



## Oxide Colouring of Precast Panels

Architectural precast concrete can be made in a range of colours, textures and finishes. Repeatable results with coloured concrete require great skill and precision. Wilco Precast is capable of providing the quality control procedures, personnel and equipment to produce coloured precast concrete. Concrete colour and texture come from the constituents used to make the concrete. These constituents include coarse and fine aggregates, cement, water, admixtures and pigments. When concrete colour comes from the constituents, it is developed from the paste (hydrated cement), matrix (sand and paste) and in some cases the coarse aggregate. When trying to achieve a desired colour, it is important to understand which finish will be used. The finish determines which constituent will predominantly contribute to the colour and uniformity. The term "finish" usually refers to the overall look of the precast and includes its texture (rough, smooth) colour, design and exposure. The term "exposure" usually describes how much coarse aggregate will be visible. All the constituents can affect the colour, but depending on finish and exposure, some constituents will dominate.

Paste is the primary contributor to colour when smooth and light exposure finishes are used. Some of these include off-the-form, honed, grit-blasted finishes and many form liner finishes. The colour of paste comes from the cement, water and pigments used. Since the hydration of cement, which creates paste, is a chemical process, the colour generated is sensitive to many things. Some of the critical sensitivities include water/cementitious (w/c) ratio, curing procedures, temperature and form materials. It is crucial to minimise fluctuations in these variables from batch to batch to minimise colour variations.



Grey cement receives most of its colour from tetracalcium aluminoferrite (C4AF), which is a component in cement that helps reduce the temperature of clinker during manufacturing. Cement can have colour variations from one batch to the next since colour control is not a monitored parameter when producing cement. Most of the cement produced ends up in structures, bridges, driveways and pavements. Off-white cement, not readily available in New Zealand, has very little ferric (iron) components and is monitored for colour variations during production. White cement is manufactured for use in coloured concrete. Therefore, precast products made with white cement have less colour variation. Also, white cement has been used to



create more brilliant colors than grey cement and usually requires less pigment. Sometimes white and gray cement are blended in order to improve uniformity of the final product.

Pigments have been used to colour concrete for over 100 years. Pigments actually tint the colour of the paste portion of concrete. The most common pigments are made from iron oxides. Iron oxides consist of 325 mesh particle sizes that provide stable colours that do not fade or leach out of concrete. The primary iron oxide colours come in yellow, red and black, with the reds having either a blue or orange tint to them. Combinations of these basic colours are used to create a multitude of other colours or shades of colour. Other colours such as greens are commonly created from chromium oxides and blues from cobalt. These pigments work well but are used more sparingly, since they are more expensive. In general, pigments are inert and do not react with cement, therefore they are not considered as part of the cementitious material content. Instead, pigments bond with the cement via the hydration process, masking the colour of cement grains. Pigments are typically dosed by weight of cement, usually in the 1 percent to 7 percent range, and should never exceed 10 percent by weight of cement. Higher doses of pigments usually do not improve color but may reduce strengths. Pigments come in powdered, granular and liquid forms. All three forms work fine but require different handling, dosing and mixing procedures. Oxide pigments are commonly used to colour architectural precast concrete. Any pigments incorporated into concrete for exterior use must be colourfast. Also, they must not affect the durability of the concrete.

## Application

### 1. Dosage Rates

The dosage rates for precast concrete are typically 0.25% to 1% by weight of cement. Some off-form and other precast concrete finishes may require as much as 8%. The rates best suited to any project will be provided by Wilco Precast and confirmed by architectural samples. Fine solid oxide pigment particles rely for their effectiveness on being adequately dispersed throughout the mixed concrete. They do not dissolve and stain the concrete as a dye colourant does.

## **2. Type and Availability**

Pigments are available in a wide range of colours from deep to pale pastel hues. The major non-blended standard pigments are green, black, red, brown, yellow, blue and white. These can be obtained in commercially blended form to produce many intermediate colours.

## **3. Characteristics**

Pigments for use in precast concrete should have the following characteristics:

- be chemically inert and particularly alkaline resistant
- be insoluble
- be chemically inorganic to prevent fading by photochemical degradation.

Mineral (metal) pigments such as oxides of iron (reds, blacks and yellows), chromium (greens), titanium (white) etc, fulfill the above requirements.

## **Pigmented Concrete and In-Service Conditions**

### **Colour Stability**

The colour stability of precast concrete coloured with mineral oxide pigments can be affected by the degree of durability and weathering of the concrete rather than by any characteristic of the pigments. The primary cause of colour changes of concrete are efflorescence, atmospheric etching and staining and any accumulated dirt and grime. These causes can be controlled by producing precast units of high performance quality concrete that have been well detailed. Just like all material surfaces left in an open-air environment, precast concrete must be occasionally cleaned to remove pollution and restore the original colour.

### **Samples**

The same rules should apply to pigmented precast concrete sample evaluations as they apply to the assessment of other architectural precast finishes. Small samples give a guide but existing buildings with similar design should be viewed and evaluated if possible. The first panels of a production run, or prototypes if they are specified, must always be inspected by the client or agent to ensure that the design requirements are being achieved. Wilco Precast's experienced staff is able to advise designers in the manufacture of oxide finishes.

### **NZ Standard**

There is no New Zealand Standard for the use of mineral oxide pigments in precast concrete.