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Experimental Tests of Reinforced Concrete Foundation Slab

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Abstract

Foundation structures, their testing and modeling is a wide area to research. A lot of different elements are tested or modeled in the world. Analysis of interaction between the foundation structures and the subsoil has been developed for many years. For the determination of stress in foundation structure is needed to determine the influence of the stiffness respectively pliability of subsoil to structural internal forces, and vice versa, how the stiffness of the foundation structure affects the resulting subsidence. This paper deals with experimental tests of square reinforced concrete foundation slabs on the subsoil which are carried out at the Faculty of Civil Engineering in Ostrava. Those slabs are loaded with concentric load and are mounted with string strain gauges to measure stress-strain characteristics. Pressure sensors are also mounted under slab to monitor contact stress in the subsoil. Total deformation of the concrete foundation slabs are measured too using potentiometric sensors. The tests results are compared with bending moments and deformations analysis according to subsoil models given in Eurocodes using FEM analysis. In this paper are described performed experimental test and presented as currently results from the test as results from the computing analysis on the slabs and their comparison.

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1. Introduction

Interaction between subsoil and foundation structures is very interesting and important field of research in civil engineering. Foundation structure is the most important part of whole structure and their quality has an important

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effect on quality of buildings. Properly designed and carried out foundations can be used for very long time. These foundations can influence durability of the building. On the contrary, wrong designed and carried out foundation can cause a lot of problems. Excessive deformation or settlement of foundation construction may cause problems with upper construction and they may increase maintenance cost. The right solution of this problem is not oversizing but right design and right execution. For the right design is necessary to known behavior of the concrete foundation on the subsoil. In the world are often tested a lot of different structures on the subsoil [1, 2, 3] and some experiments are carried out in Czech Republic too. At the Faculty of Civil Engineering in Ostrava are executed experiments too [4, 5, 6, 7, 8]. The experiments at our University are concentrated on the concrete slabs on the subsoil which are loaded with concentric load force. In these experiments are monitored deformations of the slab, stress in the slab and contact stress into foundation bottom.

2. Description of the test

2.1. Steel test equipment

Experimental tests are carried out on the steel test equipment (Fig. 1 and Fig. 2) which is placed outside the premises Faculty of Civil Engineering in Ostrava (Czech Republic) [9]. The basic principle on this equipment is clear from the Fig. 1. Foundation slab is loaded with vertical force which is introduced using system of steel attachment. These steel attachments are placed on hydraulic press which causes vertical force on the slab. The steel test equipment can be used to the maximal force 1000kN.

![Fig. 1. Steel test equipment – scheme.](image-url)
2.2. Subsoil

Under testing equipment is original subsoil which consists from clayey soil. Replacement of soil and testing on the different types of soil is expected in the future.

2.3. Test sample

This paper deals with the slab by dimension 150x2000x2000mm from the concrete C35/45. This slab is reinforced by hand knotted mesh 8/100/100 (Fig. 3). Loaded area had dimension by 400x400mm. 16 pcs potenciometric sensors (numbered 00 – 25) are fitted on the slab according to Fig. 4.
2.4. Test course

The load is introduced in steps. Steps 50kN after 30 minutes were chosen in this test. In each step was introduced load and 30 minutes keep calm because creep. On the Fig. 5 is shown concrete slab at the test. Calculated bearing capacity of the slab according to Eurocode [10] is 150kN. It was decided to test this slab to destruction but maximal to 750kN. But slab was not corrupted at this force. Results from this test are shown on the Fig. 6 and Fig. 8.

Then were decided about second test and in this test should be reached 1000kN what is bearing capacity of steel test equipment. Results from these tests are shown on the Fig. 7 and Fig. 9.
Fig. 6. Deformation of the slab (first test).

Fig. 7. Deformation of the slab (second test).
3. Results from the test

Deformations of the concrete slab are monitored using 16 sensors. Their positions are shown on the Fig.4 and on the photo on the Fig.5. In the graph on the Fig.6 are shown deformations at the first test of described slab. It is clear from the graph that substantial part of deformation was returnable which means that majority of the test was carried out in elastic area.

On this base was carried out second test on the same slab after two weeks. In this test should be reached 1000kN what is bearing capacity of the steel test equipment. In this test were the slab corrupted by punching shear at the force 950kN. Results from this test are shown on the Fig. 7.

The deformations are not perfectly symmetrical but the deformations can be separated to four groups - corner sensor (dotted line), internal sensor in the slab’s “center” (dashed line), edge and other internal sensors (solid line). Asymmetry of deformations is most probably caused by unhomogenous subsoil in the space under test equipment which confirms geotechnical tests. Based on this knowledge soil will be changed and homogenized for next tests.

Results from the test are used to other analysis as numerical modeling [11, 12, 13] or comparison with other computing method [14]. Modern methods to reduce horizontal deformation in the subsoil are tested using described test equipment too [15, 16, 17, 18, 19, 20, 21].

4. Settlement of the slab

On the graph on the Fig. 8 and Fig.9 is shown settlement of the concrete slab monitored in 6 internal sensors (04, 05, 06, 09, 20, 21 – see Fig.4). It is clear from the graph, that settlement has substantially changed its velocity by the second test at the higher values of vertical load.

![Fig. 8. Settlement of the slab (first test).](image-url)
5. Conclusion

In this paper are presented partial result from extensive research of foundation slabs at the Faculty of Civil Engineering in Ostrava. The currently result shows that foundation slabs can have very different bearing capacity as results according to Eurocodes and design according to standards is on the safe side. These results offer an idea if this safe side is not too safe. However it is not possible to write such conclusion from one or few test.

This and further tests will be used to numerical modeling interaction between foundation structure and subsoil and then used to improving existing models of this interaction.

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