No. 9 - AUGUST 2007
SPECIAL EDITION

HELLENIC SOCIETY FOR SOIL MECHANICS & GEOTECHNICAL ENGINEERING

The News of H S S M G E

9

INVITATION TO HOST THE 15TH EUROPEAN CONFERENCE ON SOIL MECHANICS AND GEOTECHNICAL ENGINEERING (2011) IN ATHENS

The Hellenic Society for Soil Mechanics & Geotechnical Engineering (HSSMGE) has submitted an application to host the 15th European Conference on Soil Mechanics and Geotechnical Engineering in 2011.

The Hellenic Society hosted successfully in Athens an International Symposium on Hard Soils – Soft Rocks, in 1993, in collaboration with the French National Society and the 4th International Conference on Earthquake Geotechnical Engineering in Thessaloniki this year. Members of our Society participated also in the organization of two International Conferences of IGS.

Furthermore, HSSMGE has organized five national conferences on geotechnical & geoenvironmental engineering since 1988 in Athens and other cities of Greece.

If there will be a positive response to our application, this will be the first time that a European Conference will be held in Greece.

Location

The Conference will be held in Athens, Greece.

The venue will be the complex of the Athens Concert Hall (Megaron Moussikis) which comprises:

- Two theatre – style halls for 1,500 – 1,800 persons respec-

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tively, for opening and closing ceremonies and main sessions.

- Two theater - style halls for 380 and 450 persons respectively, for parallel sessions.
- At least four rooms for 30 – 55 persons for Technical Committee meetings.
- Ample foyer space (more than 800 m²) for poster sessions, technical exhibition, reception and secretariat.
- Auxiliary rooms.

Date

The date of the Conference will be in the middle of September 2011.

Theme

The proposed theme of the Conference is "Geotechnics of Hard Soils – Weak Rocks".

Anticipated Registration Fees

The Conference fee for participants will be 600 €, subject to possible adjustment if needed.

Technical Content

This will include indicatively:

- Geological Features, Investigation and Classification.
- Mechanical Properties and Behaviour.
- Foundations, Excavations and Retaining Structures.
- Slope Stability and Protection.
- Fills, Embankments and Dams.
- Tunneling and Underground Works.
- Monuments and Geoenvironmental Issues.
- Earthquake Geotechnical Engineering Aspects.

Possible Technical Committee Activity Integrated into the Conference

Any Technical Committee meetings can be arranged in the framework of the Conference, upon request of the ISSMGE. At least four are anticipated, namely those of JTC6, JTC7, TC3 and TC4.

Possible Technical Tours

Possible technical visits can be arranged to the sites of the following major projects anticipated to be in progress during the Conference:

- Athens Metro Extensions.
- Athens Ring Road (Attiki Odos) Extension.
- Suburban Railway Extension.
- Korinth Canal Maintenance Works.
- etc.

Accommodation

Plenty of three to five star hotels exist in Athens, particularly after the Olympic Games. A number of them are in walking distance from the Conference venue and a lot of others with easy access to it by means of buses, metro or private cars (a metro station and car park exist at the location of the Conference buildings).

Other Relevant Information

The weather in September in the greater Athens area is that of "mild summer" (not very hot but still swimming is possible and pleasant).

There are also a lot of in-door and out-door cultural and social activities.

We hope for your support and to see you again in Greece in September 2011.

PAPERS

INTERACTION BETWEEN STRUCTURAL AND GEOTECHNICAL ENGINEER

Professor J. B. Burland, Imperial College London

ABSTRACT

A structure, its foundations and the surrounding ground interact with each other whether or not the designers allow for this interaction. In some situations the interaction can be minimised by adopting very stiff foundation elements. In many situations this approach is too costly or it is not feasible, as in the case of deep basements and cut-and-cover construction. Thus ground-structure interaction must usually be taken into account in design and this involves important interactions between specialist Structural and Geotechnical Engineers. During his career the Author has encountered profound philosophical differences in approach between Structural and Geotechnical Engineers often leading to a lack of understanding and difficulties in communication. This paper explores these differences in approach and the reasons for them.

The term *modelling* is used extensively. It is defined as the process of idealising a full-scale structure including its geometry, material properties and loading in order to make it amenable to analysis and hence assessment for fitness of purpose. It is demonstrated that traditional structural modelling is very different from geotechnical modelling. Superficially, structural modelling appears to involves fewer idealisations for the geometry and material parameters than geotechnical modelling. In reality the idealisations in structural modelling hide huge uncertainties. It is shown that Structural Engineers tend to think in terms of force and stress whereas Geotechnical Engineers are often more concerned with deformation. The difficulties between the two approaches arise when elements of the structure and/or foundation reach their full strength, which is frequently the case.

In this paper extensive reference is made to Hambly's three and four legged stool, termed by Heyman (1996) as "*Hambly's paradox*". Hambly used the simple example of a four-legged stool to show that structural design calculations are frequently wide of the mark when it comes to analysing real-world structures. It is concluded that concepts such as *ductility* and *robustness* underpin the success of both structural and geotechnical modelling and more explicit recognition of these is needed. Case histories are given where ductility has been utilised and where lack of ductility has led to failure. The importance of gaining a clear understanding of mechanisms of behaviour prior to detailed analysis is also illustrated by means of case histories.

KEYWORDS: Modelling, structural engineer, geotechnical engineer, soil-structure interaction, ground profile, ductility, brittleness, piled rafts, damage, cracking, mechanisms of behaviour, case histories.

INTRODUCTION

Although the Author has specialised in Geotechnical Engineering he began his career in the early 1960's at Ove Arup and Partners, London working on both structural and geotechnical design. Ever since then he has worked closely alongside Structural Engineers and indeed is a Fellow of the Institution of Structural Engineers.

There have been many occasions when the Author has encountered difficulties in communications between Structural and Geotechnical Engineers and it has been a continuing source of interest to him as to why this should be so. It is a matter of outstanding importance because poor communication and lack of understanding can lead to poor engineering and even failures. The invitation to deliver the keynote address at this Seminar is for the Author, not only a great honour, but has also provided him with an opportunity to explore the interactions between the Structural Engineer and the Geotechnical Engineer.

The term *modelling* will be used extensively in this paper. It is intended to describe the process of idealising a full-scale project including the geometry, material properties and loading in order to make it amenable to analysis and hence assessment of 'fitness for purpose'.

STRUCTURAL MODELLING

In 1994 the late Edmund Hambly, a most innovative structural engineer who obtained his PhD in Soil Mechanics, published a little book *Structural Analysis by Example*. It was intended as a handbook for undergraduates and professionals who like to use physical reasoning and off-the-shelf computer modelling to understand structural form and behaviour. Hambly gives fifty examples of structural problems of increasing complexity ranging from simple frames, through beams, columns and slabs, to shear lag and torsion, and then on to whole structures such as offshore platforms and spiral staircases. The book represents an admirable summary of the range of problems and types of analysis that a structural engineer will encounter in day to day practice. It is interesting and important to note that almost all of the examples concentrate on the calculation of forces and stresses.

As exercises in *modelling*, it is evident that the geometry of the structures seem reasonably easy to idealise and rather simple material behaviour is usually assumed (linearly elastic with a limiting stress imposed). Figure 1 is taken from Hambly's book and shows (a) a jackup offshore platform which consists of a deck structure supported on three legs standing on the sea bed in deep water, (b) a simple space frame model for a preliminary global analysis, (c) a local model of part of a leg and (d) a detailed model of a joint for finite element analysis. The major idealisations in the modelling process seems to be in the loading, although in the book they are specified as is usually the case in codes of practice and standards. It is evident that the process of structural modelling mainly consists in carrying out analysis – usually on the computer.

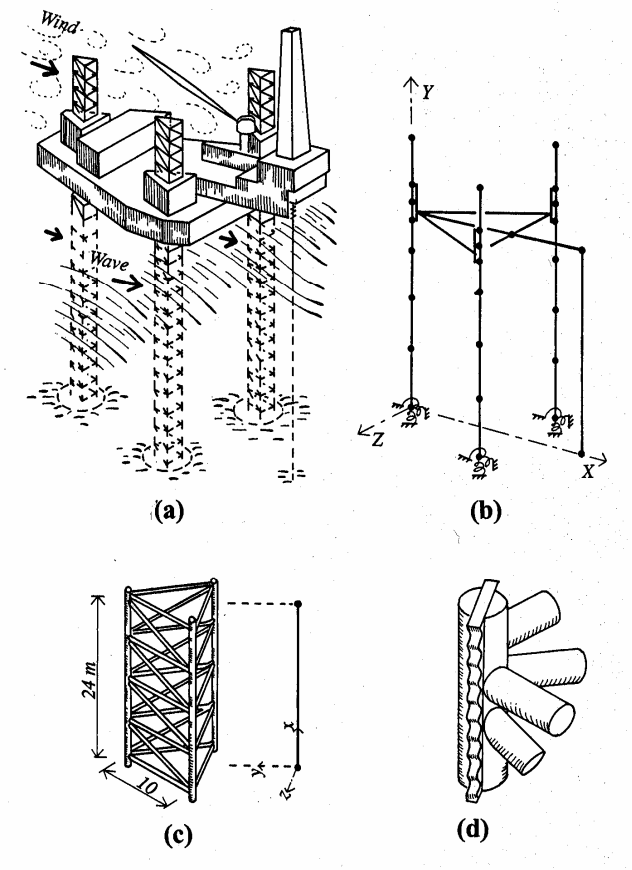


Fig. 1: Structural modelling of an offshore jackup platform (Hambly, 1994)

Limitations to structural modelling

Using Hambly's book as an exemplar, it is evident that Structural Engineers think primarily in terms of forces and stresses that are the outputs from the analytical methods they use in day to day practice. Yet most studies on real whole structures show that the measured strains and displacements bear little semblance to the calculated ones (Walley, 2001). The National Building Studies Research Paper No 28 records that the biggest change of strain in the steel beams of the Ministry of Defence Building in Whitehall was caused by the shrinkage of the concrete after the floors had been cast – this was larger than that induced by the loading of the floors subsequently. The classic experiments on large-scale steel structures carried out under the direction of Lord Baker (Baker, Horne and Heyman, 1956) revealed that the measured stresses under working loads bore very little relationship to the calculated values. Much more recently the author has found that the thermal movements of buildings is often significantly larger than the movements induced by tunnelling and yet these are not considered when assessing the response of buildings to foundation movements (Burland, Standing and Jardine, 2001).

Ductility and robustness

On page 1 of the above book Hambly makes reference to the *Safe Design Theorem* which, of course, derives from the lower bound theorem of plasticity. The *Safe Design Theorem* states that:

A structure should be able to carry its design loads safely if:

1. *The calculated system of forces is in **equilibrium** with the loads and reactions, and throughout the structure.*
2. *Each component has **strength** to transmit its calculated force and **ductility** to retain its strength while deforming.*
3. *The structure has sufficient stiffness to keep deflections small and **avoid buckling** before design loads are reached.*

If the real structure deforms under load with a different flow of forces to that calculated it should still be safe as long as the materials are ductile (like steel) and not brittle (like glass). The equilibrium check ensures that any underestimate of the force flowing through one part of the structure is balanced by an overestimate in the force in another part. Then ductility ensures that the component that is over stressed retains its strength while deforming, and sheds the excess force to the parts which have additional capacity as a result of the equilibrium check. It is the ductility of structures which ensures the success of current analytical methods in Structural Design. This is frequently overlooked and, in the Author's experience, many structural engineers seem to believe that their structures behave as calculated.

The inherent ductility and robustness of steel structures is well known and gave rise to modern methods of plastic analysis. Recently Beeby (1997, 1999) summarised the developments in the concepts of ductility in reinforced concrete design and stressed the importance of designing for robustness which can be defined as "the ability to absorb damage without collapse". For steel structures Burdekin (1999) has drawn attention to the importance of designers to be aware of the factors that give rise to brittle fracture and fatigue.

The three and four-legged stool (Hambly's paradox)

A simple but profound model can be used to illustrate what we have been discussing so far. Figure 2 shows two stools, one with three legs and one with four legs (Hambly, 1985). Imagine that each must support a milkmaid who weighs 60kg, and who always sits with her centre of gravity directly over the middle of the stool. The problem is to determine how many kg of her weight must be carried by each leg of the three-legged stool and how many kg by each leg of the four-legged stool.

The three legged stool is straight forward in that one third of the milkmaid's weight must go down each leg i.e. 20kg. This can be checked by considering the equilibrium of moments about a horizontal axis through any two of the legs. For the

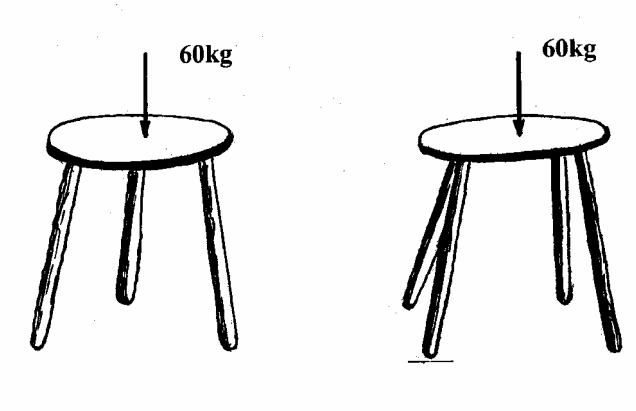


Fig 2: Three and four-legged stools – Hambly's paradox

four-legged stool the answer of 15kg is wrong! Careful inspection of Figure 2 shows that one of the four legs does not quite touch the ground, either because the leg is slightly short or because the ground is uneven, consequently the leg is not carrying any load. The opposite leg will also not be carrying any load because its load must balance that in the short leg when equilibrium of moments is considered about the diagonal through the other two legs. Thus we find that all of the weight is carried by two legs, i.e. 30kg per leg, instead of being shared by the four legs. Hence the paradox (Heyman, 1996) – the addition of a fourth leg to a three-legged stool increases, rather than decreases, the force for which each leg has to be designed. In practice the structure and the ground will 'give' under load and share the load more evenly, and the misfit might be reduced. However one cannot usually predict precisely at the design stage how unevenly the structure will press into the ground because the differences in load will depend on small imperfections in the fit of the legs during construction and the variations in the ground from foundation to foundation. So what load <u>should</u> the legs be designed to carry?

It is here that concepts of ductility and robustness come in and the illustrative model can be extended to include material properties. Figure 3 shows the load displacement properties of

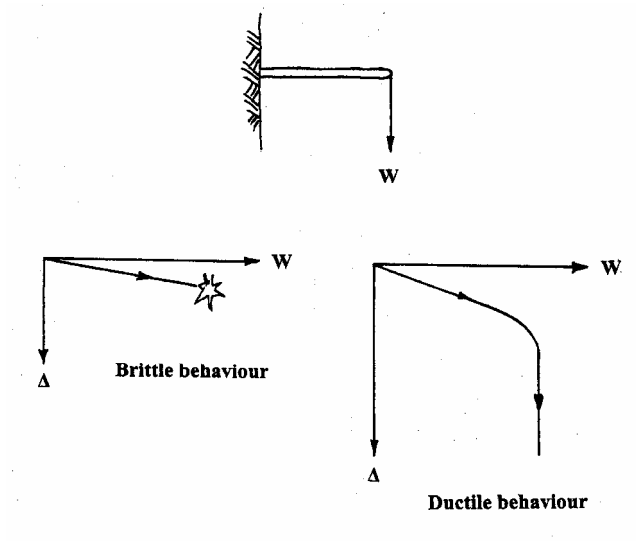


Fig 3: Brittle and ductile behaviour of leg

a leg, either when acting as a cantilever or in axial compression. In one case very brittle behaviour is illustrated such that at a certain load the strength of the leg is lost completely as it would be if it were made of glass. In the second case the member exhibits ductile behaviour and retains its strength once yield has occurred. If brittle material is used for the three-legged stool then accidental overload, due perhaps to a very heavy milkmaid or the cow kicking out at the stool, will result in total collapse – see Figure 4. Clearly high factors of safety are required to deal with this design. It may be decided to opt for four legs but this may be of little help. The design

load for each leg would have to be 1.5 times higher than for the three-legged design. Moreover accidental overload may cause loss of one member and there is then a risk of another member being overloaded resulting in progressive collapse. In other words the structure is *fragile*. If ductile properties are chosen there is scope for redistribution of load once the carrying capacity of a leg is reached (Figure 5). Moreover, even accidental removal or serious damage to one member is unlikely to give rise to progressive collapse.

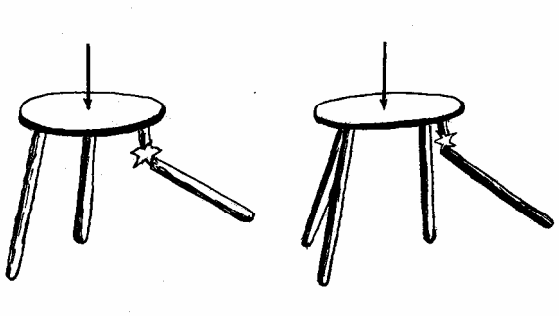


Fig 4: Fragile behaviour

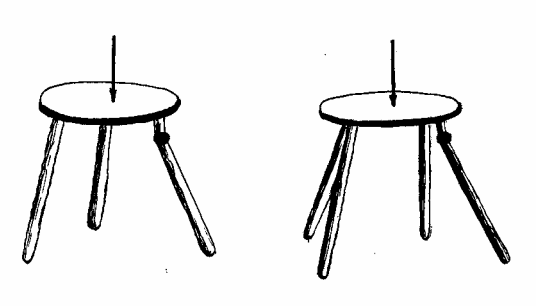


Fig 5: Robust behaviour

This simple example is very profound and can be extended to other aspects of structural behaviour and design including buckling and ground-structure interaction. Above all, it illustrates the importance of ductility and robustness. It is useful to quote Heyman's conclusions to his study of Hambly's paradox:

> *"Hambly's four-legged stool stands, of course, for the general problem of design of any redundant structure. It has long been recognised that, in order to calculate the 'actual' state of a structure under specified loading, all three of the basic structural statements must be made – equilibrium, material properties and deformation (compatibility and boundary conditions). However, the calculations do not in fact lead to a description of the actual state. Boundary conditions are, in general, unknown and unknowable; an imperfection in assembly, or a small settlement of a footing, will lead to a state completely different from that calculated. This is not a fault of the calculations, whether elastic or not – it is a result of the behaviour of the real structure..... There is no correct solution to the equations, but one solution that will lead to the greatest economy in material. This is the solution sought by the simple plastic designer, and it is safe and valid provided that no instability is inherent in the structure."*

GEOTECHNICAL MODELLING

Soil Mechanics is a difficult subject and is regarded by many structural engineers as a kind of black art. It is helpful to discuss the reasons for some of the difficulties.

One difficulty is that the soil, unlike concrete or steel, is a particulate material with little or no bonding between the particles. It is made up of an infinite variety of shapes and sizes of particles. We have to model this material as a continuum - but it is important never to forget that its properties are determined by its particulate nature. A few examples of such properties are:

(a) stiffness and strength are not fixed but depend on confining pressure;
(b) the material can dilate and contract when it is sheared;
(c) the particles can change orientation when sheared giving rise to significant reductions in strength.
(d) Another property that is extremely difficult to model but which is vital to the understanding of the behaviour of granular materials is that of 'arching'. Thus, if a tunnel or shaft is excavated in granular materials, the grains can form into a circumferential arch thereby significantly reducing the loads coming onto the tunnel or shaft lining. An example of the significance of arching will be given later.

Because soil is particulate, the water pressures acting within the soil pores are just as important as the stresses applied to its boundaries. This means that changes in the ground water regime can be crucial in stabilising, or de-stabilising a slope, retaining wall or foundation.

In summary, whereas the strength structural materials, such as steel and concrete, is primarily cohesive, soil is primarily frictional and self weight and pore water pressure determine its strength.

The soil mechanics triangle

But it is not just the complexity of the material which causes difficulty. Ground engineering involves *ground exploration*, makes extensive use of *testing and measurement*, it can involve *complex theory and analysis* and it depends critically on the use of *empirical procedures*. It is the author's experience that the major difficulty in soil mechanics lies, not so much in the complexity of the material as such, but in the fact that, all too often, the boundaries between the above four aspects become confused (Burland, 1987).

There are at least four distinct but interlinked aspects of any soil mechanics problem:

- The ground profile - what is there and how it got there.
- The mechanical behaviour of soil.
- Prediction using appropriate models.
- Empirical procedures; judgement based on precedent and "well-winnowed experience".

The first three of these may be depicted as forming the apexes of a triangle with empirical procedures occupying the centre as shown in Fig 6. Associated with each of these aspects is a distinct and rigorous activity or discipline. We can consider each of these in turn.

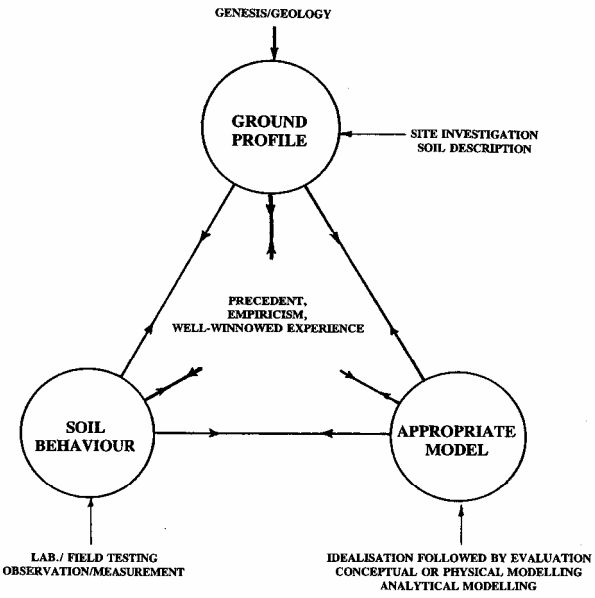


Fig 6: The Soil Mechanics Triangle

Ground Profile: Establishing the ground profile is a key outcome of carrying out a site investigation. By ground profile, I mean the visual description in simple engineering terms of the successive strata making up the ground together with the ground water conditions. It is also important to understand how the ground got there and what might have happened to it during its formation - what is termed its *genesis*. The importance of handling and describing the soil so as to establish the ground profile cannot be over-emphasised. It is relatively straight forward process that can be developed with practice.

Soil Behaviour: This is established from laboratory or in-situ tests which can be very simple through to highly sophisticated, depending on the circumstances. The properties may also be inferred from field measurements of the behaviour the mass of ground e.g. the back-analysis of a landslip or of settlement observations.

Predictive Modelling: This can be carried out at all sorts of levels. It can be purely conceptual and instinctive; it might be physical modelling or it can involve extremely sophisticated mathematical or numerical work. At whatever level, modelling first involves the process of idealisation (to analyse is to idealise) and should then be followed by review and assessment - it often isn't! Frequently in soil mechanics, as in structural engineering, it is the understanding the basic mechanisms of behaviour which is the key rather than the fine quantitative detail. It may be of interest to note that, whereas the success of structural modelling appears to have been due to the *Lower Bound Theorem of Plasticity*, geotechnical modelling has traditionally made use of both the *Lower* and *Upper Bound Theorem of Plasticity* for the study of limiting eqilibrium using slip line fields and stress characteristics. Thus both disciplines are firmly grounded in plasticity.

Empirical Procedures: With a material as complex as the ground, empiricism is inevitable and it is (and will always remain) an essential aspect of ground engineering. Many of our design and construction procedures are the product of what the author has termed *well-winnowed experience.*

Each activity in the Soil Mechanics Triangle has its own distinct methodology and rigour. Geotechnical modelling requires that each aspect be considered and that the Soil Mechanics Triangle remains in balance.

COMPARISONS BETWEEN STRUCTURAL AND GEOTECHNICAL MODELLING

It is immediately obvious from the above that the processes of geotechnical modelling will usually involve much greater explicit uncertainties and complexities in idealising both the geometry and the material properties than in structural modelling where both of these are usually specified by the engineer.

In introducing the subject of soil-structure interaction to his students, the Author starts by asking them to imagine a Utopean situation of having unlimited computational power in which, given the *geometry* of the problem, the *material properties* and the *loading* they can analyse any problem. Having considered that for a while the students are then asked how much better off they would be than they are at present. As soon as we begin to examine the idealisations that are involved in most ground-structure interaction problems it soon becomes obvious that we will not be much better off than we are today. Let us briefly consider the idealisations under the above headings of *geometry, material properties and loading*.

Geometry

For the structure the final geometry is usually accurately specified. However the geometry at any given time during construction may be uncertain and this can influence the final distribution of forces between structural members.

Every foundation problem entails carrying out a site investigation and on the basis of very limited data judgments and idealisations have to be made about the continuity and thickness of the various strata. In most cases the cost of drilling sufficient boreholes to adequately define the *geometry* of the ground is prohibitive and it is seldom that the engineer has more than an approximate model of the ground. For problems involving excavation, such as basements and tunnels, the precise geometry of the excavation at any given stage will be uncertain and will largely depend on site factors pertaining at the time of construction.

Material properties

The techniques of obtaining reasonable in-situ values of the 'simple' geotechnical properties such as compressibility, stiffness, strength and permeability are difficult and expensive. Such 'simple' properties may be adequate for settlement and stability calculations but detailed behaviour, such as relative displacements and local pressure distributions, are very sensitive to the precise form of the stress-strain-time properties of the soil and their local variations. The task of accurately ascertaining realistic in-situ constitutive equations for most natural soils and the variations with depth and plan is impossible for all but the simplest of ground conditions. Added to this must be the very important issue of the influence of construction method on the geotechnical properties. For example, the precise way in which a pile is constructed and the length of time it takes, can significantly affect its stiffness. Similarly, for a deep basement the precise of excavation method and the time taken will have a profound influence on the stiffness and strength properties of the surrounding soil.

The materials composing the building or structure are probably somewhat easier to model than the ground. Nevertheless, the stress-deformation properties of the various components that make up a building are complex, particularly with regard to creep, thermal and moisture effects. Moreover the actual properties 'as built' undoubtedly differ significantly from those that are specified and assumed in the analysis. The way the various structural members are connected together will significantly affect its overall performance. In practice the degree of fit and fixity at joints is uncertain and cladding and infills can have varying degrees of fit. The overall stiffness and strength of the structure is therefore difficult to assess with any accuracy. It is important to note that the majority of structural failures result from defects at joints and connections (Chapman, 2001).

Loading

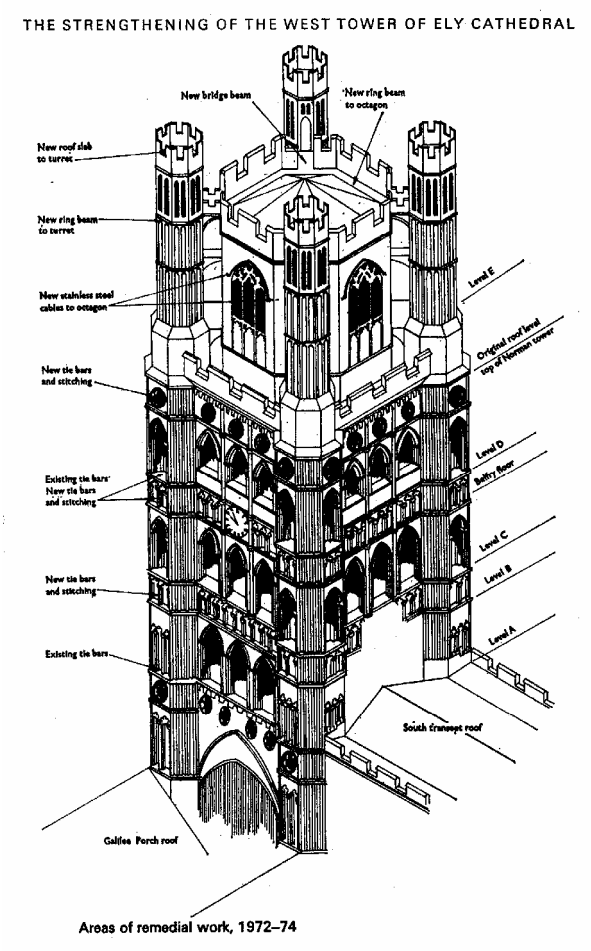
The resultant loads (as opposed to their distribution) acting on a foundation are usually reasonably well defined. The greatest difficulties arise for structures subject to dynamic forces, eg waves, earthquakes, etc. For routine buildings the largest uncertainty is the precise order in which the loads are applied eg the method of excavation or order of construction.

For the structure, the applied loading usually cannot be ascertained accurately and resort is made to probabalistic methods. Individual members have to be designed to withstand any likely magnitude and distribution of loads. Often much of the attention in structural design is devoted to the sizing of these individual members with little analysis of the overall structure.

The soil mechanics triangle revisited

Hopefully the above discussion will serve to help structural engineers to understand why the process of modelling geotechnical problems is inherently less certain than it appears to be for most structural problems. Much of the time the Structural Engineer is working with materials which are specified and manufactured under strict control. Usually the structural form can be idealised in a reasonably straight forward manner. The major uncertainties lie in the loading and often in the connections. In geotechnical engineering both the geometry (ground profile) and the properties (ground behaviour) of the 'structure' are laid down by nature and not specified. Precise analysis is usually not possible and the key requirement is to understand the mechanisms of behaviour and its likely bounds.

Perhaps the differences between routine structural and geotechnical modelling can best be illustrated by comparing the approach of the Geotechnical Engineer with that of the Structural Engineer working on an historic building (Burland, 2000). Figure 7 shows an isometric of the West Tower of Ely Cathedral which was strengthened in 1973/4 as described by Heyman (1976). Also shown on Figure 7 is the Soil Mechanics triangle of Figure 6 but with some descriptions changed to represent the key activities undertaken by the structural engineer.



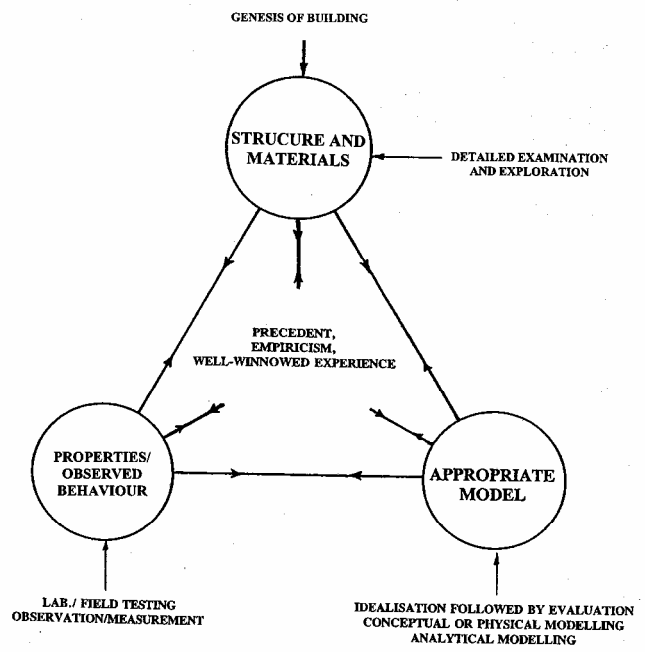


Fig 7: The strengthening of the West Tower of Ely Cathedral and associated structural activities

For the *soil profile* at the top of the triangle we can insert the *structure of the building and its materials*. To establish these requires the most careful examination and investigation. As with the ground, small discontinuities and weaknesses can play a major role in determining the overall response. It is also vital to establish the way the building was constructed and the changes that have taken place historically - we might call this the *genesis of the building* and it is analogous to the geological processes that have formed the ground profile. At the bottom left of the triangle are the *properties* of the materials and the *observed behaviour* of the building. This aspect requires observation, field measurement, sampling and testing. At the bottom right of the triangle there is the need to develop *appropriate predictive models* that take account of the form and structure of the building, its history, its material properties and known behaviour - an almost identical requirement to that of the ground. There is a whole spectrum of models that can be developed ranging from the intuitive and conceptual right through to highly sophisticated numerical models. The key is to appreciate the inevitable idealisations that have to be made and the limitations that they impose. Finally, as in ground engineering, well-winnowed experience is of supreme importance and well documented case records are invaluable. It is of interest to note that, in developing his structural understanding of the behaviour of the tower Heyman drew extensively on the *Safe Design Theorem* and did not attempt to model the 'actual' stress distributions within the structure.

It is evident from the foregoing that, even if engineers were in possession of unlimited analytical power, the uncertainties in both the soil and the structure are so great that precision in the prediction of behaviour would be unlikely to improve significantly. As in so many fields of engineering, modelling is only one of the many tools required in designing for soil-structure interaction. In most circumstances the real value of modelling will be in assisting the engineer to place bounds on likely overall behaviour, in understanding the mechanisms of behaviour and in beneficially modifying that behaviour if necessary. In the remainder if this paper case histories are given which illustrate the importance of ductility and in understanding the mechanisms of behaviour.

USING THE DUCTILITY OF PILED RAFT FOUNDATIONS

Most piles exhibit reasonably ductile load-settlement behaviour when loaded to their maximum capacity i.e. once full capacity has been mobilised the resistance of the pile does not usually reduce significantly with increasing settlement. This is because both shaft resistance and base resistance are mainly controlled by the frictional properties of the ground – a reflection of its particulate nature. An example of this behaviour is given in the paper by Lee *et al*. (2004) to this Seminar. Figure 8 shows the measured relationships between local shaft resistance and displacement at three depths down an H-pile jacked into CDG. It is evident that little change in shaft resistance takes place after full mobilisation. Such behaviour is typical of piles of various types installed in CDG and other materials in Hong Kong.

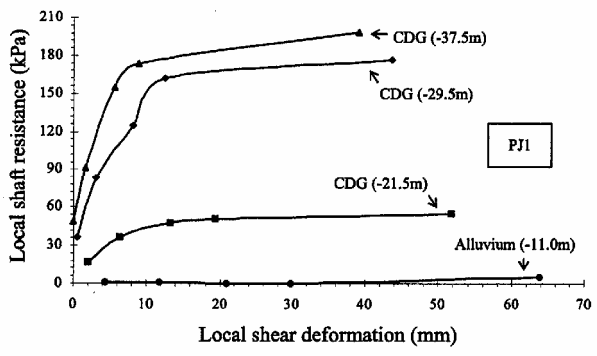


Fig 8: Relationship between local shaft friction and displacement for a jacked H-pile in CDG (Lee *et al,* 2004)

Computer programs

Powerful computer programs are becoming widely available for the analysis of pile groups. Most assume elastic behaviour of the ground. Such programs can be useful for settlement analysis and for evaluating the bending stresses in the raft itself. The programs also output the calculated magnitudes of the forces at the head of each pile. Because of soil-structure interaction effects, the distribution of load between the piles will usually be non-uniform. For a uniform load applied to a relatively rigid piled raft the piles at the edges of the raft will always carry significantly higher loads than those piles near the centre of the group as confirmed by field measurements made by Cooke *et al*. (1981). This is not unexpected as it has been well known since the work of Boussinesq that the contact stress distribution beneath a rigid footing on an elastic material gives very high stresses at the edges- see Terzaghi (1942).

Unfortunately some engineers and regulatory authorities have required that each of the pile loads calculated in this way must individually satisfy traditional factors of safety. This has led to grossly conservative pile group design with significant increases in cost. For example, when this approach was adopted by some UK Road Construction Units in the 1980's, the cost of piled bridge foundations at least doubled compared to the cost of traditional pile groups designed on the basis of overall factors of safety. As a consequence, the approach of applying factors of safety to the carrying capacity of each individual pile was quickly dropped and designers reverted to applying a factor of safety to the bearing capacity of the pile group as a whole – this is nothing more nor less than the application of the *Safe Design Theorem*. It can be justified because, if a single pile approaches its full carrying capacity, its stiffness reduces and load redistribution takes place to the adjacent piles. The analogous situation for a rigid footing is that the high edge stresses cause local yield with stress redistribution towards the middle of the footing. It has never been suggested that local factors of safety should be applied to such edge stresses beneath foundations.

The use of modern methods of pile group analysis has recently begun to enter a more creative stage in which the pile dispositions and lengths are adjusted to reduce raft bending moments and relative deflections (Katsenbach *et al*., 2000, Randolph, 1994). This approach often results in the reduction of the number and depth of piles around the circumference of the piled raft.

The situation in Hong Kong

In Hong Kong its is customary to apply a factor of safety to each individual pile within the group as well as to the overall stability. (It appears that the same limiting value is used for both). This approach of checking the factor of safety of each pile could be thought of as a check on "*local overstress*". Two situations where *local overstress* is important are (i) where there is little or no capability of re-distribution of loads between adjacent piles and (ii) where the load-settlement response of the pile is brittle. Examples of the first situation might be where a large pile group is carrying a flexible water tank or where relatively few large piles are carrying a building. Examples of the second type might be where there is a risk of brittle failure of the pile material or buckling of the pile. In both situations the consequences of *local overstress* are serious and could lead to progressive collapse. The use of elastic load distributions in pile groups could prove useful in both these situations. (The analogous situation in Structural Engineering would to limit of stress concentrations to avoid brittle fracture and fatigue). In most other situations the consequences of *local overstress* are not serious.

A way out of the problem in Hong Kong might be to adopt traditional factors of safety for the pile group as a whole and make use of a factor of safety against *local overstress* for each individual pile. For most situations the factor of safety against *local overstress* would be less than the overall factor of safety (perhaps as low as 1.5) but in special cases where there is a risk of progressive collapse it could take on a higher value. This approach offers a simple, pragmatic and rational way forward in Hong Kong.

Direct use of pile ductility

Numerous instrumented tests on bored pile have shown that the shaft friction is fully mobilised at small settlements but that much larger settlements are required to mobilise the end resistance. This is shown in Figure 9 for a test on an underreamed pile in London Clay from the celebrated tests of Whitaker and Cooke (1966). It can be concluded from this behaviour that, for an underreamed pile to operate efficiently, the shaft resistance will often be fully mobilised under working load. Indeed there can be no doubt that thousands of underreamed piles all over the world have operated satisfactorily this way.

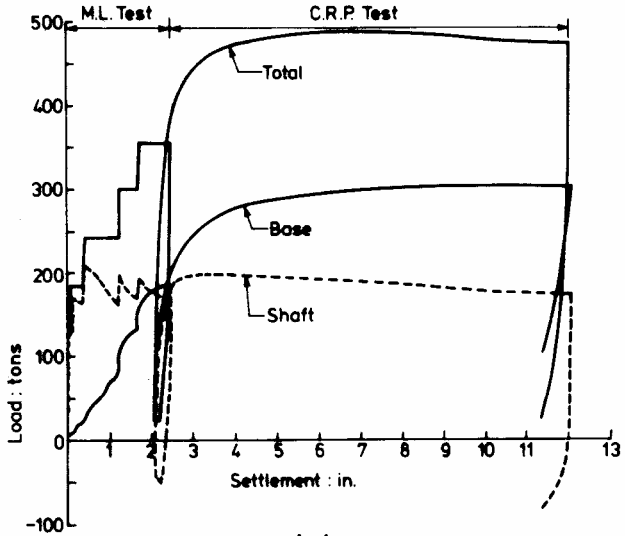


Fig 9: Results of a load test on an instrumented underreamed bored pile in London Clay showing ductile behaviour of the shaft (Whitaker and Cooke, 1966)

The Author made use of this concept of fully mobilising shaft resistance for the foundations of the Queen Elizabeth Conference Centre, London (Burland and Kalra, 1986). The conference area is founded on a 2m thick raft in a relatively shallow excavation and total settlements of the order of 20mm were calculated. Over half the weight of the superstructure is transmitted to the raft by means of a few columns carrying loads of up 26MN. Concern was expressed about the excessive bending and shear stresses in the raft set up by these loads.

One method of dealing with the problem would have been to thicken the raft locally. This would have generated a number of costly and time consuming 'knock on' effects. Instead a novel method was developed using what has been termed *stress reducing piles*. A single straight shafted piles were placed directly beneath the heavily loaded columns in the knowledge that the settlement of the raft was sufficient to fully mobilise the shaft resistance of the piles. The effect was to apply a constant upward force beneath each column. By this means the loads transferred from the columns into the raft were significantly reduced. In view of the novelty of this approach the Building Research Establishment instrumented one of the piles to measure the magnitude of the load transferred into it. The results are shown in Figure 10 where it can be seen that the long-term measured pile loads are in excellent agreement with the calculated shaft resistance and have remained constant for over twelve years.

Based on an idea put forward by Burland *et al*. (1977) the Author has suggested the use of ductile piles for substantially reducing the cost of piled rafts in situations where the piles are primarily used to reduce settlement and where there is an adequate factor of safety against bearing capacity failure (Burland 1995). The essence of the method is to employ only the number of piles that is required to reduce the settlement to an acceptable amount and the term *settlement reducing*

piles was used to describe the system. Since the acceptable settlement will invariably be enough to fully mobilise the shaft resistance, this approach implies that the piles will be operating close to full carrying capacity.

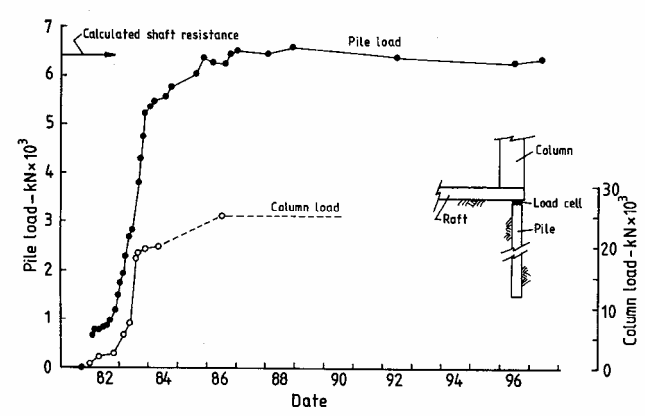


Fig 10: Queen Elizabeth Conference Centre, London. Measured performance of a stress-reducing pile designed to operate with the shaft resistance fully mobilised

This approach is slowly gaining acceptance. One of the difficulties encountered in gaining acceptance is the perception that the method "skimps on the piles". To overcome this perception, and to reinforce the message that the piles are improving the performance of the raft (or "mat"), the Author has suggested that this use of ductile piles be termed "*pile enhanced rafts (or mats)*". This term conveys the message that the raft on its own has adequate bearing capacity and that the function of the piles is simply to enhance the settlement performance of the raft. The approach has particular benefits for foundations carrying lateral loads, such as bridge foundations, since the underside of the raft or mat can be used to carry horizontal loads in friction rather than carrying these loads on piles.

THE CONCEPT OF LIMITING TENSILE STRAIN AS A MEASURE OF POTENTIAL DAMAGE

Burland and Wroth (1974) and Burland (1995) used the concept of limiting tensile strain in masonry walls as a measure of potential damage. Figure 11 illustrates the approach where a building is represented by a rectangular beam of length *L* and height *H*. Simple beam theory is used to calculate the bending and diagonal strains in the beam corresponding to a given value of relative deflection *Δ*. It has been demonstrated that the onset of visible cracking in masonry buildings corresponds to a reasonably well defined value of tensile strain (approximately 0.05 to 0.1 percent). The concept has been extended such that different limiting values of strain are related to a range of categories of damage. This simple approach has proved most valuable in the assessment of allowable distortions of buildings subject to settlement and induced subsidence due to tunnelling and excavation.

At first sight this approach appears almost naïve in its simplicity. The reaction of many Structural Engineers is to relate the relative displacement *Δ* to tensile stress. This approach does not work because the stress at which tensile failure occurs depends critically on the composition of the wall and varies over a wide range. Moreover values of *Δ/L* at which loss of tensile strength occurs are very much smaller than those that produce visible cracking. Finally the approach via tensile strength cannot easily be extended to deflections beyond 'first crack'.

The approach of relating different levels of damage to limiting values of tensile strain works very well for large masonry buildings because their response to distortion is usually relatively ductile and robust. This ductility results from the restraining effects of the floors and foundation and also the frictional nature of contacts between the masonry elements. Much still has to be learned about the behaviour of masonry structures undergoing distortions after the formation of the initial

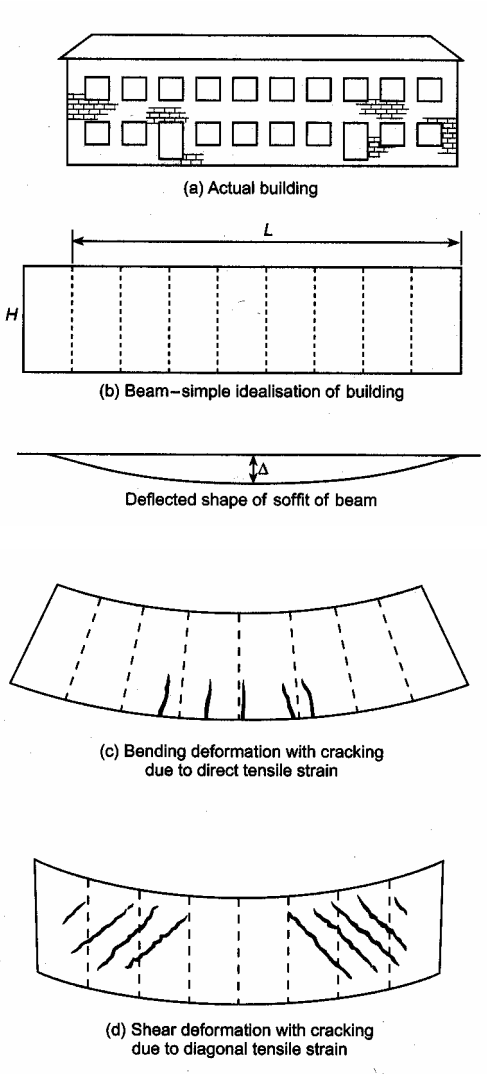


Fig 11: Cracking of simple beans in bending and in shear (Burland and Wroth, 1974)

cracks. What is interesting is that the approach to assessing the potential for damage to masonry buildings by means of limiting tensile strain is really an exercise in assessing the behaviour of a structure deforming beyond first yield.

Some examples will now be given of damage due to the *brittle* response of structures to ground movements.

CRACKING OF COLUMNS

Burland and Davidson (1976) gave a detailed case history of damage to some silos due to differential foundation movements. The four silos were founded on 20m diameter rafts, 1.2m thick and resting on soft chalk. This material is similar to CDG in that it is highly permeable and exhibits a 'yield stress' under increasing vertical pressure. Figure 12 shows a typical measured pressure-settlement relationship for one of the silos and it can be seen that the applied pressure exceeded the yield stress. Even so, the total settlement is by no means excessive being about 50mm. Figure 13 shows a cross-section through the supporting structure of the silos, together with the measured deflected shapes of the raft foundations. All the silos showed distinct hogging and silo 1 also underwent some tilting. The investigation showed that hairline cracks developed in many of the columns at a deflection ratio $\Delta/L = 0.45 \times 10^{-3}$ and by the time the deflection ratio had increased to 0.6×10^{-3} the cracking was severe enough for the engineers to install temporary props. The maximum measured deflection ratio was 1.07×10^{-3} and Figure 14 shows a sketch of one of the columns corresponding to this value of Δ/L. Even though these relative deflections are within currently accepted limits the damage was considered severe enough to warrant expensive remedial measures.

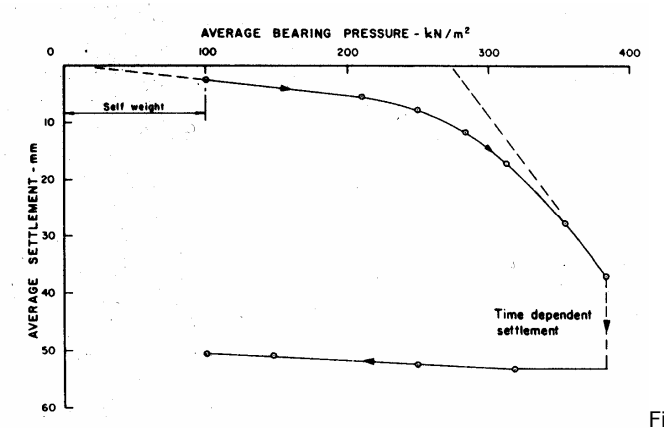


Fig 12: Relationship between average bearing pressure and average settlement for silo 3

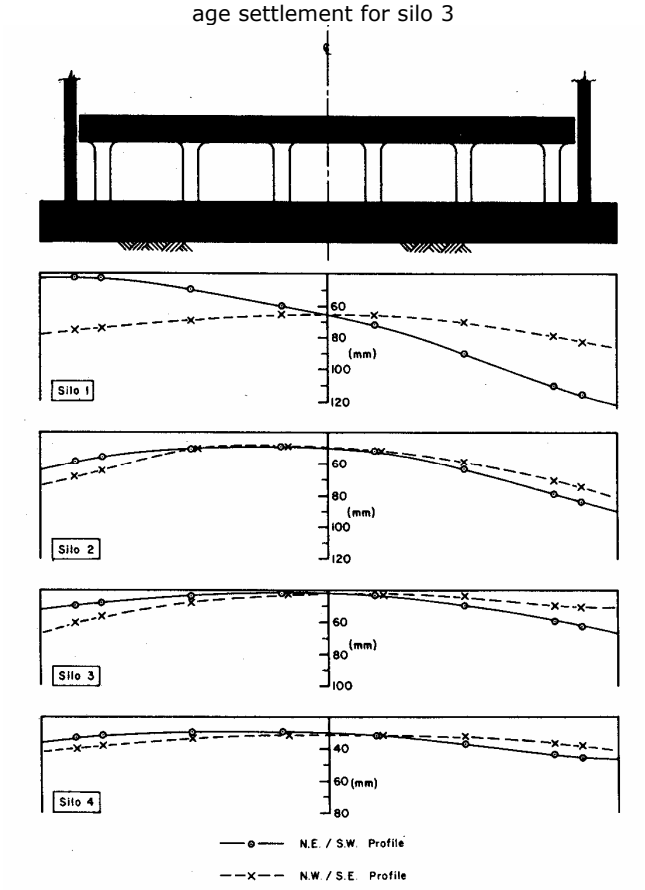


Fig 13: Deflected shapes of foundation rafts

A simple analysis of the structure reveals that it had a low transverse bending stiffness relative to the supporting ground. On the other hand it can be seen from Figure 14 that the short large diameter reinforced concrete columns made the structure 'brittle' and sensitive to differential settlement. Thus the structure had little inherent stiffnes to resist differential settlement and at the same time no 'ductility' to absorb the deformations without damage. This type of design for silos is common throughout the world. Deere and Davisson (1961) and Colombo and Ricceri (1973) have reported cracking in reinforced concrete columns supporting some silos. The Author has come across other cases of similar damage.

Having recognised the problem a number of solutions are possible for future designs. These might include:
(a) limiting settlement (e.g. by using piles),
(b) increasing the relative stiffness of the structure (e.g. by thickening the raft or introducing shear walls) or
(c) by reducing the sensitivity of the structure to relative displacement (e.g. by using steel columns or incorporating hinges).

This case history emphasises the care that must be exercised when stiff or brittle elements (particularly if they are load bearing) are introduced into an otherwise flexible structure.

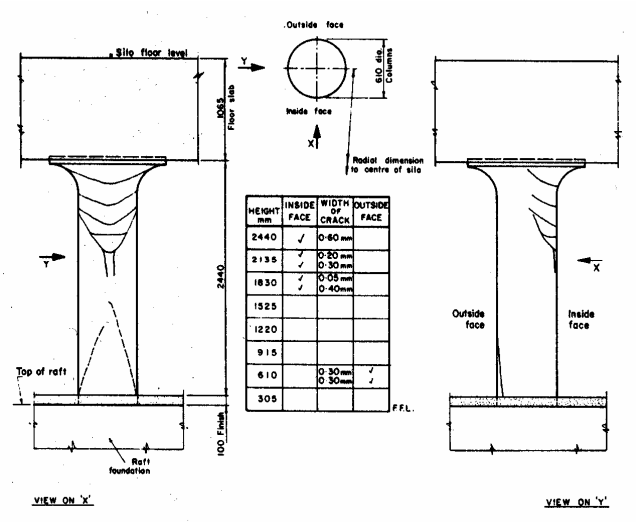


Fig 14: Typical cracked columns

More recently Powderham *er al.* (2004) described a case in which subsidence induced by the construction of the Heathrow Express tunnel caused cracking of some columns in a car park. A risk assessment had shown that the potential damage to the structure was in the category of only "very slight". The measured differential settlements over a span of 12m was 12mm – an angular distortion of only 1/1000. However the outer row of columns were founded on isolated pad footings which appear to have moved laterally of the order of 5mm to 10mm and this was sufficient to crack the short stiff columns as shown in Figure 15. Had the footings been tied together by ground beams, as they were elsewhere in the car park, the damage would not have occurred.

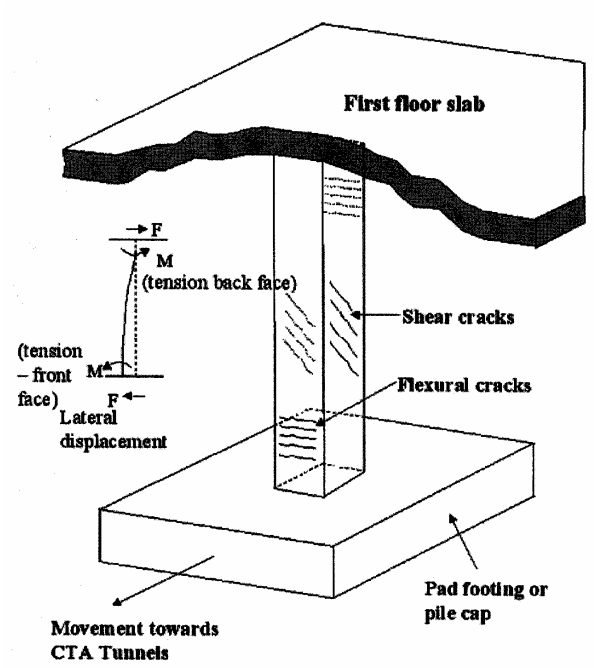


Fig 15: Typical cracking in row of columns due to ground movement towards a tunnel (Powderham *et al.*, 2004)

In summary, for both the silos and the car park, the combination of short stiff columns constructed monolithically with an otherwise relatively flexible structure resulted in high sensitivity to differential foundation movements. Heyman (1996) refers to the '*weak-beam strong-column'* philosophy of designing for multi-storey steel frames as a means of guarding against lateral buckling. The previous examples show that such a structure may be vulnerable to unforeseen ground movements when the '*strong columns*' are brittle.

THE IMPORTANCE OF UNDERSTANDING MECHANISMS OF BEHAVIOUR

In the previous sections case studies are given of the importance of understanding the concepts of ductility and robustness in soil-structure interaction problems. Reference has been made to the importance of understanding basic mechanisms of behaviour before undertaking detailed sophisticated analyses. In this section two case histories are presented where clarifying the mechanisms of behaviour proved crucial. The first relates to stabilising the Leaning Tower of Pisa and the second to identifying the cause of some silo failures.

In the previous sections case studies are given of the importance of understanding the concepts of ductility and robustness in soil-structure interaction problems. Reference has been made to the importance of understanding basic mechanisms of behaviour before undertaking detailed sophisticated analyses. In this section two case histories are presented where clarifying the mechanisms of behaviour proved crucial. The first relates to stabilising the Leaning Tower of Pisa and the second to identifying the cause of some silo failures.

Progressive movement of the Leaning Tower of Pisa

Figure 16 shows a cross section through the 14,500t tower which is nearly 60m high and the foundations are 19.6m in diameter. The foundations are inclined due south at 5.5° and the seventh cornice overhangs the ground by about 4.5m. As shown in Figure 17, the ground underlying the Tower consists of three distinct layers. Layer A is about 10m thick and primarily consists of soft estuarine deposits of sandy and clayey silts laid down under tidal conditions. Layer B consists of soft sensitive normally consolidated marine clay which extends to a depth of about 40m. This material is very sensitive and loses much of its strength if disturbed. Layer C is a dense sand which extends to considerable depth. The water table in Horizon A is between 1m and 2m below ground surface. The surface of the marine clay is dished beneath the Tower showing that the average settlement is between 2.5m and 3.0m - a good indication of how very soft the ground is.

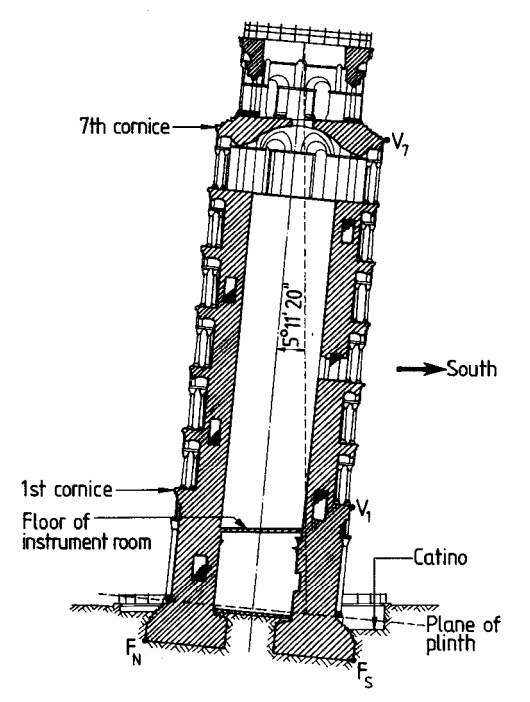


Fig 16: Cross – section through Pisa Tower

The history of the Tower and the cause of its lean are well documented (Burland *et al.*, 2003). Since 1911 precise theodolite measurements have shown that the inclination has been increasing each year by about 6 arc seconds (equivalent to about 1.5mm horizontal displacement at the top). There has been much debate about the cause of this progressive increase in inclination. It has usually been attributed to creep in the underlying soft marine clay, the assumption being made that the south side was settling more than the north side. It has also been assumed that the Tower is suffering from impending bearing capacity failure in the underlying soft clay.

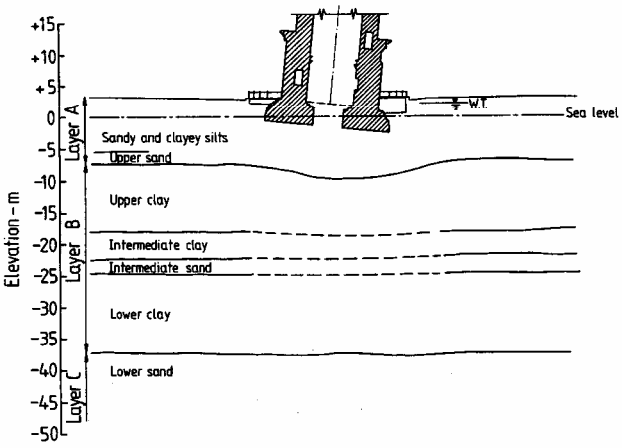


Fig 17: Ground profile beneath Pisa Tower

A careful study of the geodetic survey measurements going back to 1911 revealed a most surprising form of motion of the foundations which was radically different to previously held ideas. The theodolite measurements onto the first cornice (V1 in Fig 16) showed that it had not moved horizontally - apart from two occasions when man had intervened! Precision level measurements which commenced in 1928 showed that the centre of the foundations had not displaced vertically relative to the surrounding ground. Therefore the rigid body motion of the Tower could only be as shown in Figure 18 with an instantaneous centre of rotation at the level of the first cornice vertically above the centre of the foundations. The direction of motion of points F_N and F_S are shown by vectors and it is clear that the foundations have been moving northwards with F_N rising and and F_S sinking.

The discovery that the motion of the Tower is a shown in Figure 18 has turned out to be crucial in a number of respects. The observation that the north side had been steadily rising led directly to the suggestion that the application of a lead counterweight to the foundation masonry on the north side

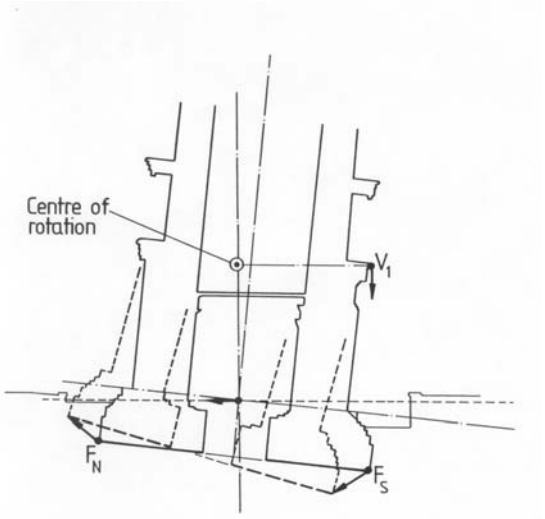


Fig 18: Observed motion of the Pisa Tower during progressive increase in inclination

could be beneficial as a temporary stabilising measure by reducing the overturning moment. This proved to be a very effective measure.

The pattern of ground movements depicted in Figure 18 led to the very important conclusion that the impending instability is not due to a bearing capacity failure but *leaning instability* due to the very compressible foundations. This conclusion not only justified the use of the lead counterweights as a temporary measure but led on to the safe use of soil extraction beneath the north side for the permanent stabilisation measure.

This mode of movement also pointed to the seat of the continuing long-term rotation of the Tower lying in horizon A and not within the underlying marine clay as had been widely assumed in the past. The progressive rotation of the Tower tends to be seasonal. Between February and August each year little change in the north-south inclination takes place. In late August or early September the Tower starts to rotate southward and this continues through till December or January amounting to an average of about six arc seconds. In the light of the measured motion of the Tower foundations, and consistent with the seat of the movement lying within Horizon A, it was concluded that the most likely cause of the progressive seasonal rotation was a rise in ground-water level in Horizon A due to seasonal heavy rainstorms that always occur in the period September to December each year. Accordingly a number of stand-pipes were installed in this Horizon around the Tower. Measurement made over a four year period confirmed this hypothesis - commencement of rotation each year coincides with very sharp rises in the ground water level in the Horizon following each heavy rainstorm. During the final stabilisation measures, drains were installed around the north side of the Tower to stabilise the water table and this measure has proved most effective in reducing the seasonal movements of the Tower.

It is true to say that the identification of the form of motion of the foundations of the Leaning Tower of Pisa is the single most important finding in the development of the strategy for stabilisation. No amount of sophisticated analysis that did not capture the mechanism of leaning instability would have led to the adopted stabilisation strategy.

Failure of some silos

My last case history relates to the failure of some silos which, at first sight, appears to be due to soil-structure interaction. I am indebted to John Laing for giving me permission describe this case. Figure 19 shows the plan view of the silos and Figure 20 shows a sectional elevation. Each silo consists of a cylindrical prestressed concrete shell with a steel-framed conical roof and conveyor bridge at roof level. Internally, a silo floor of reinforced concrete is supported at a height of about 2.5m on short reinforced concrete columns which rest on the foundation raft. The silo floors contain a number of holes, the central ones being intended for discharging the content and the remainder are used for cleaning out the silo when nearly empty. Strict operating instructions are issued for use during discharge.

Silos 1 to 4 were built in 1973 and are 20m in diameter. They are supported on circular concrete rafts 22.85m diameter and 1.22m thick bearing directly on the underlying weathered Upper Chalk. Apart from some problems experienced during first loading described previously, the silos operated successfully for many years. In 1982 a new larger silo was constructed as shown in Figures 18 and 19. Silo number 5 was founded on piles with the upper lengths sleeved so as to minimise interaction with the existing silos.

Silo 5 was filled for the first time in late 1982 early 1983 after Silos 3 and 4 had been filled. Unloading of Silo 3 then commenced. With less than 10 percent of the content removed, Silo 3 failed by extensive cracking and bulging from top to bottom. Similarly, as emptying of Silo 4 commenced, it failed in the same manner. In view of the previous satisfactory performance of the older silos, it would seem to be an open and shut case that failure was induced by the loaded Silo 5 interacting through the ground with Silos 3 and 4. Certainly the late Professor Rowe (1995) attributed the cause of the failure to such interaction. He suggested that the high stiffness of the stored material in Silos 3 and 4 reacted to the very small distortions of the silo walls imposed by the settlements induced by Silo 5.

Precision levelling points had been located around the walls of the silos and on the columns. Also magnet extensometers had been installed beneath the centre of the foundations of Silos 3 and 4 and between Silos 4 and 5 - see Figures 18 and 19. As shown in the following, the patterns of movement given by these before and during unloading suggest that interaction with Silo 5 is not the only explanation for the failures.

During loading of silo 5 the settlement at the top of extensometer E4/5, between Silos 4 and 5, was about 4mm. Moreover, over a depth of about 15m the settlement remained almost constant at this value showing that the sleeved piles were very effective in minimising any load shedding over their upper lengths. During the loading of Silo 5, Silo 4 (which was full) inclined towards Silo 5 by about 4mm across its diameter and its centre settled about 3mm. Silo3, which was also full, showed no detectable inclination during loading of Silo 5 and the centre settled about 1mm. There were no measurable distortions around the bases of the walls of Silos 3 and 4.

It is interesting and relevant to note that, during the previous operations of Silos 1 to 4, there had been significant interactions between them with induced settlements of up to 20mm but they had performed very satisfactorily (Burland and Bayliss, 1990). Therefore the key question is:

> *"Why should such small movements induced by loading Silo 5 have triggered the failure of Silos 3 and 4 on commencement of unloading when in the past much larger interactions had safely occurred"?*

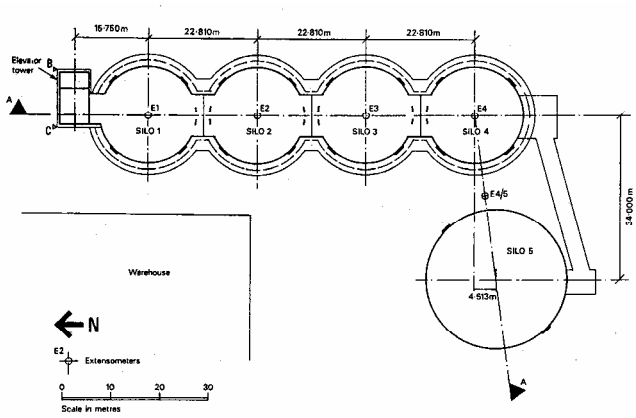


Fig 19: Plan of silo complex

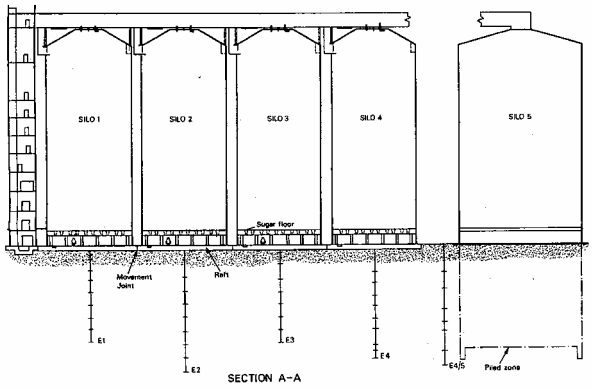


Fig 20: Cross-section through silo complex

The pattern of foundation movements that took place during unloading are crucial in attempting to answer this question.

As mentioned previously, unloading of Silo 3 commenced first. Figure 21 shows the pattern of settlements that were measured around the base of the silo walls during unloading from 12133t to 11098t during which the walls cracked. It can be

seen that a very curious settlement pattern developed. On the east side very little vertical movement occurred but on the west side two large settlement 'lobes' formed with no settlement between them, giving a kidney shaped pattern. On complete unloading this pattern almost disappeared. Silo 4 behaved in a very similar manner when it was unloaded from 12387t to 11227t as can be seen from Figure 22. Once again two settlement lobes are evident but in this case there was uplift between them.

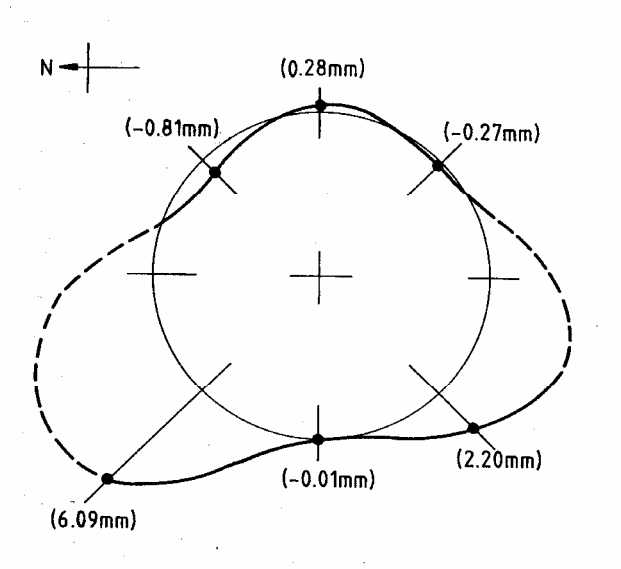


Fig 21: Silo 3 – relative settlement around base when unloaded from 12,133t to 11,098t

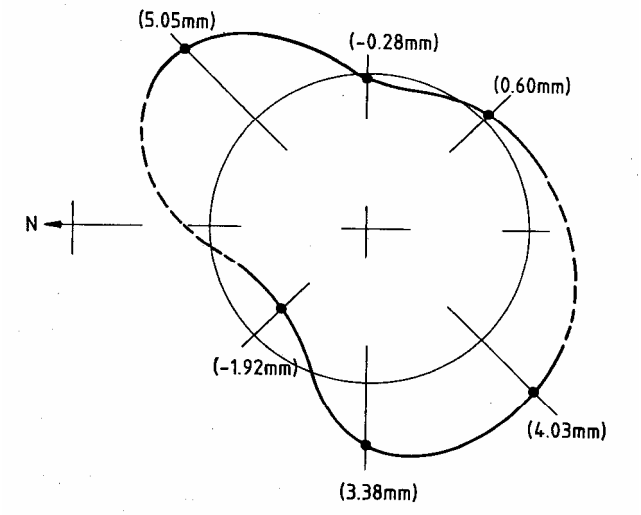


Fig 22: Silo 4 – relative settlement around base when unloaded from 12,387t to 11,227t

These observations intrigued the Author. The kidney shaped pattern is totally different from what one might expect from an interactive subsidence trough around Silo 5. Moreover, it is well known that, when subjected to differential vertical forces around its base, a vertical cylinder is extremely stiff. Could such large distortions really have resulted from vertical forces coming up from the ground - particularly when the differential settlements induced when Silo 5 was loaded were so small? On the other hand, that same cylinder will be very flexible when subjected to non-uniform internal pressures. It seemed more probable that non-uniform internal pressures were the cause of the large distortions.

The Author therefore undertook a series of simple model tests on the kitchen table to explore the effects of eccentric flow - thereby confirming the view of his family that he was completely barmy! The model silo was made from A4 paper formed into a cylinder and glued to a flexible cardboard base. The silo was founded on a layer of foam rubber. Sugar was used as the content and discharge took place from a hole in the base, the eccentricity of which could be varied. A disc of tracing paper was placed on the top of the silo and during discharge the shape of the top of the walls could be traced, having initially been circular.

Figure 23 shows the deformed shape of the top of the model silo after ten percent eccentric discharge from a radius of two thirds the radius of the silo. It can be seen that the top takes on the characteristic shape, reflecting the vertical movements around the base of the silo. In highly simplified terms, this shape is caused by arching action within the granular content. When central discharge takes place, vertical downward flow is concentrated near the centre line where a low pressure region is formed. The particles form horizontal rings or 'arches' around the central low pressure region with high circumferential stresses in the arches. When eccentric flow takes place, arching around the low pressure region still takes place but the arch reacts against the silo walls. There is therefore a low pressure region close to the wall with high pressure regions either side. It is this radially non-uniform pressure distribution that gives rise to the characteristic kidney shape. It is interesting to note that repeat experiments carried out at Imperial College on larger models gave essentially identical results to the kitchen table experiments.

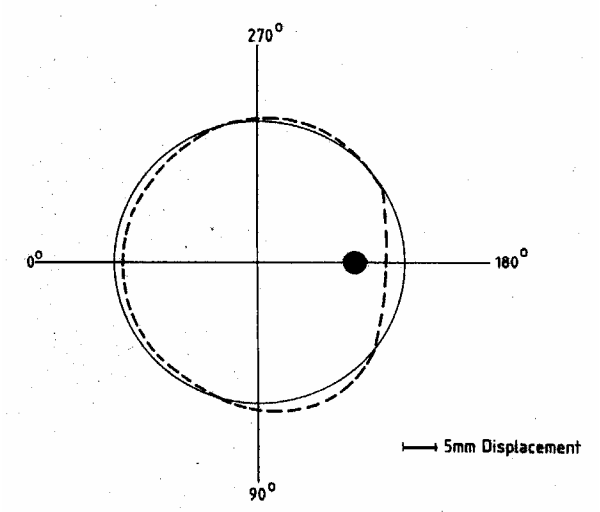


Fig 23: Pattern of radial displacements at top of model paper silo at 10% eccentric discharge

Shortly after the silo failure some trials were carried out on a full-scale sugar silo at Felsted (Driver and Dawson, 1988). Figure 24 shows a cross-section through the silo. Eccentric discharge took place from outlets towards the edge of the silo and the profile of the sugar surface is shown after about ten percent discharge. Radial displacements were measured at various levels. Figure 25 shows the measured radial displacements of the silo walls at level C at about ten percent discharge. The characteristic kidney shape is again observed. It is of interest to compare the shape in Figure 25 with that in Figures 23 - the similarity is very striking.

The above history is important for a number of reasons, not least because of the wealth of observations that were made on and beneath the silos. The measurements show that it is far from certain that the failure of Silos 3 and 4 resulted from interaction with Silo 5 - however overwhelming the circumstantial evidence appears to be. It is not possible to pin-point precisely the cause of the failures because not enough is known about the detailed operation of the silos at the time. However the possibility of eccentric flow within the silos, for whatever reason, cannot be ruled out and the measured patterns of foundation movement point strongly towards it. Nielson (1998) has drawn attention to the numerous factors that can give rise to unsymmetrical flow within silos and he points out what a dangerous phenomenon this is for the safety of the silo structure. Whatever the precise cause of failure,

this is an intriguing case of ground-structure-content interaction and one that the Author found particularly challenging. It also illustrates how instructive even simple physical models can be in identifying important mechanisms of behaviour.

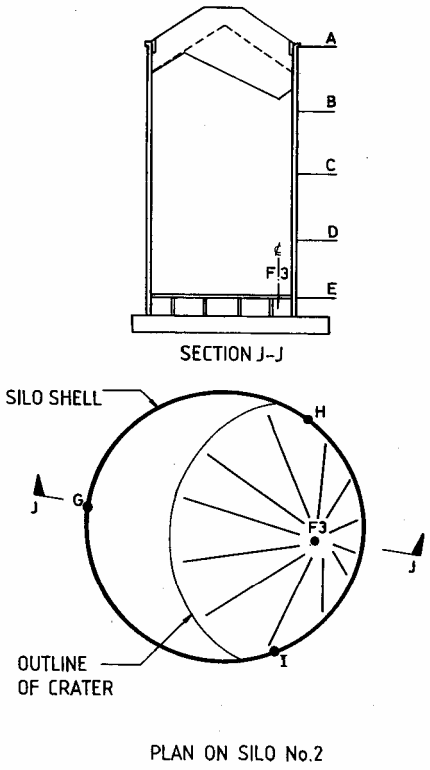


Fig 24: Eccentric discharge tests at Felsted silo

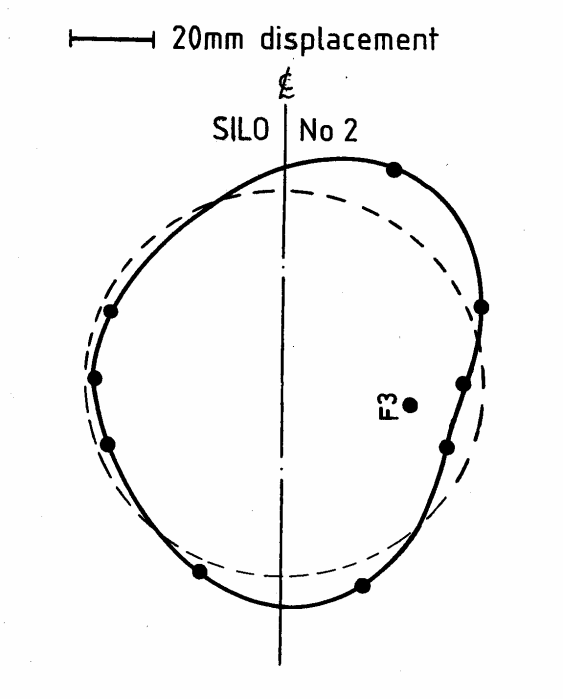


Fig 25: Measured radial displacements at level C on Felsted Silo

CONCLUSIONS

This paper explores the differences in the philosophy of modelling and analysis between Structural and Geotechnical Engineers. The idealisations that are involved in both disciplines are compared. It would seem that the approach that has to be adopted by a Structural Engineer working on an historic building is very similar to that of the Geotechnical Engineer working with the ground.

Superficially it might seem that the idealisations adopted by the Structural Engineer in routine practice are less uncertain than those that have to be adopted by the Geotechnical Engineer. However, on closer examination it has to be concluded that the calculation of the 'actual' state of a structure or building under a known set of loads is very uncertain.

The success of structural design calculations owes much to the inherent ductility of the structural elements so that the "*Safe Design Theorem*" applies. Geotechnical Engineers too owe much to the plastic behaviour of their materials and foundations for the success of their designs.

Structural Engineers tend to work and think in terms of forces and stresses. Geotechnical Engineers are much more used to working with strain and deformation. This difference becomes particularly apparent for situations in which elements of the building or ground approach their strength or maximum resistance. Structural Engineers brought up on concepts of limiting stress find it difficult to accept behaviour that implies full mobilisation of resistance (which is not the same as "failure"). Reference to Hambly's three and four-legged stool (*Hamby's paradox*) greatly aids in the understanding of the above ideas.

The paper contains a number of case histories which illustrate the importance of ductility and robustness in both structural and geotechnical design and in the interactions between the two. Particular care is needed when a relatively flexible structure of the *weak-beam strong-column* variety is subjected to ground movements. In such circumstances brittle behaviour of the columns can lead to unsafe conditions.

The paper concludes with two examples demonstrating the overriding importance of gaining a clear understanding of the mechanisms of behaviour of a soil-structure interaction system. If the analytical model does not capture the key mechanism no amount of sophisticated computation will help solve the problem.

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(this paper was presented at the Joint Structural Division Annual Seminar 2004 "New Perspectives in the Design & Construction of Foundation Structures" of Hong Kong).

GREECE's EGNATIA HIGHWAY TUNNELS

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Following the original Roman crossing of the Balkan Peninsula, the new Egnatia Highway has 73 tunnels with a total length of over 100km. The authors (see box) explain the intricacies involved in constructing this mega-project

Built in the second century B.C, Via Egnatia was the first highway built by the Romans outside Italy. It crossed the Balkan peninsula from the Adriatic sea in the west to the Marmara and the Black Sea in the east. The Egnatia Highway, currently under construction, follows a similar route.

Forming part of the Trans-European highway network the Egnatia motorway stretches from the west coast of Greece to the Turkish border. The principal axis is 680km long and has 73 tunnels with a total tunnel length of approximately 100km. This component of the project is 50% co-funded by the European Union.

An interchange and tunnel portals near the town of Metsovo in the Pindos mountains.

The geological environment

The highway traverses extremely diverse natural morphology of great beauty. It crosses the Pindos mountains which are the southern most extension of the Alps. The highway has been subdivided into the following units (figure 1):

Fig 1 - Location map of the Egnatia Highway

1 From the west coast port of Igomenitsa to the Metsovitikos River the Ionian geotectonic unit consists of flysch and alternations of various carbonate formations, mainly limestones, with very limited occurrence of cherts and siliciferous shales. Local occurrences of gypsum in diapiric intrusions can be also encountered. The rocks are folded while large scale overthrusts, big faults and mylonitized zones are present in this region.

2 From the Metsovitikos River to the Metsovo tunnel the Pindos geotectonic unit consists mainly of flysch, characterised by intense folding, heavy shearing with numerous overthrusts. The tectonic deformation at some places drastically degrades the quality of the rock mass. From the Metsovo tunnel to Panagia region the tectonic Nappe of Pindos comprises ophiolites as the predominant rock mass. These ophiolites exhibit great heterogeneity regarding their degree of serpentinisation and the occurrence of shear zones with tectonic melanges. Weak flysch, depressed by this ophiolitic nappe, is also present.

A parking bay in a typical operating tunnel on the Egnatia highway

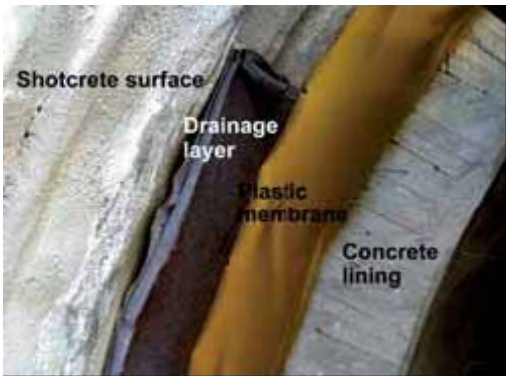
3 From Panagia to Siatista the molassic domain consists of molassic formations in the form of alternating thick-bedded conglomerates, sandstones and siltstones or claystones. From a tectonic point of view, the area is of low disturbance and although weak rock masses are present in places, there is no dramatic decrease of geotechnical quality due to the absence of significant tectonic shearing.

4 From Siatista to Lefkopetra the Pelagonian geotectonic unit is characterised by the predominance of hard rocks such as marbles, gneisses and granites. The presence of tectonically weakened zones through faulting is very localised. From Lefkopetra to Veria the Axios to Almopia geotectonic units consist of phyllites, limestones and ophiolites while overthrusts and sheared zones are the main tectonic structures.

5 From the Aliakmon River to the Axios River flood plane and Thessaloniki region the entire area consists of recent alluvial fill which exhibit insufficient natural compaction. From Thessaloniki to the Turkish border the Serb-Macedonian massif and the Rhodope massif comprise a basement of hard crystalline marbles, gneisses and granites. At some localities, the latter two appear weathered and are locally crosscut by faults with sheared zones within the rock mass. The Egnatia Highway also passes through areas of younger sediments such as marls and sandstones and areas of recent geological deposits with soft soils of loose or open structure. Responses to tunnelling through these different rock masses are shown in table 1.

Table 1

Rock type and conditions	Response to tunnelling and stability problems
Massive or bedded limestones. Marbles	Simple tunnnelling conditions. Structurally controlled failures, mainly controlled by rockbolts.
Filled karstic voids	Risk of collapses. Probing ahead essential and use of spiles or a forepole umbrella to cross void.
Sandstone flysch	Gravity driven structuraly dependent instability in low stress environments and occasionnally stress dependant instability when strength to stress ratio is low.
Siltstone flysch and shales	Stress dependent instability resulting in significant deformations and minor face instability. Control of deformation is essential and both temporary and permanent inverts may be required to form a load bearing shell.
Sheared and chaotic flysch	Squeezing conditions and face instability problems at depth (even as low as 100m in some cases, usually more than 200m). Control of deformations is essential and, to control extreme squeezing, yielding support may be required.
Sound ophiolites (peridotitees and gabbros)	Structurally dependent instability, more severe when discontinuities are serpentinised. Block size normally irregular and this requires a conservative excavation and support approach.
Sheared serpentinites and ophiolitic melanges	Squeezing conditions at depth (e.g. more than 200m). Control of deformations is essential and, to control extreme squeezing, yielding support may be required.
Molasses (tectonically undisturbed sedimentary sequence of rocks)	Simple tunnelling conditions. Gravity driven instability under low stress. Under confined conditions brittle failure can occur in high stress environments. Weak geotechnical conditions in the weathered surface layers, slope stability issues in portals.
Gneiss schists	Simple tunnelling conditions if not heavily tectonized and/or weathered. Structurally dependant instability.
Tectonics breccia in brittle rocks, kataclastes	Ravelling due to loss of interlocking as confinement is released at face. Maintaining confinement is important and this can generally be achieved by retaining a core at the face and the use of pre-reinforcement elements (e.g. face bolts, spiles)



Drainage and waterproofing layers behind the concrete lining

Tunnel geometry

The tunnels of the Egnatia Highway meet and, in many cases, exceed the minimum requirements for road tunnels recommended by the European Union[1]. All tunnels are twin two lane tunnels with unidirectional traffic in each tunnel. The tunnels have two 3.75m wide lanes, two 0.5m shoulders and two 1m wide pedestrian walkways. The traffic envelope is 8.5m wide and 5m high. The twin tunnels are linked by cross passages with fire doors spaced at 300 to 400m apart (figure 2). In tunnel bores longer than 2km every third cross passage is large enough to allow emergency vehicle access and is associated with parking bays to allow vehicles to be moved out of the way. Lighting, ventilation systems, signals and fireproof structural components are all features that have been found to contribute to the overall safety of road tunnels[2].

The interior of every tunnel is finished with a cast-in-place concrete lining which is backed by a waterproof membrane which is backed by a drainage layer. This is placed against the inner surface of the primary lining of generally shotcrete. Depending upon the difficulty of the conditions, the primary lining is supplemented by steel arches and rockbolts which are designed to support the rock mass surrounding the tunnel during excavation.

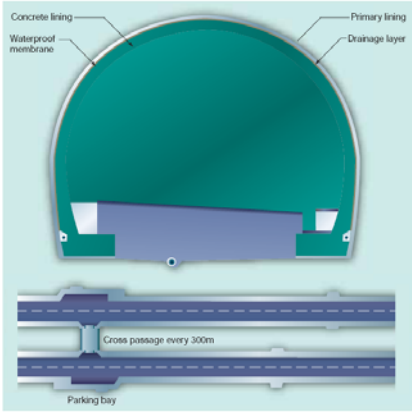


Fig 2 - Cross section and plan of a typical tunnel

Tunnel design

Egnatia Odos S.A. has developed tunnel design guidelines that cover all the aspects of tunnel design. For the design of the the appropriate combinations of shotcrete, excavation and temporary support, general rockbolts, lattice girders and steel sets with design steps are shown in Table 2 (Kazilis the occasional use of spiles as pre-and Angistalis[4]). Many of the potential problems identified the face. However, in the case of the during the preliminary design stages can be sheared flysch, weak serpentenites and easily dealt with by the timely installation of the appropriate combinations of shotcrete, rockbolts, lattice girders and steel sets with the occasional use of spiles as pre-reinforcement elements over and ahead of the face. However, in the case of the sheared flysch, weak serpentenites and ophiolitic melanges, the risk of severe deformations of both the tunnel and the face had to be recognised and dealt with.

TABLE 2

Step	Design stages
1	Assessment of the strength and deformability of the ground along the tunnel. Use of acceptable systems of rock mass classification and characterisation.
2	Calculation of deformations and plastic zones along the tunnel with no support measures. Use of analytical equations taking into consideration the stress field and the rock mass strength. Structurally dependent instability analysis is considered in cases of strong rock masses.
3	Preliminary selection of support classes based on experience and empirical methods.
4	Calculation of deformations and plastic zones along the tunnel considering support measures. Use of analytical equations taking into consideration the stress field, the rock mass strength, and the support pressure provided by the chosen support class.
5	Identification of problems. High deformations, face instabilities, floor heave etc.
6	Where potential stability problems are identified use of numerical analyses to check, confirm and finalize the support classes based on the anticipated failure mode

Figure 3 shows that, when the ratio of rock mass strength to in situ stress falls below 0.2, deformation of the tunnel increases exponentially and can develop into severe squeezing problems if not recognised and dealt with appropriately. Consequently, when the geological model indicates that materials with low rock mass strength are present and preliminary checks (such as those described by Hoek and Marinos[5]) indicate a potential for squeezing is present, a design involving the use of numerical models is required. The sequential excavation and support installation is modelled and the progressive failure and deformation of the rock mass surrounding the tunnel face is observed in detail. This permits the excavation sequence, support types and capacities and installation sequence to be optimised. In many of these cases a temporary invert is required in the top heading excavation in order to maintain a closed structural shell. Most of this numerical modelling can be carried out using wo-dimensional models but, in some cases, three-dimensional models are used to study particular details or to check the results of two dimensional models.

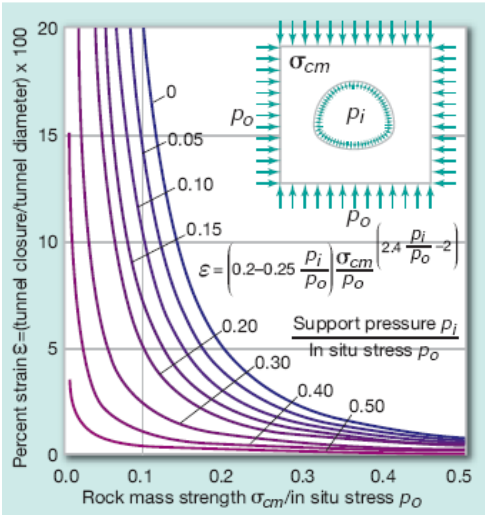


Fig 3 - Approximate relationships between tunnel strain and the ratio of rock mass strength to in situ strength for different levels of installed support, after Hoek[6]

In dealing with the relatively large displacements discussed above, the tunnel has to be over-excavated to allow the deformation to occur and still to provide sufficient room to accommodate the final concrete lining. Even the best geological models and the most sophisticated numerical analyses cannot predict the over-excavation required with sufficient accuracy and it is essential that the actual tunnel deformations be monitored and used to experience, this process has proved to be highly effective in the 59 Egnatia tunnels completed to date (June, 2006) and relatively few situations have occurred where "tights" have required trimming before the installation of the final lining.

Fortunately, in most cases, it has proved possible to arrive at a combination of support types with sufficient capacity to limit the tunnel deformations to acceptable levels. Generally this has required the installation of overlapping forepole umbrellas consisting of 12m long grouted, 114mm diameter pipes, 14m long grouted fibreglass dowels in the face and temporary invert closure in the top heading excavation.

The two exceptions to the application of heavy support systems to control deformation are the second tube of the existing Metsovo and the twin Panagia tunnels in weak rock masses at depth of up to 600m. In this case the capacity of available support systems that can be installed at the face was found to be insufficient and yielding support has been required to control the deformations. The principle of yielding support is illustrated in Figure 4 which shows that the activation of the support is delayed by the yielding elements. Obviously the tunnel has to be over excavated to allow for the much larger deformations that occur in these cases. The yielding elements used in the cross passages and the second bore of the Metsovo tunnel are "stress controllers", as described by Schubert[7]. This system has been very effective and the severe problems encountered during the driving of the first tube of the Metsovo tunnel more than 20 years ago[8] (during an earlier project) have been avoided.

Final lining design

All tunnels have a final lining of cast-in-place concrete. The design of these linings follows the same procedure and is inte-

grated into the design process used for the design of the primary support systems described earlier. In general a detailed numerical analysis of the entire excavation sequence, primary support installation, completion of the tunnel excavation and installation of the final lining is performed. Current European Union practice require that all of the primary support be discounted in the design of the final lining and hence, as a final stage in the numerical modelling process, the primary support is removed and the loads carried by this support are then automatically transferred onto the final lining.

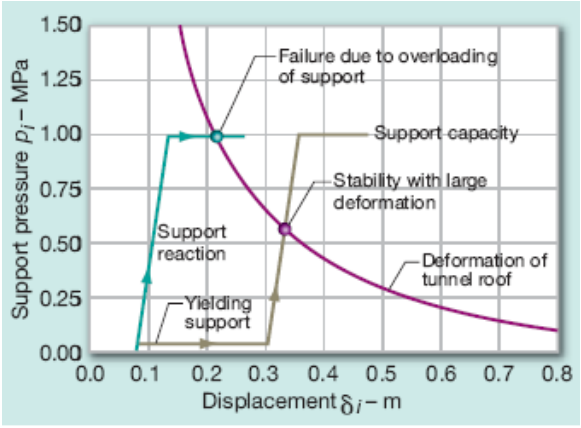


Fig 4 - Principle of delayed support activation by the use of yielding support.

Tunnel costs

The average total cost for the 32 Egnatia tunnels completed by the end of 2003 was US$26.9M per tunnel/km (figure 5).

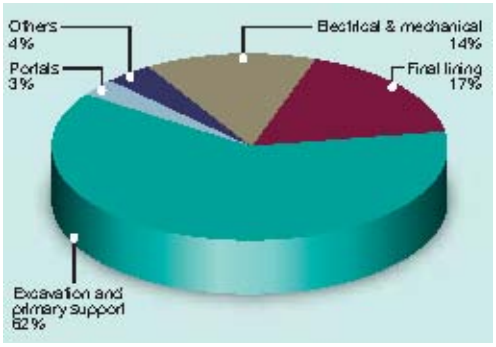


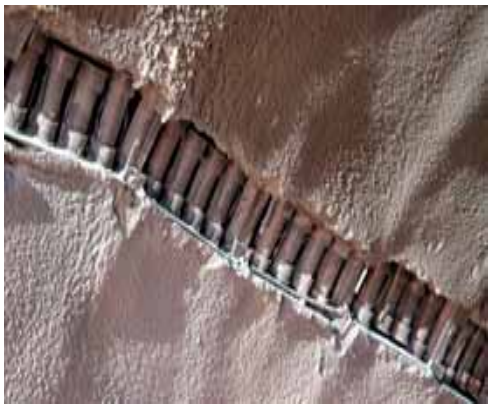
Fig 5 - Breakdown of the average total cost of tunnel construction on the Egnatia highway up to the end of 2003, after Lambropoulos[3]

A more detailed analysis of the total tunnel costs, up to 2003, shows that, as would be expected, the difficulty of tunnelling has a major impact on this cost. For tunnels in good quality rock masses, where simple relationships between tunnel strain and tunnelling methods can be applied, the total cost is in the order of US$16M per. On the other hand, difficult tunnelling conditions which occur in fault zones or heavily broken and deformed rock masses can result in total tunnel costs of up to US$35.9M per tunnel per km.

A database for the future

With technical and funding assistance from Egnatia Odos S.A., the School of Civil Engineering of the National Technical University of Athens has compiled a data base of information collected during the site investigations, designs and construction of all of the Egnatia tunnels completed to date. This data base, which operates on an SQL server contains structured digital data of all geological models, rock mass classifications and characterisations, tunnel support and lining designs, contractual details, excavation performance, results of convergence and other monitoring information and costs of all components of the tunnels.

Users of this data base will be able to examine correlations between any number of related parameters and, with such a large body of information covering a wide range of rock mass types, it is hoped that some of these correlations will provide useful guidance for future tunnelling projects.



A line of stress controller installed in one of the cross passages between the first and second tubes of the Metsovo tunnel

Acknowledgments

The authors would like to thank Egnatia Odos SA for its support in the preparation of this paper. We would also like to acknowledge the leadership and encouragement provided by Dr Sergios Lambpropoulos during his tenure as general manager of Egnatia Odos SA from 1995 to 2006.

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With the following paper Mr. A. Droudakis participated in this year's 18th Young Geotechnical Engineers Conference, which was held at Ancona, Italy.

MECHANICAL BEHAVIOR OF A FINE-GRAINED SOIL REINFORCED WITH GEOTEXTILES

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ABSTRACT

Free draining granular materials are specified as backfill materials for reinforced soil structures. However, difficulties are encountered when the available quantity of such materials is insufficient. Consequently, investigation of the mechanical behavior of reinforced cohesive soils of low plasticity became necessary. Toward this end, the behavior of a reinforced fine-grained soil was investigated by conducting triaxial compression tests and the results obtained, are presented herein. A silty soil of low plasticity (CL according to U.S.C.S.) was used in this research. Five non-woven and woven geotextiles were used for soil reinforcement. The specimens had diameter and height equal to 50 mm and 105 mm, respectively. They were compacted with water contents equal to 19% or 25.5% using energy comparable to that of Standard Proctor compaction test and contained 1 or 5 horizontally placed geotextile layers. Tests were conducted under undrained conditions, with confining pressures ranging from 10 to 200 kPa and at a constant axial displacement rate of 0.57 %/min. Strength of reinforced soil is not always higher than that of unreinforced soil, possibly due to insufficient soil – geotextile cooperation, and increases with increasing number of geotextile layers and when soil water content is close to the optimum value derived from compaction test. The maximum strength increase observed, is equal to 1.84. Reinforced soil presents either linear or bilinear failure envelopes. The bilinear form of failure envelopes possibly indicates a transition from drained to undrained behavior.

1. INTRODUCTION

Geotextile reinforced soil is used in a large number of applications because of its cost and engineering effectiveness. Free draining granular materials, e.g. sands, are specified as backfill material for reinforced soil structures. The main reasons for use of granular materials instead of cohesive soils are the volume change potential and inherent low strength of cohesive soils which make them unsuitable. However, difficulties are encountered when the available quantity of granular materials is insufficient. Since low-plasticity soils are generally not expansive, they could be used in reinforced soil structures provided that the reinforcement could increase the load-bearing capacity of the soil (Fourie & Fabian, 1987). So, it is of merit to investigate the possibility of using geotextiles as reinforcement of cohesive soils, since they are frequently used to improve the drainage characteristics of these soils.

Triaxial compression test has been extensively used in order to investigate the mechanical behavior of sand – geotextile composites (e.g Gray et al., 1982, Gray & Al-Refeai, 1986, Baykal et al., 1992, Ashmawy & Bourdeau, 1998, Haeri et al., 2000, Wu et al., 2002). However, only a few research efforts aimed at the investigation of the mechanical behavior of geotextile reinforced cohesive soils by conducting triaxial compression tests. Results obtained from unconsolidated – undrained (UU), consolidated – undrained (CU) and consolidated – drained (CD) triaxial compression tests on fully saturated, reinforced clay were presented by Ingold and Miller (1982, 1983). Permeable geotextiles and impermeable aluminum foils were used as reinforcement. It was observed that strength of specimens reinforced with aluminum foils was 50% lower than unreinforced soil strength. This was attributed to excessive pore pressure developed on soil – reinforcement interface. On the other hand, it was evident that permeable reinforcement could partly dissipate excessive pore pressure and prevent reinforced soil from early failure. Moreover, it was concluded that an increase in deviator stress of reinforced soil was achieved with decreasing the distance between reinforcement layers. Similar observations were reported by Christie (1982) who conducted CU triaxial compression tests on partly saturated clay reinforced with a variable number of permeable and impermeable layers of reinforcement. Additional research efforts by Ingold (1983, 1985) focused on the relationship between reinforced clay strength and saturation degree of clay. The results obtained from CU triaxial compression tests confirmed the reduced strength of clay reinforced with impermeable reinforcement and the increase in strength with decreasing the distance between reinforcement layers. The results also indicated that the strength of fully saturated clay decreases even when it is reinforced with permeable reinforcement. Furthermore, it was concluded that a decrease in saturation degree of soil leads to an increase in strength of reinforced soil. This strength – saturation degree relationship was found to be linear and independent of the applied confining pressure. Fabian and Fourie (1986) based on results obtained from UU and CU triaxial compression tests, reported that permeable reinforcement can increase undrained strength of silty clay by up to almost 40% and that impermeable reinforcement can decrease the undrained strength a similar degree.

Although all the above mentioned investigations have provided valuable information, they do not use failure envelopes in order to express shear strength behavior of reinforced fine-grained soils. Therefore, it is of merit to determine the failure envelope of reinforced fine-grained soil and to investigate the effect of parameters such as water content of soil, type of reinforcement and number of reinforcement layers on it. Toward this end, triaxial compression tests were conducted on a cohesive fine-grained soil reinforced with various woven and non-woven geotextiles and the observed results are presented herein.

2. MATERIALS

The fine-grained soil used in this investigation is a cohesive silty soil of low plasticity and is classified as CL according to Unified Soil Classification System (U.S.C.S.). The properties of soil are presented in Table 1 and its grain size curve is shown in Figure 1. The compaction characteristics of soil were obtained by conducting Standard Proctor compaction test. According to the compaction curve obtained, the values of dry unit weight of soil, γ_d, corresponding to water contents, w, equal to 19.5% (optimum) and 25.5% are equal to 1.70 g/cm^3 (maximum) and 1.51 g/cm^3, respectively (Table 1). The shear strength parameters of this soil were determined by conducting Unconsolidated – Undrained (UU) triaxial compression tests without saturation on specimens compacted with water contents equal to 19.5% and 25.5%. The compaction energy used was equal to that of Standard Proctor compaction test. The failure envelopes obtained, are presented in Figure 2 and the shear strength parameters of soil are shown in Table 1.

Table 1: Soil properties

Specific Gravity, G_s	2.70		
Grain Size Distribution	Sand: 32%	Silt: 58%	Clay: 10%
Atterberg Limits	w_L: 45%	w_P: 18%	I_P: 27%
Compaction Characteristics	w_{opt}: 19.5% γ_{dmax}: 1.70 g/cm^3		w : 25.5% γ_d: 1.51 g/cm^3
Shear Strength Parameters	w: 19.5% w: 25.5%	c: 72 kPa c: 37.5 kPa	φ: 17° φ: 3°

Three non-woven geotextiles and two woven geotextiles provided by five different manufacturers were used during this investigation. These geotextiles were selected in order to have comparable mass per unit area and to cover a wide range of types of commercially available products. More specifically, one thermally bonded (Typar SF 111), one needle-punched with thermally treated surfaces (Fibertex F 500) and one needle-punched (Polyfelt TS 70) polypropylene non-woven geotextiles as well as one high strength polyester (Bonar 150/60) and one standard grade polypropylene (Thrace Plastics 400) woven geotextiles were tested. These geotextiles are designated as TB, TTS, NP, HS, and SG, respectively. Pertinent geo-

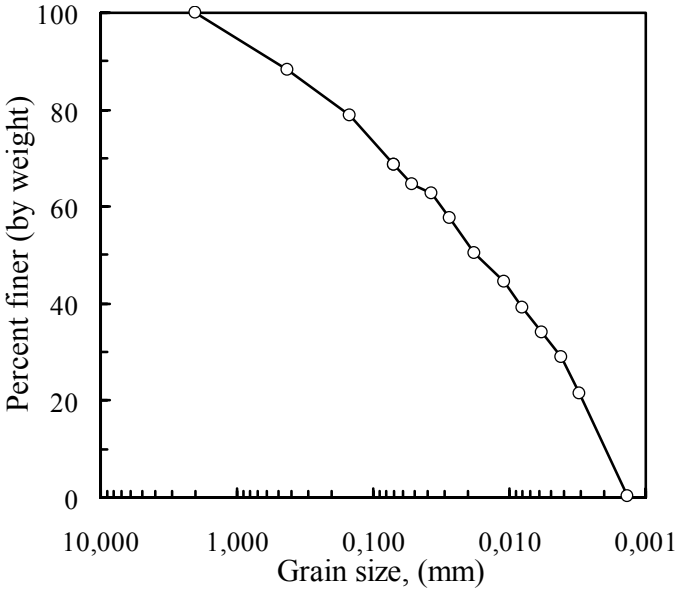


Figure 1: Grain size curve of fine-grained soil

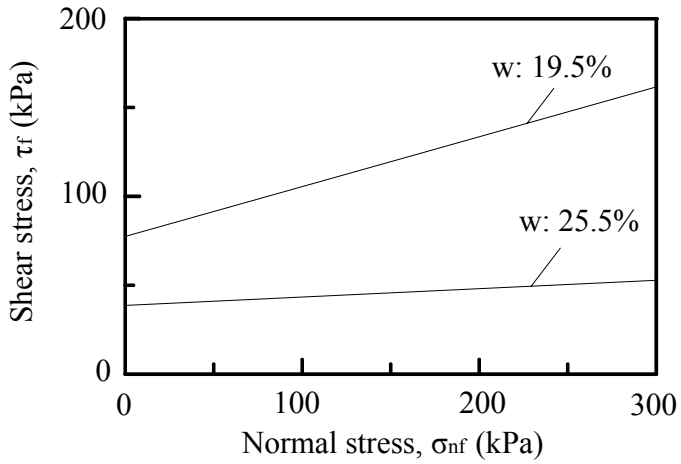


Figure 2: Failure envelopes of fine-grained soil

textile properties, according to the manufacturers, are presented in Table 2.

Table 2: Geotextile properties

Geotextile	Manufacturing process*	Thickness [mm]	Mass per unit area [g/m^2]	Tensile test results	
				Maximum tensile load [kN/m]	Extension at max. load [%]
TB	NW	0.85	375	29	70
TTS	NW	2.20	370	25	55
NP	NW	1.30	325	24	80 / 40 #
HS	W	1.30	375	161 / 63 #	12 / 11 #
SG	W	1.15	400	86 / 86 #	20 / 14 #

* NW: non-woven, W: woven

Machine direction / Cross machine direction

3. EXPERIMENTAL PROCEDURES

Triaxial compression tests were conducted on geotextile reinforced soil specimens in order to investigate the mechanical behavior of the composite material. The cylindrical specimens prepared, had a diameter of 50 mm and an overall height of 105 mm and were reinforced with a number of geotextile layers, N, equal to one or five. The geotextile layers had diameter equal to that of the specimen and placed at equal distances perpendicular to the axis of it. A schematic representation of the soil specimens reinforced with one and five geotextile layers, is shown in Figures 3a and 3c, respectively. Specimen configurations same as that of Figure 3c have been used previously (e.g. Atmatzidis & Athanasopoulos, 1994, Markou & Droudakis, 2006) in laboratory investigations using triaxial compression tests.

Reinforced soil specimens were prepared with soil water contents equal to 19±0.5% and 25.5±0.5%. A special compaction method was developed in order to produce reinforced soil specimens ready for testing, containing geotextile layers placed exactly at the desired position (Figure 3) and to ensure that the compaction energy is uniformly distributed into the soil mass. More specifically, the specimens were compacted by putting the wet soil (right after soil – water mixing) in 6 successive layers into a cylindrical, metal mold of internal diameter equal to 50 mm and using a cylindrical hand-operated tamper with a weight of 28.74 N and a diameter slightly smaller than 50 mm. The compaction of every soil layer was performed by dropping the tamper freely from a height of 11cm a certain number of blows. The used sequence of blow numbers per layer was equal to 6, 10, 14, 18, 22 and 10 from the bottom to the top of the specimen, since it was found that it produced soil layers of uniform density.

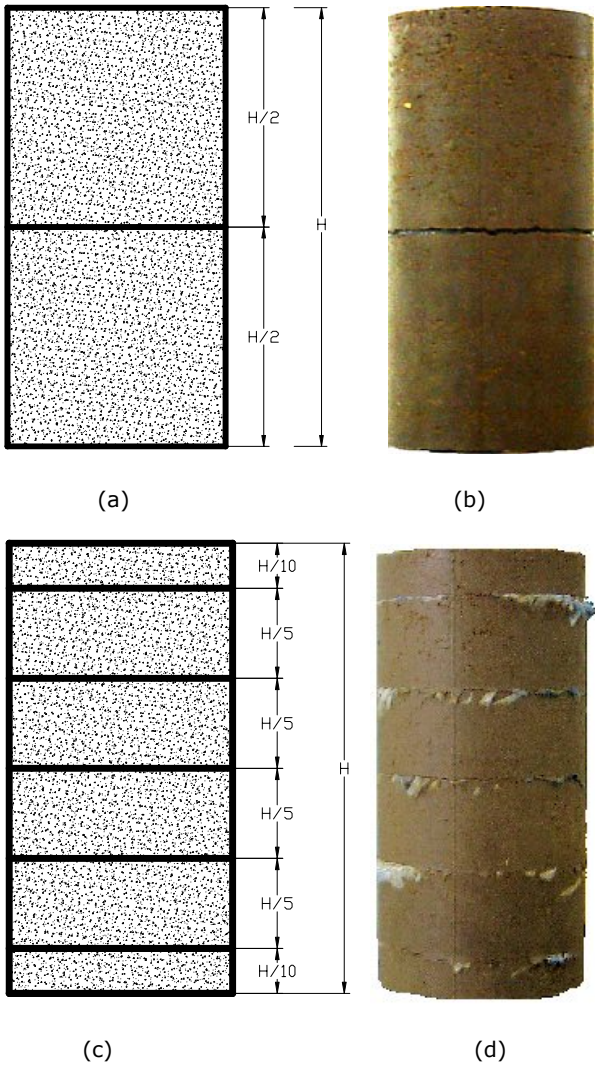


Figure 3: Fine-grained soil specimens reinforced with (a, b) one and (c, d) five geotextile layers

After the compaction of each soil layer, the surface of the layer was roughened and, depending on the desired number of geotextile layers, either a geotextile disc or the next soil layer was placed. At the end of the compaction process, the specimen was extruded from the mold using the sample extruder of Proctor compaction test and it was tested in triaxial compression. This special compaction method was applied in unreinforced soil with different water contents and the results obtained, were expressed in terms of dry unit weight – water content relationship. The resulted compaction curve is compared to the one of Standard Proctor compaction test in Figure

4. It can be observed that the difference between the two compaction curves is small indicating that the compaction energy of the method described above is comparable to the one of Standard Proctor compaction test.

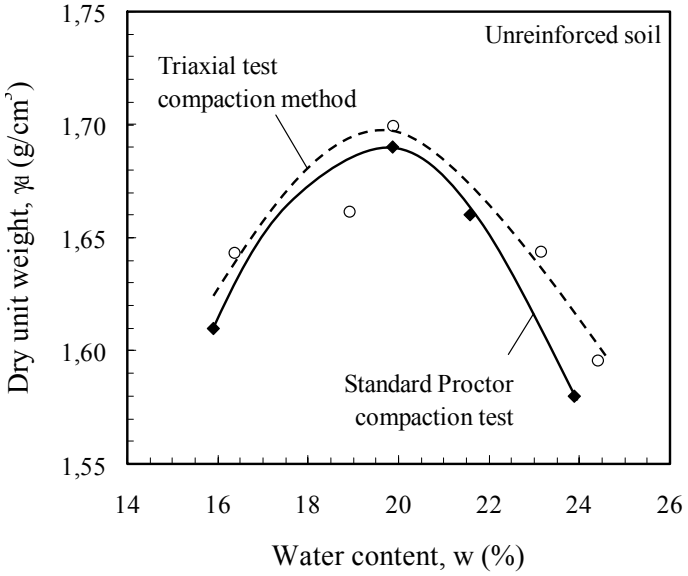


Figure 4: Comparison of compaction methods

Reinforced fine-grained soil specimens with water content equal to 19±0.5% had saturation ratio, void ratio and dry unit weight values ranging from 75% to 90%, from 0.57 to 0.68 and from 1.61 g/cm^3 to 1.72 g/cm^3, respectively. Reinforced fine-grained soil specimens with water content equal to 25.5±0.5% had saturation ratio, void ratio and dry unit weight values ranging from 93% to 96%, from 0.71 to 0.75 and from 1.55 g/cm^3 to 1.58 g/cm^3, respectively. The observed variability in the parameter values mentioned above can be attributed to the compressibility of geotextiles used, since it is believed that high geotextile compressibility leads to a decrease in compaction energy and, as a result, to a decrease in compaction degree of the soil mass. As it was expected, specimens with water content equal to 19±0.5% present higher density than the ones with 25.5±0.5%, due to the fact that the former water content is very close to the optimum value obtained in Standard Proctor compaction test.

Conventional triaxial compression equipment without modifications was used to conduct the tests. All tests on reinforced fine-grained soil specimens were unconsolidated – undrained (UU) without specimen saturation or pore water pressure measurements and conducted with confining pressures, σ_3, equal to 10, 25, 50, 100 and 200 kPa and at a constant axial displacement rate of 0.57 %/min, which corresponds to undrained loading conditions.

4. RESULTS AND DISCUSSION

The results obtained from triaxial compression tests were expressed in terms of stress – strain curves and failure envelopes. The form of specimens after testing was also recorded. The effect of water content of soil, type of geotextile, number of geotextile layers and confining pressure on the results is evaluated. The results obtained and the observations made, are presented in the following paragraphs.

4.1. Stress – strain relationship

Presented in Figure 5 are typical stress – strain curves obtained from triaxial compression tests on reinforced fine-grained soil. It can be observed that reinforced fine-grained soil presents either a peak deviator stress (failure deviator stress) followed by a negligible decrease in deviator stress or a continuous increase in deviator stress as the axial strain in-

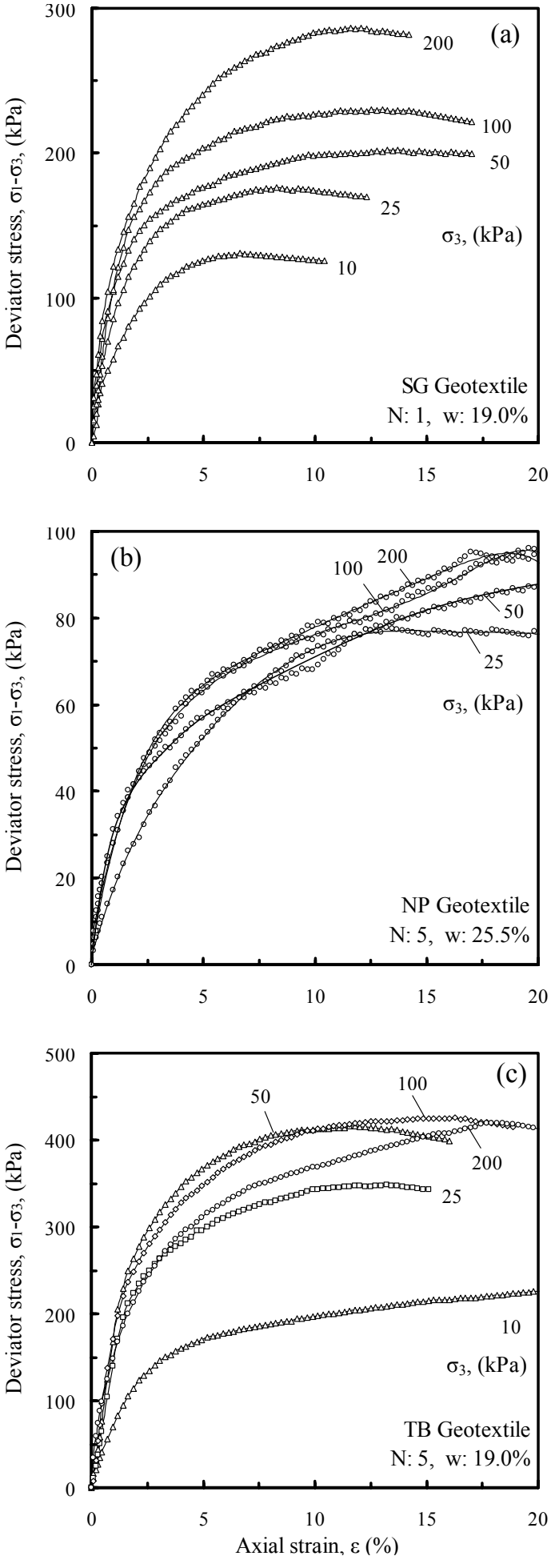


Figure 5: Typical stress – strain curves of geotextile reinforced fine-grained soil

creases. Stress – strain curve of reinforced fine-grained soil having similar shape to the ones presented herein, were reported by Fabian and Fourie (1986). Accordingly, in tests not presenting a maximum deviator stress, the failure of specimen and, as a result, the failure deviator stress was defined to correspond to a value of axial strain equal to 20%. The same failure criteria were adopted by Fabian and Fourie (1986). It is also observed (Figure 5) that an increase in confining pressure causes an increase in failure deviator stress of reinforced fine-grained soil tested with confining pressures up to 50 kPa. On the other hand, reinforced fine-grained soil specimens tested with confining pressures greater than 50 kPa, present, in most cases, either negligible increase or no increase or even a decrease in failure deviator stress as confining pressure increases (Figures 5b, 5c). In a few cases, a significant increase in failure deviator stress with increasing confining pressure was also observed for tests conducted with confining pressures greater than 50 kPa (Figure 5a). Therefore, it is evident that stress – strain relationship of reinforced fine-grained soil does not present a consistent behavior.

The ranges of axial strain at failure values obtained from the triaxial compression tests are presented in Table 3, since confining pressure was not found to affect axial strain at failure of reinforced soil. It is observed that the axial strain at failure values of unreinforced soil specimens are equal to or higher than the ones of soil specimens reinforced with one geotextile layer and are generally lower than the ones of reinforced specimens with five geotextile layers. It can also be seen that there is no effect of geotextile type and of soil water content on the axial strain at failure. The low or negligible effect of all the above mentioned parameters on the axial strain at failure of reinforced soil can be attributed to the high deformability of unreinforced soil (Table 3) and/or to the fact that in a significant number of tests, failure of reinforced specimens was defined to correspond to a value of axial strain equal to 20%, since a peak deviator stress was not recorded.

Table 3: Values of axial strain at failure

Geotextile	Number of layers, N	Soil water content, w	
		19.0%	25.5%
TB	5	11.8% – 20.0%	———
TTS	5	17.1% – 20.0%	———
NP	1	8.7% – 17.8%	———
NP	5	19.1% – 19.7%	13.2% – 20.0%
HS	5	9.3% – 20.0%	———
SG	1	6.6% – 13.7%	———
SG	5	10.9% – 19.6%	20.0% – 20.0%
Unreinforced soil		8.1% – 19.3%	14.7% – 19.5%

4.2. Shear strength

Shown in Figure 6 are the failure envelopes of reinforced and unreinforced fine-grained soil. It can be seen that reinforced soil with one or five geotextile layers and water content equal to 19% presents bilinear failure envelopes. In most cases, the part of the bilinear failure envelopes after the break point is horizontal showing that shear strength of reinforced fine-grained soil is independent of the applied normal stress. This behavior is similar to that of fully saturated fine-grained soils loaded under undrained conditions. Therefore, the bilinear form of these failure envelopes is possibly attributed to a change of draining conditions in reinforced soil as the applied normal stress increases. Although reinforced fine-grained soil with 5 geotextile layers and water content equal to 25.5% is not fully saturated (saturation ratios: 93% to 96%), it presents either linear or bilinear failure envelopes (Figures 6c and 6d). Therefore, the behavior of reinforced fine-grained soil with a water content of 25.5% is either similar to the typical behavior of fully saturated fine-grained soils loaded under undrained conditions or presents the above mentioned change of draining conditions as normal stress increases. Curved andbilinear failure envelopes were also reported by Athanasopoulos (1996) for reinforced fine-grained soil, indicating a continuous transition from drained to undrained behavior as normal stress is increased. The break point of bilinear failure envelopes corresponds to normal stress values ranging from 83 kPa to 208 kPa. However, these critical values of normal stress should not be taken to represent the transition from slippage failure to stretching failure of the reinforcement, as it happens in geotextile reinforced sand, but appear to represent transition from drained to undrained behavior.

It is also observed that reinforced soil with one geotextile layer (Figures 6a and 6b) or compacted with water content of 25.5% (Figures 6c and 6d) presents shear strength equal to or lower than unreinforced soil. Shear strength of reinforced soil becomes higher than the one of unreinforced soil when it is reinforced with 5 geotextile layers and is compacted with water content close to the optimum value obtained from Standard Proctor compaction test (Figures 6e and 6f). So, it can be concluded that the use of geotextiles for reinforcement of fine-grained soil is not always effective regarding the shear strength increase.

It is evident (Figures 6c and 6d) that shear strength of reinforced soil decreases with increasing soil water content, exactly as it happens in unreiforced soil. If the strength of reinforced soil is related to the saturation ratio of the specimens (Figure 7), it can be seen that it decreases linearly as saturation ratio increases. This linear relationship is in agreement with observations reported by Ingold (1983, 1985).

The strength ratio, S_R, defined as the ratio of failure deviator stress of reinforced soil to the failure deviator stress of unreinforced soil for the same confining pressure, is used for the quantification of the strength increase (or decrease) due to reinforcement of soil. As it can be seen in Figure 8, the S_R values range from 0.62 to 1.84. This means that fine-grained soil reinforcement with geotextiles leads to an increase as well as a decrease in strength. The above mentioned strength ratio values are in good agreement with the results of other investigators, since Ingold (1983) reported S_R values generally lower than 2 for clays reinforced with geotextiles and Fabian and Fourie (1986) reported that permeable geotextiles can increase undrained strength of silty clay by up to almost 40% and that impermeable geotextiles can decrease the undrained strength a similar degree. Strength ratio values greater than nity (strength increase due to reinforcement), resulted from specimens reinforced with five geotexti le layers and compacted with water content equal to 19.0% (Figures 8c and 8d). On the contrary, S_R values resulted from specimens reinforced with one geotextile layer (Figure 8a) or compacted with water content equal to 25.5% (Figure 8b) are generally equal to or lower than unity (no strength increase due to reinforcement). In the cases of strength increase due to reinforcement (Figures 8c and 8d), the S_R values are generally in the same range irrespective of the type of geotextile used and attain to maximum values for confining pressures between 50 and 100 kPa. The last observation is justified by the position of failure envelopes of reinforced soil relative to those of unreinforced soil (Figures 6e and 6f).

4.3. Failure mode of reinforced soil specimens

Shown in Figure 9 are typical forms of specimens of fine-grained soil reinforced with one and five geotextile layers after triaxial compression testing. The failure mode of reinforced soil specimens generally consisted of bulging of soil between geotextile layers. More specifically, the reinforced specimens presented a nearly uniform diameter increase in all soil layers and no remarkable diameter change in geotextile layers, indicating an insufficient cooperation between fine-grained soil and geotextiles. This insufficient soil – geotextile cooperation possibly justifies the low strength increases and the strength decreases obtained after incorporating the geotextiles into the fine-grained soil mass (Figure 8).

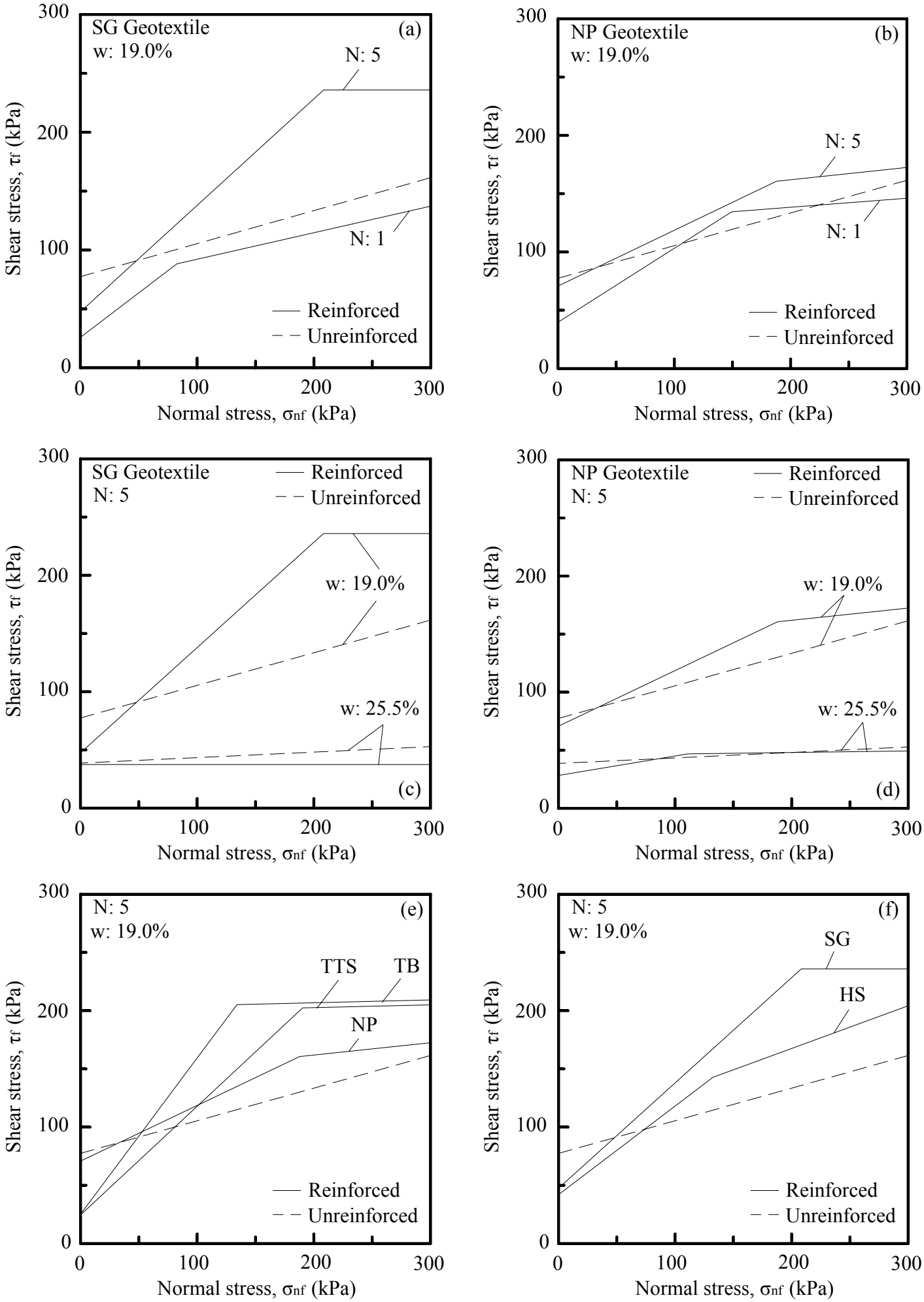


Figure 6: Failure envelopes of unreinforced and geotextile reinforced fine-grained soil

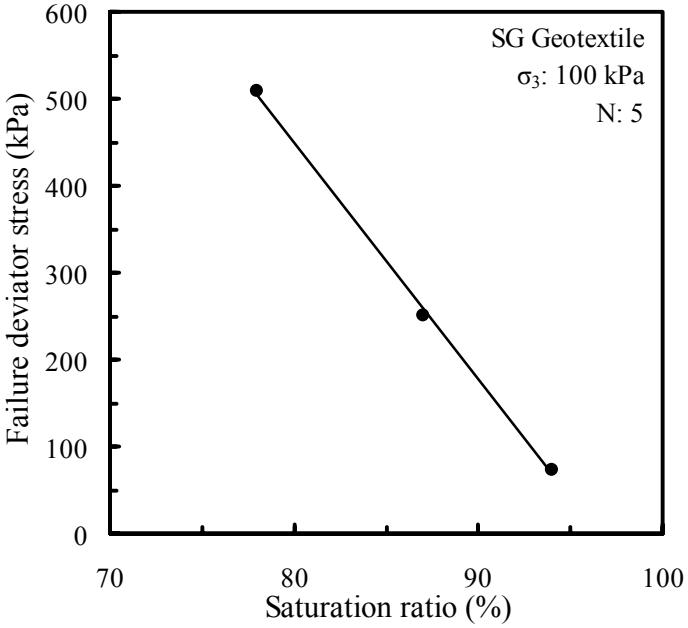
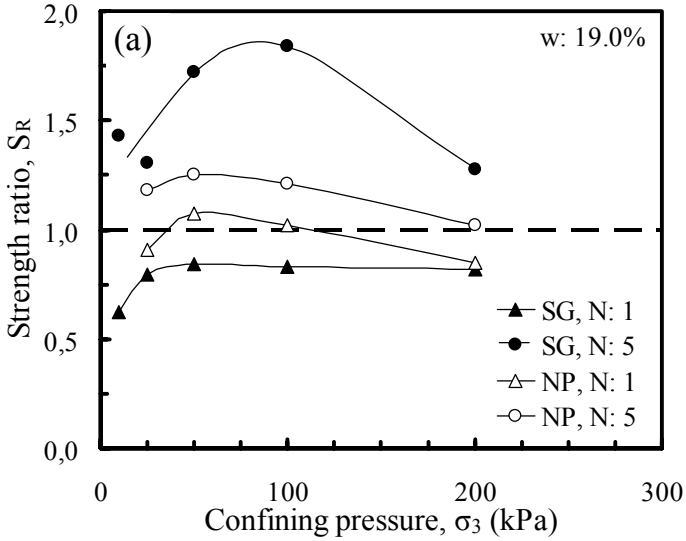


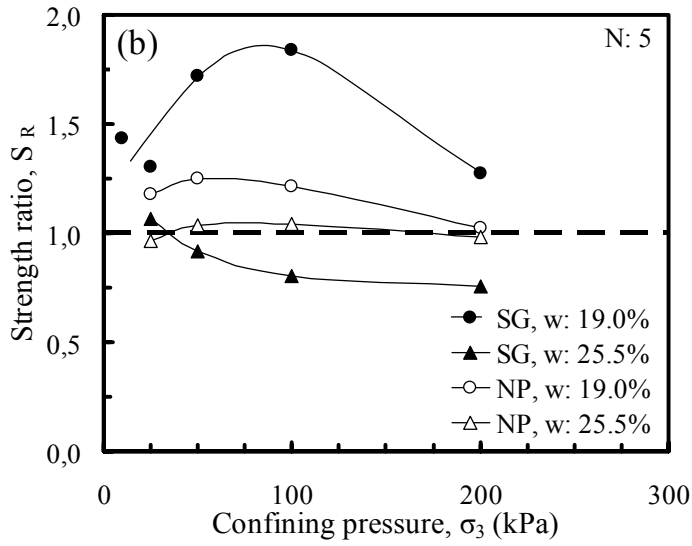
Figure 7: Effect of saturation ratio on failure deviator stress of reinforced fine-grained soil

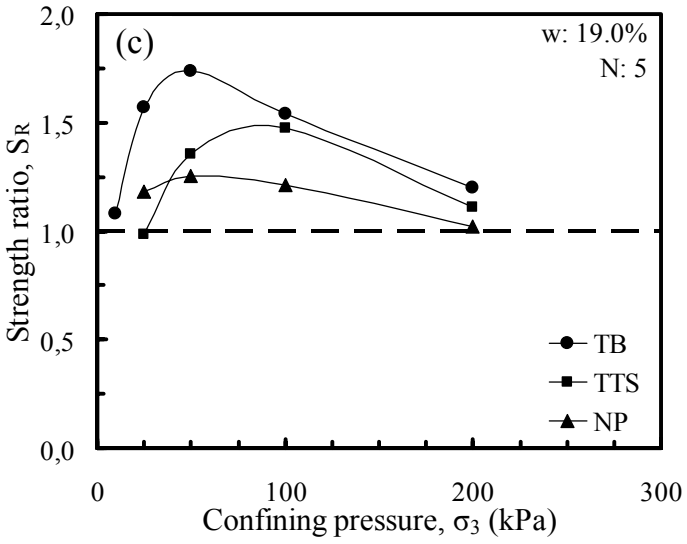
5. CONCLUSIONS

Based on the results of this investigation and within the limitations posed by the number of tests conducted and the materials used, the following conclusions may be advanced:

- Axial strain at failure values of unreinforced fine-grained soil specimens are equal to or higher than the ones of soil specimens reinforced with one geotextile layer and are generally lower than the ones of reinforced specimens with five geotextile layers.
- The triaxial compression tests yielded, in most cases, bilinear failure envelopes for geotextile reinforced fine-grained soil. This bilinear form is possibly attributed to a transition from drained to undrained behavior.
- Shear strength of unreinforced and geotextile reinforced fine-grained soil decreases with increasing soil water content.







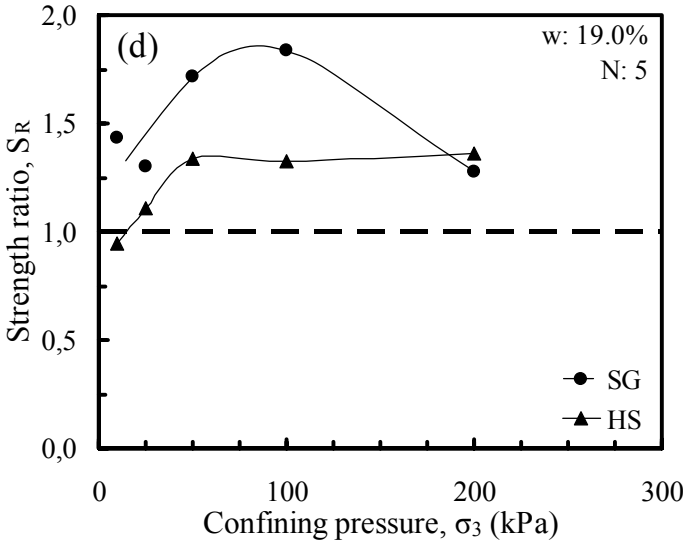
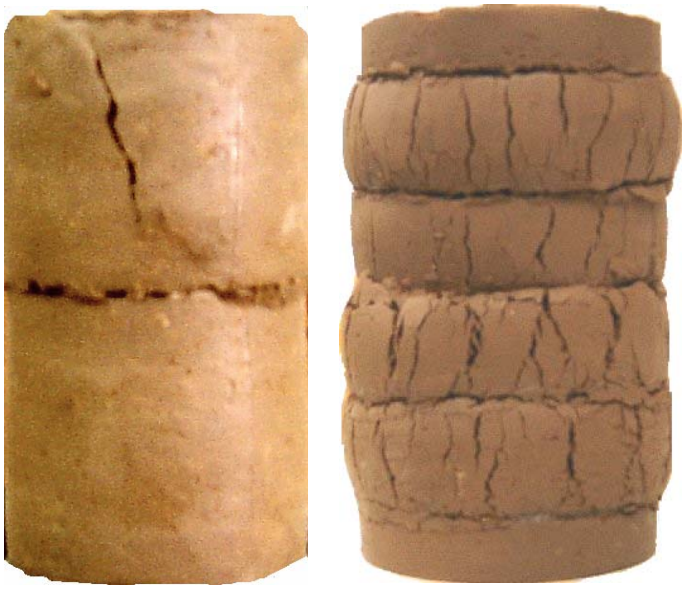


Figure 8: Relationship of geotextile reinforced soil strength to unreinforced soil strength



(a) (b)

Figure 9: Typical specimens of soil reinforced with (a) one and (b) five geotextile layers after triaxial compression testing

- Reinforcement of fine-grained soil with geotextiles leads to an increase or a decrease in strength, in agreement with the observations of other investigators.
- The highest strength increases resulted from specimens reinforced with five geotextile layers and compacted with water content close to the optimum value obtained from Standard Proctor compaction test. In these cases, strength ratios can reach a maximum value of 1.84 and are generally in the same range irrespective of the type of geotextile used.
- Failure modes of reinforced fine-grained soil specimens indicate an insufficient cooperation between soil and geotextiles, which possibly justifies the low strength increases and the strength decreases observed in reinforced fine-grained soil.
- Based on the findings of this laboratory investigation, it can be concluded that the use of fine-grained soils of low plasticity as backfill materials in reinforced soil structures requires very careful consideration.

ACKNOWLEDGEMENTS

Thanks are expressed to Mr. G. Maroulas for his valuable contribution to the design and construction of the fine-grained soil specimen preparation equipment, as well as to the development of the special compaction process used for the purposes of this investigation.

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TECHNICAL UNIVERSITIES OF GREECE 2007 PHD THESES' ABSTRACTS

NUMERICAL INVESTIGATION OF STRUCTURAL SEISMIC BEHAVIOR ENHANCEMENT UTILIZING SUBSOIL INTERVENTIONS

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The issue of safe structural design against seismic loading has been under consideration during the last decades and is currently efficiently covered by modern Seismic Codes, introducing the state-of-the-art scientific knowledge into engineering practice. At the same time an interesting discussion is conducted worldwide, regarding the policy that should be adopted in the case of older structures with insufficient seismic resistance. In both cases, of newly-built structures and of pre-seismic upgrade of older buildings, the main target of today's practice is to enhance the superstructure and the foundation body strength with proper design or intervention at the structural system.

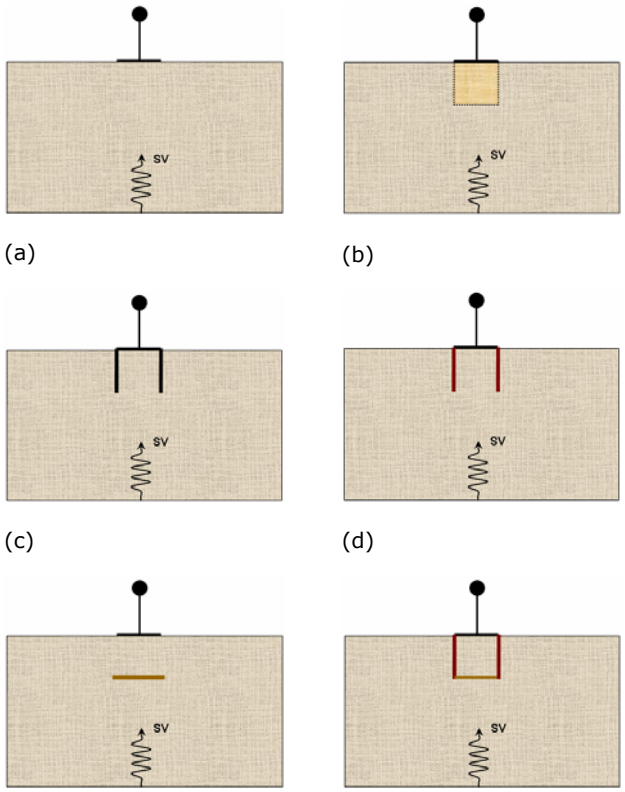
An alternative approach towards seismic risk reduction is discussed in the present thesis, employing subsoil interventions to the area neighboring the foundation. So far, subsoil interventions have been related to problematic soil cases aiming at soil strength enhancement during an earthquake event, considering the seismic motion unmodified. The difference of the present research lies in the effort to decrease the dynamic response of the structure by modifying the mechanisms related to the seismic excitation propagation towards the foundation as well as interfering with the dynamic characteristics of the soil-structure system that affect the seismic response through dynamic interaction phenomena. Strength-related issues are not considered during the investigation that is briefly described in the next few paragraphs, since the research focuses primarily on the seismic part of the response.

The potential intervention techniques examined in this thesis refer to methods of common engineering practice as well as to more innovative techniques, with respect to the employed materials or the approach of the proposed solution.

More specifically the examination concerns the response of the following potential mitigation techniques that will be compared to the response of the benchmark soil-structure case (a):

- foundation subsoil stiffening (b)
- construction of stiff vertical diaphragms next to the foundation (c)
- construction of soft (flexible) vertical diaphragms next to the foundation (d)
- construction of soft horizontal layer (of low shear capacity) in the soil below the foundation (e)
- combination of the soft horizontal layer and the soft vertical diaphragms (soft caisson) (f)

A validation procedure of the numerical code precedes the numerical analyses, in order to verify the simulation efficiency of both wave propagation and site effect analysis as well as the appropriate reproduction of soil-structure interaction phenomena. Substantial to the validation procedure is considered the role of centrifuge physical experiments conducted in Cambridge University in the framework of the European Research Project NEMISREF (New Methods of Mitigation of Seismic Risk on Existing Foundations).



(a) (b) (c) (d) (e) (f)

The main conclusion of the investigation highlights the efficiency of the low-stiffness intervention systems with respect to the resulting alteration of the dynamic response, compared to more traditional methods that involve increase of the overall rigidity. In particular during the investigation of soil stiffness increasing methods, the effect on the structural seismic response is rather detrimental than beneficial, resulting in several cases in the significant increase of the superstructural accelerations especially when stiff structures are founded on soft soil conditions. The beneficial contribution of such interventions in terms of soil strength enhancement is not certainly under question, yet a case-dependent study is recommended before application especially in cases of interventions in large areas that concern structures of high importance. Soft diaphragms construction as well as their combination with the soft horizontal layer can offer a promising mitigation approach, since under specific circumstances they lead to the reduction of the structural seismic response through the decrease of the seismic motion as well as due to the significant alteration of the dynamic properties of the oscillating soil-structure system. In certain cases mitigation could be quite important leading to a 50% reduction of the response compared to the seismic behaviour of the initial system.

CONTRIBUTION TO THE DETERMINATION OF A THREE DIMENSIONAL SOIL MODEL FOR STUDYING SEISMIC RESPONSE: APPLICATION TO THE MYGDONIAN SEDIMENTARY BASIN

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School of Engineering
Department of Civil Engineering

The main scope of the present PhD thesis is the construction of a 3D geological model which adequately describes the geo-

metry and dynamic properties -in terms of S-waves (Vs) and P-waves (Vp) velocities- of the main geological formations of a sedimentary basin. This model is appropriate for site response analysis in different dimensions (1D, 2D and 3D), for earthquake interpretation and simulation of design strong ground motion and spectra. In the present study the definition of the geological structure of the Mygdonian sedimentary basin is presented. It is an elongated tectonic graben located about 30 km E-NE of the city of Thessaloniki (Northern Greece) and it is the closest active seismic zone affecting it. The region has been investigated extensively over the past 30 years by various researchers. Most of these studies were oriented at geological or seismotectonic investigations as well as site response.

The construction of the 3D model was based mainly on array microtremor measurements and big-shot experiments, while geological, geotechnical and geophysical data from previous and recent investigations were also used. The analysis of the field measurements was performed with the following techniques: spatial autocorrelation coefficient - SPAC, surface wave inversion - SWI and intercept time. As a result, the 1D velocity profiles of the investigated sites were calculated. These 1D profiles were correlated in the horizontal direction through 2D cross-sections of different lengths and directions crossing the Mygdonian basin. The structure derived from the synthesis of all the aforementioned data using GIS software provides a description of the geometry of the main soil formations and their Vs & Vp velocities down to the bedrock.

Apart from the 3D structure construction, the site response of the basin was also studied. Ambient noise data as well as weak and strong motion earthquake recordings were analyzed using different techniques (Nakamura, HVSR, SSR και GIS). From their analysis, the characteristics of the site response, in terms of resonant frequency fres and amplification factor Amax, were calculated at about 230 sites within the basin. The results of the HVSR ratios together with the respective previous results were used to map fres values throughout the basin. The site response characteristics were correlated with the geology of the basin through the 1D theoretical approach in order to validate the proposed 3D geological model. The good agreement between the site response characteristics and the basin geology verified the 3D geometry of the Mygdonian basin as constructed in the framework of this PhD thesis. Therefore, we are convinced that our proposal is a reliable estimate of the geometry and the mechanical properties of the Mygdonian basin. As such, it provides a critical input to the simulation of its ground motion and to the interpretation of the earthquake records that are currently being obtained by the permanent strong motion array installed at the site.

ENGINEERING GEOLOGICAL FACTORS AFFECTING THE GEOTECHNICAL PARAMETERS OF INTACT ROCK – THE INFLUENCE OF ANISOTROPY

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School of Civil Engineering
Department of Geotechnics

The current research deals with the pronounced effect of the fabric ofanisotropic rocks on the strength and deformation characteristics of intact rocks. The factors that influence the strength and deformation of the intact rock are the mineral composition, the fabric (anisotropy) and the degree of weathering. Anisotropy is a characteristic of intact foliated metamorphic rocks (slates, gneisses, phyllites, schists).

Rock Mechanics laboratory testing was used to establish the anisotropic behaviour of selected metamorphic rocks. The effect of anisotropy on various mechanical properties (strength, deformation) and dynamic properties (wave velocity) was examined.

The rock samples were also tested at successively higher confining pressures in order to evaluate the effect of anisotropic behaviour at high overburden pressures.

The rocks tested incorporated Athens schist, gneiss and marble possessing different degrees of strength anisotropy. The schist tested is characterized by two types: a) quartzitic, chloritic, micaceous schist and b) chloritic, micaceous schist, possessing a well developed anisotropy due to the presence of foliation planes.

Gneiss is also characterized by two types: a) a coarse-grained micaceous gneiss with well developed banding and b) a medium grained micaceous gneiss with very well developed banding. The marble belongs to the Penteli series (well known for its used in the antiquity for building monuments, e.g. Acropolis) and is characterized by slightly developed anisotropy due to discontinuous layering of dolomite minerals.

The degree of strength anisotropy of the tested rocks rocks was indirectly estimated, by wave propagation through the rock, and thus was classified by means of geological and geotechnical indexes.

The research developed a characterization method of the inherent anisotropy of metamorphic rocks, based on the most widely used laboratory tests for rocks. The proposed classification system was based on data from literature and the results from tests carried out. It took into account the degree of anisotropy as it was determined from:

a) the uniaxial compressive strength, σci,
b) the point load strength, Is50 and
c) the longitudinal wave velocity, Vp.
d) qualitative and quantitative petrographic indexes.

A new anisotropy index for point load strength, determined from diametral tests on oriented core specimens, was also presented.

The indices that have been used for the characterization of anisotropy possess a different classification scale, as they refer to different mechanical properties of intact rock. These properties are influenced to a varying extend by the anisotropic texture of intact rock.

The classification scheme of anisotropic rocks that was proposed, takes into account apart from the fundamental anisotropy indices of mechanical properties, the uniaxial compressive strength, σci, perpendicular to the planes of anisotropy.

Thus, the strength and velocity anisotropy indices are correlated to the uniaxial compressive strength.

The influence of the strength anisotropy of intact rock on the Hoek – Brown criterion parameters (σci, mi and s) was investigated thoroughly for the rocks examined, and was found to be significant. The research resulted in a modification of the criterion by incorporating a new parameter (k), to account for the effect of strength anisotropy, thus being able to determine the strength of intact anisotropic rock under loading in different orientations of the plane of anisotropy. The range of the parameter (k) for the rocks tested has been analytically investigated from triaxial tests, carried out in different orientations of the foliation plane, and suggestions for its determination are made. The proposed modification was studied for metamorphic rocks (gneiss, schist, marble), but could also be applied to other rock types exhibiting "inherent" anisotropy, e.g. sedimentary as well as igneous rocks.

REVIEW OF GEOTECHNICAL EVENTS

THE COMPLETE STOCHASTIC DEAMPLIFICATION APPROACH: AN EFFICIENT TOOL TO DESCRIBE THE SPATIAL VARIABILITY OF EARTHQUAKE MOTION

The lecture was addressed to the students of the postgraduate course on Structural Analysis and Design of the National Technical University of Athens and to the members of HSSMGE by Mounir Khaled Berrah, Professor of Civil Engineering Ecole Nationale Polytechnique of Algeria on the 18th June 2007.

The spatial variability of earthquake ground motion has been recognized as one of the most dangerous phenomena that could lead to the collapse of extended structures. During the last three decades numerous methods have been developed to describe the spatial variability on one hand, and to understand the behaviour of structures under non uniform loads induced by the spatial variability on the other hand. The presentation focused on the first point, i.e., the description of the spatial variability.

Advanced Characterisation of Pavement and Soil Engineering Materials
Athens 20-22 June 2007
www.3dfem.org

More than 300 participants attended the international conference on the Advanced Characterisation of Pavement and Soil Engineering Materials that was held in Athens from the 20th to the 22nd of June 2007. The conference was organised by the National Technical University of Athens (NTUA) in cooperation with the Delft University of Technology and the University of Illinois and was also under the auspices of the International Society for Asphalt Pavements, the International Society for Concrete Pavements and the Hellenic Society for Pavement Engineering Research (HESPER).

About 170 paper contributions from 32 countries that had been accepted after peer review where presented and discussed during the Athens-'07 conference sessions, giving the participants the opportunity to exchange ideas, information on recent developments and research findings in several areas related to road and airport pavements, railway track beds and geotechnical aspects related to these types of transportation infrastructure. More specifically the conference contributions included research and technical presentations on the experimental laboratory material characterization, the finite element modeling and analyses of pavement and soil materials, the constitutive modeling, the subgrade testing and evaluation, the railroad ballast characterization, the non-destructive measurement techniques and several other related aspects.

Contributions and discussion during the Athens-'07 conference sessions indicated that many researchers as well as industry and governmental agencies are currently utilizing advanced experimental techniques and computational tools for the simulation and design of complex soil and pavement systems. It was also remarked that despite this fact, there are still several areas for the extension of the use and the improvement of these techniques and tools. It was also indicated that a prerequisite for an effective utilization of such tools is the close cooperation between various engineering disciplines such as mechanics, materials science, computer and computational engineering sciences.

In addition to the core activities, parallel and pre-conference workshops were organised to provide the opportunity for the exchange of scientific, technical and practical knowledge and experience in the areas of data analyses, water movements in pavements and embankments and pavement recycling. Towards this, the Transportation Research Board's Data Analyses Working Group Forum (DAWG) was held in conjunction with the Athens-'07 Conference and following the DAWG tradition high level unpublished work on data analyses was presented and discussed. Also, the final workshop of the European Cooperation in the field of Scientific and Technical Research (COST) action 351, was organised as a parallel event of the Athens-'07 conference. The workshop included a detailed presentation of the COST 351 work as well as contributions on the role of water presence and movement in pavements and embankments which is a very important topic and received considerable interest by the local and international participants. Finally, in co-operation with the Technical Chamber of Greece (TCG) a pre-conference workshop on pavement recycling was organised on June 19. Due to environmental reasons

recycling becomes an increasing demand also in pavement and railway infrastructure and therefore the presentations of the

local and international experts illustrated the current experience on the subject and the challenges for the future.

In overall the Athens-'07 Conference received very positive comments by both local and international participants which underlined the contribution made towards the establishment of a new generation of soil and pavement engineering design methodologies based on rational mechanics principles in which computational techniques, advanced constitutive models and material characterisation techniques will constitute the backbone of the design process. Especially for geotechnical aspects related to pavement and railway infrastructure, the Athens-'07 conference and parallel events were considered as a complementary, high-level scientific and technical extension of the successful international seminar on Geotechnics in Pavement and Railway Design and Construction that was held in Athens on 16-17 December 2004 and was co-organised by the ISSMGE/TC3, the NTUA and the HESSMFE.

Athens July 2007, Andreas Loizos, Chairman of 3dfem.

4TH INTERNATIONAL CONFERENCE ON EARTHQUAKE GEOTECHNICAL ENGINEERING
www.4icege.org

The Fourth International Conference on Geotechnical Earthquake Engineering was held in Thessaloniki – Greece, from 25-28 June 2007. The Conference was organized by the Technical Committee of Earthquake Geotechnical Engineering (TC4) of the International Society of Soil Mechanics and Geotechnical Engineering (ISSMGE), the Hellenic Scientific Society of Soil Mechanics and Geotechnical Engineering and Aristotle University of Thessaloniki - Laboratory of Soil Mechanics, Foundation and Geotechnical Earthquake Engineering. More than 600 participants attended the Conference from 47 countries. The attendees included a vast majority of world experts in soil dynamics, earthquake engineering, geotechnical engineering, earthquake geotechnical engineering and other related topics.

Opening ceremony. From left: Prof. K. Ishihara, Prof. K. Pitilakis, Chairman of 4ICEGE, Prof. P. Seco e Pinto, President of ISSMGE, Prof. T. Kokusho Chairman of TC4, Prof. A. Ansal, Co-chairman of TC4.

The conference covered numerous state-of-the-art topics. In 4ICEGE THESSALONIKI 2007 earthquake and geotechnical engineers, geologists and seismologists, researchers, academia and professional engineers from all over the world found an excellent forum for sharing and discussing the most recent

View of the main hall in the opening ceremony

advances in soil dynamics, earthquake and geotechnical engineering, as well as their interaction with geology and engineering seismology. Twenty invited keynote and theme lecturers were presented and discussed recent and ongoing developments, addressing unresolved issues and projecting ideas for the future.

The second Ishihara Lecture was delivered by Professor Izzat M. Idriss of the University of California at Davis (UCD) on the SPT- and CPT-Based procedures for estimating residual strength of liquefied soils. Keynote lectures were given by Professors D. Muir-Wood (UK), E. Faccioli (Italy), G. Gazetas (Greece), R. Dobry (USA), S. Iai (Japan), and Professor Th. O' Rourke (USA). State of the art and theme lectures were delivered by Professors T. Kokusho (Japan), A. Ansal (Turkey), K. Stokoe (USA), F-J. Chavez-Garcia (Mexico), M. Pender (New Zealand), G. Bouckovalas (Greece), P. Dakoulas (Greece), R. Boulanger (USA), J. Bray (USA), I. Towhata (Japan), A. Kiremidjian (USA), S. Yasuda (Japan), R. Paoluci (Italy) and K. Pitilakis (Greece). Invited lectures were also given by Professor M. Jamiolkowsky (Italy) on the Behavior of the leaning Tower of Pisa after stabilization works and by Professor R.Seed (USA) on Lessons from disaster: New Orleans and hurricane Katrina.

From left: Prof. I. Idriss, Prof. T. Kokusho, Prof. K. Pitilakis, Prof. K. Ishihara, Prof. A. Ansal.

420 papers from 40 countries, including Albania, Algeria, Argentina, Austria, Bangladesh, Belgium, Canada, Chile, China, Colombia, Croatia, Czech Republic, Egypt, France, FYROM, Germany, Greece, India, Iran, Israel, Italy, Japan, Jordan, Korea, Lebanon, Mexico, Netherlands, New Zealand, Pakistan, Portugal, Romania, Russian Federation, Singapore, Slovenia, Switzerland, Taiwan, Turkey, United Kingdom, United States and Venezuela, have finally been accepted for publication after a thorough reviewing process. They were presented and discussed in the following 12 oral and poster sessions: (1) Soil Dynamics I, (2) Seismic Hazard, Wave Propagation and Strong Ground Motion, (3) Soil Dynamics II, (4) Site Effects and Microzonation, (5) Foundations and Soil-Structure Interaction I, (6) Dynamic Analysis of Structures and Performance of Soil-

Structure Systems, (7) Foundations and Soil-Structure Interaction II, (8) Slopes, Embankments, Dams and Earth-Structures, (9) Retaining Structures, (10) Seismic Design of Infrastructures, Vulnerability, Codes, (11) Soil Liquefaction and Countermeasures and (12) Lifelines and Underground Structures. One third of the papers have been presented orally and the rest in special poster sessions. Poster papers have been summarized and discussed by the panellists of the sessions.

Prof. K. Pitilakis (right), Chairman of the 4ICEGE receives the symbol of ICEGE from Prof. R. Seed (left), Chairman of the 3ICEGE.

Four workshops on selected topics of particular engineering and societal interest included in parallel sessions on the fourth day of the conference and followed by round table discussions, aiming to broaden the horizons of the earthquake and geotechnical engineering community, to discuss specific important subject of professional interests and to reinforce cooperation links: The titles of the workshops are following:

- Workshop 1: "Large scale facilities, geotechnical strong ground motion arrays and experimental sites", coordinated by Professor Ahmed Elgamal (USA).
- Workshop 2: "Geotechnical earthquake engineering related to monuments and historic centres", coordinatated by Professor Kyriazis Pitilakis (Greece) and Dr. Christos Tsatsanifos (Greece).
- Workshop 3: "Recent advances in codes", coordinated by Professor A. Pecker (France).

From the Gala Dinner

- Workshop 4: "How can earthquake geotechnical engineering contribute to safer design of structures to resist earthquakes?", coordinated by Professor P. Seco e Pinto, President of ISSMGE (Portugal).

The plenary meeting of TC4 was held in Thessaloniki where the chairmen of TC4 Professors T. Kokusho and A. Ansal presented the progress report on the past activities. Professor R. Verdugo from Chile presented the candidacy of Santiago in Chile for the next 5th International Conference on Earthquake Geotechnical Engineering which has been voted in unanimity.

On the occasion of 4ICEGE a special session was also devoted to the Annual Shamsher Prakash Research Awards. The winners were Jonathan Stewart (USA) and Mitsu Okamura (Japan).

A commercial exhibition displayed some of the most important and active companies with geotechnical equipment and services available for researchers and professional engineers.

The proceedings of the conference include (a) a book published by Springer (ISBN 978-1-4020-5892-9) containing the invited keynote and theme lectures, (b) an abstract volume and a CD-ROM with the 420 papers of the conference, and (c) an extra CD-ROM with papers of the workshops, and other delayed papers.

Closing ceremony. From right: Prof. A. Ansal, Prof. T. Kokusho, Prof. P. Seco e Pinto, President of ISSMGE, Prof. K. Ptilakis, Chairman of 4ICEGE, Prof. Verdugo, Chairman of 5ICEGE, Prof. R. Seed, Chairman of 3ICEGE.

From the Gala Dinner

In summary the conference was a very successful event of worldwide importance. Further information are available at www.4icege.org

Thessaloniki July 2007, Kyriazis Pitilakis, Chairman of 4ICEGE

FORTHCOMING GEOTECHNICAL EVENTS

Annual Conference

Dam Safety 2007
www.damsafety.org

The conference is organized by the Association of State Dam Safety Officials and will be held at Austin, Texas, USA, on Sunday 9 September 2007.

For more information see the previous issues of the NEWS.

reliability.geoengineer.org/4DPR

All enquiries should be addressed to

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Email: geoconfina@yahoo.com
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Email: anidimas@yahoo.com

ASSOCIATED RESEARCH CENTERS FOR URBAN UNDERGROUND SPACE
ASSOCIATION DES CENTRES DE RECHERCHE SUR L' UTILIZATION URBAINE DU SOUS-SOL

11th ACUUS Conference "Underground Space: Expanding the Frontiers"
www.acuus2007.ntua.gr

The conference will be held from 10 to 13 September 2007 in Athens. It is organized by ACUUS (Associated Research Centers for Urban Underground Space) and the Laboratory of Mining and Environmental Technology of the School of Mining and Metallurgy of the National Technical University of Athens.

For more information see the previous issues of THE NEWS or contact the conference secretariat:

Athanasios Mavrikos
9 Iroon Polytehniou Street, 15780 ZOGRAFOU, ATHENS
Tel. 210.7722190
Fax. 210.7722156
Web : http://www.acuus2007.ntua.gr/
E-mail : contact@acuus2007.ntua.gr

Euro: Tun 2007
Computational Methods in Tunnelling
eurotun.tuwien.ac.at

The conference will be held on 17 – 19 September 2007 in Vienna and it is organised by the Vienna University of Technology.

For more information see the previous issues of THE NEWS.

14th German Dam Symposium and the 7th ICOLD European Club Dam Symposium
www.conventus.de/talsperre

The German National Committee on Large Dams is organising the 14th German Dam Symposium and the 7th ICOLD European Club Dam Symposium from 17–19 September 2007 in the historic diocesan and university town of Freising near Munich.

For more information see the previous issues of THE NEWS or contact the conference organizer:

German National Committee on Large Dams
Kronprinzenstraße 37
45128 Essen, Germany

Conference Organisation & Registration
Conventus Congressmanagement & Marketing GmbH
Jana Radoi
Markt 8
07743 Jena, Germany
Phone +49 3641 35 33 221
Fax +49 3641 35 33 21
E-mail talsperre[at]conventus.de

www.ta-mir.org

The symposium is organized by the YILDIZ TECHNICAL UNIVERSITY RESEARCH CENTER for PRESERVATION of HISTORICAL HERITAGE at Antalya, Turkey, from 17 to 21 September 2007.

More information in the previous issues of THE NEWS and from: F. Aköz, Yıldız Technical University, Research Center for Preservation of Historical Heritage, 34349 Yıldız, Istanbul, Turkey, Tel : + 90 212 2612004, Fax : + 90 212 2585140, e-mail : shh07@yildiz.edu.tr.

XIV European Conference on Soil Mechanics and Geotechnical Engineering
www.ecsmge2007.org

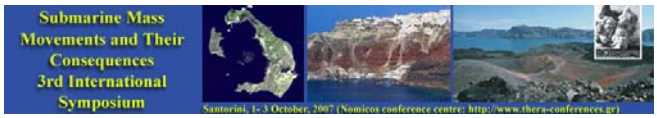
The conference will be held in Madrid, Spain on 24 – 27 September 2007. It is organised by the Spanish Society for Soil Mechanics and Geotechnical Engineering. The general theme of the conference is «Geotechnical Engineering in Urban Environments».

For more information see the previous issues of THE NEWS.

7th International Symposium on Field Measurements in Geomechanics
www.fmgm.org

The conference will be held in Boston, Massachusetts during **September 24-27, 2007**. It will showcase professionals, equipment, methods, and organizations associated with making field performance measurements to help manage risks in the design, construction and operation of engineered facilities.

For more information see the previous issues of THE NEWS.



1 – 3 October 2007, Santorini, Greece

Objectives of the conference:

Submarine landslides pose a major threat to infrastructure in ocean margins, but also to human life in coastal areas. Mitigation measures can be better established when we comprehensively understand the full set of processes that take place during sediment failure. Their resulting scars and deposits also induce the formation of specific benthic habitats and impose constrains for offshore development.

The conference will review the state of the art in risk evaluation from submarine landslides, deposit characterization and its implication for coastal and offshore development. The conference attempts to bring together professionals from the industry and academia with a range of different expertise to cover the full spectrum of aspects related to submarine landslides. The interdisciplinary view of submarine landslides arising from the conference will help to identify future challenges, mitigation strategies and better management of the seafloor.

Conference themes:

- New techniques for studying submarine slides
- Role of submarine slides in margin configuration
- Mass waste evolution: From slump to distal turbidites
- New approaches on slope stability analysis
- Monitoring stress on submarine slopes and sediment physical properties
- Submarine slides in volcanic island settings
- Mass movements and tsunamis
- Impact of mass failures to benthic ecosystem
- Impact of mass movements on seafloor structures
- Present and new challenges in submarine slide studies and main focus for the upcoming years
- Mass transport deposits: Its role in offshore hydrocarbon field development
- Risk and mitigation

Contact persons:
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Paraskevi Nomikou evi@ath.hcmr.gr

Richard Widmann Colloquy
56th Geomechanics Colloquium 2007
www.oegg.at

The conference is organized by the Austrian Society for Geomechanics in Salzburg, Austria, on 11 and 12 October 2007.

Information from: salzburg@oegg.at.

www.sardiniasymposium.it/SARDINIA_eng/index_eng.html

The symposium will be held in the Forte Village Resort, near S. Margherita di Pula, at the south cost of Sardinia, within thw context of the Biennial International Symposia in Sardinia, started in 1987.

For more information see the previous issues of THE NEWS.

NEW APPROACHES FOR A NEW ERA
www.hydropower-dams.com

The conference is organized by the journal HYDROPOWER & DAMS at Granada, Spain, from 15 to 17 October 2007.

Information from: Mrs Margaret Bourke, Aqua~Me-dia International, Westmead House, 123 Westmead Road, Sutton, Surrey SM1 4JH, UK. Fax: + 44 20 8643 8200. Email: mb@hydropower-dams.com.

ISGSR2007

First International Symposium on Geotechnical Safety & Risk
www.isgsr.org

The symposium is organized by the Tongji University and the Geotechnical Safety Network (GEOSNet) from 18 to 19 October 2007 at Shanghai, China.

Infromation from: Dongmei Zhang ή Qunfang Hu, Department of Geotechnical Engineering, Tongji University, 1239 Siping Road, Shanghai 200092, China, Tel: 86-21-65982986 Fax: 86-21-65982986 E-mail: dmzhang@mail. tongji.edu.cn (Dongmei Zhang), huqunf@mail.tongji.edu.cn (Qunfang Hu) isgsr2007@gmail.com.

5th International Symposium on Roller Compacted Concrete (RCC) Dams
www.chincold.org.cn

RCC technology has been applied in dam construction for about 30 years in the world. In order to celebrate its application and follow those successful and fruitful Symposiums held in Beijing (China) in 1991, Santander (Spain) in 1995, Chengdu (China) in 1999 and Madrid (Spain) in 2003, the 5th INTERNATIONAL SYMPOSIUM ON ROLLER COMPACTED CONCRETE (RCC) DAMS will be held in Guiyang, China on November 2~4, 2007.

The topics of the symposium are:
1. Background and new trends in RCC dams (case histories, experiences and scenarios in different countries)
2. High RCC dams: Gravity and arch dams (design, materials, thermal considerations, mixture proportions)
3. Construction of RCC dams (quality control, equipments, innovations)
4. Performance, monitoring and rehabilitation of RCC dams (performance, monitoring and evaluation, rehabilitation)
5. RCC in other hydraulic structures and upgrading (coffer dams, upgrading work, others)
6. CSG and its application (design, construction, performance)

Secretariat:
Ms. Zhongli MA, Mrs. Yulan YUAN
Secretariat of RCC 2007
Chinese National Committee on Large Dams
20 West Chegongzhuang Road, P.O. Box 366, Beijing 100044, P. R. China
Tel: +86-10-68435228, Fax: +86-10-68712208
Email: chincold@iwhr.com;mazhongli@126.com

Workshop

The GGOS Contribution to GEOSS and an Observing System for Geohazards and Disaster Prevention

November 5-6, 2007, Frascati, Italy
earth.esa.int/workshops/2007Geohazards/

Workshop Background and Objectives

The *Global Geodetic Observing System* (GGOS) of the *International Association of Geodesy* (IAG) is coordinating the geodetic support for the Earth sciences. Building upon the work of the IAG Services, GGOS provides the geodetic infrastructure necessary to support the monitoring of the Earth system and global change research. It is integrating the three pillars of geodesy, that is geometry and kinematics, Earth orientation and rotation, and gravity field and dynamics, in order to maximize the benefit for the scientific community and society in general.

With the global geodetic reference frames and observations of the variations in the Earth's shape, gravity field, and rotation, GGOS provides fundamental contributions to the *Global Earth Observation System of Systems* (GEOSS). In a detailed strategy process carried out in the frame of the GEO Work Plan (Task AR-07-03), GGOS is currently developing the plan for a geodetic observing system that will meet future requirements not only of GEOSS but also of science and society in general. To a large extent, the Workshop will be based on the results of the strategy process and discuss steps towards the implementation of the recommendations given in the strategy report.

The 2007 GGOS Workshop is integrated into the Internatio-nal Geohazards Week 2007. The GGOS Workshop is intended as an outreach activity of GGOS to both the space agencies and users. The Workshop will discuss the current and future contributions of GGOS to Earth observations and, in particular, an observing system for geohazards applications. The Workshop will be organized to help facilitate the communication between scientific user communities and those who will provide the geodetic products. Therefore, the Workshop will be held in conjunction with the Third International Geohazards Workshop, organized by the IGOS-P Geohazards Theme, which will take place after the GGOS Workshop.

Workshop Venue

Both Workshops will take place at ESRIN in Frascati, Italy. More information on the venue is available through the offical web page of the International Geohazards Week.

Workshop Program

The Workshop Program is organized in three main sessions:

- Session 1: Observing changes in Earth's shape, rotation and gravity field with an integrated observing system;
- Session 2: Understanding the Earth system: The contribution of GGOS;
- Session 3: GGOS and Geohazards.

The Spanish Tunnelling Association (AETOS) has undertaken to organize an International Tunnelling Congress in Madrid on the 5th, 6th and 7th of November 2007.

The Congress, which shall bear the title "Tunnels, drivers of change", will serve as a showcase to present not only the projects under construction in our country, i.e. the underground networks of Madrid, Barcelona, Bilbao, Seville..., high-speed train tunnels, Madrid ring-road (M-30), etc... but also projects currently under way in the countries co-sponsoring the event together with AETOS, i.e. France, Switzerland and Italy.

The Working Program will consist of four sessions that will cover all the different topics related with tunnelling, and particularly the new technologies and innovations that have contributed to the advancement of our field.

A direct consequence of the increase in the standard of living of developed countries is the sharp increase in mobility, which results in an increasing degree of overcrowding on the existing road networks. Given the ever-growing limitations on surface occupation, future society's sustainable development increasingly entails resorting to underground urbanism for the transport of people, goods and services. So much so that in the last decade underground construction technology made it possible to put into operation significant urban and intercity tunnel connexions both for road and railway infrastructures, removing physical barriers to movement and thereby transforming the social landscape.

These projects involve significant and formidable challenges since, with the development of tunnel engineering, it is now possible to conceive deeper and longer base tunnels running through mountain ranges and to consider it less of an obstacle for tunnels with thinned-out top vaults to pass through densely built-up areas. These challenges have created a new playing field that requires a transformation of technology. For that reason, AETOS, in collaboration with its sister organisations in France (AFTES), Italy (SIG) and Switzerland (SIA/GTS) has decided to organise its next International Congress of 2007 in Madrid. The topics to be covered shall be grouped into four sessions each of which will reflect the new challenges posed:

- Tunnels: drivers of change. Influence of underground connections on socioeconomic development. Mitigating the impact of the works on the existing built-up areas. Assessment of the environmental benefits.
- Planning, feasibility and new financing systems. Specificity of underground works as regards their potential risks and their influence on cost planning. Economic advantage of an equitable distribution of costs. Importance of planning to react promptly to unforeseeables.
- Technological advances and innovation. How the new challenges are changing technology. Innovations that make it possible to solve difficult situations. Improvements in the performance of construction processes.
- Operation and safety. Equipment and design features that optimize operational safety. Importance of the legislative changes at European level.

GEOTECHNICAL ENGINEERING CONFERENCES OF TORINO (ITALY)
21ª EDITION - 27th AND 28th OF NOVEMBER 2007

GEOSYNTHETICS and ENVIRONMENT

POLITECNICO DI TORINO - AULA MAGNA
CORSO DUCA DEGLI ABRUZZI, 24

www.cgttorino.org/uk/default.asp

Considering the last 25 years, it is well known that the most interesting and original products, projects and developments, in the Geotechnical Engineering field, have mostly come about through the introduction of geosynthetics and geocomposites for the environmental protection and reclamation of land and the subsoil.

The aim of the 21st edition of the Geotechnical Conferences of Torino (CGT) is to provide both an occasion for updating the general framework on this topic through the contributions of some of the most outstanding experts at a national and international level and an opportunity for an extensive discussion concerning the future developments of this specific field involving the representatives of universities, institutions, manufacturers, designers and users.

Two working days are planned: the first is devoted to landfills and the second to the control and reclamation of polluted subsoils. Attention will be paid in particular to the following subjects:

- Geosynthetics and geocomposites for drainage and barriers used within lining and capping systems for landfill facilities, including issues about the short and long term behaviour and a performance comparison with traditional materials in the light of the requirements of the National and European norms. Moreover, the problems related to geosynthetic and geocomposite applications in steep slopes and/or on very compressible foundation materials will also be analysed. Finally, rather recent products, such as geotextile containment units for dewatering, confinement and mechanical reinforcement of mining and industrial by-products, will be illustrated.

- Lateral containment and control of subsoil pollutants using drainage trenches and composite cut-off walls. Composite capping systems, for sea, river and lake bottoms, adopted as safety measure in the presence of polluted deposits consisting of industrial and harbour sludges. Flushing and extraction systems for liquid and gaseous pollutants e.g. capping systems for vacuum extraction of volatile contaminants, electrokinetics prefabricated band shaped drains for the extraction of ionic contaminants in solution, prefabricated-separated vertical drains for dry air circulation in order to enhance the dehydration of natural fine grained soil formations and in turn the extraction of solute pollutants.

The final lecture of the 21st edition of CGT will be devoted to the design and execution aspects of retaining structures, embankments, dams, levees and other constructions for the con-

trol of superficial water that very often must be able to resist extreme actions due hurricanes, earthquakes, and other catastrophic events.

The lecture by professor David Daniel, who is the chair of ASCE's Review Panel for the performance evaluation of the hurricane protection system in New Orleans before and after the Katrina hurricane disaster, will be devoted in particular to the main Geotechnical issues highlighted in the most damaged areas in south-eastern Louisiana and to the relative solutions that foresee an appropriate use of geosynthetics and geocomposites.

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International Conference on
Ground Anchorages and Anchored Structures
in Service 2007
ice.org.uk

The conference is organized by the British Geotechnical Association / Institution of Civil Engineers of U.K. on November 2007 at London.

Infromation from Jade Donovan, Societies Administrator, Engineering, Policy & Innovation, Institution of Civil Engineers, One Great George Street, Westminster, London SW1P 3AA, tel. +44 (0) 207 665 2233, fax. +44 (0) 207 799 1325, e.mail jade.donovan@ice.org.uk

5th Internatinal Conference on
Earth Reinforcement
- New Horizon in Earth Reinforcement
www.nda.ac.jp/cc/users/miyamiya/is-kyushu07

The conference will be held from 14 to 16 November 2007 at Fukuoka, Ιαπωνία. It is organized by the Japanese Geotechnical Society (JGS) and the Technical Committee for Ground Improvement of ISSMGE (TC-17).

For more information see the previous issues of THE NEWS.

SOCIÉTÉ INTERNATIONALE DE MÉCANIQUE DES SOLS ET DE LA GÉOTECHNIQUE
INTERNATIONAL SOCIETY FOR SOIL MECHANICS AND GEOTECHNICAL ENGINEERING
Groupe National du Cameroun Cameroon National Group
14ème Congrès Régional Africain de Mécanique des Sols et de Géotechnique
26-30 novembre 2007, Yaoundé
14th African Regional Conference for Soil Mechanics and Geotechnical Engineering
Yaounde, 26-30 November 2007

www.cra-yde-2007.org.cm/

The conference aims at offering to academics and practitioners in geotechnical engineering an opportunity to share information on the latest developments in research and the state of the art in practice. This conference will be an important event, for updating the knowledge of the participants in particular for problems specific to African countries. The Conference will include oral presentations, discussion sessions, poster sessions, continuing education sessions and an exhibition.

The general theme of the Conference is: The soils of Africa. The organisers have selected six themes for the conference:

Theme 1: Characterization and mapping of African soils (Inventory, regional synthesis, and characterisation of African soils including methods of predicting their performance).

Theme 2: Appropriate construction methods for typical African soils (The influence of soil type (including laterites, calcareous soils, dune sands, expansive soils, collapsible sands, soft soils, fill, etc) on construction techniques (including construction of shallow foundations, embankments and dams, excavation, piling, grouting, compaction, improvement, etc.)).

Theme 3: Geotechnical preservation of monuments and sites

Theme 4: Environmental geotechnical engineering (Offshore environment and difficult ground conditions. Degradation of the environment, as related to the behaviour of soils and the design of structures).

Theme 5: Geotechnical case histories in Africa (Case histories of interesting / unique geotechnical projects (both successes and failures) in Africa with particular regard to dealing with local soil conditions and application of solutions appropriate to African conditions).

Theme 6 : Professional practice and geotechnical education in Africa

www.set.ait.ac.th/acsig/conference

For information see the previous issues of the NEWS and from: Prof. Dennes T. Bergado, ACSIG Director, bergado@ait.ac. th, Sonny Montalbo, Manager, acsig@ ait.ac.th, Cheryl Esin, Program Assistant, esin@ait.ac.th, Orfa Kidweng, Research Assistant, igs-thailand@ait.ac.th.

Problems associated with natural hazards, particularly earthquakes, in India and across the world are quite high. Extensive research is being carried out on prediction of earthquake hazards and its mitigations at global level in the last few decades. Several seminars, symposiums, workshops and conferences are being organized at national and international levels regularly to share recent experiences and research findings among the academicians, design consultants and practicing engineers. However, the natural hazards, particularly every earthquake teaches a new lesson; causes severe problems; imposes new challenge and thus it is very important to exchange the present state of knowledge in a regular fashion and to promote different technologies in mitigating natural disasters, particularly the earthquakes. In this vein, an International workshop is planned to be organized on "Earthquake Hazards and Mitigations", at Indian Institute of Technology Guwahati, Guwahati, Assam in 7-8 December 2007.

THEMES:

- Engineering seismology
- Strong ground motion and site effects
- Seismic hazard assessment
- Geotechnical Engineering
- Structural Engineering
- Lifeline systems
- Nonstructural components and contents
- New design criteria and methods for earthquakes
- Advanced technologies: structural control, smart materials/structures, and health monitoring
- Earthquake engineering practice: recent projects, design, and construction
- Performance based design
- Earthquake loss estimation: vulnerability analysis, risk assessment and management
- Earthquake risk reduction
- Numerical Methods in Earthquake Engineering
- Lessons from recent earthquakes and tsunamis
- Others: socio-economic impacts, seismic awareness, preparedness, recovery and education, earthquake-induced fire

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2007 International Forum on Landslide Disaster Management
10 - 12 December 2007
University of Hong Kong

www.hkieged.org/LDM2007/forum.htm

Organized by the Hong Kong Institution of Engineers, the Hong Kong Geotechnical Society and the Geotechnical Engineering Office of CEDD, Hong Kong SAR Government, under the auspices of the Joint Technical Committee on Landslides and Engineered Slopes (JTC-1) of ISSMGE, ISRM and IAEG, this Forum is one of the activities that marks the 30th anniversary of landslide disaster management in Hong Kong. This high-level Forum provides a platform for the leading experts and key landslide risk managers round the globe to share their experience and thoughts on the state-of-the-art of selected subjects. Highlights include presentation of country/regional reports on landslide risk management, advances in digital technology in slope engineering and benchmarking exercise for landslide debris mobility modelling. All participants will be by invitation only.

For information contact Ken Ho (kenho@cedd.gov.hk)

www.13arc2007.com

Geotechnics for Infrastructure and Development has been chosen as the theme of the conference. This will be covered through fourteen topics covering the thrust areas of geotechnical engineering, viz.

1. Characterisation of soils (laboratory and field testing methods)
2. Tropical and problematic soils (expansive soils, volcanic and collapsible soils)
3. Foundations and soil – foundation interaction (shallow and deep foundation, retaining structures)
4. Geotechnics for transportation and infrastructure (embankments on soft ground, highway and railway subgrades)
5. Underground construction in urban areas (deep excavation, stability of adjacent structures)
6. Rock engineering and tunneling (rock characterization, rock excavations and tunnelling)
7. Dam engineering (earth and rockfill dams, tailing dams)
8. Geotechnical earthquake engineering (ground response analysis, liquefaction)
9. Geoenvironmental engineering (landfills, liners and covers, effects of contaminants and remediation, industrial waste utilization)
10. Ground improvement (land reclamation, mechanical and chemical techniques)
11. Natural disaster mitigation and management (landslides and erosion control, waterways and coastal protection)
12. Geosynthetic and natural fibres (geosynthetic applications, jute and natural fibres)
13. Failure investigation and case histories (instrumentation and monitoring, case studies)
14. Expert systems and neural network

There will be five plenary sessions, each with two keynote speakers presenting the state-of-the-art on important thrust areas of geotechnical engineering: Soil Properties and Characterization, Physical Modelling, Slope Stability and Landslides, Ground Improvement, Soil Structure Interaction, Geo-Environment, Seismic Hazard Analysis and Site Characterization, Geosynthetics and Natural Fibers, Tunneling in Rock.

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www.thinkdeep.nl

The international symposium on Underground Space Challenges in Urban Development will be held on Monday 28 January and Tuesday 29 January 2008. On Wednesday 30 January 2008 a Project Visits Day will be organised as part of the 'Underground Space Week'. Symposium participants can also take part in this unique tour of the Amsterdam North-South Underground Line Development. This project not only illustrates the opportunities underground space development has to offer, but also the technological challenges that need to be met when constructing such a project in a densely populated and partly historical city environment.

Within these topics the following themes will be addressed:

- Opening session with keynotes on: the challenge of urbanisation for planners and engineers
- Session A: Underground Space Planning & Use: the challenge for planners
- Session B: Underground Space Planning & Use: the climate change challenge
- Session C: Underground Space Planning & Use: successful urban underground projects
- Session D: Underground Space Construction: tunnelling in an urban environment – case studies
- Session E: Underground Space Construction: services & utilities – case studies & research
- Session F: Underground Space Construction: urban underground facilities – cases studies
- Session G: Underground Space Planning & Use: safe and secure underground space use

GEOAMERICAS 2008 - THE FIRST PAN AMERICAN GEOSYNTHETICS CONFERENCE AND EXHIBITION
2-5 MARCH 2008
HILTON CANCÚN BEACH & GOLF RESORT · CANCÚN, MEXICO

www.geoamericas.info

The conference is organized by the International Geosynthetics Society (IGS), North American Geosynthetics Society (NAGS), IGS Peru and IGS Brasil from 2 to 5 March 2008 at Cancun, Mexico.

For more information see the previous issues of THE NEWS.

www.geocongress.org

The conference is organized by the Geo-Institute of ASCE at New Orleans, Louisiana, USA, from 9 to 12 March 2008.

For more information see the previous issues of THE NEWS.

ICGE'08

March 28 - 30, 2008 Tunis, Tunisia

INTERNATIONAL CONFERENCE ON GEOTECHNICAL ENGINEERING

www.enit.rnu.tn/fr/manifestations/ICGE08/index.html

It can be observed in many countries around the world that geotechnical engineering is often oversimplified. It is quite true, that experience is an important factor in soil and rock engineering projects, but a sound engineering approach always should accompany design and construction.

Geotechnical Conferences have become the traditional and mandatory meetings for researchers, engineers and practitioners in this field. This has been in keeping with the advances made in the science and technology of soil and rock mechanics, geological engineering over several decades. The Unité de recherche en Ingénierie Géotechnique recognizes the need of sharing and disseminating the technical knowledge in the field of rock and soil mechanics, engineering geology and geophysics.

During the Conference several topics related to design, testing, construction, monitoring, and maintenance will be addressed.

The meeting itself is designed to represent the World Forum for presentation and publication of technical contributions to the broad subjects of rock and soil mechanics. As an international event, it also provides a unique opportunity to guide researchers in relevant directions of both applied and theoretical research and forms a forum for exchange of experience and information about practical and technical aspects.

Soil improvement
Reinforcement by stone columns, Geosynthetics, Vertical drains. Deep Mixing. Design methods. Case histories. Vacuum consolidation.

Soil Behaviour and Foundations
Soft clays. Swelling soils. Deep foundations, Shallow foundations, Constitutive laws. Experimental studies. Numerical analyses.

Analysis and management of Seismic Risk
Site effect. Seismic Hazard. Seismic induced effects: landslides, liquefaction, building vulnerability.

Rock mechanics
Design, monitoring of Underground Structures - Support Methods ahead of the Tunnel Face - Determination of Rock Mass Properties - Optimization of cutting and blasting techniques - Influence of rock parameters on performance – Blast-induced vibration and damage - Numerical Modelling.

Conference Secretariat
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3rd International Conference on Site Characterization
1 - 4 April 2008, Taipei, Taiwan

The conference is organised by TC16.
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VI International Symposium
Geotechnical Aspects of Underground Construction in Soft Ground – IS - Shanghai 2008
www.tc28-shanghai.org

The symposium will be held at Shanghai, China on 10 – 12 April 2008 and it is organized by the Tongji University and with the aid of the Hong Kong Geotechnical Society, Geotechnical Division, Hong Kong Institution of Engineers, Hong Kong University of Science and Technology, China Civil Engineering Society, Chinese Society for Rock Mechanics and Engineering, Shanghai Society of Civil Engineering under the auspicies of the International Society of Soil Mechanics and Geotechnical Engineering (ISSMGE) TC28 Committee on Underground Construction in Soft Ground.

Information from the symposium secretariat:

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18 – 22 May 2008, Sacramento, Ca., USA
content.asce.org/conferences/geesd08/nees.html

GEESD IV is the 4th decennial Geotechnical Earthquake Engineering and Soil Dynamics Conference organized by the EESD Committee of ASCE's Geo-Institute. GEESD IV follows the highly successful GEESD conferences in Seattle, Washington (1998), Park City, Utah (1988), and Pasadena, California (1978).

GEESD IV will bring together the broad community of geo-professionals working on earthquake engineering and soil dynamics problems for this comprehensive decennial examination of our technical disciplines. The coverage will be diverse, including case histories and practice-oriented papers, recent research findings, innovative technologies, and the emerging arts across many of our disciplines. Professional engineers, researchers, specialty contractors, regulators, educators, and students will interact across a broad range of technical sessions, tutorials, short courses, discussions, and equipment demonstrations.

Conference Format

The four-day conference will include 2-5 Technical Short Courses/Workshops, 3 Plenary Sessions, 27 Concurrent Technical Sessions, 5 Tutorials, a Poster Session, an Exhibition, a NEES Equipment Demonstration, and Technical Field Trips. Additional events intended for renewing acquaintances and meeting new colleagues, will include a Welcome Reception, a Networking Reception in the exhibit hall with posters, and a Gala Banquet.

2nd International Conference on Geotechnical Engineering for Disaster Mitigation and Rehabilitation
www.geohohai.com/news/english/2008/1.shtml

Under GEDMAR08's main theme – enhancing disaster mitigation and rehabilitation capabilities through research and development, proposed sub-themes may include but are not limited to:

1. Case histories on recent and past natural disasters (earthquake, tsunami, landslide)
2. Mechanisms of natural and coastal disasters (soil dynamics, liquefaction, geological and environmental factors, earthquake analysis and modeling, sub-aerial and submarine landslides, seismic ground motions)
3. Disaster mitigation and rehabilitation techniques (difficult soils, ground treatment, design against earthquake and other natural disasters, coastal protections)
4. Risk analysis and geohazard predictions (risk mapping, consequence evaluation, reliability analysis)

For more information see the previous issues of THE NEWS.

FIRST INTERNATIONAL CONFERENCE on EDUCATION and TRAINING in GEO-ENGINEERING SCIENCES:
Soil Mechanics and Geotechnical Engineering, Engineering Geology, Rock Mechanics
Constantza - Romania, 2 - 4 June 2008

www.ppm.ro/srgf

On 12 - 14 June 2000 the Romanian Society for Soil Mechanics and Geotechnical Engineering organized in Romania the First International Conference on Geotechnical Engineering Education and Training. Having in view the great success of that Conference, which brought to Romania teachers and other professionals from 37 countries and 6 continents, and also as important developments have since occurred in higher engineering education around the world, the Romanian Society was preparing to host in 2008, with the endorsement of ISSMGE, another Conference of the same kind, shifting only the venue from Sinaia, a most picturesque resort at the foot of the Carpathians Mountains, to Constantza, the large harbour, but also resort town on the Black Sea coast. During the first meeting in Nottingham, UK, in September 2006, of the Joint Technical Committee no.3 on Education and Training of the three sister geo-engineering societies: - ISSMGE - the International Society for Soil Mechanics and Geotechnical Engineering, IAEG - the International Association of Engineering Geology and the

Environment and ISRM - the International Society for Rock Mechanics - it was decided to widen, for very comprehensible reasons, the scope of the Conference to: "Education and Training in Geo-engineering Sciences: Soil Mechanics and Geotechnical Engineering, Engineering Geology, Rock Mechanics" Thus, for the first time, teachers from all over the world, sharing their interest, commitment and passion for geo-engineering ("engineering with, on or in geological materials", to use a lapidary formula given in a recent document describing and defining the cooperation between IAEG, ISRM and ISSMGE) will have the opportunity to meet and discuss the many challenges faced by the education and training in their field. To them, but also to all members of the three sister societies, a warm invitation is extended to attend the "First International Conference on Education and Training in Geo-engineering Sciences: Soil Mechanics and Geotechnical Engineering, Engineering Geology, Rock Mechanics", Constantza, Romania, 2 - 4 June 2008.

Conference topics

Topics for papers and workshops include, but are not limited, to:

- Curricular matters in geo-engineering education:
  - o first and second cycle degree programmes
  - o integrated programmes
  - o impact of the Bologna process
  - o curricula requirements for areas others than the area of prime specialization
  - o competences-oriented approach in the curricula design
  - o non-formal education

- Teaching, learning and assessment in geo-engineering education
  - o information and communication technologies
  - o multi-media tools
  - o web lab systems
  - o examination and evaluation procedures
  - o e-Learning and distance learning
  - o project-based, problem-based education
  - o case studies

- Issues in geo-engineering education of major relevance for Europe and beyond
  - o credits transfer and accumulation
  - o systems of quality assurance and accreditation
  - o students mobility
  - o Erasmus Thematic Networks, other international networks, Erasmus Mundus projects

- The challenge of research and the geo-engineering education
  - o undergraduate students and research
  - o master students and research
  - o doctoral and post-doctoral studies

- The link university - professional world in geo-engineering
  - o requirements of the industry
  - o assessment by the industry
  - o professional recognition
  - o training of young engineers
  - o continuous professional development, e.g. implementation of Eurocode 7, and the role of universities
  - o international geo-engineer

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DEVELOPMENT OF URBAN AREAS AND GEOTECHNICAL ENGINEERING

16 - 19 June 2008, Saint Petersburg, Russia
www.georec.spb.ru/eng/conf/080616/

The Conference will be organised by the International Society for Soil Mechanics and Foundation Engineering (ISSMGE), the Technical Committee TC 38 «Soil-Structure Interaction», the Russian Society for Soil Mechanics, Geotechnics and Foundation Engineering (RSSMGFE), the NPO «Georeconstruction-Fundamentproject» and the Saint Petersburg State University of Highways (PGUPS).

CONFERENCE TOPICS

- Soil-structure interaction
- Soil characterization for geotechnical and geoenvironmental purposes in urban areas as a basis for soil mechanics and geotechnical design
- Geotechnical aspects of reconstruction of historical cities and monuments preservation
- Geotechnical challenges in high-rise and underground construction
- Application of state-of-the-art geotechnologies in congested urban areas. Use of monitoring and the observational method.

CONFERENCE SECRETARIAT

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17-20 June '08 Shanghai China
GEOSYNTHETICS ASIA 2008

www.4acg-2008sh.com

The 4th Asian Regional Conference on Geosynthetics (Geosynthetics Asia 2008) will be held from 17th to 20th June 2008 at the Shanghai Exhibition Center, Shanghai, China.

For more information see the previous issues of THE NEWS.

www.dundee.ac.uk/civileng/icof2008

The aim of the 2nd BGA International Conference on Foundations is to provide a forum for practitioners and researchers to discuss state-of-the-art construction methods and analytical techniques for a broad range of foundation problems.

The conference will be organised by the Geotechnical Engineering Research Group of the University of Dundee and will be held on campus. It will comprise seven parallel sessions running over a three-day period and include keynote lectures, oral presentations, discussion and poster sessions. The conference will also be organised by the British Geotechnical Association, with the support of ICE, Scottish Geotechnical Group & Scottish Universities Geotechnical Network.

Conference Themes

- Offshore foundations
- Soil-structure interaction
- Shallow and deep foundation design and performance
- Geohazards and foundation performance in extreme environments
- Sustainable foundations (e.g. Foundation reuse, future proofing, smart foundations)
- Foundations in the urban environment
- The observational method
- Design codes and methodology
- Specialised foundations (e.g. tall structures, dynamic loading)
- Numerical and analytical modelling of foundations
- Laboratory modelling of foundation behaviour
- Specialised site investigation for foundation design
- Retaining structures & deep excavations

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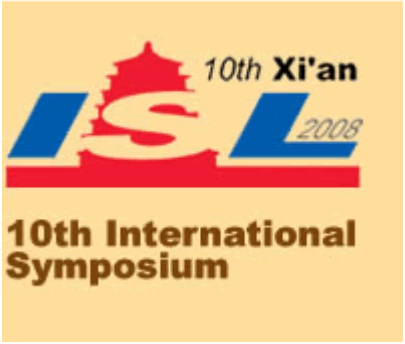

10th International Symposium on Landslides and Engineered Slopes
www.landslide.iwhr.com

The 10th International Symposium on Landslides and Engineered Slopes will be held in the city of Xi'an, China, between June 30~July 4, 2008, jointly organized by Chinese Institution of Soil Mechanics and Geotechnical Engineering, China Civil Engineering Society (CISMGE-CCES), Chinese National Commission on Engineering Geology (CNCEG), Chinese Society of Rock Mechanics and Engineering (CSRME) and the Geotechnical Division of the Hong Kong Institution of Engineers (HKIE). This Symposium aims to provide an international platform for exchange of views and experiences among delegates of different backgrounds. The symposium has also provided a variety of technical and cultural activities.

For more information see the previous issues of THE NEWS.

6th International Conference on
Case Histories in Geotechnical Engineering
and
Symposium in Honor of Professor James K. Mitchell
www.6icchge2008.org

The conference will be held at Arlington, Virginia, Washington, D.C., USA on 11-16 August 2008. It is organized by the University Missouri – Rolla.

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EuroGeo4
4th European Geosynthetics Conference
Edinburgh, UK, 7 – 10 September 2008
www.eurogeo4.org

The 4th European Geosynthetics Conference will be held at the Edinburgh Conference Centre, Heriot-Watt University, Scotland from 7th September to 10th September 2008. The conference is being organised by the UK Chapter of the International Geosynthetics Society under the auspices of the International Geosynthetics Society and is supported by the British Geotechnical Association, Scottish Geotechnical Group, Ground Forum and the Engineering Group of the Geological Society. The EuroGeo4 conference will debate the subject of **Geosynthetics in Civil Engineering Applications** within a three-day event comprising keynote lectures, paper presentations, discussions and poster sessions.

For more information see the previous issues of THE NEWS.

Stress Wave Lisbon | 2008

8-10 | September

www.stresswave2008.org

The International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE), the Portuguese Geotechical Society (SPG) and Instituto Superior Técnico of the Technical University of Lisbon (IST/UTL), invite you to participate in the 8th International Conference on the Application of Stress-Wave Theory to Piles that will be held in Lisbon from Sept. 8-10, 2008.

The main objective of the conference is to create a forum for exchange of ideas and experience between researchers, equipment manufacturers and practicing engineers regarding the application of stress-wave theory to piles and other relevant problems and developments on dynamic testing and its relation to the foundation engineering.

In order to widen the contribution of all participants, the conference format will comprise parallel sessions. State-of-the-art presentations of technological developments will also be featured. The conference will also include invited keynote lecturers and presentation and discussion of selected papers in plenary sessions.

Themes will address the following:

1. Wave mechanics applied to pile engineering
2. Relationship between static resistance to driving and long-term static soil resistance
3. Case histories involving measurement and analysis of stress waves
4. Dynamic monitoring of driven piles
5. Dynamic soil-pile interaction models. Numerical and physical modelling
6. High-strain dynamic test
7. Low-strain dynamic test
8. Rapid-load test
9. Monitoring and analysis of vibratory driven piles
10. Correlation of dynamic and static load tests
11. Quality assurance of deep foundations using dynamic methods
12. Incorporation of dynamic testing into design codes and testing standards
13. Ground vibrations induced by pile motions
14. Dynamic measurements in ground field testing

For questions about the Conference contact:
E-mail: SW2008@civil.ist.utl.pt
Address:
StressWave 2008 Organizing Committee
Att. Prof. Jaime Santos
Instituto Superior Técnico
Department of Civil Engineering and Architecture
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Phone: (+351) 218 418 418
Fax: (+351) 218 418 427

5th International Geotechnical Seminar

DEEP FOUNDATIONS ON BORED AND AUGER PILES

2008 GHENT (BELGIUM)

terzaghi.ugent.be

The Laboratory of Geotechnics of the Ghent University has the honour to invite you to the Fifth International Geotechnical Seminar on Deep Foundations on Bored and Auger Piles. We are celebrating 20 years of BAP. The seminar will be held from September 8th till 10th, 2008. The main topics will be:

- Behaviour of bored piles; capacity and deformations from field testing.
- Research needs versus professional practice in technological bored and auger piles developments.
- Monitoring experiences and design interaction.
- Design practice for groups of bored piles; screw pile raft interaction concepts.
- Soil parameters relevant to bored pile design from laboratory and in situ tests.
- Experiences from screw piles and bored piles under seismic and dynamic loading.
- International standards versus Eurocode 7 for bored and screw piles.
- Screw and bored piles under lateral loading.
- Energy piles.
- Professional practice and quality control.

For information:

Conference Organiser of BAP V
AGE bvba
Doorsteekstraat 9, 9420 Erpe-Mere, BELGIUM
Tel/Fax: +32 (0)53 834685
Tel2: +32 (0)55 424077
E-mail: PVI.AGE@skynet.be

Scientific Secretariat of BAP V
Laboratory of Geotechnics – Ghent University
Technologiepark 905, 9052 Zwijnaarde, BELGIUM
Tel: +32(0)9 2645717 – Fax: +32 (0)9 2645849
E-mai: Karla.Crombeen@UGent.be

1st International Conference on Transportation Geotechnics

www.nottingham.ac.uk/ncg

The University of Nottingham will host the 1st International Conference on Transportation Geotechnics, from 8 to 10 September 2008. The Conference will be organised by the Nottingham Centre for Geomechanics (NCG) and Nottingham Transportation Engineering Centre (NTEC).

For more information see the previous issues of THE NEWS.

www.11bc.pg.gda.pl

Construction activities, which take place in onshore and offshore conditions are very often confronted with difficult geotechnical problems. Generally, the geotechnical design in maritime engineering requires the knowledge of almost all aspects of soil-structure interaction as well as of the behaviour of different types of soils. The exchange of such experiences among engineers and researchers is therefore very important, especially when it can be accomplished at an international level.

The main aim of the 11th Baltic Sea Geotechnical Conference is to provide a forum for an intensive transfer of ideas and experiences with other engineering and research groups. Significant contributions from industry are encouraged and hence the ultimate aim is to bring together state-of-the-art research in Geotechnics in maritime engineering with current industrial experiences.

The conference is not limited only to the countries of the Baltic Sea area and participants from other regions are warmly welcomed.

The topics of the conference sessions are as follows:

- Soil Mechanics: field and laboratory testing
- Theoretical solutions, numerical analysis in soil mechanics
- Foundations of onshore and offshore constructions and maritime coasts
- Site characterisation
- Geoenvironmental engineering
- Case histories

Correspondence:

On organizational issues:

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On scientific programme issues:

Polish Committee on Geotechnics (PCG)
Office of President of PCG
Podolska St. No. 27A, 60-615 Poznan, Poland
Tel.: +48 61 847 09 25, Fax: +48 61 848 33 17
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ITA-AITES WORLD TUNNEL CONGRESS & 34th GENERAL ASSEMBLY OF ITA-AITES

www.cbip.org

The congress will be held from 19th to 25th September 2008 at Agra, India and will be organized by the International Tunnelling Association and the Indian Tunnelling Association.

Congress Topics:

Planning, Investigation and Design of Tunnel, Cavern & Underground Projects
- Planning, Investigation and Interpretation of Geological Data
- Engineering Classification and Characterization of Rock Mass
- Hydraulic and Structural Design of Tunnels;
- Stabilization and Support System for Tunnelling;
- Determination of In-situ Stresses for Underground Excavation
- Instrumentation Monitoring, Back-analysis and Modelling Methodologies
- Analysis and Design Methodologies including Effect of Seismicity on the Underground Structure.

Tunnel & Cavern Construction Technologies and Equipment
- Construction Methodologies for Tunnels, Caverns, Underground Storages including Remedial Measures for Large Collapses
- Tunnelling in Urban Areas
- Soft Ground Tunnelling including Shotcrete Methods
- New Developments – TBM Performance and NATM Experiences
- Micro Tunnelling
- Trenchless Technology – Practice and Evaluation
- Immersed Tunnels and Sub-merged Floating Tunnels.

Risk Management
- Better Preparedness against Tunnel Related Natural Hazards
- Risk Analysis and decision-making Techniques for Large Underground Projects.

Environmental and Social Impacts
- Environmental and Social Impact Assessment of Underground Works and their Norms and Methodologies
- Environmental Control in Tunnel/Cavern and Underground Spaces
- Effective Ventilation in Tunnels and Practices.

Safety Issues – Standards and Policies
- Fire Safety Arrangement and Measures in Tunnels and Transport
- Safety Standards and Policies in Different Countries and New Developments.

Contract Management and Financing of Underground Construction Works
- Costing and Contractual Practices in Tunnel and Underground works including Aspects of Measurements and Payment
- Experience and Structure of Model Contract Document
- Project and Equipment Financing Build Operate Transfer (BOT) Projects
- Securitisation and Risk Mitigation.

Research & Development
- Robotisation of TBM Tunnelling

Congress Secretartiat
Central Board of Irrigation & Power
CBIP Building, Plot No. 4, Institutional Area
Malcha Marg, Chanakyapuri, New Delhi -110021, INDIA
Contact Person : Mr. G.N. Mathur
Tel : 91-11-2611 5984 / 2611 6567
Fax : 91-11-2611 6347
E-mail : sunil@cbip.org, cbip@cbip.org
WEB : http://www.cbip.org

International Association for Computer Methods and Advances in Geomechanics

The 12th Conference (1 to 6 October 2008, to be held in Goa, India) will address recent developments and relevant issues in computer methods, constitutive models and applications to different areas of Geomechanics, and emerging and important topics, and future needs, documented case studies with integration of theory, laboratory and field tests, and validation procedures. This will be consistent with the continuing theme of IACMAG conferences and the International Journal of Geomechanics, namely **Fundamentals *through Applications***.

The special theme for the 12th International Conference has been chosen as ***Geomechanics in the Emerging Social & Technological Age***. The conference will endeavor to stress on problems raised by the present day society due to rapid industrialization and globalization, in addition to the objectives covered by the previous conferences. The conference aims to focus on some very recent and emerging trends in geomechanics such as mechanics of unsaturated soils, micromechanics, nanomechanics, bio-geo interface, infrastructure geomechanics and geomechanics for ancient monuments.

Building underground for the future
www.aftes.asso.fr

Monaco will host the coming international congress of the French Association of Tunnels and Underground Space in October 2008.

Congress Themes: Using underground space to bury our communications systems and offer new links, or create vast open chambers leaving no trace at street level, confirms our belief that the future lies beneath our feet. Monaco is a remarkable example of this.

- Underground Development
- Controlling Risks and Costs
- Innovations in Tunnelling Techniques
- Long-Lasting, Safe Tunnels

All correspondence and queries concerning the events should be addressed to:
Congress Monaco
AFTES c/o SNCF-Infrastructure,
17, rue d'Amsterdam 75008 Paris, FRANCE
Fax +33.(0)1.53.42.08.20
e-mail : aftes@sncf.fr

INTERNATIONAL CONFERENCE ON NUMERICAL COMPUTATION IN GEOTECHNICAL ENGINEERING
October, 27-29 2008, Skikda, Algeria
www.univ-skikda.dz/conference/accueil1.html

Every year, Algeria is confronted to a variety of complex geotechnical challenges, causing serious human and financial losses. Due to the fast economic growth and social development of the recent years, large civil engineering projects have been launched (East-West motorway, Algiers underground, new railway axes, one million of lodgings…), which eventually require more efficient geotechnical studies. The main objective of this conference is to provide a forum for researchers, specialists and professionals to exchange ideas, experiences, and information concerning the use of modern numerical techniques in geotechnical engineering computation.

The other aim of this event is to give an opportunity to Algerian geotechnical specialists to discover and eventually subscribe to the newly created "Algerian Geotechnical Society AGEOS".

Conference Topics

- **Theme A**. Modelling and Behaviour(problematic soils and rocks, constitutive modelling, numerical implementation, coupling problems, dynamics problems, discontinuous media modelling, the soil - structure interactions).
- **Theme B**. Methods and Techniques of Resolution (stochastic approaches, inverse analysis, genetic algorithm, geostatistic, F.E.M. and its derivatives, D.E.M., B.E.M., F.D.M., innovative methods).
- **Theme C**. Numerical Modelling of Real Cases of Geotechnical Problems (excavations and underground structures, foundations, soil movement and unstable slopes, retaining structures and soils reinforcement , geoenvironmental issues, urban geotechnics).

In addition to the conference sessions, exercises involving computations of Constantine City landslide case and the modelling of an isolated axially loaded pile behaviour, will be proposed and discussed during a *special session*.

Conference Secretariat Address

Pr. M. Hamami
Laboratoire de Recherche en Mathématiques Appliquées et Calcul Scientifique, Université de Skikda
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14th World Conference on Earthquake Engineering (14WCEE)
12-17.10.2008 Beijing, China

www.14wcee.org

The 14th World Conference on Earthquake Engineering (14WCEE) will serve as an international forum at which specialists, government officials and NGO representatives in earthquake engineering and relevant fields may exchange the

latest research results and technologies. The Conference strives to promote innovation, practice and safety in reducing the impact of earthquakes on our society and natural environment.

THEME: INNOVATION PRACTICE SAFETY

TOPICS
- Earthquake risk reduction for urban and rural areas
- Social and economic impacts of earthquakes
- Emerging technologies in earthquake engineering
- Experimental studies
- Earthquake and multi-hazards
- Numerical methods in earthquake engineering
- Tsunami

For requests about registration, visa application, hotel and tour reservation, payment and confirmation please contact:

China International Conference Center for Science and Technology (PCO of 14WCEE)
No. 86 Xueyuan Nanlu, Beijing 100081, CHINA
Tel: +86-10-62103106, Fax: +86-10-62174126
Email: pco@14wcee.org
http://www.14wcee.org, www.14wcee.com, www.14wcee.net

For requests about abstract submission, scientific and other academic issues please contact:

14WCEE Secretariat
c/o Chinese Association of Earthquake Engineering
9 Xuefu Road, Harbin 150080, CHINA
Tel: +86-451-86652900, Fax: +86-451-86652651
Email: secretariat@14wcee.org
http://www.14wcee.org, www.14wcee.com, www.14wcee.net

Tokyo, 5-7th November, 2008
icse-4.kz.tsukuba.ac.jp

Scour and erosion is the suite of processes that dynamically modify the interface where water and soil/rock meet. As such, hydraulics and geotechnics should be tied even strongly. The integrity of structures in and near water bodies is a good target in this direction. Those structures may include bridge piers, flood-control levees, seawalls and offshore pipelines. Also, a broader perspective for scour and erosion issues is becoming equally important in addressing the performance of sediment routing systems that may connect hillslope, fluvial, estuarine and coastal processes. Certainly, mitigation of riverbed degradation or coastal erosion or both will call for such a coherent approach in the context of integrated sediment management.

In essence, the Conference welcomes scientific contributions in the following themes or related subject matters:

- Scour/erosion processes (physical, theoretical or numerical modeling)
- Consequences of scour/erosion (case histories, field observations, analysis/prediction of real-life problems)
- Health monitoring of scour/erosion-vulnerable structures
- High-resolution imaging/remote sensing for erosion-related morphological features
- Applications of geographical information science/engineering
- Management of scour/erosion (structural or non-structu-ral measures, design philosophy)
- Integrated sediment management: recent advances

Conference Secretariat - Contact Person:
Professor Sekiguchi sekiguch@ujigawa.mbox.media.kyoto-u.ac.jp

The First World Landslide Forum
Implementing the 2006 Tokyo Action Plan on the International Programme on Landslides (IPL)
Strengthening Research and Learning on Earth System Risk Analysis and Sustainable Disaster Management within UN-ISDR as Regards "Landslides"
18-21 November 2008
United Nations University, Tokyo, Japan
www.iclhq.org

In January 2006, the 2006 Tokyo Action Plan on the International Programme on Landslides (IPL) was adopted by the international community. It proposed the global cooperating Network of the IPL, and established the IPL Global Promotion Committee and the IPL World Centre as its secretariat to coordinate and support implementation of the International Programme on Landslides.

The adoption of the 2006 Tokyo Action Plan took place on the occasion of the 2006 Tokyo Round Table Discussion "Strengthening Research and Learning on Earth System Risk Analysis and Sustainable Disaster Management within UN-ISDR as Regards Landslides"-towards a dynamic global network of the International Programme on Landslides (IPL) which was held at the United Nations University, Tokyo, from 18th to 20th January, 2006, to formulate a framework for cooperation and to identify focus areas to reduce landslide risk worldwide. It was further agreed that the 2006 Tokyo Action Plan would be implemented within the scope of the Hyogo Framework for Action 2005-2015, "Building the Resilience of Nations and Communities to Disasters", adopted at the United Nations World Conference on Disaster Reduction held in Kobe, Hyogo, Japan in 2005.

The Action Plan proposed organizing a World Landslide Forum in order to bring together academics, practitioners, politicians, and other stakeholders to a global, multidisciplinary, problem-focused platform. The First Landslides Forum that will take place at United Nations University, Tokyo, Japan from 18-21 November 2008.

The objectives of the First Landslides Forum (1st WLF) are the following:

1. Promotion of research and exchange of experience through open Forums, Symposia and Workshops

Various meetings to strengthen Research and Learning on Earth System Risk Analysis and Sustainable Disaster Management within UN-ISDR as Regards "Landslides" will be organized by all levels of participating groups. Rooms and time span will be allocated to promote those activities.

2. Advances and achievements of IPL

Proposals and reports on IPL projects will be presented for the planned global cooperating fields, which are listed hereafter:

Global Cooperating Fields of IPL

(1) Technology Development
  A. Monitoring and Early Warning
  B. Hazard Mapping, Vulnerability and Risk Assessment
(2) Targeted Landslides: Mechanisms and Impacts
  A. Catastrophic Landslides
  B. Landslides Threatening Heritage Sites
(3) Capacity Building
  A. Enhancing Human and Institutional Capacities
  B. Collating and Disseminating Information/ Knowledge
(4) Mitigation, Preparedness and Recovery
  A. Preparedness

B. Mitigation
C. Recovery

3. Designation of World Centres of Excellence on Landslide Risk Reduction

The IPL Global Promotion Committee will identify and promote World Centres of Excellence (WCoE) within eligible organizations, such as universities, institutes, NGOs, government ministries and local governments, contributing to "Risk Reduction for Landslides and Related Earth System Disasters". Linkages to CoE at the national level will be used to promote cooperation with the ICL and dissemination of knowledge and information. An independent Panel of Experts, set up by the Global Promotion Committee of IPL, may be appointed to endorse the CoEs. The first WCoE will be approved by the IPL Global Promotion Committee based on the recommendation by the Panel of Experts and announced at the final day of the first World Landslide Forum.

Secretariat of the First World Landslide Forum
IPL World Centre
UNESCO-Kyoto University-ICL UNITWIN Headquarter Building
Uji, Kyoto 611-0011, JAPAN
E-mail: secretariat@iclhq.org, Web: iclhq.org

"Safe Tunnelling for the City and Environment"
ITA-AITES WORLD TUNNEL CONGRESS 2009
and
the 35th ITA-AITES GENERAL ASSEMBLY
Budapest Congress and Word Trade Center
Budapest, HUNGARY - 23-28 May, 2009
www.wtc2009.org

The Hungarian Tunnelling Association is pleased to welcome you to the wonderful Capital city of Budapest for the ITA-AITES World Tunnel Congress 2009 entitled "Safe Tunnelling For The City and Environment" and the 35th ITA-AITES General Assembly, which is being held at the Budapest Congress and World Trade Center from 23 to 28 May, 2009.

Congress Main Topics

- Risk analysis, finances and contractual relationships
- Geological and geotechnical investigations
- Tunnelling in soft ground with shotcrete method
- Cut- and cover constructions
- Mechanized tunnelling
- Monitoring, settlement control
- Quality Management
- Miscellaneous (storing facilities, etc)
- Architectural design, structural design and management policy
- City, tunnel, environment and safety
- Maintenance, repair and rehabilitation
- Special tunnels (long tunnels)

WTC2009 SECRETARIAT
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IS-Tokyo 2009

15 - 17 June 2009
International Conference on Performance-Based Design in Earthquake Geotechnical Engineering - from case history to practice -

Conference Theme

One of the recent needs in practice of earthquake geotechnical engineering has been the development of performance-based design (PBD) principle, which had already been employed in seismic design of structures under strong earthquakes. The rapid development of practical and reliable performance-based design in geotechnical engineering is necessary for foundation design as well as for superstructures resting on incompetent soils.

The introduction of performance-based design requires a wide range of technical issues to be resolved, such as clarifying performance requirements of earth structures, introducing sound concepts of limit states in design principles, searching for better but affordable soil investigation technology leading to reliable prediction of seismic performance. This conference is aimed at collecting well- documented case histories in assisting the development of performance-based design, and introducing the concepts necessary for its development as well as some representative examples of design procedures. This conference is expected to provide leading researchers and practitioners with a suitable occasion to discuss issues and to exchange knowledge associated with seismic performance-based design in the light of well-instrumented case histories during recent destructive earthquakes.

Conference Topics

The conference will cover a range of topics associated with performance-based design in earthquake geotechnical engineering.

- Case histories on ground motions, site effects and soil-structure interactions including shallow foundations and pile foundations, embankments and slopes, embankment dams and underground structures
- Soil investigation with field and laboratory testing for performance-based design
- Dynamic characterization and modeling of soils for performance-based design
- Numerical analyses for performance-based design
- Methodology of performance-based design
- Recent developments in PBD codes

Contact
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E-mail : ytsoil@rs.noda.tus.ac.jp

XVII International Conference on Soil Mechanics and Geotechnical Engineering
www.2009icsmge-egypt.org

The conference will be held at Bibliotheca Alexandrina, Alexandria, Egypt on 5 - 9 Οκτωβρίου 2009. It is organized by the Egyptian Geotechnical Society. The general theme of the conference is «Future of Academia & Practice in Geotechnical Engineering».

IX International Conference on Geosynthetics
www.igsbrasil.org.br/icg2010

The conference will be held at Brazil on June 2010. It is organized by the Brazilian Chapter of International Geosynthetics Society (IGS Brazil) and the Brazilian Society for Soil Mechanics and Geotechnical Engineering (ABMS) aiming at «To divulgate the latest findings of geosynthetics behavior and the recent developments concerning design and performance of geosynthetic (on lab and on site). Besides that the event will create an excellent opportunity for Brazilian and South American geologist, geotechnical, mining and environmental engineers to be involved with, to learn and discuss geosynthetic subjects with specialists from the other parts of the globe».

For information igsbrasil@igsbrasil.org.br
icg2010@igsbrasil.org.br

NEWS FROM THE WORLD

Grand Canyon Skywalk

The Glass Bridge Construction of the Skywalk began March of 2004 and was estimated to be completed by 4th quarter of 2006. The glass bridge is suspended 4,000 feet above the Colorado River on the very edge of the Grand Canyon.

Giant Crystal Secret Recipe Found

Mother Nature's secret recipe for cooking up the staggeringly huge, pillar-like crystals of Mexico's newfound Cave of Crystals has been worked out by mineral researchers.

It turns out that with just the right pinch of minerals added at the right times for a few million years to a warm subterranean broth, you too can grow gypsum crystals 35 feet long and as thick as tree trunks. Gypsum, incidentally, is the same stuff that's ground up to make plaster of Paris.

A team of researchers from Mexico and Spain have hit on the factors that created the otherworldly crystal "beams" that were discovered by miners in 2000 in a cave of the Naica Mine in northern state of Chihuahua. By studying the crystals in the cave and testing some fluid mixtures in a laboratory, it appears that the crystals formed in delicately balanced mineral water that stayed within a narrow range of temperatures for a very long time.

"Actually the cave was filled with water until few years ago when continuous pumping requiring for mining has lowered the underground water below 290 meters deep (950 feet), the depth at which the cave is located," explained mineralogist Juan Manuel García-Ruiz of the Laboratory of Crystallographic Studies in Granada, Spain. He's also the lead author on a paper explaining the mega crystals in the April issue of the journal *Geology*.

Like the air now in the cave, the water in which the crystals formed was at least 126 degrees Fahrenheit (52 degrees Centigrade) and was enriched with the compound calcium sulfate from about 23 million years worth of geothermally heated water percolating upwards.

The enriched water dissolved sulfur-bearing rocks along the way and deposited that as hot *anhydrite* – which is essentially just another form of gypsum, except with no water trapped inside the molecules.

"The key point is that anhydrite is stable above 58 degrees Celsius (136 degrees F), while below that temperature gypsum is the stable form," said García-Ruiz. "Therefore until the temperature was kept above 58 degrees C anhydrite was stable."

Below that temperature, the anhydrite dissolves and the gypsum crystals started to form. That that's not the entire recipe for giant crystals, he said.

"To grow very large crystals it is required to form only very few nuclei ('seed' crystals) and to feed them continuously with very small amount of calcium sulfate for extremely long times," said García-Ruiz, "something that is provided by the small but continuous dissolution of anhydrite in the mine."

So the trick is having just enough — but not too much — calcium sulfate in warm water that's cooling — but not cooling too fast.

"For these huge crystals to form, it is mandatory that the cave environment never cool below 45 degrees (113 degrees F), according to our calculation," García-Ruiz told Discovery News.

"Wow! These are essentially single crystals," remarked cave geologist Laurence Davis of the University of New Haven, in Connecticut. He had not heard of the giant crystals until reading the *Geology* paper.

As for the science behind García-Ruiz's recipe, "This is pretty standard cave stuff," Davis said. "It sounds pretty good to me."

(Larry O'Hanlon, Discovery News, April 5, 2007)

Hanoi Officials Disciplined

Twenty-one local government officials in Hanoi, Vietnam are due to face disciplinary charges over their failure to ensure the illegal construction of extra floors on high rise buildings in the city were not carried out.

Four of the officials are from the city's construction department, including its deputy head Bui Van Chieu, reports state news agency Thanh Nien .

The others are local leaders of the Ba Dinh, Dong Da, and Hai Ba Trung districts, where the unlicensed floors were built. It is not clear at present if bribery was involved, said the report.

The Hanoi People's Committee has ordered the demolition of the illegal buildings, which included a 21-story tower with four "unlicensed" floors, a 10-story building with five "illegall" floors, and a 17-story tower with three "unauthorized" floors.

The building's owners will also have to pay fines for breaching construction codes, said the report.

(INTERNATIONAL CONSTRUCTION, May 4, 2007, Editor: Richard High)

Development of Island Paradise

Dubai–based Emirates Hotels and Resorts is planning to invest US $253 million in a new project in the Seychelles to bolster its portfolio of luxury properties.

The Emirates Group division is making its biggest outlay yet for the Emirates Cap Ternay Resort and Spa on Mahe, which will open in 2010.

The 9 ha resort will follow the same principles of sister properties Al Maha in Dubai and Wolgan Valley, which is currently

being built in the Blue Mountains near Sydney, Australia, but adapted to its location.

Conservation of the environment will be paramount when building and operating the Creole-style resort, said a company spokesman.

Speaking to local media, His Highness Sheikh Ahmed bin Saeed Al-Maktoum, chairman and chief executive, Emirates Airline and Group, said, "Our development will enhance this paradise into an unforgettable destination for discerning holidaymakers, especially environmentally-conscious travellers keen to ensure responsible development."

He added that while the proposed resort was large, it promised to be ecologically sensitive in its design to rival the best in the India Ocean.

The main low-rise building at Emirates Cap Ternay Resort will feature 186 rooms planned for families and budget conscious travellers.

The second tier of accommodation will comprise semi-detached cottage-style complexes housing 230 deluxe rooms, situated in landscaped beachfront locations.

A private resort area, with its own reception, will offer 15 water-bungalows as well as 40 two-bedroom villas.

Facilities for all guests include a 2.5-ha swimming pool; a Timeless Spa; the most extensive conference and meetings facilities in the Seychelles; a marine reserve; two beaches and a children's play area.

According to reports, Tim Clark, president of Emirates, said the company is currently building five to six projects, which should be completed within three years, and there are more in the pipeline.

(INTERNATIONAL CONSTRUCTION, May 9, 2007, Editor: Becca Wilkins)

World's First Zero Carbon City

Abu Dhabi, United Arab Emirates (UAE) is planning to build what it claims will be the world's first zero carbon, zero waste city.

The 6 km2 city will be an integrated energy, science and technology community. Due to open at the end of 2009 it will be situated in the centre of the UAE capital.

Developed by the Masdar Institute of Science and Technology, a joint venture between the Massachusetts Insitute of Technology (MIT) and the Abu Dhabi government in the shape of the Abu Dhabi Future Energy Company, and masterplanned by UK-based Foster + Partners, it will house the Masdar Institute, residential units, a science museum, and commercial space for other companies working on the development of energy and conservation technology.

The principle of the Masdar development, said a Foster + Partners' spokesman, is a dense walled city to be constructed in "an energy efficient two-stage phasing" that relies on the creation of a large photovoltaic power plant. This will then become the site for the city's second phase, allowing for urban growth yet avoiding low-density sprawl.

Strategically located for Abu Dhabi's principal transport infrastructure, the city will be linked to the surrounding communities, as well as the centre of Abu Dhabi and the international airport, by a network of existing road and new rail and public transport routes.

The city will be car free, with a maximum distance of 200 m to the nearest transport link and amenities. The compact network of streets is designed to encourage walking and is complemented by a rapid transport system.

The shaded walkways and narrow streets will create a pedestrian friendly environment in the context of Abu Dhabi's extreme climate. It also articulates the tightly planned, compact nature of traditional walled cities. With expansion carefully planned, the surrounding land will contain wind and photovoltaic farms, research fields and plantations, so the city will be entirely self-sustaining.

(INTERNATIONAL CONSTRUCTION, May 9, 2007, Editor: Richard High)

Vietnam's Bitexco Financial Tower Starts

Following the appointment of US-based Turner International as project manager, construction of the Bitexco Financial Tower in Ho Chi Minh City, Vietnam has started.

The 290 m high, 68-storey tower, which sits in the heart of Ho Chi Minh City's financial district, includes 100000 m2 of office and retail space and will be the country's highest building.

Developed by Bitexcoland, the property development arm of Binh Minh Import-Export Production and Trade Co., construction is expected to take 36 months.

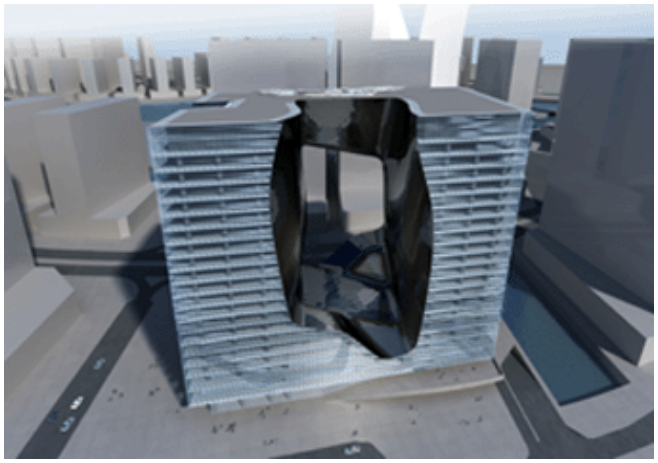
The tower's design, by US-based architects Carlos Zapata Studio, is based on the lotus flower, Vietnam's national symbol.

Commenting on the start of construction, Turners' regional manager, Dimitrios "Jimmy" Antzoulis, said, "The Bitexco Financial Tower is an iconic building which symbolises the dynamic growth as well as the culture of Vietnam, and Turner is proud to be associated with this project."

Headquartered in New York, US Turner International is currently managing projects totaling more than 8.2 million m2 in building area, with a value of about US$ 12.2 billion. In 2005 it completed US$ 7.4 billion of construction.

(INTERNATIONAL CONSTRUCTION, May 11, 2007, Editor: Richard High)

Zaha Hadid Unveils Opus



UK-based Zaha Hadid Architects has unveiled its designs for the Dubai-based Opus project, a US$ 466 million mixed-use commercial and retail development, for United Arab Emirates (UAE) property developer Omniyat Properties.

Located in the Business Bay district of Dubai it will be fringed by the Burj Dubai development, and be neighbours with the Dubai International Financial Centre (DIFC) and the World Trade and Convention Centre (WTCC).

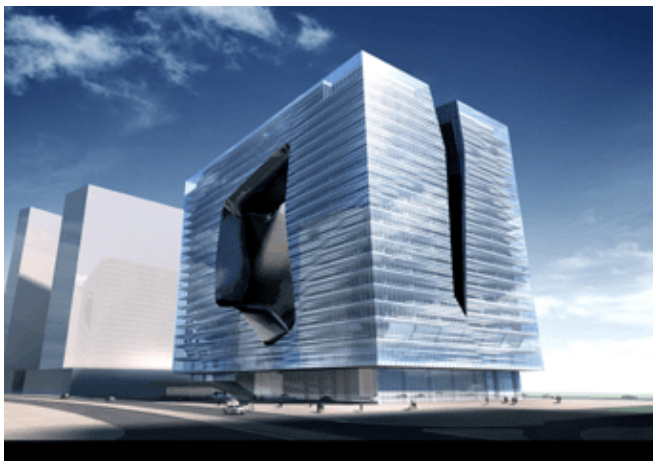
According to a Zaha Hadid spokesman, the Opus will appear "to hover from the ground".

Constructed of three separate towers the building will appear as a singular unified whole, with a distinctive void. The interiors of which will be clad with a fully engineered curved glass curtain wall to allow for eye-catching views into the void.

Reflexive fritting patterns in the form of pixilated striations will be applied to the glass facade to provide a degree of reflectivity and materiality to the cube. This will also help reduce solar gains inside the building.

Inside the building, which boasts an AAA-class rating and has 87% space efficiency, there will be a retail podium across the ground, first and second floor. The top floor will feature a tranquillity zone, a beach deck with a reflective pool and shaded roof terrace, a media zone and a gym.

Commenting on the project Zaha Hadid said, "This is a building that challenges traditional concepts of office space. Not only will it be visually stunning, it will also be a workable space, and a place that allows every occupant to experience a better quality working environment, using the very latest technological advances."



(INTERNATIONAL CONSTRUCTION, May 25, 2007, Editor: Richard High)

Dubai - JXB's first runway 70% complete

Construction of Dubai World Central International Airport's (JXB) first runway has entered the final phase.

"Over 70% of JXB's first 4.5 km CAT III runway is complete with the target month for completion set for October 2007. One of six it will enable JXB to start operations in mid-2008 as the world's largest passenger and freighter airport and cargo hub," said His Highness Sheikh Ahmed bin Saeed Al Maktoum, chairman of Dubai Aviation Corporation - Dubai World Central (DWC), Government of Dubai.

JXB is at the core of the massive 140 km2 Dubai World Central (DWC) urban aviation community being built in Jebel Ali just 40 km from Dubai city centre. Al Nabooda Contracting Company, which is building the runway - labelled Runway 12/30 - is also working on three parallel taxiways and associated rapid exits - 40% of which is now complete - the airside road network and infrastructure services such as airfield lighting, power, water, fire fighting and drainage network.

The US$ 8.1 billion JXB airport will have a capacity to handle up to 150 million passengers and 12 million tons of cargo annually upon completion.

The airport will have six parallel runways all of 4.5 km in length - separated by a minimum of 800 m - and a 92 m high control tower, the highest in the Middle East, construction of which will begin in October this year.

JXB will be linked to the existing Dubai International Airport (DXB) via an express rail system and ultimately will be serviced by the Dubai Light Railway Network (Dubai Metro). About 100000 car parking spaces will be available for airport parking and car rental services.

DWC, which will eventually be home to 750000 people, has infrastructure costs estimated at US $33 billion. It comprises six specialized clustered zones: Dubai World Central International Airport (JXB), Dubai Logistics City (DLC), which also includes a dedicated aviation area, Commercial City, Residential City, Enterprise Park and a 36-hole golf resort.

(INTERNATIONAL CONSTRUCTION, May 29, 2007, Editor: Richard High)

Loetschberg Tunnel Opens

The Loetschberg Base Tunnel, the world's longest land-based tunnel, was officially opened on Friday. The 34,6 km rail link under the Swiss Alps is due to go into full operation in December following testing. The project cost CHF 4,3 billion (€ 2,6 billion).

Construction of the tunnel between Frutigen and Raron began in 1999. Described as a 'Base Tunnel' the link has been constructed at valley floor level, some 400 m below the original Loetschberg tunnel, built in 1913. Construction at this level allowed steep gradients and sharp bends to be removed from the route, allowing higher travel speeds.

The tunnel is part of the wider AlpTranist project, which is designed to take freight off Switzerland's roads. Loetschberg is the key link in the western part of the network, ultimately completing a high speed rail link from Frankfurt, Germany and Paris, France to Milan and Turin in Italy. In eastern Switzerland the Zimmerberg, Gotthard and Ceneri Base Tunnels will provide a link from Stuttgart, Germany through Switzerland's commercial capital Zurich to Milan.

When complete in 2017 the 57 km Gotthard Base Tunnel will be the longest tunnel of any kind in the world. The longest tunnel in the world at present is the 53,8 km Seikan Tunnel, and undersea link connecting the Japanese islands of Honshu and Hokkaido, which was opened in 1998. It is followed by the undersea Channel Tunnel between the UK and France, which is 51,5 km long and which was completed in 1994.

(CONSTRUCTION EUROPE, June 18, 2007, Editor: Chris Sleight)

Σήραγγα ενώνει την Ευρώπη

Το σιδηροδρομικό τούνελ του Λότσμπεργκ συνδέει πιο γρήγορα Βορρά-Νότο

ΖΥΡΙΧΗ. Εγκαινιάστηκε η μεγαλύτερη σήραγγα που κατασκευάστηκε ώς σήμερα στην ξηρά και η τρίτη μεγαλύτερη του κόσμου, η σιδηροδρομική σήραγγα του Λότσμπεργκ, η οποία πρόκειται να συντμήσει σημαντικά τον χρόνο ταξιδιού και μεταφοράς εμπορευμάτων από τη βόρεια στη νότια Ευρώπη αλλά και θα βοηθήσει στην επίλυση της κυκλοφοριακής συμφόρησης που παρατηρείται στις Αλπεις.

Κόστισε 10 δισ. ευρώ

Το έργο που εγκαινιάσθηκε αποτελεί μόνο το πρώτο στάδιο του προγράμματος και κόστισε 10 δισεκατομμύρια ευρώ και χρειάστηκαν οκτώ χρόνια για την ολοκλήρωσή του. Ειδικότερα, τμήμα της σήραγγας που παραδόθηκε έχει μήκος 34,6 χιλιομέτρων και πρόκειται να συντμήσει σημαντικά τον χρόνο των ταξιδιών μέσω του βόρειου τμήματος του ορεινού συμπλέγματος των Αλπεων καθώς τα τρένα θα μπορούν πλέον να αναπτύξουν ταχύτητες μέχρι και 250 χλμ./ώρα, ενώ ταυτόχρονα θα βελτιώσει κατά πολύ τη δυνατότητα μεταφοράς εμπορευμάτων.

Στην τελετή των εγκαινίων, ο Ελβετός υπουργός Συγκοινωνιών και Ενέργειας, κ. Μόριτς Λεουνμπέργκερ ο οποίος έφθασε στο Φρούτιγκεν, στη βόρεια είσοδο της σήραγγας με φορτηγό τρένο, είπε χαρακτηριστικά ότι «σηκώσαμε αυτό το βουνό για το καλό της Ευρώπης». Επίσης την τελετή παρακολούθησαν ο Γερμανός και Ιταλός ομόλογός του καθώς και ο επίτροπος της Ε.Ε. για θέματα μεταφορών, κ. Ζακ Μπαρό.

Ωστόσο, το έργο δεν έχει ολοκληρωθεί καθώς μένει ακόμα η κατασκευή του δεύτερου και πιο φιλόδοξου τμήματος του προγράμματος AlpenTransit. Αυτό περιλαμβάνει την κατασκευή δίδυμης σιδηροδρομικής σήραγγας μήκους 57 μέτρων που θα διέρχεται κάτω από το πέρασμα του Σεντ Γκοτάρντ. Σήμερα το έργο βρίσκεται υπό κατασκευή και αναμένεται να ολοκληρωθεί περί τα τέλη της δεκαετίας.

Ο κ. Μπαρό τόνισε ότι η νέα σήραγγα αποτελεί βασικό συστατικό μέρος του προγραμματισμού της Ε.Ε. για τη σύνδεση του Ρότερνταμ της Ολλανδίας με τον λιμένα της Γένοβας στην Ιταλία. Μάλιστα, ο Ευρωπαίος επίτροπος κάλεσε την Αυστρία, τη Γαλλία, τη Γερμανία και την Ιταλία να στηρίξουν με τη σειρά τους ανάλογα προγράμματα που θα μπουν σε εφαρμογή στη χώρα τους ώστε να διευκολυνθούν οι συγκοινωνίες μέσω των Αλπεων.

Η σήραγγα του Λότσμπεργκ αποτελεί συμπλήρωμα μιας ήδη υπάρχουσας, μικρότερης σήραγγας, που άρχισε να λειτουργεί το 1913 και αναμένεται να περικόψει τον χρόνο ταξιδιού από τη Βέρνη μέχρι το Μιλάνο κατά 35 λεπτά.

Επίσης, η ύπαρξη της νέας σιδηροδρομικής σήραγγας θα επιτρέψει τη διέλευση φορτίου αυξημένου κατά επτά εκατομμύρια τόνους από τη δυτική Ευρώπη, κάτω βέβαια από τις Αλπεις. Τον ίδιο όγκο εμπορευμάτων θα μπορούσαν να μεταφέρουν μέσα σ' ένα χρόνο 180 χιλιάδες φορτηγά. Μέχρι σήμερα, περίπου 1,2 εκατομμύρια φορτηγά, στη συντριπτική τους πλειονότητα από τη βόρεια Ευρώπη και την Ιταλία μεταφέρουν το φορτίο τους από τις οδούς ταχείας κυκλοφορίας και τη σήραγγα του Σεντ Γκοτάρντ.

Με δημοψήφισμα

Αξίζει να σημειωθεί ότι το πρόγραμμα του συστήματος των τούνελ εγκρίθηκε το 1992 από την πλειοψηφία του ελβετικού λαού σε δημοψήφισμα. Δύο χρόνια αργότερα με νέο δημοψήφισμα το 52% των Ελβετών ψηφοφόρων απαγόρευσαν την κυκλοφορία φορτηγών στις Αλπεις. Η νέα σήραγγα, πάντως, θα δοθεί πλήρως στην κυκλοφορία στις 9 Δεκεμβρίου.

(ΚΑΘΗΜΕΡΙΝΗ / ΚΟΣΜΟΣ, 19 Ιουνίου 2007, Α.Ρ., Reuters)
(KATHIMERINI / WORLD, 19 June 2007, A.N.A., Reuters)

Highway Threatens Algerian Park

Environmentalists have presented a petition to the Algerian government calling for the re-routing of a 1200 km long highway that threatens an important wetland in the country.

A 20 km long, 200 m wide section of the DZD 769 billion (US$ 11 billion) highway, known as the East-West Highway, will cross the coastal El Kala National Park near Lac El Mellah, Lac Oubeira and Lac Tonga (shown), and link Algeria to Tunisia and Morocco. It is seen by the government as a key component to boosting Maghreb trade.

The petition, which was presented to President Abdelaziz Bouteflika, warned the 800 km2 El Kala would eventually disappear unless road was routed around it. The park is home to a vast array of wildlife, including birds, fox, lynx, tortoise and wild cat.

Quoted in Algerian daily Liberte, Public Works Minister Amar Ghoul said the project was economically profitable and the government was determined to complete it.

"It is no longer admissible to revise the line because we should take into consideration the fate of this highway once achieved," Mr Ghoul told the newspaper.

"The highway will affect only 0.2% of the park area," he said, adding re-routing the road would cost about US$ 2 billion, six times the cost of that portion of the highway as currently planned.

Campaigners against the road said if construction went ahead the government would be breaking a commitment it entered into under Algerian law when it created the park in 1983 to protect the area from environmental damage.

In addition, the park contains one site Algeria has undertaken to protect under the 1971 Ramsar Convention on Wetlands, the Ramsar website shows.

In the petition, published in the El Watan daily, more than 100 signatories said the project should avoid the park because it would undermine its status as a protected zone and make it more vulnerable to other development.

The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and use of wetlands and their resources.

There are presently 154 Contracting Parties to the Convention, with 1674 wetland sites, totaling 150 million ha, designated for inclusion in the Ramsar List of Wetlands of International Importance.

Photo: WWF-Canon/WWF-Mediterranean/H. Schmid

(INTERNATIONAL CONSTRUCTION, June 20, 2007, Editor: Richard High)

Rail Construction Scam Probed

China's Ministry of Railways is investigating a newspaper report that claims fake materials have been used in the construction of the Wuhan-Guangzhou high-speed passenger railway.

The China Economic Times reports "large quantities of fake fly ash", as part of the project's concrete supply, had been used along hundreds of kilometers of the CNY 93 billion (US$ 12.24 billion) line.

The report said contractors were "tricked" into buying the fake material and had "used it widely", putting the safety of passengers using the railway, with trains travelling at up to 350 km per hour, at risk.

The China Economic Times report states use of the fake fly ash was only discovered in March, after a blockage occurred in a concrete pumping station's delivery pipe, by an engineer named only as Zhang.

Because of the "small" need for fly ash the railway corporation was reported as saying it did not invite bids from suppliers as it had for other construction materials. Instead, it allowed the contractors to source their own suppliers.

However, in May, as demand for fly ash began to rise in a bid to keep pace with the construction schedule, fake products found their way on to the market.

An un-named official with the Ministry of Railways told China Daily an initial investigation suggested the report had exaggerated some facts, such as the reference to the wide use of the fake materials.

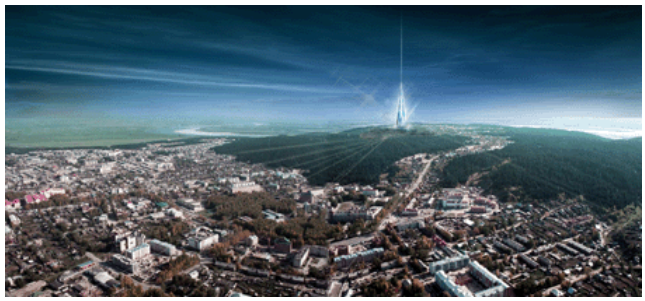
At present the Ministry has refused to make an official statement until an investigation is completed, said the source.

The Wuhan-Guangzhou Railway Corporation is also understood to have started its own investigation.

Neither the Ministry of Railways or the Wuhan-Guangzhou Railway Corporation were available for comment at the time of going to press.

(INTERNATIONAL CONSTRUCTION, July 6, 2007, Editor: Richard High)

Ecological Tower for Siberia



UK-based architects Foster + Partners has revealed its designs for an "ecological tower" in Siberia.

Dubbed the Yugra Tower by local media, the mixed-use scheme will rise above the skyline of Khanty Mansiysk, Siberia to an as yet undisclosed height.

Designed as a "new landmark", the Yugra will provide crucial amenities for the city, not least a shelter from the harsh local climate. According to a Foster + Partners' spokesman, the design concept "is driven by a progressive environmental strategy that is expected to establish new benchmarks for the region."

Set high on a hill in a densely wooded area, the tower rises above two podium buildings each facetted like a cut diamond, reflecting and refracting natural light to illuminate the interior.

At the summit, a viewing platform and restaurant will offer panoramic views over the city.

"The development will take advantage of a number of sustainable energy strategies and key to the energy performance of the building are its atria, designed to facilitate solar gain and to encourage daylight to permeate the complex," said the spokesman.

A "sensitive insertion" into the landscape, the design ensures that as much of the site as possible will remain in its natural condition.

(INTERNATIONAL CONSTRUCTION, July 10, 2007, Editor: Richard High)

Road Cartel Fined SEK 461 million

Stockholm's District Court has handed out fines totalling SEK 461 million (€ 49,5 million) to a group of six companies found guilty of operating a cartel in the Swedish road building sector between 1997 and 2001. The largest fines were given to Skanska – SEK 170 million (€ 18,3 million), NCC – SEK150 million (€16,1 million) and Peab – SEK 85 million (€ 9.1 million). The Swedish Competition Authority had originally pushed for fines totalling SEK 1,2 billion (€129 million).

All three companies have said they disagree with the Court's ruling, and Peab and Skanska say they are considering an appeal against the decision. NCC however has been more bullish, and has already announced an appeal in which it will ask for a full exemption of its fine.

NCC's senior legal counsel, Ulf Wallin said, "The City Court has not taken NCC's arguments into account. The actions taken by NCC facilitated the Swedish Competition Authority's investigations in a decisive manner and the City Court should have weighed this into its judgement.

"In addition, the amount is unreasonably high in view of the City Court's confirmation that there was no underlying general agreement to divide up all central and local government paving procurements, and that it was instead a local phenomenon that occurred over just a few years."

According to NCC its own investigations in early 2001 uncovered an illegal inter-company collaboration on contracts in Linköping in Southern Sweden. It subsequently dismissed several employees and reported the matter to the police. A subsequent investigation by the Competition Authority uncovered further infringements.

NCC argues that it should be exempt its fine on the grounds that it reported the cartel itself, and submitted evidence and its own investigation findings to the Competition Authority.

(CONSTRUCTION EUROPE, July 10, 2007 Editor: Chris Sleight)

Burj Dubai Breaks Record

The Burj Dubai, United Arab Emirates (UAE) is now the tallest building in the world having reached 512.1 m earlier this month (July), according to a statement from Dubai-based developers Emaar.

The previous record holder, Taiwan's Taipai 101, which is 508 m high, had held the record since it opened in 2004.

At 141 storeys the Burj Dubai also has more storeys than any other building in the world.

According to developer Emaar the building is still on schedule for completion in 2008, despite the collapse of original façade supplier Schmidlin Façade Technology and concerns over the concrete used in several areas (see *iC* news, April 18, 2007).

Cladding, originally expected to start being installed in the middle of last year, has now arrived, according to a statement by Emaar, and installation has begun.

Emaar has also dismissed speculation in the regional media that concrete slabs throughout the structure are being reinforced using carbon fibre. This follows news that slabs on the lower floors had been subject to significant deflections and had been repaired using external steel reinforcement.

Once complete, Burj Dubai will be the tallest structure in the world in all four of the criteria listed by the Council on Tall Buildings and Urban Habitat (CTBUH). The council measures height to the structural top, the highest occupied floor, to the top of the roof, and to the tip of the spire, pinnacle, antenna, mast or flag pole.

(INTERNATIONAL CONSTRUCTION, July 23, 2007, Editor: Richard High)

Fatalities Rise in Bridge Collapse

The death toll in the collapse of a bridge in southern China has increased to 64 after rescuers found 17 bodies in the rubble, a news report said.

It is still unclear how many victims might still be buried under the wreckage of last Monday's collapse in the tourist town of Fenghuang, the report added.

Many of those killed in one of China's worst building accidents in years were construction workers.

Local media reports state that 123 construction workers were on the 42 m high, 268 m long vehicle and pedestrian bridge removing scaffolding when it suddenly collapsed.

Most state media was banned from reporting on the disaster, and reports state that local officials punched journalists and chased them from the scene.

The reporting ban, issued by the Central Propaganda Department, came after reporters swarmed around Fenghuang.

Reports state that the accident raises questions about shoddy building and possible corruption between officials and contractors — suspicions fuelled by trying to control reporting on the disaster.

China's president Hu Jintao has called for a swift investigation into the bridge collapse, telling officials to severely punish those responsible, the report said.

According to reports, survivors have said that there had been concerns among the workers about the large size of the four stone arches capping the bridge and the lack of steel reinforcements in the structure, which consisted mainly of stone and concrete.

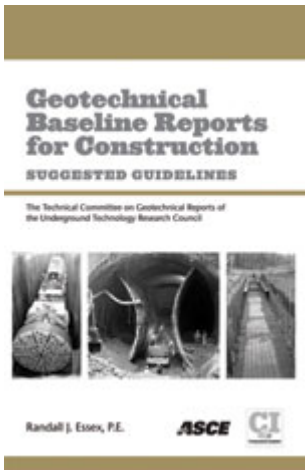
China's cabinet, the state council, has already set up a panel that will probe for problems with the project design, public bidding, construction, management or construction supervision, the report said.

Reports suggest that a large number of construction workers are still trapped in the debris of the bridge over the Tuo rivers.

More than 1500 rescue workers were looking for survivors among the debris, reports state.

(INTERNATIONAL CONSTRUCTION, August 21, 2007, Editor: Becca Wilkins)

NEW BOOKS ON GEOTECHNICAL ENGINEERING



Geotechnical Baseline Reports for Construction

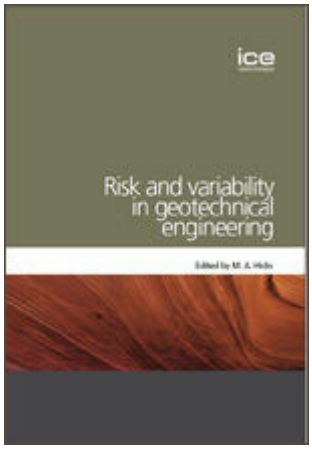
Suggested Guidelines

Randall J. Essex (Editor)

Geotechnical Baseline Reports for Construction: Suggested Guidelines examines the role of the Geotechnical Baseline Report (GBR) as a means of allocating and managing subsurface risks associated with subsurface construction. It discusses the importance and benefit of ensuring compatibility between the GBR and other contract documents, as well as the importance of involving experienced firms and individuals in the preparation and review process.

This report, prepared by the Technical Committee on Geotechnical Reports of the Underground Technology Research Council, expands on the previously published *Geotechnical Baseline Reports of Underground Construction: Guidelines and Practices.* It includes three new chapters on the application of GBR's to other types of subsurface projects, the application of GBR's in design/build project delivery, and recommendations based on industry-wide lessons learned. Other topics of this report include organization and content of a GBR, owners' perspectives, and a discussion of the rational for the use of GBR's as a risk management tool.

(American Society of Civil Engineers, 2007)



Risk and Variability in Geotechnical Engineering

M. A. Hicks (Editor)

This book presents cutting edge techniques for characterising, quantifying and modelling geomaterial variability in addition to methods for quantifying the influence of this variability on the performance of geotechnical structures. It includes state-of-the-art refereed journal papers by leading international researchers along with written and informal discussions on a selection of key submissions that were presented at a Symposium at the Institution of Civil Engineers on 9th May 2005.

The thirteenth Géotechnique Symposium in Print focused on the fact that soils and rocks are variable materials, and that taking account of this geologic variability appears crucial for a proper understanding of various geotechnical problems. The aims of the Symposium were to consider the nature, measurement and statistical characterisation of soil variability, and to demonstrate how probabilistic and stochastic methods of analysis may be used to assess the effects of soil variability and, through increased understanding, influence geotechnical design and construction. It was attended by delegates from fourteen countries, and was divided into four sessions – Characterisation, Modelling, Design, and Applications. Each session comprised three presentations, followed by an informal discussion with questions from the floor.

This book brings together, in one volume, all related papers that were published in Géotechnique, as well as written and informal discussions about the papers plus an additional late paper that was published in Géotechnique in August 2005. The papers consist of both theoretical and practical guidance, including case histories; while applications include foundations, retaining structures, slopes and soil-structure interaction.

Risk and variability in geotechnical engineering provides practitioners and researchers with an ideal opportunity to be fully updated on the latest developments in a new and rapidly developing area of geotechnical engineering.

(Institution of Civil Engineers, 2007)

Geotechnik

Bodenmechanik, Grundbau und Tunnelbau

Dimitrios Kolymbas

Sowohl das theoretische Fach Bodenmechanik (einschließlich Felmechanik) wie auch sein technisches Pendant, die Geotechnik (einschließlich Tunnelbau), stellen Wissensgebiete dar, in welchen intensiv geforscht und entwickelt wird. Die Bodenmechanik findet zunehmend Interesse auch außerhalb des Bauingenieurwesens: In der Physik, der mechanischen Verfahrenstechnik und der Geologie.

Das vorliegende Buch dokumentiert die inhärente Beziehung zwischen Bodenmechanik (Theorie) und Geotechnik (Praxis) und trägt der rasanten Entwicklung auf seinem Gebiet dadurch Rechnung, dass es sich auf die Darstellung von Konzepten konzentriert. Dafür werden Details ausgelassen, die das Verständnis erschweren, da sie vom Wesentlichen ablenken und ohnehin einer ständigen Variation unterliegen.

Die vorliegende zweite Auflage enthält viele Berichtigungen und Erweiterungen, die unter anderem auch die Felsmechanik und den Tunnelbau betreffen.

Das Buch richtet sich sowohl an Studierende als auch an Ingenieure aus der Praxis, die ihr Wissen abrunden wollen.

Geschrieben für: Ingenieure in Forschung und Praxis, Studenten des Bauwesens

(Springer, 2007)

Earthquake Early Warning Systems

Paolo Gasparini, Gaetano Manfredi, and Jochen Zschau (Editors)

During the past few decades, economic losses and human casualties due to natural disasters increased exponentially on our planet, mainly because of the increased density of population and industry in high hazard areas. Although the prediction of earthquakes is not practicable yet, the present technology allows a prompt identification of the onset of any dangerous seismic event before it hits an urban area. Earthquake early warning can provide an alert within a few tens of seconds in advance. This small lead time may be used to minimize property damage and loss of lives in metropolitan areas and to aid emergency response. The book provides information on the major EEW systems in operation and on the state of the art of the different blocks forming an EW system: the rapid detection and estimation of the earthquake's focal parameters, the signal transmission, the engineering interface and the information reliability/false alarm problem.

Written for: Academics, scientists and researchers

(Springer, 2007)

Earthquake Geotechnical Engineering

4th International Conference on Earthquake Geotechnical Engineering - Invited Lectures

Series: Geotechnical, Geological, and Earthquake Engineering , Vol. 6

Pitilakis, Kyriazis D. (Editor)

The book contains the invited keynote and theme lectures presented at the 4th International Conference on Geotechnical Earthquake Engineering (4ICEGE). The conference was held in Thessaloniki, Greece, from 25 to 28 June, 2007, and was organized by the Technical Committee of Earthquake Geotechnical Engineering (TC4) of the International Society of Soil Mechanics and Geotechnical Engineering (ISSMGE), the Hellenic Scientific Society of Soil Mechanics and Geotechnical Engineering and the Laboratory of Soil Dynamics and Geotechnical Earthquake Engineering of Aristotle University of Thessaloniki.

It provides a comprehensive overview of the progress achieved to date in soil dynamics and geotechnical earthquake engineering, as well as in engineering seismology and seismic risk assessment and management. In situ and laboratory testing, theoretical issues and numerical modeling of soil dynamics, seismic hazard with emphasis on the long-period ground motion displacements, site effects and microzonation, liquefaction assessment and mitigation, soil-structure interaction, performance based design of geotechnical structures, earthquake resistant design and performance of shallow and deep foundations, retaining structures, embankments and dams, underground structures and lifelines, are all among the different topics covered in this book. Interdisciplinary subjects such as vulnerability assessment of, transportation networks and lifelines as well as of geotechnical structures are also discussed. Finally, the book provides a thorough presentation of the existing worldwide important large-scale testing facilities and geotechnical strong ground motion arrays.

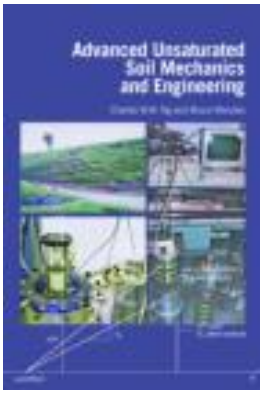
The book is organized in nineteen chapters written by distinguished experts and includes the 2nd Ishihara Lecture given by Prof. Izzat M. Idriss in honor of Prof. Kenji Ishihara. The aim is to present the current state of knowledge and engineering practice, addressing recent and ongoing developments while also projecting innovative ideas for future research and development

Audience

Earthquake geotechnical and structural engineers, civil engineers, geologists, geophysicists and seismologists will find in this book the most recent advances in soil dynamics, earthquake and geotechnical engineering, as well as their interfaces with geology, geophysics and engineering seismology. It is of interest not only to scientists, engineers and students, but also to those interested in earthquake hazard assessment and mitigation.

Written for: Civil engineers in the fields of geotechnical and earthquake engineering and soil dynamics; scientists and researchers in the fields of seismology, geology and geophysics

(Springer, 2007)



Advanced Unsaturated Soil Mechanics and Engineering

Charles W.W. Ng, Bruce Menzies

Analytical and comprehensive, this state-of-the-art book, examines the mechanics and engineering of unsaturated soils, as well as explaining the laboratory and field testing and research that are the logical basis of this modern approach to safe construction in these hazardous geomaterials; putting them into a logical framework for civil engineering and design.

It:

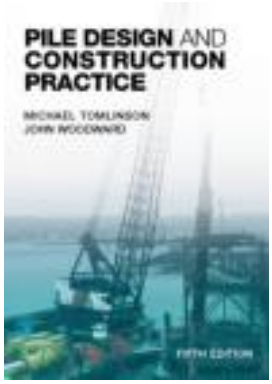
- illustrates the importance of state-dependent soil-water characteristic curves
- highlights modern soil testing of unsaturated soil behaviour, including accurate measurement of total volume changes and the measurement of anisotropic soil stiffness at very small strains
- introduces an advanced state-dependent elasto-plastic constitutive model for both saturated and unsaturated soil
- demonstrates the power of numerical analysis which is at the heart of modern soil mechanics
- studies and simulates the behaviour of loose fills from unsaturated to saturated states; explains the difference between strain-softening and static liquefaction, and describes real applications in unsaturated soil slope engineering

- includes purpose-designed field trials to capture the effects of two independent stress variables, and reports comprehensive measurements of soil suction, water contents, stress changes and ground deformations in both bare and grassed slopes

- introduces a new conjunctive surface and subsurface transient flow model for realistically analysing rainfall infiltration in unsaturated soil slopes, and illustrates the importance of the flow model in slope engineering.

Including constitutive and numerical modelling, this volume will interest students and professionals studying or working in the areas of geotechnical engineering and the built environment.

(Taylor and Francis, 2007)



Pile Design and Construction Practice

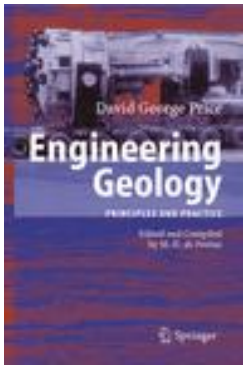
Michael J Tomlinson, John Woodward

This well-established and internationally recognized reference is an essential handbook for geotechical engineers and engineering geologists responsible for designing and constructing piled foundations for building and civil engineering structures. Michael Tomlinson and John Woodward explain the general principles and practices of piling and give a detailed review of the types of pile, piling equipment and methods which are currently used. They provide students with more comprehensive information on the subject than is generally available in a civil engineering degree course.

Chapters on pile design include calculating the resistance of piles to compressive loads, pile groups under compressive loading, piled foundations for resisting uplift and lateral loading and the structural design of piles and pile groups. Piling for marine structures, miscellaneous piling problems (including machinery foundations, underpinning, mining subsidence areas, piling contracts and frozen ground), durability of piled foundations, ground investigations, piling contracts and pile testing are also covered.

The fifth edition of this well-established book introduces the 2005 version of Eurocode7, Geotechnical Design, and covers other relevant Eurocodes. It also covers BS 8004 and refers to BS 6349 on maritime structures, and new forms of civil engineering contracts suitable for piling projects are discussed. Highly illustrated, this book includes numerous worked examples to the codes, many of which are based on actual problems encountered.

(Taylor and Francis, 2007)



Engineering Geology

David George

This text is directed at the heart of Engineering Geology where geology is used to identify potential problems arising from ground conditions. It describes how to investigate those conditions and to define an engineering response that will either avoid or reduce or even eliminate the problems revealed.

The text is written for students of geology, engineering geology and civil engineering and illustrates how geology is related to calculations of stability, deformation and groundwater flow. The reader is constantly presented with the "big geological picture" that is so often lacking when only site details are available and yet so necessary for an adequate engineering solution to be found.

Written for: Graduate students, lecturers, professionals, undergraduates (geology, civil engineering, urban and information planning)

(Springer, 2008)

Piling Engineering

Keith Elson, Ken Fleming, Mark Randolph, Austin Weltman

Piling is a fast moving field, and in recent years there have been major advances in theory, methods, testing procedures and equipment.

The third edition of this well established book has been comprehensively updated to cover these advances. Retaining the framework of previous editions, it provides a readable and well-illustrated account of design techniques, methods of testing and analysis of piles, with a marked emphasis on practice.

Piling Engineering is written for geotechnical engineers, consultants and foundation contractors. It will also be a useful reference for academics and advanced students on courses in piling, practical site investigation, and foundation design and construction.

(Taylor and Francis, 2007)

HDPE Geomembranes in Geotechnics

Müller, **Werner W.**

Original German edition published by Birkhäuser Verlag

HDPE (High-density polyethylene) geomembranes are nowadays widely used for large-area liners and construction sealings in geotechnical engineering. Lining of water ponds, dams and dykes, landfill base liners and cover systems, remediation of contaminated sites, waterproof for tunnels, beneath highways and for various other civil engineering constructions are a few examples of application. The book covers all aspects of the HDPE geomembrane field: HDPE materials, geomembrane manufacture, textured geomembranes, properties, long-term performance and testing, installation and welding of geomembranes, quality assurance and control, leak detection, standards, recommendations and regulations. Various important topics are treated in detail. As part of it, the basic physical and chemical facts necessary to fully understand HDPE geomembrane properties and performance are carefully developed and explained. The book may therefore serve as a true handbook for manufacturers, designers, testing and inspection engineers and consultants and representatives of responsible administrations giving all relevant facts for appropriate design, manufacture and installation, testing and assessment of performance. Parts of it may also be used as textbook for lectures or seminars on geosynthetics and geotechnical or geoenvironmental engineering with geosynthetics in faculties of materials science and civil engineering.

Written for: Civil engineers, geotechnical engineers, material scientists, geosynthetics industry

(Springer, 2007)

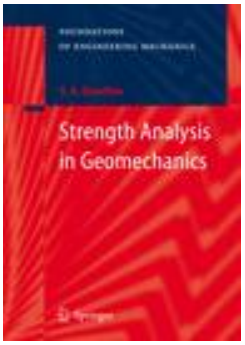
Advances in Deep Foundations: International Workshop on Recent Advances of Deep Foundations (IWDPF07)

1–2 February 2007, Port and Airport Research Institute, Yokosuka, Japan

Yoshiaki Kikuchi, Jun Otani, Makoto Kimura, Yoshiyuki Morikawa (Editors)

Civil Engineering has recently seen enormous progress in the core field of the construction of deep foundations. This book is the result of the International Workshop on Recent Advances in Deep Foundations (IWDPF07), which was held in Yokosuka, Japan from the 1st to the 2nd of February, 2007. Topics under discussion in this book include recent research achievements and case histories; and current advances in the applied aspects of deep foundations, such as reliability-based design, field tests and experimental field work. The book also features the latest numerical simulation methods and theoretical findings. There are nine keynote lectures, focusing on foundation engineering in different parts of the world, and thirty-three state-of-the-art papers from eminent international experts. The techniques covered include sheet piles, piles, pile-ground improvement and ground improvement, while dynamic aspects and design are also discussed.. This book is intended for an international audience of researchers and professionals in soil and foundation engineering.

(Taylor and Francis, 2007)



Strength Analysis in Geomechanics

Series: Foundations of Engineering Mechanics

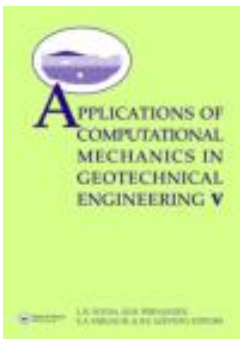
Elsoufiev, Serguey A.

The book presents a new approach for the solution of geomechanical problems - it explicitly takes into account deformation and fracture in time, which are neglected in classical methods although these properties create important effects. The method reveals the influence of the form of a structure on its ultimate state. It uses the rheological law which accounts for large strains at a non-linear unsteady creep, an influence of a stress state type, an initial anisotropy and damage. The whole approach takes into account five types of non-linearity (physical as well as geometrical ones) and contains several new ideas. For example, it considers the fracture as a process, the difference between the body and an element of the material which only deforms and fails because it is in the structure, the simplicity of some non-linear computations against the consequent linear ones, the dependence of the maximum strain in dangerous poins of the body only on the material.

Written for:

For graduate students and researchers in Mechanical and Geomechanical Engineering

(Springer, 2007)



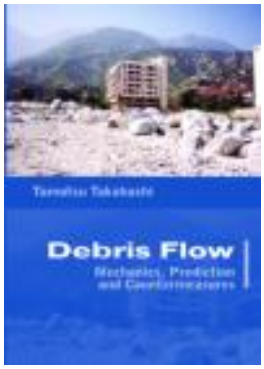
Applications of Computational Mechanics in Geotechnical Engineering V: Proceedings of the 5th International Workshop, Guimaraes, Portugal 1–4 April 2007

Luvs Ribeiro e Sousa, M.M. Fernandes, Eurvpedes Vargas Jr., Robero Azevedo (Editors)

Geotechnical works involve complex geo-engineering issues, which are reviewed in this volume presenting the very latest research and practice in computational mechanics in geotechnical engineering. *Application of Computational Mechanics in Geotechnical Engineering V* contains contributions on soil and rock excavations, underground structures and ground rein-

forcement; and on the construction of dams, embankments and rail track. Other papers consider the geomechanics of oil exploration and rock mechanics in mining; while environmental contributions include groundwater management. A wide range of methodologies are discussed: inversed methodologies, artificial intelligence and computational systems, which highlight future trends in the area of computational mechanics applied to geotechnical problems. The book will be of interest to researchers, academics, students, software developers, and practical engineers across the field of geotechnics.

(Taylor and Francis, 2007)



Debris Flow

Mechanics, Prediction and Countermeasures

Tamotsu Takahashi

A comprehensive account, treating both theoretical and applied aspects of debris flow. The text begins with a discussion of fundamental mechanical aspects, such as flow characteristics, type classification, mechanics, occurrence and development, fully-developed flow and deposition processes. The second part of the book sheds light on the application of theory in relation to computer-simulated reproductions of real disasters. Attention is paid to debris flow controlling structures, design effectiveness and performance, soft countermeasure problems, such as identification of debris flow prone ravines and the prediction of occurrence by the concept of precipitation threshold. The qualitative and fundamental character of this book makes it an excellent textbook for graduate courses in debris flow and it is recommended reading for professionals in engineering, geosciences and water resources who are concerned with mechanics and countermeasures of debris flow.

(Taylor and Francis, 2007)

Handbook of Geotechnical Investigation and Design Tables

Burt G. Look

This practical handbook of properties for soils and rock contains, in a concise tabular format, the key issues relevant to geotechnical investigations, assessments and designs in common practice. In addition, there are brief notes on the application of the tables. These data tables are compiled for experienced geotechnical professionals who require a reference document to access key information. There is an extensive database of correlations for different applications. The book should provide a useful bridge between soil and rock mechanics theory and its application to practical engineering solutions.

The initial chapters deal with the planning of the geotechnical investigation, the classification of the soil and rock properties and some of the more used testing is then covered. Later chapters show the reliability and correlations that are used to convert that data in the interpretative and assessment phase of the project. The final chapters apply some of these concepts to geotechnical design.

This book is intended primarily for practicing geotechnical engineers working in investigation, assessment and design, but should provide a useful supplement for postgraduate courses.

(Taylor and Francis, 2007)

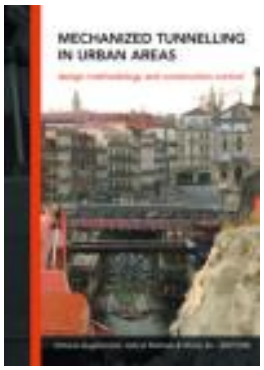
Sprayed Concrete Lined Tunnels

Alun Thomas

Practising engineers on site, in the design office or in client organizations will find this book an excellent introduction to the design and construction of sprayed concrete lined (SCL) tunnels. The complex behaviour of the early age behaviour of the sprayed concrete requires careful management. This book covers all aspects of SCL tunnelling – from the constituents of sprayed concrete to detailed design and management during construction. Although there is a close interdependence between all the facets of sprayed concrete, few engineers have the right breadth of experience and expertise, and this urgently needs to be transferred to the wider engineering community.

Disseminating essential information for tunnelling engineers, *Sprayed Concrete Lined Tunnels* is key reading for all involved in or studying the process.

(Taylor and Francis, 2007)



Mechanized Tunnelling in Urban Areas

Vittorio Guglielmetti, Ashraf Mahtab, Shulin Xu (Editors)

Internationally, the mechanized excavation of tunnels has intensified in the last two decades, as the number of tunnels being constructed for subways and railway underpasses increases. The subject of mechanized tunnelling in urban areas has not previously received the attention that it deserves, despite there being specific hazards associated with the construction of tunnels in metropolitan areas, including poor ground conditions, water tables higher than the level of tunnels, and subsidence leading to damage to the existing structures on the surface. The application of technologies for achieving the stability of the tunnel and for minimizing surface settlement is described in this book. Accurate characterization of the ground; rigorous assessment and management of risk from design to maintenance; the correct choice of a tunnel boring machine and a

plan for the advancement of the tunnel; specific excavation procedures and real-time monitoring of excavation parameters are all discussed in this thorough work.

(Taylor and Francis, 2007)

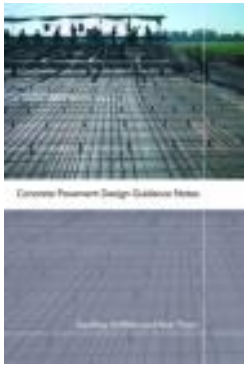
Internal Erosion of Dams and their Foundations

Selected and Reviewed Papers from the Workshop on Internal Erosion and Piping of Dams and their Foundations, Aussois, France, 25–27 April 2005

Robin Fell, Jean-Jacques Fry (Eds)

Internal erosion and piping in embankments and their foundations is the main cause of failures and accidents to embankment dams. For new dams, the potential for internal erosion and piping can be controlled by good design and construction of the core of the dam and provision of filters to intercept seepage through the embankment and the foundations. This book presents selected and reviewed papers from the Workshop on Internal Erosion and Piping of Dams and their Foundations, which was held from 25 to 27 April, 2005 in Aussois, France. The book covers the whole internal erosion process, from initiation of erosion, continuation, progression to form a pipe, and formation of a breach. An overview paper based on the papers and discussion at the Workshop describes the state of the art and research needs. *Internal Erosion of Dams and their Foundations* will be most valuable to dam engineers, researchers and students who are involved in assessing the safety of embankment dams from internal erosion and piping.

(Taylor and Francis, 2007)



Concrete Pavement Design Guidance Notes

Geoffrey Griffiths, Nick Thom

This comprehensive design guide summarizes current developments in the design of concrete pavements. Following an overview of the theory involved, the authors detail optimum design techniques and best practice, with a focus on highway and infrastructure projects.

Worked examples and calculations are provided to describe standard design methods, illustrated with numerous case studies. The author provides guidance on how to use each method on particular projects, with reference to UK, European and US standards and codes of practice.

Concrete Pavement Design Guidance Notes is an essential handbook for civil engineers, consultants and contractors involved in the design and construction of concrete pavements, and will also be of interest to students of pavement design.

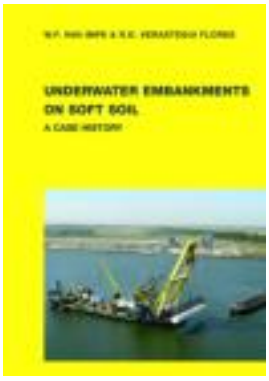
(Taylor and Francis, 2007)

Manual on Deformation Controlled Densified Stone (DDS) Columns

Author(s) - R.K. Katti, A.R. Katti, D.R. Katti, Suprakash Choudhry, Prashant Navalakha, Zeeshan Shaikh

Combining principles of Newtonian mechanics and Terzaghian soil mechanics with principles of earth sciences, thermodynamics, physical sciences and wave mechanics, the author and his team have devised a road map for a logical approach to soil as particulate matter in modern geotechnical engineering. This manual explains the analysis and design aspects of a range of DDS columns and discusses the resolution of foundation problems in so-called treacherous expansive soil deposits by the development of cohesive non-swelling soil technology. This manual will assist consulting engineers in designing DDS systems, enabling contractors to provide competitive bidding and aid in teaching the subject with greater clarity.

(Taylor and Francis, 2007)



Underwater Embankments on Soft Soil: A Case History

William F. Van Impe, R. Daniel Verastegui Flores

Ground improvement is an established technique in foundation engineering. In recent decades, modern methods of ground improvement have utilised explosives, impact energy, thermal treatment of the soil, vacuum consolidation, vibratory compacttion technologies, stabilization and solidification of soft soils, as well as combined systems of ingenious grouting systems and deep mixing technique. Internationally, deep mixing techniques are often the chosen method for dealing with increasingly-demanding foundation problems. Initial experiences, using inventive new developments of soft soil deep mixing technologies and various advanced high pressure mixing methods, have proved successful both onshore and offshore. This publication illustrates a challenging example, sited in the Port of Antwerp, Belgium, of the design and construction of a large underwater embankment on very soft soil. This text will be a valuable reference case history for the geotechnical engineer, both from the academic's as well as from the practitioner's point of view.

(Taylor and Francis, 2007)

Reliability-Based Design in Geotechnical Engineering: Computations and Applications

Kok-Kwang Phoon (Editor)

Reliability-based design is the only engineering methodology currently available which can ensure self-consistency in both physical and probabilistic terms, and which is compatible with the theoretical basis underlying other disciplines such as structural design. It is especially relevant as geotechnical design becomes subject to increasing codification and to code harmonization across national boundaries and material types, and as it begins to conform to an umbrella framework predominantly established by structural engineers. Already some

codes of practice describe the principles and requirements for safety, serviceability, and durability of structures, and thereby establish the basis for their design and verification. These codes also give guidelines for related aspects of structural reliability. A major challenge is to encourage geotechnical engineers to apply reliability-based design in a realistic context that recognizes the complex variabilities in geomaterials and model uncertainties arising from a profession steeped in empiricism. This book presents practical computational methods in concrete steps that can be followed by engineers and students. It also provides geotechnical examples illustrating reliability analyses and design. By focusing on learning through computations and examples, this book serves as a valuable reference for engineers and a resource for students.

(Taylor and Francis, 2007)

Concrete Pavement Design, Construction, and Performance

Norbert Delatte

Addressing the interactions between the different design and construction variables and techniques this book illustrates best practices for constructing economical, long life concrete pavements.

The book proceeds in much the same way as a pavement construction project. First, different alternatives for concrete pavement solutions are outlined. The desired performance and behaviour parameters are identified. Next, appropriate materials are outlined and the most suitable concrete proportions determined. The design can be completed, and then the necessary construction steps for translating the design into a durable facility are carried out. Although the focus reflects highways as the most common application, special features of airport, industrial, and light duty pavements are also addressed.

Use is made of modeling and performance tools such as HIPERPAV and LTPP to illustrate behavior and performance, along with some case studies. As concrete pavements are more complex than they seem, and the costs of mistakes or of over-design can be high, this is a valuable book for engineers in both the public and private sectors.

(Taylor and Francis, 2007)

Advanced Soil Mechanics 3rd Edition

Braja Das

This revised and updated edition of Advanced Soil Mechanics presents a step-by-step guide to all aspects of the subject to students, and addresses a wide range of topics in a logical and extensively illustrated approach, including:

grain-size distribution
the nature of water in clay
consistency of cohesive soils
weight-volume relationships
soil classification systems
concepts of elasticity
equations of equilibrium.

The book is illustrated with mathematical derivations and clear diagrams, problems and examples are provided throughout and each chapter concludes with a list of references for further in-depth review or research. Advanced Soil Mechanics is valuable not only for upper-level undergraduate and graduate level students of civil engineering, engineering mechanics, and soil mechanics, but also as a reference for professionals working in these fields.

(Taylor and Francis, 2007)

The Mechanics of Soils and Foundations 2nd Edition

John Atkinson

Ideal for undergraduates of geotechnical engineering for civil engineers, this established textbook sets out the basic theories of soil mechanics in a clear and straightforward way; combining both classical and critical state theories and giving students a good grounding in the subject which will last right through into a career as a geotechnical engineer.

The subject is broken down into discrete topics which are presented in a series of short, focused chapters with clear and accessible text that develops from the purely theoretical to discussing practical applications. Soil behaviour is described by relatively simple equations with clear parameters while a number of worked examples and simple experimental demonstrations are included to illustrate the principles involved and aid reader understanding.

(Taylor and Francis, 2007)

Underground Space – The 4th Dimension of Metropolises: Proceedings of the World Tunnel Congress 2007 and 33rd ITA/AITES Annual General Assembly, Prague, May 2007

Jirv Bartak, Ivan Hrdina, Georgij Romancov, Jaromvr Zlamal (Editors)

The so-called fourth dimension of a metropolis is the underground space beneath a city which typically includes structures such as tunnels, which facilitate transport and provide gas, water and other supplies. Underground space may also be utilised for living, working and recreational facilities and Industrial storage. These volumes focus on underground city design and planning; geotechnical survey and improvement of ground mass; and research, development and design of underground constructions in built-up areas. Also covered is the construction and monitoring of urban tunnels, including underground constructions executed from the surface; distribution and management of risks and accidents during tunnelling; tunnel equipment; fire and operational safety. This collection of papers will be invaluable to researchers, scientists, engineers and professionals working in the underground space.

(Taylor and Francis, 2007)

ABOUT THE HELLENIC SOCIETY FOR SOIL MECHANICS AND GEOTECHNICAL ENGINEERING

The Hellenic Society of Soil Mechanics and Geotechnical Engineering (HSSMGE) is the National Geotechnical Society of Greece. GSSMGE is a member of the International Society of Soil Mechanics and Geotechnical Engineering (ISSMGE) and of the International Society for Rock Mechanics (ISRM).

The Society was founded in 1966 and recently celebrated its 40th anniversary. Today it counts 190 members and is administered by an Executive committee of 9 regular and 4 substitutional members, as well as a 3-member Checking Committee. Both Committees are elected by vote, with a term of office of 3 years.

The 40-year life of our Society coincides with a period of rapid and remarkable progress of all branches of Geotechnical Engineering, such as Soil and Rock Mechanics, Soil Dynamics and Earthquake Engineering and Underground Works Technology. At the same time, new fields of geotechnics were developed, such as those concerning Geosynthetic Applications and Geoenvironmental Engineering.

Analogous also was the development of the means and technologies for the Construction of Geotechnical Works.

This progress was achieved of course at international level, but Greece had also its share, not only by importing know-how from abroad, but also by carrying out basic and applied research in the Technical Universities of the country, as well as by the experience gained during the design and construction of major infrastructure works, particularly after Greece became a member of the European Union.

The Public Power Corporation hydroelectric schemes, the "Egnatia Odos" motorway, the Patras – Thessaloniki (PATHE) motorways, the links of Rion – Antirrion and Aktion – Preveza, the "Attiki Odos" motorway, the Athens Metro, the extensions and upgrading of the railway network including the Suburban Railway of Athens, the New Athens Airport, the waste disposal schemes, the works of the Olympics and many other major infrastructure works, gave the Greek geotechnical engineers the opportunity to gain new knowledge and experience and to exercise their skills and inventiveness. Due to their significant contributions, it became common conviction to all parties associated with the production of civil works that geotechnical design is of primary importance and a basic part of the overall design of the works.

The Hellenic Society of Soil Mechanics and Geotechnical Engineering, as the official scientific institution of the Greek geotechnical engineers, in collaboration with the Technical Universities and the Technical Chamber of Greece, contributed substantially to the dissemination of knowledge and to the progress of Geotechnical Engineering in Greece, with various initiatives and activities such as:

- Organization of seminars, workshops, round table discussions, one-day conferences-meetings etc.
- Organization of lectures by geotechnical experts on subjects of their specialization.
- Organization of National (Panhellenic) Conferences on Geotechnical and Geoenvironmental Engineering, every four years, in collaboration with the Technical Chamber of Greece. Five such conferences have been held up to now, in various cities of Greece, with great success and their proceedings reflect the progress of geotechnics in Greece. The last one was held in Xanthi (Thrace) last year.
- Organization, every two years in Athens, of the "Athenian Geotechnical Lecture" delivered by a prominent Greek or foreign geotechnical engineer. Four such lectures have organized till now, delivered by Professors Harry Poulos (2000), Robert Mair (2002), George Gazetas (2004) and Alain Pecker (2006).
- Organization of International Symposia, Conferences etc. Such events have been:
  - International Symposium on Geotechnical Engineering of Hard Soils – Soft Rocks (Athens, 1993), in collaboration with the French Geotechnical Society.
  - 13th European Young Geotechnical Engineers Conference, (Santorini, 1999).
  - International Seminar on "Geotechnics in Pavement and Railway Design & Construction" (Athens, 2004).
  - 4th International Conference on Earthquake Geotechnical Engineering (Thessaloniki, 2007).
- Financial support to young geotechnical engineers for their participation in the European and International Young Geotechnical Engineers Conferences.
- Participation of HSSMGE members in official committees of Greek State agencies, as well as European and international committees, for drafting Codes, Standards and Specifications, or dealing with special subjects.
- Participation of HSSMGE members in European and International Symposia and Conferences, with paper presentations or as panel members.
- Edition of a News Bulletin with information about the Society's activities, various national and international geotechnical events, announcements of forthcoming Conferences & Symposia, new books, etc.

A diary of recent activities of the Society follows.

Diary or recent events organized or supported by H.S.S.M.G.E., or with a broad and active participation of its members (during the term of the present Executive Committee: May 2005 to date)

30.05.2005	Lecture by Prof. Roger Frank "Micropiles: Research and Applications", Athens.
13 ÷ 16.06.2005	International Workshop "Degradation, Instabilities and Bifurcation in Geomechanics", Chania, Krete.
11 ÷ 12.10.2005	1st Greece – Japan Workshop "Seismic Design, Observation, Retrofit of Foundations", Athens.
07.11.2005	Lecture by Prof. Paul Marinos "The New Base Tunnels of the Alps: The Tunnels of the New Century", Athens.
05.12.2005	Half – Day Conference "Ground Pollution – Prevention and Remediation", Athens.
23.01.2006	4th Athenian Geotechnical Lecture by Prof. Alain Pecker "Enhanced Seismic Design of Shallow Foundations: Example of the Rion – Antirrion Bridge", Athens.
13.03.2006	Lectures by Young Geotechnical PhD Engineers, Athens:

Andrew Antoniou: "Application of Geographical Informatic Systems in Geotechnical Engineering".

George Chlimintzas: "Estimate of Permanent Displacements due to Earthquake in Soil Slopes, Using a Simplified Analysis of Sliding".

31.05÷02.06.2006: 5th Panhellenic Conference on Geotechnical and Geoenvironmental Engineering, Xanthi, Thrace.

14.09.2006 Lecture by Prof. Robert Mair (Repetition of his Ranking Lecture) "Tunneling and Geotechnics – New Horizons", Athens.

11.12.2006: Lectures by Young Geotechnical PhD Engineers, Athens:

Prodromos Psarropoulos "Soil Dynamic Modeling in Seismic Analysis of Bridge Piers and Abutments".

Helena Coumoulou "Modeling in the Centrifuge of the Movement of Heavy Non-Water-Soluble Liquid Pollutants".

19.12.2006 Lecture by Mrs Ada Athanasopoulou, Geotechnical Engineer, MSc "Investigation of the Behavior of Flood Protection Systems of New Orleans, during the Katrina Hurricane on the 29th August 2005", Athens.

11.01.2007 One-Day Conference "Geotechnical Applications of Geosynthetics", Athens.

01.02.2007 One-Day Conference "Tunnel Excavation with TBMs – Recent Developments", Athens.

15.05.2007 Celebration for the 40th Anniversary of H.S. S.M.G.E., Lecture by E. Sotiropoulos, Civil Engineer MSc, Ex-President of the Society "Soil Mechanics – Past, Present and Future", Athens.

18.06.2007 Lecture by Prof. Mounir Khaled Berrah, Professor of Civil Engineering Ecole Nationale Polytechnique of Algeria, Athens.

20 ÷ 22.06.2007 International conference on the Advanced Characterisation of Pavement and Soil Engineering Materials, Athens.

25 ÷ 28.06.2007 4th International Conference on Earthquake Geotechnical Engineering, Thessaloniki.

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