Discussion of "An overview of the model container types in physical modeling of geotechnical problems" by Pouria Esmaeilpour, Arman Mamazizi, Gopal S.P. Madabhushi

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Consistent with its title, "An overview of the model container types in physical modeling of geotechnical problems" by Esmaeilpour et al. [1], the essence of the paper is literature review, and hence it is particularly important that the review is accurate. The authors have compiled an extensive list of papers relevant to the design of model containers used to study effects of seismic loading on soil behavior in shake table tests. Of course, many more container types exist for "physical modeling of geotechnical problems" beyond shake table testing. Both the paper and this discussion are focused on containers used to contain soils during shaking table tests, whether performed at 1g or on a centrifuge.

Unfortunately, we noticed inaccuracies in the way that the authors have characterized the work of others. We present examples below.

1. Examples of misrepresentation of cited literature

In referring to the early work of Lambe and Whitman [2], Whitman et al. [3], and Arulanandan et al. [4], the authors state that a vertical clamping force was required to provide an adequate seal in the container, a mischaracterization first made by Hushmand et al. [5]. This is incorrect because the seal was provided by a latex liner inside their Teflon coated rings. In fact, the vertical clamping force was required to provide the tensile reaction to resist upward complimentary shear stresses (i.e., the shear stresses on the left side of element A in Figure 2(a)). Note also that Esmaeilpour et al. [1] used the reference Lambe and Whitman [6], a self-published research report, while attributing the work to only Lambe. We have used Lambe and Whitman [2] as it is the commonly cited reference for this work.

The authors describe a variant of LSB containers where an external frame is used to carry the weight of individual rings to a fixed location off the shake table to maximize useful payload capacity. The design is attributed to [7, 8, 9, 10, and 11]. The container used in [7] was a bag with cylindrical Kevlar reinforcements, with very little in common with an LSB container. Containers described in [9] and [11] are LSB containers with external frames supporting the weight of individual rings, but the weight is transferred onto the shake table. It should be noted that the external support frames are also designed to provide tensile restraint to the laminates so that additional clamping is unnecessary.

In discussing the hinged plate container, the authors misrepresent key factors. They state that complementary shear stresses are provided by "attaching a shear sheet glued with sand to the end walls". In the HPC, as is typically true for ESB and FSB containers, the shear reinforcement members (sheets or rods) are attached to the base of the container. Tensile load transfer is through the connection of the reinforcement member to the container floor and not by transferring stress to the end wall. The thin reinforcing members can theoretically achieve compression capacity as they are confined against buckling from the soil and the end wall of the container. For clarification, the HPC used by Afacan et al. [12 and 13] used shear rods, not shear sheets. The rings of the HPC are also restrained against vertical motion by external frames, like the external frames used in some LSB containers noted above. Note the external frames of the HPC also provide lateral restraint, improving the ability of the HPC to maintain K_0

conditions while minimizing ring weight. Finally, the authors inaccurately postulate that “In general, when large strain phenomena are being studied in either 1 g or Ng model tests, HPC containers might not be an appropriate choice since they can provide a limited lateral displacement due to restricted hinge rotation.” LSB and HPC containers include physical travel stops on ring displacements to maintain container integrity. That is, allowable shear strains are restricted to limit excessive hinge rotation (HPC) / interlaminate displacement (LSB). The HPC used by Afacan et al. [12 and 13] physically limits ring displacement at a maximum uniform shear strain of about 13.5%. Afacan et al. [12] demonstrated 10% shear strains in a 1D site response study. LSB and HPC containers are similarly not appropriate for studying 2D large deformation problems.

2. Examples of inaccurate attributions

The authors state “As reported by numerous scholars, LSB containers are the most efficient and advanced type of soil container offering minimum boundary effects through 1g or Ng shake table tests.” The authors attribute this statement to [14], [15], [16], and [17]. This finding is also within the paper conclusions. While this is an accurate attribution to [17], the attribution is inaccurate, in our opinion, regarding papers [14], [15], and [16] as the authors of these references do not state that “LSB containers are the most efficient and advanced”. Furthermore, the comment in [17] is itself a secondary citation, with the author of that paper again misattributing the comment to [14], [15], and [16] in addition to misattributing it to Gazetas [18].

The authors state “Elgamal et al. [19] presented the results of centrifuge tests on saturated dense Nevada sand specimens constructed in an FSB container. Obtained shear strains were larger in the vicinity of the container end walls, which could be attributed to P-waves generation at the end boundaries of the ESB container.” This finding was not made by [19]. The authors appear to have credited this statement to [19] when in fact the statement was made in error by a secondary source (Afacan et al. [12]), who stated “For example, Lai et al. (2001) and Elgamal et al. (2005) presented a test program on dense sand constructed in an FSB container. They found that damping values back-calculated from acceleration-array data were higher than empirical curves. <u>Using wavelet analysis to analyze the time dependent frequency content of vertical-array acceleration data, they observed that near the walls of the container the frequency content of the ground motion was spread over a larger band than the motions near the center of the model. Moreover, shear strains were larger near the walls of the shear-beam container for saturated-sand models. These observations were attributed in part to p-waves generated at the container boundary.</u> The authors acknowledged that container performance might contribute to the high damping values but indicated that further investigation was needed to explain the experimental finding.” Brandenberg, a coauthor of Afacan et al. [12], by personal communication while we prepared this discussion, believes the error in attribution in Afacan et al. [12] resulted from an inadvertent contraction of two paragraphs. The underlined portion of the quoted text from [12] should have been attributed to Teymur and Madabhushi [20], while the portion before and after the underlined portion is attributable to Elgamal et al. [19] as intended. Brandenberg and his coauthors are now preparing an addendum to Afacan et al. [12]. Readers interested in container / soil interaction are encouraged to read Lai et al. [21], where the team compared 3D finite element analyses and 1D site response analyses against measured centrifuge results.

The Role of Secondary Citations in Propagating Scientific Error

Hoerman and Nowicke [22] define “secondary citation” as “the inclusion of a citation in a reference list without examining the document being cited.” They explain how they identified the occurrence of secondary and tertiary citation by examining the propagation of errors from the secondary source. Wetterer [23] examined “how quotation error (misrepresentation of previous work) and citation copying (citing unexamined publications referred to by others) led to the origin and spread of the erroneous story of ant extinctions in Madeira,” an often-cited example of mistaken scientific knowledge. Katz [24] notes the hazard of erroneous reviews, that “frequent repetition can turn fictional breakthroughs into common lore.” Searches in scholarly databases such as Web of Science for terms such as “poor citation practice” or “reference accuracy” result in dozens of citations across disciplines discussing the importance of accurate citations, the widespread commonality of inaccurate citation practice, and the resulting propagation of errors.

It is a very difficult job to review 142 papers with 100% accuracy, so the authors are to be commended for their effort. But their reliance on secondary sources, including quotation of errors from secondary sources, reduces the value of the paper. Authors, reviewers, editors, and publishers share responsibility for improving citation practice.

Compromises and trade-offs in model container selection

The discussers would like to emphasize that all containers compromise on target performance requirements. It is not possible for a container to have zero mass and allow unlimited shear strains while providing undiminished complementary shear stresses, preventing water leakage, and enforcing zero lateral strain (K_0 conditions). The authors point out the various published guidelines for maintaining adequate length-to-height ratios, limiting lateral strain, and providing complimentary shear stresses. Many LSB containers listed in this literature review, in the opinion of the discussers, are not properly designed to maintain K_0 conditions and have been built to excessive H/L ratios to the extent that the container will behave more like a bending column than a shear beam.

The various container designs present multiple challenges to model construction and instrumentation, and container boundary condition compromises must be weighed against other impacts container choice may have on the quality of the research data. If shear strains are small (e.g., less than 1 or 2%) in the experiment, a flexible or “equivalent” shear beam (FSB or ESB) may be appropriate as each offers reasonable boundary conditions and significant advantages in usability because they do not require waterproofing latex liners or external bearing systems. If transparent side walls are desired, a rigid container with large length to depth (L/H) and large enough width to length (W/L) may be a good solution. If the lateral stress K_0 condition is crucial to maintain, the HPC or Rigid container may be a good solution. Large shear strain problems may be best suited for LSB or HPC containers with respect to boundary conditions, but FSB or ESB containers may still be chosen to avoid using the latex liner. The FSB and ESB containers also do not include roller bearing elements, which are difficult to keep clean in a busy geotechnical laboratory, and they typically offer greater soil payload capacity since they do not require external support elements.

Fundamentally, one must compromise mutually conflicting demands to achieve a realizable experiment. And, critically, the real boundary conditions must be incorporated into the data interpretation and analysis.

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