N. Dean Marachi P.E., Ph.D.

Biographical Data

Dr. Marachi has 34 years of broad professional and acadamic experience including research and development, professional engineering, project management, teaching, and expert witness testimony.

EDUCATION

Ph.D., Engineering; 1969
University of California, Berkeley

M.S., Geotechnical Engineering; 1966
University of California, Berkeley

B.S., Civil Engineering; 1965
Oregon State University, Corvallis

REGISTRATIONS

Civil Engineer. *Arizona, California, Oregon, Washington*

Geotechnical Engineer, *California*

Registered Environmental Assessor, *California*

PROFESSIONAL ORGANIZATIONS

U.S. Society of Dams (USSD)

International Society of Dams (Life Member)

Association of State Dam Safety Officials (ASDSO)

American Public Works Association (APWA)

American Society of Civil Engineers (ASCE)

Bay Area Water Works Association (BAWWA)

International Society of Soil Mechanics and Foundation Engineers (ISSMFE)

Society of American Military Engineers

EMPLOYMENT HISTORY

Consultant

4/2001 – Present

Harza Engineering Company

2/1999 – 4/2001
Senior Partner

The MARK Group, Inc.

6/1984 – 1/1999
Co-founder/President

Converse Consultants

9/1983 – 6/1984
Member of Board of Directors

2/1982 – 6/1984
V.P. and Manager of S.F. Office

3/1979 – 2/1982
V.P. and Manager of Engineering of San Francisco Office

Tehran-Berkeley Consulting Engineers

3/1974 – 12/1978
Co-founder, Managing Director and Chairman of the Board for the firm and subsidiaries, consisting of Nedeco Iran, Ltd., Wimpy Laboratories Iran, Ltd., Tehran-Berkeley/Sounding, Ltd., and Enertec-Energy Technology Consultant, Ltd.

Aryamehr University

1/1973 – 6/1974
Assoc. Professor of Engineering

Converse Davis & Associates

6/1971 – 12/1972
Assistant Chief Engineer

6/1970 – 6/1971
Senior Engineer

5/1969 – 6/1970
Project Engineer

UC – Berkeley

5/1966 – 5/1969
Research Assistant

Dean Marachi
Engineers and Planners

6680 Allhambra Ave., #429
Martinez, CA 94553

Tel 925.256.9850

Fax 925.979.1457

dean@marachi.com

PERSONAL

D.O.B.: 12/27/1941

CITIZENSHIP

U.S.A.

LANGUAGES

English and Parsi

TEACHING EXPERIENCE

Dam Engineering
Earthquake Engineering
Geotechnical Engineering
Groundwater/Seepage
Special seminars on:

- Contaminant Transport
- Environmental Aspects of Soils Engineering

Dams & Reservoirs

Arch Dams

Biographical Sketch

Educational Background

Dr. Marachi graduated from the most prominent high school in Tehran, Iran, ranking 7th highest amongst 310 students of the graduating class in 1960.

One week after graduation he came to the US. He received B.S. in civil engineering from Oregon State University in 1965. He was granted a tuition scholarship for much of the time he was at OSU. He took all of the geotechnical engineering courses that were offered at OSU as well as courses in geology. He also worked in the soil mechanics laboratory on a research project for USSC to classify all soils in Oregon, and ran complete sets of soil classification tests on nearly 50 different soil types. He also worked/researched for Professor Peterson on the behavior of dis-similar materials, e.g. reinforced wood, and developed a fundamental interest in learning interactive behavior of two dis-similar materials, the effects of boundary conditions, and what happens at the contact. This is a major topic in science and technology, e.g. paint industry, reinforced concrete, lined tun-

Matilija Dam

Ventura County Flood Control Department

Project Manager and principal investigator for seismic re-analysis of the 165 ft high arch dam. The dam was constructed in 1949 and was subsequently found that the concrete has a high alkali aggregate reactivity. Concrete sampling and strength tests were performed on various occasions and the dam stability had been evaluated previously by others. For this project an evaluation of time-dependent concrete strength and properties were made and it was concluded that the dam would meet seismic safety requirements until 2008.

In conjunction with this project Dr. Marachi developed "A Quick Method For Safety Reanalysis of Concrete Dams" which was adopted for publication in "The 2000 ASDSO annual Conference" proceedings.

Vail Dam

Rancho California Water District

Project Manager for vibration monitoring, dynamic amplification analyses, and evaluation of stability under blasting vibration required to lower side spillway to accommodate SDF. Subsequently performed seismic stability analysis as well as hydrologic inundation studies including dam break flood routing. These studies showed, to the satisfaction of DSOD requirements, that inundation area caused by PMF over pour is larger than a hypothetical dam break scenario under operating pool level.

Big Tujunga

Los Angeles Department of Public Works

Project Manager for safety reanalysis of the 240 ft high arch dam utilizing the newly published hydrological data as well as the ground motion parameters which are based on most recent attenuation relationships. The analyses utilized ADAP-NS finite element program which allows opening and closing of joints due to seismic loads, and ANSYS program to design the remedial work. This included the design of a buttress to strengthen the dam for the very severe level of required ground shaking, and training of the PMF overflow through the central portion of the dam-away from the abutment bedrock.

Arch Dams

Biographical Sketch (cont'd)

nels, concrete or steel pipelines through earth dams, etc.

He attended UC Berkeley in September of 1965 and received Masters of Science Degree nine months later, and continued his graduate studies and received his Ph.D. in May of 1969 (that's only 2 years and 8 months later). In this period he took all courses offered in geotechnical engineering, including:

- Soil mechanics
- Foundation Engineering
- Earth dams
- Seepage and groundwater
- Physico-chemical properties of clays
- Theoretical soil mechanics
- Soil dynamics
- Pavement design
- Field investigations and laboratory testing

For his two minors, as required for the Doctorate degree, he selected geological engineering and physics of the earth/seismology. For the geological engineering minor he took all courses that were offered. Course contents included:

- Air photo interpretation
- Geological mapping and structural analysis
- Geophysical investigations

Concow Dam

Thermalito Irrigation District

Lead investigator of the team of independent consultants to perform Part 12 safety inspections required by FERC of the 94-ft high variable radius arch dam. As the 1925 structure had just come under FERC jurisdiction, this was the first safety inspection report which indicated many of the recently required loading and stability analyses (i.e., PMF, Seismic, etc.) were not available. As required by FERC and approved by Client, a comprehensive safety analysis of the project was performed by the team which included 3-dimensional static and dynamic finite element analyses of the arch dam under PMF and MCE loadings. The detailed analyses indicated that the old structure meets the modern safety requirements of FERC.

Hosler Arch Dam

Department of Public Works
Ashland, Oregon

Project Manager for seismic safety analysis revaluation, inundation studies, recommendations of emergency warning system, and updating of the Emergency Management Plan. Seismic safety analysis included tectonic/seismicity studies and development of ground motion time history(ies) and response spectra for maximum credible earthquake (MCE), and 3-dimensional dynamic finite element analysis of the dam using spectra-method, mode-superposition method, and non-linear step-by-step integration method. Inundation studies included dam-break/flood routing analyses and preparation of inundation maps in accordance with recent (2000) FERC guidelines.

Hume Lake Dam

U.S. Forest Service

Project Manager for the safety review and analyses of 51-ft high multiple-variable radius arch dam built in 1908. The work included investigations and evaluation of the foundation bedrock and concrete properties, faulting and seismicity studies, development of ground motion time-histories, performance of static and dynamic 3-D finite-element analyses, and stability evaluations under seismic loads, and probable maximum flood (PMF) and over pour loads. The dam was found meeting all present day safety criteria.

Biographical Sketch (cont'd)

Rock mechanics (theoretical, applied, and field and laboratory testing)

Soil and rock tunneling

Rock block stability

For the seismology/physics of the earth minor, the courses he took covered the following:

Plate tectonics

Mountain building/Isostasy

Heat transfer/convection, conduction

Physiography / geomorphology

Wave propagation in solids, liquids, gases

Faulting

Seismicity

Additionally, he audited courses in structural dynamics, computer methods/ finite element method of analysis, and statistical thermal physics.

To support himself and his family he also worked as Research Assistant during his graduate studies. Some of the research work he undertook are as follows.

Research for Professor J. M. Duncan was mostly on properties of unsaturated soils, suction pressure in unsaturated soils and its effect on measured permeability, velocity of saturated front as a function of water content. He also

Dams & Reservoirs

Arch Dams

Milliken Dam

Milliken Dam

City of Napa Department of Public Works

Project Manager for DSOD required safety analyses of the 110-ft high single radius concrete arch dam, including tectonics/faulting and seismicity studies and development of ground motion time-histories, performance of static and dynamic 3-D finite-element analyses, and stability evaluations under seismic (0.6g due to close proximity of active Greensville Fault) loads, and spillway design flood and over pour loads. The studies showed the 1924 built structure meets the present day seismic and flood requirements.

Santa Anita Dam

Los Angeles Department of Public Works

Project Manager for safety reanalysis of the 220 ft high arch dam utilizing the newly published hydrological data as well as the ground motion parameters which are based on most recent attenuation relationships. The concrete also had shown the effects of the alkali aggregate reactivity (AAR). The analyses utilized ADAP-NS finite element program which allows opening and closing of joints due to seismic loads, and ANSYS program to design the remedial work. This also included an evaluation of the locked-in AAR stresses and superposition of other stresses (i.e., Seismic) to assess safety of the structure. This included the design of a buttress to strengthen the dam for the very severe level of required ground shaking, and training of the PMF overflow through the central portion of the dam-away from the abutment bedrock.

Biographical Sketch (cont'd)

worked on the effect of intermediate principal strain (not the stress) on strength of sandy soils. Later he and Prof. Duncan published this work as it had important practical implications in geotechnical engineering.

He also did research for Prof. R. E. Goodman, which included development and stability analysis of a 3-D model of rock block and seepage pressures in the abutments of Malpasset Dam to explain the mechanism of the 1960 failure causing loss of 3,000 lives. He also performed a finite element analysis of stresses in the roof of the underground excavation of the Hyatt Power Plant at the Oroville Dam facility, then under construction, to assess rock bolt requirements for the cavity.

His doctoral research, then under the tutelage of the Late Professor H. Bolton Seed, involved a comprehensive study of strength and deformation properties of rockfill material. This research, estimated at $20M, was financed through grants from California DWR, National Science Foundation, USBR and a number of other agencies. It included design of highly elaborate testing equipment,

Dams & Reservoirs

Arch Dams

Combie Dam

Nevada Irrigation District

Principal-in-Charge of the design, construction monitoring and post-construction testing and safety evaluation of post-tensioning tie-down system for the 85-ft high arch dam. The 1928 built structure had come under FERC jurisdiction by installation of a small hydropower plant. A prior safety inspection had indicated seismically unsafe condition due to excessive uplift seepage forces. As requested by client, a tie-down system was designed and constructed which consisted of 15 sets of low relaxation steel strand tendons post-tensioned to 270 kip each (350 kip capacity).

Los Verjeles Dam

Thousand Trails Corp.

Principal-in-charge and Project Manager for the DSOD required safety analyses of the 56-ft high multiple arch dam. Built in 1915, the dam consisted of 12 cylindrical reinforced concrete arches set at 45 degrees to horizontal and supported by buttress walls. The arches had a radius of 10 feet and were 9-inches thick at top and 18 inches thick at the bottom. The investigation and evaluations included faulting and seismicity studies and development of ground motion time-histories, performance of static and dynamic 3-D finite-element analyses, and stability evaluations under seismic loads, and spillway design flood (SDF) and overpour loads. Also designed improvements required by DSOD.

Goodwin Dam

Tri-Dam Project

Principal-in-Charge of comprehensive field and laboratory investigations, including coring, sampling and testing of the foundation bedrock and dam concrete materials, followed by safety analysis of the 101-ft high double arch concrete dam built in 1912. The analyses included faulting and seismicity studies, and development of ground motion time-histories, performance of static and dynamic 3-D finite-element analyses, and stability evaluations under seismic loads, and spillway design flood and overpore loads. Also designed improvements required by DSOD which included erosion protection measures of the foundation bedrock.

Biographical Sketch (cont'd)

instrumentation, and laboratory testing of actual and modeled rockfill material. Results of his pioneering research have been used for confirmation of the design of Oroville and Pyramid dams in California, El Infernilo dam in Mexico, and Tarbella dam in Pakistan, which are all built and working satisfactorily. It is also published and/ or referred to by most text books in geotechnical engineering as well as the US Bureau of Reclamation design manual for dams.

Work Experience

Dr. Marachi started his professional career by working for Converse Davis & Associates in Pasadena, California in May of 1969 as a project engineer. He was assigned to work on the Castaic Power Plant project. His work included:

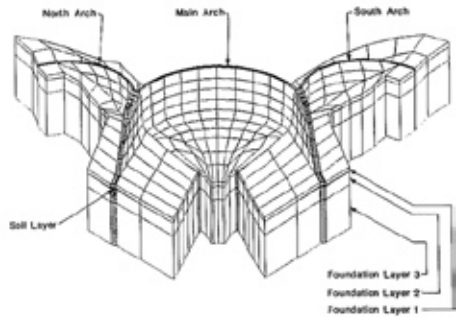
- All rock and soil stability evaluations
- All instrumentation planning and installations
- Design of various sections of the project, e.g. penstocks, manifold structure
- Design (in cooperation with Mr. Chuck Stewart) of the 180 ft. high pump-storage afterbay dam (presently named Elderberry Dam), including:

  Seepage analysis for normal operations

Arch Dams

Webber Dam
El Dorado Irrigation District

Principal-in-Charge and "independent consultant" approved by FERC to perform independent consultant safety inspection per CFR Title 18, Part 12 for the triple arch 89-ft high concrete dam built in 1924. Subsequently performed detailed stability analyses under operating pool plus seismic loads (0.45g), and under SDF or PMF using 3-D finite element method. Also performed foundation investigation drilling to assess concrete - bedrock contact quality as well as concrete and bedrock strength parameters. Designed flood overpore protection schemes and anchored tie-back system to improve stability of the buttress walls.



Salmon Creek Dam
Juno Water and Power

Project Manager and principal investigator for the Part 12 safety inspection of the 148-ft high arch dam required by FERC. Performed tectonic and seismicity studies and developed ground motion time-histories and performed static, PMF and seismic stability analyses. The studies also included evaluation of stability of the segment of the arch which had significant deterioration due to impact of tree logs.

Karun II High Dam
Acres International

Special consultant to Acres International and approved by World Bank and Iran Ministry of Water and Power to review the development of static and seismic stability safety criteria and analyses for design verification of the 560-ft high arch dam. The consulting review included seismicity, ground motion time-histories, stress analyses (temperature-induced, static, PMF, and seismic conditions) and limiting stress and deformation criteria.

Biographical Sketch (cont'd)

Seepage analysis and design of the upstream section configuration for rapid drawdown (52 ft in 65 hrs). This is an extremely high requirement for a dam.

Dynamic finite element analysis allowing for pore pressure generation and dissipation to assess liquefaction potential. This was one of the first such studies done in practice.

For another project, evaluation of seepage through the proposed soil embankment reservoir for City of Industry, Dr. Marachi was the first to utilize the first available version of the finite-element transient seepage computer program, then being developed by Professors Paul Witherspoon and Shlom Newman (then a Ph.D. candidate).

The 9 Feb. 1971 San Fernando earthquake gave him the impetus to perform a number of highly critical and challenging assignments, such as:

- Detail investigation of liquefaction at Joseph Jensen Filtration Plant and Holt boys camp,
- Dynamic soil amplification study in San Fernando Valley/ portions of a contract for NSF through Professor H.B. Seed,
- Development of the methodology and performance of a large number of site amplification studies using Fourier analysis of the random site motions.

Dams & Reservoirs

Concrete/Rollcrete Dams

Folsom Dam

U.S. Bureau of Reclamation

Principal-in-Charge of the detailed faulting/seismotectonic investigations as part of safety review of the 275-ft high gravity dam built in 1956. Investigations included air-photo lineament analysis, color IR and LANDSAT im-ageries, trenching, mapping, and age dating of the Quaternary deposits overlying the Bear Mountains Fault Zone.

New San Clemente Dam

Monterey Peninsula Water Management District

Principal-in-Charge of the investigations and preliminary design of a new 290-foot high RCC dam downstream of the existing San Clemente dam on the Carmel River. The dam would have created a 30,000 af reservoir inundating the existing San Clemente dam and reservoir. The investigation and design activities included the design of RCC aggregate/ mix, spillway, cost estimates, and placement requirements, just short of preparation of final design drawings, and specification.

Los Padres Dam

Monterey Peninsula Water Management District

QA/QC and review of the preliminary design and cost estimate for a proposed 282-foot high RCC dam on the Carmel River. Reviewed the field investigations for potential borrow areas, water pressure testing and grouting, geophysical surveys, and engineering geologic mapping. Primary subconsultants were responsible for RCC mix design, stability analysis of the RCC fill, constructibility and construction cost estimates, and fault activity studies. Subcontractors included core and rotary drilling, trenching, geophysical surveys, geo-technical laboratory tests, and RCC mix design tests.

Biographical Sketch (cont'd)

Dr. Marachi successfully applied this method to Holy Cross Hospital which was severely damaged. Subsequently, he applied this method to assess the site amplification at many critical installations, e.g. Goleta and Ellwood power plants, Hyperion treatment plant (expansion), Supermex LNG facility, and many of the critical buildings at the Jet Propulsion Laboratory. He has since used this method to measure the first few natural frequencies of arch dams and intake/outlet towers to validate/calibrate the computer finite element models of such structures prior to performing exhaustive computational efforts.

In this period Dr. Marachi also developed a method for calculating the statistical probabilities associated with different levels of ground shaking at a given site based on past recorded seismic events within a specified distance from the site. He published it in the International Conference of Seismic Microzonation in 1971. He and some of his colleagues, e.g. David Leads of Dames & Moore, used this method to assess seismic risk for many of the high rise buildings presently in Los Angeles downtown. He also used this method to develop seismic criteria

Dams & Reservoirs

Embankment Dams

Whale Rock Dam

Whale Rock Commission

Project Manager for the DSOD required comprehensive safety investigations of the 193 foot high zoned earth dam (40,000 reservoir) which was built in 1960 and is in the proximity of the Hasgri fault, anticipating a MCE of M 7½ causing peak ground acceleration of 0.6g. Investigations included drilling, sampling, and testing of the embankment and foundation alluvium, liquefaction and stability analyses based on 3D-finite element stress analyses and pore pressure generation/dissipation analyses. Analyses indicated that the dam meets the safety criteria of DSOD.

Forrest Lake Dam

California-American Water Company

Project Manager for the DSOD required comprehensive geotechnical and seismicity investigations and safety analysis of the 60-ft high dam, spillway, and the brick-mortar outlet tower built in 1892. Subsequently designed a new combined inlet outlet structure and measures to improve seismic stability of the embankment (stability berms and seepage control measures).

Elderberry Dam

Los Angeles Department of Water & Power

Co-project Manager for the design of the 180-ft high zoned earth/rockfill dam which provides the afterbay reservoir of the 1,250 MW Castaic pump-storage power facility. The design included considerations of the 52-ft in 65-hr rapid drawdown imposed by weekly operational plans for the reservoir. Design report and efforts also included instrumentation and monitoring recommendations and operations and maintenance manuals, as well as performance and evaluation of a test section to assess suitability of the siltstone bedrock locally available from the required power plant excavation. The design analyses efforts also included performance of dynamic finite element analysis (one of the first ever performed in U.S.) to assess the stability of the dam in case of a maximum credible earthquake (MCE) on the nearby San Andreas fault.

Dams & Reservoirs

Embankment Dams

Biographical Sketch (cont'd)

for all buildings in the Jet Propulsion Laboratory in Pasadena, CA. This method was important as it was one of the first methods to use 'probability' to arrive at selecting seismic design criteria. (Later in, 1976, Professors Shah and Karamidjian of Stanford University developed a probability method based on fault activity, and this was later improved by Dr. Norman Abrahamson and is presently being used to develop planning criteria for most important projects, e.g. the new section of the San Francisco / Oakland Bay Bridge.

Dr. Marachi was also very active in various engineering professional societies. He became a member of the SEAOSC committee to rewrite the seismic design section of the Uniform Building Code. He also directed a 12-hr workshop for ASCE members and taught seismicity, faulting, ground motion, liquefaction, wave propagation, and dynamic response to the practicing engineers. He also chaired an ASCE committee for developing practice standards for verification and dissemination of computer programs. He also was one of the first few to become a member of EERI (Earthquake Engi-

Pyramid Rockfill Dam

Pyramid Dam and Oroville Dam

State of California, Dept. of Water Resources

Research Assistant in charge of developing strength and deformation properties of the rockfill materials considered for the final design and construction of the Pyramid Dam, 386-ft high zoned rockfill dam creating the 180,000 the forebay reservoir of the Castaic Power complex; and the Oroville Dam, 742-ft high zoned rockfill dam creating 3.54-maf Oroville reservoir. The comprehensive testing and research results (published in ASCE, Vol. 98, SMI, as well as most resent geotechnical text book) included gradation modeling of the rockfill materials and testing of 3-ft diameter and 7.5 ft high samples (as well as smaller samples) in triaxial testing machine under effective confining pressures ranging from 30 to 750 psi. The research also included evaluation of deformation and particle breakage of the rockfill materials for final design verifications of the two dams.

Summit Dam

East Bay Municipal Utility District

Project Manager for the DSOD required safety investigations and analyses of the 61-ft high earth dam and 117-af covered reservoir built in 1881. Performed geotechnical and earthquake engineering investigations including drilling, sampling, and laboratory testing, faulting and seismicity studies, and development of ground motion time-histories, and 3D finite element dynamic stability analysis of the earth dam and its intake and outlet structures, which are only a few hundred feet from the Hayward fault. The results indicated that the dam and its appurtenant structures meet the safety criteria of DSOD.

Lake Herman Dam

City of Benicia, Dept. of Public Works

Project Manager for the comprehensive safety investigations of the 51 foot high earth dam and its intake/outlet tower built in 1905, and its foundation alluvium (the dam had survived the San Francisco 1906 earthquake). Investigations included drilling, sampling, and testing of the embankment and foundation alluvium, liquefaction, pore pressure dissipation, and stability analyses. The studies also included spillway capacity rating for SDF. The dam and foundation alluvium were found to meet the safety requirements of DSOD. Subsequently designed spillway modifications to increase capacity to accommodate SDF as required by DSOD.

Biographical Sketch (cont'd)

neering Research Institute) when such memberships were by invitation only.

On the side, he also taught a four unit undergraduate course in soil mechanics and foundation engineering at the Cal State Los Angeles in 1972.

Overseas Experience

Dr. Marachi moved to Iran in January of 1973. At the time the Shah was in power, the Country was pro west, and the local economy was enjoying a twelve percent annual growth in GNP. And there were a half-million American and nearly 1 million European engineers and technicians working on well paying and very interesting developmental projects in Iran.

He started by teaching at the Aryamehr Institute of Technology. This was a tenure track professorial position. He taught courses in:

- Soil mechanics and Foundation Engineering
- Seepage (in groundwater and through dams)
- Earthquake Engineering
- Dam Engineering
- Soil testing – also set up the soil testing laboratory.

Dams & Reservoirs

Embankment Dams

Proposed Earth Dam and Reclaimed Water Reservoir

City of Industry, Dept. of Public Works

Project Manager & Project Engineer for finite element analysis of seepage, using variable head boundary condition finite element (first time in U.S. outside of academia) analysis, through the earth dam section of the proposed unlined treated wastewater reservoir in the City of Industry. The results were then used to assess the stability of slopes, and to evaluate total seepage quantity and potential impacts to the groundwater.

Proposed Saw Mill Dam

Pebble Beach Public Utilities Department

Project Manager and Project Engineer for feasibility investigations of the proposed 35-ft high dam and treated wastewater reservoir. Investigations includes borings and sampling and laboratory testing, and preliminary design and stability evaluations for the dam, location of proposed treatment plant, and along the 1.5-mile main water line.

Warm Springs Dam

U.S. Army Corps of Engineers

Principal-in-Charge of detailed post-construction review of design memoranda, design drawings and specifications, construction records and design modifications of the 319-ft high zoned earth dam and the 381,000 af reservoir. Subsequently prepared final "As-Constructed" drawings and also the operation and maintenance (O&M) manual.

Pishin Dam

Iran Ministry of Water & Power

Principal-in-Charge of design investigations of the proposed 270 ft high dam. Investigations included foundation drilling and testing (water pressure, grouting, modulus [Menard pressuremeter] and strength tests) and borrow material investigations and tests. Also served as co-project manager for the preliminary layout and design of the dam its appurtenant structures, quality estimations, and cost estimations.

Culmback Dam

Utility District #1 of Snohomish County

Special consultant to review the technical issues regarding the proposed 62-ft raising of the existing 200-ft high rockfill dam. Examined and evaluated the strength and deformation properties of the rockfill materials and developed design details for keying the two (new and old) segments to provide deformation compatibility of different dam segments. Also provided review of the assumed rockfill material strength and slope stability of the slopes.

Chacras Deloria Dam

Atachocha Dam

Chinchan Dam

Peru (Wahler & Associates)

Project Manager for seismic stability evaluations of the dams and foundation alluvium (left in place in all three cases). The stability evaluations included development of seismic design criteria (time-history of ground acceleration), liquefaction analyses, post-earthquake stability analyses, and deformation analysis.

Biographical Sketch (cont'd)

In April of 1974 Dr. Marachi and one of his former colleagues from UC Berkeley founded the " Tehran Berkeley Consulting Engineers". By September the firm had added 2 more partners and 15 employees. By the end of 1977 Tehran Berkeley had 4 subsidiaries with employees totaling close to 300. Subsidiaries were:

- Tehran Berkeley Sounding Drilling, Ltd.
- Wimpy Iran Laboratories, Ltd.
- ENERTEC, Ltd. (energy technology consultants)
- Nedeco Iran, Ltd. (harbors and transportation systems)

Highlights of this period for which Dr. Marachi was project manager or co-project manager included many planning investigations and designs such as:

- Siting of inland and shoreline nuclear power plants:
  - Prepared ESAR for 160 miles of shorelines
  - Prepared ESAR for a 22,000 square mile section of west of the Country
- PSAR for Saveh NPP (2,400 mgw)
- PSAR for Karun NPP (1800 mgw); Co-project manager with Mr. Kim deRubertis
- Permitting of the Karun NPP site through the International AEC
- Siting and investigations of 85 miles of aqueduct and protective levees

Dams & Reservoirs

Intake/Outlet Towers

Miliken Reservoir Tower

City of Napa Department of Public Works

Project Manager for the dynamic analysis of the 108 ft high outlet tower for an MCE of M6.5 with a peak ground acceleration of 0.6g.

Lake Herman Reservoir Intake/ Outlet Tower

City of Benicia Department of Public Works

Project Manager for the safety evaluation of the 50 ft high intake/outlet tower built in 1905. The structure had survived the 1906 San Francisco earthquake. The analyses, using mode superposition method, indicated that the tower meets the safety requirements.

Forest Lake Intake/Outlet Tower

California-American Water Company

Project Manager for the safety evaluation of the 48 ft high brick-mortar intake/outlet tower built in 1892. The dynamic analyses indicated that the tower could not meet the present safety requirements. Subsequently, designed a new inlet/outlet structure to be supported on the upstream face of the dam. Also designed multi-level valves and the outlet structure (pipe) since the original outlet tunnel was found to have a number of broken sections.

Hydroelectric Projects

Biographical Sketch (cont'd)

Siting and feasibility studies of Iran's five major geothermal power resource regions

Siting and planning studies of 2 industrial towns

Siting, planning studies, and design investigations for two major dams

Design of widening and upgrading of some 400 miles of highway

Existing capacity evaluation and feasibility study of expansion alternatives of the 12 main harbors of the Country.

He also participated as a member of an international committee of experts to review the aseismic design of the nuclear power plants proposed by the French nuclear plant suppliers (Framatome and Spie Bottineau). Eighteen units of this plant were being sold to be installed in South Africa, Iran, and Brazil.

Dr. Marachi's total stay in Iran was just less than six years. He and his family left Iran in December of 1978 and came back to US, fortuitously only two days before the revolutionaries closed the Tehran airport. He fervently wished not to deal with or in any way be associated with the Khomayni regime, or any of the Islamic fundamentalist groups that have since defiled Iran's 5000 years of glorious civilization and have brought nothing but disgrace, shame, and infamy to all.

Castaic Power Project

Los Angeles Dept of Water and Power

Project Engineer in charge of the following investigations and designs:

- Performed Menard pressure-meter and plate bearing tests on the Castaic siltstone rock to assess deformation properties and limiting stresses for the final design of surge chamber.
- Performed rock deformation computations for the excavation of the 1,250 MW capacity pump-storage powerhouse (assessment of rock rebound and recompression due to excavation and subsequent reloading).
- Performed final design of the support of the bifurcation structure (30-ft diameter Angeles tunnel outlet bifurcating into six 12-ft diameter power penstocks and one 6-ft diameter starter unit penstock). The structural loads due to the penstocks were 22,000kip uplift plus 47,000 kip horizontal load against the steel penstock of Angeles Tunnel.
- Performed final design analyses of the 12-ft diameter power penstocks at the entrance to the powerplant. The 1-3/4 inch thick steel penstocks at this point were to be subjected to 750 psi internal pressure and 120-ft of backfill soils and switch yard. In addition to closed form stress and deformation analyses, Dr. Marachi performed a detailed finite element analysis, which he later verified through a physical field model test. (The difference between the physical model and finite element model was found to be less than 15 percent).
- Designed alternative lean concrete mix designs for penstock and powerhouse backfills. Performed laboratory and field tests to optimize the design.
- Prepared monitoring manual for the penstocks to check the stresses and deflections during various operational loading scenarios. The manual included design, installation, operations and interpretations of all instrumentations.
- Designed, installed and performed all monitoring activities (i.e., extensometers, slope indicators, stressmeters, piezometers, etc.) related to performance of excavated rock slopes, bottom half of the power house excavation, and computations related to rock stress relaxation and recompression due to reloading.

Hydroelectric Projects

Biographical Sketch (cont'd)

Back in the U.S.

From March of 1979 to June of 1984 Dr. Marachi worked for Converse Consultants (the same 1969 firm of Converse Davis and Associates). Initially he was the manager of engineering in the San Francisco office. In Feb. of 1982 he became the manager of the office, and in late 1983 he was also elected to serve on the Board of Directors.

During this period he investigated a large number of levees and developed a method to assess the probability of levee failure and the corresponding cost of exposure to such a potential event. He utilized this method to investigate the annualized exposure costs associated with East Bay MUD's aqueducts through the San Joaquin Delta region. He also developed alternative mitigation plans and calculated annualized cost of each. He later published this methodology in various international proceedings.

As part of levee stability studies, he performed a series of laboratory tests on peats and peaty clays of the San Joaquin delta region and over consolidated fissured clays of the Colusa Basin. His findings, utilized to elucidate

Terror Lake Penstock

Morrison Knudson
Kodiak Island, Alaska

Review consultant for the evaluation of properties of fractured rock and review and recommendation of design modification and construction procedures of the power penstock.

Camino Penstock

Sacramento Municipal Utility District
Sacramento, California

Technical review of the stability of the rock slope and penstock foundations of the 1500-ft long, vertical drop power penstock. Also performed independent stability computation of the "rock toppling" model and tie-back requirements. Also, developed and evaluated various alternatives to the original conceptual design to optimize expenditures without compromising the project safety.

Sand Bar Hydroelectric Project

Sverdrup/Tri-Dam
Stawberry, California

Principal-in-Charge of the drilling and geological investigations along the 18,000 ft long tunnel. Investigations delineated rock conditions at the tunnel grade and portal conditions. Also provided design recommendations for the tunnel boring machine (TBM) and localized lining requirements.

Forks of Butte Penstock & Power Plant

Hypower, Inc.
Butte County, California

Project Manager for the geological and geotechnical investigations and design recommendations for the foundation of the 50mw power plant and the 10-ft diameter power penstock and associated anchor blocks, and design and recommendations of anchored tie-back system for stabilization of the slope and incipient slide directly affecting the penstock and power plant.

115 Kv Cable Crossing

Alameda, California

Project Engineer for the marine geophysical surveys, offshore drilling and sampling; sable alignment recom-mendations; development of geotechnical design criteria (cutslope stability, bedding and backfill, thermal conductivity, liquefaction potential).

Levees and Aquaducts

Biographical Sketch (cont'd)

the cause of repeated levee breaks at Colusa, earned him commendation letters from the Sacramento District and San Francisco Division of the US Army Corps of Engineers. He also became very interested in investigation and safety analysis of existing dams, especially concrete arch and multiple arch dams. He performed 3-D dynamic finite element analysis of Milliken, Vail, Hume Lake, and Salmon Creek arch dams, and Whale Rock, Lake Herman, and Summit embankment dams. For a five week period he served as a special consultant to Parsons/Engineering Science in Bombay, India on a project for the World Bank to develop geotechnical investigation requirements and plans and specifications for the proposed comprehensive sewer collection, conveyance and treatment facilities of Bombay. He also served on the Board of Consultants to review the seismic design criteria and dynamic analysis of the Karun II arch dam by Acres International.

He co-founded "The MARK Group, Inc." on Memorial Day of 1984. By 1991 the firm had 98 employees and 3 main offices. In this period Dr. Marachi managed a large number of environmental

Colusa Basin Levee
US Army Corps of Engineers

Project Manager for the investigation of the causes of repeated failures of a 12-mile portion of Colusa Basin Levee and recommendations for mitigating measures. Received commendation letters from the San Francisco division and Sacramento District of U.S. Army Corps of Engineers noting the work as an "outstanding accomplishment."

CalFed Bay-Delta Program
San Joaquin Delta, California

Evaluation of the geotechnical/seismic fragility of approximately 650 miles of levee (as a member of CAL-FED Committee on Bay-Delta Program).

Old River Intake Structure & Levee Setback
Contra Costa Water District
San Joaquin Delta, California

QA/QC for the geological/geotechnical investigations, development of seismic ground motion spectra, static and seismic designs, and construction monitoring of the Old River intake and pump station and levee setback for the Los Vaqueros project.

Yuba, Feather and Sutter River Levees
US Army Corps of Engineers

Principal-in-Charge for the geotechnical investigations, including drilling and sampling, CPT, field and laboratory testing, and stability analyses of 134 miles of levees for the Sacramento District of the Corps. The levee segments studies included: Levees under jurisdiction of Marysville Levee Commission, Levee Districts No. 1 and 9, Levee Maintenance Areas No. 3, 7, and 16, and Reclamation Districts No. 10 and 784, all along Feather, Yuba and Bear Rivers, Wadsworth Canal, Sutter Bypass, and Honcut Creek and adjacent areas.

San Francisco Bay
US Army Corps of Engineers
Shoreline Studies

Principal-in-Charge for the compilation and evaluation of a data base for approximately 350 miles of levees along San Francisco, San Pablo and Suisun Bays, evaluation of their stability conditions and identification of critical areas of levees.

West Levee
US Army Corps of Engineers
Muddy River, Nevada

Project Manager for the preliminary and final designs, plans and specifications for five miles of flood control levee on the lower Muddy River through the communities of Longdale and Overton, Nevada.

Levees and Aquaducts

Biographical Sketch (cont'd)

cleanup and restoration projects at various industrial facilities and landfills. He developed a vacuum extraction method to remove volatile organic compounds from the vadose zone, and designed the system for the cleanup of a site for Motorola, the first such site in California receiving EPA approval. He also taught a condensed course on the environmental aspects of soils engineering, and contaminant transport (by convection or diffusion) at Cal State Long Beach.

He also managed many projects in the water market, i.e. safety investigations of Webber, Los Verjeles, Goodwin, Combie, Concow, Matilija, and Santa Felicia dams, to name a few. He also served on a CalFed subcommittee assessing seismic fragility of the levees in the Sacramento/San Joaquin delta.

On February of 1999 The MARK Group sold its assets to Harza Engineering Co. Dr. Marachi served as Senior Partner and manager of the Concord office at Harza from 2/99 to 4/01. During this period he spearheaded the acquisition of a number of large projects, e.g. Relicensing of Orville Dam Facilities, Safety Investigation of Santa Anita and Hosler

Jones Tract Levee Break
East Bay MUD, San Joaquin Delta, California

Project Manager for the consultation regarding levee condition antd potential failure due to piping, erosion and overtopping.

Mokelumne Aqueduct Security Plan
East Bay MUD, San Joaquin Delta, California

Project Manager for the evaluation of hazard exposure costs of the existing water transmission system through San Joaquin Delta; planning studies of alternative mitigation measures in-cluding evaluations of construction costs, repair and maintenance costs, and hazard exposure costs of each proposed mitigation measure.

East Bay MUD Aquaduct Levee Crossings
San Joaquin Delta, California

Project Manager for the investigation of the stability (drilling, CPT, sampling, testing and analyses) of approximately 150 miles of levees near the Mokelumne Aqueduct crossings in the San Joaquin Delta; evaluation of rate of subsidence, potential for failure due to liquefaction (seismic), static, and/or overtopping.

Woodward Island Engineering Studies
East Bay MUD, San Joaquin Delta, California

Project Manager for the evaluation of the stability of levees and aqueducts in Woodward Island development of hazard exposure relationships for the system and recommendation for potential mitigation measures.

Wiskey Pete Water Line
Nipon, California

Preliminary and final design of 14-inch cut-and-cover 12-mile long steel water transmission line for Whiskey Peter recreational development. Services also included terminal treatment and storage facilities.

Dynamic Stability of Mokelumne Aqueducts
East Bay MUD, San Joaquin Delta, California

Project Manager for the dynamic soil-structure interaction analysis of the Mokelumne Aqueduct system in San Joaquin Delta, including evaluation of static and dynamic properties of peat and other soft delta deposits; development of dynamic site properties and analysis of dynamic stresses in the pile foundations and elevated pipelines.

Ahwaz-Sarbandar Aqueduct
Khuzestan Water and Power Authority
Ahwaz, Iran

Project Manager in charge of investi-gation and design of the 85 km long, 264-mgpd trapezoidal aqueduct (3.5m at base and 2m high) between Karun River (near Ahwaz) and the new industrial city of Sarbandar.

Fossil Fuel

Biographical Sketch (cont'd)

arch dams, Design of Safety Mitigations for Big Tujunga arch dam, ID/IQ engineering services contract with the San Francisco PUC, ID/IQ engineering services contract with USBR /MW for the California water plan, to name a few.

As an avocation, he also developed a "quick" method to compute seismic stresses in an arch dam. The method abates the costly analyses.

In April of 2001, Dr. Marachi resigned from Harza, and presently works as a consultant. In addition to engagements on a number of proajects and cases, he is in the process of developing a method to assess seismic stability of a "generic" arch dam.

Ray Generating Station
Ray, Iran

Project Manager for the site selection, civil and geotechnical design of the new power station to house two 50mw gas turbine generating units (supplied and installed by kraftwerk Union of Germany).

Manjil General Station
Manjil, Iran

Project Manager for civil and geotechnical design and construction management and testing of the new power station to house six units of 50 mw gas turbine generators (supplied and installed by Kraftwerk Union of Germany). Also reviewed the physical aspects of the preliminary design of power transmission system to connect to the Intertie system.

115 Kv Cable Crossing
Alameda, California

Project Engineer for the marine geophysical surveys, offshore drilling and sampling; sable alignment recom-mendations; development of geotechnical design criteria (cutslope stability, bedding and backfill, thermal conductivity, liquefaction potential).

Haynes Power Plant
El Sequndo, California

Project Manager for the geotechnical investigations and pile foundation de-sign recommendations for the plant expansion. Also performed site vi-bration monitoring and site dynamic amplification studies to identify site/equipment frequency modulation.

Goleta Generating Station
Goleta, California

Project Manager for the geotechnical and earthquake engineering investigations and recommendations, including free field vibration monitoring for the proposed gas turbine generating station.

Ellwood Generating Station
Ellwood, California

Project Manager for the geotechnical and earthquake engineering investi-gations and recommendations, including free field vibration moni-toring for the proposed gas turbine generating station.

Hyperion Power Plant
Los Angeles, California

Project Manager for the monitoring and evaluation of high foundation vibrations causing excessive equipment ware and high maintenance costs and downtime; and recommendations for mitigations. Used an ultra-sensitive accelerometer to monitor foundation block vibrations and identify the prevalent mode causing equipment distress (rocking motion in this case). Subsequently, recommended cement jacking around the perimeter of the foundation blocks to minimize the rocking vibration.

Petrolane LNG Facility
San Pedro, California

Project Engineer for the geotechnical investigations and foundation design analysis and recommendations, and seismicity evaluations for the terminal storage facilities. Also performed site vibration monitoring and dynamic amplification studies and provided recommendations for dynamic analysis of the tank structure.

Nuclear Power

San Onofre

Southern California Edison, San Onofre, Calif.

In response to NRC concerns regarding fault activity of some of the "site proximity" faults, participated in a team of specialist to assess and re-evaluate peak ground acceleration criteria (maximum credible and maximum probable accelerations) for the plant.

Holister Ranch Nuclear Plant

Southern California Edison, Gaviota, California

Earthquake engineer-member of the team for the site selection/early safety analysis report (ESAR) for the potential nuclear plant (2,000mw LWR) site in Holister Ranch property located 35 miles west of Santa Barbara, California.

Shiu-Bandar Lengeh

Site Section Study
Southern Iran

Project Manager for the site selection study of 150 km of Persian Gulf coastline for installation of 2 x 1,200 mw LWR units. The investigation re-port followed US-NRC guidelines for the preparation of ESAR. Three sites were identified and evaluated, and recommended for further development.

Saveh Nuclear Power Plant

Atomic Energy Organization of Iran, Saveh, Iran

Principal-in-Charge and task manager seismological (geotechnical) for the preparation of Section 2-Site Pa-rameters, of the PSAR for licensing of 2 x 1200 mw air cooled LWR to be installed by Kraftwerk Union of Germany. Specialty subconsultants consisted of Black and Vetch (environmental sampling) and Shannon & Wilson (tectonics) and Professor Tom McEvilly of University of California (seismology). The project was 75 percent complete when the political "revolution." stopped all efforts.

Inland Nuclear Plant Siting Studies

Atomic Energy Organization of Iran,
Western Iran

Project Manager for a comprehensive study of approximately 6,000,000 acres of western portion of Iran to select 5 alternative sits for installation 2 x 900-mw air-cooled LWR. Also authored nearly 50 percent of the 2000 page report which was formatted in accordance to the requirements of US-NRC.

Nuclear Power

Aseismic Design Review of Nuclear Plants

International Atomic Energy Organization

Nominated by the Atomic Energy Organization of Iran and approved by the International Atomic Energy Or-ganization, Dr. Marachi participated as a member of an Ad-Hoc Committee to review the Framatome's aseismic design of nuclear power plants. The seven member committee also included Professors N. Newmark (University of Illinois), John Lysmer (University of California) and Jack Wolfe of Lonzane Polytechnic of Switzerland, to name a few. The main aseismic design principle was to use lead impregnated bronze frictional sheet base isolation system resting on horizontally reinforced neoprene rubber pads. The physical models and 3-D dynamic finite element models and environmental test results and analyses indicated a very high degree of reliability even under extreme loading and environmental conditions (i.e., temperature variations, dust, etc.). The committee subsequently recommended its approval for licensing. These recommendations were adopted by the Organization.

Karun Nuclear Power Plant

Atomic Energy Organization of Iran
Khuzestan, Iran

Project Manager for the preparation of Section 2-Site Parameters of the Preliminary Safety Analysis Report (PSAR) for licensing of 2 x 900 mw LWR units on the Karun River in Southern Iran. The subconsultants who served on this project consisted of Fugro (seismology), Tetratech (domino dam-break analysis), Sargent and Lundy (environmental sampling), and Wimpy Laboratories of UK (cyclic soil testing). The $18M investigation was completed in record time of 18 months and the 8,000-page report was submitted to and approved by the International Atomic Energy Organization. Also assisted and coordinated the submittals of the plant supplier (Framatome of France), the general contractor (Spie Batineau), and their outside consultant (Mecasol).

Geothermal Resources

Ministry of Water and Power
Tehran, Iran

Principal-in-Charge for Phase I and Project manager for phase II of a 3 phase, investigation, design and construction project to harness the prime geothermal resources of Iran (5 zones, each approximately 400 sq. km.) Directed and supervised detail geological mapping, and spring and stream sampling and chemical analyses, structural fracture analysis (3-D lineament analysis and depiction of high intensity fractures – zones of high hot water availability), and near surface temperature distribution. Project scientist for this assignment – Dr. Robert Bowen, authored a text book "Geothermal Resources" which was later published by Applied Science Publishers, Ltd. of London.

For Phase II, directed detailed and large scale geophysical investigations (gravity, electrical conductivity and some refraction surveys) and zoom deep borings for temperature gradient and geophysical surveys followed by one pilot production well in each of the geothermal resource zones.

Technical Publications

General Engineering

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Technical Publications

Earthquake Engineering / Risk Evaluation

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Lucia, P.C., and Marachi, N.D., 1982, Soil-structure interaction of a pile supported pipeline in organic soils: Third Int. Conf. on Microzontion, Se-attle, pp. 1054-1064.

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Marachi, N.D., and Hoffman, R.A., 1973, Engineering and geologic factors affecting Karl Holton Boys Camp: in San Fernando, California Earthquake of February 9, 1971, by U.S. Dept. of Com., NOAA, v. I, pp. 825-830.

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Marachi, N.D., and Dixon, S.J., 1972, A method for evaluation of seismicity: Proc. of the Intl. Conf. on Micron-zonation, v.1, pp. 379-394.

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