

Terra Cotta in Architecture

By Walter Geer

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(President of New York Architectural Terra Cotta Company, 1896-1919)

The lightness of terra-cotta, combined with its enormous resisting strength, and taken in connection also with its durability and absolute indestructibility, renders it specially desirable for use in the construction of all large edifices, both public and private.

A complete history of the use of clay as a constructive or decorative material in architecture would be analogous to that of civilization itself with its advances and declines, for the authentic records of this branch of pottery are older than those of any other ceramic production, extending through forty-one centuries. The art of pottery is the most ancient and universal of all, including as it does, in its widest sense, all objects made of clay moulded into form while in a moist, plastic state, and then hardened by fire (Encyclopedia Britannica, article "Pottery," 9th Edition). Connecting itself on the one hand with geology and chemistry, on the other with painting and sculpture, pottery is the natural outgrowth of two of the first necessities of man's existence: the preparation of food and the need of shelter. It is thus intimately identified with the domestic and social life of all races. Its productions are the most enduring of man's handiwork. Objects that have out-lived history are to be viewed not only as specimens of the condition of the art at the time of their production, but as exponents of the habits and domestic life, and the aesthetics of races long since passed away. The fact that in this practically imperishable material, we have presented to us more completely than in any other, the thoughts and works of artists in every successive age of the world, and in every country at any time civilized, from a period of almost fabulous antiquity down to the present time, shows the immense field for intelligent inquiry into the uses and advantages of the artistic employment of burnt clay.

It may at first seem a somewhat bold assertion, that the burnt clay of the ancients is identical in substance with the terra-cotta of to-day, but such is the fact. Terra-cotta is undoubtedly the oldest building material known to history, other than wood, and was probably employed in the making of domestic vessels before building was known as an art. The term by which this material is technically known, literally "cooked earth," dates from the period of the Italian renaissance, when terra-cotta was first largely used for

architectural purposes. But the material itself, both in the form of bricks and in the more elaborate constructive and decorative forms was largely used by the earliest builders. The fact that clay when subjected to great heat would become a hard brittle substance must have been discovered in primitive times by the kindling of fires on clayey soil, and the utility of this substance for domestic and architectural purposes have been suggested as the result. The fragments from the ruins of the most ancient temples and palaces reveal its application for these purposes. In fact, terra-cotta may be said to be prehistoric in its origin, for it is in some cases our only link with nations of the most remote antiquity. To terra-cotta we owe nearly all the information we possess in regard to the most ancient states and empires; bank notes, deeds of property, private transactions, public records, still being found in a good state of preservation among the ruins of ancient Babylon and other great cities of the past.

The public records of the Assyrians were kept minutely inscribed on cylinders and tablets of clay which were afterwards baked. These furnish complete materials for transcribing the history of those times. To these records, revealed by the researches of Layard, Rawlinson and others, we owe much of our knowledge of the ancient Assyrians, Chaldeans, and Egyptians. The historical researches with reference to the Tews have also been much assisted by the inscriptions found on earthen bowls taken from the ruins of Babylon. It seems to us important to dwell somewhat on the historical aspect of this subject, before considering its modern development and uses, as so few seem to be aware that we are not dealing with a new substance but rather with the oldest manufactured material to which we have historical references. Indeed, it may be well said that, so far from history perpetuating the records of terra-cotta, terra-cotta has perpetuated the records of history.

FIRST EMPLOYMENT.

The earliest reference to the use of burnt clay as a building material is to be found in the Eleventh Chapter of Genesis, in connection with the building of the Tower of Babel :— "And they said one to another, Go to, let us make brick and burn them thoroughly. And they had brick for stone, and slime had they for mortar." Sun-dried and baked clay was employed by nearly all the great nations of antiquity in their earlier works. The granaries and storehouses of Egypt, the vast mounds of Nineveh and Babylon, the aqueducts and other remains of Roman times, testify how wide-spread was its use. Nor was it used merely as a building material. The clay cylinders of Nineveh have been the means of treasuring up the documentary records of a monarchy, of which other direct records

have almost wholly perished; while our museums are full of wonderful evidences, in their collections of Etruscan vases, of the beautiful art, the refined taste, and the poetic imagination of this mysterious people, whose very history is lost and whose race and era are disputed questions. All nations whose early history is known to us, Assyrians, Egyptians, Greeks, Romans, Gauls, have left us records of their thoughts on terra cotta. "Art commenced with the simplest shape, and by working in clay." (John Winckelmann: History of Ancient Art, Vol. i, page 193) The invention of the art of working in terra-cotta was claimed by the Corinthians, who are said to have exhibited in their city specimens of the first efforts in it from the hand of the celebrated potter Dibutades. In order to preserve the likeness of his daughter's lover, he moulded in terra-cotta the shadow of his profile on the wall, and this production is said by Pliny to have been in existence when the city was stormed by Mummius. The invention was also claimed by the Samians, who maintained that Rhoecus and Theodorus, who were sculptors in bronze, and who flourished about 657 B. C, had first practiced the art of modelling. As the early sculptors cast their bronzes solid, like the Egyptians, who are supposed to have been the fathers of the art, it is evident that modelling in clay must have preceded working in bronze.

The Egyptians made small figures of terra cotta covered with inscriptions. Referring to these portrait statues recently discovered in the secret recesses of the tombs around the bases of the Pyramids, Fergusson says: "Nothing more wonderfully truthful and realistic has been done since that time, till the invention of photography; and even that can hardly represent a man with such unflattering truthfulness as these old colored terra-cotta portraits of the sleek rich men of the Pyramid period" (Architecture in All Countries, page 82). Bricks burned and unburned were employed in the construction of the Great Wall of China, the most stupendous work in the line of fortifications ever attempted by human hands.

GREECE AND ROME.

Among the ancient Greeks and Romans, terracotta was employed for an immense variety of purposes, from the commonest objects of every-day use to the most elaborate and ambitious works of art, such as colossal statues and groups. Pausanias mentions having seen at Athens two remarkable terra-cotta groups, representing Theseus killing the robber Sciron, and Heos (Aurora) carrying off Kephalos. The celebrated painter Zeuxis was accustomed to model in terra-cotta the subjects which he afterwards painted, and many of the artists of the later schools combined the plastic

art with that of painting. The immense number of terracotta objects at Athens is alluded to by Demosthenes in his first Phillipic.

On a larger scale, terra-cotta was adapted by the Greeks to important architectural ornamentation. Many fine examples have been found at Olympia, and among the ruined temples of Selinus. In some cases the main cornices of the building were simply blocked out square in stone, and then covered with moulded plaques of terra cotta, carefully formed to fit on and around the angles of the block. The large cymatium which forms the upper member of the cornice is curved upwards, so as to prevent the rain water from dripping all along the edge; and at intervals it is pierced by ornamental clay pipes, which project like a medieval gargoyle. In some examples from Selinus the cymatium is pierced with a beautiful open pattern of lotus leaf. The greatest care was taken in fitting these applied mouldings where each plaque joined the next, and especially in making them fit closely on to the stone blocks, in which rebates were cut to receive each plaque.

As in other branches of art, the Romans closely copied the Greeks in their wide application of terracotta for statues, reliefs, and architectural ornaments. A large number of beautiful Grreco-Roman reliefs exist, many having designs evidently copied from earlier Greek sculpture. Berlin, the Louvre, the British Museum, and many places in Italy possess fine collections. Friezes, with beautiful reliefs, twelve to eighteen inches deep, often occur, little inferior in execution to the earlier Greek work. These terra-cottas belong to the early period of the empire. At the end of the first and in the earlier part of the second century, A.D., the use of terracotta for architectural adornment was carried to a high point of perfection in Rome. Many buildings of the period have the most elaborate decoration, moulded in clay and fitted together with wonderful neatness. Not only enriched cornices and friezes were made of terra cotta, but even Corinthian columns, with their elaborate acanthus capitals. The best existing examples in Rome are the Amphitheatrum Castrense, many tombs on the Via Latina, and the barracks of the Vllth cohort of the guards in the Trastevere.

It would require too much space to enumerate all the various forms and subjects represented in terra-cotta by the ancients. Some of the extensive uses to which it was put are thus summarized by Mr. Birch: "It supplied the most important parts both of public and private buildings, as the brick, roof-tiles, imbrices, drain-tiles, columns, and other architectural members. It also served for pavements, and for the construction or

lining of cisterns and aqueducts. Among its adaptations to religious purposes may be noticed the statues of the gods which stood in the temples, besides copies of them on a reduced scale, and an immense number of small votive figures. It also supplied the more trivial wants of every-day life, and served to make studs for the dress, bases for spindles, tickets for the amphitheatres, and prizes for victors in the games. Of it were made the vats or casks in which wine was made, preserved or exported, the pitchers in which it was served, and the cup out of which it was drunk, as well as all the various culinary and domestic utensils for which earthenware is used in modern times. It furnished the material for many small ornaments, especially figures, which are often of a comic nature, and supplied the undertaker with bas-reliefs, vases, imitative jewelry, and the other furniture of the tomb" (History of Ancient Pottery, Vol. i, page 159). The Roman knowledge of pottery spread with their conquests, and fine examples of Roman brick and tiles are to be found in Germany, Spain, France, and England.

The knowledge of the art of pottery probably at no time became entirely extinct in the East; but after the 4th century, in sympathy with the decline of all other arts, and the dying Roman civilization, the knowledge of this art gradually expired and was lost in Western Europe. The Romans made brick so extensively in Germany and in England, that it seems strange that such an art when once acquired should have been lost. Nevertheless, in the remains of buildings between the Roman times and the 13th century, there is no evidence of brick having been made in England. During the darkness of the middle ages the art would probably have been entirely lost but for the monks, the great conservators of the arts and sciences during the middle ages, to whom we owe so much.

THE RENAISSANCE.

Pottery was made at Majorca by the Moors about the 12th century, and was introduced by them into Spain, when a little later they became, for a time, masters of that country. They also seem to have had knowledge of the art of making enameled ornamental tiles. It is said that the people of Pisa also introduced Moorish tiles for church decoration about the 12th century, at which time the making of terra-cotta began to revive for architectural work in Italy. During the 14th century, the manufacture of terra-cotta was carried on at Venice by the guilds of the Boccaleri and Scudeleri (or picture and plate makers), in whom the exclusive privilege of manufacture was vested (W. R. Drake: Venetian Ceramics, page 9).

In the 14th, and more especially in the 15th century, terra-cotta was adapted in various parts of Europe to the most magnificent and elaborate architectural purposes. In northern Italy this use of terra-cotta was carried to a very high point of perfection. The western facade of the Cathedral of Monza is a work of the most wonderful richness and minute elaboration, wholly executed in clay, in the latter part of the 14th century. The Cathedral of Crema, the communal buildings of Piacenza, and S. Maria delle Grazie in Milan, are striking examples of the extreme splendor of effect that can be attained by terra-cotta work. The Certosa, near Pavia, has a most gorgeous specimen of the early part of the 16th century: the two cloisters are especially magnificent. Pavia itself is very rich in Terra cotta decoration, especially the ducal palaces and the churches of S. Francesco and S. Maria del Carmine. Some delicate work exists among the medieval buildings of Rome, dating from the 14th and 16th century, as, for example, the rich cornices on the south aisle of S. Maria in Ara Cceli (1300); the front of S. Cosimato, in Trastevere, built 1490; and a once very magnificent house, near the Via di Tordinona, which dates from the 14th century.

To this period date the productions of that most famous of all workers in clay, Luca della Robbia. No sculptured work of the great 15th century ever surpassed the Singing Gallery made by him for the Cathedral of Florence, somewhere between 1430 and 1440. The works of Luca della Robbia, while not strictly terra-cottas, in the modern acceptance of the term, are among the most valuable examples of the use of burned clay in architectural decoration. From the time of Luca della Robbia, ceramic ornaments invariably entered into designs for buildings. It was then that the art of terra-cotta most flourished, and it is from the productions of this period that most of the inspiration of modern designs has been drawn, especially in those structures erected prior to the middle of the present century.

West of the Alps, clay was not so much used for building or decorative purposes. Nevertheless, in the south of France, in Toulouse, remarkable examples exist. On the Rhone, carved tiles are to be found in very elaborate cornices and balustrades. In the north of Germany, in Brandenburg, Luneberg, Hanover, and the provinces on the Baltic, brick and ornamental terra-cottas were largely used in preference to stone, not only for exterior work, but also for the interior of churches, halls, and private dwellings, even the lofty piers of the cathedrals being moulded in clay.

The mark of Brandenburg is especially rich in terra-cotta work. The Church of St. Catherine, in the town of Brandenburg, is decorated in the most lavish way with delicate tracery and elaborate string courses, and cornices enriched with foliage, all modelled in clay. The Town Hall is another instance of the same use of terra-cotta. At Tangermtinde, the Church of St. Stephen and other buildings of the beginning of the 15th century are wonderful examples of this method of decoration: the north door of St. Stephen's especially is a masterpiece of rich and effective moulding.

In England, from the time of the downfall of the Romans until about the 13th century, there are few evidences of brick or terra-cotta work being used in important buildings, except such bricks as were taken from the ruins of the ancient Roman works, as at St. Alban's Abbey and other places, and it does not appear that brick became again a favorite material for public works until about the 14th century. One of the earliest specimens in existence is to be found in Little Wenham Hall, Suffolk, supposed to have been built about the year 1260.

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The buildings of the Anglo-Saxons were usually of wood, rarely of stone, until the 11th century, and it is probable that the primitive English churches are among the earliest stone buildings of Western Europe, after the time of the Romans. In these buildings some of the arches are constructed of bricks, all of them taken from some old Roman works.

The elaborate use of terra-cotta did not come into vogue till the latter part of the 15th century, and then only in certain counties. Essex possesses some of the finest examples, such as the Manor House of Layer Marney. The richly moulded windows and battlements of this house are very un-English in style, and it seems probable that all the terra-cotta decorations were made in Holland or in Flanders.

The introduction of the Tudor style gave an impetus to the use of brick, moulded brick and terracotta, and during the 16th century many large mansions were erected in England of brick, having moulded brick cornices and terra-cotta trimmings. It is said that Holbein promoted the use of moulded brick and terra-cotta, towards the end of the Tudor period. The friezes, cornices, and other highly ornamental work in terra-cotta, of the Manor House, at East Barsham, and the Parsonage House at Great Snoring, both in Norfolk, erected during the reign of Henry VIII., are worthy of particular notice, and the use of terra cotta for decorative panels and bas-reliefs appears to have been popular

during his time. The gateway of York Palace, Whitehall, designed by Holbein, was decorated with four circular terracotta panels, which are still preserved.

During the 17th and 18th centuries many choice works in brick and terra-cotta were executed, and in many parts of London mouldings and cornices of this date still exist. About the middle of the 18th century Wedgwood began his career in the making of terra-cotta vases and other wares. About 1790, works were established at Lambeth, near London, for making terra-cotta and architectural details, statues and vases, by a lady of the name of Coade. These works were in existence until about forty years ago, when they were closed. Many of the leading sculptors who ranked high in the profession in the earlier days of the present century were employed at Coade's, and the durability of its productions can be attested by numerous examples. The capitals and other work in the oldest part of Buckingham Palace were made there, and although the stone work of this palace on all sides shows great signs of decay, the terra-cotta Corinthian capitals are as sharp as when they left the kiln. About the commencement of the present century other manufacturers began to establish themselves in competition with Coade's, and space fails us to even refer to the many work's which were established after that date in London, and various parts of England, for the manufacture of terra-cotta and brick.

Among the best modern examples of the extensive use of terra cotta, may be mentioned the South Kensington Museum, from designs by Gilbert Scott, architect, the Dulwich College, by Charles Barry, and the great Albert Hall, by Gilbert Redgrave — all admirable examples of the attractive effect produced by the judicious blending of brick and terra-cotta in architecture.

UNITED STATES.

The first brick building erected in this country was built by Wouter Van Twiller, of Amsterdam, the governor appointed by the Dutch West India Company, soon after his arrival on Manhattan Island, about the year 1633. During the succeeding years of the Dutch rule this building served as the official residence of the successive governors of the colony. The bricks used were brought from Amsterdam, and seem to have been of excellent quality, as but few were broken during the long and stormy voyage. The first bricks made in this country are probably to be credited to the people of the little colony of New Haven, and were burned about the year 1650.

There is no record, so far as we are aware, of the use of terra-cotta in this country until about the year 1853, when an attempt was made to introduce it by James Renwick, Esq., the well-known New York architect. In sketching the history of this first attempt to introduce ornamental terra-cotta in New York, we cannot do better than to quote from a letter written us by Mr. Renwick in 1886:

"In 1853, I conceived the idea of introducing terra-cotta as a building material and substitute for cut stone work in New York. I went to Mr. Young, who had a factory for making glazed and other earthen sewer pipe, in 40th Street, and told him what I proposed doing, and asked him if he would manufacture it from my designs and under my supervision. I supposed it would be a source of large profits to him, as it would be more durable and ornamental, and less expensive, than the free stones which were then in use. I made a contract with him for the belt courses and the cornice of the Tontine Building, and for the ornamental work of the St. Denis Hotel, and of three houses in 9th Street, between Fifth and Sixth Avenues. All these buildings are now standing, and the terracotta is as good as when first put up. We tried to introduce it into general use, but were violently opposed by the stone-cutters and builders who said it would not stand, and persuaded owners not to use it. The only other building it was used in, as far as I know, was in the Lafarge Hotel court. This building was destroyed by the fire which originated in Tripler Hall, which was in the rear and part of the hotel. Mr. Young, finding it impossible to introduce it, and having lost money in the attempt, gave up the manufacture and returned to making pipe. The fact is, we were ahead of the times, and could find no one who understood or would venture to use it. The buildings above mentioned, in which it was used, belonged either to my family or friends who had confidence in my judgment. About eight or ten years after this, Mr. Greenough, the sculptor, came from Rome to New York for the express purpose of introducing the use of terra-cotta. I happened to dine with him, and he broached the subject. The next morning I took him to see the work on the St. Denis Hotel, and related my experience, and he gave up the idea, being afraid of meeting the same difficulties I had experienced."

The late Richard Upjohn also did much towards encouraging the use of terra-cotta in New York. About the year 1853, Mr. Upjohn prepared the designs for the Trinity Building on Broadway, just north of Trinity Church. He determined to use brick and terra cotta, and the work was made and burned at a drain pipe factory on 17th Street near the North River. The terra-cotta work used in this building is still perfect,

although it has been found necessary to re-cut the damaged and disintegrated faces of the brown stone work in the building.

After these first attempts to introduce the use of architectural terra-cotta in New York, there followed a period of nearly a quarter of a century, during which the manufacture and use of this material, so far as New York was concerned, was practically discontinued. Although these efforts had failed, the need of such a material still made itself felt, and at Trenton, Philadelphia, Cincinnati, Louisville, Indianapolis and Chicago, at different periods, attempts were made to introduce the manufacture and supply the demand. The one thing lacking in every case was a practical knowledge of how to prepare the material in order to meet the demands of architects and the building public. At last, in 1870, a member of the Chicago Company, not being satisfied with the quality of the work they were turning out, and feeling confident that the failure to make better work came from ignorance, and not from lack of merit in the material, opened correspondence with Mr. Blashfield, the well-known English manufacturer. This correspondence was referred to James Taylor, then superintendent of Blashfield's works, who had already arranged to leave England for the United States. On Taylor's arrival in this country he visited the works at Chicago, and the result was that the Chicago Company was re-organized in August, 1870, as the Chicago Terra-Cotta Works, with James Taylor as the superintendent.

The old Roman open fire kilns were replaced with Blashfield's muffled kilns and new methods were introduced for the preparation of clay and manufacture of finished stock, similar to those used in Blashfield's works at Stamford, England. With these changes, and with the increased facilities which were introduced, the Chicago works were enabled to furnish a much better class of architectural terra cotta.

After the unsuccessful efforts noted above, no further attempts were made to introduce the use of terra-cotta in New York until 1877. In that year a residence was built on the north side of 36th Street, just west of Park Avenue, from designs of George B. Post, architect, in which terra-cotta was quite extensively used, both for decorative and constructive purposes. The terra cotta was made at the Chicago works, and was set under the supervision of James Taylor. After fourteen years this work is still perfect in form, and as fresh in color as when first put in place. The next important New York building in which terra-cotta was used was the Morse Building, corner of Beekman

and Nassau Streets, erected in 1878, the material for which was also made at the Chicago works.

A large increase in the number of brick buildings erected followed the great fires of Chicago and Boston. By these fires it was conclusively demonstrated that fire-proof buildings could not be made of unprotected stone or iron, and that only brick and terracotta walls were practically fire-proof. This increased use of brick work, and of terracotta as a constructive and decorative material in connection with brick work, revived the demand for the manufacture of this material in or near New York. At this time there was at Perth Amboy a yellow and Rockingham ware and fire brick factory known as the A. Hall & Sons Fire Brick Works. The proprietors of these works decided in 1877 to change the yellow and Rockingham ware works into a plant for the manufacture of architectural terracotta, continuing the manufacture of buff and fire bricks. The necessary changes were made and the manufacture of terracotta was commenced. R. W. Taylor, who had acquired some experience in the manufacture of terra cotta in the Chicago works during the preceding four years, was engaged by Mr. Hall as superintendent of the new works. In 1879, the business was incorporated under the name of the Perth Amboy Terra-Cotta Co. Two years later, Mr. Alfred Hall retired from the Company and started in Perth Amboy a new fire brick and architectural terra-cotta works under the name of the A. Hall Terra-Cotta Company. R. W. Taylor became superintendent of the new works. After being in business for five years, and doing some excellent work, the Company went into liquidation in April, 1887, shortly after the death of the President, Mr. Alfred Hall.

In 1879, an attempt was made to establish works for the manufacture of terra-cotta, at Long Island City. The chief mover in this enterprise was Rudolph Franc, who had had some experience in the terra-cotta works of Ernst March, Charlottenburg, Germany, and who had also been employed for some time as assistant superintendent of the Perth Amboy Company. The undertaking, however, did not succeed, and the works were closed at the end of eighteen months.

In the meantime, the demand for terra-cotta continued to steadily increase in New York, until it far exceeded the capacity of the local manufacturers to supply it, and even threatened to make the use of the material unpopular on account of delays which often occurred in the execution of orders. The recognition of this fact led in the winter of 1885-6 to the organization of the New York Architectural Terra-Cotta Company. The

new Company secured the services of James Taylor as superintendent, who in the Chicago works had first introduced better methods of making architectural terra-cotta in the United States, and who is favorably known by his productions wherever terra-cotta is used. A block of ground containing nearly two acres, with a water frontage of over 200 feet on the East River, was purchased at Long Island City, opposite 58th Street, New York, for the location of the factory. Excavations for the foundations were begun February 1st, and the first brick was laid on February 15th. On the 10th day of May, 1886, the factory was under roof and the first kiln of terra-cotta was burned.

THE NEW YORK COMPANY'S WORKS.

As these works are the largest of their kind in America and the only ones which were built especially for the manufacture of architectural terracotta, a description of them in detail may be interesting to the professional and general reader.

The main building is 170 feet by 115 feet, built of brick and terra cotta, and is six stories high. There has also just been completed (April, 1891) a large addition, 95 feet by 80 feet, which has been erected to provide additional facilities for handling the large and steadily increasing business of the Company. There are about four acres of floor room in the six stories of the entire manufactory.

The first story contains the engine, boilers, machinery for preparing clay, and the clay, coal and grit pits. The clay pits will hold about fifteen hundred tons of clay. This large capacity for the storage of prepared material enables the Company to make each contract of one grade of stock, thus insuring practical uniformity in composition and texture of the clay body, and consequent regularity of shrinkage and harmonious uniformity in the color and tone of the finished work. The value of this storage room will be fully appreciated by those who know the importance of using weathered and fermented clay mixtures in the manufacture of terra-cotta work. A much better body, and one that is weather-proof and semi-vitrified throughout the entire mass, can be made and burned from this kind of stock and with less labor, than when the manufacturer is obliged to use crude or unseasoned clays. Terra-cotta thus made requires no glaze or semi-glaze to protect its face, for the purpose of increasing the weather-resisting qualities of the material. Various glazes can be applied to face an inferior and unreliable body, but there is danger of such a face cracking and peeling from the effects of frost.

The machinery on the first floor includes the washer and slip tanks, for preparing fine clays; crushers and mill stones for preparing grit, and pug mills for preparing the different bodies used in the variety of clay wares manufactured at these works. In the second story, and on a level with this floor, are the entrances to the kilns, twelve in number. These are so constructed that they can be loaded, burned and discharged in eight days, so that on demand, more than ten kilns of work a week can be produced. These kilns will hold from twenty to twenty-five tons of burned terra-cotta. This gives the Company a total capacity of from \$20,000. to \$25,000 worth of work per week. On this floor, the work when taken from the kilns is selected, fitted and marked previous to shipment.

The whole of the third, fourth and fifth floors, which contain an area of two acres, are used for the pressing and finishing departments. These floors are capable of holding enough work to more than fill all the kilns, thus furnishing ample drying space at reduced cost and risk of handling. These floors are provided with extra steam pipes to assist in drying the work. The surplus heat of the kiln walls (which pass through these floors) assists in heating the building and drying the work. The sixth story contains the model and mould department, where there is a large storage capacity for stock models and moulds. Every convenience for making full sized details will be found here, which the Company freely offers for the use of architects and its customers.

The factory is equipped with a complete system of stand pipes and automatic sprinklers, with a duplex fire-pump, located in a fire-proof compartment, in the boiler-house outside the main building. These precautions have been taken against any possible interruption of the business by fire.

A brief statement of the process of manufacture will help one to see why time is required to make good work and large facilities are necessary, in order to do much in a relatively short time.

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The first consideration in the manufacture of terra-cotta is the selection of material. The experience of many years in the use of the best known clays adapted to the manufacture of terra-cotta, which are found in all parts of the United States of a greater or less degree of merit, has enabled the Company to determine which material is best suited for the highest grade of architectural terracotta. In fact, one of the chief secrets of the Company's success as makers has been in the selection of the material.

No one locality gives all the clay required for first-class material, and each shade and tint of terra-cotta requires the mingling of certain clays from different localities to regulate the color. It demands the artist's taste and perception to select the clay according to the colors required, and to mix it in proper proportions to control the shape and shrinkage. The clay used by the New York Company comes principally from Northern and Central New Jersey, but for certain purposes clays are procured from all parts of the United States.

The clay, after being mined, must be properly seasoned before being delivered at the factory. After being received on the docks, this clay is crushed and ground or washed, then mixed with grit and water. The clay is piled in layers, each quality being in a separate layer or stratum. As many as ten or twelve strata or layers are piled together, and from this mass perpendicular cuts are taken, and the whole again is thoroughly tempered in pug mills, or with rollers. After passing through the machinery, which thoroughly mixes all the ingredients, the plastic mass is moulded into small cakes for convenience in handling, and sent up to the moulding rooms. It is then ready for the pressers.

It is one of the principles underlying the successful manufacture of terra-cotta, that no piece should be larger than two men can conveniently handle. The most massive figures and complicated designs are made in a number of small pieces or sections. From the specifications of the architect, designs showing the full details of the work required must be made, which are sent to the modeling and moulding rooms. A full-sized model of plaster and clay is then made, and from this a plaster mould is taken. In the making of these models and moulds, the highest grade of skilled labor is necessary. Indeed, the modeler in terracotta requires the same artistic training which is necessary for the sculptor in marble or the artist who fashions the most elaborate design for casting in bronze.

When the moulds are dry, they are sent to the pressing department. The plastic clay body is pressed into these moulds, and, when partially dry, the work is turned out on the floor. The ware is now ready for the carver or modeller, if it is decorative work that requires the use of their tools, or for the clay finisher, if it only requires undercutting, or some special work to make it fit in with other work to be used in the same building. At this point, much depends upon a careful following of the intricate tracings of the architect's designs.

The work is then carefully dried on the drying floor, when it is ready to be loaded into the kilns, where it must remain seven days for burning and cooling before it is ready for use. After the work is burned, and just before shipment, it is laid out upon the floor as it is intended to go into the building, and fitted together. Nothing can be done with the face of the material after it is burned. It will not work down like stone, and only the joints can be chiseled or trimmed to insure a close fit.

The length of time required by all these steps in the process of making good terra-cotta depends, except the burning, upon the size and amount of artistic or hand work which the design and quality of finished work require. With the prepared clay stock, with extra facilities for safe drying, and with sufficient kilns for burning, a large amount of work can be turned out as quickly as a single piece. In some cases, where the moulds were already on hand, work has been made in the factory of the New York Company and delivered within ten days after receipt of the order. This is only possible, however, in the case of small pieces, or work of moderate size, and where the moulds are already on hand. It is always more expensive to attempt to turn out work in such short time, and inexpedient on account of the risk in forcing the drying.

One of the features of this institution is its photographic department. All architects' plans are photographed, and a copy furnished to the head of each department. As each man finishes his work, that portion is painted out in colored inks, so that an inspection of the photographs gives a graphic representation of the progress of the work. By a comparison and examination of these photographs, the progress and exact condition of every order can be determined at any time, within a few minutes, by the architect, or builder, or any-one interested. This method of following the work through the different stages of execution has been found the most advantageous of any heretofore tried. The negatives of these photographs are all preserved and filed away in cases suitably numbered, so that orders for any work received can be duplicated years afterwards from these negatives, without other or supplementary drawings. Besides this, the architects' original drawings are also preserved as an additional precaution. Some idea of the size and substantial character of the works can be obtained from the view of the main building, to be found opposite the title page. It must be remembered that the addition in the rear is just half the size of the main building.

The central location of the works is such as to enable the Company to deliver work with the utmost dispatch, by its own trucks, to New York, Brooklyn and adjacent cities, and by rail and water, via the great railway and steamship routes, to points at a distance from the metropolis.

The factory as already stated was erected expressly for its purpose, and to secure the most economical and perfect manufacture of architectural terra-cotta work. It is fully equipped with the most powerful, reliable and useful machinery for the manipulation of clay and the preparation of terra-cotta bodies. The best form of muffled kiln is used, which secures a uniform and safe burning of the ware. The Company has a large and efficient staff of experienced and skilled workmen in all departments, supervised by those who, by practical and continuous experience, have acquired a knowledge of the processes of manufacture, and the results of many tests of prepared and burned clay which have been made in the several terra-cotta works of this country during the past twenty years.

ADVANTAGES OF TERRA-COTTA.

Foremost among the advantages of terra-cotta as a building material, may be mentioned the facility it affords to architects to see the actual full sized details of the more ornamental portions of their designs, before the work is burned, as where no repetition is intended, no moulds are used, and the work which is afterwards to be burned and take its place in the building, is the model itself. It thus bears the impress at once of the mind of the designer, and the skill and knowledge of the modeling artist. It can be studied, improved, or modified, and when entirely satisfactory, burnt. It is, therefore, a far better reflex of the personality of the architect than can possibly be the case in any other building material.

There is another fact which should perhaps be pointed out with reference to terra-cotta in this connection, that is, that it must always remain a material in itself—it should never be regarded as a rival to stone. Terra-cotta may not compare with masonry in accuracy of lines, but with it you can produce the most beautiful surface, the most charming variety of tints, and the most brilliant effects of light and shade. There is no other material which affords such scope for the genius of the designer, no material which can be so readily impressed with the conception of the artist, as "Clay in the hand of the potter." No process in any handicraft is so beautiful as that of the modeller in clay. The ease with which the plastic clay answers to the touch of the hand, taking a whole

succession of symmetrical shapes, and seemingly, as it were, instinct with the life and thought of the modeller, makes the art beautiful and striking beyond all others, in which the desired form can only be attained by comparatively slow and laborious methods. The first question which suggests itself to architects and builders in the consideration of terra-cotta as a building material is its durability. It is quite natural to compare terra-cotta in this respect to stone. The question as to whether terra-cotta may be ranked with stone in point of durability may be unhesitatingly answered in the affirmative. The fact that burnt clay of a good quality is almost indestructible is proved by the remnants of bricks and tablets discovered by Layard and Rawlinson in the ruins of Babylon, in an almost perfect state of preservation. A small statuette, taken from the ruins of ancient Thebes, which is believed to be not less than thirty-three hundred years old, is covered with hieroglyphics as sharp and as perfect in outlines and in detail as the day it was carved and burnt. We have many modern illustrations also, in the magnificent old brick and terra-cotta structures still to be met with in different parts of England and the Continent, affording, under the most trying conditions of climate, valuable evidences of the durable nature of terra cotta.

One of the choicest specimens of ancient terracotta in existence is exhibited in the South Kensington Museum in London. This is a medallion, eleven feet in diameter, bearing the arms of King Rene of Anjou, surrounded by a massive border of fruit and foliage, and is supposed to have been made in the year 1453. It was exposed to the action of the weather for more than 400 years, fixed in the front wall of a villa near Florence. Another fine example is to be found in the Church of San Gottardo in Milan. During five centuries the tower of this church has braved the inclemencies of the seasons, without noticeable traces of decay appearing in the terra-cotta work, which is most elaborately carved and of delicate workmanship. A close inspection of this tower also reveals the interesting fact that the architect, mistrusting, perhaps, the resisting power of terra-cotta against the stress of weather, took care to furnish the windows with quoins of stone as a protection— vain precaution, as it is the stone work which has suffered from the assaults of time, and not the terra-cotta.

Coats of arms of terra-cotta, inserted in the walls of Hampton Court Palace, which have been exposed for three centuries and a half to an English climate, are practically unharmed by the action of the weather, while the brick and stone, and almost every other material used in the construction of the palace, is more or less worn and decayed.

In his report on the terra-cottas exhibited at the Paris Exposition of 1867, Mr. Henry Cole says, with reference to the durability of terra-cotta: "It is more durable than even ordinary granite, as may be seen on the lodge in Merrion Square, Dublin, which was built about 1786. The granite mouldings there are cut in stone from the Wicklow Mountains, and they are all worn away and rounded by the action of the rain, while Coade's terra-cottas, dated 1788, are as sharp as when they were first placed on this lodge" (Report on the Paris Universal Exhibition of 1867, Vol. 2, page 415).

There is at Buckingham Palace a number of Portland stone pedestals supporting terra-cotta vases of handsome design. The pedestals, though of the same age as the vases, have so far decayed that few of the carved moldings are distinct, while the bas-relief figures on the vases are as sharp and perfect as when they left the kiln.

When it was first proposed to use terra-cotta in the South Kensington Museum, it was submitted to various tests—among others, the underpinning of some of the lower members on two sides of an open court were built, one of stone and the other of terra-cotta. After a time it was seen that the stone had changed color and showed premonitory symptoms of disintegration, whereas, the terracotta had as clean and perfect a face as when first put up.

When it was a subject of debate in London whether stone paving or terra-cotta tiles should be used for the footways of Westminster Bridge, the architect was anxious to test the wearing capabilities of the two materials for foot traffic, and had an interesting experiment tried, by grinding together with sharp sand and water a terra-cotta tile, twelve inches square, and a similar piece of York stone. The friction was continued for five hours, at the end of which it was found that the terra-cotta tile had lost one-sixteenth of an inch in thickness, while the hard York stone had lost one quarter of an inch. Tiles were adopted, and after having stood the wear of six or seven years in as busy a thoroughfare as any in London, are reported by Mr. Barry, in his paper, to show no serious signs of wear. Mr. Barry also says: "If made now (1871), they would, however, be pressed by machinery, and be much harder and more durable" (Paper read before the Royal Institute of British Architects, by Charles Barry).

Innumerable other examples might be cited, proving the superior durability of terra-cotta for building, as well as for ornamental purposes, but the few cases referred to seem to us sufficient. It is a fact beyond dispute that in faithfully-made and well-burnt terra-cotta, we have the great and only lasting triumph of man over natural productions.

For timber will rot; stone, even granite, will disintegrate; iron will oxidize: these and all other materials will succumb to the action of fire; but properly made and thoroughly burnt terracotta will pass through centuries, and be the last to yield to those influences to which all natural productions must give way—the only material known which is not only absolutely fire-proof, but also in all architectural employments, practically time proof and indestructible.

We cannot pay a more eloquent tribute to the durability of terra-cotta than by quoting a few sentences from Sir Charles Lyell's "Antiquity of Man." He says, in his third chapter: "In the vast changes that this planet has undergone, few things remain to mark the arts of its earlier inhabitants. Flints, spear-heads, arrow-heads, fragments of iron, of bronze and of pottery are almost all that remain. Of the latter, burnt bricks, jars, vases, the human figure in burnt clay, are found in the remains of submerged towns in the channels of the Nile, and in Upper Egypt, in the Mexican buried ruins of America and elsewhere, as the enduring types of civilization of peoples and races whose names even are not known in the pages of history. Granite disintegrates and crumbles into particles of mica, quartz and feldspar. Marble soon moulders into dust of carbonate of lime, but hard, well-burnt clay endures for ever in the ancient landmarks of mankind." It would be very interesting to trace the steady growth of the builder's art from the mud hut of primeval times to the magnificent structure of the present day. In the first days of the human race, with forests almost untouched, and the necessity to clear the same for the cultivation of the ground, wood was almost universally used for building purposes. As the forests became exhausted, wood gave place to clay, to stone and to iron. As the cities grew in size, and land became more valuable, buildings were squeezed in closer together, and the danger from fire constantly increased. Architects and builders were thus led to pay more attention in construction to the use of imperishable material. Necessity creates a demand, and it became a necessity to construct large buildings and high buildings. Not less necessary was it that these buildings should be indestructible. The use of stone, for many years so common and universal, was found by experience to be not only expensive but dangerous. The difficulty of obtaining a really durable building stone, and the practical experience required in its selection, is well known to architects.

"In erecting large buildings," says Mr. Arthur Beckwith, "it is difficult to supply quickly enough stone of a durable quality from one quarry. Nearly all stone is not fire-proof, but cracks when exposed to high heat. These causes, without deprecating the use of stone,

point to the desirability of finding a durable fire-proof building material which can be relied on always and be supplied in large quantities. This presents an opening for the use of terra-cotta—a material which has stood the crucial test of firing. The true qualities of terracotta in its application to architecture consist in its merits as a decorative fire-proof material, possessing the three essentials of color, durability and economy. When treated with due regard to construction, so as to fulfill its part in the building as honestly as the brick-work of the wall itself, the high capacities of the material to receive artistic treatment admit of the impress of original art being reproduced for the uses of the architect, in an almost imperishable substance" (Report on the Terra-cottas at the International Exhibition at London, 1871, pages 51 and 52).

The great fires of Chicago and Boston, which occurred shortly after the above lines were written, bore conclusive testimony as to the accuracy and wisdom of Mr. Beckwith's observations. It is an astonishing statistical fact that eight per cent, of all the buildings erected in this country are sooner or later destroyed by fire. Public safety, as well as economy, is fast demanding that buildings should be constructed of non-combustible material. These facts, together with the late changes in the solidity of buildings, have notably favored the introduction and increased use of architectural terra-cotta. Well-made and thoroughly burnt clay is the only material thus far discovered which is absolutely indestructible by fire, and which has opposed all the other elements with the desired obstinacy. In this respect, terra-cotta possesses an element of strength which is not shared either by stone or iron. Heat which would disintegrate stone or fuse iron has merely the effect of rejuvenating terra-cotta, and giving it the bright, fresh appearance of having just left the kiln. Having passed through, in burning, a heat of over 2,800 degrees Fahrenheit, or the degree at which soft iron fuses, no heat to which terra-cotta is ever likely to be exposed, even amidst the fiercest flames of a Boston or Chicago fire, is able to affect it.

The strength of well-made terra-cotta is surprising. The following table has been prepared from tests made, and is a safe guide as to the approximate strength of terra-cotta properly moulded and burned, and also for the stones commonly used for building purposes. By this table it may be seen that the crushing strength of all kinds of terra-cotta is sufficiently great to meet all the probable requirements in that direction.

CRUSHING WT.

PER CU. IN.

1. Terra-cotta not exceeding 20% hollow space,

6,000 lbs

2.	"	"	30%	"	"	5,000 "	
3.	"	"	40%	"	"	4,000 "	
4.	"	"	50%	"	"	3,000 "	
BRICK.						CRUSHING	
WT.							PER
CU. IN.							

1.	Extra hard machine stock brick	-	-			8,000 lbs.
2.	Medium hard machine stock brick	-	-			4,000 "
3.	Extra hard common hand-made brick	-				3,000 "
4.	Medium hard common hand-made brick	-				2,000 "

STONE.						CRUSHING	
WT.							PER
CU. IN.							

1.	Quincy granite (hardest)	-	-	-	-	15,000 "
2.	Pennsylvania marble (hardest)	-	-	-		8,000 "
3.	Sandstone (strongest)		-			5,000 "
4.	Sandstone (common)	-				3,000 "

Terra-cotta for building purposes is generally made of hollow blocks formed with webs inside, so as to give extra strength and keep the work true while drying. This is necessitated because good, well-burned terra-cotta cannot safely be made of more than about 1¹ inches in thickness, whereas, when required to bond with brick-work, it must be at least four inches thick. When extra strength is needed, these hollow spaces are filled with concrete, which greatly increases the crushing strength of terra-cotta, although alone it is able to bear a very heavy weight. A solid block of terra-cotta of one foot cube has borne a crushing strain of 500 tons and over.

Some exhaustive experiments, made by the Royal Institute of British Architects, are shown in the following table:

CRUSHING WT.						
PER CU. FT.						
1.	Solid block of terra-cotta	-	-	-	-	523 tons
2.	Block of Portland stone	-				292 "
3.	Hollow block of terra-cotta, unfilled	-			-	186 "
4.	Block of Bath stone	-	-	-	-	104 "
5.	Stock brick	-	-	-	-	82 "
6.	Hollow block of terra-cotta, slightly made and unfilled	-	-	-	-	80 "

Tests of terra-cotta manufactured by the New York Company, which were made in New York, in April, 1888, by the Stevens Institute of Technology, gave the following results:

CRUSHING WT. CRUSHING WT.

PER CU. IN. PER CU. FT.

Terra-cotta block, 2-inch square, red,	6,840 lbs.	or	492 tons
Terra-cotta block, 2-inch square, buff,	6,236 "	"	449 "
Terra-cotta block, 2-inch square, gray,	5,126 "	"	369 "

Another important practical question is that of the comparative weight of stone and terra-cotta, and consequently of the comparative cost of transportation. With terra-cotta, unlike stone, no unnecessary or dead weight has to be carried. Stone is brought to the building in masses and there worked up, and the necessary quantity of waste makes an alarming amount of useless weight which has to be transported. With terra-cotta, on the other hand, where the work is necessarily modeled in the workshops and studios of the manufacturer, and moreover is (for evenness in burning) made of moderate thickness and hollow, the weight to be conveyed is reduced to a minimum, and the work, having been fitted previous to shipment, once at the building, nothing remains but to set it in its proper place.

From the following table it will be noted that, as compared with the ordinary building stones, terracotta weighs considerably less than half as much:

WEIGHT PER CU. FT.

Quincy granite	- - - - -	168 lbs.
Sandstone	- - - - -	103 to 176 "
Ohio or Buenavista stone	- - - - -	144 "
Terra-cotta (solid block)	- - - - -	122 "
Terra-cotta, in hollow cubes, 1 1/2 inch thick, as usually manufactured	- - - - -	68 "