Hybrid Spliced Girder Concept to Solve Bridge Constructability Challenges

Sami Megally, Ph.D., P.E., S.E.
Kleinfelder, San Diego, CA

Western Bridge Engineers Seminar
Reno, Nevada
September 2015
Conventional CIP PT Box Girders

- Cost effective
- Seismic performance
- Aesthetics

- Relatively long construction time
- Reduced temporary clearance
Project Challenges

- Insufficient vertical clearance for formwork
- Insufficient permanent vertical clearance
- Congested traffic
- Accelerated construction schedule
- Other requirements (aesthetics, geometric, etc.)
Superstructure Alternatives

- Cast-High and Lower
- Precast girders:
  - Precast girders (full span)
  - Spliced Precast girders
  - Hybrid of Precast girders spliced with CIP girders

Hybrid Precast/CIP used in two projects:

- SR-22/I-5 Separation Widening (Orange, CA)
- I-15/Felicita Road UC Widening (San Diego, CA)
SR-22 HOV Widen D/B

- $550 million project
- 12-mile freeway widening
- 34 bridges widened or replaced
- 800 day schedule
- 1st design/build in Caltrans R/W
SR-22/I-5 Widening

I-5

SR-22

SR-22 Widening
SR-22/I-5 Widening

Project Constraints:

- Traffic congestion
- Vertical clearance above I-5 NB
- Accelerated construction (D/B)
- Cost constraints (D/B)
- Aesthetics
SR-22/I-5 Widening

- Spliced bathtub girders
- Multi-stage post-tensioning
SR-22/I-5 Widening

- Re-design using hybrid precast/CIP spliced bathtub girders
- Precast bathtub girders over I-5 NB
- CIP elsewhere
- Multi-stage post-tensioning
SR-22/I-5 Widening

- Max Girder Length: 103 ft
- Max Girder Weight: 240 kip
- Girder depth: 6.2 ft
- Girder width (soffit): 6.0 ft
- Minimum curvature: 1,640 ft

First curved spliced bathtub girder project in California
SR-22/I-5 Widening

Construction Stages

[Diagram showing construction stages of SR-22/I-5 Widening]
SR-22/I-5 Widening

Construction Stages
SR-22/I-5 Widening
SR-22/I-5 Widening
SR-22/I-5 Widening
SR-22/I-5 Widening
SR-22 HOV Widen D/B
SR-22 HOV Widen D/B
I-15/Felicitia Road UC

- Insufficient temporary formwork for CIP alternative
- Insufficient permanent vertical clearance
- Minimum traffic closures

Alternative Solutions:
- CIP PT Box Girder  ➔  lower existing roadway
- Precast/CIP Hybrid with variable depth
I-15/Felicitia Road UC

- Precast girders depth is 2'-3 3/4”
- Superstructure depth is 3'-0 1/2”
- Depth-to-Span Ratio (D/S) = 0.028
- Recommended D/S = 0.040
I-15/Felicitia Road UC

Construction Stages
I-15/Felicitia Road UC

Construction Stages
Design Considerations

- Precast girders could be pre-tensioned or post-tensioned
- Multi-stage post-tensioning
- Stage construction analysis
- Tensile stresses at the CIP/Precast interface
Conclusions

• Hybrid precast/CIP spliced girder concept can be used to solve bridge constructability challenges including:
  – Geometric constraints
  – Traffic congestion
  – Aesthetics

• Lowering grade to meet required vertical clearance can be avoided

• Concept used successfully in Design-Build project with accelerated construction schedule
Thank you

Questions?