

M.C. Escher (1898-1972)
Upstairs and Downstairs
(1960; lithography)

A Contractor's Perspective: Design Approaches and Their Impact on Construction

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ASSOCIATION

Speaker Background

27 years at TxDOT

- Materials
- Pavement Design
- Pavement Construction
- Research

8 years at TCPA

Who is an Expert?



*"An expert is a person
who has found out by
his own painful
experience all the
mistakes that one can
make in a very
narrow field."*

Niels Bohr.

Group Discussion On First Hand Experience

Why Did Bid Prices Come in So High?

Why Did Project Take Longer than Expected?

Why is the Final Product Not Performing as Expected?

Group Discussion On First Hand Experience

1. Why Did Bid Prices Come in So High?

- Small Scope (Costco effect: Bulk Buying)
- Confined Working Space (Safety)
- Confined (or no) Storage Space
 - More Hand Work
 - Mobilization Costs High (Staging Challenges)
 - Material Delivery Complicated
 - Inefficient Labor Allocation
 - Difficult Working Platform

Group Discussion On First Hand Experience



TxDOT Pavement Manual

Houston Bus Stop, Sidewalk, etc.: [Houston Metro Bus Stop #shorts](#)

Group Discussion On First Hand Experience



TxDOT Pavement Manual

Houston Bus Stop, Sidewalk, etc.: [Houston Metro Bus Stop #shorts](#)

Group Discussion On First Hand Experience

1. Why Did Bid Prices Come in So High?

- Tight Schedule (Time is money)
- Material Price Instability
- Utility Coordination
- Owner Factor (prior negative experience with effective project management)

Group Discussion On First Hand Experience

1. Why Did Bid Prices Come in So High?

- Specification Issues
 - Penalties but no Bonuses
 - Performance Specs Mixed with Method Specs (e.g., detailed concrete mix components and amounts AND strength, permeability, etc. requirements)
 - Test Sample Handling

Group Discussion On First Hand Experience

2. Why Did Project Take Longer than Expected?

- **See #1!**

Group Discussion On First Hand Experience

3. Why is the Final Product Not Performing as Expected?

- See #1 and #2!



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Concrete Pavements in an Urban Environment

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Agenda

- **Differences between highways, arterials, city roads and streets**
- **Challenges**
- **Pavement types – options**
- **Resources**

Urban/City Streets vs. Highway/Arterial



Urban/City Streets vs. Highway/Arterial

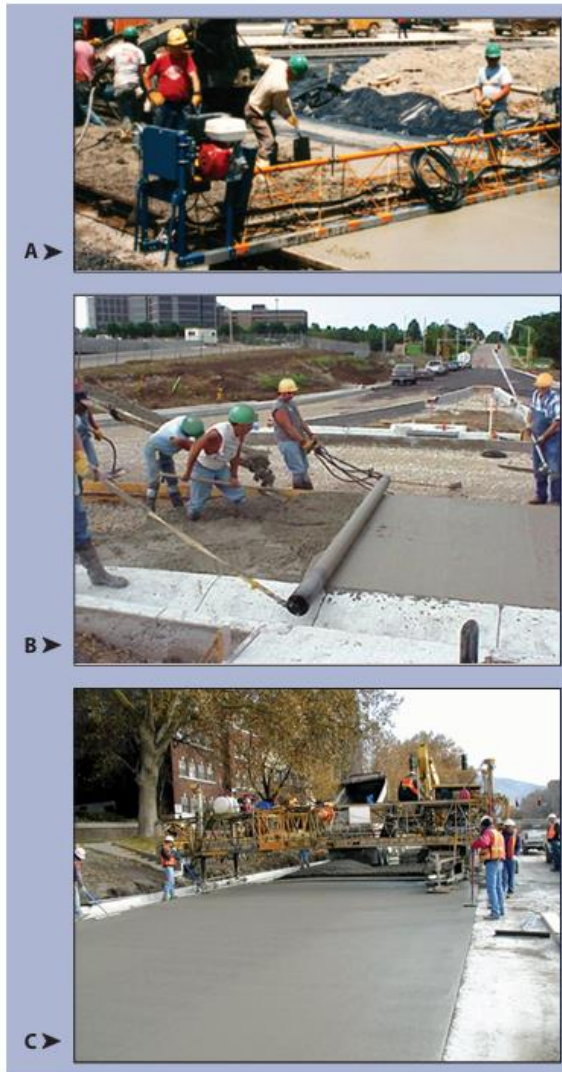


Figure 12. (A) Vibrating screed, (B) Roller screed, (C) Form-riding paver.

Challenges

- **Cost: Initial and Total (Initial, Maintenance, Rehab)**
- **Utilities**
- **Staging**
- **Access: Haul Road and Property Owner Access**
- **Intersections and Driveways**
- **Manholes, Inlets, etc.**
- **Ride Quality**

Cost: Shingle Purchasing Poll

Who buys:

- **15-yr shingles**
- **30-yr shingles**
- **50-yr shingles**

Cost: Economy of Scale

- **1 intersection vs 10 intersections**
- **1 block length vs 1 mile length**
- **Ability to use more Machine vs. mostly Human labor**

Consider:

- **Mobilization Costs**
- **Material Costs**
- **Labor Availability**

Is a Concrete Street Worth the Money?



Court Avenue, Bellefontaine, OH
1891



Belknap Place, San Antonio
1914

Challenges

- **Cost: Initial and Total (Initial, Maintenance, Rehab)**
- **Utilities**
- **Staging**
- **Access: Haul Road and Property Owner Access**
- **Intersections and Driveways**
- **Manholes, Inlets, etc.**
- **Ride Quality**

Access, Intersections, etc.

- **Phased Construction**
- **High Early Strength Concrete**
- **Use existing pavement structure as much as possible**
- **Use specification language pertaining to rain vulnerability, especially for exposed, untreated layers**

Challenges

- **Cost: Initial and Total (Initial, Maintenance, Rehab)**
- **Utilities**
- **Staging**
- **Access: Haul Road and Property Owner Access**
- **Intersections and Driveways**
- **Manholes, Inlets, etc.**
- **Ride Quality**

Ride Quality

- **How important is smoothness?**

Posted/Operating Speed

Sensitivity of Users

- **How much is it worth?**

Avoid starting/stopping (longer runs)

Diamond grinding added to bid items

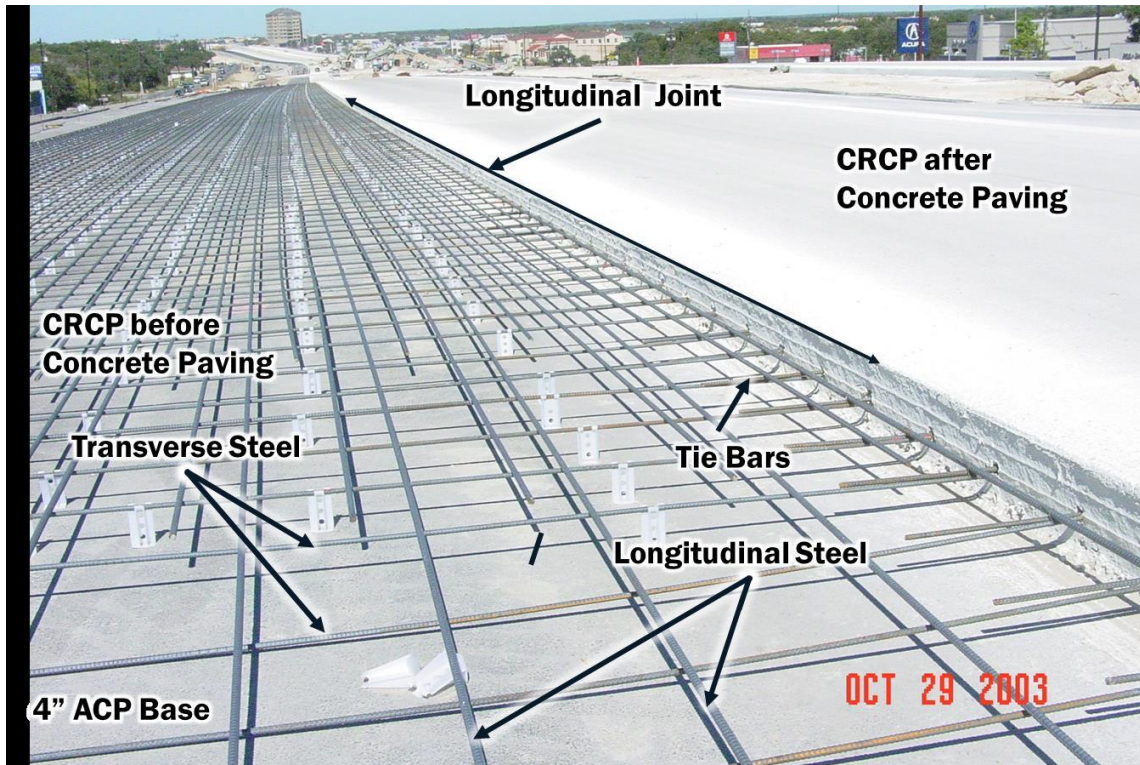
Measurement (inertial profiler) and Spec
requirement

Pavement Options

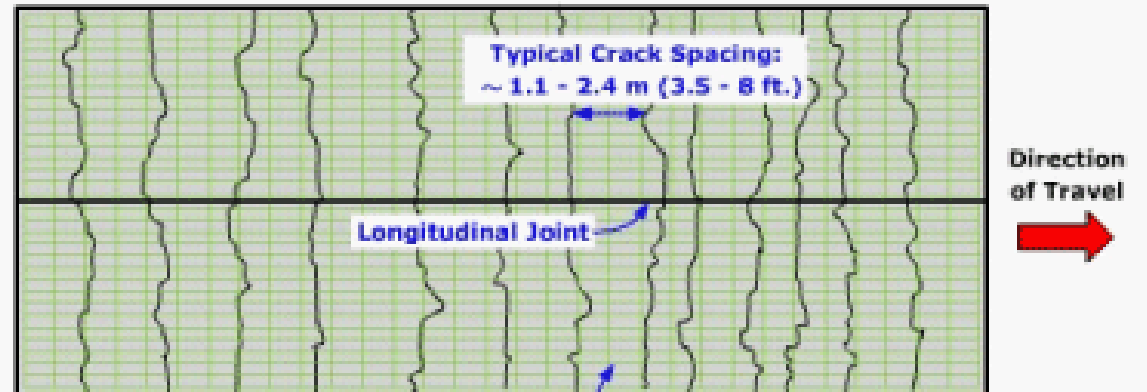
- **Continuously Reinforced Concrete Pavement**
- **Jointed (Doweled) Concrete Pavement**
- **Jointed Reinforced Concrete Pavement**
- **Roller Compacted Concrete Pavement**
- **Jointed (Undoweled) Concrete Pavement**

Pavement Options

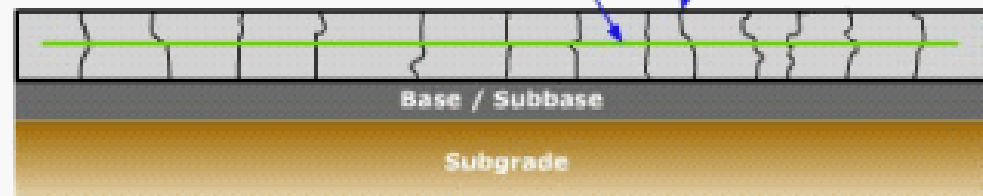
- Continuously Reinforced Concrete Pavement



Top View



Side View

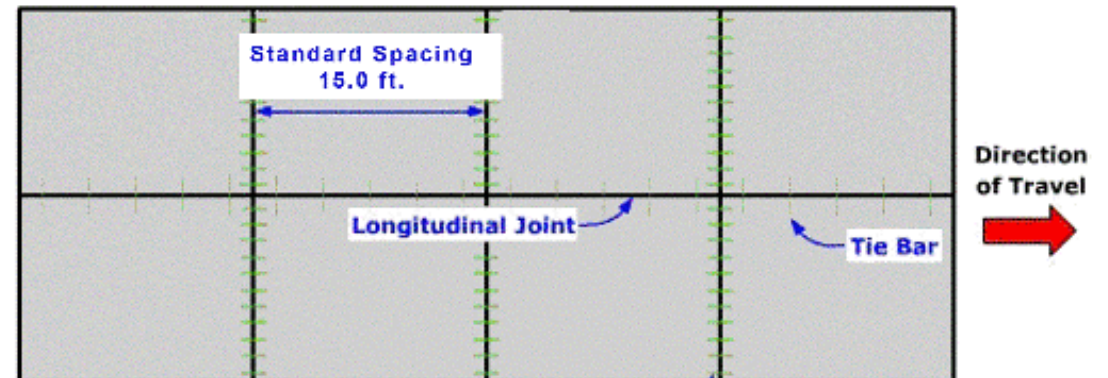


Pavement Options

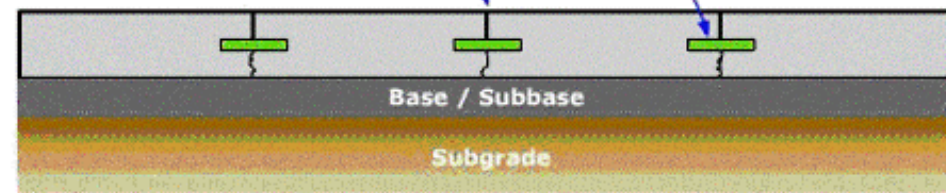
- Jointed (Doweled) Concrete Pavement



Top View

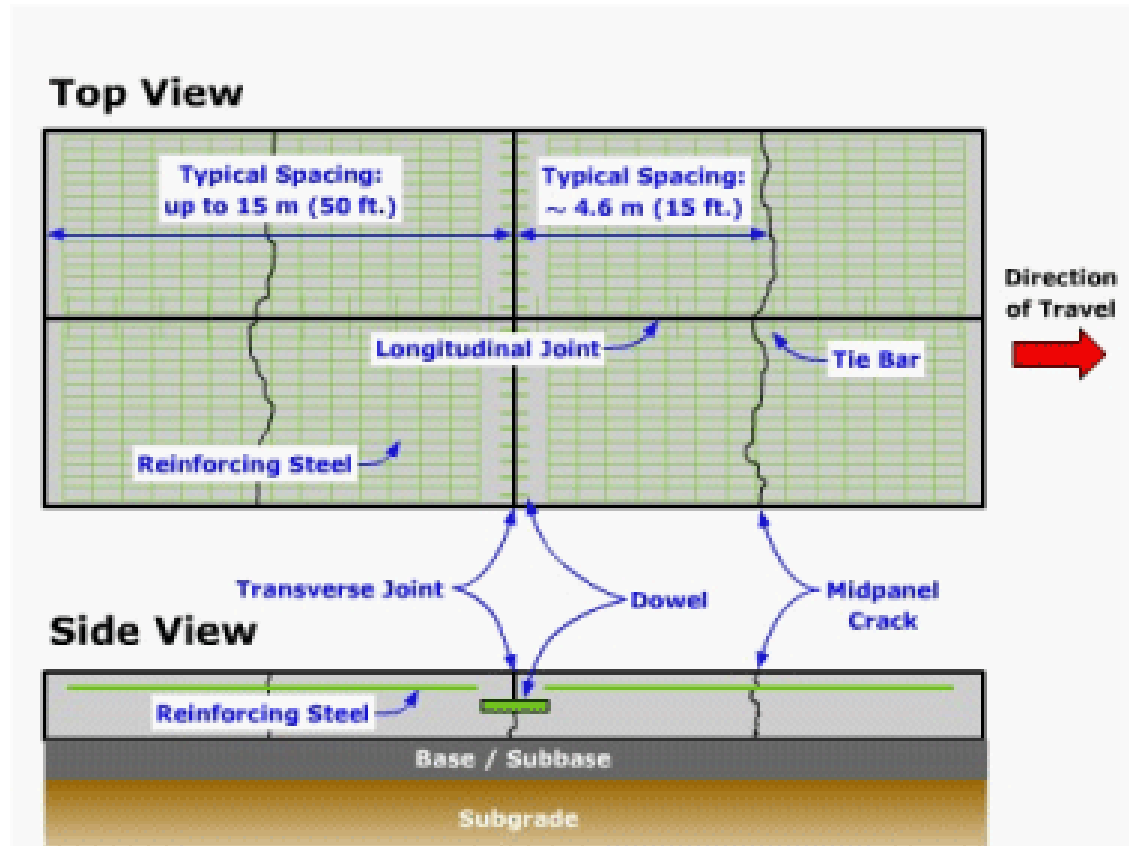


Side View



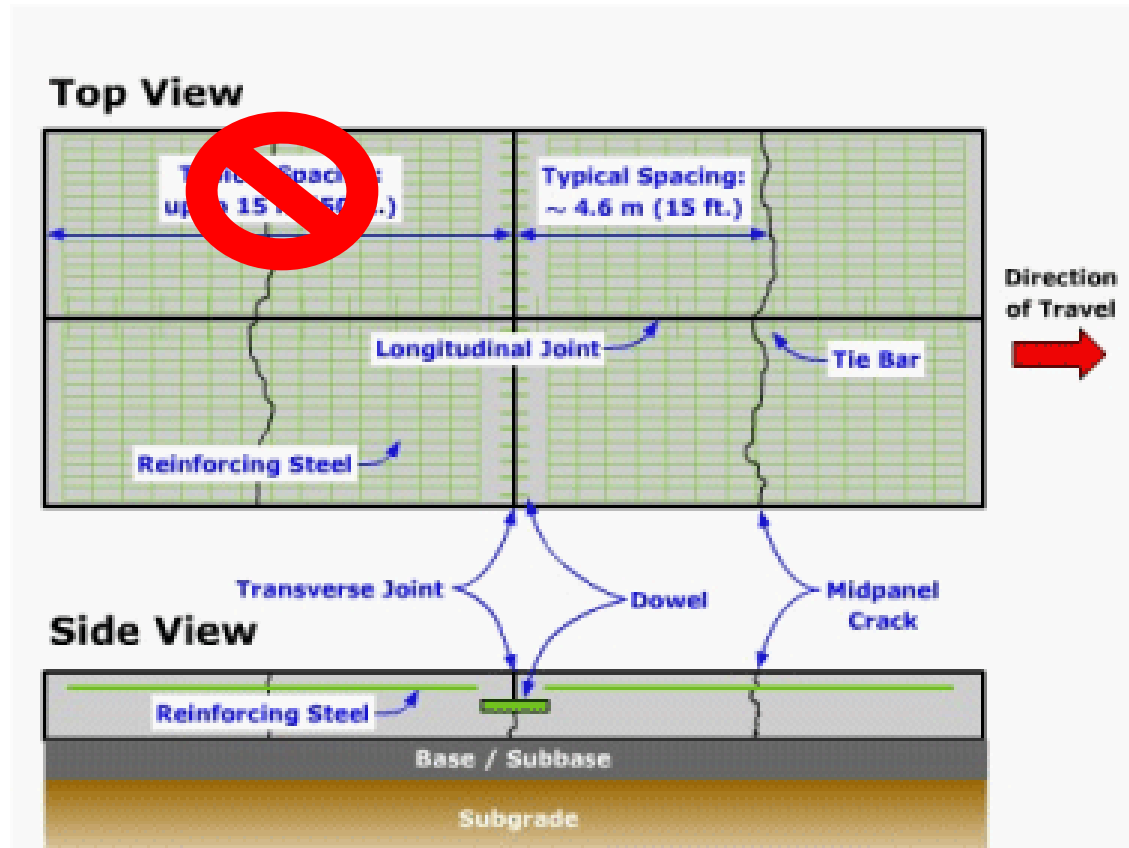
Pavement Options

- Jointed Reinforced Concrete Pavement



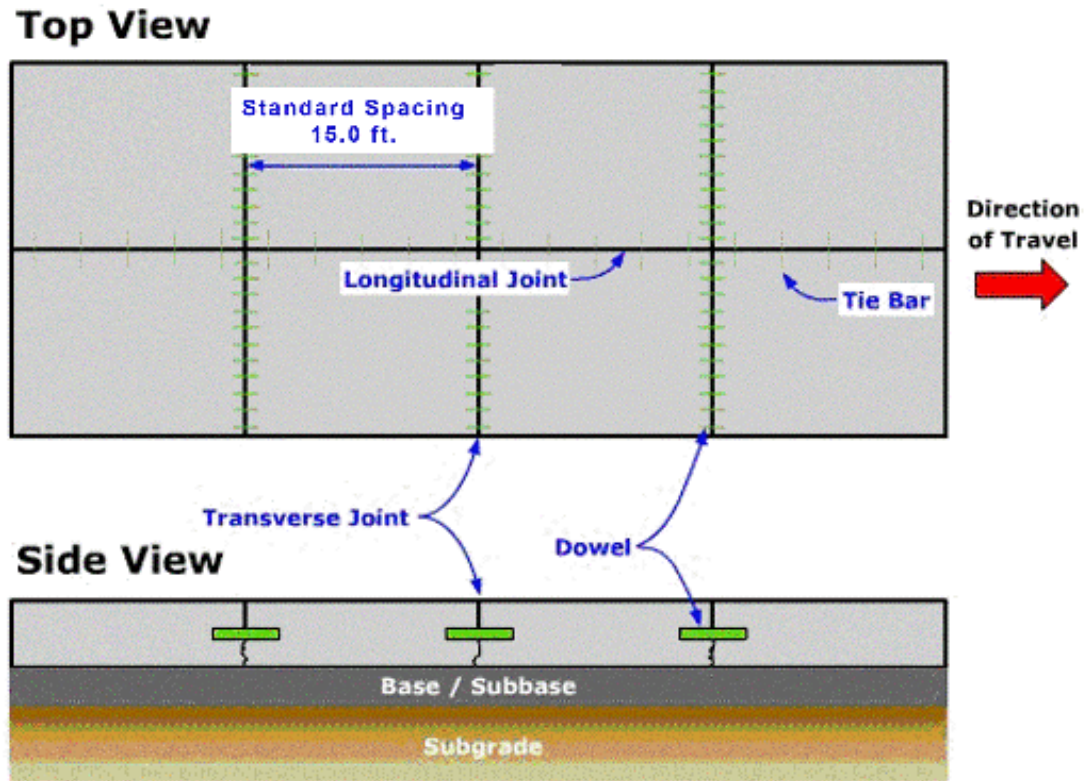
Pavement Options

- Jointed Reinforced Concrete Pavement



Pavement Options

- Jointed (Undoweled) Concrete Pavement



Minus dowels!

Tie bars still recommended

Tie Bars vs Dowel Bars



Tie Bar – Longer and Deformed steel

- Bond is wanted/needed
- Load transfer from steel AND concrete/aggregate interlock



Dowel Bar – Shorter and Smooth

- Bond is not wanted/needed
- Load transfer entirely from steel

Free Training and Information

Design and Construction of Joints for Concrete Streets

https://www.acpa.org/wpfd_file/design-and-construction-of-joints-for-concrete-streets/

Joint Layout - ACPA Wiki https://wikipave.org/index.php/Joint_Layout

Concrete Intersections Design and Construction

<https://cf.specifyconcrete.org/doc/Guide-for-Design-and-Construction-of-Concrete-Intersections.pdf>

Concrete Paving Field Inspection Workshop | National Concrete Pavement Technology Center

<https://cptechcenter.org/webinars-and-videos/concrete-paving-field-inspection-workshop/>

Note: Keep in mind that this info was developed by colder states, so make sure our very hot weather does not cause any conflicts with their recommendations.

Pavement Resource – Aggregate Properties

LIMESTONES-DOLOMITES							
		Ratings					
		Coarse Aggregate					Fine Aggregate
Product Code	Material Code	RSLA	RSSM	RSMD	CA RSAI	CoTE	FA RSAI
06, 085	018, 061	24	9	14	8	4.1	11*
06, 085	019, 061	26	9	14	13	5.1	
086	018	28	18	28	2	4.0	
06, 085	018, 061	24	7	15	2	3.8	1*
06, 085	019, 061	26	2	10	2	5.2	10*
06, 085	018, 061	29	19*	23	5	3.9	3*
06, 085	018, 061	26	18	21	1	3.8	7*
086	018	29	10	16	3		
06, 085	018, 061	27	7	11	6	4.0	
086	018	31	10	25	1	5.0	3
086	019	35	3	10	0	5.1	
06, 084	019, 061	24	13	11	68	5.8*	69

Concrete Rated Source Quality Catalog

<https://www.txdot.gov/content/dam/docs/mpl/concrete-rated-source-quality-catalog.pdf>

Thermal Expansion

LIMESTONES-DOLOMITES							
		Ratings					
		Coarse Aggregate					Fine Aggregate
Product Code	Material Code	RSLA	RSSM	RSMD	CA RSI	CoTE	FA RSI
06, 085	018, 061	24	9	14	8	4.1	11*
06, 085	019, 061	26	9	14	13	5.1	
086	018	28	18	28	2	4.0	
06, 085	018, 061	24	7	15	2	3.8	1*

For the same 50 degF increase in temperature, a 25' long concrete slab made with these 2 coarse aggregates will expand:

0.06"

GRAVELS							
		Ratings					
		Coarse Aggregate					Fine Aggregate
Product Code	Material Code	RSLA	RSSM	RSMD	CA RSI	CoTE	FA RSI
084	062						98
36, 084	012, 062	28	3	4	100	6.4*	98
36, 084	012, 062	30	2	4	90	6.0*	92
36, 084	012, 062	26	11	12	10	4.2	70

0.1"

Concrete Rated Source Quality Catalog

<https://www.txdot.gov/content/dam/docs/mpl/concrete-rated-source-quality-catalog.pdf>

Example Info from Referenced Publications

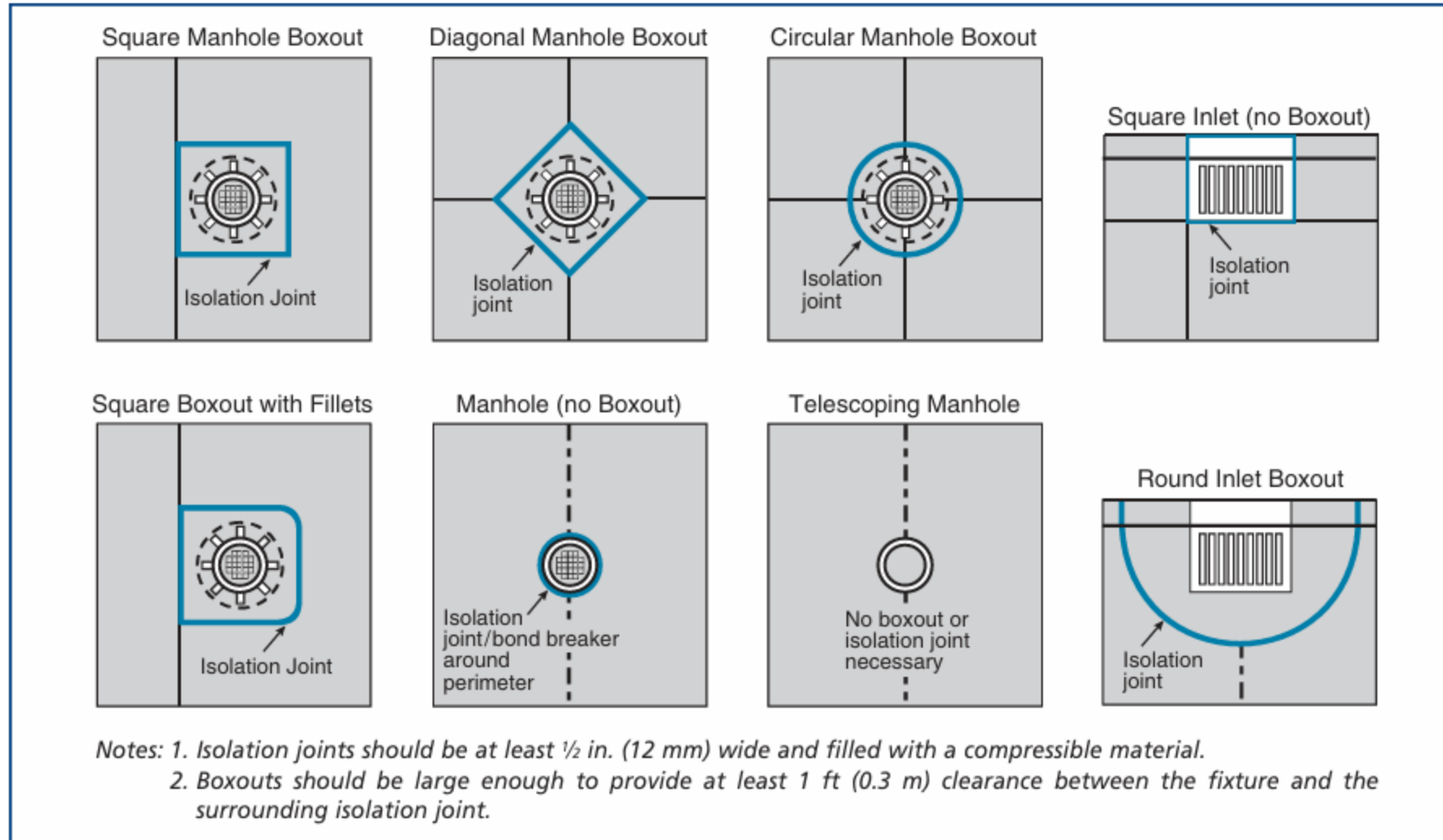


Figure 6. Details for boxing out fixtures.

Example Info from Referenced Publications

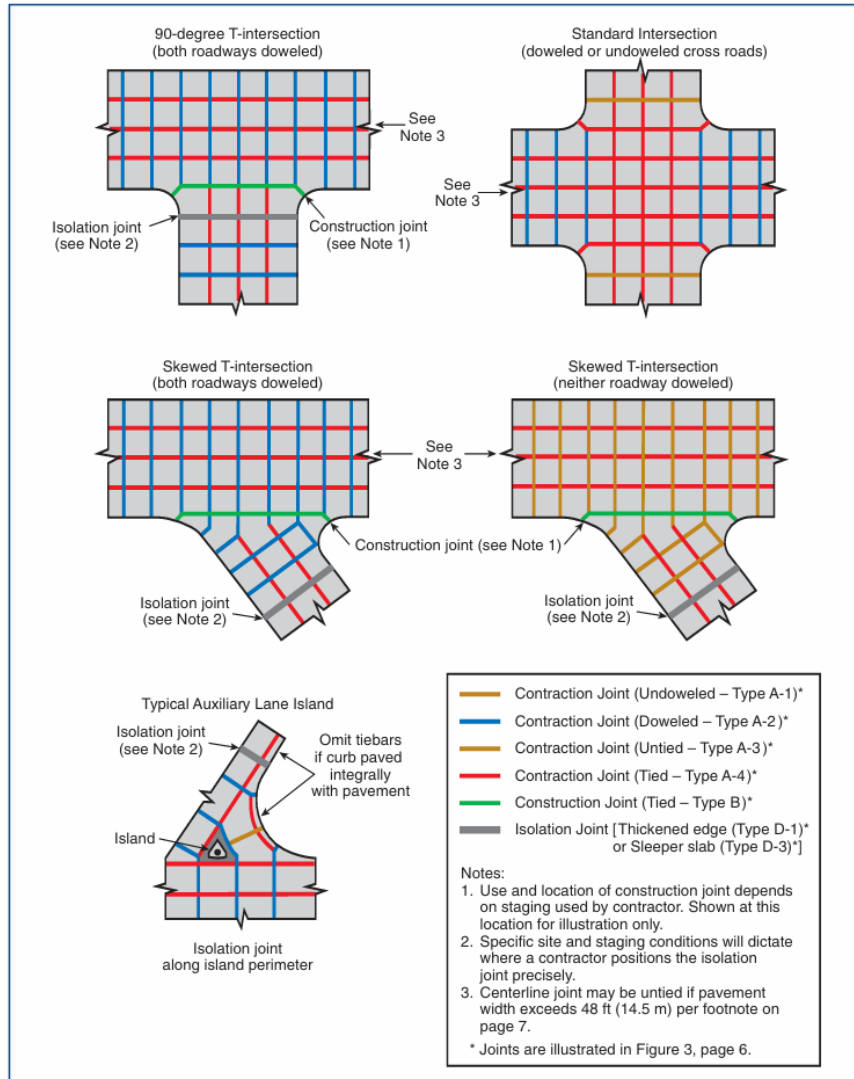


Figure 7. Use of dowel bars and tiebars in intersections.

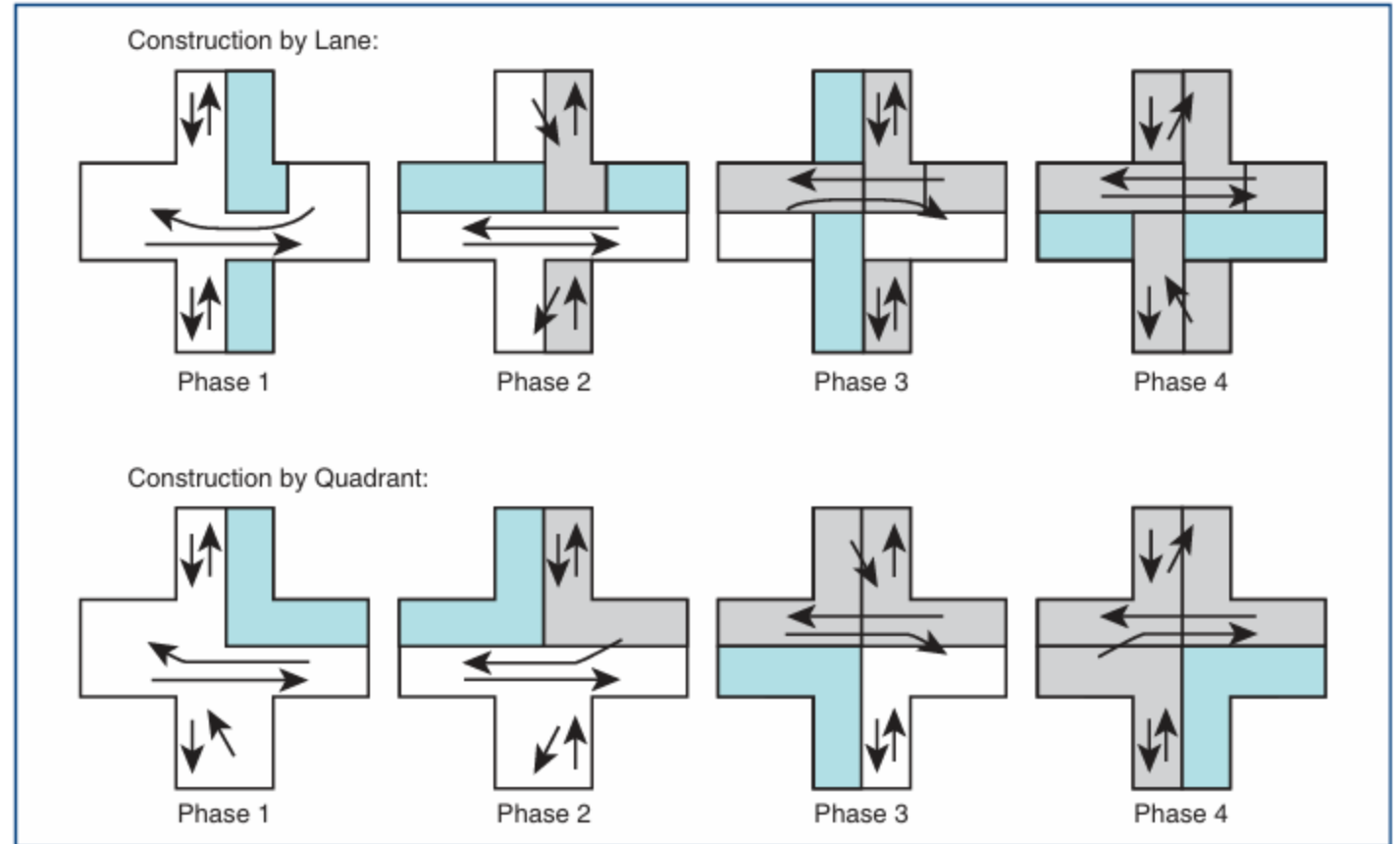


Figure 8. Possible options for phasing construction under traffic.

Pavement Resource

Pavement Manual



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Questions?