TRANSPORTATION LEARNING NETWORK

A partnership with MDT•NDDOT•SDDOT•WYDOT and the Mountain-Plains Consortium Universities

Welcome!

Implementation Guidance for Accelerated Bridge Construction in South Dakota

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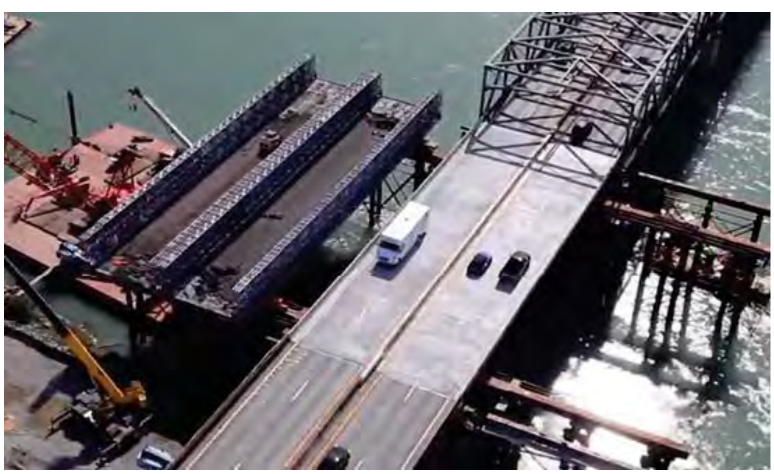
Our partners: MOUNTAIN-PLAINS CONSORTIUM · MONTANA MDT DEPARTMENT OF TRANSPORTATION · NDDOT North Dakota Department of Transportation · South Dakota DOT Connecting South Dakota and the Nation · WYOMING TRANSPORTATION DEPARTMENT

- Project Background & Motivation
- Literature review
- ABC Interviews
- ABC Catalog
- Decision making tool
- Example
- Conclusion



Accelerated Bridge Construction (ABC) can be defined as construction practices that employ innovative techniques to reduce on-site construction time and interruption to traffic.

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Safety First

Background

Project Background

A Collaborative Project between MPC and SD DOT to provide preliminary information to assist ABC application in SD DOT

EDC

Every Day Counts (FWHA)

State-based model that identifies and rapidly deploys proven, yet underutilized innovations to shorten the project delivery process, enhance roadway safety, reduce traffic congestion, and improve environmental sustainability.

The 5th least populated state (860k population)
~80,000 miles road ways, 670 miles of interstate HW

Background

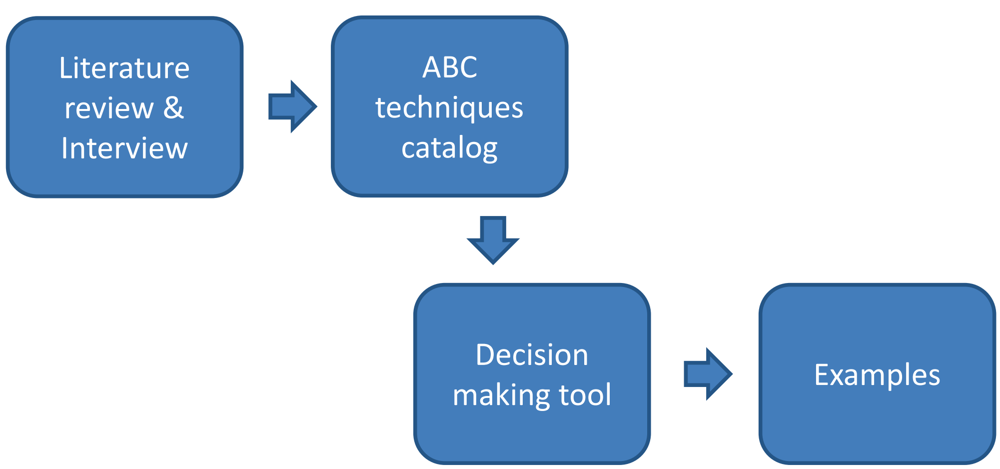
Project Title: Implementation Guidance for Accelerated Bridge Construction in South Dakota

Project Duration: 2012 ~ 2014 (Completed)

Main Objectives:

1) To investigate previously used ABC techniques
2) To estimate the potential costs and benefits of implementing ABC techniques
3) To develop a cost-benefit analysis model SD DOT can use

Background



Lit Review

First stop is the official FHWA ABC site:

https://www.fhwa.dot.gov/bridge/abc/

PBES can be broken down to four categories:

1. Materials
2. Superstructure elements
3. Substructure elements
4. Foundations elements

ABC Manual also touched on durability considerations on ABC techniques

ABC Manual by FHWA

Lit Review

Individual case and planning study reports from DOTs

- “One-Weekend Job Rapid Removal and Replacement of 4500 South Bridge in Salt Lake City, Utah” (Ardani et al. 2010) one project
- Khaleghi, B. (2010). “Washington State Department of Transportation Plan for Accelerated Bridge Construction.”
- “Accelerated Bridge Construction Applications in California—A Lesson Learned” (Chung et al. 2008) Seven projects
- “Texas’s Totally Prefabricated Bridge Superstructures” (Freeby 2005)
- “Use of Precast Concrete Members for Accelerated Bridge Construction in Washington State” (Khaleghi 2005)

Lit Review

Other Reports and References

- "Connections Details for Prefabricated Bridge Elements and Systems" (Culmo 2009)
- "Manual on Use of Self-Propelled Modular Transporters" (FHWA 2007)
- "Induced Stresses from Lifting and Moving Highway Bridges with Self-Propelled Modular Transporters" (Rasvall, Halling, Lindsey 2010).
- "Application of Accelerated Bridge Connections in Moderate-to-High Seismic Regions" (Marsh et al. 2011)
- "Framework for Prefabricated Bridge Elements and Systems Decision-Making" (FHWA 2005)
- "Guidelines for Accelerated Bridge Construction Using Precast or Prestressed Concrete Components" (PCI Northeast Bridge Technical Committee 2006
- "Selection of Durable Closure Pour Materials for Accelerated Bridge Construction" (Zhu, Ma 2010).

This is getting pretty dry...

Detailed info in report references

Creating A Catalog

So far, purely from lit review

Table 5-1. Organization of ABC Techniques

Category	Subcategory
Substructure	Abutments
	Caps
	Footings
	Miscellaneous Elements
Superstructure	Decks and Panels
	Girders/Beams
	Spans
Placement	N/A

What can be used, no info on when to use yet. But let's find out needs first

Precast Bent Caps

Description: A bent cap is the top horizontal portion of a bent that supports the superstructure of a bridge. Precast bent caps simply provide a way of precasting portions of each bent without prefabricating the entire bent away from the bridge site. Instead, the portions are brought to the job site and assembled in place.

Source: "ABC—Experience in Design, Fabrication, and Erection of PBES"

Example Project: Lake Ray Hubbard Bridge, Dallas, TX

Precast Bent Cap
http://www.fhwa.dot.gov/publications/publicroads/03nov/02.cfm
Accessed 23 Oct 2012

Example Profile in the Catalog

Interviews

Interview of SD DOT employee to identify needs

- Current Experience: ABC in South Dakota is minimal
- Completeness of the Catalog: Fairly good
- What are you interested in: these becomes info to be collected in Catalog.
- What is current decision making process: what can affect ABC implementation.

Table 5-2. ABC Catalog Columns

Category of Interest	Description
Benefit	The benefit of using a given ABC technique as opposed to conventional construction
Special Equipment	Any special construction equipment required for construction
Special Crew Experience	Any special experience that may be required of the contractor's crew (welding, specialty equipment operation, etc.)
Special Site Requirement	Any special requirement of the job site that is necessary for the ABC technique (precasting zone away from job site, etc.)
Connections Details	Any specified connections details specified for the ABC technique
Typical Duration	The duration of the ABC technique as compared to conventional construction
Potential Problems	Any potential problems that have been recognized by other crews who have utilized the ABC technique in practice
Existing Experience	Any example projects that have employed the ABC technique
Other Comments	Additional comments gleaned from literature review or interviewees

Interviews

Interview of Other DOT employees who had experience with ABC

- Most experts identified from the literature review
- Details on specific ABC process they had experience on
- Requirements, constraints, and benefits
- Decision making process (tools) for ABC

Table 5-4. Other State DOT Contacts

State DOT Office	Contact(s)
Utah (UDOT)	Josh Sletten, Carmen Swanswick
Texas (TxDOT)	Michael Hyzak
Minnesota (MnDOT)	Paul Rowekamp
Ohio (ODOT)	Tim Keller
Washington State (WSDOT)	Bijan Khaleghi, Ron Lewis
California (Caltrans)	Dorie Mellon

All interview outcome on ABC techniques included in the final Catalog

Interviews

Utah DOT:

- precast spread footings, full-depth precast deck panels, lightweight precast deck panels, precast approach slabs, self-propelled modular transporters (SPMTs), and longitudinal launching.
- Accelerated Bridge Construction Analytical Hierarchy Process Decision Tool produced by the FHWA (FHWA 2012).
- UDOT has developed a different tool due to the complexity of FHWA tool

Caltran:

- precast abutments, precast I-girders, precast bulb-T girders, and precast box girders.
- Similar concerns with Accelerated Bridge Construction Analytical Hierarchy Process Decision Tool produced by the FHWA (FHWA 2012). Subjectivity in inputs making the process more qualitative than quantitative

Interviews

Texas DOT:

- precast bent caps, proprietary retaining wall systems, precast double-T beams, and pretopped U-beam design.
- Texas does not use FHWA tool for decision making regarding ABC, but feel it can be a useful tool if all inputs are known

Ohio DOT:

- fiber reinforced polymer (FRP) deck panels, geosynthetic reinforced soil (GRS) abutments, and horizontal skidding/sliding.
- Ohio does not use FHWA ABC AHP Decision Tool for decision making regarding ABC. They conduct their own critical path analysis for individual project.

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Interviews

Minnesota DOT:

- precast inverted-T beams, arch span without deck, and barge use.
- MDOT tried to use FHWA tool for decision making regarding ABC, but feel it was too complicated and time-consuming (especially input process) for the use of the tool to be efficient and effective.

Washington DOT:

- prefabricated full height wall panels, proprietary retaining wall systems, precast box culverts, partial-depth precast deck panels, and steel grid deck systems.
- FHWA ABC AHP Decision Tool was not effective for use by the WSDOT office due to the fact that every project is site specific, and so many of the input factors included in the decision tool were not applicable to WSDOT.

Interviews

- A lot of good information about specific ABC techniques.
- None of the people interviewed found FHWA ABC AHP Decision Tool effective. It is likely a reasonable framework, but require too many detailed inputs.

Completed the Catalog

Moving on to decision making tool (with lessons learnt...)

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Catalog

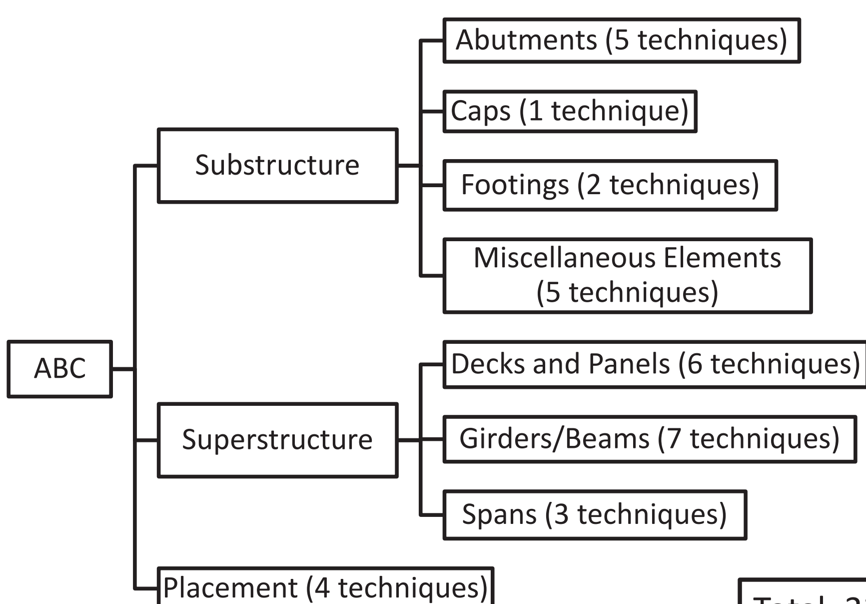
Catalog is part of the MPC final project report Appendix (Download if you need)

Contains two parts:

- Technique Profile: one-page index cards with short description, source of information(reference), and an example project. (info mostly from literature review)
- Technique Characters (table format): For each technique listed in the profile, the table outlined major benefits, special equipment needed, special crew experience, special site requirements, Connection detail, typical duration, potential problems, who has done it before, and additional comments. (info mostly from interview with experts)
- And a ball-park cost catalog (will discuss later)

Now let's take a look

Catalog



Total: 33 techniques

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Catalog

No, I'm not going to talk about all of them

Catalog

Substructure example

Precast Abutments

Description: Abutments support the ends of a bridge's superstructure. Precast abutments in general are abutments that are poured and cured off site and moved into place after curing is complete.

Source: "ABC Applications in CA—A Lesson Learned"

Example Project: I-40 Bridges Replacement in CA (20-mile stretch along I-40 about 80 miles east of Barstow, CA)

Typical Precast Abutment
http://www.fhwa.dot.gov/everydaycounts/technology/bridges/pbeswebinartraining/s3_m7.cfm
Accessed 23 Oct 2012

Precast Pier Box Cofferdams

Description: This ABC technique is used for placement of bridge support columns in channels of water. The pile cap footing is commonly placed just below the surface of the water. By prefabricating pier boxes, they can be floated downstream from wherever they were cast and set into place to block off water flow for the installation of the pile caps.

Source: "ABC—Experience in Design, Fabrication, and Erection of PBES"

Example Project: Providence River Bridge

Example of a Precast Pier Box Cofferdam
http://www.fhwa.dot.gov/bridge/prefab/if09010/04.cfm
Accessed 23 Oct 2012

Catalog

Deck example

Fiberglass Reinforced Polymer (FRP) Deck Panels

Description: These panels are much like the partial- and full-depth precast deck panels previously discussed. However, they are constructed from fiberglass reinforced polymer rather than concrete. The polymer is reinforced with fiber or some other material of equal strength to reinforce the panels in one or more directions along the span of the bridge.

Source: "ABC—Experience in Design, Fabrication, and Erection of PBES"

Example Project: Project 100 in Ohio

Full-Depth FRP Panels
"ABC—Experience in Design, Fabrication, and Erection of PBES"

Precast Approach Slabs

Description: Precast approach slabs are structural slabs that span between the bridge abutments and the approach fill. They are used to span across the potential settlement of the approach roadway fills directly behind the abutments.

Source: "ABC—Experience in Design, Fabrication, and Erection of PBES"

Example Project: UDOT

Precast Approach Slab Installation
http://www.flickr.com/photos/25664139@N06/5899098381/
Accessed 16 Nov 2012

Catalog

Superstructure example

Truss Span with/without Deck

Description: This is an example of a full-width beam element. Part of the superstructure is prefabricated and constructed off site. Then, SPMTs, barges, or other placement devices are used to move it into place. This technique also serves as a testament to ABC being implemented to different degrees. Spans can also be moved with the bridge deck already constructed to it.

Source: "ABC—Experience in Design, Fabrication, and Erection of PBES"

Example Project: Providence River Bridge, Rhode Island

Replacement of Truss Span without Deck (Barge Use)
http://www.fhwa.dot.gov/bridge/abc/docs/aashto.pdf
Accessed 23 Oct 2012

Steel Tub Girder

Description: Steel tub girder use is becoming more commonplace in modern infrastructure design. They offer advantages over other superstructure types in terms of span range, stiffness and durability—particularly in curved bridges. In addition, steel tub girders have distinct aesthetic advantages due to their clean, simple appearance.

Source: "Induced Stresses from Lifting and Moving Highway Bridges with Self-Propelled Modular Transporters"

Example Project: Brightman Street Bridge Replacement Project, Fall River, Somerset, MA

Steel Tub Girder Placement
http://www.highsteel.com/project_gallery/bridges/Brightman-Street-Bridge.cfm
Accessed 23 Oct 2012

Catalog

Placement example

Self-Propelled Modular Transporters (SPMTs)

Description: Self-propelled modular transporters are a tool used to transport bridge decks or portions of bridge decks from the prefabrication site to the project site. This is especially useful when working on projects located away from any rivers or bodies of water where barges could be used for transport. This technique is one of the main ideas behind accelerated bridge construction.

Source: "Manual of Use of Self-Propelled Modular Transporters to Remove and Replace Bridges"

Example Project: 4500 South Bridge, Salt Lake City, UT

Self-Propelled Modular Transporter Carrying a Bridge Deck
http://www.ecvv.com/product/2996068.html
Accessed 23 Oct 2012

Horizontal Skidding or Sliding

Description: This method requires that the new bridge be built in parallel to the proposed finished location. The structure is normally built on a temporary support frame that is equipped with rails. The bridge can be moved transversely using cables or hydraulic systems. Minor vertical adjustment can also be incorporated into these systems.

Source: "ABC—Experience in Design, Fabrication, and Erection of PBES"

Example Project: ODOT

Lateral Bridge Slide in Oregon
"ABC—Experience in Design, Fabrication, and Erection of PBES"

Decision Making

Now we have the techniques, also some useful information about their benefits and constraints.

But Should we do ABC on all projects?

When to use them?

Decision Making

Let's take a look at how others have done it!

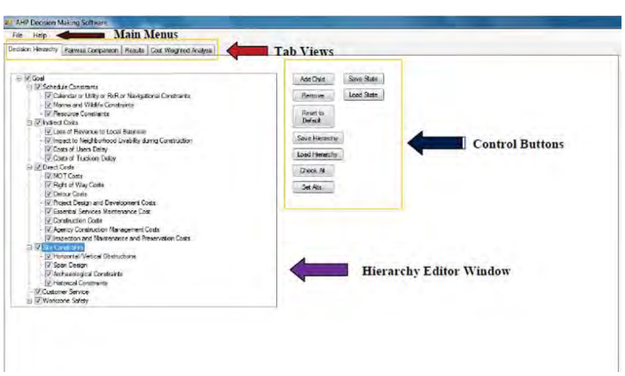
- Accelerated Bridge Construction Analytical Hierarchy Process Decision Tool by FHWA (AHP tool)
- A customized decision making tool by UDOT
- Iowa DOT decision making tool

A customized simple tool for SD DOT

Decision Making

Accelerated Bridge Construction Analytical Hierarchy Process Decision Tool by FHWA (AHP tool)

Can be readily downloaded from
https://www.fhwa.dot.gov/bridge/abc/fast.cfm



Objective of this tool is to help DOTs who might be interested in ABC to assess potential bridge projects

We did not study it in details, but this is our experience.

Decision Making

AHP depends on relative importance of all input factors.

It will ask the user to compare between subcategories, as well as categories.

Comparison was done through a pair-wise scale for all potential pairs

For 9 items, you have 72 possible pairs... If you want to compare everything.

Table 5-6. ABC AHP Decision Tool Inputs (FHWA 2012)

Category	Subcategory
Direct Costs	Construction
	Maintenance of Transport
	Design and Construct Detours
	Right of Way
	Project Design and Development
	Maintenance of Essential Services
	Construction Engineering
	Inspection and Maintenance and Preservation
	Toll Revenue
Indirect Costs	User Delay
	Freight Mobility
	Revenue Loss
	Livability During Construction
	Road Users Exposure
	Construction Personnel Exposure
Schedule Constraints	Calendar or Utility or RxR or Navigational
	Marine and Wildlife
	Resource Availability
Site Constraints	Bridge Span Configurations
	Horizontal/Vertical Obstructions
	Environmental
	Historical
	Archaeological Constraints
Customer Service	Public Perception
	Public Relations

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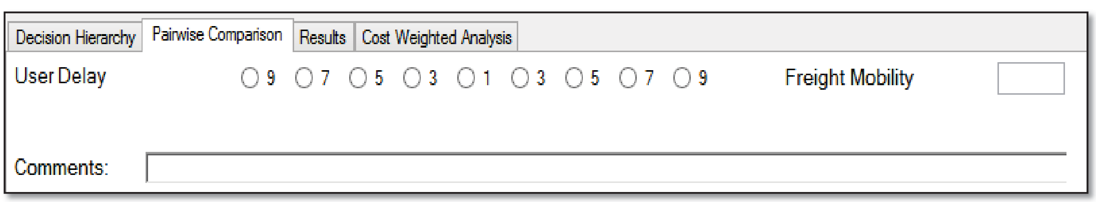
Decision Making

First you do this for each subcategory item



Intensity	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Weak importance of one over another	Experience and judgment slightly favor one activity over another
5	Essential or strong importance	Experience and judgment strongly favor one activity over another
7	Demonstrated importance	An activity is strongly favored, and its dominance demonstrated in practice
9	Absolute importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate values between the two adjacent judgments	When compromise is needed

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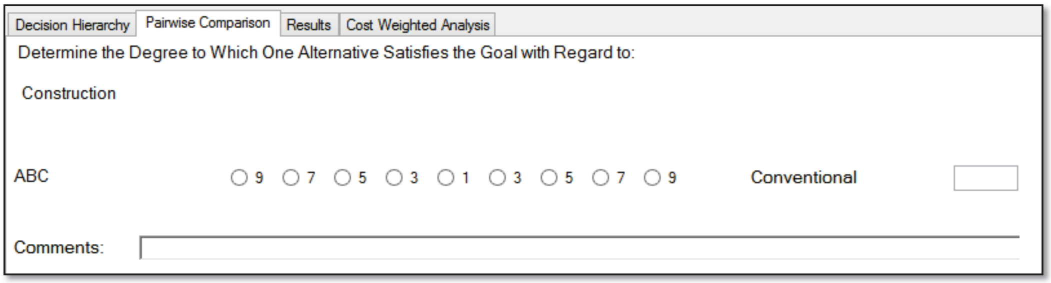
Decision Making

Then you do this for each main category regard
to ABC and Conventional options (from catalog?)



The issue is there is too many comparisons in this pair-wise format and the user can loose track...

Let's try something else

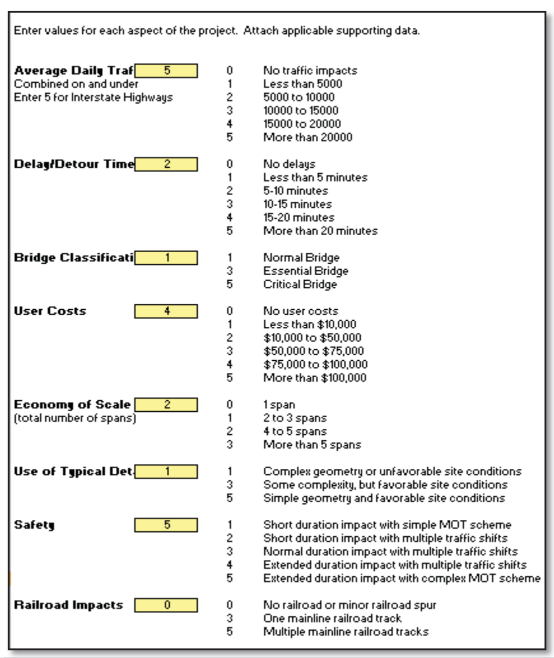
Decision Making

UDOT Tool

Utah was one of the first states in the United States to begin implementing ABC techniques as an alternative to conventional bridge construction.

The inputs are intuitive and simple

Alternatives can be compared



Enter values for each aspect of the project. Attach applicable supporting data.

Average Daily Traf Combined on and under Enter 5 for Interstate Highways	5	0	No traffic impacts
		1	Less than 5000
		2	5000 to 10000
		3	10000 to 15000
		4	15000 to 20000
		5	More than 20000
Delay/Detour Time	2	0	No delays
		1	Less than 5 minutes
		2	5-10 minutes
		3	10-15 minutes
		4	15-20 minutes
		5	More than 20 minutes
Bridge Classificati	1	1	Normal Bridge
		3	Essential Bridge
		5	Critical Bridge
User Costs	4	0	No user costs
		1	Less than $10,000
		2	$10,000 to $50,000
		3	$50,000 to $75,000
		4	$75,000 to $100,000
		5	More than $100,000
Economy of Scale (total number of spans)	2	0	1 span
		1	2 to 3 spans
		2	4 to 5 spans
		3	More than 5 spans
Use of Typical Det	1	1	Complex geometry or unfavorable site conditions
		3	Some complexity, but favorable site conditions
		5	Simple geometry and favorable site conditions
Safety	5	1	Short duration impact with simple MOT scheme
		2	Short duration impact with multiple traffic shifts
		3	Normal duration impact with multiple traffic shifts
		4	Extended duration impact with multiple traffic shifts
		5	Extended duration impact with complex MOT scheme
Railroad Impacts	0	0	No railroad or minor railroad spur
		3	One mainline railroad track
		5	Multiple mainline railroad tracks

Decision Making

UDOT Tool (cont.)

A set of weight factor for different factors is built-in. User can adjust them but have to consult with UDOT.

This is dedicated to UDOT projects

You get an ABC Rating, but that is not the end...

Note: Do not adjust weight factors without prior consultation with UDOT Structures Division Project Manager

ABC RATING SCORE FACTORS AND WEIGHTS

	Score	Weight Factor	Adjusted Score	Maximum Score	Adjusted Score
Average Daily Traffic	5	10	50	5	50
Delay/Detour Time	2	10	20	5	50
Bridge Classification	1	5	5	5	25
User Costs	4	10	40	5	50
Economy of Scale	2	3	6	3	9
Use of Typical Details	1	3	3	5	15
Safety	5	10	50	5	50
Railroad Impacts	0	5	0	5	25
		Total Score	174	Max. Score	274

ABC Rating Score: 64

The ABC Rating Score is driven by the four most heavily weighted factors: Average Daily Traffic, Delay/Detou Time, User Costs and Safety. For a detailed explanation, review the narrative on page 4 of the ABC Decision Making Process.

Cost Considerations:
Calculate the following costs for use in determining the lowest total project cost

TOTAL PROJECT COST EVALUATION

	Alternative #1	Alternative #2
Construction Costs	$2,500,000	$3,000,000
User Costs	$1,000,000	$250,000
Total Project Cost	**$3,500,000**	**$3,250,000**

Decision Making

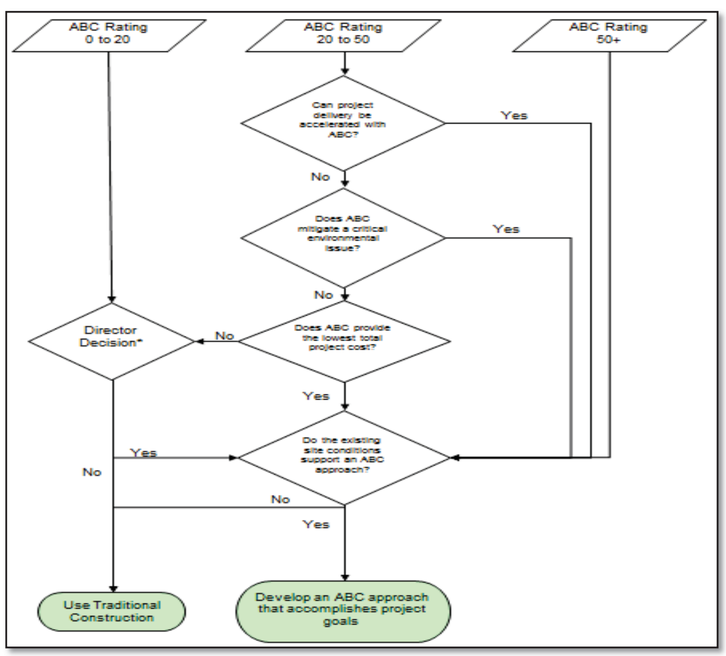
UDOT Tool (cont.)

Three levels of ABC Rating

- Below 20: No ABC
- Above 50: ABC
- 20-50: A couple of Y/N criteria checks

Subjective decision built into the process

It worked for UDOT!



Decision Making

Iowa DOT Tool

Two-stage process

First stage to weed-out projects that have no chance without complicated analysis

First stage input:
(very similar to UDOT tool)

Concept Measure Scores

Concept Measure	Input	Score	Scale	Description
Average Annual Daily Traffic Combined value of 100% on and 25% under =	18,300	4	0	No traffic impacts
			1	Less than 5000
			2	5000 to less than 10,000
			3	10,000 to less than 15,000
			4	15,000 to less than 20,000
			5	20,000 or more
Out of Distance Travel Value in miles =	9	2	0	No detour
			1	Less than 5
			2	5 to less than 10
			3	10 to less than 15
			4	15 to less than 20
			5	20 or more
User Costs Value in $ =	$76,585.50	4	0	No user costs
			1	Less than $10,000
			2	$10,000 to less than $50,000
			3	$50,000 to less than $75,000
			4	$75,000 to less than $100,000
			5	$100,000 or more
Economy of Scale Value is total number of spans =	3	1	0	1 span
			1	2 or 3 spans
			2	4 or 5 spans
			3	6 spans or more

Decision Making

Iowa DOT Tool (Cont.)

Weights and factors for Stage One analysis
You also get an ABC Rating score, only Projects with 50+ score go to Stage 2

ABC Rating Score Factors and Weights

Concept Measure	Score	Weight Factor	Adjusted Score	Maximum Score	Adjusted Score
Average Annual Daily Traffic	4	10	40	5	50
Out of Distance Travel	2	10	20	5	50
User Costs	4	10	40	5	50
Economy of Scale	1	5	5	3	15
		Total Score	105	Max. Score	165
		Calculated ABC Rating Score	64		
		ABC Rating Score	**64**		

Decision Making

Iowa DOT Tool (Cont.)

Stage 2 for Iowa is the ABC AHP Decision making tool.

At least you do not need to do this for majority of the projects.

Now move on for SD DOT

Maybe try to not use ABC AHP Decision making tool (for most of the projects).

Two-stage format seems to be good

Try use stage one to eliminate a lot of cases (as it reasonably should)

Decision Making

SD DOT tool

Focused on road use in Stage 1, cost in Stage 2

Table 5-7. Customized Tool Inputs and Descriptions

Stage	Input	Description
One	Average Annual Daily Traffic (AADT)	Combined value of 100% on and 25% under the bridge structure
	Out of Distance Travel (OODT)	Detour distance in miles
	Daily Road User Costs (DRUC)	Empirical formula shown in Equation 5-1
	Economy of Scale (EOS)	Total number of spans in a project
Two	Direct Costs (DC)	Information obtained in Section 5.3.3
	Indirect Costs (IC)	SDSU Road User Cost Tool
	Non-ABC Conventional Costs (NCC)	Information obtained in Section 5.3.1
	Schedule Constraints (SchC)	i.e. emergency repairs, seasonal deadlines, etc.
	Site Constraints (SC)	i.e. prefab/precast site, geographic constraints, etc.

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Decision Making

Stage One is done just like Iowa DOT tool

Project No.	PCN 02AB		
Inputs			
Average Daily Truck Traffic	51		
Mileage Rate	37.5		
Average Annual Daily Traffic (AADT)	1	0	No traffic impacts
Combined value of 100% on and 25% under		1	Less than 5000
structure:		2	5000 to less than 10000
746		3	10000 to less than 15000
		4	15000 to less than 20000
		5	20000 or more
Out of Distance Travel (OODT)	1	0	No detour
Detour distance in miles*:		1	Less than 5
0.25		2	5 to less than 10
*Note: OODT should not be 0 if DRUC formula		3	10 to less than 15
is to be used, as DRUC will then be $0.		4	15 to less than 20
		5	20 or more
Daily Road User Costs (DRUC)	1	0	No user costs
(AADT+2*ADTT)(OODT)(Mileage Rate)=		1	Less than $100
$79.50		2	$100 to less than $500
*Note: If OODT is 0, SDSU DRUC Tool can be used		3	$500 to less than $750
to estimate DRUC for Stage 1.		4	$750 to less than $1000
		5	$1000 or more
Economy of Scale (EOS)	2	0	1 span
Total number of repeatable of spans:		1	2 or 3 spans
4		2	4 or 5 spans
		3	6 spans or more

ABC Rating Score Factors and Weights

	Score	Factor	Adjusted Score	Max. Score	Adjusted Score
AADT	1	10	10	5	50
OODT	1	10	10	5	50
DRUC	1	10	10	5	50
EOS	2	10	20	3	30
		Total Score:	50	Max. Score:	180
		ABC Rating Score:		**28**	

Decision Making

Stage Two has similar format but different focus
(Only go there if you have Stage 1 rating >50)

Project No.			
Inputs			
Direct Costs	3	0	$100000 or more additional cost
Input approximate costs for superstructure,		1	$75000 to less than $100000 additional cost
substructure, and/or placement:		2	$50000 to less than $75000 additional cost
$32,000		3	$25000 to less than $50000 additional cost
		4	$0 to less than $25000 additional cost
		5	Lesser cost than conventional
Indirect Costs	2	0	No user costs
Transfer info from Daily Road User Cost tool:		1	Less than $100
$120		2	$100 to less than $500
.		3	$500 to less than $750
		4	$750 to less than $1000
		5	$1000 or more
Non-ABC Conventional Costs	3	0	$0 to less than $50/SF of bridge
Transfer info from SDDOT cost data per sq. ft.		1	$50 to less than $75/SF of bridge
of bridge:		2	$75 to less than $100/SF of bridge
$112		3	$100 to less than $125/SF of bridge
		4	$125 to less than $150/SF of bridge
		5	$150 or more/SF of bridge
Schedule Constraints	1	0	No schedule constraints
i.e. emergency repairs, seasonal deadlines, etc.		1	Slight schedule constraints
		2	Moderate schedule constraints
		3	Substantial schedule constraints
Site Constraints	1	0	No site constraints
i.e. critical path, geographic constraints, etc.		1	Slight site constraints
		2	Moderate site constraints
		3	Substantial site constraints

ABC Rating Score Factors and Weights

	Score	Weight Factor	Adjusted Score	Max. Score	Adjusted Score
DC	3	10	30	5	50
IC	2	10	20	5	50
NCC	3	10	30	5	50
SchC	1	10	10	3	30
SC	1	10	10	3	30
		Total Score:	100	Max. Score:	210
		ABC Rating Score:		**48**	

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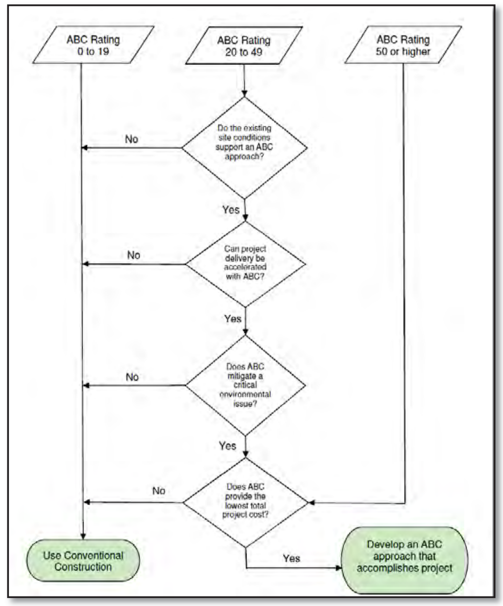
Decision Making

Stage Two Rating:

1) <20 : no ABC
2) 20~50 : More considerations on Site condition, Feasibility, Environmental concern, and Cost concern before ABC
3) >50 : Only cost concern, do ABC if cost makes sense

Very similar to UDOT flowchart, but much simpler



Decision Making

Some Details regarding SD DOT tool:

1) All factors are equally weighted (can change later, but needs more experience and data)
2) A lot of cost metrics, some guidelines needed for use
   - Daily Road User Cost (DRUC) used in Stage 1, this calculation leverage on an existing tool to calculate DRUC developed by SDSU.
   - Non-ABC conventional cost: by experience and data from past projects.
   - Direct ABC Costs: How much more expensive than conventional method? Through estimates and bids.

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Cost Estimation

Daily Road User Cost (DRUC)

How much total $ would road user incur in addition to their normal costs if you have a project going on (re-route, slow down, etc.)

Two methods:

1) Empirical equation (Iowa DOT literature)

$$DRUC\ (\$) = (AADT + 2 * ADTT)(OODT)(Mileage\ Rate)$$

2) In a previous research project managed by SDDOT (Qin and Cutler 2013), a SDSU Road User Cost Tool was developed by researchers at SDSU.

Qin, X. and Cutler, C. (2013). "Review of Road User Costs and Methods." Report No. SD2011-05, South Dakota State University, Brookings, SD.

Cost Estimation

Non-ABC Conventional Costs

This is highly localized information. Only South Dakota information is presented here (based on SD DOT data and survey)

Total of 31 projects in SD were surveyed. All costs summarized on a per-Square Ft. basis based on bridge type:

Table 5-5. Average, Minimum, and Maximum Conventional Construction Costs

Bridge Type	Average Cost/SF	Minimum Cost/SF	Maximum Cost/SF
Steel Girder	$145.04	$80.12	$160.48
Continuous Concrete	$175.18	$87.97	$188.56
Prestressed Girder	$132.48	$66.76	$195.03

Actual cost data available in project final report Appendix E.

Cost Estimation

Additional Cost for ABC Techniques

Again, this will be very localized.
Even worse, not that much data in SD (we haven't done much).
How to estimate it?

Material Costs | Placement Costs | Labor Cost Reduction

Survey Manufacturers, Contractors, and Transporters.

Cost Estimation

Additional Cost for ABC Techniques (Cont.)

For detailed cost comparison, one can always get separate Bids (ABC vs. Conventional)
This project provided a rough simplified ABC cost catalog based on surveys:

Full Table in report

Category	ABC Technique	Approximate Materials Cost		Time	Equipment
		Materials	Contractor		
Substructure	Precast Abutments	~ $30-40/CF for precasting	~ $10,000 saved	1 week	Crane transport and operation
	Geosynthetic Reinforced Soil (GRS) Abutments	INF	~ $20,000 saved	~ 2 weeks	Less equipment used than with conventional
	Spill-Through Abutments	INF	INF	INF	INF
	Precast Pier Box Cofferdams	~ $30-40/CF for precasting	Transport costs: $20,000-$25,000 plus $200-$250/hr	INF	INF
	Integral Abutments	~ $30-40/CF for precasting	Transport costs: $20,000-$25,000 plus $200-$250/hr	INF	INF
	Precast Bent Caps	~ $30-40/CF for precasting	1/2 of original labor costs	Threefold increase in speed	Crane transport and operation
	Precast Spread Footings	~ $30-40/CF for precasting	~ $2,000 saved	1-2 days	N/A

Example

Let's try the tool on Three projects

Results should be logical... But let's see

Example also serves as rough validation

Table 5-9. Case Study Information from Bridge Design Office

Project Number	AADT	ADTT	OODT	Mileage Rate	Number of Spans
SD34 (PCN 02AB)	746 on, none below	6.8% (51)	Less than ¼ mile	37.5 cents per mile	3 and 4 spans
I90 (PCN 01KK)	1,015 on, none below	2.6% (26)	None	37.5 cents per mile	4 and 5 spans
I29/I229 interchange (PCN 01QS)	18,012 on, 12,827 below (21219 total)	18.7% (1,526)	None	37.5 cents per mile	2 spans

None OODT means no official detour but will have a partial traffic flow adjustment. A minimum of ¼ mile OODT used in analysis

Example

Stage One inputs are very straight forward. The only part needs calculation is URUC:

Project SD34 (PCN 02AB):

$$DRUC = (746 + 2 * 51)\frac{vehicles}{day} * (0.25)\frac{miles}{vehicle} * (0.375)\frac{dollars}{mile} = \$79.50/day$$

Project I90 (PCN 01KK):

$$DRUC = (1{,}015 + 2 * 26)\frac{vehicles}{day} * (0.25)\frac{miles}{vehicle} * (0.375)\frac{dollars}{mile} = \$100.03/day$$

Project I29/I229 interchange (PCN 01QS)

$$DRUC = (21{,}219 + 2 * 1{,}526)\frac{vehicles}{day} * (0.25)\frac{miles}{vehicle} * (0.375)\frac{dollars}{mile} = \$2{,}275.40/day$$

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Example

Plug the ratings in, only the third project can advance to Stage Two

Table 5-10. Case Study Output Indicators and Decisions

Project Number	AADT	OODT	DRUC	EOS	Output Indicator	Decision
SD34 (PCN 02AB)	1	1	1	2	28	Conventional Construction
I90 (PCN 01KK)	1	1	2	2	33	Conventional Construction
I29/I229 interchange (PCN 01QS)	5	1	5	1	67	Advance to Stage 2

Which is expected...

Example

If you made Stage Two, you may want to "refine" your numbers

Table 5-11. Stage Two Evaluation Project Information for I-29/I-229 Project

AADT	ADTT	OODT	Normal & Work Zone Speeds	Traffic Detour Percentage	Conventional Costs	Additional Cost of Using ABC
18,012 on, 12,827 below (21219 total)	18.7% (1,526)	0.25 mi each	65 mph & 45 mph	75% (I-29) 100% (I-229)	$113.25/SF	~$420,000

COSTS WITH OVERLAY

Pre-cast ABC cost ($)	Columns & caps	deck panels	
fabrication	122950	679967	
shipping	16500	69500	
Excise & sales (15%)	18443	101995	
labor*	1200	41700	
grouting#	600	20000	
epoxy chip seal		239750	
total	159693	1152912	1312605

Cast-in-place ($)	Columns & caps	deck	
cu. Yds	136.6	755.6	
cost/yd	1000	1000	
total	136600	755600	892200

difference = 420405

epoxy chip seal = 3425 sq. yds. x $70 /sq. yd

Figure 5-13. Additional Cost of Using ABC for I-29/I-229 Project

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Example

Also do a refined DRUC analysis:

This is what that DRUC tool looks like, if you are curious...

QUICK REPORT ROAD USER COST: PROJECT C

Project Name I-29/I-229 Interchange — County Minnehaha
Project Number PCN 01QS

	Phases:			
K ZONE CONDITI	ADT	18012	12827	
	Percent Trucks	18.7 %	11.9 %	%
	Operating Speed	65 mph	65 mph	mph
	Project Length	1 miles	1.5 miles	miles
	Accident Rate	1.11	1.11	
	WZ Speed	45 mph	45 mph	mph
	Detour	75 %	100 %	%
	CMF	1	1	
	Project Duration	210 days	210 days	days
	Detour Segment	Speed / Length	Speed / Length	Speed / Length
	1	45 / 0.25	45 / 0.25	
OUTPUT	VOT	($2,502.11)	($4,250.96)	
	Auto	($2,055.17)	($3,769.56)	
	Truck	($446.94)	($481.41)	
	VOC	($1,960.97)	($3,084.91)	
	Auto	($957.99)	($1,941.89)	
	Truck	($1,002.97)	($1,143.02)	
	AC	($110.96)	($131.70)	
	Daily RUC	($4,574.04)	($7,467.57)	($12,041.61)
	Project Total	($960,548.15)	($1,568,190.66)	

Figure 5-14. DRUC Inputs and Outputs for I-29/I-229 Project

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Example

In the end, still boils down to categories:

Table 5-12. Stage Two Inputs, Output Indicator, and Corresponding Action

Inputs					Output Indicator	Corresponding Action
Direct Costs	Indirect Costs	Non-ABC Conventional Costs	Schedule Constraints	Site Constraints		
0	5	3	1	1	48	Use flowchart decision-making questions

Result is to use flowchart for more consideration... Kind of expected...

Not a knock-out case for ABC

We did not do further analysis on this example as some of the flow chart process is outside of the scope of this study

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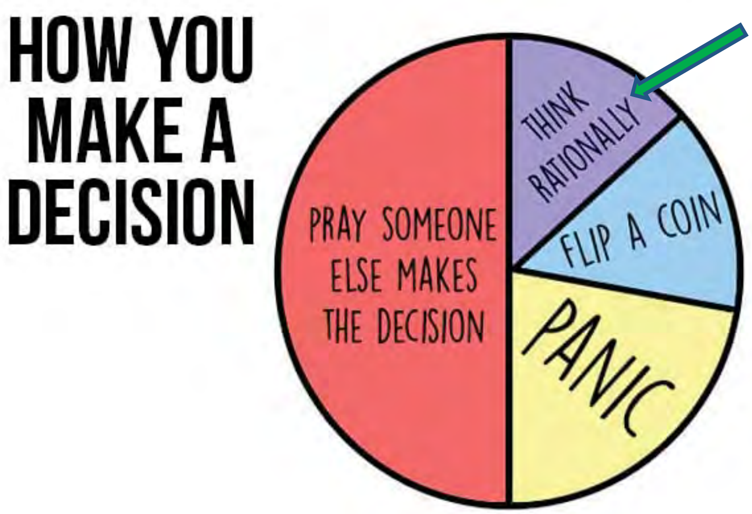
Conclusion

- This is a "First-try" effort to look at application of ABC in South Dakota. The aim is developing background info and basic tools for decision making.
- The Catalog and simple tools developed in this study can be of some reference value to other DOTs with similar constraints.
- This is not for DOTs with established experience and practice procedures for ABC.
- Decision tools have to be simple for people to use.

Download the Report (from MPC) if you want to know more...

Final word



I know it's hard, by try to do this

There is probably no "one size fit all" ABC decision making tool or procedure.

Most are "pre-screener" at best.

True decision needs to be made case-by-case

Acknowledgement

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A partnership with MDT•NDDOT•SDDOT•WYDOT and the Mountain-Plains Consortium Universities

Thank you for participating!

You will be automatically directed to a short survey, please take a moment to provide your feedback.

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