

Silica Fume - Chemical Resistance

CHEMICALLY RESISTANT CONCRETE

Silica fume concrete gains its chemical resistance from the following key components:

LOW PERMEABILITY

This result from the low bleed eliminating permeable paths around aggregate and the impermeable nature of the paste (described in “Silica Fume Waterproof Concrete”). In addition the low bleed gives a low water:cement ratio of slab surfaces. This leads to higher abrasion resistance and lower penetrability of contaminants. (See “Silica Fume Floor and Pavement Concrete”).

ACID RESISTANCE

The calcium hydroxide is weak, leachable and is attacked rapidly by acid. Silica fume converts the calcium hydroxide to calcium silicate hydrate. This compound is more chemically inert than the $Ca(OH)_2$, although it is still attacked at the most extreme conditions. Fig 1 shows the performance of silica fume chemical resistance concrete type concrete in various mild acids.

SULPHATE RESISTANCE

Acidic type of attack from SO_4 is prevented as described above. In addition mono sulphate hydrate is formed (see “Silica Fume Sulphate Resisting Concrete”).

ALKALI SILICA REACTION

The alkalis that cause the expansive reaction are locked in the dense CSH paste. Additionally, less water is available to promote the expansion. Fig 2 confirms the low expansion of silica fume chemical resistance concrete type concrete.

NITRATES

Fig 3 demonstrates that water repellency is not sufficient alone to provide chemical resistance. Corrocem

CONCRETE BENEFITS

LONG LIFE

- 4-5 times the life of OPC concrete in many environments

CAN BE AN ALTERNATIVE TO COATINGS

- lower cost
- saving on construction programme
- no re-coat interval

HIGH QUALITY SUBSTRATE TO COATING

- Removes bond to the concrete surface as the weak link
- Reduces chance of premature failure
- Acts as back up to coatings failure

REDUCED THICKNESS OF SACRIFICIAL CONCRETE

is designed to provide chemical and penetrability resistance.

PAPWORTH-BURNETT CHEMICAL RESISTANCE GUIDE

There is a large array of chemicals used in the industrial and agricultural sectors that attack concrete but little guidance on how to provide protection. Tables 1-4 give a guide for many situations. Determine the severity of the exposure from tables 2,3 or 4 and then look up the appropriate mix design in table 1.

SPECIFICATION

Where silica fume concrete is to be used the general specification clauses outlined on the “Silica Fume Concrete” brochure shall be included in the concrete specification. Additionally silica fume chemical resistance concrete can be specified by including the following clauses in the standard concrete:-

Figure 1 - Acid Resistance. Silica fume chemical resistance concrete is impermeable and $Ca(OH)_2$ that is attacked most strongly by acid is converted to CSH

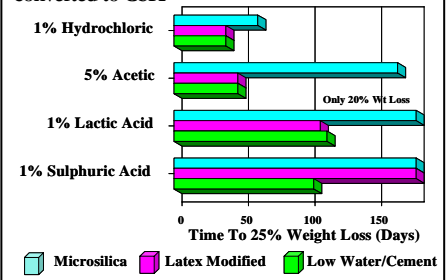


Figure 2 - Alkali Silica Resistance. The high resistance to ASR of silica fume concrete is due to its stifling of the water supply and its ability to immobilize the alkalis.

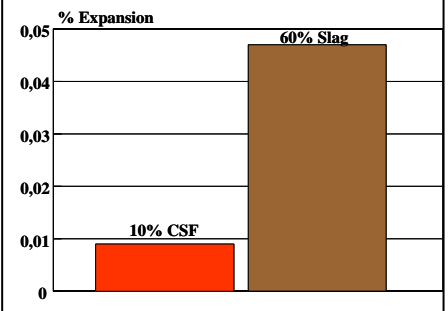
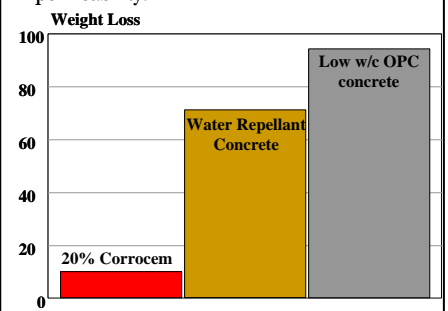


Figure 3 - Chemical Resistance in ammonium nitrate. Corrocem outperforms water repellent and low w/c concrete by many times as it incorporates chemical resistance and impermeability.



1. Concrete shall comply with the requirements of the “Papworth-Burnett guide for Chemically Resistant Concrete” for the following chemical exposure:

<List chemical exposure or give exposure severity and chemical type, eg; severe and exposure.>

Table 1 - Papworth-Burnett Design Guide for Chemically Resistant Concrete

Exposure	Environment	Cement Type	CSF (kg/m ³)	Corrocem (kg/m ³)	Max w/binder	Curing (days)
Aggressive ground water (table 4)	Slight	Type 1	-	-	0.47	3
	Moderate	Type 1	20	-	0.47	3
	Severe	Type 1	30	-	0.42	3
	V.Severe	Type 1	40	-	0.36	1
	V.V.Severe	Type 5	-	80	0.36	1
Industrial	3km of atm. discharge	Type 1	-	-	-	7
	Acid (table 2)	Slight	Type 1	20	-	0.48
	Moderate	Type 1	30	-	0.42	3
	Severe	Type 1	40	-	0.36	1
	V.Severe	Type 5	-	80	0.36	1
	Chemical (table 3)	Moderate	Type 1	30	-	0.42
	Severe	Type 1	40	-	0.38	1
	V.Severe	Type 5	-	80	0.36	1
	ASR	Slight reactive agg.	-	20	-	0.42
	+wet environment	-	30	-	0.42	3
	+salt exposure	-	40	-	0.42	3

Table 2 -Acid Concentration to Cause Designated Level of Attack (assumes frequent exposure/splashing)

Acid	Slight	Moderate	Severe	V.Severe
Acetic	5%	5-100%	-	-
Fluric	1%	2.5%	10%	20%
Formic	0-100%	-	-	-
Hydrochloric	0.1%	0.25%	1%	2%
Lactic	0.1%	1%	2%	10%
Nitric	0.1%	0.25%	1%	2%
Oxadic	Not detrimental			
Phosphoric	5%	5-100%	-	-
Slaughter House	-	-	Yes	-
Sulphuric	0.1%	0.25%	1%	2%
Sulphurous	0.1%	0.25%	1%	2%
Tanic	0-100%	-	-	-
Wine	Not detrimental			

Table 3 -Severity of Chemical Attack Caused by Different Substances

Chemical	Moderate	Severe	V.Severe
10% amm.nit	Rare	Occasional	Frequent
Amm.nit. prill	Occasional	Frequent	Continuous
Animal fat	Yes	-	-
Amm.	Occasional	Frequent	Continuous
sulphate	-	-	-
Butter milk	Yes	-	-
Calc. chloride	-	-	Sat.. soln.
Calc. Nit	-	-	Sat.. soln.
Soltn.	-	-	-
Castor oil	-	Yes	-
Fish oil	Yes	-	-
Hyd. sulphide	Yes	-	-
Mag. chloride	-	Sat.. soln.	-
Margarine	Yes	If melted	-
Pet.oil	Not detrimental	-	-
Phosphate	Yes	-	-
Potassium	-	Yes	-
Sewage	Not detrimental	-	-
Silage	Yes	-	-
Sod. Nitrate	Yes	-	-
Sugar	-	Yes	-
Urea	Frequent	Continuous	-

Table 4 - Severity of Ground Water Attack (CEB-FIP model code)

Criterion	Slight	Moderate	Severe	V.Severe
pH value	6.5-5.5	5.5-4.5	4.5-3.5	<3.5
Carbonic acid dissolving lime determined by marble according to Heyer (mg/lit)	15-30	30-60	>60	>120
Ammonium (mg/lit)	15-30	30-60	>60	>120
Magnesium (mg/lit)	100-300	300-1500	>1500	>3000
Sulphate (mg/lit)	200-600	600-3000	>3000	>6000

Resistance of Low Water/Cement Ratio Concretes”, Cement and Concrete Research, Vol 15, No 6, November 1985, pp 969-978.

TECHNICAL SUPPORT

CHEMICAL RESISTANCE CONCRETE

Advise on the correct concrete or coating/concrete substrate for different exposures.

GENERAL

Scancem 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 details the design methods and assumptions used for any analysis undertaken and includes published papers supporting the use of these design methods.
- Output from computer models for design purposes.

SUGGESTED READING

- Aitcin, P.C. and Regourd, M., “The Use of Condensed Silica Fume to Control Alkali Silica Reaction – A Field Case Study”, Cement and Concrete Research, Vol 15, No 4, July 1985, pp 711-719.
- Mehta, P.K., “Studies of Chemical

3. Glasser, F.P., and Marr, J., “The Effect of Mineral Additives on the Comparison of Cement Pore Fluids. The Chemistry and Chemically related Properties of Cement”, British Ceramic Proceedings, No 35, September 1984, Shelton, British Ceramic Society, 1984, pp 419-429.
4. Carlsson, M., Hope, R., Pedersen, J., “Use of Condensed Silica Fume (CSF) in Concrete”, Madrid, 1986.
5. Wade, M.J., “Experience in the Use of Corrocem Concrete Within the Agricultural Division of ICI”, May 1981.
6. Dingsoyr E., et al, “Nitrates/Fertilisers” The Service Performance of Concrete. Report No.4: The Influence of Chemicals, Norway, 1984.

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The information given is based on knowledge and performance of the material Every precaution is taken in the manufacture of the product and the responsibility is limited to the quality of supplies, with no guaranty of results in the field as Scancem Materials has no control over site conditions or execution of works

SCANCEM MATERIALS

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S'pore : 2 Kallang Pudding Rd, #06-10, Mactech Ind. Bldg, S349307 Tel: +(65) 6255 8737 Fax: +(65) 6255 8713 email info@scancemmaterials.com
M'sia : A-4-9, Plaza Dwi Tasik, Jln Sri Permaisuri, Bandar Sri Permaisuri 56000 Kuala Lumpur, Tel: +(60) 3 9171 2110 Fax: +(60) 3 9171 5110