Technical Bulletin No. 1

PERMEABILITY AND CHLORIDE ION PENETRATION OF **IPANEX** CONCRETE

Background

IPANEX Concrete has been used to waterproof structures since the early 1970's. Some of these have been subjected to severe saltwater exposure. Additionally, chloride ion and penetration testing has been completed at independent laboratories.

Purpose

The purpose of this technical bulletin is two-fold:

1. To identify and report on several structures exposed to concentrations of saltwater and or hydrostatic pressure.
2. To briefly describe and report the results of chloride ion penetration tests using AASHTO T-259 and T-260 procedures and permeability tests using modified CRD-C 48-55 procedures.

Case Histories

1. **Pennsylvania Turnpike Bridges**
   In 1973 and 1974 eight turnpike bridges were replaced between Bedford and Somerset. Seven decks used regular concrete. IPANEX was used on the eighth deck. In 1981 an inspection showed that the IPANEX deck did not show any deterioration. All of the other decks exhibited deterioration in the form of cracks accompanied by efflorescence and spalls. An inspection in March 1989 indicated significant increases in the spalling, cracks and efflorescence of the non-IPANEX modified decks. In one instance stalactites had formed. The IPANEX deck remains in excellent condition. The commission used IPANEX in 1986 in a bridge over the turnpike and is planning continued use of the product.

2. **Humana Inc. Headquarters Building, Louisville, Kentucky**
   This high rise office building was designed by Graves Warneke (a joint venture) and the structural engineer was De Simone, Chaplin and Associates. The building, constructed in 1983, contains a below grade two story concrete garage which must resist up to 16 ft. of hydrostatic pressure. This structure is founded on a pressure slab measuring 215 ft. by 170 ft. with thickness of 5 ft. and 2 3/4 ft. The exterior walls are 12 inches thick. After six years of service this structure remains free from water entry.

3. **Philadelphia International Airport Parking Garages B & C**
   These garages contain approximately one million square ft. of parking area built at a cost of 23 million dollars. Construction took place during 1975 and 1976 using a precast system with a concrete topping over double tees. IPANEX was used in approximately 17,000 cubic yards of topping concrete to waterproof the decks and insure long term durability. After twelve years of service the IPANEX Concrete in the topping is still in good condition. Plans and specifications for a similar structure (Garage A), which is to be built in 1989-1990, include IPANEX waterproofing admixture to insure the same level of performance.

4. **Indianapolis Zoo in White River State Park**
   Contract documents were prepared by James Architects and Engineers, Inc. and the construction manager was Geupel DeMars, Inc. The design included water containment vessels providing habitats for fish, aquatic plants, and mammals. These structures range in size to 128 ft. x 56 ft. x 22 ft. All of the concrete for the water retaining structures contained IPANEX. More than 4,500 gallons of product were used on this project. The zoo is now open to the public, and water containment facilities are performing well.

5. **Waste Water Treatment Plant New Castle County, Delaware**
   This plant constructed in 1978 was built to handle a half million gallons of flow per day. IPANEX Concrete was used for waterproofing and durability in the five biodisk tanks and the sand filter along with foundations for several other structures. It is now twelve years later and there are no signs of water leakage or concrete deterioration.

The above case histories are specific examples of IPANEX Concrete applications. Since the early 1970's IPANEX has been used in more than fifty parking structures, several watertanks, more than one hundred below grade foundation wall systems in commercial buildings, several wastewater treatment plants, in addition to the structures discussed above.

Tests and Results

1- AASHTO Designation: T259-78 Resistance of Concrete to Chloride Ion Penetration; AASHTO Designation: T 260-78 Sampling and Testing for Total Chloride Ion in Concrete. These tests involve the ponding of a 3% sodium chloride solution 1/2 inch deep for 90 days. Samples are then taken from depths of 1/16 inch to 1/2 inch and 1/2 inch to 1 inch. The average concentration of chloride ion is then determined. Concentrations at these two levels are compared from slabs with and without IPANEX.

When IPANEX was added to concrete, chloride ion penetration was reduced by 23% at the 1/16 to 1/2 inch depth and 75% at the 1/2 inch to 1 inch depth. This test was developed to measure resistance to penetration by saltwater into concrete.

2. CRD Designation: CRD-C 48-55 (Modified) Method of Test for Water Permeability of Concrete- The test was conducted to compare the permeability of IPANEX Concrete to control concrete. Six-inch diameter cylinders were cast using a six sack 4,000 psi mix design. The tops of the concrete cylinders were exposed to a point source of blue dyed water at a pressure of 100 psi for a period of 72 hours. The cylinders were then split down the middle and inspected. The procedure was repeated. The following results were obtained.

Test No.	Penetration		Reduction
	Control	IPANEX	
1	2"	1/2"	75%
2	1 3/4"	1/8"	93%
			Avg. 84%

When IPANEX was added to concrete the depth of penetration by water was reduced by 84%. However, the volume of concrete penetrated by the dyed water was reduced by more than 98%.

Product Technology

IPANEX is a liquid inorganic copolymer. It reacts with free lime to form insoluble crystals which densify the cement paste by precipitating in the pore structure and capillaries. The pore structure in IPANEX Concrete, as compared to control concrete, differs in the following way: pores are smaller and more evenly spaced throughout the IPANEX cement paste. This greatly reduces the tendency for pores to link together and form a pathway for water to enter. The above, combined with the reduction of chloride ion penetration and water permeability, preserves the concrete's positive protective environment for the reinforcing steel. IPANEX Concrete, even though it is more dense, has smaller pores and less linking of pores, can still breathe.

Conclusion

IPANEX has been successfully used to prevent deterioration and improve durability of concrete in many different types of structures. Chloride ion penetration testing and water pressure testing have proven that IPANEX admixture improves concrete. Resistance to chloride ion penetration is improved by 75% and penetration by high pressure water is reduced by 98%.

Specifiers requiring data for a specific project, contact the Engineering Department, IPA Systems, Inc., at 800-523-3834, Ext. 205.