PCI West Prestressed Concrete Bridge Workshop (3-Day Webinar Series) - November 1, 3, and 8, 2022

Questions and Answers

Please ask a question you have for our PCI West Producers here:	Answer/Response 1	Additional Responses
Are detensioning of strands done in sequence or specific order?	Yes. The order is either defined in the specifications or by experience. [Producers please elaborate or correct. It would be nice to give a bit more detail, including when draped strands are detensioned.]	General rules for strand detensioning are : First, each strand is cut at the same time at both ends of the girder, second, alternate strand cutting around girder centerline to minimize undue stresses in the girder, and third, draped strand should be detensioned and the hold down bolt should be removed immidiately afterwood before the girder strat cambering. General detensioning sequence is: First, detension bottom two outmost straight strand to create some compression in the bottom fiber, second detension all draped strand starting from top row down, third, remove hold down bolt to free the girder form the bed, fourth, continue detensioning the straight strand starting from top row down and alternating inward until all strand are detensioned.
Are the negetive moment transfer detailing and design at the joints for post-tensioned girders also discused?	For continuously post-tensioned precast girders, refer to NCHRP Report 517 and the PCI BDM Chapter 11.	
As a bridge foundation design engineer and as on-site bridge resident engineer for bridge projects, I've not often enough been close to the design or production of prestressed bridge components. All I can say, seeing the processes shown in the plant photos, is that I'm awed at the details of what it takes to get a prestressed girder or other member actually cast. I have no idea how the plant manages to get it all figured out! So my question, I guess, is "How on Earth do you do it?" -Jan J. Hartman, P.E.	There is a great amount of engineering and planning that takes place to make precast products which makes it one of the best options for constructing a structure.	

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As a designer, besides the actual engineering, planning of the route to transport girders to jobsite is paramount. Precast Plants have been very helpful with this item. It is just a general comment to tell new engineers to get transportation delivering planning from the Precast Association or nearest Precast Plant,	We strongly agree that consideration of shipping for long and/or very heavy loads is important and should be considered as early in the design process as possible to avoid unpleasant surprises later on. Contacting PCI West is a great recommendation to get initial information.	We are here to help and we encourage all designers to seek our help from the get go. We are actually in constant communication with designers and GC's during planning stages whether through direct communication or through PCI West meetings.
Can you used precast members for pilings, are there any examples?	Yes. Precast, prestressed concrete pilings have been used for many years. There are several different shapes that are common, such as square and octagonal, as well as hollow circular (cylinder piles).	Kiecon is one of the leading providers of precat piles in California. Square piles and octagonal piles with all different sizes are the most common ones. Refer to Caltrans Standard Plan B2-5 and B2-8 for more details. Please contact Kiecon for any specific question regarding precast piles.
Describe detensioning sequence in harped strands	Please see response to comment on Line 7 [or maybe we number the comments so we can refer to them later]	Detensioning sequence procedure is included on line 7 above.
Do you have plan for any FEM analysis in this course?	Unfortunately not. This course is intended to address issues related to fabrication and design rather than analysis.	
For girders with combined pre-tensioning and post-tensioning in a simple-span made continuous case, how are the stresses analyzed throughout the construction staging?	Post-tensioning and pretensioning girder stresses can be summed numerically using transformed section properties of girder. Refer to NCHRP Report 517 and the PCI BDM Chapter 11 for design guidance and examples.	

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For LWC what is the typical range of concrete strength compared to the normal weight values you presented?	Lightweight concrete can achieve typical concrete compressive strengths used for prestressed concrete elements. A 28-day strength of 7 or 8 ksi should be easily achieved. Design compressive strengths of 9 or 10 ksi have been used on some projects, but may require use of lightweight aggregate from particular sources.	
For the longer span lengths required to span roads these days, prestressed girders are being spliced using pretensioned girders with post tensioning running along both spliced girders. Are there sample details for the splice connection or any reference manual on the PCI website recommended for the splice connection details?	Chapter 11 of the PCI Bridge Design Manual is a good initial source for splice details and references to other sources, although it is not currently the most up-to-date information. The chapter is being updated. PCI offers several other more current publications, including a guide document for spliced curved U-beams (CB-03-20). There is also an eLearning course on extending span ranges (T310), as well as a series of courses on curved spliced U-beams (T350-358 - 4 courses).	
Great Presentation. Thank you very much for valuable insights from construction point of view. One question why was the first prestressed bridge in US dismantled in 1990's was it under capacity or any other problem?	An article in the May-June 1992 issue of the *PCI Journal* discusses the issues. Some of the details of this initial post-tensioned girder bridge in the US were not the best and some deterioration occurred. Current details would not have led to this relatively early deterioration.	

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Hi, the presenter mentioned about the box girders, do the cross ties always need to be post tensioned or they can be thug tied too? If they need to be post tensioned, please let me know any code section talks about the post tensioning amount. Also can those rods be skewed or should be perpendicular to the girder? Hi, is there any code section about connecting the box girders in railroad bridges using lateral poet tensioning rods?	Cross-ties can be post-tensioned, although high strength rods are also used. It is generally recommended that grout be place in the joints prior to tensioning or tightening the cross ties. However, this requires some detail to prevent grout from getting to the ties. Section 8.9 in the *PCI Bridge Design Manual* addresses transverse design of adjacent box beam bridges, as does PCI's *State of the Practice of Precast/Prestressed Adjacent Box Beam Bridges* (SOP-02-2011).	We have seen adjacent precast box girders/voided slabs are post tensioned together with strand or high strength rods primarily when they are designed without CIP composite topping. Most of the time the crosss ties are perpendicular to the girders when the end skew is not severe, but they can be skewed in situations where the girders have large skew at ends. As Reid mentioned in his response, keyways should be grouted before tensioning the cross ties. Special attantion should be made at the joints to prevent the cross tie grout from leaking out. This can be done by either applying silicon at the joints before girder setting if the cross ties are below the kwyways, or create blockouts at the joints so the cross ties conduits can be hand taped together if the cross ties are within the keyways.
How much clearance does there need to be between a diaphram hole and tendons?	[I will defer to others on this].	Strand usually are at 2" spacing at ends, so diaphragm holes (in terms of sleeves) have to be installed to fit in tight space between the strand. Since the strand are crossing the holes (not perpendicular to the holes), small clearance is acceptable (less than 1/4").
I have heard that some states do not allow WWR. Is there risk in using it? Or is it just a detailing issues they dont want to deal with?	There are no risks and many benefits in using WWR for prestressed concrete elements. DOTs that do not use the material are generally not familiar with it.	Caltrans contract drawing has alternative reinforcing detail using WWR. It is time efficient as it reduces labour time to install.

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I'm curious how multiple girders can be cast in one bed given how large and permanent the casting abutments seem to be? Also curious to hear about the fabricator's roll in determining things like proper slope of girder ends so that they are vertical when installed	The strands extend for the length of the bed and are anchored at the abutments, which may be up to 500 or 600 ft apart. The girder forms are set along the bed, with headers (end forms) placed to contain the concrete for each girder. Fabricators compute the end slope (batter) of the girders from information in the plans so the ends are essentially vertical after construction is completed. [Please add to or correct as needed]	Well explained by Reid. Casting multiple girders in large beds is cost efficinet as no strand is wasted specially in very long beds. Special attention should be made to multiple girdrs with draped strand cast in one bed. Strand force losses will increase due to strand friction around deflection points.
Is there a standard length or limit as to the length of the strand to be stressed. I see 500 ft beds, are there longer beds? What's recommended? Do you stress top and bottom stands at the same time? Is there a similar manual discussing procedures for evaluation and repair of double tees?	There is no standard length for beds - the length varies between prestress plants or even within a plant. Designers are not concerned about the bed length - the fabricators deal with this and show their plans for fabricating the girders in the shop drawings. Top and bottom strands are generally stressed separately, especially when draping is used since the top strands will have different forces and elongations. I am not aware of a repair manual for double tees, but much of the PCI girder repair manual (MNL-137-06), which is currently in the process of being updated, can be applied to double tees.	

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Is there a way the camber on the Prestressed Girder be lowered after the fabrication of the girder. Due to delays on the project, the girder was at yard longer than expected and the camber kept on increasing since there was no superstructure load on top of balance the prestressing force.	If cambers are getting too large because of a long storage period or other factors, loads can be applied to the girders to reduce the camber. However, when the loads are removed, the girders will rebound. While applying loads to girders can be done, it is not recommended due to the difficulties it provides for the plant as well as potential safety issues. It may be better to consider adjustments in the field, such as lowering the girder pedestals, to address excessive cambers.	
It looks like this will be covered in the next sections but I am looking forward to learning more about stress control at the ends and camber - how it is predicted/why it can differ from predictions/when to be concerned.	Refer to PCI BDM Section 8.7 for discussion on camber and Sections 9.4.8 and 9.5.8 for good examples of stress control at the ends of the girders.	
On slide 4, the first 2 case, the prestress cable produce upward force at the support. Do we need to consider them when designing beam/support at Strength Level?	The force shown on this slide is the prestress force and it is equilibrated within the girder, so does not produce a reaction that needs to be considered in design.	
Please discuss carbon fiber prestressing strands, including temperature adjustments for differential expansion/contraction and if draping is possible	Such a discussion has not been included in the presentations as the technology is still being developed. However, there is now an AASHTO Guide Specification for design using these strands. The strands cannot be draped as in pretensioned girders, but may be able to be used for post-tensioning with limited curvature.	

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Questions and Answers

<table>
<tr><th>Please ask a question you have for our PCI West Producers here:</th><th>Answer/Response 1</th><th>Additional Responses</th></tr>
<tr><td>Q1. There are 2 methods to control concrete tensile stress at top of girder at release: draping and debonding strands.

a) What are the advantages and disadvantages of each method?

b) Which method is more commonly used by State DOTs, if there is one?

Q2. For high strength concrete, is there a compressive strength (f'c) that is commonly used by DOTs? What is the highest f'c that has been used in pc/ps girders that you are aware of?</td><td>The features and differences between draping and debonding to control stresses at the end of a girder were discussed. There are pros and cons for each method. Fabricators may prefer one method over another, but generally prefer debonding. Beds must also be designed to resist the loads from draping. DOTs use a mixture of the methods and may allow either or both. DOTs typically use compressive strengths in the range of 8 ksi and in some cases up to 10 ksi. We should only use what is necessary, and in most cases very high strengths are not required for the design. Years ago, 12 ksi was used for some demonstration girders, but it turns out that the design only required about 9.5 ksi. Using a high strength without justification will only drive up costs.</td><td>Debonding is a fabricator prefrence for safety reasons and for time efficincy. However, draped starnd has one advantage over debonding which is related to some shipping overhang requirement. Some routes to the job site and type of hauling trucks available at the time requires longer overhang. Draped strand allow for much longer overhang.</td></tr>
<tr><td>What is the best sequence for stressing strands(to start from the middle or from the edge) also the same for detensioning</td><td></td><td>Although detensioning sequence is more cretical than tensioning sequence, they are done usually in the same manner, alternating around centerline to minimize excentricity on the abutment during tensioning and most importantly on the girder during detensioning. Theoretically, starting from middle to edge has the advantage of applying compression force with minimum eccentricity first which better manages the tensile strees due to a later larger eccentricity as we go toward the edge. However experience shows that this advantage is slim specially when alternating around centerline, making the sequence from edge to middle more preferable as the crew will have more room to do the job from the side rather than from tight area in the middle.</td></tr>
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What type of material should be specified for forming interior hollow cores in cored slab bridges? Steel, galvanized steel, hollow cardboard cylinders or polystyrene? How are hollow core forms kept from floating during concrete placement? Thank You.	As discussed by the panel, there are several types of materials used to form the interior voids in cored slab bridges. Cardboard tubes and foam are the most common materials. The voids must be held down as the concrete is placed as they will otherwise float out of position. Once concrete is place on top of the voids and vibration of the concrete is completed, the hold-downs can typically be removed and the holes filled. [fabricators please review and revise as needed]	Kiecon use cardboard (SonoVoid) in voided slabs and Styrafoam in box girders. Both types are held down by two or three rods projecting down from cross tube steel bridging the side forms at 4ft O.C. Once the concrete is set, the rods are removed and the holes are filled with concrete.
why does superelevation need to be considered along the route?	Superelevation needs to be considered if there is any potential for the movement of the girder to be slowed since the girder on a side slope will deflect laterally and potentially cause lateral stability issues.	
Why would expoxy coated strands be needed for prestressed beams?	Epoxy coated strands can be used in an extremely severe corrosive environment as another layer of protection.	
At Caltrans, Strength II often controls the number of strands required. If this is the case, the strands can be jacked to a lower percentage than 75% of GUTS to meet Service stresses.	Agreed… jacking to a stress lower than 0.75 GUTS is recommended if flexure strength demands control.	
Can you extend the strands from the edge of a precast girder for positive bending moments in an intergral bridge abutment for example?	Yes. This is Caltrans standard practice. The LRFD Specs address this practice for design.	Most bridges we do have this detail. It is very common.
For hollow core prestressed precast slabs, what method is used to hold down the hollow core forms during concrete placement? Also, what material is used for the hollow core forms?	[addressed in earlier comment]	If you are talking about voided slabs girders, see my response in row 29 above. If you are talking about spancrete voided slabs, then, the voids are metal and part of the machine which extrude dry concrete. See Spancrete web site for more info

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Have there been any studies on the relation between concrete deck cracking and the use of precast girders?	I am not aware of any formal studies on the topic. However, for some years it has generally been accepted that decks crack less on precast girders, possibly due to the reduced flexibility of the PS girders.	
Have you seen PS strands used as regular reinforcement for it's high yield strength? is there process to only tension this strand to remove slack only?	Untensioned strand is not usually used for reinforcement, but can be used in some cases. There may be some design obstacles as the material will not yield until very high strains, leading to large crack openings prior to failure if this were the only reinforcement. A more detailed analysis, such as a moment-curvature analysis, should be performed to evaluate performance of the section. For the second question, tensioned strands are always stressed to an initial load to seat the chucks and to make measurements related to stressing more consistent.	
How accurate is the full bonding assumption when we use debonding at some lengths through the beam? Are there any factors that are applied?	Using debonding, strands are considered to be either bonded or not. When bonded, a full bond is assumed, which is accurate. The design would consider when strands are debonded. The only factors applied are the same as for fully bonded strands, which is for locations within the transfer and development lengths.	I can add to that that the development length for debonded strand is double of that for bonded strand, if I remember correctly.

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How blocking(supporting location) affect the girder camber?	If girders are supported at locations at a distance from the end, the span is reduced and therefore the dead load moment is reduced (and a small negative moment is also produced due to the overhangs). This will increase the camber since the upward deflection due to prestress remains essentially constant and is unaffected by changing the support locations.	We sometime practice this approach if we need to increase camber.
How difficult is it to place girders with strand extended and lapped within a bent cap? Do you just bend strand slightly to avoid these clashes? How difficult is it to extend bars and couple them if there is not enough space between girder ends for bar or strand lapping?	With extended strands, it appears that it is fairly easy to bend overlapping strands from adjacent beams without significant conflicts. If rebar is used, conflicts can be more of an issue, especially if larger bars are used. Bars are not typically coupled in such connections. WSDOT does have a detail for coupling strands in this type of connection.	To add to that, if the space between the girders are relatively small, we tend to alternate the extended strand to avoid such clashes.

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How soon de-tension work can start? Is it possible as soon as next day? What is the sequence to release hold downs? before or after detensioning strands? Instead of expected concrete f'c can cylinder compression test used? Instead of expected concrete f'c can cylinder compression test used? Any safety concerns when detensioning? What is the sequence to release hold downs in draped strands? How anchor set/seating loss is calcualted in prestressing? How stresess are calculated at the transfer length? How close are the multiplier method vs field measurements?	[I will defer to producers for some of this] Expected concrete strengths are intended to represent cylinder breaks, but the quantity is needed during design so there are no cylinder breaks available yet. Anchor set is not typically considered as a source for prestress loss for pretensioned - it is simply an adjustment made during tensioning. Stresses within the transfer length are computed as specified in the LRFD Specifications, which is to assume a linear variation in stress from zero at the end of the girder to the full effective prestress at the transfer length. For cambers, there is a fair amount of variation between cambers estimated using the multiplier methods and field measurements. However, the bridge is detailed (or should be) to accomodate the variability in camber. Only occasionally does the difference between predicted and actual cambers cause significant issues.	The most effective way for precatsres is to detension and strip the next day. This will not happen until the required initial sterngth was achieved by breaking a cylinder. Regarding safety, all crew will stay behind a shield when detensioing and a horn is blown to alert other people walking or driving nearby. Regarding removing hold down, see my response in row 7 above. Seating loss is calculated using the measured strand slippage in the chuck. We use PCI multipliers to calculate cambers which are usually within PCI tolrenace of +-3/4". This can vary depending on time of erection. Some precaters modify the mutipliers to suit their camber history over the years.
If it's not too late for another question, I'm wondering if you could speak to precambering precast girders - is this common? have you done this before?	Precambering of pretensioned girders can be done, but it it very rare, and most fabricators have never done it. I have never specified it, nor am I aware of its use other than in the Northwest of a few bridges, and it has been in a plant where girders are cast one at a time.	We have done few of those but only for short precast conventionally reinforced girders (not prestressed). Precambered prestressed girders can be tricky as the strand profile getting hard to install.

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Is the initial strain Epo for prestress strands applicable to post tensioned members?	This difference in strain between concrete and the tensioned strand does indeed exist for post-tensioned concrete members, but it is locked in when the tendon is grouted, and the value will vary along the length of the tendon, where it is essentially constant along the length of a pretensioned girder.	
Is there a max time in between tensioning strand and pouring concrete in the girder? For example, if the strand is tensioned on a Friday, is it okay to pour the concrete the next Wednesday?	I believe there is a limit on how long you can delay the pour, which I think is 72 hours. After that, strand lift off has to be performed.	
On Slide 55, is there a reason why you debond level 3 vs level 1?	This slide was intended only to be a schematic view to illustrate the effect of debonding, not to indicate different layers of strands. Debonded strands are typically distributed among layers of strands.	
What are the lateral post-tensioing requirements for precast voided slabs? Can they be avoided if the stirrups are extended into the Cast-in-place deck?	Design of transverse ties for precast voided slabs was discussed in the response for an earlier question. It is indeed possible to avoid the use of transverse ties by using reinforcement. This has been done by using larger blockouts with bars extending into the joint, which is then filled with UHPC to make the non-contact splice between the rebar from adjacent beams. Such a detail has been tested by FHWA.	

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What was cost saving on the project using ABC? What about time? Overall (design, fabrication and erection) ?	When dicussing project cost, we need to consider project duration and taffic impacts. Considering shorter project time, less traffic impact and less public expsore to construciton accidents, ABC is the best way to do a job.	General contractors can answer this question better, but I can imagine big time and cost saving using ABC projects.
When computing the camber, the PCI handbook shows a multiplier for a composite deck, however the slide following the tables says to not use multipliers for final conditions. Could you please explain? Is this because the PCI handbook is for general Precast elements vs. long span bridge girders?	The multiplier method was developed as a general and very approximate approach. It has been found that for bridges that very little additional movement occurs in the girders after the deck is applied. Therefore, the use of final multipliers overestimates the change in camber with time. Some designers have added strands to try overcome the computed long-term sag in the girder, which is counterproductive and adds unnecessary cost. Hence the recommendation to neglect the final multipliers for composite bridges.	
which software was used for release stresses?	The software used to generate the stress plots along the beam was PSBeam by Eriksson Technologies.	
Question for bridge repair - What causes longitudinal crack on bottom flange soffit along whole girder length?	It is difficult to try to assess the reason for such a crack without more information. However, a possible explanation could be that if the ends of the strands are exposed to entry of water at the ends, water could have entered and travelled along the strands and then froze, causing expansion that cracked the cover.	PCI Journal "Fabrication and Shipment Cracks in Precast or Prestressed Beams and Columns", Vol. 30, No. 3, May-June 1985, addressed the cause and rpair of may cracks patterns in girders.

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Is lateral stability Contractor/Precaster responsibility?	It is typically the responsibility of the contractor and precaster to deliver and erect a girder. However, it is recommended that lateral stability be considered during the girder design because girders can be designed that cannot be safely moved from the bed.	If girder stability is not checked during design stage, we strongly recommend adding top strand in longer girders to improve stability or cosult with your local precater before it is too late.
Is it possible for someone like me as an attendee to have a copy of a complete bridge design and a set of complete structural drawings of a particular bridge?	http://ppmoe.dot.ca.gov/des/oe/project-bucket.php has complete sets of plans, specifications and bid results available for download.	
In GA we require a letter from our permit office for all beams that are longer than 90’ or weigh more than 135,000 (including 45,000 for the trucking apparatus) that there is at least one feasible route to get the beam there. It is part of the preliminary design process	Thank you for this comment. It is a great practice to check shipping during preliminary design to avoid later problems.	
In California, is there any refrences that make it clear to a contractor that lateral stability analysis is not the responsibility of the designer but rather the responsibility of the contractor to elect means and methods that prevents damage to the girder? I believe I saw LRFD AASHTO standard being referenced in part 1 of our presentation. Is there any other supporting documentation for this?	Refer to Caltrans Standard Specifications Section 51-4. Although the contractor is required to submit stamped and signed shop drawings, calculations, and an erection work plan; the designer is responsible for determining feasibility.	
How does one determine the presressing force that should be used in the lateral tension ties, the ones through the box beams 'transversely'?	This was addressed in an earlier response to a comment.	

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Can voids for voided slabs be held down from below. What of stay-in-place forms are used to form the voids?	Voids could possibly be held down from below, but practice is almost univeral that they are held from above. This allows removal of the hold down after concrete is placed on the void, and the hole can be filled.	See response in row 29 above.
Can a utility opening be placed in a precast box girder?	This is rarely if ever done. The solution is generally to space the boxes apart to allow space for the utility (if there is a composite slab is being applied to the bridge, which can then span the utility bay), or to use a section like the NEXT beam, which is a double tee and the utility can pass between stems.	Never seen that before, bur rather I saw utility hanging from bottom of box girders by means of inserts embedded in bottom of girders.
Are there any "standardized" details for splice closures? This is for joining 2 girders and splicing them because otherwise the girder is too long. I have not seen any details for this in the Caltrans website. I am already a Professional PCI West member and would like to be on an email list (if there is one) for future webinars on Precast Prestressed Concrete. Thank you for this webinar, it has been very informative. Thank you also for doing this during lunch hours.	I am not aware of any standard splice details, although a few states may have developed some. PCI does has guidance regarding spliced curved U-beams, which should include splice details which could be used for any type of splice.	

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Are longer girders always more cost effective (from a producing point of view)? Or can having more girders that are shorter in length lead to cheaper fabrication?	Typically, eliminating piers by using longer girders is a more cost effective solution as material, transportation, project duration, and erection activities are reduced. However, there are many factors that are involved and may affect the outcome since larger cranes and hauling equipment are also required. Designers are encouraged to look at the options.	