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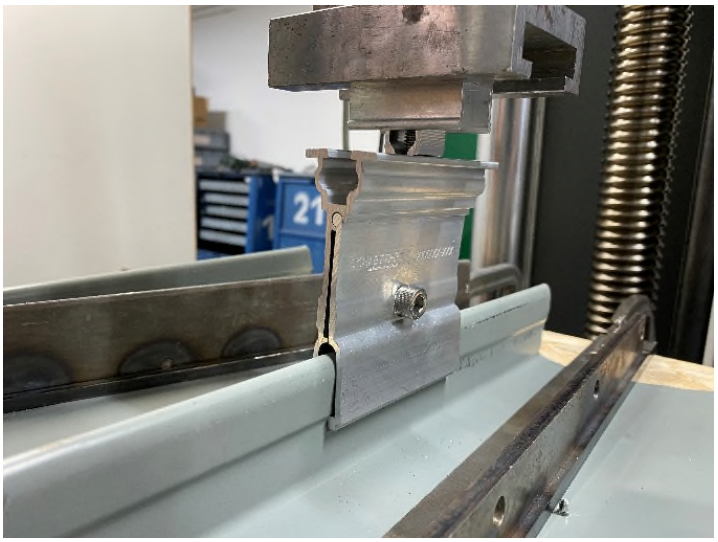
Test documentation 2020-109

Experimental examination on the load bearing capacity of a seam clamp for the roof covering Diamondek



Customer:

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1. General information

The 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 Diamondek. The profile is a concealed steel deck profile with a specific width of 407 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 a specific top chord geometry.

Fig. 1 schematic display of the profile cross section of the concealed steel deck profile Diamondek

Fig. 2 isometric display of the seam clamp

Fig. 2 shows the seam clamp for the specific geometry of the Diamondek profile. This clamp has two legs, which overlap the chord to realize a complete clamping. Tensile and pressure forces are thus introduced directly into the profile. The limiting factor is the weakness of the chord.

Shear forces parallel to the upper chords of the sheet metal resulting from the slope downforce of the solar generator are transmitted by friction. Thus it is 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 set-up 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.

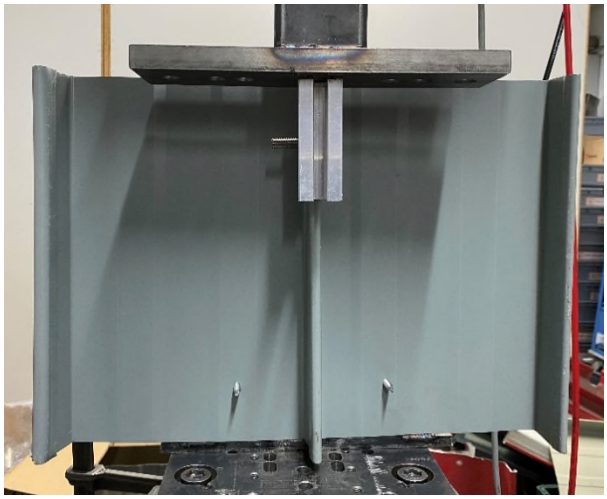
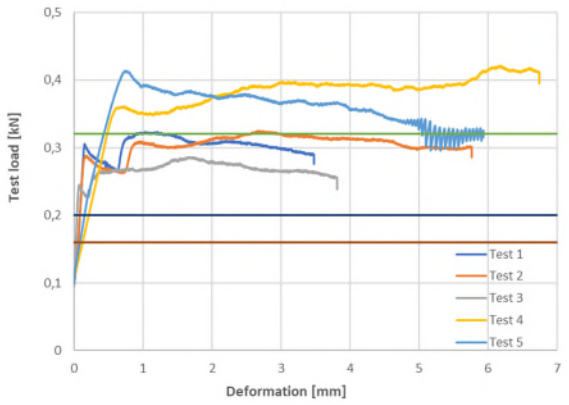


Figure 3 Test set-up for the shear tests

Figure 4 locking effects at the end of the shear tests

Fig. 5 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	=	0,31	kN	-1,17	0,00035016
S_2	=	0,28	kN	-1,27	0,01451909
S_3	=	0,25	kN	-1,39	0,05467360
S_4	=	0,35	kN	-1,05	0,01053669
S_5	=	0,41	kN	-0,88	0,07310706
average value		**0,32**	**kN**	**sum**	**0,15318660**

m_y	=	-1,15	number of tests	
s_y	=	0,1956953		
k_n	=	2,33	α_r	0,800
			β_s	4,700
P_{Rk}	=	0,20019958	k	1,645
			v_y	0,198
P_{Rd}	=	0,16015966	γ_M	1,250

Fig. 5 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 perceptible excess of static friction was selected as evaluation level. The mean value resulting from the 5 tests is P_u = 0,32 kN. Based on a statistical evaluation, the charateristic value of the load bearing capacity P_{Rk} = 0,20 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 design value for the shear strength is derived from the following equation:

$V_{Rd} = V_{Rk} / \gamma_M = 0,2 / 1,25 = 0,16$ kN

2.2. Examination of tensile force

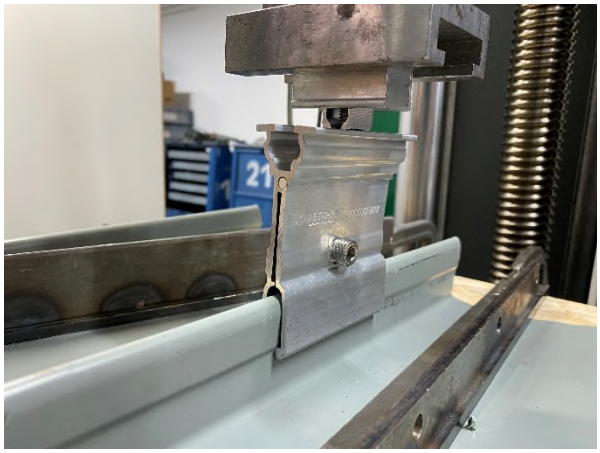


Figure 6 Test set-up for the tension tests

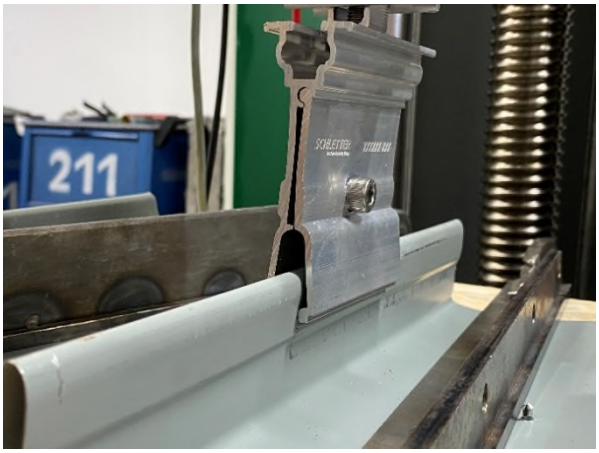
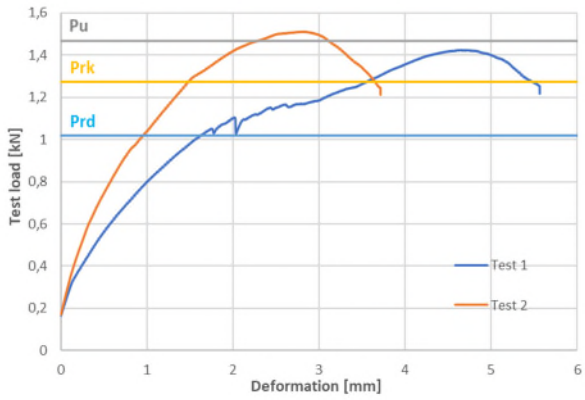


Figure 7 slip of as the observed failure criterion

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. 8 shows the measuring records. The failure was always due to slip of the seam clamp from the chord.



Statistical evaluation according to DIN EN 1990 annex D

		x_i		$\ln x_i$	
S_1	=	1,42	kN	0,35	0,00087648
S_2	=	1,51	kN	0,41	0,00087648
average value		**1,47**	**kN**	**sum**	**0,00175295**

m_y	=	0,38	number of tests	
s_y	=	0,04186828	2	
k_n	=	3,37	α_r	0,800
			β_s	4,700
P_{Rk}	=	1,27336417	k	1,645
			v_y	0,042
P_{Rd}	=	1,01869134	γ_M	1,250

Fig. 8 Test records and statistical evaluation of design values of the shear capacity

The average ultimate load was P_u = 1,47 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:

$V_{Rd} = V_{Rk} / \gamma_M = 1,27 / 1,25 = 1,02$ kN

2.3 Examination of pressure force

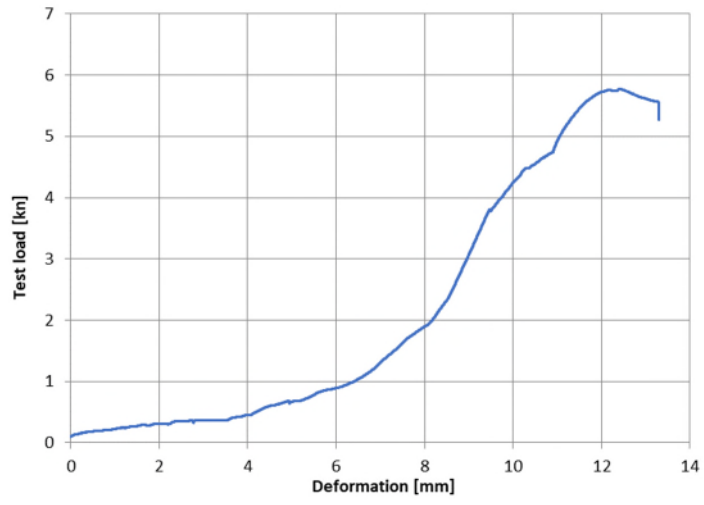


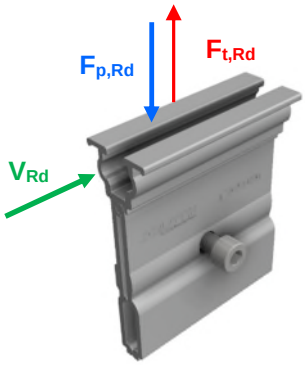
Fig. 9 Test record of the pressure test

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 fails at a load of 5,8 kN. 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 design value of the load bearing capacity in pressure direction can be limited to $F_{p,Rd}$ = 2,5 kN on the safe side.

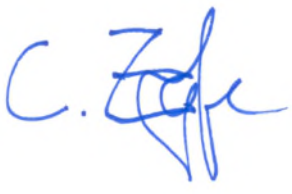
3. Summary

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 sheet deck roof Diamondek. The design values of the load-bearing capacity determined on the basis of statistical evaluations are summarized below:

design value of tensile strength	$F_{t,Rd}$ = 1,00 kN
design value of compressive strength	$F_{p,Rd}$ = 2,50 kN
design value the shear strength	V_{Rd} = 0,16 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/13/20