Gillis Quarries Limited

TYNDALL STONE

Maintenance and Cleaning

Summer 2002

TECHNICAL BULLETIN ON LIMESTONE MASONRY CONSTRUCTION # 1

STAINING AND EFFLORESCENCE

CAUSES: Brown stain in buff Tyndall Limestone (or white efflorescence in grey Tyndall Stone) is caused by water-soluble alkali reacting with organic material within the stone. This alkali usually comes from common grey Portland cement. Portland cement is a constituent of the mortar used to set the stone, as well as concrete block or concrete brick backup materials. It is also present in poured concrete foundations or backup wall, precast concrete fascia units, sills, lintels, coping and caps, etc. Another common source of water soluble alkali is ground soil or earth in planters.

Research conducted at Purdue University and a Cleveland Research Laboratory a number of years ago has proved that water causes the alkali salts present in normal Portland cement to go into solution, and when this alkali-laden water is absorbed into limestone it dissolves partially oxidized organic matter naturally present in the stone. The results of this reaction are then carried to the surface of the stone as the evaporation of the water takes place, where it accumulates in visible concentration as a brown rust coloured stain, or as a whitish grey crystalline deposit, (efflorescence) or both.

EFFECTS: The principal objection to stain or efflorescence is it's unsightly appearance. Damage to stone such as flaking or spalling due to build up of pressure from salts within the pores is theoretically possible, but has not been observed in Tyndall Stone.

PREVENTION:

A) **DESIGN:** Since the main source of stain and efflorescence is alkali from cement used in the setting mortar, the principal key to prevention lies in specifying a "non-staining" (low alkali) Portland cement for mortar. The pertinent characteristic of such cement is its low alkali content. Cements specified should meet ASTM Standard Specification for Masonry Cement C-91, which limits the water-soluble alkali content to 0.03%.

Attention should also be given to adjacent material to ensure that alkali-laden water from backup or foundation items will not come into contact with the limestone construction. Usually there is physical separation by air-space or cavity between wythes, flashing, vapour barrier and insulation, but where limestone will come into direct contact with concrete members, the concrete should be painted with a sealer to prevent moisture transmission to the stone.

Where stain or efflorescence occurs on a completed wall or existing building it can be traced to water finding entry through a roof or wall leak, picking up alkali from concrete members, and soaking into the stone. The obvious solution is to trace and correct the leaks.

Another source of stain on existing buildings is excessive vapour transmission through the wall condensing in the wall cavity and seeping into the stone. This moisture often bridges the cavity via anchors, wall ties, shelf angles or trapped mortar droppings. This condition can frequently be noted in pressurized buildings especially if a high humidity level is maintained throughout the winter. Adequate venting of the cavity to allow free air circulation and provision of weep holes at the bottom of the base course and at supporting shelf angles to drain away accumulated moisture will sometimes correct the problem.

B) **CONSTRUCTION:** Normal precautions for jobsite storage of stone should be observed. Stone should be stored off the ground and covered to protect from dirt or contamination from other jobsite sources. Sand and water should be clean and free from contaminants.

During construction, wall should be covered overnight and during rains to prevent alkali contaminated water from any source reaching the stonework. Furthermore, with excessive moisture even non-staining cement in mortar can cause some stain. This is because additional alkali not initially water-soluble is eventually dissolved when the cement hydrates. For this reason admixtures, which retard mortar-curing time, increase the risk of stain. Also, when mixing mortar for stone work it is advisable to reduce the water ration as low as possible keeping the mortar as stiff as workable.

CURE: Efflorescence can usually be scraped, brushed, or washed off quite readily, but the brown stain is largely insoluble and much more difficult to remove. On exterior surfaces, if the conditions, which caused the stain, originally are corrected, it will weather off naturally within a few weeks or months. On interior surfaces however, since weathering actions are not present, removal presents more of a problem. Smooth stone can be sanded clean, but for split face water repellent is recommend. **Water repellent will increase drying time of the stone by allowing moisture to evaporate out of the stone, and prevent new moisture from penetrating the stone. The water repellent will not change the colour of the stone but will aid in the treatment. The silicone based repellent is manufactured by Dow Corning and Union Carbide and is available from your Tyndall Stone Distributor.**

REFERENCES:

- Cleveland Research Lab., Richard C. Mielenz, Report of Work Order
- Efflorescence – T. Ritchie – CBD – 2 – National Research Council

TECHNICAL BULLETIN ON LIMESTONE MASONRY CONSTRUCTION # 2

CLEANING & WATERPROOFING

CLEANING OF TYNDALL STONE

Tyndall Limestone, like any other building material, will soil in time with exposure to the elements. Dust, soot, and other contaminants are carried from the atmosphere by wind and rain, the accumulation eventually causing an unsightly appearance on the exterior of any building. With metal and glass building, dirt is normally removed periodically by washing down the building at a substantial cost to the owner. On limestone buildings however as the dirt is allowed to accumulate and is seldom, if ever, cleaned. Tyndall Stone can nevertheless be cleaned effectively, economically and without harmful effects to the stone, and can be restored to look almost new regardless of how long the stone has been weathering, if the appropriate methods are carefully followed. Principal methods of cleaning Tyndall Stone are listed and described below. Following these are reports on testing of cleaning methods. Recommendations given are based upon our conclusions arising from these reports, coupled with over ninety years of practical field experience and observation. Another section deals with the recommended treatment to remove specific stains. A final section discusses waterproofing and water repellents.

METHODS OF CLEANING

SANDBLASTING – DRY

Sandblasting, while capable of removing all dirt, also removes some of the surface, and will destroy a smooth finish. It leaves the limestone roughened so that it becomes more susceptible to the accumulation of dirt. Dry sandblasting also creates dust from the abrasive cleaning action. However, cleaning action is at its maximum and cost is usually at a minimum. Only highly skilled, experienced personnel should ever attempt this method. Protection of surrounding property must also be considered. On very old, badly weathered surfaces the abrasive effect of sandblasting may be acceptable, and for extremely dirty areas it is the most effective method to remove stubborn grime. Wherever the foregoing conditions prevail and surrounding conditions allow, dry sandblasting may be considered as an acceptable method of cleaning Tyndall Stone.

Note: The application of a silicone water repellent is recommended for surfaces that have been cleaned by sandblasting to prevent the future accumulation of dirt by the roughened texture of the newly cleaned surface. (See Waterproofing and Water repellents section).

SANDBLASTING – WET

This type of cleaning depends on a water cushioned abrasive action for its effectiveness. The cleaning mixture is applied by compressed air through a specially designed control nozzle. The water tempers the harshness of the sandblasting effect somewhat and eliminates dust. Although this method has not been used extensively in North America on limestones, it has been used effectively for British and European stonework. A with dry sandblasting, it should only be employed where abrasion of the surface is permissible, and should only be performed by skilled, experienced personnel.

STEAM CLEANING

Steam cleaning, while it has been used fairly extensively in some North American areas, and will not harm the surface of Tyndall Stone, has limited effectiveness. It will not remove heavy concentrations of dirt, and grime without an acid or detergent additive. Strong acids are injurious to limestone, and most soaps, cleansers and detergents are alkali-based, and may cause staining. This method will only be effective on moderately soiled surfaces of recent origin.

HIGH PRESSURE WATER CLEANING

For this method, water is delivered through a special nozzle at a minimum water pressure of 1000 PSI. The nozzle contains a device, which allows the water stream to be aerated. This is a relatively economical process and will not damage the surface of Tyndall Stone, although not as thorough in its cleaning results as methods using an aggregate or abrasive. To be effective, surfaces should first be soaked thoroughly to help loosen dirt deposits for removal. This method will only be effective on moderately soiled surfaces of recent origin.

GRINDING AND SANDING

Where the surface is flat and the finish is smooth, small areas may be cleaned with a belt or disc sander. On curved surfaces such as carving and molding, the areas may be rubbed with fine sand paper. To finish, areas should be wiped down with a clean damp sponge or cloth to remove dust and waste.

CHEMICAL CLEANERS

There are a number of proprietary products available, each designed to meet a specific need in cleaning a particular type of masonry. Several state they are intended for, or may be used on limestone or other natural stone. Despite these claims however, most of these products depend on either acid or alkali for their cleaning action, therefore as a general rule (aside from the exceptions discussed below) most chemical cleaners for masonry are not recommended for Tyndall Stone.

Acids and acidic-based cleaning compounds attack and dissolve the stone surface, since limestone is composed principally of calcium carbonate.

Most soaps and detergents, while they will not cause physical damage are usually alkali-based, and can therefore cause staining and discoloration in limestone.

The exceptions to this general rule are chemicals or products tested and known to be safe for limestone, or products specifically designed for limestone. Some of these are discussed under the "Removing Stains" section following. In every instance where a chemical cleaner of any kind is to be used, a test should be preformed to an unobtrusive area of stone to check results before undertaking general cleaning. Always read and follow carefully the manufactures product literature and label instructions. Always use caution, as many chemicals are corrosive, or poisonous, or both. When scrubbing stone, always use a stiff fiber- bristle brush. Never use wire brushes as these may scratch the stone. After cleaning, always rinse the treated areas thoroughly with clean water and wipe or blot dry.

REPORT ON TESTING OF STONE CLEANING METHODS

Tests were conducted in Britain by the Advisory Service Division of The Building Research Station, Department of the Environment, on a selected dirty wall – composed of Portland Stone (limestone) at the back of the British Museum. The tests were later repeated at The Tower of London on Kentish Ragstone. Similar results were obtained at each location. The areas were divided into thirteen test panels. Methods used included – low and high pressure water spray, steam, and wet and dry grit blasting. Some variations incorporated were supplemetal hand brushing with the use of fine, medium and coarse grit.

The conclusions reached were that the best results are obtained by dry and wet grit blasting. Steam cleaning was less effective, and high pressure water treatment was considered a failure. These results were confirmed by several other recent reports commenting on widespread field experience since World War Two in cleaning historic buildings of Great Britain and France. In Paris, for example, chemical processes have been virtually discarded due to their tendency to attack and damage stone. Bry brushing is forbidden by official degree. Wash down is discouraged due to water infiltration. The process most used now is dry and wet sandblasting, with the wet method favoured.

Another report comments on competitive tests conducted in the United States by the Indiana Limestone Institute and a stone company on a sixty year old tooled Indiana Limestone building at Bedford, Indiana. Results were judged on (1) degree of restorations to original colour, and (2) damage (if any) to face of stone. Test areas were located close together, on the same building, and cleaned by the following methods:

A) Hand washing with 10% muriatic acid.
B) High-pressure steam with 10% muriatic acid.
C) Aerated water under approximately 1000-PSI pressure.
D) Dry silica sandblast.
E) Four hour soaking with garden hose rinse.

Cleaning effect of the dry silica sandblasting produced satisfactory results, however pitting of the surface occurred. The other methods produced generally unsatisfactory cleaning results.

REMOVING STAINS

BROWN STAIN & DISCOLOURATION

To date, no satisfactory treatment more effective than natural weathering has been found to successfully remove the brown stain caused by water soluble alkali salts from Portland cement. The first and most important action to be taken is to correct the conditions, which caused the stain to occur, such as repairing wall leaks, etc. (Refer to Technical Bulletin #1). On exterior surfaces, as the wall dries out natural weathering agencies will remove the stain in time, leaving no trace behind. Applying Tyndall Stone Silicone Water Repellent can hasten this action to the stonework when it is dry. On interior surfaces however, since weathering actions are not present, removal presents more of a problem. Smooth stone surfaces can be sanded clean, but for split-face, applying the water repellent is the most effective.

OIL STAINS

Oil and grease stains can usually be removed by applying a paste made up of stone dust and benzene. Apply as a poultice, allot to dry, remove, and scrub area with water and a stiff fiber bristly brush. A minimal amount of neutral soap may be used if available. Rinse well and dry. Caution: Benzene is flammable, and should be handled carefully as one would handle gasoline. Do not use near spark or open flame.

Another option is HMK R52 Poultice / Stain Remover. This chemical is effective in removing wax, oil and silicone stains left behind from mortar sealants. However, the poultice may be abrasive to older structures and should be tested first on a small hidden area.

TAR STAINS

Scrape off all the tar possible with a flat knife using care to avoid smearing surrounding areas. Then follow the directions for removing oil and grease stains.

RUST STAINS

Rust stains tend to be quite permanent due to a reaction between iron and calcium. However they can usually be removed with a solution of oxalic acid and water. Dissolve oxalic acid crystals in water overnight to make a concentrated solution. Heat this solution and scrub the stained areas with a stiff fiber-bristle brush. Then rinse with clean water and let dry.

ATMOSPHERIC STAINS

For spot cleaning or limited area cleaning, where the portion to be cleaned is not large enough to warrant wet aggregate or sandblast cleaning, and where older weathered limestone surfaces are stained with dirt, carbon, smoke, algae or other atmospheric stains, a chemical cleaner such as "Sure Klean Limestone Restorer or HMK R55 may prove useful. Test first on a small unnoticeable area. Follow the manufactures directions carefully. Rinse area thoroughly, remove excess water, and allow to dry. Repeat if necessary.

SMOKE STAIN

Light, recent smoke and soot stains on Tyndall Stone fireplaces can usually be removed safely by using a small amount of clean water and scrubbing vigorously with a stiff fiber-bristle brush. Using regular household beach or Javex has also been known to be very effective. Apply the straight concentrated solution but ensure to cover all carpets, furniture and draperies in close proximity to avoid bleaching. Heavier, older concentrations are harder to remove and a chemical cleaner such as HMK R55 may be necessary. Test first on a small area with either chemical.

WATERPROOFERS & WATER REPELLENTS

Tyndall Stone, unprotected from water, is more subject to the effects of weathering. Water carries dirt and atmospheric pollutants into the pores of the limestone, hastening surface wear and in time creating an unsightly appearance. Two types of materials are available to keep water out of limestone masonry construction – waterproofer and water repellents.

A waterproofer is an impervious coating that seals the surface so that neither liquid water nor water vapour will penetrate. Waterproofer can be extremely useful in masonry construction but are generally restricted to back up or below grade applications because masonry appearance is changed, and water vapour is sealed in.

A water repellent, in contrast with a waterproofer, permits the stone to "breathe." It keeps liquid water out but does not stop movement of water vapour. Silicone water repellents offer protection to masonry superior to that of any other type of water repellent, and for limestone, a water based solution of Sodium Methyl Siliconate with 2% to 3% solids is the most effective.

Solvent based silicone repellents with 5% silicone solids, while preferred for clay brick and concrete masonry, do not react properly with the calcium carbonate in limestone to create a satisfactory cure, and are not recommended.

Although water based silicone repellents are colourless and invisible on limestone surfaces once the cure has taken effect, they are highly alkaline and as a result sometimes cause a slight initial yellowing. This will quickly weather off outdoors but could be objectionable on interior stonework. For this reason, repellents should be tested in a small area first.

For maximum effectiveness water repellents should only be applied at temperatures above 16 degrees Celsius to stonework that is completely dry. They can be applied by low pressure spray using a pressure not exceeding 10 PSI at the gun, or by hand via brush, roller or sponge. Repellent can be applied to damp stone, however the desired results will take longer to achieve. Application should be made from the top of the wall down to grade with a flood coat and a run down of 300mm so that the maximum absorption occurs. One coat usually suffices if properly applied; however a second coat does ensure complete coverage, and may increase the useful life of the treatment.

The benefits of a properly applied silicone water repellent treatment to exterior stonework and summarized below:

1. Stops water penetration yet allows the wall to "breathe."
2. Keeps stone clean for many years. Walls become, in effect "self-cleaning."
3. Reduces the effects of weathering from atmospheric contaminants and moisture, and improves freeze-thaw resistance.
4. Prevents efflorescence and stain caused by water-soluble alkali salts from surrounding materials.
5. Economical. Material cost is only pennies per square foot.
6. Easily applied.
7. Invisible.

Approved Water Repellent:

The following products have been tested and used in the field for a number of years and are recommended for use on Tyndall Stone.

~~Union Carbide R-20~~ — DISCONTINUED
Dow Corning 772

REFERENCES:

"Testing Methods of Stone Cleaning" – I. Berkovitch – Stone Industries Magazine.

"Paris Revealed" – Ibid

"Castle Spring Clean" – Ibid

"Maintenance and Restoration of Stone Structures" – WJ11 – Western Waterproofing Co. Inc. – 1220 – 27 Syndicate Trust Bldg. St. Louis Missouri, U.S.A.

"Professional Masonry Cleaning" – 463-5M-SX – Western Waterproofing Co. Inc.

"A Guide to Silicone Masonry Water Repellents" – C.A. Bergeson, Union Carbide Corp. Silicones Division, Tonawanda, N.Y. U.S.A., Architectural Record, McGraw Hill Inc.

"Indiana Limestone Handbook" – Indiana Limestone Institute of America, Inc. – Bedford, Indiana, U.S.A.

"Dow Corning-772" – Silicone Product Data – Dow Corning Corp. – Midland, Michigan, U.S.A.

HMK Stone Care – Independent Tyndall Stone Testing Lab, San Diego, 2001

GRAFFITI PROTECTION

Gillis Quarries Ltd. works together with Winnipeg Graffiti Control in order to provide the best possible methods for graffiti prevention and removal. As graffiti chemicals such as markers, spray bombs, etc. are constantly changing along with the chemicals to remove them it is best to contact our offices for the current update.

Where graffiti is a concern, the best option always is prevention, however a professional cleaning can still remove spray paint with a 90% success rate without leaving a shadow if the wall is not protected. By using a protective coating first, spray paint can be removed with a 99% success rate without leaving a shadow.