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Experimental study of the mechanical behaviour of double twisted steel mesh gabions

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Abstract

The study of the mechanical behaviour of gabion elements is a fundamental prerequisite for an improved understanding about the overall mechanical performance of retaining structures realized using this construction technique. The paper discusses the first part of a wide experimental research program. The current article is limited to the description of the modalities to define a comprehensive experimental campaign, which involves both compression and direct shear tests. The testing matrix is designed considering several variables related to the two main components of the basic constructive element, steel cage and filling material respectively. The setup of instruments and the testing procedure are also discussed in the paper.

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Keywords: Experimental test; gabion; double twisted steel mesh; retaining structures

1. Introduction

The use of double twisted mesh gabions is a well-established technical solution for the construction of retaining structures. Nevertheless, despite the wide diffusion of this methodology, the knowledge on the overall mechanical behaviour of gabion elements is rather limited. Only a small number of studies focused on the structural behaviour of a single gabion are available [1-4]. Other studies deal with specific aspects or discuss topics only partially related to

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the final scope of this investigation [5-8]. On the other hand, the main part of the researches are focused on the understanding of the overall structural behaviour of retaining gabion structures [9-13]. Furthermore, although the gabion is a composed element (containing cage and filling material), the influence of each component on the overall performance is almost not assessable, especially in terms of deformation.

The current research aims at deeply understanding the contribution of each element to the final mechanical behaviour. The paper discusses the first part of a wide experimental research and the modalities to design a comprehensive testing program are presented. An in-depth description of the parameters mainly influencing the mechanical behaviour of gabion elements under different loading conditions are also addressed. The considered variables are related to both the containing element (gabion) and the filling material (stones). Furthermore, different loading and boundary conditions are planned: compression tests in unconfined and confined conditions, shear tests on single gabions and sliding tests on two superimposed elements. Finally, the paper deals with the testing layout and the setup of instruments, thus completing the description of the research. The experimental campaign will be started in the next period, then the test results will be presented in future papers.

2. Aims and methods

The aim of this study is the understanding of the mechanical behaviour of a gabion, considered as a constituting element of a whole retaining structure. This investigation will be carried out through a comprehensive experimental campaign. The overall mechanical response of a specimen is influenced by several parameters, hence they are considered for the definition of the testing matrix. Taking into account the constituents of a specimen, the main variables can be subdivided into two groups: the steel cage (gabion) and the filling material (stones). The full list of considered parameters is presented in Table 1. In this light, the current research aims at evaluating the capacity of each variable in influencing the overall behaviour, thus leading also to a consequent optimization of materials. The full testing matrix is composed considering all the variables listed in the following.

Table 1. List of main considered parameters.

Steel Cage	**Filling Material**
Gabion Typology	Nature of filling material
Mesh dimension	Shape
Wire diameter	Mean dimension
Mesh direction	Physical characteristics
Presence of bracings	Mechanical characteristics
Edge closure method	Filling methodology

2.1. Steel cage

The gabion typology shall consider the two main product categories, namely woven and welded gabions. Both groups are included in this experimental study.

The considered mesh sizes are 6×8, 8×10 and 10×12 in the case of woven mesh, where the first number identifies the width “M” (Fig. 1a) expressed in centimeters. Furthermore, the gabions are normally realized using different wire diameters, namely 2.7 mm or 3.0 mm. In addition to these measures, the 3.9 mm wire diameter is usually adopted to realize the so called “strong face gabions”, which are characterized by the external side of the cage having the larger diameter. This feature allows for the out-of-plane deformations of a retaining structure to be limited. A further variable related to the mesh considers its orientation, depending on the production methodology. The cage can be realized either with vertical or horizontal mesh orientation (Fig. 1b). This is mainly due to the design and installation criteria of a retaining structure and this is mainly influencing its deformation capacity.

The second relevant case considered in this study is the welded gabion. The most commonly adopted dimensions are 100 mm × 100 mm and 50 mm × 100 mm, as horizontal and vertical measures of the mesh respectively. Two bar diameters are usually adopted for welded mesh gabions, namely 4.0 mm and 5.0 mm.