INFORMATIONAL TOPICS
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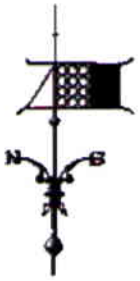
From Asbestos to Zinc

ROOFING FOR HISTORIC BUILDINGS

Technical Preservation Services

Roofs are perhaps the most critical features of a building. They protect not only the structure itself, but the interior spaces, furnishings, and human occupants. This web feature is a facsimile of an exhibit on roofing for historic buildings entitled: "From Asbestos to Zinc", prepared for roofing professionals attending the 1999 Roofing Conference and Exposition for Historic Buildings in Philadelphia, Pennsylvania. Navigate through the sidebar to learn more about the appearance, composition, manufacture and application of roofing materials and systems. Click your mouse on thumbnail images to view many of the drawings and photographs in greater detail.

Throughout history, roofing materials and installation practices have reflected both advances in technology and shifting tastes in architectural styles. Understanding something of the history of this critical building component is an important starting point for decisions about treatments that are the focus of several of the Preservation Briefs., easy to read guides on preserving, rehabilitating and restoring historic buildings. The Technical Services Branch of the National Park Service produces and publishes this information in order to foster a greater understanding and appreciation of roofing in historic buildings and to stimulate public efforts for more sensitive preservation and rehabilitation work.



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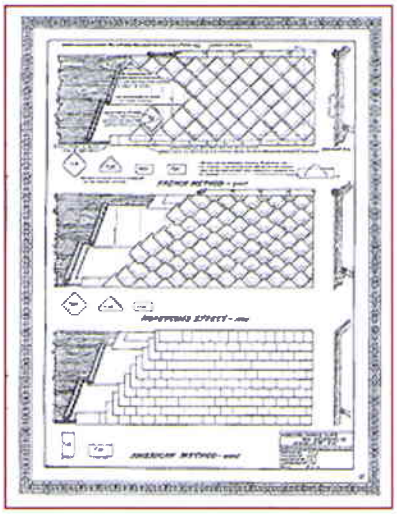
Asbestos-Cement Shingles

In the United States, mechanized production of asbestos-cement shingles began in the first decades of the 20th century, following Austrian Ludwig Hatschek's invention of a process in 1900 to manufacture rolled and pressed asbestos-cement sheets. Hatschek's patent, reissued in United Stated in 1907, led to a rapid proliferation of the new shingles. One early American manufacturer, Eternit, took their company name from the title Hatschek had given his process.

The Asbestos Shingle, Slate, and Sheathing Company touted the advantages of their shingles with depictions of successful installations in their 1927 promotional catalog and price list. (**The Catalog of Johns-Manville Building Materials, Home Owners' Catalogue, A Guide to the Selection of Building Materials Equipment and Furnishings**, F. W. Dodge Corporation, 1936. Courtesy of The Sweet's Group-The McGraw-Hill Companies, Inc.)

Made from asbestos, an inorganic, fibrous mineral, and Portland or hydraulic cement, asbestos shingles were lightweight, economical, and fireproof. Manufacturers promoted their shingles as substitutes for traditional roofing materials such as slate, wood, and clay.



Manufacturers of asbestos-cement shingles and other asbestos building products appealed to architects and builders directly with extensive advertising campaigns. These drawings accompanied Architects's Specification included in a publication of the Asbestos Shingle, Slate & Sheathing Company. [click image for larger view]

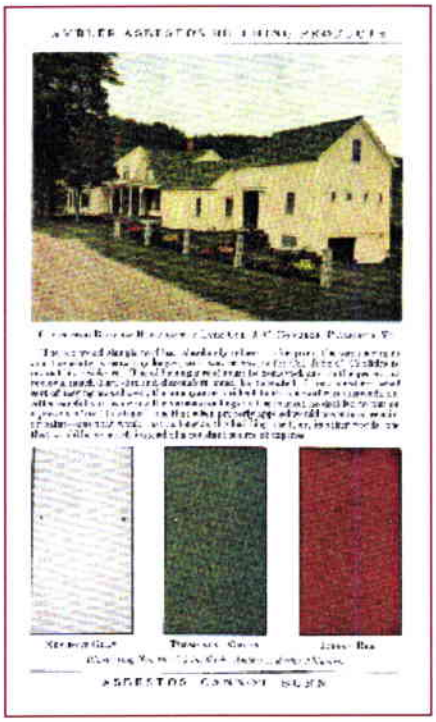
The Asbestos Shingle, Slate and Sheathing Company proclaimed in 1910: " ...these Asbestos Singles or Slates are so immeasurably superior in point of practical merit to that of any natural slating that nothing remains to be said."

A variety of shingle colors could be created by adding pigments to the wet mix before pressing or by rolling pigments onto the surfaces of shingles. Colors imitating slates, including Indian Red and Newport Gray, were common, but many other colors were available. Manufacturers assured potential customers that their shingles were colorfast. Unfortunately, many early asbestos-cement shingles faded over time, causing Columbia professor H. Vandervoort Walsh to exclaim in 1922: "For this reason we see on every hand red asbestos-shingle roofs which have bleached to sickly and thirsty pinks."

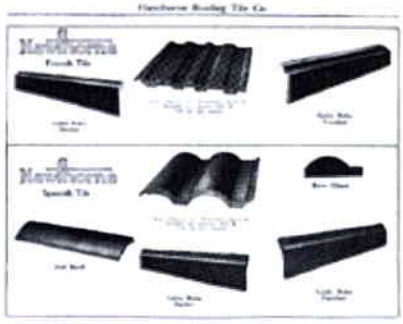
Concrete Roofing Tile

Not all cementitious roofing products were asbestos-based. Concrete roofing tiles, which date from the 1840s, were produced in Germany by Adolph Kroher, a manufacturer of cement and concrete products, who developed a machine and process for pressing concrete tiles that resembled shingles. In the United States, as the concrete industry developed in the first decade of the 20th century, cast-in-place concrete roofing systems - and systems assembled with concrete slabs - evolved. The American Cement Tile Manufacturing Company, for instance, advertised "Cementile," a large (2 feet by 5 feet by 1 1/2 inches) steel-reinforced cement tile roofing, or slab, in the 1929 issue of **Sweet's Architectural Catalogue**. "Cementile" was offered as a flat sheet for sheathing or as an interlocking tile for a finished, watertight roof covering. Such roofing products found principal application for industrial buildings. Smaller concrete roofing tiles were available in the United States from companies such as Hawthorne in Chicago by the late1920s. Hawthorne's roofing tiles, available in no fewer than fourteen colors, simulated Spanish and French Clay tiles. Unlike asbestos-cement shingles, which were nailed in place, concrete tiles were interlocking and laid on hanger strips. Hip and ridge tiles were nailed in position and holes were then pointed with matching mortar.

The hydraulic pressing process enabled the shingles to be given a texture, such as a rough rustic surface or one imitating weathered wood. The many styles and sizes of asbestos-cement shingles available, made possible roofs laid in various methods including American, Dutch Lap, and French (known in several variants as hexagonal, honeycomb or diamond). The French method was particularly popular for asbestos roofing, capitalizing on the economy of the material itself by laying it in an efficient manner requiring minimal overlap. Installation of asbestos shingles was similar to slate. Shingles could be punched, filed, or trimmed to size in the field by roofing contractors. Companies such as behemoth Johns-Manville and The Asbestos Shingle, Slate, and Sheathing in Ambler in Pennsylvania promoted asbestos shingles not only for new construction but also for roofing over existing roofs.



Johns-Manville promoted the direct application of their asbestos-cement shingles over worn roofing in this 1936 catalog. The Dutch Lap roof being applied here was easy to install and utilized a metal "clincher" to anchor exposed corners. (**Home Owners' Catalogue, A Guide to the Selection of Building Materials Equipment and Furnishings**, F. W. Dodge Corporation, 1936. Courtesy of The Sweet's Group-The McGraw-Hill Companies, Inc.) [click image for larger view]



Chicago-based Hawthorne Roofing Tile Company originally manufactured its tile from slabs by a hand-process. These concrete roofing tiles depicted in the 1929 **Sweet's Architectural Catalog** imitated French and Spanish clay tiles. They were produced with automated power-driven equipment, and the colors were impregnated on the tile surface. (**Sweet's Architectural Catalogue, 1939. Courtesy of the Sweet's Group**, McGraw Hill Companies, Inc.) [click image for larger view]

In addition to shingles, corrugated asbestos-cement sheathing, sometimes called asbestos building lumber, was produced by many manufacturers as a substitute for corrugated iron roofing. Used principally for industrial applications, corrugated asbestos could be laid directly on steel roof purlins. Industrial buildings in particular benefited from the fireproofing qualities of asbestos-cement.

Both asbestos-cement shingles--and siding--were produced into the 1980s, testimony to their popularity and affordability. The countless buildings with this roofing material also attest to the durability of the product.

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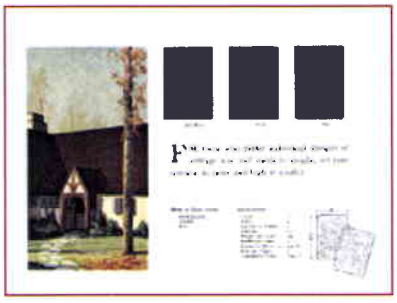
Asphalt Shingles

Asphalt shingles have three major components: asphalt, felts and colored mineral or ceramic granules. Asphalt is a byproduct of petroleum distillation and also occurs in natural deposits. This dense mixture of hydrocarbons provides the waterproofing for the shingle. The felt fibers reinforce and stabilize the asphalt, while the granule aggregates protect the assembly from sun, wind, rain and minor foot traffic.

The Barber Asphalt Co. featured their use of natural asphalt mined from Trinadad Lake in the promotion of their shingles. [click image for larger view]

The roots of asphalt shingles can be found in composition roofing that developed in the United States in the mid-19th century. In the last quarter of the 19th century the site-layered components of built up roofing were adapted to produce a factory assembled product of long strips. Packaged in rolls this material, once called "ready roofing," is now commonly known as "roll roofing." Though naturally occurring asphalt was used early as a waterproof coating, most built-up roofing systems relied on the more abundant coal tar. Asphalt, however, could be processed to be more solid than coal tar, and this solidity was necessary to facilitate the transition from a site fabricated system to a preassembled product. Despite the abundant and affordable asphalt from a growing petroleum industry, the use of natural asphalt was a point of product promotion at least as late as 1930.



Slate used for the surface aggregate determined the colors of early shingles. [click image for larger view]

The first asphalt shingles were produced in1903 by a roofing contractor and manufacturer of prepared asphalt roofing. Herbert M. Reynolds of Grand Rapids, Michigan, hand cut rolls of "stone surfaced" roll roofing into individual shingles. Early shingles were typically rectangular or hexagonal. The colors, usually red, green or black, were limited by the natural materials used for the granular surface.

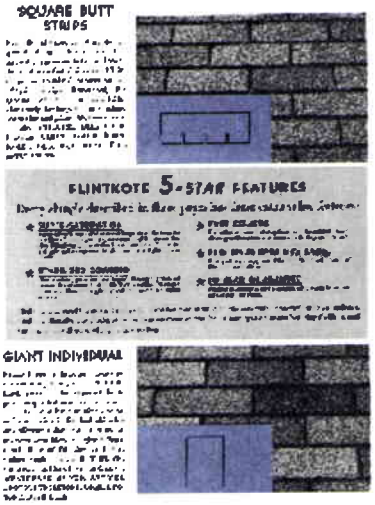
The popularity of this product led to the proliferation of shapes and sizes and attachment systems, some of which were patented. The multi-tab strip shingle was a significant development that quickly emerged. It offered the traditional effect of a small shingle with lower installation costs. By 1906 Bird and Son was marketing a notched shingle that had the appearance of two shingles when installed.

Numerous factors contributed to the increased use of asphalt shingles in the 20th century. Made of non-strategic materials and easier to transport than wood or slate, they met the constraints imposed during World War I.

Shapes

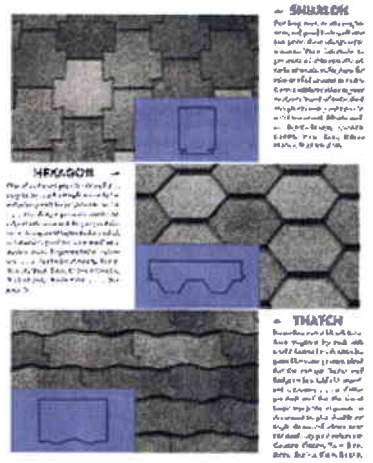
Shapes manufactured by the Flintkote Company during the 1940s.

[click images for larger views]

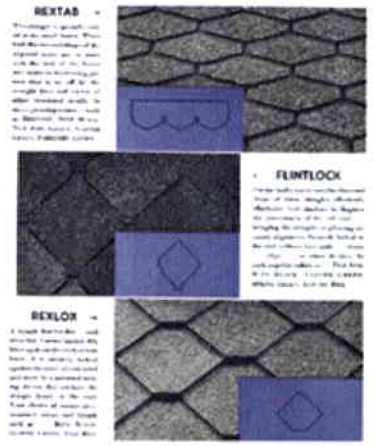


Sears, Roebuck and Co. promoted the quality of asphalt shingles used on many of the homes in their **1926 Catalogue of Houses**. (Courtesy of The Anthenaeum of Philadelphia and Dover Publications, Inc. New York.) [click image for larger view]

More flame resistant than wood, they were promoted in response to a 1916 publication of the National Board of Fire Underwriters urging the elimination of wood shingles as a fire hazard. Additionally, asphalt shingles gained a cost advantage over other materials. As improvements in manufacturing processes made asphalt shingles cheaper, increased labor costs made installation of traditional materials more expensive.



The variety of shingle shapes and sizes peaked by 1930, and by 1935 all major manufacturers were offering a 12 by 36 inch multiple tab shingle that is the standard today. At the same time the introduction of ceramic granules allowed a wider range of color choices that were often mixed to produce a blended shingle. The most significant recent change in the product itself is the replacement of organic felts with fiberglass mats resulting in a stronger, more durable shingle.



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Clay Tile

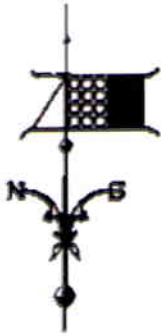
The origins of clay tile can be found in both China and the Near East, with surviving artifacts of roofing tile dating to 2,500 BC. From these locations, it spread throughout Asia and Europe. European settlers brought this tradition to the New World, and the earliest settlements like those on Roanoke Island in North Carolina, Jamestown in Virginia, and St. Marys in Maryland have yielded specimens of roof tiles from archeological investigations. Tile was also used very early by the Spanish and French in the South and West.

The tile roof on Stadt Huys (City Hall), New Amsterdam may have been imported, but by the time of its construction in 1641-42 tile was probably available from a tile yard up the Hudson in Rensselaerwyk. (Image courtesy of the Museum of the City of New York)

Both time and place are important determinants in the history of tile roofing in America. Tiles were first imported, but by 1650 they were being produced in the upper Hudson River Valley, and several factories were in operation at the time of the American Revolution. Fire was probably the single most important factor in popularizing tile for roofing in this country. Devastating urban fires in the 17th century prompted regulations that encouraged the use of tile as a fireproof roofing. The use of tile roofing began to decline during the first quarter of the 19th century as new fire resistant materials became available and tile roofs were viewed as clumsy and unattractive. However, by the middle of the 19th century, the popularity of revival styles, particularly Italianate, Gothic, and Romanesque, created new interest in tile roofs. The development of architectural terra cotta as a significant building material, the mechanization of tile production and the growth of rail transport aided a gradual resurgence of tile roofing. It was during the first few decades of the 20th century that the revival styles, drawn from the Mediterranean and the American Southwest, gave tile its broadest use. Today tile can most commonly be found in the Southwest and coastal South where its suits both the popular architectural images and regional climates.

The barrel tile roof on Vizcaya contributes to the image of an Italian Renaissance palace so grandly realized in this Miami, Florida mansion completed in 1916.

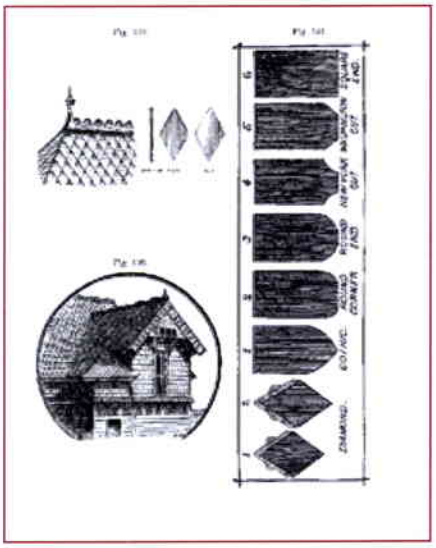
Tiles are distinguished by their shape and the way they overlap. The simplest are flat tile laid like shingles with staggered joints and less than half their surface exposed to weather. A tile system made up of alternating convex and concave or flat surfaces, generally referred to as pantile, may be formed by separate tiles (Barrel, Mission, Greek, Roman) or a single S-shaped tile (Spanish). These are laid with less overlap of each course than a shingle tile but include a side to side overlap. Interlocking tiles have mated ridges and grooves at their edges, thereby reducing the amount of overlap needed to achieve a



Manufacturing

Roofing tile begins as raw clay that is processed by drying, pulverizing, mixing with water and kneading. It is then shaped into tiles, dried and fired. In the latter half of the 19th century mechanization was introduced incrementally to what was largely a manual operation. Even as steam power was applied to the rollers that pulverized the clay and the pug mill that mixed and kneaded it, clay continued to be pressed into molds by hand. In the 1870s machines were developed that delivered and mechanically pressed slices of clay into a mold. The installation of such presses at the Celadon plant in Alfred, New York, reportedly increased daily production tenfold. Other advances allowed shapes such as a shingle or barrel tile to be cut directly from extrusions, a process commonly used today.

The kilns depicted in this drawing from an 1876 atlas have been loaded with tile and the open ends walled up with bricks. Fires for such kilns were lighted and kept slowly burning for the first five hours, and then progressively increased for the next thirty-three hours. Toward the end of the firing, the mouths of the kiln were stopped with ashes to prevent the flow of air from cooling the oven too quickly. A typical kiln consumed approximately four tons of coal per firing to produce hard fired tiles. (click image for larger view)



Outside of the Southwest, these tiles depicted in an 1884 publication are typical of what were in common use at that time. The diamond is an interlocking tile while the others are simply shingle tiles with shaped butts. [click image for larger view]

weathertight surface. Reducing the lap decreases overall weight of the roof and the need for heavier framing. The interlocking feature was only practical with the precision brought by late 19th century advances in manufacturing. It became common for most flat tiles as well as surface grooved French tiles and is also a feature of some pantiles.

Most clay tiles are nailed or wired to sheathing or battens, but lugs on the back of some tiles allow the weight of the tile itself to hold it in place on low slope roofs. Mortar is sometimes added, particularly on pantiles, to hold tile in place and make the system more watertight and wind resistant. The barrel tiles of the southwest were historically laid in a full bed of mud mortar without additional fasteners. Tile as a material often outlasts its attachments, if not the building itself, a point made in an 1884 treatise, Bricks, Tile, Terra Cotta, Etc.: "After doing service on one structure it can be taken off and used on other buildings."

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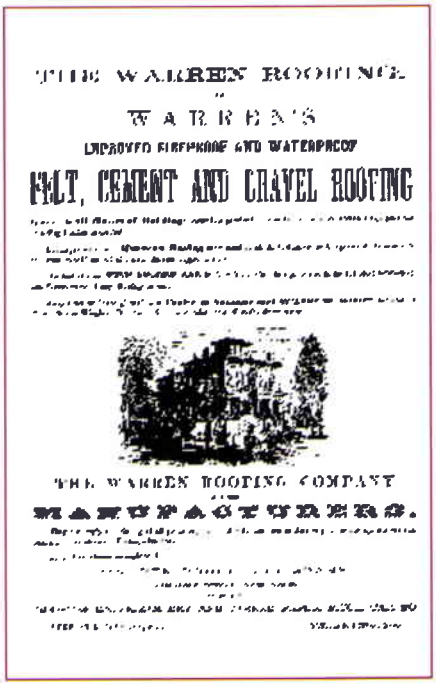
Composition

Composition or built-up roofing is a multi-ply system of fabric or paper, a viscous waterproofing substance, and a mineral aggregate. Historically, various materials have been used for each of these components. Paper, pasteboard, canvas, burlap, and felt have all served as the base membrane. These materials were often dipped in the waterproofing coating before being applied to the roof. The availability of felt in rolls facilitated the mechanization of this saturation process, and felt became the standard base. Pine tar, natural asphalt, coal tar and asphalt were the major materials to be effective as the waterproofing that saturated the base sheets and adhered the layers. Sand, gravel or slag provided the top surface. Though there is no evidence of their success, numerous other materials were tried as components, many as part of patented formulas: woven strips of paper or twine, sawdust, china clay, plaster of Paris, cattle hair, gum shellac, boiled linseed oil, boiled fish oil, and blood.

Pine tar and gravel were combined for roofing both in Europe and the United States in the 1870s. In 1800 pine tar was applied to canvas at the Octagon House in Washington, D. C., where it provided the roof covering for seventeen years. Evidence of similar systems used elsewhere in the early 19th century is very limited. In the 1840s a method learned from a roofer in Newark became the basis for a roofing business begun in Cincinnati by Samuel M. and Cyrus M. Warren. They met with success, as did others in the northeast, applying roofs of heavy paper, covered with pine tar and sprinkled with sand. The significance of the Warrens was the innovation they brought to the system. From experiments begun in 1847, they successfully replaced increasingly costly pine pitch with coal tar, a by-product of manufacturing illuminating gas from coal. Their continued development of the product and expansion to other cities assured the Warrens' status as leaders in the industry. They were the first in the 1850s to distill coal tar, producing a superior refined tar. Later they found that natural asphalt from Pitch Lake in Trinidad could produce an easy-to-mix roofing pitch when combined with petroleum tar, a by-product of oil refining.



This advertisement offering both roofing materials and installation appeared in the late 1860s. It touted the many advanatages of a composition roof. [click image for larger view]

The potential of composite roofing was apparent to many, and the number of related patent applications exploded in the 1860s and 1870s. The developments in composition roofing were well timed to meet the mid-19th

Standards

As the materials and technology of composition roofing evolved, the number of manufacturers and installers proliferated. There was little done in the 19th century to assure the quality delivered by either. Making matters worse, many companies asserted that their products could be applied by anyone. As a result, many roofs performed poorly. Because composition roofing was a multi-component system of varied materials and methods, successful performance was hard to predict.

Samual Barrett, a Chicago roofing product manufacturer, made the first significant effort to set standards for the industry. "Barrett Specifications" were compiled in 1906, providing minimal guidelines for the materials and application of a gravel or slag roof. His generic

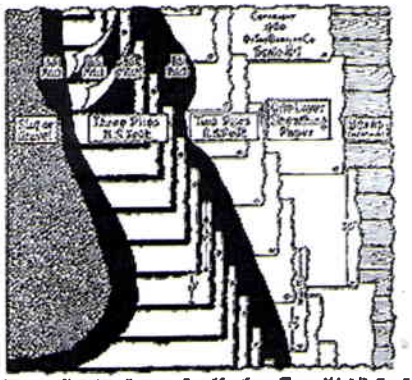


Diagram Showing Barrett Specification, Type "AA" Roof Over Boards

(**Sweet's Architectural Catalogue**, 1929. Courtesy of The Sweet's Group, The McGraw-Hill Companies, Inc.) [click image for larger view]