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ORIGINAL ARTICLE

Roughness's shapes comparative analysis of some reinforced earth elements under monotonous loading

Mohamed Khemissa *, **Smail Safer, Saâd Aidjouli**

Geomaterials Development Laboratory, Civil Engineering Department, Faculty of Technology, Mohamed Boudiaf University, M'sila 28000, Algeria

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Abstract This paper presents and analyzes the experimental and numerical results of a series of pullout tests under monotonous loading performed on five steel strips presenting various forms of roughness (smooth, ribbed, punched, W-shaped, chain) and embedded in the same dry sand massif constituting the backfill. The pullout tests were conducted by means of a small-scale model and the calculations carried out by using a finite elements computer program. Obtained results show a good agreement between the experimental and numerical data. They show in addition that the rough strips are more advantageous than the smooth strip. Among the rough strips considered, chain is most relevant.

1. Introduction

Essential purpose of the reinforcing of geotechnical structures (cuts, backfills, earth dams, etc.) is to ensure, in one way or another, the improvement of the bearing capacity of constitutive material and/or the limitation of the deformations, which can undergo under the working loads. Reinforced earth technique is the typical example. This technique, invented and patented by Vidal [1], has been the subject of many theoretical and experimental studies on small-scale and large-scale models [2–11]. It becomes increasingly regulated current practice [12], particularly in the road and motorway constructions (retaining walls, abutments of bridges). But, the operation mechanism of the composite material which is based on association between the soil massif and the reinforcement system (steel strips, geotextiles, etc.) is not yet well-known. For a soil of given geotechnical characteristics, reinforcement using rough steel strips is better felt than reinforcement using smooth steel strips. However, the performance of the steel strips is being influenced by their form, dimension and roughness's disposition.

This paper has the aim of studying the behavior under monotonous loading of five steel reinforcing soil elements presenting various roughness shapes (smooth, ribbed, punched, W-shaped, chain) and embedded in the same dry sand massif constituting the backfill. It aims in addition at comparing the performances of the ones compared to the others opposite to the pulling loads to which they are subjected. The followed experimental approach and the numerical simulation carried

* Corresponding author.
E-mail address: khemissa@univ-msila.dz (M. Khemissa).

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out are described summarily. The corresponding experimental and numerical results are also presented and analyzed.

2. Experimental approach

The experimental data presented hereafter are based on a series of pullout tests performed under monotonous loading by means of a small-scale model constituting the experimental device (Fig. 1) on five steel strips presenting various roughness forms (Fig. 2) and embedded in the same dry sand massif constituting the backfill [13].

Experimental device is composed of the following elements:

- a rigid metallic container with its internal dimensions of 100 cm long by 30 cm wide by 30 cm high, which is provided with a lid interdependent to a pneumatic tire tube ensuring a uniform distribution of the vertical overload applied on the top of the sand backfill;
- a hopper made up of a funnel resting on rail for filling of the container with a sand of density gauged by adjustment of its pluviation elevation;
- a loading system made up of a counterweight fixed to a lever arm for the monotonous loadings and of an electrical engine provided with a revolution counter for the repetitive loadings;
- a measurement system using weights for the loading and a sensitive dial gauge for the displacements.

This device makes it possible to subject a steel strip embedded in a sand massif of given geotechnical characteristics to pullout forces under monotonous or repeated loadings.

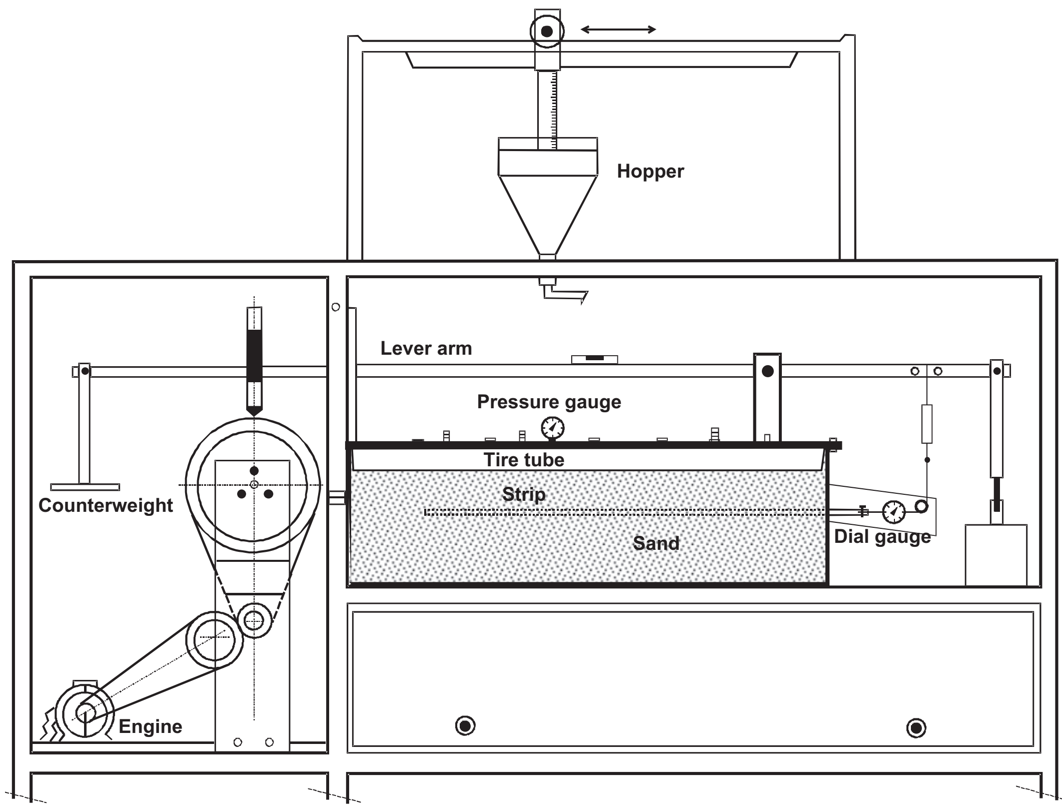

Figure 1 Schematic section of the pullout test apparatus under monotonous and repeated loadings.

Figure 2 View of the five considered steel strips.