PCI Precast/Prestressed Concrete Institute

AIA Continuing Education

Weathering

PCI designer's notebook

WEATHERING

A primary consideration in the architectural design of buildings should be weathering, that is, how the appearance changes as a result of exposure to atmospheric and environmental conditions. The action of weathering may enhance or detract from the visual appearance of a building, or may have only a slight effect. The final measure of weathering's effect is the degree to which it changes the original building appearance and distorts the designer's original design concept.

Visual changes occur when dirt or air pollutants combine with wind and rain to interact with the wall materials. The run-off water may become unevenly concentrated because of façade geometry and details. The manner in which water is shed off the structure depends primarily on the sectional profiles of the vertical and horizontal discontinuities designed into the wall.

Through the years, designers controlled the water flow down specific parts of a structure with copings, drip grooves, gargoyles, window sills, and plinth details. However, many of these useful and relevant details have been discarded as superfluous decoration.

For architectural precast concrete (as well as all other building materials), the awareness of weathering should be reflected in the design of wall elements and the integration of windows to control water sheeting and penetration and to manage water run-off. Staining that occurs through differential surface absorption and uneven concentrations of dirt due to water run-off are considered the most common weathering problems.

Many of the effects of weathering can be predicted by studying local conditions and/or existing buildings in the area. This will often give a clear indication of the levels of pollution, the velocity, principal direction and frequency of wind; and the intensity, duration, and frequency of rainfall; together with records of temperatures and relative humidity. All these factors will affect the way exposed concrete will get wet and dry out. With proper attention to the causes and effects of weathering, potentially detrimental results can be eliminated or at least minimized. Design tools for control of weathering are the massing and detailing of the building and the color, texture, and quality of the surface finishes. Precast concrete will become dirty when exposed to the atmosphere, just like any other material. Fortunately, with architectural precast concrete, the designer can choose shapes, textures, and details to counteract many of the negative effects of weathering. Although regular cleaning of a building may make detailing a less critical factor, maintenance costs should be balanced against initial design costs.

One of the major contributing factors to the weathering of precast concrete is dirt in the atmosphere. Atmospheric dirt or air pollutants include smoke or other gases, liquid droplets, grit, ash, soot, organic tars, and dust. Gaseous pollutants include SO_2, NO_X, H_2S, NH_3, and O_3. Sulphur dioxide (SO_2) can react with the lime in the concrete and the oxygen from the air to form gypsum. Gypsum's solubility allows for it to be washed away, taking dirt with it. Where there is insufficient water to wash it away it can encapsulate dirt and hold it.

The concentration of SO_2 and other corrosive compounds is high in some urban environments. When dis-

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solved in rainwater, SO_2 produces dilute sulfurous or sulfuric acid. These acids etch cement-rich paste and carbonated precast concrete surfaces, showing more fine aggregate which may appear as a color change unless the fine aggregate and matrix colors are similar.

Fig. 1 shows the pH of acid deposition falling in the U.S. during 2011. Although acid deposition (acid rain) is technically defined as precipitation with a pH level below 5.6, some researchers believe that it should be defined as low as 5.1. Using either definition, acid deposition has a far-reaching impact on both the U.S. and Canada.

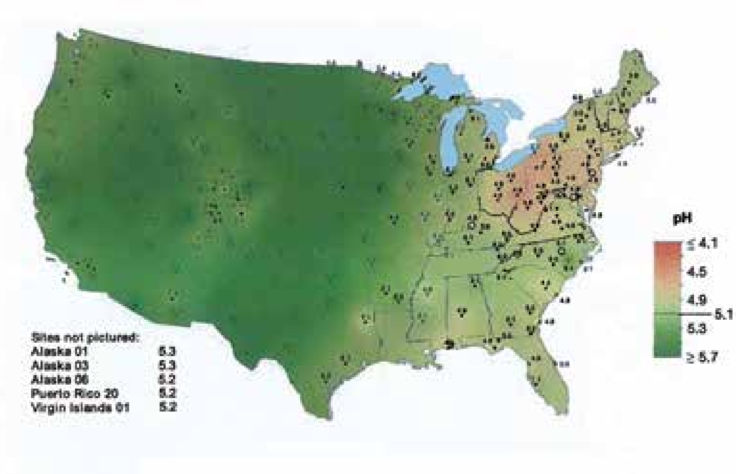

Figure 1 Hydrogen ion concentration as pH – distribution of acid rain.

In areas with unusually high concentrations of corrosive elements (pH of rainwater lower than 5.1), the designer should detail the façade for water run-off, specify concrete strengths and durabilities normally associated with architectural precast concrete, provide the required cover over reinforcement, avoid soft aggregates such as limestone and marble, and suggest more frequent washings of the building.

The flow of rainwater across the building's façade has a profound affect on weathering patterns because rain run-off redistributes particulate matter that has been deposited fairly uniformly on the external wall surfaces. This deposit takes place more rapidly on surfaces facing upward and also on surfaces with a coarse texture. The designer should attempt to anticipate and plan for water flow over the wall, tracing water flow to the final drainage point or to ground level, particularly where discontinuities exist. When run-off reaches a discontinuity the water may bead and drip free. This may increase or decrease the run-off concentration, affecting both the run-off's ability to carry suspended

dirt particles, and the subsequent drying behavior of the wall. Such changes of flow concentration may disfigure the building surfaces.

Usually rain run-off acts as a cleansing agent for the top of the building. However, at some stage the water will also pick up particulate matter already deposited on the walls and it becomes a soiling agent. The preferred lines of water flow must be arranged through shaping of surfaces and textures so that, at the point where water is expected to become a soiling agent, it will not detract from the finishes or forms of the building elements. Particulate matter will drop out of the run-off water when water flow velocity is decreased; for example, when the run-off is allowed to fan out. It may be necessary to have frequent details to throw water clear of the building, collect the water, or spread the water uniformly across sloped surfaces. Such details should be continuous to prevent differential rainwashing, or must terminate at bold vertical features, or maintain a clear distinction between washed and soiled areas. These differences can then, if required, be emphasized by the use of varying surface finishes.

The migration of run-off water is affected by:

1. The location and concentration of rain deposits.
2. The properties of water in contact with materials, especially surface tension.
3. The forces of wind and gravity.
4. The geometry, absorption, and texture of the building surface.
5. Drips.

The amount of rainwater, and the velocity and angle at which it falls is markedly different on each side of a building and at different heights. Therefore, it is not reasonable to expect equal weathering of all parts of the building. The influence of tall or massive buildings, projections, courts, or passages on prevailing winds can cause wind eddies to upset the natural flow of air and rain. This makes the effect of rainwater very difficult to predict. Also, a wall that receives a great deal of sunlight will dry out a lot faster and will be less likely to attract airborne particles.

The wettest portion of a building is typically the top corners of the windward face, followed by the top and side edges. The side wall, which is parallel to the wind direction, remains relatively dry. A wide face remains drier overall, particularly in its center region, relative to a narrow face. The taller the building and the higher the wind velocity, the relatively narrower the band of high rain impact. Increased wind speed also appears to cause greater wetting in the center of a façade. Corners may be subjected to 20 to 30 times more rain impact as compared with the central region of the building face.

Peaked roofs, cornices, or horizontal projections can substantially reduce the amount of rain that falls on a façade by reducing lateral acceleration at the wall-roof intersection. Horizontal projections that project 12 in. (300 mm) or more away from the plane of the main façade throw water off the building. These projections must have a drip on the underside to prevent water running back across the soffit. This stops soffit staining, and also prevents random staining on the surface below.

During storms, driving rain can come from any direction, but the quantity of water available on a façade for washing is normally determined by its relationship to the prevailing wind and the intensity of rain from that direction. Wind movements around buildings are affected not only by major climatic factors but by local topography, adjacent buildings, and groups of trees. All these will affect the amount and position of driving rain hitting a building and the way water runs down the façade. The drops of driving rain are guided for the most part by the air currents around the building and external wall components. The pattern of these air currents is independent of building height. Small obstacles give rise to sudden changes in direction of the air current and the raindrops cannot follow these sudden changes. The mass forces carry them forward to the obstacle. On one- or two-story buildings, the driving rain reaches the lower parts of the walls. Dirt stain patterns do not usually occur on such low buildings.

Air currents against buildings taller than a couple of stories are, on the other hand, deflected so gently that the air has time to re-orient the raindrops. When the wind blows at a building, some of the air will rise to pass at an increased velocity over the top; the rest will form a horizontal vortex and spiral away around the ends, (**Fig. 2**). Less than half the quantity of rain that should pass through a free air cross-section of the same size as the building is caught by an external wall. This applies regardless of the wind force. The rain mainly strikes the top parts of the wall. Only edge sections (corners) are reached by the driving rain and in the central sections the raindrops move almost completely parallel to the wall. As a result, water run-off very seldom reaches all the way down to the ground, except at corner areas and projecting components, unless the duration of the rain is quite long. Therefore, special care should be taken to ensure that water is not allowed to run down surfaces unless there is enough water to wash the surfaces completely. When the runoff water reaches the area of wall that is protected from driven rain by the horizontal vortex it will be absorbed into the surface causing a typical zigzag dirt line. The level at which the jagged line of dirt forms will be governed by a combination of the height of the vortex and the absorbency of the precast concrete. The height of the vortex above the ground is determined by the height of adjacent buildings or other obstructions over which the wind has passed. A typical weathering pattern caused by rain and prevailing wind is illustrated in **Fig. 3**. Parts of the building façade are clean in areas where it is washed by rain, even though the remainder of the building has become soiled.

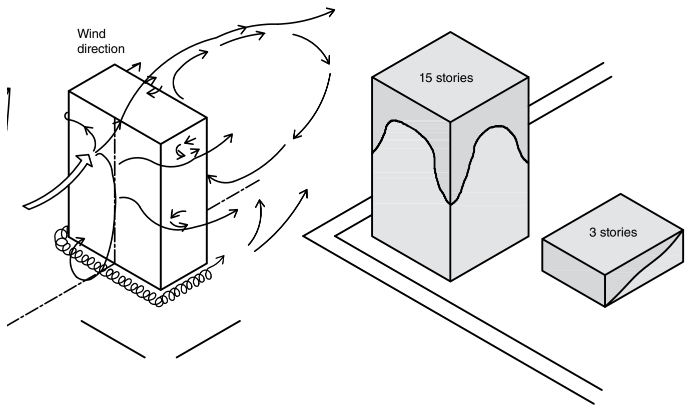

Figure 2 Wind movement around building and rain wetting of façades.

Figure 3 Water washing and dirt deposits.

Rounded or splayed corners reduce wind speed at the edges of buildings and may be useful to avoid the heavy concentrations of driving rain that are typical of these locations. Also, continuity of water flow between surfaces is improved when corners between them have rounded instead of sharp edges. A joint, groove, or projection near a corner with a long return should be used to catch the rainwater and prevent partial dirt washing from water blown around the corner.

The raindrops that reach a wall surface are absorbed to different extents depending on absorption and moisture content of the wall material. Precast concrete normally has a medium to low water absorbency of 5 to 6% by weight or 12 to 14% by volume. Water run-off on concrete surfaces consists of a very thin layer, 0.01 in. (0.25 mm) thick, and only occurs if the absorption of the concrete is lower than a certain value. The run-off flows slowly (up to 3 ft./min. [0.9 m/min.]) and vertically down the wall with lateral winds having an insignificant influence. When the water reaches lower sections, which have been struck by less driving rain and are drier, it is absorbed. The dirt accompanying the water is deposited in new places, unevenly soiling the surface. Also, a façade with high absorption normally becomes wet rapidly and remains damp for a longer period than a façade with low absorption. Airborne dirt (soiling particles) adheres easily to high absorption

Figure 4 (a) Water flow over glass depositing dirt.

Figure 4 (b) Water flow over glass depositing dirt soiling pattern.

concrete. It is desirable to break up large areas of concrete, extending over several stories, with horizontal features that either collect or throw off the water at intermediate positions. These features will reduce the amount of water on the surface, reduce the differences between panels at different levels on the façade, make the change from washed to unwashed into a gradation instead of a clearly visible line and by producing interest and shadows will make any changes less noticeable.

Surface tension causes droplets of water to converge on non-porous surfaces such as glass and metal and to drain in irregular streams. Glass areas cause build-up of water flow. Because glass is a non-absorbent material, the flow rate of water down its surface is fast and in discrete streams rather than as a continuous film with little time lag in its throw-off. By contrast, rainwater flowing down an adjacent concrete wall surface will be slower (depending on the surface texture) and its throw-off will be less complete. As a result, there is a concentration of water at the base of a window or glass curtain wall—the very thing the designer must guard against if differential patterning is to be avoided. This flow must be dissipated, breaking up its concentration. Furthermore, there is always a tendency for water flow to be in greater volume at the edges of the glass or at the mullions than in its center, (the smallest amount of wind tends to drive rain toward the edges of the glass). **Fig. 4(a) and (b)** show a soiling pattern caused by water run-off carrying particulate matter down the mullion and over the horizontal precast concrete. In Figures 4(a), an attempt to minimize staining resulted in rustications being cut under the mullions after the panels were in place. Shadows on rustications usually help mask streaks particularly when the recessed depth is equal to or greater than the recess width.

The water run-off on concrete surfaces has a tendency to divide into separate streams determined by microscopic irregularities or differences in absorption of the surface when the water layer thickness decreases below a critical value. This breakdown into irregular, separate streams takes place mainly on smooth or lightly textured surfaces but can also occur on surfaces with exposed aggregates. However, a uniformly distributed, broken flow, which results in slow water run-off, is more likely to occur over heavily textured materials, (**Fig. 5**). These streams recur at the same locations on walls or windows during most rainfalls and are reflected in the soiling pattern. The streams of water broaden out laterally when they meet horizontal or moderately sloping obstacles. They also follow surfaces facing downward (horizontal surfaces) in a similar manner. Consequently, the design of drips is extremely important. Surface tension allows water flow to take place along the underside of horizontal surfaces. Therefore, outward-sloping ledges, soffits, and bullnoses should have a drip groove in the underside to prevent particulate laden water running back onto the façade below and causing dirt streaking.

When a small volume of water maintains contact with a relatively large area of glass, conditions may be conducive to leaching of the alkaline materials in the glass. The interaction of glass and water results in the replacement of the sodium ions in the glass with hydrogen ions from the water. As sodium ions accumulate and hydrogen ions decrease in a thin film of water, the liquid will increase in alkalinity at a much greater rate than if it were absorbed into a large volume of water. Also, this reaction and, the solution pH increases much more rapidly at elevated temperature (140°F vs. 73°F [60°C vs. 23°C]). As long as the alkaline concentrations of the resulting solution remain below pH level of 8.5 (the threshold of permanent surface damage), glass etching does not occur. However, if the evaporation rate is very slow, and the pH level increases to 9.0 or above, glass network dissolution (glass etching) displaces ion exchange as the predominant reaction mechanism. Any factor that increases the length of time moisture is in contact with glass during wet-dry cycles is likely to speed tenacious staining and possibly contribute to glass etching. One of the most common contributors of differential wetting is dirt or dust. Dirt accumulation on glass holds the water on the glass longer causing moisture to attack the surface. The finely divided damp materials in contact with glass cause the glass constituents to dissolve slightly and be redeposited at the evaporating edge of the material, resulting in tenacious deposits. Frequent washing of the windows tends to remove the gel before it becomes hard, minimizing staining and etching of the glass.

Figure 5 Water flow over smooth versus rough texture.

A common response to the etching of glass in concrete structures is that concrete contributes alkaline materials to the run-off water. Hydration of cement results in the formation of hydrated calcium silicates (CSH), $Ca(OH)_2$, and aluminates, and the remaining water in the concrete becoming highly alkaline. Atmospheric acids (NO_x, SO_x, and $C0_2$) neutralize low concentrations of these alkalies from concrete to produce less alkaline salts of calcium, sodium, or potassium. Of these reaction products, only the carbonates of sodium and potassium provide the most soluble alkaline salts. However, even these salts are quickly converted to the bicarbonates that are only very weakly alkaline. Because the atmosphere is usually very acid in the larger cities (refer to Fig. 1), low concentrations of leached alkali (high pH) will be neutralized.

Although laboratory studies have demonstrated that glass can be susceptible to alkaline-induced surface damage, it does so under conditions that do not prevail in the environments typically encountered by glazing systems. A solution of calcium hydroxide (pH 11.5) placed on glass at 140°F (60°C) in a controlled environment to retard evaporation does not cause chemical erosion or etching after 20 hours. In the field, it is only the last water droplets after a rain, adhering to glass, that could present a threat to surface quality via alkaline etching, if indeed the solution pH is 9.0 or greater and the residence time is well beyond 24 hours. It is doubtful that these droplets could exist intact for the periods required for severe alkaline etching to develop. Repeated deposition and evaporation can eventually lead to tenacious deposits and subsequent chemical etching.

Concrete frames at window heads should be designed so they don't splay down and back toward the glass, unless drip details are incorporated into the frame. The drip section should be designed in relation to the slope of the concrete surface (**Fig. 6**) to prevent water from bridging the drip. To avoid chipping, the drip should not be located closer than $1^1/_2$ in. (38 mm) to the edge of the precast concrete unit. Where the window is not 2 in. (50mm) or more back from the face of the panel, it is difficult to get a drip groove in the panel.

Drips also prevent water (after a storm) from slowly running over the window glass, a primary cause of glass streaking. Without drips to prevent slow run-off and differential wetting of the windows, dirt or dust accumu-

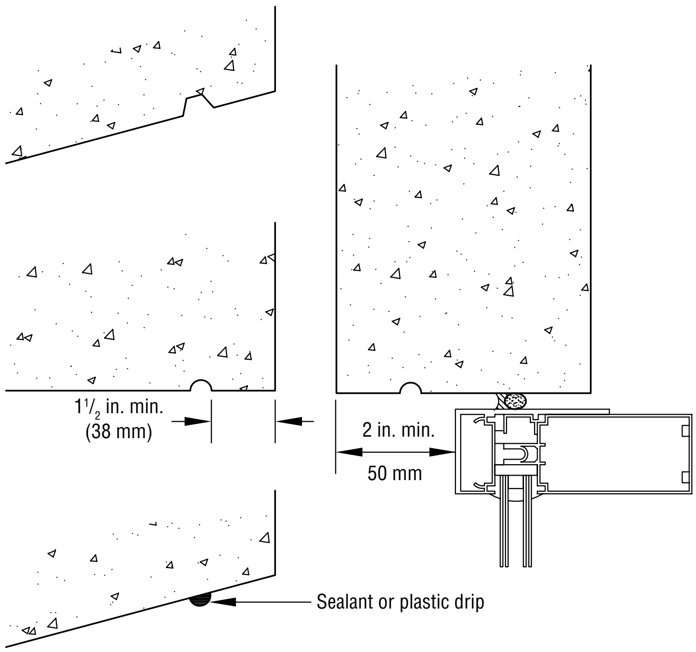

Figure 6 Design of water drip in relation to slope.

lation on windows will increase the length of time the last water droplets are in contact with the glass during wet-dry cycles. Contact of the finely divided damp dirt or dust with the glass may cause glass constituents to dissolve slightly and be redeposited possibly resulting in glass staining or etching. The time period for a stain to result depends to some degree on ambient temperatures with warmer temperatures causing the stain to occur sooner. Periodic window washing (every 90 to 180 days depending on dirt accumulation) is important in minimizing stains from occurring on the glass. By doing this cleaning, deposits will not have time to accumulate.

Water will leave a drip at its lowest point and it is important to follow its course thereafter. Small chips and cracks in the building surface may concentrate the flow, so that water will bridge drip details and allow wetting of the surface below. If particulate laden water falls onto other surfaces, the problem may be merely relocated. However, if the wind tends to spread the water out on the surface below, uniformity of weathering may be obtained. To avoid streaks on the sides of window panels, the drip may be stopped about 2 in. (50 mm) short of the window sides.

A clear sealant bead applied to precast concrete units after erection, or plastic drips glued to the concrete, are remedial drip solutions used with varying success depending on their care in application. A drip incorporated initially into the precast concrete or window frame is the least-costly and best solution. **Figs. 7 (a) and (b)** show the use of an extrusion (either aluminum or neoprene) across the head of a window which have either an integral gutter or extended drip lip of at least 1 in. (25 mm) as remedial drip details.

Although sealers are not a substitute for proper design for water run-off they do improve concrete's weathering characteristics in urban or industrial areas by reducing the absorption of moisture and increasing rainwater run-off. A combination of a base coat application of a penetrating silane sealer with a topcoat application of methyl methacrylate resin sealer may be the most effective. Sealers should be guaranteed by the supplier or applicator not to stain, soil, darken, or discolor the precast concrete finish. The use of sealers on precast concrete in locations having little or no air pollution or in dry climates is not recommended due to the additional cost, recurring periodic maintenance applications, and uncertain results of the sealer application.

The vertical angle of a surface has a major influence on the quantity of pollutants it collects and how they are discharged during rain. **Fig. 8** shows the volume of rain assumed to hit a building surface depending on the orientation of the surface. For diagrammatic purposes, the angle of rainfall direction is assumed to be 10 deg. from the vertical. However, the variability of rain under actual conditions makes all but a general prediction difficult. Vertical or near-vertical surfaces receive insufficient rainwater to be self-cleansing. Steep forward-sloping surfaces usually weather cleaner. Large areas may begin to collect dirt at the lower end unless the angle is steep. With heavy rain, the dirt on horizontal surfaces and surfaces that have little slope may be partially washed off, streaking the surfaces below. In the case of light rain or drizzle, the dirt may collect and slowly flow down other surfaces in the general direction of the water flow, resulting in pronounced, random streaking. Backward-sloping surfaces collect little or no rain but are likely to be subject to a partial, nonuniform water flow from above, which may carry dirt and cause serious streaking. Backward-sloping surfaces are often seen in shadow. In this case, the accumulation of dirt is not particularly noticeable if the dirt is acquired evenly without disfiguring streaks. The following guidelines are derived from the weathering of exposed surfaces:

- Avoid horizontal planes—they collect the most dirt and are the most exposed to rain.
- Use steeply sloping rather than flat upper surfaces—the advantage of a sloping upper surface is that the dirty water is immediately drained away. For example, sills should have a minimum slope of 2 percent to ensure water flow away from windows and minimize dirt accumulation. Adopting a steep slope and a limited height encourages run-off of rain and complete washing. If there is a risk of an uneven staining pattern, then opt for a darker color and/or a complex surface texture, for example, deep grooves.

(a)

(b)

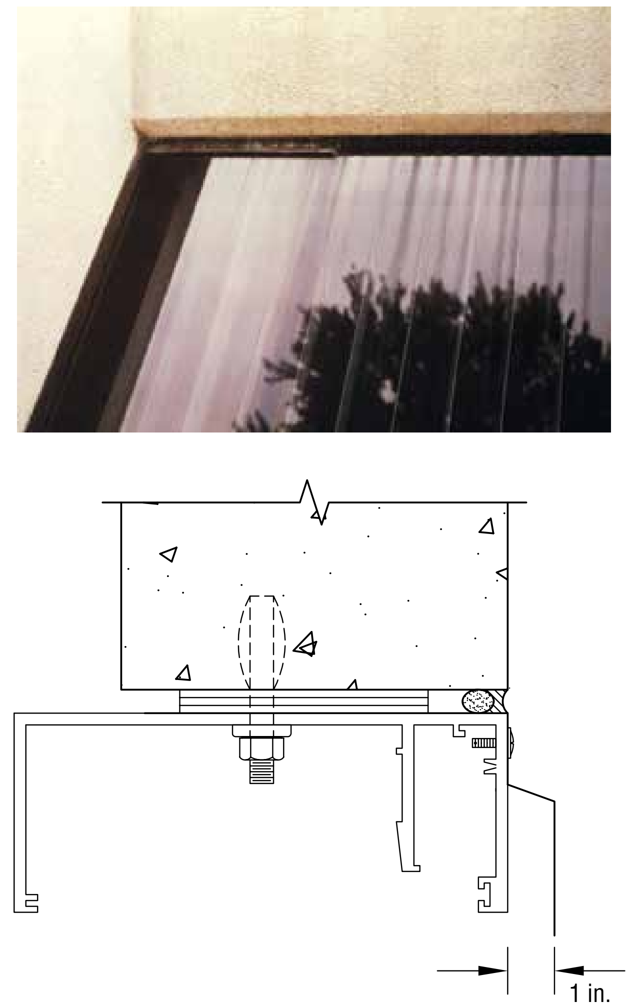

Figure 7 Gutter or drip incorporated as drip detail.

Parapets should be designed to avoid run-off from flat roofs onto the façade. A parapet of sufficient height (8 to 12 in. [200 to 300 mm]) will normally prevent water on the roof from blowing over the parapet onto the face of the building. The top of the parapet should slope backward (with a 1:4 slope) toward the roof for its full width and be narrow so that dirt accumulating on them does not cause streaking on the building face when washed off.

- Avoid run-off into areas in the rain shadow (where little rain will fall and dirt streaking is likely).
- For vertical surfaces, detail surface finishes that disperse rainwater flow over the surface or provide vertical striations that direct the flow more evenly.
- Avoid run-off from horizontal or gently sloping upper surfaces on vertical sections of walls. Investigate

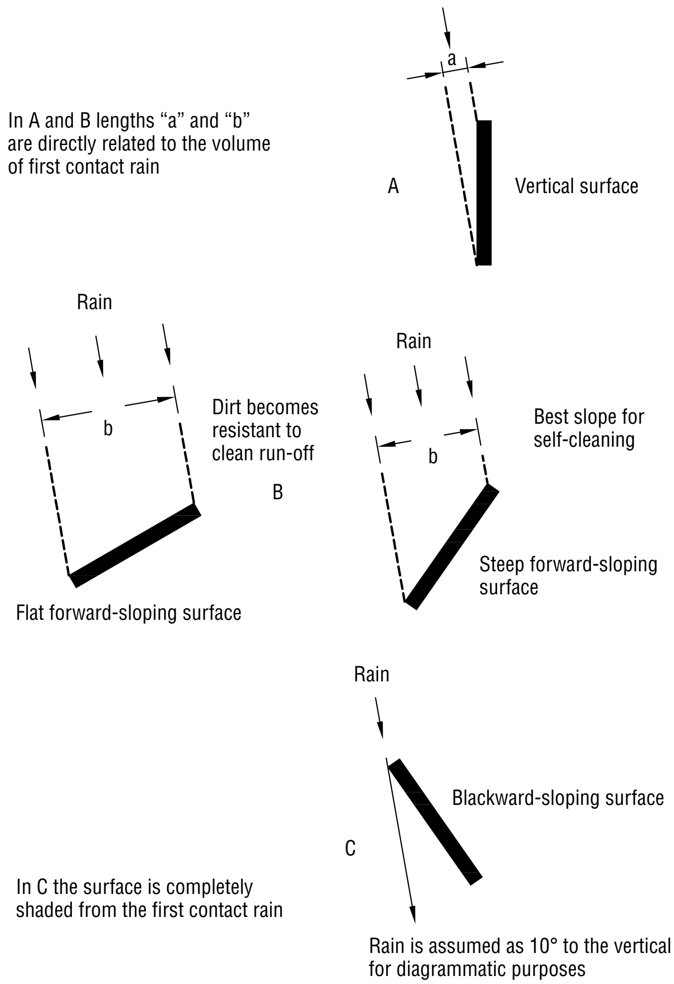

Figure 8 Volume of rain likely to hit wall surfaces.

whether the combination of the two surfaces cannot be replaced by a slope. The pattern of the spandrel under the windows is influenced by this.

- Every inclined or vertical surface with large projections must be provided with a well-profiled drip in order to prevent the rain running off into the rain-shadow area.

The façade geometry of buildings is usually responsible for local concentrations of run-off which should be avoided. Such concentrations lead to the characteristic marking patterns frequently observed on building surfaces: dirt accumulation, dirt washing, and white washing.

New buildings may show dirt washing at locations of concentrated run-off while their over-all surfaces are still quite clean. Later, the same areas may exhibit white washing (lighter, cleaner streaks) after adjacent surfaces have been darkened by dirt accumulation.

Adjacent precast concrete units should have faces aligned within accepted industry tolerances. Any discrepancy may pass undetected on a new building, but weathering will eventually emphasize the offset with uneven staining of adjacent units.

The intersection of horizontal and vertical projecting elements almost always creates dirt streaks. Such streaks run back from the edge of exposed columns and below the ends of horizontal elements even when they are steeply sloped at the top surface. To avoid such streaks, the horizontal element should be stopped short of the column. This confines rain run-off to the horizontal element and permits unimpeded washing of the column. Channeling of the column faces also will help prevent water from running back along the edges.

Water flowing laterally or diagonally downward on a surface will concentrate where it encounters vertical projections or recesses. The secondary airflow due to wind is also important. It concentrates run-off at the outside corners of the building, at columns, and at inside corners of vertical projections. Surface tension contributes to this effect by preventing flow back from vertical edges of small elements such as window mullions, often concentrating the flow at the corners.

In areas where nearby buildings show the undesirable effects of weathering and the local atmosphere is laden with pollutants, it is recommended that consideration be given to the use of sealers to increase rain run-off, reduce surface absorption of the concrete, and facilitate cleaning of the surface.

Surface Finish

Concrete surface finishes vary considerably in their ability to take up and release dirt under weathering conditions. They should therefore be chosen for their so-called "self-cleansing" properties. But the selection of color and texture may have an aesthetic significance greater than the effects of weathering. The economics of varying the surface finish from one part of the building to another should be investigated as the weathering characteristics will be different.

The surface of smooth precast concrete is hard and impervious and easily streaked by rain, unless there is enough water to form a complete film on the surface. Weathering patterns are determined by the shape and smoothness of the units and joints, which are particularly vulnerable. Any irregularity in a smooth surface will be exaggerated by weathering patterns. Non-repeating, irregular, and concentrated streams tend to form on smooth or lightly textured materials. Light-toned and smooth surfaces accentuate the contrast between washed and unwashed areas.

Textured finishes accumulate more dirt, but they can maintain a satisfactory appearance. The aggregate tends to break up and distribute water run-off more evenly, reducing the streaking that appears on smooth surfaces. Textured finishes also have a slower drain-off because each stream is small. The irregularities and shadows on the surface also tend to mask discoloration. It is not reasonable, however, to expect an exposed-aggregate finish to deal with all problems of weathering. The way water moves on such a surface is different, but concentrated flows or their effects will still be visible and must be controlled.

Rounded aggregates are preferred because they tend to collect less dirt than angular aggregates with rough texture. However, dirt pickup is generally confined to the matrix. For this reason, as well as for architectural appearance, the area of exposed matrix between aggregate particles should be minimized. The smooth, nonporous surfaces of the aggregates allow less dirt to deposit and promote more run-off to increase washing of the surface. At the same time, a slightly recessed or a darker matrix helps to absorb and mask pollution deposition.

Extreme color differences between aggregates and matrix will create uniformity problems. For example, large exposed aggregates of light color provide heavily textured surfaces that may seem to be very dirty with time because the matrix becomes very dark and the high spots of the aggregates are washed clean. In some cases, uniformly colored light surfaces contrasted with uniformly dark-colored surfaces may be used to accentuate the depth of relief on a building face. Smooth units made with dark-colored sands will slowly become darker with age when subject to weathering because the surface film of cement paste erodes away, exposing the sand. Therefore, wide differences between the color of the matrix and the sand should be avoided.

The use of appropriate colors and textured surfaces can help to mask the effect of dirt deposits. The overall darkening in tone that takes place is unlikely to be objectionable unless streaking occurs. Medium textured finishes may still allow water to run or be wind-driven into streams, causing irregular streaks. Vertical ribs or flutes that help the designer give expression to a facade will also help to control the run-off and prevent it from spreading horizontally. As dirt collects in the hollows, it emphasizes the shadow and, therefore, the texture itself. The rib must not be too wide otherwise a soiled pattern may develop in the middle area of the rib's upper surface. If the ribs are terminated above the lower edges of the walls, streaking below the ribs may occur depending on the depth of projection and the wind force and direction. As water reaches the bottom edge of a vertical or inclined panel, surface-tension effects cause it to slow down before dripping clear and it tends to deposit any dirt it has been carrying. Horizontal ribs or flutes spread stains rather than prevent them and can be used to protect the underlying surface by deflecting the flow of water. Water flows on diagonal ribs create a weathering pattern difficult to predict.

Figure 9 (a) Self-cleaning concrete on Jubilee Church, Rome, Italy.

Self-Cleaning Concrete

White or gray cement manufactured with nanoparticles of titanium dioxide becomes a photocatalyst. The architectural precast concrete face mix containing the photocatalyst uses the sun's rays (ultraviolet light) to accelerate the formation of strong oxidizing reagents which results in decomposition of organic and inorganic pollutants which are washed-off by rain. This prevents pollutants from accumulating. The catalyst is not consumed in the reaction. The concrete surface thereby becomes self-cleaning over time while ensuring the same physical and mechanical properties of conventional concrete. In addition, synthetic iron-oxide pigments can be used to color the concrete.

Figure 9 (b) North-facing cladding was a constant mildew-problem – self-cleaning concrete was the solution.

The first use of this cement for production of precast panels was for the 3 graceful "sails" in the landmark Jubilee Church (Dives in Misericordia), (**Fig. 9a**) completed in 2003 in Rome, Italy (designed by Richard Meier & Partners).

With local high humidity and rainfall levels paired with a warm climate, the white precast concrete addition to the LSU Basketball Practice Facility in Baton Rouge, LA needed to resist the inevitable mildew problems, (**Fig. 9b**). The use of a self-cleaning photocatalytic cement was the answer.

Ascent 2013 – Weathering

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Instructions

Review the learning objectives below.

Read the AIA Learning Units article. Note: The complete article is avaliable at www.pci.org/elearning

Complete the online test. You will need to answer at least 80% of the questions correctly to receive the 1.0 HSW Learning Units associated with this educational program.

Learning Objectives:

1. Explain the finish options of precast concrete.
2. Describe the methods used to achieve color, form and texture for precast concrete finishes.
3. Explain how clay products and natural stones can be veneered to precast concrete to speed.
4. Describe what composite casting is, the advantages and when best to use it.

Questions: contact Education Dept. - Alex Morales, (312) 786-0300 Email amorales@pci.org