



Sociedad Española de Mecánica de Rocas

Boletín nº 3 Diciembre 2010



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APUNTES SOBRE LOS ORIGENES DE LA SEMR

La Sociedad Española de Mecánica de Rocas (SEMR) nació el año 65 del pasado siglo, pero para ilustrar sus orígenes es preciso referirse a los albores de la Geotecnia en España.

Fue D. José Antonio Jiménez Salas quien entronizó, al menos formalmente, la Geotecnia en nuestro país. Naturalmente antes de él se llevaban a cabo estudios del terreno, particularmente en obras portuarias y presas. De hecho dentro de la Escuela de Caminos de Madrid en la asignatura de Cimientos y Puentes de Fábrica que impartía D. José Entrecanales, se estudiaban las teorías, entonces vigentes, de empujes del terreno y cimentaciones. Por otra parte en la misma Escuela y en la asignatura de Geología D. Clemente Sáenz abordaba la problemática que entrañaba en las cimentaciones de las presas y los túneles profundos, la discontinuidad que, en los macizos rocosos, representan los accidentes tectónicos. Probablemente sin saberlo estaba dejando entrever el horizonte de la posterior Mecánica de Rocas.

Pero fue Jiménez Salas quien, como decíamos, formalizó y estructuró las bases sistemáticas de los estudios geotécnicos. Jiménez Salas acabó la carrera de Ingeniero de Caminos el año 1943 y tuvo el coraje de salir a completar estudios a Alemania y Austria (la expresión coraje no es gratuita; en aquella época estudiar fuera de España era excepcional, mucho más en esas fechas en que se cernían sobre Europa las tremendas sombras de una postguerra, entonces llamada mundial). Jiménez Salas estudió con Terzaghi reconocido mundialmente como "padre" de la Geotecnia moderna, y a su regreso a España empezó a desarrollar los conocimientos adquiridos tanto como colaborador de Entrecanales en su constructora, como después con D. José Luis Escario, entonces Catedrático de Caminos en la Escuela, cuando se crea el llamado entonces Laboratorio del Transporte y

Mecánica de Suelos dentro del naciente CEDEX.

En los años 50 Jiménez Salas participa activamente en el nacimiento de la Sociedad Española de Mecánica del Suelo y al retirarse Entrecanales su asignatura se divide en dos. Puentes que la ocuparía D. Carlos Fernández Casado y Geotecnia para D. José A. Jiménez Salas que fue el primer catedrático de la Escuela por oposición.

El Laboratorio del Transporte y Mecánica del Suelo se consagra en aquellos años 50 y comienzo de los 60 en el organismo referencia de la Geotecnia en España y bajo la dirección de Jiménez Salas desarrollan sus primeros pasos profesionales Ventura Escario, Santiago Uriel y Alcibíades Serrano. Luego el Laboratorio se convirtió en el gran semillero de geotécnicos del país.

Sin embargo en esos inicios de los 60 hay, para entendernos, un cierto movimiento no diré de distanciamiento pero sí de identificación propia de los profesionales dedicados a las rocas, fundamentalmente los presistas. Habían emergido las figuras de Müller, Talobre, Rocha, subrayando las diferencias entre los medios homogéneos e isótropos de la Mecánica del Suelo, con las discontinuidades y anisotropía de los macizos rocosos que implicaban una intervención decisiva de la Geología. De forma que, en España, el Servicio Geológico de Obras Públicas, el Centro de Estudios Hidrográficos y los proyectistas, constructores y empresas especializadas en inyecciones de presas, plantean la creación de la Sociedad Española de Mecánica de Rocas (SEMR) que nace, como dijimos en 1965 y comienza su labor de ir estructurando los dispersos conocimientos del momento.

De una forma simplista cabría decir que, entonces, los estudios de Mecánica de Rocas, basándose en un conocimiento geológico de los emplazamientos, limitaban su cuantificación a reconocimientos geofísicos y sobre todo a la realización de ensayos in-situ afectando a superficies de cierta importancia. Estos estudios eran requeridos, casi con generalidad, por las Confederaciones Hidrográficas y las empresas hidroeléctricas que tanto unas como otras contaban con excelentes profesionales. Es preciso recordar que en este proceso y contexto histórico el Laboratorio de Ingeniería Civil de Lisboa representó un faro en la orientación de estos estudios. El I Congreso de la Sociedad Internacional de Mecánica de Rocas celebrado en Lisboa el año 67, con abundante participación española es, de facto, el punto de partida de la Sociedad Internacional.

Son muchos los nombres de profesionales destacadísimos que acuden a mi memoria al repasar aquellos tiempos de gran entusiasmo que suplía la escasez de medios, pero para no dejar de citar, injustamente, a nadie, me limitaré a reseñar la primera Junta Directiva de la SEMR con José A. Jiménez Salas como presidente y D. Alejandro del Campo como Vicepresidente.

De cualquier forma quiero destacar que en la Sociedad de Mecánica de Rocas recién creada tenían mucho que decir profesiones que habían tenido escasa participación en la Sociedad de Suelos. Tal era el caso de los ingenieros de minas y los geólogos y aquí sí puedo explicitar los nombres de D. Pedro Ramírez Oyanguren y D. Modesto Montoto San Miguel que en aquellos orígenes tuvieron una participación muy activa.

Ciertamente hoy, al cabo de casi cincuenta años, no puede uno menos que asombrarse del desarrollo alcanzado por los estudios en el campo de la Mecánica de Rocas que, en aquel entonces, ni siquiera intuíamos. Anecdóticamente diré que los primitivos y poco sofisticados estudios de elementos finitos que permitían hacer intervenir las discontinuidades producidas por la fracturación, nos parecían casi el máximo teórico y práctico a lo que se podía llegar.

Acabo. Y me permitís una expansión personal. Como dice un compañero amigo: "Mira hemos hecho lo que hemos sabido y podido. O sea que nos vamos satisfechos" y yo añado "y veo con mayor satisfacción como nos habéis superado" ¡Enhorabuena!

José M^a Sanz Saracho

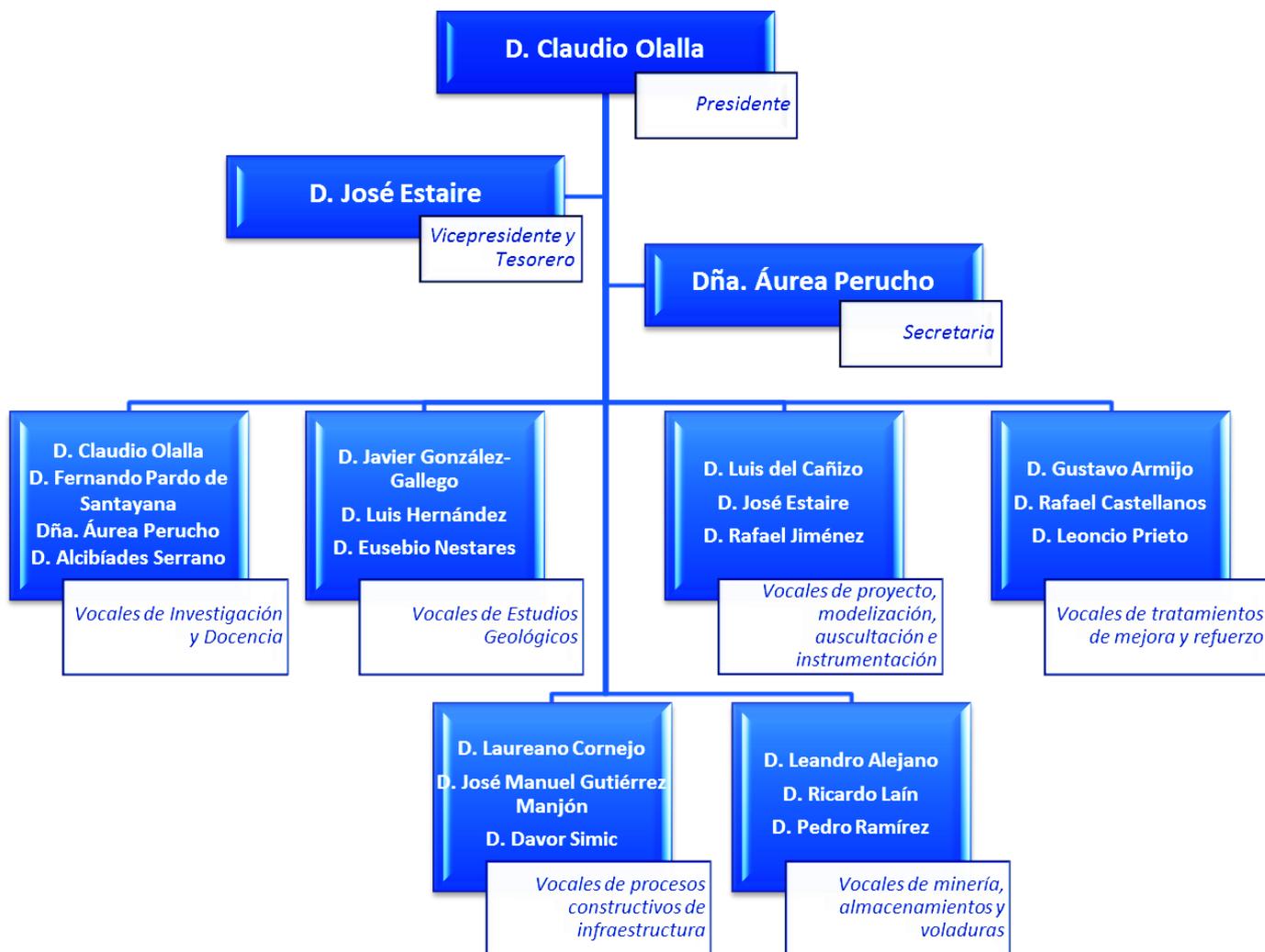
Socio Fundador y ex-Presidente de la SEMR
Enero 2011

ELECCIONES DE VOCALES Y REPRESENTANTES DE LOS GRUPOS DE ACTIVIDAD TÉCNICA, PRESIDENTE Y VICEPRESIDENTE

Tras los 4 años de mandato de la Junta Directiva de la SEMR elegida en 2006 y de acuerdo a sus estatutos, el 21 de Enero de 2010 se convocó una Asamblea General Extraordinaria de socios de la SEMR con el objetivo de elegir la nueva Junta Directiva.

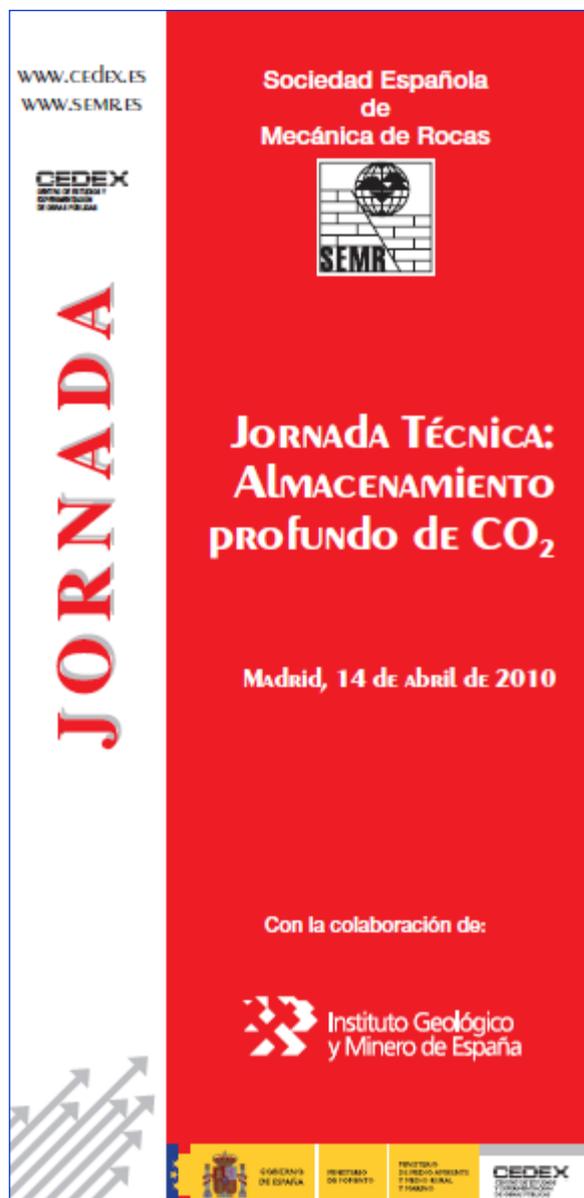
En la votación realizada por los veinte y un socios asistentes y mediante correo postal, resultaron elegidos los distintos vocales y representantes de los grupos de actividad técnica.

Entre los vocales elegidos se vota a D. Claudio Olalla para continuar el cargo presidente de la Sociedad Española de Mecánica de Rocas y a D. José Estaire como nuevo vicepresidente.



JORNADA TÉCNICA ANUAL

Bajo el título “Almacenamiento profundo de CO₂”, el 14 de abril se celebró en el salón de actos del Centro de Estudios de Técnicas Aplicadas del CEDEX la Jornada anual de 2010, en colaboración el IGME y del CEDEX.



En una ocasión más se pudo contar como conferenciantes con importantes profesionales e investigadores del campo: D. Darius Fedeyi (BRGM de Francia), D. Eduardo Alonso (UPC), premiado por su trabajo sobre “Migración de gases en rocas arcillosas”, D. Modesto Montoto (Universidad de Oviedo) y con D. Vicente Gabaldón (IGME).

PROGRAMA

- 8,45-9,00 **Inscripciones y recogida de la documentación**
- 9,00-9,15 **Presentación de la Jornada**
D. José Pedro Calvo Sorando
Director General del IGME
D. Mariano Navas
Director General del CEDEX
D. Fernando Pardo de Santayana
Director del Laboratorio de Geotecnia del CEDEX
- 9,15-10,00 **“Almacenamiento geológico de CO₂: Planteamientos generales y problemática geomecánica”**
D. Modesto Montoto
Catedrático. Universidad de Oviedo
- 10,00-10,45 **“Flujo de gases en barreras de arcilla”**
D. Eduardo Alonso
Catedrático. Univesidad Politécnica Cataluña
- 10,45-11,15 Pausa, café
- 11,15-12,15 **“Hydromechanical modelling of the integrity of CO₂ geological storage”**
D. Darius Seyed. BRGM- Francia (Bureau Recherches Geologiques et Miniers)
- 12,15-13,15 **“Áreas y estructuras geológicas susceptibles de albergar almacenamientos geológicos de CO₂ en España”**
D. Vicente Gabaldón. Subdirector General del IGME
- 13,15-13,45 Mesa Redonda
- 13,45-14,00 **Clausura**
D. José P. Calvo Sorando
Director General del IGME
D. Mariano Navas
Director General del CEDEX
D. Claudio Olalla
Presidente de la Sociedad Española de Mecánica de Rocas



En la Jornada se entregó información acerca de los últimos avances y proyectos de investigación relacionados con el almacenamiento de CO₂, sin duda un campo en el que queda mucho trabajo por desarrollar.

3rd WORKSHOP INTERNACIONAL EN ROCAS VOLCÁNICAS

Del 31 de Mayo al 3 de Junio de 2010 se celebró el “**Tercer Workshop Internacional de Mecánica de Rocas e Ingeniería Geológica en Terrenos Volcánicos**” en el Centro de Conferencias del Puerto de la Cruz, en Tenerife.

Fue organizado por la “**Sociedad Española de Mecánica de Rocas**” (SEMR) y la **Consejería de Obras Públicas y Transportes del Gobierno de Canarias** y patrocinado por la **Sociedad Internacional de Mecánica de Rocas (ISRM)** y la **Universidad de la Laguna**. Este acontecimiento, reconocido como primer ISRM Specialized Conference, supone una continuación a las conferencias técnicas sobre mecánica de rocas en terrenos volcánicos celebradas previamente en Madeira y Azores en los años 2002 y 2007, respectivamente.



El evento fue incluido dentro de la Sexta Edición de la Conferencia Internacional Ciudades sobre Volcanes (CoV6-Tenerife 2010) que reúne a geocientíficos que trabajan en volcanes activos, especialistas en prevención de desastres, y otros profesionales.

Los temas tratados en este “Tercer Workshop Internacional de Mecánica de Rocas e Ingeniería en Terrenos Volcánicos” han estado relacionados con ingeniería, minería, recursos hídricos e infraestructuras en terrenos volcánicos. En otras palabras, se han discutido temas como la caracterización tanto en el campo como en el laboratorio de las rocas volcánicas, la estabilidad de laderas,

y la excavación y construcción de túneles en terrenos volcánicos.

Al “Congreso Cities on Volcanoes 6” asistieron 864 personas de 52 países diferentes, con un total de 651 artículos presentados.

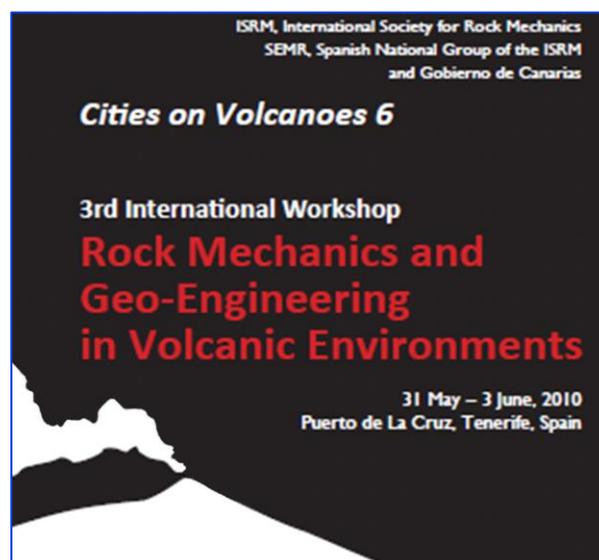
Con motivo de este congreso se fundó la World Organization of Volcano Cities y se creó el Instituto Volcanológico de Canarias. Tuvo una amplia repercusión en los medios periodísticos locales; prensa, radio y televisión.

Al Workshop organizado por la SEMR asistieron unas 120 personas, de más de 20 países, con un total de 50 artículos presentados. Se realizaron 33 ponencias orales y 17 en forma de poster. La calidad de los trabajos presentados y la intensidad de los debates producidos permiten considerar que con el desarrollo de este encuentro se han superado ampliamente las expectativas creadas.

La conferencia inaugural “Low stress and high stress phenomena in basalt flows” fue impartida por Nick Barton.

Cabe destacar el ofrecimiento por parte de Luis Llamas (Secretario General de la ISRM) para la creación de una comisión dentro de la ISRM dedicada a las Rocas Volcánicas y el explícito agradecimiento a la SEMR por la exitosa organización de este evento.

El Workshop sobre Rocas Volcánicas incluyó una visita técnica a un túnel en construcción en la isla de Tenerife.



Los artículos presentados al Workshop se recogen en un libro editado por Balkema.

Esta publicación está a la venta a través de la secretaría de la SEMR, y su coste es de 60 euros más los gastos de envío.

Para adquirirlo es necesario ponerse en contacto con la secretaría de la SEMR cuya dirección de correo electrónico es: semr@cedex.es

Desde la SEMR queremos agradecer tanto a las entidades colaboradoras como a los participantes su contribución al éxito de este tercer Workshop en Rocas Volcánicas.

RESÚMENES PUBLICADOS EN EL 3rd WORKSHOP

KEYNOTE LECTURE

Low Stress and High Stress Phenomena in Basalt Flows

N.R.Barton

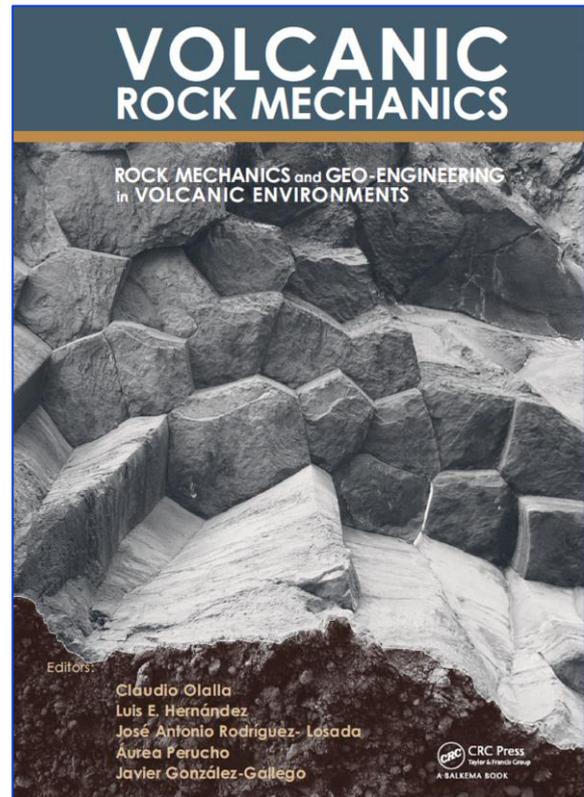
Nick Barton & Associates, Oslo, Norway

ABSTRACT: Contrasting geophysical, rock mechanics and rock engineering experience in basalts, caused by either exceedingly low or extremely high stress are described, from projects in the USA and Brazil. The first involves a nuclear waste characterization project in Hanford basalts in the USA, and the second describes, in much more detail, stress-fracturing problems in numerous large tunnels at the 1450 MW Ita hydro-electric project in SE Brazil's basalts. Particular phenomena that were noted, include linear stress-strain loading curves when columnar basalt is loaded horizontally, and a k_0 value reaching about 20-25 at Ita HEP.

The suitability of volcanic tuff from the Ethiopian plateau for earth dam construction and foundation

E. E. Alonso & E. Romero

Department of Geotechnical Engineering and Geosciences UPC, Barcelona, Spain



ABSTRACT: The intended site for the dam is located in a wide valley of the Gilgel Abbay River with an overall elevation difference between the upper plateau and the river level of about 85 m. The river has eroded a series of volcanic rock units of early Tertiary origin, with alternative levels of basaltic lava flows and ash or tuff deposits. The lava flows result in hard to medium rocks, jointed and fractured. The two volcanic units mentioned (lava flows and tuffs) are approximately laid in a horizontal manner. Tuffs and ash deposits, which have a very similar appearance, are white in colour and they are clearly identified when exposed. They constitute the substratum of a dominant proportion of the dam foundation. They tend to produce gentle slopes and, in the lower cultivated plots they are covered by alluvial clays. The exposed tuff is not cultivated. The exposed tuff is eroded by running waters and it shows erosion patterns similar to other soft clayey rocks. The resulting erosion forms tend to be rounded. However no firm evidence of piping was observed. The paper reports laboratory experiments on specimens of the intact tuff material. The suitability of the tuff, once compacted, as a core material for a zoned-earth dam was also investigated.

Geological risk at world class astronomical observatories

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Begoña García-Lorenzo ⁽²⁾

José A. Rodríguez-Losada ⁽¹⁾

Luis E. Hernández-Gutiérrez ⁽³⁾

Julio de la Nuez ⁽¹⁾

Carmen Romero-Ruiz ⁽⁴⁾

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⁽²⁾ *Instituto de Astrofísica de Canarias, Spain.*

⁽³⁾ *Área de Laboratorios y Calidad de la Construcción, Consejería de Obras Públicas y Transportes del Gobierno de Canarias, Spain.*

⁽⁴⁾ *Departamento de Geografía, Universidad de La Laguna, Spain.*

ABSTRACT: Future large and extremely large ground-based telescopes will demand stable geological settings. The world class astronomical observatories of El Teide (Tenerife, Canary Islands), Roque de los Muchachos (La Palma, Canary Islands), Mauna Kea (Hawaii) and Paranal (Chile) are in or closer to volcanic environments, and hence the impact of volcanic activity has to be studied in detail. In this sense, seismic activity, the extent of lava flows, eruptive clouds and ground deformation associated to volcanic/tectonic activity have studied in terms of probabilistic risk analysis. This information might be essential in ranking astronomical sites for emplacing future large telescope infrastructures.

Geotechnical description of halloysite clays from La Palma Island (Spain)

J. Estaire, M. Santana & J. A. Díez

Laboratorio de Geotecnia (CEDEX, M^o de Fomento) Madrid.

ABSTRACT: In this paper the geotechnical description of a halloysite clay, coming from boreholes performed in Barlovento Dam, is made. It is important to remark this material had a difficult behaviour during the performance of laboratory tests, clearly different of the materials Soil Mechanics usually treats with. The geotechnical description comprised the following aspects: a) identification tests: the grain size and plasticity tests had to be made with different procedures of the ones described in the technical

Spanish standards due to the special characteristic of the material; b) X - Ray diffraction tests; c) chemical tests; d) dry density and natural water content of the material; e) strength tests that comprised dynamic penetration tests (SPT and DPSH test), triaxial and direct shear tests and pressuremeter tests made in the boreholes; f) deformability tests that included oedometer and pressuremeter tests g) permeability and dispersibility tests.

Geotechnical parameters of basaltic pyroclastics in La Palma Island, based on convergences measured in a tunnel

Miguel Fe Marqués

AEPO, S.A. Ingenieros Consultores. Madrid. Spain

Rodrigo Martínez Zarco

INOCSA Ingeniería, S.L. Madrid, Spain

ABSTRACT: This work presents a back-analysis of a tunnel section based on measured convergences values. The tunnel, located in La Palma Island, was excavated in basaltic pyroclastics. The analysis used FLAC2D and shows the excavation and supporting of the tunnel along with other phases during construction. With this analysis we aimed to obtain realistic values of the geotechnical parameters of pyroclastics. However, its accuracy depends on a great number of variables. Finally, modulus of deformation and parameters c_M and ϕ_M of pyroclastic were estimated. These estimated values are not the only possible solution given the available data, but they represent realistic values in the authors' opinion.

The role of hyaloclastite rocks in the stability of the volcanic island flanks of Tenerife

M. Ferrer

Instituto Geológico y Minero de España

J. Seisdedos

Prospección y Geotecnia S.L., Madrid

L. I. González de Vallejo

Universidad Complutense de Madrid;

ABSTRACT: The failure mechanisms that could originate the mega paleo-rockslides of Güímar and La Orotava in Tenerife (Canary Islands) are analyzed, based on the geomechanical site investigations carried out on the pre-failure volcanic materials of Tenerife island flanks. Geological and geomorphological modelling and geomechanical characterization of the materials are presented. Hyaloclastites rocks are forming the submarine substratum of the island edifice presenting a highly deformable behaviour. Preliminary stability analyses have suggested potential failure surfaces in the hyaloclastites rocks.

Passive anchors within retaining walls to stabilize volcanic rock slopes in road widening

M.A. Franesqui

Department of Civil Engineering, University of Las Palmas de Gran Canaria, Spain

ABSTRACT: An economical and environmentally-friendly solution to stabilize jointed vertical rock slopes in works of improvement and cross section widening of a local road section in Gran Canaria Island (Spain) is presented in this paper. Due to the mountainous relief of this territory, this road cross over an extremely narrow section between two deep cliffs with vertical rock slopes on jointed phonolitic ignimbrites. The structural solution involves the construction of traditional gravity retaining walls with passive fully-grouted steel bar anchorages within its foundation. The rock mass nailing under the foundation of the retaining walls and even the adjacent rock slopes is also designed. This system combines traditional constructions of high simplicity with modern techniques of rock reinforcement.

Stability of the cone and foundation of Arenal volcano, Costa Rica

G. E. Alvarado, S. Carboni, M. Cordero, E. Avilés & M. Valverde

San José, Costa Rica

ABSTRACT: Arenal volcano is deforming the basement under $\sim 20 \times 10^3$ kPa, and affects it for several kilometers below the surface and about 5 km around the volcano base. The total settlement below the present (1968-2009) lava field (0.75 km^2 ; 0.6 km^3) is 2 m or more, but it represents at the moment only 20% of the consolidation, so its deformation will be continuous for years. The volcano grew up on the top of weathered volcanic rocks (weak and plastic portion) conditions that are ideal for deforming the basement (subsidence, folding or faulting) and generate instability on the cone according to structural and volcanic models. The results of numerical models show that Arenal is at an incipient deformation stage by spreading of the basement. The overall effect generates stability at the interior of the volcano and its foundation. The twin edifice (cones C and D) can generate rock slides (cold or hot) as well as debris avalanches ($0.03\text{-}0.75 \text{ km}^3$).

Geotechnical map and foundation solutions of Santa Cruz de Tenerife (Spain)

S. Álvarez Camacho & F. Lamas Fernández

Department of Civil Engineering, University of Granada, ETSICCP, Spain.

L. E. Hernández

Regional Ministry of Public Works of the Government of the Canary Island.

ABSTRACT: The town of Santa Cruz de Tenerife, NE Tenerife, Canary Islands, Spain, spreads on young volcanic materials which show a great heterogeneity. Very often this means a hard problem to overcome for building projects. This paper describes the geotechnical features of volcanic formations of Santa Cruz de Tenerife on data from building geotechnical studies, geotechnical maps, and rock geotechnical properties database of the Regional Ministry of Works of the Government of the Canary Islands. An inventory of different types of building foundations has been made in order to establish a correlation between

volcanic terrains and foundation solutions. As a conclusion, a geotechnical zoning map of Santa Cruz de Tenerife is proposed as preliminary foundation solutions in building projects.

Etna flank dynamics: a sensitivity analysis by numerical modelling

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C. Corazzato

*Dipartimento di Scienze Geologiche e
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ABSTRACT: The present work investigates the flank deep instability dynamics of Mount Etna volcano by means of bi-dimensional numerical modelling, comparing finite element and finite difference methods, and by limit equilibrium analysis. The complicated conceptual model was first simplified and progressively implemented with a sensitivity analysis to evaluate the effect of topography, geometry and rheological behaviour of the structural units. The model is then implemented considering the presence of magma pressure along the feeding system. The results are expressed in terms of stress-strain field, displacement pattern, plasticity states and shear strain increments, or factor of safety.

Design and construction of the Machico-Caniçal expressway tunnels

C.J.O. Baião, J.M. Brito, A.R.J. Freitas, S.P.P. Rosa & M.F.M. Conceição

*Cenorgeo – Engenharia Geotécnica Lda., Lisboa,
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ABSTRACT: The Machico-Caniçal Expressway, 8 km in length, is part of the Madeira Island's new development program, which connects Funchal city to Caniçal village via a continuous expressway along the island's southern coast. This expressway crosses an extremely mountainous region affected by the existence of two very heterogeneous geological volcanic complexes, generally covered by unstable slope deposits or by thick alluvial deposits, leading to the construction of a wide range of civil engineering

works. This paper presents the main aspects related with the design and construction of six double tunnels along the referred expressway, as well as a number of safety aspects related to these tunnels.

Innovative aspects in the execution of the strengthening and stabilizing of the volcanic cavern of "Los Jameos del Agua", Lanzarote, Canary Islands, Spain.

A. Cárdenas

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Spain*

C. Olalla & A. Serrano

Escuela de Ingenieros de Caminos. Madrid. Spain.

ABSTRACT: The rehabilitation of the volcanic natural cave that constitute "Los Jameos del Agua" Auditorium, was a challenge in the development of new technologies, materials and even machinery, specifically designed for strengthening and conditioning this impressive natural area. As a consequence that this is the biggest natural Auditorium in Europe, and a specially protected space, both, the project and its execution have required to contemplate the double condition of securing more than 800,000 people who use it every year, while maintaining the original aesthetics.

The origin and geotechnical properties of volcanic soils and their role in developing flank and sector collapses

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Department of Earth Sciences, University of Bristol, United Kingdom Publishers, Rotterdam, Netherlands

M. Hürlimann

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Barcelona, Spain*

ABSTRACT: Giant volcanic landslides are one of the most hazardous geological processes. Still, the mechanisms that trigger them remain unresolved. Recent studies suggest that the presence of weak volcanic materials is likely to play an important role. Herein, we present a study of the weakening effect of weathering and hydrothermal alteration of phonolitic

lavas, pyroclasts and ignimbrites from Tenerife. A comprehensive geotechnical characterisation of these materials reveals that, from weathering, the weakest units are porous, sandy-silty, non-plastic soils (SM) that are cohesionless, with high peak strengths and significantly lower residual strengths. In the case of hydrothermal alteration, the weakest units are porous, silty, clay-rich, medium plasticity soils (MH) with low cohesion values and varying angles of internal friction (17-45°). Secondary mineralogy produced by alteration, mainly halloysites and the presence of bonding in weathered soils and kaolinites or alunites in hydrothermally altered soils, appears to control the behaviour of the soils.

Construction experiences with volcanic unbound aggregates in road pavements

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ABSTRACT: This experimental research discusses the performance of crushed granular materials resulting from volcanic rocks employed in the construction of subgrades and continuous grading unbound aggregate road base courses. Some frequent doubts related to their suitability for the aforementioned use, to their observance of the technical specifications of different countries, and to the methodology and criteria to control field compaction and bearing capacity are intended to be clarified. For this purpose some experiences of several Atlantic islands (Azores, Canary Islands, Cape Verde, Iceland) are compiled and additional recommendations are contributed for volcanic aggregates as those of Canaries or Azores. The experimental results reveal that it is possible to reach a good load-carrying capacity with these granular materials, and also that conventional tests can be used. The in-situ study has allowed us to obtain

the rate of compaction as a function of the Effective Modulus of the base course foundation.

Geotechnical investigation guide for building in volcanic environments

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ABSTRACT: The recent emergence of the Spanish Building Technical Code set a regulatory landscape where geotechnical studies become mandatory for construction in Spain. This code provides a classification for building and terrain types, depending on which performs the geotechnical research planning. It is therefore necessary to identify and classify the terrain as one of the three types defined in the code. The Government of the Canary Islands has developed a guide that will allow code enforcement to volcanic terrains of the Canary Islands. In this paper, the geotechnical units of the Canaries as well as their classification according to the code are defined. In addition, the number and type of minimum geotechnical surveys carried out in each geotechnical unit is specified as a function of the planned building. Since the Canary Islands consist of a wide range of volcanic products, this guide can be applied to any other volcanic region.

Tunnel Inventory of Grand Canary Island (Spain), Geology and associated geotechnical problems

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ABSTRACT: In the last two decades more than 30 road tunnels has been built in Grand Canary Island, using a variety of construction methods and reaching a total extension of 14.66 km. They are 156 to 1200 m long, with an average length of 458.20 m per tunnel. The inventory of tunnels includes basic design data (i.e., ge-ometry, widths and number of lanes, velocity), geological formations and materials and the most relevant ge-otechnical problems. The article shows three tunnel examples which were excavated in different volcanic rocks: (1) Basanite pyroclast and lava flows in the Tafira ring road (GC-4); (2) Phonolite lava flow and ag-glomerates at La Laja (GC-1); and (3) Phonolitic, trachytic and rhyolitic ignimbrites and lava flows at Ar-guineguín-Puerto Rico stretch (GC-1). It is intended that this tunnel inventory could be useful for future pro-jects and works in the Canary Islands.

Detailed studies and stabilization methods of volcanic rocky slopes in coastal areas, Canary Islands, Spain

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ABSTRACT: Natural relief on mountainous volcanic islands has deep ravines, steep rocky slopes and high coastal cliffs. Volcanic formations have very heterogeneous rocks and soils. Besides, civil and building works sometimes include high cuts on the terrain and, as a result, many urban areas have been affected by rock falls and landslides. We show two case studies of the Canary Islands: (1) Rock fall hazard study and stabilization methods on Los Teques slope, Mogán, Southern Gran Canaria Island, and (2) Geologic-geotechnical study for a footpath project in

Morro Jable coastal cliff, Pájara, Southern Fuerteventura Island. We conclude that some-times classic methods of rock masses characterization are ineffective, while detailed geological studies are the best way to define and evaluate unstable zones on the slopes and to design the most convenient stabilization methods.

Basic properties of non welded basaltic lapilli and influence on their geotechnical behaviour

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ABSTRACT: In the Canary Islands there are hundreds of volcanic cones and extensive blankets of lapilli and civil works are very frequently undertaken in areas containing this material. Furthermore, basic lapilli (of ba-saltic, basanitic, or tephritic composition) are common in many volcanic regions of the world. They are small pyroclastic fragments (2 to 64 mm in diameter) emitted by Strombolian-type eruptions, very irregular in shape and with many open and closed voids. As a whole it is a light and quite loose granular material. The article covers two related aspects: (1) basic properties, such as texture, unit weight and geochemical composition; and (2) geotechnical parameters and behaviour under different situations: on slopes, under foundations and as granular layer for roads. We conclude that, resulting from their low density, high porosity and angular shape, lapilli particles have a quite different geomechanical response from other granular natural materials.

Geotechnical characterization of El Verodal Tunnel in El Hierro, Spain

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ABSTRACT: El Hierro island, 0,2 million years old, is the youngest of the Canary Islands. Since it was recognized UNESCO Biosphere Reserve in 2000, the road infrastructure to be planned has to cause a minimum

impact on the landscape of the island. This applies to El Verodal Tunnel to be built in the NW side of the island. Due not only to orography but also to administrative constraints, site studies are scarce. Moreover, the implementation of the existing rock mass classifications for volcanic rocks makes the design of the tunnel harder due to the great variability shown by these materials.

Geotechnical Characterization of Volcanic Rocks and Soils of Madeira Island

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ABSTRACT: This paper focuses on the description and the characterisation of volcanic rocks and soils of Madeira Island, based on data from expertise judgment, field survey and laboratory tests. The objective has been the compilation of data from geotechnical designs for Madeira Island, in the last 20 years, in order to describe the geological conditions and to evaluate the geotechnical parameters of the main volcanic formations such as: basalts, breccias and tuffs.

Big Telescopes Foundations in Volcanic Environments

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ABSTRACT: The development of the astrophysics science requires new technical and more sophisticated tools to complete the observation tasks successfully.

During the last years, some teams are developing bigger telescopes with the latest technologies, allowing to obtain better results in the astronomical observations. In this way, the Spanish Government and some partners developed and built a telescope with the biggest primary mirror of the world called "GRAN TELESCOPIO CANARIAS" (GRANTECAN) in La Palma, Canary Islands, Spain, being considered the biggest telescope of the world. As the engineer of the Enclosure Group, responsible of the Civil Work and

Auxiliary Installations of the GRANTECAN project, I will show in this paper a summary of the geotechnical studies, a brief description of some of the mandatory requirements for the telescope pier foundations, and the final design to accomplish the foundations and structure project re-quirements.

Contribution To Geotechnical Characterization Of Basaltic Pyroclasts

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ABSTRACT: Both the Azores and Madeira islands, located in North Atlantic Ocean, are of volcanic nature. The present work focuses on the geotechnical characterisation of basaltic pyroclasts from the Azores and Madeira, in order to get some comparison among them. In order to characterize, evaluate the geomechanical properties and get some more geotechnical data about basaltic pyroclasts, some samples were collected in both archipelagos, to do some laboratory tests. In situ tests were also made with these materials. Results include data on SPT tests, plate load tests, Los Angeles tests, in situ dry density and specific weight tests, determination of particle size distribution, compaction and CBR tests and consolidated drained (CD) direct shear tests. Some correlations between several properties are presented, namely between the strength and the deformability of volcanic materials. Finally, some considerations are made about the potentially utilizations and problems related to engineering applications.

Socorridos pumping station and water storage tunnel at Madeira Island

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ABSTRACT: The Socorridos pumping station and water storage tunnel are located at Madeira Island, Portugal, and are part of a system conceived to reutilize the water flow from the Socorridos hydroelectric plant. This facility includes an underground cavern with 26 m high, 12 m wide and 44 m length, and a tunnel 1250 m long with a storage capacity of 40,000 m³. The rock mass at the site is of volcanic origin with most of the excavation performed in a mass of volcanic breccia and basalts but with consolidated alluvia recent deposits located in the roof arch of the cavern. A description of the main characteristics of the project is presented and the results predicted by the design are compared with the values given by the instrumentation.

Road tunnel design and construction at Madeira Island

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ABSTRACT: In the last two decades a new fundamental road network was undertaken at Madeira Island. Due to the vigorous relief of the Island, the great heterogeneity, the structural and lithological complexity of volcanic rock formations and to the land occupation, tunnels became dominant and a large spectrum of innovative structural tunnel solutions were developed. The objective of this paper is to give a global vision of the importance of this group of infrastructures, focusing in the new fundamental road network evolution and construction of road tunnels at the island and in the conception and design aspects, along with the description of the geological-geotechnical conditions, primary and secondary lining, phased construction and monitoring.

Rock mass classification schemes in volcanic rocks

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ABSTRACT: Volcanic massifs, due to their origin, present certain characteristics that make their study through a classic geomechanical classification not always appropriate. The presence of discontinuities, the peculiar block shape and the presence of voids condition the behavior of lavatic massifs. Behavior of pyroclastic massifs depends mainly on their matrix rock, making the use of existing geomechanical classifications inadequate. This work represents a first step in the development of a geomechanical classification specific to volcanic massifs, accounting for all the properties that actually condition their behavior.

Geological and Geotechnical conditions of human interventions in natural volcanic caverns: The outfitting of “Los Jameos del agua” Auditorium, Lanzarote, Canary islands, Spain

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ABSTRACT: The possibility of using volcanic caverns associated with lava tubes is analysed according to their geological and geomorphological configuration and their dimensions. Each particular risk is defined and studied by considering its threat. The different natural risks are grouped into four categories: Group I: Structural instability zones due to hanged strata or extremely low width levels at the top of the cave. Group II: Medium and large block instabilities. Group III: Small block instabilities. Group IV: Surface

weathering and in-stabilities in rock particles (sand or gravel)

In this paper this methodology is applied to the well-known auditorium of "Los Jameos del Agua", located in Lanzarote. This volcanic island forms part of the Canary archipelago. This volcanic tube is visited by more than 800,000 people per year.

After an analysis of the different alternatives, the proposed technical solutions for each level of risk are de-scribed and the results of some calculations are shown.

Relationships between porosity and physical mechanical properties in weathered volcanic rocks

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ABSTRACT: Volcanic rocks are frequently found under weathered/altered conditions. Degradation and transformation can occur both at the surface and at large depth causing a progressive change in the physical mechanical properties. Degradation can cause an increase in porosity and this can control the rock behavior. In this paper we discuss the relationships between porosity characteristics, micro-structure and texture, and the mechanical behavior of lava at different degrees of weathering (lavas from the Campi Flegrei, Italy). The performed laboratory tests include: uniaxial compression, indirect tension, and uniaxial compression with ultra-sonic wave measurements. A description of the mechanical behavior is obtained and a detailed description is performed through a series of pre and post failure non destructive analyses.

Porosity values have been related to stress and strain relationship, in addition pore size characterization is pre-sented in a companion abstract/manuscript. Results are interpreted in the key of degree of weathering and its related characteristics. An empirical linking between the change in strength with the degree of alteration is presented and discussed.

Characterization and comparison of pore distribution in weathered volcanic rocks by different techniques

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ABSTRACT: Volcanic rocks are widespread in different geological contexts and exhibit complex behaviors, from hard to extremely soft rocks, depending on mineralogy, porosity, and weathering. In particular, their mechanical properties are influenced by the size and shape of pores. We report the results of porosity characterization by different techniques, performed on lavas with different degrees of alteration, sampled in the Campi Flegrei area (Italy) and characterized through petrographic analyses. Bulk-specific weight measurements, water immersion and Hg-porosimetry gave total and interconnected porosity values. Analysis of thin sections provided 2D pore size and shape estimates and insight in pore relationships with rock matrix and weathering. X-ray Computer Tomography allowed complete 3D reconstruction of rock pores. Different image processing methods for data extraction and analysis have been used to develop a standard analysis procedure. Results in terms of measured porosity and pore size and shape distributions obtained by different techniques are discussed.

Lightweight aggregate and lightweight concrete and its application in the improvement of the thermal properties of volcanic lightweight aggregate concrete blocks from Canary Islands

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ABSTRACT: Concrete blocks with volcanic aggregates currently produced in the Canary Islands (BHIC) have a high coefficient of thermal conductivity. The application of Spanish Building and Construction Regulations, known as CTE, leads to the need for multilayer construction systems in external building walls. These systems are less efficient from an economic and environmental point of view. This paper focus on the im-provement of thermal properties of the BHIC, so that the external building walls can be executed in the is-lands using single-leaf masonry without having to add thermal insulation.

Slope stability in the Canary volcanoes based on geotechnical criteria

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ABSTRACT: The stability of natural slopes in different areas of the Canary Is-lands have been analysed through the relation between cohesion, friction angle and slope height. The combination of estimates for geomechanical parameters of intact rocks of the Canary Archipelago, the geological strength index (GSI) and textural features were used to deduce geomechanical parameters of rock massifs. This paper discusses the changes in cohesion and friction angle as a function of the slopes height for different rock

massifs and geological conditions expressed in the form of GSI. Such differences may define the threshold between stability and instability of slopes and have relevant implications in the volcanic hazards of certain areas of the Canary Islands which are discussed here.

Study of lunar soil from terrestrial models (Canary Islands, Spain).

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ABSTRACT: The Moon has a surface constituted mainly of basaltic materials. They are mostly vacuolar-like basalts that are also abundant in soils of volcanic origin on Earth. The geotechnical features of these rocks from the Canary Islands are supported by the basic characteristics deduced by NASA for this type of basalts. This paper deals with the geotechnical parameters of the lunar basalts taking into account the knowledge we have of the basalts from the Canary Islands used as terrestrial models as well as their suitability as building materials in future lunar bases. It is concluded that the lunar basalt, because of their abundance, ease of management and structural strength, is the best material for the construction of roads, tracks and even blocks with regolith for shielding of dwellings and facilities required on a lunar base.

Cliff stabilization solutions at the south coast of Madeira Island

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ABSTRACT: The necessity to protect important infrastructures constructed, along the south coast of Madeira Island, at the top and at the bottom of high cliffs, against the collapse of isolated rock blocks or of significant masses of soil and rock debris, has led to the development of complex geotechnical projects and to the execution of specific stabilization works. This paper describes, for some of those cliffs, the existing geological conditions and the main instabilization processes that affect them. Attending to the acquired experience from these works, some considerations are presented about the advantages and limitations of the stabilization solutions considered, especially in what concerns the required logistics for their execution.

Geological and geotechnical conditions of the Machico Caniçal highway

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ABSTRACT: The Machico-Caniçal highway, with 8 km long, is part of Madeira Island development program, connecting Funchal city to Caniçal village through a continuous highway along the islands south coast. This highway crosses an extremely mountainous region, conditioned by the existence of two very heterogeneous volcanic complexes, generally covered by unstable slope deposits or by deep alluvial deposits. Those geological conditions lead to the execution of a wide range of civil engineering works. This paper presents the most relevant geological and geotechnical aspects identified along this highway, in particular in what special engineering structures (tunnels, bridges and viaducts) and retaining walls were concerned.

Volcanic dikes engineering properties for storing and regulation of the underground water resources in volcanic islands

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ABSTRACT: The main feature of aquifers in volcanic islands with high rainfall rates and steep topography is that they are on raised, mainly due to the presence of volcanic dikes. Dikes are igneous bodies with very high aspect ratio, which means that their thickness is usually much smaller than the other two dimensions and tend to be vertical or of high dip angle. It can be considered as impermeable and interconnected walls where aquifers, which are recharged by rain, raise the water table between the dikes. This is especially important in volcanic rift zones. The method to obtain water in these volcanic areas involves digging horizontal galleries with explosives. The galleries cross the dikes and drain the water from the water saturated area. The main problem of this type of perforation is to obtain the water continually, without the possibility of water regulation. This question has been solved by means of the reconstruction of several technically viable dikes, to enable the store of water resources through channels in order to regulate the water wealth of the built galleries. Methods, results and viability on the use of the volcanic materials as relevant works of civil engineering highlights on the following paper.

Geomechanical appraisal of the deformation potential of a deep tunnel in a volcanic rock mass

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ABSTRACT: Ophiolitic complexes can be defined as an association of ultra basic volcanic rocks (ultramafic) and basic (mafic) constituents of the oceanic crust as a result of a phenomenon of abduction clash between continental plates. An intricate structure in which volcanic rocks are intruded in the direction of the schistosity of the metamorphic rocks is further complicated by large scale over thrusts which create tectonic melanges at the base of such mega structures, affecting it by secondary tectonic contacts and inverse faults. The whole entity is found in considerable tectonic disorder where packages of peridotites or pillow lavas of various sizes “float” inside a sheared shale-like mass. It is understandable that tunnelling in such a formation requires a good appraisal of the rock mass deformation potential as it will have a direct impact in the support behaviour, particularly in the deeper sections with more than 250 m overburden. This paper deals with the geomechanical characterisation of the heterogeneous rocks mass and the different models employed to simulate its behaviour during the tunnel excavation and support.

An access gallery to the underground Fuente Santa Spring, La Palma, Spain.

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ABSTRACT: This paper presents the work done to recover the historical Fuente Santa spring, well known at Middle Age due to its miraculous medical effects. The spring was buried by San Antonio volcano eruption in 1677, with debris, cinders and lava flows. A gallery was recently excavated under extreme and difficult natural conditions, a total lack of stability with granular materials involved. The direction of the axis of the gallery was initially unknown.

Project and technical assistance to the retaining structures of Cabo Girão Tourist Resort

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ABSTRACT: Due to the existing conditionings for the implantation of the different areas that comprise Cabo Girão Tourist Resort, at Madeira Island, namely the vigorous relief and the geological-geotechnical conditions, it was necessary to conceive an important group of retaining structures, using different solutions, varying from gravity and semi-gravity cyclopean concrete structures to reinforced concrete walls and soil nailed walls or nailed slopes. This paper presents the conception of the project in its different stages and the main activities developed under the scope of the special technical assistance provided during the execution phase.

Retaining structures in Machico-Caniçal expressway at Madeira Island

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ABSTRACT: Given the conditions found along the entire expressway that connects the city of Machico and the village of Caniçal, on the Madeira Island, specifically the topography, the urban occupation and the highly unfavorable geological-geotechnical conditions, characterized by the existence of slope deposits of significant depth with very poor resistance characteristics, different solutions had to be used for the retaining structures, specifically gravity walls, reinforced earth retaining walls with jet-grouting foundation, anchored pile walls and soil nailed walls and slopes.

Shear behaviour of Stromboli volcanoclastic saturated materials and its influence on submarine landslides

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ABSTRACT: On 30 December 2002 a submarine landslide generated high tsunami waves and destabilized the subaerial slope of the NW flank of the Stromboli volcanic island. The volcano flank is a large subaerial and subaqueous scar filled by loose volcanoclastic materials. Their susceptibility to undrained shear failure is investigated through stress- and displacement-controlled large-scale ring shear tests (LRST), conducted at DPRI-Kyoto University at different hydraulic boundary conditions. Results are presented in the form of stress paths and time-histories of shear resistance and pore pressures and are discussed with reference to the different testing conditions. Finally shear bands formed in LRST are analyzed in terms of changes in porosity and grain size distribution in order to investigate the development of grain crushing at failure and at large displacement.

Geotechnical Properties of Volcanic Materials of the Mount Erciyes

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ABSTRACT: The Mount Erciyes (3917 m) is the largest volcanic mountain of Central Anatolia (Turkey) and situated 15 km south of Kayseri. Mt. Erciyes volcanic groups have produced calc-alkaline and pyroclastic rocks such as basalt, andesite, tuff, ignimbrite, dacite, rhyodacite and pumice. Thickness of these rocks varies from one to several hundred

meters and these rocks constitute of whole The Cappadocia Region comprising Nevşehir, Kayseri and Niğde provinces of Central Anatolia. These rocks are mined in more than a hundred quarries and used construction purposes. In this study several geotechnical parameters related to these rocks are determined in the laboratory. There have been found good relationship between these products such as P-wave velocities versus UCS, P-wave velocities versus thermal conductivity coefficient, UCS versus thermal conductivity coefficient. These parameters show these rocks quite suitable for construction purposes.

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Deformational behaviour of pyroclastic rocks beneath the upper reservoir of the hydro-wind plant at El Hierro

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ABSTRACT: El Hierro Hydro-wind Plant is a singular project, as its aim is to make the island energy self-sufficient. It involves constructing two reservoirs – the higher of which began being constructed in September 2009. This article attempts to reflect the peculiarity of the behaviour of the materials at the bottom of this reservoir, which will have to support a significant hydrostatic load, and the difficulty of characterising these in laboratories and design offices in order to assign geotechnical parameters to them which will reflect their geotechnical performance in situ. The studies undertaken to achieve this characterisation are described and the expected settlement of the materials is analysed. Finally, the article describes in detail the ground treatment proposed in order to minimize settlements, whose estimated values are compared with those obtained at the works site.

A Sensitive Analysis on Mohr-Coulomb and Hoek-Brown Parameters Effective in Ground Response Curve

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ABSTRACT: convergence-confinement is one of the most popular methods that is applied for analyzing the interaction of a circular opening in rock masses. It is assumed that circular tunnel excavated in a continuous, homogeneous, isotropic, initially elastic rock mass subjected to a hydrostatic stress .

Selecting appropriate failure criteria is very important in the analysis since it affects on plastic zone and on the resulted displacement and stress field around the opening. Some closed-form solutions have suggested for the ground reaction curve, although they are

driven based on elastic-perfectly plastic or elastic-brittle-plastic models of rock mass behavior.

Brown et al(1983) proposed a stepwise procedure based on Hoek-Brown criterion to solve stress and displacement around the circular opening for elastic-strain softening model of rock mass behavior. A similar stepwise procedure was extracted in this study for Mohr-Coulomb criterion. Finally a sensitive analysis was implemented for Mohr-Coulomb and Hoek-Brown criteria in respect to their parameters.

By comparison of the relative displacement caused by changing strength parameters in Hoek-Brown and Mohr-Coulomb criteria, it can be concluded that Mohr-Coulomb criterion is more sensitive in respect of variation of strength parameters of rock mass than Hoek-Brown.

Modeling of the Collapse of a Macroporous Material

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ABSTRACT: The macroporous materials are a mix of solid particles, joined together with bridges of materials that may be the same or different of the solid particles. For example, volcanic rocks like volcanic agglomerates. In this way, it is interesting to try to explain how the collapse of these materials takes place. With the great improvement of the numerical methods and the power of computers it has been possible to carry out a discrete analysis instead of a continuum one, like would had happened with the classical theories of continuum. This article shows the first steps taken in this path of modeling the collapse of macroporous materials in a discrete way.

Isotropic collapse load as a function of the macroporosity of volcanic pyroclasts

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ABSTRACT: Two main types of “macroporosity” in pyroclastic volcanic rocks can be distinguished: “reticulated” and “vacuolar”. The first type is produced when the large pores are located between grain particles. The second type is produced when large pores are located inside a vitreous rock mass. However, a mixed type can be defined in most cases, when both kinds of void are present. At other times, the pyroclasts do not exhibit any kind of “macroporosity”. An extensive study of how the type of porosity may affect the strength of the material is being carried out at CEDEX geotechnical laboratory. Samples with different types of “macroporosity” have been tested under isotropic loads. As a result of a theoretical study, an expression of the isotropic collapse load has been obtained, for any type of “macroporosity”, and compared with test results.

General method for estimating the active and passive earth pressures on retaining walls assuming different strength criteria

A. Serrano

E.T.S.I.C.C.P., U.P.M. Madrid, Spain

A. Perucho & M. Conde

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ABSTRACT: A new method for estimating the earth pressures on retaining walls has been developed. It is an extension of Coulomb’s earth pressure theory for non cohesive materials that can follow a non-linear strength criterion. This was previously done by the authors (Serrano et al, 2007) for some basic assumptions that have now been extended. The method is valid for materials that may have either a linear or non-linear strength criterion (parabolic or Hoek-Brown), a non-horizontal surface and an earth-wall friction angle. The method considers the material dilatancy. Moreover, the failure surface does not need to be plane, as in previously developed methods, but its shape is obtained as a result of the calculus, by

applying Euler’s variational method that obtains the extremal force.

Natural stone from the Azores archipelago: Relationship between lithology and physical-mechanical behaviour

João B. P. Silva ⁽¹⁾, Cristina Carvalho ⁽²⁾, Sérgio Diogo Caetano ⁽³⁾ & Celso Gomes ⁽¹⁾

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⁽³⁾ *ARENA (Regional Agency for Energy and Environment of the Azores Autonomous Region), São Miguel, Portugal*

ABSTRACT: Since the early days of the settlement in the Azores archipelago, in the 15th century, natural stone has been used in the construction of residences, religious monuments and public buildings, because of its local abundance. The purpose of this study was the characterization of the main commercial types of natural stone of the archipelago of Azores, in terms of their petrographic, mineralogical, chemical and physico-mechanical properties. This characterization allowed the appraisal of their suitability for the different types of applications. In a preliminary stage, the study comprised seven varieties of natural stones exploited in several quarries and processing plants of São Miguel Island and Santa Maria Island - two of the nine islands that form the Azores archipelago. Petrographic studies and chemical analysis were performed in all the selected varieties as well as the following physical-mechanical tests (carried out according to European Standards): uniaxial compressive strength, flexural strength under concentrated load, apparent density, water absorption at atmospheric pressure, open porosity (or apparent porosity), linear thermal expansion coefficient, abrasion resistance (with Capon machine) and rupture energy (commonly known as impact resistance). Finally, relationships were established between the main physical-mechanical properties of the natural stones under study, and their main lithological and textural characteristics.

BIBLIOTECA DIGITAL ISRM

El proyecto de biblioteca digital de la ISRM fue lanzado el 12 de Octubre de 2010. Esta biblioteca pretende incluir todos los artículos de los congresos y simposios organizados o esponsorizados por la ISRM y está disponible para todos los socios individuales

La biblioteca utiliza la plataforma OnePetro, gestionada por la SPE (Society of Petroleum Engineers).

Los socios podremos bajarnos gratuitamente hasta cien artículos por año, entrando en la plataforma (www.onepetro.org) y registrándonos como miembros de la ISRM, utilizando para ello el nombre de usuario y clave que se utiliza para bajar información de la página web de la ISRM, de la que deben disponer los socios. Por ahora hay colgados unos 500 artículos de 9 congresos pero se espera doblar esta cifra pronto.



Aprovechamos para recordar a los socios que en la página web de la sociedad también se pueden bajar algunos métodos sugeridos en pdf, varios videos con lecciones magistrales sobre mecánica de rocas de los profesores John Hudson, Evert Hoek, etc. En la web también se encuentran los medios de información de la ISRM que son el "News Journal" que se publica anualmente con noticias y artículos técnicos así como el "News Letter" trimestral con noticias breves del mundo de la mecánica de rocas.

EUROCK

La Sociedad Española de Mecánica de Rocas y la Universidad de Vigo han solicitado la Organización del congreso europeo EUROCK'2014 en la antedicha ciudad gallega. El comité de la ISRM no decidirá sobre la ciudad que acogerá este congreso hasta el año que viene en el congreso de Beijing.



GEOTECHNICAL RESEARCH MEDAL



El pasado 8 de Octubre tuvo lugar la ceremonia de los premios Institution of Civil Engineers Awards 2010 de Londres.

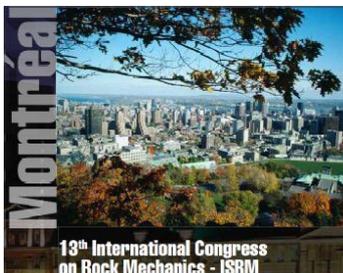
Nuestros compañeros D. Juan Jorge Munos, D. Eduardo Alonso y D. Antonio Llorent recibieron la "Geotechnical Research Medal", por su artículo "Thermo-hydraulic characterisation of soft rock by means of heating puls test" reconocido como la mejor publicación en materia de Ingeniería Geotécnica publicada por la institución en el último año.

JUNTA GENERAL Y CONGRESO INTERNACIONAL DE LA ISRM

La Sociedad Internacional de Mecánica de Rocas (ISRM) celebró el pasado 24 de octubre su junta general anual en Nueva Delhi, junto con el Congreso Internacional y 6º Simposium Asiático de Mecánica de Rocas, organizado por el Grupo Nacional Indio de Mecánica de rocas en colaboración con la Oficina Central de Irrigación y Energía del Gobierno de este país, que es a día de hoy la democracia más populosa del mundo y uno de los países que a experimentado un mayor crecimiento en los últimos años. 36 grupos nacionales, entre ellos la SEMR, de los 47 existentes estuvieron presentes o representados en dicha junta.

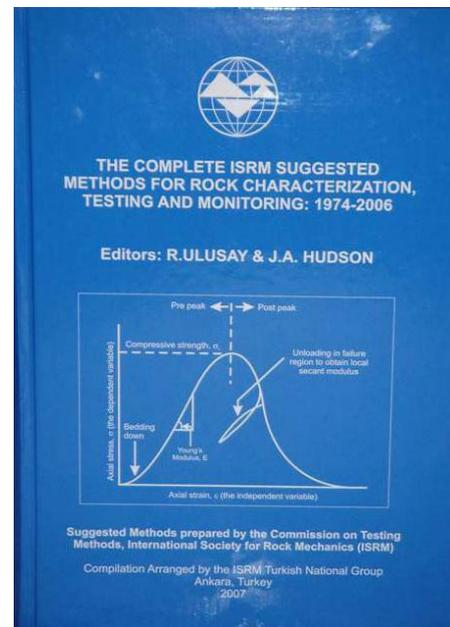


En dicha acto se tomaron algunos acuerdos y se votaron algunas propuestas que se comentan.



- Se escogió por votación la ciudad que acogerá el próximo congreso internacional cuatrienal de la ISRM. Presentaron su candidatura Agra (India) y Montreal (Canadá). Montreal fue escogida para acoger este evento que tendrá lugar del 29 de abril al 6 de mayo de 2015.

- Se presentaron de forma breve informes de las comisiones de trabajo de la ISRM que versan sobre los siguientes temas: aplicaciones geofísicas en mecánica de rocas, preservación del patrimonio, métodos sugeridos y ensayos, cierre de minas, diseño y metodología en ingeniería de rocas, almacenamiento de residuos nucleares, fenómenos dinámicos en mecánica de rocas, educación y rotura frágil. Se han creado además dos pre-comisiones que se espera puedan desarrollar su trabajo en el futuro en los temas de mecánica de rocas aplicada a la ingeniería del petróleo y tensiones en la corteza y sismos. Las comisiones presentaran sus informes definitivos el próximo año en Beijing. Cabe destacar que la comisión de métodos de ensayo está preparando más de veinte nuevos métodos sugeridos (procedimientos pre-normativos) que irán apareciendo publicados en la revista "International Journal for Rock Mechanics & Mining Sciences" a lo largo del próximo año, y que se publicaran como segundo tomo del libro azul en 2012 o



2013. Recordamos que el libro azul "The Complete ISRM Suggested Methods for Rock Characterization, Testing and Monitoring:1974-2006" que se puede adquirir a través de la página Web de la ISRM es la compilación de los métodos de caracterización, ensayo y medición publicados en los últimos treinta años por la Sociedad.

- Se informó finalmente que la ISRM cuenta actualmente con 6312 miembros individuales, 136 corporativos y 47 grupos nacionales. Europa es el continente con mayor número de socios (48 %), aunque al mayor crecimiento se ha producido especialmente en países asiáticos y especialmente China y la India. España es actualmente el quinto país Europeo en número de socios.

▪ PREMIO MULLER

El premio Müller (Müller award) que honra al fundador de la ISRM, el ingeniero austriaco Leopold Müller, es un galardón que se entrega cada cuatro años a personas que logren avances relevantes o innovaciones de alcance en el ámbito de la profesión. Entre los galardonados en anteriores ediciones, se encuentran prestigiosos ingenieros como Evert Hoek, Neville Cook o Ted Brown.



Los grupos nacionales propusieron para la sexta convocatoria del premio a Richard Goodman (desarrollo de la teoría de bloques), Peter Kaiser (avances relevantes en el ámbito de la rotura frágil de rocas) y Nicholas Barton (investigaciones, por todos conocidas, sobre la resistencia al corte de discontinuidades y propuso un método empírico de cálculo de túneles y galerías conocido como Q).

El galardón fue concedido por mayoría simple a **Nick Barton**, que presentará una **lección magistral** en el próximo congreso internacional de la ISRM en Beijing el año próximo, y a quien tendremos la ocasión de tener entre nosotros en la próxima Jornada de la Sociedad que tendrá lugar, como tradicionalmente viene ocurriendo, en el CEDEX a finales del mes de Abril.



▪ MEDALLA ROCHA



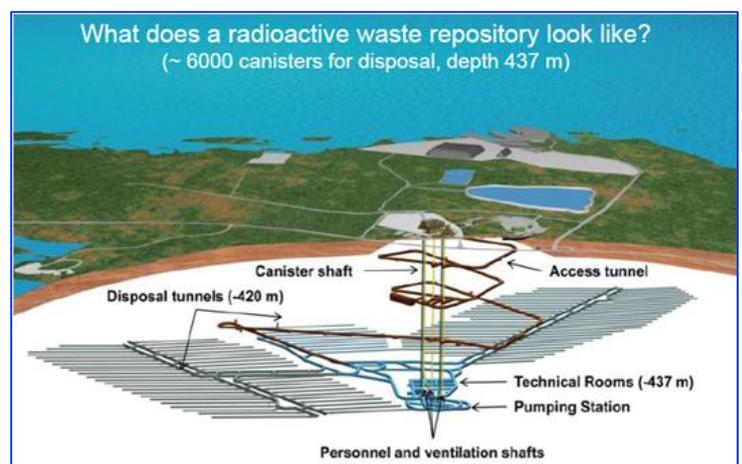
El comité del ISRM decidió la entrega de la medalla Rocha, premio al mejor trabajo de un joven investigador, a Donhyung Park, de Corea por su tesis titulada "Reducción de la vibración por voladura en túneles mediante el uso de barrenos huecos y 'air decks' o cámaras de aire".

▪ VI SIMPOSIO ASIÁTICO DE MECÁNICA DE ROCAS

Este congreso tuvo lugar en el centro de Congresos India Habita Center en Delhi, los días 25, 26 y 27 de Octubre.

Entre las charlas principales que se presentaron cabe destacar algunas.

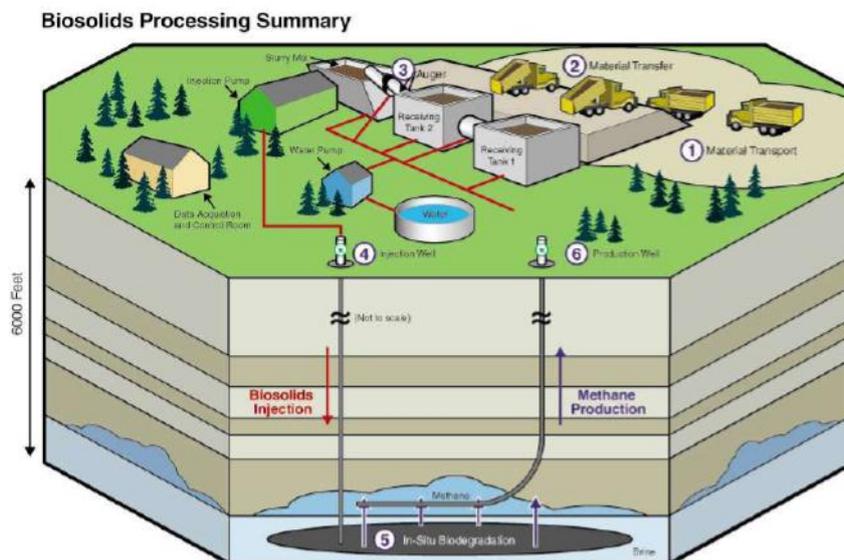
John Hudson presentó nuevas las aportaciones de la mecánica de rocas al almacenamiento subterráneo de residuos radiactivos, tema que tendrá bastante desarrollo en los próximos años.



Concepto finlandés del almacenamiento subterráneo de residuos nucleares. Imagen de la charla del profesor Hudson.

Shinichi Atanaga explicó una interesante propuesta de visualización de medidas de campo en mecánica de rocas, basada en el concepto de colocar luces de colores (como semáforos) indicativas de las medidas in-situ en tiempo real que se están produciendo, lo que permitiría saber, por ejemplo al personal que esta trabajando en un frente de túnel o bajo un talud relativamente inestable, si se están produciendo valores anómalos de deformación y en caso de riesgo abandonar la zona. El Profesor Barla disertó sobre grandes deslizamiento en taludes de roca, y en particular en el caso de afecciones a presas.

De gran interés fue la charla del canadiense Maurice Dusseault, ingeniero de petróleo, que expuso un novedoso concepto puesto en marcha en Los Ángeles en 2008 de forma experimental, que consiste en inyectar residuos biológicos urbanos en formaciones geológicas profundas (tipo yacimientos de gas o petróleos agotados), de esta manera se soluciona en parte la gestión de residuos biológicos urbanos, disminuyéndose el riesgo de transporte, generando metano subterráneo recuperable, secuestrando un porcentaje importante de CO2 e imitando de alguna manera el proceso natural de formación de yacimientos de carbón.



Propuesta del profesor Dusseault. Inyección de residuos biológicos sólidos en formaciones geológicas profundas.

Otras de las charlas relevantes fueron las que siguen:

- Dr. C. Erichsen, WBI, Germany. Challenges in the Design and Construction of Tunnels in Jointed Rock
- Prof. Xia-Ting Feng, Institute of Rock and Soil Mechanics, China and ISRM Vice President at Large. Application of Intelligent Rock Mechanics Methodology to Rock Engineering
- Prof. Yossef H. Hatzor, Ben-Gurion University of Neger, Israel. Modelling Dynamic Deformation in Natural Rock Slopes and Underground Openings with the Numerical DDA Method
- Prof. Guowei Ma and Prof. Yingxing Zhou, Singapore. Rock Dynamics Research in Singapore: Fundamentals and Practices.
- Dr. John Read, CSIRO LOP Project, Australia. The Large Open Pit Project.
- Prof. Herb Wang, University of Wisconsin, USA. Deep Underground Instrumentation and Monitoring

Los videos de la muchas de estas charlas de colgarán en la página web de la ISRM para su descarga gratuita por parte de los socios.

CONFERENCIA XXVII LIÇÃO MANUEL ROCHA

D. Luis Gonzalez de Vallejo ha sido el conferenciante de la XXVII Lição Manuel Rocha bajo el título *Design with Geo-Hazards: The Engineering Geological Approach*. Este acto se celebró en Lisboa el pasado 8 de Noviembre, y fue organizado por la Sociedad Portuguesa de Geotécni (SPG) y la Asociación de Antiguos alumnos de Geotécni de la UNL.

**Design with Geo-Hazards:
The Engineering Geological Approach**

Luis González de Vallejo (U.C.M.)

ABSTRACT: The design of large infrastructures in developed countries requires a high level of safety including possible natural hazards that may affect the site and the installations in the short, medium and long term. Their design should provide a safe and economical solution even under unfavourable geological conditions, representing a challenge for civil engineers and engineering geologists involved in the project.

This conference deals with the design criteria and the methodologies to be applied when Geo-Hazards have to be considered. These methodologies present an integrated procedure from the Engineering Geological point of view to find the required safe and economical solution for engineering design purposes. The practical application of these criteria and methodologies are illustrated through some representative case histories, ranging from a geotechnical scale to a geological scale.

The safety conditions of the Itoiz dam, one of the largest and most recent dams built in Spain, has been questioned due to induced seismicity and the instability of the reservoir slopes. The results of the investigations carried out to evaluate these hazards and the actions taken for the dam safety are presented.



The seismic hazard assessment needed for planning and development in regions of moderate seismicity with insufficient seismic and tectonic data, suppose a difficult problem when seismic actions have to be considered in the design for short, medium or long term conditions, e.g. building construction, large

infrastructures or critical installations, respectively. The case of the Canary Islands is shown, where paleo-seismic studies, and seismotectonic and marine geophysical investigations have allowed to evaluate the seismic hazard for different return periods.

The occurrence of destructive tsunamis as a consequence of volcanic island flank collapses has been object of controversy by the international scientific community. Tenerife is the largest and most populated island of the Canaries, being affected in the past by two of the largest landslides of the world. The triggering conditions and recurrence of these flank failures have been investigated, as well as their relation with the tsunami deposits encountered in the surrounding islands. The obtained results have provided a new insight in the hazard assessment of large volcanic flank failures.

Desde el año 2002 la SEMR lleva organizando una Jornada Técnica Anual, cuya fecha de celebración coincide con el segundo miércoles después de Semana Santa. Tradicionalmente y gracias a la colaboración del CEDEX esta jornada se realiza en el Salón de Actos de este organismo.

Esta Jornada Técnica ha venido teniendo gran acogida entre los técnicos que trabajan en Mecánica de Rocas. Con una asistencia media entre 150 y 200 personas, tanto de socios como no socios.

En la página web de la SEMR se puede consultar el programa detallado de todas las jornadas que se han celebrado hasta el momento y que han sido:

- **Excavaciones subterráneas en roca**, 23 de abril de 2002
- **Taludes en roca**, 23 de abril de 2003
- **Tratamiento de túneles en roca**, 21 de abril de 2004
- **Reconocimiento y estudio de medios rocosos**, 20 de abril de 2005
- **Túneles en rocas blandas**, 26 de abril de 2006
- **Cimentaciones de presas en roca**, 18 de abril de 2007
- **Túneles en condiciones difíciles**, 2 de abril de 2008
- **Cálculo de Túneles**, 22 de abril de 2009
- **Almacenamiento profundo de CO₂**, 10 de abril de 2010



Además, dado el importante avance en el campo de las tuneladoras, se han celebrado dos **Jornadas Extraordinarias** relacionadas con este tema:

- **Tuneladoras en roca**, 16 de marzo de 2006
- **Experiencias recientes en tuneladoras**, 5 de junio de 2007

JORNADA TÉCNICA DE 2011 MADRID, MIÉRCOLES 4 DE MAYO

“Últimos avances en la Mecánica de Rocas”

Los conferenciantes propuestos y temas a tratar:

- **D. Nick Barton**, “Characterization and modelling of TBM excavation through Q-histogram logged”
- **D. Antonio Soriano**, “Estabilización de taludes en rocas blandas”
- **Davor Simic**, “Caracterización y comportamiento de túneles en rocas doleríticas alteradas”
- **Luis Hernández**, “Guía de estudios geotécnicos para edificación en Canarias.”

- **Coimbra, Portugal, 14 -17 Junio 2011**, Congress on Numerical Methods in Engineering – CMNE 2011. [\[Ir\]](#)
- **Seoul, Korea, 31 Agosto - 3 Septiembre 2011**, 5th International Symposium on Deformation Characteristics of Geomaterials [\[Ir\]](#)
- **Athens, Greece, 12-15 Septiembre 2011**, XV European Conference on Soil Mechanics and Geotechnical Engineering [\[Ir\]](#)
- **Beijing, China, 16-21 Octubre 2011**, - ISRM 12th International Congress on Rock Mechanics: The 2011 ISRM International Congress. [\[Ir\]](#)
- **Stockholm, Sweden, 28-30 Mayo 2012**, EUROCK'2012 – ISRM Regional Symposium of Rock Mechanics: an ISRM International Symposium [\[Ir\]](#)

4ª Edición del Premio BIANUAL de la SEMR

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PREMIO
AL MEJOR TRABAJO DE
INVESTIGACIÓN EN
MECÁNICA DE ROCAS

4ª EDICIÓN

La Sociedad Española de Mecánica de Rocas convoca el Premio al trabajo de investigación que mejor contribuya al progreso del conocimiento en mecánica de rocas y a la innovación científica o tecnológica en este campo.

El Premio está dotado con 3.000 € y un Diploma acreditativo.

PLAZO: Hasta el 14 de enero de 2011

En el año 2004 se creó el *Premio de la Sociedad Española de Mecánica de Rocas*, con el fin de incentivar a los jóvenes para la investigación en el campo de la mecánica de rocas.

Dicho Premio, que tiene carácter bianual, se otorga al trabajo de investigación que se considere que contribuye mejor al progreso del conocimiento en mecánica de rocas y a la innovación científica o tecnológica en este campo. La elección del trabajo premiado la realiza un tribunal que es elegido por la Junta Directiva de la Sociedad.

Se aceptan trabajos de investigación como tesis doctorales, proyectos fin de carrera, tesis de master, trabajos monográficos de investigación realizados en universidades, centros de investigación públicos o en empresas.

Los candidatos deberán tener menos de 36 años en el momento de cerrarse la convocatoria y acreditar haber realizado su trabajo en España.

En la actualidad se han recibido tres trabajos correspondientes a esta cuarta edición del premio y están siendo evaluados por el jurado designado por la junta directiva de la SEMR. El Premio consiste en un diploma acreditativo y 3000 euros, y se entregará durante la celebración de la Jornada técnica anual de la Sociedad, el 4 de Mayo. Así mismo, deberá realizar una exposición del trabajo de unos 15 minutos de duración en dicha Jornada.

ENLACES INTERNACIONALES

FedIGS – Federation of the International Geo-engineering Societies
IAEG – International Association for Engineering Geology and the Environment
ICOLD – International Commission on Large Dams
IGS – International Geosynthetics Society
ISRM – International Society for Rock Mechanics
ISSMGE – International Society of Soil Mechanics and Geotechnical Engineering
ITA – International Tunnelling Association
IUGS – International Union of Geological Sciences
SPE – Society of Petroleum Engineers

ENLACES NACIONALES

Asociación Española de Empresas de Ingeniería (**TECNIBERIA/ASINCE**)
Asociación Española de Empresas de Ingeniería del Suelo y Subsuelo (**AETESS**)
Asociación Española de Ingeniería Sísmica
Asociación Española de Túneles y Obras Subterráneas (**AETOS**)
CEDEX
Colegio de Ingenieros de Caminos, Canales y Puertos
Comité Español de Grandes Presas
Confederación de Ingenieros Geólogos
Consejo Superior de Colegios de Ingenieros de Minas
Ilustre Colegio Oficial de Geólogos
Sociedad Española de Mecánica de Suelos

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- Tomar parte en las Asambleas Generales y en las votaciones estatutarias.
- Poder ser elegidos por cualquier cargo de la *Sociedad* de acuerdo con los presentes Estatutos.
- Recibir información de la *Sociedad* y participar en ella.
- Elevar a la *Junta Directiva*, las propuestas que tiendan a un mejor logro de los fines de la *Sociedad*.
- Pertenecer a la **ISRM** como miembro de la *Sociedad Española*. Esto da derecho a (más información en la página de la **ISRM**: www.isrm.net):
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- Acceso al área para miembros de la **web** (en la que se pueden descargar Informes, los "Suggested Methods", participar en Foros de discusión, etc.)
- Participar en Comisiones y grupos de interés de la **ISRM**.
- Descuentos en **Congresos** de la **ISRM** o patrocinados por ella.
- Descuentos en la suscripción de algunas revistas (*International Journal of Rock Mechanics and Mining Sciences*, *Journal Rock Mechanics and Rock Engineering*)

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