REPORT ON THE 4th WORLD CONFERENCE ON EARTHQUAKE ENGINEERING

* R. Shepherd*

Three hundred and eighty participants from 29 countries attended the 4 W.C.E.E. held in Santiago, Chile between January 13th and 18th, 1969. One hundred and twenty Chileans registered; the next largest delegations being of ninety-one from the U.S.A. and forty from Japan.

New Zealand had five representatives, G. Cooper and C. M. Strachan from Wellington, R. Shepherd and W. R. Walpole from Christchurch and J. Healy, N.Z. Government Vulcanologist at present working on a geothermal project in northern Chile. Of the three hundred and sixty papers offered, one hundred and fifty were accepted for presentation at the conference; the first four New Zealand representatives listed above each introduced one paper.

Mr C. W. O. Turner of Wellington, Vice-President of the International Association for Earthquake Engineering had the misfortune to experience a motor accident shortly before his planned departure for Chile and consequently was compelled to cancel his arrangements to attend the conference.

Feature sessions included reports of recent major earthquakes particularly those occurring in 1967 at Adapazari in Turkey and Caracas in Venezuela. Unfortunately no arrangements had been made to report on the Inangahua earthquake.

There were twelve technical sessions arranged under the following headings: Seismicity and Simulated Earthquakes, Vibration Tests of Structures, Ground Motion and Instruments, Behaviour of Structural Elements, Elastic Response of Structures, Large Buildings and Structural Details, Inelastic Seismic Response, Design of other Structures, Soils and Soil Structures, Foundations and Soil Structure Interaction, Design Criteria and Research, and Small Buildings Criteria and Research.

* Reader in Civil Engineering,
University of Canterbury, Christchurch.

As in previous conferences, a large proportion of the papers dealt with the seismic behaviour of structures or structural components although on this occasion a significant number of papers considered special structures, such as dams, and papers on underground pipe lines, suspension bridges and nuclear power plants were presented.

It was evident that since the last world conference significant progress has been made in the inelastic seismic response prediction field but the group of papers dealing with soil-structure interaction was somewhat disappointing.

On this occasion a group of papers centered attention on the seismic probability and risk problem but little new was offered on the subjects of earthquake measurement techniques and seismic loading simulation methods. The particular problems of pre-stressed concrete and masonry earthquake resistant design received regrettably sparse attention.

It is anticipated that the four volumes of conference proceedings, complete with discussions, will be available later this year from the 4WCEE Technical Secretary, P.O. Box 2777, Santiago, Chile, with whom orders should be placed. (A list of papers presented at the Conference follows this report.)

The following Officers and Directors were elected for the next four years:-

President:	G. W. Housner, U.S.A.
Executive Vice-President:	R. Flores, Chile.
Secretary-General:	J. K. Minami, Japan.
Directors:	O. A. Glogau, New Zealand.
	N. N. Ambraseys, Great Britain.
	A. Arias, Chile.
	F. J. Borges, Portugal.
	L. E. Esteva, Mexico.
	J. Krishna, India.
	S. Okamoto, Japan.
	S. Poliakov, U.S.S.R.
	K. Steinbrugge, U.S.A.

Invitations to hold the next conference in 1973 were received from Italy, India and Turkey, but the actual venue will be decided by postal ballot of the Directors.

In his closing address Professor Housner drew attention to the increasing importance of Earthquake Engineering arising from the increase in the world's population. He stressed the need to provide optimum economic protection by means of seismic design and

emphasised that, consistent with the expectation that some damage will be sustained in severe earthquakes, we need to know more about the behaviour beyond the elastic limit; specifically how close to collapse a structure moves as well as how far it is from yield when in the damage zone.

Attendance at the 4 W.C.E.E. proved to be both stimulating and rewarding. It provided an ideal opportunity to exchange information on recent progress and unsolved problems. The Proceedings will contain reference material of value to all those engaged in earthquake engineering activity.

SESSION A 1.

TITLE	AUTHOR(S)
Engineering Estimates of Ground Shaking and Maximum Earthquake Magnitude.	G.W. Housner
Seismic Risk Studies in the United States.	S.T. Algermissen
Earthquake and Reservoir Loadings.	J.P. Rothe
Statistical Inference of the Future Earthquake Ground Motion.	Hisao Goto Hiroyuki Kameda
Earthquake Probability	W.G. Milne A.G. Davenport
The Major Influences on Seismic Risk	Allin Cornell Erik H. Vanmarcke
A Physically Based Model to Simulate Strong Earthquake Record on Firm Grounds	Octavio Rascon C. Allin Cornell
Significance of Nonstationarity of Earthquake Motions.	M. Amin H.T. Ts'Ao A.H.S. Ang
Nondeterministic Analysis of Nonlinear Structures Subjected to Earthquake Excitations.	Jose Penzien Shi-Chi Liu
Structural Responses to Nonstationary Random Excitation.	Hisao Goto Kenzo Toki
Simulated Earthquake Motions for Design Purposes.	P.C. Jennings G.W. Housner N.C. Tsai
An Earthquake Map of Chile.	Cinna Lomnitz
Seismicity Prediction: A Bayesian Approach.	L. Esteva
Response of Linear Systems to Certain Transient Disturbances.	Emilio Rosenblueth Jorge Elourdy

SESSION A 2.

TITLE	AUTHOR(S)
Analysis of Strong-Motion Accelerograph Records.	D.E. Hudson N.C. Nigam M.D. Trifunac
On the Earthquake Motions for Aseismic Designing.	Kiyoshi Kanai
Characteristics of Earthquake Motion at the Rocky Ground.	C. Tamura T. Mizukoski T. Ono
Seismic Observation of Rigid Structure on Various Soils and Its Review.	Kinji Akino Tokiharu Ota Hiroshi Yamara
Influence of Geometry and Material Properties on the Seismic Response of Soil Deposits.	I.M. Idriss H. Bolton Seed H. Dezfulian
Experimental Study on the Vibrational Characteristics of Ground.	S. Yoshikawa M. Shima R. Irikura
Control of Train Operation on the New Tokaido Line on the Occasion of Earthquake.	Japanese Nat:Railway Dr. Tatsuo Nishiki Koichi Tamura Masao Nonogaki
Field Investigation of the Influence of Site Conditions on Ground and Structural Response.	S. Cherry
The Intensity of Ground Motion of the Skopje 1963 Earthquake.	Apostol Poceski
Strong Motion Records and Acceleration.	William K. Cloud Virgilio Perez
Studies on the Spectra of Ground Vibrations Caused by Nearby Earthquakes.	V.V. Shteinberg
Scale of Seismic Intensity.	S.V. Medvedev
Maximum Intensity of Ground Movements Caused by Faulting.	N.N. Ambraseys

SESSION A 3.

TITLE	AUTHOR(S)
Dynamic Analysis of Tall Buildings Founded in Deep Fill Materials.	H. Sexton R.J. Feibusch E.J. Keith
Brick Masonry Effect in Vibrations of Frames.	Simon Lamar Celso Fortoul
Dynamic Elastic Analysis in the Design of Typical New Zealand High-Rise Buildings.	R. Shepherd
Structural Dynamics of Cantilever-Type Buildings	John A. Blume
Torsion in Symmetrical Buildings	Nathan M. Newmark
A Study on the Earthquake Response of Space Structures by Digital Computers.	Kazuhiko Takeyama
Response Analysis of Framed Structures.	Y. Ohchi
Spectrum Techniques for Tall Buildings.	Paul C. Jennings
Earthquake Response of Irregularly Shaped Buildings.	Joseph Penzien
Earthquake Analysis of Suspension Bridges.	S.S. Tezcan S. Cherry
Estimating Natural Frequencies and Modes of Arch Dams with the Theory of Plates on Elastic Foundation.	Rudolph Szilard
Time-History Response of Buildings with Unusual Configurations.	John A. Blume Dilip Jhaveri
Dynamic Earthquake Behaviour of Shell Roofs.	R.W. Clough A.J. Carr.

SESSION A 4.

TITLE	AUTHOR(S)
Factors Influencing the Inelastic Response of Multi-Story Frames Subjected to Strong Motion Earthquakes.	B.P. Guru A.C. Heidebrecht
The Effect of Minimum Cross Bracing on the Inelastic Response of Multi-Story Buildings.	Robert D. Hanson William F.B. Fan
The Effect of Gravity on the Collapse of Yielding Structures with Earthquake Excitation.	Raul Husid
The Distributed Element Concept of Hysteretic Modeling and Its Application to Transient Problems.	W.D. Iwan
The Ultimate Strength of the Steel Structures Subjected to Earthquake.	Ben Kato Hiroshi Akiyama
Torsional Problems in Aseismic Design of High-Rise Buildings.	Tadaki Koh Hiromoto Takase Tsunehisa Tsugawa
Elastic and Inelastic Response of Framed Structures During Earthquakes.	N.C. Nigam G.W. Housner
Non-Linear Response Analysis of Multi-Story Structures Including Rocking and Swaying Subjected to Earthquake Ground Motions.	T. Odaka T. Suzuki K. Kinoshita
Torsional Response of Building to Strong Earthquake Motions.	Akenori Shibata Junichi Onose Toshio Shiga
The Nonlinear Response of a Multi-Story Pre-stressed Concrete Structure to Earthquake Excitation.	R.A. Spencer
Maximum Deformations of Certain Nonlinear Systems.	A.S. Veletsos
Response Spectra for Elastic and Elastoplastic Systems Subjected to Earthquakes for Short Duration.	Apostol Poceski
To The Final State of Rectangular Frames.	Ryo Tanabashi Yiyoshi Kaneta Tsuneyoshi Nakamura Shunzo Ishida
The Inelastic Response of a Steel Frame.	W.R. Walpole R. Shepherd

SESSION A 5.

TITLE	AUTHOR(S)
Pore-Water Pressures in Earth Slopes Under Seismic Loading Conditions.	H. Bolton Seed Kenneth L. Lee
Vibratory Compaction of the Soil and Tectonic Subsidence During the 1960 Earthquake in Valdiva, Chile.	Eugenio Retamal Edgar Kausel
Densification of Sand by Vertical Vibrations.	Robert V. Whitman Pedro Ortigosa de Pablo.
Techniques for Field Measurements of Shear Wave Velocity in Soils.	C. Martin Duke
Earthquake Analysis of Earth Dams.	A.K. Chopra M. Dibaj R.W. Clough J. Penzien H.B. Seed
Mechanism of Earthquake Damage to Embankments and Slopes.	Yashimasa Kobayashi Jap.National Railways.
A Study of Earth Dam Models Under Shock Loading..	Jai Krishna Shamshar Prakash S.K. Thakkar
On Vibration Characteristics of Fill Dams in Earthquakes.	Isao Minami
Seismic Analysis of Earth Dams.	Hatano T. H. Watanabe
Earth Pressure Distribution Behind Retaining Wall During Earthquake.	Shamshar Prakash B.M. Basavanna
Vibrations of Earth Dams During Earthquakes.	I.M. Lavrov G.A. Lyamzina S.V. Medvedev

SESSION A 6.

TITLE	AUTHOR(S)
Vibration Test of a Structure Supported by Pile Foundation.	K. Kubo
Effect of Size and Shape of Foundation on Elastic Coefficients in a Layered Soil Mass.	Shamshe Prakash B.M. Basavanna
Some Special Problems in the Design of Deep Foundations.	S.B. Barnes
Dam Foundation Interaction During Earthquakes.	Anil K. Chopra P.R. Perumalswam
Dynamic Analysis of a Structure Embedded in an Elastic Stratum.	Hirishi Tajimi
Some Effects of Substructure and Adjacent Soil Interaction on the Seismic Response of Building.	J. Kazuo Minami Joji Sakural
A Method of Analysis for the Evaluation of Foundation Structure Interaction.	Edward L. Wilson
Soil Structure Interaction of the Elevated Tower and of Concrete Footings.	H. Kishida K. Matsushita I. Sakamoto
On Earthquake Response of Elasto Plastic Structure Considering Ground Characteristics.	R. Minami T. Koborl Y. Inone
Equivalent Lumped System for Structure Founded Upon Stratum of Soil.	Robert V. Whitman
Elastic Soil Structure Interaction.	J. Khanna
Conventional Foundations and their Earthquake Problems.	William T. Wheele
Oscillations of Tower Like Structures with Account of Inertia and Elasticity of Solid Medium.	B.G. Korenev V.A. Illjichjov L.M. Reznikov

SESSION B 1.

TITLE	AUTHOR(S)
Earthquake Measurements in and Around a Reinforced Concrete Building.	Y. Osawa T. Tanaka M. Murakami Y. Kitagawa
Study on the Large Scale Displacement Vibration Tests for the 1/25 Scale of the 17 Storied Building J.N.R.	Chikaaki Ueda
Vibration Tests and Test to Failure of a 7 Stories Building Survived a Severe Earthquake.	Issao Funahashi Katsuhiro Kinoshita Hiroyuki Aoyama
Observed Earthquake Responses of Bridges.	Elichi Kuribatasi Toshi Iwasaki
Vibration Studies of an Arch Dam.	Tadahsi Takahashi
Periods of Buildings of Mendoza City.	Juan S. Carmona Jose Herrera Cano
A Method of Dynamic Model Test of Arch Dam.	Shunzo Okamoto Katsuyuki Kato
Use of Resonance Method in Mechanical Modeling of Seismic Effects on Structure	Sh.G. Napatvaridze P.A. Gutidze
Summarized Report of Dynamic Tests of High-Rised Buildings and Co-operative Plan for Large Scale Vibration Test in Japan.	The Group for Dynamic Tests of High-Rised Buildings
Dynamic Response of a 90ft Steel Frame Tower.	N.N. Nielsen
Resonance Testing of Multi-storey Infilled Frames.	D.V. Mallick Ph.D.
Experimental Results of the Dynamic Deformation of Multi-Storey Buildings.	H. Sandl G. Serbanexcu
Investigations into Earthquake Resistance of Large Panel Buildings.	S.V. Polyakov B.E. Denisov T. ZH. Zhunusov V.I. Konovodchenko A.V. Cherkashin

SESSION B 2.

TITLE	AUTHOR(S)
A Research Program on the Earthquake Resistance of Shear Wall Buildings.	A.C. Heidebrecht W.K. Tso
A Vibration Test of Large Model Steel Frame with Precast Concrete Panel until Failure	R. Tamura M. Murakami Y. Osawa N. Tanaka
Low Cycle Fatigue Under Multi-Axial Stress Conditions.	Koji Mizuhata
On the Aseismicity of Precast Curtain Wall	Seiji Watanabe Shozaburo Shimaguchi
Damping Capacity of a Model Steel Structure.	D. Rea R.W. Clough J.G. Bouwkamp U. Vogel
The Coupling of Reinforced Concrete Shear Walls.	Thomas Paulay
Evaluation of Inelastic Seismic Deflections of Reinforced Concrete Frames Based on the Tests of Members.	Hajime Umemura Hiroyuki Aoyama
Seismic Behaviour of Reinforced Concrete Frame Structures.	Vitelmo Bertero Boris Bresler
Repeated and Reversed Load Tests on Full-Scale Steel Frames.	Lauren Carpenter Le-Wu Lu
Low Cycle Fatigue Fracture Limits of Various Kinds of Structural Members Subjected to Alternately Repeated Plastic Bending Under Axial Compression as an Evaluation Basis or Design Criteria for Aseismic Capacity.	Minouri Yamada
Research on Behaviour of Reinforced Concrete Constructions Under the Effect of Seismic Load.	G.N. Kartsivadze L.N. Avalishvill
The Experimental Study on the Dynamic Behaviour of Reinforced Concrete Frames.	Toshio Shiga Jungi Ogawa
An Experimental Study on the Horizontal Restoring Forces in Steel Frames Under Large Vertical Loads.	M. Wakabayashi T. Nonaka Ch. Matsui

SESSION 2 CONT'D

TITLE	AUTHOR(S)
Bearing Capacity of Building Materials Under Dynamic Repeated Loading.	S.V. Polyakov H.V. Becheneva Ju.I. Kotov T.V. Potapova

SESSION B 3.

TITLE	AUTHOR(S)
Research on the Behaviour of Steel Beam to Column Connections in the Seismic-Resistant Structure.	Takeo Naka Ben Kato Makoto Watabe Masami Nakao
Reliability of Steel Beam to Column Connections Under Cyclic Loading.	E.P. Popov R.B. Pinkney
Seismic Behaviour of Steel Beam to Column Connected Subassemblages.	Vitelmo Bertero
Variability Analysis of Shear Wall Structures.	Jack R. Benjamin
An Approximate Method of Static and Dynamic Analysis of Core-Wall Buildings.	Sukenobu Tani Joji Sakurai Michio Iguchi
Design of Beam Column Joints for Seismic Resistant Reinforced Concrete Frames.	W. Gene Corley Norman W. Hanson
Seismic Moment Resisting Girder Connecting to Diagonally Aligned Columns.	Sadaichi Terada Akira Tsuruta
Antiseismic Design of Multi-Story Steel Frames by Plastic Methods.	Oscar de Buen
The Use of Steel to B.S.968:1962 in the All-Welded Frame of a 19 Storey Building.	G. Cooper
Studies on Mechanisms to Decrease Earthquake Forces Applied to Buildings.	Kiyoo Matsushita Masanori Izumi
Study of the Behaviour of a Hanging Building Under the Effect of an Earthquake.	Carlos Jose Oto Larios and others
Absorber System for Earthquake Excitations.	Y.P. Gupta A.R. Chandrasekaran

SESSION B 4.

TITLE	AUTHOR(S)
Earthquake Analysis of Reservoir Dam Systems.	Anil K. Chopra E.L. Wilson I. Farhoomand
Study on the Earthquake Proof Design of Elevated Water Tanks.	Y. Sonobe T. Nishikawa
Hydrodynamic Pressures Generated by Vertical Earthquake Component.	A. Victoria Flores L. Herrera C. Lozano
Seismic Design Criteria for Nuclear Reactor Facilities.	Nathan M. Newmark William J. Hall
Water Dam Seismic Interaction.	H. Sandi
Selection of Design Earthquakes for Nuclear Power Plants.	Joseph A. Fischer William J. Murphy
Hydrodynamic Pressures on Arch Dams During Earthquakes.	Bhaskar Nath B.Tech. Ph.D.
Dynamic Stresses of Underground Pipe Lines During Earthquakes.	Akio Sakurai Tadashi Takahashi
Studies on the Earthquake Resistant Design of Suspension Bridge Tower and Pier System.	Ichiro Konishi Yoshikazu Yamada
Some Long Span Construction in Earthquake Regions and Choice of the Structure on the Basis of Wave Dynamic Theory.	V.A. Bykhovsky F.V. Bobrov E.S. Medvedeva
The Effect of Seismic Action on the Dynamic Behaviour of Elevated Water Tanks.	Mihail Ifrim Christian Bratu
Study of Earthquake Resistance of Boilers and Recommendations for their Design.	Pavlyk. V.S.
Dynamics of Extended-in-Plan Structures in Strong Earthquakes.	M.F. Barstein
Earthquake Response Analysis and Aseismic Design of Cylindrical Tanks.	S. Moran Garcia

SESSION B 5.

TITLE	AUTHOR(S)
Seismic Forces and Overturning Moments in Buildings, Towers and Chimneys.	Steven J. Fenves Nathan M. Newmark
Seismic Design of Traditional and Pre-fabricated Reinforced Concrete Buildings.	J. Ferry Barges Artur Ravara
Factors to be Considered in Calculating the Input Earthquake Force to Buildings.	K. Matsushita M. Izumi Kuang-Jui Hsu I. Sakamoto
Comments on the New Chilean Seismic Code for Buildings.	A. Arias R. Husid J. Monge
Criteria for Earthquake Resistance Codes based on Energy Concept Draft Design Code.	Cismigiu. Al. Titaru. Em. Velkov. M.
Large Size Structures Testing Laboratory and Lateral Loading Test of a Five Storeyed Full Size Building Structure.	Toshihiko Hisada representing Joint Committee on Housing Structures.
Earthquake Simulation by Shake Table.	Enzo Lauletta Aldo Castoldi
Design and Research Potential of Two Earthquake Simulator Facilities.	J.B. Bouwkamp R.W. Clough J. Penzien D. Rea
Earthquake Engineering Research in the United States.	N. Norby Nielsen William H. Walker
University of Chile-University of California Program in Earthquake Engineering.	Martin Duke Augusto Leon R.
A Probabilistic Model for Seismic Force Design.	Jack R. Benjamin
The University of Illinois Earthquake Simulator.	M.A. Sozen S. Otani P. Gulkan N.N. Nielsen
The Problems of the Reliability and Optimality of the Earthquake Proof Structures.	I.I. Goldenblat N.A. Nicolaenko J.N. Elsenberg A.M. Zharov

SESSION B 6.

TITLE	AUTHOR(S)
Seismic Behaviour and Design of Small Buildings in Chile.	Joaquin Monge
Strengthening of Brick Buildings in Seismic Zones.	Jao Krishna Brijesh Chandra
Seismic Classification System for Old Buildings in New Zealand.	C.M. Strachan
Repairs on Power House and Boilers Support Structure Damaged by 1965 Earthquake. Ventanas 115 MW Steam Electric Station (Chile)	Santiago Arias Victor Arze Jaime Bauza
On One Method of Increasing the Seismic Stability of Brick Buildings.	A.I. Churayan Sh.A. Djabua
Restoration of Stone Buildings after Earthquake	Rasskazovsky V.T. Abdurashidov K.S.
Earthquake Engineering as an Aid to Insurability.	Frank Alberti
Seismic Failure and Repair of an Elevated Water Tank.	Elias Arze

SPECIAL PAPERS

This Session was devoted to the special papers prepared by:

RODRIGO FLORES

KIYOSHI MUTO

HENRY J. DEGENKOLB

SESSION J 2.

TITLE	AUTHOR(S)
Observation of Damages of Industrial Firms in Niigata Earthquake.	Heki Shibata Sumiji Fujii etc.
Macroseismic Observations From Some Recent Earthquakes.	N.N. Ambraseys
Structural Engineering Aspects of the 1967 Adapazari Turkey Earthquake.	Rifat Yarar Semih S. Tezcan
The Koyna, India, Earthquake.	G.V. Berg Y.C. Das K.V.G.K. Gokhale A.V. Setlur
Lessons From Some Recent Earthquakes in Latin America.	Luis Esteva Octavio A. Rascon Alberto Gutierrez
The Caracas Earthquake of July 29, 1967.	Venezuelean Official Seismic Commission
The July 29, 1967 Venezuela Earthquake Lessons for the Structural Engineer.	Henry J. Degenkolb Robert D. Hanson
Behaviour of Tall Buildings During the Caracas Earthquake of 1967.	J. Ferry Borges J. Grases A. Ravera
Damage Mechanisms and Design Lessons from Caracas.	R.I. Skinner
Implications on Seismic Structural Design of the Evaluation of Damage to the Sheraton-Macuto.	M.A. Sozen N.M. Newmark G.W. Housner
Caracas, Venezuela Earthquake of July 29, 1967.	Diego Ferrer F. Lloyd S. Cluff