

## Iowa State University

### Introduction

Iowa State University (ISU) of Science and Technology, the nation's first public land-grant institution, serves the people of Iowa, the nation, and the world through its interrelated programs of instruction, research, extension, and professional service. In academic year 2003–2004, enrollment topped 27,000 students (with more than 4,700 in graduate programs).

The College of Engineering at Iowa State has a stellar heritage in civil and construction engineering. In the early years of the 20th century, the college's first dean, Anson Marston, established Iowa State's leadership role in highway and bridge system research. He led the movement to establish the national Highway Research Board (today's Transportation Research Board) and served as its first chair.

Today, Iowa State's College of Engineering is ranked one of the best in the nation by *U.S. News and World Report*, and its construction engineering program is the top of only six accredited programs in the country, according to the Gourman Report.

### Research Areas and Programs

Established in 1988, the Bridge Engineering Center (BEC) is one of several transportation-related programs at Iowa State to continue Anson Marston's standard of excellence. Since 2000, the BEC has been housed at Iowa State's Center for Transportation Research and Education (CTRE). Still closely aligned with the university's Department of Civil, Construction and Environmental Engineering (CCEE) in the College of Engineering, the BEC conducts research in several areas:

- Structural health monitoring of bridges
- Performance evaluation for improved design efficiency
- Strengthening and field testing of bridges
- Structural dynamic behavior of bridges
- Forensic engineering and failure investigation
- Nondestructive evaluation

In addition to its close working relationship with the Office of Bridges and Structures at the Iowa Department of Transportation, the BEC has a number of partnerships:

- City and county governments in Iowa and surrounding states
- Federal Highway Administration
- State and federal departments of energy, natural resources, and other related agencies

- Industry associations
- Regional and national transportation coalitions
- Private sector industries and consultants

### BEC Timber Bridge Program

Since the mid 1980s, Iowa State University has had an active timber bridge program. A significant and important part of this program has included the field testing of bridges. In addition to a strong research component, the program also includes extension and classroom activities.

Education -- Iowa State University's CCEE Department offers an undergraduate–graduate timber design course. Timber bridge design has also been taught as one component of the undergraduate–graduate structural engineering capstone design course. In addition, a three-credit independent study summer course focusing on timber bridge design has been regularly offered during the past 5 years. Several of the dozen graduate students who currently serve as research assistants with the BEC have worked on timber bridge-related projects such as developing live load deflection criteria for timber bridges.

Extension -- The CCEE Department has a long history of civil engineering extension for engineering practitioners in the transportation area. BEC staff has participated in extension bridge engineering workshops in the past that have also included timber bridge design and rating modules. Several research projects that focused on timber bridge alternatives for bridge replacement have produced design manual information and software.

Research -- The BEC has been involved in timber bridge research since the 1980s. The research has included the development of timber bridge specifications for AASHTO Design Specifications as well as considerable field testing and evaluation of both highway and railroad bridges. Bridges have been tested in numerous states, including New York, Pennsylvania, Alabama, Texas, Washington, Oregon, Wisconsin, Iowa, and Montana. The staff also contributed to the development of timber bridge technical publications and technical presentations that have resulted from the research. Summaries of the following projects are available by following the links (most recent projects listed first):

- Evaluation of a timber bridge for the secondary road system using FRP reinforced glulam girders
- Development of acceptable live load deflection criteria for various timber superstructure and deck types

- Evaluation of the effectiveness of glued laminated helper stringers
- Maintenance, repair, and rehabilitation of low volume road bridges
- Development of bridge load testing for load evaluation TR-445
- Development of modeling preprocessors and postprocessors for evaluation of timber bridges
- Field testing and evaluation of three rehabilitated timber railroad bridges
- Dynamic performance of timber bridges
- Research needs assessment for wood transportation structures
- Development of design criteria for longitudinal glued laminated timber deck bridges
- Behavior of longitudinal glued laminated timber deck bridges

#### *Field testing of timber bridges*

As noted above, much of the timber bridge research has focused on field testing of bridges across the country. These “field laboratories” (locations identified on the map) have been important in the education process for many students and have also resulted in practical and useful experimental data.

#### *Center for Transportation Research and Education*

The Bridge Engineering Center is housed and administered by the Center for Transportation Research and Education (CTRE), Iowa State’s focal point for transportation-related research, education, and outreach.

CTRE manages nine major long-term sponsored programs and \$7 million annually in sponsored funding. Together with the BEC, several of these efforts—such as integrating pavement materials and construction practices, advancing the state of the science of geotechnicals, pavement and bridge management systems—represent a complementary, coordinated physical research and technology transfer program for roadway and bridge systems. The BEC benefits from the cooperative synergy among these programs that comes from sharing CTRE’s physical space, academic and technical expertise, and support services.

#### **Research Facilities and Capabilities**

The BEC is located in CTRE’s 14,000-ft<sup>2</sup> office suite in Iowa State University’s Research Park, roughly three miles from both the university campus and the Iowa Department of Transportation’s headquarters in Ames, Iowa. The facility includes the following:

- Geographic information systems (GIS) lab (eight computers plus peripherals—digitizing table, flatbed scanner—used for application of GIS for transportation)

- Computer training lab that accommodates up to 40 students for hands-on training
- Videoconference classroom
- State-of-the-art computing hardware and software, including desktop publishing equipment and a T1 connection to the university’s communications backbone
- Transportation technology transfer library
- Remote Monitoring Laboratory

Consisting of a central command center located at CTRE and several remote sites, the Remote Monitoring Laboratory (RML) seeks to develop, demonstrate, and implement low-cost, easy-to-use technologies for monitoring the built world. Data from a variety of sites (such as bridges, rivers, construction sites, and other locations) can be streamed, in real-time in many cases, to the RML for immediate analysis, storage, and post-processing. The RML command center consists of several computer workstations, video projection capabilities, a server with more than a terabyte of storage, and high-speed internet access.

In addition to these CTRE facilities, BEC staff has access to a variety of resources at Iowa State University and the Iowa Department of Transportation. The following facilities are maintained by the Department of Civil, Construction and Environmental Engineering at ISU:

#### *Structural Engineering Research Laboratory*

Consisting of five rooms, including a 6,900-ft<sup>2</sup> facility, the lab provides an 80- by 50-ft main testing area and an 80- by 25-ft tie-down floor with a million pound capacity, a 20-ton overhead crane, and electronic and computer equipment for controlling experiments and data logging. Major equipment includes a 400,000-lb capacity universal testing machine for applying tension and compression loading (part of the Livesay Structural Materials Testing Facility). An MTS 110,000-lb capacity materials fatigue machine is also used for dynamic and cyclic load testing. Numerous hydraulic actuators are used for testing that have capacities ranging from 5 to 200 ton and strokes up to 18 in. Two MTS 55,000-lb capacity structural actuators controlled by an MTS TestStar II controller are typically used for large specimen static and dynamic testing. A single 150,000-lb push and a 110,000-lb pull actuator with a 24-in. stroke are also available. Four data acquisition systems with reading rates up to 250,000 samples per second and five remote monitoring systems that can be controlled by modem, cellular or radio telemetry are also part of the facility.

#### *Wallace W. and Julia B. Sanders Structural Laboratory*

A second 80-by-50 ft lab is also part of the structural testing facilities. This area has an 80- by 24-ft reaction floor with 300,000-lb capacity loading points on a 3-ft grid and a 15-ton overhead crane. Additional testing space is located off campus at the Iowa State University Spangler Laboratory.

This location provides outdoor testing space most recently used to study soil-structure interaction of bridge pier columns.

#### *Geotechnical Engineering Laboratory*

This facility includes equipment for index tests and classification of soils and aggregates, as well as for permeability, strength, and stress-strain characteristics.

#### *Center for Nondestructive Evaluation*

The Center for nondestructive evaluation (CNDE) at Iowa State University is an interdisciplinary group of scientists, students, and support staff working in close cooperation with industry to advance the field of nondestructive evaluation. CNDE employs more than 50 faculty and staff, including investigators drawn from nearly all departments of the College of Engineering and selected departments in other colleges. The core of CNDE is the Industry/University Cooperative Research Center (IUCRC) in NDE, established by the National Science Foundation in 1985.

#### *Computer and Communications Facilities*

In 2000, Yahoo! *Internet Life* magazine ranked Iowa State as one of the nation's 20 "most wired" universities and research schools. Iowa State's high-speed computing network supports services for instruction and research and access to off-campus sites, including those offering supercomputers.

#### *Parks Library*

The university library collections total more than 2.2 million volumes, close to 22,000 currently received journals and serial publications, and nearly 3 million microforms, as well as maps, photographs, manuscripts, and other archival materials.

#### *Iowa State University Extension*

CTRE partners with and shares many of the outreach facilities and resources of Iowa State University Extension, particularly Engineering Extension and Extension to Communities.

#### *Iowa Department of Transportation Library*

The Iowa DOT manages an excellent transportation library and keeps copies of many specialty publications, which CTRE students and staff may access. This library also provides access to the Transportation Research Information Service (TRIS) and associated resources.

#### *Iowa Department of Transportation Materials Laboratory*

Certified by the American Association of State Highway and Transportation Officials (AASHTO), this lab provides equipment and expertise for materials quality verification and specification compliance testing, as well as pavement performance testing.

#### Staff and Contact Information

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#### Links

- Bridge Engineering Center -- <http://www.ctre.iastate.edu/bec/index.cfm>
- Timber Bridge Program -- <http://www.ctre.iastate.edu/bec/timber.cfm>
- Center for Transportation Research and Education -- <http://www.ctre.iastate.edu/>
- Department of Civil, Construction and Environmental Engineering -- <http://www.ccee.iastate.edu/>

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