전산구조탐방

♣ 연구소 소개 ♣

Center for Structural Engineering, Mechanics and Materials Georgia Institute of Technology

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1. Introduction

Center for Structural Engineering, Mechanics and Materials at Georgia Institute of Technology is trying to offer structural analysts and applied mechanicians instruction and research in structural analysis and design, behavior of structural systems, earthquake engineering, engineering science and mechanics, high-performance materials, computer-aided engineering, and intelligent engineering learning environments. This research center is equipped with state-of-the-art structural engineering and materials laboratories, instrumentation facilities, and machines shops. The laboratory includes a broad range of testing equipment and instrumentation appropriate for research in all aspects of modern structural engineering, mechanics, and materials research problems. In addition, the computing environment of the center is ranged from numerous computer clusters of Personal Computers, Macintosh, and UNIX workstations(such as SUN, Silicon Graphics, IBM, and HP) to parallel supercomputers. The experimental research, test, and evaluation capabilities at Georgia Institute of Technology have been significantly enhanced by the addition of this Structural Engineering, Mechanics and Materials Laboratory(see Figure 1).

Figure 1 Laboratory overview

2. Experimental Facilities

The facility of the laboratory includes a strong

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floor 174-ft. long, with widths ranging from 41 ft. to 53.5 ft., for a total testing area of over 8,000 ft^2. The floor has anchor points on a 4ft. grid throughout the entire testing floor, with a service load capacity of 200 kips each. The anchors consist of a set of four large Dywidag inserts that allow post-tensioning of reaction frames to the floor. The facility also includes an L-shaped reaction wall, with anchor points on a 4-ft. grid and capacities ranging up to 300 kips at a height of 32 ft. The main wall is 53.5 ft. long and 34 ft. high. The adjoining wall height varies from 34 ft to 24 ft and is 55 ft long. Each wall is 2 ft. thick, with 12 ft. buttresses 12 ft. on center. The wall system is designed to carry about 30,000 kip-ft of overturning moment in each principal direction, allowing for bi-directional testing of full-scale three-story two-bay specimens.

A high pressure, high capacity MTS hydraulic system is distributed throughout the testing bay with modular ports to facilitate quick and flexible testing setup. The main hydraulic pump is a 150-gpm unit with a planned upgrade to 300 gpm. Several smaller pumps, ranging from 21 to 55 gpm capacity also are available for stand-alone testing. Two 30-ton bridge cranes service the main testing bay, which has a total clear height of 38 ft. Modern structural testing equipment includes several digitally controlled servo-hydraulic rams with up to 30-in. stroke and 328 kip capacity. Four new OPTIM data acquisition systems for laboratory and field use are available with capacities up to several hundred channels and for a large variety of sensor inputs. Testing machines include a Riehle 400 kips screw-type universal testing machine with an opening 15 ft. high and 4 ft. wide; a state-of-the-art MTS 810 system with a capacity of 55 kips, hydraulic grips, and environmental testing chamber; and a SATEC 800 kips compression machine.

Another key element in this laboratory is a unique, large environmental chamber(see Figure 2)

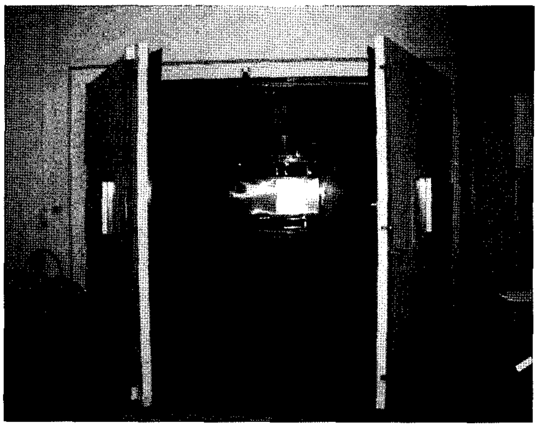

Figure 2 Environmental chamber in the laboratory

suitable for studying full size structural components under various combinations of loading and environmental conditions. This chamber is 19 ft long, 13 ft wide and 12 ft high with cyclic temperature range from -40℉ to 180℉, relative humidity range from 20% to 95%, fresh and salt water spray, and UV exposure. The laboratory also has a 400 ft^2 room having the ability to maintain constant temperature and humidity level for long-term material and structural component evaluation, a 1400 ft^2 concrete mixing and preparation facility with full ASTM test apparatus, plus a fog room, and polymer composites preparation room, and other material and testing areas.

3. Research and Development

The center's academic and research activities have attained an international reputation for excellence in areas such as computer-aided engineering; cladding effects on, and hybrid control of, the response of tall buildings to earthquake and wind; steel connection design and behavior, and the creative use of advanced structural materials and composite systems to improve the infrastructure. Current work in the laboratory also includes tests on high performance concrete girders, retrofit of bridge components using advanced polymer composite materials, bolted steel connections subjected to cyclic loads, seismic retrofit of bridges using cable restrainers, and innovative polymeric composite decks for bridges and wharves.

3.1 High-Performance Materials

Experimental and analytical programs are being conducted for assessing the capacity of fiber-reinforced polymer(FRP) composites(see Figures 3, 4 and 5), high performance concrete(HPC), and high-performance steel(HPS) for use in new construction and in the rehabilitation of aging infrastructure. Particular emphasis is placed on the development of:

- Design guidelines for FRP structural systems under static and dynamic loads in adverse environmental conditions
- Modular FRP deck concepts for building, bridge, and offshore applications
- Development of new optimized polymer composite structural shapes
- Development of polymer composite railroad crossties
- Cyclic testing and analytical evaluation of advanced cladding connections
- Design of HPC mixes for strength and durability
- Applications of HPC to bridge prestressed girders
- Innovative repair and rehabilitation technologies
- Detection of damage in FRP composites and concrete with ultrasonic waves
- Application of optical techniques for quantitative nondestructive evaluation
- Strength ductility of high-performance steel components

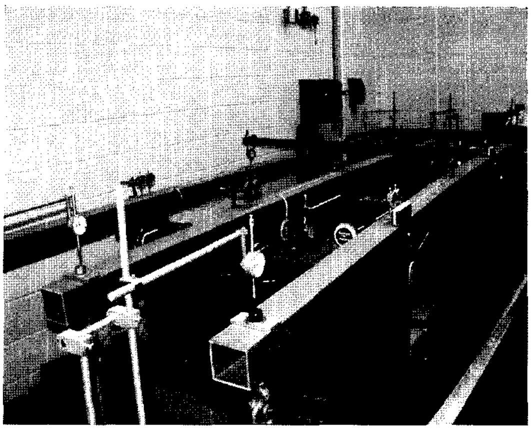

Figure 3 Creep tests for FRP structural tubing sections

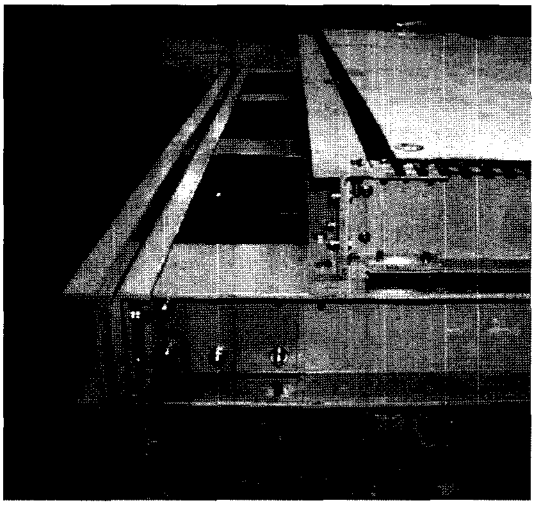

Figure 4 FRP composite bridge deck assembly

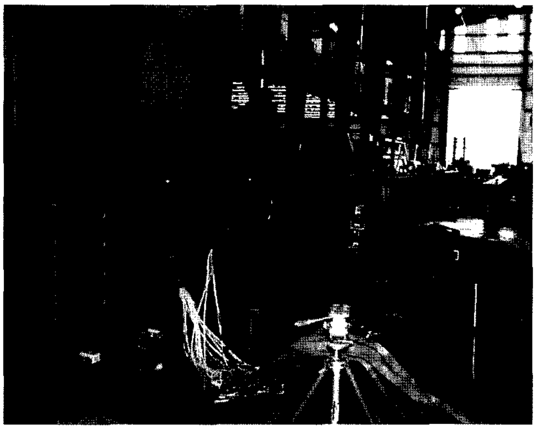

Figure 5 Shear test for Pultruded I-beam

3.2 Seismic Hazard Mitigation

Experimental and analytical research is being conducted in multidisciplinary areas of earthquake engineering and seismic hazard mitigation(see Figures 6 and 7). The Georgia Tech's Center for Structural Engineering, Mechanics and Materials is one of the seven Core Institutions in the NSF-funded Mid-America Earthquake(MAE) Center. The MAE Center is a multidisciplinary center that focuses on reducing losses in future earthquakes that may effect the central and southeastern United States. Current research areas include:

- Inventories of essential facilities and transportation networks in Mid-America
- Performance of rehabilitated steel connections
- Foundation remediation for buildings and bridge columns
- Response modification of highway and railroad bridges
- Seismic mitigation using smart materials
- Retrofit of bridges using fiber-reinforced polymeric (FRP) composites
- Response modification of buildings using passive and semi-active controls
- Nonlinear dynamic response of low-rise buildings with flexible floor and/or roof diaphragms
- Large-scale tests of beam-column connections of typical Mid-America buildings
- Testing of large-scale low-rise building systems

3.3 Computer-Aided Structural Engineering (CASE) Center

The Computer-Aided Structural Engineering Center is an advanced computer software research and development facility. It is dedicated to maintaining a national and international leadership role in the research and development of structural engineering analysis and design software. The Center serves as a technological pipeline through which results of research and development flow from Georgia Tech to industry, government, and educational institutions in a form with the highest standards of quality and performance. Such results are embodied in the computer program GT STRUDL. Current focuses are on the following:

- Man-machine communication, including specialized graphical modeling and results interpretation in the Windows environment
- Large sag cable network analysis
- Non-linear dynamic analysis, including multi-support excitation
- Sequential analysis and construction simulation
- Reinforced concrete design based upon finite element results

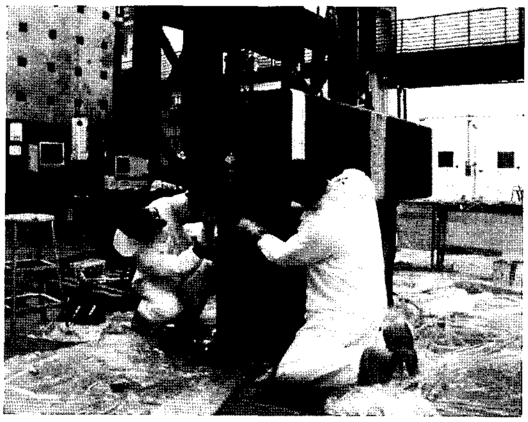

Figure 6 Retrofit of bridge cap beam with carbon fiber reinforced polymer sheet

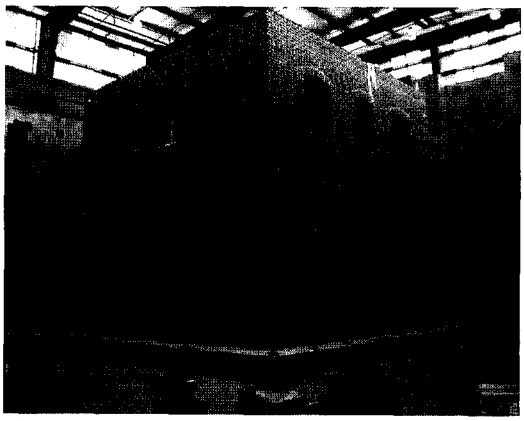

Figure 7 Large-scale two-story brick building

What follows is a summary of research projects currently performed from Georgia Tech's Center for Structural Engineering, Mechanics and Materials:

- Acceptance Test Specifications and Guidelines for FRP Bridge Decks - Federal Highway Administration(FHWA)
- Performance of Repaired & Strengthened Bridge Cap Beams Using Carbon Fiber Composites - Georgia Department of Transportation(GADOT)/Federal Highway Administration(FHWA)
- Composite Railroad Crosstie Development Program - Seaward International, Inc.
- Experimental Evaluation of Flexural Behaviors of Composite Marine Timbers and Sea Piles - Seaward International, Inc.
- Evaluation of Shear Capacity of Curved Steel Bridge I-Girders - Professional Service Industries, Inc
- Large-Scale Test of Low-Rise Building System - National Scientific Foundation(NSF)