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

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Introduction

- Fiber adding for improve the mechanical behavior of soils;
- Characterization of positive effects under static loading conditions;
- Possibility of using this technique for ground improvement in cyclic loading situations:
  - Wind generators;
  - Seismic events;
  - Tidal effects;
- Limited knowledge about the behavior of these material that conditions.

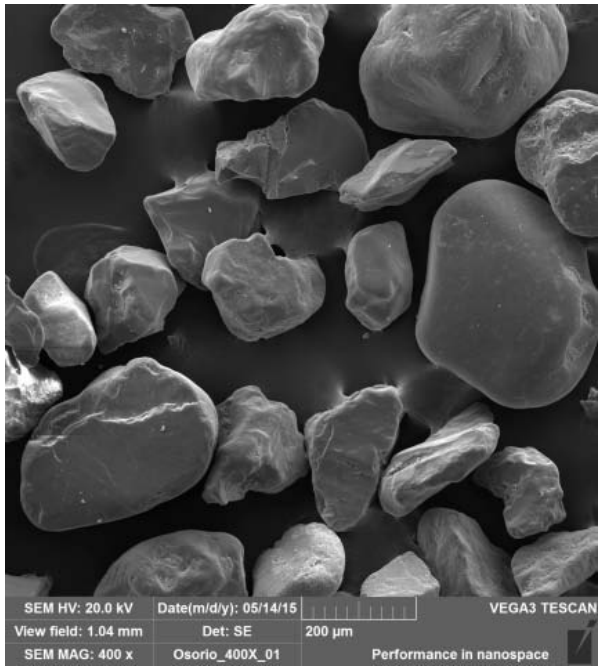
Objective

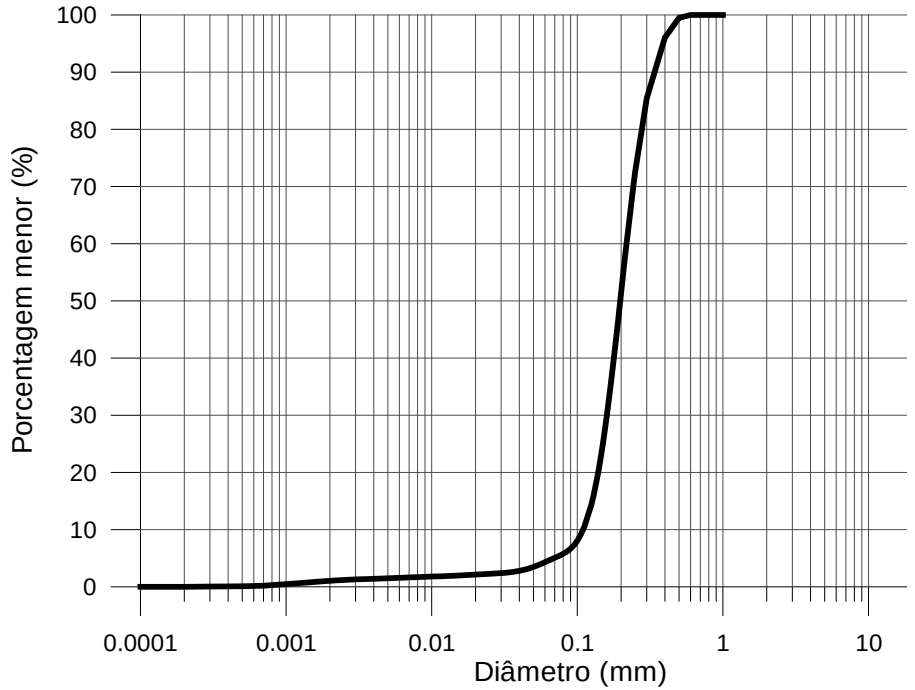
- Evaluate the effect of fiber addition in a sand, when submeted to monotonic and cyclic loading, in two conditions: no fiber and, with 0.5% of fiber in weight. To study the effect of compaction, the sand samples were tested in two different void ratio.

Materials

1. Sand - Source: Osorio, Southern Brazil

Index	Value
g_s	26,2 kN/m³
C_u	2,0
C_c	1,1
D_{10}	0,11 mm
D_{50}	0,20 mm
e_{min}	0,6
e_{max}	0,9





Materials

2. Fiber: Polypropilene

- Diameter: 0,1 mm
- Length: 50 mm
- Density: 0,91
- Secant modulus: 10 GPa
- Tensile Strength: 200 MPa

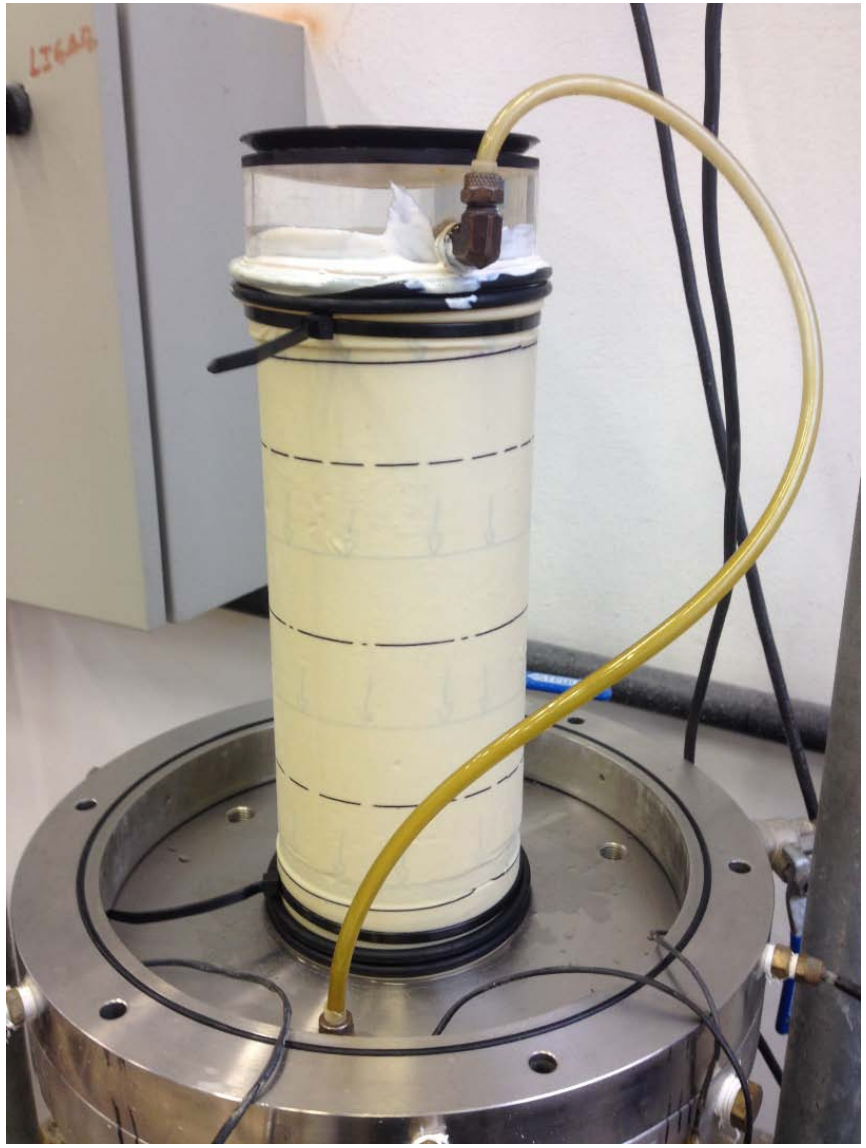
- Distilled water

Experimental program

- Monotonic Triaxial tests (CD)
  - Fiber: 0,5 % (constant)
  - Water: 10 % (constant)
  - Effective confining pressures: 20, 100 and 200 kPa
  - Number of tests: 6
- Cyclic Triaxial tests (CU)
  - Fiber: 0,5 % (constant)
  - Water: 10 % (constant)
  - Effective initial confining pressure: 100 kPa
  - Number of tests: 12
  - Frequency: 0.1 Hz
  - Loading path: Sinusoidal
  - Deviatoric stresses: ±20 to ±100 kPa

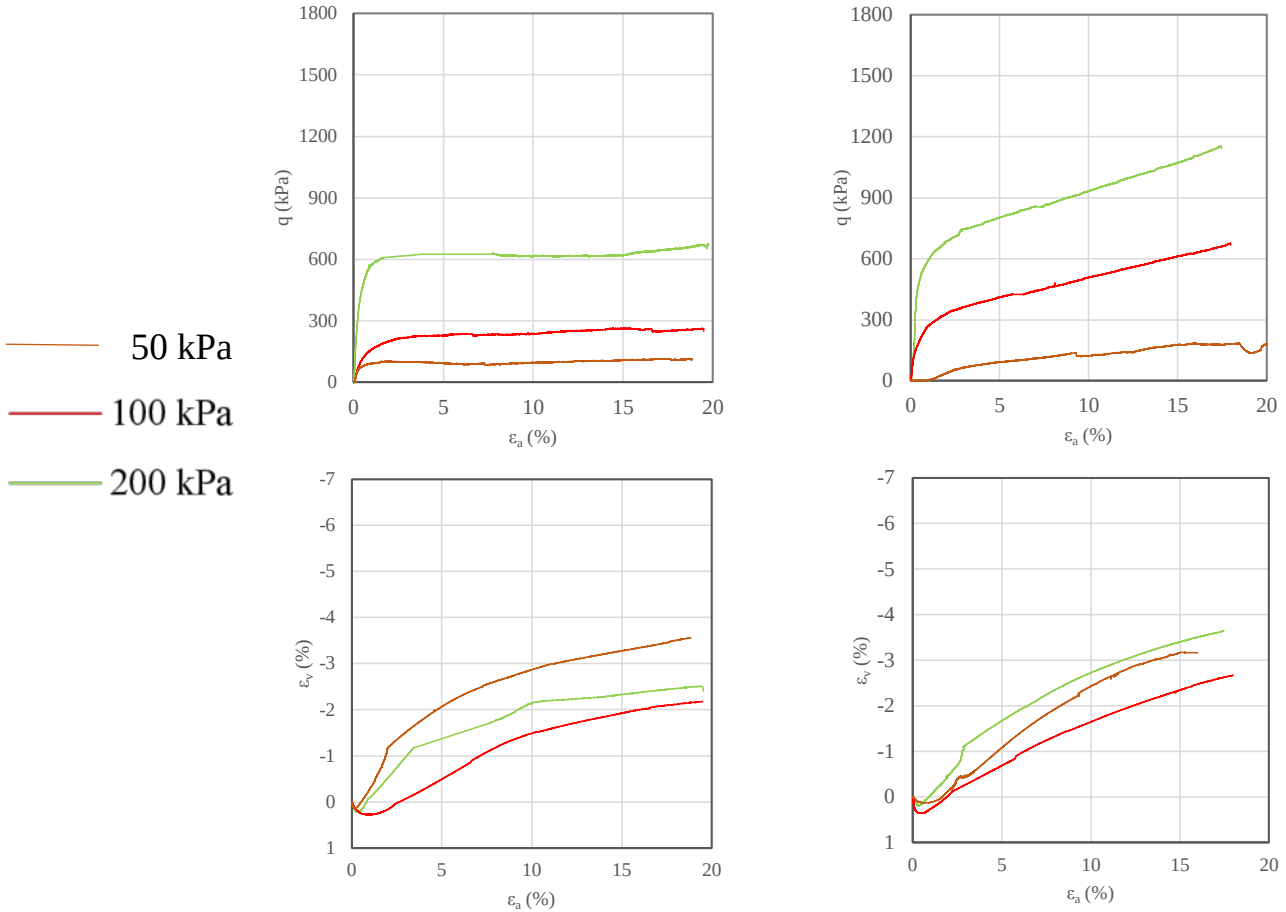
Molding conditions

- Sand — Water – Fiber
- Moist tamping (3 layer)
- Sample size:
  - Diameter = 10 cm
  - Height = 20 cm
- Moisture content: 10%

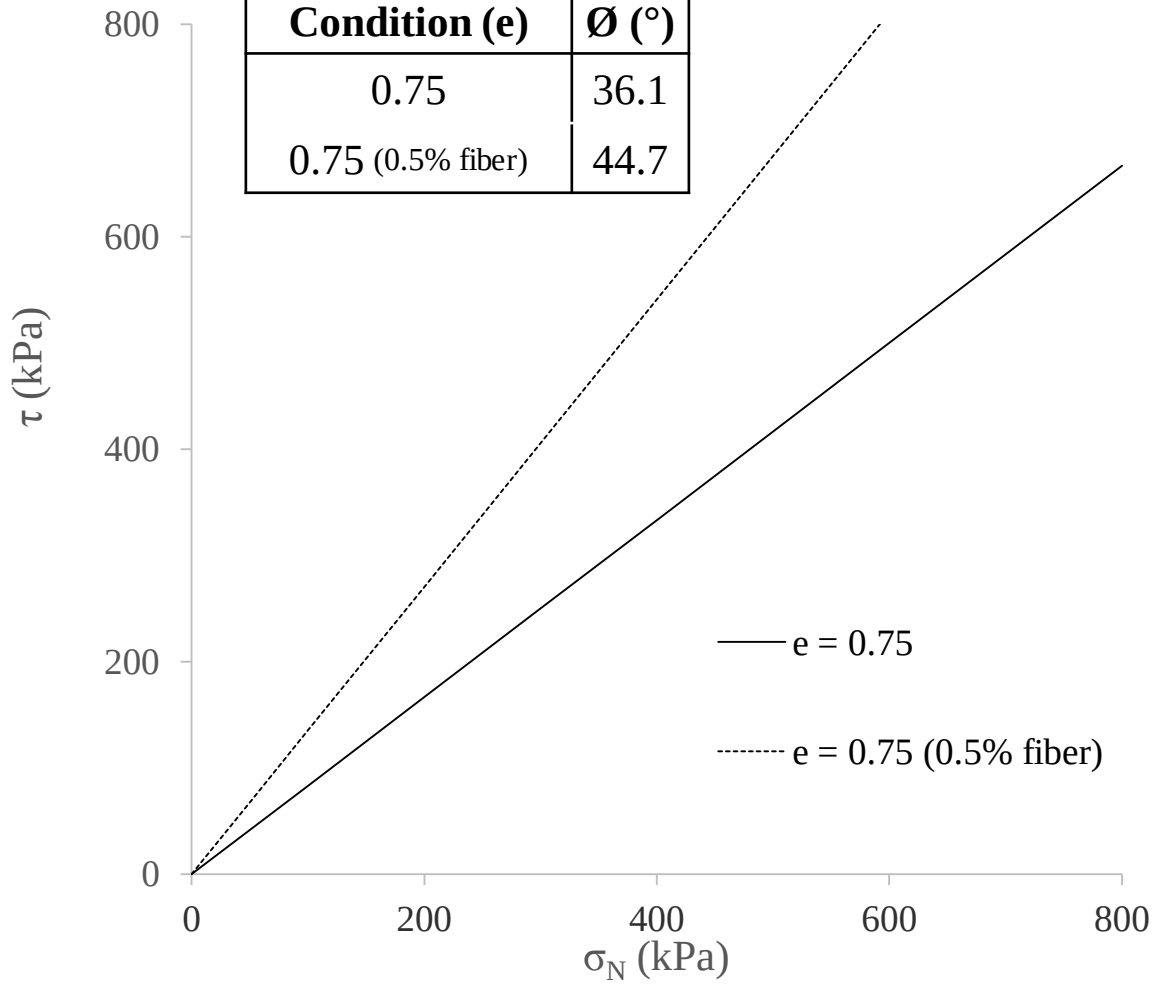


Results – Monotonic triaxial tests

Void ratio: 0,75 **No - fiber** **0,5% fiber**



Condition (e)	Ø (°)
0.75	36.1
0.75 (0.5% fiber)	44.7

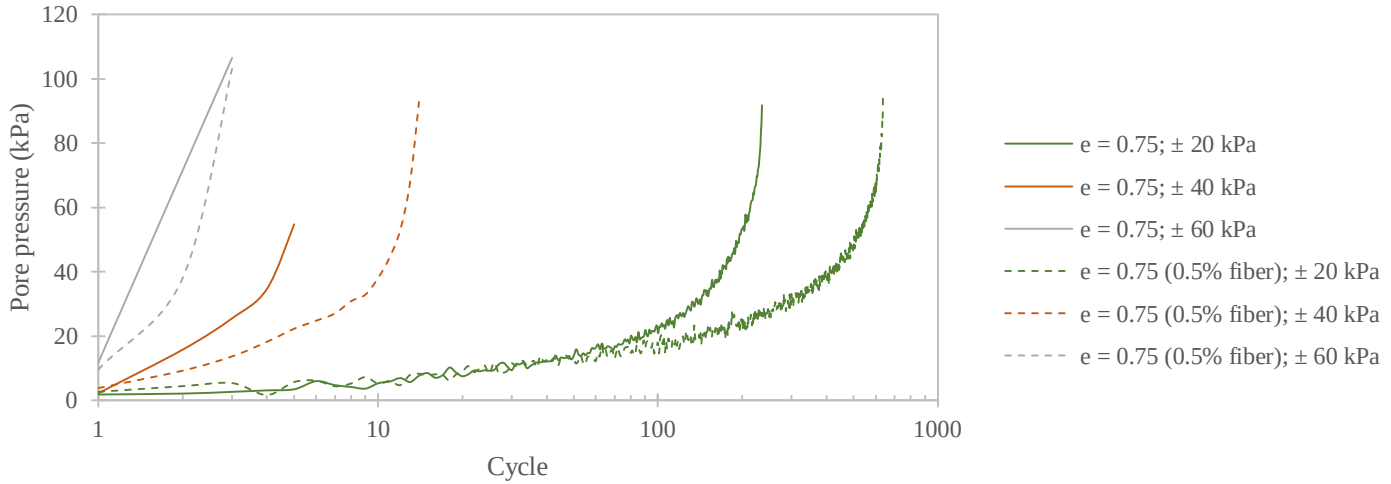


Results – Cyclic triaxial tests

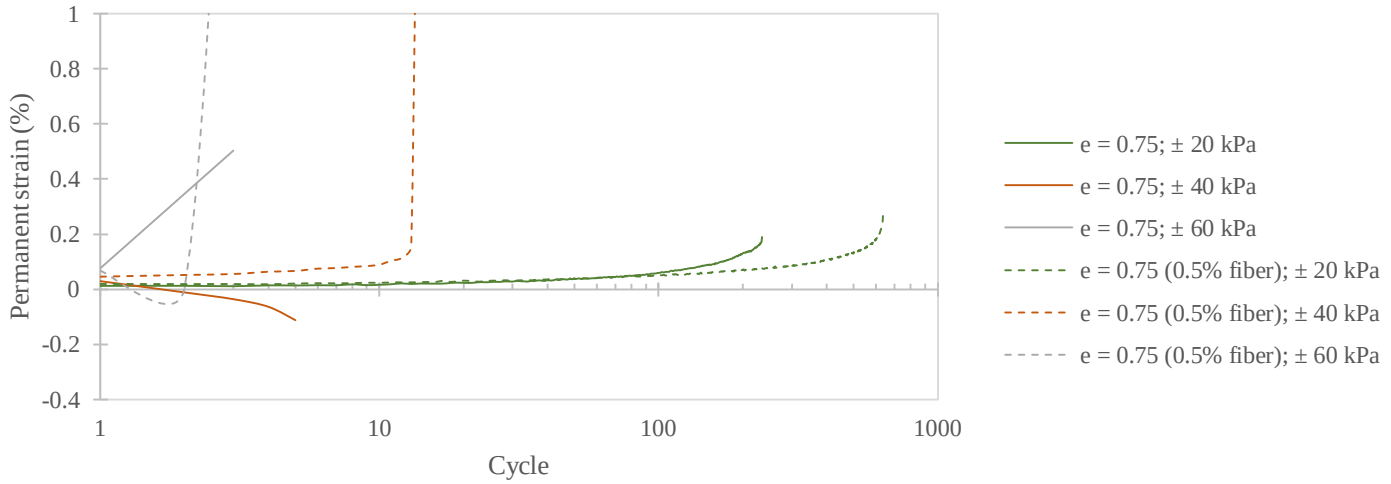
Void ratio	σ_D (kPa)	N_f	
		0,5% fiber	No-fiber
0.75	± 20	635	234
0.75	± 40	14	6
0.75	± 60	3	1

Results – Cyclic triaxial tests

- Evolution of pore pressure

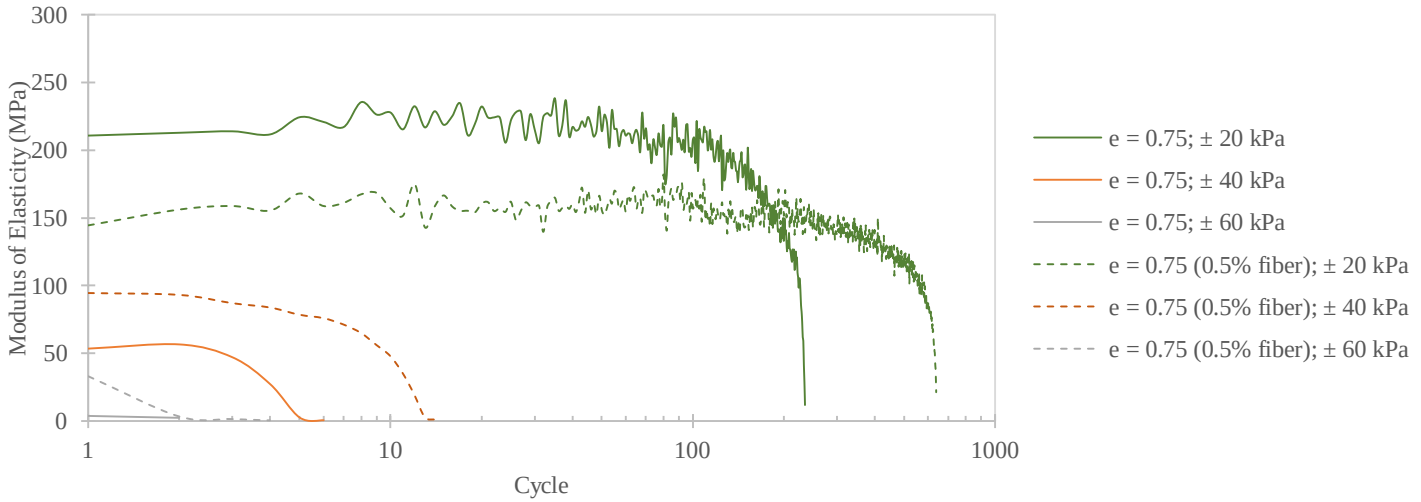


- Accumulation of permanent deformation

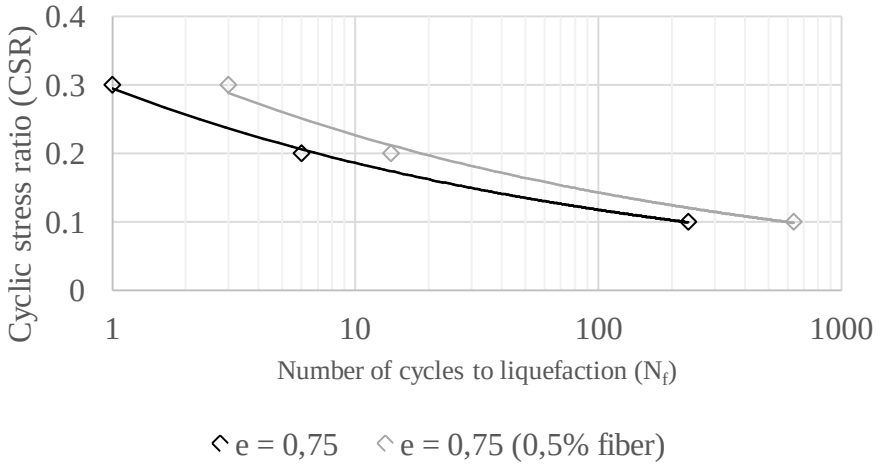


Results – Cyclic triaxial tests

- Degradation of moduli of elasticity



- Cyclic stress ratio



Conclusions

For shear strength parameters, the post-breaking effect in the case with fiber addition, is an increase of strength due to fiber elongation, but this do not have, apparently, any effect in the volumetric strains.

The contribution of fibers is more effective for the higher void ratio, which is the condition with less deformation, delaying the fibers response.

Improvement due to the addition of fibers is not limited to increase in the maximum number of cycles:

Conservation of moduli of elasticity by controlling de accumulation of permanent deformations.

Preservation of test specimens even after liquefaction is reached.

References

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