Session 1 Unanswered Questions:

Q: What are the implications of high water cement ratio in enhancing ASR environment?

A: Water-to-cementing-materials ratio (w/cm) has limited impact on ASR. At very low w/cm internal self-desiccation can temporarily halt the process but exposure to external moisture will eventually lead to an internal relative humidity (RH) that is high enough to sustain ASR. The w/cm will affect the rate at which ions and water can diffuse to sites of reaction so there is a tendency for the rate of reaction to increase with increasing w/cm (assuming all other factors – e.g. alkali content – are equal). However, it has been claimed that there is more space in high-w/cm concrete to accommodate alkali-silica gel. Overall, the impact of w/cm is secondary and is unlikely to have an impact on whether or not ASR occurs in the long-term or a significant influence on the ultimate extent of ASR.

Q: Is there any specific mineral in a rocks composition that leads to greater reaction in the process?

A: Yes! Different alkali-silica reactive minerals react at different rates. Hydrous opaline silica (e.g. Beltane opal) is one of the more reactive forms of silica whereas strained quartz tends to me one of the least reactive … at least in terms of rate of reaction. However, it is not that simple! The more reactive forms of silica are more likely to exhibit a "pessimum effect" and if the quantity of silica in the concrete is in significantly in excess of this "pessimum proportion" there may be no damaging expansion. Reference should be made to the "ASR Facts Book" for a more complete discussion on this issue.

Q: The source of the glass is variable. Can changes in alkaies of the aggregate vary enough to cause ASR, or would the 0.11% swing in cement be enough to cause this; or is it a little of each?
Q: Are there sealers on the market that could sufficiently keep ambient moisture out of a precast product to lessen the likelihood of ASR? A recycled glass is being used as coarse aggregate, a low alkali cement in the 0.55-0.60 range, and metakaolin to mitigate reaction. The mix was developed when the cement was down around 0.44%, but now some ASR is being detected.

A: The alkalis in some aggregate are available for reaction and, if the content or availability of these alkalis changes, this would certainly have an impact on the risk of ASR occurring and on the extent of any damage. A change on the cement alkali content of 0.11% Na_2Oe would certainly be expected to affect the risk of ASR occurring and the amount of expansion. Regarding the use of sealers, there are products that have been shown to reduce the rate of ASR expansion; however, such products may not completely eliminate the risk of ASR. The efficacy of a sealer depends on its formulation, its application, the composition of the concrete, the type of concrete element being treated and the exposure conditions. Every case needs to be assessed individually. Reference should be made to the report on field studies. Regarding the issue with the use of recycled glass, low-alkali cement and metakaolin, it is not clear what question is being asked.

Q: Do we know how much water is needed to cause the reaction?

A: It is not really a question of how much water, but what is level of internal relative humidity (RH) is required to sustain the reaction. If the exposure conditions are sufficient to produce an internal RH > 80% then ASR can occur and the rate of reaction (and expansion) will increase with increasing RH above 80%.

Q: If Li cannot control ACR-induced expansion, how we can reason ACR expansion is due to ASR?

A: In the workshops it was reported that there is a growing school of thought that ACR may really be a form of ASR. The workshop presenters do not necessarily subscribe to this theory and did stress that regardless of the mechanism the rocks that exhibit typical ACR behavior (e.g. delomitization) should be treated as a separate class of AAR. Furthermore, there are some known alkali-silica reactive aggregates that cannot be controlled by lithium; generally, these are NOT carbonates and the reaction cannot be attributed to ACR.

Q: If low alkali cement, pozzolans, slags, and lithium are not effective against ACR, what can be used short of using another source of aggregate?

A: some researchers have shown that reducing the aggregate size or diluting with other non-reactive rocks can be an effective solution. This is not necessarily the view of the workshop presenters.

Q: Is there a pessimism effect due to particle size of reactive silica species? Do some aggregate sizes that do not cause expansion although they contain reactive species?

A: Generally the rate of reaction increases as the particle size decreases. However, if the reactive aggregate is ground to sufficient fineness and used in sufficient quantity reaction can be prevented. There is no universal agreement regarding how fine the aggregate needs to be before it ceases to cause expansion.