Feasibility Investigation of Precast Bridge Piers

tech transfer summary

This research examines the possibility of using precast bridge piers to accelerate bridge construction.

Objectives

The objectives of this research are as follows:

- Accelerate bridge pier construction
  - Reduce traffic delays
  - Improve work zone safety
  - Reduce environmental impact
- Improve structural performance and stability of bridge piers when subjected to extreme loads
- Provide rapid, cost-effective means of repairing bridge piers if damaged
- Reduce cost of bridge pier construction

Background and Problem Statement

Precast substructures have been used around the country with varying degrees of success during the past two decades. The system investigated in this research offers a different design approach with several details that have the potential to reduce construction time, improve structural performance, and introduce cost-effective repair options.

Description of Proposed Structural System

The system features precast segments connected by continuous, elastic elements (internal, unbonded post-tensioning in this research), and sacrificial structural fuses. In the event of an extreme lateral load arising from wind, flood, impact, earthquake, or other disaster, the system is designed to concentrate deformation at the joints between segments. The continuous elastic elements provide the pier with a self-centering capability to straighten

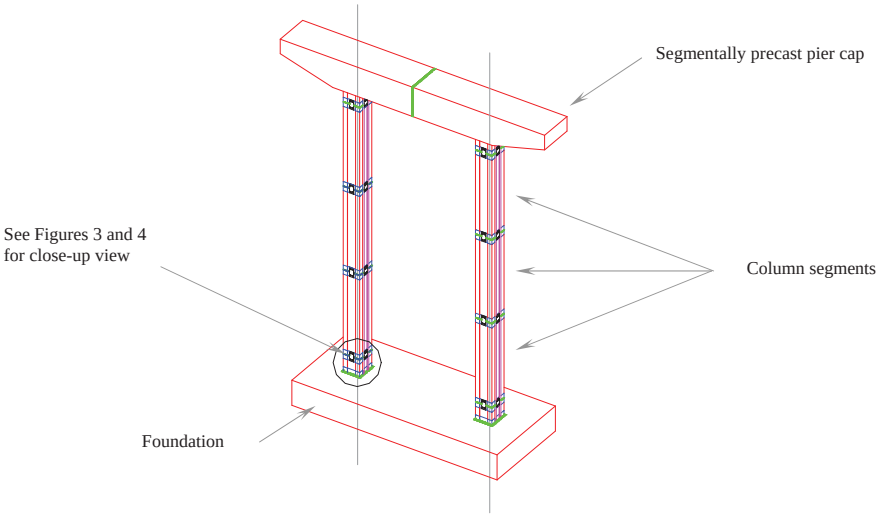

Figure 1. The basic proposed pier assembly

Continued on next page

July 2008

RESEARCH PROJECT TITLE
Feasibility Investigation of Segmentally Precast Bridge Piers for Accelerated Construction

SPONSORS
Iowa Highway Research Board (TR-556)
Iowa Department of Transportation (CTRE Project 06-257

PRINCIPAL INVESTIGATOR
Jon M. Rouse
Assistant Professor
Bridge Engineering Center
Iowa State University
jmr19@iastate.edu
515-294-6139

CO-PRINCIPAL INVESTIGATOR
F. Wayne Klaiber
Distinguished Professor
Bridge Engineering Center
Iowa State University

RESEARCH ASSISTANT
Mark C. Currie

MORE INFORMATION
www.bec.iastate.edu

BEC
Iowa State University
2711 S. Loop Drive, Suite 4700
Ames, IA 50010-8664
515-294-8103

The Bridge Engineering Center (BEC) is part of the Center for Transportation Research and Education (CTRE) at Iowa State University. The mission of the BEC is to conduct research on bridge technologies to help bridge designers/owners design, build, and maintain long-lasting bridges.

Continued from previous page

the structure after an event while plastic deformation is concentrated in the replaceable structural fuse elements at the joint. This arrangement allows quick repair by simple replacement of the structural fuses.

Research Description

Cantilever columns, including one conventionally reinforced control column, were subjected to constant axial and cyclic, quasi-static lateral loads to observe behavior. Variables examined included

- connection details at segment joints,
- materials used in structural fuses and prefabricated bearing plates placed between the joints, and
- magnitude of initial post-tensioning force.

Behavior of each jointed column was compared with that of the control column as well as with analytical predictions.

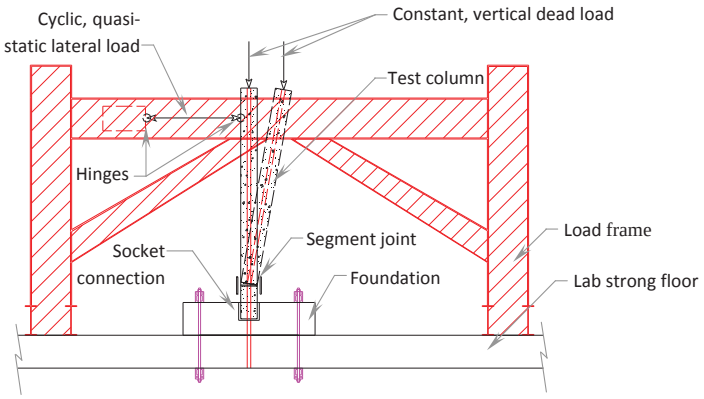

Figure 2. Schematic test set-up

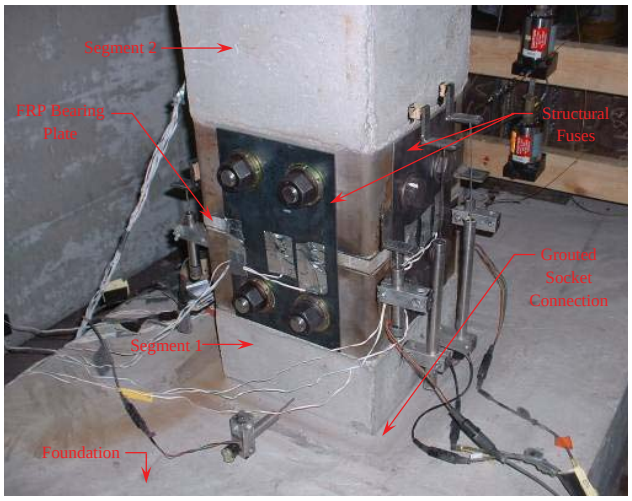

Figure 3. Segment joint prior to testing

Key Findings

- Several details expediting construction of the proposed system proved to be effective from both the labor and structural performance perspectives.
- Testing identified both effective and unsatisfactory details used in the jointed columns.
- Damage in the jointed columns could be successfully concentrated in the structural fuses.
- The proposed segmented columns compared favorably to the conventional, reinforced-concrete, control column in many respects, including
  - equivalent lateral strength,
  - greater lateral stiffness,
  - greater lateral deformation capacity, and
  - reduced residual deformations.
- Repair of the jointed columns by replacing the structural fuses was demonstrated to be easy and highly effective.

Recommendations

Additional research is recommended to verify these findings and specifically address the following items:

- Slippage of the bolted fuse plates
- Means of improving energy dissipation
- Alternative options and details for both the continuous elastic elements and structural fuses
- Corrosion protection for all components in the system
- Details for connecting the columns to the pier caps
- Development of standardized design specifications and procedures
- Opportunities for systems with multiple joints

Figure 4. Segment joint after testing