MDOT RC-1610

Accelerated Bridge Construction and Structural Move - Workshop

MARCH 2014

Research

Department of Civil & Construction Engineering
College of Engineering and Applied Sciences
Western Michigan University

Accelerated Bridge Construction and Structural Move - Workshop

Appendices

Project Manager: Matthew Chynoweth, P.E.

Submitted to:

MDOT

Submitted by

Haluk Aktan, Ph.D., P.E.
Professor
(269) 276 – 3206
haluk.aktan@wmich.edu

Upul Attanayake, Ph.D., P.E.
Associate Professor
(269) 276 – 3217
upul.attanayake@wmich.edu

Abdul Wahed Mohammed, EIT
Graduate Research Assistant
(269) 276 - 3204
abdulwahed.mohammed@wmich.edu

Western Michigan University
Department of Civil & Construction Engineering
College of Engineering and Applied Sciences
Kalamazoo, MI 49008
Fax: (269) 276 – 3211

APPENDIX D (PART-II)

WORKSHOP PRESENTATIONS

Accelerated Bridge Construction / Structural Slide and Move Workshop

A range of proven techniques for the sliding of bridges and structures

Presented by Brent Archibald, P.Eng.

Delcan

Acknowledgement

Some of these projects were carried out by others than Delcan

Delcan

A Historical Note: Jacques Cartier Bridge - Montreal

Bridge Sliding is not a new initiative:

On October 20,1957 a 3000 ton truss was laterally rolled into position as a part of the raising of the bridge for the St. Lawrence Seaway. This is the same weight as the Dundas Street Bridge in Trenton, Ontario (presented later).

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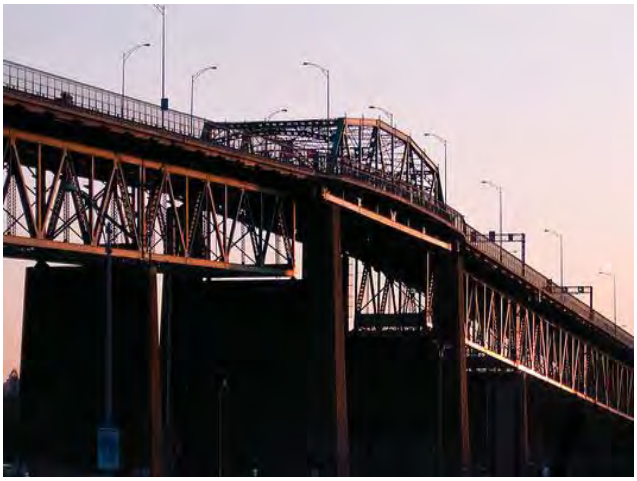


Projects for Discussion

- Dundas Street Bridge – lateral slide
- Don Valley Parkway Underpass – jacking and mining
- West Toronto Diamond – lateral slide

Common constraints which have lead to the implementation of non-traditional construction methods:

- Maintenance of traffic / operations
- Maintenance of utilities
- Maintenance of transportation structures and buildings

Delcan

Inspiration for Dundas Street Bridge

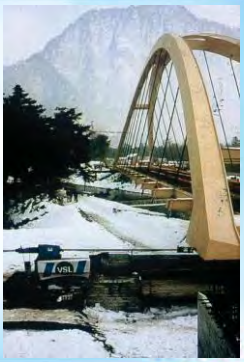
Qauibrucke Bridge, Switzerland

- River Limat at Zurich
- 7800 tonnes
- 54 hour slide performed by VSL
- Both bridges slide at once
- Flexible foundations
- 20 months saved

Inspiration for Complex Bridges

Bridge Near Landquart, Switzerland

- Arch Bridge
- 112 meter (367 ft) span
- Dual plane guiding system



Dundas Street Bridge

- 3 Span Continuous Bridge
- 3000 tonnes
- 4 hour slide
- 10 meter (33 ft) slide
- 8 day possession
- Year 1990

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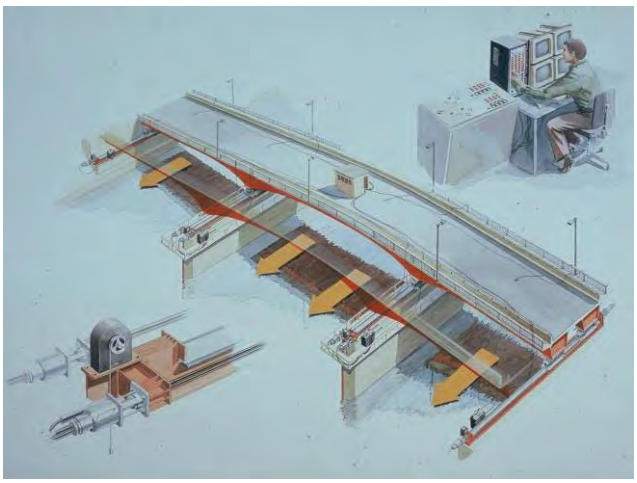

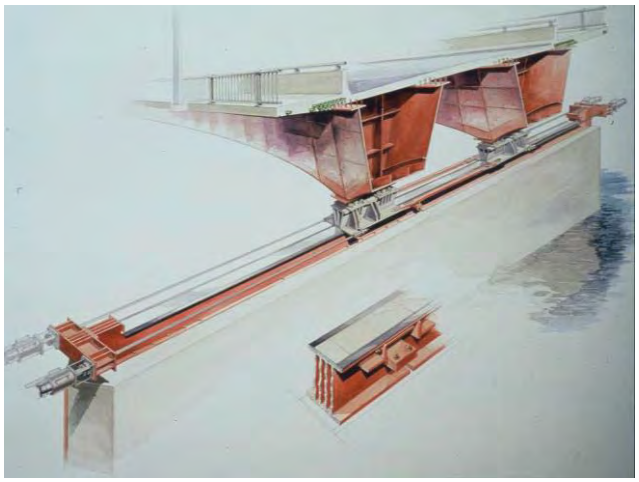

Computer Controlled Jacking System

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Dundas Street Bridge

System Characteristics

- Integration with overall bridge design
- Communication system
- Central computer control
- Precision hydraulic jacking system
- Safety and backup system
- Maximum cost-effectiveness

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Inspiration for DVP Underpass

Bochum Underpass

- Twin cell
- Totally shielded
- 5 electrified rail lines
- Long stroke jacks
- 3 slide paths
- Mixed face

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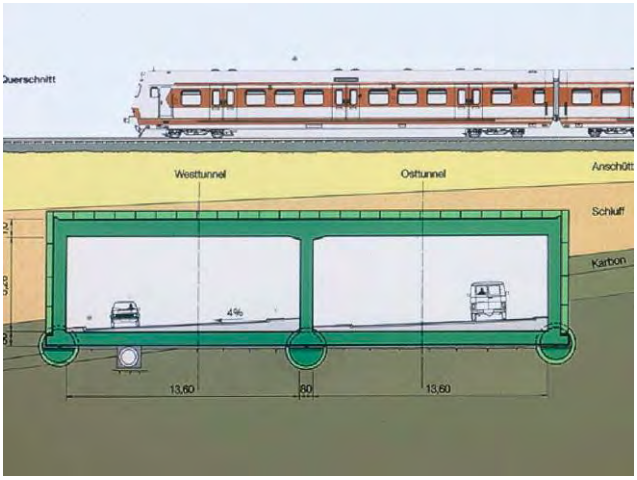
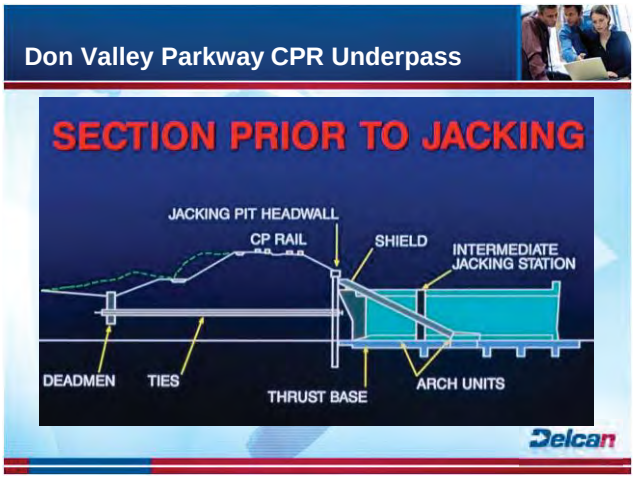
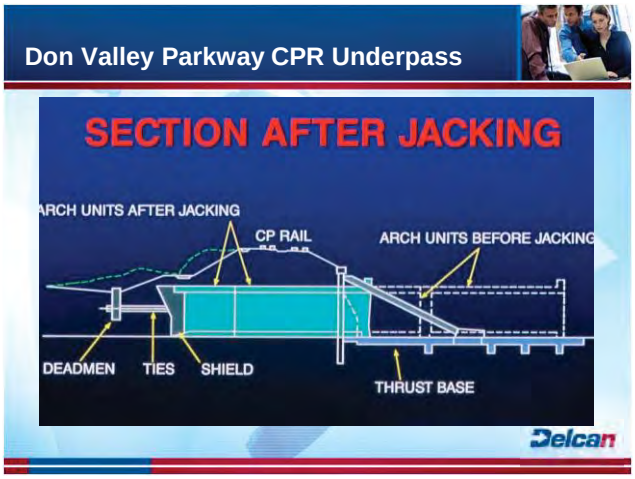


Don Valley Parkway CPR Underpass

- Single cell
- 2000 tonnes
- 11 day jacking and mining operation
- 30 meter (98 ft) slide


Don Valley Parkway CPR Underpass
SECTION PRIOR TO JACKING
JACKING PIT HEADWALL
CP RAIL
SHIELD
INTERMEDIATE JACKING STATION
DEADMEN
TIES
THRUST BASE
ARCH UNITS
Delcan


Don Valley Parkway CPR Underpass
SECTION AFTER JACKING
ARCH UNITS AFTER JACKING
CP RAIL
ARCH UNITS BEFORE JACKING
DEADMEN
TIES
SHIELD
THRUST BASE
Delcan


JOHN DEERE 15


CP Rail
CP Rail


OFFICE LEASING
863-1215

Don Valley Parkway CPR Underpass

Conclusion

- Construction completed successfully
- No damage to existing structures
- No interference with CP Rail traffic
- No effect on Don Valley Parkway traffic
- 6 months ahead of schedule
- Introduction of new technology to North America
- Potential application at major transportation corridors

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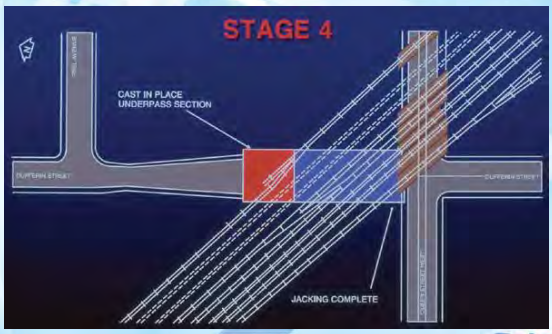
Dufferin Underpass - Toronto
Not everything gets to slide



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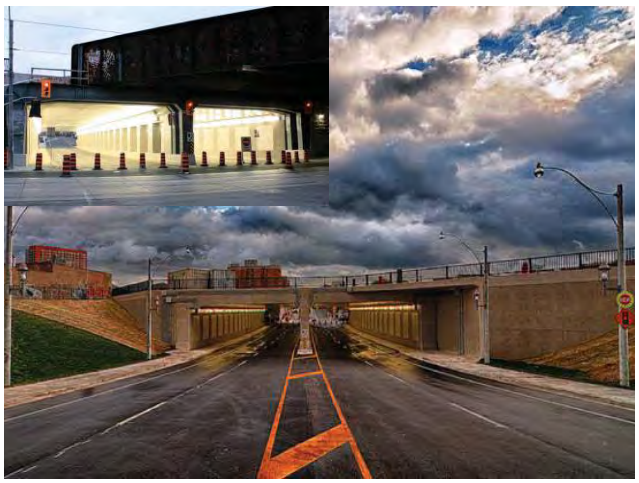

West Toronto Diamond

- 4 pre-stressed /post-tensioned slab bridges
- 5m test slides
- NOTO (2 bridges)
  - 1800 tonnes each
  - 28m (92 ft) slide in 2 hours
  - 24 hr track possession
- OWR (2 bridges)
  - 4500 tonnes each
  - 80m (262 ft) slide in 6 hours
  - 40 hour possession

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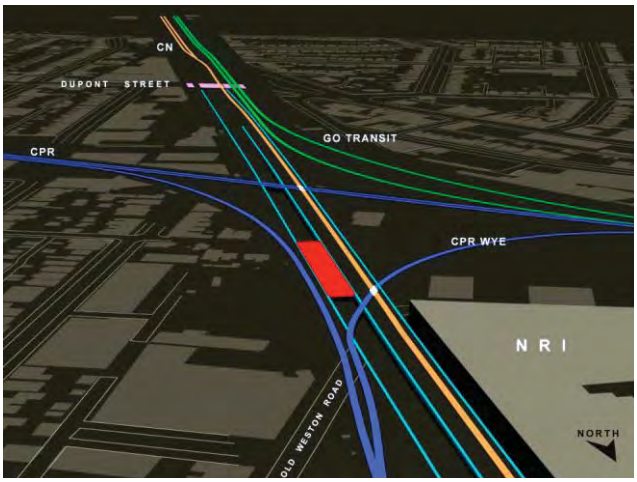

West Toronto Diamond

- Tandem jacks
  - Est. Rate = 20m/hr (65 ft/hr)
- Single jack
  - Est. Rate = 10-12m/hr (33-40 ft/hr)
- Bronze on Steel (friction)
  - 15% static
  - 8% dynamic

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Shop Trial / Friction Test (cont)

Friction

- Greased
  - μ = 0.074 (static)
  - μ = 0.059 (dynamic)

- Oiled
  - μ = 0.11 (static)
  - μ = 0.077 (dynamic)

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GRABCAN
CAT

West Toronto Diamond

Conclusion

- First two slides completed successfully, second two scheduled for summer 2014.
- Limited interference with CP Rail traffic
- Eliminated need for track diversion, property and relocation of railway infrastructure.

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ABC - Structural Slide and Move Workshop

Lansing, MI
December 09, 2013

HNTB

DISCUSSION

Part 1 – Sliding
Part 2 – Launching
Part 3 – Lifting and Floating

HNTB

CONSTRUCTION METHODS

- Floating
- Launching
- Sliding
- Jacking
- Lifting
- Combination

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MDOT Workshop

Part – 1
Sliding

Trenton
Dingle Ridge
Jamaica – Hillside

HNTB

Reconstruction of Hillside and Jamaica Avenue Bridges - Van Wyck Expressway

Pier Bents

Jacking Down

Rolling Technology

Bearing carriage

Sliding Jacks – Manifolded and Synchronized

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MDOT Workshop

Part – 2 Launching

Iowa River
Puenta Chiapas
Schrote
Meaux

HNTB

Incremental Launching!

Segmental concrete

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OPTIMAL DIMENSIONS FOR LAUNCHING

- Spans over 80' with a steel launching nose
- Spans up to 210' with king post and stays
- Temporary piers
- Bridge length between 300' and 4500'

HNTB

GEOMETRY REQUIREMENTS

- Tangent in plan and tangent or circular in profile
- Circular in plan and horizontal in profile
- Spirals possible with wider launch bearings
- Varying-width deck slab possible

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US-20 Iowa River Bridge

HNTB

Launching Nose

HNTB

Launching Pit

HNTB

Rolling Hardware

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Replacement of Belleaire Causeway

HDR

Project Background

HDR

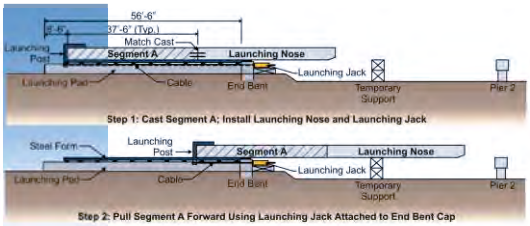
Work Space

HDR

Work Space

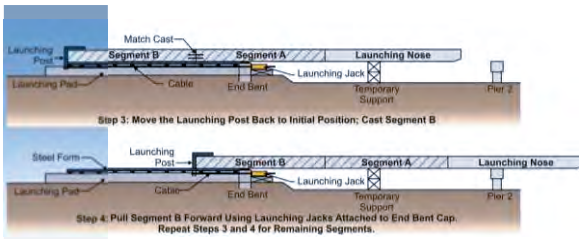
HDR

Launching Sequence



HDR

Launching Sequence



HDR

Formwork

Bulkheads and Anchors

PT and Rebar

HDR

HDR

Hydraulics

HDR

Launching Nose and Intermediate Pier

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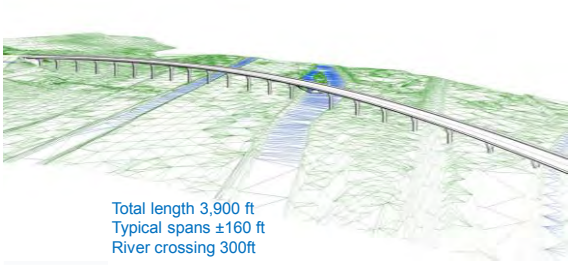
Puente Chiapas – Mexico
Long Span

HNTB

Puente Chiapas – Mexico
300 feet of water

Meaux - Panorama



Total length 3,900 ft
Typical spans ±160 ft
River crossing 300ft

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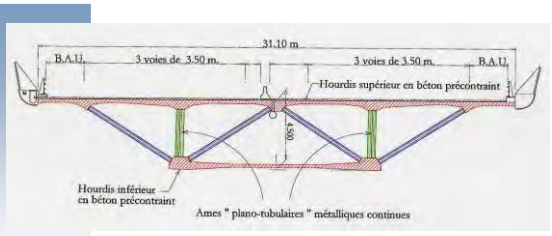
Superstructure Cross Section



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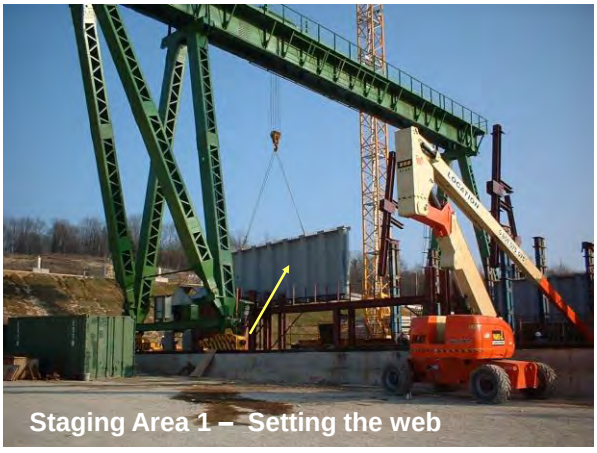

Staging Area 2 –
Bottom Slab

Staging Area 3 –
Construction of top slab and struts

Staging Area 4 –
Final posttensioning and painting

Launching nose – 130ft
Jacking force 1,430 tons

Temporary Pier

Clifford Hollow - WVa

Congested Urban Environments

Small casting yard with no additional right-of-way

- compact casting yard on the footprint of approach embankment
- easy duplication of existing overpasses
- no need for heavy transportation, minimal use of ground cranes
- high quality from no form deflections

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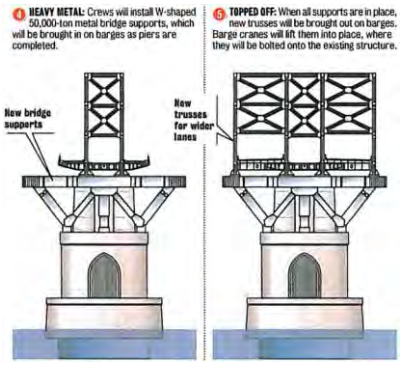
Part – 3
Lifting, Floating and Equipment

Huey P. Long
Hastings
Chavanon
US 17

HNTB

HUEY P. LONG



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WIDENED PIERS

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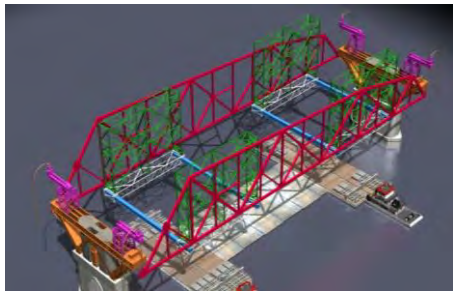
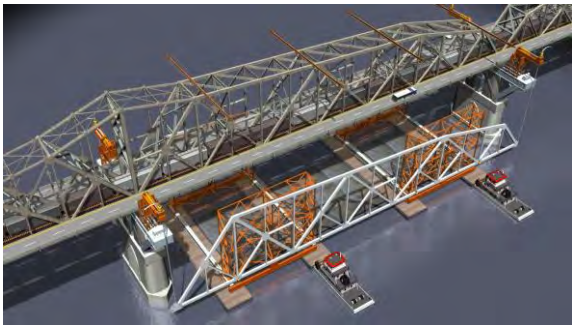
Erection Frame



Erection Frame – Preassembly off site

Float In

Span-By-Span Erection



Straddle Widening Trusses

HNTB

Lateral Slide

HNTB

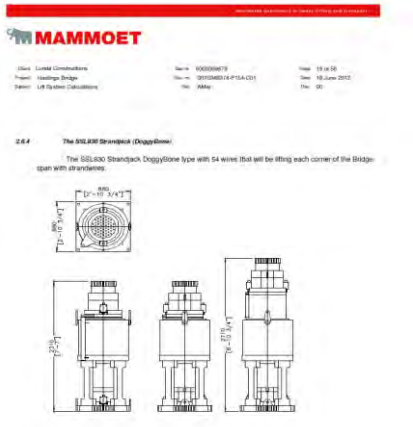
HASTINGS - Foursome

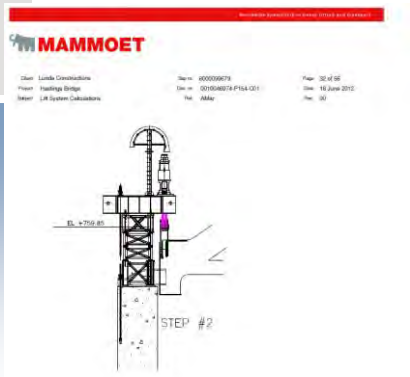
HNTB

HASTINGS - Float

Hastings – Sliding and Lifting

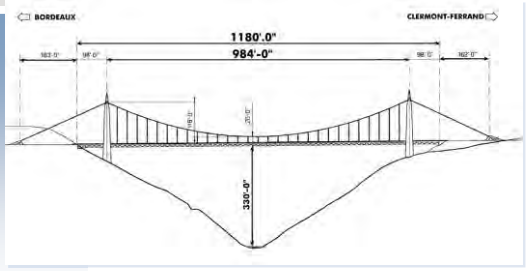
Skidding and Lifting



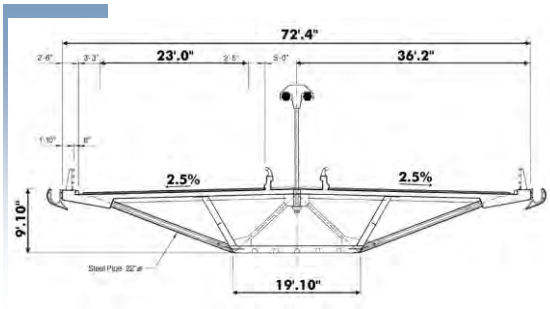


Chavanon

Axial Suspension Bridge

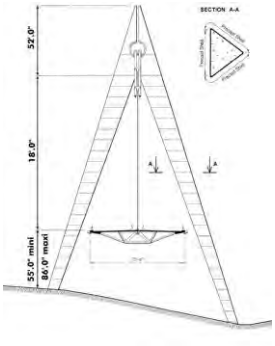


Steel Box Girder - Struts



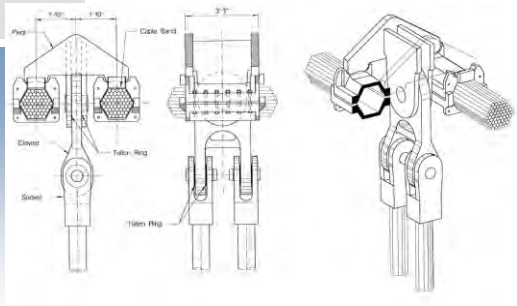
Fabrication Shed

Towers



Prepare to Launch

Permanent Hanger Assemblies



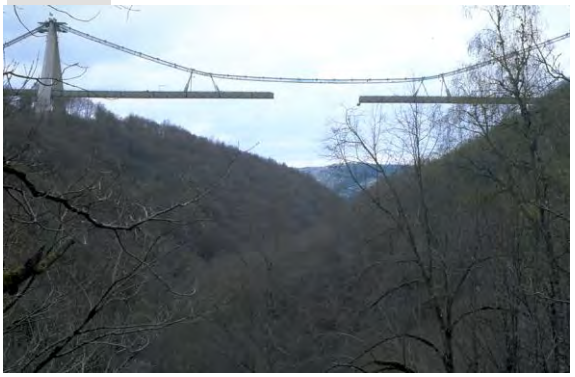
Installation of Permanent Hanger Assemblies

Temporary Hanger – Stage 1

Temporary Hangers 2– Stage

Temporary Hanger Details

Dual Launch



Approaching Closure

Exotic Equipment

US 17 Bypass – Washington, NC

HNTB

Federal Highway Administration

Every Day Counts

Innovation Initiative

National Perspective
on
ABC Implementation

Benjamin Beerman, P.E.
FHWA Resource Center

Michigan DOT
December 9, 2013

Overview

- EDC Initiative: ABC and PBES
- What is PBES
- Resources implementation
- What are we realizing with ABC/PBES?

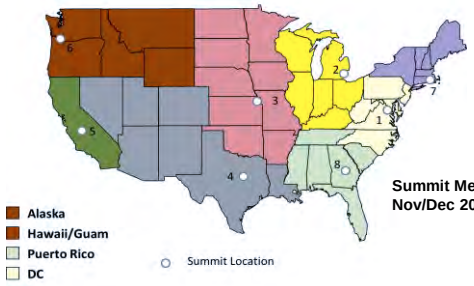
Every Day Counts Initiatives

Safety

Quality

Overall Program Delivery

Every Day Counts II 2012-14



Summit Meetings Nov/Dec 2012

www.fhwa.dot.gov/everydaycounts

EDC II – Initiatives

Shortening Project Delivery

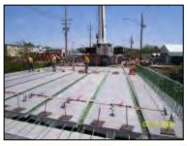
- Programmatic Agreements II
- Locally Administered Federal Aid
- 3 Dimensional Modeling
- Intelligent compaction
- **Accelerated Bridge Construction**
- Design Build
- CMGC
- Alternative Technical Concepts (ATC)

21ST Century Solutions

- High Friction Surfaces
- Intersection and Interchange Geometrics
- Geospatial Data Collaboration
- Environmental Documentation
- First Responder Training (SHRP 2)

Opportunity!

"The EDC program allows bridge practitioners an opportunity to ***advance ABC innovations such as PBES into the mainstream of the bridge industry***. "

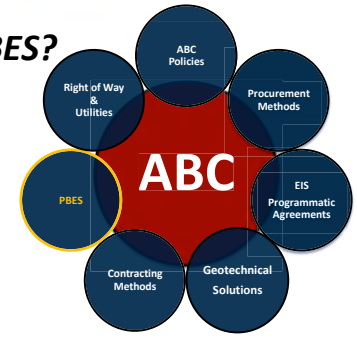


Deployment Activities

- **Workshops**
- **Webinars**
- **Scanning Tours**
- **Project Reviews**
- **Project Showcases**
- **Regional Peer Exchanges**




ABC and PBES?

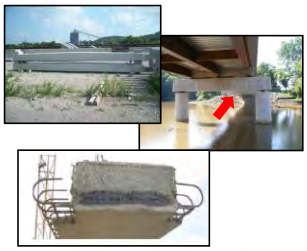


Definition of PBES

PBES are structural components of a bridge that are built offsite, or adjacent to the alignment, and includes features that reduce the ***onsite construction time*** and ***mobility impact time*** that occurs from ***conventional construction*** methods.

Element vs. System?

Elements



Systems

What are PBES?

Elements: single structural component of a bridge

- Deck Element
- Beam Elements
  - "Deck" Beam Elements
  - "Full-Width" Beam Elements
- Pier Elements
- Abutment & Wall Elements
- Miscellaneous Elements

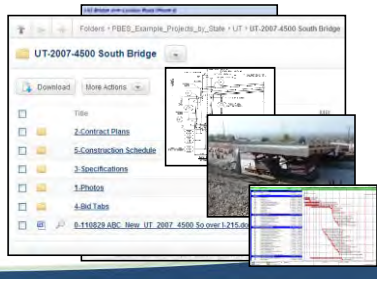
What are PBES?

Systems: - entire superstructure,
- entire superstructure & substructure,
- total bridge

National ABC/PBES Project Exchange

Project Examples use PBES/ABC

- Contract Plans
- Specifications
- Bid Tabs
- Schedule
- Pictures



- **ABC Project Exchange User's Guide**:
  Refer to the **July 25, 2013** (National ABC Project Exchange) webinar hosted by the FIU ABC Center
  http://www.abc.fiu.edu/archive-of-past-events/

- **FHWA External Collaboration Portal**
  1) Register &
  2) Request Site Access
  https://www.transportationresearch.gov/dot/fhwa/default.aspx

Other Resources

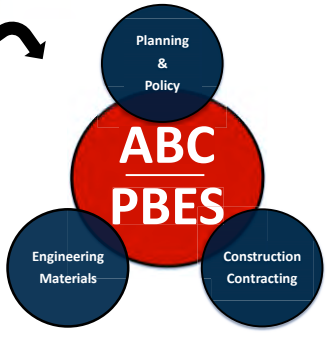
Webinar Training - Industry

www.fhwa.dot.gov/everydaycounts/technology/bridges/pbeswebinartraining

Publications

www.fhwa.dot.gov/bridge/prefab/pubs.cfm

Publications - future



Regional Peer Exchange

http://p2p.ara-tracker.com/

Webinar Training - FIU

FIU | Accelerated Bridge Construction (ABC) Center
Florida International University

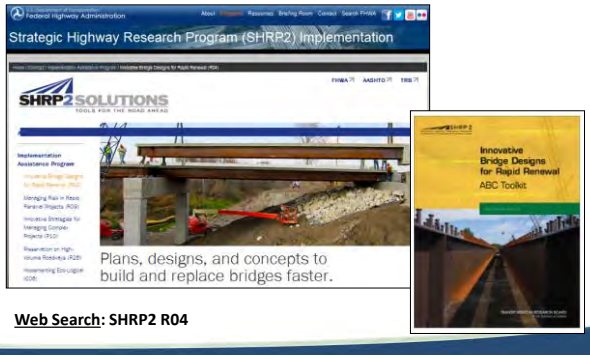
Thursday, December 19, 2013 – 1:00 to 2:00 p.m. Eastern

New York State's I-84/Dingle Ridge Lateral Slide Project

Jerry A. DiMaggio, PE
Bala Sivakumar, PE

www.abc.fiu.edu

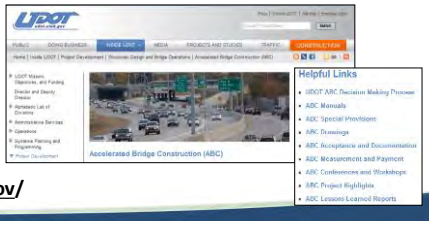
SHRP2 – R04



Web Search: SHRP2 R04

Other Websites

www.pcine.org/



www.udot.utah.gov/

TRB TRANSPORTATION RESEARCH BOARD OF THE NATIONAL ACADEMIES

Formation of ABC Subcommittee

AFF10 General Structures – parent committee
AFF10(3) – Subcommittee for ABC

Chair: Ben Beerman, FHWA
Vice Chair: Mary Lou Ralls

https://sites.google.com/site/trbaff103

TRB TRANSPORTATION RESEARCH BOARD OF THE NATIONAL ACADEMIES

Recent ABC NCHRP projects

- Development of an Accelerated Bridge Construction (ABC) Design and Construction Guide Specification: NCHRP 12-102

- Guidelines for Tolerances for Prefabricated Bridge Elements and Systems and Dynamic Effects in Large-Scale Bridge Moves: NCHRP 12-98

PBES/ABC and MAP-21

- **Section 1304**

  Allows Federal participation to be increased by up to 5% (not to exceed 100%) of the total project cost for projects that include innovations such as PBES technologies.

Incentive Grant Program

- Accelerated Innovation Deployment Grant

  FHWA-2013-0048
- NOFA comments due 11/22/13
- $15M/year
- Up to $1M/project

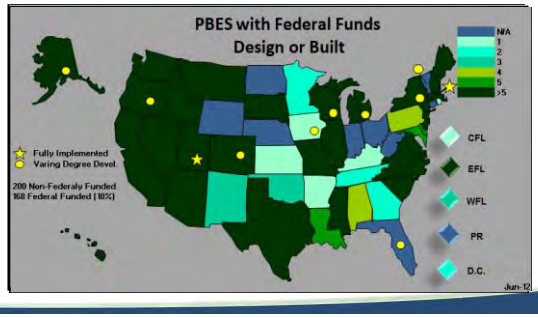
www.fhwa.dot.gov/accelerating/grants/index.cfm

Resources - Summary

- **ABC Project Exchange:**
  - User Guide (FIU – July 25, 2013 webinar) http://www.abc.fiu.edu/event-on-07252013/
  - FHWA Collaboration Portal https://www.transportationresearch.gov/dot/fhwa/default.aspx
- **PBES Webinar Training:**
  - www.fhwa.dot.gov/everydaycounts/technology/bridges/pbeswebinartraining
- **PBES Peer Exchanges:**
  - http://p2p.ara-tracker.com/
- **ABC/PBES Publications:**
  - www.fhwa.dot.gov/bridge/prefab/pubs.cfm
- **Ongoing monthly ABC webinars via FIU:**
  - www.abc.fiu.edu
- **SHRP2 R04 Product:**
  - http://www.fhwa.dot.gov/goshrp2/
- **PCI North East:**
  - www.pcine.org/
- **Utah DOT:**
  - http://www.udot.utah.gov/main/f?p=100:pg:0:::1:T,V:1991
- **TRB ABC Subcommittee AFF10(3):**
  - https://sites.google.com/site/trbaff103
- **MAP 21:**
  - http://map21.transportation.org/Pages/MAP21Bill.aspx
- **Innovative Funding Grant Program:**
  - http://www.fhwa.dot.gov/accelerating/grants/index.cfm

What has been done?

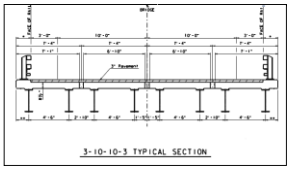
850 bridge projects

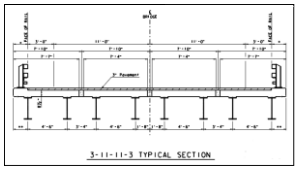


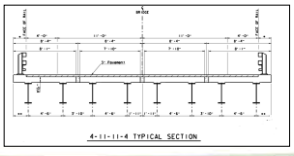
Paradigm Shift old practices

Paradigm Shift strategies

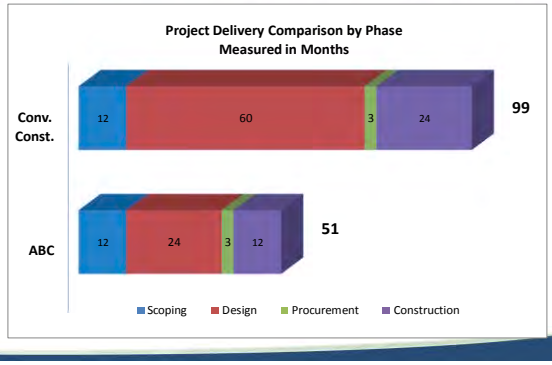
Paradigm Shift – standards







Other Reasons for PBES

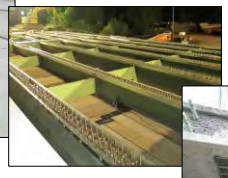


Contractor's Feedback

Prefabricated Piers (columns/caps)

Contractor's Feedback

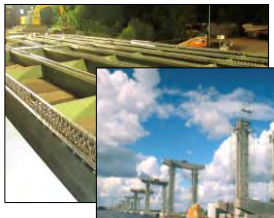
Full Depth Deck Panels



Contractor's Feedback

SPMTs

Opportunities for Improvement



Public and Political Capitol

PBES/ABC is a positive message!

"As stewards of the transportation program, we are doing due diligence to meet the needs of the traveling public."

Thank You!

FHWA

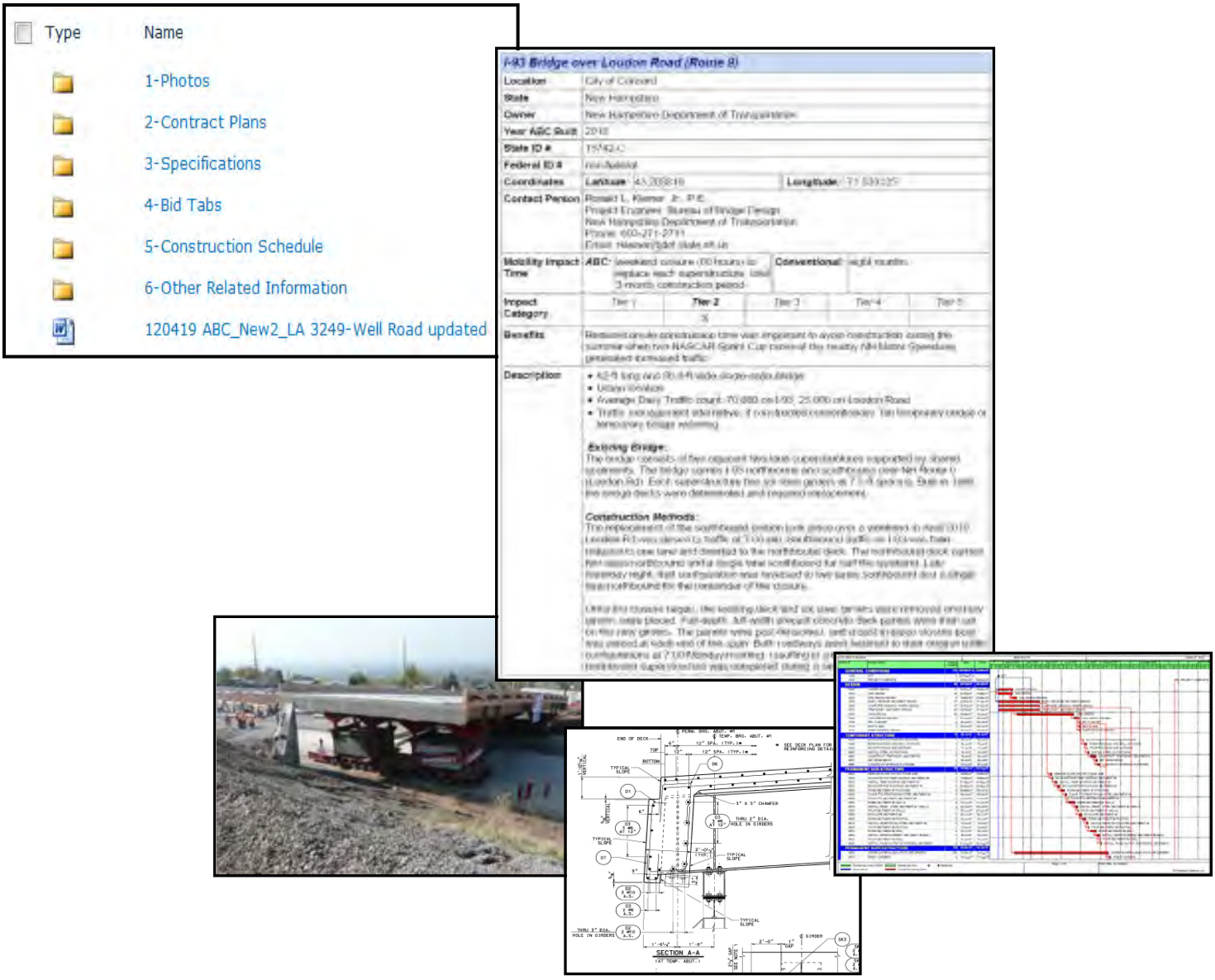
Benjamin Beerman, P.E.

Resources - Summary

- **ABC Project Exchange:**
  - User Guide (FIU – July 25, 2013 webinar) http://www.abc.fiu.edu/event-on-07252013/
  - FHWA Collaboration Portal https://www.transportationresearch.gov/dot/fhwa/default.aspx
- **PBES Webinar Training:**
  - www.fhwa.dot.gov/everydaycounts/technology/bridges/pbeswebinartraining
- **PBES Peer Exchanges:**
  - http://p2p.ara-tracker.com/
- **ABC/PBES Publications:**
  - www.fhwa.dot.gov/bridge/prefab/pubs.cfm
- **Ongoing monthly ABC webinars via FIU:**
  - www.abc.fiu.edu
- **SHRP2 R04 Product:**
  - http://www.fhwa.dot.gov/goshrp2/
- **PCI North East:**
  - www.pcine.org/
- **Utah DOT:**
  - http://www.udot.utah.gov/main/f?p=100:pg:0:::1:T,V:1991
- **TRB ABC Subcommittee AFF10(3):**
  - https://sites.google.com/site/trbaff103
- **MAP 21:**
  - http://map21.transportation.org/Pages/MAP21Bill.aspx
- **Innovative Funding Grant Program:**
  - http://www.fhwa.dot.gov/accelerating/grants/index.cfm

National ABC Project Exchange
User's Guide

July 18, 2013



National ABC Project Exchange User's Guide

Intro

The Accelerated Bridge Construction (ABC) Project Exchange is a nationwide repository of projects that have incorporated Prefabricated Bridge Elements and Systems (PBES) with other innovative strategies to accomplish the objects of ABC. The purpose of the site is to share detailed project information and experiences among bridge practitioners located throughout the United States and abroad.

Development and management of this site is through a collaborative effort between the Federal Highway Administration (FHWA) and the American Association of State Highway and Transportation Officials (AASHTO).

The posted information is made available to anyone who has registered and requested site access.

This User's Guide provides detailed information and instructions in the following areas:

- Site structure & navigation
- How to register & request site access
- Using the ABC Project Exchange
- Support

Disclaimer

The State Departments of Transportation (State DOT's) who submitted their information to help develop this site have approved the material contained in the ABC Project Exchange for posting and distribution. All attempts are made to assure the accuracy of the content posted; however, the FHWA, AASHTO, State DOT's and any person or organization that has assisted in collecting and compiling the posted information are not responsible for the accuracy of the material, or the manner in which it is interpreted or used.

Site Structure and Navigation

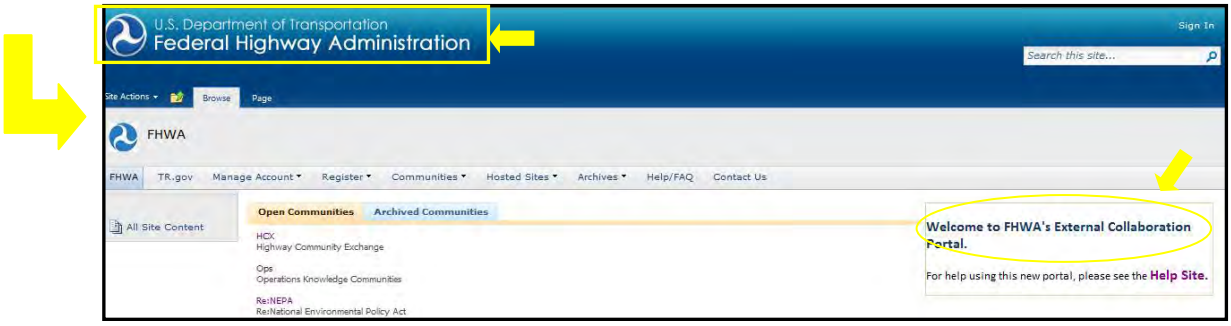
Site Structure and Navigation

The information in the **ABC Project Exchange** is housed on the **Innovation Exchange** - which is a shared platform for discipline specific groups to exchange information as a means to advance innovations into the transportation industry.

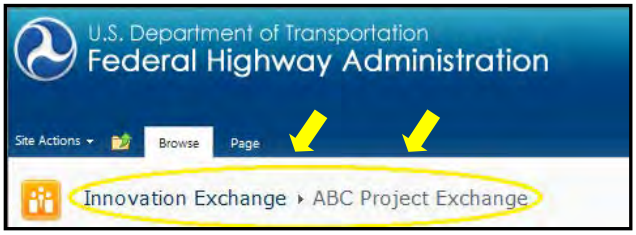
The **Innovation Exchange** is a closed community that resides on the **FHWA's External Collaboration Portal** - which is hosted on the U.S. Department of Transportation's Research and Innovation Technology Administration site (**DOT's RITA** site).

The following demonstrates the hierarchy of the site structure…

DOT's RITA site



FHWA's External Collaboration Portal



Innovation Exchange
ABC Project Exchange

Note: You will be required to **Sign In** when:

- requesting site access to the **Innovation Exchange**
- accessing the **ABC Project Exchange** from the **FHWA External Collaboration Portal**

After successfully signing in, you will be sent to the **DOT's RITA** site. As shown above…

- Select the "**Federal Highways Sites**" tab to return to the **FHWA External Collaboration Portal**.
- Scroll down the page and select the **ABC Project Exchange** link to go directly to the **ABC Project Exchange** welcome page.

Banner headings similar to what is shown above are captioned in yellow throughout this User's Guide as a navigational aid.

How to Register and request Site Access

Privacy Policy

Your contact information will be required for site access to the ABC Project Exchange. Apart from your first and last name, no other contact material will be posted on the ABC portion of the Innovation Exchange. Sharing of contact information that is not approved for posting on the ABC Project Exchange is considered illegal. For more information related to the privacy policy for the ABC Project Exchange go to the following link: https://www.transportationresearch.gov/dot/fhwa/SitePages/ContactUs.aspx.

Registration & Site Access

Access to the **National ABC Project Exchange** is a sequential, two-step process. An overview of the process is shown below:

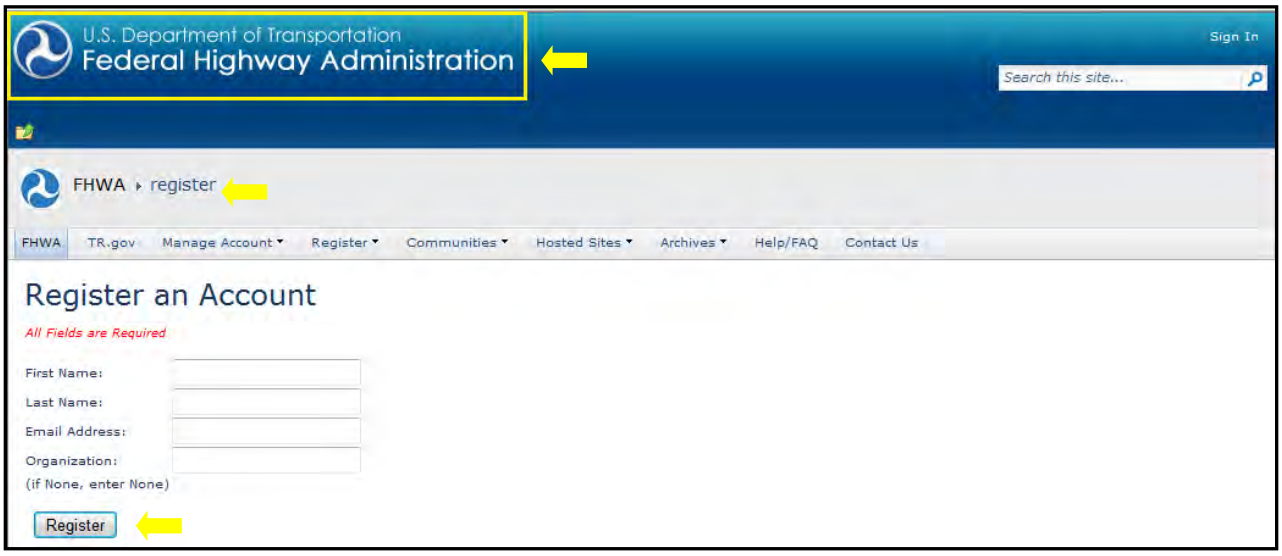
Step 1: **Register** an account on the **FHWA's External Collaboration Portal**
[**Registration** approval occurs within 24 hours]

Step 2: **Request Access** to the **Innovation Exchange** – which is a closed Community on the **FHWA's External Collaboration Portal** that houses the **ABC Project Exchange**
[**Site Access** approval occurs within 24 hours]

Note: Registration approval in Step 1 must be received prior to proceeding to Step 2.

Step 1: Registration

- Go to the **FHWA's External Collaboration Portal** Registration link:
  https://www.transportationresearch.gov/dot/fhwa/SitePages/register.aspx
- Enter the information requested as shown below.

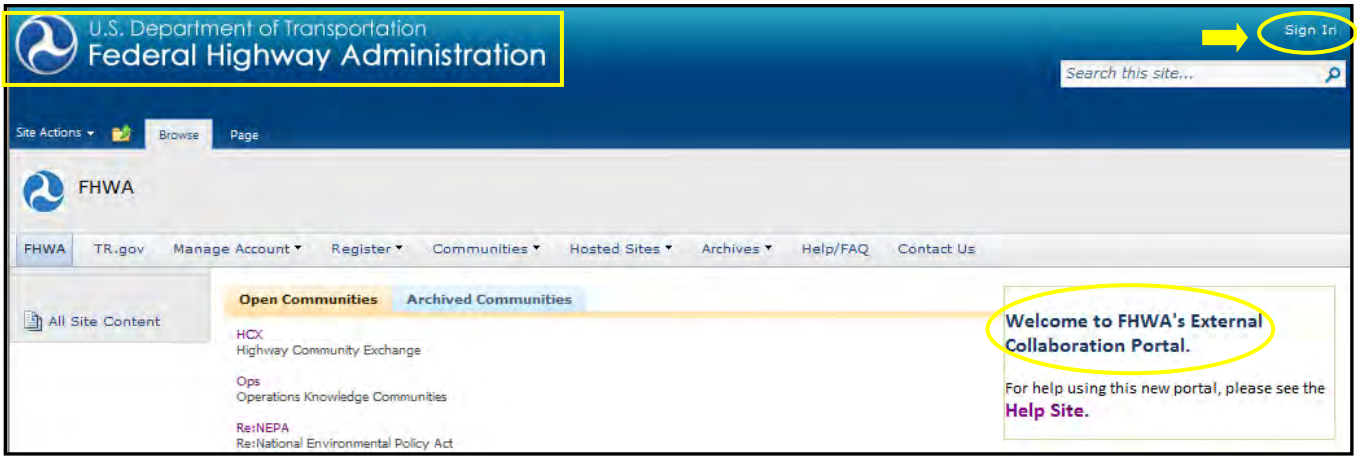


- For security purposes, two emails will be provided within ***24 business hours.*** They will include a UserID and Temporary Password required for Step 2.
- Proceed to Step 2. **Site Access** (next page)

Step 2: Site Access

- After a UserID and password is provided from Step. 1, go to the **FHWA's External Collaboration** site: **https://www.transportationresearch.gov/dot/fhwa/default.aspx**

- As shown below, select the **"Sign In"** icon located in the upper right hand corner of the screen…



- and the Login Screen as shown below will appear.

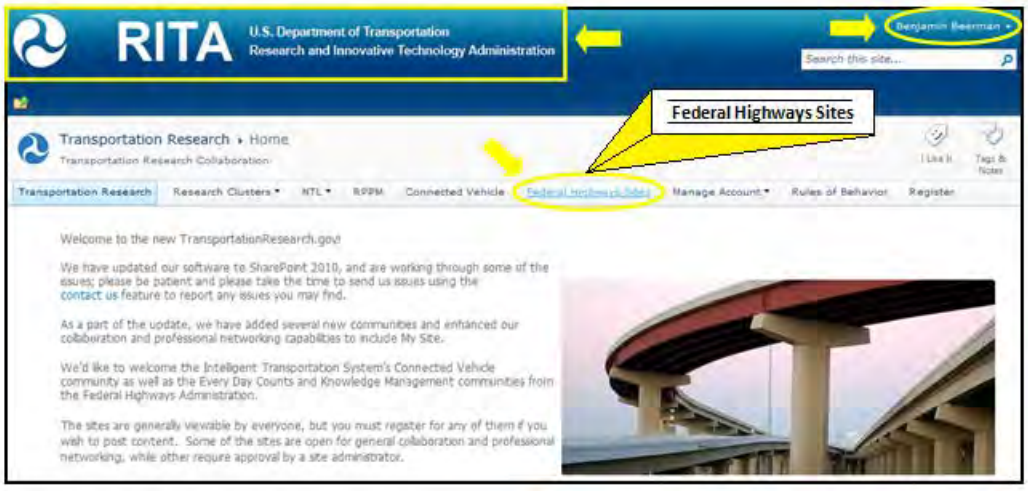
- Enter the Information Requested using the UserID and Password provided in Step 1.

- Select the "**Submit**" icon.

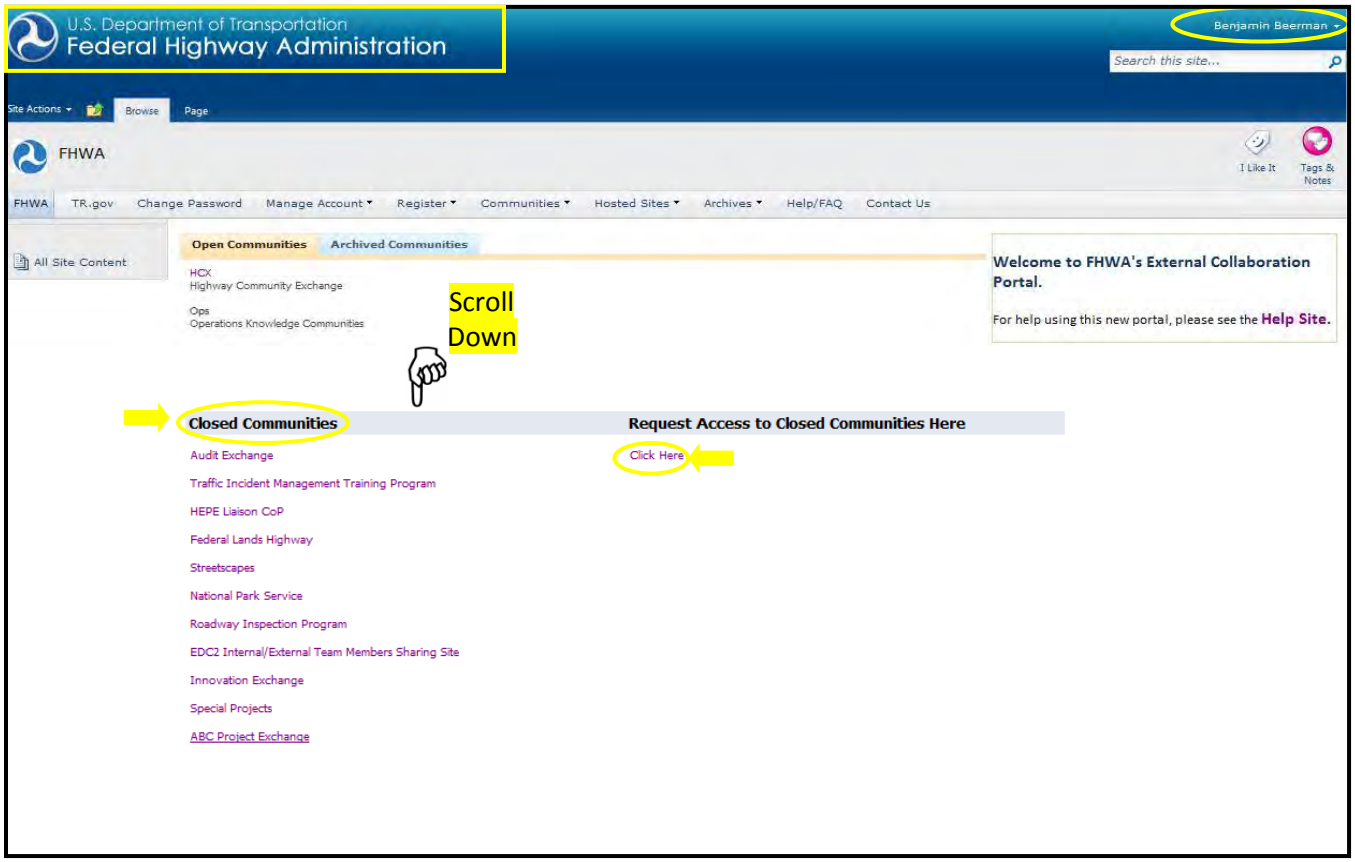
- As shown below, you will be sent to the **DOT's RITA** site.

Note: your user name shown to the right of the screen indicates that you are **Signed In**

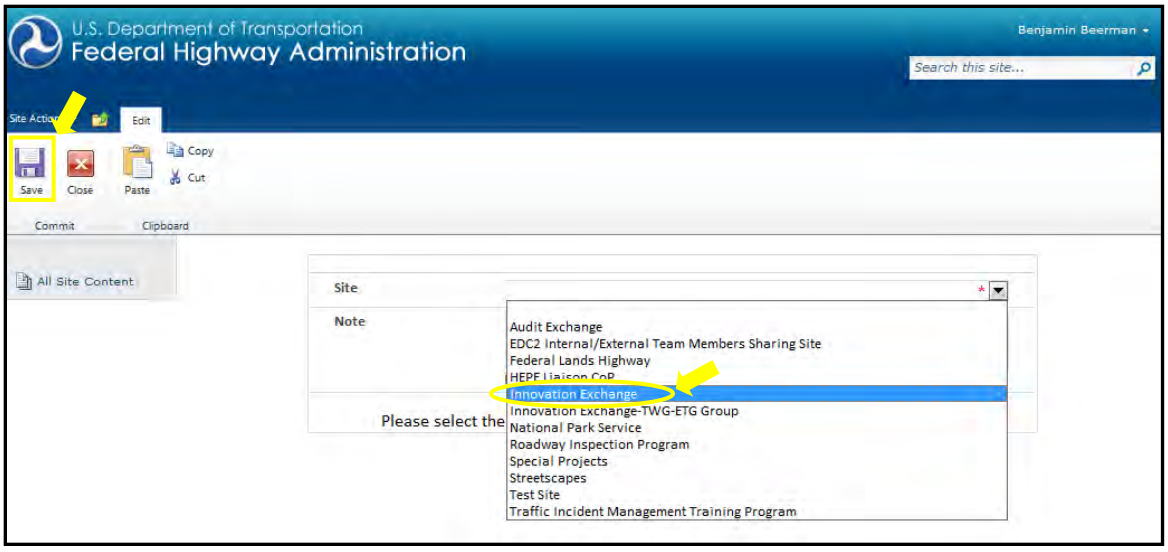
- Select the "**Federal Highways Sites"** tab as shown….



- to be sent back to the **FHWA's External Collaboration Portal** as shown below.
- Scroll down the page to the "***Closed Communities"*** heading and
- **Request Site Access** to the **Closed Communities** by selecting the "***click here***" link as shown.



- Select "**Innovation Exchange**" from the pull down menu as shown below…
- In the "**Note**" box type the following: "***Request access to the ABC Project Exchange***"
- Select the "**Save**" icon.

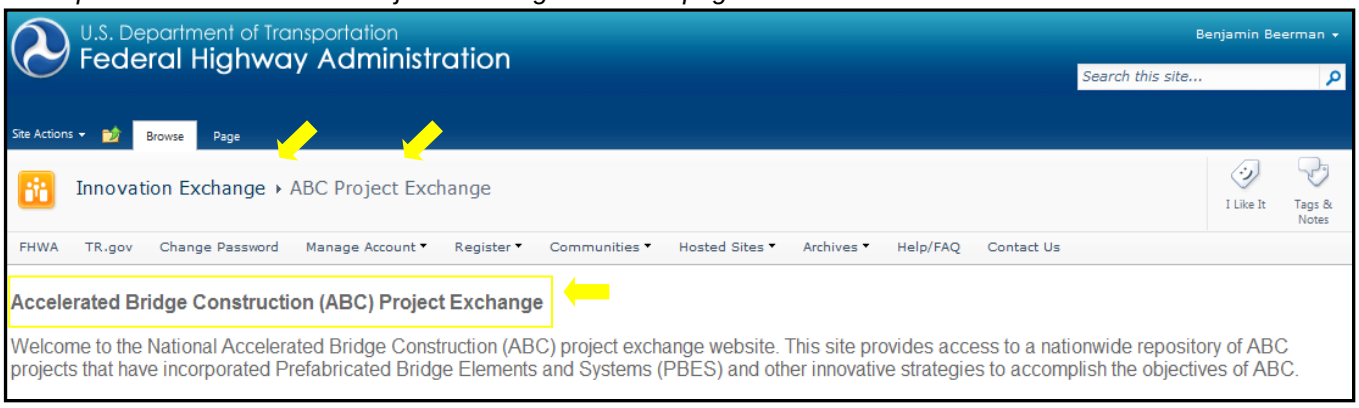


- A second email confirming **Access** to the **Innovation Exchange,** which houses the **ABC Project Exchange** will be provided within ***24 business hours***.

Registration and Site Access is now complete.

Once an email confirming you have access to the Innovation Exchange is received, you will be allowed to access to the National ABC Project Exchange.

A partial view of the ABC Project Exchange welcome page is shown below…



Using the ABC Project Exchange

- Contents and Organization
- Sign In and Navigation
- Search for project information
- Download and View documents and photos
- The Project Summary Report
- Support

Contents and Organization

The **ABC Project Exchange** contains detailed project information organized by state directory. Within each state directory are project folders that include a **Project Summary Report** (in a MS Word document) and information organized in the following subdirectories:

1. Photos
2. Contract Plans
3. Specifications
4. Bid Tabs
5. Construction Schedule
6. Other related information

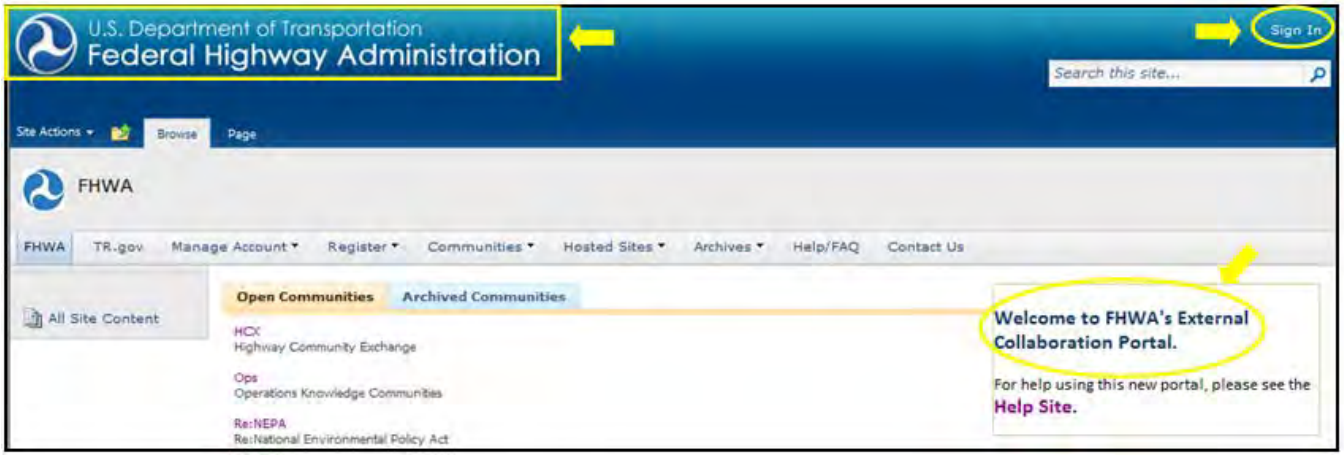
Project Summary Report

Note: If a subdirectory is not shown, the information is not available.

To access this information, you must be **Registered** and have **Site Access** to the **Innovation Exchange**.

Sign In and Navigation- after Registration and Site Access

- Go to the **FHWA's External Collaboration Portal** at the following link: https://www.transportationresearch.gov/dot/fhwa/default.aspx
- Select the "**Sign In**" tab as shown below.

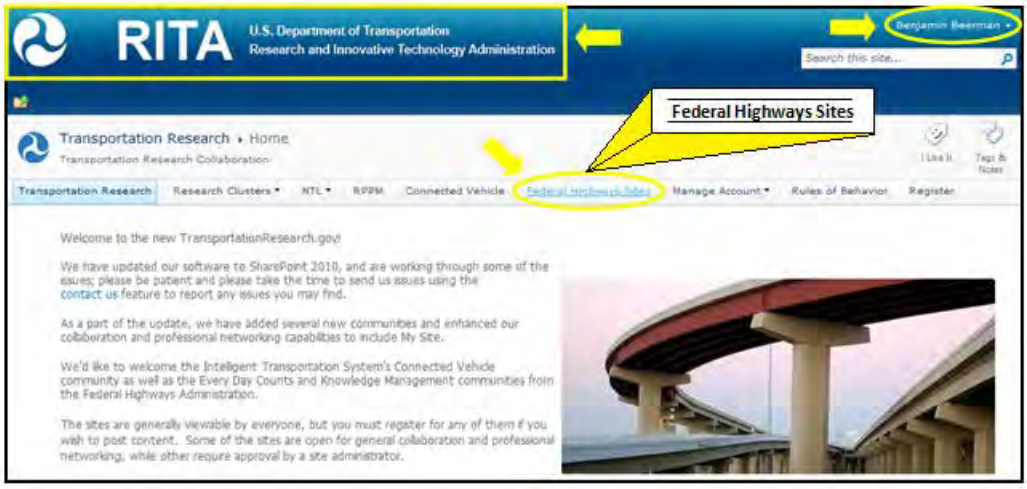


- The following Login window will appear.
- Enter your UserID and Password and click the "**Submit**" icon.

- You will be sent to the **DOT's RITA** site as shown below.

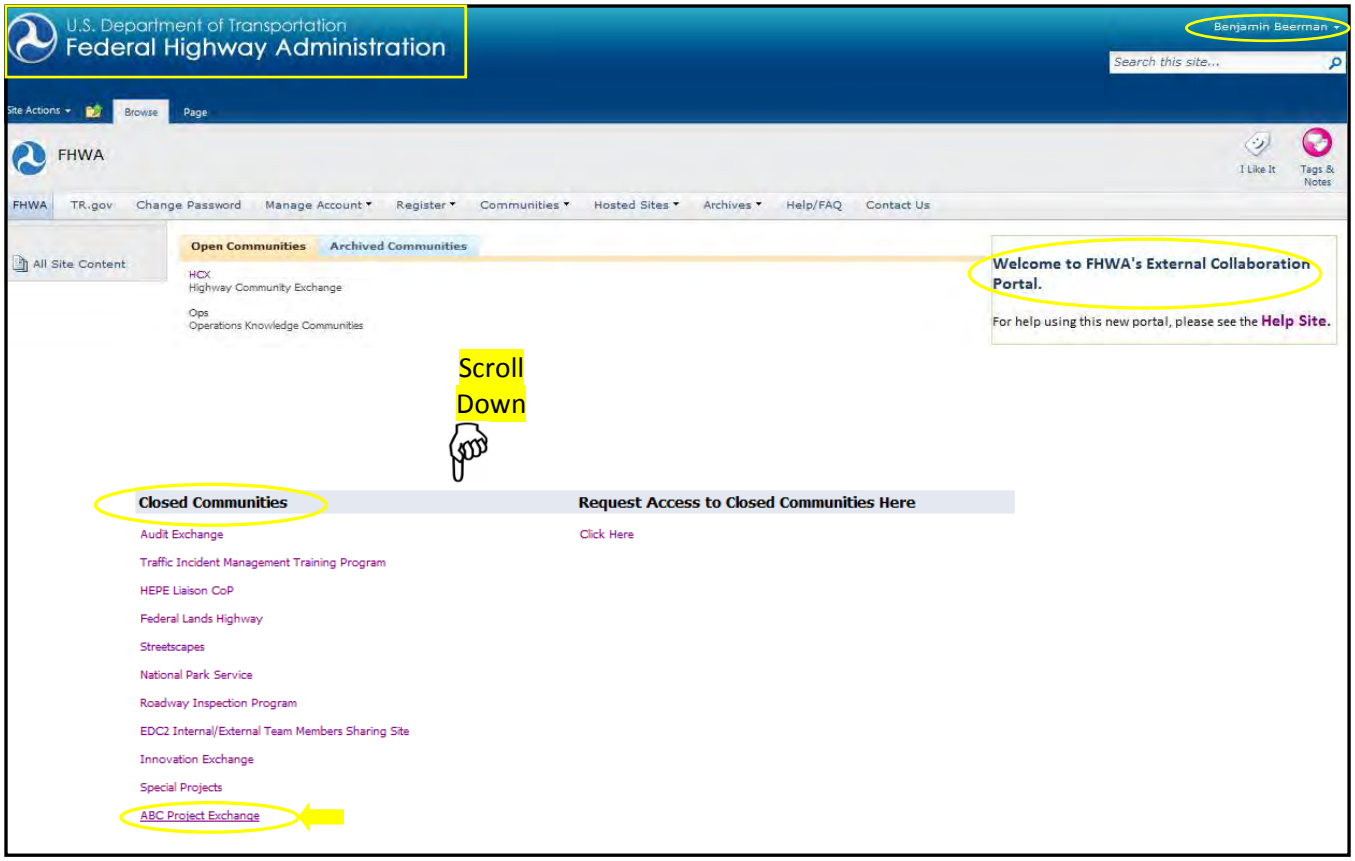
  Note: Your user name is shown in the upper right indicating that you are **Signed In**

- Select the "**Federal Highways Sites"** tab as shown.



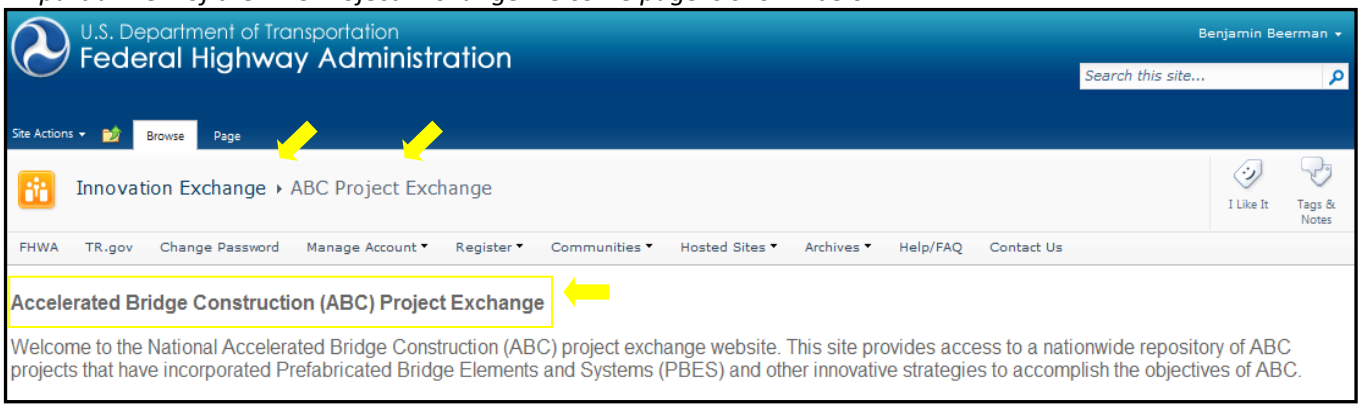
- Which will bring you back to the **FHWA's External Collaboration Portal** as shown below.

- Scroll Down to the **"*Closed Communities*"** heading and select the **ABC Project Exchange** tab as shown…



- To arrive at the **ABC Project Exchange** Welcome page

A partial view of the ABC Project Exchange welcome page is shown below…



Search for project information

There are two options to search for project information in the ABC Project Exchange. An overview, and step-by-step instructions is provided below:

Option 1: Uses a **Microsoft Excel Spreadsheet** to give you the ability to search for specific technologies using *key words* from pull down menus (direct method).

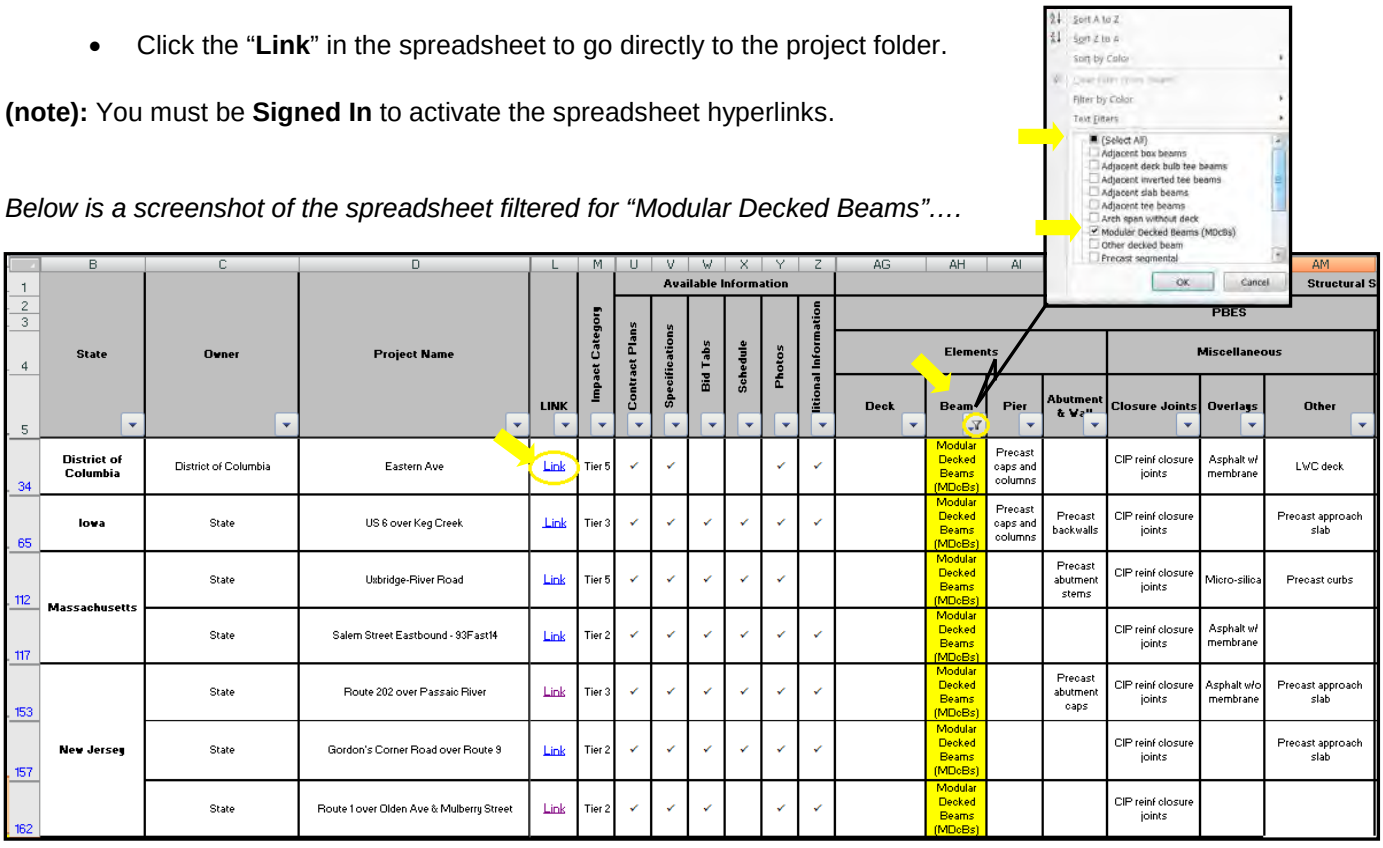
Option 2: By **State** directory – which requires you to navigate through individual project folders and subdirectories (indirect method).

Option 1: Search using the **Microsoft Excel Spreadsheet**

- On the **ABC Project Exchange** welcome page, select the **MS Excel Spreadsheet** link (picture not shown)
- The spreadsheet will open as shown below.
- Search for specific technology using the *key words* in the pull down menus available in the spreadsheet. A glossary of key terms is on the **ABC Project Exchange** welcome page.
- Click the "**Link**" in the spreadsheet to go directly to the project folder.

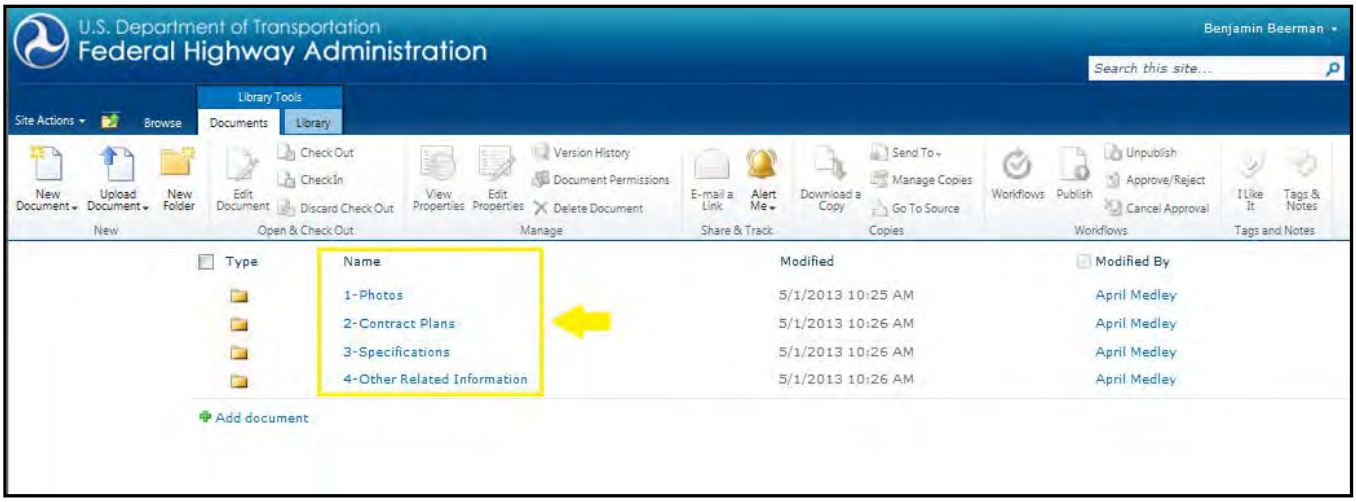
(note): You must be **Signed In** to activate the spreadsheet hyperlinks.

Below is a screenshot of the spreadsheet filtered for "Modular Decked Beams"….



	State	Owner	Project Name	LINK	Impact Category	Available Information: Contract Plans	Specifications	Bid Tabs	Schedule	Photos	Additional Information	PBES: Elements: Deck	Beam	Pier	Abutment & Wall	PBES: Miscellaneous: Closure Joints	Overlays	Other	Structural S
34	District of Columbia	District of Columbia	Eastern Ave	Link	Tier 5	✓	✓			✓	✓		Modular Decked Beams (MDcBs)	Precast caps and columns		CIP reinf closure joints	Asphalt w/ membrane	LWC deck	
65	Iowa	State	US 6 over Keg Creek	Link	Tier 3	✓	✓	✓	✓	✓	✓		Modular Decked Beams (MDcBs)	Precast caps and columns	Precast backwalls	CIP reinf closure joints		Precast approach slab	
112	Massachusetts	State	Usbridge-River Road	Link	Tier 5	✓	✓	✓	✓	✓			Modular Decked Beams (MDcBs)		Precast abutment stems	CIP reinf closure joints	Micro-silica	Precast curbs	
117		State	Salem Street Eastbound - 93Fast14	Link	Tier 2	✓	✓	✓	✓	✓	✓		Modular Decked Beams (MDcBs)			CIP reinf closure joints	Asphalt w/ membrane		
153	New Jersey	State	Route 202 over Passaic River	Link	Tier 3	✓	✓	✓	✓	✓	✓		Modular Decked Beams (MDcBs)		Precast abutment caps	CIP reinf closure joints	Asphalt w/o membrane	Precast approach slab	
157		State	Gordon's Corner Road over Route 9	Link	Tier 2	✓	✓	✓	✓	✓	✓		Modular Decked Beams (MDcBs)			CIP reinf closure joints		Precast approach slab	
162		State	Route 1 over Olden Ave & Mulberry Street	Link	Tier 2	✓	✓	✓		✓	✓		Modular Decked Beams (MDcBs)			CIP reinf closure joints			

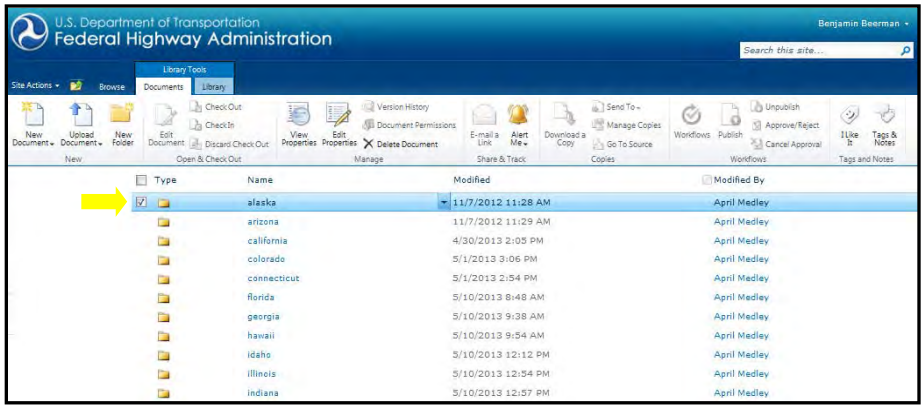
*Selecting the "**Link**" in the spreadsheet will take you to the project folder that contains the available detailed information. An example is shown below…*



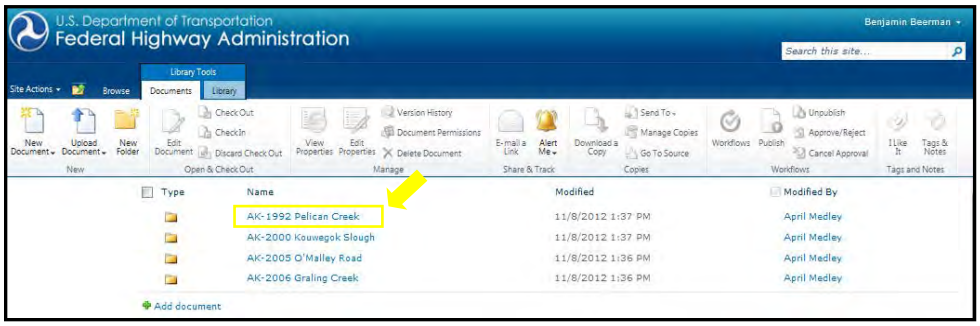
Option 2: Searching by **State Directory**

- On the **ABC Project Exchange** welcome page, select the **"ABC projects by state**" link

Shown below is the State directory. Selecting a State directory will take you to the posted projects folders. Within each state project folder is the Project Summary Report (MS Word document) and the subdirectories that contain the available project information. An example is shown below….



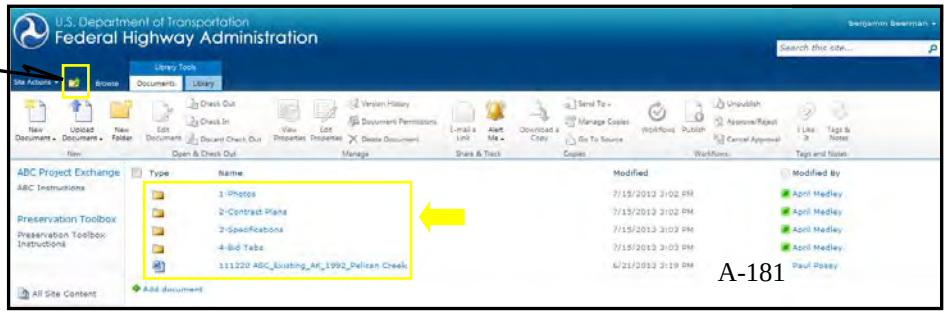
State Directory



Project Folders

Project Subdirectory

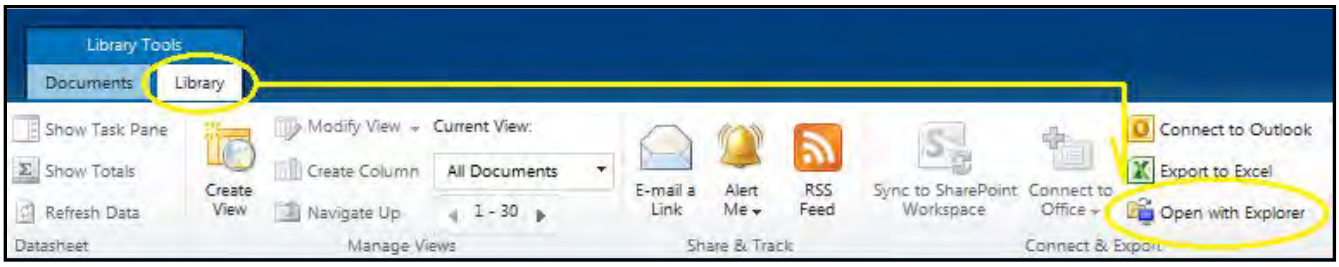
Note: the "folder" icon will allow you to go back.



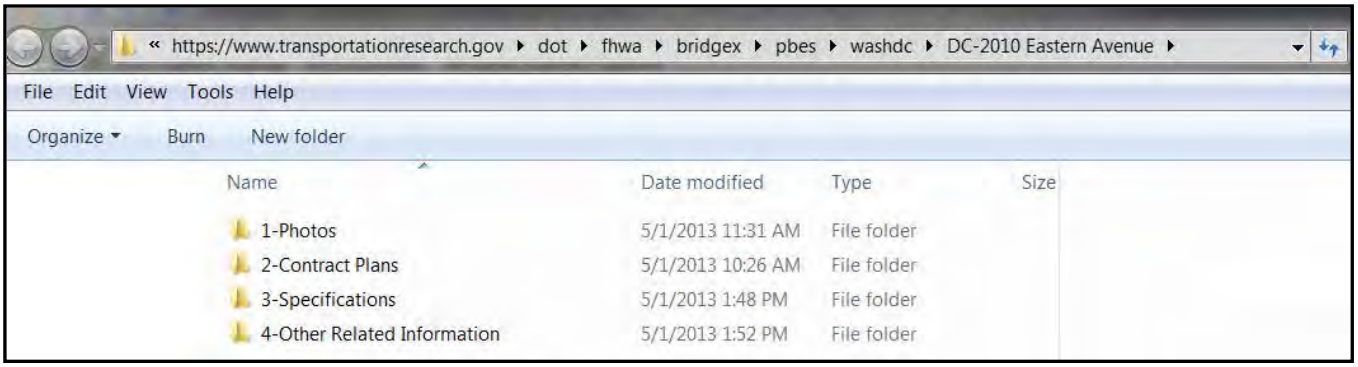
Download and view documents and photos:

All material, including documents and photos, can be viewed and downloaded to your computer.

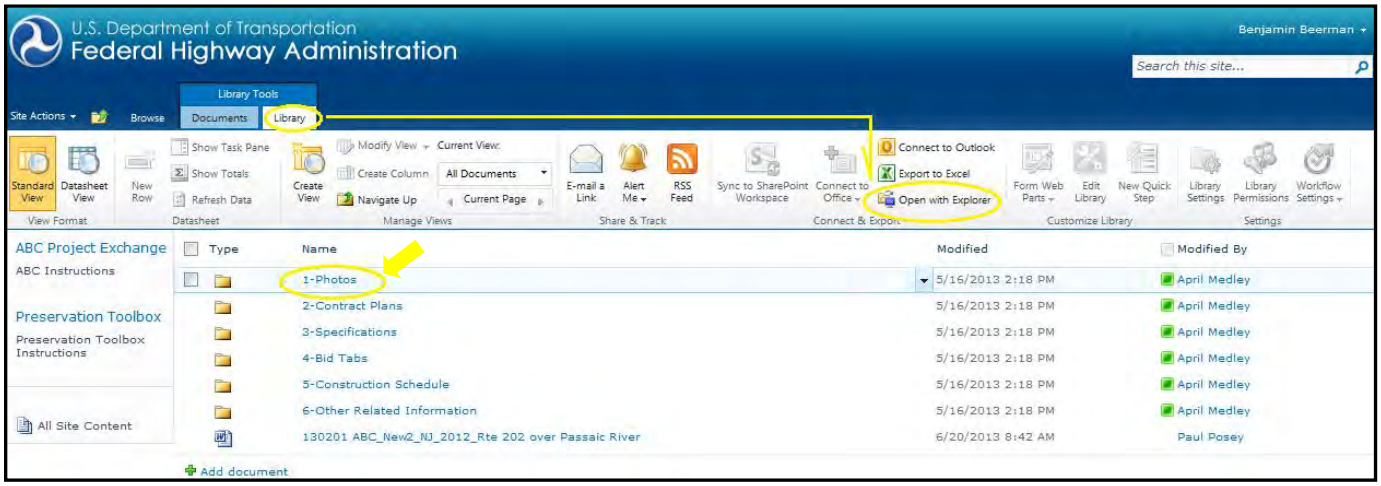
- **To download documents**: From the **Library Tool** bar shown below, click **Open with Explorer**, select the directories, files, or photos needed.
- Material can be **dragged and dropped** to your computer.



*Below is a screenshot showing the available information that can be downloaded using the **Open with Explorer** feature. Select the material needed to **drag and drop** them to a location on your computer.*

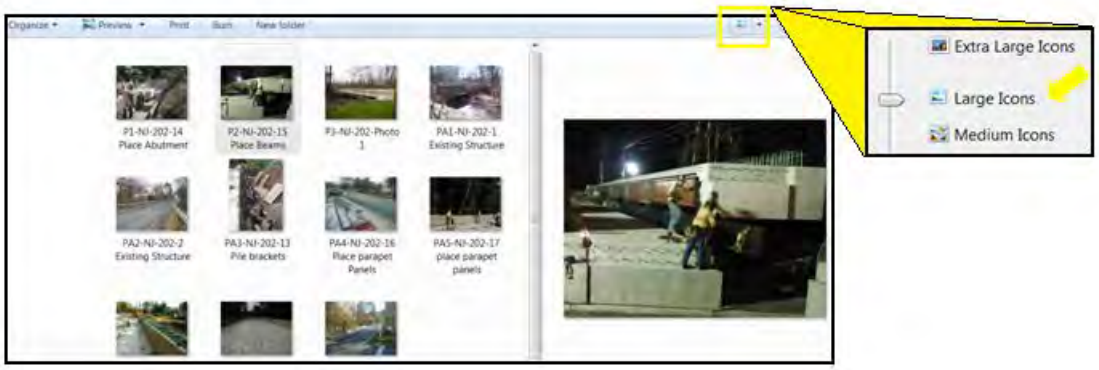


- **To View Photos**: Go to any Photo directory, select the **Open with Explorer** feature.



- Select the "**Large Icon**" option in your Windows Explorer as shown below.
- Photos can also be **dragged and dropped** to your computer.

  *Below is a screenshot showing how pictures can be viewed using the **Open with Explorer** feature…*



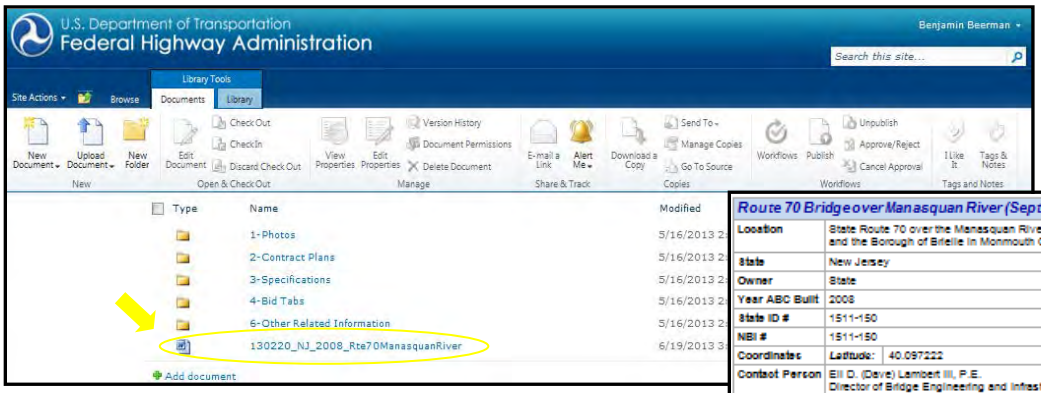
The Project Summary Report:

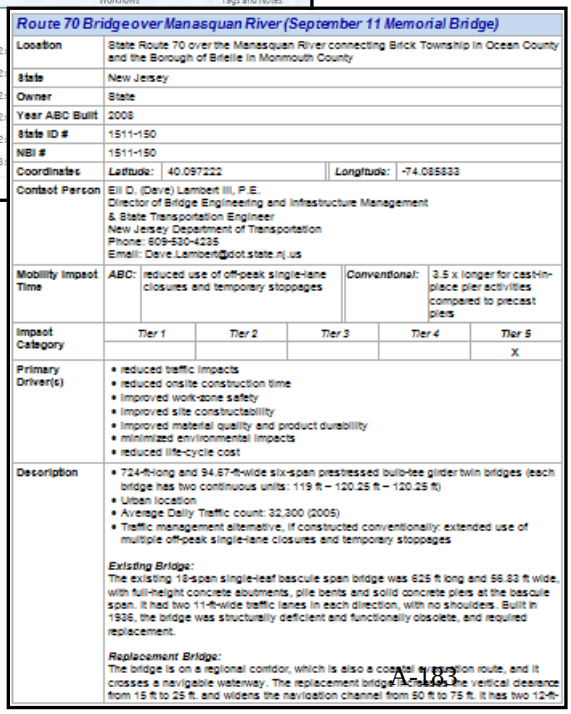
In every project folder resides a MS Word document. This document is the Project Summary report that includes, but is not limited to, the following information:

- Project description
- Owner contact information
- Stakeholder feedback (Owner, Engineer, Contractor, Public, etc…)
- Costs
- Links to Additional Information

You are encouraged to review the material in the Project Summary Report, including any hyperlinks to ***additional information*** that is included in the write-up.

`





Route 70 Bridge over Manasquan River (September 11 Memorial Bridge)

Location	State Route 70 over the Manasquan River connecting Brick Township in Ocean County and the Borough of Brielle in Monmouth County
State	New Jersey
Owner	State
Year ABC Built	2008
State ID #	1511-150
NBI #	1511-150
Coordinates	*Latitude:* 40.097222 *Longitude:* -74.085833
Contact Person	Eli D. (Dave) Lambert III, P.E. Director of Bridge Engineering and Infrastructure Management & State Transportation Engineer New Jersey Department of Transportation Phone: 609-530-4235 Email: Dave.Lambert@dot.state.nj.us
Mobility Impact Time	*ABC:* reduced use of off-peak single-lane closures and temporary stoppages *Conventional:* 3.5 x longer for cast-in-place pier activities compared to precast piers

Impact Category	*Tier 1*	*Tier 2*	*Tier 3*	*Tier 4*	*Tier 5*
					X

Primary Driver(s)
- reduced traffic impacts
- reduced onsite construction time
- improved work-zone safety
- improved site constructability
- improved material quality and product durability
- minimized environmental impacts
- reduced life-cycle cost

Description
- 724-ft-long and 94.67-ft-wide six-span prestressed bulb-tee girder twin bridges (each bridge has two continuous units: 119 ft – 120.25 ft – 120.25 ft)
- Urban location
- Average Daily Traffic count: 32,300 (2005)
- Traffic management alternative, if constructed conventionally: extended use of multiple off-peak single-lane closures and temporary stoppages

Existing Bridge:
The existing 18-span single-leaf bascule span bridge was 625 ft long and 56.83 ft wide, with full-height concrete abutments, pile bents and solid concrete piers at the bascule span. It had two 11-ft-wide traffic lanes in each direction, with no shoulders. Built in 1936, the bridge was structurally deficient and functionally obsolete, and required replacement.

Replacement Bridge:
The bridge is on a regional corridor, which is also a coastal evacuation route, and it crosses a navigable waterway. The replacement bridge raises the vertical clearance from 15 ft to 25 ft, and widens the navigation channel from 50 ft to 75 ft. It has two 12-ft-

Support:

- **To report issues related to the project information posted on the ABC Project Exchange**

  Please send an email to the following link: **ABC Project Exchange - comments**

- **To inquire about adding a new project to the ABC Project Exchange**

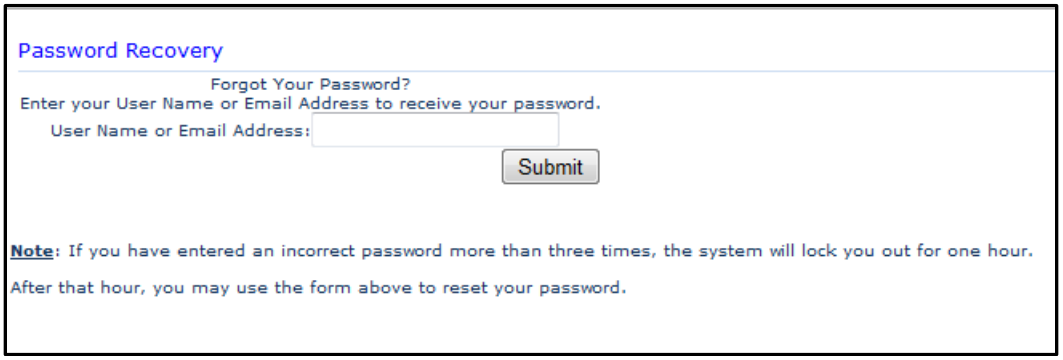
  Please send an email to the following link: **ABC Project Exchange - new project request**

- **For IT support related to site Registration, Access, and Navigation**

  Please use this form to contact the Site Administrator:
  https://www.transportationresearch.gov/dot/fhwa/SitePages/ContactUs.aspx

- **Password Reset**

  Your Password can be reset at the following link:
  https://www.transportationresearch.gov/dot/fhwa/SitePages/RecoverPW.aspx



Note: Please use the same user name or email address that was used to register the account.

ACM - Web Resources

- FHWA SEP-14 Active Project List: http://www.fhwa.dot.gov/programadmin/contracts/sep14list.cfm
- FHWA CMGC home page http://www.fhwa.dot.gov/construction/cqit/cm.cfm
- FHWA Design-Build home page http://www.fhwa.dot.gov/construction/cqit/desbuild.cfm
- June 2009, "Current Design-Build Practices for Transportation Projects," http://www.fhwa.dot.gov/construction/contracts/pubs/dbpractice/
- "AASHTO Guide for Design-Build Procurement" (hard copy only - https://bookstore.transportation.org/item_details.aspx?ID=1181)
- Caltrans April 2008, "Alternative Procurement Guide", http://www.dot.ca.gov/hq/oppd/contracting/AlternativeProcurementGuide.pdf

Alternative Analysis for Project Delivery

Accelerated Bridge Construction/
Structural Slide and Move
Workshop
December 9, 2013

Haluk M. Aktan
Western Michigan University
Haluk.Aktan@wmich.edu

PROJECT DELIVERY ALTERNATIVES

Conventional Construction (CC)

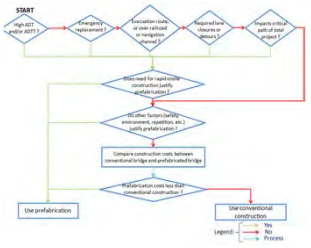
ABC – Prefabricated Bridge Elements and Systems (PBES) Assembling

ABC – Self Propelled Modular Transporter (SPMT) Moving

ABC – Bridge Sliding

PROJECT DELIVER ALTERNATIVE ANALYSIS

- Decision-making process to evaluate ABC as a project delivery alternative is evolving:
  - Flowcharts
  - Structured Binary Tables
  - Scoring Models
  - Analytical Hierarchy Process



FHWA – PBES Decision-Making (2005)

DECISION-MAKING PROCESSES

- Bridge Construction Plan (BCP) Evaluation Process 2001
  - Decision is based on *Scoring Model*
    - Assign percentage weights (W_i) to each category
    - Rate the parameters listed under each category on an ordinal scale and summed to a total S_{ij}, A_{ij}, C_{ij}, etc.
    - Calculate the final score "F_j" for each BCP alternative

$$F_j = \sum_i \left(W_i \times S_{ij}\right)$$

	Safety	Accessibility	Carrying capacity	Schedule	Budget	Other factor(s)	Total
Weights	W_S	W_A	W_C	W_T	W_B	W_Q	100%
BCP #1	S_1	A_1	C_1	T_1	B_1	Q_1	F_1
BCP #2	S_2	A_2	C_2	T_2	B_2	Q_2	F_2
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
BCP #n	S_n	A_n	C_n	T_n	B_n	Q_n	F_n

BCP Comparison Objective Matrix
(Source: El-Diraby and O'Conner 2001)

DECISION-MAKING PROCESSES

- PBES Decision-Making Model (2005)
  - To evaluate the potential and effectiveness of using an ABC for a particular site
  - Three sections
  - Flowchart
    - Provides an overview of parameters that need to be considered in decision-making

Flowchart by Ralls (2005) for FHWA

DECISION-MAKING PROCESSES

- PBES Decision-Making Model (2005)

Question	Yes	Maybe	No
Does the bridge have high average daily traffic (ADT) or average daily truck traffic (ADTT) or is it over an existing high traffic-volume highway?			
Is the bridge over a railroad or navigable waterway, or is it in an emergency evacuation route?			
Will traffic be subject to back-ups when using the bridge during construction, or be subject to excessive detours during construction of the bridge?			
Is this project an emergency bridge replacement?			
Must traffic flow be maintained on the bridge during construction?			
Can the bridge be closed during off-peak traffic periods, e.g., nights and weekends?			
Does the bridge have multiple identical spans?			
Can the bridge be grouped with other bridges for economy of scale?			
Will roadway construction activities away from the bridge be completed quickly enough to make rapid installation of prefabricated bridge a cost effective solution?			
Can adequate time be allocated from project award to site installation to allow for prefabrication of components to occur concurrently with site preparation?			
Do worker safety concerns at the site limit conventional methods e.g., adjacent power lines or over water?			
Is the site in an environmentally sensitive area requiring minimum disruption (e.g., wetlands, air quality, noise, etc.)?			
Is the bridge location subject to constraining time restrictions due to adverse economic impact?			
Are there natural or endangered species at the bridge site that necessitate short construction lane windows or suspension of work for a significant time period, e.g., fish passage or prompt for timely nesting?			
If the bridge is on or eligible for the national register of historic places, is prefabrication feasible for replacement/rehabilitation per the memorandum of agreement?			
Is the bridge site accessible for delivery of prefabricated components or use of heavy lifting equipment?			

Matrix by Ralls (2005) for FHWA

DECISION-MAKING PROCESSES

- ABC Decision-Making (2006)
  - Decision-making parameters identified thru a survey of 25 U.S. DOTs
  - The survey also asked the share of each of 6 major-parameters in the ABC decision-making process, and the significance of the sub-parameters

Parameters and Mean Weights from Survey (2006)

Major-Parameter	Confidence interval (95%)	Mean percentage weight
Cost	16-31	25
Traffic flow	11-29	20
Safety	11-31	20
Economy	8-18	15
Social	7-16	10
Environment	7-13	10
Total		100

DECISION-MAKING PROCESSES

ABC Decision-Making Model (2006)

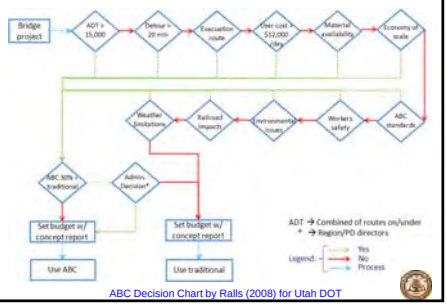
- Evaluation for a specific project
  - Each construction alternative is evaluated for its effectiveness: "e" with respect to each sub-parameter
  - The total effectiveness under each major-parameter (e_{1x} to e_{6x}) is calculated
  - The effectiveness is then multiplied with the major-parameter mean percentage weights (preset weights)
  - The resulting vector provides priority percentage of the construction alternatives for that specific project

$$\begin{bmatrix} Alternative\ X \\ Alternative\ Y \\ Alternative\ Z \end{bmatrix} = \begin{bmatrix} e_{1x} & e_{2x} & e_{3x} & e_{4x} & e_{5x} & e_{6x} \\ e_{1y} & e_{2y} & e_{3y} & e_{4y} & e_{5y} & e_{6y} \\ e_{1z} & e_{2z} & e_{3z} & e_{4z} & e_{5z} & e_{6z} \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ w_3 \\ w_4 \\ w_5 \\ w_6 \end{bmatrix}$$

Evaluation of Construction Alternatives (2006) for Ohio DOT

DECISION-MAKING PROCESSES

- UDOT ABC Decision-Making (2008)
  - Extended version of "FHWA – PBES Decision-Making Model"
  - The *Yes/No* option selection was retained; triggering of one *Yes* on a critical parameter may lead to ABC implementation decision



ABC Decision Chart by Ralls (2008) for Utah DOT

DECISION-MAKING PROCESSES

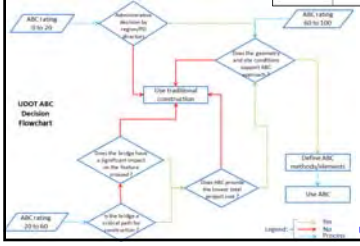
- UDOT ABC Decision-Making Scoring Model (2010)
  - A scoring table and associated flowchart
  - One set of parameters utilized rather than grouping under major-parameters and sub-parameters
  - *Scoring model* was utilized
  - For a specific site, the values are assigned based on site characteristics (field observation)

UDOT ABC Scoring Table (2010)

UDOT ABC SCORING MODEL (2010)

- Predefined weights were assigned to each parameter (preset weights)
- The values from field observation are multiplied with preset weights and summed to obtain a *total score*
- The *ABC rating* is used in the flowchart to provide the decision

ABC rating	Score	Weight factor	Adjusted score	Maximum score	Adjusted score
Average daily traffic	X1	10	X1 * 10	5	50
Delay time	X2	10	X2 * 10	5	50
Bridge classification	X3	4	X3*4	5	20
User costs	X4	10	X4*10	5	50
Economy of scale	X5	3	X5*3	3	9
Use of typical details	X6	3	X6*3	5	15
Safety	X7	8	X7*8	5	40
Railroad impacts	X8	5	X8*5	5	25
Weather limitations	X9	3	X9*3	5	15
		Total score	Σ	Max. score	274



$$\text{ABC rating} = \frac{\text{Total score}}{\text{Maximum score}} \times 100$$

UDOT – ABC Decision Flowchart (2010)

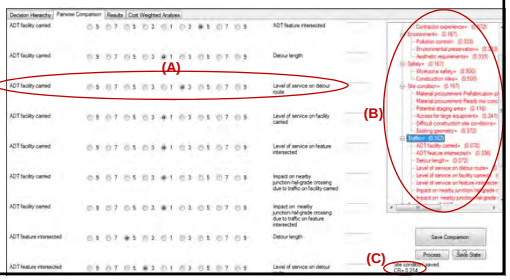
DECISION-MAKING PROCESSES

- AHP Decision-Making Software (2011)
  - Developed by Oregon State University under a FHWA pooled fund study
  - Based on Analytical Hierarchy Process (AHP)
  - A *Microsoft Visual Studio.NET* application to evaluate between conventional and ABC alternatives
  - The user can: i) edit/view the decision hierarchy, ii) perform pair-wise comparisons, iii) view results, and iv) perform cost weighted analysis

OSU – AHP Decision-Making Software (2011)

AHP FOR DECISION-MAKING (2011)

- Pair-wise comparisons of unrelated parameters **(A)**
- Repeated pair-wise comparison steps **(B)**
- The pair-wise comparison process need to be repeated until AHP consistency ratio (CR) < 0.10 is achieved **(C)**
- The cost weighted analysis requires neglecting the cost related parameters in the pair-wise comparisons and entering the total project cost instead



OSU – AHP Decision-Making Software (2011)

DECISION-MAKING MODEL

- Requirements for a useful and robust tool
  - Incorporation of project-specific quantitative data
  - Incorporation of life-cycle (LCC) cost data and user cost (UC) models
  - Input from multiple experts for collaborative decision making
  - Automation to improve usability and efficiency of the decision-making process along with addressing the sensitivity of results
  - Decision making method with mathematical validity

LCC ANALYSIS MODELS

Parameters \ LCA models		FHWA Model & NIST Model	Finnish Transport Agency Model	Remaining Life Prediction Models	LCA based on Ecological Parameters	Lifetime Assessment through Reliability Concept
Net Present Value (NPV) of Life-Cycle Cost		☑	☑			
Probabilistic Approach		☑				
Construction Cost, R&R Cost, Demolition Cost		☑	☑		☑	☑
User Cost		☑	☑	☑		
Deterioration Mechanisms				☑		☑
Monitoring, NDT & Visual Inspection				☑		☑
Material, Type of Design & Load bearing capacity				☑		☑
Resource Production Cost					☑	
Discount factors		☑	☑			
Society Cost	Environmental (Noise, Vibration, Pollution)		☑	☑	☑	
	Global stressors (CO_2 Equivalents)		☑		☑	
Risks	Agency		☑			☑
	Users		☑			☑
	Society		☑		☑	

15

LCC PARAMETERS FOR ABC

Parameters \ LCA models		FHWA Model & NIST Model	Finnish Transport Agency Model	Remaining Life Prediction Models	LCA based on Ecological Parameters	Lifetime Assessment through Reliability Concept
Net Present Value (NPV) of Life-Cycle Cost		☑	☑			
Probabilistic Approach		☑				
Construction Cost, R&R Cost, Demolition Cost		☑	☑		☑	☑
User Cost		☑	☑	☑		
Deterioration Mechanisms				☑		☑
Monitoring, NDT & Visual Inspection				☑		☑
Material, Type of Design & Load bearing capacity				☑		☑
Resource Production Cost					☑	
Discount factors		☑	☑			
Society Cost	Environmental (Noise, Vibration, Pollution)		☑	☑	☑	
	Global stressors (CO_2 Equivalents)		☑		☑	
Risks	Agency		☑			☑
	Users		☑			☑
	Society		☑		☑	

16

USER COST ANALYSIS MODELS

User cost models / Parameters	FHWA Model	NIST Model	Quickzone	CA4PRS (UCB)	CO³ (UofM & MDOT)
Traveler delay cost	☑	☑	☑	☑	☑
Vehicle operating cost	☑	☑	☑	☑	☑
Accident cost	☑	☑			
Decrease in demand cost					☑
Detour travel cost	☑	☑	☑	☑	☑
Contemporary economic parameters (e.g., wage rate, etc.)	☑	☑	☑	☑	☑
User cost breakdown per hour			☑	☑	☑
User cost due to backups	☑				☑
User cost w.r.t different work zone times/strategies				☑	☑
Traffic simulation				☑	
Network of roadways considered (to select low user cost incurring route)			☑		

USER COST PARAMETERS FOR ABC

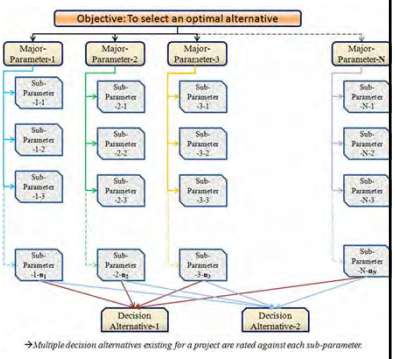
User cost models / Parameters	FHWA Model	NIST Model	Quickzone	CA4PRS (UCB)	CO³ (UofM & MDOT)
Traveler delay cost	☑	☑	☑	☑	☑
Vehicle operating cost	☑	☑	☑	☑	☑
Accident cost	☑	☑			
Decrease in demand cost					☑
Detour travel cost	☑	☑	☑	☑	☑
Contemporary economic parameters (e.g., wage rate, etc.)	☑	☑	☑	☑	☑
User cost breakdown per hour			☑	☑	☑
User cost due to backups	☑				☑
User cost w.r.t different work zone times/strategies				☑	☑
Traffic simulation				☑	
Network of roadways considered (to select low user cost incurring route)			☑		

OUTLINE

- Michigan Accelerated Bridge Construction Decision-Making [Mi-ABCD] Model
- Mi-ABCD Guided Software
- Mi-ABCD Implementation
- Conclusions

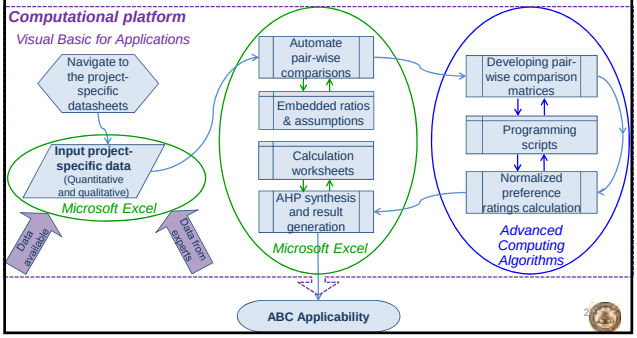
Mi-ABCD MODEL

- Implementing Analytical Hierarchy Process (AHP)
  - Define major-parameters and sub-parameters
  - Perform Pair-wise comparison of parameters on an ordinal scale of 1 to 9
  - Develop AHP matrices
  - Calculate priority vectors
  - Calculate preference probabilities for the decision alternatives



Mi-ABCD Model

- Graphical User Interface (GUI) to acquire user data



Mi-ABCD Model

- Major-parameters and sub-parameters

Major-Parameters	Site and Structure Considerations (S&ST)	Cost	Work Zone Mobility (WZM)	Technical Feasibility and Risk (TF&R)	Environmental Considerations (EC)	Seasonal Constraints and Project Schedule (SC&PS)
Sub-Parameters	Precaster/Ready-mix supplier proximity	Initial Construction cost	Significance of maintenance of traffic on facility carried	Contractor experience	Environmental protection (e.g., wet land)	Seasonal limitations
	Availability of staging area	Life-cycle cost	Significance of maintenance of traffic on feature intersected	Manufacturer/ Precast plant experience	Aesthetic requirements	Construction duration
	Existing structure type and foundations	User cost	Length of detour	Work zone traffic risk		Stakeholder(s') limitations
	Terrain to traverse	Economic impact on surrounding businesses	Significance of level of service on detour route	Construction risks		
	Access and mobility of construction equipment	Economic impact on surrounding communities	Impact on nearby major intersection/highway-rail grade crossing due to traffic on facility carried**			
	Number of similar spans		Impact on nearby major intersection/highway-rail grade crossing due to traffic on feature intersected**			

Blue text → Quantitative parameters Red text → Qualitative parameters

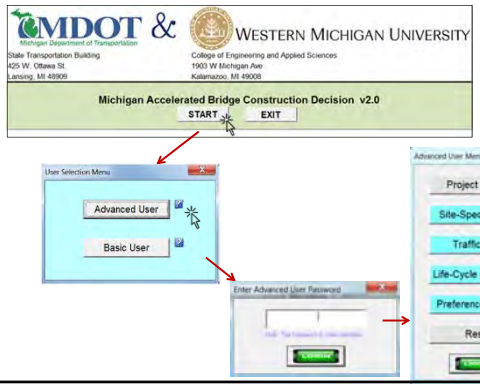
** Number of nearby major intersections/highway-rail grade crossing affected may vary

Mi-ABCD Guided Software

- The software is developed using Microsoft Excel and Visual Basic for Applications (VBA) scripts
- The VBA's GUI → interact with the user
  - Pop-up menus
  - Datasheets
  - VBA scripts
  - Embedded worksheets

Mi-ABCD Guided Software

- Start menu



Mi-ABCD Guided Software

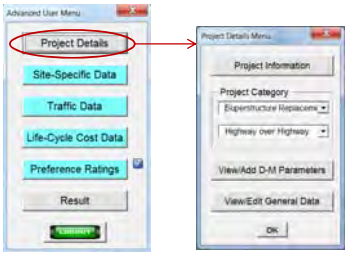
- Key steps
  - Project Specific Data input by Advanced User
  - Preference Data input by multiple Basic Users
  - Data analysis
  - Interpretation of results

Mi-ABCD Guided Software

- Advanced User
  - Project manager with access to site-specific data, cost estimates, and traffic data.
  - Enter and edit Project Details, Site-Specific Data, Traffic Data, Life-Cycle Cost Data, and Preference Ratings
  - Execute data analysis and review Results
- Basic User(s)
  - Project team members enter preference ratings based on their experiences on recent bridge projects
  - View Project Information, enter Preference Ratings, execute data analysis, and review Results

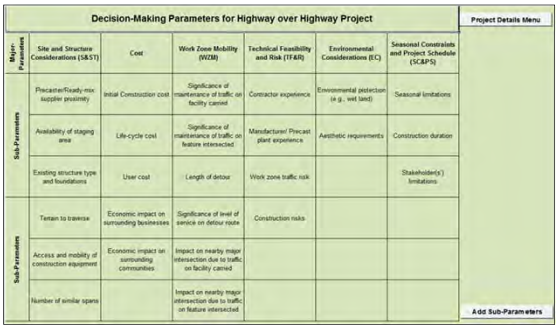
Mi-ABCD Guided Software

- Project Details Menu
  - Accessed by Project Details button on the Advanced User Menu to enter project information, select project category, view/add decision-making parameters, and view/edit the general data



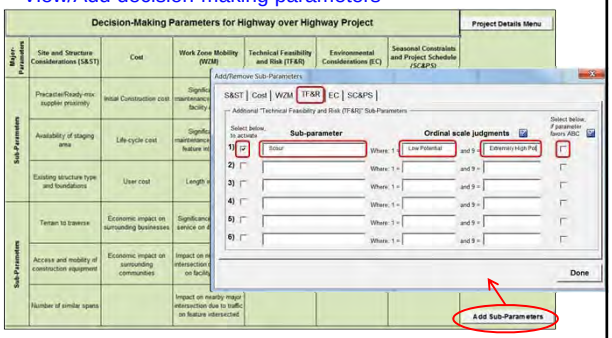
Mi-ABCD Guided Software

- View/Add decision-making parameters



Mi-ABCD Guided Software

- View/Add decision-making parameters



Mi-ABCD Guided Software

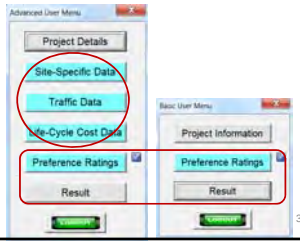
- General data
  - The average wage rate of the drivers,
  - County job multipliers that give significance of a particular county on surrounding counties,
  - Ready-mix concrete plants/prefabrication plants/staging area distances,
  - ADT limits,
  - Significance of maintenance of traffic based on LOS change,
  - Detour length ranges,
  - Range for the number of similar spans,
  - Peak hour factors for roadways, and
  - Predefined tables based on site/state specific criteria.

Mi-ABCD Guided Software

- Preference ratings

Mi-ABCD Guided Software

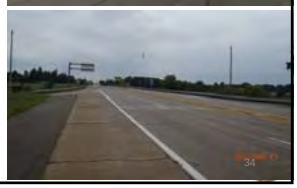
- Access datasheets and Results sheet
  - Command buttons on the Advanced User Menu
    - Site-specific data
    - Traffic data
    - Life-cycle cost data
  - Command buttons on Advanced User Menu and Basic User Menu
    - Preference ratings
    - Results



IMPLEMENTATION

33

- Stadium Drive (I-94 BR) over US 131 in Kalamazoo County, Michigan
  - Single structure
  - Year built = 1963
  - Length = 236.91 ft
  - Width = 85.30 ft
  - Skew = 5°
  - No. of main spans = 4
  - Max. span length = 81.99 ft
  - Underclearance = 14.83 ft
  - ADT = 29,643 (2007 data)
  - Future ADT = 41,774 (2018 estimate)



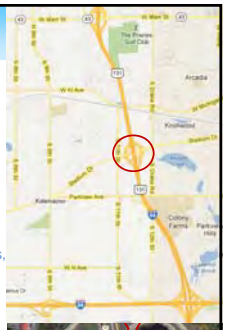
34

IMPLEMENTATION

- Full bridge replacement
- Project delivery alternatives → ABC Vs. CC

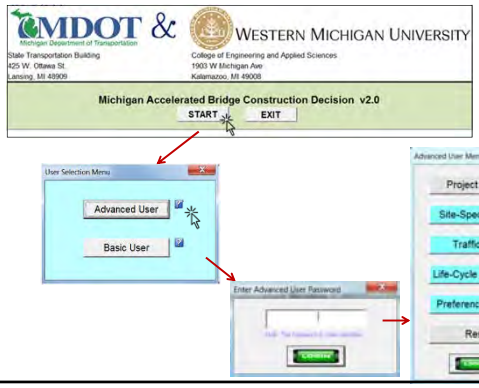
Bridge replacement considerations

- Underclearance ≥ 16.25 ft
- Alignment change
  (Requires changing the elevation of the approach, abutments, bent cap(s), and girders)
- Two-exit and two-entrance ramps
  (Need to be closed for either staged construction or full closure)
- Project planning
  (Recommend *full closure* to resolve project complexities and to improve safety (FHWA 2003))
- Ramps closure & construction duration impact
  (Significant impact to the stakeholders including the WMU)



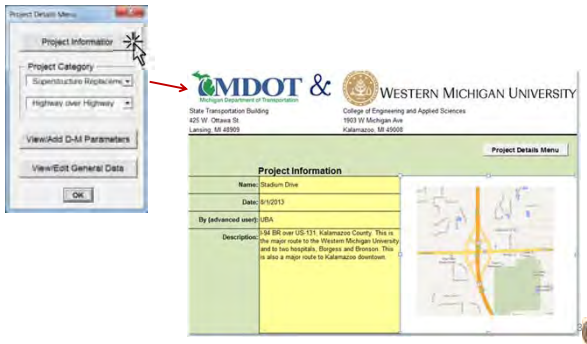
IMPLEMENTATION

- Execute the software and access the *Advanced User Menu*



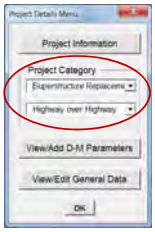
IMPLEMENTATION

- Advanced User enters the Project Information



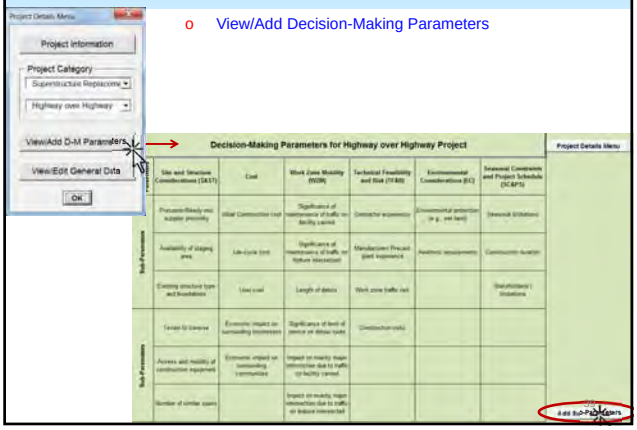
IMPLEMENTATION

- Select Project Category

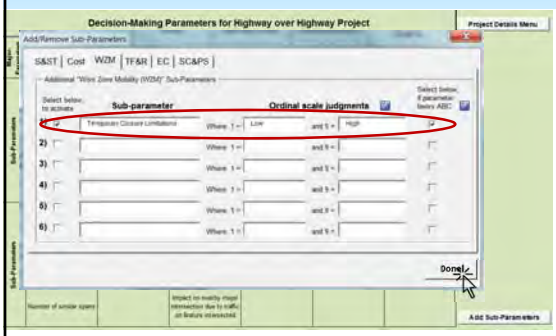


IMPLEMENTATION

- View/Add Decision-Making Parameters

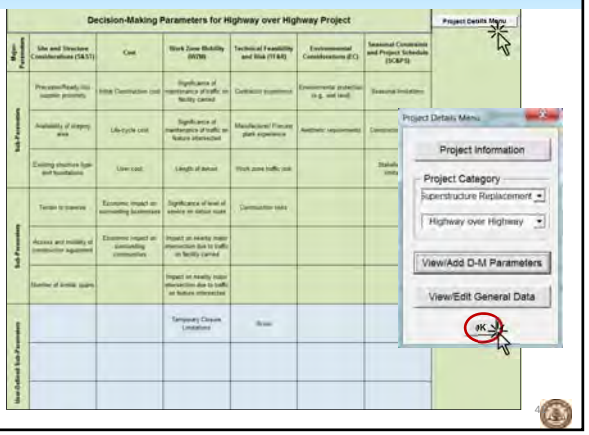


IMPLEMENTATION



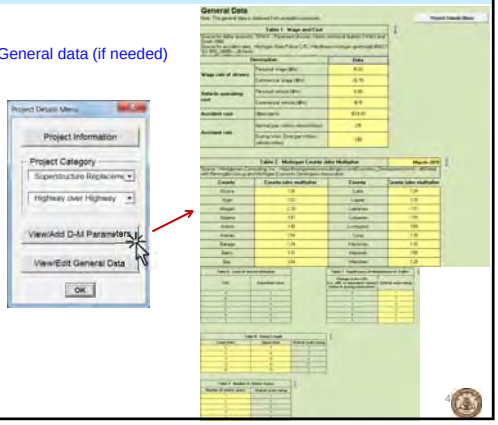
- Under the “WZM” tab add “Temporary Closure Limitations” sub-parameter

IMPLEMENTATION



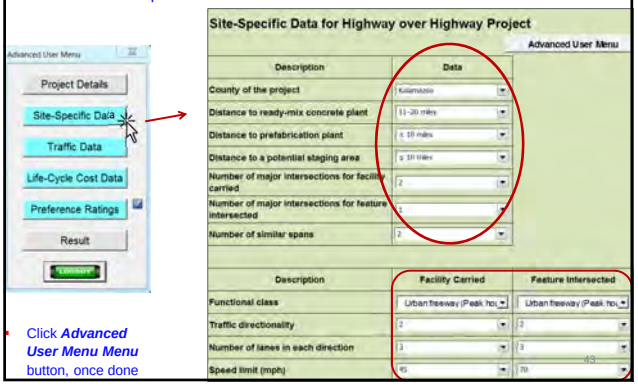
IMPLEMENTATION

- View/Edit General data (if needed)



IMPLEMENTATION

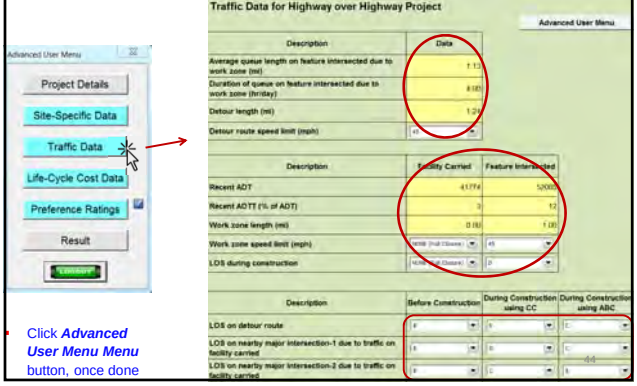
- Enter Site-Specific Data



- Click ***Advanced User Menu Menu*** button, once done

IMPLEMENTATION

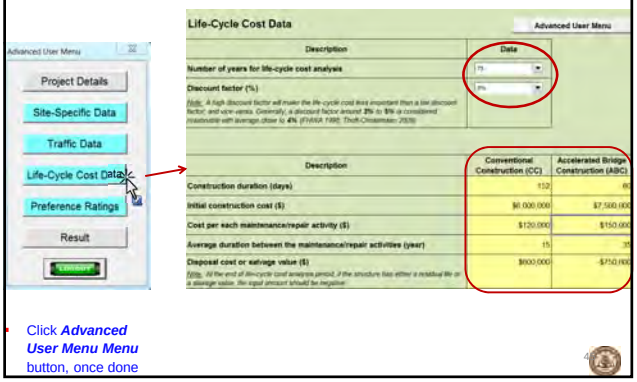
- Enter Traffic Data



- Click ***Advanced User Menu Menu*** button, once done

IMPLEMENTATION

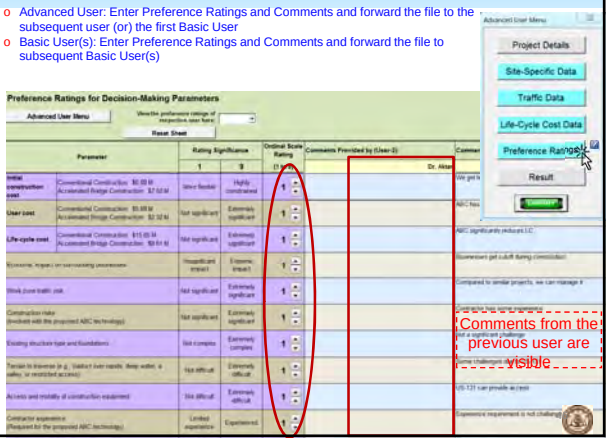
- Enter Life-Cycle Cost Data



- Click ***Advanced User Menu Menu*** button, once done

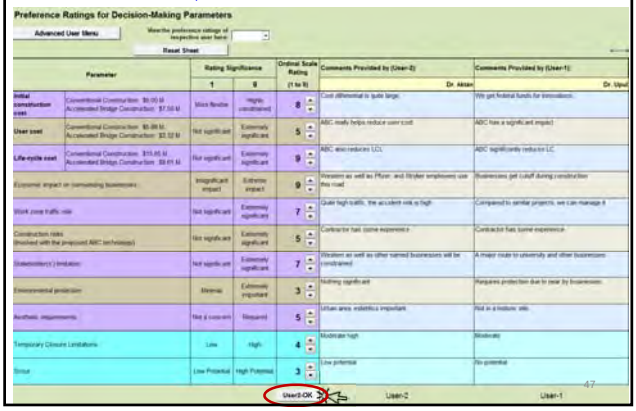
IMPLEMENTATION

- Advanced User: Enter Preference Ratings and Comments and forward the file to the subsequent user (or) the first Basic User
- Basic User(s): Enter Preference Ratings and Comments and forward the file to subsequent Basic User(s)



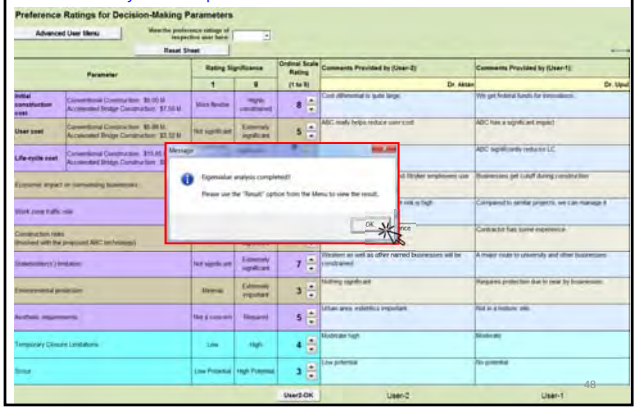
IMPLEMENTATION

- Click ***User2-OK*** button, ***2*** is the current **user**



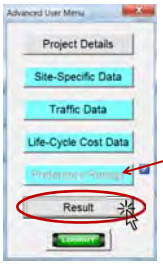
IMPLEMENTATION

- Wait! for analysis to complete



IMPLEMENTATION

- Click on the ***Result*** command button

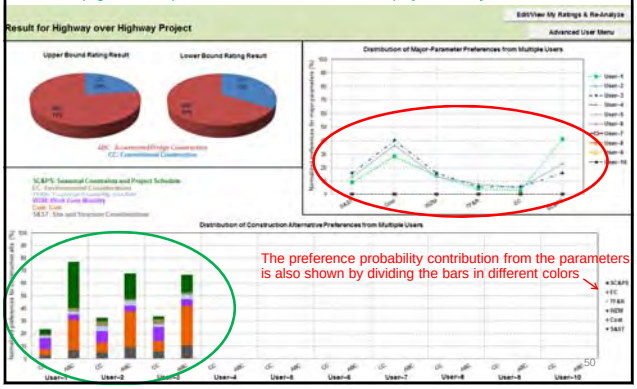


This button will be inactive until the current user clicks ***LOGOUT*** and the subsequent user logs in.

Note: This is programmed so that all the user ratings and respective comments are preserved under corresponding user numbers.

IMPLEMENTATION

- Pie charts (Figure-top left) show the upper and lower bound of user data.
- Line chart (Figure-top right) shows the distribution of major-parameter user preferences.
- Bar chart (Figure-bottom) shows *Preference Probabilities* of project delivery alternatives.



The preference probability contribution from the parameters is also shown by dividing the bars in different colors

IMPLEMENTATION

- Tabular format of Preference Probabilities Bar Chart

Users or Decision Makers	Construction Alternatives	Site and Structure Considerations (S&ST) (%)	Cost (%)	Work Zone Mobility (WZM) (%)	Technical Feasibility and Risk (TF&R) (%)	Environmental Considerations (EC) (%)	Seasonal Constraints and Project Schedule (SCAPS) (%)	Overall Preference (%)
User-1	IDC	7	8	9	13	7	9	73
	ABC	7	14	4	3	2	47	77
User-2	IDC	9	8	9	4	4	3	33
	ABC	3	29	4	4	1	8	56
User-3	IDC	8	8	8	11	4	2	39
	ABC	9	12	5	4	2	9	67
User-4	IDC	8	8	8	8	3	8	0
	ABC	8	8	8	8	8	8	0
User-5	IDC	8	8	8	8	8	8	0
	ABC	8	8	8	8	8	8	0
User-6	IDC	8	8	8	8	8	8	0
	ABC	8	8	8	8	8	8	0
User-7	IDC	8	8	8	8	8	8	0
	ABC	8	8	8	8	8	8	0
User-8	IDC	8	8	8	8	8	8	0
	ABC	8	8	8	8	8	8	0
User-9	IDC	8	8	8	8	8	8	0
	ABC	8	8	8	8	8	8	0
User-10	IDC	8	8	8	8	8	8	0
	ABC	8	8	8	8	8	8	0

IMPLEMENTATION

- Exit and forward the file to subsequent Basic User.

Logout button takes user back to ***Start Menu***

EXIT button closes the program

FINAL NOTES

- The decision-making process is based on site-specific data.
- Methodology integrates quantitative data to assist user in qualitative decisions.
- Experts opinions are based on their experiences on “recent projects” and NOT on pair-wise comparisons.
- The AHP consistency of results are assured by Eigenvalue analysis.
- The decision-making model is limited to typical bridges of short and medium span and less than 30° skew.
- The model is being extended to incorporate all ABC alternatives.