Development of new connection systems between facing block and geogrid

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ABSTRACT: The use of geogrid-reinforced earth wall technologies has progressed rapidly over the past 10 years in Korea because these technologies have advantages such as economical efficiency, graceful appearance, and easy construction. The geogrid used in the reinforced earth wall with concrete block facing can be subjected to damage among the upper and lower blocks and at the interface between the block and the geogrid. Therefore, when design of the geogrid-reinforced earth walls the required connection strength of the geogrid to the wall facing is an issue. In this study, new connection system between facing block and geogrid is developed to improve the damages of geogrid in the existing connection systems. The new connection devices are made of steel and have I-shape. This paper describes the test method and results of the laboratory testing for determination of connection strength in connection system using the I-type connection device.

1 INTRODUCTION

The use of geogrid-reinforced earth wall technologies has progressed rapidly over the past 10 years in Korea because these technologies have advantages such as economical efficiency, graceful appearance and easy construction.

For conventional geogrid-reinforced earth wall, geogrid reinforcement is placed among the upper and lower block with shear key or shear pin. Geogrids used in the reinforced earth wall with concrete block facing can be subjected to damage among the upper and lower blocks and the interface between the block and the geogrid as shown in figure 1(Han et al., 2009). Therefore, the required connection strength of the geogrid to the wall facing is an issue in design of the geogrid-reinforced earth walls(Shin et al., 2005).

In this study, the connection system between facing block and geogrid, which economical efficiency is similar to the existing one and, moreover, which is more stabilized than existing one, is developed. This paper describes the test method and results of the laboratory testing for determination of connection strength in the new connection systems.

2 DEVELOPMENT OF NEW CONNECTION SYSTEM

The connection strength in existing connection systems depends on frictional force between facing blocks and geogrid since the geogrid reinforcement is placed among the upper and lower blocks. The new connection system was developed to improve the problems in the existing connection systems. Figure 2 shows the new connection device. Although the shape of the connection device looks like 'T', it is called 'I-type connection device' due to the fact that one side of connection device is united with facing block and the other side is connected to geogrid. The facing block is developed to increase the connection efficiency as shown in Figure 3. The developed connection devices are installed between blocks and geogrid by mechanical process on field. The connection strength of geogrid can be increased because the connected part of geogrid is produced larger than the united part of facing block.

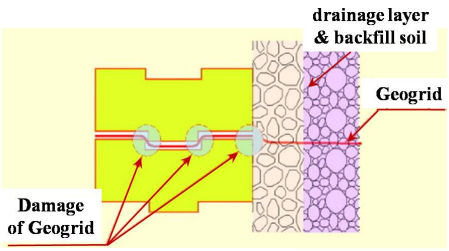
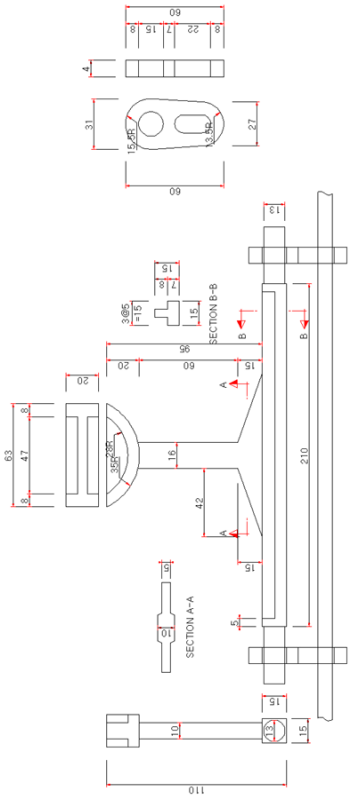


Figure 1. Damage parts of geogrid

The I-type connection system using the developed connection device can have advantages such as prevention of geogrid damage and reduction(about 700mm) of geogrid quantity. It can protect a damage of geogrid against ground settlement behind the wall



(a) Drawing of I-type connection device

(b) Front view of I-type connection device

Figure 2. Developed the I-type connection device

Figure 3. Front view of the developed facing block

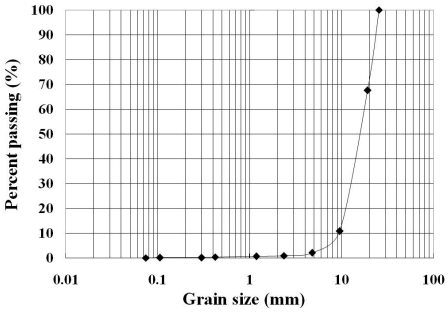


Figure 4. Grain size distribution curve of the crushed granite

because the connection part between blocks and geogrid is able to do simultaneous settlement of I-type connection device and drainage layer behind the wall.

3 CONNECTION STRENGTH TEST

The connection strength test was conducted to evaluate connection strength of I-type connection system based on the design guidelines specified by NCMA(Collin, 1997).

3.1 *Characteristic of materials*

3.1.1 *Facing block and filling soil*

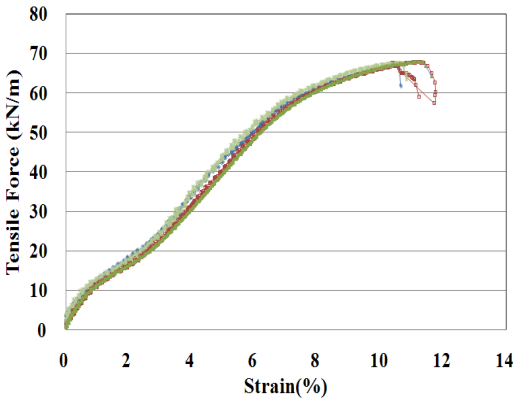
The facing block is made of concrete; its absorption ratio and compressive strength are less than 8% and more than 21MPa, respectively. The facing block with various colors enables graceful appearance to be designed. In order to fixed decline of reinforced earth wall, the upper and lower surfaces of block have shear key and groove, respectively.

The used fill material on the connection strength test consists of the crushed granite, which is used widely to the drainage material of reinforced earth wall. The soil classification by USCS is identified as well-graded gravel. Figure 4 shows grain size distribution curve.

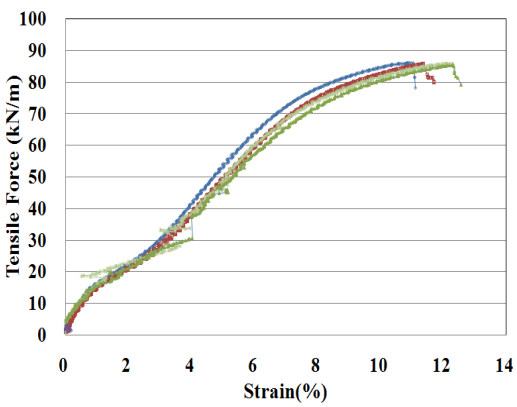
3.1.2 *Engineering property of geogrid*

The geogrids using connection strength test are made of the polyester yarn of high strength coated with polypropylene. The tensile strength of geogrids is in 60kN/m and 80kN/m in the connection strength test.

The tensile characteristics of the geogrids were determined by the wide width tensile test method that is specified by ISO 10319. Figure 4 shows the results. Two kinds of geogrid could be confirmed in higher than about 7.3%~13.2% in the tensile



(a) Tensile strength: 60kN



(b) Tensile strength: 80kN

Figure 5. Results of the wide width tensile test

strength of product standard; It means that the extra safety factor was contained as much as 7.3%~13.2%. The strains of geogrids were confirmed in a range of 10.9%~11.7% as shown in figure 5.

3.2 *Connection strength apparatus and test procedure*

To evaluate connection strength of I-type connection system, a apparatus is manufactured with soil box in a size of 1.6m(B)×1.0m(L)×1.1m(H), which is the result from considering that I-type connection device is buried at the drainage layer behind the facing block on field and the block size is larger than the existing block. The apparatus can be used to evaluate friction characteristic as shown in figure 6. The apparatus consists of soil box, pullout clamp, shear clamp and so on. The geogrid is possible pullout freely because the behind of soil box has slit in 2cm. The procedure of connection strength test is as follows(Figure 7);

(a) Set of facing block and crushed granite
(b) Cut of geogrid sample; 1m in length and Connect between facing block and geogrid using the I-type connection device
(c) Filling of crushed granite in the upper
(d) Set of clamp and LVDT
(e) Loading of vertical load; 10, 20, 40, 60, and 80 KN/m
(f) Pullout of geogrid and the end of test

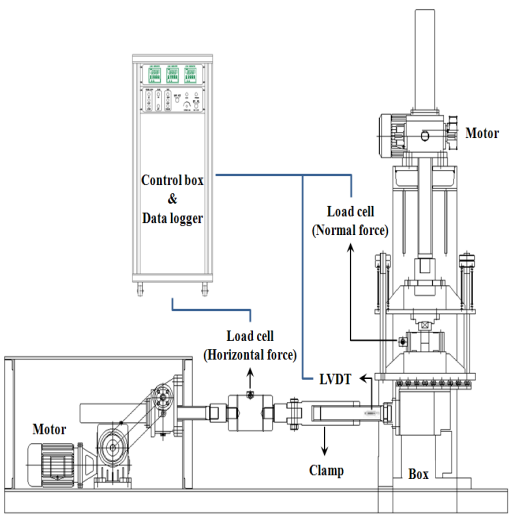


Figure 6. Drawing of connection strength apparatus

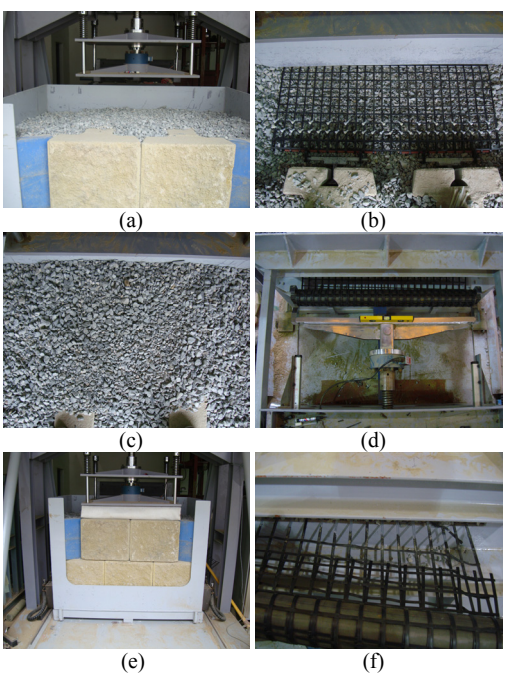
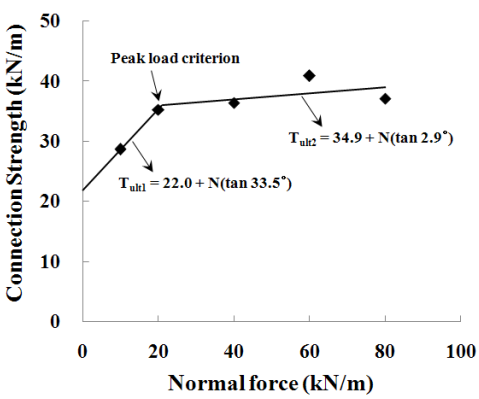


Figure 7. The procedure of connection strength test

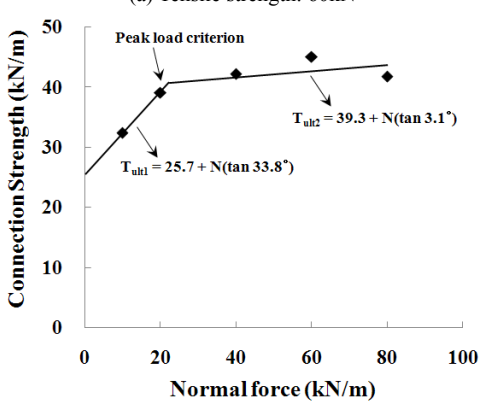
3.3 *Test results*

The connection strength of existing connection system is affected by vertical load because the geogrid located between upper and lower block. In other words, the connection strength is increased according to increasing of vertical load, and then it is fixed since ultimate vertical load. The reason is that the existing connection systems depend on friction characteristic between blocks and geogrid.

The test results confirmed that I-type connection system was not directly affected by vertical load, as shown in figure 8. The ultimate connection strength of 60kN and 80kN were confirmed in a range of 35.3kN/m~40.9kN/m and 39.1kN/m~45.0kN/m, respectively when vertical load was 20, 40, 60, and 80kN/m; there were similar to each value except that vertical load was 10kN/m. Therefore, it confirmed that I-type connection system had the ultimate connection strength of 55% and 49% comparing with the wide width tensile strength.



(a) Tensile strength: 60kN



(b) Tensile strength: 80kN

Figure 8. Results of connection strength test

4 CONCLUSIONS

The laboratory tests were conducted to confirm the connection strength characteristic of I-type connection system, which was developed to prevent from damage of geogrid at the connected part between geogrid and facing blocks. The quantity of geogrid by I-type connection system could be reduced about 700mm on the field construction.

The results of connection strength test indicated that I-type connection system had the ultimate connection strength of 55% and 49% comparing with the wide width tensile strength. Therefore, it confirmed that I-type connection system would be able to apply in the construction of reinforced earth wall.

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