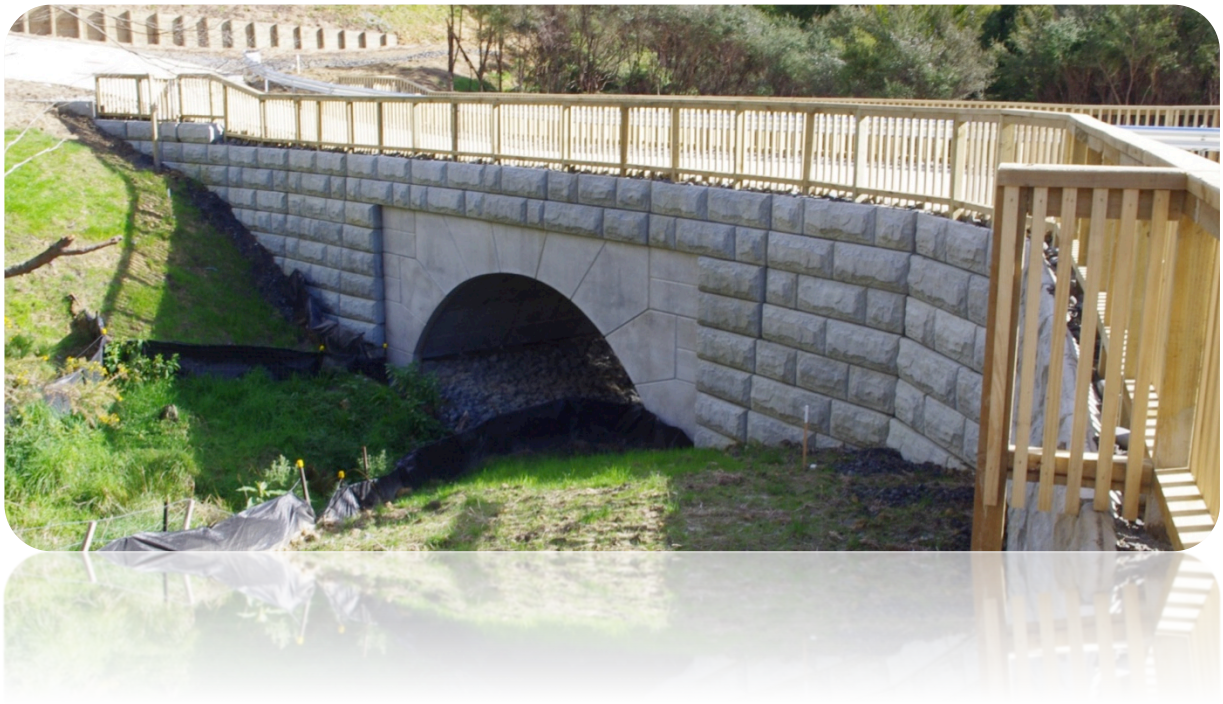
Submission for the
NEW ZEALAND CONCRETE SOCIETY
CONCRETE AWARDS 2015



OKURA RIVER BRIDGE

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Bridge Concepts
Smart Bridges

SUMMARY

Masonry arches transmit structure loads to their abutments and foundations by transferring compression forces through the arch ring.

Arch bridges have proved themselves to have lives typically 10 times greater than other types. Some have been in use for 2000 years. They became expensive to produce and the ability to design them was lost. Believing that they could be re-engineered for economy and speed, the Bridge Concepts team set about developing a new arch bridge for New Zealand markets.

The bridge at Okura River represents a major step in that process. It is built from 6 x 1 m wide lightweight precast concrete ring sections which are lifted together to form an arch which then has a dense concrete saddle applied. The concept of making lightweight sections that are still strong enough to carry the load of the saddle is entirely new. So is the system of analysis created for dealing with earthquake loading.

A load test showed the bridge to deflect about 1mm under a 10-tone axle load. That is 1/7000 of the span or about 1/20th of the deflection of normal designs.

THE PROJECT

The original conforming design for the bridge crossing comprised a conventional bolted steel arch culvert faced off with hand placed and grouted rock walls with tender pricing coming in relatively high due to site access and underlying ground conditions.

Fraser Geologics Ltd in conjunction with Gibbons Contractors proposed a range of alternatives and settled on the Smart Arch alternative of Bridge Concepts as providing the developer with a more cost effective, similar looking structure while addressing underlying ground conditions through piling the arch structure and detailing the flanking spandrel walls for minor differential settlement and ground movement.

Construction proved relatively straightforward with spandrel walls and abutments constructed prior to arch installation, sidewall placement and backfilling. Provided the initial ground work is completed first, the Smart Arch system lends itself to rapid construction and backfilling and is considered

particularly cost effective as an alternative to precast box culverts or shorter (nominally 7-12m) span bridges, particularly where the client needs to minimize in stream works and wants to achieve an aesthetically pleasing structure as part of overall landscaping design.

The Smart Arch comprises a precast arch system based on modern precast concrete replacing the masonry blocks with adjacent precast faces fully touching and avoiding the need for mortar and other detailing to transfer compressive forces.

Construction

Construction began with the installation of 4 bored piles to create foundations in soft ground. Around these, StoneStrong hollow retaining wall blocks were placed on a simple foundation. The pile reinforcement was bent over to lock the blocks to the piles and the blocks filled with concrete to form a base for the arches.

The arch units were delivered flat to site and lifted by an 80-t crane into arch shape prior to placement. Timber wedges were used temporarily to provide reaction for the thrust. Precast spandrel walls were assembled from 3 pieces of precast elements and tied across to provide short-term resistance to pressure from the concrete saddle that was then placed in a low slump low strength concrete mix capable of being rammed into place without sliding off the arch.

Finally the walls were filled to level with normal compacted material and two more courses of StoneStrong blocks were placed and fill placed between them to bring the road to the level required. The bridge could be used for traffic only 7 days after the lightweight arch rings were placed.

Statement of Features

Long hollow planks that used to form arch rings were cast to fit to form a faceted arch capable of carrying substantial load. They have walls only 50mm thick and are made from self-compacting fibre reinforced concrete.

The hollow planks of the arches have no conventional steel reinforcement allowing for long lasting maintenance free design life.

The arches were delivered flat and were light enough for the whole bridge to be carried on a single truck.

Each arch ring was lifted and placed in a single lift by an 80-t crane. The same crane lifted and installed elements of the precast spandrel wall.

The use of StoneStrong blocks to form the abutment, and parts of the spandrel walls required minimum foundations and no formwork on site.

The construction methods used ensure that working in waterways can be avoided and therefore the waterway is not impeded nor passage of fish or habitat affected. This may help avoid the need for Resource Consents in suitable applications.

PHOTOGRAPHS

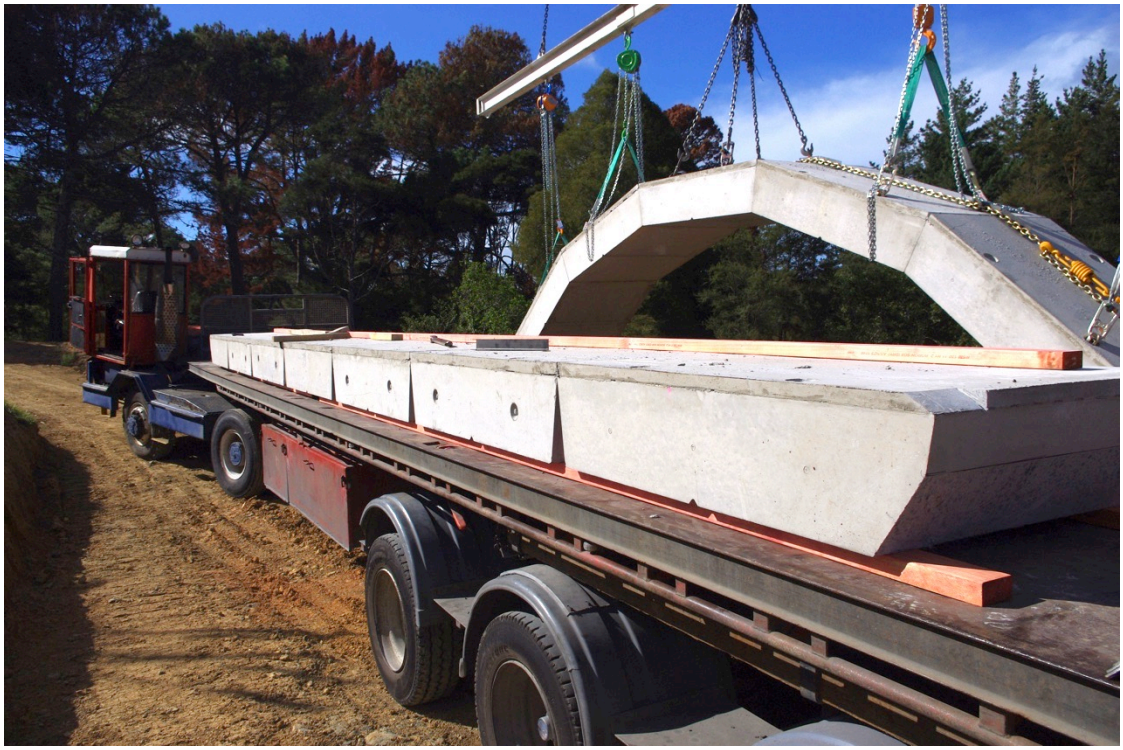

Fig 1. Arch units are delivered flat to site and lifted into arch shape prior to placement.

Fig 2. Lifted arch unit in shape on end of crane hook. Note spreader bars and individual chain.

blocks to create and hold arch shape in position.

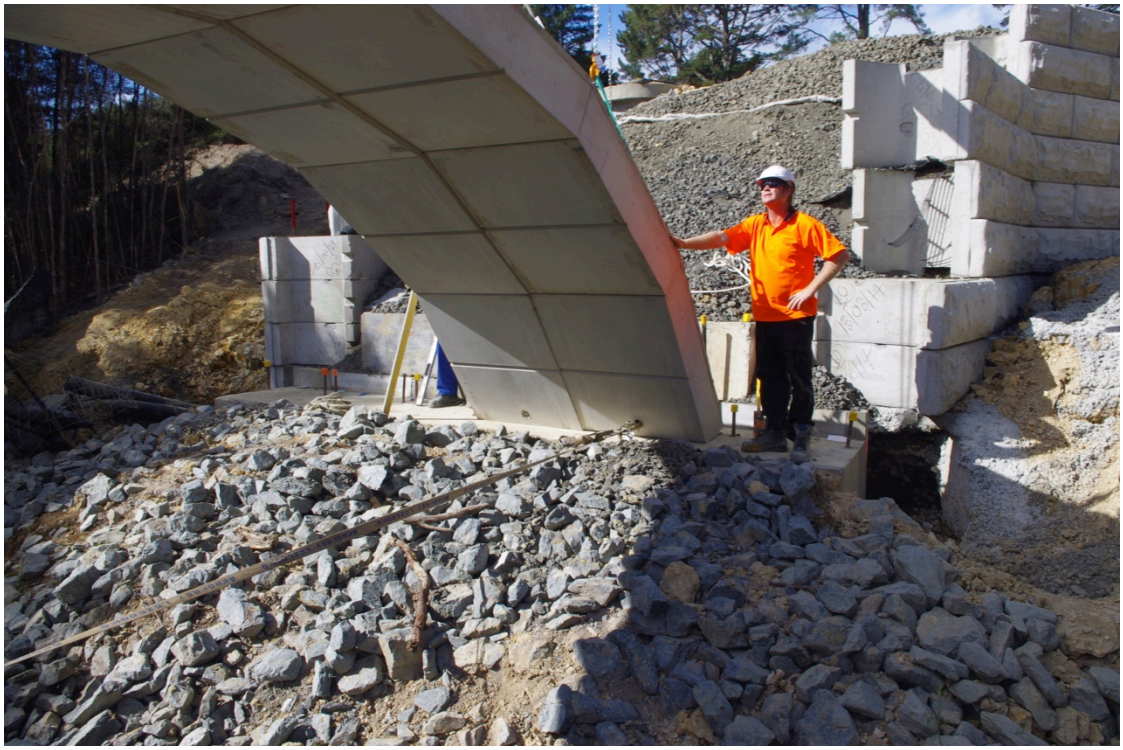

Fig 3. Two arch units in position. Note pre placement of rock riprap erosion protection under bridge prior to arch installation and close fitting nature of arch units.

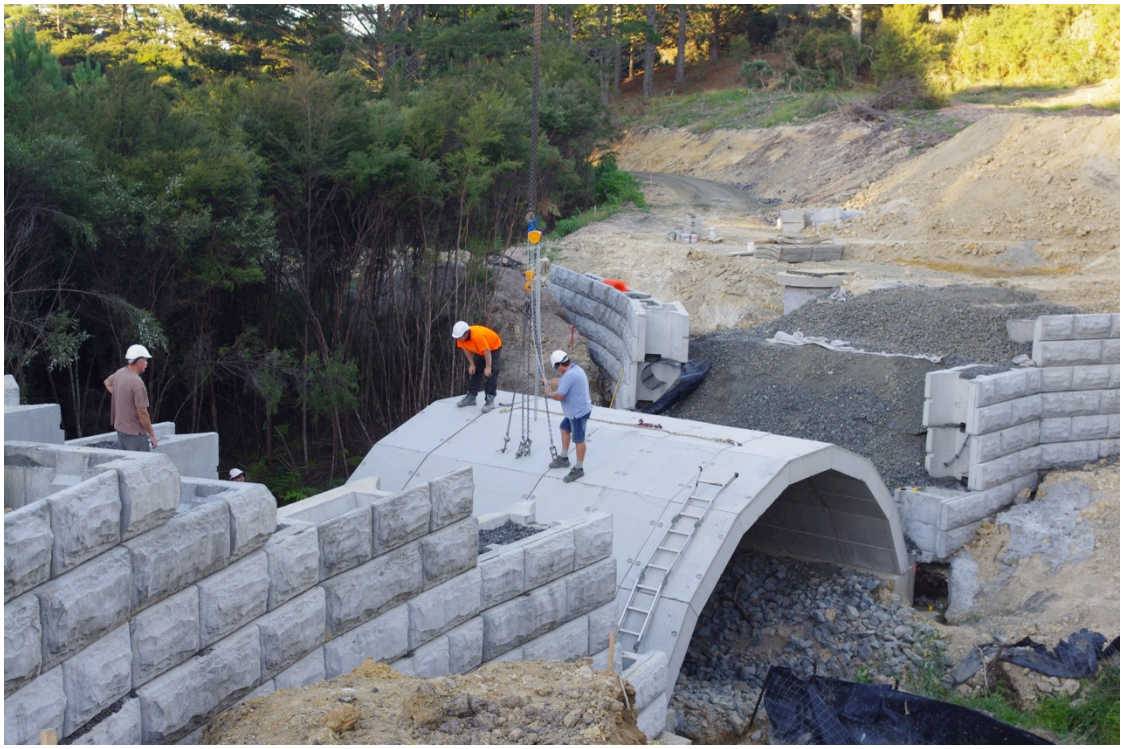

Fig 4. All six arch units in position

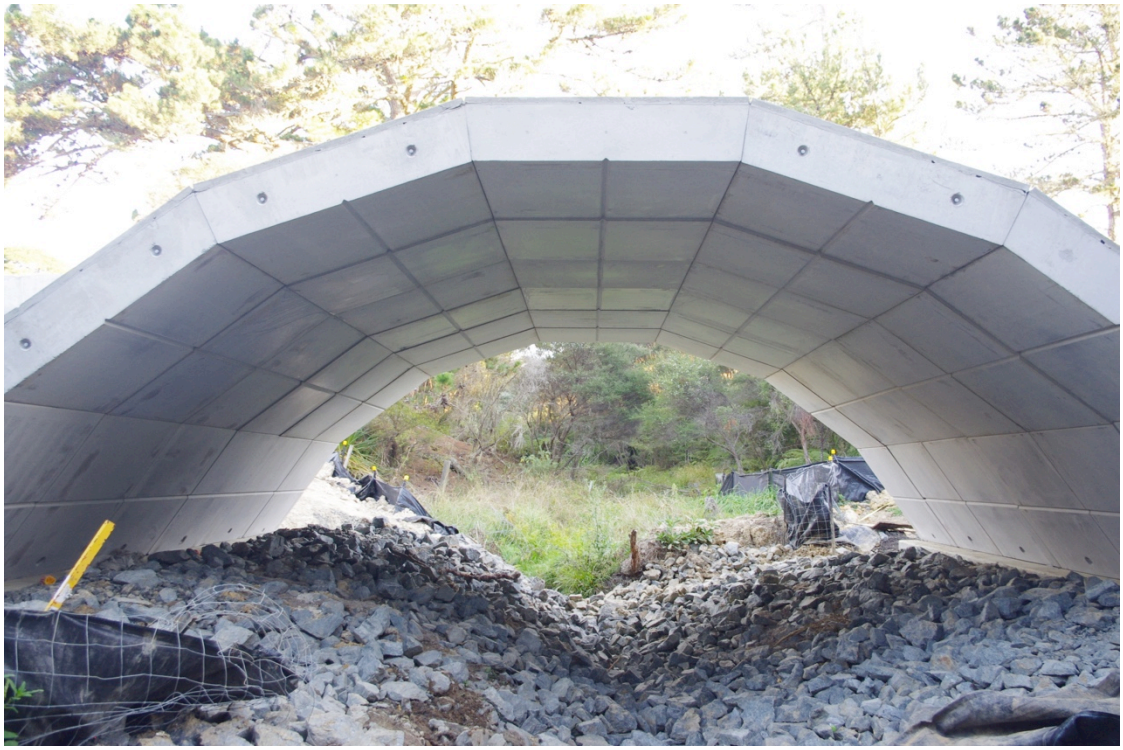

Fig 5. All six arch units in position

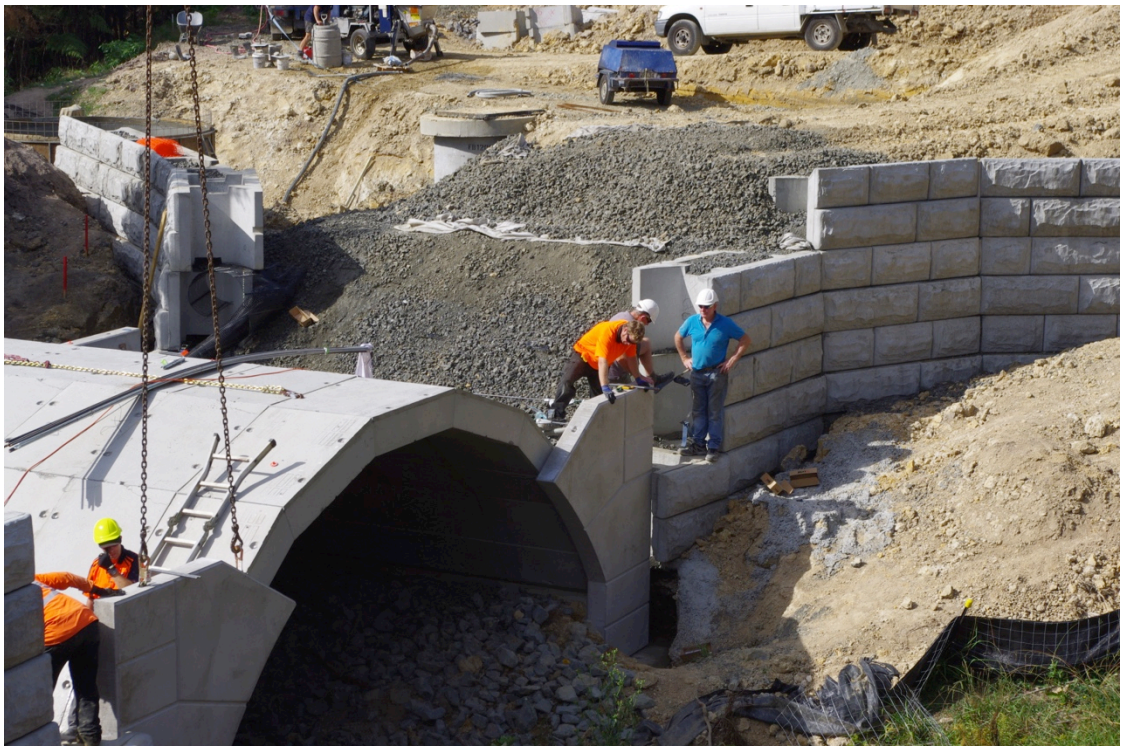

Fig 6. Side panels – end panel units in place.

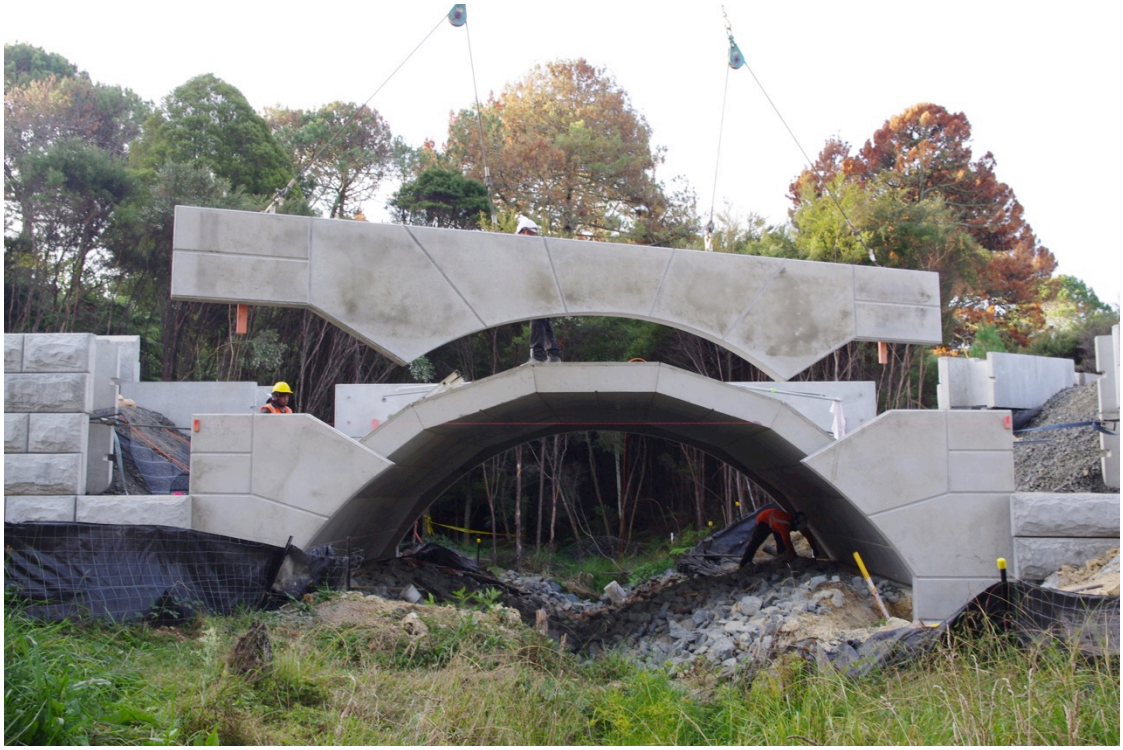

Fig 7. Top panel piece being lifted in place.Panels held in place with a range of reidbar tie fittings and geogrid reinforcement in hardfill back fill as required.

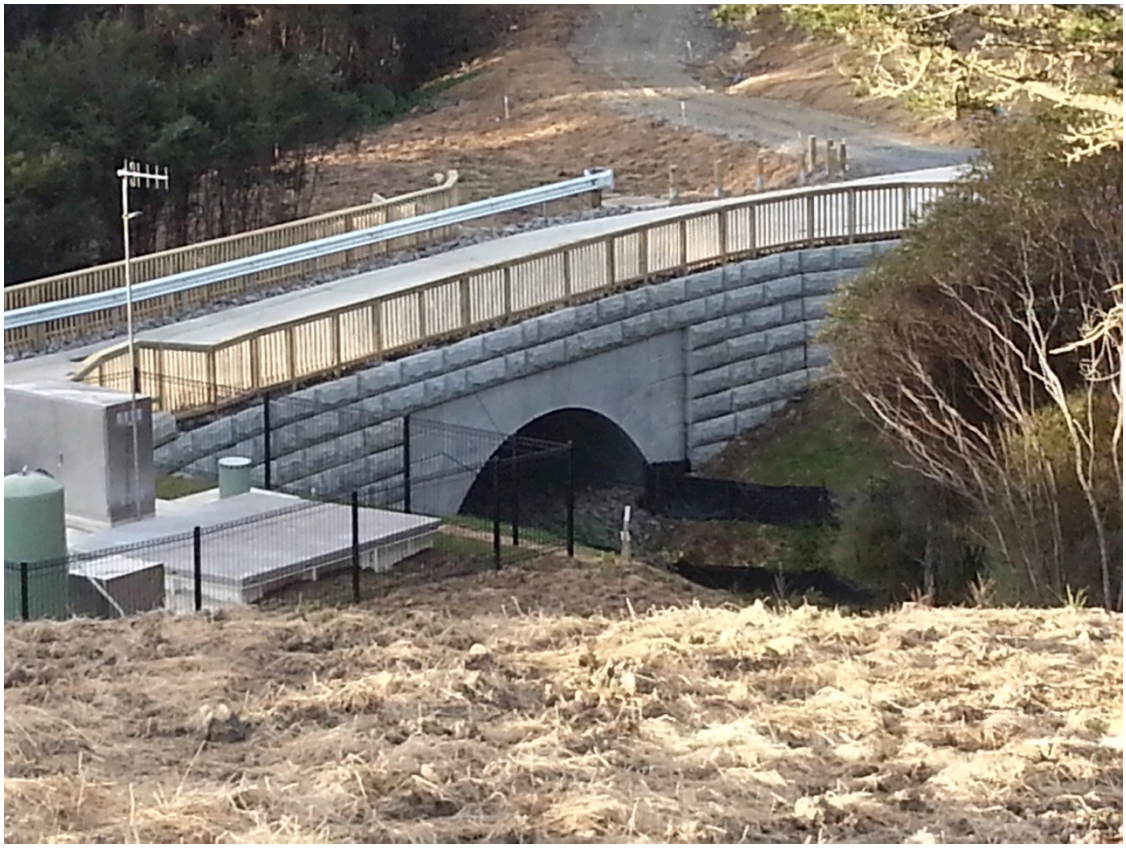

Fig 8. Completed bridge

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