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In this issue

Editorial: Social Media for Earthquake Engineers

Social media have not been embraced within the civil and earthquake engineering communities to anywhere near the extent of other technology sectors. Tech conferences and trade fairs incite a torrent of tweets, each limited to 140 characters in length, on new developments in the field and juicy revelations by keynote speakers. The recent 15th World Conference on Earthquake Engineering (15WCEE), on the other hand, drew a mere whimper of tweets to its #15WCEE hashtag (for more on hashtags and other Twitter termology, see the sidebar on the next page). However, as civil engineering blogger Thomas Michael Wallace (@beingbrunel) observed (over a Twitter conversation with me, naturally): "the engineers who do [use Twitter] … seem to do pretty well …. The smaller the club, the better connected the members." With this editorial, I hope to invite you all to join the small "club" of earthquake engineers who use social media, suggest some reasons why the SECED readership may want to engage on a professional level with some of the available services, and to promote SECED's recent entrance into the Twittersphere (@SECED_UK).

Users of social media include individuals (professionals and researchers), organisers of conferences and talks (one-off or recurring) and institutions. Each has different motivations for getting involved and will therefore use different services in different ways. In the following, I discuss some of these motivations, and some good examples of social media use that I've seen in earthquake engineering and related fields. My focus is primarily on Twitter (where you can find me on @damoslim), but much of the following also applies to other services like Facebook and LinkedIn.

Sharing and soliciting opinions and knowledge

Social networking is primarily about sharing. Despite the 140-character limit, a tweet containing but a single hyperlink can connect readers to a whole newspaper article, research report or PhD thesis. In fact, 140 characters are just enough to paste a link along with a brief comment or question about the contents. Done well, this will encourage readers to follow the link and possibly post their own thoughts or responses on the material.

Twitter is also used frequently to solicit information from others – with more success for the likes of Stephen Fry (with more than 5 million followers) than me (with substantially fewer). Jascha Polet (@CPPGeophysics), a seismologist at Cal Poly, finds Twitter "useful to get expert opinion about articles in popular science media on topics outside of my direct field such as engineering". I found Twitter particularly useful in sourcing information following the 2010–2011 Christchurch earthquakes (on the hashtag #eqnz) and for sharing concerns about the recent l'Aquila verdict in Italy (in which 7 seismologists and engineers were sentenced to 6 years in prison for failing to adequately communicate seismic risk leading up to the earthquake in 2009).

Of course, Twitter and other social media are not subjected to the same fact-checking as traditional media, and their advantages in speed and volume are sometimes clouded by their lack of quality control. In Hurricane Sandy, New Yorkers turning to Twitter for updates found hoax photographs and public service announcements being distributed as quickly as they could be debunked. Ironically, several of these were picked up by mainstream media, showing the blurring divisions between traditional and social news sources. *Caveat lector!*

Establishing an individual profile

Company websites tend to highlight only the more senior members of staff, as it is their profiles and experience that will aid in creating opportunities and winning projects. Younger graduate or project engineers are lucky to appear out of focus in the background of the team photo, if at all. Yet, Wallace notes that few engineering company directors tweet, while "all the NCE Graduate of the Year [2012] winners have Twitter accounts that they use in a professional manner" (Wallace was one of them). Especially in today's challenging job market, younger engineers understand the value of establishing a personal profile outside the corporate branding of their company. Of course, today's top graduates are tomorrow's directors, and an increasing role of social media in the workplace is all but inevitable.

Academics and researchers arguably have more incentive to self-promote, due to both the nature of their work and the increasing attention on public outreach in the promotions process. Many academics maintain a blog to document and publicise their work. Some tweet when new papers are successfully published or presented at conferences. Blogger Eva Lantsoght (@evalantsoght) argued that even scientific failures should be documented on blogs to combat publication bias, and to allow others to learn from one's missteps (http://phdtalk.blogspot.nl/2012/10/blogging-as-means-to-tackle-publication.html).

Networking

The social media service most associated with professional networking is LinkedIn, and an actively-maintained LinkedIn profile is no longer an indication that someone is actively looking for a new job. Other services can also provide networking opportunities, and contacts made in the virtual world can readily cross into "meatspace" in the relatively small international community of earthquake engineers. At the 15WCEE, I made a point of stopping by the conference poster of Ben Deaton (@jbendeaton), whose blog and Twitter profile I had recently started following, and we had an interesting discussion about his PhD

Twitter Terminology

Tweets are messages, limited to 140 characters in length. Importantly, they can also contain URLs that link to longer web content. My tweets appear in the twitter **feed** of anyone who chooses to **follow** me. They also appear in relevant searches, unless my account is designated as **private**, in which case only my followers can read them. Accounts are **public** by default.

User account names are called **handles**, and are marked with an @ symbol. e.g. @SECED_UK is the official SECED twitter handle.

Hashtags are labels for events or topics, marked with the # symbol. They either evolve organically (e.g. #eqnz was used in tweets referring to the Christchurch earthquake) or are suggested by an event organiser (e.g. #15WCEE was advertised as the hashtag for last year's 15th World Conference on Earthquake Engineering by conference organisers).

Retweeting is forwarding someone else's tweet to rebroadcast to one's own followers (who may not have seen the original message). A common way of doing this is using the abbreviation "RT", followed by the handle of the original tweeter, and then the original message.

Participants may **live tweet** an event or talk by posting immediate reactions to a presentation, often marked with a relevant hashtag (see the @SECED_UK Twitter feed from 24/4 for an example from a recent SECED evening meeting).

research and other shared interests.

Writing as a creative outlet and public journal

For most engineers, the only writing we do is preparing dry factual reports to document a design process, and to ensure that a technical message is unambiguously imparted. Technical reports allow little room for opinion, philosophical reasoning and development of a literary style. Social media, and blogging in particular, allow a creative outlet that we seldom have in our day jobs. Tech blogger James Somers (@jsomers) even argues that regular writing and blogging can change your overall perspective on the world, as everything you read and experience can percolate with other half-formed arguments and blog posts in the brain (http://jsomers.net/blog/more-people-should-write).

In a similar vein, some use Twitter to keep an ongoing record of events attended and articles read (or the more quotidian, such as great breakfasts eaten or bus rides taken). For example, for this editorial, I made use of my own Twitter feed to dig up relevant material, such as Somers' article cited above (which I had retweeted after seeing a tweet by @jbendeaton).

Marketing a company's work and staff

Many large engineering companies now engage with social media, maintaining official profiles and discussion groups on Twitter, Facebook and LinkedIn. Companies must tread a thin line of maintaining interesting content without alienating potential followers with over-the-top advertising.

As well as official profiles, companies should be aware that employees' personal social media presence can also be a marketing opportunity. Some companies perceive this as a risk, in that controversial comments from their staff may reflect poorly on the firm. Many Twitter profiles contain a variant on the disclaimer "all opinions are my own", to clarify that the user is not acting as a company spokesperson.

Managed properly, a company's social media relationship with its staff is of mutual benefit, and official policies on use of these media should be careful not to stifle this.

Advertising talks and engaging with audience

Many institutions use Twitter and other social media to advertise events and talks. Unless official websites are maintained regularly, there is little incentive for readers to pay frequent visits, and therefore they can easily miss announcements of technical sessions that may be of interest. A few well-timed tweets leading up to an event can be a useful reminder for followers.

But social media are not supposed to be a one-way communication conduit, and institutions or conference organisers also use social media to provide an alternative forum for people to engage with content. Many conferences these days advertise an official hashtag that attendees can use to hold discussions and share thoughts on technical content. People even "live tweet" during talks, by providing periodic sub-140-character summaries of a speaker's main points.

The 15WCEE encouraged use of Twitter hashtag "#15WCEE", but this was not as successful as its Facebook page. This page was set up by researcher Mónica Amaral Ferreira, and conference organisers also asked a dozen or so younger earthquake engineers around the world to periodically contribute content for the site (for example, links to news articles about recent earthquakes). Ferreira reasoned: "As Facebook has become part of everyday life for many young people and students, why not have a 15WCEE page?" More than 6 months after the conference, the Facebook page is still active, and, according to Facebook's diagnostics, some posts are seen by over 1000 people.

Conclusions

I do not pretend to be an expert on social media, or on their best use in the professional realm. I have, however, found Twitter in particular very useful for finding out about interesting technical talks, research developments, engineering projects and up-to-the-second information on earthquakes occurring throughout the world (amongst other news items). I hope to encourage as many of you as possible to start tweeting – I look forward to hearing what you have to say!

Selected Highlights of Social Media for Earthquake Engineers

For SECED readers, the first ports-of-call in your voyage into social media should be one or both of the official SECED Twitter feed (@SECED_UK) and Facebook page (https://www.facebook.com/groups/261864180545298/). The former is open to all, while the latter is for SECED members only.

On **Facebook**, the page for the 15th World Conference on Earthquake Engineering (https://www.facebook.com/15wcee) continues to post stories of interest more than six months after the conference itself was held in Lisbon. Another personal favourite is the CHCH EQ Photos page (https://www.facebook.com/CHCH.EQ.Photos), which posts photos from before and after the Christchurch earthquakes of 2010 and 2011, documenting the recovery process.

On **Twitter**, I can recommend the following users: @jbendeaton, @beingbrunel, @CPPGeophysics, @evalantsoght, @Profiainstewart. They are not all earthquake engineers, but are good examples of what can be done with the medium. I also maintain a list of earthquake engineers on Twitter which you can "subscribe" to from my Twitter account (@damoslim). You may also be interested in following the engineering institutions, such as: @IstructE, @ICE_engineers, @IMechE, @AssociatedSoc.

I have deliberately not given any recommendations for **LinkedIn**, as I have not made much use of its "Groups" feature, but I welcome recommendations on this or other services from the SECED readership on the official Twitter or Facebook pages!

Roy Severn
1929–2012

Emeritus Professor Roy Severn CBE FREng FICE died suddenly on 25th November 2012, aged 83. He was one of the pioneers of earthquake engineering and a leading international researcher.

Joining the University of Bristol as a lecturer in 1956, Roy became a Pro Vice Chancellor, twice Dean of Engineering, Head of the Department of Civil Engineering and Director of the Earthquake Engineering Research Centre, before retiring in 1995. He was elected President of the Institution of Civil Engineers in 1990–1991.

Roy Severn was born in Hucknall Nottinghamshire on 6th September 1929. He eventually moved with his family to Great Yarmouth, spending his final 6th form year at Great Yarmouth Grammar School.

At the end of the war, in 1947, he read mathematics at the Royal College of Science in London. He played cricket, rugby and soccer and as a direct consequence met Professor Sammy Sparkes of Imperial College when they both played for the Wasps Rugby Club. Sparkes persuaded Roy that a career in Civil Engineering would be sensible. At that time Roy also met Deryck N. de G. Allen who was later to become his PhD supervisor at Imperial College. Allen was a student of Sir Richard Southwell who was developing numerical techniques for solving complex mathematical equations. The Consulting Engineers, Binnie, Deacon and Gourley had a commission to design the Dokan Arch Dam near Baghdad (which is still operational in 2013). They asked Allen for help so he and Severn took on the task and spent many hours with hand calculators grinding out solutions using a manual numerical relaxation technique.

In 1956, after National Service with the Royal Engineers, during which he served as a 2nd Lieutenant in Egypt, Cyprus and Aden, Roy was offered a lectureship in civil engineering at Bristol.

In that same year, the Institution of Civil Engineers set up an Arch Dams Committee chaired by Sir Angus Paton. Roy was the most junior member and was allocated the task of developing numerical earthquake response analysis techniques. This was a turning point. He had already published a paper on what is now the ubiquitous finite element technique and he saw that it could be applied to earthquake calculations.

In 1968, at the age of only 38, Roy was appointed head of civil engineering at Bristol when Sir Alfred Pugsley retired. Sir Alfred had built a significant reputation for the Department and was a hard act to follow. In the years that followed, without doubt Roy fulfilled that early vote of confidence by developing the Department into one of the top Civil Engineering Departments in the UK and an Earthquake Engineering Research Centre which ranks with the best in the world.

In 1984, he became a member of the Civil Engineering Committee of the Science and Engineering Research Council. Roy won the bid from that committee to set up a shaking table capable of testing large structural components and models with simulations of real earthquakes. At the same time, Roy promoted the SERC's initial funding of the Earthquake Engineering Field Investigation Team. Then, in 1990, the European Commission invited Roy to co-ordinate the large earthquake engineering facilities in LNEC (Lisbon), ISMES (Italy), Athens and Bristol in a joint programme to calibrate and improve the performance of shaking tables. This project put Europe's facilities amongst the best in the world. Roy continued to co-ordinate European laboratory-based earthquake engineering research until 2005 – some 10 years after his official retirement – leaving behind a thriving, world class, research community that continues to underpin improvements in global earthquake safety.

In 1981, he was elected a fellow of Royal Academy of Engineering. In the same year he won the Telford Gold Medal of the Institution of Civil Engineers with Alan Jeary and Brian Ellis of BRE for their pioneering work on forced vibration testing of embankment dams using a novel eccentric mass exciter system. In 1992, he was awarded a CBE for services to Civil Engineering. In 1997 he delivered the 6th Mallet-Milne Lecture entitled "Structural Response Prediction Using Experimental Data".

As well as his research, Roy insisted that the Professor and Head of Department should teach the basics, and for many years he lectured to the first year students in structures.

Roy was still working right to the end. His last big project was a book of the history of the Faculty of Engineering at the University. He, very generously, funded its production and donated the royalties to the University to set up a scholarship fund for students.

He is survived by his wife Hilary, daughters Fiona and Elizabeth and his five grandchildren.

– David Blockley and Colin Taylor, 24th April 2013

Nicholas Neocles Ambraseys 1929–2012

Nicholas (Nick) Ambraseys was born in Athens on 19th January 1929 and died peacefully at his home in Putney on 28th December 2012 at the age of 83.

Nick Ambraseys attended the National Technical University of Athens, receiving his diploma in Rural Engineering in 1952. Following this and service in the Royal Hellenic Navy, he moved to Imperial College to study for his Diploma of Imperial College and later his PhD, which he was awarded in 1958. Following a few years at universities in Greece and in the United States of America (working with Nathan Newmark, one of the fathers of earthquake engineering) he returned to Imperial College and remained there until his death. He became Professor of Engineering Seismology in 1974. In 1968 he established the Engineering Seismology Section in the Department of Civil Engineering and from 1971 to 1994 he led this section. In 1994 he officially retired from this position but he remained very active as an Emeritus Professor. Even during the last few months of his life he continued working and collaborating on various research topics, including the stability of ancient Greek columns.

His research covered many problems connected with earthquakes and their effects on the ground, structures and populations. His PhD and early articles were concerned with the response of earth dams to earthquakes, in connection with the construction of large dams in the Himalayas (e.g. at Mangla). However, early on in his career he began studying historical accounts of earthquakes, particularly those occurring in the eastern Mediterranean region, and it is in this field where he arguably made his greatest contributions. His meticulous study of historical documents on earthquakes that occurred in the eastern Mediterranean and elsewhere (e.g. Central America and north-western Europe) is second-to-none and he published many dozens of articles and books on this painstaking work. In 2009 his magnum opus on eastern Mediterranean seismicity (entitled 'Earthquakes in the Mediterranean and Middle East: a multidisciplinary study of seismicity up to 1900'), comprising almost 1000 pages, was published by Cambridge University Press.

Nick Ambraseys's contributions to earthquake engineering in the UK were varied. In addition to his teaching and research supervision of generations of students at Imperial College, from the mid-1960s until the early 1970s he was chairman of the British National Committee for Earthquake Engineering, until the mid-1980s he was the UK National Delegate of the European Association for Earthquake Engineering and for many years he filled the same role for the International Association for Earthquake Engineering (later he became a honorary life member of both of these associations). He also served on various engineering and scientific committees and advisory boards in the UK and overseas. He was one of the founders of SECED and was an honorary life member. In the 1980s Nick undertook (with others, including Charles Melville and James Jackson) an extensive study of the seismicity of the British Isles and surrounding areas, which culminated in a series of publications including two articles in the Proceedings of the SECED Conference on the Seismicity of the UK in 1985.

In all his works he sought to act as a bridge between earth sciences and engineering and between research and practice. These studies were enlightened by the knowledge and insights he gained during dozens of post-earthquake field missions in various parts of the world, many of which were under the aegis of UNESCO. These missions led to a series of reports that had an impact on the reconstruction of the cities affected (e.g. Skopje and Managua). He was awarded in 1998 the Freedom of the City of Skopje in recognition of the field work that he undertook in the aftermath of the devastating 1963 Skopje earthquake and the advice that he provided to the local authorities.

In recognition of his lifetime of achievements he was given numerous awards (e.g. Harry Fielding Reid Medal of the Seismological Society of America, 2006), and fellowships from prestigious institutions in the UK and overseas, for example: the Royal Academy of Engineering, the Institution of Civil Engineers, the Geological Society and the Royal Geographical Society. From his election in 2003, he was an active member of the First Section of the Academy of Athens and he divided his time between London and Athens.

Nick Ambraseys's contributions to engineering seismology and earthquake engineering were immense, wide-ranging and spanned almost 60 years. The worldwide community in these fields owe him a great debt and he will be greatly missed. He is survived by his wife, Xeni.

– John Douglas, 31st January 2013

On 25th April 2012, we were lucky to have Andrew Marriott, an engineer over from New Zealand, to speak at our SECED evening technical meeting. Andrew has been intimately involved in the assessment of heritage buildings in Christchurch following the earthquakes in 2010 and 2011, and here he offers his perspectives on their performance, and on the ongoing reconstruction effort.

The Performance of Heritage Buildings in the 2010/2011 Christchurch Earthquake Swarm

Andrew Marriott
Marriott Consulting Engineers Ltd
Christchurch, New Zealand

On 4th September 2010 a M_w 7.1 earthquake struck the Canterbury region of the South Island of New Zealand. It was followed by numerous aftershocks, some of which were large enough to be significant earthquakes in their own right. There were no known faults in and around Christchurch City until 4th September 2010. The city of Christchurch was settled based on plans drawn up in England by the Canterbury Association and the early buildings were therefore built largely in unreinforced stone and brick masonry, known as URM buildings (unreinforced masonry). The 2010 and 2011 earthquake swarm has affected the heritage building stock severely, with many buildings either collapsing, partially collapsing or being damaged to a lesser extent.

New Zealand is situated on the Pacific Rim and lies on the interface between the Pacific plate and Australian plate – an area of well documented seismic activity. This results in movement on the Alpine Fault where the land to the west is rising (Southern Alps) and the land to the east is dipping. The movement between the plates results in seismic and volcanic activity with the activity prior to September 2011 being more intense closer to the Alpine Fault. Areas lying on the fault line are subject to higher building standards under local government seismic retrofitting policies, or a more active programme of retrofitting. The Alpine fault has long been studied and used as the model for designing buildings (post-1931) in Christchurch and the surrounding region. The first earthquake of the current swarm occurred at 4:35 am (NZ Standard time) with a Magnitude of M_w 7.1, focal depth of 10 km and Maximum Intensity: MMI 8. The epicentre was at Darfield, located 47 km west of the Christchurch CBD. There were no direct fatalities (one heart attack), and only one major casualty due to a falling chimney. It was the largest earthquake on record to occur within 40 km of any major city, worldwide, and cause no fatalities. In all, 162 URM buildings suffered more than 10% damage.

On February 22nd 2011 a major earthquake occurred at 12.51 pm (NZ Standard time) with a Magnitude of M_w 6.3, right in the middle of a busy working day, and major loss of life and injury occurred. The epicentre was located in the nearby Port Hills at a depth of 5 km. The earthquake was characterised by very large vertical movements – the vertical accelerations peaked at over 2g, an amplitude not previously observed in New Zealand and certainly not required to be designed for in local Codes of Practice.

Figure 1. Face loading failure of unreinforced masonry (URM) walls.

The earthquake events have had a devastating effect on the heritage building stock of Christchurch, with 159 listed heritage buildings having collapsed or having been demolished at the time of writing. The Government has been supportive of efforts to strengthen heritage buildings prior to September 2010 to help prevent collapse during an earthquake, but the timeframes for this being implemented across the country, and the low level of strengthening required by local government, led to very few buildings in the Christchurch area being strengthened. The heritage stock was mainly built prior to the 1931 Napier earthquake (which led to New Zealand's first seismic code), and was therefore not generally strong enough to sustain the earthquakes in 2010 and 2011. Selected photos of damaged heritage buildings are shown in Figures 1 through 3.

Where buildings had been well strengthened they

Figure 2. Collapse of verandah due to out of plane failure of brick wall.

Figure 3. Christchurch Cathedral.

generally performed very well. The key appeared to be reliance on a large number of lowly stressed elements working together as a structural system, rather than, say, a steel frame with discrete fixings to the heritage fabric. In some cases where buildings were propped following earlier earthquake events, successive shocks led to collapse of the original building, leaving the propping standing. Many examples were noted of strengthening techniques that did not perform to an acceptable level. These included: epoxy resin anchor fixings which simply pulled out of the wall; structural steel frames added to support brick buildings where the frame was standing, but the brick had collapsed due to a failure of or lack of fixings to the brickwork; parapets poorly secured to the roof with inadequate fixings.

The mortar in the masonry heritage buildings was often a weak to very weak lime mortar that had not been repointed. Tests by others revealed mortar strengths of 1–5 MPa, which is very weak structurally. Indeed most mortar could be raked out of the joints by hand. This resulted in walls which failed due to a lack of strength in the mortar. Weak mortar also resulted in walls failing in face loads

Other issues that were noted were poor selection of materials, such as using a brick firewall in a timber framed house where the horizontal force on the heavy brick element pulled the rest of the house out of plumb. A lack of horizontal and vertical diaphragms resulting in no load sharing with other elements and poor connectivity of the floor diaphragms to walls led to walls, roof and floors collapsing. Many buildings lost parapets, or upper levels, and these fell onto the street, neighbouring buildings, or into the building itself. This type of failure led to the largest number of deaths from heritage buildings. Other buildings were severely damaged when the loads were transferred into the weakest element which was unable to resist the subsequent lateral loads; for example, the brick arches. Many buildings also failed due to panel shear failure.

Following the February 22nd earthquake I volunteered through the Institution of Professional Engineers of New Zealand (IPENZ) to provide engineering support during the Civil Defence emergency. Due to my heritage experience I was assigned to advise exclusively on listed heritage buildings and monuments.

A placard system was used following an initial Level 1 (external visual) inspection of each building. Green placards were given to buildings we believed were largely undamaged and could safely be occupied. Yellow placards were placed on buildings with moderate damage that could be entered for a limited time for assessment or retrieval of important items such as computer servers. Red placards were given to buildings likely to be demolished due to the structure being compromised. This was followed by Level 2 (internal and external) inspections to confirm the type of placard and what work would be required to either make safe, partially demolish or fully demolish each building. The results of these inspections were then added into reports by heritage planners, often with input from a conservation architect, and sent to the National Civil Defence Controller for approval of the recommended action.

The Civil Defence emergency ended on 30th April 2011 and management of this process was handed over to the Canterbury Earthquake Recovery Authority (CERA). The major difference was that the Government took a negative attitude to the retention of heritage buildings. This meant that there was a higher chance of a heritage building being demolished and a strong argument had to be made by Council's heritage team for saving buildings. The recovery phase was interrupted by two significant aftershocks on 13th June. These earthquakes caused significant additional damage to heritage and other buildings and led to a raft of urgent demolitions, many of them heritage buildings which in my opinion were demolished too quickly and with insufficient input from specialist heritage professionals.

People who were in or near heritage and high rise buildings during the significant earthquakes are reluctant to enter these types of buildings again. The local council has created a policy that all buildings are required to be checked by a Chartered Professional Engineer and have at least 67% of new building strength (NBS), an increase from the previous 33%. The Department of Building and Housing has, along with the engineering profession's help, determined that the local seismic hazard factor should be increased from 0.22 to 0.3. These increases will result in buildings being required to have approximately 91% of NBS. This level of strengthening was, prior to September 2010, very rarely used due to the cost and the invasive nature of the strengthening. It is becoming very clear that the public are expecting to see that buildings they are using have been adequately strengthened. The result of this is likely to be that more heritage buildings will be lost due to insufficient funding to save them all.

Following the June 13th aftershocks, insurance companies have been informed by their overseas reinsurers that they will not cover any future events. This has left most owners of heritage uninsured and therefore more likely to make a claim on the earlier earthquake damage and demolish their buildings, using the insurance money to rebuild in modern materials and to current codes of practice.

Being a part of a team trying to save the heritage buildings and monuments, it has been frustrating to see the effects of the consecutive earthquakes on the heritage building stock. The ongoing damage is a result of the initial damage having reduced the strength of the lateral resisting elements which then progressively lose the ability to sustain further shocks. Under the Civil Defence Emergency there was no provision for making buildings safe urgently and this lead to more damage and loss of buildings.

The wider engineering community needs educating in sensitive and adequate methods of strengthening that protect the heritage buildings. Too many examples were noted of very poor detailing that did not perform and was left standing whilst the heritage fabric collapsed around it.

Disaster of this scale means we have to consider higher protection for significant buildings. Have we diluted the conservation of our heritage by trying to save too many buildings and stretching the money too far, resulting in poorer protection for more buildings?

There was considerable debate on the value of human life versus value of heritage buildings. As engineers, we risked our lives to enter severely damaged heritage buildings in order to try to fully assess their condition. If repairs or make-safe works are required, then building contractors need to spend considerable periods of time inside these buildings, putting themselves at a high risk of being injured or killed if the building collapses in an aftershock, as in the example of one church that collapsed onto specialists repairing the organ, killing three people.

The work following the earthquakes has highlighted the value of using an experienced heritage engineer. Very diverse recommendations were provided to officials and owners, resulting from unfamiliarity with the building materials and construction methods common to heritage buildings. This raises the question of whether general structural engineers are operating outside their area of expertise when working with heritage buildings – a serious concern for professional bodies. A large volume of data has been gathered on the effects of earthquakes on heritage buildings and I believe funding should be provided to the universities and others to bring this together to assist with revised detailing of preferred structural repairs and strengthening of heritage buildings. Seminars should then be provided to disseminate the information to the engineering community at large. This will help to raise the general level of knowledge and prevent some of the poor decision making and detailing that has occurred. This will not however, negate the need for experienced heritage engineers to be involved in work on listed heritage, as this is a highly specialised area of expertise.

SECED

SECED, The Society for Earthquake and Civil Engineering Dynamics, is the UK national section of the International and European Associations for Earthquake Engineering and is an affiliated society of the Institution of Civil Engineers. It is also sponsored by the Institution of Mechanical Engineers, the Institution of Structural Engineers, and the Geological Society. The Society is also closely associated with the UK Earthquake Engineering Field Investigation Team. The objective of the Society is to promote co-operation in the advancement of knowledge in the fields of earthquake engineering and civil engineering dynamics including blast, impact and other vibration problems.

For further information please contact the SECED Secretary at the ICE on:
Tel: +44 (0) 20 7665 2229, or Email: secretary@seced.org.uk.

On 31st October 2012, Stavroula Kontoe chaired a SECED evening technical meeting on "Recent Advances in Site Response Analysis", with presentations from Gaetano Elia and Myrto Papaspiliou. The presenters provided the following summaries of their main findings.

Equivalent Linear Versus Non-Linear Site Response Analysis

Gaetano Elia
Newcastle University

Numerous seismic events have demonstrated the relevance of local geotechnical and geomorphologic conditions on the seismic ground response and its crucial impact on geotechnical structures during an earthquake. The site response analysis has traditionally been performed using a one-dimensional frequency-domain numerical scheme based on the equivalent visco-elastic approach. This approach has been successfully adopted in the last thirty years and it is widely accepted in engineering practice, although its limitations are well-known. Being based on a total stress formulation, it disregards the build-up of excess pore water pressures in the soil deposit. Moreover, the adopted equivalent visco-elastic material properties cannot properly represent the soil behaviour under cyclic loads for high seismic intensities at bedrock. Time-domain finite element (FE) schemes are nowadays available to solve the wave propagation problem in a more realistic way, accounting for the solid-fluid interaction by means of a coupled effective stress formulation. In those schemes, the behaviour of the soil can be described using either simple or sophisticated non-linear constitutive models of differing levels of complexity. Time-domain non-linear analyses are seldom adopted by non-expert users because (i) calibration of advanced soil constitutive models can be challenging, and (ii) code usage protocols are often unclear or poorly documented in the literature.

In the first part of the presentation, the main results of the numerical investigation performed by Amorosi et al. (2010) were summarised. In particular, a set of 1D ground response numerical analyses performed in the frequency-domain (using the code *EERA*) was compared with the corresponding time-domain based 2D FE simulations. 1D frequency-domain analyses were performed modelling the soil as a single phase visco-elastic equivalent-linear medium. These results, besides the possible drawbacks they can contain, were taken as target solutions for the 2D finite element analyses based on linear visco-elasticity. This latter assumption is underpinned by the following hypothesis: the results of any 1D analysis performed in the frequency-domain and based on (equivalent) linear visco-elasticity should, in principle, coincide with the corresponding 2D FE analysis performed in the time-domain assuming the same constitutive behaviour, provided an appropriate calibration of the parameters is adopted. The above comparison scheme is obviously no longer valid once more complex constitutive laws are adopted in the FE analysis as, for example, when plasticity is included in the formulation.

In order to provide a useful framework for finite element users, the implementation of advanced constitutive models was avoided. Soil behaviour, in fact, was described in terms of visco-elasticity, with viscous damping accounting for all the dissipative material behaviour. Realism was introduced in the investigation by considering a soil deposit characterised by variable stiffness and damping ratio with depth.

To generalise the investigation, a parametric study was carried out using four real earthquake signals, three clayey deposits characterised by different heights, two finite element codes (*PLAXIS* and *SWANDYNE*) and two different boundary conditions (tied-nodes and viscous boundaries). Some of the several factors potentially influencing the numerical results were highlighted and critically discussed. In particular, the stiffness values and the amount of viscous damping adopted in visco-elastic analyses, the spatial and time discretisation and the nature of boundary conditions were examined.

The main results are summarised in the following. Most of the analyses were performed using a linear visco-elastic soil model characterised by the Rayleigh formulation for the viscous damping. The calibration of the Rayleigh coefficients as well as the selection of the appropriate mobilised stiffness represents a critical issue for this kind of simulation. The investigation shows that the traditionally adopted procedures for the calibration of the Rayleigh coefficients can lead to large overestimation of the peak ground acceleration. Therefore, a novel calibration procedure was proposed and discussed: in this case the results of the FE analyses compared well with those obtained by the frequency-domain approach. The FE simulations performed with the code *SWANDYNE* were characterised by tied-nodes at the lateral boundaries, thus limiting the case to a proper 1D condition.

The possibility of performing 2D finite element simulations was investigated by re-running the numerical analyses with the finite element code *PLAXIS*, adopting the standard Lysmer and Kuhlemeyer conditions at the lateral boundaries. The match between the results of the two different geometrical configurations assumed in the two codes was obtained employing 2D meshes characterised by a width-height ratio larger than eight, while satisfactory results were already achieved for a ratio equal to four. No influence of the values of the Lysmer and Kuhlemeyer coefficients was observed in the 2D analyses.

Finally, accuracy and damping characteristics of the time integration algorithm were analysed. It was found that the standard values of the time-stepping coefficients for the Generalised Newmark scheme represented the best compromise to obtain satisfactory results both in terms of frequency content and peak ground acceleration.

In the second part of the presentation, the results of Amorosi et al. (2011) were summarised. The free-field response at the Large-Scale Seismic Test (LSST) site in Lotung, Taiwan (Tang et al., 1990), during the earthquake of May 1986 was studied comparing the downhole motions recorded *in situ* with the results of simple equivalent-linear visco-elastic analyses (using the code *EERA*) and advanced finite element numerical simulations (performed with *SWANDYNE*). The results showed that *EERA* predicted the E-W motion reasonably well, particularly at the depth of 11 m, both in terms of peak acceleration and zero crossing. The peak value of the E-W acceleration recorded at ground surface was slightly over-predicted. A poorer prediction was obtained applying the N-S component at bedrock level: the equivalent-linear analysis under-predicted the peak acceleration significantly, both at ground surface and at the depth of 11 m. Moreover, a time shift in the acceleration peak between the recorded and predicted motions was observed at the surface, thus indicating a poor prediction of the frequency content of the recorded signal.

The influence of plasticity on the numerical results was investigated with particular reference to the relationship between the hysteretic and viscous damping effects and to the prediction of excess pore water pressures within the soil deposit during the seismic action. Specifically, plasticity was added in the FE simulations through the advanced elasto-plastic constitutive model MSS (Model for Structured Soils) developed by Kavvadas and Amorosi (2000) for structured clayey soils and implemented in *SWANDYNE*. In this case, the peak acceleration of the E-W motion was under-predicted, especially at ground surface. Also for the N-S motion, a significant under-estimation of the peak ground acceleration was observed, but an overall better prediction was obtained with respect to the equivalent-linear analyses in terms of frequency content. Moreover, a good agreement between recorded and predicted excess pore pressures in the first 20 m of the deposit was achieved using the advanced FE non-linear approach.

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SECED Newsletter

The SECED Newsletter is published quarterly. All contributions of relevance to the members of the Society are welcome. Manuscripts should be sent by email. Diagrams, pictures and text should be attached in separate electronic files. Hand-drawn diagrams should be scanned in high resolution so as to be suitable for digital reproduction. Photographs should likewise be submitted in high resolution. Colour images are welcome. Hard copy manuscripts are also welcome. Please contact the Editor of the Newsletter, Damian Grant, for further details: damian.grant@arup.com.

The Incorporation of Site Response in PSHA

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Site effects are now considered in many studies, whether through relatively simplistic, generic amplification factors provided in building codes or through the performance of elaborate site response studies, typically conducted for more critical facilities. However, the use of sophisticated, site-specific amplification factors is not necessarily more reliable than simpler, site-generic approaches, unless these are properly incorporated in the hazard calculations by considering all sources of uncertainty in the site response analysis. A deterministic application of soil amplification factors to the results of a hazard analysis performed for rock conditions often leads to biased (underestimated) hazard estimates, with the effects being more pronounced for softer soil sites. In addition, such a deterministic approach can lead to surface hazard estimates with unknown frequency of exceedance. In order to overcome such deficiencies, Bazzurro and Cornell (2004), among others, developed a methodology that allows the incorporation of uncertainties associated with the site response analysis by transforming a generic ground-motion prediction equation (GMPE). The efficiency of the Bazzurro and Cornell (2004) approach makes it a particularly useful tool for the incorporation of site effects in probabilistic seismich hazard analysis (PSHA).

The presentation explored issues related to the performance of site response analysis giving particular emphasis to the impact of different analysis options on the site amplification function and ultimately on the soil surface hazard curve.

Site response analyses were performed for a sandy, NEHRP Class D, site using different methods of analysis and input parameters to explore the sensitivity of the ground response estimates and to identify the dominating factors. Equivalent linear and nonlinear site response analyses were performed using different target dynamic soil curves. The nonlinear analysis was performed using the modified hyperbolic model (MKZ) (Matasovic and Vucetic 1993), while different viscous damping formulations and fitting procedures for the constitutive model parameters were also considered. The findings of the site response analyses are summarised below:

- The highly nonlinear dynamic behaviour of alluvial deposits, and particularly deposits with soft surface layers, results in noticeable differences between equivalent linear and nonlinear analyses for records with peak ground acceleration (PGA) values higher than about 0.2g. Moreover, equivalent linear analysis can suffer from convergence issues, which impede its use for high

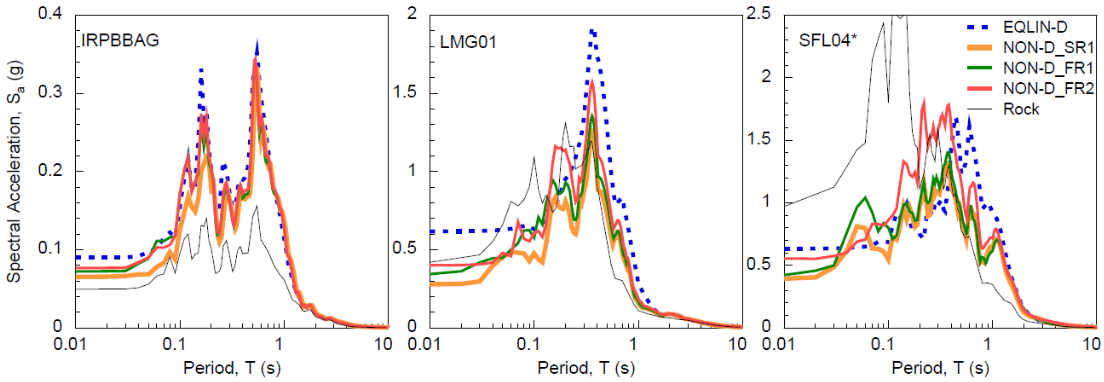

Figure 1. Comparison of acceleration response spectra using different analysis approaches.

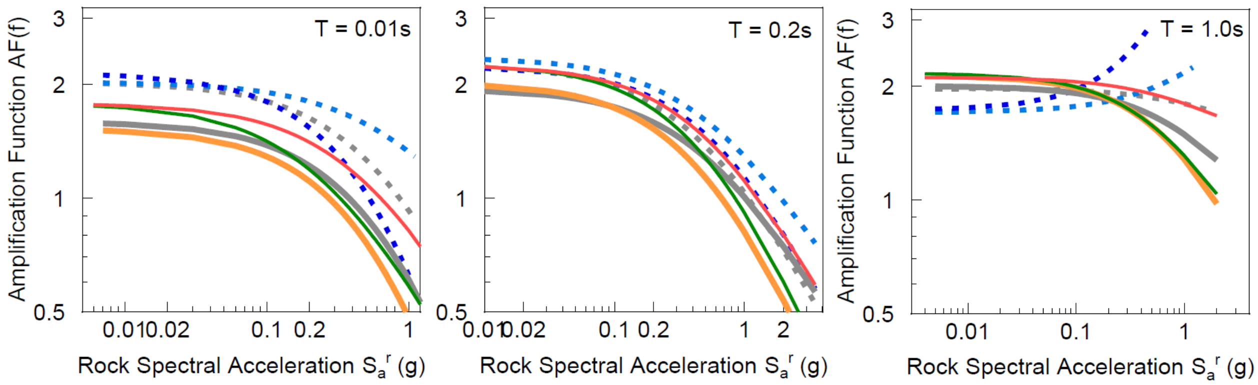

Figure 2. Site amplification functions for various spectral periods using different site response analysis approaches.

intensity shaking, further to the existing shortcomings of the methodology.

- The most dominant factor in the nonlinear analysis results is the choice of the fitting parameters (β and s) of the constitutive model (Figure 1). The choice of viscous damping formulation only influences the ground response estimates for periods T = 0.2 s. The inherent overestimation of damping in the MKZ model can be limited when the parameters are selected to match better the damping curve, at the expense of a more linear stiffness degradation. The effects of the different choices are clearly intensity-dependent and become particularly evident for strains larger than about 0.3%.
- The selection of the soil-stiffness degradation and damping curves has an important effect on the ground response estimates for intermediate and high shaking intensity.

The results of the site response analyses were used to investigate the sensitivity of the median site amplification function and its standard deviation to different site response analysis choices. Subsequently, the site amplification functions were used to transform a rock GMPE and the sensitivity of the PSHA results was explored for a site in California.

The following conclusions were drawn:

- The differences between the amplification functions derived from nonlinear analyses and those derived from the equivalent linear analyses were mostly pronounced in the short-period range. The effects of the different modelling parameters for the nonlinear analysis influence the amplification function across the entire acceleration range in the short-period range, while in the intermediate periods their effects are noticeable for $Sa^r(f)$ > 0.2g (Figure 2). The results of the equivalent linear analysis were seen to suffer from larger scatter implying that a larger number of records is needed for the robust estimation of the median amplification factor, $AF(f)$, and its standard deviation when the site response analysis is performed using equivalent linear methodologies.
- The use of site-specific site response analysis and its proper incorporation in a rock GMPE was found to provide a significant reduction in the standard deviation, $\sigma_{\ln Sas}(f)$, especially in comparison to estimates obtained with cruder approaches that do not consider the effect of soil nonlinearity on the standard deviation. As expected, the influence of sigma on the results of the PSHA is dominant and a great proportion of the differences observed among the hazard curves were driven by the differences

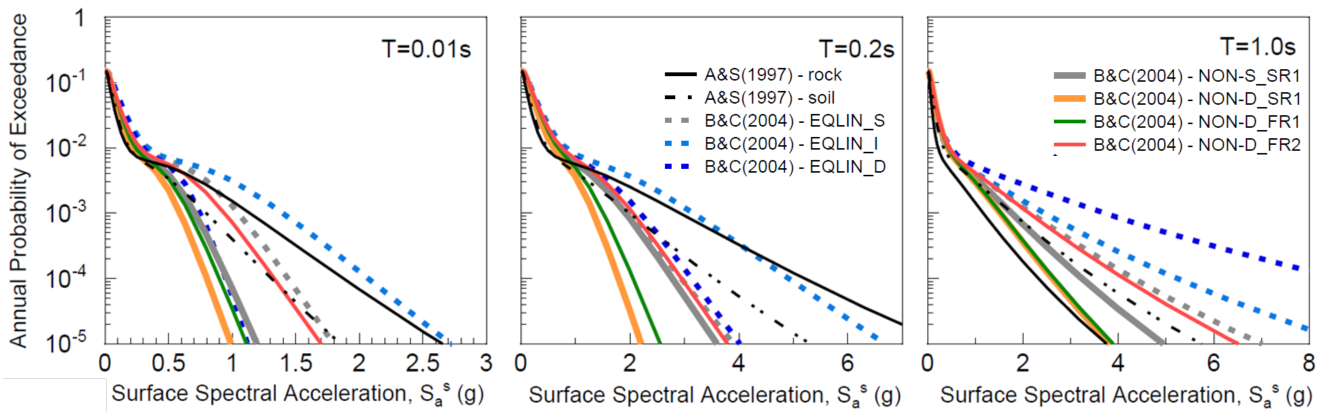

Figure 3. Surface hazard curves for a location in California incorporating the site amplification functions obtained using different analysis procedures.

in the standard deviations of the corresponding ground-motion prediction equations, especially at lower probabilities of exceedance.

- Significant differences, which are further increased with decreasing source-to-site distance, were noted among different site response analyses. The nonlinear site response analysis was found to provide consistently more stable hazard estimates, avoiding issues associated with the convergence problems in the equivalent linear methodology, which significantly influence the hazard analysis results, particularly in the intermediate period range (Figure 3). The above shortcoming of the equivalent linear analysis makes it unsuitable for the estimation of the site amplification for highly nonlinear alluvial sites and high levels of shaking intensity.

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Forthcoming Events

Date	Venue	Title	People
29/05/2013 at 18:00	Institution of Civil Engineers, 1 Great George St, London	*The Fourteenth Mallet-Milne Lecture: A History of British Seismology*	*Speaker*: **Roger Musson** (British Geological Survey) *Organiser*: **Andrew Mair** (Jacobs)
04/07/2013	Newcastle University, Newcastle-upon-Tyne	*SECED Young Engineers Conference*	*Organiser*: **Sean Wilkinson** (Newcastle University)

For up-to-date details of SECED events, visit the website: **www.seced.org.uk**

EEFIT Research Grant Scheme – Call for Proposals

The Earthquake Engineering Field Investigation Team (EEFIT) has launched a Research Grant to support short-term projects that will benefit earthquake (and related hazards) disaster mitigation and post-disaster reconnaissance efforts.

Up to TWO awards of £1,500 each will be made and the research must be completed within six months of the award date.

Applicants may be from any country/organisation and must be 18 or over.

Eligible topics for the research grant include: hazard assessment, post-disaster impact assessment, field data collection tools, post-disaster data assessment methods, damage assessment techniques, mitigation measures, monitoring recovery and/or reconstruction, assessing resilience.

The grant winner will:

- Allow outline details of the project to appear on the EEFIT website with the researcher's contact details;
- Provide EEFIT with a written report on the project, within six months of the award date;
- Present the results of their research at an EEFIT evening meeting at the Institution of Structural Engineers.

It is important to note that £1000 will be paid upfront to the award winner and £500 on receipt of a project report of appropriate quality.

The application form available from the EEFIT website at www.eefit.org.uk/grant must be used and the application should be emailed to mail@eefit.org.uk. The deadline for applications is: 5pm on 7th June 2013.

For further information see: www.eefit.org.uk/grant.

New SECED Website

As you may have noticed by now, the SECED website has recently had a make-over. The old website was built on a custom-made framework dating back to 2006. New content within this framework was limited to a set of predefined categories (such as "evening meetings"), and, without an in-depth knowledge of PHP and SQL database management, adding new categories or changing the layout of the website was difficult. The new website is built on Joomla! (The name is frequently spelled with an exclamation mark, a silly affectation in my opinion. I am going to drop the exclamation mark from now on.) Joomla is a modern content mangement system for building and maintaining websites. It is freely available from http://www.joomla.org. Content can be anything from simple news bulletins, blogs and events, to user groups and surveys. A large numbers of extensions are available that expand and complement the basic functions of Joomla. Some of these extensions are free and others can be purchased at varying cost. For example, the online issues of the Newsletter are now catalogued by means of the Alexandria Book Library extension (which is free). This extension makes it possible to record every article published in the newsletter, and it allows users to search for articles by title, author or issue number. I am still in the process of adding older issues of the Newsletter to this database. Another extension called BF Survey has been used to conduct a survey about the future direction of SECED, and yet another extension is used to manage events. The possibilities are limited only by the web administrator's lack of time to look after the website on a voluntary basis.

In the online survey one of the questions was about the SECED website and the use of online media. In this regard, we have to recognise that there are limits to how far we can take the website on the current voluntary basis. Therefore, from one point of view it does make sense to use external, advert-driven services such as those provided by Facebook or Google, which have professional developer teams behind them. From another point of view, it could be argued that SECED's identity would be somewhat diminished if it does not offer a distinct online presence on its own terms, free of adverts and commercial interests. Therefore, we should continue to maintain and develop the website. As a means to invigorate the website, an option is to create member accounts with special privileges – another feature which is built into the Joomla framework. This would allow members of the society to become active users of the website with the ability to create content and make the website an altogether more dynamic force in the life of the Society. I am hopeful that member accounts will be one of the new features in 2013. In the meantime, if you wish to advertise an event of interest to the members of the society, or otherwise contribute to the website, please get in touch (my contact details are on the website).

Contributed by SECED website editor, Andreas Nielson. The website can be found at www.seced.org.uk.

Notable Earthquakes July 2012 – September 2012

Reported by British Geological Survey

Issued by: Davie Galloway, British Geological Survey, February 2013
Non British Earthquake Data supplied by The United States Geological Survey.

			Time			Dep	Magnitude			
Year	Day	Mon	UTC	Lat	Lon	km	ML	Mb	Mw	Location
2012	15	JUL	08:52	53.35N	1.12W	1	1.7			WORKSOP, NOTTS
Felt Carlton in Lindrick (3 EMS).										
2012	19	JUL	14:43	55.77N	6.37W	9	1.7			ISLAY, ARGYLL/BUTE
Felt Bridgend, Ballygrant, and Bruichladdich, Islay (3 EMS).										
2012	20	JUL	12:11	32.98N	119.59E	10		4.9		JIANGSU, CHINA
One person killed and a further two injured at Yangzhou.										
2012	20	JUL	23:13	55.76N	6.36W	6	1.3			ISLAY, ARGYLL/BUTE
Felt Bridgend, Portnahaven and Bruichladdich, Islay (3 EMS).										

Year	Day	Mon	Time UTC	Lat	Lon	Dep km	Magnitude ML	Mb	Mw	Location
2012	22	JUL	11:43	55.81N	6.36W	9	2.3			ISLAY, ARGYLL/BUTE
Felt Bridgend, Braigo, Bowmore, Ballygrant, Port Charlotte, Portnahaven, Kilchoman, Keills and Bruichladdich, Islay (3 EMS).										
2012	26	JUL	05:33	17.61S	66.37E	10			6.7	MAURITIUS
2012	28	JUL	20:03	4.66S	153.16E	41			6.5	PAPUA NEW GUINEA
2012	10	AUG	10:59	56.56N	5.70W	13	2.3			LOCHALINE, HIGHLAND
Felt Lismore, Oban, Glencruitten and in Croggan, Mull (3 EMS).										
2012	11	AUG	12:23	38.36N	46.81E	10			6.4	NORTHWESTERN IRAN
At least 306 people killed, over 2,000 injured in several villages in the epicentral area. Four villages were completely destroyed and 60 were heavily damaged.										
2012	14	AUG	02:59	49.78N	145.13E	626			7.7	SEA OF OKHOTSK
2012	18	AUG	09:41	1.32S	120.10E	10			6.3	SULAWESI, INDONESIA
Six people were killed, 43 were injured and at least 1,500 homes were destroyed or damaged in the epicentral area.										
2012	26	AUG	15:05	2.19N	126.84E	91			6.6	MOLUCCA SEA
2012	26	AUG	20:37	50.55N	2.28W	10	2.0			ENGLISH CHANNEL
2012	27	AUG	04:37	12.14N	88.59W	28			7.3	EL SALVADOR COAST
Small tsunami recorded, with maximum wave heights (one-half peak to trough) of 11 cm at Acajula, El Salvador and 22 cm on Isla Santa Cruz, Ecuador.										
2012	27	AUG	12:57	55.78N	6.37W	8	1.6			ISLAY, ARGYLL/BUTE
Felt Bowmore, Ballygrant, Port Charlotte, Kilchoman, and Bruichladdich, Islay (3 EMS).										
2012	30	AUG	13:43	71.44N	10.58W	14			6.8	JAN MAYEN ISLAND REGION
2012	31	AUG	12:47	10.82N	126.63E	28			7.6	PHILIPPINE ISLANDS
One person killed and another injured in Cagayan de Oro, Mindanao.										
2012	01	SEP	07:04	55.75N	6.29W	9	1.1			ISLAY, ARGYLL/BUTE
Felt Bruichladdich, Islay (2 EMS).										
2012	05	SEP	14:42	10.10N	85.31W	35			7.6	COSTA RICA
Two people killed, several others injured, numerous houses collapsed and a bridge damaged in the epicentral area.										
2012	07	SEP	03:19	27.56N	103.99E	10			5.5	SICHUAN/YUNNAN/GUIZHOU
At least 81 people killed, some 821 others injured and over 170,000 buildings and homes either destroyed or damaged.										
2012	08	SEP	19:02	55.03N	7.57W	1	1.1			COUNTY DONEGAL, IRELAND
Felt Tamney (2 EMS).										
2012	21	SEP	09:29	56.37N	3.97W	2	1.4			COMRIE, PERTH/KINROSS
Felt Comrie (3 EMS).										
2012	22	SEP	07:39	56.38N	3.98W	2	1.1			COMRIE, PERTH/KINROSS
Felt Comrie (3 EMS).										
2012	25	SEP	17:19	49.80N	0.08E	5	2.1			ENGLISH CHANNEL
2012	30	SEP	16:31	1.93N	76.36W	170			7.3	COLOMBIA