



Efflorescence in Cementitious Systems

Cement Research & Application Center



Efflorescence in Cementitious Systems

The main impacts that damage durability of concrete chemically and physically are:

- **Efflorescence**
- Sulphate Attack
- Alkali Silica Reaction
- Sea Water Effect
- Acid Attack
- Carbonation
- Chloride Attack
- Freezing – Thawing Effect
- Wetting-Drying
- Abrasion

Efflorescence in Cementitious Systems

- Efflorescence occurs as follows; the water inside of the concrete's porous structure moves between the capillar voids and reaches the surface of the structure than the water evaporates leaving its crystal salts on the surface.
- There becomes white spots and leakages on surface. After the water leaves, voids are occurred where before water exists. These voids cause strength loss and durability problems due to excess permeability.
- As long as the concrete serves, it should keep the necessary strength and durability against physical and chemical effects.

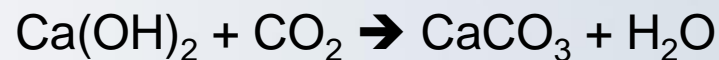
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Calcium hydroxide (CH) in the water reacts with the carbon dioxide in the air when the capillary water hits the surface. Then calcium carbonate formed as a consequence of this reaction. White and grey spots on the concrete surface are the signs of efflorescence.



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Water can slip into the concrete with the rainfall or ground leakages. $\text{Ca}(\text{OH})_2$ exists in the concrete in high amounts and it is soluble in the water, so basically the main reason of the efflorescence is water permeability of the concrete.



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The reasons of efflorescence:

- The ground water, which includes sulphate, nitrate, chloride, chromium, molybdenum salts, movement into the concrete structure;
- The use of unstandardized material;
- Permeable concrete structure;
- Insufficient or absence of drainage in the structures;
- Un-rehabilitated cracks.

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Suggestions for preventing from efflorescence:

- Low water/cement ratio should be selected.
- Fitting and compacting of the concrete should be done appropriately.
- The curing water and the aggregates should be checked whether the salt content is applicable or not.
- Pozzolanic mineral additives should be used in order to decrease Ca(OH)_2 amount and permeability, also the durability is positively affected from the pozzolanic additives,
- The alkali amount of the cement should be kept low.

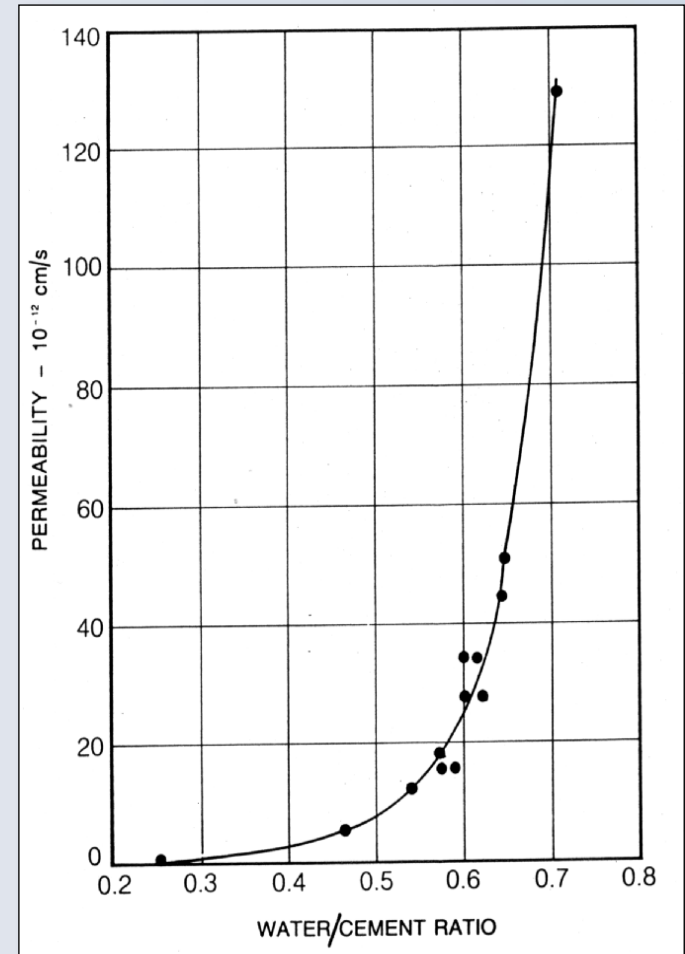
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Effect of w/c ratio of the concrete mix:

When water/cement ratio is increased to 0,7 from 0,4 the 28 day strength value diminishes about 60%.

Moreover, if water/cement ratio increased to 0,7 from 0,4, permeability of the system becomes 6 times more.

Also, as the curing time gets longer, the concrete becomes less permeable and more durable.



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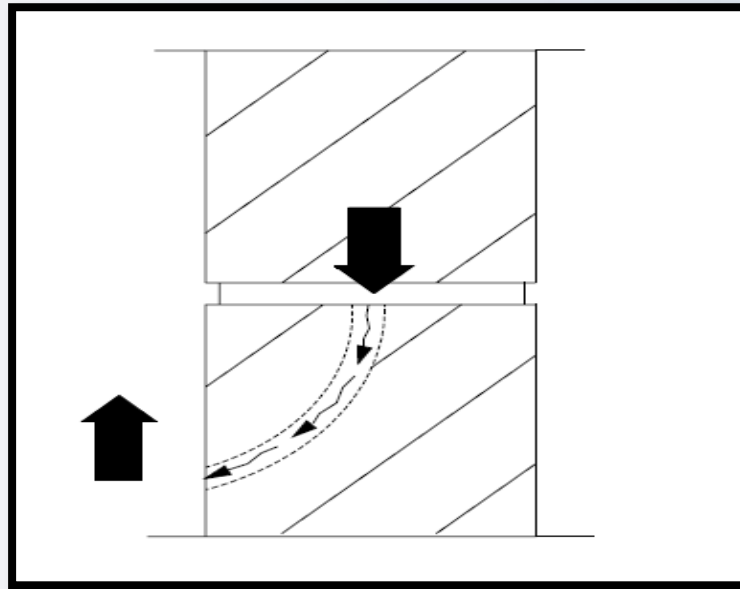
Efflorescence because of the excess water usage in mortars and not providing the necessary impervious structure.



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The usage of mineral additives against efflorescence:

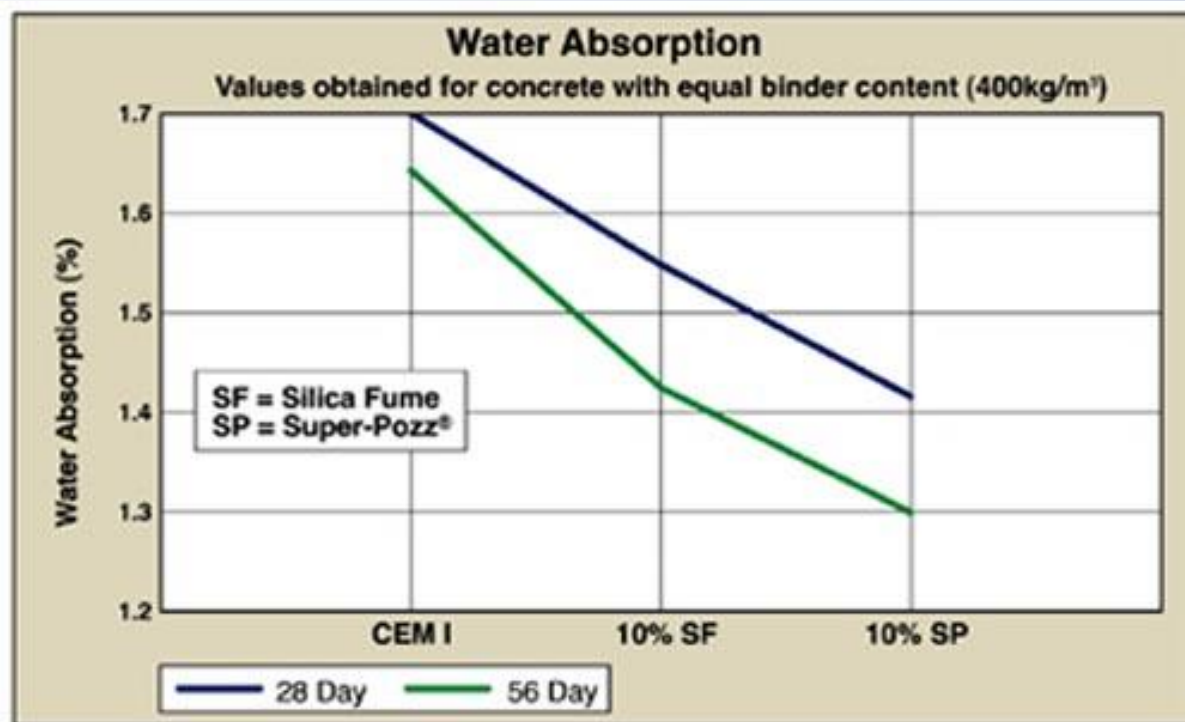
With the help of mineral additives concrete structure becomes more impermeable so the movement of the water inside the concrete can be hindered.



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The usage of mineral additives against efflorescence:

Below, it can be seen that silica fume as a mineral additive hinders the water permeability. Also, the usage of chemical additives can be helpful for getting a more rigid concrete structure.



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The usage of mineral additives against efflorescence:

- The usage of mineral additives can help to block the possible CH formation by decreasing the amount unreacted calcium molecules inside the concrete.
- As a mineral additive Metakaoline has effective outcomes in the production of impermeable concrete production..

White cement and Metakaoline has a mechanism together which hinders the formation of the CH molecules.

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In general chemical additives (plasticisers or water repellants) help to prevent efflorescence by decreasing water/cement ratio. So the amount of water encapsuled inside of the concrete diminishes.



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For the repair of the damaged structures;

Concrete surface can be washed with pressurized water and scrubbed with a firm brush. Also, low concentrated acid solutions can be used for the repairing purposes. For this application adequate experience and knowledge is necessary in order to avoid possible damages while cleaning the surface.

For example; Pressurized water + 5% HCL Solution

Pressurized water + 20% Vinegar Solution



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