NUMERICAL COMPARATIVE ANALYSIS OF STRESS DISTRIBUTION FOR DIFFERENT SHAPES OF SPREAD FOOTING FOUNDATIONS

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1. Introduction

In Polish national standard [1, 2] spread footing calculations are limited only to the basic shapes of foundations. Also in the literature [3, 4] there are discussed basic shapes only, however authors mention that different shapes may be calculated via appropriate software. Despite that there is a very small number of articles concerning the spread footing shape optimization. This paper concerns comparative analysis of stress distribution for different shapes of spread footing foundation with the utilization of finite element method (FEM) based software. In order to perform numerical analysis SolidWorks FEM based software has been chosen.

2. Model geometry and results

For the numerical analysis purposes six different shapes of spread footing have been adopted. Two different shapes of foundation bottom surface have been analysed – circular and rectangular pattern. For the circular shape of foundation base, diameter of 2.50 m has been assumed, whereas for the rectangular shape – square with side edge equal 2.50 m has been assumed, respectively. Height of each foundation has been set to 1.40 m, which is the maximum ground frost depth value in Poland on the basis of Polish national standard.
Following spread footing foundation shapes have been adopted: simple, sloped and stepped column footing. In the simple column footing, circular and square foundation base surface have been extracted vertically by 1.40 m. In sloped column footing, rectangular foundation base has been extracted vertically by 0.60 m, then by 0.80 m sloped by 45 degrees to the centre, whereas for the circular plate vertical extraction has been adopted as 0.30 m, and then 1.10 m sloped by 40 degrees to the body revolution axis. In stepped column footing, two steps were created: for the square and circular foundation base, the first step has been extracted by 0.60 m, whereas second step, located in the centre of former step has been extracted by 0.80 m.
For square shape foundation the second step dimensions have been adopted as: $1.00 \times 1.00 \times 0.80$ m (width; depth; height), whereas in the circular shape the second step has diameter 1.30 m. In each case, the column has been placed onto the top surface of foundation and longitudinal axis of column has coincided with the centre point of foundation top surface. For the square shape foundations, square shape column has been adopted with following dimensions: $0.40 \times 0.40 \times 1.00$ m, whereas for the circular shape foundation circular columns with 0.40 m diameter and 1.00 m height have been adopted, respectively. To reflect footing located onto the ground, each analysed foundation had on its whole bottom surface vertical displacement boundary condition fixed and in the centre of that surface all displacements had also been fixed to provide model stability. It should be noted that ground weight located onto the foundation, ground friction and subsidence have been neglected in the analysis. In order to compare obtained results constant static concentrated force have been adopted equal 500 kN, which has been evenly distributed onto the top of each column surface.
For the foundations and columns isotropic concrete material model has been assumed, which correspond to the C25/30 concrete class. According to the fact that stress results concerning only concrete material had been the subject of interest, reinforced steel has been neglected in the analysis.
Hence, on the basis of stress isolines in concrete optimal foundation shape could be determined. Exemplary stress results for the circular pattern of sloped column footing has been presented in Fig. 1. Moreover, in paper obtained maximum stress results from the connection between footing-column and from the centre point of bottom foundations surfaces have been compared.

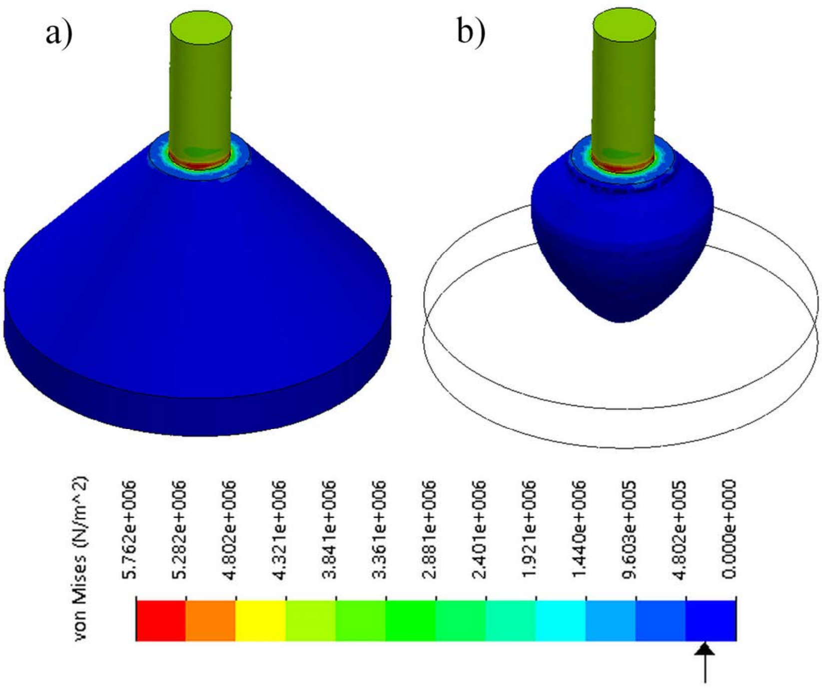

Fig 1: Misses stress distribution in circular sloped column footing: a) stress distribution in the whole numerical model, b) minimum Misses stress limited to the range of 0.30 MPa.

3. Conclusion

Through the numerical analysis performed it has been shown that the dimensions and even assumed shape of spread footing foundation subjected to the pure axial loading may be furtherly optimized. In [3, 4] has been shown the procedure of spread footing calculations concerning only basic shapes. Thus with the utilization of FEM method it is possible to propose another shape, which correspond to the stress distribution in any spread footing and with any boundary and loading conditions.

References

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