TEST RESULTS ANALYSES
OF KALMATRON® KF-A,
HIGH ALUMINA CEMENT, &
ORDINARY PORTLAND CEMENT
FOR PRODUCTION OF CONCRETE SEWAGE PIPES.

TEST PROCEDURE PROVIDED BY “TONDALEE TRADING CO., LTD”

8F,219, SECTION 1, TUNG HWA S. ROAD **Phone: 886-2-2721-8069**

TAIPEI, TAIWAN, R.O.C. **Tondalee@ms14.hinet.net**

TEST ANALYSES PROVIDED BY KALMATRON® CORPORATION

276 Michele Ct., S. San Francisco **Phone: 415-385-3290**

CA, 94080, USA **kalmatronworld@aol.com**

Excellence in testimonial procedure of every group of concrete specimens allows us to find plenty of advantages and some limitations in every component of the concrete mix recipes. The concrete mix design containing KALMATRON® KF-A was proposed by KALMATRON® CORPORATION and the mix design with Portland Cement and High-Alumina Cement was developed by the research team. Every group of specimens was tested for slump, flow ability, compressive strength, concrete density, Dynamic Modulus of Elasticity, and Chemical Resistance.

Test results for KF-A specimens and test results for Portland (Pol) and High Alumina (AL) Cements can not be recognized as acceptable for comparison because:

1.the cement content in mix designs for Pol and AL is larger than in KF-A mixes by 150 Kg.

2.the water to cement ratios are smaller for Pol and AL than in KF-A mixes by 0.14.

3.application of Superplasticizers with large amount of cements (480 Kg/m^3) in mixes containing Pol and AL classifies them as High Performance Concrete mix designs, while mixes with KF-A are conventional concrete mix designs with a moderate amount of Ordinary Portland Cement (330 Kg/m^3).

By nature of experiment it is essential to compare conventional concrete mix design with added KF-A and High Performance Concrete mixes in terms of resistance to corrosion.

SLUMP & FLOW OF CONCRETE BATCH

KF-A: During batch installation and mixing, it was noticed that there was no creamy effect, which can be explained by somewhat insufficient water content. The recommended water to cement ratio is based on the standard moistness of sand and aggregate. Often it is a bit lower, which can be correlated by adding water according to original instructions of KF-A application. In our case it caused very low slump and the absence of flow ability. In accordance with previous experience we find that a ratio of W/C = 0.492 solves the problem. Pol & AL: Both groups of specimens showed excellent slump and high flow ability.

COMPRESSIVE STRENGTH

KF-A: Insufficiency of W/C caused absence of creamy effect and some reduction of compressive strength, to 37.7 MPa. The compressive strength for this mix design is between 42 MPa and 45 MPa. Also, batch vibration after casting into the cone produced a higher compressive strength than the opposite technique.

Pol & AL: Lower W/C and higher cement content gave excellent strength reading at 52.6 MPa, which is higher than the expected average of 45 MPa for specimens with KF-A.

ULTRASONIC VELOCITY

Readings of concrete specimen density for KF-A, Pol, and AL are over 4500 m/s [1] indicating excellent structure forming performance of all tested groups. The difference between readings is far below 10% and does not exceed 3.5%.

MODULUS OF ELASTICITY

The difference between the lowest and highest readings is 4.5%, twice below the 10% limitation, which is insignificant for any distinction between the mixes.

CHEMICAL RESISTANCE

Tests for erosion of concrete specimens in Acid Solution showed dominating resistance to Acid corrosion by KF-A specimens, 1.5 to 2.45 times above Pol & AL resistance.

Erosion variation of concrete specimens in Alkaline Solution showed dominating resistance to Alkaline corrosion by KF-A specimens, 4 to 10 times, where result for Pol is excluded since it showed higher readings than AL, which is contradictory. That test reading was taken at an earlier stage of C_3A maturing and should not be viewed as the final result of the test.

Dr. Alex Rusinoff

[1] - Neville, Adam M Properties of concrete, 3rd edition 1993, page 583.

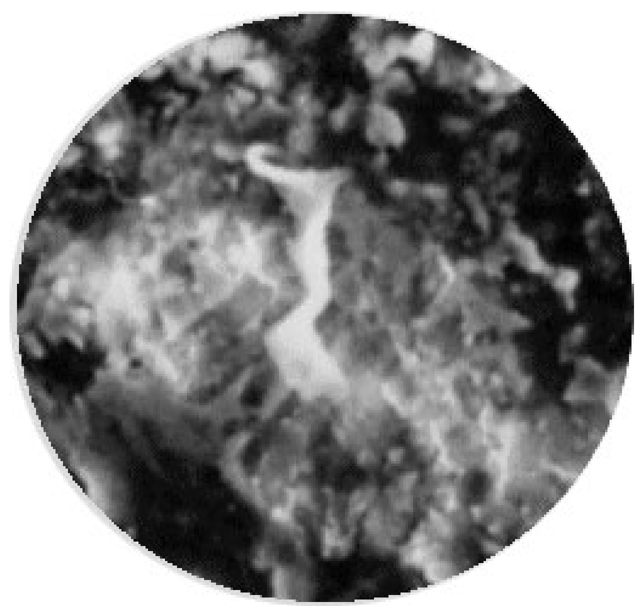
THE PETROGRAPHY ANALYSES OF CONCRETES CRYSTALLINE STRUCTURE

Present petrography analyses are dedicated to the research results provided by "Tondalee Trading Co.", Taiwan, for recognition of concrete mix design with the highest resistance to microbiologically developed acidic corrosion in sewage precast concrete structures.

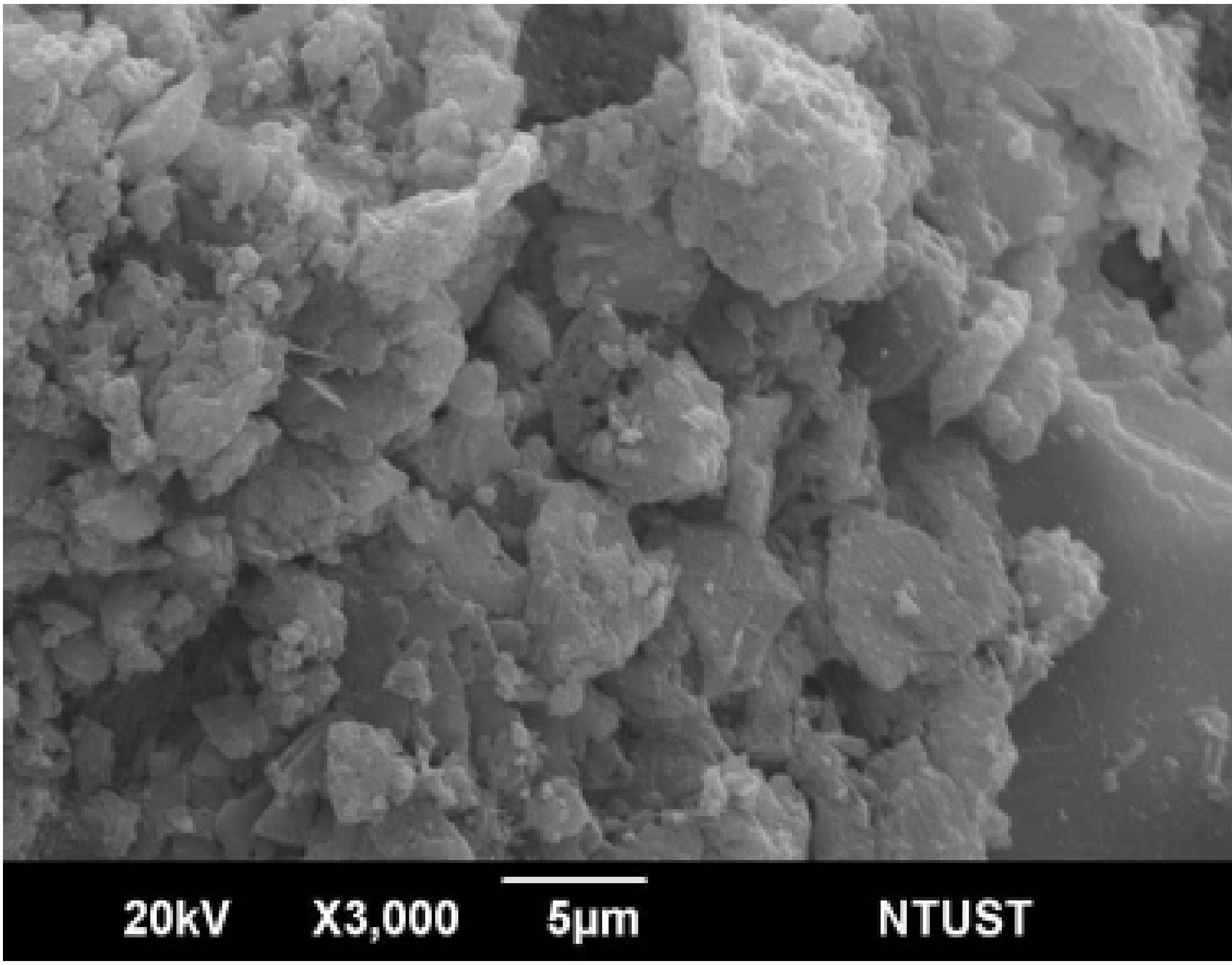
This type of corrosion may exist in an environment containing self decaying organic elements under oxidation by free molecules of water. In a matured concrete structure these are unhydrated cement particles. The higher their content is, the more vulnerable the concrete is. Concrete's resistance to corrosion decreases as the amount of Calcium Silicate Hydrates (C_3S & C_2S) decreases. That is why concrete mix designers tend to increase the amount of cement to get more C_3S & C_2S with higher effect of C_3A, or to apply High Alumina cement, or micro cements.

Another way to get a higher amount of C_3S & C_2S is increasing the speed and volume of cement hydration with the KALMATRON® KF-A concrete admixture, which was developed for that purpose.

"Tondalee Trading Co." also provided research for replacement of micro-cement by Ordinary Portland Cement with added KALMATRON® KF-A. Specific Surface of Portland Cement is 2,300 cm^2/gr. With KF-A admixture, the same cement achieved SS at 6,000 cm^2/gr to 8,000 cm^2/gr.



Microphotographs (X600) of concrete with added KALMATRON® KF-A after 28 days. The upper picture shows shell-like opened formations, which are relevant to Calcium Silicate Hydrates shaped as a layered structure. The picture below shows a flat crystalline field and funnel formed new growths.

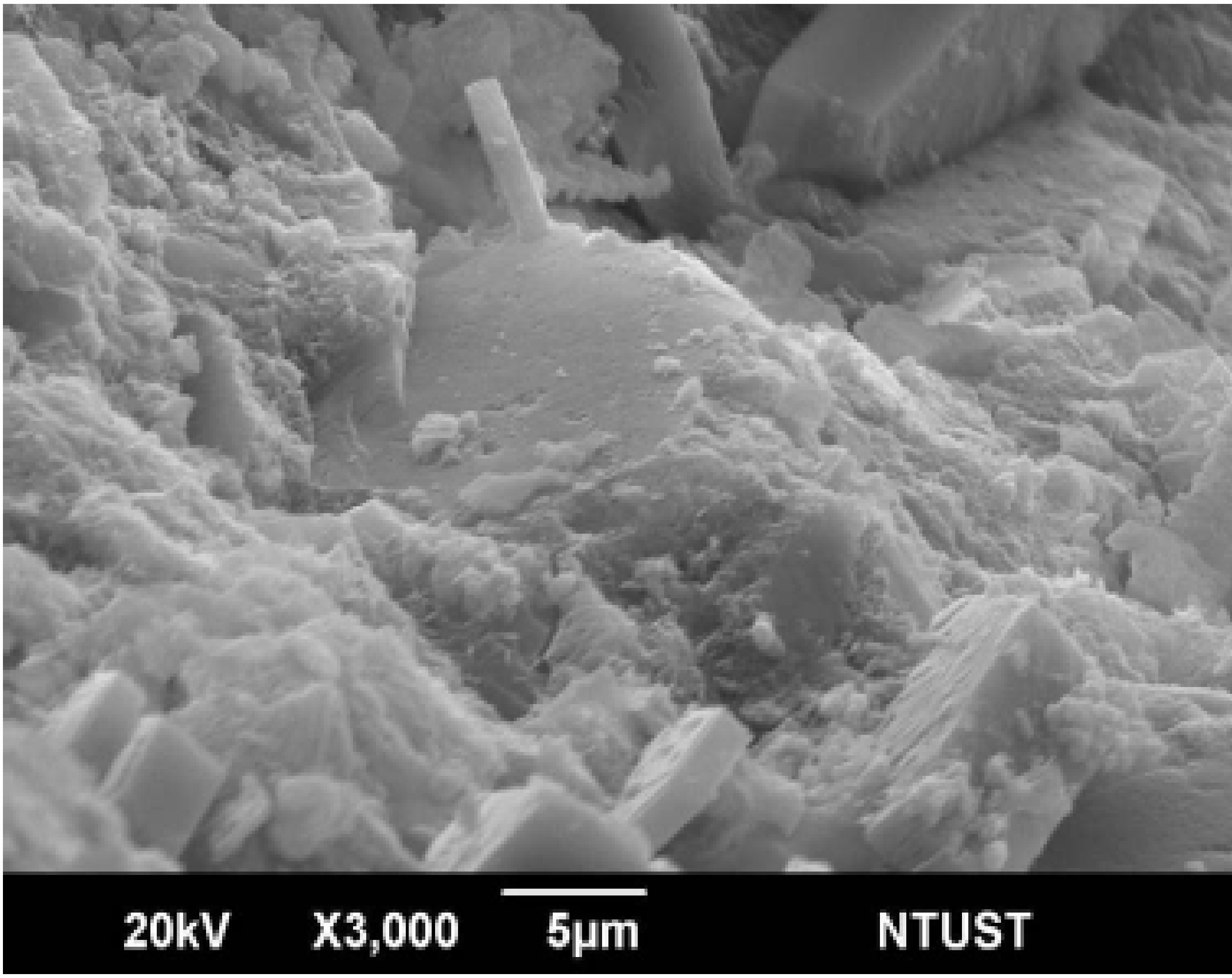


2 SEM photograph of Standard Concrete (Enlarge 3000 times)

A scanning electron micrograph of Standard Concrete illustrating chaotic formation of prisms in accordance with probabilistic nature of multi centered crystallization. With a convenient simplification we can see C_3S (alite) in the largest amounts of equidimensional colorless grains; C_2S (belite) represented in basic shapes from thin prisms to linear grows, and C_4AF as a solid solution among other crystals.

Since the speed of every type of crystal formation is different (from a few hours to decades), the compaction of the crystalline field is low, as shown in photograph 2. Those crystalline structures are the most unstable in response to changes in temperature, humidity, and chemicals.

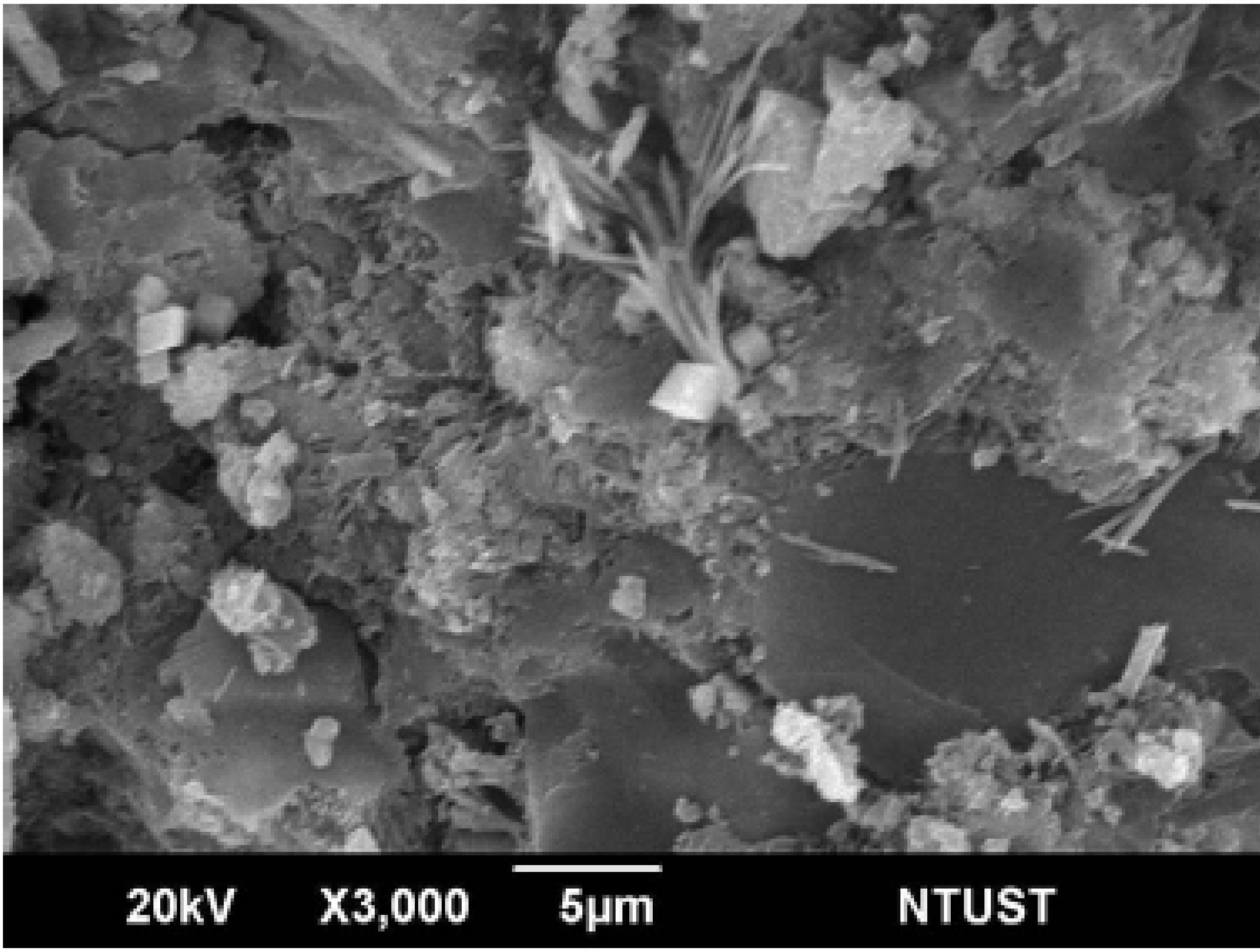
Imaginary integral area of the surface of such crystalline field is much large than any other field formed by spontaneously grown crystals. Hence, the less integral area of crystalline surface, the higher its density, resistance to rupture and corrosion where the fineness of cement or its hyper hydration is the key operator in that process.



3 SEM photograph of High-Alumina Concrete (Enlarge 3000 times)

A scanning electron micrograph of High-Alumina Concrete illustrating crystalline space formed by cubic crystals C_3AH_6 and the plates of C_3A presented by quadrangular prisms. On micrographs C_3A appears as a prismatic dark interstitial material, and is often in the form of flat plates individually surrounded by the calcium silicates hydrates. $Ca(OH)_2$ as a result of hydrolyses, always form hexagonal plates as thin as 0.001 µm. Eventually, they merge into a massive, continuously crystalline deposit. At the early stage of crystallization, those prisms can be dissolved with an Alkaline Solution.

Present test results show that resistance to Alkaline corrosion of High Alumina cement is lower than that of Ordinary Portland Cement. That test reading was taken in earlier terms of C_3A maturing and should not be considered a final result for that test.



4 SEM photograph of Concrete with KF-A (Enlarge 3000 times)

A scanning electron micrograph of Concrete containing KALMATRON® KF-A illustrating crystalline spaces formed by continuous plates or opened shell-like new growths. It shows that Calcium Silicate Hydrates exist as a layered structure: e.g. montmorillonite and halloysite, containing fibrous particles, flattened particles, and a reticular network of opened shells.

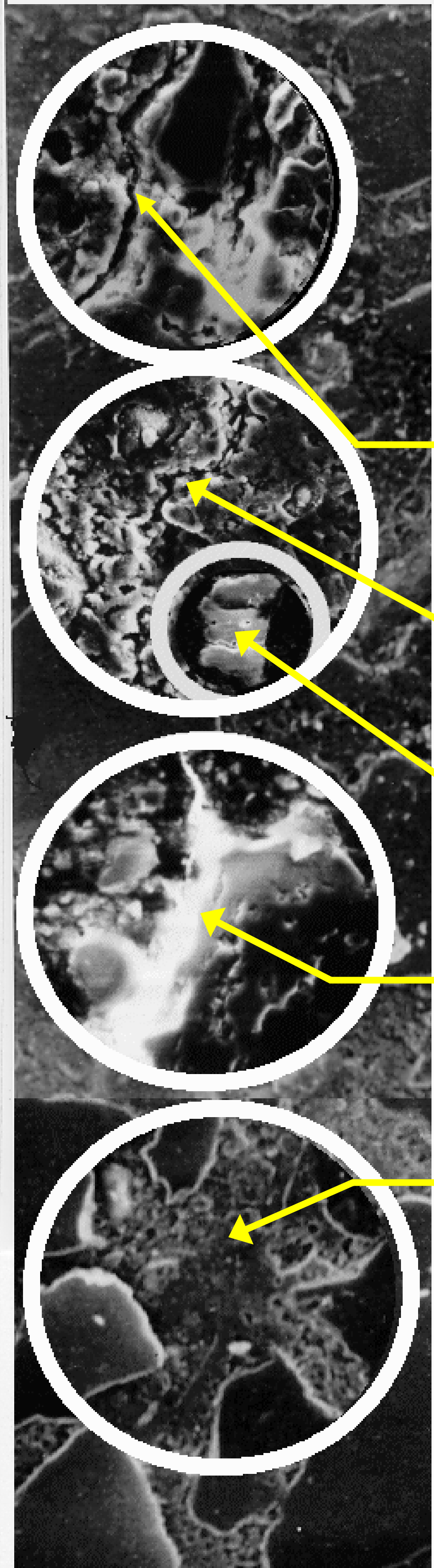
Separate tetrahedral shaped particles result from overly concentrated mineral solutions, which become the centers of crystallization during additional hydration.

Another type of crystal is a singular thingonia or "cilia" like new growth, developing on the edges of flake-like new growth areas. These types of crystals provide micro-sewing of the structural voids and are widely used in the industry for rehabilitation of damaged or aged concrete.

MICRO-SEWING OF CRACKED CONCRETE BY BELITE REHABILIRATION

The following microphotographs (X60 and X600) were made during studies conducted with 28-day old concrete specimens containing KALMATRON® after a thermal shock at 400°C.

Magnetically sprayed concrete sawdust on an aluminum film was taken four times every 24 hours and photographed, as shown below.



Cracks in the concrete specimen at the age of 28 days after thermal stress (X60).

The edges of the cracks are shown with the new crystalline formation (X60).

Magnification of the prismatic belite grain as the new crystalline formation (X600).

Micro-crack is filled with new crystalline formations or healed due to a cross - linking effect (X600).

Regenerated concrete micro structure as a result of re-crystallization by KALMATRON® (X 60).

Ability to fill up cracks, voids, and pores of aged or environmentally attacked concrete by regenerated belite with enormous new growths produce a highly dense micro-structure on Feret's curve.