ASR Webinar – Questions and Answers

3/14/2021

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

Key resources available include:

CP Tech MAP Brief –
https://intrans.iastate.edu/app/uploads/2020/12/MAPbriefWinter2020.pdf

FHWA ASR Factbook –
https://www.fhwa.dot.gov/pavement/concrete/asr/pubs/hif13019.pdf

FHWA ASR Reference Center – https://www.fhwa.dot.gov/pavement/concrete/asr.cfm

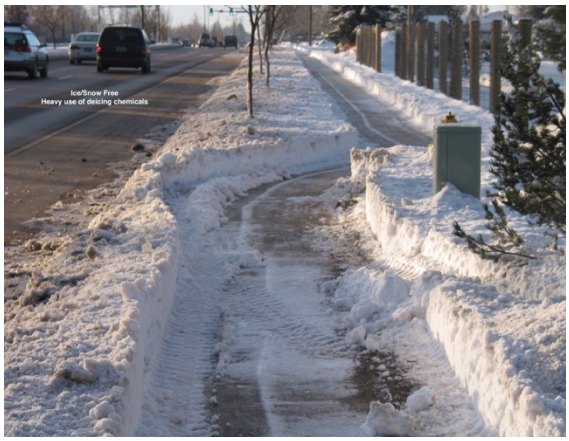
1. Is ASR an issue with cement treated soil? Are the mitigation methods for ASR applicable to cement treated soil, and are there any design guidelines and tests available? Washington

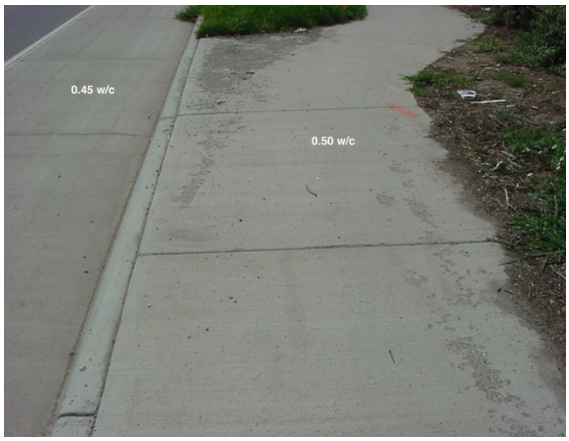
   I have not heard of this being an issue. The soil would need to have reactive silica, which would be unexpected. Also, the soil would be able to absorb, to some degree, any expansion, being essentially unconstrained. So, I think I would say no (LLS).

2. On the sidewalk scaling photo (PACA presentation), is there an explanation as to why the scaling was more prevalent on the right side of the sidewalk (as shown in the photo)? North Carolina

   When I have seen this in other cases, the scaling is worse underneath where snow is piled as the snow is usually salt-laden and that trickles down and exacerbates the scaling. See Figure 1. Clearly finishing could be a factor as well. (LLS).

   This is a great question and one that we ask to lead off the finisher's certification class. Scaling very often exhibits a pattern. As Larry noted it can be from increased exposure to deicers on one part of the flatwork of the as clearly shown in Figure 1. Other times, the pattern can be from differences in finishing within a section of concrete or within a day's placement. On the sidewalk shown in the presentation there is a very pronounced straight line of more severe scaling on one side of this sidewalk. It is very likely that a finisher went along the right edge prematurely causing a lower w/c ratio and weaker surface. The straight line shows how far he could reach into this wide sidewalk. Figure 2 shows another example of this type of pattern. (Jim)





(a) (b)

Figure 1. Winter (a), road heavily deiced and plowed. The snow/deicer from the road gets put on the sidewalk, which is kept open with a skid steer. Spring (b), scaling where snow was piled. The only difference between the concretes was the *w/c*.

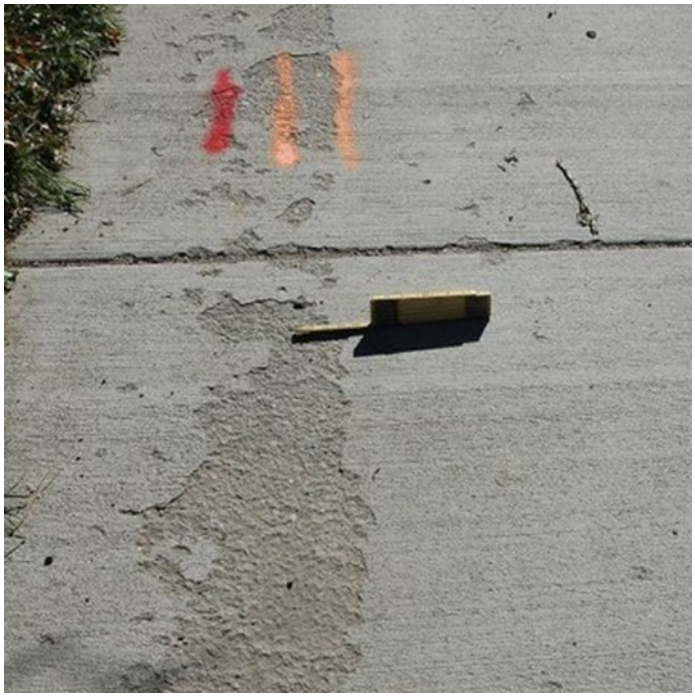


Figure 2. This pattern of scaling is more likely to be from differences in finishing.

3. FA speeds up hydration and slag reduces it, right? Sweden

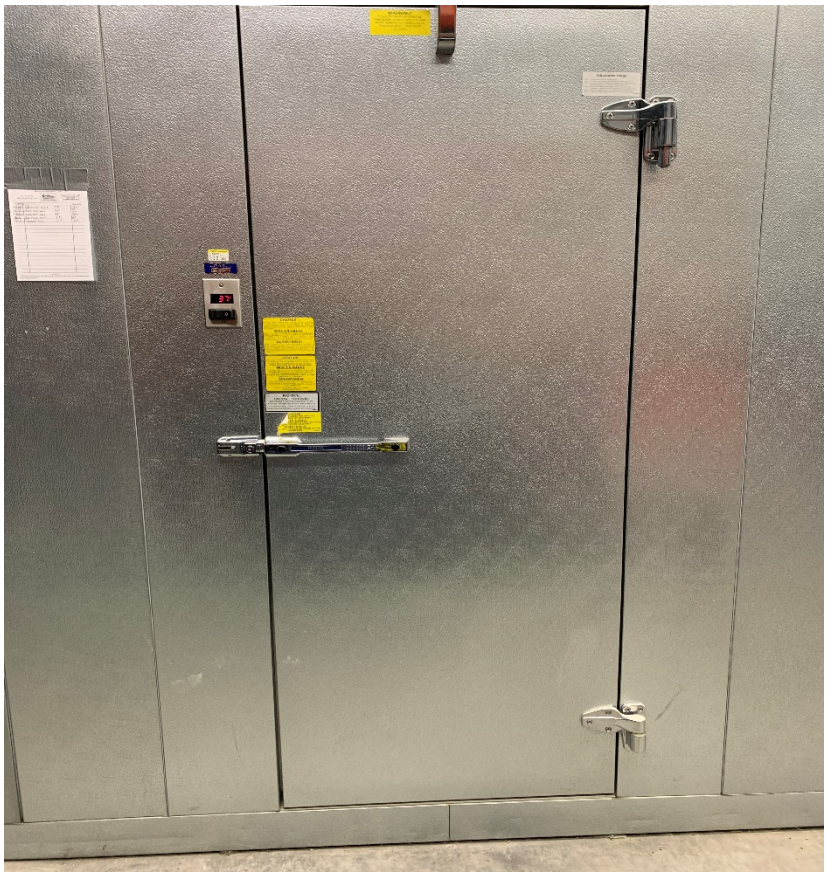
   Slag is a latent hydraulic material so yes, it sets and gains strength slower than portland cement. For fly ash it depends on the type of fly ash. High calcium ash can set and gain strength in some cases faster than portland cement. Low calcium fly ash

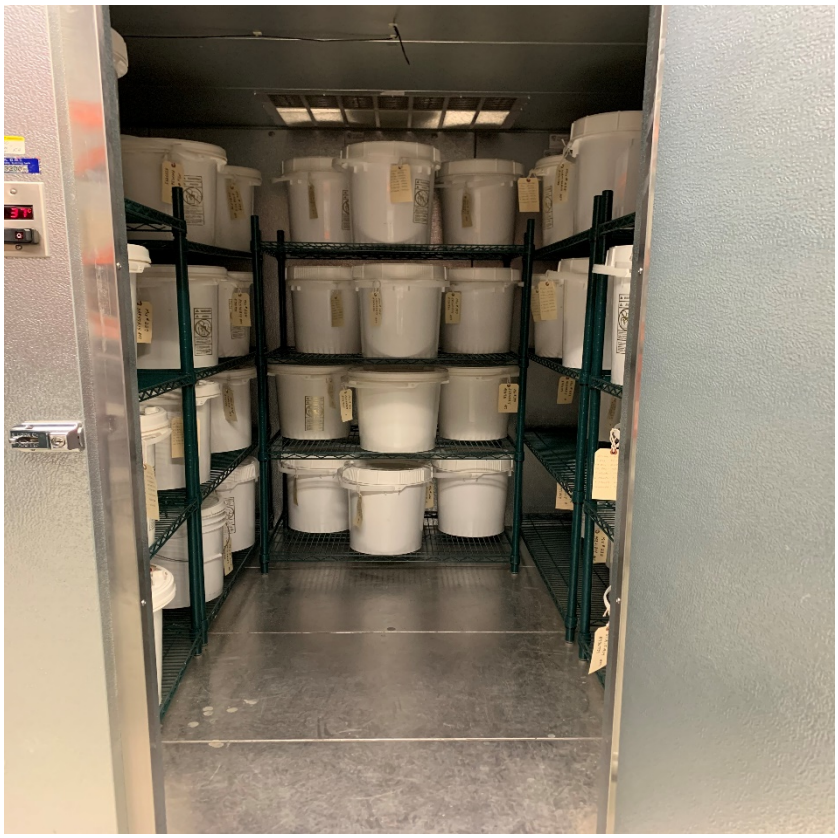
tends to set and gain strength slower than portland cement but typically not as slow as slag (LLS).

4. Pat: what is a warm room? Kansas

   The samples for ASTM C 1293 need to be kept at to be 38° +/- 2° C. It is a self-contained room with shelves lining the walls to hold the buckets used for testing.

   I have included some pictures of the rooms that we use. If you would like more information, please let me know. (PIB)





5. I've been in contact with a recycled glass manufacturer who is claiming that their product is a suitable replacement to pozzolans, and is effective against ASR, do you have any thoughts or experience with this material? Massachusetts

   Ground glass pozzolan is an extremely good pozzolan in terms of strength development and permeability reduction. Regarding ASR, the answer is maybe. The issue with ground glass pozzolan is that it has a very high alkali content (e.g., 10-15% Na_2O_{eq}). Ground glass pozzolan will reduce ASR expansion but because of the alkali it is contributing (the alkali loading issue), it tends to be not as effective as Class F ash. I would suggest that if ASR is your concern, before you move to a ground glass pozzolan, perform the ASTM C1293 test with the aggregate of interest. There is ongoing research on this question and hopefully this year we will have better data on how ground glass pozzolan performs when it comes to ASR. If ASR is not a concern, ground glass pozzolan is an excellent material (LLS).

6. We have been using AASHTO T 380 Mini Concrete Prism Test, which we feel has been a great in between from the accelerated test and the concrete prism test, do you have any opinions or experience with this test? Massachusetts

   I have not done any work with it but I have been following other research and so fa, it seems to perform OK. Long-term correlation is lacking so I hesitate to say it is the test to turn to. There is an NCHRP project ongoing now that is looking at the test in more detail and I think that is scheduled to be completed in the next 12-18 months. I think after that project we will have a better idea about how T 380 correlates with C1293 and field performance (LLS).

We are doing the AASHTO T 380 testing along with the ASTM C 1293 testing for this round of testing. Our final readings start this month and will continue for the next year so we will have comparisons soon. (PIB)

7. I've also heard about the Accelerated Concrete Cylinder Test (ACCT) for ASR, any thoughts or comments on this? Massachusetts

   I have not done any work with it either. Kind of the same answer as above. (LLS).

   Rich for more information on this test method feel free to contact Anol Mukhopadhyay, A-Mukhopadhyay@tti.tamu.edu. Jim

8. I've been wondering where the Turner Fairbank Test is at in their development for ASR testing, also known as the T-FAST Test. Last time I checked it was still in development, had great promise. Massachusetts

   I have not heard much since about a year ago. I know they are testing. They have the same challenge as T 380, establishing correlation with field performance. Based on what I know, I believe their aggregate test may have application. I am concerned about their version of the test that tests all materials combined because we all know materials in a project rarely remain constant, especially in this day and age of limited fly ash supply. The other concern is the sophisticated equipment required. I think it's an interesting test but I need to see some independent verification and also correlation with field performance (LLS).

9. Have you had any experience with Class N pozzolans like Metakaolin? With fly ash becoming more and more scarce, we are looking for other alternatives, like the recycled glass. Massachusetts

   Natural pozzolans can be very effective. As with all materials, test. But natural pozzolans have been used since the early 1900's and have had great performance. One issue is that the Class N specification itself is not very restrictive and there are materials that meet the specification but in fact are not pozzolans. So, as stated, test, test, test. That said, metakaolin is an excellent, proven material. In terms of mitigating ASR, there is really nothing more effective than metakaolin. (LLS)

   We are looking into them also. It would be great if the states could get together and discuss information or testing that everyone has done to this point. We will probably be doing some in house testing in the near future. I know PSU is working on looking at alternative SCM's. I am not sure how soon their results will be published. (PIB)

10. MassDOT is having the same "finger pointing" issue with scaling as well, we ended up doing a mockup of 54 panels of concrete, consisting of different mix designs, curing methods, and de-icer methods. We found out that residual spray from the road, and lack of curing to be culprit, as they performed the worst. Massachusetts

    Your experience is perfectly consistent with what I have seen in other states. The salt spray from the road to sidewalk is a common source of problems as typically, the side walk is high w/c or otherwise not as durable as paving concrete and the road salt can cause issues to the sidewalk, but not impact the pavement. As for curing, it is always an issue (LLS).

I am not surprised to hear that you face similar challenges, as we all face similar freeze thaw cycles and materials in the Northeast and Midwest. In the petrographic analysis done on the project(s) I referred to, lack of curing was indicated and identified as a leading cause. The NRMCA finishers' certification program enables us to provide education that shows why there is a need for curing and to emphasize its importance. I understand that this program has been presented in Mass. I would like to know more about how your state is using this program. Jim (jimc@pacaweb.org)

11. Can you explain why there was a drop in the % reactive aggregates when you started testing (from 70 to 35%)? Florida

    This was due to the fact that prior to the new specification, the test used was ASTM C1260 (AASHTO T 303) and it was reporting false positives (i.e., saying the aggregate was reactive, but it wasn't). The new program brought in ASTM C1293 which showed that many of those were marked as reactive, were not. Following the guides we discussed, a test result from C1293 takes precedence (LLS).

    I believe that decrease was due to a better test method was being used to determine the reactivity of our aggregates. (PIB)

12. C1567 is very severe - with options in C1778 which should govern? i.e. alkali loading, prescriptive SCM, or C1567, Virginia

    I am wondering if this is a typo and he is asking "which" options in C1778 should govern. C1567 is severe and the only way to circumvent that, in terms of the performance approach, is to use the two-year C1293 test. The other option that is available is to not take the performance approach but rather, use the prescriptive approach. But then, one could argue that the C1260 suffers from the same "severity", being the same test, in principal, as C1567. And you would need to run C1260, at a minimum, to establish your aggregate reactivity. So it may not circumvent the issue. In general, the purest approach would be the performance approach based on C1293. Anything else relies on either C1260, C1567, or both, and there is a risk of over estimating or underestimating reactivity. All that said, even C1293 is not perfect, no test is. So there is always a risk of getting it wrong. However, knowing what we know now, the safest approach would be the performance approach based on C1293 (LLS).

13. What do you think on having ASTM C 1567 with SCM but at 28 days. We have FAA specs that require this test at this age. California

    Using the 28 days limit will invariably lead to situations where you overestimate the reactivity, and you therefore over dose with SCM. If you have an ample supply of SCMs, or if you are not concerned with other effects of high SCM replacement, then go for it. However, most are concerned about the other effects and the 28 day limit is, in some cases, not conducive to an overall optimized mixture (LLS).

    Our experience in PA shows that our previous reliance on this shorter duration test methodology resulted in us over mitigating. Jim

14. What is "active silica" in aggregate? Aggregate (especially sand) is mainly made of silica. So what is the difference between "inactive silica" and "active silica" in the microscopic level? This reminds me about cancer. Cancer cells are regular cells turned to bad cells. Can we say ASR is the "cancer" of concrete? Wisconsin

Certain forms of silica are reactive and it primarily relates to the crystal structure of the mineral, or lack of crystal structure. An inorganic material without crystal structure is amorphous. A good example is glass.

For stable silica minerals, like quartz, you have a very uniform structure with tetrahedral coordination meaning each silicon atom is surrounded by four oxygen atoms. The bonds between the Si and O are very, very strong. Other forms of silica have either water molecules or atoms other than oxygen in the structure and the bonds between those other things and the silicon is weaker. The hydroxyl ion from the alkali minerals attacks the bonds and breaks them down, causing the mineral to disintegrate. The stable Si-O bond in quartz cannot resists the hydroxyl and therefore the quartz is stable or non-reactive. Basically, the more disorder there is in the silicate mineral structure, the more reactive it is. Silica glass has no order so it is very reactive. Many minerals are in fact a form of silica glass

15. Why fly ash is not recommended as SCM to alleviate ASR? Wisconsin

Fly ash IS recommended as an SCM to mitigate ASR. In fact, fly ash is the most common SCM used to mitigate ASR. Class F ash (low calcium) is the most effective ash. Some Class C ash (high calcium) will also mitigate ASR but it requires higher replacement levels than Class F ash. A key issue facing the concrete industry is that fly ash is in short supply in some markets and because it is the most common SCM for ASR mitigation, there is concerns about what to use when fly ash becomes unavailable. This is a primary reason why using the guidelines is important. We need to begin using scarce fly ash more wisely, not over dosing concrete because of not performing tests correctly, or at all.

Fly ash contains silica glass phases or components if you will, and like a reactive aggregate that contains glassy minerals, or components, glass phases in fly ash are also reactive. Unlike an aggregate, a fly ash particle is very small (microns in diameter) so when the fly ash particle reacts there is no physical expansion. The reaction does, however, consume the hydroxyl ions (so they cannot attack aggregate) and produces a hardened cement past that is more dense, So basically, fly ash consumes hydroxide and produces more calcium silicate hydrate (CSH).