PCI™ Precast/Prestressed Concrete Institute

Solicitation
for
Research Fellowship Applications for 2019-2020

The **Precast/Prestressed Concrete Institute** is pleased to announce that several $40,000 awards for the 2019-2020 academic year will be offered under the Daniel P. Jenny Fellowship program. These fellowships are intended primarily for support of candidates for master's degree level research related to precast/prestressed concrete. Ph.D. candidates will also be considered.

The program allows for at least one fellowship to be awarded to a student with an untenured advising professor if such an application is submitted and is on a relevant topic and of good quality.

Also tied to the Jenny Fellowship program is an offering by the PCI Foundation. One $4,000 graduate scholarship in memory of Dr. Alan Mattock may be awarded. The student will be selected from the group of fellowship awardees to enhance the benefit provided with the fellowship. Students interested in this award must provide additional information as outlined in the attached scholarship rules document.

You are invited to submit one or more applications for these fellowships. If part of a larger research program, the work to be covered by the PCI fellowship must be clearly delineated. The PCI fellowship cannot be contingent upon the subsequent approval of funding for related research.

The proposal submittal 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. A minimum of a brief statement by student candidate describing personal objectives and interest in the subject of the proposed research (1 page maximum). Additional submittal requirements are described in an attached document if the student is interested in competing for the Alan Mattock Graduate Scholarship.
6. Evidence of precast industry support.

Four attachments are provided for the benefit of the proposer. The first is a summary of the rules of the PCI Research and Development Council for the fellowship program. The second is the Review and Rating form used by the PCI Research and Development Council to evaluate all proposals submitted. Please note the weighting of the five evaluation criteria. Of significance is the relevancy of the proposed research to improving the state of the art of precast/prestressed concrete design and/or construction. In parallel is the potential for market impact as a result of the research. Innovative ideas are viewed very positively.

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

The third attachment is a list of research topics of interest to the industry. This list is provided only for guidance on topics and proposals need not be limited to these topics. The fourth attachment describes the Alan Mattock Graduate Scholarship and the additional submittals required to be considered for this scholarship.

Proposals are due at PCI headquarters no later than **January 14, 2019**. The PCI Research and Development Council will meet in late February to decide on the awards. Results will be available by March 29, 2019. Please submit electronically to:

Roger Becker
Vice President Technical Services
Precast/Prestressed Concrete Institute
200 West Adams Street
Suite 2100
Chicago, IL 60606
rbecker@pci.org
312-360-3213

PCI is a non-profit organization, and the projects funded by the Institute do not cover overhead costs. Therefore, the approved amount of $40,000 should be exclusively used for supporting a graduate student and should not include any indirect costs.

We are excited to be able to offer this program again 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.

PCI DANIEL P. JENNY RESEARCH FELLOWSHIP PROGRAM

Proposal 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	

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

	Rank
Rank – relative to the other applications, rank this proposal if in the top ten with a 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 2018

Category	Subject	Comments
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
Seismic	Improved diaphragm connection performance when subject to earthquake loading	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.
	Simplified seismic connections for precast concrete shear walls	
	Precast Buckling Restrained Braced Frame – Determine feasibility and outline research needs	Buckling Restrained Braced Frames have significantly reduced costs in the steel industry. This system is so dominant in steel construction that you rarely see other types of lateral systems in steel these days. A precast BRBF could be used to make our lateral systems more efficient in seismic regions. This could be practical for 2 to 6 story parking and up to 8 story office buildings in regions of high seismic (taller in others) The advantage is that the lateral demand of the system is reduced in two ways. 1) the higher R factor lowers demand. 2) the more flexible system increases building period further reducing base shear. The smaller demand would translate to savings in foundations, couplers, and possibly collectors.
	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
	Refine Ωv in ASCE 7-16 Diaphragm design	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. Understanding that this is having a large impact on our systems a more in depth study is justified to refine or validate this factor.
Anchorage to Concrete	Effects of reinforcement in anchorage concrete breakout zones	
	Simplification of anchorage calculations	Combine with a study of LW vs NW 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.
Connections	Effective shear friction coefficient for various surfaces	
	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
	Application of headed bars in precast concrete connections	Compare headed bars welded to plates to headed concrete anchors
Wall Panels	Crack mitigation for insulated panels with continuous insulation	
	Effect of reinforcement to improve edge lifting devices in thin panels	
	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.
	Seismic Design for wall panels with horizontal joints without minimum wall steel 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.
	Simplified method of calculating the partial composite action percentage for insulated wall panels.	
Erection	Temporary bracing design for vertical precast members and partially erected structures	
	Probability study for temporary bracing loads	Provide design guide for address temporary loads
	Tripping and rotating erection methodology	
	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.
Systems	Hybrid frame application to disproportionate collapse	Hybrid frames used for seismic resistance may have significant capacity for disproportionate collapse
Component Design	Improved detailing of double tee bearing plates	
	Shear strength in end regions of pretensioned members	In particular, this should address anchorage of longitudinal reinforcement for reliable shear strength.
	Headed deformed bars as shear reinforcement*	
	Effects of partial debonding of prestressing strands	Include consideration of lightweight concrete

	Release stresses in pretensioned members	Consider all sections where compression and tension must be considered
	Post cracking shear strength of bridge girders using self-consolidating concrete	
	Use of high strength reinforcement for spirals in prestressed concrete piles or prestressed columns	Can allowable yield strength of spirals be increased to 120 or 150 ksi?
	Minimum spacing requirements for large prestressing strands	
	Inverted tee or spandrel beams that require more prestress than a plant can pull on beds/abutments	How to determine strength and stresses for combined pretention (with strain compatibility) and unbonded post-tensioning (without strain compatibility)
	Hangers for openings in hollow core slab systems	Explore different hanger designs and effectiveness including support of reaction at adjacent members.
	Deflection calculations for Class T and C prestressed flexural members	Examine available data to evaluate current calculation methods and propose better methods
	Determination of plate-bending applications of eccentric transverse loading (torsion) for prestressed concrete beams with aspect rations less than 4.5	Current limitations on plate-bending design are based on available research and are likely more conservative that needed.
	Rational determination of A'_{sh} reinforcement requirements in dapped ends.	Current requirements for A'_{sh} steel area (horizontal reinforcement at the bottom of the member) is given as "not less than A_{sh}." The requirement for reinforcement at the bottom of the beam is likely less than that for diagonal tension at the re-entrant corner, and the requirement creates difficulties in detailing.
	Dapped end stress limits in extended ends in thin-stemmed members	For thin-stemmed members, the shear in the extended ends is limited by Handbook equations 5-71 or 5-72, with no relief for added reinforcement. When these shear strengths are reduced by λ for lightweight concrete, previously viable double tee designs are no longer possible. No specific research has been conducted to verify that the strength reduction for lightweight concrete is merited or that no form of reinforcement in the extended end can mitigate the reduction in strength.
	Surface roughness required for tension and shear bonding between cast-in-place concrete topping and precast concrete members for composite design	Requirements for measured surface roughness and the relationship between roughness and strength are not prescribed in sufficient detail to support rational design for composite members without transverse reinforcement.

	New cost effective flooring system design that can be cast on long-line steel prestress beds	For total precast concrete building construction where double tees may be overkill and hollowcore may not work or may not be available. The system should be conducive to receiving integral plumbing, HVAC piping and/or electrical conduit.
	Examine the radius required for dap reinforcement in thin stemmed members	
	Through testing and analysis, examine the longitudinal splitting strength of hollow core slabs subject to point loads and line loads parallel to the span	Some 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 hollow core 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 are to be studied.
	Concrete compressive ø factor in seismically confined columns	Ø=0.65 was developed for concrete columns years ago. At the time, spiral reinforced columns were given a higher ø because they provided more confinement than a typical column. The current phi factors correlate to #3 or #4 ties at roughly 16" OC wrapping every other leg. A seismically tied column today looks more like #5 ties at 4 inches oc. This added confinement that provides seismic ductility also makes the column capacity much more reliable. AISC uses ø=0.9 for compression in columns and ø=0.75 for composite columns. A seismically confined column should have similar if not superior performance to a steel or steel composite column. This should be explored this to determine if a higher ø is justifiable in seismically tied columns.
Sustainability	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	

Materials	Cement replacement in concrete mixes	Sustainable concrete specific to precast
	Characteristics of SCC	Include creep, shrinkage, early age modulus and shear strength
	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
	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.
	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 Precast	Effect of moisture content on APC color	Architectural panel color can be judged at many different ages. What is the effect of moisture content?
	Anchorage in thin APC panels constructed of UHPC	
	Durability of textured finishes used for APC	
	Form suction for stripping APC with projections and rustications	
	Bond of brick, tile, and precast concrete medallions in APC	
	Post pour replacement techniques for brick, tile, and precast concrete medallions in APC	

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

Alan Mattock Graduate Scholarship

1. An annual Alan Mattock Graduate Scholarship will be established in the amount of $4,000.
2. The Scholarship will be awarded to a student who is also the recipient of a Daniel P. Jenny Research Fellowship.
3. The PCI Research and Development Council will select the scholarship awardee on the basis of the student statement provided with the Jenny Fellowship application at the time Jenny Fellowships are awarded.
4. Student statement requirements:
   a. The student statement must describe the reason precast or precast, prestressed concrete is a field of interest to the student. This may be based on past experiences or future endeavor.
   b. The student statement must describe the relevance of the proposed fellowship research to the future goals of the student.
   c. Based on the research contributions of Alan Mattock to the industry, the student must include a brief discussion of how Alan Mattock might view the proposed research.
   d. The student's transcript and resume (two page maximum) must be submitted.
5. Members and families of the PCI Board of Directors and of the PCI Foundation Board of Trustees are not eligible.