

# High Volume Fly Ash Concrete for Colorado's Ocean Journey Aquarium

From the visually breathtaking use of shotcrete to create the architectural features of rocks and trees in the Ocean Journey complex, to the 8,500 cubic yards of high performance concrete for the salt-water tanks and the structure in general – all benefited from the use of Headwaters Resources fly ash.

S.A. Miro Engineering sought a high performance concrete with the following features:

- Low drying shrinkage
- Low permeability
- High compressive strength
- Corrosion resistance
- High slump for constructability

Initial concrete specifications were:

- 6600 psi at 28 days
- Max .35 w/c ratio
- Minimum 725 lb cement
- 110 – 115 lb/cu yd Class F fly ash
- 4.5 – 6.5% entrained air
- Max 9 inch slump
- .040% max. drying shrinkage
- 1.5 lb cu yd Fibermesh MD
- Rheocrete 222+ corrosion inhibitor

Trial batches by Aggregate Industries Technical Services Manager Kevin Kane indicated the best combination of materials to achieve the specified performance would require changes to the limits on the mix constituents. Aggregate Industries determined that reducing the cement content to 610 pounds and raising the fly ash content to 210 lb/cu yd provided the specified performance including 8000 psi (to allow for ACI overdesign), slump retention, workability and reduced heat of hydration required for quality in-place concrete. Additionally, supplementary water reducers were introduced to the mix, and the engineer agreed to remove

*The Ocean Journey aquarium project utilized up to 30% fly ash in its concrete mixes. Fly Ash was used in every phase of the project – from salt water tanks to decorative features.*



the need for air entrainment because the high performance concrete would only experience freeze / thaw cycles during construction.

• • •

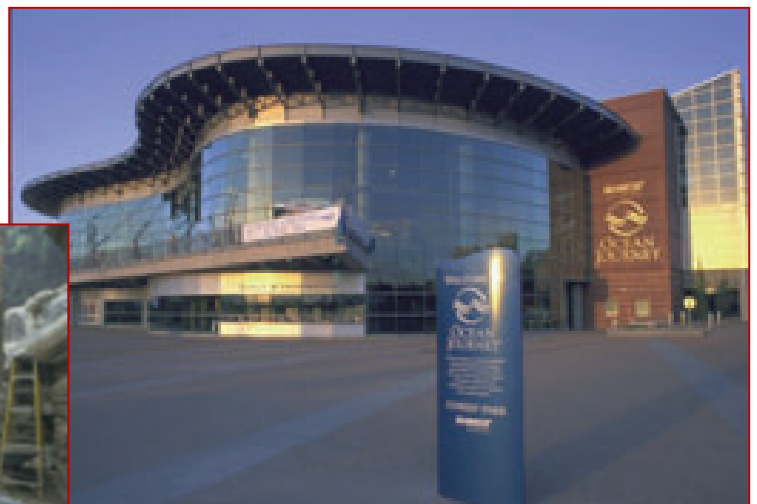
*Aggregate Industries of Denver, Colorado selected concrete mixes with 25% to 35% Class F fly ash for general contractor Hensel Phelps/Alvarado to meet the high performance concrete specifications set by S.A. Miro Engineering for Colorado's Ocean Journey Aquarium project in Denver.*

• • •

Variations of the high performance mix developed throughout the project included higher slumps for increased flow around large blockouts, low slumps of 2-3 inches on stairs and a variety of set times for different elements on the project.

The 65,000 square feet of fabricated rockwork and 800 fabricated trees by The Larson Company utilized approximately 800 cubic yards of shotcrete designed with 30% Class F fly ash. The mix provided long drum life, extended workability time for the detailed (hand) rockwork, and minimal rebound. The reduced rebound alone was a substantial savings for the contractor.

Based on what was learned on the project, Aggregate Industries would make some minor changes in the mineral and chemical admixtures for a similar project. But, the knowledge gained from this and subsequent projects has allowed them to continue using high Class F fly ash contents in performance concrete. This includes low permeability water tanks, high strength columns and slab on grade mixes with 30% fly ash that finish the same as straight cement, but have improved strength and durability.



Images by Scott-Dressel Martin

**For more information or answers to questions about the use of fly ash in specific applications, contact your nearest Headwaters Resources Technical Sales Representative or call 1-888-236-6236.**

**HEADWATERS**  
RESOURCES

10701 S. River Front Parkway, Suite 300  
South Jordan, UT 84095  
[www.flyash.com](http://www.flyash.com)