Geosynthetics - 7th ICG - Delmas, Gourc & Girard (eds) © 2002 Swets & Zeitlinger, Lisse ISBN 90 5809 523 1

Development of a new junction strength tester for quality control on laser welded geogrids

J.M. ELIAS, Colbond Geosynthetics, Arnhem, The Netherlands

ABSTRACT: With the introduction of a new type of geogrid produced with laser technolgoy, several established test methods are not possible to use. One of those test methods is the junction strength method which is used for quality control procedures. This paper describes the development of a new junction strength tester. The current junction strength test GRI-GG-2 gave inaccurate results with large variances and was not a proper test for the quality control of the laser welded geogrids. By trial-and-error a new junction test clamp is developed. Currently, this clamp is being used for quality control procedures within Colbond Geosynthetics.

1 INTRODUCTION

In 1999 Colbond Geosynthetics introduced Enkagrid, a laser welded geogrid with rigid junctions (Figure 1). By using transparent and black extruded polymer bars, the laser heats up the black bar while at the same moment the transparent bar is being pushed onto the welded area of the black bar. The black polymer melts together with the transparent polymer creating a grid structure for soil reinforcement purposes. Two transparent bars are welded to one back bar (one on the top and one at the bottom). For quality control reasons the junctions need to be tested during the production process. In 1999 only one junction test existed and described in the GRI-GG-2 standard [GRI, 2000]. This test has been designed for extruded geogrids in 1987.

Although the standard has been developed for manufacturing quality control purposes of a geogrid junction, the standard is regularly being misused for specification work. Over the years no relation of the junction test standard to the performance of a geogrid has been found. This resulted in deleting the prEN ISO 13426-3 standard [CEN/TC189/WG3, 2000] (Determination of the strength of structural junctions – Part 3: Geogrids) from the working program of CEN/TC189 in 2000 because of technical irrelevance.

In spite of the above semi-commercial discussions, Colbond still had to perform manufacturing quality control on the rigid laser welded junctions. Since the existing GG-2 test device (Figure 2) was based on extruded geogrids, an extended search for a new laser weld junction tester had to be done.

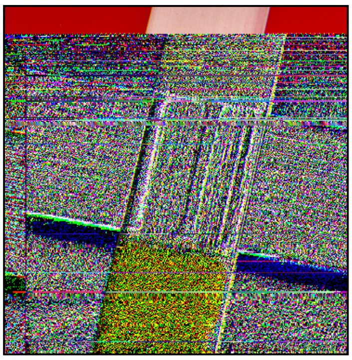

Figure 1. Laser welded junction

2 CRITERIA FOR A NEW JUNCTION TESTER

Criteria were needed to be set to which a new junction tester for the laser welded geogrids should apply. Based on the existing GG-2 junction test method, the following three criteria were the basis for further development.

1. Junction strength should be based on in-plane shear stresses only

Only by in-plane shear stress the total welded area can be fully tested. No other stresses like peal stresses should be developed as this causes peak stresses on one part of the junction without fully utilising the total welded area.

2. No normal pressure should be on the junction during the test

Although a normal pressure models the behaviour of the earth-pressure in a soil-reinforced structure, adding a normal force to the junction will cause scattered results. The test is for quality control purposes only so no relation to real-practise is needed.

3. Ease of use of the tester for the production operators

Since this test is used for on-line production control only it should be easy to use by the production operators. Therefore, no difficult actions have to be done before, during and after the test. The test should be executed quickly because of efficiency.

3 EXISTING GRI GG2 - JUNCTION CLAMP

In house tests have been executed during the development of the laser welded geogrid with the existing GG-2 tester (Figure 2). Bolts are used to clamp the 2 transverse bars. During the test, movement of the transverse bars was noticed in the clamping system due to poor clamping. This movement resulted in peak-stresses at the edges of the welded area resulting in large variations of the junction strength. Since laser technology was selected to precisely weld the junction for consistent quality, these large variations of the junction test results were not acceptable so that further development on the junction tester was needed. The average result of the GG-2 junction test was used as the baseline for this development.

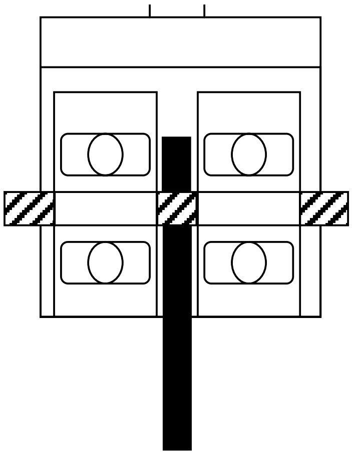

Figure 2. GRI-GG-2 junction test clamp

4 RESEARCH STEPS TOWARDS A NEW JUNCTION TESTER

4.1 Clamp 1

In 1999 a junction clamp was produced to clamp the transverse bars without influencing the junctions (Figure 3). A spacer was used between the transverse bars to increase the clamping of the longitudinal bars. The distance between the clamping mechanism and the longitudinal bar was fixed to 10 mm. Due to this large spacing the junction moved during the test resulting again in large variations.

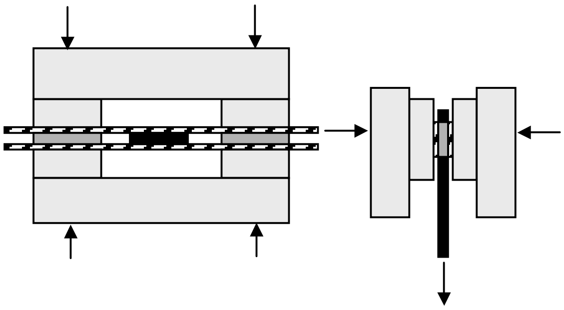

Figure 3. Clamp 1

4.2 Clamp 2

Instead of having a fixed spacing of 10 mm, a new tool was designed in which the parts of the clamp could be moved towards the longitudinal bar so that minimum spacing was left (Figure 4). A minimum spacing was needed so that the welded junction was not influenced by the clamps.

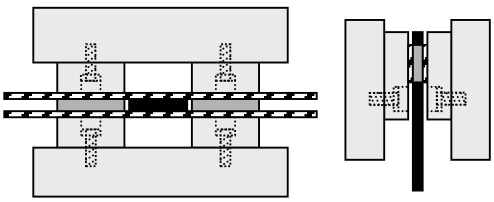

Figure 4. Clamp 2

Still the use of Clamp 2 for production quality control was difficult due to the extra spacer and the moveable parts of the clamp.

4.3 Clamp 3

Research led toward a new set-up of the clamp without moveable parts and creating an increase in the ease of testing (Figure 5). The new clamp was like a hook were the junction was placed so that the transverse bars were supported vertically. Only a minimum distance to the longitudinal strap was used. Unfortunately, during the junction tests the transverse bars moved resulting in unintended peak stresses at the edge of the welded area, leading again to test results with a high variation.

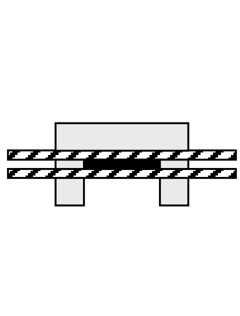

Figure 5. Clamp 3

4.4 Clamp 4

To take out the movement of the transverse bars, a new tool was developed to fix the transverse bars by a stamp and a bolt (Figure 6). This fixation was done manually by screwing the bolt. Next to the junction the transverse bars were supported by the clamp to take out the vertical movement of these bars. Besides that this clamp was not user-friendly it was also not clear if the transverse straps were really fixed or not. The manual fixation was not a reliable parameter for this type of test.

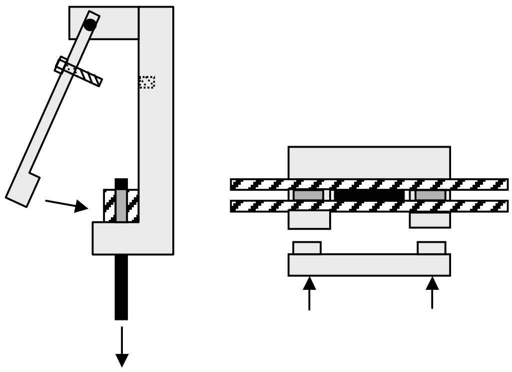

Figure 6. Clamp 4

4.5 Clamp 5

Instead of using manual fixation of a bolt, a new tool was developed where the bolt was replaced by a mechanical device with springs to build the pressure on the transparent bars for fixation. After a few tests this device broke down due to the sensitivity of the material.

4.6 Reassessment of the results so far

In spite of all the trials and different clamping techniques it was, till now, not possible to have consistent results. Also, for production control it was not possible to use moving parts like in clamp 2 and 4. With the experiences of the last 5 clamps and the GG-2-clamp the behavior of the junction during the test was examined again.

The assessment let to the conclusion that the horizontal movement of the junction itself, including the transverse bars, caused the large variation in the test results. Already with a small movement of the junction during the test, peak stresses appear resulting in an increase of variance in the test results. Therefore, the horizontal movements of the junction during the test needed to be controlled.

4.7 Clamp 6

With the above conclusion clamp 6 was developed (Figure 7). The junction was horizontally kept in place but vertical displacements were allowed. To eliminate the horizontal movements a perfect fit between the junction and the clamp was needed. This resulted that only one clamp could test one type of geogrid. The clamp was very simple and an operator had to place the longitudinal bar in a small opening and the transverse bars in a groove.

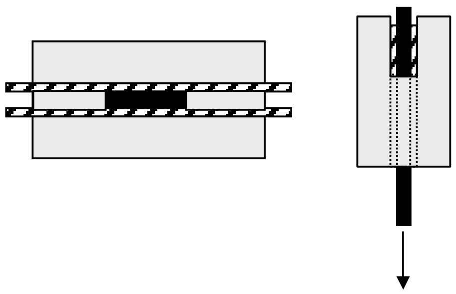

Figure 7. Clamp 6

After testing clamp 6 it appeared that the vertical displacement caused the junction to be clamped itself tight in the opening for the longitudinal bar. This resulted in too high results and large variations.

4.8 Clamp 7

The final step was to eliminate the vertical displacements as well (Figure 8). A small adjustment to clamp 6 resulted in a supporting ridge underneath the transverse bar at the junction. With this ridge it is now possible to create a perfect junction strength test where the total welded area on both sides is tested on in-plane shear stress. This test device gives production a better insight in the quality of the welded junctions. An other important issue is that this test method is very easy to execute. From early 2001 it is being used as an index test for production quality control. Because of the perfect fit there is one specific clamp for every laser welded geogrid type .

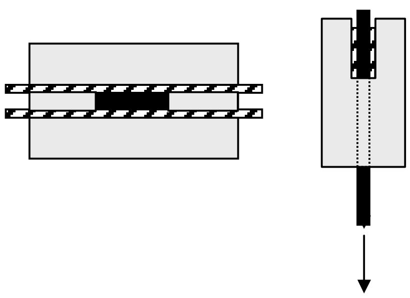

Figure 8. Clamp 7

4.9 Future developments: Clamp 8

To introduce the new clamping technique to testing institutes a specific clamp will be developed which can test all 8 different types. This clamp will be a combination of clamp 2 and clamp 7. Clamp 8 will have moveable parts and a supporting edge underneath the transverse bars. By moving the sides of the clamp towards the longitudinal bar, the clamp can follow the shape of the longitudinal bar dimensions.

5 CONCLUSION

To perform quality control on junctions of the laser welded geogrid a new junction test clamp has been developed. The clamp tests the welded area on in-plane shear stress only and is used by the production operators. To reduce peak stresses on all of the welded area, the horizontal and vertical movement had to be eliminated. By trial-and-error and continuous developments in new clamping techniques (Figure 9), a new junction tester has been developed which is currently in use for quality control measurements of the laser welded geogrid (Figure 8). Since the clamp is made for a perfect fit of the grid, each geogrid type has its own junction clamp. At this moment a new clamp is being developed so that all laser welded grid types can be tested with one clamp.

Figure 9. Overview of all the trial-testers

REFERENCES

GRI, ,2000, 'Individual Geogrid Junction Strength', Test Method GG2

CEN TC 189, 2000, WG 3'Determination of the strength of structural junctions – Part 3: Geogrids', prEN ISO 13426-3 (rejected)