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SAIA SCAFFOLD & ACCESS INDUSTRY ASSOCIATION

ACHIEVING CONCRETE DREAMS

SEATTLE CENTER ARENA

THE 2020 SCAFFOLD & ACCESS INDUSTRY ASSOCIATION (SAIA) SHORING PROJECT OF THE YEAR AWARD WAS PRESENTED TO D.H. CHARLES ENGINEERING, INC. FOR THE SEATTLE CENTER ARENA PROJECT.

BY MARK PALMATIER

D.H. Charles Engineering, Inc.

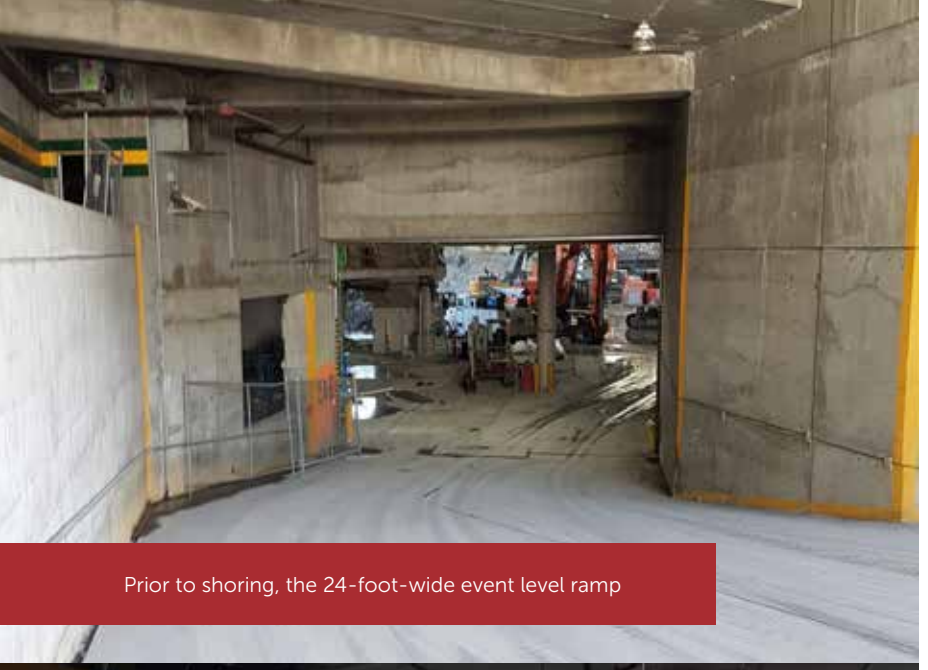
• SAIA Member

D.H. Charles Engineering, Inc. is a civil/structural engineering firm specializing in providing construction engineering services to contractors throughout the United States and Canada. Read more at https://charlesengineering.com.

Originally built in 1962, the Seattle Center Arena (originally known as Key Arena) is located in the heart of the historic Queen Anne district of Seattle. To take advantage of its prime but densely populated location, the arena was built down into the ground, with a pavilion-like sloping roof that has become a staple of the Seattle skyline. As part of a $700 million remodel, the entire interior structure was demolished and rebuilt from the ground up. With the majority of the arena built underground, this meant that the existing concrete retaining walls would no longer have the concrete floors to support them and would require soil anchors to be installed for support.

Due to the construction sequencing, a micro piling drill rig was driven onto and deployed on the Main Concourse level of the arena. The weight of the drill rig exceeded the strength of the slab, so vertical shoring was needed to help strengthen the concrete slab.

In May 2019, D.H. Charles Engineering, Inc. (DHC) was contacted by Performance Contracting, Inc. (PCI) in Auburn, Washington, to assist in the structural shoring of the existing slab. Due to the rapid pace of the construction schedule, any shoring installed could not impede the work progressing at the event level just below. This was most critical at the event level's 24-foot-wide ramp, which served as the



Prior to shoring, the 24-foot-wide event level ramp

Shoring tunnel

only access point down to the level to move equipment and material into and out of the arena.

DHC representative Mark Palmatier, P.E., was met on site by Darrell King of PCI as well as representatives of both the general contractor, Mortenson, and the structural engineer for the structure, KPFF. The site to be shored was walked extensively, with each party noting critical locations that needed to be shored, to be left open for access, or had obstructions to work around. KPFF made it clear the Main Concourse slab above the event level ramp needed to be shored to support the drill rig. At the same time, Mortenson was adamant that the ramp had to stay open and unimpeded so that construction would stay on schedule. With demolition well underway, the ramp saw a constant stream of dump trucks as material was moved out of the stadium. The scope was to design a shoring system that fully supported the upper slab while taking up no space on the floor below.

To keep the demolition process moving smoothly throughout the shoring operation, there was constant communication between DHC, the scaffolding contractor, PCI, the general contractor, Mortenson, and even the demolition sub-contractor, Rhine. When it became clear that keeping the entire ramp section open would be vital to the project, DHC brought RMD Kwikform into the conversation.

KPFF had provided shoring requirements, including maximum allowed spacing of the shoring, as well as a required load of 18,000 pounds that, due to the roaming nature of the drilling rig, could be placed anywhere within the scope area of the Main Concourse. These parameters would be used as a launching point for what would become an iterative design process. The same afternoon as the initial job walk, preliminary analysis was performed, and a rough conceptual layout of the shoring was sent out to all parties for feedback. It was at this point that Rhine was brought into the loop to ensure the shoring did not impede on the demolition process.

With so little space to work with, clearances had to first be verified in the field and then compared to the equipment available. After some careful consideration in the field, it was determined that the original requirement of leaving at least a 12-foot-wide section of the ramp open for trucks and equipment outlined by Rhine would not be adequate. The dump trucks needed every inch of space to make it down and around the curved, 24-foot-wide ramp.

After exploring some options, the team determined that the most feasible way to adequately support the Main Concourse slab while simultaneously leaving the ramp open would be to essentially build a “tunnel” in the

shoring. The slab itself would be shored up using modular cuplok scaffolding, which would then be set onto large steel beams spanning the width of the access ramp. It was at this point DHC reached out to KPFF for clarification on the provided shoring loads. With an 18-kip load requirement, the size of the steel beams needed were a concern. After confirming the type of drill rig that would be used, DHC performed a detailed moving load analysis of the drill rig to model the loading that would be applied to the shoring. By modeling how the load would spread through the slab to the various shoring posts, it was determined the worst-case point load would not exceed 6,300 pounds. This drastically reduced the load on each shoring beam, allowing for the use of lighter, more easily erectable beams.

Due to the slab above the ramp dropping as the ramp descended, as well as the presence of concrete beams at awkward angles, the modular, flexible nature of cuplock scaffold was used to its fullest as the main support of the Main Concourse slab. To support the steel beams on either side of the ramp, RMD Kwikform Super Slims were used as vertical post shores. While originally designed for use in falsework and concrete wall-pouring applications, this formwork material had high axial capacity. Additionally, DHC had experience in using it in shoring applications. By bracing them to each other, as well as anchoring them to concrete wall and ramp for stability, a stable base for the shoring tunnel was created that took up less than a foot of width. Once fully installed, the tunnel shoring allowed for the tie back installation to successfully move forward without any hinderance to the demolition work.

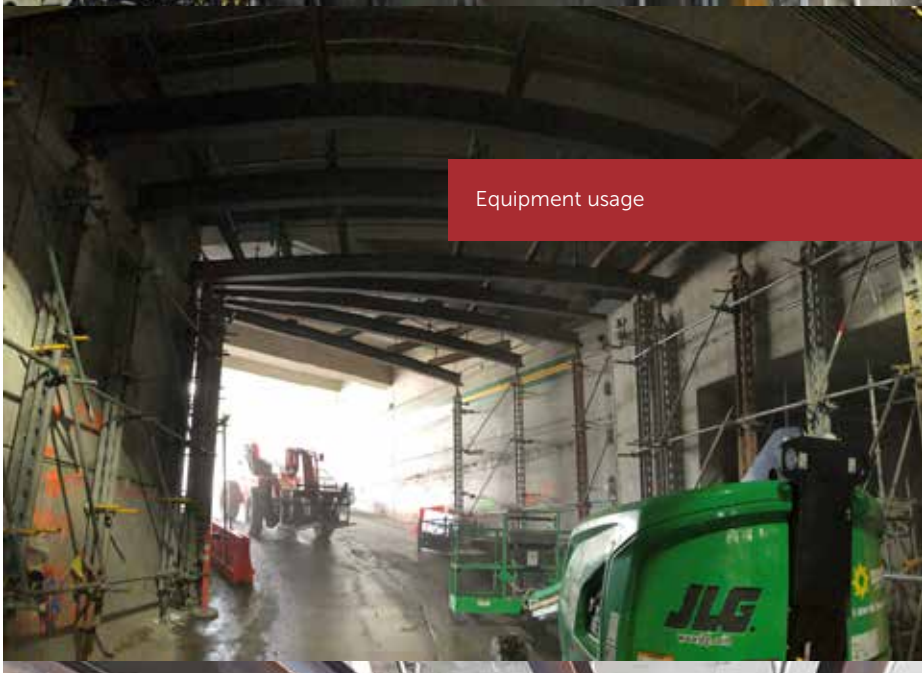
At the event level, a similar solution was deployed. Where possible, cuplock towers were used to directly support the slab above. Where a drive lane was needed, shoring towers were used to support steel beams spanning over the event level floor. Set on the steel beams was more cuplock scaffolding, installed tight to the slab above. The versatility of modular scaffolding as shoring was on full display throughout the project.

This project used a combination of standard modular scaffolding with more unconventional shoring equipment to create a safe shoring system that also provided the contractor with the necessary room to continue work. The shoring was completely removed in December 2019.

About the Author

Mark Palmatier, P.E., is Senior Associate Engineer and Manager at D.H. Charles Engineering. He can be reached via email at markp@charlesengineering.com or phone, (707) 537-8282.

Concrete ties stabilized the shoring.



Equipment usage

Versatile shoring