Follow the Yellow Striped Road
But Watch Out for that Manhole

By:
Hunter Venne
Background
How the Study Began

- ASU Masters Courses & Applied Project
  - Pavement Courses
- Internship
  - Transportation Projects
  - Infrastructure Rehabilitation Projects
Manhole Installation

- Maricopa Association of Governments
  - Uniform Standard Details for Public Works Construction

- MAG Detail No.
  - 224
  - 420-2
  - 422
Manhole Installation
Manhole Installation

NOTES:

1. PRECAST, MANUFACTURER SHALL BE AN NATIONAL PRECAST CONCRETE ASSOCIATION (NPCA) CERTIFIED PLANT. ENTIRE PRECAST BASE SHALL BE MANUFACTURED AT THE PLANT PER ASTM C478.

2. MAG "AA" 4000 PSI CONCRETE SHALL BE USED FOR PRECAST MANHOLE BASES.

3. SPRING LINE OF CAST-IN-PLACE BELL SHALL STOP AT INSIDE FACE OF MANHOLE.

4. JOINTS FOR BARREL SECTION SHALL BE TONGUE AND GROOVE TYPE. ALL LIFTING HOLES SHALL BE SEALED WITH GROUT.

5. ALL PRECAST MANHOLE BASES SHALL BE PLACED ON 8" MINIMUM OF ABC PER SECTION 702 COMPACTED TO 100% MAXIMUM DENSITY.

6. ALL MODIFICATIONS SHALL BE APPROVED BY THE ENGINEER.

7. MINIMUM WALL THICKNESS SHALL BE PER ASTM C478 (MIN 5").

8. REINFORCEMENT SHALL BE DESIGNED BY AN ARIZONA REGISTERED PROFESSIONAL ENGINEER.

9. CHANNEL TRANSITION SHALL BE CONSTANT FROM INLET TO OUTLET OF MANHOLE TO FACILITATE SMOOTH TRANSITIONS AND ACCOMMODATE CORRESPONDING MANDREL.

10. THERE SHALL BE NO HARD CONNECTIONS (GROUTED) INTO THE MANHOLE BASE UNLESS APPROVED BY THE ENGINEER.

11. ALL SEWER SERVICE CONNECTIONS SHALL HAVE THE SAME CONNECTION TYPES IN THE PRECAST MANHOLE BASE.

12. ALL CORE HOLES INTO THIS STRUCTURAL PRECAST BASE SHALL BE COATED WITH AN APPROVED COATING MATERIAL.

13. THE MANHOLE BOTTOM SHALL EXTEND OUTSIDE THE MANHOLE WALL A MINIMUM 6" WIDE ON 48" BASES, 7" WIDE ON 60" BASES, AND 8" WIDE ON 72" BASES. EXTENDED BOTTOM SHALL BE A MINIMUM OF 5" THICK.

14. ALL PIPE CONNECTIONS SHALL BE IN COMPLIANCE WITH ASTM F477 OR ASTM C425. AN EXTRA STRENGTH VCP BELL WITH A POLYURETHANE JOINT THAT MEETS ASTM C425 MAY BE USED WITH VCP.
Manhole Installation

NOTE:
1. Contractors shall adjust all manhole rings and covers, including manholes outside of the pavement.
2. Adjustment shall be constructed per MAG section 345.
3. Manhole coatings per agency.
4. Grout shall be used between frame and adjusting ring to achieve water tightness.

<table>
<thead>
<tr>
<th>SPACER TYPE</th>
<th>REQUIRED THICKNESS</th>
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<tbody>
<tr>
<td>Brick</td>
<td>Greater than 2&quot;</td>
</tr>
<tr>
<td>4&quot;x2&quot; Steel Spacer</td>
<td>½&quot; to 2&quot;</td>
</tr>
<tr>
<td>Grout</td>
<td>Less than ½&quot;</td>
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ADJUSTING RING DETAIL

CONCRETE COLLAR, CLASS 'AA' CONCRETE PER SECT. 725 & 505
SUBGRADE PREPARATION TO CONFORM TO SECT. 301 OR 601

EXISTING OR RECENTLY INSTALLED PAVEMENT

#4 REINFORCING STEEL HOOP EQUALLY CENTERED HORIZONTALLY & VERTICALLY (IF REQUIRED BY AGENCY)

ADJUSTING RINGS
Sewer Manhole Data
Chandler Manhole
Ring and Cover Assessment

- The City of Chandler hired the Dibble Engineering Infrastructure Rehabilitation Team
- Ring and Cover Assessment
  - Manholes within Arterial Roadways
Manhole Investigation with ArcGIS Collector

- The ArcGIS Collector Application
- Bad Elf GPS
- Windows Surface
Manhole Investigation with ArcGIS Collector

- Based on the NASSCO Pipeline Assessment, the following data was collected:
  - Ring and Cover Conditions
  - Collar Condition
  - Recess Distance
  - If the Cover Moves
  - If in Wheel Track, Turn Lane, or Not
Manhole Investigation with NASSCO PACP

- Using Conditions put forth by NASSCO PACP Section 8, the Conditions documented consisted of the following:
  - Ring and Cover Conditions
    - Sound, Damaged, Corroded
  - Collar Condition
    - Sound, Cracked, Fractured
Manhole Investigation with NAASCO Rating System

- The condition information graded based on NAASCO grading system
  - Appendix C – PACP Condition Grading System
  - The higher the grade, the worse the condition
- The grades were applied to each manhole based on conditions
- Overall Grade was applied
In Wheel Track Grading System

- No NASSCO grading system for manhole location
- Similar hierarchy coding value was applied representing manhole location
  - Not in Wheel Track: 1
  - In Turn Lane Wheel Track: 3
  - In Wheel Track: 5
Manhole Investigation - ArcGIS Collector
Manhole Investigation - ArcGIS Collector
Roadway Data
### Roadway Data from City of Chandler

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<tr>
<th></th>
<th>Germann Road</th>
<th>Spring 09</th>
<th>Spring 10</th>
<th>Spring 11</th>
<th>Spring 12</th>
<th>Spring 13</th>
<th>Spring 14</th>
<th>Spring 15</th>
<th>Spring 16</th>
<th>Spring 17</th>
<th>2016 <strong>Surveyed Average PQI</strong></th>
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<td>Alma School Rd to Arizona Ave</td>
<td>HIP</td>
<td>TRMSS</td>
<td>M/I*</td>
<td>72.08</td>
<td>71.90</td>
<td>78.13</td>
<td>72.90</td>
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<td>1a</td>
<td>Arizona Ave to Hamilton Street (County Until 2016)</td>
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<td>TRMSS</td>
<td>M/I*</td>
<td>72.08</td>
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<td>1b</td>
<td>Hamilton ST to McQueen Rd</td>
<td>HIP</td>
<td>TRMSS</td>
<td>M/I*</td>
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<td>72.90</td>
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<td>TRMSS</td>
<td>M/I*</td>
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<td>71.90</td>
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<tr>
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<td>Cooper RD to Gilbert RD</td>
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<td>Arizona Ave to McQueen Road</td>
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<td></td>
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<td>3c</td>
<td>McQueen RD to Cooper RD (Town of Gilbert Jurisdiction)</td>
<td>S/S</td>
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<td>Alma School Rd to Arizona Ave</td>
<td>S/S</td>
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<td>S/S</td>
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<td>4d</td>
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</table>

**Abbreviations**

- HIP: Hot in place
- TRMSS: Tire Rubber Modified Surface Seal
- M/I: Mill and Inlay
- S/S: Slurry Seal
- AC: Asphalt Concrete
- ABC: Asphalt Base Course
- PQI: Pavement Quality Index
- MAG: Maricopa Association of Governments

**Cross Section**

- Standard City Pavement Structure/MAG is 17" Thickness all new construction or repave to attempt to meet this criteria. 2" AC (1/2" mix) - tack coat- 3" AC (3/4" mix) - 12" ABC, on subgrade.

**Notes**

- Not part of 2016 Survey, work completed March 2017
- **COC uses and outside consultant to survey condition of roadways.** Survey results are used as a base point, but PQI’s referenced need to be field verified by City Staff and treatments/programmed years may be adjusted accordingly.
- **All Data and information presented herein is an attempt to provide accurate information for use in an ASU assigned Applied Project to ASU Representative "Hunter Venne" and its intended use is for that such. While accuracy is attempted it is not guaranteed. Future Budgets, Programs, Treatments, and Treatments years requires City Upper Management and Mayor/Council Approvals.**
Traffic Data
City of Chandler Traffic Counts

2016 City of Chandler Segment Traffic Volumes
Average Weekday Total (in Thousands)
(Raw Data)

**Under Construction**
# City of Chandler Traffic Counts Summary

<table>
<thead>
<tr>
<th>Road Segment</th>
<th>Elliot Rd</th>
<th>Warner Rd</th>
<th>Ray Road</th>
<th>Chandler Rd</th>
<th>Germann Rd</th>
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<td>I-10 to 56th</td>
<td>-</td>
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<td>29600</td>
<td>32600</td>
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<td>5th - Kyrene</td>
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<td>29900</td>
<td>33700</td>
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<td>Kyrene - Rural</td>
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<td>Rural to Mcklintock</td>
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<td>29300</td>
<td>26000</td>
<td>21900</td>
<td>12100</td>
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<td>Cooper - Gilbert</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>18300</td>
<td>18000</td>
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</table>
Summary Statistics
Summary Statistics

- 791 Manholes Investigated by Dibble
- 432 Manholes Assessed in this Study
Asphalt vs. Concrete Collar
Summary Statistics for Asphalt vs. Concrete Collars

Sound  Cracked  Fractured
Summary Statistics for Asphalt vs. Concrete Collars

- 556 Concrete Collars, 235 Asphalt Collars

Collar Condition Percentages

- Sound: 58% Concrete Collar, 60% Asphalt Collar
- Cracked: 25% Concrete Collar, 38% Asphalt Collar
- Fractured: 17% Concrete Collar, 2% Asphalt Collar
# Wheel Track Summary Statistics

## Recessed Distance (in)

<table>
<thead>
<tr>
<th>Recessed Distance (in)</th>
<th>Total Number</th>
<th>In Wheel Track</th>
<th>In Turn Lane</th>
<th>Not in Wheel Track</th>
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<td>-1</td>
<td>16</td>
<td>10</td>
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<tr>
<td>-0.875 to -0.5</td>
<td>233</td>
<td>152</td>
<td>20</td>
<td>61</td>
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<td>-0.5 to 0</td>
<td>522</td>
<td>244</td>
<td>98</td>
<td>180</td>
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<tr>
<td>&gt;0</td>
<td>20</td>
<td>4</td>
<td>6</td>
<td>10</td>
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<tr>
<td>Total</td>
<td>791</td>
<td>410</td>
<td>126</td>
<td>255</td>
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</table>

## Recessed Distance (in) - Percentages

<table>
<thead>
<tr>
<th>Recessed Distance (in)</th>
<th>In Wheel Track</th>
<th>In Turn Lane</th>
<th>Not in Wheel Track</th>
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<tbody>
<tr>
<td>-1</td>
<td>63%</td>
<td>13%</td>
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<td>-0.875 to -0.5</td>
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<td>9%</td>
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<td>-0.5 to 0</td>
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<td>&gt;0</td>
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<td>50%</td>
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<tr>
<td>Total</td>
<td>52%</td>
<td>16%</td>
<td>32%</td>
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Study Methods
Study Methods

- Performed statistical analysis on the Ring and Cover Data
- Determined Correlation Matrices between the following
  - Ring and Cover Conditions in relation to AADT
  - Ring and Cover Conditions in relation to location within lane (i.e. in wheel track)
- Perform Literature Review
Study Results and Analysis
## Study Results

### Correlation Matrix

- Ring and Cover Condition in relation to AADT
- Ring and Cover Condition in relation to location within lane (i.e. in wheel track)

<table>
<thead>
<tr>
<th></th>
<th>AADT</th>
<th>In Wheel Track Factor</th>
<th>Recessed Distance</th>
<th>Concrete Collar Grade</th>
<th>Asphalt Collar Grade</th>
<th>Ring Condition Grade</th>
<th>Cover Condition</th>
<th>Cover Moves</th>
<th>Overall Grade</th>
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<td>In Wheel Track Factor</td>
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<td>Concrete Collar Grade</td>
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<td>Asphalt Collar Grade</td>
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<td>Cover Condition</td>
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Other Studies

- ASCE Study: Effects of traffic on manhole settlement (Longitudinal Vibration) (4)
  - The model was not perfect, and they recommend further studies
Other Studies

- Manhole rehabilitation techniques Compared to How they:
  - Withstand traffic
  - Weather
  - Chemicals within the manhole (5)
  - All of the techniques held up to traffic loads, when implemented properly
    ✓ i.e. proper materials and methods
Other Studies

- One study tested strains on soils due to:
  - Manhole structures
  - Vehicle loading \((6)\)

- The trucks loads had smallest effect on soils stresses & settlement
  - The weight of the manhole and surrounding soils had the largest effect
Analysis Conclusions
Conclusions

- The correlations between AADT and the Manhole conditions are minimal
- Manhole location within roadway does show higher correlations with most of the manhole conditions
  - Concrete and Asphalt Collar Conditions
  - Ring and Cover Conditions
  - Overall Condition
Recommendations
Recommendations

- With more time, more detailed data could be obtained for a more thorough analysis using this same framework
  - More Detailed Traffic Data
  - PQI Data for Smaller Sections of Roadways
  - Age of manhole components
  - Age of Pavements
  - Further Breakdown of Comparisons and Correlations
Recommendations

- **Composite Manholes (Manganaro Lift Station in the City of Chandler)**
  - Makes the manholes lighter
  - Comes in one piece
  - Less possibility for installation errors and leaking

- **3-D Printing Options**
  - Some studies are being conducted
References


2. 2016. Pipeline Assessment Certification Program. NASSCO.


Questions?