Bearing capacity of steel plate anchor in cellular concrete block masonry. Research aims, programme and methodology

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Abstract* – *The current article is devoted to the start of new topic of wide scientific researches of cellular concrete structural properties and its application in civil engineering held in Lviv Polytechnic National University. Nowadays we are focused at problem of estimation of bearing capacity of plate steel anchor applied in aerated concrete thin-bed blockwork. Aim, research tasks and programme of experiment is presented.

Key words – plate steel anchor, cellular concrete, masonry, bearing capacity, research program

I. Introduction

Cellular concrete masonry systems are familiar to civil engineers for a long time, since their invention in the mid-1920s. Cellular concrete blocks provide high thermal insulation, structure and fire resistance and are used for external and internal wall construction. Elimination of separate materials for structural and insulating purposes leads to time and cost savings. Blocks can also be handled by plain tools on the construction site.

Listed advantages made cellular concrete block masonry very popular not only in Ukraine but throughout the world. There are also significant amount of technical literature, design codes and manuals for design and construction of buildings using cellular concrete masonry but analysis of such literature showed some problem questions that were not covered in them.

One of such problems that needs to be solved is bearing capacity of plate anchors in cellular concrete block masonry.

II. Aims and Objectives

There are many cases when structural elements need to be fixed in masonry and plenty of them causes tensile stresses. Mounting of such structures uses wall plugs or anchors of different types as commonly used practice. It is also known that anchoring of wall plugs in porous masonry units should rely on the dowel's shape instead of friction forces in solid materials. In our previous researches [1, 2] we had already proposed the usage of steel plate anchors in nonautoclaved in-situ foam concrete structures and now we want to study the behaviour of such anchors in aerated concrete blockwork.

There is no particular design code for leightweight concrete blockwork in Ukraine. The only calculation formula for estimation of bearing capacity of plate anchor in masonry is DBN V.2.6-162:2010 [3] expression (11.10) for calculation of masonry resistance to local vertical load. That's why necessity to learn the bearing capacity of steel plate anchor in cellular concrete blockwork by experimental and theoretical way was induced and it became the main aim of current study.

In order to reach aim of research we need to accomplish several tasks that are as follows:

- to perform literature review ;
- to check declared compressive strength of cellular concrete masonry units and obtain other physical properties of aircrete;
- to develop laboratory model of masonry element that meets requirements of next research task;
- to determine experimentally bearing capacity of steel plate anchor in cellular concrete block masonry;
- to compare obtained results with previous researches [1, 2];
- to prepare some recommendations for structural design of anchors in leightweight concrete masonry.

Following programme and methodology of experiments is proposed.

III. Experimental Programme and Methodology

We decide to prepare for experiments two identical masonry fragments in order to solve research tasks mentioned above. The shape of test specimens is shown on Fig. 1. Each specimen will consist of four cellular concrete blocks. Fourth block should be divided to halves and set at the ends of second row. As cellular concrete masonry units it is proposed to use prefabricated autoclaved aerated concrete blocks AEROC EcoTerm (D400 density grade) or AEROC Classic (D500 density grade) with compressive strength not less than B2.5 class.

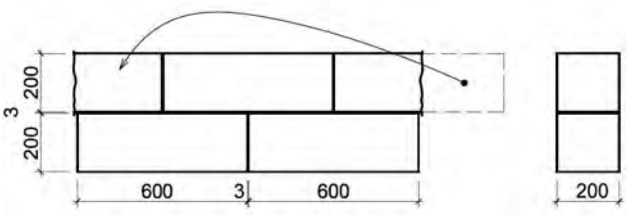

Fig. 1. Shape of test masonry specimen

Blockwork is supposed to have thin mortar layers with the depth of the mortar set to 3 mm or less. Pre-mixed cement-based mortar should be applied to the bed joints and perpends.

Completed blockwork specimens will be left for hardening for a week. Before the experiment there will be drilled three holes in masonry element at marked on Fig. 2 locations that should match the diameter of used stud 2 showed on Fig. 3 (approx. 10–12 mm in diameter). Such holes will help to avoid the influence of bonding between rod and cellular concrete on experimental results. Numerical marks on Fig. 2 shows the order of planned loadings: first anchor will be tested at the wickest point of masonry between the masonry units, the second will be located not far from the edge of middle block (100 mm) and the last testing position will be at the center of the specimen.

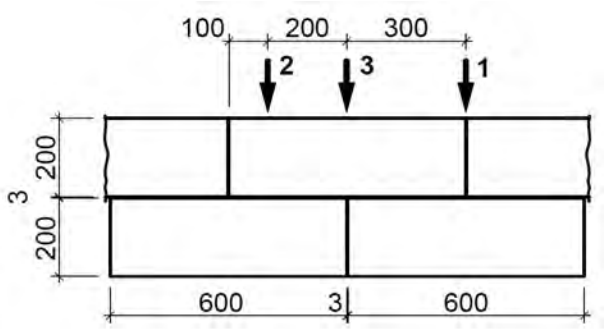

Fig. 2. Test specimen with marked locations and order of load applying.

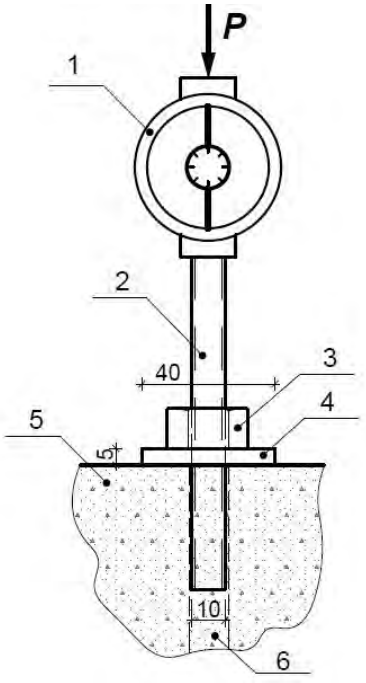

Fig. 3. Side view of steel plate anchor in cellular concrete block masonry loading experiment:
1 – compression dynamometer; 2 – steel threaded rod;
3 – steel nut; 4 – steel plate square anchor 40×40×5 mm;
5 – cellular concrete masonry; 6 – drilled hole

As it is shown on Fig. 3, applied to the stud loading will be compressive but the plate anchor and surrounding masonry will behave exactly the same as we'll pull the stud from another side.

Loading will be developed by means of hydraulic jack (carrying capacity of 12 tons), and measured by means of preliminary calibrated dynamometer 1 (see Fig. 3). Measurement of the vertical displacements of plate anchor will be held by the indicator with the precision up to 0,01 mm. Loading of all anchors will consist of steps which reach 0,1..0,15 of the expected size of the destructive load. On every stage the shows of devices will be taken with delay of 5–10 min.

After main experiments on achor's bearing capacity four lower blocks of specimens that are expected not to be damaged will be used for obtaining of aircrete physical properties. They will be weighed to check declared density grade of blocks. Three of them will be compressed to check declared compressive strength of cellular concrete masonry units and the last block will be splitted several times to estimate the tensile strength of cellular concrete. Detailed methodology of splitting can be read in previous article [4].

Conclusion

Modern design manual for cellular concrete blockwork construction [5] recommends to mount wall top plates and other beams with rods anchored in plain reinforced concrete. We suppose such strict recommendations caused by not only relatively low strength of cellular concretes but also few and fragmented scientific researches on the topic of anchoring in cellular concrete block masonry. This paper is devoted to the beginning of experimental studies in the field of bearing capacity of plate steel anchor applied in aerated concrete thin-bed blockwork estimation. Aim, research tasks, programme of experiment and methodology in details is presented.

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