MULTIPLE CHOICE

Use of modular bridges has increased in recent years

Modular bridges can be a smart choice for both temporary and permanent applications, but what should clients consider when they are thinking about procuring this type of structure, and how can they be assured of its quality? **Bill Killeen** offers some useful tips

The use of modular steel bridging in both temporary and permanent applications has increased in recent years with improved material quality and new innovations in design. These changes have successfully addressed many of the concerns in bridge construction projects such as speed of construction, cost-management, and improved work zone safety.

The speed of construction is paramount to containment of on-site construction activities that impact mobility as well as safety. The direct and indirect costs of traffic detours or lane closures can have a huge economic impact on commercial activities in an area, and active on-site construction work occurring near adjacent traffic can pose real safety issues. The Federal Highway Administration's *Work zone road user costs* report, which was published in 2011, contains in-depth data on the dollar cost to drivers, including freight companies, as a result of construction delays, as well as an examination of the crash rates in work zones.

In terms of real costs, it is a given that a prefabricated bridge can be constructed at high speed. In somewhere like the eastern part of the Democratic Republic of the Congo, an estimated 50 or more prefabricated bridges can be constructed in the same time as it would take to build just a single conventional bridge. In somewhere less remote, such as the US or Canada, it is still possible to build several prefabricated bridges in the same time as each conventionally-constructed bridge. This reduction in construction time means less crew and machine hours on a job site, lower down-time for weather-related issues, and as the FHWA figures confirm, a reduction in traffic impacts and enhanced safety for the travelling public.

The use of a prefabricated modular steel bridge may be the only possible alternative for a project. For example, if a 24m clear span bridge needs to be constructed in a remote site well away from an urban area, an owner may only be able to build a modular steel bridge at the job site, since constructing a conventional bridge of 24m in situ could be out of the question. Bringing in a prefabricated concrete structure in such an area may not be possible due to its weight.

In many areas, bringing in a steel bridge with 24m-long girders is also not an option, when roads are too small to allow safe manoeuvrability of a large vehicle. Modular steel bridging is a good solution for such areas. On a recent job in a very isolated area in India, for example, Acrow shipped components in a container and they were subsequently unpacked and loaded onto 6m-long trucks. These short and light vehicles were able to negotiate the twists and bends of the road and, once in place, the bridge could be assembled with minimal machinery.

One of the benefits of using prefabricated modular bridges is that the quality of materials can be assured, which is particularly important in many parts of the world. For example, when a bridge is constructed in situ at a site that is not easily accessible, quality is at risk for many reasons. Concrete may be mixed using locally-excavated stone as the aggregate, which may be contaminated with debris, or the local stone may not be suitable for use in concrete. A prefabricated bridge brings many benefits in these cases, since it can be fabricated in a shop that has strict and stringent quality assurance systems in place. Whether a bridge is concrete, steel or any other material, a shop-built bridge will be produced in a controlled environment, and will be a stronger and more durable structure.

Ensuring quality across all aspects of a project should also be a key consideration, from design through fabrication and construction. A solid quality-assurance programme should ensure that all of the components, including materials, welding and overall workmanship, meet both the contract requirements and engineering standards. This will reduce construction delays and costs, and the possibility of order changes, improve safety, and meet government guidelines.

What then, should potential buyers of modular steel bridges consider in order to obtain a high quality, durable product that will meet their specifications and needs?

As far as the basic building blocks go, structural steel for bridges generally has more exacting performance requirements than steel for buildings and other structural applications. It must be durable enough to perform in an outdoor environment, sometimes with large temperature fluctuations, where it is often exposed to corrosive environments containing chlorides. It is important to ensure that all the steel is certified under the International Organization for Standards (ISO). Does the fabricator hold a certification with the American Institute of Steel Construction to an appropriate category of the bridge requirements and standards or equivalent? Are they compliant with EU safety, health and environmental protection requirements and do their products carry the EU quality assurance declaration of performance, the CE mark? Additional considerations should be given to the supplementary materials such as bolts and welding. It may also be helpful to have a working knowledge of National Steel Bridge Alliance's *Steel bridge design handbook*.

The surface protection of the structure is another important component where planning can pay off. There are a number of options: weathering steel, painting, metallising or galvanising. Weathering steel, a high strength, low alloy steel popular for some outdoor structures, is generally not recommended for bridges as accumulation of water under decking or overall continued damp conditions can result in the same corrosion rates as unprotected metal. Painting presents many problems, including the hazards of toxic substances in the initial preparation and paint application and the subsequent maintenance evidenced in the extreme by the neces-

Whatever the application, modular bridges can offer many benefits

sity of the continuous painting of the Golden Gate Bridge. In addition to maintenance costs, each time a structure is repainted the paint removal creates risks for the environment; paint must be contained to prevent it becoming airborne or polluting waterways.

Metallising is a technique of coating the steel to provide corrosion protection for longer, and most often involves the spray application of zinc and aluminium. While metallising and hot-dip zinc galvanising are similar, the latter holds advantages for bridge construction. In the hot-dip galvanising process, the surface is cleaned of any paint, weld slag or varnish and then further cleaned in a series of acid baths before dipping into a zinc kettle where the zinc reacts with the steel so the two metals become one, creating in a highly-durable free zinc layer on the outside. During this process, all corners, threads, edges and hollow sections of the steel are submerged in the galvanising kettle, so all corners, threads, edges, and hollow sections are completely covered. Hot-dip galvanised coatings are applied in a factory setting, protected from the weather. Spray metallising techniques, by contrast, do not increase the steel temperature so do not yield the robustness of the two metals fusing together. As well as being dependent on applicator skill, the outcome of metallising also relies on it being carried out at a temperature that is at least 12°C above the dew point.

The cost of hot-dip galvanising is usually lower than metallising, but the ultimate benefit of this method can be best seen by comparing the time to first maintenance. Hot-dip galvanised steel is currently considered to be maintenance free for 50-75 years in many types of environments, including marine. Because current metallised coatings last only 15-22 years before the first maintenance is necessary, the additional up-front costs combine to make metallising four to five times as expensive as hot-dip galvanising. A final plus for galvanising is that most companies that galvanise tend to be environmentally-friendly, and many use 100% recycled zinc. A buyer only needs to check with a vendor on whether their zinc is recycled or not.

At the start of the project, there should be a clear understanding of who is responsible for reviews and testing at each phase, what types of defects or problems might occur, and whether suppliers have their own comprehensive testing procedures in place. This person also needs to be sufficiently trained to enable them to more easily identify defects and problems.

The use of modular steel bridging, no matter the application, can deliver enormous benefits to a bridge owner, both in terms of cost and speed of construction. Whatever material is used for construction, once the type of bridge required has been established, a rigorous quality assurance programme should be set up. This is a critical part of the project from design through commissioning, whether the structure be made of steel, precast concrete or prefabricated timber. The importance of this cannot be underestimated ■

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