SECED

SECED NEWSLETTER

THE SOCIETY FOR EARTHQUAKE AND CIVIL ENGINEERING DYNAMICS

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LETTER TO THE EDITOR

RESEARCH AND THE PRACTISING ENGINEER

My letter is in response to that from Mr. Bommer in the April Newsletter. The subject of Mr Bommer's letter was the SECED meeting of 20th January in which informal presentations and discussions took place in regard to the present SERC Earthquake Engineering Research Programme.

The first point made by Mr. Bommer is that the presentation did not cover all of the UK current research in the fields of engineering seismology and earthquake engineering. The letter further notes that this was unfortunate since a wider discussion of this topic would be of greater benefit, particularly as a forum for the exchange of information and views between researchers and practising engineers.

I would agree that such a meeting would prove useful. However, I would also like to assure Mr. Bommer that (as one of the four engineers from industry present), I did appreciate that both the SERC projects being discussed did not represent all the earthquake engineering research being carried out in the UK and that only a brief resume was possible for each of the SERC projects that were discussed.

Mr. Bommer's second point is reflected in the recollection that following the discussion, one of the four practising engineers had been left with the impression that current UK research would not assist in industrial practice. It was considered that this impression may well have been in part due to the enforced brevity of the topics presented.

There has of course already been a wealth of research carried out in other more earthquake prone countries and I would expect that research topics proposed for the UK would concentrate upon those problems peculiar to this country. Topics like those pursued by Mr. Bommer himself for instance. It is a fact that practising engineers have not in the past had a Code of Practice for the design of seismic resistant structures in the UK and considerable industrial effort has gone into devising acceptable rules. Since there has been no common Code then this effort has had to essentially be repeated each time a different organisation has entered the field. It might be salutary to note that very basic aspects such as the method to be used in combining the effects of orthogonal components have provided for considerable discussion. Such rules can have a significant effect upon the outcome of any design. Importance in these aspects are evidenced by papers presented at the recent SECED Bristol Conference.

The SECED Newsletter is published four times a year by the SOCIETY FOR EARTHQUAKE AND CIVIL ENGINEERING DYNAMICS and is available to all members of the society. Articles for inclusion should be sent to The Editor, SECED Newsletter, Mr. D.A. Howells at The Institution of Civil Engineers, Great George Street, London SW1P 3AA.

Research is of course essential and, whatever the practical outcome, will always lead toward our understanding of the problems investigated. Inevitably some of the topics presented at the meeting of the 20th January lay closer to the practical needs of the engineer than others. However, if it is accepted that such meetings are desirable, I would consider that the interest of those in practice is in fact best served by short concise deliveries from the specialist speaker. The fact that the research engineer may well be concerned with acquiring a high degree of specialist knowledge whilst the practising engineer will be concerned with acquiring a more global appreciation provides for a difference that must be recognised. The view of the 'great divide' is not new and certainly not restricted to those involved in seismic engineering. It would perhaps assist if the engineer recognised that it may sometimes legitimately be the case that a particular line of research is instigated with no clear idea of what may prove to be of immediate or direct practical benefit. Similarly the researcher must appreciate that the results from any singular item of research must take its place amongst the many other (highly variable) parameters which must come together in the design process. If the final objective is to provide a highly seismic resistant structure then the manner in which the structure is put together is certainly just as important as the computations involved, if not more so. Detailing of the structure caters for the imponderables which are known to exist.

Mr. Bommer is right, there must be a mechanism whereby practising and research engineers in the fields of dynamics and earthquake engineering can understand each other's needs. SECED and its meetings can provide an ideal forum for this to be achieved. As a step in the right direction, a SECED sub-committee has recently been formed under Dr. David Key with the basic objective of liaison with the SERC in respect of research proposals and educational needs in the fields of dynamic and seismic engineering.

Chris Sharman
Allott & Lomax

STRUCTURAL DAMPING: UNCERTAINTIES IN MEASUREMENT AND IMPLICATIONS FOR DESIGN

SECED Meeting, 25th May 1988

Reported by John Wilson

Dr John Dougill, Director of Engineering Affairs at the Institution of Structural Engineers introduced and chaired this meeting. It took the form of seven short presentations by researchers and designers, to discuss the current state of the art in the measurement of damping, and the current practice employed by industry in the use of damping in design and analysis.

Dr John Maguire (W.S. Atkins Engineering Sciences) provided a general overview of structural damping. Typical design damping values for various materials and stress levels were provided. These values were compared with measured results from USA data. A number of people in the audience felt the damping values presented in the USA studies were too high, particularly for low stress levels. It was concluded that the scatter associated with actual damping values was wide, realistic estimates of damping for higher modes were difficult to obtain, and that the value of damping selected can have a significant influence on the performance of the structure particularly when subject to resonant harmonic vibrations. A more rigorous probabilistic design approach which considered the variance associated with the chosen damping value was briefly introduced.

Professor Hans Bucholdt (Polytechnic of Central London) discussed the different methods available to measure damping with particular reference to cable stayed roof structures. For such structures, the effects of aerodynamic damping are significant, particularly if no wall cladding is present. From the research work performed on full scale beams, (at PCL) it was concluded that the log decrement method was a more accurate method to measure damping compared with the half power method.

James Brownjohn (Earthquake Engineering Research Centre, Bristol University) discussed the measurement of damping in suspension bridges using ambient vibration testing. Such testing is much cheaper (and less disturbing to occupants) than forced vibration testing, and provides data for many modes as compared with the transient (snap back) testing where the first mode dominates the overall response. It was noted that the damping measured was associated with low stress levels. Damping was evaluated using spectral analysis and curve fitting techniques. The measured damping values for the first mode of the Humber bridge were presented, and the wide scatter of results and the importance of aerodynamic damping were discussed. Numerical simulation techniques were employed to test the significance of a number of likely error sources in the measurement and analysis procedure. It was concluded that to reduce the variance of the measured damping values it was important to improve the spectral resolution by maximising the length of the signal recorded, and to use at least 16 averages in the spectral averaging procedure.

Mike Willford (Ove Arup Partnership) illustrated the significance of damping to the design engineer, with two examples; the dynamic wind response of a tall building, and the pedestrian induced vibration of a long span floor. By assessing the worst credible variations in all the uncertain parameters and performing a sensitivity analysis it was shown that uncertainty in damping only slightly affects the along wind bending moments, but has a more significant affect on the acceleration response of a building. Uncertainties in the windspeed were more significant in both cases. The effect of damping on pedestrian induced vibration of long span floors were studied using finite element models and time history dynamic analysis techniques.

Although the response of the floor was quite sensitive to the value of damping selected, reducing the damping by half did not double the floor response, indicating the response was more transient than steady state harmonic. It was concluded that damping was only one of many unknowns in the design process. The importance of the variance associated with the chosen damping value could be tested using parametric studies.

Dr Neil Harwood (National Engineering Laboratory, East Kilbride), described the use of a recently developed technique involving the measurement of surface temperatures by highly sensitive infra-red detectors. These were used to generate a colour map of the distribution of principal stresses over the surface scanned by the detector. The technique was applied to dynamic load tests on a range of different engineering structures. A measure of the damping was evaluated using a Niquist plot from the thermoelastic data.

Dr Jack Pappin (Ove Arup and Partners) described damping in soils and its influence on soil structure interaction. Both the hysteretic material damping and the viscous, frequency dependent radiation damping were introduced. Soil damping is of particular significance in the field of soil structure interaction. Usually the structural damping is significantly different from the foundation damping. However, in response spectrum analysis only one overall damping value per mode is possible. The overall damping can be evaluated approximately by considering the ratio of structural stiffness to foundation stiffness. When the structural stiffness is much greater than the soil stiffness, the overall damping can be approximated by the soil damping. Conversely a structure which is very flexible compared with the foundation will possess overall damping value close to the structural damping. For stiffness ratios between these bounds the overall damping value can be evaluated by weighting and summing each of the subsystem damping values by the ratio of the overall system stiffness to the subsystem stiffness values.

Dr John Littler (BRE Structural Design Division) discussed some practical considerations in measuring and processing vibration signals from forced and ambient vibration tests. Damping evaluated using the half power method is sensitive to the spectral resolution. A coarse resolution will produce unrealistically high damping values. It was concluded that to obtain absolute confidence in the calculated damping values 28 hours of stationary data would have to be recorded and analysed.

ENGINEERING ASPECTS OF THE 1 OCTOBER 1987 WHITTIER NARROWS EARTHQUAKE:

SECED Meeting, Imperial College, 29th June 1988.

Introduced by Professor Robin Shepherd, University of California, Irvine.
Reported by Dr Chris Browitt.

With a Richter magnitude of 5.9 this earthquake was of moderate size by Californian standards and on average such an event occurs every two years. They often have little consequence for people and property and it is 16 years since southern California suffered damage on this scale (greater than $400m) and casualties (7 dead). A significant aftershock (ML = 5.5) contributed to the damage of previously weakened structures and the socio-economic aspects of these events cannot easily be quantified. For example, Professor Shepherd noted great reluctance on the part of many people to re-occupy University buildings even though they have been declared safe. Previously, similar situations have resulted in sound buildings being demolished.

With most of the damage occurring in the town of Whittier, SE of downtown Los Angeles, the hypocentre was at first thought to be on the NW-SE trending Whittier fault. More detailed analysis showed, however, that the main shock occurred on a shallow-angled north dipping plane with E-W strike and the 5.5 ML aftershock, a few miles to the west, had right lateral strike-slip movement on a steeply dipping plane. Neither of these is consistent with the mapped Whittier fault and as so often is the case, previously unidentified faults are the cause. This conclusion has implications for the safety of downtown Los Angeles which had been judged not to be in immediate proximity to a fault and, therefore, to be relatively safe from small nearby earthquakes.

The many instrumental recordings show that horizontal ground motion peaks were 63% g at Whittier, 40% g at 6 km from the epicentre and 20% at 20 km. The dominant frequency was around 3 Hz and the duration of strong motion at Whittier about 4 seconds.

With the area under development for some 200 years, a wide range of building types were tested during the earthquake and its principal aftershock. Many pre-code buildings in the most strongly shaken area collapsed or were weakened to the point that made them uninhabitable. Other dwellings, whilst structurally sound, had to be vacated owing to a loss of services at foundation level and with a general lack of insurance cover such cases often resulted in hardship for owners and tenants. Whilst some new structures behaved disappointingly, there is evidence that the code provisions are fulfilling the objectives of minimising casualties and preventing total building collapse. There are, of course, no residential building codes in common with all areas other than New Zealand. It is clear that modest strengthening and attention to details would reduce the homelessness caused by such moderate earthquakes.

Professor Shepherd provided several illustrations of damage to reinforced masonry buildings with loss of parapets, outer withes of untied bricks in walls, and corner damage at floor and roof levels. There is evidence in Los Angeles, where there has been a recent programme of reinforcement, that such work is beneficial: 31% of unstrengthened and 20% of strengthened buildings suffered significant damage and 6% of the former but only 2% of the latter had to be vacated. Lessons learned from the test which these earthquakes have provided should lead to future improvements.

In some engineered buildings there was structural damage which can be attributed to already identified deficiencies in the code applied 20-30 years ago. Examples are the use of flexible lower storeys and asymmetrical footprints. There were a few cases, however, of damage to buildings designed and constructed in the past 10 years which casts doubt on aspects of the present code provisions. On the other hand, many recently constructed buildings came through the test with no damage. Professor Shepherd illustrated these with a slide of the Home Savings of America Bank showing the absence of even a cracked pane of glass in its facade.

A more complete description of the analysis can be found in: R. Shepherd, 1987. The October 1, 1987 Whittier Narrows earthquake, Bull. New Zealand National Society of Earthquake Engineering, Vol. 20, No. 4.

The summary from that paper is reproduced below:

> The Whittier Narrows earthquake is an example of those expected to occur every ten or twenty years somewhere in the Los Angeles basin. It was not a major event judged either in terms of energy release or by economic loss. Most of the evidence supports the contention that the earthquake mitigation efforts of the last fifty years, as reflected in the building codes, have provided progressively improved protection.
>
> Sufficient damage was sustained to enable the learning about earthquake processes to benefit from careful analysis of the failures which did occur. The retrofitting of existing structures to increase seismic resistance appears to be meeting with some success in such areas as the pre-code unreinforced masonry buildings. Refinements of the strengthening procedures are likely as a result of the experiences gained in this earthquake.

In closing the meeting, Dr Browitt thanked Professor Shepherd for a stimulating, topical presentation. He also expressed SECED's gratitude to the Department of Civil Engineering at Imperial College for their offer of facilities during alterations at ICE.

C.W.A. BROWITT
4 July 1988

SECED CONFERENCE ON CIVIL ENGINEERING DYNAMICS,

Bristol University, 24-25 March 1988.

The second in SECED's triennial series of conferences was hosted by the civil engineering department of Bristol University, home of the new SERC 6 axis shaking table. The conference covered design, analysis, testing and performance in dynamics, and 28 papers were presented covering the effects of impact, wind, explosions, machinery and traffic vibrations, as well as earthquakes. 80 Delegates from 7 countries attended and a wide range of disciplines from both industry and universities were represented.

The first day covered dynamic testing at model and prototype scale, and in his keynote address, Professor Roy Severn, head of civil engineering at Bristol, stressed the vital importance of testing to validate dynamic computer analyses. The work carried out by his department on vibration measurements on large dams, long span suspension bridges and buildings provided instructive examples of the comparisons - and divergences - between computer predictions and practice.

The theme of the second day was analysis and design. In his keynote address, Michael Shears of the Ove Arup Partnership emphasised the dangers of design based on complex dynamic analysis without a proper understanding of the physical processes involved. He referred to the need to build up confidence in computer predictions by hand calculations, parametric studies and physical testing where appropriate.

There was a lively poster section, with displays from industry and universities, and the conference was preceded by a one day seminar on Eurocode 8: Structures in seismic regions, which was addressed by distinguished speakers from the UK and continental Europe. Bound copies of the conference proceedings will be available later this year at a cost of £30 from Thomas Telford Ltd.

EEFIT INAUGURAL GENERAL MEETING

Wednesday 28 September 1988, Institution of Civil Engineers at 5.30 p.m.

The Earthquake Engineering Field Investigation Team, EEFIT was begun 6 years ago by a small group of enthusiasts from both university and industry interested in earthquake engineering. They foresaw the need to establish a British team of earthquake engineers and scientists ready to mount field missions at short notice in order to capture the lessons of damaging earthquakes. Since then, the scope of the team has widened and EEFIT has published 3 major field mission reports, the latest being announced below. EEFIT has attracted the formal sponsorship of both SECED and the Institution of Structural Engineers and has benefited from the advice of a number of British and overseas engineers experienced in earthquake engineering and sciences. Funding for the field missions has come from government, industry and university sources.

The time has now come to establish EEFIT on a more formal basis. A draft Constitution and Aims and Methods statement, circulated with this newsletter, is to be presented for ratification to the Inaugural General Meeting (IGM) of EEFIT on 28.9.88 at the ICE. Voting at the IGM will be open to all SECED members who complete the membership form included with the Constitution/Aims and Methods booklet before the formal start of business and to all others (subject to approval by the EEFIT Committee) who send a completed application form to the Chairman of EEFIT (address below) before the IGM. Following the business of the meeting, an invited speaker will talk on "The importance of earthquake field missions to the engineering community". Everyone (members, prospective members and anyone interested in improving our ability to mitigate the effects of earthquakes) is very welcome to attend. Further details from:

Dr Colin Taylor
Chairman, EEFIT,
Bristol University Earthquake Engineering Centre
Queens Building
Bristol BS1 8TR. Tel: 0272 303729

EEFIT FIELD REPORTS

The Liege earthquake of 8th November 1983. Published by Ove Arup & Partners, London, January 1984.

The Chilean earthquake of 3rd March 1985: a field report by EEFIT. Published by SECED, July 1988. £22.50 from Thomas Telford; see details of prepublication price in this Newsletter.

The Mexican earthquake of 19th September 1985: a field report by EEFIT. Published by SECED September 1986. £22.50 from Thomas Telford.

The San Salvador earthquake of 10th October 1986: a field report by EEFIT. Published by Rendel Palmer and Tritton (RPT), London 1987. £10.00 from RPT or from Julian Bommer, Imperial College.

EEFIT constitution and Aims and Methods booklet. Free, from the Secretary, SECED. (Circulated with this Newsletter).

EEFIT REPORT ON THE CHILEAN EARTHQUAKE OF 3RD MARCH 1985

In March 1985, the same year as the great Mexican earthquake, a magnitude 7.4 event struck central Chile. Although of smaller magnitude than the Mexican event, it affected a large number of engineered facilities and produced a number of results of great importance for the earthquake engineering community. The epicentral accelerations were considerably greater than for the Mexican event and the distribution of ground accelerations, which were captured by 31 strong motion instruments, contained a number of unusual features. 13 major bridges were affected, 2 of which collapsed, there was a major harbour embankment wharf failure which was associated with liquefaction and a number of tall reinforced concrete shear wall buildings were damaged, a class of building for which data are relatively scarce. Many non-engineered buildings suffered badly, and about 1,000,000 people were rendered homeless.

EEFIT sent a 2 man team to investigate the earthquake 9 days after it occurred. Its long delayed report has now been published. The report contains 80 pages including 46 photos of the earthquake damage, and can be obtained from the Thomas Telford Bookshop at the Institution of Civil Engineers for £22.50. The report is available to SECED members at the special prepublication price of £15.50 plus £1.00 p&p UK, £2.50 overseas. Cheques payable to the Institution of Civil Engineers with order by September 15th to:

The Secretary
SECED
Institution of Civil Engineers
25 Eccleston Square
London SW1V 1NX

The report has been reviewed by a SECED/EEFIT editorial panel consisting of Drs Key, Papastamatiou, Pappin and Spence. Their preface to the report is reproduced below.

PREFACE TO THE EEFIT REPORT ON THE CHILEAN EARTHQUAKE OF 3RD MARCH 1985

By SECED-EEFIT Editorial Panel

EEFIT is a non-profit organisation which enables the engineering and scientific communities in the UK and abroad to learn from major destructive earthquakes. The most important link with these communities is established through the publication of field reports. These reports serve many purposes and are unique in conveying the achievements of the particular investigating team within the specific EEFIT set-up. In this respect, the field reports have a long term value as reference material for colleagues sharing the EEFIT interests as well as for future participants to post-earthquake field missions.

The 1985 Chile mission was mounted only six months before the destructive Mexican earthquake, which was also visited by EEFIT; the short interval between the two major earthquakes is primarily responsible for the delayed publication of the Chile report.

Chile has experienced among the largest earthquakes in the world. The 1835 Concepcion earthquake produced spectacular changes to the landscape; this earthquake was experienced and described by Charles Darwin in his Beagle scientific voyage. The 1985 earthquake, although large by European standards, was short of the expected 'big bang' in Chile. Still, the earthquake generated a large epicentral region containing a variety of structures and local geological/topographical conditions. It is unfortunate that the seismotectonic conditions prevailing in Chile have not been adequately exploited in deploying extensive strong motion arrays (synchronised free-field networks, special 3-D arrays, special instrumentation of structures etc.) However, a number of important strong motion records were obtained in 1985.

The EEFIT mission was restricted, due to the adverse logistics involved, to a minimum team of structural engineers for just over a week in the field. The team was very effective in coordinating with Chilean and North American investigators. This coordination is reflected in the overall picture conveyed in the report. Detailed reports from other investigators have already appeared. However, the wealth of information generated by an earthquake, particularly a large one, cannot be contained in any single contribution. In this respect, the EEFIT report has the lasting value of recording the observations of a team from outside the Americas; this 'outside' view of an earthquake scene has proved valuable in the past.

The minimum scope of the EEFIT investigation restricts the report to an appraisal of the post-earthquake conditions, rather than the local implications of earthquake resistance. The report is well presented and contains the salient features of the earthquake that attracted the attention of European earthquake engineers. The observations are often put within the perspective of European standards and practices. Moreover, the EEFIT report poses some interesting questions that have not yet been given a satisfactory answer.

Dr D E Key
Dr D Papastamatiou
Dr J W Pappin
Dr R Spence

ENGINEERING SEISMOLOGY AND EARTHQUAKE ENGINEERING AT IMPERIAL COLLEGE

The SECED newsletter is being re-organised under new management. It was decided that there will be a permanent feature on activities undertaken by universities and other educational establishments. This is the first such article on activities and facilities in the general field of earthquake engineering at Imperial College. Additional information on the activities listed below may be obtained from Professor N.N. Ambraseys.

Post-Graduate Training

The well-established MSc course in Soil Mechanics and Engineering Seismology (SMES), launched in 1968, has been complemented by a course in Earthquake Engineering (EE). We are coming to the end of the first academic year, which has been very successful.

Part of the two courses is a field mission; this year 16 students, research assistant and staff went to Kalamata (Greece), the site of the 13 September 1986 earthquake. Partial funding was provided by the Fellowship of Engineering, supplemented by the students, their sponsors and Section funds. The SERC declined to support because 'a survey of the effects of an earthquake that took place over 18 months ago would be of limited value'. Notwithstanding, we came back with a wealth of information on repair and retrofitting, damage and repair statistics and a number of full design drawings usable for back-analyses. Additionally, two students are currently undertaking MSc dissertations on the Kalamata earthquake.

Research Activities

A number of research projects are currently underway, most of which are funded from British and European sources. There are currently 6 research assistants and 12 research students working on the following subjects:

- Strong-motion Data Bank.
- Response of Foundation Materials to Earthquakes.
- Seismicity of Eastern Mediterranean and the Arab Peninsula.
- Stability of Dams under Earthquake Loading.
- Earthquake-Resistant Design of R/C Walls.
- Composite Columns for Earthquake-Resistant Buildings.

- Dynamic Fluid-Structure Interaction.
- Nonlinear Dynamic Analysis of Steel Frames.
- Energy Absorption Devices for Steel Frames.
- R/C Beam-Column Connections under Cyclic Loading.
- Behaviour of Joints in Precast R/C Structures.
- Design of Masonry Infill Panels to Resist Earthquakes.

Several of the above projects involve staff from Sections other than Engineering Seismology and Earthquake Engineering.

Testing and Analysis Equipment

The Department has recently upgraded laboratory facilities by the purchase of advanced dynamic testing equipment. A number of reciprocating hydraulic actuators and servo-control equipment have been commissioned. The actuators have a capacity of up to 1000KN dynamic, and are served by a hydraulic power pack of 400 ell per min. capacity, feeding several outlets in the Structures and Concrete Laboratories.

The Departmental shake-table (Biaxial, 5T, 1-40Hz) continues to be used in teaching, research and commercial testing. A third year UG project on the effect of mass and stiffness distribution on storey shears in multi-storey buildings has just been completed. Users of the shake-table have access to a sub-set of the above-mentioned strong-motion data bank for use as input. These records have been processed taking into account the characteristics of the shake-table. A digitizing facility has also been purchased, and is being used in digitizing newly acquired strong-motion records, for addition to the data bank and use on the shake-table.

In addition to the wide range of structural testing equipment, the IC group has the benefit of full soil mechanics laboratory facilities, including a fast rate ring shear apparatus.

A MicroVax computer dedicated to dynamics work has been in operation for about a year. This is where the strong-motion data bank resides, together with a wide range of analysis programs.

Links with Industry

Members of the Department are involved in consultancy work in seismicity, soil response, risk analysis, stability of dams and slopes, steel and composite construction etc. Also, the testing facilities listed above are available to industry and have been used on commercial jobs in the past.

Publications

All research work is published regularly in conferences, journals and reports. Five papers have been accepted for presentation at the Ninth World Conference of Earthquake Engineering in Japan.

Three years ago the ESEE report series was started. Since then there has been an average of seven reports per year. These are sent to all major research centres and libraries around the world. Also, a list of past reports is sent to interested persons on request, and copies may be obtained, at cost, from the ESEE Section.

The most recent in the series is a two-volume report comprising field observations from 11 earthquake reconnaissance missions undertaken by Professor Ambraseys.

Amr Elnashai
8 July 1988

THIRD SHORT COURSE ON SOIL DYNAMICS AND FOUNDATION ENGINEERING

San Francisco, 13-17 March 1989

The Third Short Course on Soil Dynamics and Foundation Engineering will be conducted by the Department of Civil Engineering, University of Missouri-Rolla from March 13-17, 1989, in San Francisco, California. Engineers, scientists, and teachers all over the world are invited to join this short course.

Dynamic loads due to earthquakes and other sources pose a serious hazard for structures and foundations. Understanding of dynamic benaviour of foundations and soils is of great importance in developing earthquake resistant design of foundation systems.

In this course, dynamic soil structure interaction, retaining structures, mat and pile foundations, liquefaction of soils, earth dam stability, and selection of design soil parameters will be covered. Emphasis will be placed on behaviour and design of structures. Workshop sessions will be devoted to problem solving both with the computer and by manual methods.

State-of-the-art information on the behaviour and analysis of foundations under dynamic loads will be presented.

Elementary knowledge of soil and/or structural dynamics is desirable.

"SOIL DYNAMICS" by Shamsher Prakash, published by McGraw-Hill Book Company, New York, 1981, will be furnished to course participants. The text will be supplemented by detailed lecture notes. Details are available from:

Shamsher Prakash
Course Director
Third Short Course on Soil Dynamics and Foundation Engineering
308 Civil Engineering
Rolla. MO 65401 USA

PROGRAMME OF MEETINGS 1988

Wednesday 21 September at ICE at 5.30 p.m.	Vibration Experiences introduced by Professor Crockett
Wednesday 26 October at University of Bristol at 2.00 p.m.	Half-day meeting on Base Isolation
Wednesday 23 November At Imperial College London at 5.30 p.m.	Vibration of Bridge Beams introduced by Dr G Tilley

VENUE FOR MEETINGS

As accommodation may not be available at the Institution of Civil Engineers due to refurbishment members are requested always to check the venue of meetings. Some of the London meetings will take place in the Department of Civil Engineering at Imperial College and some meetings will be held outside London.

COPY DATES

The Newsletter is dated January, April, July and October. News items are welcome at any time. The latest date for inclusion in a particular Newsletter is the end of the month preceding the month of issue.