RAPID ORTHOTROPIC DECK REPLACEMENT FOR ALBERTA THREE-SPAN BRIDGE REHABILITATION

M. Spartlin[1], D. Saunders[2], E. Levesque[3], Y. Martin[3], F. Jutras[4]

[1]Alberta Transportation, Edmonton
[2]Alberta Transportation, Peace River
[3]Structal-Bridges, a division of Canam Group, Quebec
[4]Roche ltée, Québec

BACKGROUND

Alberta Transportation has to rehabilitate a 3-span bridge over Redwillow River

Existing Bridge

•Built in 1958
•Three spans: 19.5 m – 24.4 m – 19.5 m
•Carrying Highway 722 in northwestern Alberta
•Type: concrete deck on steel girders

The 3-span bridge over Redwillow River

Rehabilitation needs

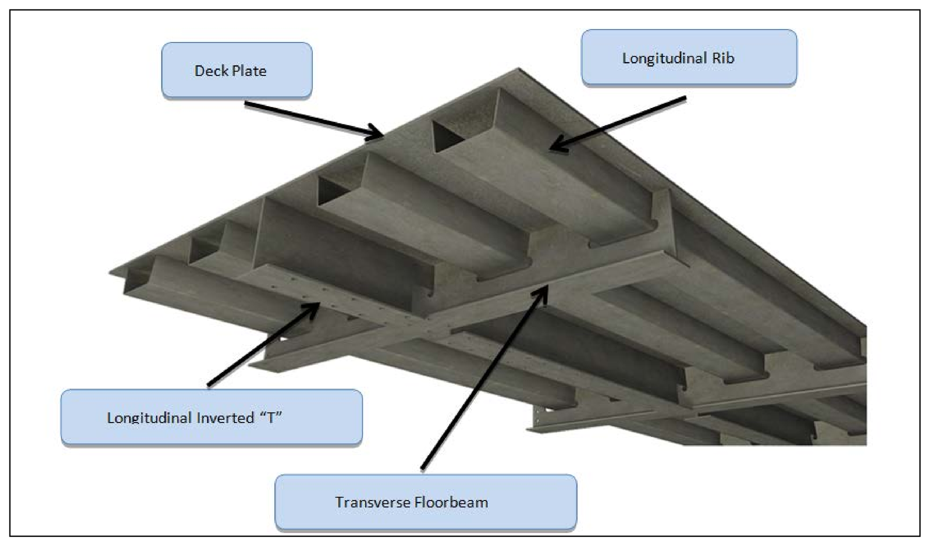
The concrete deck reached the end of its service life and had to be replaced, but budget cons-traints delayed the complete replacement of the structure

Requirements

•Replacement of the concrete deck
•Widening of the roadway from 7.3 m to 8.9 m
•Lightweight solution: existing girders and foundations cannot support the additional load of a thicker, wider deck without strengthening

Solution: Orthotropic steel deck

•Lightweight structure
•High strength to weight ratio of steel
•Efficient use of material in longitudinal and transverse components
•Opportunity for rapid deck replacement with one traffic lane open at all time



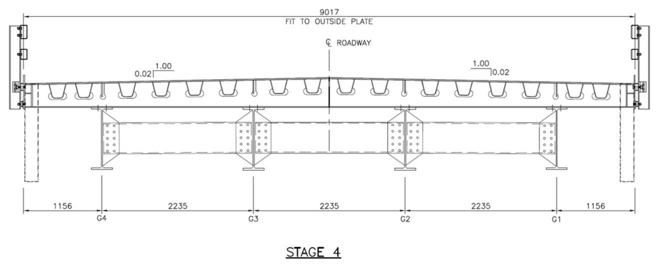
Conceptual orthotropic steel deck with components description

DESIGN

Detailed design of orthotropic steel deck was developed by Roche ltée

Design specifications

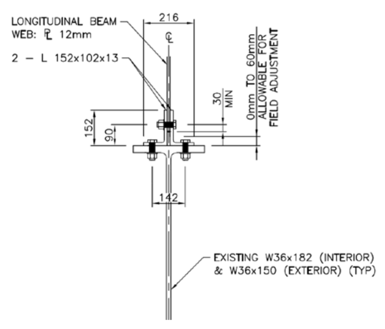
•CSA-S6 Class B roadway
•Design vehicle: CL-800
•Average Annual Daily Traffic: 1080 vehicles
•Average Daily Truck Traffic: 216 trucks
•25 year design life
•PL-2 traffic barriers



Profile of the designed orthotropic steel deck

100% composite action

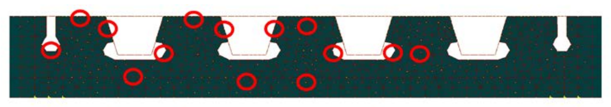
•New orthotropic steel deck is fixed to the existing girders with slip-critical bolted connections to achieve 100% composite action



Bolted connection to main girders

Fatigue resistance analysis

•Finite element analysis was used for assessing the fatigue stress range in weld details of transverse components



Fatigue detail analyzed with finite element model

Weight savings and roadway width

•Orthotropic steel deck has a reduced overall mass and an increased roadway width in comparison with the existing deck and the Alberta Transportation Standard Bridge Deck configurations

OVERALL MASS COMPARISON FOR DIFFERENT DECK SYSTEMS

Existing deck	
Roadway: 7.3 m	
Concrete deck (175 mm)	4.3 kPa
Asphalt (50 mm)	1.2 kPa
Total	5.5 kPa
Overall mass	**283 T**

AT Standard Bridge Deck	
Roadway: 8.4 m	
Concrete deck (225 mm)	5.4 kPa
Asphalt (80 mm)	1.9 kPa
Total	7.3 kPa
Overall mass	**325 T**

Orthotropic Steel Deck	
Roadway: 8.9 m	
Steel deck	2.6 kPa
Bimagrip	0.2 kPa
Total	2.8 kPa
Overall mass	**178 T**

MASS REDUCTION AND ROADWAY WIDTH INCREASE

	Orthotropic steel deck	
	Overall Mass Reduction	Roadway Width Increase
Existing Deck	37%	22%
AT Standard Bridge Deck	45%	7%

FABRICATION

Eight orthotropic panels were fabricated in Structal-Bridges' plant located in Quebec City, QC

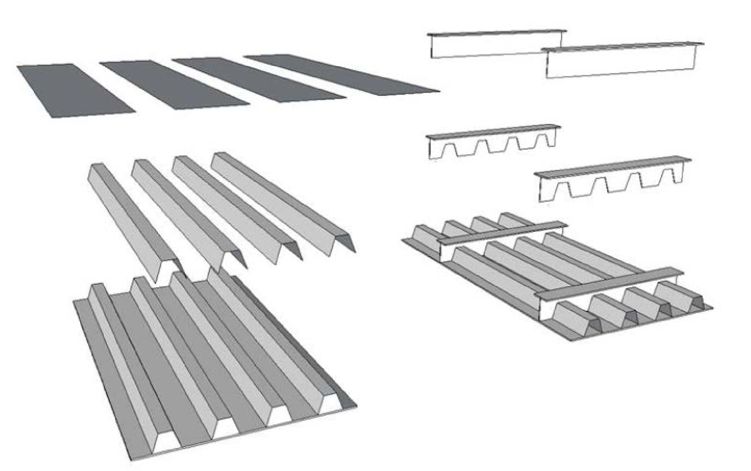
•Cutting of steel plates is made with CNC machines for accurate assembly

•Ribs are cold bent and assembled to the deck plate with 80% partial joint penetration, one side submerged arc welds. For this step, quality control is managed with 100% phased-array ultrasonic testing (PAUT)

•Longitudinal inverted T's and transverse floorbeams are assembled to the deck plate with well-tried welding procedures

•Quality control of all welds is achieved with either ultrasonic testing (UT), magnetic testing (MT) or radiography testing (RT)

•The 16 m long and 4.5 m wide panels are shipped to site by train.

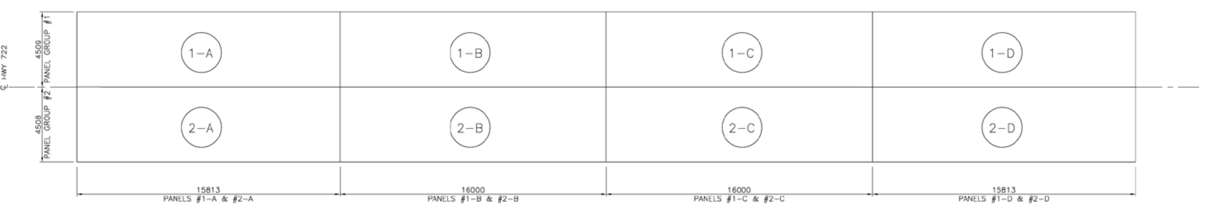


Schematic assembly of orthotropic panel [FHWA 2012]

Rib to deck plate 80% partial joint penetration weld

CONSTRUCTION

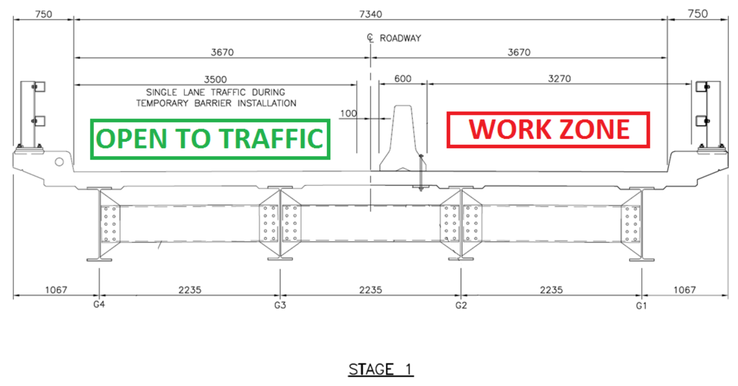
On-site operations are scheduled from June to October 2014



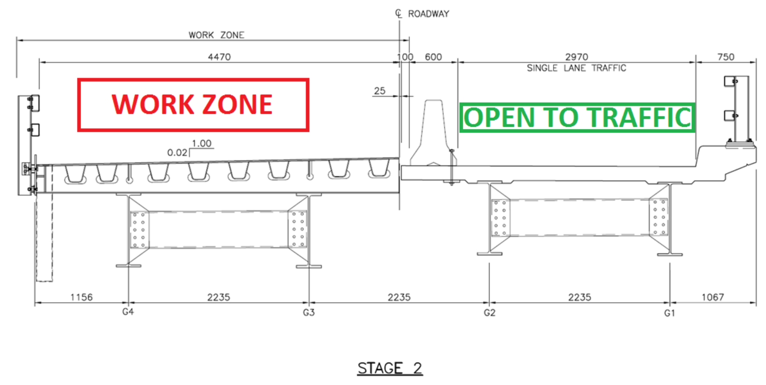
Plan view of the bridge showing orthotropic panel placing sequence

To minimize traffic disruption, construction sequences have been staged so that the bridge remains open to a single lane of traffic at all times:

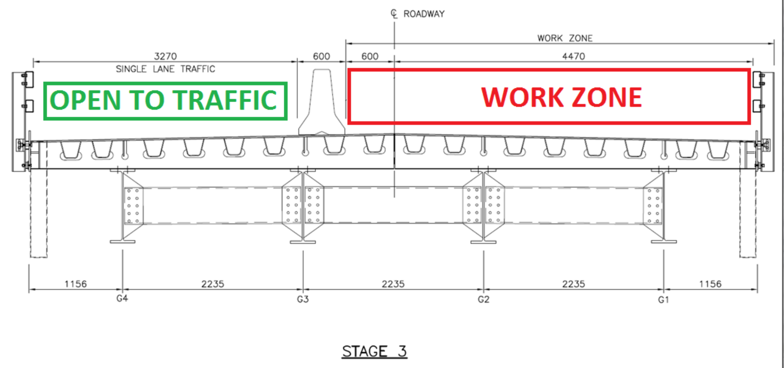
Stage 1: Installation of temporary precast F shape barriers.



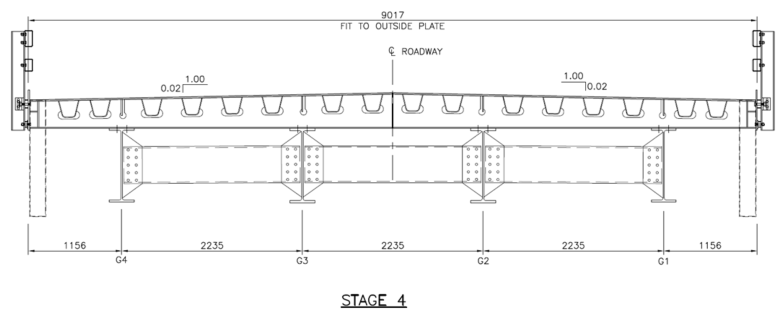
Stage 2: Removal of east half of existing deck and installation of orthotropic panels 1-A through 1-D



Stage 3: Removal of west half of existing deck and installation of orthotropic panels 2-A through 2-D. Assembly of the longitudinal splice



Stage 4: Removal of temporary precast F shape barrier. Opening of the bridge to 2 lanes of traffic



On-site work also includes: replacement of the bearings, repair and widening of the abutments, and reconstruction of the approaches

REFERENCES

•CSA. (2006). *Canadian Highway Bridge Design Code.* Mississauga: Canadian Standard Association.

• Federal Highway Administration. 2012. *Manual for Design, Construction and Maintenance of Orthotropic Steel Deck Bridges.* FHWA, Washington, DC, USA.