Introduction

It is pleasing to note the increase in variety of concrete surface finishes in recent years and improvements in the quality of those finishes.

But some finishes that are excellent in themselves when new, become stained and unattractive in just a few years through the process of weathering.

All buildings weather, but some better than others. Dirt is deposited on them mainly when it is not raining, and most of the natural cleansing is provided by rainwater. Although rainwater is an effective wash when it first hits a building, it can contribute to weather staining of expansive surfaces if allowed to run over them at slow speeds and deposit or spread dirt in the process. Wind flow over a facade influences the depositing and build-up of dirt and the flow of cleansing rainwater.

The problem of weathering manifests itself most when a dirt-laden surface is only partially cleansed by rainwater, thereby leaving lighter coloured areas contrasted by darker dirt-covered patches.

Weather staining can be minimised, if not eliminated, by full consideration being given at the design stage to the mass and form of the building, its location and micro-climate, its elements and its materials. Such consideration should include prediction of how rainwater will flow or be blown over the facades of the building. Thought should be given to how that rainwater flow could be controlled to produce desirable cleansing actions and minimum staining.

Rainwater flow can be controlled and utilised in several ways.

1. Shaping of surfaces and textures to create preferred lines of flow.
2. Arranging surfaces so that they present themselves to direct rainfall.
3. Incorporating design features to prevent rainfall flowing freely over surfaces.

All of these methods have the objective of allowing each section of a facade that can be cleaned by direct rainwater to be cleaned, and then for the water to be led along preferred lines of flow or to be taken away by drainage.

Surfaces that cannot be cleaned by direct rainfall are likely to be only partially cleaned, with the consequent result of streaky or blotchy staining. In such cases it might be preferable to exclude rainfall from the surface completely and to allow dirt to accumulate more or less evenly over the surface.

Horizontal or slightly sloped surfaces such as window sills and parapet cappings, tend to collect dirt to a greater extent than vertical or steep surfaces and care should be taken to avoid that deposited dirt being carried onto cleaner surfaces by the flow of rainwater.

Similarly, rainwater flowing from relatively clean vertical surfaces directly onto dirtier lower surfaces could cause streaking of those lower areas unless the flow was controlled in a way that would prevent such disfigurement. The same applies to windows.
1. Modelling and fenestration related to preferred lines of water flow.
2. Partial cleansing by rainwater causes streaking.
3. Vertical modelling controls water flow but absence of collection at beam leads to staining.
4. Corners do not collect as much dirt and are more fully washed than the main body of large walls.
5. Exposed aggregate collects dirt and emphasises need for even overall rainwater flow.
6. Water flow on rounded spandrels is unpredictable. Staining results.
7. Horizontal textures spread stains rather than prevent them.
8. Vertical textures attractively resolve more problems than just weathering.
Dirt washed from windows is still dirt, and could cause staining of sills or lighter coloured spandrel panels if the form and texture of those surfaces were not self-cleansing by rainfall, or somehow controlled the flow of cleaning water.

In order that the effect of weathering can be foreseen it is important that prediction be made at the design stage of water flow over the whole building, bearing in mind the frequency and quantity of rainfall and the micro-climate.

It is strongly recommended that close study be made of local buildings to assess the extent of dirt accumulation, rainfall, wind eddies and sunshine and their influence on weathering.

Part and parcel of the prediction of rainwater flow is the detailing of surfaces and modelling of the facades. Every situation will require individual consideration but the following notes have wide application in controlling weather-staining of buildings.

**The Drip**

The drip is a traditional feature of the building industry and is usually found as a groove running the length of, and near the outer edge of, a horizontal projection such as a sill course, window lintel or exterior beam.

In some cases the drip is formed by a rebate in the soffit of the projection, but where the projection runs into a vertical element (e.g. junction of window lintel and reveal) it is recommended that a groove be used.

A drip groove or rebate will stop the flow of water across the underside of a projection, while the projection will check the rate of flow down the facade. Where a projection checks water flow and has an associated drip groove or rebate on its soffit to even out the flow onto lower surfaces, it is essential that the outer lip of the drip be true and dead level. If the drip runs one way or the other, water will run to the lower end and will have to be handled at that point by means of a vertical groove or other feature. Not to do so would be to risk streaking on the vertical reveal or column face.

The consequence of horizontally-channelled rainwater meeting vertical surfaces cannot be over-emphasised. Full attention should be given to tracing the path of rainwater from the time it hits the building until it reaches the ground or is drained away.

**Plain Walls**

Although simple and straight-forward in themselves, plain walls are perhaps the most unpredictable of surfaces in the matter of weather staining. A large high plain building facade may be well washed on the side of prevailing rain, whereas
a similar wall on the sheltered side of the same building might receive little rain and therefore spasmodic or uneven washing. Dirt on the latter side will not be removed completely or evenly and the result will be weathered staining in the form of random light and dark streaks. An interesting point is that such dark streaks rarely run down the outer edges or corners of tall facades. Observation indicates that wind eddies around the corners of buildings minimise the accumulation of dirt at those points. Furthermore, rain flow over a tall plain facade seems to be towards the outer edges, thereby providing more cleansing there than in the main body of the wall - hence relatively clean edges to many plain walls that are otherwise marred by staining. It is suggested that the moulding of more vertical "edges" into a facade would limit the transverse flow of rainwater and thereby produce a more even and predictable result.

The use of vertically-striated finishes has proved to be very successful in limiting or controlling weathering of large expanses of concrete. Many types of surface finishes having vertical grooves are available and some are described in CCANZ Information Bulletin IB 18.

Exposed aggregate surfaces spread the flow of rainwater through the channels formed between the aggregate particles, but it must be borne in mind that dirt will readily lodge in those same crevices. It is therefore important that exposed aggregate surfaces be well exposed to cleansing rainwater or be sheltered from it.

Very few horizontal surface treatments are successful from a weathering point of view and should be limited to boarded-formwork finishes and then only when they will be fully rain-washed over the whole surface.

Precast concrete cladding panels require regular vertical joints and these help in channelling water, provided the joint is not pointed flush with a sealant or gasket. The concentration of water at such joints requires careful detailing so as to prevent leaking.

Openings

Openings in facades, such as windows and doorways require special attention but the principles outlined before still apply.

In most cases rainwater flow should be encouraged to pass over windows, sills and spandrels as evenly and freely as possible. Window frames should be of materials that do not stain easily, and sills should be well sloped and smooth so as to minimise dirt accumulation. Many recent buildings have used concrete spandrel panels and windows in more or less the same plane, without sill ledges or projections, and they have weathered well without staining. This method seems to be at best when the spandrels are of a darker colour. Again, the path of flow must be anticipated and provision made to collect and drain away the water in due course.

The use of projecting sill courses has had mixed success from a weathering point of view. It is therefore recommended that sill courses be omitted in favour of the "in-plane" method mentioned above.

If strong modelling of the facade requires the use of recessed windows and their associated deep sills, it is recommended that the sills be designed to check and arrest rainwater and direct it to intentional run-off channels in reveals or spandrels or to a drainage system.

Conclusion

It would not be possible in an article such as this to contemplate all the forms, textures and situations that arise in concrete structures of all shapes and sizes. But in designing all those structures the principles of rainwater flow must be applied and solutions designed as part of the building fabric.
Not to do so is to risk uncontrolled and unsightly weathered staining that would give displeasure to many.

It must be stressed that the many concrete buildings that have weathered well have been the subject of careful design and detail as much as of good workmanship. The most excellently formed, placed and finished concrete will not be spared from weather staining unless the design itself is efficient.

Further Reading

- **Weathering:** Design of concrete buildings, John Partridge; "Concrete" November 1975.
- **Weathering:** Appearance of concrete structures, W.L. Monks; "Concrete" May 1975.
- **Weathering:** Cleaning and restoration of concrete structures, Ian Clayton; "Concrete" April 1975.
- **Design for Weathering of Buildings using Architectural Precast Concrete:** Prestressed Concrete Institute, Chicago, 1978.
- Reports on "The Weathering of Concrete Symposium" London; "Concrete" February and March 1971.