Continuously Reinforced Concrete Pavement Resiliency – A Case Study

(Celebrating a Concrete Victory)

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What is Resilience?

Definition 1.1

Resilience: The ability to prepare and plan for, absorb, recover from, or more successfully adapt to actual or potential adverse events.
Traditional vs. Emerging Objectives for Pavements

• **Durability**
  - Does not fail or disintegrate prematurely

• **Resiliency**
  - Can handle traffic after flooding, icing, drought, fire events
  - Can handle unexpected traffic loads (overall levels or individual super-heavy loads)
Pavement Performance

• Structural
  • Thickness Design
  • Withstand truck traffic loading and environmental effects without premature deterioration

• Functional
  • Ride Quality
  • Skid Resistance
  • Noise Reduction
Pavement Performance

• Pavements are normally designed for a specific performance period (i.e., 30 year designs, overlay intervals of 10 to 15 years)

• However, some pavements in general have performed for much longer than we expected.
Continuously Reinforced Concrete Pavement (CRCP)
CRCP

- No transverse joints except at bridge ends and construction joints
- Crack spacing varies from 3 feet to 15 feet
- TxDOT has used CRCP since the early 1950’s
Flooding During Hurricane Harvey

Rainfall totals during Hurricane Harvey

Total precipitation (inches)

0.1 10 20 30 40 50

NOAA Climate.gov Data: AHPS

August 25-30, 2017

ACPA 55th Annual Meeting, November 2018
Flooding During Hurricane Harvey

Area roughly the same as the entire state of West Virginia
What would 33 trillion gallons of water look like?
As of Saturday, Sep. 1, about 33 trillion gallons of rain have fallen along the Gulf of Mexico.

If all that water were collected into a cube, this is how that would look next to downtown Houston.

Sources: Ryan Maue, Capital Weather Gang, Google Earth

THE WASHINGTON POST
Locations of IH 10 and SH 288 Sections
IH 10 from IH 610 to IH 45

- Reconstructed from October 1995 to October 2000
- Used recycled crushed concrete aggregate in the CRCP
- Designed for 43 million 18KESALs using the 1986 AASHTO rigid pavement design procedure and TxDOT’s recommended inputs.
- Estimated 92 million 18KESALS have travelled on IH 10 in the design lane from 2001 to 2016.
  - Same pavement is now on its 3rd life!
    - 2016 two way ADT of 226,390 with 6.4% trucks
IH 10 from IH 610 to IH 45
Reconstructed Sections

• 14” CRCP
• 3” Asphalt Stabilized Base
• 6” Lime Treated Subgrade
IH 10 from IH 610 to IH 45
Unbonded Concrete Overlay Sections

- 11” CRCP
- 1” Asphalt Stabilized Base
- 8” Existing CRCP
- 6” Existing Cement Stabilized Base
IH 10 from IH 610 to IH 45

• Has been flooded at least three times since reconstruction

• TxDOT Maintenance Expenditures for pavement-related* items from 2001 to 2016 on this section were $303,113, or $3,125/lane mile
  • Less than $200/year/lane mile up to this point

* Does not include trash pick-up, striping, etc.
IH 10 after Harvey, Oct 2017
IH 10 Eastbound
Ground Penetrating Radar Data
October, 2017
IH 10 Westbound
Ground Penetrating Radar Data
October, 2017
SH 288

ACPA 55th Annual Meeting, November 2018
SH 288 from Southmore to Yellowstone

- MacGregor to Yellowstone opened around 1983
- Southmore to MacGregor opened around 1984
- Expected to perform for about 7 million 18KESALs according to the 1993 AASHTO rigid pavement design procedure using TxDOT’s recommended inputs.
- Estimated 22 million 18KESALS have travelled on SH 288 in the design lane from 1983 to 2016.
  - Same pavement is on its 4th life!
  - 2016 two way ADT of 145,504 with 9.4% trucks
SH 288 from Southmore to Yellowstone

- 9” CRCP
- 0.75” Asphalt Concrete Pavement (assumed)
- 5.25” Cement Stabilized Base (assumed)
- 6” Lime Treated or Cement Treated Subgrade (depending on the subgrade type)
- Note: TxDOT allowed either cement or asphalt stabilized base, but if cement stabilized base was used, 0.75” ACP was required on top. If ASB was used, the total thickness was 6” ASB.
SH 288 from Southmore to Yellowstone

• Has been flooded at least three times since it’s been constructed

• TxDOT pavement* maintenance expenditures on this section from 1993 to 2016 were $206,598, or $11,738/lane mile
  • $510/year/lane mile (for a pavement well past design life)

• Note: no TxDOT maintenance expenditures available before 1993

* Does not include trash pick-up, striping, etc.
SH 288 after Harvey, Oct. 2017
SH 288 Northbound
Ground Penetrating Radar Data
October, 2017
SH 288 Southbound
Ground Penetrating Radar Data
October, 2017
Resiliency Requires Quick Responses

- Must Drive Over Saturated Pavements
- Using Heavy Vehicles (overweight restrictions waived for relief efforts)

And Even after Days of Harvey

- With exception of only one area on non-TxDOT road where Buffalo Bayou eroded behind retaining wall and under pavement, no CRCP repairs needed

Soldiers from the 79th Quartermaster Company assists in Hurricane Harvey rescue efforts. Army Times, September 1, 2017

Crews repair a flood-damaged section of the southbound lanes of the West Sam Houston Tollway on September 8 in this photo by the Harris County Toll Authority.
How Did These CRCP Sections in Houston Perform So Well Despite Repeated Saturation Cycles and Excessive Traffic Levels?

- Heavily stabilized, erosion-resistant bases that retain strength even when saturated
- Reinforced concrete to distribute load over saturated bases
Conclusions

• Using heavily stabilized bases and subgrades results in waterproof layers

• There is more traffic, and more truck traffic, in most urban areas of Texas than pavement designers are using for pavement designs

   Based on many examples, we conclude:

• The CRCP pavement system is resilient to extreme weather events like flooding and extreme traffic loading conditions.

   ➢ Celebrating Concrete Victories
Concrete Cracks

• A man walks into a bar holding a chunk of concrete and tells the bartender, “I’ll take one for me and one for the road.”

• Two fish swim into a concrete wall. One turns to the other and says: "Dam"
Thanks for your time and attention!