DEVELOPMENT OF A SLAB-ON-GIRDER WOOD-CONCRETE COMPOSITE HIGHWAY BRIDGE

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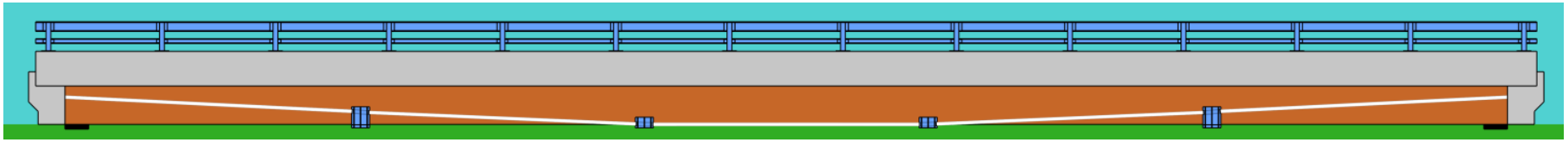
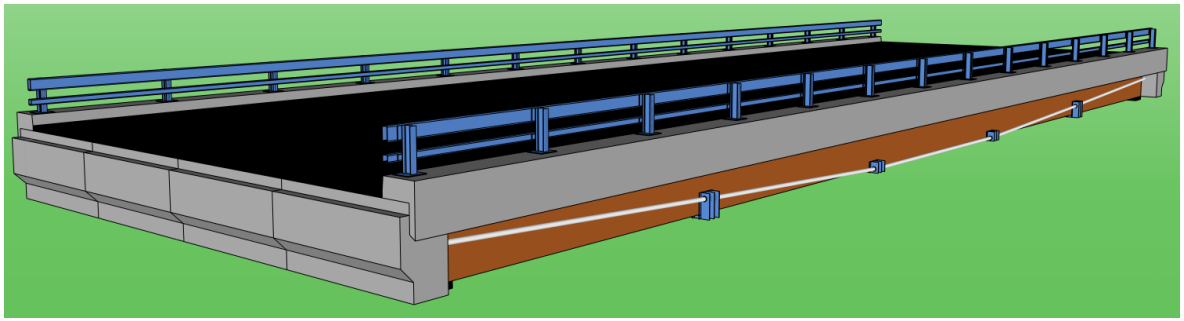
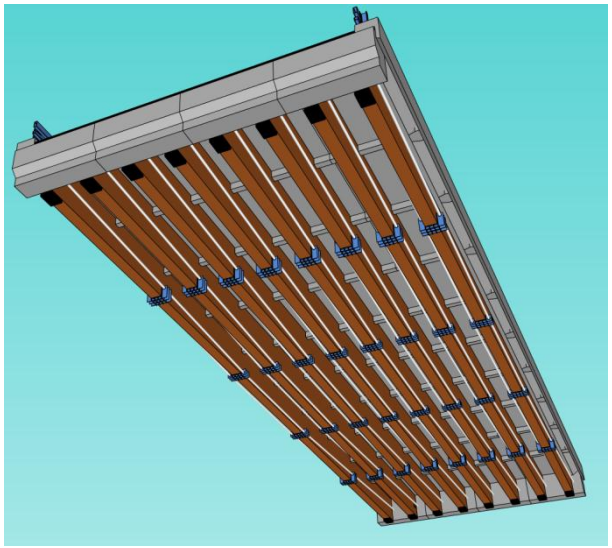
THE ``*PROPOSED CONCEPT*``





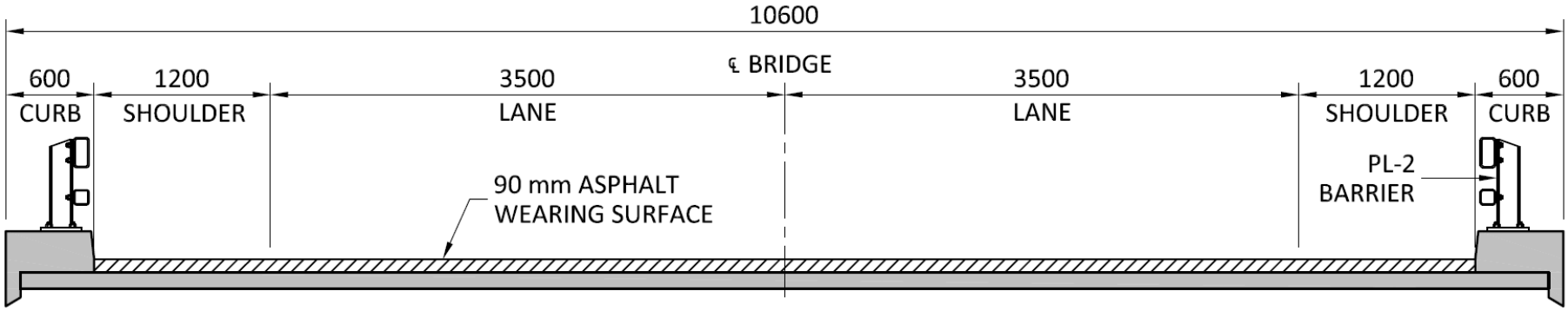


- Slab-on-girder bridge superstructure
- Vehicular bridge
- Applied loads as per the Canadian Highway Bridge Design Code
- Designed for spans ranging from 10 m – 30 m in 5 m increments

THE NEED FOR A WOOD-CONCRETE COMPOSITE BRIDGE?

- Wood bridges are rare in Canada in spite of a large forestry industry
- Advancements in material technology afford longer span opportunities for wood bridges:
  - Ultra-high performance fibre-reinforced concrete
  - External unbonded post-tensioning
- Slab-on-girder bridges are common in Canada
- Cast-in-place concrete is scarce in many remote regions

ROADWAY CROSS-SECTION

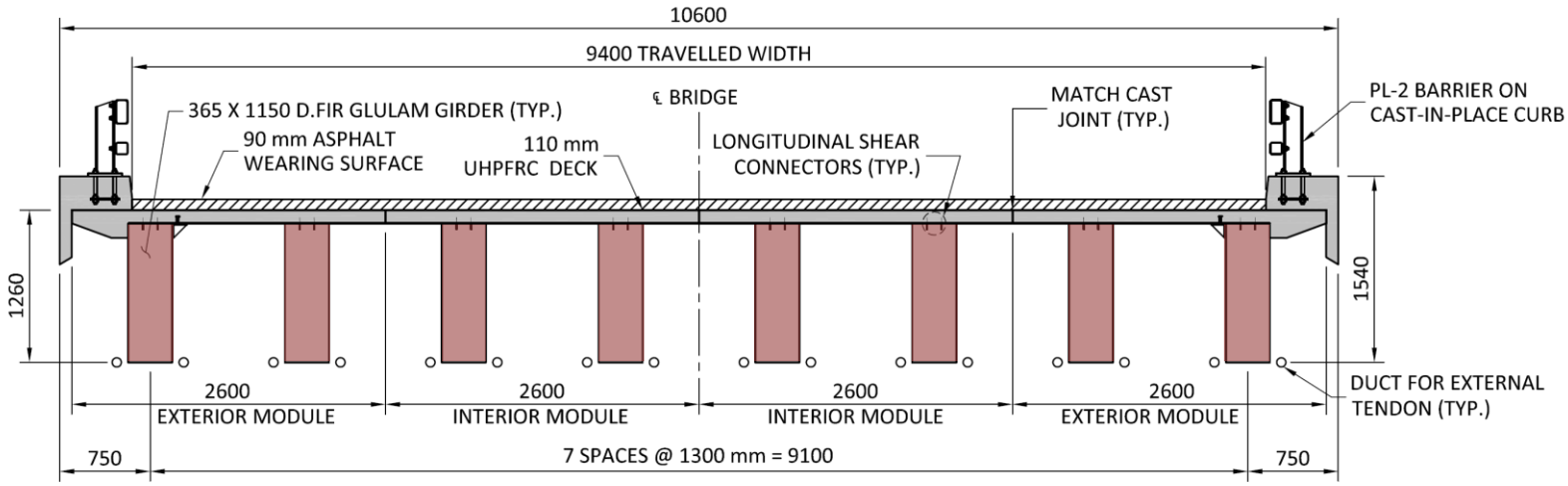


Roadway cross-section valid for:

1) an undivided local rural road with a speed limit of 100 km/h

2) an undivided urban collector road with a speed limit of 80 km/h

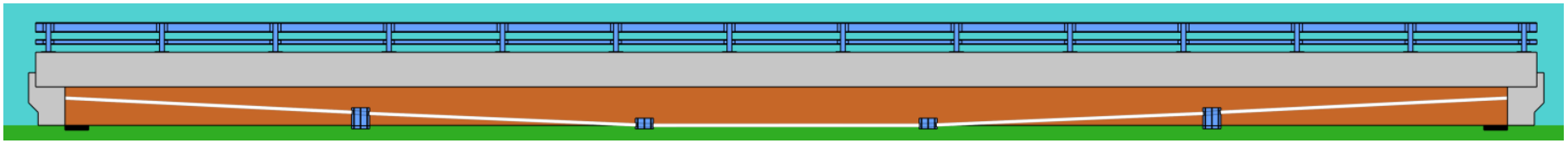
STRUCTURAL CROSS-SECTION



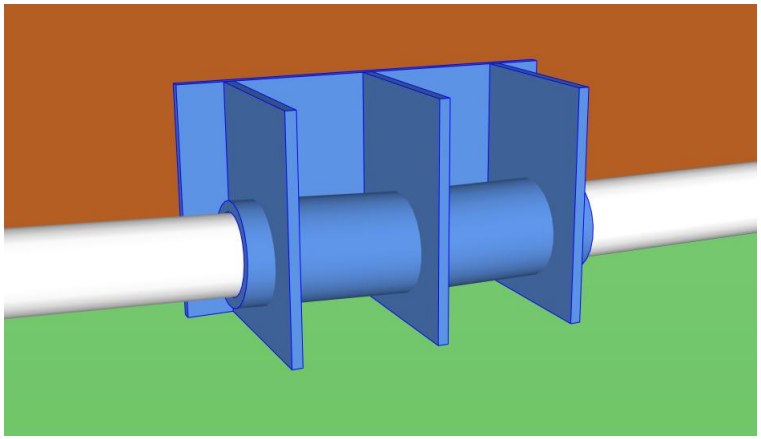
CROSS-SECTION IN-BETWEEN DIAPHRAGMS

- Four double-T modules
- Eight glued-laminated girders
- 110 mm thick ultra-high performance fibre-reinforced concrete deck
- Composite action between deck and girders
- Longitudinal and transverse post-tensioning

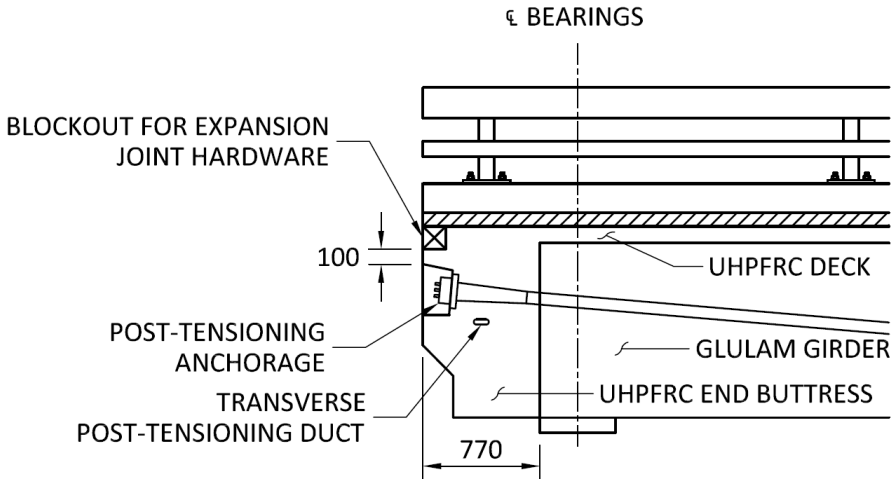
PRESTRESSING CONCEPT



Longitudinal Tendon Profile

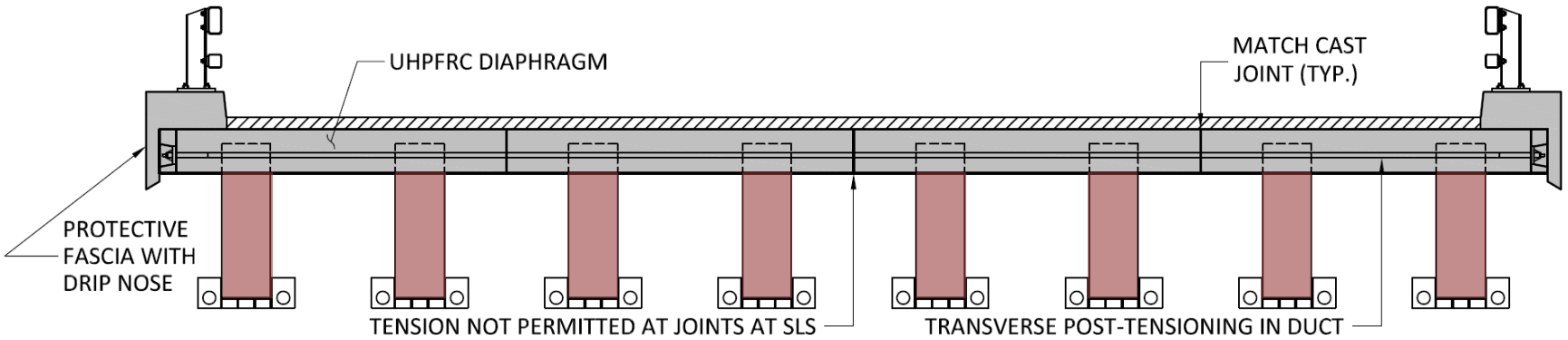


Tendon Deviator

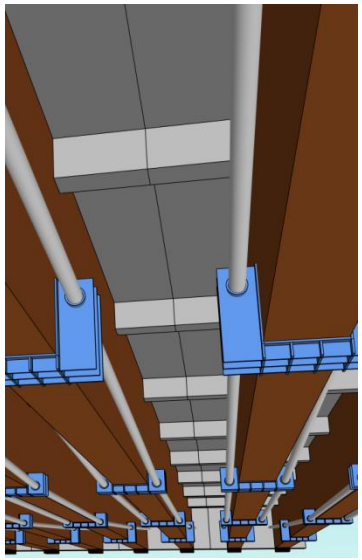


End Buttress

DIAPHRAGMS

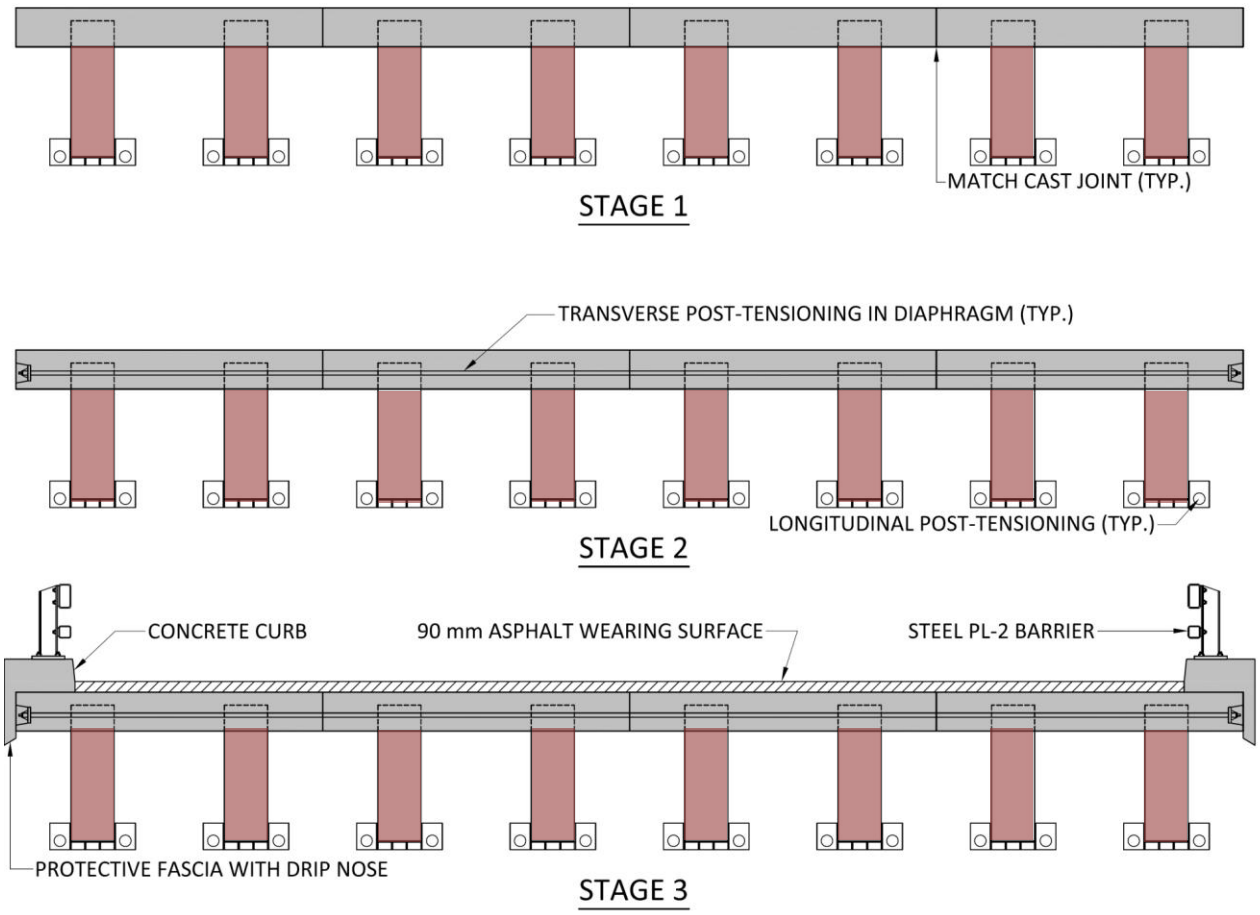


CROSS-SECTION AT DIAPHRAGMS



- Cast monolithically with deck slab
- Improve live load distribution between girders
- House transverse post-tensioning ducts & anchorages

CONSTRUCTION SEQUENCE



Stage 1

- Erect modules

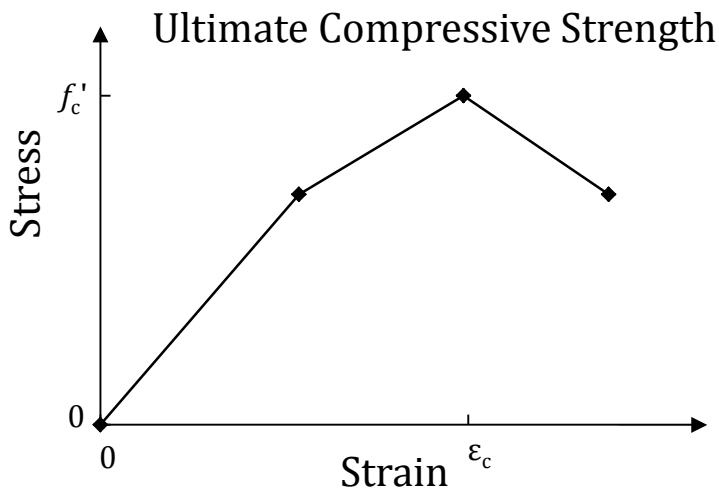
Stage 2

- Stress transverse & longitudinal tendons

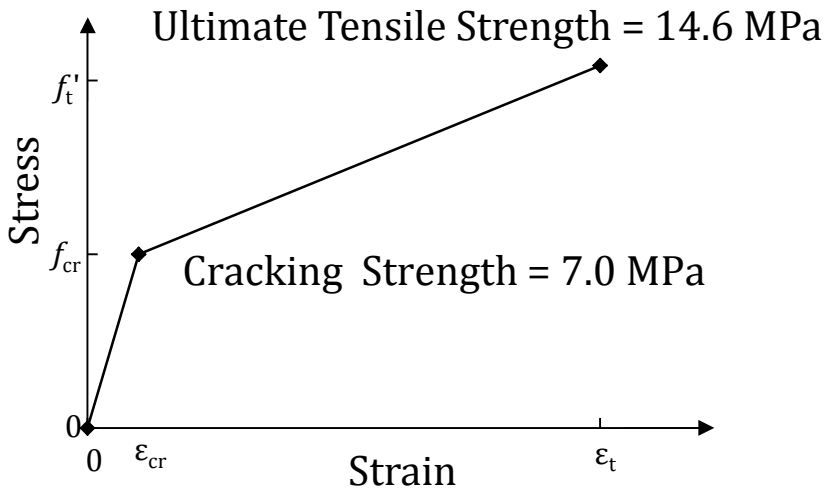
Stage 3

- Construct curbs & barrier
- Pave deck

ULTRA-HIGH PERFORMANCE FIBRE-REINFORCED CONCRETE



Behaviour in Compression

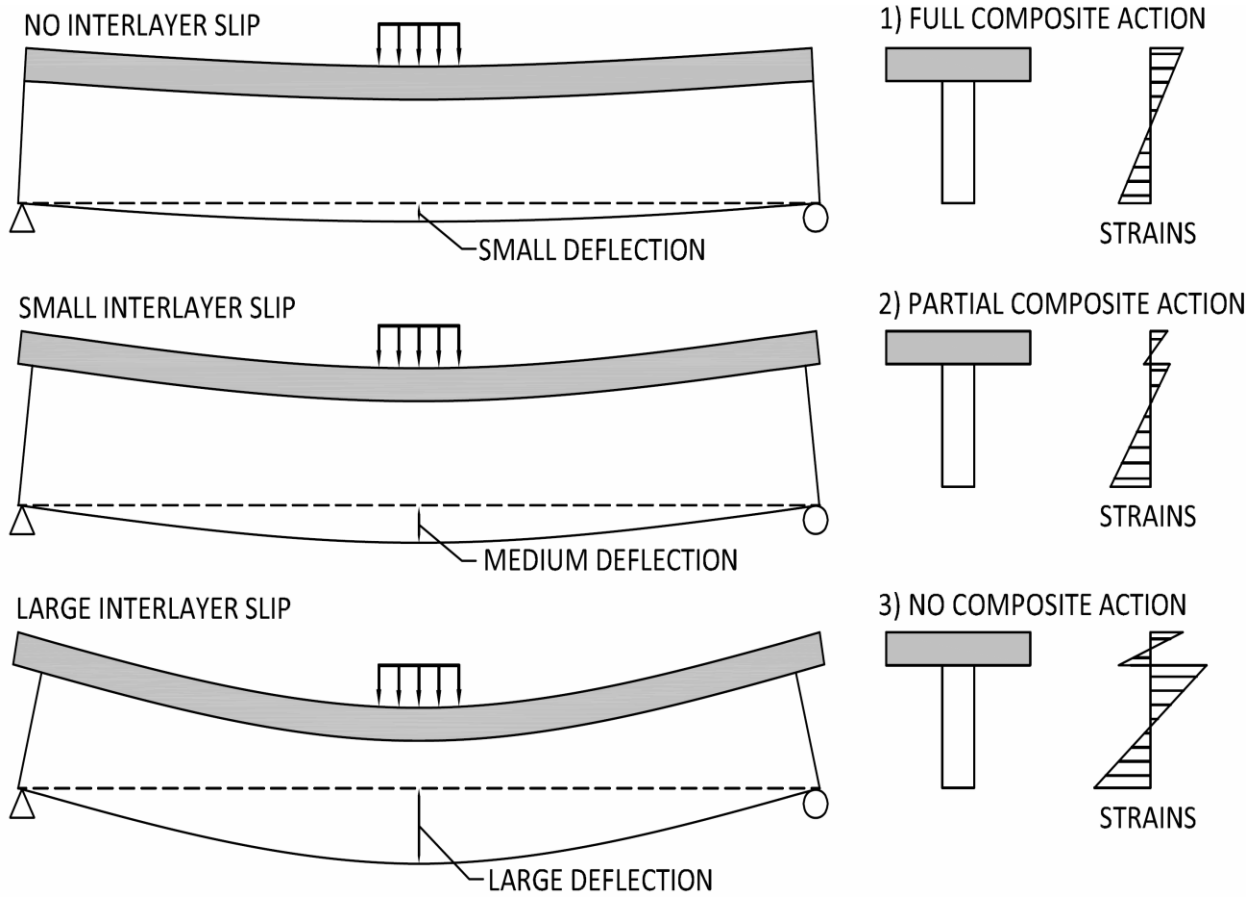


Behaviour in Tension

Benefits:

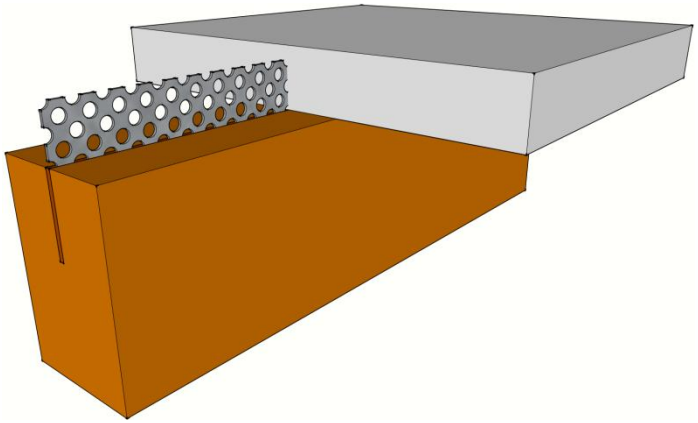
- Allows for slender slab, unlike conventional concrete
- High tensile strength precludes most passive reinforcement
- Very low permeability (enhances durability)
- Excellent freeze-thaw resistance (enhances durability)

COMPOSITE ACTION



- Proposed concept is a partially-composite system

LONGITUDINAL SHEAR CONNECTOR

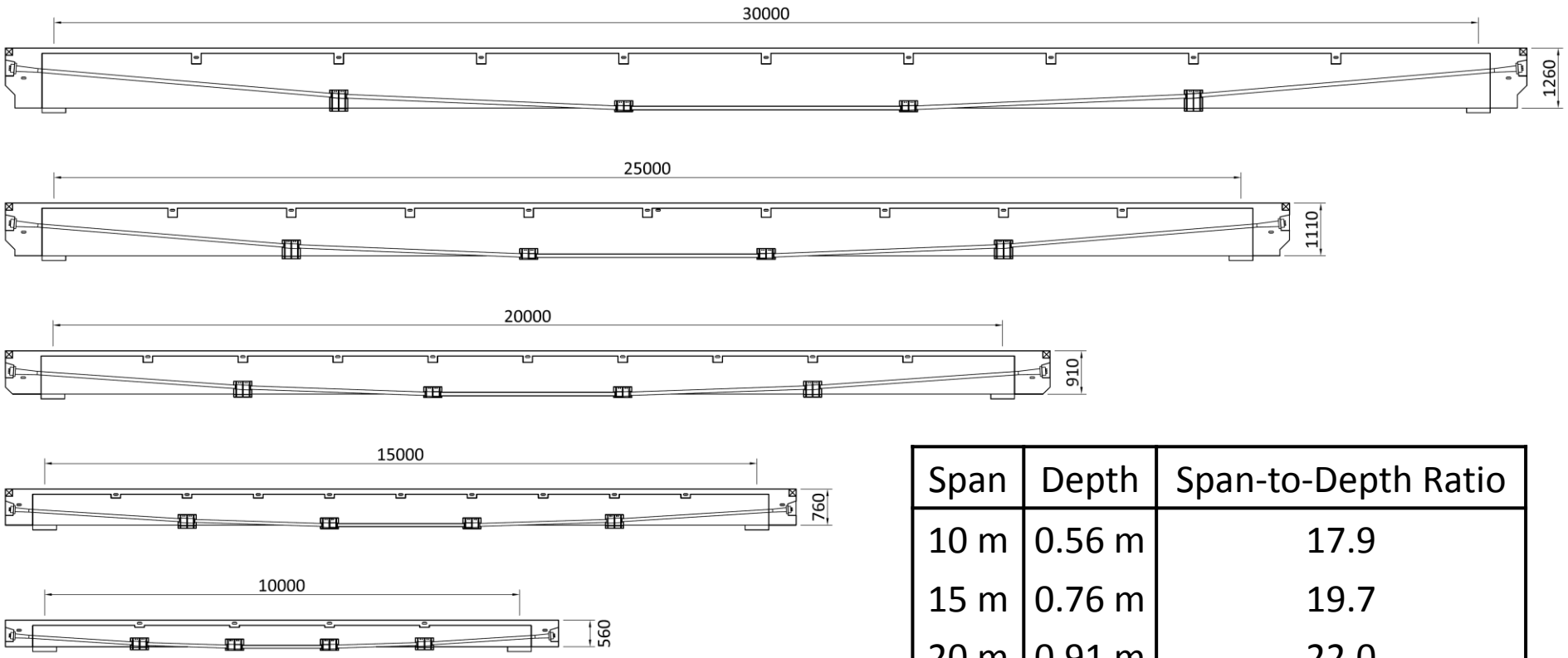


Idealized Connector Behaviour

Span	% Composite Action
10 m	87%
15 m	92%
20 m	95%
25 m	96%
30 m	87%

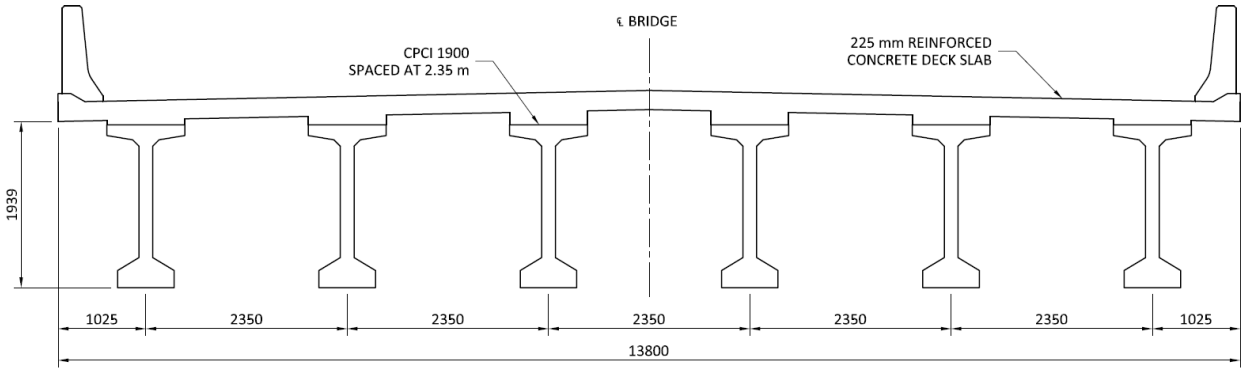
- Idealized behaviour is supported by experimental evidence
- Nearly full composite action is attainable

SUMMARY OF THE PROPOSED CONCEPT



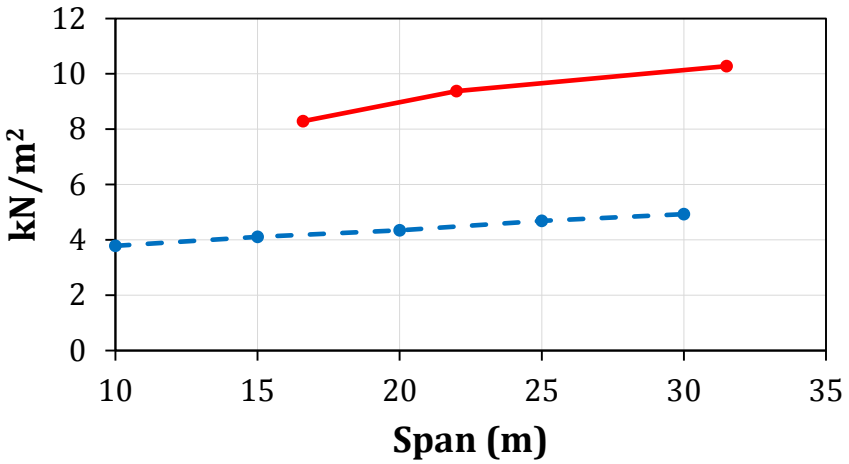
Span	Depth	Span-to-Depth Ratio
10 m	0.56 m	17.9
15 m	0.76 m	19.7
20 m	0.91 m	22.0
25 m	1.11 m	22.5
30 m	1.26 m	23.8

SLAB-ON-CPCI-GIRDER BRIDGES

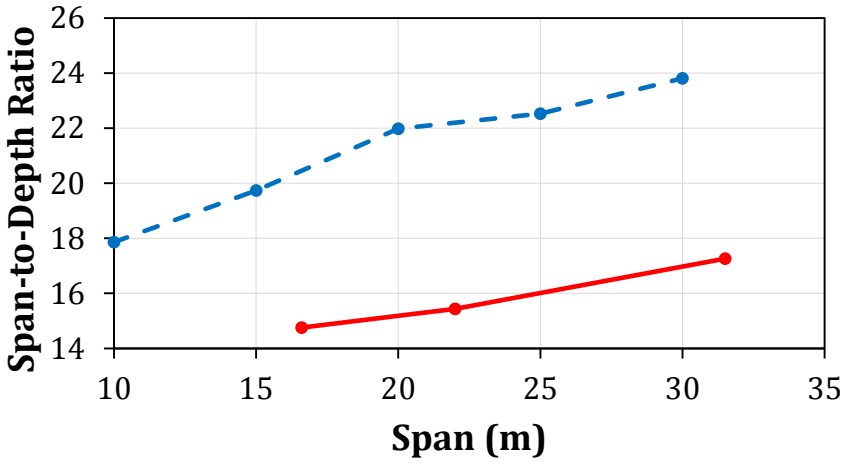


TYPICAL CROSS-SECTION

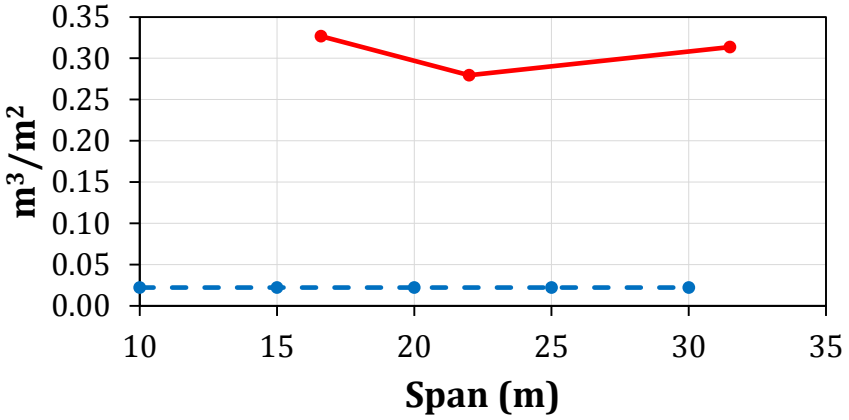
COMPARISON TO SLAB-ON-CPCI-GIRDER BRIDGES



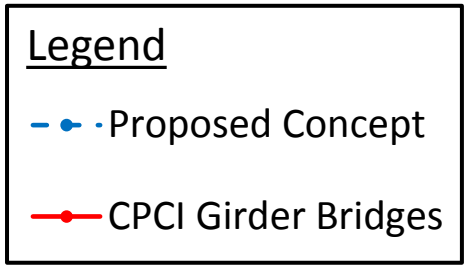
Superstructure Weight



Slenderness



Volume of Cast-in-Place Concrete



CONCLUSIONS RELATIVE TO SLAB-ON-CPCI-GIRDER BRIDGES

1) **The Proposed Concept is half as heavy**
    - Less expensive foundations
    - Less expensive transportation of materials to site
    - Lesser inertial forces during seismic event
2) **The Proposed Concept uses much less cast-in-place concrete**
    - Shorter duration of on-site construction
    - Likely more durable
3) **The Proposed Concept is much more slender**
    - Greater structural efficiency
    - Less approach fill and shallower fill retaining structures