Hollis J. Stevens - S. Z. Lewin - A. E. Charola

FACADE RESTORATION OF THE RENWICK GALLERY OF ART: MATERIALS INVESTIGATION AND ARCHITECTURAL ANALYSIS

I. *Historical*

The building presently occupied by the Renwick Gallery of Art, S. I., located at 17 Street N.W. and Pennsylvania Ave. in Washington, D.C. (Figure 1) is at the present writing about 120 years old. Construction was initiated in 1859, and although the exterior shell was done within one or two years, the interior was not completed until some 10 or 15 years later. The structure has had a checkered career, going through a number of transformations and changes of occupancy and use. It was originally commissioned by W. Corcoran, a banker and philanthropist [1], as an art gallery for his private collection. During the U. S. Civil War, the building, of which only the shell was complete, was seized by the Government and used by the Quartermaster Corps for the storage of uniforms and records. In 1864 interior work was done to create office spaces. In 1869 the building was returned to Corcoran, and when in 1870 the Corcoran Gallery of Art was chartered by the U. S. Congress, it finally became the housing for an art gallery, and remained such until 1897. At that time, the art collection was moved to larger quarters at the newly built Corcoran Gallery of Art at 17 Street N.W. and New York Avenue. The building then began (1899) to be used in part by the U. S. Court of Claims; it had been used solely for government storage in the interim. The Court gradually utilized more and more of the structure, modifying it to the Court's needs. From 1912 on, the entire building served as the Court of Claims. It was finally turned over to the Smithsonian Institution in 1965; it was then renamed the Renwick Gallery of Art in honor of its original architect, and it was formally dedicated to " use as a gallery of art, crafts, and design ".

James Renwick, Jr., was an important figure in the history of American architecture. His works include several noted buildings in Washington (e.g., the Smithsonian Institution's " Castle " and St. John's Episcopal Church) and New York (e.g., Grace Church and St. Patrick's Cathedral).

II. *Environmental Stress*

Currently, the Renwick Gallery of Art (R.G.A.) serves a wide public as one of the popular museums in Washington, being host to about 200,000 persons annually. It mounts an average of 8 or more special exhibitions each year, displays a permanent collection on a revolving basis, and offers a variety of public activities, including lectures, musical events, educational programs, etc. It is open to the public 364 days each year.

The attempt is made to maintain the galleries at a constant temperature and relative humidity (viz., 21-2°C and 50% R.H.) throughout the year. The average exterior temperatures (i.e., that of downtown Washington) have ranged during the past 100 years from —4° to +8°C in the month of February (with daily temperature excursions by 3° to 8°C above and below these mean values), to averages ranging between 20° and 28°C in the month of August. The annual rainfall averages about 105 centimetres, and an average winter includes 6 days of snowfalls exceeding 3 centimetres.

Thus, the interior of the building is subjected to heavy use, and the exterior experiences substantial thermal and humidity variations. Concomitantly, there are large and variable gradients in moisture content and temperature between the inner and outer surfaces of the building shell.

III. *Construction*

The R.G.A. is an early and historically important example of the Second Empire architectural style [2]. It is of sufficient artistic and historic significance to have warranted its designation in 1969 as a Historic American Building in a Landmark District [3].

" This building is one of the earliest French Renaissance structures in in the United States and exhibits many outstanding features of architectural embellishment and design. It is red brick with brownstine trim, two stories in height with a mansard roof. Its Pennsylvania Avenue facade is divided into a central pavilion flanked by single bay wings and an end pavilion at each corner. An unusual feature is the curve of the central pavilion mansard roof which contrasts with the straight lines of the smaller end pavilion

mansards, yet does not detract from the essential formal and decorative symmetry of the entire facade " [4].

The shell of the building consists of a load-bearing brick masonry construction with engaged decorative stone elements. The basic brick fabric ranges in thickness from 0.3 to 0.6 meters, and the largest projections with engaged stone members extend outward an additional 0.6 to 1 meter [5].

It is the stone and west facades of the building that contain the significant architectural stone elements (Figure 2) with which this study is concerned. On these surfaces, the stone elements comprise approximately one-quarter of the total area; the remainder consists of a hard-fired finish brick. Figure 2 shows the richness of carved stone embellishment that characterizes the design. Most of this stone trim is badly deteriorated or patched; what appears in the Figure to show the original detail consists mostly of molded resinous restorations (*vide infra*).

The decorative stone members are toothed perpendicularly from the the exterior face into the brick, creating a homogeneous bearing wall construction. The interior brick (behind the stone elements and the finish brick) is a soft, red clay brick (commonly known as " salmon brick ") that contains a small but significant amount of leachable salts. This is the structural feature (a form " inherent vice ") that has been responsible for a part of the deterioration which the stone elements have suffered, as is shown in more detail below.

The architectural stone is a red quartzite sandstone, quarried in 1858 in Belleville, New Jersey [6]; that quarry no longer exists, and no other source of similar sandstone is currently known.

The stone trim consists of numerous vermiculated stone piers, engaged pilasters, Indian-corn capitals, tympani/pediment decorations, dentils/modillions, fluted columns, window jamb frames/keystones, decorative/medallions and inscriptions, bannister railings, water tables, band courses, cornices, and entablatures (examples of some of these elements can be seen in Figure 2).

The thickness of the stone trim ranges from 15 centimetres to as much as 1.25 meters. The stone is mineralogically a ferruginous sandstone composed predominantly of alpha-quartz grains ranging in dimensions between 1 and 100 micrometers, cemented by cryptocrystalline silica. Figure 3 shows the microstructure of fracture sections of the sandstone, as well as details of the constituent minerals. There is enough plagioclase feldspar present to classify this as an arkose sandstone. The minor components present are phlogopite, and in localized places, small amounts of calcite. The stone would be categorized as a high-porosity, low permeability type [7]. Liquid water penetrates into the dry stone at rates ranging from 0.25 to 1.5 liters per square meter per hour. The total porosity (i.e., percent increase in weight due to filling of all internal pores with water) ranges from 10 to 20% by weight; the vapor permeability ranges from 7 to 10 md. The rather wide ranges given for the preceding data reflect a considerable heterogeneity in the properties of this sandstone at the various places in the facade that were sampled.

IV. *Deterioration*

The impetus for the present study was the dramatically obvious advanced state of decay of the stone trim of the south and west facades of the R.G.A. in 1975. Some of the decay of the sandstone appears to have proceeded continuously ever since the building shell was completed, and, in fact, the rate of this component of the total decay appears to have been more or less constant during the past hundred years. This conclusion is based upon the following considerations.

A quite extensive photographic record was made of the state of the R.G.A. facade in 1956. Some of these photos are shown in Figures 1, 2, 5 and 8. In several of the photos of selected areas and details, the widths of shadows cast from various elevations of the surface can be calibrated in terms of corresponding recorded architectural design data[5]. Such measurements yield an estimate of the difference in level between residual original stone surface, and adjacent surfaces which show the effects of flaking and spalling. as they existed in 1956. We have measured these same differences in level at these places in 1980. Thus, we can employ the 1956 photos to estimate the cumulative depth of surface losses that had occurred since about 1860, and the difference between those data and the 1980 measurements to indicate the amount of further surface loss occurring in the course of the most recent 25 years.

The areas selected for these measurements are recesses under the cornices and along the sides of engaged columns at the middle level of the building. An example of the type of site employed for these estimates is shown in Figure 4. In these places, the surface losses are primarily due to the effects of salts from the immediate vicinity (viz., the masonry), and are not complicated by salt migration from the ground up, or by the freezing of water retained in cracks or at joints.

On this basis, we are led to the estimate that, in those places where the surface decay appears to be related to the original materials and their manner of juxtaposition, flaking away of the surface sandstone has resulted in the loss of about 3 to 5 millimeters of surface between 1860 and 1956.

An additional 1 millimeter has been lost from the same areas in the period from 1956 to 1980.

Hence, these data suggest that in the places referred to, the process of local salt decay has occurred and is occurring at an approximately constant rate.

The historical record provides a measure of additional support for this conclusion. Already in 1903, the Architect of the Capitol petitioned the Congress for $ 30,000 to repair the stone and masonry. Goode[1] reports that " The Court of Claims felt that the Renwick Gallery should be pulled down for several reasons ... (among them) danger of falling stones from the building. Part of the sandstone decoration was removed in 1947 and 1951 because of deterioration. Between 1951 and 1956 a number of pieces of the stone had broken away and fallen onto the sidewalk, creating a serious hazard ". Figure 5 shows the extent of the surface losses due to salt decay before any major restoration had been undertaken.

In 1967-8, the Smithsonian Institution and the General Services Administration completed a series of exterior repairs. The stone portion of this work was executed by Universal Restoration, Inc., and consisted in the filling-in of lacunae, the replacement of missing, damaged, or unsound sections with molded copies of the lost carvings, and the painting of the entire sandstone trim with a synthetic resin (pigmented Dekosit) — all of this employing the Dekosit as the principal ingredient. This is a nitrocellulose polymer and it was mixed with ground sandstone to pigment it. This mixture served as the exterior 1-cm shell that was formed in a mold; this was then back-filled with a lighter weight mixture of the Dekosit and expanded perlite aggregate, and the composite piece was bonded to the sandstone by means of a synthetic adhesive. The product " Dekosit " is a proprietary resin based upon nitrocellulose as the principal polymer; the adhesive bonding agent was a product produced by the W. R. Grace Co., and named " Daraweld ". Figure 6 shows the structure of these replacement parts. The technique employed in preparing the molds of the carved stone surfaces, and of casting the resin-aggregate mixtures, has been described in the press[8].

Shallow losses in flat areas were filled in with the resin-ground sandstone mixture. Simple compound shapes, typically 15 cm in projection X 10 cm deep and 10 to 45 cm in length were molded of the Dekosit-sand mixture, reinforced with embedded 3 to 6 mm steel-deformed reinforcing bars, and bonded to the residual sandstone surface by means of Daraweld. The exterior portion of the molded Dekosit composite in which the carved detail was contained was typically 1 cm in thickness; wherever much additional volume had to be filled, a mixture of the Dekosit with expanded perlite as the aggregate was employed (Figure 6).

Larger compound shapes, such as the vermiculated corner elements (see Figures 2 and 8) were molded similarly, and were anchored to the underlying stone by means of simple unprotected machine bolts. Some elements contained metal wire mesh (" chicken wire ") as a reinforcement.

In 1975-6, large pieces of these restorations were found to be falling from the facade, and the potential hazard to pedestrians was deemed sufficient to require the construction of a protective canopy over the sidewalk along the south and west facades. Figure 7 shows the losses that had developed since the 1967-8 restoration due to the detachment of patchings and of replacement elements. Figure 8 contrasts the pre- and post-restoration conditions of a typical stone-trim area.

Thus, it is evident that the original sandstone has deteriorated significantly, and the attempt to replace missing parts with an organic polymeric composition has been a temporary and, with the passage of time, an increasingly unsuccessful palliative.

V. *Mechanism of the Stone Decay*

The stone trim shows evidences of decay over at least 88% of the total exposed surface. This is based upon visual inspection and quantitative measurement of the approximately 3100 stone elements on the south and west facades, for all of which detailed drawings were prepared. These manifestations range from flaking, blistering, and spalling of flat surfaces to losses of substantial portions of carved, detailed, or projecting sections (Figure 5). The latter type of decay was so disfiguring that the 1967-8 restoration undertook to duplicate a large number of the carved elements so that these losses could be replaced with faithful copies made by a skilled sculptor (8).

The stone trim on the building facade is subject to a generalized deterioration that afflicts all of the exposed surface. In addition, other decay processes are superimposed upon this pervasive phenomenon in certain areas.

The general, ubiquitous decay is due to the leaching of soluble salts (viz., alkali sulfates and carbonates) from the interior brick and mortar and the crystallization of these salts at the exposed surface. This is established by: (1) analysis of the sandstone, which has been found to contain no soluble or easily hydrolyzable constituents (2), analysis of the masonry, which has been found to contain leachable salts (3), mapping of the surface decay, which shows flaking and spalling of the sandstone to be present in all parts

of the facade, and to be most pronounced where the stone trim on the brick masonry is thinnest, and (4) microscopic examination of the surface flakes, which show the structure characteristic of salt decay processes (i.e., successions of thin laminae, evidences of efflorescences on and between the laminae).

Water gets into the interior masonry walls via condensation of vapor due to the ever-present thermal and humidity gradients, as well as via direct migration of liquid from the external surface in wet and damp weather conditions. When the ambient temperature rises and the humidity falls, the surface stone dries out, and the water within the masonry is drawn by capillarity to the surface, where it evaporates and leaves behind the dissolved matter it had leached from the bricks and mortar. This phenomenon is an inherent feature of the construction and materials as they exist in this particular building. It has been occurring throughout the history of the structure, and continues unabated at the present time.

Greater concentrations of salts than are generated by leaching from the interior masonry are found in the lower courses of the building. This is due to soluble matter carried by rainwater into the stone from the sidewalks and the earth base, and results in part from de-icing salts, and in part from the air pollution generated by vehicular and heating plant emissions. The latter source of soluble matter tends also to deposit stonedamaging concentrations of salts in stone elements that have projecting surfaces along which rainwater flowing down over the facade is channeled and retained. This effect is particularly evident at window arches and sills, and along string courses (see Figure 5).

In addition, cracks and crevices generated by these salt decay processes serve as traps and channels for liquid water, and freeze-thaw cycling during winter months aggravates the deterioration and leads to the detachment of discrete chunks of the stone.

The 1967-8 restoration attempt involved the patching of surface defects, the replacement with molded copies where losses were substantial, and the application of a thin coating of Dekosit to the entire surface to disguise and minimize the unsightly differences in color that were found to develop shortly after the introduction of the Dekosit-sand restorations between these and the remaining original stone. Some of the restorations began to detach from the underlying sandstone within several years (Figure 8), and in 1978-9 were in such a precarious state that to protect the public the decision was made to remove all that were not securely dowelled or otherwise rigidly keyed into the facade.

The failure of a substantial portion of this restoration was due to two principal effects. One was the procedure of directly bonding a polymeric resin composite to the sandstone. The linear coefficient of thermal expansion of the R.G.A. sandstone is 6.2 parts per million. The corresponding parameter of the Dekosit-aggregate composite that detached from the building was found to be 58 parts per million. It is evident that with two such disparate materials directly bonded together, the unremitting diurnal and seasonal thermal excursions must eventually lead to the failure of the bond.

Secondly, the problem was exacerbated by the fact that the restoration material was non-porous and water-vapor-impermeable, and thus served to prevent "breathing" of the porous sandstone it covered. Consequently, water tended to be trapped at the interface between the stone and the restoration material. This was dramatically shown by means of gentle abrasion of the stone trim with a fine grit, the underlying sandstone was observed to be visibly wet as it came into view while freeing it of its resin coat. And this took place at a time when there had been no rain for the preceding 20 days in the warm temperatures of early summer! This "sweating" of the freshly revealed sandstone surface was to be seen everywhere as the non-porous surface film was being abraded away. Figure 9 shows an area where there was only the thin coating of Dekosit on original stone; the type of spalling evident here was to be seen in many places, and is well-known to be characteristic of the presence of a water-vapor-impermeable film on a porous substrate under conditions that permit water to collect at the interface between the two materials.

It is abundantly clear that the freezing of this entrapped subsurface liquid water greatly accelerated the rate of failure of the restoration.

VI. *Implications for Conservation of the Facade*

The unique character of the R.G.A. lies in its architectural style, as well as the texture and color of its facade, closely surrounded as it is by government buildings of a great variety of styles, colors, and textures.

The first question that must be addressed is whether the stone trim is to be treated as a work of art which bears the individual imprint of a master sculptor, and which should be freed of all subsequent replacements and additions in order to retain and display whatever is left of its pristine quality. That such has never been the approach to this structure is amply demonstrated by the numerous major design alterations that have been carried out during its 120-year history, as well as by the extensive replacement of missing parts that was carried out during the 1967-8 restoration (see Figure 7, 8).

The niches at the second floor, which originally held statues, were removed and windows were installed in their place *circa* 1912, as the Court of Claims expanded to the second floor.

A moat around the building was created *circa* 1905, exposing the fieldstone basement walls. These were subsequently coated with a colored cement parge, simulating a truncated base for the building.

Numerous attempts at patching eroded stone were evident as a result of the latest removal of previous coating material, which took place in 1978-9. A stone-by-stone survey undertaken at that time disclosed that at least 88% of the original sandstone is either in such a state of deterioration that it would require replacement, or that such replacements had already been made previously.

The quality of the stone sculpture is high, but not exceptional, and the great merit of this structure lies in its overall unity and style, rather than in any special beauty or technique exhibited by the individual components.

If, then, filling-in of missing elements of the architectural stone design is an acceptable strategy, the type of replacement material acceptable for that purpose should satisfy the following desiderata:

a) It must be a close, though not an exact match to the remaining original stone. That is, what is original and what is replacement should be immediately recognizable to the expert or informed observer, but the difference between the two should not be jarring or unpleasant to the layman.

b) It must be stable both physically and chemically under the ambient conditions of the locale, so that it will not alter seriously in appearance or strength during weathering and aging.

c) It must be compatible with the existing stone and masonry with which it will be in contact. It must not promote or accelerate the decay of adjacent or contiguous materials.

d) It must be available and workable in quantities and at a cost appropriate to the practical requirements of the building and its support services.

f) Any replacements of missing parts must be installed in a manner which inhibits the migration of salts leached from the inner brick masonry outward through the new material, yet the creation of an interface between the original porous stone and the restorations must permit the stone to breath.

VII. *Planning For The Future*

The presently available materials that could be employed for a new, thoroughgoing restoration that would complete the architectural stone design of the R.G.A. are: Indiana limestone; a West German sandstone; and precast architectural stone. The selection of one of these alternatives is the subject of debate at the present time. The pros and cons of each appear to be as follows:

a) *Indiana Limestone*: chemically susceptible to acid rain; different in color and texture from the original red sandstone: weathering products would increase the rate of decay of the sandstone; requires skilled artisans for the carving of copies of the missing details; available readily in fully adequate quantities; expensive, but not impossibly so.

b) *West German Sandstone*: chemically compatible with original sandstone; not more resistant to weathering and salt decay than the original stone; very expensive in materials and workmanship; will weather differently from the original stone; compressive strength adequate, but not as high as the alternatives; texture pleasing and natural.

c) *Precast Architectural Stone*: chemically compatible with the original sandstone; can match the original stone very satisfactorily in color and texture; excellent match in coefficient of thermal expansion; offers the best compressive strength; best flexibility in production scheduling, future replacements, and rate of production; there is some uncertainty with respect to the effective period of survival in mint surface condition (weathering tests of acceptably pigmented specimens are in progress); lowest cost of fabrication.

There are, in addition, certain factors that pertain to the use of precast stone that are unique to it. The flexibility it allows in the formulation of the material (chemical composition and particle size distribution), and the uniformity that can be achieved throughout the entire quantity that is to be employed, even if there are long periods of time between phases of the work, or between periods of later interventions, are not available with natural stone from any source. It appears feasible to design the form and technique of attachment of precast pieces so as to minimize or entirely arrest the decay processes to which the original stone is subject. The utilization of a casting technique also offers the practical capability of incorporating into various of the replacement pieces transducers for the continuous long-term electromechanical monitoring of e.g. capstone units to record the effects of

thermal variations, absorption of chemical agents, intrinsic consolidation rates, and other aging and weathering processes.

Extensive physical and chemical testing of the various materials under consideration are now in progress. The final elaboration of the conservation and restoration strategy to be adopted will take into account the data these tests will provide, in the light of the insights and principles discussed in the foregoing.

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THEME: MATERIAUX

TITRE: RESTAURATION DE LA FAÇADE DE LA GALERIE D'ART RENWICK; EXAMEN DES MATERIAUX ET ANALYSE ARCHITECTONIQUE.

RESUME:

Les auteurs décrivent le plan et la structure de la Galerie d'Art Renwick, à Washington D. C., construite il y a 120 ans. Ils expliquent la nature des matériaux de la façade et le processus de détérioration qu'ils ont subits. La première tentative de restauration a été peu satisfaisante compte tenu du scellage de la superficie poreuse de la pierre et de l'incompatibilité des propriétés thermiques de la pierre et des apprêts résineux. Une nouvelle proposition de restauration est en étude.

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SUBJECT: MATERIALS

TITLE: FACADE RESTORATION OF THE RENWICK GALLERY OF ART: MATERIALS INVESTIGATION AND ARCHITECTURAL ANALYSIS.

SUMMARY:

The design and structure of the 120-year old Renwick Gallery of Art in Washington, D. C., are described. The nature of the materials composing the facade, and the deterioration processes to which they have been and are subjected are detailed. A previous attempt at restoration was unsatisfactory due to the sealing of the surface of the porous stone, and to a mismatch in thermal properties between the stone and the resinous additions. The principles and strategy of a proposed new restoration undertaking are discussed.

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TEMA: MATERIALES

TITULO: RESTAURACION DE LA FACHADA DE LA GALERIA DE ARTE RENWICK; INVESTIGACION DE MATERIALES Y ANALISIS ARQUITECTONICO.

SUMARIO:

Se describen el diseño y la estructura de la Galería de Arte Renwick en Washington, D. C., construida hace 120 años. Se detallan la naturaleza de los materiales de fachada y los procesos de deterioro a los que han estado y están sujetos. Un intento previo de restauración resultó poco satisfactorio, debido al sellado de la superficie porosa de la piedra y a la inadecuación de las propiedades térmicas de la piedra con los aditivos resinosos. Se discuten los principios y estrategia de una nueva proposición de restauración.

Оглавление : РЕСТАВРАЦИЯ ФАСАДА РЕНВИКСКОЙ ХУДОЖЕСТВЕННОЙ ГАЛЛЕРЕИ ИССЛЕДОВАНИЕ МАТЕРИАЛОВ И АРХИТЕКТУРНЫЙ АНАЛИЗИС

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ВЫДЕРЖКА

Краткий Очерк : Здесь описывается план и структура стодвадцатилетней Художественной Галлереи Вашингтона, Д. К.. Природа материалов составляющих фасад и процесс повреждения которым они подвергаются и были подвержены описаны здесь в подробности. Одна предидущая попытка реставрации была неуспешна, благодаря закупорке поверхности пористого камня и/древесно-смоляными прибавками. Теперь изучаются принцыпы и стратегия нового предприятия реставрации.

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TEMA: MATERIALI

TITOLO: RESTAURO DELLA FACCIATA DELLA GALLERIA D'ARTE RENWICK: INDAGINE DEI MATERIALI ED ANALISI ARCHITETTONICA.

SOMMARIO:

Sono qui illustrati il disegno e la struttura della Galleria d'Arte Renwich a Washington D.C. (costruita 120 anni fa).

Vengono descritti dettagliatamente la natura dei materiali che compongono la facciata ed i processi di deterioramento ai quali sono stati e sono ancora sottoposti.

Un precedente tentativo di restauro risultò insoddisfacente a causa del suggellamento della superficie della pietra porosa ed anche di una incompatibilità delle proprietà termiche della pietra e delle aggiunte resinose.

Per concludere vengono trattati i principi ed i procedimenti di un nuovo metodo di restauro.

KRISTIN TOLLESTÉN

SHINGLES AND SHINGLED ROOFS

RETROSPECT

Shingles and, to a lesser extent, leading are the main roofing methods used in the early phase of Swedish monumental architecture, i.e. medieval churches. Both methods come from the Mediterranean countries and are descended from the ancient building traditions of classical times. Shingling was practiced in well-wooded areas, i.e. in practically the whole of Sweden except for the southermost province of Skåne, where lead sheeting was used instead. Copper sheating was also employed to a limited extent during the late medieval period.

The shingled roof came to Sweden as a fully evolved technique. It rapidly gained immense popularity in the Scandinavian countries and is still very much alive. Conscientiously and expertly done, shingles are superior to many other kinds of roofing in terms of durability, elegance and monumentality.

The various positive characteristics of shingling have really come into their own on spires and belfries. In this type of popular architecture, shingling is pre-eminently a mode of expression and a determinant of form. The elegance and flexibility of the material is readily apparent from Gothic spires and turrets and also from Baroque and Rococo roofs, with their frequent intricacies of form.

Shingling used to be reserved for the buildings which were to be covered with the best material available. It was commonly used for castles and manor houses as well as churches.

Nowadays rural churches are practically alone in perpetuating the shingling tradition. But unfortunately, the number of shingled churches is constantly declining.