Modelling the pile load test

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Abstract. This paper deals with the modelling of the load test of horizontal resistance of reinforced concrete piles. The pile belongs to group of piles with reinforced concrete heads. The head is pressed with steel arches of a bridge on motorway D1 Jablonov - Studenec. Pile model was created in ANSYS with several models of foundation having properties found out from geotechnical survey. Finally some crucial results obtained from computer models are presented and compared with these obtained from experiment.

1 Introduction

This paper deals with modelling the horizontal load test resistance of reinforced concrete piles. The pile is a part of a group of piles with reinforced concrete heads. The head is pressed with steel arches bridge construction on motorway bridge D1 Jablonov – Studenec.

1.1 Description of the object

Bridge structure consists of three parts (Fig. 1), its total span is 668.6 meters:

- 3 pre-stressed reinforced concrete clearways of spans 26.0 m; 32.0 m and 26.3 m; total span of 84.3 meters;
- 7 major steel arch bridge fields with spans of 2×60 m, 2×70 m and 3×80 m; comprehensive length of 500 m;
- 3 pre-stressed reinforced concrete clearways of spans 26.0 m; 32.0 m and 26.3 m; total span of 84.3 meters.

Fig. 1. General view of the bridge structure.

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The assessed pile is located in 7th pillar supporting steel arches of the bridge (Fig. 2, Fig. 3). In the preliminary stage, followed by a detailed engineering geological survey, 10 exploring boreholes as a basis of 7 subsoil layers models were realized. From them the calculation model of the subsoil at the site of exploration was used according to drilled borehole 205-7/V 7. During the phase of control survey overall 8 boreholes were completed.

Fig. 2. View of steel bridge arch.

Fig. 3. Detail view of steel bridge arch and bridge support.

2 Load test of a pile

Different load tests on horizontal direction of piles were conducted. The purpose of the tests was to create a basis for any design modifications of the pile foundation of the bridge and verify the bearing capacity of piles for horizontal loads and assess the deflection - load relationship in the given geological conditions as well. A detailed description can be found in [1]. In order to verify the bearing capacity of piles loaded by horizontal forces, the test of lateral resistance was performed on a pair of piles. The test was carried out by mutual mashing of piles by loading device. Load assembly was formed with beams, jacks and power measuring box.

2.1 Foundation conditions

Geological profile at the site of tested pile is as follows:

- 0.0 – 8.5 m proluvial sandy clay with intermediate plasticity (F4/CS),
- 8.5 – 10.5 m paleogene - heavily weathered and decomposed claystone (R5, F6/CI),

• 10.5 – 13.5 m paleogene - heavily weathered and decomposed claystone (R5-R6, F6/CI),
• 13.5 – 14.7 m paleogene - replacing of 0.1-0.3 m thick layers of heavily weathered sandstone (R5, R4).

Ground water encountered in cracked claystone was found at a depth of 13.6 meters.

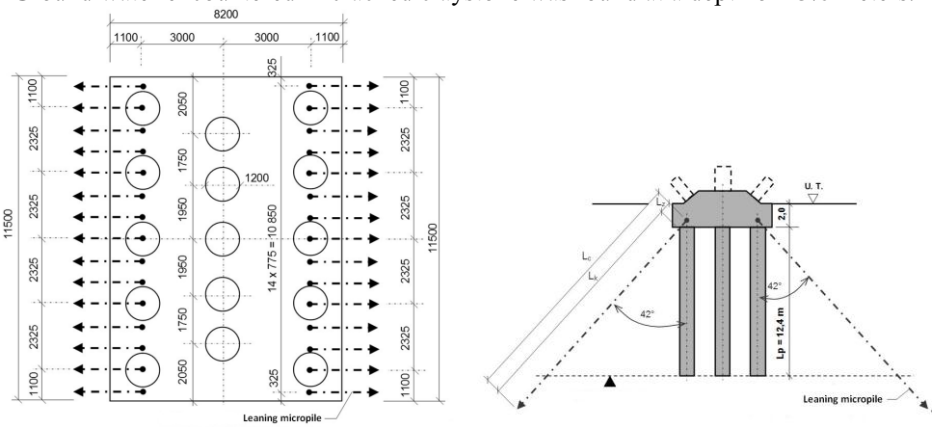

Fig. 4. Pillar Nr.7 – suggested arrangement of piles and piles of oblique.

3 Numerical model of structure

A numerical model of pile was created as 3D model using software ANSYS (Fig. 5). The nominal diameter of the pile was 1.2 m and the length of 12.4 m. Two stages of loads were selected: 280 kN and 420 kN.

Reinforced concrete piles were modelled using SOLID65 elements and surrounding ground mass by SOLID45. These elements were assigned by properties of the individual layers of soil. Contact of piles with geological environment was modelled using TARGE170 and CONTA173 elements using the contact surface - surface [3].

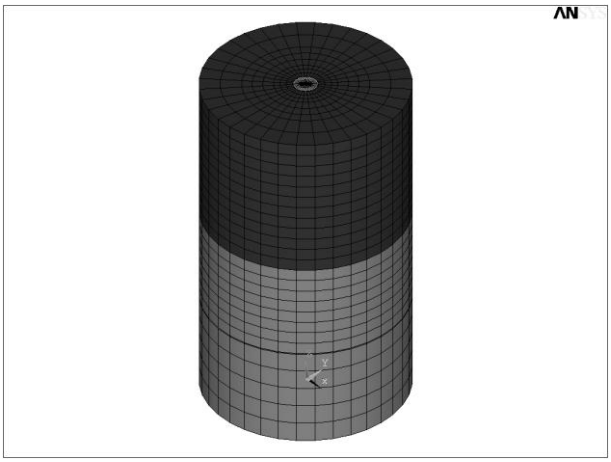

Fig. 5. FEM model.

4 Results

The results obtained for the horizontal deformation of the piles are shown in the graphs in Fig. 6. From the deformations it can be seen that the coincidence of the measurement results and the numerical model is very good.

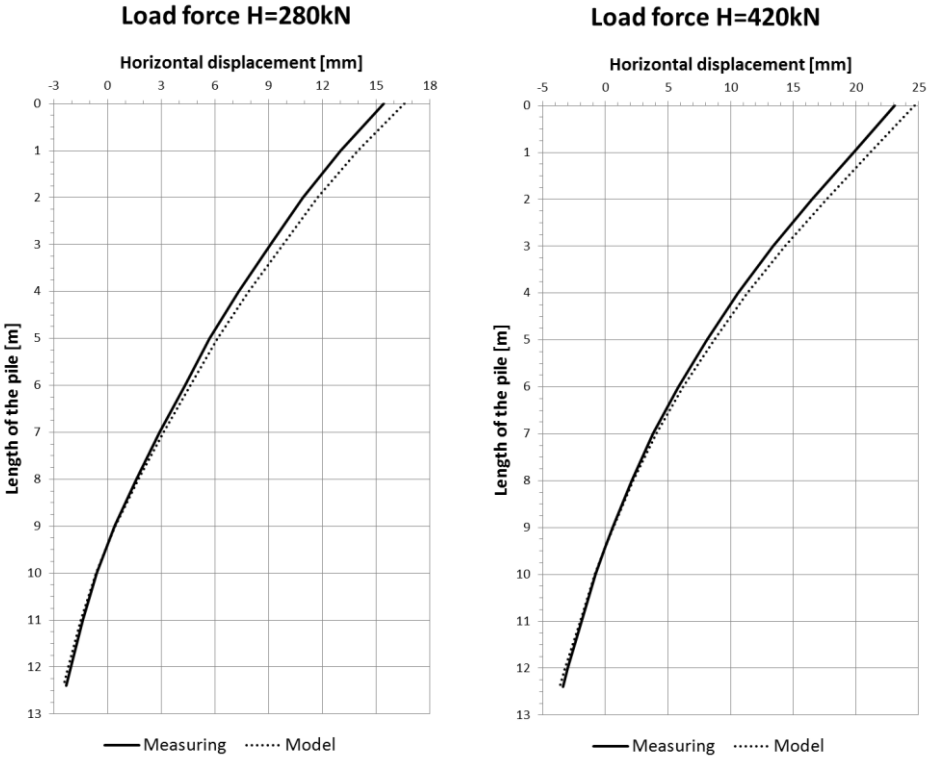

Fig. 6. Comparison of horizontal displacement of the pile.

5 Conclusion

As it is clear from final diagram, the results obtained by numerical modelling correspond very well with the measured values from the experiment. Higher values of horizontal deformation of the numerical model can be justified because of rather complicated modelling of contact piles – multi layered soil.

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