

Concrete Constructability

Where do students/young professionals learn it?

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Can We Define Constructability?

The effective and timely integration of concrete construction knowledge into the planning, design, and construction of a project to achieve the overall objectives with the goal of optimizing time, safety, and cost while maintaining the target level of quality.”

ACI 134

Can We Define Constructability?

The effective and timely integration of concrete construction knowledge into the planning, design, and construction of a project to achieve the overall objectives with the goal of optimizing **time**, **safety**, and **cost** while maintaining the target level of **quality**.”

ACI 134

Where do we teach “Constructability” ?

- We currently have no course titled “Constructability” in the CM curriculum at ASU
- We currently do not even have a class inside of a course titled “Constructability” *
- We teach constructability in a similar fashion to how we teach Ethics and that is ‘across the curriculum’

How do we teach “Constructability” ?

- Most faculty incorporate constructability issues into their material from their own personal experience as it relates to the topic they are teaching.
- For example, we include an example problem in the computer applications course where Navisworks is introduced to show students how a typical clash can occur during preconstruction
- We incorporate constructability into our estimating and scheduling courses when comparing different alternatives to construct involving equipment choices and related cost

How Industry helps us teach “Constructability”

- Due to our geographic location our faculty are fortunate to be able to bring in many industry guest speakers to speak to our students in their classes
- Approximately 25% of our CM classes are taught entirely by adjunct faculty who face constructability issues daily and bring that awareness to our students
- Most faculty embed field trips into their classes as well
- Each student must complete 2 summer internships in the industry to graduate and an estimated 80% of our students work part time during the school year

Techniques we use to improve Constructability

- Federal and State Procurement Laws that allow early contractor involvement
- Construction Partnering
- Building Information Modeling
- Prefabrication
- All this is done in AZ but still we struggle

We have all seen this

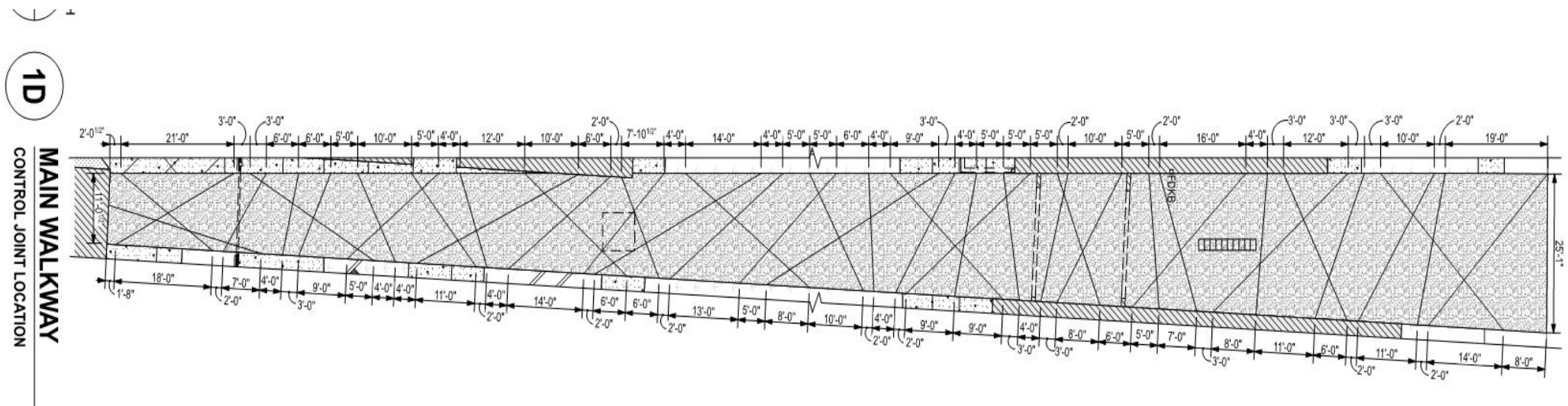


Monte Vista School Sidewalk

ISSUE – Concrete Jointing and Subsequent Cracking



- Backstory - Contractor is contracted to demolish a 1940s school and totally rebuild it on the same site. The current school principal was a student at the original school and planted a tree on the property and wanted to save it.
- The new site structure orientation could not save the tree so the architect decided to incorporate the tree into the design of the main sidewalk leading through the school by designing the joints to resemble the bark on the tree

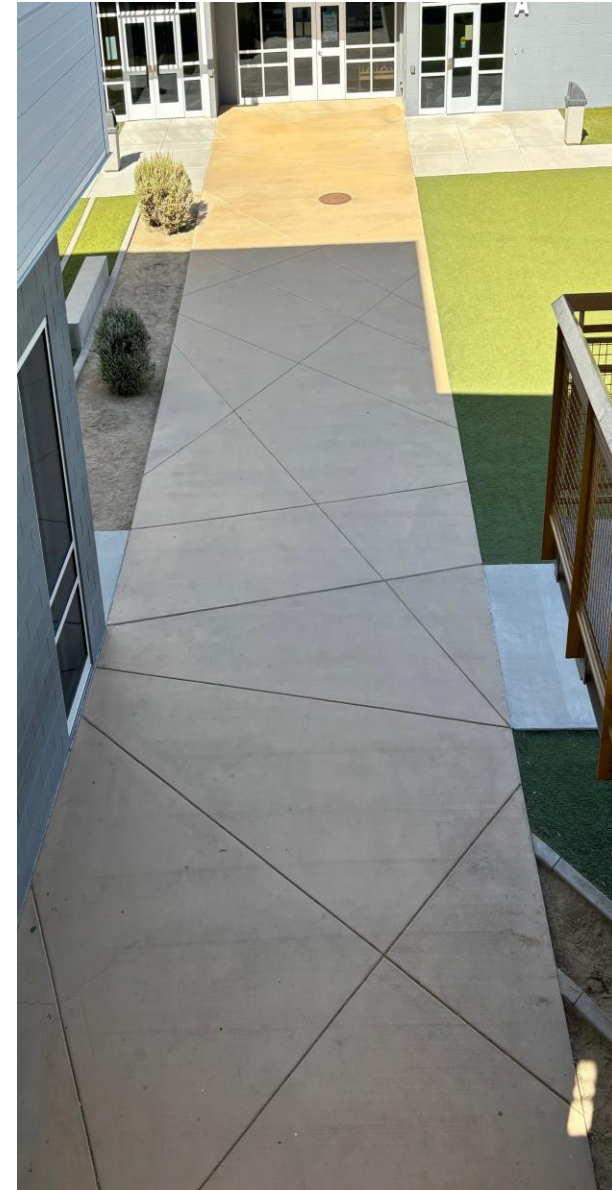


Monte Vista School Sidewalk

ISSUE – Concrete Jointing and Subsequent Cracking



- The Contractors project engineer immediately recognized the problem and called a meeting of all concerned and explained the risks involved in following this jointing design
- The team ‘jointly’ came up with ‘alternate’ jointing plan
- Sadly, at the 2 year warrantee meeting the contractor decided to replace the entire sidewalk **at their expense** in order to maintain the relationship with the school district



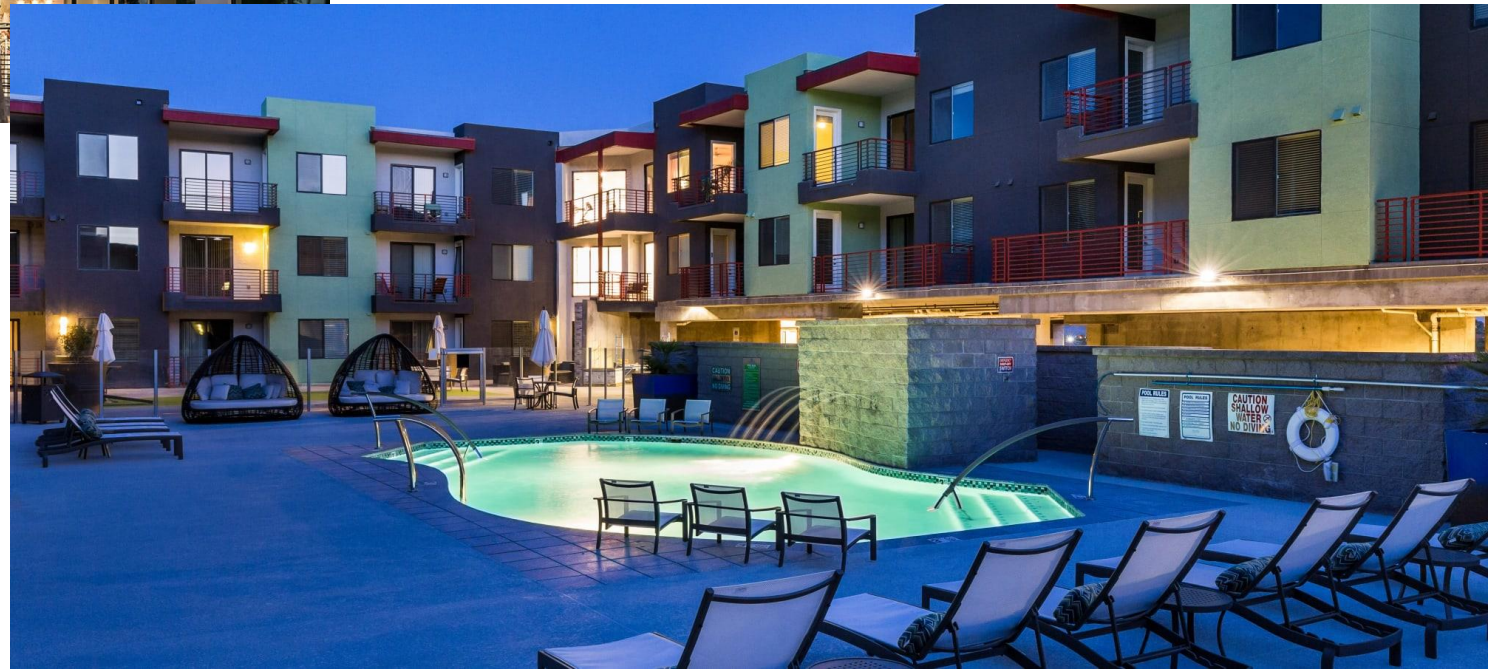
Park Place Residential Project

Issue – Post Tensioning Failure



This luxury apartment 3 story complex is wood frame over a post tensioned concrete podium on the first floor. Our graduate was an employee of the ready mix producer so was not directly involved in the issue but nevertheless was splashed with the cost.

Some changes were made to the design and two post tensioned grade beams were combined into one for some reason.



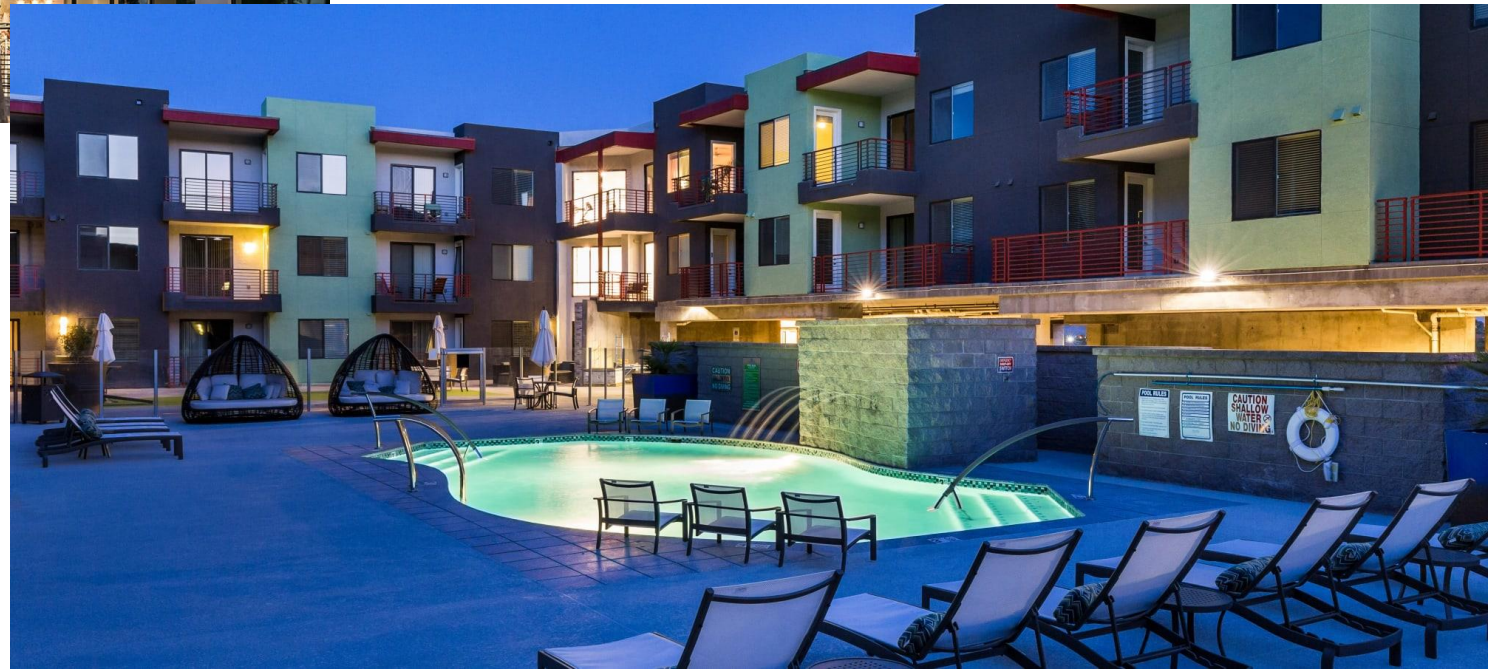
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Park Place Residential Project

Issue – Post Tensioning Failure

As normal when this happens it is extremely hard to find out information on exactly what caused this as well as who then paid for the repair. The ready mix concrete producer had to verify his concrete cylinders and took cores which all exceeded the required strength



Perhaps it was constructability related and perhaps not

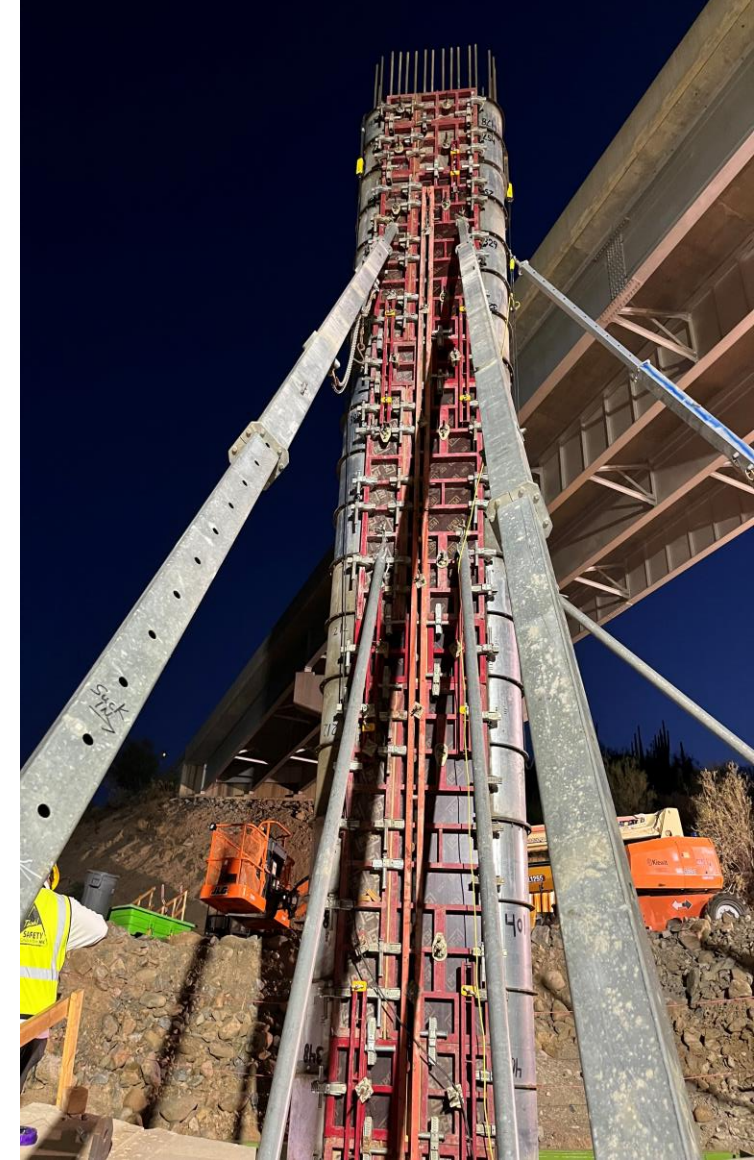
The repair cost was around \$500K

Freeway Bridge Column

Issue – Owner Driven Congestion



The 45 foot tall columns on this widening project were mandated by the owner to match the existing columns (cast 40 + years previously). The existing columns were cast in two lifts with a joint at mid height. The owner would not allow the two lift method requiring the contractor to consolidate concrete 45 ft down and limited the slump to a maximum of 6 inches.



Freeway Bridge Column

Issue – Owner Driven Congestion



The contractor had vibrators with 35 foot hoses and thus struggled to consolidate the column all the way to the bottom actually getting the vibrators caught on the rebar and clogged in the column

They removed the concrete after the first truck and then improvised a method to keep the vibrators from getting stuck and managed to complete the column

Seems like an unnecessary mandate to require the column to be cast in one lift



Highrise Building Column Size Adjustment

Issue – Designer not considering formwork cost



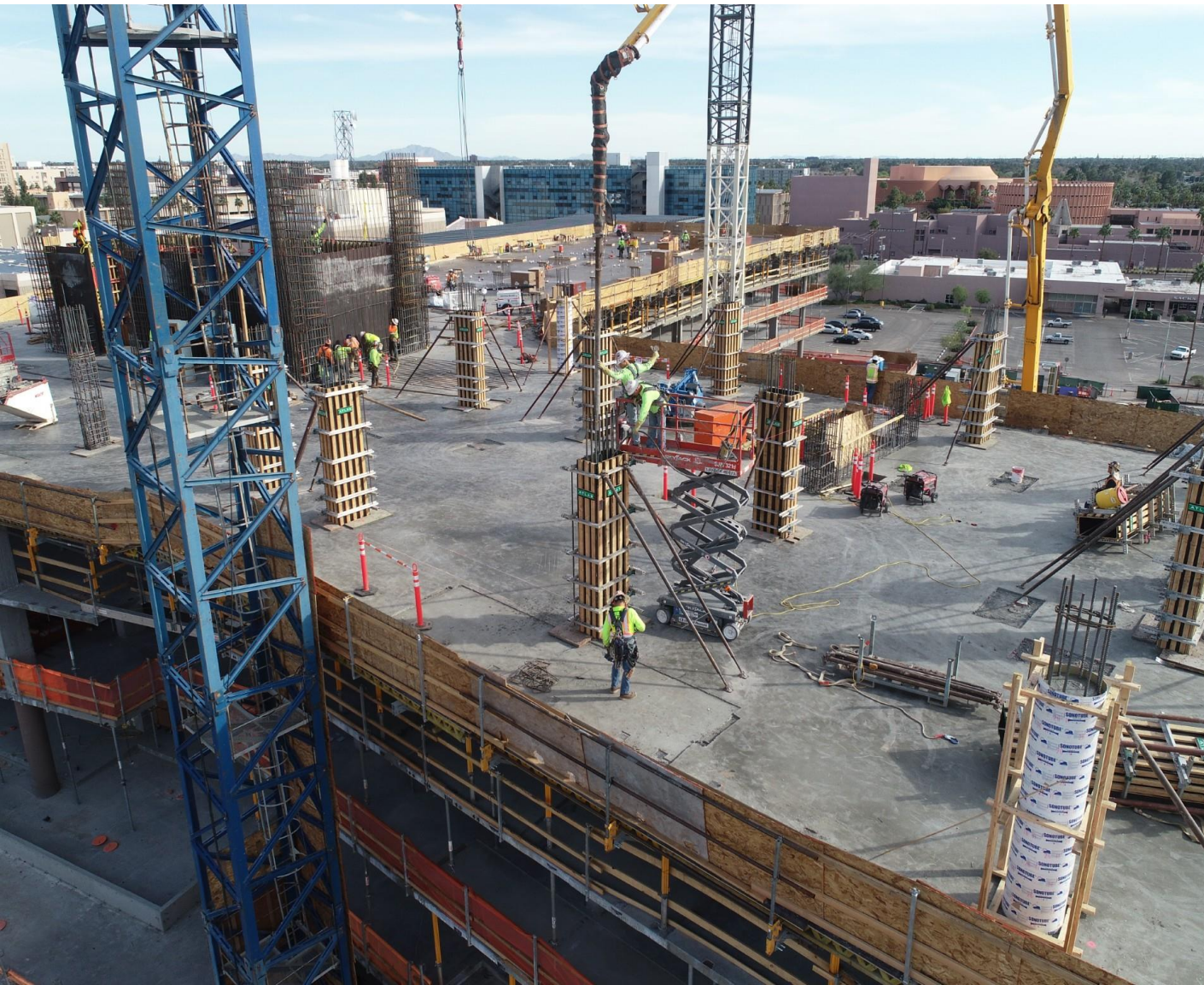
This senior living center on the ASU campus is one of the first of its kind in the country in 2021

It has 250 independent living units plus 50 health care units

As often happens during design, priority is given to minimizing column sizes to maximize usable square footage with little or no thought being given to the cost of formwork placed on the contractor

Highrise Building Column Size Adjustment

Issue – Designer not considering formwork cost



Fortunately this was a CMAR project which required the contractor, the designer and the owner to work together during the preconstruction phase.

The initial design drawings for the 20 story, 600,000 sf structure contained 32 different column sizes.

The Contractor was able to trim that number to 14 by adjusting the concrete strength and amount of reinforcing steel in the columns thus saving significant dollars on formwork cost

Del E Webb School of Construction Building

ISSUE – BAD Concrete Jointing Operations that wasn't caught



- We all know concrete cracks due to shrinkage so we tool or saw joints to remove material and create a “weakened plane” right?
- Or maybe we don’t...
- At least this project team did not
- This long driveway has three 2 foot diameter holes taken out of its width in order to install those bollards
- Where is the tranverse joint needed here?

Crack



Crack 1

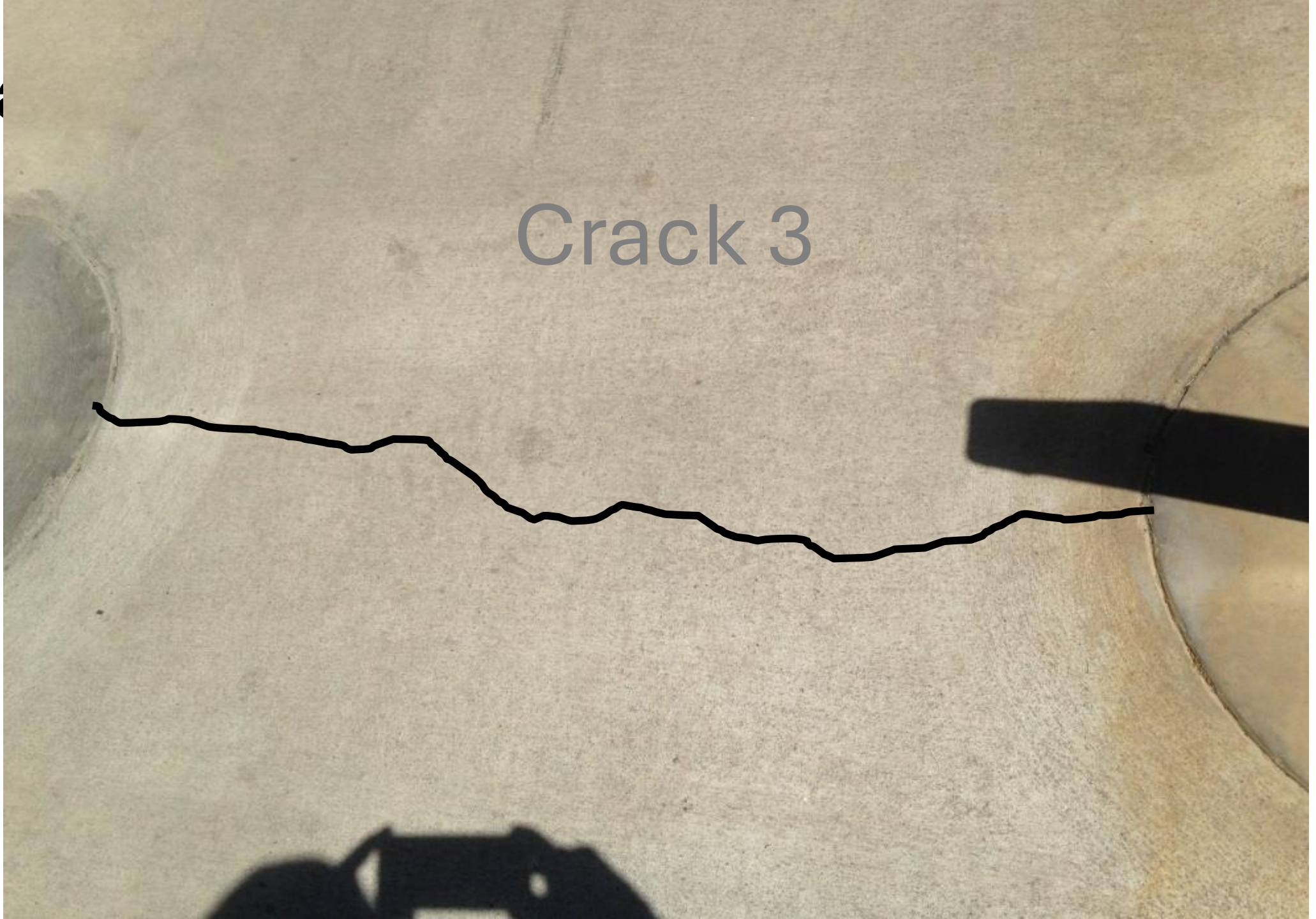
Crack

Crack 2



Cr

Crack 3



Crack

Crack 4



We have a large generator outside our building at ASU
Notice it is sitting on a separate pad that isolates it from the
driveway concrete (due to vibration)



On the south end, the joints in the driveway are lined up with ends of the Generator Pad
Nicely done – no cracks noted



It would make sense to do it on the other side as well right?



It would make sense to do it on the other side as well right?



Nah – that would be too easy!!!

Here is the other corner at the south end

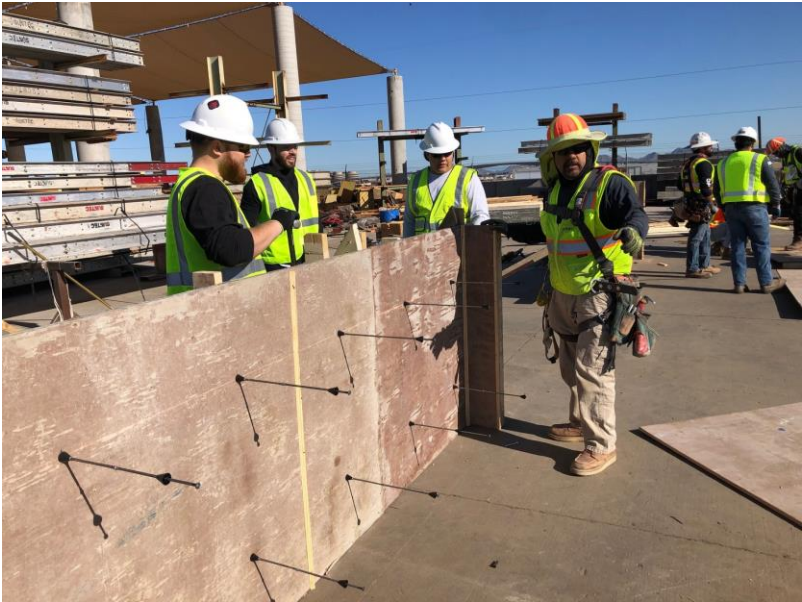


In fact, they liked that look so much
they copied it on the north end corners!
(and placed a joint within 12 inches of where it needed to be!)



LESSON: Concrete does not shrink around corners well!

So how do we teach constructability?



Summary

- What can we do in Academia to better prepare students for constructability issues they will face as young professionals?
- Industry interaction - Guest Speakers - Field Trips – Internships
- Form ACI Young Professional Groups as part of local chapters
- This can be a challenge due to university location
- It can also be a ‘culture issue’ for engineering and architecture programs
- How can we better support new faculty who join these programs without any construction experience?
- Could ACI Foundation model AGC’s Faculty Internship Program?

Thank you

To the many industry supporters who contributed to this presentation.

Disclaimer

‘No animals, owners, or design professionals were harmed in the making of this presentation’

