KALICI ZEMİN ÇİVİLİ İKSA DUVARI PROJELENDİRME, UYGULAMA VE ALETSEL GÖZLEM ÇALIŞMALARI

Dr. Mahmut Baran ÖZSOY

BSc MSc PhD CEng MICE

İnşaat Mühendisleri Odası İstanbul Şubesi

Mayıs 2016

Sunum İçeriği:

1. Giriş
2. Zemin Çivili Duvar Tasarımı, İnşası ve Aletsel Gözlemlenmesi ile İlgili Kısa Özet Bilgiler
3. Rozak Makine Gebze Tesisleri Projesi
4. A650 Bibley Relief Road Projesi
5. Suffolk College Projesi
6. Antepia Projesi
7. Soru ve Cevaplar

DERİN KAZILAR

- Yüksek yapılar genellikle derin bodrum yapıları ve zemin durumuna göre derin temellerin inşasını gerektirmektedir.
- Günümüzde 30m'yi geçen derin bodrumlar yaygın olarak uygulanmaktadır.
- Derin kazıların çevre yapılarla etkileşimlerinin doğru değerlendirilmesi gerekmektedir. Özellikle inşaat safhasında deformasyon değerlerinin aletsel gözlem metodları ile anında gözlemlenmesi uygun bir yaklaşımdır.
- Derin kazı sisteminin seçiminde güvenlik, ekonomi ve estetik değerler ön plandadır.

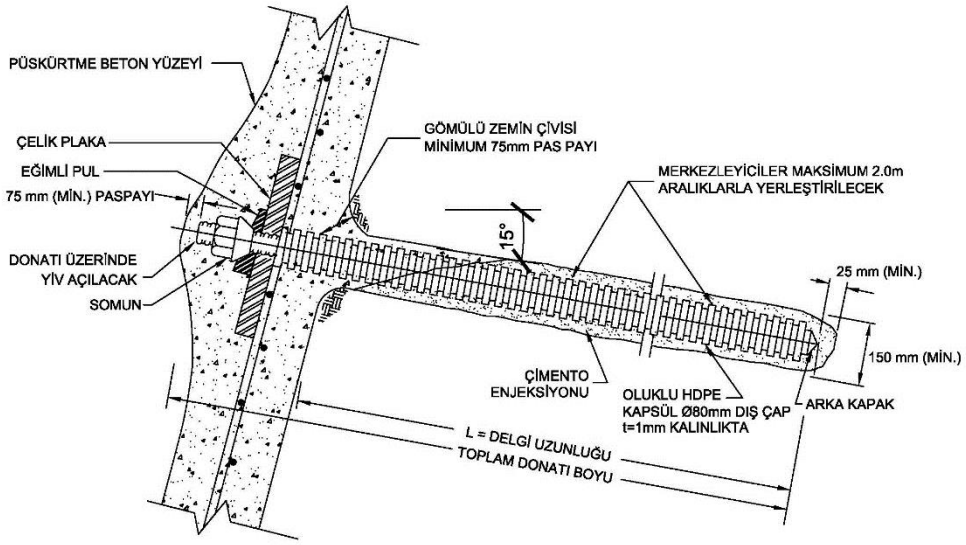
Manchester City Parks (AECOM)

Derin Kazı Projelerinde Gözlemlenen Performans Problemleri

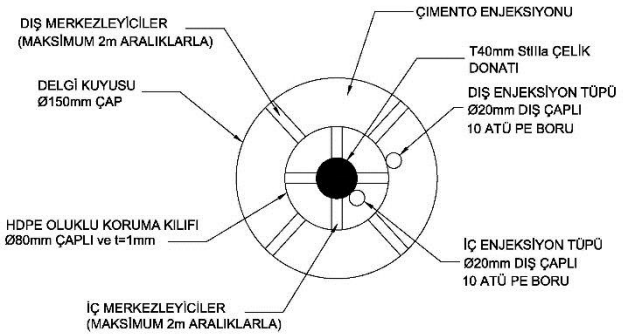
- İksa sisteminin yatayda ve düşeyde aşırı deformasyon yapması
- Deformasyona bağlı olarak çevre yapılarda istenmeyen hasarlar oluşması
- Sistemin öngörülen tasarım ömrüne erişilemeden ankrajlarda yük kayıplarının meydana gelmesi
- Su sızdırmazlığı istenilen projelerde bu hedefin tutturulamaması

Nicoll Highway
(Singapur)

Zemin Çivisi Nedir?



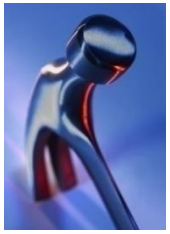
NOT: SOMUNUN DIŞ KISMINA, EĞİMLİ PUL YÜZEYİNE, PLAKA VE SAPLAMALARA KOROZYONA KARŞI EPOKSİ (EPOXY) KAPLAMA UYGULANACAKTIR.



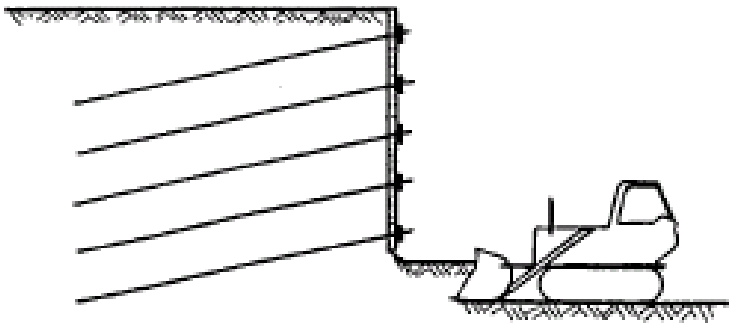
Zemin çivisi mevcut zemine narin çekme kuvveti alabilecek donatıların yerleştirilmesi ile gerçekleştirilen bir iksa tekniğidir.

Kalıcı tipte zemin çivilerinde enjeksiyon ve kılıf ile korumaya alınan elemanlar püskürtme beton ve hasır çelik ile yüzey kaplaması yapılır.

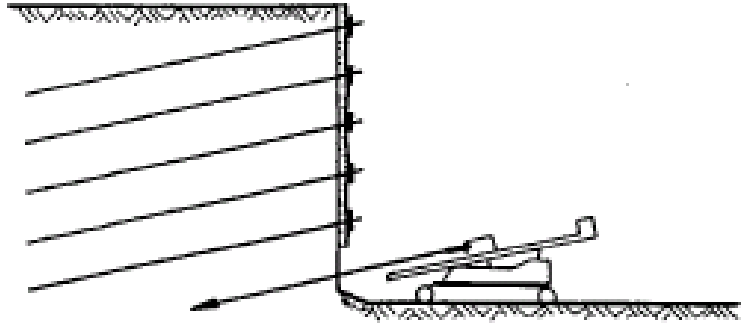
Pratikte kullanılan diğer sistemler yumuşak yüzey kaplama elemanlarını ve kendinden delgili çivi elemanları içerir.



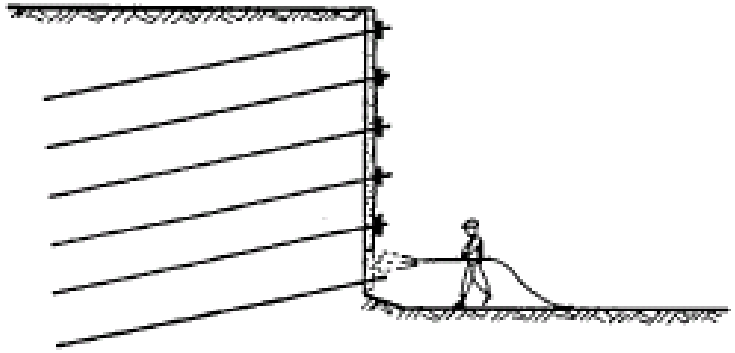
Zemin Çivisi Tekniğinde İnşaat Adımları



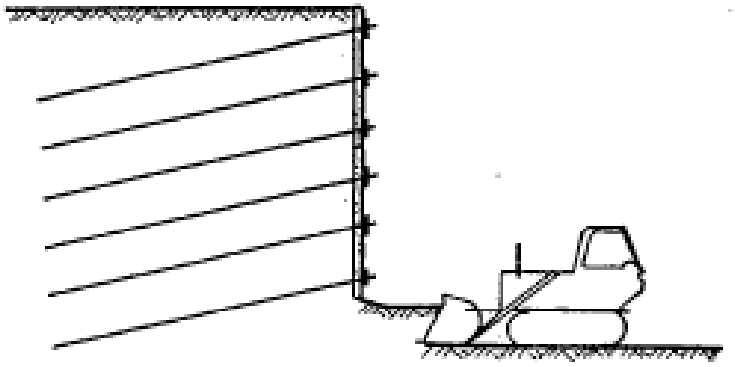
1. Kazı



2. Delgi



3. Hasır Çelik ve Püskürtme Beton Uygulaması



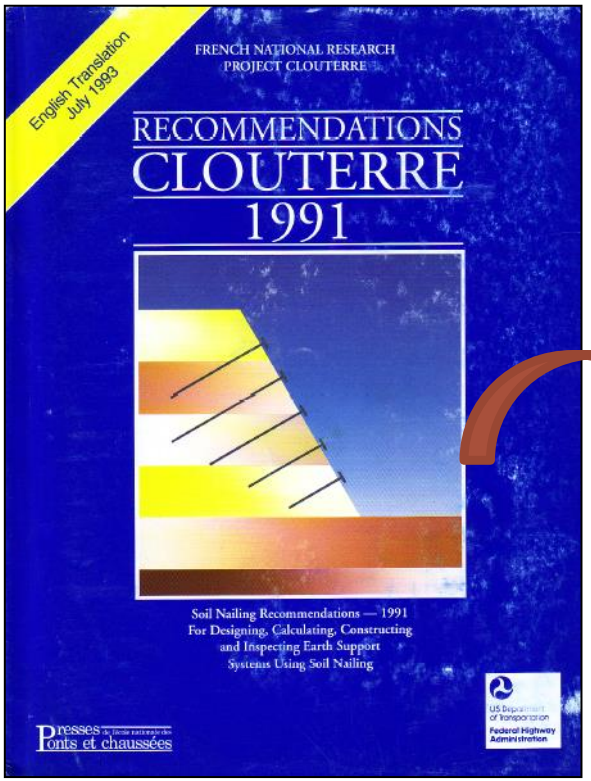
4. Bir Sonraki Kazı Kademesine Geçilmesi

Uygulamadan Örnekler

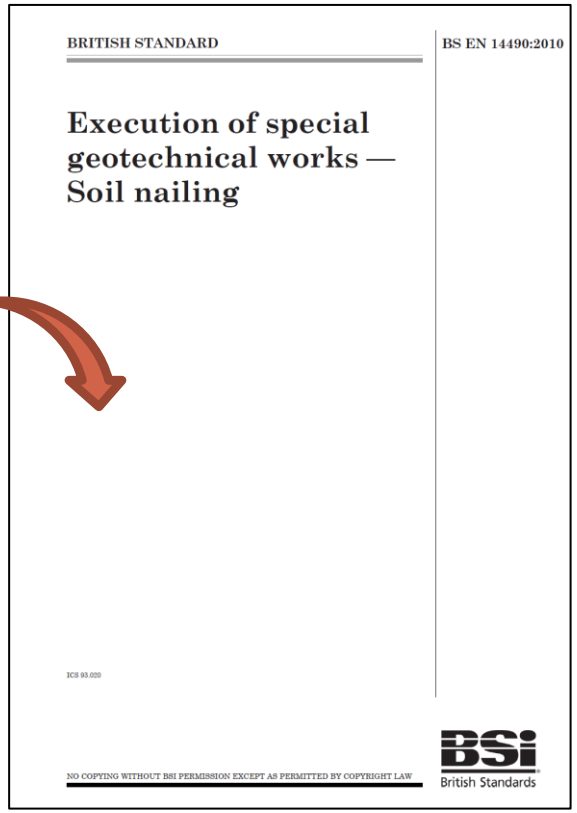
İstanbul Kanyon AVM Projesi (Arup/Zetaş)

Tarsus – Adana – Gaziantep Otoyolu (Tekfen/Zetaş)

İstanbul Etiler Erdem Holding Derin Kazı Projesi (Zetaş)


English Translation
July 1993
FRENCH NATIONAL RESEARCH
PROJECT CLOUTERRE
RECOMMENDATIONS
CLOUTERRE
1991
Soil Nailing Recommendations — 1991
For Designing, Calculating, Constructing
and Inspecting Earth Support
Systems Using Soil Nailing
Presses des Ponts et chaussées
US Department of Transportation
Federal Highway Administration


Soil nailing
best practice guidance
dti


BRITISH STANDARD
BS EN 14490:2010
Execution of special geotechnical works — Soil nailing
ICS 93.020
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BSI
British Standards

PUBLICATION No. FHWA-SA-96-069R

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Federal Highway Administration

MANUAL FOR DESIGN & CONSTRUCTION MONITORING OF SOIL NAIL WALLS

Revised October 1998

Innovation Through Partnerships

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Office of Technology Application Office of Engineering/Bridge Division Federal Highway Administration U.S. Department of Transportation 400 7th Street, S.W. Washington, D.C. 20590	Technical Manual, 2001-2002 14. Sponsoring Agency Code

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FHWA Technical Consultant: J.A. DiMaggio, P.E. (HIBT-20)
Contract Technical Representative (COTR): Chien-Tan Chang (HTA-22)

16. Abstract

This document presents information on the analysis, design, and construction of soil nail walls in highway applications. The main objective is to provide practitioners in this field with sound and simple methods and guidelines that will allow them to analyze, design, and construct safe and economical structures. This document updates information contained in FHWA-SA-96-069R (Byrne et al., 1998). The focus is on soil nailing techniques that are commonly used in the U.S. practice. The contents of this document include: an introduction, a chapter on applications and feasibility, descriptions and guidelines for field and laboratory testing in soil nailing applications, descriptions of the common U.S. practice, analysis and design of soil nail walls, chapters on contracting approach and construction specifications and design examples. Because of the popularity of the Allowable Stress Design (ASD) method [also known as Service Load Design (SLD)] among practitioners, the methods presented in this document are based on the ASD method.

17. Key Word	18. Distribution Statement
soil nailing, soil nail walls, soil nail testing, shotcrete, soil nail wall design, soil nailing specifications	No restrictions.

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
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Course No. 132085

Soil Nail Walls Reference Manual

Developed following:
AASHTO LRFD Bridge Design Specifications, 7th Edition.

NHI
NATIONAL HIGHWAY INSTITUTE

Korozyon Değerlendirmesi

Table B.2 — General method for corrosiveness assessment

Criterion	*Features*	*Weight A of Criterion*
Type of soil [2)]	**Texture**	
	— heavy, plastic, sticky impermeable;	2
	— clayey sand;	1
	— light, permeable, sandy, cohesionless soils	0
	Peat and bog/marshlands	8
	Industrial waste	
	clinker, cinders, coal	8
	builders waste (plaster, bricks)	4
	Polluted liquids	
	waste water, industrial	6
	water containing de-icing salts	8
Resistivity ($\Omega \cdot cm$)	$p < 1\,000$	5
	$1\,000 < p < 2\,000$	3
	$2\,000 < p < 5\,000$	2
	$5\,000 < p$	0
Moisture content	Water table – brackish water (variable or permanent)	8
	Water table – pure water (variable or permanent)	4
	Above water table – moist soil (water content > 20 %)	2
	Above water table – dry soil (water content < 20 %)	0
pH	< 4	4
	4 to 5	3
	5 to 6	2
	> 6	0
	Global Index	Sum of above ΣA

Table B.1 — Classification of soil condition

Soil features	*Classification*	*Index ΣA*
Highly corrosive	I	13 or greater
Corrosive	II	9 to 12
Average corrosive	III	5 to 8
Slightly corrosive	IV	4 or less

Table B.3 — Indication loss of steel thickness (in millimetres) due to corrosion (total reduction of diameter or thickness including both sides)

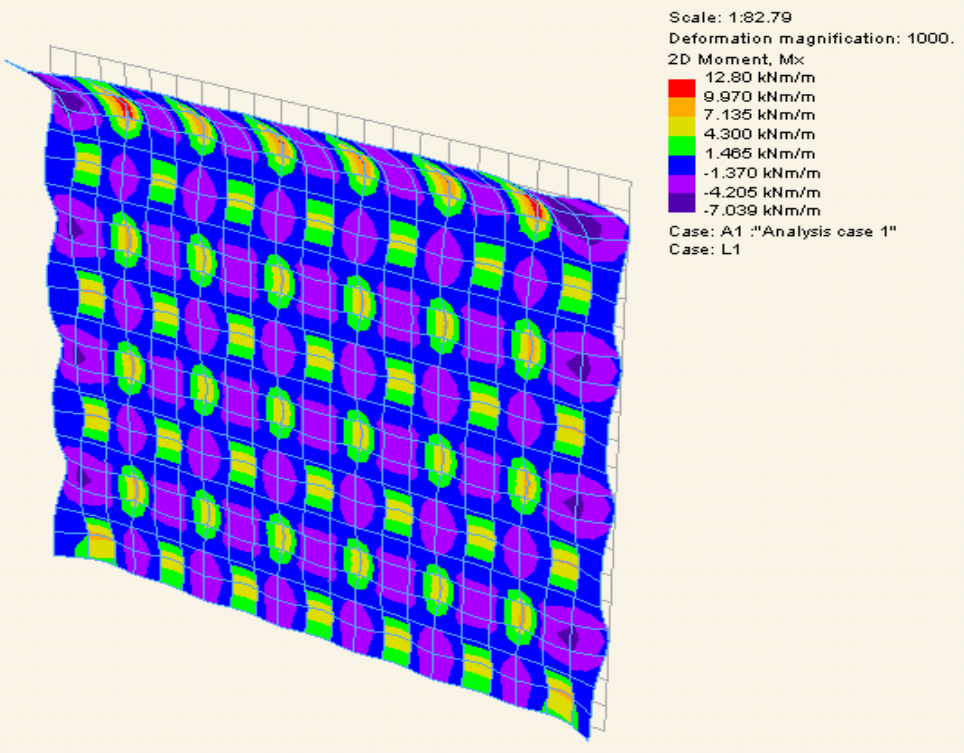
Overal index I [3]/Classification	*Short-term* *≤ 18 months*	*Short-term* *1,5 years to ≤ 30 years*	*Long-term* *30 years to ≤ 100 years*
≤ 4/IV	0	2 mm	4 mm
5 to 8/III	0	4 mm	8 mm
9 to 12/II	2 mm	8 mm	plastic sheath [a]
≥ 13/IV	Plastic sheath shall be provided [a]		

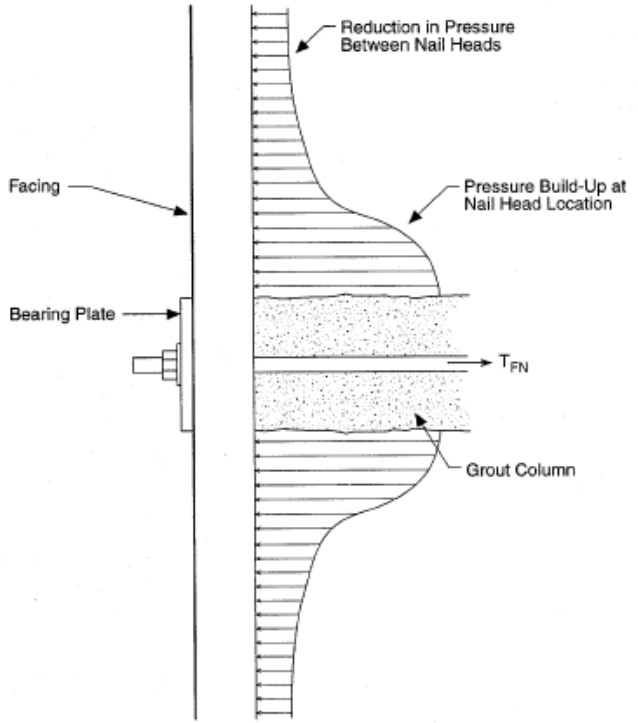
[a] A metal casing is not recommended unless there are special reasons for using it.

Table B.4 — Guidance on minimum grout cover to metallic parts in the borehole depending on soil condition and service life

		Service – life of the structure (years)				
		Grout cover (mm)				
	Soil condition	***5***	***25***	***50***	***75***	***100***
IV	Non aggressive	10	20	25	35	$^{a}{}_{1}$
III	Sligthly aggressive	20	30	40	50	$^{a}{}_{1}$
II	Aggressive	30	40	50	75	$^{a}{}_{1}$
I	Highly aggressive	n.a.	n.a.	n.a.	n.a.	n.a
$^{a}{}_{1}$ Special consideration, required for determination of necessary grout cover.						

Yüzey Kaplaması

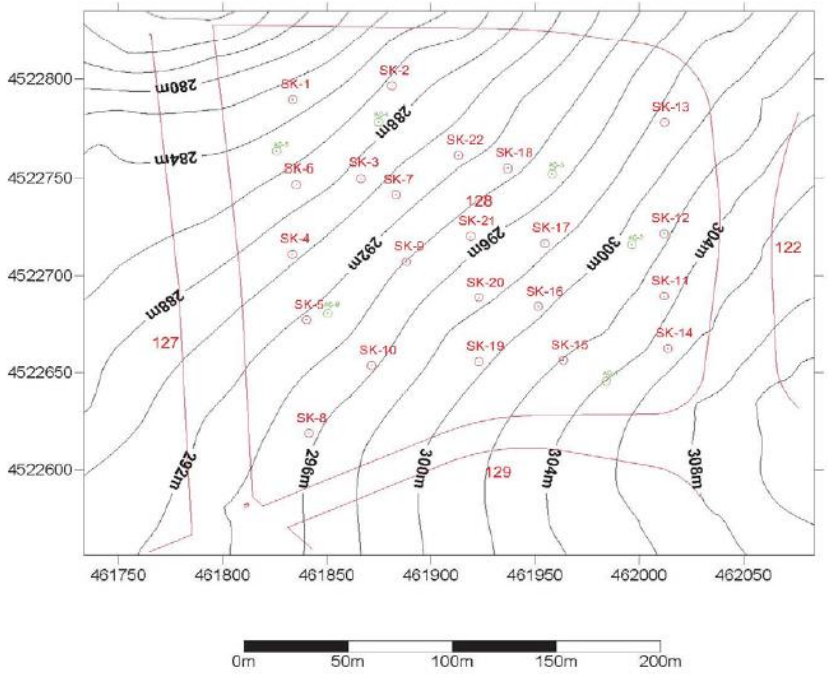


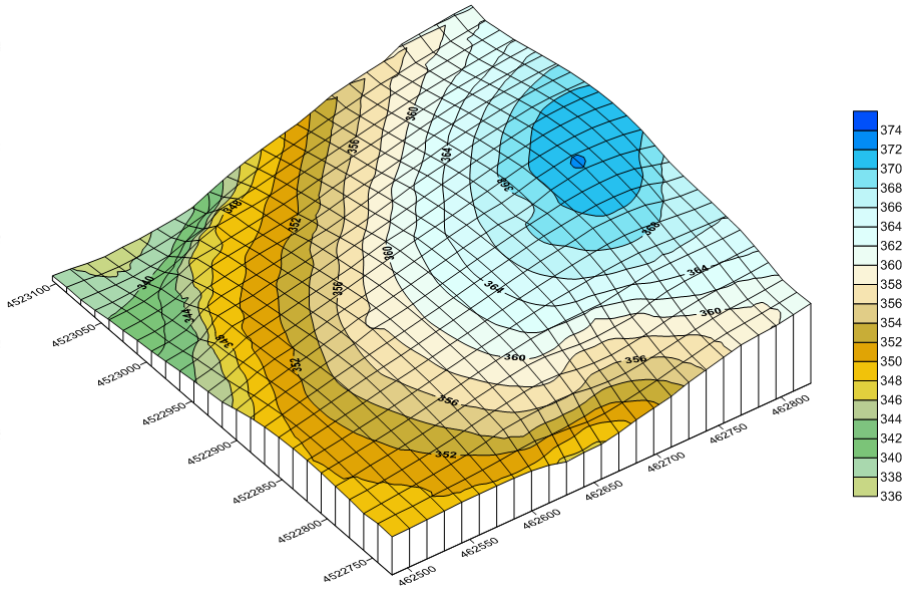


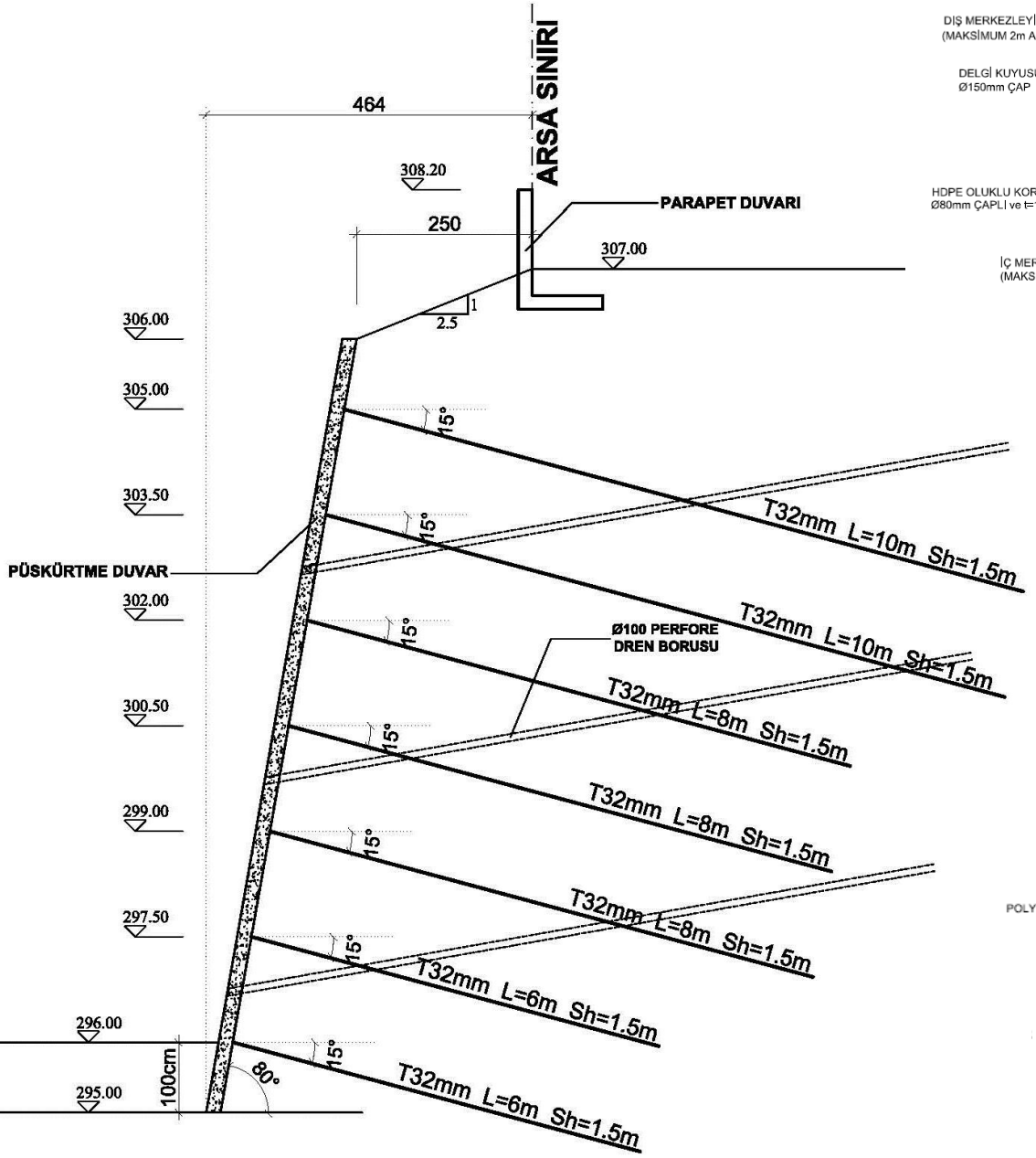
Kaplama malzemesi seçimi aşağıdaki unsurların bir fonksiyonudur:

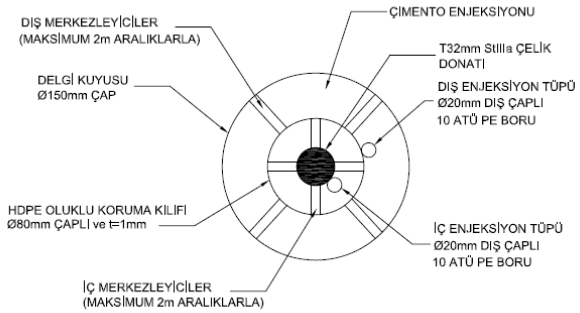
- Zımbalama Mukavemeti
- Eğilme Momenti
- Çivi-Enjeksiyon ve yüzey kaplaması arasındaki rijitlik farkı

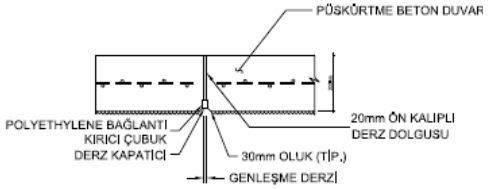
Rozak Makine Gebze Tesisleri (BKS İnşaat / Mensaş)

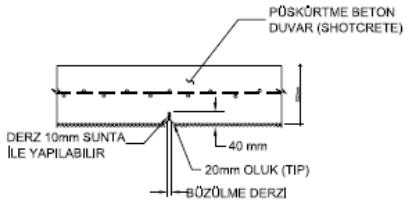


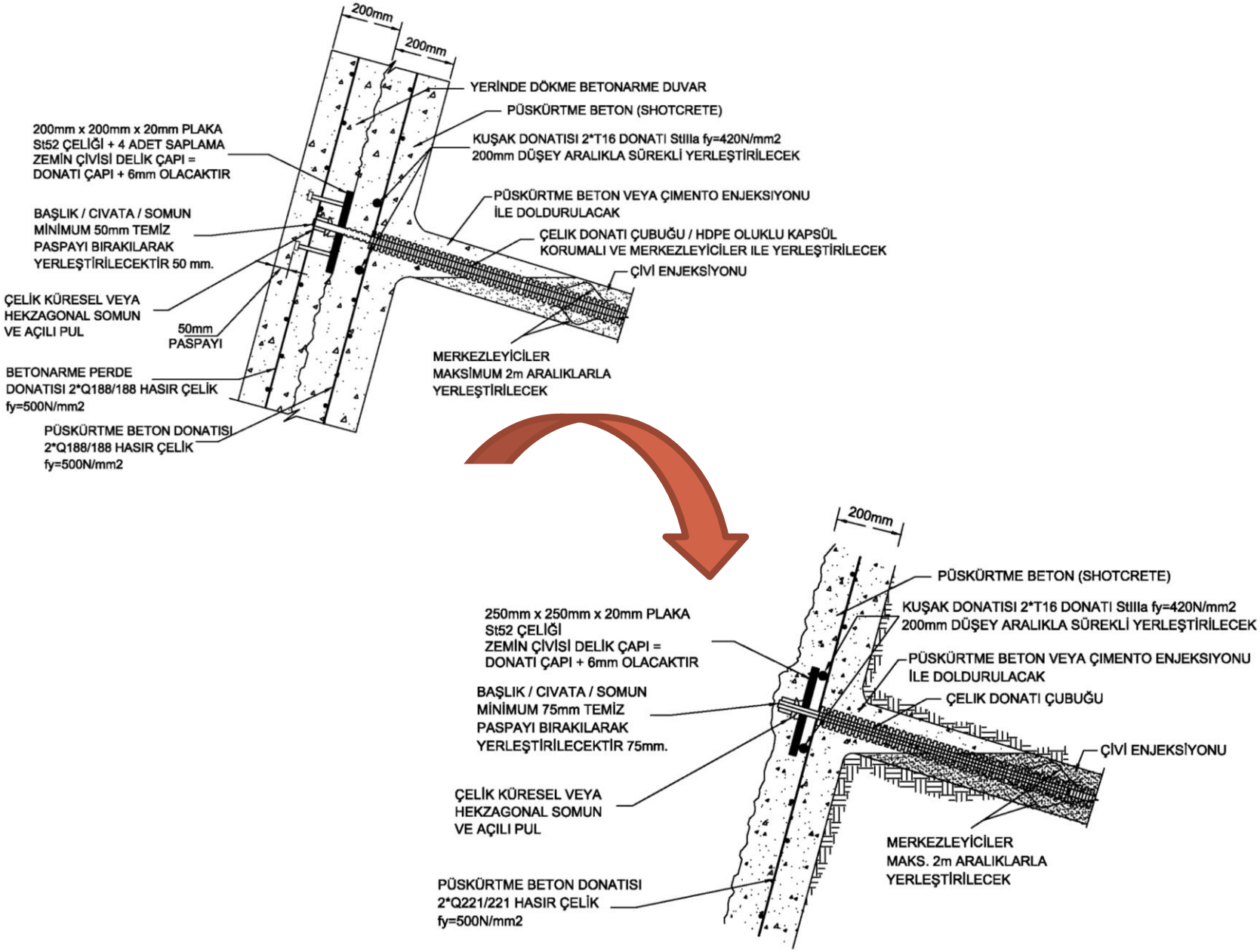


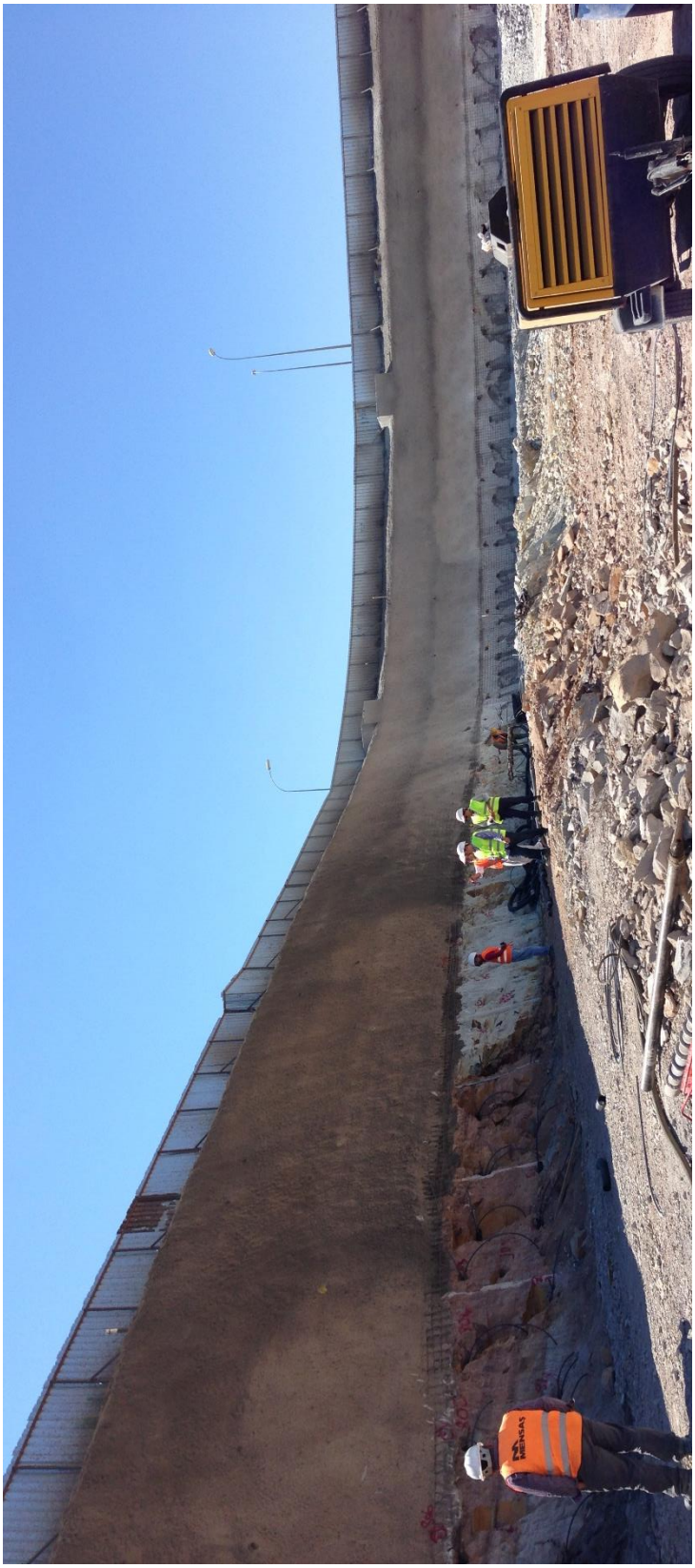

ARSA SINIRI
464
308.20
PARAPET DUVARI
250
307.00
1
2.5
306.00
305.00
303.50
PÜSKÜRTME DUVAR
302.00
300.50
299.00
297.50
296.00
295.00
100cm
80°
15°
Ø100 PERFORE
DREN BORUSU
T32mm L=10m Sh=1.5m
T32mm L=10m Sh=1.5m
T32mm L=8m Sh=1.5m
T32mm L=8m Sh=1.5m
T32mm L=8m Sh=1.5m
T32mm L=6m Sh=1.5m
T32mm L=6m Sh=1.5m


DIŞ MERKEZLEYİCİLER
(MAKSİMUM 2m ARALIKLARLA)
ÇİMENTO ENJEKSİYONU
T32mm Stilla ÇELİK
DONATI
DELGİ KUYUSU
Ø150mm ÇAP
DIŞ ENJEKSİYON TÜPÜ
Ø20mm DIŞ ÇAPLI
10 ATÜ PE BORU
HDPE OLUKLU KORUMA KİLİFİ
Ø80mm ÇAPLİ ve t=1mm
İÇ ENJEKSİYON TÜPÜ
Ø20mm DIŞ ÇAPLI
10 ATÜ PE BORU
İÇ MERKEZLEYİCİLER
(MAKSİMUM 2m ARALIKLARLA)

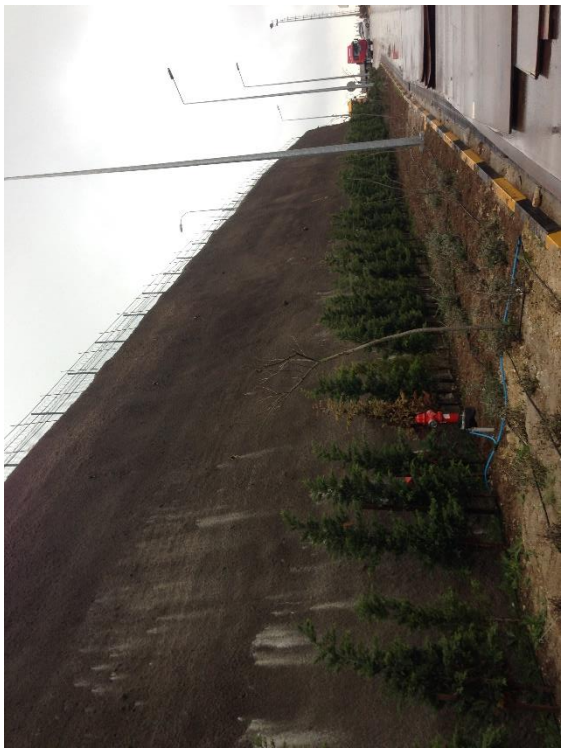

PÜSKÜRTME BETON DUVAR
POLYETHYLENE BAĞLANTI
KIRICI ÇUBUK
DERZ KAPATICI
20mm ÖN KALIPLI
DERZ DOLGUSU
30mm OLUK (TİP.)
GENLEŞME DERZİ


PÜSKÜRTME BETON
DUVAR (SHOTCRETE)
DERZ 10mm SUNTA
İLE YAPILABILIR
40 mm
20mm OLUK (TIP)
BÜZÜLME DERZİ

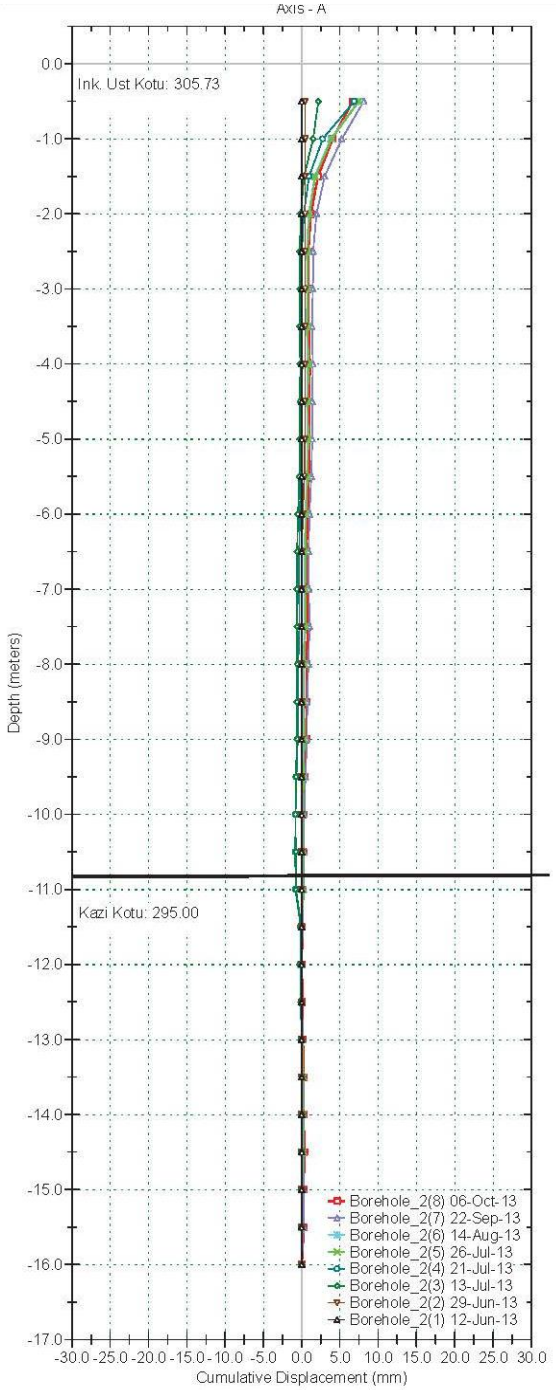

200mm
200mm
YERİNDE DÖKME BETONARME DUVAR
PÜSKÜRTME BETON (SHOTCRETE)
200mm x 200mm x 20mm PLAKA
St52 ÇELİĞİ + 4 ADET SAPLAMA
ZEMİN ÇİVİSİ DELİK ÇAPI =
DONATI ÇAPI + 6mm OLACAKTIR
KUŞAK DONATISI 2*T16 DONATI StIIa fy=420N/mm2
200mm DÜŞEY ARALIKLA SÜREKLİ YERLEŞTİRİLECEK
PÜSKÜRTME BETON VEYA ÇIMENTO ENJEKSIYONU
İLE DOLDURULACAK
BAŞLIK / CIVATA / SOMUN
MİNİMUM 50mm TEMİZ
PASPAYI BIRAKILARAK
YERLEŞTİRİLECEKTİR 50 mm.
ÇELİK DONATI ÇUBUĞU / HDPE OLUKLU KAPSÜL
KORUMALI VE MERKEZLEYİCİLER ILE YERLEŞTİRİLECEK
ÇİVİ ENJEKSİYONU
ÇELİK KÜRESEL VEYA
HEKZAGONAL SOMUN
VE AÇILI PUL
50mm
PASPAYI
MERKEZLEYİCİLER
MAKSİMUM 2m ARALIKLARLA
YERLEŞTİRİLECEK
BETONARME PERDE
DONATISI 2*Q188/188 HASIR ÇELİK
fy=500N/mm2
PÜSKÜRTME BETON DONATISI
2*Q188/188 HASIR ÇELİK
fy=500N/mm2
200mm
PÜSKÜRTME BETON (SHOTCRETE)
250mm x 250mm x 20mm PLAKA
St52 ÇELİĞİ
ZEMİN ÇİVİSİ DELİK ÇAPI =
DONATI ÇAPI + 6mm OLACAKTIR
KUŞAK DONATISI 2*T16 DONATI StIIa fy=420N/mm2
200mm DÜŞEY ARALIKLA SÜREKLİ YERLEŞTİRİLECEK
PÜSKÜRTME BETON VEYA ÇIMENTO ENJEKSIYONU
İLE DOLDURULACAK
BAŞLIK / CIVATA / SOMUN
MİNİMUM 75mm TEMİZ
PASPAYI BIRAKILARAK
YERLEŞTİRİLECEKTİR 75mm.
ÇELİK DONATI ÇUBUĞU
ÇİVİ ENJEKSİYONU
ÇELİK KÜRESEL VEYA
HEKZAGONAL SOMUN
VE AÇILI PUL
MERKEZLEYİCİLER
MAKS. 2m ARALIKLARLA
YERLEŞTİRİLECEK
PÜSKÜRTME BETON DONATISI
2*Q221/221 HASIR ÇELİK
fy=500N/mm2

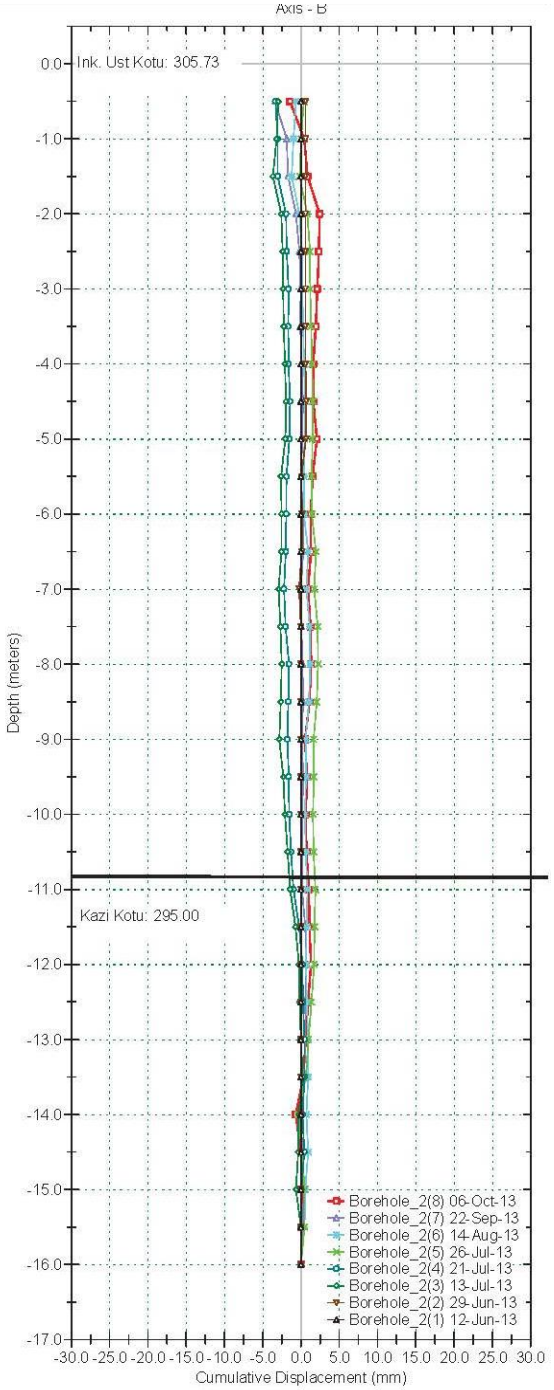


Rozak Makine Gebze Tesisleri

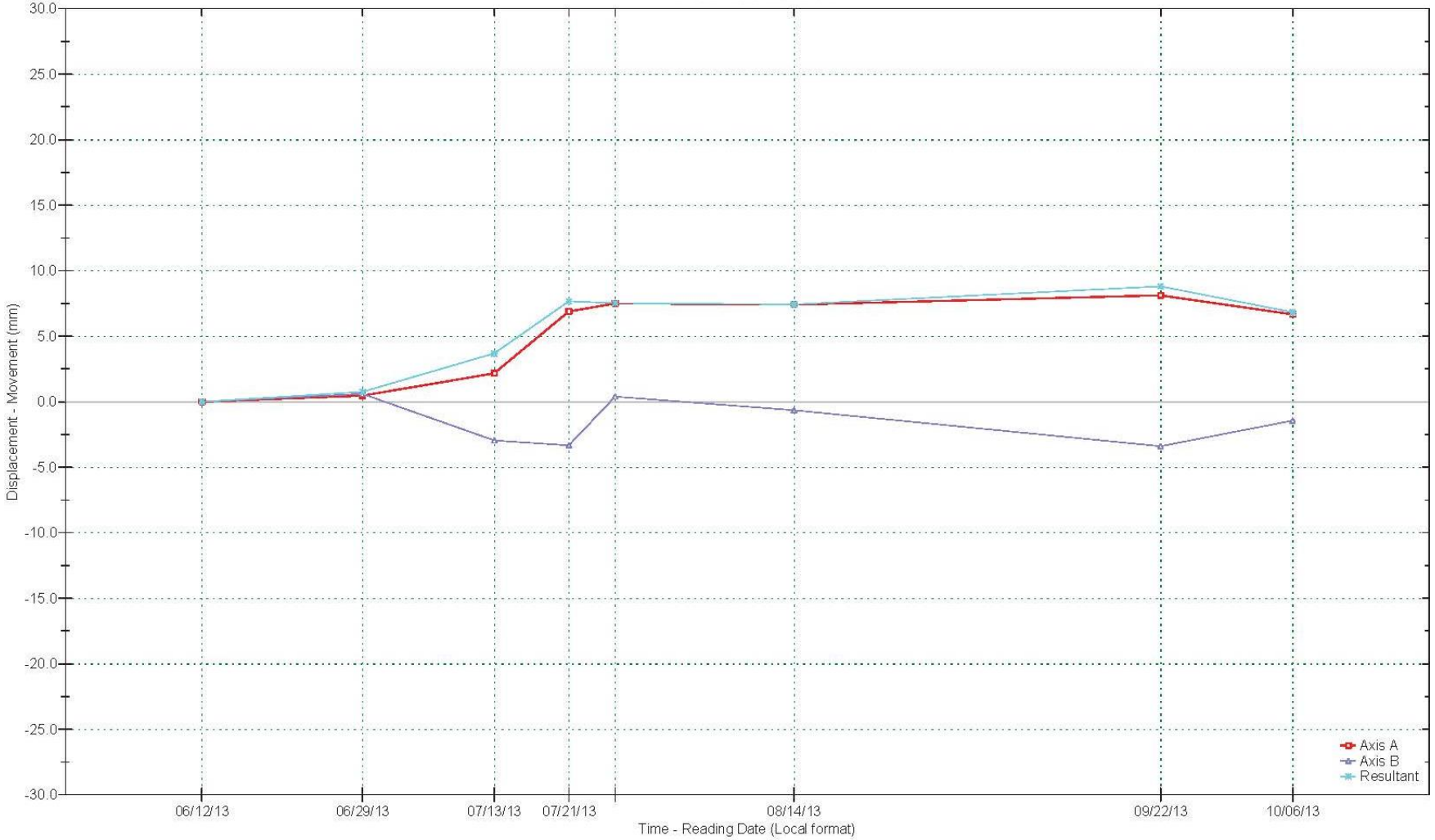


No	Sınır Tanımı	Kritik Deformasyon Değeri (δ)	Alınacak önlemler
1	Yeşil Limit	$\delta \leq \%0.1H$	Herhangi bir ilave önlem alınmadan okumalar ve inşaat kademeleri normal seyrinde devam ettirilecektir.
2	Sarı Limit	$\%0.1H < \delta \leq \%0.2H$	Okumalar günlük gerçekleştirilecek ve test çivisi sayısı arttırılacaktır. Ayrıca tasarım ve uygulama kayıtları gözden geçirilecek ve gerekirse ilave çiviler yerleştirilecektir.
3	Kırmızı Limit	$\delta > \%0.3H$	Kazı durdurulacak ve açık bölgeler varsa acil geri dolgu yapılacaktır. Deformasyonun kritik değeri aştığı bölgedeki imalat durdurulacak ve gerekiyorsa proje revizyonuna gidilecektir.


Axis - A
Ink. Ust Kotu: 305.73
Kazi Kotu: 295.00
Depth (meters)
Cumulative Displacement (mm)
Borehole_2(8) 06-Oct-13
Borehole_2(7) 22-Sep-13
Borehole_2(6) 14-Aug-13
Borehole_2(5) 26-Jul-13
Borehole_2(4) 21-Jul-13
Borehole_2(3) 13-Jul-13
Borehole_2(2) 29-Jun-13
Borehole_2(1) 12-Jun-13


Axis - B
Ink. Ust Kotu: 305.73
Kazi Kotu: 295.00
Depth (meters)
Cumulative Displacement (mm)
Borehole_2(8) 06-Oct-13
Borehole_2(7) 22-Sep-13
Borehole_2(6) 14-Aug-13
Borehole_2(5) 26-Jul-13
Borehole_2(4) 21-Jul-13
Borehole_2(3) 13-Jul-13
Borehole_2(2) 29-Jun-13
Borehole_2(1) 12-Jun-13

Rozak Makine Gebze Tesisleri



Kanıt Testi (5 Adet)

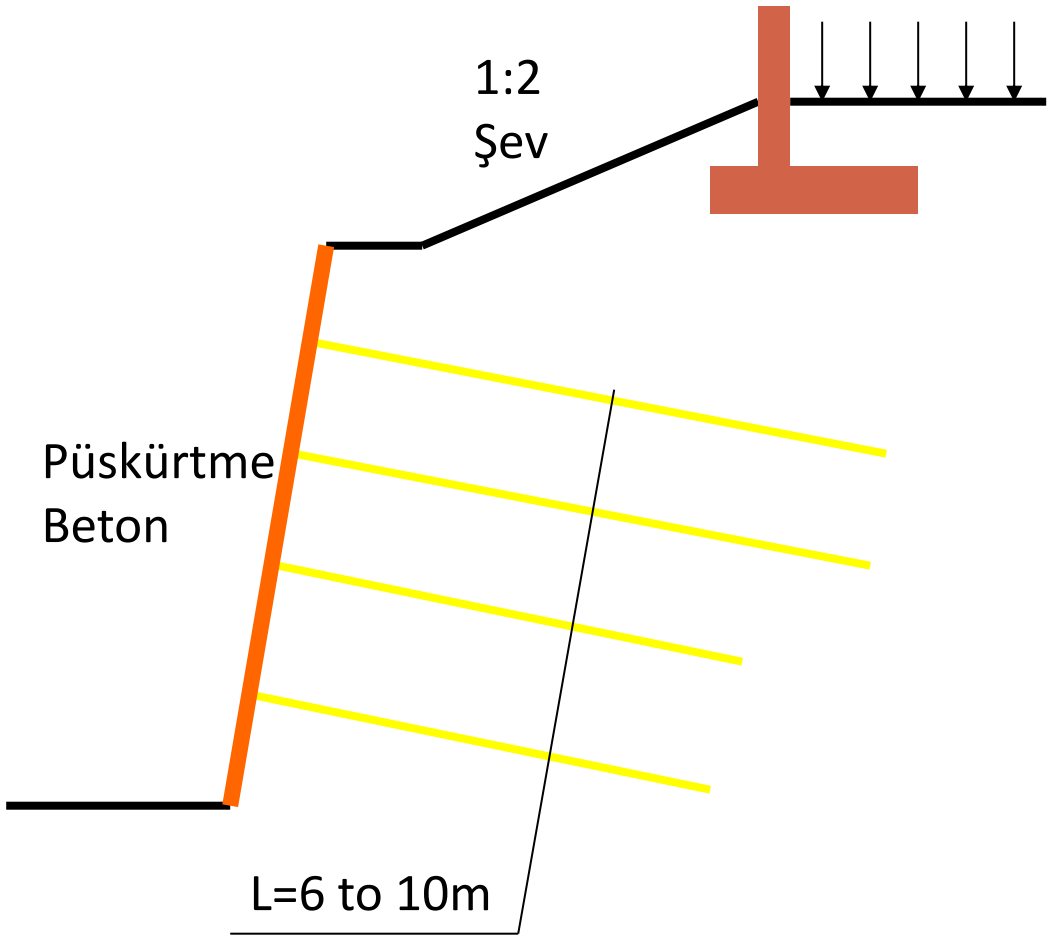
Zaman Aralığı	Yük Tutma Süresi(dk)	Yük Artışları %	Basınç Yükü (ton)	Basınç Göstergesi psi	Deformasyonlar 1.Okuma cm	2.Okuma cm	Ortalama cm	Açıklamalar
	1	0(dengeleme)	0.000	0	0.00	0.00	0	
	10	0,25 DTL	3.810	32	0.26	0.32	0.29	
	10	0,50 DTL	7.625	64	0.99	1.21	1.10	
	10	0,75 DTL	11.438	95	1.89	2.03	1.96	
	10	1,00 DTL	15.250	127	2.57	3.01	2.79	6. ve 60. dakikalar
	10	1,25 DTL	19.063	159	3.49	3.71	3.60	arası fark=
	6 1.	1,50 DTL	22.875	191	3.50	4.51	4.01	
	0 2.	1,50 DTL	22.875	191	3.51	4.51	4.01	< 0,20 cm ise kabul
	3.	1,50 DTL	22.875	191	3.52	4.51	4.02	
	D 5.	1,50 DTL	22.875	191	3.53	4.51	4.02	
	A 6.	**1,50 DTL**	**22.875**	**191**	**3.55**	**4.52**	**4.04**	
	K 10.	1,50 DTL	22.875	191	3.56	4.53	4.05	
	İ 10.	1,50 DTL	22.875	191	3.58	4.54	4.06	6.dak-60.dak= x cm
	K 10.	1,50 DTL	22.875	191	3.58	4.55	4.07	0.07
	A 40.	1,50 DTL	22.875	191	3.61	4.58	4.10	**0,07 cm < 0,20mm**
	50.	1,50 DTL	22.875	191	3.62	4.59	4.11	
	60.	**1,50 DTL**	**22.875**	**191**	**3.62**	**4.60**	**4.11**	

Doğrulama Testi (5 Adet)

Zaman Aralığı	Yük Tutma Süresi(dk)	Yük Artışları %	Basınç Yükü (ton)	Basınç Göstergesi bar	Deformasyonlar 1.Okuma cm	2.Okuma cm	Ortalama cm	Açıklamalar
	1	0(dengeleme)	0.000	0	0.00	0.00	0.00	
	10	0,25 DTL	3.810	32	0.12	0.21	0.17	
	10	0,50 DTL	7.625	64	0.49	0.35	0.42	
	10	0,75 DTL	11.438	95	0.95	0.77	0.86	
	10	1,00 DTL	15.250	127	1.17	1.06	1.12	6. ve 60. dakikalar
	10	1,25 DTL	19.063	159	1.43	1.28	1.36	arası fark=
	6 1.	1,50 DTL	22.875	191	2.06	1.79	1.93	
	0 2.	1,50 DTL	22.875	191	2.06	1.79	1.93	<2mm ise kabul
	3.	1,50 DTL	22.875	191	2.07	1.80	1.94	
	D 5.	1,50 DTL	22.875	191	2.07	1.80	1.94	
	A 6.	**1,50 DTL**	**22.875**	**191**	**2.07**	**1.81**	1.94	**2,00-1,94=0,06 cm**
	K 10.	1,50 DTL	22.875	191	2.08	1.82	1.95	0,6mm<2mm kabul
	İ 10.	1,50 DTL	22.875	191	**2.08**	1.83	1.96	
	K 10.	1,50 DTL	22.875	191	2.08	1.83	1.96	
	A 40.	1,50 DTL	22.875	191	2.10	1.85	1.98	
	50.	1,50 DTL	22.875	191	2.11	1.86	1.99	
	60.	**1,50 DTL**	**22.875**	**191**	2.13	1.86	2.00	
	10	1,75 DTL	26.690	222	3.37	2.46	2.92	
	10	**2,00 DTL(max. Yük)**	**30.500**	**254**	4.14	3.99	4.07	

A650 Bingley Relief Road (Arup / AMEC)

Ferncliffe Junction



İşveren: AMEC Capital

Müteahhit: AMEC Piling

Tasarımcı: Arup

Yaklaşık 5500m^2

2,400 Zemin Çivisi

120 yıl Tasarım Ömrü

H_{max} = 10m

S_v=S_h=1.5m

Glacial Sands & Gravels, Made Ground

- Kohezyonsuz zeminler sebebiyle delgi ve stabilite problemleri.
- Büyük bloklar sebebiyle kılıflı delgi kullanılmıştır.
- Düzensiz yüzeyler sebebiyle püskürtme beton miktarında %60'a varan artışlar.
- Çimento enjeksiyonunda zeminin yüksek permeabilitesi sebebiyle kayıplarların telafi edilmesi gerekti.

A650 Bingley Relief Road


50
A650 Bingley Relief Road
Winner of Prime Minister's Award
in UK Construction Awards 2004

Suffolk College (AECOM)

İşveren : Suffolk New College

120 Adet Zemin Çivisi

60 yıl Tasarım Ömrü

$S_v=S_h=1.0 – 2.0m$

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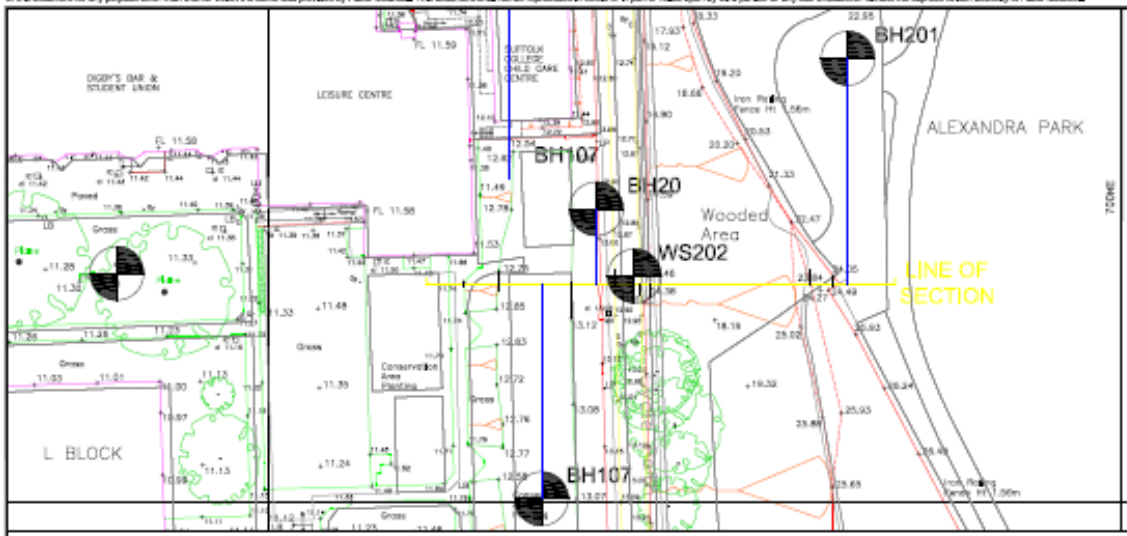


N

NOTES:

1. SECTION PROFILE INTERPOLATED FROM SHOWN TOPOGRAPHICAL SURVEY DATA.
2. TO BE READ IN CONJUCTION WITH LATEST REVISION OF FABER MAUNSELL SPECIFICATION FOR SOIL NAILED SLOPE 56356ISAG/SPEC/MN.

LEGEND:

- Made Ground
- London Clay
- Granular Lambeth Group
- Groundwater
- Ground Profile

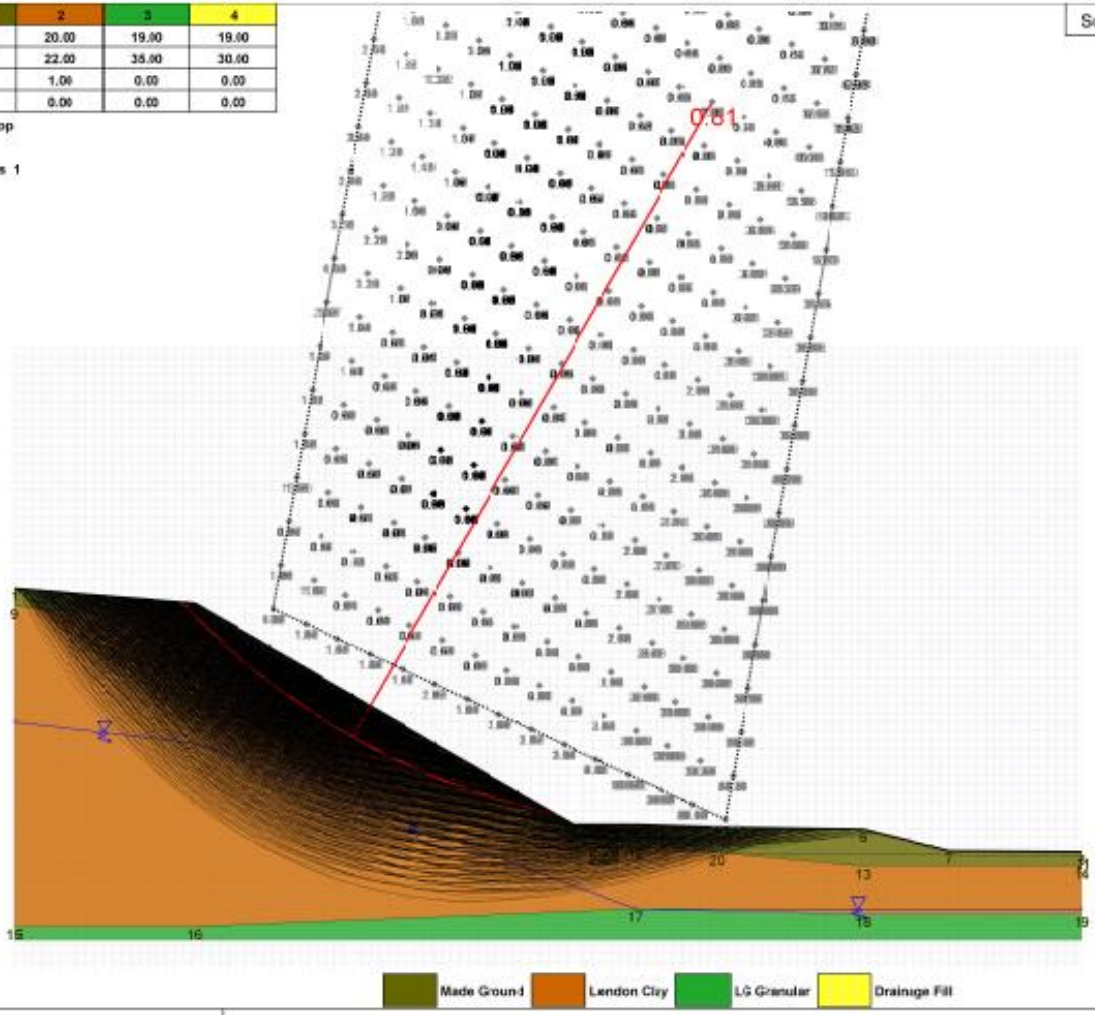
Client: SUFFOLK COLLEGE	Title: SECTION THROUGH EXISTING SLOPE	FABER MAUNSELL | AECOM	Design: FG; CAD: FG
Project: SUFFOLK COLLEGE SLOPE			Chkd: GGS; Appd: MBO
			Date: 12/11/07; Scale: NTS
		Marlborough House, Upper Marlborough Road, St Albans, Hertfordshire, AL1 3UT. Tel: +44 (0)20 8784 5784 Fax: +44 (0)20 8784 5700 www.fabermaunsell.com	No. 56356ISAG/02; Rev: 0

..ayer r°	1	2	3	4
γ(kN/m³)	19.00	20.00	19.00	19.00
φ(°)	21.00	22.00	35.00	30.00
c(kPa)	1.00	1.00	0.00	0.00
Δc(kPa/m)	0.00	0.00	0.00	0.00

Calculation method : Bishop
Units : kN,kPa,kN/m3
Safety factors : Coefficients 1

Scale: 1/346

F_{min}= 0.81



TALREN 4 v1.3

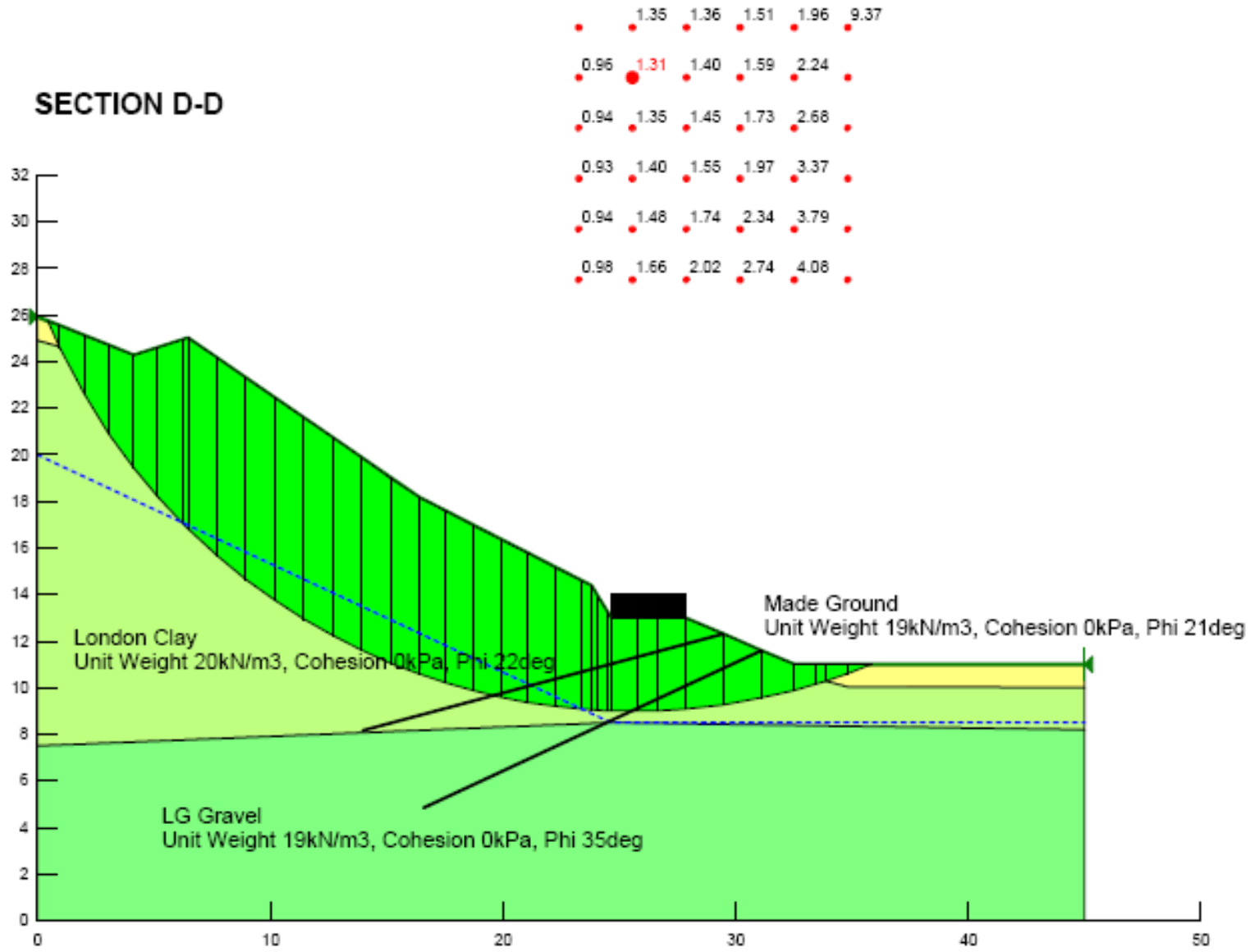
TERRASOL

56356 ISAG / Alexandra Park Slope

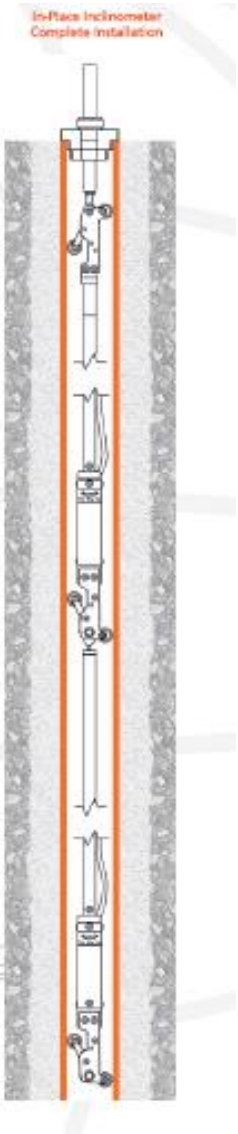
F:\...\E-E Existing.prj / Phase 1 / Slope 1

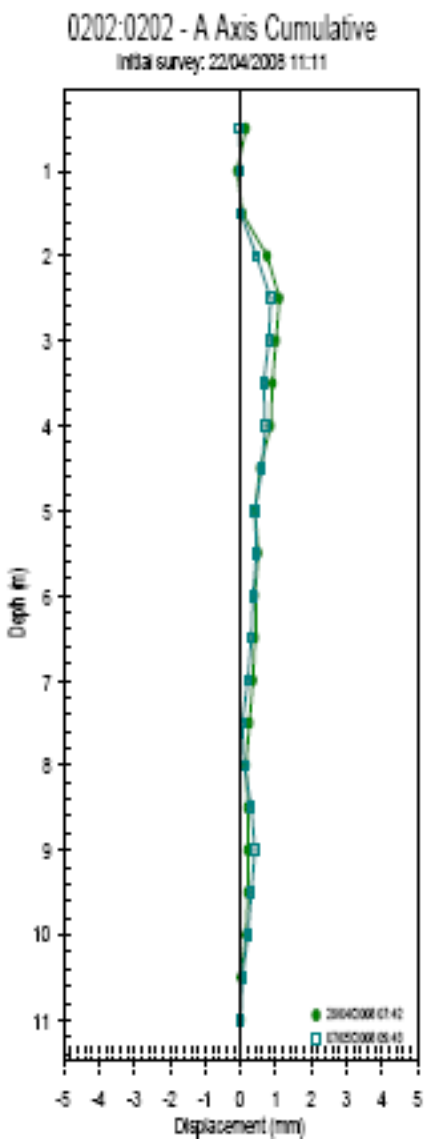
Calculation by :
FABER MAUNSELL

Printed on : 04/03/08 at 12:21:51


SECTION D-D
1.35 1.36 1.51 1.96 9.37
0.96 1.31 1.40 1.59 2.24
0.94 1.35 1.45 1.73 2.68
0.93 1.40 1.55 1.97 3.37
0.94 1.48 1.74 2.34 3.79
0.98 1.66 2.02 2.74 4.08
London Clay
Unit Weight 20kN/m3, Cohesion 0kPa, Phi 22deg
Made Ground
Unit Weight 19kN/m3, Cohesion 0kPa, Phi 21deg
LG Gravel
Unit Weight 19kN/m3, Cohesion 0kPa, Phi 35deg
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
0
10
20
30
40
50

Suffolk College





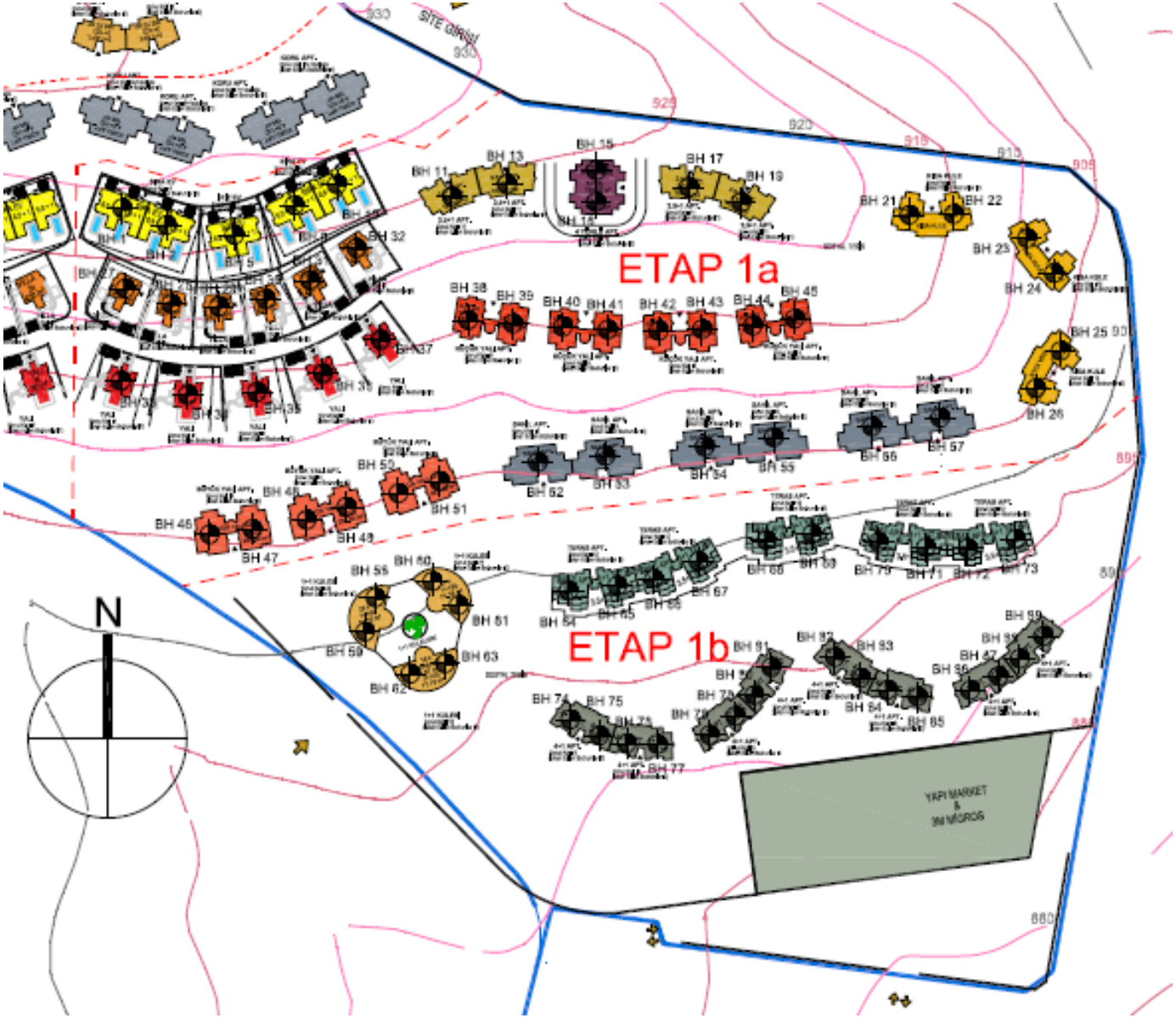
Suffolk College


ENERPAC

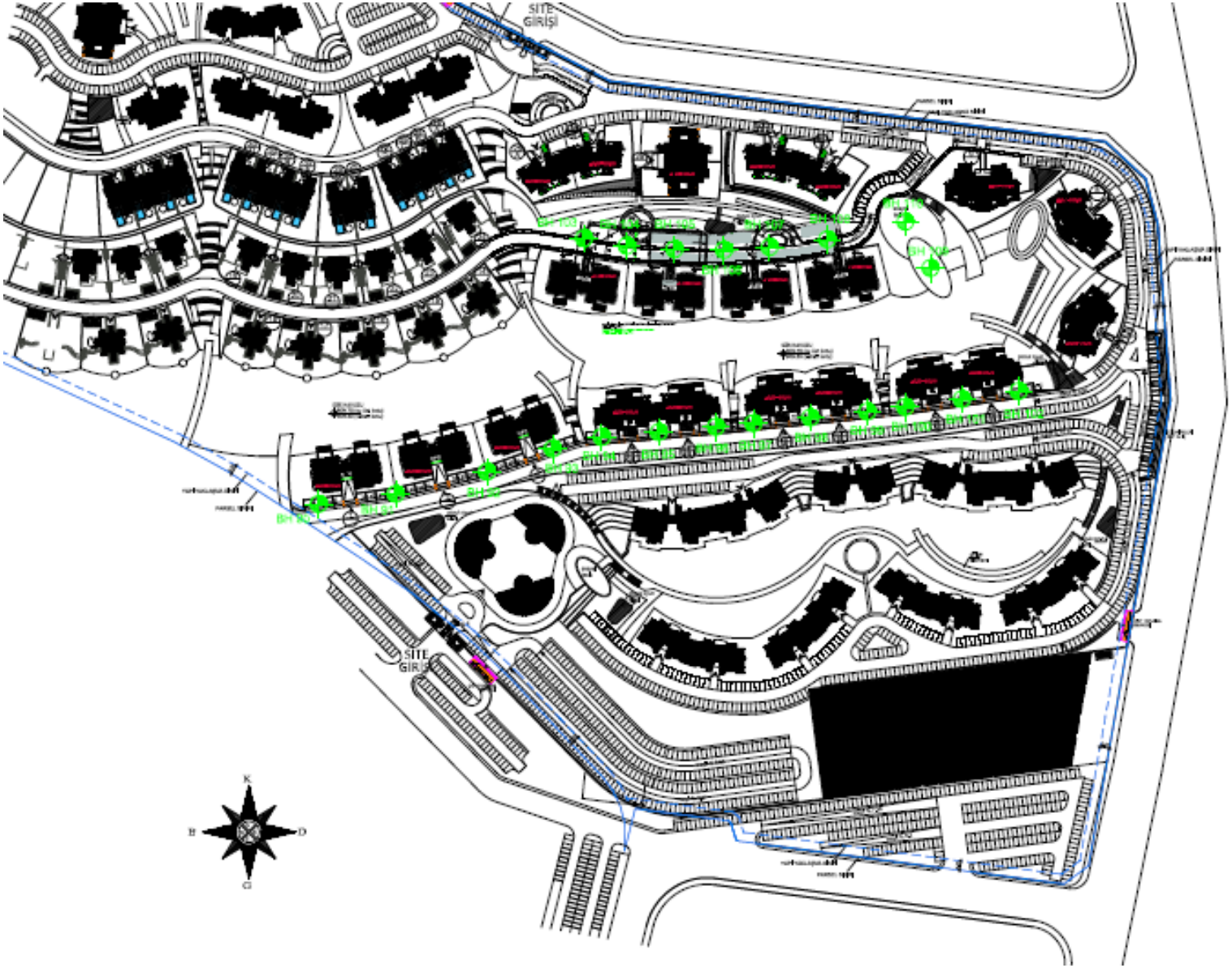
15 DAKİKA ARA…

Antepia Projesi
(Sinpaş / Paralel Gayrimenkul)

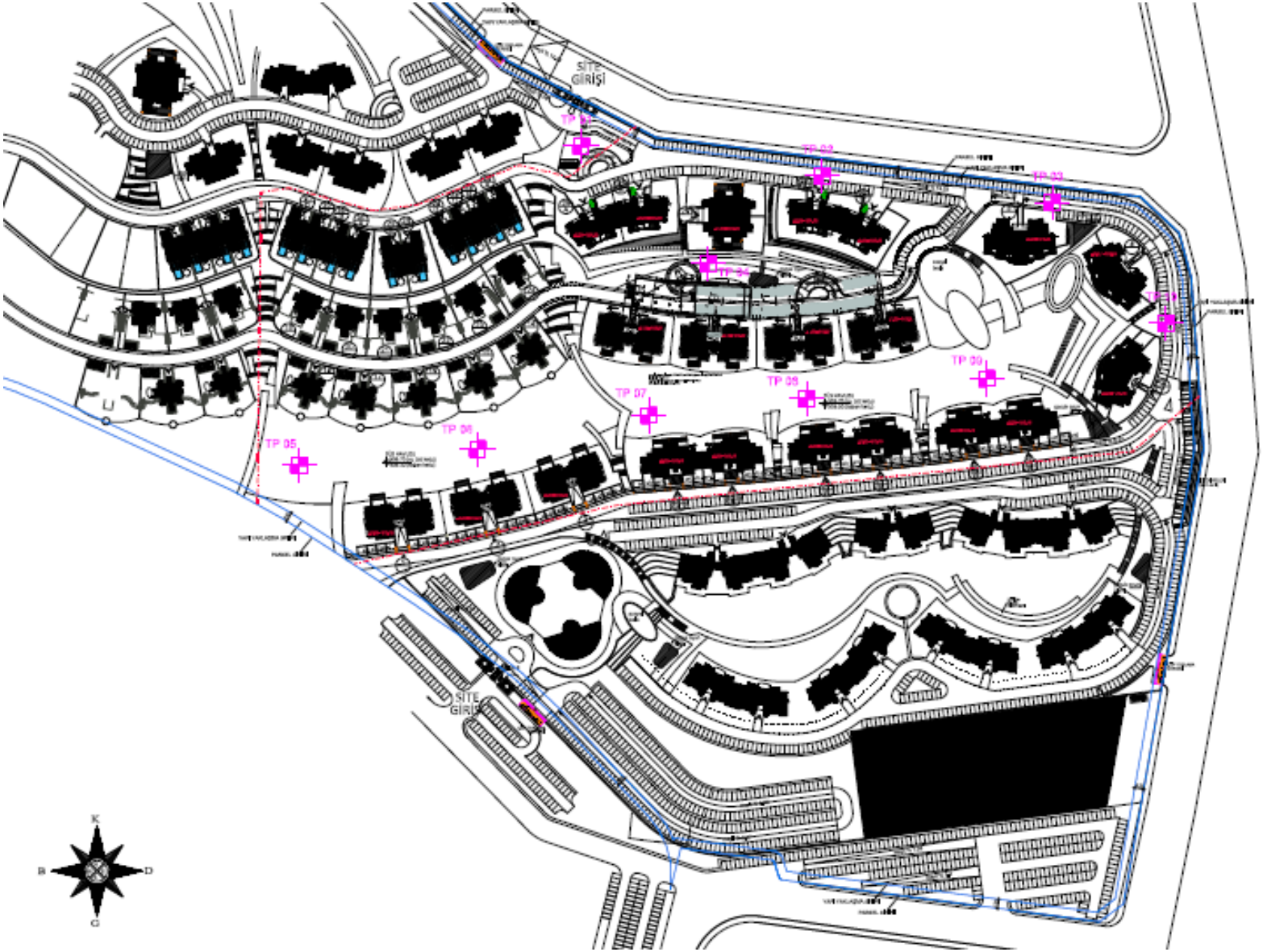
- Zemin Etüdü: Geoteknik A.Ş.
- Zemin Çivisi Alt Yüklenici: Naturel Çevre
- 60 yıl Tasarım Ömrü
- Sh = Sv = 1.5m
- L = 6 – 14



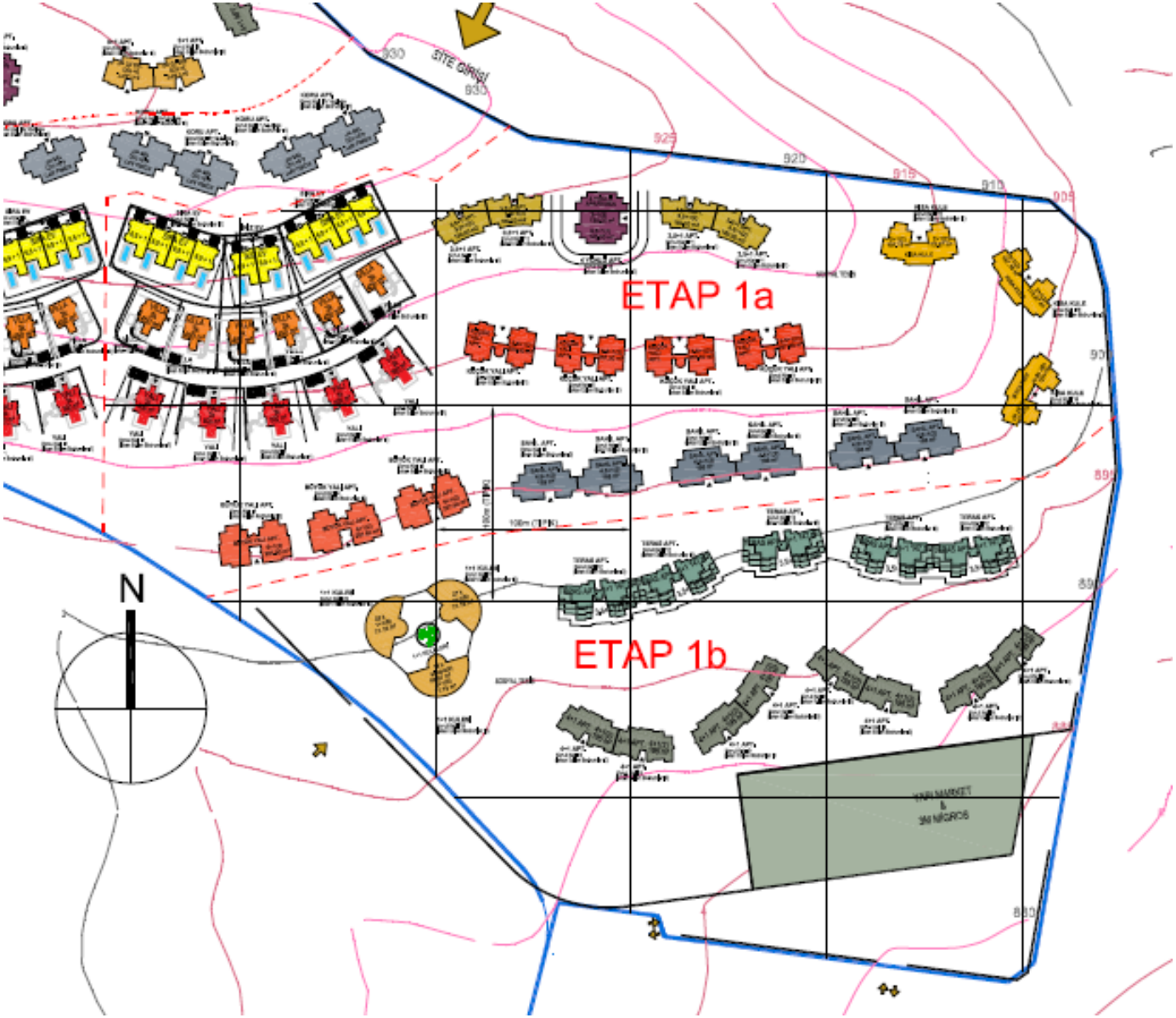
Etap 1A – 48 Adet Sondaj



Etap 1A – 21 Adet İlave Otopark Sondajı

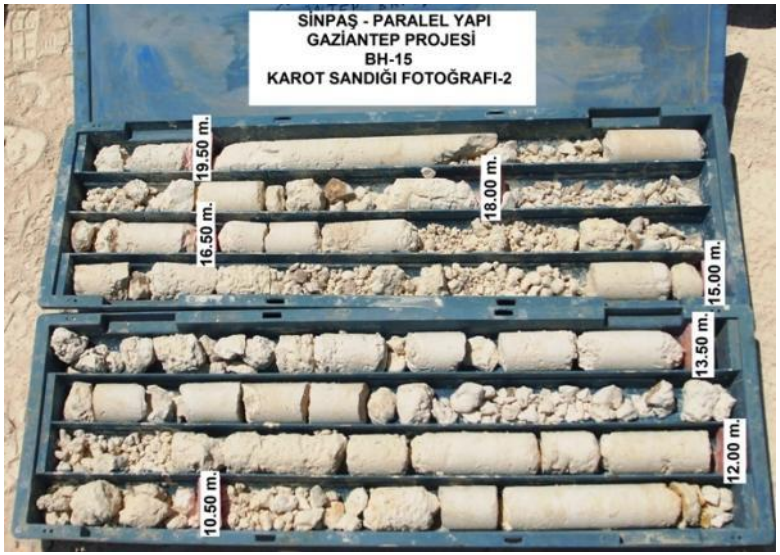


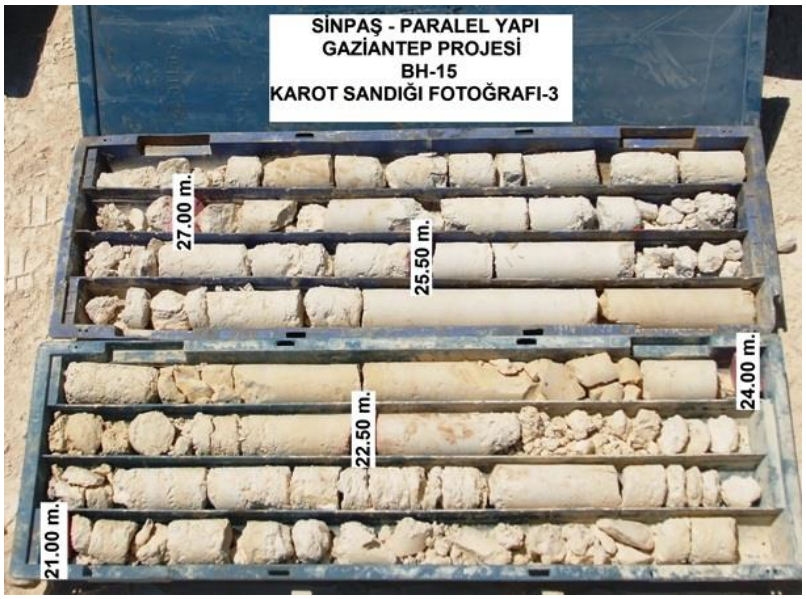
Etap 1A – Araştırma Çukurları



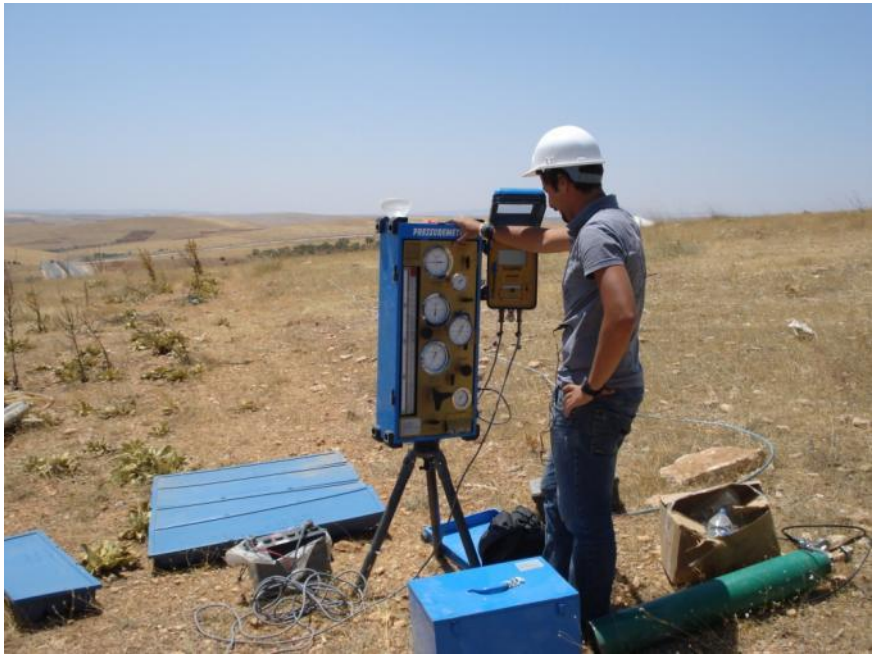
Etap 1A – Jeofizik Araştırmalar

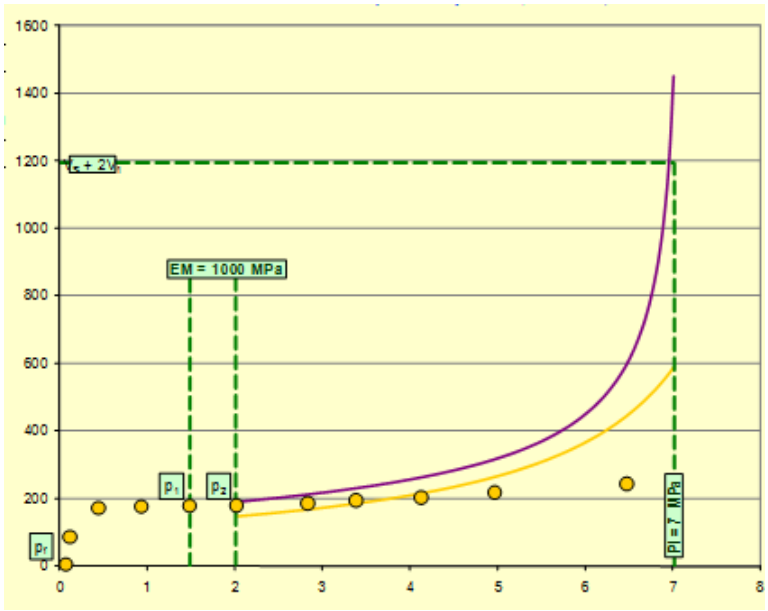
Etap 1A – Sondaj çalışmalarından örnekler



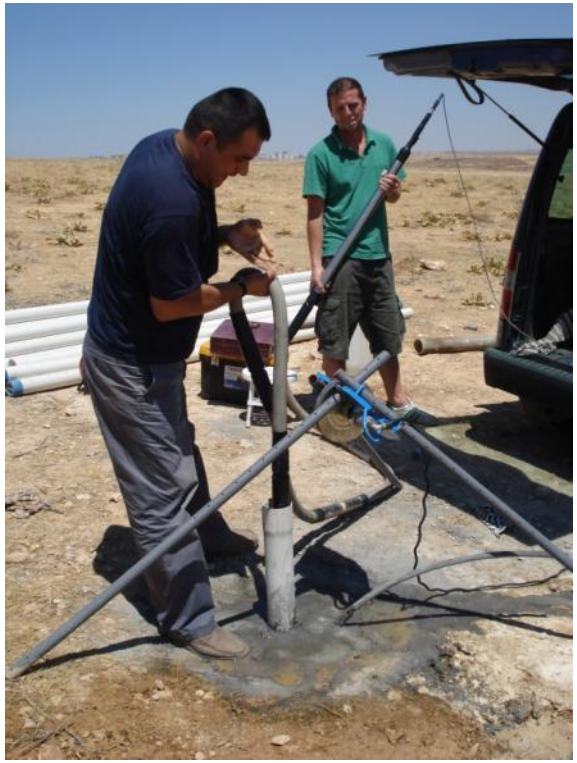


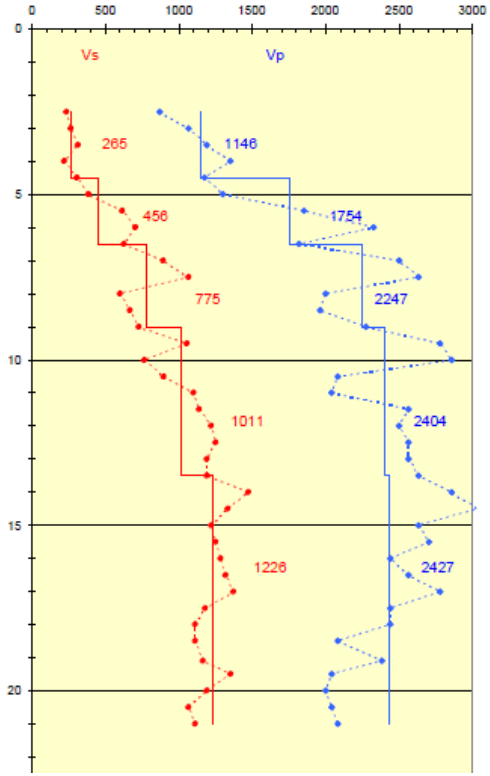
Etap 1A – Sondaj karot örnekleri

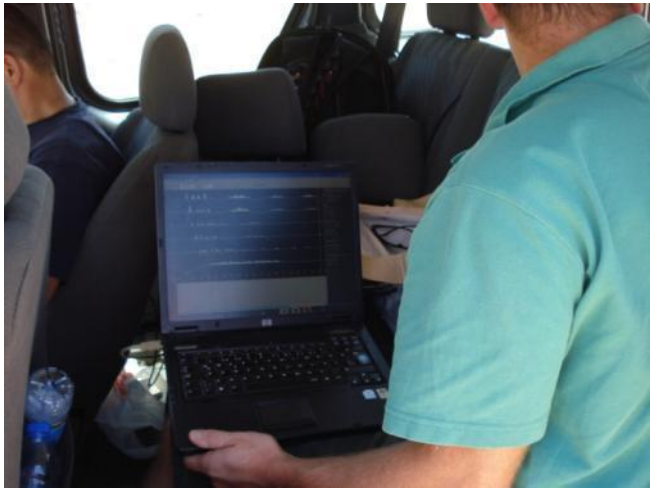




Etap 1A – Presiyometre Deneyleri



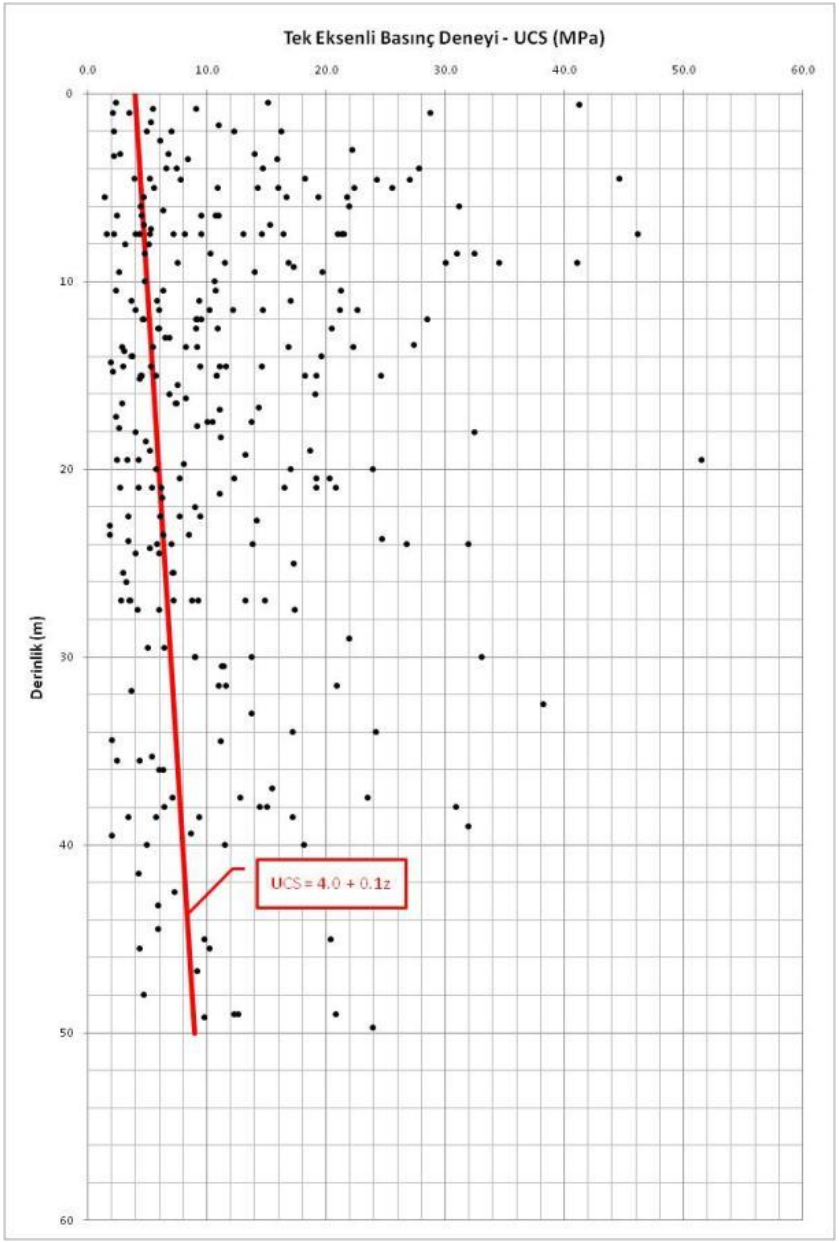


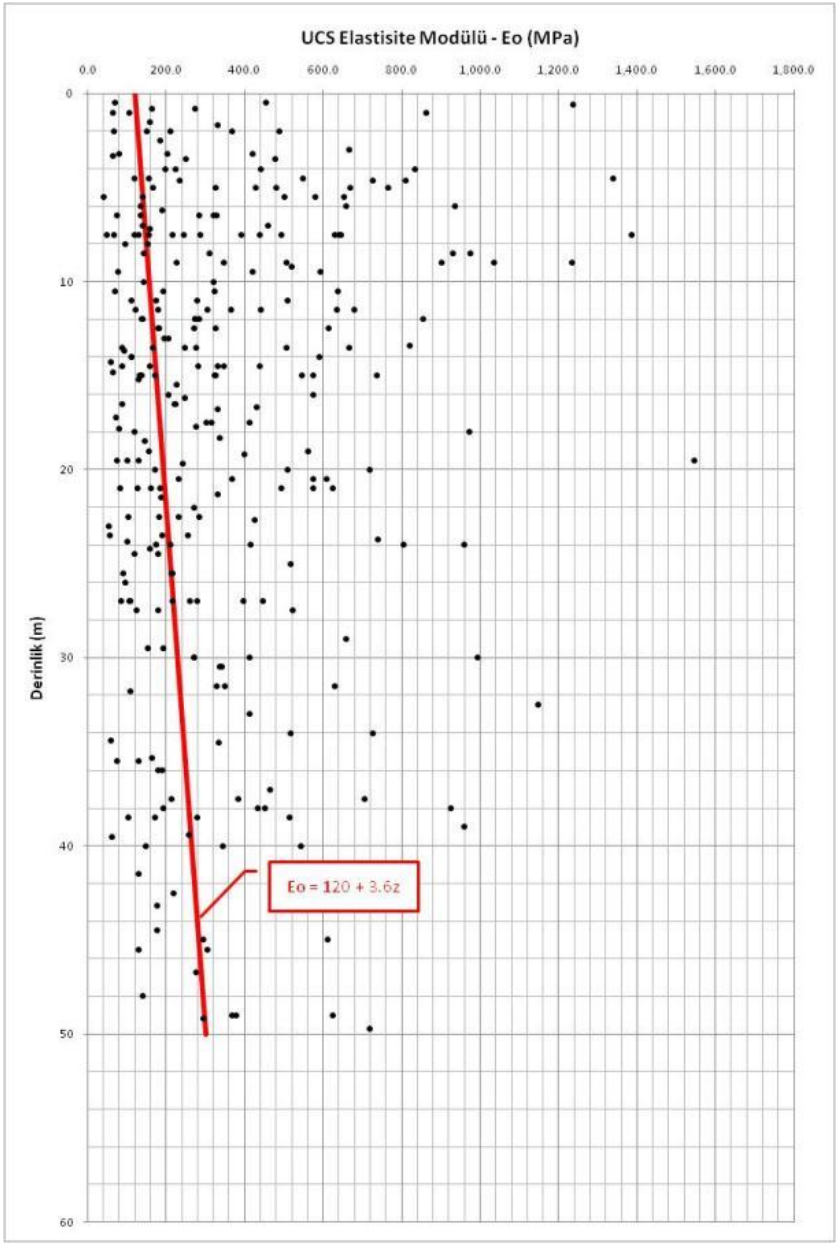


Etap 1A – Suspension PS Logging Ölçümleri

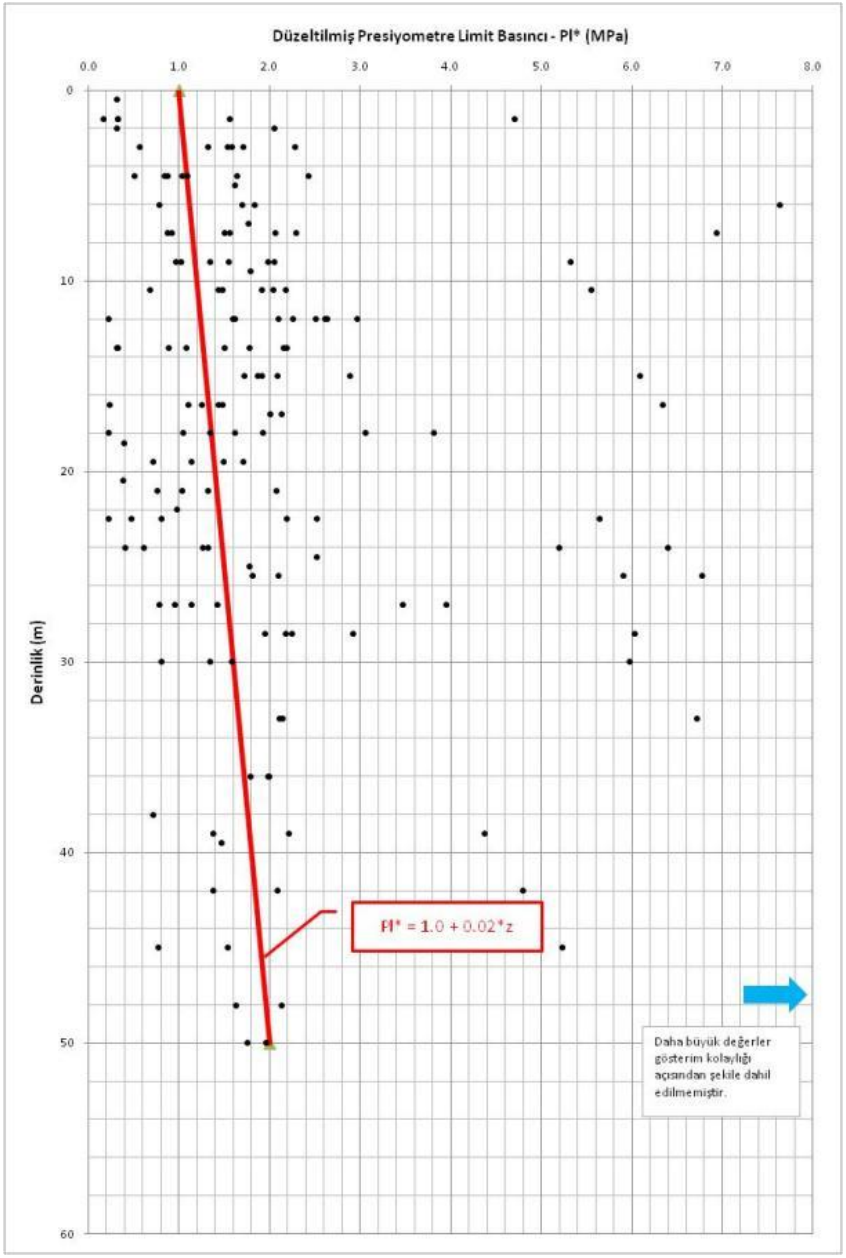
Etap 1A – Laboratuar Çalışmaları

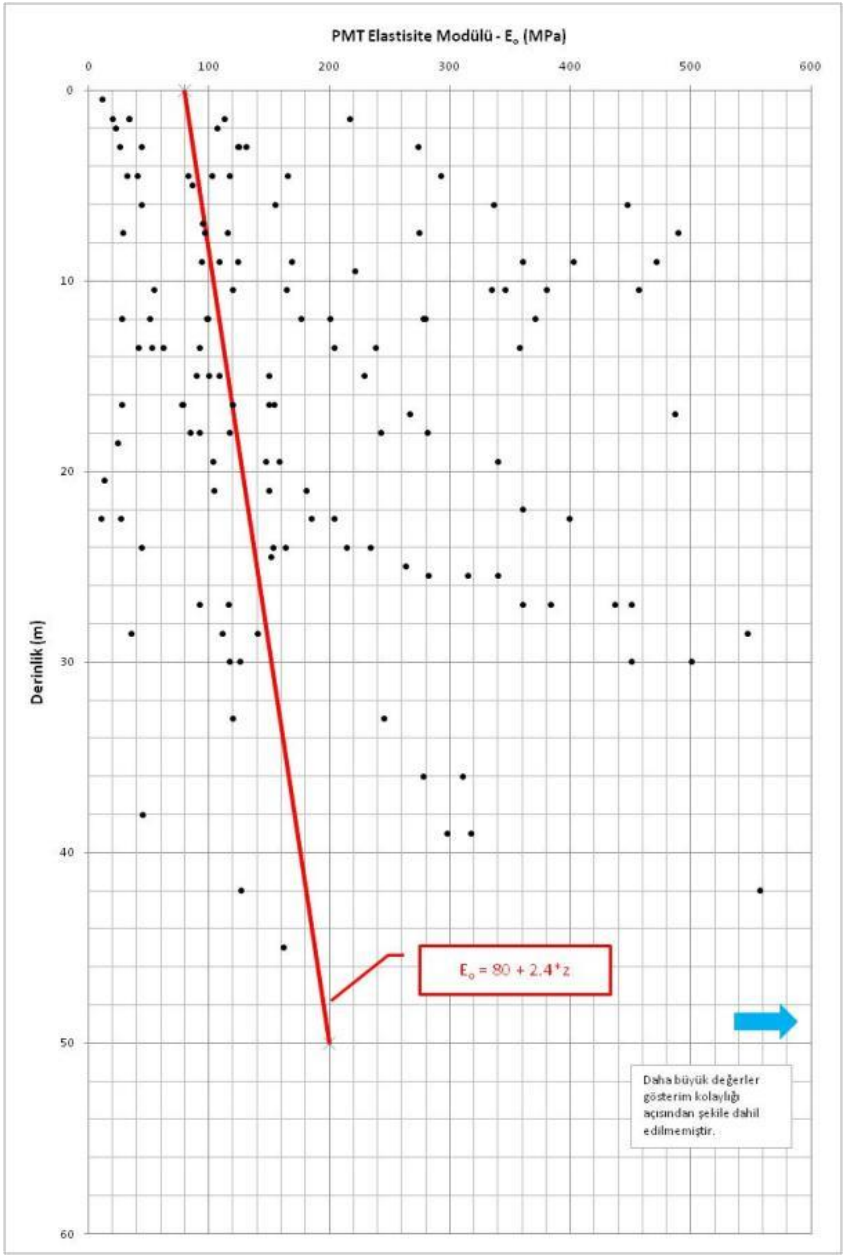
Sahada Karşılaşılan Karstik Boşluklar



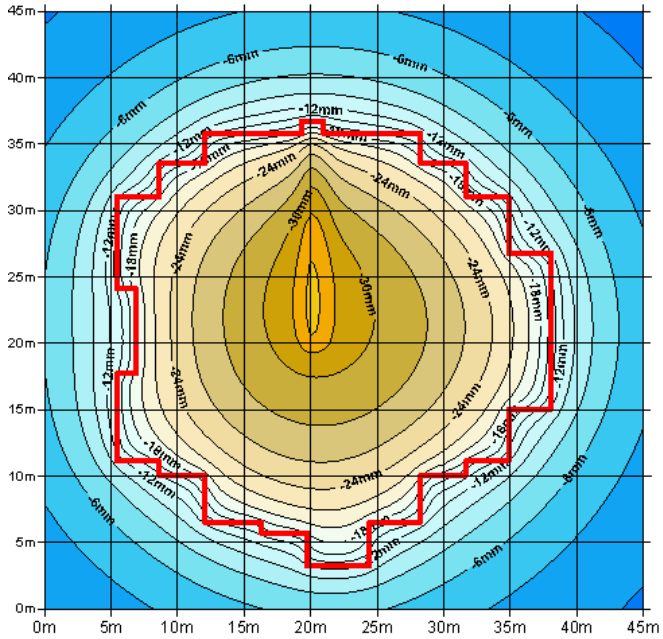


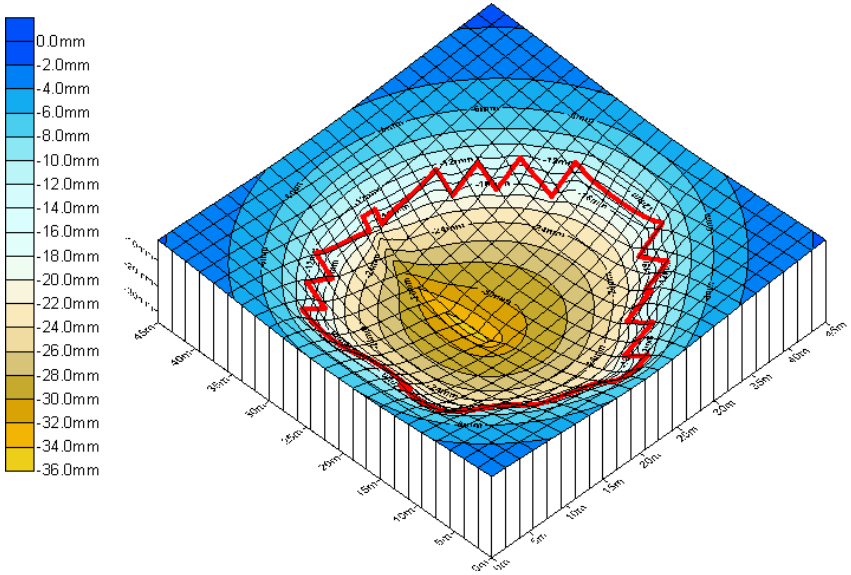
Etap 1A – Tek Eksenli Basınç Deneyi Sonuçları

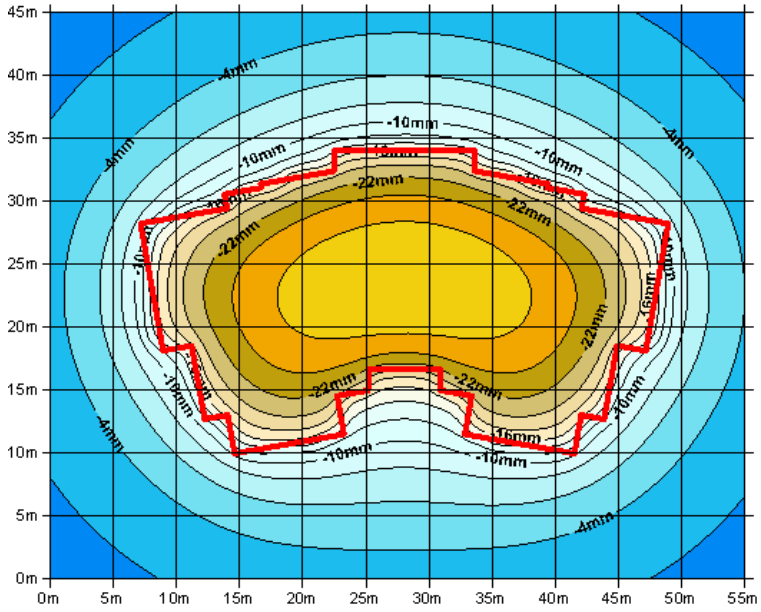


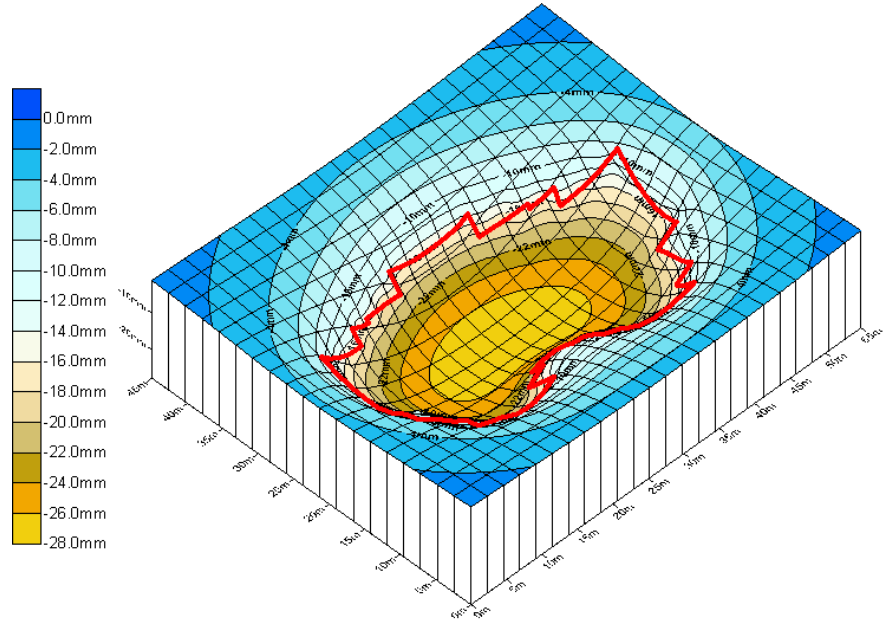


Etap 1A – Presiyometre Deneyi Sonuçları





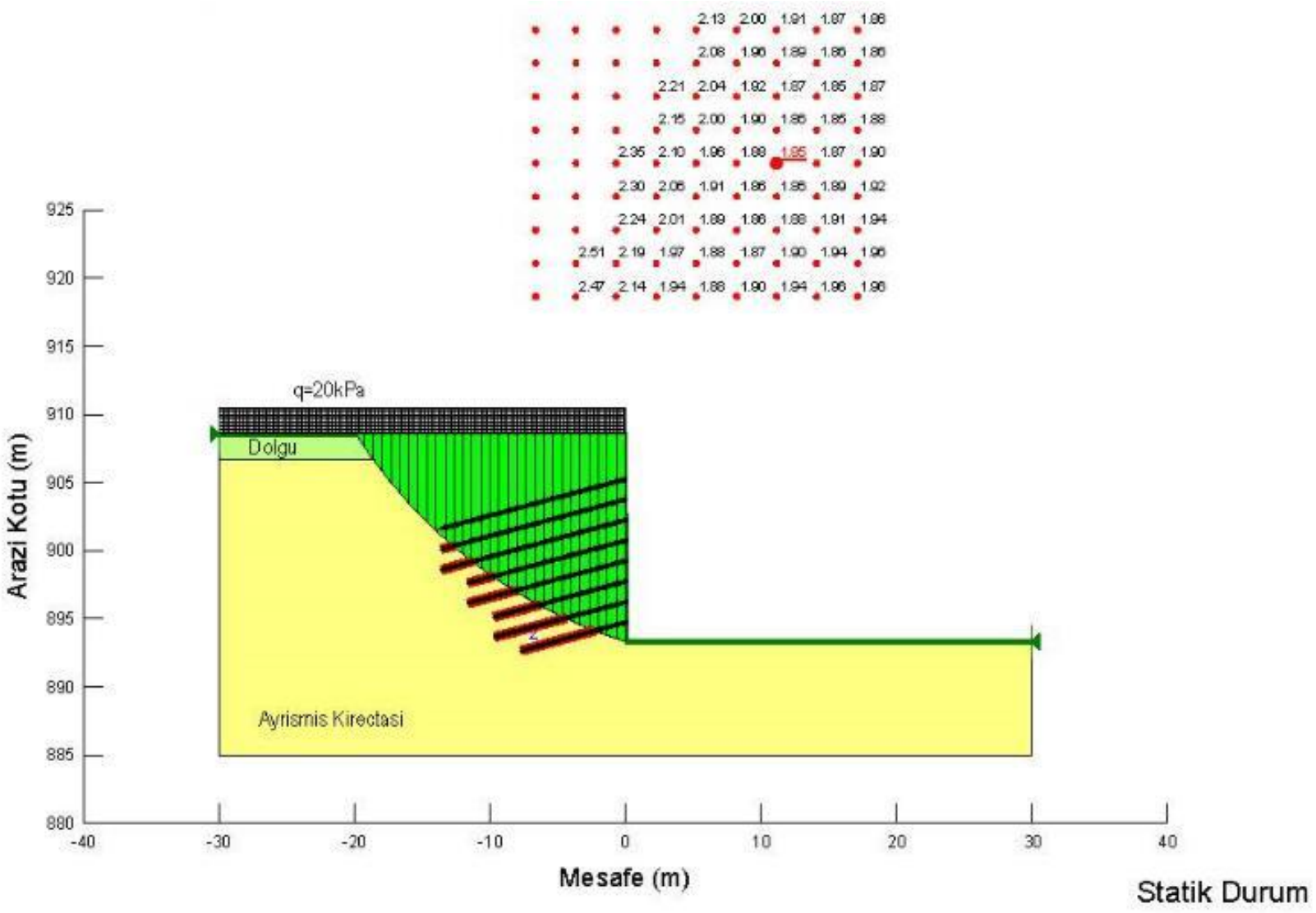




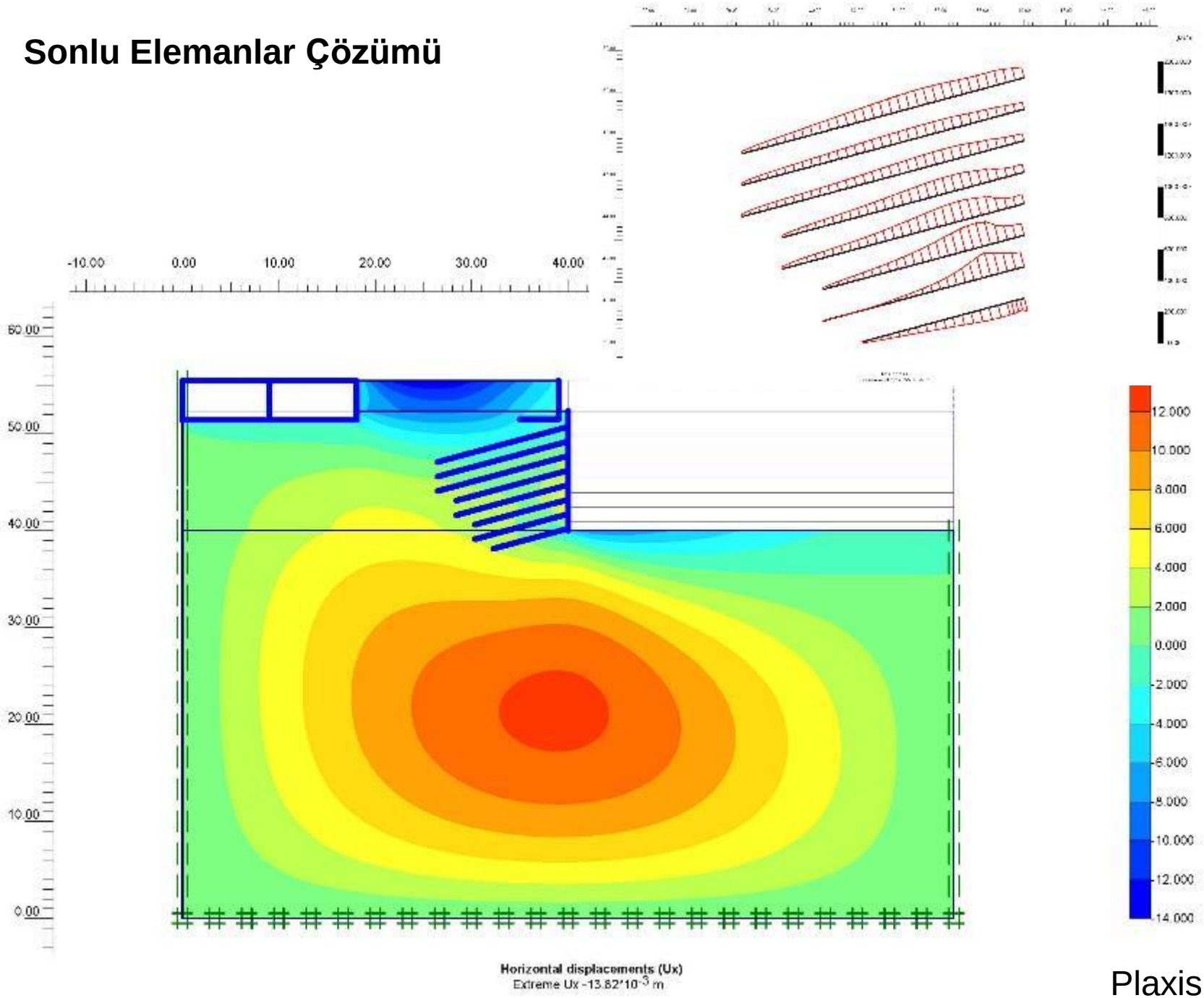
Dört Yönlü Apt ve Kısa Kule İçin Radye Temel Oturması Hesapları (Oasys Pdisp)

İksa Kazısı Öncesi Cephe Görünüşleri ve Şev Üstü Temel Kazıları

Zemin Çivisi Tasarımı

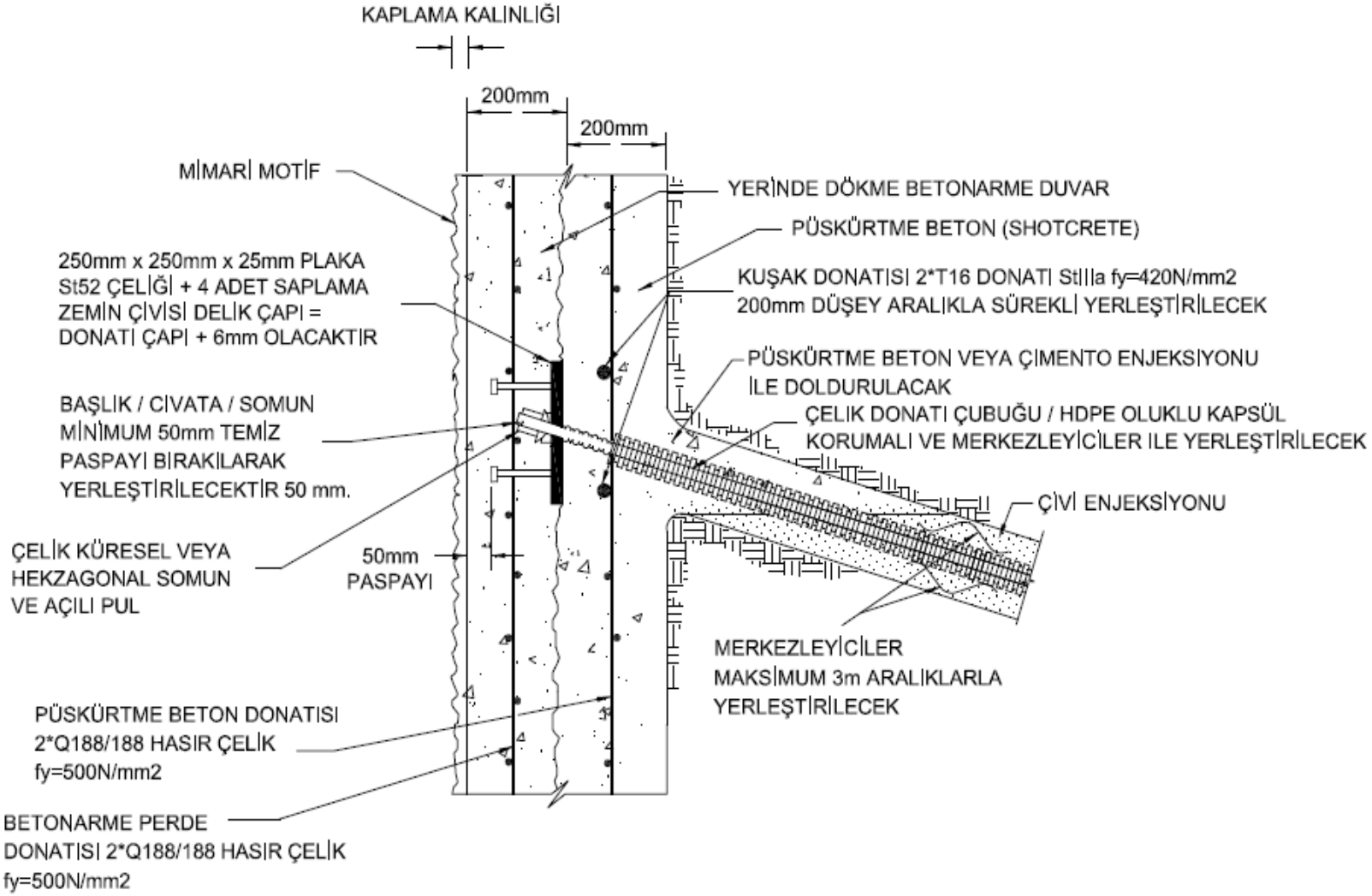


Sonlu Elemanlar Çözümü

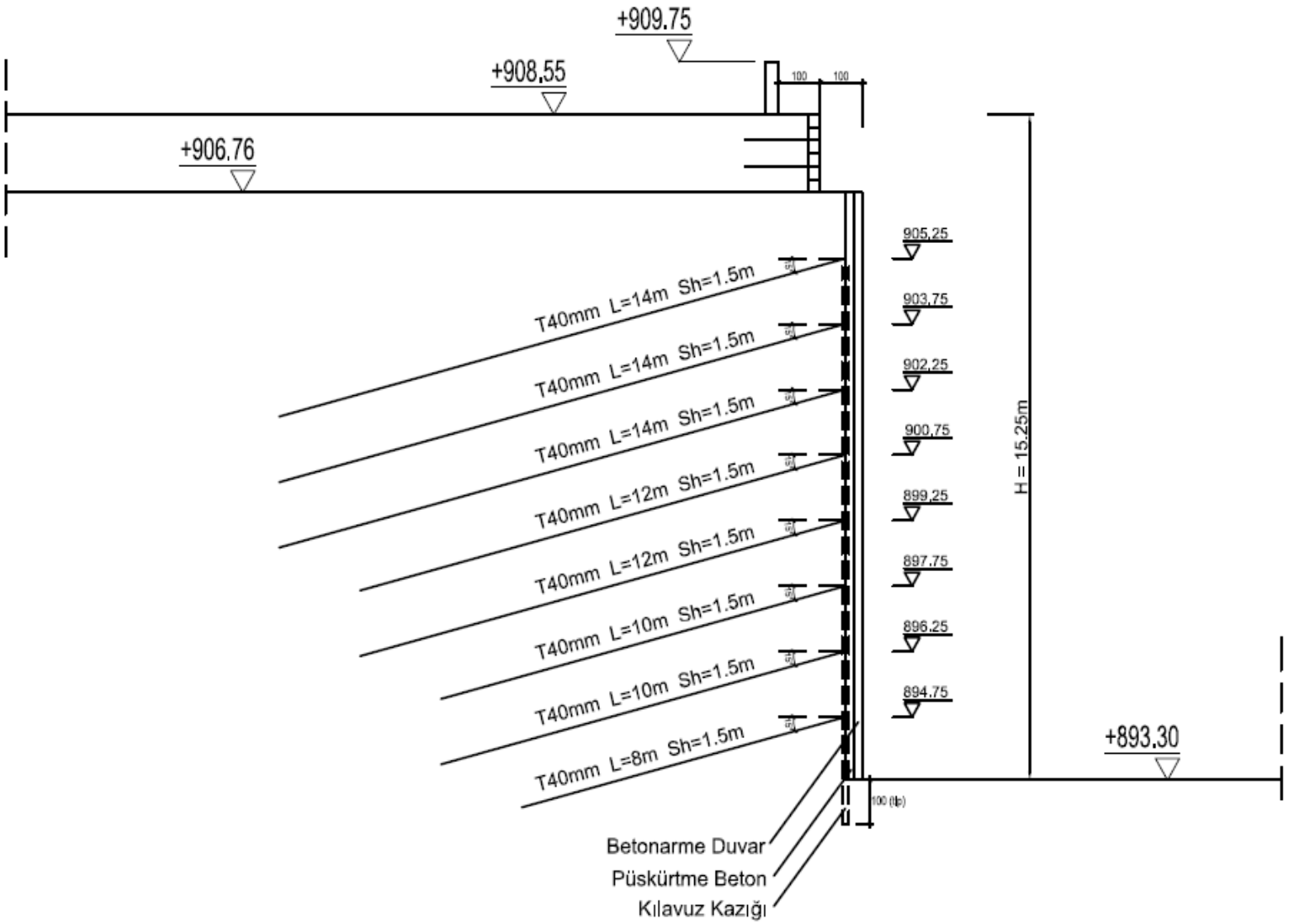


Plaxis 2D

Sistem Detayı Çözümü (Kalıcı Perde)

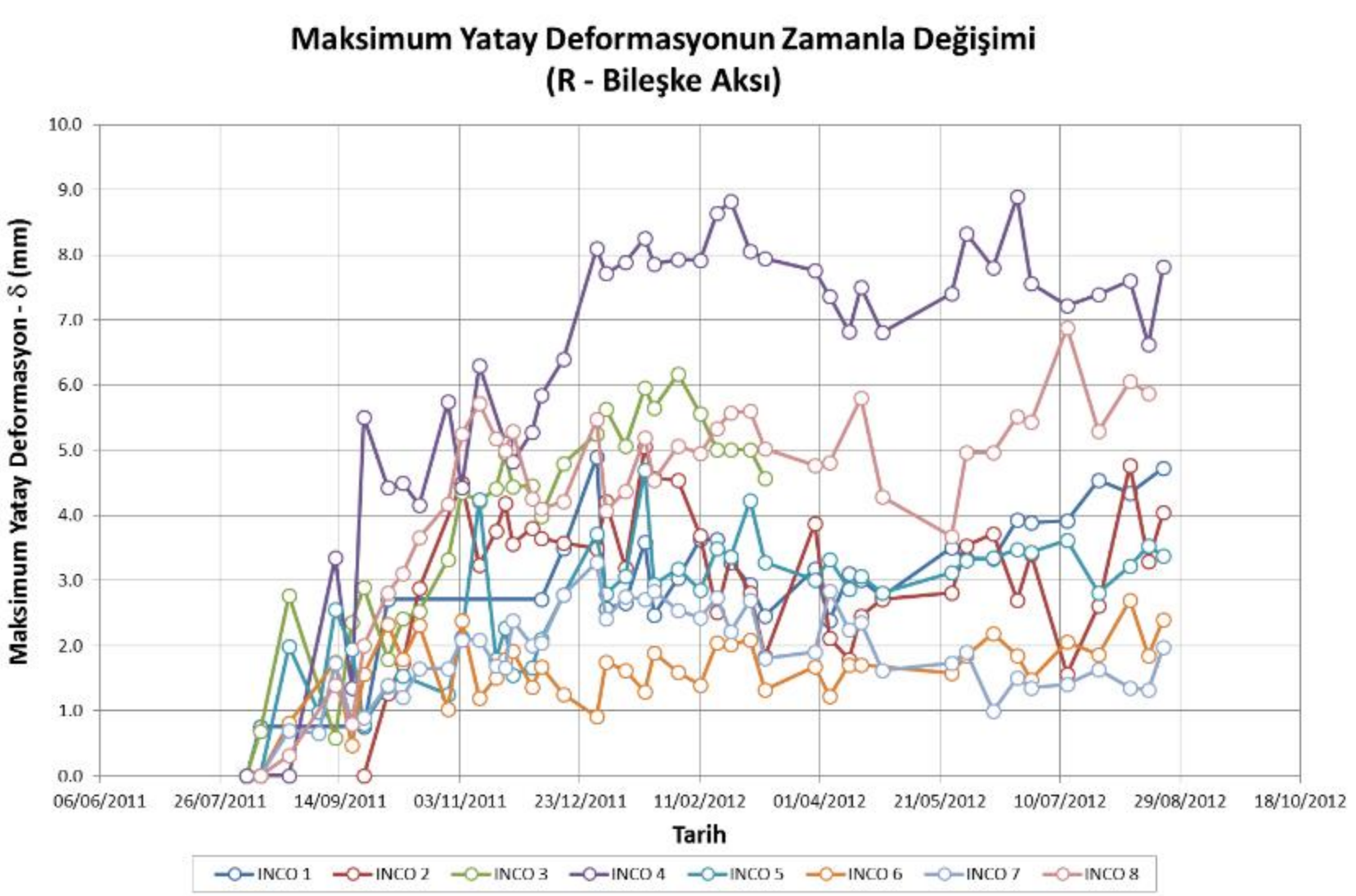


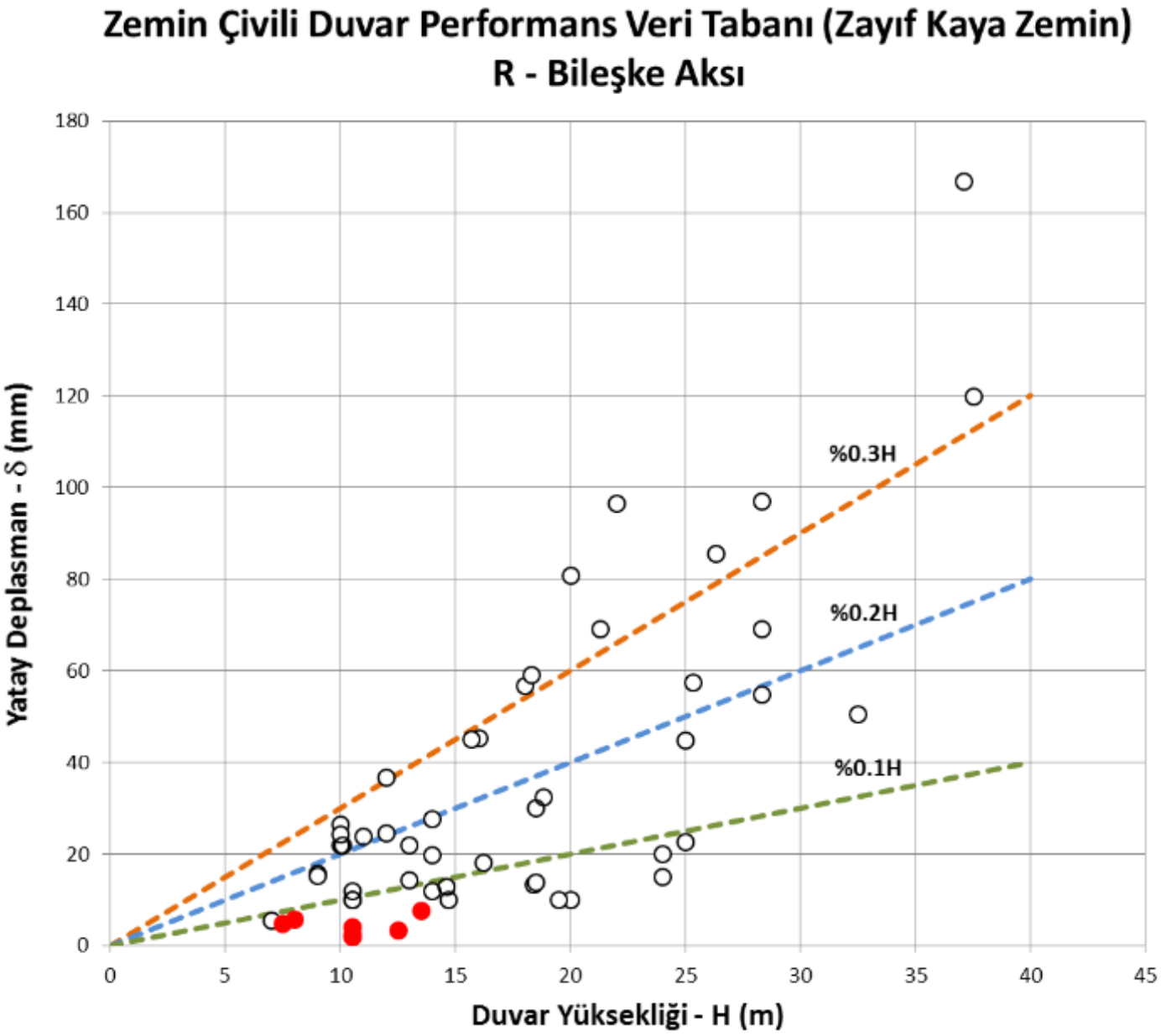
Sistem Kesiti



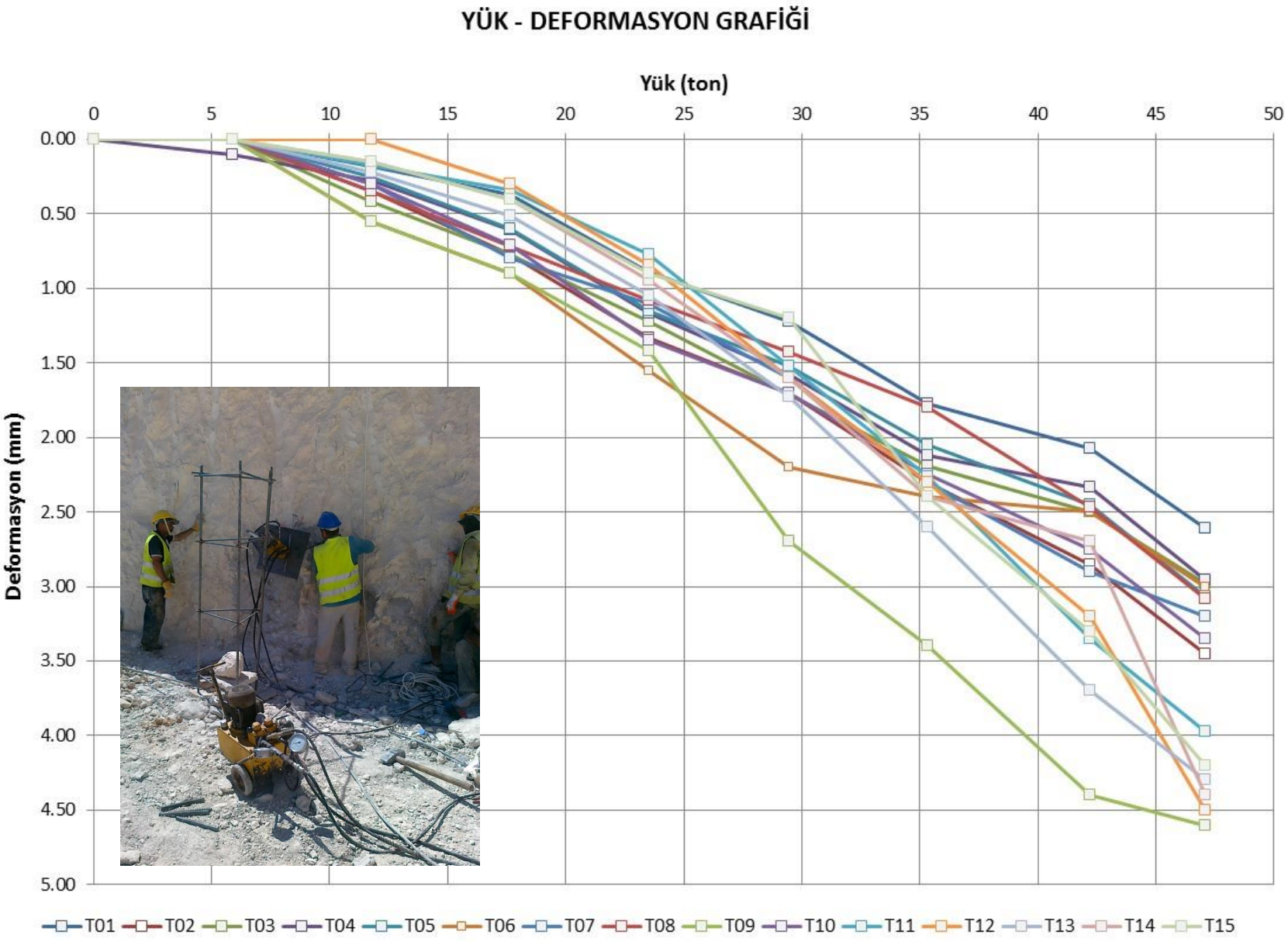
Kaplama Duvar İmalatı

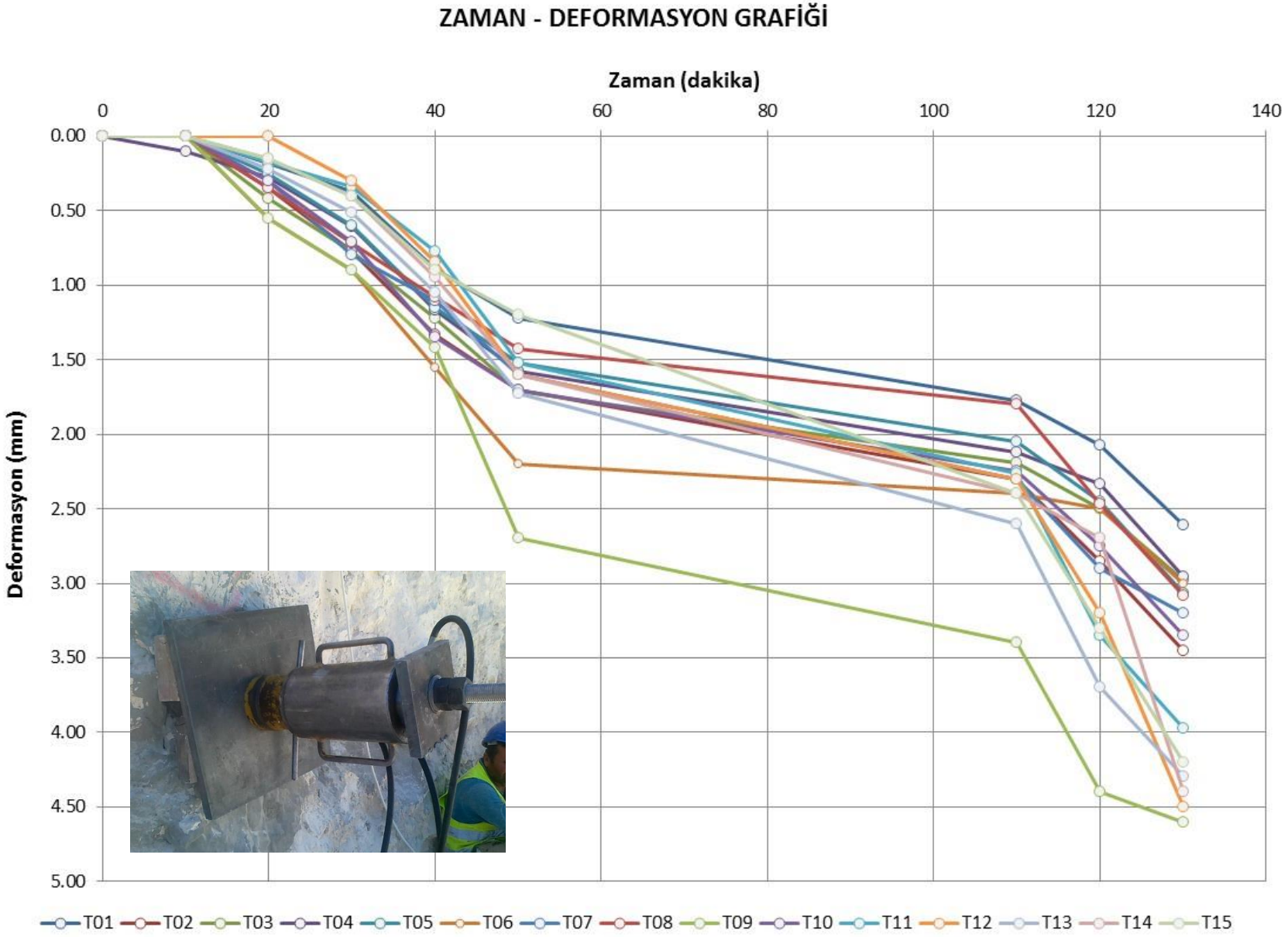
Projenin Bitime Yakın Hali


Maksimum Yatay Deformasyonun Zamanla Değişimi
(R - Bileşke Aksı)
Maksimum Yatay Deformasyon - δ (mm)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
06/06/2011
26/07/2011
14/09/2011
03/11/2011
23/12/2011
11/02/2012
01/04/2012
21/05/2012
10/07/2012
29/08/2012
18/10/2012
Tarih
INCO 1
INCO 2
INCO 3
INCO 4
INCO 5
INCO 6
INCO 7
INCO 8



Veri tabanı karşılaştırması (Ref. Keskin, 2008)


YÜK - DEFORMASYON GRAFİĞİ
Yük (ton)
0
5
10
15
20
25
30
35
40
45
50
Deformasyon (mm)
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
T01
T02
T03
T04
T05
T06
T07
T08
T09
T10
T11
T12
T13
T14
T15


ZAMAN - DEFORMASYON GRAFİĞİ
Zaman (dakika)
0
20
40
60
80
100
120
140
Deformasyon (mm)
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
T01
T02
T03
T04
T05
T06
T07
T08
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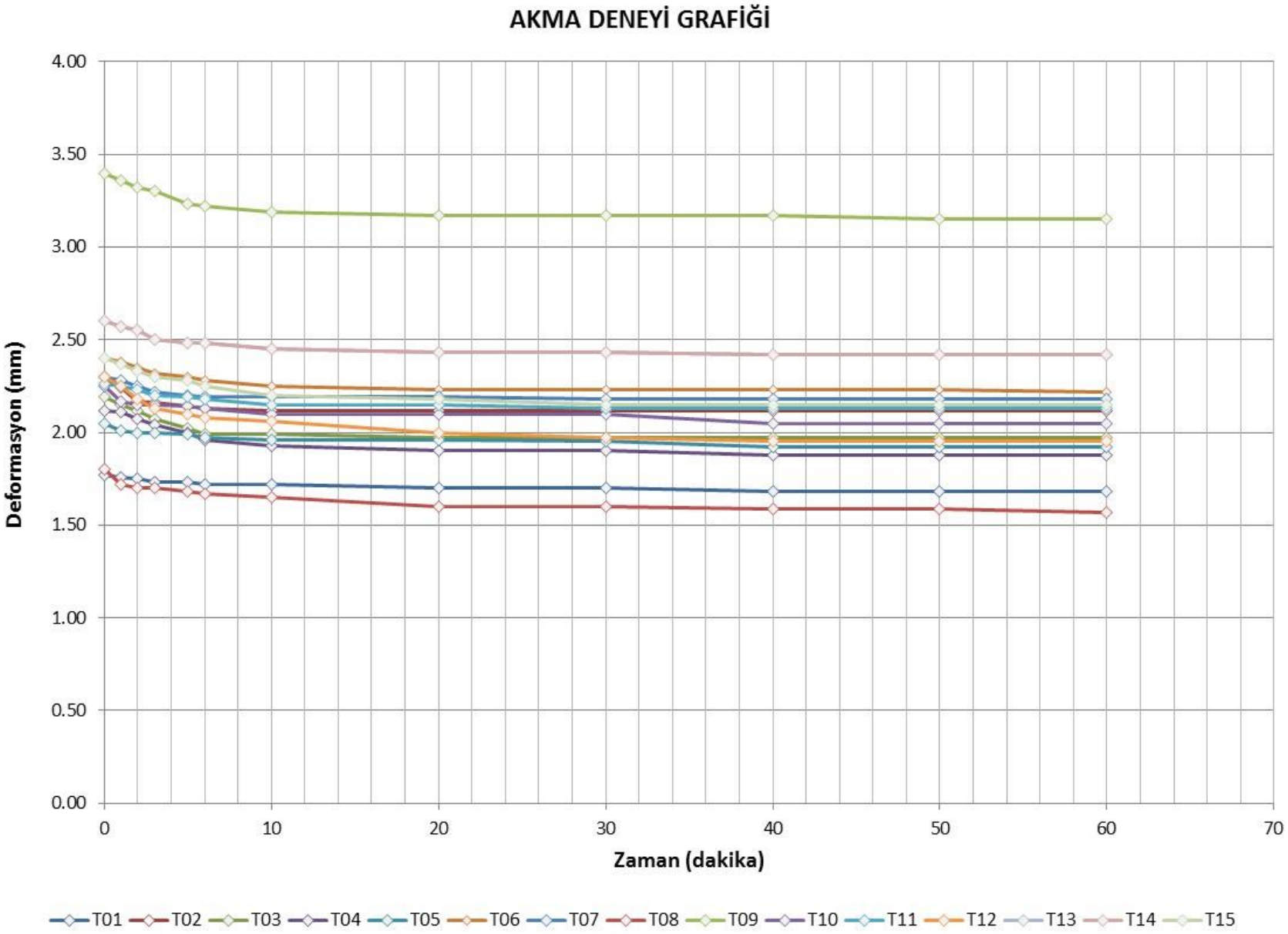
AKMA DENEYİ GRAFİĞİ
Deformasyon (mm)
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
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0
10
20
30
40
50
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70
Zaman (dakika)
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T05
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T07
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SORULAR & YANITLAR