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DETAIL DESIGN AND CONSTRUCTION PROCEDURE OF A LARGE-SCALE ALUMINUM LAMINAR SHEAR BOX FOR 1G SHAKING TABLE TESTS

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In the past few decades, physical modeling has been increasingly employed by researchers to simulate the behavior of various full-scale or reduced-scale geotechnical problems through the use of appropriate scale laws. One of the requirements of physical modeling for geotechnical earthquake problems is the model soil container for replication of semi-infinite extent of the ground in a finite dimension. A container is required to hold the soil in place and provide confining stresses in 1g shaking table test or Ng centrifuge experiments. The ideal container is one that gives a seismic response of the soil model identical to that obtained in the prototype, i.e. the semi-infinite soil layer 1D response under vertically propagating shear waves. The boundary conditions created by the model container walls have to be considered carefully, otherwise, the field conditions cannot be simulated properly. To correctly model a problem of one-dimensional (1D) shear wave propagation through an infinite soil layer in a dynamic centrifuge test, Whitman and Lambe (1986) proposed the following three criteria for seismic simulation model container designs: (1) the container must maintain a constant horizontal cross-section during shaking; (2) the container must have zero mass and zero stiffness for horizontal shearing; and (3) the container must develop complementary shear stresses on the end walls of the container that are equal to those present on the horizontal surface (Whitman & Lambe, 1986). To fulfill the goal of each project and meet the condition of proposed problems, different model containers have been developed through these years; rigid container, rigid container with flexible boundaries, hinged-wall container, equivalent shear beam (ESB), laminar shear box (LSB), and active boundary container. Each of these containers has its own advantages and disadvantages.

In the first part of this paper, a full review of six different types of used soil container is presented and the main advantages and disadvantages of each are discussed. In addition, requirements and specifications of each model container for carrying out the seismic model test in 1-g shaking table or augmented gravity field, N-g geotechnical centrifuge experiments (with N time earth's gravity) are covered. As a result, the laminar shear box is to be found the most common container due to the simplicity of design and modeling and also the accuracy of large strain modeling problem. Many researchers concluded that laminar soil containers are the most advanced and efficient type of soil containers.

In the second part, the design method of the newly developed large-scale aluminum LSB at International Institute of Earthquake Engineering and Seismology (IIEES) is thoroughly demonstrated (Figure 1). Geometric features along with physical properties of the LSB is also presented (Table 1). Then, for obtaining fundamental properties of the box such as natural frequency and deformation characteristic, a software model of the designed LSB is developed using program SAP2000 and the results are discussed as well.

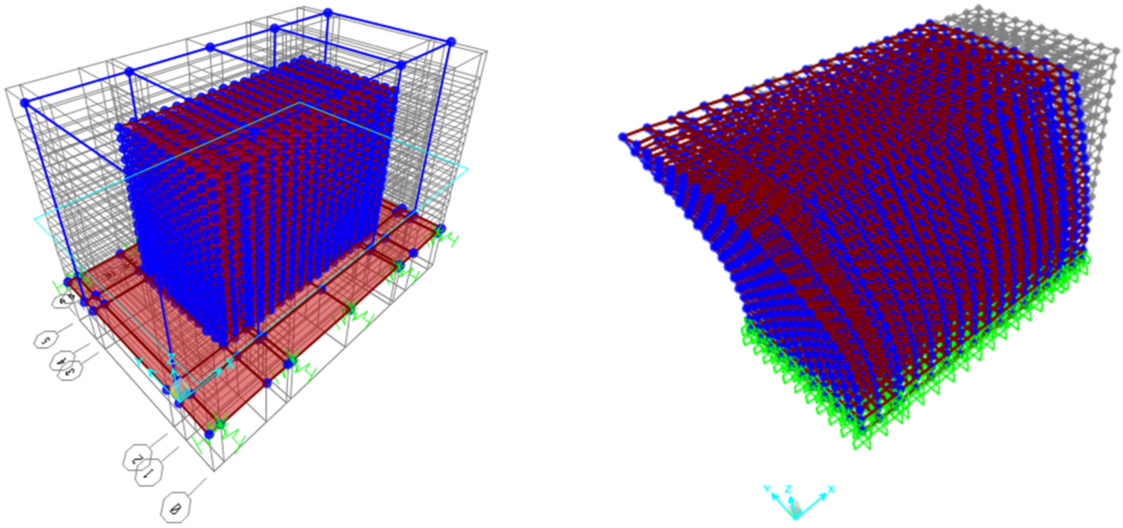
Table 1. Geometric and physical properties of fabricated aluminum LSB.

Geometric/ Physical Properties	Description		
Outer dimension	2012 mm	1056 mm	1576 mm
Inner dimension	180 mm	900 mm	1576 mm
No. of frames	18 (including one fixed stack at the base)		
Box-to-soil mass ratio	0.09 (with assumption of ρ=2 ton/m^3 for soil media)		
Friction coefficient	0.01		
Approximate weight (kg)	475/5581 (full/empty)		

In the end, the construction procedure of designed LBS is described step by step in full detail.

(a) (b)

Figure 1. Overall view of the aluminum LSB; (a) Actual box before painting, (b) Box model using CATIA software.



(a) (b)

Figure 2. Software model of the LSB using SAP2000. (a) Overall box model, (b) LSB first mode of deformation.

REFERENCES

Whitman, R.V. and Lambe, P.C. (1986). Effect of boundary conditions upon centrifuge experiments using ground motion simulation. *Geotechnical Testing Journal*, *9*(2), 61-71.