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PLUGGING PHENOMENON OF OPEN-ENDED PILE ON A ROTARY INSTALLATION

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Summary: The plugging phenomenon at the toe of open-ended piles on a rotary installation was discussed in this study using a micro-focus X-ray CT scanner. Three penetration experiments with different shaft rotate condition of model piles were conducted. The behavior of the surrounding ground at the pile toe is discussed with the image of digital image correlation.

1. INTRODUCTION

Recently, making progress in pile driving technology is remarkable. Especially, new construction equipment such as Rotary and Press-in[1] type are developed. On the other hands, evaluation of the bearing capacity of open-ended piles is a constant problem. In order to estimate the bearing capacity of piles with sufficient accuracy, elucidation of the pile toe resistance mechanism of an open-ended pile is necessary. The main problem regarding the toe resistance of an open-ended pile is the plugging phenomenon, which was thought to occur for the soil plugged at the toe of the pile inside. An X-ray CT scanner was applied[2] to this study in order to measure the model ground displacement in detail. The plugging phenomenon was discussed from the results of deformation analysis. In the present research, vertical penetration tests on different shaft rotary condition were conducted in order to investigate the plugging effect in open-ended piles.

2. EXPERIMENTAL METHOD

Fig. 1 shows the summary of penetration test. The tests were carried out in the cylindrical aluminum mold with 50 mm inner diameter. Soil used in the tests was dry *Toyoura* sand. The sand was packed in the mold by the air-pluviation method on the relative density condition of D_r = 73% which was 210 mm in height. Size of the model pile, made from stainless steel, is 19 mm outer diameter with 0.4 mm thickness. Through the whole penetration process, the load and vertical penetration displacement at the pile head was measured. The velocity of penetration was 2 mm/min. The shaft rotate conditions are [Locked] and [Rotation (1 rpm)]. The test apparatus was fixed on the rotary table in the CT scanner room, and the penetration tests were conducted on the table.

3. RESULTS

The relationship between the pile head load and the penetration depth is shown in Fig. 2. The penetration resistance were reduced with shaft rotate condition. Although, the resistance increases suddenly when the shaft rotation was stopped (Case: Rotation-Locked). At this moment, it was guess that the growth of effective plugging began. Fig. 3 shows the vertical section of CT images. These figures show the X-Z plane, which through the model piles centre. At the toe of inner pile of Fig. 3(c), white thin layer was observed. It is expected that the model ground compacted with growth of plug. Fig. 4 shows the images of model ground displacement. 2D-DIC method applied to the CT images that at the position about penetration depth at 0 to 46 mm and at 46 to 50 mm. The displacement of model ground under the pile reduced with the shaft rotate condition. From this time forward, the change of volumetric strain around the model pile toe on rotary installation will be found by 3D-DIC method.

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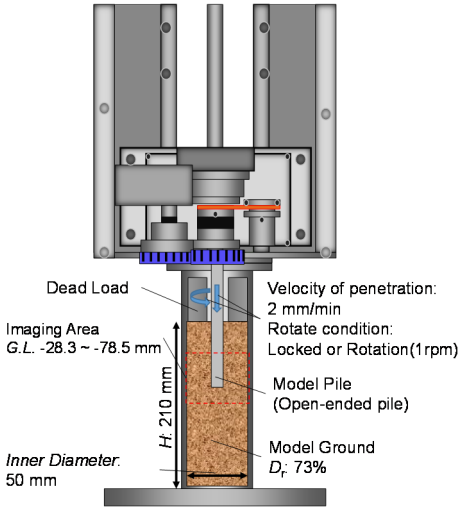

Figure 1: Summary of penetration test.

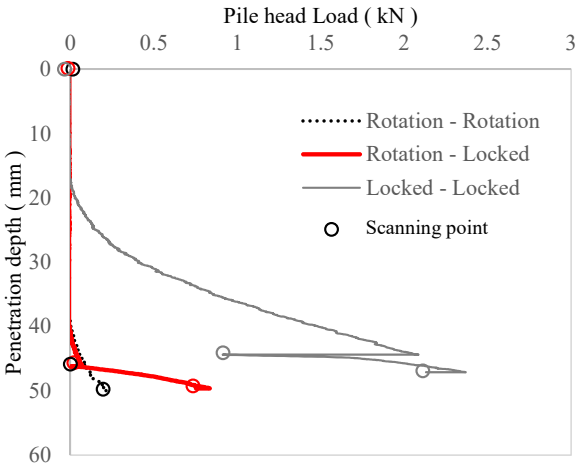

Figure 2: Relationship between pile head load and penetration depth.

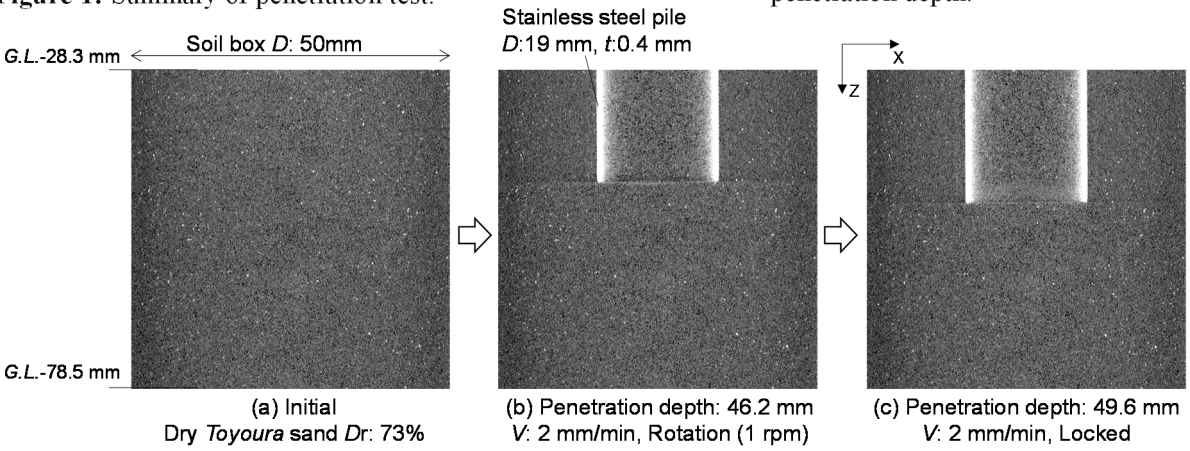

Figure 3: Vertical cross-sectional CT images of penetration test (Case: Rotation-Locked).

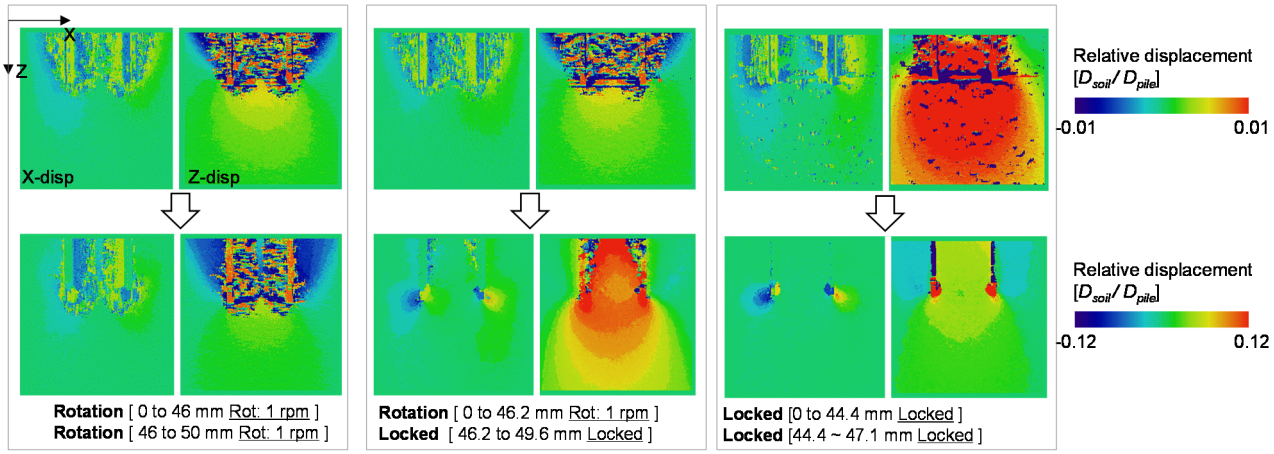

Figure 4: Displacement of model ground (Vertical cross-sectional images using 2D-DIC).