International Journal of Civil Engineering Research.
ISSN 2278-3652 Volume 5, Number 2 (2014), pp. 191-196

http://www.ripublication.com/ijcer.htm

Estimation of Stresses during Vertical Excavation Using Finite Element Method in Two Dimensional Simulation

Sanjay Gupta

Department of civil engineering, Faculty of engineering and Technology, Manav Rachana International University, Faridabad-121004.

Abstract

Stability of the vertical excavation had been examined using finite element method for a different depth of excavation while structural static and dynamic load with worst possible moment criteria .The critical depth had been examined based on finite element method value of two dimensional interface stresses, ignoring the third dimension stresses, were verified experimentally for an exact analysis. Tension is being important in the excavation of two dimensional analysis using finite element method on clay. At the higher depth , collapse behavior of the vertical cut was more significant. Hence to prevent from the collapse a systematic study of the tension profile would be made for the higher depth of excavation. The two dimensional excavation using finite method value might be possible to examine for evaluating the exact bearing pressure below any depth from the ground level of a complex geometric and materials properties of soil.

1. Introduction

The forgoing study reported concerned the stability of two dimensional excavation in clay using finite element method. Seven different layer of excavation were carried out to simulate the lift to follow construction sequence. The depth of the lift were studied as under 12.0m,11.0,10.0m,8.0m 4.0m,2.0m,1.0m .The width of the excavation was limited to 12.0m.The discretization of the continuum was made on one side of the axes for the 12.0m of the excavation. The analysis was based on the static and self weight of the foundation on the excavated surface .The value of loading condition was estimated as 1814.36 KN based on the vertical and horizontal amplitude and worst possible combination of moment over the excavated surface with appropriate boundary condition at the end of excavation for the design of the turbo generator foundation structure.

2. Result Discussion of Vertical Excavation Using Finite Element Method

The contour of principal stress at the higher depth of excavation as such 12.0 m were more significant at the corner and ¾ of the bottom of excavated surface.

The contour of principal stresses at the vertical cut were observed significant at the higher depth and hence extreme care was required while proceeding to higher depth of excavation.

The shear stress contours at the depth of 12.0m below the ground level were observed as very critical. The most critical contour of shear stresses were obtained at the bottom of the excavated profile as well as ¾ th of the vertical cut. The value of shear stress contours was high at the corner. The shear stress contour were estimated very high at the corner of the vertical cut compared to the contour value of shear stresses adjacent to the bottom of the excavated profile .The vertical excavation were carried out at higher depth with extreme care. The tensile nature of stresses at the 12.0 m depth below the ground level were estimated.

The shear stress contours were varying from 2 to 3 % in the second layer of the excavation compared to the first layer of excavation .The contour of shear stress at the depth of 11.0 m from the ground surface were estimated as negative .The negative shear stress contour showed that extreme care was required while excavation at higher depth as such 11.0 m from the ground surface. The nodal strain rate at the ¼ th of the excavated boundary were observed more ,while the contour value of nodal strain showed higher than the excavated boundary of the vertical cut at the corner and bottom surface of vertical cut. The variation strain rates were very critical.

The element stresses were varying from lower to higher stresses .On the other hand the stress contour values were found negative at the vertical excavation for higher depth of excavation.

The higher principal strain contour values were observed adjacent to the vertical excavation boundary. The higher value of contours were observed at the higher depth of excavation .In the third layer of the excavation , 10.0 meters depth below the ground surface ,the principal stresses were observed critical at the ¼ th of the corner of the excavated boundary of the vertical cut. The principal stress contours were predicted very high adjacent to the axes of the excavation. The variation of the bearing pressure based on finite element method and experimental value were compared. The variation of the bearing pressure based on the observation were 2.36% for the lower lift of the excavation.

The experimental value gave higher value than the finite element value. The experimental value gave the exact bearing pressure. The variation of the shear stress estimated based on the triaxial test was 41.5 %, taking one of the finite element minor principal stresses as fluid pressure and examined the major principal finite element stresses .But these values were varying from 32 to 88.9 %.

The variation of normal stress was experimentally verified. These values were varying from 2.801 to 8.6 times of the finite element value of normal stresses estimated as 5.7 times of the actual value of the finite element values. The experimental verification of the bearing pressure for the two dimensional problem were estimated. The verification of bearing pressure with respect to the original value based on the finite element approach were obtained as such 5.58% .The exact % of variation of the bearing pressure were estimated as 5.58 %.

The variation of shear stresses were significant at the higher depth .At the lower depth of excavation stress contour values were reduced. But the shear stresses at the cut of the boundary had much more significant and higher shear stresses were developed at higher depth .At the corners, the negative shear stresses were estimated as well as at certain height from the bottom cut. The bearing pressure based on the finite element method value was estimated. The value had an average variation and perdition of soil below the ground surface based on the soil properties were estimated as clay. The nodal strain rate from the axes of $1/4^{th}$ of the excavated boundary were observed critical. Hence the value were once again increasing with other contour value showing at the corners and adjacent to the excavated boundary .These contours showed that the strata had been observed very critical.

3. Conclusion

i) The concept of finite element method gave realistic and economic approach of the two dimensional analysis. The problem of complicated geometric properties and materials properties might be solved with the finite element method with an exact analysis. The experimental verification of the finite element method values for two dimensional excavation using finite element method dealt with the higher value than the two dimensional excavation using finite element techniques . Henceforth the complete solution could be achieved within low cost time framed computer aided design with an exact solution of the problem.

ii) The approach of finite element approach it was seen that as depth of the excavation exceeds the 8.0m or so, the tensile stresses were developed .The development of the tensile stresses showed the vertical excavation were instable to stand. The suitable technical approach as such soil injection or stabilization approach was required .The tension were seen more prominent near the vertical sides from the 1/4rth of the height of the bottom surface as well as corners of the excavated profile . The exact analysis would forecast the failure mechanism develop during excavation.

iii) Based on two dimensional excavation using finite element method , the two dimensional stresses could be analyzed for the normal stresses, shear stresses and cohesive strength of the existing strata and the bearing pressure could be estimated for the design of the foundation, structure of power house, underground power house ,dam and surged shaft .

iv) The modified equation of Mohr-coulomb's which would be the basis of the analysis of bearing pressure for evaluation of the foundation area of turbo generator were established .The structural components could be analyzed based on the above bearing pressure which would provide a realistic ,economical and exact approach based on the experimental verified values. The comparative statement of the experimental and actual finite element value stresses, the experimental value became more economical in case of area of steel and design of concrete.

v) The computer aided geotechnical design provided analysis of the complex behavior of the soil. The analysis which was not analyzed by the analytical method was analyzed by the finite element method for two dimensional excavation.

vi) The experimental verification of the finite element method values for two dimensional excavation using finite element method dealt an exact approach compared to the analytical and conventional approach.

vii) Based on the above analysis it had been observed that at the higher depth of excavation ,extreme care would be required . The exact analysis would forecast the failure mechanism develop during excavation.

viii) Based on two dimensional excavation using finite element method , the two dimensional stresses could be analyzed for the normal stresses, shear stresses and cohesive strength of the existing strata and the bearing pressure could be estimated for the design of the foundation, structure of power house, underground power house ,dam and surge shaft .

ix) The experimental verification of two dimensional stresses based on two dimensional excavation using finite element method gave the exact value of normal stresses ,shear stresses and bearing pressures .These values might gave the modified equation of Mohr-coulomb’s which would be the basis of the analysis of bearing pressure for evaluation of the foundation area of turbo generator .

x) The structural components could be analyzed based on the above bearing pressure which would provide a realistic, economical and exact approach based on the experimental verified values. The comparative statement of the experimental and actual finite element value stresses, the experimental value became more economical in case of area of steel and design of concrete.

xi) The result of finite element method gave very large data. These data required to be stored in warehouses based on the data mining concept. These would gave future growth of any company in view of design and consultancy of mega civil engineering project.

xii) The vertical cut using finite element method on clay gave the contours of the stress,strain,elastic stress, principal strain,prinicipal stress contours for analyzing the stability and mechanical state .The Critical collapse mechanism was estimated during the vertical excavation .Advance collapse mechanism of the large excavation was estimated.

References

[1] La Baws, Aggour M,"Earth pressure in trench rescue shoring system ,"in the year of 2012.

[2] Dr Hassan in F. Hassan,Saif M. Jawed ,"Finite element analysis of earth retaining structure problems in non linear partially saturated soil, "in the year of 2012.

[3] Teruo Nakai, M.ASCE, Hossain Md. Shahin, M.ASCE, Naoyuki Iwata,"3D Effects in Excavation Problems: Model Tests and Numerical Simulations," M.ASCE, Eunsu Sung, M.ASCE, and Masaya Hinokio, M.ASCE, ASCE Conf. Proc. oi:10.1061/40870(216)27/2011

[4] T T Slopess "Three dimensional analysis of soil and rock slopes using finite element method " 16 Nov 2011.

[5] Mollon, G., Phoon, K. K., Dias, D. & Soubra, A.-H.,"Validation of a New 2D Mechanism for the Stability Analysis of a Pressurized Tunnel Face in Spatially Varying Sand," Journal of Engineering Mechanics, ASCE, 137(1), Jan 2011, 8-21.