BERLIN FREE LIBRARY

BELFRY CONDITIONS ASSESSMENT

Prepared for:

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EXECUTIVE SUMMARY

The Town of Berlin acting through the Berlin Historic District Commission on behalf of the Berlin Free Library Association obtained grant funding for a conditions assessment of the Belfry balustrade through the National Park Service as administered by the Department of Economic and Community Development, State Historic Preservation Office in the Fall of 2015. The purpose of the grant is to document the current condition of the balustrade, make recommendations for preservation and repair, and estimate the cost of repairs. CME Associates, Inc. was enlisted by the Town to prepare the report and associated drawings contained in this document.

The Belfry balustrade is composed of wood elements, some of which are original to the building (1833), and some of which are replacement features. It is clear that the urns and vasiform balusters are from the original construction as are the corner panels and moldings. These elements are made of old growth hardwoods that, for the most part, have weathered well over the course of 182 harsh New England weather years. It is evident that the top and bottom railings are replacement parts as they are constructed of saw-tooth style finger jointed wood, a contemporary manufacturing technique typically reserved for softwoods. The lower rail has failed on the north elevation and shows signs of deterioration on other elevations. The top rail and urn bases are also contemporary construction and although they are not severely deteriorated, they were not designed to shed water and therefor, warrant replacement at this time. Concern that conditions related to the balustrade might be contributing to water infiltration in the belfry were also reviewed and addressed in the report finding that water is not infiltrating at the balustrade (roof) level, but rather at the juncture between the main roof and the northwest corner of the Belfry.

Considering all options for repair of the balustrade, it is the recommendation of this report that the balustrade construction be removed from the building and reconstructed, reusing and repairing all historic materials, and replacing the deteriorated top and bottom rails with wood of a species that will be compatible with and suitable for the exterior environment. While maintenance is of utmost concern to a non-profit institution such as the Berlin Free Library Association, recognition that the Worthington Academy building is a unique and significant resource within the Worthington Historic District and an asset to the town of Berlin, the state, and the nation, the building should be maintained in its original condition to the greatest extent possible. Cost estimates for several options conclude that restoration of the original fabric, rather than reconstruction with new or substitute materials, is the most cost effective approach to restoration.



BUILDING HISTORY

Originally constructed as the Worthington Academy in 1833, the Berlin Free Library building is a fine example of a Federal Style academic structure. Listed on the State Register of Historic Places and located within the Worthington Ridge Local Historic District, the two-story brick building is oriented with the gable end to the street and distinguished by a recessed, oversized-door entrance with fanlight, and a wood framed belfry. While the interior of the building was modified over the years to accommodate the school, use by the Congregational Church Ecclesiastical Society, annual Worthington borough meetings, Sons of Temperance meetings, court sessions, as a private residence and finally as the Berlin Free Library, the exterior has remained remarkably, historically intact.

Since the distinctive balustrade is the focus of this study it is useful to understand the concepts and construction methods behind its design. Composed of vasiform balusters engaged by top and bottom rails, the railing is framed by decorative panels which are topped by staved urns. The use of decorative balustrades can be traced to the 16th century where Renaissance architects Bramante and Michelangelo utilized the vasiform baluster in both civic and residential structures. One notable example is Michelangelo's use of the stone balustrade in the Palazzo Degli Conservatori on Capitoline Hill in Rome.



Figure 1: Palazzo degli Conservatori by Michelangelo, 1536.



Figure 2: Old State House in Hartford by Bulfinch, 1796.

Subsequent use of this decorative element can be found in early American buildings of the Federal style. With the exception of monumental stone buildings such as the US Capitol, the balustrade was constructed of wood which was more readily available and less expensive than stone. Wood could be said to be a "substitute material", replicating the balusters of the monumental stone structures, on smaller scale buildings constructed of wood and brick. While the architect or builder of the Worthington Academy is not known, it is interesting to note that the design of the urns and the balusters is very similar to those detailed in New England architect Asher Benjamin's pattern books and in the work of his contemporary, Charles Bulfinch, architect of the Old State House in Hartford (1796) and the Massachusetts State House in Boston (1798).

Benjamin's pattern books were widely distributed during the time when the Academy was under construction. Founded in the Federal Style, his book, *The Architect, or Practical House Carpenter* of 1830 illustrates his recognition of, and transition to, the Greek Revival Style. Both styles are evident in the Academy building form and ornament. Benjamin's design of the Ashby, Massachusetts First Parish Church (1805) shows a belfry balustrade utilizing elements in a similar manner to the Worthington Academy belfry balustrade (Figure 3). Benjamin's close association with Charles Bulfinch and other early American Architects demonstrates the use of standard elements typical in the Federal style. The balustrade (Figure 4) of the

Meeting House in Lancaster, Massachusetts (1815) is an example of Bullfinches' use of the split baluster illustrated in Benjamin's pattern books and found at the Worthington Academy building Belfry balustrade.



Figure 3: The First Parish Church in Ashby (1805)



Figure 4: Meeting House (1815) Lancaster, MA

The following illustrations from Asher Benjamin's pattern books show the typical architectural detailing widely reflected in New England architecture throughout the first half of the 19th Century. The balustrades and urns are important elements which Benjamin detailed in almost every one of his seven books. The split baluster was also typical in furniture design of the time being used as applied ornament. As with most things, economy of means and materials is important to be efficient and competitive. The split baluster was not actually a turned baluster split in half, but rather constructed out of three pieces of wood temporarily secured together, turned as one and then separated. Twice as many balusters could be made with one turning. Apparently the center block of wood was not used in the balusters iillustrated, but it would have been a flat profile of the vasiform design that could have been useful for another purpose.

The urns are also constructed out of multiple pieces of wood staved together as may be seen in the base of the urns that are awaiting reinstallation. While the Academy urns are not exactly like those pictured in Benjamin's books, they are a craftsman's interpretation of the popularly used element. Both of these elements are key character defining features of the building that should be retained and preserved.

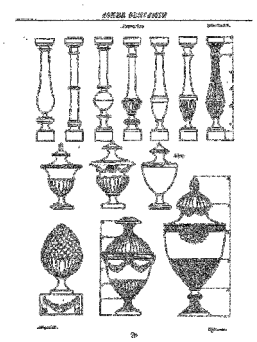


Figure 5: Asher Benjamin, *American Builder's Companion*, 1816. (Google Books)

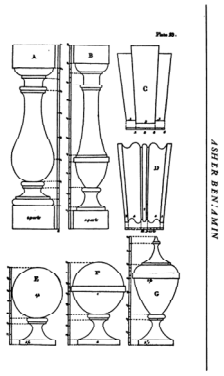


Figure 6: Asher Benjamin, *Rudiments of Architecture*, 1814. (Google Books)

There is some question as to whether or not the Belfry is an original feature of the Worthington Academy building as there are no early drawings or other documentation of the structure that would clarify the issue. A study of the Belfry framing shows that the timber frame to the east is inset into the brick front façade. The bricks are not cut as they would be if the Belfry tower had been added later.



Figure 7: The Belfry beam and post engaged in the east, front brick wall.

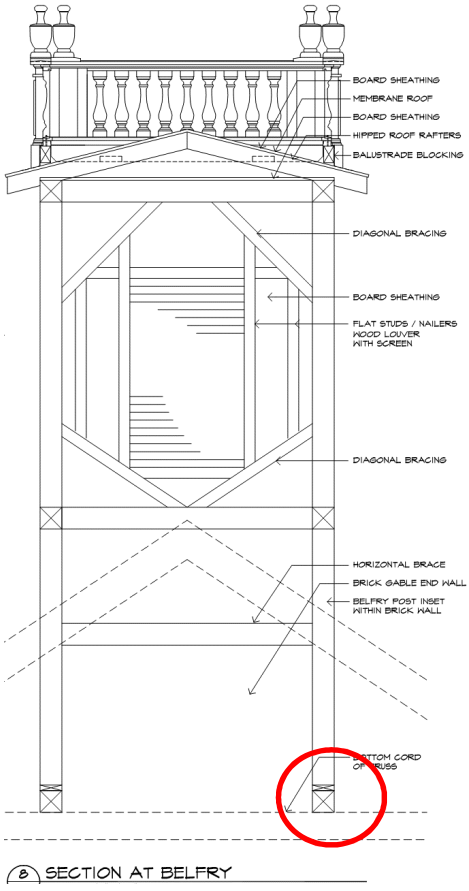
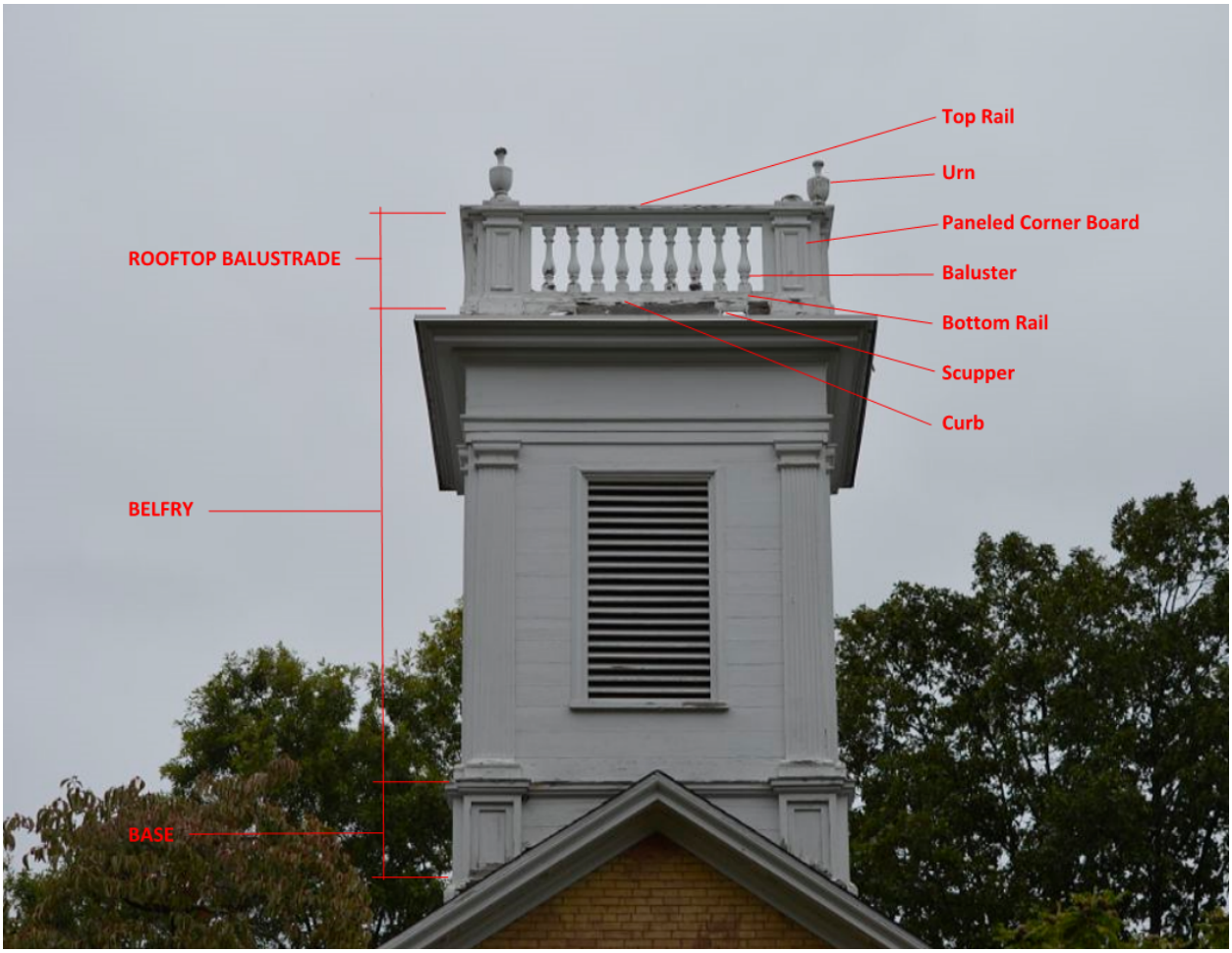


Figure 8: View of the Belfry framing looking east where the framing is engaged in the brick gable end wall. Figure 7 location circled.

EXISTING CONDITIONS SURVEY



DEFINITIONS

Baluster - A small molded shaft, square or circular, in stone or wood, sometimes metal, supporting the coping of a parapet or the handrail of a staircase; a series of balusters supporting a handrail or coping.

Balustrade - A railing composition composed of upper and lower rails, balusters and pedestals.

Belfry - A small chamber or stage in a tower where bells are hung.

Curb - a raised edge or margin to strengthen or confine.

Paneled Corner Board - A flat, usually rectangular piece forming a raised, recessed, or framed part of the surface in which it is set.

Rail - A bar extending horizontally between supports.

Scupper - An opening in the wall of a building through which water can drain from a floor or flat roof.

Urn: A tall, rounded vase with a base, and often a stem.

CHARACTER DEFINING FEATURES



Photo 1: The belfry of the Library is composed of three parts: The base which provides the flat transition to the next tier; the belfry which houses the bell in an enclosed room with vertical vents on all four sides to protect against weather while allowing sound to disperse; the rooftop balustrade, a decorative feature that balances the entire rooftop element and is constructed to be open and airy.



Photo 2: The rooftop balustrade is composed of nine turned vasiform (vase-shaped) balusters equally spaced between built up panelized corner pilasters and supported between top and bottom rails. Two decorative solid wood urns sit atop the paired corner pilasters. A curb with scuppers has been added below the bottom rail to contain snowmelt and ice.



Photo 3: A close up of the balustrade reveals the detailing of the various elements. The balusters, urns and moldings are original elements while the railings and urn bases are replacement materials.

CONDITIONS ASSESSMENT



Photo 4: Paint failure is typical on the components of the rooftop balustrade. The paint has served its function as a sacrificial surface which has protected the wood substrate.



Photo 5: Portions of the baluster fabric have been lost over time. Note the way the top of the baluster is slotted to fit over the spline in the connecting rail. This system has successfully kept the balusters in place.



Photo 6: Paint failure has allowed the corner boards to check. After the paint is removed, the boards should be filled with a consolidant prior to repainting.



Photo 7: The two part lower railing has been replaced at some point in modern history. The wood is finger jointed. Note the circular saw marks of the right hand vertical member indicating an original component.



Photo 8: the tight grain of old growth wood seen in the split balusters has contributed to their longevity. Note the punky lower rail made of new wood which will need to be replaced.



Photo 9: The original balusters on the west elevation are in fair condition while the upper railing, fabricated from new wood, will need to be replaced with a tapered cap t shed water.



Photo 10: The paired urns which are original to the balustrade are in fair condition. Notice that the urns sit on blocks of wood that are new as is the top rail. The top rail is flat. A new top rail and urn pedestals should be tapered to shed water.



Photo 11: While several urns are no longer in place, all but one are accounted for and could be reinstalled. This urn on the northwest corner will need to have a piece fabricated to recreate the base.



Photo 12: One of the urns shows the checking of the wood as it has weathered. The wood is still strong and the cracks can be filled with consolidant prior to refinishing. All wood should be cleaned of biological growth to insure positive paint adhesion.



Photo 13: A single ply rubber membrane roof was installed on the hip roof of the belfry sometime in the 1990's. This material probably replaced (or was installed over) a flat seamed copper roof, and will be a long lasting solution to keeping the roof waterproof. Scuppers allow water and snow to disperse slowly however the curb retains snow against the wood lower rail potentially damaging the wood. Additional scuppers could be added, giving the appearance of the rail sitting on blocks. Originally there probably was no curbing or blocks but rather a gap between the lower railing and the copper roof.



Photo 14: The exterior face of the curb is wood which has not retained paint but the wood appears as a tight grain species that is in good condition.



Photo 15: Wrought iron rods secure the corner pilasters to the hip roof. The rods are likely to be original to the structure and should be retained and re-secured. The corner framing is original building fabric as is the inset and lower portion of the top rail.



Photo 16: The attic is composed of heavy timber trusses that allow for a clear span of the spaces below. The joints appeared tight and the members are in good condition. There is some indication of past water damage on the old roof sheathing boards but the old boards have been sheathed over with plywood providing a double layer of sheathing below the asphalt shingles.



Photo 17: Framing and sheathing of the exterior walls of the Belfry showed minor areas of past water leakage which is not of concern at this time. The framing and joints are tight and true. The board sheathing at the ceiling level obscures the underside of the hipped Belfry roof and the opportunity to confirm the connection of the balustrade. From the look of the connection at the post and beams, it appears that the post does not penetrate the roof line to support the balustrade.



Photo 18: Signs of water infiltration are evident in the northwest corner of the Belfry at the attic level. Framing of this corner under the balustrade level shows no signs of water infiltration leaving one to suspect ineffective flashing at the juncture of the main roof and the Belfry. This condition is obscured by framing on the interior of the building.



Photo 19: A likely means of water entering the building and affecting the joint shown in Photo 18 is the flashing between the base of the tower and the roof. The lower courses of wood trim at the northwest corner in particular should be removed and the area re-flashed to insure that water will not infiltrate.



Photo 20: The bell housing appears to be in good condition having no signs of deterioration.



Photo 21: The cast bronze bell is marked “Hartford 1834”.

RECOMMENDATIONS

The condition of the rooftop balustrade is such that the paint has entirely failed leaving both original and replacement elements exposed to the deleterious effects of sun and rain. The original decorative elements including the balusters and urns are in fair condition but able to be restored. The lower rail, which was previously replaced, is in very poor condition and should be rebuilt. The upper rail is a three part railing, the top portion of which is a replacement element, in fair condition, which will deteriorate as a result of the flat top which does not allow water to drain off the surface.

As per item number five of the Secretary of the Interior's Standards for Rehabilitation contained in the Appendix, "distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize the restoration period will be preserved". As was outlined earlier, the character defining features of the rooftop balustrade include the overall composition, and the decorative elements such as the urns, the paneling and the balusters. Every effort should be made to repair and retain the overall composition and the decorative elements.

According to item six in the Standards, when an element is severely deteriorated and requires replacement, "the new feature should match the original in design, color, texture, and, where possible, materials". In the case of the rooftop balustrade, the railings are the elements that require replacement. Ideally they should be replaced in-kind although improvements to the top rail could be made to allow for better drainage without hurting the scale of the overall component.

While the Berlin Free Library Association values the historic integrity of its building and the historic district in which it stands, practical considerations regarding maintenance of the rooftop balustrade should be addressed to determine if low maintenance substitute materials are compatible with the Secretary of the Interior's Standards and considered appropriate in a review by the Historic District Commission. Is the use of materials other than wood such as fiberglass, acrylic resins and PVC appropriate?

According to the National Park Service *Preservation Brief 16, The Use of Substitute Materials on Historic Building Exteriors* (included in the Appendix), there are four circumstances that may warrant the consideration of substitute materials:

- the unavailability of historic materials;
- the unavailability of skilled craftsmen;
- inherent flaws in the original materials; and
- code-required changes (which in many cases can be extremely destructive of historic resources).

The railings, which are in need of replacement at this time, can be replaced with historic materials, do not require specially trained craftsman to produce, and, as witnessed by the longevity of the urns and balusters, reflect an appropriate use of wood material able to withstand conditions on the rooftop. Building codes do not affect the type of material to be installed in this case although the balustrade structure and its components should be securely installed. Reusing the metal rod ties is appropriate to this task. The use of substitute materials is therefore not warranted except to reduce building maintenance.

There are several options for repair listed here in order of adherence to the Standards:

Option 1: Retain historic elements to the greatest extent possible and repair all deteriorated materials in-kind using wood species such as cypress or Spanish cedar that can withstand the elements. Recognize that paint is a

sacrificial coating system, designed to protect the wood, that needs to be inspected annually, and maintained on a regular basis;

Option 2: Retain historic elements to the greatest extent possible and replace selective deteriorated materials with substitute materials that can withstand the elements. This option may be appropriate for replacement of elements that are not visible from the public way. Typically substitute materials will weather differently from historic materials creating an unattractive contrast of materials. If substitute materials can be installed out of sight, they may be appropriate alternatives that would reduce maintenance. If this option were to be selected, the installation of substitute materials should be carefully detailed so as to not damage the remaining historic fabric with inappropriate connectors, and to allow for expansion and contraction of differing materials.

Option 3: Replace the balustrade system with substitute materials. This is the least desirable option and is not consistent with preservation strategies, as the use of substitute materials reduces the integrity of the historic resource. If used, substitute materials should meet three criteria: they must be comparable to historic materials in appearance; the physical properties must be similar to the historic materials and; they must meet basic performance expectations over an extended period of time. A full discussion of these criteria may be found in the Preservation Brief 16 included in the Appendix.



Photo 22: Stock railing components could be fabricated out of substitute materials. Pictured is a PVC railing system. Note that stock materials will not match the historic profiles exactly. Also note the blocks below the bottom rail which could serve as snow guards.

The roof curb that was installed directly below the balustrade was intended to reduce runoff from snow and ice but it may in fact be retaining moisture against the wood materials of the balustrade, potentially hastening damage from water. Historically there probably was no curb or fascia at the base of the railing, specifically to allow water to drain. Consideration should be given to redesigning the curb to balance the need for gradual drainage of the roof surface with the preservation of the balustrade structure. Given that the space below the base of the railing is visible from the public way (across the street), accommodation for blocks, which not only support the lower rail but also decrease the chance for large blocks of snow and ice to slide off the roof, could be made (See Photo 22 which illustrates a similar condition). These blocks could be constructed of a durable wood such as cypress, or could be made of a composite material compatible with the composition of the railing itself.



Photo 23: A view of the railing from the elevated sidewalk on the opposite side of the street, taken with a telephoto lens. Note the scuppers (openings) in the roof curb that allow water to flow under the rail. Also note the poor condition of the wood face of the curb which is unable to hold paint due to high moisture content in the wood. Opening up the curb and adding blocks below the bottom rail could mitigate snow slide while allowing water to drain.

The single ply membrane roof is a good solution for a roof covering that is not visible from the road. As mentioned earlier, the original roof was probably flat seamed copper. The existing roof material is in good condition and well flashed around the curbs, tie rods and the scuppers. This roof is purported to have been installed in the 1990's so that, with a life expectancy of 30 to 40 years, it can be expected to function well for many years to come. The roof, like the railing should be inspected on an annual basis to assess the condition of the seams and the overall field of the roof.

COST ESTIMATE

Option 1: Repair in-kind

Scope of work: Dismantle the entire balustrade system in panels taking care not to disturb historic fabric. This can be achieved by cutting through the top and bottom rails at the middle of each span so as to keep the corner paneling intact. Remove the panels to a workshop and replace the upper and lower rails *in-kind* with new cypress, mahogany, Spanish cedar or black locust elements. Repair the urns and balusters by consolidating the wood. Reassemble all elements and paint with one coat of oil based primer and two coats of alkyd paint. Reinstall the panelized balustrade.

- Labor (prevailing wage) $12,000
- Materials (including lift) 10,000
- Subtotal $22,000
- Contingency @ 10% 2,200
- **Total Option 1** **$24,200**

Option 2: Repair and Replace

Scope of work: Dismantle the entire balustrade system in panels taking care not to disturb historic fabric. Remove the panels to a workshop and replace the upper and lower rails with *composite elements*. Repair the urns and balusters by consolidating the wood. Reassemble all elements and paint wood elements with one coat of oil based primer and two coats of alkyd paint. Reinstall panelized balustrade.

- Labor (prevailing wage) $12,000
- Materials (including lift) 9,000
- Subtotal $21,000
- Contingency @ 10% 2,100
- **Total Option 2** **$23,100**

Option 3: Replace entire balustrade with substitute materials

Scope of work: Dismantle the entire balustrade system and remove from site, storing a portion for retention by the owner. Reconstruct the entire balustrade in *composite materials* matching the original design to the greatest extent possible.

Option 3 – A: Polyurethane and PVC components

The following costs were obtained by the Berlin Free Library Association from a private contractor and adjusted for inflation using stock Polyurethane parts similar to, but not exactly the same design as the existing balustrade components. CME also obtained a quote on replacement materials from the local distributor of Fypon materials which confirmed the BFLA estimate. Note that the polyurethane system is a light-weight foam combined with resin to produce a closed cell material that is resistant to rot and insect damage. Polyurethane components are appropriate for decorative elements such as the urns and balusters, but not appropriate for structural or load bearing elements such as the railing and corner posts which should be constructed of a stronger PVC product. Careful consideration should be given to the detailing between the two materials. Polyurethane products need to be painted while some solid PVC products do not take paint, potentially creating a visual discontinuity between the two materials. Polyurethane products need to be repainted every five to ten years.

- Labor, materials and installation $25,000
- Adjustment for prevailing wages ($12,000 x 25%) 3,000

- Subtotal $28,000
- Contingency @ 10% 2,800
- **Total Option 3-A** **$30,800**

Option 3 – B: Solid Cellular Vinyl

An additional option explored by the Berlin Free Library Association was to recreate the balustrade in solid cellular vinyl. Solid Cellular Vinyl is a weather and rot resistant, foamed and extruded, vinyl product. The product can be painted, but does not need to be. It can be milled similar to wood and can be incorporated with structurally reinforced hollow vinyl elements to produce a structurally sound railing system. The BFLA requested a quote from Walpole Woodworkers to replicate the existing balustrade system in Solid Cellular Vinyl. The cost of materials was $24,125 in January of 2015. Assuming delivery to the site, lift rental and a crew of two at prevailing wages to dismantle the old and install the new railing at$10,000, the cost for total replacement in kind is roughly $38,500.

- Materials $25,000
- Labor (including delivery and lift) $10,000
- Subtotal $35,000
- Contingency @ 10% 3,500
- **Total Option 3** **$38,500**

It should be noted that composite materials, as described in Options 2, 3 and 4, are composed of vinyl products which are produced from non-renewable resources and that these products produce toxic fumes when consumed by fire. Preservation Brief 16 does not evaluate the use of PVC or vinyl as an appropriate substitute material for wood as wood replacement parts can readily be fabricated.

APPENDIX

Secretary of the Interiors Standards for Rehabilitation

1. A property shall be used for its historic purpose or be placed in a new use that requires minimal change to the defining characteristics of the building and its site and environment.

2. The historic character of a property shall be retained and preserved. The removal of historic materials or alteration of features and spaces that characterize a property shall be avoided.

3. Each property shall be recognized as a physical record of its time, place, and use. Changes that create a false sense of historical development, such as adding conjectural features or architectural elements from other buildings, shall not be undertaken.

4. Most properties change over time; those changes that have acquired historic significance in their own right shall be retained and preserved.

5. Distinctive features, finishes, and construction techniques or examples of craftsmanship that characterize a property shall be preserved.

6. **Deteriorated historic features shall be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and other visual qualities and, where possible, materials. Replacement of missing features shall be substantiated by documentary, physical, or pictorial evidence.**

7. Chemical or physical treatments, such as sandblasting, that cause damage to historic materials shall not be used. The surface cleaning of structures, if appropriate, shall be undertaken using the gentlest means possible.

8. Significant archeological resources affected by a project shall be protected and preserved. If such resources must be disturbed, mitigation measures shall be undertaken.

9. New additions, exterior alterations, or related new construction shall not destroy historic materials that characterize the property. The new work shall be differentiated from the old and shall be compatible with the massing, size, scale, and architectural features to protect the historic integrity of the property and its environment.

10. New additions and adjacent or related new construction shall be undertaken in such a manner that if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.

Note: Author's emphasis of recommendations relating to the Belfry balustrade in bold.

Preservation Brief 16: The Use of Substitute Materials on Historic Building Exteriors

Some of the web versions of the Preservation Briefs differ somewhat from the printed versions. Many illustrations are new and in color; Captions are simplified and some complex charts are omitted. To order hard copies of the Briefs, see Printed Publications.

PRESERVATION BRIEFS

16

The Use of Substitute Materials on Historic Building Exteriors

Sharon C. Park, AIA

Introduction

Historical Use of Substitute Materials

When to Consider Using Substitute Materials

Cautions and Concerns

Choosing an Appropriate Substitute Material

Pros and Cons of Various Substitute Materials

Summary and References

Reading List

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Cast alumnimum used as a replacement for cast iron. Photo: NPS files.

The Secretary of the Interior's Standards for Rehabilitation require that "deteriorated architectural features be repaired rather than replaced, wherever possible. In the event that replacement is necessary, the new material should match the material being replaced in composition, design, color, texture, and other visual properties." Substitute materials should be used only on a limited basis and only when they will match the appearance and general properties of the historic material and will not damage the historic resource.

Introduction

When deteriorated, damaged, or lost features of a historic building need repair or replacement, it is almost always best to use historic materials. In limited circumstances substitute materials that imitate historic materials may be used if the appearance and properties of the historic materials can be matched closely and no damage to the remaining historic fabric will result.

Great care must be taken if substitute materials are used on the exteriors of historic buildings. Ultraviolet light, moisture penetration behind joints, and stresses caused by changing temperatures can greatly impair the performance of substitute materials over time. Only after consideration of all options, in consultation with qualified professionals, experienced fabricators and contractors, and development of carefully written specifications should this work be undertaken.

The practice of using substitute materials in architecture is not new, yet it continues to pose practical problems and to raise philosophical questions. On the practical level the inappropriate choice or improper installation of substitute materials can cause a radical change in a building's appearance and can cause extensive physical damage over time. On the more philosophical level,



In the reconstruction of the clock tower at Independence Hall, the substitute materials used were cast stone and wood with fiberglass and polyester bronze ornamentation. Photo: NPS files.

the wholesale use of substitute materials can raise questions concerning the integrity of historic buildings largely comprised of new materials. In both cases the integrity of the historic resource can be destroyed.

Some preservationists advocate that substitute materials should be avoided in all but the most limited cases. The fact is, however, that substitute materials are being used more frequently than ever in preservation projects, and in many cases with positive results. They can be cost-effective, can permit the accurate visual duplication of historic materials, and last a reasonable time. Growing evidence indicates that with proper planning, careful specifications and supervision, substitute materials can be used successfully in the process of restoring the visual appearance of historic resources.

This Brief provides general guidance on the use of substitute materials on the exteriors of historic buildings. While substitute materials are frequently used on interiors, these applications are not subject to weathering and moisture penetration, and will not be discussed in this Brief. Given the general nature of this publication, specifications for substitute materials are not provided. The guidance provided should not be used in place of consultations with qualified professionals. This Brief includes a discussion of when to use substitute materials, cautions regarding their expected performance, and descriptions of several substitute materials, their advantages and disadvantages. This review of materials is by no means comprehensive, and attitudes and findings will change as technology develops.

Historical Use of Substitute Materials

The tradition of using cheaper and more common materials in imitation of more expensive and less available materials is a long one. George Washington, for example, used wood painted with sand-impregnated paint at Mount Vernon to imitate cut ashlar stone. This technique along with scoring stucco into block patterns was fairly common in colonial America to imitate stone.

Molded or cast masonry substitutes, such as dry-tamp cast stone and poured concrete, became popular in place of quarried stone during the 19th century. These masonry units were fabricated locally, avoiding expensive quarrying and shipping costs, and were versatile in representing either ornately carved blocks, plain wall stones or rough cut textured surfaces. The end result depended on the type of patterned or textured mold used and was particularly popular in conjunction with mail order houses. Later, panels of cementitious permastone or formstone and less expensive asphalt and sheet metal panels were used to imitate brick or stone.

Metal (cast, stamped, or brake-formed) was used for storefronts, canopies, railings, and other features, such as galvanized metal cornices substituting for wood or stone, stamped metal panels for Spanish clay roofing tiles, and cast-iron column capitals and even entire building fronts in imitation of building stone.



Substitute materials need to be located with care to avoid damage. The fiberglass column base has chipped, whereas the historic cast iron would have remained sound. Photo: NPS files.

Terra-cotta, a molded fired clay product, was itself a substitute material and was very popular in the late 19th and early 20th centuries. It simulated the appearance of intricately carved stonework, which was expensive and time-consuming to produce. Terra cotta could be glazed to imitate a variety of natural stones, from brownstones to limestones, or could be colored for a polychrome effect.

Nineteenth century technology made a variety of materials readily available that not only were able to imitate more expensive materials but were also cheaper to fabricate and easier to use. Throughout the century, imitative materials continued to evolve. For example, ornamental window hoods were originally made of wood or carved stone. In an effort to find a cheaper substitute for carved stone and to speed fabrication time, cast stone, an early form of concrete, or cast-iron hoods often replaced stone. Toward the end of the century, even less expensive sheet metal hoods, imitating stone, also came into widespread use. All of these materials, stone, cast stone, cast iron, and various pressed metals were in production at the same time and were selected on the basis on the basis of the availability of materials and local craftsmanship, as well as durability and cost. The criteria for selection today are not much different.

Many of the materials used historically to imitate other materials are still available. These are often referred to as the traditional materials: wood, cast stone, concrete, terra cotta and cast metals. In the last few decades, however, and partly as a result of the historic preservation movement, new families of synthetic materials, such as fiberglass, acrylic polymers,

and epoxy resins, have been developed and are being used as substitute materials in construction. In some respects these newer products (often referred to as high tech materials) show great promise; in others, they are less satisfactory, since they are often difficult to integrate physically with the porous historic materials and may be too new to have established solid performance records.

When to Consider Using Substitute Materials in Preservation Projects

Because the overzealous use of substitute materials can greatly impair the historic character of a historic structure, all preservation options should be explored thoroughly before substitute materials are used. It is important to remember that the purpose of repairing damaged features and of replacing lost and irreparably damaged ones is both to match visually what was there and to cause no further deterioration. For these reasons it is not appropriate to cover up historic materials with synthetic materials that will alter the appearance, proportions and details of a historic building and that will conceal future deterioration.

Some materials have been used successfully for the repair of damaged features such as epoxies for wood infilling, cementitious patching for sandstone repairs, or plastic stone for masonry repairs. Repairs are preferable to replacement whether or not the repairs are in kind or with a synthetic substitute material.

In general, four circumstances warrant the consideration of substitute materials:

1. the unavailability of historic materials;
2. the unavailability of skilled craftsmen;
3. inherent flaws in the original materials; and
4. code-required changes (which in many cases can be extremely destructive of historic resources).



The core of a deteriorated wood outrigger was first drilled out. Photos (left and right): Courtesy, Harrison Goodall.



An inert material was injected into the hollow outrigger, permitting the outer wood to be retained and preserved.

Cost may or may not be a determining factor in considering the use of substitute materials. Depending on the area of the country, the amount of material needed, and the projected life of less durable substitute materials, it may be cheaper in the long run to use the original material, even though it may be harder to find.

Due to many early failures of substitute materials, some preservationist are looking abroad to find materials (especially stone) that match the historic materials in an effort to restore historic buildings accurately and to avoid many of the uncertainties that come with the use of substitute materials.

1. The unavailability of the historic material.

The most common reason for considering substitute materials is the difficulty in finding a good match for the historic material (particularly a problem for masonry materials where the color and texture are derived from the material itself). This may be due to the actual unavailability of the material or to protracted delivery dates. For example, the local quarry that supplied the sandstone for a building may no longer be in operation. All efforts should be made to locate another quarry that could supply a satisfactory match. If this approach fails, substitute materials such as dry-tamp cast stone or textured precast concrete may be a suitable substitute if care is taken to ensure that the detail, color and texture of the original stone are matched. In some cases, it may be possible to use a sand-impregnated paint on wood as a replacement section, achieved using readily available traditional materials, conventional tools and work skills. Simple solutions should not be overlooked.

2. The unavailability of historic craft techniques and lack of skilled artisans.

These two reasons complicate any preservation or rehabilitation project. This is particularly true for intricate ornamental work, such as carved wood, carved stone, wrought iron, cast iron, or molded terra cotta. However, a number of stone and wood cutters now employ sophisticated carving machines, some even computerized. It is also possible to cast substitute replacement pieces using aluminum, cast stone, fiberglass, polymer concretes, glass fiber reinforced concretes and terra cotta. Mold making and casting takes skill and craftsmen who can undertake this work are available. Efforts should always be made, prior to replacement, to seek out artisans who might be able to repair ornamental elements and thereby save the historic features in place.

3. Poor original building materials.

Some historic building materials were of inherently poor quality or their modern counterparts are inferior. In addition, some materials were naturally incompatible with other materials on the building, causing staining or galvanic corrosion. Examples of poor quality materials were the very soft sandstones which eroded quickly. An example of poor quality modern replacement material is the tin coated steel roofing which is much less durable than the historic tin or terne iron which is no longer available. In some cases, more durable natural stones or precast concrete might be available as substitutes for the soft stones and modern terne-coated stainless steel or lead-coated copper might produce a more durable yet visually compatible replacement roofing.



Cast aluminum has been used as a replacement material for cast iron. Photo: NPS files.

4. Code-related changes.

Sometimes referred to as life and safety codes, building codes often require changes to historic buildings. Many cities in earthquake zones, for example, have laws requiring that overhanging masonry parapets and cornices, or freestanding urns or finials be securely re-anchored to new structural frames or be removed completely. In some cases, it may be acceptable to replace these heavy historic elements with light replicas. In other cases, the extent of historic fabric removed may be so great as to diminish the integrity of the resource. This could affect the significance of the structure and jeopardize National Register status. In addition, removal of repairable historic materials could result in loss of Federal tax credits for rehabilitation. Department of the Interior regulations make clear that the Secretary of the Interior's Standards for Rehabilitation take precedence over other regulations and codes in determining whether a project is consistent with the historic character of the building undergoing rehabilitation.

Two secondary reasons for considering the use of substitute materials are their lighter weight and for some materials, a reduced need of maintenance. These reasons can become important if there is a need to keep dead loads to a minimum or if the feature being replaced is relatively inaccessible for routine maintenance.

Cautions and Concerns

In dealing with exterior features and materials, it must be remembered that moisture penetration, ultraviolet degradation, and differing thermal expansion and contraction rates of dissimilar materials make any repair or replacement problematic. To ensure that a repair or replacement will perform well over time, it is critical to understand fully the properties of both the original and the substitute materials, to install replacement materials correctly, to assess their impact on adjacent historic materials, and to have reasonable expectations of future performance.

Many high tech materials are too new to have been tested thoroughly. The differences in vapor permeability between some synthetic materials and the historic materials have in some cases caused unexpected further deterioration. It is therefore difficult to recommend substitute materials if the historic materials are still available. As previously mentioned, consideration should always be given first to using traditional materials and methods of repair or replacement before accepting unproven techniques, materials or applications.

Substitute materials must meet three basic criteria before being considered: they must be compatible with the historic materials in appearance; their physical properties must be similar to those of the historic materials, or be installed in a manner that tolerates differences; and they must meet certain basic performance expectations over an extended period of time.



A waterproof coating is an inappropraite substitute material to apply to adobe as it seals in moisture and may result in spalling. Photo: NPS files.

Matching the Appearance of the Historic Materials

In order to provide an appearance that is compatible with the historic material, the new material should match the details and craftsmanship of the original as well as the color, surface texture, surface reflectivity and finish of the original material. The closer an element is to the viewer, the more closely the material and craftsmanship must match the original.

Matching the color and surface texture of the historic material with a substitute material is normally difficult. To enhance the chances of a good match, it is advisable to clean a portion of the building where new materials are to be used. If pigments are to be added to the substitute material, a specialist should determine the formulation of the mix, the natural aggregates and the types of pigments to be used. As all exposed material is subject to ultraviolet degradation, if possible, samples of the new materials made during the early planning phases should be tested or allowed to weather over several seasons to test for color stability.

Fabricators should supply a sufficient number of samples to permit onsite comparison of color, texture, detailing, and other critical qualities. In situations where there are subtle variations in color and texture within the original materials, the substitute materials should be similarly varied so that they are not conspicuous by their uniformity.

Substitute materials, notably the masonry ones, may be more water-absorbent than the historic material. If this is visually distracting, it may be appropriate to apply a protective vapor-permeable coating on the substitute material. However, these clear coatings tend to alter the reflectivity of the material, must be reapplied periodically, and may trap salts and moisture, which can in turn produce spalling. For these reasons, they are not recommended for use on historic materials.

Matching the Physical Properties

While substitute materials can closely match the appearance of historic ones, their physical properties may differ greatly. The chemical composition of the material (i.e., presence of acids, alkalines, salts, or metals) should be evaluated to ensure that the replacement materials will be compatible with the historic resource. Special care must therefore be taken to integrate and to anchor the new materials properly. The thermal expansion and contraction coefficients of each adjacent material must be within tolerable limits. The function of joints must be understood and detailed either to eliminate moisture penetration or to allow vapor permeability. Materials that will cause galvanic corrosion or other chemical reactions must be isolated from one another.

To ensure proper attachment, surface preparation is critical. Deteriorated underlying material must be cleaned out. Noncorrosive anchoring devices or fasteners that are designed to carry the new material and to withstand wind, snow and other destructive elements should be used. Properly chosen fasteners allow attached materials to expand and contract at their own rates. Caulking, flexible sealants or expansion joints between the historic material and the substitute material can absorb slight differences of movement. Since physical failures often result from poor anchorage or improper installation techniques, a structural engineer should be a member of any team undertaking major repairs.

Some of the new high tech materials such as epoxies and polymers are much stronger than historic materials and generally impermeable to moisture. These differences can cause serious problems unless the new materials are modified to match the expansion and contraction properties of adjacent historic materials more closely, or unless the new materials are isolated from the historic ones altogether. When stronger or vapor impermeable new materials are used alongside historic ones, stresses from trapped moisture or differing expansion and contraction rates generally hasten deterioration of the weaker historic material. For this reason, a conservative approach to repair or replacement is recommended, one that uses more pliant materials rather than high-strength ones. Since it is almost impossible for substitute materials to match the properties of historic materials perfectly, the new system incorporating new and historic materials should be designed so that if material failures occur, they occur within the new material rather than the historic material.

Performance Expectations

While a substitute material may appear to be acceptable at the time of installation, both its appearance and its performance may deteriorate rapidly. Some materials are so new that industry standards are not available, thus making it difficult to specify quality control in fabrication, or to predict maintenance requirements and long term performance. Where possible, projects involving substitute materials in similar circumstances should be examined. Material specifications outlining stability of color and texture; compressive or tensile strengths if appropriate; the acceptable range of thermal coefficients, and the durability of coatings and finishes should be included in the contract documents. Without these written documents, the owner may be left with little recourse if failure occurs.



The historic cornice was successfully replaced with a fiberglass cornice. Photo: NPS files.

The tight controls necessary to ensure long-term performance extend beyond having written performance standards and selecting materials that have a successful track record. It is important to select qualified fabricators and installers who know what they are doing and who can follow up if repairs are necessary. Installers and contractors unfamiliar with specific substitute materials and how they function in your local environmental conditions should be avoided.

The surfaces of substitute materials may need special care once installed. For example, chemical residues or mold release agents should be removed completely prior to installation, since they attract pollutants and cause the replacement materials to appear dirtier than the adjacent historic materials. Furthermore, substitute materials may require more frequent cleaning, special cleaning products and protection from impact by hanging window-cleaning scaffolding. Finally, it is critical that the substitute materials be identified as part of the historical record of the building so that proper care and maintenance of all the building materials continue to ensure the life of the historic resource.

Choosing an Appropriate Substitute Material

Once all reasonable options for repair or replacement in kind have been exhausted, the choice among a wide variety of substitute materials currently on the market must be made. The charts at the end of this Brief describe a number of such materials, many of them in the family of modified concretes which are gaining greater use. The charts do not include wood, stamped metal, mineral fiber cement shingles and some other traditional imitative materials, since their properties and performance are better known. Nor do the charts include vinyls or molded urethanes which are sometimes used as cosmetic claddings or as substitutes for wooden millwork. Because millwork is still readily available, it should be replaced in kind.

The charts describe the properties and uses of several materials finding greater use in historic preservation projects, and outline advantages and disadvantages of each. It should not be read as an endorsement of any of these materials, but serves as a reminder that numerous materials must be studied carefully before selecting the appropriate treatment. Included are three predominantly masonry materials (cast stone, precast concrete, and glass fiber reinforced concrete); two predominantly resinous materials (epoxy and glass fiber reinforced polymers also known as fiberglass), and cast aluminum which has been used as a substitute for various metals and woods.

Pros and Cons of Various Substitute Materials

Cast Aluminum

Material: Cast aluminum is a molten aluminum alloy cast in permanent (metal) molds or onetime sand molds which must be adjusted for shrinkage during the curing process. Color is from paint applied to primed aluminum or from a factory finished coating. Small sections can be bolted together to achieve intricate or sculptural details. Unit castings are also available for items such as column plinth blocks.

Application: Cast aluminum can be a substitute for cast iron or other decorative elements. This would include grillwork, roof crestings, cornices, ornamental spandrels, storefront elements, columns, capitals, and column bases and plinth blocks. If not self-supporting, elements are generally screwed or bolted to a structural frame. As a result of galvanic corrosion problems with dissimilar metals, joint details are very important.

Advantages:

- light weight (1/2 of castiron)
- corrosion-resistant, noncombustible
- intricate castings possible
- easily assembled, good delivery time
- can be prepared for a variety of colors
- long life, durable, less brittle than cast iron

Disadvantages:

- lower structural strength than castiron
- difficult to prevent galvanic corrosion with other metals
- greater expansion and contraction than castiron; requires
- gaskets or caulked joints
- difficult to keep paint on aluminum

Checklist:

- Can existing be repaired or replaced inkind?
- How is cast aluminum to be with other metals attached?
- Have full-size details been developed for each piece to be cast?
- How are expansion joints detailed?
- Will there be a galvanic corrosion problem?
- have factory finishes been protected during installation?
- Are fabricators/installers experienced?

Cast Stone (dry tamped)

Material: Cast stone is an almost-dry cement, lime and aggregate mixture which is dry-tamped into a mold to produce a dense stone-like unit. Confusion arises in the building industry as many refer to high quality precast concrete as cast stone. In fact, while it is a form of precast concrete, the drytamp fabrication method produces an outer surface resembling a stone surface. The inner core can be either drytamped or poured full of concrete. Reinforcing bars and anchorage devices can be installed during fabrication.

Application: Cast stone is often the most visually similar material as a replacement for unveined deteriorated stone, such as brownstone or sandstone, or terra cotta in imitation of stone. It is used both for surface wall stones and for ornamental features such as window and door surrounds, voussoirs, brackets and hoods. Rubberlike molds can be taken of good stones on site or made up at the factory from shop drawings.

Advantages:

- replicates stone texture with good molds (which can come from extant stone) and fabrication
- expansion/contraction similar to stone
- minimal shrinkage of material
- anchors and reinforcing bars can be built in
- material is firerated
- range of color available
- vapor permeable

Disadvantages:

- heavy units may require additional anchorage
- color can fade in sunlight
- may be more absorbent than natural stone
- replacement stones are obvious if too few models and molds are made

Checklist:

- Are the original or similar materials available?
- How are units to be installed and anchored?
- Have performance standards been developed to ensure color stability?
- Have large samples been delivered to site for color, finish and absorption testing?
- Has mortar been matched to adjacent historic mortar to achieve a good color/tooling match?
- Are fabricators/installers experienced?

Glass Fiber Reinforced Concretes (GFRC)

Material: Glass fiber reinforced concretes are lightweight concrete compounds modified with additives and reinforced with glass fibers. They are generally fabricated as thin shelled panels and applied to a separate structural frame or anchorage system. The GFRC is most commonly sprayed into forms although it can be poured. The glass must be alkaline resistant to avoid deteriorating effects caused by the cement mix. The color is derived from the natural aggregates and if necessary a small percentage of added pigments.

Application: Glass fiber reinforced concretes are used in place of features originally made of stone, terra cotta, metal or wood, such as cornices, projecting window and door trims, brackets, finials, or wall murals. As a molded product it can be produced in long sections of repetitive designs or as sculptural elements. Because of its low shrinkage, it can be produced from molds taken directly from the building. It is installed with a separate noncorrosive anchorage system. As a predominantly cementitious material, it is vapor permeable.

Advantages:

- lightweight, easily installed
- good molding ability, crisp detail possible
- weather resistant
- can be left uncoated or else painted
- little shrinkage during fabrication
- molds made directly from historic features

- cements generally breathable
- material is firerated

Disadvantages:

- non-loadbearing use only
- generally requires separate anchorage system
- large panels must be reinforced
- color additives may fade with sunlight
- joints must be properly detailed
- may have different absorption rate than adjacent historic material

Checklist:

- Are the original materials and craftsmanship still available?
- Have samples been inspected on the site to ensure detail/texture match?
- Has anchorage system been properly designed?
- Have performance standards been developed?
- Are fabricators/installers experienced?

Precast Concrete

Material: Precast concrete is a wet mix of cement and aggregate poured into molds to create masonry units. Molds can be made from existing good surfaces on the building. Color is generally integral to the mix as a natural coloration of the sand or aggregate, or as a small percentage of pigment. To avoid unsightly air bubbles that result from the natural curing process, great care must be taken in the initial and longterm vibration of the mix. Because of its weight it is generally used to reproduce individual units of masonry and not thin shell panels.

Application: Precast concrete is generally used in place of masonry materials such as stone or terra cotta. It is used both for flat wall surfaces and for textured or ornamental elements. This includes wall stones, window and door surrounds, stair treads, paving pieces, parapets, urns, balusters and other decorative elements. It differs from cast stone in that the surface is more dependent on the textured mold than the hand tamping method of fabrication.

Advantages:

- easily fabricated, takes shape well
- rubber molds can be made from building stones
- minimal shrinkage of material
- can be load bearing or anchorage can be cast in
- expansion/contraction similar to stone
- material is firerated
- range of color and aggregate available
- vapor permeable

Disadvantages:

- may be more moisture absorbent than stone although coatings may be applied
- color fades in sunlight
- small air bubbles may disfigure units
- replacement stones are conspicuous if too few models and molds are made

Checklist:

- Is the historic material still available?
- What are the structural/anchorage requirements?
- Have samples been matched for color/texture/absorption? Have shop drawings been made for each shape?
- Are there performance standards?
- Has mortar been matched to adjacent historic mortar to achieve good color/tooling match?

- Are fabricators/installers experienced?

Fiber Reinforced Polymers (FRP, Fiberglass)

Material: Fiberglass is the most well known of the FRP products generally produced as a thin rigid laminate shell formed by pouring a polyester or epoxy resin gelcoat into a mold. When tack-free, layers of chopped glass or glass fabric are added along with additional resins. Reinforcing rods and struts can be added if necessary; the gel coat can be pigmented or painted.

Application: Fiberglass, a non load-bearing material attached to a separate structural frame, is frequently used as a replacement where a lightweight element is needed or an inaccessible location makes frequent maintenance of historic materials difficult. Its good molding ability and versatility to represent stone, wood, metal and terra cotta make it an alternative to ornate or carved building elements such as column capitals, bases, spandrel panels, beltcourses, balustrades, window hoods or parapets. Its ability to reproduce bright colors is a great advantage.

Advantages:

- lightweight, long spans available with a separate structural frame
- high ratio of strength to weight
- good molding ability
- integral color with exposed high quality pigmented gel-coat or takes paint well
- easily installed, can be cut, patched, sanded
- non-corrosive, rot-resistant

Disadvantages:

- requires separate anchorage system
- combustible (fire retardants can be added); fragile to impact.
- high coefficient of expansion and contraction requires frequently placed expansion joints
- ultraviolet sensitive unless surface is coated or pigments are in gelcoat
- vapor impermeability may require ventilation detail

Checklist:

- Can original materials be saved/used?
- Have expansion joints been designed to avoid unsightly appearance?
- Are there standards for color stability/durability?
- Have shop drawings been made for each piece?
- Have samples been matched for color and texture?
- Are fabricators/installers experienced?
- Do codes restrict use of FRP?

Epoxies (Epoxy Concretes, Polymer Concretes)

Material: Epoxy is a resinous two-part thermosetting material used as a consolidant, an adhesive, a patching compound, and as a molding resin. It can repair damaged material or recreate lost features. The resins which are poured into molds are usually mixed with fillers such as sand, or glass spheres, to lighten the mix and modify their expansion/contraction properties. When mixed with aggregates, such as sand or stone chips, they are often called epoxy concrete or polymer concrete, which is a misnomer as there are no cementitious materials contained within the mix. Epoxies are vapor impermeable, which makes detailing of the new elements extremely important so as to avoid trapping moisture behind the replacement material. It can be used with wood, stone, terra cotta, and various metals.

Application: Epoxy is one of the most versatile of the new materials. It can be used to bind together broken fragments of terra cotta; to build up or infill missing sections of ornamental metal; or to cast missing elements of wooden ornaments. Small cast elements can be attached to existing materials or entire new features can be cast. The resins are poured into molds and due to the rapid setting of the material and the need to avoid cracking, the molded units are generally small or hollow inside. Multiple molds can be combined for larger elements. With special rods, the epoxies can be structurally reinforced. Examples of epoxy replacement pieces include: finials, sculptural details, small column capitals, and medallions.

Advantages:

- can be used for repair/replacement
- lightweight, easily installed
- good casting ability; molds can be taken from building material can be sanded and carved.
- color and ultraviolet screening can be added; takes paint well
- durable, rot and fungus resistant

Disadvantages:

- materials are flammable and generate heat as they cure and may be toxic when burned
- toxic materials require special protection for operator and adequate ventilation while curing
- material may be subject to ultraviolet deterioration unless coated or filters added rigidity of material
- often must be modified with fillers to match expansion coefficients
- vapor impermeable

Checklist:

- Are historic materials available for molds, or for splicing-in as a repair option?
- Has the epoxy resin been formulated within the expansion/contraction coefficients of adjacent materials?
- Have samples been matched for color/finish?
- Are fabricators/installers experienced?
- Is there a sound substrate of material to avoid deterioration behind new material?
- Are there performance standards?

Summary and References

Substitute materials—those products used to imitate historic materials—should be used only after all other options for repair and replacement in kind have been ruled out. Because there are so many unknowns regarding the longterm performance of substitute materials, their use should not be considered without a thorough investigation into the proposed materials, the fabricator, the installer, the availability of specifications, and the use of that material in a similar situation in a similar environment.

Substitute materials are normally used when the historic materials or craftsmanship are no longer available, if the original materials are of a poor quality or are causing damage to adjacent materials, or if there are specific code requirements that preclude the use of historic materials. Use of these materials should be limited, since replacement of historic materials on a large scale may jeopardize the integrity of a historic resource. Every means of repairing deteriorating historic materials or replacing them with identical materials should be examined before turning to substitute materials.

The importance of matching the appearance and physical properties of historic materials and, thus, of finding a successful longterm solution cannot be overstated. The successful solutions illustrated in this Brief were from historic preservation projects involving professional teams of architects, engineers, fabricators, and other specialists. Cost was not necessarily a factor, and all agreed that whenever possible, the historic materials should be used. When substitute materials were selected, the solutions were often expensive and were reached only after careful consideration of all options, and with the assistance of expert professionals.

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This publication has been prepared pursuant to the National Historic Preservation Act of 1966, as amended, which directs the Secretary of the Interior to develop and make available information concerning historic properties. Technical Preservation Services (TPS), National Park Service prepares standards, guidelines, and other educational materials on responsible historic preservation treatments for a broad public.

September 1988

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Schematic Design Drawings

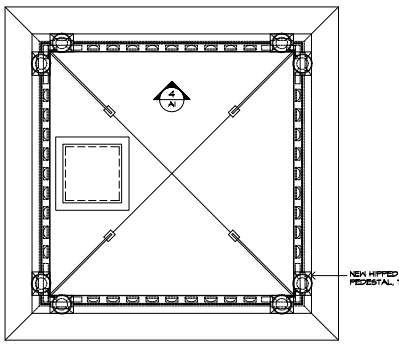
Berlin Free Library Balustrade Repairs Study

834 Worthington Ridge, Berlin, Connecticut

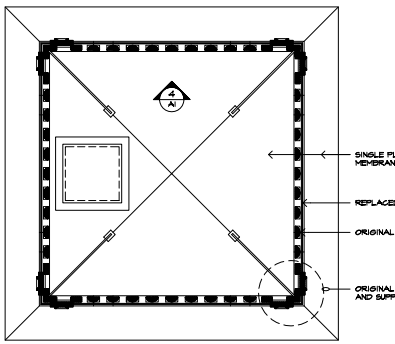
Date: January 15, 2016

GENERAL NOTES

1. THE CONTRACTOR SHALL FAMILIARIZE HIMSELF WITH THE SCOPE OF THE ENTIRE PROJECT SO AS TO FACILITATE THE WORK OF FUTURE PHASES AND TO ACCOMPLISH ONLY THAT WORK NOTED UNDER THE CONTRACTED PHASE.
2. THE CONTRACTOR SHALL OBTAIN AND PAY FOR ALL FEES, PERMITS AND CHARGES ASSOCIATED WITH THE SCOPE OF WORK AS OUTLINED IN THE CONTRACTED PHASE(S) OF WORK.
3. THE CONTRACTOR SHALL INSPECT AND VERIFY THE LOCATION AND CONDITION OF ALL ITEMS AFFECTED BY THE WORK UNDER THE CONTRACTED PHASE(S) AND REPORT ANY DISCREPANCIES TO THE ARCHITECT BEFORE DOING THE WORK.
4. CAREFULLY MEASURE AND LAYOUT NEW WORK AND PERFORM SELECTIVE EXPLORATORY DEMOLITION AS REQUIRED PRIOR TO ACTUAL REMOVAL SO AS TO REMOVE ONLY THAT PORTION OF THE EXISTING STRUCTURE, LANDSCAPING OR OTHER CONSTRUCTION THAT IS REQUIRED TO INSTALL THE NEW WORK.
5. TEMPORARILY SUPPORT AND PROTECT ALL EXISTING FRAMING AND OTHER ELEMENTS AFFECTED BY THE WORK PHASE UNTIL SUCH TIME AS RELATED WORK IS COMPLETED.
6. ALL SALVAGEABLE MATERIALS REMOVED DURING THIS PROJECT ARE THE PROPERTY OF THE OWNER AND SHALL BE STORED ON THE PREMISES AS DIRECTED BY THE OWNER. ALL OTHER MATERIALS AND DEBRIS SHALL BE LEGALLY DISPOSED OF OFF-SITE.
7. PROTECT FROM DAMAGE ALL EXISTING MATERIAL AND EQUIPMENT TO REMAIN.
8. PROVIDE TEMPORARY PROTECTION FROM WEATHER, VERMIN AND THEFT IN WORK AREAS.
9. PROVIDE TEMPORARY BARRIERS TO PROTECT WORKERS AND THE PUBLIC FROM HAZARDS THAT ARE A RESULT OF CONSTRUCTION ACTIVITIES.
10. WORK TO BE REPLACED SHALL BE REPLACED IN-KIND, REMOVING THE LEAST AMOUNT OF ORIGINAL FABRIC BACK TO SOUND MATERIAL.
11. THE CONTRACTOR IS SOLELY RESPONSIBLE FOR THE MEANS AND METHODS USED TO ACHIEVE THE DESIRED RESULTS OUTLINED IN THE CONSTRUCTION DOCUMENTS.



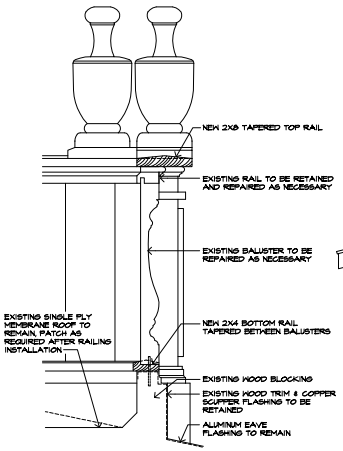
1 A1 UPPER RAIL PLAN
SCALE: 1/2"=1'-0"



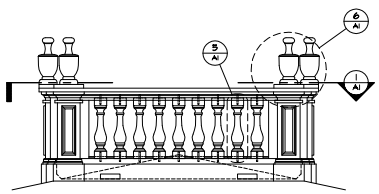
2 A1 LOWER RAIL PLAN
SCALE: 1/2"=1'-0"



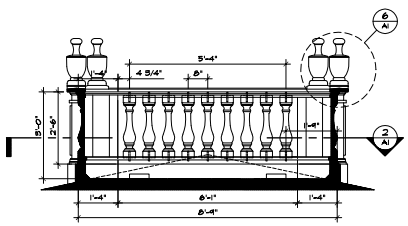
5 A1 BALUSTER DETAIL
SCALE: 1-1/2"=1'-0"



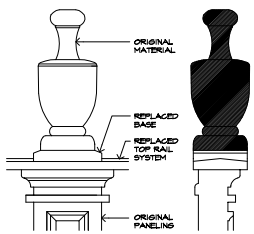
7 A1 TYPICAL RAILING SECTION
SCALE: 1-1/2"=1'-0"



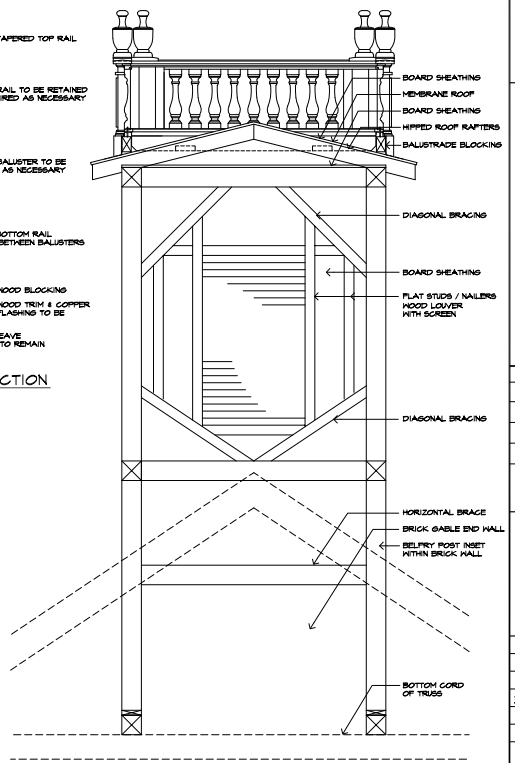
5 A1 EXTERIOR ELEVATION
SCALE: 1/2"=1'-0"



4 A1 INTERIOR ELEVATION
SCALE: 1/2"=1'-0"



6 A1 URN DETAIL
SCALE: 1-1/2"=1'-0"



8 A1 SECTION AT BELFRY
SCALE: 1/2"=1'-0"

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SEAL:

DESIGNED

PROJECT:

Berlin Free Library
Balustrade
Repairs Study

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Berlin, CT 06037

Prepared For

Town of Berlin

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REVISIONS

	Date	Description

SHEET TITLE:

PROJ. NO.	2015510
SCALE	AS NOTED
DATE	01/15/2016
DESIGNED	EVELYN COLE SMITH
DRAWN	CLINTON RICHMOND
CHECKED	RCS

SHEET:

A1



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