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THE SOCIETY FOR EARTHQUAKE AND CIVIL ENGINEERING DYNAMICS

SECED NEWSLETTER

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EXPLOSIONS: MANAGING THE AFTERMATH

The Structures and Building Board of the Institution of Civil Engineers held a one day seminar on the 12th July entitled **"Explosions, Managing the Aftermath"**. The seminar brought together consulting engineers, surveyors, planners, local authority staff, and the emergency services in a forum to discuss methods available to mitigate against, and support recovery from, major explosions in urban environments. The day was chaired by Robin Wilson immediate past President of the Institution and was addressed by nine speakers in addition to a keynote speech by Sir Francis McWilliams, the Right Honourable Lord Mayor of London and also a Fellow of the Institution of Civil Engineers. The Lord Mayor stressed the importance of an efficient, effective scheme for the management of such events and thanked all those who have been involved in the last two major incidents in the City of London for their tremendous efforts for minimising the losses and speeding recovery from the disruption caused by terrorist bomb attacks.

The first speaker was Chief Superintendent Tim Hillier of the City of London Police who described the authority's immediate reaction following alert to the placing of bombs. The need to have an efficient, well thought-out means of protecting people in the immediate vicinity of a device, once it has been located, was considered to be of primary importance. He discussed the merits of either dispersion or gathering in fixed safe locations. The local authorities work closely with the police and Colin Snowden, City Engineer,

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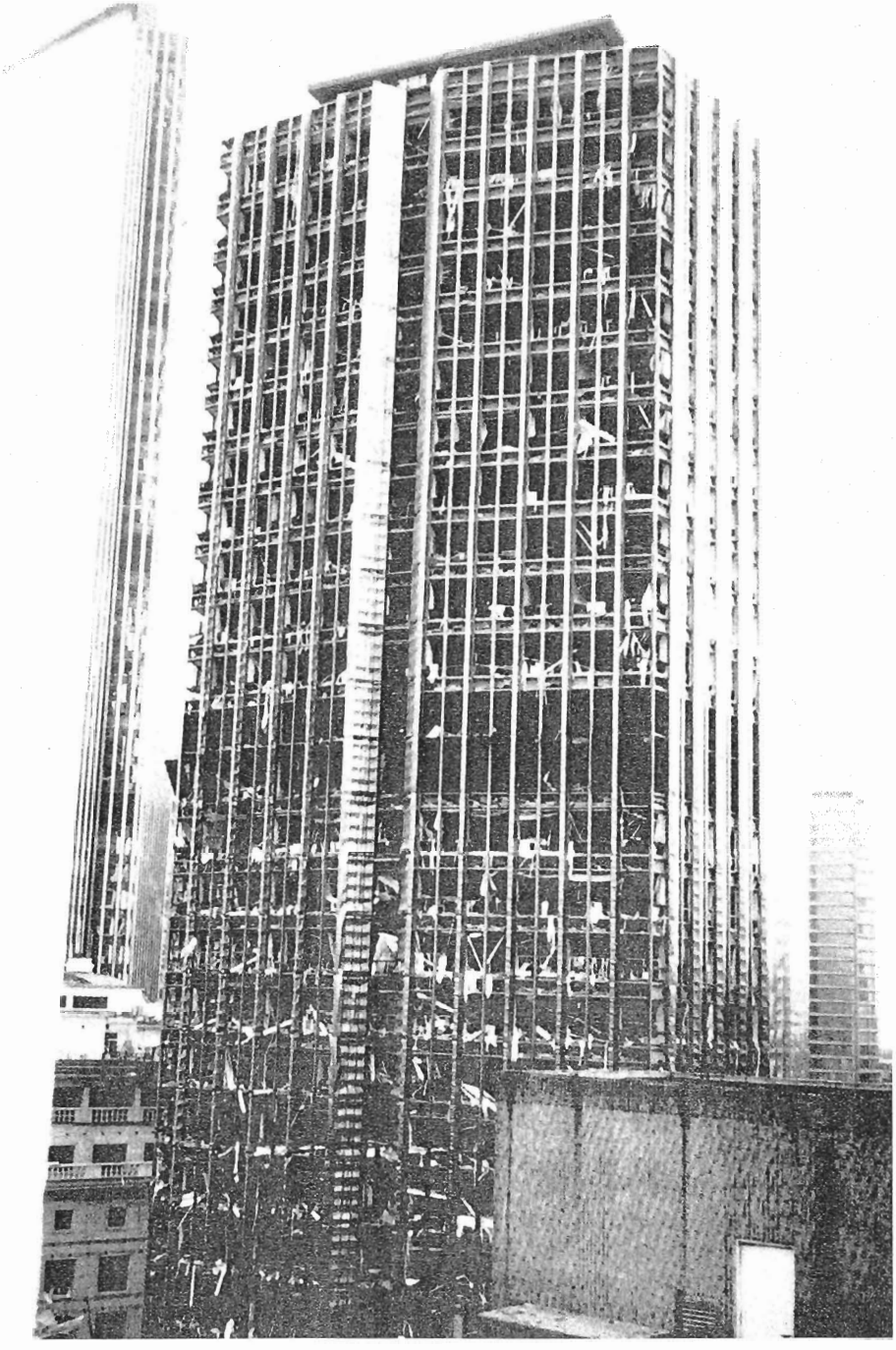
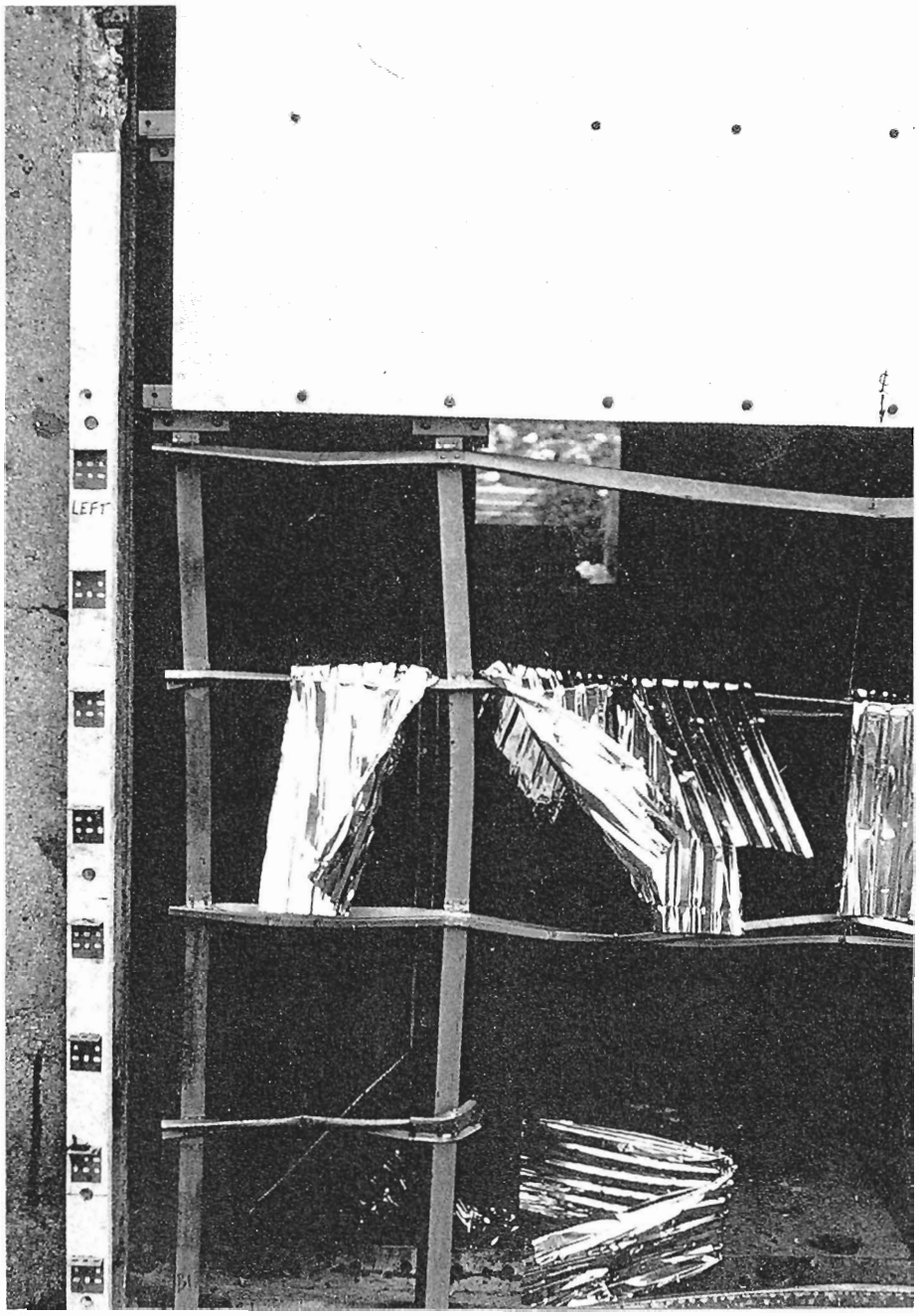


Above: Blast damaged facade following the Bishopsgate's bomb attack in the City of London in April 1993

RESEARCH IN CIVIL ENGINEERING DYNAMICS AT THE UNIVERSITY OF SHEFFIELD

A brief review by Alan Watson



Sheffield University has been carrying out research into the adverse and beneficial effects of transient dynamic forces for many years. When one of the founding institutions of the University was established in 1886, it advertised courses relating to safety in the local industries such as mining and steel, where explosives, drop hammers, forges, cranes, rolling and cutting machines were in regular use.

This concern with the effects of dynamic forces continued and in 1920 a University Professor, R V Wheeler, was also Director of the Safety in Mines Research Laboratories in Sheffield and today there is a memorandum of agreement on research between the University and the Health and Safety Executive.

In 1959, the Department of Civil and Structural Engineering had research projects on the design of reinforced concrete foundations for forging hammers, and in 1970, on the response of steel structures to impulsive loads. Since 1977, laboratories for Civil Engineering Dynamics at the University of Sheffield, CEDUS, have provided an exceptional University facility for carrying out a greater range of experiments using dynamic loads.

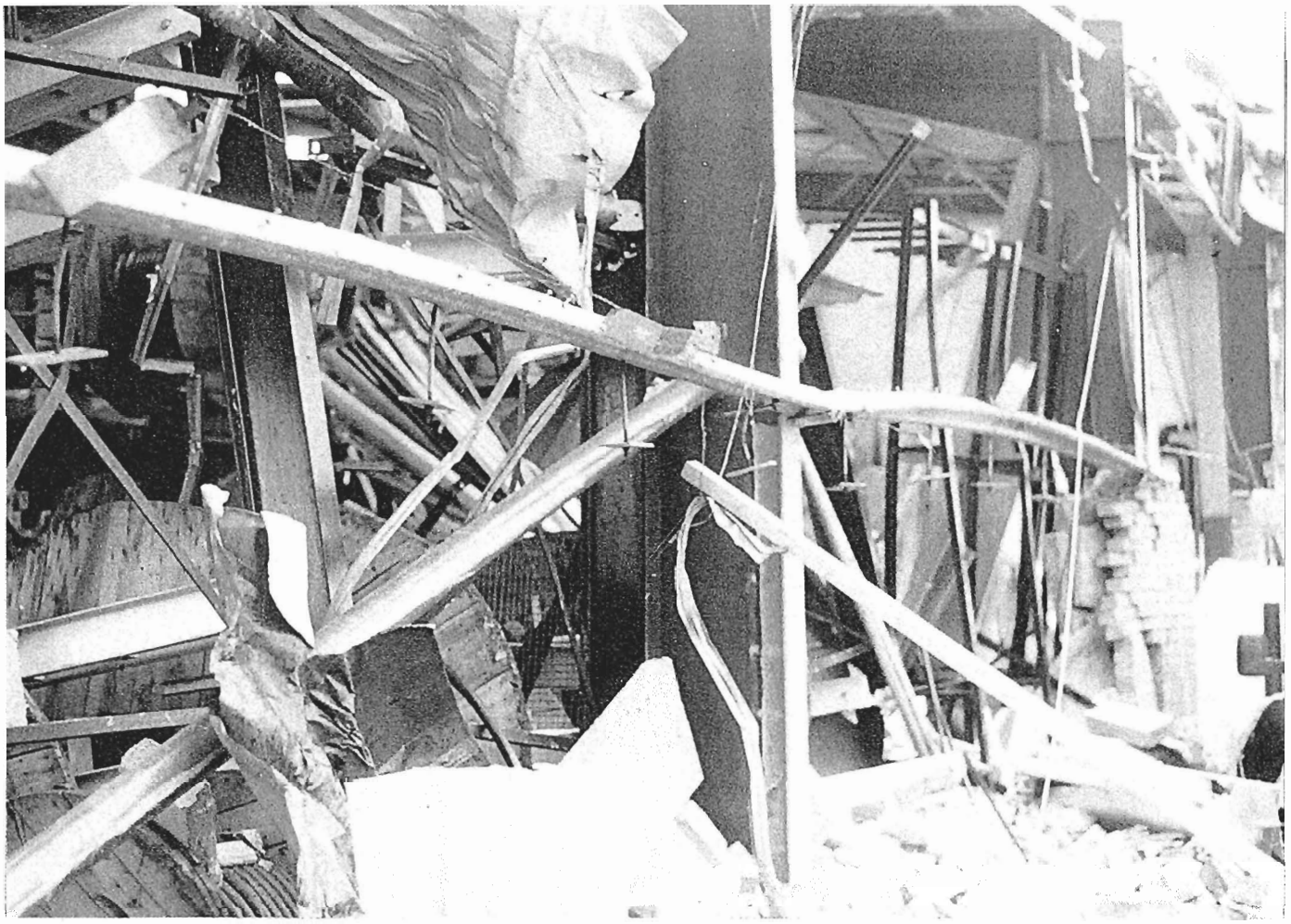
The CEDUS laboratories are on a remote site in concrete bunkers built partly underground. Equipment for the application of transient loads includes drop hammers and explosives. Transient data is recorded by high speed photography at rates up to 2 million pictures per second, and by high speed radiography with 2 remote heads for hard and soft X-rays and exposure times of 50ns. Displacement and strain can be recorded at rates up to 100 million readings per second on digital storage oscilloscopes. The experiments have provided phenomenological and measured data for the development and validation of numerical and theoretical models.

Research in civil engineering dynamics at Sheffield is presently being carried out to determine:

- The complete force-time curve of impulsive loads.
- The local and overall response of structural systems and elements to impact, explosive blast and seismic forces and non-linear time history F E analysis.
- Vibration response and monitoring of concrete slabs and bridges.
- The residual strength and stability of structural systems after some members have been damaged or removed completely by transient dynamic forces. Repair of damaged members.
- The properties and fracture of materials under high rates of stress.
- The mechanisms of projectile penetration into construction materials.

For example:

1. **Building vulnerability to blast loading:** a PC based program using energy absorption criteria, has been



Above: Blast damage to full scale building

Left: Form of damage replicated in model due to a blast at scaled distance

developed for blast analysis and damage estimation of multi-bay, multi-storey buildings when there is an explosion inside or outside the building. The structural framework is defined and if a building element which supports other elements is destroyed by the blast loading, then all supported elements also collapse. The damage due solely to blast and that due only to progressive collapse can be viewed separately. This program has been used to predict the damage to a single storey, steel clad portal frame building from an explosion outside the building and the results compared with experimental results on structural steel cladding supported on Z-section steel rails and H-section columns. Comparisons were also made between damage produced on an experimental model and on a full scale building of similar construction which had been accidentally exposed to blast loading. Using cube root scaling the scale factor between the model and full scale explosion was eight, so that the peak over-pressure produced by the charge at 4m on the model is equal to that produced at 32m on the prototype. Although at this range the positive impulse and duration would be eight times greater on the full scale building, the photographs above show that the damage to both model and full scale cladding and rails was similar at these scaled distances.

2. **Concrete fracture close to the point of application of explosive shock pressures:** The extent of the crushing and cracking from an explosive charge in contact with a concrete slab was measured and compared with the stress distribution. The peak pressure transmitted at the explosive/concrete interface was calculated from the velocity of the shock wave as 6.65kN/mm^2 which is greatly in excess of the compressive strength

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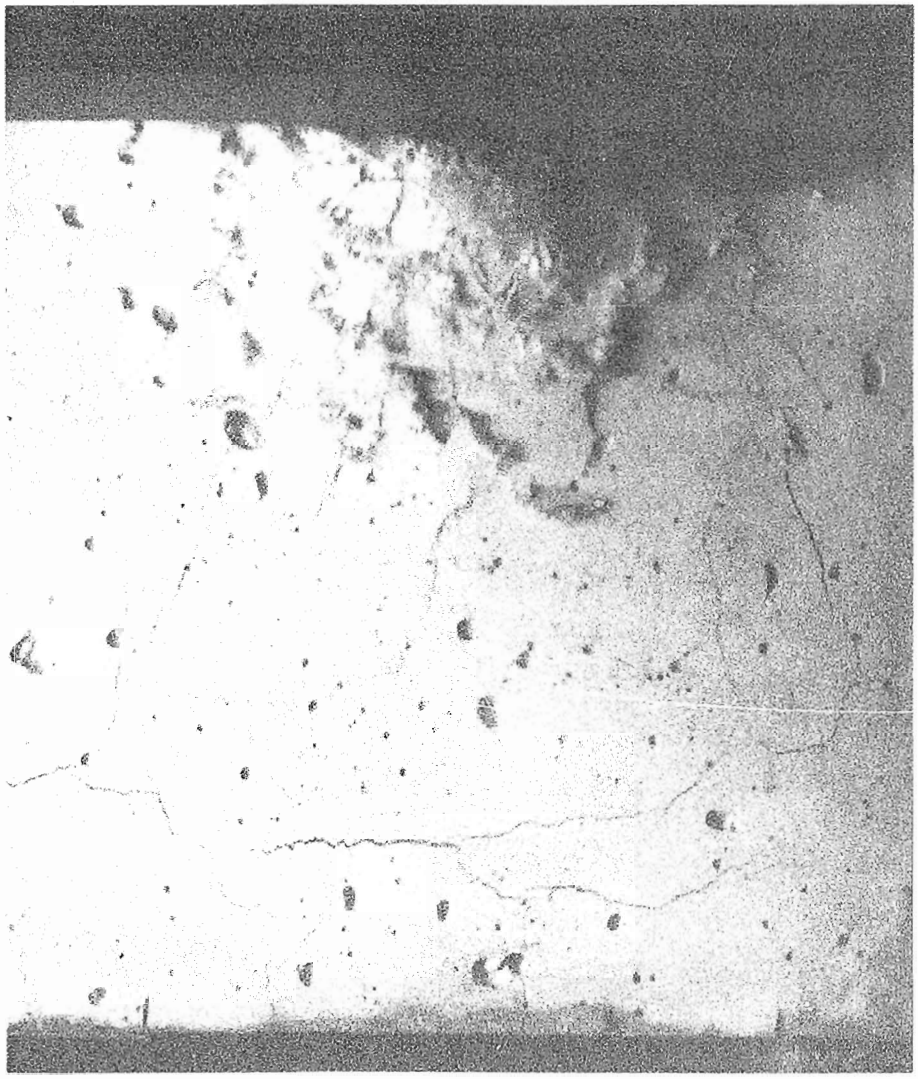
Left: Concrete fracturing under explosive shock



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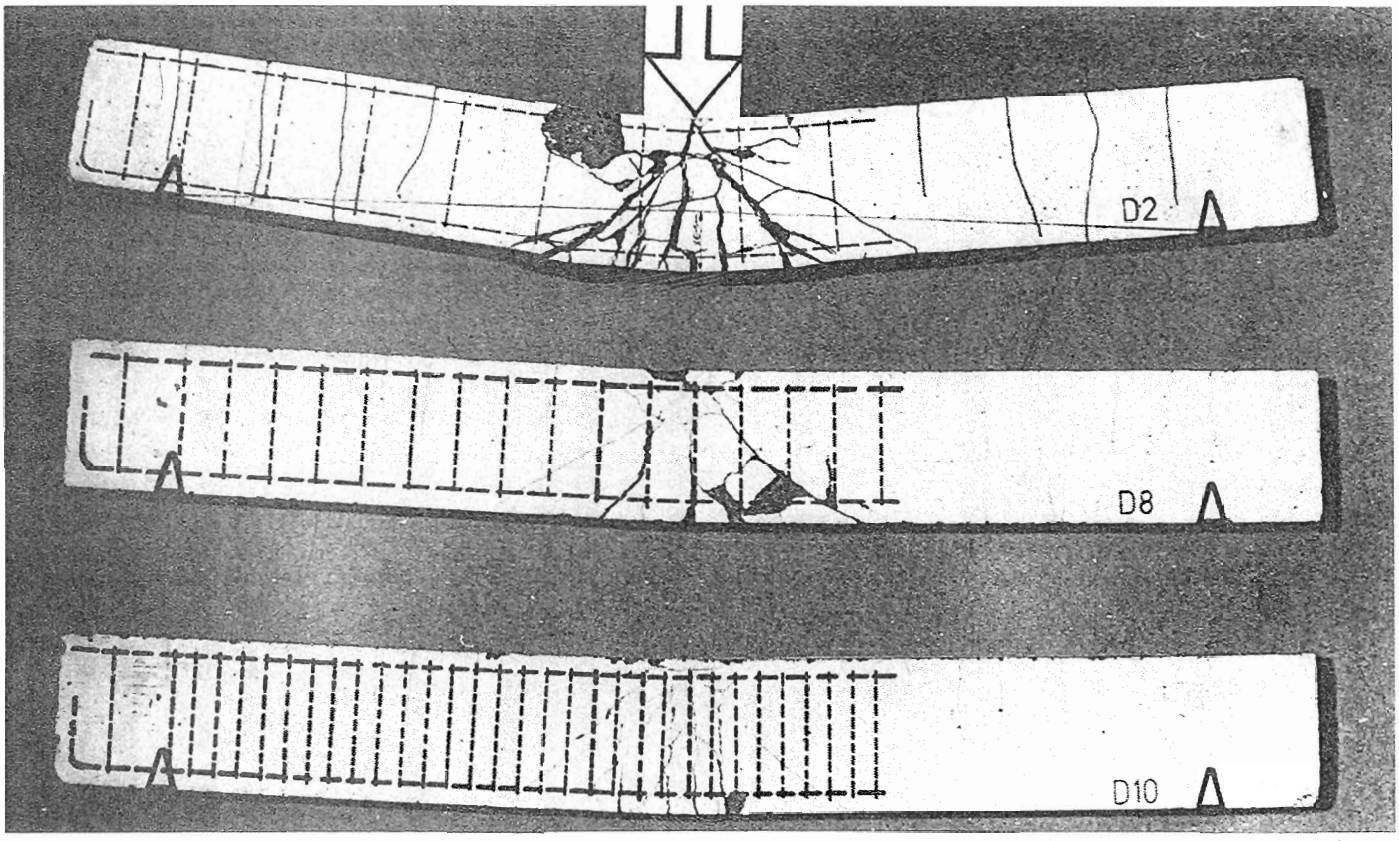
of the concrete. A crater was formed and extended as far into the concrete as the applied compressive stress exceeded the dynamic compressive strength of the concrete under this stress condition. The true crater depth coincided with a stress contour of 7% of the peak pressure measured by stress analysis and hence indicated an almost ten-fold increase in the compressive concrete strength for a stress duration of 50μs compared with the static strength. This is much greater than the increase measured in uniaxial dynamic tests at strain rates of 10^3 strain/sec and indicates that the loaded region received considerable inertial confinement. The formation of the crater was filmed using high speed photography, see illustration above.

3. **The uniaxial dynamic properties of construction materials:** Using 50mm diameter steel rods in the configuration of a split- Hopkinson or Kolsky bar, a small explosive charge is detonated on one end of the input rod to produce a stress pulse in a mortar sample. A peak stress up to 600N/mm^2 was produced at a strain rate up to 10^3 strain/sec in the disk specimen of mortar sandwiched between the input and transmitter rods. Electrical resistance strain gauges on the steel rods provide a record of the transient stress on either side of the mortar specimen from which coincident stress, strain and strain rate values are calculated. To avoid interference between incident and reflected stress pulses, the strain gauges could not be closer than half of the pulse length from the specimen and so the strain-line records were corrected for dispersion using a Fast-Fourier transform technique and published data on the velocities of different wavelengths. From the corrected data, full compressive stress-strain relationships were obtained, for cementitious materials, masonry and metals. A 100mm diameter bar has now been constructed and used to measure stress pulses produced by projectile impact. It is planned to use this bar for specimens of concrete and natural ground materials.

4. **New materials for use as reinforcement in concrete under dynamic loading:** There are many semi-structural concrete units such as wall and roof cladding panels which are very lightly loaded under normal service conditions, but which may receive impact or impulse loads caused by vandalism, accident or mis-handling during construction. The energy input of these dynamic loads can be absorbed in large deformation and crushing, providing total collapse can be prevented. The damaged unit can then be repaired or replaced. If the units are made from concrete with steel reinforcement, then the thickness of the unit is largely determined by the necessary cover to prevent corrosion of the steel and this cover concrete is particularly vulnerable to stress wave reflection. Polymer grids offer a suitable alternative to steel because the material is less corrosive, has a high ultimate strain and tensile strength and both increase significantly with rate of strain. Contact explosive charges of 25g on 450mm square x 75mm thick concrete slabs produced a



Above: Control of impact damage by link reinforcement in a simply supported reinforced concrete beam

crater on the loaded face and a spall on the distal face. The crater volume was marginally less and the spall volume was much less, in slabs doubly reinforced with polymer grid than with steel mesh, even though the steel provided a larger tensile resistance than that of the polymer grids. It is important that the extensive cracking does not lead to total collapse and is repairable. Repair techniques using external steel binding straps and carbon fibre plates are also under investigation.

5. **The response of pretensioned and reinforced concrete beams to an impact load at mid span:** Shear resistance is important in determining the resistance of reinforced and prestressed concrete to impact loading and although prestressing can improve the ultimate shear resistance of concrete beams under static loading, it is observed that prestressed concrete beams may be more vulnerable to impact loading and produce a more brittle type of failure than comparable reinforced concrete beams. To determine how the impact resistance could be improved by changing the spacing of the shear links, the beams were impacted at mid-span and the impact force-time and reaction force-time relationships were measured, as were the deflection-time relationships at half, third and sixth span. It was found that the development of the cracks at the impact point can be clearly controlled by the spacing of the links at the impact point as shown in test results shown above where the reinforced concrete beams were all subjected to the same impact force at mid-span. The steel reinforcement is indicated diagramatically on the surface of each beam.

Further developments are now taking place at the CEDUS laboratories with the enlargement of the explosive blast testing capabilities and construction of a large impact pendulum. These new facilities are required for an investigation of masonry walls under impact and for external wall cladding under explosive blast loading.

In addition to blast and impact loading, the Department intends to proceed with the development of pseudo-dynamic testing facilities.

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BRYAN SKIPP - HIS CAREER

Bryan Skipp, a driving force behind many SECED achievements, was awarded honorary life membership of the Society at the April AGM in recognition of his significant contributions to the field of civil engineering dynamics and earthquake engineering. Bryan, known to most SECED members, can always be relied upon to raise thought-provoking ideas on almost any subject in the field. Profile by Peter Eldred, Soil Mechanics Associates (aided by David Mallard and Robert Muir Wood)

Bryan Skipp has devoted most of his working life to the study of the movement of the ground, whether man-made or natural, covering much of the field of civil engineering dynamics and earthquake engineering. In this varied subject, he has written around 50 publications, including several chapters of books, and has participated in numerous committees and editorial boards. He has contributed much to any conference or meeting he has attended, always finding the relevant question to probe the speaker and enhance the general understanding of the subject.

Not only is Bryan recognised by his colleagues for his outstanding contributions to dynamics and all aspects of earthquakes, but also for his wide reading and knowledge in other fields, especially his interest in the Balkans, not totally unconnected with the fact that he has a Bulgarian wife.

Bryan was born and brought up in Bolton and started his career as a trainee in the Lancashire coal mines. This developed his interest in mining and he consequently studied for a degree in Mining Engineering at Birmingham University. This led on to research into geophysical resistivity methods, for which he was awarded a doctorate.

In 1956, after a short period back with the National Coal Board, when he undertook his pioneering, but largely unrecognised work on slate-bloating, Bryan joined Soil Mechanics Limited as a research engineer, where he has been employed ever since. He now works within Soil Mechanics Associates as Internal Consultant, the highest technical grade in the company.

During his 37 years with the company, he has carried out much of our research and development and has been associated with many innovative ideas in the fields of soil and rock mechanics, geophysics and vibrations. Latterly he has been mainly employed, as his title suggests, as a consultant for our own staff and for external clients. His expertise ranges from geology (especially that of faults) through seismic hazard, seismicity, earthquake engineering, ground and air vibrations, foundation dynamics, demolitions, instrumentation, geophysics, hydrogeology and grouting to the more mundane routine soil and rock mechanics.

Of particular note is that Bryan was involved in the first demolitions of cooling towers, following the collapses at Ferrybridge. At this time, little was known about how a cooling tower would collapse, even under the conditions of a controlled explosive demolition. His expertise in instrumentation and ground and air vibrations, as well as a large dose of lateral thinking, proved invaluable. This involvement in demolitions still continues today, although the subject is now more likely to be a 1960s tower block than a cooling tower.

For the past 10 years, Bryan has devoted a proportion of his time to Nuclear Electric's Seismic Hazard Working Party (SHWP). He was one of the three original external members of

this group, which studies all aspects necessary for a site specific seismic hazard assessment. This gives Bryan full scope for his free ranging interests, in particular the rock mechanics aspects of earthquake generation, the role of in-situ stress and the various geophysical techniques, as well as interrogation of other members of the team who put forward new ideas. As revealed in the January 1993 edition of this newsletter, this involvement resulted in the award to him and three other members of SHWP of the George Stephenson Medal by the Institution of Civil Engineers for a paper on recent developments in seismic hazard assessment.

A further proportion of his time is spent on committee work. Amongst many such positions, he is currently a member of the Parliamentary and Scientific Committee, of the SECED Committee and of the ICE Ground Board. He is on the editorial board of the International Journal of Earthquake Engineering and Structural Dynamics and of the Quarterly Journal of Engineering Geology, as well as on several British Standards Institution and International Organization for Standardization committees. He is also active in the development of Eurocode 8.

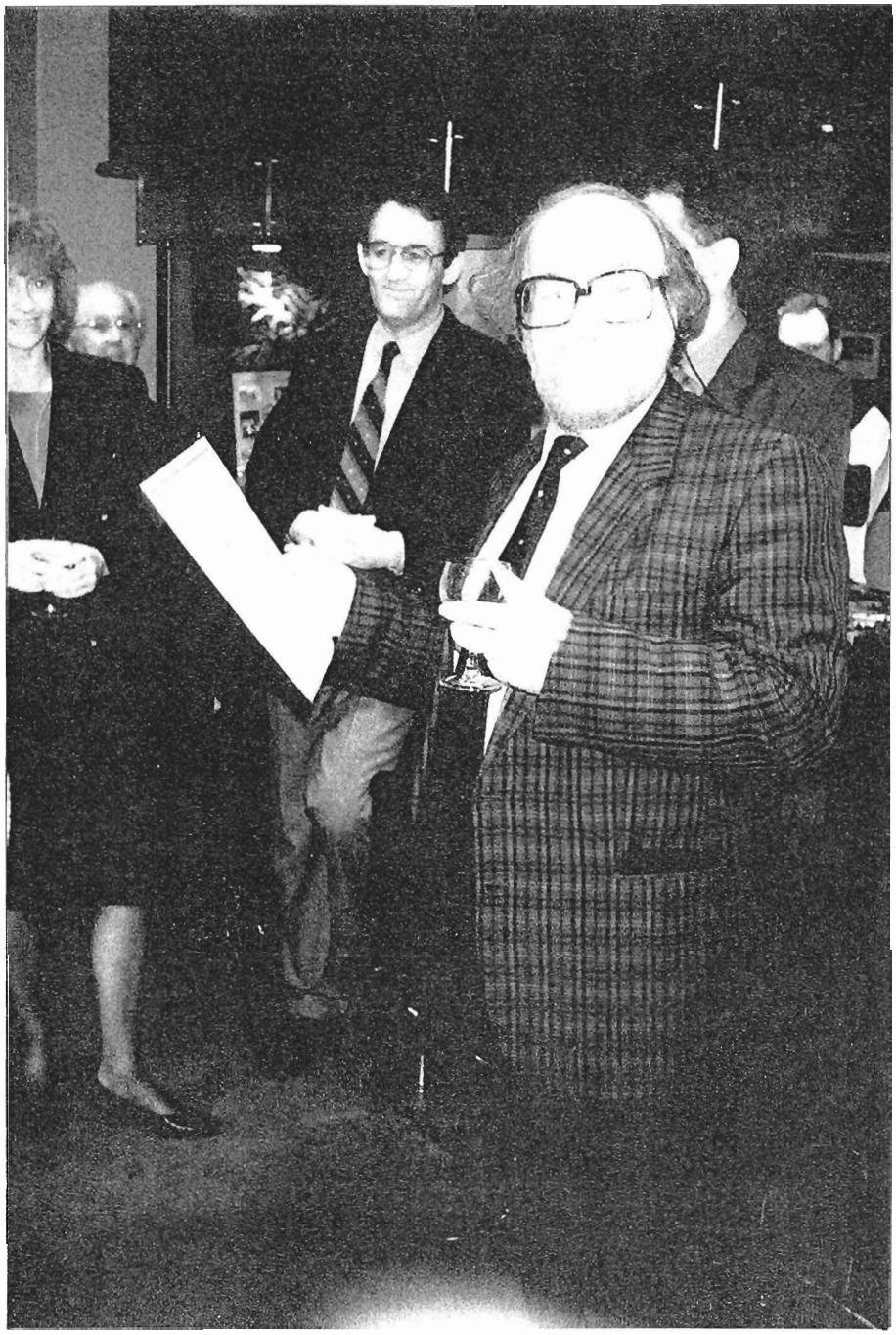
As well as presenting his papers at conferences, he has lectured widely in the United Kingdom and overseas and is a visiting lecturer for the postgraduate course in engineering geology at Madrid University. He also maintains close links with many British higher education establishments, acting as supervisor and external examiner for higher degrees.

Bryan has an intuitive feel for his subject, although he sometimes has his own idiosyncratic approach to a problem. Many is the time he has produced a set of calculations which, upon checking, were found to be in error by a factor of 2 or 10 in Line 2 and have a similar, but opposite error, in Line 10, thereby arriving at the correct answer. He, of course, knew what the answer was before starting the calculation and was unconcerned by such slips.

He also has his own unique approach to administration, much to the frustration (and sometimes amusement) of the secretaries and staff at Soil Mechanics. This is only surpassed by his handwriting. It is inconceivable that anyone receiving a handwritten fax from him can decipher what is being said; we often can't decipher the original. Now that he uses his computer more, the characters are individually perfectly formed, but whole words are more of a problem and sentences remain largely enigmatic.

There are many accounts of his endeavours outside the office, most of which must be apocryphal and for which there is insufficient space in this article. Suffice it to say that it is reputed that a new security system was abandoned by one of our major clients shortly after Bryan had to use it. As for the Christmas chicken and the railway station at which the train didn't stop, I never did find out whether the incident occurred or not. Neither can any of his colleagues confirm how well he performed in René Cutforth's cricket trousers.

Bryan's friends and colleagues at Soil Mechanics, as well as within the whole field of civil engineering, congratulate him on his award of life membership of SECED and hope he may continue to make his valued and varied contribution for many years to come.



Above: Life membership certificate presentation at the Mallet-Milne reception

Fourth Mallet-Milne Lecture

SIMPLICITY AND CONFIDENCE IN SEISMIC DESIGN

Earthquake engineers from all parts of the United Kingdom converged on the Institution of Civil Engineers in London to hear Professor Paulay's Mallet-Milne lecture on 'Simplicity and Confidence in Seismic Design'. A packed lecture hall was treated to a masterly exposition on the capacity design approach and learnt much about the selection of appropriate failure hierarchies in the design of earthquake resistant building structures. The reception following the lecture was exceptionally well attended, and this gave opportunity to not only meet the speaker but also to catch up with events with other colleagues. A private dinner was given in honour of the speaker the evening before the lecture. Despite all efforts by Professor Paulay to keep the matter quiet, it had been learnt that the day of the lecture coincided with Professor Paulay's seventieth birthday. A surprise birthday cake had been arranged and the invited dinner guests joined to provide a rousing rendition of 'Happy Birthday', accompanied by Joan Cottell, the ICE President's wife, on piano. The occasion demanded a short speech, after which the guests retired early in preparation for the events of the day ahead.

Above from left to right: Professor Thomas Paulay, David Key, Amr Elnashai and Mike Cottell. SECED Chairman Amr Elnashai chaired the meeting; the introduction was given by David Key, and the vote of thanks by Mike Cottell, the President of the Institution of Civil Engineers.

The Fourth Mallet-Milne Lecture dealt with the design of earthquake resistant structures and is the first one to do so. Professor Ambraseys dealt with earthquake phenomena in 1987 and Professor Housner spoke on natural disasters in 1989. The third lecture in 1991 was given by Professor Warburton on the reduction of vibrations. Professor Thomas Paulay is eminently qualified to speak on seismic design.

Thomas Paulay, Professor Emeritus at the University of Canterbury, Christchurch, New Zealand, has been associated with the origin and development of the capacity design philosophy from its inception.

Professor Paulay was elected to the Presidency of the International Association of Earthquake Engineering at the World Conference held in Madrid in July 1993 and was awarded the OBE in 1986. He was born in Hungary and graduated from the Royal Military College in Budapest in 1943. A year later at the age of twenty one he was in command of a cavalry squadron facing the advancing Soviet tank divisions in eastern Poland. The end of formal hostilities left him facing unbelievable difficulties in attempting to study civil engineering in Budapest culminating in his escape across the closely guarded border to Austria and West Germany where he became a DP (displaced person).

A group of students in Victoria University, New Zealand, scraped together the money to offer a scholarship and Tom Paulay was selected. In the care of the International Refugee Organisation he arrived in New Zealand with his wife Herta and fifteen month old daughter in 1951. He joined the University of Canterbury and obtained his BE in civil engineering in 1953. From then until 1961 he worked with a Wellington firm of consulting engineers, and obtained the invaluable project experience that has helped to keep his subsequent research so directly relevant to the practising engineer.

In 1961 he returned to Canterbury as a lecturer and derived great pleasure in 'being able to smuggle new ideas into professional practice via his graduates'. From 1964 he carried out research under Professor Harry Hopkins leading to his PhD in 1969.

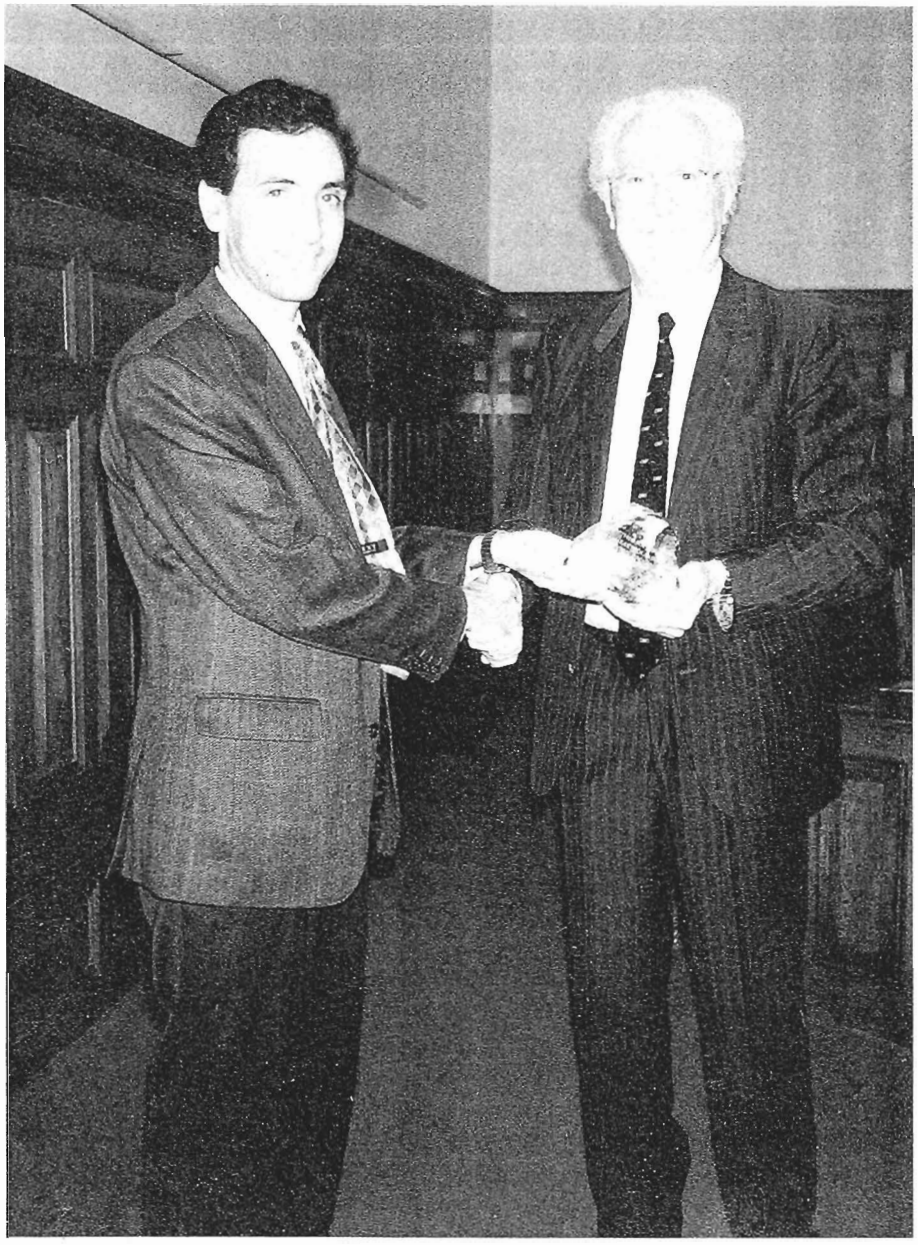
This research into the design of reinforced concrete structures with special emphasis on designing for earthquakes continued up to his formal retirement in 1989 and informally beyond then.

West Indian cricket had the three 'W's - Weekes, Worrell and Walcott who brought great distinction to the team. The Canterbury Department of Civil Engineering had the three 'P's - Professors Park, Paulay and Priestley who also brought great distinction to their team. Among his many publications Tom Paulay has co-authored books with both of the other members of the triumvirate. The first was with Professor Park "Reinforced Concrete Structures" in 1976 and the second "Seismic Design of Reinforced Concrete and Masonry Buildings" with Professor Priestly in 1992. He has also been responsible for about 100 papers on structural design and earthquake engineering published in Australia, Canada, China, France, Germany, Switzerland, United Kingdom, New Zealand, USA, India, Yugoslavia, Italy, Trinidad, Puerto Rico, Portugal and France.

In addition to his OBE he has received awards for his work in New Zealand, Canada, USA and Japan. New Zealand is a long way from practically everywhere yet Tom Paulay remains an indefatigable traveller almost invariably willing to respond to demands on his time if it enables him to continue bringing his ideas to the attention of the practising engineer. He has also been active in influencing the development of seismic design codes in the USA (for both the ASCE and ACI), New Zealand and Europe (including Eurocode 8).

As well as his qualifications from Canterbury Tom Paulay has an Honorary Doctorate from both the Swiss Federal Institute of Technology in Zurich and the technical University of Budapest. His professional affiliations include fellowships of the Institution of Professional Engineers New Zealand, the Royal Society of New Zealand and the New Zealand National Society for Earthquake Engineering. He is also an Honorary member of the American Concrete Institute.

David Key



Above: Amr Elnashai, SECED Chairman, presenting Professor Paulay with a glass momento after the Mallet-Milne Lecture

The fourth Mallet-Milne lecture by Professor Thomas Paulay on 'Simplicity and Confidence in Seismic Design' is published by John Wiley. A very limited number of copies are available from SECED at a reduced pre-publication price. For information contact Mary Kinsella at the Institution of Civil Engineers (tel 071 222 7722; fax 071 222 7500)

IMPROVED SEISMIC MONITORING AND ASSESSMENT OF SEISMIC HAZARDS AND RISK IN THE UK.

An initiative to secure improved information and advice

Background

Although the UK is an area of relatively limited seismic activity, the Department of the Environment, and its predecessor Departments, have long had an interest in seismic events. Parliamentary questions and Ministerial correspondence often arise following seismic events which may cause disproportionately high levels of public alarm. Some such events are natural whilst others are related, or are attributed, to mining subsidence. The need to discriminate between natural and induced seismicity sometimes led to the funding of local monitoring networks. Some of these were temporary, for instance at Stoke-on-Trent in the 1970s. Others later formed part of the longer-term monitoring capacity, such as the MIDNET system covering a substantial part of the English Midlands.

The main background monitoring system in the UK is operated by the Global Seismology Unit of the British Geological Survey. This grew from a network in the south of Scotland (LOWNET) mainly by retaining all, or parts, of networks which were set up for specific projects. The distribution of instruments reflected, therefore, patterns of specific investigations rather than a system designed for adequate national monitoring. In addition, some instruments were becoming outdated and resources for maintaining archives of historical material and digital data were limited. A number of other organisations maintained localised monitoring networks and results from these were not necessarily available to the wider community.

During the early 1980s, the Department decided to support a rapid deployment facility to monitor selected seismic events. A contract was let to the British Earthquakes Research Group (then the Universities of Durham and Keele and, later, Durham with Liverpool). The network was used for general background monitoring at a number of locations but could be redeployed quickly to monitor selected events. Background monitoring was undertaken in South Wales, the Welsh Borderlands, the Wirral and the Cheshire Basin. In addition, reports were prepared on specific events in mid Wales and the Lleyn Peninsula of North Wales, both in 1984.

When this contract approached its end, the Department's seismic monitoring requirements were reviewed. Since a number of other organisations supported seismic monitoring, the Department invited these to discuss the range of seismic research which was needed and the best ways of commissioning the work. The group considered that independent advice was needed. The Department, therefore, commissioned Dr R D Adams of the International Seismological Centre, to prepare a report [1]. Dr Adams recommended that the UK background seismic monitoring network, operated by the Global Seismology Unit of the British Geological Survey, should be improved and that an assessment of seismic hazards and risks in the UK should be undertaken. Both recommendations were accepted. It was agreed that a number of organisations would jointly support improvements to the national monitoring network (Table 1). In addition, the Department commissioned a study of seismic hazards and risk in the UK as part of an overall series of reviews of land instability problems and also to provide background for the UK response to draft Eurocode 8.

Table 1 : Participants in the "Customer Group" between 1988 and 1993

AEA Technology
British Gas
British Nuclear Fuels plc
British Coal Corporation
Department of Economic Development, Northern Ireland
Department of the Environment
Department of Trade and Industry
Health and Safety Executive Major Hazards Unit
International Seismological Centre
Ministry of Defence
Natural Environment Research Council
Nuclear Installations Inspectorate
Nirex
Nuclear Electric plc
Renfrew District Council
Scottish Hydro-Electric plc
Scottish Nuclear Ltd.
Scottish Office Environment Department
Welsh Office

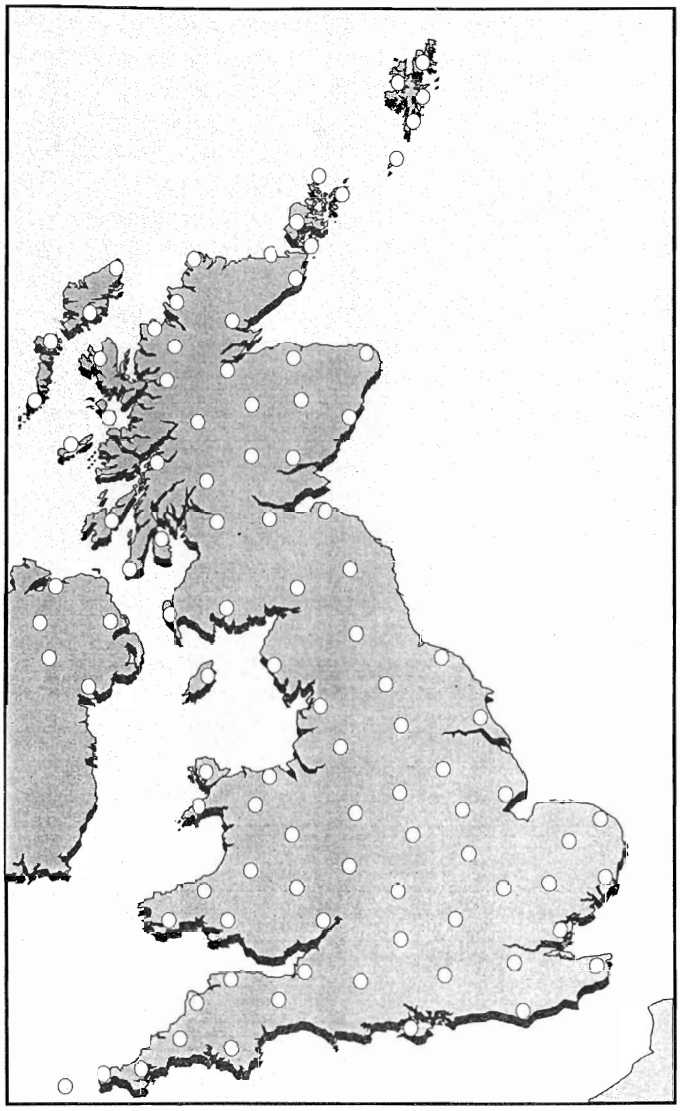
National Seismic Monitoring and Information Service

It was agreed that a number of steps were required to improve the National Seismic Monitoring and Information Service. These included:

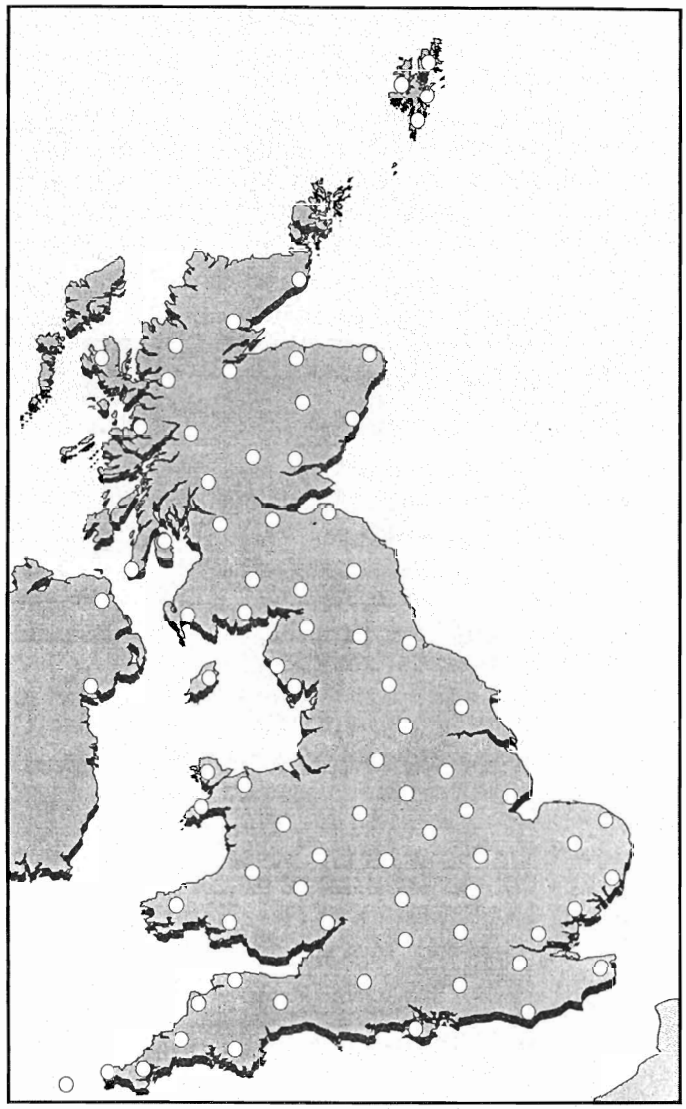
- upgrading and augmenting the existing monitoring network to give a detection capability of 2.5 M_L in the worst background noise conditions, by means of stations spaced at an average of 70 km;
- introducing direct transmission capabilities between monitoring networks and the BGS offices in Edinburgh;
- curation of archive tapes and documents and improved access to and storage of records; and
- maintenance of a rapid deployment monitoring capability (although funding of deployment would come from separate commissions).

It was recognised that good dissemination of information was essential. The approaches taken were to provide:

- members of the customer group with fax notification of the basic information on detected events within a few hours and subsequent updates as necessary;
- a monthly bulletin of recorded events issued two months in arrears;



Above: Proposed long-term UK background seismic monitoring network with an average station spacing of 70km



Above: Proposed UK seismograph network coverage for 1993 at background station spacing after discounting site-specific dense networks

- an annual catalogue of seismic events : and

- improved facilities for visitors to the Edinburgh Offices of the Global Seismology Unit of BGS.

It was recognised that these objectives could not be achieved entirely within the available funds. A staged approach was, therefore, taken. The initial priorities were to fill certain major gaps in the instrumental coverage, to curate existing records, and to ensure good access to and dissemination of information.

The monitoring coverage in 1988 were relatively good for Cornwall, north and central Wales, part of the West Midlands of England, south and northern Scotland. However, there were few instruments in most of eastern and southern England, south Wales and the Cheshire Basin. There were none in Northern Ireland.

Since 1988, the system has been improved to the extent that instruments are now present in most areas except for the Western Isles of Scotland and the western part of Northern Ireland and a few other scattered locations. By end of 1993/4 some 82 stations, of the 102 needed for an "ideal" coverage, will be in place. This will give an earthquake identification capability of 2.5 M_L for almost all, and 2.0 M_L for most, of the UK for 20 nanometres of noise and S-wave amplitudes twice that at the fifth nearest station. Most stations will have been upgraded to digital remote access standard and their geographical locations will have been checked. A small number of triggered strong motion recorders will be in place. The digitising of records held on analog tape will be almost complete and the historical archives will be up to date. A catalogue of material is in preparation. Valuable records will be in better, more secure storage. New improved accommodation at Murchison House will be occupied [2].

Many of the initial objectives of the work have, therefore, been achieved. However the remainder of the monitoring stations have yet to be secured. As the monitoring capacity has improved, an increased proportion of the budget has gone on operation and maintenance. There is proportionately less leeway for new monitoring instruments unless more funds can be attracted from contracts or more income generated from selling information. In addition, monitoring in

some areas depends on networks which were placed for specific projects, for instance the hot dry rock geothermal energy project in Cornwall. If such networks are closed as projects come to an end funds may not be available to fill the resulting gaps. The Customer Group will continue to monitor the position.

Assessment of seismic hazards and risk

Research was commissioned in order to develop an appreciation of seismic risk in the UK and to determine whether seismicity should be taken into account in future planning decisions and, if so, how. Following a tender competition, a contract was awarded to a team from Ove Arup and Partners led by Dr J W Pappin. Contributions to the study were also made by Cambridge Architectural Research, Delta Pi Associates, Geomatrix, and Earthquake Documentation and Research Cambridge. The management of the work was guided by a steering committee drawn mainly from the "Customer Group" but which also had the benefit of advice from Professor N N Ambraseys, Dr R M W Musson, and Dr B O Skipp.

Studies of seismic activity in the UK and seismic hazard assessment were undertaken. The nature of the building stock in the UK and vulnerability of buildings were assessed, and annual risk in terms of damage cost as a ratio of reconstruction cost was calculated. Earthquake impact studies were undertaken for two selected areas leading to predictions of costs, damage and casualties for earthquakes of credible magnitudes. Earthquake risks were compared with other risks to set them in context.

It was concluded [3] that:

- the variation of seismic hazard across the UK is relatively small and is less significant than the uncertainties of the parameters used in the risk assessment;

- there is only a small possibility of an earthquake causing significant damage and the risk to society is sufficiently low not to cause undue concern;

- in the event of a large (by UK standards) earthquake the amount of damage would depend on the location but there is a slight possibility of extensive damage and casualties within an area of a few square kilometres;

- in these circumstances it is not sensible to enact extensive earthquake requirements in the design of conventional structures;

- it would be prudent to subject new buildings to a basic level of earthquake checks and to check buildings of national and historical importance; and

- earthquake loading should be incorporated in the design of structures (in addition to nuclear installations for which this is already done) where the failure of any single element could lead to a significant number of casualties.

Recommendations arising from these conclusions were that:

- earthquake detection threshold should be maintained to enable at least magnitude 2.0 M_L events to be reliably detected and ensure that large events do not exceed the range of the instruments;

- the earthquake risk of a selection of potentially vulnerable structures should be established as a first step towards deciding whether any modification of the Building Regulations is required;

- a check list of basic earthquake requirements for conventional structures should be developed and, if any vulnerable features are identified, brief design rules should be given; and

- guidance is required on how to decide whether a structure or installation is sufficiently hazardous to require its design to directly consider earthquake loading and, if so, what level of earthquake ground motion is appropriate.

Next steps

The key recommendations of the study carried out by Ove Arup will be considered by the Department and other interested organisations following publication of the reports. Publication is expected to take place in late July, 1993.

A new group of contracts has been let to consolidate and build upon the improved National Seismic Monitoring and Information Service over the next 3 years. The initial step will be to commission a south central England network covering counties from Oxfordshire to the south coast. Efforts will be made to identify potential new customers since additional funds will be required to carry the initiative through to completion and to ensure that the UK is relatively well supplied with seismic monitoring information.

For further information contact:

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London SW1P 3EB

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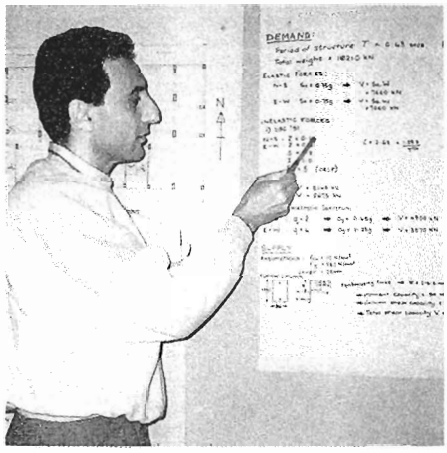
2. Browitt, C W A and Walker, A B, 1993 *UK Earthquake Monitoring 1992/3 - BGS Seismic Monitoring and Information Service: Fourth Annual report,* British Geological Survey Technical Report WL/93/08. Global Seismology Series. British Geological Survey (Edinburgh) iii + 35 pp

3. Ove Arup and Partners (in press), *Earthquake Hazards and Risk in the UK* HMSO (London) 32 pp [summary report]

EFTU Mission to Turkey

The Earthquake Field Training Unit (EFTU) of Imperial College sent a large contingent of mostly would-be earthquake engineers to north east Turkey. The group comprised ten MSc students in Earthquake Engineering, lead by Amr Elnashai with the help of Assaad Salama (PhD candidate at Imperial). The mission formed part of the MSc students' training and is an essential requirement for the award of the degree of MSc in Earthquake Engineering. The party departed London on 2 May 1993, spent the night in Istanbul, then flew the following morning to Erzurum via Ankara. From Erzurum, the group took the bus to Erzincan, arriving on 3 May 1993. The following five days were spent on a targeted inspection task preceded by briefing meetings in the morning. In the evenings, the students, divided into two groups, made technical presentations on their observations and conclusions. This covered general seismic hazard in Anatolia, structural damage statistics and case studies of supply and demand evaluations. The students also calculated and sketched various repair and strengthening options for specific structures. The group returned to Istanbul on 8 May after what was voted unanimously as a most successful and enjoyable (technically and socially) field mission.

EFTU is awaiting a suitable earthquake, in size, location and timing, for the field trip of the 1993/94 class.



Above: Evening de-briefing meeting reviewing seismic rapid assessment techniques.

Above: Shear failure in a 3 storey RC building in Erzincan.

Royal Academy Soirée

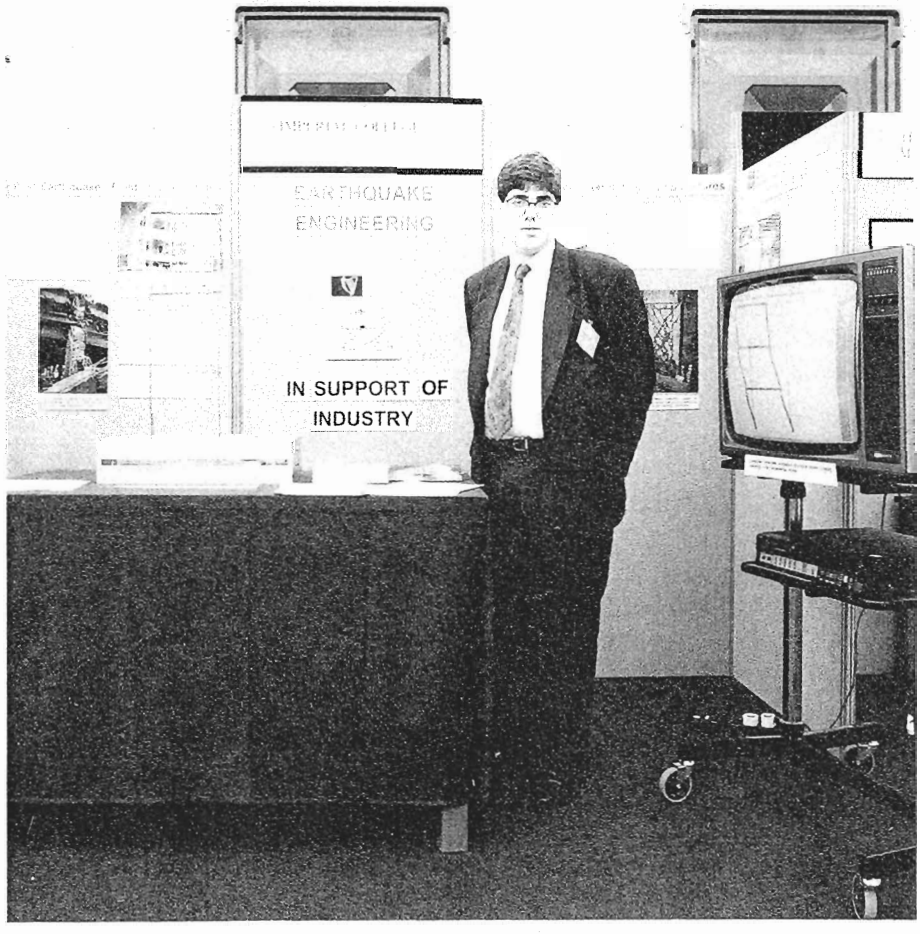
The Royal Academy of Engineering held its first 'Royal' Soirée on June 22nd at Imperial College. A total of 35 exhibitors contributed to the event. The Civil Engineering Department presented a display on Earthquake Engineering, which was accepted by the Organizing Committee. The display was designed and executed by Mark Manzocchi, Research Assistant at Imperial, with support from Professor Roger Hobbs and Dr. Amr Elnashai. The stand was opened in the morning by Professor Patrick Dowling at the start of the Press View.

In the evening, the stand was manned by Professor Ambraseys, Dr Elnashai and Mr. Manzocchi. It was clearly noticeable that it was attracting considerable interest from the distinguished Royal Academicians and their guests.

The Duke of Kent inspected the stand and was given a brief description of the seismological and structural aspects of earthquake risk problems by Professor Ambraseys. He seemed to have been intrigued by the idea of accommodating and accepting damage.

Feedback from some old friends of the ESEE Section confirm that the venture was a success and that it had brought to the attention of visitors the expertise available in the subject area, not only at Imperial College, but also in the UK.

Below: Mark Manzocchi manning the Imperial College Earthquake Engineering stand at the Royal Academy Soirée.



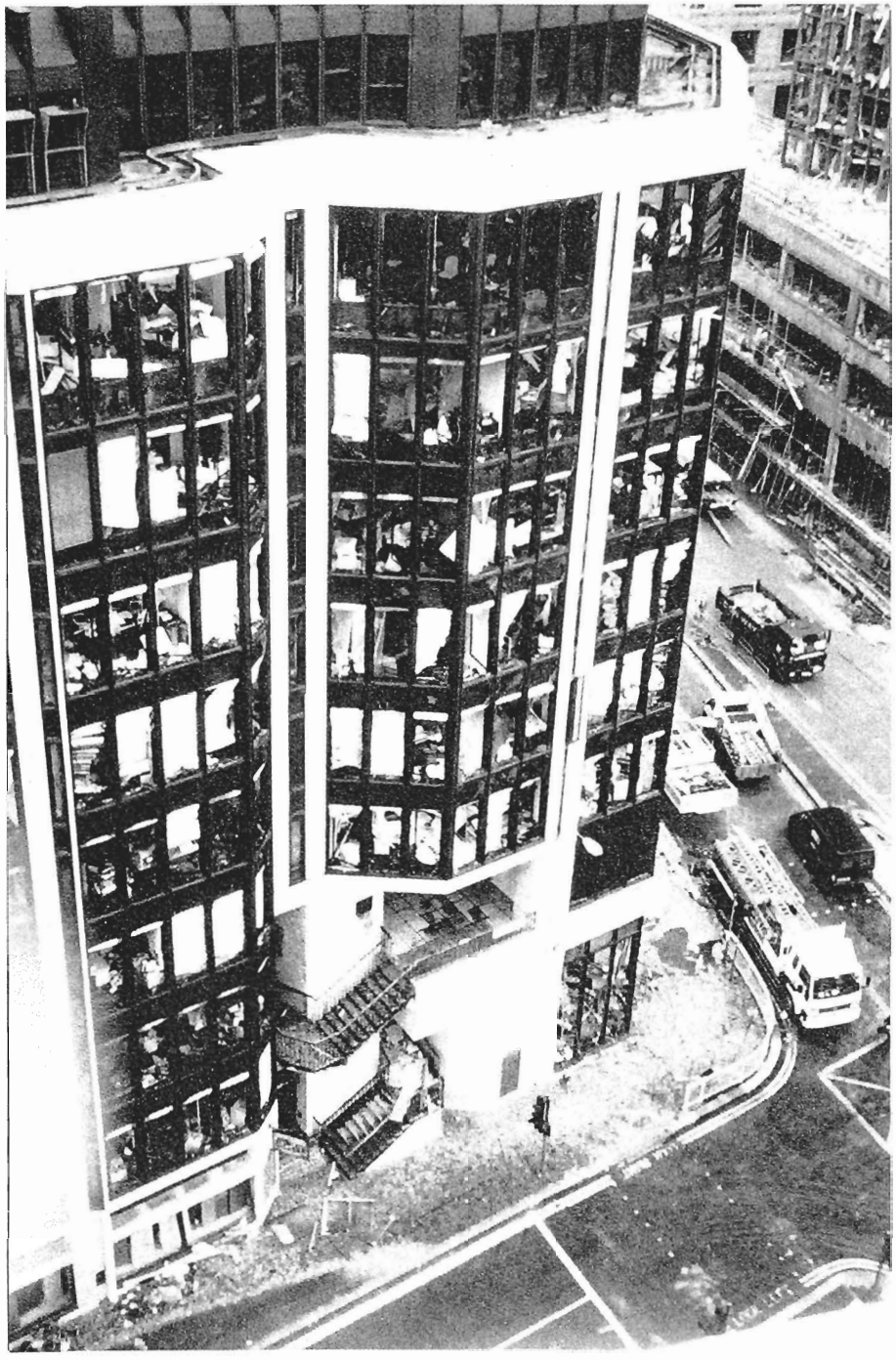
ICE Explosion Seminar
continued from page 1

Corporation of the City of London, explained the authority's response immediately following damage caused by an explosion, which have been developed from lessons learnt from recent incidents in the City. The necessity to have in place a well thought out contingency plan was highlighted. It was emphasised that one of the main objectives was to put buildings back into the hands of their owners and occupiers as soon as possible after an event.

A speaker from the Department of the Environment gave a Northern Ireland perspective to the problem. DOE (NI) have had experience of many thousands of instances where blast damage has occurred and this has resulted in response reactions being refined. A set of simple recommendations have also been devised to enhance the resistance of buildings to blast damage and reduce the level of damage. Particular attention to the necessity to improve the design and fixing of windows helps. Overall it is estimated that the increase in capital cost of a building to sensibly reduce damage was in the order of 2%. The DoE do not currently recommend that strengthening beyond this level is warranted.

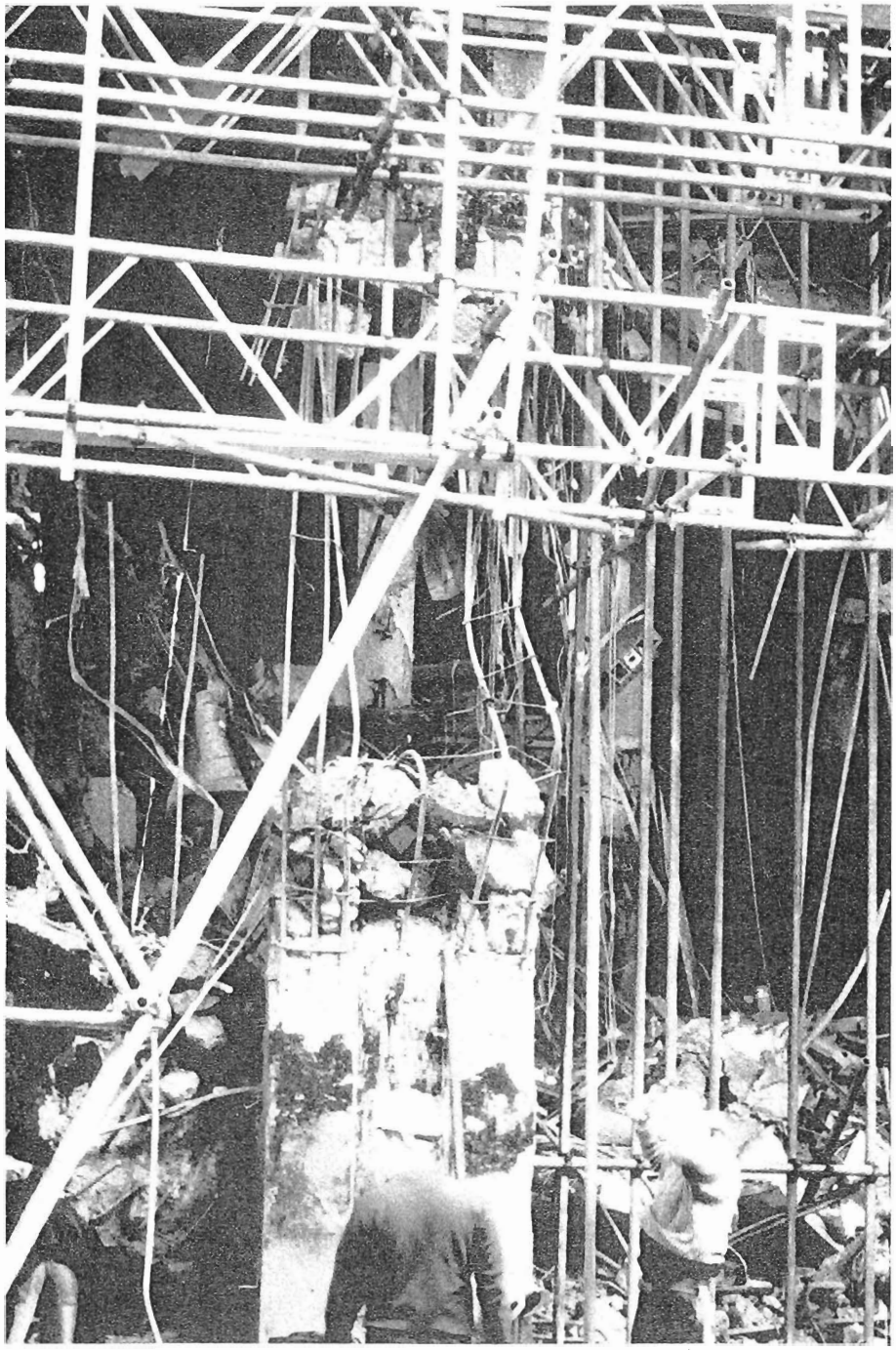
David Hay, who is the study leader of the Home Office Emergency Planning College, presented a studied view of the approach towards emergency planning as highlighted in the HMSO publication 'Dealing with Disaster', produced by the Home Secretary's Civil Emergency Advisor. The presentation emphasised the need for having a generic plan available to overcome a wide range of problems. He made it clear that it was vital to achieve a well organised, combined, co-ordinated response to major disasters. The concept of integrated emergency management is central to this process.

Gordon Millington, of consultants Kirk McClure Morton, who has had some 20 years experience of dealing with blast damage in Northern Ireland, gave a short review of the nature of the forces which result from a blast and explained that whilst these are dynamic in character, they appear somewhat different from the inertial effects of earthquakes. Indeed the DoE speaker from Northern Ireland pointed out that the DoE (NI) recommendations for enhancing building strength to resist blast damage differed in detail to the design guidelines often applied to improve earthquake resistance. Gordon Millington explained different repair strategies available during recovery and contrasted the approach adopted for the repair of a listed building, which was not a fully commercial operation, with a commercial property, where it was important to minimise consequential losses as quickly as possible following an incident.



Above: Glass blown out due to Bishopsgate blast

Case studies resulting from recovery from the last two major blasts in the City of London were given by Francis Ives, Cyril Sweett & Partners. Francis produced some very useful checklists for ascertaining and agreeing on the value of damage. The whole problem of obtaining agreement on the extent of the damage and the means for carrying out the remedial work was examined. Francis stressed the importance to building owners of having available a plan on how to deal with damage and particularly the



Above: Structural damage close to source in Bishopsgate

drawings and construction details of their buildings. It is also important to maintain a list of people who know the structural details. The commonsense point that information is best held somewhere other than the building in question was highlighted.

A Contractor's view point was given by Ken Russell of Costain Building and Civil Engineering's Dangerous Structures Group. Ken has many years experience in responding to major incidents in London. Rapid response to deal with a wide variety of structural problems requires highly skilled teams backed up by a broad resource of building materials. Adaptability was the key to speedy recovery. Once called in, the team's primary objective was to make buildings safe and then to start repairs to speed recovery.

The final paper was given by John Hill who is currently, on behalf of the Institution of Structural Engineers, preparing an advisory booklet on the assessment and repair of blast damaged buildings. Information that would aid assessment and repair is not currently readily available and the purpose of the booklet is to bring together a wide variety of data given in a number of publications to provide a comprehensive guideline in this specialised subject. A parallel publication is being prepared by the Institution of Civil Engineers Structures and Building Board, and this focuses on the design of buildings to minimise blast damage.

There was lively debate after the papers and it was clear that the long standing experience in Northern Ireland has created a different attitude towards recovery from damage to that prevailing in the City of London. The attitude in Northern Ireland appeared to be one of returning buildings rapidly to a condition that can be used. The approach in London seemed to be to repair buildings more slowly but to a pristine condition. The Chairman closed the meeting saying that he "felt a lot of useful information had appeared during the day and he was sure that many people had learnt a lot in the last few years and welcomed the part played by the participants".

Gordon Millington
Kirk McClure Morton

GUIDANCE DOCUMENTS ON DESIGN AND ASSESSMENT FOR BLAST

The Institution of Civil Engineers, through its Structures Board, is currently preparing a publication containing advice on measures intended to provide enhanced structural resistance to external blast loading. In parallel, the Institution of Structural Engineers has in preparation a booklet which will deal with the assessment and repair of blast damaged buildings. Liaison has been established between the Institutions to ensure a common aim in the development of the two publications. Anyone with experience to contribute in these fields should contact the secretariat at either the Institution of Civil Engineers or Institution of Structural Engineers. A one day seminar entitled "Structural Response to Explosions in Buildings" is planned for Thursday 27th October 1993 at the Institution of Structural Engineers. It is expected that parts of the assessment and repair publication will be aired at the seminar, and that there will be opportunity for some useful feedback.

THOUGHTS ON BOMB DAMAGE TO BUILDINGS POST-BISHOPSGATE

by John Maguire, Lloyd's Register

Objective

The purpose of this discussion paper is to outline the author's personal opinions on risk assessment and mitigation following the 1993 Bishopsgate bomb. Your comments are welcomed!

Background

Over the last 20 years (1972-92) there have been 461 bomb incidents in London, out of a total of 926 in mainland Great Britain. In the last year (1992-93) the corresponding figures have been 48 in London, 198 in mainland Great Britain. The problem seems to be here to stay! The damage caused by recent major bomb blasts is estimated to be,

- St Mary Axe (1992) £320m
- Bishopsgate (1993) £400m
  (early estimate only)

Preventative Measures

Many businesses take preventative measures to deal with bomb blast. It would not be appropriate to describe these in detail but it is admissible to describe some of the general approaches. Businesses are generally concerned, in order of priority, with:-

- safety of their staff;
- continuity of their business;
- protection of their building(s).

Of these three priorities safety of staff and continuity of business are much more significant than the protection of buildings. Businesses are very prepared to walk away from their buildings as long as they can safely continue their business elsewhere.

Disaster Plans

Many businesses have documented disaster plans in existence. These address hazards such as:-

(a) fire;
(b) flood;
(c) aeroplane crash;
(d) electrical failure;
(e) restricted access;
(f) explosion (gas, chemical, letter bomb, terrorist bomb).

Hazards (a) - (e) can largely be planned and controlled. Hazard (f) is different in that what will happen, and when, is less well known. Terrorist bomb blast is the subject of much current interest.

Disaster plans often emphasise how to keep the business running. Structural issues are often of lower priority but nonetheless important if they affect human safety and business continuity.

Making the Building Safe

After a bomb blast and police check, the company (building owner) is required to make the building safe. Structural engineering input is obviously essential here, and ideally integrated within the overall disaster plan.

Threats and Evacuation

Businesses have to decide how to respond to threats. It is usual in a fire to evacuate a building. For an internal threat (bomb) evacuation to the outside may be the chosen response. For an external threat (such as at Bishopsgate) a decision needs to be made whether to evacuate or not. Many businesses are starting to decide to stay within a building under bomb threat and seek temporary safe refuge (TSR). Favoured locations for TSR's are basements and near to internal cores but structural strengthening may be required. Secondary effects (e.g. collapsing services) need to be considered.

Structural Strategies

Although protection of buildings is a relatively low priority, strategies are evolving to deal with bomb threats in the short, medium and long term. Some of the strategies, and resulting questions, are given below.

Short term

Since most damage is caused by debris and glass, businesses are considering rapid low cost mitigation measures such as "bomb film" on windows. Services may be planned to be switched off to isolate the possibility of resulting fires, etc. In the short term many businesses have yet to get their disaster plans "up to scratch".

Medium term

The generic performance of cladding and glazing systems needs investigation - which are vulnerable systems and which are not? Building vulnerability also needs to be assessed - should insurers offer corresponding premiums for low risk buildings? Or refuse to insure high risk buildings?

Long term

Building design and construction needs to be reconsidered in the light of future terrorist attacks. Guidelines could be produced to aid architects, engineers, etc., to produce bomb-resistant buildings (in a manner analogous to guidelines for earthquake-resistant buildings).

The Costs

The financial side of terrorist attack is becoming increasingly worrying to government, insurers, owners, tenants and others. Post St Mary Axe and prior to Bishopsgate an insurance 'pool' was set up but this contingency has now been largely used up. Decisions need to be taken shortly on how risks in future are identified, quantified, mitigated (including shared) and/or avoided. Experience from the shipping and offshore industries may be relevant here.

The Future

Many lessons have been learned from the St Mary Axe and Bishopsgate bomb blasts. Strategies adopted by businesses within the City of London have generally worked well in 1993 though there is no room for complacency. Once the basic human safety and business continuity issues have been addressed the structural engineering issues of building protection need to come to the fore.

EURODYN '93

The second European Conference on Structural Dynamics (Eurodyn '93) took place in Trondheim, Norway between 21-23 June. I didn't attend the first Eurodyn conference which took place in Bochum in 1990 although it appears that it was quite a successful event, and I was interested to see if the Eurodyn concept was a truly European venture with a bright future. The fact that papers were contributed from individuals in 35 different countries shows that it is somewhat wider ranging than just a European conference and the presentation of 151 papers selected from 250 abstracts received, illustrates the interest shown.

The opening address *'The role of dynamics in civil engineering'*, was given by Prof J M Roesset of the University of Texas at Austin, USA. This took the form of an historical review of developments in dynamics, a review of the current status including a breakdown of the subject content of the Eurodyn papers and his view of the main items of work for the future. It is always a pleasure to listen to such an expert in the field talking about a subject on which he has worked for so long, but in my mind it is a pity that the address was not included in the proceedings as, for me, it was one of the highlights of the conference. I do remember that he thought the main needs for research were in Non-linear dynamics, Damping and Wave propagation

As my paper dealt with non-linear behaviour and included damping measurements I was happy to agree with him. One 'negative' point which he made was that he estimated that only 10% of the papers in the conference included work of an experimental nature which he considered to be imbalanced. Later I did hear a number of comments expressing the view that, in the work presented, there was perhaps too much theory with too little direct application.

With such a large number of papers being presented over just 3 days, the presentations were split into 5 parallel sessions. The target being 3 or 4 papers per 1 1/2 hour session. I had mixed feelings on this format, but the organisers had taken some care over the programme so that there were no similar sessions running in parallel. The 1/2 hour presentation time does allow the speaker to present his work in some detail and is excellent (or perhaps even too short) for those papers in which you're interested, but perhaps too long for some of the mathematically based presentations on those subjects to one side of your direct line of interest. The breakdown of the subject content was roughly as follows: *Earthquakes 20%; Blast/ impact 12%; Soils 11%; Stochastic Response 11%; Wind response 10%; Others (inc. dams, bridges, buildings, traffic, system identification & control) 36%.*

This breakdown perhaps reflects the balance of research effort on structural dynamics.

The conference was well organised by Prof Moan and his colleagues from the Norwegian Institute of Technology, with the two volumes of the proceedings being issued on registration and all the sessions running strictly to time-table. The social programme was by necessity limited to 2 nights, and provided a concert in the splendid Nidoras Cathedral followed by a reception hosted by the Mayor of Trondheim at the Archbishop's Palace, and on the next evening an excellent conference dinner including the 'best of the region' cooking accompanied by regional entertainment.

In all it proved a very successful conference and I expect that in future the number of UK participants will increase greatly from the 8 who went to Trondheim. For those who didn't have adequate warning of Eurodyn '93, it appears likely that the next Eurodyn conference will be held in Florence in June/July 1996. I, for one, hope to be there.

Brian Ellis, BRE

SECED Seminar

UNCERTAINTY AND CONSERVATISM IN THE SEISMIC DESIGN FOR NUCLEAR PLANTS

The AEA Conference Centre in Risley was the venue for a one day seminar addressing the important issue of uncertainty and conservatism in the seismic design for nuclear plants. Whether it was the joint sponsorship by BNES and SECED, or the anticipation of balmy April sunshine in Warrington, the seminar was particularly well-attended, with a fair cross-section of representatives from industry, academia, consultancy and the regulatory organisations. The diversity of audience affiliations enlivened the many discussions which punctuated a full day's schedule of talks, covering all aspects of the seminar theme, ranging from ground motion and soil-structure interaction to structural analysis and design management.

Uncertainty and conservatism are the two sides of the risk analyst's coin. So we were reminded by David Mallard, who opened the proceedings with an enigmatic photograph nostalgic of the early post-war when English seismic risk analysts were as few as Test-class cricketers are today. The more we appreciate the bounds of earthquake engineering knowledge and understanding, the more precise will be the quantification of uncertainty, and the more transparent will be the degree of conservatism achieved in seismic design. If undue conservatism is to be avoided, attention must be directed towards improvements in estimating uncertainty, and reducing uncertainty where practically possible. Throughout the morning and afternoon sessions, efforts to do this were described.

If conservatism in risk assessment must, to some residual extent, remain in the eye of the beholder, then the last word must be the prerogative of regulators. So it was left to Richard Bye of the NII to conclude the seminar with an exposition of the regulatory view. As a contribution to a dialogue with utilities, this presentation was admirable in the clarity with which the regulatory position was stated, and points of concern were carefully elucidated. Whatever the prospects for the next meeting on uncertainty and conservatism in the seismic design of nuclear plants, there must be some regret that such open seminars have not been held regularly over the past decade.

Gordon Woo, EQE International

NOTABLE EARTHQUAKES APRIL - JUNE 1993

Reported by British Geological Survey

YEAR	DAY	MON	LAT	LON	DEP KM	MAGNITUDE ML	MB	MS	LOCALITY
1993	6	APR	58.668N	1.008E	26	3.5			NORTHERN NORTH SEA
1993	6	APR	56.132N	3.682W	0	1.6			CLACKMANNAN, CENTRAL
			Felt strongly in the village of Forest Mill. This event is one in a continuing series of mining related earthquakes.						
1993	18	APR	11.611S	76.552W	90		6.1		CENTRAL PERU
			Six people were killed, including 3 killed by earthquake induced landslides at Lima. Thirty houses were destroyed at Lima. Felt throughout the Western coastal area of Peru.						
1993	18	MAY	19.829N	122.357E	198		6.6		PHILIPPINE ISLANDS
1993	24	MAY	22.960S	66.440W	238		6.6		NORTH WEST ARGENTINA
			Felt in north west Argentina and northern Chile						
1993	8	JUN	51.386N	157.729E	70		6.2	7.1	KAMCHATKA
			Some damage reported on Kamchatka. Minor tsunami detected on Hawaii.						
1993	13	JUN	55.177N	160.458W	32		6.4	6.8	ALASKA PENNINSULA
			Felt throughout the Alaska Penninsula and Kodiak Island.						
1993	26	JUN	54.209N	2.890W	10	3.0			GRANGE-OVER-SANDS, CUMBRIA
			Felt in southern Cumbria from Barrow-in-Furness to Kendal and in Lancashire around Morecambe Bay.						
1993	29	JUN	53.036N	2.193W	5	1.7			STOKE-ON-TRENT, STAFFORDSHIRE
			Felt in the Stoke-on-Trent area.						

PROGRESS ON EC8

London in December this year will see, hopefully, the launch of the first tranche of EC8, on to the European construction scene as an 'ENV'.

The occasion will be the fifth meeting of CEN TC250/SC8 and it will be held at the BSI conference centre, Hampden House.

The fourth meeting of SC8 was held in Berlin on May 17 and 18 1993. It was attended by twenty delegates. Eight full member countries were present together with an observer from the Czech Republic. The UK were represented by Bryan Skipp, Edmund Booth and Amr Elnashai.

The final revisions of Part 1.1, 1.2 and 1.3 (General and Building) were discussed along with comments received from UK, Germany, Greece, Denmark and Italy, and a resolution was passed recognising the considerable advances made. These parts will be the first to be given a formal vote for passing to the ENV stage at the London meeting.

Further discussion was held on Part 3 (Towers and Chimneys), and Part 4 (Tanks). The issue of soil-structure interaction and behaviour factor together with damping in both structure and foundation received some attention and the Project Team was directed towards some re-evaluation of these matters.

The UK submitted a bound document of comment on Parts 1.1, 1.2, 1.3 and 3 in draft form to which 17 experts contributed. A final form was sent at the end of June.

The remaining five parts of EC8 (Part 2 - Bridges; Part 3 - Chimneys; Part 4 - Tanks; Part 5 - Foundations; Part 6 - Strengthening) are to be presented as final drafts by the early summer of 1994 so the last few months of the project are going to be hectic.

Experimental methods in earthquake engineering & structural dynamics, 2 - 3 September 1993

A two day seminar on this theme will be held jointly with SECED's French counterpart society, AFPS, at St-Remy-les-Chevreuse, a suburb to the south of Paris. The intention is to gather together clients, contractors, research establishments, building and local government authorities who are concerned with dynamic testing in the two countries. The colloquium will create a forum for exchanging experience and presenting the state of the art in France and the UK. Topics to be covered include:

- shaking table testing
- pseudo-dynamic testing
- dynamic testing for soils
- testing for wind dynamics
- shock and impact testing ⇒

Conference Report

DTA/NAFEMS INTERNATIONAL CONFERENCE ON STRUCTURAL DYNAMICS MODELLING (TEST, ANALYSIS AND CORRELATION)

MILTON KEYNES, UK
JULY 1993

This Conference addressed the important topic of combined analysis and test procedures for the development of valid structural dynamics models. The conference organisers were the Dynamic Testing Agency (DTA) and NAFEMS, both DTI supported organisations.

A total of 42 papers were presented, including invited keynote addresses from Prof Larry Mitchell (VPI) on experimental aspects, Prof Oleg Zienkiewicz (Swansea) on analytical aspects and Prof Sam Ibrahim (Old Dominion) on correlation aspects. The conference was opened by Bill Edgar (NEL) and summarised by the rapporteur, Prof. Michael Link (Kassel). During the three days, sessions were chaired by the organisers, Prof David Ewins (Imperial), Prof Alan Morris (Cranfield), Dr John Maguire (Lloyd's Register), Dr Mike Fox (Nuclear Electric), Dr Geoff Wright (Assessment Services Ltd.) and Dr Malcolm Nash (DRA).

The conference was truly international in flavour - although there were naturally a high number of UK delegates (49), there were also delegates from Europe (23), USA (8), the Asia Pacific Region (6), South America (2), the Middle East (1) and Australia (1). In addition to the conference there was an interesting exhibition alongside, displaying the capabilities of SDRC, MSC/NASTRAN, STRUCOM, LMS, Dynamic Engineering, Lloyd's Register, John Wiley, DTA and NAFEMS.

The conference was split into distinctly different "morning" and "afternoon" sessions. The morning sessions concentrated on theories related to test, analysis and correlation, and featured the three keynote addresses. The afternoon sessions concentrated on case history presentations, illustrating the application of the various different theories and strategies. Notable structures modelled included the Maracana Stadium (Brazil), the Kessock Bridge (UK), the Barcelona and Sevilla bridges (Spain), the Lynx helicopter (UK), the SPACEHAB shuttle module (Italy), the STARS II missile (USA) and the GM Saturn car (Belgium). Components modelled included printed circuit boards, a gun barrel, rotor systems, a ship gas turbine and concrete floors, amongst others.

It became clear during the 3 days that model correlation and updating is a far from mature technology, although much work has been done over the last 20 years. There are uncertainties relating to both analysis and experimental data, which need to be recognised and reconciled, and the importance of the experienced engineer making appropriate judgements was highlighted. Critical questions include - should I update or not? If I do, what criteria should I satisfy?

In conclusion, a fascinating conference which the attendees enthusiastically appreciated. For those of you unable to attend there are a limited number of copies of the proceedings available from the NAFEMS office at a cost of £50 plus postage and packaging. For details contact Anne Creechan at
NAFEMS, NEL Technology Park,
East Kilbride, Glasgow G75 OQU,
Tel: 03552-72639,
Fax: 03552-72749.

The colloquium has received financial support through a generous donation by the Earthquake Engineering Research Centre, University of Bristol. The cost of the seminar, to include documentation and lunch, is 1600FF (SECED and AFPS members) 2000FF (non-members) 1000FF (faculty members, students and retired people). Half board accommodation is available on site for 417FF (single room) or 312FF (double room).

For further information contact the Secretary of SECED for a full programme and application form.

WHAT'S ON

July - September 1993

11th - 14th July 1993
2nd International Conference on Emergency Planning and Disaster Management
Lancaster University, UK

2nd - 3rd September 1993
Joint SECED/AFPS Seminar
Experimental methods in earthquake engineering & structural dynamics
Paris, France

6th - 10th September 1993
22nd Advanced Course in Noise & Vibration
University of Southampton

29th September 1993
SECED/IStructE Meeting
Structural Analysis Software (Standards, Certification & Practice)
Institution of Civil Engineers

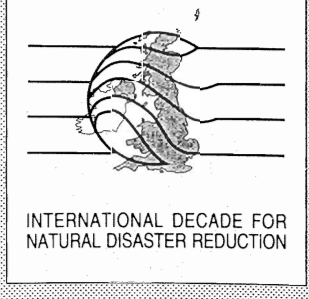
Register now for

IDNDR Conference: Protecting Vulnerable Communities

starting IDNDR Day, 13th October
until 15th October
at
The Royal Society, London

For registration contact

Rachel Coninx
IDNDR Conference Office
Institution of Civil Engineers
Great George Street
London SW1P 3AA



Forthcoming Events

11th - 15th October 1993
University of the West Indies
Caribbean Conference on Volcanology, Seismology and Earthquake Engineering
St Augustine, Trinidad

12th - 13th October 1993
International Conference on Successful Management for Safety
Institution of Mechanical Engineers

13th - 14th October 1993
Safety & Reliability Society
Engineers and Risk Issues
Manchester

13th - 15th October 1993
IDNDR Conference
Natural Disasters: Protecting Vulnerable Communities
The Royal Society, London

25th - 28th October 1993
SAVIAC
64th Shock and Vibration Symposium
Ft Walton Beach, Florida

26th - 29th October 1993
Commission of European Communities
International Conference on Natural Risk and Civil Protection
Italy

27th October 1993
1 Day Seminar
Structural Response to Explosions in Buildings
Institution of Structural Engineers

27th October 1993
SECED /WES Meeting
Wind and Earthquake Effects on Towers, Masts and Chimneys
Institution of Civil Engineers

1st - 4th November 1993
Japanese Gov, World Bank, UN Centre for Regional Development
Disaster Management in Metropolitan Areas for the 21st Century
Nagoya, Japan

1st December 1993
SECED/OES Meeting
Offshore Dynamics
Institution of Civil Engineers

10th - 21st January 1994
IASPEI/Royal Society of New Zealand
27th General Assembly of the International Association of Seismology and Physics of the Earth's Interior (IASPEI)
Wellington, New Zealand

26th January 1994
SECED/AFPS Meeting
Shaking Table Tests on a Model Shear Wall Building
Institution of Civil Engineers

23rd February 1994
SECED Meeting
Blast Vulnerability of Building Structures
Institution of Civil Engineers

30th March 1994
SECED/EEFIT/EFTU Meeting
Earthquake Field Studies
Institution of Civil Engineers

27th April 1994
SECED Meeting
Earthquake Engineering Design Case Studies
Institution of Civil Engineers
+ SECED AGM
+ Biennial Dinner

18th May 1994
SECED Meeting
Maximum Credible UK Earthquake
Risley, Warrington

23rd - 27th May 1994
IDNDR
World Conference on Natural Disaster Reduction
Yokohama, Japan

17th - 20th July 1994
Institute of Sound and Vibration Research
5th International Conference on Recent Advances in Structural Dynamics
University of Southampton

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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, United Kingdom (Tel. +44 (0)61 962 1214; Fax +44 (0)61 969 5131).

SECED

SECED, The Society for Earthquake and Civil Engineering Dynamics is the British 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 EEFIT, the UK Earthquake Engineering Field Investigation Team. The objective of the Society is to promote cooperation 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, Institution of Civil Engineers, Great George Street, London SW1P 3AA, United Kingdom.

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