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ABSTRACT

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Transfer of horizontal loads by means of trapezoidal sheeting

Horizontal wind forces acting on an attic lead to considerable reaction forces at the upper level the roofing of the roofing made of trapezoidal sheeting. Generally, no rails are provided (especially for liner tray walls) or even possible here. But it is possible to introduce the horizontal forces into the crest of the adjacent sheeting of the roof. Thus, they are loaded with a line load transversely to the direction of span.
A comparable problem arises with forces from roof thrust from the outer layer of double-layer roof structures (fixed point at the roof ridge). An outer layer of standing seam profiles attached to crests of the inner layer of trapezoidal sheeting at discrete points is a typical example. In this case, additional transverse bending moments occur.
For double-layer roof structures, these loads in the roof level lead to an additional load of the inner layer made of trapezoidal sheeting and in a loading condition for which no calculation approach is available.
Within the scope of this research program, tests as well as calculations were performed using the method of finite elements for the determination of the load-bearing and deformation behavior of trapezoidal sheeting under a horizontal load. The investigations can be summarized as follows:

- Because of the introduction of the load into the crest, displacements arise in the direction of the load (sway of frame) as well as perpendicular to the roof. The latter displacements result from torsion of the sheeting. The displacements and torsions can be limited through coupling of the crests.
- The problem regarding torsion of the sheeting gets worse when introducing the forces with a lever arm, for example when introducing forces from roof thrust from the outer layer. In this case, the coupling of six or more crests does not result in justifiably small displacements. In fact, the developing moment must be transferred by vertical forces perpendicular to the roof.
- The coupling of crests should have a significant bending stiffness to be also effective under compression load. Plain sheets do not fulfill these requirements. U- or L-sections are to be preferred, despite the problems with embedding them into the roof structure.
- The connections have to be designed for additional tension and shear forces.
- The webs have to be designed against web crippling for the additional support forces.
- For multi-span systems, the support actions at the intermediate supports have to be increased corresponding to the static system of a multi-span beam.

Generally, the introduction of horizontal loads at the longitudinal edge of roof fields cannot be recommended without hesitation since there is the risk that the roof system is damaged due to deformations and, for example, leakages occur directly behind the attic. Especially for those applications for which forces from roof thrust are to be introduced from the outer layer, it must be feared that the outer layer is damaged (for example pull-out of halters from the seam) due to deformations of the supporting trapezoidal sheeting.

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