The San Vincente Pipeline is a raw water transmission pipeline of the San Diego County Water Authority's Emergency Storage Project. The pipeline links San Vincente Reservoir, located on the east side of the County, and the Water Authority's second aqueduct, located on the west side of the County. The project involves the construction of an eight and one-half foot diameter water pipeline in an eleven mile long tunnel.

The tunnel was excavated in extremely variable geologic conditions consisting of strong granitic and metamorphic rocks, weak sedimentary rocks, abrasive conglomerates and mixed face conditions. Groundwater levels vary along the tunnel alignment ranging from below the tunnel invert to about 110 feet above the tunnel invert. Approximately 60 percent of the tunnel is below the groundwater level, although groundwater levels in only about 20 percent of the tunnel are more than 50 feet above the tunnel invert.

The design of the tunnel liner was prepared by Jacobs Associates and required conventional rebar reinforced precast concrete segments as an initial liner. An eight and one-half foot inside diameter steel carrier pipe was to be built within the liner and the annulus between the steel pipe and the concrete segments was filled with concrete.

The precaster, Traylor Shea Ghazi Precast, proposed to redesign segments to utilize steel fiber reinforcement. Their designer, Halcrow, provided detailed design calculations and drawings to eliminate the entire rebar cage and use 50 lb/yd$^3$ of steel fibers that provided a residual flexural strength of 435 psi. Since the liner was to be grouted in-situ during mining and backfilled with concrete, the joints would not be gasketed. This allowed the Traylor Shea Ghazi Precast to use vertical segment moulds and self compacting concrete.

The precaster plant produced approximately 66,000 individual segments using over 33,000 cubic yards of concrete. Production took 15 months.

**Challenge:**
- Cost savings
- Faster segment production
- Less damage of segments during installation

**Solution:**

<table>
<thead>
<tr>
<th>Dramix® RC-80/60-BN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lining Thickness:</strong> 7 inches (177 mm)</td>
</tr>
<tr>
<td><strong>Tunnel Diameter:</strong> 11.67 feet (3.6 m) O.D.</td>
</tr>
<tr>
<td><strong>Tunnel Length:</strong> 58,080 feet (17.7 km)</td>
</tr>
<tr>
<td><strong>Concrete Strength:</strong> 6,000 psi (41 Mpa) SCC</td>
</tr>
<tr>
<td><strong>Fiber Dose:</strong> 50 lb/yd$^3$ (30 kg/m$^3$)</td>
</tr>
</tbody>
</table>

Vacuum mechanism is used to lift and rotate segments.
Clarion is a large manufacturer of various cosmetics. This facility is intended to expand their warehouse and distribution capacity. The floor-on-ground slab is subject to automatic guided vehicle (AGV) traffic throughout a 25-foot tall storage rack system. After the floor is placed, a wire system will be installed along the center aisles to guide lift truck traffic.

A Crown Automatic Guided Vehicle (AGV) is used to access products in Clarion's existing warehouse and distribution facility. Similar equipment will be installed in the new addition.

The contractor partitioned the floor into four areas. Each area constituted one day's work. Craftsmen are preparing area one on the morning of the first day.

Design specifications called for completion of roof construction prior to start of slab placement. The roof deck along with side-wall tarpaulins helped protect the young concrete during placement.

Dramix® Steel fibers were conveyor fed to the concrete trucks onsite. Each 10 yard load was conveniently loaded with ten 50 lb. bags of Dramix®.

Finishing operations included power "pizza pan" and rotating blade trowels (above) and a walk-behind power trowel (left). Note that pan floats were used to establish flatness (Fmin = 50) and the blade trowels were used for high quality finishing.

While the laser screed team was completing placement activities on the fourth day, craftsmen sawcut floor joints in area three which was placed during day number three.

Challenge:

Capability to withstand AGV traffic

Solution:

Dramix® RL 45/50 BN

- Project Size: 60,000 ft²
- Floor Thickness: 9 inches
- Strength: 4,500 psi
- Joint Spacing: 15 – 18 ft on center
- Fiber Dose: 50 pcy

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Dramix® Steel Fibers

GE MAINTENANCE HANGAR & APRONS

Aircraft Hangar
Floor and Apron

Location: Victorville, CA

Contractor: The Haskell Company
Concrete Supplier: Robertson's Ready Mix
Year: 2003

This facility will be used by GE to maintain aircraft engines on any size plane up to a Boeing 747. The Haskell Company is a design/build contractor and chose Dramix® RC-65/60-BN Steel Fibers for toughness and durability for the project's hanger floors and exterior apron pavements. In addition, Haskell wanted to reduce the schedule of slab construction by eliminating the time and labor of placing conventional rebar mats. The project plan was "fast-tracked" so all slab placements would be completed in a condensed time frame - approximately 6 months.

The project included an 82,000 ft² hangar floor that was 7-inches thick and sloped toward two large trench drains running east to west. The slab between the trench drains was 11-inches thick. The 200,000 ft² exterior apron pavement is 11-inches thick. All slabs on this project used 33 lb/yd³ of Dramix® RC-65/60-BN steel fibers. An epoxy floor coating was later applied to the hanger floor upon completion. The exterior pavement was broom finished.

The concrete mix was 5,000 psi compressive and 700 psi flexural strength per The Haskell Company's requirement. The concrete was supplied by ready mix and the Dramix® fibers were added at the jobsite. All interior slabs were water cured for seven days to eliminate having to remove membrane curing compounds before subsequent applications of epoxy coatings in the hangar and floor coverings in the office areas.

Challenge:
To strengthen slabs and improve project scheduling

Solution:
Dramix® RC-65/60-BN

Floor Thickness: 7 & 11-inch floor
Concrete Strength: 5,000 psi
Fiber Dose: 33 lb/yd³

The hangar is large enough for a Boeing 747

Engine maintenance is performed at the facility for a number of carriers.
Ikea Furniture Warehouse needed additional space for their Burlington location for warehouse storage, maintenance space and offices. Extensions were built on the east and west sides of the existing building increasing the square footage by 38,000 feet.

Super plasticizer was used to increase slump to 150 mm and 25 kg/m$^3$ of Dramix® Steel Fibers was added to the concrete mix. Traprock, a non metallic surface hardener, was used as a finishing surface. A total of 160 m$^3$ of concrete was used to complete this additional warehouse space.

**Challenge:**
Design to accommodate rack loads and fork truck loads

**Solution:**

Dramix® RC 80/60 BN

- Project Size: 38,000 Ft$^2$
- Floor Thickness: 175 mm slab
- Design Loading: 3500 lb forklift axle and 4500 lb post loads
- Concrete Strength: 35 MPa
- Fiber Dose: 25 kg/m$^3$