Fraunhofer IBP

Abstract

Title

Long version title: **„Tragverhalten von Haften in Doppelfalzdächern“**

Occasion / Initial position

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Metal roofs with standing seam are fastened to the substructure by "clamps". Experience values are used to determine the number of clips to be used. In the event of damage, correct execution cannot be proven due to a lack of dimensioning methods. These must be developed urgently! The aim is a validated basis on which a general building authority approval (AbZ/ETA) can be issued.

Subject of the project

Description of Description of work steps and way to solution
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Metal roofs in standing seam design are extremely weather-resistant and durable. They are installed in inclinations of more than 3°. The panels (metal sheet webs) are attached to the substructure with metal brackets, so-called "clamps". The purpose of the clamps is to fix the roof cladding and to transfer the loads to the substructure. They are usually made of stainless steel so that they can be combined with various covering materials (zinc sheet, copper, aluminium, etc.) and fastened to different substrates. For this purpose, the clamps on the substructure (roofing) are usually fixed with grooved nails.

In addition to primary loads due to dead weight, snow pressure and wind suction, shear and tensile loads due to temperature effects, also additional loads (secondary loads) are applied to metal roofs, which originate from additional roof structures such as snow catchers, fall protection devices for persons and building services installations (PV modules, hot water collectors, etc.). All these effects result in multi-axial stress conditions for the individual clamps. Eccentricities are also given by the design of the clamps. Since they must secure the position of the entire roof skin and ensure load transfer, including the secondary roof structures attached to them, it is urgently necessary to have a valid design method for clamps. At present, the number of clips to be used is determined on the basis of the experience of the specialist companies carrying out the work. In the event of damage, it will thus be practically impossible for the executing company to prove the technically correct execution. There is currently a lack of a corresponding design procedure for the design of metal roofs, but also of a valid test and inspection procedure for clamps in order to determine their system-relevant parameters. This project is intended to lay the foundation for both requirements. The objective was to investigate and describe suitable methods for determining the design values of adhesives and to develop design concepts for their use, so that general building authority approvals (AbZ/ETA) are possible on this basis. Such approvals or their application are not part of the project. These must be applied for by the manufacturers of the clamps and carried out at approved test centres. However, the relevant test and examination procedures are available with the project result.

To achieve this, two consecutive steps were necessary. In step 1, suitable test procedures were searched for, determined and adapted as required. On the one hand, selected, commercially available clamp types were tested for their material behavior up to material failure. On the other hand, after knowledge of the failure characteristics of the adhesives, their holding behavior was tested in exemplary, application-relevant situations. For example, the system failure under increasing load (e.g. snow) and increasing tension (e.g. wind suction) was recorded or the material fatigue under continuous suction-pressure changes (continuous oscillation examination) was examined, for which a separate test method had to be developed. For the determination of the stresses and the characteristic design values, fundamental investigation methods were developed. The results derived from this were then transferred in step 2 into a testing and design system which enables planners to provide proof of structural safety. From this, it is now possible to derive constructive specifications for the clamps and its integration into the roof skin as well as its connection to the substructure.

Conclusion

Description of planned objectives and results achieved
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Up to now, it has not been possible to prove roof structures (e.g. snow guard devices, solar systems, etc.) mounted on a metal roof with seam clamps using current knowledge. With the successfully implemented goals of defining test procedures for clamps and thus developing a verification procedure, it is now possible to determine load capacities and design values, which can be incorporated into technical rules and used as a basis for general building authority approvals (AbZ/ETA). This makes it possible to design metal roofs and in particular the roof structures attached to them.

Key figures

Short title:	TraHaDo
Researcher/Project leader:	Andreas Kaufmann (IBP)
	Prof. Jörn Lass (TH Rosenheim) Florian Hess (IBP)
Total costs:	119.145,95 €
Share of federal grant:	83.145,95 €
External funds:	36.000,00 €
Project duration:	12 months (requested), 21 months (cost-neutral extension)

Zukunft Bau

PICTURES / FIGURES

5 - 7 Printable image data as a separate file (.tif, *.bmp,...) with a resolution of at least 300 dpi in the image size (e.g. width 10 - 20 cm). Images free of rights of third parties.*
Picture credits in each case:

Fig. 1: fig 1 - bond with stress.png
Schematic representation of a fixed bond with principal stress situation.

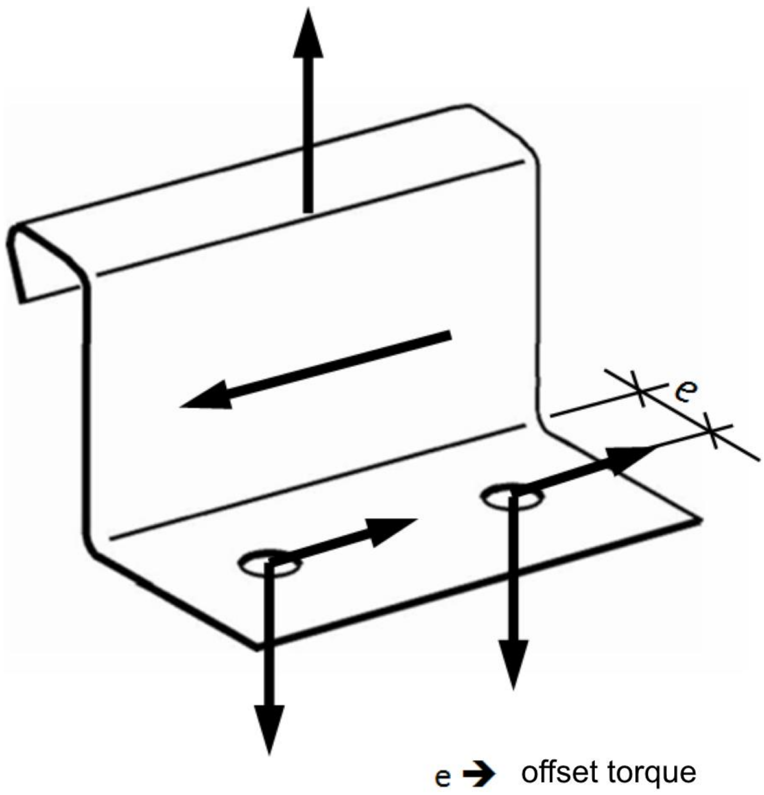
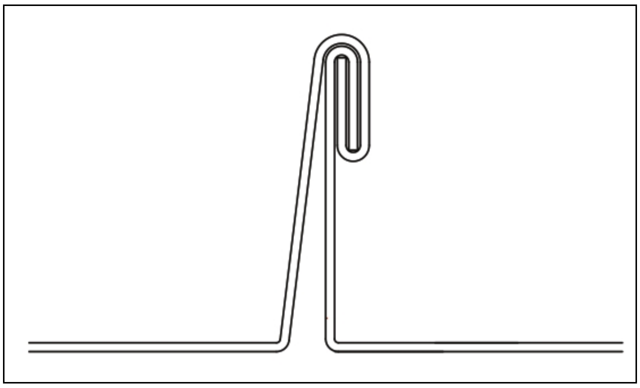
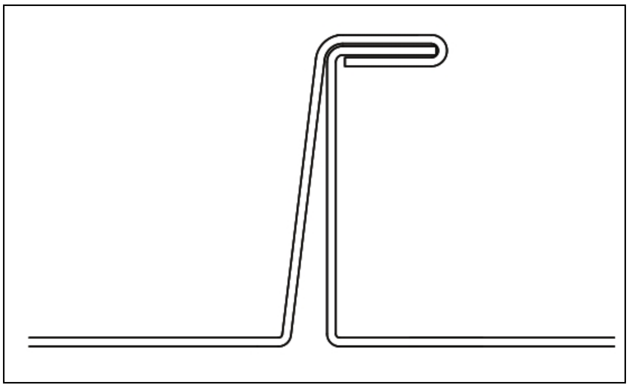


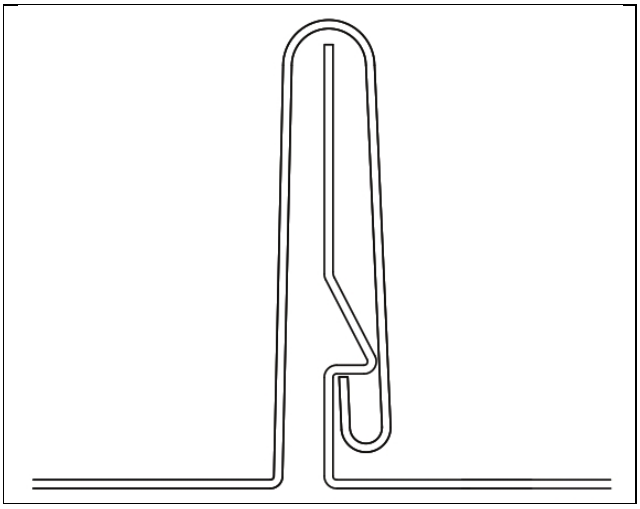
Fig. 2: fig 2 - clamp-seams.docx
Principal characteristics of standing seams.



Double standing seam



Angled standing seam



Snap-in seam

Fig. 3: fig 3 - test machine for pull tests.jpg
Structure of the testing machine for tensile tests.

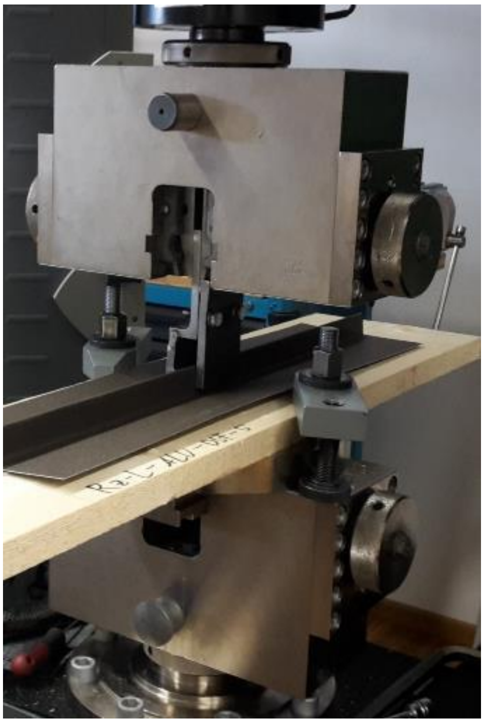


Fig. 4: fig 4 - pull test clamp
Pull-out test with traction engine.

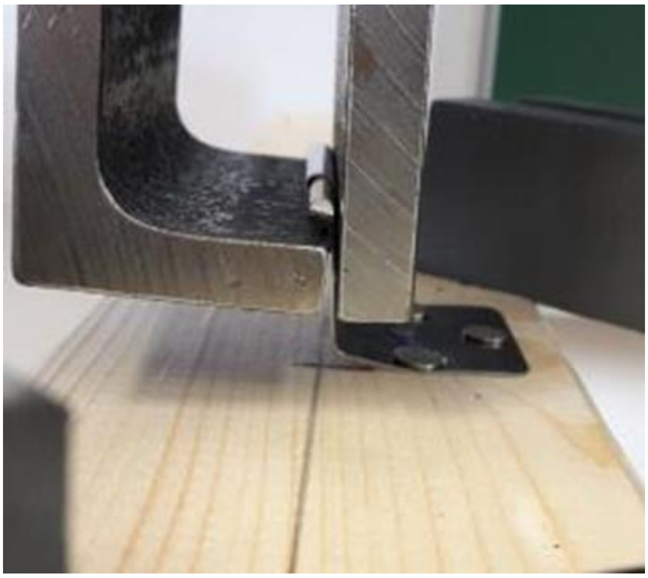


Fig. 5: fig 5 – failure pattern wind suction test.jpg
Investigation of the most unfavorable load situation with maxi-mal clamp distance. Failure pattern.