

Leopold MULLER Distinction

French National group suggestion

Charles Fairhurst C Senior Consultant, rock mechanics, mining & civil engineering. Dr. Fairhurst, who recently retired from the University of Minnesota, has more than 45 years of experience in mining rock mechanics and has consulted on rock stability problems for tunnels, dams, mines, and excavations throughout the world. He served as President of the International Society of Rock Mechanics from 1991 through 1995 and has been elected to the U.S. National Academy of Engineers and the Royal Swedish Academy of Engineering Sciences.

Charles FAIRHURST - Génie minier et mécanique des roches appliquée. Mr Fairhurst possède plus de 45 ans d'expérience de la mécanique des roches appliquée à la mine et a fourni des services de consultant sur des problèmes de stabilité de roches pour des tunnels, des barrages, des mines et des excavations dans le monde entier. Professeur à l'Université de Minnesota, il a été président de la Société Internationale de Mécanique des Roches de 1991 à 1995.

CHARLES FAIRHURST

EDUCATION

B.Eng. (Mining Engineering, with First - Class Honours), 1952
Sheffield University, England

Ph.D. (Mining Engineering), 1955
Sheffield University, England

EXPERTISE

Rock Mechanics
Mining Engineering

PROFESSIONAL EXPERIENCE

- 1997 - Present Senior Engineer and Chairman, Itasca Consulting Group, Inc., Minneapolis, Minnesota
- 1995 - Present Chairman, Peer Review to Atomic Energy of Canada Limited (AECL), on the Tunnel Sealing Experiment at the Underground Research Laboratory, Pinawa, Canada
- 1995 - Present Chairman, International Geomechanical Commission, invited by the French Government to study the effects of underground nuclear tests in French Polynesia on the stability and hydrology of the atolls Mururoa and Fangataufa
- 1993 - Present Chairman, Working Group 4, Geosphere Modelling, for IAEA, Vienna, to study radionuclide releases from French nuclear tests in the Pacific
- 1993 - Present Member, Conseil Scientifique (Scientific Advisory Board), Laboratoire Mixte CNRS/LCPC, Marne La Vallée, France, on the Application of Mathematics and Physics to Civil Engineering
- 1993 - Present Member, Conseil Scientifique (Scientific Advisory Board), ANDRA (French Radioactive Waste Agency), France
- 1993 - 1995 Member, Committee on Technical Bases for Yucca Mountain Standards U.S. National Academy of Sciences

PROFESSIONAL EXPERIENCE (continued)

- 1992 - Present Member, Conseil Scientifique de G.3S (Scientific Advisory Board), Groupement pour l'Etude des Structures Souterraines de Stockage (Underground Waste Storage Group), Ecole Polytechnique, Palaiseau, France
- 1991 - 1997 T. W. Bennett Professor of Mining Engineering & Rock Mechanics University of Minnesota
- 1989 - 1995 Vice Chairman, Board on Radioactive Waste Management (BRWM) U.S. National Academy of Sciences
- 1989 - 1997 Chairman, WIPP (Waste Isolation Pilot Project) Committee, Board of Radioactive Waste Management (BRWM) [Completed June 1997]
- 1988 Chairman, Second International Symposium on Rockbursts & Seismicity in Mines, University of Minnesota
- 1987 - 1992 Member, Rauma Co. (Finland), Scientific Advisory Group
- 1986 - Present Senior Editor, *Tunnelling and Underground Space Technology*
- 1985 - 1989 Member, Waste Isolation Pilot Project (WIPP) Advisory Panel, National Academy of Sciences
- 1985 - 1986 Member, Conference Steering Committee, National Science Foundation Initiatives in the States Program
- 1984 - 1985 Member, NAK (Sweden) Advisory Board on the WP-Cave Radioactive Waste Isolation Concept
- 1983 - 1991 E. P. Pfleider Professor of Mining Engineering and Rock Mechanics, University of Minnesota
- 1983 Member, U.S. Environmental Protection Agency Advisory Subcommittee on Radioactive Waste Isolation
- 1983 Chairman, Engineering Review Group, Crystalline Rock Disposal Program, Office of Nuclear Waste Isolation, Battelle Laboratory, Columbus, Ohio
- 1983 Program Chairman, Subspace 83 Conference, Minneapolis
- 1982 Session Chairman, Subsurface 82, (U.N. Workshop on Utilization of Underground Space), Stockholm, Sweden
- 1982 - 1984 Chairman, National Science Foundation Advisory Sub-Committee on Civil and Environmental Engineering

PROFESSIONAL EXPERIENCE (continued)

- 1982 - 1985 Member, Engineering Advisory Board, National Science Foundation
- 1981 Program Chairman, Underground Space Conference and Exposition American Underground Space Association, Kansas City
- 1980 Session Chairman, Sub-Surface Space Symposium, Sweden**
- 1978 - 1980 Member, National Science Foundation Review Panel, Division of Applied Research
- 1978 - 1980 Chairman, Committee on Rock Mechanics, American Society of Civil Engineers
- 1978 - 1979 Member, National Science Foundation Review Panel, Division of Policy and Analysis
- 1978 Member, Office of Science and Technology Policy Panel on U.S. Radioactive Waste Management Program
- Member, National Academy of Sciences/National Research Council Panel on Savannah River (Nuclear) Plant
- 1977 - 1978 Member, National Science Foundation, U.S. Centrifuge Facility Selection Panel
- 1977 - 1978 Member, National Academy of Sciences/National Research Council Panel on Implementation Requirements of Environmental Standards
- 1977 Member, U.S. Delegation to the Soviet Union (NSF/AIME)
- 1976 - 1977 President, American Underground Space Association
- 1976 - 1986 Senior Editor, *Underground Space*, published by Pergamon Press, Oxford
- 1976 Member, National Science Foundation Advisory Panel on Engineering Mechanics
- 1975 - 1978 Member, National Academy of Sciences Board on Mineral and Energy Resources
- 1975 Chairman, National Science Foundation Workshop on Research Opportunities in Mining
- 1974 - 1975 Chairman, Underground Construction Research Council, American Society of Civil Engineers/American Institute of Mining Engineers

PROFESSIONAL EXPERIENCE (continued)

- 1974 Program Chairman, 3rd International Congress on Rock Mechanics (Denver)
- 1974 Member, Commission on Research, International Congress on Rock Mechanics (Denver)
- 1973 - 1974 Chairman, National Academy of Science/National Research Council Committee on Feasibility of Returning Coal Mine Wastes to Underground
- 1973 - 1977 Member, U.S. Geological Survey Advisory Panel on Earthquake Research
- 1973 Member, Commission on Publications, International Society of Rock Mechanics
- 1972 - 1987 Head, Department of Civil & Mineral Engineering, University of Minnesota
- 1972 - 1974 Chairman, U.S. National Committee on Rock Mechanics, National Academy of Sciences
- 1971 Member, AEC (Oak Ridge National Laboratory) Advisory Panel on Radioactive Waste Disposal in Lyons Salt Mine, Kansas
- Member, National Academy of Sciences / National Research Council Advisory Panel on "Bedrock Disposal" (Underground Disposal of Radioactive Wastes)
- 1969 - 1973 Chairman, American Institute of Mining Engineers (AIME) Committee on Rock Mechanics
- 1969 Member, National Academy of Sciences / National Research Council Committee on Rock Mechanics
- 1966 - 1969 Member, American Society for Testing and Materials (ASTM), Subcommittee on Rock Mechanics
- 1965 - 1966 Publications Chairman, Rock Mechanics Section, *AIME (SME) Transactions*
- 1963 - 1970 Corresponding Member, International Buro of Rock Mechanics (Berlin)
- 1962 - 1966 Director (one of two from U.S.), International Society of Rock Mechanics (Salzburg)

PROFESSIONAL EXPERIENCE (continued)

- 1956 - 1964 Co-Chairman, Annual Symposia on Drilling and Blasting Rock Mechanics
- 1948 - 1956 Mining Engineer, National Coal Board, England

PROJECT EXPERIENCE
(Itasca Consulting Group, 1981 - Present)

Charbonnages de France — Consultant on coal bumps in the mines of Lorraine and Provence (1992 - Present)

Spie Batignolles (France) — Member, Board of Experts, Guavio Hydroelectric Project (Colombia) (1985 - 1989)

Potash Mine Design, Mines Dominiale de Potasse d'Alsace, Thailand (1981 - 1983)

Official Critic of Swedish Radioactive Waste Disposal Program, Ministry of Defense, Sweden (1978)

Geotechnical Advising, Lawrence-Berkeley Laboratories, Berkeley (1978)

U.S. Army Corps of Engineers, R. D. Bailey Dam (1977 - 1981)

Potash Mine Design, Petrobras Mineracao Corporation, Brazil (1975 - 1989)

Hydraulic Fracturing, Geothermal Energy, and Rock Blasting Studies, Los Alamos Scientific Laboratory, Los Alamos, New Mexico (1975 - 1981)

Lunar Drilling and Rock Blasting Programs, Martin Marietta Corporation (1973 - 1975)

U.S. Army Corps of Engineers, Niagara Falls Preservation Project (1968 - 1974)

Rock Drilling Research [at various times for Holman Brothers (Cornwall, England), Atlas Copco AB (Stockholm, Sweden), Tamrock (Tampere, Finland), HDRK Inc. Canada)]; Tunnel Lining Problems (at various times for Al Johnson Construction Company)

PROFESSIONAL AFFILIATIONS AND AWARDS

American Institute of Mining Engineers (AIME)

American Society of Civil Engineers (ASCE)

American Underground Construction Association (AUA)

International Society of Rock Mechanics

Sigma XI

U.S. National Committee on Rock Mechanics

Honorary Doctorate, University of Sheffield, England, 1997

Honorary Doctorate, National Institute of Lorraine (INPL), France, 1996

Honorary Doctorate, St. Petersburg Mining Academy and Technical University, Russia, 1996

Professor Emeritus, University of Minnesota, (from 1997)

President, American Rock Mechanics Association (1995 - 1997)

Advisory Professor, Tongji University, Shanghai, China, 1995

President, International Society of Rock Mechanics (1991 - 1995)

Member, U.S. National Academy of Engineering, (from 1991)

Theodore W. Bennett Professor of Mining Engineering and Rock Mechanics (1991 - 1997)

E. P. Pfeleider Professor of Mining Engineering and Rock Mechanics (1983 - 1991)

U.S. National Committee on Rock Mechanics Special Award

for "25 Years of Distinguished Achievements," 1983

Distinguished Professor of Mining Engineering and Rock Mechanics, University of Minnesota,
1982

Pergamon Medal, American Underground Space Association, 1981

Foreign Member, Royal Swedish Academy of Engineering Sciences, (from 1979)

AIME Outstanding Achievement Award in Rock Mechanics, 1972

Inter-Society Committee on Rock Mechanics Medal for Best Mechanics Research Paper

Published in 1970 (with B. Haimson)

SELECTED RECENT PUBLICATIONS

«A General Stability Criterion for Tunnels in Soft and Hard Ground» (with C. Carranza-Torres), in *Proceedings of the World Tunnel Congress (Austria, April 1997)*, pp. 29-35. J. Golser et al., Eds. Rotterdam: A.A. Balkema, 1997.

«Insights on the Stability of Large Excavations from Analytical and Numerical Models» (with C. Carranza-Torres and L. Lorig), *Felsbau*, **15**(1), 45-63 (1997).

«On the Stability of Tunnels Under Gravity Loading with Post-Peak Softening of the Ground» (with C. Carranza-Torres), *Int. J. Rock Mech. & Min. Sci.*, **34**(3-4), Paper No. 054 (1997).

«Análisis de Estabilidad de una Falla Geológica con el Método de las Discontinuidades de los Desplazamientos (Analysis of the Stability of a Geological Fault Using the Displacement Discontinuity Method)» (with C. Carranza-Torres), *Actas de la Asociación de Geología Aplicada a la Ingeniería*, **X**, 73-81 (1996).

«A Model For the Time-Dependent Behavior of Rock» (with A. A. Fakhimi), *Int. J. Rock Mech. Min. Sci. & Geomech. Abstr.*, **31**(2), 117-126 (1994).

«Analysis and Design in Rock Mechanics — The General Context,» in *Comprehensive Rock Engineering*, Vol. 2, pp. 1-29. J. A. Hudson, Editor-in-Chief. Oxford: Pergamon Press Ltd., 1993.

«Evolving Towards 'Mechanics Based' Design Procedures in Geomechanics (Abstract),» in *Proceedings of the 1992 Rock Engineering Symposium in Taiwan (Tainan, Republic of China, December 1992)*, p. 1. S.-T. Chen et al., Eds. Tainan, Taiwan: National Cheng Kung University, 1992.

C. Fairhurst. «Three-Dimensional Discontinuum Modeling for Underground Excavations» (with L. Lorig), in *Proceedings of the 1992 Rock Engineering Symposium in Taiwan (Tainan, Republic of China, December 1992)*, pp. 349-358. S.-T. Chen et al., Eds. Tainan, Taiwan: National Cheng Kung University, 1992.

«Design of Excavations in High Rock-Stress Conditions,» in *Rockbursts and Seismicity in Mines*, pp. 421-423. Rotterdam: A. A. Balkema, 1990.

«Micro-Computer Modelling and Practical Design/Monitoring of Large Underground Excavations,» in *Static and Dynamic Considerations in Rock Engineering*, pp. 113-124. Rotterdam: A. A. Balkema, 1990.

«Verification and Validation of Coupled Mechanical/Water Flow Effects in Rock Masses: Some Possibilities and Limitations» (with R. D. Hart), in *GEOVAL-87 (Stockholm, April 1987)*, pp. 527-545. Stockholm: SKI, 1987.

SELECTED RECENT PUBLICATIONS (continued)

«Comparison of Numerical Modeling with Predictions from Laboratory Tests and Field Observations of Deformation in a Potash Mine in Sergipe, Brazil» (with Alvaro Maia da Costa),

in *Research and Engineering Applications in Rock Masses*, pp. 269-278. Boston: A. A. Balkema, 1985.

«Correlation of Numerical and Physical Models — An Approach to the Estimation of Rock Mass Properties» (with P. A. Cundall), in *Proceedings of the 34th Geomechanics Colloquium (Salzburg, Austria, October 1985)*.

«Fuzzy Methodology in Tunnel Support Design» (with Dezhang Lin), in *Research and Engineering Applications in Rock Masses*, pp. 269-278. Boston: A. A. Balkema, 1985.

«Rock Mechanics of Underground Excavations, General Report» (with B.H.G. Brady), in *Proceedings of the 5th International Congress of Rock Mechanics (Melbourne, 1983)*.

«Generalization of the Ground Reaction Curve Concept» (with E. Detournay), in *Proceedings of the 23rd U.S. Symposium on Rock Mechanics (Berkeley, August 1982)*, pp. 924-934. Littleton, Colorado: American Institute of Mining Engineers, 1982.

«Rock Fracture and Fragmentation, General Report» (with F. Cornet), in *Rock Mechanics : From Research to Applications*, pp.21-46. Cambridge, Mass.: MIT, 1981.

«The Application of Mechanics to Rock Engineering (in French),» *Revue Française de Géotechnique (Paris)*, No. 1-45F TTC, 18-36 (July 1977).

Dr. Fairhurst has some 75 additional publications and has supervised 20 Ph.D. theses and over 20 M.S. theses.

Reports

Fairhurst, C. «Optimization of the Rock Cutting Action of the HDRK-Wirth Hard Rock Continuous Mining Machine (Final Report),» ICG, Report to HDRK Mining Research Ltd., Rev. 1, April 1994.

Fairhurst, C., and J. P. Tinucci. «Findings for Anglo American Corporation's Rockburst Mitigation Program Review,» ICG, Report to Anglo American, June 1992.

Asgian, M., M. Christianson and C. Fairhurst. «A Numerical Method for Predicting Fracture Crater Geometry for Simulation of Drill and Detach Excavation Methods,» ICG, Report to Tampella (Finland), March 1984.

Fairhurst, C. «Calculation of Time-Dependent Rock Swell In the Vicinity of the Nine Mile Point Unit 2 Reactor Excavation Over a 50 Year Period,» ICG, Report to Dames & Moore (New York), June 1982.