Some effects of fiber addition on the behavior of clean sands under cyclic loadings

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1 Introduction

Studies about Soil improvement and their different techniques are gaining importance, in some cases due the need for use of existing materials. In other cases, the infrastructure expansion processes make it unfeasible the use of conventional techniques of foundations construction.

In this field, the effects derived by inclusion of fibers with several origins have motivated an increasing number of studies, which in some cases have led to isolate its mechanical effects, mainly in statically conditions (Consoli, Casagrande, & Coop, 2005; Diambra, 2010). However, the comprehension in this field when the material is subjected to cyclic regimens of loading still remains less understood. Some studies are trying to identify this issues (Festugato, Consoli, & Fourie, 2015; Festugato, 2011; M. H. Maher & Ho, 1993; Mohamad H. Maher & Woods, 1990).

This study aims to study the effect of polypropylene fiber addition on the response of a sand, when subjected to cyclic loadings.

2 Experimental program

The experimental program (in process) considers two different materials: (a) Uniform quartzitic sand (Osorio sand) from southern Brazil, and (b) polypropylene fibers, with length 50 mm and diameter 0,1 mm. The specimens were prepared by moist tamping in three layers, following the process described by Ladd (1978), until they reached a high of 20 cm and diameter of 10 cm. The failure of specimen was obtained in every cases, which was obtained when the pore pressure reaches a value of 10 kPa or less.

The specimens tested were subjected to load controlled cyclic triaxial test in undrained conditions according to ASTM D5311, frequency of 0.1 Hz, an initial effective confining pressure of 100 kPa, and deviator stresses varying between ±20 and ±60 kPa.

The shear strength parameters was obtained in monotonic CD triaxial tests, considering effective confining pressures of 20, 100 and 200 kPa.

3 Results

Molding, test conditions and results are summarized in Table 1

Table 1. Molding, test conditions and maximum number of cycles

Void ratio	σ_D (kPa)	Frequency (Hz)	Loading path	p'_0	N_f	
					0,5% fiber	No-fiber
0.75	± 20	0.1	Sinusoidal	100	635	234
0.75	± 40				14	6
0.75	± 60				3	1

The behavior of the sand, with and without fiber addition, is represented in Figure 1.

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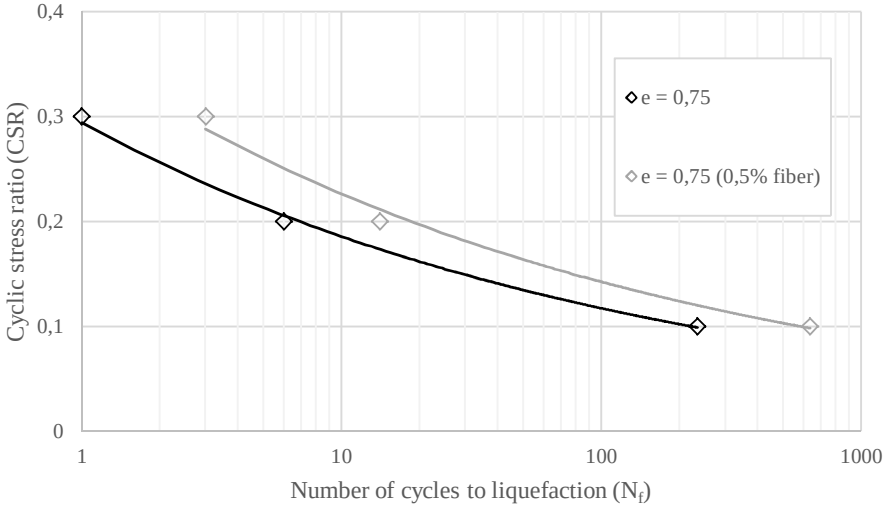

Figure 1. Maximum number of cycles obtained for each deviator stress condition

4 Conclusions

Fiber addition generated, in all cases, a better material performance when subjected to cyclic loadings. This situation is not limited to the maximum number of loading cycles resisted by the material, as well to the conservation of elasticity modulus and the control of the permanent deformation increase during test.

The effect due to fiber addition in the control of permanent deformation as well the pore pressure increase, even in compression conditions, confirms the study carried out by Consoli et al (2005) in isotropic compression. This last study was made using the same materials that were used in the present work

References

Consoli, N. C., Casagrande, M. D. T., & Coop, M. R. (2005). Effect of Fiber Reinforcement on the Isotropic Compression Behavior of a Sand. *Journal of Geotechnical and Geoenvironmental Engineering*. http://doi.org/10.1061/(ASCE)1090-0241(2005)131:11(1434)

Diambra, A. (2010). *Fibre reinforced sands: Experiments and constitutive modelling* (Dissertation (Doctor of Philosophy)). University of Bristol, Bristol.

Festugato, L. (2011). *Comportamento de hidratação e resposta cisalhante cíclica de resíduo de mineração cimentado feforçado com fibras* (Tese (Doutorado em Engenharia)). Programa de Pós-Graduação em Engenharia Civil, Universidade Federal do Rio Grande do Sul, Porto Alegre.

Festugato, L., Consoli, N. C., & Fourie, A. (2015). Cyclic shear behaviour of fibre-reinforced mine tailings. *Geosynthetics International*, *22*(2), 196–206. http://doi.org/10.1680/gein.15.00005

Ladd, R. S. (1978). Preparing Test Specimens Using Undercompaction. *Geotechnical Testing Journal*, *1*(1), 16–23. http://doi.org/10.1520/GTJ10364J

Maher, M. H., & Ho, Y. C. (1993). Behavior of Fiber-Reinforced Cemented Sand Under Static and Cyclic Loads. *Geotechnical Testing Journal*. http://doi.org/10.1520/GTJ10054J

Maher, M. H., & Woods, R. D. (1990). Dynamic Response of Sand Reinforced with Randomly Distributed Fibers. *Journal of Geotechnical Engineering*, *116*(7), 1116–1131. http://doi.org/10.1061/(ASCE)0733-9410(1990)116:7(1116)