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Technical report – Testing and materials session

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ABSTRACT: For the TESTING and MATERIALS SESSION of IS Kyushu 2001 32 papers have been accepted. Eight of these papers have been selected for oral presentation in the conference program. The other papers have been presented in the well attended evening poster sessions. Discussion took place during poster session straight with the authors but the discussion session after the oral presentation allowed to reflect and discuss all papers and items.

The SESSION was dealing with the main topics:

- partial factors of safety for the design strength
- soil and reinforcement interaction
- reinforcing by mixing soil and fibres
- special items like Geotubes, Anchors or Grouting

Some key information presented to the main topics are (oral presentations are indicated by numbers 2.1 to 2.8):

Partial factors of safety for the design strength:

- long-term creep test experience for PET yarns for about 12 years residual strength not decreased significantly, modulus increased, verified method to calculate time to rupture from creep tests (Voskamp, 2.6)
- the factor of safety for the long-term strength should apply to the loss of strength during service time and not on the residual strength residual strength important, when temporary "overloads" are possible (Segrestin)
- partial factors vary with time and strain level, they should be applied differently over design life (Khan)
- method to model the load-strain-time-temperature behaviour of geosynthetic reinforcements under combined sustained and seismic loading introduction of a short term loading factor, actual tests are not in-soil for seismic loading, the full characteristic strength is available also after long times.
  (Kupec, Greenwood, 2.8)
- field tests with flexible geogrid (PVC coated PET grid) installation damage depends on grain size distribution, angularity, lift thickness
  (Hsieb/Linn)

Soil and reinforcement interaction

- x-ray computed tomography (CT) method used at reinforced sand (d = 125 mm, h = 340 mm, pull-out, geogrid and geomembrane)
  (Otani)
- new geogrid with welded flat bars
  Isocronous Strain Energy (ISE) approach is used for characterisation
  (Heerten/McGown)
  the advantage in geogrid-soil-interaction of the high modulus, stiff new geogrid is shown in pull-out test and model, test of steep slopes
  (Heerten/Floss, 2.7)
- shear tests with organic silty clay
  (Salehi, 2.3)
- inclined plane test
  application of the CEN-standards, friction angle found by inclined plane (IPT) lower than by direct shear test (DST) IPT too conservative for loads on horizontal interfaces use IPT for load

conditions on slopes
(Cancelli, 2.4)

- triaxial test (d = 100 mm, h = 200 mm) with unreinforced and reinforced (with non woven geotextile) soil
prediction charts are given for strength of reinforced soil and coefficient of interface friction
(Mofiz)

- effectiveness of a geogrid reinforcement within a subbase;
pushing (statically) a cone through a soil layer on top of a geogrid lying on the subgrade until a certain deformation is reached
(Baslik)

- pull-out tests
long-term tests with geogrid in clay using static and dynamic (0,1 Hz and 0,5 Hz) tensile loads, creep strain higher for static than for cyclic load
(Pamuk)
test with different model geogrids:
same horizontal surface area (but different shape of longitudinal/transverse members), stiffness and thickness leads to same friction angle, but different apparent cohesion, displacement and strain distribution stiff geogrid shows small pull-out displacement, soft geogrid needs large one, stiffness essential at the beginning of pullout test
(Izawa)

- progressive pullout failure
analytical approach by finite difference analysis (FLAC)
higher mobilisation with increasing geosynthetic stiffness and decreasing length of box soil stiffness, from wall roughness and sleeve design have minimum effect on mobilisation
(Mak/Lo, 2.5)

Soil reinforced by mixing

- mixture of soil with pieces of different plastic waste (model tests and analyses, 48 mm)
(Omine)

- mixture of lateritic soils with jute fibres (optimal 0,4 % by weight of dry soil, 20 mm, 30 mm)
(Kumar)

- mixture of cement mixed clay and sand with fibres (raw material is not mentioned!. 24 mm, static and dynamic triaxial tests)
(Yasuda, 2.2)

- mixture of clay and sand with short nylon and polypropylene fibres (effects of fibre's length 5 mm to 160 mm, diameter, roughness)
(Makiuchi)

- mixture or stabilised volcanic cohesive soil with short polyester fibres (15 mm, 30 mm)
(Kudo)

- mixture of fly ash with short polyester fibres (6 mm, 20 mm)
(Kaniraj)

- clay-cement mix with reinforcing fibres for diaphragm walls (4,6 and 12 mm, raw material PVA, homogeneous mixture, increased amount of workability agent, no breaking of the material, no continuous cracks)
(Bucher/Brinkmann, 2.1)

Geotubes

- construction and monitoring of geotubes laboratory and field tests, woven geotextile
(Shin)

Anchors

- using wired rope anchors instead of steel rod anchors
resistance against pulling was higher in case of rope
(Fujimura)

Grouting

- grout injection in the laboratory (sand)
(Dano)

In the discussion session only one written question/comment was received by S. Kaniraj dealing with definitions of fibre and stabiliser content and related specimen conditions by soil / fibre / cement mixtures.

To stimulate discussion the following discussion topics were brought to the attention of the audience:

1. How to test for damage during installation
   - in the field?
   - in the lab?

2. How to translate soil / fibre mixtures from lab to practice in the field?

3. Can x-ray technique help to better understand soil/reinforcement interaction even in the field – e. g. to study inhomogenities of dif-

ferent reinforced soil layers from bottom to top of the structure?

4. Some trust on steel reinforcement – other trust on geosynthetics - can we not relay on both, using the appropriate design tools?

5. Will the ISE approach improve the understanding of material specific behaviour of synthetic reinforcing products? A new and better design tool?

To 1.) Discussion showed that there are still big problems to investigate damage during installation in the lab. Field test often are giving a better understanding and more reliable results.

To 3.) Otani explained his x-ray investigations as starting point of a challenging new method to show and interpret the soil / reinforcement interaction.

To 5.) J. Kupec gave his personal view of the Isochronous Strain Energy approach developed by A. McGown at Strathclyde University. This method being a real step forward in understanding the special and different behaviour of individuell reinforcing products. The method needs time for be widely excepted by the engineering community.