NCBC MEMBER SPOTLIGHT

Celebrating 70 Years of PCI Accomplishments

by Dr. Richard Miller, Managing Technical Editor of *ASPIRE*®

In 2024, the Precast/Prestressed Concrete Institute (PCI) celebrated its 70th anniversary. It is significant that the first prestressed concrete structure in the United States was a bridge. The original Walnut Lane Memorial Bridge opened in 1951, and PCI was formed just three years later. In those early years, there was a lot that was not known about reinforced precast concrete structures and prestressed concrete structures, so a group of dedicated engineers started to research this new engineered-to-order building solution. In 1956, just two years after PCI was formed, the first issue of the *PCI Journal* was published. (Every issue of the *PCI Journal* is available online at pci.org.)

Initial research focused on learning about the behavior of precast, prestressed concrete components. The first issue of the *PCI Journal* had two articles written by individuals who were later named PCI Titans of the Industry, Dr. T. Y. Lin and Dr. Paul Zia. Eventually, the basic behavior of precast, prestressed concrete components was reasonably well understood, and the research evolved to improving and refining our understanding of the behavior of prestressed (pretensioned and post-tensioned) concrete components and developing new materials, shapes, and fabrication processes. A quick glance at the table of contents of any issue of the *PCI Journal* will show articles that influenced all aspects of the industry.

To celebrate the 70th anniversary of PCI, the Journal Editorial Advisory Committee assembled and published a list of 70 influential articles in the November–December 2024 issue of the *PCI Journal*. The committee specifically did not call them the most influential or most important, as opinions about such rankings will vary. What is important or influential for one sector of the industry may be less important to another sector, and vice versa. Among the criteria that the committee members considered in their selection process are the following: items that are influential or provide a remarkable contribution to the industry's body of knowledge; articles that have been frequently cited by other researchers and engineers around the world; and articles that serve as a point of reference in codes or standards.

There are items on the list related directly to bridges and many on general subjects, such as materials, that have also influenced bridge design. The following are the *PCI Journal* articles that are among my favorites and have influenced my career.

"Plant Certification—A Program of Merit in the Prestressing Industry," by Charles W. Wilson (1968)[1]

When I taught, my students would ask why in the American Association of State Highway and Transportation Officials' *AASHTO LRFD Bridge Design Specifications*,[2] the resistance factor for bending for tension-controlled prestressed concrete sections with bonded strands or tendons (ϕ = 1.0) is more favorable than that for tension-controlled (regular) reinforced concrete sections (ϕ = 0.9). I explained that difference is because prestressed concrete is made in a plant under carefully controlled conditions, which improves the quality and reliability of the product. The PCI Plant Certification Program started in 1967 with 35 volunteer plants. This paper, written by past PCI president and Titan of the Industry Charles W. Wilson, outlines


70 significant items from seven decades of *PCI Journal*

70 years PCI ANNIVERSARY

A feature from the November-December 2024 *PCI Journal*. All Figures and Photos: PCI.

EDITOR'S NOTE

Welcome to my first issue as managing technical editor of ASPIRE®. *After 36 years as a professor, I decided I had done all I could do at the university, so I retired. One of my favorite parts of being a professor was "disseminating knowledge," and taking over as managing technical editor of* ASPIRE *beginning with this Winter 2025 issue will allow me to continue to do that. I look forward to working with members of the National Concrete Bridge Council and the* ASPIRE *Editorial Advisory Board to bring you interesting and relevant articles about concrete bridges and related topics.*

I want to thank the previous managing technical editors and my good friends, Dr. Henry Russell, Dr. Reid Castrodale, and Dr. Kris Brown, for creating and maintaining the excellence of this publication. I especially want to thank Reid and Kris for helping me in this transition.

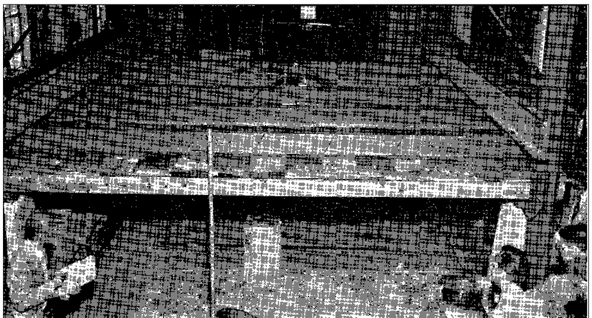

Fig. 2. Testing a 5-inch prestressed concrete slab, uniform load being applied by air pressure in plastic bags (University of California).

CAN WE DESIGN PRESTRESSED CONCRETE BY ALLOWABLE STRESSES

By Dr. T. Y. Lin

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(I) Introduction

Prestressed-concrete design has been made on the basis of the elastic theory, using working loads and allowable stresses. It has been also based on the ultimate strength theory, using factors of safety on the loads, often termed as load factors. For most countries in Europe, recommendations and codes for prestressed concrete permit design on either the ultimate or the elastic basis. In this country, our engineers, being used to the elastic theory for reinforced concrete, tend to prefer the elastic rather than the ultimate approach. While the elastic theory works beautifully for prestressed concrete before cracking, the strength after cracking can only be determined by the ultimate theory. Unless care is exercised in setting up variable allowable stresses to suit different conditions, design by the elastic theory will yield divergent degrees of safety.

Ultimate design is based on a set of given load factors. Hence, structures designed by that method will possess the desired degree of safety, although they may be overstressed or understressed if judged by the elastic theory. However, ultimate strength design gives no assurance of proper behavior under service conditions, unless the design is checked by the elastic theory or a suitable factor of safety is chosen for each case.

(II) What Should We Design Our Structures For?

Let us try to determine our basic requirements in design. First of all, it must be made clear that we should not design for fictitious or even real stresses unless we understand the significance of their values. Owing to the over-emphasis on stress calculations in our engineering training, our graduates do not know very much about real engineering although they do know how to compute stresses by theoretical and empirical formulas. They do not have sufficient idea of the actual behavior and strength of structures. The less they understand the structures, the more they tend to blindly follow certain codes of practice. It often ends up that we are simply designing our structures to satisfy certain code requirements which can be either too conservative or not sufficiently safe.

To experienced engineers, the real criteria for designing are:

1. We should design our structures so that they will perform satisfactorily under the usual service conditions. This means freedom from excessive camber, deflections, vibrations, cracks, etc.

May, 1956 3

An article by Dr. T. Y. Lin opened the first issue of the *PCI Journal*.

An early *Journal* cover from the newly formed Prestressed Concrete Institute.

the PCI Plant Certification Program. The Plant Certification Program is based on the continuous improvement of industry practices which advance the high quality of precast and precast, prestressed concrete components.

"Lateral Stability of Long Prestressed Concrete Beams—Parts 1 and 2," by Robert F. Mast (1989 and 1993)[3,4]

Several years ago, I participated in the drafting of PCI's *Recommended Practice for Lateral Stability of Precast, Prestressed Concrete Bridge Girders*[5] and the associated learning modules published on the PCI eLearning website (https://oasis.pci.org/Public/Catalog/Home.aspx). These resources made extensive use of Bob Mast's papers. Bob realized that precast, prestressed concrete girders did not fail in lateral torsional buckling like steel, but instead rolled over about a roll axis. His elegant mathematical solution forms the basis of our understanding of girder stability.

"The NU Precast/Prestressed Concrete Bridge I-Girder Series," by K. Lynn Geren and Maher K. Tadros (1994)[6]

Early in my career, I participated in the Federal Highway Administration's High-Performance Concrete Showcase. Several states were chosen to design and construct bridges using high-performance concrete and 0.6-in.-diameter strand. One of the goals was to extend girder spans. In Ohio, we designed a box girder but found we could not extend the span very much with that shape. The Nebraska University (NU) girder was optimized to take advantage of the larger strand area and higher-strength concrete to obtain longer spans with a favorable span-to-depth ratio. Another innovation was in the forming. AASHTO-type girders have a different shape for each depth of girder, so fabricators need a different set of forms for each shape. The NU girder uses a standard top and bottom flange, and the girder height is changed using inexpensive flat forms to vary the web height. The NU girder is used in some states, and many other states have created their own versions of this girder to fit their needs.

"Shear Transfer in Reinforced Concrete—Recent Research," by Alan H. Mattock and Neil M. Hawkins (1972)[7]

"Torsion Design of Prestressed Concrete," by Paul Zia and W. Denis McGee (1974)[8]

"Shear Transfer in Reinforced Concrete with Moment or Tension Acting Across the Shear Plane," by Alan H. Mattock, L. Johal, and H. C. Chow (1975)[9]

"Shear and Torsion Design of Prestressed and Non-Prestressed Concrete Beams," by Michael P. Collins and Denis Mitchell (1980)[10]

Whenever I taught bridge design or advanced concrete design, my favorite lectures were on shear behavior. Research dating back to the 1920s first proposed that shear failure was a diagonal tension failure and that a truss model could be used for shear. These four papers were instrumental in our understanding of shear and torsion in prestressed concrete and are among the most-cited papers from the *PCI Journal*. They form the basis of the modified compression field theory that is used in the AASHTO LRFD specifications.

I invite you to read "70 Significant Items from Seven Decades of *PCI Journal*," in the November–December 2024 issue of *PCI Journal* to see where many industry practices and design provisions started. Then go back and read or reread the papers. I then would ask you to look at the recently published second edition of the recommended practice for strand bond that is in the January–February 2025 issue of *PCI Journal*.[11]

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