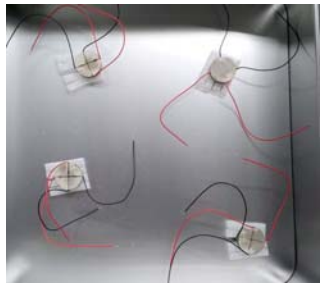
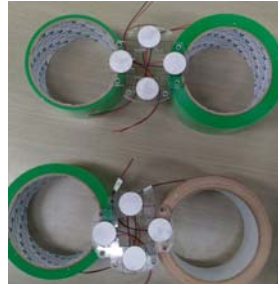


Granular materials are observed to be inherently anisotropic in nature exhibiting dissimilar stiffness in vertical and horizontal directions during the process of deposition of the particles or during compaction. In the current research, the development of a novel test setup which employs disk transducers (DTs) for the measurement of vertical and horizontal small strain moduli to quantify stiffness anisotropy has been described. The disk transducers were installed in a large triaxial apparatus having rectangular specimen of dimension $235 \times 235 \times 500$ mm. The test results indicated that the stiffness measured in the horizontal direction is greater than those calculated in the vertical direction. A good agreement has been detected between the dynamically (using DTs) and statically derived vertical small strain stiffness (by applying small cyclic loadings) verifying the suitability of the present test setup for stiffness estimation.

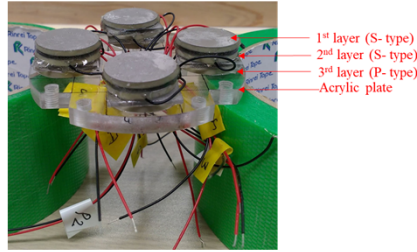
Development of Vertical Disk Transducers



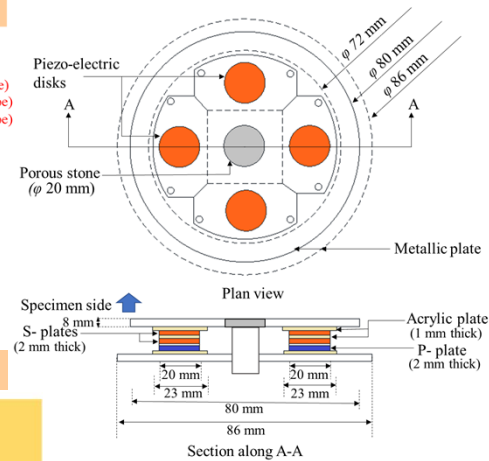
SS- pattern (oscillation in mutually perpendicular direction)



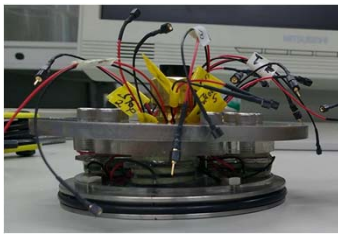
P- plate glued to acrylic disk



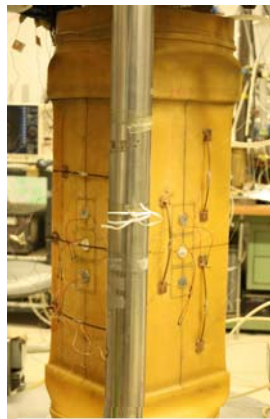
SSP- assembly of vertical DT



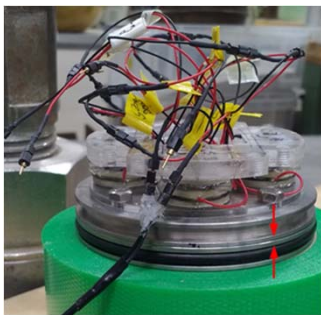
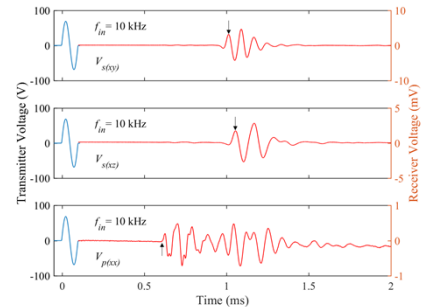
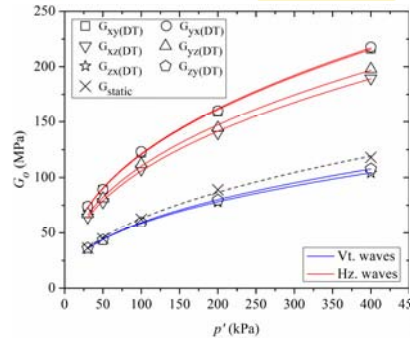
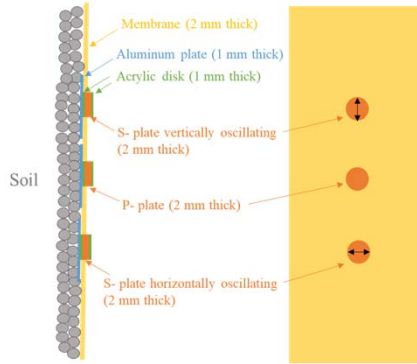
Schematic of vertical DT



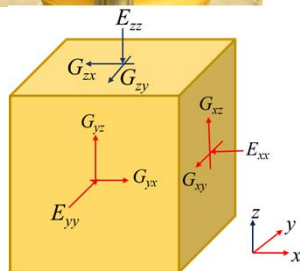
Transmitter assembly



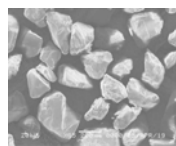
Horizontal Disk Transducers



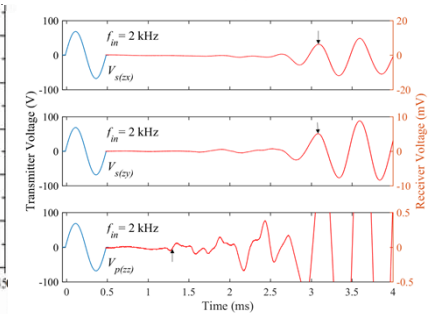
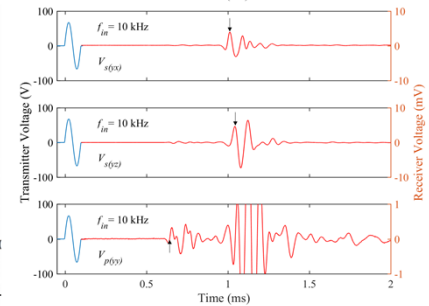
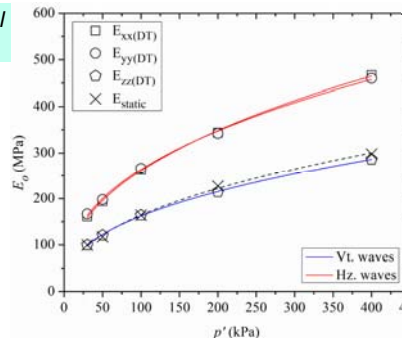
Calibration of vertical DT



Notation of multidirectional stiffness



Toyoura sand



Time domain responses ($p' = 50$ kPa)

★ Negligible time lag

★ E_0 & G_0 in hozt. > E_0 & G_0 in vert.

★ Comparable results from dynamic and static measurement

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