PROJECT RECORD

BSE Structural Engineers LLC
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From: Justin E. Burgoon, P.E., S.E. - BSE
To: Ernie Shaw – City of Lawrence Park & Rec.
RE: Lawrence Sports Pavilion Concrete Crack Assessment

Date: 7/3/2017
Project No: 17-236

BSE was requested by Ernie Shaw with the City of Lawrence to revisit the existing cracks in both the exterior concrete tilt walls and the interior concrete mezzanine slab. The purpose of the visit was to assess the current condition of these cracks. BSE walked the building and observed the cracks with Ernie Shaw on June 16th 2017.

These cracks have been previously addressed in two separate letters. The concrete mezzanine cracks were addressed in a letter to Gould Evans and Paul Werner Architects dated November 17, 2014. The exterior concrete tilt wall cracks were addressed in a letter to Gould Evans and Paul Werner Architects dated January 22, 2015. Both of these letters are attached to this letter for reference.

During the walk through BSE photographed several of the existing cracks in both the exterior concrete tilt walls and the interior concrete mezzanine slab. BSE has several record photos of the existing tilt wall cracks from January 2015 and a few record photos of the existing mezzanine cracks from May 22, 2014.

Focusing on the tilt wall cracks and comparing photos 1 through 4 (attached to this letter) it appears that these specific cracks in the concrete tilt walls have not changed in size or length over the last 30 months. BSE's conclusions and recommendations from the January 22, 2015 letter are still accurate.

Focusing on the mezzanine slab cracks and comparing photos 5 through 7 (from 2014) with photos 8 and 9 (from 2017) it appears that the cracks have occurred in areas in which random shrinkage cracks are common. These areas include corners of floor openings (duct penetrations and stairwells) and points of floor support (column locations and girder lines). The photos from 2014 show that cracks immediately showed in these areas. In addition to the cracks mentioned above, several transverse cracks have occurred in an 8 foot to 16 foot spacing with a longitudinal crack running in the perpendicular direction along the length of the mezzanine. See attached photo 10. These cracks have occurred in a pattern that is similar to the control joint pattern sawn into the concrete slab on grade. See attached photo 11. The difference between the cracks in photo 10 and photo 11 is that the cracks were controlled in the slab on grade with sawn control joints. The cracks in the mezzanine slab were not controlled because sawn control joints were not sawn into the mezzanine slab. The pattern and spacings of these cracks are consistent with temperature and shrinkage cracking. BSE's conclusions and recommendations from the November 17, 2014 letter are still accurate.

In addition to observation of the above mentioned cracks, BSE did a cursory walk through specifically observing the masonry walls, cast-in-place concrete walls, and inside face of concrete tilt panels to look for signs of movement or settlement in the basement area. There were no signs of settlement or movement in the basement areas of this structure.

In conclusion, these cracks, in our opinion, are not a concern structurally and are likely a result of shrinkage during curing. In general, these cracks do not appear to have widened or lengthened over the last 30 months. The existing patches placed over existing cracks appear to be maintaining the patch integrity. The majority of the cracks are hairline and do not show any signs of tearing.

Please feel free to call with any questions or comments regarding this letter. We appreciate the opportunity to provide our services to you.

Sincerely,
BSE Structural Engineers, LLC

Justin E. Burgoon, P.E., S.E.
Senior Structural Engineer

Photo 1 – 2015

Photo 1 – 2017

Photo 2 – 2015

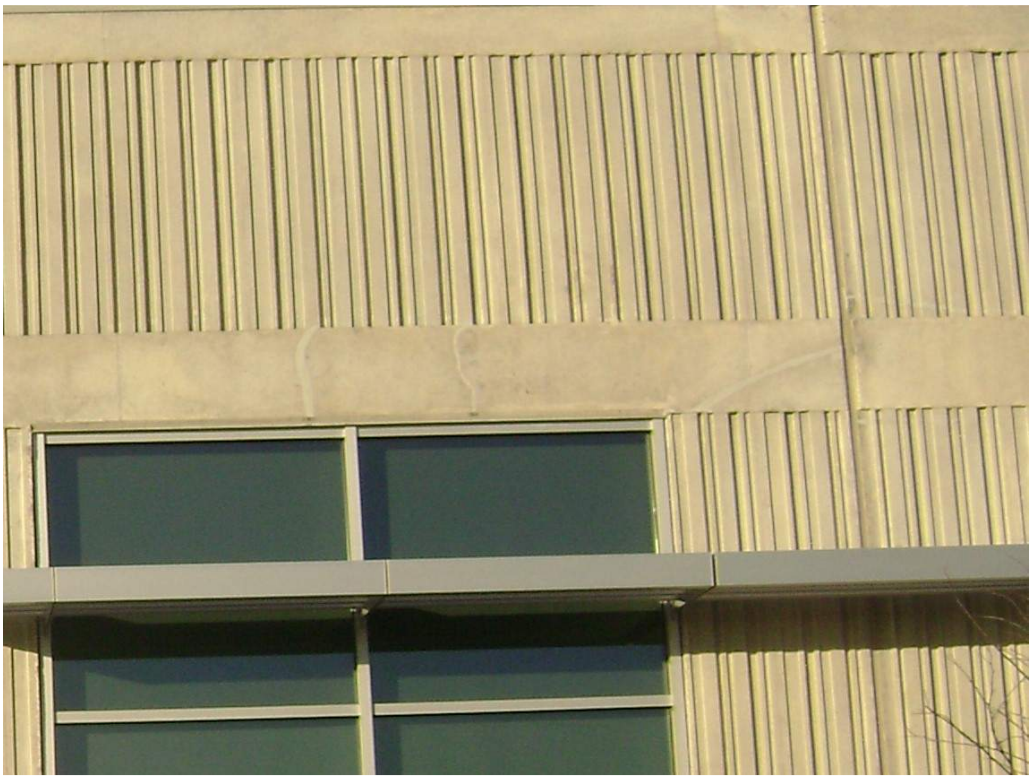

Photo 2 – 2017

Photo 3 – 2015

Photo 3 – 2017

Photo 4 – 2015

Photo 4 – 2017

Photo 5 - 2014

Photo 6 - 2014

Photo 7 - 2014

Photo 8 – 2017

Photo 9 – 2017

Photo 10 – 2017

Photo 11 – 2017

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From: Justin E. Burgoon, P.E., S.E. - BSE Structural Engineers **Date:** 11/17/2014
To: John Wilkins - Gould Evans, Paul Werner - Paul Werner Architects **Project No:** 12-083
RE: Rock Chalk Park Rec. Center Mezzanine Cracks

BSE was asked by Paul Werner with Paul Werner Architects and John Wilkins with Gould Evans to write a letter referencing the mezzanine slab cracks which have occurred for the referenced project.

The mezzanine slab and support framing are defined in the structural documents on sheets S2.1 and S2.2. Note 16 on sheet S2.1 and note 10 on sheet S2.2 specifies control joints in the mezzanine slab at 10'-0" maximum spacing and in a pattern to be coordinated with the Architect for aesthetics. The specified control joints were not cut by the sub-contractor.

As discussed previously in an email dated May 21, 2014, typically if elevated concrete slab on metal decks are going to be covered by a finish material, control joints are not cut into the concrete and the slab is allowed to randomly crack. The design intent is that the reinforcing steel in the slab, when placed properly, holds the cracks tight and prevents them from separating. If the concrete is to be covered by a finish material, then the unsightly random cracks are not typically an issue and sawed control joints probably wouldn't be necessary. Exposed concrete areas obviously require a little more consideration. The intent of sawing control joints into the slab is to try and localize random slab cracking into a more visibly appealing pattern. The reality with a concrete slab on metal deck is that the concrete will likely crack randomly, even when control joints are placed. Most cracking is a result of shrinkage of the concrete due to curing. Also, the slab has the highest potential to crack where the top surface goes into tension which is typically at interior load bearing walls and beam or column supports. If possible, it would be recommended to locate sawed control joints at these locations.

Structurally, as long as the reinforcing steel is placed properly, the cracks are not a concern. Based on the description listed above, the cracks are not unusual and likely a result of shrinkage during curing.

These cracks could be routed to remove all loose material and filled to a level condition with epoxy.

Please feel free to call with any questions or comments regarding this letter. We appreciate the opportunity to provide our services to you.

Sincerely,
BSE Structural Engineers, LLC.

Justin E. Burgoon, P.E., S.E.
Senior Structural Engineer

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From: Justin E. Burgoon, P.E., S.E. - BSE Structural Engineers **Date:** 1/22/2015
To: John Wilkins - Gould Evans, Paul Werner - Paul Werner Architects **Project No:** 12-083
RE: Rock Chalk Park Rec. Center -Sawed Control Joints in Slabs on Grade & Exterior Tilt Panel Cracks

BSE was asked by Paul Werner with Paul Werner Architects and John Wilkins with Gould Evans to write a letter referencing requirements for filling the sawed control joints in the slabs on grade as well as the elevated mezzanine slabs. BSE was also asked to reference the cracks in the architectural wythe (exterior face) of the insulated concrete tilt panels on the referenced project.

Control joints are sawed into concrete slabs in an attempt to localize shrinkage cracking, due to curing, into a more visibly appealing pattern. The sawed control joints also aid in the maintenance of the slab joint. Joint filling was not specified for this project. Typically joints are only required structurally to be filled if there are heavy loads to be transferred across the joint. These loads would be anticipated in a warehouse/industrial application, but not for a recreation center. Ultimately it is up to the owner to determine if joint filling is required. Water collecting in the slab joints is not a concern structurally for this application as we are indoors. Water would be a concern if the slab was exposed to freeze thaw cycles. The maintenance required to keep the slab joints clean of dirt and debris is another consideration for the owner.

BSE received several photos from John Wilkins via email referencing numerous cracks in the architectural wythe of the insulated tilt panels. BSE observed the exterior of the panels on January 15, 2015. The majority of the cracks occur at the corner of window/door openings and typically continue diagonally until they reach the panel edge. The majority of the cracks appear to be less than 1/16" wide and are considered to be tight. BSE was also contacted by Casey Stewart of DFC on August 7, 2014 referencing these cracks. BSE documented several photos of the cracks on August 8, 2014.

The insulated tilt panels are composite panels consisting of a 6 1/2" structural panel, 2" of insulation and a 2 3/4" architectural wythe. The architectural wythe is continuously supported by the structural panel and does not carry any structural load besides a portion of its own self weight. The 6 1/2" structural panel is reinforced to support bearing loads, its own self weight (including the weight of the architectural wythe), as well as wind and seismic loads. As previously mentioned, the architectural wythe is supported by the structural panel through inserts designed by and coordinated with Thermomass. Typically, the architectural wythe is only reinforced for temperature and shrinkage stresses. Our construction documents detailed 6x6 W2.9xW2.9 W.W.F. sheets to be located in the center of the wythe. This architectural wythe thickness and reinforcement are common in the insulated tilt-up industry. This reinforcement meets the minimum requirements defined in ACI.

The general contractor requested to use fiber reinforcement in lieu of the W.W.F. shown in order to aid in coordinating with reveals and form liner panels and also due to the challenge of accurately placing the W.W.F. in the center of the architectural wythe. Fiber reinforcement is also a common reinforcement method in the concrete industry and has a reputation as providing better crack control as compared to W.W.F. due to a more uniform distribution of reinforcement across the entire thickness of concrete. The approved alternate fiber reinforcement was 5 pounds per cubic yard of Helix micro-rebar. The manufacturer verified that this approved volume was equivalent to the W.W.F. shown in our construction documents.

The referenced cracks are more than likely caused by either shrinkage of the architectural wythe due to curing or thermal movement due to temperature changes or a combination. The architectural wythes of the insulated tilt panels were poured in the fall of 2013. The wythes have cycled through the extreme winter temperatures and the extreme summer temperatures. In comparing the cracks in the referenced photos from August 2014 to the photos taken in January 2015, it appears that the separation of cracks has stabilized.

It is not unexpected for some cracks to appear at the corners of concrete openings. The design intent of the W.W.F or micro-rebar is to hold those cracks tight. Some of the micro-rebar was visible at the surface across some of the cracks. Because the cracks have continued to be less than 1/16" wide throughout the extreme temperatures of the winter, it appears that the Helix micro-rebar is holding the cracks tight and preventing them from opening up more. Our experience with insulated tilt-up projects is that the architectural wythe is typically painted which helps cover the cracks. The referenced cracks for this project are more prominent probably because of the unfinished concrete surface. Some limited patching of cracks was observed. The material used appeared to be applied sparingly and was a different color than the concrete, thus highlighting the crack. It may be difficult to find a patch color that blends with the existing wall surface.

It was also observed that sealant at some panel joints appeared to be pulling away from the panels.

In conclusion, the referenced cracks in the architectural wythe are cosmetic and not a structural concern. The separation appears to have minimized to the point that these cracks can be sealed. One method of sealing these cracks would be to paint the exterior. Otherwise, a surface applied elastomeric sealant could be knifed into the cracks to keep moisture out.

Please feel free to call with any questions or comments regarding this letter. We appreciate the opportunity to provide our services to you.

Sincerely,
BSE Structural Engineers, LLC.

Justin E. Burgoon, P.E., S.E.
Senior Structural Engineer