Oriental Trexim Pvt.Ltd.

Building Future

Silica Fume / Microsilica for Water-Proofing

Silica Fume Waterproof Concrete

Any waterproofing system must meet all serviceability criteria (see fig 2) i.e.:

- Permeability – The concrete, joints and cracks must all have an acceptable water penetration rate.
- Durability – The concrete must be durable in respect to chemical attack and corrosion resistance.
- Structural – The concrete's physical properties (strength, creep, modulus and shrinkage) must be acceptable.

Silica fume WPC satisfies all these criteria in regards to the concrete matrix and provides the designer with the first rational design approach (a supporting spreadsheet is available) to this problematical area. The design of integral waterproofing is based on Valenta and Darcy equations for permeability, modified using standard factors of safety i.e.:

Depth of penetration

$$d = (2f_1.f_2.f_3.k.t.h)^{0.5}/v$$

Flow Rate (m^3/sec)

$$Q = f_1.f_2.f_3.k.Ah/d$$

where

f_3 = load factor
f_2 = materials factor
f_1 = test factor
k = permeability (m/s)
h = pressure head (m)
t = time(secs)
v = voids fraction (0.1)
A = area of flow

Using these equations, the required permeability can be calculated for any design situation. A suitable mix design can then be determined from permeability graphs like those shown in figs 4 & 5.

Figure 6 shows that silica fume WPC reduces permeability by reducing the pore size.

Other properties achieved include increased chemical and corrosion resistance and lower heat of hydration.

Silica fume WPC should not be confused with damproof concrete achieved using water repellents in above ground concrete.

Benefits of Silica Fume Waterproof Concrete

No Membranes or Drainage Required

- Major cost saving in materials
- Reduction in programme time
- Less subcontract labour

Enhanced Placing Characteristics

- Better pumpability
- Lower heat of hydration
- No segregation
- Shorter curing period

Improved Durability

- Very high sulphate resistance
- Corrosion resistant
- Resistant to mild acids

Structural Improvements

- High strength
- Low creep
- Low shrinkage
- High modulus

Silica Fume Waterproof Concrete Specification

Where silica fume concrete is to be used, the general specification clauses outlined on the silica fume concrete data sheet should be included in the concrete specification. Additionally, Silica fume Waterproof Concrete can be specified by including the following clauses in the standard concrete specification:

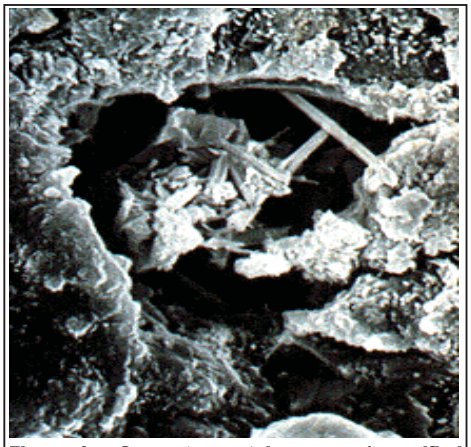

Figure 1 – Concrete contains pores (magnified image shown here) of a wide range of sizes. Water flows readily through the larger (>600A°)

Figure 2- Diagram of basement showing durability serviceability criteria. Silica Fume WPC assists in all areas.

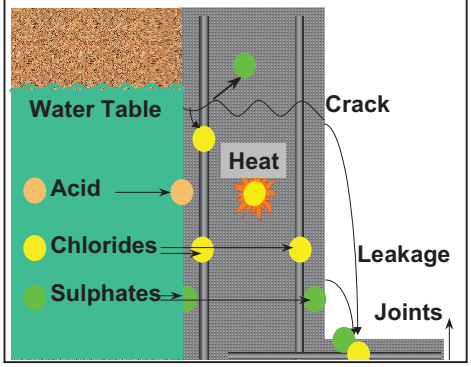

Figure 3 - Diagram of basement showing the permeability equations. Factors of safety are added to these and then they are used as the design base.

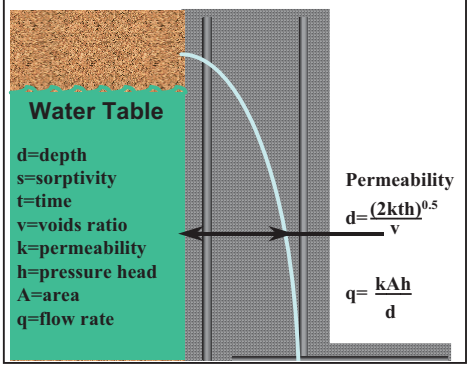

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Figure 4 – The permeability of OPC concrete is the basis from which the permeability of Silica Fume WPC is calculated (Concrete Society, 1985)

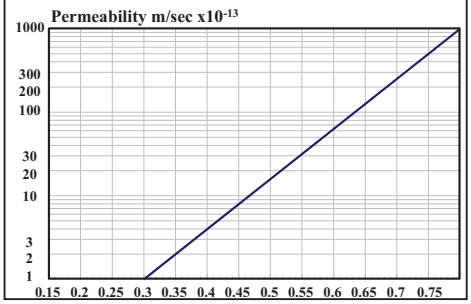


Figure 5 – The reduction in permeability due to si;ica fume depends on the silica fume dosage and w/c ratio

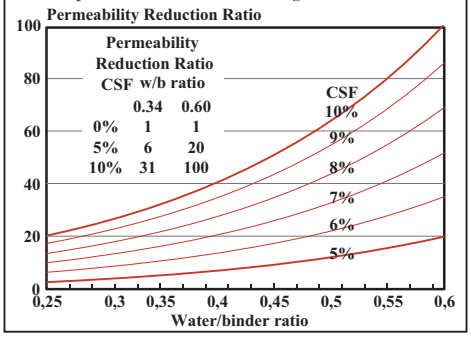
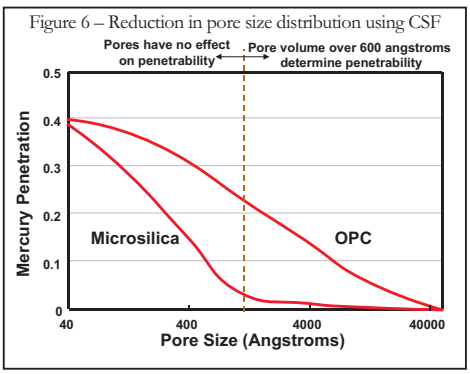


Figure 6 – Reduction in pore size distribution using CSF



1. The structure has the following design parameters:-

Normal pressure head _____m

Minimum concrete thickness _____m

f_3 = load factor =_____.

f_2 = materials factor =_____.

f_1 = test factor =_____.

Minimum time before any flow_ yrs

Maximum water inflow rate _lt/m^2

Minimum time before any flow _ yrs

2. The contractor shall supply a 10year warranty that the structure shall not leak provided that the crack size is less than 0.2mm at the surface

3. The contractor shall submit the proposed concrete mix design for approval together with permeability calculations, verifying that the proposed mix requirements set out in clause 1.

TECHNICAL SUPPORT

A spreadsheet is available which, on input of the design criteria, gives an indication of the most economic mix that will achieve the performance required. Support documentation is also available. Advice on crack width and joint design is available.

GENERAL

Orisil Materials are able to provide technical support related to most aspects of the use of concrete in construction. This support takes the form of:-

- Meeting with the Owner, Architect, Engineer and/or Contractor to develop a cost effective and technically appropriate Silica Fume Concrete option that invariably offers advantages to all parties; "the win, win, win approach".
- Presentation to interested parties on the mechanisms by which silica fume Concrete provides solutions to construction problems.
- Report preparation that detail the design methods and assumptions used for any analysis undertaken and includes published papers supporting the use of these design methods.
- Use of computer models to calculate

SUGGESTED READING

1."Permeability Testing of Site Concrete – A preview of Methods and Experience". Concrete Society Technical Report London, 1985.

2. Sellevold, E.J., Bager, D.H., Jensen, E.K., and Knudsen, T., "Silica Fume Cement Pastes: Hydration and Pore Structure", Report BMI 82.610, Trondheim, Norwegian Institute of Technology, 1982, pp19-50.

3. Markestaad, A., "An Investigation of Concrete in Regard to Permeability Problems and Failures Influencing the Results of Permeability Tests", NTH report, 1969.

4. Mehta, P.K., and Gjorv, O.E., "Properties of Portland Cement Concrete Containing Fly Ash and Condensed Silica Fume", Cement and Concrete Research, Vol 12, No 5, September 1982, pp 587-595.

5. Manmohan, D., and Mehta, P.K., "Influence of Pozzolanic, Slag and Chemical Admixtires on Pore Size Distribution and Permeability of Hardened Cement Pastes", Cement, Concrete and Aggregates, 1981, 3, No 1, Summer, 63-67.

6. Feldman, R.F., and Huang Cheng-yi, "Properties of Portland Cement 0 Silica Fume Pastes in Porosity and Surface Properties", Cement and Concrete Research, 1985, 12, 765-774.

7. Hustad, T., and Loland, K.E., "Report 4: Permeability", FCB/SINTEF, Norwegian Institute of Technology, Trondheim, 1981, Report STF65 A81031.

8. Maage, M., "Effect of Microsilica on the Durability of Concrete Structures", FCB/SINTEF, Norwegian Institute of Technology, Trondheim, 1984, Report STG65 A84019.

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