

## DBR Webinar – Questions and Answers (1/12/21)

The questions submitted during the webinar follow with answers that our speakers have provided.

1. Any specific material for the caulking process?

JR – No the materials used in the caulking process vary from state to state and specification to specification. Some states require silicon caulk while others will allow the use of spackling compound. The key is to ensure that the gap is filled without placing the material so wide beyond the joint reservoir that it reduces bonding surface for the concrete backfill.

2. Are all dowels placed at mid-depth of the slab? What is the typical spacing of dowels?

JR – The typical configuration of the dowels by most Agencies places the bar at mid depth of the slab, spaced at 12 inches on center. The outer bars are spaced at least 12 inches from pavement edge and perhaps more from the centerline joint to ensure no contact with tie steel. That said research has shown that placing the bar somewhat higher than mid depth does not negatively impact the load transfer efficiency of the DBR. See the following report.



Performance Testing  
of Experimental DBR I

3. Can DBR be completed 'over' the existing dowel bars?

JR – No. If you have faulting on a slab that already has mechanical load transfer (dowel bars), you need to do a thorough investigation to see why and how much dowel bar socketing is taking place. It is likely caused by a poor base, undersized dowels, corroded dowels or weak concrete. Some states have in the past placed DBRs in between existing bars with some success but in cases like this it is likely that a full depth repair in these locations is a better investment of one's money.

4. Can we place the expansion cap on only one side? Why do we need the cap on both sides?

JR – Yes you can but having the cap on both sides provides insurance with little cost. Additionally, the cap and chair assembly typically come as a set from the manufacturer and it only takes a second to install and therefore it has become a common practice.

5. Can you achieve success with diamond grinding only the dowel bar retrofit areas not the entire length of the slab?

JR – Theoretically yes but the dollar cost benefit typically does not favor this approach. Feathering in and out of an area takes time and expertise, whereas a continuous grind allows the operator to set into the cut and obtain maximum speed down the roadway only requiring minimal adjustment now and again making the sq yd cost much cheaper. Additionally, the driving public will better appreciate the ride,

aesthetic and tonal aspects of a continuous grind far more than a “patch-work quilt” approach.

JE - Our spec allows a max of 5/8” of grinding. The grinders on our projects do have some areas that are missed since the high spots would need to be ground more than 5/8”. We’ve had some areas where the panels were curled and only the middle was ground.

6. Can you provide a definition for fins?

JR – Fins are the unwanted slivers of concrete that fail to break off at the desired level following the grinding process, typically due to a blade spacing that is too wide.

7. Difference in modulus between the patch material will cause stresses at the border area of the two materials. How much of a concern is matching up the modulus of the two materials?

JR – It is important to pay attention to the modulus of the two materials to ensure a good bond and minimal cracking within the DBR section. Using aggregates from similar sources and proprietary backfill materials that minimize shrinkage are always recommended.

8. Do the costs of \$600k/4-lane mile for DBR include diamond grinding costs?

JE - Yes the cost we (Oklahoma Turnpike Authority) included the cost of DBR, Grinding, Striping, Mobilization, panel stitching for cracked panels, and some panel replacement.

9. For Joe, Do you turn the pavement back to traffic after the DBR, but before the Diamond Grinding? If so, what strength (psi) does the patching material reach before turning the traffic onto pavement?

JE - Yes, we do allow traffic to drive on the DBR prior to grinding. Since the lane closures are long some of the DBR will have been placed for weeks. We use 3,000 psi as our allowed strength to open to traffic.

10. For OTA DBR projects what is rough breakdown between joint repair versus crack repair?

JE - A rough estimate is that only 2% of the dowels used were for cracks.

11. Have there been any smoothness grinds done without DBR to see if the panels stay in place after all those years have passed; to see if they are even needed? We are seeing DBR filler material that is spalling out and leaving voids for moisture to do it's damage as the seasons change.

JR – DBR is almost always accompanied by diamond grinding. This is done to remove any faulting, thereby reducing the dynamic loading and increasing the life of the repair. Additionally, The Washington State DOT found through extensive research that DBR projects that didn’t include diamond grinding did not perform nearly as well as those that did include grinding.

If you have spalling of the DBR materials, that is likely a material or installation issue, assuming that the candidate slabs were in reasonably good condition to begin

with. There is a point where DBR is NOT a good investment if the candidate slab is too far gone. There are ways to patch spalled DBRs. Please contact IGGA @ [jroberts@igga.net](mailto:jroberts@igga.net) for further assistance.

JE - Yes. In the late 90's the Oklahoma Turnpike Authority did some grinding of faulted panels at the worst locations on our network. The ride was significantly improved immediately but within months the faulting was back and after 5 years the ride was not significantly improved from its condition prior to grinding. We've had some areas where DBR was done 10-15 years ago and a small number of failed mortar 'pop outs' have occurred. Our maintenance personnel do spot repairs on those isolated areas every couple of years. We also seal all joints and cracks with maintenance personnel.

12. Are there any extra considerations for doing these treatments in cold weather?

JR – Cold weather applications of DBR are typically driven by the ability to cut the slots without the cooling water freezing and the backfill material manufacturers recommendations. Diamond grinding requires temps above freezing and rising. Most specifications have cold weather cut-offs cited within.

13. How deep are the slots into the pavement?

JR – The slots are typically cut to a depth that allows the bar to be placed at mid slab with room beneath the bar for backfill material consolidation.

14. How deep is the grind or removal in the left picture on the Cimarron project?

JE - Our spec is not more than 5/8" of grind. We do not require that the entire panel be ground.

15. How do you determine the appropriate pattern for each crack/joint? We saw a "three bar pattern" in the wheel paths but are there other viable layouts?

JR – Yes there are. Some states with very heavy truck traffic choose to use a 4 bar pattern per wheel path but this is only in extreme conditions. Meandering transverse cracks can also be addressed with DBR as long as you center the bar on the crack, but this requires a longer slot at times to accommodate the length of bar thereby increasing the material and labor costs.

16. I have seen a note in the past that doesn't allow pavement grinding between June 10 and Sept 5 due to warm temperatures, and that grinding shall only be performed between the hours of midnight-10AM. Is this a national best practice? For example, on an urban arterial street.

JR – No, not at all. The peak season for grinding is May through November and there are no warm-temperature limitations associated with grinding. Night grinding is very common due to traffic concerns but by no means necessary.

17. If we have doweled concrete pavement, is there a certain distance you have to be from the joint if we want to use DBR for mid-slab cracking to avoid slab replacements?

JR – There are no hard and fast requirements pertaining to this but it is good practice to be several feet away from the (doweled) joint to prevent third stage cracking in the area.

18. If your blade spacing is inappropriate for the aggregate type and you get a section with large fins, what is the remedy? Do you change the blade spacing and redo, or can you use a motor grader to skim the surface and pop them off?

JR - If the number of fins is significant the contractor should stop and restack the head with thinner spacers. Randomly occurring fins here and there often break off under the first day or two being subjected to traffic. A grader can remove fins as well with little damage to the pavement as long as it meets your final smoothness specification.

19. Can diamond grinding effect the freeze thaw resistance of the concrete? Water/ice/snow seeps into the indentation from the diamond grinding. Does this not effect the friction of the surface?

JR - Typically not. The grooves created by grinding are no deeper than the grooves imparted to the concrete from transverse or longitudinal tinning. The MNDOT has reported that they have improved safety performance on their diamond saw cut surfaces as they retain deicing chemicals. See MNDOT video by pasting the following link in your web browser..

<https://youtu.be/urGtJIuKNaQ>

20. Is DBR more suitable for concrete pavement without dowels at the original construction joints? How would you retrofit the DBR between the originally installed dowels?

JR – DBR is best applied to undoweled pavement slabs in good shape exhibiting faulting. If you have faulting on a slab(s) that already has mechanical load transfer (dowel bars), you need to do a thorough investigation to see why and how much dowel bar socketing is taking place. It is likely caused by a poor base, undersized dowels, corroded dowels or weak concrete. Some states have in the past placed DBRs in between existing bars with some success but in cases like this it is likely that a full depth repair in these locations is a better investment of one's money.

21. Is the joint reformer left in place or removed after joint is filled?

JR – The joint reformer is essentially removed by the joint sawing operation that takes place after the retrofit is installed. The sawing operation recreates/cleans the sealant reservoir in anticipation of the joint resealing operation (which is done after the diamond grinding operation).

22. Is there a point where too many dowel bar retrofits in a small area, which replace the original dowels, can negatively affect the life of the pavement?

JR – Absolutely. Assuming that you have a significant amount of cracking, it may be more appropriate to utilize full depth repair. Numerous cracks in confined areas may indicate that you have a base or drainage issue that need be addressed prior to repair. Full depth repair would expose these areas and allow for the proper remedy to be applied.

23. Please comment on the diamond grooving operation. When would you recommend diamond grooving in addition to diamond grinding (i.e. NGCS)?

JR – It is important to recognize that applying grooving on top of a diamond ground surface is different than the Next Generation Concrete Surface (NGCS). NGCS is a hybrid diamond saw-cut surface that does in fact utilize both grinding and grooving but is quite different than a grooved, diamond ground surface. NGCS is designed to have a very low noise signature with high friction characteristics. It is used in areas where tire/pavement noise is of high concern.

Grooving applied on top of a diamond ground surface is done when you have a soft aggregate that is prone to polishing. The grooving is applied to extend the life of the saw-cut surface and reduce the potential for wet weather accidents well into the future.

24. JR mentioned that sealing of the joints should be done after diamond grinding and grooving. My understanding was that if the joints are properly sealed, grooving shouldn't pull the sealant out, and so sealing can be done before grinding and grooving, which prevents effluent from getting into the joint. What are your thoughts on this?

JR – When constructing a DBR project, it is relatively safe to expect that there is a measure of joint faulting (stepping) or at least movement at the joints. This typically would tear the joint sealant away from the joint reservoir walls leaving an unsealed condition. DBRs perform far better when moisture is sealed out and away from the repair, hence the recommendation that sealing follow the grinding operation (that is used to remove the faulting). In short it is rare that properly sealed joints would be found in a typical DBR candidate. Sealing before or after grinding/grooving is another lengthy discussion that must consider a number of important factors on its own aside from the DBR process. Whenever possible sealing is best conducted after grinding and grooving.

25. Should (or do) agencies account for an increased thickness in PCCP at initial construction to account for the thickness reduction during diamond grinding?

JR – Yes. Agencies that consider the whole life cycle of the pavement cradle to grave will add sacrificial thickness to their pavements and bridge decks to account for subsequent diamond grinding in the future. Other agencies simply rely on the ongoing strength development of the concrete throughout its life span to account for the removal of concrete thickness due to the grinding process. See RT Update attached.



RT Update DG Affect  
on Structural Capacity

26. Slide 48 - do the fins that break off under traffic cause windshield damage?

JR – No. The fins are typically wafer thin and contain no mass, so it is very unlikely to happen.

27. The essential part of DBR is concrete material in slots. Variation of this concrete materials, cement content, and aggregate thermal coefficient with the concrete pavement will increase the risk of cracking in the slot or in the boundary of the slot

that will decrease the bonding and dowel efficiency. Please explain more about the mix design of concrete used in slots.

JR - It is important to pay attention to the modulus of the two (new and existing) concrete materials to ensure a good bond and minimal cracking within the DBR section. Experience has shown that using aggregates from similar sources (controlling factor) and backfill materials that minimize shrinkage are always recommended.

28. Using a 4 ft grinder tends to leave a lip between adjacent passes, which can be a safety hazard for motorcyclists. Can you speak briefly about this, and how to avoid this problem?

JR – Most grinding specifications require a straight edge measurement transversely to prevent this condition. This is entirely preventable. Informed inspection and enforcement should be applied to prevent this from happening.

29. What is the difference between diamond grinding and longitudinal tining?

JR – Diamond grinding is a process that uses a grinding head consisting of closely spaced diamond tipped saw blades to remove a thin layer of hardened pavement surface to improve ride quality, reduce noise and improve safety (by providing an escape for water trapped beneath the tire and the pavement).

Longitudinal tinning is a process whereby a wire comb is drawn across a green (freshly placed/uncured pavement) concrete pavement surface to impart drainage channels to improve safety (by providing an escape for water trapped beneath the tire and the pavement). Tinning will not improve smoothness or reduce tire pavement noise however. It should be noted that tinning is cheaper than diamond grinding.

30. What is the expected service life following the DBR and diamond grinding before the next major rehabilitation/reconstruction?

JR – That depends on a number of factors including age and condition of the pavement prior to DBR, climate, traffic (trucks), base type, quality of construction and inspection etc. MANY DBR projects across the country have achieved 20 yrs (and counting) life with little maintenance. According to the Washington State DOT (WSDOT has installed over 700,000 DBRs since 1992), the condition of the pavement prior to the DBR is the most important factor. They state that applying the DBR process early in a pavement's life is a significant factor in the repair longevity.

JE- Oklahoma Turnpike Authority answer – We expect 15-20 years before the panels will need a major replacement, however, another grinding could be done if needed due to budgetary constraints.

31. What is the minimum thickness of the existing concrete slab to be a viable candidate for DBR?

JR – A PCCP with 7 inches of thickness is viable although DBR has been constructed on concrete overlays as thin as 6.5 inches thick. See CALTRANS Report on Colfax Test Location (7 inch thick DBR) and IGGA Case Study on MN DBR (6.5 inch thick DBR).



Caltrans-DBR\_Evaluation-July2002.pdf



CSJune2017\_MN\_dowel\_bar\_retrofit.pdf

32. What is the typical cost for diamond grinding per square yard?

JR – It depends on many factors including aggregate hardness and size, amount of removal, project size, wage rates, traffic control, working hours etc. On large projects with reasonable conditions (as listed above) prices would likely range from \$2.50 to \$5.50 per sq yd but can vary widely based on site specific conditions. If you have specific projects in mind it is best to contact IGGA and ask for an estimate to be more exact.

33. What longitudinal angle you advise for grinding?

JR – The diamond grinding texture is applied parallel to the centerline joint in most situations. Areas such as shoulders, auxiliary or ramp lanes may require a different orientation based on site conditions.

34. When diamond grinding, what is the best way to treat the adjacent areas that are not being diamond ground, such as asphalt shoulder. The diamond grinding will remove material/lower the profile and may result in uneven surface between the ground surface and the surface that is not ground.

JR – In situations like this, it is advised to include a requirement for a feather pass of grinding over these areas (into the shoulder or gutter) in the project bid documents. The IGGA recommends the following language in its sample grinding specifications:

“When conditions require a feather pass into the shoulder, auxiliary or ramp lanes, payment will be by the square yard based on a width of 2 feet times the length of the required feather pass. The minimum length of a feather pass will be 100 feet. Gutter sections requiring a feather pass will be paid by the square yard based on a width of 1 foot times the length of the required feather pass. The minimum length of a feather pass will be paid as 100 feet.”

JE - Oklahoma Turnpike Authority answer – our plans require the contractor do daylight the grind across the shoulder. Most of the outside shoulder was ground between 2 and 4 feet from the edge of the concrete panel.