65 million-year-old chalk outcroppings mark the end of the Jurassic Coast - Old Harry Rocks!

Αρ. 152 – ΙΟΥΛΙΟΣ 2021

ΕΛΛΗΝΙΚΗ
ΕΠΙΣΤΗΜΟΝΙΚΗ
ΕΤΑΙΡΕΙΑ
ΕΔΑΦΟΜΗΧΑΝΙΚΗΣ
& ΓΕΩΤΕΧΝΙΚΗΣ
ΜΗΧΑΝΙΚΗΣ

Τα Νέα της Ε Ε Ε Ε Γ Μ

152

What makes good design?

Good design in the built environment begins in the instant that an idea or improvement is born. In practice, however, it is all too often assumed that good design simply relates to the appearance and function of a piece of infrastructure, or how it fits into its wider systems.

The National Infrastructure Commission (NIC)'s design principles go beyond simply aesthetic and technical appraisal and relate to climate, people, places and value. This report addresses the question, "What makes good design?" by drawing on the NIC's work, the basis of a detailed survey of ICE members' experiences.

Our findings paint a picture of how civil engineers work and how they feel about issues related to climate, people, places and value, identifying the gap between aspiration and day-to-day practices. Discussions about the responses point to where we can share best practice and make improvements. It has been a fascinating journey. We are enormously grateful to the NIC Design Group for its valuable input into this review, to the ICE members who took part and the industry experts who shared their views.

A major Institution of Civil Engineers survey report provides an insight into members' understanding of 'good' design and the cultural shift needed to help them deliver it.

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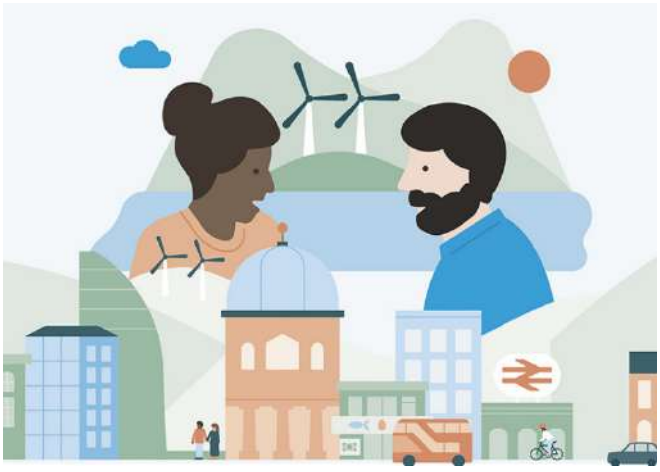
What makes good design?

A major ICE survey report provides an insight into members' understanding of 'good' design and the cultural shift needed to help them deliver it.



Some 900 ICE members were surveyed about their awareness and understanding of what makes good design.

- **Updated:** 13 July 2021
- **Author:** Ruby Kitching, ICE Head of Engineering Insight

As ICE President Rachel Skinner points out in her foreword to the Institution of Civil Engineers' new What Makes Good Design? report, good design in the built environment begins in the instant that an idea is born. In practice, however, it is too often assumed that good design simply relates to the appearance and function of a piece of infrastructure, or how it fits into its wider systems.

In February 2020, the National Infrastructure Commission (NIC) published a set of four design principles for new infrastructure projects. These were:

- **Climate**: Infrastructure must help to set the trajectory for the UK to achieve net zero greenhouse gas emissions by 2050 or sooner and be capable of adapting to climate change.
- **People**: Projects should be human scale, instinctive to use and seek opportunities to improve the quality of life for people who live and work nearby.
- **Places**: Schemes should provide a sense of identity for communities, supporting the natural and built environment and enriching ecosystems.
- **Value**: This should be added beyond the main purpose of infrastructure, solving problems well and achieving multiple benefits.

In September 2020, ICE, in collaboration with the NIC Design Group, surveyed ICE members to establish how relevant they believed the four principles to be to their work, and to discover more about how they perceived their own role in the development of good design. Some 900 UK-based ICE members responded.

While their responses were being analysed, the Government announced that it had adopted the NIC's recommendations on design made in the National Infrastructure Assessment, highlighting its call for a design champion to be appointed on every infrastructure project.

Findings and next steps

This report contains the survey results. One key finding was that about 60% of respondents thought climate issues were not given enough importance in design. Another was that while respondents broadly supported the view that wherever they were in the project lifecycle they had a responsibility to influence design, they believed the skills to achieve this were lacking at every level.

Based on the findings, and input from the NIC Design Group, ICE has identified recommendations to pursue both for itself and in collaboration with other bodies.

Among these, the climate needs to be higher up the agenda for all institution activities to help create the right environment to support the implementation of low carbon solutions.

More widely, best practice examples of design for climate, people, places and value need to be showcased to help the profession to upskill and for all people involved in a project to identify as 'designers' wherever they are in its lifecycle. From this, design champions can naturally emerge.

Download this document

https://www.ice.org.uk/knowledge-and-resources/briefing-sheet/what-makes-good-design-report?_ga=2.142336693.682149997.1626342396-1395896321.1580225714

bulletin · δελτίο
OF THE GEOLOGICAL SOCIETY OF GREECE ΤΗΣ ΕΛΛΗΝΙΚΗΣ ΓΕΩΛΟΓΙΚΗΣ ΕΤΑΙΡΙΑΣ

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Table of Contents

Natural Hazards

https://ejournals.epublishing.ekt.gr/index.php/geosociety/issue/view/1637

What is GEOLAB?

Investing in Europe's geotechnical research facilities

GEOLAB is an alliance of eleven unique research installations. This European consortium led by Deltares was established to boost geotechnical research and innovation. Innovative solutions are needed to safeguard the proper functioning of critical European infrastructure for the long term.

The alliance was facilitated by the European Horizon 2020 programme for supporting experimental research and improving European research facilities. The total funding for the project amounts to €5 million. The project started on 1 February 2021 and it will run for four years.

Why is it needed?

Critical European infrastructure in the water, energy, urban and transport sectors is at risk from climate change, extreme weather and ageing. At the same time, roads, railway lines or electricity grids are expected to manage more intensive use and new requirements, for example as a result of the energy transition.

Work in these research facilities has, until now, been conducted independently and without central coordination. That has limited the scope of the results for use by academic institutions and industry. The integration of the European research facilities will remedy that situation. With cutting-edge research and innovation, GEOLAB aims to tackle the challenges of preserving Europe's critical infrastructure for future generations.

"The Geolab project will deliver new data that provide distinctive and novel insights, allowing for innovative solutions in the field. These tests and validation procedures are absolutely necessary for contractors, especially those working on vital and sensitive infrastructure. I expect this network of data and testing to become the new model in geo-engineering."

Annette Esnault-Filet, R&D Project manager at Soletanche Bachy

Which research facilities are involved?

- Deltares, The Netherlands
- Delft University of Technology (TU Delft), The Netherlands
- ETH Zurich, Switzerland
- University of Maribor – Slovenian National Building and Civil Engineering Institute (ZAG), Slovenia
- Technical University of Darmstadt (TUDa), Germany
- NGI – Norwegian Geotechnical Institute, Norway
- CEDEX, Spain
- University Gustave Eiffel (Uni Eiffel), France
- University of Cambridge (UCAM), United Kingdom
- KPMG Future Analytics (KPMG FA), Ireland

The GEOLAB objectives

Forty – subsidised – experiments have been planned for the coming years. A university or the industry can submit a proposal for an experiment that contributes to the improvement of critical infrastructure. An independent committee will assess the proposals, and experiments can begin once access has been granted.

The joint knowledge will allow each project partner to improve their own research centres further by using new technologies such as 3D printing, smart sensors, or camera and laser technology.

"The coordination of experiments and the sharing of experimental data will improve and accelerate the research results of these facilities. The data archives will, in the long term, ensure that GEOLAB research can support geotechnical engineering a long way into the future."

Dr. Ellen Rathje, professor at the University of Texas in Austin (United States)

Where can GEOLAB make a difference?

Underwater landslides

Landslides under water constitute a risk during dredging in rivers. They can endanger the infrastructure on land and in the riverbed. This dynamic interaction between water and the subsurface can be simulated with numerical modelling. But that requires validation in research facilities. The results can be used to develop user-friendly software products that contribute to improving the engineering of the dredging operation and reducing the risks.

Dike stability

Research has been conducted in the Netherlands into the strength of peat, which is the basic material in many historical dikes in the Ijsselmeer region. Dike stability is affected by two trends: in addition to the need to increase freshwater storage capacity, there is the increased likelihood of heavy rainfall due to climate change, resulting in high water levels. Both trends affect dike stability. New research based on numerical modelling and validation with field trials has shown that peat is much stronger than previously thought. Major interventions are therefore not needed as much and that results in cost savings and the preservation of the historical landscape.

Failure of a railway embankment

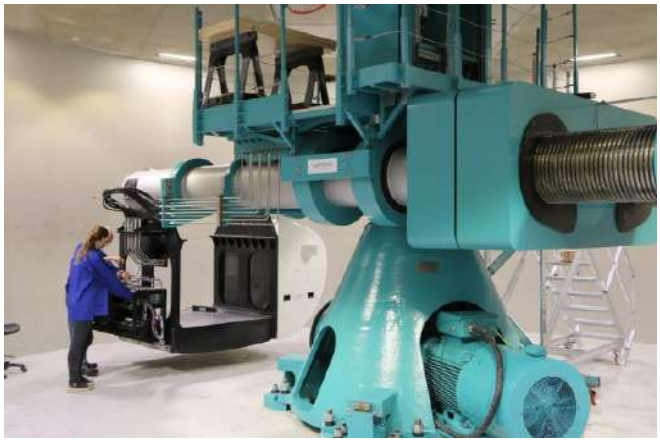
After a period of intensive rainfall in Sweden, an eight-metre-high railway embankment suddenly collapsed. A train had just gone by and so this was a narrow escape. The committee established to investigate the incident concluded that more research is needed about how climate change and extreme weather can affect transport infrastructure. GEOLAB will contribute by simulating conditions of this kind in the research facilities

GEOLAB & collaboration

To encourage integration, GEOLAB will organise workshops, training courses and an annual event. The consortium wants to strengthen mutual collaboration by sharing results. That is possible by coordinating activities and the joint storage of data. An experiment in a centrifuge in Cambridge can be re-used elsewhere in Europe through a database.

The GEOLAB network also includes a user group. Universities, industry and managers of critical infrastructure such as ProRail will participate in the events, provide feedback about the results and promote the project.

This is a European consortium but one with contacts all over the world. There is a similar alliance in the United States between a number of universities and the management of that alliance is represented on the GEOLAB international advisory board. There are also contacts internationally with universities in Brazil, Japan and South Africa, among others.



The Project will achieve

01. Efficient, standardized data exchange between the research installations

02. Re-use of open experiment data sets

03. Reinforced partnerships with industry, academia and stakeholders

04. New users attracted to the Research Infrastructure

05. Innovation of the GEOLAB-RI modelling and measurement capabilities

06. Effective research and innovation across scales and disciplines

During Transnational Access (TA), users outside the consortium gain access to the GEOLAB installations to perform research and innovation. The scientific research community will use the innovative capabilities of GEOLAB to perform groundbreaking experiments. For CI managers and policy makers, the activities will result in a more comprehensive understanding of the challenges facing CI and evidence to base decision making upon. The construction industry will use GEOLAB to proof innovative solutions for the CI and so gain more leadership in the industrial and enabling technologies.

There will be close interaction with Small and Medium-sized Enterprises (SME) that develop user-friendly engineering software from numerical modelling advances which are validated in the TA projects. We will explicitly challenge SME on sensing, new materials and other niches for innovative solutions, which will have spinoff in other fields of application, contributing to the competitiveness of Europe.

Networking Activities are another core element of GEOLAB, culminating in workshops and other outreach events that foster a digital and In Real Life community, thereby providing a productive channel to communicate with different stakeholder groups.

More information

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A homogeneous earthquake catalogue for Turkey

Onur Tan

Abstract

A new homogenized earthquake catalogue for Turkey is compiled for the period 1900–2018. The earthquake parameters are obtained from the Bulletin of International Seismological Centre that was fully updated in 2020. New conversion equations between moment magnitude and the other scales (m_d, M_L, m_b, M_s, and M) are determined using the general orthogonal regression method to build up a homogeneous catalogue, which is the essential database for seismic hazard studies. The 95 % confidence intervals are estimated using the bootstrap method with 1000 samples. The equivalent moment magnitudes (M_w*) for the entire catalogue are calculated using the magnitude relations to homogenize the catalogue. The magnitude of completeness is 2.7 M_w*. The final catalogue is not declustered or truncated using a threshold magnitude in order to be a widely usable catalogue. It contains not only M_w* but also the average and median of the observed magnitudes for each event. Contrary to the limited earthquake parameters in the previous catalogues for Turkey, the 45 parameters of ~378 000 events are presented in this study.

1 Introduction

The earthquake catalogues are the first output of seismological observations. Several institutions around the world generate national and international catalogues for understanding the seismic activity of a region. Principally, a catalogue contains the parameters such as origin time, coordinates, and focal depth. Earthquake magnitude is another vital parameter which is a dimensionless scale of energy being released. Magnitude is defined with different scales (types) based on different seismic wave phases and calculation approximations (Table 1). A catalogue may not contain all magnitude scales for an event. If an earthquake catalogue is used to show seismicity on a map, the magnitude type may not be important because the differences among the values of scales are not too large for visualization. However, magnitude scale information used in energy calculation is crucial for seismic hazard studies.

There are several unknowns in magnitude calculations by institutions due to the equations coefficients, seismic network structures, human-made mistakes, etc. Both amplitude and distance coefficients in the magnitude equations are the major items. Although the coefficients must be specific for a region because of seismic wave attenuation in the crust and mantle, the calculated values for the Californian earthquakes (i.e. for local magnitude by Richter, 1935; Hutton and Boore, 1987) are widely used. On the other hand, magnitudes, except m_d, are calculated using the waveform amplitudes at each station for an event. Different amplitudes are observed for an event because of the source radiation pattern. Generally, the average magnitude for all stations is calculated to minimize the effect of the radiation pattern. The median is also preferred to exclude the magnitude outliers (Havskov and Ottemöller, 2010). Consequently, the average magnitude is closely related to several factors such as the number of stations, the standard deviation of the average, amplification or attenuation due to the geological structure beneath the station, and the radiation pattern that depends on the azimuthal distribution of stations. Therefore, institutions may report different magnitudes for an event.

Table 1 Symbols for different magnitude scales in the priority order of magnitude saturation.

M_w	Moment magnitude
M_s	Surface wave magnitude
m_b	Body wave magnitude
M_L	Local (Richter) magnitude
m_d	Duration magnitude
M	General magnitude (unreported type)

Another issue picked out in this study is the reported moment magnitudes (M_w) in the catalogues. M_w is determined using waveform modelling for events (M_w≥3.5–4.0) with a high signal-to-noise ratio. However, a few institutes report M_w for small events to the international catalogues (M_w<3.0, i.e. 25 January 1999 at 13:06 UTC M_w=1.8 by Cyprus Geological Survey Department; 29 May 2014 at 01:14 UTC M_w=1.8 by the Earthquake Research Center, Ataturk University, Turkey). These small moment magnitudes are obviously determined by using an empirical relationship without using waveform data. As a result, there is more than one reported magnitude value for an event with known and unknown calculation errors. One common magnitude scale should be used to standardize analyses in the studies based on the parametric data such as hazard mitigation. Therefore, a homogenized catalogue with a unified magnitude scale becomes essential. In the last two decades, the studies on unifying earthquake magnitudes and generating improved catalogues have been carried out for different regions on the Earth (i.e. Grünthal et al., 2009; Chang et al., 2016; Manchuel et al., 2018; Rovida et al., 2020).

This study focuses on earthquakes in Turkey. The region is one of the most geodynamically active areas because of the deformation among the Eurasian, African, and Arabian plates (Fig. 1). Both the Arabia–Eurasia continental collision and the subduction of the African Plate beneath Eurasia started in the early and middle Miocene (11–23 Ma). The interactions of the three plates are the major driving forces for the tectonics of the region. The plate motions result in thrust faulting in eastern Anatolia, Caucasus, and Iran, normal faulting in western Turkey and Greece, and transform faults due to escaping to the west and east (see Bozkurt, 2001, for a brief synthesis). The complexity of the eastern Mediterranean tectonics causes high earthquake activity with different faulting mechanism and a wide range of focal depths. Western Anatolia is the most seismically active part of Turkey. Both the north–south extension in the Aegean and the westward motion of the Anatolian Plate along the North Anatolian Fault Zone (NAFZ) cause a dense deformation with small to moderate earthquakes in western Turkey. The NAFZ and East Anatolian Fault Zone (EAFZ) are also the primary seismic sources that generate destructive earthquakes (M_w≥6).

The destructive earthquakes in Turkey and the surrounding countries through the centuries are found in the historical records. Pınar and Lahn (1952), Ergin et al. (1967, 1971), Soysal et al. (1981), Güçlü et al. (1986), Ambraseys and Finkel (1995), and Ambraseys and Jackson (1998) compile the historical earthquakes in the region. Tan et al. (2008) present the historical events in a digital database and the first focal mechanism catalogue of Turkish earthquakes. On the other hand, Leptokaropoulos et al. (2013) and Kadirlioğlu et al. (2018) introduce homogenized catalogues. The main component of homogenization is to obtain reliable magnitude conversion from one scale to moment magnitude. Several empirical relations are also proposed for the region (Papazachos et al., 1997; Ambraseys, 2000; Baba et al., 2000; Papazachos and Papazachou, 2003; Burton et al., 2004;

Ulusay et al., 2004; Scordilis, 2006; Akkar et al., 2010; Deniz and Yücemen, 2010; Makropoulos et al., 2012).

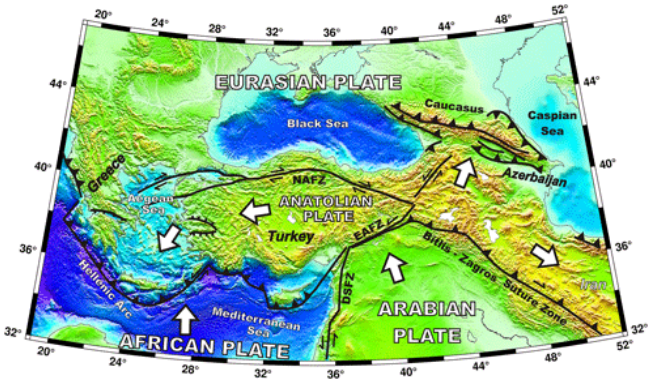

Figure 1 Simplified tectonic map of the eastern Mediterranean. DSFZ: Dead Sea Fault Zone; EAFZ: East Anatolian Fault Zone; and NAFZ: North Anatolian Fault Zone. Triangles indicate the direction of vergence or subduction. Bars are the down-thrown side of normal faults. White arrows are relative plate motions. The relief model is generated with the ETOPO1 model (Amante and Eakins, 2009).

The motivation of this study is to build a widely usable earthquake catalogue (i.e. for geophysicists, geologists, earthquake engineers) that contains homogenized moment magnitudes and the other seismological parameters. During the international seismic hazard studies of the Sinop Nuclear Power Plant planned in northernmost Turkey, it is clearly understood that a comprehensive homogenized earthquake catalogue for Turkey is needed for future studies. For this aim, the earthquakes in Turkey are statistically analysed, and the empirical magnitude relation equations are obtained using a refined dataset. Then, an extensive homogenized earthquake catalogue is constructed. The distinguishing feature of the new homogenized catalogue is that it contains all earthquakes in a manageable format without removing aftershocks and truncating small events.

2 Database and processing

The Bulletin of the International Seismological Centre (ISC, 2020) is used as the main database to generate a new and comprehensive homogeneous earthquake catalogue for Turkey. The ISC Bulletin contains a large amount of parametric data for any event that occurred anywhere on the Earth. Because national and international seismological centres contribute to the bulletin, it contains not only moderate-to-large events ($M \geq 4$) but also local earthquakes with small magnitudes ($M < 4$). The most important feature of the bulletin is that an event with sufficient data is manually checked and relocated by a seismologist. Therefore, the latest earthquake information in the database is 2 years behind real time (ISC, 2020). The bulletin also presents the event parameters reported by the contributing centres. The ISC finished rebuilding the entire database in 2020 by utilizing a new location algorithm (Bondár and Storchak, 2011) with the ak135 seismic velocity model (Kennett et al., 1995). Furthermore, previously unavailable hypocentre and station phase readings from the permanent and temporary networks are added to the rebuilt bulletin (ISC, 2020; Storchak et al., 2017). Therefore, the latest and revised international dataset is used in this study.

The earthquake parameters in the bulletin are in the IASPEI Seismic Format (ISF, 2020). Each event has its own data block that contains several data types and comments such as origin and magnitude. Data and comment lines have no specific flag to identify their types, and it is not possible to read the database using a simple computer programme or shell scripts. A Fortran code is written to analyse the ISF lines using the parsing subroutines provided by the ISC. The different parsers check each line in the database to identify the data type. After determining the origin and magnitude sub-blocks of an event properly, the parameters are analysed. The overall data processing is given in the flowchart in Fig. 2. Because the bulletin may contain multiple hypocentres from multiple agencies for an event, the ISC considers that one of them is primary and assigns the *PRIME* flag to it. A hypocentre determined by the ISC always has the *PRIME* flag. In this study, the event origin parameters such as time, location, and focal depth with the PRIME flag are searched in the first step. If there is no *PRIME* flag, the origin data are searched in the secondary hypocentres using the institute priority order given in the flowchart. The parameters reported by the ISC are preferred first. If there is no information from the ISC, the availability of the hypocentre parameters from the European-Mediterranean Seismological Centre (CSEM or EMSC) is searched (see Appendix A for the institute abbreviations). The priority of both institutes is high because they use all available data in the study area. In turn, the hypocentre parameters of the two Turkish seismological networks are searched (ISK: Kandilli Observatory and Earthquake Research Institute, KOERI; DDA: General Directorate of Disaster Affairs until September 2017 and Disaster and Emergency Management Presidency, AFAD, after October 2017). The local institutes are preferred for the events that occurred in the neighbouring countries. Moreover, the earthquake information reported by the International Seismological Summary (ISS) and Gutenberg and Richter (GUTE) is used for the period of 1900–1964. If the event origin parameters are found in any step of the query order, this event is added to the homogenized catalogue with these parameters.

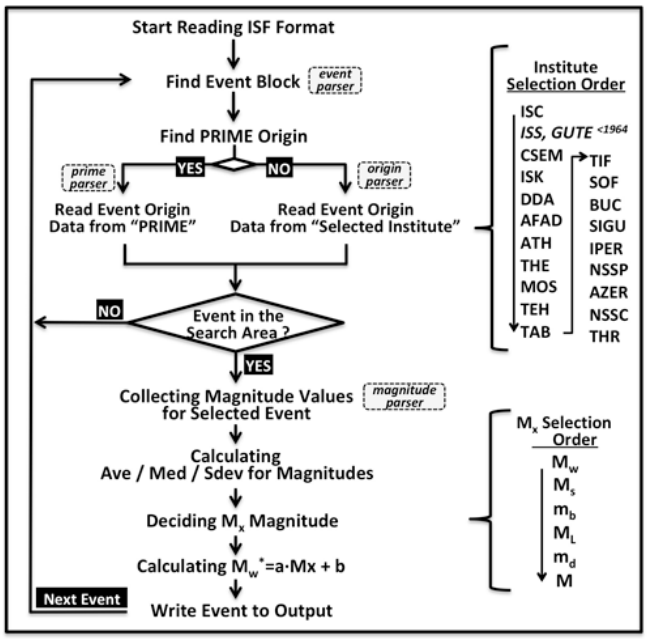

Figure 2 Flowchart of the ISC database processing. Ave: average (mean); med: median; and Sdev: standard deviation. M_w* is equivalent moment magnitude. See Appendix A for the institute codes.

After determining the event origin parameters in the selected area, the magnitude data sub-block is analysed by the magnitude parser. The reported values of different magnitude scales given in Table 1 are collected. If there are two or more values for a magnitude scale, the arithmetic mean and median of all reported values are calculated. Selecting a magnitude value from a particular institute such as KOERI, Harvard, and EMSC is not preferred to overcome the problems

such as unreported magnitude, the effect of network distribution, and calculation errors.

More than 8.3 million events in the ISC monthly datasets are analysed for the final catalogue. The study area is bounded by 35–44° N and 25–46° E (Fig. 3). The final catalogue contains 377 429 events that occurred in the period from 1900 to October 2018. The modern instrumental period (1964–present) data are used for all statistical analyses. The number of events (1964–2018) reported with local magnitude (M_L) is 227 726 (60 % of the total), and it is the highest rate concerning the other magnitudes types (Fig. 4, Table 2). About 39 % of the events have duration magnitudes (m_d). Because both magnitude types are widely determined by the national institutions, especially for the local events, they are dominant in the catalogue. The body (m_b) and surface wave (M_s) magnitudes are reported for only 3.0 % and 1.4 % of the total events in the region, respectively. Though moment magnitude (M_w) is the most preferred magnitude scale for seismic hazard studies, only 0.9 % of all events have M_w because waveform analyses are not an easy and routine process. On the other hand, the final catalogue contains 18 859 (5 %) events with no specified magnitude types (M). The magnitude M is mostly reported until 1990, and the number of events with M dramatically decreases after this year. Approximately 2 % of the annual activity is reported without a magnitude value in the study area. These events are excluded from the final homogenized catalogue.

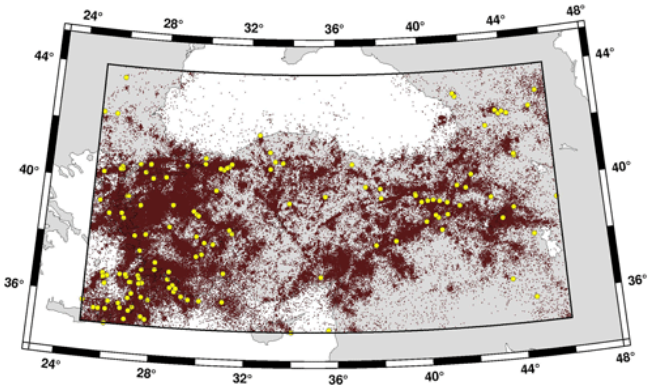

Figure 3 The earthquakes in the homogenized catalogue (dots). Yellow circles are the events with an equivalent moment magnitude (M_w*) greater than 6.0 (total 145 events).

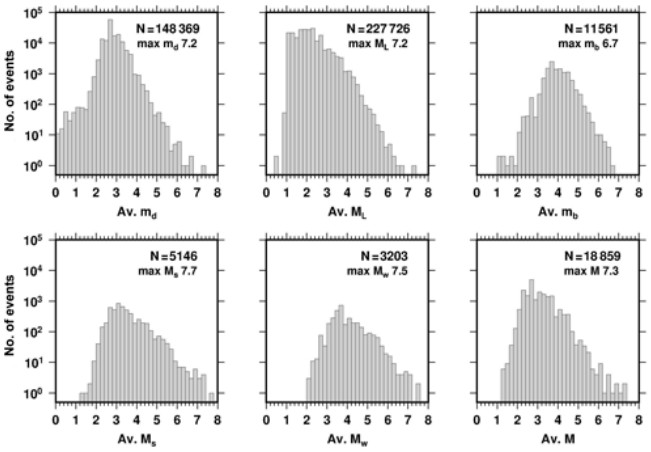

Figure 4 The number of events in the final catalogue for each average magnitude (1964–2018). N is the total number of events for each magnitude.

3 Catalogue homogenization and completeness

3.1 Refining the dataset

The dataset is refined in detail for regression analyses to obtain the empirical relations between the magnitude scales. In the first step, the catalogue is declustered using the second-order moment approximation of Reasenberg (1985) because removing aftershocks is necessary to determine reliable magnitude completeness. For aftershock analysis in space, a subsequent event is searched for in an area with a radius 20 times that of the circular source dimension of the preceding event considering ±4 km hypocentre uncertainties (Kanamori and Anderson, 1975; Reasenberg, 1985). The maximum interaction period for the next event in a sequence is 10 d to build a temporal cluster extension. After declustering, the earthquakes that occurred after 1980 are selected for the subsequent analyses because the Turkish national station networks and data processing become much more reliable (i.e. Mignan and Chouliaras, 2014; Canbaz et al., 2019). In the third step, completeness (M_c) for each magnitude is determined. It is found that M_c is ~2.8 for m_d and M_L, whereas it is ~4.0 for m_b and M_s. The events with an average magnitude smaller than the M_c thresholds of each magnitude scale are excluded from the regression. Using a threshold also helps eliminate possible blasts (M<2.0–2.5) before the regression. In the last step, a cut-off value is applied for large differences between magnitude pairs. There are, naturally, differences among the reported magnitudes for an earthquake. Occasionally, the difference between the magnitude pairs may be as large as 2 or more magnitude units. After obtaining the difference scattering for each pair, the data points that are out of the 95 % confidence interval (±2σ) are removed by using the interquartile range (IQR) method (Galton, 1869; MacAlister, 1879). The IQR is one of the robust methods for outliers and can be successfully applied to seismological data (i.e. Tan et al., 2010, 2014; Tan, 2013). The cut-off values are determined as 0.85 (m_d–M_w), 0.67 (M_L–M_w), 0.57 (m_b–M_w), 1.1 (M_s–M_w), and 0.9 (M–M_w). These cut-offs overcome the scattering of the pairs. After refining the magnitude pairs in the four steps, the number of data points used in regression is 978, 1664, 685, 351, and 38 for m_d–M_w, M_L–M_w, m_b–M_w, M_s–M_w and M–M_w, respectively (Fig. 5).

Table 2(a) Number of magnitudes with zero and non-zero values between 1964 and 2018 in the catalogue. **(b)** The number of magnitude pairs with non-zero values.

(a)						
	m_d	M_L	m_b	M_s	M_w	M
$=0$	228 818	149 461	365 626	372 041	373 984	358 328
$\neq 0$	148 369	227 726	11 561	5146	3203	18 859
(b)						
	m_d, M_w	M_L, M_w	m_b, M_w	M_s, M_w	M, M_w	
$\neq 0$	1306	2898	2080	1684	73	

3.2 Regression analyses

The relationships of the refined magnitude pairs are estimated using the general orthogonal regression (GOR). The method is a better estimator than the least-square (LS) approximation when both x and y variables have non-negligible size errors (Castellaro et al., 2006). The slope (a) and intercept (b) values of the GOR line in the form of $y=a\cdot x+b$ are given by

$$a = \frac{S_Y^2 - \eta S_X^2 + \sqrt{(S_Y^2 - \eta S_X^2) + 4\eta S_{XY}^2}}{2S_{XY}},$$

$$b = \overline{Y} - a\overline{X},$$

where S^2_X, S^2_Y, and S^2_{XY} are the covariance of X (independent variable), Y (dependent variable), and between X and Y, respectively (i.e. Castellaro et al., 2006; Das et al., 2014). $\bar{X}$ and $\bar{Y}$ are the average values of the variables, and η is the error variance ratio of the variables ($\sigma\varepsilon_X$, $\sigma\varepsilon_Y$) and is defined as $\eta=(\sigma\varepsilon_X/\sigma\varepsilon_Y)^2$. When the standard errors of the variables are not known, η is arbitrarily set to a value. In practice, η=1 (squared Euclidean distance) gives good results (Castellaro et al., 2006; Das et al., 2014). In this study, η is tested for the values from 0.5 to 2.0 to seek a better fit. The R^2 values do not increase when η is assigned a different value than 1.0, and a significant improvement is not observed in the regressions. Moreover, the real errors of the magnitudes are not known; η=1 is used. The squared Euclidean distance gives better results for all magnitude scales. The 95 % confidence intervals of the best-fit regression are determined with the bootstrap method (Efron, 1979). A total of 1000 new regressions are calculated using 50 % of the total amount of data of each relation. The bootstrap samples are randomly selected using the Mersenne Twister random number generator (Matsumoto and Nishimura, 1998). The random numbers are unique in each test to prevent multiple selections of any datum. After obtaining a large set for the constants a and b of the linear fits, the outliers are removed utilizing the IQR method. Then, the standard deviation (σ) of the normally distributed dataset is calculated.

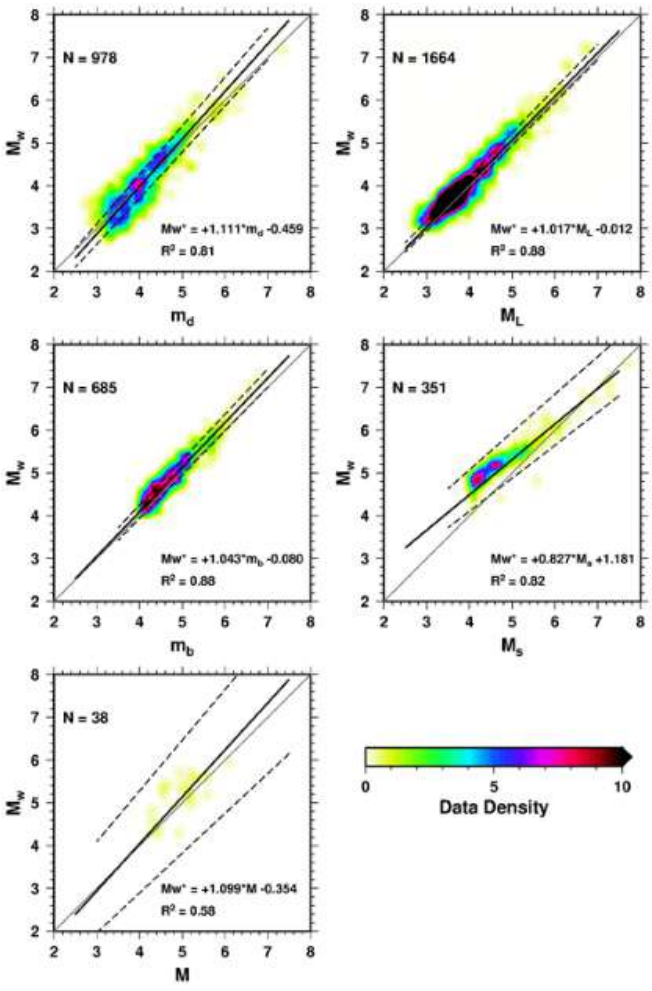

Figure 5 Magnitude relations between M_w and the other scales. The data density in 0.1 magnitude intervals is shown with coloured counters. N is the total number of magnitude pairs. The solid line is the best linear fit of the orthogonal regression, whereas the dashed lines show the 95 % confidence interval after bootstrapping. Grey line indicates the $y=x$ relation.

The GOR results are given in Table 3 and Fig. 5. Because the number of magnitude pairs is high for each relation, the data are shown with coloured density contours in 0.1 magnitude-unit grids. It is clear that all relations are linear and that the minimum misfit regression lines are in good agreement with the data distribution. The number of pairs is generally dense between magnitude values of 3.0 and 5.0 and decrease for larger magnitudes. In general, the slopes of the regression lines are close to 1, and the intercept values are negative except for M_s magnitude. The relation between m_d and M_w indicates that both magnitude scales are equal at m_d=4, and the difference increases up to 0.4 magnitude units at larger values. M_L values are dense between 3 and 5, and the linear fitting line extends close to the $y=x$ line. The difference between local and moment magnitudes is about 0.25 at M_L=7.0. The conversion equation of m_d–M_w is similar to that of M_L–M_w. The most considerable difference between the two different magnitude scales is observed for surface and moment magnitudes. M_s is always smaller than M_w, and the difference is about 0.6 at M_s=4.0. Both scales are equal at M_s=7.5. The magnitude M (the real type is not known) is mostly reported in the past. There are 27 events with $M\geq5.0$ before 1964 in the study area. Therefore, an M–M_w conversion is necessary for seismic hazard analyses using long-term seismicity data. There are few magnitude pairs (N=38), and they are distributed sparsely between 4.0 and 6.5 with a high standard deviation (Fig. 5).

Table 3 Equivalent moment magnitude (M_w*) relations for different magnitude scales.

Relation	$a\pm2\sigma$	$b\pm2\sigma$	Amount of data	Magnitude range	R^2
$M_w* = a\cdot m_d + b$	$+1.111\pm0.03$	-0.459 ± 0.14	978	2.8–7.3	0.80
$M_w^* = a\cdot M_L + b$	$+1.017\pm0.02$	-0.012 ± 0.07	1664	2.8–7.2	0.89
$M_w* = a\cdot m_b + b$	$+1.043\pm0.02$	-0.080 ± 0.08	685	4.0–7.0	0.88
$M_w^* = a\cdot M_s + b$	$+0.827\pm0.05$	$+1.181\pm0.21$	351	4.0–7.7	0.83
$M_w^* = a\cdot M + b$	$+1.099\pm0.13$	-0.354 ± 0.68	38	3.4–6.9	0.51

3.3 Homogenization

The GOR results are implemented in all events in the study area. First, M_w is searched and assigned as M_w* if found. For the events without an observed M_w, the first average magnitude with a non-zero value is chosen according to the priority of saturation order in Table 1. For example, if an event has only average M_s and M_L values, M_s is selected for M_w* calculation. The chosen magnitude is also named M_x and is used to calculate the equivalent moment magnitude (M_w*) with the relevant equation. After applying homogenization equations to all earthquakes, the catalogue is presented with a total of 45 parameters described in Appendix B. The catalogue has three sections: "Event Origin Section", "Magnitude Section", and "Comments". There are 23 parameters in the origin section. The origin time, coordinates, and depths with their uncertainties are given. If one of these parameters is fixed, it is marked with the "f" flag. The magnitude section contains the average with standard deviation and median for the six magnitude scales. The selected M_x value, its source magnitude scale, and the calculated equivalent moment magnitude (M_w*) are presented. The ISC event ID number and the epicentre region are given in the comment section as a reference.

In the homogenized catalogue, 57 % of the event origin parameters are flagged as *PRIME* by the ISC. The ISC and EMSC (CSEM) origin parameters are generally reported with the prime flag (~90 %–98 %). On the other hand, approximately half of the reported parameters (~60 %–65 %) by the national institutes in Turkey (KOERI, AFAD/DAD) and Greece (ATH) have the flag. The catalogue contains the event origin information from the national sources (Fig. 6a) in a high percentage. The distribution of the magnitude scales for the equivalent magnitude calculation is given in Fig. 6b. The vast

majority of M_w* are obtained from M_L and m_d; the con-tribution of the other magnitude scales is small.

3.4 Completeness of the catalogue

One of the important parameters of an earthquake catalogue is the magnitude of completeness (M_c). M_c is a threshold magnitude and indicates that all earthquakes with magnitudes greater than M_c are recorded in a study area. It is determined using cumulative frequency–magnitude law (GR) of Gutenberg and Richter (1954). The GR relation is simple but powerful and formulated as $\log(N)=a-b\cdot m$, where N is the cumulative number of events with magnitudes equal to or greater than m. The other useful parameter derived from this equation is the b value (slope). The b value is around 1 for the tectonically active areas.

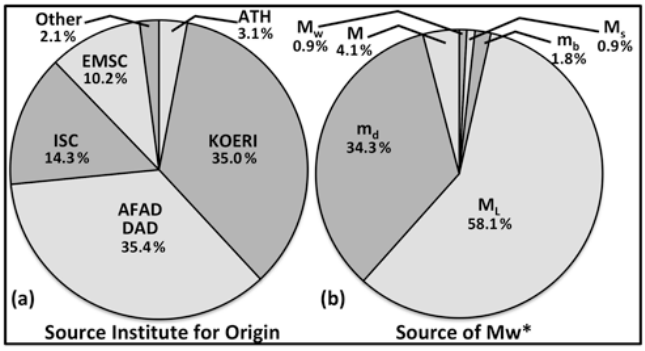

Figure 6 Distribution of the parameters in the homogenized catalogue. **(a)** Source institutes for the origin parameters. **(b)** Percentage of the magnitude scales used for M_w* calculation.

The modern instrumental period (1964–present) observations for the region show a linear relation with b=0.96 between the cumulative number of earthquakes and equivalent moment magnitude, M_w* (Fig. 7). If the dataset is extended to cover the period from 1900 to 1964, the linearity of the GR relation for the magnitudes between 5 and 7 disappears due to the magnitude calculation uncertainties and lack of small events in the catalogues for that time span. The M_c, the lowest intercept point of the linear fit with the slope b, is 2.7 for all earthquakes between 1964 and 2018.

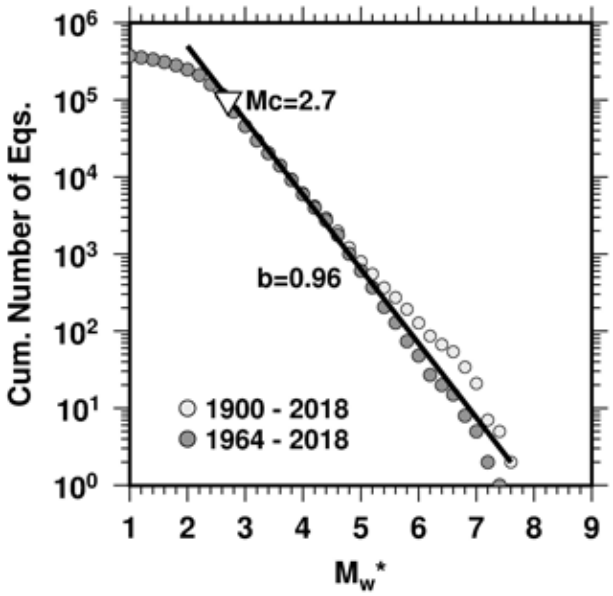

Figure 7 The Gutenberg–Righter frequency–magnitude distribution for the homogenized catalogue. Light and dark grey circles represent the cumulative number of earthquakes in the periods 1900–2018 and 1964–2018, respectively. The b value and magnitude completeness (M_c) for the period of 1964–2018 are 0.96 and 2.7, respectively.

The maximum curvature method (Wyss et al., 1999; Wiemer, 2001) is applied to investigate the spatial and temporal change in M_c for the modern instrumental period. Equal horizontal sampling in latitude and longitude degrees is not used to prevent artificial elongation because the length of 1° of longitude is ~94 and ~76 km in the south and north of the study area, respectively. I use 20 km grid spacing and at least 100 events in a 100 km radius for the spatial distribution of M_c. On the other hand, the temporal variation is estimated using a window with 200 events and a moving step of 40 events. These sampling parameters are sufficient to avoid erroneous statistical results for the b value and M_c due to under-sampling and non-homogenous subsets (Amorese et al., 2010; Kagan, 1999, 2002, 2010; Kamer and Hiemer, 2013; Shi and Bolt, 1982). The contour map in Fig. 8 shows that the homogenized catalogue is complete down to M_w*=2.6–2.7 in Turkey. The white areas have deficient seismic activity (see Fig. 2), and there are not sufficient data to ensure the criteria. The variation of M_c throughout the years indicates that the standard deviation band is narrow after the 1990s. The M_c has been stable at about 2.6 since 2007 because the number of seismological stations increases after the devastating earthquakes (M_w>7) in 1999.

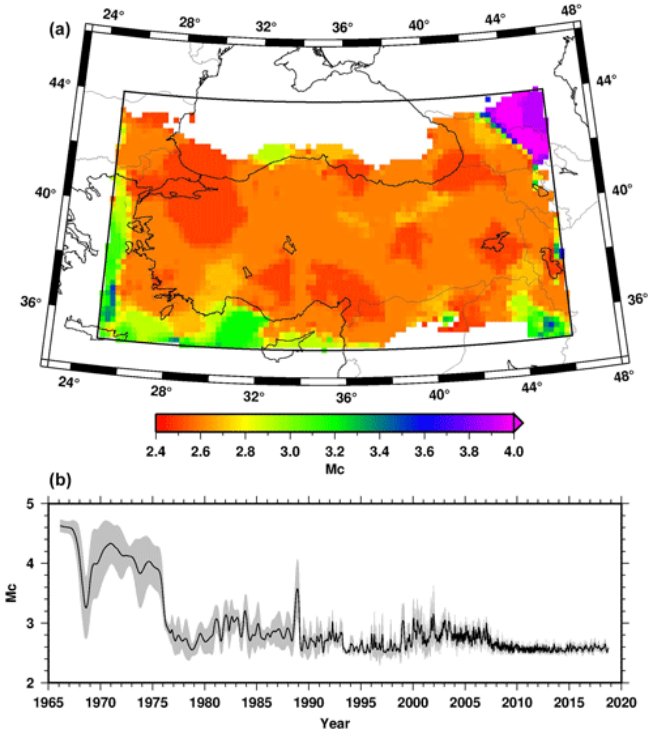

Figure 8(a) M_c spatial distribution map for the events since 1964. There are no data in white areas. **(b)** Temporal M_c variation as a function of year. Grey area is the ±σ interval estimated by bootstrapping.

4 Discussion

Generating an earthquake catalogue is one of the main study areas for seismologists. An institution that operates a costly seismological network provides the primary parametric information of an event from raw waveform observations. Although accessing catalogues is very easy via the internet in recent decades, it is difficult to obtain all available data due to some limitations of the data providers' web pages. The problems of online datasets, such as absent or limited observations for the past years, a limited number of parameters,

lack of parameter uncertainties, listing limitations, and useless formats in web pages, make it difficult to handle the earthquake data for an extensive range of users. However, most of the researchers only pay attention to the homogenized magnitudes and the number of events. Unfortunately, the importance of providing more parameters and their uncertainties in the previous catalogues are missed. For example, the SSG-9 (item #3.27i) safety document of the International Atomic Energy Agency for nuclear power plants requires the uncertainties of all earthquake parameters. Therefore, the previously given datasets are less useful, especially for seismic hazard analyses.

The earthquake information for Turkey comes from two national networks operated by the KOERI and AFAD. Both institutes have a large number of stations around Turkey (~1240) and report recent events online. The date, time, depth, and magnitudes without uncertainties can be obtained by using web search engines. While the KOERI lists only 50 000 events in a single search with a downloadable text file, the AFAD's search result is given with a maximum of 100 events at each window, and it can be downloaded in the comma-separated CSV file format. The other online catalogue with the same parameters is provided by the EMSC. The searched events can be downloaded in CSV format with the limitations of 5000 lines. Among the three institutions, only the KOERI provides all available magnitude scales for an event. Additionally, the EMSC does not provide the type of magnitude scale for an event. In contrast, the ISC provides all available parameters for an event determined not only by itself but also by the other institutions, as mentioned in the previous chapter. The magnitudes in the ISC event list are given in separate lines, so it is not easy to use without knowledge of the comprehensive bulletin format and programming. The online bulletin search of the ISC also has an output limitation of 60 000 events.

Besides the online catalogues, some catalogue compilations based on magnitude homogenization for Turkey and its vicinity are published. Leptokaropoulos et al. (2013) statistically analyse the earthquakes in western Turkey (1964–2010) and construct a catalogue with an equivalent moment magnitude. They obtain conversion equations for different magnitude scales reported by different institutions. The catalogue contains 9875 events with only the parameters of date, time, coordinates, and focal depth. Kadirioğlu et al. (2018) present another homogenized catalogue for Turkey containing ~6573 events between 1900 and 2012 by utilizing the same dataset and conversion equations presented in the previous studies (Kadirioğlu et al., 2014; Kadirioğlu and Kartal, 2016). Their final catalogue is declustered and contains events only with M_w*>4.0. On the other hand, Kadirioğlu et al. (2014, 2018) mention that a focal depth of 10 km is assigned to the events without a reported depth or that are shallower than 1 km in the final catalogue. This assignment is arbitrary and unrecoverable. It may generate artificial errors in future studies using this catalogue, especially in seismic hazard analyses.

Burton et al. (2004) generate a homogenized catalogue that contains both reported and equivalent magnitudes for earthquakes in Greece and western Turkey using the previous conversion equations. There are ~5200 events without M_c analysis. The catalogue by Bayliss and Burton (2007) contains ~3680 homogenized events in Bulgaria and the surrounding Balkan region with M_c~4.0. More recently, Makropoulos et al. (2012) have presented ~7350 homogenized events for calculated M_s* and M_w* in the excel format for Greece and western Turkey.

The common structure of the previous catalogues mentioned above and others has limited earthquake parameters, such as date, location, depth, and M_w*. Especially, the observed magnitudes and error/uncertainty values are not included. The source institute of the parameters is also missing. Therefore, it is impossible to trace back to the origin of the parameters, and the equivalent moment magnitude (M_w*) cannot be recalculated using newly determined conversion equations. On the other hand, a truncated final earthquake list using a magnitude threshold is not useful for the researchers who want to analyse or plot all seismic activity in a region. The new homogenized catalogue in this study overcomes the common deficiency of the previous earthquake catalogues for Turkey.

5 Conclusions

Turkey and the surrounding area is one of the most seismically active regions on the Earth. Therefore, improved earthquake catalogue studies are necessary. A new, comprehensive, and homogenized earthquake catalogue is compiled in this study. The main aim is to present an earthquake database in an easily manageable ASCII format for a wide range of researchers in earth sciences. This study is based on the latest ISC Bulletin rebuilt in 2020. All earthquakes during the period from 1900 to October 2018 in Turkey and its near vicinity are analysed. The origin parameters and magnitude data in the IASPEI Seismic Format are systematically parsed with a Fortran algorithm.

Approximately 378 000 events in the study area bounded by 35–44° N and 25–46° E are compiled (Fig. 3). The equivalent moment magnitude (M_w*), which is the mandatory parameter for the seismic hazard studies, is calculated for all events. For this purposes, new conversion equations for m_d, M_L, m_b, M_s, and M are determined using the well-refined magnitude pairs and the general orthogonal regression method that is useful when the two variables have different uncertainties. According to the values of M_w*, the overall catalogue is complete down to M_c=2.7. The spatial completeness variation indicates M_c=~2.6–2.7 in Turkey. One of the advantages of the catalogue is that it is not declustered or truncated using a threshold magnitude so that it is useful for geophysicists, geologists, and geodesists. The M_w* values can be easily recalculated, and the catalogue can be declustered by seismologists and earthquake engineers using different parameters. The final dataset contains not only M_w* as in the previous studies but also the average with standard deviation and median of the observed magnitudes. The ISC event ID number and geographic region of each event are also given to trace an event in the bulletin. Presenting 45 parameters for all events is the most valuable part of the new homogenized catalogue.

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Appendix A

The ISC contributor institutes mentioned in this study are given below. The ISS and GUTE catalogues are used for the events in the period of 1900–1964.

Table A1 The ISC contributor institutes.

Code	Institute
ISC	International Seismological Centre
ISS	International Seismological Summary (for 1900–1964)
GUTE	Gutenberg and Richter (1954) (for 1900–1952)
CSEM	European-Mediterranean Seismological Centre – EMSC (France)
ISK	B. U. Kandilli Observatory and Earthquake Research Institute (Turkey)
DDA	General Directorate of Disaster Affairs (Turkey), until September 2017
AFAD	Disaster and Emergency Management Presidency (Turkey), since October 2017
ATH	National Observatory of Athens (Greece)
THE	Department of Geophysics, Aristotle University of Thessaloniki (Greece)
MOS	Geophysical Survey of Russian Academy of Sciences (Russia)
TEH	Tehran University (Iran)
TAB	Tabriz Seismological Observatory (Iran)
TIF	Institute of Earth Sciences/National Seismic Monitoring Center (Georgia)
SOF	National Institute of Geophysics, Geology and Geography (Bulgaria)
BUC	National Institute for Earth Physics (Romania)
SIGU	Subbotin Institute of Geophysics, National Academy of Sciences (Ukraine)
IPER	Institute of Physics of the Earth, Academy of Sciences, Moscow (Russia)
NSSP	National Survey of Seismic Protection (Armenia)
AZER	Republican Seismic Survey Center of Azerbaijan National Academy of Sciences (Azerbaijan)
NSSC	National Syrian Seismological Center (Syria)
THR	International Institute of Earthquake Engineering and Seismology (Iran)

Appendix B

The first and second lines of the homogenized catalogue are the parameter names and column numbers, respectively. The earthquake parameters are given below.

Table B1 Parameters in the homogenized catalogue.

	Column	Parameter		Column	Parameter
Event origin section	1	Year	Magnitude section	24	M (average)
	2	Month		25	SD of M
	3	Day		26	M (median)
	4	Hour		27	m_d (average)
	5	Minute		28	SD of m_d
	6	Second		29	m_d (median)
	7	Time fix flag		30	M_L (average)
	8	RMS (s)		31	SD of M_L
	9	Latitude (°)		32	M_L (median)
	10	Longitude (°)		33	m_b (average)
	11	Location fix flag		34	SD of m_b
	12	Semi-major axis of 90 % ellipse (km)		35	m_b (median)
	13	Semi-minor axis of 90 % ellipse (km)		36	M_s (average)
	14	Depth (km)		37	SD of M_s
	15	Depth fix flag		38	M_s (median)
	16	Depth error (km)		39	M_w (average)
	17	Number of stations		40	SD of M_w
	18	Azimuthal gap (°)		41	M_w (median)
	19	Closest station distance (km)		42	M_x
	20	Furthest station distance (km)		43	Source magnitude scale for M_x
	21	Event type		44	M_w^*
	22	Institute			
	23	Prime flag	Comments	45	# (null)
				46	ISC information (event ID and region)

Fixing flags: n – not fixed (free), f – fixed. Prime flags: n – not prime location, p – prime location. Event types: de – damaging earthquake, fe – felt earthquake, ke – known earthquake, se – suspected earthquake, uk – unknown. Unreported numerical parameters in the ISC Bulletin are given as "0.00". Uncalculated standard deviations are given as "−1.00". Unknown or blank character fields are filled with "–".

How to cite.

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https://nhess.copernicus.org/articles/21/2059/2021/

Modelling of the joints between segments in TBM tunnel

For a correct modelling of the joints between segments in a TBM tunnel

Dr. Cosimo Iasiello

1. Introduction

A tunnel boring machine is a machine capable of excavating a tunnel with the complete cross section, and can be equipped, according to the different cases, with auxiliary modules for the positioning of provisional linings. The injection of the space between the ring and the ground (the so-called gap), created by the difference between the rear of the shield and the ring, is an element related more to the construction process of the tunnel than to design as stated in ITA, 1999 and ITAtech, 2014. Gap backfill is meant to perform several functions:

- It ensures a uniform distribution of the ground pressures.
- It reduces decompression of the ground that could have negative effects on subsidence (in particular for superficial tunnels)
- It works as an additional barrier for waterproofing.
- The alkalinity of the contact between the ground and the lining increases, so the durability of the ring improves.

(More information on gap back-fill can be found in references Cavalaro 2009 and Pelizza et al. 2010)

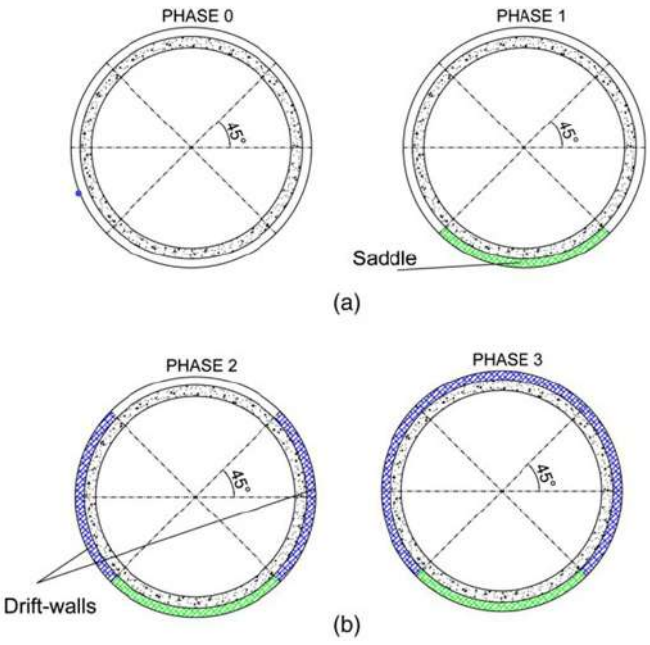

Figure 1. Gap filling phases carried out in the real case

Figure 1 shows the procedure of gap filling for tunnels in rock/soil. The phases of gap filling are:

- Phase 0: the ring has been installed and is held in place by longitudinal and circumferential bolts within the shield
- Phase 1: Execution of the so-called "saddle". This operation starts just after the ring installation. The ring, at this stage, is outside the shield.
- Phase 2: Execution of the drift-walls gap filling. This operation takes some time to be covered and starts after the installation of 2 to 4 other rings.
- Phase 3: gap-filling completion. This operation takes place after the installation of another 2 to 4 rings

In summary, the time each ring has to "wait" before its gap is filled can vary from four to eight other ring installations. If the TBM advance does not encounter any problems (geological formation, local presence of water table) or any maintenance problems (cutters, convoy belt and so on), the time between phase 1 and phase 3 theoretically lasts from one to three days. During this time, the ring is experimenting deformations, which can alter its internal stress distribution.

The importance of simulating the joints between rings can be due to particular structural and geotechnical conditions as a more reliable assessment of the ring deflections, earthquake conditions and so on. In this blog we are going to focus our attention to the so-called longitudinal joints, defined as the joints between segments of the same ring because their modeling is more frequent.

2. Joints within the same rings (longitudinal joints)

The first studies on tunnel joints were carried out by Gladwell, 1980, and Jansenn,1983, based on the study of concrete joints carried out by Leonhardt and Riemann in 1966. Their idea was to simulate the contact between two segments, i.e. the joint, considering concrete as an elastic material and its contact as direct and uniform. In other words, they proposed to simulate the mechanism dowels/joint /segment as an equivalent beam made of three distinctive beams with a "finite" discontinuity as shown in **Figure 2**.

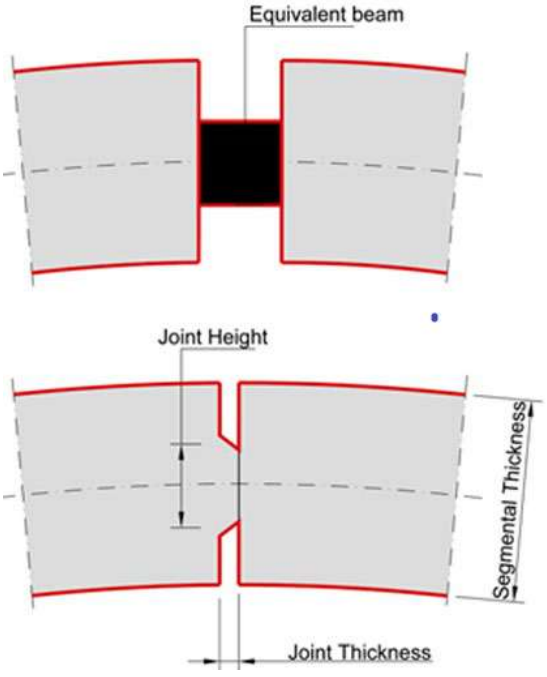

Figure 2. Jansenn´s Equivalent beam approach

This artifice allows simulating the joint rotation and its curvature using a beam of variable depth. If we refer to Jansenn's approach it is possible to see how the linear relationship between bending moment, M, and joint rotation a function of the axial force is, N, and of the joint geometry:

$$\varphi_1 = \frac{Mh}{E_c I} = 12\frac{M}{E_c h^2 b} \text{ if } \quad M < \frac{1}{6}Nh \qquad (1)$$

$$\varphi_2 = \frac{8N}{9bhE_c\left(\frac{2M}{Nh} - 1\right)} \text{ if } M \geq \frac{1}{6}Nh \qquad (2)$$

where:

h= joint height (m)

b= joint thickness (m)

Ec and I have the same definition employed for equation (1) and N, M are the internal forces (Axial load and bending Moment).

φ= joint rotation (radians)

This equation expresses the rotation (φ) of the joint in radians.

Jansenn´s approach is more accurate for thick joints because in the equivalent 'beam' a curvature will develop resulting in a rotation. In reality, when the joint is very thin, only a very minor additional rotation will occur. Because of the hypothesis that the joint has a length equal to the height of the joint, according to Janssen, a rotation will develop taken into account for the spread of load in the region of the joint.

Regarding this, the Janssen relation will be more accurate when describing a thick joint. Gladwell proposed another relationship Moment/joint rotation, which is very similar to the Janssen's except for the introduction of the intrinsic properties (E_c and moreover Poisson ratio) of reinforced concrete. The formula is:

$$\varphi_1 = \frac{32(1-\upsilon)^2 M}{E_c b h^2} \text{ if } M < \frac{1}{4}F_n \qquad (3)$$

$$\varphi 2 = \frac{4(1-\upsilon)^2 N}{\pi E_c bh\left(\frac{2M}{Nh} - 1\right)} \text{ if } M \geq \frac{1}{4}F_n \qquad (4)$$

As shown by Van Der Vliet, 2010, and afterwards by Peña, 2012, there are three main differences between the Gladwell's and Janssen's approach:

- The initial stiffness obtained by Gladwell is greater than Janssen's. This is due to the type of analysis carried out by Gladwell in which the contact stress is concentrated on the edges of the joint.
- The non-linear branch proposed by Gladwell reaches very quickly the maximum theoretical bending moment because Gladwell´s approach stiffness is higher and the joint stayed close longer than Jansenn´s one (**Figure 3).**
- The differences encountered between the two solutions, in particular in the linear branch, are due to the different formulation of joint and the segment height.

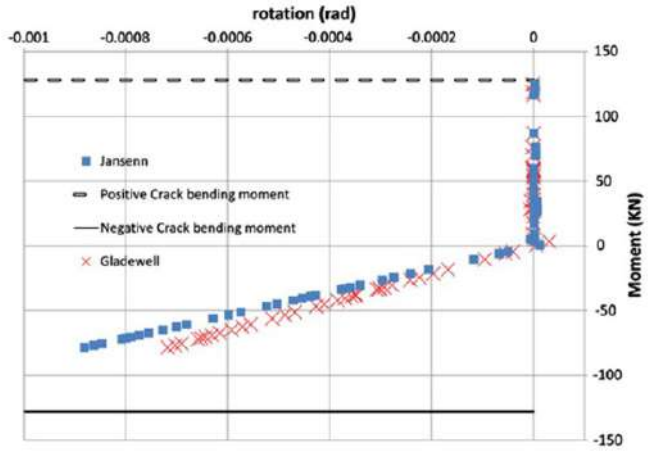

Figure 3. Comparison between Jansenn and Gladwell approach for the studied case

Van Der Vliet, 2010 showed that the joint simulation in finite element modelling, seems to better follow the Gladwell's approach than Janssen's if the structure is simulated as solid element, because it takes into account the mechanical properties of concrete (E_c and υ). In the engineering practice, however, the structure elements are usually simulated as beam/shell elements and they implement already the mechanical features of the elements; in this case the Janssen approach results more reliable in terms of numerical approach. This is the reason why in Midas GTS NX is possible to simulate the joints between segments as Janssen (see **Figure 4**)

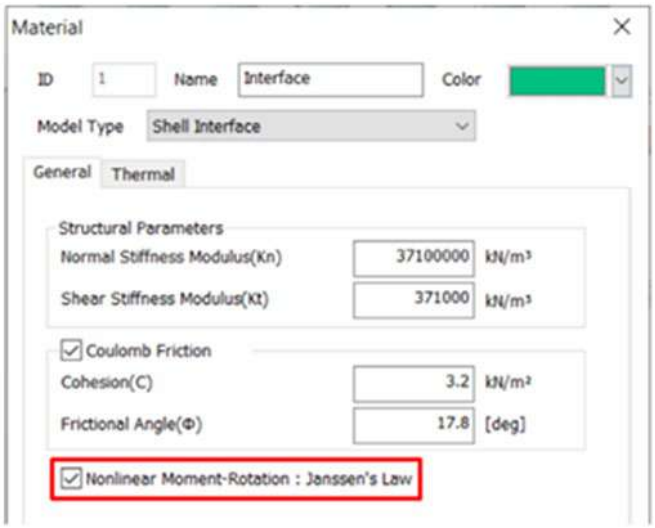

Figure 4. Janssen's law in Midas GTS NX

In order to better simulate the joints in finite elements models, Blom, 2002 considered the longitudinal joints as flexural springs with stiffness, "c_r", defined as:

$$c_r = \frac{1}{\varphi_1} \text{ if } M < \frac{1}{6}Nh \qquad (5)$$

$$c_r = \frac{1}{\varphi_2} \text{ if } M \geq \frac{1}{6}Nh \qquad (6)$$

Where the terms φ_1 and φ_2 are those of equations (1) and (2). **Equation 5** is employed when the rotational stiffness is non-linear but the ultimate compressive strains are in the elastic branch. The circumferential joints are considered as shear springs too. Arnau, 2012 has adopted this formulation

in his experimental study with good results.

If we wanted to simulate the Blom criteria, in MIDAS GTS NX we have to create a "Node connection/rigid link".'

These cited studies were carried out determining the stress distribution and deformation of an ovalised ring assuming three main hypotheses, which are not in fact realistic:

- The ring is radially loaded,
- The Gap between rock and lining is completely filled
- Concrete ring behavior is always linear elastic

These hypotheses are not fulfilled in absence of a significant axial force or when the gap is not yet filled, for example during construction phases. In this case the only bending capacity to support the weight of the segment is provided by the longitudinal bolts.

The main issue in engineering practice is the magnitude of the deformation when the load is not radial, in the absence of a significant axial force acting on the ring, and when the ring, because of the lack of gap-fill is free to expand. In this case, the deformations and the stress distributions are completely out of range when comparison is made between the field data and those values calculated with the models available in technical literature and summarized above because all of them take into consideration that the ring is perfectly confined and immersed into the soil: in other words, the ring displacements would be very small.

It is, therefore, not possible to study these effects referring to the technical literature available. The new approach presented in this study is based on non-linear behavior of R.C. based on the constitutive laws of the materials which leads to a redistribution of the internal forces, in particular of bending moments, and considers provisional bolts which are actually responsible for the achievement of equilibrium in the unfavorable conditions typical of construction phases.

3. Non-linear analysis

Let's imagine studying the installation of the ring and its annular gap filling to double check the crack patterns and the ovalisation (the lack of circular shape). In this case the stresses in the steel of the re-bars, could reach values up to 400 MPa, when cutting the steel bar. Indeed, it is worth pointing out that a kinematic model of the structure shows how a small angle offset (0.5%) at one joint during ring installation results in a displacement equal to 45mm, e.g 0.4% of the inner diameter.

In non-linear analysis the segments are modelled as non-linear frame elements, while the back-filling material is modelled by means of linear springs. The joints between segments have been simulated as non-linear frame elements with a section of steel at the middle of the cross section.

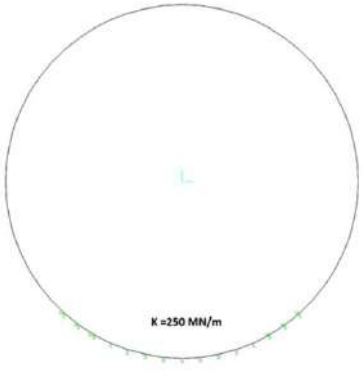

Figure 5. Non linear model

The structural elements considered in the analysis have the following geometrical characteristics and uncracked mechanical properties:

Table 1. Geometrical characteristics and gross mechanical properties of structural elements

Element	h (m)	A (m^2)	I (m^4)
Segments	0.4	0.4	5.33×10^{-3}
Joints	0.17	0.17	4.09×10^{-4}

In order to limit the deformations, the extension of the saddle (usually measured in degrees) takes on a fundamental importance in the problem definition. In fact, the greater the extension of the saddle area, in phase 1 of **Figure 1**, the smaller the displacements which appear along the ring.

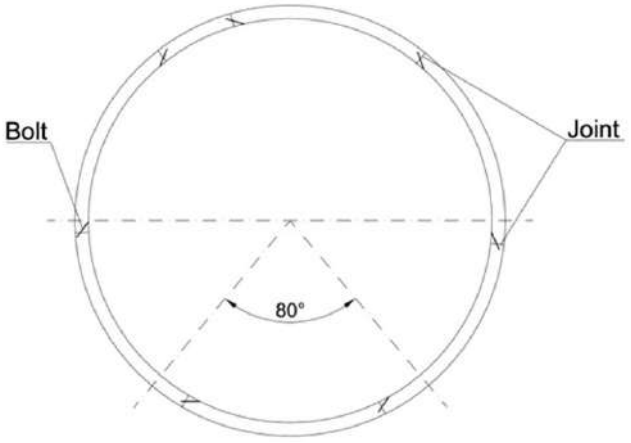

Figure 6 Ring saddle (80º, split in in 40°+40°). Bolts are visible between segments

Figure 6 shows the positions of longitudinal bolts whose main function is to "close" and ensure proper ring geometry of the ring from phase 1 to phase 3 of Figure 1.

The project, object of this study, provided a theoretical extension of saddle zone of 80º divided in two symmetric portions of 40º, as shown in **Figure 6**. The first step in the analysis was to recreate the theoretical conditions. The length of the saddle ring zone has been modelled using vertical springs. The springs can be derived from the subgrade modulus

Formula based on Galerkin approach (see Bowels 1997)

$$K = \frac{E}{R(1+\upsilon)}$$

where: K= subgrade modulus, E= Young modulus of the soil., R= radius of the tunnel (5.57m), v= Poisson ratio (0.2)

Formula by Bowels, based on Vesic´s approach (see always Bowles, 1997)

$$K = \frac{E}{B(1-\upsilon^2)}$$

where: E= Young modulus of the soil, B= equivalent foundation width [see for instance page 509 of Bowles, 1997, v= Poisson ratio

To evaluate the equivalent subgrade modulus along the saddle area, three different hypotheses were made.

- The subgrade modulus is a function only of the mortar Young´s modulus (evaluated 30GPa). The thickness of the mortar is 0.125m which is the gap between the rear of the TBM and the surface of the lining.
- The subgrade modulus is a function of the mortar and that of underlying soil. The thickness of the equivalent layer is 0.25m which is two times the gap thickness. Each layer is considered with a depth of 0.125 m
- The subgrade modulus is a function of the Young´s modulus of the mortar and that of the underlying soil. The thickness of the equivalent layer is 1.5m which is 12 times the gap extension. The mortar layer is 0.125m deep and the underlying soil is 1.375m.

Each of three hypotheses was examined using both Galerkin´s and Bowels´ approach. In summary 6 calculations were made. Following Bowels 1997, the Young modulus for a layered soil can be expressed as:

$$E_{tot} = \frac{E_1 H_1 + \ldots . E_n H_n}{(H_1 + \ldots H_n)}$$

where: E_{tot}= layered Young´s modulus, $E_1 \ldots E_n$= Young´s modulus of layer 1…n, $H_1 \ldots H_n$= thickness of layer 1…n

Once the subgrade moduli have been obtained for each one of the six possible combinations, each value has been multiplied by the equivalent frame area (0.157m) and the subgrade modulus, for each frame, has been obtained as shown in **Figure 7**, where it is possible to see how the difference between the various subgrade moduli can be six times (model 1 / model 6).

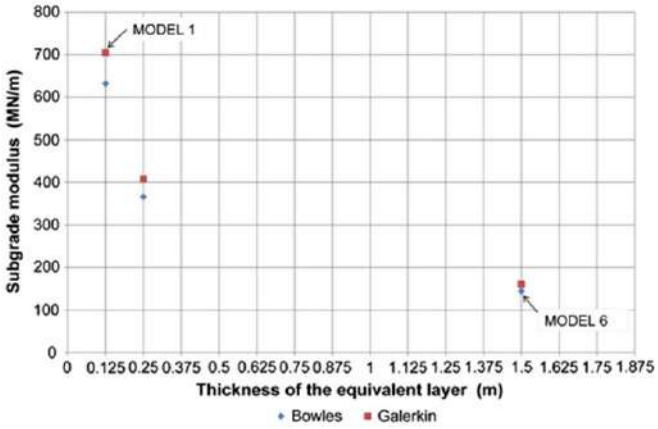

Figure 7 Sub-grade Moduli Variation

Table 2 Different Sub-grade Scenarios

Approach	Model	Thickness (m)	K (MN/m^3)	Area (m^2)	Subgrade modulus (MN/m)
Galerkin	1	0.125	4,488	0.157	704
Galerkin	2	0.25	2,598	0.157	408
Galerkin	3	1.5	1,023	0.157	161
Bowels	4	0.125	4,027	0.157	632
Bowels	5	0.25	2,331	0.157	366
Bowels	6	1.5	918	0.157	144

Table 2 collects all the subgrade moduli employed in non-linear calibrations. **Figure 7** shows the relation between thickness of the equivalent layer and the subgrade modulus. Model 1, for example, corresponds to subgrade modulus following Galerkin´s approach with an equivalent thickness of 0.125 m while model 6 corresponds to Bowles´s approach with an equivalent thickness of 1.5m.

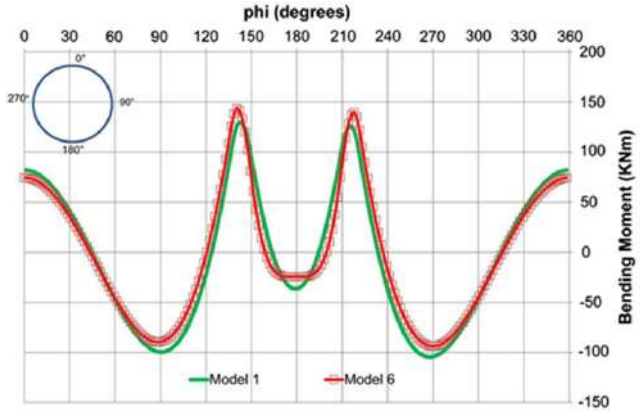

Figure 8. Relation of Bending moment depending of the models employed

Figure 8 shows the values of the bending moments as function of the tunnel angle (0° at crown and 180° at invert arch) for the two different subgrade moduli (model 1 and model 6). It is possible to see how the difference in terms of bending moments is about 9% at the crown and 21% at invert arch. These differences are rather small, in spite of the significant difference in the value of the subgrade modulus.

It was finally decided to employ a value of subgrade modulus equal to 250 MN/m, because, within the estimated range, it better simulates the plastic zone around the tunnel. The model is shown in the **Figure 9**:

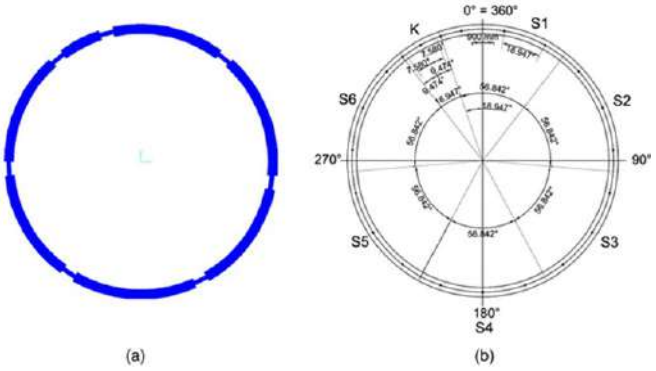

Figure 9. Model employed in analysis (at right) vs real ring (at left)

As it is visible in **Figure 9**, two cross sections were employed:

- Cross section of the segment with a height of 0.40m of concrete and steel rebars
- Joint section, with a height of 0.17m and a steel bolt exactly at the centre of the section

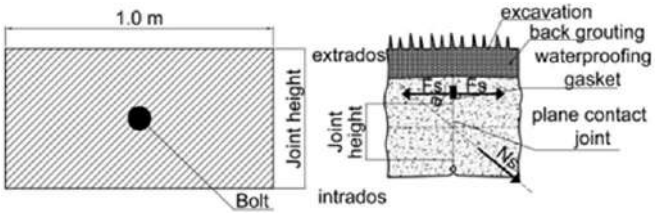

Figure 10. Joint section area

Each segment, in fact, is connected to the others along the longitudinal joint with two longitudinal bolts (along the same ring) and along the transverse joints also with transverse bolts (with the adjacent ring). Each bolt is 25 mm diameter with tensile strength of 1040 MPa and a length of 0.520 m.

The insertion angle is 30º (**Figure 10)**. $F_{d,n}$ is fixed at 700 MPa. The joint section with the concrete in compression and the bolt in tension works as a rotational spring with elasto-plastic behavior.

It is important to underline that the main function of the bolts, mainly the one placed along the longitudinal joints, is to connect all the segments within the same ring, providing enough resistance to balance the ring´s self-weight in absence of a significant axial force.

This is the main reason why bolts must be taken into account during the verification of the construction phases. The bolts were modelled with a frame element whose cross section is shown in **Figure 9 (left)**. Constitutive laws, with average values for concrete and steel bars have been employed.

The methodology of the analysis carried out is based on Pérez et al, 2012 and it consists in the following steps:

- First of all a linear analysis is carried out to determine the internal force envelopes along the ring.
- For each section of the model, the bending moment is compared to the yielding moment. The yielding moment has been evaluated as 128 KNm
- When the computed bending moment is greater to than the value established for yielding (128KNm), a hinge is considered to be formed at that location, carrying a bending moment equal to this value. In this way, internal forces redistribute along the ring. This artifice allows to reproducing the r response of a structure under bending moments when yielding is reached.
- This process has to be repeated until bending moments within the ring are less than the yielding moment or until the structure has collapsed (formation of 5 plastic hinges).

Three scenarios have been reproduced varying the extension of the saddle area as shown in **Figure 11.**

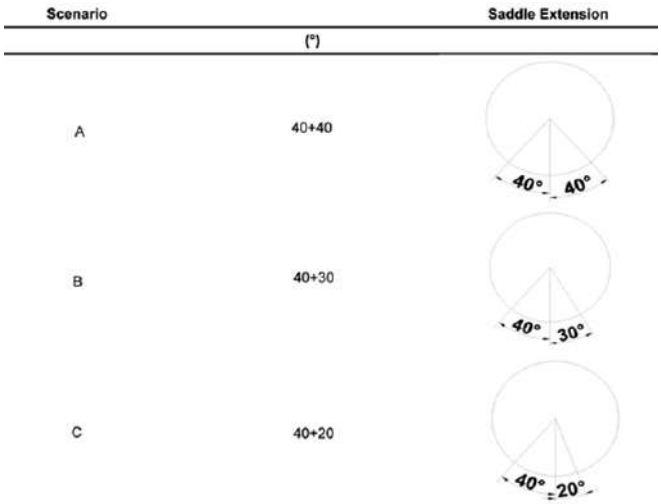

Figure 11 Scenarios analyzed depending of the saddle extension

The results of the models are shown in **Table 3** where it is possible to check the evolution of the internal force redistribution when a hinge is inserted in the model. Model "A" reaches a maximum crack width of 0.3 mm and the ovalisation seems to be constant with a value of 13mm. Model B reaches a maximum crack value of 1.0 mm at the tunnel crown while the ovalisation increases from 17.0 mm with model "B1" to 56.0 mm with model "B3".

Table 3. Summary table among the different scenarios and their evolution after the redistribution steps

Scenario	Description	N_{crown} (kN)	M_{crown} (kN · m)	Δ_{EI} (mm × 10^{-4})	σ_{c1} (MPa)	Crack at crown (mm)	Ovalization (mm)
A1	Model 0 (no hinge)	−1.1	60.1	5.19	272.5	0.3	11.0
A2	Model two hinges	−2.5	65.7	5.69	298.7	0.3	13.0
B1	Model 0 (no hinge)	6.0	86.3	7.68	403.4	0.4	17.0
B2	Model one hinge	11.5	99.5	8.95	470.0	0.5	35.0
B3	Model two hinges	14.9	121.6	3.39	573.6	1.0	56.0
C1	Model 0 (no hinge)	9.0	94.2	8.50	446.4	0.4	33.0
C2	Model one hinge	32.0	152.0	—	—	—	74.0
C3	Model two hinges	9.9	225.0	—	—	—	—
C4	Model three hinges	62.3	466.0	—	—	—	—
C5	Model four hinges	27.0	128.0	4.65	600.0	4.1	151.0

Model C assumes the formation of a series of hinges, during the redistribution process, where the bending moment is higher than the moment producing yielding of the reinforcement one until "C5" where equilibrium is reached at all sections.

4. Conclusions

From the above discussions the following conclusions can be drawn:

1 The approach of tunnel design based on elastic behavior of reinforced concrete, while generally acceptable for service conditions, is not always adequate for the initial phase of ring installation, since the axial forces at the joints are very low.
2 For the construction phase the usual models (Jansenn, Blom) are not applicable due to lack of axial force. For this case, the analysis must take into account provisional bolts which guarantee the structural integrity during this phase. This analysis can be carried out in MIDAS GTS NX simulating the segments as shells with different thickness.
3 For the permanent phases the usual models (Jansenn, Blom) can be applicable because of the ground forces. These joins can be efficiently simulated in Midas GTS as interface with Jansenn formulation
4 During construction phase, it is important also to evaluate the asymmetrical configuration of the saddle because it can lead big values of ovalisation of the rings.

The model employed, simulating the joints among the segments, allows to model hinges within the ring which lead to redistribution of internal forces. This redistribution capacity is the reason why the formation of a hinge within the ring does not lead to collapse.

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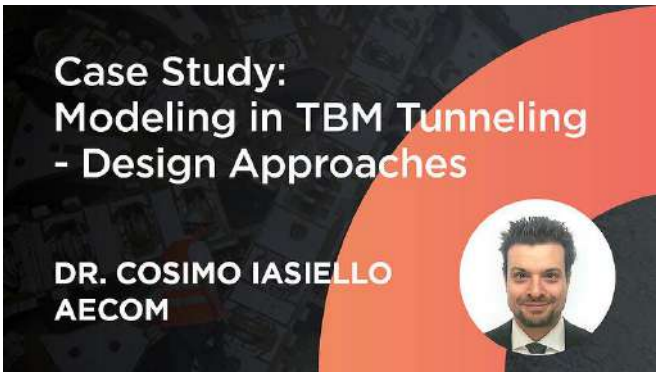


https://www.youtube.com/watch?v=M3CgyCo6fpI

https://www.midasgeotech.com/blog/joints-tbm-tunnel-part1, https://www.midasgeotech.com/blog/joints-tbm-tunnel-part2

Drilled Shaft Foundations for the Hurricane Deck Bridge (A RCD Story)

Introduction

The Missouri Department of Transportation (MoDOT) recently replaced the Hurricane Deck Bridge that carries Highway 5 traffic across the Osage Arm of the Lake of the Ozarks in Camden County, Missouri. The replacement structure is on a new alignment adjacent to the existing bridge and is founded on large diameter drilled shafts socketed into the bedrock using full-face, casing top mounted, Reverse Circulation Drilling (RCD). This article describes the foundation design and construction for this interesting $32 million bridge replacement project.

The owner is MoDOT, the general contractor was American Bridge, and the design consultant was Parsons. Both Case Foundation and Hayes Drilling acted as sub-contractor to American Bridge to install drilled shaft foundations; Case in the water using RCD equipment and Hayes on the land using traditional rotary drilling equipment. Dan Brown and Associates (DBA) provided foundation engineering and design services as sub-consultant to Parsons.

Foundation Design

Dozens of boreholes including rock coring were drilled form a barge during the design phase. The location of each drilled shaft included at least one boring per shaft. Some of the borings were also logged with an Acoustic Tele-Viewer (ATV) in an effort to further evaluate the in-situ quality of the bedrock. This region is known to contain karstic features in the bedrock and the ATV logs provided a reliable means to inspect borehole walls for such features. An example of the ATV results in the bedrock is provided in Figure 1a, along with the corresponding photograph of recovered rock core in Figure 1b.

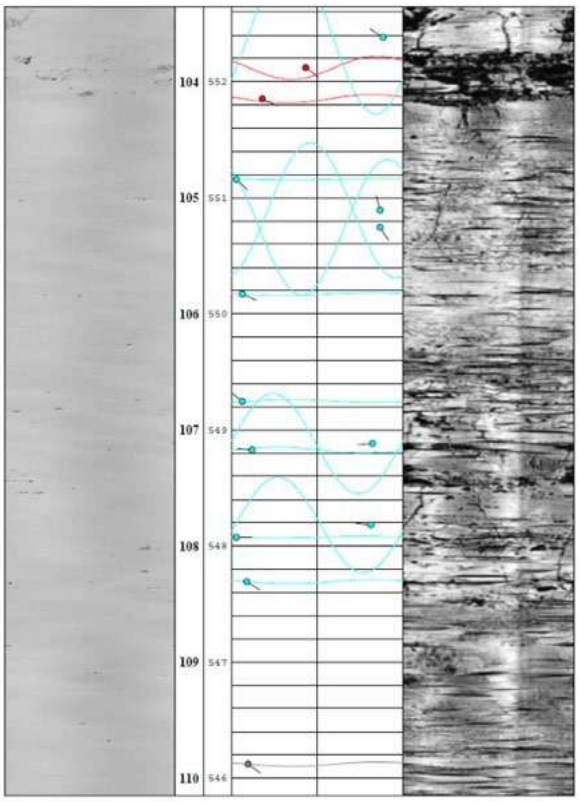


Fig 1a: Representative ATV Results in Dolostone Bedrock

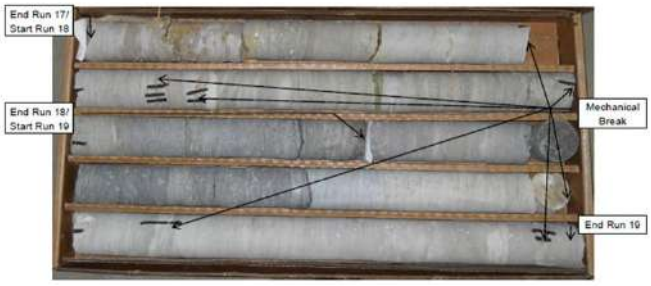


Fig 1b: Corresponding Photograph of recovered Dolostone Bedrock core

The dolostone bedrock was determined to be adequate on the basis of the core results. The average unconfined compressive strength (q_u) of the bedrock cores as measured in the laboratory was 5,680 psi (39162 KN/m2). As is typical with sedimentary bedrock in the Midwestern United States the q_u of the bedrock cores contained a fair amount of variability and therefore many tests were performed in an effort to quantify the variability. The measured q_u values on the 225 samples tested ranged from 650 psi to 18,420 psi with a standard deviation of 3,090 psi (21305 KN/m2). The average unit weight of the bedrock core samples prior to testing in the laboratory was 159 pcf (2547 Kg/m3). Core recovery and Rock Quality Designation (RQD) were both good with the exception of some zones of karst near the surface of the bedrock.

The bridge design includes eleven two-column bents supported on drilled shafts with rock sockets. The two shafts at each bent were tied together with a waterline strut oriented in the transverse direction of the bridge. Each column was supported by an 8.5ft (2.59m) diameter drilled shaft permanently cased to rock and with an 8ft (2.43m) diameter socket extending about 20ft (6.09m) into dolostone bedrock. The contributions of both side resistance and base resistance generated in the rock socket were included in the calculations of geotechnical axial compressive resistance.

The diameter was controlled by lateral considerations and the relative large unsupported length between the mudline and the waterline strut. The submerged overburden soil was soft and provided little lateral resistance. A schematic of the subsurface profile longitudinal with the bridge is provided in Figure 2 with the bent locations superimposed. At some locations, the water is 80ft (24.38m) deep with only about 10ft (3.04m) of soil above bedrock. Due to the relatively large unsupported shaft length, the structural engineer concluded and specified that the maximum allowable plumbness tolerance was one percent.

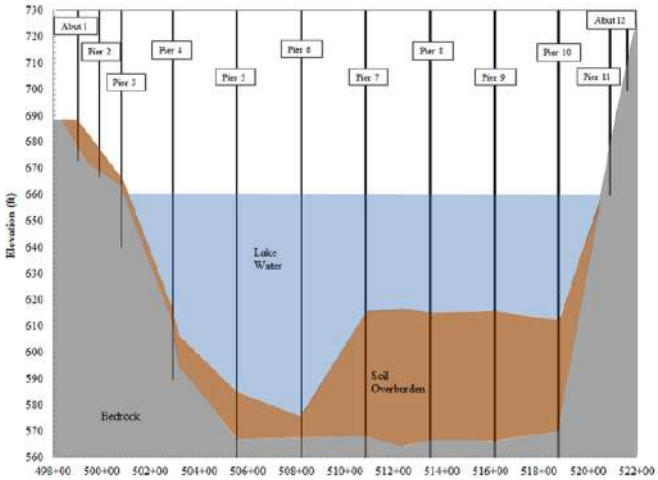


Fig 2: Subsurface Profile

The socket length was controlled by axial considerations and less favorable bedrock conditions were encountered at some shaft locations. The core recovery and RQD at some locations indicated soil-filled solution cavities and poor-quality bedrock at a few of the shafts near the surface of the bedrock.

Foundation Construction

The drilled shafts at Bents 4 through 10 were constructed by Case Foundation under subcontract to American Bridge. These locations represent the over-water bents and included a total of 14 shafts. The drilled shafts necessary to support the bents on land were constructed by Hayes Drilling under subcontract to American Bridge.

After installing the permanent casing into bedrock and removing the soil overburden inside the casing, Case Foundation drilled the rock sockets with an RCD rig. The rig was mounted to the top of the permanent casing as shown in Figures 3a and 3b and the excavation was advance using a full-face cutter assembly as shown in Figure 4.

Fig 3a: Reverse Circulation Drill Rig

Fig 3b: Reverse Circulation Drill Rig

The configuration of drill rig and cutting tool combined to make what was essentially a large plumb bob. This proved beneficial in achieving the maximum one percent vertical tolerance specified in the construction documents.

Another benefit of the reverse circulation drilling method is that an airlift is constantly working to remove cuttings. This process results in a very clean excavation which greatly reduces the risks of post-construction integrity test anomalies as well as provides more reliable base resistance.

Fig 4: Full-Face Cutter Assembly

Following the excavation of the drilled shaft, standard MoDOT drilled shaft construction specifications required each rock socket be visually inspected with a television camera. The socket walls and base were viewed with the camera and indicated a very clean excavation and rock socket conditions commensurate with the design.

At one shaft location, a clay-filled solution cavity was encountered that required mitigation. The cavity was approximately 2-3ft (0.61-0.91m) in vertical dimension and the top of the cavity was approximately 5ft (1.52m) beneath the top of bedrock. Upon encountering this feature, the drill stem advanced rapidly as would be expected when transitioning from bedrock to clay. The drill assembly was immediately retrieved to prevent potential loss of the tool.

A previously agreed upon contingency plan was instituted immediately to mitigate the issue. This contingency plan was included in the drilled shaft installation plan and proved very valuable. Because the risk of encountering such features were made known early in the project, the Owner, Engineer, and Contractor were able to rapidly respond to the issue and successfully and efficiently mitigate the problem under fair financial terms. A well out thought installation plan provided by the Contractor in combination with a thorough identification and description of construction risks by the Engineer helped the Owner feel comfortable agreeing to the financial terms of the possible mitigation effort prior to the commencement of construction. A photograph of the completed Hurricane Deck replacement bridge is provided below in Figure 5.

Fig 5: Photograph of New Hurricane Deck Bridge

Summary

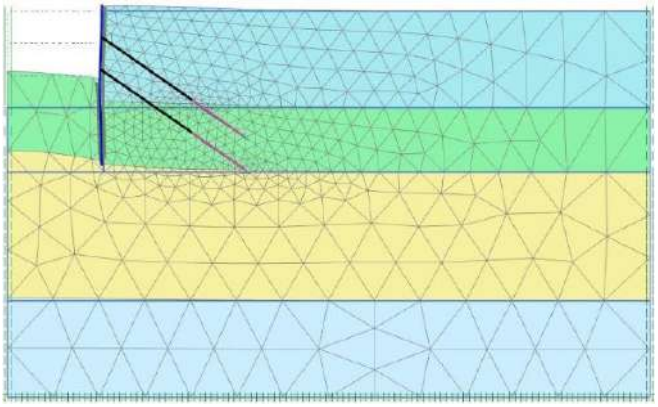
Several aspects of foundation engineering were necessary during the design phase of this interesting bridge replacement project. The final selected foundation elements included drilled shafts with rock sockets and one instance of a spread footing bearing on shallow bedrock.

During the investigation of the existing caissons, ATV testing proved very beneficial, particularly in zones with low core recovery or RQD.

A comprehensive drilled shaft installation plan agreed upon by all parties in advance of the construction can and did yield benefit. A good plan should include a consideration of the anticipated risks and an agreement on how to proceed if difficulties associated with those risks are encountered. A good faith effort is necessary by the Contractor and a willingness to share risk is necessary by the Owner, along with a competent and experienced design engineer retained throughout the entire design and construction process.

(DFI of INDIA News, Volume 7 Book 2, July 2021, pp. 8-10, http://www.dfi.org/update/DFI%20India%20News%20July%202021.pdf)

Numerical Modelling: On the Importance of an Appropriate Soil Model



Numerical Analysis of a Deep Excavation: Unrealistic heave of the soil behind the retaining wall (credits: Virtuosity)

The following was prepared by Dr. Ronald B.J. Brinkgreve, and first presented by Virtuosity.

Numerical modelling of geotechnical applications requires appropriate soil models to obtain realistic and accurate results. In this respect, a simplified model like the linear elastic perfectly plastic Mohr-Coulomb model can be regarded as inappropriate, since it lacks important features of real soil behavior. If you are still addicted to Mohr-Coulomb, it's time to move on. This blog explains why, and what are the better alternatives.

Features of Soil Behavior

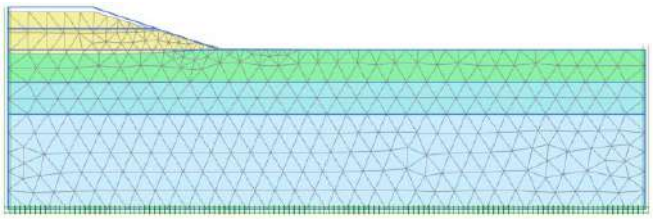
Compared to other 'engineering materials' like steel and concrete, soil is a much more complex material. Typical 'engineering properties' of soil, such as 'strength' and 'stiffness' depend on many other properties and on the particular conditions that apply in the situation at hand. For example, soil strength and stiffness depend on the stress level, the loading direction, the strain level, short or long term, density, overconsolidation, and several more. Stress-dependency and strain-dependency of stiffness and strength are some of the 'features of soil behavior'. Other features are compaction and dilatancy, drained or undrained behavior (the latter involves a simultaneous change of pore water pressure), creep, anisotropy, structure, and several more.

Constitutive Models

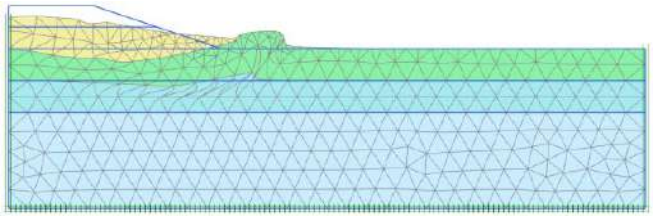
Geotechnical Finite Element (FE) programs use constitutive models to model the mechanical behavior of soil and rock layers. Constitutive models, or in short, soil models or rock models, are a theoretical framework for the relationship between stress and strain (and time); it is the qualitative description of the soil or rock behavior in the computer program. The linear elastic perfectly plastic Mohr-Coulomb model is a simple combination of Hooke's law of isotropic elasticity and the generalized Mohr-Coulomb failure criterion formulated in a non-associated plasticity framework. This sounds complicated, but, in fact, it isn't; it provides only a bilinear stress-strain relationship, which is far from realistic, because it lacks many features of real soil behavior.

More advanced soil models, such as the Soft Soil model and the Hardening Soil model with small-strain stiffness (HSsmall), are based upon more complicated theories. They have been validated based on many test results and several real-life applications. As a user, you do not need to fully understand the theories behind, as long as you are aware of the capabilities and limitations of the models and how to determine the corresponding parameters. Some constitutive models are more appropriate for soft soils; others are more appropriate for harder types of soils and some models are applicable for rocks or other engineering materials; and there are also special models for dynamic applications (earthquake simulations) or for temperature-dependent applications. It is important to choose the right model in accordance with the type of soil and the features of soil behavior that are considered relevant for the application at hand.

Images shown below: Staged undrained construction of an embankment on soft soil



Using Mohr-Coulomb model with effective strength parameters: No failure (stable)



Using Soft Soil model with effective strength properties: Failure (instable)

Model Parameters

Besides the model itself (theoretical framework; qualitative description of soil behavior), the model parameters are there to quantify the soil properties (stiffness, strength, etc.) in the constitutive model. Admittedly, more advanced soil models generally have more parameters that need to be determined based on site investigation data, which is usually scarce. This is a reason why some engineers stick to simple models, because they think it will cost them less time and effort to determine the parameters. However, appearances are deceptive, since parameters in a simple model cannot be determined unambiguously for most practical applications. On the other hand, parameters in advanced soil models have a much more precise meaning and can mostly be determined unambiguously for each soil layer.

Simple Models can be Dangerous

Simple models lack important features of soil behavior. In some cases, this may lead to dangerous situations. Some examples:

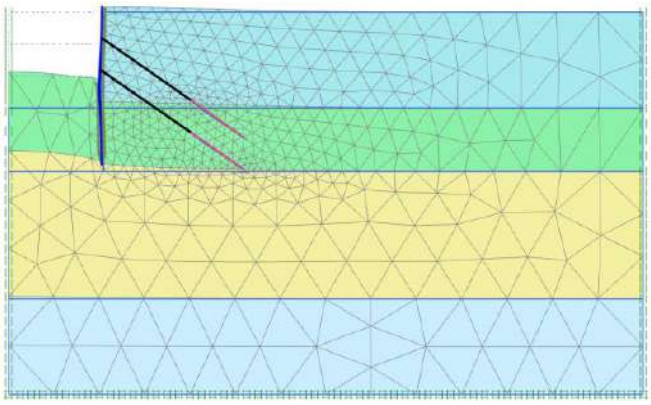
1. Soft soils show a reduction of effective mean stress under undrained loading conditions, which results in undrained shear strength (s_u) that is less than what would result from the initial effective mean stress. Linear elastic perfectly plastic models do not capture this reduction of effective mean stress. Hence, they overpredict the soil's undrained shear strength when modelled by even the correct effective strength properties (φ', c'), which can be dangerous. See first example below.

2. Simple models do not distinguish between primary loading and unloading or reloading. When using such models in excavation projects to predict deformations around the retaining wall, unrealistic heave of the wall and heave of

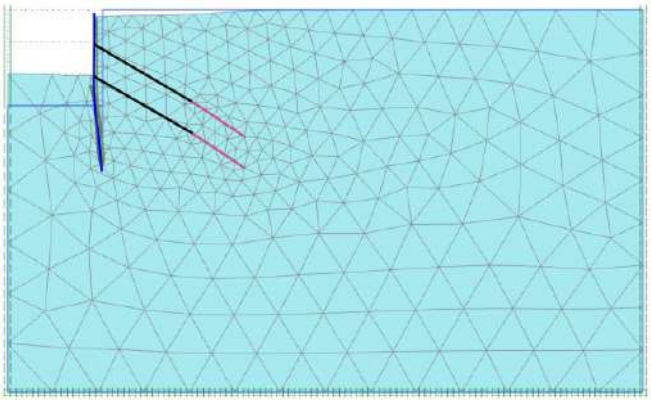
the soil behind is often found. Practitioners know that excavations always cause settlement instead of heave. Simple models predict the opposite, which can be dangerous. See second example below.

There may be ways to avoid this dangerous behavior of simple models by means of 'engineering judgment'. However, it is better to use more advanced soil models and rather spend your time on a proper determination of the model parameters. The model does then most of the job for you.

Image shown below: Staged excavation, supported by an anchored retaining wall



Using Mohr-Coulomb model, showing unrealistic heave of the soil behind the retaining wall



Using the Hardening Soil model with small-strain stiffness showing realistic settlement behind the wall

Note:

1. Instead of sub-dividing the homogeneous soil into multiple sub-layers, as necessary for the MC model, the soil can simply be modelled with a single layer using the HSsmall model.

2. Deformations are plotted on an exaggerated scale.

3. The heave of the excavation bottom (swelling) is a result of unloading, but is generally not noticed in practice, since it is simply excavated.

More to Come

After reading this contribution, you should consider the use of advanced constitutive models in your next geotechnical finite element application. In the next series of blogs the focus will be on some such models with the purpose to take away the fear and make you more confident of using them.

An important hurdle is the determination of model parameters, especially since good site investigation is often lacking in an early stage of a project. It should be mentioned that preliminary work on a tool to help you with parameter determination of advanced soil models, was published in a Geostrata article two years ago by Brinkgreve (2019). Starting from basic field test data (**CPT**, **SPT**), the tool uses chains of correlations to propose parameter values, and it transparently shows how they are calculated. This shall stimulate the use of advanced constitutive models and it shall lead to more consistent results from geotechnical finite element calculations.

Credits: Virtuosity Software

https://www.geoengineer.org/education/numerical-constitutive-modeling/numerical-modelling-on-the-importance-of-an-appropriate-soil-model?utm_source=twitter&utm_medium=social&utm_campaign=page_post

Forensic Delay Analysis for Dispute Resolution

Dimitrios Tousiakis

Delay expert and Director of HKA Dubai, looks at applying Linear Scheduling Methodology tools to simplify forensic delay analysis for dispute resolution

CLEAR PRESENTATION WHEN DEMONSTRATING A fact in construction dispute proceedings is essential. It can dictate the outcome of a dispute and applies equally to claim submissions and any independent testimony required in court, arbitration or other formal proceedings.

A 'linear' project such as a tunnel involves longitudinal, spatial and repetitive construction activities

Because of the complexities arising in delay analysis and its terminology, it is often characterised as a 'dark art'. A simple presentation of a sound methodology arriving at clear and persuasive conclusions, goes a long way to demystify this so called dark art.

The nature of the construction project and the details of the dispute usually dictate the most appropriate delay analysis method to be applied.

Here, two fundamental scheduling methods are examined for their application to projects of a 'linear' nature (such as roads, bridges, tunnels, etc.):

- The Critical Path Method (CPM)
- The Linear Scheduling Method (LSM).

CPM is a scheduling method that is more widely used for construction programme development and management.

However, for linear projects, the lesser known LSM is a more informative approach. This methodology uses graphical representation in a two-dimensional (2D) diagram within time and location axes.

In this article, the potential and benefits of LSM graphs for the purposes of forensic delay analysis of linear construction projects are reviewed. A hypothetical tunnelling project case study is used to demonstrate how as-built information can be incorporated into the LSM graphic to demonstrate the various project parameters, the actual progress of works, and the cause and effect of delay events.

WHAT IS A LINEAR PROJECT?

'Linear project' is the term that characterises a construction project with longitudinal, spatial and repetitive construction activities. Examples include highways, pipelines, bridges, railway-track systems and tunnelling.

Linear scheduling for forensic delay analysis can benefit linear projects

The main characteristics of linear projects are:

- Repetitive identical activities along the length of the project (for tunnels, pipelines, etc.).
- Repetitive activities carried out irrespective of location and without a dependency on any particular spatial sequence. For example, if one section of a tunnel is temporarily inaccessible, work might still progress along other sections.
- The timely completion of linear projects is highly dependent upon efficient productivity rates and optimum resource utilisation for repetitive activities.

CRITICAL PATH VERSUS LINEAR SCHEDULING

The CPM and the LSM are both scheduling and programming methods used for developing, managing and monitoring the time aspect of construction projects.

CRITICAL PATH METHOD

The Delay and Disruption Protocol published by the Society for Construction Law[1] describes the CPM programming method as:

'The methodology or management technique that, through the use of calculation rules (usually automatically carried out by programming software), determines the critical path and calculates float.'

CPM is the most commonly known and used scheduling method in construction management. Schedules are prepared by inputting data for individual activities (i.e. durations, dates, logic relationships, dependencies, etc.) into proprietary programme software tools. The software subsequently applies algorithms to calculate free float, total float, critical and near critical paths for the combined elements of the project.

CPM is a valuable tool that can display graphical visualisations, normally in the form of a Gantt Chart.

However, because CPM focuses primarily on the time aspect of construction projects, the outcome is a one-dimensional (1D) overview. Caution should be applied when using this scheduling methodology because several important elements are not factored into the process[2].

For example:

- Spatial analysis and the constraints/parameters of the physical layout of the site are not automatically considered. CPM algorithms work on activity and relationship inputs and rely on the planner to avoid conflicting spatial requirements on the site.

- Optimum productivity rates for construction elements activities are not visually demonstrated in typical CPM graphs.
- Resources requirements, availability, cost, productivity levels and continuity of work are not visually demonstrated in typical CPM Gantt Charts.

An example of a typical CPM graph (Gantt Chart) is presented in figure 1.

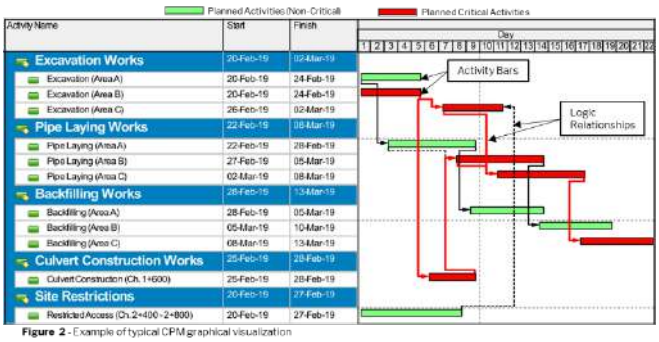


Figure 2 - Example of typical CPM graphical visualization

figure 1: Example of a typical CPM graphical visualisation (Gantt Chart)

LINEAR SCHEDULING METHOD

LSM is a graphical method, the output of which is a two-dimensional (2D) diagram that depicts both time and space in one chart.

Unlike CPM which is activity-focused, LSM is production-focused. Individual activities are represented by single lines on a chart, whose gradient is proportional to the rate of productivity. Thus, the graphical output shows the combined relationship between duration and output at a particular time and in a particular location.

The use of the linear scheduling method can enable:

- Avoidance of impact from space restrictions on site.
- Optimum productivity of all activities, ensuring that one activity does not adversely impact upon production rates of another.
- Continuity / uninterrupted working of resources.

The LSM methodology is particularly suitable for application to projects with a longitudinal or spatial dimension, or where repetitive activities occur, and optimum productivity rates are essential to achieve timely completion (e.g., tunnelling projects)[3].

LSM graphs display two axes: one for time and the other for location, with data symbols depicting:

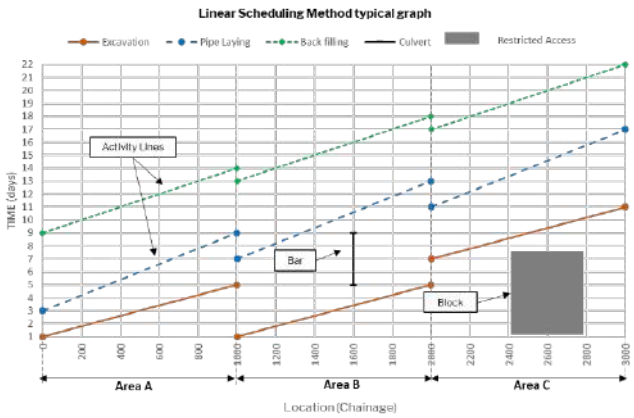


figure 2: Example of a typical LSM graphical visualization

- Activity lines with different styles to identify different activities or resource crews (for example, the excavation activity of a road project). The gradient of each activity line depicts the productivity rate of that activity.
- Bars depicting an activity or constraint at a specific location for a specific period of time (for example, construction of culverts at specific locations of a road project).
- Blocks depicting an activity or constraint at a wide area of the site arising for a specific period of time (for example, areas of restricted access).

An example of a typical LSM graph is presented in figure 2.

Additional information can be added to LSM graphics to enhance the overall picture. This may include the site's profile section drawing or the type of soil at various locations and other relevant information.

A comparison between CPM and LSM graphs is depicted in figures 1 and 2 and shows the construction works of a theoretical pipe-laying linear project, including the construction of a culvert and a site-access restriction.

The CPM graphical visualisation is in the form of a Gantt Chart. Time is depicted along the horizontal axis with the activities depicted in the form of bars.

By comparison, the LSM graphical visualisation uses a two-dimensional graph showing time on the vertical axis, and location on the horizontal axis, (i.e. a steeper line reflects a slower activity)[4].

APPLICATION OF LSM IN FORENSIC DELAY ANALYSIS

Construction dispute resolution processes often require a retrospective delay analysis to demonstrate the effect of delaying events[5]. The importance of a clear and easily understandable delay analysis presentation, within a construction claim or other dispute resolution proceedings, cannot be overstated.

Retrospective delay analysis methodologies that are based on factual data and linked to contemporaneous as-built project records (for example the 'as-planned versus as-built' methodology)[6], provide realistic results when compared to theoretical prospective delay analysis methodologies (for example the 'impacted as planned' methodology)[7].

CPM scheduling methods are frequently used in forensic delay analysis. This method has several limitations, particularly when analysing linear projects[8]. CPM graphs do not visually demonstrate changes in productivity rates, for example, caused by potential disruption. Furthermore, CPM graphs do not visually identify the location of activities and/or restrictions that occurred during the project.

The LSM method is particularly suitable for application to projects with a longitudinal or spatial dimension

LSM scheduling methods used for forensic delay analysis of linear projects can display valuable insight of the actual progress of the works in relation to location. LSM can graphically depict changes in production rates, the interrelationship between resources, locations and durations.

Its visual representations are easy to understand and read, even for those with little to no experience in construction programme management or the project specific details. They are also useful for those who become involved in the project during the latter stages, or where dispute resolution processes introduce new individuals, such as mediators, adjudicators, arbitrators and judges.

Contemporaneous as-built information can clearly and concisely display project history or specific activities / events in relation to the physical conditions in a single graph.

The delay analyst, by reviewing and analysing the LSM graphs, can make considerable observations of the actual progress of the works and structure the delay analysis around the LSM graphs.

Below is a hypothetical tunneling project case study providing an example demonstrating how the asbuilt information can be incorporated into LSM graphical tools and what observations / conclusions can be produced by reviewing the LSM graphs for the purposes of forensic delay analysis of linear projects.

CASE STUDY: FORENSIC DELAY ANALYSIS OF A TUNNEL CONSTRUCTION PROJECT

The following hypothetical case study assumes a 4km tunnel that has been built using one tunnel boring machine (TBM).

With its large rotating cutterhead, a TBM can build tunnels through soil, rock, or a mixture of both. This multifunctional construction tool can excavate and at the same time install the permanent reinforced concrete lining of the tunnel as it progresses. The main characteristic of the TBM is that while boring, it installs precast concrete lining segments and uses hydraulic rams to push itself forward.

The timely completion of the tunnel is usually reliant upon the efficient and uninterrupted operation of the TBM. Two main parameters that affect the TBM operation and productivity are:

- The actual soil conditions; and
- The timely production and availability of the precast concrete tunnel wall segments against which the TBM can push against and continue drilling.

The process of plotting data for the planned and actual progress of the TBM operation into the LSM graph highlights the periods and locations of:

(a) Slower than planned progress.

(b) Any work stoppages.

(c) Any changes to the planned sequence.

These observations can then form the basis of further forensic examination in order to identify the cause and effect of these delay events.

Figure 3 depicts a theoretical LSM example where:

- The dotted black activity line represents the planned progress of the TBM.
- The straight black activity line represents the actual progress of the TBM.
- The gradients of the respective activity lines depict the planned and actual productivity rates. The steeper the gradient indicates less work completed in the period, thus a lower rate of productivity.
- The arrows represent the direction of travel of the TBM and the actual productivity (gradient). Red arrows highlight periods of lower productivity rate than planned.
- Some significant locations are shown in yellow circles, for annotation purposes (i.e. location A, B, C, etc.).
- The observations arising from the LSM graph are listed in the grey boxes to the right of the graph and are numbered with Roman numerals (I, II, III, etc.)

This simple LSM graph with explanatory notes efficiently depicts a comparison of planned vs actual progress of the works and highlights specific delay events.

Further forensic investigations into each delay event enables enhancement of the LSM graph to include additional as-built information that informs detailed conclusions as to specific causes of the delays.

In addition, enchased LSM graphs can provide an easy-to-understand snapshot that convey the periods and causes of low productivity assisting in a more detailed disruption analysis. The disruption analysis helps to demonstrate whether works were disrupted by contract delay events or, whether the contractor was not able to perform efficiently.

Figure 4 depicts an enhanced LSM graph where the following enhancements have been added:

a. The actual restricted areas and periods (grey bars / blocks).

b. The actual period required for the assembly of the TBM (blue bar).

c. The period required for the replacement of a TBM's defected part (red bar).

d. The actual soil conditions under the horizontal axis (location chainage).

e. The percentage of the fabricated precast concrete segments of the tunnel wall to the left of the vertical axis (time).

LIMITATIONS OF THE LSM IN FORENSIC DELAY ANALYSIS

LSM graphs used for forensic delay analysis have limitations.

As with all retrospective delay analysis methods, a typical problem that is often encountered is the availability, format, and accuracy of the contemporaneous data records. Creation of LSM graphics requires the delay analyst to import a vast amount of as-built data into the proprietary software application.

A lack of contemporaneous or inappropriately formatted records can be problematic, resulting in a time consuming and resource-intensive analysis.

LSM for the purposes of forensic delay analysis is a graphical method that does not rely upon an underlying mathematical model. Various published scientific papers have attempted to define a mathematic model for LSM analyses9, but these have not been widely adopted in proprietary software packages. Consequently, the conclusions deriving from LSM graphs, especially regarding the critical/driving activities, are based on the delay analyst's observations, construction knowledge experience and common sense, rather than automated software calculations.

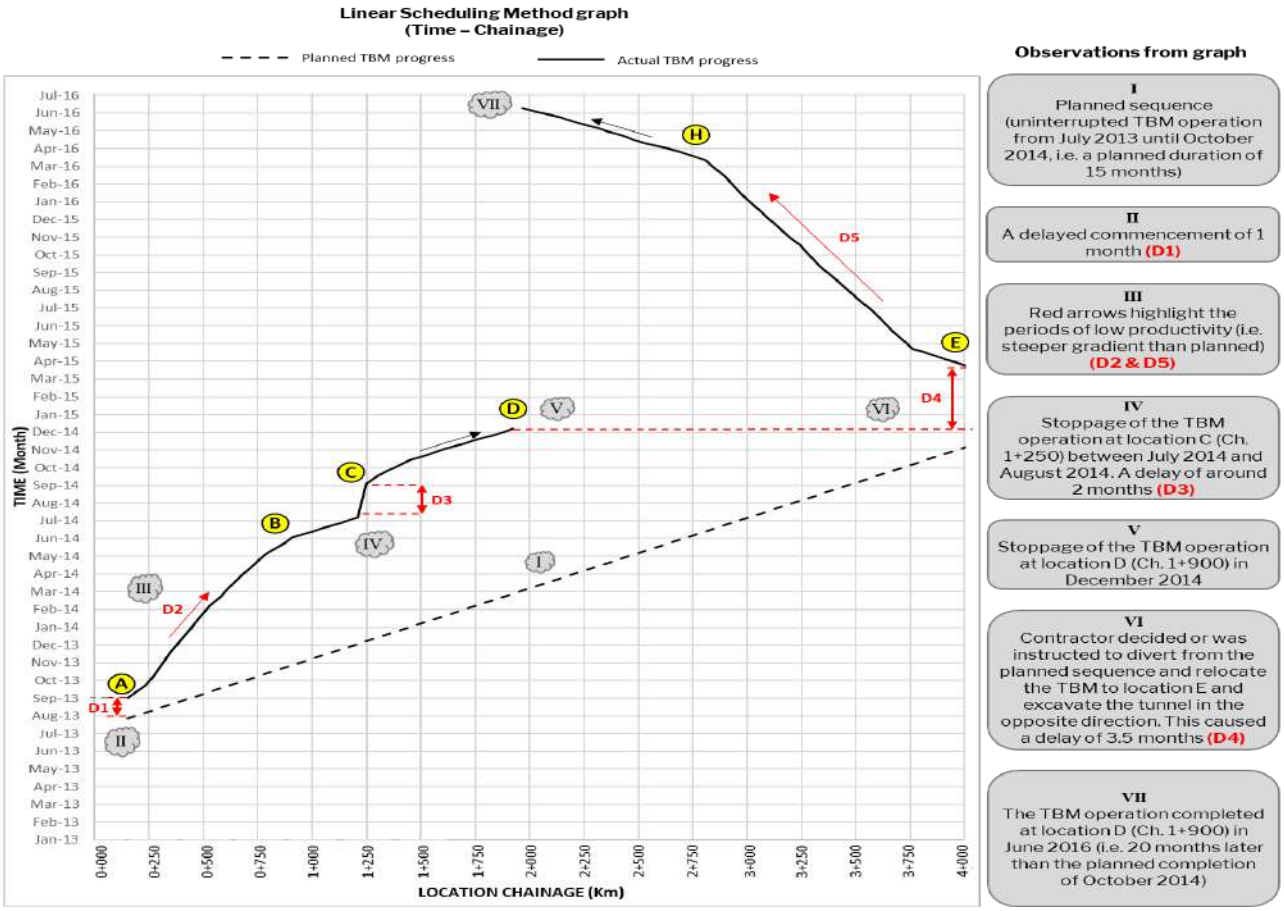


figure 3: As-planned versus as-built time-chainage graph of the operation of a tunnel boring machine

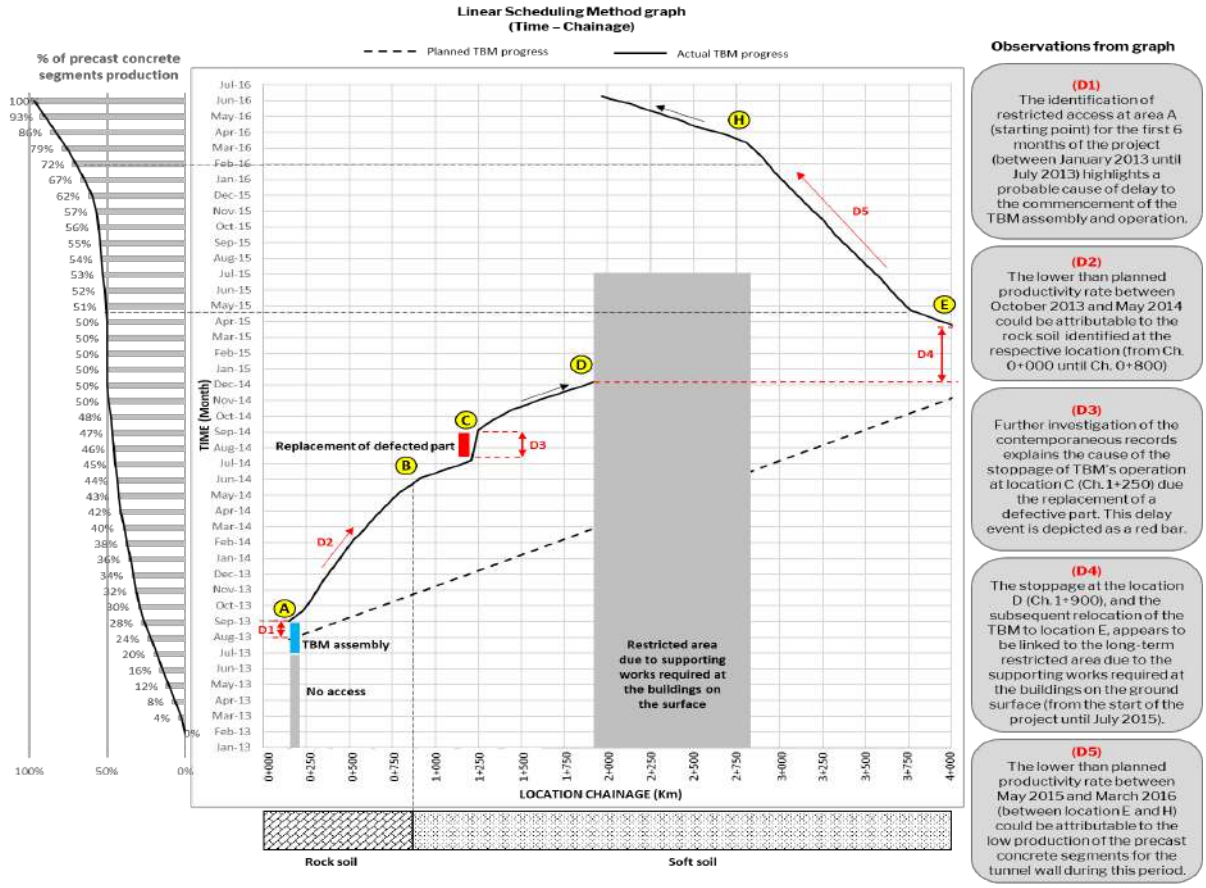


figure 4: Depicts an enhanced LSM graph where various enhancements have been added (see paragraph 5)

CONCLUSION

When applied to linear projects (such as tunnel construction), LSM can provide a more thorough and informative analysis of the cause and effect of delay events when compared to the CPM method.

As with any delay analysis, the output of LSM is dependent on the quality and accuracy of the raw data available at the input stage and the experience and technical ability of the analysts.

The LSM two-dimensional (2D) graphical representations ('time-chainage graphs') enable a snapshot view and valuable insight comparing, at a glance, planned vs actual performance and productivity, in time and space.

Further forensic analysis can then focus on key events or periods.

LSM graphs are practical, relatively easy to understand, and convey a wide range of information in a format that is easy to assimilate. These are important attributes to consider when supporting claims or opinions before a wider audience in formal dispute resolution proceedings.

References

1. SCL Delay and Disruption Protocol 2nd edition – February 2017, Appendix A (p. 62)

2. This applies to the typical CPM scheduling via Gantt Charts. More recent CPM methods have been developed which can consider both space and time (for example 4D scheduling) but are not widely used and require proficient use of advanced and sophisticated software.

3. Some examples of published scheduling methodologies which address similar objectives but with different terminologies are listed below:

Methodologies for unitary projects or work elements (floors, houses, apartments, stores, or offices), include:

- Line of Balance (LOB) (O'Brien 1969; Carr and Meyer 1974; Halpin and Woodhead 1976; Harris and Evans 1977).
- Construction Planning Technique (CPT) (Peer 1974; Selinger 1980).

For longitudinal projects (highways, pipelines, tunnels, etc.), published methodologies include:

- Time Versus Distance Diagrams (Gorman 1972).
- Linear Balance Charts (Barrie and Paulson 1978).
- Velocity Diagrams (Dressler 1980).
- Linear Scheduling Method (LSM) (Johnston 1981; Chrzanowski and Johnston 1986; Russell and Casselton 1988).

4. There are numerous sophisticated scheduling software tools available for producing graphs for both CPM and LSM. For this paper and for demonstration purposes only, all the CPM graphs have been created in Primavera P6 and all the LSM graphs in Microsoft Office applications, which is a very basic way of creating such scheduling graphs.

5. Retrospective delay analysis is an analysis performed after the delay events (or the whole project) have completed (i.e. a delay analysis looking backwards to what actually happened)

6. Defined by the SCL Delay and Disruption Protocol 2nd edition – February 2017, para 11.6(d)

7. Defined by the SCL Delay and Disruption Protocol 2nd edition – February 2017, para 11.6(a)

8. Projects which are characterised primarily by their longitudinal spatial nature and/or by their repetitive construction activities.

9. Some of the more recent scientific papers include:

- The Repetitive Scheduling Method (RSM) by Harris and Ioannou (1998).
- The Linear Scheduling Model (LSM) by Harmelink and Rowings (1998).
- The Critical Path Linear Scheduling Method by Ammar and Elbeltagi (2001).
- The Kallantzis-Lambropoulos Repetitive Project Model (KLRPM) by Kallantzis and Lambropoulos (2004).

About the Author

Dimitrios Tousiakis BEng MSc (Eng) MSc MICE is a Delay Expert and Director of the HKA office in Dubai. He is a Chartered Civil Engineer (ICE and TEE) and an RICS Accredited Expert Witness with international experience in forensic delay analysis for dispute resolution and directly in the construction industry.

He has been appointed as independent Delay Expert Witness for ICC, DIAC, DIFC-LCIA and ADCCAC arbitrations and provided oral evidence during cross-examination. He has also provided independent expert opinion to contractors and employers on multiple occasions on a range of projects including high-rise buildings, airports, health care, rail, and oil & gas.

Dimitrios holds a MSc in Civil Engineering and Business Management by Imperial College London, UK and a BEng in Civil Engineering by Aristotle University of Thessaloniki, Greece.

ΝΕΑ ΑΠΟ ΤΙΣ ΕΛΛΗΝΙΚΕΣ ΚΑΙ ΔΙΕΘΝΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΝΩΣΕΙΣ

ΕΛΛΗΝΙΚΗ ΕΠΙΤΡΟΠΗ ΣΗΡΑΓΓΩΝ και ΥΠΟΓΕΙΩΝ ΕΡΓΩΝ (Ε.Ε.Σ.Υ.Ε.)

Προς: Μέλη ΕΕΣΥΕ

Αθήνα, 21 Ιουλίου 2021
Αρ. πρωτ. : εξ1

Θέμα: Συγκρότηση νέου σώματος Διοικητικού Συμβουλίου ΕΕΣΥΕ

Σχετικά: Πρακτικό Εξελεγκτικής και Εφορευτικής Επιτροπής (ΕΕΕ) της ΕΕΣΥΕ με θέμα «Εκλογές για ανάδειξη νέου Δ.Σ.» της 1ης Ιουλίου 2021

Αγαπητοί συνάδελφοι,

Σε συνέχεια του σχετικού πρακτικού της ΕΕΕ αναφορικά με τα αποτελέσματα των εκλογών για την ανάδειξη νέου Διοικητικού Συμβουλίου της ΕΕΕΣΥΕ, που έλαβαν χώρα την 1η Ιουλίου 2021 στο MS Roof Garden στην οδό Αθηνάς 1 και Ερμού, ταυτόχρονα με την Απολογιστική Συνέλευση του Σώματος, πραγματοποιήθηκε η 1η συνάντηση των εκλεγέντων μελών στις 15 Ιουλίου 2021, όπου ορίστηκε ομόφωνα η συγκρότηση του σώματος.

Το νέο Διοικητικό Συμβούλιο της ΕΕΣΥΕ έχει την ακόλουθη σύσταση:

Πρόεδρος: Νικόλαος Ρούσσος, Μετ. Μηχανικός
Αντιπρόεδρος: Δημήτριος Αλιφραγκής, Πολ. Μηχανικός
Γεν. Γραμματέας: Χρυσόθεμις Παρασκευοπούλου, Μετ. Μηχανικός
Ταμίας: Ευάγγελος Περγαντής, Πολ. Μηχανικός
Εκδότης: Ανδρέας Μπενάρδος, Μετ. Μηχανικός
Μέλος: Αιμιλία – Μαρία Μπαλάση, Πολ. Μηχανικός
Μέλος: Ιωάννης Φίκιρης, Πολ. Μηχανικός

Η θητεία του νέου Δ.Σ., σύμφωνα με το καταστατικό, είναι τριετής (περίοδος 15-7-2021 έως 15-7-2024).

Ελπίζουμε στην συμπαράσταση και ενεργή συμμετοχή των μελών στις δράσεις της ΕΕΣΥΕ και ιδιαίτερα στην προετοιμασία του Διεθνούς Συνεδρίου Σηράγγων του 2023 (WTC2023) που έχουμε αναλάβει.

Με εκτίμηση,

Νικόλαος Ρούσσος
Πρόεδρος Ελληνικής Επιτροπής Σηράγγων & Υπογείων Έργων

ΓΕΝΙΚΗ ΣΥΝΕΛΕΥΣΗ ΕΕΣΥΕ 2021
Πρακτικό Εξελεγκτικής και Εφορευτικής Επιτροπής της ΕΕΣΥΕ με θέμα
«Εκλογές για ανάδειξη νέου Δ.Σ.» την 1η Ιουλίου 2021.

Σε συνέχεια της από 14-06-2021 Επιστολής της ΕΕΕ προς το Σώμα Εκλεκτόρων της ΕΕΣΥΕ και κατόπιν της περαίωσης των εργασιών της Γενικής Συνέλευσης της 1ης Ιουλίου 2021, ακολούθησε διεξαγωγή εκλογών στο MS Roof Garden στην οδό Αθηνάς 1 και Ερμού, με τα ακόλουθα αποτελέσματα:

Σύνολο καταμετρηθέντων ψήφων 40

1. Δια αλληλογραφίας παρελήφθησαν 16 Επιστολές. Από τους ψηφίσαντες δια αλληλογραφίας έγκυρα ψηφοδέλτια 16

2. Παρόντες ψήφισαν 24. Έγκυρα ψηφοδέλτια παρόντων 24

Σύνολο εγκύρων ψηφοδελτίων 40

Έλαβαν ψήφους

Για το Δ.Σ. της ΕΕΣΥΕ

1. Αλιφραγκής Δημήτριος 29
2. Βάσιος Αθανάσιος 6
3. Γεωργίου Δημήτριος 7
4. Κάλλου Παρασκευή-Βασιλική 6
5. Λίτσας Δημήτριος 7
6. Μπαλάση Αιμιλία-Μαρία 15
7. Μπενάρδος Αντρέας 22
8. Παρασκευοπούλου Χρυσόθεμις 16
9. Περγαντής Ευάγγελος 30
10. Προυντζόπουλος Γεώργιος 9
11. Ρούσσος Νικόλαος 20
12. Φίκιρης Ιωάννης 35

Για την ΕΕΕ της ΕΕΣΥΕ

1. Γιούτα-Μήτρα Παρασκευή 29
2. Μπακογιάννης Ιωάννης 20
3. Μπακογιάννης Σωτήριος 21
4. Ραπτόπουλος Σταύρος 16

Εκλέγονται για το Δ.Σ. με τη σειρά

1. Φίκιρης Ιωάννης
2. Περγαντής Ευάγγελος
3. Αλιφραγκής Δημήτριος
4. Μπενάρδος Αντρέας
5. Ρούσσος Νικόλαος
6. Παρασκευοπούλου Χρυσόθεμις
7. Μπαλάση Αιμιλία-Μαρία

Αναπληρωματικά μέλη του Δ.Σ.

1. Προυντζόπουλος Γεώργιος
2. Γεωργίου Δημήτριος, Λίτσας Δημήτριος (ισοψηφία)

Εκλέγονται για την ΕΕΕ με τη σειρά

1. Γιούτα-Μήτρα Παρασκευή
2. Μπακογιάννης Σωτήριος
3. Μπακογιάννης Ιωάννης

Αναπληρωματικό μέλος της ΕΕΕ

Ραπτόπουλος Σταύρος

Ο Πρόεδρος της ΕΕΕ — **Τα Μέλη**

Μπακογιάννης Ιωάννης — Γιούτα-Μήτρα Παρασκευή
Ραπτόπουλος Σταύρος

International Society for Soil Mechanics and Geotechnical Engineering

ISSMGE News & Information Circular July 2021
www.issmge.org/news/news-and-information-circular-july-2021

1. ELECTION OF ISSMGE PRESIDENT 2022-2026

As a consequence of the 20ICSMGE being pushed back to May 2022, and in accordance with the Statutes and Bylaws, the deadline for receiving nominations for the next ISSMGE President has been extended to 30th January 2022.

2. ISSMGE REGIONAL VICE-PRESIDENTS 2022-2026

The ISSMGE is pleased to announce the names of the regional vice-presidents for the next term (2022 - 2026). They are:

Africa: Dr Marawan Shahin (Egypt)
Asia: Professor Keh-Jian Shou (Chinese Taipei)
Australasia: Mr Graham Scholey (Australia)
Europe: Professor Lyesse Laloui (Switzerland)
North America: Mr Walter Paniagua (Mexico)
South America: Professor André Pacheco de Assis (Brazil)

3. 20ICSMGE / 7iYGEC NEW DATES MAY 2022

New dates have been confirmed for the conferences in Sydney as follows;

7iYGEC - Friday 29 April-Sunday 1 May 2022
20ICSMGE Sunday 1 May Thursday 5 May 2022.

For more information, please visit the conference website (https://icsmge2021.org/) which is in the process of being updated.

4. TIME CAPSULE PROJECT (TCP)

You may already know that an ISSMGE Blog section has been launched as part of the ISSMGE Time Capsule Project (https://www.issmge.org/the-society/time-capsule), the idea being to stimulate personal consideration on the practice of Geotechnical Engineering. Contributions of 200-400 words on any topic that will generate debate within the Geotechnical Engineering profession are encouraged, and may be submitted via the website. For further information, examples of current and upcoming articles, and instructions on submission, please go to the TCP pages on the ISSMGE site https://www.issmge.org/news/tcp-blog-posts

5. NEW WEBINAR

Experiences in Sustainable Geotechnics, delivered by Prof. Nilo Consoli, is a new webinar now available from the ISSMGE website.

6. 3rd HUTCHINSON LECTURE - 3rd JTC WORKSHOP NORWAY, 2022 CALL FOR PROPOSALS

The Joint Technical Committee (JTC1) on Natural Slopes and Landslides of the Federation of the International Geo-engineering Societies (FedIGS) is organizing the 3rd JTC1 workshop, which will be held in Norway in Spring, 2022; the provisional title of the event is Landslide initiation, prediction and risk mitigation.

The workshop will host the 3rd Hutchinson Lecture, which has been established by the same JTC1 to award a scholar, aged 42 or less at the time of the event, who has significantly contributed to the development of knowledge in the field of slope stability and landslides. The Hutchinson Lecture should deal with a subject consistent with the workshop issues. The lecture will be published in an international journal.

The Hutchinson lecturer, who should have a disciplinary background from one or more of the domains of the geosciences, will be chosen - by vote of JTC1 Committee members - among candidates proposed by national societies. All countries are then asked to propose their own candidate. The proposals, accompanied by the candidate CV, should be submitted to the JTC1 chairman, Luciano Picarelli, by September 15th 2021 (luciano.picarelli@unicampania.it) .

7. BULLETIN

The latest edition of the ISSMGE Bulletin (Volume 15, Issue 3, June 2021) is available from the website https://www.issmge.org/publications/issmge-bulletin/vol-15-issue-3-june-2021

8. ISSMGE FOUNDATION

The next deadline for receipt of applications for awards from the ISSMGE Foundation is the 30th September 2021. Click here for further information on the ISSMGE Foundation.

9. CONFERENCES

For a listing of all ISSMGE and ISSMGE supported conferences, and full information on all events, including deadlines, please go to the Events page at https://www.issmge.org/events. However, for updated information concerning possible changes due to the coronavirus outbreak (ie. postponements, cancellations, change of deadlines, etc), please refer to that specific events website.

Many events have been rescheduled and we update the Events page whenever we are advised of changes.

The following are events that have been added since the previous Circular:

ISSMGE EVENTS

10TH INTERNATIONAL CONFERENCE ON PHYSICAL MODELLING IN GEOTECHNICS - 19-09-2022 - 23-09-2022 KAIST, Daejeon, South Korea; Language: English; Organiser: Korean Geotechnical Society (KGS); Website: http://icpmg2022.org/; Email: secretariat@icpmg2022.org

ICPMG2022 - official website launched & abstract submission

The revised final information of the 10th International Conference on Physical Modelling in Geotechnics (ICPMG) is provided below. The conference will be held from Monday September 19 to Friday September 23 in 2022 at KAIST, Daejeon Korea, organised by Korean Geotechnical Society (KGS) un-

der the auspices of TC104 of the ISSMGE. The abstract submission system is ready on the website until August 15. Please circulate this information among your colleagues.

For more information, please visit the official website - https://icpmg2022.org

https://www.issmge.org/news/icpmg2022-web-launch

Survey of the present and future of numerical methods - VTCP

In the framework of the Virtual Time Capsule project (https://www.issmge.org/the-society/time-capsule/time-capsule), we prepared a questionnaire to evaluate the present use of numerical methods in geotechnical engineering, the future trend and collect suggestions. Please spend a few minutes to complete the survey available here: https://forms.gle/TWkMyeWCKQmzZG7t7 (it wont take more than 5 minutes).

If you have any idea to improve this survey or you want to share your thoughts about VTCP, please contact us.

Best regards,

Francesca Ceccato
Secretary of TC103

https://www.issmge.org/news/survey-of-the-present-and-future-of-numerical-methods-vtcp

Coupled 2021 Successful session organized by TC103

TC103 organize a successful session on NUMERICAL METHODS IN GEOMECHANICS, organized by: R. Uzuoka, K. Fujisawa, A. Murakami and M. B. Can Ulker.

You can find the report here.

https://www.issmge.org/news/coupled-2021-successful-session-organized-by-tc103

New TC103 Lecture "From Discrete to Continuum: Multiscale Approach of Failure in Geomaterials" by Dr. Nicot

Watch Lecture on ISSMGE Virtual University

Solving boundary value problems requires implementation of sufficiently robust constitutive models. Most models try to incorporate a great deal of phenomenological ingredients, but this refining often leads to overcomplicated formulations, requiring a large number of parameters to be identified. On the other hand, geomaterials are known to have an internal microstructure, made up of an assembly of interacting particles. Most of the macroscopic properties, observed on a specimen scale or even on larger scales, mainly result from the microstructural arrangement of grains. Thus, a powerful alternative can be found with micromechanical models, where the medium is described as a distribution of elementary sets of grains. The emergent complexity is not related to the constitutive description, but to the basic topological properties taking place on the microscopic scale. This presentation discusses this issue, showcasing very recent results obtained from discrete element simulations. Then, an advanced micromechanical model (3D-H model) is presented. It introduces an intermediate scale (mesoscopic scale) made up of a set of adjoining particles. This new approach makes it possible to recover many constitutive properties observed on the macroscopic scale in a very natural way, such as the occurrence of diffuse versus localized failure modes. Some recent numerical results obtained from FEM computations are presented in order to give clear insights into the capability of such multiscale approaches to deal with engineering scales in the future. In particular, failure occurrence within soil masses or geo-structures is thoroughly discussed.

Dr. F. Nicot received his Engineer and PhD degrees in civil engineering in 1995 and 1999, respectively, at Centrale School of Lyon (France). As a world-renowned researcher in soil mechanics, his activities deal with geomechanics, with a special focus on micromechanics of granular materials and multiscale failure modeling. Application fields span from constitutive modeling of geomaterials to gravity-driven natural hazards analysis, including slope engineering issues. He has published more than 200 articles, including 125 papers in international journals together with more than 20 collective books.

He is co-director of the International Research Network Geo-Mech (Multi-Physics and Multi-scale Couplings in Geo-environmental Mechanics), gathering more than 25 academic institutions over the world. He is currently Editor-in-Chief of the European Journal of Environmental and Civil Engineering (T&F Publ.), and he is Associate Editor of Granular Matter (Springer Publ.)

https://www.issmge.org/news/new-tc103-lecture-from-discrete-to-continuum-multiscale-approach-of-failure-in-geo-materials-by-dr-nicot

New TC103 Lecture "Numerical Simulations by Energy Piles" by Prof. McCartney

Watch Lecture on ISSMGE Virtual University

This presentation focuses on numerical simulations of the thermal, thermo-mechanical, and thermo-hydro-mechanical response of energy piles and surrounding soils. Simulations include finite element analyses of heat transfer and coupled water flow in soils surrounding energy piles and load transfer analyses of thermo-mechanical soil-structure interaction in energy piles. Case studies involving full-scale energy piles installed in sandstone layers and centrifuge-scale energy piles installed in unsaturated silt and dry sand are presented to provide calibration data for the simulations.

John S. McCartney is a Professor in the Department of Structural Engineering at the University of California San Diego, specializing in Geotechnical and Geoenvironmental Engineering. He has received several research awards, including the Walter L. Huber Research Prize from ASCE in 2016, the Arthur Casagrande Professional Development Award from ASCE in 2013, the J. James R. Croes medal from ASCE in 2012, the 2019 R.M. Quigley award from CGS in 2020, the DFI Young Professor Award in 2012, the NSF Faculty Early Development (CAREER) Award in 2011, and the IGS and Young IGS Awards from the International Geosynthetics Society in 2018 and 2008, respectively. He is an editor of ASCE Journal of Geotechnical and Geoenvironmental Engineering (JGGE) and Computers and Geotechnics, an associate editor of Canadian Geotechnical Journal and is active on the editorial boards of several other journals. He received BS and MS degrees in Civil Engineering from the University of Colorado Boulder in 2002 and a Ph.D. degree in Civil Engineering from the University of Texas at Austin in 2007.

https://www.issmge.org/news/new-tc103-lecture-numerical-simulations-by-energy-piles-by-prof-mccartney

TC218 Meeting Minute - June 2021

To download the file, please click on the link below:

https://www.mygeoworld.com/file/139832/tc218-meeting-minute-june-2021

Next conference call will be on **Tuesday Sept 28th, 2021 7 AM (UTC)**.

If anyone wishes to join TC218 Committee, please feel free to contact:

Shahriar Mirmirani - smirmirani@recocanada.com - TC218 Secretary
Giulia Lugli - g.lugli@maccaferri.com - TC218 Chairman

https://www.issmge.org/news/tc218-meeting-minute-june-2021

Know of directly useful geotechnical research? Speak up!

Research in applied fields of practice, e.g. Engineering, Education, Medicine, aims to improve existing practices and create new ones. Such research is deemed to be useful if improvements and new practices are indeed being applied. Hence, the litmus test for the direct usefulness of research projects in applied fields is whether their results have been used in practice.

This test can be performed by asking for their input the intended recipients of the research results, i.e. engineering consultants and contractors, instructors, physicians. Strangely, although the need for performing usefulness tests has been recognized (Sullivan et al., 2014), reporting on test outcomes is scarce (Fraser et al., 2018).

The purpose of this communication is to bring to the fore research papers directly useful to the practice of geotechnical engineering and geotechnical engineering education.

If you are a geotechnical engineering practitioner or a geotechnical engineering educator and you have used research results published in the literature by a third party unrelated to you, click on this link to share with us the reference of the published research and describe briefly which specific results you have incorporated in a project (for geotechnical engineering) or a course (for geotechnical engineering education).

If you are a geotechnical engineering researcher and the results of your research have been incorporated in state, national or international codes/regulations, please respond, provided that the research has not been commissioned nor funded by the agency promulgating the code/regulation. Click on this link to share with us the research publications with the findings incorporated in the codes/regulations, as well as references to the codes/regulations, and explain to us the relationship of what is stipulated in the code/regulation to your research findings.

This blog focused on three strong ideas: i) directly useful research is research being used in practice (engineering practice or teaching); ii) the intended recipients of research are the ultimate arbiters of its direct usefulness; iii) dissemination of directly useful research should be promoted. Hence, this survey.

Speak up and reply to this blogpost. Share examples of useful research with your colleagues and help close the gap between state of art and state of practice. In order to keep the focus on research results deemed useful by third-party users, please avoid sending research results produced and applied by the same or a related research team or co-produced by industry-academia teams or commissioned/funded by regulatory agencies.

About the author

Marina Pantazidou is the ISSMGE-TC306 (Geo-Education) Chair and associate professor at the National Technical University of Athens, Greece. Her 30-year profes-sional experience includes university appointments in the US and Greece and work in hazardous waste consulting. Her research topics are drawn from environmental geotechnics and engineering education.

About these articles:

To debate past, current and future issues in Geotechnical Engineering, the Time Capsule Project is welcoming and publishing short articles on the ISSMGE website.

We challenge you to write 200-400 words on any topic that will generate debate within the Geotechnical Engineering profession. Click here to submit your message for consideration.

Articles will be displayed for a limited time and views expressed need not be shared by the ISSMGE or held strongly by authors.

https://www.issmge.org/news/know-of-directly-useful-geotechnical-research-speak-up

Announcing the ISSMGE VIRTUAL UNIVERSITY, an open-access global educational initiative

The International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE) is pleased to announce the launch of its Virtual University (VU) Platform, a new part of ISSMGE's cyber-infrastructure. The Virtual University is the outcome of President Charles Ng's major educational priorities announced at his inaugural address in September 2017.

The objective of the Virtual University is to provide open-source, high quality technical and educational content that can be used by engineers of practice and graduate students initially all around the world, and it will be extended to undergraduate students at a later stage. The VU is based on the current OpenEdX platform which was developed by the Innovation and Development Committee chaired by Dimitrios Zekkos, with oversight from the Board. The Virtual University includes, free courses, webinars, as well as short educational videos.

The content of the Virtual University will continue to be updated through various initiatives of ISSMGE, and with the support of its Technical Committees, conference organizers and Member Societies.

Users can view directly any content without enrolling. By registering, users can track their course attendance history, participate in course discussions and receive notification about important updates on each course they are enrolled.

ISSMGE is currently working on the second phase of the VU platform that can support the delivery of homeworks and examinations, a capability that is expected to become available by the end of 2020.

The platform is available at http://virtualuniversity.issmge.org/ as well as through the Education tab on the main ISSMGE navigation bar.

https://www.issmge.org/news/announcing-the-issmge-virtual-university-an-open-access-global-educational-initiative

News
https://www.isrm.net

The Summer 2021 ISRM newsletter is online 2021-07-01

The Summer 2020 Newsletter with the latest news and future events was sent to all members and is available on the site.

New ISRM Website 2021-07-20

Dear ISRM members and friends,

it is our pleasure to announce that the ISRM has launched a new website, to be found at the same address www.isrm.net.

The modern image and new site functionalities are another step for the modernazation of our Society, one of the Board's objectives.

During the first days you may find small bugs, for which we antecipatedly apologize and will correct immediately.

The ISRM hopes that you enjoy our new website.

Scooped by ITA-AITES #47, 6 July 2021

Deep rock tunnel work wraps up; officials mark step along the way to cleaner rivers | United States of America

Deutsche Bahn unveils plans to expand Frankfurt main station underground | Germany

Stage 2 of Thomson-East Coast MRT Line to open on Aug 28 | Singapore

Metro Tunnel backing jobs and launching careers | Australia

Tunnel boring machine to start digging in Fremont for Ship Canal Water Quality project | United States of America

China starts building underground lab : waste & recycling

Japan's particle observatory upgrading from 'Super' to 'Hyper'

Tunnelling: Simultaneous pipe jacking for energy from waste scheme | UK

Constructing New high-speed railway line Halkali-Ispartakule-Cerkezkoy in Turkey

Delhi: What lies beneath? Dhansa Bus Stand first underground metro station with parking | India

Scooped by ITA-AITES #48, 20 July 2021

Acciona, Ferrovial to build central section of Sydney Metro West | Australia

TMX tunnel project moving slowly in Burnaby | Canada

Mumbai: Work on India's longest road twin-tunnel linking Thane-Borivali to start in city from March 2022 | India

Lyon-Turin €3bn base tunnel contracts awarded | France-Italy

Work in Eğribel Tunnel continues uninterrupted | Turkey

Here's what Austin's Underground Light Rail could look like | United States of America

Construction of Ang Mo Kio station on Cross Island Line to start in Q4 | Singapore

Plans for Silvertown Tunnel's Greenwich entrance are revealed | UK

The fascinating subterranean world beneath Kraków's main market square | Poland

Survey: Commuters want Metro into Prince William County | United States of America

Geotechnical engineering update

FREE TO READ

Environmental geotechnics and Covid-19

The outbreak of the Covid-19 pandemic has led geo-environmental professionals to re-consider the role of the discipline on how to best meet the novel natural and anthropogenic challenges of the 21st century that have and are expected to exert global impacts. This issue of *Environmental Geotechnics* addresses these issues and is free to read for the next month.

Read the issue in full

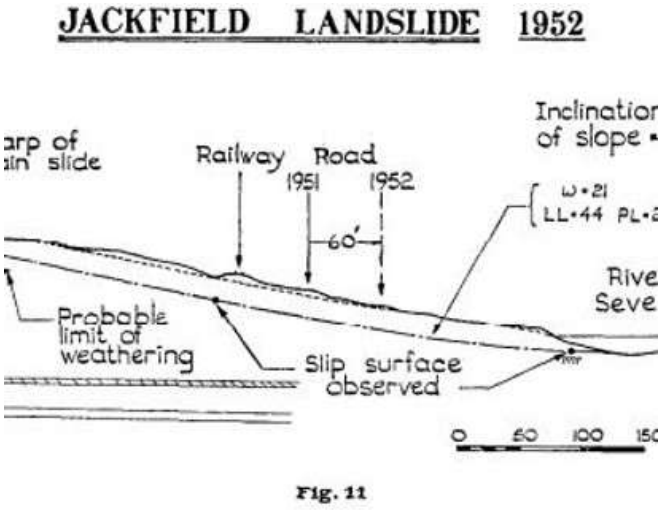


Fig. 11

Géotechnique Rankine Lecture papers

The Rankine Lecture is widely viewed as the most prestigious invited lecture in geotechnics. Each lecture is subsequently prepared as a *Géotechnique* paper. Papers published after 2003 are free to read in perpetuity, including Triggering and motion of landslides, the most recent lecture to be published.

Find out more

More free to read papers

A Weibull-based damage model for the shear softening behaviours of soil–structure interfaces - open access

Deflection and failure of high-stiffness cantilever retaining wall embedded in soft rock

Embedded strip footing in a geotextile-reinforced sand slope

Interaction between PFASs and geosynthetic liners: current status and the way forward

Mathematical modelling of cumulative erosion ratio for suffusion in soils

Microplastics in soils: an environmental geotechnics perspective - open access

Relating physical properties to temperature-induced damage in carbonate rocks - open access

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WRITE FOR US

Open call for papers

Physical-chemical coupling in environmental geotechnics

This themed issue is focused on collecting and summarising our achievements on the state-of-the-art understanding in physical-chemical coupling, with applications in environmental geotechnics topics.

Submit your abstract

Soil behaviour under multi-coupled physical/chemical actions

Water and energy security present new research challenges associated with the fields of geoenviromental engineering and energy geotechnology. We want to hear about the work you are doing.

Submit your abstract

What makes a good journal?

Following the recent impact factor announcements, we look at how our journals are performing and how they are measured.

Find out more

Author tips

Managing change

Writer's block

Using your PhD

LATEST NEWS

18 geotechnical books you should read

If you specialise in the field of geotechnical, geology and ground engineering, or want to, you've come to the right place. Here we're introducing 18 of our most popular geotechnical engineering books. Welcome to our geotech bookshelf.

Take a look

The price of food

Desertification, drought and food security. How can we manage land sustainably and make ground improvements.

Find out more

Five ways we are helping civil engineering businesses

Our customers and members include global players in the construction industry. Find out how we are helping them.

Read now

[Geopolymer injection treatments](#)

Could geopolymer injection treatments significantly extend the lifecycle of concrete roads?

Find out more

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International Geosynthetics Society

4th ICTG 2021 - Session Recordings Now Available until August 31, 2021

Dear Geosynthetics Colleagues,

The 4th International Conference on Transportation Geotechnics (ICTG) took place as a virtual event on May 24-27, 2021 with support and sponsorships of ISSMGE TC202 on Transportation Geotechnics, ASCE Geo-Institute, International Geosynthetics Society, AREMA, ASCE T&DI, TRB, US Army ERDC, and US DOT. We had nearly 400 participants from 44 countries. The 4th ICTG virtual event platform provided access to all the conference sessions, exhibit halls, and more than 230 presentations in live, simu-live and poster sessions, and preconference specialty workshops / Geosynthetics short course / meeting of the Young Transportation Geotechnics Engineers.

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CIGB ICOLD

International Commission on Large Dams

Κυκλοφόρησε το Newsletter #19 – 2021 https://www.icold-cigb.org/article/GB/news/newsletters/newsletter-19

Virtual Event from 15 to 19 November 2021

Originally scheduled for June 2021, the MARSEILLE CONGRESS had already been postponed to November 2021 due to COVID 19. The current situation of the pandemic and the uncertainties about the possibilities of participation in the Congress by our member countries still does not allow us to consider holding it in 2021.

ICOLD will organize a **Virtual Conference on November 15th - 19th, 2021** (same week as initially foreseen for the Marseille Congress) mainly including a Tech. Cttees Chairs Meeting, a Symposium, Tech. Cttees Workshops and a General Assembly (detailed information and program will be sent later)

This one-year postponement is also applied to all other ICOLD events. This is the new agenda:

2022 MARSEILLE (France) **CONGRESS**

2023 GOTHENBURG (Sweden) ANNUAL MEETING

2024 NEW DELHI (India) ANNUAL MEETING

2025 CHENGDU (China) **CONGRESS**

2026 SHIRAZ (Iran) ANNUAL MEETING

ΔΙΑΚΡΙΣΕΙΣ ΕΛΛΗΝΩΝ ΓΕΩΤΕΧΝΙΚΩΝ ΜΗΧΑΝΙΚΩΝ

Evangelia Garini, Ioannis Anastasopoulos & George Gazetas

Award Winning Paper:
"Soil, basin, and soil–building–soil interaction effects on motions of Mexico City during seven earthquakes"

ICE Journal: Géotechnique, Volume 70 Issue 7, July, 2020, pp. 581-607, DOI: https://doi.org/10.1680/jgeot.18.P.314

Dear Professor Gazetas,

I am delighted to inform you that your paper has been awarded the **Tso Kung Hsieh Award – Best Paper on Structural/Soil Dynamics (nominated by SECED).**

Your winning paper will shortly be made free to read in perpetuity on the ICE Virtual Library, the most comprehensive online civil engineering resource in the world, and will be promoted to the wider community in a significant marketing campaign. If your paper was co-authored, we have also contacted your colleague(s) today.

Every year papers are recognised as being of exceptional quality and benefit to the civil engineering, construction and materials science community are celebrated at the ICE Awards Ceremony at **One Great George Street, London in October.**

I would like to take this opportunity to thank you for submitting your paper and congratulate you on your well-deserved award.

Kind Regards,

Abi

Miss Abiola Lawal MA, BA (Hons)
Assistant Journals Manager, ICE Publishing
ICE Publishing, part of registered UK charity ICE

Soil, basin and soil–building–soil interaction effects on motions of Mexico City during seven earthquakes

Evangelia Garini, Ioannis Anastasopoulos, George Gazetas

Abstract

Starting with the destructive 1985 Michoacan M_w 8·0 earthquake, the lake zone of Mexico City has been experiencing ground motions bearing the effects of strong soil amplification at specific site-dependent periods. Last year's $M_w = 7·1$ Puebla earthquake, although less damaging, with different orientation and mechanism, and at a much shorter distance than the 1985 event, nevertheless produced records bearing similar soil amplification effects and even rather similar motions on rock. This paper concentrates on four sites, distinguished mainly by the thickness of the soft clay, on which three to seven seismic events (with $M_w > 6·5$) have been recorded. Using the corresponding records on two hilly zone sites as base rock motions, amplification functions in terms of ratios of top-over-base recorded acceleration response spectra are studied. Although the dominant periods of each amplification function confirm the occurrence of resonance at the fundamental natural period of each particular soil stratum, differences between the amplification functions of the east–west and north–south components are evident. Using the actual soil profile of two of these stations, along with the $G{:}\gamma$ and $\xi{:}\gamma$ curves from the general literature and from site-specific measurements, one-dimensional wave propagation analyses are conducted. Reasonable agreement with the records is generally found in terms of response spectra. However, weak motions recorded in some events (where soil behaved essentially linearly) exhibit a number of beating cycles which last for almost one additional minute beyond 60 s, and which are barely noticeable in the computed motions. An oversimplified (in geometry and properties) two-dimensional basin, 6 km long, containing 60 m of Mexico City clay, is analysed with finite elements, excited by the rock outcrop hilly zone records. Wave propagation in this basin reveals the generation of Rayleigh waves at the edge, which move towards the centre and interfere with the incident and reflected S and P waves. The resulting motions away from the edge resemble the recorded motions at the CAO site in a 1999 earthquake better than the one-dimensional analysis, but are still far from satisfactorily reproducing the beating. An additional factor to qualitatively explain reality is generically examined: the oscillations of a tall (15-storey) building and the feedback of its free oscillations into the ground (soil–building–soil interaction) are found to increase free-field accelerations slightly.

https://www.icevirtuallibrary.com/doi/10.1680/jgeot.18.P.314 (open PDF)

ΠΡΟΣΕΧΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΚΔΗΛΩΣΕΙΣ

Για τις παλαιότερες καταχωρήσεις περισσότερες πληροφορίες μπορούν να αναζητηθούν στα προηγούμενα τεύχη του «περιοδικού» και στις παρατιθέμενες ιστοσελίδες.

DFI Deep Mixing, 5-8 July 2020, TBD, Gdansk, Poland, www.dfi.org/DM2020

II International Seminar "Tailings and Waste Rock Disposal", July 12 – 14, 2021, Lima, Peru, www.geoingenieria.org.pe

7th ICRAGEE International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics, 12-17 July 2021, Bengaluru, India, http://7icragee.org

GEOCHINA 2021 - 6th GeoChina International Conference Civil & Transportation Infrastructures: From Engineering to Smart & Green Life Cycle Solution, July 19 to 21, 2021, Nan-Chang, China, http://geochina2021.geoconf.org

Keller Webinar Series: Groundwater Control, July 21, 2021, https://www.keller-na.com/events/keller-webinar-series-groundwater-control

PanAm Unsat 2021 3rd Pan-American Conference on Unsaturated Soils, 25-28 July 2021, Rio de Janeiro, Brazil, https://panamunsat2021.com

7th International Conference on Industrial and Hazardous Waste Management 27-30 July 2021, Chania, Crete, Greece, http://hwm-conferences.tuc.gr (online participation available)

ACE 2020 14th International Congress on Advances in Civil Engineering, 6-8 September 2021, Istanbul, Turkey, www.ace2020.org/en

XVIth International Congress AFTES 2021 Underground, a space for innovation, 6 to 8 September 2021, www.aftes2020.com

COMPLAS 2021 XVI International Conference on Computational Plasticity, Fundamentals and Applications, 7-10 September 2021, Barcelona, Spain, https://congress.cimne.com/complas2021/frontal/default.asp

RMEGV 2021 - 5th International Workshop on Rock Mechanics and Engineering Geology in Volcanic Fields, 9÷11 September 2021, Fukuoka, Japan, https://ec-convention.com/rmegv2021

International Conference on Textile Composites and Inflatable Structures (MEMBRANES 2021), 13-15 September 2021, Munich, Germany, https://congress.cimne.com/membranes2021/frontal/default.asp

EUROGEO WARSAW 2020 7th European Geosynthetics Congress, 19-22 September 2021, Warsaw, Poland, www.eurogeo7.org

37th General Assembly of the European Seismological Commission, 19-24 September 2021, Corfu, Greece, www.escgreece2020.eu

37th General Assembly of the European Seismological Commission, Session: Advances in engineering seismology stemming from practice.

EUROCK TORINO 2021 - ISRM European Rock Mechanics Symposium Rock Mechanics and Rock Engineering from theory to practice, 20-25 September 2021, Torino, Italy, http://eurock2021.com

Instead of the ITA's major WTC event, which will not be held this year, ITA has decided to organize a **fully digital week** dedicated to tunnels and underground space.

The ITA Tunnelling Week will take place from **20 to 24 September 2021**

These 5 days of conferences and debates dedicated to the underground construction industry, will be the occasion to give an annual overview of the global tunnelling activity, present key figures, and future projects all over the world. This moment also intends to gather the industry to discuss about innovations and advances, but also to deal with current challenges like underground space in sustainable planning, structural use of fiber reinforced concrete precast segments, tunnels refurbishment… The different tasks forces composing ITA, Working Groups and Committees, will present their latest reports and publications.

Thanks to a digital platform, each session will include live or prerecorded presentations as well as a live debate with the panelists. The participants will be able to access an exhibition hall, a cinema room with different videos of projects, ITA library with many publications and a chat to exchange with other participants.

The whole week will be rhythmed with technical sessions from ITA's working groups and committees and projects presentation. More info in the **programme** hereafter. ITA Tunnelling Week Programme

ITA Tunnelling Week Registration is open. Click on the link below:

This British Tunnelling Society "BTS 2020" Conference and Exhibition, Sept 30th - Oct 1st, 2021, London, United Kingdom, www.btsconference.com

6 October 2021, London, United Kingdom
https://basements.geplus.co.uk
https://monitoring.geplus.co.uk

Challenging engineers to deliver better underground spaces

Ground Engineering is delighted to bring you the **14th Basements and Underground Structures Conference**; the only event **which explores the design and delivery of underground spaces**.

Ground Engineering is delighted to bring you the **tenth biennial Instrumentation and Monitoring conference**: an essential gathering for anyone involved in monitoring and looking for up-to-date insight into projects, technologies and techniques.

Whether you are interested in the infrastructure, commercial or residential sectors, the event will give you **expert knowledge, best practice** from major projects and **networking opportunities** with innovative clients, contractors and designers.

Over the course of the event, you will **gain insight into technical challenges** of current projects, receive updates from experts on the latest design solutions being employed and witness discussions on key areas such as retrofit, carbon reduction and the future of the office.

These are exciting times for the industry as major projects prepare for construction, new solutions begin to change how we monitor, and clients look to better understand the data collected and its applications.

Whether you are a project manager on a complex tunnel scheme, a designer looking to mitigate the risks to third party assets or a client wanting to improve knowledge of your structures, this is an important event for you to attend.

EUROENGEO 3RD EUROPEAN REGIONAL CONFERENCE OF IAEG, 7 - 10 October 2021, Athens, Greece, www.euroengeo2020.org

10th International Conference on Scour and Erosion (ICSE-10), October 17-20, 2021, Arlington, Virginia, USA, www.engr.psu.edu/xiao/ICSE-10 Call for abstract.pdf

3rd International Symposium on Coupled Phenomena in Environmental Geotechnics, 20-22 October 2021, Kyoto, Japan, https://cpeg2020.org

ARMS11 11th Asian Rock Mechanics Symposium, Challenges and Opportunities in Rock Mechanics, 21-25 October 2021, Beijing, China, www.arms11.com

HYDRO 2021 Roles of hydro in the global recovery, 25-27 October 2021, Strasbourg, France, www.hydropower-dams.com/hydro-2021

EURO:TUN 2021 Computational Methods and Information Models in Tunneling, October 27th - 29th, 2021, Bochum, Germany, http://eurotun2021.rub.de

GFAC 2021 International Conference "Geotechnics fundamentals and applications in construction: investigations, design, technologies", October 27–29, 2021, Saint Petersburg, Russia https://gfac.spbgasu.ru

Emerging Technologies and Applications for Green Infrastructure, 28-29 October 2021, Ha Long, Vietnam, https://cigos2021.sciencesconf.org

5TH World Landslide Forum Implementation and Monitoring the USDR-ICL Sendai Partnerships 2015-2025, 2-6 November 2021, Kyoto, Japan, http://wlf5.iplhq.org

ICGE – Colombo – 2020 3rd International Conference in Geotechnical Engineering, 6-7 December 2021, Colombo, Sri Lanka, http://icgecolombo.org/2020/index.php

Specialty Geotechnical Workshop for Dam & Levee Investigations & Modifications
December 6-8, 2021, Fort Lauderdale, Florida, USA
www.aegmeetings.org

The workshop is co-sponsored by AEG and USSD and will be two days of presentations followed by an optional field trip to Herbert Hoover Dam. Presentations will cover geotechnical investigations and dam modifications best practices and risk management, followed by a round table discussion with all the speakers.

The goals of the Workshop are to:

- Highlight best practices in geotechnical exploration and construction in dams and levees
- Present case histories with a range of exploration and construction techniques
- Discuss issue resolution and decision making in a risk framework

Contact Us

If you have any questions, please contact AEG Meeting Manager, Heather Clark, at heather@aegweb.org or 303-518-0618

2nd International Conference TMM-CH Transdisciplinary Multispectral Modelling and Cooperation for the Preservation of Cultural Heritage - Rebranding The World In Crisis Through Culture, 12-15 December, 2021 Athens, Greece https://tmm-ch.com/

GeoAfrica 2021 - 4th African Regional Conference on Geosynthetics Geosynthetics in Sustainable Infrastructures and Mega Projects, 21-24 February 2022, Cairo, Egypt, https://geoafrica2021.org

16th ICGE 2022 – 16th International Conference on Geotehnical Engineering, Lahore, Pakistan, 23-24 February, 2022, https://16icge.uet.edu.pk/

15 - 17 March 2022, Kuala Lumpur, Malaysia
www.hydropower-dams.com/asia-2022

16th International Benchmark Workshop on Numerical Analysis of Dams
6–8 April 2022, Ljubljana, Slovenia
https://icold-bw2022.fgg.uni-lj.si

The design and maintenance of existing dams are a challenge for the whole engineering community. Numerical modelling has become an indispensable tool for design and safety assessment of dams. The ICOLD Committee on "Computational Aspects of Dam Analysis and Design" has, during its long activity, organized 15 Benchmark Workshops with the aim to provide an opportunity for engineers, researchers, and operators to present and exchange their experiences and the latest developments related to the proper use of numerical modelling for design, performance evaluation and safety assessment of dams.

The 16th Benchmark Workshop will provide an excellent opportunity for engineers, researchers, and operators to meet and present their experiences on numerical modelling of dams.

The Benchmark Workshop 2022 will be held at the **University of Ljubljana**, Faculty of Civil and Geodetic Engineering. U**niversity of Ljubljana** is the **oldest and largest higher education and scientific research institution in Slovenia**. It has approximately 38,000 undergraduate and postgraduate students and employs approximately 6,000 higher education teachers, researchers, and administrative staff in 23faculties and three arts academies.

Topics

Theme A: Dam Behaviour Prediction

Theme B: Aar Affected Dam

Theme C: Behaviour of the Embankment Dam

Open Theme: Choice of the Contributor

REGISTER NOW

ICEGT-2020 2nd International Conference on Energy Geotechnics, 10-13 April 2022, La Jolla, California, USA, https://icegt-2020.eng.ucsd.edu/home

2022 GEOASIA7 - 7th Asian Regional Conference on International Geosynthetics Society, April 11 - 15, 2022, Taipei, Taiwan, www.geoasia7.org

WTC 2022 World Tunnel Congress 2022 - Underground solutions for a world in change, 22-28 April 2022, Copenhagen, Denmark, www.wtc2021.dk

SYDNEY 7iYGEC 2021 7th International Young Geotechnical Engineers Conference A Geotechnical Discovery Down Under, 29 April - 1 May 2022, Sydney, Australia, http://icsmge2021.org/7iygec

SYDNEY ICSMGE 2021 20th International Conference on Soil Mechanics and Geotechnical Engineering, 1–5 May 2022, Sydney, Australia, www.icsgme2021.org

LARMS 2021 – IX Latin American Rock Mechanics Symposium Challenges in rock mechanics: towards a sustainable development of infrastructure, 15 – 18 May 2022, Asuncion, Paraguay, https://larms2021.com

ICOLD 27th Congress - 90th Annual Meeting
27May - 3 June 2022, Marseille, France
https://cigb-icold2022.fr/en

The French Committee on Dams and Reservoirs (CFBR), which is organizing this event, will welcome more than 1000 delegates, and among them the world's leading experts in the field of dams, representing the 104 member countries of ICOLD.

Themes of the symposium

SHARING WATER: MULTI-PURPOSE OF RESERVOIRS AND INNOVATIONS

Theme 1: Territorial and Water Multi-purpose Issues

- **1A**. Evaluation of current and future resources and needs
- **1B**. Evaluation of socio-environmental and biodiversity benefits and impacts, positive and negative externalities
- **1C**. Analysis of resilience and adaptability of projects to respond to climate change and changing uses. Decision making methods for choosing a solution, cost-benefits analysis at a regional scale
- **1D**. Lessons learnt from recent water resource crises (drought, floods…)

Theme 2: Governance and Funding

- **2A**. Institutional aspects, stakeholder commitments and inter-relationships
- **2B**. Financial aspects, project funding
- **2C**. Participatory approaches, stakeholders involvement
- **2D**. Special cases of cross-border assets

Theme 3: Innovative solutions in reservoir uses

- **3A**. Multi-purpose hydraulic projects: energy storage, hydropower, hybrid solutions with other renewable intermittent energies, irrigation, navigable waterways, water supply, floods mitigation, protection against marine submersions...
- **3B**. Combining structural and non-structural solutions
- **3C**. Integrating a project into a territory with multiple reservoirs
- **3D**. Complementarities and synergies with intermittent renewable energy, related issues

Theme 4: Operating Multi-purpose facilities

- **4A**. Hydrology for resource management at short and medium term
- **4B**. Tools for operation related decision making including risk management
- **4C**. Short, medium and long-term operation simulation and modelling
- **4D**. Water sharing criteria, trade-off between uses, operation compatibility of additional uses
- **4E**. Performance evaluation of asset management methods

Short Courses

Short courses will be given on the side-lines of the ICOLD Congress in Marseille, inspired by those proposed by the Canadian Committee just before the Ottawa meeting in 2019.

The five course themes are based on the practices of the profession, described, for the most part, in publications of French COLD and the French community:

1. Risk analysis for dams: French practice through Safety Review Risk Assessment
2. Risk analysis for levee systems
3. Analysis methods of dam survey data
4. Justification of dams: French practice through the semi-probabilistic approach
5. Stochastic methods for flood estimation

Technical Committees Meetings

On **Saturday, May 28**, the **ICOLD Technical Committee workshops** will be held. They aim to present and discuss the content of new work for technical committees in their start-up phase or to present the results of technical committees at the end of their mission (typically the publication of a Technical Bulletin). The list of workshops will be established in coordination with the chairs of the technical committees. We have three time slots for seven parallel sessions.

On **Sunday, May 29**, the ICOLD Technical Committee meetings will be held throughout the day (8:30 a.m. to 5:30 p.m.). We have twenty-six rooms available for these meetings, which will be allocated in consultation with the chairpersons, depending on the expected attendance.

Contact us:
CIGB-ICOLD 2022
c/o MCO Congrès
Villa Gaby - 285, Corniche Kennedy
13005 Marseille - France
Tél.: +33 (0)4 95 09 38 00
Email: claire.bellone@mcocongres.com

CPT'22 5th International Symposium on Cone Penetration Testing, 8-10 June 2022, Bologna, Italy, http://cpt22.org

3rd European Conference on Earthquake Engineering and Seismology (3ECEES), 19-24 June 2022, Bucharest, Romania, https://3ecees.ro

3rd International Symposium on Geotechnical Engineering for the Preservation of Monuments and Historic Sites 22-24 June 2022, Napoli, Italy, https://tc301-napoli.org

9th International Congress on Environmental Geotechnics
Highlighting the role of Environmental Geotechnics in Addressing Global Grand Challenges
26-29 June 2022, Chania, Crete island, Greece
www.iceg2022.org

The 9th International Congress on Environmental Geotechnics is part of the well established series of ICEG. This conference will be held on an outstanding resort in the town of Chania of the island of Crete in Greece. The theme of the conference is "Highlighting the role of Environmental Geotechnics in Addressing Global Grand Challenges" and will highlight the leadership role of Geoenvironmental Engineers play on tackling our society's grand challenges.

Contact Information

- Contact person: Dr. Rallis Kourkoulis
- Email: rallisko@grid-engineers.com

IS-Cambridge 2020 10th International Symposium on Geotechnical Aspects of Underground Construction in Soft Ground, 27 - 29 June 2022, Cambridge, United Kingdom, www.is-cambridge2020.eng.cam.ac.uk

UNSAT2022
8th International Conference on Unsaturated Soils
June or September 2022, Milos island, Greece

ICONHIC2022: THE STEP FORWARD - 3rd International Conference on Natural Hazards & Infrastructure, 5 – 7 July 2022, Athens, GREECE, https://iconhic.com/2021

16th International Conference of the International Association for Computer Methods and Advances in Geomechanics – IACMAG
01-08-2022 – 02-09-2022, Torino, Italy

Organiser: Politecnico di Torino
Contact person: Symposium srl
Address: via Gozzano 14
Phone: +390119211467
Email: info@symposium.it, marco.barla@polito.it

ISFOG 2020 4th International Symposium on Frontiers in Offshore Geotechnics, 28 – 31 August 2022, Austin, United States, www.isfog2020.org

11th International Symposium On Field Monitoring In Geomechanics
04-08 September 2022, London, United Kingdom

Organizer: TC220

Contact person: Dr Andrew Ridley; Email: andrew.ridley@geo-observations.com

The 17th Danube - European Conference on Geotechnical Engineering
5-7 September, 2022, Bucharest, Romania
https://sites.google.com/view/17decgero/home

Eurock 2022

Rock and Fracture Mechanics in Rock Engineering and Mining
12÷15 September 2022, Helsinki, Finland
www.ril.fi/en/events/eurock-2022.html

You are invited to reunite with your colleagues on solid bedrock at the EUROCK 2022 - *Rock and Fracture Mechanics in Rock Engineering and Mining* in Espoo, Helsinki-region, Fin-

land, 12 to 15 September 2022. The conference themes include but are not limited to latest advances in rock mechanics, interesting mining and rock engineering cases, and engineering education. The call for papers is now open.

The conference will feature two main tracks: the scientific track and the industrial track. The presentations will be arranged in general and parallel sessions over two days. There will be short courses and workshops on the day preceding the conference and excursions to sites of interest on the day following the conference.

Should the COVID-19 situation allow, the conference will be held in the Dipoli conference center in Espoo near the Aalto University campus in the Helsinki region. The touristic city of Helsinki will be at your disposal with its underground and above ground marvels. Virtual participation with networking possibilities will be offered in parallel.

Themes

- Rock mass Characterization
- Geophysics in rock mechanics
- Mechanics of rock joints
- Jointed rock mass behaviour
- Rock support, probability based design
- Rock stress measurements
- Constitutive modelling of rock
- Rock drilling
- Blast induced fractures
- Rock engineering and mining education
- Geological disposal of spent nuclear fuel
- Recent advances in rock mechanics research
- Field and laboratory investigations
- Case studies

Contact Person: Lauri Uotinen
E-mail: lauri.uotinen@aalto.fi

IAEG XIV Congress 2022

Chengdu, China September 14-20, 2022

As a quadrennial global academic event initiated by the International Association for Engineering Geology and the Environment (IAEG), the IAEG Congress has been successfully held for 13 sessions, which aims to propagate the latest research results in the field of engineering geology and the environment, facilitate international academic exchanges and interdisciplinary integration, and promote the disciplinary construction of engineering geology and the environment. To further strengthen theoretical innovation, technological breakthrough and international cooperation in the field of engineering geology and the environment.

The XIV Congress of the International Association for Engineering Geology and the Environment will be held in **Chengdu Century City New International Convention and Exhibition Center**, Chengdu, China from **September 14 to 20, 2022**. Based on the theme of "**Engineering Geology for a Habitable Earth**", the congress is expected to enhance the disciplinary and research development of international engineering geology and the environment, and contribute to the advancement of major projects, ecological progress, and habitable earth with research and discussion in the engineering geology and global climate change, geological hazard assessment and prevention, geotechnical properties of rock and soil mass, engineering geology and the environmental issues concerning marine, transportation, urban and ecological environment protection in major projects, engineering geology and resilience engineering construction, intelligent engineering geology, and new theories, methods, and techniques in engineering geology, etc.

We warmly welcome the worldwide engineering geological community to come to Chengdu to participate in this academic event.

General scientific themes

- Climate Change Mitigation and Adaption
- Engineering Geology and Sustainable Development
- Mechanism, Monitoring and Early Warning, Prevention and Assessment of Geological Disasters
- Environmental Engineering Geology and Ecosystem Protection
- Geotechnical Properties of Rock and Soil Mass
- Traffic Engineering Geology and Sichuan-Tibet Railway Construction
- Energy Engineering Geology and Deep Earth Resource Exploitation
- Urban Engineering Geology and Underground Space Utilization
- Marine Engineering Geology and Coastal Development
- Polar, Planetary Engineering Geology and Disasters
- Artificial Intelligence, Big Data and Engineering Geology
- New Theory and Technology of Engineering Geology
- Preservation of Cultural Heritage and Engineering Geology
- Education and Disciplinary Development of Engineering Geology

Contacts

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Email Address: sklgp_cdut@126.com

28th European Young Geotechnical Engineers Conference and Geogames, 15 – 17 – 19 September 2022, Moscow, Russia, https://www.eygec28.com/?

https://icpmg2022.org

On behalf of the Local Organizing Committee and 12,300 members of the Korean Geotechnical Society (KGS), I'm pleased to welcome you all with warm hearts to the 10th International Conference on Physical Modelling in Geotechnics (ICPMG 2022). This welcome is also on behalf of our late friend Professor Dong-Soo Kim, who was the chair of TC104. The conference will be held from September 19 to 23 in 2022 at KAIST, Daejeon, Korea under the auspices of Technical Committee 104 (TC104: Physical Modelling in Geotechnics) of the International Society of Soil Mechanics and Geotechnical Engineering (ISSMGE).

Following the successful precedents from the first one "Centrifuge 88" in Paris to the last "ICPMG 2018" in London, the ICPMG 2022, being the tenth of its kind, will be another commemorative one full of remarkable programs.

Since the last conference in London, the community of physical modelling has been longing for opportunities to communicate in a fully direct way. The 4th European Conference on Physical Modelling in Geotechnics was held online in Luleå Sweden after 6 months of delay. Asiafuge 2021 in Singapore is going to be a hybrid event in November after being delayed by one year. We sincerely hope that ICPMG 2022 is to be an opportunity for us to gather together again with a hope of a new leap forward and we are planning a meaningful program to fulfill the objective.

We are ready to reach out and listen to various and valuable voices from the member societies of ISSMGE and are willing to reflect their opinions into the program. The host KGS will do its best to make the ICPMG 2022 a success as we did for the 19th International Conference on Soil Mechanics and Geotechnical Engineering in Seoul 2017.

We welcome all the physical modelling specialists from all over the world and want to have precious time for the future of physical modelling in geotechnics in the city of Daejeon. We thank you for your participation and contributions in advance.

Moonkyung CHUNG
President, Korean Geotechnical Society (KGS)

Conference Topics

Papers containing original works in all aspects of Physical Modelling in Geotechnics. Topics included, but are not limited to, the followings;

- Physical modelling facilities and equipment
- Scaling principles and modelling techniques
- Sample preparation and characterisation
- Instrumentations and measurements
- Physical/Numerical interface and comparisons
- Soft ground and improvements
- Offshore geotechnics
- Earthquake related problems
- Geohazards
- Underground structures and pipelines
- Excavations and retaining structures
- Foundations
- Dams and embankments
- Education
- Applications in engineering practice
- Others

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11th International Conference on Stress Wave Theory and Design and Testing Methods for Deep Foundations, 20 - 23 September 2022, De Doelen, Rotterdam, The Netherlands, https://www.kivi.nl/afdelingen/geotechniek/stress-wave-conference-2022

IX Latin American Rock Mechanics Symposium - Rock Testing and Site Characterization, an ISRM International Symposium, 16-19 October 2022, Asuncion, Paraguay, http://larms2022.com

AUSROCK Conference 2022, 6th Australasian Ground Control in Mining Conference –an ISRM Regional Symposium, 29 November – 1 December 2022, Melbourne, Australia, www.ausimm.com/conferences-and-events/ausrock/

4th African Regional Conference on Geosynthetics – Geosynthetics in Sustainable Infrastructures and Mega Projects February 2023, Cairo, Egypt, www.geoafrica2023.org

88th ICOLD Annual Meeting & Symposium on Sustainable Development of Dams and River Basins, April 2023, New Delhi, India, https://www.icold2020.org

17th Asian Regional Geotechnical Engineering Conference
14-18 August 2023, Nur-Sultan, Kazakhstan

Organiser: Kazakhstan Geotechnical Society;
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XII ICG - 12th International Conference on Geosynthetics, September 17 – 21, 2023, Rome, Italy, www.12icg-roma.org

International Congress in Rock Mechanics
9÷14 October 2023, Salzburg, Austria
https://www.isrm2023.info/en/

The Austrian Society for Geomechanics has the pleasure to invite you to the 15th ISRM Congress 2023 to be held in conjunction with the 72nd Geomechanics Colloquium in Salzburg, the city where the International Society for Rock Mechanics (ISRM) was founded in 1962. The Geomechanics Colloquium in Salzburg since its initiation in 1951 has always been a perfect and distinguished meeting place for researchers and practitioners. The success of this concept not only shows in the continuous meetings over more than 70 years, but also in the attendance of regularly around 1000 participants.

The following topics are currently planned:

- Deep geothermal energy
- Underground storage for liquid and gaseous media
- Natural hazards
- Long term behaviour of underground structures
- Challenging rock engineering projects
- Digitalization & Automatisation
- Monitoring
- Numerical methods in rock engineering
- Geological investigation and characterization
- New developments in rock support
- NATM versus TBM
- Comparison of international tunnelling contracts
- Hydropower projects and dams
- Rock and rock mass properties
- Mining engineering
- Geotechnical aspects of petroleum engineering
- Early Career Forum (Young Researchers)

Organizer: Austrian Society for Geomechanics
Innsbrucker Bundesstraße 67
5020 Salzburg, Austria

XVIII European Conference on Soil Mechanics and Geotechnical Engineering
25-30 August 2024, Lisbon, Portugal

Organiser: SPG
Contact person: SPG
Address: Av. BRASIL, 101
Email: spg@lnec.pt
Website: http://www.spgeotecnia.pt

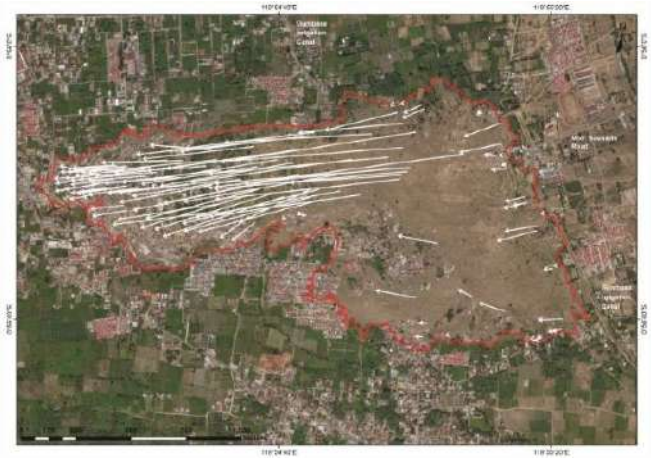
ΕΝΔΙΑΦΕΡΟΝΤΑ ΓΕΩΤΕΧΝΙΚΑ ΝΕΑ

The cause of the Petobo landslide from the 28 September 2019 Palu-Donggala Indonesia earthquake

Possibly the largest landslide-induced loss of life of the last few years was caused by the series of large liquefaction landslides triggered by the Mw=6.1 28 September 2019 Palu-Donggala Indonesia earthquake. I blogged about these events extensively at the time, and also noted that the GEER reconnaissance mission had provisionally suggested that the major cause might have been the presence of a series of canals high on the slopes.

A paper has recently been published in the journal *Landslides* (Kusumawardani *et al.* 2021 – you should be able to read the paper here) that examines one of the largest of these events, the landslide at Petobo in Palu. Just this landslide alone caused the destruction of about 3,300 houses and almost 2,000 people lost their lives.

The paper is a detailed description arising from a site reconnaissance. It is a very valuable catalogue of the features observed, accompanied by a high quality interpretation of them. This, for example, is an interpretation of the movement vectors of the observed features on the ground. These are remarkable given that the average slope gradient is just 2°.



Movement vectors for the landslide at Petobo in Indonesia. Figure from Kusumawardani *et al.* (2021).

Kusumawardani *et al.* (2021) have revisited the issue of the cause of the Petobo landslide. They have considered carefully the role of the irrigation canal near to the crown of the landslide – note that this can be seen on the image above. The authors note that the unlined canal was constructed around 110 years ago. It had been upgraded through time but was unlined, and thus would have been charging the local groundwater levels. Prior to the earthquake the canal was full, and that it was being used to flood the local paddy fields to a depth of 30 to 50 cm.

Thus, Kusumawardani *et al.* (2021) have concluded that it is highly likely that the canal, and the resultant high groundwater levels and inundated paddy fields, led to a high level of susceptibility at Petobo to the effects of the earthquake.

An interesting aside is that the landslide was not rapid – the authors estimate that the rate of movement was in the order of 2.5 to 5 km/h, which is no more than a rapid walking pace.

An interesting question is whether this situation occurs in other earthquake prone areas in Indonesia.

Reference

Kusumawardani, R., Chang, M., Upomo, T.C. *et al.* 2021. Understanding of Petobo liquefaction flowslide by 2018.09.28 Palu-Donggala Indonesia earthquake based on site reconnaissance. *Landslides* https://doi.org/10.1007/s10346-021-01700-x

(Dave Petley / THE LANDSLIDE BLOG, 12 July 2021, https://blogs.agu.org/landslideblog/2021/07/12/petobo-landslide-1/)

Understanding of Petobo liquefaction flowslide by 2018.09.28 Palu-Donggala Indonesia earthquake based on site reconnaissance

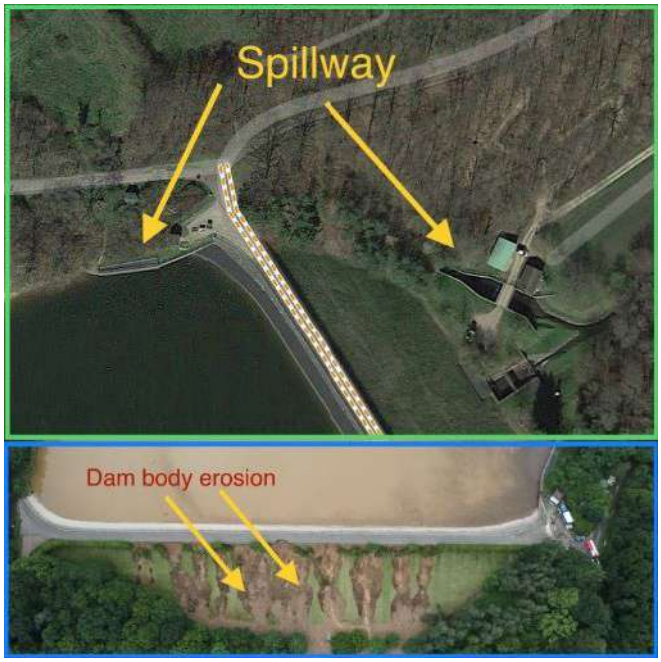
Rini Kusumawardani, Muhsiung Chang, Togani Cahyadi Upomo, Ren-Chung Huang, Muhammad Hamzah Fansuri, Galih Ady Prayitno

Abstract

The Palu-Donggala earthquake struck Palu city of Sulawesi island, Indonesia, on 28 September 2018. A large-scale liquefaction phenomena occurred in some areas which caused massive fatalities and destructions. The most severe liquefaction incident during the earthquake followed by flowslides occurred in Petobo district of the city. The affected area due to Petobo flowslide liquefaction was approximately 1.64 km2. The damages were severe because of densely populated area with estimated more than 3300 houses collapsed and nearly 2000 fatalities. The slide materials transformed into debris and flowed on the low-relief ground of about 2% with a slide distance of more than 800 m. A site reconnaissance of Petobo flowslide was conducted in early 2020, which covered surface observations and documentations before and after the flowslide, interpretations of geological characteristics, summary of witness interviews, analyses of ground displacement and changes in surface elevation and slope due to the flowslide. The results reveal insights as to the failure mechanism of the Petobo flowslide. Based on the observed phenomena on the surface, the Petobo flowslide area could generally be divided into four types of morphology, namely, ground slide (GS), liquefaction spread (LS), liquefaction flow (LF) and debris flood (DF). The GS and LS were considered to be the initiation zones, then the slide materials spread down and formed LF zone. In this area, the soils became wet and muddy as triggered by liquefaction. The liquefied materials then transported into DF zone where densely populated areas in lower elevation of the site were hit.

Steinbachtal dam at imminent risk

The Steinbachtal dam (Germany) is at imminent risk of failure due to overtopping. Earth dams like this can get washed away within an hour by overtopping! We avoid overtopping by large-capacity spillways which this dam doesn't have! It has a side tunnel spillway which is small!



(Dr Mohammad Heidarzadeh, twitter)

Fears German dam could collapse as severe flooding hits Europe

A reservoir dam near Cologne, Germany is at risk of collapse as the region is hit by severe flooding.

Authorities in the Rhine-Sieg county south of Cologne have ordered the evacuation of several villages below the Steinbach reservoir amid fears the dam there could suffer a catastrophic failure.

Flooding in Germany and Belgium has so far claimed the lives of more than 100 people with hundreds more unaccounted for.

In total, 4,500 people have been evacuated from the area and are unlikely to return today with more rain forecast.

Engineers and the fire brigade worked through the night last night and this morning to pump water from the reservoir, reducing the water level by around 2cm.

A statement from the local government this morning confirmed that "The situation is now stable, but not uncritical."

The bottom outlet of the Steinbach dam is still not working and an overflow pipe remains in place to drain more water.

The nearby stretch of Autobahn 61 is also completely closed.

The Steinbach valley drinking water dam was built from 1934 to 1936, and thoroughly renovated between 1988 and 1990.

The reservoir covers 14.6ha and is 17.4m deep at its deepest point. It has a total capacity of 1M.m3

A major renovation was carried out to dam in the 1940s after two cracks appeared in the dam's crown and erosion was detected in its the clay core.

Further work was carried out between August 1988 to June 1990 due to fears of further erosion.

Other dams in the area have also overflowed, leading to concerns about a potential breach.

Draining is also taking place at the Rurtalsperre dam, Wupper dam and the Bever dam near Radevormwald. The residents along the Wupper River were asked to leave the area immediately.

The German regions of Rhineland-Palatinate and North Rhine-Westphalia have been worst hit by the extreme weather, but the Netherlands and Belgium is also badly affected.

Landslips have been recorded in all three countries with many rail lines and roads closed.

More heavy rain is forecast across Europe on Friday, with some officials blaming climate change for the deluge.

Armin Laschet, the leader of the North Rhine-Westphalia region, blamed the extreme weather on global warming.

"We will be faced with such events over and over, and that means we need to speed up climate protection measures [...] because climate change isn't confined to one state," he said.

(Rob Horgan / New Civil Engineer, 16 July, 2021, https://www.newcivilengineer.com/latest/fears-german-dam-could-collapse-as-severe-flooding-hits-europe-16-07-2021)

Dramatic collapse of Xinfa embankment dam

Dramatic collapse of Xinfa embankment dam in northern China due to overtopping that happened yesterday. Note how quickly dam is washed away! This is despite the dam has a

large-capacity chute-type spillway and a bottom outlet which acts as an emergency spillway. See photo below.

Dr Mohammad Heidarzadeh, @Mo_Heidarzadeh, https://twitter.com/Mo_Heidarzadeh/status/1417111827834621961

Hulunbuir: a very serious double dam failure in China on 18 July 2021

There has been surprisingly little international reporting of a very serious double earthen dam failure in the Hulunbuir area of Inner Mongolia in northern China on Sunday 18 July 2021. This looks to have been one of the most serious dam failure events in recent years, with 46 million cubic metres of water having been released, causing massive flooding. Reuters has a report of the event, but there are few other outlets providing much attention to it.

The dams in question are called Yong'an Dam and Xinfa Dam, located in Morin Dawa Daur. There is dramatic footage of the collapse of the Xinfa Dam on Youtube (apologies for the awful music):-

This dam is located at 48.609, 124.241. This is a Google Earth image in happier times:-

Google Earth image of the Xinfa Dam in Hulunbuir, Inner Mongolia, China, which collapsed on 18 July 2021.

Note that this dam has a substantial spillway structure, so overtopping is surprising. However, the video of the collapse shows that a very substantial volume of water had already overtopped the structure:-

The collapse of the Xinfa Dam in China, as captured in a video posted to Youtube.

A good working hypothesis is therefore that this dam was affected by the collapse of the Yong'an Reservoir, which would have released a catastrophic volume of water. About 10 km upstream of the Xinfa Dam there is another dam, located at 48.675, 124.327. The Google Earth image below shows the comparative position of these two structures. Interestingly the adjacent town is called Yongfu:-

Google Earth image of the Xinfa Dam and the possible Yong-an Dam in Hulunbuir, Inner Mongolia, China, which collapsed on 18 July 2021.

One of the videos of the dam collapses, posted to twitter, appears to show the failure of a structure that is definitely not the Xinfa Dam:-

This is a still from this video:-

A still from a video posted to Twitter showing the collapse of the Yong'an dam in Hulunbuir, China on 18 July 2021.

I'm reasonable confident that this is the dam located upstream of the Xinfa Dam – the configuration looks to be identical. Edit: indeed this is now the confirmed location of the Yong'an Dam – see comments below:-

Google Earth image showing detail of the possible Yong'an Dam in Hulunbuir, China.

Thus, my hypothesis (untested at the moment) is that the Yong'an Dam failed due to the intense rainfall, which released a huge wave of water that overtopped and failed the Xinfa Dam, releasing a far greater volume to inundate the surrounding area.

There are images and videos online showing very extensive and damaging flooding from this event, such as this:-

Flooding from the dam collapses in Hulunbuir in China on 18 July 2021. Still from a video posted to Youtube.

A report on Apollo News details the damage (I have edited lightly to improve the English):

"16,660 people were affected; 325,622 mu [21,775 hectares] of farmland was flooded; 22 bridges, 124 culverts, and 15.6 kilometres of highway were destroyed….Casualties are unknown."

Given the sale of the disaster it would be surprising if there were no human casualties although the Reuters report claims that there were no casualties. In the past such reports from China have not been reliable, so the jury is still out.

Large-scale dam collapses such as this are rare but very serious. Interestingly, the Reuters reports includes the following:

China has more than 98,000 reservoirs used to regulate floods, generate power and facilitate shipping. More than 80% of them are four decades old or older, and some pose a safety risk, the government has acknowledged.

Given the rate of change of intense rainfall events, this must be of great concern.

(Dave Petley, 20 July 2021, https://blogs.agu.org/landslideblog/2021/07/20/hulunbuir-1)

Massive landslide in northern India caught on video

A massive landslide caused by heavy rains hit Kinnaur District in the Indian state of Himachal Pradesh on July

25, 2021, claiming the lives of 9 people and injuring 3. All of them were tourists from Delhi.

Videos of the event show massive rocks tumbling down a mountain before crashing into a bridge and destroying it.

Shivangi Thakur, @thakur_shivangi 9 dead and 3 injured as a bridge in #SanglaValley of Kinnaur collapses. #HimachalPradesh

Videos of the event show massive rocks tumbling down a mountain before crashing into a bridge and destroying it.

https://www.youtube.com/watch?v=EO2pd3fe89A

(Teo Blašković / THE WATCHERS, July 26, 2021, https://watchers.news/2021/07/26/himachal-pradesh-kinnaur-landslide-july-25-2021)

The rockslide at Batseri in India

It has been a busy weekend for landslide stories to the degree that it's been difficult to know where to start this morning. However, I have decided it is worth writing about the rockslide at Batseri in the Kinnaur district of Himachal Pradesh in northern India, the videos of which circulated yesterday.

There are several videos of this event, taken from different perspectives. I think it is worth starting with this one as it shows, right at the start, the source of the rockslide:-

Batseri village - landslide Sangla kinnaur, https://www.youtube.com/watch?v=ZEPVXBMiqNI

Nine seconds into the video it also shows traffic passing along the road that traverses the slope, of which more later.

The second and third videos are both in the clip that you should be able to view below:

Tragic landslide in Batseri, Sangla District Kinnaur Himachal Pradesh, https://www.youtube.com/watch?v=9DtJ_fQmcA8

These show the dramatic movement of the boulders down the partially forested slope.

And then there is the viral video (which is also in the compilation above), which is best shown in this version:-

Himachal Pradesh: Valley bridge Batseri in Sangal valley of Kinnaur collapses.tourists dead, https://www.youtube.com/watch?v=oO1QnFqOL0g

The rockslide appears to have started as a result of a collapse on a very steep, rocky outcrop above the bridge at Batseri. The image below shows the terrain using Google Earth. The rock slope has numerous rockslide scars:-

Google Earth view of the terrain at Batseri.

It appears that a mass collapsed, maybe about 700 m vertically above the bridge, and fragmented to generate the "evil dancing boulders". I have noted previously that the situation in which the boulders start to rotate about a short axis and to bounce is very dangerous. This is the case for numerous boulders here, generating extremely high velocities. Before the bridge is hit one boulder (visible at about 19 seconds into the final video above) takes an enormous bounce due to the terrain:-

The evil dancing boulders at Batseri in India. Still from a video posted to Youtube. The boulder circled has take a huge bounce.

The boulder that destroys the bridge also bounced very high, meaning that it impacted the structure in close to free-fall. The bridge was unable to withstand the impact.

Unfortunately there is a tragic footnote to this event. A tourist bus was traversing the road at the time of the landslide, and was hit directly by at least one boulder. Nine people were killed and three were injured. Included in those tragically killed was Dr Deepa Sharma, a well known nutritionist with a large following on Twitter. Earlier in the day she had tweeted a selfie of herself standing at the start of the militarised zone along the border with Tibet.

This stands testament to the tragedy of the event.

Acknowledgement

Many thanks to the various people who brought this to my attention. It is much appreciated.

(Dave Petley / THE LANDSLIDE BLOG, 26 July 2021, https://blogs.agu.org/landslideblog/2021/07/26/batseri-1/)

Massive landslide near Barwas in Himachal Pradesh's Sirmaur; NH-707 blocked

Massive landslide occurred at Kali Khan area in the remote Shilai subdivision of Sirmaur district in Himachal Pradesh. National Highway 707 connecting Shilai with the Paonta Sahib area in Sirmour has been cut off.

https://www.youtube.com/watch?v=EyAh2BjTkPM

(July 30, 2021)

The future of tunnel technology is being used in Moss

A new technical communication solution is now being used in the construction of the double-track railway through Moss. This innovation can contribute to better control and safety in large construction tunnel projects.

Norwegian building and construction projects are becoming increasingly complex at the same time as higher demands are placed on efficiency and cost control. The joint venture between Implenia Norge AS and ACCIONA, known as MossIA ANS, is using a new real-time technology to provide better control and ensure progress in building a 10-km double-track railway between Sandbukta and Såstad, crossing the municipality of Moss.

"The Bane NOR project is an excellent example of what the future holds. Over the last couple months, we have installed sensors, cameras and other equipment in Moss. We believe this solution can have enormous potential for the entire industry," says Jacobo Arnanz, Construction director for ACCIONA in Norway.

Increased safety and control

Digitunnel is a solution that collects and integrates enormous amounts of real-time information generated at the project site and transforms this data into meaningful information that is made available to all parties involved. The data is made available via a web-based platform. The data can be accessed on computers in control rooms, technical offices in the project, or elsewhere in the world through computers or mobile devices. It provides immediate information about the project's progress, gives increased safety for workers, and dramatically reduces the need for paperwork and manual control.

Using Digitunnel, it is possible to quickly get an overview of how many people and vehicles there are in the tunnel at all times, resulting in good control in the projects. The system also monitors the air inside the tunnel. It will, for example, immediately detect if there are dangerous gases in the tunnel. This result in increased safety for the workers in the tunnel

Can potentially save large amounts with portable technology

Many large construction projects are characterized by large amounts of paperwork, double work, and unnecessary delays which can be costly. By automating such processes, crucial time is freed to concentrate on progress. Simultaneously, the chances of something going wrong are reduced and budgetary control are enhanced.

"Paperwork and inspections can be time-consuming processes, and human error is an ever-present danger. Digitunnel makes the construction process safer and easier for everyone involved in a project because all necessary information is practically at your fingertips", says Jacobo Arnanz

Hopes to use Digitunnel all over the world

The Innovasjonsbarometeret 2020, or Innovation Barometer which was carried out by Norstat among 170 companies in the construction industry on behalf of Cramo, shows increasing strategic work on innovation in the construction industry. New ideas and better solutions are crucial for better competitiveness, cost control, and higher value creation. ACCIONA is among the leading international companies that invest heavily in innovation, development, and research.

"ACCIONA has invested 237 millions euro in 2020 in research, technology, and development through our departments and collaborate with universities and companies worldwide. Our new solutions are developed for the benefit of the projects we build across the world. The new technology is being tested locally at our construction sites, such as here in Moss. If the testing goes as we hope, we will use Digitunnel and revolutionise construction projects around the world", says Jacobo Arnanz.

(06/18/2021, https://www.acciona.no/press-room/news/2021/june/the-future-of-tunnel-technology-is-being-used-in-moss/)

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΣΕΙΣΜΟΙ & ΑΝΤΙΣΕΙΣΜΙΚΗ ΜΗΧΑΝΙΚΗ

Τα μυστικά των υποθαλάσσιων κρατήρων της Πάτρας

Μεγάλο ερευνητικό πρόγραμμα με τη χρήση νέων τεχνολογιών

Για να ερευνηθεί το υποθαλάσσιο πεδίο κρατήρων στον Πατραϊκό Κόλπο, θα ποντιστεί ένα πλέγμα από οπτική ίνα σε έναν από αυτούς αλλά και κατά μήκος ενός ενεργού ρήγματος. Επιπλέον, σταθμοί καταγραφής θα τοποθετηθούν μέσα στον πυθμένα ενός κρατήρα και σε ένα ενργό ρήγμα, ενώ τα δεδομένα θα συλλέγονται από έναν επίγειο σταθμό (DTS). Κατά μήκος της παράκτιας ζώνης θα εγκατασταθεί δίκτυο για την παρακολούθηση της σεισμικής δραστηριότητας.

Στις 14 Ιουλίου 1993 ένας ισχυρός σεισμός, μεγέθους 5,5 Ρίχτερ, προκαλεί πολλές ζημιές στην Πάτρα και σε χωριά στα νοτιοδυτικά και βορειοανατολικά της. Γίνεται όμως αφορμή και για μια μοναδική ανακάλυψη: στην περιοχή του νέου λιμανιού, μόλις μερικές εκατοντάδες μέτρα από την ακτή, βρίσκεται ένα πεδίο υποθαλάσσιων κρατήρων το οποίο κατά τη διάρκεια του σεισμού «άτμισε», απελευθερώνοντας μεγάλες ποσότητες αερίων. Το πεδίο αυτό είναι σήμερα το αντικείμενο ενός νέου ερευνητικού προγράμματος από το Πανεπιστήμιο Πατρών, που με τη χρήση νέων τεχνολογιών θα εξετάσει αν η απελευθέρωση αερίων από τους κρατήρες μπορεί να θεωρηθεί πρόδρομο φαινόμενο σε έναν σεισμό, αλλά και τις συνέπειες της διαφυγής αυτής στο φαινόμενο του θερμοκηπίου.

«Ανακαλύψαμε τυχαία το φαινόμενο αυτό το 1993, όταν διαπιστώσαμε μετά τον μεγάλο σεισμό μια περίεργη δραστηριότητα στη θάλασσα και την αλλαγή της θερμοκρασίας της. Ξεκινήσαμε λοιπόν να χαρτογραφήσουμε τον πυθμένα και ανακαλύψαμε ένα πεδίο υποθαλάσσιων κρατήρων, το οποίο έκτοτε μελετάμε συστηματικά», εξηγεί ο Γιώργος Παπαθεοδώρου, καθηγητής στο τμήμα Γεωλογίας του Πανεπιστημίου Πατρών. Πριν από την κατασκευή του νέου λιμένα Πατρών το πεδίο αριθμούσε 72 κρατήρες, ο μεγαλύτερος των οποίων έχει διάμετρο 200 μέτρα και βάθος, σε σχέση με τον πυθμένα, 20 μέτρων. Οι κρατήρες αυτοί όμως δεν σχετίζονται με ηφαιστειακή δραστηριότητα. «Οι διαφυγές αυτές των ρευστών και κυρίως των αερίων δεν θα πρέπει να συγχέονται με την ηφαιστειακή δραστηριότητα, καθώς τα αέρια και υγρά που διαφεύγουν έχουν σχηματιστεί στα ιζήματα μετά την αναερόβια αποικοδόμηση του συσσωρευμένου οργανικού υλικού», εξηγεί ο κ. Παπαθεοδώρου. «Το στοιχείο που καθιστά το συγκεκριμένο πεδίο ιδιαίτερα σημαντικό και αναγνωρίσιμο στη διεθνή επιστημονική κοινότητα είναι το γεγονός ότι σε τουλάχιστον δύο σεισμούς ενεργοποιήθηκε, αποδεδειγμένα, και "άτμισε" απελευθερώνοντας μεγάλες ποσότητες αερίων. Στον σεισμό της Πάτρας του 1993 καταγράφηκε με ενόργανο μέσο η δραστηριότητα του πεδίου ακόμη και ώρες πριν από τη σεισμική δραστηριότητα, προτείνοντας το σενάριο ότι πιθανώς οι διαφυγές αερίων να εμφανίζονται ως πρόδρομα φαινόμενα λίγες ώρες πριν από την εμφάνιση του σεισμού. Εκτεταμένη δραστηριότητα του πεδίου, με μεγάλες διαφυγές αερίων, διαπιστώθηκε και στον σεισμό της Ανδραβίδας του 2008 (8 Ιουνίου, 6,4 R)».

Για τη μελέτη του φαινομένου, το Πανεπιστήμιο Πατρών ξεκινάει ένα νέο πρόγραμμα που ονομάζεται BLUEL, με χρηματοδότηση από το Ελληνικό Ιδρυμα Ερευνας και Καινοτομίας. «Ο στόχος του BLUEL είναι να παρακολουθήσει, για μακρύ χρονικό διάστημα, τη διαφυγή των ρευστών και κυρίως των αερίων μεθανίου και υδρόθειου (CH_4 και H_2S) από το υποθαλάσσιο ενεργό πεδίο κρατήρων και να διερευνήσει τη σχέση της με τη σεισμική δραστηριότητα στη Δυτική Ελλάδα. Ο κύριος στόχος του είναι να εξετάσει την εμφάνιση πιθανών αλλαγών στη συμπεριφορά της διαφυγής των ρευστών κατά τη διάρκεια εκδήλωσης σεισμών και να αποφανθεί εάν μπορούν ή όχι να θεωρηθούν πρόδρομα φαινόμενα σεισμών. Επιπλέον, το BLUEL θα εξετάσει τη συμβολή της διαφυγής ρευστών πυθμένα στην υπερθέρμανση του πλανήτη μέσω της διαφυγής του θερμοκηπιακού αερίου μεθανίου στην ατμόσφαιρα», εξηγεί ο κ. Παπαθεοδώρου.

Στο πλαίσιο του προγράμματος, ξεκίνησε να ποντίζεται σε έναν κρατήρα ένα πλέγμα από οπτική ίνα για την παρακολούθηση της θερμοκρασίας των διαφυγόντων αερίων. «Ενας σταθμός καταγραφής θα ποντιστεί τόσο στον πυθμένα στο εσωτερικό ενός ενεργού κρατήρα όσο και κατά μήκος ενός ενεργού ρήγματος. Επιπλέον, θα εγκατασταθεί ένα μικροσεισμικό δίκτυο για την παρακολούθηση της σεισμικής δραστηριότητας γύρω από το πεδίο κρατήρων. Ενας σταθμός θα μεταδίδει μετεωρολογικά δεδομένα κατά τη διάρκεια της υποθαλάσσιας παρακολούθησης, ενώ συστηματικές χημικές αναλύσεις πραγματοποιούνται στα αέρια που διαφεύγουν, στα ιζήματα του πυθμένα και στην υδάτινη στήλη της περιοχής», καταλήγει ο κ. Παπαθεοδώρου.

Το BLUEL συντονίζεται από το Oceanus Lab (Εργαστήριο Θαλάσσιας Γεωλογίας και Φυσικής Ωκεανογραφίας) του Τμήματος Γεωλογίας του Πανεπιστημίου Πατρών με επικεφαλής τους καθηγητές Γ. Παπαθεοδώρου και Μ. Γεραγά και τους ερευνητές Δ. Χριστοδούλου, Η. Φακίρη, Ν. Γεωργίου, δρ Π. Μεγαλοβασίλη, Ξ. Δήμα, Σ. Σεργίου και Μ. Παπακωνσταντίνου. Για την παρακολούθηση της σεισμικότητας υπεύθυνο είναι το Εργαστήριο Σεισμολογίας του Τμήματος Γεωλογίας και οι καθηγητές Ε. Σώκος και Ζ. Ρουμελιώτη και η ερευνήτρια Γ. Γιανναράκη, ενώ για τη μελέτη των ρηγμάτων υπεύθυνος είναι ο καθηγητής Σ. Κοκκάλας του ίδιου τμήματος.

Στο μικροσκόπιο ο δυτικός Κορινθιακός

Η περιοχή του δυτικού Κορινθιακού Κόλπου είναι από τις πιο στενά παρακολουθούμενες στην Ευρώπη. «Η περιοχή από το Αίγιο έως το Αντίρριο χαρακτηρίζεται από πολύ έντονη σεισμικότητα και μικροσεισμικότητα. Είναι από τις πρώτες περιοχές στην Ελλάδα σε αριθμό σεισμών», εξηγεί ο Θύμιος Σώκος, καθηγητής σεισμολογίας στο Πανεπιστήμιο Πατρών. «Είναι γνωστό ότι ο δυτικός Κορινθιακός "ανοίγει" κατά 1,5 εκατοστό κάθε έτος, ενώ τον διατρέχουν πολλά μικρά και μεγάλα ρήγματα. Το γεγονός αυτό έχει οδηγήσει στην περιοχή επιστήμονες όχι μόνο από την Ελλάδα αλλά και από αρκετές ευρωπαϊκές χώρες, όπως η Ιταλία, η Γαλλία και η Τσεχία, που παρακολουθούν το φαινόμενο».

Η περιοχή από το Αίγιο έως το Αντίρριο είναι από τις πρώτες στην Ελλάδα σε αριθμό σεισμών. (Φωτ. INTIME NEWS)

Την περίοδο αυτή, η κατάσταση στον δυτικό Κορινθιακό είναι ήσυχη. «Ανά διαστήματα έχουμε περιόδους έντονης σεισμικότητας, με σεισμούς 2,5-3 Ρίχτερ, οι οποίες κρατούν για μερικούς μήνες. Η τελευταία ήταν στις αρχές του 2021, σε μια περιοχή από το Επιτάλιο έως τα Τριζόνια. Το μεγαλύτερο και πιο επικίνδυνο από τα ρήγματα της περιοχής είναι του Ψαθόπυργου, που εκτιμάται ότι είναι μεγαλύτερο από 20 χλμ. και μπορεί να δώσει ισχυρούς σεισμούς, αλλά δεν παρουσιάζει δραστηριότητα την περίοδο αυτή», εξηγεί ο κ. Σώκος. «Αντίθετα με τον δυτικό Κορινθιακό, η περιοχή του Πατραϊκού Κόλπου είναι πιο ήσυχη. Εχει λιγότερα ρήγματα και παρατηρείται μικρότερη παραμόρφωση». Τα τελευταία χρόνια έχουν γίνει σημαντικά βήματα για την ενίσχυση της επιστημονικής έρευνας στην περιοχή, όπως η δημιουργία του Εθνικού Σεισμογραφικού Δικτύου, στο οποίο εντάχθηκε και το Πανεπιστήμιο Πατρών. «Ερευνητικά παρακολουθούμε τη σεισμικότητα στην περιοχή μας και ευρύτερα στον ελλαδικό χώρο. Μας ενδιαφέρει ποια είναι η επίδραση στα κτίρια, πώς κατανέμονται οι τάσεις, ποια είναι τα μήκη των ρηγμάτων», λέει ο κ. Σώκος. «Σε δεύτερο επίπεδο πρέπει να δούμε πώς όλη αυτή η νέα γνώση μπορεί να χρησιμοποιηθεί πρακτικά, για παράδειγμα για την ανανέωση του χάρτη σεισμικής επικινδυνότητας. Σε άλλες χώρες με υψηλή σεισμικότητα, όπως η Ιαπωνία, είναι ήδη λειτουργικά συστήματα έγκαιρης προειδοποίησης σε περίπτωση ισχυρού σεισμού, πεδίο που στη χώρα μας δεν έχει αναπτυχθεί ακόμα».

(Γιώργος Λιάλιος / Η ΚΑΘΗΜΕΡΙΝΗ, 19.07.2021, https://www.kathimerini.gr/society/561437656/ta-mystika-ton-ypothalassion-kratiron-tis-patras)

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΓΕΩΛΟΓΙΑ

Massive sunken continent could be resting underneath Iceland

An international team of geologists believes they have identified a sunken continent hidden under Iceland and the surrounding ocean, which they called Icelandia. The scientists said the continent could stretch from Greenland all the way to Europe. If proven, this new theory will challenge all previous theories around the extent of continental and oceanic crust in the North Atlantic region, as well as contradict the belief that Pangea broken up more than 50 million years ago.

Iceland could be the tip of a massive sunken continent, according to the international team, led by Gillian Foulger, Emeritus Professor of Geophysics in the Department of Earth Sciences at Durham University in the UK, who published their study in GeoScience World.

The landmass is believed to cover an area of around 600 000 km^2 (231 600 $miles^2$), but when adjoining areas of Britain are included in a "Greater Icelandia" - the total area could be 1 million km^2 (386 000 $miles^2$).

If confirmed, this will contradict the previous theory that the giant supercontinent of Pangea, which is thought to have broken up over 50 million years ago, has not fully broken up.

This new theory also challenges long-held scientific ideas around the extent of continental and oceanic crust in the North Atlantic region, as well as how volcanic islands, like Icelands, formed.

The presence of continental crust, rather than oceanic, could also trigger discussions about a new source of hydrocarbons and minerals, both contained in the continental crust.

"Until now Iceland has puzzled geologists, as existing theories that it is built of and surrounded by oceanic crust are not supported by multiple geological data," said Foulger.

"For example, the crust under Iceland is over 40 km (25 miles) thick-- seven times thicker than normal oceanic crust. This simply could not be explained."

He continued, "However, when we considered the possibility that this thick crust is continental, our data suddenly all made sense. This led us immediately to realize that the continental region was much bigger than Iceland itself—there is a hidden continent right there under the sea."

"There is fantastic work to be done to prove the existence of Icelandia but it also opens up a completely new view of our geological understanding of the world. Something similar could be happening at many more places."

"We could eventually see maps of our oceans and seas being redrawn as our understanding of what lies beneath changes."

The team is now working with collaborators across the world to test their theory, which will commence once the pandemic restrictions ease up.

"Countries around the world are spending enormous resources conducting subsea geologic research in order to identify their continental shelves and claim exclusive mineral rights there," said Professor Philip Steinberg, Director of IBRU, Durham University's Center for Borders Research, who is not involved in the study.

"Research like Professor Foulger's, which forces us to rethink the relationship between the seabed and continental geology, can have far-reaching impact for countries trying to determine what area of the seabed are their exclusive preserve and what areas are to be governed by the International Seabed Authority as the 'common heritage of humankind."

Reference

"Icelandia" - Foulger, G. R., et. al. GeoScience World - https://doi.org/10.1130/2021.2553(04)

Abstract

We propose a new, sunken continent beneath the North Atlantic Ocean that we name Icelandia. It may comprise blocks of full-thickness continental lithosphere or extended, magma-inflated continental layers that form hybrid continental-oceanic lithosphere. It underlies the Greenland-Iceland-Faroe Ridge and the Jan Mayen microplate complex, covering an area of ~600,000 km2. It is contiguous with the Faroe Plateau and known parts of the submarine continental rifted margin offshore Britain. If these are included in a "Greater Icelandia," the entire area is ~1,000,000 km2 in size. The existence of Icelandia needs to be tested. Candidate approaches include magnetotelluric surveying in Iceland; ultra-long, full-crust-penetrating reflection profiling along the length of the Greenland-Iceland-Faroe Ridge; dating zircons collected in Iceland; deep drilling; and reappraisal of the geology of Iceland. Some of these methods could be applied to other candidate sunken continents that are common in the oceans.

(Julie Celestial / THE WATCHERS, July 11, 2021, https://watchers.news/2021/07/11/icelandia-massive-sunken-continent-hypothesis)

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΛΟΙΠΑ

This Super Fast Train Will Zoom At Aircraft-Like Speeds

Japan has been building superfast trains for a few decades now and their efforts have revolutionized ground transportation forever. But the country's new Superconducting Maglev (SCMaglev) is all set to take high-speed train travel to the next level. This powerful vehicle will be zooming at astonishing speeds of 503 km per hour (312 mph) and is all set to become the world’s fastest train. Find out more about this incredible train in this video.

https://www.ba-bamail.com/video.aspx?emailid=40661

ΕΝΔΙΑΦΕΡΟΥΣΕΣ ΑΝΑΜΝΗΣΕΙΣ

Τατζικιστάν

Παύλος Μαρίνος

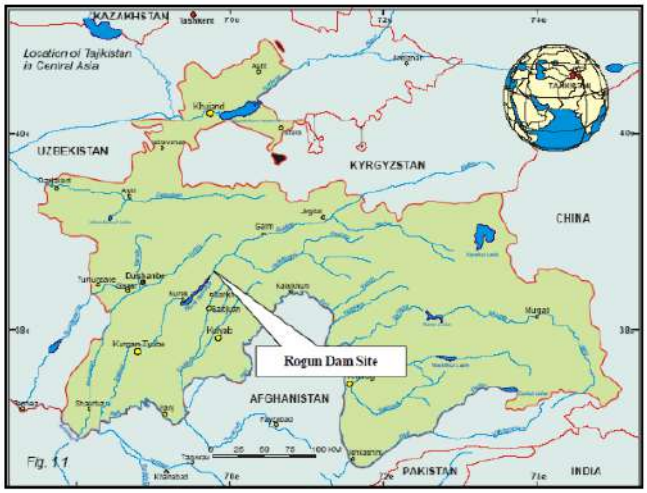
<u>Οι ειδήσεις αυτές τις μέρες, αρχή Ιουλίου 2021</u>: Αφγανιστάν, οι ΗΠΑ φεύγουν, οι Ταλιμπάν[1] προελαύνουν ξανά. Ύστερα από 20 χρόνια μετά την 11η Σεπτεμβρίου 2011. Ήδη οι Ταλιμπάν αναφέρεται ότι ελέγχουν το μεγαλύτερο μέρος της χώρας. Είδαμε στην τηλεόραση κυβερνητικοί στρατιώτες να ενώνονται με τους Ταλιμπάν και να παραδίνουν τον προχωρημένο αμερικανικό οπλισμό τους. Πολλοί άλλοι να καταφεύγουν στο γειτονικό Τατζικιστάν, μαζί με κυβερνητικούς, περνώντας το σύνορο μεταξύ των δύο χωρών που είναι ο ποταμός Άμου Ντάρια. Το Τατζικιστάν στέλνει 20. 000 στρατό κατά μήκος του ποταμού (Υπάρχει μόνο μία γέφυρα)

*Ο ποταμός **Άμου Ντάρια** καταλήγει στην αλήστου μνήμης λίμνη Αράλη (έχει συρρικνωθεί δραματικά από υπερεκμεταλλεύσεις του νερού). Είχα περπατήσει κατά μήκος του, σε ένα μικρό του τμήμα, το 2013, κάτω από αφόρητη ζέστη (μας είπαν ότι ήταν 56°), βλέποντας απέναντι το ερημικό πεδίο του Αφγανιστάν. Ο ποταμός είναι **ο Όξος της αρχαιότητας μας** που διέσχισε και αυτόν στην εκστρατεία του ο Μέγας Αλέξανδρος. Επανέρχομαι.*

Με αυτήν την αφορμή επαναλαμβάνω, με μικρές αλλαγές, τις «ανταποκρίσεις» που είχα στείλει από το **Τατζικιστάν** το 2013 και 2016. Οι φωτογραφίες είναι από την περίοδο αυτή, όπως και κάποιοι πληροφοριακοί αριθμοί για την χώρα.

Στο Τατζικιστάν πηγαίνω από το 2013 μέχρι και σήμερα ως μέλος Επιτροπής Εμπειρογνωμόνων της Διεθνούς Τράπεζας. Επρόκειτο αρχικά για το φράγμα Rogun, που τώρα κατασκευάζεται και θα είναι το πιο ψηλό φράγμα στον μικρό μας πλανήτη, 325μ ύψος. Τώρα, για τον έλεγχο του φράγματος Nurek, 300μ ύψος, σήμερα ακόμη το πιο υψηλό φράγμα που λειτουργεί από την Σοβιετική περίοδο. Τα 2 τελευταία χρόνια η Επιτροπή λειτουργεί με εικονικές αποστολές και συνεργασίες, λόγω του Covid-19.

Η **Δημοκρατία του Τατζικιστάν** . Το Τατζικιστάν ήταν μέρος της Σοβιετικής Ένωσης από το 1917 έως το 1991. Έγινε ανεξάρτητη το 1991 με εμφύλιο πόλεμο να ξεκινά σχεδόν αμέσως μετά την ανεξαρτησία, με διάρκεια από το 1992 μέχρι το 1997. Το Τατζικιστάν είναι κυρίως ορεινό κι οι κορυφές της είναι από τις ψηλότερες ολόκληρης της περιοχής της Κεντρικής Ασία (υψηλότερη 7.495μ). Καλύπτεται και από τα βουνά της οροσειράς Παμίρ, ενώ μεγάλο μέρος της χώρας βρίσκεται σε υψόμετρο άνω των 3.000 μέτρων. Οι Τατζίκοι, είναι ιρανική φυλή, η μοναδική στην Κεντρική Ασία, έξω βέβαια από το Ιράν. Φυλή ινδοευρωπαϊκή σαν και εμάς με πολλούς όμως να έχουν από την επιμιξία ελαφρά τουρκικά ή μογγολικά χαρακτηριστικά. Φυλετικά δεν έχουν καμιά συγγένεια με τους γύρω λαούς (Ουσμπέκους, Τουρκομάνους, Κυργκίσιους – τουρκογενείς/μογγολοειδείς).



Το Τατζικιστάν με τα περίεργα όρια του. Τα χάραξε ο ατσάλινος για αφαίρεση των χαρακτήρων εθνότητας. Η χώρα είναι σαν κομμάτι από puzzle. Προσπάθησε να μπερδέψει και πληθυσμούς.

Θρήσκευμα το Ισλαμ, Σουνίτες (ενώ στο Ιράν Σιίτες) που αποτελούν το 83% του πληθυσμού. Ο κόσμος όχι από τους φανατικούς μωαμεθανούς. 8% του πληθυσμού είναι Ρώσοι σύμφωνα με εκτίμηση για το 2021.

Η Τατζικ γλώσσα, μια διάλεκτος των Περσικών φαρσί. Πολλοί Τατζίκοι μιλάνε τα ρώσικα ως δεύτερη γλώσσα.

Σαν την Ελλάδα σε έκταση και 9,3 εκ. κάτοικους (1919). Η πιο φτωχή Σοβιετική Δημοκρατία τότε, κοιτά στο μέλλον σήμερα μετά τον πολύ αιματηρό εμφύλιο στη δεκαετία του 90

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[1] **Ταλιμπάν**, δηλαδή *σπουδαστές του κινήματος της ισλαμικής γνώσης*, εννοείται το πολιτικό-θρησκευτικό κίνημα που κυβέρνησε το Αφγανιστάν από το 1996 έως το 2001. Οι Ταλιμπάν ανήλθαν στη εξουσία μετά από έναν μακρύ εμφύλιο πόλεμο. Εκδιώχθηκαν βίαια από την εξουσία μετά την πολεμική σύρραξη Αφγανιστάν–ΗΠΑ, τον Δεκέμβριο του 2001. Το 2015, οι Ταλιμπάν ορκίστηκαν πίστη στο Ισλαμικό Κράτος. Οι Ταλιμπάν εφαρμόζουν με τον πιο αυστηρό τρόπο τη σαρία, προσπαθώντας να δημιουργήσουν το γνήσιο ισλαμικό κράτος, επιβάλλοντας σε άνδρες και πολύ αυστηρότερα σε γυναίκες περιορισμούς στην καθημερινότητα και την ατομική εξέλιξη. Απαγορεύτηκε στις γυναίκες να σπουδάζουν και να εργάζονται σε οποιονδήποτε παραγωγικό τομέα, εκτός των υπηρεσιών υγείας, μόνο και μόνο για να εξετάζουν γυναίκες ασθενείς. Οι άνδρες υποχρεώθηκαν να συμμορφωθούν ενδυματολογικά σύμφωνα με τις ισλαμικές παραδόσεις. Σε πολιτισμικό επίπεδο απαγορεύτηκε η μουσική, η τηλεόραση και το βίντεο, όπως και ό,τι μη εγκεκριμένο από τους θρησκευτικούς ηγέτες Ταυτόχρονα απαξιώθηκε δραστικά η μη ισλαμική κληρονομιά του Αφγανιστάν. Οι Ταλιμπάν προκάλεσαν σοκ στην παγκόσμια κοινή γνώμη τον Μάρτιο του 2001 με την απόφασή τους να καταστρέψουν μνημεία της Παγκόσμιας Πολιτιστικής Κληρονομιάς με την αιτιολογία ότι είναι είδωλα και συνεπώς αντίθετα προς τον νόμο του Ισλάμ. Θυμόμαστε τα βίντεο των φοβερών καταστροφών.

Αμερικάνοι και ΝΑΤΟ αποχωρούν και οι Τούρκοι επωφελούνται. Προσφέρθηκαν να στείλουν, ως ΝΑΤΟ, στρατό για την φύλαξη του αεροδρομίου της Καμπούλ ! Οι ρώσοι στην «αναμονή». Δέχθηκαν χθες αντιπροσωπία των Ταλιμπάν στην Μόσχα! Λέει ότι θέμα ήταν για την μη διείσδυση τρομοκρατών στην Κεντρική Ασία. Η έγνοια επίσης και του Τατζικιστάν. Το θέμα « Αφγανιστάν» ξεκίνησε με την εισβολή της Σοβιετικής Ένωσης στα τέλη του'80.

που την είχε καθηλώσει από πλευράς ανάπτυξης. Πόλεμος περίεργος: οι πρώην κομουνιστές μεταλλαγμένοι πλέον - που και νίκησαν - και όλοι οι άλλοι απέναντι, αντιπολίτευση, ισλαμιστές, κάποιες μειονότητες. Προεδρική Δημοκρατία. Πρόεδρος από τότε ο Emomali Rakhmon.

Μερικά αγάλματα του Λένιν έχουν διατηρηθεί στην χώρα. Αυτό στην πόλη του Νούρεκ

Ο Πρόεδρος

Μέγας Αλέξανδρος

Και από εδώ πέρασε ο **Μέγας Αλέξανδρος,** στην φοβερή πορεία του στη Ασία. Κατάκτηση αλλά και εκπολιτισμός, έστω έμμεσος. Ο Μέγας Αλέξανδρος ίδρυσε εδώ, το 329 (28 χρονών), τη 9η Αλεξάνδρεια, την πιο απομακρυσμένη, ***Την Εσχάτη***. Στη Σογδιανή. Είναι στο βόρειο Τατζικιστάν εκεί που σήμερα είναι η δεύτερη πόλη της χώρας, το Khuzand (που ονομαζόταν Leninabad πριν το 1991), 270 km βορείως από την πρωτεύσασα Dushanbe. Ενδιαφέρον είναι ότι εδώ ο Μέγας Αλέξανδρος συνάντησε την πιο πεισματική αντίσταση από ο-ποιουδήποτε, γιατί είχε να κάνει με μη ορθόδοξο πόλεμο, ένα ανταρτοπόλεμο, 18 μήνες. Νίκησε τους Σογδιανούς στα εκεί βουνά του Zerafshan Ο αρχηγός μαζί με το οχυρό του, παρέδωσε στον Αλέξανδρο και μια όμορφη Βακτριανή. Από την πόλη που έκτισε δεν μένει σήμερα τίποτε. Όπως και στις άλλες πόλεις που δημιούργησε στη Κεντρική Ασία και φυλάκια και τελωνεία που επάνδρωνε με βετεράνους και τραυματίες που άφηνε στην πορεία του. Πιθανολογείται ότι η ελληνική διέλευση και επικοινωνία και με τον κινέζικο πολιτισμό, άνοιξε λίγο αργότερα εμπορικό δρόμο, τον περίφημο «Δρόμο του Μεταξιού». Στη Αλεξάνδρεια την Εσχάτη παντρεύτηκε τελικά την όμορφή αυτή Βακτριανή, την Ρωξάνη που του παρέδωσε ο Σογδιανός αρχηγός (Roshanak, συνηθισμένο όνομα εδώ και επί τη ευκαιρία οι κοπέλες του Τατζικισταν είναι όμορφες, μετά μπαταλεύουν, αναζητήσατε γάμο και οικογένεια). Έκανε και γιό που όμως μάλλον τον δολοφόνησαν αμέσως οι αξιωματικοί του, ίσως γιατί δεν ήθελαν, λέει, ο διάδοχος και κληρονόμος της αυτοκρατορίας να έχει και ξένο αίμα. Σε μια από τις επόμενες φωτογραφίες μια φιλντισένια κεφαλή του Μέγα Αλέξανδρου, από το εδώ Μουσείο του Dushanbe, της πρωτεύουσας.

Οι «απόγονοι» της Ρωξάνης. Οι όμορφες κόρες της χώρας. Καταλαβαίνει κανείς τον Μέγα Αλέξανδρο για την Ρωξάνη.

Και κάτι καταπληκτικό: Όταν διηγούμουνα τα διάφορα για τον Μέγα Αλέξανδρο στους της εδώ αντίστοιχης ΔΕΗ (που είναι και υψηλόβαθμα στελέχη της κυβέρνησης, ο αντιπρόεδρος της κυβέρνησης ο πρόεδρος), στη διάρκεια γεύματος που μας πρόσφεραν- και που συνεχώς μας παρότρυναν όλους για άσπρο πάτο με σφηνάκια από βότκα (δεν ενοχλεί που είναι μουσουλμάνοι οι Τατζίκοι, εξ άλλου η βότκα ως γνωστό είναι αγνό ποτό) - ο αντιπρόεδρος όσο περιέγραφα είχε ένα ελαφρό καλοπροαίρετο χαμόγελο και στο τέλος με ρωτάει: «Όλα αυτά που είπες τα ξέρω, αλλά εσύ ξέρεις γιατί ξεκίνησε την εκστρατεία ο Αλέξανδρος και έφθασε μέχρι εδώ και ήθελε να πάει και παρά πέρα; Από ένα λάθος του δασκάλου του που τον είχε πείσει ότι η Γη είναι επίπεδη. Του δασκάλου του, του Αριστοτέλη». Είναι να μην συγκινηθείς!

Pamir

Στο **Pamir** στα ΝΑ της χώρας, υπάρχει λίμνη που ονομάζεται του «Λίμνη του Μεγαλέξανδρου» (Iskanderkul). Ο θρύλος λέει ότι την δημιούργησε ο Μ. Αλέξανδρος όταν στάθμευσε για λίγο εδώ στην πορεία του προς Ινδία, εκτρέποντας τα νερά δύο ρεμάτων Και μηχανικός ο Μέγας.

Ο αντιπρόεδρος της Κυβέρνησης μας κάνει το τραπέζι. Τι τραπέζι! Πολλά και όλα εξαιρετικά πιάτα (μίγμα ντόπιας και Ρωσικής κουζίνας). Και η βότκα να ρέει ασταμάτητα με συνεχή παρότρυνση σε όλους συνεχώς για άσπρο πάτο. Δίπλα η Ναργίς η μεταφράστρια και τα άλλα μέλη της Επιτροπής Εμπειρογνωμόνων.

Το Παμίρ, επιτηρούμενη περιοχή, αποτελεί ένα από τους πιο σπουδαίους παγκόσμιους ορειβατικούς προορισμούς με μερικές από τις πιο υψηλές κορυφές της Κεντρικής Ασίας. Το Pik Somona (πρώην Pik Kommunizma, +7495).

Η λίμνη «Μέγας Αλέξανδρος» στα βουνά του Παμίρ

Η φιλντισένια κεφαλή του Μέγα στο Μουσείο του Dushanbe

Pamir

Το πρόβατο «Marko Polo» της περιοχής

Dushanbe

Η πόλη του Dushanbe, νέα, του περασμένου μόλις αιώνα, καθαρή, με φαρδιές και πολλές λεωφόρους πλαισιωμένες ακόμη σε μεγάλο βαθμό από τα ιδιότυπης αρχιτεκτονικής κτίρια της Σοβιετικής περιόδου. Αλλά το κτίριο της όπερας!! Νέα κτίρια φαραωνικά κατασκευάζονται με συζητήσιμη αισθητική.

Αγορά. Όχι δεν έφαγα στο ανοικτό εστιατόριο της φωτογραφίας, παρ' όλο που το πιλάφι μύριζε τόσο ωραία.

Οι Τατζίκοι περσικής προέλευσης όπως ήδη ανέφερα με λίγη μόνο επιμιξία. Η γλώσσα τους, είδος φαρσί ήταν με περσικούς χαρακτήρες μέχρι που ο Ατσαλένιος υποχρέωσε την Κυριλλική γραφή. Σήμερα τα Ρώσικα και τα Τατζίκ, με κυριλλικά, είναι οι χρησιμοποιούμενες γλώσσες. Εδώ στη δουλειά μας η επικοινωνία γίνεται στα Ρώσικα μέσω μεταφράστριας που ήταν πάντα μαζί μου. Εξαιρετική επαγγελματίας. Τους Ρώσους έχω την εντύπωση τους κρατούν, με ισορροπίες, μακριά (εξ άλλου έφυγαν οι πολλοί στην δεκαετία του 90).

Dushanbe. Η σημαία, τεράστια, περήφανη και το μνημείο Ismoili Somoni, ιδρυτή της δυναστείας των Σαμανιδών τον 10ο αιώνα.

Μισθός περίπου $600, ο μεγάλος. Το λίτρο βενζίνης $ 0.7 (όλοι που έχουν ΙΧ παίρνουν στο δρόμο και συμπολίτες τους - οι πειρατές στην Αθήνα της νιότης μας - οι νέοι μας το γνωρίζουν πιά από τις παλιές ελληνικές ταινίες που, ευτυχώς, παίζονται και ξαναπαίζονται στη τηλεόραση). Τηλεόραση $400. Φρούτα $1-3/κιλό. Συμπεράσματα βγαίνουν. Υπάρχει όμως και μια παράλληλη οικονομία που αφήνει χρήματα. Ερώτηση μου στους μηχανικούς που συνεργαζόμουνα: βλέπω αξιόλογη ανοικοδόμηση στην χώρα. Απάντηση: «Πράγματι αυτή η χρονιά ήταν καλή στο Αφγανιστάν». Το Τατζικιστάν αποτελεί μια πύλη εξόδου του οπίου από το Αφγανιστάν προς τη Δύση για την παραγωγή ηρωίνης, αυτού του έξοχου και τόσο ευεργετικού προϊόντος για την μακαριότητα και ηρεμία - αποχαύνωση της ανθρωπότητας.

Η Όπερα του Dushanbe, κόσμημα

Το «Σπίτι» των λογοτεχνών

Στο Dushanbe μένουμε στο Hyatt. Οποία αντίθεση! Η τιμή είναι ειδική για την World Bank $180 την βραδιά. Αντίθετα σε επαρχιακά ξενοδοχεία, κοντά στο υπό μελέτη φράγμα, $10-30 (το εκεί χαρτί τουαλέτας είναι βιομηχανικής αντοχής με αμμόκοκκο – πάντως χαρτί υπάρχει, όχι σαν σε κάποια άλλα κράτη, της Ευρώπης νομίζω, ή σε τουαλέτες των Πανεπιστημίων τους που πρέπει να το έχεις μαζί σου). Στο Hyatt και τι δεν βλέπεις από κόσμο. Να μην έχεις δουλειά να χαζεύεις στο Lobby: Επιχειρηματίες με τεράστια αυτοκίνητα με μαύρα τζάμια και τους οδηγούς να τους περιμένουν, στρατιωτικοί του ΝΑΤΟ από διάφορες χώρες (που ξεκουράζονται μέχρι να πάνε με ελικόπτερα στο Αφγανιστάν ή που έρχονται από εκεί) με τις στολές εκστρατείας τους (σε χρώμα παραλλαγών του μπεζ – όχι! το πράσινο χρώμα ήταν για το Βιετνάμ). Όλα τα αυτοκίνητα τα ψάχνουν από κάτω, στην είσοδο του ξενοδοχείου, με καθρέπτες μήπως έχουν κρυμμένες στρακαστρούκες.

Το φαί στην πόλη και την ύπαιθρο καλό ως πολύ καλό. Μίγμα ρώσικης, τουρκικής και περσικής κουζίνα (ευτυχώς όχι ινδικής). Και πάντα σούπες.

Τα Φράγματα

Φράγμα Nurek. Σε κύριο κλάδο του ποταμού Όξου, τον Vakhsh. Το φράγμα είναι το υψηλότερο του κόσμου σήμερα, 300μ. Χωμάτινο με αργιλικό πυρήνα. Κατασκευασμένο την Σοβιετική περίοδο με μελέτη από Γραφείο της Τασκένδης[2]. Λειτουργεί με ασφάλεια από το 1979. Ύστερα από τόσα χρόνια γίνεται επιθεώρηση, έλεγχοι ασφαλούς λειτουργίας και αναβαθμίσεις που χρηματοδοτούνται από την Διεθνή Τράπεζα. Στο αριστερό αντέρεισμα ενεργό έρπον ρήγμα τέμνει τις 2 σήραγγες του υπερχειλιστή κι εδώ ιδιαίτερη η προσοχή μας.

Το φράγμα Rogun, 335μ ύψος. Όταν τελειώσει το υψηλότερο. Λίμνη 13 Km^3. Εγκατεστημένη ισχύς 3600MW (6x600). Θα καλύψει το πρόβλημα ηλεκτροδότησης που σήμερα είναι πολύ σημαντικό (υποφωτισμός παντού στην χώρα, με διακοπές, εκτός από την πρωτεύουσα και το Khuzand). Η Διεθνής Τράπεζα το παρακολουθεί αυτή την περίοδο από πλευράς εφικτότητας (από κάθε πλευρά). Δεν το χρηματοδοτεί. Υπάρχει και γεωπολιτικό θέμα τεράστιο: το ποτάμι μπαίνει στο Ουζμπεκιστάν, στο Τουρκμενιστάν, ξανά στο Ουζμπεκιστάν και καταλήγει στην Λίμνη Αράλη που ανήκει και στο Καζακστάν.

Το φράγμα άρχισε να μελετάται την ένδοξη εποχή του Μπρέζνιεφ (δεκαετία 70). Έγινε μεγάλος αριθμός υπογείων έργων για τον υπόγειο σταθμό παραγωγής. Η κατασκευή σταμάτησε το 1991με την κατάρρευση του συστήματος και τον επακόλουθο εμφύλιο. Αξίζει να σημειωθεί ότι οι Σοβιετικοί φοβούμενοι την παρακολούθηση από αέρος και δορυφόρους, έκαναν τότε τις γεωέρευνες με ερευνητικές στοές και από εκεί μέσα γεωτρήσεις. Ενδιαφέρον είναι ότι ορισμένοι χάρτες, ό-

[2] Βρήκα σήμερα στην Θεσσαλονίκη Έλληνες μηχανικούς παιδιά προσφύγων, που γύρισαν από την Τασκένδη και είχαν λάβει μέρος στην μελέτη.

πως ο πιεζομετρικός, δεν έχουν ισουψείς. Απαγορευόταν να εμφανίζονται στα παραδοτέα οι ισοϋψείς. Μελετητής σήμερα η Hydroproject Moscow και σύμβουλος μελέτης κονσόρτσιουμ όπου επικρατεί η Γαλλική Coyne et Bellier. Η αφεντιά μου ως μέλος της Επιτροπής Εμπειρογνωμόνων σε θέματα Γεωλογίας-Βραχομηχανικής. Τεράστια ευθύνη σε μένα σ' αυτή την φάση. Και τι δεν έχει ο μπαχτσές:

Το 300μ ύψους φράγμα Nurek. Η Takhmina εκτός από εξαίρετη μηχανικός είναι και κούκλα

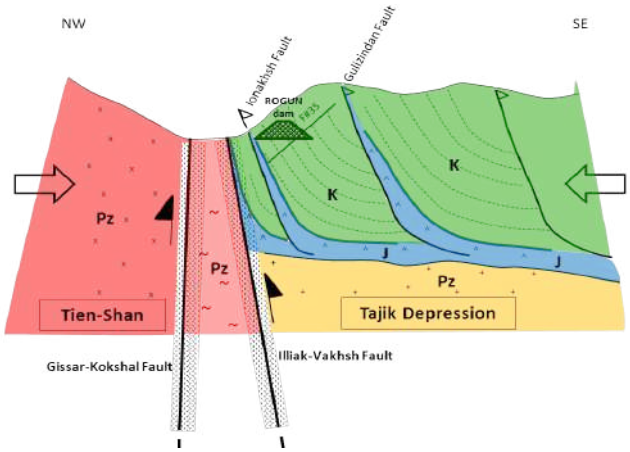
Η θέση του φράγματος Rogun. Πτυχώσεις μούρλια στο βάθος

(α) Διαπειρική διείσδυση από ορυκτό αλάτι και γύψο σε εφιππευτικό ενεργό ρήγμα κάτω από το ανάντη σώμα του φράγματος, πάχους 5-10μ. Λύση να μείνει ανάντη της κύριας κουρτίνας του έργου, ώστε να βρίσκεται κάτω από το ίδιο υδραυλικό φορτίο, το φορτίο της λίμνης, ώστε να μην υπάρχει υπόγεια ροή και διάλυση. Διατάξεις υποβοήθησης.

(β) Εκτός από το προηγούμενο ενεργό ρήγμα και άλλο κάτω από το κατάντη κέλυφος (με ερπυσμό – ευτυχώς, γιατί έτσι ελευθερώνεται ενέργεια - στην περιοχή δεν προκαλούνται πολύ ισχυροί σεισμοί παρ' όλο το μεγάλο μήκος των ενεργών ρηγμάτων). Ερπυσμός από 1 ως 3mm/χρόνο. Αν και οι σχηματισμοί (ισχυροί ψαμμίτες με παρεμβολές ισχυρών ιλυολίθων) είναι κατ' αρχή ικανοί για φράγμα από σκυρόδεμα, επιλογή, τελικά, εύκαμπτου τύπου με παχιά φίλτρα ώστε αν διαρραγούν να μη χαθεί η συνέχεια τους και να περιβάλλουν πάντα τον αργιλικό πυρήνα.

(γ) Τεράστια περιοχή με μορφολογικούς χαρακτήρες παλιάς κατολίσθησης αμέσως κατάντη του φράγματος (900.10^6 – Vajont Ιταλίας $250.10^6 m^3$). Αν ενεργοποιηθεί θα φράξει τις εξόδους των υπερχειλιστών και των σηράγγων φυγής του νερού από τον υπόγειο σταθμό παραγωγής ενέργειας και το φράγμα θα υπερχειλίσει καταστρεφόμενο. Διατύπωσα την άποψη, από την γεωλογική αυτοψία που έκανα στο γυμνό βουνό (ευτυχώς είχε που και που νοστιμότατα άγρια κορόμηλα), ότι δεν είναι κατολίσθηση αλλά πρόκειται για τεκτονική δομή από την διαπειρική διείσδυση, δομή που είναι απολύτως ευσταθής σήμερα. Οι ερευνητικές εργασίες που πρότεινα και έγιναν το επιβεβαίωσαν. Μεγάλη ανακούφιση στη κυβέρνηση.

(δ) κλπ



Ο διαπειρισμός ορυκτού άλατος σε ρήγματα αποκόλλησης από την Ιουρασική βάση. Ρήγματα με ερπυσμό και σήμερα. Διπλή πρόκληση στα τεχνικά έργα.[3]

Επίλογος

Μια χώρα με προσδοκίες για την ανάπτυξη και ευημερία στο άμεσο μέλλον.

[3] Γεωλόγοι: Διαπειρισμός με «ει», όχι με «υ». Προέλευση από ομηρική λέξη.

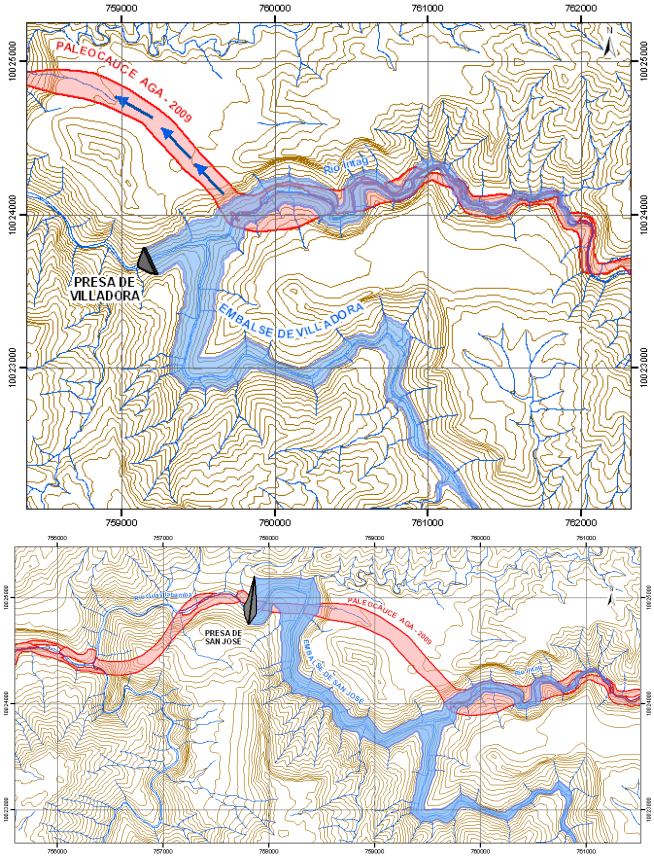
Ισημερινός (Ecuador)

Παύλος Μαρίνος

Η επίσκεψη έγινε τον Ιανουάριο του 2010. Γράφθηκε τον Ιούλιο του 2021

Η επίσκεψη μου στον Ισημερινό έγινε για την παροχή συμβουλευτικής υπηρεσίας σε μεγάλη Ιταλική μελετητική εταιρία που μελετούσε την κατασκευή φραγμάτων στην χώρα. Μελετητής γεωλόγος, ο Νίκος Καζίλης, από τους πολύ πρώτους μαθητές όταν ήμουν Επιμελητής στο ΕΚΠΑ την δεκαετία του '70. Και όχι μόνο χρονολογικά από τους πρώτους.[1]

Το συγκεκριμένο υπό μελέτη φράγμα ήταν στην δυτική πλευρά των Άνδεων, που αποστραγγίζεται προς τον Ειρηνικό. Στα ανατολικά είναι η άνω λεκάνη του Αμαζονίου. Το ποτάμι Guallabamba. Η περιοχή καλύπτεται από ηφαιστειακά λαχάρ που δημιουργήθηκαν κατά την πολύ πρόσφατη γεωλογικά περίοδο. Ενεργά ηφαίστεια υπάρχουν στην περιοχή[2]. Ο Νίκος Καζίλης κάτι μυρίστηκε. Το κάλυμμα λαχάρ είχε καλύψει την κοίτη του ποταμού, ο οποίος υποχρεώθηκε σιγά να διανοίξει νέα κοίτη σε άλλη θέση, αυτήν την σημερινή. Αλλά παλιά κοίτη και σημερινή κοίτη συναντιόνταν σε ορισμένα σημεία. Οι κοίτες βέβαια γεμάτες με αμμοχάλικα πολύ υδροπερατά. Η θέση για φράγμα που αρχικά είχε επιλεγεί βρέθηκε να είναι ανάμεσα στα 2 σημεία που οι δύο κοίτες συναντώνται. Συνεπώς θα προέκυπταν μεγάλες διαφυγές νερού από τον μελλοντικό ταμιευτήρα (στο πάνω σχήμα, με κόκκινο χρώμα η παλιά κοίτη). Βρέθηκε και επελέγη λοιπόν νέα θέση για την θεμελίωση του φράγματος αν και λιγώτερη στενή, αλλά όπου όλα τα σημεία τομής παλιάς και σημερινής κοίτης να είναι ανάντη της θέσης αυτής, μέσα στον ταμιευτήρα. Και τέτοια υπήρχε (το κάτω σχήμα).



Τα σχήματα είναι από την μελέτη

Πίσω από την ομάδα φαίνεται η παλιά θαμμένη κοίτη με τα αμμοχάλικα που συναντά την σημερινή του ποταμού

Όπως βλέπετε η γέφυρα αντέχει. Τώρα αν γλιστρήσεις και πέσεις εσύ φταις.

Το περπάτημα, κυρίως οι αναβάσεις, εξαντλητικό. Μη ξεχνάμε τα ψηλά εδώ υψόμετρα.

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[1] Ο Νίκος Καζίλης είναι σήμερα από τους υψηλά εξειδικευμένους σε θέματα σχεδιασμού και κατασκευής φραγμάτων. Σημαντική και η συμβολή του στην Εγνατία Οδό στην κατασκευή σηράγγων. Οποία ικανοποίηση για τον δάσκαλο, σήμερα συχνά συνεργάτη και φίλο!

[2] Τα λαχάρ είναι λασπορροές από ηφαιστειακά αναβλήματα τεμαχίων λάβας (πυροκλαστικά) αναμεμιγμένα με υγρό υλικό. Τα υλικά αυτά κινούνται από το ηφαίστειο στις πλαγιές και τις κοιλάδες σκεπάζοντας όλο το χαμηλό ανάγλυφο των γύρω περιοχών, αναπτύσσοντας μεγάλες ταχύτητες. Ο όρος προέρχεται από την Ινδονησιακή γλώσσα

Ισημερινός της Γης

Στο Κίτο, la Mitad del Mundo, το γεωγραφικό πλάτος 0![3] Το μήκος του ισημερινού της Γης είναι περίπου 40.075,2 χιλιόμετρα. Ζυγίζουμε λιγότερο στον ισημερινό. Ψυχραιμία! Η διαφορά με τους πόλους είναι μόλις 0,3%.

Πάνω στον ισημερινό, ο ήλιος δεν περνά από το ζενίθ κάθε μεσημέρι του χρόνου, όπως πιστεύουν μερικοί. Στην πραγματικότητα, αυτό συμβαίνει και εκεί μόνο δύο ημέρες τον χρόνο, και αυτές δεν είναι τα ηλιοστάσια, αλλά οι ισημερίες. Στους τόπους που βρίσκονται στον ισημερινό, τα δύο ηλιοστάσια του έτους είναι οι ημερομηνίες κατά τις οποίες ο Ήλιος βρίσκεται στη *μέγιστη* απόσταση από το ζενίθ το τοπικό μεσημέρι, με ύψος 66°34΄ πάνω από τον ορίζοντα (βόρειο ή νότιο στο αντίστοιχο ηλιοστάσιο). Το μόνο ιδιαίτερο στον ισημερινό είναι ότι όλες οι ημέρες του έτους έχουν την ίδια διάρκεια, κάπου 12 ώρες.

Υπάρχει μικρή επίδραση πάνω στη θερμοκρασία ή τη διάρκεια της ημέρας, οπότε στην πραγματικότητα δεν υπάρχουν εποχές.

Η ανατολή και η δύση του ήλιου είναι πολύ πιο σύντομες πάνω στον Ισημερινό– χρειάζονται λίγα μόλις λεπτά για να μετατραπεί η μέρα σε νύχτα. Ο Ήλιος ανατέλλει γύρω στις 6 το πρωί και δύει γύρω στις 6 το απόγευμα κάθε μέρα όλο τον χρόνο.

Κρύο δεν κάνει στον Ισημερινό αλλά δεν έχει πάντοτε λιακάδα. Ο συνεχής καυτός ήλιος εξατμίζει το νερό του ωκεανού, το οποίο επιστρέφει στο έδαφος με τη μορφή δυνατής βροχής. Ο ζεστός υγρός καιρός είναι ιδανικός για τα τροπικά δάση όπου θεριεύουν ζώα και τα φυτά.

Η χώρα

Ο Ισημερινός είναι προεδρική δημοκρατία. Πρωτεύουσα: Κίτο Πρόεδρος (2021): Γκυγιέρμο Λάσσο, συντηρητικός που μόλις κέρδισε τον αριστερούτσικο Αντρές Αραούζ. Το κόμμα των ινδιάνων με το μικρό του ποσοστό είναι πάντα παρόν στην Βουλή.

Πληθυσμός: 17,37 εκατομμύρια (2019) Η έκταση του Ισημερινού είναι σχεδόν τετραπλάσια σε σχέση με την Ελλάδα. Νόμισμα: Δολάριο ΗΠΑ. Το κατά κεφαλή εισόδημα σε 6.200 δολάρια. Ο κατώτατος μισθός είναι τα 300 δολάρια τον μήνα και κάπου εκεί γύρω είναι η κατώτατη σύνταξη. Έχει Πετρέλαιο (37% εξαγωγών).

Η χώρα περιλαμβάνει επίσης τα Νησιά Γκαλαπάγκος (Archipelago de Colón) στον Ειρηνικό, περίπου 950 km δυτικά της χώρας.

Δεν μπορώ να το χωνέψω που δεν τα επισκέφθηκα. Δεν είχα καθόλου χρόνο. Είχα άμεση υποχρέωση αλλού.

Το Κίτο (Σαν Φρανσίσκο ντε Κίτο), στους πρόποδες του ηφαιστείου Πιτσίντσα, σε υψόμετρο 2.850 μέτρων, κάτι που την κάνει τη δεύτερη πιο ορεινή πρωτεύουσα του κόσμου μετά την πρωτεύουσα της Βολιβίας, Λα Παζ.[4] Πληθυσμός 2 εκ. περίπου (2020). Το 1978 η UNESCO περιέλαβε την πόλη του Κίτο στον Κατάλογο Μνημείων Παγκόσμιας Κληρονομιάς. Θερμοκρασίες: βράδυ 7 βαθμούς, ημέρα 25. Βροχή Οκτώβριο με Απρίλιο.

Κίτο, Πανόραμα

Κίτο, κεντρική πλατεία

Γηγενείς προηγμένοι πολιτισμοί ήκμασαν στον Ισημερινό πολύ πριν η περιοχή κατακτηθεί το 1460 από την αυτοκρατορία των Ίνκας. Το 1531, Ισπανοί κατακτητές, υπό τα όπλα του μέγα Φρανσίσκο Πισάρρο, αφίχθησαν στην περιοχή και νίκησαν τον αυτοκράτορα των Ίνκας, Αταουάλπα και το στρατό του. Ο γηγενής πληθυσμός αποδεκατίστηκε τόσο από τις ασθένειες στις πρώτες δεκαετίες της ισπανικής κυριαρχίας όσο και από το δουλοκτητικό σύστημα. Οι αυτόχθονες ήταν δουλοπάροικοι για λογαριασμό των Ισπανών ιδιοκτητών.

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[3] Νεώτερες μετρήσεις έδειξαν ότι περνά δίπλα, 250m πιο μακριά, αλλά εσείς δεν το ξέρετε. Που να χαράσσεται τώρα νέα γραμμή. Άσε που περνά και από δομημένη περιοχή δίπλα στην πλατεία.

[4] Λα Παζ, Βολιβία, +3640. Η Λάσα, πρωτεύουσα του Θιβέτ, είναι στα +3656. Αλλά το Θιβέτ, όσο και να θέλει, δεν είναι ανεξάρτητη χώρα. Η Κίνα το θεωρεί τμήμα της Λαϊκής Δημοκρατίας της. Λεπτομέρειες ίσως σε άλλη ανταπόκριση.

Εκεί στις 10 Αυγούστου του 1809 πρωτακούστηκε η κραυγή για την ανεξαρτησία. Τελικά ο στρατηγός Αντόνιο Χοσέ ντε Σούκρε κατάφερε να απελευθερωθεί ο Ισημερινός το 1820 και να συμπεριληφθεί στην, υπό τον Μπολίβαρ, ιδρυθείσα Μεγάλη Κολομβία και το 1830 ανακηρύχθηκε ανεξάρτητη χώρα.

Συνοικία. Βλέπετε πουθενά ρύπανση με γκράφιτι;

Οικονομικές κρίσεις, λαϊκισμός και στρατιωτικά κινήματα στη συνέχεια και συνεχώς. Κυρίως την δεκαετία του1960. Θυμόμαστε οι παλιότεροι από εμάς, ενώ οι ξένες επιχειρήσεις εκμεταλλεύτηκαν τα κοιτάσματα πετρελαίου στην περιοχή της. Το 1972, ένα εθνικιστικό στρατιωτικό καθεστώς κατέλαβε δια της βίας την εξουσία και χρησιμοποίησε τα κέρδη από το πετρέλαιο και τα δάνεια από τις ξένες χώρες για την ολοκλήρωση ενός προγράμματος εκβιομηχάνισης, της απαλλοτρίωσης της γης και των επιχορηγήσεων προς τους πολίτες. Με τη δύναμη του πετρελαίου, που όμως εξασθένιζε, ο Ισημερινός επέστρεψε στη δημοκρατία το 1979 αλλά όχι χωρίς οικονομική αστάθεια.

Δημογραφικά ζουν κυρίως μιγάδες, Ινδιάνοι και λευκοί (μεστίζο) Οι τελευταίοι σε ποσοστό 65%, Ινδιάνοι σε ποσοστό 25%, μιλώντας διάφορες δικές τους γλώσσες, με τα έθιμα τους, τις δικές τους ενδυμασίες, μικροκτηνοτρόφοι και μικροκαλλιεργητές στις Άνδεις. Οι υπόλοιποι είναι Ισπανοί και λίγοι μαύροι.[5] Η χώρα σε σχέση με τις άλλες χώρες της Ν. Αμερικής παρουσιάζει σε μεγάλο βαθμό μίξη εντοπίων με Ισπανούς-Ευρωπαίους. Στην Αργεντινή: Μηδέν. Μόνο Ευρωπαίοι, εντελώς ελάχιστοι ινδιάνοι στα βόρεια της χώρας.

Οι ινδιάνοι είναι πρώτο μπόι. Μπασκετμπολίστες. Οι άνδρες 1.5μ ύψος κατά μέσον όρο σε ορισμένες φυλές. Το τροπικό δάσος του Αμαζονίου που ζουν τους τα παρέχει όλα τα προς το ζειν ακόμη και τα φάρμακα.

Χειραψία στην συνάντηση και στην αποχώρηση (λίγο πολύ όπως στη Γαλλία). Οι Ινδιάνοι όμως δεν απλώνουν το χέρι πρώτοι. Η χειραψία τους είναι ένα ανεπαίσθητο απλό άγγιγμα, όχι σφίξιμο. Όχι ψευτο-φιλιά στις χαιρετούρες με γυναίκες.

Το προσδόκιμο ζωής στο σύνολο του πληθυσμού, σύμφωνα με εκτιμήσεις του 2019 του Παγκόσμιου Οργανισμού Υγείας, ήταν 78,4 χρόνια (76,4 χρόνια οι άνδρες και 80,5 οι γυναίκες). Ελλάδα Α: 82, Γ: 84.5!

Περίπου το 90% των κατοίκων ασπάζονται το Ρωμαιοκαθολικό δόγμα. Ένα μεγάλο μέρος του πληθυσμού λαμβάνει μέρος σε εκκλησιαστικές εκδηλώσεις πολύ τακτικά.

Η γαστρονομία καλά κρατεί. Μίγμα ισπανικών και ινδιάνικων και θαλασσινά… δεν είχα καιρό για πλήρη εντρύφηση.

Το σχολικό στην ύπαιθρο χώρα, με χαρά πάμε σχολείο

Ινδιάνοι διαμαρτύρονται για μεταλλευτικές δραστηριότητες στην παραδοσιακή γη τους.

[5] Αισθητή η παρουσία Αμερικάνων συνταξιούχων που πάνε να ζήσουν στον Ισημερινό και σε άλλες χώρες της Λατινικής Αμερικής γιατί το κόστος ζωής εκεί είναι χαμηλότερο σε σύγκριση με τις ΗΠΑ και κυρίως οι συνήθεις ιατρικές δαπάνες. Και όχι παγωνιές του Αμερικάνικου βορρά.

ΗΛΕΚΤΡΟΝΙΚΑ ΠΕΡΙΟΔΙΚΑ

International Journal of Geoengineering Case Histories

An official journal of the International Society for Soil Mechanics and Geotechnical Engineering

Volume 6, Issue #2, https://www.geocasehistoriesjournal.org/pub/issue/view/48

The Case Histories Journal is a peer-review journal on the geotechnical engineering practice with a focus on careful documentation of case histories with an **emphasis on observations and data collected during and after project construction.** Papers are reviewed by a distinguished international Editorial Board and a selected number of reviewers. All papers published in the journal are accompanied by electronic data for better documentation of each case history.

On behalf of the Case Histories Journal,

Dimitrios Zekkos, University of California at Berkeley, Editor-in-Chief
Jean-Louis Briaud, Texas A&M, Co-Editor-in Chief

Table of Contents

Settlement of shallow foundations on sand – a database study Mostafa Bahmani Shoorijeh, Jean-Louis Briaud

Field Test of Temporary Excavation Wall Support in Sensitive Clay Miah Alam, Omar Chaallal, Bertrand Galy

International Geosynthetics Society

Κυκλοφόρησε το IGS Newsletter της International Geosynthetics Society με τα παρακάτω περιεχόμενα:

IGS NEWSLETTER – July 2021

Helping the world understand the appropriate value and use of geosynthetics

httpwww.geosyntheticssociety.org/newsletters

- Message From The IGS President READ MORE
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- IGS Brazil Elects New Board READ MORE
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- Upcoming Webinars
  - Pit Thermal Energy Storage – A Sustainable Energy Resources with Geosynthetic Solution REGISTRATION INFORMATION
  - Geosynthetics and Sustainability – How is our industry doing? REGISTRATION INFORMATION
  - Latest findings regarding PFAS containment by modern liner systems: the good news - and the bad! REGISTRATION INFORMATION
- Upcoming Webinars

International Commission on Large Dams
https://www.icold-cigb.org/article/GB/news/newsletters/newsletter-19

Κυκλοφόρησε το Newsletter #19 – 2021 με τα ακόλουθα περιεχόμενα:

- Editor's letter "A Letter of New Hope for 2022 from ICOLD President Rogers"
- The 27th ICOLD Congress of Marseille, a great opportunity to meet again
- ICOLD Coordinates the Hydropower Europe Forum Sucessfully
- A General Assembly for a Time of Crisis
- New ICOLD Planning
- Collecting Stakeholders' Views : Dams And Territories Workshops in Italy
- Dams are Part of the Solutions to Climate Change
- INCOLD Symposium on SUSTAINABLE DEVELOPMENT OF DAMS AND RIVER BASINS & APG SYMPOSIUM ON WATER AND DAMS
- Ageing Water Storage Infrastructure
- Comments on recent United Nations University publication: "Ageing Water Storage Infrastructure: An Emerging Global Risk"

International Association of Engineering Geology Newsletter
IAEG Electronic Newsletter 2021 Issue No.1

Κυκλοφόρησε το Τεύχος No. 1 του Newsletter 2021 της IAEG με τα ακόλουθα περιεχόμενα:

- News of IAEΓ Executive Committee
- Announcement of New Established National
- Groups
- Call φor Membership Update 2021
- Yeg Webinar Series
- Events of National Groups
- 1st IAEΓ South American Regional Conference
- 3rd European Regional Conference
- Meeting Information
- Contact Information

ΕΚΤΕΛΕΣΤΙΚΗ ΕΠΙΤΡΟΠΗ ΕΕΕΕΓΜ (2019 – 2022)

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