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Rapid Construction:
Considerations and Case Studies

Rocky Mountain Asphalt Conference
February 26, 2016

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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

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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

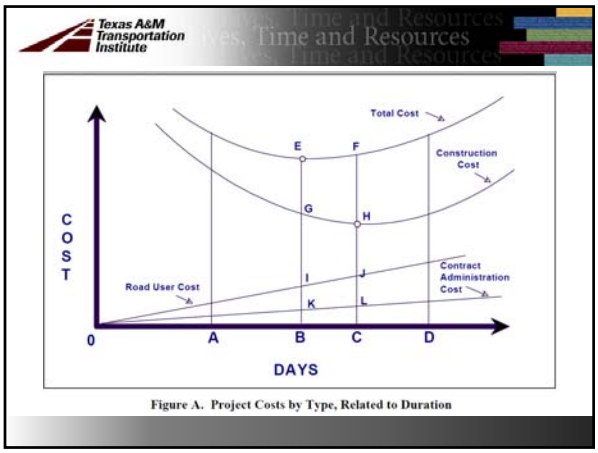
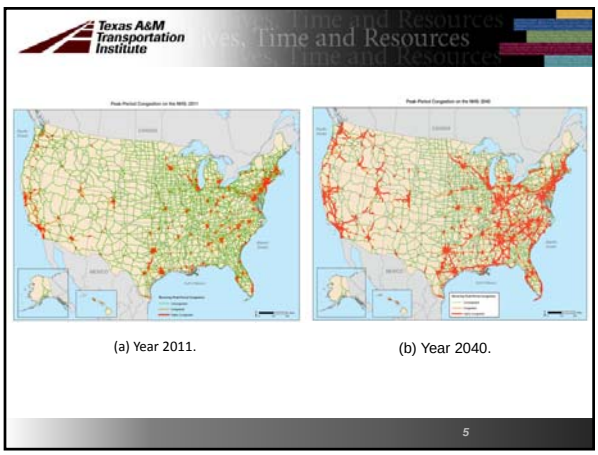
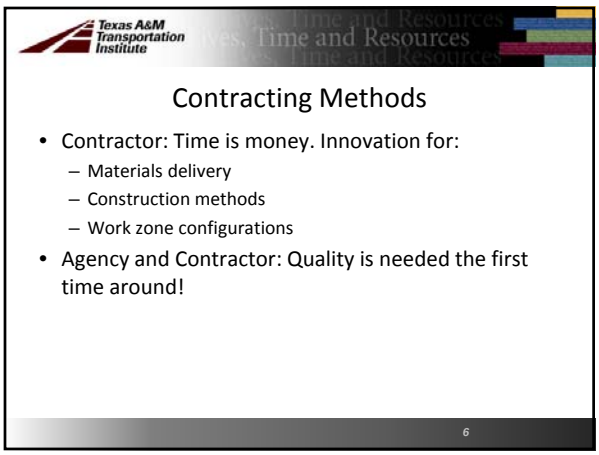


Figure A. Project Costs by Type, Related to Duration



(a) Year 2011.

(b) Year 2040.



Contracting Methods

- Types of Contracts (Anderson & Damnjanovic, 2008)
  - Design-Build
  - Incentives/Disincentives
  - Cost + Time (A+B)
  - Interim Completion Dates
  - No-Excuses Incentives
- Design-Build
  - Joint Venture – designer/contractor
  - Cost/Technical Evaluation
  - State Specs/Standards Apply
  - Warranty – increases risk

- Reduce Duration $\geq$ 10%
- Actual Cost ~ 5% of Planned
- Project Quality Same as Normal Methods

Contracting Methods

- 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
- 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"

Project Evaluation

- Risk Based (Golder Assoc. et al., 2011; Blanchard et al., 2009)
  - Project diagnosis (issues, impacts, likelihood)
  - Risk register – track possible issues, reassess threats
  - Contingency and implementation plans
  - Good for high-profile projects
- Performance Specifications (Scott et al., 2014)
  - Benefits:
    - Contractor innovation
    - Reduced inspection cost
    - Improved quality
  - Very dependent upon project parameters

Construction Productivity

- Allow contractor creativity
  - Take advice from constructability review
- Materials
  - Production issues
  - Movement in/out of project limits
- Repetition of tasks increases productivity
- Consider additional lanes to allow material removal/delivery – Allows concurrent activities
- Minimize mobilization/demob
- Evaluate variety of traffic control scenarios

Construction Productivity

- Rehabilitation (Jackson et al., 2012; Lee et al., 2007)
  - Use as much existing in-place material as possible
    - Rubblization
    - Mill & Overlay
  - Demolition is slowest process in construction
- Construction rate factors
  - Mob/Demob
  - Traffic/Construction Separation
  - Rural/Urban
  - Terrain
  - Existing Geometrics
  - Traffic Volumes

Example of Available Production Rates

Agency	Production Rate URL	Date
Delaware DOT	https://www.deldot.gov/information/business/drc/misc_files/deldot_production_rates.pdf	undated
FHWA Central Federal Lands	www.cflhd.gov/resources/design/toolsguidance/documents/CFLHD_production_rates.xls	2009
Minnesota DOT	http://www.dot.state.mn.us/const/documents/Productionrates_000.pdf	2005
Oregon DOT	www.oregon.gov/ODOT/HWY/OPL/docs/SEOPL/production-rates.xls	2012
Virginia DOT	www.virginiadot.org/business/resources/const//CTDR_Production_Rates.xls	2008

Not much consistency.

Traffic Evaluation

- Models should provide range of outcomes
  - Increasing complexity = Increased inputs
  - Risk assessment
- Sketch Planning Tools – Use simple relationships to assess general conditions, not detailed.
  - CA4PRS (Caltrans, 2004)
  - QuickZone 2.0
- User Delays
  - Total user delay
  - Total user costs due to delays
  - Max. queue length

Traffic Evaluation

- Use simplicity and predictability
  - AR Rubblization Projects – "Always Merge Left"
    - Merge well ahead of WZ
    - WZ Speed Limit 50 mph
    - Radar Speed Feedback
- Public outreach
  - Time of lane closures
  - Alternates
  - Can be very effective in minimizing user delay (e.g. I-710, AR Rubblization)
- Performance specifications for WZ traffic control
  - Need contractor flexibility

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

Construction Scheduling

- Iterative process:
  - Schedule dictates traffic control
  - Production rates tied to length and number of lane closures
  - Minimize RUC by keeping WZ capacity at or above expected traffic levels
- Options for lane closures:
  - Partial or Full night – may need counter-flow or bypass
  - Partial or Full day – may need counter-flow or bypass
  - Partial or full weekend (usually 55 hours)
  - Partial or full week-long (168 hours)

Costs

- Road User Costs
  - Delay:

$$\text{Delay/mile} = \frac{(TT_a - TT_{ff}) \times V \times VO}{L_{wz} \times 60} \qquad \text{(Equation 1)}$$

Where: TTa = 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

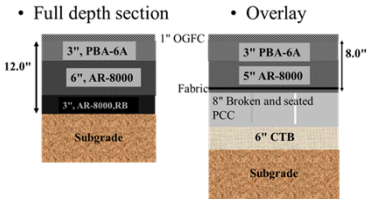
- RUC used by NJ and TX in relation to construction costs
  - Minimize inconvenience
  - Basis of incentives/disincentives
- Life Cycle Costs
  - NPV of initial costs and subsequent maintenance and rehabilitation
  - RUC of future activities is a VERY uncertain quantity

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

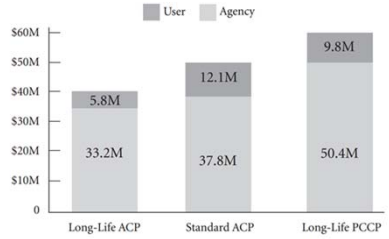


CA Crack & Seat – I-710 – 2003

- 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)



Portland, OR – I-284, 2002 (FHWA, 2003)

- 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

Detroit, Michigan – M-10, 2002 (FHWA, 2003)

- 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

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

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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

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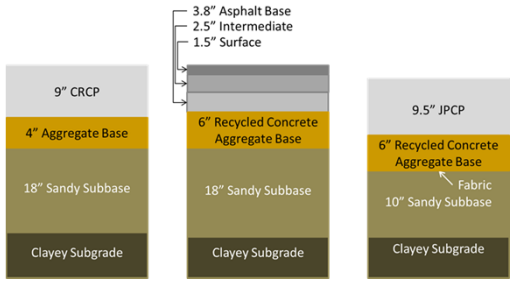
Existing & Proposed X-Sections



Daily User Delay Costs

Lane Closure Segment	Assessment
US-31 Single Lane	$6,441.49
Ramp B (NB Off-Ramp)	$6,843.41
Ramp C (SB On-Ramp)	$4,486.52
Ramp F (SB On-Ramp)	$2,885.95
Ramp E (NB On-Ramp)	$527.96

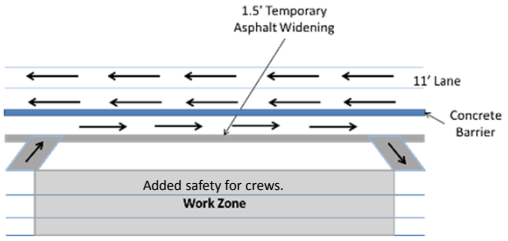
Bids

Option	Construction	Time	Total
Engineer's Est.	11,625,739	---	---
Asphalt	10,769,004	1,330,466	12,099,470
Concrete	9,612,573	3,010,646	12,623,219

Demolition

Rieth-Riley Solution to User Delay

State Plans: One lane in each direction during construction.



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 Pontchaitrain & Pearl River
  - Alternate Bids
  - Contains "Fast" Sections – Big Penalties ($15,000/hr)
  - Rest of the roadway - $15,000/day
- Construction is ongoing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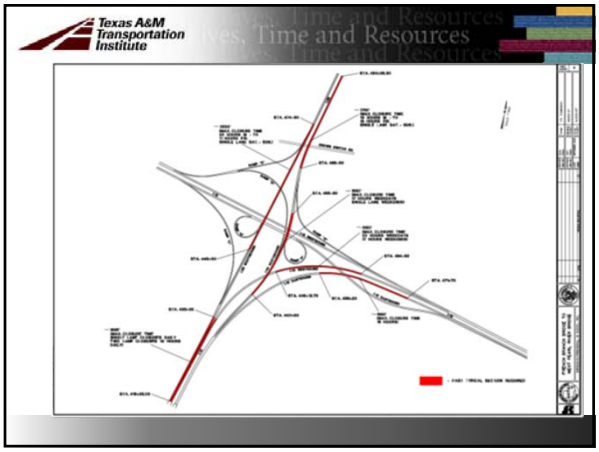
Time and Resources
Covington
Slidell
French Branch Bridge Project
Lake Pontchartrain
Lake Borgne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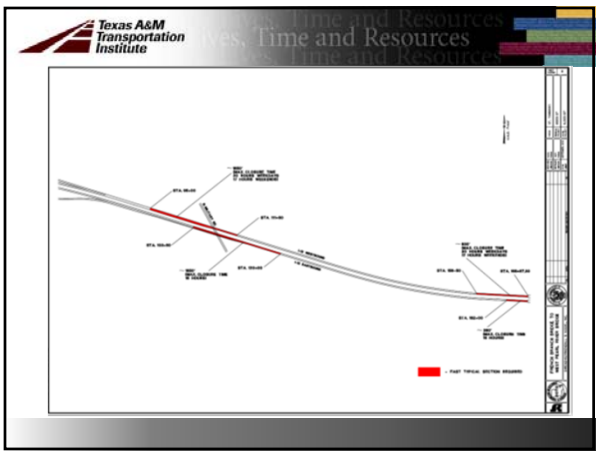
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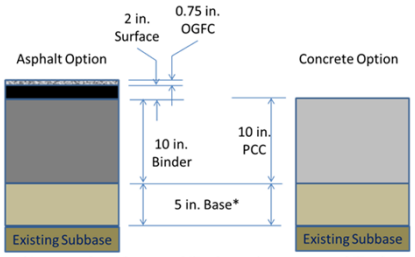
Alternatives



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

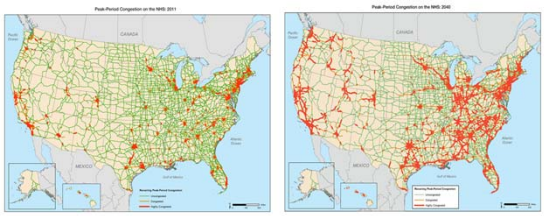
Bids

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

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