ISSN 0967-859X
THE SOCIETY FOR EARTHQUAKE AND
CIVIL ENGINEERING DYNAMICS

NEWSLETTER

Volume 23 No 4
August 2012

In this issue

An Introduction to SSHAC

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Many people with any connection to the subject of seismic hazard will by now have heard the acronym SSHAC, usually pronounced "shack". There is, however, still a good deal of confusion, not helped by misinformation from some quarters, as to exactly what is entailed in a "SSHAC study". Hence a short and somewhat simplified description may be timely.

SSHAC itself stands for the Senior Seismic Hazard Analysis Committee, a group of experts set up in the USA in the early 1990s, specifically to give advice to the US Nuclear Regulatory Commission (NRC) on the direction seismic hazard analysis for nuclear facilities should be taking, particularly after the fallout from some much-criticised studies in the late 1980s. The title of the SSHAC's 1997 report gives a good indication of its priorities: Recommendations for Probabilistic Seismic Hazard Analysis: Guidance on Uncertainty and the Use of Experts (Budnitz et al. 1997). This report (often referred to as "the SSHAC guidelines") has recently been updated, and the new version (NRC 2012) can be freely downloaded from http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr2117/.

At the outset, it is important to dispel two myths about SSHAC. Firstly, it is not a "methodology". There is such a thing as the "SSHAC process", but this is a way of conceptualising and organising seismic hazard studies, not a way of analysing hazard. The methodology used in a study following the SSHAC guidelines will usually be probabilistic seismic hazard analysis (PSHA), but one could in theory undertake a deterministic hazard study using SSHAC principles.

Secondly, it is not the case that any study following the SSHAC guidelines will automatically result in ground motion levels higher (or much higher) than any other study. The results of any PSHA study are dependent on the modelling decisions made by the analysts. The fact that two high profile studies, Yucca Mountain (Stepp et al. 2001) and PEGASOS (Abrahamson et al. 2002) produced very high ground motion hazard values is entirely due to individual scientific decisions made by certain participants, which were in no way obligatory due to the SSHAC process.

Although a number of procedural recommendations are made by the SSHAC guidelines, the key issue is the approach to the issue of uncertainty, as indicated by Budnitz et al.'s (1997) title. It is common parlance these days in the hazard community to distinguish between two types of uncertainty. These are given the names "epistemic uncertainty" (from epistemos, knowledge) and "aleatory variability" (from alea, dice). The terminology seems to go back to Hacking (1975), though the distinction is much older. Epistemic uncertainty refers to things that are uncertain due to lack of data, but, at least in theory, this uncertainty could be reduced if more data became available. Aleatory variability refers to an irreducible randomness in Nature that will never go away. It might seem that, logically, irreducible variability is a worse problem than uncertainty due to lack of data, but in fact the reverse is the case. An example will illustrate this.

Consider the following game. I announce that I will roll an unspecified number of dice. The players are required to guess the resulting total. They immediately have two problems. Firstly, they don't know how many dice I have (epistemic uncertainty). Secondly, even if they did, the total I roll will be random (aleatory variability). Let us suppose we first remove the epistemic uncertainty; one of the players sneaks a look and discovers there are six dice. Even though the total rolled will be random, the players now know that the result will be in the range 6-36 with a most probable result of 21. In terms of betting odds, this is very manageable. Suppose instead, we remove the aleatory variability, by telling the players that all the dice are weighted and always come up 3. If the players now guess that I am rolling two dice when in fact I have ten, their guess will be seriously off-target, and managing this probabilistically is much harder.

To give a more seismological case, if a 6.0 Mw earthquake occurred in the UK 15km away from a nuclear facility, what would be the expected ground motion? Would it be more likely to be 0.2 g or 1.0 g? We have no local data to constrain our estimates.

The SSHAC guidelines offer a way of approaching this problem. The goal is to characterise the epistemic uncertainty in a way that allows a hazard analysis to take it fully into account, and the conceptual tool for doing this is what is referred to as the "centre, body and range of technically defensible interpretations", or "CBR of the TDI". The TDI are effectively all the credible possibilities for some uncertain issue. In the case of ground motion characterisation, there are very many published models that are conceivable candidates, but many of these (especially the older ones) can be ruled out for one reason or another (limited data, physical infeasibility, etc). In other words, these old models are no longer technically defensible. Of those that are, the CBR expresses the best estimate (the centre), the likely alternatives (the body), and the other possibles (the range).

One of the great advantages of this is that it improves the robustness of one's study; it is much less likely that one will be surprised later on by a discovery that invalidates a key assumption. It is possible in some cases that the body and range may collapse down onto the centre where there is really only one viable alternative, but making (and justifying) this decision is much preferable to plumping for a best estimate without any consideration of possible choices.

The question now is this – given the aim of determining the CBR of the TDI, how does one do it? There are a number of possible approaches, of which four are described in the SSHAC guidelines as four "levels", increasing in complexity, but also in accountability. In describing these, it will be necessary to introduce some terminology proposed by the SSHAC guidelines; terms that have proved so useful that they have percolated into usage in other seismological projects. The first of these terms is the technical integrator (TI). This is what might have been called a hazard analyst, but a TI is specifically a model builder, someone who takes technical information, data, ideas, and integrates them into a form that can be processed in PSHA. In fact, there is a two stage process. First comes evaluation – the consideration of all the data, models, etc, that are available, and sorting out which are actually relevant, and then the integration, the representation of the CBR of the TDI in terms of a numerical model.

Often there will be more than one TI; a project will have a TI team. A large project will have more than one TI team to cover different aspects: for instance, one to handle seismic source characterisation, and another for the characterisation of ground motion.

In a Level One study, the TI team consult the relevant literature and make their own assessment of the CBR of the TDI. This is the simplest, quickest, cheapest and commonest approach. Guidance on any specific issue is limited to what the TI team can glean from publications.

A Level Two study addresses the possibility that the published literature may be insufficient to provide enough guidance on some issues. The TI team identify experts outside the project who can be questioned on specific problems. As an example, an academic geologist may be the best expert on a particular tectonic structure, but may not have adequately addressed in her publications some issues that are hazard-sensitive. Being able to question the expert directly allows these points to be clarified. It goes without saying, though, that interaction must be significant; two short emails and a quick phone call does not turn a Level One study into Level Two.

The SSHAC guidelines distinguish two types of expert: resource experts and proponent experts. A resource expert is someone who knows a lot about some corpus of data of interest to the project and can speak impartially about it: it might be an earthquake catalogue or a fault database. A proponent expert is someone with a theory or a method, who wants to persuade the TI team to believe his theory or use his method. A single individual may at different times take on different roles, but clarity as to which role they are operating in at any time is essential. (Someone may say, "Speaking as a proponent expert, I would recommend …").

A Level Three study represents a major step up from Level Two in complexity and required resources (but with a resulting gain in robustness and accountability). The elicitation of expert opinion by the TI team (or often teams) follows a structured series of workshops. The first part of the project will focus on gathering and evaluating the required data, and hence the first workshop will be concerned entirely with meeting resource experts. The second part of the project is concerned with the integration of the data into the hazard model, and thus the second workshop will be populated with proponent experts.

A Level Three study introduces a new layer in the project structure: the participatory peer review panel (PPRP). The PPRP has oversight of the whole project and has three prime responsibilities. First, they must be satisfied that the SSHAC process is followed; for instance, that one member of the TI team does not become such a proponent that they bully the other team members into submission. Second, they will be the arbiters of whether the CBR of the TDI has been adequately expressed. Third, they will ensure that all decisions made by the TI teams are technically sound and fully justified. It must be stressed very strongly that the PPRP do not have to agree with the decisions made by the TI teams. The TI teams have full intellectual ownership of the hazard model. The PPRP has to be satisfied that the model development has been rigorous; and they will report to the client to that effect. Ultimately, they are the client's guarantee that the result is robust.

The PPRP (typically four to six people with a range of specialisms) sit in at workshops as observers, reporting to the project management and client at the end of each day with any issues needing addressing. The great advantage of this continuous assessment is that potential problems can be caught at an early stage, and mid-course corrections applied to the project. The difficulty is that membership of a PPRP is demanding; it requires scientists who not only have a suitable depth of expertise, but who are also capable of laying aside their personal prejudices when assessing whether the TI teams have made reasonable decisions. Someone who cannot leave off being a proponent for some position is absolutely unsuited to join a PPRP, however knowledgeable they may be. A potential problem for organising a Level Three study is that the global pool of experts suitable and available for this duty is currently limited (Bommer 2012).

The Level Four study is a large increase again in complexity, and another additional layer. In this study, there are multiple evaluator teams running in parallel on the same task, supervised by the technical facilitator integrator (TFI) to whom the evaluator teams report and who will oversee the final model. With each evaluator team separately and independently assessing the CBR of the TDI, the likelihood of anything being missed is remote. Once again, there is a structured series of workshops and the process is overseen by a PPRP. The number of experts involved is so large that project management is difficult and the overall project cost is very high. There have only been two Level Four studies to date (Yucca Mountain in the USA and PEGASOS in Switzerland), and it is unlikely there will be another. Level Three is now really the preferred level for high-consequence projects.

It is, of course, possible to find schemes that don't quite fit the definitions laid down in NRC (2012) but aspire to them to a lesser degree. A study could technically qualify as Level Two but incorporate elements of a Level Three study to good effect. For any particular project, the project plan will be tailored to the resources and time available. The overall scientific director of the project (the TI Lead or Project TI) will aim to find the best way to manage the SSHAC goals (the expression of the CBR of the TDI, and also the goals of accountability and review, about which I have said less in this account of the SSHAC process) within an appropriate project scope. (The SSHAC guidelines recommend external peer review even at Levels One and Two, and preferably at a sufficiently early stage in the project to allow for significant adjustments to be made.)

It will be seen from the foregoing that the four levels can be seen not only as a set of aspirations, but also a classification of any existing study. To that end, it has been suggested informally that one can also distinguish a "Level Zero" – studies that don't fit into any of the above categories because they don't actually share the goal of expressing the CBR of the TDI. Thus a study that was quite unconcerned about epistemic uncertainty (for instance, using only a single ground motion model out of habit) would be a Level Zero study. To this extent, it could be said that there is no such thing as a "non-SSHAC" study. All PHSA studies fall somewhere in the classification, but many (probably including all UK seismic hazard assessments from the 1980s and 1990s) are Level Zero.

To sum up, the SSHAC process is not a way of computing seismic hazard, but a way of conceptualising and formalising issues that arise in managing a PSHA project. The fact that terms such as "technical integration" and "proponent expert" have now been widely adopted reflects the fact that they are useful terms that meet a need. It is not necessarily the case that the results of a PSHA study will change, as a result of following Level Two or Level Three guidelines, from what they would have been had the study been carried out without specific reference to the guidelines at all. As is so often the case, to a large extent the SSHAC guidelines provide a formalisation of what was good practice anyway. Epistemic uncertainty exists, and it has to be handled somehow.

There is nothing in the SSHAC guidelines than mandates heaping on extra uncertainty or directs one towards double-counting of uncertainty. In fact, since double-counting is technically indefensible, one would expect to see this guarded against, with the PPRP carefully watching. So the result of a Level Two or Three study, expressed as a hazard curve, may be identical to the result that would be obtained by a single astute hazard analyst following his own good judgement. The difference is in the accountability, and the much greater assurance given to the client that nothing important has been missed, all angles have been covered, and all decisions have been transparent and clearly justified.

That degree of assurance has resulted in SSHAC Level Three studies increasingly being seen as a desirable standard by both clients and regulators, especially in North America, but recently also in South Africa. It can't be denied that managing the organisation of a Level Three project with its three major workshops (usually involving a number of international participants) comes at a financial cost. But where high-consequence facilities are involved, having that extra confidence in the results is likely to be seen as worth the expense.

Acknowledgements

This paper is published with the permission of the Executive Director of the British Geological Survey (NERC).

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EEFIT Mission: Haiti Photo Archive

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A geo-referenced archive of the photos (each photo is referenced to the location in which it was taken on a map), taken during the period 7th to 13th April 2010 by the EEFIT team, following the Haiti earthquake 2010 is now available on the Institute of Structural Engineers website, at the following address: http://www.istructe.org/resources-centre/technical-topic-areas/eefit/haiti-photo-archive. The archive was prepared by Cambridge Architectural Research Ltd and Edmund Booth and there are 468 photos which can be displayed using Google Earth.

The photos were taken at different locations in the city covering commercial, downtown, industrial and low and high density residential areas. The majority of photos show single buildings and have associated attribute information which includes:

- Building height, usage and structural type
- Contemporary notes on building damage taken by the EEFIT team
- Level of building damage assessed from the field survey and from remote sensing (GEOCAN and Pictometry).

Further details of the EEFIT mission to Haiti are given in the survey team's report, available to download for free from: http://www.eefit.org.uk, hosted by the Institute of Structural Engineers.

Recent months have seen damaging earthquakes in Italy and Iran.
Here we present brief reports on these two events.

The Emilia Earthquake, Mw 6.0, 20 May 2012, Italy

Contributed by Researchers from the European Centre for Training and Research in Earthquake Engineering (EUCENTRE), Pavia, Italy

On Sunday May 20, 2012 at 4:03am local time, a Mw 6.0 earthquake struck the region of Emilia-Romagna, Italy. The hypocentre was located at 44.89°N 11.23°E, at a shallow depth of 6.3km. The affected area included the provinces of Modena (Finale Emilia), Ferrara, Rovigo and Mantova, which have a combined population of approximately 244 thousand. The event caused 7 deaths, 50 injured persons, and approximately 4500 homeless.

The main event was followed by a cluster of aftershocks, four of them particularly severe: Mw 5.8 (May 29, 2012 at 9:00am), 5.3 (May 29, 2012 at 12:55pm), 4.9 (May 29, 2012 at 01:00pm) and 5.2 (May 29, 2012, about 20 seconds after the previous event) at depths of 10.2, 6.8, 11 and 5.4 km respectively. The aftershocks of May 29 brought the death toll to a total of 26, with 350 injured persons and approximately 14,000 homeless.

The region impacted by the earthquake is an industrial area in northern Italy and it is well known for its historical and artistic heritage; in fact, warehouses and monuments have been particularly affected by this event. The most commonly observed damage to warehouses was due to loss of support of the beams due to lack of proper connections between vertical and horizontal structural elements, whilst many of the existing bell and clock towers were irreversibly ruined by the earthquake. The dwellings in this district are mainly characterized by unreinforced masonry structures (in particular in the rural areas) and low-ductile reinforced concrete structures with hollow clay brick infill panels. Greater levels of damage have been observed for older and poorly maintained masonry structures, but in general the majority of the residential buildings performed well.

Further details and reports from various field teams can already be found, and continue to be added, to the clearinghouse that was set up between the European Centre for Training and Research in Earthquake Engineering (EUCENTRE), Pavia, Italy and EERI:

http://www.emiliaearthquake.it.

Traditional reinforced concrete precast structures damaged after the main aftershock (Massa Finalese)

The Ahar Earthquake, 11 August 2012, Iran

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An earthquake struck northwestern Iran on 11 August 2012 in the Ahar region which is 60km north-east of Tabriz, at 16:53 local time (12:23:18 GMT) of magnitude Mw 6.4 according to European Mediterranean Seismology Centre (EMSC) and Mw 6.2 according to the International Institute of Earthquake Engineering and Seismology (IIEES) at a depth of 10 km, 23km west of Ahar (location 38.41 N, 46.81 E). The second earthquake followed 11 minutes later, of magnitude Mw 6.1 at 30km west of Ahar.

The Iranian health minister, Ms Marzieh Vahid-Dastjerdi, declared on 13 August 2012 that these earthquakes caused the death of 306 people, with 3037 injured and 30,000 made homeless.

These tremors were felt in the cities of Ahar, Varzaghan, Kalibar and Hariss, and also in Tabriz - the largest city in northwest Iran with an approximate population of 1.5 million. Most of the damage is reported to be in the villages of Gourdeh and Dino which are provinces of Ahar. The earthquake was also felt in Marand, Shabastar, Mamaghan and Bostanabad in East Azarbaijan Province, Ardabil and Meshkinshahr in Ardebil Province, Urumieh, Khoy and Salmas in West Azarbaijan Province, and Astara, Rasht and Somehsara in Gilan Province.

There were 110 aftershocks with a magnitude greater than 3.0 recorded in the IIEES broadband seismic network in the first 40 hours after the main earthquakes.

A ShakeMap of macroseismic intensity produced by the IIEES is shown in Figure 1. Based on this assessment and early reports, an intensity of VIII is estimated to be observed in the epicentral region (the ShakeMap for peak ground acceleration indicates a peak estimate of 0.5g).

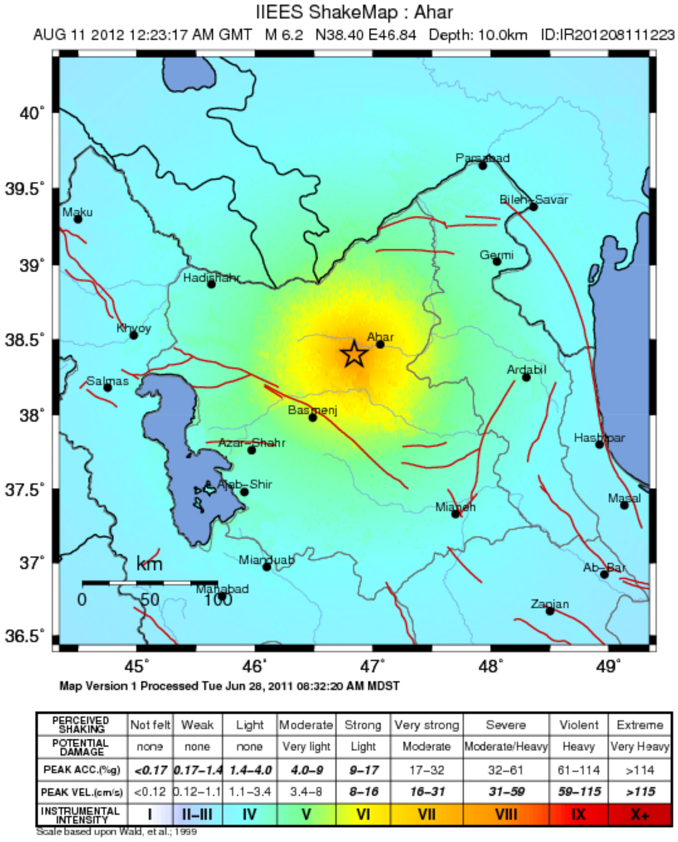

Figure 1. ShakeMap produced by IIEES

EMSC findings indicate that there is strike-slip movement in these shocks and the causative fault is assessed to be the South Ahar fault, having a east-west trend. and a length of 60km.

Damaged buildings were predominantly of adobe and masonry construction with timber roofs (Figure 2). The road of Ahar was also severely cracked following the earthquake.

Figure 2. Building collapses in the city of Varzaqan (EMSC)

Acknowledgements

Th European Mediterranean Seismology Centre (EMSC)

International Institute of Earthquake Engineering and Seismology (IIEES)

Dr Mehdi Zare and Dr Mohammad P.M. Shahvar of IIEES

Japanese Demand for High Seismic Performance and Energy Efficiency

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Japan is one of the world's countries with the greatest potential for seismic intensity, and a newly increased demand for energy efficiency has arisen after the Pacific Tohoku Earthquake of 11th March 2011. Meanwhile, this demand has been exacerbated by the recent stoppage of all NPPs up and down the country for maintenance surveillance. In such a context, new approaches to building design must surely be a part of the solution.

Tokyo Institute of Technology, one of the top Japanese universities in all fields of applied technology, has recently completed a new Energy and Environmental Innovation Center designed as a "self-generating energy provider" fully overlaid with solar panels (Fig. 1). The building has seven stories above ground and one storey at basement level, together

Figure 1. Environment and Energy Innovation Center, Tokyo Tech (photo: Tomio Ohashi)

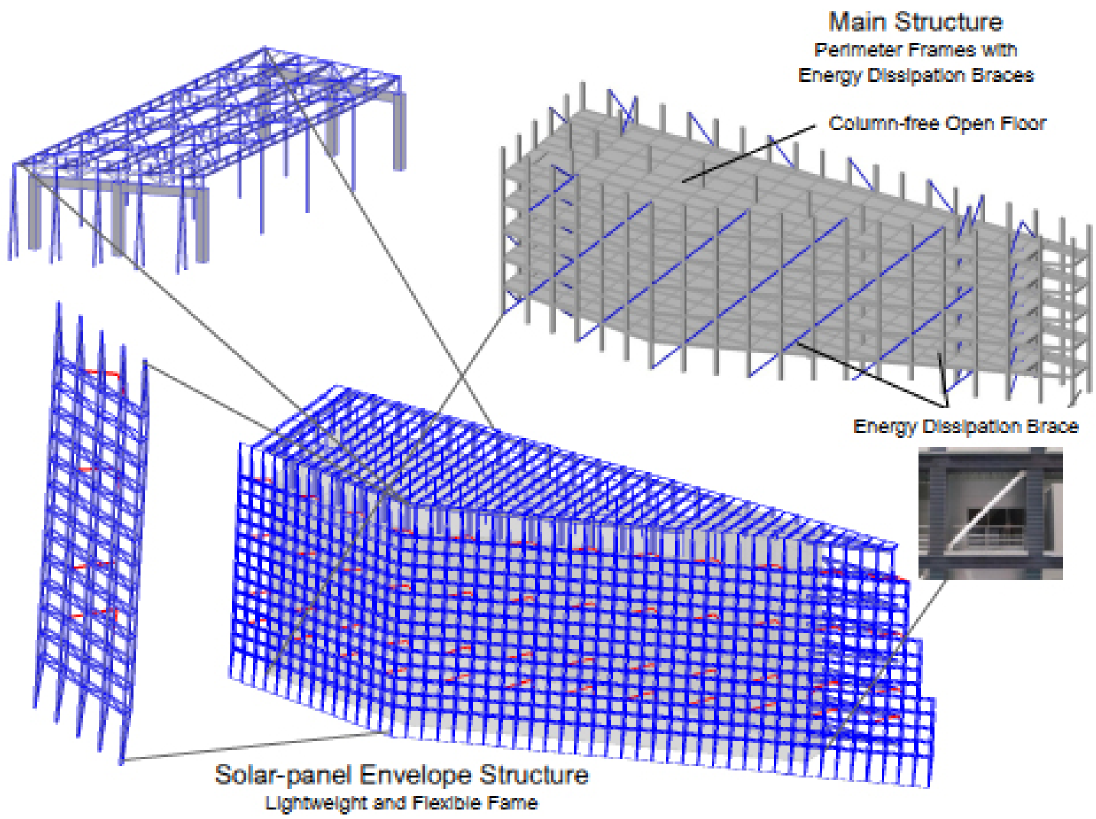

Figure 2. Structural design concept.

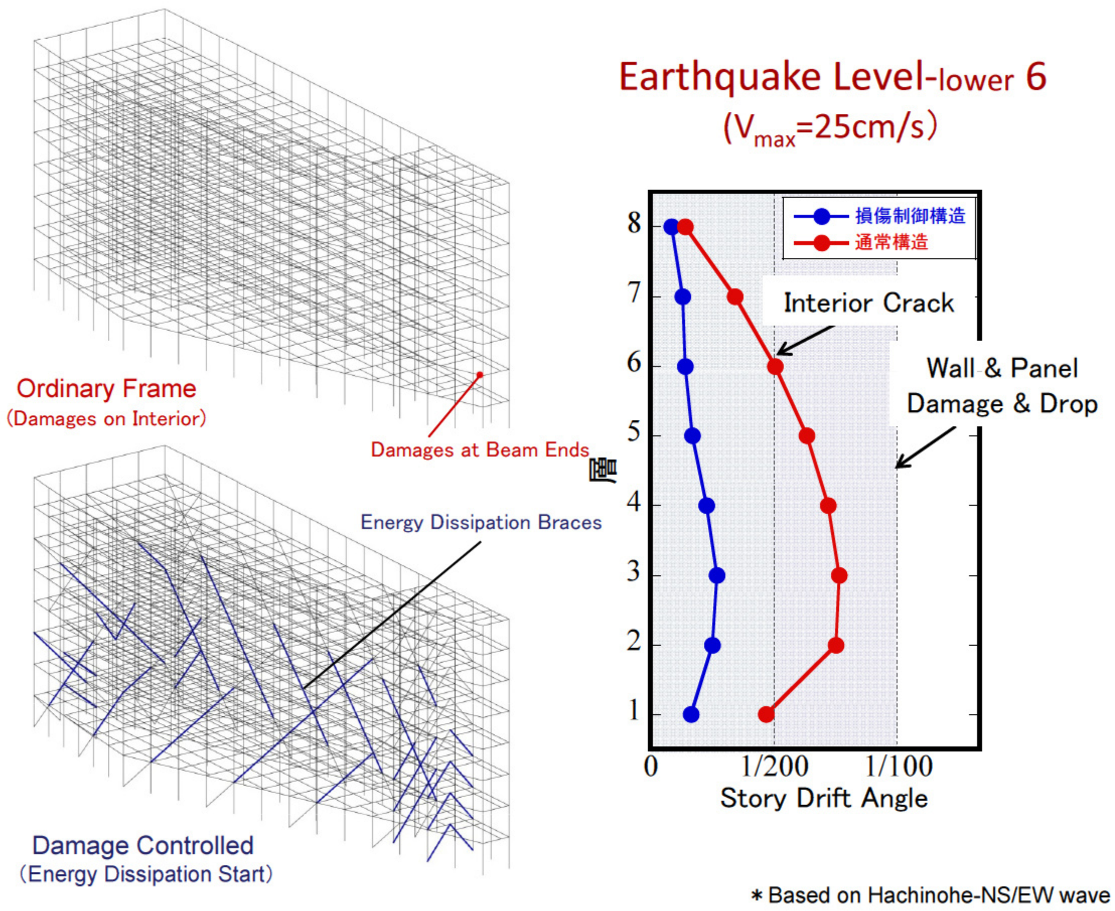

Figure 3. Seismic damage and drift levels under Earthquake Level lower 5 (V_{max} = 25 cm/s).

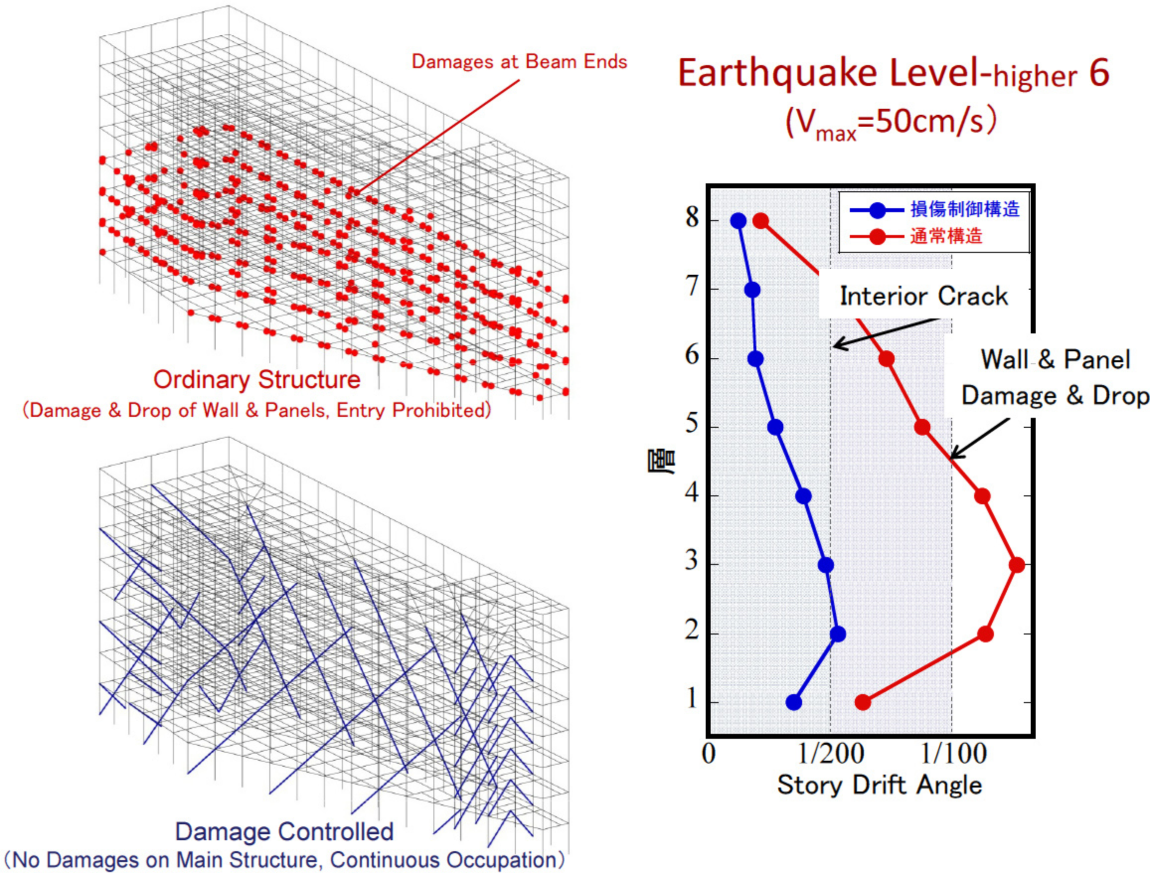

Figure 4. Seismic damage and drift levels under Earthquake Level higher 6 (V_{max} = 50 cm/s).

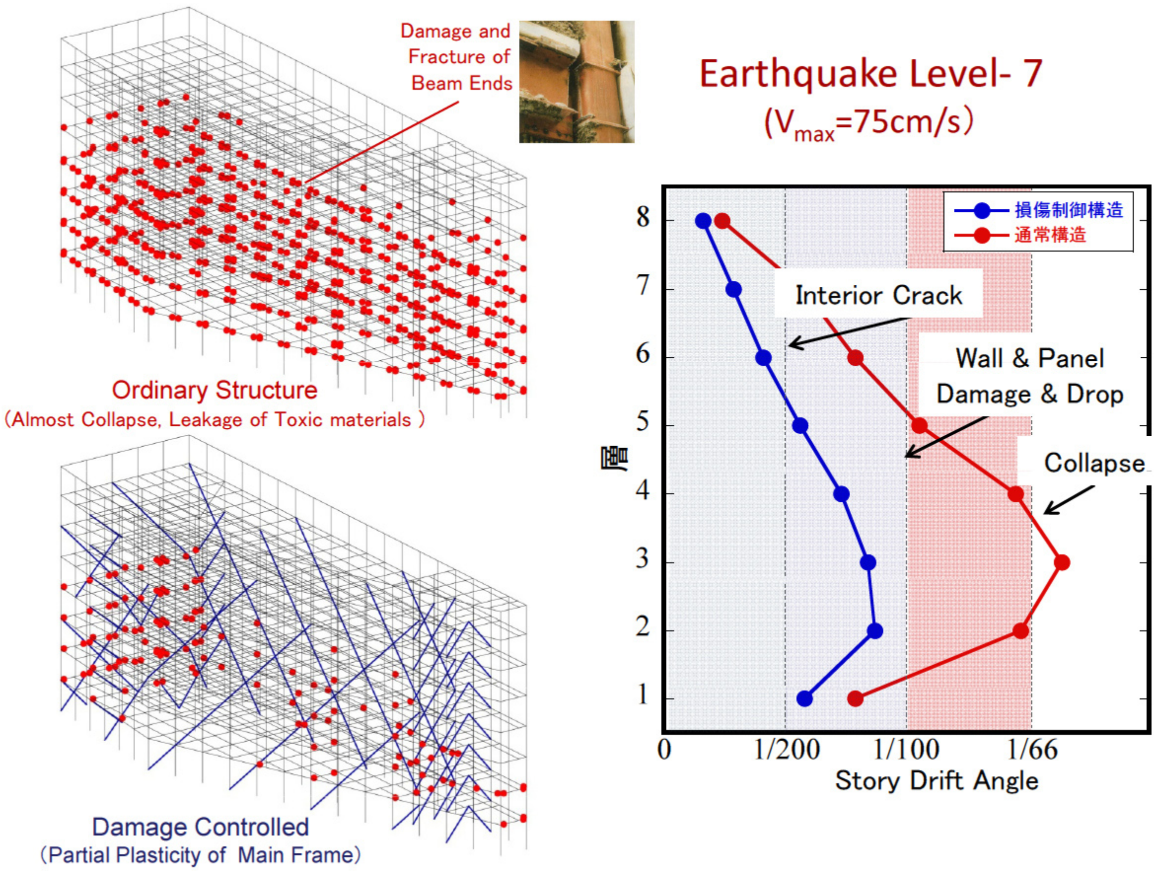

Figure 5. Seismic damage and drift levels under Earthquake Level lower 7 (V_{max} = 75 cm/s).

providing some 9,000 m^2 of usable floor area. The unit is conceived as a research and development center for future innovation in energy and environmental strategies, including photovoltaic and fuel cells, as well as other related chemical and mechanical technologies. The building is revetted in various types of solar panel, 4,570 in total, all of which are manufactured in Japan.

In good weather, these are capable of generating a maximum of 750 kW of electrical power. With an additional 100 kW derived from fuel cells, this is sufficient to operate the building without external power sources on a sunny day. The introduction of a mega-battery is also anticipated, which will provide enough electricity to keep the campus web-server in operation, even in the wake of a major seismic event capable of causing a total shutdown of all outside electricity supplies over an extended period.

To maintain the new EEI Center in full operation after a large earthquake, high-level seismic resistance is of course a sine qua non. Fig. 2 shows the structural concepts we employed. The enveloping frame that supports the solar paneling is flexibly designed to follow virtually any movement in the main structural frame. The latter is equipped with "seismic-energy dissipation braces" at perimeter zones, in order to ensure the elasticity of the main column-and-beam lattice in large earthquakes. Owing to their superior hysteretic damping potential such braces are now widely employed throughout Japan. Fig. 3–5 provide a comparison between an ordinary frame and a damage-controlled structure at various intensity levels. For Higher-Level 6 (Vmax = 50 cm/sec) the main frame should remain perfectly elastic, and even at Level 7 (Vmax = 75 cm/sec) maximum story drift angle ought to be within a 0.8% radian, resulting in minimal damage to the facade and its component solar panels.

Besides projects for mega-solar plants in the Tokyo suburbs, the EEI Center at Tokyo Tech should be considered a prototype solar-panel scheme for the dense Inner-Ward core region of the Tokyo Metropolitan Area or its semiautonomous outlying satellite centers.

GEM Building Taxonomy

Global Earthquake Model (GEM) Building Taxonomy group

Global building stock is highly heterogeneous in terms of design and construction practices, and vulnerability to natural hazards and earthquakes in particular. A common terminology or taxonomy is critical to document variations in building design and construction practices around the world.

More than 133 building typologies are included in the global building taxonomy that was developed by the international consortium working on the GEM Ontology and Taxonomy project in interaction with selected international experts, as critical input for development of homogenous databases and global vulnerability functions that form the basis for reliable risk assessment on a global level.

A first version of the GEM Building Taxonomy includes all basic attributes that are required for the other physical global projects, as a basis for reliable risk estimation. The taxonomy is developed to be extended into an even more detailed one, to support for instance assessment of building vulnerability based on analytical procedures.

The GEM Basic Building Taxonomy (v1) is currently undergoing a process of global evaluation and testing, to ensure that it applies to all regions in the world. The O&T group is therefore keen on receiving input from engineers, experts and others working with building exposure and vulnerability from around the globe.

Download the GEM Basic Building Taxonomy v1 report and leave your comments and suggestions here: http://www.nexus.globalquakemodel.org/gem-ontology-taxonomy/posts/updated-gem-basic-building-taxonomy-v1.0.

You can also consult the GEM Basic Building Taxonomy and its 8 sub-tables online: http://www.nexus.globalquakemodel.org/gem-ontology-taxonomy/posts/building-taxonomy.

The Building Taxonomy is accompanied by a Glossary that contains descriptions and photos of the attributes of the taxonomy. The O&T group is looking to incorporate more photos and looks forward to comments on the glossary as a whole and on the single definitions.

- Download the Glossary report and leave general comments here: http://www.nexus.globalquakemodel.org/gem-ontology-taxonomy/posts/glossary-for-the-building-taxonomy.
- Look at the single definitions and comment on the ones of your interest: http://www.nexus.globalquakemodel.org/gem-ontology-taxonomy/building-taxonomy/glossary.
- Send in additional photos via email buildingtaxonomy@globalquakemodel.org.

Notable Earthquakes November 2011 – February 2012

Reported by British Geological Survey

Issued by: Davie Galloway, British Geological Survey, June 2012.
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
2011	04	NOV	23:40	53.20N	1.01W	1	1.6			OLLERTON, NOTTS
Two people injured, 14 homes destroyed, many more damaged and Highway 62 buckled in the Shawnee/Sparks area.										
2011	06	NOV	03:53	35.53N	96.77W	5			5.6	OKLAHOMA, USA
2011	08	NOV	02:59	27.29N	125.74E	217			6.9	NORTHEAST OF TAIWAN
2011	12	NOV	00:28	52.52N	2.04W	8	1.5			DUDLEY, WEST MIDLANDS
Felt Stourbridge (2 EMS).										
2011	13	NOV	05:23	50.79N	0.79W	7	1.7			CHICHESTER, WEST SUSSEX
Felt Chichester (3 EMS).										
2011	14	NOV	00:33	57.51N	5.55W	4	2.2			TORRIDON, HIGHLAND
Felt Torridon and Lochcarron (3 EMS).										
2011	15	NOV	16:05	51.62N	3.58W	9	1.5			MAESTEG, BRIDGEND
2011	22	NOV	18:48	15.34S	65.16W	555			6.6	BENI, BOLIVIA
2011	04	DEC	02:40	50.48N	4.87W	3	2.2			BODMIN, CORNWALL
Felt Bodmin, Liskeard, St Austell, Padstow, Camborne, Bocastle, Wadebridge and Callington (3 EMS).										
2011	11	DEC	01:47	17.99N	99.78W	59			6.5	GUERRERO, MEXICO
Two people killed, 4 people injured, over 50 homes damaged and several power outages in Mexico City. Several landslides reported in Guerrero.										
2011	14	DEC	05:05	7.57S	146.81E	148			7.1	EASTERN NEW GUINEA
2011	17	DEC	14:33	53.68N	2.41W	8	2.2			BLACKBURN, LANCASHIRE
Felt Egerton (3 EMS).										
2011	21	DEC	06:40	56.25N	3.75W	6	1.6			BLACKFORD, PERTH/KINROSS
Felt Glendevon (2 EMS).										
2011	23	DEC	00:58	43.52S	172.97E	8			5.8	SOUTH ISLAND, N ZEALAND
At least 60 people injured, a few buildings damaged and several potholes and cracks appeared in roads in the Christchurch area. Rockslides and liquefaction observed in the eastern suburbs of the city and power supplies were cut, freight and passenger trains were suspended and the airport was closed.										
2011	25	DEC	17:11	51.67N	2.39W	15	1.5			DURSLEY, GLOUCESTERSHIRE
2011	27	DEC	15:21	51.84N	95.92E	15			6.6	SW SIBERIA, RUSSIA
2012	01	JAN	05:27	31.46N	138.07E	365			6.8	IZU ISLANDS, JAPAN
2012	10	JAN	18:36	2.43N	93.21E	19			7.2	NORTHERN SUMATRA
2012	10	JAN	23:13	54.13N	3.78W	7	2.1			IRISH SEA
2012	11	JAN	12:00	53.05N	2.13W	1	2.4			STOKE-ON-TRENT,STAFFS
Felt Stoke-on-Trent (3 EMS).										
2012	15	JAN	13:40	60.95S	56.11W	8			6.6	SOUTH SHETLAND ISLANDS
2012	18	JAN	18:33	49.63N	4.92W	10	3.5			ENGLISH CHANNEL
2012	19	JAN	12:35	36.29N	58.84E	8			5.1	NORTHEASTERN IRAN
2012	24	JAN	12:12	49.81N	0.27W	5	2.5			ENGLISH CHANNEL

Year	Day	Mon	Time UTC	Lat	Lon	Dep km	Magnitude ML	Mb	Mw	Location
2012	26	JAN	01:04	55.16N	7.62W	3	2.2			BUNCRANA, IRELAND
Felt Buncrana area (3 EMS).										
2012	02	FEB	13:34	17.83S	167.13E	23			7.1	VANUATU
2012	05	FEB	15:15	55.80N	6.37W	6	1.5			ISLAY, ARGYLL & BUTE
Felt Bruichladdich, Islay (3 EMS).										
2012	06	FEB	03:49	10.00N	123.21E	11			6.7	NEGROS, PHILIPPINES
At least 51 people killed (with 62 still missing), 112 injured and over 23,000 displaced, around 15,000 buildings destroyed or damaged and several bridges and roads severely damaged on Negros. Many landslides reported including two that buried over 100 homes in La Libertad and over 30 homes in Guihulngan. Landslides also occurred on Cebu. Damage estimated at $15 million.										
2012	20	FEB	05:35	55.78N	6.35W	13	2.6			ISLAY, ARGYLL & BUTE
Felt Bowmore, Port Charlotte, Portnahaven, Kilchoman, Bridgend, Foreland, Bruichladdich and Sanaigmore, Islay (3 EMS).										
2012	20	FEB	07:18	55.75N	6.32W	9	1.4			ISLAY, ARGYLL & BUTE
Felt Port Charlotte, Islay (2 EMS).										
2012	22	FEB	08:40	53.33N	2.53E	11	2.7			SOUTHERN NORTH SEA
2012	26	FEB	06:17	51.71N	95.99E	12			6.7	SW SIBERIA, RUSSIA
2012	26	FEB	22:31	54.65N	0.84W	5	2.9			LOFTUS, CLEVELAND
2012	27	FEB	08:20	55.78N	6.30W	13	1.6			ISLAY, ARGYLL & BUTE
Felt Port Charlotte, Bruichladdich and Ardnave, Islay (3 EMS).										
2012	27	FEB	18:48	31.43N	56.78E	10		5.2		CENTRAL IRAN
Six people injured and several buildings damaged in the Ravar region.										
2012	29	FEB	07:04	55.77N	6.34W	10	1.0			ISLAY, ARGYLL & BUTE
Felt Ardnave, Islay (2 EMS).										
2012	29	FEB	07:50	55.78N	6.34W	9	0.9			ISLAY, ARGYLL & BUTE
Felt Ardnave, Islay (2 EMS).										
2012	29	FEB	09:14	55.78N	6.34W	12	2.8			ISLAY, ARGYLL & BUTE
Felt Bowmore, Port Charlotte, Portnahaven, Kilchoman, Bridgend, Ardnave, Bruichladdich and Ballygrant, Islay (3 EMS).										
2012	29	FEB	09:25	55.78N	6.35W	10	2.1			ISLAY, ARGYLL & BUTE
Felt Bowmore, Bridgend, Bruichladdich, Ardnave, Ballygrant and Glenegedale, Islay (3 EMS).										
2012	29	FEB	09:32	55.77N	6.35W	10	1.2			ISLAY, ARGYLL & BUTE
Felt Bowmore, Bruichladdich, Ardnave and Kilchiarin, Islay (3 EMS).										
2012	29	FEB	14:55	56.23N	4.84W	2	2.4			ARROCHAR, ARGYLL/BUTE
Felt Arrochar, Lochgoilhead, Succoth, Tarbet and Cairndow (3 EMS).										

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: email: damian.grant@arup.com.