DESCRIBING THE SETTLEMENT OF THE FOUNDATION PILE SUBJECT TO TEST LOADS

Krzysztof Mroczkowski
Uniwersytet Warmińsko-Mazurski w Olsztynie

1. INTRODUCTION

Static and dynamic test loads are an indispensable part of quality control of the foundation piles. Dynamic test loads involve generation of the forces or stresses in the pile cap and shaft. The hammer hitting the cap generates a wave of stresses travelling in the pile shaft. The following methods of dynamic testing of piles can be distinguished: high-stress method, low-stress method, kinetic method, dynamic patterns. Static test loads, on the other hand, involve axial loading of the driven pile. The static tests are considered the most reliable method of actual piles behaviour in the ground. If the anchoring piles are absent in the vicinity of the test-loaded pile or their load capacity is insufficient, the test loads are performed with a ballast. Nevertheless, the most popular method of test loading is with the anchoring piles on which the thrust structure is installed as a set of steel beams. A hydraulic cylinder is placed between the beam and the pile cap to apply loads. The settlement of the piles is most often measured with a mechanical dial sensors of the 0,01 mm accuracy. The sensors are installed on the pile cap and rest on an independent measurement frame. To eliminate large errors, it is recommended to apply the precision levelling of the cap pile movement and measurement frame stability. The basic control and acceptance checks of the piles, during test static loads, are limited to determination of the loading force and pile cap movement in time. This paper presents examples of the settlement of foundation piles subjected to the static test loads with the anchoring piles.

2. INTERPRETING THE TEST LOADS RESULTS

The test load results are interpreted in four stages:

- **determination of maximum displacement for given load degrees,**
- **determination of the relationship between settlement and load,**
- **preparation of the auxiliary diagram,**
- **determination of permissible and limit load capacity.**

The paper presents an example of determination of the relationship between settlement and load. The settlement very often can be approximated by means of a parabolic function:

$$s(N) = aN^3 + bN^2 + cN \quad (1)$$

$$s(N) = aN^3 + bN^2 + c \quad (2)$$

3. SETTLEMENT EXAMPLE OF THE TEST-LOADED FOUNDATION PILES

The tests have intended to determine the load capacity of the reinforced concrete piles of the lost-steel-tube type. The advantage of this type of piles is that they can be made in the vicinity of existing buildings, and even inside the industrial facilities if higher than 9

metres. The tests have been performed with anchoring piles. The thrust structure has comprised a steel beam made of two 400 H-sections weighing 25 kN. The load has been applied by a PDD 200/250 30 Mpa= 942 kN hydraulic jack driven by a PHD-1-63/25 hydraulic pump; the measurements have been made with Metron instruments with the 0,01 mm accuracy. The test loads have been plied as per the recommendation included in the Polish Standard on piles. The pile load increased in 50 kN increments until achieving the value equal to 2,5 times the design load. If, after achieving the required load, the limit load capacity of the pile was not achieved, the tests continued until the same was finally obtained. The readings were recorded every 10 minutes. If in two successive 10-minute periods, the settlement increase was below 0,05 mm, the tests were discontinued.

The interpretation of test load results is based on the auxiliary diagram and the pile settlement vs. load curve. The examples of the pile settlement as the function of the load is shown in figures 1-4.

3.1 Tests of foundation piles made inside the buildings

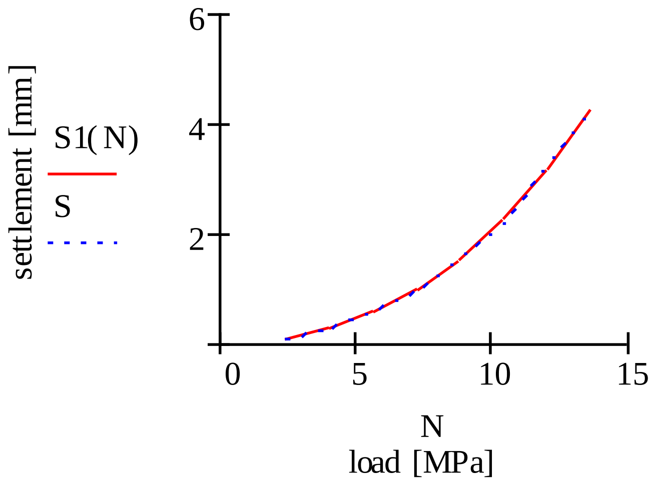

Fig. 1. Pile No. 1 settlement vs. load
S1(N) – approximated settlement, S – measured settlement.

Approximation standard deviation:
σ_{app}=0.070

Values of parameters and standard deviations of estimated variables:

a=0.000643	**σ_a=0.000333**
b=0.014418	**σ_b=0.006457**
c=-0.0014	**σ_c=0.0300**

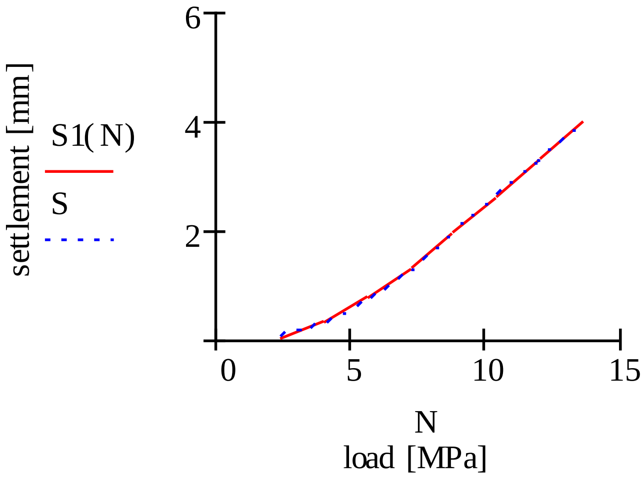

Fig. 2. Pile No. 2 settlement vs. load
S1(N) – approximated settlement, S – measured settlement.

Approximation standard deviation:
σ_{app}=0.035

Values of parameters and standard deviations of estimated variables:

a=-0.001546	**σ_a=0.000165**
b=0.049623	**σ_b=0.003191**
c=-0.0941	**σ_c=0.0150**

3.2 Tests of foundation piles made outside the buildings

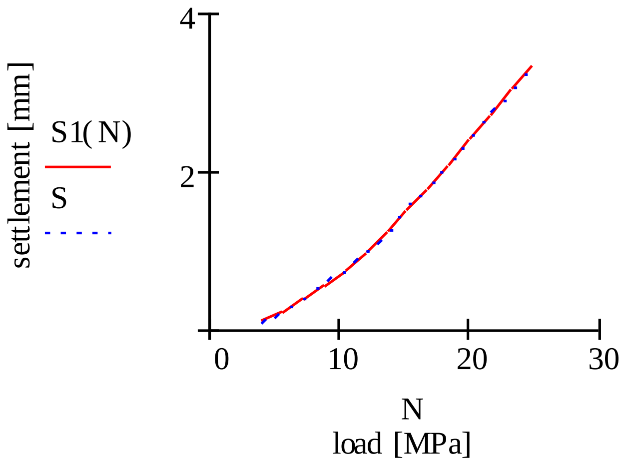

Fig. 3. Pile No. 3 settlement vs. load
S1(N) – approximated settlement, S – measured settlement.

Approximation standard deviation:
m_0=0.021

Values of parameters and standard deviations of estimated variables:

a=-0.000124 **σ_a=0.000013**

b=0.008727 **σ_b=0.000458**

c=-0.0046 **σ_c=0.0038**

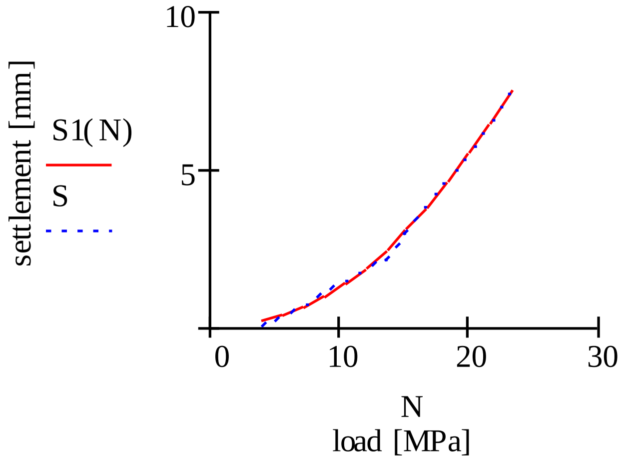

Fig. 4. Pile No. 3 settlement vs. load
S1(N) – approximated settlement, S – measured settlement.

Approximation standard deviation:
m_0=0.118

Values of parameters and standard deviations of estimated variables:

a=0.000054 **σ_a=0.000094**

b=0.013164 **σ_b=0.003055**

c=-0.0090 **σ_c=0.0240**

4. SUMMARY

The test loads are an indispensable part of quality control of the foundation piles. Typical examples of foundation piles settlements as presented in this paper are one of the four stages of interpreting the test load results. The remaining stages which accompany the interpretation, i.e. determination of maximum displacement for given load degrees, reparation of an auxiliary diagram, determination of maximum and limit load will be dealt with in the future.

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