THE IMPORTANCE OF GEOGRID MODULUS

Whenever a biaxial geogrid is proposed at the base of an embankment or at the base of a road or railway structure, among the various characteristics that can be measured through index tests, it is important to evaluate and identify the geogrid characteristics that are crucial for design.

Generally speaking these characteristics can be summarized as follows:

- Geogrid modulus
- Geogrid junction resistance
- Direction of the geogrid strength
- Resistance to compaction damage
- Interaction with the soil

The peak tensile strength is a value that is commonly measured to identify and compare products, but it has no relevance in design. This is due to many reasons:

1. **At the peak tensile value a geogrid usually develops strain values that are not compatible with the stability of a structure.**
   Let's assume a geogrid is laid at the base of a railway embankment 30m wide. If we decide to carry out a design using the peak tensile strength of a geogrid, this means we are accepting a strain equal to at least 10%. This would be equivalent to a geogrid deformation of 3m. Therefore, the new railway base extends from 30 to 33m which means that in the middle we are accepting a settlement equal to $[(33/2)^2-15^2]^{1/2}$ = 6.87m...! This value is clearly not realistic in practice.

2. **At the peak tensile value the creep behaviour of the geogrid would not create safe structures.**
   When dealing with plastic materials, the creep behaviour corresponding to peak tensile strength values are very high. Therefore, structures cannot be designed safely.

In common practice, in ground stabilisation the parameter used to define the effectiveness of a product is the **modulus** at low strains, usually at **2% strain**, or sometimes even at smaller strains.

At these lower value strains, viscous type phenomena ('creep') do not occur, even if the strain is applied for a relatively long time. As BS 8006-1995 states:

"...the stability of an embankment on soft soil is most critical during construction. This is because the relatively low permeability of the soft foundation does not permit full consolidation in the normal time scale of construction. At the end of construction the embankment loading has been applied, but the gain in shearing resistance of the foundation due to consolidation may be insufficient for stability. Once consolidation has occurred, the resulting improvement in shearing resistance in the foundation will usually remove the need for the reinforcement to improve stability. Thus, during the period between the end of construction and consolidation of the foundation, the fundamental strength requirement of the reinforcement is that at any instant in time the factored reinforcement design strength equals or exceeds the design load..."

Following this approach, designing with an allowable state of stress corresponding to a 2% strain is then a safe and correct design value to use.

Hence, the correct value to use during design and when comparing products is the 'design tensile strength at 2% strain'.

Peak tensile strength is not relevant for design purposes, and it should not be included in tender specification documents as this could lead to the selection of an inappropriate products leading to catastrophic failures.
Having the possibility to choose, a geogrid with a higher resistance at low strain even if with a lower resistance at peak is far better than a geogrid with a higher peak value but a lower strength at low strains.

Reference:

BS 8006: 2010: "Code of practice for Strengthened reinforced soils and other fills"

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