9 March 2020
Witness Statement (1) by Ernest Schrader

Due to personal issues this past month I was unable to develop a witness statement before this, but I also was not specifically asked to prepare one. I have been responding as best I can by email to specific questions as they were raised by PDI, and have had a couple of conference calls both with PDI and Hydro Tasmania. I have also provided Hydro Tasmania and PDI with various self-initiated emails containing supplemental pertinent information. I am now preparing two witness statements that substantially "cut and paste" from those emails. Statement 1 primarily concerns the basis for shear properties that I recommended to the designer. It comments briefly on shear testing and potential ways to obtain or make proper shear test samples. It also briefly addresses the Lift Joint Quality Index (LJQI). Statement 2 concerns a variety of miscellaneous but very important issues, some of which may have been overlooked. I apologize for the last minute "cut and paste" nature of these statements and for the fact that I have not had a chance to proof read it. It has not been reviewed by Hydro Tasmania or anyone else, nor has anyone advised me regarding what to include or say. It therefore also has not been fitted to any special format.

My general CV and a separate file covering my experience with RCC have been provided previously. It includes a list of more than 100 RCC projects throughout the world. Footnotes indicate what I did on each project, ranging from design to construction. I was intimately involved with the very beginnings of RCC, starting with design and shear testing of both lean and high cementitious content mixes in the mid 1970's, and then with design, construction and shear testing for what became the first all RCC dam in the world, Willow Creek. My experience includes all types of RCC ranging from high to low cementitious content with both wetter and drier consistencies. It includes extensive shear testing and development of appropriate equipment and procedures for shear testing that can accommodate lean mixes.

I am currently under an agreement with Hydro Tasmania to assist the PDI, but have not been interacting with the Engineers or management. Only lawyers. At the start of the Paradise project I was engaged first as a consultant by Walker Construction. Later my invoices were sent to the BDA project manager and then to Hydro Tasmania.

For new projects, and especially for projects that are small or medium sized, shear properties are typically just estimated or assumed. Unless the dams are very large, have suspect aggregates, or are part of an academic/research effort, shear tests are seldom, if ever, done to confirm or adjust the estimated shear properties at the time of design, and very seldom are samples taken after construction to confirm them. Instead, typical recommendations of industry guides and codes to use 45 degrees as a base assumption for friction and some percentage or function of compressive strength as a value for cohesion are adopted. At times, and almost always for projects in which I am involved, initial values from industry guides are then adjusted by careful consideration of shear values that have been adopted and/or determined by actual tests at other projects with similar mixes, aggregates, gradations, and properties. This is what was done at Paradise.

There a numerous references and industry standards supporting the assumption of 45 degrees (or more) for a friction angle when there are no sight specific test data available. Industry references and standards show that this is a conservative estimate, and also document that that unbonded lifts can have "apparent" cohesion that should be taken into account.

The 2013 ANCOLD Guideline states that "It is common practice to assume c'=0 and phi = 45^0 for residual strength of concrete." If residual friction is 45 degrees the peak will be greater and, of course, there should be a peak value for cohesion prior to testing to failure and getting a residual condition. The ANCOLD document also states that “this is consistent with EPRI (1992) data which has 90% of samples with a strength >c’=0, phi = 48^0.” ANCOLD does go on to say that if lift surfaces are subjected to grinding (Paradise is not), or if there are other special circumstances such as chemical attack, friction can be lower and values should be based on “… laboratory tests carried out on samples from the dam by appropriately qualified experienced assessment personnel.” The key point here is that the samples must properly represent the in-situ situation (not damaged by drilling, extraction, storage, shipping, and handling) and the test must be done by people properly experienced with the type of RCC being tested. With due respect, there can be very qualified people for testing conventional concrete, high strength RCC, and foundation materials, but they may not be well experienced in the nuances of shear testing lower strength lean mix RCC. This is very difficult and specialized. Even those few people who now have become very good at it experienced difficulty and typically poor results at the start.

American Concrete Institute (ACI) report 207.5-99 (the version in effect at the time of Burnett Design) is titled Roller Compacted Mass Concrete. It states “Total shear resistance is the sum of cohesion plus internal friction, mainly across generally bonded, intact, horizontal lift joints. Shear resistance of unbonded lift lines includes apparent cohesion and sliding resistance between the lift surfaces. Typical shear test values for parent RCC and bonded and unbonded joints are given in Table 3.4 “

Table 3.4 has 21 examples for 7 different projects, some with multiple mixes. Compressive strengths vary from 10 MPa to 39 MPa. Friction angles vary from 33 to 76 degrees with an average of 57 degrees. The one mix that had a low initial friction angle of 33 degrees was an anomaly with a higher residual angle of 45 degrees. The lowest cementitious content mix with 47 kg cement + 19 Kg ash (66 kg total cementitious) had a friction angle of 62 degrees. The average residual friction for all the data is 46 degrees with a range of 40 to 53 degrees. Ten of the example projects also reported the percent bonded when coring. The average was 59% bonded with a range of 24% to 80%. It is typical that lean mix RCC, and to some extent some higher cementitious content RCC, that is bonded in situ will debond or separate when cored. Saw cuts and excavations into lean RCC that have poor core recovery routinely show that the RCC lifts are bonded in-situ. Expecting 100% bond is not realistic, at least not as evidenced by coring. Cohesions in the ACI table varied from 586 KPa to 3861 KPa, with the lowest cementitious content mix (66 Kg) having a cohesion value of 793 KPa. The highest cementitious content mix (386 Kg) had cohesion of 3861 KPa. Residual cohesion after bond failure and sliding varied from 69 KPa to 1379 KPa, with one “outlier” at 0 KPa. These values all justify the shear values used during the design of Paradise, and actually indicate that they were conservative.

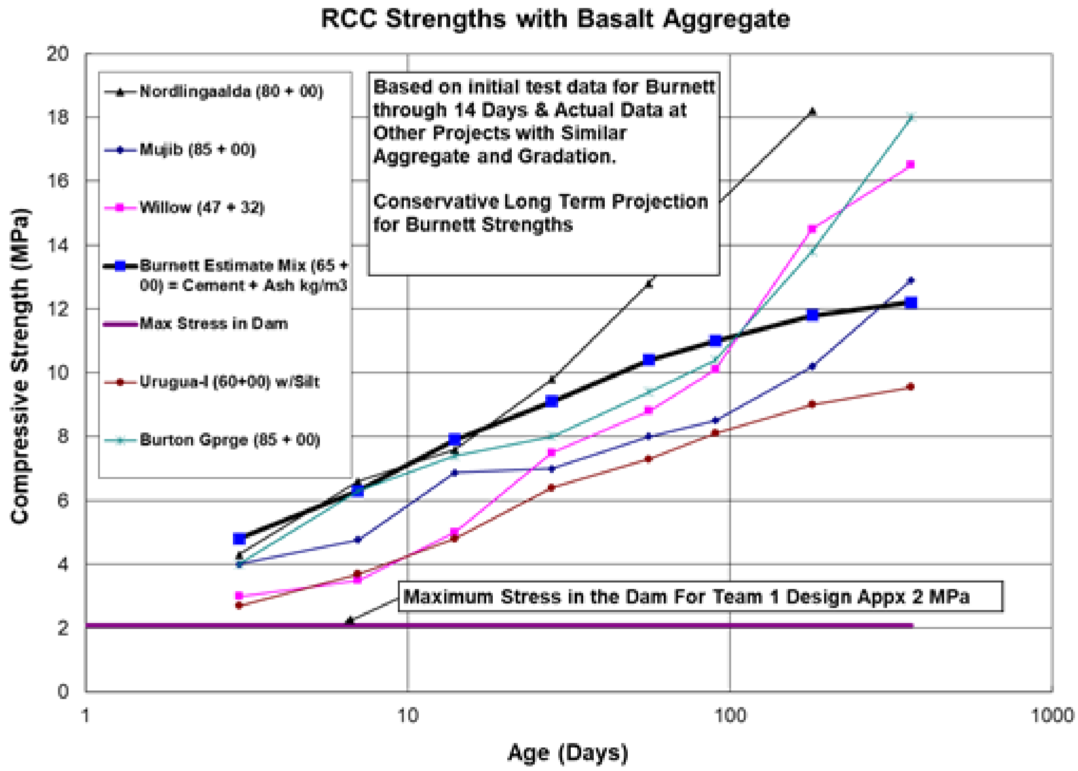
The ACI report also states that “The unconfined shear strength (cohesion only) of an unjointed section of RCC has varied from 16 to 39% of its compressive strength.” This is in line with the Paradise estimates. The QC cylinder compressive strengths were typically on the order of about 12 MPa (1 year) so the expected cohesion for unjointed RCC (or RCC with bedding) would reasonably lie in the range of 1.9 to 4.7 MPa. The initial design basis Paradise estimates prepared by myself (before being conservatively reduced by the designer, Richard Herweynen) of 2.2 MPa in July 2003 and 3.1 MPa in 2004 fall comfortably in this range.

The ACI report also states that “The coefficient of friction within the mass has usually been taken to be 1.0 (phi = 45 degrees) for RCC if no project specific tests have been conducted.” That is exactly what I suggested to Richard as a design basis, which he then apparently reduced for conservatism.

The US Corps of Engineers Engineering Manual 1110-2-2006 (dated 15 January 2000) titled Roller Compacted Concrete states that ""Cohesion generally varies based on the amount of paste, cementitious content, and lift joint preparation and exposure. Cohesion can be improved by correcting these problems and by the application of a bedding mortar or concrete. Shear friction angle is relatively unaffected by factors affecting cohesion and is more dependent on aggregate type and shape. McLean and Pierce (1988) found that use of phi = 45 degrees for preliminary design was generally conservative with use of c = 0.1 f'c not conservative. For unbonded lift joints c/f'c has varied from 0.03 to 0.06. For bedded lift joints, c/f'c has varied from 0.09 to 0.15. Friction angle for bedded and unbonded lift joints has been essentially unchanged. Evaluation of shear strength from cores requires caution when interpreting results since joint core recovery can vary dramatically depending on drilling and extraction procedures….unbonded or poorly bonded RCC generally debond during coring or extraction and is not tested further…. A value of phi = 45 deg can be assumed for preliminary design or for small projects, for both the parent and lift joitn shear strength." This further justifies the estimates for Paradise.

The 0.03 to 0.06 factors are for lift joints with no bedding. Applying those factors to our cylinder strength of about 12 MPa results an expected cohesion in the range of 360 to 720 KPa compared to my suggested design value of 400 KPa and Richard's conservative lesser values of 325 KPa for "good" quality joints and 250 KPa for "poor" quality joints.

Specific test information from other projects that was considered (and presented) when the proposed Paradise concrete mix and estimated properties were developed is provided below. It starts with the following chart of basic compressive strength as predicted for Paradise compared to what was achieved at other projects with lean mixes, similar basalt aggregate, similar gradation, similar *paste* and similar (or worse) workability. Cohesion is related to compressive strength.



The test cylinder compressive strength of Paradise turned out to be very similar to wat was predicted, about 12 MPa at 1 year.

For shear, the five comparison projects shown on the chart (Nordlingaalda, Mujib, Willow, Urugua-I, and Burton Gorge) all used a design friction angle of 45 degrees.

Willow had actual tests performed on large shear blocks. At only 90 days the blocks with no bedding typically had results of 44 to 55 degrees for fiction angle with cohesion of 900 KPa to 1000 KPa. These were typical bi-axial tests of lift surfaces with maturities on the order of 350 to 600 C degree hours compared to the Paradise cold joint criteria at paradise of 500 degree hours. A tri-axial test that uses three dimensional load conditions (instead of bi-axial) as well as uplift pressure within the lift joint was also done. It showed expected improved friction angles of about 60 degrees. Tri-axial testing is most representative of real conditions in the dam but these tests are very complicated and almost never done due to difficulty, cost, and the fact that very few labs in the world have the ability to do concrete samples. Therefore, the more conservative bi-axial shear testing is usually done.

Urugua-I dam (appx 88 m high, 750,000 m3) one of the first high RCC dams. It used a lean mix with typically 60 or 65 Kg of cement per cubic meter, no fly ash. It was very similar to the Paradise mix except that it had somewhat less paste and it was less workable, with larger (76 mm) coarse aggregate that had a tendency to segregate. The fiction and cohesion values at 700 Degree-hr. maturity (more than the 500 used at Paradise) and no bedding were established at 60 degrees and 900 KPa. The values adopted for design were 45 degrees fiction and 800 KPa cohesion.

Burton Gorge dam (Australia, 30 m high) was also a lean mix (typical 85 Kg cement no ash). It used the following design basis (no tests) for shear properties of different quality joints: With bedding, cohesion 2000 KPa and fiction 46 degrees. Clean joints with no bedding, cohesion 500 KPa and friction 45 degrees. Conservative for design with no bedding, cohesion 250 KPa with friction 41 degrees. As with most smaller and medium sized dams, no shear tests were performed.

Nordlingaalda, not yet built, used a design basis lean mix with 65 kg cement and no ash, no bedding, cohesion 310 KPa and friction 45 degrees.

Other actual shear test results that were considered at the time of the Paradise estimates were taken from my personal hand written data base (pre-personal computer) including 35 proper and credible determinations of fiction and cohesion of various RCC mixes. Typically, each determination used at least three individual large samples of the same mix and conditions, with each samples tested at a different confining load. So, the total number of samples was on the order of a hundred.

From this data base the worst test result was actually for a high cementitious high ash mix (121 + 269 kg) with high workability, highly retarded, and low lift joint maturity of about 72 degree hours. The friction angle was 35 degrees (probably an anomaly). Overall, friction angles ranged from the low 35 degrees to a high of 71 degrees, with an average of 51 degrees. The overall variables included large and small rollers for compaction, wet and dry lift surfaces, lift joint maturities from about 2 to over 1300 degree hrs (typically 300 to 600), dry and wet mixes, fresh and hard lift surfaces, various quality aggregates from good to poor, various types of aggregates ranging from basalt to sandstone, cylinders and large block samples (mostly large blocks), various lift joint cleaning or conditions, cement contents from 41 to 139 kg/m3, various ash contents from 0 to 170 kg/m3, various total cementitious contents ranging from about 70 to 300 kg/m3, and ages from 35 to 481 days. There was no correlation between cementitious content or type of mix and the friction angle, although subsequent tests have indicated that very high cementitious content mixes tend to have slightly lower friction angles. The type of mix, lift joint quality, maturity, and degree of cleaning also had little or no impact on fiction angle. This has been very well substantiated by other subsequent large scale credible shear testing.

For the above shear tests and conditions the overall average cohesion was 1125 KPa with a range of 440 KPa to 2441 KPa. One of the worst values for cohesion (510 KPa) was for one of the highest cementitious content mixes (275 Kg/m3) at a lift maturity of only 66 Degree-Hours (an anomaly?). Generally lean mixes had lower (but adequate) cohesions on the order of about 700 KPa while the high cementitious mixes tended to have greater cohesion on the order of about 2000 KPa.

Subsequent additional examples from other projects that further support the estimated shear property values for Paradise follow. Some of this information was available at the time of Paradise, and some came afterwards, but it is all consistent.

Mujib dam used similar (and worse) crushed basalt aggregate and a similar gradation to Paradise. It originally was designed and tendered as a high cementitious and high ash RCC mix but was changed to a lean mix (typical about 85 kg) with no ash because the fly ash would have to be imported, because the lean mix was judged quite acceptable (without a change in friction angle), and due to cost savings (value for money). It originally had an upstream membrane but that was eliminated after initial construction because the quality of lift jojnts was judged to be very good and water tight due to excellent inspection by the full time on-site RCC engineer Jose Lopez (our primary on-site RCC & QC Engineer at Paradise).

The friction angle was not changed with the change of mix type. For design basis the 1 year compressive strength of the lean mix was 10 MPa (basically similar to Paradise). The design basis estimated values used for cohesion and friction with (no bedding) were 500 KPa and 45 Degrees. With Bedding the values were 2500 KPa and 45 Degrees.

Additional support follows that the Paradise estimates were very reasonable and justified, and that the in-situ condition is most probably much better than indicated for friction and cohesion by what myself, Rizzo, and Tatro-Hinds, consider to be suspect.

Gibe 3 is a very impressive 243 m high RCC dam with 5,000,000+ m3 of RCC. An extensive coring and shear test program was done after completion. The dam was zoned with different mixes for different stress conditions in the dam. As is typical in the industry, bedding was only used in the zones that needed it… just like what we did at Paradise. Robert Montalvo was questioned pretty hard along the lines that all of our dam and all of the locations we cored needed to be bonded, and that because they were not always bonded it demonstrates bad construction and serious defects. That is simply not correct. We have zones where good bond is not needed. I believe the cores in 2006, and it seems most if not all of the recent cores are in those areas of no bedding. These cores should not expect to be bonded enough to resist the rigors of coring.

Gibe 3 is an excellent example that RCC does not need to be bonded throughout. The middle part of the dam had a lean mix with 70 kg cement (no ash). It also had no bedding and did not have any requirement for bond or good lift joint quality. The design was based on friction with zero cohesion for this large zone that was about 200 meter high and extended upstream-downstream about 50 meters. Gibe used a crushed quarried aggregate with gradation and paste content similar to Paradise. Shear tests on cores of the 70 Kg mix resulted in friction values from 48 to 51 degrees with residual values form 45 to 54 degrees. For comparison there were some tests of the lean 70 k mix with bedding. Those samples had cohesion 1100 KPa and friction 48 to 59 degrees. Once again a very though program of proper sampling and testing with RCC similar to Paradise showed that the friction angle of lift joints with excellent clean surfaces and bedding are not much different from the friction for lift joints with essentially no inspection, cleaning, or bedding.

I developed the initial estimates used for the basis of design at Gibe, as well as for other projects in this statement. In all cases the predictions were close to final tested values, or conservative.

The PDI has the detailed article on shear testing and results at Saluda dam. A quick summary follows. Crushed granite aggregate was used with a gradation and *paste* content (not cementitious content) similar to Paradise. The primary mix had 89 Kg of cement + 89 Kg of waste ash per cubic meter, but the ash was only partially effective. The compressive strength (1 yr) was about 22 MPa. Most of the shear samples were deliberately "pre-cracked" to debond the lift joints before testing. Friction angles were 57-60 degrees with residual 45 degrees and "apparent" cohesion of 60 to 410 KPa. Some samples were tested without first pre-cracking and de-bonding. They had typical fiction of 54 degrees peak and 45 degrees residual, with cohesion 1330 KPa.

Susu dam also used a crushed granite with gradation and paste content similar to Paradise. We intended to have a lean mix at about 60 to 75 kg cement (no ash). This was possible with good quality granite, but the quarry ended up not having good quality until we were very deep into it and near the end of the job. Consequently we used a poor quality aggregate and increased the cement content to 95 kg (sometimes 100 Kg) to compensate for the bad aggregate. For the majority of the dam, with poor quality aggregate, the compressive strength was only 8 to 9 MPa in cylinders and 7 MPa in the cores. This jumped to 13 MPa for cylinders and 11 MPa for cores for the last part of the dam that was done when we reached the good aggregate. Essentially all shear tests were for samples with the bad aggregate and low strength. Typical friction was 52 to 57 degrees with 42 to 54 degrees residual. Cohesion of the unjointed mass and of lift joints with bedding was about 1000 KPa with friction 55 degrees. As typically happens, the friction angle of bonded lift joints, lift joints with bedding, unbonded lift joints, and the unjointed RCC mass were all similar. Hot and warm joints without bedding had cohesion 800 KPa and friction 54 degrees. The estimate for cold joints (no bedding) was cohesion 150 KPa and friction 54 degrees. It was not possible to retrieve bonded god cores for this lift joint condition.

There seems to be a perception that if a different type of mix with a high fly ash content and higher total cementitious content were used at Paradise it would have resulted in dramatically better strengths, cohesion, and friction. First, as clearly demonstrated by the many examples above, friction is basically independent of strength and cementitious content. It is almost entirely determined by the quality of coarse aggregate, which would be the same regardless of mix type. Cohesion typically increases with compressive strength. This in turn typically increases with increasing cementitious content. However, this was not what happened at Paradise. The competing Thesis team pursued a mix with high fly ash and high cementitious content. However, their strength results were about the same as the BDA lean mix as shown in the following table. These are results from the independent Main Roads lab that did the mixes for both teams. The reason for this is not clear, but it is the fact of what happened and may well have influenced the owner to adopt the BDA proposal with lean mix. The data is from the *Final Progress Report on RCC Testing – Main Roads*. The BDA mix with 55 kg cement and no fly ash had the same 180 day strength of 12 MPa as the Theiss mix with 55 Kg of cement plus 155 Kg of fly ash. The BDA mix with 65 Kg of cement and no fly ash had a 180 day strength of 14 MPa compared to the Theiss strength of 18 MPa for 65 Kg cement plus 145 Kg fly ash. The BDA mix with 75 Kg cement and no flay ash had a higher strength of 19 MPa than the Theiss mix at 18 MPa with 75 Kg cement plus 135 Kg fly ash.

Thesis (kg/m^3)			**Alliance (kg/m^3)**			**7 Day (MPa)**		**180 Day (MPa)**	
C	**F**	**C + F**	**C**	**F**	**C + F**	**Theiss**	**Alliance**	**Theiss**	**Alliance**
35	**175**	**210**	**35**			**2**		**5**	
45	**165**	**210**	**45**			**3**		**8**	
55	**155**	**210**	**55**	**0**	**55**	**3**	**5**	**12**	**12**
			60	**0**	**60**		**6**		**13**
65	**145**	**210**	**65**	**0**	**65**	**6**	**6**	**18**	**14**
75	**135**	**210**	**75**	**0**	**75**	**8**	**8**	**18**	**19**

I fully concur with both the Rizzo and Tatro-Hinds reports that additional, and better, shear testing is needed in order to confidently establish real in-situ cohesion and friction. This should be done for areas with bedding and without bedding. The Tatro-Hinds report contains more than a dozen paragraphs that raise suspicion regarding the test procedure and results. I would be pleased to provide additional concerns and questions, but frankly did not see the test equipment and am not fully aware of exactly how the samples were taken, handled, shipped stored, and mounted for testing. I have strong suspicions that better care and detail is needed, for example with mounting or securing the samples for testing, for how the confining load and shear load are moved with the sample while maintaining a constant axial and “normal” (perpendicular) alignment, and especially how the samples are handled.

Mr. Tarbox commented that he saw pictures of cores that separated at lift joints and the surface was “dusty,” implying that the RCC was placed on a dry surface. However, due to excess moisture in the RCC (more than is needed for hydration) the RCC is damp in-situ, and the wet coring operation would have saturated the sample in any event. I believe what happened is that after coring the core sample was erroneously separated at the lift joint and allowed to dry. The samples should have been maintained in tight contact, even if debonded, and they definitely should not have been separated for inspection or during handling.

When supplemental sampling and testing is done it should be done by, or at least closely supervised by, someone who has considerable experience with shear testing this type of RCC. It is very different from handling and testing conventional concrete, high strength RCC, or foundation rock. Jim Hinds and I are two suggestions. I have also provided the names of Le Ngoc Hung (Teddy) and Paolo Mastrofini who both have very successfully sampled and tested thousands of lean mix RCC samples. I agree totally with Rizzo that the best tests are done on properly obtained and handled large test blocks.

I disagree with the test procedure of grinding the samples back and forth and/or using the same sample for different confining loads. Yes, this has been done before but it can substantially decrease test results. The dam does not slide back and forth. It sits there in place. If loaded sufficiently, it will start to slide in one direction, one time, at one confining load. Sliding the sample back and forth is like starting to sand a piece of wood. The first time that the new sand paper slides across the wood it is hard to move. Subsequent sliding back and forth smooths both the wood and the sand paper, requiring less and less effort until the sanding is not even effective.

Obtaining proper samples can be done various ways. Some examples follow:

- Large diameter (say 1 meter) core, in which case a person can also then actually enter the hole and see the in-situ quality of lifts. Mining companies may have this capability, but usually do not want to do commercial drilling other than for themselves, or the equipment is tied up.

- Additional coring for 150 mm minimum diameter samples, but even with special care it may still be difficult to obtain proper representative samples, especially if there is no bedding.

- Contact Wagner who made the aggregates and RCC. They may recall an area where left over original aggregate might be found, possibly under an area of reclamation. I have done this before for a different situation, then made samples for testing. In this case shear pads would be made with different lift joint conditions. Samples would then be saw cut from the pads, banded so that they do no separate until they have been mounted in the shear machine with the confining load applied, and then tested properly.

- Excavate trenches (probably 1-2 meters wide) from the downstream face or top of the dam into the RCC, both where there is bedding and where there is no bedding. Everyone can then see the real in-situ condition of the RCC and lift joints. One of the observations will be if the RCC all pops apart at lift joints or if it fractures across lift joints. Although I do not like testing horizontal core it may then be possible to extract horizontal cores at lift joints (if they can be identified).

- The probable best option is to wire saw cut trenches into the dam and test large blocks in-situ or taken from the dam at different locations and elevations.

Trenches have become the best way of inspecting and scrutinizing RCC test fills and the real RCC mass. They allow everyone to see the real in-situ situation and quality. By blowing off the surfaces with air, and then washing it, everything can be easily seen by everybody. For example, is there any segregation and are the lift joints tight? Is the density uniform? By washing the surface and allowing it to dry back any defects will be highlighted. They will tend to stay dark and damp longer than the surrounding areas that will dry back to a light grey color. A person can also pick at the lift joints to see if they have contamination and are tight or not. The photographs below are of the full section of the right abutment (the trial section) at about chainage 902. The dam was constructed past this chainage and then excavated back to expose the interior for all to see. Despite being the trial section and the first RCC where crews were on a “learning curve” the RCC is basically one very solid mass. There are two lift joints where wetting showed tight, but less than perfect, lift joint quality. However, this is in an area where good bond is not required and it is not through the entire section. It may also be where, as part of the trial, something was done as a variable to see the outcome. At any rate, even these joints will clearly have good friction but probably reduced cohesion. Unfortunately I have not had the opportunity to see if any cores were taken near this chainage, and what they might look like as a compared to what is really inside the dam. This should be done, or at least go back to core with the same procedures and care as previously to see what the cores show compared to the true condition within the dam. The downstream face for this section is unformed. That is, the RCC was simply placed out to the natural angle of repose. Obviously, for this situation the outside loose surface will have "raveling" and look rough, and may have some segregation, but as can be seen in the photos the RCC is tight and sound just inside the exposed unformed surface.

Photo 87 . View of D/S face after was cleaned by air jetting method. See Local areas with segregation in the contact

Photo 88. View of vertical face at Chainage 903 approx from D/S face. See damped bond in two lift joints.

Photo 89. Detailed view of joint between RCC layer without bedding.

Photo 90. View of vertical face at Chainage 902 approx. See joint between layer with & without bedding mix.

Photo 91 . Detailed view of upstream bond between lift joints treated with bedding

It is well established that the fiction angle of RCC with bedding is essentially the same as the unjointed parent RCC. It is also well established that the friction angle of lift joints without bedding is about the same or slightly less even if the joints are not bonded. It would be relatively easy to do a series or PROPER shear tests on sections of the unjointed RCC core, even if the diameter of the core is only 150 mm. If results show a low friction angles of say 35 degrees, and there is insufficient cohesion for bonded areas (primarily with bedding) to carry the required excess shear load, we have a real problem that needs real resolution. However if the friction angle is closer to 45 degrees, or more, there likely is no stability problem.

The Lift Joitn Quality Index (LJQI) has received considerable attention. This has been perplexing to me because it has been around for a long time, published, and used formally and informally, around the world on various dams representing over 20 million cubic meters of RCC. But, it apparently is not familiar to everyone.

It seems that somehow somebody got the erroneous idea that the LJQI is used to establish or calculate values for cohesion and friction. **This is absolutely not the case.** The LJQI is simply a tool that can be used to help assure thorough and appropriate inspection and QA/QC of lift joints, and also to be sure that lift joint inspection is well documented. Without the LJQI, lift joint inspection can slip through the cracks, the basis for acceptance is often arbitrary or not clear, and documentation has been lacking.

Without the LJQI system, the same thing is basically done as part of inspection but without the same clarity, diligence, consistency, and documentation, and without being called lift joint quality… although that is what it really is.

Dr. Ernest Schrader