REPLACEMENT BRIDGES FOR LOW TRAFFIC VOLUME ROADS
PART ONE: CONCRETE HOLLOWCORE BRIDGE

Chris Dowding
Director – Structures Group
TOD Consulting - engineers and project managers

BACKGROUND

- What is the true function of a bridge?
  - Bridges link people, services and goods together
- How many hardwood girder bridges are there in Australia?
  - Approximately 20,000+ (no nationwide register)
  - Hardwood girder bridges are dilapidating
  - Replacement estimate is AUD$20 billion+ (standard concrete plank bridge, roadworks and project management)
  - Majority owned by Local Governments, National Park Authorities and Timber Forestry Operators.
- Community thinks bridges should just work
  - But what are the consequences if they don't work?

WHAT HAPPENS TO SOCIETIES IF THE LINKS BREAK?

- Tasman Bridge collapse, Hobart 1975
  - Traffic delays on alternate routes (if there are any)
  - People cannot get to work, hospitals and schools on time.
  - Business can close and jobs can be lost.
  - Economies suffer
- These issues can occur for any population – large or small
- Australia relies on these links to travel and to move its goods and services.

Photo credit: http://www.abc.net.au/news/2015-01-05/tasman-bridge-disaster-40th-anniversary/5998396

TWO REPLACEMENT SITES WITHIN MARY RIVER CATCHMENT

- Neilson Rd & Elliott Rd Timber Bridges, Gympie
  - 10m long bridges, washed away January 2013
  - Rural, low traffic location
  - Rapid Flow velocities 3.4-3.9 metres per second
  - Community preference for waterway protection
  - Client preference for box culverts, willing to consider alternatives

CAN WE BUILD A BRIDGE FOR LARGE BOX CULVERT COSTS?

Box Culvert Depends → Cheapest & Best Solution? It

- ❑ High-Velocity Flows can damage culvert structures
- ❑ Box Culverts: for many waterways, Fish Passage Laws require:
  - ➢ Special buried culvert base,
  - ➢ Larger box culverts, and
  - ➢ Fish refuge baffles along the outside walls
  - ➢ Fish passage isn't an Australian-only "invention"

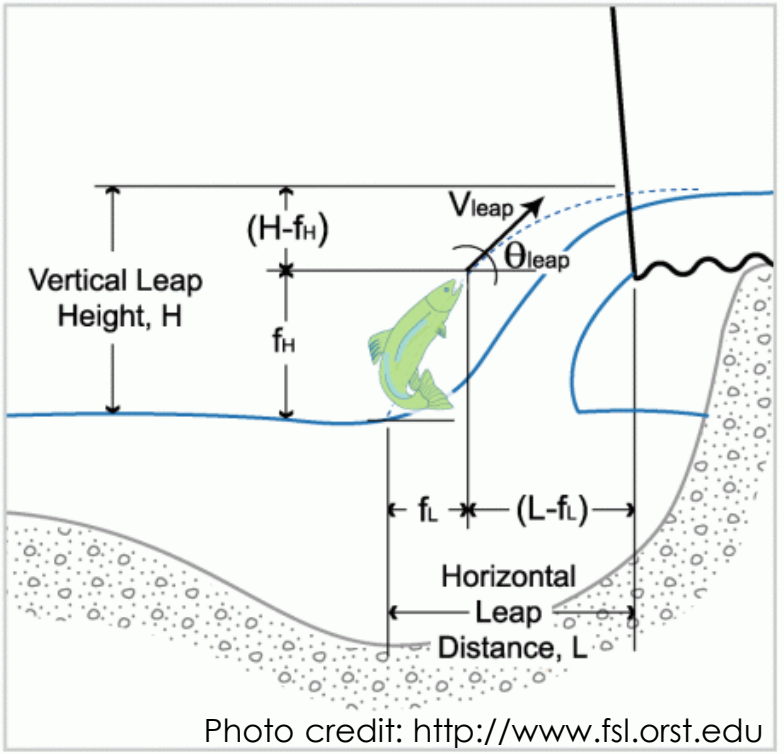


Photo credit: http://www.fsl.orst.edu

Downstream ledge stops fish

Photo credit / source: www.multco.us

BOX CULVERT CONSTRUCTION – MAYBE DOESN'T SUIT FISH

Photo credit / source: www.southernenvironmental.org

Photo credit / source: www.thomastonct.org

LOOK AT OPTIONS – COST VERSUS RISK

Criteria	Option A: 600 mm Conventional Precast Plank 12m Bridge on piles	Option B: "Fish-passage ready" RCBC culverts with allowance for tiedown	Option C: Conventional RCP pipes (4/1800 dia)	Option D: Alternative 12m "Precast Hollowcore" Bridge with Q2000 riprap
Estimated bridge construction cost average/site (excluding roadworks)	**$ 371,932** (Includes 10% contingency)	**$ 301,072** (Includes 10% contingency)	**$ 271,767** (Includes 10% contingency	**$ 267,131** (Includes 35% contingency)
Environmental impact	Low	Medium to High	High	Low
Resistance to flood damage	Excellent	Medium	Poor	Very Good

* All figures exclude GST, and exclude project delivery costs

WHAT IS HOLLOWCORE?

- Produced in Europe, USA, Canada, Australia (Melbourne and Brisbane)

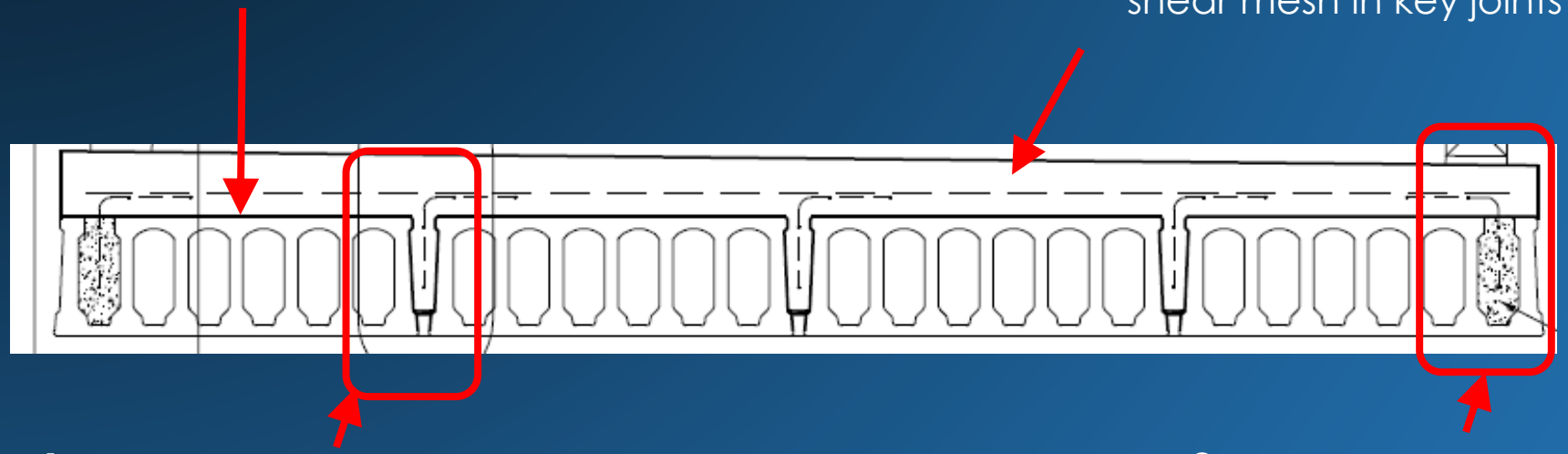
- Uses a patented extrusion process with 50MPa concrete. Very efficient and very cost effective:
  - 1200mm width (nominal)
  - 100-420 mm plank thickness in Australia. (Up to 500 mm thickness in Europe & USA)
  - Contains pre-stressed strands. How many? Discuss with manufacturer
  - No shear ligs
  - Normally a cast-insitu topping slab added on site

- Commonly used in buildings and carparks:
  - Engineer, Des Menz, designed and built T44-rated bridges for farms in Victoria during 1990s using Hollowcore
  - *Precast Hollowcore (Victoria)* has supplied planks for numerous T44-rated bridges

DESIGNING A BRIDGE USING HOLLOWCORE PLANKS

3. No of strands can be increased , within limits.
Specify plank finish to get Composite action:
- Standard Longitudinal broom for T44 or lower.
- Special Transverse broom for SM1600

4. Cast-insitu topping slab (plastic fibres for crack control):
a) Increases bending capacity
b) Acts as deck wearing surface (could add two coat bitumen seal to protect from gravel of unsealed roads)
c) Mesh to transfer wheel loads across full width of plank, and to shear mesh in key joints



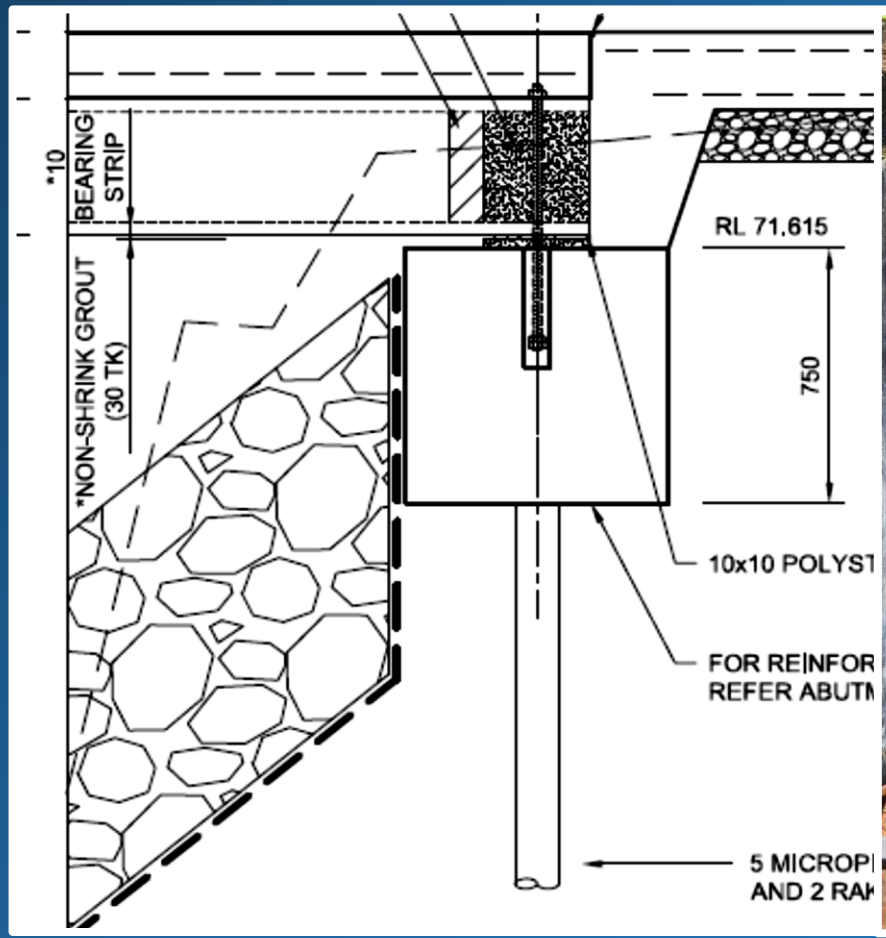
1. Key: S32/10 concrete fill to transfer loads between planks. Include mesh for:
a) Flood and traffic-vibration tiedown of topping slab
b) Minimum shear reo (Prestress in planks gives majority of shear capacity)

2. Outside cores:
Pre-opened in factory
Add mesh and grout fill for same reason as Key

TOD
engineers & project managers

SIMPLE CONSTRUCTION

- No large piling rig (for single span bridges):
  - Micropiles + Simple reinforced headstock, or
  - Mass concete footings founded below creek bed level, sized to prevent overturning/sliding
- Headstock could be precast, with ducts for post-installation of micropiles
- Self healing riprap (ungrouted rock) sized for Q2000 flood



SIMPLE CONSTRUCTION

- Smaller crane
- Dimensionally tolerant planks
- No transverse stressing: Just fill key joints while pouring slab
- Mesh in cast-insitu slab
- No asphalt required – concrete slab is deck wearing surface
- Could be built by Council crew familiar with box culverts; or by a Building Contractor

STATIC LOAD TESTING SUCCESS
(2MM SAG < 4MM ANTICIPATED)

TOD
engineers & project managers

DYNAMIC LOAD TESTING – VIDEO*

DYNAMIC LOAD TESTING – VIDEO

SUMMING UP

- Final construction cost was **$234,554** average per bridge,
  - < **$261,131** pre-construction estimate including 35% contingency
  - < **$301,932** estimate for "Fish-passage-ready" large box culverts
  - < **$371,932** estimate for Conventional precast plank bridge
  - All figures excluding GST & Roadworks.

  - Neilson Rd & Elliott Rd Bridges were designed for T44 load (12 metres single span)
  - Just completed an SM1600 design (13 metres single span)
  - About to design an SM1600 multi-span bridge (40 metres length)

- Hollowcore Bridge suitability:
  - Country roads (low traffic volume < **approximately 250** vehicles per lane per day, including 10% Commercial vehicles)
  - High-environmental-value waterways – creek bed kept in natural state
  - 100 year Design Life

CONCLUSION

- Hollowcore Bridge Design Manual / Book being developed by TOD Consulting
  - Register your interest: http://www.todconsulting.com/bridge-survey
- Want to find out more?
  - Video: https://youtu.be/G3UtvDOXJAQ
  - www.todconsulting.com
  - reception@todconsulting.com