



ENGINEERING RESEARCH CENTER

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**The San Francisco Bay Armenian
Professional Society supported and ERC
projects**

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AMERICAN UNIVERSITY OF ARMENIA
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Research Grants of the San Francisco Bay Armenian Professional Society



Administered by ERC

Duration of the grants: June 1, 1993 to May 31, 1994

Alexander Bagdov

Nonlinear Waves in Different Continuous Media

Nicolj Manukian

Creation of the Anti Friction Materials with High Wear Resistance and Low Friction Coefficient

Artiom Grigorian

Regulating Operators for Solving the Problem of Image Restoration

Vadim Fatalov

Asymptotic Analysis of Gaussian Infinite Dimensional Probability Distribution with an Application to the 1-Valued Ornstein-Uhlenbeck Processes.

Gagik Tsaturian

Reliability Theory and Application for Complex Systems

Arman Karapetian

Investigations on Multidimensional Complex Analysis

Vladimir Aroutunian

Transport Phenomena at the Semiconductor- Electrolyte and Semiconductor - Gas Interfaces

Samvel Shoukourian

Software for Tuning the Architecture of Personal Computers

Rafik Hakopian

Interaction of Laser Radiation with Orientation and Hydrodynamic Motions in Nematic Liquid Crystals

Atom Muradian

Quantum-Mechanical Motions of Atoms and Formation of the Regular Structures in the Laser Radiation Field

Temur Markarian, Levon Davidian, Arkadi Aronchik

The Development of Estimate System on the degree of Damage and Reliability of Masonry Buildings Structures

Arshak Poghossian

Research and Development of Integrated Biosensors

Vladimir Sarkissian

Some Modern Problems on the Theory of Elasticity of Anisotropic Body.

Sergey Nikogosian

Influence of Impurity Substitutions and Sintered Compositions on Critical Parameters of Y- and Bi-Based Superconductivity Ceramic Before and After Electron Irradiation

Tigran Magakian

Detailed Investigations of the Optical Collimated Outflows from Young Stars

Anahit Yeghiazarian

Spectrophotometry Morphology of the Galaxies with UV Excess

CENTER OBJECTIVES AND STATUS

The Engineering Research Center (ERC) is a nonprofit division of the American University of Armenia (AUA) established with the purpose of providing a free environment for the conduct of basic and applied scientific research by AUA students and faculty as well as scientists or engineers from various institutes in Armenia. A major objective of the Center is to foster collaborative research projects with established and newer scientists and engineers from various institutions of higher learning and research in Armenia. Towards that end, the center accepts and reviews research proposals from such institutions and approves them on the bases of scientific merit, chances of leading to a commercial product or process and available of funds. Although originally established to conduct research mainly in earthquake and industrial engineering, in the last two years the Center has grown into a multidisciplinary research entity supporting a broad spectrum of research activities.

Currently the Center supports about a dozen research projects with approximately forty participants. The Center features several high speed Intel-i486-based computers, a laser printer and a broad range of commercial and in-house software for scientific and engineering applications. The Center is also connected to the world wide computer network through the AUA computer lab and a radio link to Moscow. In addition, the Center has set up an experimental facility to test scaled models of frame structures under simulated earthquake conditions. The Center has access to other research facilities in Yerevan through the collaborative projects it supports.

COLLABORATING INSTITUTIONS

Armenian Earthquake Engineering Research Institute

National Survey for Seismic Protection

State Engineering University of Armenia

Institute of Informatics and Automation Problems, Armenian Academy of Sciences

Mechanics Institute, Armenian Academy of Sciences

Mathematics Institute, Armenian Academy of Sciences

Ministry of Energy

Institute of Armenian Encyclopedia

Yerevan State University

University of California, Berkeley

University of Southern California, Los Angeles

University of Michigan, Ann Arbor

University of Arizona, Tucson

University Illinois, Urbana-Champaign

The U.S. National Science Foundation

INVESTIGATION OF METHODS FOR SEISMIC REHABILITATION OF BUILDINGS

Dr. Michael Melkumian, David Chalkatrian, Ashot Minassian, Grigor Vartanian, Avetik Gasparian

The purpose of this project is to examine various means of reinforcing or rehabilitating earthquake-damaged buildings in Armenia in order to raise their earthquake resistance to the new standards that were set in Armenia following the Spitak earthquake in 1988. For this purpose a 1:5 scale model of a two-story frame has been built. The frame is subjected to increasing cycling loads until it fails. After the frame collapses it is strengthened with additional concrete and steel. The strengthening is accomplished by providing a reinforced concrete jacket over the the columns and beams. After the concrete develops its full strength the strengthened frame is tested under similar types of loading. The reinforced frame is expected to be twice as strong than the initial one. An analytical model has been developed to compare predictions obtained from a finite-element program with experimental results.

ELASTIC EARTHQUAKE ANALYSIS OF COUPLED BENDING AND TORSIONAL VIBRATION FOR MULTISTORY BUILDINGS

Dr. Movses Kaldjian, Lusine Gevorkian

Numerous investigations of consequences of strong earthquakes indicate that coupled bending and torsional vibration in asymmetric structures results in additional serious damage. The main purpose of this project is to include the said effect in the analysis and design of earthquake-resistant buildings. Analytical and numerical methods have been developed to offset the effects of this phenomenon and ways are being sought to set standards in building codes. The results of this research can be used in the Armenian Building Codes, which were revised after the Spitak earthquake in 1988.

EXPANDING PILE FOR STRENGTHENING SOFT SOILS.

Rouben Harutunian

The purpose of this project is to investigate the load-carrying capacity and other characteristics of a novel type of pile that transforms vertical loads into lateral ones when installed in soft soil. Unlike standard bored or drilled piles, the pile being investigated expands after its installation. The lateral expansion of the pile compresses the soil around it and increases elastic stresses in the soil. As a result of this soil pressure the pile remains suspended in the soil, thus increasing the bearing capacity of the pile. The stress distribution around the pile in soils with different parameters is being investigated using analytical and numerical tools. Also, the pile is being tested with different static loads at the Armenian Earthquake Engineering Research Institute (AEERI). One of the goals of this project is to compare experimental results with theoretical and computational ones.

REHABILITATION OF MULTISTORY STRUCTURES BY AN UPPER FLEXIBLE FLOOR

Dr. Edward Khatchian, Petros Keshishian

The purpose of this project is to investigate the effects of adding one or more flexible floors to the tops of existing structures as a means of absorbing the effects of ground motion caused by earthquakes. After the Spitak earthquake the rehabilitation of existing structures became an urgent problem. It has become necessary to rehabilitate not only damaged structures but also those which have sustained little or no damage, because the earthquake-resistance standards have been raised in Armenia's building codes. The main advantage of rehabilitating structures by an upper flexible floor is that there is no need for the tenants to vacate inhabited buildings. The effect of adding one or more flexible floors is being investigated from a standpoint of reliability and sensitivity under different earthquake motions. The analysis is being performed for different types of structures with the ultimate goal of estimating overall effectiveness of this method of rehabilitation.

ON-LINE COMPUTERIZED ARMENIAN-RUSSIAN-ENGLISH TECHNICAL DICTIONARY

Sashig Darbinian, Vladimir Sahakian, Norair Hovoumian, Suren Sharambeyan, Ruzan Manvelian

This is a computer program that remains resident in memory and provides translations of technical terms from and into Armenian, Russian and English within any word processor. The program is activated by pressing a single key and translations appear from one language into the remaining two. One feature of this program that distinguishes it from other similar programs is its ability to work with three languages simultaneously. The list of words and their translations can also be printed out which may be used as a dictionary of three languages. Currently the database has roughly 5,000 terms and it is expected to grow to approximately 15,000 terms.

RESEARCH ON ALTERNATIVE ENERGY SOURCES

Artak Hambarian

The main objectives of this project are: (a) to draft laws regarding alternative energy source in order to create favorable conditions for producers and users of such sources; and (b) to formulate policies which will stimulate foreign investments in alternative energy projects (e.g. free economic zones). This project is jointly sponsored by the AUA and the Armenian Ministry of Energy.

RESIDUAL STRESSES IN MICRO HETEROGENEOUS MATERIALS

Suren Gevorkian

In recent years materials with crystalline structures have been widely used in the manufacture of micro-electromechanical devices. The dimensions of elements of such devices do not exceed a few microns. The manufacture of such materials requires the application of high temperatures which, as a result of subsequent rapid cooling, produce residual stresses in the material. The main purpose of this research is theoretical and experimental analysis of these residual stresses, and to recommend criteria for manufacturing processes so that residual stresses and corresponding strains are minimized.

EARTHQUAKE RECORD DIGITIZATION

Levon Aslanian

There are three principal types of seismographs used in modern seismology to record ground motion acceleration during an earthquake: (a) seismographs that write the record on magnetic tape, (b) seismographs that write the record on photographic film and (c) digital seismographs. For recording strong motion earthquakes the second type of seismographs is used. The disadvantage of this type of seismograph is that it provides only the graph (picture) of the record, which has to be digitized so that it can be used for design purposes. Also, there are hundreds of earthquake records in Armenia in either optical or magnetic analog form that have to be digitized. The goal of this project is to develop a software package which can read the record from photographic film by a scanner and to convert it to a digitized data.

SOFTWARE FOR GEOLOGICAL, GEOPHYSICAL AND GEOGRAPHICAL MAP AND DATA PROCESSING SYSTEM

Vartan Douvalian

The purpose of the project is to develop a software package which can create, maintain, edit and print geographical or geological maps and which can be integrated with different types of data bases. The principal application of this package would be in seismic studies, but it can also be used in other fields, such as mineral exploration, road construction and so forth.

COMPARATIVE STUDY OF BUILDING CODES

Dr. Michael Melkumian, Armen Martirosian

This study aims at comparing the newly developing Armenian Building Code with codes from the U.S.A., Japan and other countries.

ENHANCEMENT OF STOCAL INSTRUCTIONAL SOFTWARE.

Dr. Ashot Hakobian

This is a computer program for random vibration analysis of linear structural system. It is used primarily for teaching and research. It was developed at UC Berkeley and is used at a number of other universities in the U.S. The objective of this project is to develop an enhanced version of STOCAL with improved computational and graphics capabilities. The enhanced version of the program might have potential for marketing.

STRONG MOTION INSTRUMENTATION NETWORK.

Valery Arzumianian

In conjunction with the National Survey for Seismic Protection, the Center operates a network of strong motion accelerographs in Yerevan and other parts of Armenia. This is an on-going effort with monitoring and operation of the instruments and processing of data generated by these instruments.

DEVELOPMENT OF A CONTROL METHOD FOR REORIENTING AN ARBITRARY COMPONENT OF A MULTIBODY SYSTEM IN 3-D SPACE

Dr. Ara Arabyan, Tigran Parikian

The main purpose of the project is to investigate the inner reorientation ability of a free multibody system in 3-D space without using liquid fuel and reactive jets. The effects of the degrees of freedom, kinematics structure, inertial parameters of the bodies and power capabilities of the drives of the multibody system are to be considered in order to build an adequate control method for given reorientation maneuvers. Application of such a non-fuel approach in maneuvering can become a reasonable solution to the spacecrafts, where the rechargeable solar batteries can supply the necessary power for motion control.

SEQUENTIAL MONTE-CARLO METHOD OF CALCULATION OF MULTIVARIATE NORMAL PROBABILITIES FOR BRICKS.

Dr. Rouben Hambartzumian, Rafik Aramian, Haig Sukiassian, Victor Ohanian

This method is based on the theorem that the conditional distribution of the k -th component of a vector with multinormal distribution, given the values of the preceding $k-1$ components, is one-dimensional normal. The analytical expressions of the corresponding expectation and standard derivation are available. This permits sequential generation of random multinormal sequences S , using any generator of one-dimensional normal independent random variables, by means of past-dependent transformation of the latter variables on each step.

Given a brick $B \in R^n$ and $S = (x_1, \dots, x_n)$, let r be the minimal number for which x_r does not belong to the r -th projection of B . The events $\{S \in B\}$ and $\{r \in N\}$ are equivalent. This suggests that $P\{S \in B\}$ can be often Monte-Carlo evaluated using relatively many short sequences of length $r \ll n$. This may result in considerable gain in computation time.

The problem consists in computer realization of these ideas and in evaluation of the results.

CONTRACTIONS COMPUTATION.

Dr. Movses Kaldjian, Ashot Aslanian

This work is devoted to computation of different contractions. Programs are written in FORTRAN programming language and applied on Macintosh computers. Software contains programs, which can make computation, when local and global coordinate systems have different orientations and when the local coordinates are not orthogonal.

APPROXIMATE DYNAMIC SYNTHESIS OF LINKAGE MECHANISMS

Dr. Ara Arabyan, Kolya Stepanian, Ashot Martirosian

The mechanisms can contain solid and elastic links. The problem requires to define cinematic, geometrical and inertia parameters of mechanisms which provide the minimum of the functional of the mechanism's work quality.

The purpose of the project is to work out the theoretical basis of the method and the algorithm for the numerical solution of the problem with a software.

The proposed method allows to include desirable dynamic properties of a mechanism on the basis of designing in advance and define optimal parameters appropriate to those properties.

INVESTIGATIONS ON SEISMIC ISOLATION

**Dr. Michael Melkumian, Valery Arzumanian, Arthur Manukian, Tigran Nersisian,
Paruir Zadoyan, Gagik Jrbashian**

Seismic isolation is one of the methods of seismic protection of buildings which has become widely used lately. In Armenia, under high seismicity conditions, it is worthwhile to use this method primarily for protecting school buildings, hospitals, etc. In the case of successful development seismic isolation may find application in mass scale housing construction and also for protecting the existing buildings.

In this connection it is planned to begin investigations in the field of designing and manufacturing laminated rubber bearings and their use for seismic isolation. World experience is going to be studied, on the basis of which a seismically isolated experimental building will be designed. Later on it is planned to carry out full scale dynamic tests of this building within the framework of the AUA over a period of 6 months from April 1, 1993 to September 30, 1993 the following activities are planned:

1. Designing a laminated rubber bearing for loads obtained from the dynamic design of the experimental building (the literature of the AUA library will be widely used during this work);
2. Manufacturing the test specimens of laminated rubber bearings at one of the plants in Yerevan (the tire plant, Nairit, the rubber plant);
3. Development of specimen testing technique in view of world experience;
4. Development and manufacturing a reaction system for carrying out static load reversal tests on laminated rubber bearings.
5. Preparations for the experiment.

In case of success of mentioned activities, the investigations on seismic isolation within the framework of ERC activities will be continued.

DYNAMIC ANALYSIS OF THE AUA BUILDING

Arkadi Aronchik, Lucine Gevorkian, Ruzan Agazadian, Marat Rostomian

The aim of the project is to carry out the dynamic analysis of the AUA Building, 40 Marshall Baghranian Street. The following tasks should be carried out:

1. Based on the drawings and measurement of the original building, develop mathematical models of the building. Three models with increasing sophistication are to be developed. The simplest one might be a stick model, whereas the more sophisticated model should be a three dimensional model individually accounting for all significant structural elements.
2. Using SAP90 program the analysis of the building should be carried out as well as computing of the modal frequencies and mode shapes which are to be shown through tables or graphs. Comparison of the estimated properties from various models is also to be done.
3. The dynamic analysis of the system for specified ground motions will be carried out. And consideration of the effect of soil structure interaction will be done, if it is significant.

INVESTIGATION OF FLEXIBLE STORY AS A MEANS FOR MITIGATION OF EARTHQUAKE EFFECTS ON BUILDINGS.

Dr. Edward Khatchian, Arsen Tonoyan

The aim of the project is the development of an analytical method based on perturbation theory and previous results of Igusa and Der Kiureghian to investigate the effect of adding a flexible story to reduce earthquake forces on existing buildings.

RESEARCH OF THE APPLICATION OF OPERATIONS RESEARCH AND INFORMATION SYSTEMS AT THE YEREVAN LAMP PLANT

Dr. Vaughn Hukfeldt, Marush Hasratian, Susanna Durinian

Today the YLP operates about 20% of its capacity. But its product is in great demand both in Armenia and outside of Armenia. In the former USSR there were only 4 such plants. They produced about 30 different kinds of lamps. Therefore we think that improvement of economic situation for the plant might be important not only for them but for Armenia as well.

The aim of the project is to identify:

1. current status and needs in data systems;
2. potential areas for economic improvements using OR technique;
3. creation of data bases needed to apply OR technique to the most important problem.

DATA SYSTEMS FOR ENERGY IN ARMENIA.

Dr. Vaughn Hukfeldt, Gagik Gulbudagian, Arthur Hairumian, Ruben Ispirian, Hrachya Kiureghian

Energy problems are one of the most important problems in Armenia. The French group "BIOS" is involved in the development of energy policy for Armenian Government. The "BIOS" members of the project will work together with this group and with Ministry of Energy.

In the frame of the present project planned to carry out data acquisition on fuel supply, distribution and consumption. The problem of data acquisition on fuel trucks is supposed to be solved by OR method.

The creation of data base on fuel distribution will make it possible to forecast the fuel demand. Statistical analysis will be used to accomplish the mentioned goals.

HOSPITAL INFORMATION SYSTEM

Dr. Vaughn Hukfeldt, Lilit Mirzakhanian

Medical diagnosis and treatment requires analysis of gathered information. Data collection takes place at many locations in the hospital. The physician uses the collected data information in complex decision making. This information may be replaced into the computer. It is a better basis for physicians decision in a shorter time and with less effort.

Purpose of the medical record: making diagnosis, choice of treatment, forecasts.

It is also possible to make an optimal choice of further examinations to minimize the total cost of medical care, including the costs of the examinations, the room charges, the physician charges and the patient's loss of work time.

APPLICATION OF OPERATIONS RESEARCH TECHNIQUE TO LASER PRODUCTION.

Dr. Vaughn Hukfeldt, Armen Saroyan

The problem of construction of laser with given parameters can be solved using Linear Programming methods. The aim of the project is to apply Linear programming methods for to components selection to develop the least cost laser systems.