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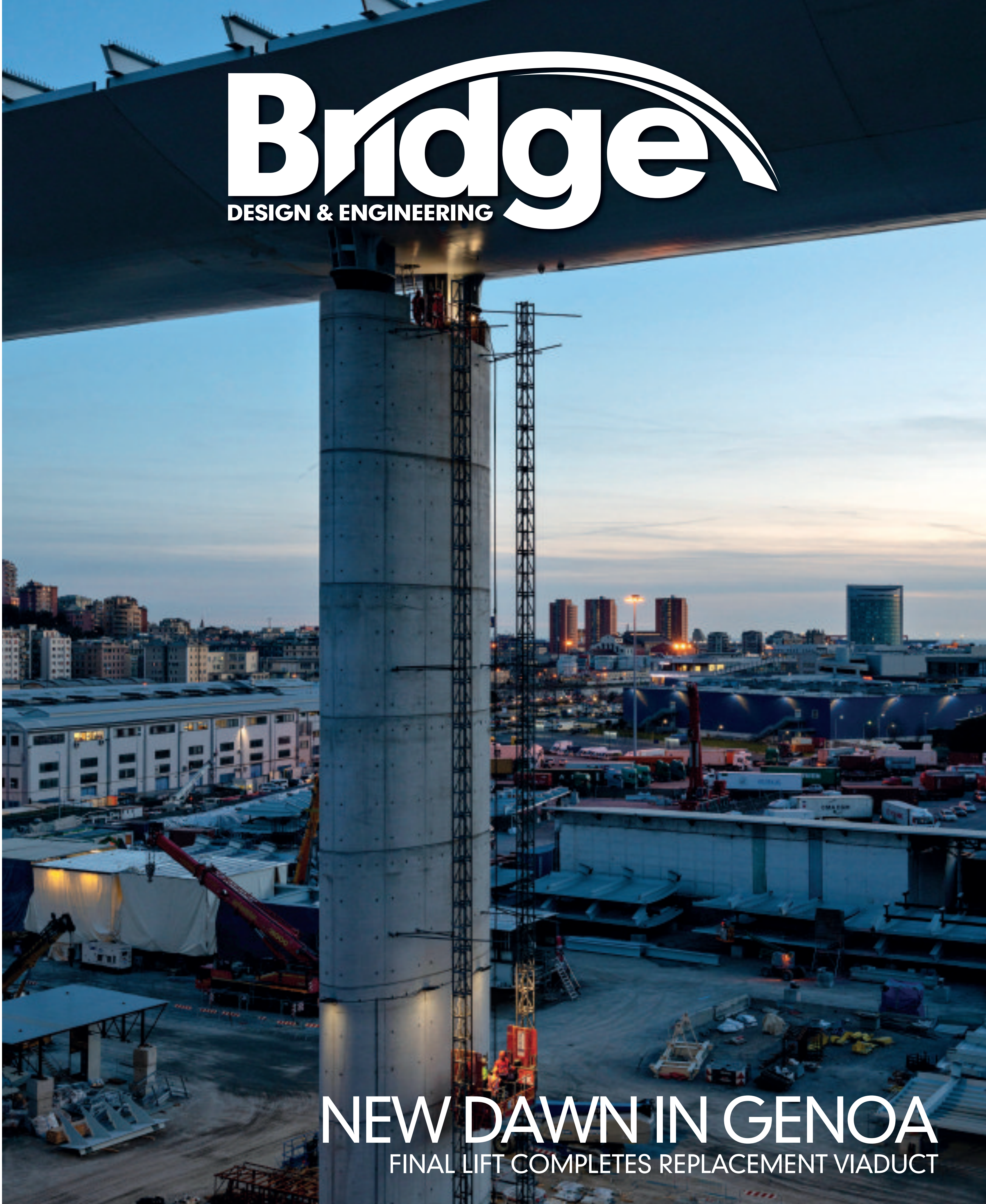
Bridge
DESIGN & ENGINEERING



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BRIDGE DESIGN & ENGINEERING


Jefferson St Bridge is one of six bascule crossings that are maintained by Illinois Department of Transport on the Des Plaines River (*Shutterstock*)

CHAIN OF COMMAND

Network reliability and technology are advancing the idea of remotely controlling movable bridges in a safe manner, writes Joseph Strenkoski

Movable bridges are marvels of engineering, but they are often considered a necessary evil by the agencies that own, operate, and maintain them. They are complex and prone to financial, operational, and maintenance challenges. It is no wonder the owners of these bridges are continuously seeking ways to make them more reliable, efficient, and less costly to maintain and operate. One solution is remote control operations.

The railroad industry has been using the concept of remote control for trains and movable bridges for a very long time. Railway movable bridges that carry passenger or freight trains are not controlled by the local operator or 'bridge department' circuits, but instead by remote 'permissive' commands generated by the railroad's signals department circuits. This system is responsible for determining if the movable bridge is ready to safely allow train traffic to proceed. The bridge may be operated locally but the control of its openings is dictated remotely. Automation of the local operator role in the control of the bridge has also been employed by the railroad. Based on Modjeski & Masters' experience working with Class I railroad clients, several factors come into play when considering converting a bridge, or multiple bridges, from local to remote/centralised control.

In 2017, Modjeski & Masters was asked by a Class I railroad client to prepare a feasibility study with recommendations to convert four of its movable bridges to operation from a remote off-site location. Our client was interested in any potential issues they might encounter with the US Coast Guard, which governs operational licences for all movable bridges over navigable waterways. Operational reliability becomes an even more important consideration due to the absence of local personnel and the additional time it would take for someone to get to the bridge for troubleshooting. Controlling these bridges from a remote location requires a reliable and robust data and communication connection to each bridge for transmission of control, video, radio, voice communication, and fire/security. Our client also had to consider various internal and external factors such as troubleshooting and response to emergency conditions, which all change with the lack of a local operator.

The bridge's electrical, control, and mechanical systems were evaluated based on age, condition, and compatibility with remote control consideration. Maintenance logs were studied for each structure to identify any recurring problems resulting in bridge inoperability. Client personnel, operators, maintenance, and dispatch were interviewed to glean any inside information regarding reliability and operational efficiency. The data was valuable in assisting the client to decide whether converting these four movable bridges from local to remote operation made sense operationally and financially.

Many movable bridge owners are seeing the benefits inherent in the centralised control of multiple bridges on their system. In some cases, Modjeski & Masters has found the predicted return on investment warrants a closer look. Let's look at the process – from feasibility study to construction – of the Illinois Department of Transportation's (DOT) project to convert six movable bridges from local to centralised control. Consider this: on any given busy movable highway/pedestrian bridge, a trained local operator is needed 24 hours per day, seven days per week, and in some cases, depending on where the bridge is located, 365 days per year. This is done in three eight-hour shifts or two 12-hour shifts, where the operator is alone the entire time. Salary costs, overtime, holiday pay, and training costs are substantial to maintain this skilled staff. The bridge operator position can be a stressful job considering the trust that the travelling public put in their hands every day. The operational dynamic on these highway movable bridges is more complex than that on a comparable rail movable bridge. The 'permissive' on a highway movable bridge is solely the call of the local operator. This operator must assure that all vehicular traffic has stopped at the gate points and that the bridge is clear of all bicycle and pedestrian traffic prior to beginning the opening sequence.

Illinois DOT owns, maintains, and operates six bascule bridges along the Des Plaines River in Joliet, Illinois. These bridges are relatively close to each other along the Des Plaines River, starting with the Ruby St Bridge to the north and ending with the Brandon Road bridge roughly 9km south. The bridges are similar, with the four central bridges – Jackson St, Cass St, Jefferson St, and McDonough St – being almost identical. Illinois DOT also maintains a local bridge office near the Jackson St Bridge, making it a possible bridge control centre. The proximity of the bridges, the availability of a potential central control building, the increase in motoring and marine public safety, and the potential operating cost savings made this an excellent candidate for consideration. However, this did not mean it was going to be easy. The engineering services phase required for development of contract documents began in December of 2011. The project is currently under construction and will likely continue well into 2021.

The purpose of the project is to provide the centralised control and operation of six drawbridges on the Des Plaines River from the Illinois DOT bridge office in Joliet. Doing so increases the safety of the motoring public on the river and roadway by introducing camera, communication, and detection systems, as well as the safety of the local bridge operators, who do not have to work long shifts alone.

The Illinois DOT bridge office in Joliet will be renovated and fitted out to serve as the central bridge control centre. Three bridge operators will control two bridges each from their respective stations and there will be three eight-hour shifts. Operators will have visual, voice, and radio communications to replicate local operation, along with a common video wall that will illustrate what is happening at each operator's station.

All six bridges must have a reliable and robust network and communication connection to the central command centre. Because the bridges are close in proximity, it is feasible to install a redundant self-healing fibre optic ring connecting the bridges to the command centre serving as the primary communication method. The bridges must be equipped with technology capable of simulating on-site controls, visual, and audible cues from the operator station at the central command centre such as CCTV, two-way public address systems, and boat detection systems, to name a few. A wireless radio transmission system will be installed to back up the fibre-optic network, adding another level of redundancy. Furthermore, all six bridges must have updated local controls capable of working with the overall supervisory control and data acquisition (SCADA) system and must have reliable electrical and mechanical components to maximise bridge operational reliability.

The SCADA system is the heart of the project, and the fibre-optic networks connecting the bridges to the command centre are the arteries. The logistics required for routing this fibre-optic network crossed different jurisdictional boundaries. Extensive coordination was required with the US Coast Guard, US Army Corp of Engineers, Illinois Department of Natural Resources and the City of Joliet. These are often overlooked factors when considering a project of this type, and care must be taken to build time into the project schedule to accommodate them.

The six local bridge houses associated with this project are registered with the state historic preservation society. This must be taken into consideration when making any changes affecting the house appearance, and a review with approval must be obtained. This is another aspect that has the potential to delay the project start and schedule.

As construction proceeds to start-up and then day-to-day usage, Illinois DOT and Modjeski & Masters will be monitoring aspects such as reliability, maintenance costs, ease of use for operators, public perception, and the important return on investment numbers.

We were approached by another DOT a few years ago, who was considering converting most of its highway movable bridges from local operator control to a single central bridge control command centre. This major undertaking encompassed 25 movable structures spread over hundreds of kilometres. Unlike Joliet, which has the luxury of geographical proximity, it would be cost prohibitive to use a hard-wired fibre-optic connection based on material cost alone on this project. Network reliability, speed, and bandwidth are key, as each movable bridge can require up to 12 or more cameras to adequately simulate the visual feed to safely operate the bridge remotely, which requires a tremendous amount of data transmission to maintain the video feed quality. The connection plays a significant role and many networks are not robust or reliable enough. Fibre-optic connections and leased cellular are other options, but with 5G here, and greater availability on the horizon, it may be possible to accomplish this with leased hotspot locations. This project was ultimately put on hold, but it is an entirely feasible concept using the technology we have at our disposal today.

In the future, bridge owners and operators will likely be able to use a combination of connection methods. And soon, we may even see virtual reality and augmented reality technologies applied in the control of movable bridges from a remote location ■

Joseph Strenkoski is director of electrical engineering at Modjeski & Masters

A centralised control will operate six bridges on the Des Plaines River