Rapid Construction: Considerations and Case Studies

Ohio Transportation Engineering Conference
2018
Dave Newcomb, TTI
Introduction

• Accelerated construction means “. . .minimizing time impacts to the public. . .” (Blanchard, 2009)
• Currently takes 10 to 15 years to get project from planning through construction.
• Needs an integrated approach:
  – Planning
  – Design
    • Structures
    • Roadways
  – Traffic Control
  – Safety
  – Construction
  – Administration
Introduction

• Blanchard et al. (2009) –
  – Project delivery:
    • Right attitudes
    • Right personalities
  – Both contractor and agency:
    • Push decision-making to lowest level
    • Must remain customer focused
  – Must be open to new approaches
Figure A. Project Costs by Type, Related to Duration
(a) Year 2011. (b) Year 2040.
Contracting Methods

• Contractor: Time is money. Innovation for:
  – Materials delivery
  – Construction methods
  – Work zone configurations

• Agency and Contractor: Quality is needed the first time around!
Contracting Methods

• Design-Build
  – Joint Venture – designer/contractor
  – Cost/Technical Evaluation
  – State Specs/Standards Apply
  – Warranty – increases risk

• Incentives/Disincentives
  – Bonus for early completion and penalty for late
  – Contractor may or may not have traffic control latitude
  – Design and specs are fixed
  – Constructability review prior to work is critical
  – Money depends on traffic safety, flow, and RUC
Contracting Methods

• Cost + Time (A+B)
  – A = Cost of construction
  – B = Cost for time of completion (RUC X No. Days)
  – Contractor paid on basis of “A”
  – Award made on basis of “A+B”
  – Incentive/Disincentive may be applied to speed construction
Construction Productivity

• Rehabilitation (Jackson et al., 2012; Lee et al., 2007)
  – Use as much existing in-place material as possible
    • Rubbllization
    • Mill & Overlay
  – Demolition is slowest process in construction

• Construction rate factors
  – Mob/Demob
  – Traffic/Construction Separation
  – Rural/Urban
  – Terrain
  – Existing Geometrics
  – Traffic Volume
  – Peak Hour
Traffic Evaluation

• Advantages of long lane closures (FHWA, 2003) - Full lane closures, weekend, week-long
  – Faster project delivery
  – Reduced motorist inconvenience
  – Larger work area/more productivity
  – Reduced congestion
  – Reduced hazard exposure for workers/motorists
  – Reduced traffic accidents
  – Smoother pavement
  – Better public image
Costs

• Road User Costs
  – Delay:

  \[
  \text{Delay/mile} = \frac{(TT_a - TT_{ff}) \times V \times VO}{L_wz \times 60}
  \]

  (Equation 1)

  Where: 
  \( TT_a \) = Actual Travel Time through the Work Zone, minutes
  \( TT_{ff} \) = Free Flow Travel Time through the Work Zone, minutes
  \( V \) = Vehicle Volume, number of vehicles
  \( VO \) = Vehicle Occupancy, persons/vehicle
  \( L_wz \) = Length of Work Zone, miles

  – Costs calculated according to time cost associated with delay of certain class of vehicles: passenger, single-unit truck, combination truck
  – Should calculate range of RUC
Costs

• RUC used by NJ and TX in relation to construction costs
  – Minimize inconvenience
  – Basis of incentives/disincentives

• Life Cycle Costs
  – NPV of initial costs and subsequent maintenance and rehabilitation
  – RUC of future activities is a VERY uncertain quantity
AR and LA Rubblization Projects

• 300 Miles of Interstate Concrete Pavement (Decker and Hansen, 2005)
  – Rehabilitation needed
  – Slowest construction operation – demolition and removal
  – Rubblization kept in-place PCC to serve as high-quality base
  – Rate of production for rubblization = 1 lane-mile/day (twice the rate for PCC removal (Mn/DOT, 2005)

• Louisiana (Landers, 2011)
  – Used for I-55 (hurricane evac route)
  – Completed in seven months as opposed to 2-3 years for reconstruction
CA Crack & Seat – I-710 – 2003

- Long Beach Freeway – 2.7 miles (Caltrans, 2004)
  - BSOL in non-bridge areas
  - Remove/replace under bridges
CA Crack & Seat – I-710 – 2003

• Work done in 8 weekend full shut-downs (55-hour windows)
• Contractor placed ~ 15,000 tons of asphalt mix
• Strict performance-based quality control/assurance (Santucci, 2011)
• Pavement performance has been better than predicted (Monismith, 2009)
CA Crack & Seat – I-710 – 2003

• Life-Cycle Cost Analysis (Lee et al., 2011)

- Consisted of 33 lane-miles of asphalt paving
- AADT = 180,000 vpd (7% Commercial)
- Project dates: Aug 2 – 12
- In one 100-hour window
  - 5.5 miles of 6-lane road paved
  - 40,000 tons of asphalt mix
- Total duration of project was reduced 85%
- If night closures had been used, would have required 32 nights
- Project savings only about 2 percent
- ODOT reported improved safety for public and workers

- Project
  - Remove/replace concrete pavement
  - A+B contract with incentives
  - Included 7.6 lane-miles and five bridges needing upgrades
  - $12.5 million
  - AADT = 98,000 vpd (1% Commercial)
  - LCCA: Remove/replace with asphalt
  - Full closure reduced project duration by 71 percent
  - 6-month project reduced to less than 2 months
  - Traffic control costs reduced by more than 85%
Wilmington, DE - I-95, 2000 (FHWA, 2003)

- $23.5 million and 2 years
- 6.1 miles long (24.4 lane-miles), 10 interchanges, bridge repairs, drainage improvements, lighting/safety
- AADT = 100,000 vpd (11% Commercial)
- Full road closure feasible (reroute to I-495)
- Rubblilzation with asphalt overlay used in non-bridge areas – avoid demolition
- SB and NB I-95 closed for 3 months each
- $25,000/day bonus for early completion and penalty for delay
- 75% reduction in duration (185 days)
- Because of detour, overall project costs were increased
Maine – I-295, 2008 (Lane, 2009)

- 1970’s JRCP in S. Maine had ASR
- Important tourist route
- AADT = 13,500 vpd
- Remove top 3” JRCP and rubblize the rest
- Full road closure from mid June to end of Aug
- Conventional lane closures would have lasted over 3 construction seasons
- Traffic detoured onto local roads – required some improvements
- Incentive/disincentive of up to $2 million for early/late finishing
- Work completed 20 days ahead of schedule
- Contractor used up to 5 paving crews at once on project
- Bonus also awarded for quality and smoothness
Case Study

Rieth-Rilely – Michigan – U.S. 31

• Good example for innovative traffic control and accessability.

• Features
  – 4-lane divided, 3.27 miles long
  – 20,000 ADT, 7.4 MESAL
  – 9” CRCP over 22” granular matl over clay
  – 25 years old, poor condition
  – Alternate bid

• Construction in 2009
Existing & Proposed X-Sections

- **9” CRCP**
  - 4” Aggregate Base
  - 18” Sandy Subbase
  - Clayey Subgrade

- **3.8” Asphalt Base**
  - 2.5” Intermediate
  - 1.5” Surface
  - 6” Recycled Concrete Aggregate Base
  - 18” Sandy Subbase
  - Clayey Subgrade

- **9.5” JPCP**
  - 6” Recycled Concrete Aggregate Base
  - Fabric
  - 10” Sandy Subbase
  - Clayey Subgrade
## Daily User Delay Costs

<table>
<thead>
<tr>
<th>Lane Closure Segment</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>US-31 Single Lane</td>
<td>$6,441.49</td>
</tr>
<tr>
<td>Ramp B (NB Off-Ramp)</td>
<td>$6,843.41</td>
</tr>
<tr>
<td>Ramp C (SB On-Ramp)</td>
<td>$4,486.52</td>
</tr>
<tr>
<td>Ramp F (SB On-Ramp)</td>
<td>$2,885.95</td>
</tr>
<tr>
<td>Ramp E (NB On-Ramp)</td>
<td>$527.96</td>
</tr>
</tbody>
</table>
## Bids

<table>
<thead>
<tr>
<th>Option</th>
<th>Construction</th>
<th>Time</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineer’s Est.</td>
<td>11,625,739</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Asphalt</td>
<td>10,769,004</td>
<td>1,330,466</td>
<td>12,099,470</td>
</tr>
<tr>
<td>Concrete</td>
<td>9,612,573</td>
<td>3,010,646</td>
<td>12,623,219</td>
</tr>
</tbody>
</table>
Demolition
Rieth-Riley Solution to User Delay

State Plans: One lane in each direction during construction.

Added safety for crews.
2015 Performance – 6 Years
Case Study

Barriere – Louisiana – Interchange in Swamp

- Traffic management – safety and speed

- Features
  - Interchange of 3 Interstates
  - All of them hurricane evacuation routes
  - Northeast of New Orleans
  - Boundaries: Lake Pontchartrain & Pearl River
  - Alternate Bids
  - Contains “Fast” Sections – Big Penalties ($15,000/hr)
  - Rest of the roadway - $15,000/day

- Construction is ongoing
Alternatives

Asphalt Option

2 in. Surface

0.75 in. OGFC

10 in. Binder

Existing Subbase

5 in. Base*

Concrete Option

10 in. PCC

Existing Subbase

*Base may be either unstabilized granular, cement stabilized, or asphalt stabilized
# Bids

<table>
<thead>
<tr>
<th>Rank</th>
<th>Construction Bid, $</th>
<th>Proposed Time, days</th>
<th>Time Cost, $</th>
<th>Total Bid, $</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (asphalt)</td>
<td>39,888,687</td>
<td>360</td>
<td>5,400,000</td>
<td>45,288,687</td>
</tr>
<tr>
<td>2 (concrete)</td>
<td>37,473,810</td>
<td>675</td>
<td>10,125,000</td>
<td>47,598,810</td>
</tr>
<tr>
<td>3 (concrete)</td>
<td>47,524,942</td>
<td>699</td>
<td>10,485,000</td>
<td>58,009,942</td>
</tr>
<tr>
<td>4 (concrete)</td>
<td>53,532,280</td>
<td>640</td>
<td>9,600,000</td>
<td>63,132,280</td>
</tr>
<tr>
<td>5 (concrete)</td>
<td>59,918,761</td>
<td>700</td>
<td>10,500,000</td>
<td>70,418,761</td>
</tr>
</tbody>
</table>
Barriere’s Advantages

• Plants on either side of project – speed delivery.
• “Fast” sections
  – Use 54 – 60 hour work windows on weekends
  – Complete all Fast sections in 8 weekends
  – Placed asphalt widening on shoulder to help handle traffic
    – contractor’s expense
• Rest of project done behind barriers.
• Publicity of work days very important.
Life Will Not Get Easier/Less Complicated

(a) Year 2011. (b) Year 2040.
Obstacles to Overcome

• Higher user (Political) expectations
• Static or lower agency operating budgets
• Loss of experience/expertise in agencies
• Uncertain funding outlook
• Accelerated rate of deterioration
• Lower levels of college training in pavements
We Need To Seriously Address Speed of Construction Through Research & Development

- Improved productivity
  - Equipment
  - Personnel
  - Methods

- Improved material production
  - Quantity
  - Quality

- Improved integration of functions – applies to agencies and researchers
  - Traffic
  - Construction
  - Materials
  - Safety
  - Etc., etc.