

Detailing of ABC Bridges for Simplicity and Durability

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DETAILS

- This presentation contains many preferred details
- My favorite details will be denoted with a gold star
- Other good details and systems do exist
 - Limited by the timeframe for the webinar
 - The goal is get people thinking about simplicity of detailing and durability
- Each agency has different needs and preferences

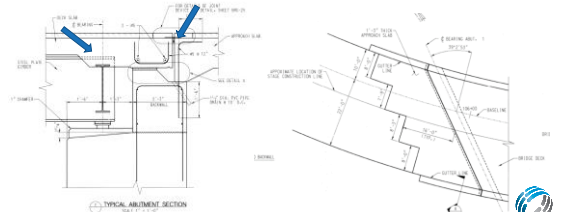


WHY SIMPLIFY DETAILS?

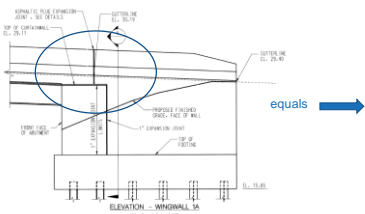
- Reduced risk during construction
 - Less chance of things not fitting
 - Faster construction
 - Less risk = Less cost
- Improved durability
- Emulation of CIP is good, but strict conversion to precast can be problematic
- Elimination of deck expansion joints should be a priority.



CIP DETAIL EXAMPLES



CIP DETAIL EXAMPLES



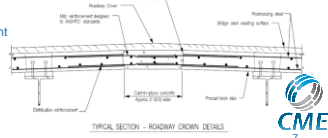
DETAILING FOR SIMPLICITY

- Investigate ways to simplify details without sacrificing durability
 - Avoid complex 3D shapes
 - Avoid sloped surfaces if possible: Level is ok
 - Account for tolerances
 - If expansion joints are used, place them where they will not lead to problems
 - If joints are required in sensitive areas, choose details that are proven to be durable



DECK DETAILS

- Roadway crowns:
 - Casting a crown in a precast deck panel is possible, but the complexity of the fabrication and erection of the element is increased.
 - Better to detail a longitudinal closure pour at the crown.
 - Easier element to fabricate
 - Allows for horizontal adjustment
 - Allows for cross slope adjustment



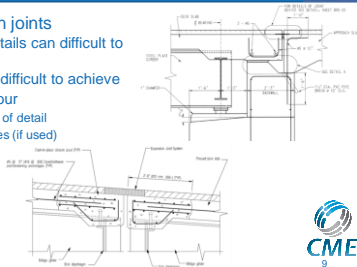
DECK DETAILS

- Parapets precast integral with deck
 - Tolerances can be problematic
 - Option 1: Specify line casting or match casting.
 - Option 2: Place temporary barrier in shoulder and cast the parapet after opening the bridge
 - Option 3: Use longitudinal closure pour for horizontal adjustment
 - Option 4: Slip forming



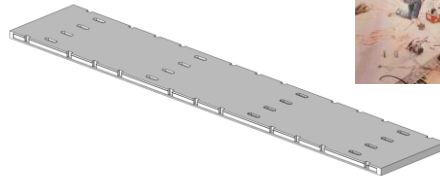
DECK DETAILS

- Deck ends at expansion joints
 - Complexity of typical details can difficult to prefabricate
 - Joint tolerances can be difficult to achieve
 - Consider CIP closure pour
 - Accommodates complexity of detail
 - Protection of PT anchorages (if used)



DURABLE DECK DETAILS

- Decks with longitudinal post-tensioning have proven to be very durable



LONG TERM PERFORMANCE EXAMPLE

I-84/Route 8 Interchange –Waterbury, CT



PROJECT EXAMPLE

- Curved structure (straight beams)
- 6 Span bridge with continuous spans
- Single lane
- Pretensioned transversely and post tensioned longitudinally
- 42 Day construction
 - No construction problems
- Built in 1990



AFTER 24 YEARS IN SERVICE

- Excellent condition
- Used membrane waterproofing and Asphalt Wearing surface
- No leakage through joints



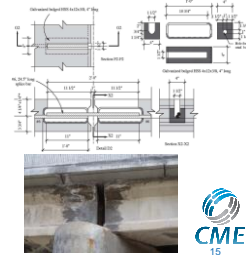
AFTER 24 YEARS IN SERVICE

- No leaks
- No cracks
- No problems



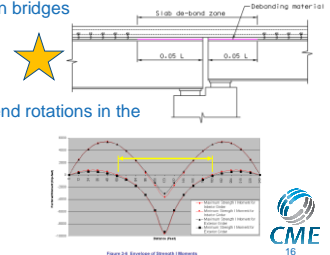
DURABLE DECK DETAILS

- Non-post tensioned decks
- There are new details that are in use that do provide durable structure
 - Reinforcing bars placed in slotted inserts (NCHRP 12-65)
 - Reinforced concrete closure pours
 - Grout or concrete
 - Ultra High Performance concrete
- Care should be taken on continuous structures
 - Live load deck tension can lead to leaks



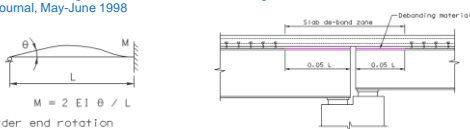
LINK SLABS

- Another option for multi-span bridges
- Jointless, not continuous
 - Less complicated
 - Less Expensive
 - Great for prefabricated beam elements
- Used to accommodate the end rotations in the beams



LINK SLAB DESIGN

- Theory
 - Based on research
 - "Behavior and Design of Link Slabs for Jointless Bridge Decks", PCI Journal, May-June 1998



$M = 2 E I \theta / L$
 θ = Girder end rotation
 L = debond length
 E = modulus of elasticity of link slab
 I = Gross moment of inertia of slab

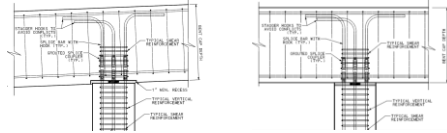


COMPLETED LINK-SLAB BRIDGE



PIER CAPS

- Emulation works well for most pier elements
- Details can be simplified
 - Level caps
 - Beam seats as secondary pours
 - Detail skewed ends as square



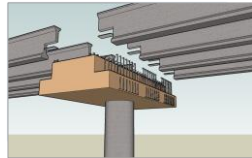
PIER CAPS

- Consider congestion of cap reinforcement when choosing connection type
 - Grouted PT Ducts are an excellent connection, but can be problematic with congested caps
 - Designers should layout reinforcing and connectors during design development



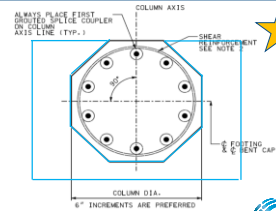
INTEGRAL PIER CAPS

- Virtually impossible to emulate in precast
 - Too many elements to connect
 - Too many tolerances to account for
- Closure pours will be required
 - Slow process to form and pour
- Consider non-integral bent caps if feasible
 - Faster construction
 - Less chance for fit-up problems



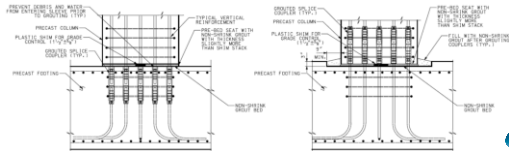
COLUMN DETAILING

- Use faceted columns versus round
 - Round Columns need to be cast vertically
 - Faceted columns can be cast flat
 - Form all but one side
 - Allows for line casting of multiple columns in one form



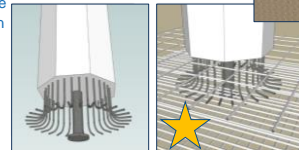
COLUMN AND WALL BASE JOINTS

- Base joint
 - Flush joints have proven to be durable
 - If this is of concern, consider setting joint into grout pocket
 - Be careful with grout ports for grouted sleeves
 - Makes footing thicker



ANOTHER OPTION

- Consider Precast column or wall with CIP Footing
 - WSDOT Detail
 - Use projecting reinforcing from column
 - Temporary strut used to support column
 - Simple, easy durable
 - Still fast construction



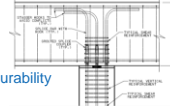
ANOTHER OPTION

- Consider Precast column with CIP Footing
 - WSDOT Detail – FHWA Highways for LIFE Research
 - No reinforcing passing through column
 - Tested for seismic: Develops full moment capacity
 - Simple, easy, durable
 - Still fast construction



COLUMN DURABILITY

- Grouted sleeves
 - Proven to be very durable
- Grouted PT Ducts
 - Should be result in similar durability
- Joints
 - No different than construction joints
 - Long term maintenance = Repointing



Fort Meyers Bridge
20 years in service



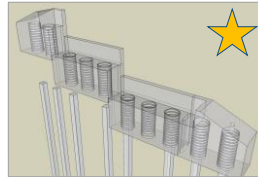
INTEGRAL ABUTMENTS

- Jointless = Durable
- Good for seismic
- Keep details simple
 - Consider backwall integral with stem
- CMP Voids are recommended
 - Easy and cost effective
 - Fast
 - Strong and durable



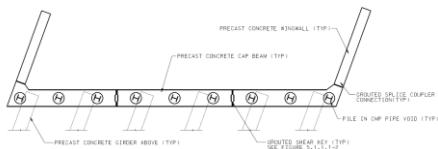
INTEGRAL ABUTMENTS

- Corrugated Void Pocket details and joints



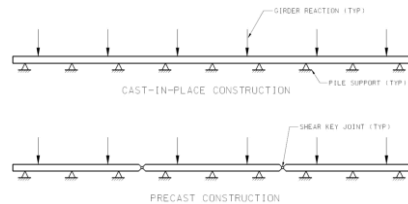
STEM JOINTS

- Transverse PT has been used
- Shear keys have proven effective also
- Faster and easier



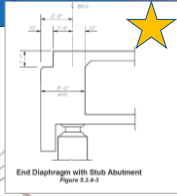
STEM JOINTS

- Free Body Diagram



SEMI-INTEGRAL ABUTMENTS

- No moment connection
- Fast, Cost effective & Durable
- Excellent option for:
 - Prefabricated deck beam units
 - SPMT bridge moves
 - Slide in Bridge Construction



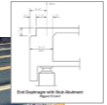
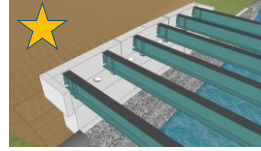
WSDOT CIP Detail



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SEMI-INTEGRAL ABUTMENTS

Precast Backwall bolted to beam end



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CANTILEVER ABUTMENTS AND WALLS

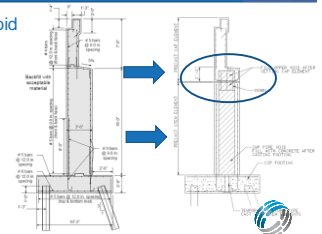
- Consider use of CMP Pipe void to connect stem to footing
- Use for lower moment demand connections
- Easy, Fast & Cost effective



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CANTILEVER ABUTMENTS

- Consider cap piece with CMP Void Connection
 - Complex details left to one piece
 - Simplifies wall panels
 - Low moment demand connection
 - Easy construction



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CANTILEVER ABUTMENTS

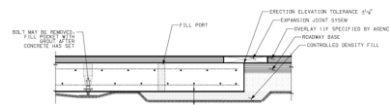
- Maine DOT Bridge



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PRECAST APPROACH SLABS

- Slabs DO NOT need to be fully supported
 - Only at ends
- Use flowable fill to set slab on grade
 - Faster and less expensive
 - Consider non-shrink grout only when time is critical



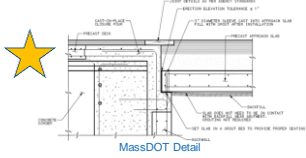
© TYPICAL SECTION, APPROACH SLAB END WITHOUT SLEEPER SLABS



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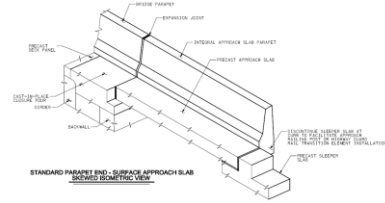
PRECAST APPROACH SLABS

- Consider buried approach slab
- Massachusetts Detail
- Effective at preventing settlement bump
- Eliminates need for tight tolerances on top of slab elevations
- May be a problem with utilities



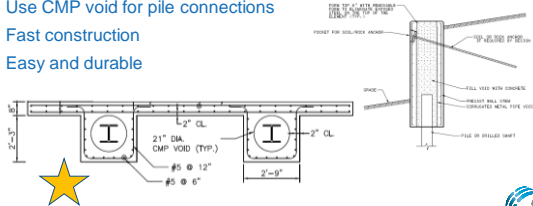
PRECAST APPROACH SLABS

- Consider integral barriers
- Utah Detail



SOLDIER PILE WALLS

- Use CMP void for pile connections
- Fast construction
- Easy and durable



PREFAB DECK BEAMS

- Precast deck on steel beams
- Any type of beam will work
 - Two I beams
 - One box beam
 - Folded plate beam
- Eliminates the complex forming of decks
- Easy to form closure pours
- Use link slabs for multi-spans
- Fast construction

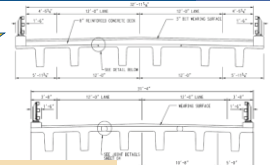


PREFAB DECK BEAMS



NEXT BEAMS OR DOUBLE TEES

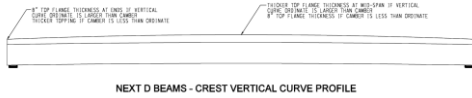
- NEXT F: Form
- NEXT D: Deck
- Cost effective
- Relatively fast construction
- Limited deck forming and stripping
- No cross frames



Additional Details available at www.pcaine.org



VERTICAL CURVES WITH PRECAST DECKED SECTIONS



NEXT D BEAMS - CREST VERTICAL CURVE PROFILE

Additional Details available at www.pcine.org



CONCLUSIONS

- It is possible to emulate CIP construction with prefabricated elements
- Emulating CIP details can be problematic
- Minor changes to bridge detailing can:
 - Improve fit-up and constructability → Saves time
 - Reduce risk and costs → Less risk = Less cost
 - Improve durability



QUESTIONS

