Joints and Joint Sealing

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Scope

- Purpose of joints
- Load transfer at joints
- General cracking behaviour
- Joint types
- Joint layout
- Reinforcement
- Joints vs Reinforcement

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Introduction

Introduction

- Joints are needed to control stresses and strains due to environment
- Joints can be source of
  - edge and corner spalling and cracking
  - faulting
  - poor riding quality
- Joint maintenance is a substantial part of maintenance costs

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Purpose of joints

Functions of Joints

- Accommodate drying shrinkage
- Accommodate dimensional changes due to changes of temperature and moisture content
- Isolate the pavement from fixed structures
- Provide for planned or emergency interruptions of concrete placing, i.e. when concrete placing is interrupted for more than half an hour
- Facilitate control of surface levels during concrete placing
- Provide adequate load transfer across joints

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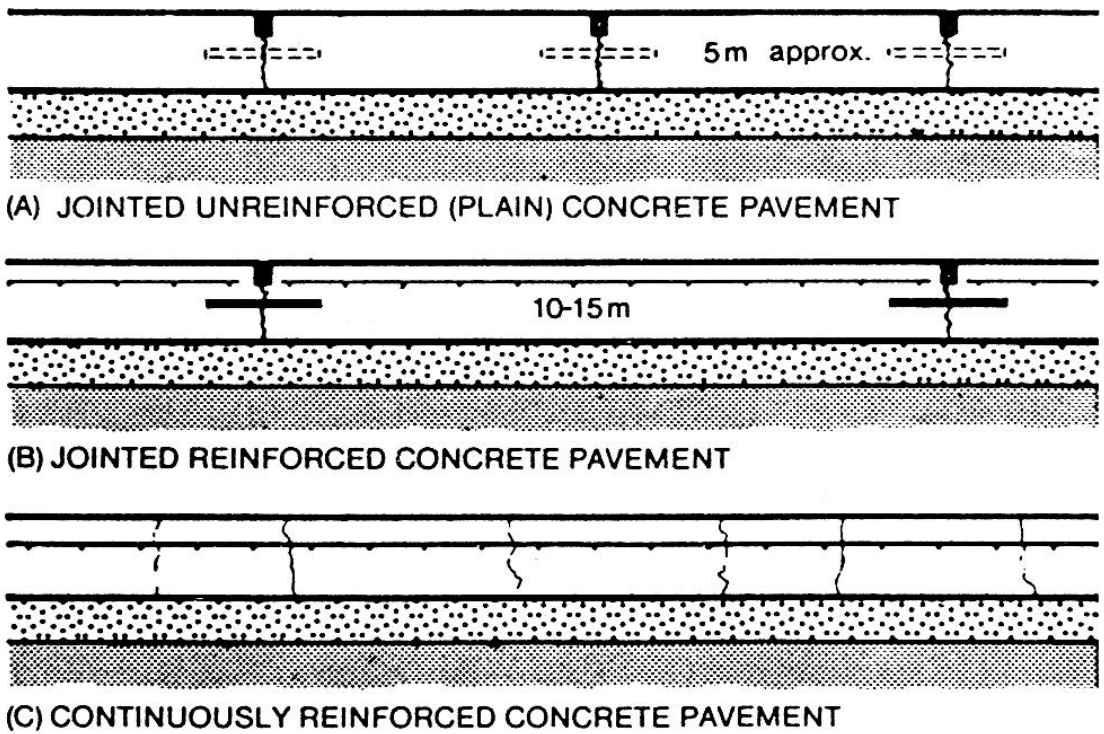
Joint spacing

- Pavement type will determine
- Three options
  - plain
  - jointed reinforced
  - CRCP

Joint spacing



Load transfer

Load transfer

- Why?
  - To ensure stresses are closer to those for interior loading than edge or corner loading
- How?
  - Aggregate interlock
  - Dowels
  - Tiebars
  - CTS

Aggregate interlock

- Matching crack faces across cracks
- Small openings
- Under normal conditions < 4,5m
- Improve by:
  - Larger and stronger aggregate
  - Dowels and tiebars
  - Angular aggregate
  - CTS

Aggregate Interlock

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Dowels

- Where large openings
- Heavy loads
- Allow horizontal opening but not relative vertical movement
- Installed at mid-depth

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Dowels

- Should
  - Be simple and easy to install
  - Be parallel to each other, centreline and surface
  - Not overstress the concrete
  - Allow opening
  - Be stable
  - Not corrode

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Dowels

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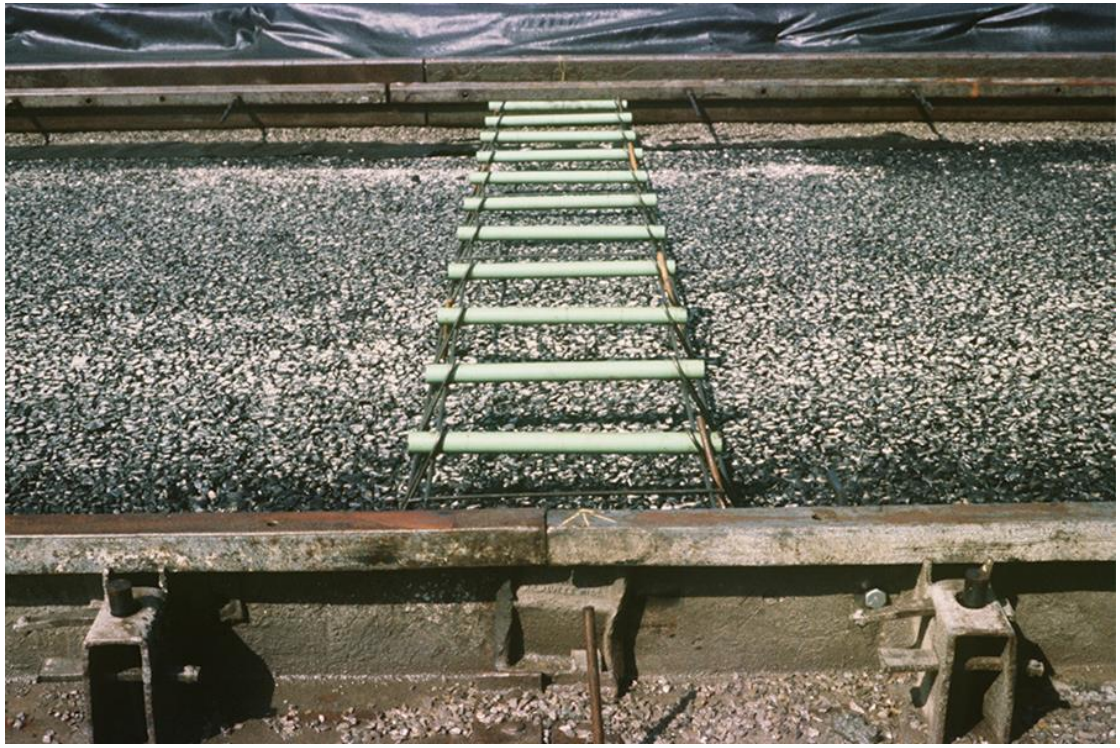
Dowels



Dowels

Tiebars

- Prevent opening
- Hold faces together
- Smaller and larger spacing than dowels

Tiebars

Tiebars

Keyways

- Can be formed by side or slipform
- Only at close spacings
- Dimensions important
- Only in pavements > 150 mm
- Don’t tie more than 13 - 15 m

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Keyways

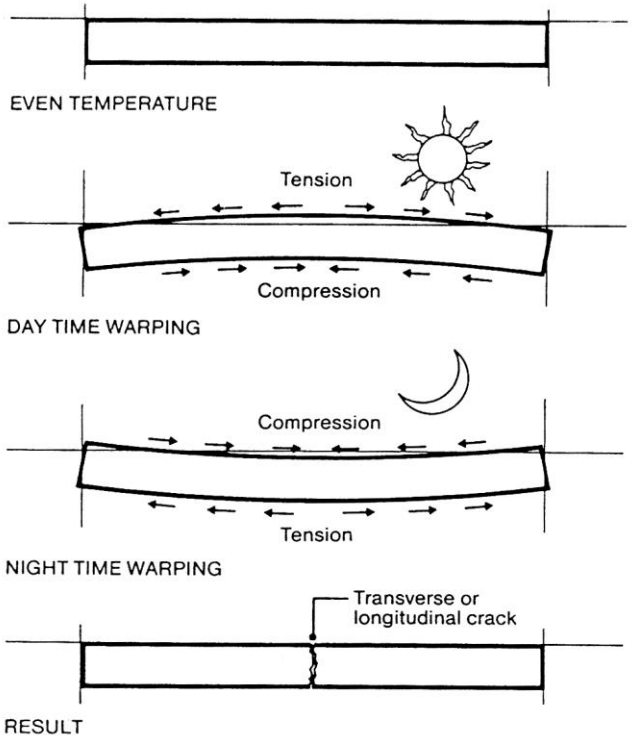
Keyways

CTS

- Reduces deflections
- Improves load transfer

General cracking behaviour

Cracking


EVEN TEMPERATURE
Tension
Compression
DAY TIME WARPING
Compression
Tension
NIGHT TIME WARPING
Transverse or
longitudinal crack
RESULT

Joint types

Joint types

- Two basic types
  - Transverse
  - Longitudinal

Transverse contraction joint

- More critical than longitudinal
- Requirements
  - Induce crack
  - Allow opening and closing
  - Transfer loads
- Max spacing 4,5 m
- Depth 25% of slab thickness

Transverse contraction joint

- Load transfer by aggregate interlock or dowels
- Can be skewed
- Sometimes randomised

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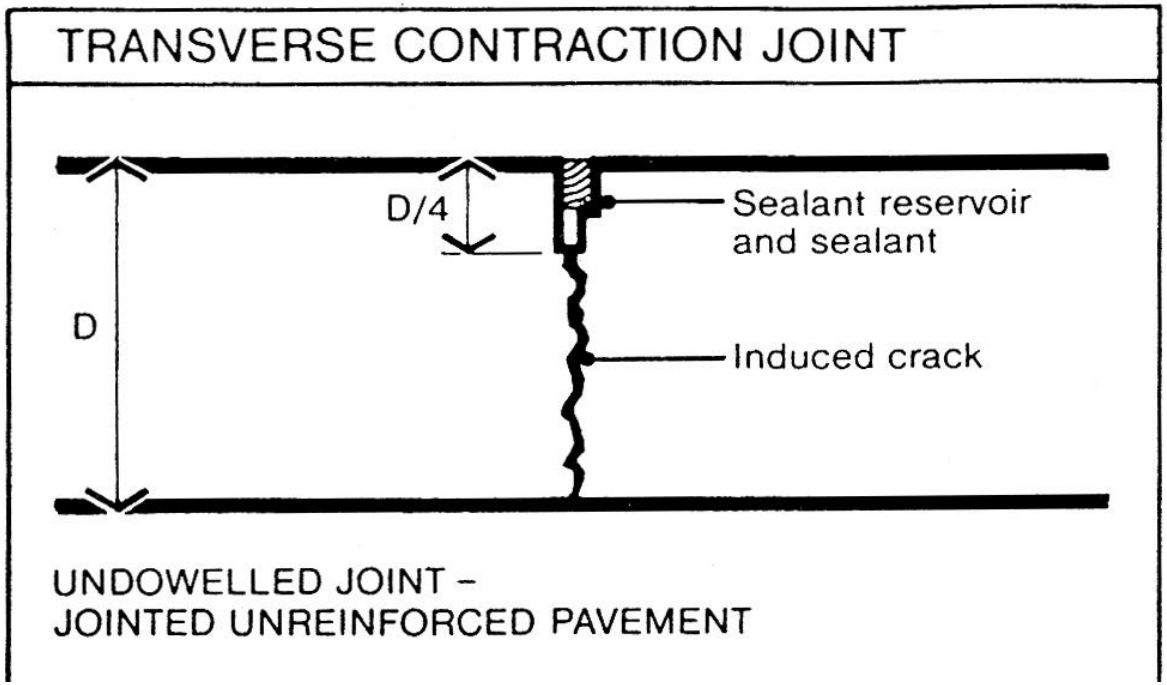
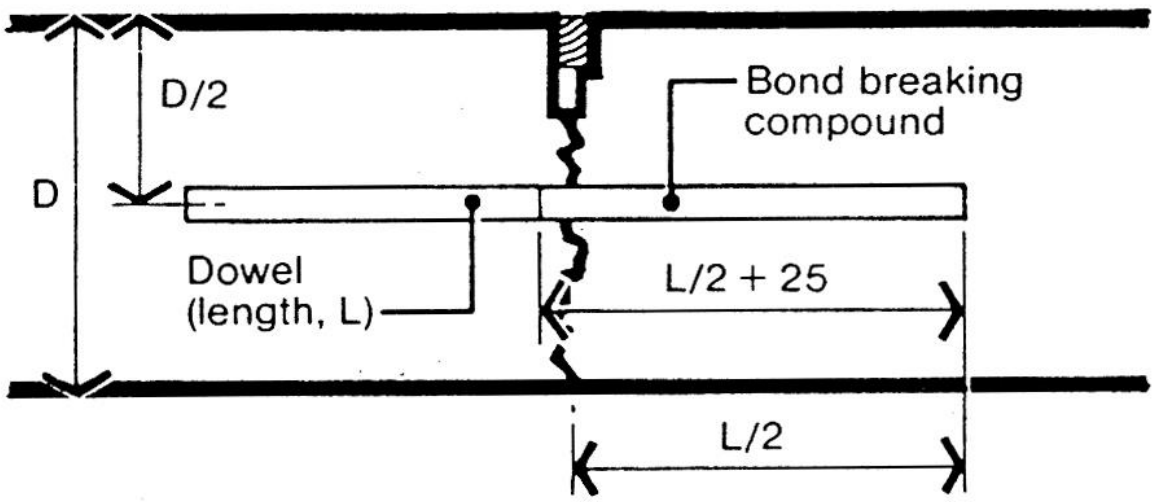
Transverse contraction joint

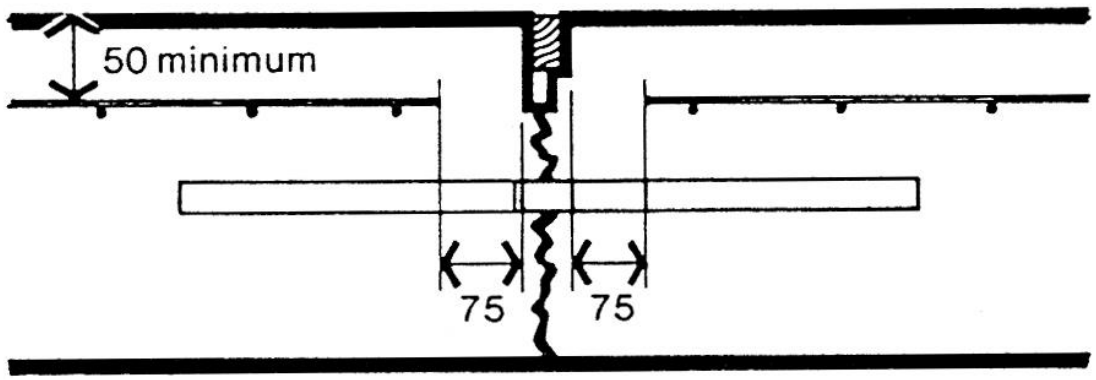


Transverse contraction joint



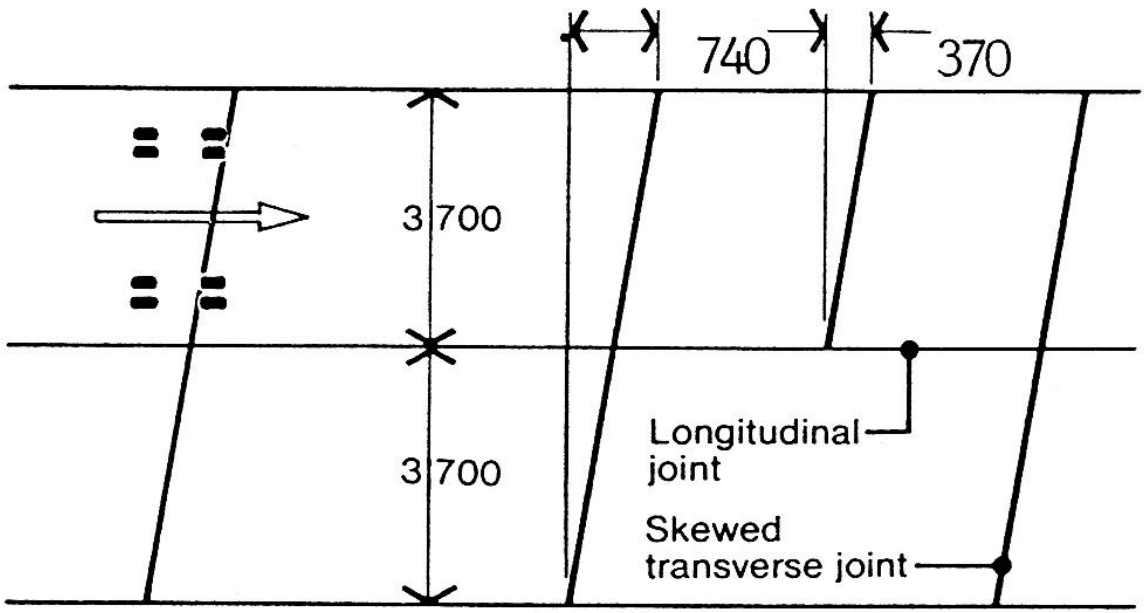
DOWELLED JOINT –
JOINTED UNREINFORCED PAVEMENT

Transverse contraction joint



DOWELLED JOINT –
JOINTED REINFORCED PAVEMENT

Transverse contraction joint



(Skew = 1:10)

Expansion/Isolation joints

- Stresses < 10 MPa for no shrinkage and high temps
- Stresses >20 MPa with filled cracks and joints
- Compression failures rare
- These joints are generally not needed

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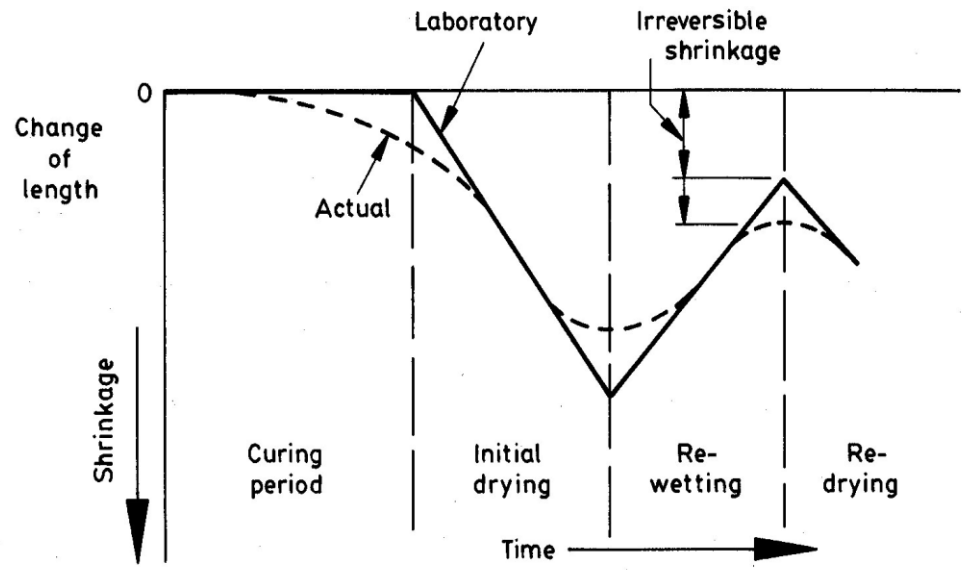
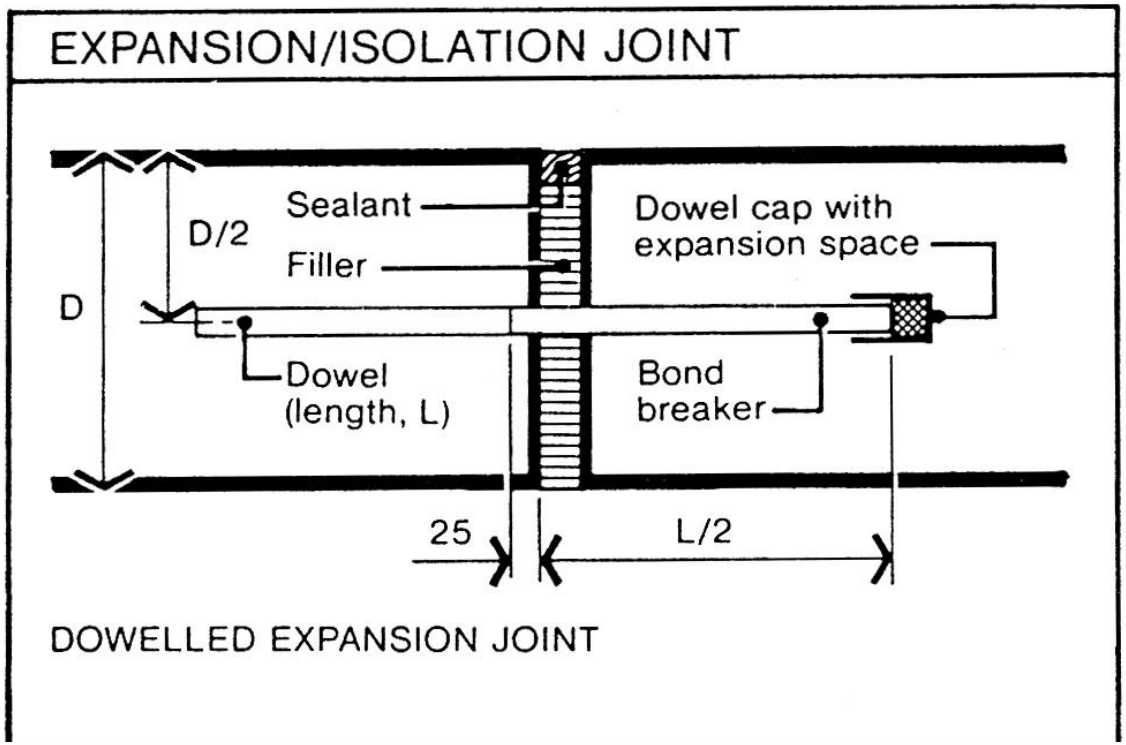
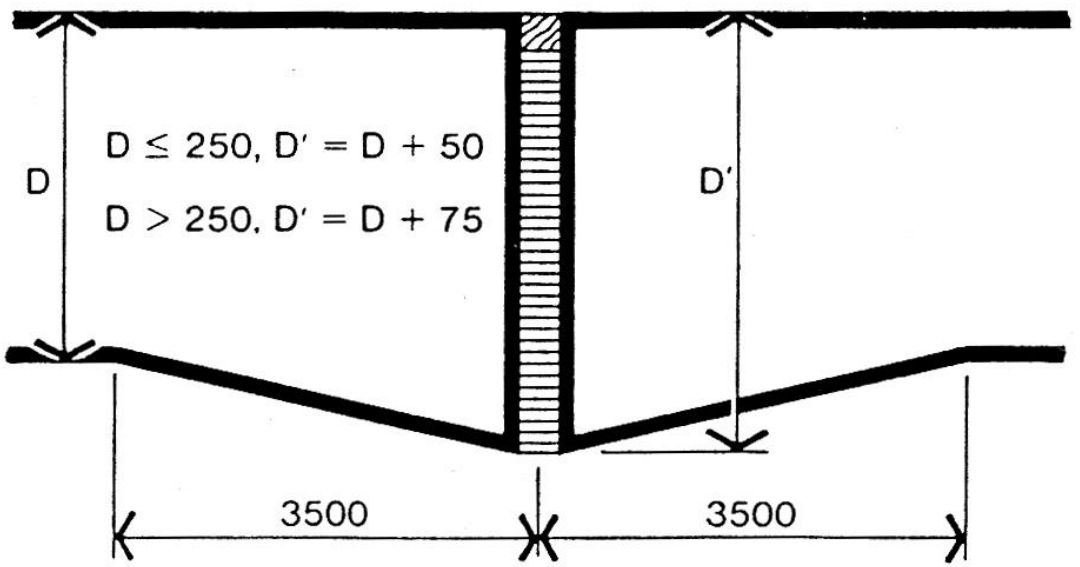
Expansion/Isolation joints



Expansion/Isolation joints



Expansion/Isolation joints

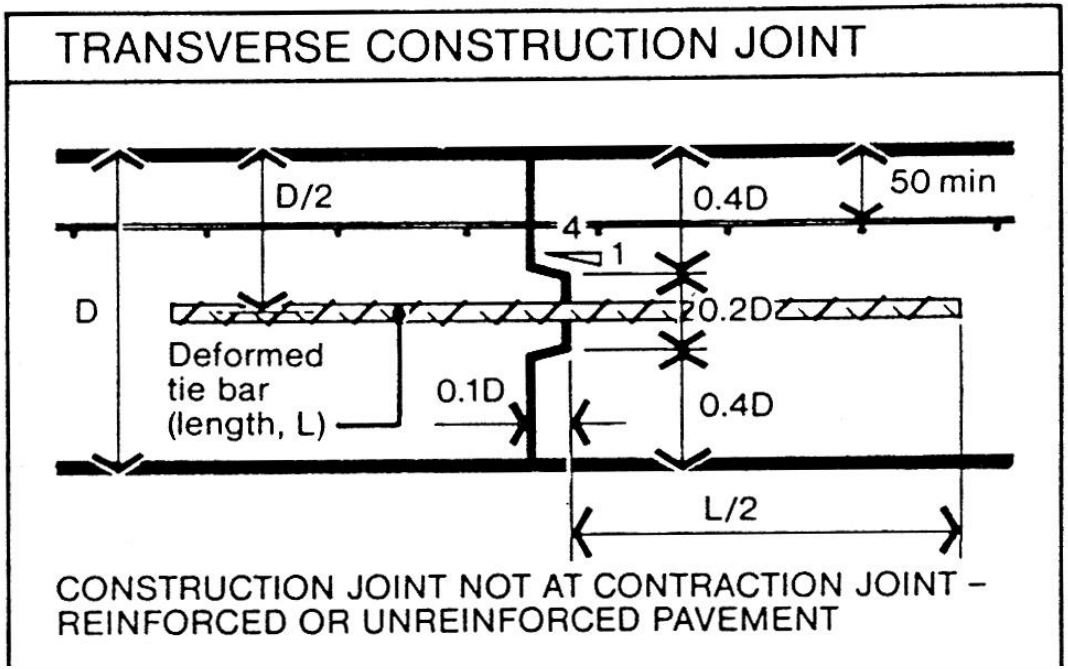


THICKENED EDGE EXPANSION JOINT

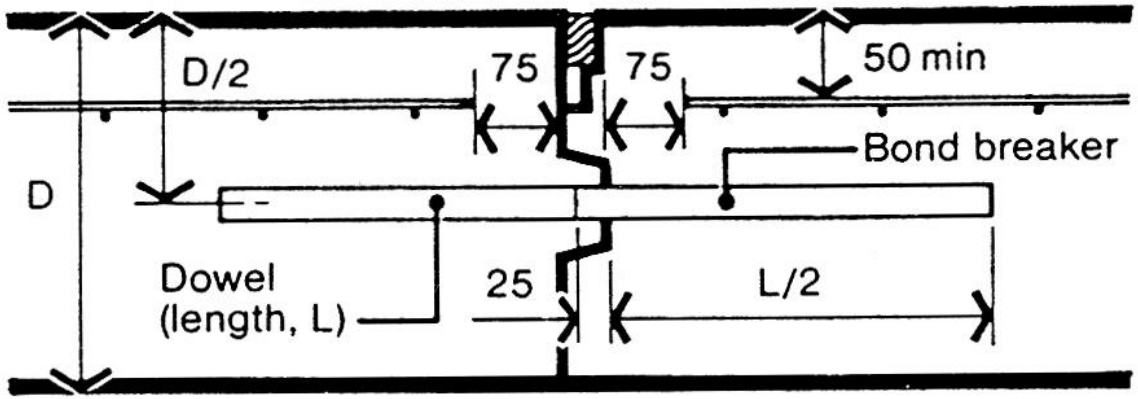
Transverse construction joint

- For planned and emergency interruptions

Transverse construction joint



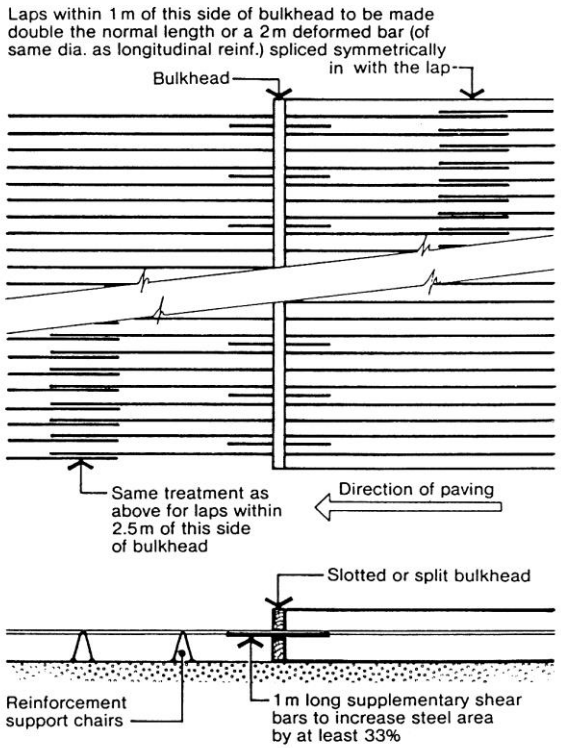
Transverse construction joint



NOTE: Keyway may be omitted (see text)

CONSTRUCTION JOINT AT CONTRACTION JOINT – REINFORCED OR UNREINFORCED PAVEMENT

Transverse construction joint



Longitudinal joints

- To control longitudinal cracking
- Usually provided between lanes
- Range 3 to 4,5 m
- Tiebars not required where kerbs provide restraint
- No keyways < 150 mm thickness
- Cut 33% of depth

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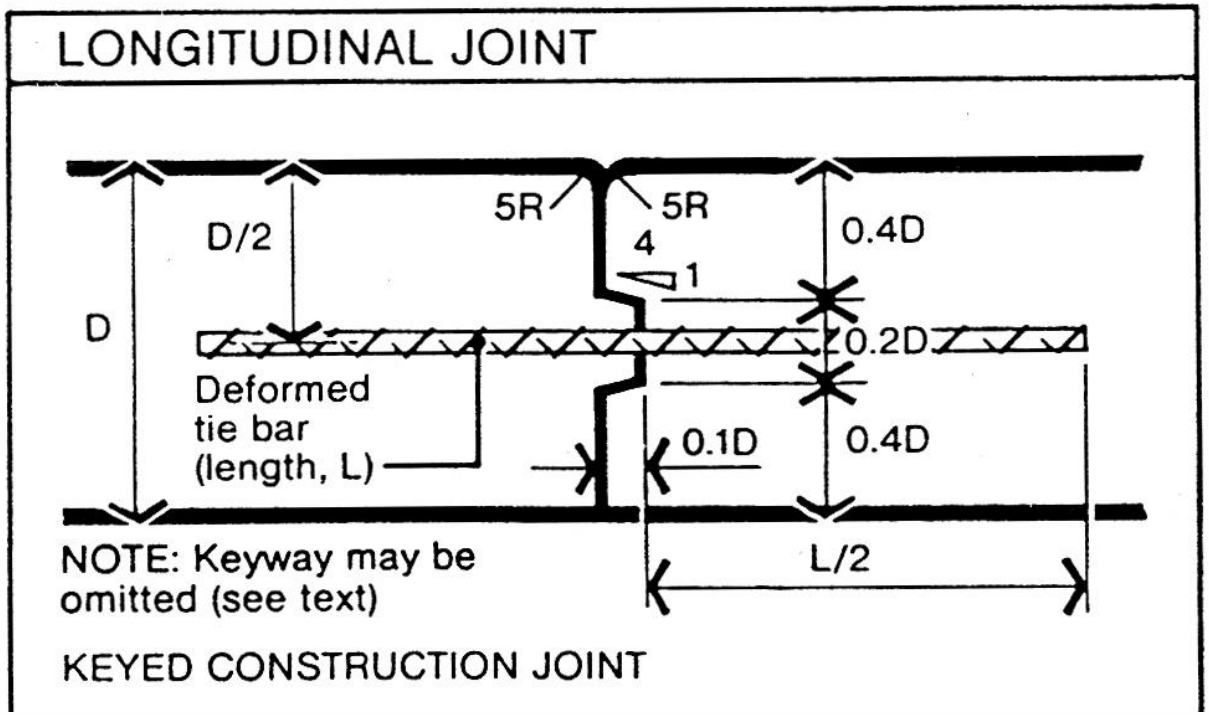
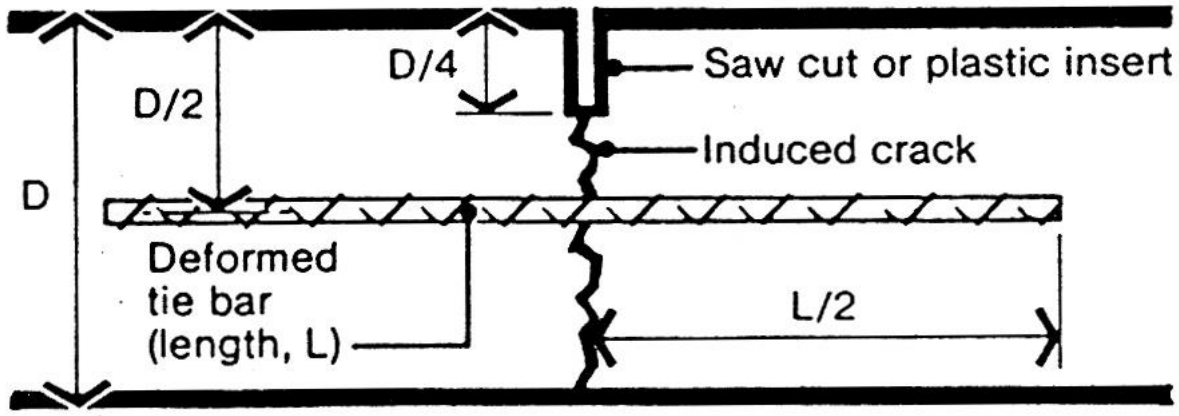
Longitudinal joints



Longitudinal joints



WEAKENED PLANE JOINT –
MULTIPLE LANE PAVING

Terminal joints in CRCP

- Active section 90 to 150 m
- Movements up to 50 mm
- Two options:
  - Cater for movement
  - Resist movement

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Terminal joints in CRCP

- Cater for movement
  - Series of expansion joints
  - Finger type expansion joints
  - Bellows type
  - Wide flange beam
- Resist movement
  - Ground anchors

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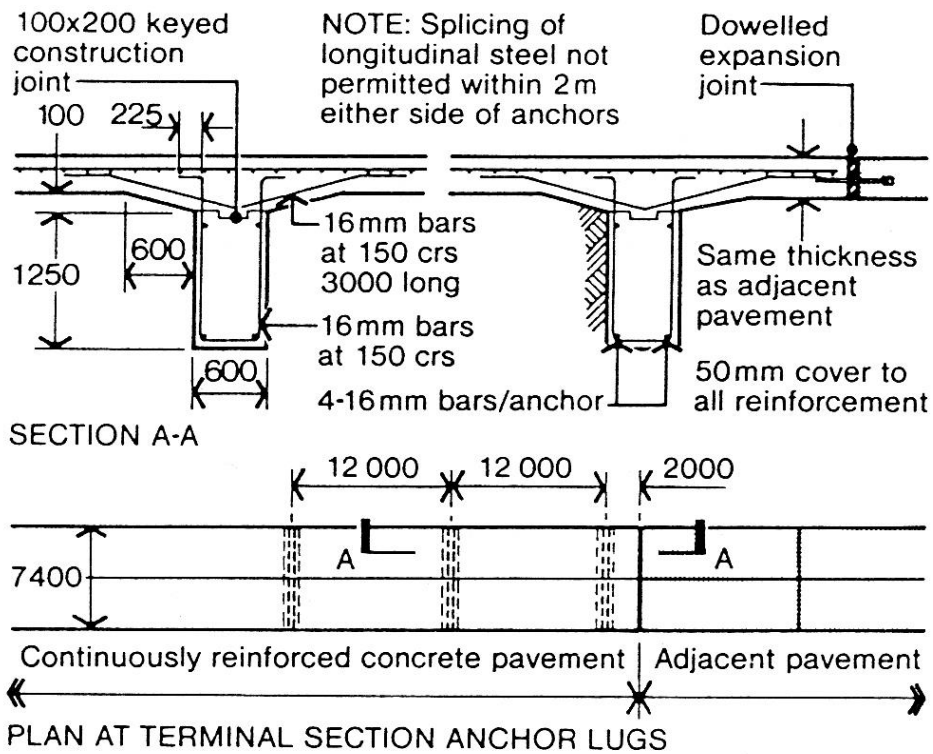
Terminal joints in CRCP



Joint layout

Joint layout rules

- Avoid odd shapes
- Spacing
  - longitudinal < 4m
  - Transverse < 30T or 4,5m
- Square as possible
- Correct depth
- Meet at a point

Joint layout rules

- Avoid angles < 60
- Isolate structures
- Thicken edges
- Tie in to manholes
- Reinforce odd shapes and reentrant angles

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Things to Ensure

- Match existing joints or cracks
- Reduce/eliminate crack risks
  - Develop a jointing plan
  - Watch timing
  - Understand joint location (make adjustments!)
- Consider non-obvious factors

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Things to Avoid

- Slabs < 0.3 m wide
- Slabs > 5.0 m wide
- Angles < 60º (<90º is better)
- Creating interior corners

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Intersection Jointing

- Develop a jointing plan
  - Bird's eye view
- Follow 10-step method
- Be practical!

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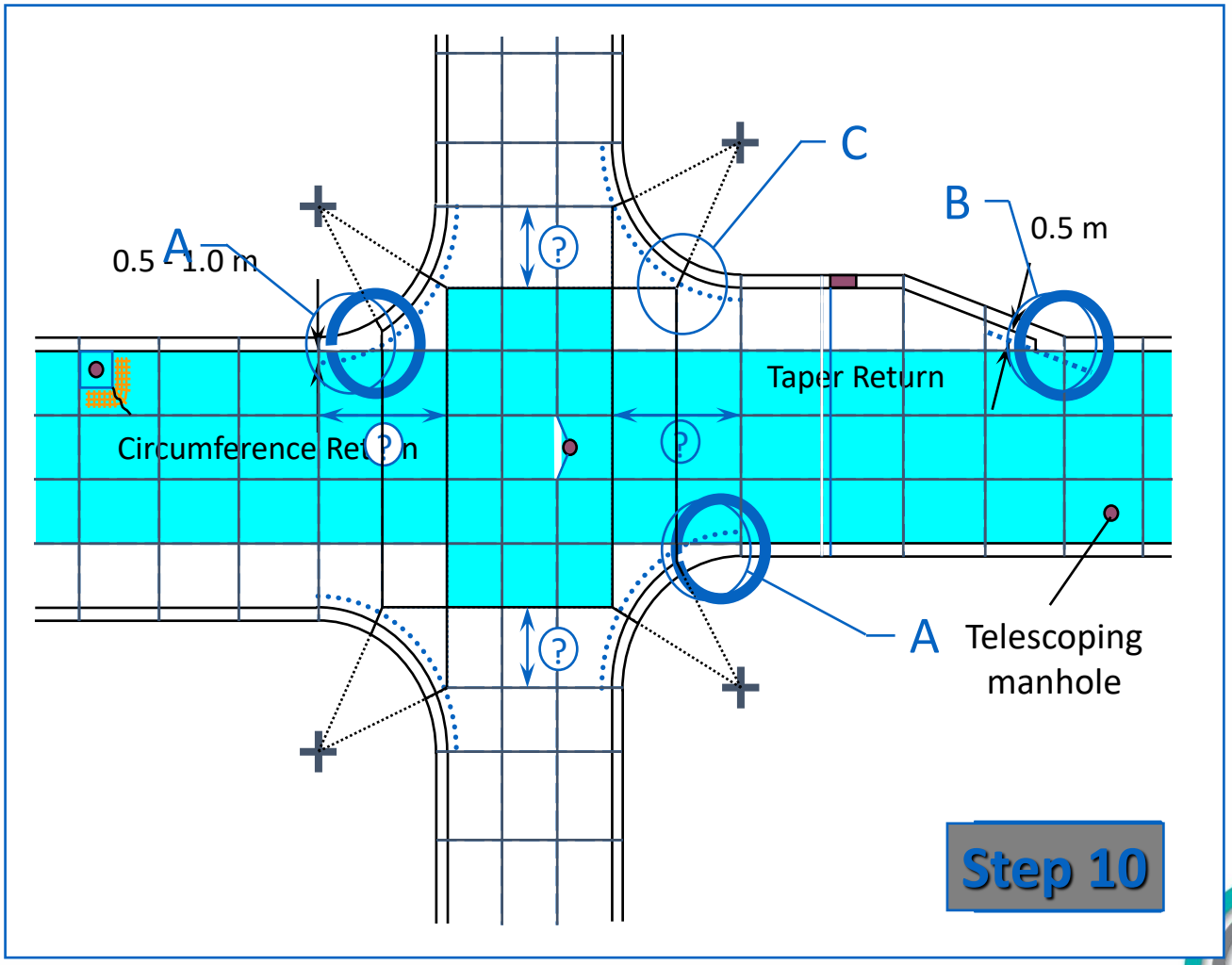
C
B
0.5 m
A
0.5 - 1.0 m
Taper Return
Circumference Ret n
A
Telescoping
manhole
Step 10

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It’s not nice to fool with mother nature

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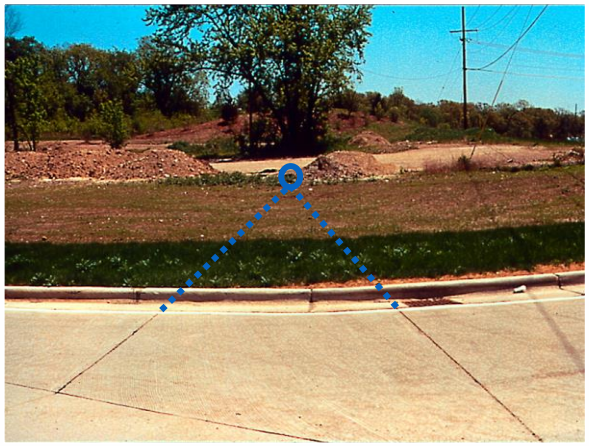
Follow the radius return...



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If it gets too Wide...

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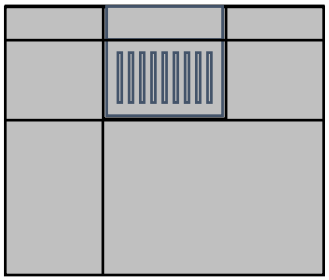
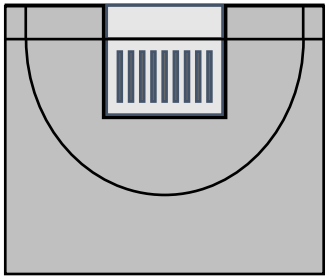
Matching Cracks...

In-Pavement Objects

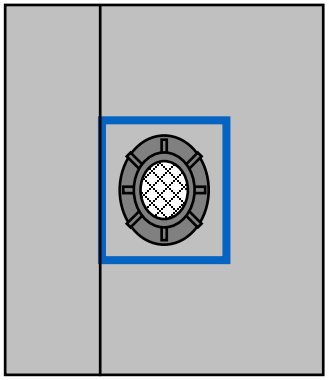
Square Inlet (no boxout)



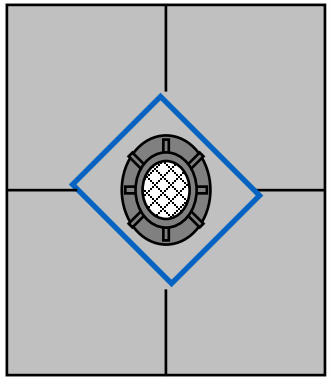
Round Inlet Boxout



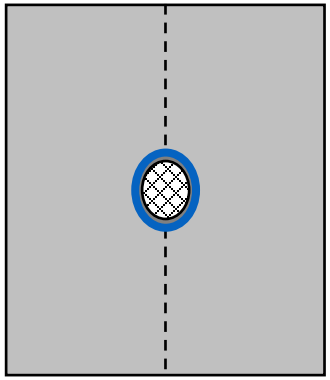
Square



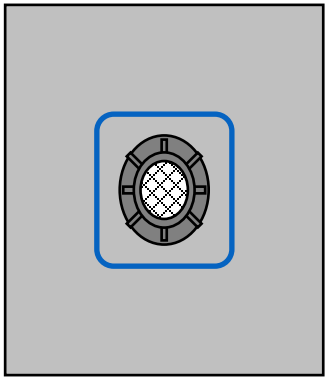
Diagonal



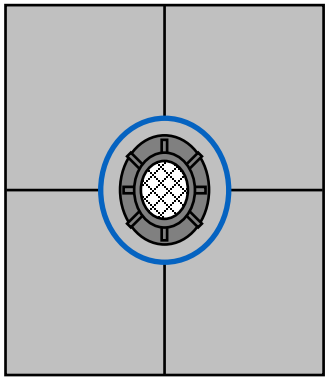
Isolate Perimeter



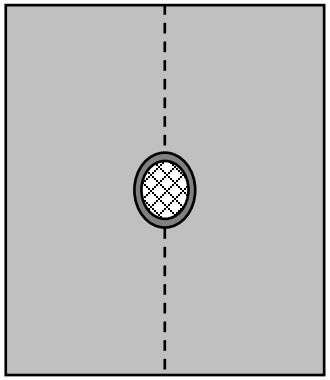
Square w/ Fillets



Circular



Telescoping



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What were they thinking?

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Joint through or Perimeter Isolation?

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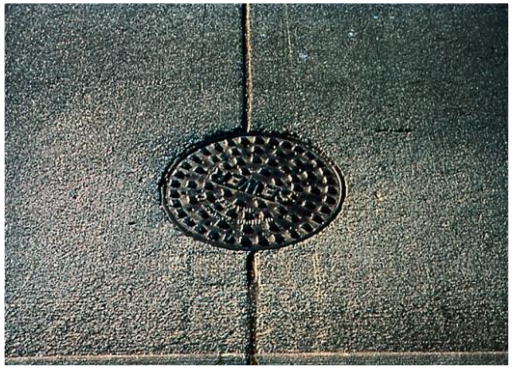
Good Practice!



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Pretend you are a Crack …

What would you do?

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Conclusion

- Proper jointing requires only a few simple rules
- Jointing Intersections can be confusing to novices
- If you keep it simple and practical - jointing is easy!

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Joint Sealing

Introduction

Introduction

- Sealants should prevent:
  - ingress of water
  - ingress of incompressible material
- Unsealed joints??
- Two categories
  - Field moulded
  - Pre-formed

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Pavement distress vs defective sealing

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Defective sealing

- Ingress of water
  - softening of support
  - pumping and voids
  - corrosion of tiebars and dowels
- Ingress of incompressibles
  - non-uniform pressures
  - spalling of joints
  - pavement growth
  - blow-ups

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Defective sealing

- Oversealing
  - riding quality
  - loss of sealant
- Wide joints
  - aesthetics
  - riding quality
  - joint damage

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Effect of design factors

Effect of design factors

- Joint type and size
- Slab length
- Subbase type
- Temperature and moisture effects

Joint type and size

- Transverse
  - Not all joints crack out
  - First ones are wider
  - Movement due to temp, moisture and warping
  - Sealants subjected to high adhesive, cohesive and shearing stresses

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Joint type and size

- Longitudinal
  - If tied, small movements
  - Mainly warping stresses

Slab length

- Use shorter slabs
  - narrower openings - no incompressible material
  - less movement - smaller stresses
  - reduced spalling

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Subbase type

- CTS reduces deflections and shearing stresses
- CTS result in more uniform joint openings

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Temperature and moisture effects

- Both affect overall movement
- Both affect warping stresses

Functions and behaviour

Functions and behaviour

- Sealants behave in composite plastic and elastic manner
- Depends on
  - Type and shape
  - movement and rate of movement
  - installation and service temperatures
  - physical properties of sealant

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Functions and behaviour

- Two conditions exist
  - Always in compression
  - Cyclically in tension and compression

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Functions and behaviour

- Compression only
  - Adhesion failure
- Compression and tension
  - Repetitive stress reversal
  - Sustained stress at constant deformation

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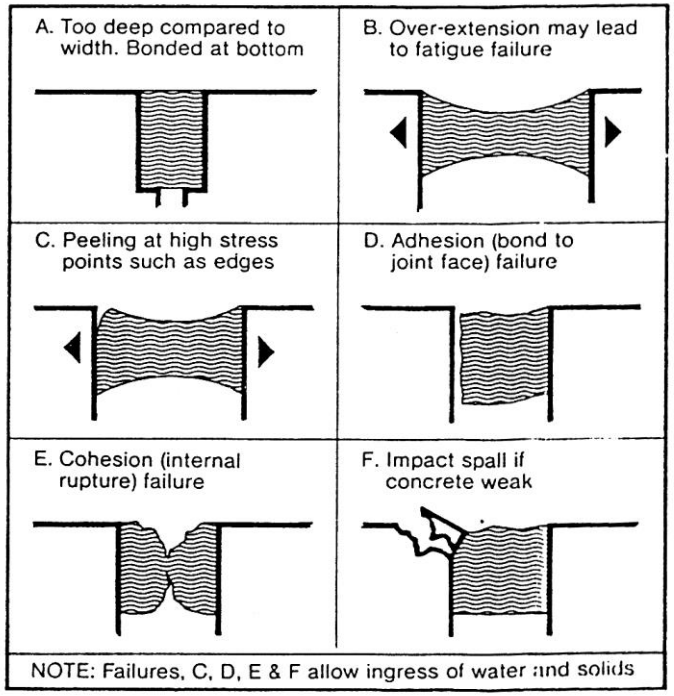
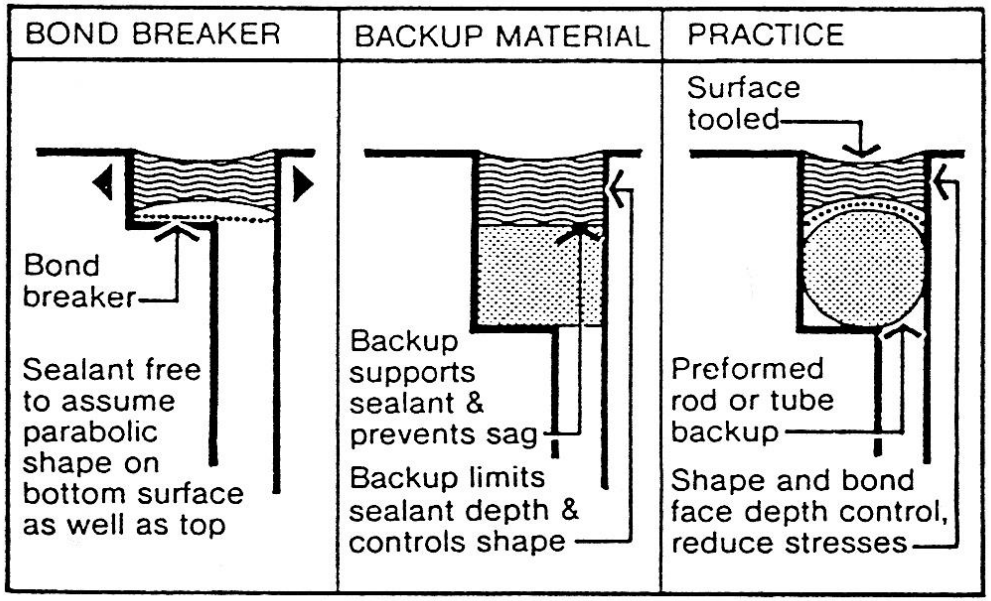
Functions and behaviour



Functions and behaviour



Sealant materials

Sealant materials

- Sealant must:
  - be impermeable
  - accommodate movements
  - recover after cyclical deformations
  - remain in contact with joint faces

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Sealant materials

- Sealant must:
  - not fail in cohesion
  - resist flow and softening
  - not harden or become brittle
  - not be affected by ageing, weathering etc

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Field-moulded sealants

- Include:
  - Polysulphides
  - Urethanes
  - Low-modulus silicones
  - Epoxies
- In COTO only low-modulus silicone

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Field-moulded sealants

- Accessories:
  - Primers
  - Bond breakers
  - Backup materials

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Pre-formed sealants

- Extruded closed-cell compression seals made from neoprene rubber
- Compressed to insert in the joint
- Always in compression

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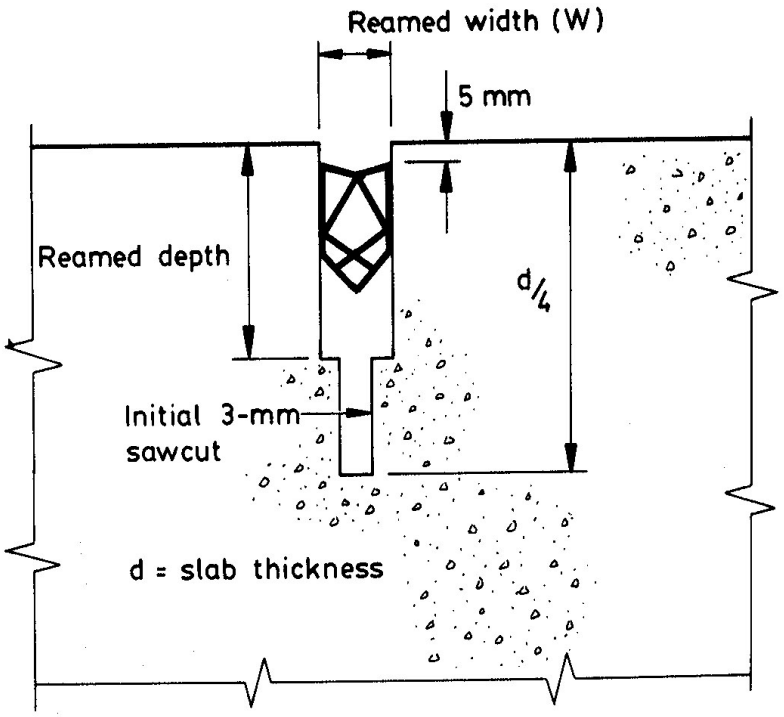
Pre-formed sealants

- Must have special properties:
  - good resistance to compression set
  - crystallization resistance
  - completely cured
  - adequate web thickness
  - uniform web thickness

Pre-formed sealants



Reservoir dimensions

Reservoir dimensions

- Allowable sealant strain
- Expected movement
- See manufacturers recommendations

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