I - 566 REAL-TIME OBSERVATION OF CHANGES IN THE STRESS STATE IN AN EMBEDDED STRUCTURE DUE TO SURFACE OVERPRESSURE

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INTRODUCTION

The behavior of structures, buried with a relatively shallow soil cover and subjected to overpressure on the surface, were studied analytically and examined in a series of model tests supervised by various researchers. However, most experimental studies make use of real soil (e.g. sand), within which it is quite difficult to measure accurately the stresses, primarily because the presence of stress gauges disrupts the stress field that would otherwise exist if the gauge was not present. The scope of this paper is to demonstrate that by means of a combination of two methods, namely the photo-elasticity and the Laser-Aided Tomography [1], it is possible to visualize the real time changes in the stress state of a model structure with rectangular cross-section buried within a sandy granular material and subjected to surface overpressure.

PERFORMED EXPERIMENTS

Fig.1 shows the experimental setup. Crushed glass particles (properties cited in reference [2] and accumulation curve depicted on **Fig.2)**, serving as a model for soil layer (depth=120 mm) are submerged in a water tank (W300 x D150 x H300) containing a liquid which ensures the transparency of the whole model. At a depth of 50 mm from the surface, an epoxy beam (W265 x D7 x H17) representing an embedded structure is placed in the central cross-section of the granular specimen. A glass cylinder (D=70 mm) is attached to a uniaxial loading machine and used to apply loading pressure on the surface. The load-settlement curve is shown on **Fig.3**. A conventional polariscope with a laser-light source enables the stress visualization in the embedded structure. A zoomed in image of the induced fringes in the embedded epoxy bar at a settlement of 25.1 mm and applied load on the footing of 190.2 kgf is presented on **Fig.4**. After examination of this photograph, the distribution of the fringe order N over the longitudinal cross-section of the epoxy bar is established, see **Fig.5**. It should be noted the fact that the stress neutral axis moved upwards, which indicates that despite the predominant bending component a tension component contributes also to the stress state in the epoxy bar (embedded structure). This tension stresses are caused by both restriction of the ends of the bar which is embedded in the granular specimen and restriction of its outer surfaces due to friction. On **Fig.6,** the bearing stress and the induced shear stress in the middle of the epoxy beam's top side are plotted as function of the settlement of the footing. Naturally, the shear stress in the embedded structure increases with increasing bearing stress. This calculation was possible through the study on the material properties of the employed epoxy resin and the completed annealing procedure on the epoxy bar [2].

CONCLUSION

Embedded structures in soil or rock present a number of unusual aspects which make their theoretical and experimental analysis very complicated. The proposed experimental approach combines the merits of both photo-elasticity and LAT [1] and by taking into account the discrete nature of soil enables the study on the behavior of embedded structures under surface overpressure, i.e. when the displacements in the soil cover are large and out of the elastic range. Under similar conditions in the carried out experiments it was found that bending is the predominant stress component. Due to frictional restriction of the outer surfaces a tensional component contributes to the stress state of the embedded structure.

REFERENCES

(1) Konagai, K.; Tamura, C.; Rangelow, P.; Matsushima, T.: Laser Aided Tomography: a Tool for Visualization of Changes in the Fabric of Granular Assemblage, Proceedings of the JSCE, Structural/Earthquake Eng., No.445/I-21, pp.25-33, 1992.
(2) Rangelow, Optical Stress and Strain Measurement in Sandy Material, Master of Engineering Thesis, Department of Civil Engineering, University of Tokyo, 1992.

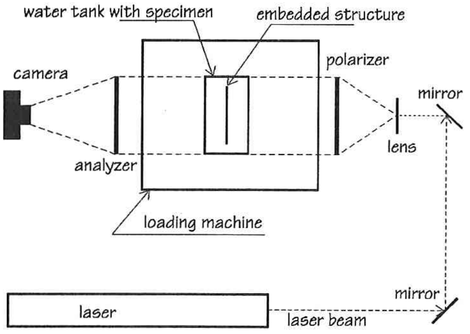

Figure 1
Setup of experimental apparatus (conventional plane polariscope).

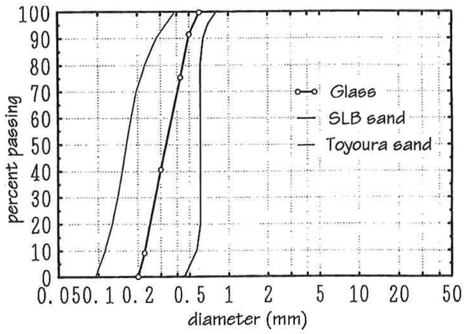

Figure 2
Particle-size-accumulation curves.

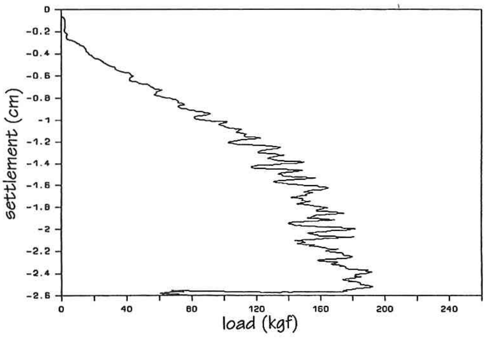

Figure 3
Load-settlement curve.

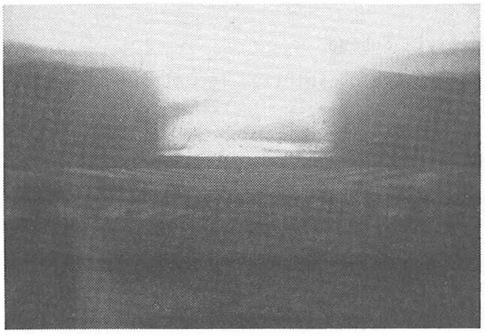

Figure 4
Observed photoelastic fringes in embedded structure at settlement, s = 2.51 cm.

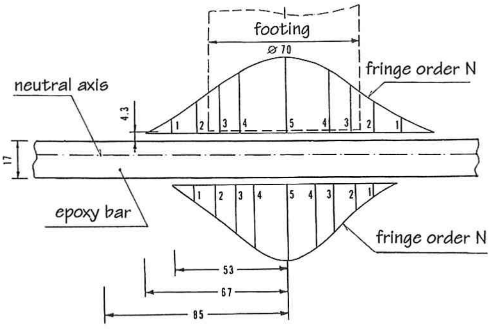

Figure 5
Distribution of fringe order *N* over the top and bottom sides of embedded structure.

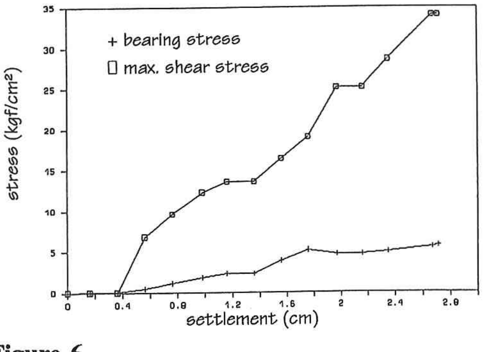

Figure 6
Induced shear stress in the top side of the epoxy bar and bearing stress on the surface of glass specimen as function of settlement.