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PORTABLE AND LOW COST BRIDGES

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Figure 1 - Low cost temporary bridge located across Zalas Creek

ABSTRACT

When short term access is required for harvesting operations, portable or removable bridges for stream crossings should be considered as an alternative to permanent installations. Prefabricated bridges are versatile, low cost and the waterway is easily restored to its original condition after the bridge is removed.

The use of a portable bridge can offer greater flexibility for skid road location, and can minimise waterway disturbance from roading or harvesting operations. An approximate cost for a six metre long by four metre wide portable bridge for use by forest machines is NZ$12,000. Although this may appear to be expensive, repeated use should make them a cost effective alternative to conventional bridges and culverts where permanent crossings are not required.

Bridges that are simple in design, rugged, light and use the least amount of materials have the most potential for use in New Zealand. These and other types of portable and permanent bridges used overseas, and in New Zealand, are also discussed.

INTRODUCTION

In New Zealand, the use of portable bridges on forest roads has been minimal because continuous access to commercial plantation forest areas is required for re-establishment and silviculture. However, in the near future, approximately 17% of our wood supply (New Zealand Forestry Statistics, 1991) will be from small woodlots of less than 1000 hectares. Many of these woodlots have been planted in locations considered unsuitable for farming and have poor or non-existent road access. Any moderate sized stream crossings required for harvesting access can become a major expense and may render harvesting uneconomic. A portable bridge could be used on stream crossings and the cost distributed over several sites without the full expense of a permanent structure. If they were available, portable bridges could be hired for the duration of harvesting.

Roads and road construction during harvesting are a great threat to water quality. As much as 90% of the erosion material in a catchment comes from roads (Anderson et al., 1976). Steep gradients, deep cut and fill sections, poor drainage and eroding soil are the predominant cause of sediment.

The most frequent sources of sediment in timber harvesting are from the use of poor stream crossings (Rothwell, 1983). Sediment in streams can cause unacceptable visual impact, aggradation of the stream channel, and impacts on the fauna in the stream or marine environment (Watson, 1979). To mitigate these effects, logging contractors and forest owners need to be informed of a wider choice of methods for crossing streams with rubber-tyred skidders, forwarders, tracked machines and logging trucks. One method is the use of low cost prefabricated portable bridges. Field trials have shown that using a portable bridge substantially reduces the sediment entering the stream compared to using a rock ford, geotextile silt fence, or the straight stream crossing (MacConnell et al., 1990). The use of culverts can produce large amounts of sediment during installation and removal, due to the earthworks involved.

Prefabricated portable bridges are widely used in the United States, Canadian and Alaskan forests where they are a competitive, cost effective option because they are reusable, easy to install, and have ready availability. Environmental constraints placed on stream crossings (water quality and fish passage) is another reason for their use. With similar constraints likely to become more common in New Zealand, the use of bridges, portable or permanent, can be expected to increase.

The portability, economics and reusability of portable bridges are discussed in this report. The current New Zealand situation on portable bridges and the types of portable bridges used in the United States and Canada are also reviewed. There is a review on some low cost permanent bridges used in New Zealand that may be used as portable bridges. In summary, the bridges described in this report have potential for use in New Zealand.

ACKNOWLEDGEMENTS

LIRO acknowledges the portable and low cost bridge manufacturers for their supply of information and photographs.

THE NEW ZEALAND SITUATION

Off-the-shelf prefabricated portable bridges, specifically designed for quick installation and removal, have not been available in New Zealand because there has been little demand. In situations where short-term access (less than six years) across a stream is required, a bridge is usually specifically designed for this purpose, featuring quick construction and easy dismantling so that the structural materials can be reused. Decking is usually timber that may not be reusable. For these temporary bridges, second-hand materials are often used to keep the costs down.

A good New Zealand example of cheap short-term bridging can be seen in indigenous forest areas of the West Coast. Generally access is for limited periods of time as no establishment or silviculture is required. The bridges are usually constructed from the cheapest materials either locally produced or recycled. The abutments are typically large timber logs.

A more sophisticated example can be seen in South Westland, where access across Zalas Creek was required to log a new block of forest giving two years production for the local sawmill (Figure 1). Zalas Creek is flood prone in an area of high rainfall. The bridge was designed to carry fully loaded logging trucks and other heavy forestry equipment, over one single lane 12m span. The superstructure and deck have been designed for easy removal (and reuse at another site) when logging is complete. At each abutment, three steel "H" piles, driven to 10m can also be withdrawn for reuse if required.

The prefabricated structure, consisting of beams and cross bracing, was transported to the site and lifted into place with a hydraulic excavator and small tracked crane. To reduce the need for surface maintenance, the steel beams were sandblasted and a protective epoxy paint coating system used. Locally produced timber reduced construction costs. Total cost for constructing the bridge in 1990 was NZ$19,000 (NZ$1,583 /m).

REQUIREMENTS FOR PORTABLE OR LOW COST BRIDGES

Portability

Portable (often prefabricated) bridges are designed and built for ease of transportation and reusability. Transportation is usually by truck and the bridge may be split longitudinally in two pieces to be within any width restrictions. One or two loaders, excavators or cranes are needed to unload the bridge and place it in position, although two machines are needed to install and remove longer span (greater than 15m) bridges. Smaller bridges used by forest machines can be unloaded by a loader and then dragged into position using a skidder. Similarly, to recover the bridge, loaders, excavators or cranes are required to load the bridge onto a truck for transportation. Skidders can be used to drag smaller bridges to the next location if it is nearby.

Construction techniques should be such that damage is minimal when installing or removing the bridge. In the United States and Canada, prefabricated bridges as "off the shelf units" are available in various sizes, to suit either logging trucks or forest machines. In New Zealand, a portable bridge will need to be specifically designed and constructed to meet the requirements of a particular owner.

Prefabricated portable bridges must be rugged in design, and construction, to resist damage caused during installation and removal.

Cost

The costs of bridges for stream crossings vary greatly and depend on span, bridge load, type of bridge, site access, approaches and abutments. At difficult sites, a major cost is the construction of the bridge approaches and abutments, which can cost as much as, or more than, the bridge. The costs for each bridge type quoted in this report do not include the cost for approaches and abutments as these can only be costed on an individual and site specific basis. Factors that effect the cost of a stream crossing are stability of banks and riverbed, stream gradient, proposed road level, flood flow levels, availability of suitable fill, and access to site for cranes and machinery. For the small to medium span bridges (less than 25m), used by logging trucks, the cost varies from NZ$1,500 per metre to NZ$2,500 per metre of span. Longer bridges (greater than 25m) can be as much as NZ$5,000 per than 25m) can be as much as NZ$5,000 per metre span for a sophisticated truss type bridge.

The capital cost of a 8m long portable bridge, for forest machines, is approximately NZ$16,000 (no abutments, transportation and installation costs are included). The cost for a culvert of the same span is difficult to estimate, as the size of the culvert depends on many factors such as waterway area, soil type, catchment size and rainfall. The cost could be as high as the portable bridge or as low as NZ$3,000. It is anticipated that the use and reuse of portable bridges and their obvious benefits will show them to be a cost effective alternative to conventional bridges and culverts in New Zealand. Second-hand materials could reduce the cost further, but satisfactory designs will need to be developed and the extent of the cost reduction will depend on material availability and individual ingenuity.

Reusability

Culverts are often used as temporary stream crossings to access logging compartments. They are removed on completion of the harvesting operation and are reused, although they are difficult to retrieve and tend to be easily damaged, which renders them unserviceable after only three or four recoveries. In some situations, earthworks and disruption to the waterway, caused by installing and removing culverts, may be unacceptable, particularly on environmentally sensitive streams. If temporary bridges are used, the disruption to the waterway is minimal and the bridges can be reused many times at different sites.

TYPES OF BRIDGES

The following is a brief description of some of the types of portable and low cost bridges used overseas and in New Zealand. Many of the overseas bridges could easily be manufactured in New Zealand. However, it is likely they will be made to order and not available as "off the shelf" units.

Forestry Machine Bridges

Stream Crossing Mats

These timber mats (Howe, 1991) are used to reduce waterway disturbance caused when skidders cross small streams. They are used extensively in the United States and Canada, where the Carolina Mat Company produces 15,000 mats each year.

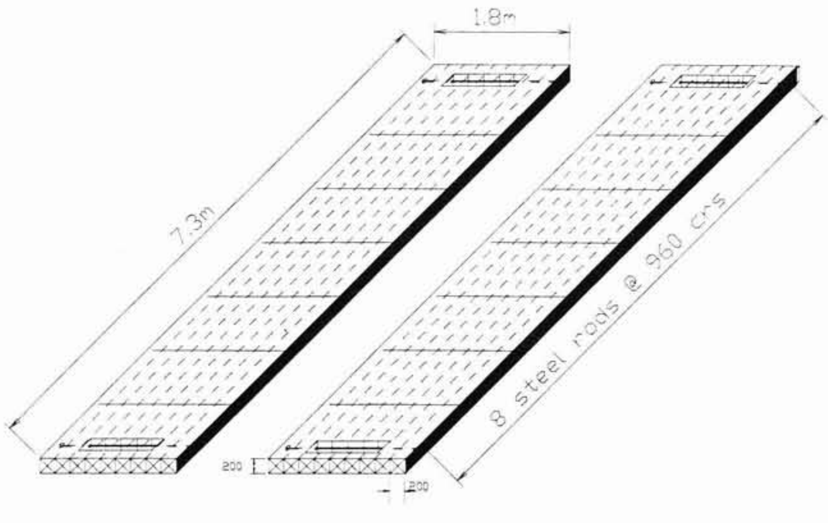

Figure 2 - Stream crossing mats

The mats are 1.83m wide by 7.32m long and are made of 200 x 200mm oak timbers bolted together with 25mm steel rods. Each mat has a slot cut at each end so the steel rod is exposed for a cable to be hooked on for transportation. The maximum allowable load on this bridge is 35 tonnes for a 6.5m span.

A skidder is used to place two mats side by side across a stream bed allowing water to flow under them. No foundation material is required, because each mat has enough bearing surface at each end to support the skidder and its load. Correct alignment when driving on to the mat is needed, to avoid logs catching the mat and moving it. When harvesting operations are complete, the mats are pulled out and reused.

The cost for two mats using oak timbers from the United States is NZ$1,500. The lifespan is difficult to estimate but would be a minimum of three years and could be expected to last a total of approximately 50 installations.

Dam Bridge

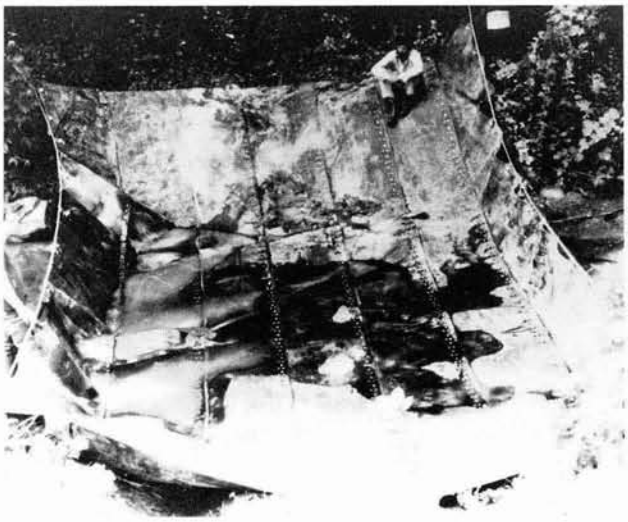

Figure 3 - Dam bridge

The dam bridge is a rectangular rubber mat made from strips of 12mm rubber conveyor belting joined side by side with a recommended length extending 3m each side of the water's edge, to protect the approaches. Support cables hold the sides upright so the mat floats on the water to form a "U" shaped, trough-like structure, through which skidders can pass.

When a load enters the bridge, the mat is pressed down to the stream bottom by the vehicle's weight. This momentarily dams the stream and after the load has passed, the bridge floats to the water's surface, allowing the stream to flow again unobstructed. This action allows the vehicle to be supported by the stream bottom while the rubber mat protects the stream bottom from rutting and abrasion.

The dam bridge offers an alternative where location, anticipated period of use, and the economics of an operation do not permit the expense and effort involved in installing either steel culverts, or a more elaborate portable bridge.

Looney (1981) researched the use of the dam bridge by making a comparison with a ford and a culvert for skidder stream crossings. The results showed a significant reduction in the amount of suspended solids being carried by the stream, when compared to a ford crossing. During the test, a skidder with chains on had difficulty in obtaining sufficient traction to climb out of the dam bridge. In the study, it was assumed the dam bridge would be used at only 10 different sites at an estimated cost of NZ$500 each time. This is cheaper than a culvert installation, which costs a minimum of a NZ$1,000 for a 450mm diameter culvert.

Temporary Steel Bridge

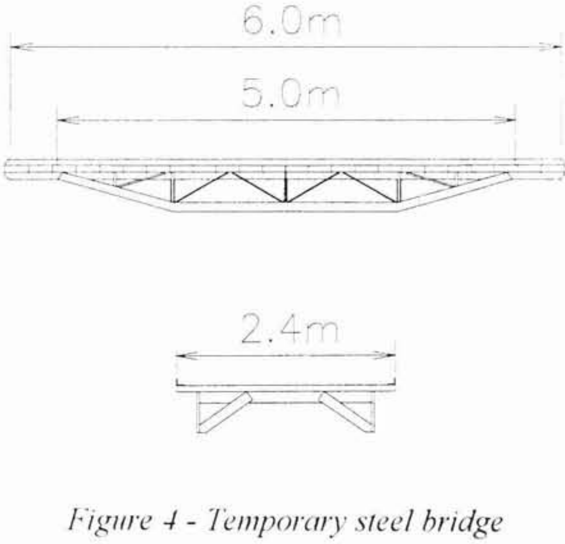

Figure 4 - Temporary steel bridge

This is a temporary bridge to support skidder traffic (Phillips, 1986). It is not commercially available overseas (or in New Zealand) but it could be readily constructed in most engineering workshops. The bridge was designed for a 15 tonne skidder weight (including load) with a span of 4.9m by 2.4m wide and is light and strong enough for repeated use. Construction is from steel angle and plate sections with all the joints welded and wooden deck planks bolted to the top steel chord. Minimum abutments are required to hold the bridge in place as the load is distributed over the ground at each end of the bridge.

Recovering the bridge is by use of a hook bolted to each top rail at the end of the bridge. A vertical lift is applied to the hook, freeing the 200mm wide plate that prevents the bridge from sliding out of place during use. The bridge is then dragged to the next stream crossing location, or to a position where it can be transported by truck.

The cost for the 4.9m skidder bridge has been quoted in New Zealand as approximately NZ$12,000 + G.S.T. (includes material supply, fabrication and painting). The timber decking will probably need to be replaced every two to three years, but this will depend largely on the type of use. Alternatively, prestressed concrete panels 1.2m wide x 4.0m long could be used for the decking. They are more durable, cheaper and quicker to replace than timber decking, although some design work would be required to ensure the additional weight of concrete is acceptable and safe.

ADM Portable Skidder Bridge

ADM portable bridges (Domenech, 1991) have been used by many United States and Canadian forestry companies. They are designed to minimise bridge transportation and installation cost.

The ADM bridge primarily used by skidders is available in one size only (3.35m wide x 7.92m long) and is capable of supporting a 15 tonne load. The bridge is hinged longitudinally along its entire length for transporting it on public roads. This reduces the width to 1.7m which is within New Zealand's legal limit of 2.5m. Loading, transportation and unloading is carried out using a standard skidder winch. A truck-mounted loader, tilt bed truck or transporter could also be used.

Figure 5 - ADM portable skidder bridge

Once unloaded, the bridge can be skidded or winched into place, to give an installation time of 30 minutes. The cost of the ADM skidder bridge is NZ$15,000 or it can be rented for NZ$50 per day plus the delivery cost in the United States.

Portable Forwarder Bridge

This two piece steel forwarder bridge (Makkonen, 1991) is widely used by harvesting contractors in Canada and was designed by Stora Forest Industries, Port Hawkesbury, Canada. The forwarder bridge design is inexpensive, simple, rugged and easy to install.

The forwarder bridge consists of two fabricated steel sections (1.2m wide x 4.9m long) and two abutment logs. In effect, it is

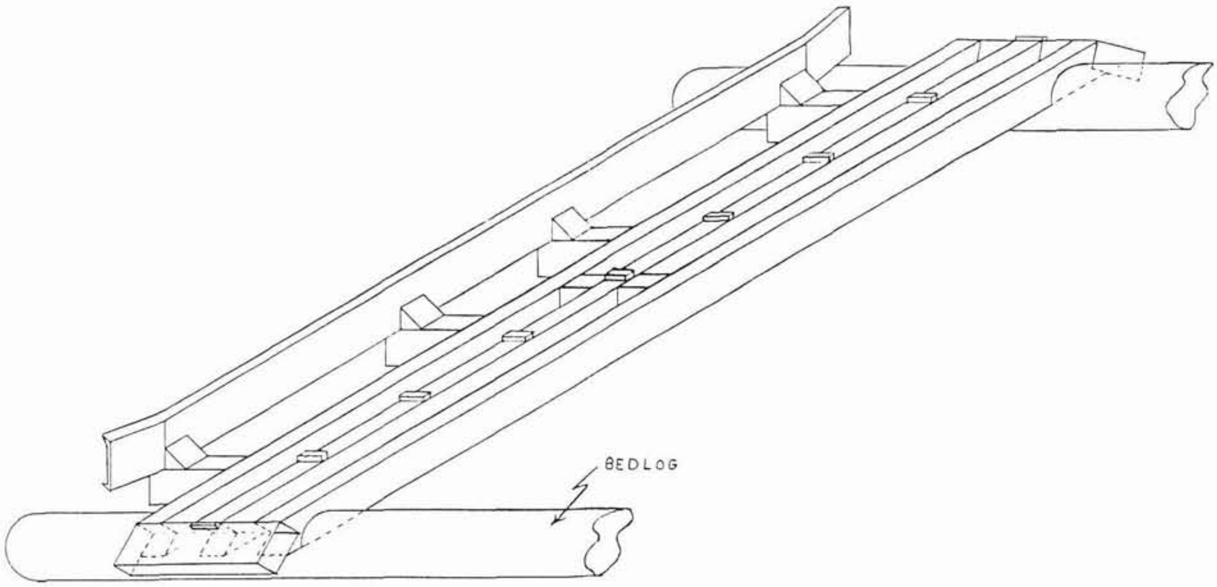

Figure 6 - Portable forwarder bridge

two composite bridge beams, one under each side of the forwarder. The bridge sections rest in notches cut in both ends of the abutment logs (alternatively, precast concrete units could be used) at the desired track width. Each bridge section consists of three hollow square sections, with cross members for rigidity. In addition, a 250mm high guard rail is mounted 410mm outside each bridge beam. The middle beam of each bridge section is equipped with traction bars spaced every 610mm.

To install the bridge, the abutment logs, and the beams, are lifted into place by the forwarder. The abutment logs typically weigh 350 to 500 kg each and the bridge sections about 680 kg each. A forwarder in the seven tonne and above class equipped with a 6 t/m crane can install this bridge in about 45minutes.

Given the limited reach of most forwarder loaders, a special installation technique was developed. The forwarder is parked along the edge of the stream at the crossing site. One abutment log is placed on the near stream bank beside the forwarder, and both bridge sections are lifted into place. The forwarder carefully crosses the bridge and parks crosswise at the far end of the bridge. The unsecured bridge ends are swung to the side, the second abutment log is placed and then the bridge ends are lifted on to it.

During forwarding, the approaches must be kept covered with slash to ensure the forwarder tyres are cleaned before reaching the bridge. This reduces dirt dropping from the tyres into the stream. These bridges should not be used to cross streams in very soft areas since the approaches can deteriorate rapidly and the abutment log may sink into the stream bank.

A pair of bridge sections cost NZ$3,000 and depending on the protective coating on the steel, the bridge should last 15 years.

Bridges for Logging Trucks

ADM Portable Bridges

Figure 7 - ADM portable bridge

This is similar in concept to the ADM skidder bridge, but for logging trucks they have a width of 4.27m and range in length from 6.1m to 15.24m and are capable of supporting 50 tonne gross weight. The bridge is hinged longitudinally along its entire length for transporting the bridge on public roads. This reduces the width to 2.2m, which is within New Zealand's legal width of 2.5m. Loading, transportation, and unloading is carried out using a standard winch. A truck-mounted loader, tilt bed truck, or transporter could also be used.

Once unloaded, the bridge can be skidded or winched into place. The 50 tonne capacity bridge can be installed in one hour. The cost ranges from NZ$16,000 for the 6m span to NZ$36,000 for the 15m span or they can be rented from NZ$50 to NZ$80 per day plus delivery costs in the United States.

Similarly, this bridge has been in use for only three years and it is, therefore, difficult to determine its life expectancy, but it would be comparable with other steel bridges.

Stress Laminated Timber Bridges

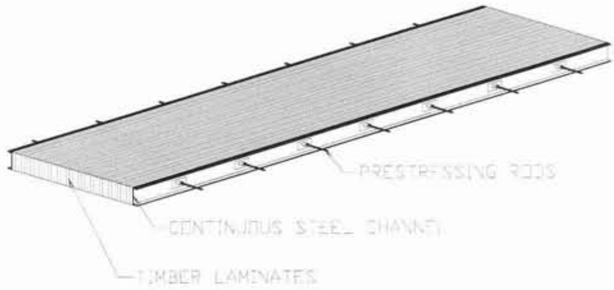

Figure 8 - Stress laminated timber bridge

Stress laminated timber is constructed from sawn timber laminations clamped together on their wide faces by high-strength steel stressing rods. These stressing rods can be either placed on the outside of the laminations or in holes through the laminations. The stressing pressure is transferred to the timber through bearing plates located along the outer laminations to develop sufficient friction between the laminations to cause them to perform structurally as a single unit. For use at other sites, the bridge can either be removed as one unit or the stressing pressure can be released and the laminates separated for ease of transport.

The maximum span for stress laminated bridges is 12m, limited by the 500mm maximum depth of readily available sawn timber. For a single lane bridge spanning 4.3m, a depth of 185mm is required for the timber laminations and the cost is estimated in New Zealand at NZ$670 per metre span (including handrails). Similarly, for a span of 12m a depth of 410mm is required with an estimated cost in New Zealand of NZ$1,500 per metre span (including handrails).

Stress laminated timber bridges are very light structures that can be easily erected and removed. However, the wood can be damaged when handling the bridge and this limits their reusability. They are estimated to have a maximum life span of thirty years with periodic re-stressing required. Stress laminated timber bridges is a relatively new concept and any design will need to be checked and approved by a suitably qualified engineer. These bridges are for gross weights of around 50 tonnes but can be designed to carry larger loads.

Glue Laminated Timber Bridges

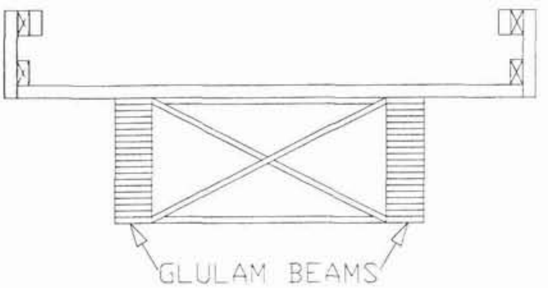

Figure 9 - Glue laminated timber bridge

The glue-laminated timber bridge is constructed from beams made up of timber laminates that are glued together to form a solid large beam. Laminates can vary in size from 50mm to 500mm wide and are usually 25mm deep. Timber decking and hand rails are typically used. Commonly, glulam bridges are used for spans ranging from 6m to 25m, although they have been used for clear spans of 43m, where four glulam beams (350mm wide by 2300mm deep) were used. The beam depth and length is limited only by transportation and manufacturing capabilities. Therefore, they can be designed to carry virtually any load.

For reuse at other sites the timber decking is removed, and it is either discarded or used again depending on its condition. The glulam beams are then removed individually for transportation to another site. Glue laminated timber bridges are very light structures that can be easily erected and removed by logging machines for smaller span lengths. However, the wood can be damaged when handling the bridge and this will limit its reusability.

For example, a 15.2m span bridge, capable of supporting 50 tonne logging trucks, uses five glulam beams 160mm wide by 1300mm deep. The cost for these five glulam beams in New Zealand has been quoted as NZ$38,395 + G.S.T. ex factory Auckland, while for the whole bridge including decking and hand rails the estimated cost is approximately NZ$50,000 (NZ$3,300 per metre span). These bridges are not expected to last more than thirty years.

Prestressed Concrete Bridge

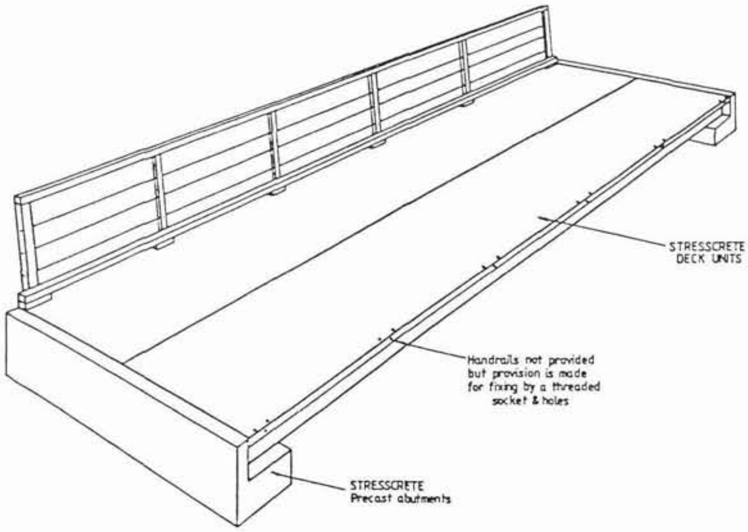

Figure 10 - Prestressed concrete bridge

This prestressed concrete bridge is commonly used by local authorities as a minor road bridge and as a farm bridge. In New Zealand, they are competitively priced, convenient, maintenance free and easy to construct. All concrete units are precast and prestressed in controlled conditions. For economy, standard units are used that can be quickly designed in-house to meet the load and span requirements. This bridge is very quick to construct, requiring assembly of only two double tee units and two abutments on site.

By using longer span units than strictly necessary abutment height can be reduced and the costs minimised.

These bridges for highway loads spanning 9.2m cost approxmately NZ$1,600 per metre (including abutments and handrails) for single lane bridges. For larger spans a combination of steel beams and concrete slabs will be required and the cost per metre of a span will increase.

Prestressed concrete bridges are very durable (expected life is over 30 years) and are suited to permanent bridge installations, due to their weight. Two 40 tonne cranes are usually required to erect (and remove) the concrete bridge, which requires strong foundations for the cranes to work from and access to both sides of the stream. This process is expensive and could inhibit removal and installation at another site. Forestry machines (such as loaders) are not adequate to remove and install this type of bridge.

Skip Gibbs Bridge

Figure 11 - Skip Gibbs railcar bridge

A Skip Gibbs bridge consists of steel deck railcars (open deck railway wagons), placed side by side, for any desired width and a maximum span of 25m. This bridge is very durable, capable of supporting off-highway logging trucks and can be reused many times. Transportation to the crossing site is by use of a flatbed truck, where it is then hauled into place by a loader. Total installation time including log abutments and bridge approaches is less than a day.

These railcars were once discarded by railways as scrap metal. Structurally, these railcars were in good condition and "Skip Gibbs" in the United States are now marketing these railcars as temporary or permanent bridges. The railcars are one of the cheapest options for a portable bridge at a cost of NZ$28,600 (NZ$1,060/m) for two 27m by 2.6m steel deck railcars. However, as these railcars are second-hand the supply is sometimes limited. With adequate maintenance they are claimed to last 30 years.

Railcars in New Zealand, when discarded, are fatigued (through repeated use) and may not be safe as a bridge. The New Zealand railcars are not as large or as strong as the United States railcars and have been commonly used for foot and stock bridges only, although one was used near Reefton for some years to provide access to an indigenous logging area. Also one is being used at a Marlborough Sounds logging operation. Recently a trial near Tokoroa found the New Zealand railcar was too small and unable to safely support the required weight. The use of discarded New Zealand railcars will require design checks and careful costing.

Tapered Steel Beams

Figure 12 - Tapered steel beams

Tapered steel welded beams are manufactured by Steltech Structural Limited in Auckland. The tapered steel beam is an unique concept in New Zealand. Plates of steel are cut to size and are welded together to form "I" beams from 200 to 2000mm in depth, with flanges up to 600 x 50mm. When optimising the design of the welded beams, the web and flange thicknesses are tapered to achieve a 30% lighter steel beam than conventional hot rolled members for the same load capacity. Costs are reduced due to less steel in the beam and for two beams 16.2m long, the cost is approximately NZ$3,900 (NZ$240/m).

A precast concrete deck, or stress laminated timber sections, is bolted on to the steel beams to provide the trafficable surface. These bridges are very light and could easily be erected and removed by standard logging machines. The steel beams are deeper in the middle where the greatest strength requirement is and are tapered down at the support ends. This results in a light and very efficient beam to support the required load.

For spans of 10m to 25m, bridges using tapered steel beams are likely to be the lowest cost option and, therefore, will have the greatest potential for use in New Zealand. The cost of the bridge including decking, cross bracing and two tapered steel beams is approximately NZ$1,200 to NZ$1,800 per metre (excluding abutments and approaches). Expected life for these bridges is up to 30 years, which is comparable to other steel bridges.

Big R Mini Bridge

Big R Manufacturing has been one of the leading suppliers of portable steel bridges to the United States forest industry. This bridge is constructed of steel girders with a seven gauge (4.5mm), roll-formed steel deck with timber running planks for rigidity. Spans vary from 3.7m to 7.3m for their mini bridges.

Figure 13 - Big R mini bridge

The Big R Mini bridges were developed in response to environmental concerns regarding water quality and fish passage, which required bridges to be used for stream crossings. They have been widely used on temporary roads built for salvage logging in the United States forests.

The mini bridges cost from NZ$6,900 for the 3.7m span (NZ$1,870/m) to NZ$15,500 for the 7.3m span (NZ$2,130/m). These bridges are claimed by the manufacturer to last 50 years, although an economic life of 30 years is probably more realistic.

Big R Bridge

Figure 14 - Big R Bridge

This bridge is constructed of steel girders with a seven gauge (4.5mm), roll-formed steel deck with timber running planks for rigidity. Spans vary from 9.1m to 27.4m.

The cost of the Big R bridges range from NZ$30,900 for the 9.1m span (NZ$3,400/m) to NZ$142,000 for the 27.4m span (NZ$5,190/m). These bridges are claimed by the manufacturer to last 50 years, although an economic life of 30 years is more realistic.

Eastbridge Bridging Systems

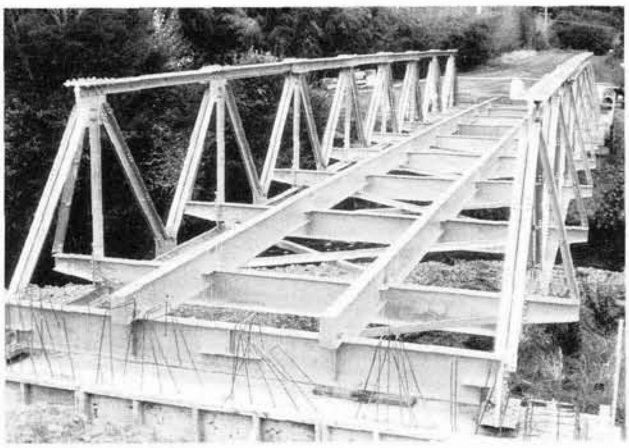

Figure 15 - Eastbridge truss bridge

Manufactured in New Zealand, the Eastbridge component bridging system consists of a unique bolted construction and has been in service in the Asia Pacific region for over 25 years. Bolted construction allows large bridges to be transported to, and erected in, remote areas. When no longer required, the span can be unlaunched and unbolted for reuse. It retains considerable value even as a used bridge. In Huntly, New Zealand, a heavy construction access bridge was in place for nearly 10 years before it was disassembled and many of the components were shipped overseas for reuse.

Eastbridge have plate girder designs that are suitable for short to medium spans, while their truss design suits the medium to large spans. The largest truss bridge component is approximately 6m in length for ease of transportation and construction.

Generally, these bridges have been used for permanent installations, due to the time involved in assembly and erection. However, there is scope to partly disassemble the bridge for transportation to another site and as all of the components are bolted it can be relatively easily dismantled. All of the steel components are hot dip galvanised and require minimum maintenance. The expected life span is approximately 30 years and cost is approximately NZ$3,000 to NZ$5,000 per metre span.

EZ Bridge

The EZ Bridge was developed by the Hamilton Construction Company in the United States to provide an easily installed and removable modular bridge system. It is constructed of two steel bridge sections joined longitudinally with hinged diaphragm plates, and is available with double or triple lane decks, in spans from 6m to 24m.

There are currently 150 bridges in service in the United States with the modular bridge system now well accepted. This is a rugged system, allowing ease of transport by standard logging trucks and installation using typical road building equipment in half a day. The bridges are kept in stock for immediate delivery and are designed to meet the United States highway design requirements.

The manufacturer claims an expected life span of 50 years with adequate maintenance. In a harsh environment it is expected they will not last longer than 30 years. The cost is about NZ$4,700 to NZ$6,400 per metre span. In the United States, it is easily resold and retains its value well.

Modular Bridge

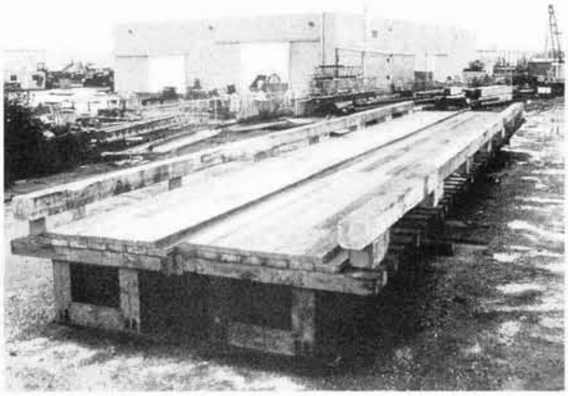

Figure 16 - Modular bridge

Modular Bridge Systems in Canada manufacture portable steel bridges similar to the EZ Bridge. It is constructed of two independent steel bridge sections complete with wooden decking and guard rails. The two bridge sections are fastened together only at the abutments. This allows quick installation and removal to another site.

These bridges are available in spans from 15m to 30m spans and a load capacity of 54 tonnes to 150 tonnes. The expected life span is around thirty years. The cost is about NZ$3,200 to NZ$6,400 per metre span. Similarly to the EZ Bridge, it is easily resold and retains its value well.

Acrow Panel Bridge

The Acrow Panel Bridge is assembled on site using prefabricated hot-dipped galvanised steel panels. These panels are pinned end-to-end to form trusses between the abutments. The span can be varied by increasing or decreasing the number of panels used. This means the bridge can be used again at other sites with a different span.

This design is similar to the well-known Bailey Bridge. In New Zealand, these bridges are limited in supply as the few available are in storage for emergency use by Transit New Zealand. Their use is also decreasing as they are slow to construct and more expensive than other alternatives for stream crossings (NZ$8,000/m). Generally, the Acrow panel and Bailey bridges are more suitable for spans greater than 30m. These bridges can be assembled without the use of machines but are labour intensive to construct.

BRIDGES SUITABLE FOR USE IN NEW ZEALAND

The bridges that have the most potential as portable bridges in New Zealand are the cheapest. For portability and low cost, these bridges need to be very simple in design, rugged, light and use the least amount of materials. The portable forwarder bridge, consisting of two bridge sections is very simple, rugged and cheap and will have potential for use by forwarders for deep stream crossings. In these locations it will be impossible to drive through the stream and expensive or environmentally unacceptable to install a culvert.

For protecting small streams in a compartment from skidders, the stream crossing timber mats have the greatest potential followed by the "Temporary Steel Bridge". These are simple to construct and relatively cheap. These bridges are very light, to enable quick installation and removal by the skidder. Therefore, the skidder is not limited to one stream crossing site as would have been the case for a culvert.

Bridges with tapered steel beams have the most potential for portable bridges used by logging trucks. This type of bridge is very light and cheap as the tapered beam is very efficient in supporting the load. As the bridge is light, loaders can be used to install and remove the bridge. Prefabricated concrete bridges are the cheapest for smaller spans (less than 9m) although two 40 tonne cranes are needed to install and remove the bridge. They would be ideal for permanent bridge installations as they require little maintenance.

The Eastbridge componentised system will have potential for larger spans (greater than 25m), where a truss or plate girder system will need to be used. They are expensive and are more likely to be used as a permanent structure.

SUMMARY

Portable and low cost bridges:

- are an environmentally sound method of crossing streams as compared to culverts and fords. They cause less disruption to the natural flow of water, allow for easy fish passage and stream bank erosion is minimised

- are easily removed at completion of harvesting and the waterway can be restored to its original condition

- can provide access to small woodlot areas where the expense of building a permanent stream crossing is not justified

- can be easily transported and erected in minimal time

- can be erected by forest machines

- are an investment in which the capital cost can be distributed over several sites (or they can be resold). Forest companies who own the cutting rights to large numbers of farm woodlots requiring bridging could buy a portable bridge for use when crossing streams. This bridge could then be resold or hired to other interested parties if they have no further immediate use.

When short-term access is required for harvesting operations, portable or removable bridges should be considered as an alternative to permanent installations for stream crossings. They offer the flexibility for location of roads and skidder tracks as well as minimising the adverse effects on the environment. Timber harvesting can be carried out and the waterway easily restored to its original condition.

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