PCI Precast/Prestressed Concrete Institute

Solicitation

for

Daniel P. Jenny Research Fellowship Applications for 2021

The **Precast/Prestressed Concrete Institute** is pleased to announce the solicitation for applications under the Daniel P. Jenny Research Fellowship program for the 2021-2022 academic year. Fellowship awards of up to $40,000 are intended to engage the interest of young engineering students in the precast concrete industry while providing valuable research experience to the student, faculty, and PCI.

Accompanying the Jenny Fellowship program is a scholarship opportunity from the PCI Foundation. One $4,000 graduate scholarship in memory of Dr. Alan Mattock may be awarded. The recipient will be selected from the Jenny Fellowship awardees to enhance the benefit provided with the fellowship. Students interested in this award must provide additional information as outlined in the scholarship rules.

Students are invited to submit one application for the Jenny Fellowship program. Faculty are invited to submit multiple applications if advising more than one student. If the proposed research is part of a larger research project, the scope of work under the Jenny Fellowship must be clearly delineated. Completion of the proposed research program should not be contingent upon any subsequent approval of funding for related research.

The Research and Development Council has designated at least one fellowship to be preferentially awarded to a student advised by an untenured professor if such an application is submitted, is on a relevant topic, and is of appropriate quality.

Attached are four documents regarding the Jenny Fellowship program:

1. The fellowship program rules from the PCI Research and Development Council.
2. An example Review and Rating form used by the PCI Research and Development Council to evaluate applications. Please note the weighting of the five evaluation criteria.
3. A PCI research needs list summarizing topics of interest to the industry. This list is provided for guidance on topics of interest; applications need not be limited to these topics.
4. The Alan Mattock Graduate Scholarship rules and the additional submission requirements.

Of significance is the relevancy of the proposed research to improving the state of the art of precast concrete design, fabrication, or construction. As shown in the research needs, projects need not be limited to structural components or materials testing. Innovative ideas to improve design, fabrication or erection are viewed very positively. In parallel is the potential for market impact as a result of the research.

Please note the importance of industry support in the review criteria. The intent is for applicants to solicit support from one or more precast producer members of PCI for their proposed research program. See the fellowship program rules for additional information. Though not weighted the highest, final award deliberations will be significantly influenced by industry support. It is further suggested that a visit to a precast concrete plant to gather potential research topics would be helpful and potentially provide for a more relevant proposal. If any assistance is required in locating a potential industry partner, please use the contact information below.

The application shall include the following information:

1. Title page with the names of the university and the research team including all contact information and signatures of the advising professor and department chair.
2. Description of the proposed research program (3 pages maximum).
3. Time and cost schedule, including any additional support.
4. Brief résumé of the faculty advisor (2 pages maximum).
5. Brief statement by student candidate describing personal objectives and interest in the subject of the proposed research (1 page maximum).
6. Evidence of precast industry support.

Additional submission requirements for the Alan Mattock Graduate Scholarship are described in the attached rules if interested in competing for the scholarship.

Applications are due at PCI headquarters no later than **January 15, 2021**. Please submit electronically to:

technical@pci.org

PCI is a non-profit organization and the fellowships funded under this program by the Institute do not cover indirect overhead costs. Therefore, the fellowship award of up to $40,000 should be exclusively used for supporting a graduate student and the research and should not include any indirect costs.

The PCI Research and Development Council will meet in late February to select the awards. Awardees will be notified by March 31, 2021 with funding provided on or after July 1, 2021.

We are excited to be able to continue this program and encourage your participation.

Very truly yours,

Greg Force
Chair
PCI Research and Development Council

cc: PCI Research and Development Council
PCI Staff Managers
PCI Regional Directors

Daniel P. Jenny Research Fellowships

Goal: To engage the interest of young engineering students in the precast concrete industry while providing a research experience of value to both the student and PCI.

Rules:

Eligibility: The fellowship program is open to any university in North America with the facilities to conduct structural research. Students may be PhD candidates, but Masters students are preferred. Competition is restricted to North America to ensure interaction with one or more PCI Producer members in the development and execution of the project.

Grant: The amount of the fellowship will be established by the PCI Research and Development Council as part of the budgeting process. The funds will be provided to the advising professor with the stipulation that they are an unrestricted grant and, therefore, no university overhead may be taken from the funds. All funds are to be used in support of the student and the project.

Number of annual awards: The PCI Research and Development Council shall establish an annual budget for the program. The number of awards each year shall be decided by the council based on the quality of the fellowship applications received.

Solicitation: A solicitation shall be distributed by PCI staff in December of each year with a due date for applications established to allow six weeks for council review prior to the spring meeting of the council. The solicitation shall include a listing of research topics identified as being high priority for the institute.

Applications: Applications shall be submitted electronically no later than the due date established in the solicitation. Applications submitted after the due date will not be considered. Application shall include the following minimum information:

1. Title page with the names of the university and the research team including all contact information and signatures of the advising professor and department chair.
2. Description of the proposed research program (3 pages maximum).
3. Time and cost schedule, including any additional support.
4. Brief résumé of the faculty advisor (2 pages maximum)
5. Brief statement by student candidate describing personal objectives and interest in the subject of the proposed research (1 page maximum).
6. Evidence of precast industry support.

Project: It is intended that the project would be relevant to the precast concrete industry. Where the proposed project is part of a larger project, the work proposed for fellowship funding shall be clearly identified. Applications that are contingent on approval of other funding will be rejected.

Industry support: Applicants are encouraged to solicit support for the proposed project from members of PCI. Support requested could range from a letter endorsing the project to financial participation. Letters of support must address the merits of the proposal. Specifically, the letters must address why the problem is of interest to PCI or the concrete industry and how this proposal will address that problem. If possible, the industry support letters should state why the approach has a reasonable chance of success. Industry support letters which simply support the researcher, the student or the University and do not address the merits of the proposal will not be considered.

Evaluation: All voting members of the PCI Research and Development Council will be expected to evaluate submitted applications. Evaluation criteria shall include relevancy, market impact, research capability, supplemental support, and overall quality. PCI Producer support is highly desirable. Evaluation criteria and scoring may be modified each year by the council, but evaluation criteria shall be distributed with the Jenny Research Fellowship solicitation.

Award: A simple majority vote of attending council members (assuming a quorum is present) will be required to approve an award. Awarded funds shall be distributed at the beginning of the next institute fiscal year.

Advisory Committee: At the time of selection, an advisory committee shall be appointed to monitor and provide guidance to the project. The chair of the advisory committee shall be a council member but the advisory committee can be composed of any PCI members with interest or expertise in the subject of the project.

Deliverables: Because the fellowship funds are provided as an unrestricted grant, no deliverables can be required of the recipient. PCI shall request a copy of the final student report or thesis and shall encourage the student and professor to publish a summary paper in the PCI Journal. The professor and student will also be invited to present updates and final results at the R&D education sessions at the annual PCI Convention.

DANIEL P. JENNY RESEARCH FELLOWSHIP PROGRAM

Application Review and Rating Form

Project:	Weight	Rating	Score
Relevancy of Research: Is the research relevant to precast, prestressed concrete products or precast systems? Will the research contribute to the state-of-the-art or advance the usage?	5		
Potential Impact on Market: Is there potential for this research to improve current products or systems or provide thrust into new markets? Are there innovative features in the application?	4		
Research Capability: Is the faculty advisor experienced in precast, prestressed concrete research or the subject matter? Are there suitable facilities and equipment available? Has the graduate student been identified?	3		
Supplemental Support: Is there support from either a producer or the regional association? Is there support from the university or other funding agencies that contributes directly to the fellowship? (Support must be financial or tangible if rating is 3 or above. On analytical applications 3 or more support letters will count as support for ratings 3 or higher.)	4		
Overall Quality: Are the objective and scope clearly identified? Is there a research plan and a budget? Can the research plan be accomplished within the budget? Is the application well written?	4		
		Total Score:	

Ratings:
Outstanding - 5 Very Good - 4 Good - 3 Fair - 2 Poor - 1 Not Provided – 0

Rank this application relative to the other applications if in the top ten (rank of 1 being best)	

If the fellowship is part of a larger project being carried out for a sponsor other than PCI, that part must be clearly identified and the evaluation shall be made only with respect to the part that pertains to the fellowship.

PCI Research Needs List

November 2020

Category	Subject	Comments
Component Design	Deflection calculations for Class T and C prestressed flexural members	New methods of deflection prediction have been proposed (tri-linear); however, limited data shows no current method is reliably better than others. Examine available data to evaluate current calculation methods and propose better methods.
	Shear strength in end regions of pretensioned bridge components	Address anchorage of longitudinal reinforcement (tension tie) for reliable shear strength.
	Release stresses in pretensioned members	Consider all sections where compression and tension must be considered. Increase allowable compressive stress from 0.6 to 0.7 or 0.75. Determine minimum concrete strength requirements at release of prestressing.
	Inverted tee or spandrel beams that require more prestress than a plant can pull on beds/abutments	Methodology for strength and stresses for combined pretention (with strain compatibility) and unbonded post-tensioning (without strain compatibility)
	New cost-effective flooring system design that can be cast on long-line steel prestress beds	For total precast concrete building construction, develop alternative sections to double tees and hollowcore. Develop floor system conducive to receiving integral plumbing, HVAC piping and/or electrical conduit.
	Examine the longitudinal splitting strength of hollowcore slabs subject to line loads parallel to the span	Guidance is available on splitting strength under point loads but nothing is available for heavy line loads parallel to the span.
	Effects of joint size and configuration in hollowcore systems subject to non- uniform loads	Building tolerances may require joints between slabs to increase in size and many layouts require splits creating non-standard joint configurations. The effects on load distribution need to be studied.

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Component Design	Strength reduction factor for seismically confined columns	The compression-controlled phi factor for columns is 0.65. Spiral reinforced columns are given a higher factor of 0.75 due to improved confinement. The tied columns factor of 0.65 was based on #3 or #4 ties at roughly 16" o.c. wrapping every other leg. A seismically tied and confined column today has #5 ties at 4 inches o.c. This added confinement, for seismic ductility, provides much more reliable column capacity. A seismically confined column should have similar reliability to a spiral confined column. Investigate if a higher factor is justifiable in seismically confined (tied) columns.
	Post cracking shear strength of bridge girders using self-consolidating concrete	
Component Detailing	Hangers for openings in hollowcore slab systems	Explore different hanger designs and effectiveness including support of reaction at adjacent members.
	Surface roughness required for horizontal shear between precast concrete member and cast-in-place concrete topping for composite design	Requirements for measured surface roughness. Relationship between roughness and strength are not prescribed in sufficient detail to support rational design for composite members without transverse reinforcement.
	Improved detailing of double tee bearing plates	
	Headed deformed bars as shear reinforcement	
	Minimum spacing requirements for large prestressing strands	
Structural Systems	Hybrid frame application to disproportionate collapse	Hybrid frames used for seismic resistance may have significant capacity for disproportionate collapse

Category	Subject	Comments
Seismic	Improved diaphragm connection performance when subject to earthquake loading (**priority**)	Connection characteristics are defined – new connections need to be qualified. In particular, high deformability connections in shear and tension are needed for more severe SDC's. Develop a ductile welded chord connector with high deformability.
	Connections at wall corners for Intermediate Precast Walls used for shear walls where there is a shear flow requirement to develop overturning resistance across a joint	Anchorage to concrete requirements in Section 17.10 of ACI 318 are excluded in plastic regions in the seismic force-resisting system. Steel yielding is required as the limit state for intermediate wall connections. Development and testing is needed.
	Enhanced Joint Shear in Hybrid Moment Frame Columns	Currently the HMF system comes at a cost premium to a Concrete Special Moment Resisting Frame(SMRF). This cost is mostly due to the fact that columns in HMF systems need to be larger to accommodate the larger joint shear as well as the reduced column cross section due to the duct. If we could come up with a way to enhance the joint shear of the column by 25% +/- it could help make this system more cost compatible with an emulative SMRF
	Effective stiffness of vertical panel groups mechanically connected across vertical joints	Concern is how to evaluate the effective stiffness of such panel groups considering the flexibility of connections across vertical joints for proper modeling of systems. ACI 318 permits the design of special moment frames of precast concrete considering strong or ductile connections. The Code does not afford the same consideration for connections in vertical joints of precast concrete walls. The design of strong or ductile connections requires the characterization of wall stiffness as well as strength and/or ductility in these connections for design to be standardized.

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Seismic	Seismic Design for wall panels with horizontal joints without minimum reinforcement crossing the joints	ACI 318 permits the design of special precast concrete shear walls that meet the requirements for CIP special structural walls and the connection requirements for intermediate precast concrete structural walls. An interpretation of these provisions is that the joints between walls are connections, and do not require the minimum wall reinforcement to cross the joints. This is disputed by some building officials. Research is needed to characterize the joint-opening and plastic-region behavior of walls without minimum wall steel, but with debonded length of vertical reinforcement in the ends of the walls to increase the strain distribution near the joints
	Refine Ω_v in ASCE 7-16 Diaphragm design (**priority**)	This factor currently makes untopped diaphragms impractical in regions of high seismicity. This factor was derived from a parametric study completed during the DSDM research. This is having a large impact on precast systems a more in-depth study is justified to refine or validate this factor.
Anchorage to Concrete	Effects of reinforcement in concrete anchorage breakout zones (**priority**)	Anchorage reinforcement is allowed in Chapter 17 of ACI 318, but the provisions are limited to direct transfer of shear and tension forces in the direction of the load and require development of the reinforcement on either side of the breakout surface. There is a need to develop resistance to side-face breakout using shear friction reinforcement with development achieved by longitudinal reinforcement inside the bends of ties or hairpins.
	Replacement of headed anchors with headed reinforcement (**priority**)	Considerations for the replacement of headed concrete anchors welded to embed plates with headed reinforcement.
	Simplification of anchorage calculations	Combine with a study of LW vs NW concrete

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Anchorage to Concrete	Anchorage of standard hooks with transverse reinforcement inside hook bend	Currently we are limited to L_d for standard hooks controlled by breakout and crushing in the bend. These lengths will increase due to changes in ACI 318-19. There is no research to support reduced L_d values when transverse reinforcement is placed inside the bend to resist breakout cracking and to spread the crushing/bearing stresses from the bar tension.
	Dowel action as an alternative to shear friction	ACI 318 does not cover dowel action in connections. New provisions in ACI 318-19 add shear-lug design that shares strength with studs with dowel mechanism that is not explicitly defined.
	Simplified connections of prestressed bridge girders to deck	
	Reduction of volume change restraint forces in bearing pads	The N_u force used in bearing calculations can be calculated if the shear stiffness or slip stress of bearing pads is known.
	Post-tensioning anchorages in hybrid frames	Early research on the hybrid frame indicated potential issues with P-T anchors under cyclic load
Wall Panels	Crack mitigation for insulated panels with continuous insulation	Insulated wall panels with thin wythes tend to crack during detensioning. Develop alternative details, materials, or criteria to minimize cracking.
	Effect of reinforcement to improve edge lifting devices in thin panels	
Handling and Erection	Productivity in the field	More efficient connections to replace welding in order to release product from the crane quicker to allow more pieces to be installed per day.
	Drone and/or laser scanning use for layout, clash detection and as-builts	Is a 3D point cloud produced by a drone's LiDAR survey accurate enough to use for layout for erection, clash detection in a BIM model and for as-builts.

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Sustainability	Life-cycle costs for pretensioned concrete bridges (**priority**)	Limited information is available on life-cycle assessments for pretensioned concrete bridges. A comparison of life-cycle costs for pretensioned concrete bridges to other typical bridge systems, in particular simple- and short-span bridges is needed.
	Development of tools for Life Cycle Assessment of parking structures	Sustainability assessment of parking structures requires new criteria to understand the benefits of high performance precast concrete construction
	Development of detailing to enhance resiliency in precast concrete structures	As compared to other construction materials, precast concrete has opportunities for superior resiliency for fires and natural events.
	Development of better tools to assess the positive effects of thermal mass on operational efficiency of structures	
3D Printing	Feasibility of pre-printed concrete components in plant	Precast producers have experience with handling, shipping, and erection. 3D printed concrete elements can have infinite shapes. Evaluate the feasibility of “pre-printed” (3D printed in a precast plant) elements and the type of structural components that can be achieved.
Materials	Cement replacement in concrete mixes (**priority**)	Investigate alternative cementitious materials or carbon sequestration materials to reduce embodied carbon in precast elements. Note that most precast elements require high-early strength concrete mixtures to facilitate prestress release or stripping and handling.
	Characteristics of SCC	Include creep, shrinkage, early age modulus and shear strength
	100 year life for structure and repairs	Bridges and, eventually, parking structures will have requirements for a 100 year life. Materials and detailing need development to meet this requirement.

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Materials	Provisions for concrete strengths less than UHPC	An ongoing research project is defining a PCI-UHPC with a compressive strength of 18ksi along with flexural strength around 2ksi and other tensile property requirements. Determine procedures for concrete strengths that develop flexural strengths higher than conventional concrete, along with tensile ductility, but do not meet PCI-UHPC criteria.
	Structural design guidelines for sand lightweight concrete	
	Effects of elevated temperatures from fire on fiber reinforcement and FRP composites in precast concrete structural members	
	Rate of tensile strength gain vs compressive strength gain in lightweight concrete	This information would contribute to knowledge on early age strength of anchorage in concrete
	Delayed ettringite formation (DEF)	This research will evaluate the use of the "delta ettringite" testing method, which was developed as part of a PCI funded study in the late 1990's. This proposed work will extend the scope to include measurements of concrete at later ages.
	Improved flexural strength in concrete mixes to make the product less susceptible to cracking especially in high-end architectural product.	Stresses are generally held to $5\sqrt{f'c}$ for design with no discernible cracking. Rather than a UHPC that concentrates on high compressive strength, this research should concentrate on a high early flexural strength that may or may not correspond to the currently accepted ratios between the two strengths
Architectural	Effect of moisture content on APC color	Architectural panel color can be judged at many different ages. What is the effect of moisture content?
	Post pour replacement techniques for brick, tile, and precast concrete medallions in APC	

Category	Subject	Comments
Architectural	Form suction for stripping APC with projections and rustications	
	Bond of brick, tile, and precast concrete medallions in APC	
	Anchorage in thin APC panels constructed of UHPC	
	Durability of textured finishes used for APC	
Parking Structures	Durability enhancement in precast concrete parking structures including performance of double tee flange connections and joint leakage	All material and installation requirements need to be included in the study
Operations	Trucking of precast concrete members from manufacturing plants to job sites	Managing specialty carriers and non-standard sized loads to arrive at the crane at the correct time + or – 5 minutes
	Handling of steel reinforcing, connection plates and inserts is the majority of work done in the manufacturing plant.	Eliminating or drastically reducing non-value added materials handling work in the manufacturing plants. Robotic application for highly repetitive low skilled work? Impact of autonomous delivery vehicles?
	Improved ergonomics in work tasks of production employees	Reduced bending and stooping, lifting of heavy and awkward loads.
	Inspection of product, both finished goods and work in process, by electronic means	Utilize cameras, lasers or specialized AR or VR equipment to measure product vs. conventional steel tape. Compare to CAD drawings or 3D models for tolerances.
	Understand ability of current processes to meet tolerances, especially dimensional tolerances that affect fit-up and subsequently productivity on job sites.	Capture all variances from standard dimensions, not just go/no go based on adherence to published tolerances. Use data captured to calculate and publish process capability analysis.
	Machine learning / artificial intelligence / robotics	A general investigation into how these things might benefit our industry