Within the building of greenhouses I have been busy with constructive improvements (R&D). I did tests to improve the interconnection between gutter and handle and I did tests to improve the console that connects the gutter with the supports. The gutter is for rainwater drainage and the handle is the aluminum profile that connects the ridge with the gutter. Glass can slide into this handle. Due to the fact that greenhouses have to commit with NEN construction standards, stronger connections will bring weight savings in the delivered aluminum extrusion products.



Above you see a cross section of something more as half of a part of the roof of a greenhouse. The greenhouse consists of several roofs next to each other. During glazing a part of the roof next to this roof in above picture is not glazed jet. Due to the high weight of the glass the gutter in above picture will be bent outward (see black arrow in above picture). Due to this bending there is less space to place the glass on the next roof. Due to this the gutter needs to have a high horizontal bending stiffness. If we can connect the gutter with the supports in a stiffer way the outward bending of the gutter will be lowered. The console connects the gutter with the supports (see red hatched part in above picture). This console is about 20 centimeters long and is secured with the gutter with two or more pop rivets. The console is bolted on the supports. This console is not stiff because not much material is oriented in the direction of the force (black arrow in above picture). I tested new kinds of consoles. The best new design (see underneath picture) did bent out 8 times less compared with the old console. Also the rotation of the gutter was lowered with a factor 5. So this new console lowers the bending and rotation of the gutter. If we accept the same amount of bending with the new console the gutter can be made less stiff. This means a weight reduction of the gutter. Also the cover plate welded on top of the supports is not necessary anymore.



The new console consists of two steel or aluminium plates that can be connected to the gutter by rotating both plates and connecting the plates with a screw. The red plates in the drawing are made of RVS and not of the softer aluminium because we want a very stiff connection. With this new console the bending of the gutter between two supports is lowered by 100%. Due to this the bending strength of the gutter can be lowered by 100%. This means a weight reduction. Also no top cover plate has to be welded on the supports.

I also did tests on the connection between gutter and handle. With this test the handle was pulled out of the gutter. TNO (Dutch company) does these tests in the same way to confirm with NEN construction standards. During my tests some design errors came up (see underneath picture). When we look at the cross section of the handle we see an extra material thickness at the top of the cross section. The aim of this extra material was to strengthen the connection between gutters and handle. The handle has to be adapted to connect with the gutter (see dotted blue line at the left of this drawing). Due to this saw treatment the thickening is cut through. The thickening should be placed in a lower position. In the cross section drawing we can also see a bend in the handle. During tests of breaking the connection between handle and gutter I saw that this bend causes the breakdown of this connection. See the drawing below.



The two handles at the left of underneath picture failed from the bend in the handle. Just by connecting both sidewalls of the handle (connect the sidewalls exactly where the bend is) with a screw or pop rivet collapsing force was raised from 100 to 200 kilo's (1 kilo is 10 Newton force). Due to this, not the handle is the weak part but the gutter. Off course no screw or pop rivet is necessary to stabilize the side walls of the handle. Just by adjusting the extrusion die we can add some extra material just were the bend is in the handle. This extra wall (see above cross section of the handle) will also stabilize the bend in the handle. Underneath you see a picture of three handles after the tests. The two handles on the right did collapse due to the bend in the cross section of the handle. By using a pop rivet this collapse mechanism is excluded. That is why collapsing will than take place at a higher force and another failure mechanism.



By application of the new console and the improvements in the design of the handle it can be possible to make the gutter and handle thinner. A weight reduction of about 10 until 15% is possible. Due to the fact that aluminum is very expensive the profit of this firm could raise from 5 to 10%.