Edison Coatings, Inc.

# GUIDE TO THE REPAIR OF ARCHITECTURAL TERRA COTTA

Once considered unreliable and temporary in nature, repair systems for terra cotta have become a mainstream component in Historic Restoration work. This evolution can be attributed to the development of effective, high quality specialty materials designed specifically for long-term compatibility with terra cotta substrates.

With a record of more than 20 years of successful performance on thousands of architectural Terra Cotta Restoration projects, Edison Coatings offers the most complete, time-proven, compatible terra cotta restoration systems available today. Edison's custom color and formulation capabilities provide the highest levels of aesthetic match and finish as well.

A completely integrated system, Edison's products include the following specialty materials designed specifically for use in terra cotta restoration:

- **COMPOSITE PATCHING MORTARS**
- **CASTING MORTARS**
- **RE-PROFILING MORTARS**
- **BONDING ADHESIVES**
- **CRACK REPAIR RESINS & GROUTS**
- **REPOINTING & REBUILDING MORTARS**
- **COATINGS FOR GLAZE REPLICATION**
- **COATINGS FOR GLAZE DETAIL REPLICATION**

The following is a brief guide to terra cotta repair system options and preliminary selection criteria. It should be noted that proper investigation and correction of the causes underlying the observed deterioration is prerequisite to undertaking repairs, and repair plans and sequencing must include consideration of the significant quantities of liquid moisture often found within compromised terra cotta building wall systems.

## STEP 1: DEEP REPAIR

After proper surface preparation, repairs to spalls greater than 1/8" (3 mm) in depth are best achieved using ***Custom System 45 TC*** grade. A two component cementitious system, ***Custom System 45*** provides higher bond strength, lower shrinkage and more efficient stress relief than competitive systems. This allows installation of large and deep repairs without cracking, special curing regimens or distress to historic substrates. Low coefficient of thermal expansion ($<4 \times 10^{-6}$ in/in/$^0$F) assures long term thermal compatibility with fired clay substrates, even in areas subject to rapid, wide swings in ambient temperatures.

***Figure 1: Replacement finial (right) was cast with custom color-matched Custom System 45 using Restoration Latex RL-2.***

The standard liquid component is ***Restoration Latex RL-1*** which allows non-sag application for vertical and overhanging repairs. In cases involving very large and deep areas of loss, ***Restoration Latex RL-2*** (Superplasticized) may be used with ***Custom System 45 TC*** to form and pour repairs in place or to cast replacement elements. ***Restoration Latex RL-3*** (Marine Grade) may be used for repairs subject to high constant moisture exposure, such as fountains and planters. In cases requiring exceptional levels of moisture and vapor permeability, ***Restoration Latex RL-4*** (Air Entraining) may be used. For hot weather work at temperatures up to $120^0$F, ***Restoration Latex RL-5*** may be used to extend working times.

| GRADE | DESCRIPTION | RECOMMENDED USES |
|---|---|---|
| **RL-1** | Non-Sag Grade | General Use: Vertical, Horizontal and Overhanging Repairs |
| **RL-2** | Superplasticized | Castings and Poured Repairs |
| **RL-3** | Marine/Immersion | Fountains, Planters, High Constant Moisture |
| **RL-4** | High Permeability | Retaining walls, Ruined Masonry, for Highest Permeability Repairs |
| **RL-5** | High Temperature | For Repairs under Hot Weather Conditions up to $120^0$F ($50^0$C) |

## STEP 2: THIN SECTION REPAIR

It is common for terra cotta subjected to bulk moisture infiltration to develop thin glaze spalls, in which a section of terra cotta glaze and bisque surface delaminate from an otherwise sound terra cotta element. Typically, section thickness is no more than 1/16" (1.5 mm).

After repairing the sources of leakage, unobtrusive repairs in depths up to ¼" (6 mm) are achieved by using ***Thin-Fill 55*** Reprofiling Mortar. There is no ***minimum*** depth and the mortar is designed for easy sanding and/or polishing to achieve perfectly smooth surfaces, when required to replicate existing glazed terra cotta profiles. The product is also easily filed after initial set to produce fluted profiles, when required to match existing terra cotta.

***Figure 2: Thin-Section glaze spalls are common in terra cotta subjected to bulk moisture infiltration.***

A cementitious mortar with low coefficient of thermal expansion, high bond strength, low Modulus for efficient stress relief and positive moisture and moisture vapor permeability, ***Thin Fill 55*** facilitates achievement of excellent aesthetic finishes for repairs to architectural terra cotta. It is fully compatible with ***Custom System 45***, and may be applied over deeper patches to achieve special surface finishes when required.

***Thin Fill 55*** is frequently matched to the color of the existing terra cotta glaze, to facilitate subsequent glaze replication. For translucent glazes, ***Thin Fill*** is matched to the bisque color.

## STEP 3: CRACK REPAIR

A variety of potential causes of cracking in terra cotta mandates that a variety of repair alternatives be made available. Ideally, crack repair details and material selections are specified by a design professional experienced in the specific properties, assembly details and deterioration mechanisms of terra cotta. Crack width monitoring can assist in determining the movement capacity required, if any, for the repair system.

The following systems are used in the repair of cracks in terra cotta:

▸ ***Custom System 45*** is often used to repair cracks determined to be stationery, or non-working. The crack is typically grooved out to approximately 1/4" width x ½" depth, and is then filled with a matching ***Custom 45 TC*** repair mortar.

▸ ***Flexi-Fill 530,*** a 2-component flexibilized acrylate epoxy paste filler allows less invasive repairs with higher tensile strength and elongation, for cracks exhibiting some limited movement. A Dremel tool may be used to slightly open the face of the crack to a nominal 1/16" x ¼"depth, and the narrow opening is then filled with the color-matched ***Flexi-Fill 530*** paste grade filler. At initial cure stage (typically 30 – 90 minutes) the product cures to a soft rubber which is easily trimmed with a razor or utility knife.

▸ ***Pump-X53-Series*** cement and lime-based injection mortars are also used in certain repair situations. Although injection of cracks in hollow masonry units is impractical when using epoxy injection resins, cement and lime-based compositions are more compatible and can be used to fill voids and cracks without distress to the terra cotta. A variety of grades is available, including ***Pump-X53 Masonry Grout*** for filling of large voids and cracks (>1/4"), ***Pump-X53i Microinjection Grout*** for fine cracks down to 1/16" (1.5 mm), ***Pump-X53iE Expanding Microinjection Grout*** for filling of cracks where slight expansion of the grout is desired (+2%) and ***Pump-X53iL Hydraulic Lime Injection Grout*** where softer, self-healing performance is desired.

## STEP 4: REBONDING MASONRY UNITS

Fractured terra cotta elements can often be salvaged and repaired rather than replaced. The use of ***Flexi-Weld 520T*** masonry adhesive permits cleanly broken pieces to be quickly and cleanly rebonded, without creating a gap between the broken surfaces. When a narrow gap between the pieces must be filled by the adhesive, color-matched ***Flexi-Fill 530*** is used.

Both two-component, 100% solids acrylate-epoxy adhesives can be used under a wide range of temperatures to quickly grab and re-bond all types of broken masonry elements. Variable mix ratio allows users to adjust working times and consistencies under varying working conditions.

***Figure 3 (left): Pump-X53 was used to fill voids between terra cotta band courses and rubble masonry backup on this project in New York City. Figure 4 (right): Injection points are marked on an interior wall surface; Pump-X53i was injected through the back-up wall into the masonry exterior veneer to fill cracks and voids in the stonework.***

***Figure 5: Stone column base, before and after rebonding with Flexi-Weld 520T.***

## STEP 5: GLAZE REPLICATION

Once the appropriate repairs have been made and the correct surface profiles restored, specialty coatings are used to replicate the color, reflectance and density of the original glaze. Two systems may be used:

▸ ***Aquathane UA210 Type NCL*** is used to achieve the finest finishes, as it allows tight control of gloss level (from Flat to High Gloss) and translucence (from Opaque to Clear). It is a highly durable waterborne aliphatic polyurethane capable of withstanding decades of weathering with minimal effect. Clear coats may also be used to provide higher gloss and depth of finish. It is generally combined with ***Type G Bonding Additive*** to assure tenacious adhesion to smooth, non-porous existing glaze surfaces.

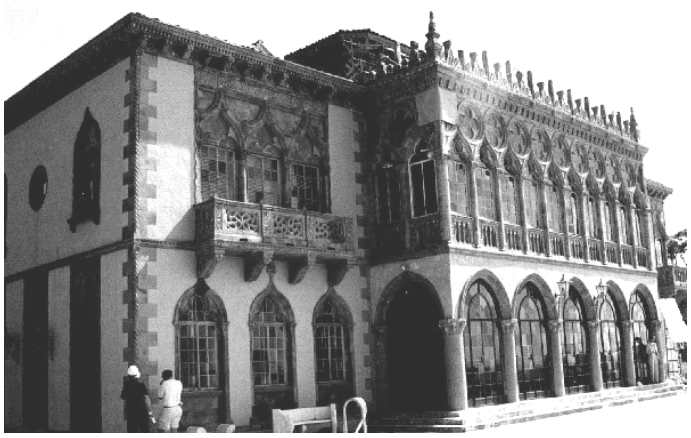

***Figure 6: More than 30 colors of Aquathane and Elastowall coatings were custom-matched to the polychrome terra cotta at this elaborate oceanfront museum building in Florida.***

▸ ***Elastowall 351*** is an internally plasticized 100% acrylic coating which has been used for decades to both provide an aesthetic matte finish and to aid in exclusion of water from terra cotta exhibiting small working cracks. It is favored by some Conservators for its high rate of moisture vapor transmission, its ability to bond to less aggressively prepared surfaces and to a wide variety of existing materials, and its ability to be removed/reversed if so desired at some later date. Luster can be imparted to ***Elastowall 351*** coatings by applying a clear top coat of ***Aquathane UA210 Type E***.

Both products are available in over 900 standard colors, which can be prepared in-house by Edison Dealers who participate in the Edison Coatings Tint Base program. Custom color matching service is also available from Edison Coatings, Inc.

***Figure 7: Terra Cotta gargoyle, before and after repair with Custom System 45 and coating with Elastowall 351.***

## STEP 6: GLAZE DETAIL REPLICATION

A particular challenge in terra cotta restoration work is the replication of special details frequently found in original glazes. These may include speckles, smears, mottling or even multiple layers of glaze of different colors.

These special finishes can often be recreated using multiple applications of ***Aquathane UA210 Type NCL*** and/or ***Type E***, employing various faux finishing techniques.

In addition, ***AquaSpex 220*** may be used to provide speckles of specific size, concentration and color. ***AquaSpex 220*** incorporates color-matched flakes in a clear binder, permitting close control of speckle color, density and size.

***Figure 8: Terra Cotta fragment sits atop a precast concrete panel which has been base-coated with light grey Aquathane UA210 NCL and top-coated with AquaSpex 220, incorporating 1500 micron Charcoal Grey flakes. The combination provides a final finish which closely matches the original material.***