



PRESENTATION TO



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Overview of patch repairs to rigid airport pavements

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Overview of patch repairs to rigid airport pavements

INTRO

- ➔ Most runways in Canada are surfaced with asphalt
- ➔ Many taxiways and most hard-standings and maintenance areas are made of concrete
- ➔ There is at least 250,000m² of concrete that is trafficked regularly by aircraft and support vehicles



There is a great deal of traffic on the concrete, using it on a regular basis

This puts considerable stress on the concrete and combined with severe weather conditions, leads to deterioration of the surface and in some cases, structural instability



Typical problems



Surface erosion due to frost



Settlement cracking

Typical problems



Shrinkage cracking



Surface crazing : poor curing

Typical problems



Defective joints



Bay cracking

Typical problems

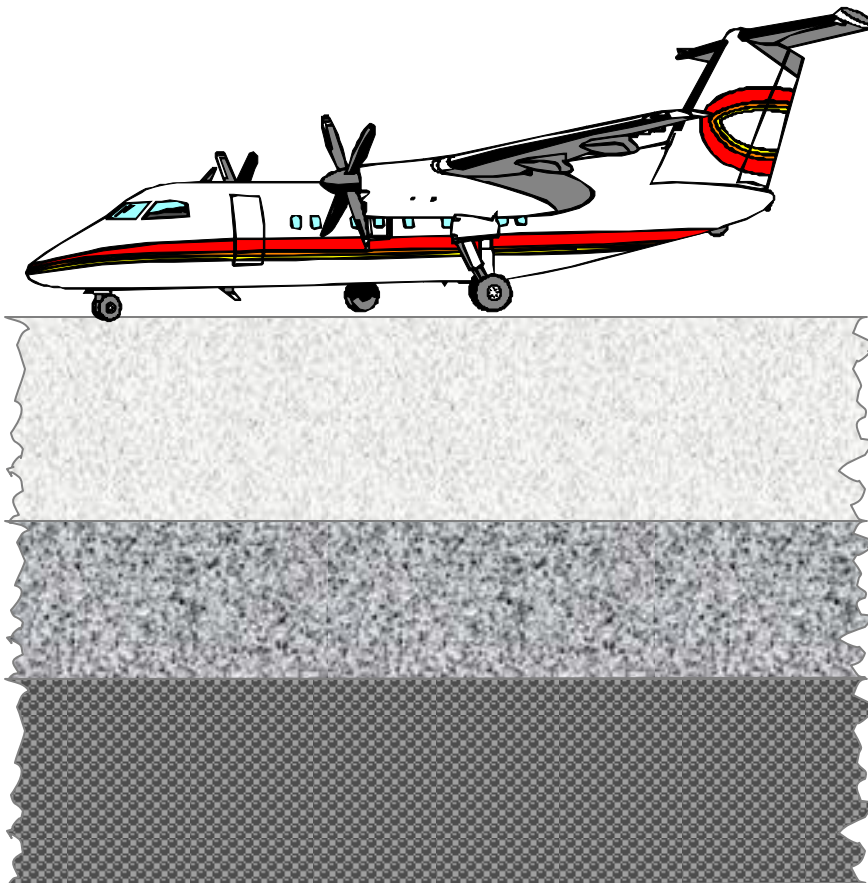


Poor repairs



Poor repairs

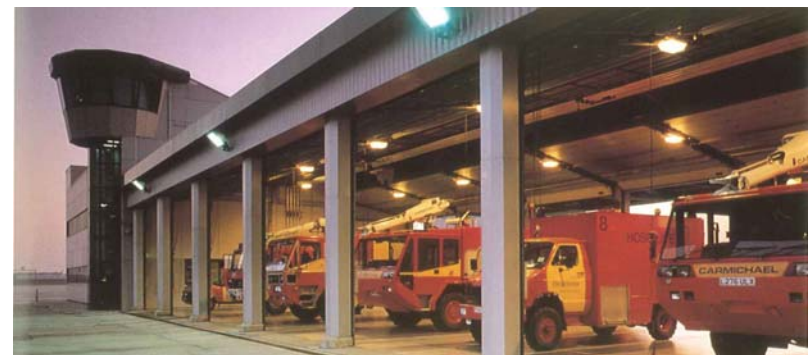
Main functions of rigid airfield pavements



- To support the critical loads imposed on them.
- To produce a level, smooth, skid-resistant, and hazard-free surface
- To be durable enough to resist abrasion due to traffic
- To be durable enough to withstand severe weather conditions
- To resist other agents such as de-icing salts and jet fuel

Why are repairs needed ?

- To reinstate the concrete surface to a safe condition
- To prevent further degradation
- To eliminate any possibility of FOD
- To reduce the need for substantial costly remedial works
- To keep the airports, airplanes and support vehicles running smoothly and safely



EN 1504: A guide to concrete repair

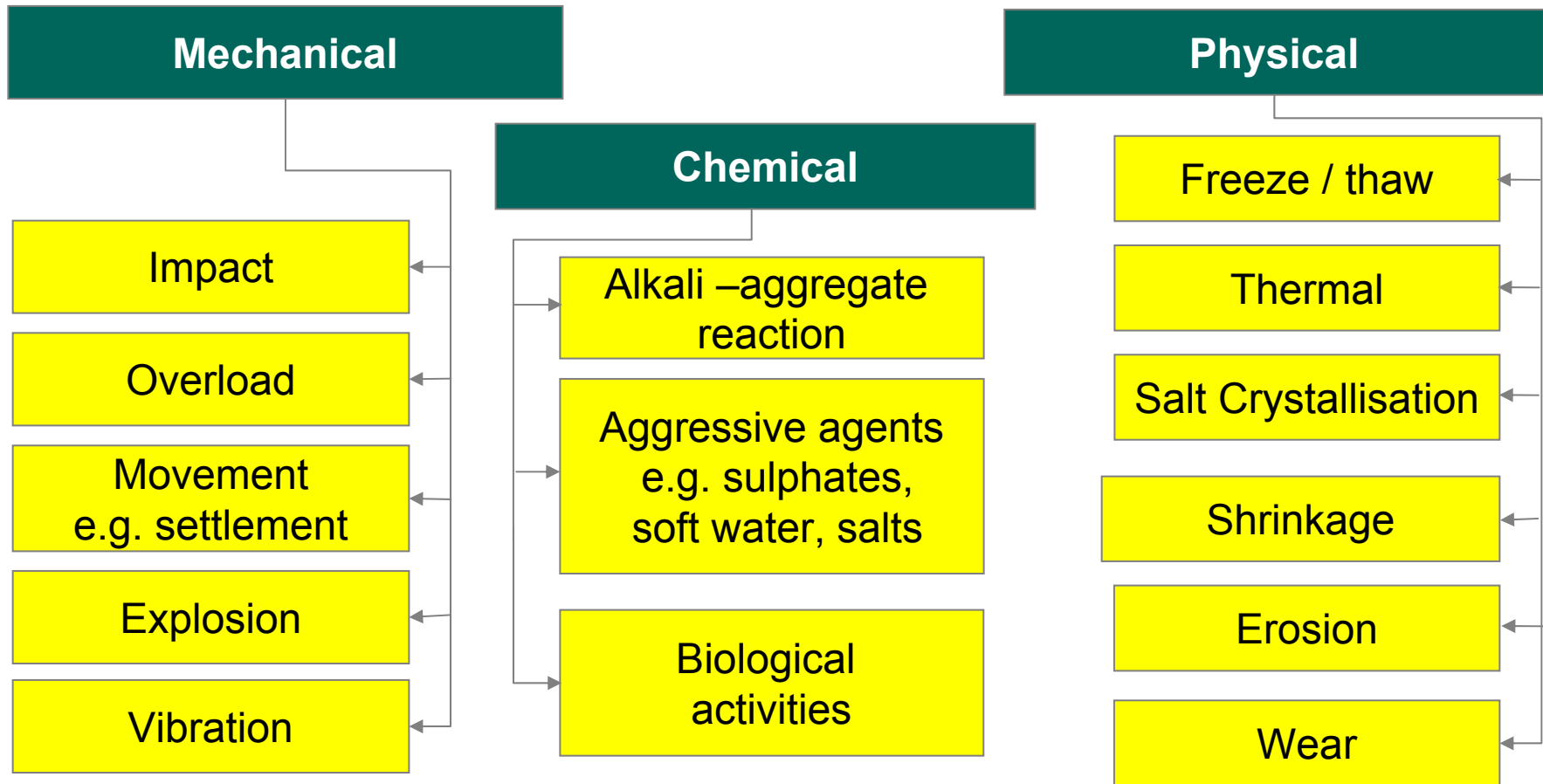
- ❑ **EN 1504** is the new European Standard for the protection and repair of concrete.
- ❑ The standards apply across the 25 member states of the EU as well as Switzerland, Norway, and Iceland.
- ❑ There are ten parts to the standard covering test methods for material properties and specification for the key repair materials, including coatings, mortars, bonding agents and injection materials.

BS EN 1504: A guide to concrete repair

- ❑ EN 1504 also includes general principles for repair work and a standard for site application of products and systems.
- ❑ For the first time there is a combined package of product and test standards relating to the concrete repair industry.
- ❑ This helps specifiers, engineers and others to make genuine comparisons of performance based on common data for the various products.

Defects in concrete

(Common causes of defects: EN 1504 Part 9 Figure 1)



Defects in concrete pavements

Many reports have been published on the types of defects, their causes and suggested methods of repair

TYPE OF PCC PAVEMENT DISTRESS		UNDERLYING CAUSES			REPAIR AND/OR MAINTENANCE					
Distress Category	Distress Type	Structural Failure	Temperature or Moisture Changes	Construction Deficiencies	Repairs Using PCC		Repairs using HMA/C	Repairs Using Cold-Mix AC	Joint or Crack Sealing	Special Repairs
					Full Depth	Surface Patch				
Cracking	Transverse/Longitudinal	X	X	X	X				X	
	Corner Cracking	X	X	X	X	X	X			X
	Diagonal Cracking	X	X	X					X	
	Edge Cracking	X			X	X	X		X	
	"D" Cracking		X		X	X	X	X		X
	Crazing			X	X	X	X	X		X
	Random Cracking	X	X						X	
	Joint/Crack Sealant Failure		X	X					X	
Slab Movement (Permanent Deformation)	Repping/Faulting	X	X		X	X	X	X		X
	Pumping	X	X		Requires Specialized Repair not Covered in this Circular					
Disintegration	Scaling		X	X		X	X	X		X
	Spalling		X	X		X	X	X		X
Slid Resistance	Polished Aggregate	Winter Operations Maintenance Equipment			Surface friction characteristics may be restored by ShotBlasting					
	Rubber Deposits	Caused by Repeated Landing of Aircraft			Rubber Removal Techniques Covered in PMS 5510 to PMS 5540					

TABLE 1. MAINTENANCE AND REPAIR OF PAVEMENT SURFACES.

PROBLEM	PROBABLE CAUSE	REPAIR
Crack and joint sealer missing or not bonded to slabs	Faces of joints (cracks) not clean when filled; incorrect application temperature of sealer; wrong kind of seal material; improper joint width.	Remove old material sealer if extensive areas affected; sandblast joints and cracks; reseal properly.
Random cracking	Uncontrolled shrinkage (improper joint spacing); overstressed slabs; slab support lost; subgrade settlement; bitumen too hard or overheated in mix.	Seal newly formed cracks; replace subbase to establish support; if pavement being overloaded, probably will require overlay.
Surface scaling or breakup	Rigid Pavement - Overworked finishing operation; inadequate curing. Flexible Pavement - Overheated binder; poor aggregate gradation; insufficient binder; incorrect binder or aggregate; fuel spillage, stripping.	Rigid Pavement - Remove and replace panel; resurface with thin bonded concrete; resurface area with a bituminous concrete. Flexible Pavement - Apply seal coat, overlay.
Joint (1) faulting or (2) spalling	(1) Variable support for un-bonded slabs; loss of load-transfer capability. (2) Incompressible matter in joint spaces; excessive joint finishing.	(1) Remove problem slab; replace slab (dowel to existing pavement). (2) Clean joint; refill with bituminous-sand mix; reseal.
Pumping	Saturated pavement foundation; lack of subbase.	Prevent entrance of water (correct the drainage problem); pump slurry under slabs to reseal; replace slabs and slab foundation; install drainage.
Surface irregularities (rutting, washboarding, ripples, undulations)	Rigid Pavement - Poor placing control; broken slabs; poor finishing. Flexible Pavement - Non-uniform settlement from inadequate compaction of pavement components or fill; unstable mix (poor aggregate gradation, too rich, etc.); poor laying control.	Rigid Pavement - Patch local areas, or overlay if widespread. Flexible Pavement - Patch local areas; apply leveling course; roller.
Bleeding of bituminous binder	Too much binder in mix (overly rich mix).	Scrape off excess material; blot with sand. NOTE: Bleeding is usually an indication that other surface deformities (rutting, washboarding, etc.) will occur.
Potholes	Water entering pavement structures; segregation in base course material.	Remove and replace base (and subbase if required); replace surface and seal.
Oxidation of bituminous binder	Lack of timely seal coat; binder overheated in mixing; wrong grade of asphalt for climate.	Apply seal coat; heater planer; resurface.
Map cracking, crazing, alligator cracking	Rigid Pavement - Excessive surface finishing; Alkali-Aggregate Reactivity. Flexible Pavement - Overload; oxidized binder; underdesigned surface course (too thin).	Rigid Pavement - If surface deforms or breaks, resurface, grind. Flexible Pavement - Overlay, apply seal coat.
Popouts at joints	Dowel misaligned.	Fill popout hole with bituminous concrete or bituminous sand mix (if recurring, may require replacement of slabs).
Slab blowup	Incompressible material in joints preventing slab from expanding; Alkali-Aggregate Reactivity.	Replace slab in blowup area; clean and reseal joints.
Slipperiness	Rigid Pavement - Improper finish (too smooth); improper type of curing membrane; excessive curing membrane, polished aggregate, rubber deposits. Flexible Pavement - Overly rich mix; poorly designed mix; polished aggregate; improperly applied seal coat; wrong kind of seal coat, rubber deposits.	Rigid Pavement - If finish too smooth, resurfacing required to provide texture; wire broom to remove curing membrane; grooving; remove rubber. Flexible Pavement - Apply textured seal coat; grooving; remove rubber.

Solutions have been provided for many types of paving defects

Defect treatment



Fig 1: Surface scouring

ACTIVITY
EXTERNAL PAVING

PROBLEM
E1 : Concrete surface erosion

CAUSE

- Poor concrete quality; poor curing
- Freeze-thaw action spalls the surface
- Weak surface is not resistant to abrasion

EFFECT

Weak and porous concrete will allow penetration of water which when frozen, expands and delaminates the surface layer. Spalling can progressively go deeper every year. Eventually, the concrete slab will need total replacement.

REMEDY & WEBER SOLUTIONS

For minor surface erosion (Fig 1), where the texture depth is less than 3mm, the service life can be prolonged by impregnating with a penetrating consolidating sealer. Use compressed air and a stiff brush to blow out all embedded debris. Ensure surface is dry. Seal the surface with **Hardac Acrylic Sealer** applied by brush or roller in accordance with the instructions on the product data sheet. (Fig 2)

Where the texture depth is greater than 3mm (Fig 3), and water can be seen ponded in small puddles, remove all damaged concrete back to a sound firm base. High pressure water jetting is recommended. Mechanical scabbling is not recommended as it tends to fracture the concrete.

Mix and apply the rapid setting pavement repair concrete **Pyratop** to a minimum thickness of 25mm in accordance with the instructions on the product data sheet.

Texture with a steel-tined texturing brush and when firm, spray with **Ritecure** curing membrane.

Apply a mastic or sealant to adjacent joints in accordance with manufacturers instructions.



Fig 2: Sealing with **Hardac Acrylic Sealer**



Fig 3: Surface detail

Defect treatment




Fig 1: Cracks across concrete slab

ACTIVITY
EXTERNAL PAVING

PROBLEM
E2 : Narrow or wider cracks across slabs

CAUSE

Shrinkage of concrete or thermal movement

EFFECT

Cracks can allow penetration of contaminated water and other deleterious chemicals into the groundwater

REMEDY & WEBER SOLUTIONS

For narrow cracks, less than 2mm wide, use compressed air to blow out all embedded debris. Ensure cracks are dry. Seal the cracks with a penetrating sealer that will remain slightly flexible; pour in **Mulsibond Sealer** in accordance with the instructions on the product data sheet

For narrow cracks, less than 5mm wide, rake out the cracks with a sharp raking tool such as a **weeder** to remove all loose debris and blow out all embedded debris with compressed air. Allow to dry. Fill the gap with a **mastic** or a sealant.

For cracks wider than 5mm, need to treat the cracks as a joint. Cut a chase along the line of the crack. For wider cracks, cut two parallel grooves. Remove debris and dust and clean thoroughly. Allow to dry. Insert a **compressible joint filler**. Apply a **mastic or sealant** in accordance with manufacturers instructions.




Fig 2: Detail of single crack




Fig 3: Multiple cracks



Solutions have been provided for many types of paving defects

Defect treatment




Fig 1: Pot-hole




Fig 2: Deep pot-hole




Fig 3: Shallow pot-hole

ACTIVITY

EXTERNAL PAVING

PROBLEM

E3 : Pot holes in concrete surface

CAUSE

- Localised erosion
- Frost damage
- Weak concrete

EFFECT

Pot-holes will open up progressively, letting in water which when frozen, will spall the concrete even more.

Pot-holes will cause damage to vehicles and are a danger to pedestrians.

REMEDY & WEBER SOLUTIONS

Remove all damaged concrete back to a sound and firm base. Cut all peripheral edges square to leave a uniform roughened concrete vertical face. Do not cut an uneven jigsaw pattern but leave the removed area rectangular.

In normal temperatures (10 to 25°C) mix and apply the rapid setting pavement repair concrete **Pyrapatch** to a minimum thickness of 25mm in accordance with the instructions on the product data sheet.

When the temperature is below 10°C, use the ultra rapid setting pavement repair concrete **weber.com set45** to a minimum thickness of 25mm in accordance with the instructions on the product data sheet.

When firm, spray with **Ritecure** curing membrane.

Defect treatment




Fig 1: Damage around drain




Fig 2: Cracks around drain




Fig 3: Cracks around manhole

ACTIVITY

EXTERNAL PAVING

PROBLEM

E4 : Cracks around drains and manholes

CAUSE

- Impact damage
- Thermal movement between adjacent slabs
- Lack of joints at points of stress caused by sharp corners of ironwork.

EFFECT

Cracks can allow penetration of contaminated water and other deleterious chemicals into the groundwater. Cracks can progressively get bigger and cause damage to tyres.

REMEDY & WEBER SOLUTIONS

For damaged surrounds to drains (Fig 1), remove all cracked and broken concrete back to a firm base. Use **Certe Bedding Mortar** to rebed and fix the drain assembly.

The infill area surrounding the drain will be subject to movements and corner stress. Use **Pyrabed T60 Frame Mortar**. Reinforce the corners with nylon mesh or non-corroding mesh. Alternatively mix 100g of 12mm **CenFill** fibre with every 25 kg bag of **Pyrabed T60** and compact well into the recesses. Allow to cure.

For cracks around manholes (Figs 2 & 3) where the manhole is not seated firmly, rebed as above. Seal gaps around manhole with a mastic or sealant.

Treat any diagonal cracks as movement joints.

Cut a chase along the line of the crack. For wider cracks, cut two parallel grooves. Remove debris and dust and clean thoroughly. Allow to dry. Insert a compressible joint filler. Apply a mastic or sealant in accordance with manufacturers instructions.

Solutions have been provided for many types of paving defects

Defect treatment




Fig 1: Narrow corner crack




Fig 2: Wide corner crack




Fig 3: Multiple corner cracks

ACTIVITY

EXTERNAL PAVING

PROBLEM

E5: Cracks across corners of concrete slabs

CAUSE

- Impact damage
- Thermal movement between adjacent slabs
- Subsidence of sub-base

EFFECT

Cracks can allow penetration of contaminated water and other deleterious chemicals into the groundwater. Cracks can progressively get bigger and cause damage to tyres.

REMEDY & SOLUTIONS

For single corner crack (Fig 1), less than 2mm wide, use compressed air to blow out all embedded debris. Ensure cracks are dry. Seal the cracks with a penetrating sealer, pour in **Mulsibond Sealer** in accordance with the instructions on the product data sheet.

For single wider corner crack (Fig 2), remove all damaged concrete back to the sub-base. Compact the base and consolidate with **Mulsibond Sealer**. If possible, fix horizontal dowels into the parent slab using **Certite Anchor Grout**. Otherwise, prime the broken surface of the parent concrete with **Epoxy Plus Bonding Aid** and while tacky, mix and apply the deep-fill pavement repair concrete, **Pyratop**. Allow to cure. Fill adjacent joints with fresh mastic or sealant.

For extensive corner cracking, need to consider full-depth repairs. Remove all damaged concrete back to the sub-base. Cut back the sides to leave a uniform roughened concrete vertical face. Compact the base and consolidate with **Mulsibond Sealer**. Fix horizontal dowels into the parent slab using **Certite Anchor Grout**. Mix and apply the deep-fill pavement repair concrete, **Pyratop**. Cure with **Ritecure**. Apply a mastic or sealant to adjacent joints in accordance with manufacturers instructions.

Defect treatment



Fig 1: Broken edge and sunken base



Fig 2: Typical edge spall



Fig 3: Edge spall and border of repair

ACTIVITY

EXTERNAL PAVING

PROBLEM

E6: Edge cracking of concrete slabs

CAUSE

- Impact damage
- Differential movement of slabs
- Sinking of sub-base

EFFECT

Concrete will break up progressively under impact load, letting in water which in turn, erodes the sub-base. The area will sink further under load from vehicles.

The main danger is damage to tyres and fork-lift trucks could topple over.

REMEDY & SOLUTIONS

If the area has obviously sunk due to erosion of the sub-base, remove all damaged concrete. Cut all peripheral edges square. Do not cut an uneven jigsaw pattern but leave the removed area rectangular. Compact and fill the sub-base and consolidate with **Mulsibond Sealer** if necessary.

Lay in a compressible joint filler against adjacent slabs or put in temporary battens which should be removed later.

Mix and apply the rapid setting pavement repair concrete **Pyratop** to the required thickness in accordance with the instructions on the product data sheet. For depths greater than 75mm, bulk out with 10mm crushed granite aggregate.

In cold weather, use the ultra rapid setting pavement repair concrete **weber.com set 45** to a minimum thickness of 50mm in accordance with the instructions on the product data sheet.

Spray with **Ritecure** curing membrane immediately after finishing off.

Remove battens and apply a mastic or sealant to adjacent joints in accordance with manufacturers instructions.

Solutions have been provided for many types of paving defects

Defect treatment




Fig 1.: Map cracking

ACTIVITY

EXTERNAL PAVING

PROBLEM

E7 : Extensive cracking of concrete

CAUSE

- Impact damage
- Differential movement of slabs
- Sinking of sub-base

EFFECT

Cracks will open up progressively, letting in water which in turn, erodes the sub-base. The area will sink further under load from vehicles.

Groundwater may become affected by contaminated surface water.

REMEDY & WEBER SOLUTIONS

There is no point in treating the cracks singly. The affected area must be treated as a whole.

If the area has obviously sunk due to erosion of the sub-base, remove all damaged concrete. Cut all peripheral edges square. Do not cut an uneven jigsaw pattern but leave the removed area rectangular. Compact and fill the sub-base and consolidate with **Mulsbond Sealer** if necessary.

Mix and apply the rapid setting pavement repair concrete **Pyrapatch** to the required thickness in accordance with the instructions on the product data sheet. For depths greater than 75mm, bulk out with 10mm crushed granite aggregate.

Texture with a steel-tined texturing brush and when firm, spray with **Ritecure** curing membrane.

Apply a mastic or sealant to adjacent joints in accordance with manufacturers instructions.




Fig 2.: Extensive cracking




Fig 3.: Severe cracking

Defect treatment




Fig 1.: Mix of repair mortars

ACTIVITY

EXTERNAL PAVING

PROBLEM

E8 : Poor previous repairs

CAUSE

- Inadequate preparation
- Repair did not account for cause
- Poor repair material

EFFECT

Poorly prepared repairs will break up and are a waste of effort.

Poor choice of materials will not give durable or cost-effective remedial solutions. Materials must be fit for the purpose.

REMEDY & WEBER SOLUTIONS

The choice of repair material must be suitable for the problem it has to solve. As a general example...

Remove all damaged concrete back to a sound and firm base. Cut all peripheral edges square to leave a uniform roughened concrete vertical face. Do not cut an uneven jigsaw pattern but leave the removed area rectangular.

In normal temperatures (10 to 25°C) mix and apply the rapid setting pavement repair concrete **Pyrapatch** to a minimum thickness of 25mm in accordance with the instructions on the product data sheet.

When the temperature is below 10°C, use the ultra rapid setting pavement repair concrete **weber.com set45** to a minimum thickness of 25mm in accordance with the instructions on the product data sheet.

When firm, spray with **Ritecure** curing membrane.




Fig 2.: Poor patch repair




Fig 3.: Poor material performance

Defects in rigid airport pavements



Transverse crack caused by slab flexure, requiring grout injection, resin injection or dowelling



Diagonal cracks caused by settlement of the basecourse, requiring full slab replacement

Defects in rigid airport pavements



Extensive crazing (map cracking) caused by expansion of the concrete due to ASR or aggregate expansion. This will require full bay replacement



Extensive scaling and spalling caused by frost attack. Too large for small patch repairs, needing partial depth full slab replacement

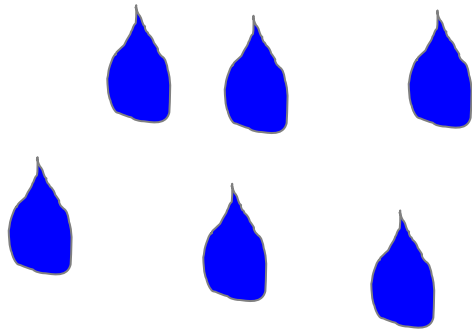
Mechanism of frost attack 1

Unsound concrete surface due to poor mix design, over-vibration compaction, poor curing, freezing during curing period, surface crazing, micro-cracking

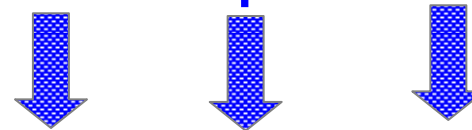


Frost attack 2

Water penetration



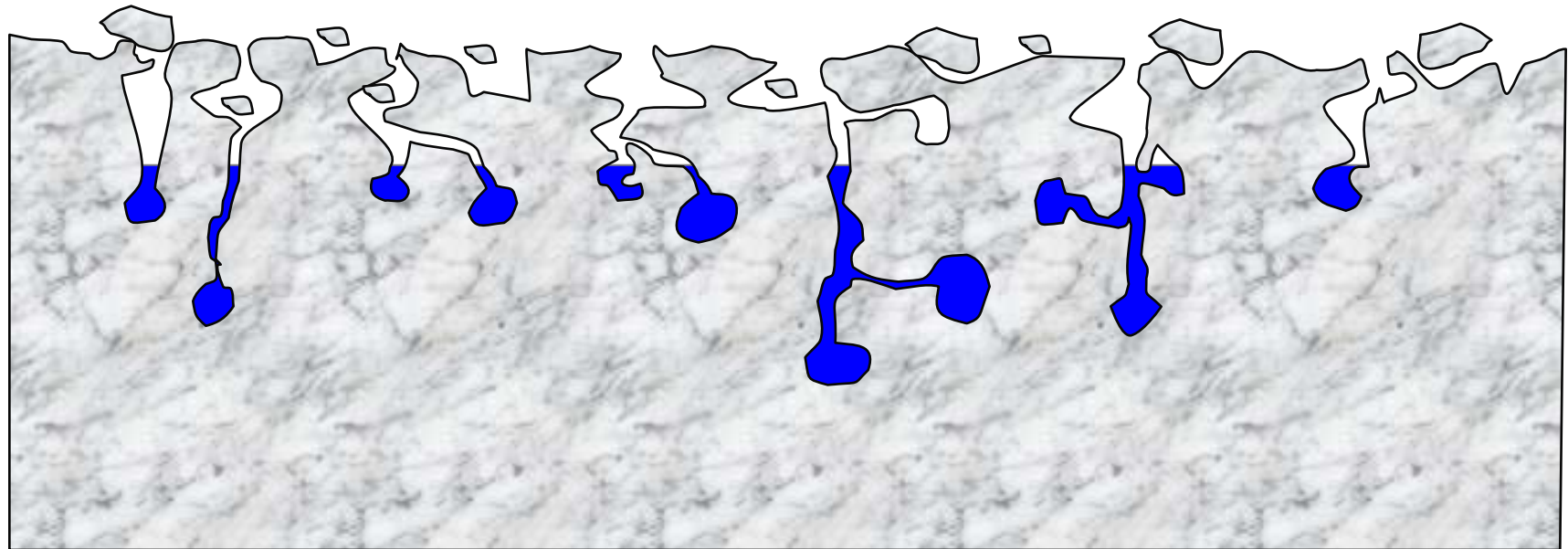
Ice expands and enlarges the capillaries



Frost attack 3

Freeze-thaw action

This leads to further degradation of the concrete surface as the ice melts, more water is let in and then on freezing, progresses the disruption.



Frost attack 4

Progressive the disruption of the concrete surface



Frost attack 5

Minimising the effects of freeze-thaw by surface impregnation



IN-SURFACE SEALERS

Pore liner functions

1. Reduces surface tension of pores
2. Reduces ingress of water
3. Reduces ingress of chloride ion
4. Increases the penetration of pore blockers



Function of Pore blockers

1. Reduced water penetration
2. Increased abrasion resistance
3. Dust proofer
4. Improved chemical resistance
5. Protects the surface of the concrete against freeze/thaw
6. Retains concrete colour
7. Good non-slip resistance



Defects in rigid airport pavements



Shrinkage cracks caused by poor curing requiring application of a protective penetrating sealer to stop further degradation



Scouring, loss of binder from surface as a result of abrasion could lead to frost attack. Requires a penetrating acrylic sealer to stop further damage

Common defects requiring patch repairs



Corner cracking



Edge cracking

Common defects requiring patch repairs



Previous repairs



Edge scouring

Common defects requiring patch repairs



Pop-out



Poor repair

Common defects requiring patch repairs



Minor scaling



Minor crazing

The keys to successful patch repairs

- 🔑 **Inspection and diagnosis of causes**
- 🔑 **Selection of materials and method**
- 🔑 **Cost effective specification**
- 🔑 **Surface preparation**
- 🔑 **Application and supervision**

Inspection and diagnosis



- It is imperative that a full visual and sampling survey is carried out to determine the cause and extent of any damage to the concrete pavement
- Electronic mapping and measuring equipment, NDT
- Core samples taken from sides and centreline areas
- Pull off strengths carried out



Selection of appropriate repair materials

Selection of the repair material depends on :

- ✓ **Ambient temperature**
- ✓ **Time required for early trafficking, return to service**
- ✓ **Size and depth of repair**
- ✓ **Product performance**
- ✓ **Compliance with specified properties**
- ✓ **Previous good experience**
- ✓ **Cost effectiveness and delivery**
- ✓ **Technical support from the manufacturer**

Selection of appropriate repair materials

The perfect repair product should have physical, chemical and mechanical properties, similar to the parent concrete.

Key properties are modulus of elasticity, thermal and moisture movement adhesive bond and ultimate strength

- ❖ The ideal repair should have a modulus just lower than the parent concrete
- ❖ The repair should have thermal expansion similar to the parent concrete
- ❖ The repair should have shrinkage lower than the parent concrete
- ❖ The repair should have strength just greater than the parent concrete

Compatibility of patch repair materials

Property	Resin mortar (epoxy, PE or PU)	Polymer-modified cement mortar	Cement mortar
Compressive strength MPa	50-100	30-60	20-50
Tensile strength MPa	10-15	3-5	1-3
Elastic modulus GPa	10-20	15-25	25-35
Coefficient of thermal expansion (degC)	25-30x 10 ⁻⁶	10-20x 10 ⁻⁶	10x 10 ⁻⁶
Volume stability Shrinkage (μ)	EP 250, PU 200 PE 1000	200-500	250
Adhesive bond	> concrete	>= concrete	=concrete
Service temperature (°C)	40-100	100-250	250-500

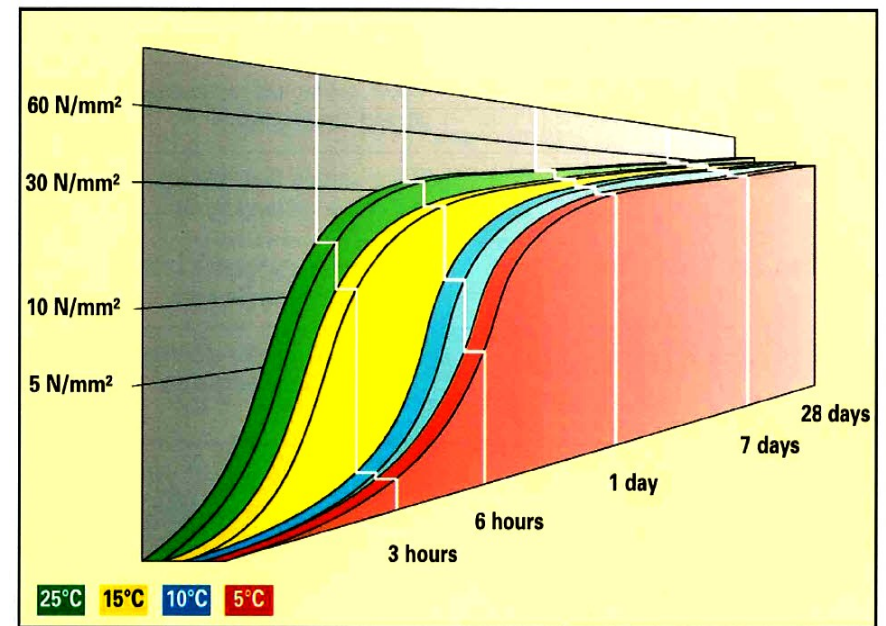
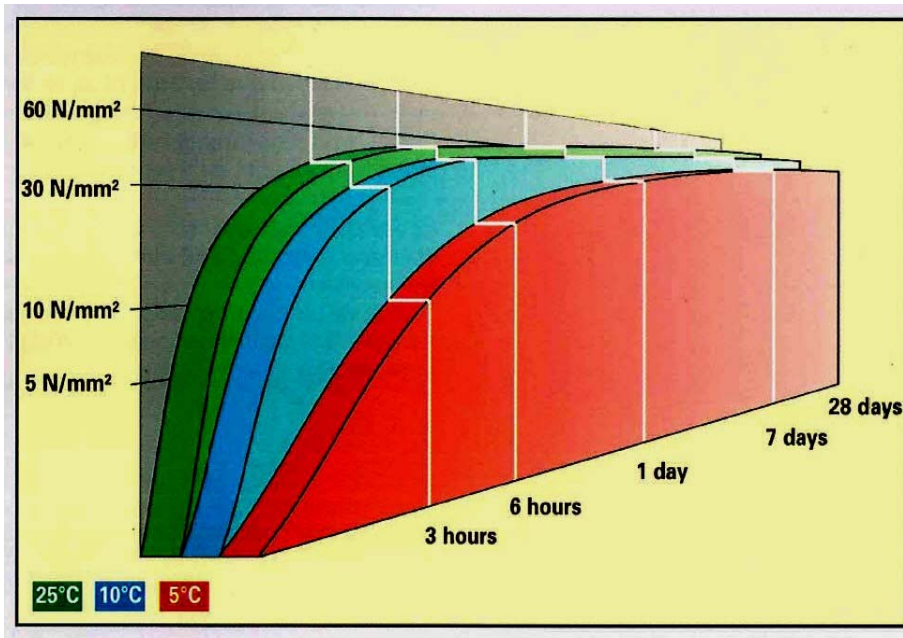
Compatibility of patch repair materials

There are certain advantages and limitations of the materials





	Resin mortar (epoxy, PE or PU)	Polymer-modified cement mortar	Cement mortar
Advantages	All have excellent bond to concrete PU is UV stable All can be fast setting PU flexible	Good bond Low shrinkage UV stable Waterproof Can be fast setting	Low shrinkage UV stable Relatively cheap
Limitations	PU poor in damp conditions EP & PE poor in UV light PE high shrinkage High thermal movement Expensive	More expensive than sand-cement mortars	Prone to cracking if misused Poor tensile strength and high stiffness Unable to resist movements

Compatibility of patch repair materials

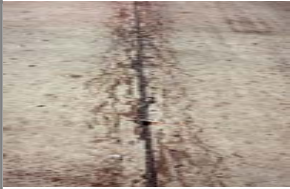




- Experience worldwide has led to greater use of premixed polymer-modified cementitious mortars for patch repairs.
- Some reactive-resin-based mortars have been shown to have inferior long-term compatibility with parent concrete.
- Polymer-modified cement mortars can be made to have all the required properties and have excellent durability.



Selection of patch repair method (1)

Problem	Picture	Area	Depth	Method
Transverse crack		N/A	Through slab	Grouting, injection, dowelling or Full depth repair
Longitudinal crack		N/A	Through slab	Full depth repair
Corner crack		$< 0.5\text{m}^2$ $> 0.5\text{m}^2$ $> 0.5\text{m}^2$	$< \frac{1}{3}$ depth $< \frac{1}{3}$ depth $> \frac{1}{3}$ depth	Partial depth Full depth Full depth
Edge crack		Any	$< \frac{1}{3}$ depth $> \frac{1}{3}$ depth	Partial depth Full depth

Selection of patch repair method (2)

Problem	Picture	Area	Depth	Method
D-crack		Any	< 1/3 depth > 1/3 depth	Full depth Full depth
Crazing		Any Any	1-5mm >5mm	Impregnation Partial depth
Scaling		Any	>5mm	Partial depth
Spalling		Any	< 1/3 depth > 1/3 depth	Partial depth Full depth
Popouts		< 10mm diam. >10mm diam.	<10mm > 10mm	Drill & fill Core & fill

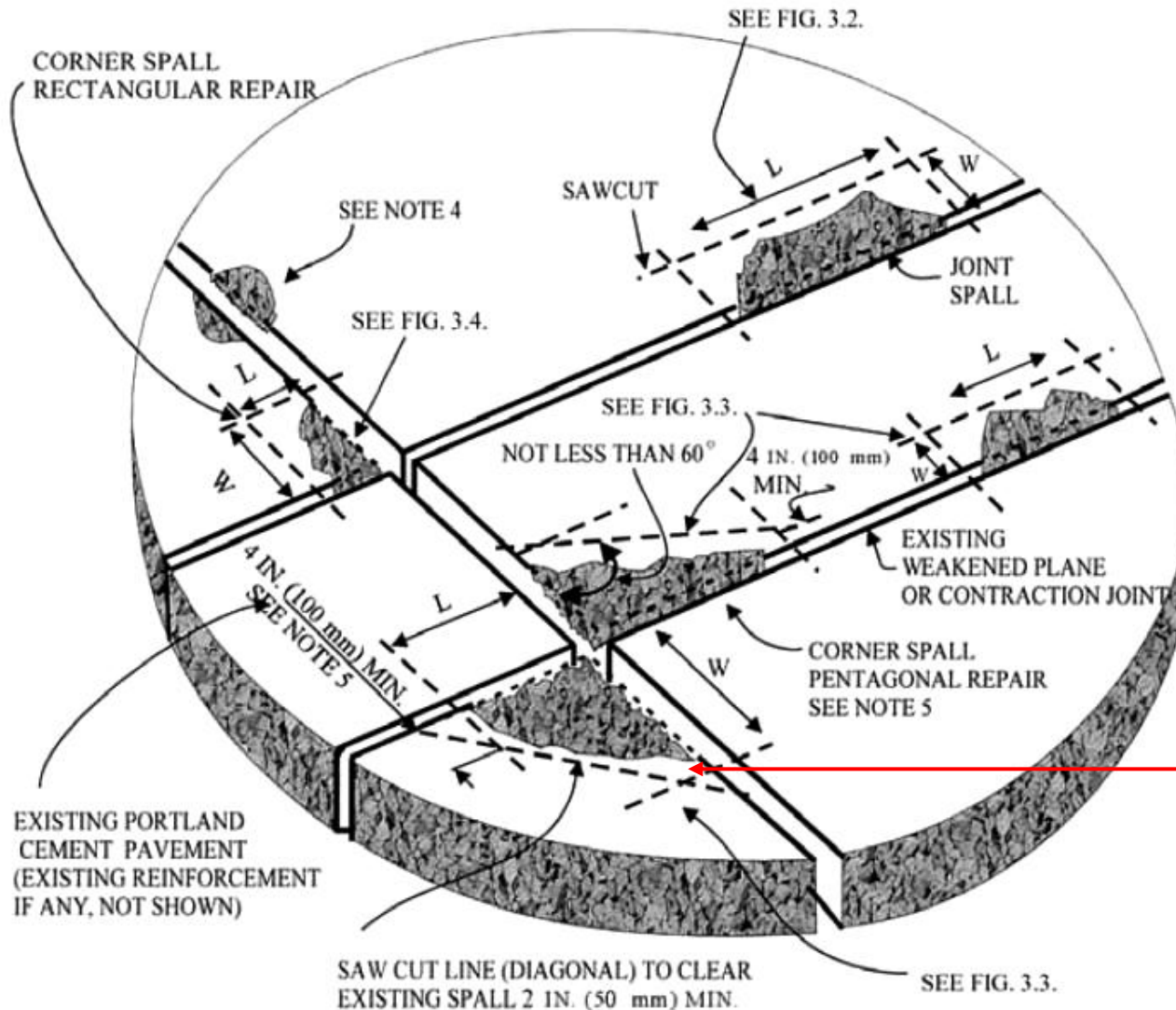
Selection of patch repair method

If the damage is confined to the top 3rd of the concrete slab, then **partial depth patch** repairs can be undertaken



If the damage goes deeper than the top 3rd of the concrete slab, or reaches dowel bars, then **full depth patch** repairs must be carried out

Design of repairs



An good depiction of small patch repair design is given in UFC report 3-270-03 to which reference should be made

However we question the efficacy of triangular repairs which may give rise to delamination at the feather edges

Partial depth repair of concrete pavements (1)

- Remove all deteriorated and/or delaminated concrete as shown by survey and indicated by paint lines in accordance with preferred method of removal
- Ensure size of repair is at least 50mm beyond damaged areas
- The perimeter of the repair should have a vertical face and should not be feather-edged.
- This can be done by saw cutting (preferable method) or milling.
- Joint preparation including an appropriate bond breaker is required at joint/crack edges

Partial depth repair of concrete pavements (2)

- Clean concrete surface by water jetting or high pressure air blast
- Mix the repair material using a forced action mixer
- Apply the repair material in accordance with manufacturers instructions
- Compaction of repair material
- Finishing the repair, providing skid free surface by steel tine brush
- Cure the repairs with a curing membrane with min 90% curing efficiency
- Partial depth repairs at joints must include sealing joints when finished

Full depth repair of concrete pavements (1)

- Remove all deteriorated and/or delaminated concrete as shown by survey and indicated by paint lines in accordance with preferred method of removal
- Ensure size of repair is at least 100mm beyond damaged areas
- The perimeter of the repair should have a vertical face and should not be feather-edged.
- This should be done by saw cutting
- Joint preparation including an appropriate bond breaker is required at joint/crack edges
- Check the sub-base for soundness and if necessary, compact with a vibrating plate

Full depth repair of concrete pavements (2)

- Provide dowels or other load transfer mechanisms at edges
- Mix the repair material using a forced action mixer or use ready mixed concrete
- If using a prebagged material, use good quality aggregates for bulking out in accordance with manufacturers instructions.
- Apply the repair material in accordance with manufacturers instructions
- Compaction of repair material
- Finishing the repair, providing skid free surface by steel tine brush
- Cure the repairs with a curing membrane with min 90% curing efficiency

Some recommended repair techniques



Over-sawing the edges of repairs can lead to corner cracking



Use a 4" core to cut neat rounded corners, then cut into these cores with a saw

Some recommended repair techniques



Coring is an excellent technique for preparing patch repairs



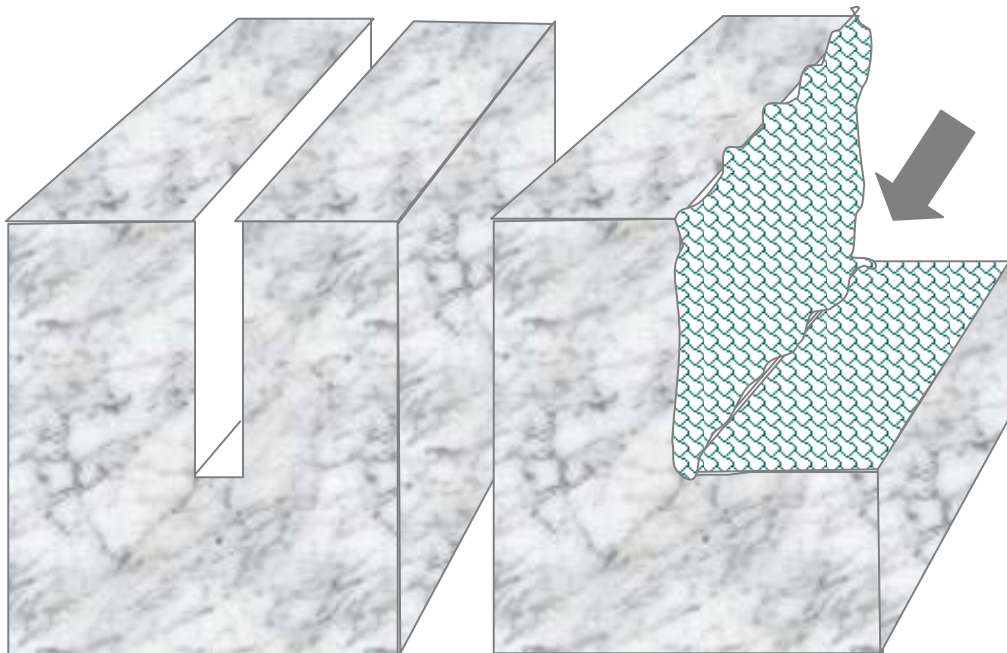
Cored corners of patch repairs



Popout cored and filled

Surface preparation techniques

In most cases, the use of a concrete saw is recommended for cutting vertical borders around the periphery of the delineated repair area. In such a case the sides of the saw cut must be roughened by grit blasting after excavating the centre of the repair



Alternatively, cut into the sides at an angle of 75° to form a mortice joint to hold the patch



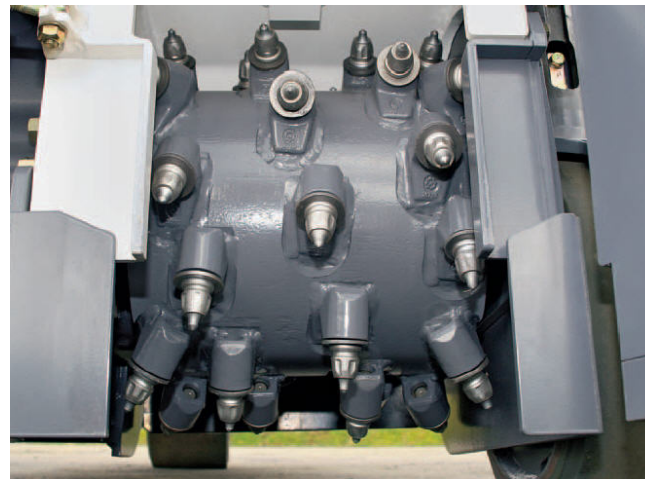
Surface preparation techniques

- For partial depth repairs, the use of jack-hammers is not recommended. The impact causes micro-cracking in the concrete and shattering of aggregate. This results in poor bond and may lead to delamination of the repair.
- Jack-hammering may be used for full-depth repairs provided that the repair area is isolated by saw cutting.
- Ultra high pressure water blasting is the preferred method for partial depth repairs. There is no vibration to damage the freshly exposed concrete surface and key is better.
- Cold-milling is a good method for removing large areas of concrete but if the concrete is weak, the aggregates may be pulled out of the bonding interface and weaken adhesion.

Surface preparation techniques



High pressure water blasting



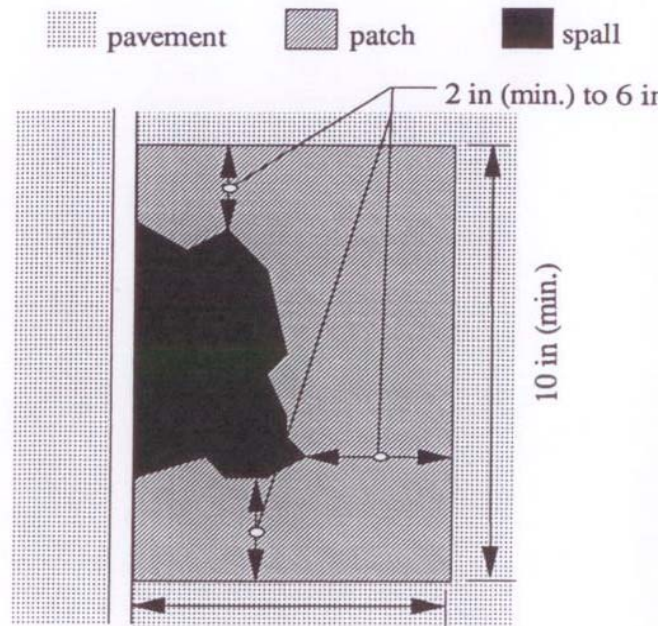
Milling machine and drum

Important factors for successful patch repairs

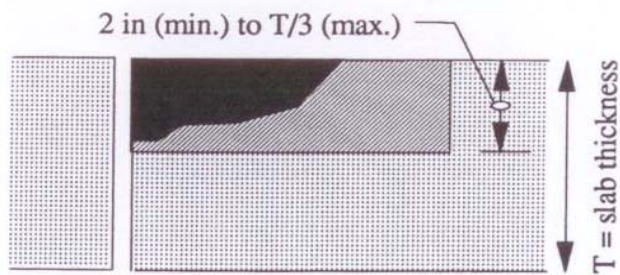
- Understanding the cause of damage
- Establishing extend of damage therefore size of repair
- Surface Preparation : *UHPWB*
Electropneumatic Breakers
Milling
- Correct material selection
- Correct Application: Mixing, Placing, Curing

Rogues gallery and works of art

- The following slides show what can happen if correct procedures are not followed
- Examples of good practice are also discussed



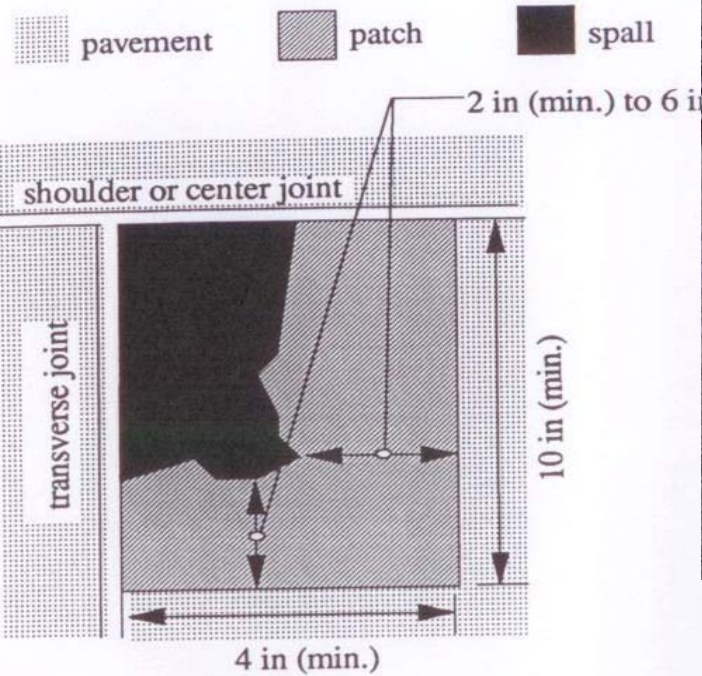
Plan View



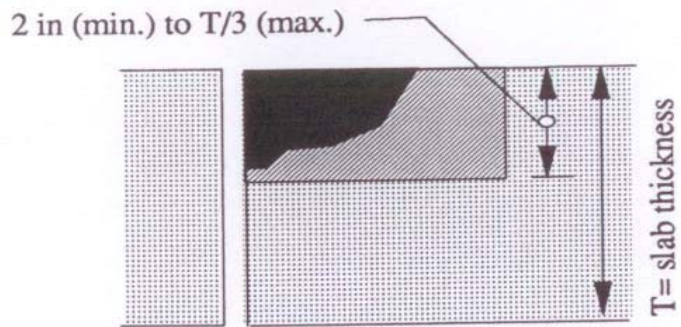
Profile View

Figure 3. Dimensions of patch at one joint.
1 in = 25.4 mm



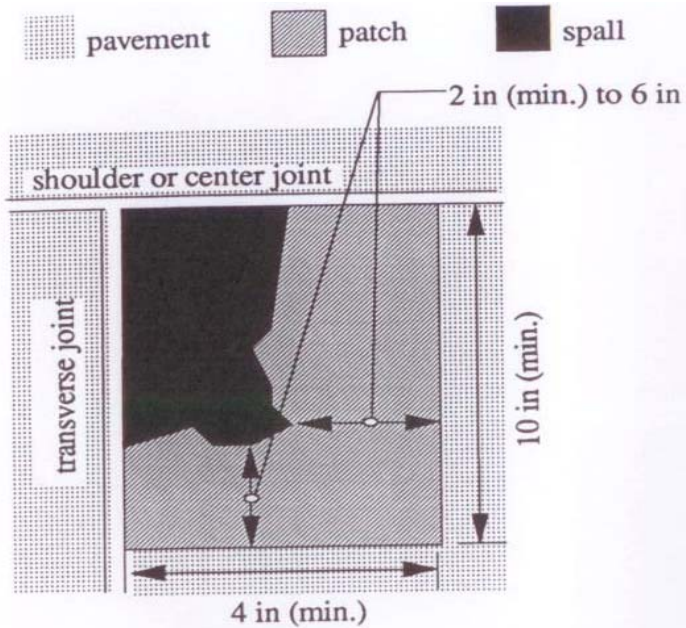


Plan View

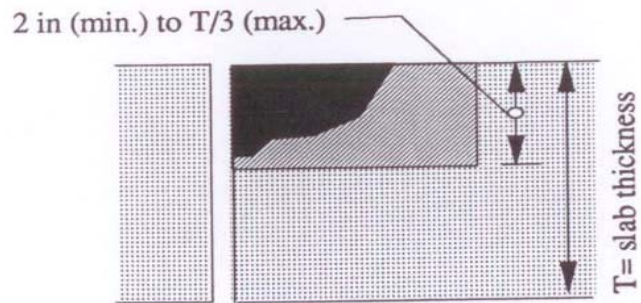


Profile View





Plan View



Profile View

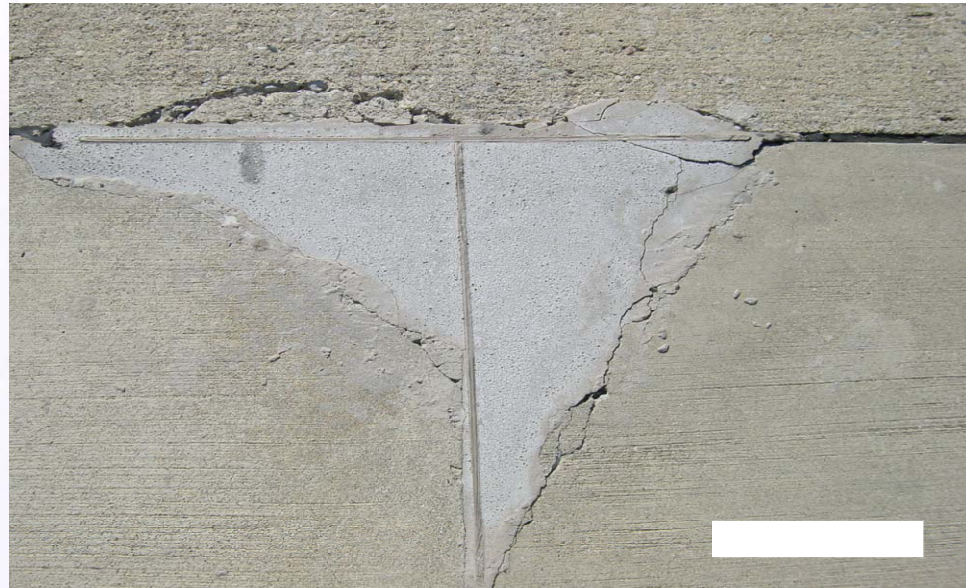
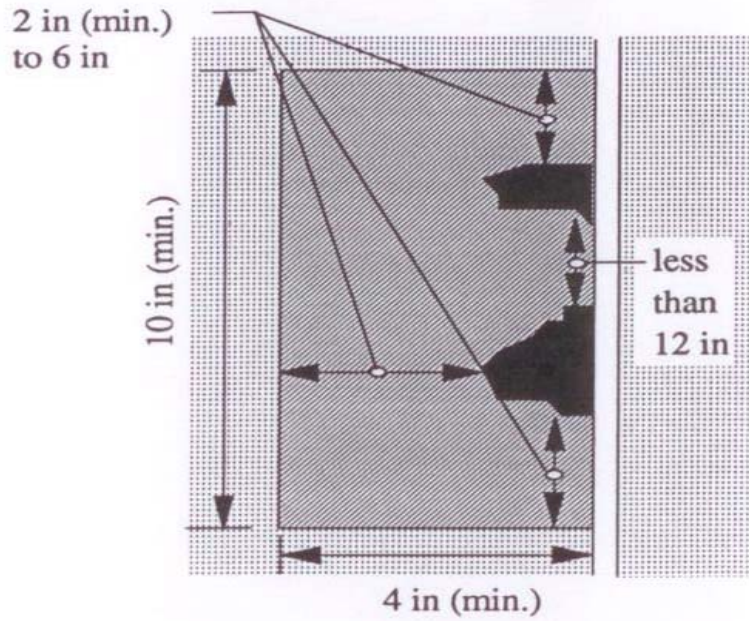
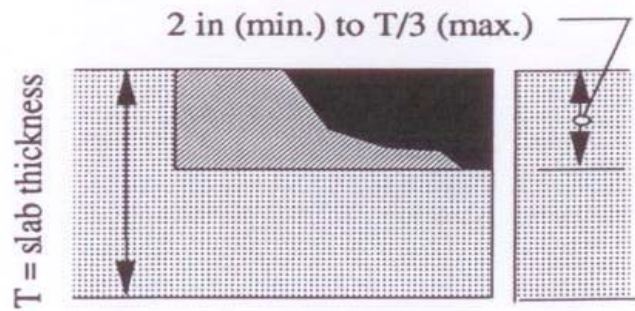


Figure 5. Dimensions of patch at two joints.
1 in = 25.4 mm

pavement
 patch
 spall



Plan View

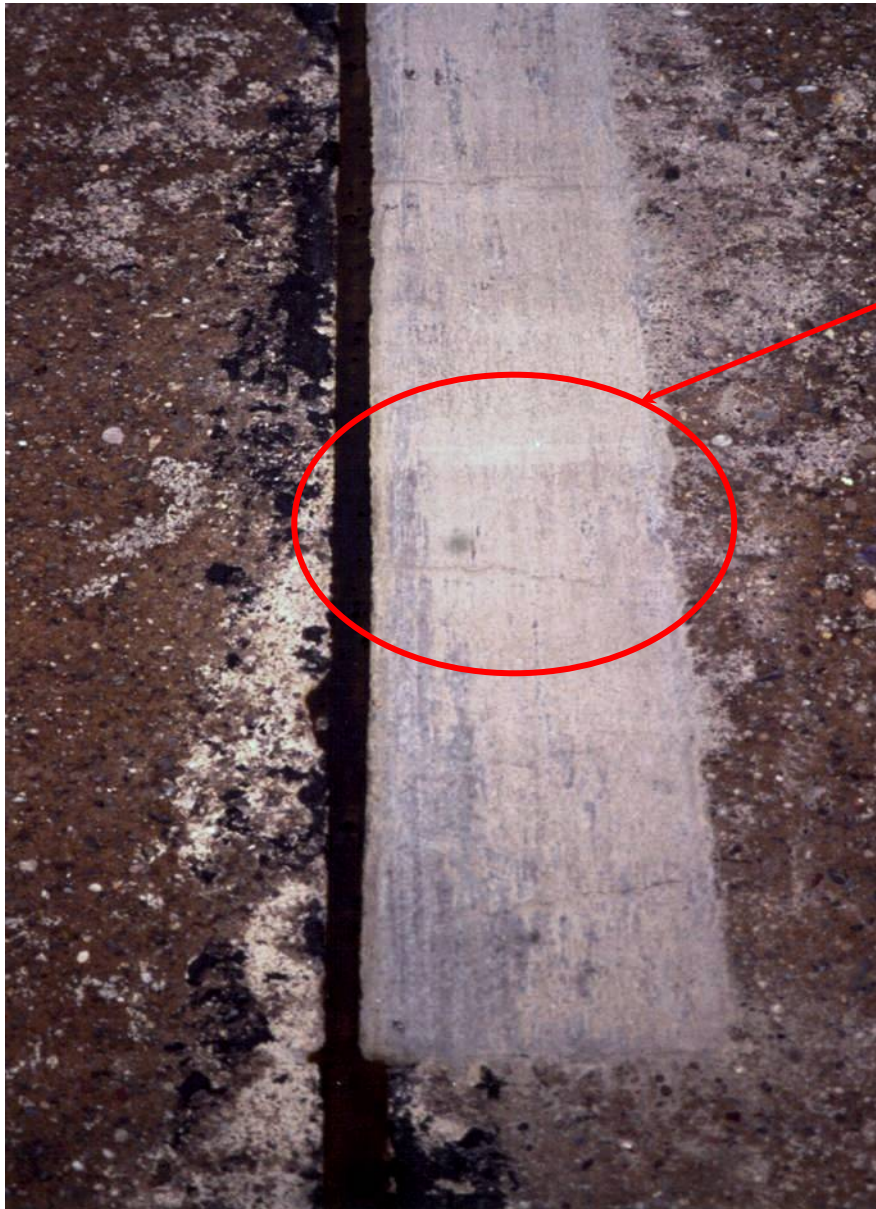


Profile View









Shrinkage Cracks





Proper Mix
Consistency

Patched repair



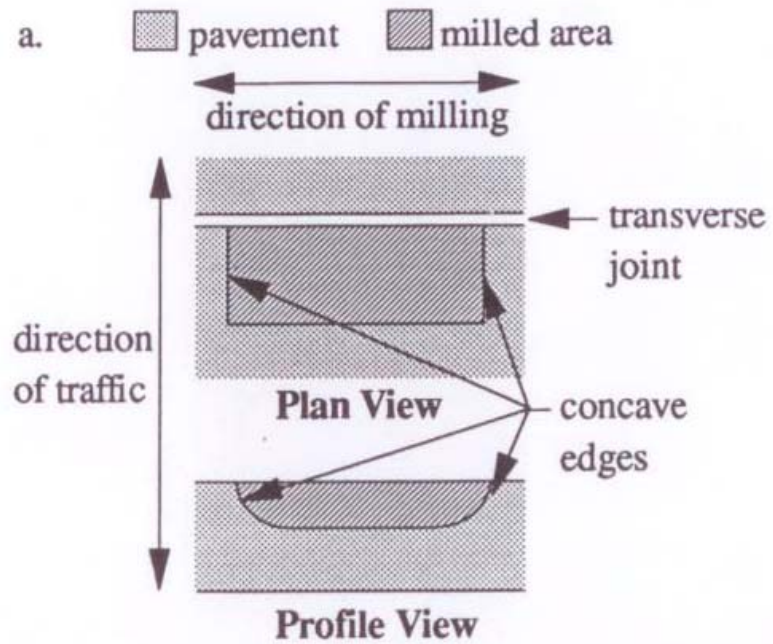


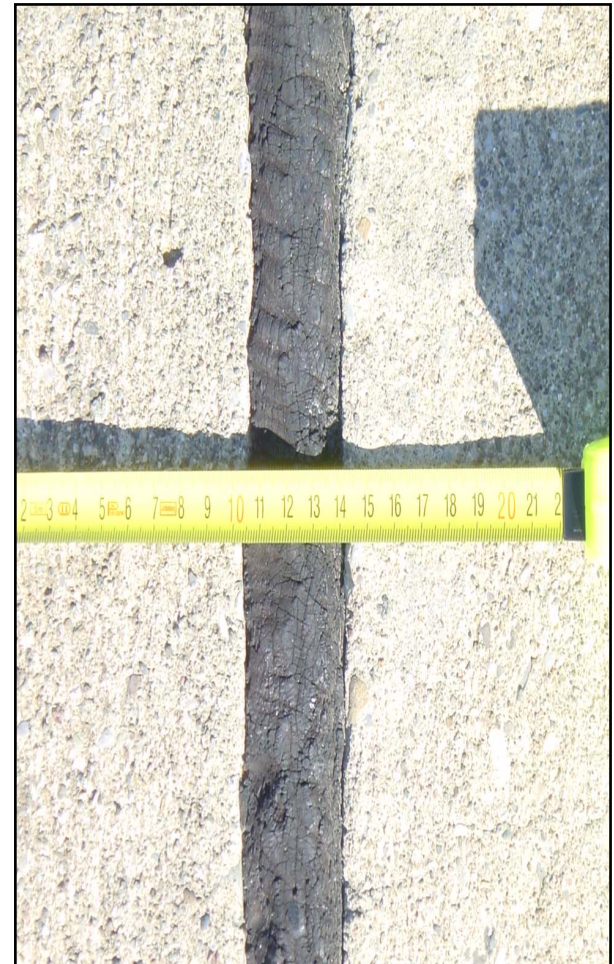
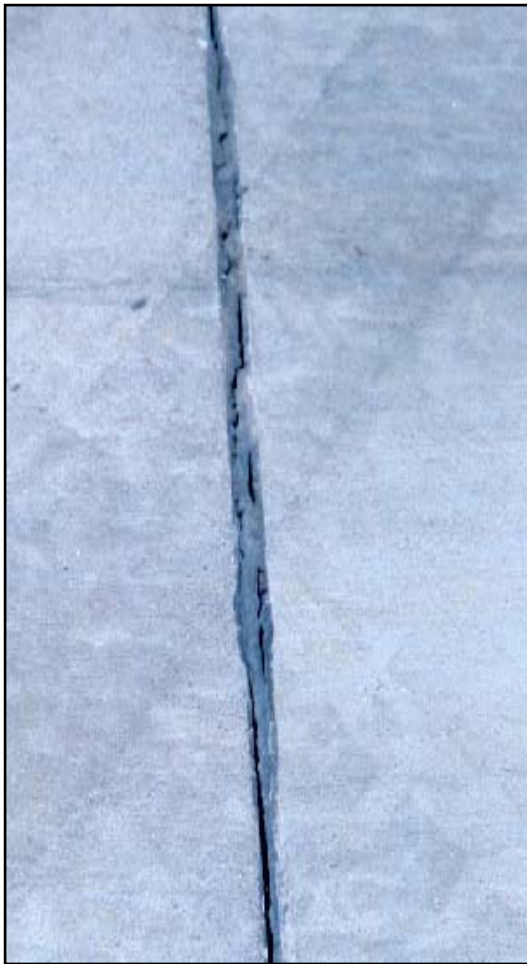
Figure 2. Recommended orientation of milled patch





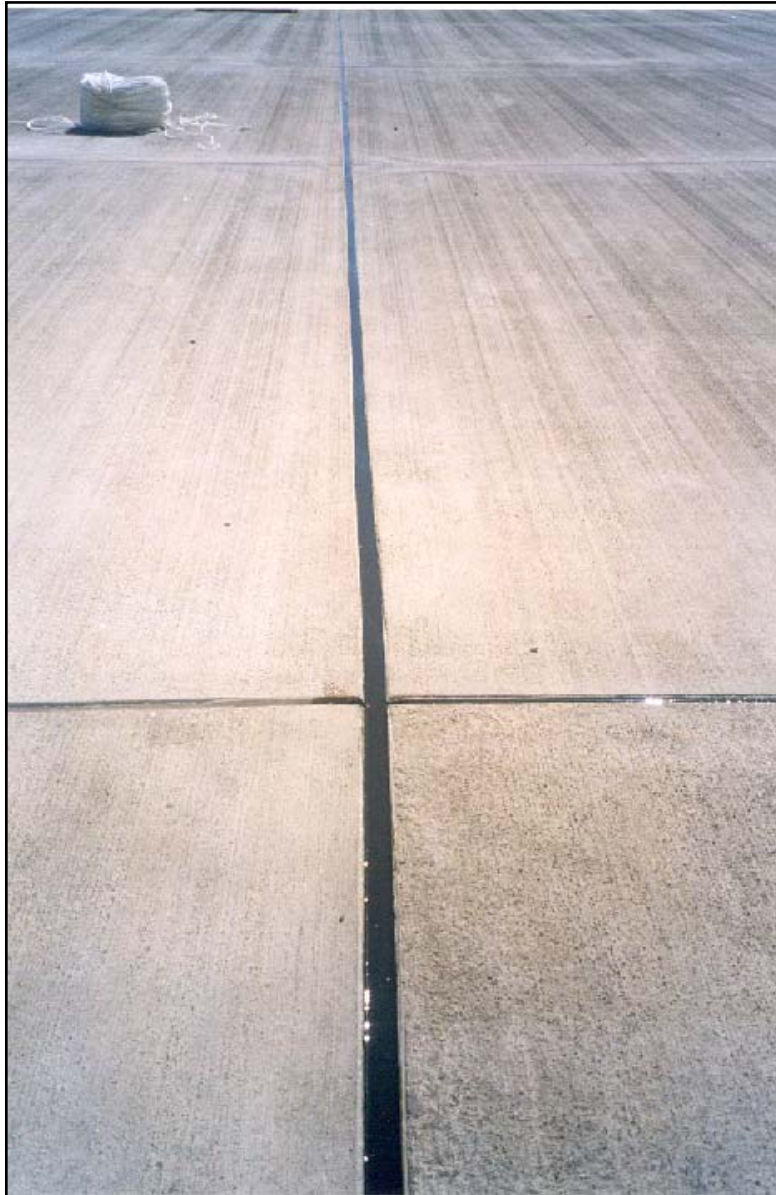












**Thank you for the opportunity to present
our experiences to you**

Any Questions?