Numerical Modelling of the Response Hydromécanique 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 bibliographic analysis and numerical modeling 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 estimate numerically the different movements caused by the construction of a tunnel at shallow depth (vertical and horizontal as well as pressure dissipation yard soil consolidation movement.

Keywords
Tunnel, the Algiers Metro, consolidation, coupled hydro-mechanical finite element method. Free surface, settlement, PLAXIS 8.2

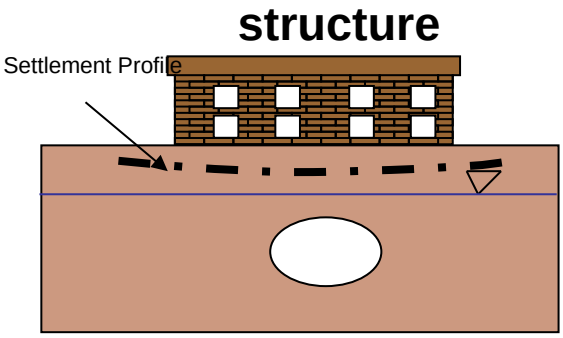
1. INTRODUCTION

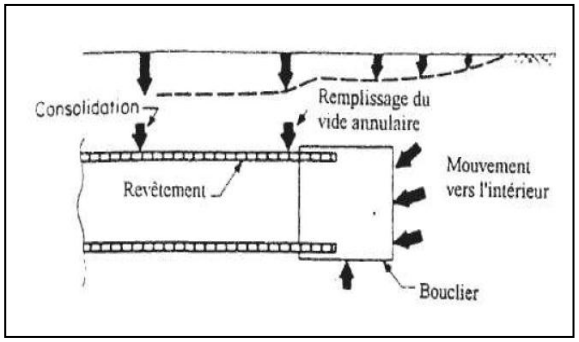
The digging of underground is nowadays one of the most suitable for the construction of infrastructure road and rail transport solutions, and drinking water and sanitation networks with major cities of the world have a growing need .

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 functional, usually constructed shallow reasons, movements

they cause, can damage the existing structures on the surface.

This problem is even more important in the presence of compressible soils. Settlements due to construction of the book are in the most important cases and they develop over time, sometimes for long periods of time after completion. These deferred deformations mainly concern the consolidation of fine soils that occurs over time by expulsion of excess pore water occupying the voids in the massif..





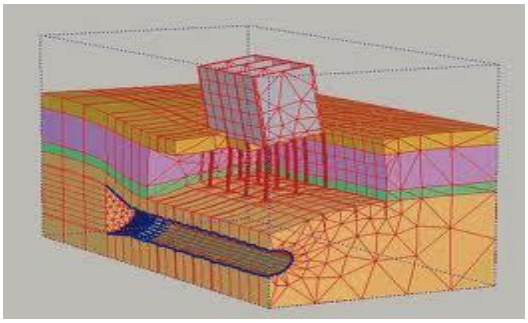


Fig.1: problematic

2. Mesh and numerical model

Given the complexity of movement resulting from tunnelling, 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 8.2 finite element 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 engineering namely:

The input data program **(Input)**
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 selected in the test section hamma garden

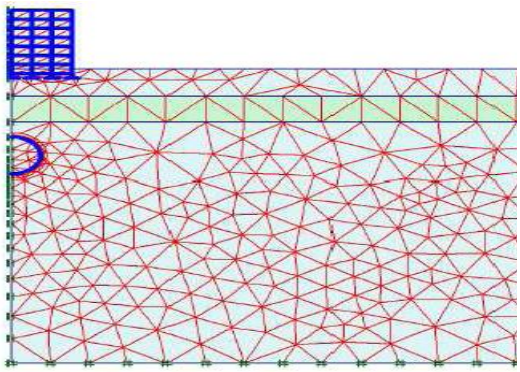
The results can be through this program PLAXIS are many

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

Note that a movement of soil occurred at the natural surface, so that e at the excavation

The deformed mesh shows clear ing the existence of a basin of settlement caused by the construction of the tunnel

Here 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



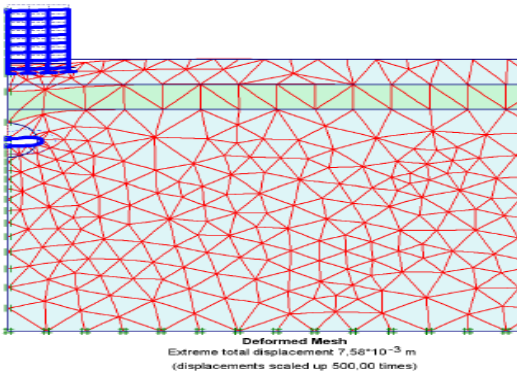
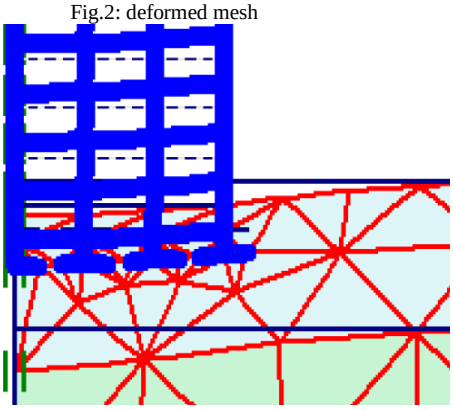


Fig.2: deformed mesh



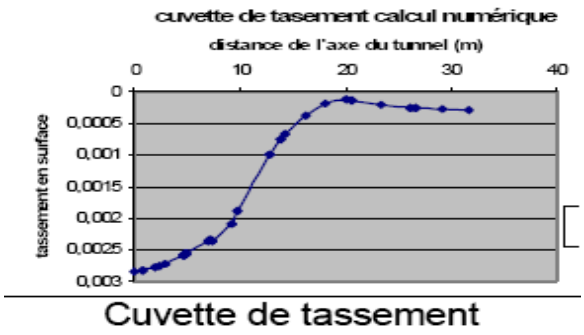


Fig.2: deformed mesh

3. Vertical displacement

The fig.3 shows the distribution of vertical displacement is in shade or color curves iso value

Thereafter we consider cuts in the horizontal direction (surface and above the tunnel) (key point called tunnel) we note that the key vertical displacement is greater than the surface

4. horizontal movements

In Simulator way we analyze the distribution of horizontal displacement Nuance color and iso value curve

We have shown in a vertical section the evolution of these last we note that the Horizontal displacement is almost zero below the tunnel

5. Evolution of pore pressure in the massive

Up to this point we have to mention the mechanical parameter, as engineer changing the pi implies emblem on the principle of Terzaghi bishop or a change in the effective stress which gives a mechanical effect that is why we presented the evolution of pi in time with differing section

Over time it decreased pi therefore water overpressure induced by the excavation are completely dissipated

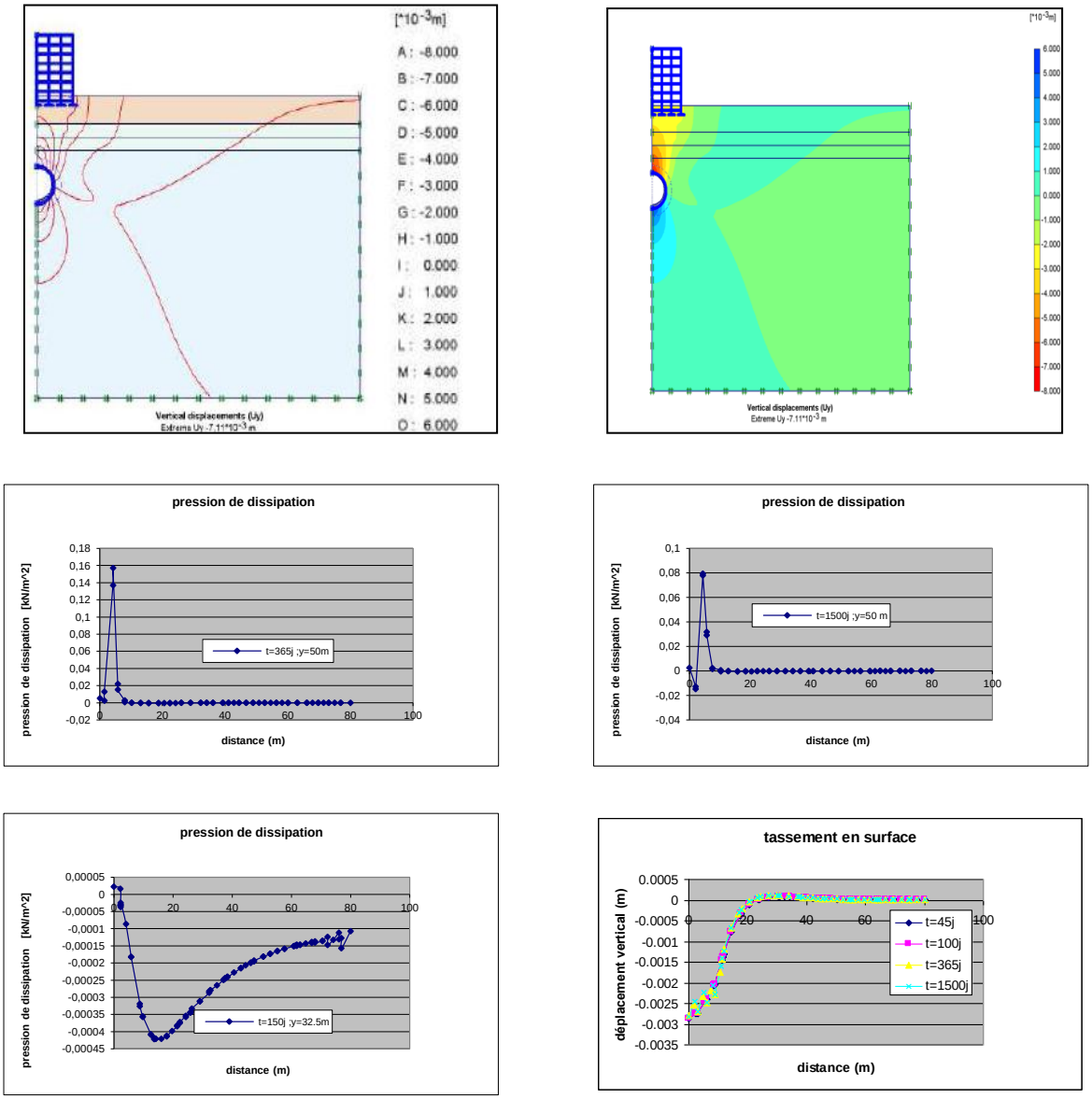


Fig.3: Vertical displacement

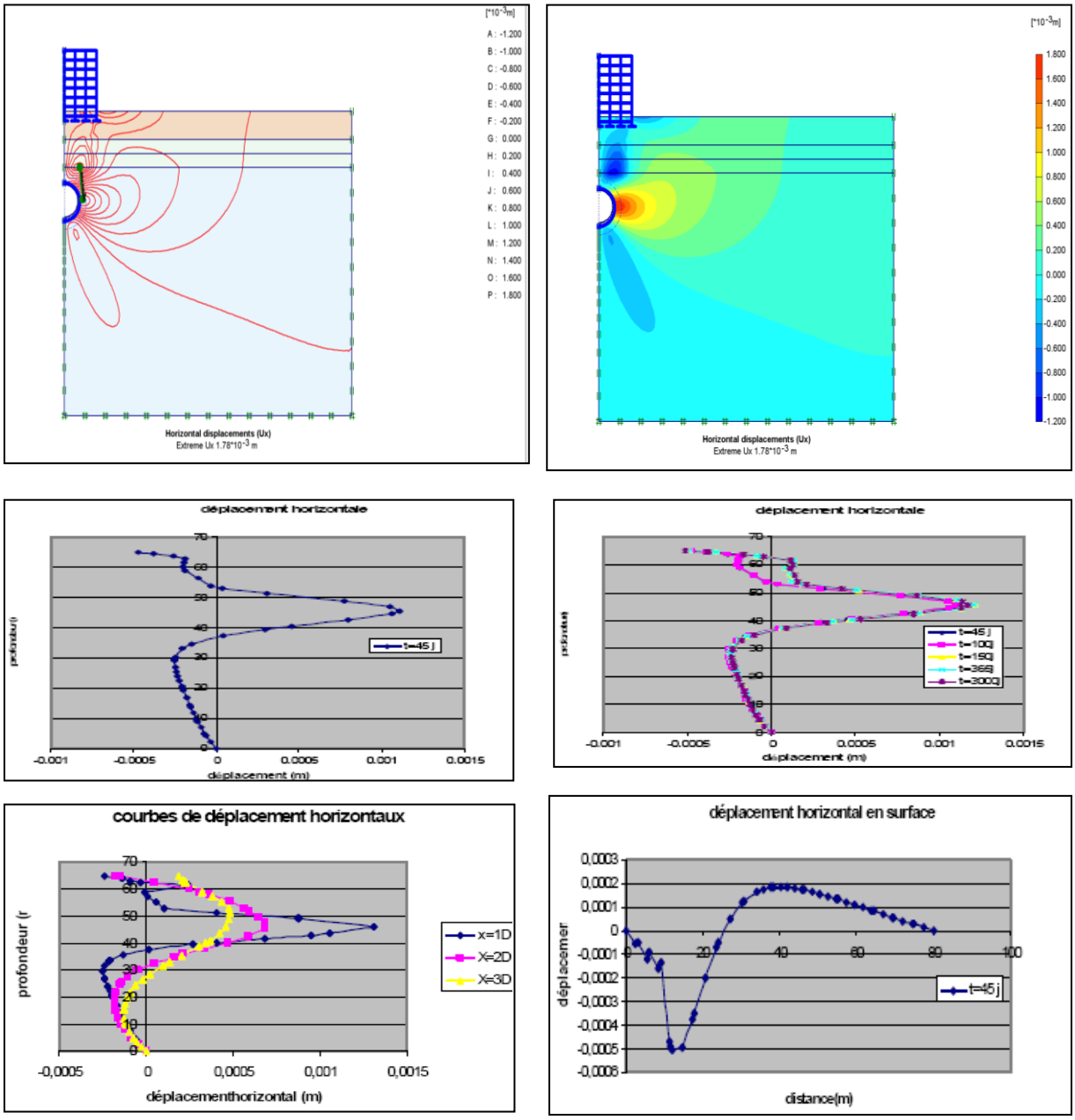


Fig.4: Horizontal Movements

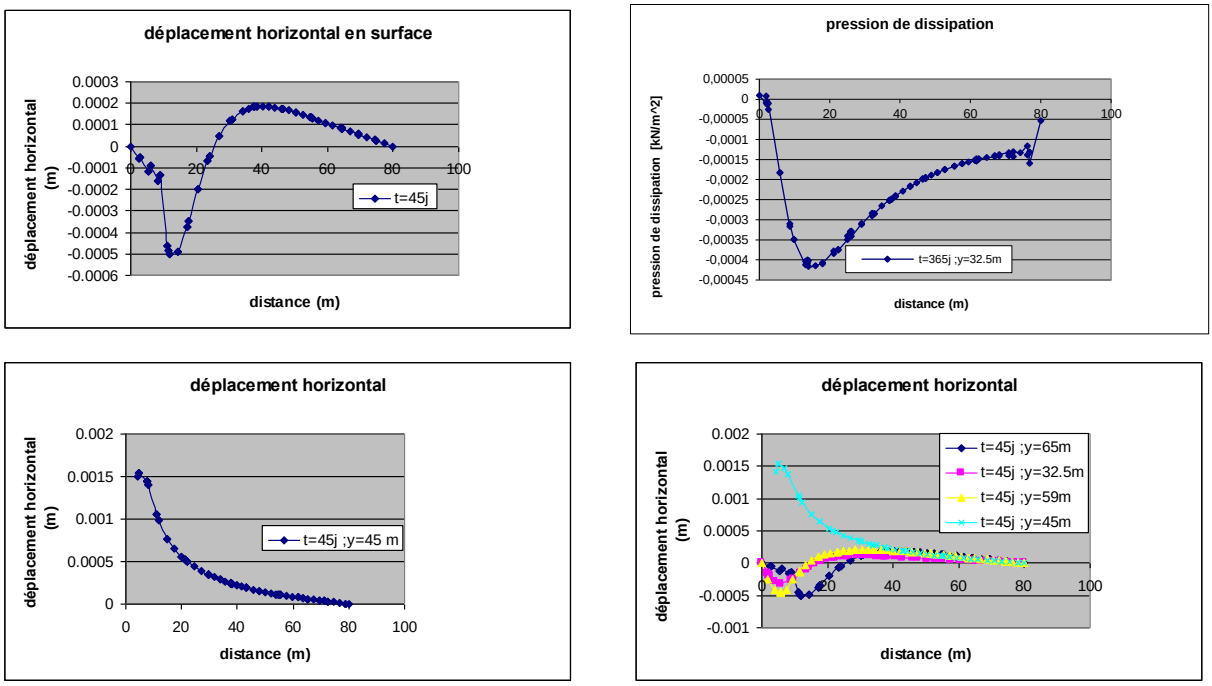


Fig.4: Horizontal Movements

Conclusion

The use of computer code Plaxis has enabled us to make a two-dimensional analysis of this phenomenon based on the finite element method and the results obtained are comparable to those obtained by other codes (Melanie), and measures in situ

The choice of parameters used in the finite element is very important, taking into account that the variation curves of the mechanical characteristics of the soil represent the means values of the measurements

Hydromechanical behavior of soils in tunnelling Take into account the phenomenon of tunnelling interaction with other structures on the surface and in depth such as masonry buildings, pipelines and underground pipes, deep foundations, tunnel existing study of a real example of reference Algiers metro study of consolidation around the tunnel and the influence of time on the appearance of long term settlements

7. 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

6.

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). modelling 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.

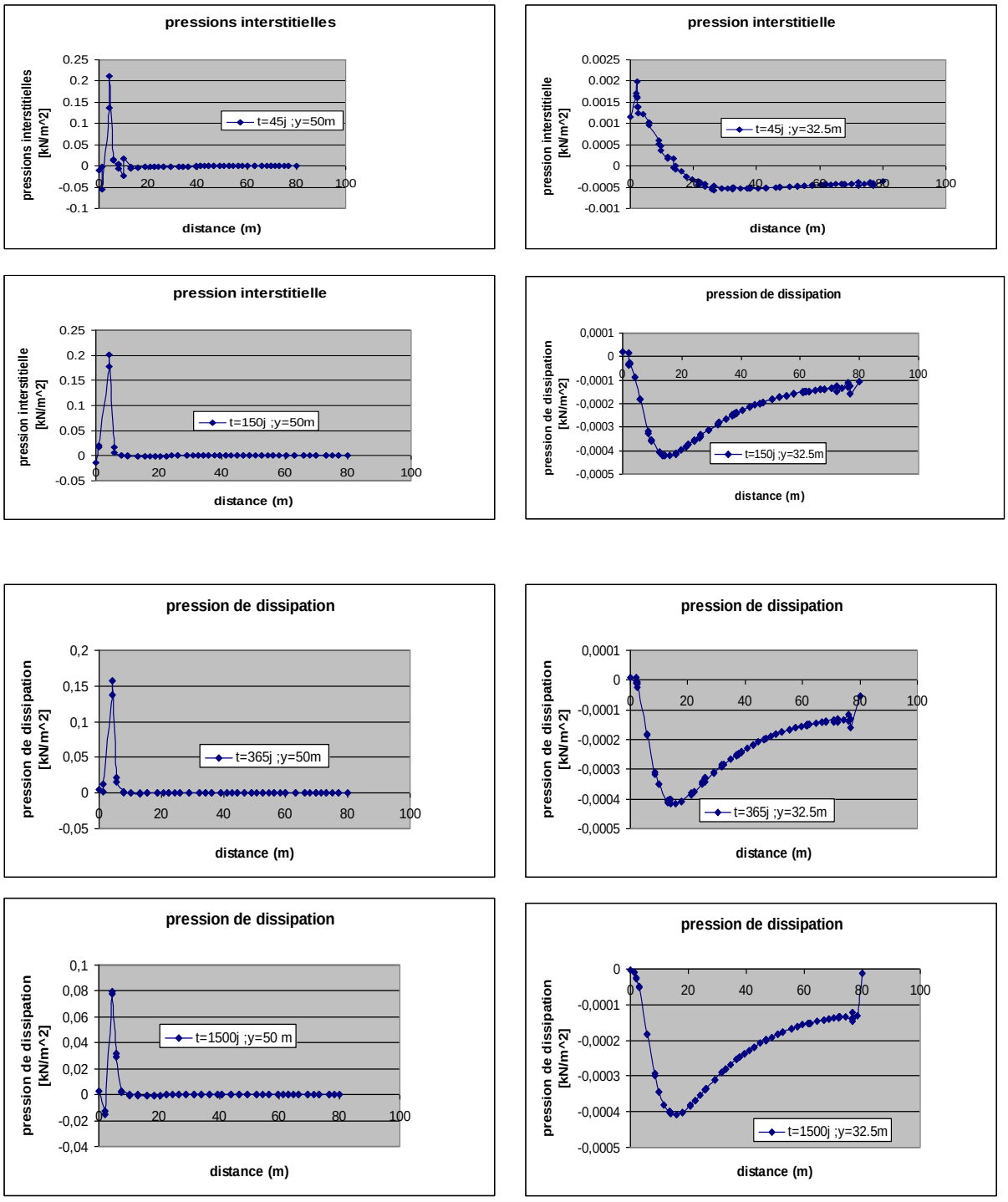


Fig.5: Evolution of pore pressure in the massive