Innovative Safety Applications in Tennessee

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TSITE Summer Meeting, July 27th 2017
Safety Initiatives and Projects

- Fatal Trends in Tennessee
- Rural Road Diet
  - Chapman Highway
- Urban Bottlenecks
  - I-40 with I-640
  - I-40 between I-275 and US 129
- Wrong Way Safety Solutions
  - Region 1 Pilot
Fatality Trends in Tennessee – 1950 to 2011

- **Fatalities**
- **VMT**
- **Fatal Rate**
Fatality Trends in Tennessee

Fatalities Percent of Total by Contributing Factor

- Roadway Departures: 63%
- Unrestrained: 42%
- Alcohol: 29%
- Speeding: 21%
- Senior Drivers: 18%
- Intersections: 16%
- Motorcyclists: 13%
- Teen Drivers: 12%
- Large Trucks: 10%
- Pedestrians: 7%
- Work Zones: 1%
- Bicyclists: 1%
- Railroad Crossings: 0%
US 441, Chapman Highway

- 24-mile Route from Knoxville to Sevierville
- 3 counties & 5 different State Routes designations
- Varies from Urban 5-Lane (40k AADT) to Rural multi-lane (13K AADT)
- Before Interstate – Route was the Gateway to the Smoky Mountains
US 441, Chapman Highway

Proposed lane reconfiguration:
4 lane undivided to 3 lane with center turn lane and passing lanes
Tittsworth Springs and Rogers Road to Whites School Road
Sevier County
### Existing Chapman Highway Typical Section

7.2-mile Section from Seymour to Sevierville

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(4) Narrow lanes (10.5 feet wide)</td>
<td>14 Fatal Crashes</td>
</tr>
<tr>
<td>Limited Shoulders (2 to 4 feet)</td>
<td>48 Incapacitating Injury Crashes</td>
</tr>
<tr>
<td>No buffer between opposing traffic</td>
<td>198 Other Injury Crashes</td>
</tr>
<tr>
<td>Speed Limit 55 mph</td>
<td>685 Total Crashes</td>
</tr>
<tr>
<td>Significant Vertical and Horizontal Curves</td>
<td>38% Severe Crashes</td>
</tr>
<tr>
<td>Challenging Topography</td>
<td></td>
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</tbody>
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Image: Aerial view of Chapman Highway with vehicles on the road, surrounded by greenery and houses.
Coordination and Communication

Implementation Partners

- **Internal**
  - Regional Director
  - Traffic
  - State Forces (Floating)
  - Design
  - Construction
  - Commissioner
  - Others

- **External**
  - General Public
  - Public Officials
  - Property Owners
  - Contractors

Communication between many is required and is not a natural strength for engineers.

**4 C’s**

- Clarity of Purpose
- Customers Context
- Concise Content
- Communicate with
Chapman Highway Alternative 1
Widen to 5-Lane

**Pros**
- Efficient Operations
- Future Capacity
- Center Turn Lane
- Travel Time Reliability
- Safety

**Cons**
- **Cost approximately $82 million**
  - Volumes do not require concept in near future
  - Competes for funding with other Regional Projects
- Time for Delivery
- Project Impacts
  - ROW Acquisition
  - Environmental
  - Utility Relocations

**Cost Information for 5-L Widening Projects**

- Chapman (Evans to Burnett Ln)
  - Length – 0.9 Miles
  - Cost – $5.9 million
- Chapman (Macon to SR-338)
  - Length – 1.18 Miles
  - Cost – $19 million

Average Cost per mile – $11.4 million
Estimated Cost for 7.2 miles - $82 million
Pros

• Safety

• **Cost Feasible = $2.1 million**

• No ROW, Environmental or Utility issues

• Safe designated passing areas

• **Center Turn Lane**
  – Buffer between opposing traffic
  – Safe Refuge for turning traffic
  – Reduces Rear-end crashes
  – Reduces delays for left-turning traffic
  – Improves access

• **Paved 7 ft. Shoulders**
  – Refuge for emergency or disabled vehicles
  – Recovery area for errant vehicle
  – Safe refuge for mail carrier
  – Use for right turning traffic

• **Posted Speed Reduced to 50 mph**
  (Reducing speed differentials)

• **Eliminates Weaving**

• **Simplifying road scanning** and gap selection for entering vehicles
Crash Reduction Factors

- Adding a Center Turn Lane
  - Total Crashes – Reduction of 37%

- Adding Paved Shoulders
  - Up to 47% Reduction of roadway departure type crashes, depending on shoulder width

**Impact Over 10 years**

Total Crash Reduction = 250

Severe Crash Reduction = 104
Current Roadway Section

Capacity Utilization - Existing Conditions

- Current Volume (1677)
- Excess Capacity (6723)
Proposed Roadway Section

Capacity Utilization - Projected 2035

- Projected Volume yr 2035 (1932)
- Excess Capacity (1268)
Level-of-Service (LOS)

LOS A

LOS B

LOS C

LOS D

LOS E

LOS F
Synchro Model - Existing Sugar Loaf

Delay 101.1 sec
Synchro Model - Proposed Sugar Loaf

Delay 36.3 sec
Project Summary

- **Time** - Less than 2 years from conception to construction
- **Cost** - $2,006,669.71
- **Cost Saving** - $80 million
- **60% 3-Lane** 40% 3-Lane with passing lane
- **Thin-Lift Overlay**
- **Enhanced Pavement Markings** – 6” lines, Snowplowable Markers, Edge line Rumble Stripes and Channelization for Open Frontage
- **Reduced Speed Limit** - 50 mph & Trucks Use Right Lane

### Before and After Study Chapman Highway

<table>
<thead>
<tr>
<th>Study Period</th>
<th>Time Period</th>
<th>Days of Study Period</th>
<th>Crashes Total</th>
<th>Fatal Total</th>
<th>Incapacitating Total</th>
<th>Yearly Average</th>
<th>Injury Total</th>
<th>Yearly Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>After</td>
<td>12/1/2016 - 7/1/2017</td>
<td>212</td>
<td>27</td>
<td>1</td>
<td>1</td>
<td>1.7</td>
<td>12</td>
<td>20.7</td>
</tr>
<tr>
<td>Before</td>
<td>9/30/2006 - 9/30/2016</td>
<td>3653</td>
<td>616</td>
<td>12</td>
<td>44</td>
<td>4.4</td>
<td>183</td>
<td>18.3</td>
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<tr>
<td></td>
<td>9/30/2013 - 9/30/2016</td>
<td>1096</td>
<td>167</td>
<td>2</td>
<td>9</td>
<td>3.0</td>
<td>49</td>
<td>16.3</td>
</tr>
<tr>
<td></td>
<td>9/30/2015 - 9/30/2016</td>
<td>366</td>
<td>56</td>
<td>0</td>
<td>3</td>
<td>3.0</td>
<td>19</td>
<td>18.9</td>
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</table>

<table>
<thead>
<tr>
<th>Study Period</th>
<th>Crashes</th>
<th>Incapacitating</th>
<th>Minor Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>After</td>
<td>212 Days</td>
<td>-24.5%</td>
<td>-60.8%</td>
</tr>
<tr>
<td>Before</td>
<td>10-years</td>
<td>0.0%</td>
<td>0.0%</td>
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</table>
Chapman Highway – Post Construction
Urban Bottlenecks
Knoxville Area

Westbound I-40 between I-275 and US 129

Westbound I-40 @ I-640 Merge
Urban Bottleneck
I-40 with I-640

Before
Westbound Merge

AADT 193,911 (2015)

I-640 WB Ramp
AADT 46,984 (2015)
Urban Bottleneck
I-40 with I-640

After
Westbound Merge

Stay in lanes

Image: Landsat/ Copernicus

Google Earth

TN TDOT
Department of Transportation

Tennessee Section Institute of Transportation Engineers

ITE
Southern District
Measuring Effectiveness
RDS Speed Data

Please note that,
• Black-colored horizontal lines refer to locations of the detector stations working on a specific day.
• Congestion might be caused by recurrent demand fluctuation or non-recurrent traffic incident(s).
• 12 Horizontal lines from RDS data
• University of TN prepared 21 maps
  • 10 hours each
• Thanks to Dr. Lee Han, Mr. Bumjoon Bae and Mr. Brandon Whetsel
Measuring Effectiveness
Westbound I-40 with I-640

<table>
<thead>
<tr>
<th>2015 - Before</th>
<th>2016 - After</th>
</tr>
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<tbody>
<tr>
<td>Affected area saw less congestion</td>
<td></td>
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Westbound I-40 with I-640
Friday Before Labor Day

- 8 AM
- 2 PM
- 6 PM

Papermill
17th Street
Measuring Effectiveness
Westbound I-40 with I-640

2015 - Before

2016 - After

Affected area saw less congestion
Urban Bottleneck
I-40 between I-275 and US 129
Wooden Walls?
Before: I-40/I-275 to 17th Street

Minimum lane changes needed:
2 lane changes needed to exit on 17th Street

Not to scale
Before: I-40/I-275 to US 129, Alcoa Highway

Minimum lane changes needed:
1 lane change needed to exit on US 129

Not to scale
Before: I-40/I-275 to 17th Street

Total Conflict Points: 23

Not to scale
After: I-40/I-275 to 17th Street

Minimum lane changes needed:
1 lane change needed to exit on 17th Street

Not to scale
Minimum lane changes needed: 0 lane changes needed to exit on US 129
After: I-40/I-275 to 17th Street

Total Conflict Points: 16

Not to scale
Open-Graded Friction Course, OGFC

- Reduces spray and surface water
- Increases friction
- Shorter pavement lifespan

Traditional Pavement

OGFC
Post Construction Photographs
Measuring Effectiveness
I-40 between I-275 and US 129
Wednesday (September 2015 vs January 2017)

2015 - Before

2017 - After

Papermill

17th Street

Affected area saw less congestion
Project Summary

- **Time** - Less than 1 year from conception to construction
- **Cost** - $2,022,939.90 for paving & $55,076.64 for signs
- **Wet Weather Crashes**
  - Open Graded Friction Course
- **Simplified Decision Making**
  - Improved Guide Signs
  - Pavement Shields
  - Option Lanes – Longer Time for Decision
- **Improving Interchange**
  - Reducing Conflicts & Lane Changes
  - Option Lanes
  - Changed without Widening

<table>
<thead>
<tr>
<th>Study Period</th>
<th>Westbound Crashes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yearly Average</td>
</tr>
<tr>
<td>After 242 days</td>
<td>28.7</td>
</tr>
<tr>
<td>1-year</td>
<td>68.0</td>
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</table>
Wrong Way Safety Solutions

- 4 Wrong Way Crashes in 2013
- (2013) Low Cost Pilot project (24 counties)
  - Wrong-Way Arrows ($130,000)
  - Reflective Post Strips and Oversizing Signs (In House Forces)
- (2016) Targeted Problem Ramps
  - Flashing Beacons
  - Doubling Signs
  - LED Blank Out

13 BI-DIRECTIONAL RED AND WHITE SPMS

23' 6"

2 SPACES @ 3' 6" = 7

2 SPACES @ 5' 6" = 11'

10'

WRONG WAY PAVEMENT ARROW WITH SNOWPLOWABLE PAVEMENT MARKERS TO BE USED ON SINGLE-LANE RAMPS ONLY

25'

3'

4'

5'

14 MONO-DIRECTIONAL RED ONE-DIRECTIONAL SPMS

WRONG WAY ARROW USING SNOWPLOWABLE PAVEMENT MARKERS TO BE USED ON MULTI-LANE RAMPS ONLY
Wrong Way Safety Solutions
Thank you