# DEVELOPMENT OF LARGE SIZE FLAT TYPE DISK TRANSDUCER TO MEASURE THE ELASTIC WAVE IN LARGE TRIAXIAL CELL

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## INTRODUCTION

Elastic wave measurement technique to evaluate mechanical property of geomaterials is gaining popularity by its low cost, rapid and non-destructive nature. Recently Disk Transducer method [1] [2] has been introduced to overcome the disadvantages of Bender element method. The Disk Transducer method is feasible to test all kind of samples (soft to hard) without disturbing the sample. The flat shape helps to minimize the bedding error [3] between the specimen and disk transducer. In this method compression and shear wave can be transmit and receive simultaneously as well as separately on an identical soil specimen. On the other hand, the application of wave measurement to coarse grained material is not easy, because the tested material does not behave as continuous media. Besides this, to study the small to large grain size geomaterials on single apparatus, large size triaxial apparatus is necessary. And to avoid the bedding error the size of piezo ceramic element should be at least 10 times more than the mean diameter of material. So, none of the successful elastic wave study has been carried out on the large grain size material yet, because of the limitation of size of piezo ceramic element.

Hence to facilitate to study the elastic wave of large size granular material large size (80mm dia.) flat shaped disk transducer has been developed and implemented on large triaxial apparatus. Further to clarify the workability of such disk transducer elastic wave study of Toyoura sand has been carried out with the specimen size of 50cm*23cm*23cm.

## DEVELOPMENT OF DISK TRANSDUCER

Piezo ceramic element generates electric charge when a mechanical stress is applied on the application of an electric field. It is defined as the relation between mechanical distortion and an electrical voltage in solids as shown in figure 1 and 2. Various types of -electric transducers are being extensively used on the study of geo-materials on laboratory specimen. In this study to develop a large size disk transducer flat disk shaped piezo elements consisting of a central core of polarized piezoelectric ceramic sandwiched between two thin electrodes at the top and bottom surfaces are employed. Such P-type and S-type element having a dimension of 20mm*20mm*2mm are attached with the metallic plate and merged together applying a thin layer of araldite. And then 4 sets of P-S type electric elements were attached on a circular metallic plate of diameter 80mm as a single element (PS-type) with good bond of Araldite as shown in figure 3. In order to increase the receiving amplitude of waveform piezo ceramic elements of transmitter and receiver are in parallel and series connection respectively. The disk transducer was encapsulated into top cap and pedestal of the triaxial apparatus.

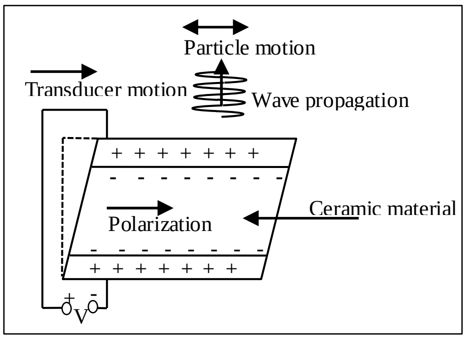


**Figure 1**: sketch of S-type element

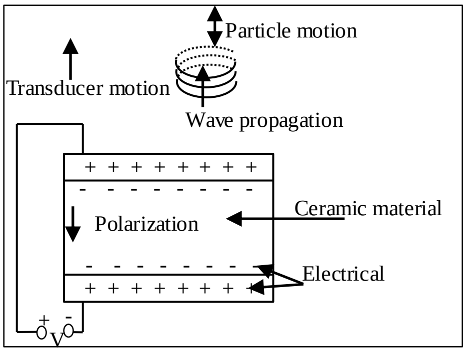


**Figure 2**: sketch of P-type element

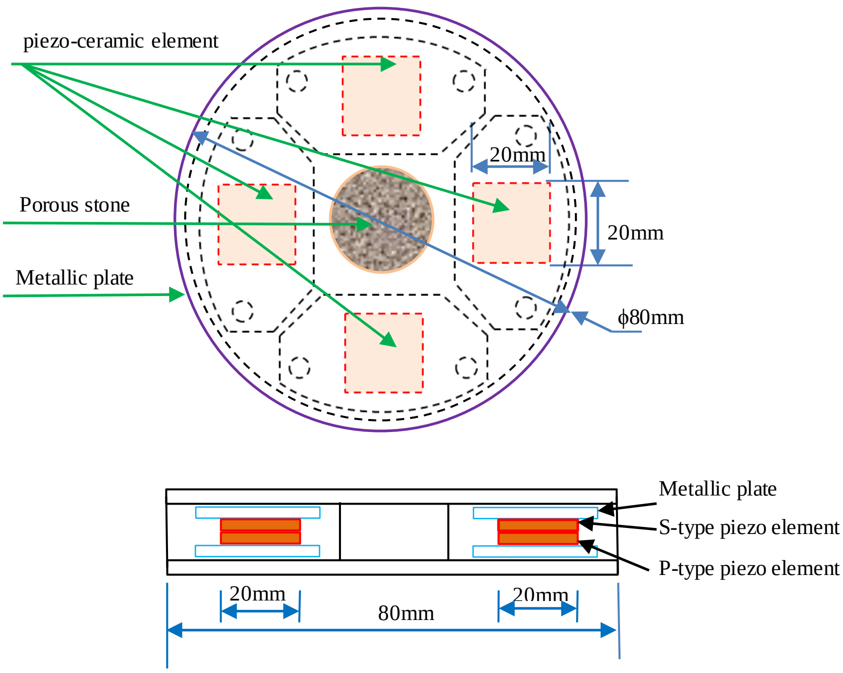


**Figure 3**: Schematic diagram of large size flat shaped disk transducer

## RESULTS

After the development of large size disk transducer by increasing the number of receiving piezo ceramic element, received waveform are studied. As the number of piezo ceramic element increases in receiver the receiving amplitude also goes on increasing as shown in figure 4. By using such disk transducer in large triaxial cell (specimen length 50cm) elastic wave of toyoura sand is studied. Figure 5 shows the received waveform of compression and shear wave. From where estimation of arrival time of compression and shear wave is done. By using such first arrival time of shear wave shear modulus of toyoura sand is evaluated at the confining stress state of 50, 100, 200 and 400 kPa. In figure 6, the normalized shear modulus (with the void ratio) obtained by the large disk transducer and previously developed [1] disk transducer shows the similar trend which proves the applicability of newly developed large size disk transducer.

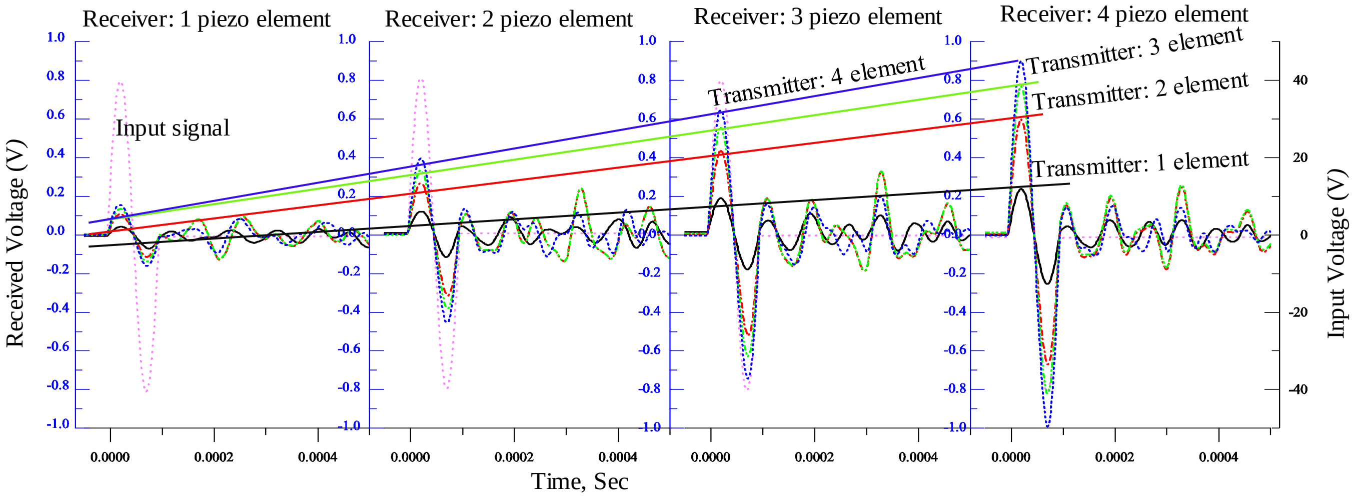


**Fig. 4**: Received S-wave signal at receiver and transmitter disk are facing each other, input sine 10 kHz

## CONCLUSIONS

By increasing number of piezo ceramic element in transmitter/ receiver desired size and capacity of disk transducer can be developed. Evaluating the results, it is concluded that large size disk transducer is applicable to study elastic wave of geomaterials. Additionally, the bedding error reported in bender element due to the inserted part will be eliminated by this method. Considering the performance, its scope can't be minimized as future's leading tool for elastic wave measurement on large size granular material on laboratory specimen.

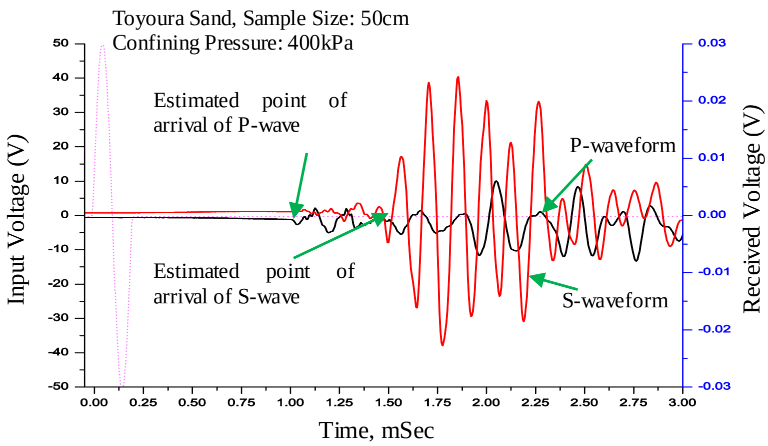


**Fig. 5**: typical received waveform

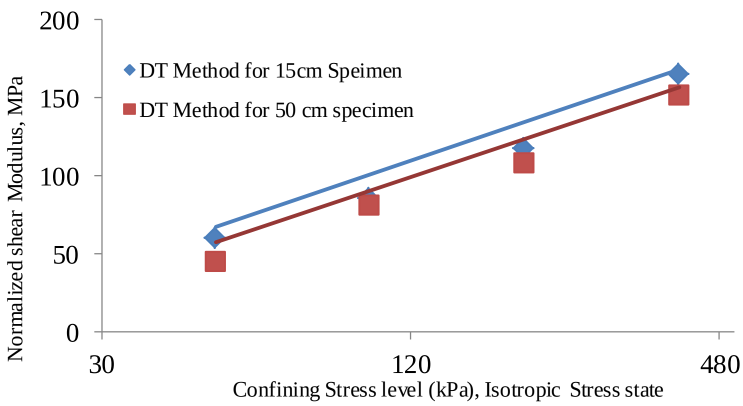


**Fig. 6**: comparison of Normalized shear modulus of toyoura sand in different specimen length

## REFERENCES


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