IMPREGNATORS FOR NATURAL STONES
7.1 WHY NATURAL STONES ARE PRONE TO STAIN?

Most natural stones are porous, permeable and absorbent to some extent depending on the characteristics of pores and degree of polish finish. Stains can be classified into two types: organic and inorganic. Organic stains are caused mostly by food, drinks, plants, wood and dyes, etc. Inorganic stains are usually mineral in nature. For example, iron compounds are found naturally in stone which can oxidize and cause the stone to turn yellowish brown. This occurs quite frequently in white marble, granite and some limestone. Other common causes of discoloration of natural stones are:

A. Liquid ingress from top surface
B. Rising moisture from minerals contained in the natural stone
C. Contamination carried up from the mortar bed
D. Moisture from the grouting compound which discolours stone edges
E. Calcium hydroxide in the mortar bed which reacts and becomes calcium carbonate (known as efflorescence)
F. Moisture spots caused by freeze/ thaw activity

\[ \text{Fig. 7.1 – Common causes of discolouration in stones.} \]

- **Porosity Vs Permeability Vs Absorption rate**

Porosity is the ratio of pores (micro-voids) in the stone to its total solid volume. Pores and the capillary structure develop differently in each stone group. In most cases, the porosity ratio is lower in igneous and metamorphic stones (granite) and generally higher in sedimentary types (marble).

Permeability is associated with the stone’s porosity and the extent to which the pores and capillary structures are interconnected throughout the stone. Their size, structure and orientation affect the degree and depth to which moisture, vapours and liquids can be absorbed into the interior of the stone or migrate from the substrate by capillary action. Permeability may be greater in some directions than others based upon the pore size, shape and the distribution of the interconnectedness of the system. Permeability is increased when a stone is highly fractured or open veined. A particular variety of stone may be highly permeable although its porosity is low.
Absorbency is the result of porosity and permeability. Absorbency is an important determining factor in stones sensitivity to stains. The size of the pores, their orientation, how well they are networked and the type of finish the stone has are important contributing factors to the stone’s overall absorbency. The polishing process has a tendency to close off most pores resulting in a low absorbent surface. However, some varieties of stone have large internal pores and capillary structures and they still remain very absorbent even after they are polished.

7.2 PURPOSE OF APPLYING IMPREGNATOR TO STONE
The purpose of applying impregnator is to prevent liquids seeping into the stone and staining it. However this process is quite different to sealing other floor types e.g. sealing of wooden floor which requires a protective coat to be applied to the top layer. But here, the impregnator penetrates into the stone surface and chemically interacting through the pores. This penetration then forms an invisible resistant barrier on the pores surface thus protecting the surface from staining and preventing fluids from penetrating through the pores. However, impregnators do nothing to protect the top surface from physical damages such as scratches and chips and also will not prevent “etching” from acid spills.

7.3 HOW DOES AN IMPREGNATOR WORK?
It is a subsurface treatment formulated to penetrate into stones which enhances resistance to stains. At the same time, it does allow the stones to breathe. This does not refer to the stone breathing is like what we do. Stone is made up of a variety of crystals. Each crystal is made up of different minerals. The minerals that make up the crystallized structure of the stone determine whether it is marble, or limestone or granite. To maintain the integrity of these crystals, they must interact with the air and hence they must be allowed to breathe. It is also essential that water that gets into the stone is able to evaporate by moving through these micro spaces.

Fig. 7.3 – Stone without the application of impregnator. Possible salt entry from substrate.
Impregnators are a mixture of silicone and resins, and usually mixed with a mineral spirit which is a solvent. But some are water-based, depending on the manufacturer. The mineral spirit is added to the mixture because it acts as a carrier for the silicones and resins. The mineral spirit rides the resin and silicone into the stone in a liquid form. Later, the mineral spirit evaporates out of the stone and leaves the silicone and resin. The silicone and resin now begin to cure and forms a fluid repellent membrane in the pores of the stone. This all happens within five to ten minutes. However a complete curing requires usually 12 to 24 hours depending on the characteristics of the stone.

**7.4 TOPICAL COATING VS IMPREGNATOR**

Coating creates a barrier and forms a protective film on the surface of the stone to protect it from foot traffic, soil, dirt, oil, and other stains. Mostly, they are formulated from natural wax, acrylic and other plastic compounds. Conversely, certain coatings may block “breathing capability” of the stone.

An impregnator penetrates below the surface and becomes repellent. They keep contaminants out but do not stop the moisture escaping from stone. Some impregnators have dual properties such as hydrophobic (water-repelling) as well as oleophobic (oil-repelling). However some solvent based impregnators are unfavorable to the environment as they can release volatile organic compounds (VOCs).
7.5 “SOLVENT BASED” VS “WATER BASED” IMPREGNATORS
The protection repellents come from silicones, silanes, siloxanes and various polymers, and they are carried into the substrate by carriers of either solvent or water. Typically, solvent-based products penetrate into stone quicker and deeper due to their low surface tension. The curing process which is a result of evaporation, can also be faster and adjusted using different solvents. On the other hand, water-based products are generally lower in toxicity and have little or no smell as compared to similar solvent-based products. However the difference in performance of these two carriers are getting narrower due to technological development.

7.6 HOW MANY LAYERS TO APPLY?
Applying thick coats of an impregnator is not always the answer to sealing stone properly. Usually, thin coats are sufficient. The reason is natural stone can only absorb up to a certain extent depending on the voids. Putting on too many layers may be ineffective. Some manufacturers recommend applying the “five minute rule” i.e. if the stone completely absorbs the first coat from the surface within five minutes, a second coat may be required. But if the sealer still remains on the surface after five minutes, no additional coat is required.

7.7 MEASURING THE STRENGTH OF THE IMPREGNATOR
A practical way to measure the strength of an impregnator is to apply liquid on the surface of the stone or soak into pigmented liquid and monitor the absorption. If the stone does not darken or change colour, it reflects that it is not allowing the stone to be penetrated. When selecting an impregnator, it should be noted that there is no single brand or product of impregnator that suits all stone types. The compatibility may vary from stone to stone depending on its characteristics. Therefore trial and error tests (either laboratory or field test) such as determining the absorption rate before and after applying impregnator, and a pull off test to verify the bonding strength with adhesives should also be carried out.

7.8 LIFE SPAN AND OTHER FACTORS TO CONSIDER IN CHOOSING IMPREGNATORS
The time it takes to break down an impregnator can be accelerated by certain conditions. For example, in a high-traffic floor area, the impregnator wears away as the stone surface wears down. This is because an impregnator only penetrates about 0.5 to 1.5 mm into a stone. Furthermore, though impregnators are transparent liquid; they may pose a slight risk of changing the appearance of the stone to a certain extent. Thus, it is sensible to carry on a sample test before starting actual application.

Also, impregnators serve only as a preventive measure that provide an extra protection to the stone against stains. Though the stone can be applied with superior impregnators, the stone still needs to be maintained with care. As the time goes, the ability to protect is also reduced due to its life span and other external factors. Hence, a periodic re-application is necessary and the interval should be based on manufacturer’s recommendation, which should take into account of other factors such as traffic volume and abrasion resistance of the stone.