Research Highlights 2009

Department of Structural Engineering
Jacobs School of Engineering

The Department of Structural Engineering @ UC San Diego . . .

Founded in 1997 as an off-shoot of Applied Mechanics and Engineering Sciences, the Department of Structural Engineering at UC San Diego has enjoyed twelve years of growth and success. Our mission is to provide a comprehensive education and training to engineers using a holistic approach to structural systems engineering by emphasizing and building on the commonality of engineering structures at the levels of materials, mechanics, analysis and design.

Powell Labs...Over Twenty Years of Research Innovations . . .

The Charles Lee Powell Laboratories were dedicated in 1986, with the Engelkirk Structural Engineering Center added in 2005. The multiple-location, multi-million-dollar labatories are committed to research at the materials, component, assembly, and systems-levels, and features one of the largest assemblies of reaction wall/strong floor systems in the world. The Englekirk Structural Engineering Center, a one-of-a-kind facility, is enabling structural tests that have never been possible before. The Center is equipped with the world's first outdoor shake table, adjacent to the country's largest soil-structure interaction facility, researchers to perform dynamic earthquake safety tests on full-scale structural systems. The Center's blast simulator is used to study the effects of bomb blasts and to test new technologies to harden buildings against terrorist bomb attacks.

SE Welcomed Four Faculty Members in 2008 . . .

Yuri Bazilevs, Assistant Professor, joins UC San Diego from the University of Texas at Austin, where he served as Lecturer in the Department of Aerospace Engineering and Engineering Mechanics, following graduate school there. Dr. Bazilevs' expertise is in computational mechanics, isogeometric analysis (integration of design and analysis), fluid-structure interaction, vascular blood flow, biomechanics, turbulence modeling and computation, and mathematics of finite elements and isogeometric analysis.

David J. Benson, Professor, comes from UC San Diego's Department of Mechanical and Aeronautical Engineering, where he served as Faculty since 1997. Dr. Benson's expertise is in computational mechanics, solid mechanics and materials science. Benson co-authored with Dr. John Hallquist on the finite element code, Dyna3d, which Livermore Software Technology later commercialized into LS-DYNA, a code used by nearly all car companies in automobile crashworthiness calculations.

Maurizio Seracini, Adjunct Professor, comes to us from the Center of Interdisciplinary Science for Art, Architecture, and Archaeology (CISA3; UC San Diego Division, Calit2), where he serves as Director. Currently, Dr. Seracini is collaborating on an 18-month project to rediscover a long-lost Leonardo da Vinci mural, the "Battle of Anghiari," in the famed Palazzo Vecchio in Italy. Dr. Seracini is a graduate of UC San Diego (1973).

Yael ("Lelli") Van Den Einde, Lecturer (LPSOE), returns to the Department of Structural Engineering after serving as Assistant Director and Co-Principal Investigator of NEESit Cyberinfrastructure Center (San Diego Supercomputer Center/UC San Diego), which serves the Network for Earthquake Engineering Simulation (NEES) program. Van Den Einde specializes in earthquake engineering data, metadata development and management, performance-based earthquake engineering, and the development of educational programs. Dr. Van Den Einde is a graduate (M.S./Ph.D.) of our program.

About Our Degree Programs . . .

UC San Diego's Department of Structural Engineering offers B.S., M.S., and Ph.D. degrees. Our programs and curricula provide education and training through a holistic approach to structural engineering by emphasizing and building on the commonality in materials, mechanics, and analysis considerations across the disciplines of civil, aerospace, and marine engineering. Our programs feature strong components in laboratory experimentation, basic theory, information technology, and engineering design. For admissions information, contact Graduate Student Affairs Advisor, Ms. Debra Bomar (dbomar@ucsd.edu; 858-822-1421), or Undergraduate Student Affairs Advisor, Ms. Danielle Swenson (dswenson@ucsd.edu; 858-822-2273).

Blast Resistant FRP Composite Designs & Verification

Principal Investigator: Professor Robert Asaro
Co-Principal Investigators: Professors Gil Hegemier & Hyonny Kim

Professors Asaro, Hegemier and Kim are working with the Office of Navy Research on concept designs of the new DDX deckhouse-steel connections, related to the U.S. Navy's newest class of destroyers, the DDG 1000. Hybrid joints are subject to complex internal stress states and are critical in terms of how they transfer loads between the massive steel hull structures and the lower density fiber reinforced polymer (FRP) composite deckhouse structure - - these researchers have impressive experience in this area. In addition to the study of joints, another team is evaluating blast damage vulnerability of the deckhouse structure. The Navy has plans for the production of three DDG 1000's.

Lightweight Composite Portable Bridges for Military and Emergency Applications

Principal Investigator: Professor John Kosmatka

The need for immediate mobility in the aftermath of natural disasters, or on the battlefield, has lead to the development of light-weight bridging composed of aerospace composite materials. At UC San Diego, a broad multi-disciplinary research program is underway on the design, analysis, fabrication, and testing of these large (20-40 m) structures capable of supporting 100-ton vehicles. Improved composite manufacturing methods are leading to innovative structural solutions.

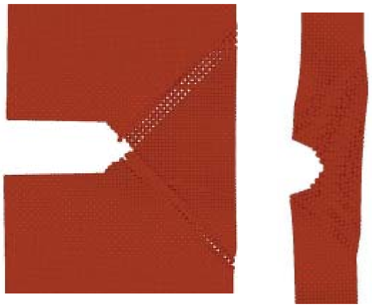
Simulating Bomb Blasts

Principal Investigator: Professor Gilbert Hegemier

The Explosive Loading Laboratory and Testing Program, funded by the Technical Support Working Group (TSWG), is the first program in the world to develop a hydraulic-based blast simulator to simulate full scale, live explosive events up to 3000 psi-msec without the use of explosive materials or a fireball. Energy deposition, which takes place in time intervals of 2 to 4 ms, is accomplished via an array of ultra-fast, computer controlled hydraulic actuators with a combined hydraulic/high -pressure nitrogen energy source based on blast physics models and codes. The blast simulator has been validated through comparison with the live explosive field test data, and computational blast physics models and codes are being improved and validated using the blast simulator and field test data. The simulator is being used to generate high fidelity data on the response and failure processes associated with critical infrastructure components subject to explosive loads, to evolve effective blast hardening/protective methodologies for existing and new structures, and to standardize test protocols for product validation. The simulator performs fully repeatable blast load simulations on structural elements such as columns, beams, girders, and walls; on nonstructural elements such as windows, masonry walls, and curtain walls; and on bridge components such as decks, piers, and towers. Testing results are viewed by still shots taken by three ultra high-speed Phantom cameras, each capable of capturing 5,000-10,000 frames per second!

Testing Biomineralized Composites for Greater Toughness

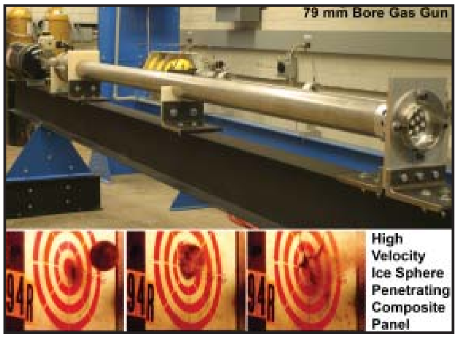
Principal Investigator: Professor Robert Asaro



Are biomineralized composites tougher due to their nano-scale size? Atomistic studies of the resistance to crack propagation in nano-sized ceramic platelets that exist in teeth, bone, or the shells of mollusks, reveal that they are far more ductile than their bulk counterparts. The principal reasons are concerned with the increased ease of crack tip blunting and the inability for cracks to sustain the stress concentration required for brittle fracture. Examples of crack tip response are shown for cracked plates of thickness 4 nm and 16 nm, subjected to uniaxial tension; the former displays ductile rupture whereas the latter demonstrates more brittle-like crack growth. At left, cross-sections of cracked plates with thickness 16 nm (far left) and 4 nm (left) show crack propagation in the 16 nm thick plate and crack tip blunting in the 4 nm thick plate due to profuse dislocation nucleation.

High Velocity Impact on Composite Structures

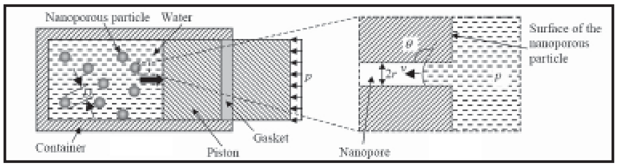
Principal Investigator: Professor Hyonny Kim



High performance composite aircraft structures are exposed to various impact threats such as bird, hail, ice, and ground maintenance damage. Ongoing research projects are particularly focused on the development of damage to carbon and glass epoxy structures as a result of impact by hailstones traveling at high velocities, e.g., equivalent to aircraft flight speeds. A gas gun is used to launch ice projectiles onto composite test panels to determine the threshold at which impact damage develops in the structure, thereby defining the resistance of these structures to the formation of damage under such threats. Such tests are also used to determine the morphology of the resulting damage. This latter information is critical in the definition of the impact-created flaws that the aircraft structure must be tolerant to since impact damage to composites is often difficult to detect.

Developing High-Performance Energy Absorbing Liquids

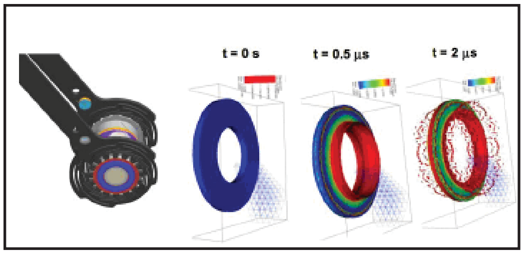
Principal Investigator: Professor Yu Qiao



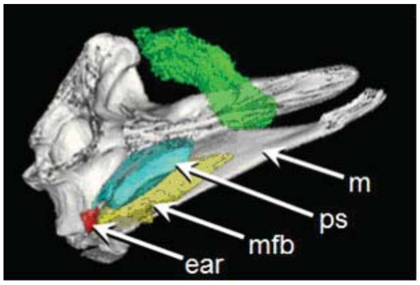
By immersing nanoporous materials in a non-wetting liquid phase, the system becomes an energy absorbing liquid, or a "liquid super-sponge." When sufficient high pressure is applied, the liquid can be forced into the nanopores, leading to a significant energy dissipation characteristic. Prof. Qiao and other UC San Diego researchers are exploring ways that these liquids can be used for protection and damping applications, such as liquid armors, health care products, and protective layers for buildings.

Micromechanical Analysis of Fragmentation using ALE-AMR

Principal Investigator: Professor David J. Benson



Fragmentation is a fundamental process that naturally spans micro to macroscopic scales. Recent advances in algorithms, computer simulations, and hardware enable us to connect the continuum to microstructural regimes in a real simulation through a heterogeneous multiscale mathematical model. We apply this model to the problem of predicting how targets in MegaJoule-class laser chambers dismantle, so that optics and diagnostics can be protected from damage. The mechanics of the initial material fracture depend on the microscopic grain structure. In order to effectively simulate the fragmentation, this process must be modeled at the subgrain level with computationally expensive crystal plasticity models. However, there are not enough computational resources to model the entire laser target at this microscopic scale. In order to accomplish these calculations, a hierarchical material model (HMM) is being developed. The HMM allows fine-scale modeling of the initial fragmentation using computationally expensive crystal plasticity, while the elements at the mesoscale can use polycrystal models, and the macroscopic elements use analytical flow stress models. The HMM framework is built upon an adaptive mesh refinement (AMR) capability. Figure: Fragmentation of a cooling ring in an inertial confinement fusion experiment using the ALE-AMR code.



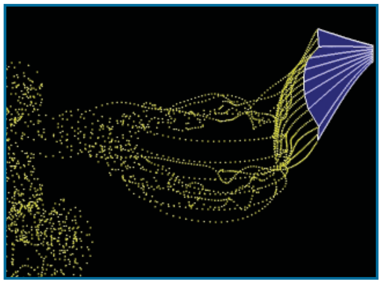
Acoustic Pathways Revealed: Simulating Sound Reception in Cuvier's Beaked Whale

Principal Investigator: Professor Petr Krysl

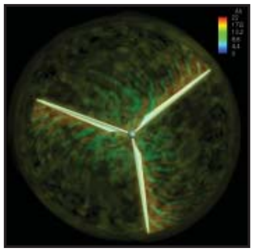
In this collaborative research with San Diego State University's Department of Biology and with Scripps Institution of Oceanography, a finite element vibroacoustic toolkit was applied to the sound transmission in the head of a beaked whale. The model is based on CT data sets as well as physical measurements of sound-propagation characteristics of actual tissue samples. FEM results concern pathways by which sounds reach the ears. Simulations are revealing a previously undescribed 'gular pathway' for sound reception in this species. Propagated sound pressure waves enter the head from below and between the lower jaws, pass through an opening created by the absence of the medial bony wall of the posterior mandibles, and continue toward the bony ear complexes through the internal mandibular fat bodies. This new pathway has implications for understanding the evolution of underwater hearing in beaked whales; this model also provides evidence for receive beam directionality, off-axis acoustic shadowing and a plausible mechanism for the long-standing orthodox sound reception pathway.

Bio-inspired Engineering about Fish Fins

Principal Investigator: Professor Qiang Zhu



The fins of a fish are often strengthened by embedded rays, and therefore possess anisotropic flexibility. Tendons and muscles attached to these rays also allow the fish to actively control the motion and deformation of its fins. This design greatly enhances the efficiency of fish locomotion. Dr. Zhu is concentrating on numerical characterization of the structure versus function of these bio-structures. The eventual application will be bio-inspired propulsion systems.



Fluid-Structure Interaction of Wind Turbines

Principal Investigator: Professor Yuri Bazilevs

The rising costs and highly fluctuating prices of oil and natural gas, as well as their constantly diminishing supplies worldwide create the need for cheaper, sustainable alternative energy sources. Wind turbines that harvest wind energy and convert it to electrical power are such an energy source, playing an increasingly important role and receiving much attention from governments and industry around the world. Wind turbines present several substantial engineering challenges and would greatly benefit from the use of advanced predictive simulation tools. Computational analysis plays a key role in the design and analysis of complex engineering systems. Automobile crash analysis, as well as the design and evaluation of commercial and military aircraft, routinely use advanced computational tools. As such, wind turbines should not be an exception. Regretfully, advanced high-fidelity computational methods for wind turbine analysis that are capable of addressing the above mentioned issues are notably lacking. In this work, we directly address this deficiency by jump-starting, taking leadership in, and setting the standard for computational fluid-structure interaction research and education on wind energy applications world wide. This work is a collaborative work with Professor Benson (UC San Diego), Dr. Tayfun Tezduyar (RICE), and Professor Gil Hegemier (UC San Diego). At left is a three-dimensional simulation of a full-scale wind turbine rotor. The blade diameter is 120 m, the wind speed is 15 m/s, and the rotation rate is 10 RPM. These are typical operating conditions for off-shore wind turbines, which are more severe and challenging to compute than in-land designs. This preliminary computation makes use of over 2,000,000 second-order NURBS isogeomeric elements and 90 processors on a Dell PowerEdge Cluster.

How to Shake 1 Million Pounds of Concrete

Principal Investigator: Professor Jose Restrepo

SE researchers spent three months rigorously conducting earthquake simulation tests on a half-scale, three-story structure, and are analyzing the results to be used in the future designs of buildings (parking garages, college dormitories, hotels, stadiums, prisons, and increasingly, office buildings) across the nation. Precast concrete, which is built in pieces and then put together to construct buildings, has been a breakthrough in the industry in terms of saving both time and money and increasing durability. While precast concrete has proven to be a robust design material for structures, researchers are working to provide the industry with new methods of connecting these pieces more efficiently. Researchers produced a series of earthquake jolts as powerful as magnitude 8.0 on a structure resembling a parking garage. The 1 million-pound precast concrete test structure had the largest footprint of any structure ever tested on a shake table in the United States. The $2.3 million research project is a collaboration between UC San Diego, the University of Arizona, and Lehigh University. It is funded by the Precast/Prestressed Concrete Institute and its member companies and organizations, along with the National Science Foundation, the Charles Pankow Foundation and the Network for Earthquake Engineering Simulation (NEES).

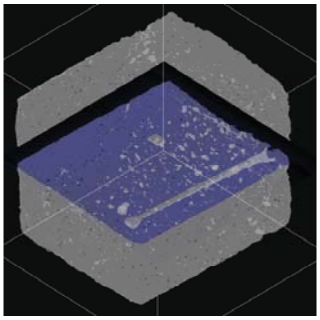
San Francisco-Oakland East Bay Bridge Replacement Project: Precast Prestressed Concrete Skyway

Principal Investigator: Professor Frieder Seible

Dr. Seible led the proof-testing of the new San Francisco-Oakland East Bay Bridge, including the 2.5 km long precast-prestressed concrete skyway (pictured at left). Joints between superstructure segments and the skyway piers were tested at 1/4 scale under simulated seismic loads to establish performance limit states.

Concrete Damage-Transport Properties Correlations

Principal Investigator: Professor Tara Hutchinson



Concrete is by far the most widely-used building material in the United States, with extensive use in the construction of our nation's buildings, highways, tunnels, water supply and sewage systems and other infrastructure. The strong dependency of the service life of concrete on its transport properties means that investigations of the performance of concrete components need to link these transport properties to observed damage states. In collaboration with Los Alamos National Laboratories and supported by the National Science Foundation, Prof. Hutchinson and other UC San Diego researchers are developing damage-transport property correlations, using an integrated program of structural testing of concrete components, gas permeability testing, and X-ray computed tomography (see 3-D reconstruction at right).

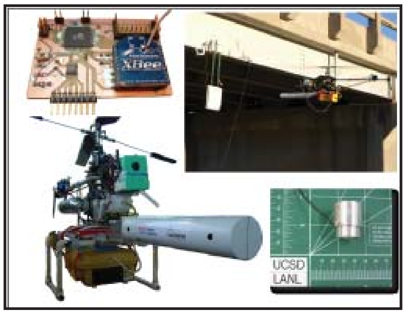
Improving Seismic Performance of Concrete and Masonry Structures

Principal Investigator: Professor P. Benson Shing

Assessing the seismic performance of older reinforced concrete (RC) frames that have masonry infill walls presents a most difficult problem for structural engineers. Currently, there are no reliable engineering guidelines. In a collaborative project sponsored by the National Science Foundation (NSF) under the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) program, Professor Shing is leading an effort to develop advanced computational models as well as simplified analytical methods to assess the performance of these structures, and to develop practical and effective techniques based on innovative materials to improve their seismic performance. Final proof-of-concept tests are being conducted on a full-scale three-story RC frame, using the Large High Performance Outdoor Shake Table (LHPOST) at UC San Diego. Strength design of reinforced masonry (RM) structures has been under continuous development and evolution for many years. With structural design moving toward a performance-based approach, research is needed to have a better understanding of the performance of RM structures under different earthquake levels and to develop reliable predictive tools. Professor Shing is working on a second collaborative project sponsored by NSF's NEES program and the masonry industry and led by the University of Texas at Austin. The project involves large-scale testing on the LHPOST and computational simulation.

Advanced Sensor Networking Paradigms and Data Processing for Autonomous Structural Assessment

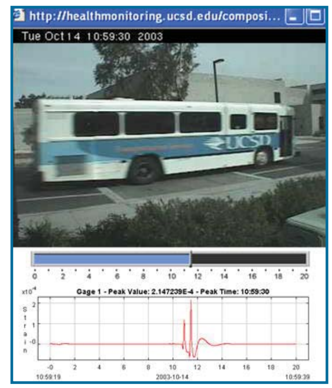
Principal Investigator: Professor Michael Todd



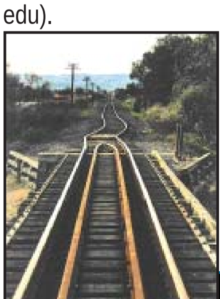
Damage assessment of large-scale structures (e.g., bridges, buildings, or dams) after an extreme event such as an earthquake or a blast load is a challenging task. In many cases, critical damage is not visible or obvious, human inspection poses serious life-safety concerns, and downtime for the structure results in large economic losses. Dr. Todd and other researchers at UC San Diego, with partners in the Computer Science and Engineering Department, California Institute for Telecommunications & Information Technology (Calit2), and the Los Alamos National Laboratory, are developing components for a new systems approach that combines Radio-Frequency Identification (RFID) -based wireless sensing, advanced networking and embedded system architectures, and autonomous network interrogation via unmanned platforms such as robots or unmanned UAV. The unmanned platforms are programmed to move to and query these wireless sensor networks and compute features that would facilitate structural health assessments after such extreme events.

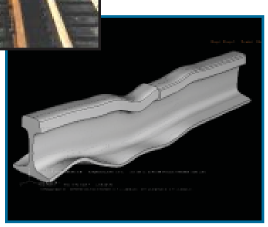
Bridge and Traffic-Pattern Monitoring

Principal Investigator: Professor Ahmed Elgamal



Information technologies are increasingly allowing for advances in monitoring and analysis of structural response. An integrated structural health monitoring analysis framework encompassing data acquisition, database archiving, and model-free/model-based system identification/data mining techniques has been created toward the development of practical decision-making tools. Bridge testbeds at UC San Diego are serving as an environment for the development of such integrated structural health monitoring technologies. Instrumentation includes accelerometers and strain gages for measuring the bridge spatial response, as well as video cameras for tracking the related vehicle traffic. A hardware and software setup records synchronized video and sensor data, and allows real-time Internet transmission and data archiving. Image processing techniques are used to translate the recorded video into corresponding load time histories. Machine learning techniques are employed to correlate the input traffic excitation to the output bridge response. Anomalies in this correlation may be used as a basis for structural health monitoring and related decision making applications (http://healthmonitoring.ucsd.edu).





Rail Monitoring Systems

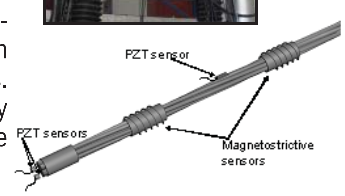
Principal Investigator: Professor Francesco Lanza di Scalea
Co-Principal Investigator: Professor Chia-Ming Uang

Railroad infrastructure is in need of technologies able to prevent derailments and perform repairs/replacements in a timely manner. Due to heavy tonnage and aging conditions, several structural problems affect railroads today, including the growth of cracks hidden from the surface of the rail. Professor Lanza di Scalea and his post-doctorals, Stefano Coccia and Ivan Bartoli, are working with the Federal Railroad Administration (FRA) to develop a system which can detect cracks in rails while in motion, using ultrasonic waves and non-contact (laser) probing to detect the flaws. Additionally, in another FRA project, Professors Lanza di Scalea and Uang are studying ways to detect incipient buckling of rails. Lateral buckling, a severe problem since the advent of continously-welded rail, is one of the most frequent causes of derailments worldwide today. UC San Diego researchers will extract high- and low-frequency dynamic signatures of rails in a non-contact manner as indicators of imminent buckling. Plans are for the development of an incipient buckling detection prototype working in motion at regular train speeds.

Health Monitoring of Post-Tensioned Concrete Bridges

Principal Investigator: Professor Francesco Lanza di Scalea

Ninety-percent of California's bridges are post-tensioned concrete structures. There is a need to develop technologies able to monitor the state of health of the prestressing tendons which carry most of the loads. Recent bridge collapses have further highlighted the problem of the deteriorating conditions of the transportation infrastructure which require information on weak components. Professor Lanza di Scalea and post-doctorals Ivan Bartoli and Salvatore Salamone are working with Caltrans to develop an ultrasonic-based monitoring system for the prestressing tendons of post-tensioned concrete structures. The method is based on embedded sensors and ultrasonic guided waves which can provide information on the level of stress as well as the presence of defects such as corrosion or broken wires. Laboratory tests have indicated the suitability of the guided-wave method to achieve these goals. If further laboratory tests are favorable, the tendon monitoring system will be installed and tested on an operational post-tensioned bridge in California.



System and Damage Identification of a Seven-story Reinforced Concrete Building Slice Tested on the UCSD-NEES Shake Table

Principal Investigator: Professor Joel P. Conte

A full-scale, seven-story reinforced concrete building slice was tested on the UCSD-NEES shake table. Six different state-of-the-art system identification algorithms including three input-output and three output-only methods were used to estimate the modal parameters (natural frequencies, damping ratios, and mode shapes) based on the measured response of the building subject to ambient as well as white noise base excitations at different damage states. The identified modal parameters obtained using different methods were compared to study the performance of these system identification methods, and also to investigate the sensitivity of the estimated modal parameters to actual structural damage. The results obtained in this study were then used to identify damage in the building based on a sensitivity-based finite element (FE) model updating algorithm. The damage identification results were verified through comparison with the actual damage observed in the test structure. Furthermore, the performances of the three output-only system identification methods as well as the FE model updating for damage identification were (numerically) investigated due to variability of different input factors such as amplitude of input excitation, spatial density of measurements, measurement noise, length of response data used in the identification process, and the modeling error.

The NEES Data Model and NEEScentral Data Repository: A Framework for Data Collaboration in Support of Earthquake Engineering Research

Principal Investigator: Professor Lelli Van Den Einde

The George E Brown Jr. Network for Earthquake Engineering Simulation (NEES) is a shared national network of 15 experimental facilities, collaborative tools, a centralized data repository, and earthquake simulation software, all linked together to enable engineers to develop better and more cost-effective ways of mitigating earthquake damage. To support data organization, archiving and dissemination resulting from NEES related research, the NEES Cyberinfrastructure Center (NEESit) has developed a central data repository (NEEScentral) to capture important reservoirs of data and expose them to the community where their useful lifetime can be extended. NEEScentral provides a centralized location for researchers to securely organize, store, and share data and metadata in a nonproprietary format that can be used in data manipulation and visualization tools. To define the structure by which NEES experiment data are organized, the NEES Data Model was developed, which represents classes of entities and relationships to provide essential data for reproducing experimental and computational simulation results. It is based on a hierarchical structure, consisting of Projects, Experiments, Trials and Repetitions, that collects highly detailed information from each experiment or computational simulation in order to be able to reproduce the research. The NEEScentral Data Repository and supporting data model provide a data management infrastructure to shorten the gap between research and practice through long-term preservation and sharing of data. The ultimate goal is to provide access to different types of experimental and computational data to promote and facilitate collaborative and interactive processes required to address the complex nature of seismic events and their physical and societal impacts, ultimately reducing vulnerabilities from earthquakes.

Load Testing on Boeing's 787 Landing Gear Components

Principal Investigator: Professor Hyonny Kim; Co-Principal Investigator: Dr. Gianmario Benzoni

Professor Kim and Dr. Benzoni recently conducted the Federal Aviation Administration (FAA) certification testing of landing gear components for the new Boeing 787 aircraft. These components were made by Messier-Dowty using advanced composite materials. The parts were subjected to loads exceeding 1 million pounds using the Powell Lab's unique Seismic Response Modification Device (SRMD) test facility, of which Dr. Benzoni is the Project Manager.

Virtual Vecchio: Creating a Digital Clinical Chart for a Landmark Building of the Renaissance

Principal Investigator: Professor Maurizio Seracini; Co-Principal Investigator: Professor Falko Kuester

Professors Seracini and Kuester are developing a "digital clinical chart" for the Palazzo Vecchio in Florence, Italy, part of Calit2's cultural heritage preservation initiative. Their team spent two months in 2007 and 2008 laser-scanning and imaging the interior of the Palazzo's main hall. The goal: to understand the structure's performance and changes over time, and hopefully, to help find Leonardo da Vinci's long-lost masterpiece mural, "The Battle of Anghiari." They have created an interactive 3-D model based on 60 gigabytes of data collected in Florence, including x-y-z coordinates for 2.5 billion points generated from the laser scans in combination with color values for each point, based on giga pixel photography. This model serves as the baseline and reference for a broad range of multi-spectral imaging techniques that already have been acquired, such as GPR (Ground Penetrating Radar), Thermography, NIR (Near Infrared Reflectography), mmw and THz Tomography. Professor Kuester's team is currently developing algorithms and techniques needed to visualize and analyze this massive model, on the 286-million-pixel resolution HIPerSpace display, the highest-resolution such display in the world. Additionally, the team is studying the Palazzo Medici to better understand its history, structural integrity and hidden treasures. This research is made possible, in part, through generous support by SE's Adjunct Professor, Robert Englekirk, and his wife, Natalie, along with Paul and Stacy Jacobs, Sandra Timmons, Richard Sandstrom, and the Chancellor's Interdisciplinary Collaboratories Fund.

> faculty <

Professor Robert J. Asaro, Ph.D.—Experimental and computational studies of nonlinear material behavior. Marine civil structural design. Advanced structural materials.

Assistant Professor Yuri Bazilevs, Ph.D.—Fluid-structure interaction. Vascular blood flow. Turbulence. Isogeometric analysis.

Professor David J. Benson, Ph.D.— Computational mechanics. Solid mechanics. Materials Science.

Professor Joel P. Conte, Ph.D.—Structural reliability and risk analysis. Probabilistic design. Computational structural mechanics. Experimental structural dynamics. System identification. Structural health monitoring.

Professor Ahmed Elgamal, Ph.D.— Health monitoring sensor networks, database and data mining applications. Computational and experimental simulation of soil/structure systems. Seismic load mitigation solutions.

Adjunct Professor Robert Englekirk, Ph.D., P.E.—Reinforced concrete. Design of buildings and bridges. Seismic response of mid-rise buildings. Large-scale structural analysis and design.

Adjunct Professor Charles Farrar, Ph.D.—Integrated approaches to Structural Health Monitoring. Damage detection. Damage prognosis technologies and solutions.

Professor and Chair Gilbert Hegemier, Ph.D.—Blast mitigation. Mechanics of composite materials with applications to aerospace and civil structures. Infrastructure renewal via composites. Large-scale experiments on structures.

Associate Professor Tara Hutchinson, Ph.D., P.E.—Experimental and analytical studies in earthquake engineering. Seismic performance assessment of structures. Soil-structure interaction. Seismic response of concrete and timber structures. Response of non-structural components.

Associate Professor Hyonny Kim, Ph.D.—Mechanics of composite structures and materials. Failure prediction of adhesive joints. Multifunctional composite materials. Hail ice impacts. Characterization and modeling of ice material. Buckling and stability of composite structures. Nano-structured materials and modeling.

Professor John B. Kosmatka, Ph.D., P.E.—Advanced composites for aerospace, civil, and sports structures. Linear and nonlinear structural dynamics, stability, aeroelasticity, and structural health monitoring. Vibration control using embedded passive and electro-active materials.

Associate Professor Petr Krysl, Ph.D.—Computational analysis of solids and structures with finite element and element-free methods. Computer-aided geometric analysis and design. Computational biomechanics and bioacoustics.

Associate Professor Falko Kuester, Ph.D.—Tera-scale scientific visualization and virtual reality. Image-based modeling and rendering. Distributed and remote visualization.

Professor Francesco Lanza di Scalea, Ph.D.—Nondestructive evaluation. Structural health monitoring. Wave-based diagnostic systems for smart structures. Time-frequency processing. Experimental mechanics.

Professor J. Enrique Luco, Ph.D.—Earthquake engineering. Strong motion seismology. Wave propagation in solids. Dynamics. Soil-structure interaction. Foundations. Active control of seismic response of structures. Effects of topography on earthquake ground motion.

Professor Emeritus M. J. Nigel Priestley, Ph.D.—Seismic design of concrete and masonry structures. Seismic design philosophy.

Associate Professor Yu Qiao, Ph.D.—High performance infrastructural materials. Novel applications of nanoporous technology in damping and intelligent structures. Size effects in thin solid films. Energy-related materials.

Professor José I. Restrepo, Ph.D.—Seismic design and retrofit of buildings and bridges. Development of construction alternatives suited to performance-based design. Large-scale shake-table tests, and nonlinear dynamic response of buildings and structural components.

Professor and Dean Frieder Seible, Ph.D., P.E.—Bridge design. Earthquake engineering. Structural concrete and advanced composite design. Large-scale structural testing.

Adjunct Professor Maurizio Seracini, Ph.D.—Collaborative work on mapping ancient works using visualization technologies. Decay and diagnosis of materials in historical buildings. Thermographic analysis of wall structures. Restoration of historical monuments.

Professor and Vice-Chair P. Benson Shing, Ph.D.—Theoretical and experimental investigations of nonlinear behavior of concrete and masonry structures under extreme static and dynamic loads, including nonlinear finite element modeling and large-scale testing.

Associate Professor and Vice-Chair Michael D. Todd, Ph.D.—Structural health monitoring methodologies. Applied nonlinear dynamics and chaos. Structural dynamics and vibrations. Time series analysis. Fiber optic sensors for structural monitoring.

Professor Chia-Ming Uang, Ph.D.—Seismic design of steel structures. Earthquake engineering. Seismic design methodology. Large-scale testing. Seismic design of wood frame structures.

Lecturer Yael ("Lelli") Van Den Einde, Ph.D.—Performance-based earthquake engineering. Large-scale experimentation. Data management. Cyberinfrastructure. Curriculum development.

Assistant Professor Qiang Zhu, Ph.D.—Nonlinear free-surface waves, wave-body interactions. Dynamics of highly-flexible mooring systems. Computational simulation of offshore structures. Locomotion of aquatic creatures. Modeling of biopolymers.

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