Parametric study of the mechanical response Around a Tunnel (Example of application: Algiers metro)

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Abstract-*Tunneling at shallow depth can induce ground movements that may cause deformation and in extreme cases of severe damage to surface structures this work deals with the setting of the hydro mechanical response around a tunnel. a numerical analysis of the effect of excavation of a tunnel towards a low multiple-stage structure centered over the axis of a tunnel. The study is performed using the computer code Plaxis 8.2 which is based on the finite element method (FEM) in plane strain. The analysis applies to a real case in this instance the Algiers metro, excavation was conducted using the New Austrian Method (NMA) taking account of deconfinement.*

Our objective in this work is to make a parametric study of geometric parameters differing and so the geotechnical parameter mesh position and lap

Keywords

Tunnel, the Algiers Metro, consolidation. Finite élément method. Settlement, PLAXIS 8.2

1. INTRODUCTION

The digging of underground is nowadays one of the most suitable for the construction of infrastructure road and rail transport solutions, and drinking water and sanitation networks with major cities of the world have a growing need.

One of the major problems associated with these structures is formed by the movement induced by the work floor. These works are, for both economic and practical reasons, usually constructed shallow movements they cause, can damage the existing structures on the surface.

2. Mesh and numerical model

Given the complexity of movement resulting from tunneling, it seems necessary for the determination of these movements have a reliable computational tool for the numerical simulation of this extremely delicate behavior.

Our contribution is a proper use of a computer code PLAXIS finite element 8.2 is a program in two dimension finite element specifically designed for analyzes performed deformation and stability for differing type of application in geotechnical

This last is made up of 04 modules summarize the almost unique approach to solving the problem of civil engeniring namely:

The input data program (Imput)

The calculation program (Calculations)

The program results (Output)

The program curves (Curves)

This code was used for modelling a digitally the case of Algiers metro in particular cutting calculation was chosen in the section hamma- garden test

The results can be thanks to this program are many PLAXIS

It is clear that the choice of a mesh enormously influenced the results we selected only the optimal mesh shown in Fig.2 the 1st forward calculation and second by giving against the deformation of the mesh into account the existence of a structure on the surface (cup packing)

Note that a ground movement occurred at the natural surface, so that e at the excavation The deformed mesh ment clearly shows the existence of a basin compaction caused by the construction of the tunnel

There has been some shortening the tunnel lining; this is due to the differing phases of construction such as excavation, filling the annular space, the paving

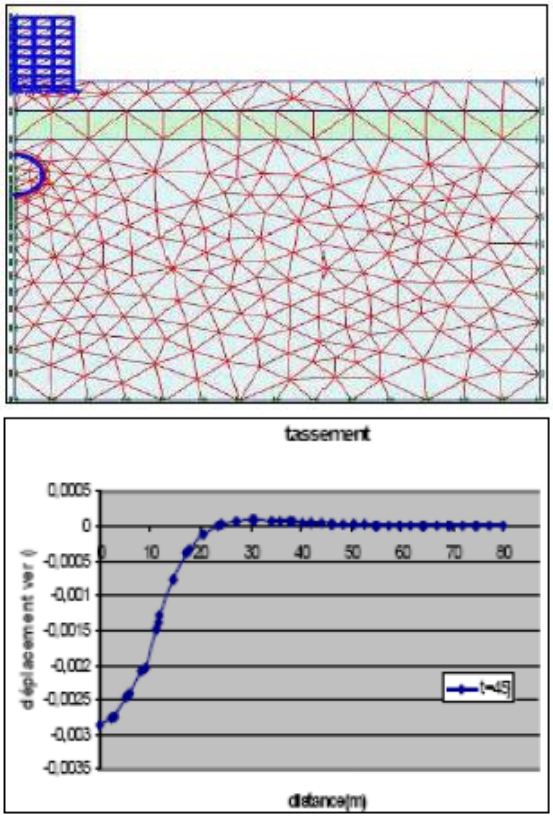

Fig.1 deformed mesh and cup of settlement

3. Parametric study:

3.1 The influence of geometric and geotechnical parameters

In this section, we studied the influence of the pro splitter and the diameter of the tunnel as well as some mechanical characteristic of the field as the coefficient of land, friction angle, Poisson's ratio, modulus of elasticity, on movement across the solid

3.1.1 The influences of geometric parametric

Influence depth to study the influence of the ratio of the tunnel on ground motion, we performed calculations for three different relationship

We plotted the cup packing for these differing depths in the end better see the différence that can undergo compaction by varying the ratio

Figure .2 below include the value of settlement found through our simulation, as well as the value of the width of the bowl

It is clear, that ratio increases more than the movement increases, this may be explained by the fact that the surface settlements are strong relationship with the convergence of the ground level to the excavation, and the radial movement around the tunnel is influenced by the variation of the ratio (the

radial displacement increases by increasing the ratio, panet, 1995) which leads to a vault effect less important on the contour of the excavation, and the settlements the same report were plotted for different values of key report similar findings were obtained

The purpose of a parametric study is to draw at the end of the study of charts to guide the user in his work by facilitating the task to its first approximations

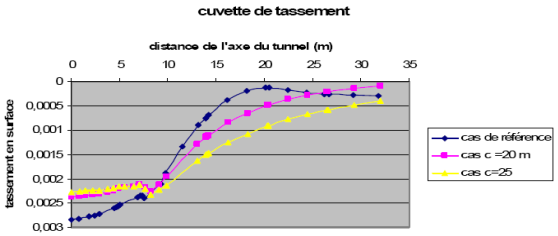

Figure A.2: Variation of depth

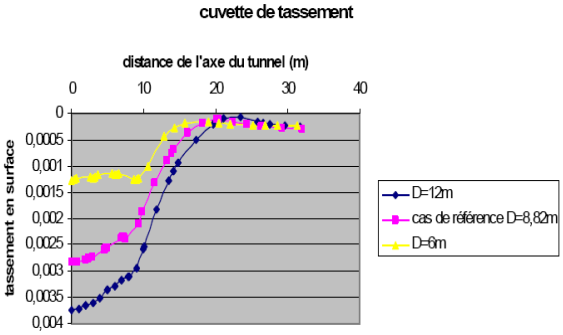

Figure.3: variation of the diameter

3.1.2 Influence of geotechnical parameters of the land

3.1.2.1 Coefficient of land at rest (ko)

To see the influence of geotechnical parameters of the land on soil behavior vis-à-vis the tunneling, we studied the influence of parameter ko to see the influence of the anisotropy of the initial stresses three cases been studied with coefficient values of land resting+ 0, 2.+ 0.4

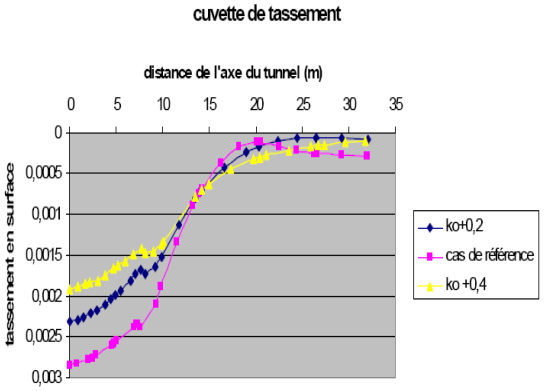

Figure.4: Coefficient of variation of land at rest (ko)

There through Figure.4 the surface settlements are influenced by the coefficient of land at rest, in fact, there is a reduction in the maximum surface settlement when ko augment

However, lateral movement does not seem to be affected, which allows us to say that the influence of the coefficient of land at rest is important on the final results of the settlement, these results were confirmed by some authors Mroueh (1998) Dolzhenko (2002), Robeert (2005)

3.1.2 .2 soil friction angle:

The angle of internal friction is a solid friction in a skeleton grains order to study the influence of this angle on the behavior of land undergoing excavation; we performed two calculations for the results found were prepared as next the curves

The variation of the angle of friction affects the maximum settlement and seems not to influence the width of the bowl, in fact, there is a reduction in the amplitude of the maximum settlement when the friction angle is about and when there is an increase in the settlement there is also a significant increase in horizontal displacements

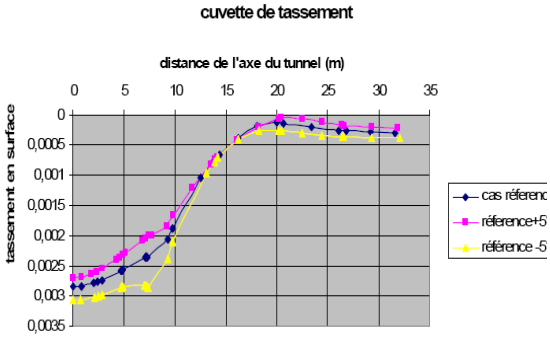

Figure.5: variation of the angle of friction of the soil

3.1.2.3 Poisson's ratio:

The Poisson's ratio characterizing the elastic behavior of the material in order to study the influence of Poisson's ratio on the behavior of soils, we performed two calculations with values of Poisson's ratio

The results for these values have allowed us to conclude that this parameter does not substantially affect the magnitude of settlements, in fact, the use of equations of the mmc.

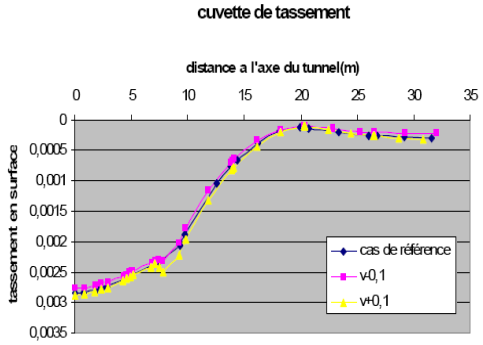

Figure.6: variation of Poisson's ratio

3.1.2.4 Soil Stiffness (E):

Soil stiffness was changed to three calculations due to analyze soil movements vis-à-vis Changing this parameter The results from these calculations show that the maximum settlements are affected by the change in stiffness soil, their amplitudes decrease by increasing this module

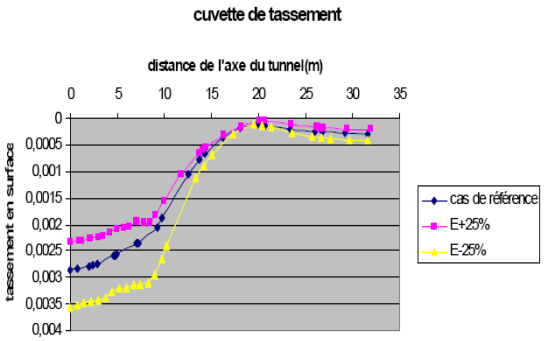

Figure.7: variation of soil stiffness (E)

These results we seem obvious that the increase in the modulus of elasticity and stiffens the floor therefore are reduced settlements

3.1.2.5 Mesh

Modification of this parameter The results from these calculations show that the maximum set-

tlements are affected by the variation of the model grid, their amplitudes decrease with decrease in the mesh

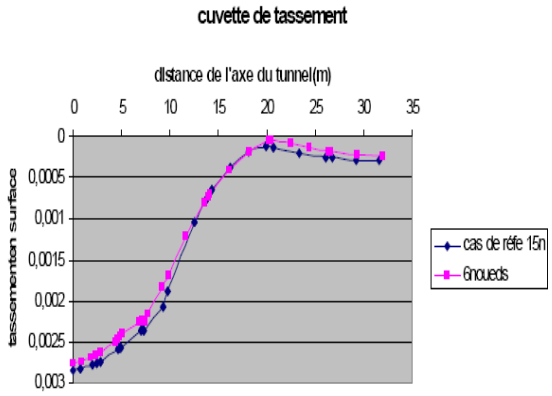

Figure.8: variation of mesh

3.1.3 .6 change in position of the Nappe

The change of this parameter indicates that the maximum subsidence are affected by the variation of the position of the web will increase when the amplitudes of the position away from the web natural surface

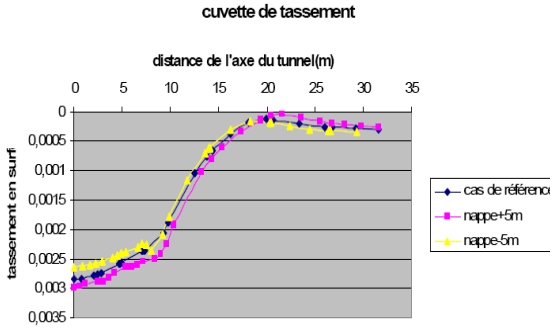

Figure.9: change in position of the Nappe

4. Conclusion:

According to the parametric study on the influence of rheological parameters, it was noted that the geotechnical parameters have an obvious influence on the behavior of soils especially in settlements where the need for a proper determination of these parameters,

The most influential parameters are Poisson's ratio, Young's modulus and the friction angle and the parameter mesh type and position of the water on the influence of digging a tunnel on the possible appearance of settlements due to the presence of a surface structure, the effect is significant and preliminary studies should consider this type of work during the various phases to correctly size the structure

5. Bibliographical references:

1-N, Dolzhenko (2002). Experimental and numerical modeling of two-dimensional underground urbain.réalisation bi trials
axial and oedometer on the analog ground taylor-Schneebeli, PhD thesis, INSA Lyon

2-D DIAS. (1999). Strengthening gauge tunnels by bolting. Numerical study and application to a real case in urban areas. PhD thesis, INSA Lyon

3-K, TERZAGHI, Peck, Mesri. Soil Mechanics in Engineering Practice 1940.534 pages

4-K, Terzaghi. (1943). Theoretical soil mechanics, 526 pages

5 - K, Terzaghi. Theoretical Soil Mechanics (New York, 1943) 278.

6- M. A. BIOT, *J. Appl. Phys.* 12 (1941) 155.

7- C. W. CRYER.a comparison of the three-dimensional consolidation theories of biot and terzaghi (1962)

8-I, BENAMAR (19-12-1996). Study of delayed effects in deep tunnels, PhD of the National School of Bridges and Roads, 205pages

9-M, Zouhair Babchia, J-P, Magnan. Numerical analysis of the behavior of massive clay, LPC N° 140 October 1986

10-H, Mroueh (27-05-1998). Tunnels in urban areas and numerical modelling interaction widening existing structures, PhD Central School of Lille, 132 pages

11-J-P, Magnan & L LEPIDAS. Parametric study of horizontal displacements of soft soil under the embankment during construction, GT42 July 1990

12-M, MRAD. (2005). modeling of the hydromechanical behavior of unsaturated expansive soils, PhD Thesis of National School of Geology, Nancy, 342 pages

13-A, ZADJAOUI (2000). Bibliographic analysis and numerical modeling of flow around tunnels. Magisterial memory, Department of Civil Engineering, Faculty of Engineering, University aboubakr Belkaid tlemcen. (Algeria).

14-M, ATWA. (1996). numerical analysis of water flow and soil consolidation around tunnels in clay, Doctoral Thesis of the National School of Bridges and Roads, 492 pages.

15-M, Ould AMY. (1990). Numerical modelling of flows and deformations in earth dams constructed on soft soils, PhD Thesis of the National School of Bridges and Roads, 275 pages.