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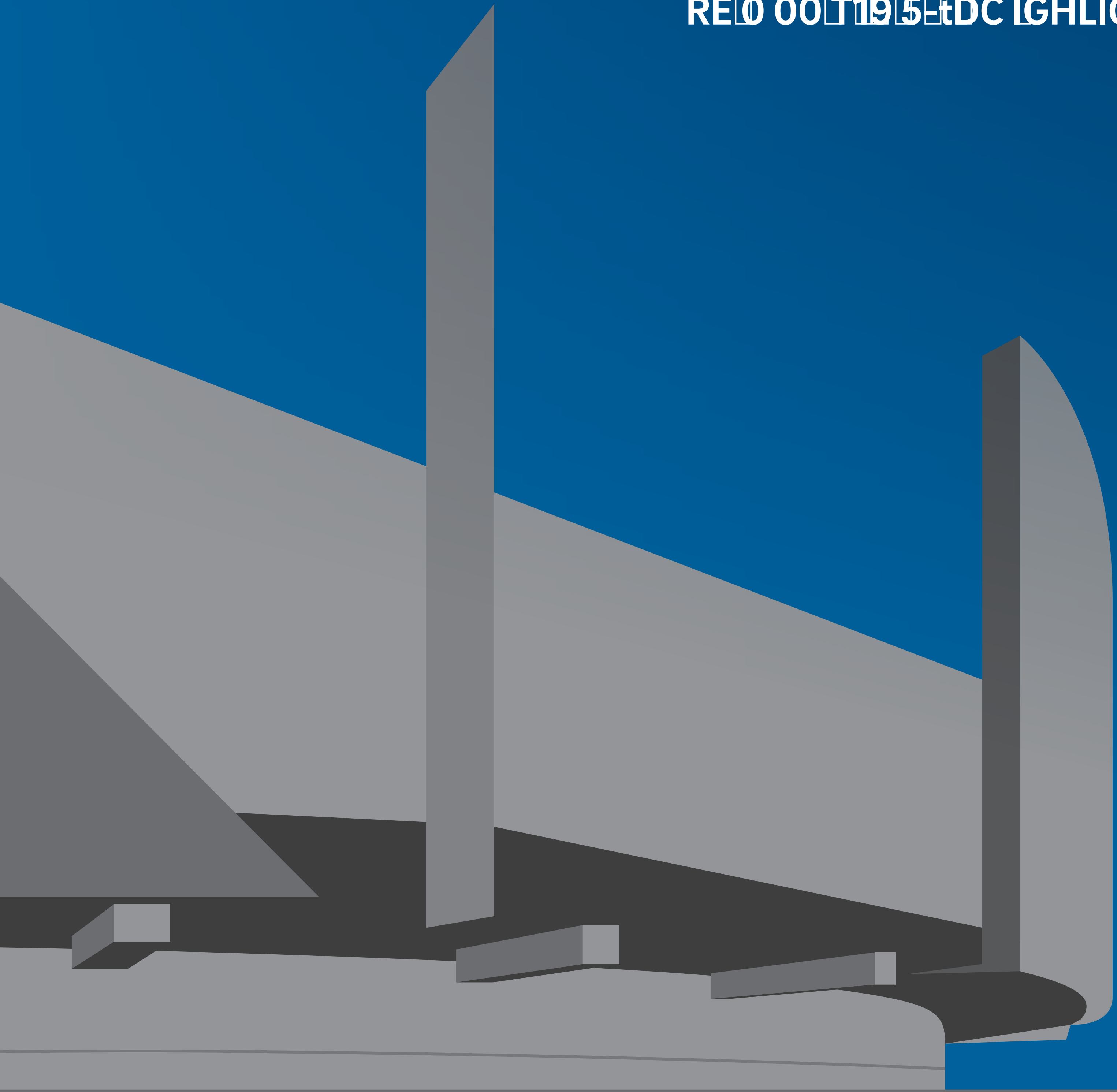

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The 183,000-square-foot building houses the Structural Engineering Department, Nano-engineering, a Medical Devices group, the EnVision Maker Studio and parts of the Visual Arts department. The building includes 62 research and instructional laboratories, 160 faculty, graduate student and staff offices, 12 Visual Arts studios distributed across all four building's floors, art exhibition and performance space, and Cymer Conference Center. Frieder Seible, the former Dean of the Jacobs School of Engineering, remarked, "The hope and aspiration for this building is that it is not a physical location for four seemingly disparate academic units, but that it will be transformational for our campus and how we collaborate in our research and education mission."

[illegible] In 2005, the Englekirk Structural Engineering Center opened as an expansion of the Powell Labs, equipped with the world's first outdoor shake table. It is adjacent to the country's largest Soil Foundation-Structure Interaction Testing Facility. The Blast Simulator, housed in the Center, is the world's first laboratory to simulate the effects of bombs without the use of explosive materials.

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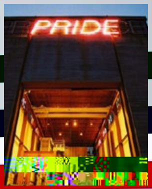
The Charles Lee Powell Structural Research Laboratories are among the largest and most active full-scale structural testing facilities in the world. With its 50 ft. tall reaction wall and 120 ft. long strong floor, the Structural Systems Laboratory is equipped for full-scale testing of bridges, buildings and aircraft. The Structural Components Laboratory includes a 10 x 16 ft. shake table for realistic earthquake simulations. The main testing facility was dedicated in 1986. Throughout the years, additional facilities have been added as the scope and nature of Powell Labs research has expanded.



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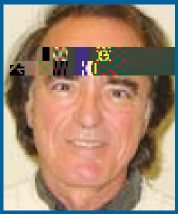
[illegible] One of the world's largest shake tables, the six-degree-of-freedom shake table is used for the dynamic testing of full-scale base-isolation bearings, and dampers. Computer-controlled hydraulic actuators that can apply up to 12 million pounds of force during earthquake simulations power the SRMD.

Jacqueline Vo
A.S. Graphic Studio



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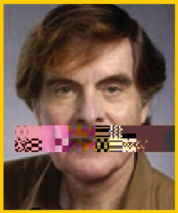
Professor

Composite design and manufacturing technologies for large scale structures and marine applications as welles



[illegible]

Distinguished Professor Emeritus

Earthquake engineering to retrofit bridges, roadways and buildings for improved public safety and structural performance.

[illegible]

Distinguished Professor Emeritus

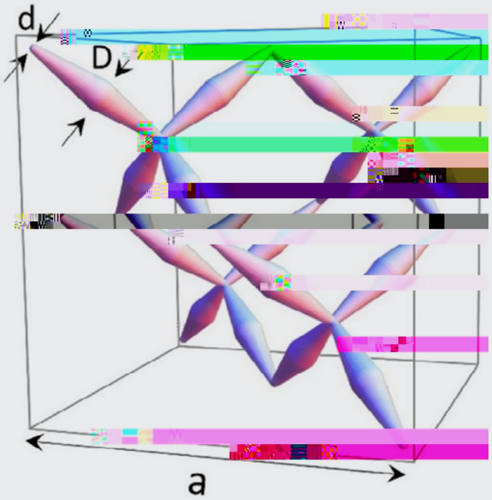
Earthquake engineering, strong motion seismology, soil structure interaction.

[illegible]

Distinguished Professor Emeritus

Design and retrofit of buildings and bridges for earthquake safety, new technologies to renew the en-US/Lang (en-

Steel special moment frame is widely used for multistory building construction in high seismic regions due to its excellent ductility capacity and architectural versatility. To control lateral deflection, design engineers also prefer to use “deep” columns to gain higher flexural stiffness. While a significant amount of research has been conducted on the cyclic performance of beams and beam-to-column connections, research on columns, especially deep columns, is very limited. This study showed that deep, slender columns were prone to local buckling and significant axial shortening, a phenomenon typically not captured in nonlinear finite element simulation. Column global buckling would occur when not only the member slenderness ratio was high but also more compact sections were used that caused significant strain hardening. Based on the test results, criteria that would limit the amount of local buckling to ensure sufficient column rotation capacities



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The ability of pentamode lattices to have both very soft and very stiff deformation modes suggests they are potentially suitable for use as seismic isolators. Unlike most other seismic isolators, where the response depends entirely on the properties of the materials used, the response of pentamode lattices depends mostly on their geometry. This is advantageous, as their response can be easily tuned by altering the geometry to control the vertical and horizontal stiffness for each application.

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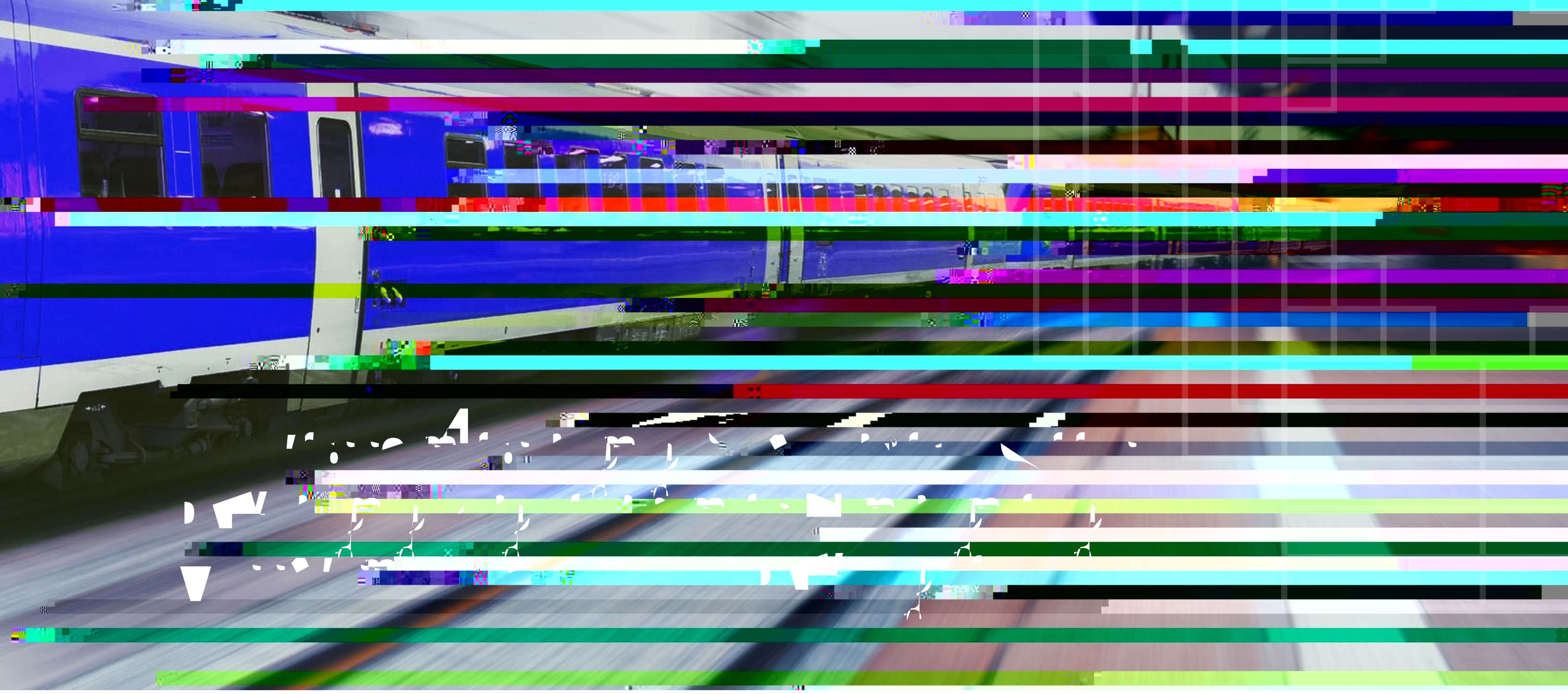
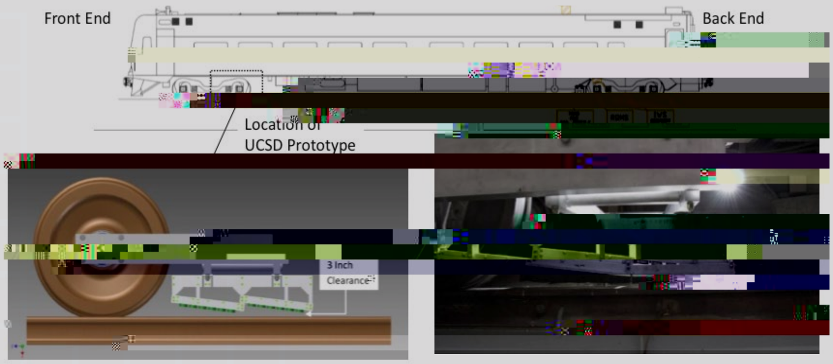
Seismic isolation is one of the most effective strategy to protect critical facilities including



Internal defects in rails cause a number of train accidents worldwide, including derailments. Current rail inspection systems use ultrasonic transducers hosted in fluid-filled wheels to detect internal cracks before they reach critical size. These systems are operated at a maximum speed of 25-30 mph by dedicated inspection vehicles that need to be scheduled during normal train operations.

Under Federal Railroad Administration (FRA) funding, UCSD is working on a radically new method to inspect rails that can enable “smart trains” to conduct the inspection at regular traffic speeds (80 mph and beyond). The approach is based on the idea of passive reconstruction of an acoustic transfer function between two points of the rail by cross-correlating (and opportunely normalizing) apparently-random measurements of dynamic excitations naturally occurring in the rail due to the rotating wheels of a traveling train. A system based on this idea was designed and constructed using pairs of non-contact air-coupled acoustic receivers. Special signal processing algorithms are being developed to increase the stability of the passively-reconstructed transfer function, i.e. minimize the variance and bias of the transfer function’s estimate. A prototype has been tested at the Transportation Technology Center (TTC) in Pueblo, CO, the premiere testing facility in the country for railroad engineering research. For these tests, the UCSD prototype was mounted underneath the FRA DOTX216 test car. Very promising results were obtained at speeds up to 80 mph, with positive identification of rail discontinuities (joints, welds , defects) from changes in the passively-reconstructed transfer function solely using the train wheels as the dynamic excitation of the rail.



Passive-only rail inspection prototype mounted on DOTX216 car during field test at TTC.

Sample of inspection results at 80 mph test speed (TTCI RTT track)

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Shale is a highly heterogeneous material at multiple scales. A typical shale has a complex microstructure comprised of nanometer-scale pores and minerals mixed with macro-scale fractures and particles of varying size. Computational modeling of this complex and highly heterogeneous rock requires detailed characterization of heterogeneities and microstructure of the material using imaging and visualization techniques. Advances in high-resolution imaging capabilities have made it possible to image heterogeneous materials down to the nano-scale resolution. However, it is generally not feasible to image a large sample of shale at a high resolution over a large field of view (FOV), thus limiting a full characterization of the microstructure of this material. We have developed a statistical framework that uses high-resolution images to enhance low-resolution images obtained over a large FOV. The approach has been demonstrated using X-ray micro-tomography images of organic-rich Woodford shale obtained at different resolutions and FOV.

Multiscale imaging of shale. A single slice of shale with pixel size of 4.14 um, obtained using a low-resolution micro-tomography scan, is shown in (a), and the marked region is enlarged in (b). (c) Illustrates the same region shown in (b) obtained using a micro-tomography scan with a pixel size of 0.517 um. Region 3 marked in (b, c) is enlarged in (d, e), respectively, showing small pyrite particles, framboids, pores/organics, and matrix of low-density minerals and clay, which appear as a blurred range of gray values in the low-resolution image (after Semnani and Borja, 2017)

Hydrodynamic interaction between bridge piers and river water causes erosion at the base of the pier, known as scour, which can undermine structural integrity and ultimately lead to bridge failure. The ARMOR Lab, funded by the U.S. Army Corp of Engineers (under a project led by Prof. Michael Todd), is developing a scour monitoring system that can function even under the most extreme river conditions. A piezoelectric polymer was embedded inside of a flexible, water-resistant, cylinder that can be easily driven into the sediment around a pier. Due to the nature of piezoelectric materials, this sensor requires no external power, making monitoring completely passive. As the river flows, the cylindrical structure vibrates, and the sensor outputs a voltage in response to vibration of the rod. This voltage time history can be processed in t-US[illegible]iền-UT9 Tw 9 0 0(w)7 (s,)16.8 (the cylindrical)12.1 (time ding19.8 d)21.8corrical.8 (vibr)6 (

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There is an increasing demand in minimizing cost associated with operation and manufacturing, weight while maximizing a structure's functional performance across all engineering sectors. With the recent advances in materials, manufacturing technology, digital engineering and model based engineering, we crystalize the benefits of these technologies in a structural design by developing high fidelity optimization methods and create novel and unintuitive multifunctional structures applicable to aerospace, marine, automotive, robotics, medical, built structures and materials.

Our current research is in design optimization of coupled multiscale and multiphysics problems and our primary interest is in developing Topology Optimization (TO) as it is capable to exploring the largest design space and provide the most creative and the best performing structures. Multiscale TO considers the simultaneous design of materials and structures crossing giga-resolution features. This allows the concept of an integrated material-structural system where multiple materials are specifically tailored to the structural functional requirements instead of simply selecting from existing materials. We have shown that our optimization will find the optimal material whether it is a specific microlattice or porous material, metamaterial, graded composite material or the traditional solid isotropic material and the corresponding structural design for the optimal functionality or functionalities.

An expertise of the M2DO lab is the development of the state of the art level set topology optimization methods. A recent development in this area is the large-scale method, called VDB-LSTO. Inspired by the academy award winning VDB level set method, we formulated the new VDB-LSTO method that can solve orders of magnitude larger problems. Therefore, we are able to discover novel designs that cannot be obtained by the other existing methods.

We are actively engaged in applying level set topology optimization to coupled multiphysics design problems. Modern complex systems have integrated multiple functionalities. For example, an aircraft wing has aerodynamic functionalities as well as the load carrying functionality and it is subjected to multiple failure mechanisms governed by structural mechanics and coupled aeroelasticity. Aircraft engine components are typically subject to three major physics, i.e. aerodynamics, thermodynamics and structural mechanics. Our research formulates such coupled multiphysics optimization for a wide range of complex structural system designs.

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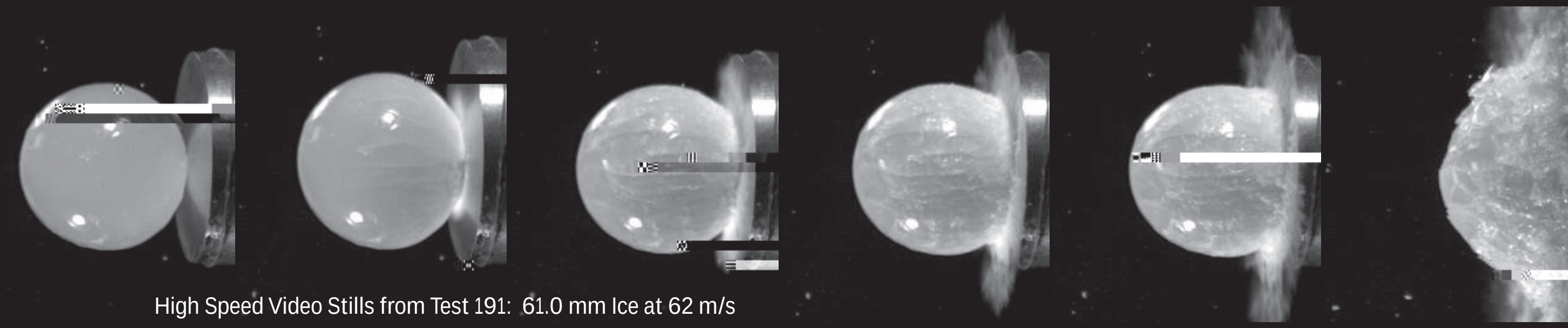
Geosynthetic reinforced soil (GRS) bridge abutments are widely used in transportation infrastructure, and provide many advantages over traditional pile-supported bridge abutments, including lower cost, faster and easier construction, and smoother transition between the bridge beam and approach roadway. However, the adoption of this technology in areas with high seismicity like California is pending until their seismic deformation response is better understood. The objective of an ongoing study funded by Caltrans and a FHWA pooled fund project is to characterize the seismic response of GRS bridge abutments using both shake table tests and numerical simulations. A series of five shaking table tests were performed by Yewei Zheng and the Powell Laboratory staff to investigate the seismic deformation response of half-scale GRS bridge abutments. The tests permit evaluation of the effects of bridge load, reinforcement spacing and stiffness, and shaking direction, and results show that reinforcement spacing and stiffness have the most significant effects on the deformation response. Shaking in the longitudinal direction also resulted in considerable facing displacements in the transverse direction, which indicates the importance of considering three-dimensional (3D) effects. The shaking table data is being used to validate 3D numerical simulations, which will be

If the prospect of a mega-earthquake has you quaking — fear not, because UC San Diego engineers are making sure our world will withstand the rumble. And in addition to using the world's largest outdoor shake table, researchers at the Jacobs School of Engineering also turned to drones to capture the damage from a simulated, large-scale earthquake on a six-story, lightweight steel-frame building on the UC San Diego



High Speed Video Stills from Test 191: 61.0 mm Ice at 62 m/s

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Impact damage to laminated composite aircraft structures, when subjected to in-flight impact by hailstones, can be extensive internally while exhibiting low external visual detectability. Basic research studies have established methods for determining minimum aircraft skin thickness to be resistant from hailstone impacts. Fundamental study of ice behavior and properties enabled establishment of finite element based modeling simulation which accurately represents the ice during impact.

Buildings designed according to current codes in the US are expected to have a low probability of collapse in an extreme seismic event. In specific, ASCE 7 targets a collapse probability of not greater than 10% in a 2,500-year event. To develop effective design specifications to achieve this goal, reliable analytical tools are essential for assessing the collapse potential of a building design. Simulation or