GBG Australia

Some of our work undertaken on bridges:

Sydney Harbour Bridge, Reinforcement location and utility mapping (1999/2000)

Anzac Bridge – Tendon duct & Reinforcement mapping, RTA NSW (2001)

Garret St Timber bridge, Perth, Evaluation of Radar on timber bridge components, WA Main Roads (2002)

Redbank & Purga Creek Bridges, Validation investigation of NDT methods for timber bridge investigations. (2002)

Cowra shire council region, Assessment and rating of 9 timber bridges in the shire, provision of maintenance or replacement requirements and costs. (2003)

Musgrove Road Bridge, QLD, Retaining wall investigation due to ground slippage. (2006)

Melbourne Road Bridge, subsurface steel location and mapping. (2006)

Church Street Bridge, Melbourne, Location and mapping of moisture movement beneath deck overlay and waterproofing membrane. (2008)

Stockton Bridge NSW, Assessment of grout pads for void mapping. (2008)

Barwon Heads Bridge, Assessment of timber elements for re-use. VicRoads (2008)

Ellerslie Bridge, Assessment of timber elements for condition. VicRoads (2008)

Tharwa Bridge, ACT, Reinforcement mapping of headstocks within the approach spans. (2008)

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Non-destructive methods for

BRIDGE INVESTIGATIONS

A number of methods are available to provide a means of obtaining information from structures in a non-invasive, non-destructive manner. Techniques including impulse radar, acoustic impedance, Schmidt hammer, gamma density testing and rebound hardness testing can all be performed under certain conditions on bridges to provide our clients with the most accurate and cost effective investigations.

Radar profiling timber girders at Redbank bridge QLD.

CONCRETE/STEEL BRIDGES

Determination of surface layer thicknesses

Determination of reinforcement detail and Depth of Cover

Location of Post-Tension cables and services

Concrete strength testing

Steel beam hardness testing

Delamination of surface

Location of corrosion or voids/honeycombing

Assessment of moisture content or movement

Determination of cracking

TIMBER BRIDGES

Determination of voids/ termite damage

Location of services

Assessment of moisture content and rotting

Determination of cracking

Further information on impulse radar investigations on timber bridges please visit this website: **www.ipwea.org.au/papers/download/Muller_W.pdf**

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Non Destructive Techniques for

BRIDGE INVESTIGATIONS

GBG Australia

GBG Australia is a specialist in applying non-destructive investigative techniques for the assessment of buildings and structures. We offer our clients innovative methods of defining structural and condition information whilst minimising both costs and disturbances to the site.

Company Profile

GBG Australia is a subsidiary of the GBG Group, a multi-national company specialising in the application of geophysical and advanced applied physics for precision investigations of geotechnical, environmental sites and engineered structures in UK and Europe since 1982. GBG has had a presence in Australia since 1993 originally through a joint venture with CMPS&F and GHD before becoming a stand alone company in 2003, operating in three main areas of business; geotechnical and environmental investigations and non destructive investigation of structures and contracting of staff and / or equipment for data collection or processing and interpretation of data.

GBG Australia is an independent provider of non destructive and shallow geophysical investigation services with applications ranging from the location of a single pre-stressing strand in a concrete slab to mine scale exploration geophysics. With clients ranging from Local to Federal Government, and from developers and engineering companies to private individuals, we can provide tailored solutions to your particular subsurface investigation requirements.

Bridge Investigations

Bridges are a major asset in the total transport infrastructure network within any country. In Australia there are a wide variety of constructions from simple timber bridges to complex suspension bridges.

Australia has a large transport infrastructure system particularly in road pavements and their associated bridges. As with most developed countries, the bridge stock consists of aging assets that are costly to repair or replace and are now part of a transportation system that can be seriously affected by the closing or weight limit of a structure.

The bridge stock within Australia are generally maintained by either local councils or state road authorities with both of these organisations undertaking mandatory periodic inspections to rate their assets and undertake maintenance as required.

At a time when maintenance of existing infrastructure is becoming more important, Non-Destructive Investigation (NDI) methods can provide early detection of internal problems within a structure and can offer valuable re-specification of components from within a structure where for example, loading calculations are required for a bridge without reliable records. NDI methods are reasonably quick for data collection and, as the name suggests, do not damage the structure. These methods also supply far more information than a purely visual investigation which relies on the surface expression of subsurface problems and point examination methods such as drilling or coring.

Within this brochure we have presented a number of examples of the use of non destructive techniques for the assessment of bridge structures.

Applications for

Non-destructive techniques

Concrete Bridges

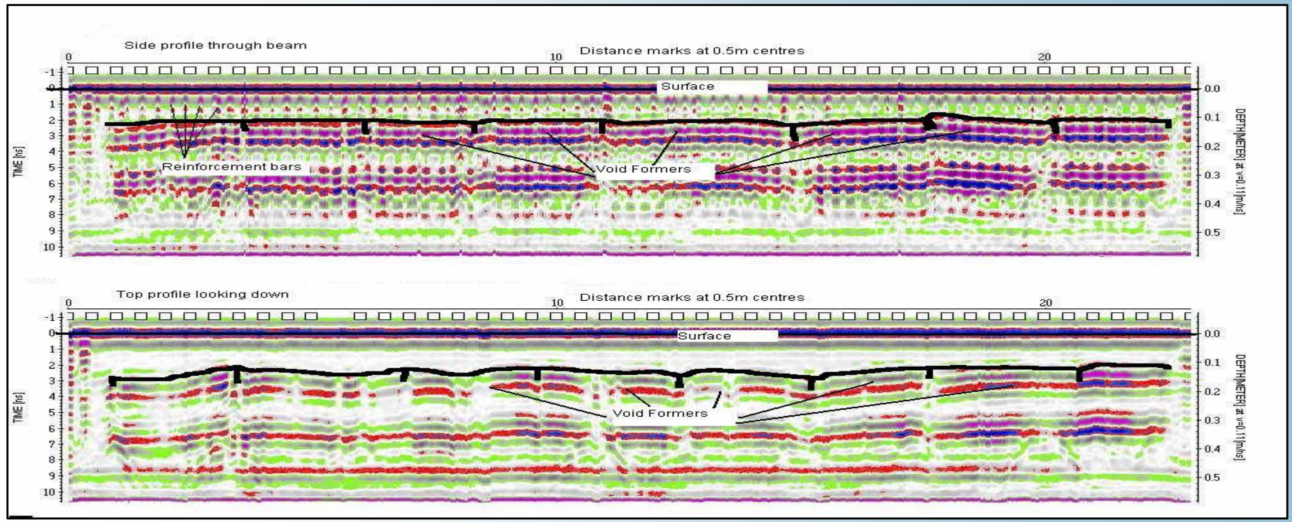
Void Former location / Compliance testing

Many modern road bridges are constructed of pre-cast elements shipped to site and assembled. The main bridge girders often consist of pre-cast beams containing pre stressed tendons in the bottom of the beam and large internal void spaces formed by inclosing polystyrene formers within the beam. The tolerances on the placement of these formers is generally quite small and is required to provide enough concrete cover to the steel components within the beam. Movement within the casting process can also produce voids or honeycombing around the internal steel under the void former thus allowing moisture entrapment resulting in corrosion or the potential for corrosion.

GBG Australia staff were commissioned to undertake compliance testing on pre cast concrete bridge beams prior to there departure from the casting yards to site. The commission was to assess the capabilities of high frequency impulse radar to accurately locate the placement of polystyrene void formers within pre-cast beams of varying cast ages from 12 hrs to 2 months old.

Methodology

Data profiles were collected using a 1.5GHz frequency antenna along the centre line of the top, side and bottom of each beam. From these profiles the position of void formers and the internal reinforcement frame can be plotted and accurately positioned to compare with the specification. (refer to data profile example).



1.5GHz impulse radar profiles through side and top of concrete beam.

Results / Outcomes

The investigation found that the radar profiles could quickly indicate on site whether void formers had moved during casting and could target the void former locations within the beam. Calibration could be carried out on site by drilling a small bore hole through the top of the targeted location for inspection with a wire hook. After a few calibration measurements the radar was able to profile and plot void former depth to an accuracy of 4mm from the surface profiled.

The same method was used on a completed bridge with accurate profiling along the beams through the deck. This allowed the location of non compliant beams within the structure that could then be monitored for evidence of failure or damage.

Tendon Duct Location and Mapping

GBG Australia staff have undertaken a number of investigations involving the accurate location of post tension tendon ducts within reinforced bridge structures. High frequency impulse radar imaging or X ray radiography are the only two methods currently able to accurately locate tendon ducts and distinguish them from the surrounding reinforcing.

Impulse radar is a rapid and non-invasive method that allows accurate location of ducts in order to target them for drill inspection to assess whether voiding is present in the grout fill. The accuracy of location and depth can be as good as +/- 4mm with calibration. This allows 3D plotting of the ducts which can be used to investigate load paths through a structure, re-specification of the load capacity or simply providing clear access points for coring or drilling.

Timber Bridge inspection

Timber bridges make up a significant component of Australia's rural bridge assets. Australian hardwood timber is ideal for structural use and generally long lasting (some bridges have timber components over 100 years old). However, being timber it is susceptible to the process of weathering damage, rot and insect attack (white ant). Also in many rural areas these bridges were designed to carry light traffic loads which have increased dramatically in the last 20 years putting greater load demands on these structures and over stressing the timber components.

GBG Australia undertook a non-destructive investigation using high frequency impulse radar on the Barwon Heads Bridge for VicRoads. The Barwon Heads Bridge is a heritage listed timber structure 300 m in length connecting the townships of Barwon Heads and Ocean Grove in southern Victoria. The purpose of the investigation was to determine the condition of the various timber elements comprising the bridge and the suitability of these elements to be used for the reconstruction of the bridge.

Methodology

The investigation was undertaken using a 1.2 GHz centre frequency antenna with a SIR3000 GPR data collection system. Data collection involved profiling each accessible timber girder, corbel, crosshead and pile on the spans and piers of the bridge. The system was set for full penetration allowing the internal condition of each element to be determined. Real time viewing of the collected data enabled the initial detection of internal defects during acquisition.

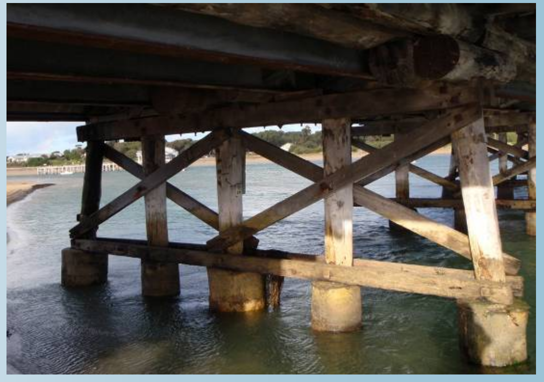
Visual inspection was undertaken in conjunction with impulse radar. Detailed notes and photos on the surface condition for each timber element inspected was recorded. These together with coring results during a previous investigation enabled a detailed study of the current condition of the bridge to be presented.

Barwon Heads Bridge Victoria

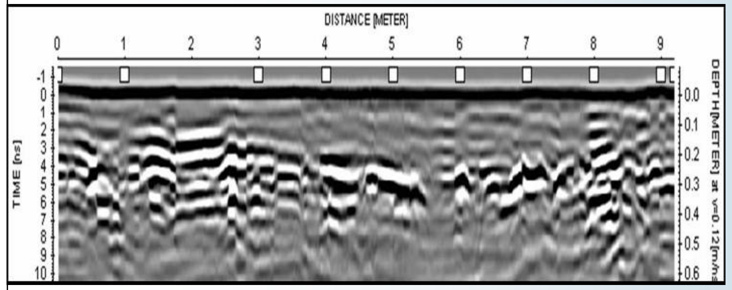
Results and Outcomes

In less than 5 days of field work at the Barwon Heads Bridge, a total of 468 timber elements over 34 spans were inspected using high frequency impulse radar. The investigation provided a detailed analysis of the internal condition of each timber element including whether it is sound, or is rotted, suffered insect attack, cracked or has increased moisture content. The results of the investigation were presented in as spread sheets and schematic drawings of each pier and span of the bridge indicating whether each timber element is suitable or not for re-use. The investigation proved successful and showed that HFIR has a number of positive attributes:

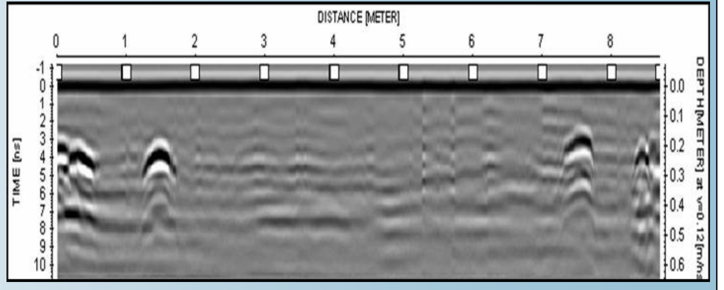
- Portable system with rapid data collection.
- Allowed real time output for evaluation on site
- Data along the entire length of the timber element is collected, not just spot checks as with drilling.
- When used in conjunction with visual inspection and drilling provides a comprehensive and cost effective inspection of timber bridges.



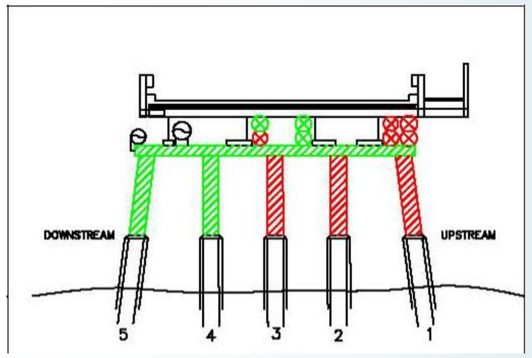
Barwon Heads Bridge pier 28 from bay 29.



Timber girder profile containing a termite pipe / void along its length.



Sound timber girder containing metal bolts.



Schematic drawing of Barwon Heads Bridge pier 6. Green indicates suitable for re-use, red indicates not suitable for re-use.

Timber	Start	End	Condition	Visual Inspection	GPR Investigation
crosshead A	pile 1	pile 5	✓	fair condition, wet especially over pile 5	wet and damaged at pile 5
crosshead B	pile 1	pile 5	✓	good condition	wet and damage at pile 5 end
corbel 1	bay 6	bay 7	X	poor condition, large open crack at end, wet in middle	poor
corbel 2	bay 6	bay 7	X	poor condition, half missing	poor
corbel 3	bay 6	bay 7	✓	fair condition, closed cracks at end	possible cracking around bolts
corbel 4	bay 6	bay 7	X	good condition, minor closed cracking at end	rot / piping or crack , possible cracking around bolts
pile 1	top	bottom	X	poor to fair condition, cracks along length	split entire length
pile 2	top	bottom	X	fair condition, rot at bottom, minor cracks along length, wet	split along entire length, rot at base
pile 3	top	bottom	X	fair condition, timber brace, wet	split along entire length, rot at base
pile 4	top	bottom	✓	fair condition, wet	cracked from base to mid-way
pile 5	top	bottom	✓	fair condition, timber braces, wet	good

Spread sheet of timber condition for Barwon Heads Bridge pier 6.