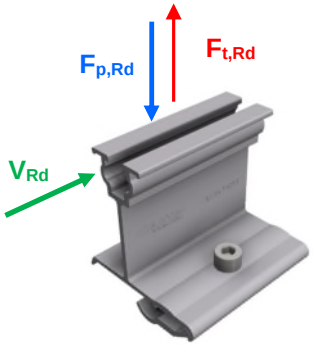
Fig. 6 Test record of the pressure test

Only a single test was carried out as a reference for the compressive strength, as pressure forces are typically not decisive for the verification of the seam clamp. The measuring record shows that the seam only fails at a load of This load level in pressure direction only represents the load bearing capacity of the clamp itself. Usually, the load capacity of the roof is on a much lower level. Thus, the rated value of the load bearing capacity in pressure direction can be limited to $F_{p,Rd}$ = 1,5 kN on the safe side.

3. Summary

The subject of the present test report is the explanation of load-bearing tests to determine the load-bearing capacities of seam clamps for the attachment of solar generators on a concealed fix roofing deck of the manufacturer Clotan Steel with the product designation Craft.Lock. The design values of the load-bearing capacity determined based on statistical evaluations are summarized below:

design value of tensile strength	$F_{t,Rd}$ = 1,65 kN
design value of compressive strength	$F_{p,Rd}$ = 2,00 kN
design value the shear strength	V_{Rd} = 0,37 kN



The verification of the seam clamps does not replace the verification of the roof profiles themselves and their fastening to the supporting structure. These two factors are to be verified by the customer.

Kirchdorf, Dec/09/20