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UNR Structural Engineering Program Continues to Grow

By David Sanders, Professor of Civil and Environmental Engineering, University of Nevada, Reno

In 1984, an ambitious proposal, led by Dr. Bruce Douglas, Professor in the Civil and Environmental Engineering Department at the University of Nevada, Reno (UNR), was submitted to the National Science Foundation for a National Bridge Center to be located in Stead, Nevada. While that proposal was not funded, it laid the ground work for a program that has grown tremendously over the last 27 years.

Last year, the program celebrated the 25th anniversary of the Center for Civil Engineering Earthquake Research (CCEER) at the University of Nevada, Reno. Bridge engineering research and the Nevada Department of Transportation (NDOT) have been a big part of the advancement of the program. In addition to NDOT, other supporters have included the National Science Foundation (NSF), Network for Earthquake Engineering Simulation (NEES), Federal Highway Administration (FHWA), Department of Energy (DOE), Federal Emergency Management Agency (FEMA), Multidisciplinary Center for Earthquake Engineering Research (MCEER), California Department of Transportation (Caltrans), and private companies.

The initial Bridge Structures Laboratory was completed in 1992 (5700 sq. foot strong floor for testing) with funding from the state of Nevada and private sector. The laboratory allowed the program to build a reputation in large scale experimentation with an emphasis on bridges. In 1996, two 50-ton capacity biaxial shake tables were acquired through a grant from FEMA. Once the shake tables were installed, this made it difficult to do large-scale experiments. The lab was extended in 1990 southward 50 feet with principal funding from James E. Rogers, at which time the laboratory was renamed the "James E. Rogers and Louis Wiener Jr. Large-Scale Structures Laboratory."

Figure 1: Site Plan for New Laboratory

The extra space was soon consumed. In 2000, the National Science Foundation asked for proposals to establish a network of laboratories to form the Network for Earthquake Engineering Simulation (NEES). Fifteen sites were awarded

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equipment money with only three shake table sites. The UNR team, with Dr. Ian Buckle as Principal Investigator (PI), was successful in receiving an award to upgrade the two existing uniaxial shake tables to biaxial motion and add a third identical biaxial table. The total budget for this upgrade was approximately $7.2 million and comprised $4.6 million from NSF with cost sharing from the Department of Energy ($1.0 million) and the Department of Housing and Urban Development ($1.6 million). In 2004, the Large Scale Structures Laboratory became part of NEES facilities. Using remaining funds from the NSF-NEES Construction Award, a grant from FHWA, and a contribution from the Office of the Vice President for Research, a fourth shake table was designed, constructed, and commissioned in 2009. This 50-ton table has six degrees-of-freedom [3 translations (x, y, and z) pitch, yaw, and roll] and can be used synchronously with the other three tables or operated independently. With the addition of the fourth shake table, space again became a problem in the laboratory.

Figure 3: New Laboratory Floor used Temporarily for Outdoor Experiments

Figure 2: View from Evans Avenue of the New Building

In 2010, the laboratory received a $12.2 million competitive grant from the National Institute of Standards and Technology to expand the lab strong floor by 9000 sq. feet in a new building that will run perpendicular to the existing laboratory (see Figure 1 (Ian Buckle (PI)). Only five of 125 proposals were funded. The new building will contain 23,000 sq. feet of lab, office and auditorium space (see Fig. 2). In addition, $2.9 million came from US Department of Energy and $3.1 million is to be raised by the University from non-federal funds. The strong floor (80 ft x 120 ft) is of the same style as the current laboratory floor and will be the new home for the shake table facility. This will enable the existing laboratory to be used for large-scale testing. The new facility is being constructed in two phases. The first phase is completed (half the strong floor, fabrication yard, and site works) and is being used for experiments this summer and fall (see Fig. 3). Construction of the remaining portion of the building will continue in the fall of 2011.

One of the projects that will be tested on the outdoor floor this summer is an NDOT project on "Unbonded Prestressed Columns for Accelerated Bridge Construction and Earthquake Resistance". The project PI is David Sanders with Saiid Saiidi as a Co-PI. Two columns will be tested under cyclic loading to determine the ability of columns with unbonded tendons to mitigate damage during a seismic event. Since the 1971 San Fernando, California earthquake, the focus of bridge

seismic engineering has been on life-safety due to the tremendous damage that occurred to bridges during that earthquake. The need to focus on life safety was further emphasized by the 1989 Loma Prieta and the 1994 Northridge, California Earthquakes. These earthquakes exposed insufficient seismic detailing practices for bridges. Since then, bridge design practice has changed substantially and many bridges have been retrofitted. With these new details, bridges will not collapse but post-earthquake damage can be substantial.

Because of the cost of earthquakes, bridge research has turned towards three areas: 1) Repair of damage after an earthquake, 2) Reducing the amount of damage caused by an earthquake, and 3) Finding ways to construct bridges faster, i.e., accelerated bridge construction (ABC). The project funded by NDOT focuses on two of the three target areas. When a column with vertical unbonded post-tensioning is subjected to an earthquake (see Fig. 4), the post-tensioning not only provides part of the column strength but it also provides a restoring force which greatly reduces the amount of residual lateral displacement that exists after the earthquake. In addition these systems have reduced levels of damage. Therefore, the ability of a bridge to stay open after an earthquake is greatly enhanced and any repairs are substantially less.

Figure 5: 3-Span Curved Bridge on 4 Shake Tables

By using post-tensioning, the column can be constructed in segments and then assembled on site. This reduces the onsite construction time. Figure 4 also shows tendons exiting from the side of the footing. This will enable tendons to be replaced if necessary for long-term durability. In an actual bridge footing, the tendons could go through a 180 degree bend and exit out the top of the footing. The unbonded tendons are encapsulated to provide another layer of protection against corrosion.

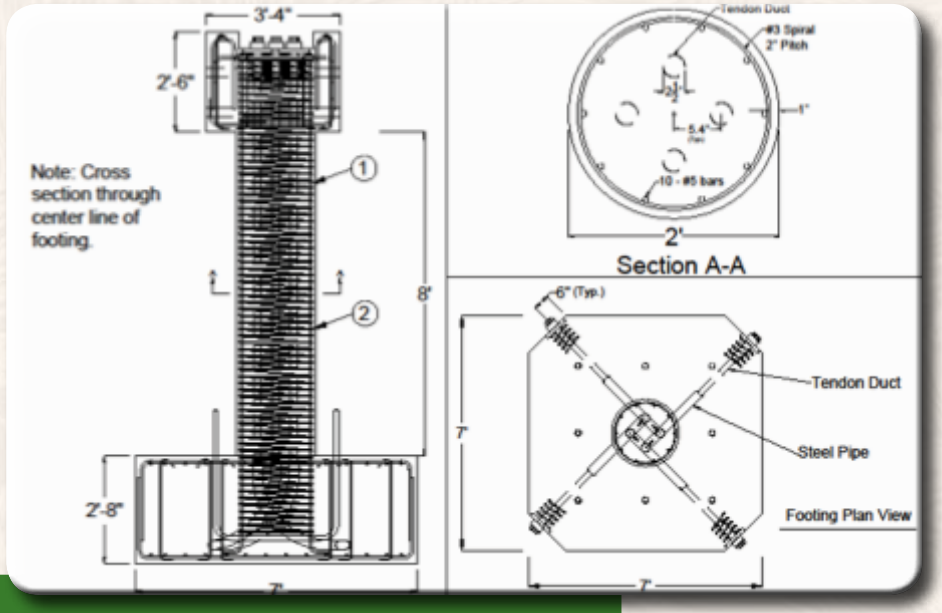

Figure 4: Details of Unbonded Tendon Column

Another exciting project that is currently going on in the laboratory is a 3-span 4-shake table curved bridge (see Fig. 5). This project is supported by FHWA with Ian Buckle as PI, and Ahmad Itani, Gokhan Pekcan and David Sanders as co-PIs. The laboratory program will consist of 6 experiments: Conventional, Conventional plus Live Load (supplement from Caltrans), Isolated, Hybrid Isolation with Ductile Cross Frames, Abutment Pounding, and Rocking Columns. The project demonstrates the emphasis on system testing and has a substantial analytical component. The first experiment will be done this summer.

PRODUCT EVALUATION COMMITTEE (PEC) JUNE 13, 2011, MEETING SUMMARY

The Product Evaluation Committee met on June 13, 2011 and the following recommendations were made:

- Add new QPL Category 408.02.05; All Weather Asphalt Cold Patch.
- Add new QPL Category 623.02.31, Driver Feedback Signs.
- Remove QPL Category 619.03.01, Reflectors Prismatic, Acrylic.

The Product Evaluation Committee also discussed legislative amendments to the anti - graffiti law.

The next Product Evaluation Committee meeting is Tuesday, September 13, 2011, at 1:30 p.m. in the third floor conference room of the Nevada Department of Transportation headquarters.

Library Corner

The library is here to help! It holds a large selection of magazines, journals, study materials, and publications from AASHTO, FHWA, TRB, TRR, and US DOT. If the library doesn't have what you want, the librarian can get it! We can purchase items for the library that you feel would be beneficial for everyone to have access to as well! The library is located in room 115 of the NDOT Headquarters building.

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When requesting articles or other materials from the library please include as much of the following information as you can:

• Author • Year • Article Title • Journal Title • Volume Number • Issue Number • Page Numbers (inclusive) • Subject • Any other information you think might help!

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If you have comments or need additional information regarding any of the topics discussed in this issue, please contact the Research Section. Edited by: Gizachew Zewdu

Contact Information • Research Section
1263 S. Stewart Street Rm. 115 • Carson City, NV 89712
Phone: 775-888-7223 • Fax: 775-888-7203

Research Chief
Ken Chambers
kchambers@dot.state.nv.us
775-888-7220

Research Coord.
Manju Kumar
mkumar@dot.state.nv.us
775-888-7803

Product Evaluation Coord.
Roma Clewell
rclewell@dot.state.nv.us
775-888-7894

Research Analyst
Gizachew Zewdu
gzewdu@dot.state.nv.us
775-888-7223

Research Librarian
Sena Loyd
sloyd@dot.state.nv.us
775-888-7895