

# **Evaluation & Minimization of Bruising (*Microcracking*) in Concrete Repair (364. 7T)**

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# Introduction

- Bruising (microcracking) induced in a concrete substrate during the concrete removal or surface preparation process prior to repair is detrimental to the bond between the repair material and the substrate. Preventing or minimizing bruising and its effect on bond is an important requirement for a successful repair.



# What is “bruising”

Concrete repair projects commonly involve the removal of unsound concrete and replacement with new material. The concrete removal process can damage the substrate surface, resulting in varying degrees of microcracks and fractures, commonly referred to as “bruising”. A bruised surface is a surface layer weakened by interconnected microcracks.

Figures 1 and 2 show optical microscope images of concrete core cross sections exhibiting bruising below the surface.



Fig 1a, Slab Prepared with 30-lb Breaker (6)

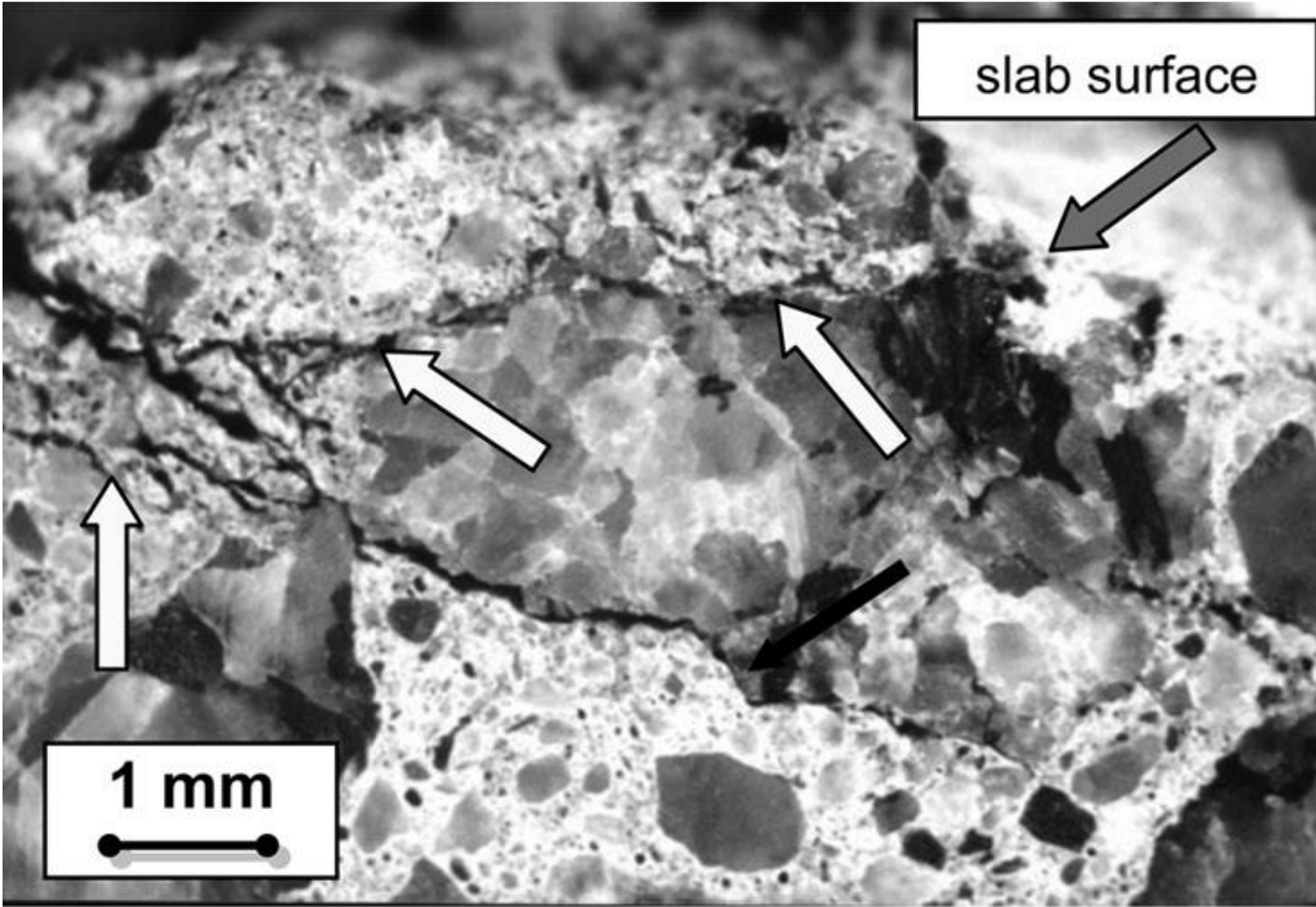


Fig 1b, Slab Prepared with 45-lb Breaker (6)

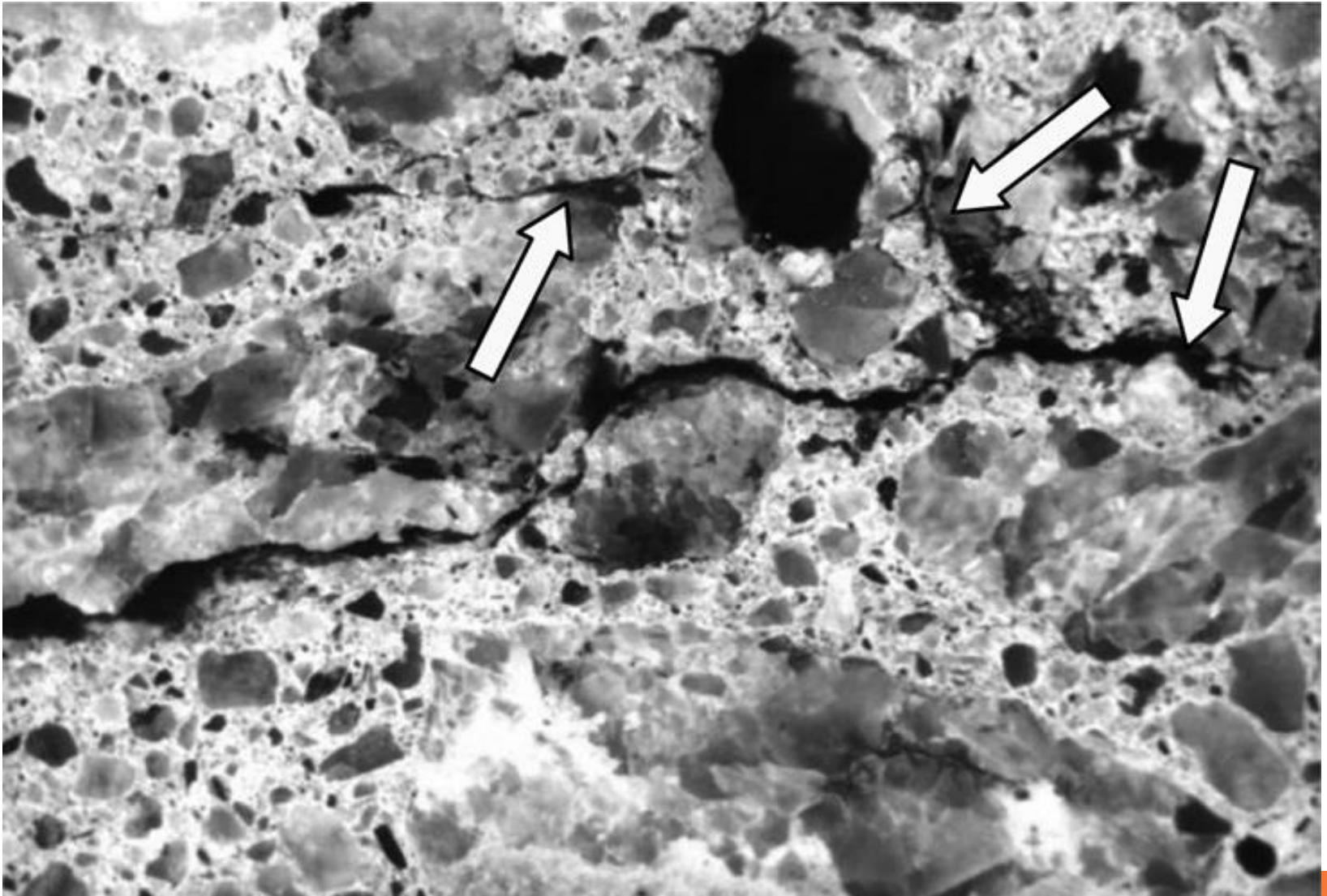
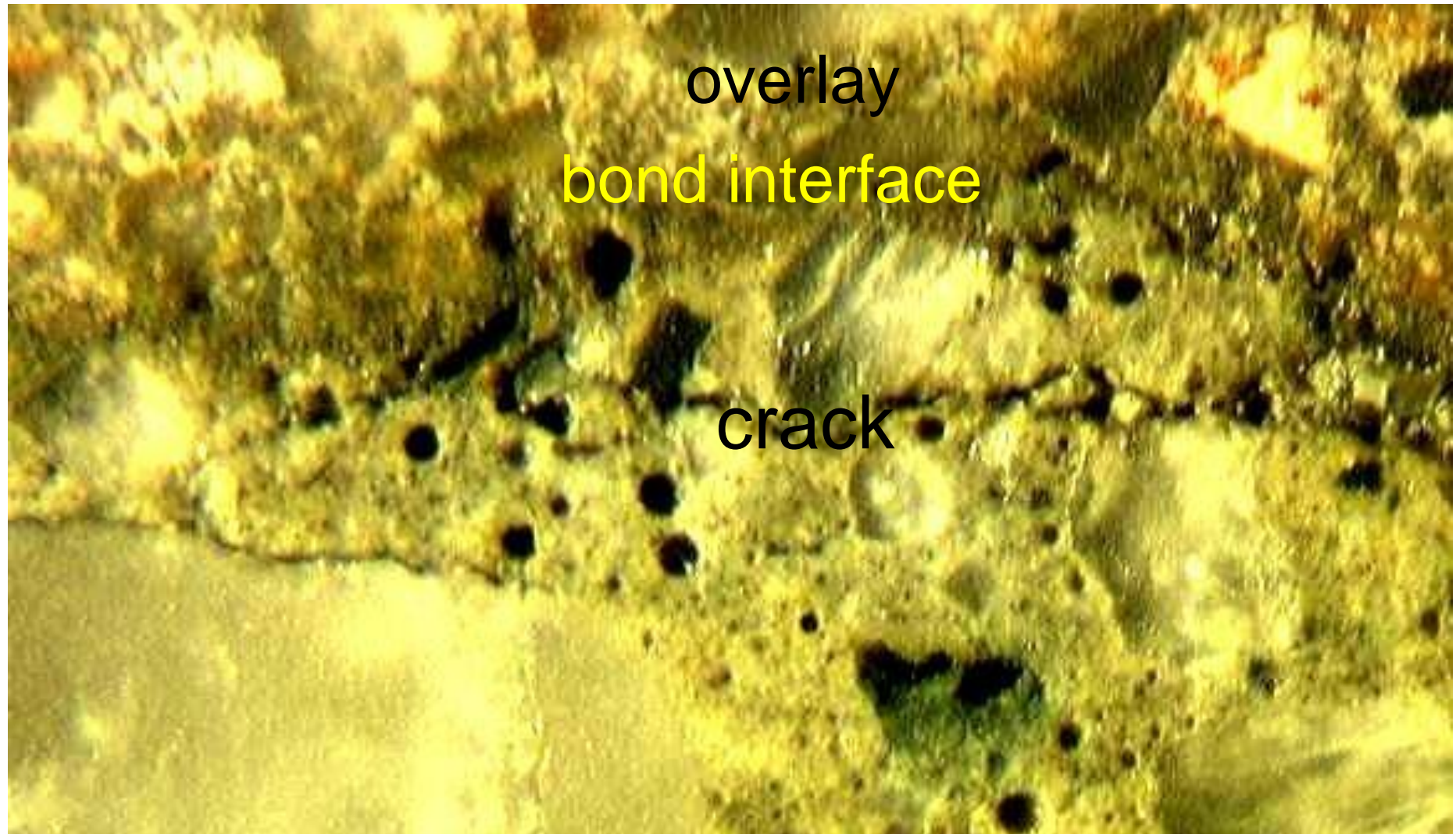


Fig 2, Slab Prepared with milling machine



# How can it be minimized

Concrete can be removed using a variety of methods such as chipping hammers, milling, abrasive blasting, and hydrodemolition (Fig. 3 - 8). Removal of unsound and sound concrete subjects the concrete substrate to a wide range of impact and dynamic loads, and the resulting bruising will depend on the method used and the quality of the concrete. The depth of the bruised layer varies, but is usually superficial (typical depth of the order of 1/8 in. [3 mm]). There are no criteria yet for the degree of bruising that reduces service life.



Fig 3, Chipping hammers





# Fig 4, Milling Machine



Fig 5, Micro milling heads do less damage



Fig 6, Abrasive blasting



Fig 7, Abrasive shot-blasting



# Fig 8, Hydrodemolition



# How is it evaluated

Pull-off testing of the repair system (surface repair and substrate) can be conducted to determine the bond strength. (1-4) Bruising translates into a weakened concrete surface layer and will result in lower recorded pull-off strengths, (5,6) with failures occurring predominantly in the substrate. The incidence, severity, and depth of bruising can be identified by microscopic examination (such as petrographic examination using ASTM C8567 methods) (7) of the concrete.



## How is it evaluated, cont.

Microscopic examination can further be used to assess remedial actions taken to eliminate bruising of the concrete. To identify bruising, a polished surface needs to be magnified 20 to 100 times, depending on the width of the cracks (Fig. 1 and 2 shown earlier).



# How can it be minimized

Bruising can be minimized by selecting the appropriate concrete removal equipment and techniques for the given repair application (8) and avoiding whenever possible those that are known to induce significant microcracking. The latter techniques include scabblers, scarifiers, bush hammers, or pneumatic hammers, especially those equipped with wide chisel tools. Bruising problems can be prevented by using methods such as abrasive shotblasting, water-blasting, or hydrodemolition.





# Mitigating Damage

Where the use of more damaging methods is required to increase production rate or reduce costs, the damage can be mitigated somewhat by abrasive shot- or water-blasting as a final preparation step. If bruising is detected, the depth and extent of the damage to the substrate should be assessed and mitigated. In some cases, the damage may go beyond surface bruising and can extend into the concrete.



## Mitigating Damage, cont.

Replacing the commonly used sand in abrasive blasting with alternative materials such as sintered slag, flint silicon carbide, or aluminum oxide can reduce damage. The use of lightweight pneumatic-chipping hammers equipped with sharp, pointed tools can also limit the extent of bruising, but may make concrete removal more time consuming.



# References

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3. ASTM C1583-04, 5 pp.
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5. Sprinkel, M. M., *Concrete Repair Digest*, V. 8, No. 5, 1997, pp. 242-247.
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# Questions

