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NEWSLETTER

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In this issue

The Macroseismic Survey of the 27 February 2008 Market Rasen Earthquake

RMW Musson

British Geological Survey, Edinburgh

Immediately following the occurrence of the Market Rasen earthquake on 27 February 2008 (5.2 ML, 4.5 Mw), an online questionnaire was opened on the BGS web site to collect felt reports. In addition, questionnaire data were collected automatically by USGS as part of the "Did You Feel It?" (DYFI) programme (Wald et al. 1999), and also by EMSC as part of its European monitoring. Some additional data were also gathered by agencies on the fringe of the felt area, notably ROB in Brussels, and DIAS in Dublin. This report summarises the findings.

The total number of usable data collected were as given in Table 1.

Each agency initially processed its own data according to its own procedures. The map produced by USGS was based on its principle of "community intensity", in which each questionnaire was assigned a score based on several indices, and a Modified Mercalli intensity value assigned to the average score for a particular place, based on a correlation between such scores and assigned intensities for the 1994 Northridge earthquake (Wald et al. 1999). The BGS data was assessed for EMS-98 intensities according to a procedure described by Musson (2006). The data were aggregated by squares 5x5 km in size, and an intensity assigned to each square according to the proportion of reports of various different effects. The EMSC data was processed by town or city, but the intensity assessment procedure was one based closely on Musson (2006), as described in Gilles (2008). A difference between the BGS and EMSC procedures is that the former only attempts to assign intensity given at least five responses, otherwise it is only noted as "felt". Both USGS and EMSC attempt to assign intensity values to a place even if there is only one observation.

It should be noted that none of these are intensity assessments as they might have been made twenty years ago, by a seismologist comparing data to the text of the intensity scale. The DYFI process never really assigns intensity at all; it is based on a correlation between a set of scores and a training data set. The Musson (2006) procedure is intended to mimic the mental processes of a seismologist assigning intensity, but in the end,

Agency	Number of responses
BGS	19,927
USGS	10,794
EMSC	596
Others	31
Total	31,348

Table 1. Data received, by agency

the intensity values are assessed according to a set of rules (detailed in Musson 2006) rather than the wording of EMS-98 (Grünthal 1998). In both cases, the procedures are totally objective.

Following the web publication of the immediate results of the three macroseismic surveys, the three data sets (the raw data, not the intensity values) were combined. In the case of the EMSC data, this was easy, since the EMSC questionnaire is based on the BGS one. For the USGS data this is much more of a challenge, since the USGS does not collect data on some common macroseismic diagnostics. For instance, one of the key differences between intensity 3 and 4 EMS is that at intensity 4, the shaking is strong enough to rattle doors, windows, crockery, etc. This information is missing from the USGS data and has to be recorded as "no answer" in the final data set.

The final data set of 31,348 responses is the largest macroseismic data set ever assembled for a UK earthquake. The previous record was held by the 19 July 1984 Lleyn peninsula earthquake, for which about 12,000 paper questionnaires were collected (and not all of which were ever processed because of the magnitude of the task; Musson 1992). Values were assigned to a total of 2,763 places, including those where only "felt" or "not felt" is given.

The data points are shown in Figure 1. Figure 2 provides an isoseismal map. The results are heavily dominated by the BGS data set, because of the superior geo-coding used, by which each questionnaire response can be located to 1 km. The USGS data, when converted to the 5 km grid system, give only 390 points. Thus 85% of the locations in Figure 1 do not include USGS data. However, many of the locations in the far-field are based purely on USGS data.

Nevertheless, aside from the issues of diagnostics missing from the USGS data, the different data sets are overall rather compatible. Of the total collection of questionnaires, the

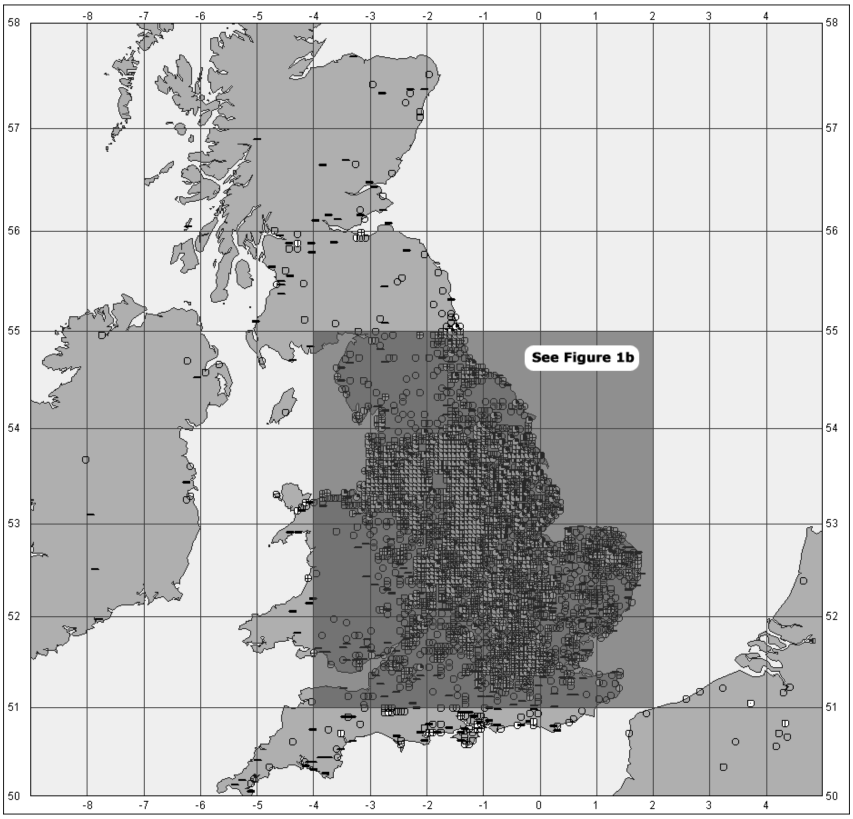

Figure 1a. Intensity point map for the 2008 Market Rasen earthquake

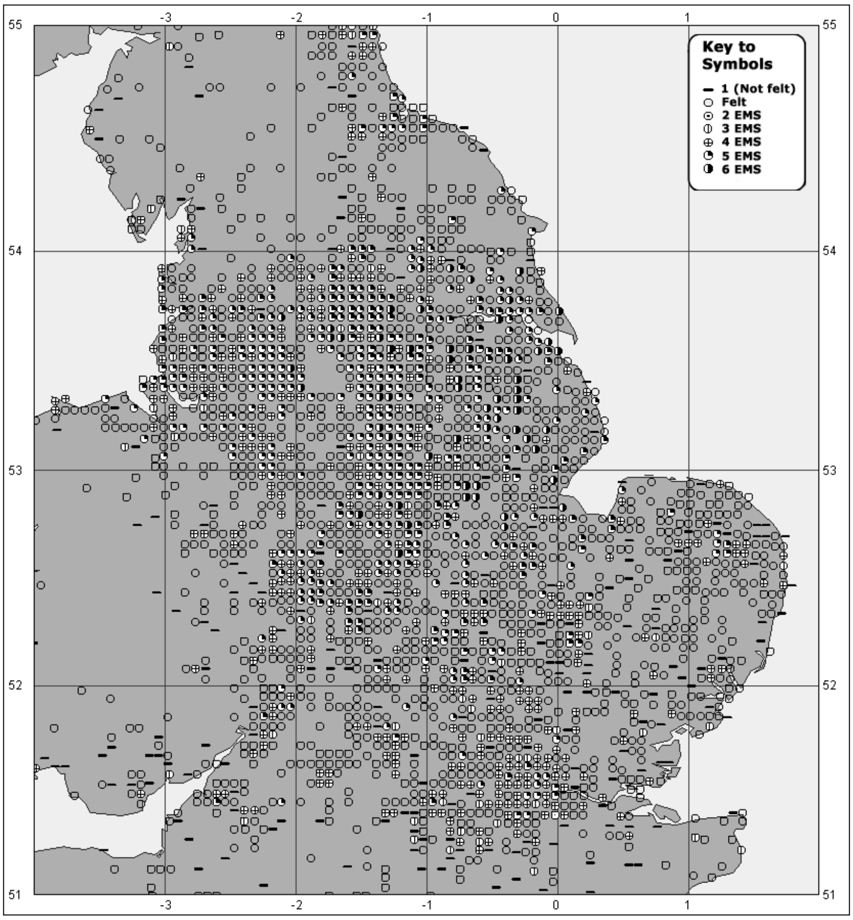

Figure 1b. Detail for inset area in Figure 1a

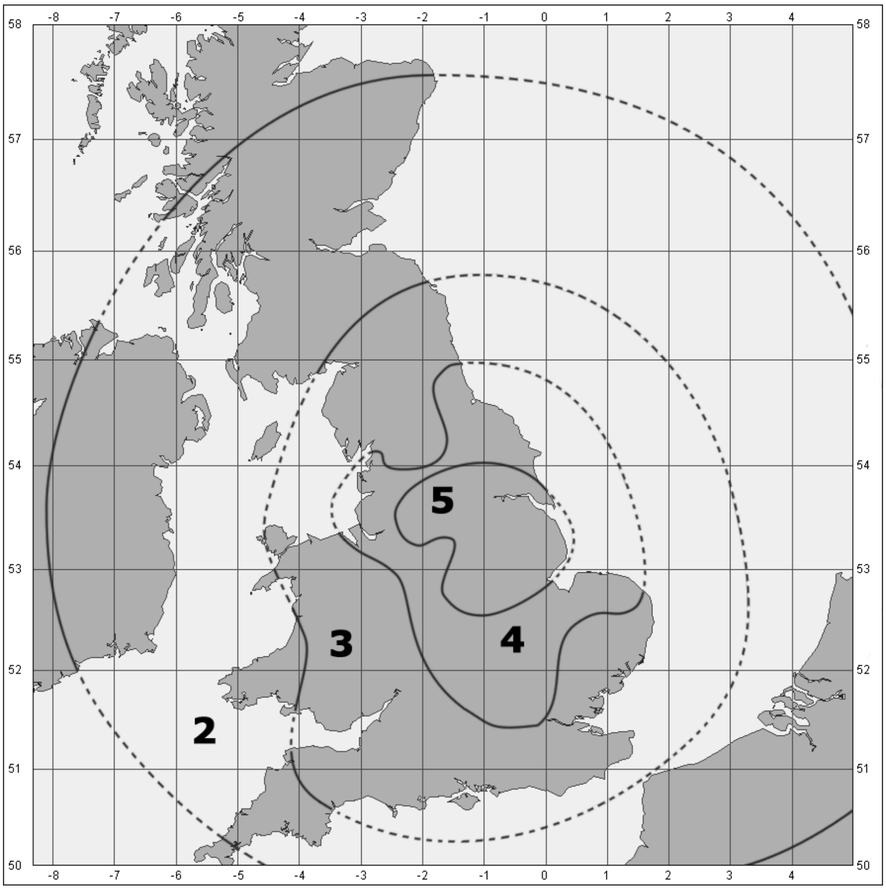

Figure 2. Isoseismal map based on Figure 1

Figure 3. Street scene in Gainsborough on the day of the earthquake, showing an instance of chimney damage (BGS photo by SL Sargeant)

number of respondents to the BGS survey who reported some kind of damage to property was 7%. The figure for the USGS data set was 7%. The figure for the EMSC data set was also 7%. A comparison was also made on the issue of the overthrow of objects. The BGS/EMSC questionnaire asks two questions: were any small objects moved or knocked down, and were stable objects like books moved or knocked down. The USGS questionnaire asks only about objects on shelves, and offers the responses of a few things fell down, many fell down, or everything fell down. Probably the answers to the USGS question are better compared to "stable objects" in the BGS questionnaire. The percentage of the entire USGS data set reporting at least a few objects thrown down was 10%. The percentage of the entire BGS data set reporting objects like books shifted or fell was 10% (the equivalent EMSC value was higher: 31%, but the EMSC data is more biased towards the near-field of the epicentral area).

The results show isolated values of 6 EMS at 59 locations, widely scattered over England in an area roughly between York and Nottingham, and east of Manchester. In no part of this area was the density of such observations sufficient to draw an isoseismal 6. It was a very noticeable characteristic of the earthquake that damage was reported in isolated cases over a very wide area; much greater than is normal in comparable earthquakes, and probably related to depth. The 1984 earthquake, which also had a depth of around 20 km, caused damage as far away as Liverpool. Examination of the area around the epicentre on the day of the earthquake did not suggest intensity 6; the isolated damaged chimneys were in almost all cases in very poor condition anyway (Figure 3 and Sargeant 2008, pers. comm.). This may well be true of more distant chimney damage. Five of the intensity 6 locations were assessed on the minimum of five responses to assess intensity; however, fifteen were based on twenty or more responses, and two on more than 100 responses.

Since the questionnaire respondents are self-selecting, there is likely to be an inherent bias towards stronger effects, which may lead to assessments of intensity 6 where this was actually observed only very locally, or even not at all, compared to what would be obtained from an exhaustive survey based on random selection. On the other hand, field investigation tends to neglect interior damage and non-damaging effects, which also contribute to intensity 6 assessments. One should beware, in assigning intensity, of becoming fixated on a few damage diagnostics, especially those

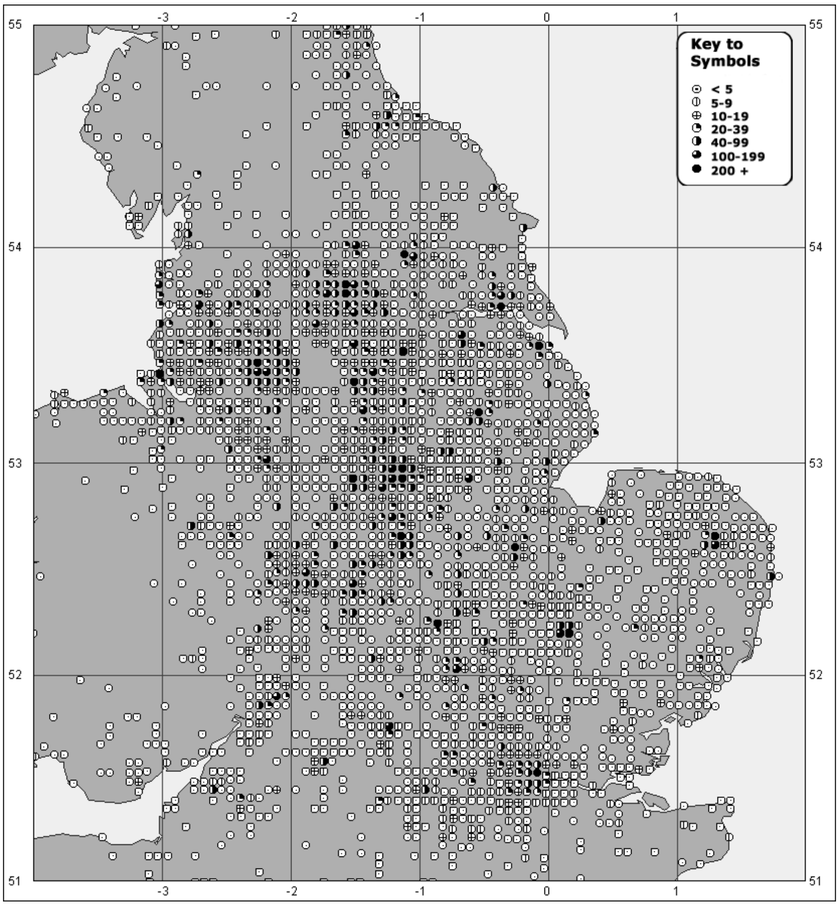

Figure 4. Number of reports per place on which intensity values are based, for the area shown in Figure 1b

that can be discerned just by walking round the streets looking at the outside of houses. Ultimately, however, it can be stated that in the context of this study, intensity 6 is defined according to whether the data received passes or fails certain tests laid down in the intensity-assessing algorithm. This process is entirely transparent and objective, and consistent from earthquake to earthquake.

The earthquake was felt very widely over an area bounded by the Lancashire coast, York, Norwich, London, and Birmingham, and additionally in two pockets around the mouths of the rivers Tyne and Tees. Over this area the intensity was a mixture of 4 and 5 mingled and almost undifferentiated by distance; south of Bedford there are signs that the intensity was reducing, but the shaking seems to have been quite marked in London. The isoseismal 5 has been drawn to enclose the area where the intensity was predominantly 5 EMS. Isoseismal 4 is open to some interpretation; it is clear that the intensity dropped sharply west of Birmingham, but the northern part of the contour is partly shaped by population distribution. Figure 4 is also useful; it shows the number of reports received from each location, and confirms, for instance, that the intensity values around Norwich were assigned on large samples, and not just a few questionnaires.

The course of the isoseismal 3 is also somewhat subjective, given that data beyond the area of intensity 4 are mostly too sporadic for good intensity assessments. The course of the isoseismal 3 in such cases is often influenced chiefly by a decrease in the density of observations.

The earthquake was definitely felt in Aberdeen at very low intensity, and there are a few isolated reports from the countryside north of Aberdeen. A very small number of people felt the earthquake in Ireland, France, Belgium and the Netherlands. The most distant report was from Liege, just off the east of Figure 1a.

Processing the isoseismals to yield macroseismic parameters for the earthquake (Musson 1996) gives a magnitude of 5.2 ML and a depth of 25-30 km. The magnitude is in very good agreement with the instrumental data; the instrumental depth is not well constrained but the event is clearly deep and at least 20 km. Not surprisingly, given the absence of high intensities in the epicentral area, the macroseismic epicentre is not well determined. Using a method based on the attenuation method proposed by Peruzza (1992) but better known in its development by Bakun and Wentworth (1997) gives a solution at 53.20 -0.82 (39 km from instrumental location). The Boxer solution (Gasperini et al. 1999) is better, at 53.43 0.69 (24 km from instrumental location).

The Market Rasen earthquake was not only the largest earthquake in Britain since 1984, it is looking like being one of the most expensive, with the total cost to insured property likely to be in the low tens of millions of pounds, according to the Association of British Insurers. Thanks to internet technology, it has been possible to gather and process a huge macroseismic dataset in a very short amount of time.

Acknowledgements

I would like to record my thanks to Dave Scott, BGS, Dave Wald and Vince Quitoriano, USGS, Sébastien Gilles, EMSC, Thierry Camelbeeck, ROB, and Tom Blake, DIAS for their assistance. This paper is published with the permission of the Director of BGS (NERC).

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SECED member awarded 2007 EERI Innovation Prize

Dr Rui Pinho, a SECED member since 1996, was the recipient of the 2007 edition of the prestigious EERI Innovation Prize (Earthquake Engineering Research Institute, California, USA) in recognition of his “exceptional leadership qualities, problem-solving capabilities, and entrepreneurship in defining and executing major programs leading to the reduction of earthquake risk”.

Dr Pinho, a past lecturer at Imperial College, now based at the University of Pavia, was awarded for his major role in the development of the Centre for Post-Graduate Training and Research in Earthquake Engineering and Engineering Seismology (the ROSE School), which is widely recognized as a leading international training center in the field.

Pinho’s role as deputy coordinator of the LESSLOSS project, involving nearly 50 European partners focused on risk mitigation for earthquakes and landslides was also recognised, as was his position as co-founder and technical director of SeismoSoft, an enterprise that develops and distributes a free collection of structural analysis and signal processing programs that have been accessed by users in over 100 countries.

The Shah Family Innovation Prize is a cash award granted to younger professionals and academics, currently in its tenth edition. For further information, visit http://www.eeri.org/home/honors_shah_innovation.html.

Seismic design of masonry structures

Evening Technical Meeting, Thursday 18 September 2008 at 6pm, Institution of Structural Engineers, London, presented by Prof A. Plumier and Prof H. Degée.

This meeting will focus on the seismic design of masonry structures in moderate seismicity regions. Presentations will be made by Professors André Plumier and Hervé Degée from the University of Liège, and will address key technical issues related to the assessment and design of masonry construction. The meeting is complementary to the short course *Seismic Design to Eurocode 8* (see p. 8). Attendance at the presentation is free, and reservation can be made for the dinner held after the meeting at a cost. Further information regarding the event and the venue will be available at the website of the Institution of Structural Engineers (http://www.istructe.org.uk).

Notable Earthquakes July – December 2007

Reported by British Geological Survey

Issued by: Davie Galloway, British Geological Survey, January 2008.
Non British Earthquake Data supplied by: The United States Geological Survey.

<table>
<tr><th rowspan="2">Year</th><th rowspan="2">Day</th><th rowspan="2">Mon</th><th>Time</th><th rowspan="2">Lat</th><th rowspan="2">Lon</th><th>Dep</th><th colspan="3">Magnitude</th><th rowspan="2">Location</th></tr>
<tr><th>UTC</th><th>km</th><th>ML</th><th>MB</th><th>MW</th></tr>
<tr><td>2007</td><td>16</td><td>JUL</td><td>01:13</td><td>37.54N</td><td>138.45E</td><td>12</td><td></td><td></td><td>6.6</td><td>WESTERN HONSHU</td></tr>
<tr><td colspan="11">Nine people killed, at least 1,000 others injured, severe damage to at least 875 houses and many roads and bridges damaged in the prefectures of Nagano, Niigata and Toyama. A train was derailed at in Kashiwazaki and a minor tsunami was observed on Sadogashima.</td></tr>
<tr><td>2007</td><td>16</td><td>JUL</td><td>05:27</td><td>53.46N</td><td>2.32E</td><td>10</td><td>3.0</td><td></td><td></td><td>SOUTHERN NORTH SEA</td></tr>
<tr><td>2007</td><td>17</td><td>JUL</td><td>17:17</td><td>52.80N</td><td>0.96W</td><td>3</td><td>2.6</td><td></td><td></td><td>MELTON MOWBRAY</td></tr>
<tr><td colspan="11">Felt Kirkby Bellars, Leicestershire (3 EMS).</td></tr>
<tr><td>2007</td><td>21</td><td>JUL</td><td>22:44</td><td>38.94N</td><td>70.49E</td><td>10</td><td></td><td></td><td>5.2</td><td>TAJIKISTAN</td></tr>
<tr><td colspan="11">Three people killed, several others injured and 100's of houses damaged in nineteen villages throughout the Rasht District. Twelve others were killed in the Asht District when a landslide occurred shortly after the earthquake.</td></tr>
<tr><td>2007</td><td>24</td><td>JUL</td><td>01:01</td><td>57.00N</td><td>1.88E</td><td>10</td><td>3.2</td><td></td><td></td><td>CENTRAL NORTH SEA</td></tr>
<tr><td>2007</td><td>01</td><td>AUG</td><td>17:08</td><td>15.60S</td><td>167.68E</td><td>120</td><td></td><td></td><td>7.2</td><td>VANUATU</td></tr>
<tr><td>2007</td><td>02</td><td>AUG</td><td>02:37</td><td>47.12N</td><td>141.80E</td><td>5</td><td></td><td></td><td>6.2</td><td>SAKHALIN, RUSSIA</td></tr>
<tr><td colspan="11">Two people killed, twelve others injured and 31 buildings either destroyed or severely damaged in Nevel'sk.</td></tr>
<tr><td>2007</td><td>08</td><td>AUG</td><td>17:05</td><td>5.86S</td><td>107.42E</td><td>280</td><td></td><td></td><td>7.5</td><td>JAVA, INDONESIA</td></tr>
<tr><td>2007</td><td>10</td><td>AUG</td><td>10:50</td><td>53.49N</td><td>2.17W</td><td>4</td><td>2.5</td><td></td><td></td><td>MANCHESTER</td></tr>
<tr><td colspan="11">Felt Manchester and Stockport, Greater Manchester (4 EMS).</td></tr>
<tr><td>2007</td><td>15</td><td>AUG</td><td>23:40</td><td>13.39S</td><td>76.60W</td><td>39</td><td></td><td></td><td>8.0</td><td>CENTRAL PERU (COAST)</td></tr>
<tr><td colspan="11">At least 514 people killed, over 1,100 others injured and more than 39,000 buildings either damaged or destroyed in the Provinces of Chincha Alta, Ica and Pisco. Communication and power outages occurred all over the region and a tsunami was generated as a result of the earthquake.</td></tr>
<tr><td>2007</td><td>30</td><td>AUG</td><td>04:46</td><td>53.48N</td><td>2.18W</td><td>4</td><td>2.2</td><td></td><td></td><td>MANCHESTER</td></tr>
<tr><td colspan="11">Felt Manchester and Stockport, Greater Manchester (3 EMS).</td></tr>
<tr><td>2007</td><td>02</td><td>SEP</td><td>01:05</td><td>11.61S</td><td>165.76E</td><td>35</td><td></td><td></td><td>7.2</td><td>SANTA CRUZ ISLANDS</td></tr>
<tr><td>2007</td><td>12</td><td>SEP</td><td>11:10</td><td>4.44S</td><td>101.37E</td><td>34</td><td></td><td></td><td>8.4</td><td>SUMATRA, INDONESIA</td></tr>
<tr><td colspan="11">At least 25 people killed, 161 others injured and more than 56,000 buildings either damaged or destroyed in Bengkulu and Sumatera Barat from both the earthquake and the tsunami which was generated.</td></tr>
<tr><td>2007</td><td>12</td><td>SEP</td><td>23:49</td><td>2.63S</td><td>100.84E</td><td>35</td><td></td><td></td><td>7.9</td><td>SUMATRA, INDONESIA</td></tr>
<tr><td>2007</td><td>17</td><td>SEP</td><td>19:35</td><td>55.80N</td><td>5.99W</td><td>19</td><td>3.0</td><td></td><td></td><td>JURA, STRATHCLYDE</td></tr>
<tr><td colspan="11">Felt on the islands of Jura and Islay, Strathclyde (3 EMS).</td></tr>
<tr><td>2007</td><td>26</td><td>SEP</td><td>18:33</td><td>53.45N</td><td>2.23E</td><td>10</td><td>3.3</td><td></td><td></td><td>SOUTHERN NORTH SEA</td></tr>
<tr><td>2007</td><td>28</td><td>SEP</td><td>13:38</td><td>22.00N</td><td>142.65E</td><td>276</td><td></td><td></td><td>7.4</td><td>VOLCANO ISLANDS</td></tr>
<tr><td>2007</td><td>30</td><td>SEP</td><td>05:23</td><td>49.27S</td><td>164.12E</td><td>10</td><td></td><td></td><td>7.4</td><td>AUCKLAND ISLANDS</td></tr>
<tr><td>2007</td><td>05</td><td>OCT</td><td>07:33</td><td>53.02N</td><td>2.29E</td><td>10</td><td>3.4</td><td></td><td></td><td>SOUTHERN NORTH SEA</td></tr>
<tr><td>2007</td><td>15</td><td>OCT</td><td>12:29</td><td>44.79S</td><td>167.58E</td><td>26</td><td></td><td></td><td>6.8</td><td>SOUTH ISLAND, NZ</td></tr>
<tr><td colspan="11">Minor damage reported in Fiordland.</td></tr>
<tr><td>2007</td><td>16</td><td>OCT</td><td>21:05</td><td>25.78S</td><td>179.53E</td><td>509</td><td></td><td></td><td>6.6</td><td>FIJI ISLANDS REGION</td></tr>
<tr><td>2007</td><td>24</td><td>OCT</td><td>21:02</td><td>3.90S</td><td>101.02E</td><td>20</td><td></td><td></td><td>6.8</td><td>SUMATRA, INDONESIA</td></tr>
</table>

Notable Earthquakes (continued)

			Time			Dep	Magnitude			
Year	Day	Mon	UTC	Lat	Lon	km	ML	MB	MW	Location
2007	26	OCT	06:50	35.30N	76.75E	10		5.3		NORTHWEST KASHMIR
One person killed and twelve others injured in Ghanche, Pakistan.										
2007	27	OCT	06:30	62.89N	1.72E	9	3.1			NORTHERN NORTH SEA
2007	31	OCT	03:30	18.90N	145.36E	223			7.2	MARIANA ISLANDS
2007	06	NOV	09:38	21.18N	70.72E	10		5.0		GUJARAT, INDIA
One person killed, five others injured and several buildings either destroyed or badly damaged in the Talala region.										
2007	07	NOV	04:12	9.72N	124.65E	72		5.1		BOHOL, PHILIPPINES
One person killed in Mabini in the Province of Batangas, Philippines.										
2007	14	NOV	15:40	22.25S	69.89W	40			7.7	ANTOFAGASTA, CHILE
Two people killed, 73 others injured and several thousand homes either destroyed or damaged, leaving over 15,000 people homeless, in the Maria Elena and Tocopilla areas, Chile										
2007	15	NOV	15:05	22.93S	70.24W	26			6.8	ANTOFAGASTA, CHILE
2007	16	NOV	03:13	2.31S	77.84W	123			6.8	ECUADOR
Minor damage reported in Guayaquil, Ecuador.										
2007	22	NOV	08:48	5.76S	147.10E	53			6.7	EASTERN NEW GUINEA
2007	25	NOV	16:02	8.28S	118.34E	35			6.5	SUMBAWA, INDONESIA
Three people killed, scores injured and hundreds of houses destroyed in the Bima, Dompu and Raba areas of Sumbawa.										
2007	27	NOV	11:49	10.99S	162.23E	16			6.6	SOLOMON ISLANDS
2007	29	NOV	19:00	14.97N	61.24W	147			7.4	MARTINIQUE
One person killed, at least 100 injured and several buildings either damaged or destroyed on Martinique. Two people injured and several buildings damaged on Barbados. Minor damage also occurred on St Lucia, St Vincent and on Guaeloupe.										
2007	30	NOV	17:08	55.80N	3.20W	6	2.3			PENICUIK, MIDLOTHIAN
Felt Penicuik, Midlothian (3 EMS).										
2007	30	NOV	22:05	52.87N	3.28W	12	2.9			LLANGOLLEN, N WALES
Felt throughout the Llangollen area, North Wales (4 EMS) and also felt in Shropshire, England (3 EMS).										
2007	09	DEC	02:03	15.03S	44.25W	10		4.9		MINAS GERIAS, BRAZIL
One person killed, six injured, 76 buildings damaged and 380 people left homeless in the Itacarambi, Januaria and Manga regions of Minas Gerias, Brazil.										
2007	09	DEC	07:28	26.06S	177.52W	143			7.8	FIJI ISLANDS REGION
2007	09	DEC	15:59	55.79N	3.22W	5	2.3			PENICUIK, MIDLOTHIAN
Felt Penicuik, Midlothian (3 EMS).										
2007	16	DEC	08:09	22.92S	70.07W	45			6.7	ANTOFAGASTA, CHILE
2007	19	DEC	09:30	51.37N	179.55W	29			7.1	ALEUTIAN ISLANDS
2007	20	DEC	07:55	38.86S	178.52E	36			6.6	NORTH ISLAND, NZ
One person killed (due to a heart attack), three buildings destroyed and several others damaged in Gisborne.										

Seismic Design to Eurocode 8

A two day course with design workshops organised by Imperial College London, in collaboration with SECED 18 - 19 December 2008, Imperial College London

Background

Since this popular course was last presented in 2006, all parts of Eurocode 8 have been published by BSI as British Standards, with publication of the accompanying UK National Annexes expected by summer 2008. The course is therefore timely; it combines a presentation of the Eurocode 8 provisions for steel and concrete buildings (including their foundations) with design workshops which will give participants hands-on experience of applying the code. The course concentrates on buildings and their foundations in areas of moderate to high seismicity, but the material covered is also applicable to many other types of structure and sub-structure.

Course methods

The two day course takes the form of a series of morning lectures, presented by leading experts from both the university and consulting sectors, followed by practical design workshops on Eurocode 8 in the afternoon. Workshops on geotechnical and structural design aspects will run in parallel. Every participant will obtain a copy of an extensive course publication covering the background material. Participants are expected to have access to a copy of Eurocode 8 Parts 1 & 5; course members can purchase these at the time of booking for £180, a saving of £168 on the normal price to non-BSI members (See registration form).

Course content

The first day starts with presentations dealing with the fundamental elements of seismic design to Eurocode 8, covering the choice of earthquake actions, loading and spectra, scheme design of buildings, seismic behaviour of soils and the design of shallow foundations. The two parallel workshops on the first day involve application of structural and geotechnical design aspects, respectively, covered in the morning lectures. The second day lectures deal with the design of deep foundations as well as reinforced concrete and steel structures. The afternoon will take the form of two parallel workshops, one focusing on geotechnical aspects and the other on structural design. The course covers the relevant provisions of Eurocode 8 Part 1 (general rules, seismic actions and rules for buildings) and Part 5 (foundations, retaining structures and geotechnical aspects).

Who should attend?

The course will be of value to a wide range of practising civil and structural engineers at different stages of their careers, who would like to acquire a practical appreciation of the design and analysis of structures (particularly buildings) for earthquake resistance, with emphasis on the design according to the provisions of Eurocode 8. This event may be considered as contributing to a recognised CPD scheme; delegates should check their individual scheme requirements.

Queries

For queries regarding the technical contents of the course, contact Dr. Ahmed Elghazouli (a.elghazouli@imperial.ac.uk, tel. 020 7594 6021). For general information, contact Ulrika Wernmark (cpd@imperial.ac.uk, tel. 020 7594 6886).

SECED Newsletter

The SECED Newsletter is published quaterly. Contributions are welcome and manuscripts should be sent on a CD or by email. Diagrams, pictures and text should be in separate electronic files. Copy typed on paper is also acceptable. Diagrams should be sharply defined and prepared in a form suitable for direct reproduction. Photographs should be high quality (black and white prints are preferred). Diagrams and photographs are only returned to authors on request.

Contributions should be sent to the current editor of the Newsletter, Andreas Nielsen.

Email
andreas.nielsen@jacobs.com

Post
Editor SECED Newsletter
c/o The Secretary
SECED
Institution of Civil Engineers
One Great George Street
London, SW1P 3AA
United Kingdom

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 about SECED contact:

The Secretary
SECED
Institution of Civil Engineers
One Great George Street
London, SW1P 3AA, UK

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