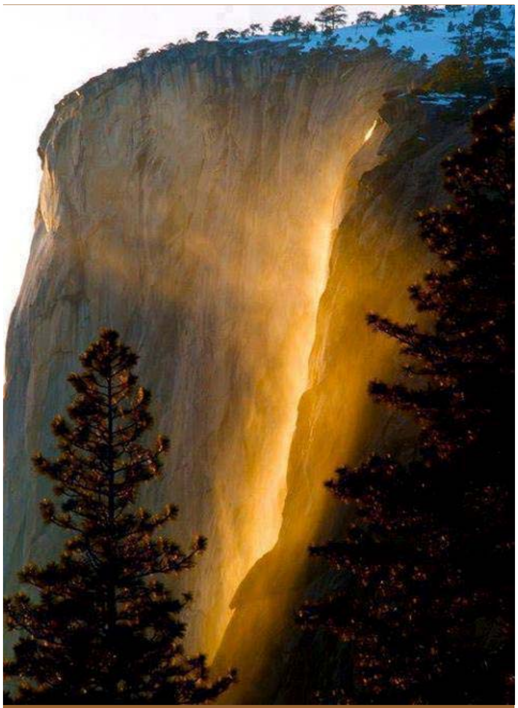

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Αρ. 77 – ΑΠΡΙΛΙΟΣ 2015

FEDERATION OF INTERNATIONAL GEO-ENGINEERING SOCIETIES

The FedIGS website has just been officially launched
www.geoengineeringfederation.org

The **Federation of International Geo-Engineering Societies (FedIGS)** is a collaborative forum within which learned societies or associations involved in engineering with, on, or in geo-materials can meet and interact. The purpose of the Federation is to facilitate interaction among the member societies, explore opportunities to promote their common interests and provide a unified response to common issues through effective collective actions that are more effective than individual responses of the members.

The members of the federation are:

- International Society of Soil Mechanics and Geotechnical Engineering (ISSMGE)
- International Society of Rock Mechanics (ISRM)
- International Association of Engineering Geology (IAEG)
- International Geosynthetics Society (IGS)

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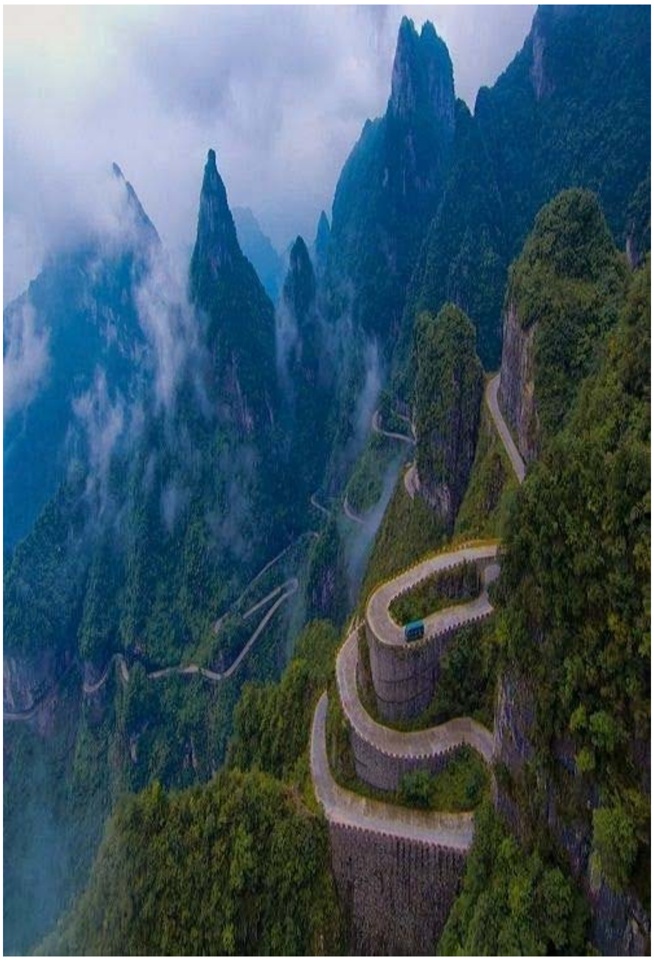

Swichback Mountain, Tiaman highway - China

Balls Pyramid off the Eastern Coast of Australia

ΑΡΘΡΑ

TC10 – Seismic cone downhole procedure to measure shear wave velocity: A guideline

ISSMGE Technical Committee 10, "Geophysical Testing in Geotechnical Engineering", (TC 10) was established in 1989. The work of TC 10 was led by a Core Group, consisting of: Mr. Tony Butcher, United Kingdom, Dr. Amir Kaynia, Norway; Dr. K. Rainer Massarsch, Sweden (Chair); Dr. Nils Rydén, Sweden (Secretary, 2004 - 2005) & Dr. Anders Bodare (Secretary, 2001 – 2003); Prof. Kohji Tokimatsu, Japan and Dr. Bob Whiteley, Australia.

A primary objective of TC 10 was to develop the Guidance Document "Seismic Cone Downhole Procedure to Measure Shear Wave Velocity - A Guideline". A Task Force was set up to implement the development of a Guidance document on Seismic Cone Downhole Testing (SCPT). The members of the Task force were: Tony Butcher (Chairman), Richard Campanella, Amir Kaynia and K. Rainer Massarsch. A Draft of the document was presented at the TC 10 Member Meetings in, respectively, Prague and Porto, for the occasion of the 2nd International Conference on Site Characterization, organized by ISSMGE. Technical Committee on "Ground Property Characterization from In Situ Testing", TC16, presently TC102. Thereafter, the Final Draft was submitted to TC 10 members and sister TCs for commenting. The final document was presented at the TC 10 Member Meeting, which was held in connection with the 16th ICSMGE, held in Osaka 2005. However, the document was never published in the proceedings of the Osaka conference.

The activities of TC 10 have since been merged with those of ISSMGE TC102. Upon suggestion by ISSMGE President Roger Frank, and with the support of TC 102 chairman Antonio Viana da Fonseca, the document is endorsed by TC 102 and now formally published in this issue of ISSMGE Bulletin. The formal reference to the document is:

Butcher, A. P., Campanella, R.G., Kaynia, A.M. and Massarsch, K. R., 2005. "Seismic cone downhole procedure to measure shear wave velocity - a guideline", prepared by ISSMGE TC10: Geophysical Testing in Geotechnical Engineering. ISSMGE Bulletin April 2015 issue.

Seismic cone downhole procedure to measure shear wave velocity - a guideline prepared by ISSMGE TC10: Geophysical Testing in Geotechnical Engineering

Procédé séismique de downhole de cône à la vitesse d'ondes de cisaillement de mesure - une directive a préparé par ISSMGE TC10 : Essai géophysique dans la technologie géotechnique

A.P. Butcher (BRE, UK), R.G. Campanella (University of British Columbia, Canada), A.M. Kaynia (Norwegian Geotechnical Institute, Norway) and K.R. Massarsch (Geo Engineering AB, Sweden)

Abstract

The International Society for Soil Mechanics and Geotechnical Engineering, Technical Committee No. 10: Geophysical Testing in Geotechnical Engineering has as part of its brief the task of drafting guidelines for geophysical techniques where no other national or international standards or codes of practice exist. This document is the first of these guidelines and concerns the use of the Seismic Cone to measure downhole seismic wave propagation.

Resume

La Société Internationale de Mécanique des Sols et de la Géotechnique, le Comité technique No. 10: L'essai géophysique dans la technologie géotechnique a en tant qu'élément de son dossier le charger des directives de rédaction pour des techniques géophysiques où aucune autre norme ou recueil d'instructions nationale ou internationale n'existe. Ce document est le premier de ces directives et concerne l'utilisation du cône séismique de mesurer la propagation séismique d'ondes de downhole.

Introduction

This document is to provide guidance to practitioners and procurers on downhole seismic wave measurement using a seismic cone penetrometer. The guideline has been prepared by ISSMGE TC10: Geophysical Testing in Geotechnical Engineering and is a supplement to the International Reference Test Procedure (IRTP) for the electric Cone Penetration Test (CPT) and the Cone Penetration Test with Pore pressure (CPTU) as produced by the ISSMGE TC16. The document therefore follows, and should be used with, the CPT IRTP (1999).

The addition of a seismic sensor (usually a geophone but may be an accelerometer or seismometer) inside the barrel of a standard electric CPT is termed a Seismic Cone Penetrometer Test (SCPT) (Robertson et al., 1986). Such a sensor allows the measurement of the arrival of vertically propagating seismic body waves, generated from a source on the ground surface, in addition to the usual cone parameters that are used for detailed stratigraphic logging.

There are two types of seismic body waves, Pressure or Compression waves (P waves) as well as Shear waves (S waves) and seismic sensors react to both. The P wave always arrives first. In soils below the ground water table the P wave typically travels 2 or more times faster than the S wave, so separation of the two body waves is easy. Above the water table, however, the difference is small and separation of P and S waves may be very difficult, requiring specialized techniques. However the most significant difference between P and S waves is that S waves are reversible. Therefore using a source that can produce shear waves of opposite polarity facilitates the identification of S waves.

Since shear waves travel through the skeletal structure of the soil at very small strains, one can apply simple elastic theory to calculate the average elastic small strain shear modulus, over the length interval of measurement, as the mass density times the square of the shear wave velocity. Thus, the shear wave velocity relates directly to stiffness (Massarsch, 2004) and may also be used to estimate liquefaction susceptibility in young uncemented sands (Youd et al., 2001).

Definitions

The following definitions will be used:

- Accelerometer: Sensor that produces an output in response to a seismic wave by way of a change in capacitance caused by the relative movement of a mass and the sensor case. An accelerometer detects particle accelerations.
- Array: group of devices at one location orientated orthogonally to each other.
- Data recording equipment: Equipment to log the signals from the seismometers.
- Geophone: Sensor that gives an output in response to seismic waves using the relative movement of a mass

(magnet) moving within a coil fixed to the sensor case. A geophone detects particle velocities.

- Hammer: Heavy mass to impact the Shear Beam as part of the Source.
- Interval time: The difference in arrival times of seismic waves at the receivers at two depths/distances from the Source. The 'true interval' is the difference in arrival times between receivers at a fixed distance apart and the 'pseudo interval' is the difference in arrival times to the same receiver when placed at two different distances from the source.
- Seismometer: Device that produces a calibrated self generated output response to imposed seismic waves and gives maximum output at its natural frequency or fundamental mode (goes into resonance) when activated by seismic waves. A seismometer can be an accelerometer, geophone or a sensor able to detect deflections in the range 0 to 250 Hz.
- Seismometer natural frequency: Frequency at which the seismometer gives its maximum output and above which the seismometer response is constant. • Shear beam: Beam that forms part of the downhole seismic shear wave Source that is impacted by a Hammer to maximize S waves and minimize P waves.
- Source: Device that, when activated, generates polarised shear waves that propagate into the ground. (A basic source will include a loaded Shear Beam, Hammer and a Trigger to activate the data recording equipment).
- Trigger: Device attached to either the Shear Beam or the Hammer to initiate the data recording equipment at the instant the Shear Beam is struck by the Hammer.

Methodology

During a pause in cone penetration, a shear wave can be created at the ground surface that will propagate into the ground on a hemi-spherical front and a measurement made of the time taken for the seismic wave to propagate to the seismometer in the cone. By repeating this measurement at another depth, one can determine, from the signal traces, the interval time and so calculate the average shear wave velocity over the depth interval between the seismometers. A repetition of this procedure with cone advancement yields a vertical profile of vertically propagating shear wave velocity. Fig. 1 shows two alternative schematic arrangements of the SCPT, and Fig. 2 shows a typical arrangement of the surface shear wave source.

Equipment

The general arrangement of equipment is shown in Figs 1 and 2.

Seismometer: The seismometer will typically have a natural frequency of less than 28 Hz and must fit inside the cone barrel. The seismometer must be mounted firmly in the cone barrel with the active axis in the horizontal direction and the axis alignment indicated on the outside of cone body. The cone barrel at the location of the seismometer should be of a greater diameter than the sections immediately below the location of the seismometer to ensure good acoustic coupling between the cone barrel and the surrounding soil.

Comment: Some seismic cones include 2 seismometers in an array in the horizontal plane set with their active axes orthogonally. This configuration allows compensation for possible rotation of the cone drive rods, (and the cone containing the seismometer) with the subsequent loss in response and also gives orthogonal seismic wave traces from the same source activation. In variable and layered ground conditions, with ambient noise or ground structures that would corrupt the received signals, wave characteristics of the source can be used to identify the shear wave amongst the other waves.

The inclusion of a vertically orientated seismometer will allow the P wave element of the seismic wave to be as-sessed or P wave arrival measured if a P wave source is used. In many cases the combination of P and S wave data can enhance the identification of stratigraphic boundaries.

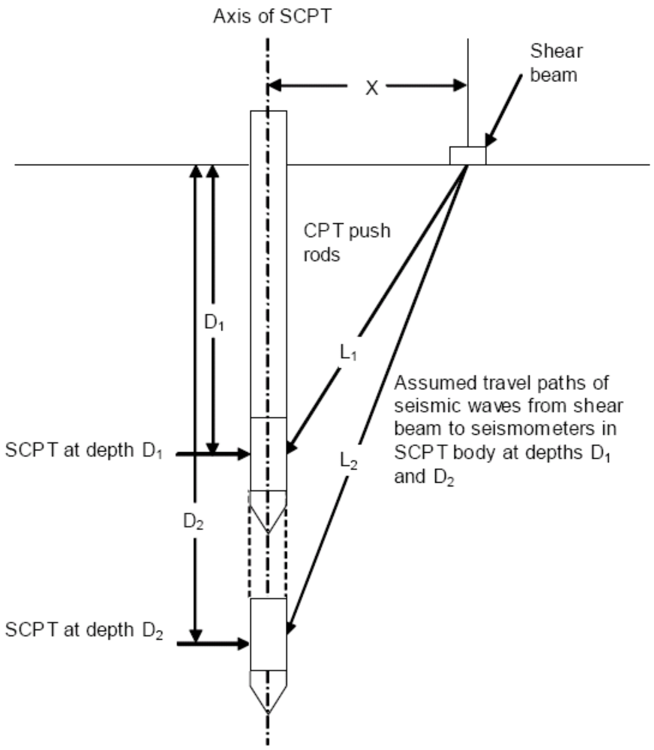

Figure 1a. Schematic diagram of the seismic cone test with required dimensions, D1, D2, and X

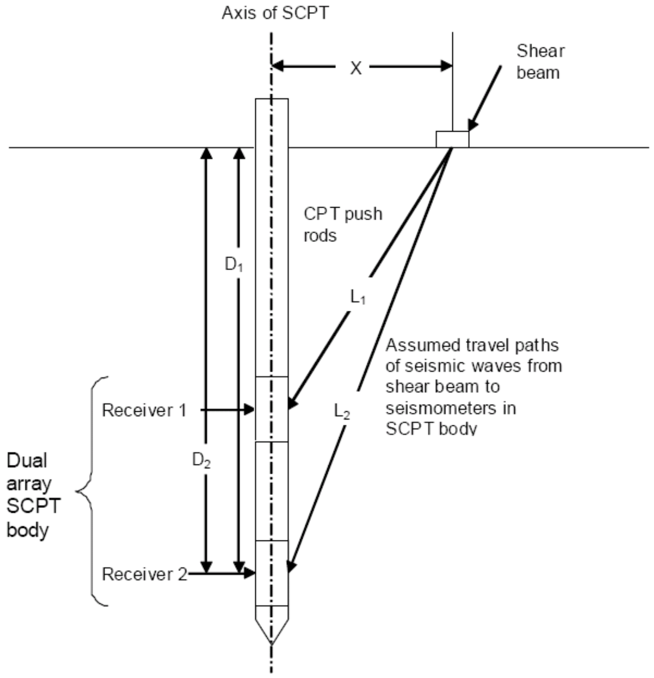

Figure 1b. Schematic diagram of the dual array seismic cone test with required dimensions, D1, D2, and X

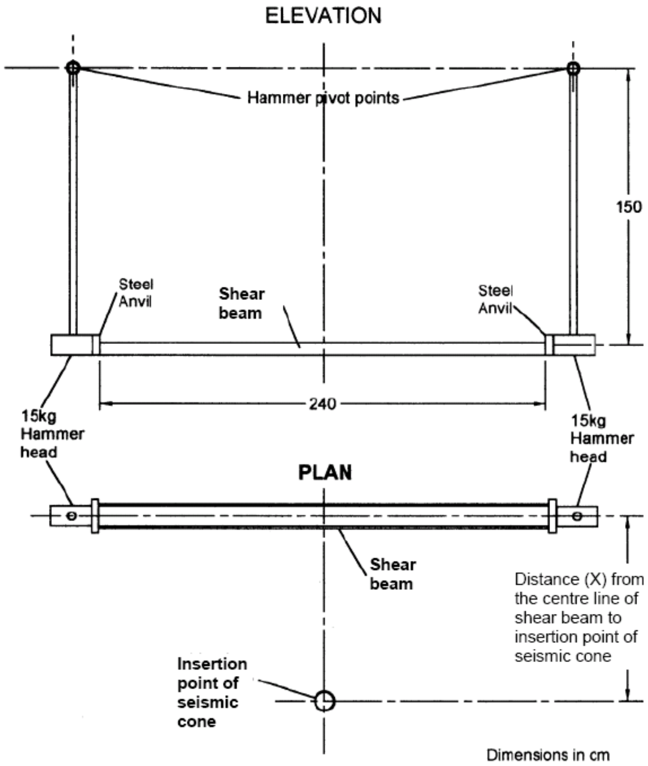

Figure 2. Typical downhole shear wave source setup with shear beam and fixed axis

Shear Beam: The beam can be metal or wood encased at the ends and bottom with minimum 25 mm thick steel. The strike plates or anvils at the ends are welded to the bottom plate and the bottom plate should have cleats welded to it, to penetrate the ground and prevent sliding when struck. The shear beam is placed on the ground and loaded by the levelling jacks of the cone pushing equipment or the axle load from vehicle wheels. The ground should be prepared to give good continuous contact along the whole length of the beam to ensure good acoustic coupling between the beam and the ground. The Shear Beam should not move when struck by the hammers otherwise energy is dissipated and does not travel into ground and does not produce repeatable seismic shear waves. The anvils, on the ends of the Shear Beam, when struck in the direction of the long axis of the Shear Beam, will produce shear waves of opposite polarity.

Comment: The beam can be continuous (approximately 2.4 m long) i.e. greater than the width of a vehicle or equipment used to load the beam and 150 mm wide or alternatively can be two shorter beams placed and loaded so that the anvils oppose and can be struck by the hammers to produce shear waves of opposite polarity. Care must be taken to position the beams and strike direction to maximise S waves and minimise the production of P waves.

Heavy hammer(s)

Comment: Two fixed axis hammers, one to strike each end of the beam in the specified directions, will significantly speed up the operation and give controllable and consistent source output. A typical setup is shown in Fig. 2.

Data recording equipment: The recording equipment can be a digital oscilloscope, a P.C. with installed A/D board and oscilloscope software or a commercial data acquisition system such as a seismograph. The data recording equip-ment must be able to record at 50 μs (microsecond) per point interval, or faster, to ensure clear uncorrupted signals and to start the logging of the seismometer outputs using an automatic trigger. An analogue anti-aliasing filter should be used to avoid corruption of signal frequencies above the device limits. Commercial data recording equipment usually include amplifiers and signal filters to help enhance recorded signals. The effect of these processes on the recorded signals must be considered before their use. For example, filtering can cause phase shift of signals and amplification is usually limited to a frequency range. In either case, the signals may not be directly comparable.

Comment: Experience has shown that there is a significant advantage to record the unprocessed data and then the effect of filtering and processing can be assessed during post processing. Most modern acquisition equipment allows the viewing of filtered signals during acquisition (to assess quality and repeatability) but saves the data un-filtered. Most modern acquisition equipment allows signal stacking to improve signal to noise ratio.

Trigger: The trigger can be fixed to the hammer head or the beam. The trigger is required to be very fast (less than 10 microsecond reaction time) and repeatable. When the hammer hits the shear beam, the electrical reaction of the trigger activates the trigger circuit that outputs to the signal recording equipment. A typical trigger circuit is given in Campanella & Stewart (1992). A seismic trigger mounted on the beam may be used if it is fast enough, repeatable and delay time is checked and known or a contact trigger that works the instant contact is made between the hammer and the anvil.

Comment: The use of 2 arrays of seismometers set in the cone barrel a fixed distance apart, say 0.5 m or 1.0 m, (termed a dual array seismic cone, see Fig. 1b) would enable the travel time of the shear wave to be measured between the seismometers from the same source activation thereby avoiding possible errors from selection of signal from different source activation, the speed of the trigger, and the accuracy of distance from the source to the receivers from successive pushes of the drive rods to each depth. In this case the seismometers must have identical response characteristics (natural frequency, calibration and damping). However if signals are to be stacked, that is the signals from successive source activations added together to improve signal to noise ratio, the trigger time must be repeatable.

Test procedures

At the start of the SCPT, the body of the cone should be rotated until the axis of a seismometer is parallel to the long axis of the shear beam.

(a) The cone is pushed into the ground, monitoring the inclination of the cone barrel during the push.

Comment: It is important to know the exact location of the receivers in all three axes and the inclinometer in the cone barrel will give the horizontal component and the depth measuring system of the CPT the vertical component.

(b) The penetration of the cone is stopped and the seismometer depth is recorded. The horizontal offset distance, X, from cone to centre of the shear beam should also be recorded (see Fig. 1).

Comment: Typically this procedure is carried out at depths greater than about 2-3 m in order to minimize the interference of surface wave effects. If the seismic cone includes a fully operative electric cone then it will be advanced at 2 cm/s and stopped typically at a rod break at 1m intervals or for pore water pressure dissipation tests. If acceptable, such stoppages can also be used for downhole seismic wave measurements. Alternatively the seismic cone can be pushed to a predetermined depth at which the shear wave velocities are required and the measurements made. To avoid the possible effects of time between stopping, pushing and making measurements, it is advisable to keep this time interval consistent. The horizontal distance, X, between the entry point of the seismic cone and the source should be *kept at around 1m. Greater distances will require the effects of curved travel paths, that particularly affect single array SCPT's, to be addressed. It is advisable at the first depth of measurement to monitor the output of the receivers without activating the source to determine the ambient seismic noise in the ground and thereby enable the filtering, as far as possible, the ambient noise. Experience has shown that ambient noise can be reduced by retracting the cone pushing system, so that the drive rods are unloaded and there is no contact between the shear beam system and the cone drive rods through the cone drive vehicle, and the cone driving equipment motors are not running.*

(c) The shear beam is struck by the hammer and the trigger activates the recording equipment that then displays the time based signal trace received by the seismometer.

Comment: For quality assurance, it is recommended to reset the trigger and repeat the procedure until a consistent and reproducible trace is obtained. The voltage-time traces should lie one over the other. If they do not, continue repeating until measured responses are identical. In the case of the dual array SCPT the traces from both the seismometers can be displayed together giving a rapid assessment of the shear wave propagation time. If the seismic wave velocity appears too high then there may be a connection between the cone drive system and the seismic cone so allowing the seismic waves to travel through the cone drive rods instead of the ground.

(d) The trigger is reset and the shear beam is then struck by the hammer on the opposite end on the other side of vehicle (causing initial particle motion in the opposite direction and a shear wave of opposite polarity) and procedure in step (c)) is again completed.

(e) Show the traces from steps (c) and (d) together and identify the shear wave (usually clearly seen with traces from the opposite polarity shear waves as a mirror image in time) and pick an arrival time. An example of a pair of signals is shown in Fig. 3.

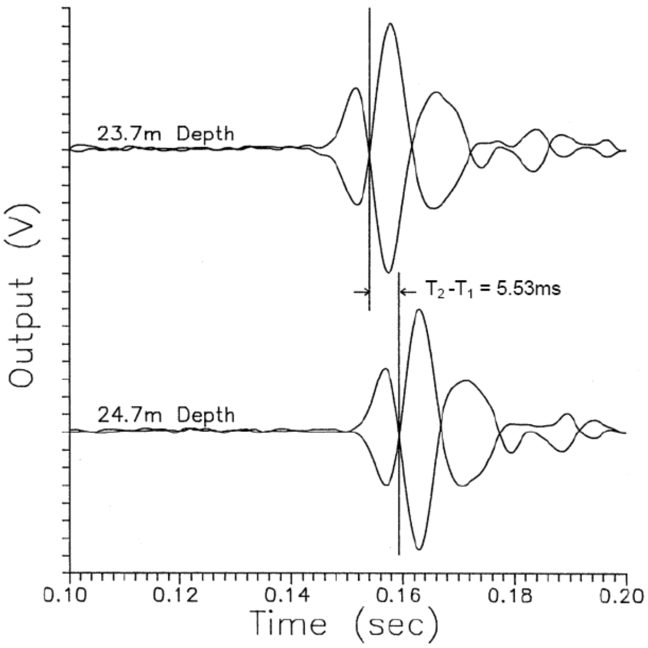

Figure 3. An example of oppositely polarised shear wave traces with clear crossover of traces showing the interval time T2 – T1

With reversed image traces, the first major cross-over can be taken as the "reference" arrival, or one trace may be used and an arrival pick made visually by an experienced operator. If the wave arrival point is not clear then a significant point that occurs on both traces can be used provided it occurs shortly after the likely wave arrival, later selections are likely to be affected by signal attenuation and dispersion. Alternately, a cross-correlation procedure may be used to find the interval travel time using the wave traces from strikes on the same side at successive depths (Campanella & Stewart, 1992). This technique is more complex, but eliminates the arbitrary visual pick of arrival time and is necessary if symmetry of reverse wave traces is lacking. If a dual array seismic cone is used then the wave traces from each seismometer can be compared to get the travel time between seismometers. Fig. 4 shows an example of 'pseudo interval' traces between 4 and 15 m depth.

Comment: As depth increases the signal to noise ratio decreases. At large depths it may be necessary to increase signal/noise (depending on the amplification, resolution and accuracy of the data recording equipment). This can be achieved by using multiple source activation events (from 4 to 10) and adding (or stacking) the measured signals. This will reduce most of the random noise and increase signal/noise ratio.

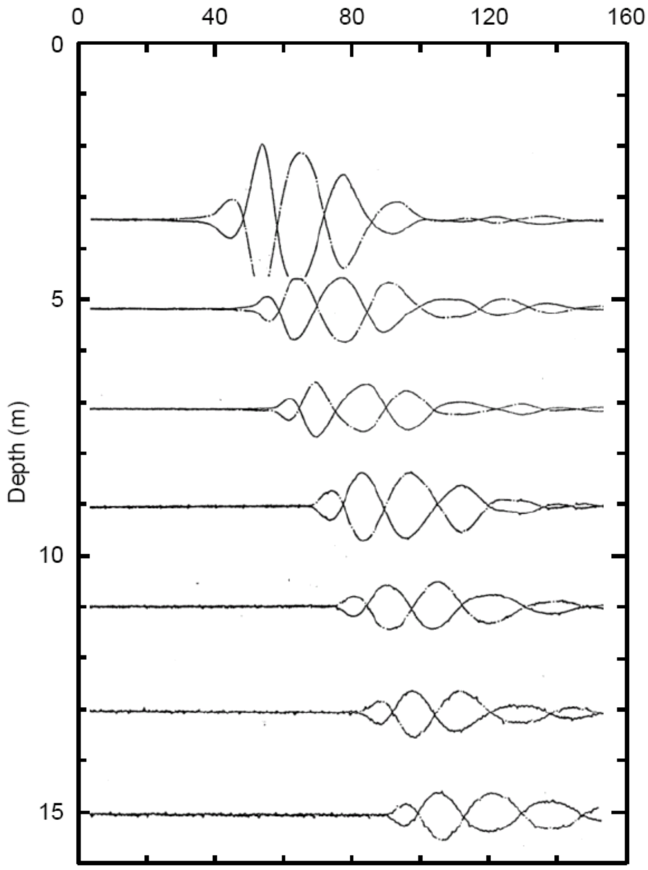

Figure 4. Example of 'pseudo interval' traces of shear waves at depths 4m to 15m

The average downhole shear wave velocity is calculated for the depth interval the cone has been driven between measurements or the fixed distance between the two seismometer sets in a dual array seismic cone.

The average shear wave velocity for the given depth interval in units of m/s and assuming straight ray paths (see Fig. 1) is given by Equation (1):

$$V_S = \frac{L_2 - L_1}{T_2 - T_1} \tag{1}$$

where

L1 = calculated length, m of the straight travel path distance from source to receiver at shallower depth (use horizontal offset, X, and vertical depth D1).

L2 = calculated length, m of the straight travel path distance from source to receiver at greater depth (use horizontal offset, X, and vertical depth D2).

T1 = shear wave travel time from source to receiver at shallower depth (along wave path L1).

T2 = shear wave travel time from source to receiver at greater depth (along wave path L2).

T2 -T1 = interval travel time.

Reporting of results and interpretation procedures

The following information shall be reported:

For each site:

(a) Length of shear beam (lengths if two beams are used) and material and composition including anvils

(b) Mass of swing hammers

(c) Fixed or free pivot point of swing hammers

(d) Trigger type and location. (for single seismometer seismic cones a typical trigger delay time)

(e) Distance (X) of shear beam from insertion point of SCPT, and distance of impact points from the insertion point of the SCPT

(f) Type of receivers, their specifications, serial numbers and name of manufacturer and last dated response calibration

(g) Type, serial number and specification of data recording equipment and name of manufacturer

For each location:

(h) Date and time of test

(i) Identification of test

(j) Altitude and location of insertion point of SCPT

For each depth:

(k) Depth of receiver(s) from ground level

(l) Direction of swing hammer action

(m) Rate of sampling and sample length for each record.

(n) Name of files where raw and processed data are recorded including media and location of storage

(o) Type and specification of real time processing included in the recorded data

(p) Type and specification of post measurement processing included in the presented data

(q) Calculated propagation times of the shear waves and the depth range over which the measurement was taken

(r) Calculation of the Shear Wave velocities and the depth range over which the velocity was calculated

The data files in n) should be stored for future access or for further processing until the end of the project or as specified by the client.

Acknowledgements

Drafts of this document were discussed at the TC 10 Members Meetings in Prague (2003) and Porto (2004). Valuable comments and suggestions for improvements were made by members of TC 10 as well as members of TC 16 'Ground Properties from In-situ Testing' and TC 1 'Offshore and Nearshore Geotechnical Engineering'. Their contributions are acknowledged with gratitude.

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Appendix

Maintenance, Checks and Calibrations:

This appendix contains informative guidance on maintenance, checks and calibrations for the SCPT but excludes those parts that are common to the CPT and are included in the CPT IRTP (1999).

1. Seismometers

The seismometers should be checked to ensure they comply to the manufacturers specification in response to seismic waves in regard to frequency, phase and damping before each profile. Where arrays of seismometers are used, such as for true interval time measurements, each seismometer must have an identical response, in laboratory test conditions, to seismic waves in regard to frequency, phase and damping.

2. Source and Triggers

Where single seismometer seismic cones are used the source activation and trigger time delay will have to be quantified. The trigger delay time needs to be repeatable and not vary by more than 1%.

(ISSMGE Bulletin: Volume 9, Issue 2, April 2015, pp. 17-25, http://issmge2014.ust.hk/~issmge/apr2015/3a.TC_corner_10.pdf)

Ground penetrating radar used to investigate tunnel deterioration

Using the GPR technology allowed the tunnel to be repaired effectively

Using ground penetrating radar to determine reason for serious pavement settling in Kentucky-Tennessee tunnel

Just a few years after the opening of the Cumberland Gap Tunnel, highway officials noticed moderate to severe settling of the continuously reinforced concrete pavement. The mountain tunnel provides an important link between Kentucky and Tennessee along US25E and the problem looked serious, with many voids discovered beneath the pavement surface.

To investigate the problems, the Kentucky Transportation Centre (KTC) brought in a research team to establish the cause of the settlement issues, using ground penetrating radar (GPR) and hydro-geochemical water testing (HGWT). The use of the GPR equipment, manufactured by Geophysical Survey Systems, Inc. (GSSI), provided information that slashed the costs for the tunnel repair project by showing precisely where repairs were necessary. The equipment now forms an integral part of the long-term inspection process that will assist in finding other distressed areas within the tunnel should they arise in the future.

The Cumberland Gap Tunnel is a twin-bore mountain tunnel in the Appalachian Mountains, which goes through the Cumberland Gap. Constructed in 1996 at a cost of US$260 million, the tunnel is located within the Cumberland Gap National Historic Park on the Kentucky-Tennessee state line. An existing narrow, winding and somewhat hazardous two-lane road goes up and over the mountain, and the state decided to build the four-lane tunnel through the park and the mountain to improve traffic safety without interfering with the scenery.

Located about around 305m below the pinnacle, the tunnel carries about 22,500 vehicles/day. About 10% of the traffic is for heavy vehicles, predominately transporting coal from mines in Kentucky to fuel a Tennessee power plant.

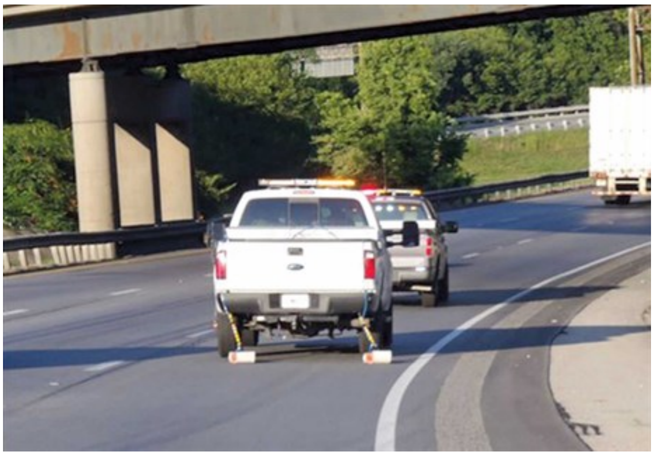
Not more than four years after the tunnel opened, highway officials noticed a settlement area and an odd dipping of pavement. The steel-reinforced concrete pavement had settled in various areas of both the north and southbound tunnels. And 10 years after the tunnel's completion, approximately 687.5m2 of pavement surface had voids beneath it that ranged from 12mm-1m deep. Only the steel reinforcement was keeping the pavement from collapsing.

The state made several attempts to shore up the settled pavement areas before starting investigative repair in 2007 that attempted to tackle the most severely damaged section and get to the root of the causes of the settlement issues.

The effort was led by a team from the University of Kentucky, College of Engineering, Kentucky Transportation Centre. The facility is contracted to perform the Kentucky Transportation Cabinet's investigative research tasks for highways, roads, bridges.

The research began with an analysis of the economic impact to tunnel users if the pavement was to fail and the link had to be closed. The study showed that if they could no longer transport coal through the tunnel and had to find an alternate route, there would be about a four hour diversion. User costs for that diversion, along with costs associated with delays for people living in Kentucky but commuting to work in Tennessee, amounted to about $1.1 million/day.

Based on the high level of economic impact, the state made the decision to find a permanent fix for the problem. But first it was necessary to locate the voids and determine why the concrete pavement had settled in various areas throughout the tunnel. In order to do this, the research team performed GPR surveys and HGWT.



GPR equipment was towed behind a vehicle for fast analysis

The tunnel was constructed with a 1.22-1.52m layer of crushed limestone-based material placed beneath the concrete pavement. By design, between 19-45.5 million litres of groundwater flows beneath the tunnels on any given day through the layer of crushed limestone. The HGWT testing showed that the groundwater inflow in certain areas is aggressive to calcite, so the calcium-rich limestone backfill material placed beneath the concrete pavement was dissolving and leaving the tunnel through the groundwater collection system every day. Some of the groundwater entering the tunnel was runoff from coal seams; when water runs through coal it changes chemical properties, becoming more acidic.

The testing results indicated that approximately 0.59-1.18m3 of limestone sub-base material disappeared from the tunnel every month due to calcium-deficient groundwater beneath it. "That's about a wheelbarrow and a half of material leaving the tunnel in solution, dissolving and washing out through drainage every day," said *Brad Rister, senior research engineer with the Kentucky Transportation Centre. This led to about 6.5-14m2 square surface feet of new void area opening up beneath the concrete pavement/month.

The team then used GPR technology developed by Geophysical Survey Systems, Inc. (GSSI) to identify the location and size of the voids or cavities. The equipment, SIR-20 and SIR-3000 control units with a 900 MHz antenna and survey wheel, was used to scan from one end of the tunnel to the other on both tunnels. Each side of the tunnel takes about 4-5 hours to scan, or about 10 hours total.

The first void found was 1.22m deep and 9m long; some of the void areas span across both lanes (9m wide) and extend from 0.3-21m in length. "The concrete pavement was essentially performing as a bridge in these void locations," said Rister. "Structural loading calculations indicate that a concrete slab if designed as a bridge would only be able to span 6" (1.82m) before starting to fail. The only reason the pavement structure did not completely collapse is because reinforcing steel is placed inside the concrete."

According to Rister, the GPR equipment was able to delineate where the problems were and gave the team a way to continue to track the problem. They had originally started using the GPR technology in 2002 to conduct scans every 6 months to identify areas where new voids were appearing. Several costly but temporary fixes had been performed that involved digging a hole and backfilling it with concrete to support the structure. "GPR gave us a visual on where the problems were located," said Rister. "It was such a large area that I don't know what else we could have done to visually see where the problems where."

The study determined that the best remediation strategy was to remove the existing limestone sub-base material and replace it with layers of crushed granite, separated by a geo-grid fabric, and a new 254mm reinforced concrete pavement. Granite is inert and has properties not affected by the low pH water.

Rister explained that the mountain through which the tunnel goes is a thrust fault – the bottom is limestone, then there is a layer of sandstone and then fieldstone. In Tennessee, the water runs through limestone, while the water coming in from Kentucky was running through fieldstone, so it didn't have calcium elements. Groundwater with no calcium to neutralise the acid was what dissolved the limestone fill in the tunnel. "Being able to confirm the geologic formation gave us confidence that there were no voids that needed to be fixed on one end of the tunnel, significantly reducing repair costs."

The initial proposal was to replace approximately 853m of pavement in each tunnel at an approximate cost of $10 million. The GPR and HGWT results, however, allowed crews to limit repairs to the isolated areas and save considerably. Completed in 2012, the project cost around $3 million. The project took 35 days, with work done 24 hours/ day.

As part of the tunnel's routine maintenance sequence, scans will be performed with the GPR every six months. The equipment is a key component of a long-term inspection process that will assist in finding other distressed areas within the tunnel if they arise in the future.

The project was selected for inclusion in the American Association of State Highway and Transportation Officials (AASHTO) 2012 High Value Research compendium, Research Impacts: Better - Cheaper - Faster. It was also featured in the National Cooperative Highway Research Program (NCHRP) executive brochure Research Makes the Difference 2012.

According to Rister, whose group performs forensics work on failures of bridges, tunnels, and roads, GPR is an important tool available to obtain discernable information, providing an understanding of whether the problem is a sink hole or settling pavement, and if the cause is water trapped beneath a roadway. "Our success goes back to use of the GPR," explained Rister. "Without it we wouldn't have had the ability to image what's going on beneath the surface."

* Brad Rister is senior research engineer with the Kentucky Transportation Centre at the University of Kentucky. His current research involves using remote sensing technologies such as: Ground Penetrating Radar; LiDAR; infrared; and laser inspection to assist in identifying and solving transportation problems non-destructively.

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2014 Oso mudslide

On Saturday, March 22, 2014, at 10:37 a.m. local time, a major landslide occurred 4 miles (6.4 km) east of Oso, Washington, United States, when a portion of an unstable hill collapsed, sending mud and debris across the North Fork of the Stillaguamish River, engulfing a rural neighborhood, and covering an area of approximately 1 square mile (2.6 km^2). Forty-three people were killed.[2]

Overview

The March 2014 landslide engulfed 49 homes and other structures in an unincorporated neighborhood known as "Steelhead Haven" 4 mi (6.4 km) east of Oso, Washington.[5] It also dammed the river, causing extensive flooding upstream as well as blocking State Route 530, the main route to the town of Darrington (population 1,347), approximately 15 miles east of Oso.[7]The natural rock and mineral formation (referred to by geologists as a "geological feature") with the most recent activity in the area of Oso is known as the Hazel Landslide; the most recent landslide event is being referred to in the media as "the Oso mudslide".[8] Excluding landslides caused by volcanic eruptions, earthquakes or dam collapses, the Oso slide is the deadliest single landslide event in United States history.[9]

2009 view to the southwest overlooking the slide site (on the left) and the Steelhead Haven plat across the river. The unstable area is the area of lighter green trees to the right and beneath the river section that is visible. The mudslide flowed towards the upper left, across the river. All of the houses visible in the image were destroyed.[6]

The Hazel Landslide has a history of instability dating back to 1937.[10][11] Prior to the March 2014 mudslide, the Oso area experienced up to 200 percent normal rainfall over the previous 45 days.[12] Described by witnesses as a "fast-moving wall of mud", the slide, which contained trees and other debris, cut through homes directly beneath the hill on the south side of the Stillaguamish River. A firefighter at the scene stated, "When the slide hit the river, it was like a tsunami". A Washington state geologist stated the slide was one of the largest landslides he had personally seen. The mud, soil and rock debris left from the mudslide covered an area 1,500 ft (460 m) long, 4,400 ft (1,300 m) wide and deposited debris 30 to 70 ft (9.1 to 21.3 m) deep.[13][14] A national geologist stated the flow of the landslide was extreme because of the extraordinary run-out of mud and debris. While the landslide is now very well documented, a research team from the Geotechnical Extreme Events Reconnaissance (GEER) plans to investi-gate the factors contributing to the slide.[15]

Casualties and damage

More than 100 first responders from Snohomish County and other surrounding counties were dispatched to assist with emergency medical and search-and-rescue efforts, including the Navy's search and rescue unit stationed at nearby Naval Air Station Whidbey Island.[16] Over 600 personnel, including more than 160 volunteers, worked on landslide recovery operations.[17]

Late in the evening of March 22, 2014, Washington's Lieutenant Governor Brad Owen declared a state of emergency in Snohomish County. Washington state Governor Jay Inslee toured the area by air the following day before joining county officials at a news conference.[18]

On March 22, the day of the slide, eight people were rescued and taken to regional hospitals.[1] Four survivors of the slide were still in Seattle-area medical facilities as of April 7, with two of the four admitted to intensive care, one remaining in stable condition at Harborview Medical Center, and another discharged from Harborview to a rehabilitation facility.[3] While the official search for victims ended in April 2014, workers and volunteers continued to screen debris and look for one victim still unaccounted for. As of July 22, the Snohomish County Sheriff's Office confirmed 43 fatalities after remains of the final victim had been located and identified.[19]

The slide blocked the North Fork of the Stillaguamish River, causing it to back up eastward. Because of concerns the mud and debris dam could fail and cause downstream flooding, a flash flood watch was issued by the National Weather Service. On April 2, with the river flowing in a new channel at the north end of the debris dam, the flash flood watch was lifted. Flooding due to the partially obstructed river continued to occur upstream of the debris dam.[20] As a result, flood warnings were still being issued for the Stillaguamish one month after the March 2014 slide.[21]

State Route 530 was indefinitely closed after the slide by the Washington State Department of Transportation (WSDOT) with an alternative local route opened the following week after snow was cleared from the unpaved portion of Mountain Loop Highway south of Darrington.[22] The highway was cleared enough by May 31 to open one lane of escorted traffic. Because the highway was badly damaged, and because the topography of the area had been altered by the landslide, WSDOT decided to elevate that section of the highway when it was rebuilt. As of July 27, the first of four stages in rebuilding the highway had been completed. The new roadway was opened September 22,[23] and the project was expected to be finished in early October 2014.[24]

Federal aid

On April 3, the mudslide was declared a major disaster by President Barack Obama. The declaration was requested on April 1 by Governor Inslee, who stated approximately 30 families needed help with housing and other needs. Inslee further stated that financial loss estimates had reached $10 million. Snohomish County Emergency Management Director

John Pennington advised residents to register with FEMA.[25] Four days later, during the passing of the Green Mountain Lookout Heritage Protection Act, the landslide was publicly mentioned by Senator Patty Murray (D-WA), saying the bill would "provide a glimmer of hope for the long-term recovery of this area."[26]

On April 22, 2014, President Obama visited the west side of slide area. After arriving in Air Force One at Paine Field in Everett, he met with officials and boarded Marine One. There, he was joined by Governor Inslee and Senators Patty Murray and Maria Cantwell as well as Rep. Suzan DelBene for a flyover of the slide and debris field. After viewing the site, the president met privately with survivors, families of the victims, and some of the scene's first responders and rescuers at a chapel and fire hall in Oso.[27]

Controversy

On March 24, two days after the slide, John Pennington, Director of Snohomish County's Department of Emergency Management, stated at a news conference, "This was a completely unforeseen slide. This came out of nowhere."[28] The same day *The Seattle Times* published an article[29] about previous slides at the same location, as well as the likelihood of future slides. The article contained comments from geologists, engineers, and local residents, and stated that the area was known among locals as "Slide Hill". On the next day, *The Times* followed up with a full page article, "'Unforeseen' risk of slide? Warnings go back decades".[28] Snohomish County Public Works Director Steve Thomsen was quoted as saying, "A slide of this magnitude is very difficult to predict. There was no indication, no indication at all."

On March 27, 2014, *The Seattle Times* reported[30] that a 2010 study, commissioned by the county, warned the hillside above Steelhead Drive was one of the most dangerous in the county. According to Rob Flaner, one of the authors of the 2010 report, "For someone to say that this plan did not warn that this was a risk is a falsity."[30] In the days following the slide, criticism of Snohomish County officials received national attention in a *New York Times* editorial.[31] *The Seattle Times* further reported that in 2004, county officials became concerned about the possibility of a dangerous landslide in the Steelhead Haven area, and considered buying out the homes of that area's residents. The idea was rejected with the county building a new wall in an attempt to stabilize the slope. Some disaster experts criticized this decision as a serious mistake.[32] According to environmental engineer and applied geomorphologist Tracy Drury, "[after the 2006 slide they] didn't even stop pounding nails." As to any kind of buy-out program, Drury further stated, "I think we did the best we could under the constraints that nobody wanted to sell their property and move elsewhere."[28]

Aerial view of slide ridge

Repairs to the slide area extend back several decades prior to the March 2014 slide. A rock revetment installed in 1962 to protect the toe of the slide area from erosion from the river was overrun by a slide two years later. An effort in 2006 to move the river 430 feet south of the erosion area failed when another landslide moved the river a total of 730 feet.[33]

Top view of slide area

Logging

In the days following the slide, scientists questioned whether logging in the area could have been a factor contributing to the hillside collapse.[34][35] Grandy Lake Forest Associates of Mount Vernon, Washington[36] proposed a 15-acre clearcut at the upper edge of the Oso landslide zone in 2004. Washington state forester Aaron Everett stated in an interview with KUOW that the application was rejected and "The one that was approved in the end eliminated the part of the harvest that would have been inside the groundwater recharge area." Everett further stated the resulting 7-acre clearcut operation reached to the edge of the groundwater danger zone.[37] An investigation is being conducted to determine whether Grandy Lake crossed into the restricted area that could theoretically feed groundwater into the landslide zone, affecting it for 16 to 27 years.[38]

Ground activity surrounding the slide

Ground vibrations generated by the Oso landslide were recorded at several regional stations and subsequently analyzed by the Pacific Northwest Seismic Network (PNSN). The initial collapse began at 10:37:22 a.m. local time (PDT; 17:37:22 UTC), lasting approximately 2.5 minutes. Debris loosened by initial collapse is believed to contain material previously disturbed and weakened by the 2006 slide. Following the initial event was another large slide occurring at 10:41:53 PDT. Additional events, most likely smaller landslides breaking off the head scarp, continued for several hours. The last notable signal came at 14:10:15.[39] Examination of records from the nearest seismic station 7 mi (11 km) to the southwest indicate small seismic events started around 8 a.m. the day of the slide and stopped in the late afternoon. However, they were not detected at the next nearest seismic station. They are also seen in the days before and after the slide, but only during daylight hours. They are believed to be related to some kind of human activity. No other indications of possible precursors have been found.[40]

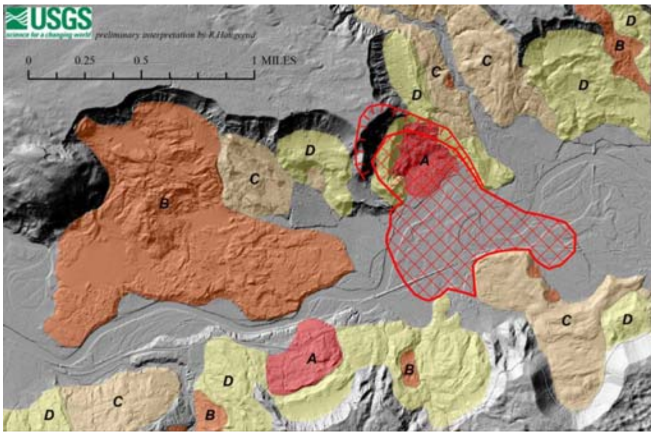
In the days following the slide, Snohomish County Emergency Management Director John Pennington speculated a 1.1 magnitude earthquake on March 10 may have triggered the landslide.[41] Data collected by the PNSN shows a magnitude 1.1 earthquake on that date in the vicinity of the Oso landslide (about 2 ±0.8 km to the northeast), at a depth of

3.9 ±1.9 km.[40][42] Regardless, the United States Geological Survey (USGS) determined the slide was not caused by seismic activity.[43]

Aerial view of the damage

Geological context

The landslide occurred at the southeastern edge of *Whitman Bench*, a land terrace about 800 ft (240 m) above the valley floor and consisting of gravel and sand deposited during the most recent glaciation.[44] When the Puget Lobe of the Cordilleran Ice Sheet moved south from British Columbia, Canada filling the Puget Lowland, various mountain valleys were dammed and lakes were formed.[45] Sediment washed down from the higher mountains settled in the lake bottoms forming a layer of clay. As the glacial ice pressed higher against the western end of Mount Frailey, water flowing around the edge of the ice from the north was forced around the mountain, eventually pouring in through the long valley extending to the northwest and now occupied by Lake Cavanaugh. Sand and gravel carried by the flow and entering the glacial lake dropped out to form a delta, the remnant of which is now known as Whitman Bench.[46]



Shaded-relief geomorphologic map of Oso Landslide of 2014 and adjacent areas. Oso is two miles west of this map, Hazel, one mile east. Colored areas are older landslides, "D" being the oldest. Upper "A" is the March 2014 landslide, lower "A", Skaglund Hill. Topography shown is from 2006; red line is approximate location of the current head scarp. Red cross-hatching is the runout area, now buried in mud and debris. Terrace on the upper-left is Whitman Bench. Image from USGS OFR 2014-1065.

Following the glacier's retreat and allowing for the lake to be released, the river carved out most of the clay and silt deposits, leaving the former delta "hanging" approximately 650 ft (200 m) above the current valley floor.[47] When the sand portion of a deposit has very little clay or "fines" to cement it together, it is structurally weak, leaving the area around it vulnerable. Such an area is also sensitive to water accumulation, increasing the internal "pore" pressure and subsequently contributing to ground failure. Water infiltrating from the surface will flow through the surface, save for contact with the less permeable clay, allowing the water to accumulate and form a zone of stability weakness.[48]Such variations in pore pressure and water flux are one of the primary factors leading to slope failure. In case of the area of the Stillaguamish River where the March 2014 slide occurred, erosion at the base of the slope from the river flow further contributes to slope instability.[49] Such conditions have created an extensive series of landslide complexes on both sides of the Stillaguamish valley. Additional benches on the margin of Whitman Bench are due to deep-seated slumping of large blocks, which also creates planes of weakness for future slippage and channels for water infiltration.[50]

History of slide activity

According to a 1999 report submitted to the Army Corps of Engineers[51] by geologist Daniel J. Miller, PhD:[52]

The Hazel landslide has been active for over half a century. Thorsen (1996) noted a tight river bend impinging on the north bank with active landslides visible in 1937 aerial photographs. The next 60 years involves two periods of relatively low landslide activity, and two periods of relatively high activity, the last of which extends to this day [1999].

Known activity at this specific site includes the following:[53]

- 1937: aerial photographs show active landslides.
- 1951: mudflow from a side channel briefly blocked the river.
- 1952: movement of large, intact blocks, leaving head scarps 70 ft (21 m) high. Later photographs show persistent activity through the next decade.
- 1967 January: slump of a large block and accompanying mud flows push the river channel about 700 ft (210 m) south. This protects the toe from erosion, activity is minor for about two decades.
- 1988 November: erosion of the toe leads to another slide, and the river is again moved south, but not as far as in 1967.
- 2006 January 25: large slide blocks the river, new channel is cut to alleviate flooding.[54]

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9 / 1989

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7 / 2005

4 / 2006 – Evidence of Landslide

8 / 2007

5 / 2009

9 / 2009

11 / 2011

7 / 2013

ΝΕΑ ΑΠΟ ΤΙΣ ΕΛΛΗΝΙΚΕΣ ΚΑΙ ΔΙΕΘΝΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΝΩΣΕΙΣ

FEDERATION OF INTERNATIONAL GEO-ENGINEERING SOCIETIES

The FedIGS website has just been officially launched
www.geoengineeringfederation.org

The **Federation of International Geo-Engineering Societies (FedIGS)** is a collaborative forum within which learned societies or associations involved in engineering with, on, or in geo-materials can meet and interact. The purpose of the Federation is to facilitate interaction among the member societies, explore opportunities to promote their common interests and provide a unified response to common issues through effective collective actions that are more effective than individual responses of the members.

The members of the federation are:

- International Society of Soil Mechanics and Geotechnical Engineering (ISSMGE)
- International Society of Rock Mechanics (ISRM)
- International Association of Engineering Geology (IAEG)
- International Geosynthetics Society (IGS)

Each of the Member Societies has its own, unique but related group of Geo-Engineering members. Some Member Societies work through chapters and individual members while others are a collection of National and Regional Societies. FedIGS creates a forum where in each of these Societies can harmonize their efforts to improve the quality and efficiency of service to their communities.

HISTORY OF FedIGS

The evolution of FedIGS can be summarized in the following two figures. In a first phase (1936 to 2000), ISSMGE, ISRM, IAEG, and then IGS were formed. There was a consistent desire to collaborate, several discussions took place but no formal structure was established and each attempt to get organized faded. I a second phase (2000-2009) there was a recognition that a formal structure was essential and FedIGS bylaws were proposed. The councils of the three founding societies (ISSME, ISRM, and IAEG) approved the FedIGS bylaws. In 2010, FedIGS saw a significant restructuring with a simplified vision for the organization described in Figure 3.

The Presidents of the four Sister Societies, IAEG, ISRM , IGS and ISSMGE created a number of Joint Technical Committees and approved the JTC Guidelines. These JTCs operate now under the umbrella of the Federation of International Geo-engineering Societies – FedIGS.

These JTCs are: JTC 1 – Natural Slopes and Landslides, JTC 2 – Representation of Geo-engineering Data and JTC 3 – Education and Training

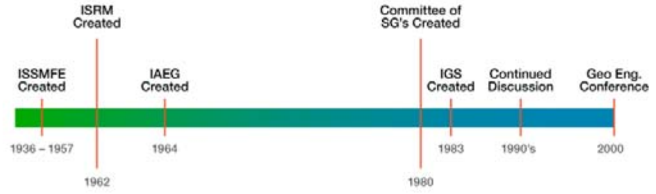

Fig. 1. First Phase: 1936 – 2000

Fig. 2. Second Phase: 2000 – 2009

1. No dues paid by member societies
2. FedIGS is unfunded; each member society pays its own way and so does the president
3. One meeting per year attended by presidents, past presidents and secretaries general
4. Limited number of joint technical committees in areas of clear overarching needs
5. No corporate associate members from industry
6. No FedIGS conferences; instead emphasize cooperation between member conferences
7. Emphasis on learning from each other and sharing successes and difficulties
8. Increase in size (IGS joins in 2014)
9. Simple web site currently sponsored by IGS

Fig. 3. FedIGS since 2010

Joint Activites

JTC1 - Natural Slopes and Landslides
JTC2 - Representation of Geo-Engineering Data
JTC3 - Education and Training

Contact Us

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President of FedIGS
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Website: www.geoengineeringfederation.org

TC19 – Asian Technical Committee (ATC): Workshop on Geo-Heritage (2nd – 4th December 2014)

Foundation of ATC19

TC19, the Technical Committee for Geotechnical Engineering for Conservation of Cultural Heritage and Historical Sites had organized a symposium in Naples in 1996.

Since then, JTC6, a Joint Technical Committee among three sister societies of Soil Mechanics, Rock Mechanics, and Engineering Geology was established in 2005. Since the TC19 had been dissolved in 2005 when the JTC6 was organized. The JTC6 was very slow with no activity for the following four years. In 2009, the TC301 for preservation of cultural heritage and historical sites was established within the organization of ISSMGE.

The most members of TC301 are from Europe and were not interested in having workshop. The Asian region where so many sites of cultural heritage awaits for being studied and needs to have workshops to exchange experiences and to collect case studies. The Vice President for Asian region, Professor Askar Zhussupbekov had agreed to establish ATC19 on geotechnical engineering for conservation of cultural heritage and historical sites.

ATC19 has been active since 2011 as follows:

- 2010/8: Establishment of ATC19
- 2011/5: ATC19 Symposium as Technical Session in the 14th Asian Regional Conference for Soil Mechanics and Geotechnical Engineering in Hong Kong
- 2012/10: Symposium in 4th Central Asian Regional Conference in Samarkand
- 2013/9: Technical Session in 18th International Conference on Soil Mechanics and Geotechnical Engineering in Paris
- 2014/12: Workshop in Angkor, Cambodia

ATC19 Workshop in Angkor

ATC19 organized a workshop in Angkor from December 2-4, 2014.

Angkor is one of the most important archaeological sites in South-East Asia. Stretching over some 400 km2 , including forested area, Angkor Archaeological Park contains the magnificent remains of the different capitals of the Khmer Empire, from the 9th to the 15th century. They include the famous Temple of Angkor Wat and, at Angkor Thom, the Bayon Temple with its countless sculptural decorations.

Angkor, in Cambodia's northern province of Siem Reap, is one of the most important archaeological sites of Southeast Asia. It extends over approximately 400 square kilometres and consists of scores of temples, hydraulic structures (basins, dykes, reservoirs, canals) as well as communication routes. For several centuries Angkor, was the center of the Khmer Kingdom.

Figure 1. Location of Angkor, Cambodia

The ATC19 workshop consists of two parts of site visit of Angkor on December 1 and paper presentation and discussion at conference room of UNESCO-JASA Office, Siem Reap.

Site Visit (1st December, 2014)

Figure 2. Banteai Srey

Figure 3. Site Visit in front of Angkor

Figure 4. Site Visit in front of the Moat of Angkor Wat

Program Workshop of ATC19 (2nd December, 2014)

08:30: Opening Address: Yoshi Iwasaki, Chair ATC19

08:35: Italian Contribution to Restoration of Angkor since 1995, by *Valter M. Santoro, IGeS World srl - IGeS Ingegneria Geotecnica e Strutturale snc*

09:05: Geotechnical Aspects of Angkor and Characteristics Elements of Authenticity, by *Yoshi Iwasaki, Ph.D., PE*

09:35: Development of Numerical Analysis for Earthen and Mason Structure Angkor by *Tomofumi Koyama, Prof., Kansai Univ.*

10:05: Numerical Simulation of N1 Tower, Prasat Suor Prat, Angkor by *Ryota Hashimoto, Ph.D. Candidate, Kyoto Univ.*

10:35: Countermeasures for Restoration of Central Tower, Bayon by *Shunsuke Yamada Ph.D. Candidate, Waseda Univ.*

11:05: Case Study in Estonia by *Mait Mets, Prof. Estonian University of Life Sciences*

11:35: History of Foundation in Tartu by *Vello Pallav, Lect. Estonian University of Life Sciences*

12:05: Discussion

12:30: Lunch

14:00-15:30: Workshop for Bayon Presentation to Advisory Member, UNESCO

16:00: Geotechnical Problems of Historical Structures in St-Petersburg and Yekaterinburg, Russia by *Askar Zhussupbekov, Prof. Eurasian National University, Kazakhstan*

The site visit includes two temples of Angkor Wat and Bayon where high central towers of heights of 60 m and 42 m respectively stand upon foundation mound of manmade soils.

Figure 5. Lunch near the Angkor Wat

Fig. 8 shows vertical section of the Bayon at the central temple in Angkor Thom. As you may understand the structures are made of masonry and manmade fill of very high mound with trenched foundation of about 15 m in thickness. The masonry tower has the dimensions of 32 m in height and 20 m in radius of the foundation. It results in bearing pressure of as large as 40 tons/m2 , which is equivalent to Reinforced Concrete Building of 30 stories. At present, when you build a RC building with 30 stories on manmade fill, what kind of foundation system you prepare.

The ancient Khmer engineer did not use pile but direct foundation on the manmade fill. The construction steps for the foundation of Bayon are shown in Fig. 9.

Figure 6. In front of Angkor Wat with central tower with 60 m in height

Figure 7. Bayon Temple with central tower with 42 m in height

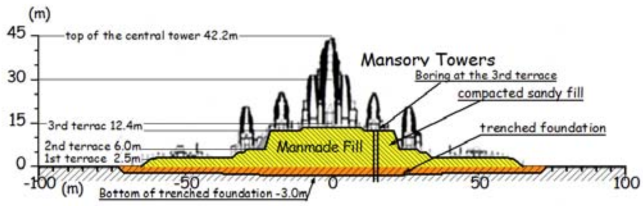

Figure 8. NS section of Bayon Temple, Angkor Thom

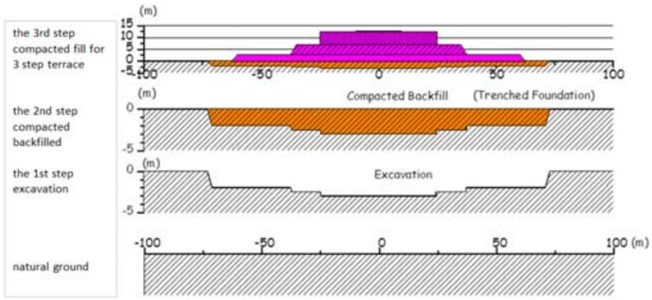

Figure 9. Construction step of foundation for masonry structures in Bayon temple, Angkor

The central tower has been stable for more than 800 years since its construction approximately 1190 A.D. In 2012, Japanese Government Team for Safeguarding Angkor has carried out boring at the top of the filled mound.

The results were shown in Fig.10. We found very large number of the SPT N-values reaching over N=100. The sampled core is very "dense sand" and the decrease of water contents of the samples corresponds to increase of the SPT N-values as shown in Fig. 11.

The secret of the strong stability is considered from hydrogen bonding among sand grains.

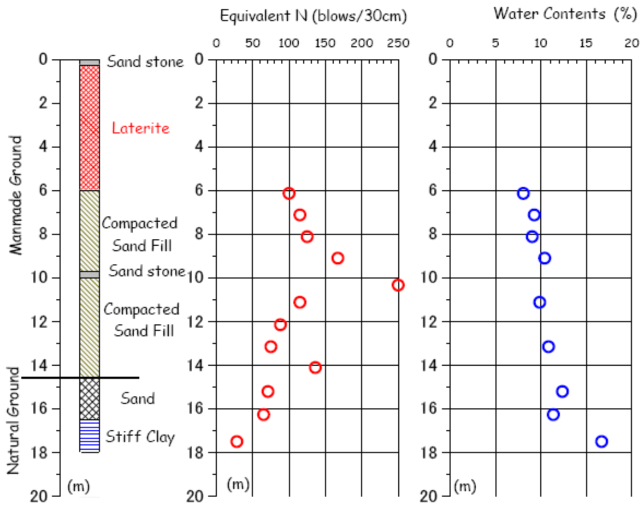

Figure 10. Boring at the 3rd terrace of Bayon

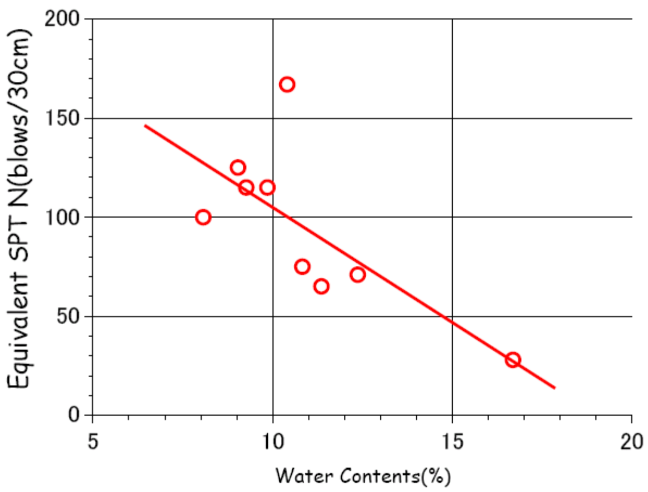

Figure 11. SPT N-values vs. water contents

Preventive Conservation

It is anticipated that the hydrogen bonding shall be lost due to heavy rain in the current trend of global warming climate. If the bonding is destroyed, the bonding strength of dense sand that is composed of surface tension shall be lost resulting in the failure of the bearing capacity to support heavy central tower.

To prevent such foundation failure, it is now planned to monitor the effects of infiltration of rain water to the manmade sandy ground. In this way, the concept of "Preventive Conservation" is being proposed rather than conservation after recognition of deformation, damage or even failure.

Figure 12. Angkor Wat (Central Tower: 65 m in height)
Foundation system unknown

The Authenticity of Angkor Monuments

Cultural Heritage such as historical structures or monuments like in Angkor is basically recognized as valuable to be preserved in the future as "Heritage."

The very essence of the heritage that is to be preserved is called as the characteristic element of the authenticity of the heritage.

In Angkor, as shown in Figs 8 and 9, the trenched foundation and high manmade soil mound at Bayon temple is the unique system that support heavy stone masonry and is identified as the characteristic element of the Angkor heritage.

In the past, geotechnical engineering was considered as only to provide repairing technique for foundation of the upper structure of the cultural heritage.

The foundation has been considered as only to support upper structure. However, the foundation is one of the important parts of the structure and the heritage structure should be evaluated including foundations as well.

As shown above, geotechnical engineering could contribute in providing the fundamental knowledge to discuss the authenticity in addition to only repairing and strengthening foundation.

Yoshinori Iwasaki, Chairman of ATC19

(ISSMGE Bulletin: Volume 9, Issue 2, April 2015, pp. 26-31, http://issmge2014.ust.hk/~issmge/apr2015/3b.TC_corner_19.pdf)

ΠΡΟΣΕΧΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΚΔΗΛΩΣΕΙΣ

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

ICGE 2015 International Conference in Geotechnical Engineering – Colombo-2015, 10 - 11 August 2015, Colombo, Colombo, Sri Lanka, http://www.slgs.lk/?p=564

Numerical Analysis in Geotechnics, 20 August 2015, Hanoi, Vietnam, nag2015secretariat@gmail.com

Subsea Tunnels, 2-3 September 2015, Seoul, Korea www.tu-seoul2015.org

SICAT 2015 - Symposium on Innovation and Challenges in Asian Tunnelling 2015, 2 to 3 September 2015, Singapore, tucss@cma.sg, www.tucss.org.sg.

China Shale Gas 2015 - an ISRM Specialized Conference, 6-8 September 2015, Wuhan, China, http://english.whrsm.cas.cn/ic/ic/201405/t20140509_120692.html

"Underground Construction" Conference, 8-9 September 2015, Krakow, Poland, www.inzynieria.com

13th International Benchmark on the Numerical Analysis of Dams, 9 - 11 September 2015, Lausanne | Switzerland http://icold2015bmw.epfl.ch

International Symposium on Geohazards and Geomechanics 10-11 September, 2015, Coventry, U.K., www.warwick.ac.uk/isgg2015

24th European Young Geotechnical Engineers Conference in Durham, UK, 11-12 September, 2015, https://www.dur.ac.uk/conference.booking/details/?id=419

16th European Conference on Soil Mechanics and Geotechnical Engineering "Geotechnical Engineering for Infrastructure and Development", 13 - 17 September 2015, Edinburgh, UK, www.xvi-ecsmge-2015.org.uk

2015 Cutting Edge "Urban Tunneling", September 21-23, 2015, Denver, USA, www.ucaofsmecuttingedge.comwww.ucaofsmecuttingedge.com

Workshop on Volcanic Rocks & Soils, 24 - 25 September 2015, Isle of Ischia, Italy, www.associazionegeotecnica.it

The 7th International Symposium on Roller Compacted Concrete (RCC) Dams, Chengdu, China, Sept. 24th-25th, 2015, www.chincold.org.cn

Athens 2015 International Landfill Mining Conference, September 24-25, 2015, Athens, http://www.erasmus.gr/microsites/1050/welcome-address

TranSoilCold 2015 - The 2nd International Symposium on Transportation Soil Engineering in Cold Regions, September 24-26, 2015, Novosibirsk, Russia, http://transoilcold2015.stu.ru/index.htm

International Conference on Landslides and Slope Stability (SLOPE 2015), September 27-30, 2015, Bali, Indonesia, www.slope2015.com

Sardinia 2015 International Waste Management and Landfill Symposium, 5-9 October 2015, Santa Margherita di Pula, Italy, www.sardiniasymposium.it

GE Basements and Underground Structures Conference 2015, 6 - 7 October 2015, London, UK, http://basements.geplus.co.uk

EUROCK 15 ISRM European Regional Symposium & 64th Geomechanics Colloquy, 7 – 9 October 2015, Salzburg, Austria, www.eurock2015.com

Shotcrete for Underground Support XII New Developments in Rock Engineering, TBM tunnelling, Deep Excavation and Underground Space Technology, October 11-13, 2015, Singapore, www.engconf.org/conferences/civil-and-environmental-engineering/shot-crete-for-underground-support-xii

5th International Symposium on Geotechnical Safety and Risk (ISGSR 2015), 13-16 October 2015, Rotterdam, The Netherlands www.isgsr2015.org

International Workshop on Tsunamis in the World: from Source Understanding to Risk Mitigation, 14 to 16 October, 2015, Heraklion, Greece, www.gein.noa.gr/itw2015

LTBD2015

3rd International Workshop on Long-Term Behaviour and Environmentally Friendly Rehabilitation Technologies of Dams

Hohai University, Nanjing, October 17-19, 2015

LTBD2015@gmail.com

The 3rd International Workshop on Long-Term Behaviour and Environmentally Friendly Rehabilitation Technologies of Dams (LTBD2015) is a non-profit event without registration fee and will be held from 17th -19th October 2015 in Nanjing, China. The meeting will provide an excellent opportunity for high level scientists, engineers, operators and young PhD students to present and exchange their experiences and the latest developments related to the design, performance rehabilitation and environmental aspects of earth, rockfill and concrete dams.

Topics of the Workshop

- Methods of Design and Analysis of Dams
- Dam Monitoring and Instrumentation
- Time Dependent Properties of Construction Materials for Dams and their Constitutive Modelling
- Internal Erosion and Interface Problems
- Dam Foundation and Structure Interactions
- Seismic Aspects and Earthquake Analysis
- Safety Assessment - Environmental Issues
- Operation and Dam Maintenance
- Rehabilitation

International Workshop
Civil Engineering Applications of Ground Penetrating Radar
19 –20 October 2015, Athens, Greece
http://pavnet.civil.ntua.gr

HYDRO 2015, 26-28 October 2015, Bordeaux, France, www.hydropower-dams.com/pdfs/hydro2015.pdf

International Conference on Engineering Geology in New Millennium, 26-31 October 2015, New Delhi, India, http://isegindia.org/pdfs/1st%20circular-international-IAEG.pdf

6th International Conference on Earthquake Geotechnical Engineering, 2-4 November 2015, Christchurch, New Zealand, www.6icege.com

SEOUL 2015 - 25th World Road Congress Roads and Mobility – Creating New Value from Transport, 2–6 November, 2015, Seoul, Republic of Korea, http://www.aipcrseoul2015.org

4° Πανελλήνιο Συνέδριο Αναστηλώσεων, Νοέμβριος 2015, Θεσσαλονίκη, www.etepam.gr.

The 15th Asian Regional Conference on Soil Mechanics and Geotechnical Engineering, 9-13 November 2015, Fukuoka, Japan, http://www.15arc.org

Tunnels and Underground Construction 2015, 11-13 November 2015, Žilina, Slovak Republic, www.tps2015.sk

15th Pan-American Conference on Soil Mechanics and Geotechnical Engineering, 15 - 18 November 2015, Buenos Aires, Argentina, http://conferencesba2015.com.ar

GEOMATE, 16 -18 November 2015, Osaka, Japan, www.geomate.org

VIII South American Congress on Rocks Mechanics, 15 - 18 November 2015, Buenos Aires, Argentina, http://conferencesba2015.com.ar

Sixth International Conference on Deformation Characteristics of Geomaterials IS Buenos Aires 2015, November 15th to 18th 2015, www.saig.org.ar/ISDCG2015

TBM DiGs Tunnel Boring Machines in Difficult Grounds, 18-20 November 2015, Singapore, www.tbmdigs.org

Arabian Tunnelling Conference & Exhibition: Innovative Underground Infrastructure - And Opportunities, 23-25 November 2015, Dubai, UAE, www.atcita.com

Geo-Environment and Construction, 26-28 November 2015, Tirana, Albania, Prof. Dr. Luljeta Bozo, lulibozo@gmail.com; luljeta_bozo@universitetipolis.edu.al

ICSGE 2015 - The International Conference on Soft Ground Engineering, 3-4 December 2015, Singapore, www.geoss.sg/icsge2015

The 1st International Conference on Geo-Energy and Geo-Environment (GeGe2015) 4th and 5th December 2015, Hong Kong, http://gege2015.ust.hk

2015 6th International Conference Recent Advances in Geotechnical Engineering and Soil Dynamics, December 7-11, 2015, New Delhi (NCR), India, wason2009@gmail.com; wasonfeq@iitr.ernet.in, sharmamukat@gmail.com; mukutfeq@iitr.ernet.in, gvramanaiitdelhi@gmail.com, ajaycbri@gmail.com

Southern African Rock Engineering Symposium an ISRM Regional Symposium, 5 January 2016, Cape Town, South Africa, http://10times.com/southern-african-rock

ASIA 2016 - Sixth International Conference on Water Resources and Hydropower Development in Asia, 1-3 March 2016, Vientiane, Lao PDR, www.hydropower-dams.com/pdfs/asia20161.pdf

GeoAmericas 2016 3rd Panamerican Conference on Geosynthetics, 11 – 14 April 2016, Miami Beach, USA, www.geoamericas2016.org

International Symposium on Submerged Floating Tunnels and Underwater Structures (SUFTUS-2016), 20-22 April 2016, Chongqing, China, www.cmct.cn/suftus

World Tunnel Congress 2016 "Uniting the Industry", April 22-28, 2016, San Francisco, USA, http://www.wtc2016.us

International Symposium "Design of piles in Europe - How did EC7 change daily practice?", 28-29 April 2016, Leuven, Belgium, www.etc3.be/symposium2016

7th In-Situ Rock Stress Symposium 2016 - An ISRM Specialised Conference, 10-12 May 2016, Tampere, Finland, www.rs2016.org

84th ICOLD Annual Meeting, 16-20 May 2016, Johannesburg, South Africa, www.icold2016.org

13th International Conference Underground Construction Prague 2016 and 3rd Eastern European Tunnelling Conference (EETC 2016), 23 to 25 May 2016, Prague, Czech Republic, www.ucprague.com

GEOSAFE: 1st International Symposium on Reducing Risks in Site Investigation, Modelling and Construction for Rock Engineering - an ISRM Specialized Conference, 25 – 27 May 2016, Xi'an, China, www.geosafe2016.org/dct/page/1

www.ege2016.gr

The Geological Society of Greece (EGE) announces its 14th International Conference. The Conference is going to be held in Thessaloniki (Northern Greece), during May 25-27, 2016 and will be hosted at the Aristotle University Research Dissemination Centre (kedea.rc.auth.gr).

The primary goal of the Conference is the presentation of the most recent advances in Earth and Environmental Sciences, mainly in the Aegean Region and its surroundings, aiming at highlighting their impacts on natural resources, natural hazards, and environmental problems.

SUBJECTS - THEMES

The Conference addresses all subjects of Earth Sciences. A tentative list of themes follows: Active Tectonics, Applied Geophysics, Applied Mineralogy, Archaeometry, Atmospheric Environment, Climatology, Energy Resources, Engineering Geology, Environment and Health, Geoarchaeology, Geochemistry, Geochronology, Geology and Education, Geosciences and Environment, Geothermal Energy, Geotopes, GIS and Geoinformatics, Hydrogeology, Industrial Rocks and Minerals, Marine Geology, Meteorology, Mineralogy, Mineral Exploration, Natural Hazards, Neotectonics, Oceanography, Ore Deposits, Palaeoclimatology, Palaeontology, Physical Geography, Physics of the Earth's Interior, Quaternary Geology, Remote Sensing / Earth Observation, Sedimentology, Seismology, Speleology, Stratigraphy, Structural Geology, Sustainable Development, Tectonics, Urban Geology.

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http://nbevents.gr

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NGM 2016 - The Nordic Geotechnical Meeting, 25 - 28 May 2016, Reykjavik, Iceland, www.ngm2016.com

19SEAGC – 2AGSSEAC Young Geotechnical Engineers Conference, 30th May 2016, Petaling Jaya, Selangor, Malaysia, seagc2016@gmail.com

19th Southeast Asian Geotechnical Conference & 2nd AGSSEA Conference Deep Excavation and Ground Improvement, 31 May – 3 June 2016, Subang Jaya, Malaysia, seagc2016@gmail.com

ISSMGE TC211 Conference Session within the framework of the 19th Southeast Asian Geotechnical Conference "GROUND IMPROVEMENT works: Recent advances in R&D, design and QC/QA"

ISL 2016 12th International Symposium on Landslides Experience, Theory, Practice, Napoli, June 12th-19th, 2016, www.isl2016.it

4th GeoChina International Conference Sustainable Civil Infrastructures: Innovative Technologies for Severe Weathers and Climate Changes, July 25-27, 2016, Shandong, China, http://geochina2016.geoconf.org

6th International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics August 1-6, 2016, Greater Noida (NCR), India, www.6icragee.com

EUROC 2016 - ISRM European Regional Symposium Rock Mechanics & Rock Engineering: From Past to the Future, 29-31 August 2016, Ürgüp-Nevşehir, Cappadocia, Turkey http://eurock2016.org

3rd ICTG – 3rd International Conference on Transportation Geotechnics 4 - 7 September 2016, Guimaraes, Portugal, www.civil.uminho.pt/3rd-ICTG2016

IAS'5 5th International Conference on Geotechnical and Geophysical Site Characterisation, 5-9 September 2016, Gold Coast, Queensland, Australia http://www.isc5.com.au

SAHC 2016 - 10th international Conference on Structural Analysis of Historical Constructions 13-15 September 2016, Leuven, Belgium, www.sahc2016.be

13 Baltic States Geotechnical Conference Historical Experiences and Challenges of Geotechnical Problems in Baltic Sea Region, 15 - 17 September 2016, Vilnius, Lithuania, http://www.13bsgc.lt

EuroGeo 6 – European Regional Conference on Geosynthetics, 25 – 29 Sep 2016, Istanbul, Turkey, www.eurogeo6.org

ARMS 9, 9th Asian Rock Mechanics Symposium, ISRM Regional Symposium, 18-20 October 2016, Bali, Indonesia, http://arms9.com

GeoAsia 6 - 6th Asian Regional Conference on Geosynthetics 8-11 November 2016, New Delhi, India, http://seags.ait.asia/news-announcements/11704

☙ ❧

Recent Advances in Rock Engineering - RARE 2016 - an ISRM Specialised Conference
16-18 November 2016, Bangalore, India

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☙ ❧

AfriRock 2017, 1st African Regional Rock Mechanics Symposium, 12 – 17 February 2017, Cape Town, South Africa, www.saimm.co.za/saimm-events/upcoming-events

☙ ❧

World Tunnel Congress 2017
Surface problems – Underground solutions
9 to 16 June 2017, Bergen, Norway
www.wtc2017.no

"Surface problems – Underground solutions" is more than a slogan; for ITA-AITES and its members it is a challenge and commitment to contribute to sustainable development. The challenges are numerous and the availability of space for necessary infrastructure ends up being the key to good solutions. The underground is at present only marginally utilized. The potential for extended and improved utilization is enormous.

☙ ❧

EUROCK 2017
13-15 June 2017, Ostrava, Czech Republic

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☙ ❧

19th International Conference on Soil Mechanics and Geotechnical Engineering, 17 - 22 September 2017, Seoul, Korea, www.icsmge2017.org

☙ ❧

GeoAfrica 2017
3rd African Regional Conference on Geosynthetics
9 – 13 October 2017, Morocco

☙ ❧

11th International Conference on Geosynthetics (11ICG)
16 - 20 Sep 2018, Seoul South Korea
csyoo@skku.edu

☙ ❧

10th Asian Rock mechanics Symposium - ARMS10
October 2018, Singapore

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E-mail: zyingxin@dsta.gov.sg

☙ ❧

AFTES International Congress
"The value is Underground"
13-16 November 2017, Paris, France

☙ ❧

World Tunnel Congress 2018
20-26 April 2018, Dubai, United Arab Emirates

☙ ❧

14th ISRM International Congress
2019, Foz de Iguaçu, Brazil

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ΕΝΔΙΑΦΕΡΟΝΤΑ ΓΕΩΤΕΧΝΙΚΑ ΝΕΑ

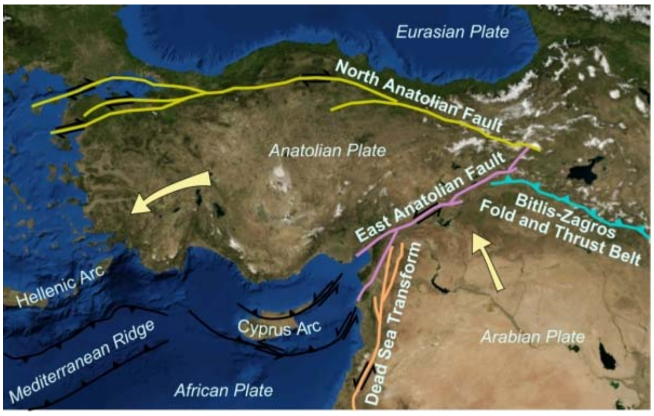
ΛΑΣΠΟΡΟΗ στην Ρωσία

Την σπάνια αυτή περίπτωση κατέγραψε κάποιος στη Ρωσία. Το βίντεο που κάνει το γύρο του διαδικτύου θα μπορούσε αν είναι απόσπασμα από ταινία επιστημονικής φαντασίας, αλλά στη πραγματικότητα είναι κάπου στη Ρωσία. Οι ελάχιστες πληροφορίες που δίνονται προσδιορίζουν την καταγραφή σε δασική περιοχή στην πόλη Zarechnyi.

(Оползень Заречный 01.04.2015, https://www.youtube.com/watch?v=1gSDgZaHvtg)

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΣΕΙΣΜΟΙ

Earthquake history of Istanbul hidden in seabed soil samples



Although earthquakes along the North Anatolian Fault (NAF) have been very frequent and devastating to the city of Istanbul, recurrence rate has been difficult to evaluate as faults are located offshore. A new study published in the Bulletin of the Seismological Society of America (BSSA) brings new evidence on the earthquake history of NAF's main segment based on seabed soil samples.

According to Laureen Drab, a seismologist at the Ecole Normale Superieure in Paris France, the important finding of the study is the assignment of past earthquake events to specific fault segments. The particular information, knowing which segment of the fault ruptured when, has a great impact on the recurrence rate of earthquakes along the main fault that shakes Istanbul from time to time.

Examining two cores of sediment deposits from the area's seabed, the research team tried to identify and date earthquake-induced disturbances. Rapidly deposited layers, or turbidites, of silt and sand of different grain sizes, minerals and geochemical properties, as a result of underwater landslides, were the leading earthquake-induced evidence. To date the specific disturbances, radiocarbon and other tests were performed on the two samples.

Drab and her research team, managed to reconstruct the earthquake time occurrence along Cinarcik fault, being the NAF's main segment, based on historical and the newly obtained data. Turbidites revealed that six events from 136 to 1896 AD were attributed to the Cinarlik Fault, while the 1766 AD rupture, previously assigned to the Cinarlik Fault, was now attributed to another segment.

(Geoengineer.org, Monday, 06 April 2015)

Seabed samples rewrite earthquake history near Istanbul

Located in the Marmara Sea, major earthquakes along the North Anatolian Fault (NAF) system have repeatedly struck what is current-day Istanbul and the surrounding region, but determining the recurrence rate has proven difficult since the faults are offshore. Cores of marine sediment reveal an earthquake history of the Cinarcik Segment, a main branch of NAF, and suggest a seismic gap where the next earthquake is likely to rupture, as detailed in a new study published in the *Bulletin of the Seismological Society of America* (BSSA).

The area has experienced several large earthquakes (>M6), and the scientific community has debated the exact location of the ruptures along the North Anatolian Fault, which extends nearly 750 miles across Northern Turkey and in the Aegean Sea. Most of the deformation on the fault is localized on the northern branch of the NAF, which crosses the Marmara Sea.

"The important part of this study is that it assigns past earthquakes to specific segments of the fault," said lead author Laureen Drab, a seismologist at the Ecole Normale Superieure in Paris, France. "Knowing which segment ruptured when has a big impact on the recurrence rate of earthquakes on the main fault segment that affects Istanbul."

Drab and her colleagues examined two cores of sediment deposits removed from the seabed to identify and date widespread quake-induced disturbances. Large earthquakes on submarine faults can cause underwater landslides, shaking up sediments that result in rapidly deposited layers, or turbidites, of silt and sand of jumbled grain sizes, minerals and specific geochemical properties. Radiocarbon dating and other tests of two core samples identified the age and timing of deposits.

Combining the historical catalogue and the new data from the core samples, Drab reconstructed the timing of earthquakes along NAF's main segment. The turbidites reveal six large earthquake-related events, from 136 to 1896 AD, along the Cinarcik Fault and reassigned the 1766 AD rupture previously thought to have occurred on the Cinarcik Fault to another segment.

"The combined records show three entire rupture sequences on the NAF, with the current sequence incomplete along the Cinarcik Fault," said Drab. "Based on this new data, we see that there is a seismic gap on the Cinarcik Segment, which, from my point of view, is where the next earthquake is likely to occur."

Story Source:

The above post is reprinted from materials provided by **Seismological Society of America**. *Note: Materials may be edited for content and length.*

Journal Reference:

Laureen Drab et al. **Submarine Earthquake History of the Çınarcık Segment of the North Anatolian Fault in the Marmara Sea, Turkey**.*Bulletin of the Seismological Society of America*, April 2015 DOI:10.1785/0120130083

Submarine Earthquake History of the Çınarcık Segment of the North Anatolian Fault in the Marmara Sea, Turkey

Laureen Drab, Aurélia Hubert-Ferrari, Sabine Schmidtc, Philippe Martinezc, Julie Carlutd, and Meriam El Ouahabib

Abstract

The North Anatolian fault (NAF) in the Marmara Sea is a significant hazard for the city of Istanbul. The use of paleoseismological data to provide an accurate seismic risk assessment for the area is constrained by the fact that the NAF system is submarine; thus a history of paleoearthquakes can be inferred only by using marine sediment cores. Here, a record of turbidites was obtained in two cores and used to reconstruct the earthquake history along the Çınarcık segment, a main branch of the NAF. KIg04 was

collected from a berm north of the fault, and Klg03 was positioned in the Çınarcık basin, south of the fault. The cores were correlated using long-term geochemical variations in the sediment, and turbidites deposited simultaneously at both sites were then identified. Radionuclide measurements suggest the most recent turbidite was triggered by the 1894 C.E. M_w 7.3 earthquake. We conclude that the turbidites identified at both sites are earthquake generated, based on their particular sedimentological and geochemical signatures; the correlation of turbidites at berm and basin sites; and the match of the most recent turbidite with a nineteenth century historical earthquake. To date older turbidites, we used carbon-14 and paleomagnetic data to build an OxCal model with a local reservoir correction of 400±50 yr. The Çınarcık segment is found to have ruptured in 1509 C.E., sometime in the fourteenth century, in 989 C.E., and in 740 C.E., with a mean recurrence interval in the range of 256–321 years. Finally, we used the earthquake record obtained to review the rupture history of the adjacent segments over the past 1500 years.

(http://www.bssaonline.org/content/105/2A/622)

Εξυπνα κινητά σε ρόλο σεισμογράφου

Το κινητό στην τσέπη σας ίσως κάποια στιγμή να σας σώσει από σεισμό. Τα «έξυπνα» τηλέφωνα (smartphones) και άλλες ηλεκτρονικές φορητές συσκευές μπορεί στο μέλλον να αξιοποιηθούν μαζικά για την έγκαιρη προειδοποίηση κάποιου μεγάλου επερχόμενου σεισμού. Ερευνητές στις ΗΠΑ έδειξαν για πρώτη φορά ότι αν συνδυαστούν στοιχεία από τους δέκτες GPS πολλών συσκευών, είναι δυνατό να αποκαλυφθεί ότι επίκειται ισχυρός σεισμός.

Οι ερευνητές της Γεωλογικής Υπηρεσίας των ΗΠΑ, της NASA και αμερικανικών πανεπιστημίων (Caltech, Χιούστον, Κάρνεγκι Μέλον), με επικεφαλής τους γεωφυσικούς Σάρα Μίνσον και Μπένζαμιν Μπρουκς, που έκαναν τη σχετική δημοσίευση στο νέο επιστημονικό περιοδικό "Science Advances", σύμφωνα με το "Science" και το "New Scientist", διαπίστωσαν ότι οι αισθητήρες GPS, αν και δεν έχουν την ακρίβεια των επιστημονικών οργάνων όπως ένας σεισμογράφος, παρόλα αυτά είναι σε θέση να ανιχνεύσουν την μετακίνηση του εδάφους λόγω ενεργοποίησης ενός ρήγματος, πράγμα που προαναγγέλλει έναν μεγάλο σεισμό.

Αν υπάρχει ένα σύστημα που συλλέγει επιμέρους στοιχεία από χιλιάδες κινητά τηλέφωνα όσων θέλουν να συμμετάσχουν σε ένα τέτοιο πρόγραμμα, τότε είναι δυνατό -με την κατάλληλη ανάλυση των μαζικών δεδομένων από υπολογιστές- να ανιχνευθεί ο επερχόμενος σεισμός και να εκδοθεί σχετική άμεση προειδοποίηση, κατ' αρχήν στους ίδιους τους χρήστες που έστειλαν τα σχετικά στοιχεία μέσω του κινητού τους.

Μια τέτοια τεχνολογία θα ήταν χρήσιμη τόσο ως συμπληρωματικό εργαλείο σε ανεπτυγμένες χώρες, όσο και σε φτωχότερες χώρες όπου δεν υπάρχουν ακόμη εξελιγμένα συστήματα επιτήρησης σεισμών. Πρόκειται για μια ακόμη περίπτωση όπου ο πληθο-πορισμός (croud-sourcing) και οι ερασιτέχνες πολίτες έρχονται να συμβάλουν στην επιστημονική έρευνα και μάλιστα με πολύτιμο πρακτικό αντίκρυσμα.

Σήμερα στη Γη υπάρχουν πολύ λίγα συστήματα έγκαιρης προειδοποίησης (σε Καλιφόρνια, Ιαπωνία και Μεξικό), τα οποία μπορούν να ανιχνεύσουν αμέσως την έναρξη του σεισμού και να πάραυτα να μεταδώσουν αυτόματα σήματα προειδοποίησης στους κατοίκους μιας περιοχής, προτού αυτοί νιώσουν τη γη να τρέμει. Το μεγαλύτερο μέρος του πληθυσμού της Γης δεν έχει όμως τη δυνατότητα να πληροφορείται έγκαιρα για καποιον σεισμό, λόγω του μεγάλου κόστους μιας τέτοιας υποδομής.

Οι ερευνητές υπολόγισαν ότι δεν χρειάζονται πάνω από 5.000 άτομα να στείλουν στοιχεία από το κινητό τους για να γίνει ανίχνευση του ακριβούς επικέντρου του σεισμού σε λίγα μόλις δευτερόλεπτα από την έναρξή του και έτσι να υπάρξει έγκαιρη προειδοποίηση μιας μεγάλης πόλης για το επικείμενο συμβάν.

Όπως είπε ο καθηγητής του Πανεπιστημίου του Χιούστον Κρεγκ Γκλένι, «η ταχύτητα ενός ηλεκτρονικού σήματος προειδοποίησης είναι μεγαλύτερη από την ταχύτητα μετάδοσης του ίδιου του σεισμού (σ.σ. των σεισμικών κυμάτων)». Μια προειδοποίηση έστω και λίγα δευτερόλεπτα προτού αρχίσει ο σεισμός, μπορεί να κάνει τη διαφορά μεταξύ ζωής και θανάτου.

Αρχικά, το σύστημα φαίνεται να «δουλεύει» μόνο με ισχυρούς σεισμούς τουλάχιστον 7 βαθμών και όχι με μικρότερους, οι οποίοι όμως μπορεί να είναι άκρως καταστροφικοί. Η νέα τεχνολογία θα δοκιμαστεί πιλοτικά στην ακτή της Χιλής, όπου συχνά λαμβάνουν χώρα δυνατοί σεισμοί. Και καθώς οι αισθητήρες GPS ενσωματώνονται σε ολοένα περισσότερες συσκευές και οχήματα, οι δυνατότητες στο μέλλον φαίνονται πραγματικά θετικές.

(Κέρδος online, 14.04.2015, http://www.kerdos.gr/%CE%B5%CF%80%CE%B9%CF%83%CF%84%CE%AE%CE%BC%CE%B7-%CF%84%CE%B5%CF%87%CE%BD%CE%BF%CE%BB%CE%BF%CE%B3%CE%AF%CE%B1/122646-e%CE%BE%CF%85%CF%80%CE%BD%CE%B1-%CE%BA%CE%B9%CE%BD%CE%B7%CF%84%CE%AC-%CF%83%CE%B5-%CF%81%CF%8C%CE%BB%CE%BF-%CF%83%CE%B5%CE%B9%CF%83%CE%BC%CE%BF%CE%B3%CF%81%CE%AC%CF%86%CE%BF%CF%85?utm_source=KerdosNLetterApp&utm_medium=email&utm_campaign=html_newsletter)

Νεπάλ: το χρονικό ενός προαναγγελθέντος σεισμού
Τα αίτια της καταστροφής

Ο σεισμός που σκότωσε χιλιάδες ανθρώπους στο Κατμαντού και έθαψε ορειβάτες στο Έβερεστ συνέβη σε μια από τις πλέον σεισμογόνες ζώνες του πλανήτη, εκεί όπου η τεκτονική πλάκα της Ινδίας συγκρούεται με την πλάκα της Ασίας και ανυψώνει τα Ιμαλάια.

Οι σεισμολόγοι περίμεναν μια μεγάλη δόνηση, και ορισμένοι μάλιστα πιστεύουν ότι το τελευταίο συμβάν δεν ήταν αρκετά ισχυρό για να απελευθερώσει την συσσωρευμένη ενέργεια.

Στην πρωτεύουσα του Νεπάλ, η γη ακόμα τρέμει

Πριν από περίπου 50 εκατομμύρια χρόνια, η υποήπειρος της Ινδίας, τότε ένα νησί στον ωκεανό, χτύπησε την ηπειρωτική Ασία. Ακόμα και σήμερα, η τεκτονική πλάκα της Ινδίας σπρώχνει την πλάκα της Ασίας, τη λεγόμενη ευρασιατική πλάκα, και γλιστρά κάτω της με ρυθμό γύρω στα 4-5 εκατοστά το χρόνο. Η διαδικασία αυτή δημιούργησε τη μεγάλη οροσειρά των Ιμαλαΐων, η οποία συνεχίζει να ψηλώνει και να ψηλώνει.

Όμως στο όριο των δύο τεκτονικών πλακών συσσωρεύονται τάσεις που απελευθερώνεται με σεισμούς όταν τα ρήγματα ανοίξουν απότομα.

Οι σεισμολόγοι είχαν προειδοποιήσει για συσσώρευση τάσεων στο Νεπάλ, αναφέρει την Κυριακή ο δικτυακός τόπος του Nature. Όμως η δόνηση της 25ης Απριλίου, έντασης 7,8 βαθμών, συνέβη πιο ανατολικά και ήταν λιγότερο ισχυρός από ό,τι περίμεναν ορισμένοι ειδικοί.

Μιλώντας στο BBC, η ομάδα του Λορέν Μπολινγκέρ, γεωλόγου της γαλλικής ερευνητικής υπηρεσίας CEA, ανέφερε ότι είχε προειδοποιήσει για σεισμό στο Κατμαντού μόλις πριν από δύο εβδομάδες, σε συνέδριο της Γεωλογικής Υπηρεσίας του Νεπάλ.

Ο ίδιος πιστεύει ότι ο σεισμός του Σαββάτου ήταν αποτέλεσμα ενός φαινομένου ντόμινο που συνεχίζεται τουλάχιστον από το 1255 μΧ. Τη χρονιά εκείνη εκδηλώθηκε ισχυρή δόνηση ανατολικά του Κατμαντού, η οποία φαίνεται ότι μετέφερε τάσεις προς τη δυτική πλευρά του ίδιου μεγάλου ρήγματος. Το σταδιακό άνοιγμα του ρήματος σαν φερμουάρ θα μπορούσε να είχε προκαλέσει το μεγάλο σεισμό που χτύπησε το Κατμαντού 89 χρόνια μετά, το 1344.

Στο σημείο όπου εκδηλώθηκε ο σεισμός του 1255, σημειώνει ο Μπολινγκέρ, συνέβη και ο σεισμός των 8,1 βαθμών που σκότωσε πάνω από 10.000 ανθρώπους το 1934.

Επομένως, ο σεισμός του Σαββάτου δεν αποκλείεται να ήταν η επανάληψη της ιστορίας των σεισμών του 1255 και του 1344.

Σε κάθε περίπτωση, οι μελέτες του Μπολινγκέρ, οι οποίες βασίστηκαν σε ραδιοχρονολόγηση του άνθρακα που βρέθηκε μέσα στο ρήγμα, δείχνουν ότι η περιοχή του ρήγματος που ενεργοποιήθηκε το Σάββατο δεν είχε μετακινηθεί από το 1344.

Ο Μπολινγκέρ και οι συνεργάτες του προειδοποιούν μάλιστα ότι το τελευταίο χτύπημα του Εγκέλαδου ίσως δεν ήταν αρκετά ισχυρό για να απελευθερώσει όλη τη συσσωρευμένη τάση.

Όπως είπε ο ίδιος, «οι πρώτοι υπολογισμοί υποδεικνύουν ότι ο σεισμός του Σαββάτου πιθανότατα δεν ήταν αρκετά μεγάλος για να ανοίξει το ρήγμα μέχρι την επιφάνεια, και πιθανότατα θα πρέπει να περιμένουμε ακόμα έναν ισχυρό σεισμό στα δυτικά και τα νότια αυτής της περιοχής τις επόμενες δεκαετίες».

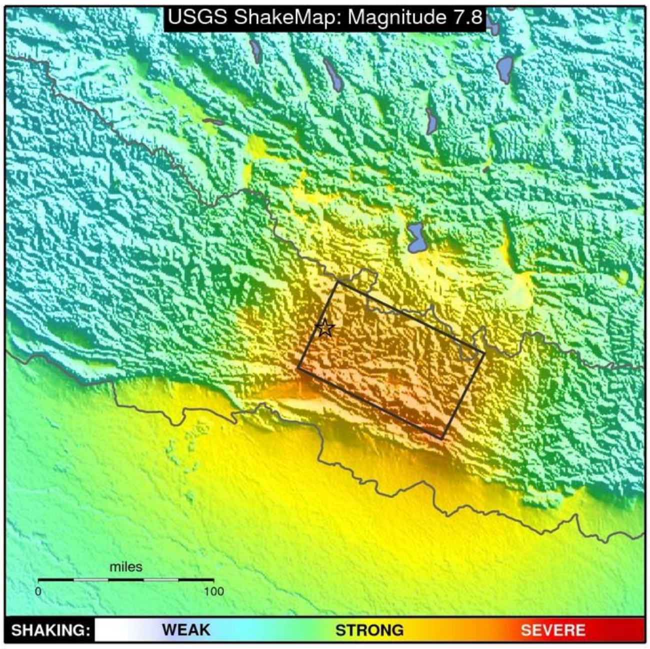
(Βαγγέλης Πρατικάκης / Newsroom ΔΟΛ, 26 Απριλίου 2015, http://news.in.gr/science-technology/article/?aid=1231402935)

Major earthquake hits Nepal

Scientists have long warned that mounting seismic stress put region near Kathmandu at risk for a severe tremor.

A magnitude-7.8 earthquake hit just 80 kilometres north-west of Nepal's capital Kathmandu on 25 April, destroying buildings and devastating much of the city. The ground shook well beyond Nepal's borders, into Tibet and northern India, in one of the worst natural disasters to strike the Himalayas in years; thousands of people are feared dead. *Nature* looks at the geological and social circumstances that combined to make the Nepal quake so deadly.

In Kathmandu, many older buildings were constructed of unreinforced masonry that cannot survive a strong earthquake.



This map shows the projected intensity of shaking near the quake's epicentre, which is marked with a star.

Why did the quake happen?

The ground ruptured along one of the planet’s biggest geological collision zones, where the crustal plate that carries India slams into and dives beneath the crust of central Asia at a rate of 4–5 centimetres a year. That smash-up raises the Himalayas to their great height and makes the region one of the most seismically dangerous in the world. Geological stress builds up along the Himalayas and releases itself periodically in earthquakes.

The 25 April quake was relatively shallow — just 15 kilometres deep, according to the US Geological Survey (USGS). Preliminary data suggest that the Himalayan fault broke a chunk of crust some 150–200 kilometres long, says Susan Hough, a seismologist at the USGS offices in Pasadena, Cali-fornia, who has worked in Nepal.

Were scientists expecting it?

To a large extent, yes. Seismologists including Roger Bilham of the University of Colorado Boulder, and Jean-Philippe Avouac of the California Institute of Technology in Pasade-na, have long warned that crustal stresses are building up in Nepal[1,2]. “This is not an oddball earthquake,” says Hough.

Even so, the 25 April earthquake was a little smaller and farther east than what some had expected. It occurred close to the site of a magnitude-8.1 earthquake in 1934 that killed more than 10,000 people and sent buildings in northern India sinking more than a metre deep into the ground.

Brick temples in Kathmandu crumbled, including the iconic Dharahara tower. Other buildings slumped sideways or pancaked to the ground. Damage assessments are underway, but Hough says that she was relatively heartened to see buildings standing in the background of photographs that focused on collapsed temples.

Officials in Nepal estimate that at least 3,700 people are dead as of 27 April, and that number is likely to rise in the days to come. On Mount Everest, the earthquake triggered an avalanche that swept into base camp. At least 18 people are thought to have been killed on the mountain.

Why weren’t people more prepared?

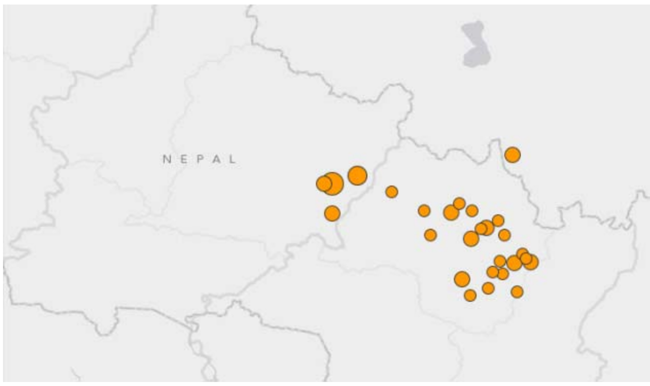
Nepal has a small but experienced community of earthquake professionals, and a national network of seismic and geodetic monitoring stations. Several organizations that focus on risk reduction have been working actively in Kathmandu in recent years. On 12 April, two of them — the National Society for Earthquake Technology-Nepal in Sainbu and GeoHazards International of Menlo Park, California — updated their earthquake scenarios for the Kathmandu Valley. That long-running project envisioned a quake similar to the 1934 disaster and laid out what to do in the aftermath.

In Kathmandu, older buildings were often constructed from unreinforced masonry, which cannot withstand the ground shaking from a quake so nearby. The area has also become more urban, and many newer buildings are built in dense neighbourhoods without structural reinforcements such as steel rebar.

“It’s not a problem of ignorance, it’s a problem of resources,” Hough says. “People are building houses to live in with the resources that they have. They can’t afford rebar and engineering.”

What happens next?

Assuming that this earthquake is the largest event in this seismic episode, Nepal can expect more than 30 aftershocks greater than magnitude 5 over the next month. One magnitude-6.6 aftershock has already hit.



Aftershocks have continued in the hours after the main earthquake hit; the locations of all of the tremors are shown with orange dots.

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(Alexandra Witze / Nature, 26 April 2015, doi:10.1038/nature.2015.17413, http://www.nature.com/news/major-earthquake-hits-nepal-1.17413)

Nepal quake 'followed historic pattern'

A sadly prescient turn of events: Geologists uncovered his

Nepal's devastating magnitude-7.8 earthquake on Saturday was primed over 80 years ago by its last massive earthquake in 1934, which razed around a quarter of Kathmandu to the ground and killed over 17,000 people.

This latest quake follows the same pattern as a duo of big tremors that occurred over 700 years ago, and results from a domino effect of strain transferring along the fault, geologists say.

The researchers discovered the likely existence of this doublet effect only in recent weeks, during field work in the region.

Saturday's quake, which struck an area in central Nepal, between the capital Kathmandu and the city of Pokhara, has had a far-reaching impact.

More than 4,000 people have lost their lives, with victims in Bangladesh, India, Tibet, and on Mount Everest, where avalanches were triggered.

Death tolls and casualty figures are likely to rise over the coming days, and the risk of landslides on slopes made unstable by the quake mean that the danger is far from passed.

Trench investigations

In a sadly prescient turn of events, Laurent Bollinger, from the CEA research agency in France, and his colleagues, uncovered the historical pattern of earthquakes during fieldwork in Nepal last month, and anticipated a major earthquake in exactly the location where Saturday's big tremor has taken place.

Down in the jungle in central southern Nepal, Bollinger's team dug trenches across the country's main earthquake fault (which runs for more than 1,000km from west to east), at the place where the fault meets the surface, and used fragments of charcoal buried within the fault to carbon-date when the fault had last moved.

Ancient texts mention a number of major earthquakes, but locating them on the ground is notoriously difficult.

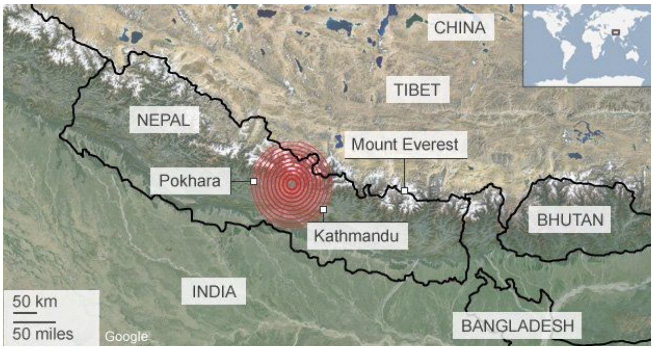
Monsoon rains wash soils down the hillsides and dense jungle covers much of the land, quickly obscuring earthquake ruptures.

Bollinger's group was able to show that this segment of fault had not moved for a long time.

"We showed that this fault was not responsible for the great earthquakes of 1505 and 1833, and that the last time it moved was most likely 1344," says Bollinger, who presented his findings to the Nepal Geological Society two weeks ago.

Previously, the team had worked on the neighbouring segment of fault, which lies to the east of Kathmandu, and had shown that this segment experienced major quakes in 1255, and then more recently in 1934.

The deadly pattern of quakes around Kathmandu



- Saturday's magnitude-7.8 earthquake struck to the north-west of Kathmandu
- The last time the fault ruptured at this location was back in 1344
- It was preceded in 1255 by a big event to the east of Kathmandu
- The last rupture there was in 1934, hinting strain might accumulate westward
- 2015's quake follows the pattern with a gap between events of 80 years or so

When Bollinger and his colleagues saw this historic pattern of events, they became greatly concerned.

"We could see that both Kathmandu and Pokhara would now be particularly exposed to earthquakes rupturing the main fault, where it likely last did in 1344, between the two cities," explains Paul Tapponnier, from the Earth Observatory of Singapore, who was working with Bollinger.

When a large earthquake occurs, it is common for the movement to transfer strain further along the earthquake fault, and this seems to be what happened in 1255.

Over the following 89 years, strain accumulated in the neighbouring westerly segment of fault, finally rupturing in 1344.

Now, history has repeated itself, with the 1934 fault transferring strain westwards along the fault, which has finally been released today, 81 years later.

And, worryingly, the team warns there could be more to come.

"Early calculations suggest that Saturday's magnitude-7.8 earthquake is probably not big enough to rupture all the way to the surface, so there is still likely to be more strain stored, and we should probably expect another big earthquake to the west and south of this one in the coming decades," says Bollinger.

(Kate Ravilious / BBC News, 27 April 2015, http://www.bbc.com/news/science-environment-32472310)

Laurent Bollinger "Nepal Himalaya 's deformation and seismotectonics", https://sites.google.com/site/laurentbollinger

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΛΟΙΠΑ

Τα υδραυλικά του τέρατος
Γιγάντιος θάλαμος μάγματος τροφοδοτεί το υπερηφαίστειο του Γέλοουστοουν

Η διάσημη Μεγάλη Πρισματική Λίμνη του Γέλοουστοουν αντλεί ενέργεια από τους υποκείμενους θαλάμους μάγματος. Το βίντεο δείχνει τη δομή τους (https://www.youtube.com/watch?v=Rt4XjA_PUP0).

Είναι ένα από τα μεγαλύτερα «υπερηφαίστεια» του κόσμου, ικανό να θάψει μεγάλο μέρος της Βορείου Αμερικής κάτω από τέφρα. Είναι η καλδέρα του Γέλοουστοουν στις βορειοδυτικές ΗΠΑ, κάτω από την οποία ανακαλύφθηκε ένας δεύτερος θάλαμος μάγματος, με αρκετό υλικό για να γεμίσει το Γκραν Κάνιον 11 φορές.

«Για πρώτη φορά, απεικονίσαμε το συνεχές υδραυλικό σύστημα κάτω από το Γέλοουστοουν» καμαρώνει ο Σιν-Χουα Χουάνγκ, σεισμολόγος του Πανεπιστημίου της Γιούτα, πρώτος συγγραφέας της δημοσίευσης στο Science (http://www.sciencemag.org/content/early/2015/04/22/science.aaa5648).

Το Γέλοουστοουν, μοιρασμένο ανάμεσα στις πολιτείες του Ουαϊόμινγκ, της Μοντάνα και του Άινταχο, είναι περισσότερο γνωστό ως εθνικό πάρκο που φιλοξενεί θερμοπίδακες, όξινες λίμνες και άλλους θαυμαστούς γεωλογικούς σχηματισμούς.

Όμως οι θερμοπίδακες αντλούν ενέργεια από ένα υπερηφαίστειο που κρύβεται κάτω από την επιφάνεια και εξερράγη για τελευταία φορά πριν από 600 χιλιάδες χρόνια. Οι διαστάσεις της καλδέρας που δημιουργήθηκε είναι περίπου 50 επί 70 χιλιόμετρα.

Σήμερα, ο κίνδυνος νέας έκρηξης εκτιμάται σε μία περίπτωση ανά 700.000 το χρόνο.

Η νέα μελέτη δεν αναθεωρεί αυτή την πιθανότητα, αποκαλύπτει όμως για πρώτη φορά πως το ηφαίστειο αντλεί υλικό από το γήινο μανδύα. Το Γέλοουστοουν βρίσκεται ακριβώς πάνω από μια σταθερή στήλη μάγματος, με πλάτος τουλάχιστον 50 χιλιομέτρων που πηγάζει στον εσώτερο μανδύα και φτάνει μέχρι το βάθος των 60 χιλιομέτρων από την επιφάνεια.

Πολύ πάνω από τη στήλη μάγματος, σε βάθος περίπου 10 χιλιομέτρων, ήταν γνωστό ότι υπάρχει ένας θάλαμος μάγματος με χωρητικότητα 10.000 κυβικών χιλιομέτρων.

Η νέα μελέτη αποκαλύπτει ότι κάτω από αυτόν τον πρώτο θάλαμο βρίσκεται ένας δεύτερος θάλαμος 4,5 φορές μεγαλύτερος. Μέσα από σχισμές στο υπέδαφος, ημίρρευστα, θερμά πετρώματα ανεβαίνουν από τη στήλη μάγματος και γεμίζουν αυτόν τον βαθύ θάλαμο πριν κινηθούν προς τον υπερκείμενο θάλαμο.

Η μελέτη, η οποία περιγράφει για πρώτη φορά ολόκληρο το σύστημα θαλάμων και αγωγών που τροφοδοτούν το υπερηφαίστειο, βασίστηκε στην τεχνική της σεισμικής τομογραφίας, μια μέθοδο απεικόνισης του υπεδάφους που μετρά την ταχύτητα σεισμικών κυμάτων στο υπέδαφος.

Τα σεισμικά κύματα κινούνται με πιο μικρή ταχύτητα μέσα σε ημίρρευστα, θερμά υλικά από ό,τι στα στερεά, πυκνότερα πετρώματα. Το υλικό του κατώτερου θαλάμου είναι λιγότερο πυκνό από ό,τι η γύρω περιοχή, κάτι που αποκάλυψε τελικά την ύπαρξη αυτής της γιγάντιας δεξαμενής.

Οι ερευνητές διευκρινίζουν πάντως ότι οι δύο θάλαμοι μάγματος δεν είναι γεμάτα από λιωμένα πετρώματα. Το υλικό που περιέχουν είναι καυτό, ημιστερεό και σπογγώδες και περιέχει μικρές κοιλότητες από υγρό μάγμα.

Η νέα μελέτη δεν προσφέρει νέα στοιχεία για την πιθανότητα έκρηξης του υπερηφαιστείου στο προσεχές μέλλον, επιβεβαιώνει όμως ένα μοντέλο που έχει προταθεί για ορισμένα ηφαίστεια, στο οποίο ένας βαθύς θάλαμος με ημίρρευστο βασάλτη, ένα πυκνό πέτρωμα πλούσιο σε σίδηρο και μαγνήσιο, τροφοδοτεί έναν υπερκείμενο θάλαμο που περιέχει ελαφρύτερα, πλούσιο σε πυρίτιο πετρώματα.

Το υπερηφαίστειο του Γέλοουστοουν εκτιμάται ότι έχει εκραγεί περισσότερες από 140 φορές καθώς η τεκτονική πλάκα της Βορείου Αμερικής κινείται προς τα νοτιοδυτικά πάνω από την σταθερή στήλη μάγματος.

Η τελευταία έκρηξη πριν από 600.000 χρόνια εκτιμάται ότι απελευθέρωσε 1.000 κυβικά χιλιόμετρα λάβας και τέφρας.

(Βαγγέλης Πρατικάκης / Newsroom ΔΟΛ, 24 Απριλίου 29015, http://news.in.gr/science-technology/article/?aid=1231402653&ref=newsletter)

Η Νεκρά Θάλασσα εξαφανίζεται αφήνοντας πίσω χιλιάδες καταβόθρες

Η Νεκρά Θάλασσα εξαφανίζεται σε ανησυχητικό ρυθμό, αφήνοντας πίσω χιλιάδες καταβόθρες και κρατήρες κατά μήκος της ακτογραμμής της.

Η Νεκρά Θάλασσα – η οποία είναι στην πραγματικότητα μια λίμνη – είναι γνωστή για το σχεδόν 10 φορές πιο αλμυρό νερό της από τους ωκεανούς και επίσης για το γεγονός ότι βρίσκεται στο χαμηλότερο υψόμετρο. Ωστόσο, κατά τις τελευταίες δεκαετίες, καταβόθρες ξεπροβάλλουν στις ακτογραμμές από το πουθενά.

Υπάρχουν περισσότερες από 3.000 καταβόθρες και κρατήρες στις όχθες της Νεκρής Θαλάσσης, αναφέρει το ABC News. Και μερικές από αυτές έχουν βάθος 40 μέτρα – όσο περίπου ένα κτίριο οκτώ ορόφων.

Ο Gidon Bromberg, Ισραηλινός σκηνοθέτης στο EcoPeace της Μέσης Ανατολής, δήλωσε στο ABC News ότι «αυτές οι καταβόθρες είναι το άμεσο αποτέλεσμα της κακής διαχείρισης των υδάτινων πόρων στην περιοχή.»

Η Νεκρά Θάλασσα χάνει πάνω από 2 δισεκατομμύρια γαλόνια νερού κάθε χρόνο εξαιτίας της εκτροπής των νερών από την κύρια πηγή που ανεφοδιάζει την λίμνη – τον Ιορδάνη ποταμό – που από το 1960, σύμφωνα με το Πανεπιστήμιο Ben-Gurion της Νεγκέβ. Η εξόρυξη μετάλλων από τη Νεκρά Θάλασσα έχει επίσης συμβάλει στην μείωση της λίμνης.

Τα 2 δισεκατομμύρια γαλόνια νερού μεταφράζεται σε μείωση της στάθμης των υδάτων σε ένα μέτρο κάθε χρόνο (κατά μέσο όρο), ή συνολικά 30 μέτρα από το 1970, σύμφωνα με έρευνα που διεξήχθη από το Πανεπιστήμιο Duke. «Με το επίπεδο της Νεκρής Θαλάσσης να πέφτει τόσο γρήγορα, αυτές οι καταβόθρες είναι αναπόφευκτες», δήλωσε ο Mark Wilson, καθηγητής γεωλογίας στο Κολέγιο του Γούστερ. Αν και αρκετοί ερευνητές έχουν διαφορετικές θεωρίες, δεν είναι πολλοί αυτοί που διαφωνούν, ότι αυτό είναι το φαινόμενο πίσω από την πτώση της στάθμης των υδάτων.

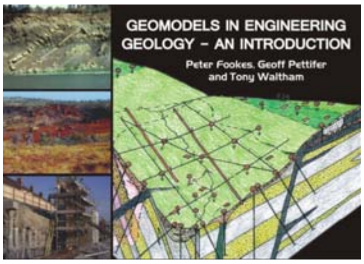
Ο David Ozsvath, καθηγητής Γεωλογίας στο Πανεπιστήμιο του Ουισκόνσιν, δήλωσε ότι κάτω από το αργιλώδες επιφανειακό έδαφος υπάρχουν σπηλαιώδεις αίθουσες που γεμίζουν με νερό. Ωστόσο, καθώς αυτές οι υπόγειες θέσεις ξεραίνονται με την υποχώρηση της στάθμης των υδάτων, το επιφανειακό στρώμα μπορεί να καταρρεύσει δημιουργώντας χάσματα κατά μήκος των ακτών.

Ο Ozsvath είπε επίσης ότι οι καταβόθρες εμφανίζονται με την πάροδο ενός ορισμένου χρόνου, ενώ άλλες εμφανίζονται κατά την διάρκεια μιας μόνο νύχτας. Ένας σεισμός ή ακόμα και μια δυνατή βροχή μπορεί να δημιουργήσει επίσης μια καταβόθρα η κρατήρα.

Πρόσθεσε ότι ο αριθμός των αναπτυσσομένων κρατήρων θα μπορούσε να μειωθεί εκτρέποντας λιγότερο νερό από τον Ιορδάνη ποταμό και επιτρέποντας στη στάθμη των υδάτων να αυξηθεί.

(Ηλίας Σιατούνης /accuweather.com, 15 Απριλίου 2015)

ΝΕΕΣ ΕΚΔΟΣΕΙΣ ΣΤΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΠΙΣΤΗΜΕΣ

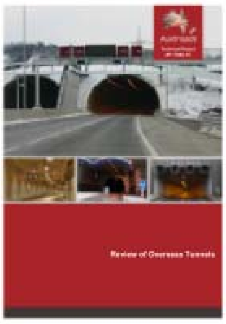


Geomodels in Engineering Geology - An Introduction

P. Fookes, G. Pettifer and T. Waltham

The book provides a valuable systematic guide to the evaluation and understanding of ground and worldwide environmental conditions of sites and their surroundings. This is done through a series of annotated block models and supporting photographs of common geological and geomorphological situations around the world, with basic text explanations and information on each principal block diagram and its annotated photographs.

(Whittles Publishing, April 2015)



Review of Overseas Tunnels

Publication no: AP-T300-15

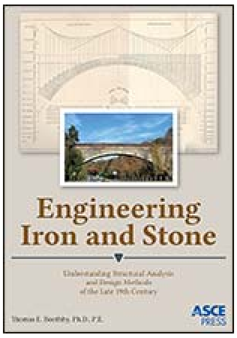
This report provides information about the design, construction and maintenance of 122 road tunnels in Europe, Asia, North and Central America, Australia and New Zealand.

The project was designed to assemble information on the construction and operation of a large number of recently completed road tunnels from across the world. With this information it was proposed that standards applicable to road tunnel construction in Australasia be reviewed to reduce the costs of designing, building and operating Australasian road tunnels.

A considerable data searching process was undertaken during this project, with a number of sources of information utilised, including a literature review of printed and on-line media, consultation with industry experts and industry bodies and a survey issued to tunnel operators.

The project was not able to obtain a high level of quality tunnel information which could be used to identify best practices, however, a large number of tunnels were identified for which at least partial information was obtained on the targeted attributes to be collected.

(Austroroads Publications, 2015, https://www.onlinepublications.austroads.com.au/items/AP-T300-15)



Engineering Iron and Stone

Understanding Structiral Analysis and Design Methods of the Late 19th Century

Thomas E. Boothby

In the late 1800s new design opportunities to serve business and transportation abounded, and the civil engineering profession responded with efficient design methods to meet the surging demands.

Engineering Iron and Stone: Understanding Structural Analysis and Design Methods of the Late 19th Century presents a comprehensive explanation of the empirical, graphical, and analytical design techniques used during this period in the construction of both large and small buildings and bridges in wood, stone, brick, and iron. Drawing on a career-long fascination with how structural engineers do their work, Thomas Boothby provides specific examples of these analysis and design methods applied to arches, girders, trusses, beams, and columns. The numerous calculations, drawings, and photographs, both historic and contemporary, illustrate the application of these techniques to a wide range of structures.

While major civil engineering works of the Gilded Age are acknowledged, Boothby focuses on the smaller, more ordinary local projects that today's engineers might encounter and analyzes the significant body of engineering design that went into their construction. Boothby also points out the historic value in preserving the engineering techniques and ideas of that era. The rapidity of computation and the intimate relationship between the structure and its analysis have been lost in the numerically intensive analytical methods currently employed.

Undertaking the historic preservation or rehabilitation of structures from the late 19th century can be challenging. Understanding the original design intent, however, can aid in a successful outcome. The quick and computationally efficient methods described in this book can assist present day engineers in understanding the behavior of these structures and give insight into their actual performance.

(ASCE Press, 2015)

ΕΚΤΕΛΕΣΤΙΚΗ ΕΠΙΤΡΟΠΗ ΕΕΕΕΓΜ (2012 – 2015)

ΕΕΕΕΓΜ
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