
# Concrete Pavement & Subgrade Foundations

Clive PUBLIC WORKS

## Municipal Streets Seminar – November 5, 2019

HRGreen

# Introduction

## Larry Stevens, PE

- Project Director, HR Green, Inc.,
- City Engineer for multiple communities
- Past SUDAS Director
- APWA National Past President
- Served on the ISI Board of Directors

# Overview of Today's Topic

You will have a better understanding of:

- Clive's pavement management study – why and how
- Clive's approach to improve the sustainability of its pavement system
- Clive's policy changes to extend the life and serviceability of its PCC pavements
- Potential benefits of the pavement design improvements

# Clive, Iowa - Background

- Incorporated on October 9, 1956
- Population:  17,506 (2015 Special Census)
  - 1960  752
  - 1970  3,005
  - 1980  6,064
  - 1990  7,515
  - 2000  12,809
  - 2005  13,985
  - 2010  15,447
- Landlocked
- Projected Population:  27,000 – 28,000

# Why change how Clive streets are managed?

- Unique situation
- No really old infrastructure
- Time to begin considering replacement/No large backlog
- What is the cost of ownership for SUSTAINABLE infrastructure

# Why Change?

## There’s a Looming Problem!

# City Responsibility

- Developer constructs infrastructure
- City accepts improvements with obligation to maintain in PERPETUITY
- City provides all maintenance
- City is responsible for reconstruction when necessary
  - May use assessments, may be big impact on home owners (25% of value of home)
  - Future reconstruction costs include removal of existing in addition to reconstruction costs.

# Dellwood Drive – 3 years old

(west of Berkshire)

# Airline Drive – 4 years old

# Dellwood Drive - 4 years old

(East of Berkshire)

# Tanglewood Drive – 10 years old

# Hammontree Court – 15 years old

# Sheridan Avenue (20 years old)

# Rosewood Drive – 25 years old

# Woodcrest Drive – 25 years old

# How Do We Solve the Problem?

- Starts with creating long-lasting sustainable streets.
- What is the cost to increase pavement life, and does it make economic sense?

## 11 year Street – Current

## 12 year Street – Proposed

# Summary – City Position

- **Why should we make a change?**
  - Longer life pavements
    - Sustainable
  - Prolonged higher service level reduces traveling public's cost of vehicle maintenance
  - Reduced disturbance to property owners due to reconstruction and maintenance
  - Reduced Maintenance Cost
- **How?**
  - HR Green to review and recommend changes
  - Council approval of new standards.
- **When?**
  - Prior to addition of new streets in 2018

# Clive Pavement Management Study Goals

- Review City Standards
  - Street Construction
  - Street Maintenance
- Develop inventory of streets in Clive
- Determine rehabilitation and reconstruction alternatives and trigger thresholds for improvements
- Develop 2 pavement replacement schedules for existing and future streets (existing and proposed standard)
- Develop sustainable maintenance replacement schedules for the following scenarios
  - Maintaining different levels of PCI
  - Using various funding levels

# Study Goals – This Presentation

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# Pavement Standards Study

**Analysis of the following components**

- PCC Pavement foundation – why and how
- PCC Pavement – proper design principles
- Current Clive design standards for pavements
- Recommended Clive design standards
- Cost/Benefit Comparisons

# Study Sources

## Appendix A: References


1. Gross, J., Harrington, D., Wiegand, P., and Cackler, T. *Guidance for Improving Foundation Layers to Increase Pavement Performance on Local Roads, Iowa*: Report No. TR-640, Iowa Department of Transportation. 2014.

2. Schaefer, V., Stevens, L., White, D., Ceylan, H. *Design Guide for Improved Quality of Roadway Subgrades and Subbases,* Iowa: Report No. TR-525, Iowa Department of Transportation, 2008.

3. Iowa Statewide Urban Design and Specifications Program (SUDAS), *Design Manual,* 2017.

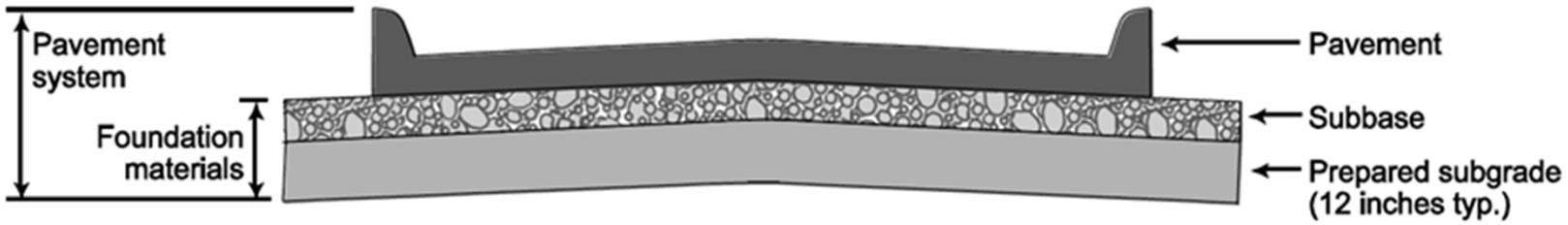
4. Taylor, P., Zhang, J., Wang, X. *Conclusions from the Investigation of Deterioration of Joints in Concrete Pavement,* Report No. TPF-5(224), Federal Highway Administration, 2016.

5. ACPA, *Subgrades and Subbases for Concrete Pavements,* EB204P, American Concrete Pavement Association, 2007.

6. ACPA, *Design and Construction of Joints for Concrete Streets*, American Concrete Pavement Association, 1992.

7. Weiss, J., Ley, M.T., Sutter, L. Harrington, D., Gross, J. Guide to the Prevention and Restoration of Early Joint Deterioration in Concrete Pavements, Iowa: Report No. TR-697, Iowa Department of Transportation, 2016.

# Pavement System




**Proper design, construction, and maintenance of the various components of the pavement system are critical to the performance of long-life pavements**

# PCC Pavement Foundation

**Performance of pavements depends on the quality of its subgrade and subbase layers**

Quality Pavement Foundation Guidelines

- Subgrade soils
  - Prepared subgrades with minimum CBR of 10
  - Iowa soils generally provide poor support
    - Stabilized subgrades
      - Chemical
      - Reinforced, geosynthetics
- Subbases
  - Necessary for subsurface drainage in Iowa's cold, wet climate
  - Longitudinal subdrains necessary
  - Drainage helps to prevent early pavement joint deterioration

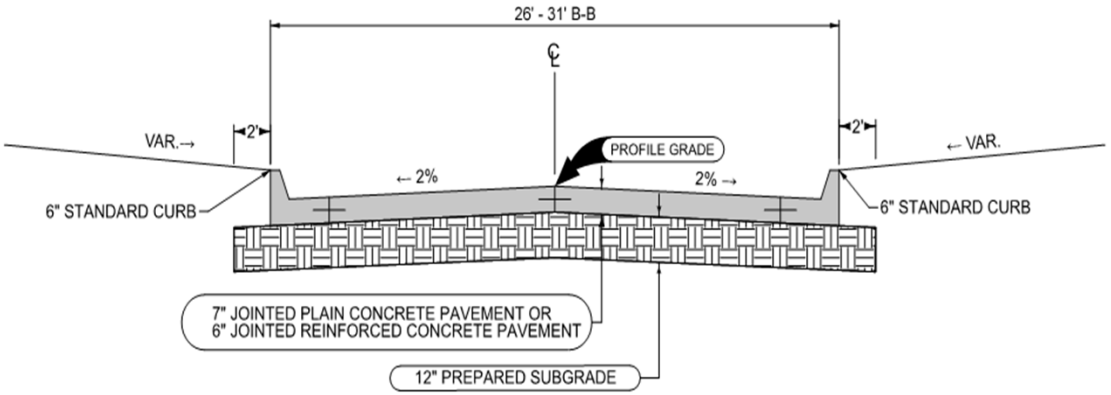
# PCC Pavement

## PCC Pavement Guidelines

- Pavement thickness
  - Thickness design tables
  - Default thickness
  - Iowa experience
- Pavement jointing
  - Proper transverse and longitudinal spacing
  - Plain (JPCP)and reinforced (JRCP)
- Pavement mix
  - Provide durability and resistance to degradation (primarily due to de-icing)
  - C-SUD Mix

# Current Residential Standard

- **Pavement Foundation**
  - 12” subgrade prep below pavement
- **Pavement**
  - Concrete – Varies
  - Jointing - Varies
    - 7” Jointed Plain Concrete Pavement (JPCP) w/ CD baskets, or
    - 6” Jointed Reinforced Concrete Pavement (JRCP)
    - Gutterline Jointing




**CURRENT STANDARD**

# PCC Pavement Foundation

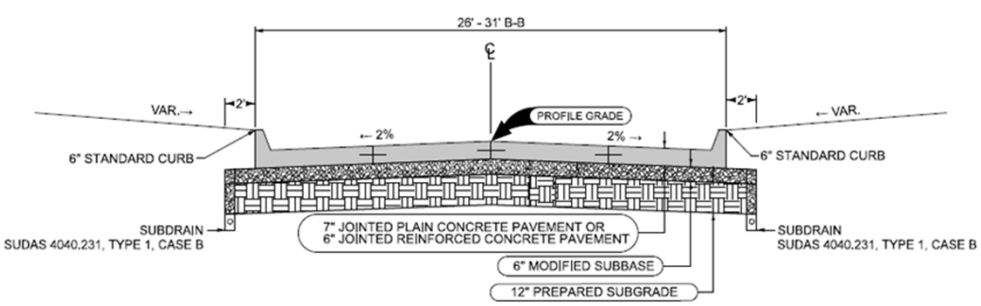
## PCC Pavement Foundation Recommendations:

- Conduct geotechnical study
  - Typical Iowa soils have CBR of 1 to 3
  - Recommendation(s) to achieve prepared subgrade CBR of 10
- Improve pavement foundation
  - Ensure prepared subgrade has CBR of 10
  - Construct a drainable, stable granular subbase
  - Install longitudinal subdrains

# PCC Pavement

## PCC Pavement Recommendations - Residential

- Pavement thickness
  - 7” Jointed Plain Concrete Pavement (JPCP)
  - 6” Jointed Reinforced Concrete Pavement (JRCP)
- Pavement jointing
  - Transverse, ‘C’
    - 14’ for 7” JPCP
    - 12’ for 6” JRCP
  - Longitudinal
    - Quarter point for both 26’ and 31’-wide pavements
- Pavement mix
  - Class C-SUD
    - 6% to 8% air content in placed concrete
    - W/C of 0.40 to 0.45
  - Replace cement with SCMs to decrease permeability
  - Assure air content is 6% to 8%, after placement



RECOMMENDED PAVEMENT SYSTEM

# Cost/Benefit Analysis

- Typical residential street segments analyzed
- Average cost of pavement system increase approx. 24.3% due to higher standards
  - $56.11/SY to $71.63/SY
- Life expectancy of pavement increased by 42.8%
  - 35 years to 50 years
- B/C of 1.8:1
- Average cost to each lot about $2500 for improved standards, initially
  - Over a 100-year cycle, this additional investment reduces future reconstruction costs by $9,745, in present day dollars

# SUMMARY

- **Why should we make a change?**
  - Longer life pavements
  - Prolonged higher service level reduces traveling public's cost of vehicle maintenance
  - Reduced disturbance to property owners due to reconstruction and maintenance
  - Reduced cost for sustainable streets

# City of Clive Pavement Design Policy

- Adopted on 6/22/17
- Geotechnical investigations and report with actions necessary to provide prepared subgrade (top 12”) with minimum CBR of 10
- 6” of modified subbase with subdrains
- Class C mix (C-SUD), no slag
- Air – 6-8%
- W/C ratio shall be 0.40 with a max of 0.45
- Flyash - 20% Class F or Class C
- 7”Jointed Plain Concrete (JPCP) or 6” Jointed Reinforced Concrete Pavement (JRCP)
- Quarter Point Jointing for 26’ and 31’
- Transverse Joint Spacing – 14’ for 7” pavement and 12’ for 6” pavement
- Collectors and Arterials – designed for 50 year pavement life

# Implementation Observations

- Experienced difficulty achieving subgrade CBR of 10 without modification/stabilization
  - Normally use fly ash modification
- Contractor experienced difficulty with finishing C-SUD mix for hand pours

# Contact Information

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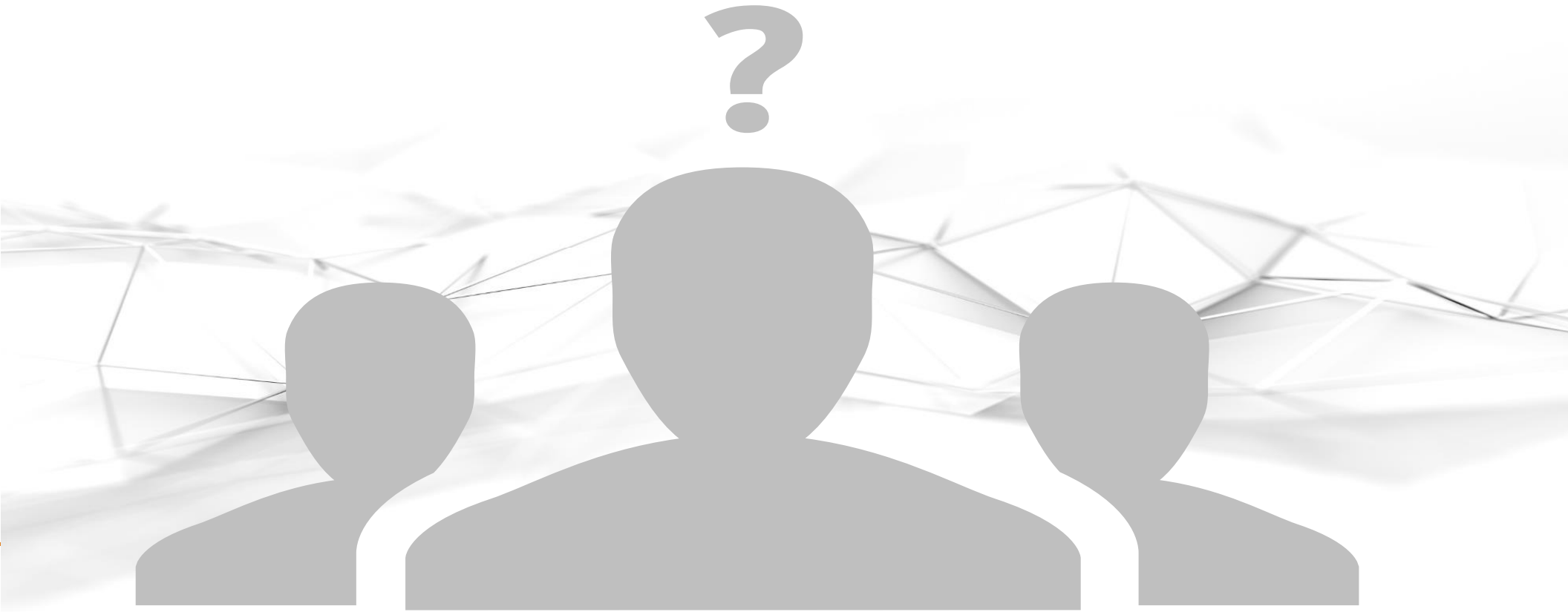
# Questions?



# Average PCI by Budget