NORTH CENTRAL TEXAS COUNCIL OF GOVERNMENTS 17TH ANNUAL PUBLIC WORKS ROUNDUP JUNE 8, 2016

Concrete Street Insanity

Jerry Murawski, P.E.

With Special Thanks to Jan Prusinski, P.E.
Cement Council of Texas

ARS Engineers, Inc.

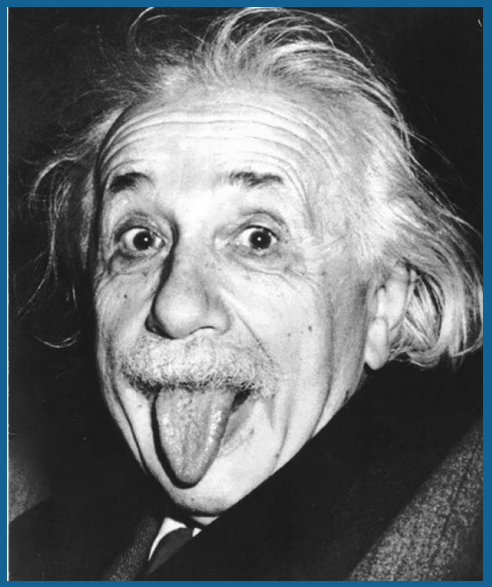
Do these look like any of your streets?

Especially before they are 20 years old?

ARS

Engineers, Inc.

CONCRETE STREET INSANITY



Building concrete streets the same way over and over again and expecting different results each time?

ARS Engineers, Inc.

CRITICAL QUESTION

Q: Why did the engineers cross the road?

A: Because they looked in the file and that's what they did last year.

ARS Engineers, Inc.

CRITICAL QUESTION

Almost every element of a street is engineered – geometry, profile, drainage, utilities, traffic control, signage, signals, sidewalks (ADA), etc.

BUT the pavement design often comes from standards developed decades ago.

I contend that it is time to stop the insanity and take action to design pavements that will have longer lives.

ARS Engineers, Inc.

CONCRETE STREET INSANITY

Quick Overview:

- North Texas clays
- Subgrade Treatment
- Pavement Design – highways vs streets
- Concrete Pavement – facts & types
- Considerations – joints, strength, depth
- Design options
- My thoughts

ARS Engineers, Inc.

NORTH TEXAS CLAY SOILS

Wet: expansive and slick as snot!

Dry: shrunken, cracked, hard.

- Clay soils water absorption is 0.02”/hour
- Volume change up to 10 times
- Bearing capacities range from 10 to 20 psi

ARS Engineers, Inc.

NORTH TEXAS CLAY SOILS

"Treating 6" to 8" of soil with lime or cement doesn't add anything to the pavement's strength." - *Barry Grubbs, president of Terra Mar 1987*

12'-14' deep borings in dense clay soil had moisture contents exceeding 30%. – *My experience 1994*

Does treating 6" to 8" of clay with lime/cement have any real benefit for clay 8' to 20' deep? – *My rhetorical question 1996*

ARS Engineers, Inc.

CONCRETE STREET DESIGN

What is this insanity that we've been perpetuating:

- Dallas standard since 1970s or earlier.
- Developed from AASHTO Road Test in 1958-60.
- No longer supported by AASHTO. (Obsolete)

ARS Engineers, Inc.

PAVEMENT DESIGN

FOR MANY NORTH TEXAS CITIES

6”to 8” Concrete
#3 or #4 bars at 18” or 24” c-c

6” Lime or Cement Stabilized Soil

Deep Expansive Clay Soil

ARS
Engineers, Inc.

PAVEMENT DESIGN

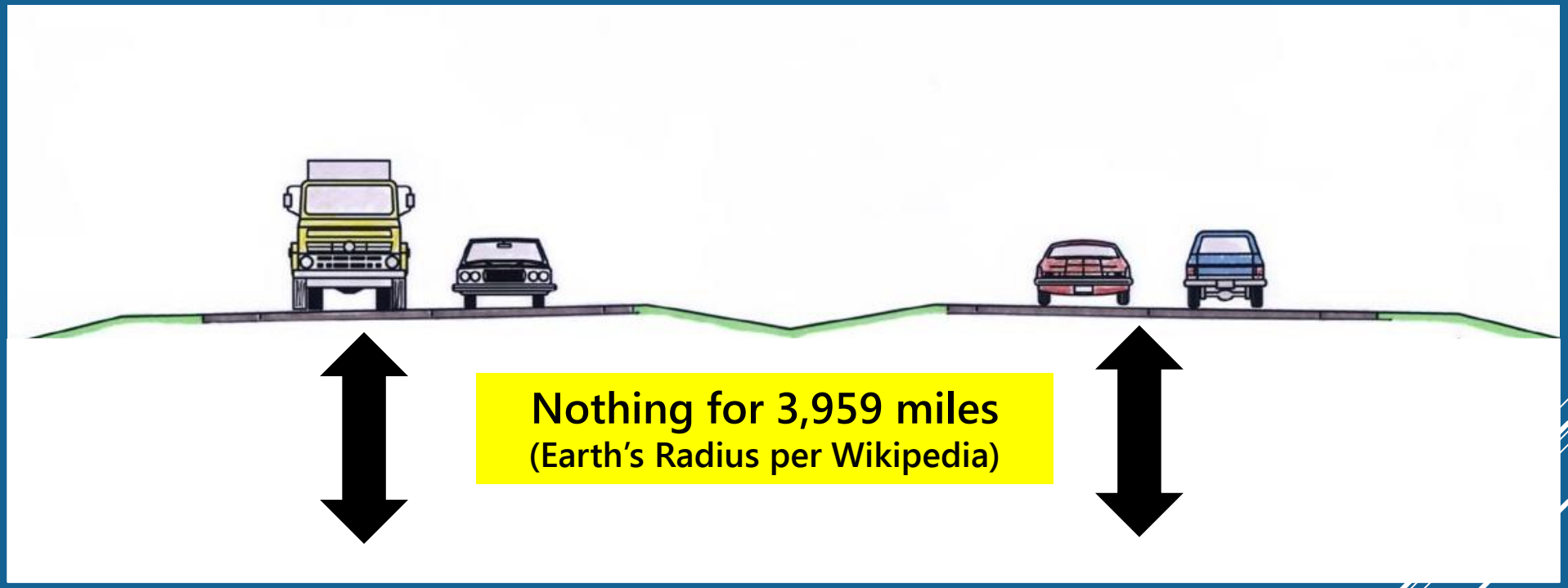
BY THE BOOK

1. **Stabilize the subgrade to support loads.**
   - *Modify with lime/cement or replace existing soil to -*
     - *Minimize volume changes*
     - *Add strength/bearing capacity*
2. **Cover subgrade protect/maintain the subgrade.**

(TXDOT designs based on PVR - often requires removal of several feet of high PI soils replacement with low PI material.)

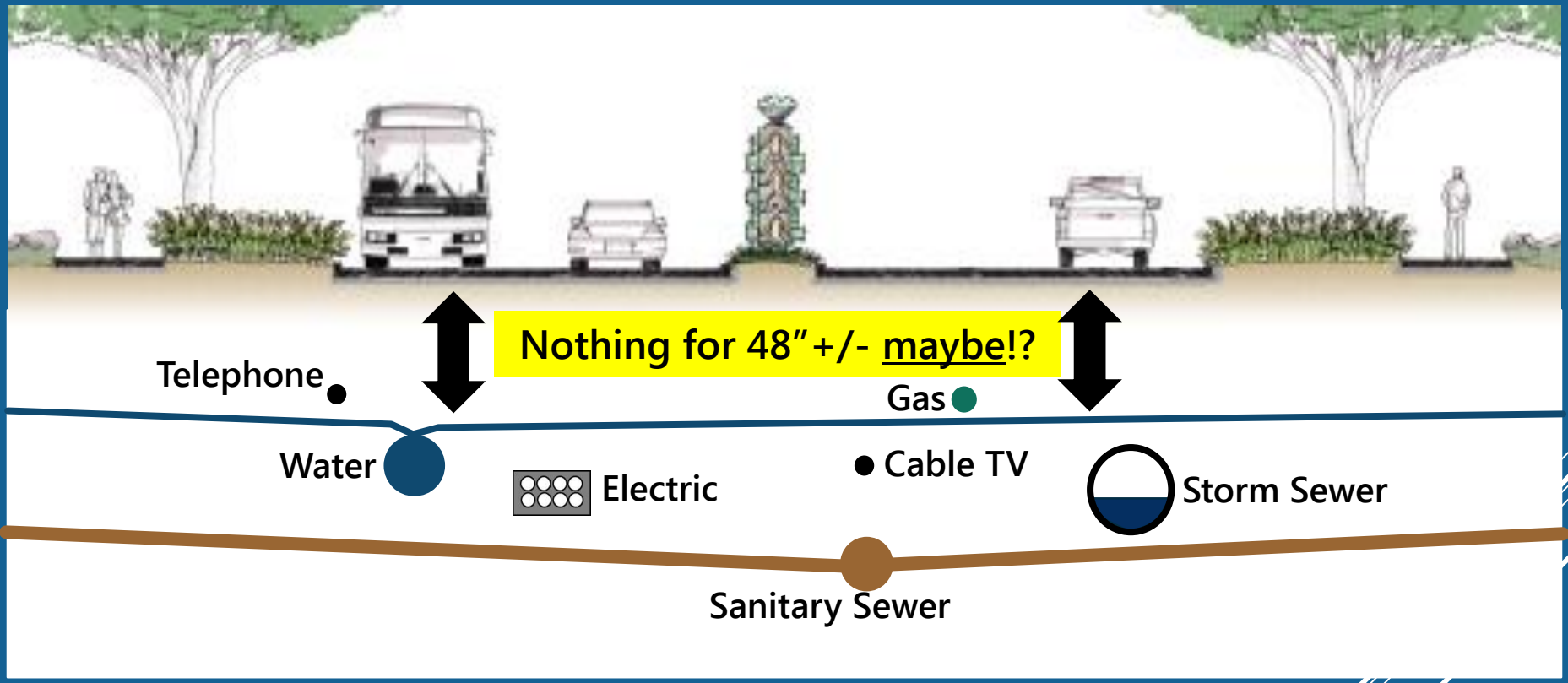
ARS Engineers, Inc.

PAVEMENT DESIGN
TXDOT HIGHWAYS



ARS
Engineers, Inc.

PAVEMENT DESIGN
CITY STREETS



ARS Engineers, Inc.

CONCRETE PAVEMENT TYPES

Continuously reinforced concrete pavement (CRCP)

- Heavy continuous reinforcement.
- Small cracks distribute movement (no saw cut).
- Used extensively by TxDOT and others DOTs.

Continuously Reinforced Concrete Pavement (CRCP)

ARS Engineers, Inc.

CONCRETE PAVEMENT TYPES

Jointed plain concrete pavement (JPCP)

- Unreinforced continuous concrete slabs
- Moderately spaced saw cuts distribute movement, narrow cracks
- Can be placed with or without dowels, depending on design
- Now used by many state DOTs and local governments in U.S.

Jointed Plain Concrete Pavement (JPCP)

ARS Engineers, Inc.

CONCRETE PAVEMENT TYPES

Jointed reinforced concrete pavement (JRCP)

- Light reinforcement
- Doweled "expansion" joints at long intervals
- Slab ends can move significantly
- State DOTs, AASHTO, and most U.S. local agencies no longer permit JRCP, due to performance problem at joints and cracks

Jointed Reinforced Concrete Pavement (JRCP)

Yet, that's what we use!!!

ARS Engineers, Inc.

CONCRETE PAVEMENT TYPES

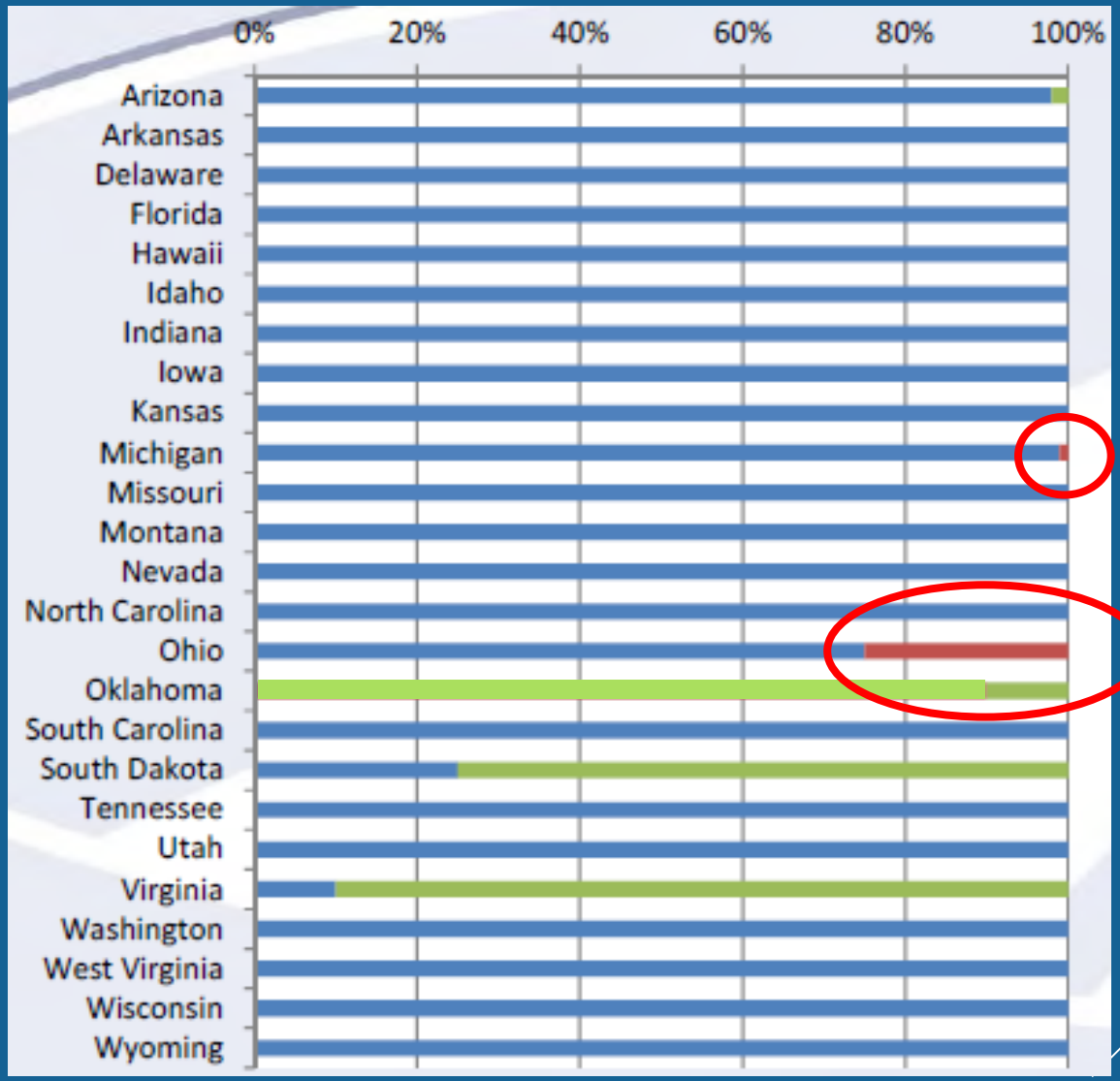
Roller Compacted Concrete Pavement (RCCP)

- A sub-type of JPCP
- Zero-slump concrete, usually produced in pug mill
- Placed with high-density asphalt-style pavers, compacted w/ vibratory rollers
- No reinforcing, no dowels, no finishing
- Fast, efficient placement on large projects

Roller Compacted Concrete Pavement (RCCP)

ARS Engineers, Inc.

WHAT DO 26 OTHER STATES USE?



ARS Engineers, Inc.

BEFORE PROCEEDING, I HAVE ONE QUESTIONS TO ASK:

Are you satisfied with your concrete streets?

If so, please feel free to take a break.

If not, then stop building them the way you have been!!!

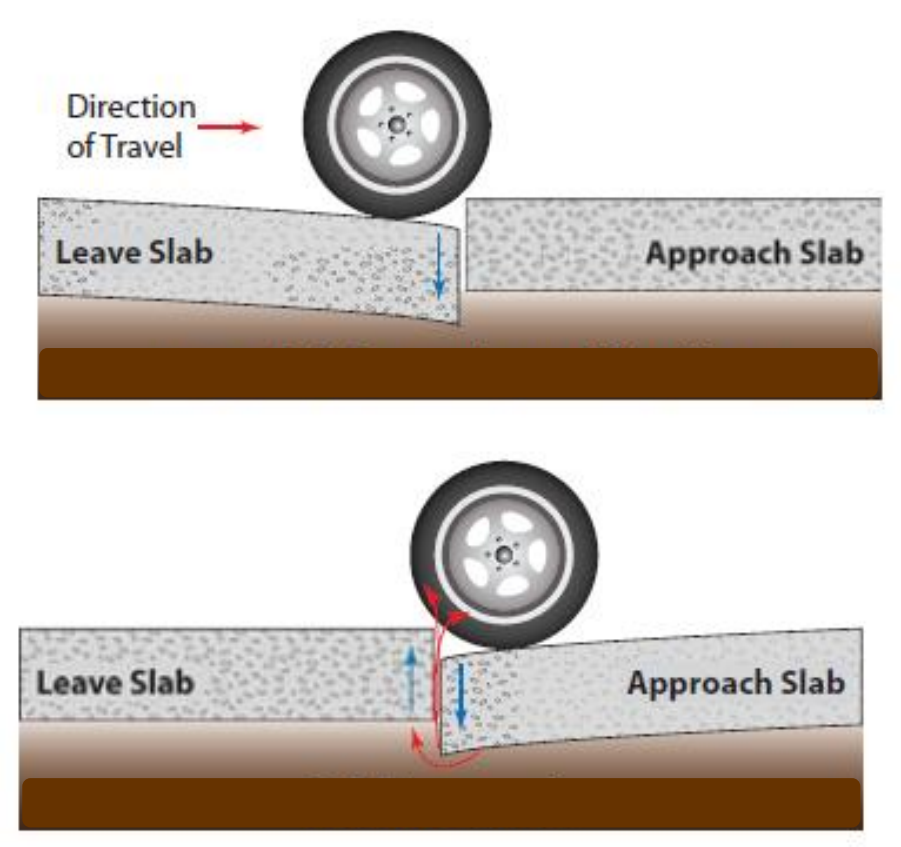
ARS Engineers, Inc.

MY GOAL

1. Use sound engineering in the design of streets
2. Recognize that we can't build streets like highways -
   - ROWs are utility corridors
   - Too costly to design based on PVR
   - Focus more on pavement and less on subgrade

ARS Engineers, Inc.

CONSIDERATIONS - JOINTS



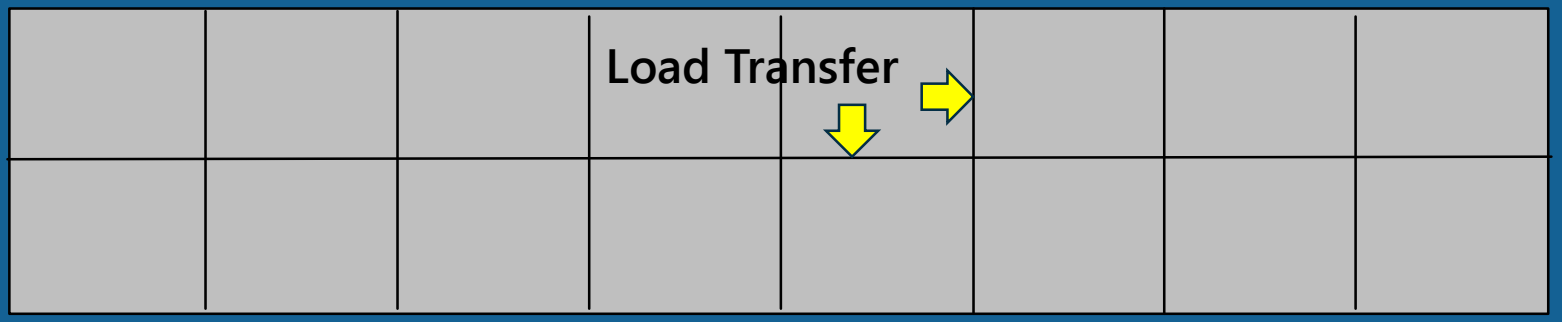
Mitigation:

- Supportive Subgrade
- Load Transfer Steel Dowels
- Aggregate Interlock
- Increased Flexural Strength

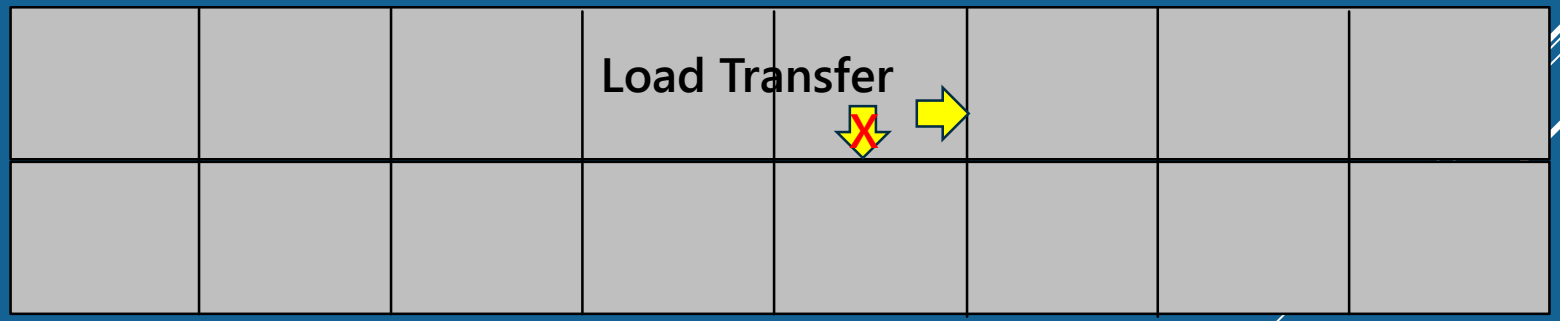
ARS Engineers, Inc.

CONSIDERATIONS - CONSTRUCTION

New Street



Street Reconstruction



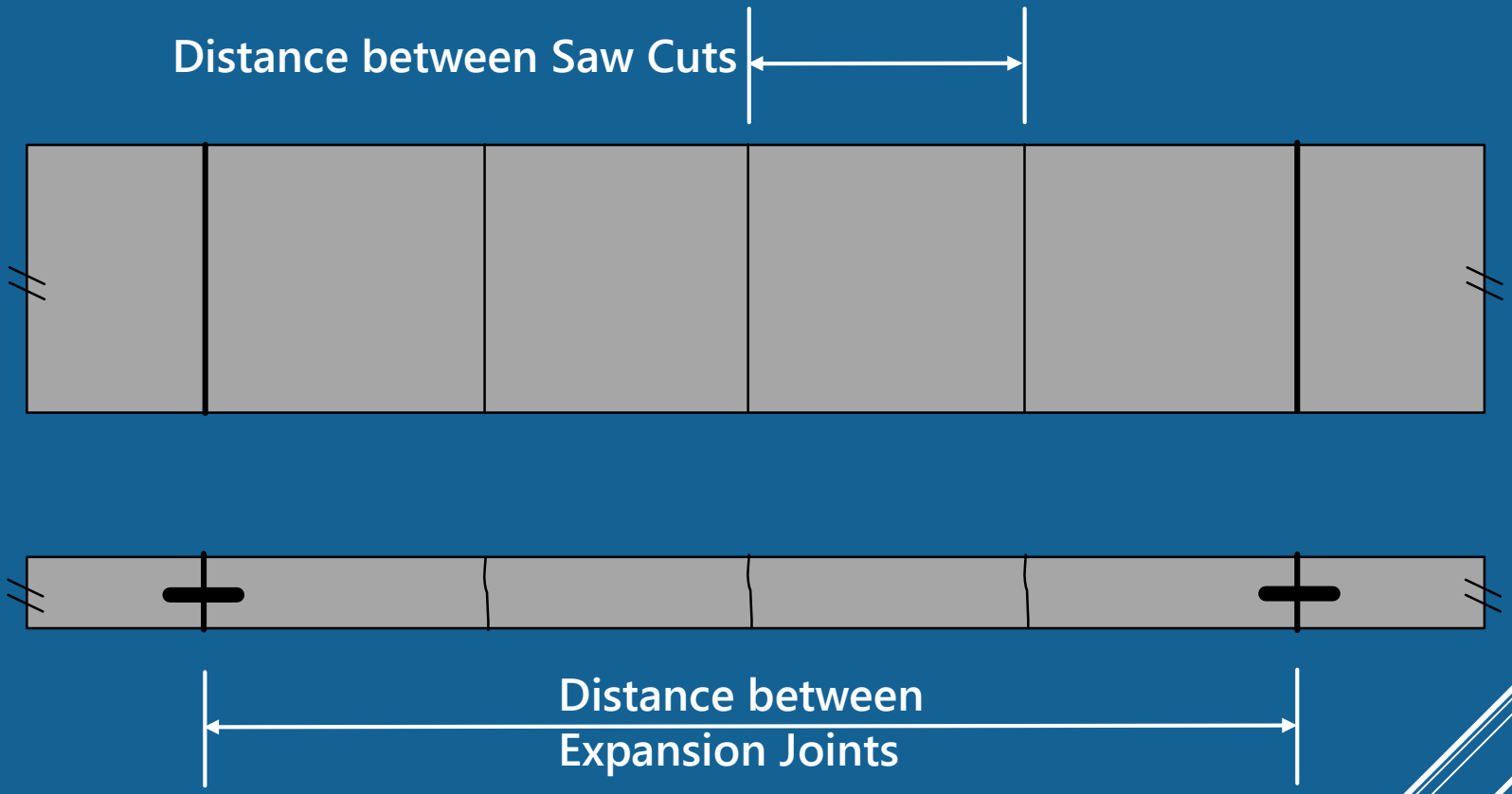
CONSIDERATION - JOINTS

Joint Spacing:

- ACI and most codes recommend 75’ to 120’ maximum expansion joint spacing. What does your city do?
- The greater the sawed joints spacing, the wider the joints and loss in aggregate interlock, which is more load resistant that #4 bars at 18” centers.

ARS Engineers, Inc.

CONSIDERATIONS - JOINTS



ARS
Engineers, Inc.

CONSIDERATIONS - JOINTS

120 ft between Expansion Joints

Shrinkage = 0.0004 in./in. x 600' x 12" x 0.8 friction= 0.0461 in.

- Per Joint @ 20' spacing = 0.0077 in. joint gap(> $^{1}/_{16}$")
- Per Joint @ 15' spacing = 0.0058 in. joint gap ($^{1}/_{16}$")
- Per Joint @ 12' spacing = 0.0046 in. joint gap (< $^{1}/_{32}$")

(Note: Temperature variations will have a varying effect on joint gap)

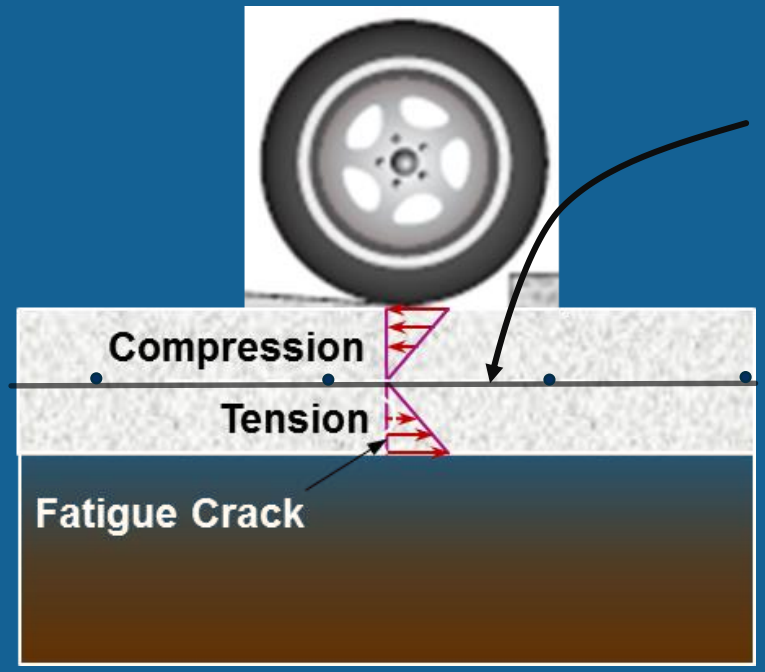
ARS Engineers, Inc.

CONSIDERATIONS - STRENGTH

Flexural Strength

ARS Engineers, Inc.

CONSIDERATIONS - STRENGTH



Steel in middle does not have any benefit.

Tension Fatigue

ARS Engineers, Inc.

STRENGTH

Flexural Strength = Modulus of Rupture

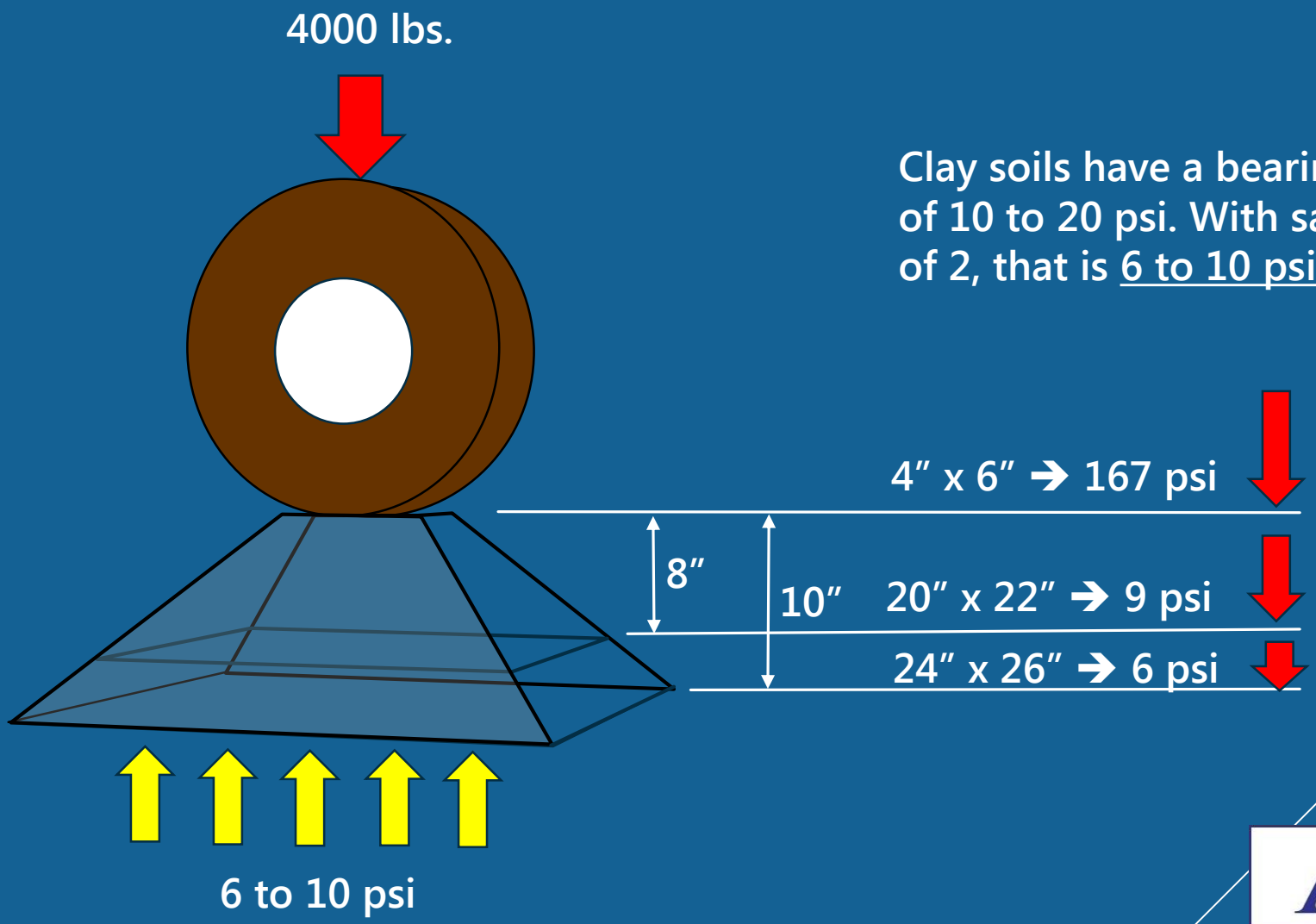
$$\sigma = \frac{3 \times P \times L}{2 \times b \times d^2}$$

σ = modulus of rupture
P = maximum load
L = span length
b = average width
d = average depth

P (lbs)	L	b	d	σ (ksi)	% Increase
4000	20′	10′	8″	76,800	-
4000	20′	10′	9″	97,200	26.6%
4000	20′	10′	10″	120,000	56.3%

ARS Engineers, Inc.

DEPTH



Clay soils have a bearing capacity of 10 to 20 psi. With safety factor of 2, that is 6 to 10 psi.

ARS Engineers, Inc.

DESIGN OPTIONS

40,000 ADT, 15% Trucks, 6LD

- StreetPave/American Concrete Pvmt Association 2005
  - 9" thick (20 yr) or 10" thick (30 yr)
  - Non-reinforced, 15' max joint spacing
- ACI 325.12 – Guide for Design of Jointed Concrete Pavements for Streets & Local Roads
  - 10" thick
  - Non-reinforced, 12'-15' joint spacing

ARS Engineers, Inc.

OTHER CONSIDERATIONS

Lime or Cement Stabilization $5.00 per sy

Versus

1” Concrete Pavement ($90/cy) $2.50 per sy

ARS Engineers, Inc.

MY THOUGHTS

- ✓ We can't build streets like highways.
- ✓ Design pavements for each thoroughfare.
- ✓ Develop new standards for residential streets.
- ✓ Trade lime/cement stabilization for thicker pavements.
  - 6" to 8" of lime/cement does little to deep clay soils.
  - Need 10 times more reinforcing to be structural slab.
- ✓ Spacing of expansion and contraction (sawcut) joints is important.
- ✓ Use #4 bars at 18" centers if you must.

ARS Engineers, Inc.

A man in love is incomplete until he has married.

Then he's finished.

And I am too!

ARS Engineers, Inc.

Questions?

Jerry Murawski, P.E.
Senior Project Manager
ARS Engineers, Inc.
jmurawski@arsengineers.com

ARS
Engineers, Inc.