Embedded Data Collectors

The Virginia Experience

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Virginia Department of Transportation
Real Solutions Web Conference
July 25, 2013
Virginia’s Highway System

- Interstate – 1,118
- Primary – 8,111
- Secondary – 48,305
- Frontage – 333
- Total Mileage - 57,867

Only California and Texas maintain more mileage
# Table 1a – Total Number of Structures (Bridges and Culverts)

<table>
<thead>
<tr>
<th>DISTRICT</th>
<th>Number of Structures (Bridges and Culverts)</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Interstate</td>
<td>Primary</td>
<td>Secondary</td>
<td>Urban</td>
<td>Total</td>
</tr>
<tr>
<td>Bristol</td>
<td>216</td>
<td>956</td>
<td>2,188</td>
<td>83</td>
<td>3,443</td>
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<tr>
<td>Salem</td>
<td>217</td>
<td>807</td>
<td>1,943</td>
<td>103</td>
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<td>665</td>
<td>1,394</td>
<td>59</td>
<td>2,118</td>
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<tr>
<td>Richmond</td>
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<td>801</td>
<td>1,146</td>
<td>161</td>
<td>2,619</td>
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<tr>
<td>Hampton Roads</td>
<td>458</td>
<td>458</td>
<td>515</td>
<td>257</td>
<td>1,688</td>
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<tr>
<td>Fredericksburg</td>
<td>79</td>
<td>249</td>
<td>474</td>
<td>8</td>
<td>810</td>
</tr>
<tr>
<td>Culpeper</td>
<td>122</td>
<td>495</td>
<td>1,053</td>
<td>23</td>
<td>1,693</td>
</tr>
<tr>
<td>Staunton</td>
<td>429</td>
<td>827</td>
<td>2,140</td>
<td>100</td>
<td>3,496</td>
</tr>
<tr>
<td>NOVA</td>
<td>345</td>
<td>446</td>
<td>1,181</td>
<td>79</td>
<td>2,051</td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td><strong>2,377</strong></td>
<td><strong>5,704</strong></td>
<td><strong>12,034</strong></td>
<td><strong>873</strong></td>
<td><strong>20,988</strong></td>
</tr>
</tbody>
</table>
VDOT’s Annual Budget

$4.19 Billion

$1.830 Billion – Road Maintenance
$1.605 Billion – Construction
$449.7 Million – Support to other agencies, administration, tolls and other programs
$300 Million – Debt service
VDOT’s Annual Budget

$4.19 Billion

$1.830 Billion – Road Maintenance
$1.605 Billion – Construction
$449.7 Million – Support to other agencies, administration, tolls and other programs
$300 Million – Debt service

A new gas tax will significantly increase these numbers.
VDOT’s first project using **DYNAMIC PILE TESTING** was in the Summer 1984
This is a sample image. Similar documentation will be posted to the TIG Embedded Data Collectors website in the near future.
EDC

EMBEDDED DATA COLLECTORS
EDC

EMBEDDED DATA COLLECTORS
EDC | EMBEDDED DATA COLLECTORS
Monitor- Merrimac Memorial Bridge
Interstate Route 664 in Newport News, Virginia

Pile Driving Program

2 Pre-Construction Pile Load Test Programs ($333,000)
16 Construction Load Tests ($387,000)
45 Construction Dynamic Pile Tests ($95,000)
Monitor - Merrimac Memorial Bridge
Interstate Route 664 in Newport News, Virginia

Pile Driving Program

430,000 linear feet of pile
12” Prestressed Concrete Piles
24” Prestressed Concrete Piles
54” Prestressed Concrete Cylinder Piles
Monitor- Merrimac Memorial Bridge
Interstate Route 664 in Newport News, Virginia

Pile Testing Program Costs: $815,000

Estimated savings in Construction Cost due to increased pile capacities: $12 Million

Estimated savings in Construction Cost due to reduced pile lengths through Dynamic Testing: $2 Million
EDC

EMBEDDED DATA COLLECTORS
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What followed was 25 Years of productive and cost effective Pile Driving using Dynamic Testing.
Six 24” square prestressed concrete piles were cast with EDC’s in the top and at the tip.

The piles were used as Driving Test Piles.
EDC

EMBEDDED DATA COLLECTORS
The tests were only partly successful due to the failure of several of the sensors possibly due to the heat of hydration in the concrete.
No new Virginia projects with EDC’s were developed but we followed the progress of Florida DOT’s EDC research.
When the Florida research was completed and the use of EDC’s was allowed in the Florida pile specification, Virginia followed suit.
In December of 2011 VDOT organized a one day new product information transfer workshop on EDC’s for our consultants and contractors.
The first project where EDC’s were chosen for use by the Contractor is the new bridge on Dominion Boulevard in Chesapeake, Virginia, advertised in 2012.
# Pile Driving Program

on Dominion Boulevard

<table>
<thead>
<tr>
<th>Pile Size</th>
<th>Driving Tests</th>
<th>Linear Feet of Pile</th>
</tr>
</thead>
<tbody>
<tr>
<td>12”</td>
<td>2</td>
<td>1,668</td>
</tr>
<tr>
<td>16”</td>
<td>16</td>
<td>15,146</td>
</tr>
<tr>
<td>24”</td>
<td>20</td>
<td>36,657</td>
</tr>
<tr>
<td></td>
<td>38</td>
<td>53,471</td>
</tr>
</tbody>
</table>
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EDC  EMBEDDED DATA COLLECTORS
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In What Ways Does VDOT Plan To Use Embedded Data Collectors?
The new Special Provision allows Contractors the choice to use either EDC or PDA.
The new Special Provision allows Contractors to choose to use either EDC or PDA.

We may begin to require that the first Driving Test Pile have a top and bottom sensor.
realization of 200uE shift in static pre-stress level....
Cost Benefits – Advanced Damage Detection
(early detection saves $$)
This is a sample image. Similar documentation will be posted to the TIG Embedded Data Collectors website in the near future.
Driving Tests are usually done on a pile that will be incorporated into the bridge foundation.
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When the Contractor remobilizes to begin production pile driving, the EDC in the Driving Test Pile can easily be reactivated and a second restrike performed, giving us soil setup weeks after initial driving.
This is a sample image. Similar documentation will be posted to the TIG Embedded Data Collectors website in the near future.
Long Term Monitoring using Embedded Data Collectors (EDC) in Bridge Structures
A pier cap with Embedded Data Collectors installed in it was built for FHWA’s Turner-Fairbank Highway Research Center. It will provide data for ongoing studies into lifecycle monitoring and cost. The work is being done by Carl Ealy.
EDC

EMBEDDED DATA COLLECTORS
Remote Monitoring – System Elements

EDC Piles, Beams, Columns, ETC.
(Localized wireless sensor network)

Gateway
Remote Monitoring
Harvests sensor data and moves data to the Portal

Internet
All raw sensor data processed and reported via Portal

Browser Access
Commercial Users
Governmental Users
Researchers

3G

Database (Portal)
EDC Drilled Shaft Instrumentation Layout – Bridge B606, I-95 Hot lanes Project, Virginia, USA
Step 1
Strain transducers and temperature sensors are installed on drilled shaft rebar cage

Step 2
Preliminary data is collected from the dataport before and after concrete pour in drilled shafts
Step 3
Cables are installed for cap monitoring

Step 4
Sensors are connected through cables and are connected to data port
Step 5
Data port attached to the form work, to collect data after concrete pour

Step 6
Cap instrumentation set up before concrete pour
Concrete Pour
Data Collection Equipment

Data port cover on the back wall of abutment
Purpose of using EDC Instrumentation & Monitoring in Drilled Shaft
EDC

Purpose of Using EDC Instrumentation & Monitoring in Drilled Shafts

- Static Load measurements at various locations along the shaft and shaft cap.
- Changes in shaft strain during live load, dead load and service loads.
- Temperature of concrete at various stages of the shaft and shaft cap construction and post construction.
- Determine the load transfer along the shaft.
This information will be extremely valuable if States want to revisit and modify load and resistance factors based on their local conditions and practices.
Embedded Data Collectors
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Want more information?

Visit the Embedded Data Collectors webpage at:

tig.transportation.org

Embedded Data Collectors

Jesse Sutton
Florida Department of Transportation

NHI Real Solutions Web Conference
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