

## RCC Webinar – Questions and Answers

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

Key resources available include:

[https://www.cement.org/docs/default-source/cement-concrete-applications/sn298.pdf?sfvrsn=7e76fdbf\\_2](https://www.cement.org/docs/default-source/cement-concrete-applications/sn298.pdf?sfvrsn=7e76fdbf_2)

<http://rccpavementcouncil.org/>

1. How does the smoothness compare to standard placed concrete and asphalt? Iowa

After diamond grinding, the US-78 project in Aiken met SCDOT rideability specifications for full pay. At that time, I believe the requirement was a Mean Ride Index (average IRI for two wheel paths) of 60 inches/mile or less. (Andy Johnson)

From a measured ride quality standpoint, RCC will not be as smooth as PCC or HMA. Without grinding, we would not recommend RCC for speeds in excess of 45 MPH. We have successfully ground RCC to meet ride requirements on non-interstate routes. To my knowledge, RCC has not been placed as the final riding surface on a travel lane on the interstate. It has been used for shoulders and turn lanes. (Chris Carwie)

2. Traditional concrete pavement longitudinal joint requires tie bars, and pavement wider than 3 lanes width requires longitudinal butt joint or keyway. Does RCC require any special attention when constructing wider than 3 lanes wide? Ontario

SCDOT constructed a 3-lane RCC which had one lane in each direction plus a center turning lane in 2009, which I did not discuss in the presentation due to time constraints. This section had quality issues during original construction that make it a poor example. Although it has got problems with surface finish and compaction at the longitudinal joints and around manholes and valves, it has not had any issues with joints opening. However, this section was also constructed with a PCC valley gutter that may provide some restraint against joint opening. You can virtually visit the site at <https://goo.gl/maps/YPwrXhnrNNPq7oFV7>. (Andy Johnson)

The theory behind RCC load transfer is through aggregate interlock. To my knowledge, we have not built any public roadways which are wider than 2 lanes in a single direction. However, we have lots of experience building adjacent lanes on intermodal facilities, storage areas, distribution centers, etc. No special treatment is required. (Chris Carwie)

3. Do you have any examples of parking lots where the curb was placed after the RCC? Iowa

Every parking project I have seen has had the curb placed first. However, both Powell Pond Road and another site in South Carolina have had PCC valley gutters added after construction without issue. So, I don't see why a curb could be placed after the RCC. (Andy Johnson)

Yes. Although we recommend installing the curb prior to the RCC placement, we have paved facilities in the past where the curb was installed after the RCC was

placed. We prefer the curbs to be in place prior to RCC construction except in areas where space is required for equipment runoff when constructing the RCC pavement. We can explain further if needed. (Chris Carwie)

4. When you pave with this material, do you leave it high so the rollers can push it down to grade? New York

Yes, but a properly designed mix and a properly functioning paver have minimal rolldown. So, typically it is only slightly high, maybe one-quarter inch at most, coming out of the paver. Once a paving project is underway, the rolldown can be controlled to achieve the proper elevation. If the rolldown is excessive, that is probably an indication of a problem at the plant or with the paver. (Andy Johnson)

The RCC mix is extremely stiff with zero slump. We typically only have about 3/8" of rolldown. (Chris Carwie)

5. What is the PSI requirement that you see for DOT work? Arkansas

SCDOT uses 4000 psi minimum at 28 days. Georgia DOT uses 3500 psi at 28 days. NCDOT uses 4500 psi at 28 days. (Andy Johnson)

It varies by project and state, but 4000 PSI at 28 days is typical. Often DOT's require a flexural strength also. A typical flexural strength requirement would be 650 psi. (Chris Carwie)

6. What is the difference between RCC and cement treated base? Hawaii

Conceptually they are very similar, but RCC has much higher compressive strength, typically 4000 psi for RCC versus less than 1000 psi for CTB. The higher strength allows RCC to be used as a surface while CTB is friable and needs an additional material (chip seal, asphalt, or concrete) to protect it from traffic and erosion. RCC has a much higher cement content and has sawn contraction joints while CTB typically does not. RCC is placed with a high-density paver while CTB is typically spread and trimmed using a motor grader. CTB can be mixed in place while RCC is produced in a mixer and hauled to the site. In the southeast US, several contractors are now placing CTB using a paver instead of a motor grader. This allows better control of the grade and a smoother platform for the overlying lifts of concrete or asphalt. (Andy Johnson)

Roller Compacted Concrete (RCC) is concrete pavement, placed with high density asphalt type pavers and compacted with vibratory rollers. Very similar in materials and strengths to PCC but placed differently. It is generally comprised of coarse and fine aggregates, water, and cement content of 450 – 550 lbs per cubic yard. Most of the time, it is utilized as a final wearing surface pavement with compressive strengths in 4000-6000 PSI at 28-day range.

Cement Treated Base (CTB) is a general term that applies to mixture of native soils and/or aggregates with measured amount of Portland Cement (3-6%, 125-225 lbs per CY typical) and water that hardens to form a durable base layer where in most cases, additional surface pavement layers are required. There are several other terms often used to describe CTB which include: soil cement, cement treated aggregate base,

cement stabilized base, and cement stabilized roadbed. Typical CTB compressive strengths are in the 500-1000 PSI range at 28 days. (Chris Carwie)

7. Given that compaction is critical to concrete pavement performance, that thickness design for JPCP or PCP-D are identical (from say PavementDesigner) for a given design life, and that RCC is only rolled (not internally vibrated), how can RCC possibly deliver equivalent life expectations to say a 40-year JPCP/PCP-D? Australia

Well, I think this question answers itself. Compaction is critical to developing the appropriate strength. As long as the mix design gradation allows for a dense, well-compacted mix and the mix is properly compacted, it's going to behave similarly. Anything, including JPCP, can have its performance diminished by improper construction. (Andy Johnson)

The life expectancy for most pavement designs is affected by several factors but two of the major governing factors is the thickness and strength of the pavement material. RCC mixtures can be designed to meet or exceed the flexural strength requirements of traditional concrete pavement mixtures. It is not uncommon for routine RCC pavement mixtures to achieve flexural strengths in excess of 750 psi. If the density of the RCC pavement after external compaction is the concern, most RCC mixtures have higher unit weights than their PCC counterparts. The achieved density with the RCC pavement is often greater than those of PCC pavements although all of the consolidation is achieved externally. PCC pavement mixtures contain excess water for workability and entrained air, both of which lower the unit weight of the pavement. This denser matrix for RCC mixtures has also proven to be less permeable than comparable PCC mixtures in laboratory testing. (Chris Carwie)

8. What are the widths and depths of transverse and longitudinal joints? Is there a need? Quebec

Typically, RCC joints are initially cut to somewhere between D/3 and D/4, similar to regular JPCP with a 1/8-inch single saw cut. If sealed, the typical widths are 1/4-inch to 3/8-inch.

We use early entry saws to saw transverse joints usually following the T/4 recommendations (1/4 depth of pavement) at 1/8" width. The treatment of longitudinal joint varies. Typical are 3/8" width and 1" depth. (Chris Carwie)

9. What should be the max width between longitudinal joints? Quebec

I would suggest no more than 15 feet based on my experience with JPC pavement. However, my experience is in a milder climate so I would encourage you to use your local experience with joint spacing on regular concrete pavement. (Andy Johnson)

For longitudinal joints, we do not see a need to limit the width between them. If the paving machine is capable of placing pavement in widths up to and in excess of 30', we would recommend this approach as it reduces the occurrence of longitudinal construction joints within the paved area. With this being said, any time the placement lane exceeds 20' we recommend a sawn contraction joint in the center of the lane. Typically, we try to achieve a 15' x 15' grid pattern for jointing throughout the paved area. (Chris Carwie)

10. What is the curing time for 10" RCC? New York

Unlike typical PCC, RCC's compaction creates a granular solid force chain that can carry foot traffic immediately and, as I mentioned, I have not had a problem allowing light-vehicle crossing traffic immediately as well. Recent projects in SC and TN have developed well over 3000 psi under lab curing conditions in 72 hours, which is more than sufficient to open to traffic. So, I think it is possible to open to unrestricted traffic in 24 to 48 hours depending on the ambient temperature and the mix you are using. (Andy Johnson)

There are several factors to answer this question. What is your intended application and traffic expectation? Typical specs require a 7-day cure prior to meet design strengths. We do have example where RCC has been opened to local traffic within 48 hours although this is not recommended. The ACPA RCC Specification (page 26) provide guidance as to strength need to return traffic. Roller-Compacted Concrete Pavements ([rccpavementcouncil.org](http://rccpavementcouncil.org)). (Chris Carwie)

11. Did you use the tamper bars when you paved the 5' shoulder? If so were there issues with the bars hitting the existing roadway when you scabbed on the 5'? Pennsylvania

Yes, the pavers are equipped with tamper bars. In-house paver modifications make this possible. (Chris Carwie)

12. What was the joint spacing for the Bel Aire, KS project? Pennsylvania

Transverse joint spacing was 14 feet, each lane was 13.5-feet wide. (Andy Johnson)

13. Are there any RCC pavement designs that can accommodate interstate traffic or is RCC only intended for the shoulders of interstates? North Carolina

Theoretically, it is possible to design a thick concrete pavement with short slabs, a high degree of support, and low erodibility (I'm thinking lean concrete or another layer of RCC with offset joints) that would work in PavementME without dowels. But typical practice has included dowel bars at transverse contraction joints for decades for very high volume, high speed pavements, which are incompatible with RCC. I would encourage trying it on non-interstate arterial routes before moving to interstates. (Andy Johnson)

RCC has been primarily utilized for shoulders on Interstates. We do have examples of RCC being used for turn lanes, ramps, acceleration lanes, and travel lanes on secondary roadways. We have also seen RCC utilized as a base layer for high volume traffic routes. We have not yet tried a ground RCC on the interstate, but believe a properly designed system could be successful in this application. (Chris Carwie)

14. What moisture content is normal, Arkansas

I would say somewhere in the neighborhood of 6 percent, but that's going to vary depending on your aggregate absorption and the specific mix design. (Andy Johnson)

230-280 # of water – 5-7.5% is typical. (Chris Carwie)

15. Most of the projects that have been presented have been located in southern climate areas. How does RCC paving perform in northern climate areas that experience freeze/thaw cycles? Iowa

As someone who has worked his entire career in the Southeast, I can't address this directly. However, I would refer you to a report on the Burlington-Northern & Santa Fe Railroad Intermodal Facility in Denver. It was constructed in 1986 and the report was done in 2002, 16+ years after construction. You can see it at the following link: <http://rccpavementcouncil.org/wp-content/uploads/2020/05/2002-RCC-Intermodal-Denver-Ground-Eng-Conslt.pdf>. I also attended a TRB presentation three or four years ago that noted that the site had finally required some repair due to deterioration at the joints from deicers, which are highlighted in the 2002 report. Despite some issues with the joints, this site managed to last for 30 years with minimal maintenance. Current construction practice is better than it was in 1986, so I would expect better performance from more modern construction. It is also believed to be the first site using two-lift RCC construction to achieve a 15-inch thickness, although this degree of thickness is not needed for highway-legal loads. (Andy Johnson)

Most of the early RCC projects were placed in Canada and the Northwest United States. In addition, several southern states actually have more freeze thaw cycles than states that experience significant snowfall. While almost all pavements experience problems with freeze thaw, RCC has performed well in most all different type of climates. (Chris Carwie)

16. Can recycled concrete be used in the RCC mix? Virginia

Although it would be possible, recycled concrete aggregate is prone to highly variable absorption. As a result, I believe it would be challenging to control the water and maintain a consistent mix. I have been involved with a conventional PCC concrete project that used recycled concrete aggregate for the coarse fraction and, while it has worked out well over the last 20 years on I-95 in South Carolina, it was a hassle for the contractor. (Andy Johnson)

Our company has not utilized recycled concrete in RCC, but in theory, if the gradation was within specified limits and variability reduced, it should be allowed. (Chris Carwie)

17. Can you tie the RCC pavement with a curb & gutter by using tie bars drilled into the RCC at a later stage to prevent the joint from opening over time? Australia

Yes. We did exactly that to tie the PCC valley gutter to the Powell Pond project as well as another project in South Carolina. (Andy Johnson)

Yes, you can retrofit tie bars into RCC at fixed structures as required. We typically do not tie into curb and gutter, but in areas where curbs can pull away from the pavement, this could be accomplished. If tie bars are utilized, it will be especially important to match the curb jointing with the pavement jointing. (Chris Carwie)

18. Does the reduction in max coarse aggregate size reduce the flexural strength capacity or is this potential reduction taken up in additional cement content? Australia

That is a good question. I have not seen research on this topic but have had similar thoughts as the trend in RCC mix design has moved towards finer mixes to achieve better surface characteristics. The Louisiana Transportation Research Center at Louisiana State University in Baton Rouge has done some accelerated loading tests in which the RCC pavement has lasted longer than anticipated by the designs. This has

led some to speculate that the compressive strength-flexural strength relationship for RCC is different from PCC (as in, RCC has higher flexural strength for a given compressive strength). However, this needs further investigation.

My concern with reducing the coarse aggregate top sizes would be whether it would affect the long-term load transfer efficiency at the transverse contraction joints. This is particularly salient because of our inability to use positive load transfer at these joints. However, there is no evidence that this change is reducing long-term LTE. (Andy Johnson)

Historically it has been thought the reduction of the maximum aggregate size will reduce the strength of concrete mixtures. While this is true for the compressive strength, it has not been shown to have the same effect on flexural strengths. Therefore, the reduced max aggregate size is not a concern for flexural strength development. (Chris Carwie)

19. Have you considered the use of conventional diamond grinding on large RCC pavement parking lots to improve ride and surface drainage? Australia

I have not seen diamond grinding done on a parking lot, but it has worked well on three projects in South Carolina done 10 to 12 years ago. I would note that SC has excellent granitic aggregates, so your results may vary. Trowel-finished RCC has been used in parking facilities quite successfully, however. (Andy Johnson)

Yes, we have been successful with diamond grinding on both roadways and other pavements to improved drainage, smoothness/ride. (Chris Carwie)

20. Been doing RCC for over thirty years and have a 25-year-old 10-acre RCC distribution center. Since large aggregate provides load transfer at joints and this prevents pavement curl, I would highly discourage reducing aggregates below 1". RCC on county roadways in Liberty County in the Houston area are being removed as these were constructed using pea gravel maximum aggregates which largely eliminates load transfer and is the first RCC I have ever seen with curl!!! Iowa

Great observation. See my comments on question 18. My experience has been in areas with high-quality crushed granite aggregates but areas with marginal aggregate (like Houston) may be more sensitive to these issues. (Andy Johnson)

While max aggregate size has an effect on load transfer, several other factors also contribute to the load transfer efficiency of unreinforced joints in concrete pavement. These include joint opening width, overall pavement depth, and depth of jointing cuts which remove all interlock. As we have reduced the contraction joint spacing to 15' we have noticed better joint performance which I believe can be attributed to joint faces that stay in better contact due to the reduced length of the pavement elements between joints. Most of these pavements have 3/4" maximum aggregate size and most are 7" or greater in total depth. It would be interesting to know the total pavement depth and maximum aggregate size for the problem pavements in Liberty County, TX. (Chris Carwie)