D 0519 | 505E

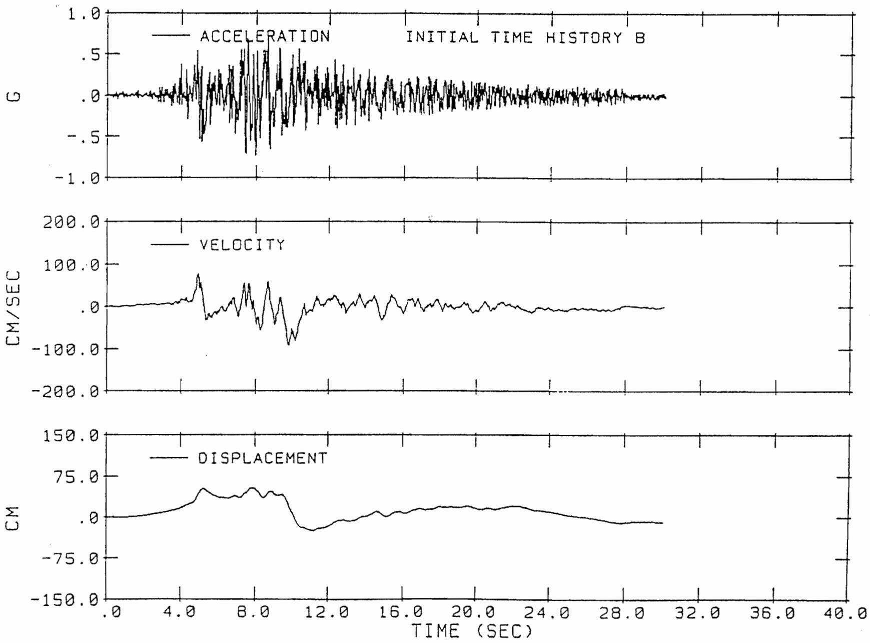
THE SOCIETY FOR EARTHQUAKE AND CIVIL ENGINEERING DYNAMICS

SECED NEWSLETTER

April 1991, Vol. 5, No.2

UNDERSTANDING EARTHQUAKE SOURCE PROCESSES AND THEIR IMPLICATIONS FOR ENGINEERS

The traditional procedure of constructing an estimate of strong seismic ground motion (time-history and/or response spectrum) as site input for structural design is to extrapolate from a set of observed ground motions. Selection is usually in terms of relevant seismic source parameters (magnitude, moment, mechanism), propagation path (distance, stratification, attenuation) and site characteristics (soil properties, topography). Recently, seismologists have developed seismic source and wave propagation modelling sufficiently for synthetic time histories to be considered as an alternative. Thus, synthetic time histories have been computed for both higher frequency motion applications (nuclear power plants) and for longer period structures (long viaducts and bridges).



Synthetic time-history (horizontal component) for a rock site a few kms from a surface strike-slip fault rupture (ML = 7.2). The scaling parameters are compatible with seismic source theory and available strong-motion observations. Used as one starting record for the 1990 BART studies (Bolt, 1990).

Advanced engineering studies now incorporate the phase properties of seismic wave motions that shake structures. Specifically, structures with multiple supports respond so as to average the free-field accelerations incident upon the supports. Hence dynamic analysis of these structures requires suitably zoned and phased time histories (ZPATH) applied at each support or a model response analysis with complete phase information appropriate to the local tectonic zone. In the past, the usual response spectrum described only the amplitude of the oscillator motion and did not define the phase behaviour. For large bridges, overpasses, and dams, out-of-phase wave motions over inter-support distances cause, however, differential ground accelerations and differential rotations along the base of the structure. Thus, full spectral representation must be used (see Abrahamson & Bolt, 1985).

Seismic zoning is highly significant because the location, size and type of seismic source and propagation path may affect ZPATH strongly. If they all emerged from a point source, then phasing, or order of arrival, at a series of support points would depend only upon wave speeds. In fact, earthquake waves are radiated from many points along an extended fault slip and depend on the type of slip involved. (In the 1989 Loma Prieta earthquake, this slipped area was about 40 km long and 20 km deep.) Waves from different parts of the ruptured fault are thus delayed by various amounts due to the different distances that they travel from their source points to the station (see Bullen & Bolt, 1985).

continued on page 2

continued from page 1

It follows that between seismogenic zones, a set of strong motions ZPATH, constructed as boundary conditions at the various input points, will not in general be alike.

It should be noted that the different phase spectra of the often-used accelerograms can be used to generate artificial but more suitably zoned time histories by interchange of phase spectra. This substitution procedure preserves the amplitude spectra and maximum motions but varies the duration and phasing pattern.

In undertaking time-history synthesis in appropriate frequency bands, the best practice now is to construct simultaneously, accelerograms and velocity and displacement seismograms (subject to spectral compatibility) by an iterative process. Cross-reference to any available strong ground motion records is a crucial check. The first step is to specify the geometry, size and dynamical characteristics of the causative fault rupture.

The construction of zoned and phased time histories, ZPATH, is not unique but this initial specification is important. The available geological and seismological information defines the appropriate earthquake sources for the zones of interest. The source selection may be deterministic or probabilistic and may be decided on grounds of acceptable risk (Bolt, 1991).

Next, specification of the propagation path distance is needed, and of the P, S and surface wave velocities in the zone. These speeds allow calculation of the appropriate wave propagation delays between support points and the angles of approach of the incident waves.

For high-moment near-earthquakes, the extended fault rupture can then be modelled by a succession of lagged elementary ruptures (theoretical or empirical "Green's functions") that capture as realistically as possible the faulting process. An important question, still uncertain, is to what extent the various parameters of the seismic source influence the final synthetic time-history or wave coherency (Bolt, 1987).

The construction of realistic ZPATH sets proceeds as a series of iterations from the most appropriate observed strong motion record already available, to a set of more specific time histories which incorporate the seismologically defined phase patterns. Where feasible, strong motion accelerograms are chosen which satisfy the seismic source and path specifications for the seismic zone in question.

The usual seismological and engineering constraints can be applied to ZPATH. For example, their response amplitude spectra should fall within one standard error of the target spectrum. Similarly, each number of the set must preserve prespecified peak ground accelerations, velocities and displacements within statistical bounds. The durations of each section (mainly P, S and surface wave portions) of each time history must also satisfy prescribed source, path and site conditions (see figure on page 1).

Some progress has been made in the use of ZPATH in practice. After the damage to the San Francisco-Bay bridge and 1880 viaduct in the 1989 Loma Prieta earthquake new considerations were given to the appropriate design criteria for large structures in high seismic hazard zones. The California Department of Transportation, for example, initiated thorough motion studies for its existing and future bridges both in the San Francisco Bay and Los Angeles areas. The Bay Area Rapid Transit Authority (BART) adopted new zoned ground motions for extensions of its rail system, some of which passes across or near major active faults. Also, the Golden Gate Bridge Highway and Transportation District undertook a detailed seismic analysis of the Golden Gate bridge which might need to respond to a 1906 San Francisco type earthquake. A set of ZPATH was developed for the evaluation. Ketchun & Seim, 1990).

The large size of the above bridges focused attention on relatively long period seismic motions, i.e. from 0.5 to 5 sec or more. It should be remembered that for energetic S wave components of period about 1 sec, the wave lengths incident on the supports are of the same order as key bridge dimensions. Hence, specifications for these studies required consideration of the effects of phased strong-motion inputs and, in some cases, the incorporation of coherency factors. Such studies challenge the state of modelling knowledge. First, few strong motion records are available for large near earthquakes, that define the spatial variation of shaking over distances of hundreds of meters. Secondly, because there are relatively large distances between the support points (320 ft arch span for the Golden Gate bridge) ZPATH in terms of gained velocity and displacement are essential inputs for analysis.

Bruce A. Bolt

Bruce A. Bolt is Professor of Seismology at the Department of Geology and Geophysics and Department of Civil Engineering University of California, Berkeley.

References

N.A. Abrahamson & B.A. Bolt. "The spatial variation of the phasing of seismic strong ground motion", Bull. Seism. Soc. Am. 75: 1247-1264 (1985).

B.A. Bolt (editor) Strong Motion Synthetics: Computational Techniques Series, Academic Press, New York (1987).

B.A. Bolt. "Balance of risks and benefits in preparation for earthquakes", Science 251: 169- (1991).

K.E. Bullen & B.A. Bolt. An Introduction to the Theory of Seismology. New York: Cambridge University Press (1985).

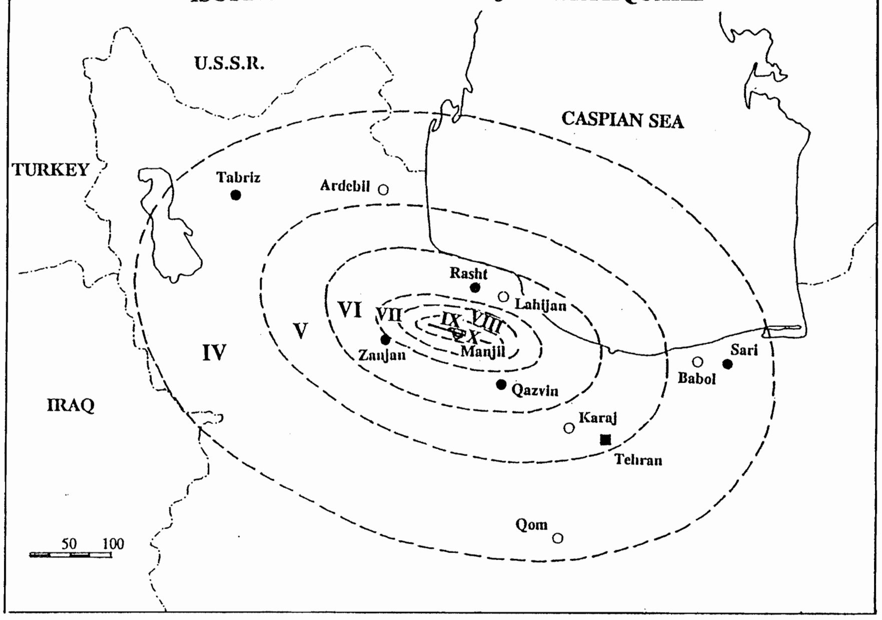
M.A. Ketchum & C. Seim. Golden Gate Bridge Seismic Evaluation. San Francisco: T.Y. Lin International (1990)

Manjil Earthquake

In order to investigate the engineering aspects of the earthquake damage, Mahmoud Maheri of W.S. Atkins visited the epicentral area shortly after the earthquake on behalf of the British Earthquake Engineering Field Investigation Team (EEFIT) and in collaboration with the International Institute of Earthquake Engineering and Seismology in Iran (IIEES).

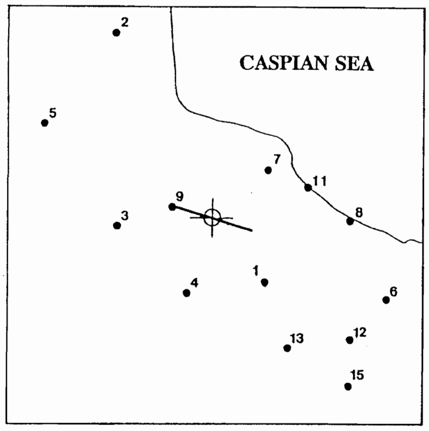
Scale of Event

The Manjil earthquake of 20 June 1990 devastated a vast, densely populated rural area of northern Iran destroying a number of towns and hundreds of villages. The official reports of casualties put the number of dead at over 40,000 with half a million homeless. The earthquake was strongly felt over an estimated area of 600,000 km^2 and as far afield as Turkey and the Soviet Union. In Tehran, about 200 km south of its epicentre, the quake caused widespread panic and some minor cracking in a number of tall buildings (MMI = V). There were however no reports of damage in Tabriz, 300 km north-west of the epicentre where the quake was also strongly felt (MMI = IV). Other cities near the epicentre such as Zanjan (80 km), Gazvin (75 km) and Rasht (60 km) experienced stronger ground shaking with some damage to the weaker and taller buildings. The near total destruction of buildings in the towns of Manjil and Rudbar however suggests intensities of between MMI = IX and MMI = X in the epicentral area.



ISOSEISMAL MAP OF MANJIL EARTHQUAKE

PEAK GROUND ACCELERATION RECORDED BY SOME ACCELEROGRAPHS



No	Instrument Location	Long. Comp. (%g)	Trans. Comp. (%g)	Vert. Comp. (%g)
1	Qazvin	19	8	9
2	Ardebil	2	9	2
3	Zanjan	10	6	6
4	Abhar	13	19	6
5	Mianeh	2	2	-
6	Gachsar	6	10	3
7	Lahijan	9	10	6
8	Tonekabon	11	6	3
9	Abbar	65	15	23
10	Kahrizak	3	2	2
11	Rudsar	7	5	6
12	Karaj	4	2	3
13	Eshtehard	6	7	5
14	Rudshur	3	3	1
15	Robat Karim	4	5	2

Different seismological centres have given the size of the quake as between 7.3 and 7.7 on the Richter scale. This makes the Manjil quake the strongest earthquake in recent years to strike a centre of population. Early indications are that the quake was associated with an 80 km to 100 km long ground rupture running east-west just north of the town of Manjil.

Numerous rock falls and land slides followed the main event and the stronger aftershocks, blocking roads and damaging structures. The quake also caused changes in the level of water table, and resulted in soil liquefaction in vast areas.

Ground Motion Data

Although there are no direct records of the ground accelerations at the epicentre of the earthquake, a number of accelerographs situated within a 200 km radius of the epicentre recorded the ground accelerations of the main event. The preliminary readings from the nearest of these accelerographs at Abbar (some 40 km west of epicentre) revealed high maximum horizontal and vertical ground accelerations of 0.65g and 0.23g respectively. One may assume accelerations in excess of the above figures for the epicentre of the quake around the town of Manjil.

Performance of Building Structures

The behaviour of traditional masonry buildings in Iran during the Manjil earthquake proved, yet again, the vulnerability of these buildings to seismic loading. In this respect very little could be learnt from the Manjil earthquake that had not already been observed and noted in numerous strong earthquakes of the past few decades in the country. In many other respects, however, the Manjil earthquake may be considered different to the past earthquakes, in that it struck a densely populated and relatively industrialised part of the country, affecting a large number of engineered and semi-engineered buildings and other structures. As a result, perhaps for the first time, the performance of such code-recommended measures as concrete ring-beams, engineered version of steel I-beam, jack-arch roofing system and the more recent concrete beam-block system in small buildings, as well as the behaviour of taller steel and concrete framed buildings could be studied in relative detail in the field.

General destruction in Manjil

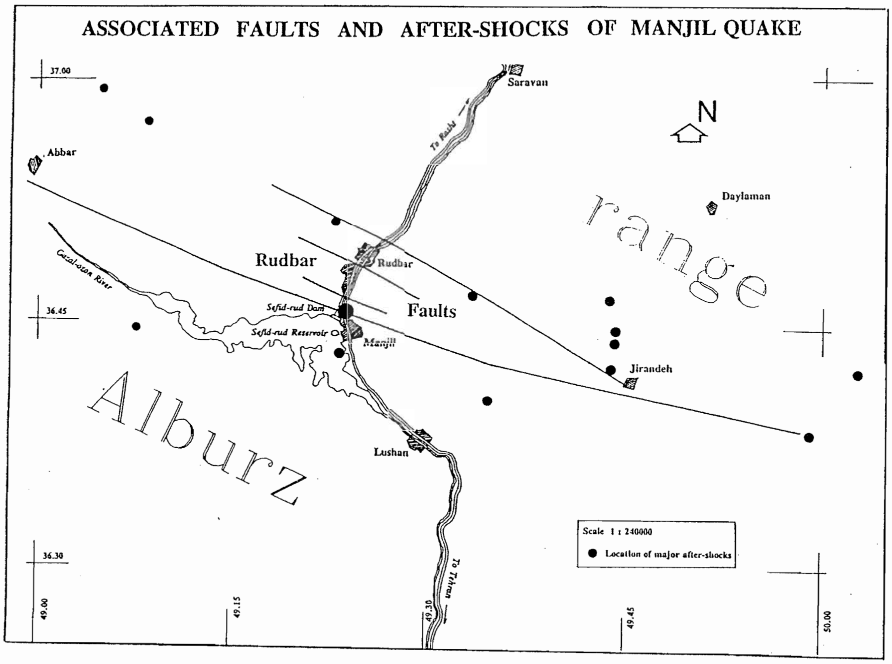
Amongst many field observations, the good behaviour of concrete ring-beams in mitigating the collapse of the roof and floor slabs is worthy of mention. The importance of providing principal or secondary load-bearing elements in the form of concrete columns was also evident in many cases. An important observation made on the response of the engineered version of steel I-beam jack-arch slabs (in which I-beams are restrained by transverse beams and/or tie-bars) was that such composite slabs are only suitable as roof slabs, simply supported on the walls via the ring-beam. Because of heavy interaction between the brittle brick arches and the flexible steel beams, their behaviour as fixed-sided floor slabs in two-storey and higher buildings is less favourable.

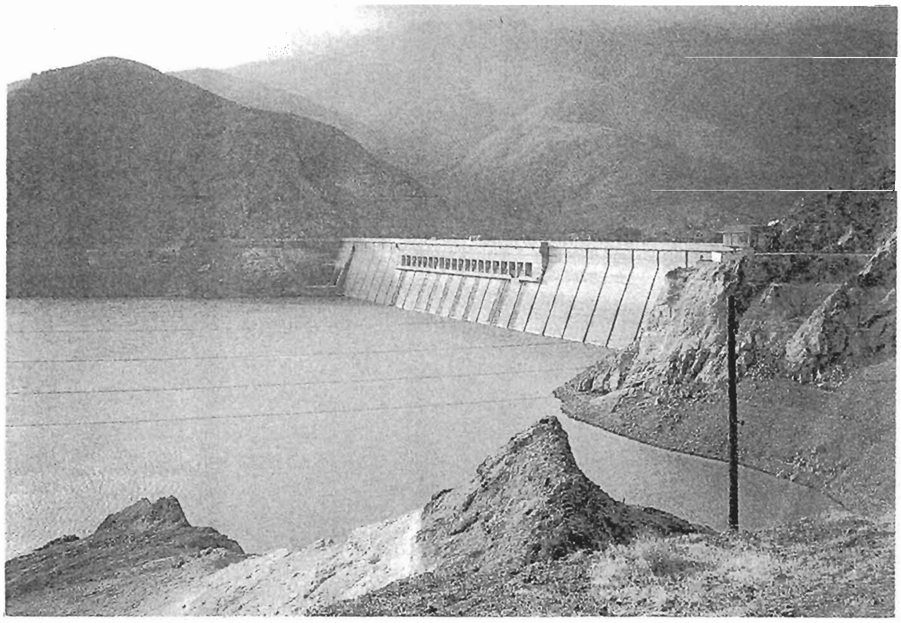
Failure of Vali-asr hospital, Rudbar

The performance of the steel-framed buildings appeared very poor. Save for a few buildings situated in the epicentral area, they suffered heavy damage or collapsed. Those which were not badly damaged, survived the earthquake as a result of the incidental frequency range of the ground shaking which was much higher in that area than the fundamental frequencies of the buildings. The main point of weakness of the steel-framed buildings was in their welded joints. Poor welding rendered weak connections which snapped before the steel sections could develop any significant dynamic stresses. The response of concrete-framed buildings, as a whole, appeared much more favourable than their steel-framed counterparts. An interesting aspect of the response of a number of framed buildings was the clear evidence of the effects of lateral-torsional dynamic interaction in these buildings. Such interactions are caused by stiffness and/or mass eccentricities in a building which result in amplified response of one side of the building.

Dams and Other Large Structures

The region devastated by the Manjil earthquake is a well watered agricultural, and industrial area. As a result a number of large engineered structures such as dams, ground-based and elevated liquid storage tanks, silos, concrete and steel bridges, industrial plants and factories were affected by the earthquake. Perhaps the most important structure to be subjected to severe ground shaking was the 106m high, 425m





Sefid-Rud dam, Manjil - drawn down after the earthquake

long, aseismic designed buttressed Sefid-Rud dam. This dam is an important source for electricity generation and imperative to the agriculture in the area. Although the surface expression of the active fault associated with the earthquake was determined as only 300m north-east of the dam it survived the estimated 0.65g ground acceleration with some minor cracking in the central buttresses and the crown. Two other dams in the area, Sangar and Tarik, both diversion dams also survived the quake. Failure in two of the thirteen steel gates of the Sangar dam and the spalling of concrete due to the pounding of the bridge deck against the piers in the Tarik dam was the main damage in these two dams. The only large structure to completely fail under the earthquake was a 47m high reinforced concrete, elevated water tank in the city of Rasht. The tower was apparently not designed to withstand earthquake forces. Two similar water towers in Rasht, however, survived with minor damage, mainly because they were empty at the time of the quake. Steel and concrete bridges, on the other hand, behaved well during the earthquake, partly as a result of their relatively low natural frequencies of vibration. None of those visited had suffered serious structural damage. Other large structures, including a number of factories suffered varying degrees of damage.

Conclusions

Two important seismic design considerations, absent in most of the above structures include, (i) appropriate seismic joints and (ii) the safety of secondary elements or systems. Inadequate (or complete lack of) seismic joints between different sections of the structure which are invariably of different dynamic properties resulted in many local failures due to pounding. It was also apparent in many instances that in the seismic design of secondary structures and associated elements and in installation of systems and equipment, the secondary response of such elements and systems had been overlooked.

Mahmoud Maheri

The EEFIT report is now available at a cost of £25 (£15 for SECED/EEFIT members) and is obtainable from Pauline Ashwood, W.S. Atkins Engineering Sciences, Woodcote Grove, Ashley Road, Epsom, Surrey KP18 5BW (0372-726140).

see also

Report No. IIEES-69-5, August 1990, "The Majil-Roudban Earthquake of June 20, 1990", International Institute of Earthquake Engineering and Seismology, Tehran, Iran.

obtainable from

International Institute of Earthquake Engineering and Seismology
P.O. Box 19395/3913
Tehran
Islamic Republic of Iran

Earthquake Reconstruction for Future Protection

Introduction

Mexico 1985

Each of the major earthquakes occurring over the past decade has generated a programme of protection planning against future earthquakes. After the Mexico City earthquake of 1985, a major project was instigated by the United Nations (funded by UNDP, and executed by UNCHS) to initiate protection planning within the reconstruction activities and future planning of Mexico City - the largest conurbation in the world.

Iran 1990

After the major earthquake in Iran in June 1990, the United Nations again mounted a technical assistance programme to assist the Iranian government in developing their plans for reconstruction. An international team was sent in to evaluate government plans and propose a structure for coordinating international aid and development planning. The project that has just been initiated as a result comprises a range of measures including code reviews, code enforcement measures and technical assistance in non-engineered construction to resist earthquakes.

Philippines 1990

The earthquake in the Philippines in July 1990 destroyed much of the infrastructure and transportation network in the affected area. The main impact of the earthquake was on the economy of the region, affecting businesses, agriculture and tourism. Recovery planning needs to revitalise the economic production of the region as a prerequisite for successful reconstruction and to mitigate the effects of future earthquakes. The United Nations team assembled as technical assistance to the Presidential Reconstruction Task Force focussed on regional development issues and economic planning. The four-man team worked on the city masterplans and reconstruction strategies of Dagupan and Baguio.

These United Nations projects and others have now given rise to a set of accepted principles for the design of an earthquake reconstruction strategy. These are as follows:

Use the Reconstruction for Economic Recovery

Economic regeneration is the key to successful reconstruction: restore income as well as buildings. *A strong economy is the best protection against future earthquakes.* A strong economy means more money to spend on stronger buildings and larger financial reserves to cope with future losses.

Identify the weakest members of the economy. Those who have lost their economic reserves (house, livestock, livelihood) and ensure that assistance reaches them. Marginal families without reserves can quickly become destitute. Migration of families from rural areas to the towns is accelerated by earthquake losses.

Recovery of Agricultural Economies

Understand the market structure of the region - what is normally produced, how much is sold or consumed by the community itself, where produce is sent to market, the supply and distribution network and how the earthquake has affected the market process. Recovery should ensure both the continued supply of produce to areas outside and to revitalise the livelihoods of farmers within the earthquake affected area. The earthquake has destroyed reserves that farmers use to survive poor harvests and bad times: replacement of these reserves is needed for full recovery. Identify the most economically vulnerable members of the community and target aid towards them. Help replace animal losses, tools and seed. Instigate programmes of income supplementing (bee-keeping, dairy processing, craft production).

Revitalising Industrial Economies

Infrastructure is critical to industry: repair this first. Promote a partnership between private sector and government. Smaller companies are likely to be under-insured and may be unable to recapitalise and continue in business even if profitable. Look at the government-imposed restrictions on industry - e.g. locational zones, pollution controls, labour laws etc. In the emergency is it possible to remove them or relax them during the reconstruction period? Industry is interdependent - look at linkages between factories and where their employees live - is housing damaged as well as their income?

Recovery of Commerce and Service Industries

Service industries, (shops, small businesses and trades) provide employment and income to a large proportion of the population. Premises are vital to continuity. Provide temporary (lockable) structures for use during the emergency and rehabilitation phase. Loss of customers is the biggest damage caused by earthquake. Restore communications and information linkages between customers and businesses: Newspapers, Radio, TV for trade information dissemination.

Central Business Districts tend to be located where they are for very specific reasons of trade routes and proximity to markets. Unless the earthquake has changed these basic factors, the CBD will repair itself - damaged buildings form only a small part of the office costs (staff and operating overheads far exceed structural costs of office buildings). Communications and utilities are vital to the early recovery of CBD.

Recovery of Tourism

Negative publicity associated with earthquakes can harm short term tourism returns. An effective and efficient reconstruction programme can be used to counter negative publicity with positive images of recovery and improved facilities. Past examples in other countries (Italy, Greece, Yugoslavia) include making the reconstruction and restoration of earthquake damage into a tourist attraction in its own right. Public relations and tourism marketing should be seriously considered, running promotional campaigns for the region in the main places that tourists come from.

Construction Industry and Building Materials Manufacture

The construction industry is a primary employer in the region and reconstruction operations is a good method of injecting capital into the local economy: local building labourers spend their wages in the local shop - both shop and local labourer benefit. Use an expanded local building industry for rebuilding - use outside contractors as little as possible, and in partnership with local companies. A strong local construction industry is a good protection against future earthquakes.

Develop an Integrated Building Materials Plan: use locally manufactured building materials as much as possible, regional materials if necessary and imported materials as little as possible.

Examine the materials market and normal production levels. Consider expanding local material production in preference to using materials from elsewhere. Consider substituting materials for local equivalents, even if these are currently poorer quality (use technical assistance to improve quality). Small scale manufacturing processes are quicker to set up and expand than large-scale, and distribute investment more rapidly to the local community.

Ensure Cultural Continuity in the Reconstruction

Many examples of reconstruction have failed through assistance being insensitive to local needs and preferences. Relocation and bad reconstruction decisions can cripple the local economic productivity of a settlement and render it more vulnerable in the future.

Relocation of settlements should be avoided wherever possible

Most settlements are where they are for a reason and it is rare that the threat of future hazard outweighs those reasons. Earthquake damage alone rarely justifies resiting. Major landslide or flooding threats may.

Rehousing in buildings that are different to those normally built by the community for themselves will generate long-term problems: they may quickly become unpopular and investment will be wasted. *Do not provide housing: make housing happen.* Facilitate the normal housing operations and help the local construction industry expand to meet the demand.

Radical agricultural reforms, like farm collectivizations and major land reforms instigated following earthquakes have rarely been successful.

Decisions on reconstruction should be taken at the most local level possible.

Deconcentrate Cities and Services

An earthquake also presents an opportunity to reappraise physical fabric and urban services. A key strategy for future earthquake protection is to deconcentrate facilities: *Services provided by one central facility are always more at risk than those provided by several smaller facilities.* This principle applies equally to hospitals and campuses, for example, as it does to power stations, telephone exchanges, and water treatment plants. Where damage has been suffered by a facility, rebuild it as a number of smaller units, preferably spread out over an area rather than as a single unit or in one place.

Similarly, densities of cities may be reappraised in the reconstruction planning. Lower densities can be encouraged by the morphology of urban areas: the area and distance between streets, plots of land made available and in allowable plot ratio developments.

Instigate Safe Construction Procedures

Earthquakes will continue to occur long into the future. It may be a long time before such a destructive earthquake hits the same region again, but it is likely to happen. The region is likely to continue to experience lower intensities fairly frequently.

The next time that Baguio or Dagupan is hit by such a large earthquake may be a century or more away. The steps that are taken to restore the towns and region now must be capable of providing proper protection to the region in that future time, as well as against the frequent tremors it will experience in the meantime.

Some of the buildings built in today's reconstruction will still be around for the next big earthquake, but not many. Buildings that last for 20, 50 or even 100 years will be replaced by others. *The earthquake reconstruction must be used to instigate safe construction procedures that will continue for the next century.* Just building a set of stronger reconstruction buildings will not be enough if the buildings built later on are as weak as the ones built before the earthquake.

Procedures for a stronger building stock include strong quality control and building code compliance checks. The method of checking and enforcing building standards has to be firmly instigated in a new process that cannot be easily revoked. Quality control needs trained engineers. *Municipal engineers are the front-line troops in future earthquake protection.* Engineering design and training may be reviewed as part of a wider strategy for implementing better construction procedures.

Non-engineered buildings form the highest percentage of the building stock in every region. *Improving the process of producing safer non-engineered buildings involves training the builders that produce them.* Education processes have to be designed specially for them: practical hands-on training is more effective than audio-visual material or books.

Institutionalise Safety Culture

In a 'Safety Culture', people take account of day-to-day risks they face in their normal decision-making processes: special earthquake-risk programs are not needed to make it happen.

Public awareness of risk levels is the first step. Public education on risk should be integrated within normal TV programmes, newspaper articles and entertainment rather than as public service announcements. All profession training of engineers, planners, architects, public officials etc. should include earthquake risk as a module.

Planning decisions, building design, road construction and economic strategies should take earthquake risk into account as a normal part of the factors under consideration. Basic ground rules need proposing for risk minimisation in each profession.

Export Improvements Beyond the Reconstruction Area

The next earthquake to hit the Philippines is unlikely to happen in the same place. It may occur on another part of the same earthquake fault, further north, or further south, or on another fault system in Luzon, or on another island. To reduce the impact of that event, the full lessons of the Luzon earthquake and the improvements that are instituted in the reconstruction have to be implemented outside the damaged area.

The national institutions responsible for hazard mitigation have to be built up and maintained.

A national risk mitigation plan will identify the areas most at risk from future earthquakes and propose strategies to reduce it. Risk identification involves mapping hazard and future earthquake occurrence, looking at where that hazard threatens major settlements and infrastructure, and how vulnerable the elements are to earthquake occurrence. Public awareness, training, reassessment of investment strategies, deconcentration and safe construction procedures can then be implemented in these areas to ensure that future earthquakes in the Philippines do not pose the same threat to life and economic prosperity as the earthquake of 16 July.

Dr. Andrew Coburn

The Martin Centre for Architectural and Urban Studies, University of Cambridge, United Kingdom

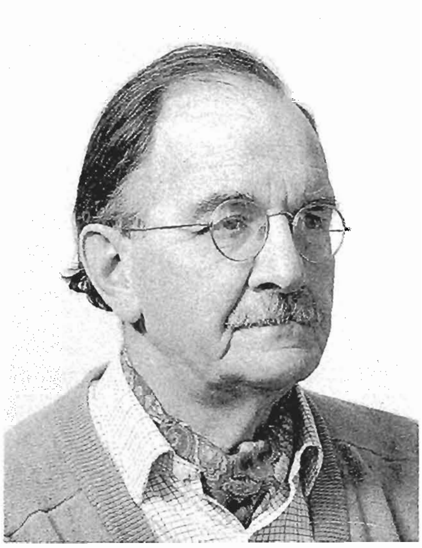
---

New United Kingdom Delegate to the International Association of Earthquake Engineering

Following his retirement from his University post, Professor Warburton F.Eng relinquished his responsibilities as UK delegate to IAEE. The committee considered the matter and decided unanimously to approach Professor Ambraseys to act as UK delegate, a responsibility which he has kindly accepted. His deputy in this post will be Dr. Elnashai.

We would like to express our gratitude to Professor Warburton, who over so many years as a UK delegate commanded great respect amongst the IAEE community. We also welcome Professor Ambraseys back to this post, since his last service as UK delegate during the period 1960-1972.

For the few of our membership who do not know Professor Ambrasey's background, he joined the staff at Imperial College in 1959, and has headed the Engineering Seismology



Professor Ambraseys

Section at IC since 1962. He was appointed Professor of Engineering Seismology in 1974, and currently heads the Engineering Seismology and Earthquake Engineering Section at Imperial College.

Professor Ambraseys was adviser to UNESCO on engineering seismology from 1968, up to the time when UK ceased to be a member of that organisation. During this period he undertook post-earthquake reconnaissance missions on behalf of UNESCO in various parts of the world. Professor Ambraseys is also consultant to several firms in the UK and abroad.

He served as Director of the IAEE from 1960 to 1978 and he is a founder member of the European Association of Earthquake Engineering (EAEE) and its Vice-President during the period 1964-1975. He is also a founder member of SECED and an Honorary Life Member.

New French Rules

New guidelines called *DTU Règles PS-MI 89*, for the design of houses and similar small buildings to resist earthquakes are now available. The guidelines indicate how to apply the more general rules for seismic protection to small buildings. They concern traditional construction having a structure of masonry, in-situ concrete, ordinary large prefabricated concrete panels, timber and steel.

Earthquake Field Training Unit (EFTU) Mission to Algeria

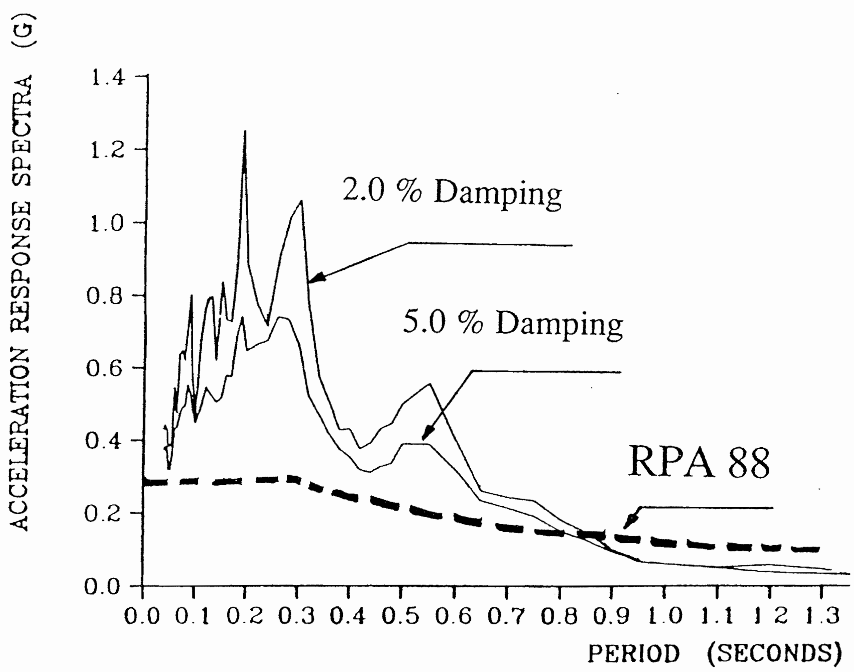
An EFTU field investigation team visited the area affected by the Chenoua earthquake of 29th October 1989. A total of 32 man-days were spent studying the effects of the earthquake. Below is a brief description of the main observations from the mission. A full report, including an appendix on the historical seismicity of the Maghreb and a re-visit of the area affected by the El Asnam earthquake of 1980, is available from the ESEE section at Imperial College.

The earthquake occurred at 19:09:12 UTC, and an epicentre at 36.37N 2.20E, and a depth of 10 km. There were no reports of premonitory observations of any kind. The surface wave magnitude was Ms = 5.7 while the body wave magnitude was Mb = 5.7. Maximum epicentral intensity was estimated to be VIII. Plots of energy flux points towards a simple source mechanism of a single rupture, with an estimated length of 5 km. Twelve minutes later, a second shock occurred with Ms = 5.5 and Mb = 5.6.

The epicentre of this small magnitude earthquake was located within the Chenoua mountain region and no surface manifestation of a surface rupture was observed. Ground cracks on the road along the coast on the east side of Chenoua are thought to be due to lateral spreading; minor landsliding was also produced. No evidence of ground liquefaction was observed.

Strong-motion instruments triggered by this event indicate that the peak horizontal ground acceleration at a distance of 14 km from the epicentre was 0.28g, with a vertical component of 0.14g. The strong-motion duration was 13 seconds, with a predominant frequency, as observed from the response spectrum of the Cherchell record, of 3 to 10 Hz, thus mainly affecting structures of one to three storeys.

The earthquake affected structures within an area of 10,000 square km.



Ground Motion Response Spectra (Cherchell, N18OS)

Damage was concentrated in the towns of Nador, Menaceur, Sidi Mousa, Bakoura, Sidi Amar, Tipaza and Cherchell, with minor non-structural damage reported from further afield. Whereas several cases of total collapse of engineered structures were reported, the earthquake affected mainly traditionally constructed dwellings and caused the death of 28 persons. It was concluded that damage to buildings was due to direct earthquake ground motion and was little affected by the local soil conditions.

The main causes of damage to engineered structures are similar to those identified in previous earthquakes in Algeria and elsewhere, and include the use of sub-standard materials, seismically vulnerable architectural configurations, inadequate earthquake-resistant design practices and non-ductile detailing. Moreover, repair material and methodologies used are thought to be deficient.

It is concluded that the northern region of Algeria, and the Maghreb in general, is subjected to relatively frequent small to medium size earthquakes, usually of shallow depth. Such events expose the vulnerability of old poorly maintained structures as well as more modern buildings that were not built with rigourous supervision and earthquake-resistance provisions. It is therefore important that concerted efforts are directed towards retrofitting of structures in areas of the highest seismic risk, in order that the hazard is reduced to an acceptable level.

Amr Elnashai and Julian Bommer

Imperial College London

News from EFTU

The ESEE Section at Imperial College is preparing for the annual field mission, which is part of the Master of Science courses run by the Section. This year EFTU will study the Goumenissa (Greece) earthquake of 21 December 1990. This trip is scheduled for 2-9 May, and will include field work in both Greece and Yugoslavia, as well as a visit to Aristotle University of Thessaloniki. A report on the earthquake covering seismological, geotechnical and structural field observations is planned.

For information about earthquake engineering courses and publications available from Imperial College contact Dr Amr Elnashai at the Department of Civil Engineering, Imperial College of Science and Technology, Imperial College Road, London SW7. (071 589 5111)

NOTABLE EARTHQUAKES JANUARY - MARCH 1991

Reported by British Geological Survey

YEAR	DAY	MON	LAT	LON	DEP KM	MAGNITUDE ML	MB	MS	LOCALITY
1991	05	JAN	23.478N	95.983E	20		6.3	7.1	BURMA
			Some landslides reported. Felt strongly at Mandalay. Also felt in much of northwestern Burma, in the Silchar area of India and in parts of Thailand.						
1991	09	JAN	51.668N	3.290W	3	1.2			GELLIGAER, M. GLAMORGAN
			Strongly felt (IV MSK) in Edwardsville and felt over about seven square kilometres. Believed to be coalmining induced.						
1991	23	JAN	53.672N	1.551W	0	1.5			WAKEFIELD, W. YORKSHIRE
			Felt in the Wakefield area. Believed to be coalmining induced.						
1991	31	JAN	36.059N	70.483E	152	6.4			HINDU KUSH
			At least 500 people killed and much damage in northeastern Afghanistan and northern Pakistan. Severe damage (VII MM) and landslides in the Khorog area, USSR. Felt throughout northeastern Afghanistan, northern Pakistan, northern India and Tajikistan.						
1991	09	FEB	9.859S	159.091E	10		6.3	6.9	SOLOMON ISLANDS
			Minor damage at Honiara and felt strongly on Guadalcanal.						
1991	21	FEB	58.419N	175.445W	10		6.3	6.5	BERING SEA
			Felt (IV MM) on St. Paul in the Pribilof Islands, Alaska.						
1991	21	FEB	53.188N	1.227W	0	1.5			MANSFIELD, NOTTS
			Felt at Radmanathwaite and Pleasley with intensities of up to V MSK. The strongest in a series of felt events in the same area. These events are believed to be coalmining induced.						
1991	21	MAR	57.897N	0.735E	18	3.3			CENTRAL NORTH SEA
			A moderate earthquake located in the Witch Ground Graben area of the North Sea about 15km northwest of the Forties oil field and near to other oil fields.						
1991	29	MAR	56.121N	3.715W	1	1.7			CLACKMANNAN, CENTRAL
			Felt strongly (IV MSK) in the Birkhill area. The strongest in a series of similar events affecting this area. Believed to be coalmining induced.						

EEFIT NEWS

The EEFIT Annual General Meeting on March 18 heard Dr. Jack Pappin present the chairman's report on behalf of Dr. Scott Steedman.

The year's achievements were outlined and the field missions made following the Philippines Earthquake of 16th July 1990, the Romanian Earthquake in May 1990 and the Sicilian Earthquake of 13th December 1990 provided the main focus of interest. In addition a visit by EEFIT member Dr. M. Maheri to Iran following the Manjil earthquake of 20th June 1990 is to be the subject of an EEFIT report. Each of these expeditions proved highly successful and a considerable body of data has been gathered.

Six reports are currently in preparation and five of these (Loma Prieta, Newcastle, Philippines, Iran and Sicily) will be published shortly under the EEFIT name. This represents a considerable achievement for EEFIT and the high standard of these reports is based on thorough preparation and careful review. This has taken time and in some cases more time publications will, no doubt, be a credit to EEFIT and to the individual authors. The availability and prices of these reports will be notified in due course.

Ian Morris (BNFL) and Gavin Trott (W S Atkins) were elected onto the Management Committee.

For copies of the Chairman's annual report and further information about EEFIT contact Dr. R.S. Steedman at The Institution of Structural Engineers, 11 Upper Belgrave Street, London SW1X 8BH.

THIRD MALLET-MILNE LECTURE: "REDUCTION OF VIBRATIONS"

Professor Warburton

SECED started the Mallet-Milne lecture series in 1987 to commemorate two distinguished Victorian pioneers of seismology and earthquake engineering, Robert Mallet and John Milne. The lecture is the most prestigious event in SECED's calendar and takes place every 2 years. Previous lecturers have been Professor Ambraseys (Imperial College, London) and Professor Housner (California Institute of Technology).

This year, we are fortunate in having secured another speaker with an international reputation, namely Geoffrey Warburton, Emeritus Professor at the University of Nottingham and Visiting Professor at Imperial College. During his distinguished career, Professor Warburton has published a standard text on structural dynamics and is currently General Editor of the influential international journal "Earthquake Engineering and Structural Dynamics". Professor Warburton is a long standing member of SECED and for many years has been active on the committee as representative of the Institution of Mechanical Engineers. He also serves on the executive of the International Association for Earthquake Engineering.

In his lecture Professor Warburton will present a definitive review of "Reduction of Vibrations". This is a topic of major importance in many fields of engineering, including rotating machinery, traffic and noise vibrations, vibrations caused by human footfall and those due to wind or waves. It has a special significance in the field of earthquake engineering, where ground induced vibrations can lead to disasters such as occurred in Mexico City, 1985 and Armenia, 1988.

The lecture will be accompanied by an exhibition at the Institution of Civil Engineers and will be followed by a reception. The lecture is free and open to all; no tickets are required. However, tickets are required for the wine and cheese reception which follows; these can be obtained from the Secretary of SECED, James Dawson (071 839 9836) at a cost of £12.50. The receptions following the last two Mallet-Milne lectures have been lively social events, providing an opportunity for SECED members to meet each other and it is hoped that as many members as possible will come, bringing friends, spouses, clients and colleagues.

The third Mallet-Milne lecture has been made possible by the generous sponsorship of Arup Acoustics (London), Kajima Corporation (Tokyo) and John Wiley (Chichester). Once again it will be published in a high quality special publication, this year by John Wiley. It will be offered at a special prepublication price, to SECED members only, and should prove an invaluable source document on "Reduction of Vibrations".

WHAT'S ON
April - June 1991

Wednesday-Friday, 17th-19th April 1991
Joint Inst. Struct. E./BRE Three Day International Seminar
Structural Design for Hazardous Loads - The Role of Physical Testing
Convener: Dr. F.K. Garas
The Old Ship Hotel, Brighton

Wednesday, 24th April 1991
SECED ½day Workshop
Soil-Structure Interaction
Introduced by Dr. B.O. Skipp
2 pm, Risley, Warrington

Wednesday, 8th May 1991
British Geotechnical Society
Seismic Risk in the UK : Fact or Fiction
Dr. J.W. Pappin
5.00 for 5.30 pm, Institution of Mechanical Engineers

Wednesday, 29th May 1991
Mallet-Milne Lecture
Reduction of Vibrations
Prof. G. Warburton
4.30 for 5.00 pm, Institution of Civil Engineers

Tuesday, 11th June 1991
British Geotechnical Society
Dynamic Soil Behaviour
Dr. M.D. Bolton and Dr. R.S. Steedman
5.00 for 5.30 pm, Institution of

Student Bursaries

Thanks to the kind sponsorship of Ove Arup & Partners, W.S. Atkins Consultants Ltd and British Geological Survey, SECED are pleased to announce that it will be offering a limited number of bursaries to students to attend the SECED Conference on 18-20 September 1991. Students who are interested in financial support to attend should write to Rachel Cominx at the ICE Conference Office, stating their reasons for wishing to attend and giving details of their course (topic, location, duration and supervisor). The SECED Conference Subcommittee will contact applicants in due course with further details. Successful applicants would be expected to write a brief report on the conference for their sponsors.

FORTHCOMING EVENTS

15th-18th July, 1991
Fourth International Conference on Recent Advances in Structural Dynamics
Southampton University, Southampton

19th August 1991
15th International Tsumami Symposium
Vienna, Austria

22nd-23rd August 1991
American Society of Civil Engineers
The 3rd US Conference on Lifeline Earthquake Engineering
Contact Dr. M. Cassaro, Louisville, USA.

26th-29th August 1991
Fourth International Conference on Seismic Zonation
John Blume Earthquake Engineering Center, Stanford, California, USA.

17th-19th September 1991
International Symposium on Natural Disaster Reduction and Civil Engineering
Osaka, Japan

18th-20th September 1991
3rd SECED Conference
Earthquake, Blast and Impact (Measurement and Effects of Vibration)
Organising Chairman - Dr. J. Maguire.
UMIST, Manchester.

22nd-25th September 1991
Thirteenth Biennial ASME Conference on Mechanical Vibration and Noise
Miami, Florida, USA

23rd-26th September 1991
Fifth International Conference on Soil Dynamics and Earthquake Engineering.
University of Karlsruhe
Karlsruhe, Germany

October 1991
Strasbourg Conference on Earthquake Prediction
Earthquake Prediction: State-of-the-Art
Strasbourg, France

18th-23rd November 1991
NZ Nat. Soc. Earthq. Eng.
Pacific Conference on Earthquake Engineering
Auckland, New Zealand

DIARY NOTE

19th-25th July 1992
Tenth World Conference on Earthquake Engineering, Madrid, Spain.

RECENT PUBLICATIONS

"Directory of Practitioners in Earthquake Engineering and Civil Engineering Dynamics", Issue No. 2, April 1988.

1987 Mallet-Milne Lecture, "Engineering Seismology", by Prof. N.N. Ambraseys, Volume 17 of Earthquake Engineering and Structural Dynamics (Special Issue).

1989 Mallet-Milne Lecture, "Coping with Natural Disasters", by Prof. G.W. Housner.

"Earthquakes and Earthquake Engineering in Britain", 1st SECED Conference, 18-19 April 1985, University of East Anglia.

"Civil Engineering Dynamics", 2nd SECED Conference, 24-25 March 1988, University of Bristol.

"The San Salvador Earthquake of 10th October 1986", A field report by EEFIT, 1987.

"The Chilean Earthquake of 3rd March 1985", A field report by EEFIT, 1988.

"The Mexican Earthquake of 19th September 1985", A field report by EEFIT, 1986.

"Engineering Aspects of the Manjil (Iran) Earthquake of 20 June 1990", A Field Report by EEFIT.

"EEFIT Constitution and Aims and Methods", EEFIT booklet.

"Earthquake Design Practice for Buildings", David Key, 1988.

"Dams and Earthquake", A conference held at the ICE 1st-2nd October 1980.

"Earthquakes", Books, pamphlets and serial publications of interest to earthquake engineers, Thomas Telford Ltd.

The Loma Prieta Earthquake (Santa Cruz, California) of 17th October 1989; Seismological, Geotechnical and Structural Field Observations. A report from Imperial College, London.

Contact James Dawson at The Insitution of Civil Engineers, Great George Street, Westminster, London SW1P 3AA for information about the availability and cost of SECED publications

SECED NEWSLETTER

The SECED Newsletter is published four times a year by the SOCIETY FOR EARTHQUAKE AND CIVIL ENGINEERING DYNAMICS. The Newsletter is issued in January, April, July and October and contributors are asked to submit articles as early as possible in the month preceding the date of publication. Manuscripts should be sent typed on one side of the paper only, and a copy on a PC compatible disk would be appreciated. Diagrams should be sharply defined and prepared in a form suitable for direct reproduction. Photographs should be high quality and black and white prints are preferred wherever possible. Diagrams and photographs are only returned to authors upon request. Articles should be sent to Nigel Hinings, Editor, SECED Newsletter, Allott & Lomax, Fairbairn House, Ashton Lane, Sale, Manchester, M33 1WP. (Tel 061 962 1214; Fax 061 969 5131).

Produced by Fairbairn Services Ltd., Manchester.

SECED NEWSLETTER

THE SOCIETY FOR EARTHQUAKE AND CIVIL ENGINEERING DYNAMICS

April 1991, Vol. 5, No.2

SOCIETY NEWS SUPPLEMENT

Chairman's annual report for May 1990 to April 1991

The past year has been another good one for SECED, with a very strong and well attended technical programme supported by further increases in the Society's membership and successful measures to place the Society on a sound financial basis. The chairman's annual report to the AGM gives the chance to reflect on what we have achieved and what we are aiming at and this I have attempted to do in what follows.

Technical programme

The heart of SECED must always be its technical programme, allowing practitioners from universities and industry to exchange ideas and keep up to date with the fast advancing frontiers of our subject and also to learn of the work of colleagues from overseas. Our society should also try to assist those who are under training or just starting in engineering dynamics - one of the reasons why we are keen to support and encourage our student members. (The other of course is that they are our future!).

Judging by the attendance, averaging about 60, at our 7 evening meetings and 2 half day seminars this season, the regular technical meetings are fulfilling a real need and I believe the technical quality of the presentations has been uniformly excellent. We have had three distinguished overseas speakers (Dr Peter Yanev and Professor Bruce Bolt from California and Mr Mushtaq from Pakistan) and over a dozen equally excellent UK speakers. Most have addressed specifically earthquake engineering topics with only one presentation on general engineering dynamics. If you want to redress this balance, the committee would be happy to receive your suggestions for subjects and speakers although it should be noted that there is an even split between earthquake engineering and other topics in dynamics at next September's Conference.

In order to strengthen our technical activities and involve the membership more closely, the former 'Working Parties' are being been reorganised into four 'Technical Reporting Groups' which will have the task of reporting via the Newsletter on their field of interest and organising meetings or workshops. An article on the reporting groups will be carried in the Newsletter soon and I hope they will become a lively part of the Society.

Periodically, the general technical programme is supplemented by special events by which we set great store: every two years, by the Mallet-Milne lecture and every three years, by the Conference. As you will know, both events take place at the start of the coming season and the work of the Committee has been dominated by the necessary preparations. We are confident that both events will be a great success. Professor Warburton's Mallet-Milne lecture looks set to become an essential reference work; as for the Conference, 49 excellent papers have been selected from 75 submitted on a wide range of topics from blast and impact to earthquakes. I hope you will support both these major events.

Membership

As reported elsewhere by the vice-chairman, Amr Elnashai,membership has continued to grow strongly and now totals 190 ordinary members,29 corporate members and 30 student members. The many leading companies which are corporate members provide an important part of our subscription revenue and their support is valuable to us in other ways; please persuade your firm to become a corporate member if it is not one already. We welcome our student members, who pay no membership dues; many have played a lively role at the evening meetings and we hope they will join us to become ordinary members at the end of their studies. The growth in numbers has equally applied to ordinary members and we hope it will continue; the larger our membership, the more effective we can be.

Most of our meetings end with informal discussions over a glass or two of beer and there is a more formal opportunity for socialising at the reception following the biennial Mallet-Milne lectures. In years when this does not take place, we have decided to arrange a dinner to follow the AGM. The first will be on 29th April, 1992 at Imperial College, London so make sure that the date is kept free.

Newsletter

While 45% of our membership live in London, an equal number live elsewhere in the UK and 10% are overseas. Yet most of our meetings are in London, though during 1991, two important events - the AGM with half day workshop and the triennial Conference - have been deliberately arranged outside London. The preponderance of London based activities makes the Newsletter especially
important to out-of-town members and the Committee has decided to devote considerably more resources to it. This year, about a quarter of the subscription income or just under £4 a member has been allocated to an improved Newsletter and you will already have received the first in the new format. I hope you approve; effectively costing less than £1 an issue, I believe it is very good value, carrying technical reports of all our meetings as well as updates on other information of use to the profession. The committee is considering further improvements and the editor, Nigel Hinings,would welcome suggestions.

Finances

The Society's accounts have been distributed to the membership and you will be pleased to note that the deficit for 1989 has been covered and a certain amount has been added to reserves. The deficit was largely a cash flow problem resulting from expenditure on three SECED publications (the Mexican and Chilean earthquake field reports and the Second Mallet-Milne lecture) which this year have brought in substantial income. It is also gratifying to note that the increase in membership brought a significant increase in subscription revenue, although the increase in dues had not yet taken place.

This year, the Committee has also prepared a financial report, in addition to the more formal accounts. This is intended primarily as a planning document and shows our expected revenue and expenditure for 1991. In computing subscription revenue, we have conservatively assumed that membership numbers will be the same as last year whereas of course we hope that the steady rise of the last five years will continue. The rise in dues explains the large increase in projected subscription revenue.

The major expenditure item is the 1991 Conference. It should be noted that it has been underwritten by the generous sponsorship of Lloyds Register, so that there is no possibility of it proving a liability. In fact, from the interest shown to date and the number of papers submitted, there is every reason to expect that we will pass the break even number of 100 delegates and make a modest profit. Another main item of expenditure is the Third Mallet-Milne lecture. Here again, the cost is not met by the membership; we have been fortunate in securing generous sponsorship for the event, this year from Arup Acoustics, Kajima Corporation and John Wiley; Wiley's have agreed to publish and distribute this year's lecture (though there will be a special pre-publication offer for members), an arrangement which we hope will continue in future years.

The return to financial health has been due to the efforts of the treasurer, Chris Browitt and the patient guidance of the Institution's chief accountant,Mary Macbride. We are advised that we should have a minimum reserve of £2000 and that we should prepare ourselves to make a contribution towards the considerable cost of management services that the Institution currently provides free of charge to the Society. We also want to set aside money to be able to invite an overseas lecturer to present the Fourth Mallet-Milne lecture in 1993. However, if we meet these costs and still have something over, we are keen to use the money to increase still further the effectiveness of the Society and its value to members. Your suggestions are always welcome.

Relations with the outside world

SECED's membership comprises some of the leading engineers and scientists in the field of earthquake engineering and dynamics and has a contribution to make outside the confines of our profession. Sometimes this is on a formal basis; SECED's research and education sub-committee assesses on a regular basis applications to SERC for dynamics research and is currently preparing a report on a proposed undergraduate syllabus on engineering dynamics prepared by Professor Hans Bucholdt which it will present to the Institution's Structural and Building Board. More usually, SECED's external relationships are on an informal basis. As prime examples, the Society has taken a keen, active and continuing interest in the International Decade for Natural Disaster Reduction and SECED members have dominated the Institution's Working Party on Eurocode 8 and the BSI's committee on the same topic. We interface with the general public in other ways; major earthquakes usually arouse great interest in the media and SECED members are often called to comment on radio, television and the press. Last year's Romanian event coincided with a SECED evening meeting and we had a television crew filming it as a result. The outside world seems to find it hard to accept that engineers have anything interesting to say or anything other than the mundane to contribute to society. SECED has expertise of both great interest and value and I believe we should make positive efforts to make sure that the message gets through.

I look forward to sharing a successful new season with you and to seeing you at future SECED events.

Edmund Booth (Chairman)

April 1991

APPLICATION FOR MEMBERSHIP OF THE SOCIETY FOR EARTHQUAKE AND CIVIL ENGINEERING DYNAMICS

INDIVIDUAL MEMBERSHIP

Name: ______________________________

Address: ______________________________

____

Telephone: ______________

Academic Qualifications: ______________________________

Membership of Professional Bodies: ______________________________

Present Employer: ______________________________

CORPORATE SUBSCRIBER

Organisation: ______________________________

Address: ______________________________

____

Telephone: ______________

Nominated Representatives (3 only)

1. Name: ______________________________

   Home Address: ______________________________

   ____

   Telephone: ______________

2. Name: ______________________________

   Home Address: ______________________________

   ____

   Telephone: ______________

3. Name: ______________________________

   Home Address: ______________________________

   ____

   Telephone: ______________

STUDENT MEMBER

Name: ______________________________

Address: ______________________________

____

Telephone: ______________

Confirmation of student status: (To be signed by tutor or supervisor)

I confirm that this applicant is currently a full-time student

Date: ______________ Signature: ______________

Institution and position: ______________________________

____

Annual Subscription :	Individual:	£15
	Corporate:	£75
	Student:	Free

Please return to: The Secretary
SECED
Institution of Civil Engineers
1-7 Great George Street
London, SW1P 3AA

COMMITTEE (1990 - 1991)

Chairman	Edmund Booth	Ove Arup & Partners
Vice Chairman	Dr. Amr Elnashai	Imperial College London
Secretary	James Dawson	ICE Secretariat
Elected Members	Dr. W.P. Aspinall	Mass Data Systems
	J. Barr	Rendel, Palmer & Tritton
	N.P. Hinings	Allott & Lomax
	Dr. J.R. Maguire	Lloyds Register
	D.J. Mallard	Nuclear Electric plc
	Dr. P.A. Merriman	BNFL
	M. Raybould	Nottingham University
	Dr. R.S. Steedman	BEQE
Representatives	Prof. H.A. Bucholdt (ICE)	Polytechnic of Central London
	Prof. G.B. Warburton (IME)	University of Nottingham
	Dr. D. Key (ISE)	CEP Research
	Dr. B. Skipp (GS)	Soil Mechanics Limited
Immediate Past Chairman	Dr. C. Browitt	British Geological Survey
Co-Options	Dr. R.D. Adams	International Seismological Centre
	Dr. B. Ellis	Building Research Establishment
	Dr. R. Kunar	BEQE

SECED

The Society for Earthquake and Civil Engineering Dynamics (SECED) is the British national section of the International Association for Earthquake Engineering and is an associated society of the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Structural Engineers and the Geological Society. The Society is also closely associated with EEFIT, the UK Earthquake Engineering Field Investigation Team.

The objectives of the Society are to promote co-operation in the advancement of knowledge in the fields of earthquake engineering and civil engineering dynamics, and to implement the statutes of the International Association for Earthquake Engineering, and the requirements of the executive committee of the International Association, as applicable to the United Kingdom.

SECED organises reporting groups, informal discussions, conferences and symposia, as well as a biennial prestige lecture, the Mallet-Milne Lecture. The Society publishes a quarterly Newsletter and a Directory of Practitioners in the field of earthquake engineering and civil engineering dynamics.

Application for membership should be made by completing the appropriate part of the form overleaf.