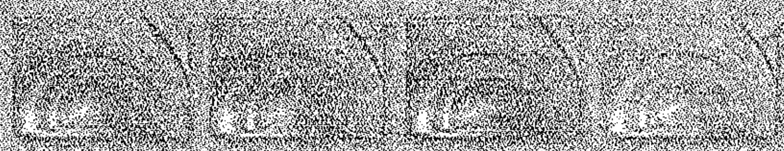
1.1.2.

Máster Universitario en Túneles y Obras Subterráneas



ÁREA: B
MÓDULO: DISEÑO Y PROYECTO DE TÚNELES

MÉTODOS NUMÉRICOS II

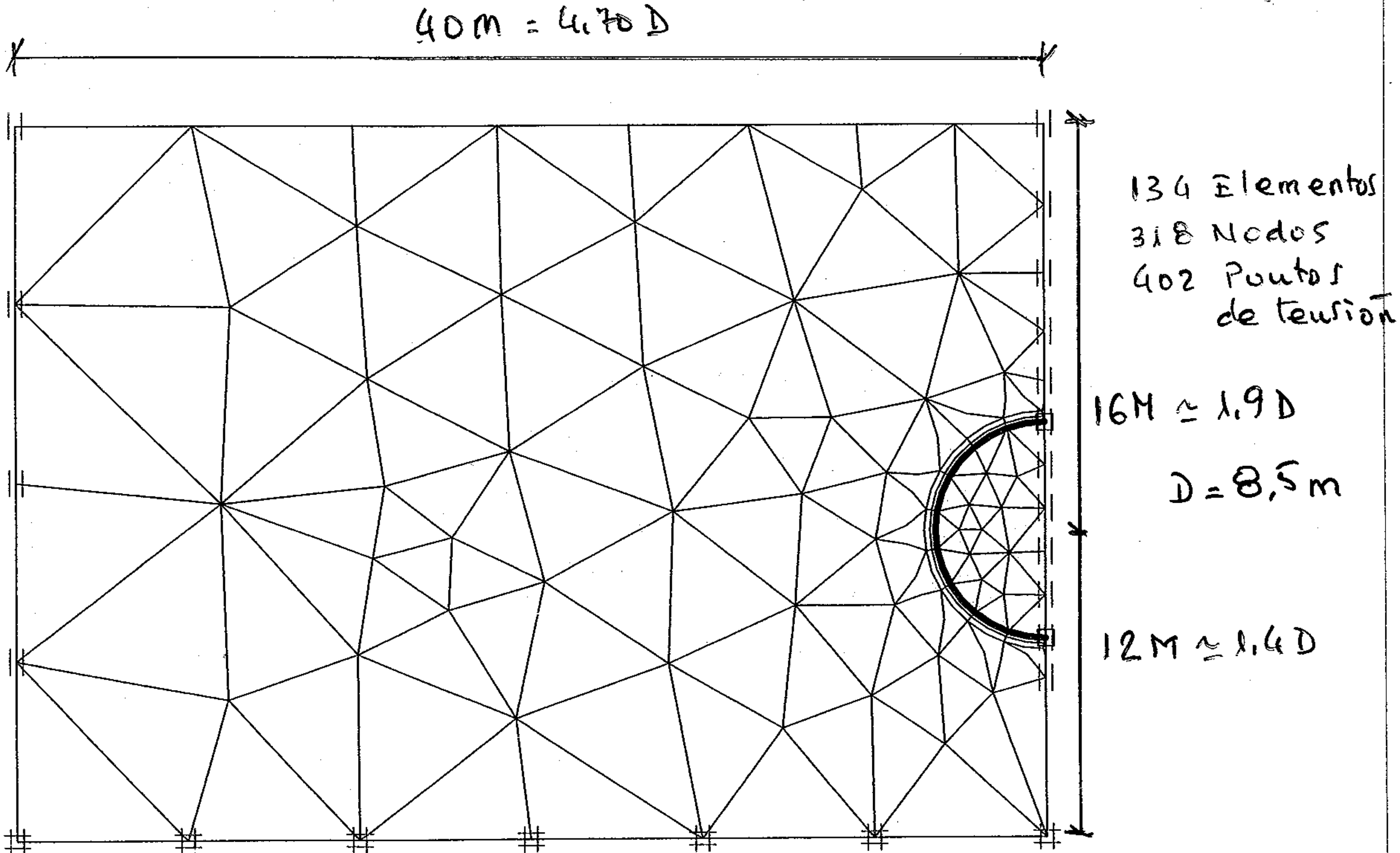
Ponente: Pablo de la Fuente
ETSCCIP. UPM
Día: 26/03/07
Hora: 19:15 a 20:15

MASTER EN TÚNELES Y OBRAS SUBTERRANEAS

MÉTODOS NUMERICOS CONTINUOS (II)

DR. PABLO DE LA FUENTE MARTÍN
E.T.S. INGENIEROS DE CAMINOS, C. Y P.
UNIVERSIDAD POLITÉCNICA DE MADRID

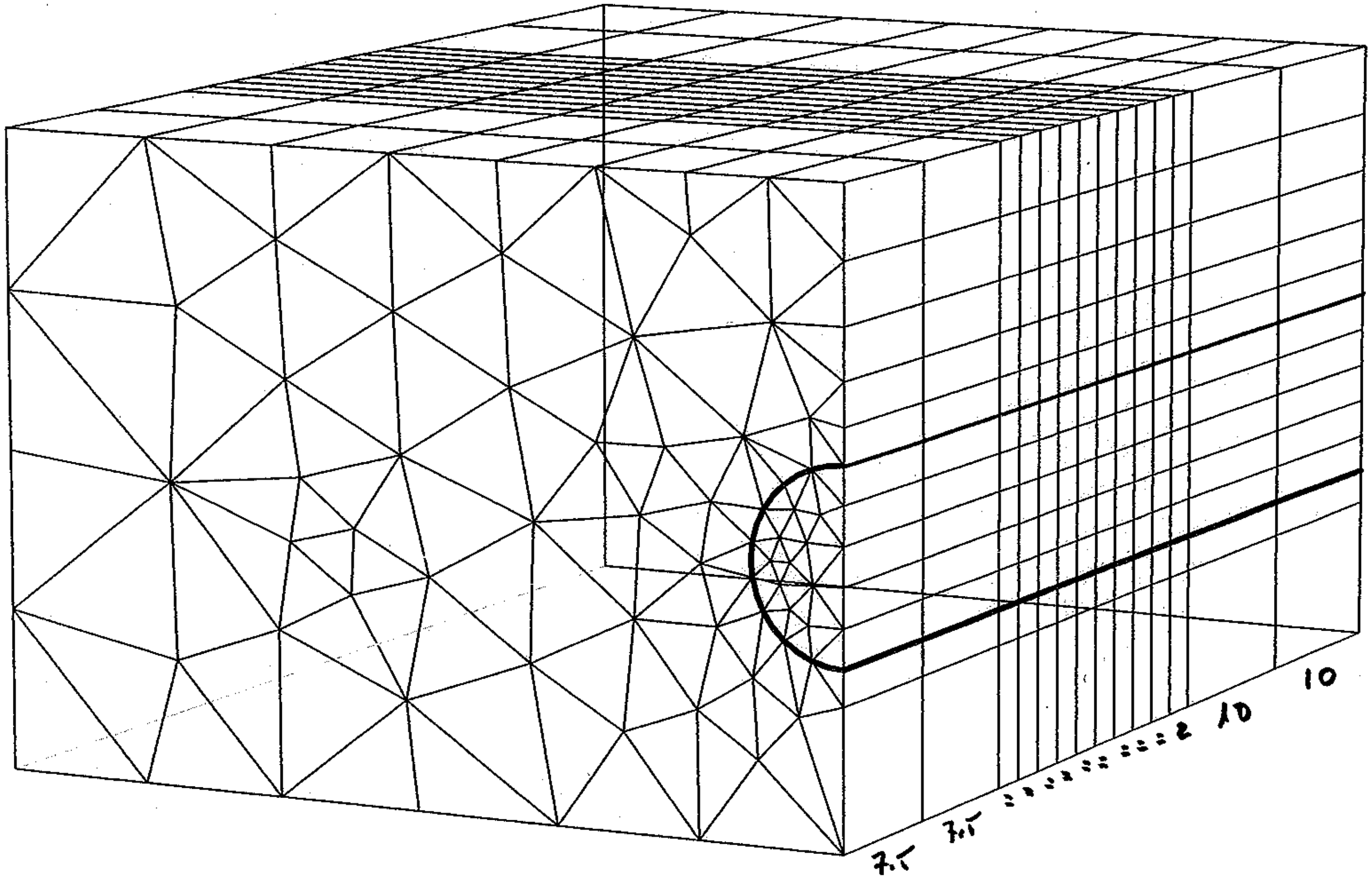
EJEMPLO DE APLICACIÒN EN 3D



Connectivities

PLAXIS Finite Element Code for Soil and Rock Analyses	Project description TUNEL_T_2		
	Project name	Date 31/05/05	User name Universidad Politecnica de Madrid

Version 1.2.1.210



1876 Elementos
6072 Nodos
11256 Puntos de tensión

Connectivities

PLAXIS Finite Element Code for Soil and Rock Analyses	Project description TUNEL_T_2		
	Project name	Date 31/05/05	User name Universidad Politecnica de Madrid

TUNEL_T_2

PROPIEDADES DEL TERRENO

HARDENING-SOIL MODEL.

$\gamma = 20\ kN/m^3$

$E_{50}^{ref} = 50.000\ kN/m^2$

$E_{oed}^{ref} = 50.000\ kN/m^2$

$E_{ur}^{ref} = 150.000\ kN/m^2$

$c' = 15\ kN/m^2$

$\phi' = 32^\circ$

$m = 0.5$; $R_f = 0{,}9$

ANILLOS DE HORMIGÓN

$e = 0{,}32\ m$

$EI = 7{,}6468E4\ kNm^2/m$

$EA = 8{,}96E6\ kN/m$

AVANCE

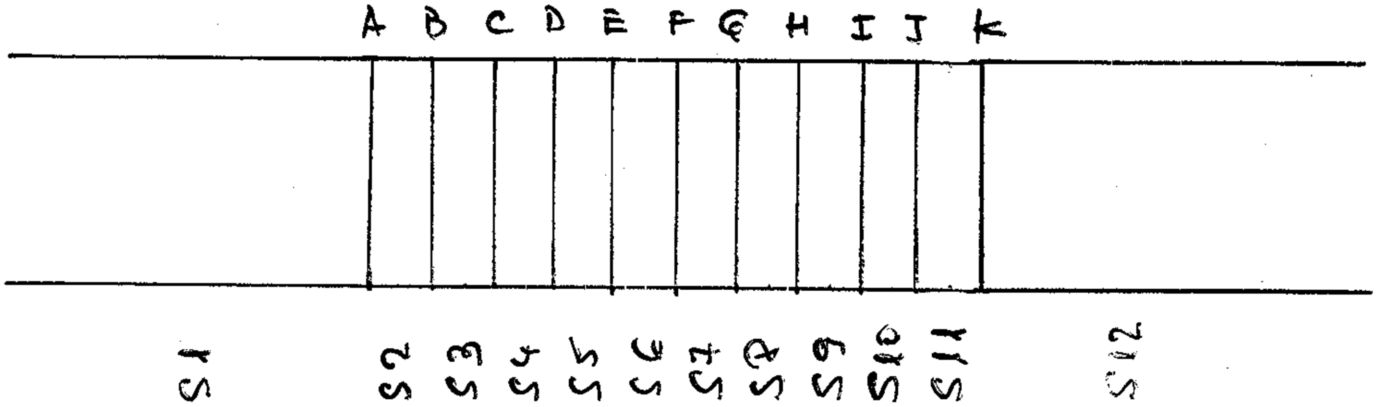
$e = 15\ cm.$

$EI = 703{,}125\ kNm^2/m$

$EA = 37{,}5E4\ kN/m$

TUNEL_T_2

ESTADO INICIAL DE TENSIONES: $K_0 = 0.5$



$p(\text{CLAVE}) = 100 \, kN/m^2$

$\nabla p = 10 \, kN/m^2/m$

FASE 1 : SE SIMULA LA EXCAVACIÓN Y COLOCACIÓN DE ANILLOS EN S1 (p en A)

FASE 2 : AVANCE DE ESCUDO EN S2 (p en B)

FASE 3 : COLOCACIÓN DE ANILLOS EN S2 Y AVANCE DE ESCUDO EN S3 (p en C)

FASE 4 : COLOCACIÓN DE ANILLOS EN S3 Y AVANCE DE ESCUDO EN S4 (p en D)

FASE 5 : COLOCACIÓN DE ANILLOS EN S4 Y AVANCE DE ESCUDO EN S5 (p en E)

FASE 6 : COLOCACIÓN DE ANILLOS EN S5 Y AVANCE DE ESCUDO EN S6 (p en F)

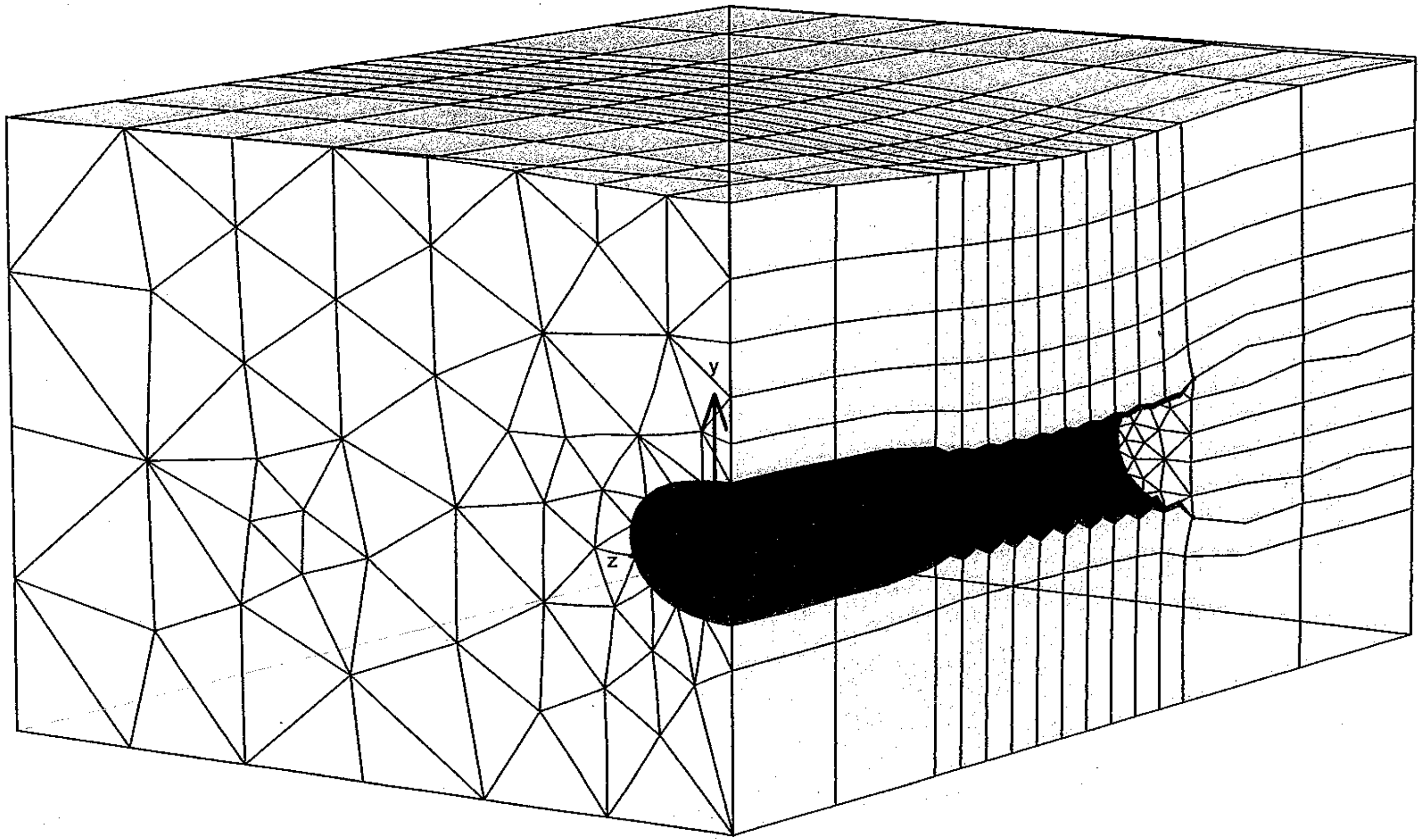
FASE 7 : COLOCACIÓN DE ANILLOS EN S6 Y AVANCE DE ESCUDO EN S7 (p en G)

FASE 8 : COLOCACIÓN DE ANILLOS EN S7 Y AVANCE DE ESCUDO EN S8 (p en H)

FASE 9 : COLOCACIÓN DE ANILLOS EN S8 Y AVANCE DE ESCUDO EN S9 (p en I)

FASE 10: COLOCACIÓN DE ANILLOS EN S9 Y AVANCE DE ESCUDO EN S10 (p en J)

FASE 11: COLOCACIÓN DE ANILLOS EN S10 Y AVANCE DE ESCUDO EN S11. (p en K)

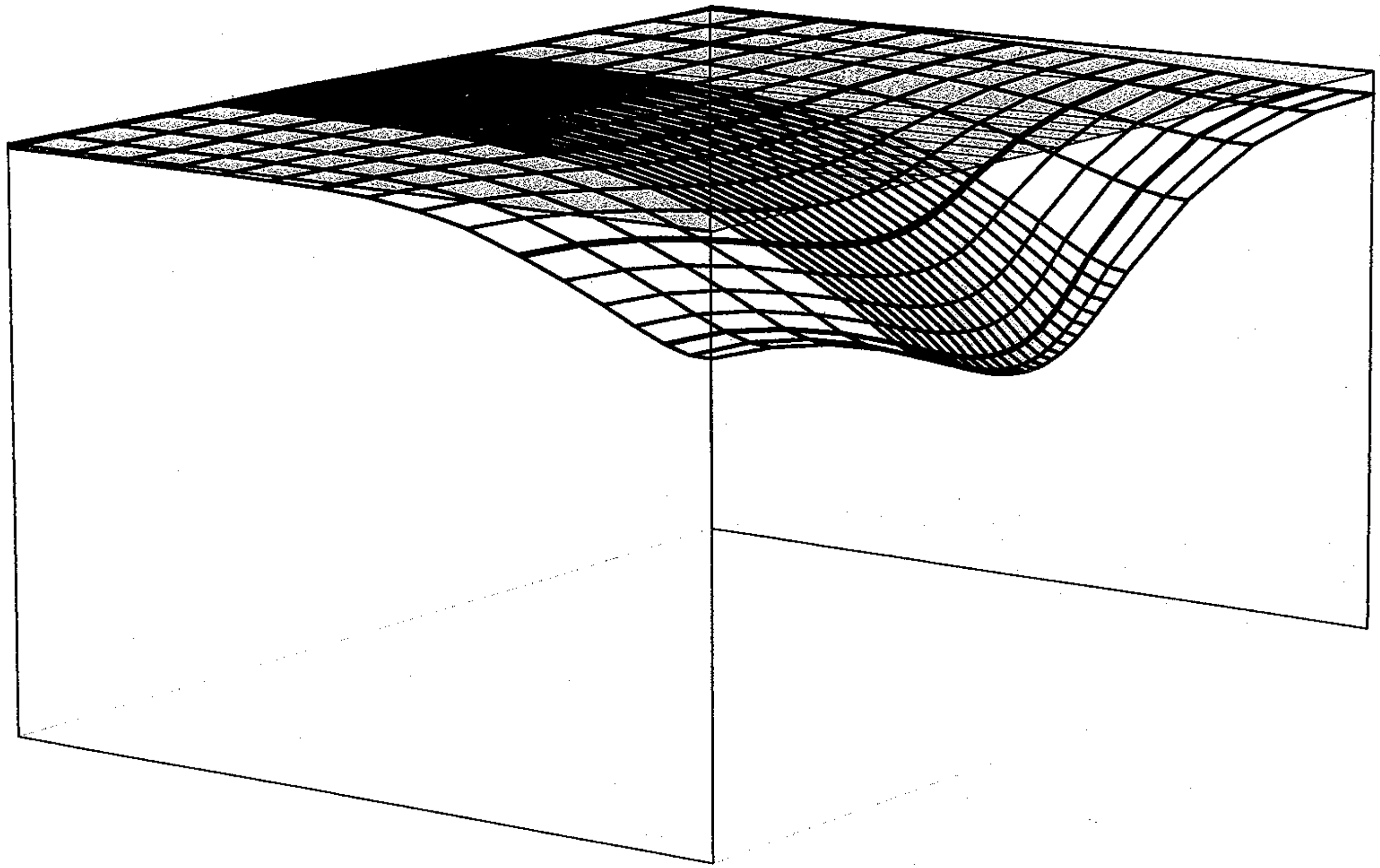


Deformed Mesh
Extreme total displacement 8,24*10^{-3} m
(displacements scaled up 300,00 times)

PLAXIS Finite Element Code for Soil and Rock Analyses	Project description TUNEL_T_2		
	Project name TUNEL_T_2	Step 16	Date 31/05/05

User name: Universidad Politecnica de Madrid

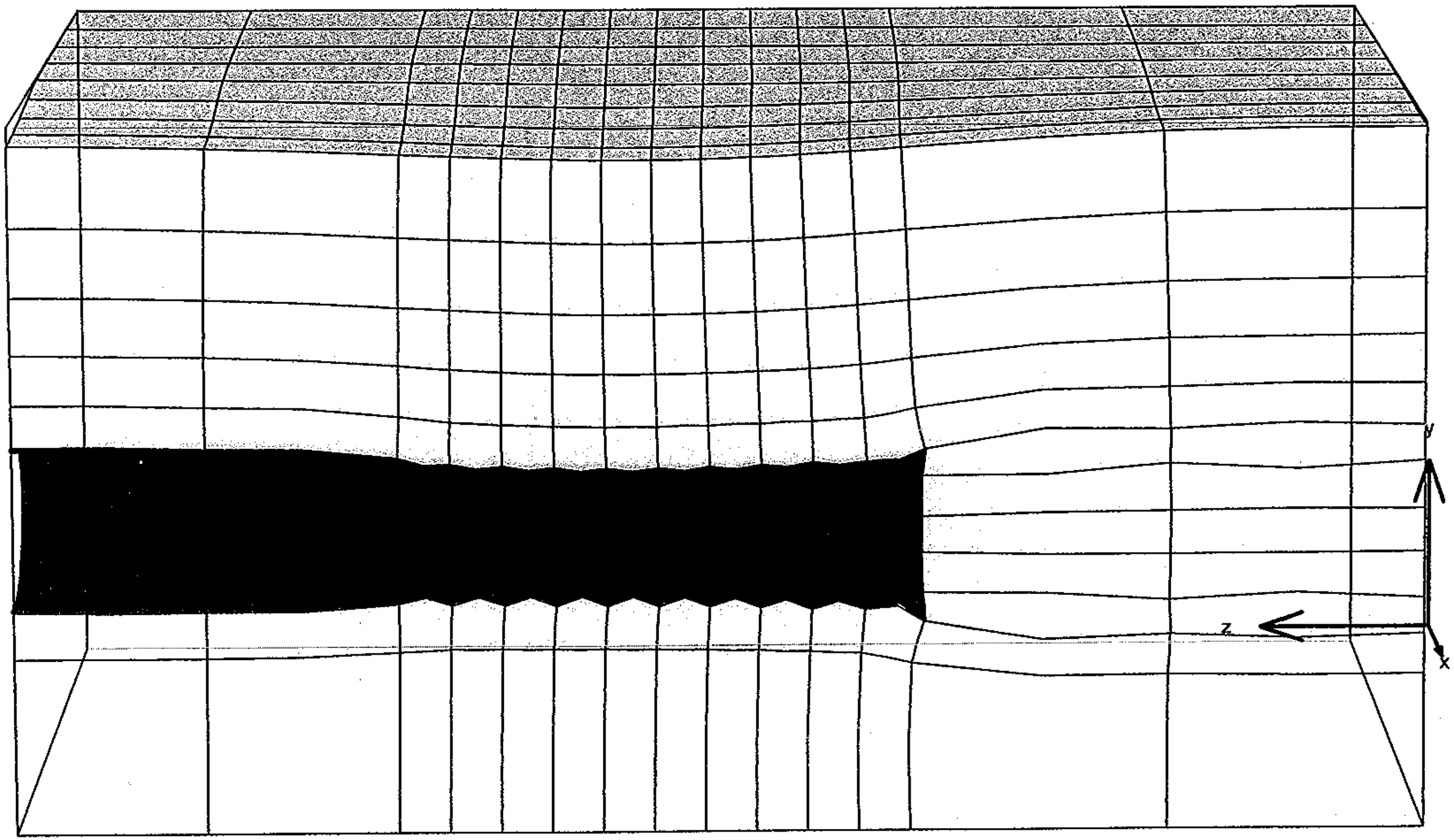
Version 1.2.1.210



Total displacements Utot
Extreme Utot $5,36*10^{-3}$ m

PLAXIS Finite Element Code for Soil and Rock Analyses	Project description TUNEL_T_2		
	Project name TUNEL_T_2	Step 16	Date 31/05/05

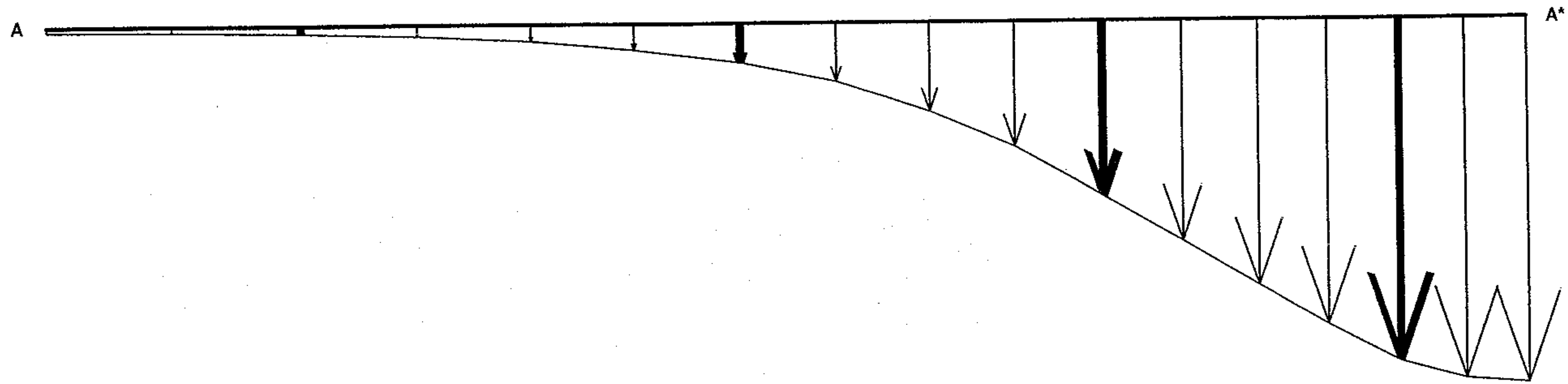
User name: Universidad Politecnica de Madrid



Deformed Mesh
Extreme total displacement $8,24 \cdot 10^{-3}$ m
(displacements scaled up 250,00 times)

PLAXIS Finite Element Code for Soil and Rock Analyses	Project description			
	TUNEL_T_2			
	Project name: TUNEL_T_2	Step: 16	Date: 31/05/05	User name: Universidad Politecnica de Madrid

Version 1.2.1.210

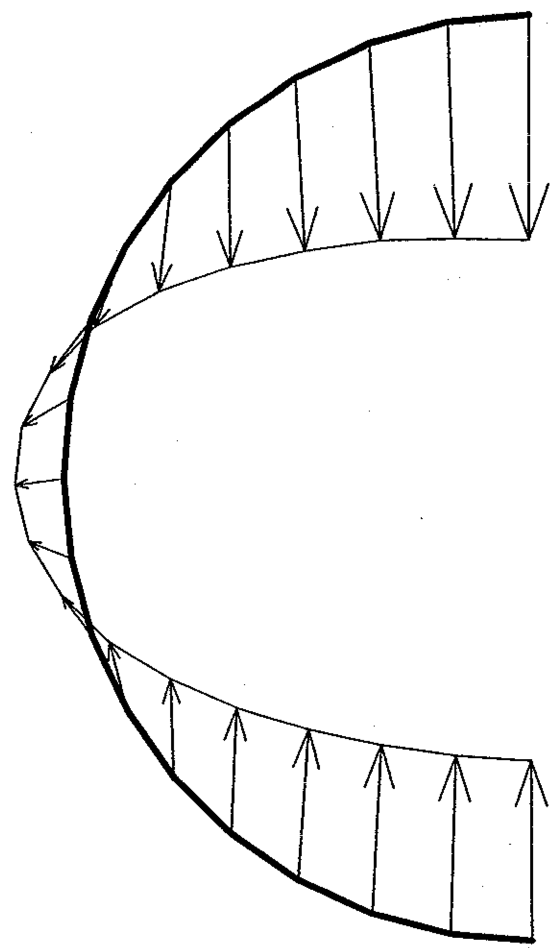


Vertical displacements Uy
Extreme Uy for this plane 5,35*10^{-3} m

PLANO F

PLAXIS Finite Element Code for Soil and Rock Analyses	Project description TUNEL_T_2		
	Project name TUNEL_T_2	Step 16	Date 31/05/05	User name Universidad Politecnica de Madrid

Version 1.2.1.21

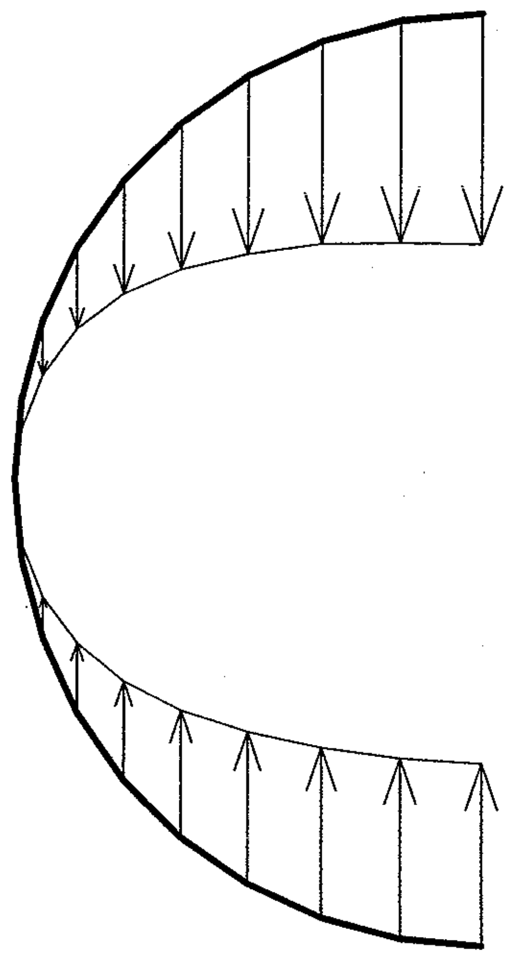


PLANO F

MOV. TOTALES MÁX = 1,29 mm

PLAXIS Finite Element Code for Soil and Rock Analyses	Project description TUNEL_T_2			
	Project name TUNEL_T_2	Step 16	Date 31/05/05	User name Universidad Politecnica de Madrid

Version 1.2.1.210



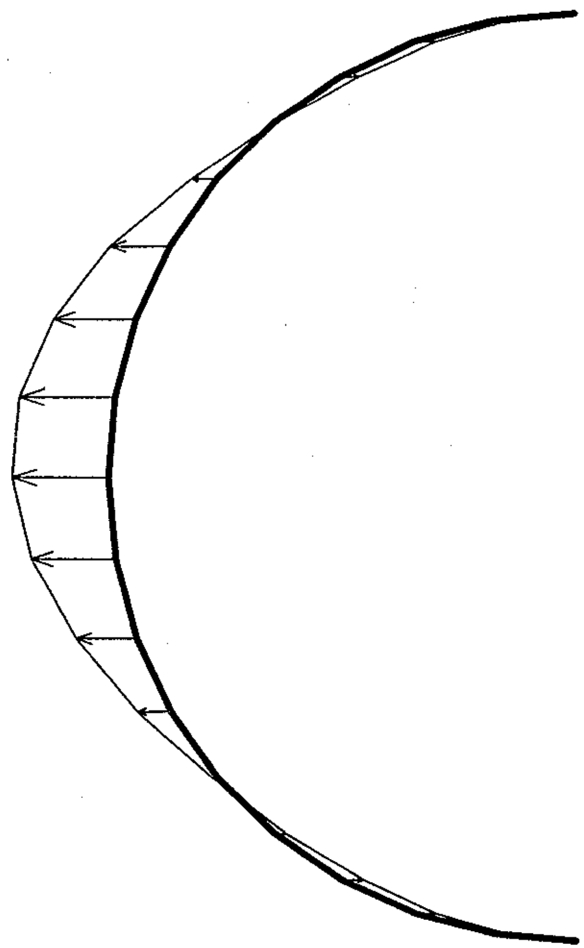
PLANO F

MÁX = 7,19 mm

MOV. VERTICALES

PLAXIS Finite Element Code for Soil and Rock Analyses	Project description TUNEL_T_2		
	Project name TUNEL_T_2	Step 16	Date 31/05/05	User name Universidad Politecnica de Madrid

Version 1.2.1.210

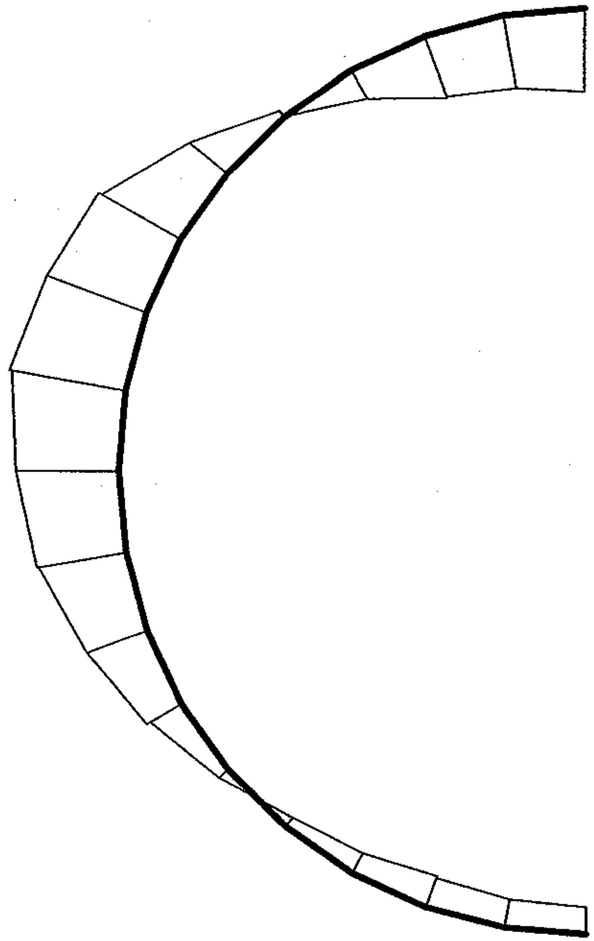


MAX = 1,55 mm

MOV. HORIZ.

PLAXIS Finite Element Code for Soil and Rock Analyses	Project description TUNEL_T_2		
Project name TUNEL_T_2	Step 16	Date 31/05/05	User name Universidad Politecnica de Madrid

Version 1.2.1.210



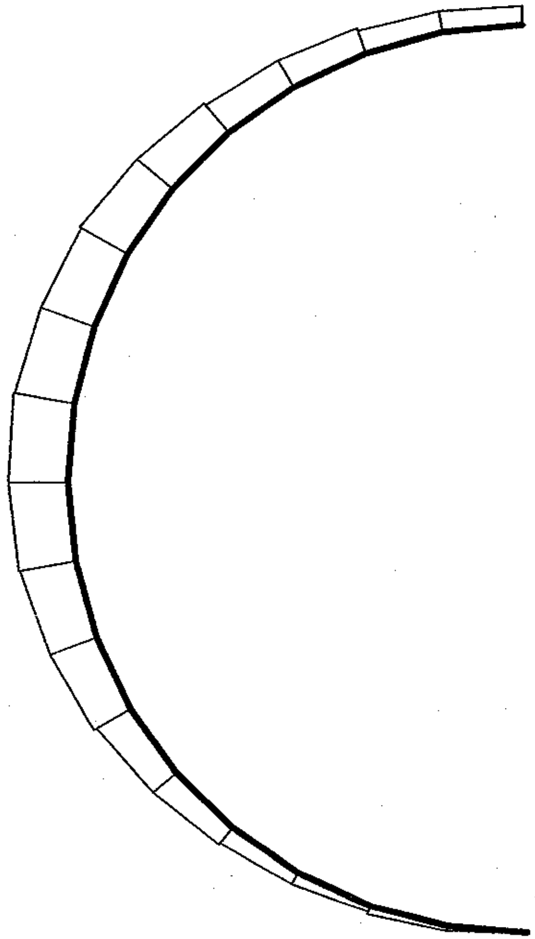
PLANO C

LEY DE MOMENTOS

MÁX = 34 kNm/m

PLAXIS Finite Element Code for Soil and Rock Analyses	Project description TUNEL_T_2		
Project name TUNEL_T_2	Step 16	Date 31/05/05	User name Universidad Politecnica de Madrid

Version 1.2.1.210



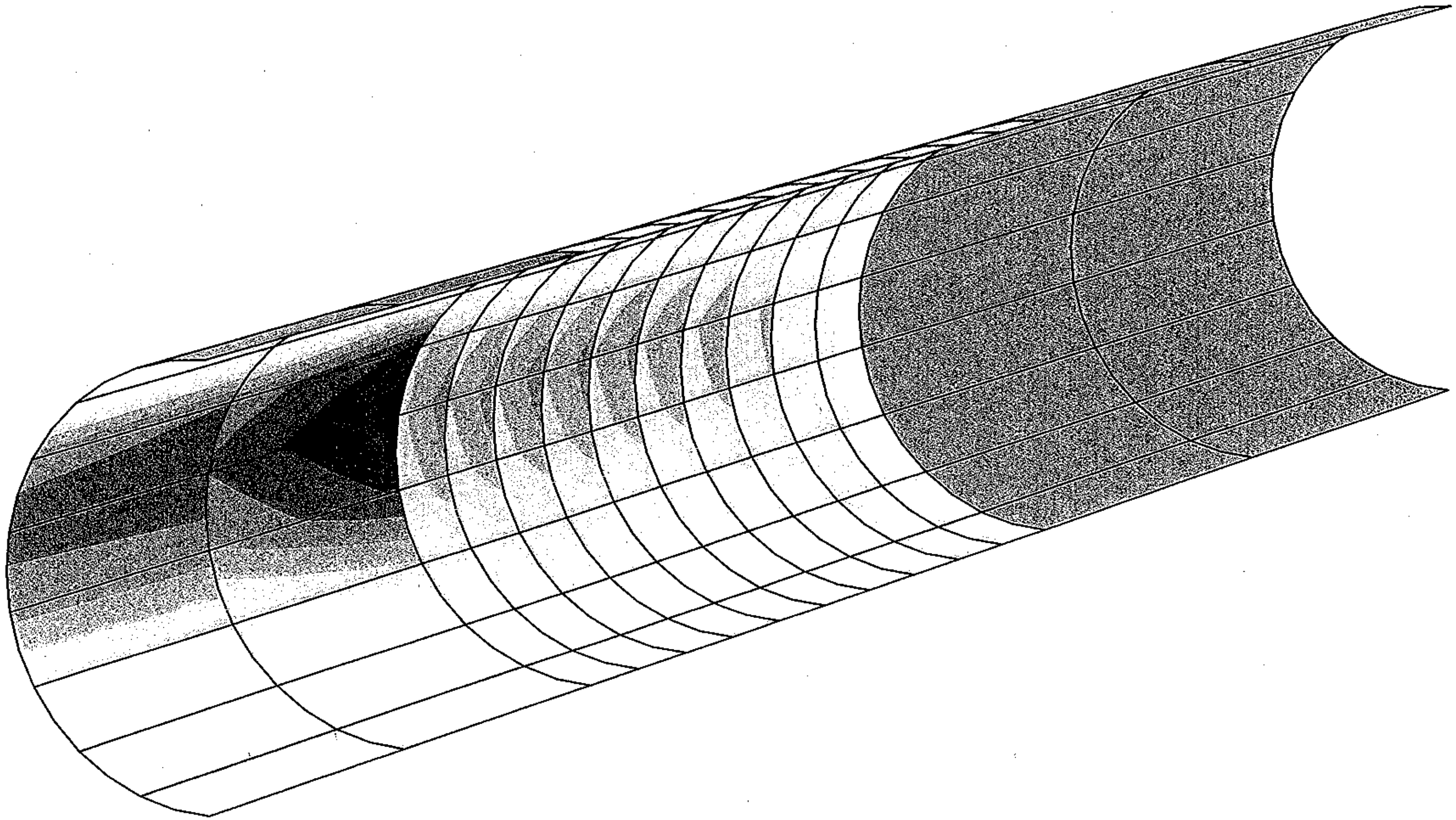
PLANO C

LEY DE AXILES

MÁX = 401 kN/m

PLAXIS Finite Element Code for Soil and Rock Analyses	Project description TUNEL_T_2		
Project name TUNEL_T_2	Step 16	Date 31/05/05	User name Universidad Politecnica de Madrid

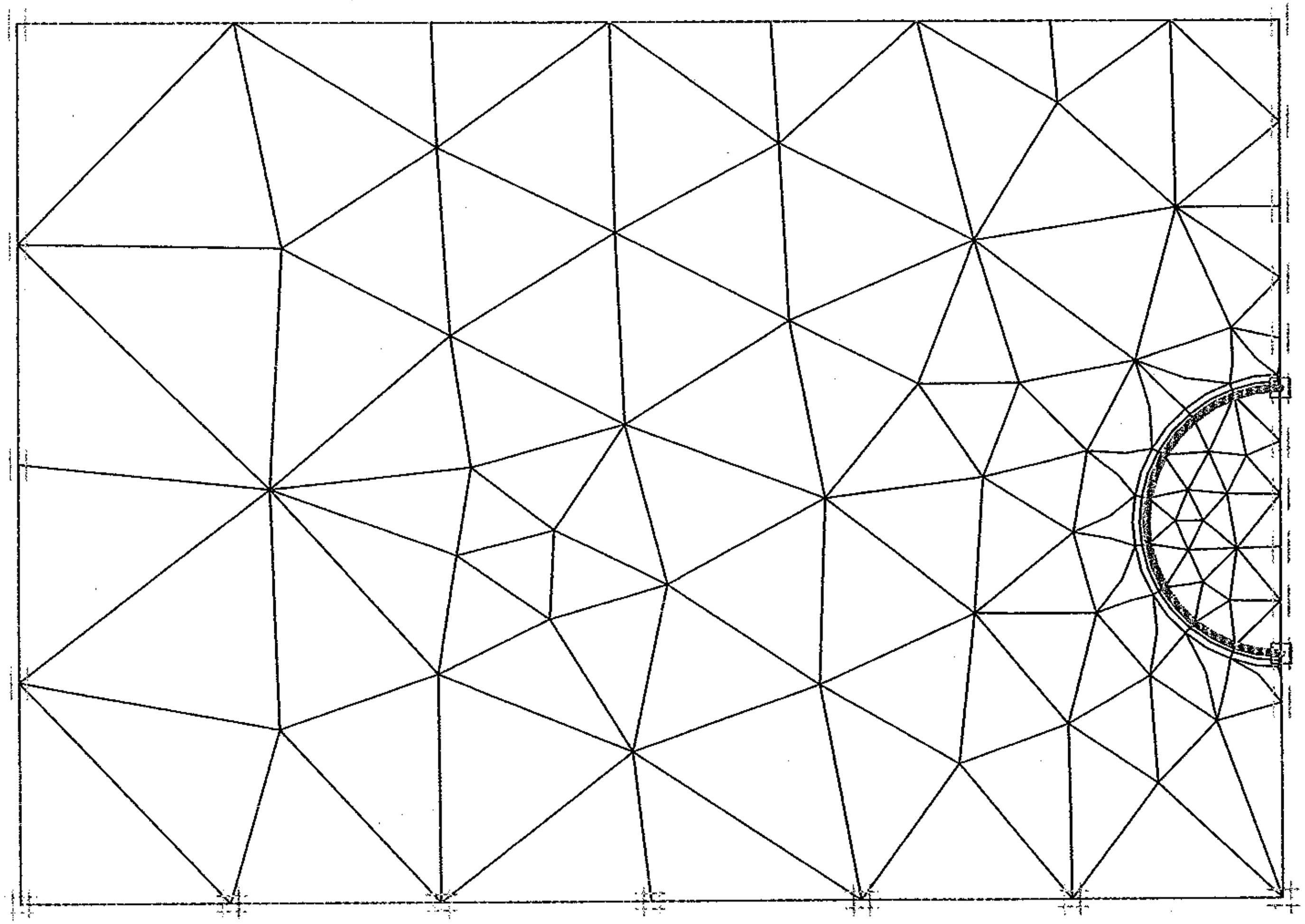
Version 1.2.1.210



Bending moments M11
Extreme bending moment -75,11 kNm/m

PLAXIS Finite Element Code for Soil and Rock Analyses	Project description TUNEL_T_2		
	Project name TUNEL_T_2	Step 16	Date 31/05/05	User name Universidad Politecnica de Madrid

EJEMPLO DE APLICACIÓN EN 2D



COEF. RELAJACIÓN
$\alpha = 0.3$

$K_0 = 0,5$

Connectivities

PLAXIS
Finite Element Code for Soil and Rock Analyses

Project description

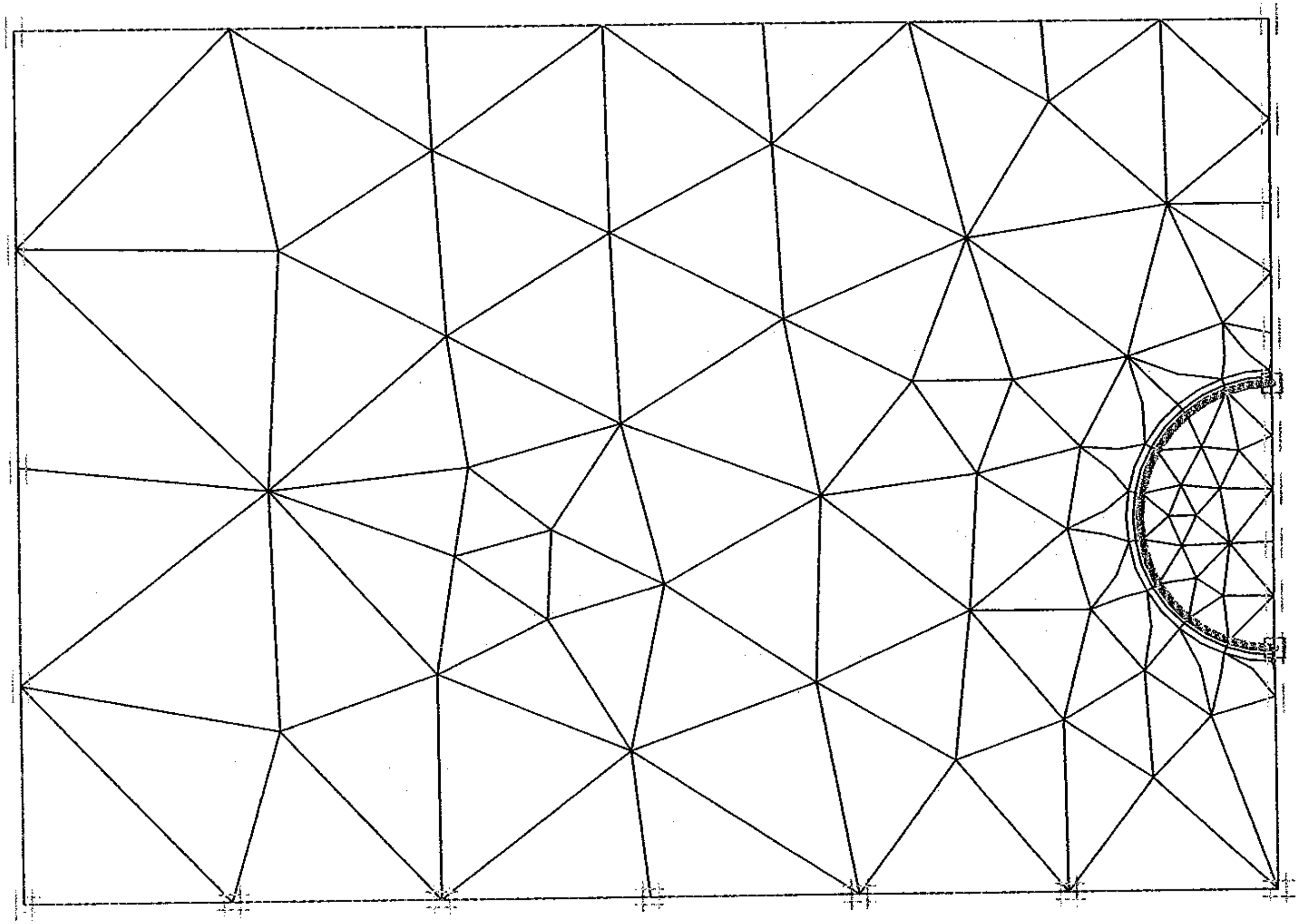
TUNEL_B_2

Project name

Date
31/05/05

User name
Universidad Politecnica de Madrid

Version 1.2.1.210



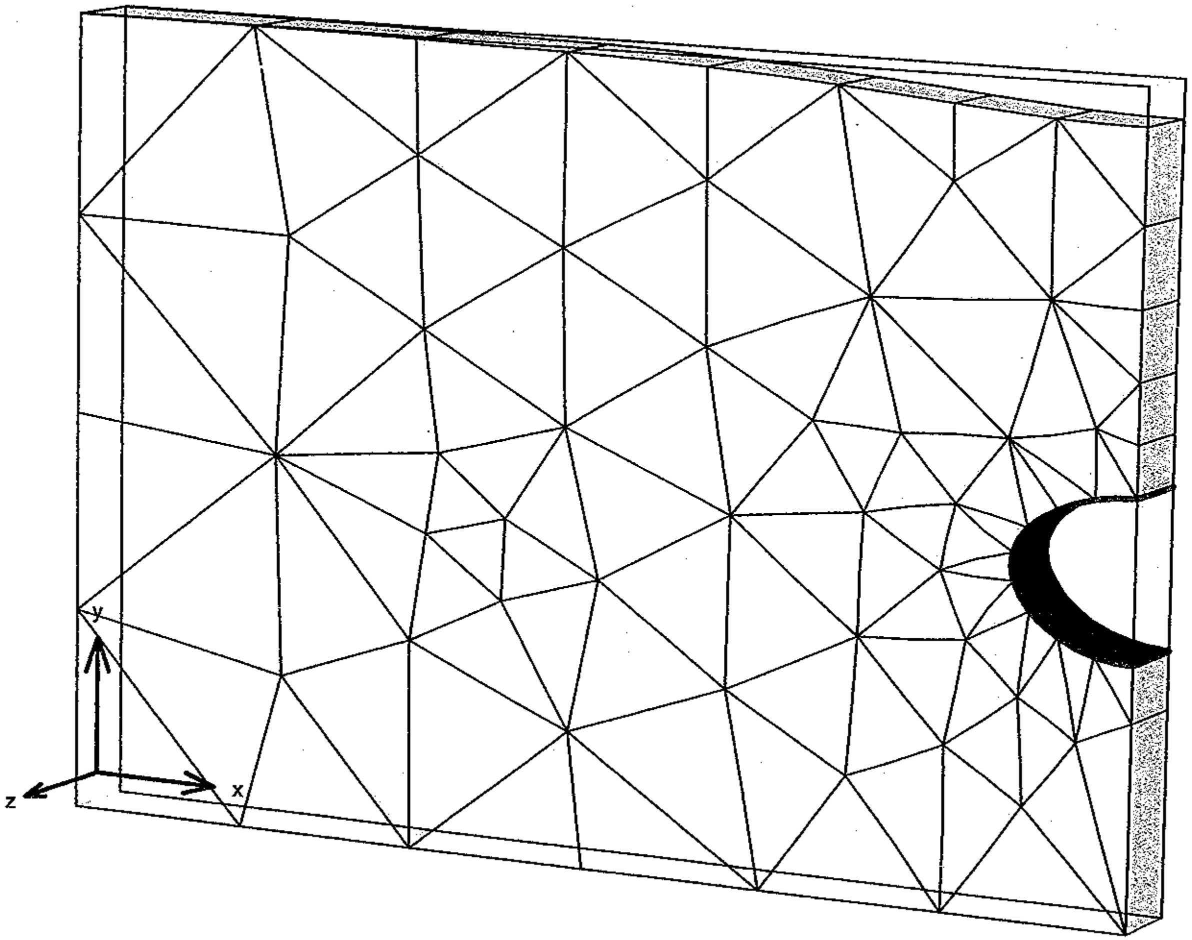
COEF. RELAJACIÓN
$\alpha = 0.3$

$K_o = 0,5$

Connectivities

PLAXIS Finite Element Code for Soil and Rock Analyses	Project description	TUNEL_B_2	
	Project name	Date 31/05/05	User name Universidad Politecnica de Madrid

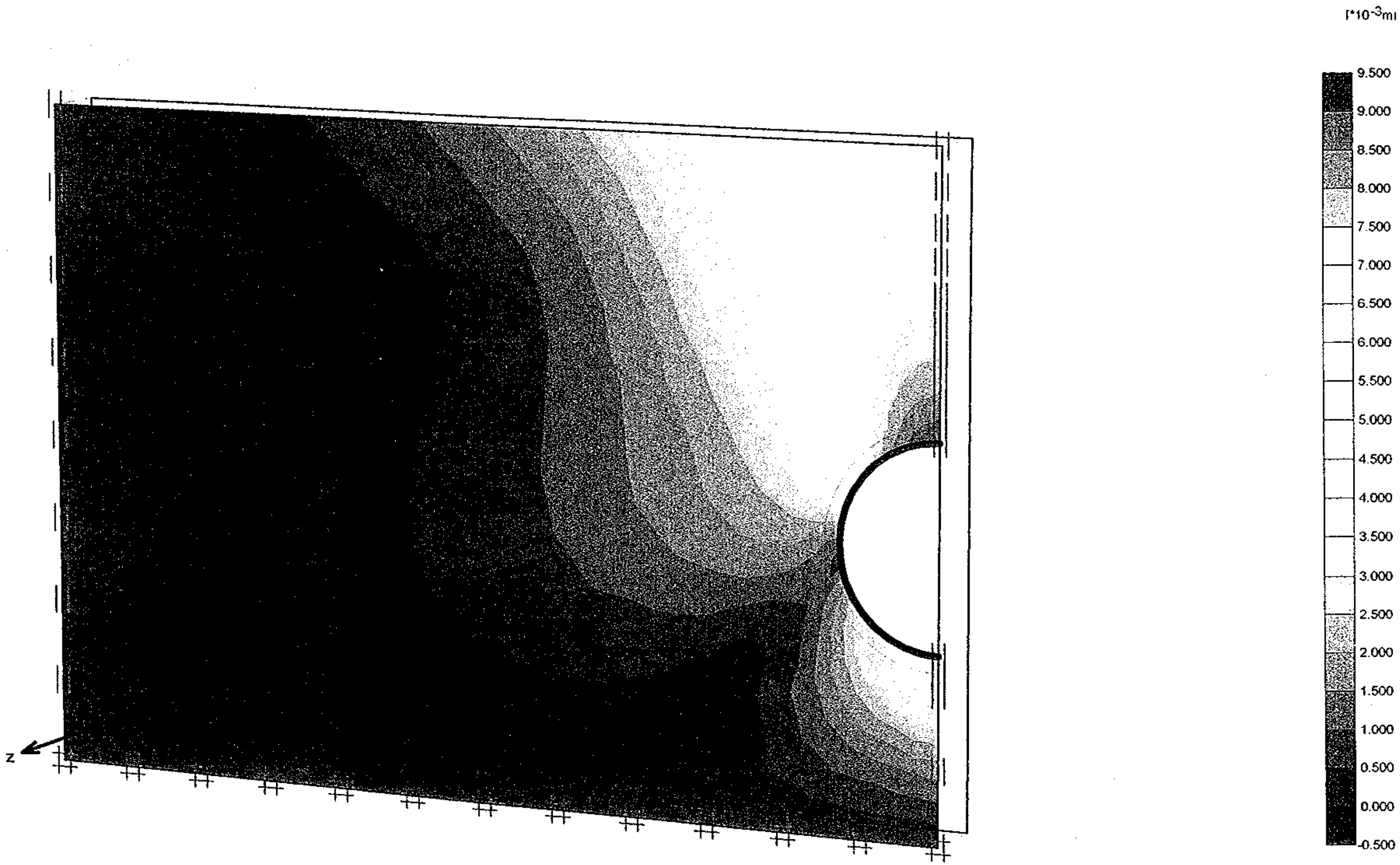
Version 1.2.1.210



Deformed Mesh
Extreme total displacement $9{,}31 \cdot 10^{-3}$ m
(displacements scaled up 200,00 times)

PLAXIS
Finite Element Code for Soil and Rock Analyses
Version 1.2.1.210

Project description			
TUNEL_B_2			
Project name	Step	Date	User name
TUNEL_B_2	4	31/05/05	Universidad Politecnica de Madrid



Total displacements (Utot)
Extreme Utot $9.11 \cdot 10^{-3}$ m

PLAXIS Finite Element Code for Soil and Rock Analyses	Project description			
	TUNEL_B_2			
	Project name: TUNEL_B_2	Step: 4	Date: 31/05/05	User name: Universidad Politecnica de Madrid

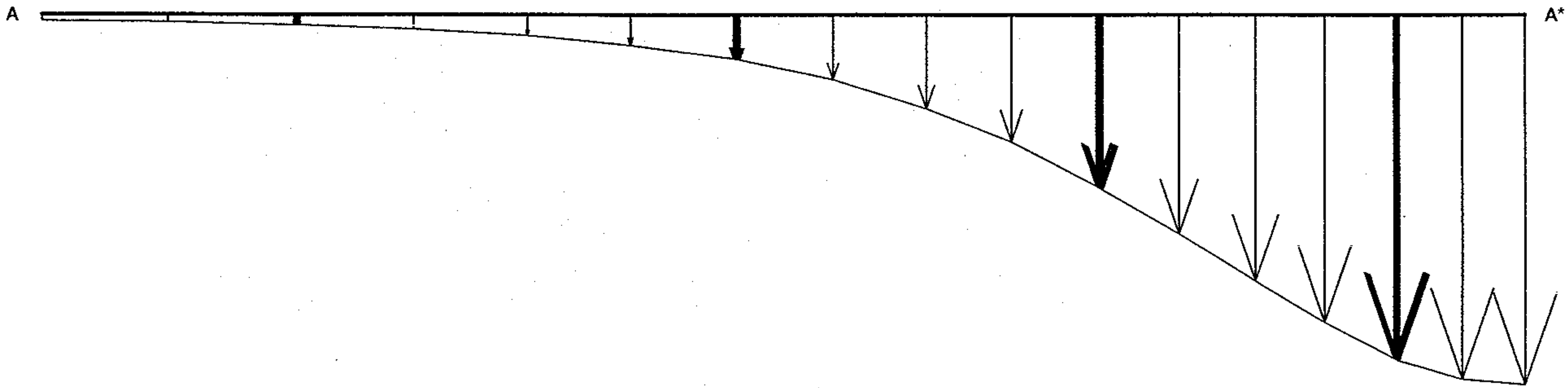
Version 1.2.1.210

PLAXIS 3D Tunnel

$$\delta = \frac{\gamma D^2}{E}(0{,}85 - \nu)\,\psi \quad \text{(OTEO Y SAGASETA. 1974)}$$

$$\gamma = 2\,t/m^3;\ D = 8.5\,m;\ E \simeq 6000\,t/m^2;\ \nu \simeq 0.3$$

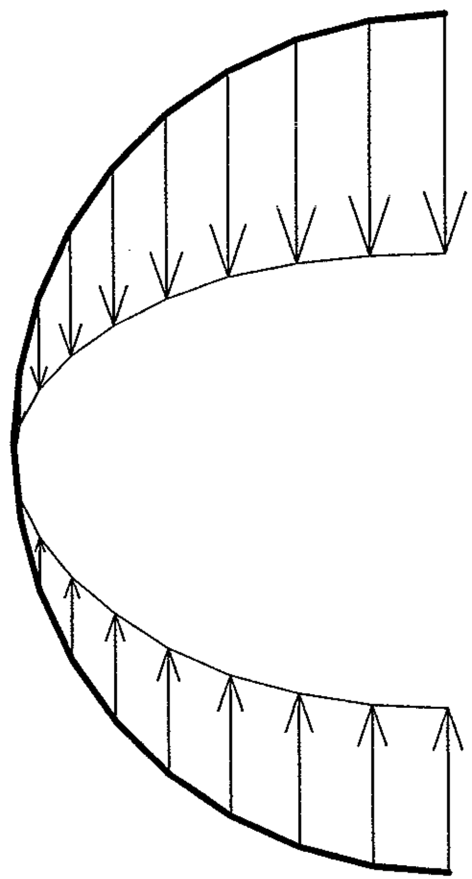
$$\psi \simeq 0.5 \Rightarrow \delta = 0.0066\ m = 6.6\ mm.$$



Vertical displacements Uy
Extreme Uy for this plane $6{,}63 \cdot 10^{-3}$ m

PLAXIS
Finite Element Code for Soil and Rock Analyses
Version 1.2.1.21

Project description			
TUNEL_B_2			
Project name	Step	Date	User name
TUNEL_B_2	4	31/05/05	Universidad Politecnica de Madrid



MOV. VERTICAL

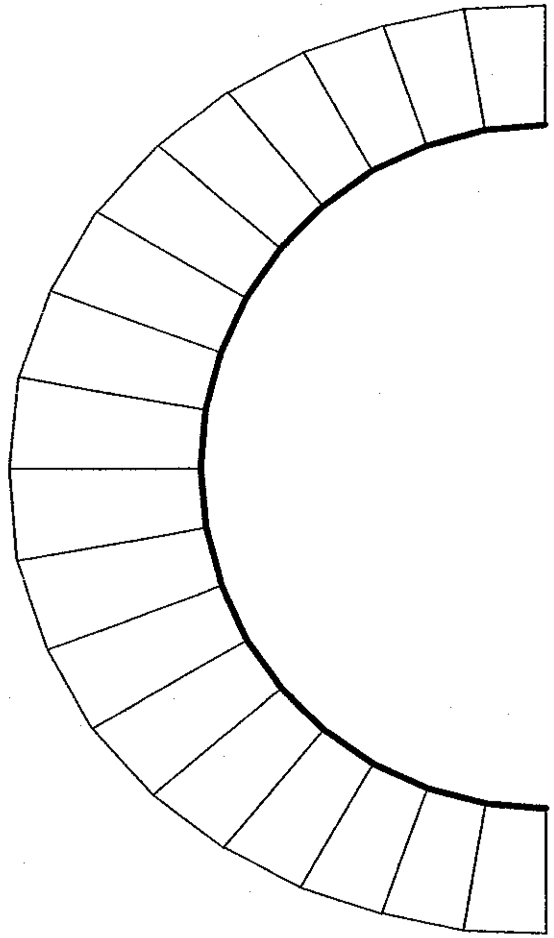
MÁX = 9.31 mm.

Project description	TUNEL_B_2		
Project name: TUNEL_B_2	Step: 4	Date: 31/05/05	User name: Universidad Politecnica de Madrid

PLAXIS

Finite Element Code for Soil and Rock Analyses

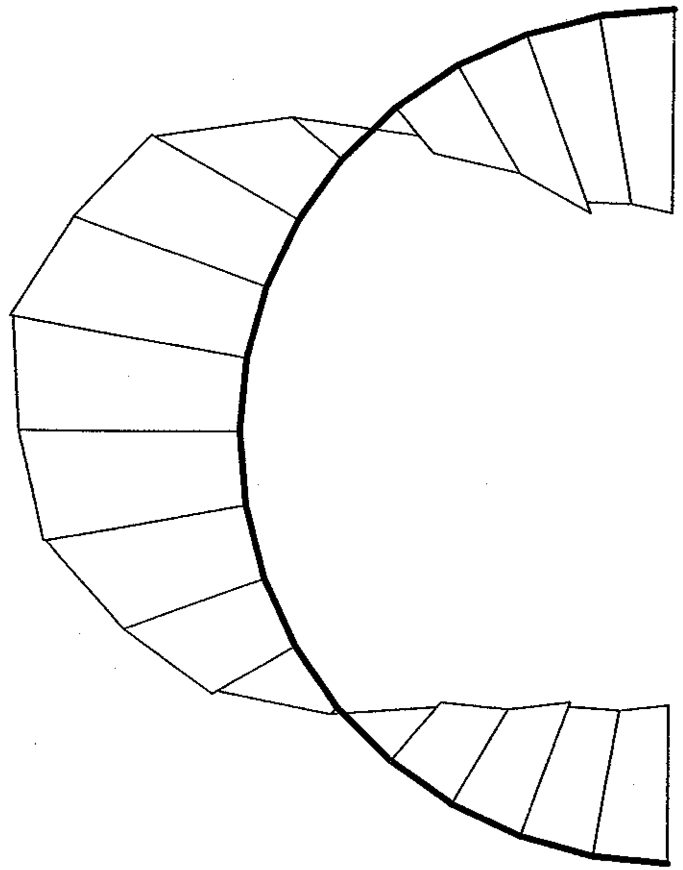
Version 1.2.1.210



Axial forces N11
Extreme axial force for this plane -797,41kN/m
Realised contraction increment: 0,01% - Total realised contraction: 0,17%

PLAXIS Finite Element Code for Soil and Rock Analyses	Project description			
	TUNEL_B_2			
	Project name: TUNEL_B_2	Step: 4	Date: 31/05/05	User name: Universidad Politecnica de Madrid

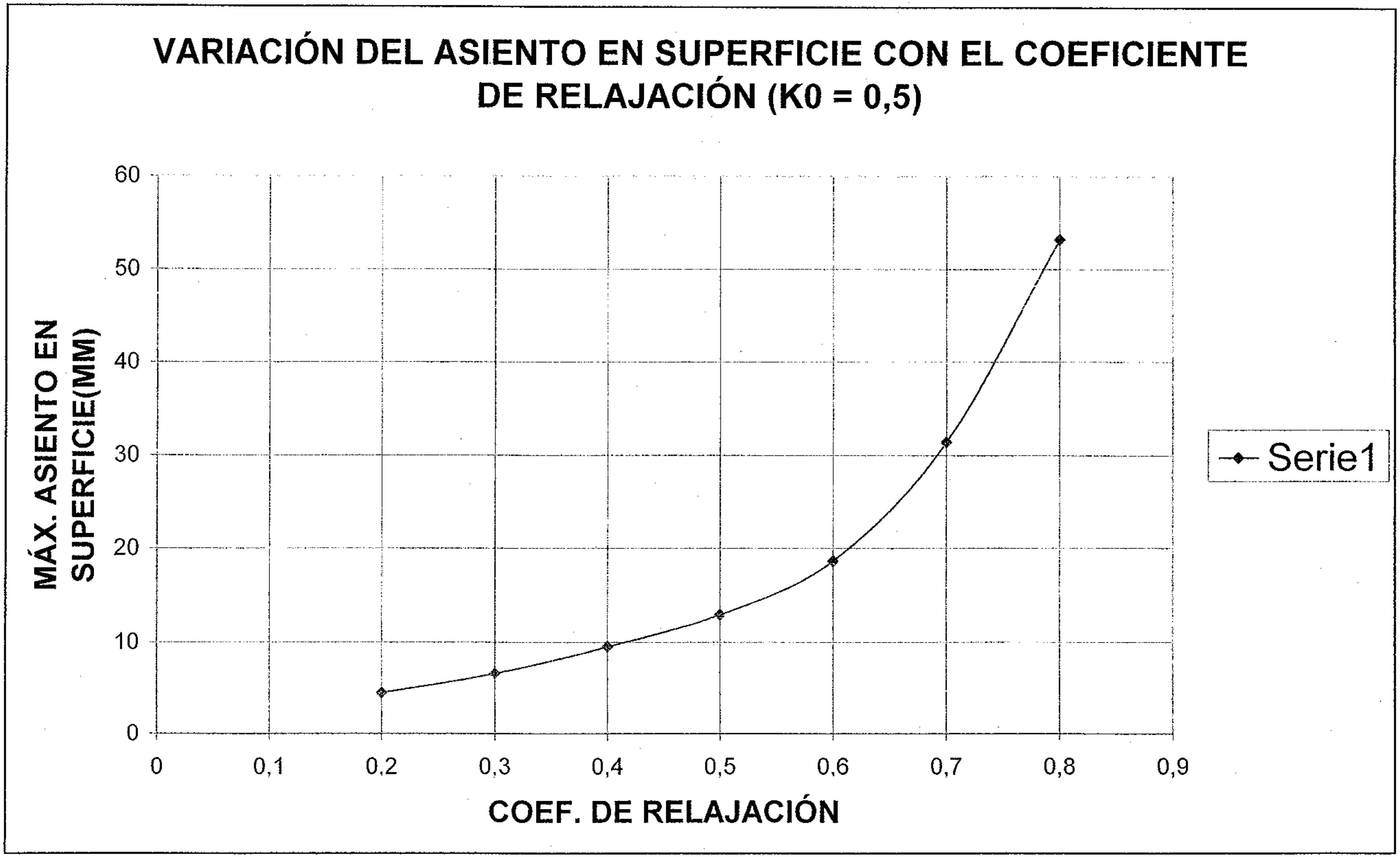
Version 1.2.1.210

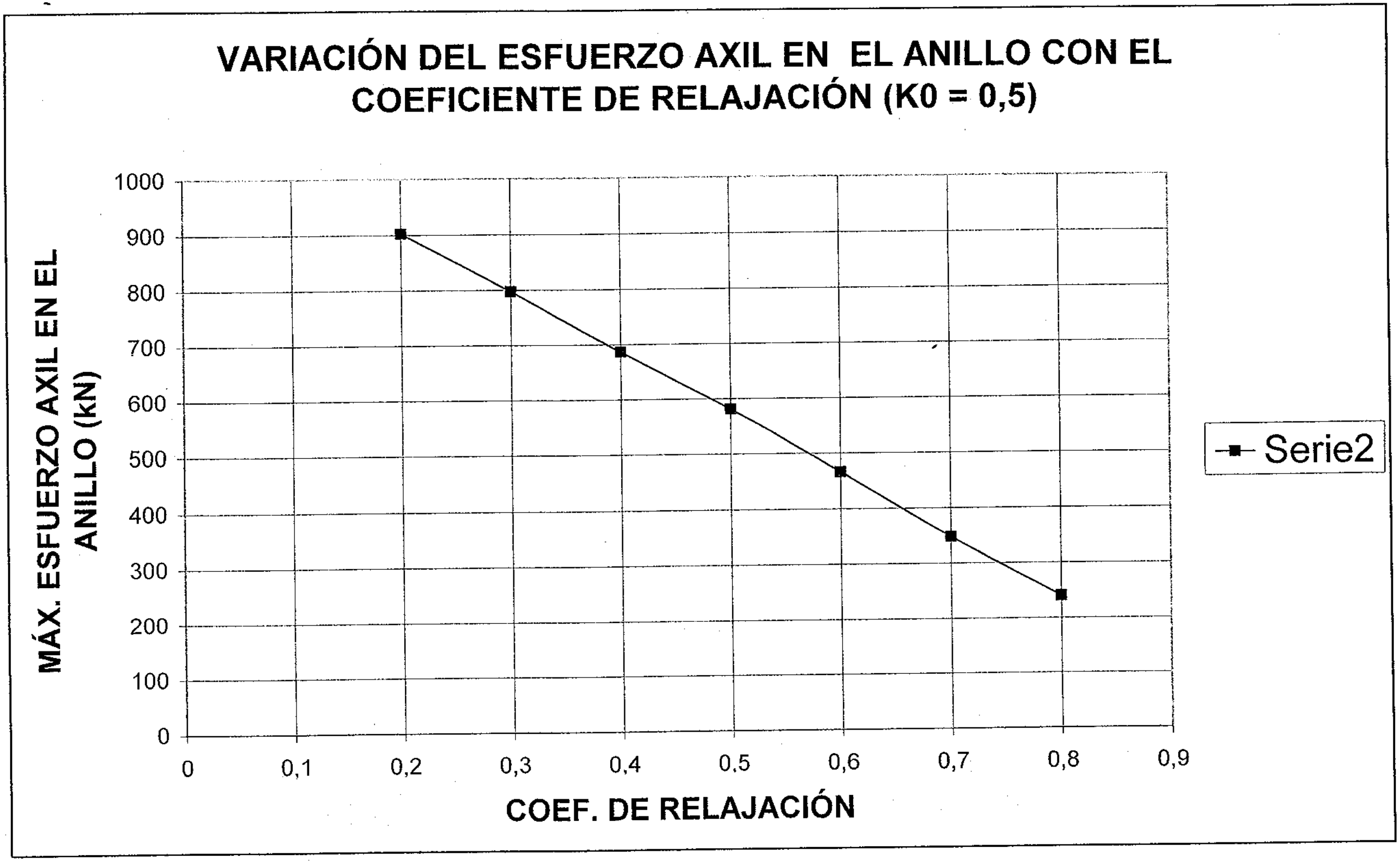


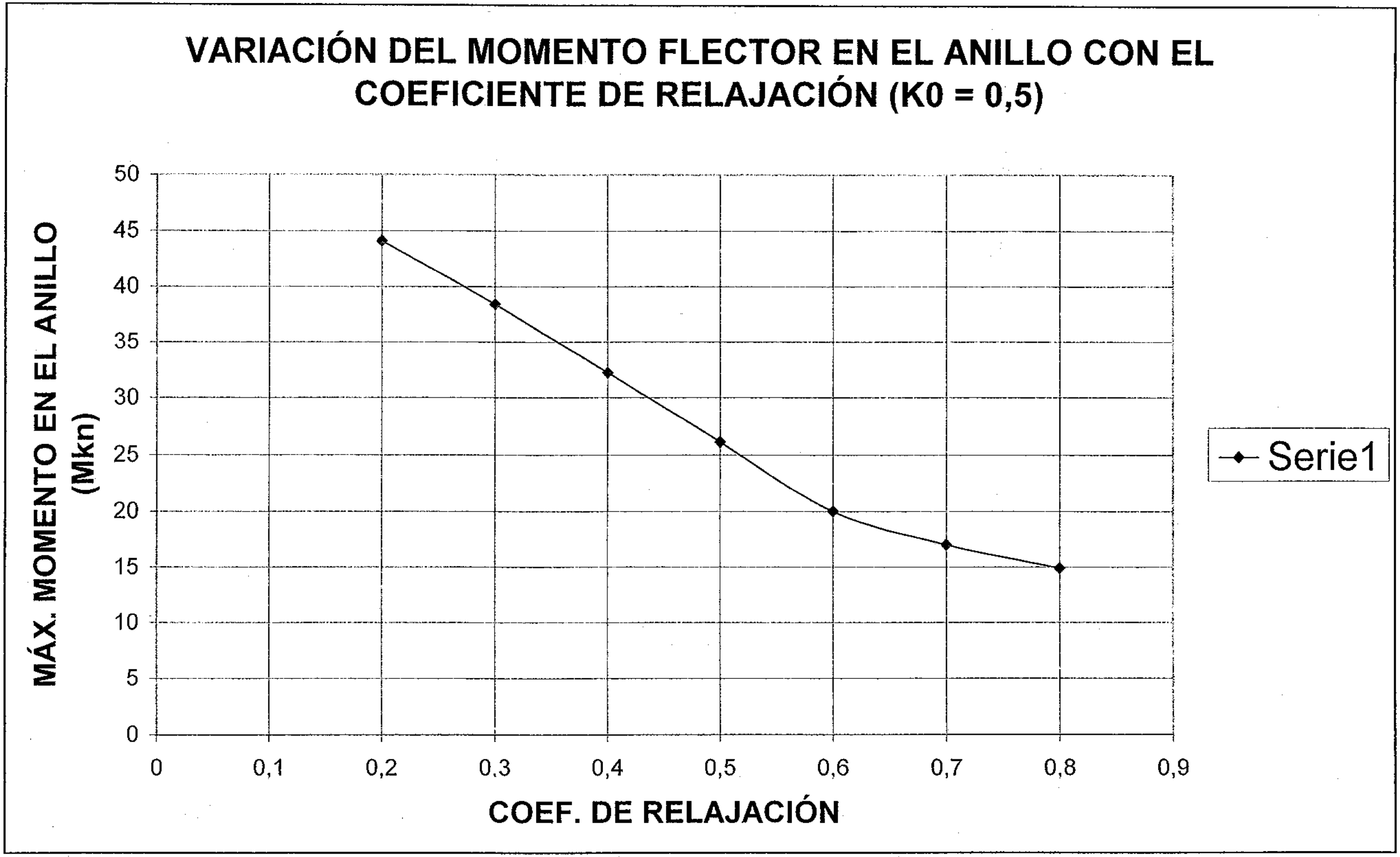
LEY DE MOMENTOS   Mxx = 38,44 mkN/m

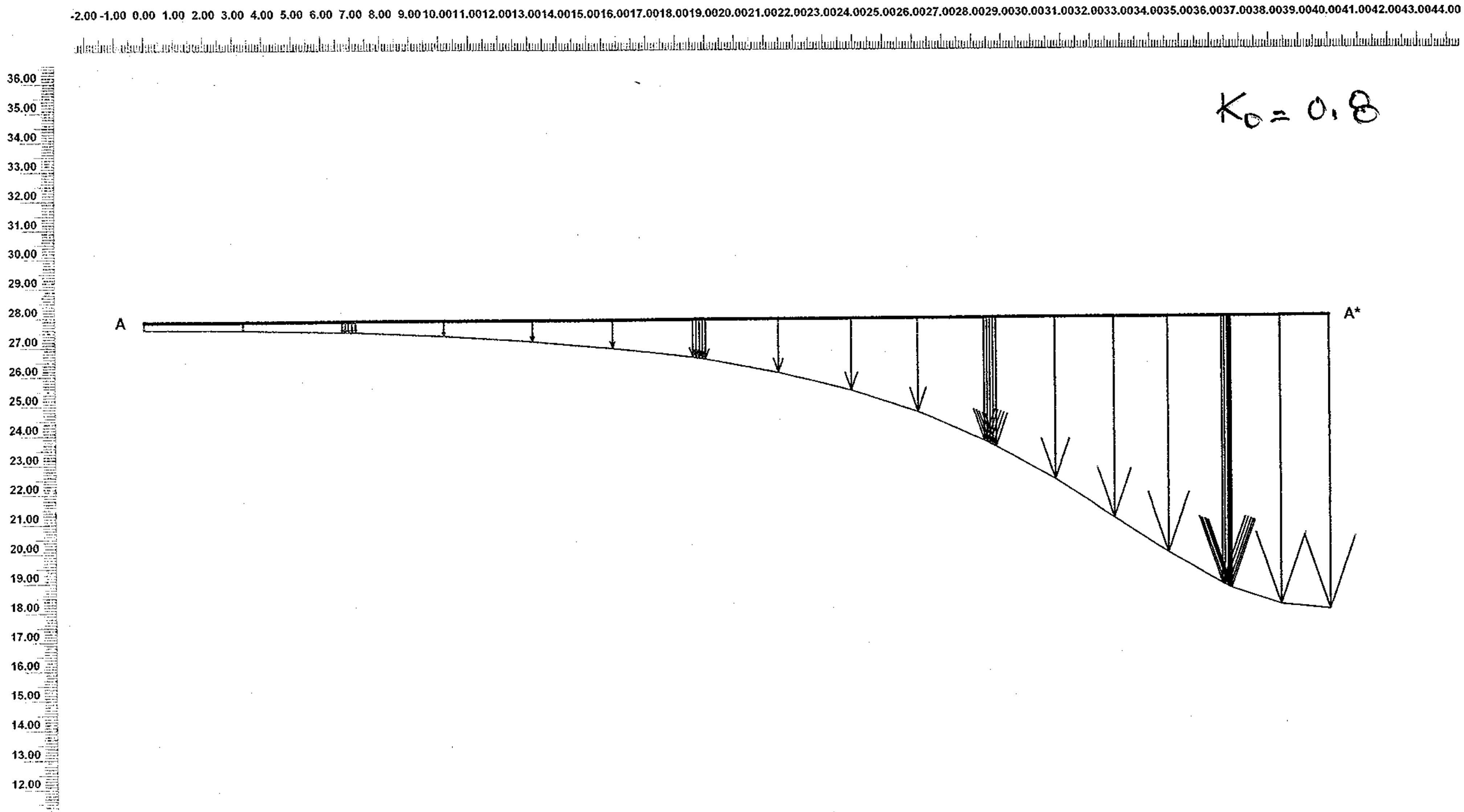
PLAXIS
Finite Element Code for Soil and Rock Analyses
Version 1.2.1.210

Project description: TUNEL_B_2			
Project name: TUNEL_B_2	Step: 4	Date: 31/05/05	User name: Universidad Politecnica de Madrid


VARIACIÓN DEL ASIENTO EN SUPERFICIE CON EL COEFICIENTE DE RELAJACIÓN (K0 = 0,5)
MÁX. ASIENTO EN SUPERFICIE(MM)
60
50
40
30
20
10
0
0
0,1
0,2
0,3
0,4
0,5
0,6
0,7
0,8
0,9
COEF. DE RELAJACIÓN
Serie1


VARIACIÓN DEL ESFUERZO AXIL EN EL ANILLO CON EL COEFICIENTE DE RELAJACIÓN (K0 = 0,5)
MÁX. ESFUERZO AXIL EN EL ANILLO (kN)
1000
900
800
700
600
500
400
300
200
100
0
0
0,1
0,2
0,3
0,4
0,5
0,6
0,7
0,8
0,9
COEF. DE RELAJACIÓN
Serie2


VARIACIÓN DEL MOMENTO FLECTOR EN EL ANILLO CON EL COEFICIENTE DE RELAJACIÓN (K0 = 0,5)
MÁX. MOMENTO EN EL ANILLO (Mkn)
50
45
40
35
30
25
20
15
10
5
0
0
0,1
0,2
0,3
0,4
0,5
0,6
0,7
0,8
0,9
COEF. DE RELAJACIÓN
Serie1

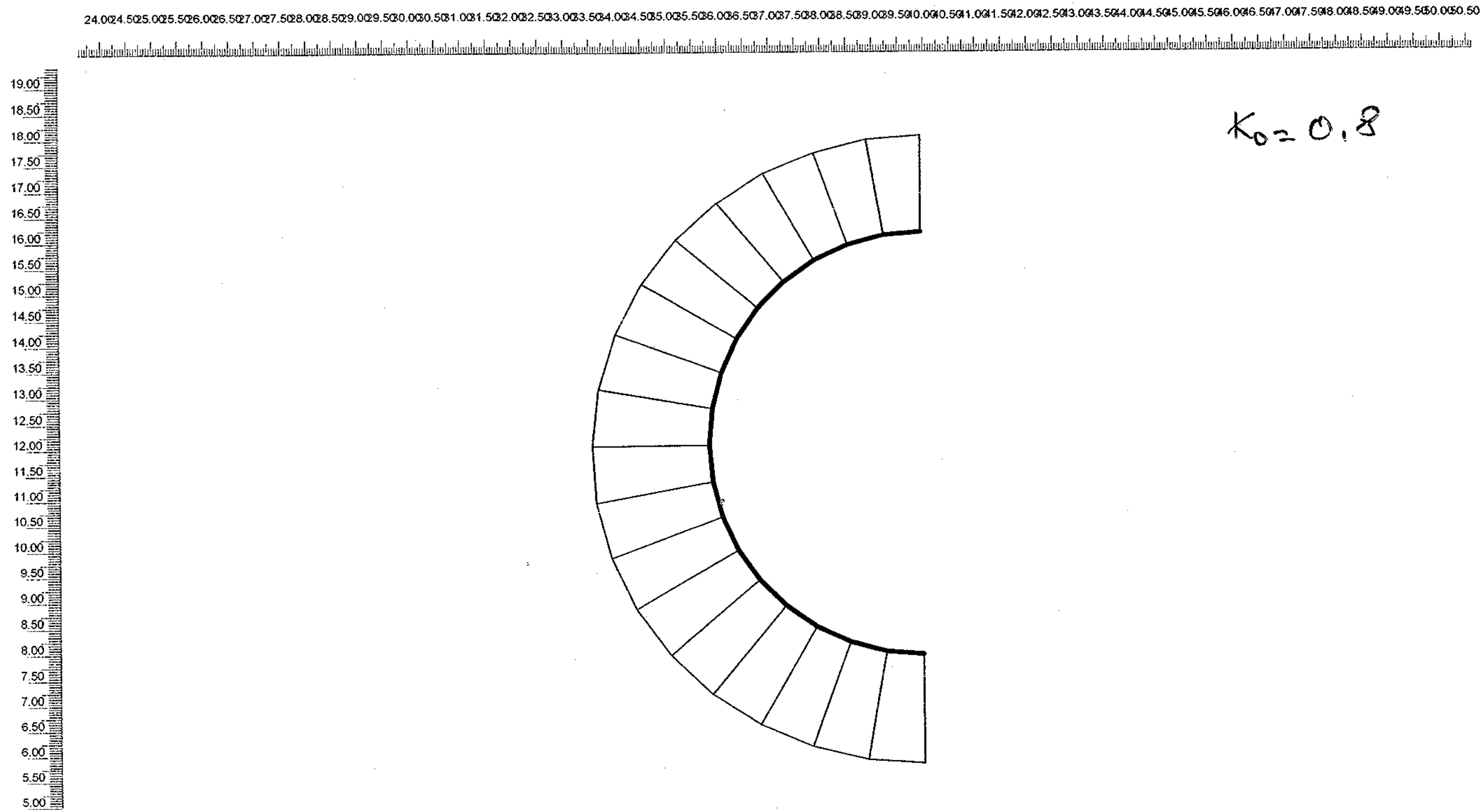


Vertical displacements Uy
Extreme Uy for this plane 2,09*10^{-3} m

PLAXIS Finite Element Code for Soil and Rock Analyses	Project description			
	TUNEL_B_2(A)			
	Project name TUNEL_B_2(A)	Step 4	Date 31/05/05	User name Universidad Politecnica de Madrid

Version 1.2.1.210

PLAXIS 3D Tunnel



Axial forces N11

Extreme axial force for this plane -800,83kN/m

Realised contraction increment: 0,02% - Total realised contraction: 0,13%

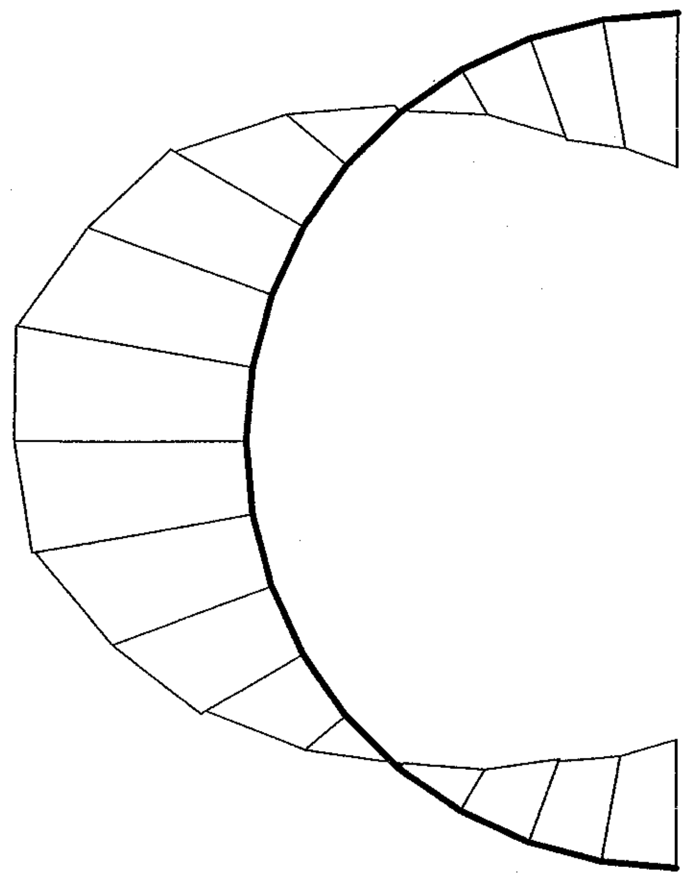
PLAXIS

Finite Element Code for Soil and Rock Analyses

Project description			
TUNEL_B_2(A)			
Project name	Step	Date	User name
TUNEL_B_2(A)	4	31/05/05	Universidad Politecnica de Madrid

Version 1.2.1.21…

Ko = 0,8



LEY DE MOMENTO   MÁX: 8,24 mkN/m

Project description

TUNEL_B_2(A)

Project name	Step	Date	User name
TUNEL_B_2(A)	4	31/05/05	Universidad Politecnica de Madrid

PLAXIS
Finite Element Code for Soil and Rock Analyses

Version 1.2.1.210