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Authors

Duque, J.

Yang, M.

Fuentes, W.

et al.

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## Reply to the discussion by Dimitrios Kolymbas of the article entitled “Characteristic limitations of advanced plasticity and hypoplasticity models for cyclic loading of sands”

J. Duque<sup>1,2</sup> · M. Yang<sup>3</sup> · W. Fuentes<sup>4</sup> · D. Mašín<sup>1</sup> · M. Taiebat<sup>3</sup>

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The authors welcome the note provided by Prof. Kolymbas regarding his analysis of the characteristic limitations using the Barodesy model. It is very enriching to let users know about the performance of some other constitutive models around the characteristic limitations shown by the authors. Self-criticism of own constitutive developments and letting the users be aware of each model’s advantages and limitations demonstrates the seriousness of each work and is essential for future improvements. In the following, the authors present some comments and thoughts regarding the simulations with the Barodesy model:

- “Limitation 1”: A significant undershooting is observed in the undrained cyclic simulation, suggesting that small strain effects are not properly reproduced. This can be expected since the model lacks internal variables, such as intergranular strain or reversal back stress tensors and the relevant mechanisms for controlling the memory of stress reversals.
- “Limitation 2”: Similar to many other constitutive models in the literature, the Barodesy model does not accurately reproduce the reduction rate of pore water pressure toward liquefaction in the successive undrained cycles of shearing. This behavior leads to underestimating the number of cycles to reach liquefaction. The results in the  $q - \varepsilon_1$  space reveal a bias in the axial strain accumulation on the extension side, similar to most models. In addition, the simulated stress–strain response in the post-liquefaction cycles

shows a significant softening, unlike the experimental results.

- “Limitation 4”: The stress path reproduces the experimental results in terms of reaching the attractor point  $p = q = 0$ , leading to the progressive reduction of the stiffness. The simulated stress–strain response leads to a significant overdamping not supported by the experiment.
- “Limitation 6”: In general, the Barodesy model performs well. Two minor observations are worth to be mentioned about the unloading paths: a) their initial stiffness seems to be overestimated, and b) they ultimately fall short of approaching the monotonic path.
- “Limitation 7”: Simulations provide, in general, a qualitative agreement with the experimental observations; however, the influence of the deviatoric preloading is slightly underpredicted, similar to what was observed in the simulations we presented in Fig. 12 of the original manuscript.

As a final remark, the authors partially agree with the statement “*The coincidence of experimental results with simulations is considered as the only criterion for the quality of the latter. However, experimental results are also prone to enormous scatter, as known by comparing undrained test results obtained with pluviated and tampered samples*”. The authors were careful to cite additional experimental references, in which similar experimental observations and conclusions were provided by others. Hence, although scatter in the experimental data is common, most of the noted limitations are discussed in a qualitative perspective because they have been observed in modeling several experimental works that considered different sample preparation methods.

✉ J. Duque  
jduque@cuc.edu.co

<sup>1</sup> Charles University, Prague, Czech Republic

<sup>2</sup> Universidad de la Costa, Barranquilla, Colombia

<sup>3</sup> University of British Columbia, Vancouver, Canada

<sup>4</sup> Pontificia Universidad Javeriana, Bogotá, Colombia

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