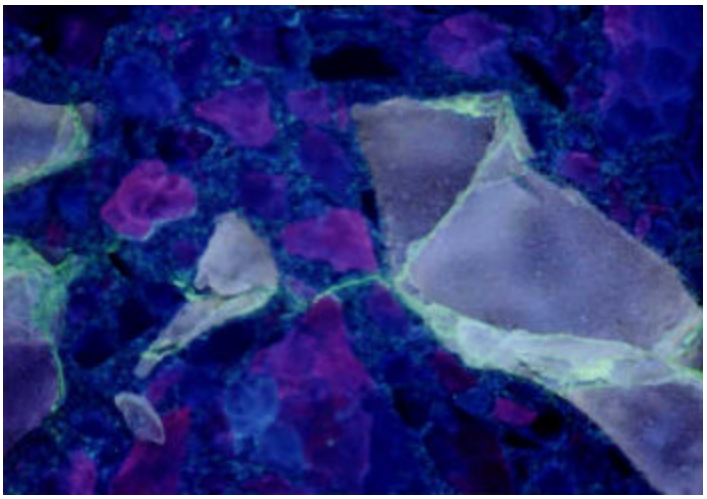
# Glass Concrete

The recycling of waste glass poses a major problem for municipalities nationwide. New York City alone collects more than 100,000 tons annually and pays Material Recycling Facilities (MRF's) up to $45 per ton for the disposal of the glass, commingled with metals and plastics. While the MRF's have little difficulty with profitably disposing of the metals and plastics, markets for recycled glass are limited to nonexistent.

The use of crushed waste glass as aggregate in concrete is problematic because of the chemical reaction between the alkali in the cement and the silica in the glass. This alkali-silica reaction (ASR) creates a gel, which swells in the presence of moisture, causing cracks and unacceptable damage of the concrete. It can also occur in regular concrete, if the natural aggregate contains certain reactive (typically amorphous) silica.

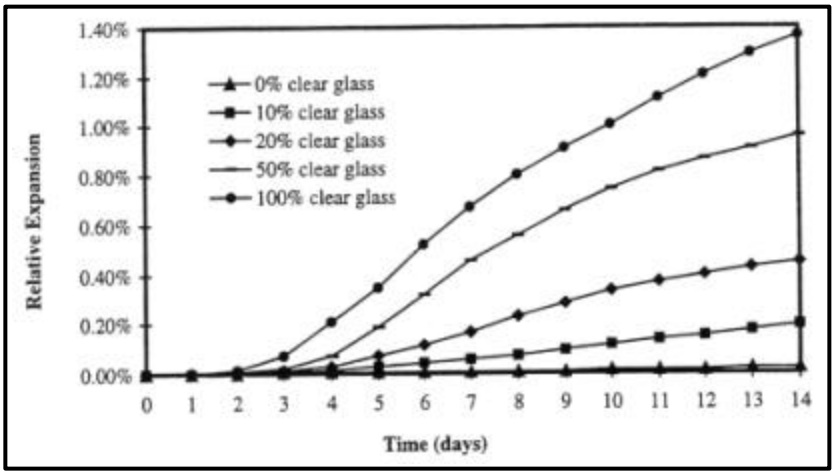


*ASR in uranyl acetate treated concrete, visualized under UV-light*

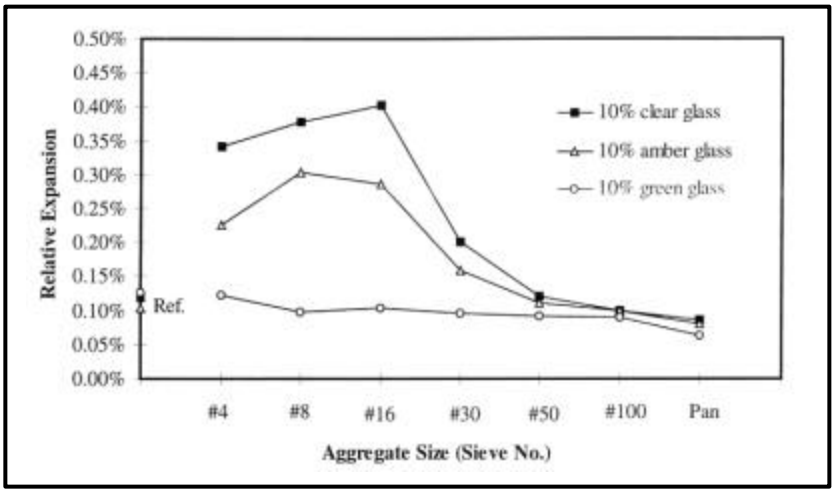
This phenomenon is particularly vexing, because it is a long-term problem, and the detrimental consequences may not show for years. Predictions of the susceptibility of naturally occurring aggregates are uncertain, as they require accelerated laboratory tests, which are of limited reliability.

There is not much uncertainty with regard to ASR if waste glass is used as aggregate in concrete. Research at Columbia has focussed on a basic understanding of the ASR phenomenon and on searching for ways to avoid it or to mitigate its detrimental consequences. Some of the techniques developed so far or under investigation are:

- Grinding the glass fine enough. Mortar bars containing glass particles, which pass US standard sieve #100 show no measurable expansion in the ASTM C 1260 Test.
- Replacing part of the cement by metakaolin. This solution is well known in the concrete industry and utilizes the fact that the metakaolin absorbs the alkali ions responsible for the reaction.
- Since metakaolin is relatively expensive, costing about three times as much as cement, we are now searching for other, low-cost ASR-suppressing admixtures.
- Applying protective coatings to the glass particles. The efforts of expanding this solution into a viable and economical alternative are still at the conceptual stage.
- Modifying the chemical formulas for the glass. Our research has shown that small amounts of additives added to the glass melt have the potential of suppressing the ASR expansion. Columbia University has obtained a patent for discovering that green glass (e.g. Heineken and Beck's beer bottles), which owes its color to chromium oxide, causes little or no reaction according to the ASTM C 1260 Test.
- Similarly, the FMC Corporation is at present commercializing another patented Columbia invention, namely the fact that glass powder containing lithium can serve as an effective ASR suppressant.




*Expansion of mortar bars vs. time with variable amounts of clear glass aggregate (ASTM C 1260 Test)*




*Expansion of mortar bars vs. aggregate size of clear, amber, and green glass aggregate (ASTM C 1260 Test)*

## Research Sponsors

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- New York State Department of Economic Development
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