

Integration of Information in Bridge Engineering, for creating a Data Interchange for Bridge Designers, based on the analysis and study of the information obtained from the FDOT

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Approach to current bridge design

- It is not enough to draw good plans and create detailed technical specifications; now, it is necessary to integrate every part of a project as a whole (Shirole' and Chen, 2006).
- Building Information Modeling as a tool to integrate areas (AEC Modeling).
- Several software packages related to BIM have been developed.
- These software can be applied to Bridge Engineering (BrIM).

Approach to current bridge design

- Bridge designers seek information concerning past bridge projects as input to their design processes on new bridges.
- Valuable time is wasted trying to gather the information needed in preliminary design.
- Information for preliminary modeling and design is widely dispersed.
- Most bridge designers spend too much time to gather all the information.

Approach to current bridge design

- Organizing and Standardizing the information needed for preliminary design through a schema.
- Creating a database with helpful information for preliminary design, such as: basic design summaries, location, changes or delays during construction, and contact information.
- Data Interchange for Bridge Designers (DIBD), including the creation of a web-based application.

Integration of information in Bridge Engineering, why?

- As mentioned, most of the information is widely dispersed.
- There is no a unified schema to classify and organize the information in Bridge Engineering.
- In the same way, there is no a unified Database.
- Current efforts to unify information in Bridge Engineering is merely related to describe geometry and location of bridges.

Benefits for the DOTs

- The BrIM system will provide substantial benefits for the DOTs.
- Bridge structures require a relatively high capital investment.
- Improving the design development process offers the potential for significant savings, which can be reinvested in additional infrastructure.

Benefits for the DOTs

- It is probable to minimize the possibility of delays and changes during construction due to design.
- By being more efficient, we can do more with less.
- This information tool will also save valuable management and designer time for both the FDOT and its design consultants.

Database Standardization Benefits

(McVay, 2004)

- Savings from unified DB
 - Single entry of data
 - Reusable data
 - QA/QC
 - More accurate bids (using existing data)
- Time Reduction
 - Reduce data transfer time and re-keying
- Accessibility
 - Open standard
 - Web entry and retrieval (with security)

Getting start with the DB

- 10,000 bridges in the State of Florida.
- Approximately, 80% of these bridges are "Prestressed Concrete Bridges".
- It would be feasible to collect data on a representative sample. This might include one of the more common bridge categories of structures, completed within the last 5 years.

Getting start with the DB

- The goal would be to obtain sufficient data to populate the BrIM and demonstrate feasibility of the approach.
- First approach for the DB is being conducted based on the information found in the FDOT offices located in Lake City and Tallahassee, FL.

Data to be included into the DB

Information will be separated in two main categories:

- Qualitative.
- Quantitative.

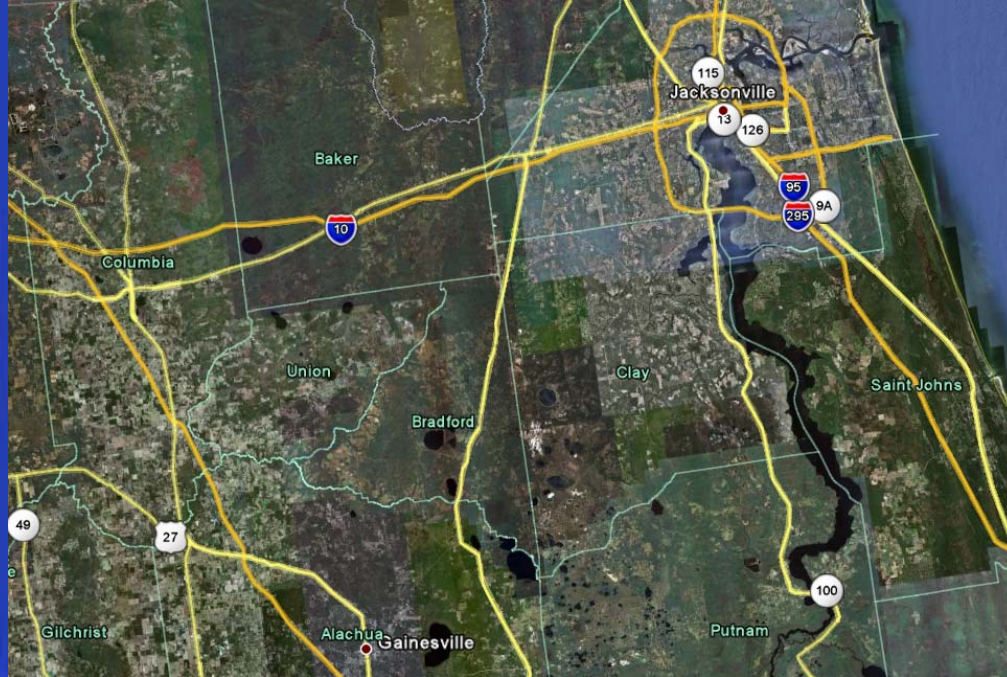
Data to be included into the DB

Qualitative Information:

- Location.
- Description of the project.
- Summary of any significant changes or delays that occurred during construction.
- Contact information for key structural fabricators.
- Contact information for design project managers.
- Contact information for FDOT construction managers.

Data to be included into the DB

Qualitative Information:



PROJECT INFORMATION

General Notes

Design Method..... Load and Resistance Factor Design (LRFD) except that the Prestressed Beams and Prestressed Piles have been designed for Service Load.

Design Loading..... HL-93 Truck

Future Wearing Surface... Design provides allowance for 15 psf

Earthquake..... Seismic acceleration coefficient in Florida varies from 1% to 3.75% or Seismic provisions for minimum bridge support length only, SDG 2.3.

Concrete	Class	Minimum 28-day Compressive Strength (psi)	Location
	II	f c = 3400	Traffic Barriers
	II (Bridge Deck)	f c = 4500	CIP Bridge Deck
	IV	f c = 5500	CIP Substructure
	V (Special)	f c = 6000	Concrete Piling
	V	f c = 6500	Prestressed Beams

Environment..... The superstructure is classified as slightly aggressive. The substructure is classified as moderately aggressive.

Reinforcing Steel..... ASTM A615, Grade 60

Concrete Cover	Superstructure	Substructure
	Top deck surfaces	External surfaces exposed
	All other surfaces	External surfaces cast against earth
		Prestressed Piling
		Top of Girder Pedestals

Concrete cover does not include reinforcement placement or fabrication tolerances, unless shown as "minimum cover". See FDOT Standard Specifications for allowable reinforcement placement tolerances.

Distribution Values	Item	Interior Beams	Exterior Beams
	Live Load (**/beam)	+	*
	Traffic Railing (plf)	+	*
	Wearing Surface (plf)	+	*
	Utilities (plf)	+	*
	Stay-in-Place Metal Forms (plf)	+	*

Dimensions..... All dimensions are in feet or inches, except as noted.

Stay-in-Place Metal Forms..... The design includes an allowance of 20 psf for the unit weight of metal forms and concrete required to fill the form flutes. The allowance is distributed over the project plan area of the metal forms. Stay-in-place concrete forms will not be permitted.

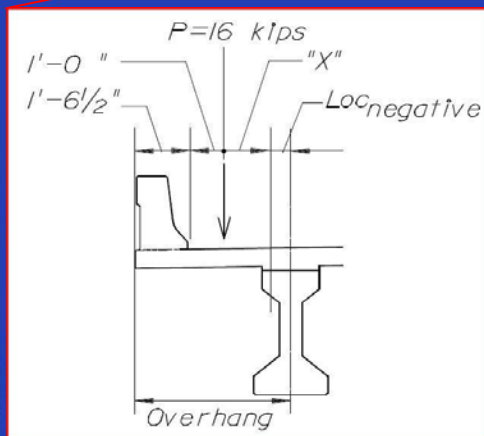
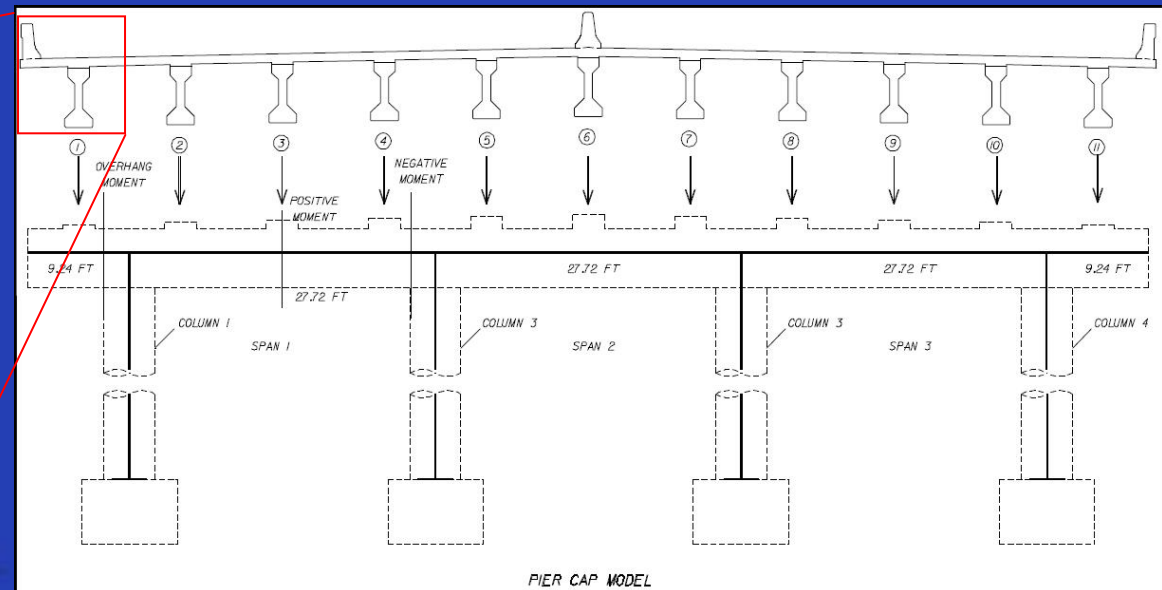
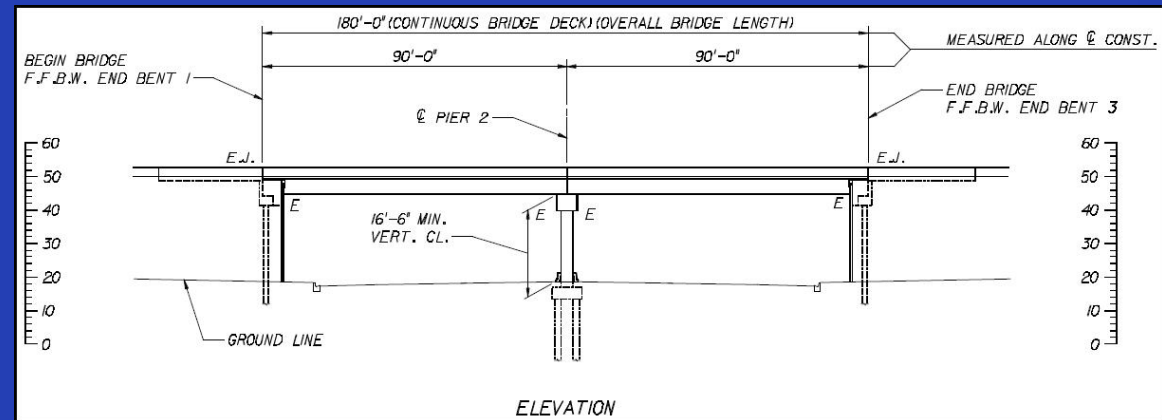
Data to be included into the DB

Quantitative information:

- Geometry (dimensions, typical sections, etc).
- Design criteria (design parameters, general notes, etc).
- Superstructure design data (types of loads, beams, etc.).
- Substructure design data (types of loads, piers, etc.).
- Costs \$/ft² (separated in Superstructure and Substructure).

Data to be included into the DB

Quantitative information:



Prestressed Concrete Bridge (FDOT)

(Quantitative Information)

1. PROJECT INFORMATION

1.01. About the Design

1.02. General Notes

1.03. Design Parameters

Prestressed Concrete Bridge (FDOT)

(Quantitative Information)

2. SUPERSTRUCTURE DESIGN

2.01. Dead Loads

2.02. Live Load Distribution Factors

2.03. Live Load Analysis

2.04. Prestressed Beam Design - Part I

2.05. Prestressed Beam Design - Part II

2.06. Empirical Deck Design

2.07. Traditional Deck Design

2.08. Deck Overhang Design

2.09. Creep and Shrinkage Parameters

2.10. Expansion Joint Design

2.11. Composite Neoprene Bearing Pad Design

Prestressed Concrete Bridge (FDOT)

(Quantitative Information)

3. SUBSTRUCTURE DESIGN

3.01. Dead Loads

3.02. Pier Cap Live Load Analysis

3.03. Pier Cap Design Loads

3.04. Pier Cap Design

3.05. Pier Column Live Load Analysis

3.06. Pier Column Design Loads

3.07. Pier Column Design

3.08. Pier Foundation Design Loads

3.09. Pier Pile Vertical Load Design

3.10. Pier Footing Design

3.11. End Bent Cap Live Load Analysis

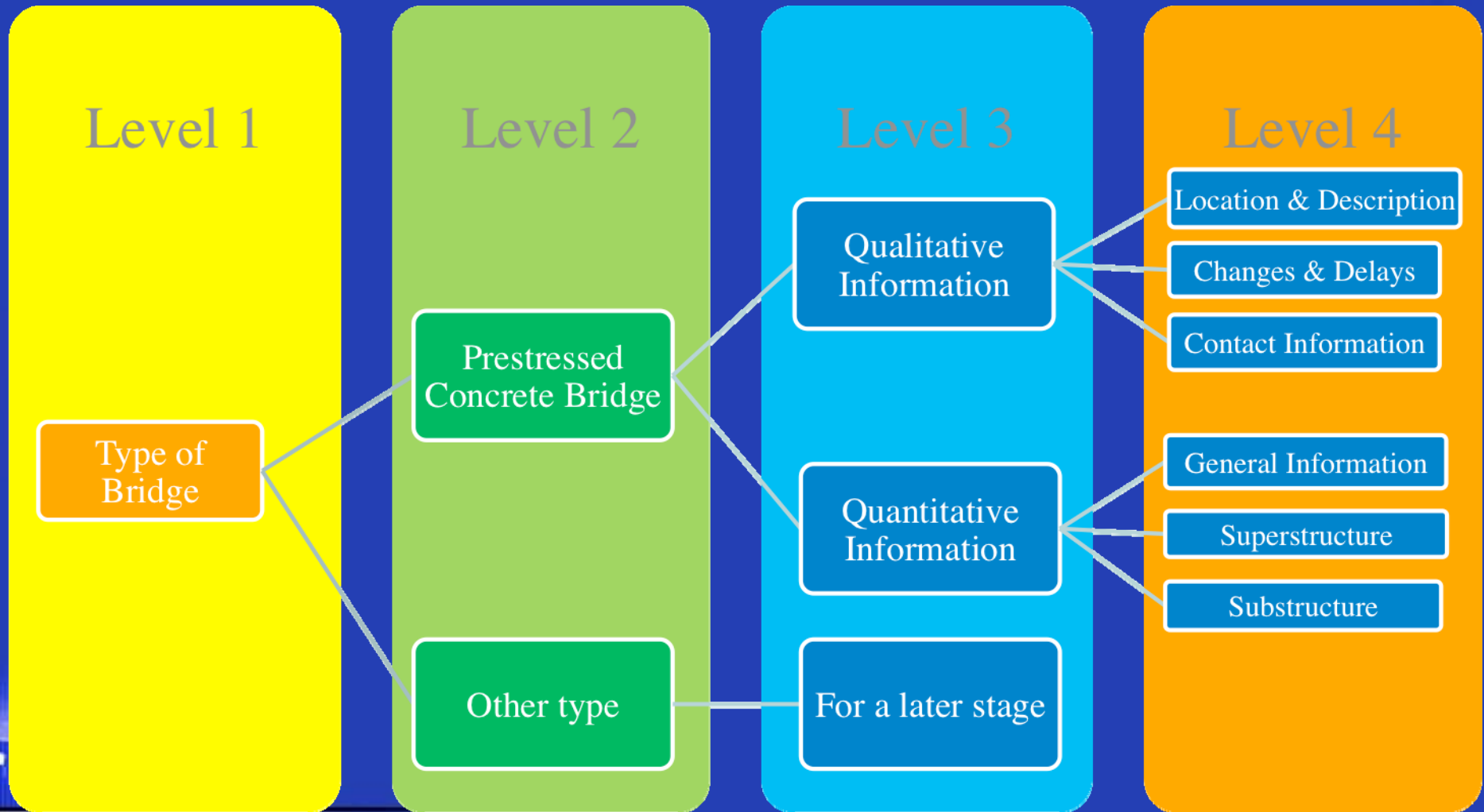
3.12. End Bent Cap Design Loads

3.13. End Bent Cap Design *(similar to Section 3.4)*

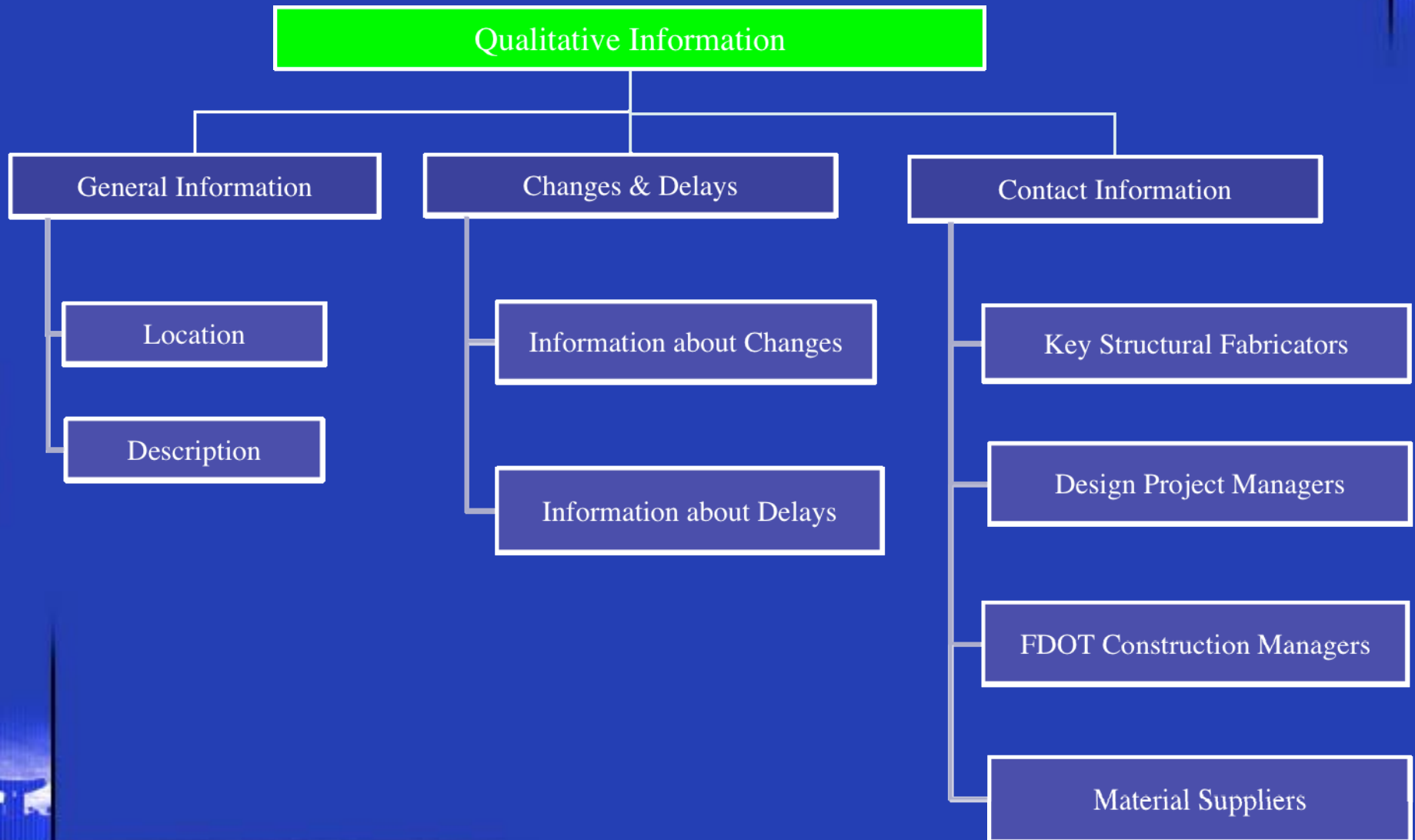
3.14. End Bent Pile Vertical Load Design *(similar to Section 3.9)*

3.15. End Bent Backwall Design

High Levels for the Bridge Data Schema



Bridge Data Schema from Level 3



Bridge Data Schema from Level 3



How does Data Interchange work?

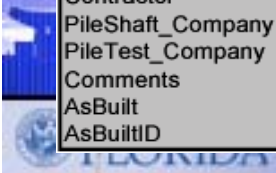
- Database is application centered
- Repository for bridge data
- Designed for using data in decision process
- Acts as archive
- Security is table based and hierarchical
 - Access established by FDOT

Data Structure - Architecture

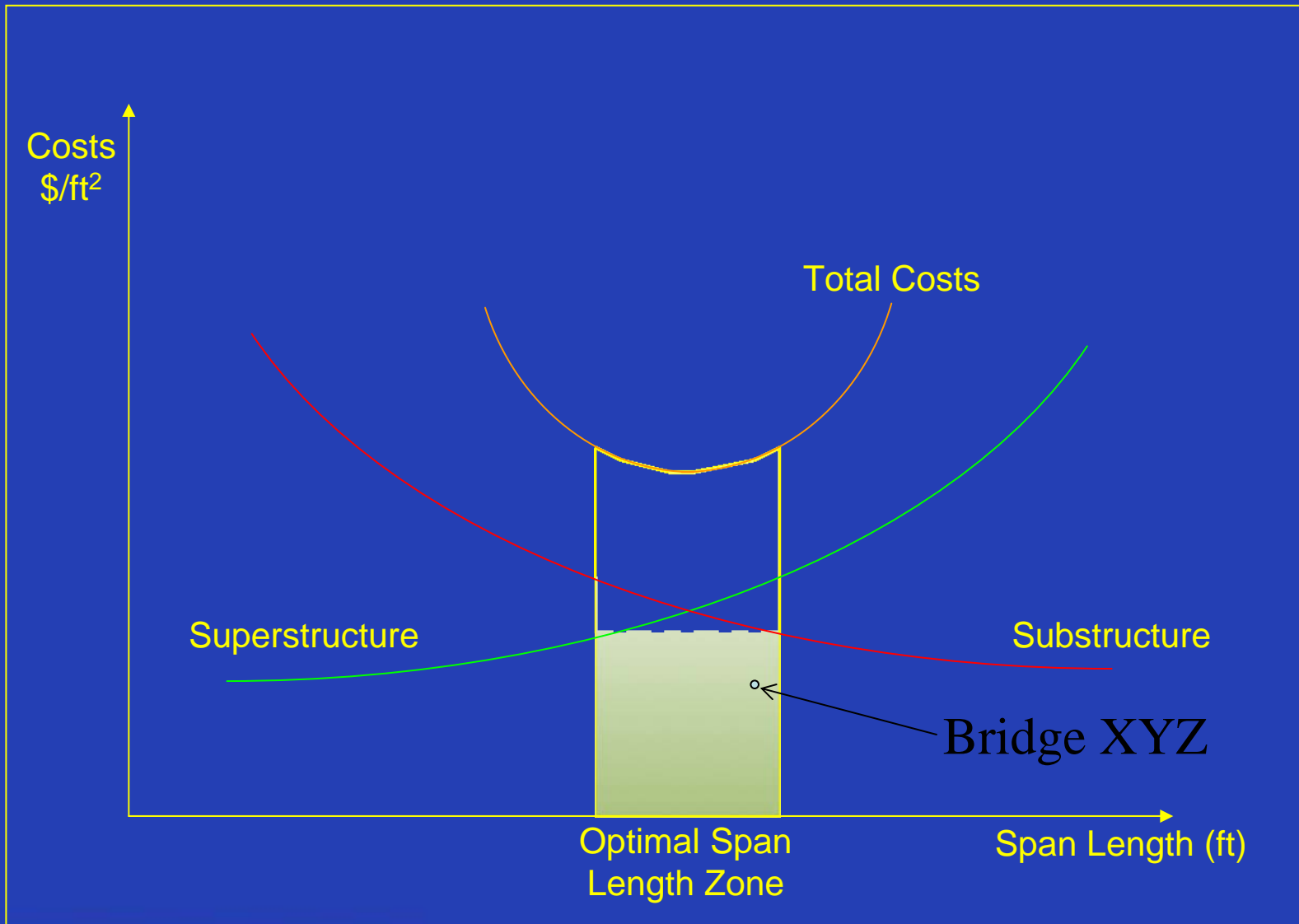
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BridgeID	32
Bridge_Name	Lion Bridge
ProjectID	3
Finiancial_Number	113B-59
Latitude	235
Longitude	28
Station	214+10
Offset	-11
State	FL
County	45
Zipcode	
Client	FDOT
Consultant	Yet Another Corporation
Contractor	GoodWork Contractor
PileShaft_Company	Industrial Contracting Company (ICC)
PileTest_Company	Schmertmann_Crapps, Inc.
Comments	There are no comments
AsBuilt	1
AsBuiltID	

Table: Bridges	
BridgeID	23
Bridge_Name	St. Johns Bridge
ProjectID	3
Finiancial_Number	123A-49
Latitude	235
Longitude	28
Station	214+10
Offset	-11
State	FL
County	45
Zipcode	
Client	FDOT
Consultant	Another Corporation
Contractor	GoodWork Contractor
PileShaft_Company	Industrial Contracting Company (ICC)
PileTest_Company	Schmertmann_Crapps, Inc.
Comments	There are no comments
AsBuilt	1
AsBuiltID	

Table: Bridges	
BridgeID	27
Bridge_Name	Port Orange Bridge
ProjectID	3
Finiancial_Number	123A-45
Latitude	135
Longitude	20
Station	221+10
Offset	-11
State	FL
County	50
Zipcode	
Client	FDOT
Consultant	Sverdrup Corporation
Contractor	Danis Industries Corporation
PileShaft_Company	Industrial Contracting Company (ICC)
PileTest_Company	Schmertmann_Crapps, Inc.
Comments	There are no comments
AsBuilt	1
AsBuiltID	



Cost Curve



How does this DB work? Example



Problem Statement: a bridge designer in Orlando has to design a bridge in Pensacola (450 miles)

How does this DB work? Example



Radius: 50 miles

How does this DB work? Example



Summary

- A more efficient and effective process for managing the critical information for preliminary design is needed.
- The idea is to collect data on a representative sample, including one of the more common bridge categories of structures. The goal is to obtain sufficient data to populate the BrIM and demonstrate feasibility of this approach.

Summary

- To develop the previous idea, the process that we suggest is a web-based application where authorized users can query needed information.
- This web-based application will begin with the information of two counties in the State of Florida; however, with expectancies of growing through populating this database on Internet, reaching the rest of the state and, if it is possible, others states in US.

Thank you for your attention...