

CINTEC

TERRA COTTA SOLUTIONS



Cintec, working with North American Architects, Engineers, Preservation Consultants and Contractors to provide specialized fixings for Terra Cotta repairs and re-attachment.

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CINTEC ANCHOR.

A SELECTION OF TYPICAL ANCHORING DETAILS FOR TERRA-COTTA

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This bulletin is intended to give a guide to the Cintec Designed Anchor System and is not intended to be fully comprehensive. Cintec in North America, on behalf of itself, its employees, or agents excludes any or all liability what so ever arising directly or indirectly from the use of this bulletin or the Cintec Anchoring System is so far as the exclusion is permitted by Federal or State Law.

Acknowledgements

Cintec would like to thank and acknowledge the help and assistance of **John A. Fidler, RIBA**, Consultant, Preservation Technology, Simpson Gumpertz & Herger Inc Consulting Engineers Los Angeles. **Richard McGuire, PE**, Structural Engineering Associates, Kansas City ,Missouri ,**James W Rhodes, FAIA**, Preservation Design, Croton-on-Hudson NY ,**Philip [Pete] Pederson** ,Gladding Mc Bean ,CA. and all the other Engineers and Architects who have contributed to this bulletin.

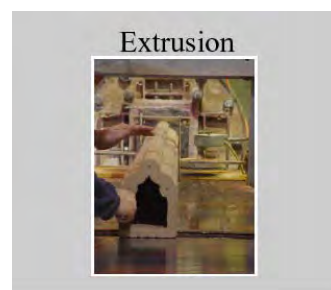
FOR ENGINEERING ASSISTANCE FOR PROJECTS VIA E-MAIL CONTACT US
AT engineers@cintec.com



SECURING THE PAST FOR THE FUTURE

What is Terra-Cotta?

The definition of terra-cotta refers to a high grade of often blended, weathered or aged clay which, when mixed with sand or pulverized fired clay is called “grog”. This can be molded and fired at high temperatures to a hardness and compactness not obtainable with brick. A class A Engineering brick as found in the UK and best red terra-cotta would not be far apart. The word terra-cotta is derived from the Latin word terra-cotta—literally; “cooked earth” terra-cotta clays vary widely in color according to geography and types, ranging from red and brown to white. Historically, the color of the terracotta was a very good indication of the overall properties of the material because the color of the clay determined the final color and certain clay types could only be fired at certain temperatures in order to achieve those colors. For example, the reds and deep browns were made from Fire Clay and were able to be baked at high temperatures to provide the strongest, least porous terracotta. At the other extreme, the light brown/buff terracotta was made using a kaolinitic clay which had to be burnt at low temperatures and thus was relatively weak and porous. By the 1900s englobe **[Liquid clay dip or spray applied as finish coating then fired to provide a different colour to underbody or biscuit Sometimes known as slip glaze. Differs from lead, tin and other clear glazes that add gloss to underbody]**finishes were being applied to mimic stones etc and so the color indications no longer worked because the slip glaze finish could be designed in any color. . Terra-cotta is usually hollow cast with several means of manufacture: “hand-pressed” into plaster moulds; molded by hand; extruded and slip cast blocks which are open to the back, like boxes, with internal compartment-like stiffeners called webbing. Webbing substantially strengthens the load-bearing capacity of the hollow terra-cotta block without greatly increasing its weight, but not always. It certainly stiffens the wet clay while drying, but are often undercut near the walls

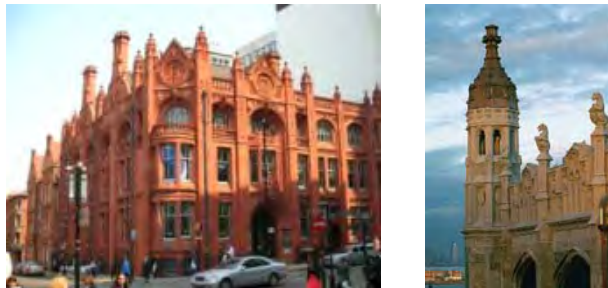


Terra-cotta blocks are often finished with a glaze; that is, a slip glaze (clay wash) or englobe finish applied before firing. Glazing changed the color, imitated different finishes, and produced a relatively impervious surface on the weathering properties when properly maintained. It had rich color and provided a hard surface that was not easily chipped off. Glazing offered unlimited, fade-resistant colors to the designer. Even today, few building materials can match the glazes on terra-cotta for the range and, most importantly, the durability of colors. Poor “glaze fit” would mean crazing and flaking

glaze.

Glazed architectural terra-cotta has many material properties similar to brick or stone. It also has many material properties radically different from traditional masonry materials. It is those differences which must be considered for a better understanding of some of the material characteristics of glazed architectural terra-cotta when it is used as a building material. Terra Cotta has a relatively high compressive strength but weak in shear and tension, especially from forces exerted by corroding ironwork.

Glazed architectural terra-cotta probably comprises one of the largest if not the largest constituent material in some urban environments today. However, the infinite varieties of glazing have hidden this fact from the casual observer. One of the attractive features of glazed architectural terra-cotta in its time was that it could be finished (glazed) in exact imitation of stone. In fact, many professionals are often surprised to discover that what they presumed to be a granite or limestone building is glazed architectural terra-cotta instead.



Deterioration:

Deterioration is, infinitely complex - - particularly when glazed architectural terra-cotta has been used as a cladding material.

Deterioration creates a “domino” like breakdown of the whole system: glazed units, mortar, metal anchors, and masonry backfill. In no other masonry system is material failure potentially so complicated.

The root of deterioration in glazed architectural terra-cotta systems often lies in a misapplication of the material. Historically, glazed architectural terra-cotta was viewed as a highly waterproof system needing neither flashing, weep holes nor drips. This supposition, however has proved to be untrue, as a serious water-related failure was evident early in the life of many glazed architectural terra-cotta clad or detailed buildings.

No one case of deterioration in glazed architectural terra-cotta is ever identical to another owing to the infinite number of variations with the material: original manufacture, original installation

inconsistencies, number of component parts, ongoing repairs or the various types and sources of deterioration. However, certain general statements may be made on the nature of glazed architectural terra-cotta deterioration.

As with most building conservation and rehabilitation problems, water is a principal source of deterioration in glazed architectural terra-cotta. Terra-cotta systems are highly susceptible to such complex water-related deterioration problems as glaze crazing, glaze spalling and material loss, missing masonry units and DETERIORATED METAL ANCHORING, among others.



Fig 1
Example of steel beam corrosion causing failure of the decorative terra cotta facade.



Fig. 2 - Corroded restraint fixing

Deterioration of Metal Anchoring:

Deteriorated anchoring systems are perhaps the most difficult form of glazed architectural terra-cotta deterioration to locate or diagnose. Often, the damage must be severe and irreparable before it is noticed. Water which enters the glazed architectural terra-cotta system can rust the anchoring system and substantially weaken or completely disintegrate those elements. Total deterioration and the lack of any anchoring system may result in the loosening of the units themselves, threatening the architectural or structural integrity of the building. Recently, falling glazed architectural terra-cotta units have become a serious safety concern to many building owners and municipal governments. Early detection of failing anchoring systems is very difficult.

Repairs to Deteriorated Anchors and Iron Work:

The source of moisture must be determined and rectified to mitigate further corrosion of the anchors and original iron work. Serious consideration should also be given to stabilizing the original iron work and anchors which will continue to rust and jack even if no longer performing any structural service. One way to deal with this problem is to use Cathodic / Impressed current protection.

CINTEC TERRACOTTA SOLUTIONS WHAT IS TERRA-COTTA ?

- Best Use**
- ▲ Use to stop corrosion
 - ▲ Heavily reinforced elements
 - ▲ Deeply embedded steel
 - ▲ Aggressive environments
 - ▲ High chloride environments
 - ▲ Beams and columns
 - ▲ Historical steel frame buildings, generally built between 1900 and 1950
 - ▲ Provides very long service life



The Cintec anchors as shown in this manual are all fabricated from stainless steel Grade 304 or 316 depending upon site location and conditions. The anchors can be installed from either the inside of the building or from the exterior face again depending upon site conditions.

If the application is from the outside face of the terra-cotta consideration must be given to patching the drilled holes and the adjacent spalled areas. The project conservator/architect will advise on the most suitable product to use.

SPECIAL NOTE

CINTEC'S PURPOSE IS NEVER TO STABILIZE LESS THAN SATISFACTORY TERRA COTTA , EITHER FRACTURED OR WITH A POOR GLAZE CONDITION . IT IS ONLY MEANT TO STABILIZE SOUND TERRA COTTA PIECES WHOSE ANCHORAGE HAS FAILED OR IS ABOUT TO FAIL, TYPICALLY DUE TO CORROSION , BUT WHICH HAS NOT CAUSED RUST JACKING TO THE POINT OF TERRA COTTA FRACTURE.

Enhanced Fixing Technology For Terra Cotta and Hollow Masonry Units



• The Cintec anchor is inserted into a predrilled hole.
• El ancla Cintec es introducido en el orificio taladrado.



• The injection equipment is attached to the anchor and inflation commences under a pressure of 42PSI.
• El equipo para inyección es fijado a el ancla y comienza a inflar a una presión de 42 P.S.I.

• Grout is pumped into the hollow steel section which flows into the socked area via a number of flood holes.
• El cemento se bombea en la secciones huecas de las estructuras de acero para fluir en los varios agujeros para inyección de el forro.



• As the anchor fills, grout milk flows through the sock creating a chemical bond between anchor and substrate.
• Cuando el ancla se llena, la lechada de cemento penetra el forro y forma una alianza química con el ancla y el substrato.

• After approximately 15 seconds the anchor is totally inflated with a micro fine concrete grout giving a mechanical fixing. In addition the grout milk has passed through the sock forming a chemical bond to the substrate.
• Aproximativamente 15 segundos más tarde el ancla esta totalmente llena de concreto micro fino que produce una fijación mecánica. Entre otras la lechada de cemento penetra el forro y forma una alianza química con el ancla y el substrato.



• In a test carried out by an independent laboratory on a building of similar material, axial pull results in excess of 3000lbs. were achieved.
• Los ensayos efectuados sobre una construcción de materiales homogéneos por laboratorios independientes compilaron resultados más allá de 3000 lbs sobre la tensión axial.



DESIGNED ANCHOR SYSTEMS FOR THE CONSTRUCTION INDUSTRY

Engineering Design for Terra Cotta Repairs and Stabilization

Terra Cotta (TC) sections appear to be fragile and brittle. However the material itself is strong.

This is borne out by the fact that our historic terra cotta is not deteriorating faster, and most deterioration is caused by factors external the units themselves.

ASTM C67 specifies a minimum compressive strength of 6,000 psi, shear strength of 1,500 psi and a glaze adhesion bond of 1,200 psi for new terra cotta units.

We believe that the historic terra cotta elements found in North America will meet or exceed these values.

The challenge lies in the thin walls of the units. Minimum face thickness is 1" according to good practice.

The cross walls or webs are another matter. We find that 1/2" is typical and recommend this value as a maximum if site verification is not possible.

The most common failure modes are:

1. cracking due to oxide jacking of embedded or adjacent metals.
2. loss of support and attachment due to corrosion of attachments.

The most common details we are asked to deal with on historic terra cotta facades are very similar to Plates 25, 26 and 27 of the National Terra Cotta Society manual which now forms part of Cintec's North American Terra Cotta Solutions manual.

In these details the corbelled or cantilevered TC cornice has come loose from its fastenings, which have been lost to corrosion.

The solution as overlaid on these plates is to add a cantilevered horizontal anchor into sound (minimum imbed is six inches) back up beyond the inner edge of the TC unit. These anchors then act as cantilever brackets, transferring the vertical load of the TC unit by bearing on the Cintec grout bulb formed within the hollow interior of the TC unit.

Any outward separation of the unit is arrested by the grout bulb within the void in the unit.

A second anchor is installed vertically to reattach the

dentil units under the main cantilevered unit. These units were typically attached by J bolts to the upper units. The J bolts are the first to corrode through and are usually the first sign that the cornice is failing.

Full scale testing was performed on a similar TC unit taken from a High School in New York. The bond of the grout bulb on the inside faces of the TC unit, and the mechanical keying of the expanded grout bulb within the void allowed the anchor to develop sufficient transfer of load to fail the TC unit in diagonal tension in the top and bottom faces. The anchor and its bond remained intact after failure.

The load was applied in tension to the anchor at the back face of the unit, away from the unit. A testing bridge was used to ensure that the load was transferred to the TC unit. The failure load was 4,600 pounds.

When the shell of a TC unit must be relied on to transfer a load, typically pull out, diagonal tension within the shell is calculated to determine the cone failure load. We typically use 10 psi unfactored (allowable) for this value. This is very conservative in view of the high compressive strength these units provide. But caution is warranted because of the thin sections. The strength of the original units can be reduced near corners and thicker decorations where firing of the clay may not be uniform.

The thin sections around a hole drilled for the anchors may also be damaged by the drilling. Years of experience have proven that air cooled dry diamond core drilling should exclusively be used. Hammer drilling will put more stress on the TC section, causing spalling on the back web of the section and can cause fracture cracks.

The above deals with reattaching existing TC units in place.

Cintec has developed solutions for anchoring one or more new TC units within a line of existing units where a TC unit has to be replaced. See Cintec's North American Terra Cotta Manual or www.cintec.com

**For additional information please contact
1 613 225 3381 / 1 800 363 6066 or review
more information at www.cintec.com**

Fire Rating

Cintec anchors are fire resistant

Building Research EstablishmentGarston Watford WD2 7JR
Telephone 0923 894040 Telex 923220 Fax 0923 664010Direct line 0923 66-
GTN 3532Mr. J. Dymmock
Cavity Lock System
Factory Road
Newport
Gwent
NP9 5FA

your reference

our reference

BRE/67/50/1

date

23/11/93

Sent by FAX to : 0633 246110

Dear John

Fire testing of the Cintec remedial cavity wall ties.

In the latest test in our fire test rig with a static dead load on each tie of 1.3kN your tie survived a two hour test without failure of any of the three replicate samples.

All three samples are now placed in the upper half of the wall and would have reached several hundred degrees in the part of the tie nearest the fire face.

This indicates that this tie system can, when installed using the correct techniques, be recommended for repair work to buildings having a fire period requirement of up to 2hrs.

Yours sincerely



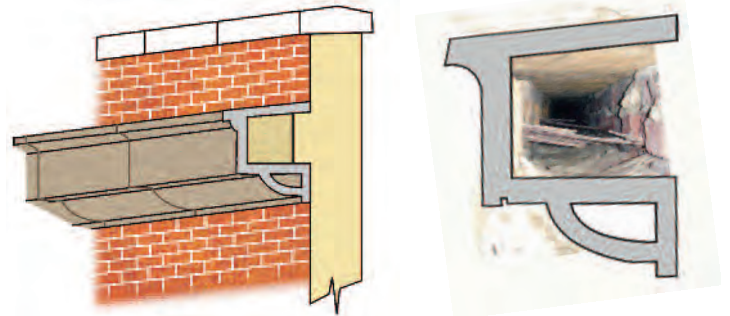
R.C. de Vekey

Head of Masonry Structures Section, Structural Design Division, Geotechnics and Structures Group

Inside Detail on Terra Cotta Repairs and Stabilization



SITE PHOTO



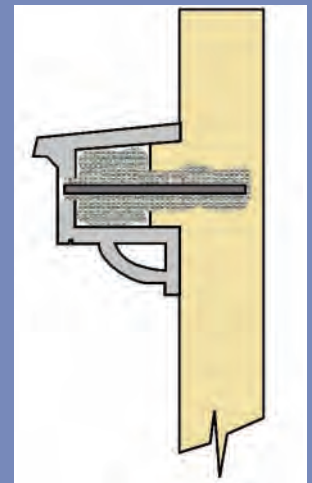
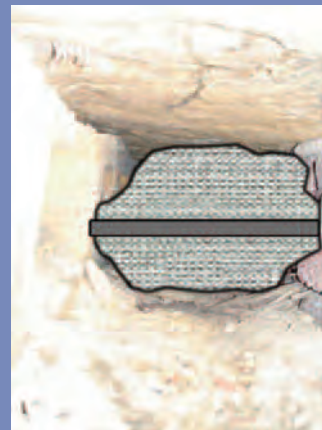
AS FOUND

Over time the steel hangers that hold back the terra cotta corrode. When this happens you have the potential for sections, or pieces, of the terra cotta to fall off the structure. The challenge is how to secure the new pieces to the existing facade, or how to stabilize the existing. Cintec has designed a stainless steel anchoring system that is compatible with the terra cotta and the substrate. The system has a 2 hour plus fire rating and can be installed to be invisible. There is no other anchor system, in the world, that offers this level of design flexibility.



AS FOUND

PROPOSAL FOR STABILIZATION



Proposed terra cotta design retrofit of the Union Station Power House in Kansas City, Missouri.

Design included by permission of SE of record Richard McGuire, PE, Structural Engineering Associates, Kansas City, Missouri.

Typical anchor detail Cintec M16 5/8th" Dia body 3" Dia sock set into 1 1/2" Dia hole subject to field conditions and requirements.

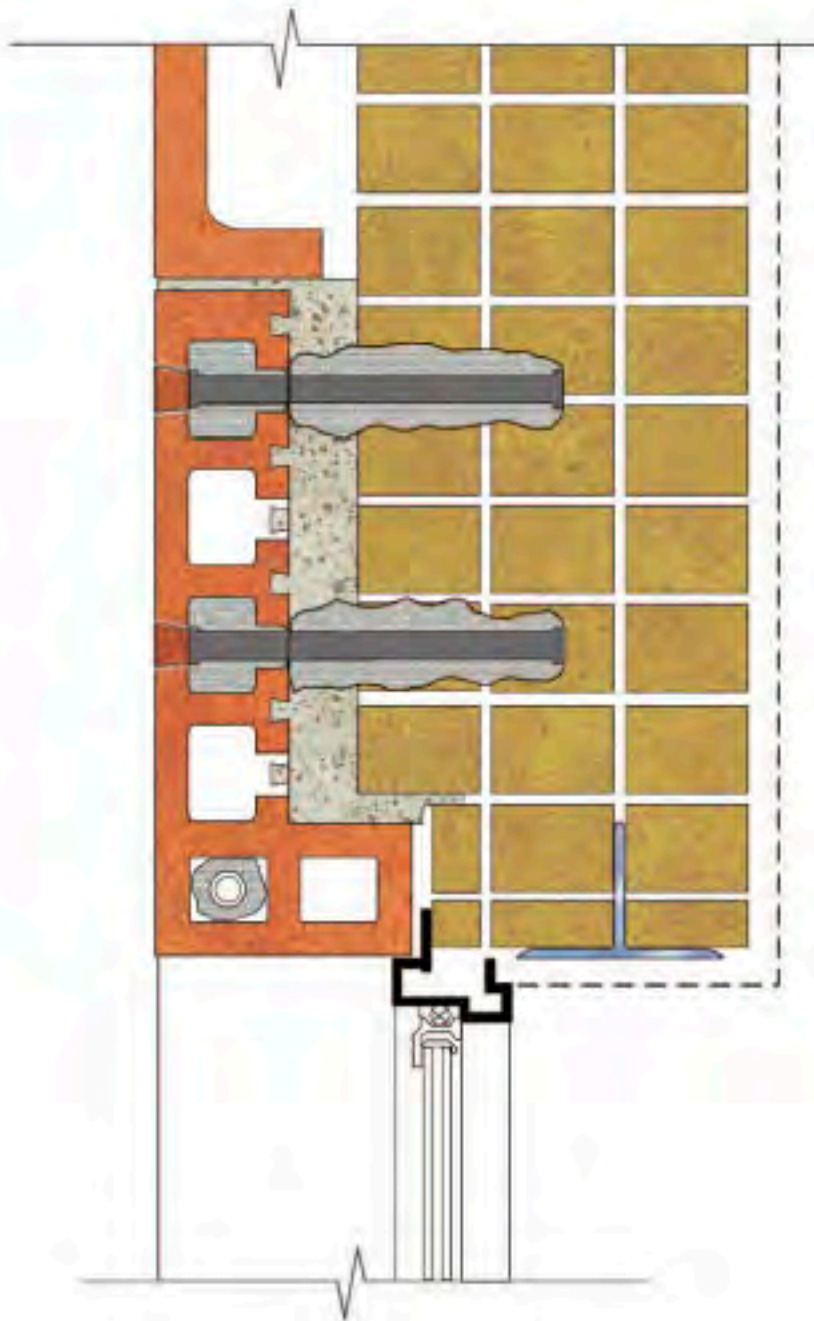


PLATE 1

FIXING TERRA COTTA CLADDING TO BRICK BACK UP

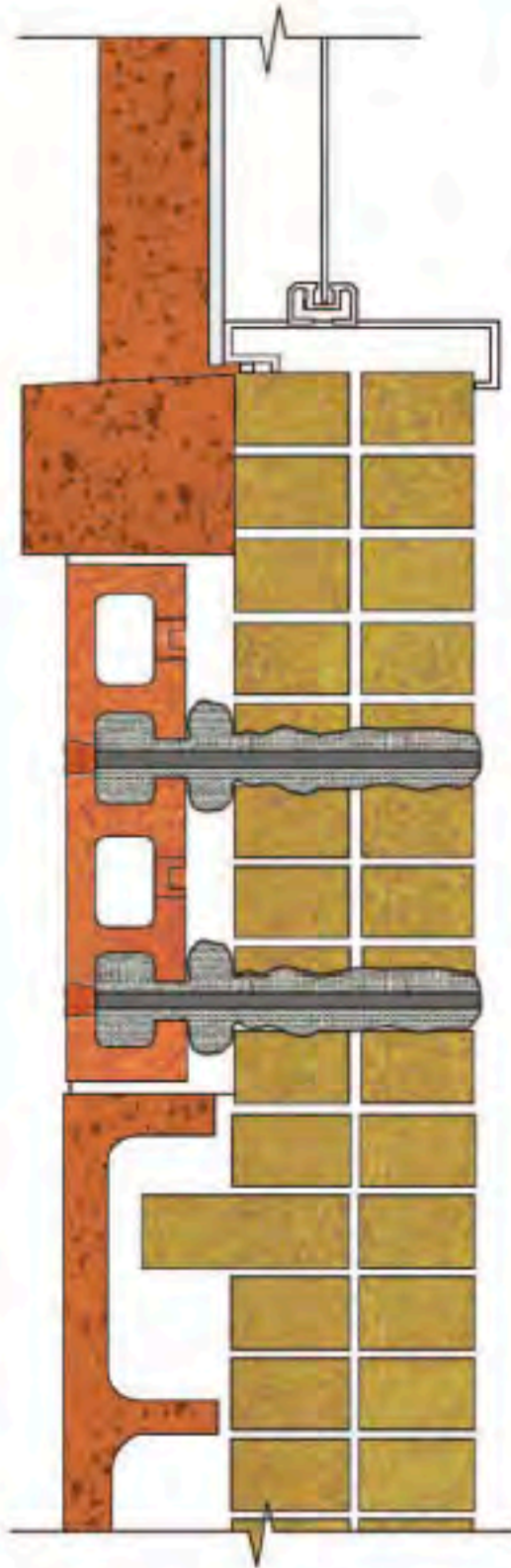


PLATE 2
FIXING TERRA COTTA CLADDING TO BRICK BACK UP WITH AIR GAP

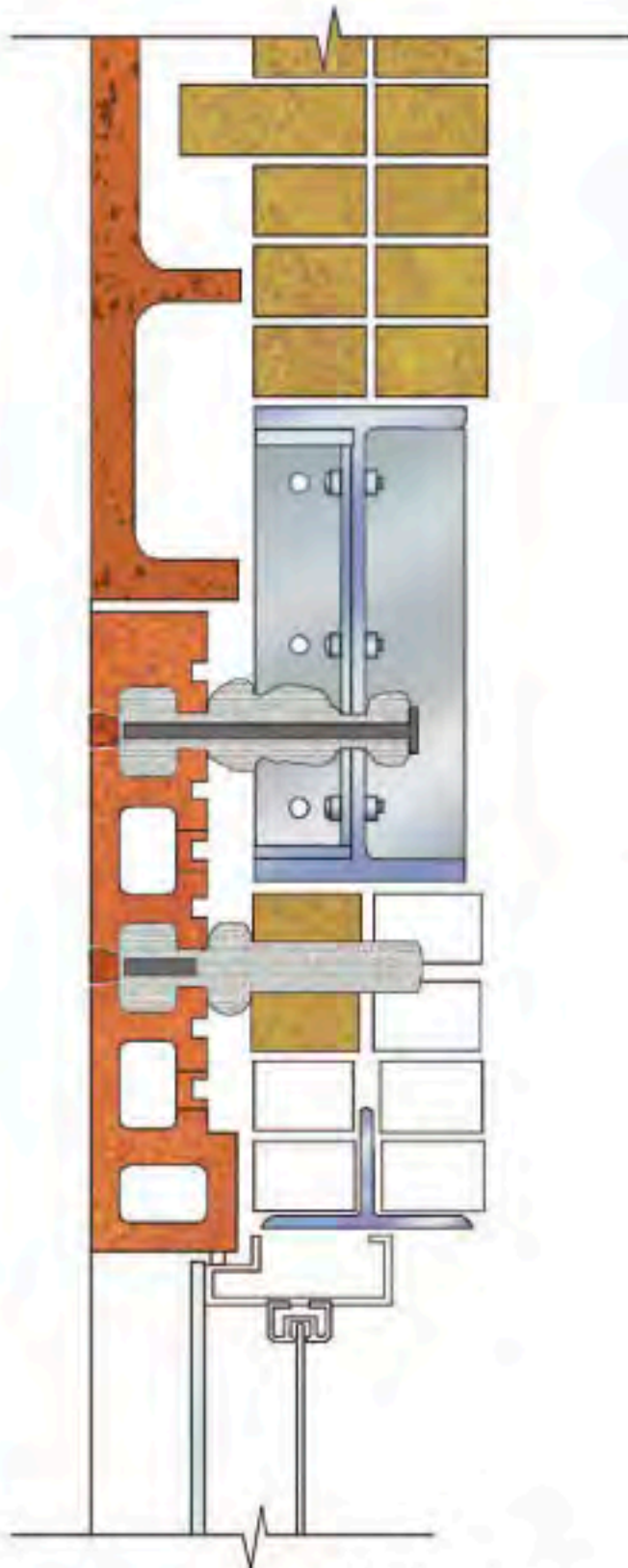


PLATE 3
FIXING TERRA COTTA CLADDING TO STEEL SPANDREL
AT WINDOW HEAD

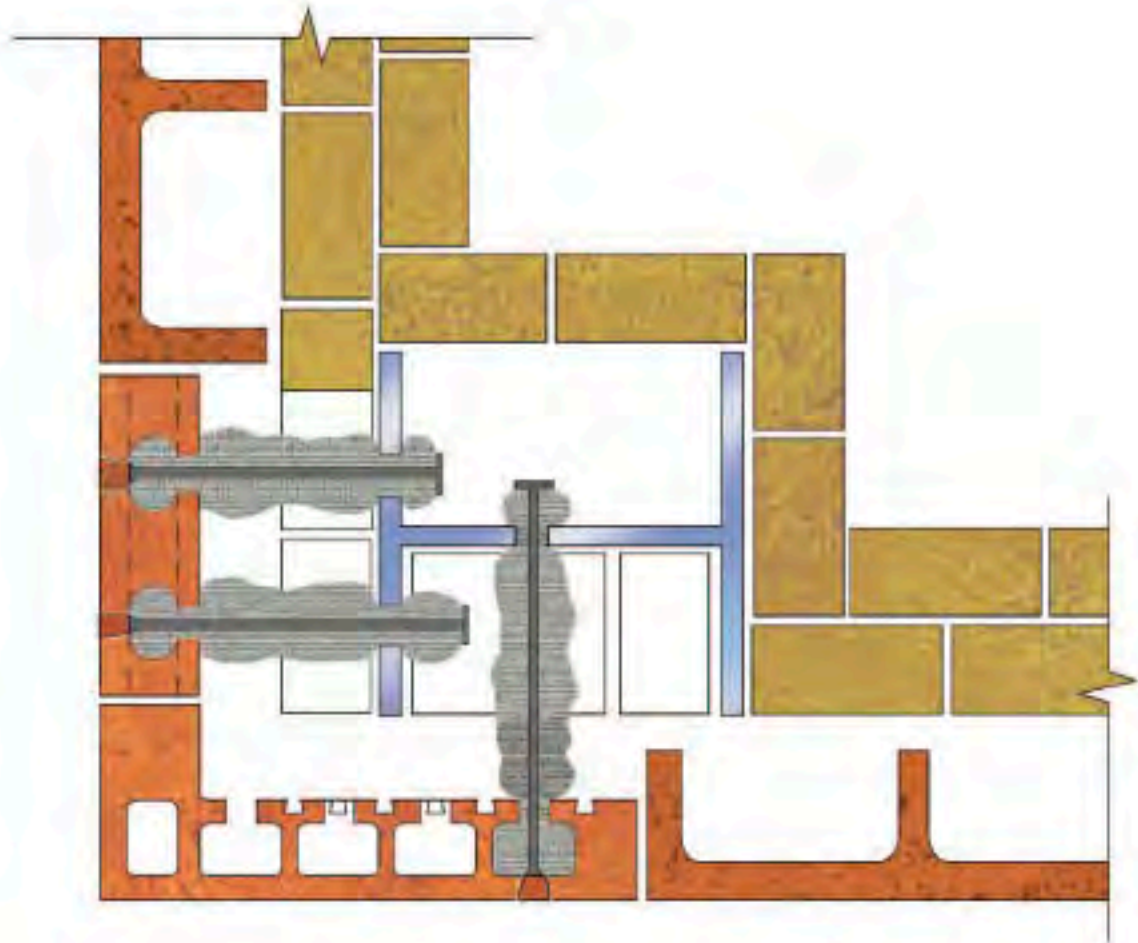


PLATE 4
FIXING TERRA CLADDING TO A STEEL COLUMN

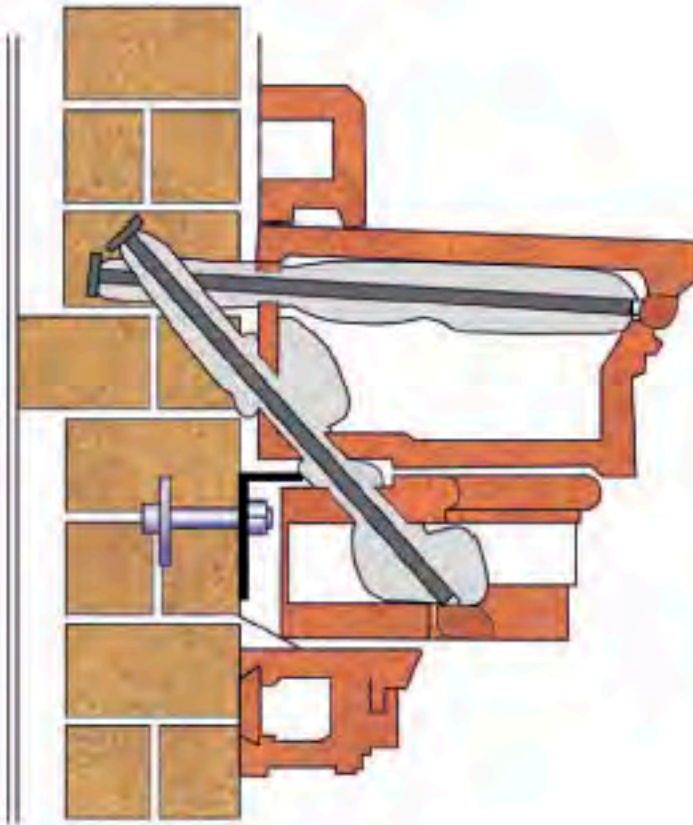


PLATE 5
FIXING TERRA COTTA CORNICE TO BRICK PARAPET

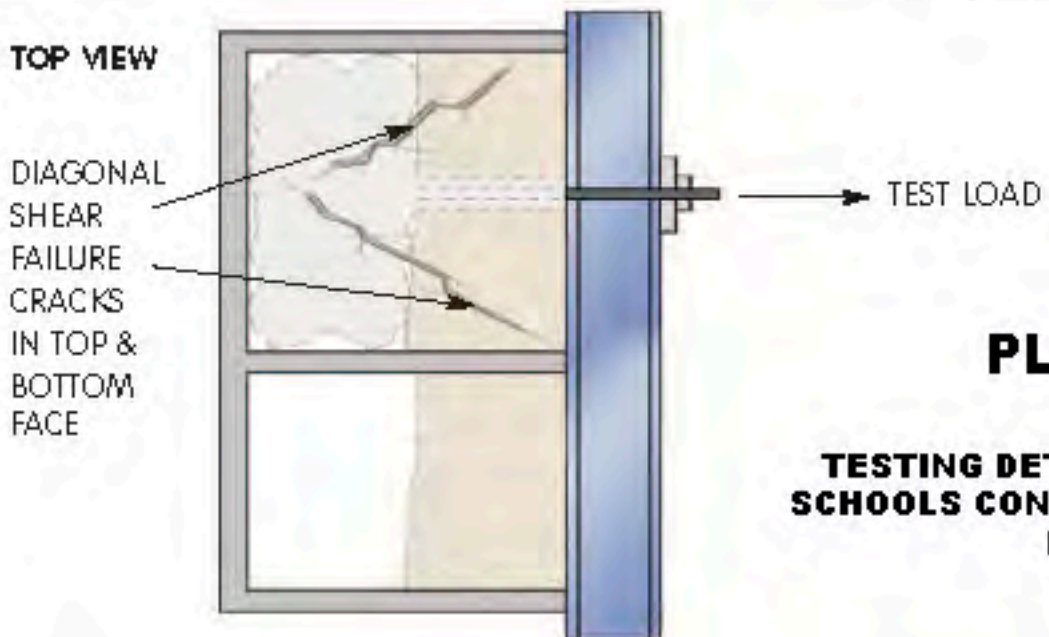
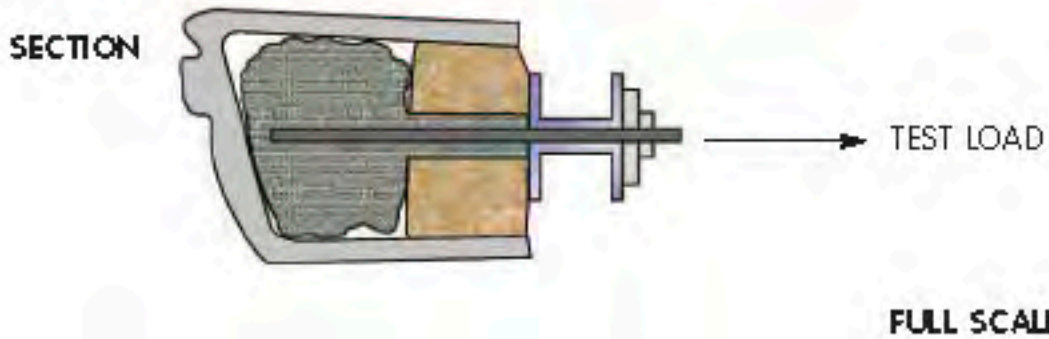
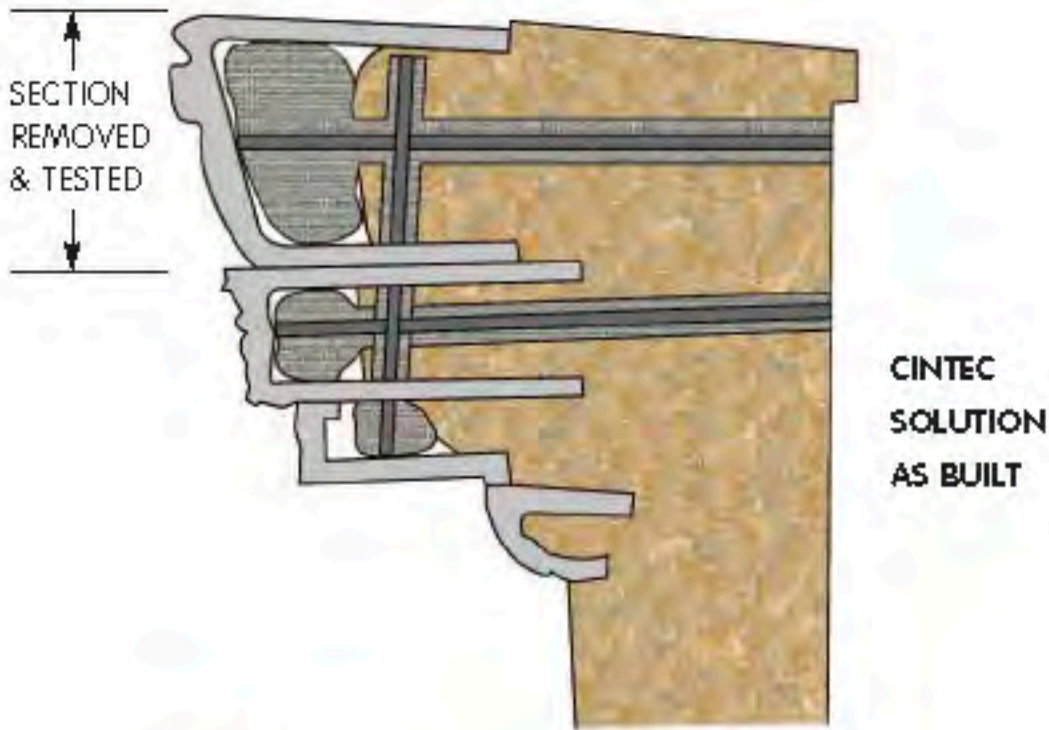


PLATE 6

**TESTING DETAILS FOR NEW YORK
SCHOOLS CONSTRUCTION AUTHORITY
PS 230 K**

ANCHOR INSTALLED IN 2 PARTS

TERRA COTTA DETAILS

Part one anchor is installed some 100mm into the existing brick backing. This may require some temporary jiggling to keep the anchors level!

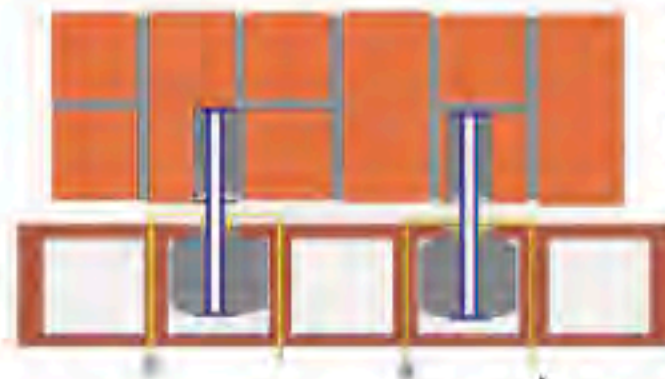
The Terra Cotta is set in place and fitted carefully over the outer end of the anchor and inflated with the flexible injection tube positioned through an existing mortar joint



SECTION

SHS stainless steel corbel anchors either 15 x 15 1.5 or 30 x 30mm dependent on load

SECTION



CONTROL SOCK

PLAN

INJECTION tube

DRILLED HOLE SIZE
15 x 15 mm in 40mm
30 x 30mm in 65mm

EMBEDDED DEPTH
dependent on load
and cavity size

SUBJECT TO INTERNATIONAL PATENTS AND COPYRIGHT

PLATE 7

Fixing New Terra Cotta to existing back up wall

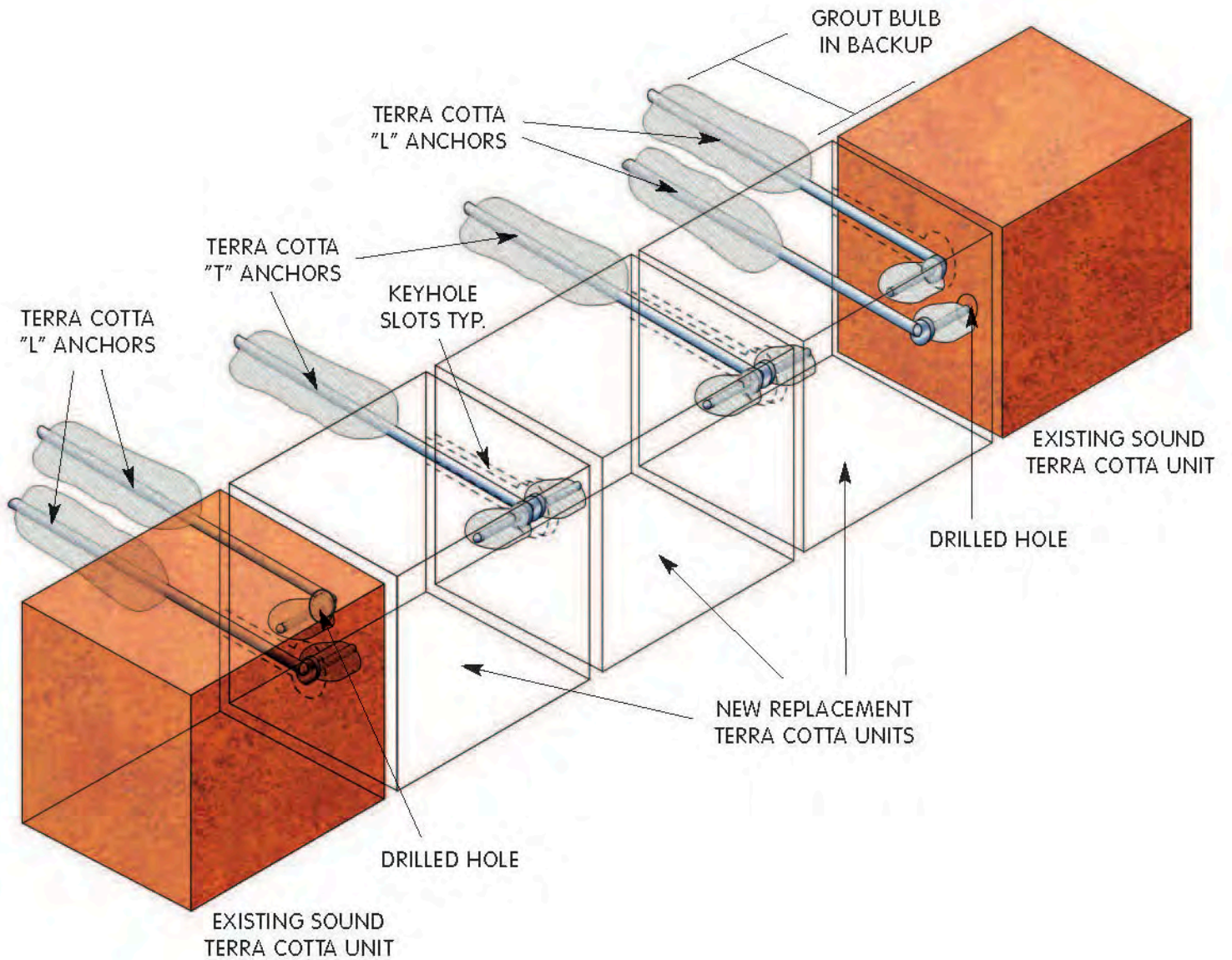


PLATE 8

INSERTING NEW TERRA COTTA UNITS BETWEEN EXISTING UNITS

Cintec repair details
base upon
TERRA COTTA

· STANDARD ·
CONSTRUCTION

REVISED EDITION

Cintec anchor type A

CINTEC STAINLESS STEEL (304) M10 ANCHOR

3/8"th dia body

2" diameter sock

***Set into a 1 1/2"
diameter hole***



Cintec anchor type B

CINTEC STAINLESS STEEL (304) M16 ANCHOR

5/8"th diameter body

3" diameter sock

***Set into a 1 1/2"
diameter hole***



NATIONAL
TERRA COTTA SOCIETY

19 WEST 84th STREET U · S · A NEW YORK, N. Y.

1927

*This manual provides general information for use in preliminary selection of a Cintec anchor.
Final designs must be prepared by Cintec and approved by the project Architect or Engineer of Record*

▲ ▲ ▲ ▲ **TERRA COTTA** ▲ ▲ **STANDARD CONSTRUCTION** ▲ ▲ ▲ ▲

Introduction

The present volume is a revision of Architectural Terra Cotta—Standard Construction, originally published in 1914.

Like the previous issue, this edition does not presume to suggest architectural design. It shows illustrative architectural forms of assumed proportions, and their proper constructional features. It shows the correct use of Terra Cotta. For a number of examples several good solutions of the structural problems are possible. Variations in size of similar sections sometimes necessitate radical changes in both jointing and construction.

The changes made in this revision are the result of a more extended experience in manufacturing and in modern building methods, and are based on a careful study of the behavior and weathering properties of exterior building materials.

The following are the most important of the structural principles upon which this revision has been developed:

- Shelf Supports* In concrete or steel frame buildings, the veneer or facing material should be fully and continuously supported, at each floor level on shelf supports, of adequate strength and stiffness, rigidly connected to the structural frame. Steel shelf angles or supports, in all cases, should be located in mortar joints. The strength of the Terra Cotta should not be unnecessarily reduced by cutting the webs to receive the steel.
- Expansion Joints* Proper provision should be made for expansion joints, at shelf supports, over column caps, etc., to prevent the development of disruptive stresses caused by deflection, wind pressure, temperature changes, settlement and like forces.
- Terra Cotta on Concrete Frames* The volume changes incident to the setting and hardening of concrete, and the variations in volume of concrete due to humidity and temperature conditions, require provisions to allow free movement of the supporting frame and make it undesirable to completely fill a facing applied to a concrete structure.
- Protection against Corrosion* Proper care should be exercised to prevent the corrosion of all steel supports, ties, etc. Where such protection cannot be permanently secured through encasement with mortar or concrete, or through the use of corrosion resistant metallic coatings, non-corrosive metals should be employed.
- Free-standing Construction* Exposed free-standing construction, subject to the absorption of water through mortar joints and liable to injury from subsequent freezing, or the expansion of improper filling material, should generally be left unfilled and should be ventilated by means of small, inconspicuously placed weep-holes (indicated by W. II. on the plates).
- Flashing and Drips* Properly constructed flashing should be provided to cover the top of large projecting horizontal courses, the backs and tops of parapet walls, wide-exposed sill courses, etc., and all projecting features should have drips.

▲ ▲ ▲ ▲ **TERRA COTTA** ▲ ▲ **STANDARD CONSTRUCTION** ▲ ▲ ▲ ▲

Terra Cotta

A brief synopsis of the manufacture of Terra Colla

- | | |
|-----------------------------------|--|
| <i>Drawings</i> | The architect's complete scale drawings and steel framing plans are furnished the manufacturer, who, following the design, makes scale shop drawings showing the jointing and construction, and full size details to the proper shrinkage dimensions. These drawings are submitted to the architect for approval before proceeding with the work. |
| <i>Models and Moulds</i> | Full size models to shrinkage scale are made of plaster for each different shape shown on the shop drawings. Over these models sectional moulds of plaster are cast, from which later the required number of pieces of Terra Cotta are produced. |
| <i>Decoration</i> | From the architect's drawings or sketches, in the style and period indicated, modelled ornament is applied in clay to the face of the plaster models. Photographs of the ornamental models are submitted to the architect for approval or he may personally examine these models at the factory—the soft clay permits of such corrections or improvements which may be desired. |
| <i>Clay</i> | The mixture of clays and fusible minerals used in forming the Terra Cotta is carefully selected and proportioned to give the desired degree of plasticity and a composition which, when fired at high temperatures, will produce a homogeneous body, amply strong to carry the required structural loads. |
| <i>Pressing</i> | The foregoing processes are preparatory to actual production, the first step of which is pressing. This is a manual operation and consists of pressing the plastic clay into the mould. The walls of the pieces should not be less than one inch thick, following the contour of the mould, and the partitions should be of such thickness and so spaced as to perform their proper functions with regard to form and structure. The pressed piece remains in the mould until the clay stiffens. It is then removed from the mould and is skillfully retouched. Then it is placed in driers, where the moisture is evaporated. |
| <i>Color</i> | From the drying process, the Terra Cotta passes into the spraying department where, by means of compressed air apparatus, the exposed surfaces are coated with the ceramic mixture which, during the firing process following, develops into the desired color or glaze.
These colors or glazes are prepared with scrupulous care, according to exact ceramic formulae. The variety of shades and textures which may be obtained opens up an unlimited field of permanent color design in architecture. |
| <i>Firing</i> | Following the coloring process, the Terra Cotta is fired in kilns where it is subjected to a temperature rising gradually to 2,000 degrees Fahrenheit or more, depending upon the temperature of maturity of the clay and glaze. After proper firing, the kiln is allowed to cool slowly to normal temperature, an operation that causes a slow annealing of the Terra Cotta.
Terra Cotta is usually fired in periodic muffle kilns. In recent years, the tunnel kiln has been developed for the firing of Terra Cotta. In the latter type of kiln the Terra Cotta is set or loaded on cars, which travel through a long heated tunnel. |
| <i>Fitting</i> | From the kiln, the Terra Cotta is removed to the fitting department, where it is laid out and marked to correspond with the piece numbers shown on the shop drawings. It is also marked to indicate the position it is to occupy in the building. Where required, the joints are squared, or cut to proper alignment and size, either by hand or grinding. Careful fitting is essential to assure satisfactory results in the erected Terra Cotta. |
| <i>Shipping</i> | For rail transportation, Terra Cotta is usually shipped in bulk, securely packed in hay and braced to prevent shifting.
Upon arrival at the building site, the hay should be removed and the Terra Cotta placed in the order marked, in piles on wooden strips.
For export by vessel, the Terra Cotta is usually packed in boxes or crates, according to the special conditions encountered. Another method that has been found to be economical and entirely satisfactory is to ship the Terra Cotta loose after it has been wrapped and tied in corrugated cardboard. |
| <i>Erection</i> | The appearance of erected Terra Cotta is greatly affected by inaccurate setting and defective pointing of the mortar joints. As the individual pieces of Terra Cotta have been carefully fitted and numbered to correspond with the erection drawings, the PIECES MUST BE ERECTED IN ACCORD WITH THE NUMBERS THEREON if satisfactory results are to be secured. |
| <i>Time</i> | The Terra Cotta manufacturer will contract to submit shop drawings for approval within a fixed time after receipt of the architect's drawings and other required information. All shipping dates are computed from the date of receipt by the manufacturer of architect's approval of shop drawings and complete data on color and texture desired. Work cannot be definitely scheduled for production until all essential information is on hand. The process of manufacture may take from six to ten weeks, depending upon the size and architectural character of the order. |
| <i>Specification and Contract</i> | A Standard Specification for the Manufacture, Furnishing and Setting of Terra Cotta and a standard form of contract have been adopted by the NATIONAL TERRA COTTA SOCIETY . They are recommended for general use. A copy of either may be secured by addressing the Society. The specifications are incorporated in this volume. |

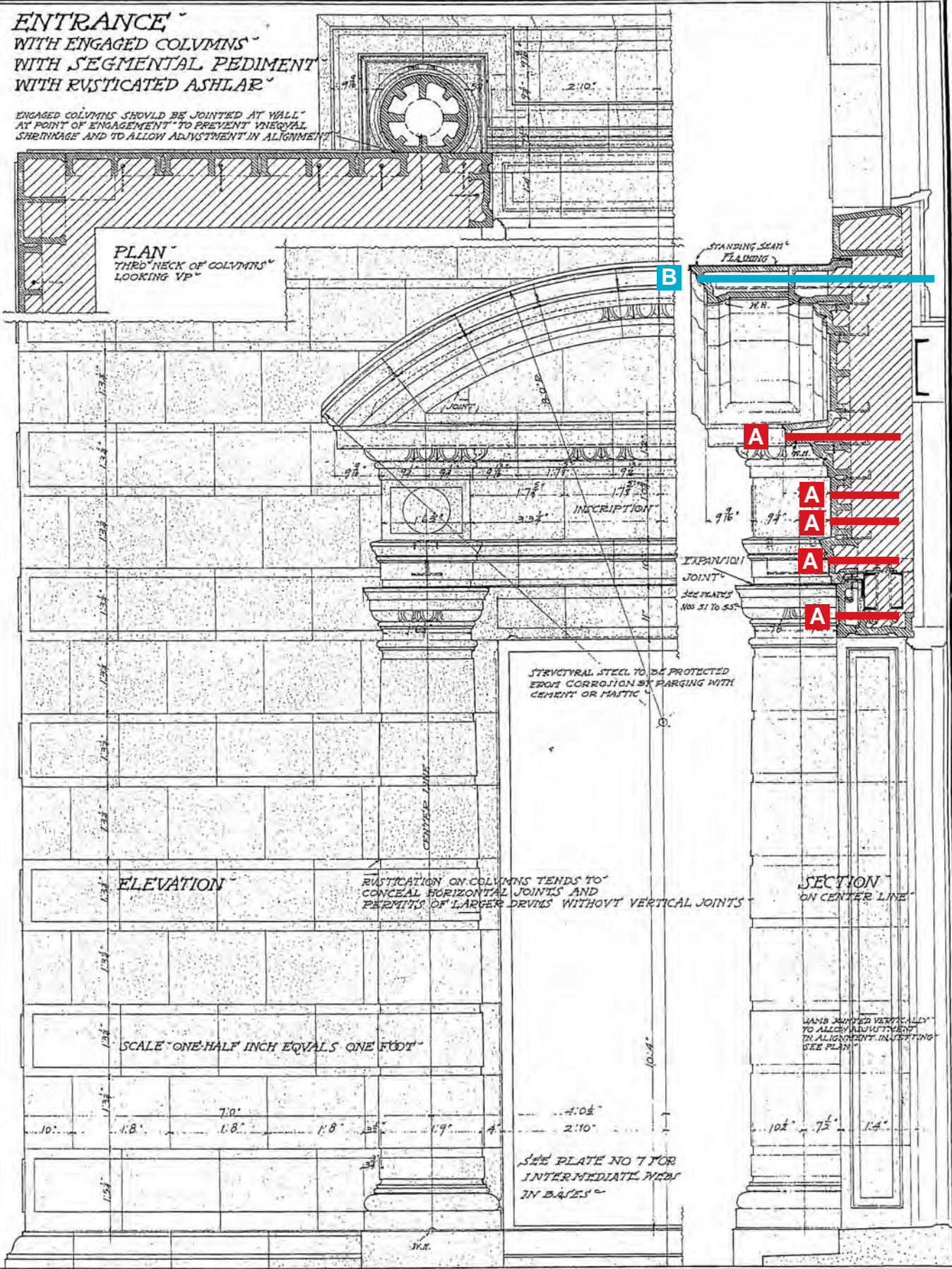
Terra Cotta factories are conveniently located in the Eastern, Central and Western sections of the United States (see list in back of this volume). All of the Society's membership will be glad to have any architect or designer interested in the processes of manufacture of Terra Colla visit their plants.

TERRA COTTA STANDARD CONSTRUCTION

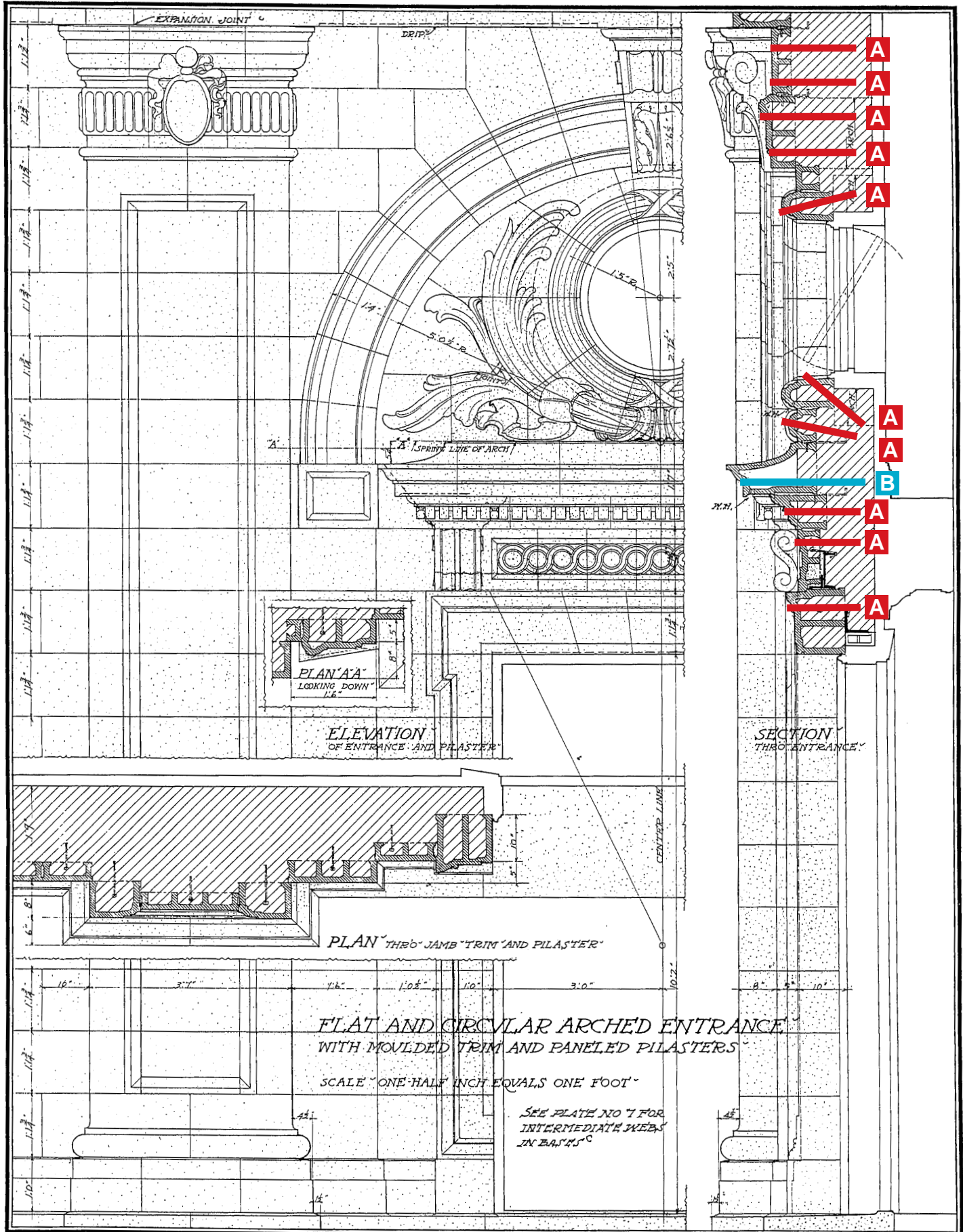
ENTRANCE
WITH ENGAGED COLUMNS
WITH SEGMENTAL PEDIMENT
WITH RUSTICATED ASHLAR

ENGAGED COLUMNS SHOULD BE JOINTED AT WALL AT POINT OF ENGAGEMENT TO PREVENT UNEQUAL SHRINKAGE AND TO ALLOW ADJUSTMENT IN ALIGNMENT

PLAN
THRU NECK OF COLUMN
LOOKING UP

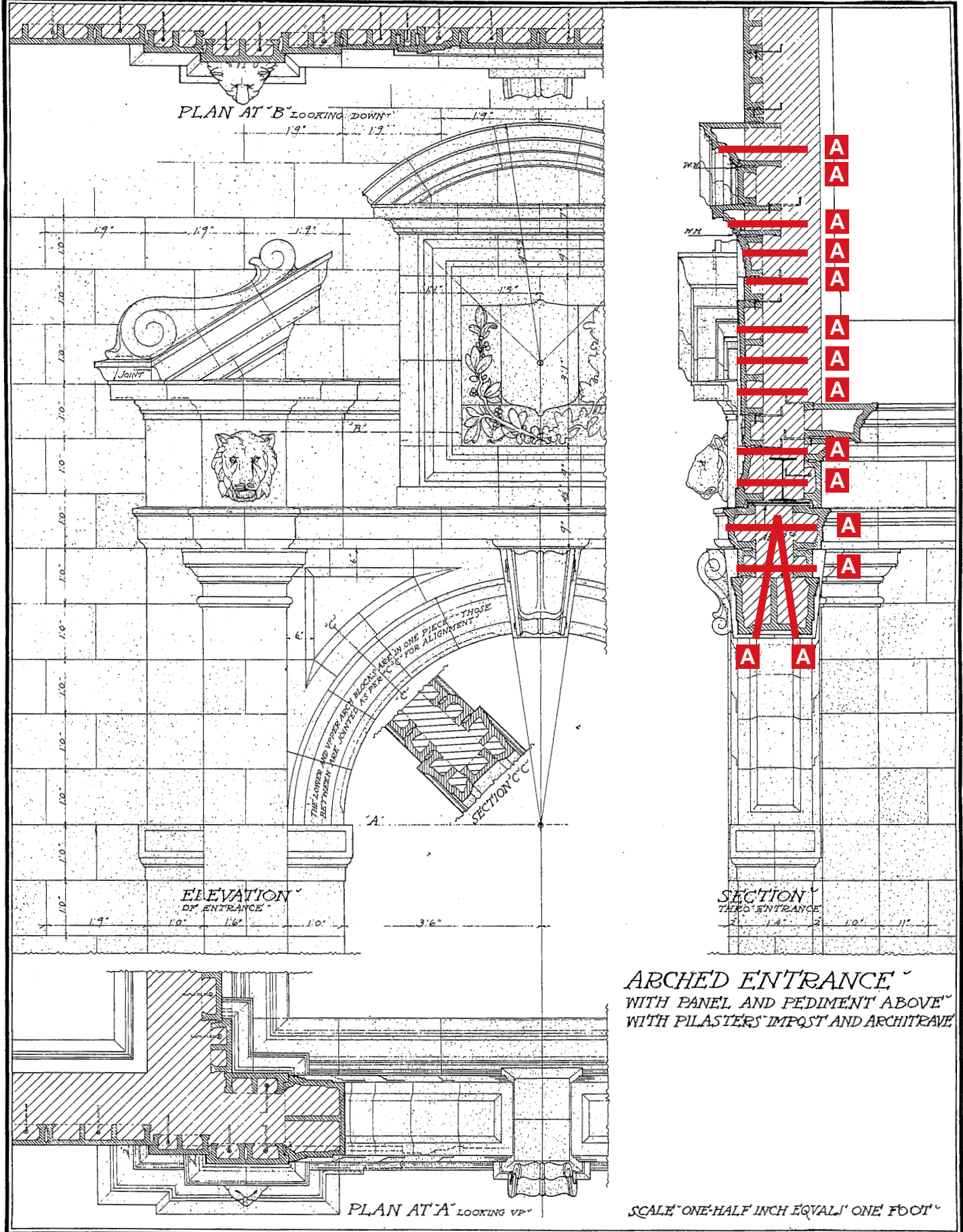


TERRA COTTA STANDARD CONSTRUCTION



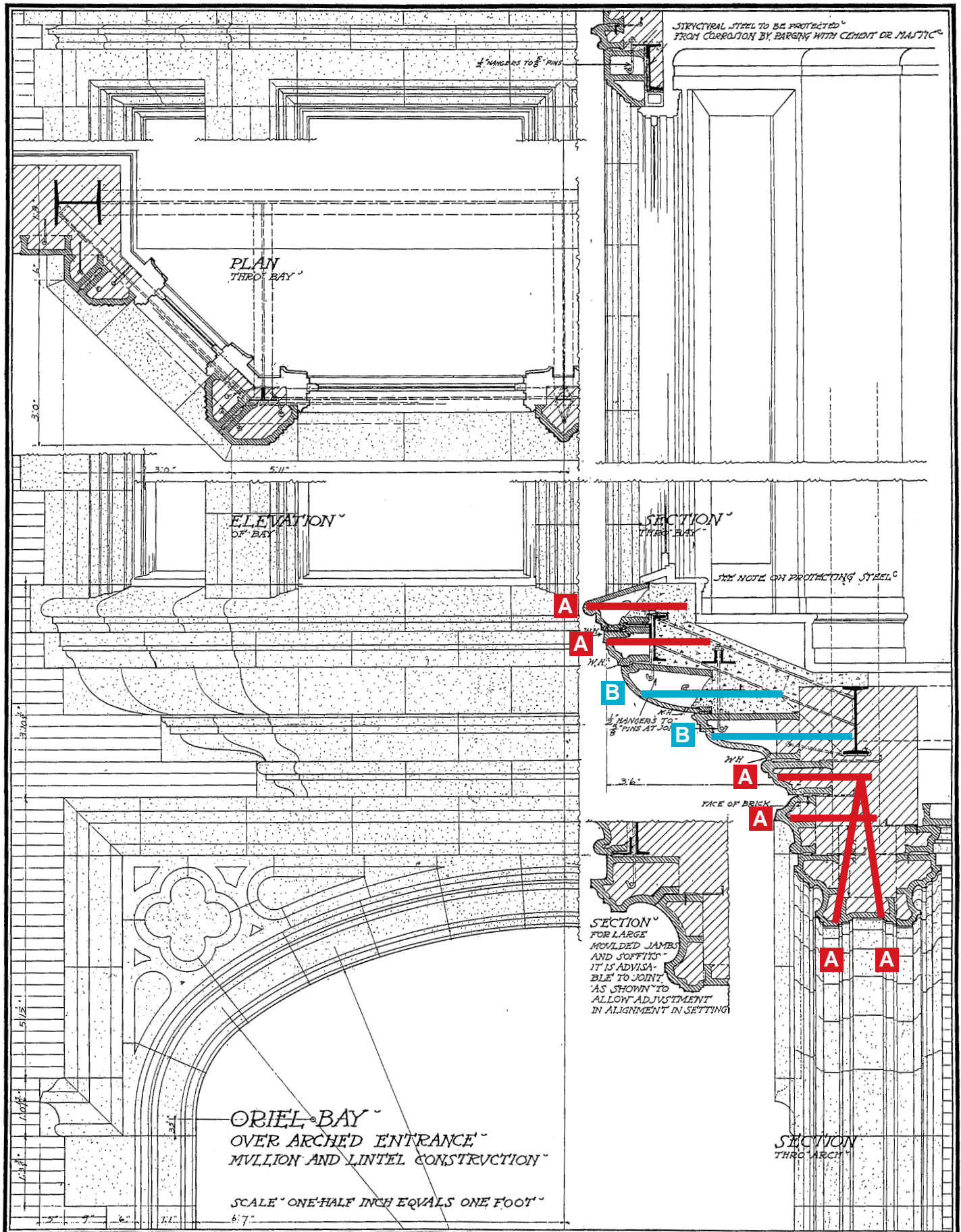
This manual provides general information for use in preliminary selection of a Cintec anchor. Final designs must be prepared by Cintec and approved by the project Architect or Engineer of Record. **PAGE 22**

TERRA COTTA STANDARD CONSTRUCTION

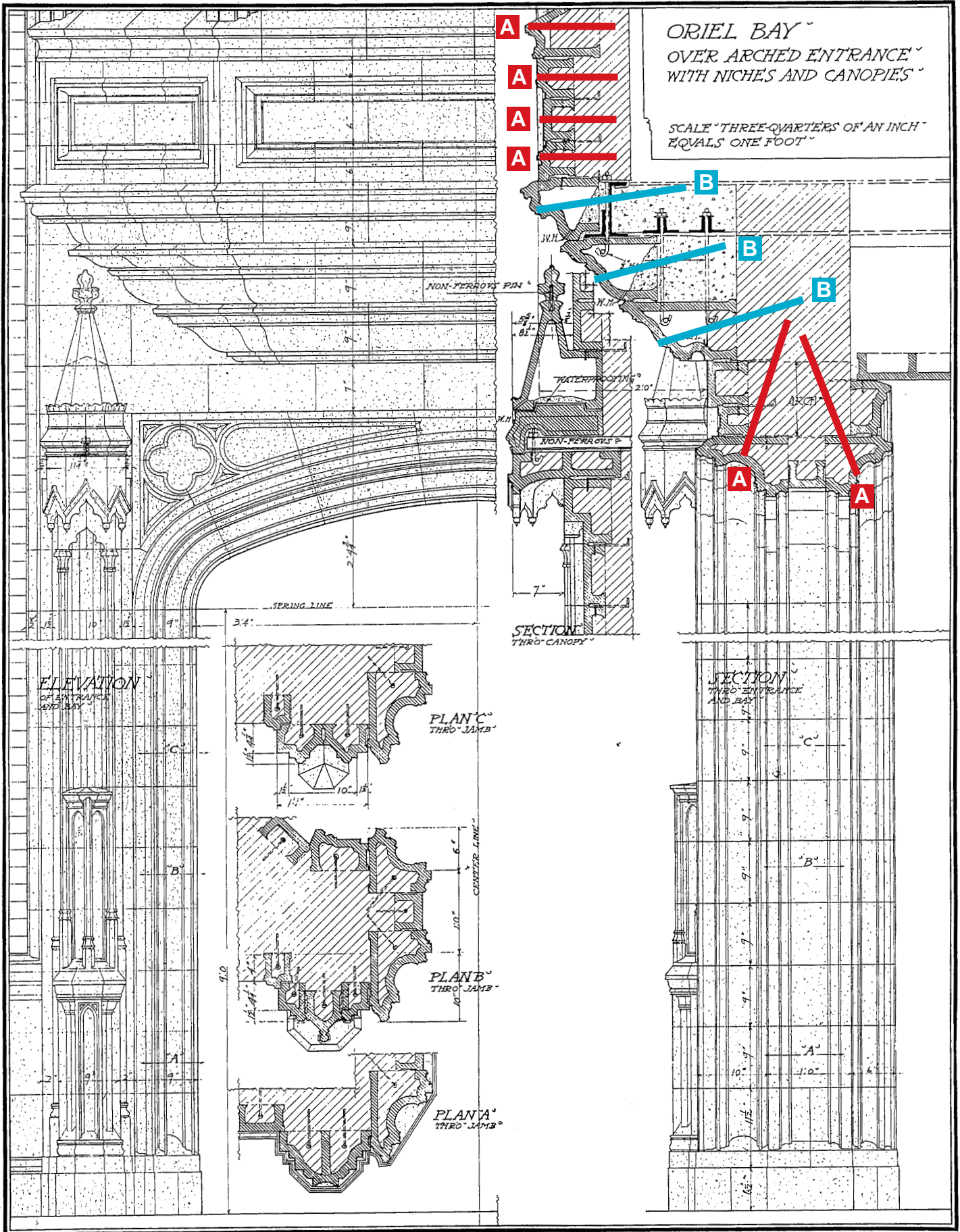


ARCHED ENTRANCE WITH PANEL AND PEDIMENT ABOVE WITH PILASTERS IMPOST AND ARCHITRAVE

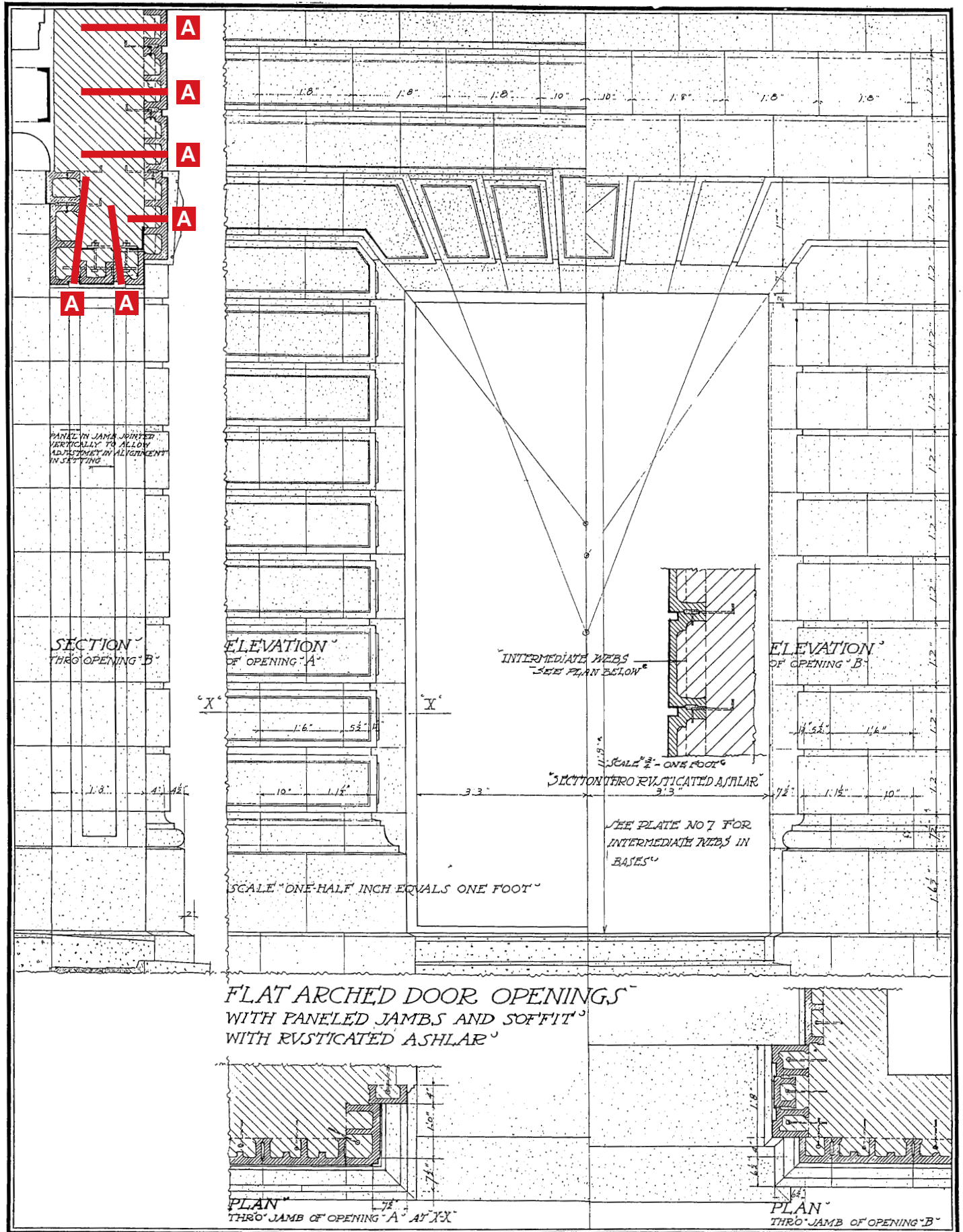
TERRA COTTA STANDARD CONSTRUCTION



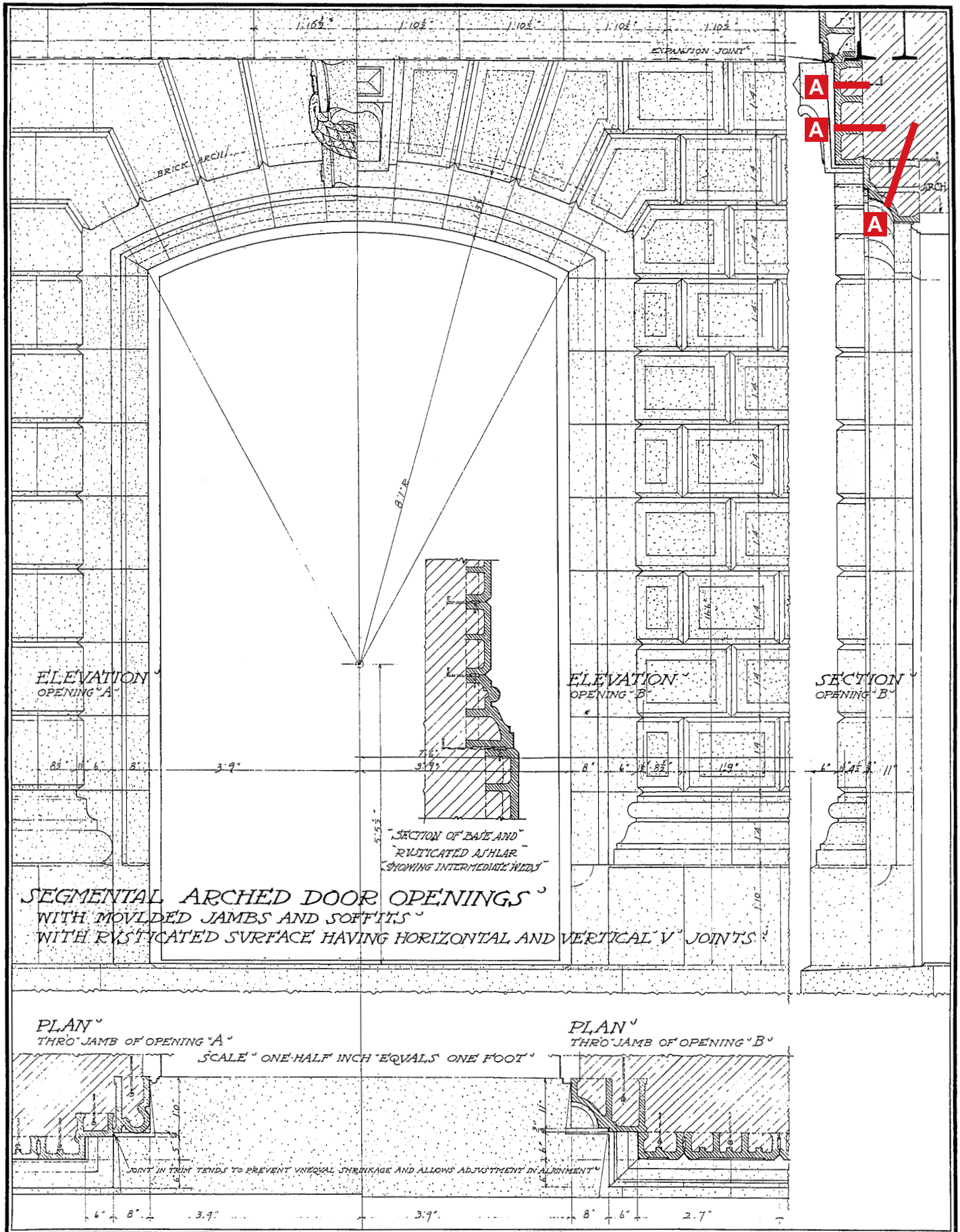
TERRA COTTA STANDARD CONSTRUCTION



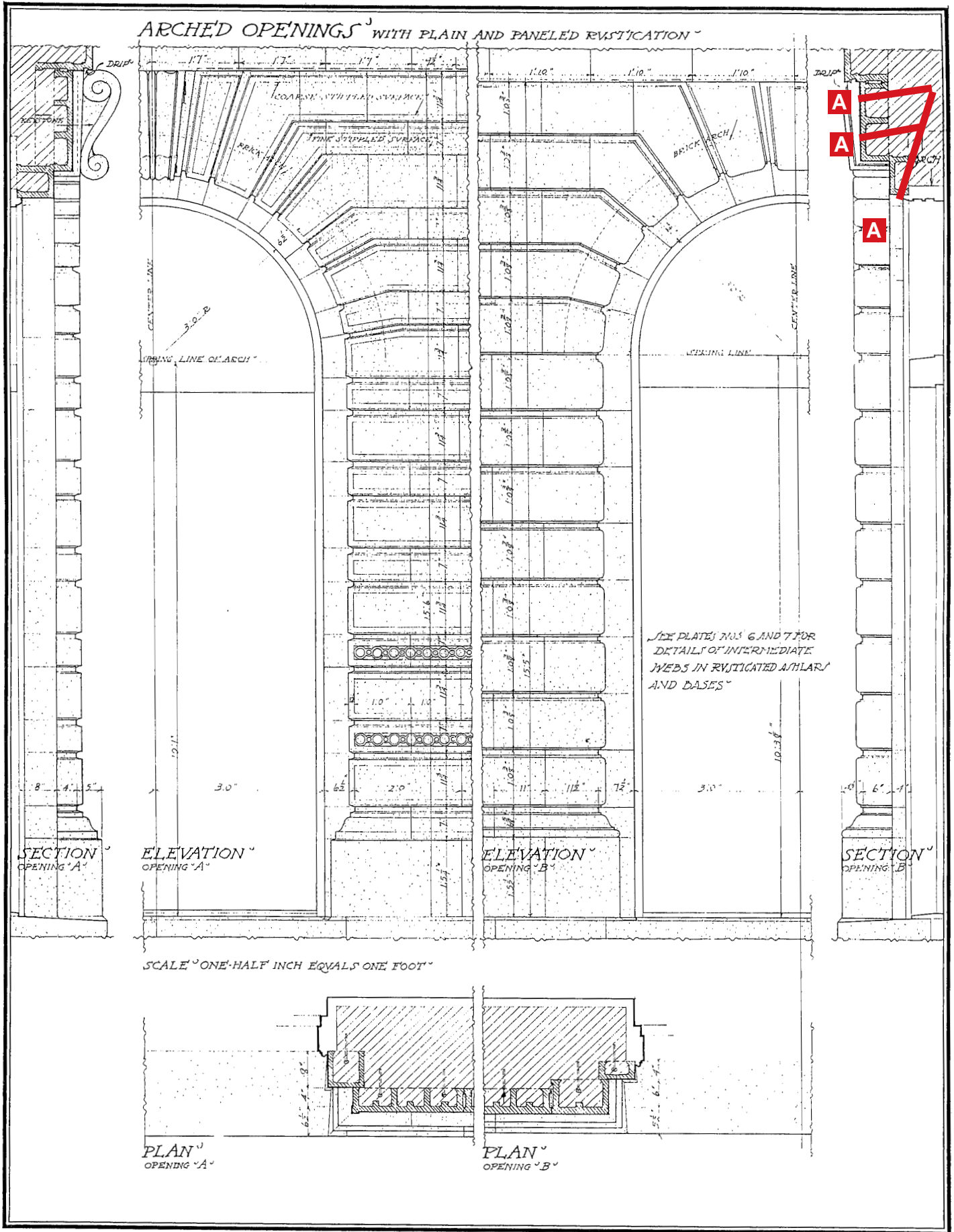
TERRA COTTA STANDARD CONSTRUCTION



TERRA COTTA STANDARD CONSTRUCTION

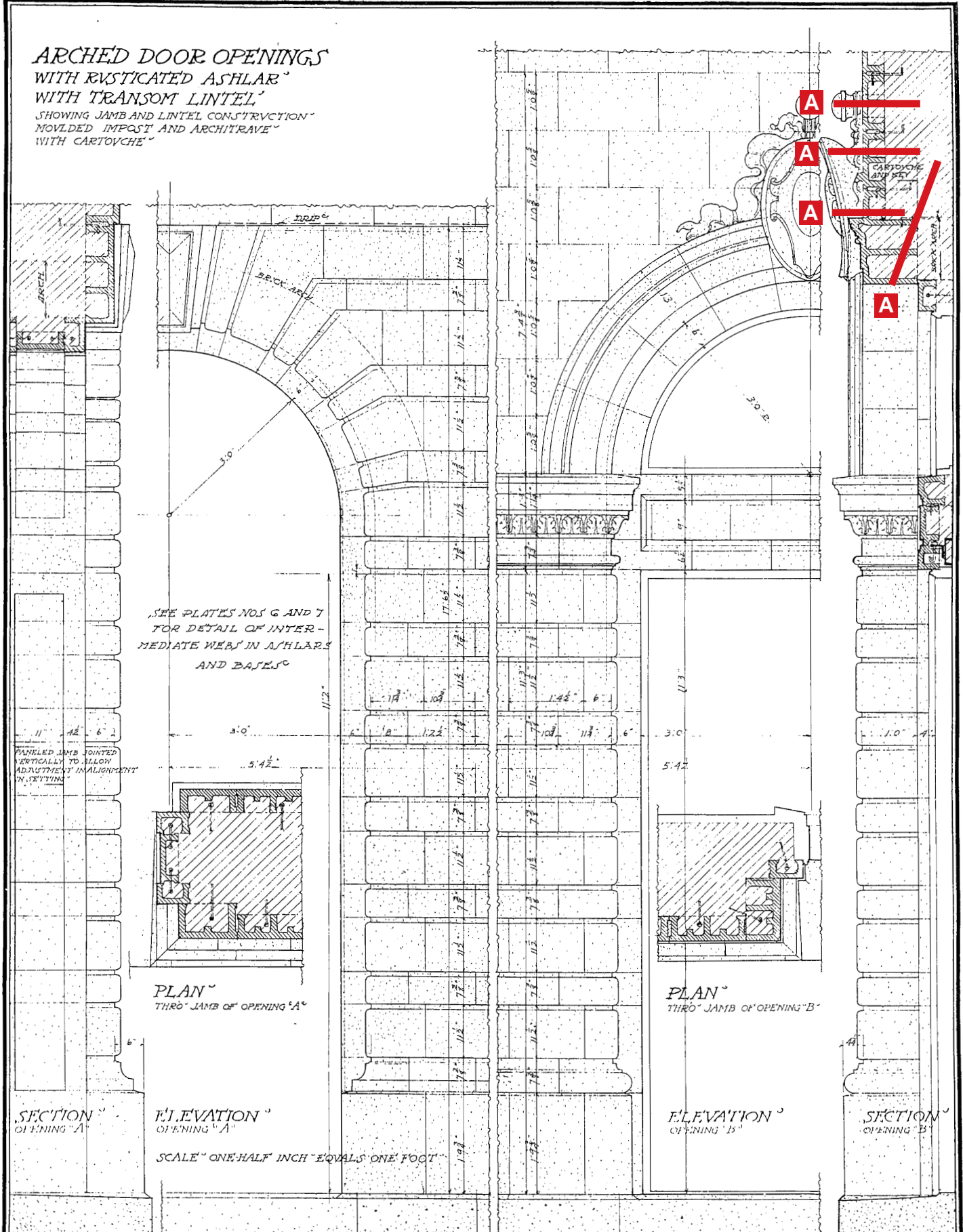


TERRA COTTA STANDARD CONSTRUCTION



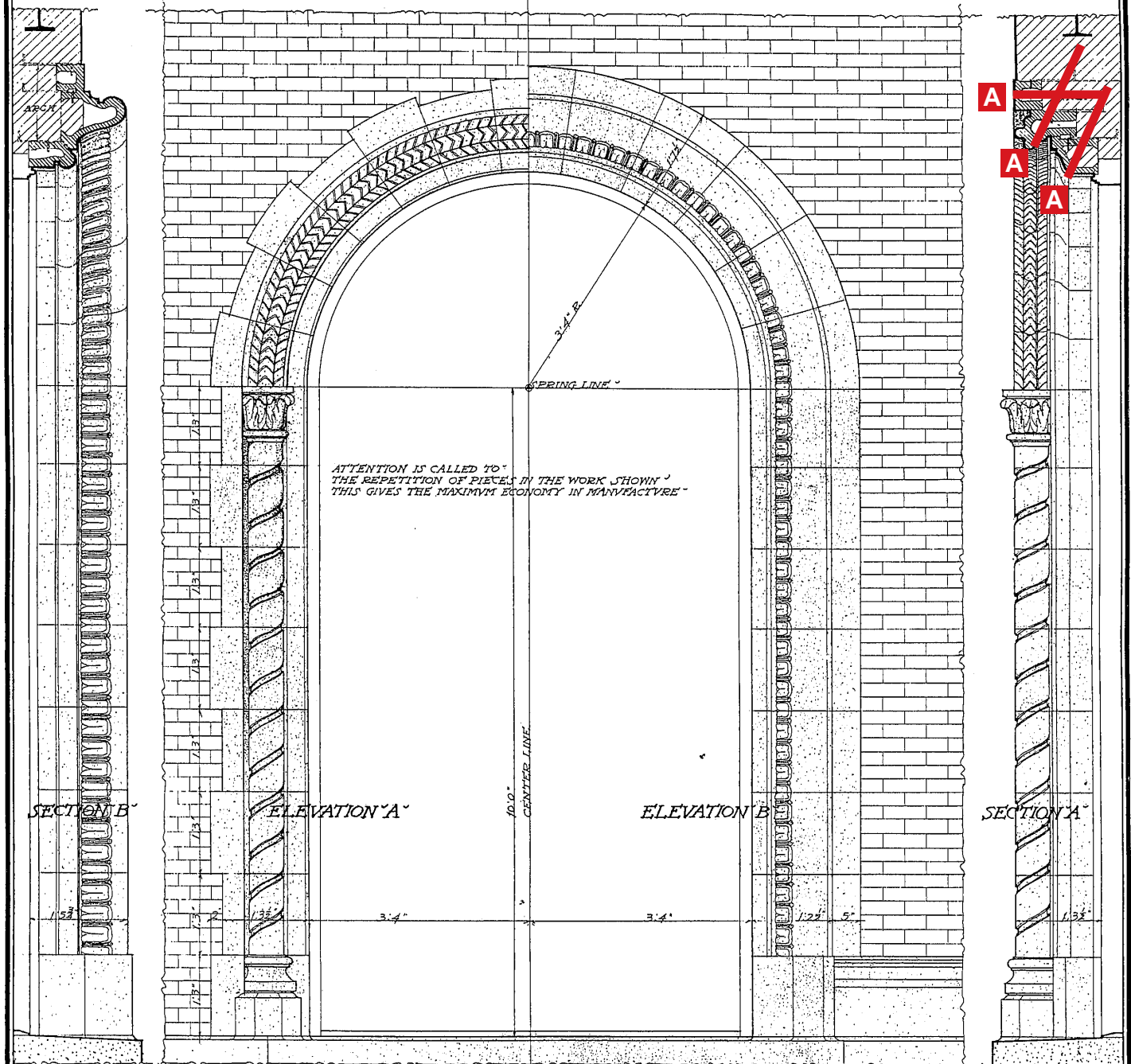
TERRA COTTA STANDARD CONSTRUCTION

ARCHED DOOR OPENINGS
WITH ELASTICATED ASHLAR
WITH TRANSOM LINTEL
SHOWING JAMB AND LINTEL CONSTRUCTION
MODELLED IMPOST AND ARCHITRAVE
WITH CARTOUCHE

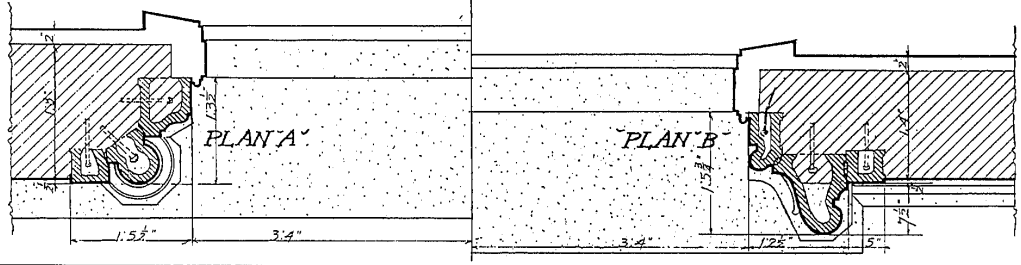


TERRA COTTA STANDARD CONSTRUCTION

ARCHED OPENINGS WITH MOULDED AND ORNAMENTED TRIM WITH BRICK FIELD

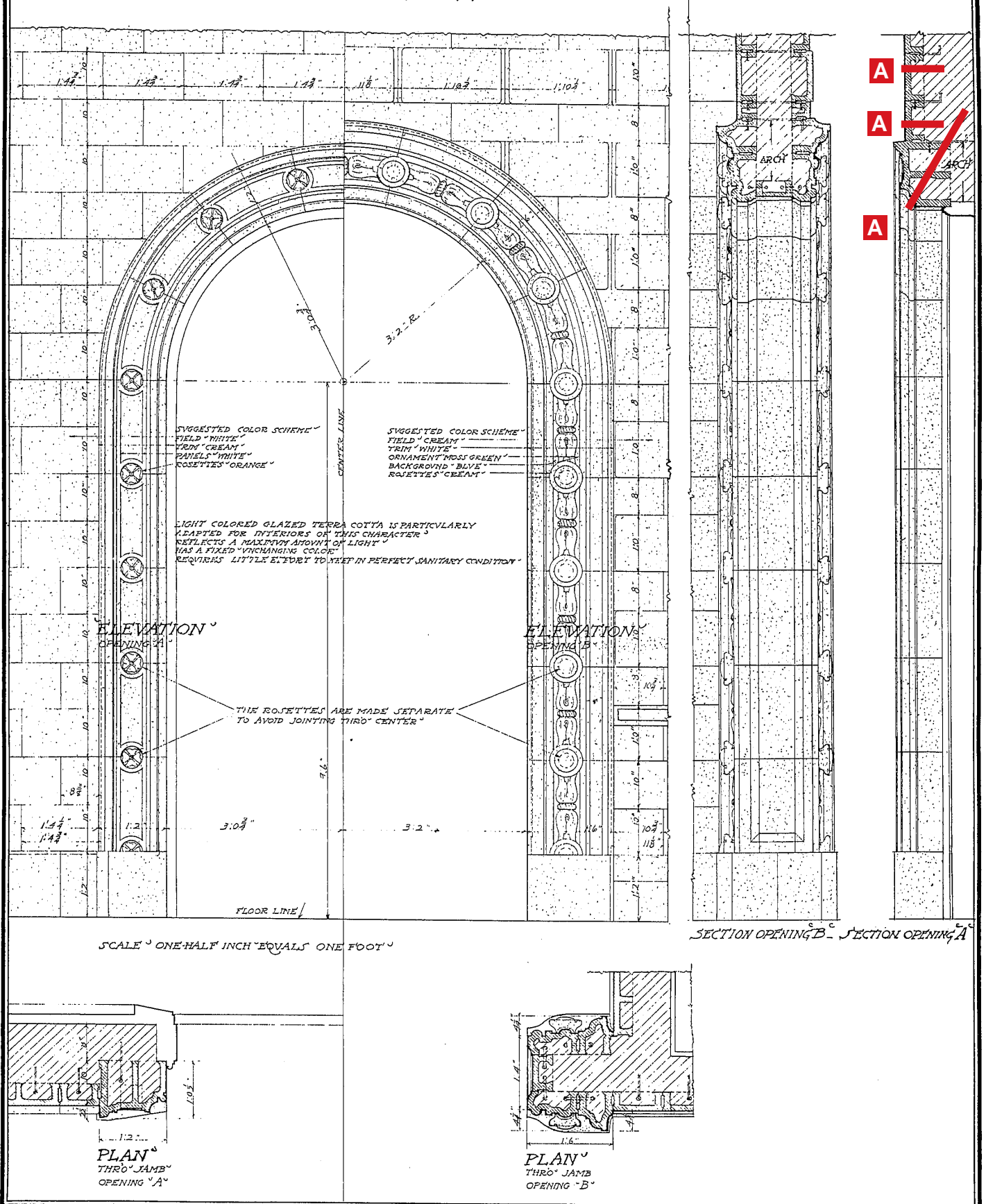


SCALE - ONE-HALF INCH EQUALS ONE FOOT

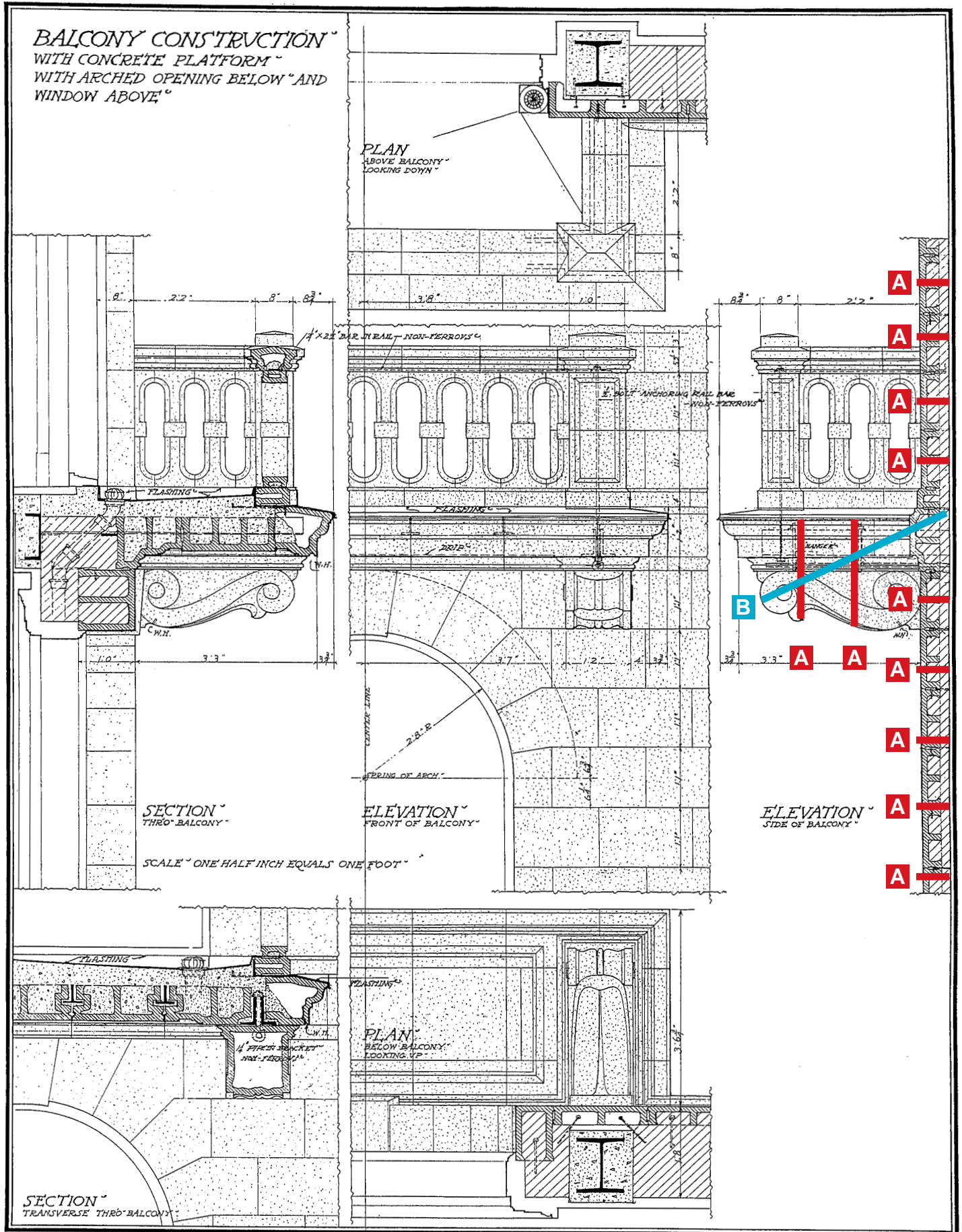


▲ ▲ ▲ TERRA COTTA ▲ ▲ STANDARD CONSTRUCTION ▲ ▲ ▲

ARCHED OPENINGS
WITH MOULDED AND ORNAMENTED TRIM



TERRA COTTA STANDARD CONSTRUCTION

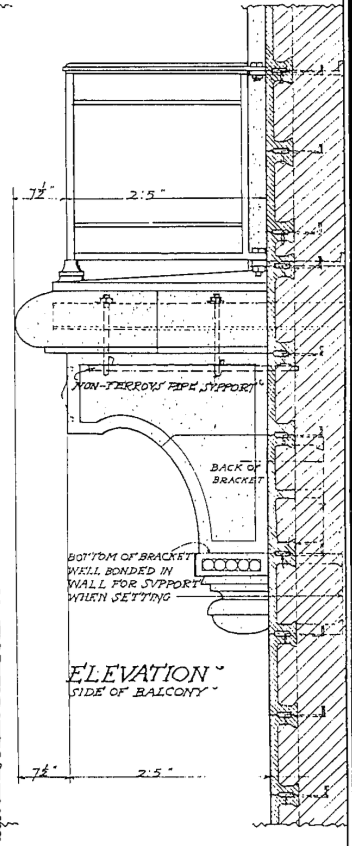
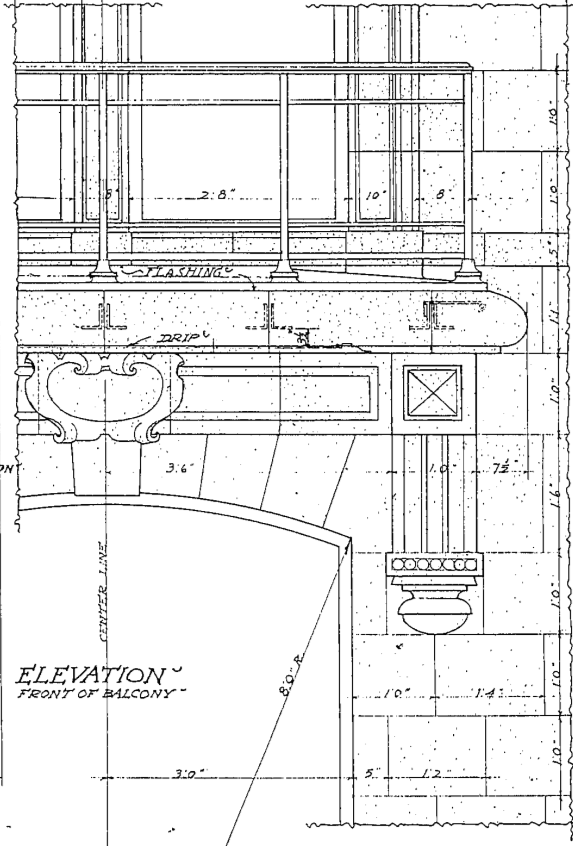
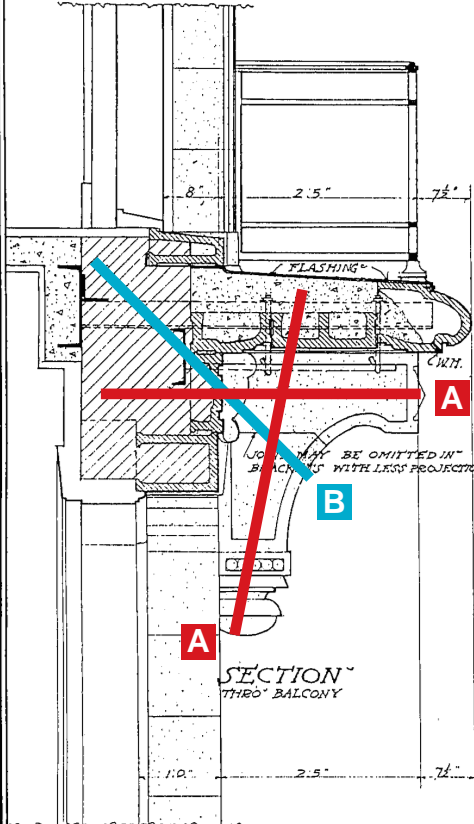
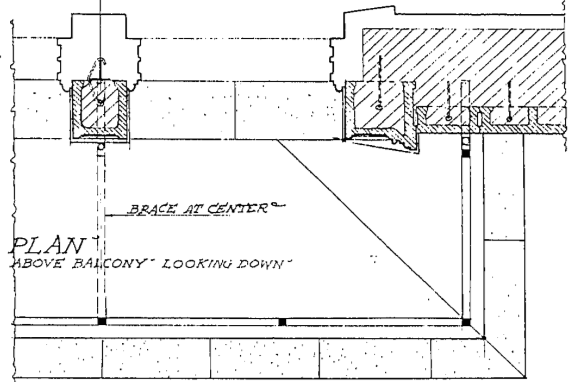


NATIONAL TERRA COTTA SOCIETY · V · S · A · PLATE NO · 12

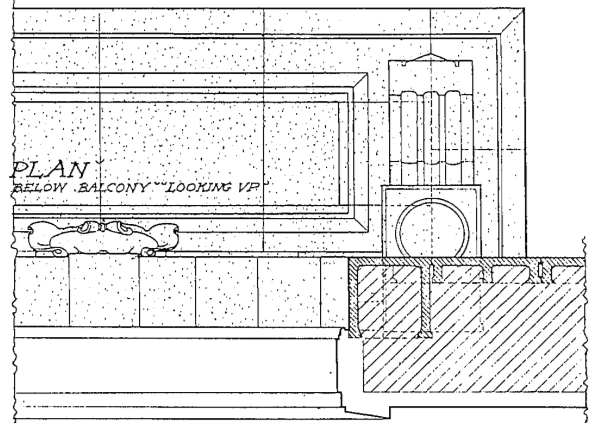
This manual provides general information for use in preliminary selection of a Cintec anchor.
 Final designs must be prepared by Cintec and approved by the project Architect or Engineer of Record.

TERRA COTTA STANDARD CONSTRUCTION

BALCONY CONSTRUCTION WITH CONCRETE PLATFORM WITH SEGMENTAL ARCH UNDER AND WINDOWS ABOVE



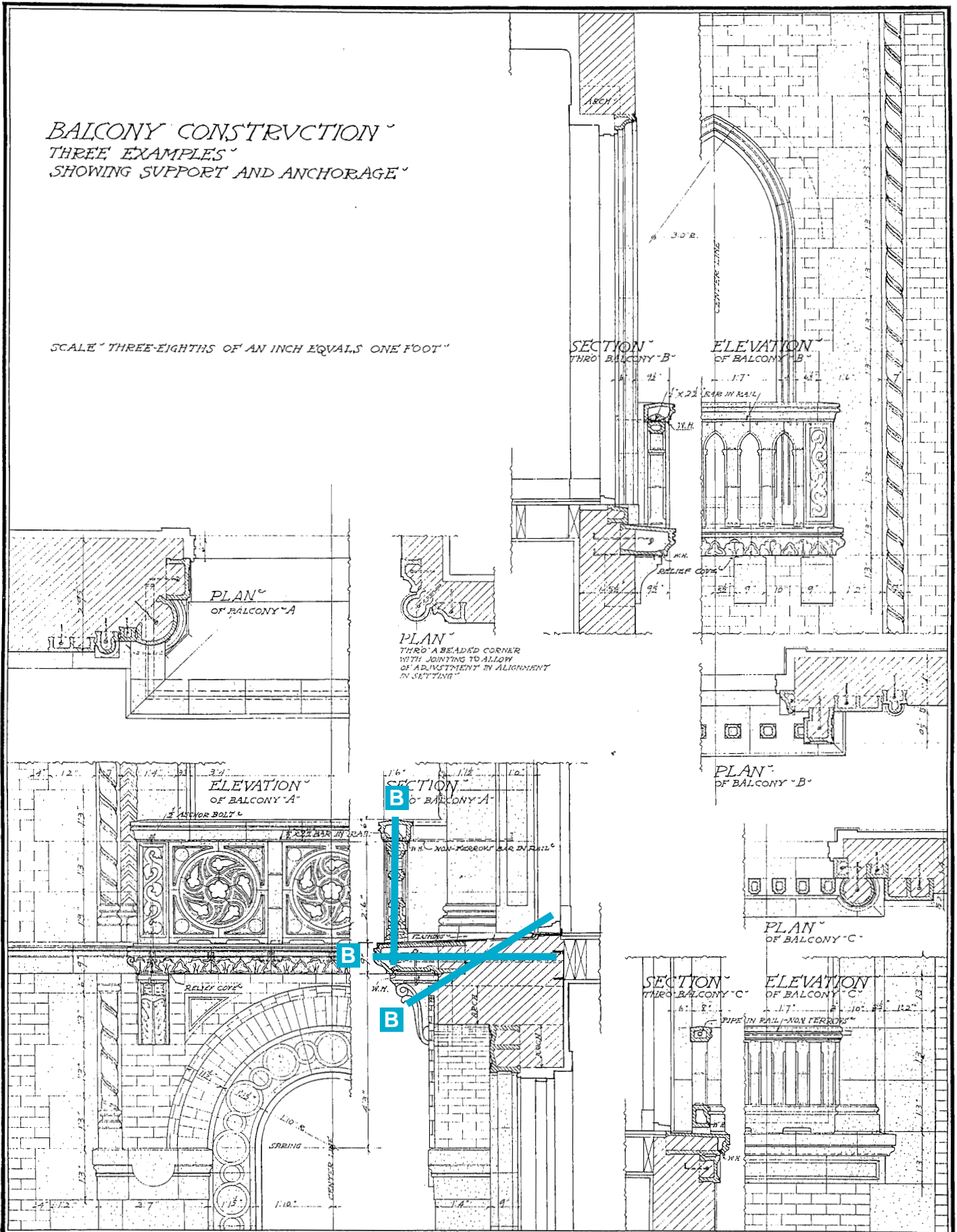
SCALE ONE-HALF INCH EQUALS ONE FOOT



TERRA COTTA STANDARD CONSTRUCTION

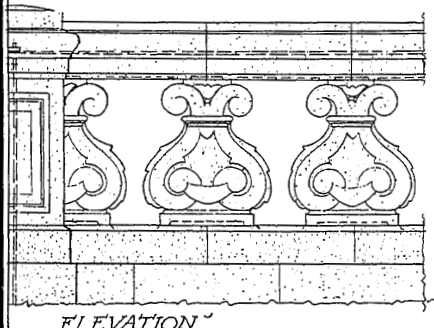
BALCONY CONSTRUCTION
THREE EXAMPLES
SHOWING SUPPORT AND ANCHORAGE

SCALE THREE-EIGHTHS OF AN INCH EQUALS ONE FOOT

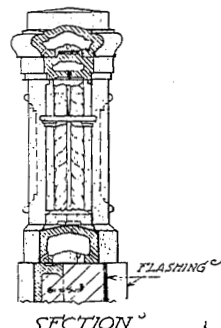


TERRA COTTA STANDARD CONSTRUCTION

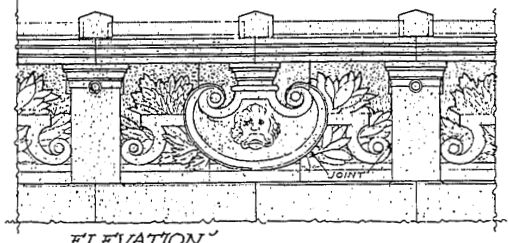
BALUSTRADES PARAPETS



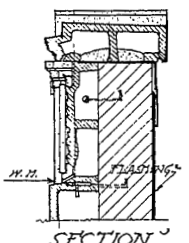
ELEVATION



SECTION

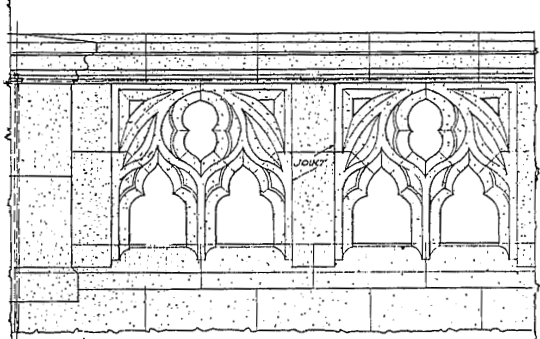


ELEVATION

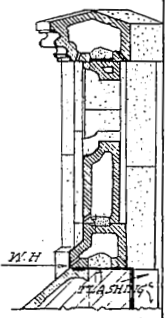


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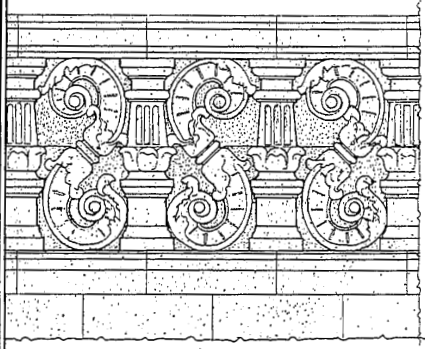
SCALE ONE-HALF INCH EQUALS ONE FOOT



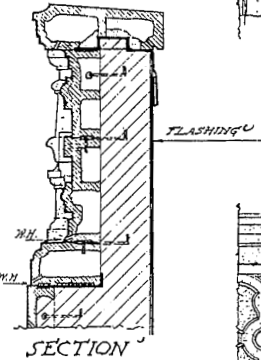
ELEVATION



SECTION

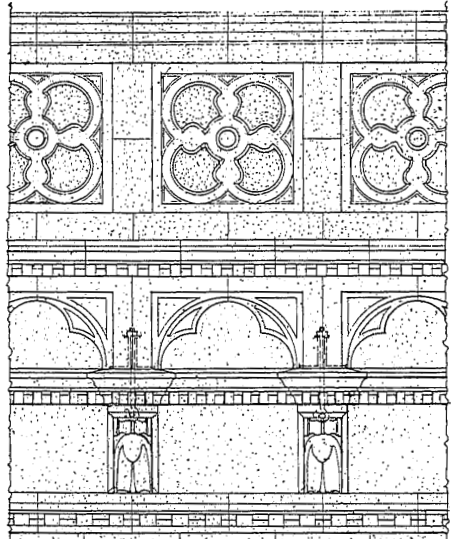


ELEVATION

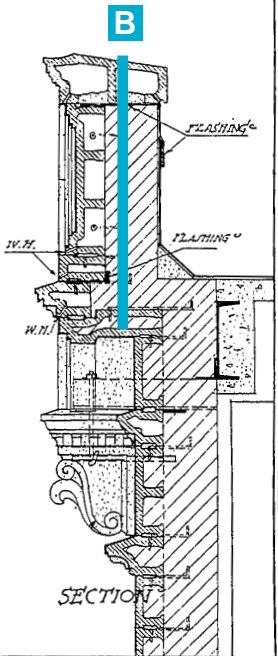


SECTION

IN BALUSTRADES WITH SOLID BACKS THE USE OF DARK COLORS IN THE FIELD OF PANELS WILL GIVE THE APPEARANCE OF PERFORATED WORK



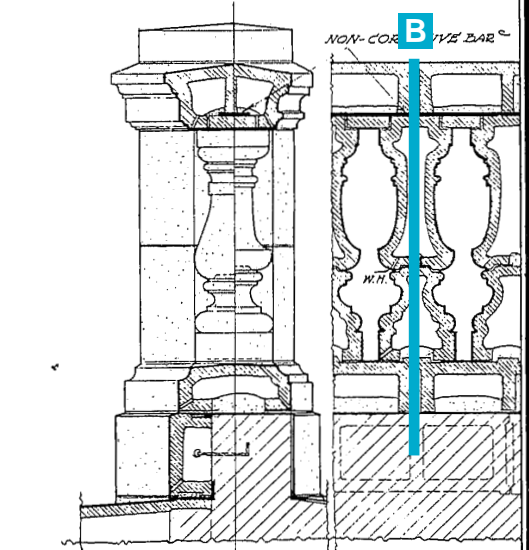
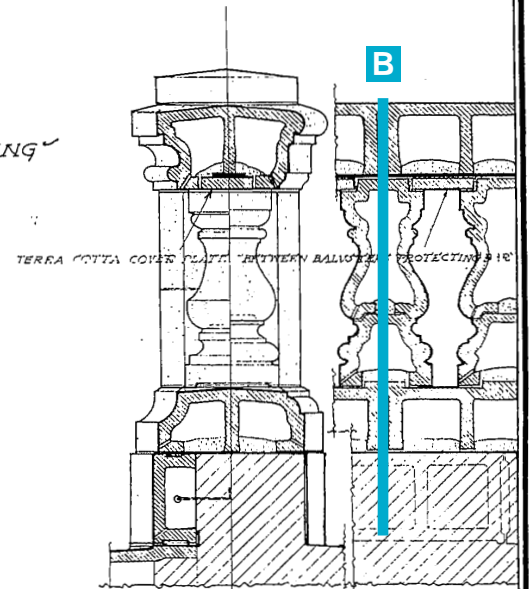
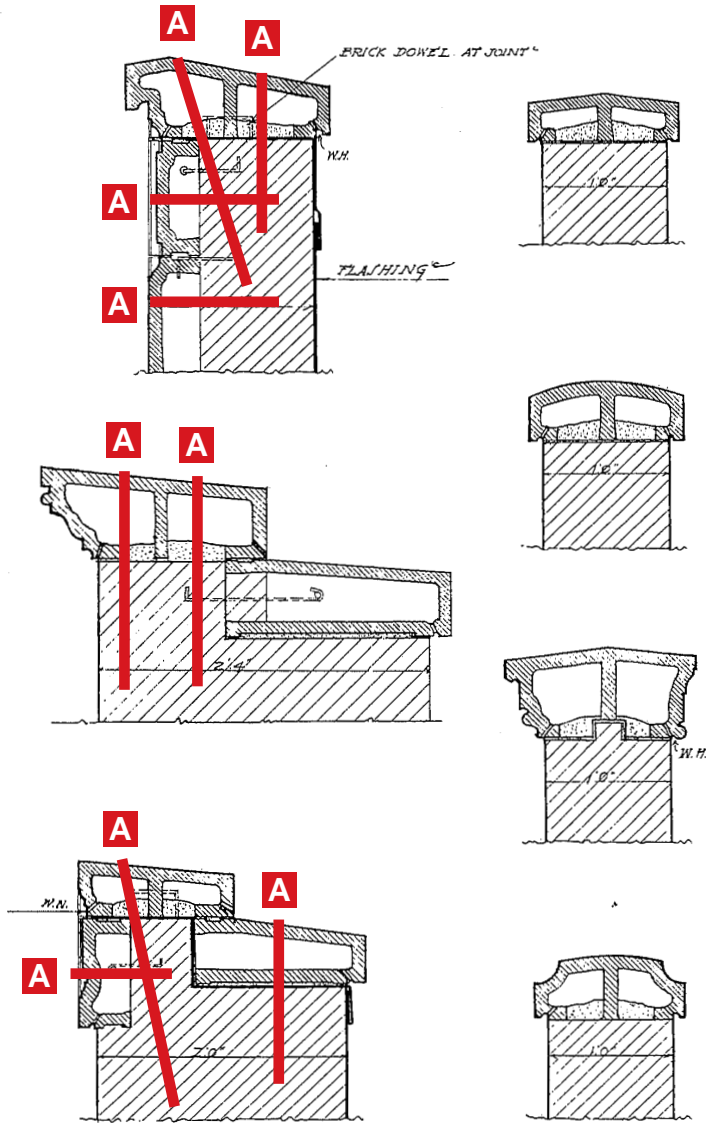
ELEVATION OF CORNICE AND BALUSTRADE



SECTION

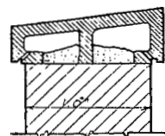
TERRA COTTA STANDARD CONSTRUCTION

WALL COPINGS AND BALUSTRADES
SHOWING VARIOUS METHODS OF JOINTING AND ANCHORING

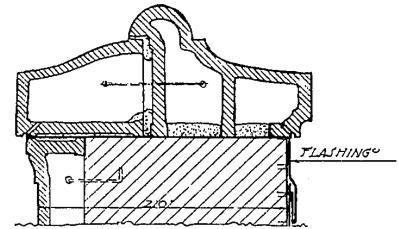
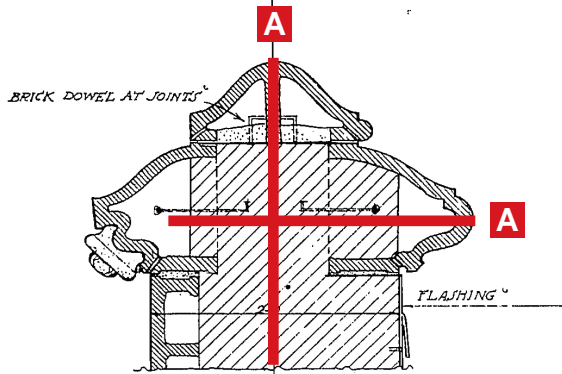


WHERE TERRA COTTA ASHLAR IS USED TO FACE PARAPET WALLS, THE ASHLAR SHALL BE LEFT UNFILLED AND SUPPLIED WITH WEEP HOLES

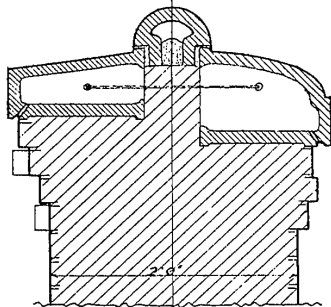
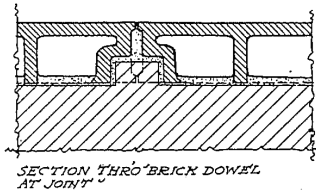
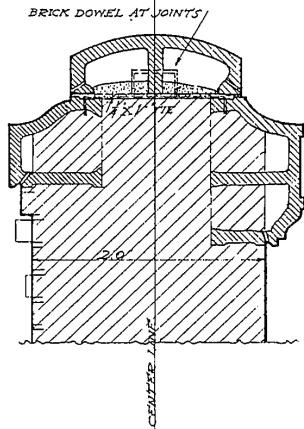
SCALE THREE-QUARTERS OF AN INCH EQUALS ONE FOOT



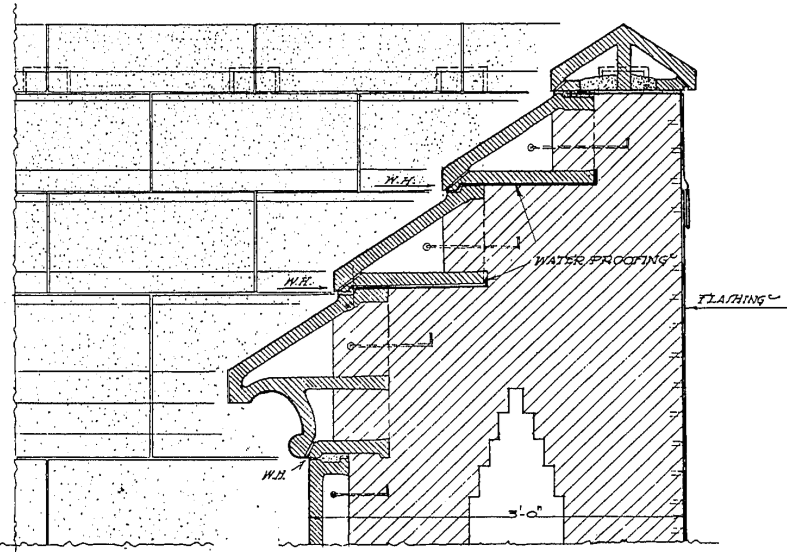
▲ ▲ ▲ ▲ TERRA COTTA ▲ ▲ STANDARD CONSTRUCTION ▲ ▲ ▲ ▲



SCALE ~ THREE-QUARTERS OF AN INCH EQUALS ONE FOOT ~



THE PROFILE OF EACH COPING IS VARIED BOTH SIDES OF CENTER LINE FOR SUGGESTING POSSIBILITIES ~



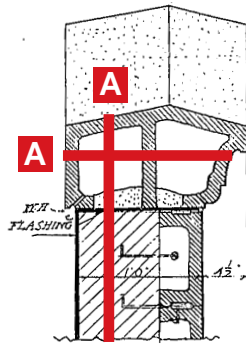
WHERE TERRA COTTA AJHLAR IS WIED TO FACE PARAPET WALLS, THE AJHLAR SHALL BE LEFT UNTILLED AND STREKKED WITH WEEPHOLES ~

COPINGS ~

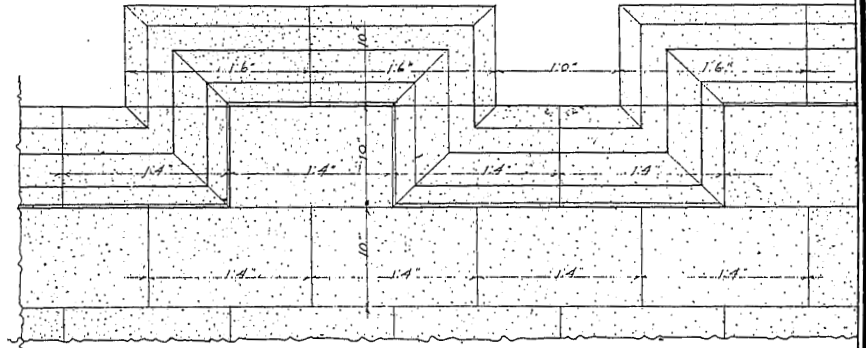
FOR WALL 2:0" AND MORE THICK ~
SHOWING VARIOUS METHODS OF JOINTING AND ANCHORING ~

TERRA COTTA STANDARD CONSTRUCTION

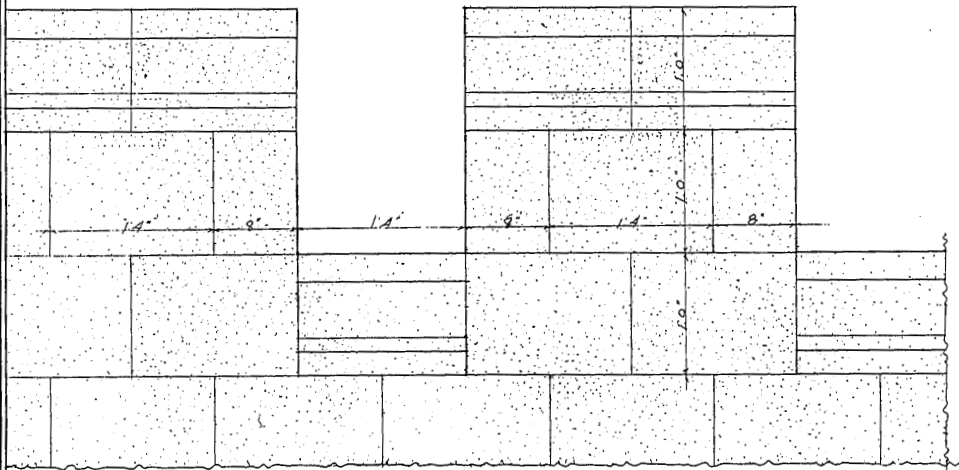
BATTLEMENTED COPING AND SET-OFFS



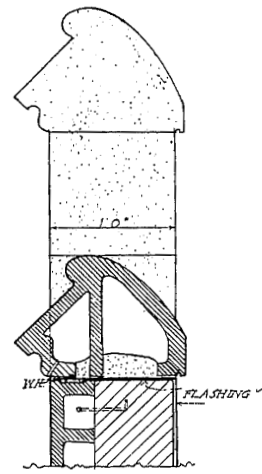
SECTION THRO' COPING "A"



ELEVATION OF COPING "A"

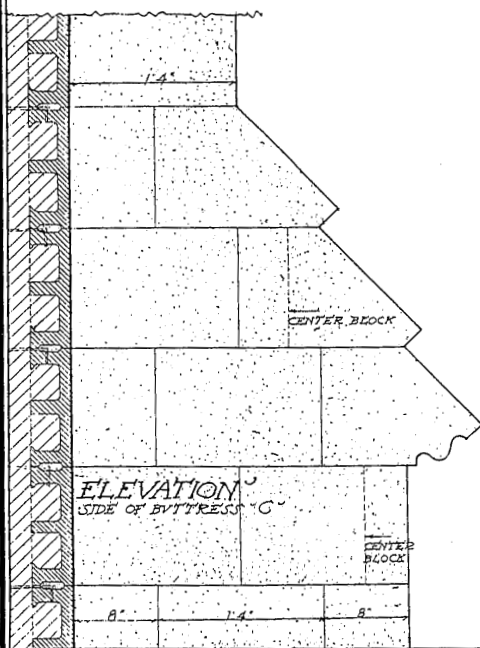


ELEVATION OF COPING "B"

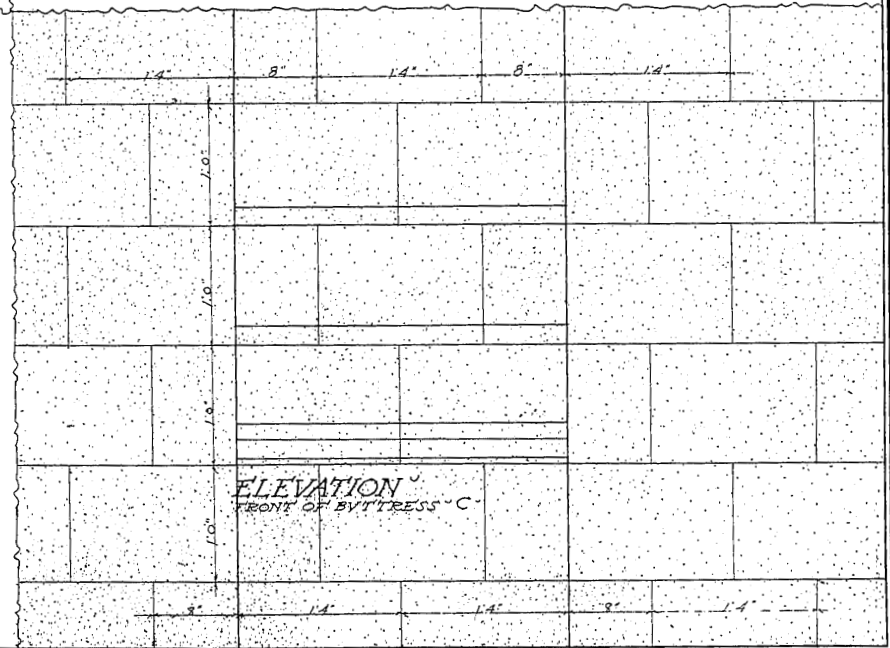


SECTION THRO' COPING "B"

SCALE THREE-QUARTERS OF AN INCH EQUALS ONE FOOT

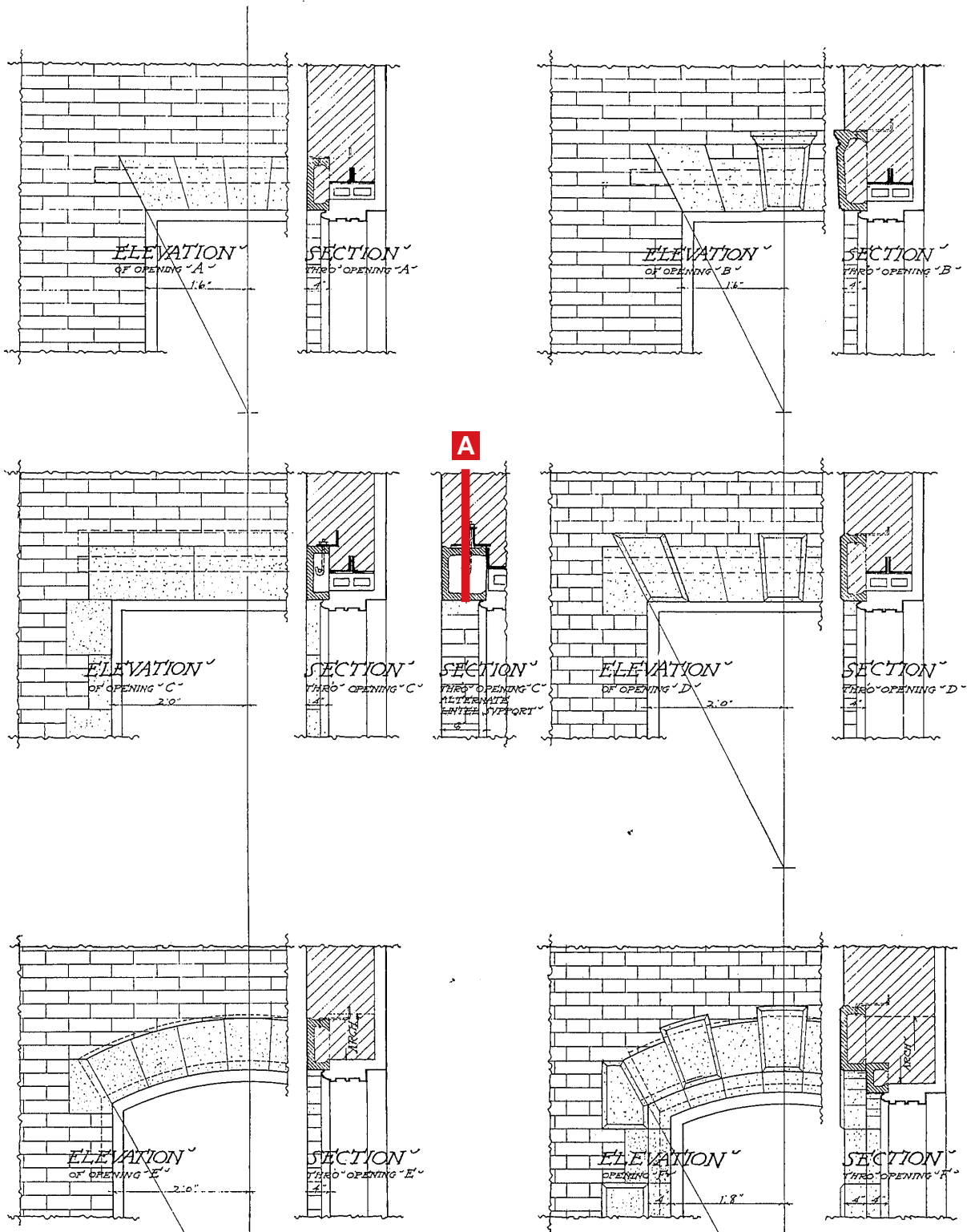


ELEVATION SIDE OF BUTTRESS "C"



ELEVATION FRONT OF BUTTRESS "C"

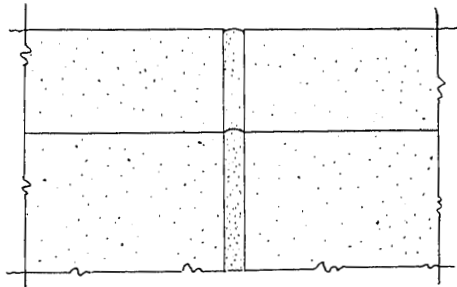
TERRA COTTA STANDARD CONSTRUCTION



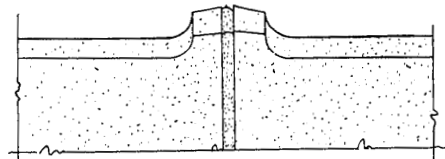
ARCH AND LINTEL TREATMENT FOR SMALL AND MEDIUM SIZED OPENINGS WITH BRICK FIELD

SCALE ONE-HALF INCH EQUALS ONE FOOT

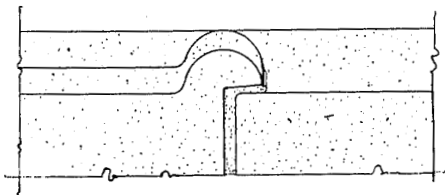
▲ ▲ ▲ TERRA COTTA ▲ ▲ STANDARD CONSTRUCTION ▲ ▲ ▲ ▲



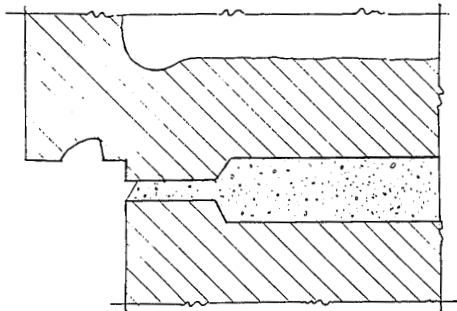
STANDARD FLUSH JOINT RECOMMENDED AS SUPERIOR TO THE OLD STYLE RAISED AND ROLL JOINTS SHOWN BELOW



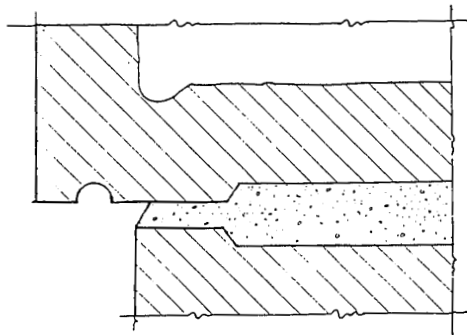
OLD STYLE RAISED JOINT



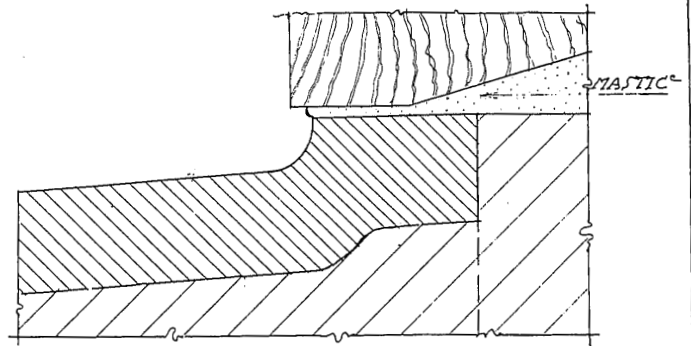
OLD STYLE ROLL JOINT



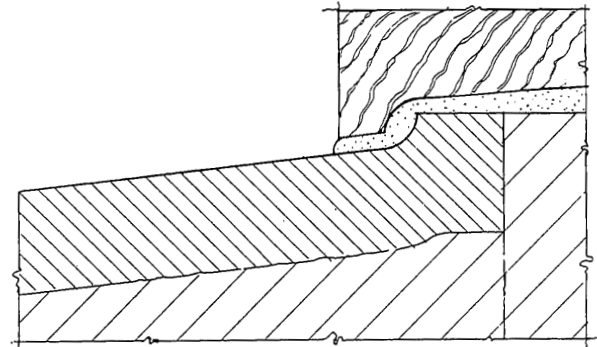
TYPICAL DRIP DETAILS



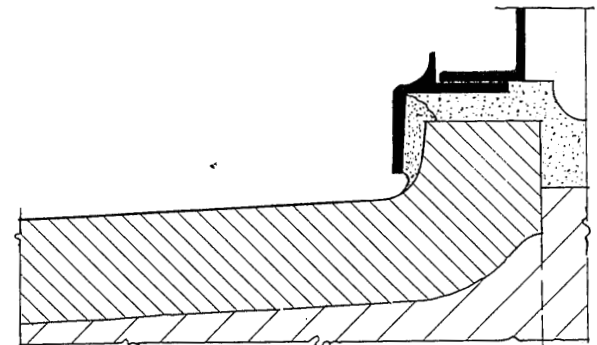
SCALE HALF AND QUARTER FULL SIZE



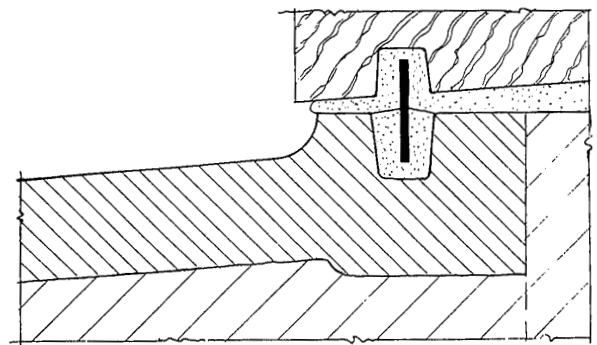
WOOD OR HOLLOW METAL SILLS



TUCK UNDER SILL

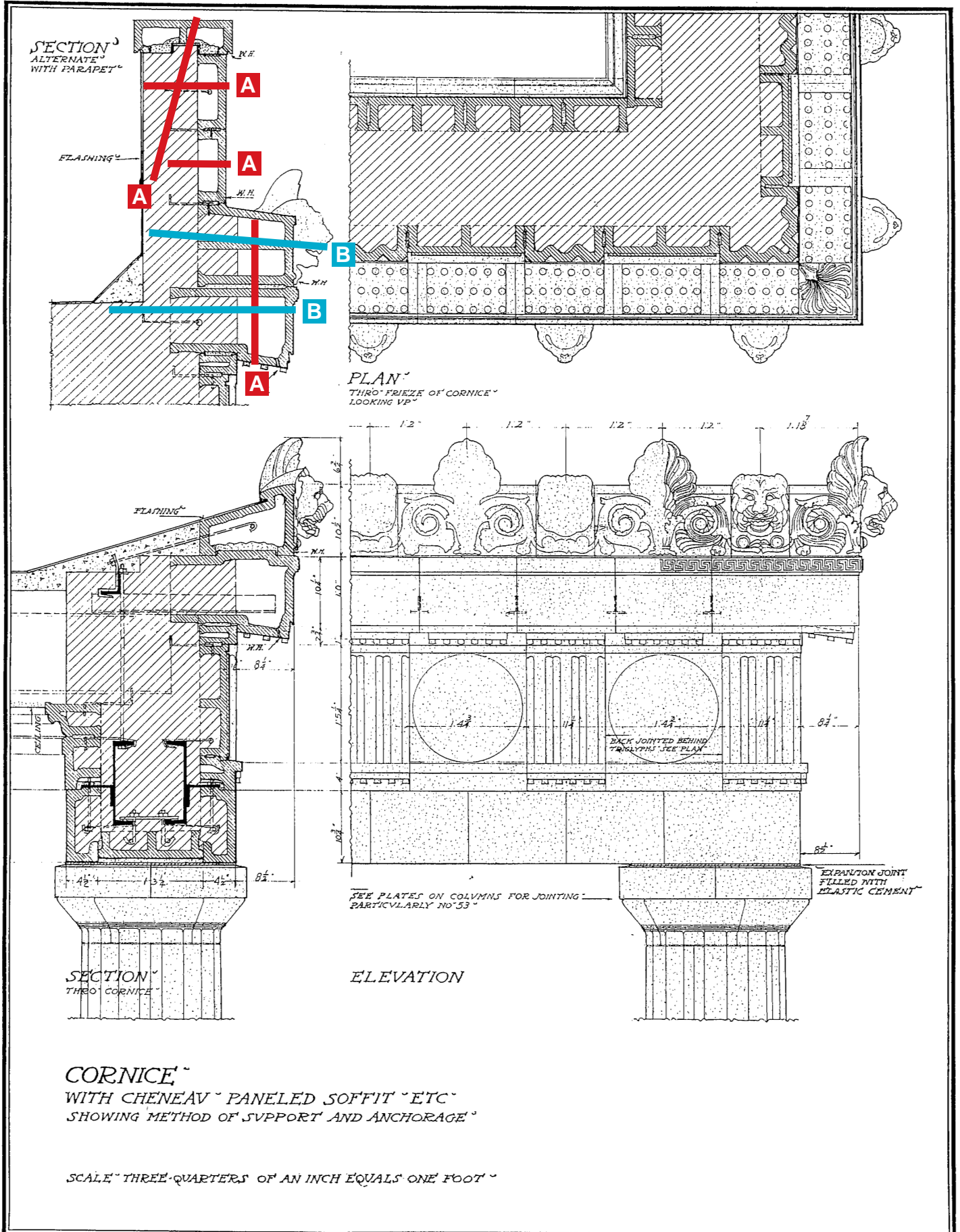


SILL FOR SOLID METAL FRAMES



SILL WITH NON-FERROUS WATER BAR

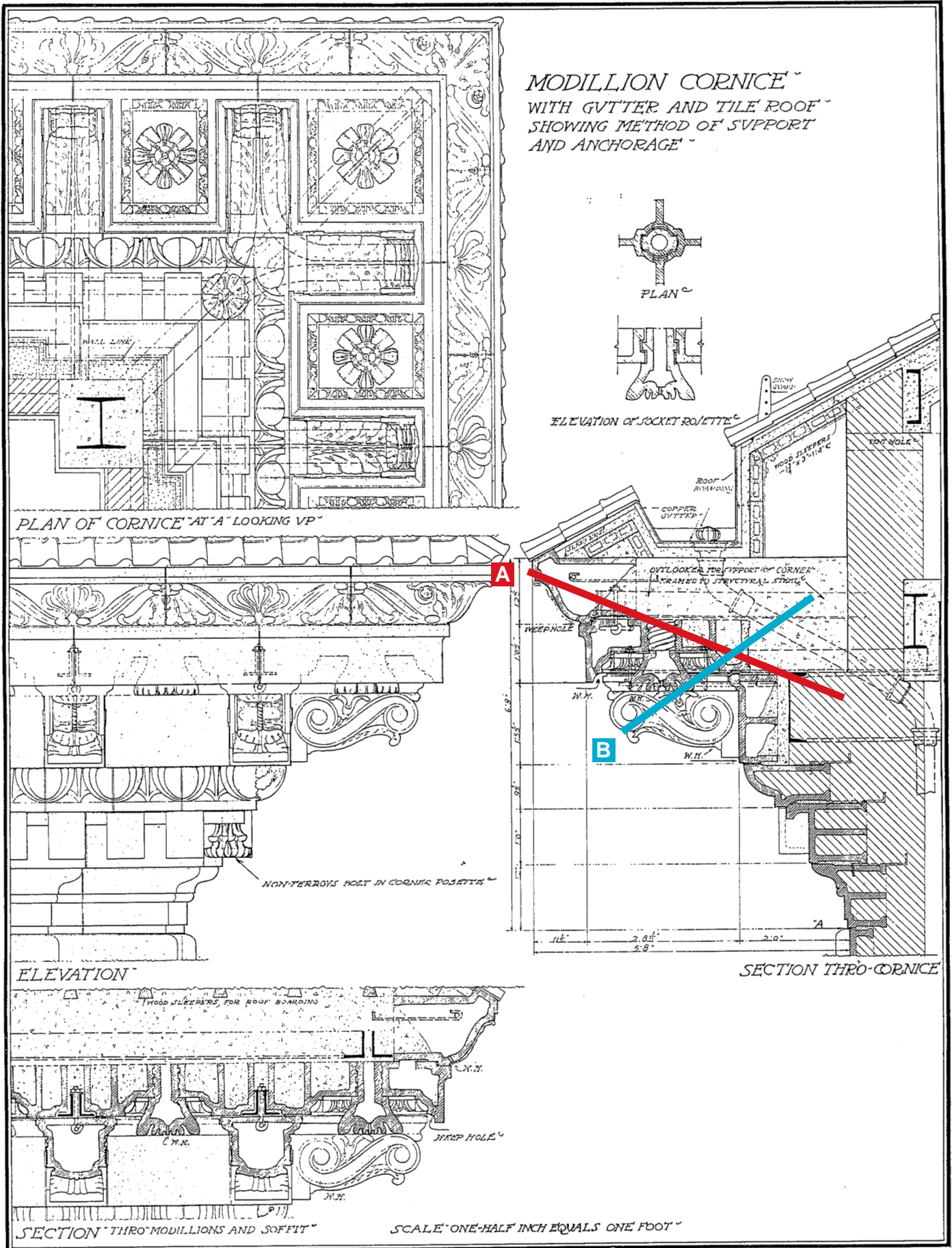
TERRA COTTA STANDARD CONSTRUCTION



CORNICE WITH CHENEAV PANEELED SOFFIT ETC SHOWING METHOD OF SUPPORT AND ANCHORAGE

SCALE THREE-QUARTERS OF AN INCH EQUALS ONE FOOT

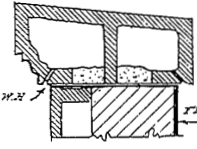
TERRA COTTA STANDARD CONSTRUCTION



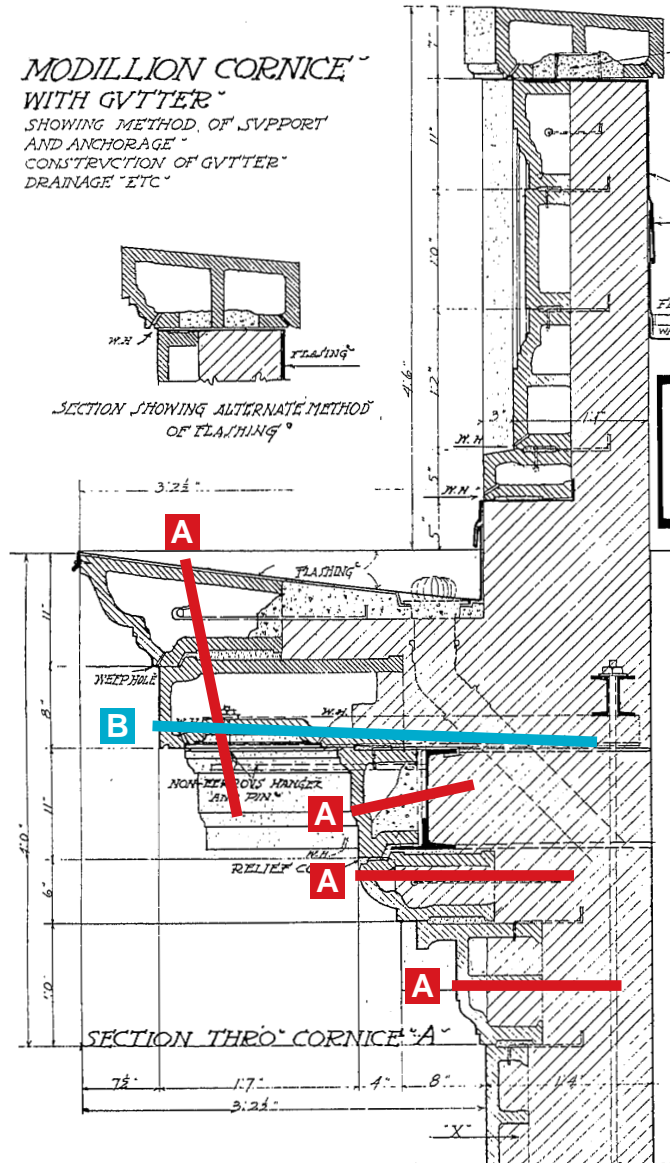
TERRA COTTA STANDARD CONSTRUCTION

MODILLION CORNICE WITH GUTTER
 SHOWING METHOD OF SUPPORT AND ANCHORAGE
 CONSTRUCTION OF GUTTER DRAINAGE ETC

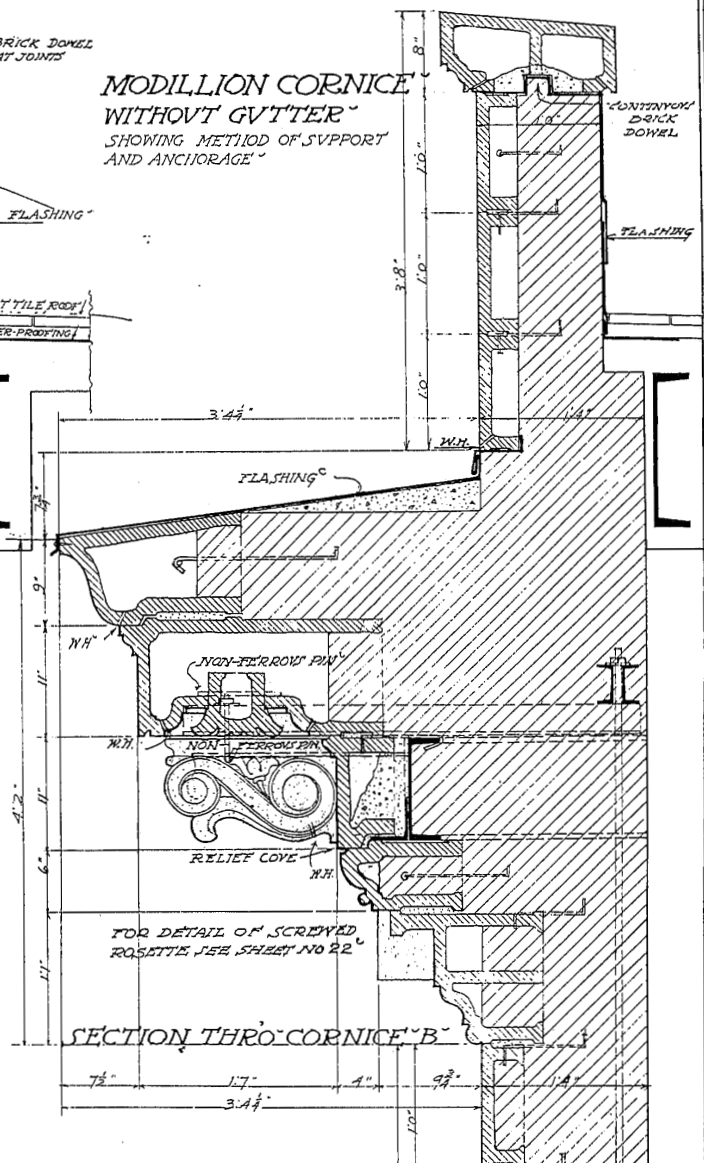
MODILLION CORNICE WITHOUT GUTTER
 SHOWING METHOD OF SUPPORT AND ANCHORAGE



SECTION SHOWING ALTERNATE METHOD OF FLASHING



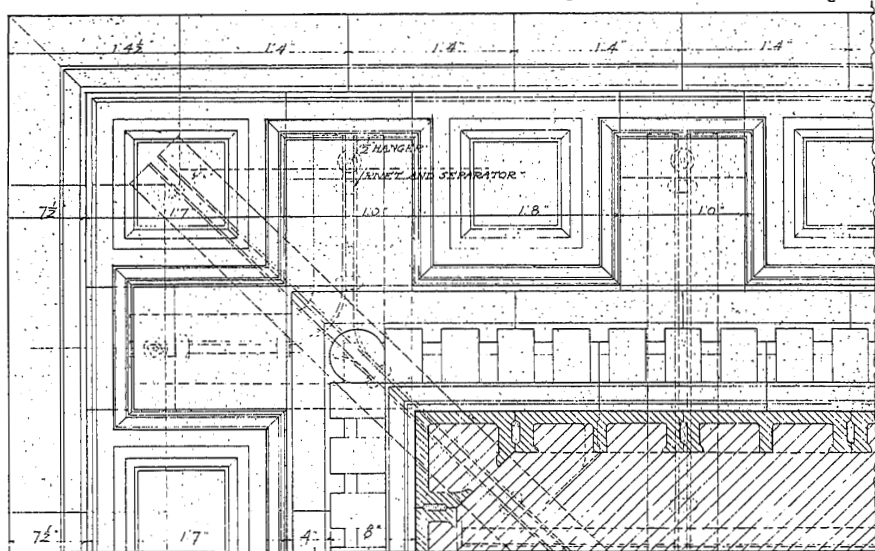
SECTION THRO CORNICE A



SECTION THRO CORNICE B

PLAN OF CORNICE A
 TAKEN AT X LOOKING UP

SCALE THREE QUARTERS OF AN INCH EQUALS ONE FOOT

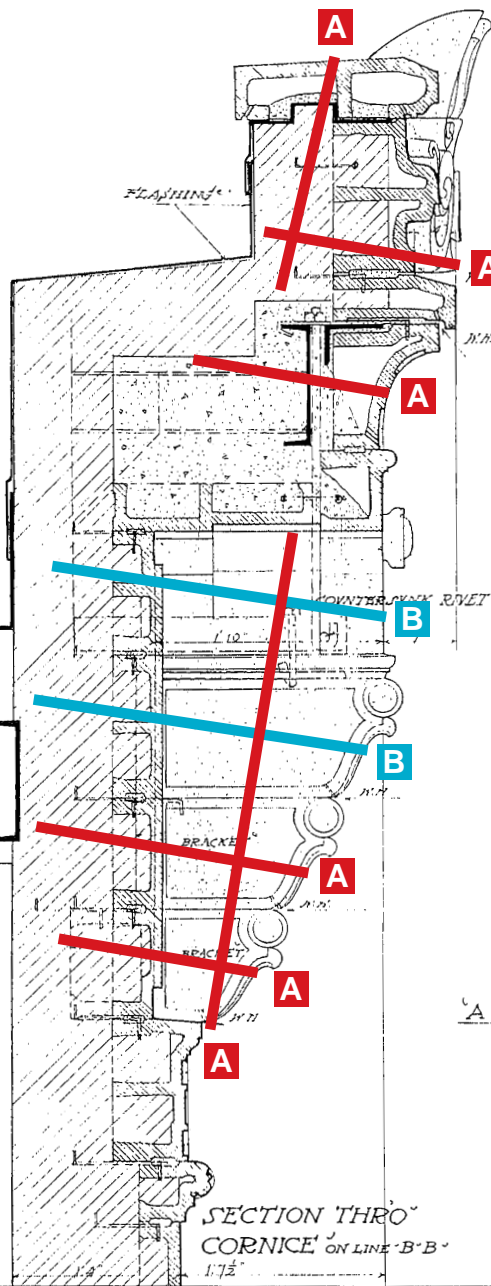
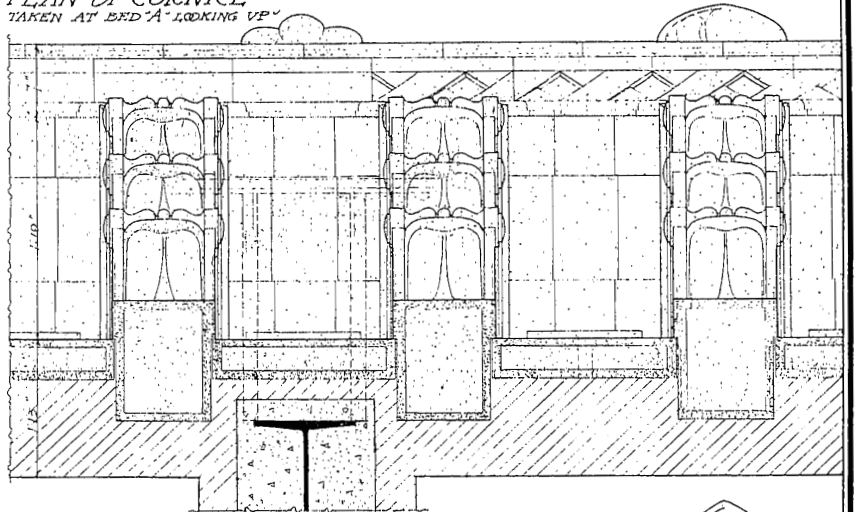


TERRA COTTA STANDARD CONSTRUCTION

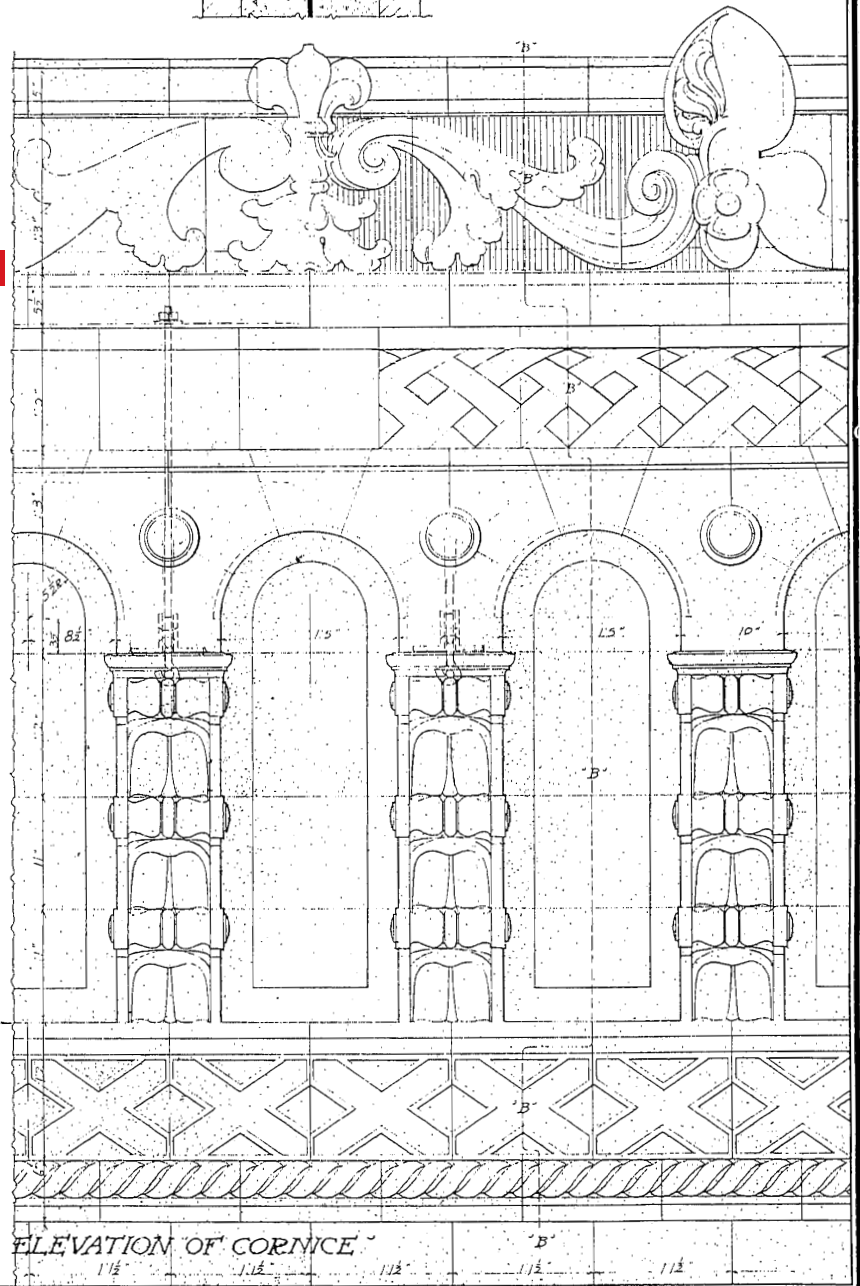
HEAVY BRACKETED CORNICE WITH ORNAMENTED CHENEAU SHOWING METHOD OF SUPPORT AND ANCHORAGE

SCALE THREE QUARTERS OF AN INCH EQUALS ONE FOOT

PLAN OF CORNICE TAKEN AT END 'A' LOOKING UP

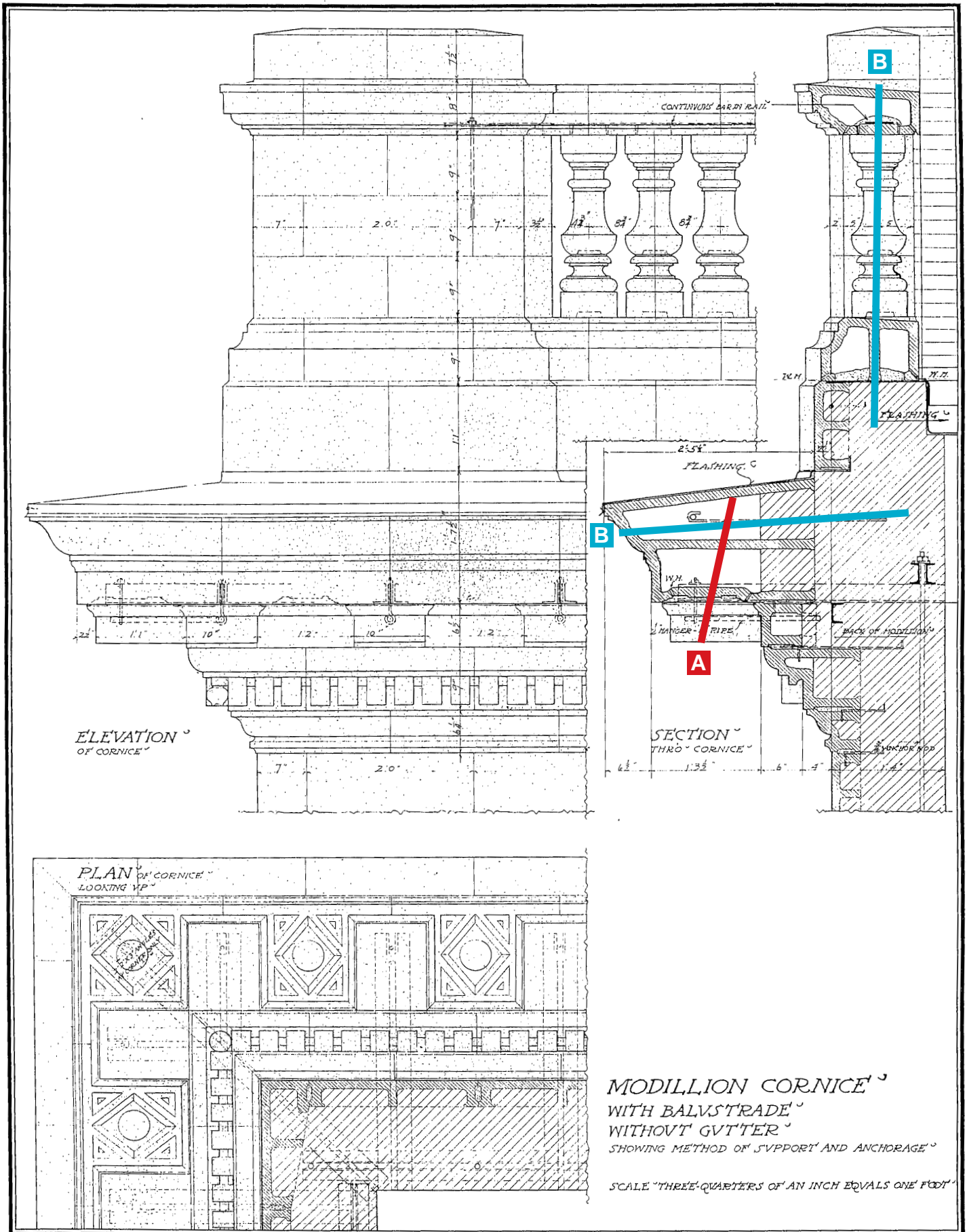


SECTION THRO' CORNICE ON LINE 'B-B'



ELEVATION OF CORNICE

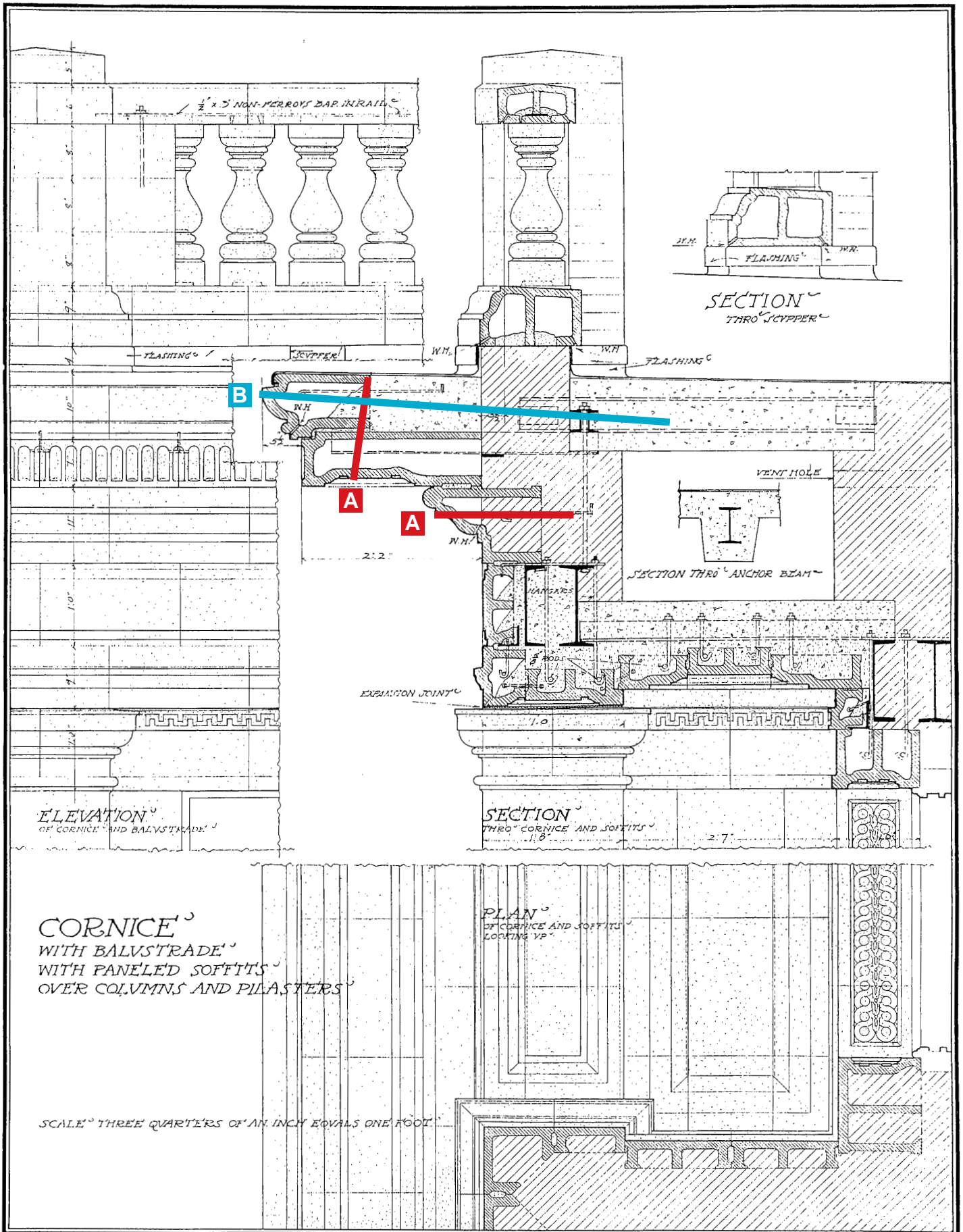
TERRA COTTA STANDARD CONSTRUCTION



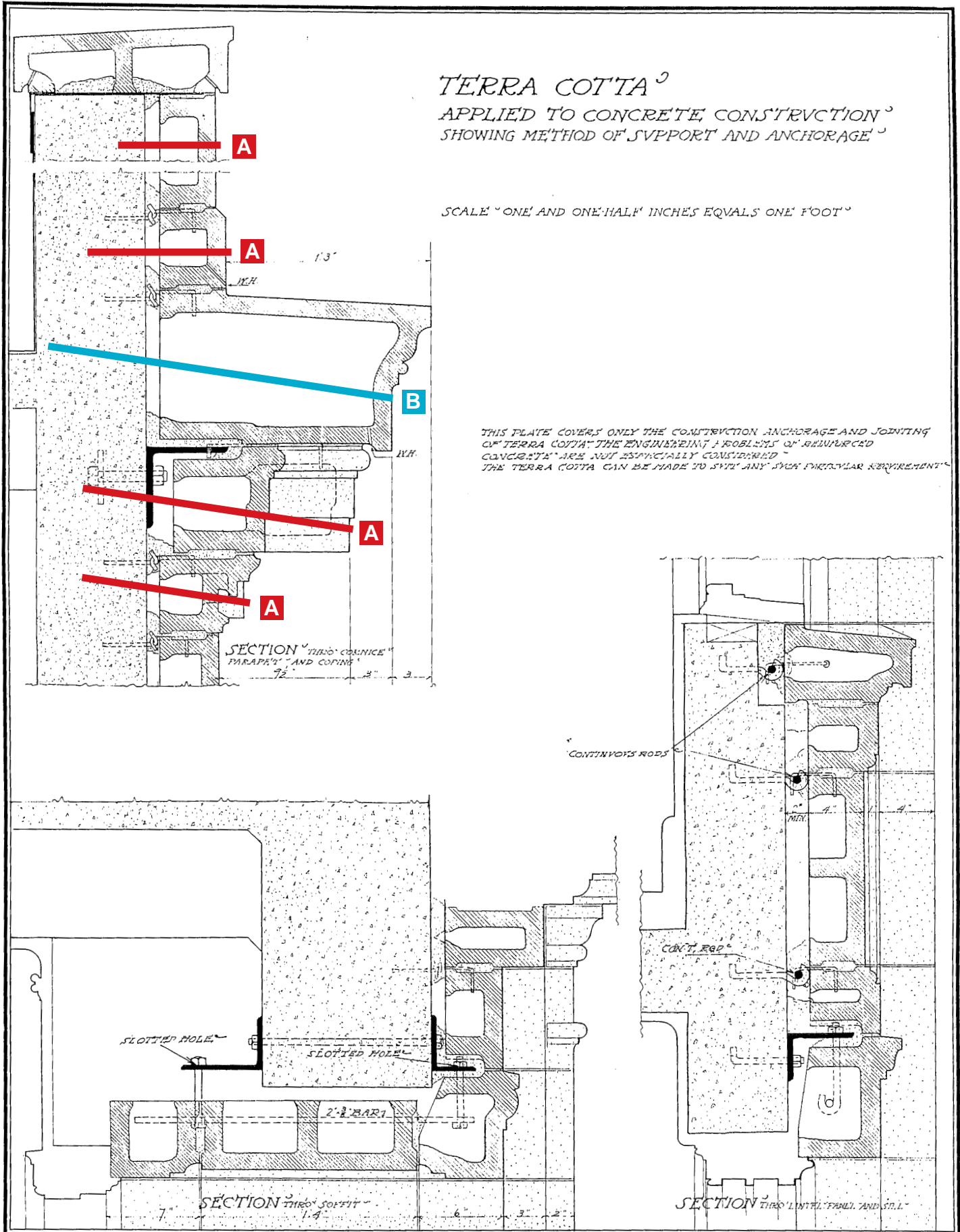
MODILLION CORNICE WITH BALVSTRADE WITHOUT GUTTER SHOWING METHOD OF SUPPORT AND ANCHORAGE

SCALE THREE-QUARTERS OF AN INCH EQUALS ONE FOOT

▲ ▲ ▲ ▲ TERRA COTTA ▲ ▲ STANDARD CONSTRUCTION ▲ ▲ ▲ ▲

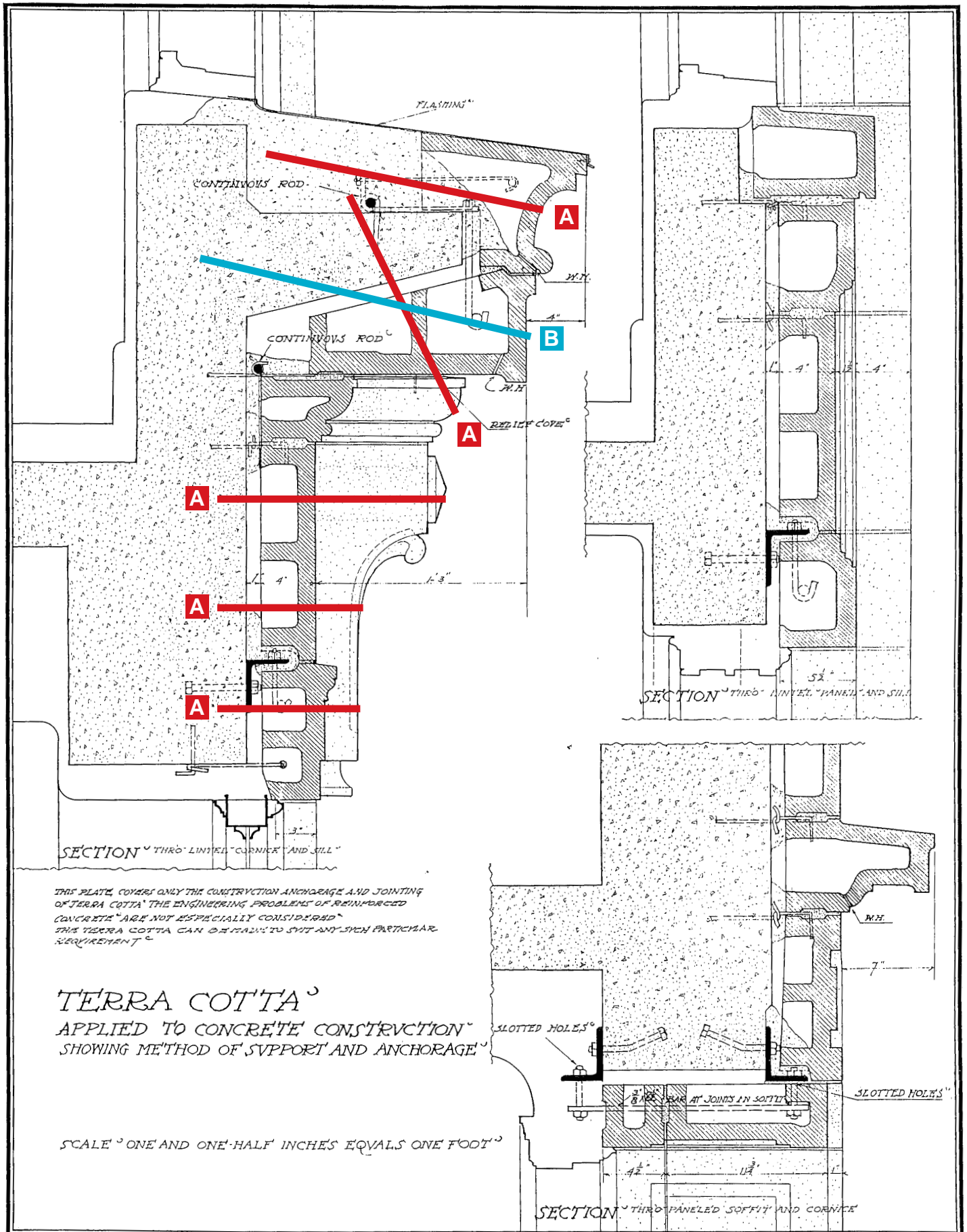


TERRA COTTA STANDARD CONSTRUCTION



THIS PLATE COVERS ONLY THE CONSTRUCTION ANCHORAGE AND JOINTING OF TERRA COTTA. THE ENGINEERING PROBLEMS OF REINFORCED CONCRETE ARE NOT ESPECIALLY CONSIDERED. THE TERRA COTTA CAN BE MADE TO SUIT ANY SUCH PARTICULAR REQUIREMENT.

TERRA COTTA STANDARD CONSTRUCTION

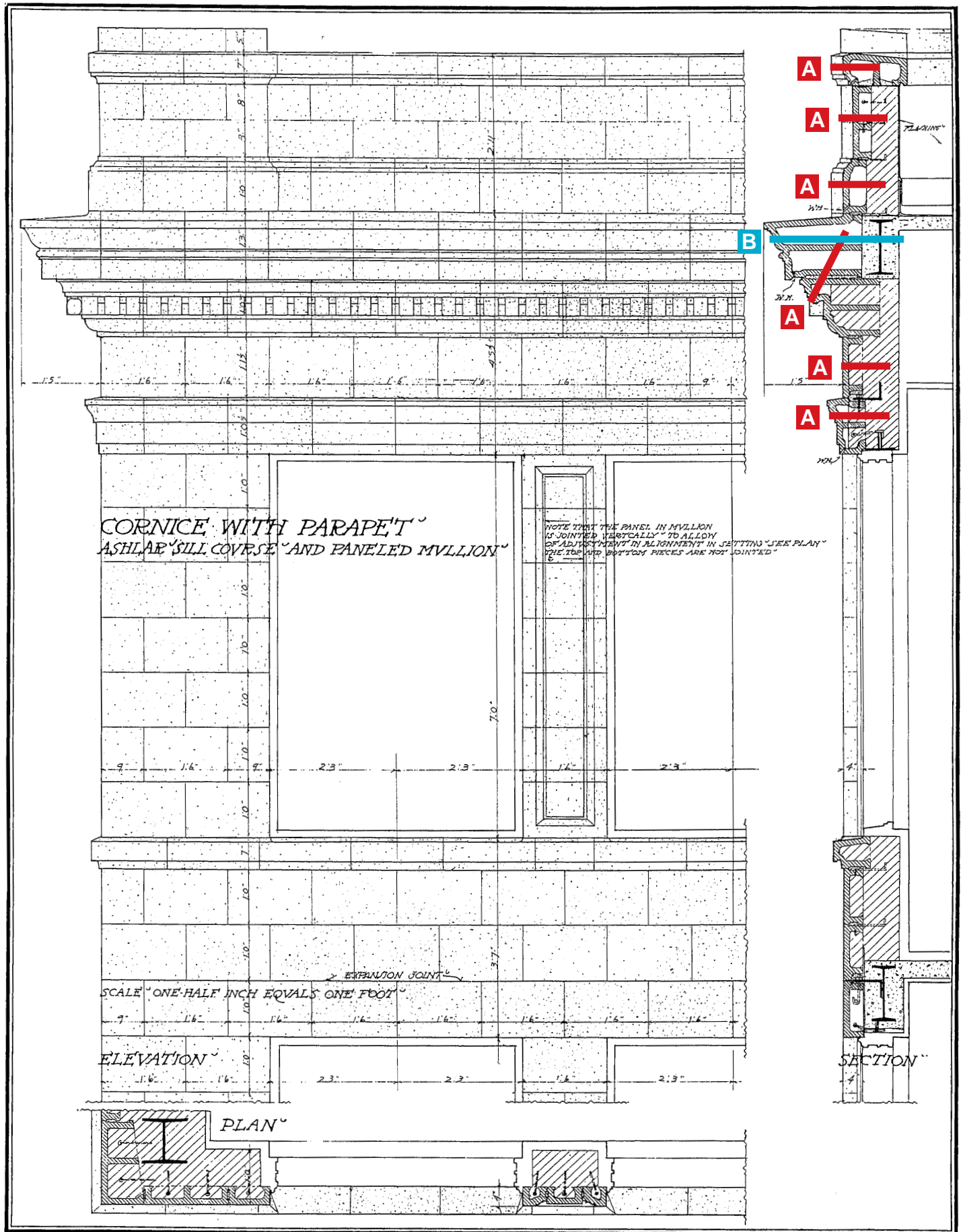


THIS PLATE COVERS ONLY THE CONSTRUCTION ANCHORAGE AND JOINTING OF TERRA COTTA. THE ENGINEERING PROBLEMS OF REINFORCED CONCRETE ARE NOT ESPECIALLY CONSIDERED. THE TERRA COTTA CAN BE MADE TO SUIT ANY SUCH PARTICULAR REQUIREMENT.

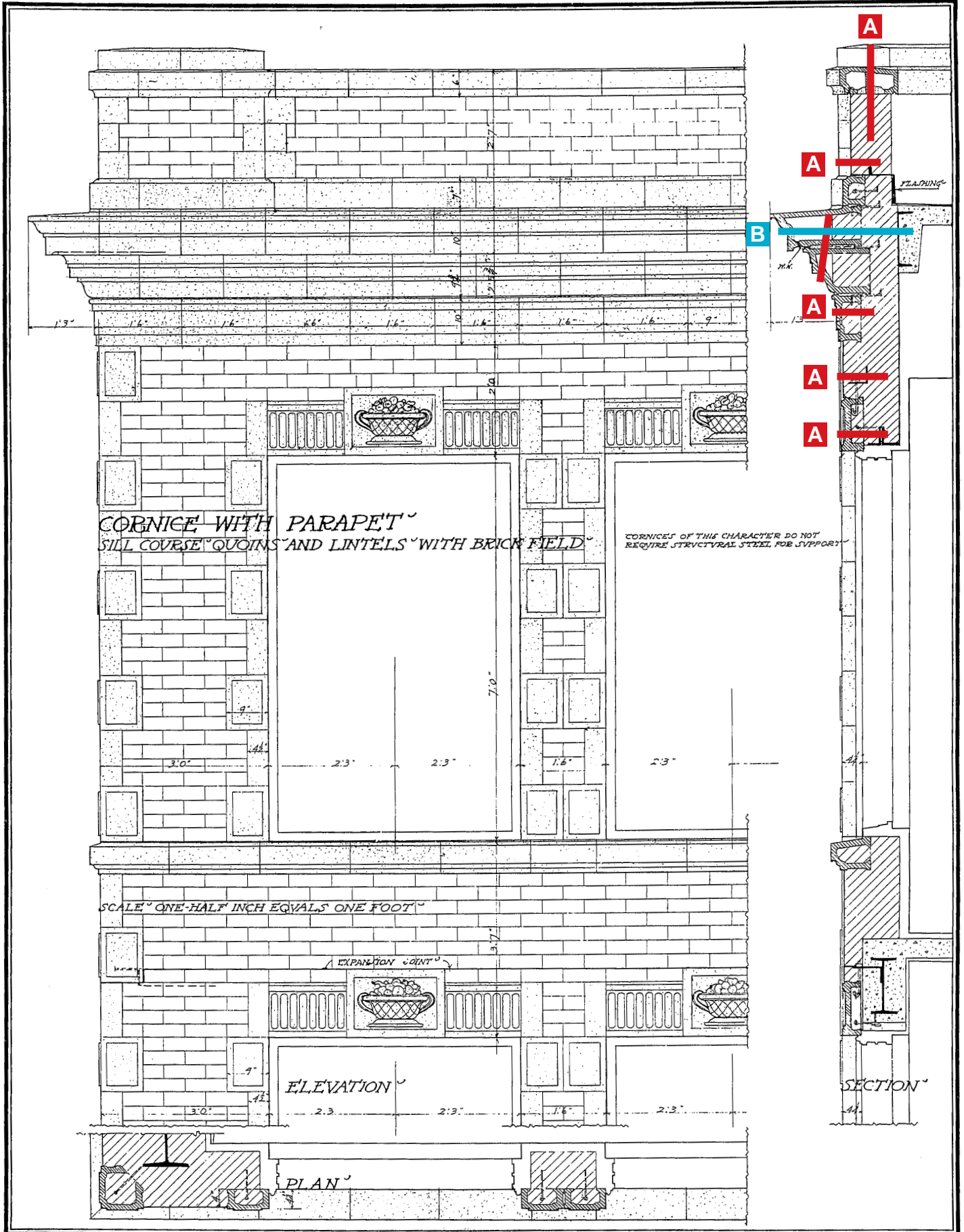
TERRA COTTA³
 APPLIED TO CONCRETE CONSTRUCTION³
 SHOWING METHOD OF SUPPORT AND ANCHORAGE³

SCALE³ ONE AND ONE-HALF INCHES EQUALS ONE FOOT³

TERRA COTTA STANDARD CONSTRUCTION



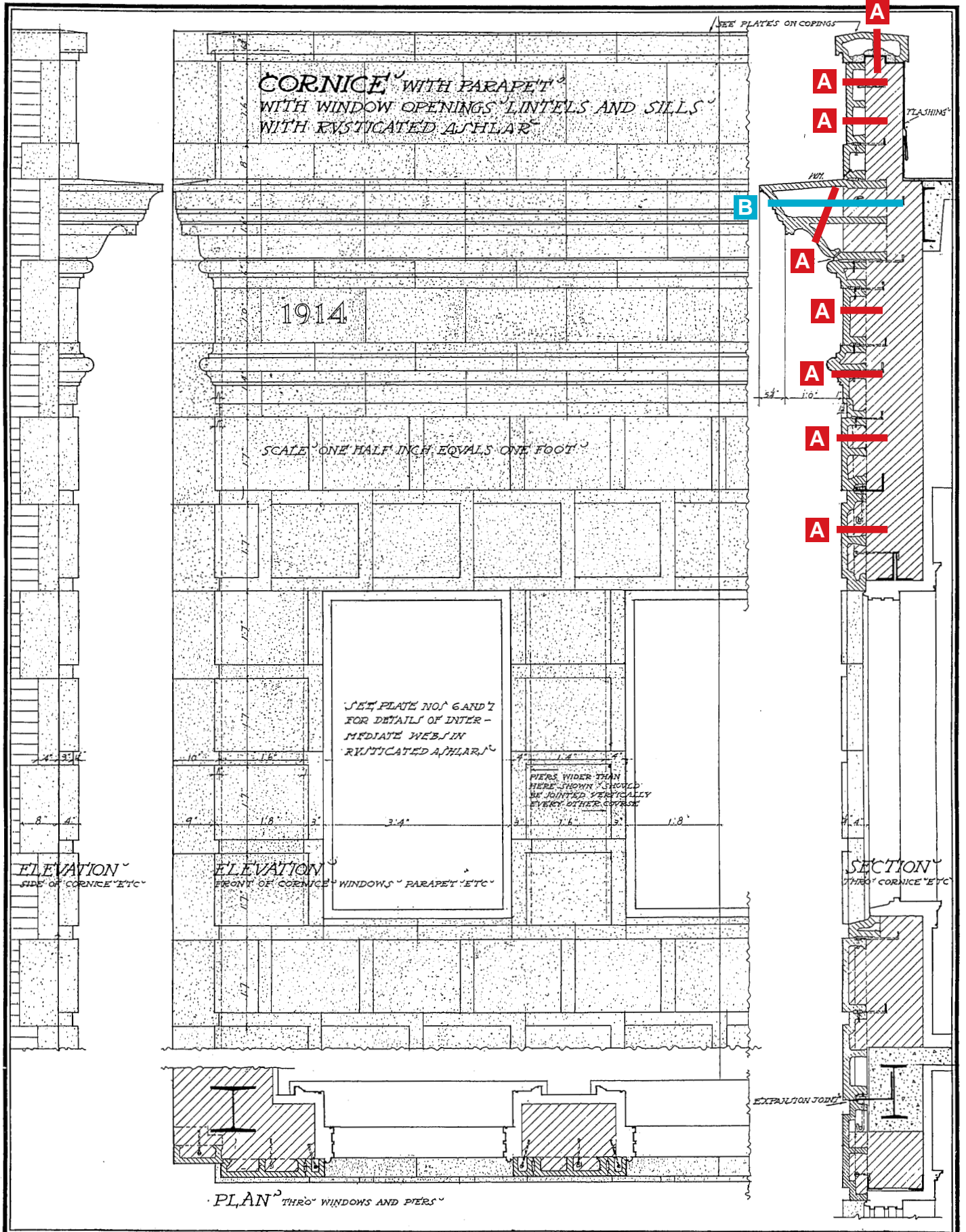
TERRA COTTA STANDARD CONSTRUCTION



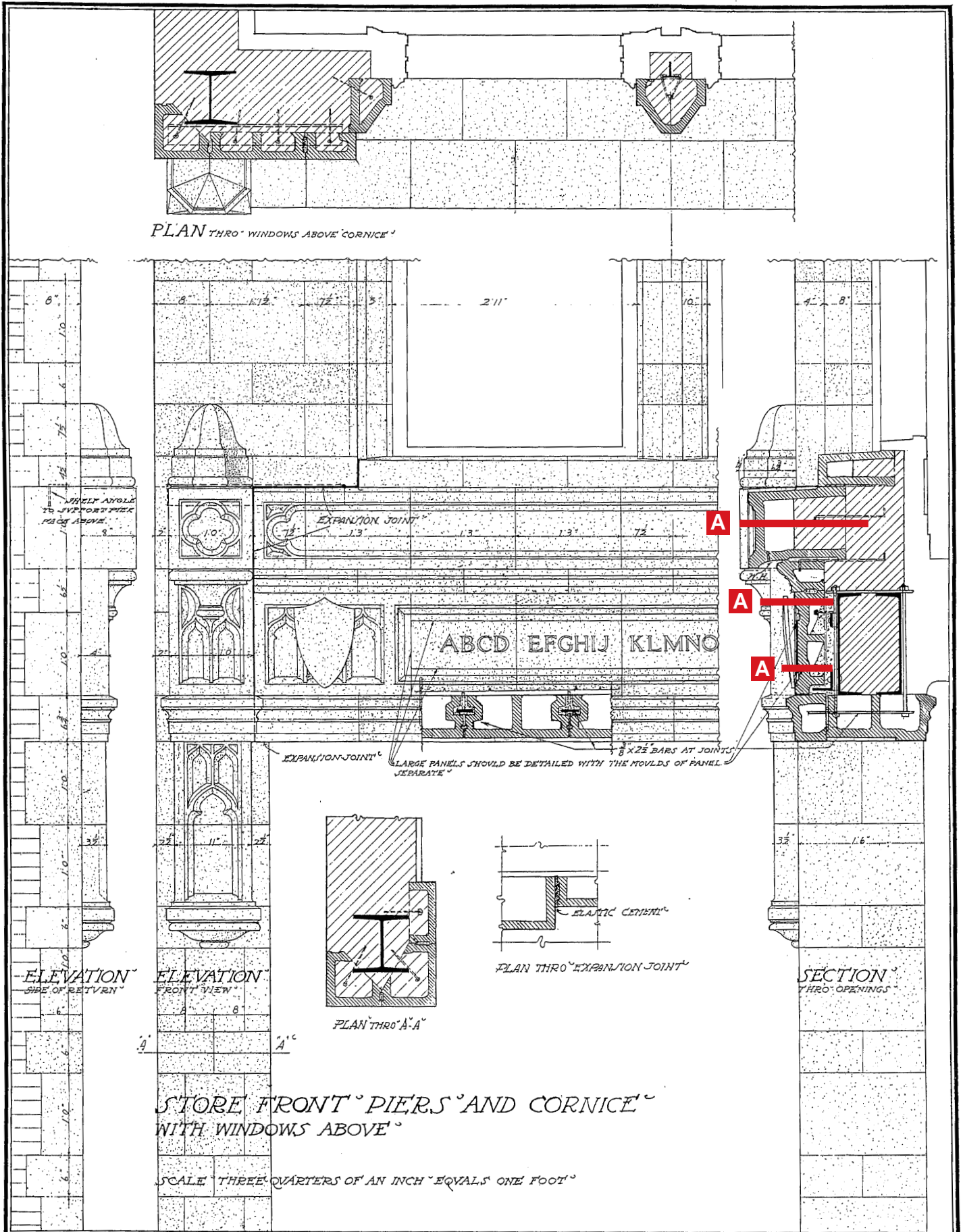
NATIONAL TERRA COTTA SOCIETY V.S.A. PLATE NO. 30

This manual provides general information for use in preliminary selection of a Cintec anchor. Final designs must be prepared by Cintec and approved by the project Architect or Engineer of Record.

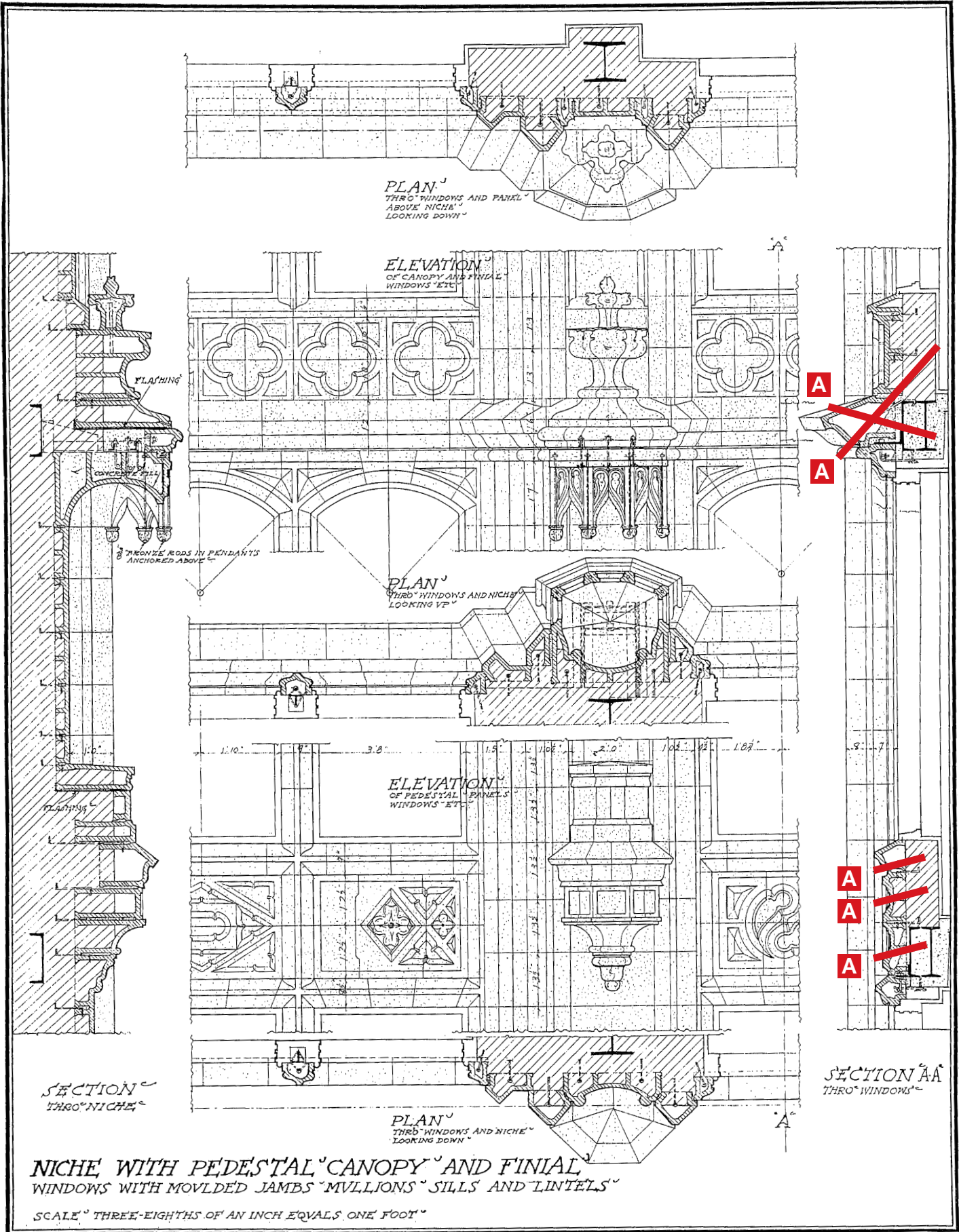
TERRA COTTA STANDARD CONSTRUCTION



TERRA COTTA STANDARD CONSTRUCTION



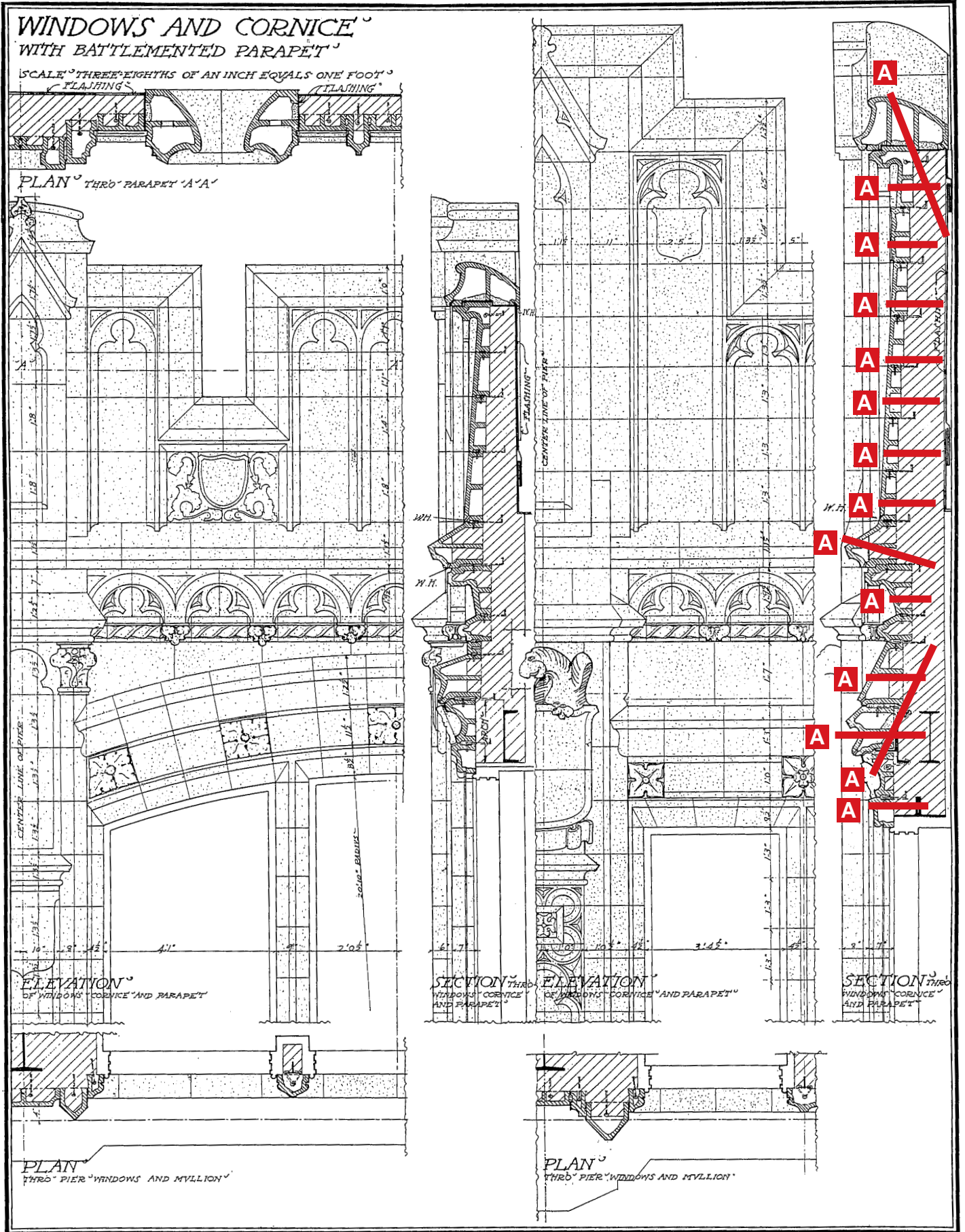
▲ ▲ ▲ ▲ TERRA COTTA ▲ ▲ STANDARD CONSTRUCTION ▲ ▲ ▲ ▲



NATIONAL TERRA COTTA SOCIETY V S A PLATE NO 33

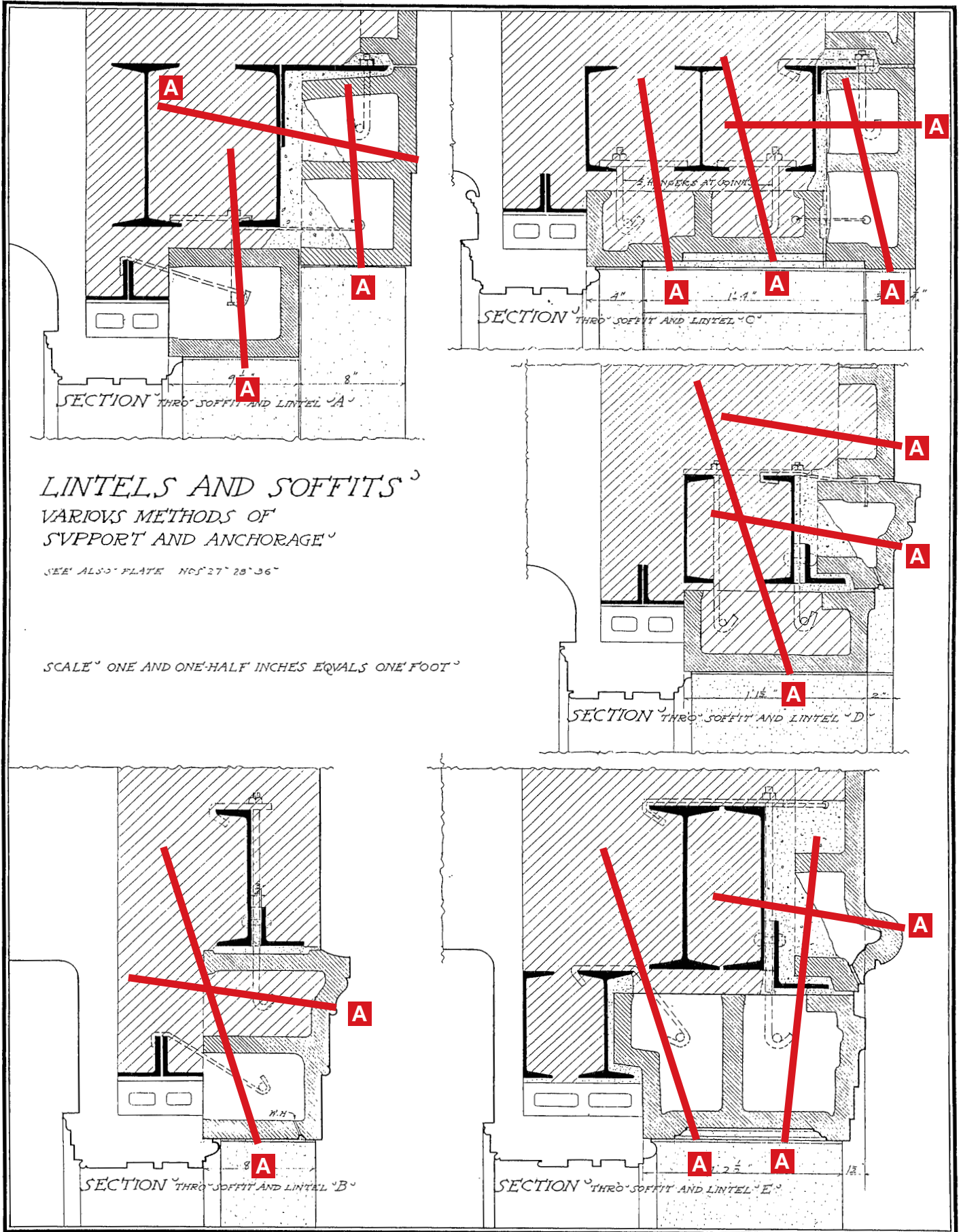
This manual provides general information for use in preliminary selection of a Cintec anchor.
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TERRA COTTA STANDARD CONSTRUCTION



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TERRA COTTA STANDARD CONSTRUCTION

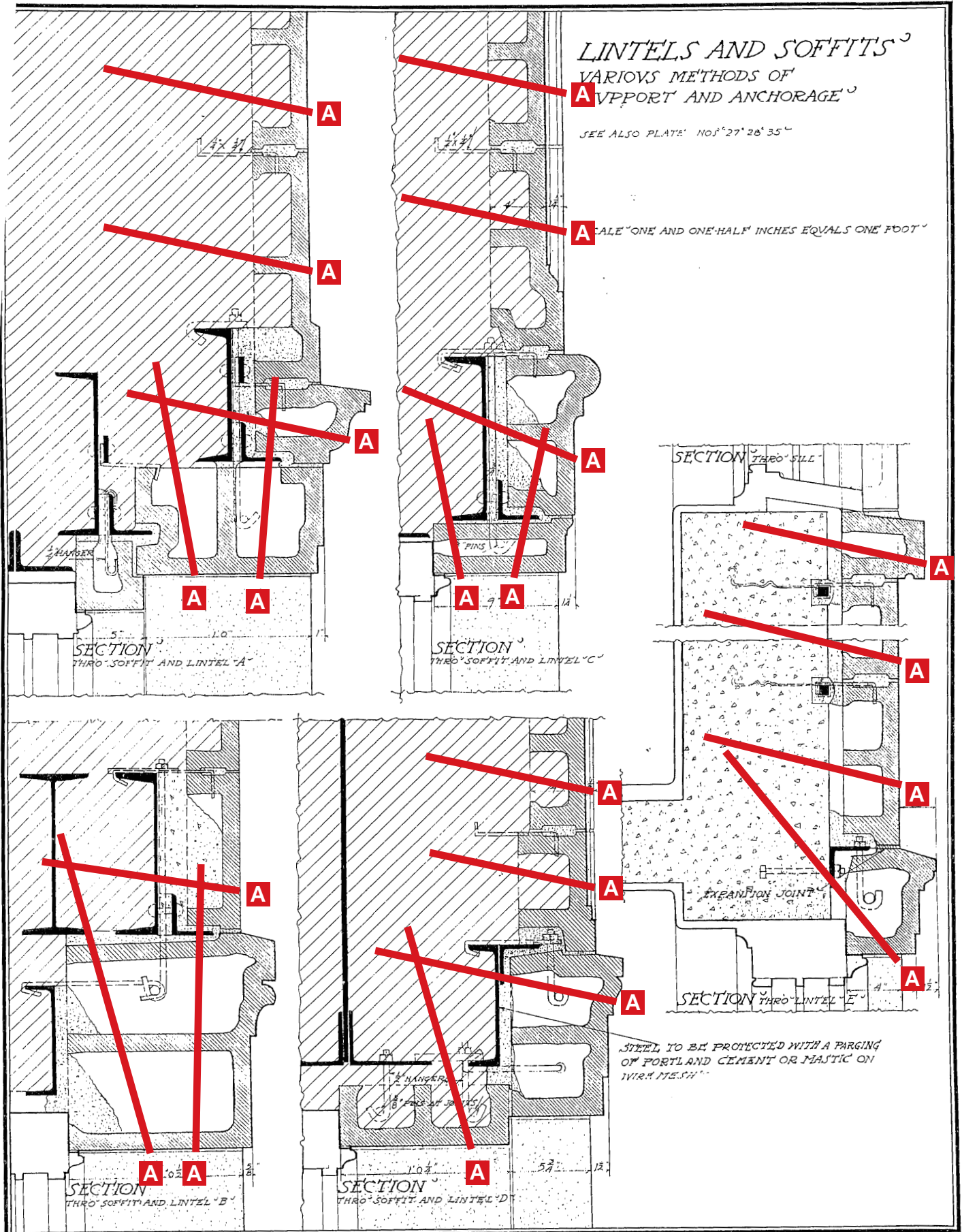


LINTELS AND SOFFITS³
 VARIOUS METHODS OF
 SUPPORT AND ANCHORAGE³

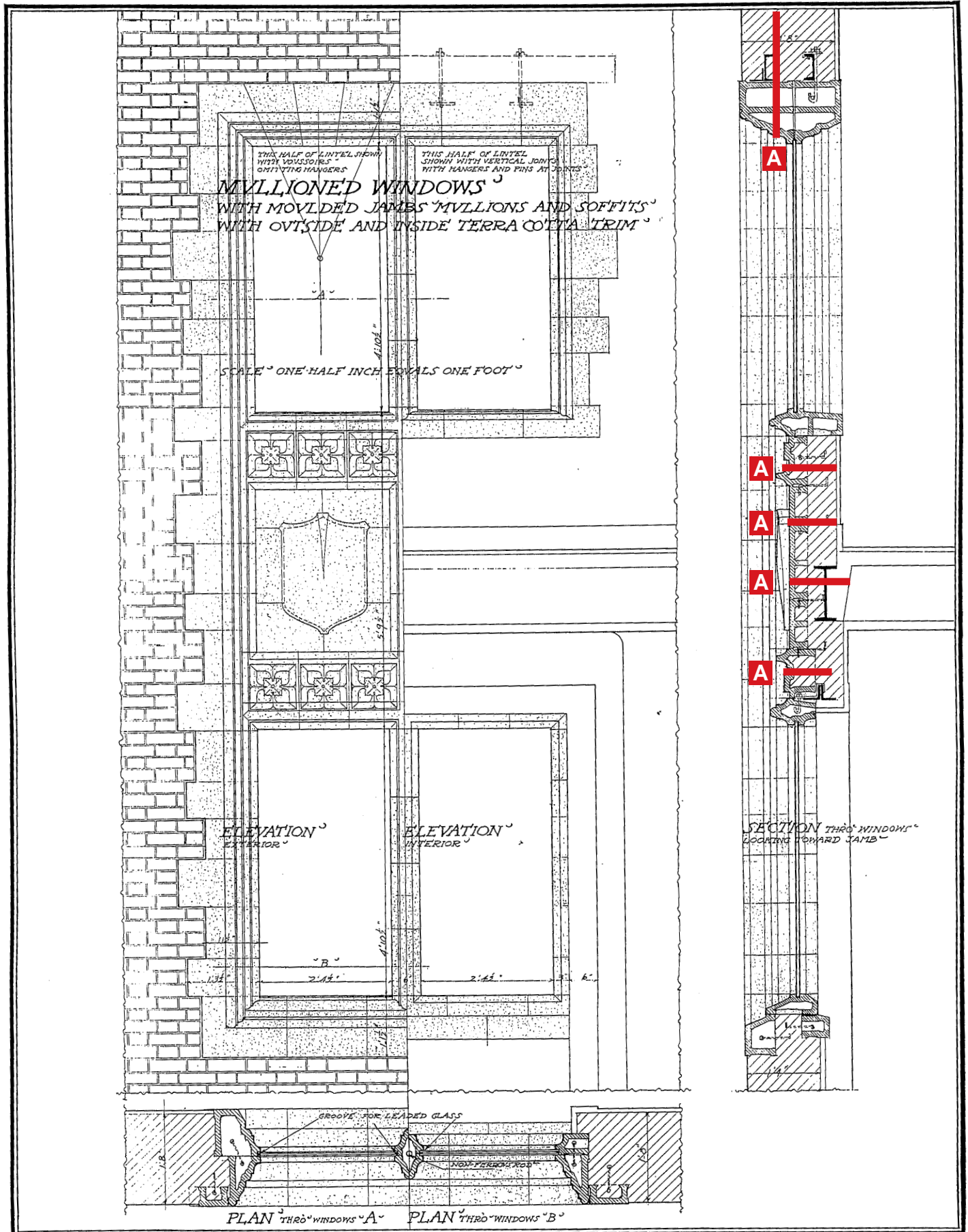
SEE ALSO PLATE NOS 27 28 36

SCALE ONE AND ONE-HALF INCHES EQUALS ONE FOOT

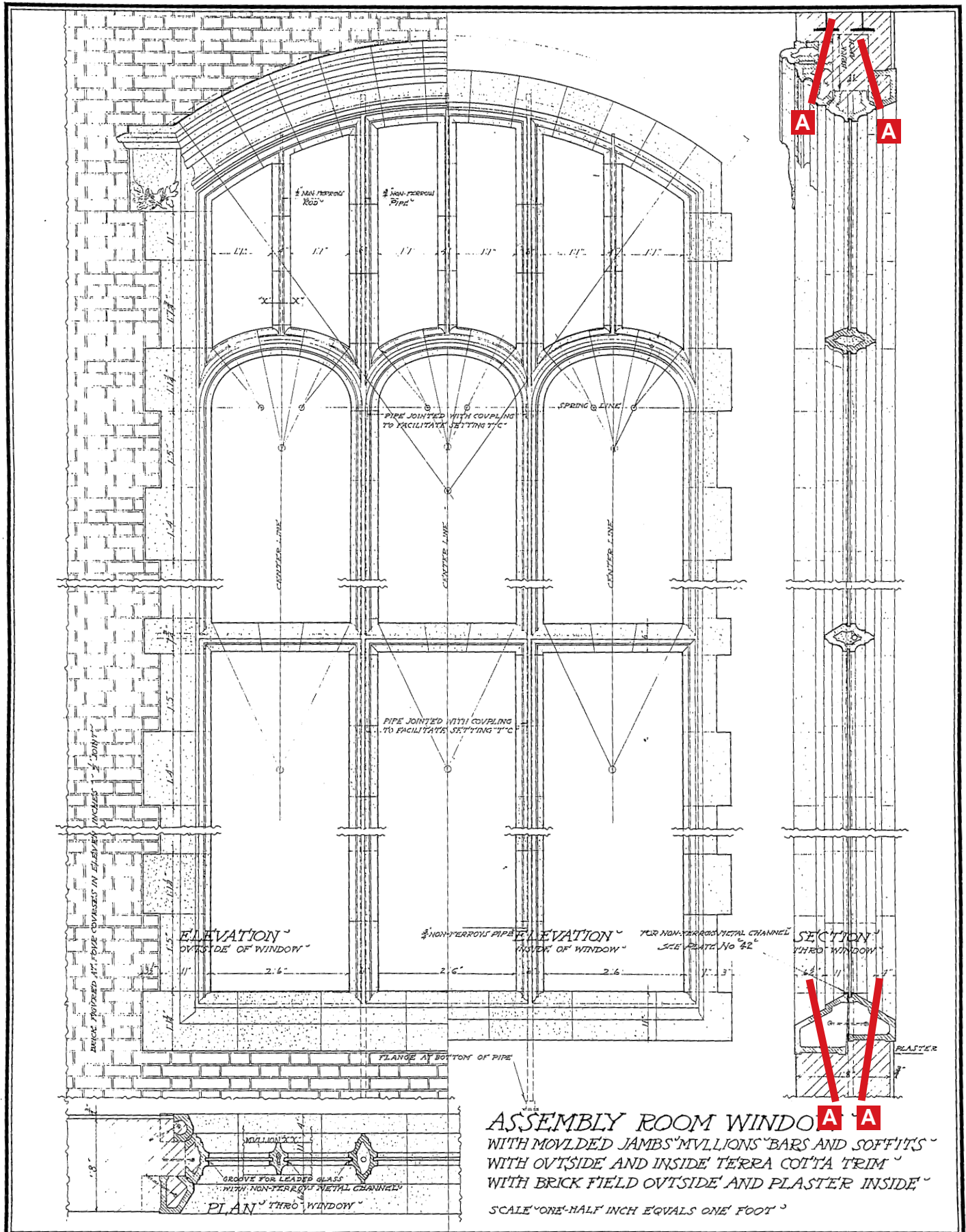
▲ ▲ ▲ ▲ TERRA COTTA STANDARD CONSTRUCTION ▲ ▲ ▲ ▲



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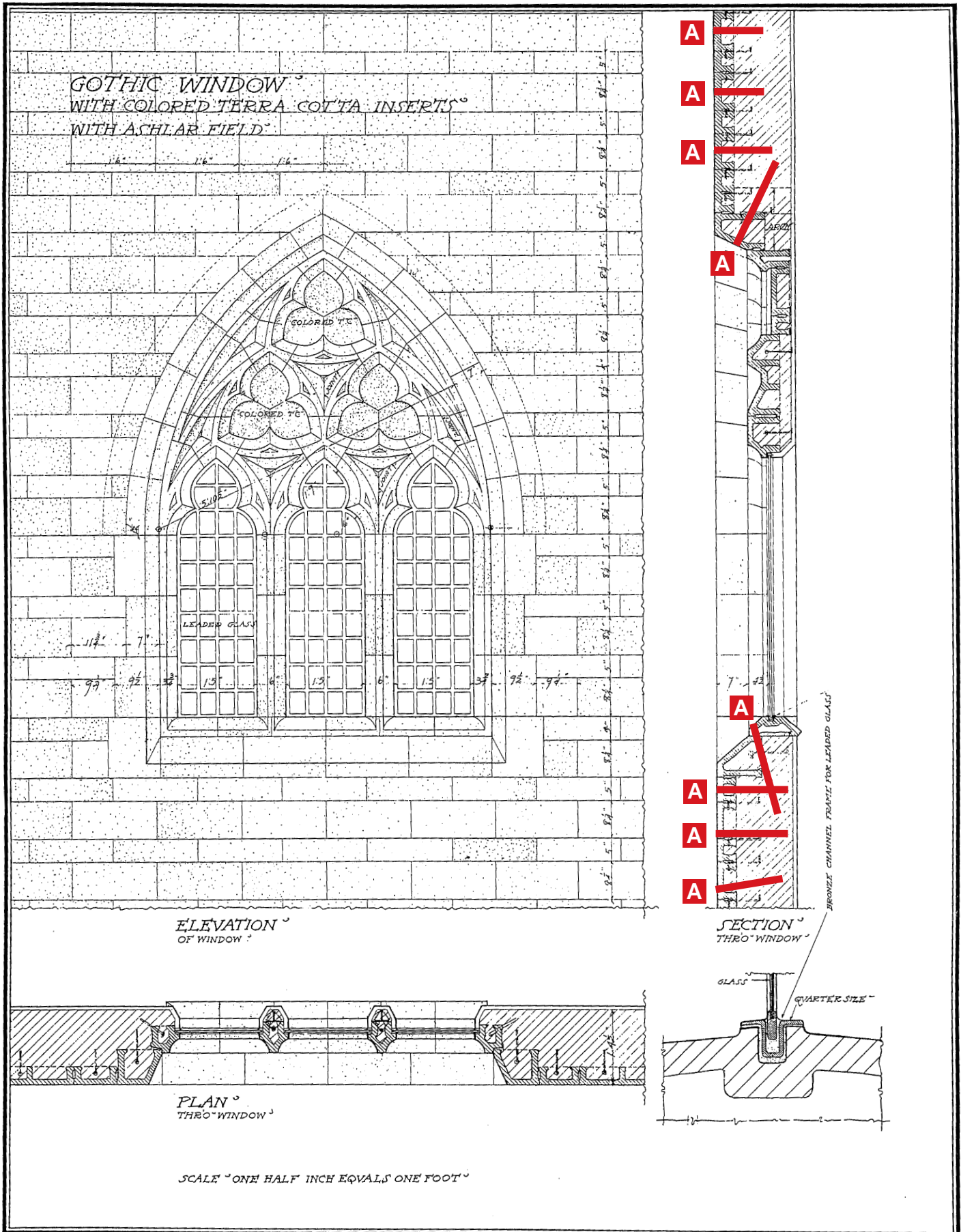


▲ ▲ ▲ ▲ TERRA COTTA ▲ ▲ STANDARD CONSTRUCTION ▲ ▲ ▲ ▲

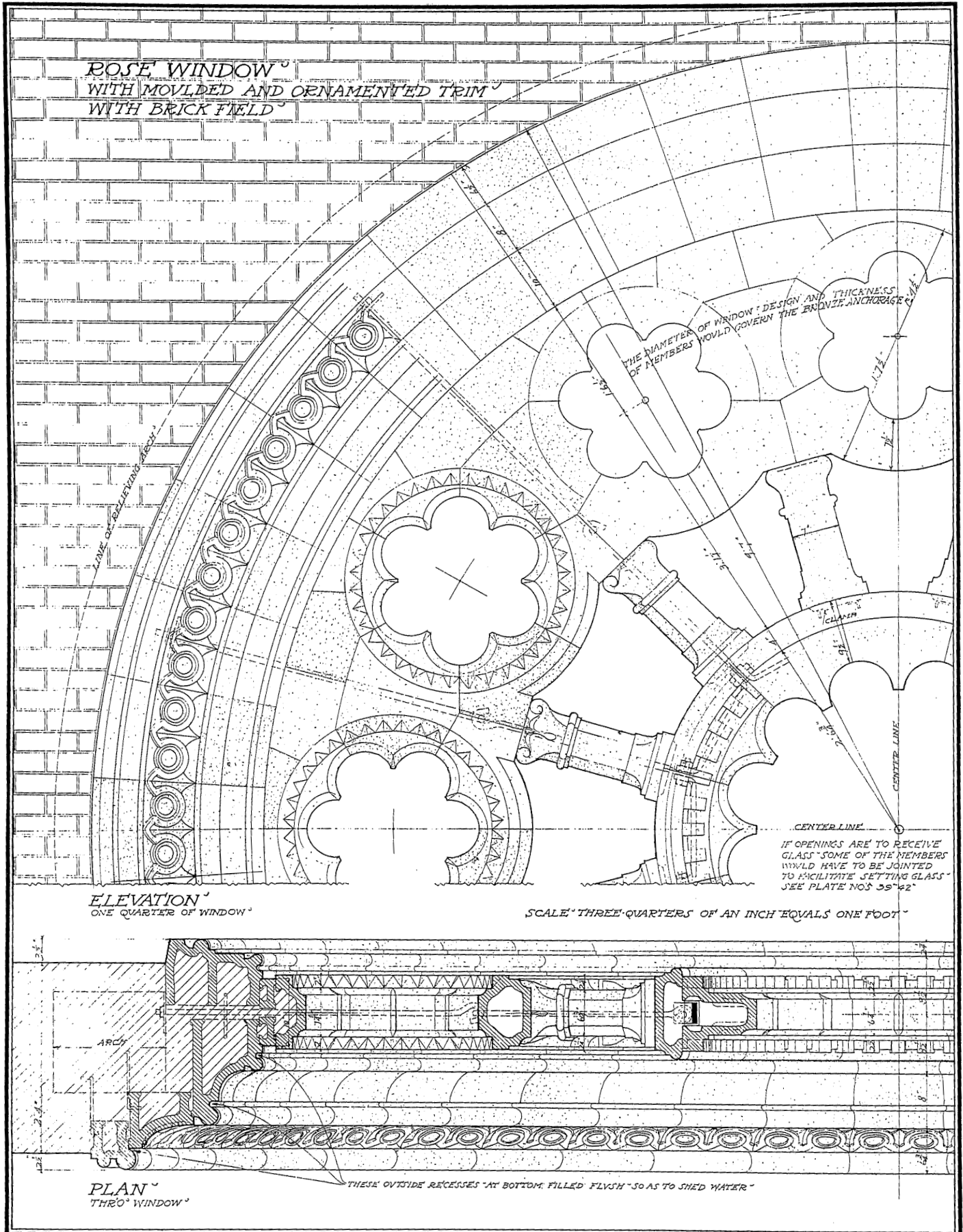


ASSEMBLY ROOM WINDOW WITH MULLIONS BARS AND SOFFITS WITH OUTSIDE AND INSIDE TERRA COTTA TRIM WITH BRICK FIELD OUTSIDE AND PLASTER INSIDE
 SCALE ONE-HALF INCH EQUALS ONE FOOT

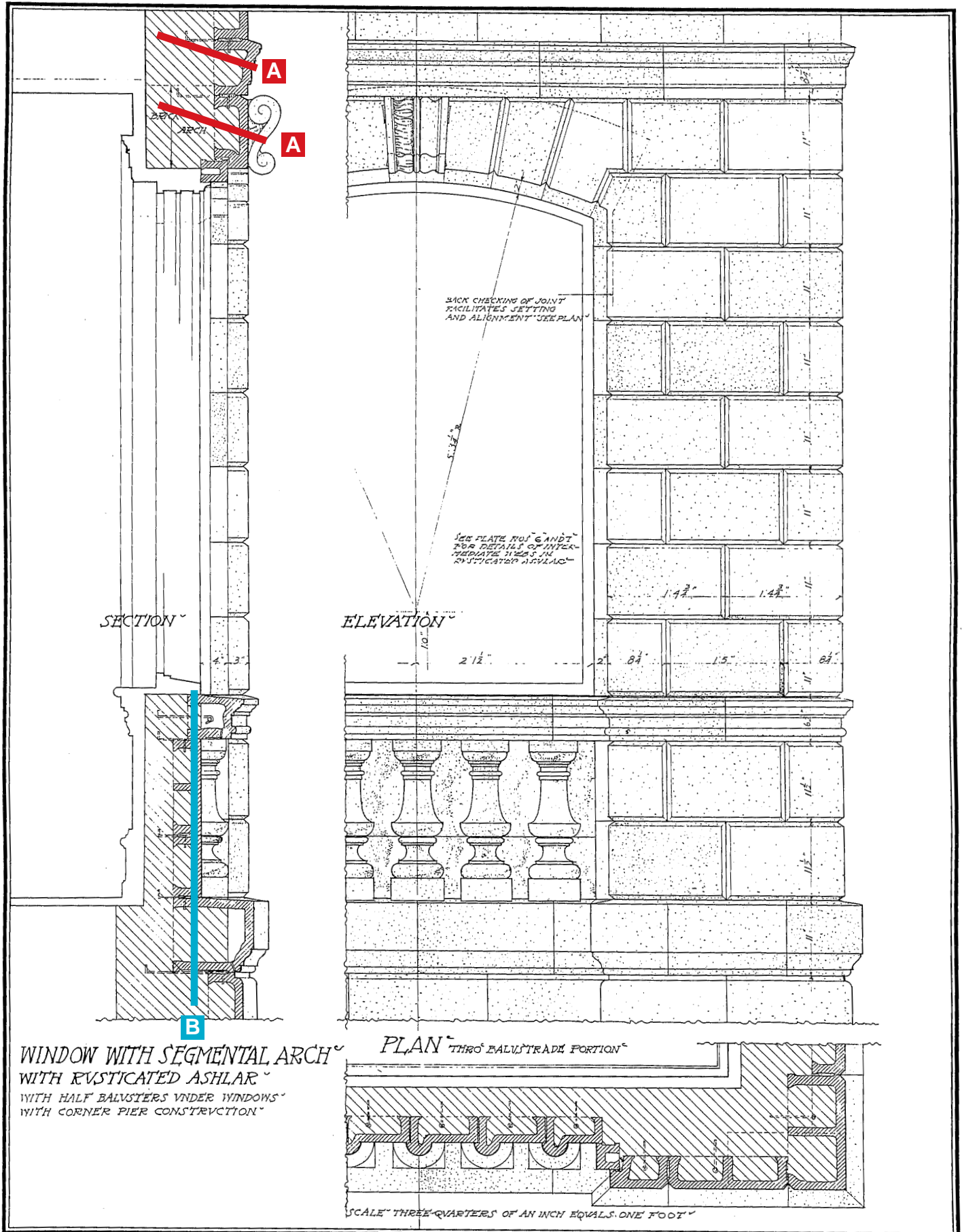
TERRA COTTA STANDARD CONSTRUCTION



TERRA COTTA · STANDARD CONSTRUCTION

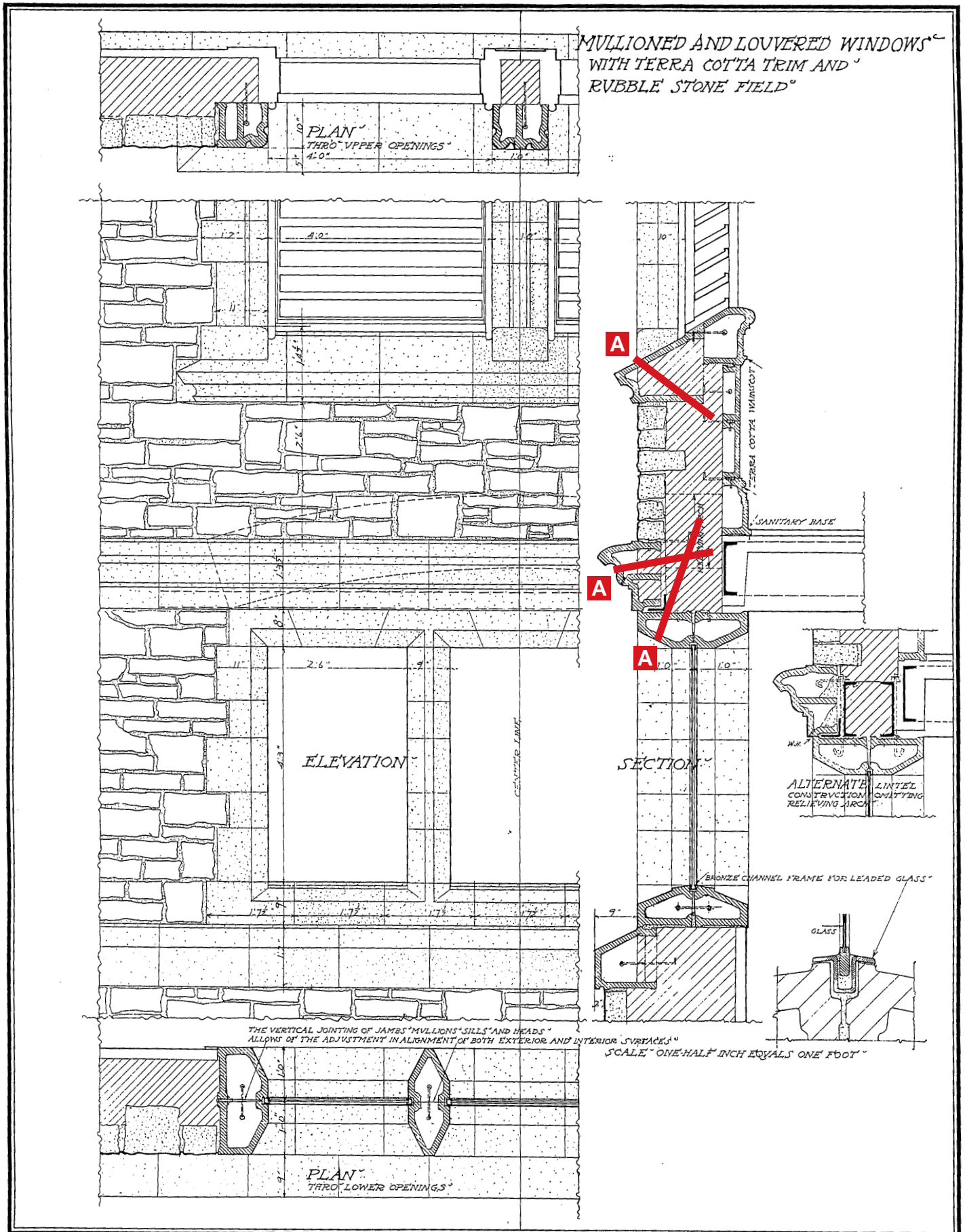


TERRA COTTA STANDARD CONSTRUCTION

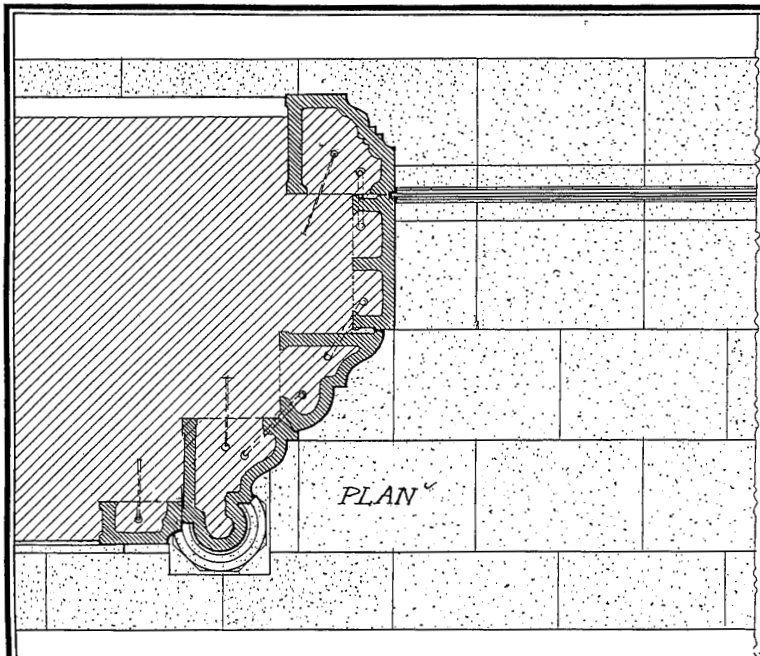


WINDOW WITH SEGMENTAL ARCH WITH RUSTICATED ASHLAR WITH HALF BALUSTERS UNDER WINDOWS WITH CORNER PIER CONSTRUCTION

TERRA COTTA STANDARD CONSTRUCTION

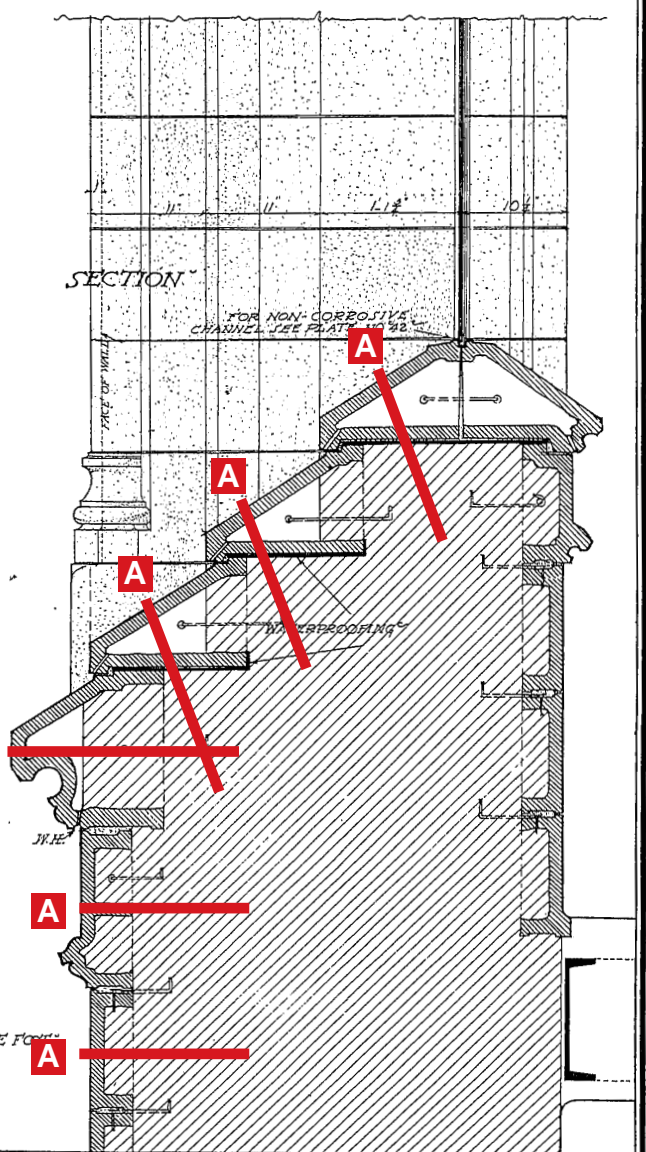
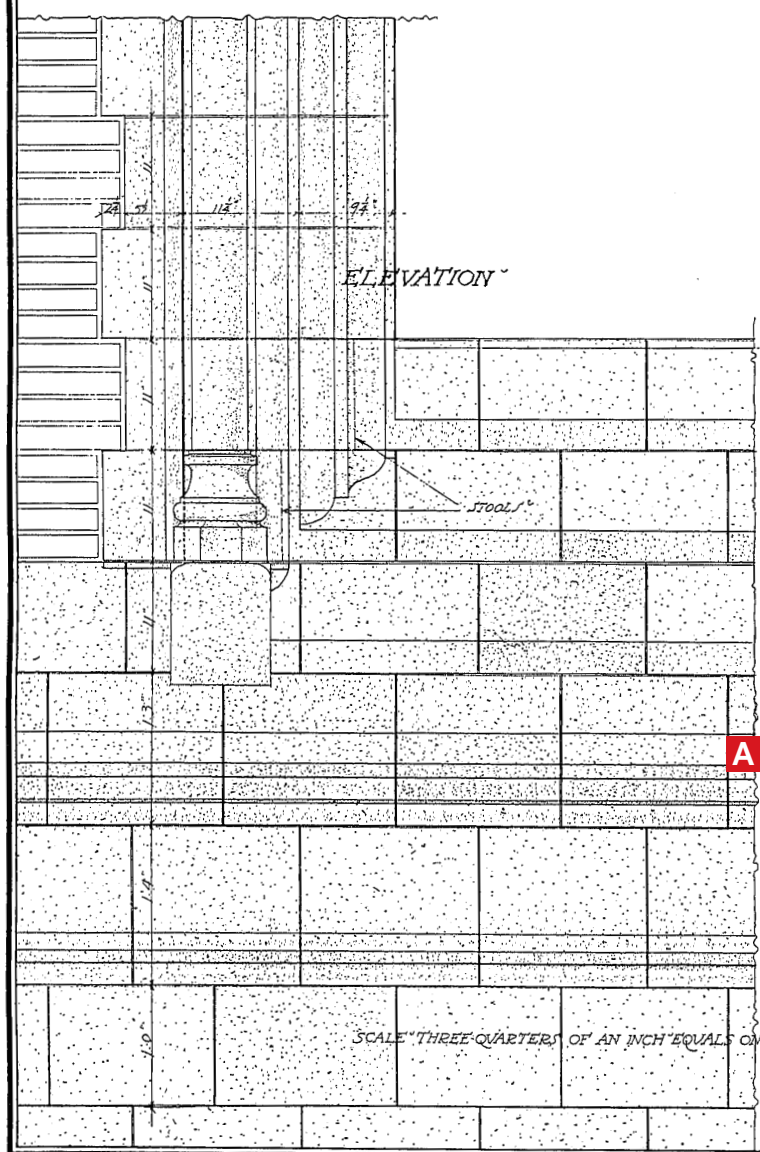


TERRA COTTA STANDARD CONSTRUCTION



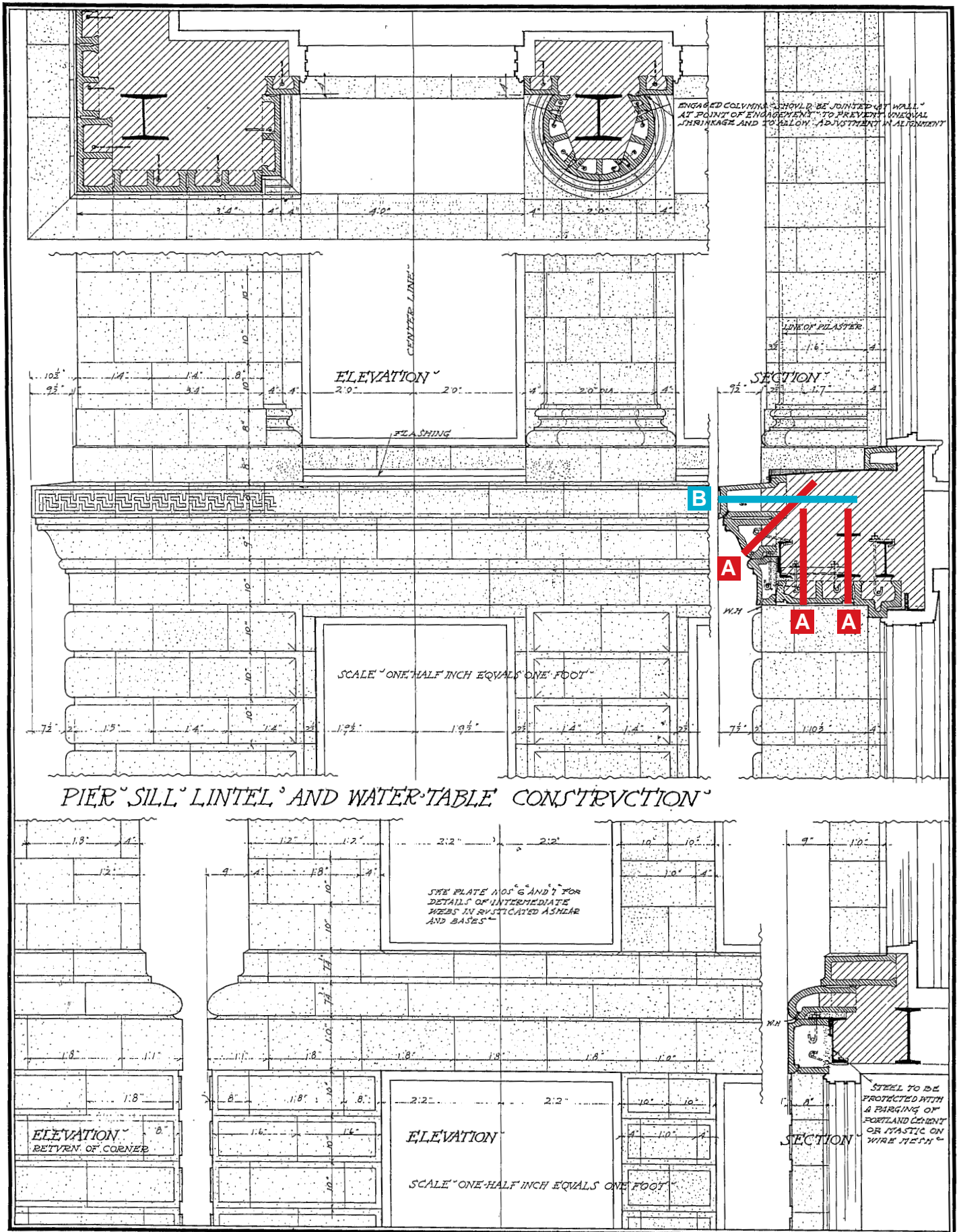
WINDOW WITH MOULDED JAMB AND SYLL WITH INTERIOR TERRA COTTA WAINSCOT

THE VERTICAL JOINTING OF MOULDED JANBS (PARTLY CONCEALED BY BACK CHECKING) AS SHOWN PERMITS OF ADJUSTMENT IN ALIGNMENT IN SETTING

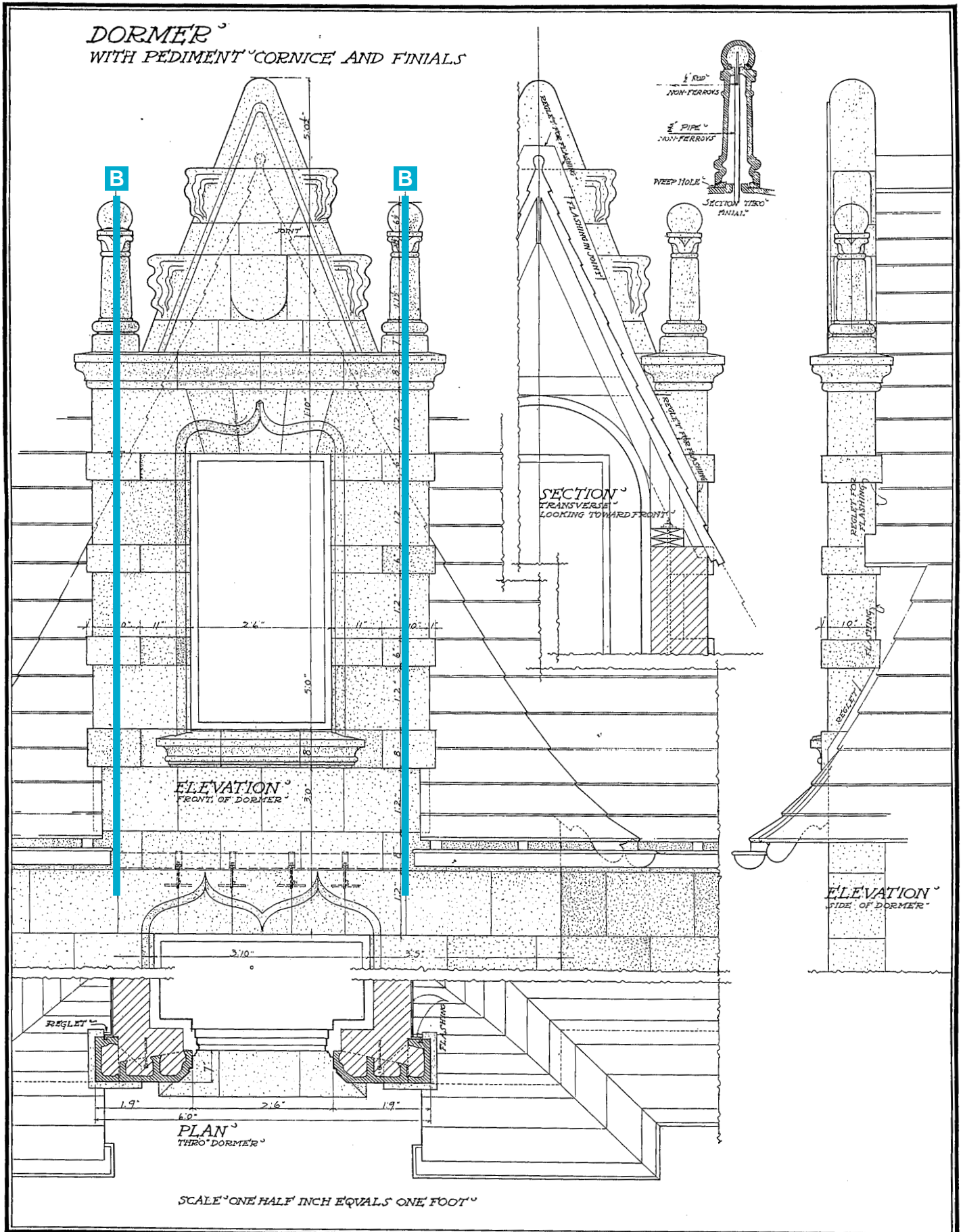


SCALE THREE-QUARTERS OF AN INCH EQUALS ONE FOOT

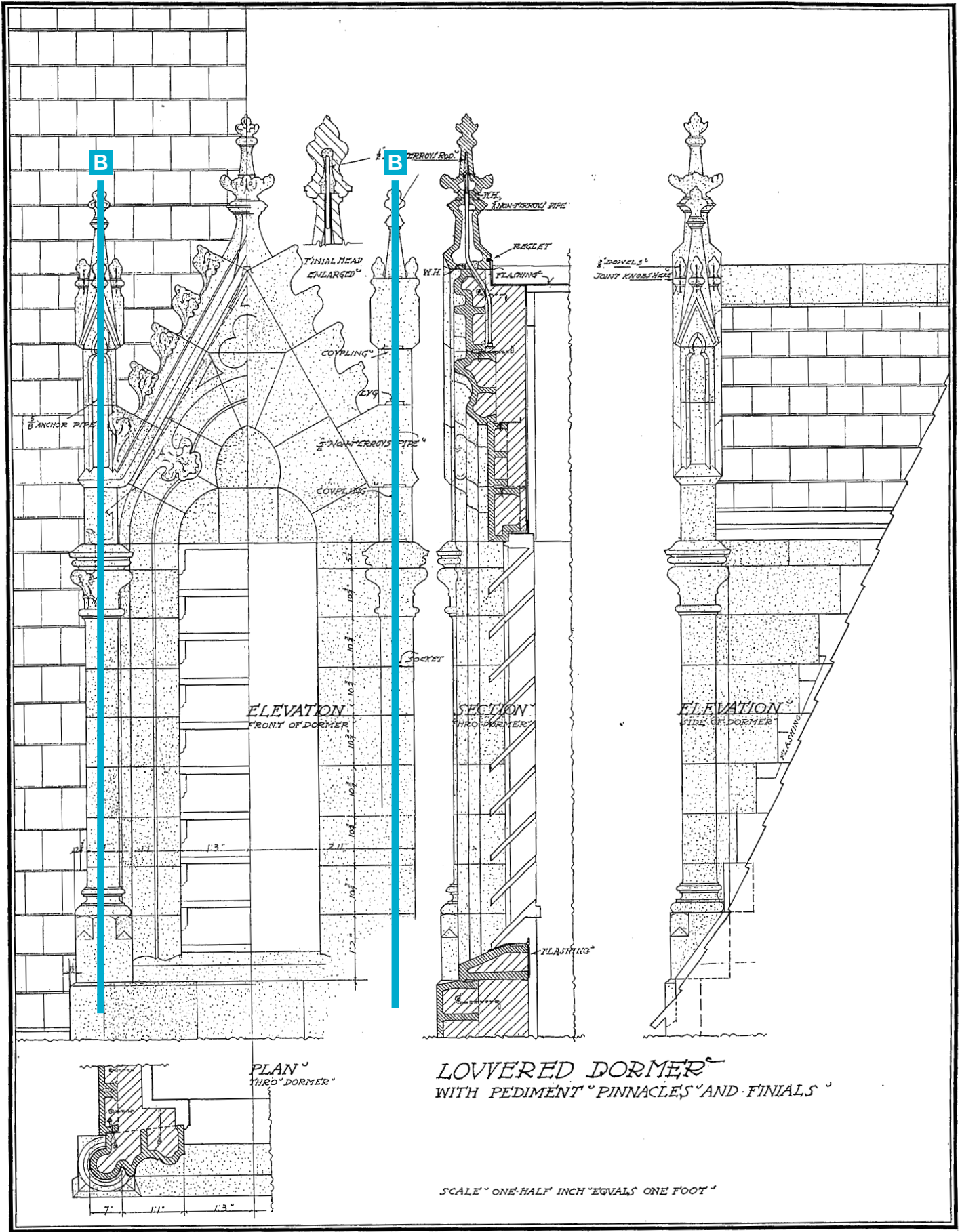
TERRA COTTA STANDARD CONSTRUCTION



▲ ▲ ▲ ▲ TERRA COTTA ▲ ▲ STANDARD CONSTRUCTION ▲ ▲ ▲ ▲



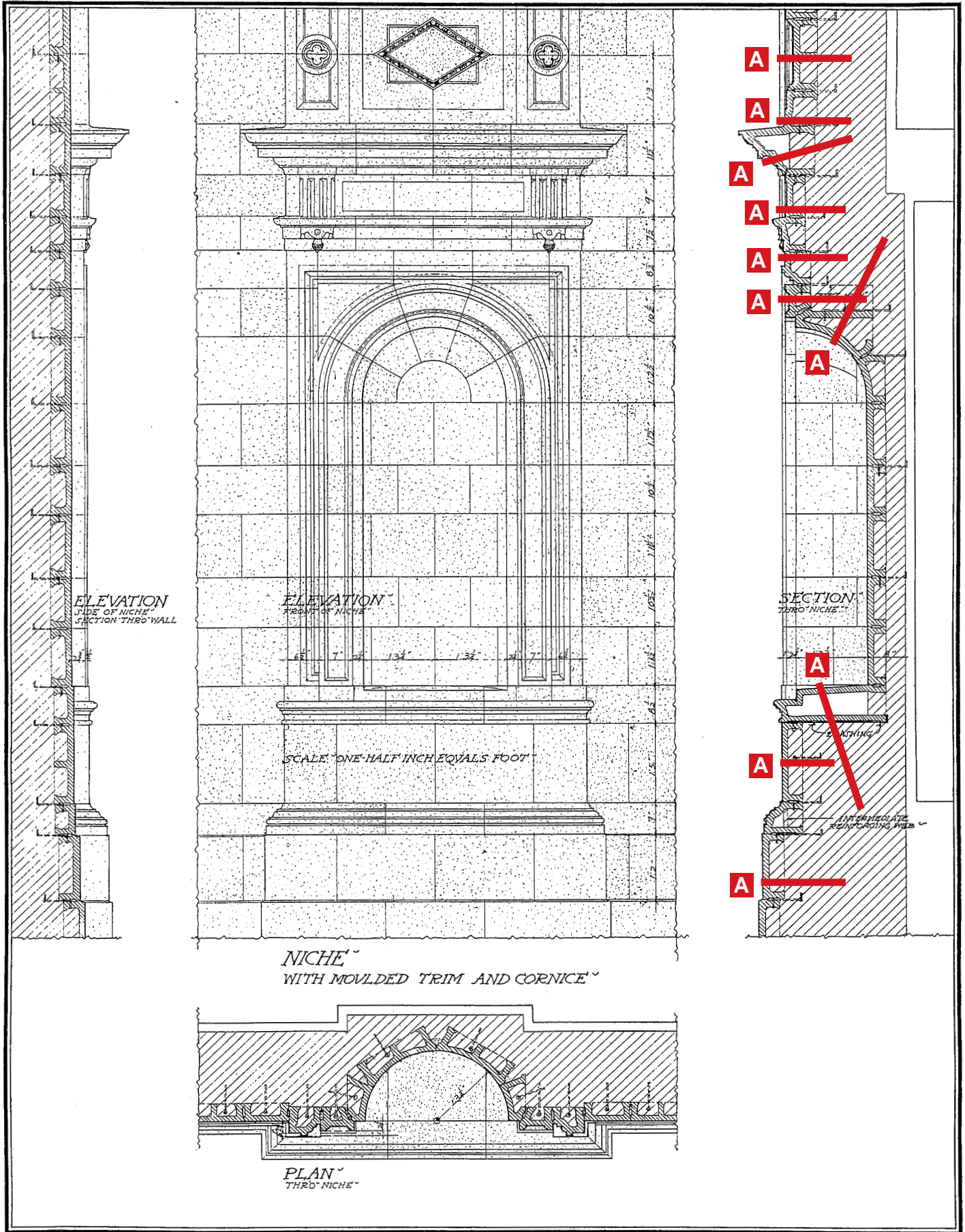
▲ ▲ ▲ ▲ TERRA COTTA ▲ ▲ STANDARD CONSTRUCTION ▲ ▲ ▲ ▲



LOWERED DORMER WITH PEDIMENT PINNACLES AND FINIALS

SCALE ONE-HALF INCH EQUALS ONE FOOT

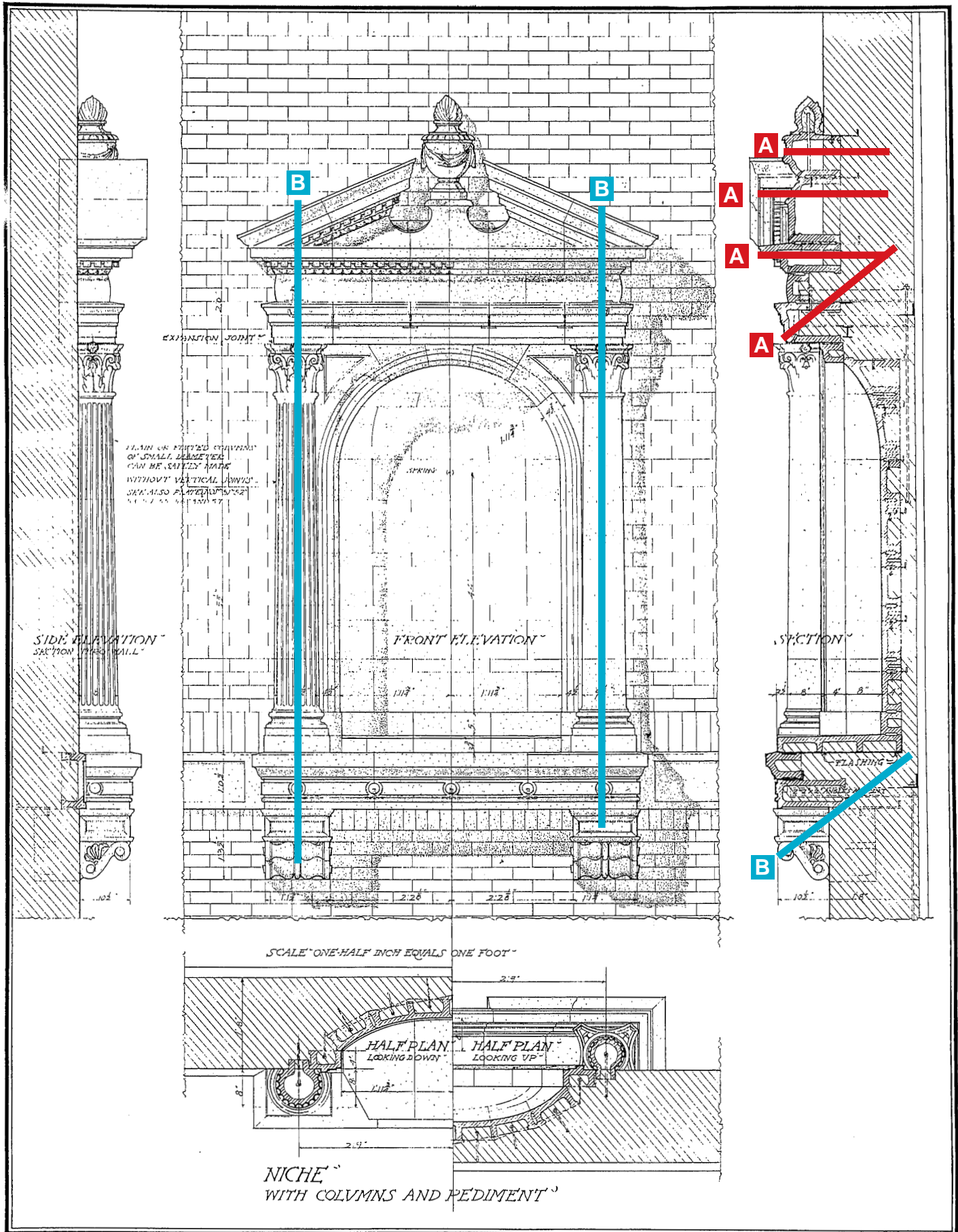
TERRA COTTA STANDARD CONSTRUCTION



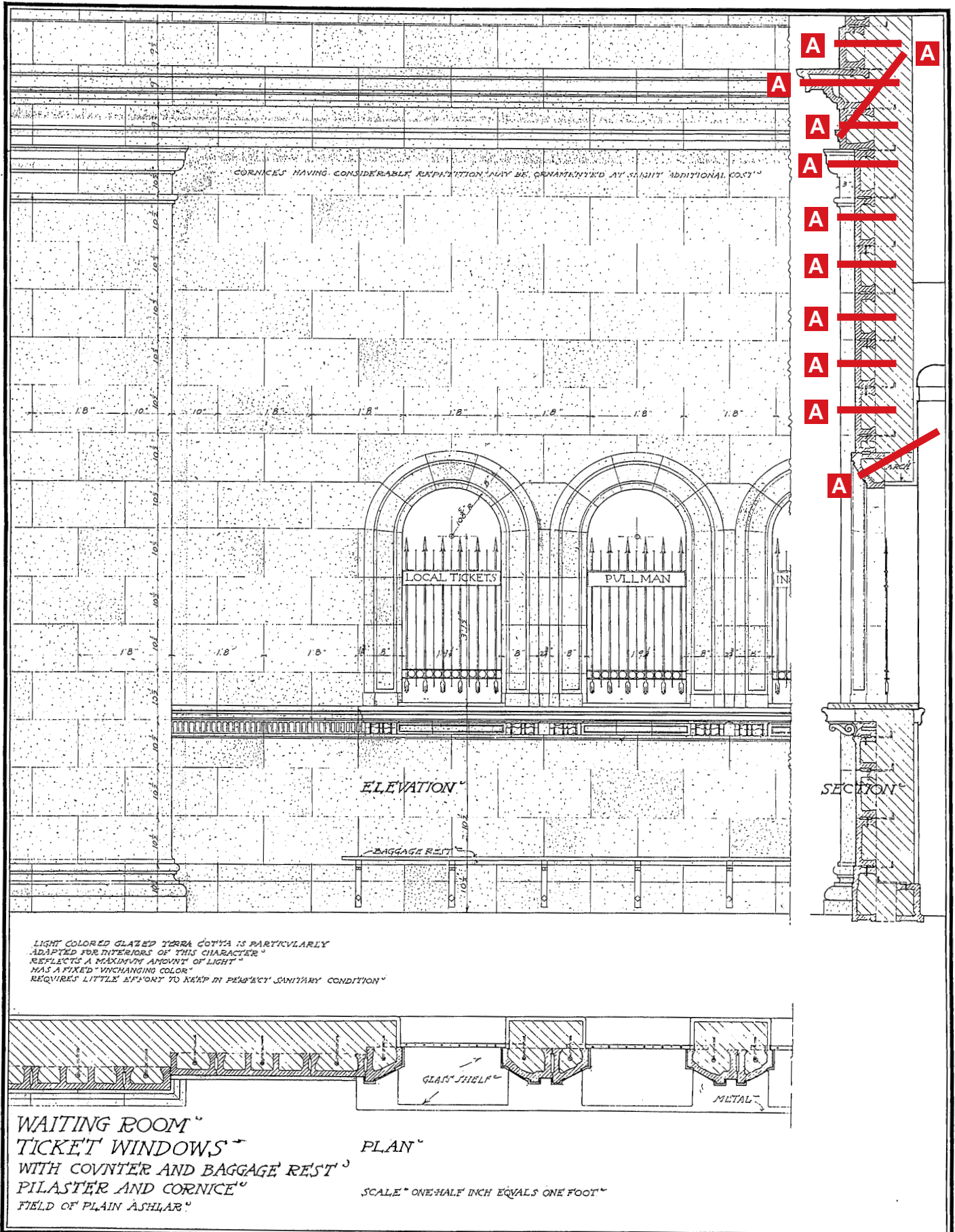
NATIONAL TERRA COTTA SOCIETY V.S.A. PLATE NO 48

This manual provides general information for use in preliminary selection of a Cintec anchor.
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TERRA COTTA STANDARD CONSTRUCTION

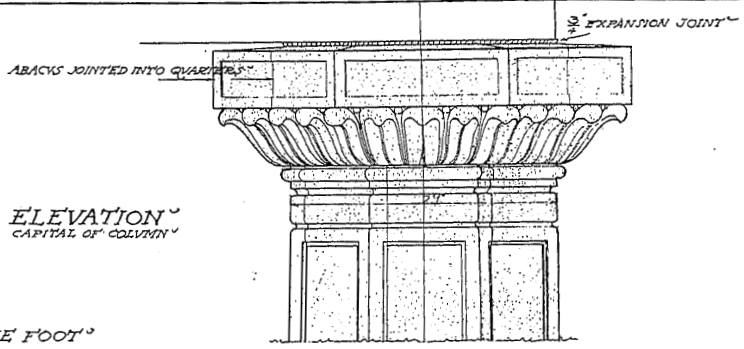


▲ ▲ ▲ ▲ TERRA COTTA ▲ ▲ STANDARD CONSTRUCTION ▲ ▲ ▲ ▲



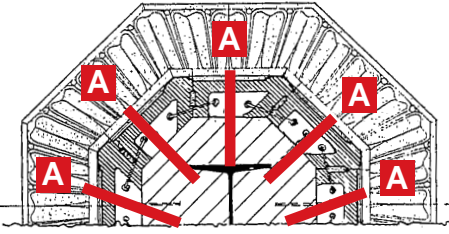
▲ ▲ ▲ ▲ TERRA COTTA ▲ ▲ STANDARD CONSTRUCTION ▲ ▲ ▲ ▲

OCTAGON COLUMN WITH CAPITAL AND BASE

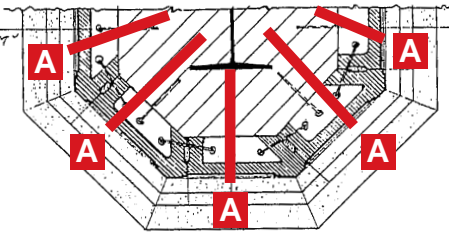


ELEVATION CAPITAL OF COLUMN

SCALE THREE-QUARTERS OF AN INCH EQUALS ONE FOOT



PLAN THROUGH NECK LOOKING UP



PLAN THROUGH BOTTOM LOOKING DOWN

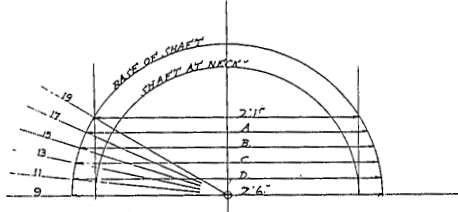
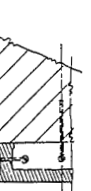
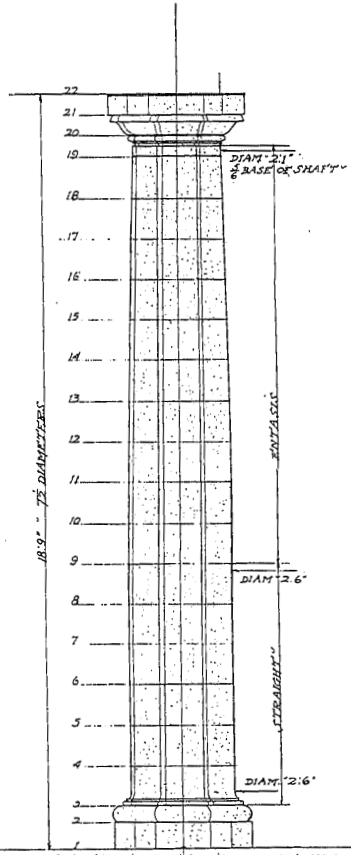


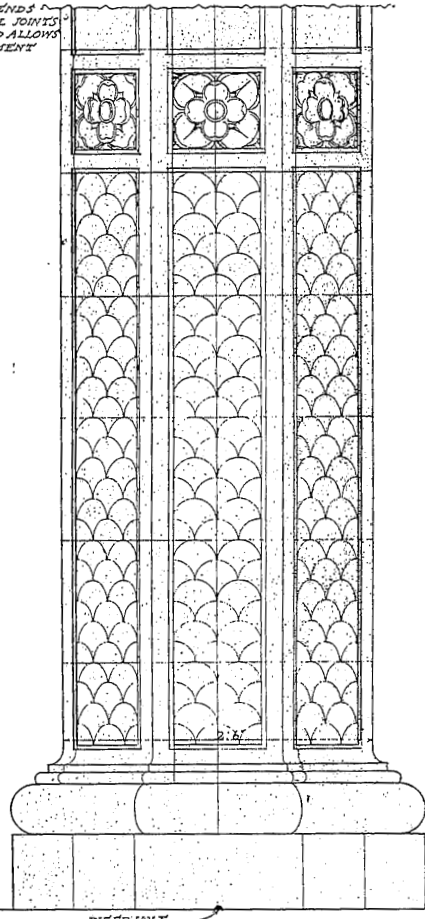
DIAGRAM OF METHOD FOR OBTAINING ENTASIS OF SHAFT LAY OUT ACCURATELY TO FULL SIZE OF COLUMN "A" "B" "C" AND "D" CAN THEN BE ACCURATELY MEASURED GIVING THE DIAMETERS AT "11" "13" "15" AND "17"

THE SHAFT AS JOINED TENDS TO CONCEAL THE VERTICAL JOINTS PERMITTING CLOSE FITTING AND ALLOWS OF ADJUSTMENT IN ALIGNMENT IN SETTING



THE MOULDED CORNERS OF LARGE COLUMNS SHOULD BE JOINED SEPARATELY

SEE PLATE NO 7 FOR INTERMEDIATE NEEDS IN BASES



ELEVATION BASE OF COLUMN

SCALE ONE-QUARTER OF AN INCH EQUALS ONE FOOT

TERRA COTTA STANDARD CONSTRUCTION

EXPANSION JOINT

PLAN THRO' NECK - LOOKING UP

COLUMNS WITH RUSTICATED AND ORNAMENTED SHAFTS

EXPANSION JOINT

CAPITAL JOINTED INTO QUARTERS

COLUMNS WITH ORNAMENTED SHAFTS CAN BE MADE WITH DEVICES IN ONE PIECE UP TO 16" DIAMETER AND WITH HEIGHT UP TO 20'

COLUMNS WITH ALTERNATING RUSTICATED AND FLUTED DRUMS CAN BE MADE WITHOUT VERTICAL JOINTS UP TO 20" DIAMETER

ELEVATION OF COLUMN

ENGAGED COLUMNS SHOULD NOT BE ATTACHED TO ASHLAR AT WALL - JOINT AT THIS POINT ALLOWS ADJUSTMENT IN ALIGNMENT IN SETTING

COLUMNS WITH STRUCTURAL CORES WOULD OF COURSE REQUIRE THE VERTICAL JOINTING OF ALL DRUMS - SEE ALSO PLATE NOS 56 AND 57

SCALE THREE-QUARTERS OF AN INCH EQUALS ONE FOOT

ELEVATION OF COLUMN

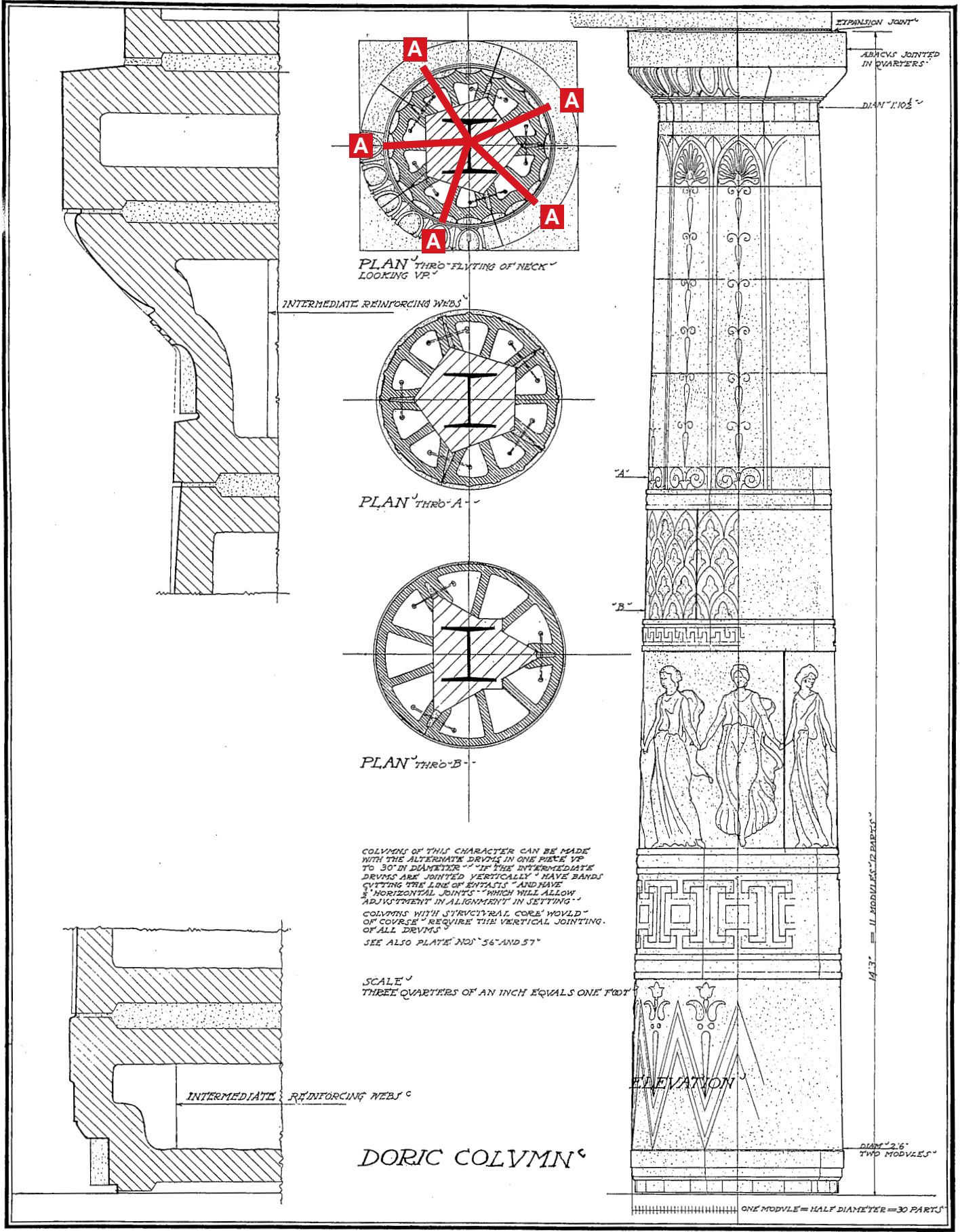
PLAN THRO' BASE OF SHAFT - LOOKING DOWN

SEE PLATE NO 7 FOR INTERMEDIATE WEBS IN BASES

PLAN THRO' SHAFT - LOOKING DOWN

PLINTH JOINTED INTO QUARTERS

▲ ▲ ▲ ▲ TERRA COTTA ▲ ▲ STANDARD CONSTRUCTION ▲ ▲ ▲ ▲



PLAN THROUGH FLUTTING OF NECK
LOOKING UP

PLAN THROUGH A-A

PLAN THROUGH B-B

COLUMNS OF THIS CHARACTER CAN BE MADE WITH THE ALTERNATE DRUMS IN ONE PIECE UP TO 30" IN DIAMETER. IF THE INTERMEDIATE DRUMS ARE JOINED VERTICALLY, HAVE BANDS CUTTING THE LINE OF EMPHASIS AND HAVE 3 HORIZONTAL JOINTS WHICH WILL ALLOW ADJUSTMENT IN ALIGNMENT IN SETTING. COLUMNS WITH STRUCTURAL CORE WOULD OF COURSE REQUIRE THE VERTICAL JOINTING OF ALL DRUMS. SEE ALSO PLATE NOS 56 AND 57

SCALE
THREE QUARTERS OF AN INCH EQUALS ONE FOOT

DORIC COLUMN

ELEVATION

ONE MODULE = HALF DIAMETER = 30 PARTS

TERRA COTTA STANDARD CONSTRUCTION

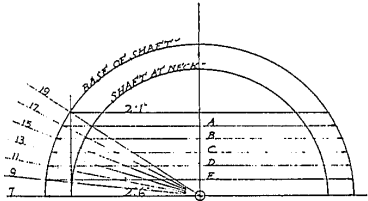
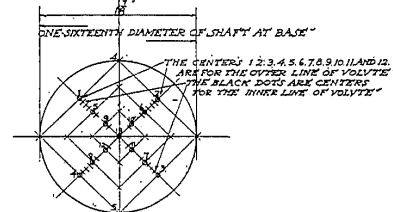
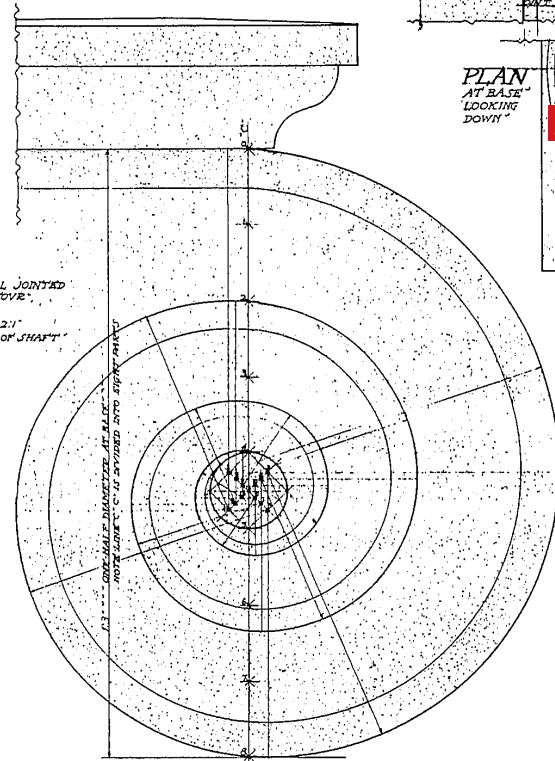
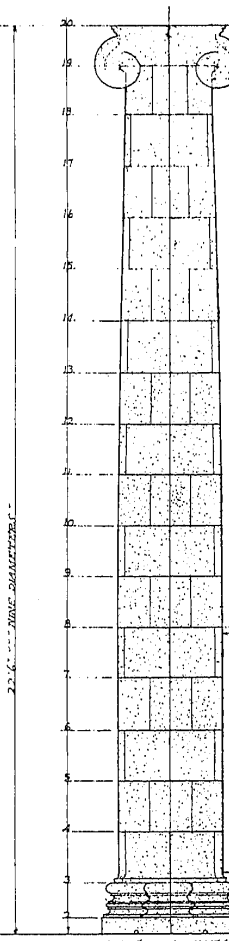
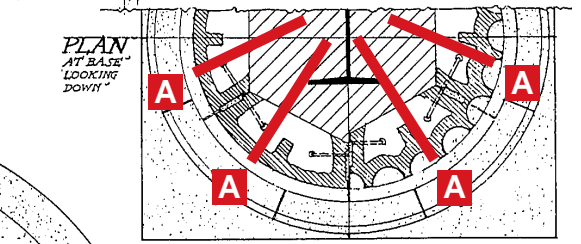
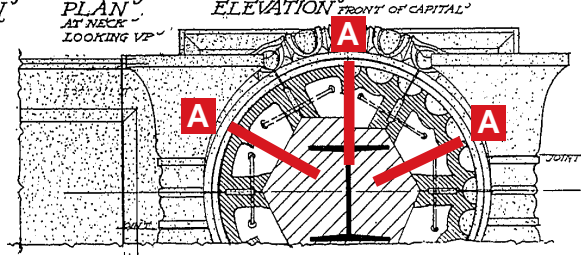
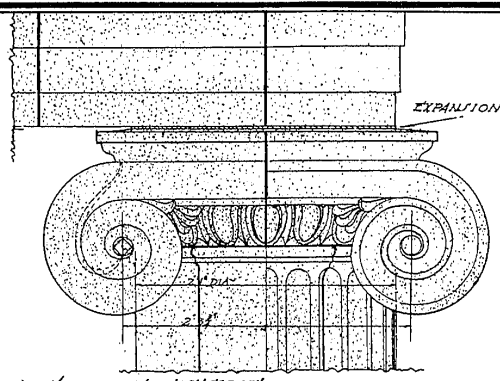
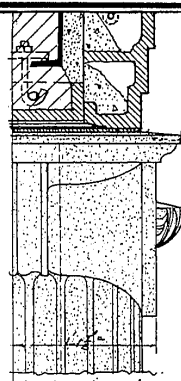


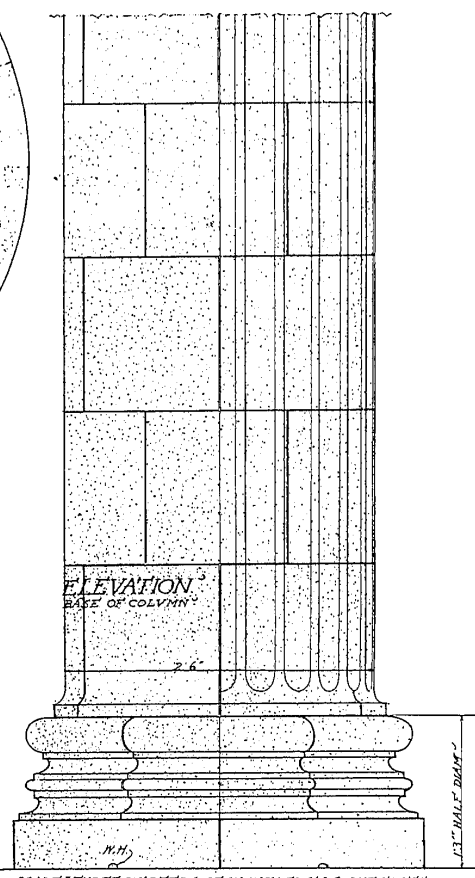
DIAGRAM OF METHOD FOR OBTAINING ENTASIS OF SHAFT LAY OUT ACCURATELY TO FULL SIZE OF COLUMN. A, B, C, D AND E CAN THEN BE ACCURATELY MEASURED GIVING THE DIAMETERS AT 9" 11" 13" 15" AND 17"

COLUMNS OF THIS CHARACTER CAN BE MADE WITH DRUMS IN ONE PIECE VP TO 16" IN DIAMETER AND IN HEIGHT VP TO 20" THE HEIGHT OF DRUMS WOULD GENERALLY BE GOVERNED BY THE PROPER JOINTING OF COLUMN WITH ADJOINING WORK AND FOR APPEARANCE. COLUMNS WITH STRUCTURAL CORES WOULD OF COURSE REQUIRE THE VERTICAL JOINTING OF DRUMS. SEE ALSO PLATE NO'S 36 AND 37

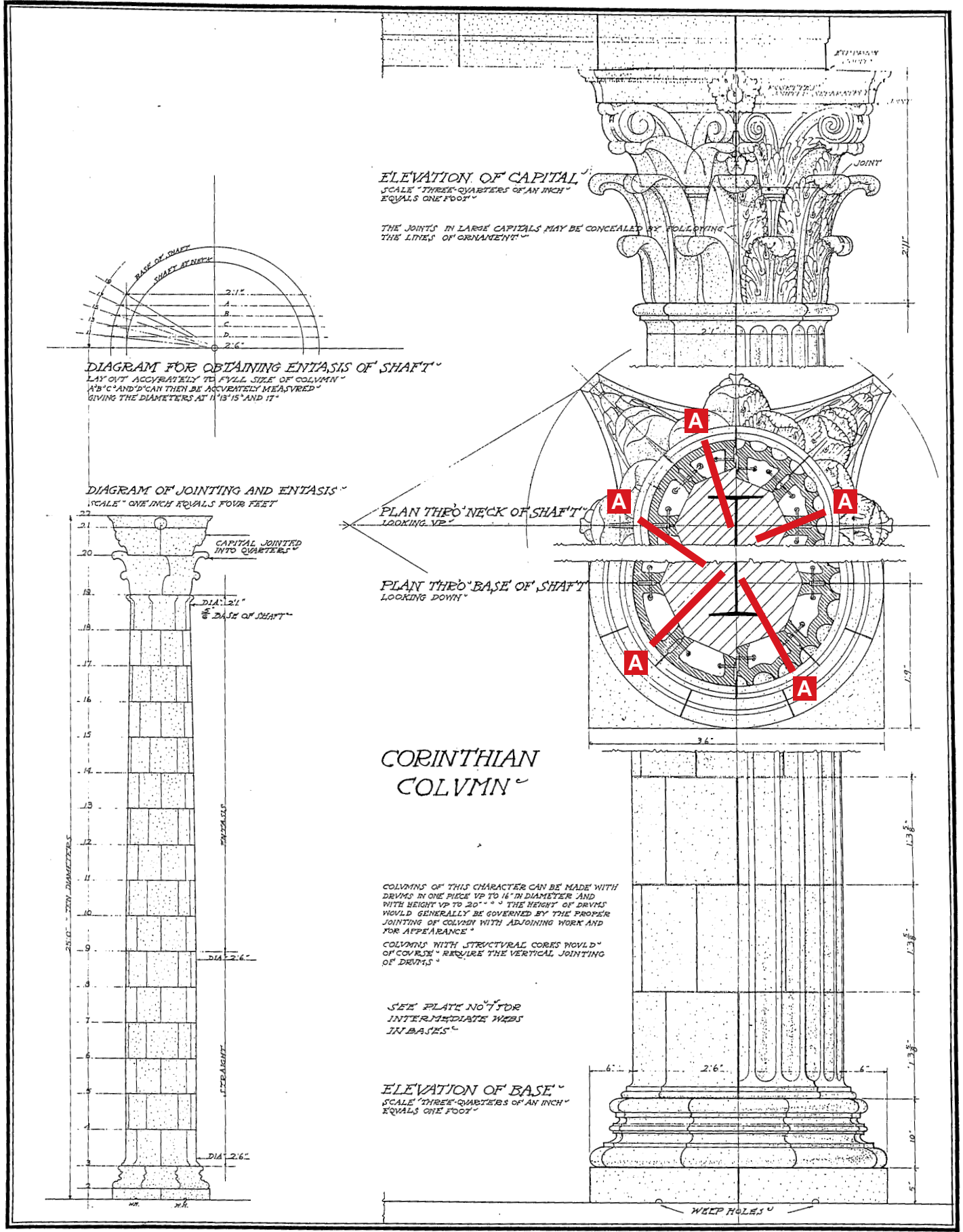
SEE PLATE NO 7 FOR INTERMEDIATE REBS IN BASES



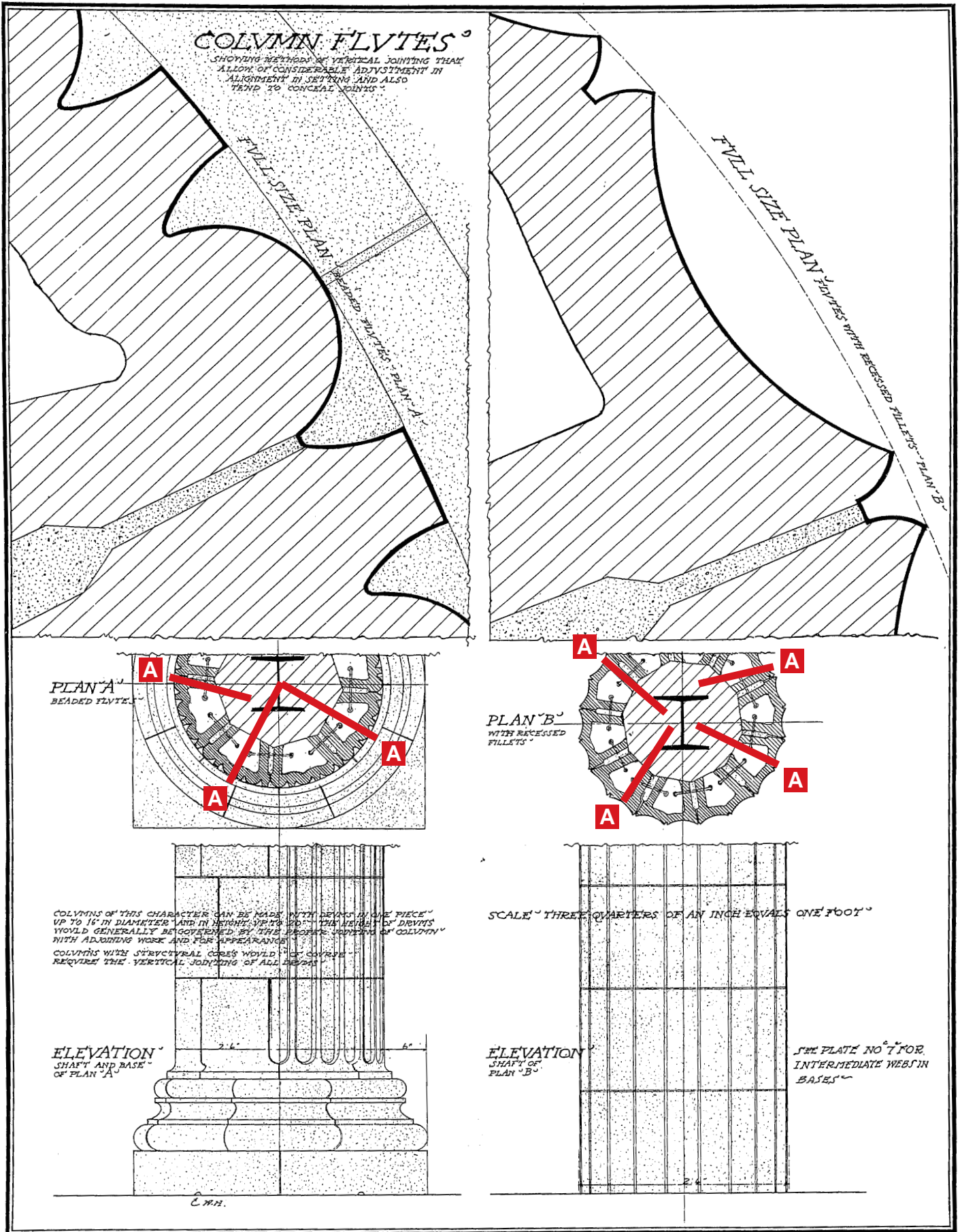
IONIC COLUMN



TERRA COTTA STANDARD CONSTRUCTION



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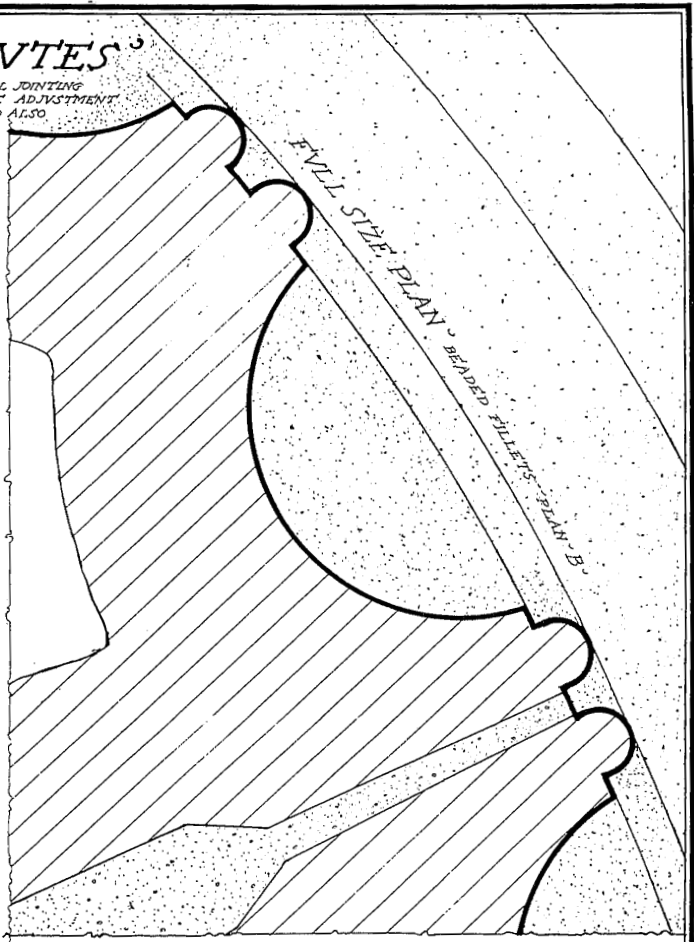
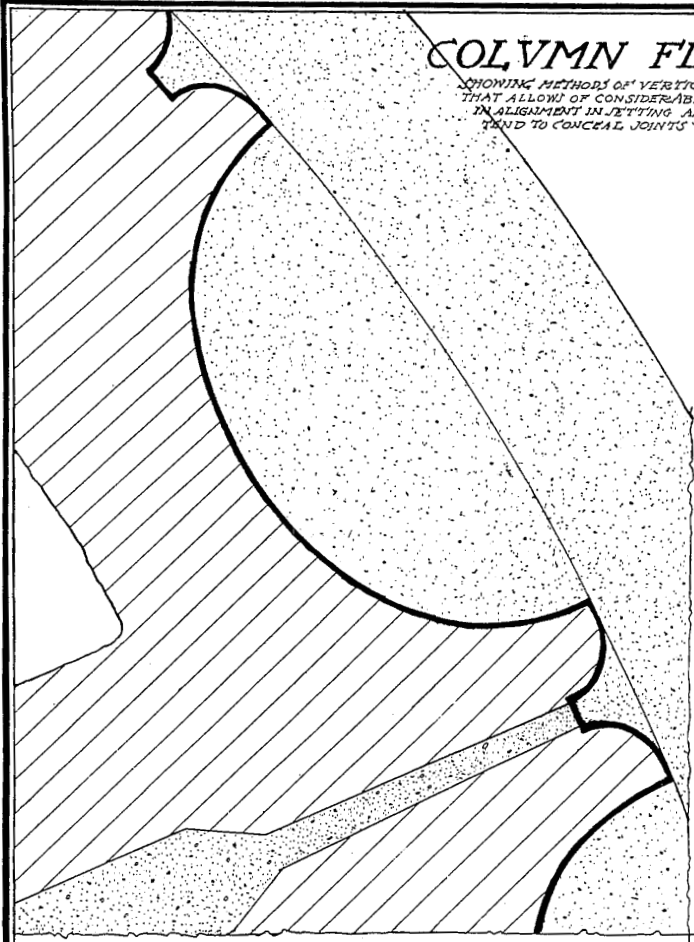
NATIONAL TERRA COTTA SOCIETY · V · S · A · · · PLATE NO · 56

TERRA COTTA STANDARD CONSTRUCTION

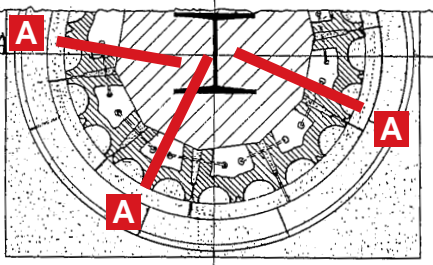
COLUMN FLUTES

SHOWING METHODS OF VERTICAL JOINTING THAT ALLOW OF CONSIDERABLE ADJUSTMENT IN ALIGNMENT IN SETTING AND ALSO TEND TO CONCEAL JOINTS

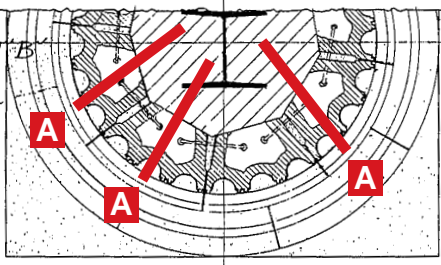
FULL SIZE PLAN - BEADED FILLETS - PLAN B



PLAN A FLUTES WITH SQUARE FILLETS



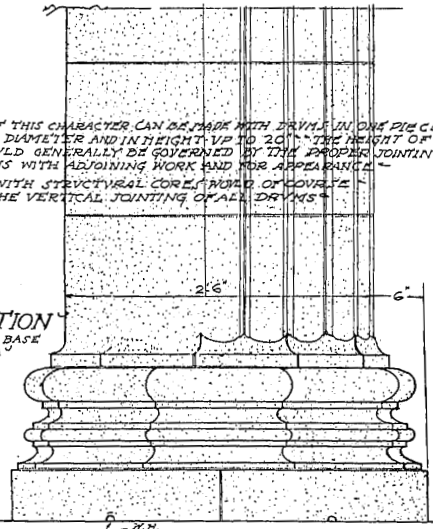
PLAN B FLUTES WITH BEADED FILLETS



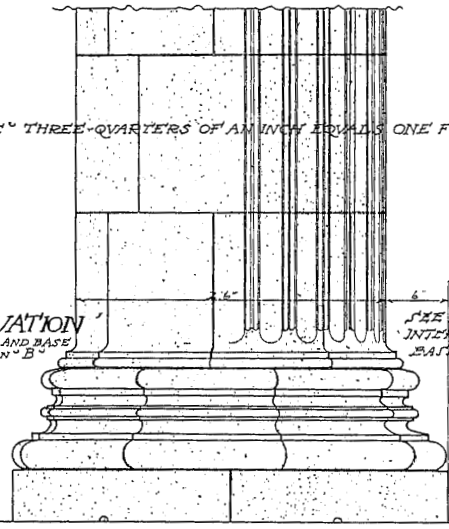
COLUMNS OF THIS CHARACTER CAN BE MADE WITH DRUMS IN ONE PIECE UP TO 16 IN DIAMETER AND IN HEIGHT UP TO 20 THE HEIGHT OF DRUMS WOULD GENERALLY BE GOVERNED BY THE PROPER JOINTING OF COLUMNS WITH ADJOINING WORK AND FOR APPEARANCE COLUMNS WITH STRUCTURAL CORES MADE OF DOUBLE REQUIRE THE VERTICAL JOINTING OF ALL DRUMS

SCALE THREE-QUARTERS OF AN INCH EQUALS ONE FOOT

ELEVATION SHAFT AND BASE OF PLAN A

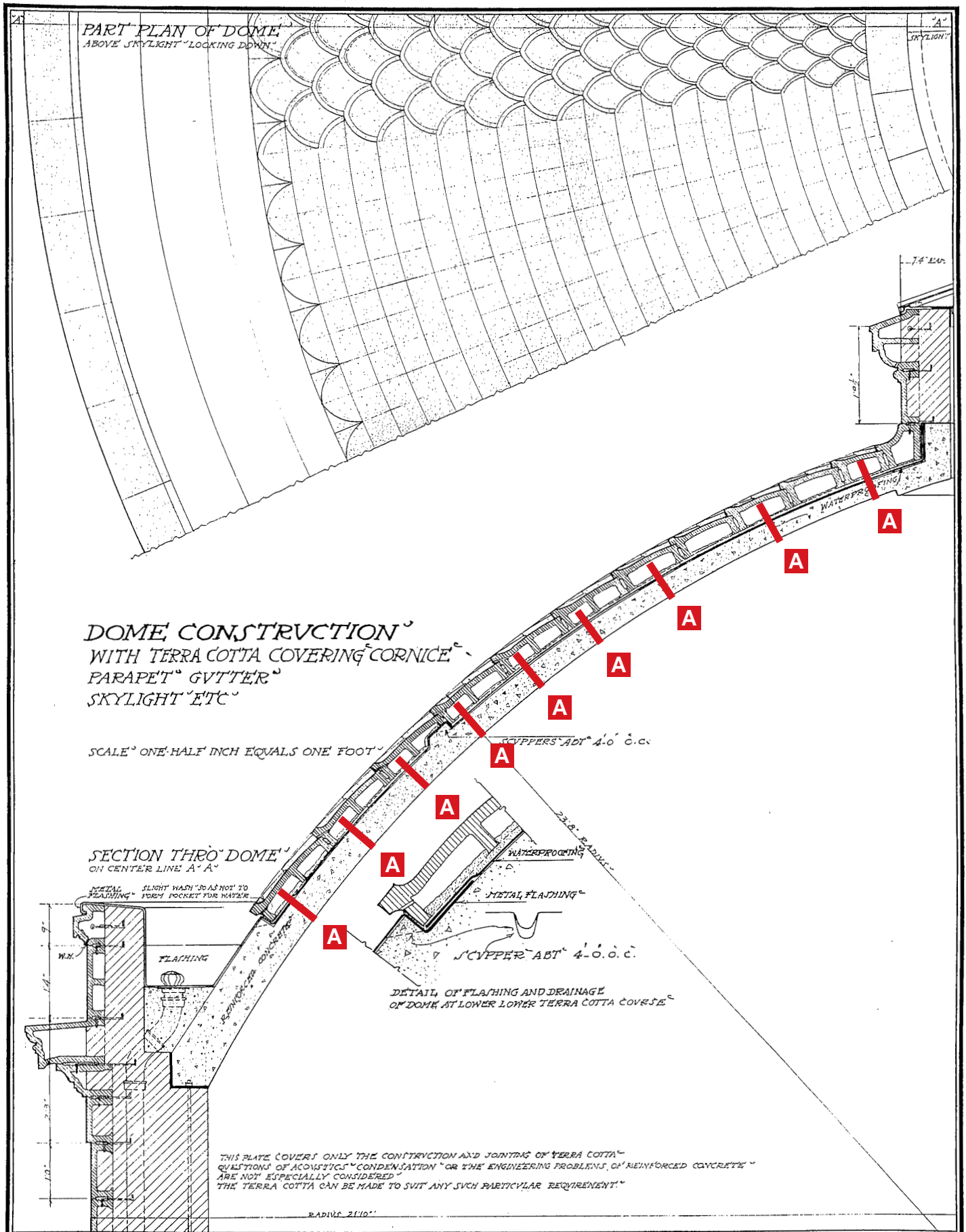


ELEVATION SHAFT AND BASE OF PLAN B

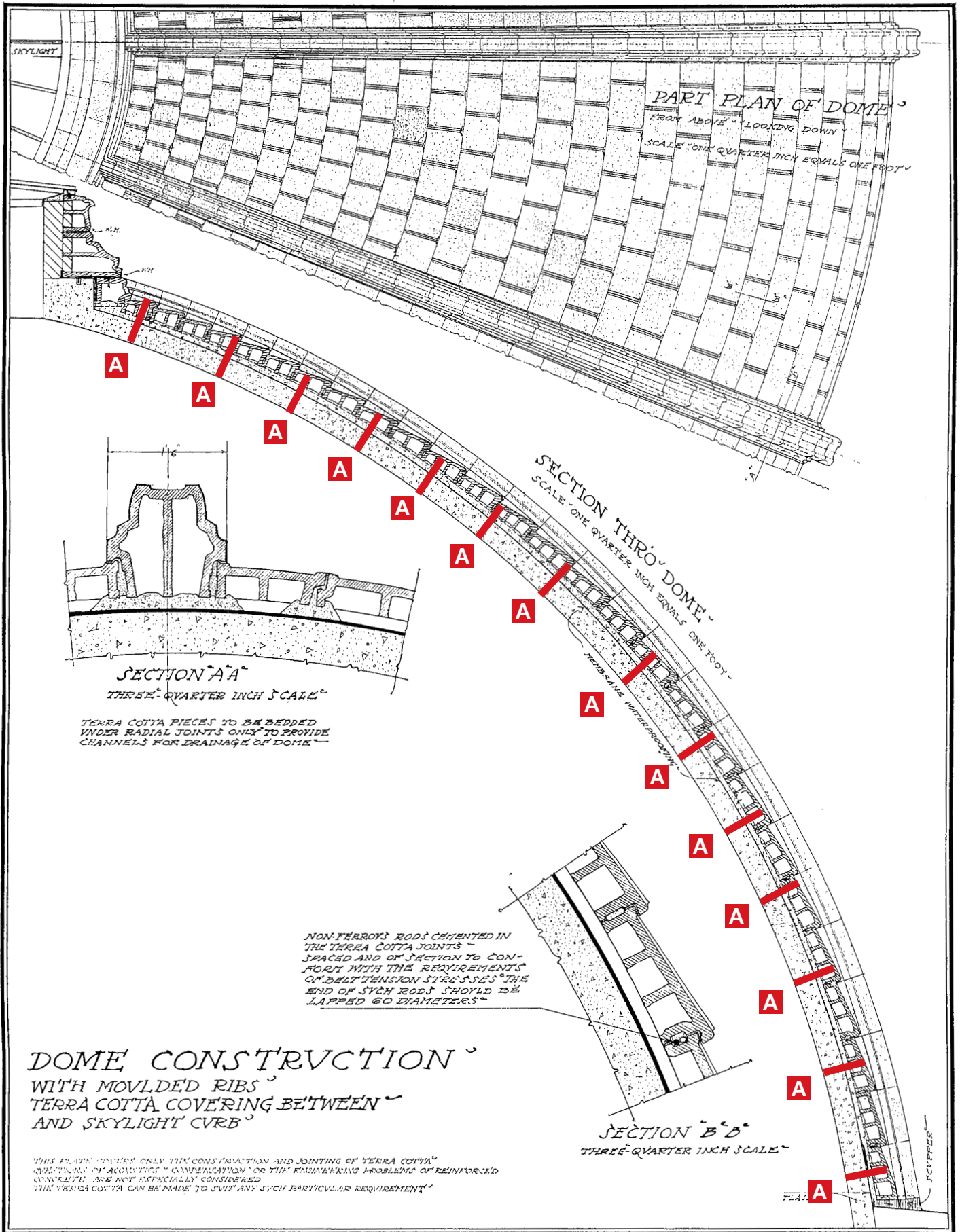


SEE PLATE NO 7 FOR INTERMEDIATE MEMS IN BASES

TERRA COTTA STANDARD CONSTRUCTION



TERRA COTTA STANDARD CONSTRUCTION



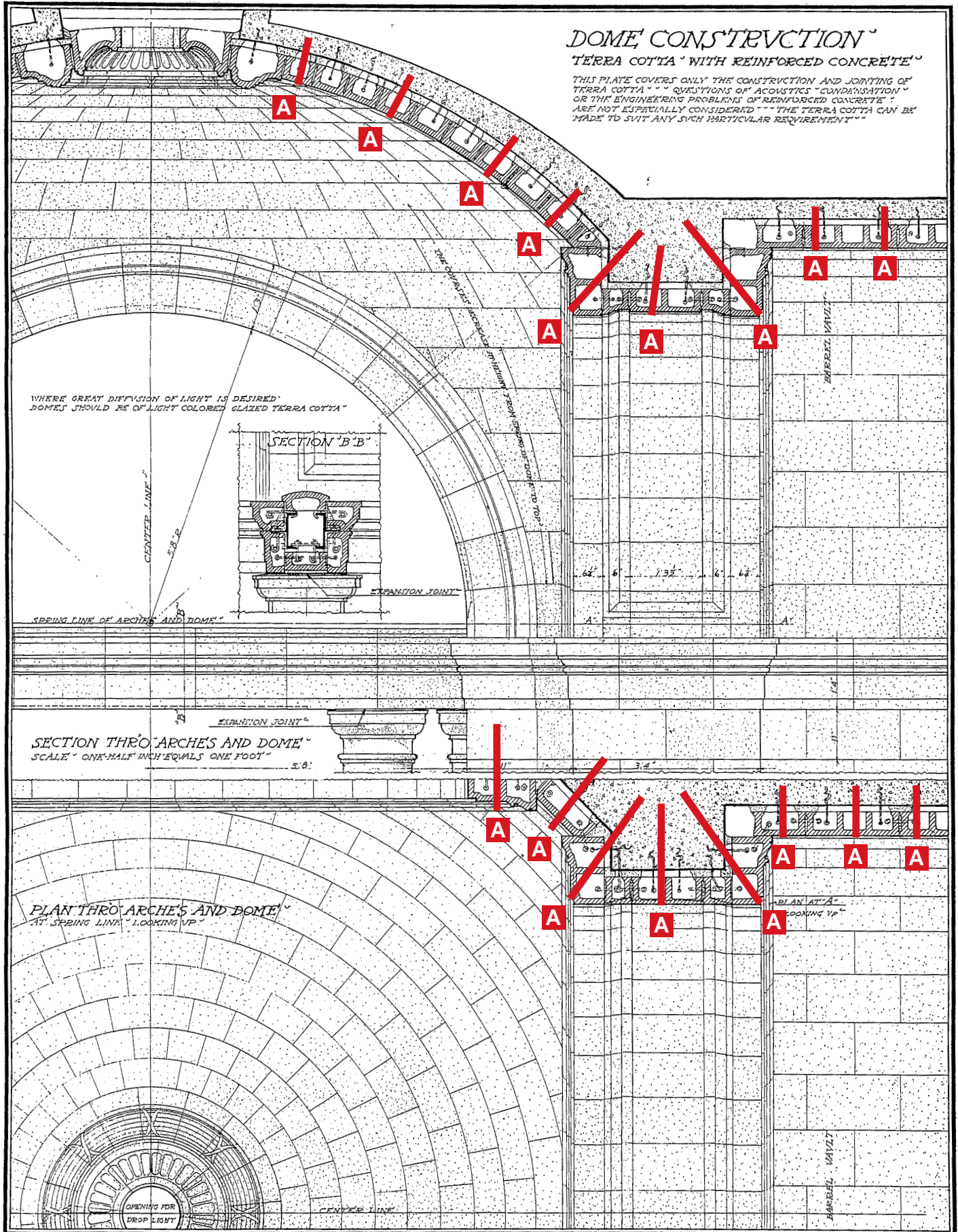
TERRA COTTA PIECES TO BE BEDDED UNDER RADIAL JOINTS ONLY TO PROVIDE CHANNELS FOR DRAINAGE OF DOME

NON-FERROUS RODS CENTERED IN THE TERRA COTTA JOINTS - SPACED AND OF SECTION TO CONFORM WITH THE REQUIREMENTS OF BELL TENSION STRESSES THE END OF SUCH RODS SHOULD BE LAPPED 60 DIAMETERS

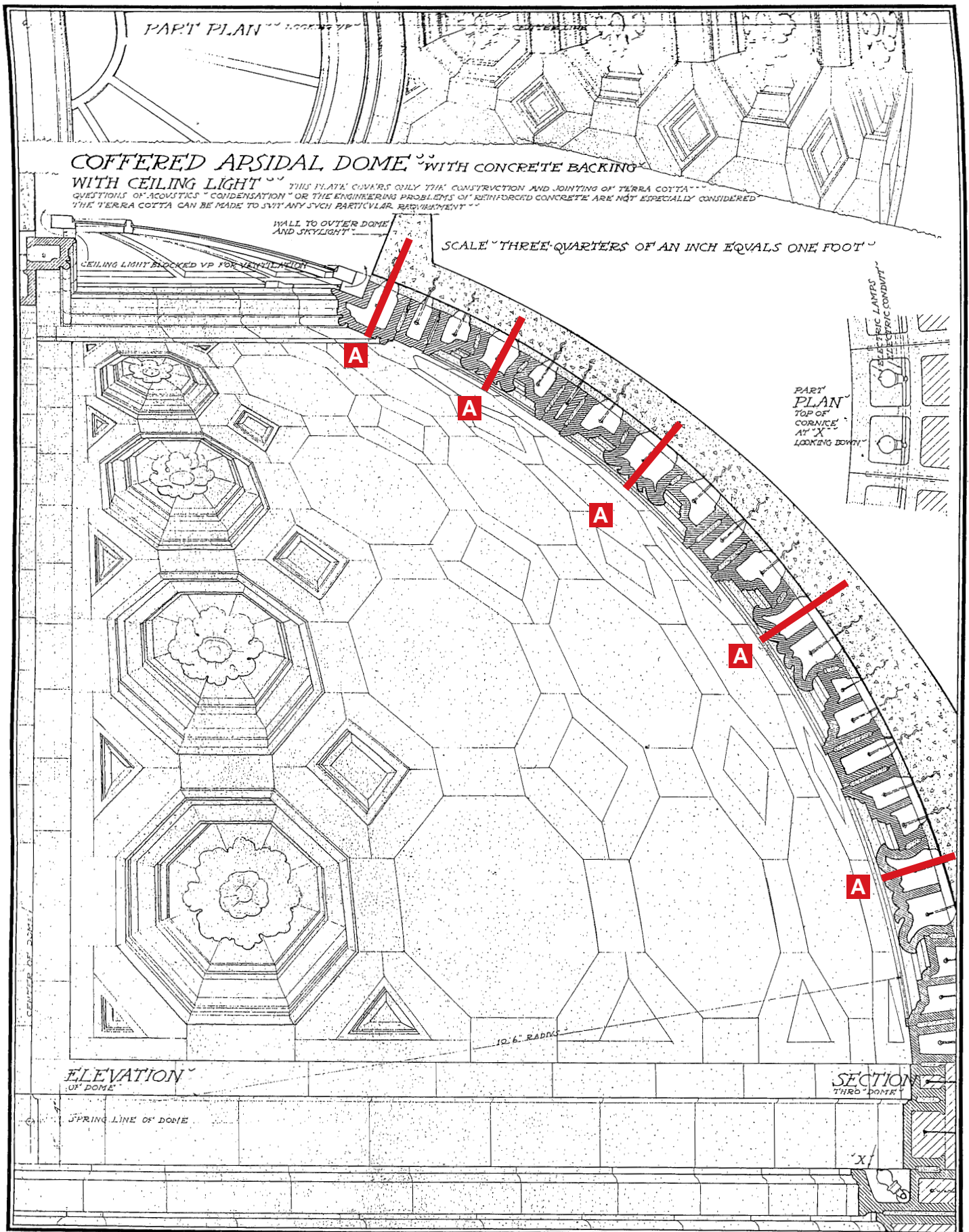
DOME CONSTRUCTION WITH MOULDED RIBS TERRA COTTA COVERING BETWEEN AND SKYLIGHT CURB

THIS PLATE COVERS ONLY THE CONSTRUCTION AND JOINTING OF TERRA COTTA. QUESTIONS OF ACQUISITION, CONDENSATION, OR THE ENGINEERING PROBLEMS OF REINFORCED CONCRETE ARE NOT ESPECIALLY CONSIDERED. THE TERRA COTTA CAN BE MADE TO SUIT ANY SUCH PARTICULAR REQUIREMENT.

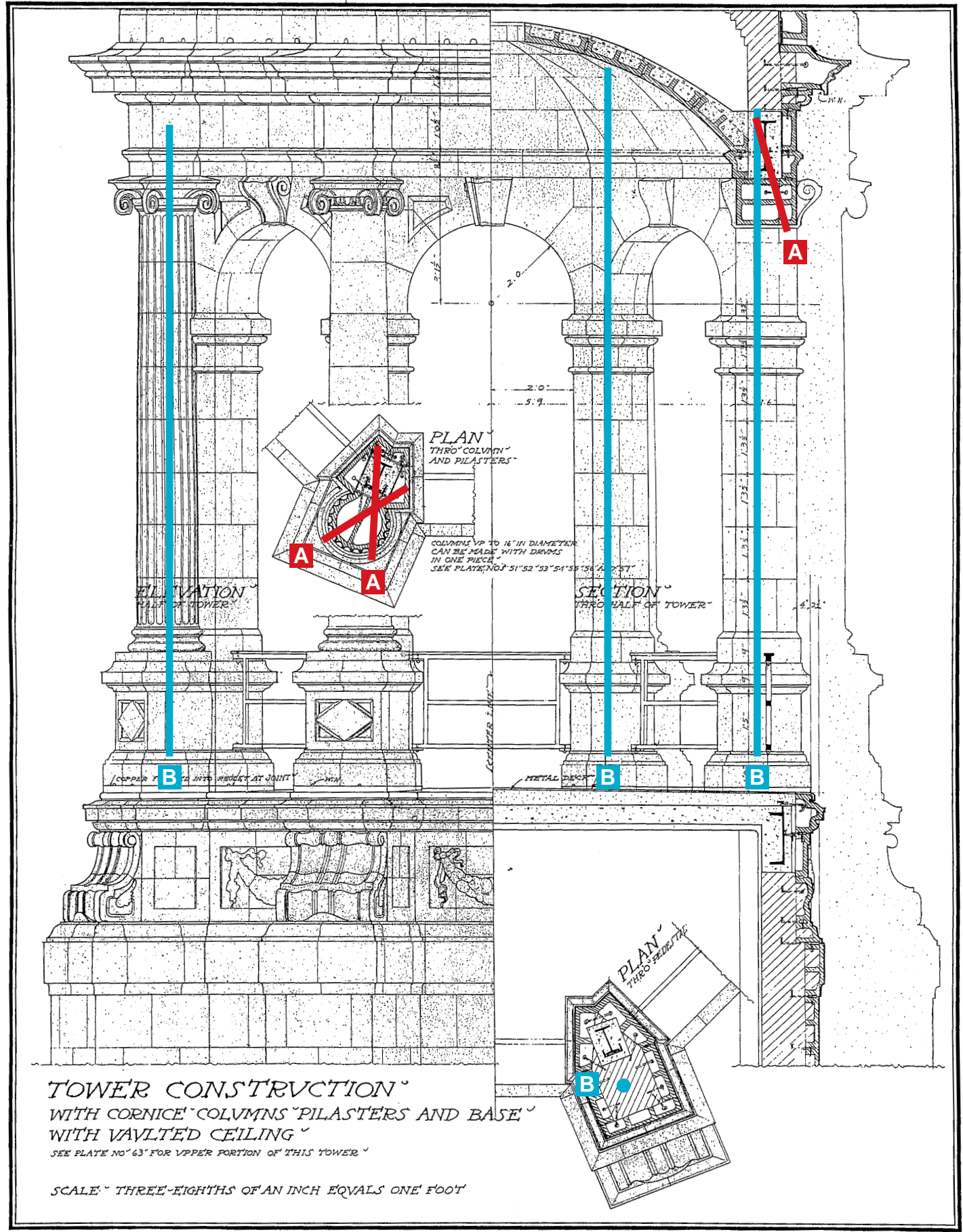
TERRA COTTA STANDARD CONSTRUCTION



TERRA COTTA STANDARD CONSTRUCTION



TERRA COTTA STANDARD CONSTRUCTION



TOWER CONSTRUCTION
 WITH CORNICE COLUMNS PILASTERS AND BASE
 WITH VAULTED CEILING
 SEE PLATE NO. 63 FOR UPPER PORTION OF THIS TOWER

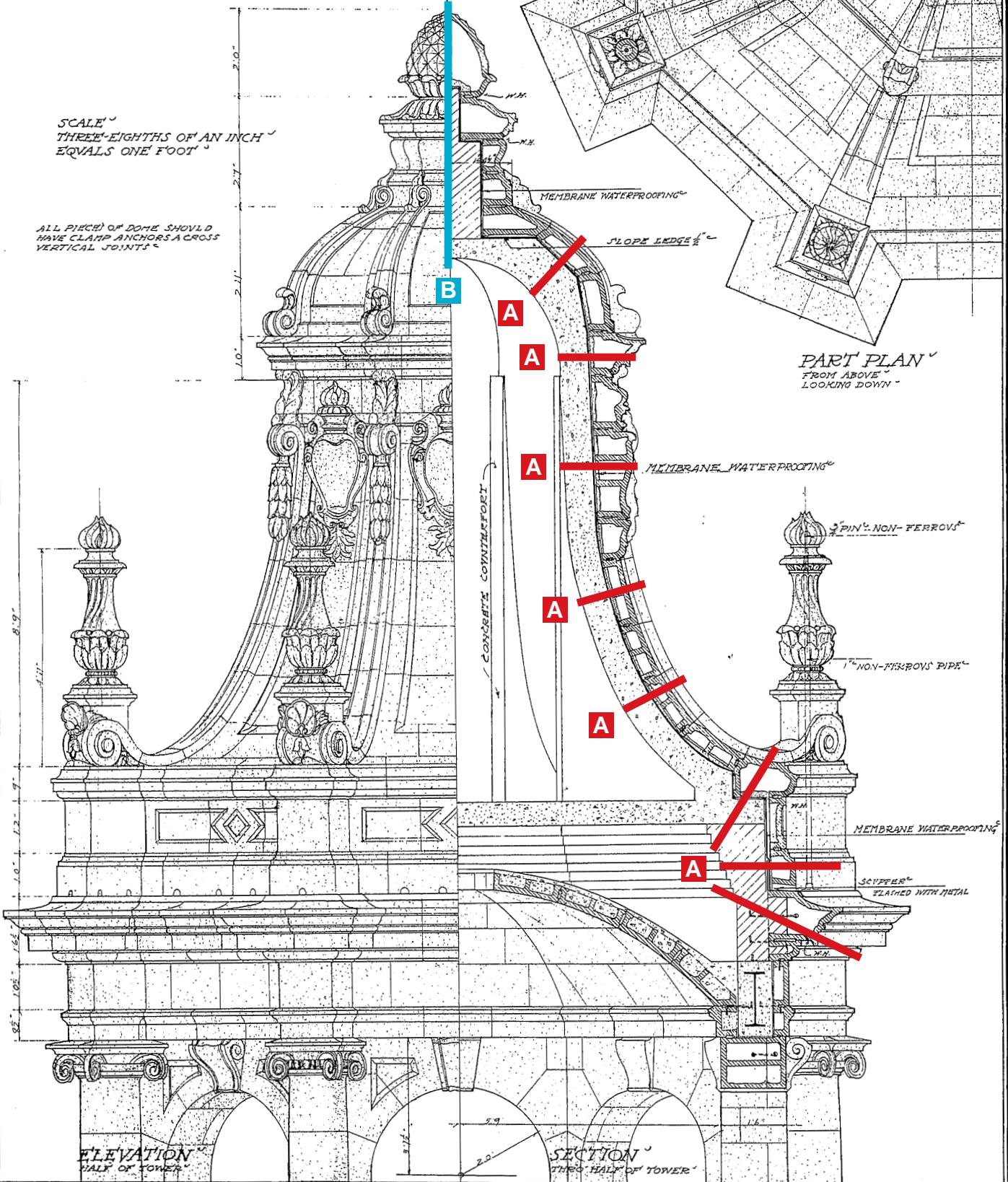
SCALE THREE-EIGHTHS OF AN INCH EQUALS ONE FOOT

TERRA COTTA STANDARD CONSTRUCTION

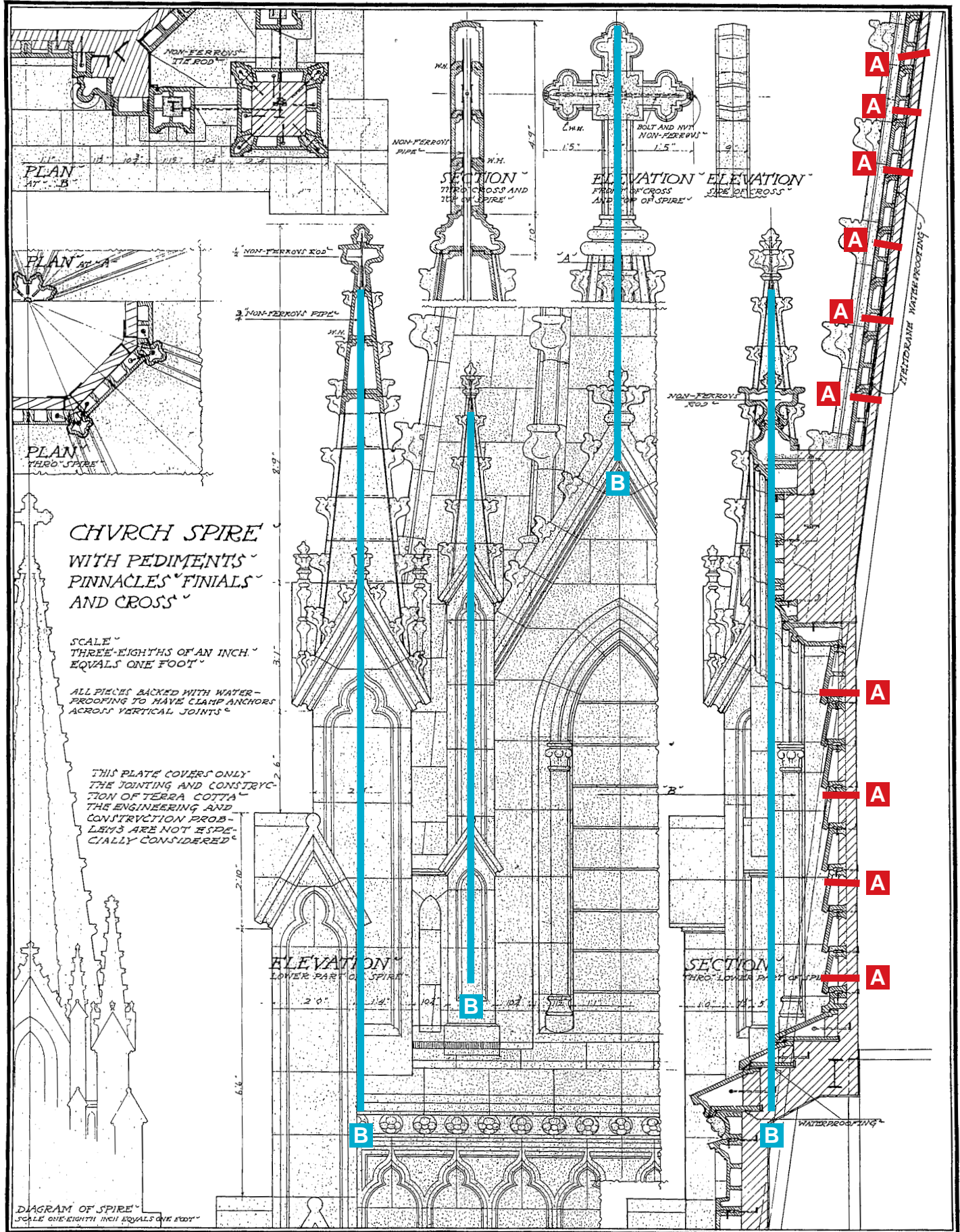
TOWER CONSTRUCTION WITH CORNICE CARTOVCHES RIBS AND CROWN SEE PLATE NO. 62 FOR LOWER PORTION OF THIS TOWER

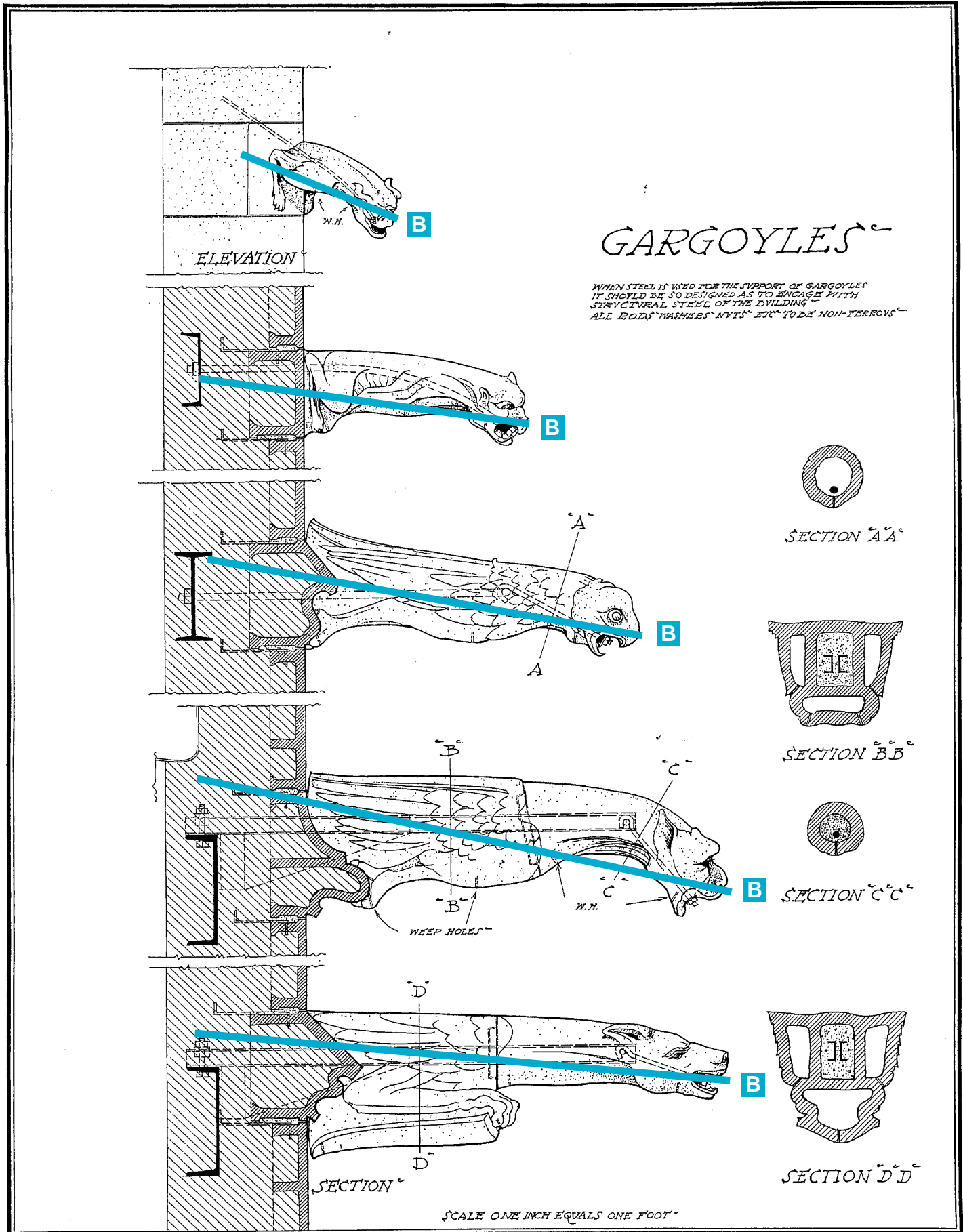
SCALE THREE-EIGHTHS OF AN INCH EQUALS ONE FOOT

ALL PIECES OF DOME SHOULD HAVE CLAMP ANCHORS ACROSS VERTICAL JOINTS



TERRA COTTA STANDARD CONSTRUCTION





CINTEC ANCHOR TESTING

New York Schools Construction Authority

TESTING AT:

PS230K

1 ALBERMARLE ROAD, BROOKLYN

AND

PS238K

1633 EAST 8TH, BROOKLYN, NEW YORK

TESTING ENGINEERS:

**VERSATILE CONSULTING AND TESTING
SERVICES (JULY 2001)**



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is What
This Firm
is Built On

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Douglaston, New York 11362 1925
Tel.: (718) 428-5025
Fax: (718) 428-1036
www.versatileconsulting.com

Contracts: PS 230 K and PS 238 K
Date: July 9, 2001
Client: Cintec North America

PROFESSIONAL ENGINEER SERVICE

Procedure: Anchors Installation

Location: Parapet Wall

I, Roman Sorokko, P.E., being duly sworn say: I am a Professional Engineer, (Lic. # 072800) assigned by Hill International, Inc. to conduct the controlled inspection for the subject contract. I have read all provisions of the Building Code of the City of New York, and I am thoroughly familiar with the plans, specifications and standards referred to herein.

As an Engineer of Record, and as directed by Hill International, Inc. and NYC DDC I will personally perform the controlled inspection of the Cintec anchors installation for this project.

I was also directed to generate an engineering calculation in order to confirm the adequacy of the anchors to the design purpose – to secure the terra cotta blocks attached to the exterior surface of the parapet wall (as per as per Item 04525 – Terra Cotta Restoration and Repair, Paragraph 2.2 Anchors).

I certify that I have carefully analyzed the proposed anchors' parameters using a conservative engineering approach (see attachment No. 1) to the best of my knowledge, and I have found that their application will be adequate to the design purpose, and it will be in compliance with the Specifications of the subject contract.

I executed the full scale pull out tests (see Attachment No. 2) for these anchors, and I have found that the achieved results are significantly exceeded the design criteria.

Therefore, I recommend these anchors to be used for the above mentioned contract.

Prep. by Roman Sorokko, P.E.



**ANCHOR DESCRIPTIONS FOR CORNICE STABILIZATION
AND MODILLION REATTACHMENT**

**ANCHOR TYPE A
MODILLION REATTACHMENT**

1/2" DIA SOLID THREADED SS CINTEC ANCHOR-
PLAIN ENDS- IN 1 1/4" DIA HOLE APPROX
24" LONG SOCKED FULL LENGTH. SOCK
OVERSIZED TO EXPAND INTO CELL OF NEW
T/C UNIT

ANCHOR DESIGN - TENSION

**ANCHOR TYPE B
CORNICE STABILIZATION**

1 1/2" x 1 1/2" x 1/8" HSS SS CINTEC
ANCHOR-PLAIN ENDS -IN 3" DIA HOLE APPROX 30" LONG
SOCKED FULL LENGTH. SOCK OVERSIZED
TO EXPAND INTO VOID AT FRONT
OF EXISTING T/C UNIT.

ALTERNATE DESIGN - EXTEND ANCHOR TO
INSIDE FACE OF PARAPET AND PROVIDE
SS NUT, WASHER AND BEARING PLATE

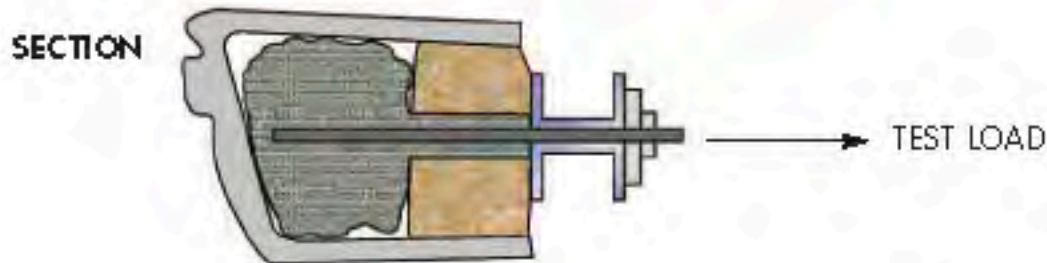
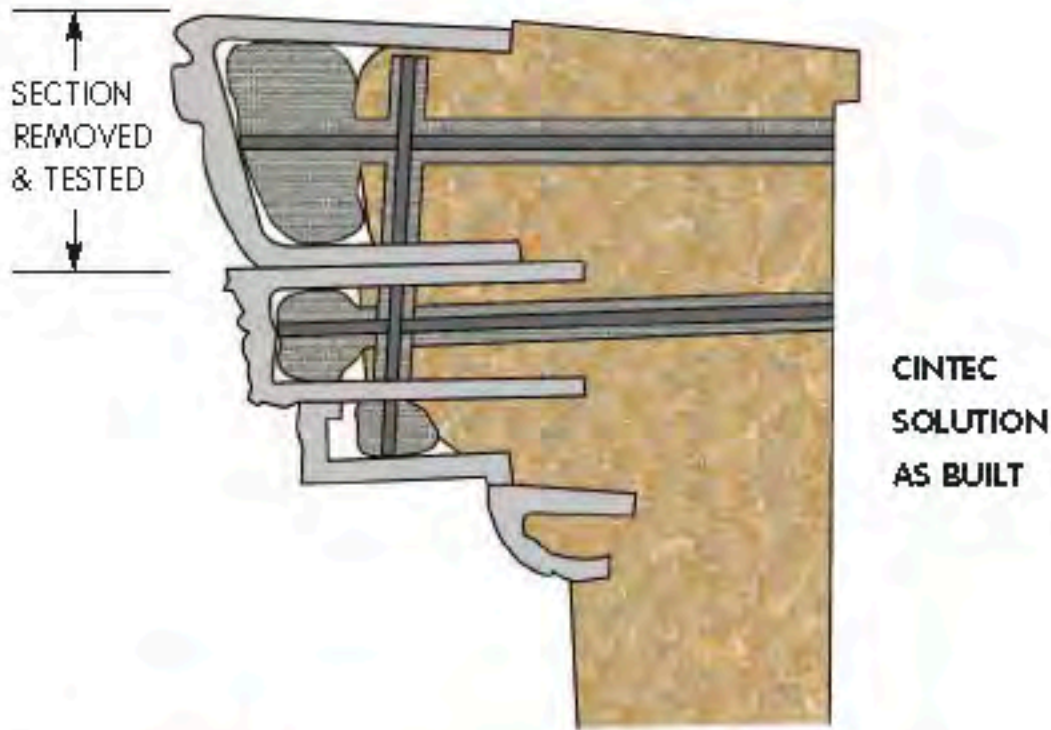
ANCHOR DESIGN - COMBINED BENDING AND SHEAR



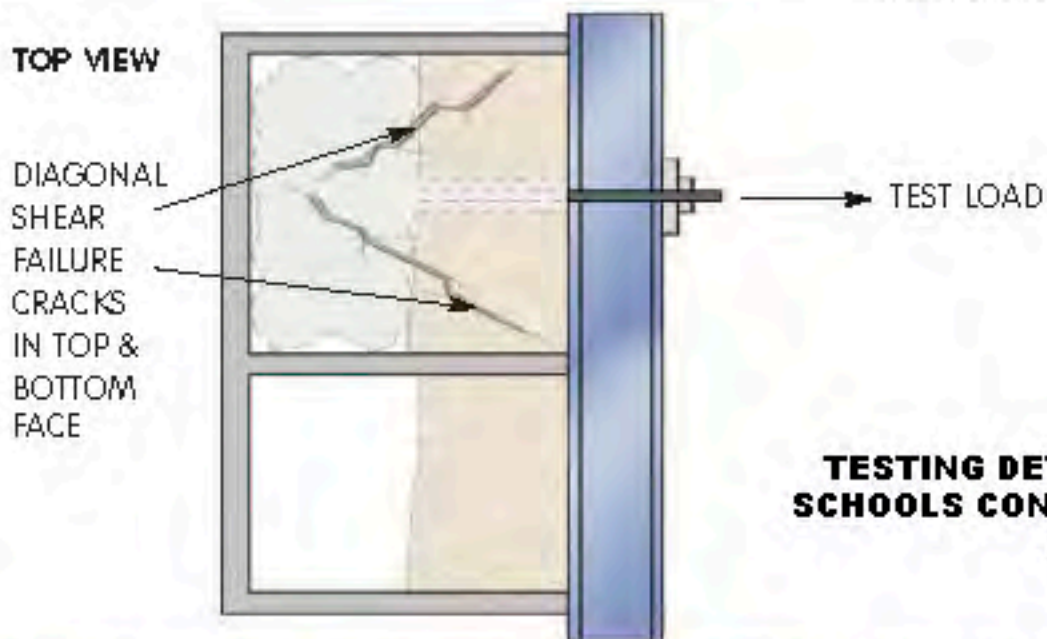
**OPTION I
CANTILEVERED DESIGN
(CONSERVATIVE)**

Project Name PS 230 & PS258
Location BROOKLYN NEW YORK
Consultant: TAMS CONSULTANTS

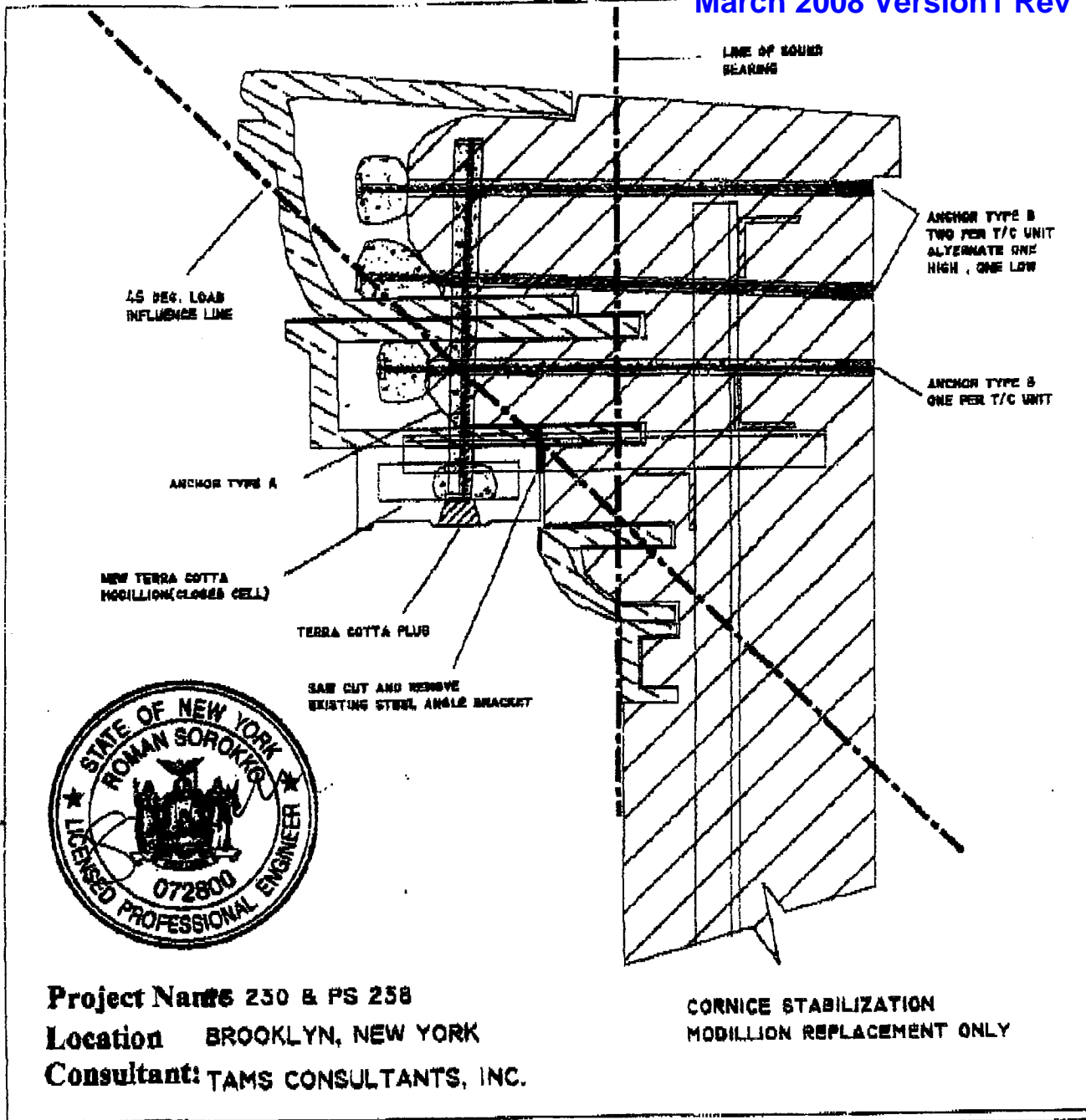
<p><i>Engineered Grout Injection Anchors by:</i> CINTEC AMERICA INC. Tel 613 225 3381 Fax 613 224 9042 E-mail: rlr@cintec.com</p>		<p>Project #:</p>
		<p>By: AZ</p>
		<p>Date: JANUARY 2001</p>
<p>Product Engineering By: JOKINEN ENGINEERING SERVICES Tel 905 333 1079 Fax 905 333 3659 E-mail: eria.jokinen@sympatico.com</p>		<p>SK 2A 0 DRWG #: REV. #</p>



FULL SCALE TESTING



**TESTING DETAILS FOR NEW YORK
SCHOOLS CONSTRUCTION AUTHORITY
PS 230 K**



<p><i>Engineered Grout Injection Anchors by:</i></p> <p>CINTEC AMERICA INC.</p> <p>Tel 613 225 3381 Fax 613 224 9042 E-mail: rh@cintec.com</p>		<p>Project #:</p> <p>By: AZ</p> <p>Date: Dec 14/2000</p>
<p>Product Engineering By: JOKINEN ENGINEERING SERVICES</p> <p>Tel 905 333 1079 Fax 905 333 3659 E-mail: eric.jokinen@sympatico.com</p>		<p>JES C129</p> <p>SK 1 1</p> <p>DRWG #: REV. #</p>

ANCHOR DESCRIPTIONS FOR CORNICE STABILIZATION AND MODILLION REATTACHMENT

**ANCHOR TYPE A
MODILLION REATTACHMENT**

1/2" DIA SOLID THREADED SS CINTEC ANCHOR-
PLAIN ENDS - IN 1 1/4" DIA HOLE APPROX
24" LONG SOCKED FULL LENGTH. SOCK
OVERSIZED TO EXPAND INTO CELL OF NEW
T/C UNIT

ANCHOR DESIGN - TENSION

**ANCHOR TYPE B
CORNICE STABILIZATION**

3/4" DIA SOLID THREADED SS CINTEC ANCHOR-
PLAIN ENDS -IN 2" DIA HOLE APPROX 30" LONG
SOCKED FULL LENGTH. SOCK OVERSIZED
TO EXPAND INTO VOID AT FRONT
OF EXISTING T/C UNIT.

ALTERNATE DESIGN - EXTEND ANCHOR TO
INSIDE FACE OF PARAPET AND PROVIDE
SS NUT, WASHER AND BEARING FLARTE

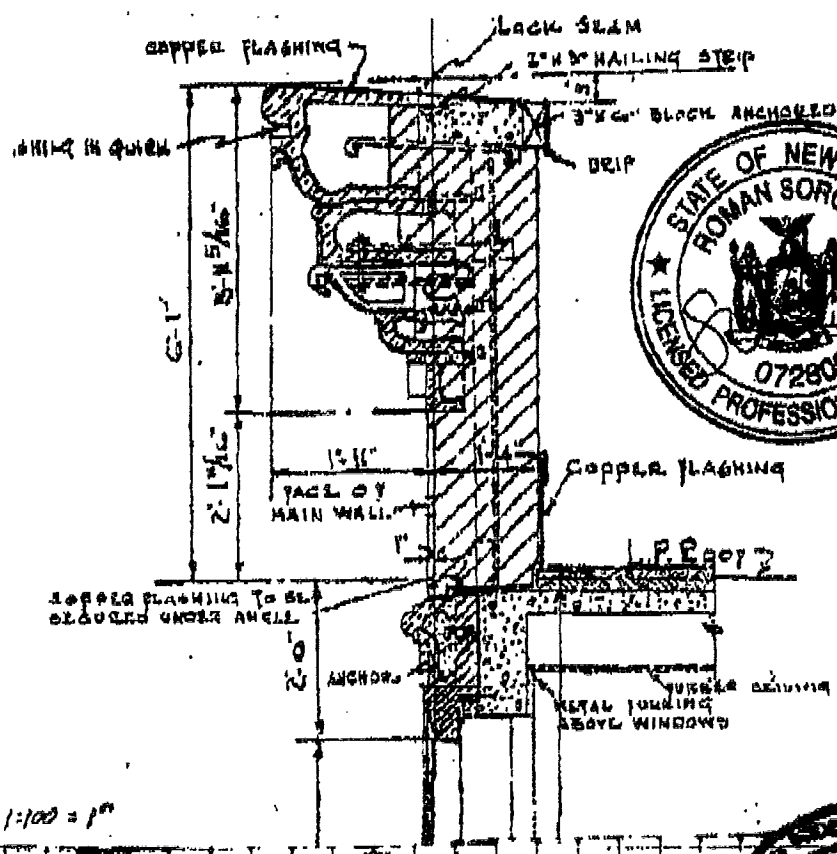
ANCHOR DESIGN - COMBINED PULL-OUT AND SHEAR



**OPTION 2
CORBELLED DESIGN
(LESS CONSERVATIVE)**

Project Name PS 230 & PS236
Location BROOKLYN NEW YORK
Consultant: TAMS CONSULTANTS

<p><i>Engineered Grout Injection Anchors by:</i> CINTEC AMERICA INC. Tel 613 225 3381 Fax 613 224 9042 E-mail: rin@cintec.com</p>	<p>Project #:</p>	
	<p>By: AZ</p>	
<p>Date: JANUARY 2001</p>		
<p>Product Engineering By: JOKINEN ENGINEERING SERVICES JES C-029 Tel 905 333 1079 Fax 905 333 3659 E-mail: eric.jokinen@sympatico.com</p>	<p>SK 2B</p>	<p>0</p>
	<p>DRWG #:</p>	<p>REV. #</p>



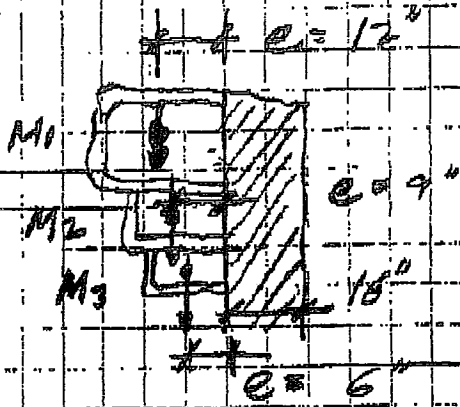
EXISTING CONDITION

Project Name: PS 230 & PS 238
Location: BROOKLYN, NEW YORK
Consultant: TAMS CONSULTANTS, INC.

DESIGN CALCULATIONS

COANKE / PAR. N. PET

Engineered Grout Injection Anchors by:		Project #:	
CINTEC AMERICA INC.		By: AZ	
613 225 3331 Fax 913 224 9042 E-mail: cira@cintec.com		Date: Dec 14/2000	
Product Engineering By: JOKINEN ENGINEERING SERVICES		JES	DE / 0
Tel 905 333 1079 Fax 905 333 1450 E-mail: eric.jekinen@sympatico.com		CL29	DRWG #: REV. #



M1: 2' x 1.5' x 2.5 @ 10PCF = 750#

M2: 1' x 1.5' x 3.0 @ 100PCF = 450#

M3: 1' x 0.67' x 2.0 @ 50PCF = 100#

MATL: A307 304 SS

$f_y = 29,000 \text{ PSI}$

$E_c = 5,000 \text{ PSI}$

$f_b = 300 \text{ PSI}$ BACK SUBSTRATE

STEEL

GROUT



Project Name: PS 230 & PS 238

Location: BROOKLYN, NEW YORK

Consultant: TAMS CONSULTANTS, INC.

DESIGN CALCULATIONS

CORNER PARAPET

Engineered Grout Injection Anchors by:

CINTEC AMERICA INC.

613 223 3381 Fax 613 223 9042 Email: rhr@cintec.com

Product Engineering By: **IOKINEN ENGINEERING SERVICES**

Tel 903 333 1079 Fax 903 333 3659 E-mail: eric.iokinen@symptivo.com

Project #:

By: AZ

Date: Dec 14, 2000

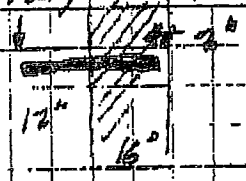
JES
C129

DE 2 0

DRWG #: REV. #

OPTION 1: CANTILEVER DESIGN (CONSERVATIVE)

Block M1: 750# / 2 ANCHORS



2 anchors / block



1/2 x 1/2 x 6 Anchor body $A_v = 0.531 \text{ in}^2$
 $S_b = 0.266 \text{ in}^3$

Show:

$V = \frac{750}{2} = 375 \text{ #}$

$F_v = \frac{V \times 2.0}{0.531} = 1,412 \text{ PSI} < 0.4 F_y$

$M = \frac{750}{2} \times 12 = 4500 \text{ in-lb}$

$F_b = \frac{M}{S_b} = \frac{4500}{0.266} = 16,917 < 0.66 F_y$

Project Name: PS 230 & PS 238
 Location: BROOKLYN, NEW YORK
 Consultant: TAMS CONSULTANTS, INC.



DESIGN CALCULATIONS

Engineered Grout Injection Anchors by:		Project #:
CINTEC AMERICA INC.		By: AZ
613-224-3381 Fax 613-224-3042 E-mail: rlr@cintec.com		Date: Dec 14/2000
Product Engineering By: JOKINEN ENGINEERING SERVICES		JES DE 3
Tel 905 333 1079 Fax 905 333 3659 E-mail: eric.jokinen@jokinen.com		0129 REV. #

OPTION 1: CANTILEVER (CONSERVATIVE)

BLOCK M1 (CONT'D)

CHECK BAG ON BRICK

ASSUME 3" Ø DIA HOLE

BAG ON 1/2 CIRCUMF.



EMBEDMENT = $7 - 2" = 16" - 2" = 14"$

$S_b = \frac{3 \times 3.14 \times 14^3}{2} = 154 \text{ in}^3$

$A_b = \frac{3 \times 3.14 \times 14}{2} = 66 \text{ in}^2$

Moment about centroid of brick bag area

$M = \frac{e}{12} + \frac{14}{2} = 19" \times 375 = 7125 \text{ in-lb}$

$S_{bend} = \frac{7125}{154} = 46 \text{ psi}$

$F_{brg} = \frac{375}{66} = 6 \text{ psi}$

$S = 52 \text{ psi} < 300 \text{ psi ALLOWABLE}$



Project Name: PS 230 & PS 238

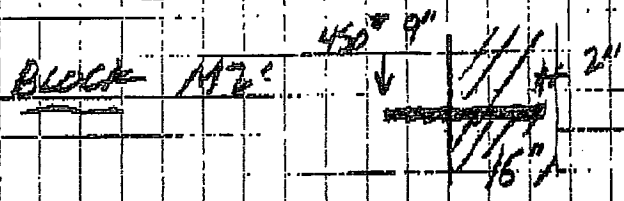
Location: BROOKLYN, NEW YORK

Consultant: TAMS CONSULTANTS, INC.

DESIGN CALCULATIONS

Engineered Geom Injection Anchors by:		Project #:
CINTEC AMERICA INC.		By: AZ
613 225 3381 Fax 613 224 9042 E-mail: rlr@cintec.com		Date: Dec 14/2000
Product Engineering By: JOKINEN ENGINEERING SERVICES		JES: DE 4 0
Tel 905 333 1079 Fax 905 333 9659 E-mail: eric.jokinen@sympatico.com		C129 DRWG #: REV #

OPTION 1 - CANTILEVER



TRY 1 ANCHOR/BLOCK

$1\frac{1}{2} \times 1\frac{1}{2} \times \frac{1}{8}$ in 3" HOLE - EMBED 14"

$M_c = 450 \times 9 = 4050 < M_c (\text{BLOCK}) \therefore \text{OK}$

$M_{BRG} = 450 \times (9 + 7) = 7200 \text{ in-lb} \approx M_{BRG} (\text{BLOCK}) \therefore \text{OK}$

USE SAME DESIGN AS

BLOCK 1 EXCEPT 1 ANCHOR/BLOCK

BLOCK M3 IN TENSION

$P = 100 \text{ #/sq in}$ 1/2" THRD ROD $A_{net} = 0.11 \text{ in}^2$

$P_{allow} = 0.11 \times 2000 \times 0.6 = 1900 \text{ # OK}$

Pull out 1 1/4" HOLE x 12" EMBED @ 65 PSI BOND

$P_u = 3060 \text{ # OK}$



Project Name PS 230 & PS 238

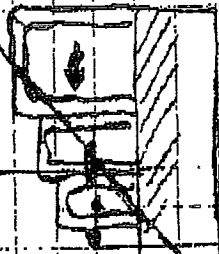
Location BROOKLYN, NEW YORK

Consultant TAMS CONSULTANTS, INC.

ENO " OPTION 1 DESIGN CALC. ROKINEN

Engineered Grout Injection Anchors by:		Project #:
CINTEC AMERICA INC.		By: AZ
613 225 3381 Fax 613 224 9042 E-mail: cti@cintec.com		Date: Dec 14/2000
Product Engineering By: JOKINEN ENGINEERING SERVICES		IES DE 5 0
Tel 905 333 1679 Fax 905 333 3659 E-mail: eric.jokinen@sympatico.com		CL29 DRWG #: REV. #

OPTION 2 = CORBELLED



CORBEL



$$P = M_1 + M_2 + M_3$$

$$= 750 + 450 + 100$$

$$= 1300$$

$e = 12"$
(CONSERVATIVE)

$$M_c = 12 \times 1300 = 15600 \text{ in-lb}$$

$$P_o = \frac{M}{d} = \frac{15600}{16} = 975 \text{ PULL OUT ON ANCHOR}$$

TRY $\frac{3}{4}" \phi$ in $1\frac{1}{2}" \phi$ HOLE - 14" EMBED

STEEL: $P_a = 0.25 \times 29000 \times 0.6 = 4350 < 975$

BOND: $P_a = 1.5 \pi \times 12 \times 65 \text{ PSI} = 3673 < 975$

= OK

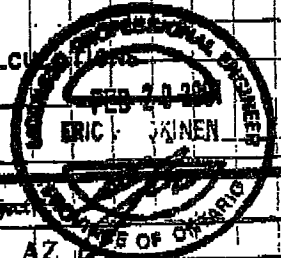
BLOCK M3 HANGER (AS OPTION 1 DESIGN)

Project Name: PS 230 & PS 238

Location: BROOKLYN, NEW YORK

Consultant: TAMS CONSULTANTS, INC.

DESIGN CALC



Engineered Grout Injection Anchors by:
CINTEC AMERICA INC.

613 228 3381 Fax 613 228 9042 Email: rlr@cintec.com

Product Engineering By: JOKINEN ENGINEERING SERVICES

Tel 905 333 1079 Fax 905 333 3659 E-mail: eric.jokinen@symmetric.com

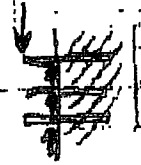
Project: PS 230 & PS 238
By: AZ
Date: Dec 14/2000

JES
C129

DE 6
DRWG #: REV. #

OPTION 2: CORRODED

CHECK SHEAR IN ANCHORS @ PARAPET EXT. FACE



3 - 3/4" THRD ROD DOWN

$$V_{allow} = \frac{0.15 \times 29000 \times 0.4}{1.33} = 2180 \text{#/anchor}$$

1300* TOTAL REQD
:OK

END OPTION 2



Project Name: PS 230 & PS 238
Location: BROOKLYN, NEW YORK
Consultant: TAMS CONSULTANTS, INC.

DESIGN CALCULATIONS

Engineered Grout Injection Anchors by:		Project #:
CINTEC AMERICA INC.		By: AZ
Tel: 613 224 3781 Fax: 613 224 9042 E-mail: cin@cinotec.com		Date: Dec 14/2000
Product Engineering By: JOKINEN ENGINEERING SERVICES	JES C129	DE 7 0
Tel: 905 313 1079 Fax: 905 313 3659 E-mail: eric.jokinen@cinotec.com		DRWG #: REV. #

Versatile Consulting and Testing Services, Inc.

ANCHORS TESTING PROGRAM

Project: PS 230K

Prepared for Hill International, Inc.

by Roman Sorokko, P.E.
/Lic. No. 072800



JUNE 2001

THE CEMENTITIOUS INJECTED GROUT ANCHORS TESTING PROGRAM.

I, Roman Sorokko, P.E., being duly sworn say: I am a Professional Engineer, (Lic. # 072800) assigned by Hill International, Inc. to conduct the anchor testing for the Project E3000.

I have read all provisions of the Building Code of the City of New York, and the Project Specifications, and I am thoroughly familiar with the plans, and standards referred to herein, and I am thoroughly familiar with all responsibilities for the inspection of the subject item.

1. Introduction

As per NYC DDC request, and as directed by Hill International, Inc. we performed the pull out test of the steel anchors fabricated by Cintec America Inc. The purpose of the test is to verify the anchors' design parameters as per Item 04525 – Terra Cotta Restoration and Repair, Paragraph 2.2 Anchors.

2. Equipment

20 tons hydraulic jack with center hole cylinder, gage 1000 psi, hydraulic hand pump, loading valve.

3. Procedure

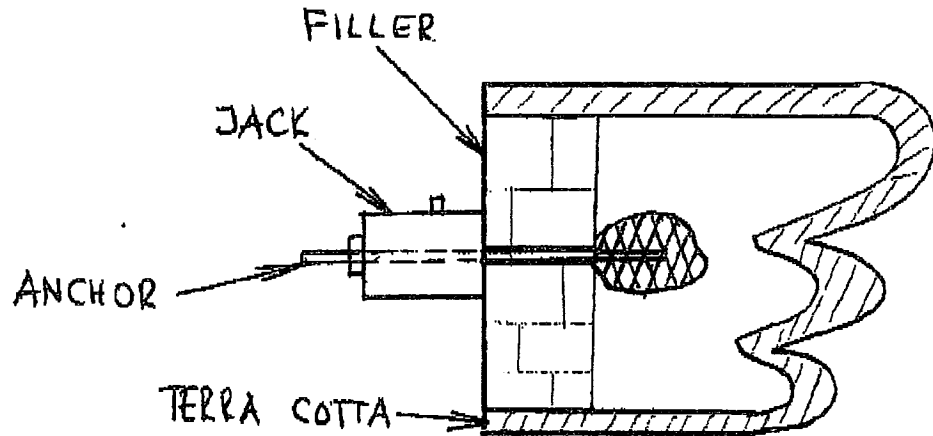
On June 18, 2001 the anchors Type A and Type B were installed by the representatives of Cintec America Inc. This installation was also a part of the Contractor's training program. Two Type A anchors (1/2" in diameter) designated for the testing were placed into the pies of terra cotta which was previously removed from the building. One designated for testing Type B anchor 1.5" x 1.5" x 1/8" HSS shape was installed into the parapet wall.

4. Test Results

TEST No. 1

Type A anchors were tested under two different schemes. During the first setting the jack was placed directly on top of the terra cotta's masonry filler (see Photo No. 1 and Sketch below). Therefore, the forces developed by the hydraulic jack

were transformed into the anchor's expanded part through the brick masonry filler. Hence, the terra cotta, as well as the joints between the terra cotta and the filler were not stressed.

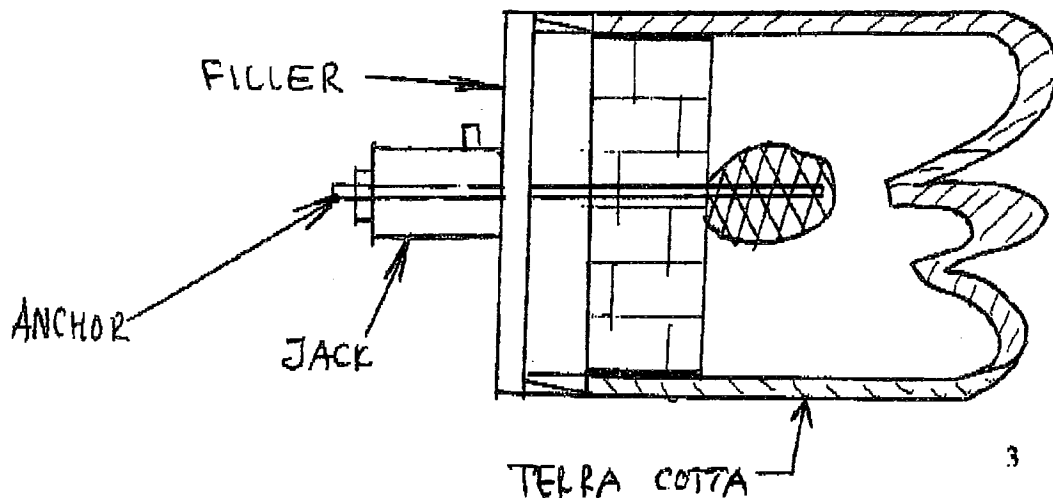


Under this format the Type A anchor was loaded up to 4,690 lbs or 2.3 tons (equivalent of 1,000 psi reading). The load was gradually applied in steps of 100 psi increment.

The tested anchor sustained the maximum load of 4,690 lbs or 2.3 tons during 15 minutes.

TEST No. 2

During the second test the same (previously tested) Type A anchor was loaded in such way that the terra cotta was under the compression stress from the hydraulic jack. Therefore, the pull out forces were developed along the joint between the terra cotta and the masonry filler (see Photos No. 2 and 3 and Sketch below).



The anchor was gradually loaded up to 2,580 or 1.3 tons which equivalent to 550 psi reading. At this point the joint between the terra cotta and the masonry filler failed (see Photos No 4, 5, 6 and 7).

TEST No. 3.

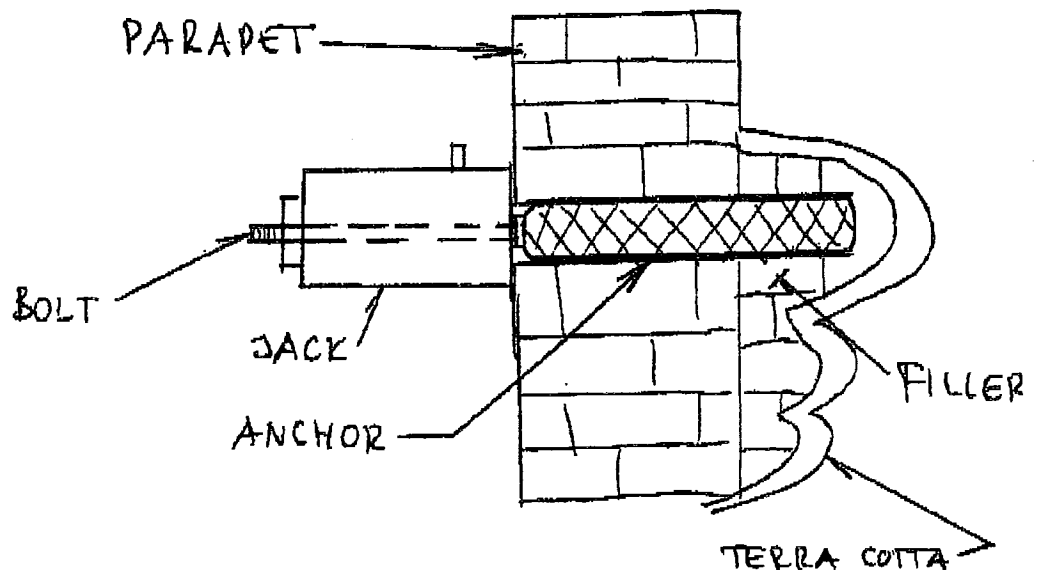
The second Type A anchor was loaded similar to the TEST No. 2 – pull out forces were applied to the joint between the terra cotta and the masonry filler.

The joint failed under the load of 3,987 lbs or 2.0 tons (equivalent to 850 psi reading).

TEST No. 4

The anchor Type B (installed into the brick masonry parapet wall and partly inserted into the terra cotta) was tested under the similar setting to the TEST No. 2 and 3 as shown on Sketch below.

For the testing purpose the steel bolt, $\frac{3}{4}$ " in diameter, was welded to the anchor's cover plate.



The anchor was gradually loaded up to 2,814 lbs or 1.4 tons (equivalent to 600 psi reading). The anchor has sustained this load for 15 minutes.

5. Conclusion

Therefore, the results of the performed testing program can summarized as follows:

Anchor Type A

1. Pull out forces acting between the anchor and the terra cotta's masonry filler – the system sustained the load of 4,690 lbs or 2.3 tons.
2. Pull out forces acting along the joint between the terra cotta and the filler – The system failed under the load of 2,580 or 1.3 tons and 3,987 lbs or 2.0 tons (average 3,284 lbs or 1.64 tons)

Anchor Type B

Pull out forces acting along the anchor and the masonry parapet wall – the system sustained the load of 2,814 lbs or 1.4 tons.

I certify that I have carefully performed this test to the best of my knowledge, and I have accurately reported all the obtained results.

Prep. by Roman Sorokko



A CONSERVATION STUDY OF

A Terra-Cotta Building

Circa 1917-1918

By: Professor Martin E. Weaver, AA Dipl



INTRODUCTION

This Terra-Cotta Building was built 1917-18 as the Norlite Building and was designed by Richards and Abra with C.P. Meredith.

From an examination of copies of some of the original drawings for the building, it was apparent that the building was constructed with a reinforced concrete frame and floors; and was clad on its North with off-white glazed terra-cotta cladding. The terra-cotta cladding was returned round the East and West façade for one bay, and small, terra-cotta clad towers were formed one and a half storey's high above the main parapet wall at the North West and North East corners. These two small towers were designed to be capped by copper-clad domes; and the parapet was decorated with two free-standing terra-cotta urns on bases or acroteria. Both the domes and the urns have disappeared.

The first studies on the Building commenced when Martin Weaver was commissioned to carry out a brief examination of the North or main terra-cotta façade in November 1993.

Martin Weaver had initially been requested to advise on the repair of the terra-cotta cladding on one of the piers at the 7th and 8th storey's (Bay 4 numbering from the East) and to make a proposal for further studies if these should be found necessary. In the course of the initial study Martin Weaver found that parts of the terra-cotta cornices on the East and West towers were in a dangerous state and in need of immediate stabilization. The risk of injury to pedestrians on the sidewalks beneath was in fact so serious that barriers need to be erected immediately. These observations were forwarded directly to the client.

The terra-cotta work was found to be generally cracked in a number of places and bowed and cracked away from the main structure in others. Mortar, stucco and other repairs were also showing signs of failure.

THE CONDITION SURVEY

Martin Weaver was thus commissioned to make the study, and the condition survey was carried out from a personnel basket suspended at the end of the cable from the jib of 110 ton mobile crane. The survey was carried out in very poor weather with snow and extremely cold windy conditions in December 1993. The temperature with the wind-chill factor was often lower than -25°C.

Parts of the structure were obscured by snow and thus could not be surveyed. Every part of the exposed external surface of the terra-cotta work was examined closely and loose and dangerous fragments were removed from the building wherever possible.

As a result of the writers' immediate observations a second emergency report and recommendations were issued. The object of these recommended works was to remove risk of injury to the public which might be caused by falling fragments of terra-cotta.

OBSERVATIONS

The problems of the terra-cotta cladding of the Building are typical of such structures and materials of the period of the golden era of architectural terra-cotta from the early 1900's to the 1920's.

It may be helpful to list the major deterioration categories which were present in this case:

1. Over a long period of time a combination of initial shrinkage and long term "frame-shortening" of the reinforced concrete frame of the building has tended to transfer loads onto the relatively thin terra-cotta cladding. The terra-cotta units have thin brittle walls and fail in compression, usually cracking horizontally at their mid-points, or suffering from spalls at their loaded upper edges and sometimes lower edges (see for example areas W7-8); the sides of the terra-cotta units usually tend to have a slight recess immediately behind the outer edge, the resulting projections over and under the bed joints then tend to receive the concentrated loads; units in cladding which is loaded in this way may also buckle outwards and may cause extremely dangerous conditions to develop if the anchors are corroded; or are insufficiently numerous or if they break out of the brittle terra-cotta. This might also be a part of the problem with the cornices on the East and West Towers.
2. Leakage of water into the wall, usually from open joints in skyward-facing surfaces, can lead to freezing water within the wall and to the terra-cotta units being forced off the walls; or the water can cause corrosion in hidden steel anchors and rods which were used to tie the cladding back to the back-up brickwork or to the concrete of the frame, columns or edge beams; in which cases the damage was probably also the main cause of the failure of the cornices on the East and West Towers.
3. Localized spalling and exfoliation of glaze/slip coats caused by water being trapped in the terra-cotta body behind the latter;
4. Surface cracqueure on some blocks where "lack of fit" or differences in thermal expansion coefficients cause the body to shrink or expand more, and more quickly than the glaze/slip combination;
5. Extensive failures of joints; failures of ineffective repairs to jointing and pointing and failures of repairs to previously damaged terra-cotta have all contributed substantially to the entry of water behind the terra-cotta cladding where it can freeze or cause corrosion in hidden steel anchors;
6. Extensive failures of cementitious repairs where original balconies or terra-cotta and ironwork have been removed (8th storey North façade) have contributed to the entry of water with the results noted in the above case; there was also a failure to remove all of the associated with the balconies and this has led to continuing corrosion causing expansion, cracking of the terra-cotta and renders, and extensive rust staining.

REMEDIAL ACTION AND RESTORATION MEASURES

The tops of the two towers should be carefully dismantled after first recording them and numbering all the terra-cotta units. The terra-cotta work should be dismantled at least to the level of the base of the cornices as indicated on the drawings. After the security of the masonry has been established and a sound level has been reached, the terra-cotta and the brick back-up masonry can be rebuilt.

All corroded steel anchors, cramps, ties and other terra-cotta cladding-attachment devices must be carefully removed and replaced with appropriately designed replacements in stainless steel (AISI Type 304).

All shattered and irreparable terra-cotta units should be replaced using new units of fine-faced pre-cast concrete or fiber reinforced plastic carefully fabricated to match original dimensions and surface finishes including fine ribbing or "tooling". It would probably not be practical to obtain the small number of replacement units required, using actual matching terra-cotta. Delivery times for terra-cotta would normally be a major problem.

The entire terra-cotta cladding must be tied back to the back-up masonry in such a way that the load of the cladding is transferred back onto the reinforced concrete edge beams on the floor slabs. This tying back should be effected by the use of specifically designed Cintec grout injection anchors, which are the only type that can effectively be used in this case.

Once the cladding had been tied back and effectively stabilized, all the mortar joints in the terra-cotta work should be carefully cut out and the caulking or sealants removed. This work of mortar removal must be carried out with great care using small diameter diamond saws (120mm diameter) and specially designed diamond impregnated router bits. Both should be used with pneumatically powered tools with attached dust extraction intakes. Special care should be taken to ensure that the terra-cotta blocks are not damaged by over-cutting or "Straightening" of bed joints or by over-cutting or "nicking" at the top and bottom of vertical joints.

Replace all jointing and bedding mortar with a mortar mix of 1;1;6 p.b.v. (non staining white Portland cement) hydrated lime sand with 16% entrained air obtained by thoroughly machine mixing for approximately 8-10 minutes.

The purpose of the entrained air is to confer and freeze/thaw cycle resistance.

One bed joint at each storey immediately at or below the floor slab should not be pointed with mortar but should be pointed with a high quality dymeric or similar caulking compound or sealant, to produce a soft compressible joint, thus preventing compression of the panels of cladding between floor slabs.

Prior to any cleaning of the masonry, all corroding steel and ironwork, bolt stubs, and redundant electrical conduits, junction boxes and brackets should be removed from the Masonry and the holes made good to match surrounding material. Embedded bolts and fragments of bars or rails should be drilled out using a diamond-tipped coring bit of slightly larger diameter. The resulting hole should be plugged with a limestone core in limestone and with a Jahn Terra-Cotta Restoration Mortar in the terra-cotta. The latter shall be carefully matched to the original color and texture of the terra-cotta. Spalls in the terra-cotta and areas of failing cementitious repairs in the terra-cotta should be carefully cut out as necessary and should also be repaired with matching Jahn Terra-Cotta Restoration Mortar.

Slight losses of the glaze/slip coating should be repaired after cleaning of the terra-cotta, by the application of a tinted breathable masonry coating carefully selected to be color matched to the original terra-cotta – ie, a light cream-stone color. The known appropriate coats are:

Conservare BMC, ProSoCo, Kansas City, Kansas US
Keim Granital, Keim gmbh, Germany
Minasil Mineralfarben, MCS Chemie, Salzburg, Austria

Field testing and research of the selected manufacturer's literature would be required to determine if the above coatings could be applied over the Jan Mortar repairs.

Following a carefully organized test program, the rust stained and soiled terra-cotta should be cleaned. The limestone cornice of the 2nd storey should also be repaired and cleaned.

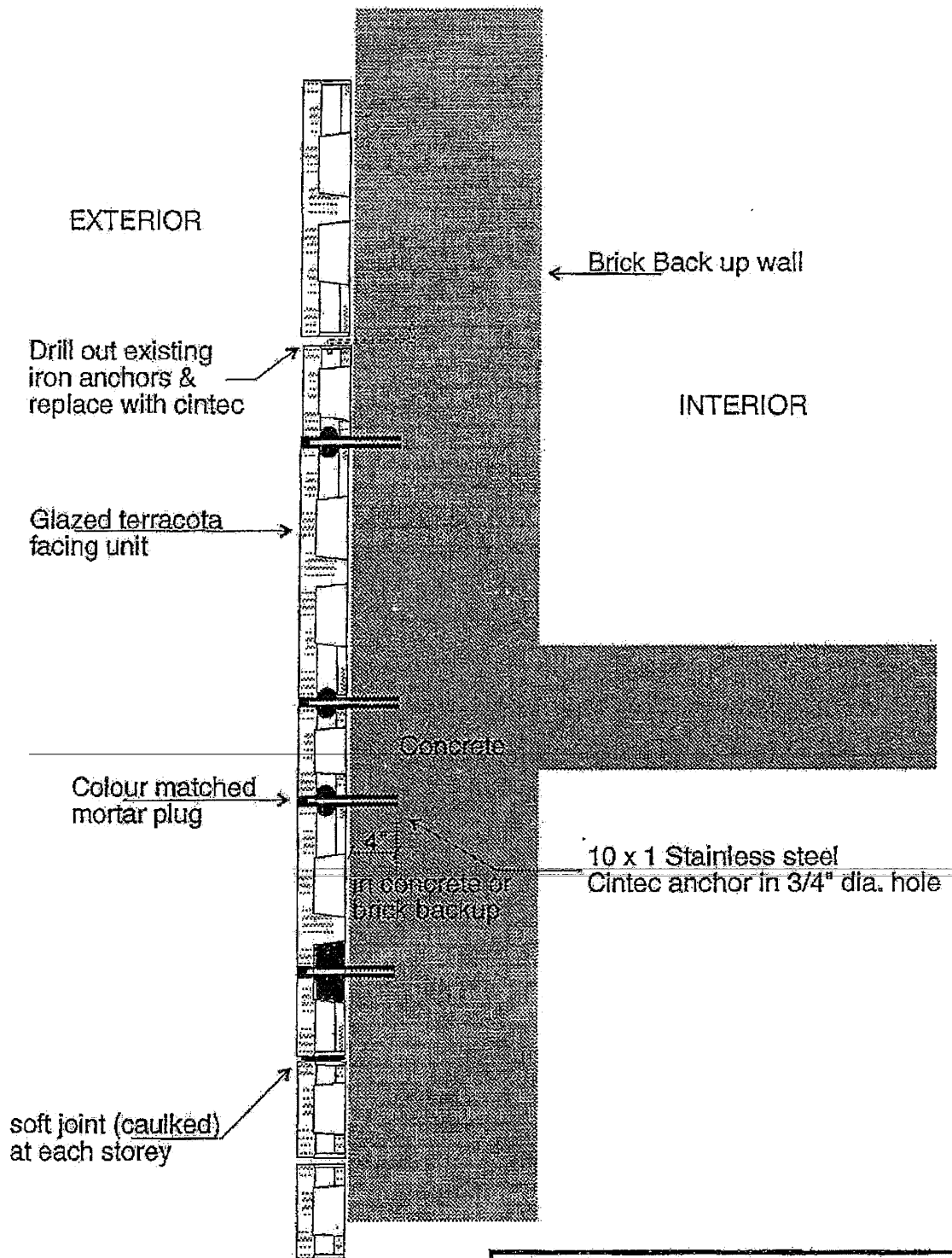
Spall damage should be repaired by careful cutting out and the insertion of matching Indiana Limestone Dutchmen. Cleaning of the limestone should be by means of nebulous spray washing and limited use of neutral, non-ionic detergents such as Triton X100. Following appropriate testing and the establishment of successful techniques, rust staining may be removed using Ferric Stain Removing Poultices from ProSoCo.

BRICK FACADES

The east, west and south facades, except for the terra-cotta returns at the north end of the building, are clad in a fired clay brick, which has been painted.

However, observation from the ground with binoculars and from the observation bucket indicated that these walls were in no immediate danger.

Deterioration was noted at shelf angles at a number of locations, particularly near the top of the building. This appears to be typical damage caused by the expansion of products of corrosion of the shelf angles.



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CONSERVING A TERRA-COTTA CORNICE

March 2008 Version 1 Rev 1

A treatment report by Conservation Solutions, Inc., on a terra-cotta cornice adorning the Capitol Building in San Juan, Puerto Rico, shows the potentially catastrophic effects of corrosion in a marine environment, and offers some innovative solutions to the problem.

by Joseph Sembrat, Head Conservator and
President of Conservation Solutions, Inc.

Conservation Solutions, Inc., was contracted by the government of Puerto Rico to assist Pablo Quinones of OPQ & Associates in the investigation of the main terra-cotta cornice at the base of the dome of San Juan's Capitol Building.

CSI subcontracted the services of Martin Weaver, President of Martin Weaver and Associates International Conservation Consultants (MWAICC), who performed investigative work and partial disassembly of a 6-ft. section of the cornice. This was done in order to prevent the collapse of this section of the cornice, determine the cause and nature of the failure, better understand the materials and techniques used in its construction, and provide the architect with various design solutions, cost estimates, and assistance with the writing of specifications.

The Capitol Building of Puerto Rico was inaugurated on February 11, 1929, as the seat of the Legislative Branch of the Puerto Rican Government. A vast marble staircase faces Ponce de Leon Avenue and gives access to the building to the south. Eight Corinthian columns rise at both main entrances and seven imposing doors give access to its interior at the north and south. At the center of the structure there is a rotunda which extends upwards to the three floors of the building, and in the center of the first floor there is a display case which has the original Constitution of Puerto Rico permanently on display. The cornice adorns the base of the dome which rises at the center of the building on an octagonal drum.

To help understand the condition of both the terra-cotta anchoring system and the concrete substructure that supports it, and to assist the clients in their portico-restoration project, CSI conducted an on-site investigation of the terra-cotta cornice and concrete substructure from scaffolding. CSI and Martin Weaver performed written and photographic documentation of the work and provided field drawings to OPQ & Associates.

continued on following page



Puerto Rico's Capitol Building, or "El Capitolio," in San Juan, was completed and inaugurated in 1929. A major port city, San Juan faces the Atlantic Ocean to the north. This marine environment was a major factor in the dangerous corrosion of the anchoring system of the building's terra-cotta cornice.



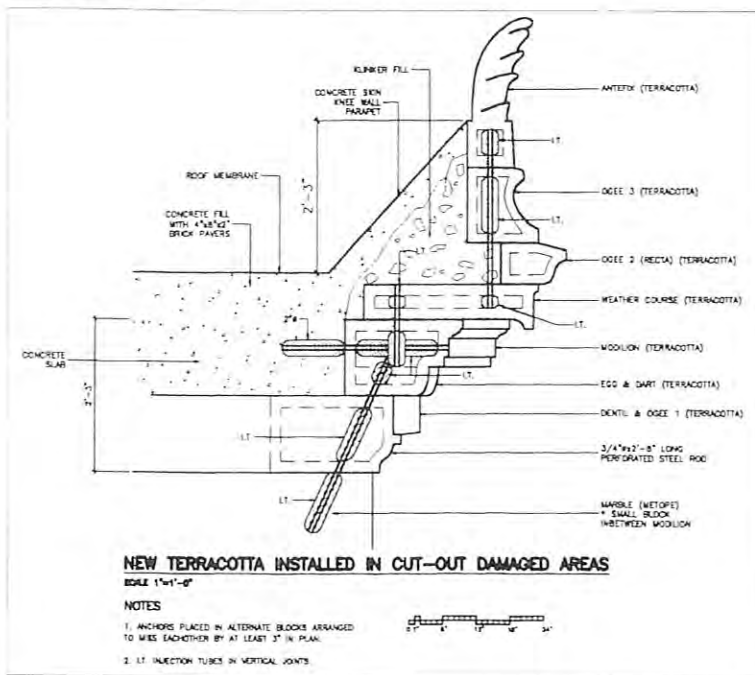
The poor condition of the terra-cotta cornice is evident in this view. The separation of the terra-cotta units is due to not only the failure of the anchoring system, but also the expansion of the corroded material.



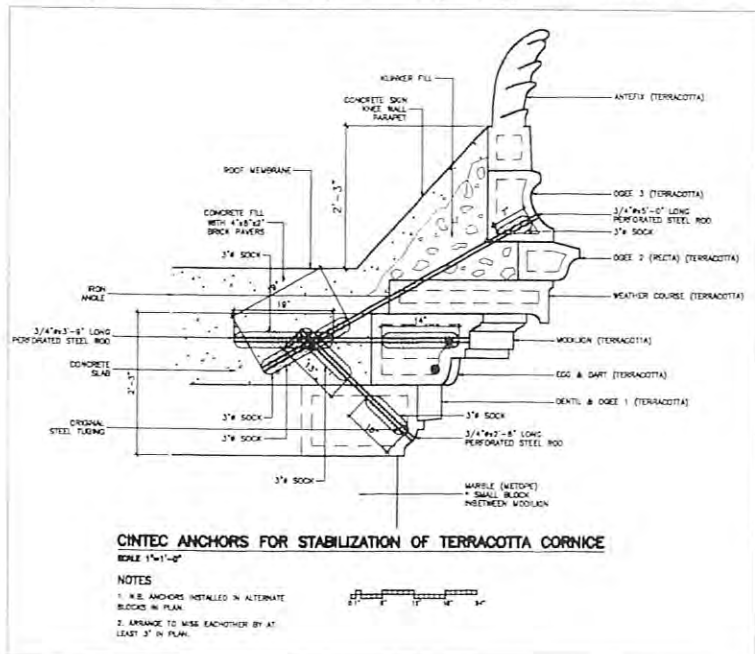
A worker is seen here cutting the mortar joints between the terra-cotta blocks in preparation for the disassembly of the cornice.



Once the cornice had been partially disassembled, the materials and techniques used in its construction could be easily identified. Note the clinker concrete, or "cindercrete," between the terra-cotta blocks and the brick backup material, and the severe deterioration of the steel supports. CSI recommended that all new steelwork be AISI Type 516 stainless steel, a non-corroding type, which is essential in this chloride-rich maritime environment.



Conservation Solutions, in collaboration with the project architect and conservation consultant Martin Weaver, designed these two new anchoring systems for the cornice. The design for the dismantled section (above) uses AISI Type 316, non-corroding stainless-steel rods in a grout-injection anchor system by CINTEC. Small injection tubes are positioned in the joints between the terra-cotta units for inflation with grout after assembly. The stabilizing anchors (below) are designed to be installed in-situ by means of a different type of CINTEC grout-injection system, also using AISI Type 316 stainless-steel rods.



Most importantly, we disassembled approximately 6 feet of the cornice to reveal its construction and its anchoring system. We also exposed a portion of the parapet decking to determine the condition of the underlying concrete substructure. In collaboration with the architect and Martin Weaver, a new anchoring system was designed. We also worked with the noted terra-cotta manufacturer, Gladding, McBean, to determine which sections of terra cotta would need to be replicated.

Finally, after our investigative work was done, CSI made the opening in the cornice watertight.

Following observation of severe cracking and movement at the corners of the main terra-cotta cornice of the octagonal lower drum of the dome, it was jointly decided to erect scaffolding and to carefully make an exploratory opening into the terra-cotta work.

The purposes of this intervention were to establish if the cracking and movement were evidence of a dangerous situation, to establish the types, locations, and conditions of the hidden steel support structure and anchors, and to establish the type, location, and condition of the reinforced concrete sub-structure.

We selected the southeast corner of the octagonal lower drum, apparently the area of the cornice with the worst conditions, as the best site for our investigations. Pablo Quinones and Martin Weaver had noted what appeared to be evidence of severe damage in this same area in 1998.

As the careful cutting away commenced at the cornice's upper level, a few blocks of terra-cotta were seen to be a mass of clinker concrete or cindercrete. This material is based on an aggregate of furnace ash and large fragments of clinker. Its use has been suspended for many years because the large quantities of sulfur compounds present in the ash and clinker have been found to cause severe corrosion of adjacent steel in the presence of moisture.

After removal of the cindercrete from the adjacent area, the cutting-out proceeded and it was noted that the movement of the terra cotta was beginning to accelerate. The terra-cotta mass at the corner — probably weighing in excess of 500 lbs. — was pulling away from the main mass of the cornice by active diagonal cracks propagating down on either side of the corner. The unstable mass was immediately secured by ropes and temporary supports and was carefully cut apart and removed.

Water had penetrated down into the cornice, and all its steel structural supports and anchors had been totally destroyed by corrosion. The total failure of the structural-support steel and anchor system had led to the structural failure of the cantilevered, and now unreinforced, terra-cotta cornice. The only reason that it had not collapsed was a combination of the cohesive and frictional effects of the mortar and brick fragments used as back-up to the hollow terra-cotta units.

Moisture had entered via open joints and cracks and, to a lesser extent, through leaks in the roof above and behind the cornice. The reason for the extreme corrosion of the steel was a combination of chlorides from sea spray and the sulfuric acid formed when saline moisture saturated and then passed through the contaminated cindercrete. The corrosion had been so severe that it was no longer possible to establish the exact dimensions of any of the former steel elements. Some had disappeared totally, leaving only rusty stains in the terra-cotta work.

It should be noted that any corrosion of embedded steel is associated with massive expansion of the corrosion products. In the case of the Capitol Building, this expansion had resulted, and will continue to result, in the shattering of the immediately adjacent terra cotta. Thus, all stabilization, conservation, and restoration work must involve the removal of all corroding steel and/or the prevention of any further corrosion and associated expansive effects. All new steelwork must be AISI Type 316 stainless steel, which is non-corroding in the chloride-rich maritime environment present here. AISI Type 304 stainless steel is attacked by chlorides and cannot be used here under any circumstances because it will corrode.

On the basis of our observations, we concluded that in any and all locations where the terra-cotta cornices show evidence of cracking and movement, with open joints and possibly rust staining on the lower surfaces, then this terra-cotta work has had all, or most, of its structural-support steel and anchoring system so severely corroded that it is either totally gone or is so seriously deteriorated that the whole cornice, or parts thereof, are liable to become dangerous and could collapse suddenly and without further evidence of failure.

The extreme nature of the deterioration process was such that it will inevitably lead to catastrophic failure, with collapse of the terra cotta onto, and possibly through, the openings in the roof below. Accordingly, we recommended that all cracked and deformed areas of the cornice should be carefully dismantled as soon as possible. Shattered terra-cotta units should be replaced with high-quality matching new units from a well-established terra-cotta manufacturer such as Gladding, McBean of California. This firm has been in continuous practice since before the erection of the Capitol and is known for the high quality of its architectural terra cotta.

The dismantled corners should be rebuilt using AISI Type 316, non-corroding stainless-steel rods in a grout-injection anchor system by CINTEC, specially designed with small injection tubes positioned in the joints between the terra-cotta units for inflation with grout after assembly.

Undamaged areas of terra cotta may be stabilized in-situ by means of a different type of CINTEC grout-injection anchor system, also using AISI Type 316 stainless-steel rods. It will be necessary to open up a series of areas in the terra-cotta work at random locations to determine if, in fact, the apparently undamaged terra cotta can be safely stabilized in this way.

Once the water has been prevented from getting into the top of the cornices and other details, and the CINTEC in-situ stabilization system has been applied in diamond-tipped core-drilled holes, the crucial factor then will be whether any existing embedded steel can be left in-situ. All in-situ stabilization work must involve dry-drilling with advanced air-cooled drilling equipment. Under no circumstances can water-cooled drilling systems be used because of the danger of the water causing further deterioration.

It was recommended that a complete condition survey of all the terra-cotta work should be carried out as soon as possible to locate any other dangerous areas which may already exist. ■

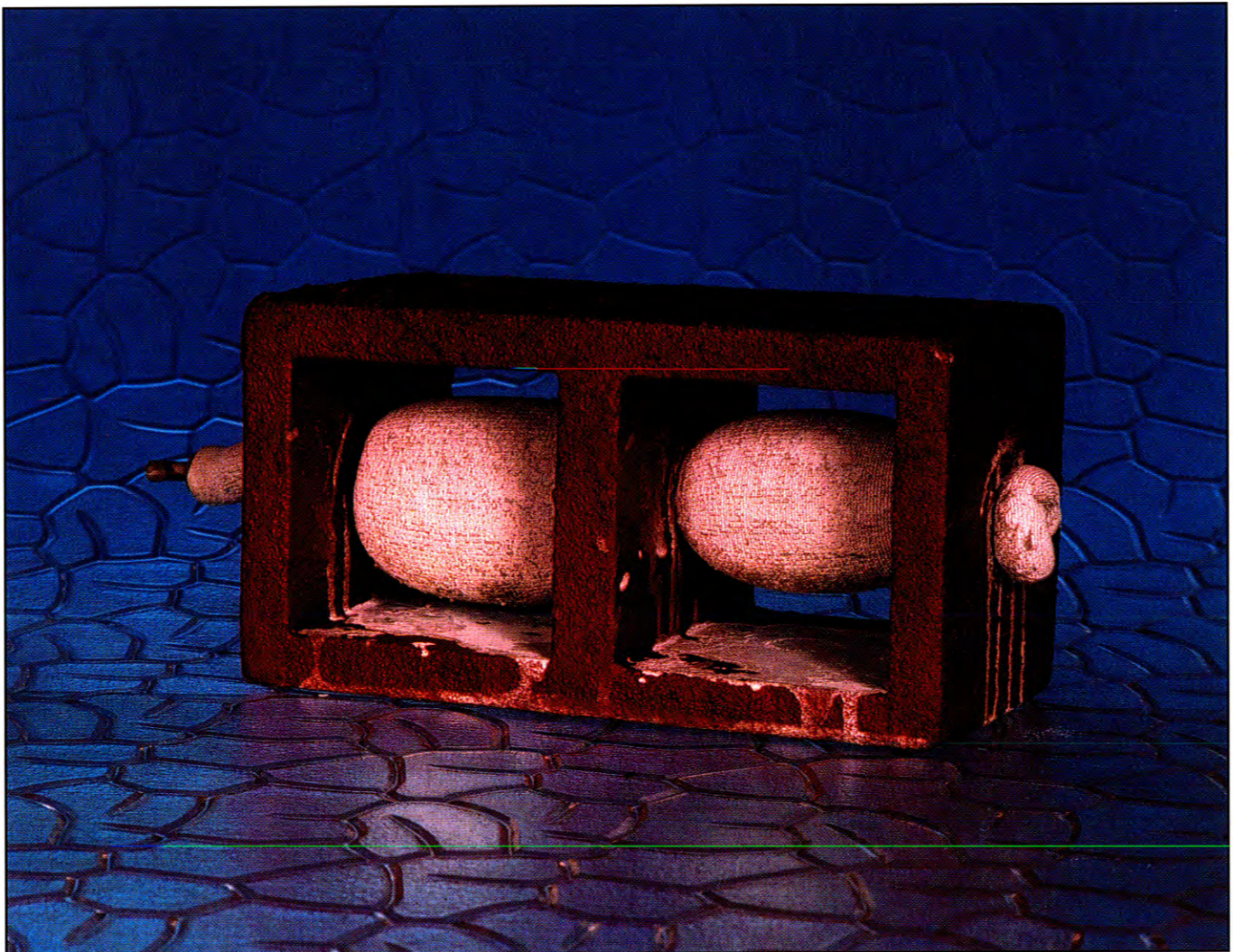
Joseph Sembrat is President and Head Conservator of Conservation Solutions, Inc., District Heights, MD. The firm specializes in the conservation of historic structures, monuments, sculpture, and fountains in such materials as metal, stone, and terra-cotta.

CINTEC

ENHANCED FIXING TECHNOLOGY FOR TERRA-COTTA AND HOLLOW MASONRY UNITS

**NOUVELLE TECHNOLOGIE D'ATTACHEMENT POUR TERRE CUITE
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DESIGNED ANCHOR SYSTEMS

SYSTÈME D'ANCRAGES ÉTUDIÉS
SISTEMAS DE ANCLAS DE DISEÑO



THE CINTEC ANCHOR IS INSERTED INTO A PREDRILLED HOLE.

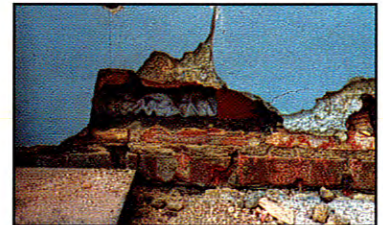
L'ANCRE CINTEC EST INSÉRÉE DANS UN TROU PRÉ-PERFORÉ.

EL ANCLA CINTEC ES INTRODUCIDA EN EL ORIFICIO TALADRADO.

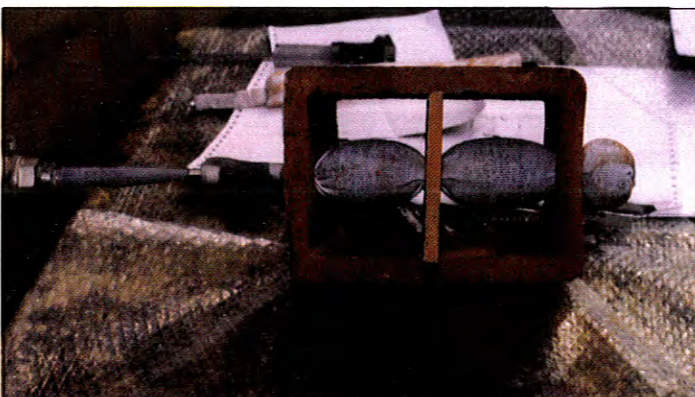


THE INJECTION EQUIPMENT IS ATTACHED TO THE ANCHOR AND INFLATION COMMENCES UNDER A PRESSURE OF 42 P.S.I.

LE SYSTÈME D'INJECTION EST ATTACHÉ A L'ANCRE ET LE GONFLAGE COMMENCE SOUS UNE PRESION DE 42 P.S.I.



EL EQUIPO DE INYECCIÓN ES FIJADO AL ANCLA Y COMIENZA A INFLARSE A UNA PRESIÓN DE 42 P.S.I.



GROUT IS PUMPED INTO THE HOLLOW STEEL SECTION WHICH FLOWS INTO THE SOCKED AREA VIA A NUMBER OF FLOODED HOLES.

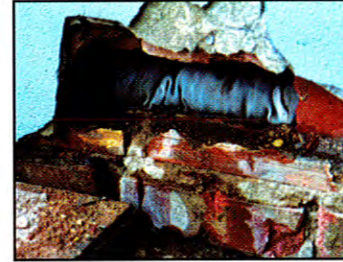
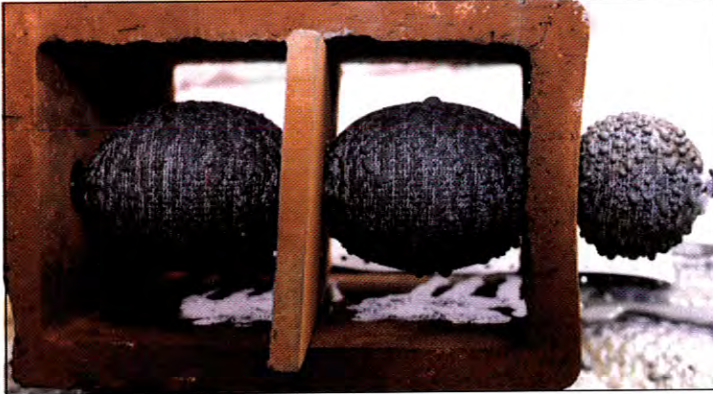
LE MORTIER EST POMPÉ DANS LE TUBE D'ACIER ET S'INFILTRE DANS LA GAINÉ PAR DE NONBREUSES OUVERTURES D'ÉCOULEMENT.

EL CEMENTO ES BOMBEADO EN LA SECCIÓN HUECA DE ACERO PARA POSTERIORMENTE FLUIR A TRAVÉS DE NUMEROSOS AGUJEROS HACIA EL FORRO.

AS THE ANCHOR FILLS, GROUT MILK FLOWS THROUGH THE SOCK CREATING A CHEMICAL BOND BETWEEN ANCHOR AND SUBSTRATE.

EN REMPLISSANT L'ANCRE, LA LAITANCE DU MORTIER PÉNÈTRE LA GAINE ET FORME UNE LIAISON CHIMIQUE ENTRE L'ANCRE ET LE MATÉRIAU SUPPORT.

CUANDO EL ANCLA SE LLENA, LA LECHE DE CEMENTO PENETRA EL FORRO Y FORMA ASI UNA REACCIÓN QUÍMICA ENTRE EL ANCLA Y EL SUBSTRATO.



AFTER APPROXIMATELY 15 SECONDS THE ANCHOR IS TOTALLY INFLATED WITH A MICRO FINE CONCRETE GROUT GIVING A MECHANICAL FIXING. IN ADDITION, THE GROUT MILK HAS PASSED THROUGH THE SOCK FORMING A CHEMICAL BOND TO THE SUBSTRATE.

APPROXIMATIVEMENT 15 SECONDES PLUS TARD, L'ANCRE EST TOTALEMENT REMPLI AVEC DU MORTIER A BÉTON MICRO FIN QUI PRODUIT UN ATTACHEMENT MÉCANIQUE.

APPROXIMADAMENTE 15 SEGUNDOS MÁS TARDE EL ANCLA SE LLENA TOTALMENTE DE CONCRETO MICROFINO PRODUCIÉNDOSE UNA FIJACION MECANICA.



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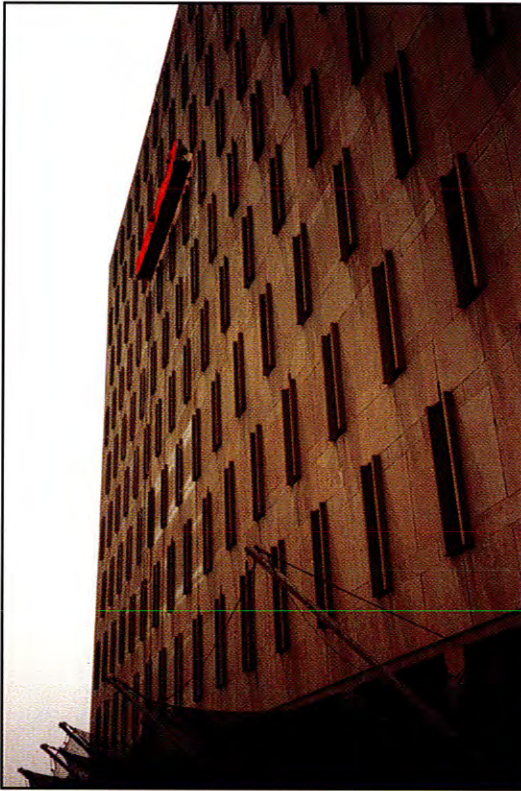
EN ENSAYOS LLEVADOS A CABO POR LABORATORIOS INDEPENDIENTES EN UN EDIFICIO DE MATERIALES SIMILARES SE CONSIGUIO UNA PRESION AXIAL DE MAS DE 3000 LBS.

TEST RESULTS AVAILABLE ON REQUEST – RÉSULTATS DISPONIBLES SUR DEMANDE – LOS RESULTADOS A SU DISPOSICIÓN, MEDIANTE SOLICITUDE.

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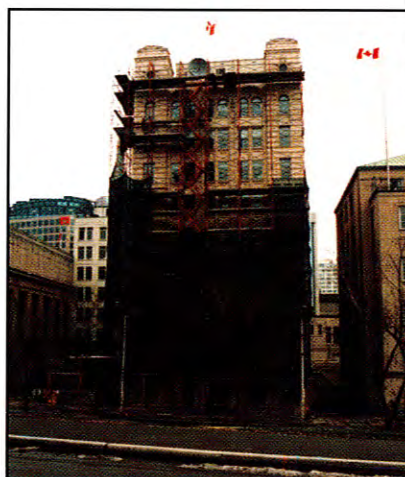


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PARA MÁS INFORMACIÓN, CONTACTAR CON NEUSTRO DEPARTAMENTO TÈCNICO.



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TERRA COTTA

· STANDARD · CONSTRUCTION

REVISED EDITION

NATIONAL
TERRA COTTA SOCIETY

19 WEST 44th STREET U - S - A NEW YORK, N. Y.

1927

▲ ▲ ▲ ▲ TERRA COTTA ▲ STANDARD CONSTRUCTION ▲ ▲ ▲ ▲

Introduction

The present volume is a revision of Architectural Terra Cotta—Standard Construction, originally published in 1914.

Like the previous issue, this edition does not presume to suggest architectural design. It shows illustrative architectural forms of assumed proportions, and their proper constructional features. It shows the correct use of Terra Cotta. For a number of examples several good solutions of the structural problems are possible. Variations in size of similar sections sometimes necessitate radical changes in both jointing and construction.

The changes made in this revision are the result of a more extended experience in manufacturing and in modern building methods, and are based on a careful study of the behavior and weathering properties of exterior building materials.

The following are the most important of the structural principles upon which this revision has been developed:

- Shelf Supports* In concrete or steel frame buildings, the veneer or facing material should be fully and continuously supported, at each floor level on shelf supports, of adequate strength and stiffness, rigidly connected to the structural frame. Steel shelf angles or supports, in all cases, should be located in mortar joints. The strength of the Terra Cotta should not be unnecessarily reduced by cutting the webs to receive the steel.
- Expansion Joints* Proper provision should be made for expansion joints, at shelf supports, over column caps, etc., to prevent the development of disruptive stresses caused by deflection, wind pressure, temperature changes, settlement and like forces.
- Terra Cotta on Concrete Frames* The volume changes incident to the setting and hardening of concrete, and the variations in volume of concrete due to humidity and temperature conditions, require provisions to allow free movement of the supporting frame and make it undesirable to completely fill a facing applied to a concrete structure.
- Protection against Corrosion* Proper care should be exercised to prevent the corrosion of all steel supports, ties, etc. Where such protection cannot be permanently secured through encasement with mortar or concrete, or through the use of corrosion resistant metallic coatings, non-corrosive metals should be employed.
- Free-standing Construction* Exposed free-standing construction, subject to the absorption of water through mortar joints and liable to injury from subsequent freezing, or the expansion of improper filling material, should generally be left unfilled and should be ventilated by means of small, inconspicuously placed weep-holes (indicated by W. II. on the plates).
- Flashing and Drips* Properly constructed flashing should be provided to cover the top of large projecting horizontal courses, the backs and tops of parapet walls, wide-exposed sill courses, etc., and all projecting features should have drips.

▲ ▲ ▲ ▲ **TERRA COTTA** ▲ ▲ **STANDARD CONSTRUCTION** ▲ ▲ ▲ ▲

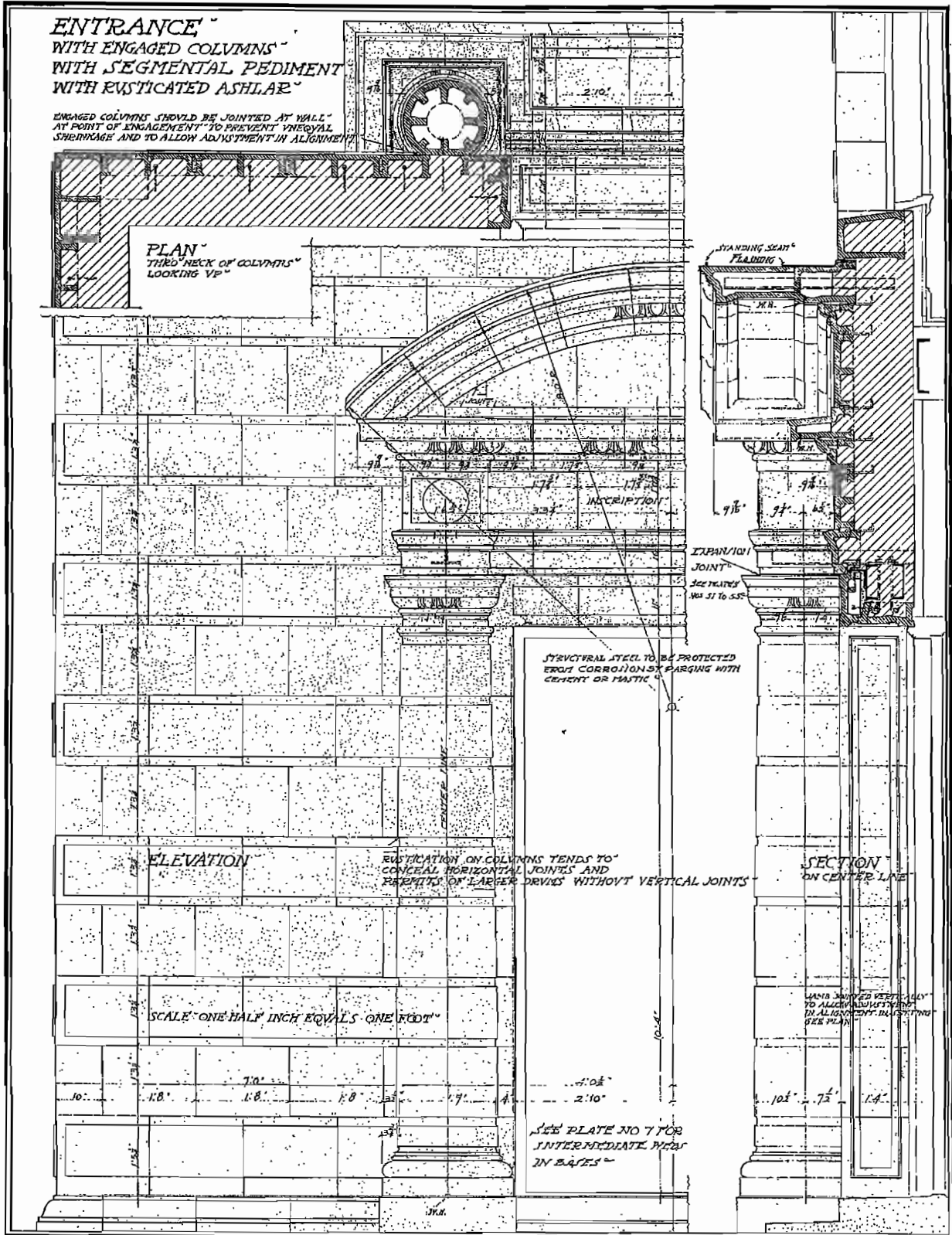
Terra Cotta

A brief synopsis of the manufacture of Terra Cotta

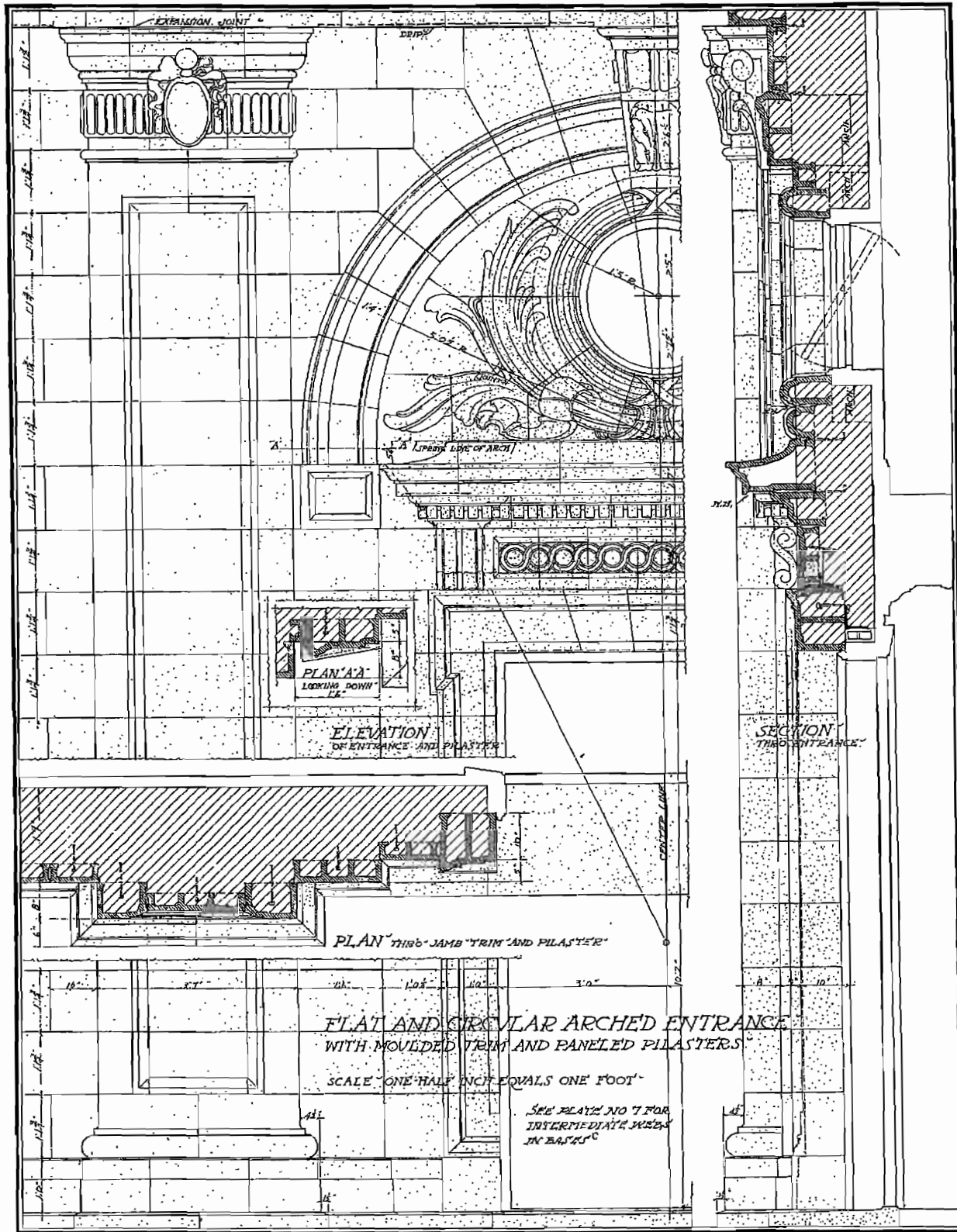
- | | |
|-----------------------------------|--|
| <i>Drawings</i> | The architect's complete scale drawings and steel framing plans are furnished the manufacturer, who, following the design, makes scale shop drawings showing the jointing and construction, and full size details to the proper shrinkage dimensions. These drawings are submitted to the architect for approval before proceeding with the work. |
| <i>Models and Moulds</i> | Full size models to shrinkage scale are made of plaster for each different shape shown on the shop drawings. Over these models sectional moulds of plaster are cast, from which later the required number of pieces of Terra Cotta are produced. |
| <i>Decoration</i> | From the architect's drawings or sketches, in the style and period indicated, modelled ornament is applied in clay to the face of the plaster models. Photographs of the ornamental models are submitted to the architect for approval or he may personally examine these models at the factory—the soft clay permits of such corrections or improvements which may be desired. |
| <i>Clay</i> | The mixture of clays and fusible minerals used in forming the Terra Cotta is carefully selected and proportioned to give the desired degree of plasticity and a composition which, when fired at high temperatures, will produce a homogeneous body, amply strong to carry the required structural loads. |
| <i>Pressing</i> | The foregoing processes are preparatory to actual production, the first step of which is pressing. This is a manual operation and consists of pressing the plastic clay into the mould. The walls of the pieces should not be less than one inch thick, following the contour of the mould, and the partitions should be of such thickness and so spaced as to perform their proper functions with regard to form and structure. The pressed piece remains in the mould until the clay stiffens. It is then removed from the mould and is skillfully retouched. Then it is placed in driers, where the moisture is evaporated. |
| <i>Color</i> | From the drying process, the Terra Cotta passes into the spraying department where, by means of compressed air apparatus, the exposed surfaces are coated with the ceramic mixture which, during the firing process following, develops into the desired color or glaze.
These colors or glazes are prepared with scrupulous care, according to exact ceramic formulae. The variety of shades and textures which may be obtained opens up an unlimited field of permanent color design in architecture. |
| <i>Firing</i> | Following the coloring process, the Terra Cotta is fired in kilns where it is subjected to a temperature rising gradually to 2,000 degrees Fahrenheit or more, depending upon the temperature of maturity of the clay and glaze. After proper firing, the kiln is allowed to cool slowly to normal temperature, an operation that causes a slow annealing of the Terra Cotta.
Terra Cotta is usually fired in periodic muffle kilns. In recent years, the tunnel kiln has been developed for the firing of Terra Cotta. In the latter type of kiln the Terra Cotta is set or loaded on cars, which travel through a long heated tunnel. |
| <i>Fitting</i> | From the kiln, the Terra Cotta is removed to the fitting department, where it is laid out and marked to correspond with the piece numbers shown on the shop drawings. It is also marked to indicate the position it is to occupy in the building. Where required, the joints are squared, or cut to proper alignment and size, either by hand or grinding. Careful fitting is essential to assure satisfactory results in the erected Terra Cotta. |
| <i>Shipping</i> | For rail transportation, Terra Cotta is usually shipped in bulk, securely packed in hay and braced to prevent shifting.
Upon arrival at the building site, the hay should be removed and the Terra Cotta placed in the order marked, in piles on wooden strips.
For export by vessel, the Terra-Cotta is usually packed in boxes or crates, according to the special conditions encountered. Another method that has been found to be economical and entirely satisfactory is to ship the Terra Cotta loose after it has been wrapped and tied in corrugated cardboard. |
| <i>Erection</i> | The appearance of erected Terra Cotta is greatly affected by inaccurate setting and defective pointing of the mortar joints. As the individual pieces of Terra Cotta have been carefully fitted and numbered to correspond with the erection drawings, the PIECES MUST BE ERECTED IN ACCORD WITH THE NUMBERS THEREON if satisfactory results are to be secured. |
| <i>Time</i> | The Terra Cotta manufacturer will contract to submit shop drawings for approval within a fixed time after receipt of the architect's drawings and other required information. All shipping dates are computed from the date of receipt by the manufacturer of architect's approval of shop drawings and complete data on color and texture desired. Work cannot be definitely scheduled for production until all essential information is on hand. The process of manufacture may take from six to ten weeks, depending upon the size and architectural character of the order. |
| <i>Specification and Contract</i> | A Standard Specification for the Manufacture, Furnishing and Setting of Terra Cotta and a standard form of contract have been adopted by the NATIONAL TERRA COTTA SOCIETY. They are recommended for general use. A copy of either may be secured by addressing the Society. The specifications are incorporated in this volume. |

Terra Cotta factories are conveniently located in the Eastern, Central and Western sections of the United States (see list in back of this volume). All of the Society's membership will be glad to have any architect or designer interested in the processes of manufacture of Terra Cotta visit their plants.

TERRA COTTA STANDARD CONSTRUCTION



TERRA COTTA STANDARD CONSTRUCTION



ELEVATION OF ENTRANCE AND PILASTER

SECTION THROUGH ENTRANCE

PLAN "AA" LOOKING DOWN "AA"

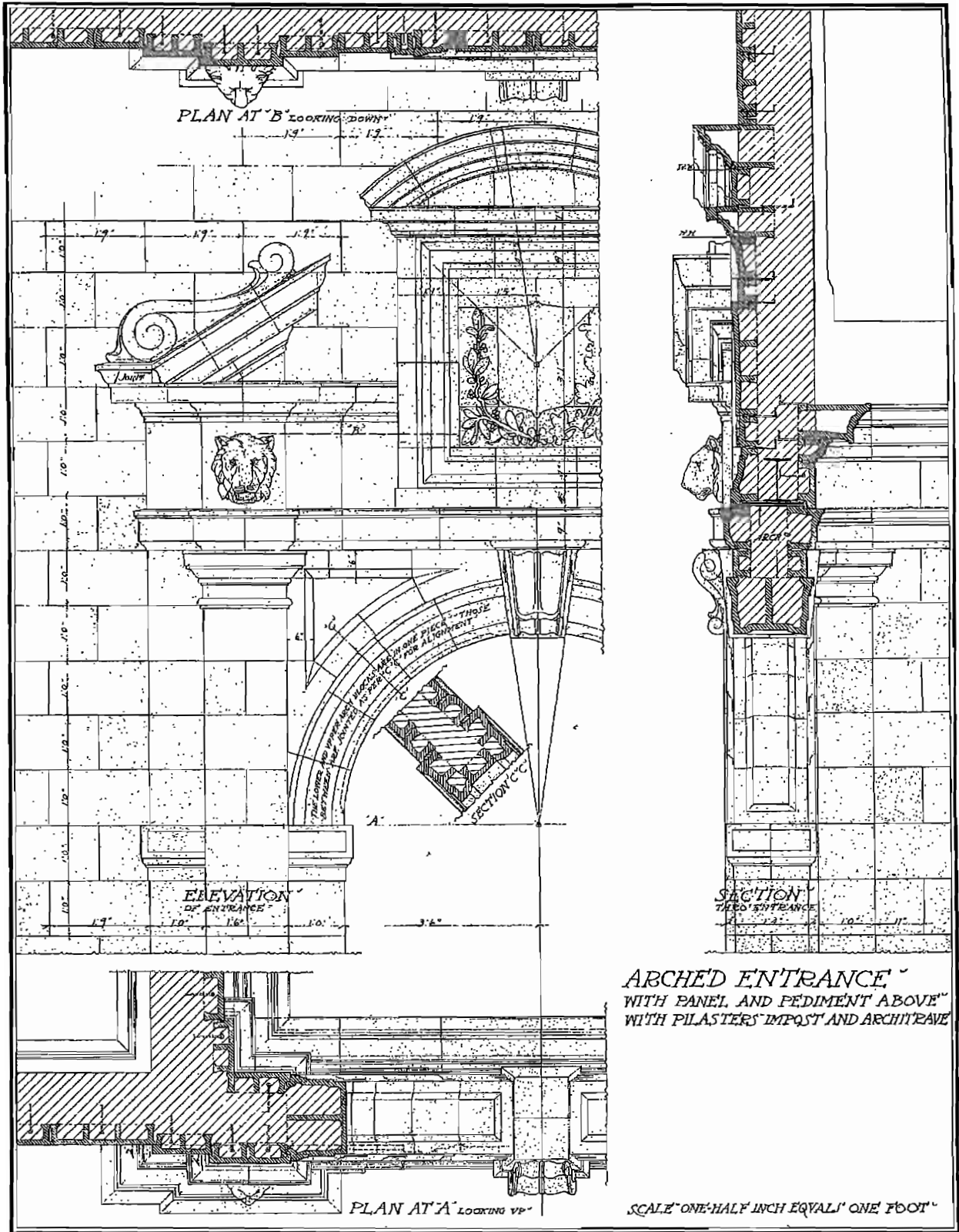
PLAN THROUGH JAMB TRIM AND PILASTER

FLAT AND CIRCULAR ARCHED ENTRANCE WITH MOULDED TRIM AND PANEELED PILASTERS

SCALE ONE HALF INCH EQUALS ONE FOOT

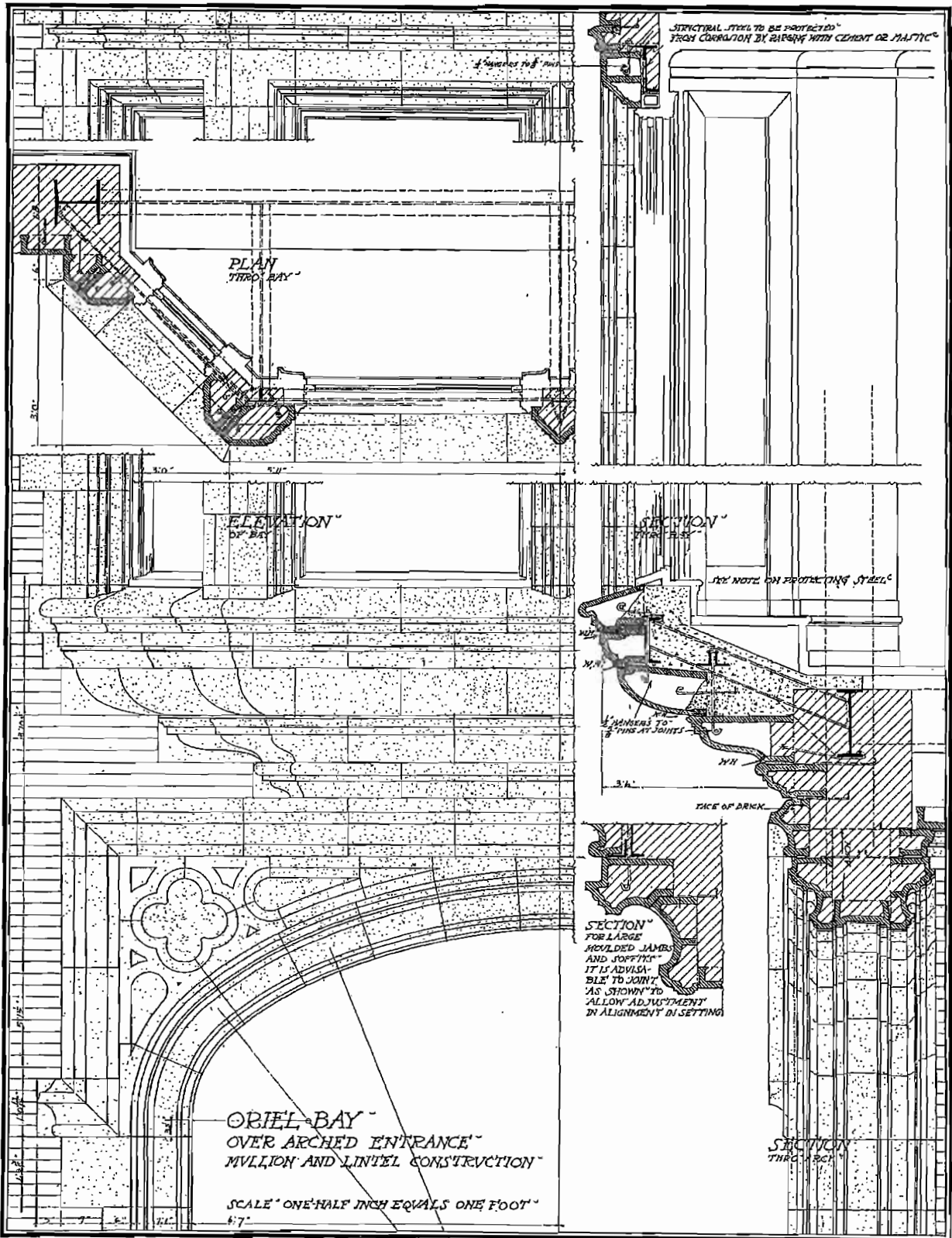
SEE PLATE NO. 7 FOR INTERMEDIATE WORK IN BASES

TERRA COTTA STANDARD CONSTRUCTION

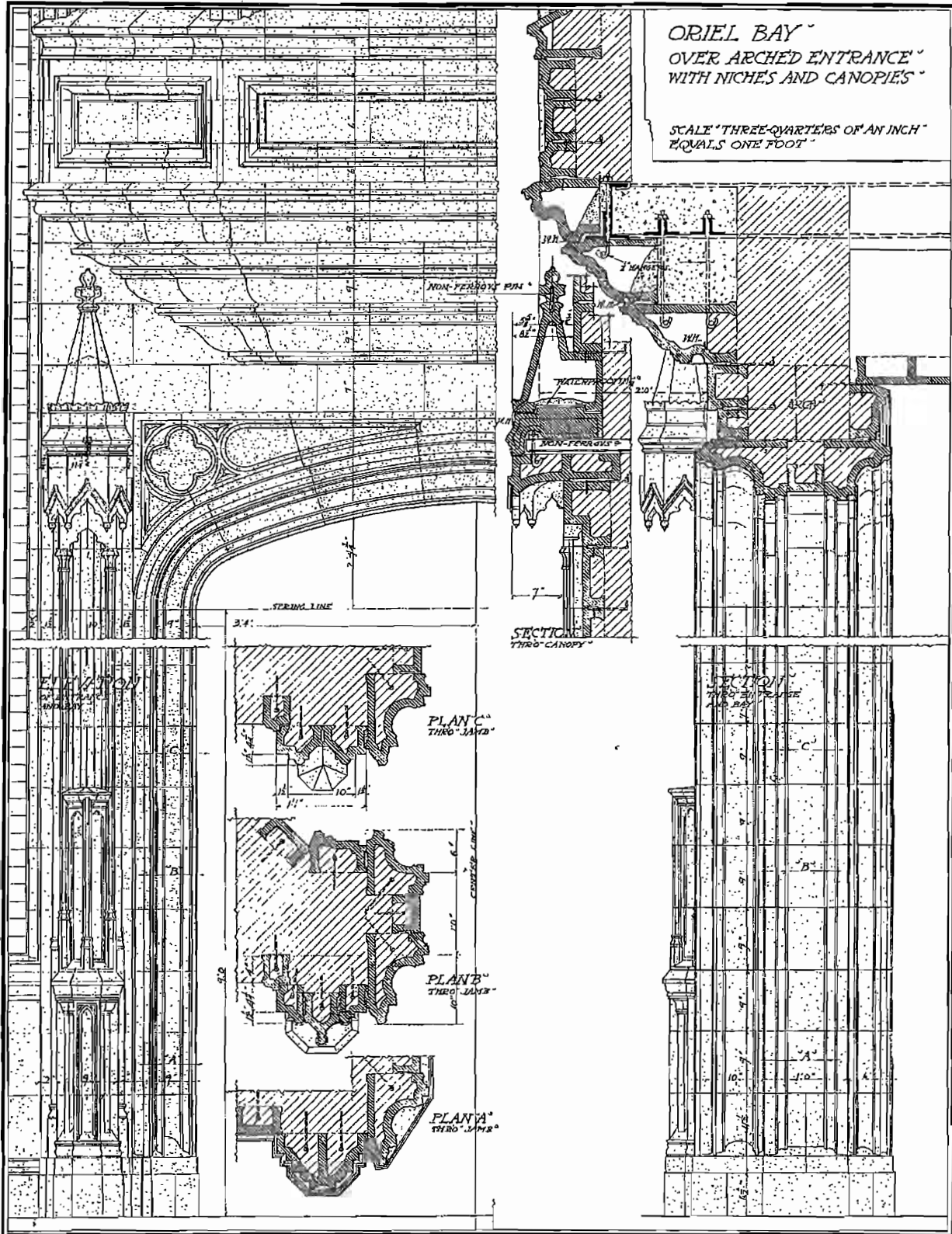


ARCHED ENTRANCE WITH PANEL AND PEDIMENT ABOVE WITH PILASTERS IMPOST AND ARCHITRAVE

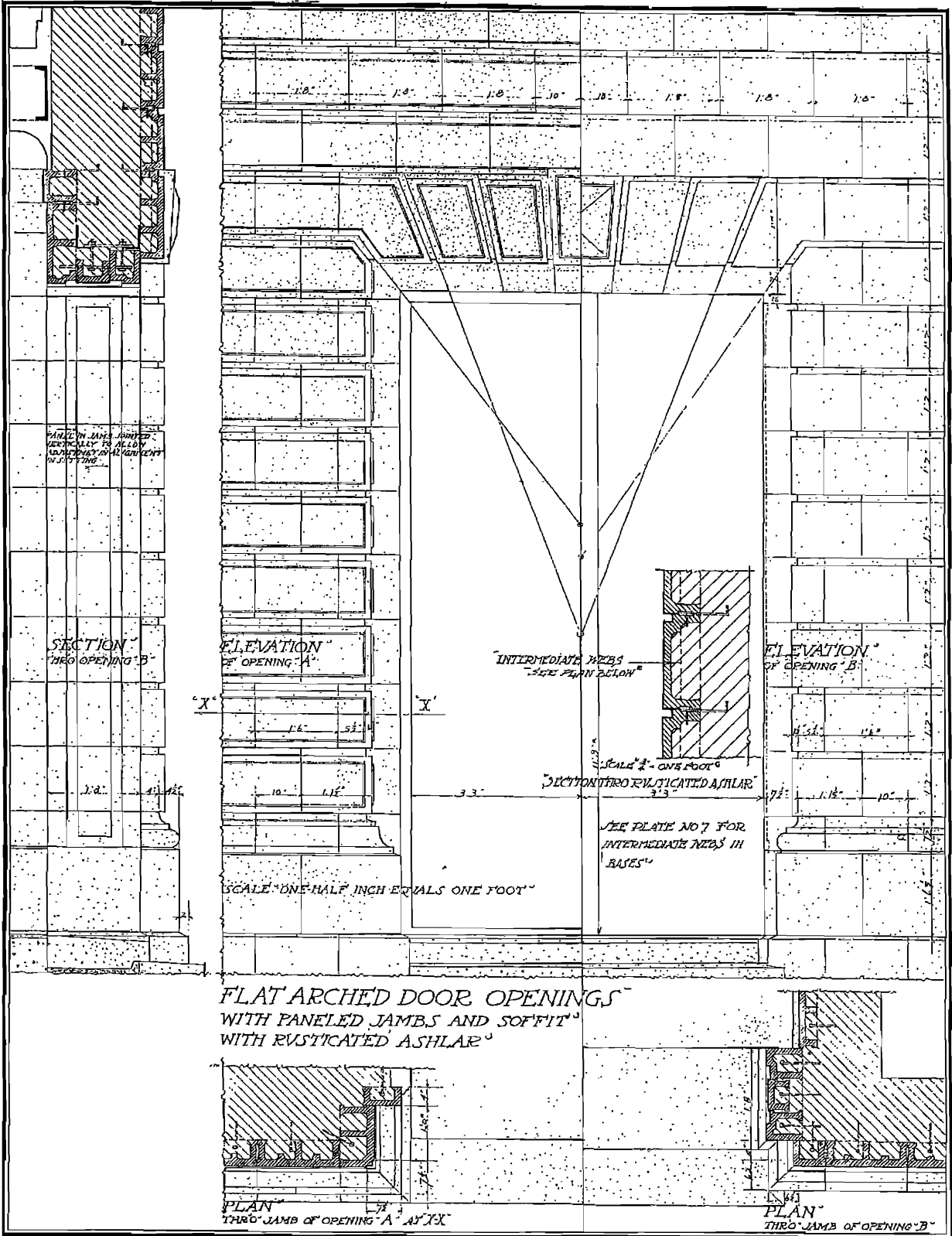
TERRA COTTA STANDARD CONSTRUCTION



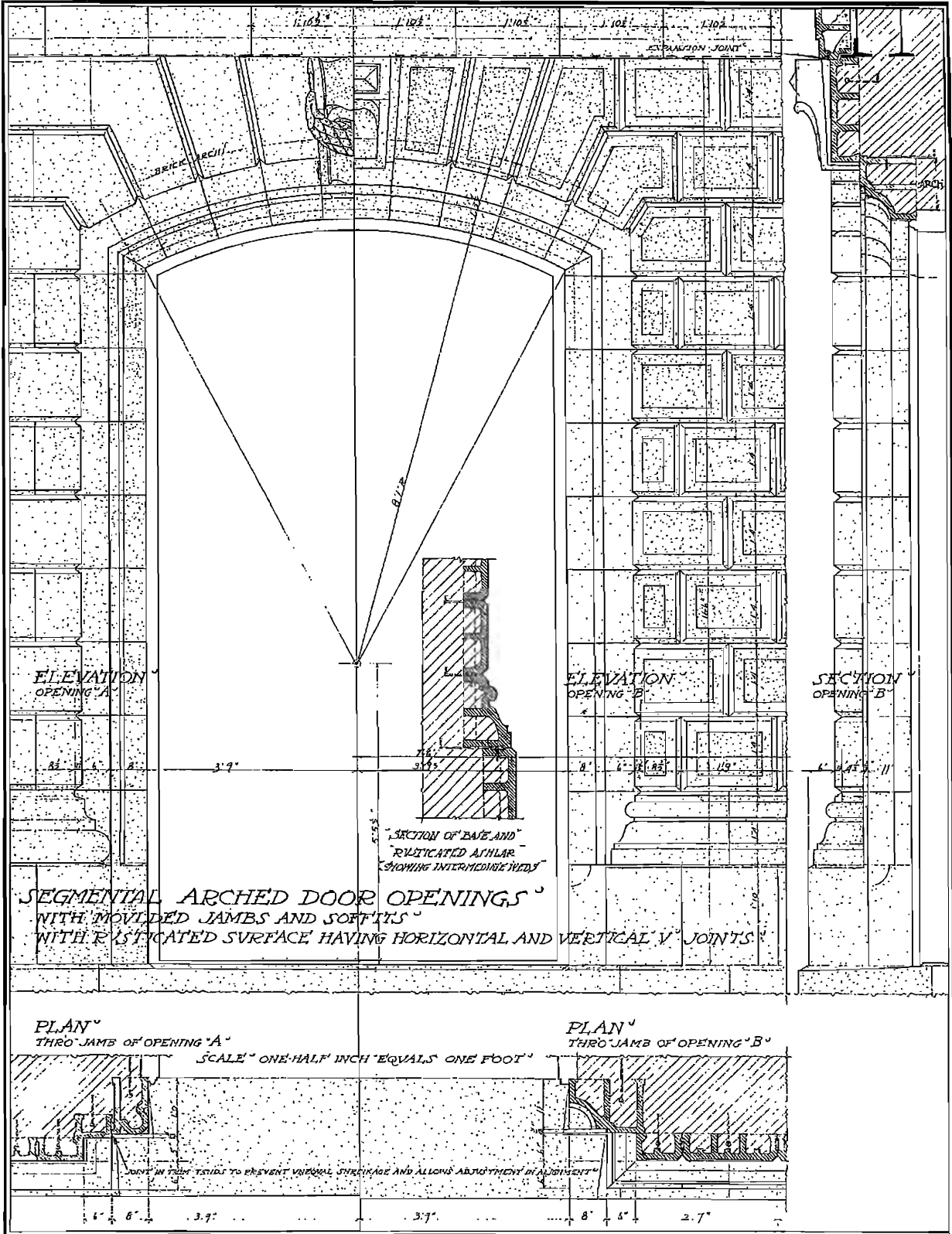
▲ ▲ ▲ ▲ TERRA COTTA · · STANDARD CONSTRUCTION · · ▲ ▲ ▲ ▲



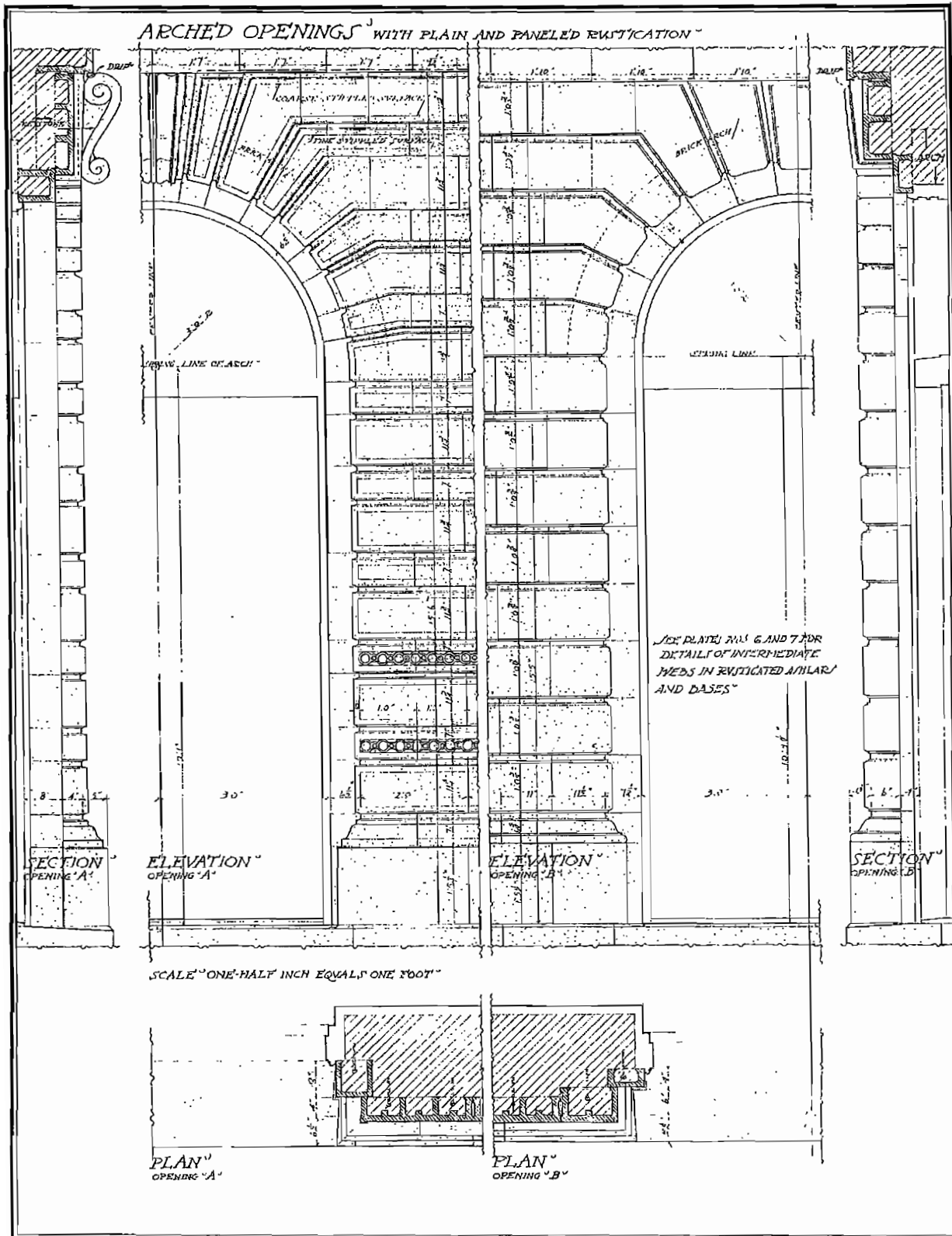
TERRA COTTA STANDARD CONSTRUCTION



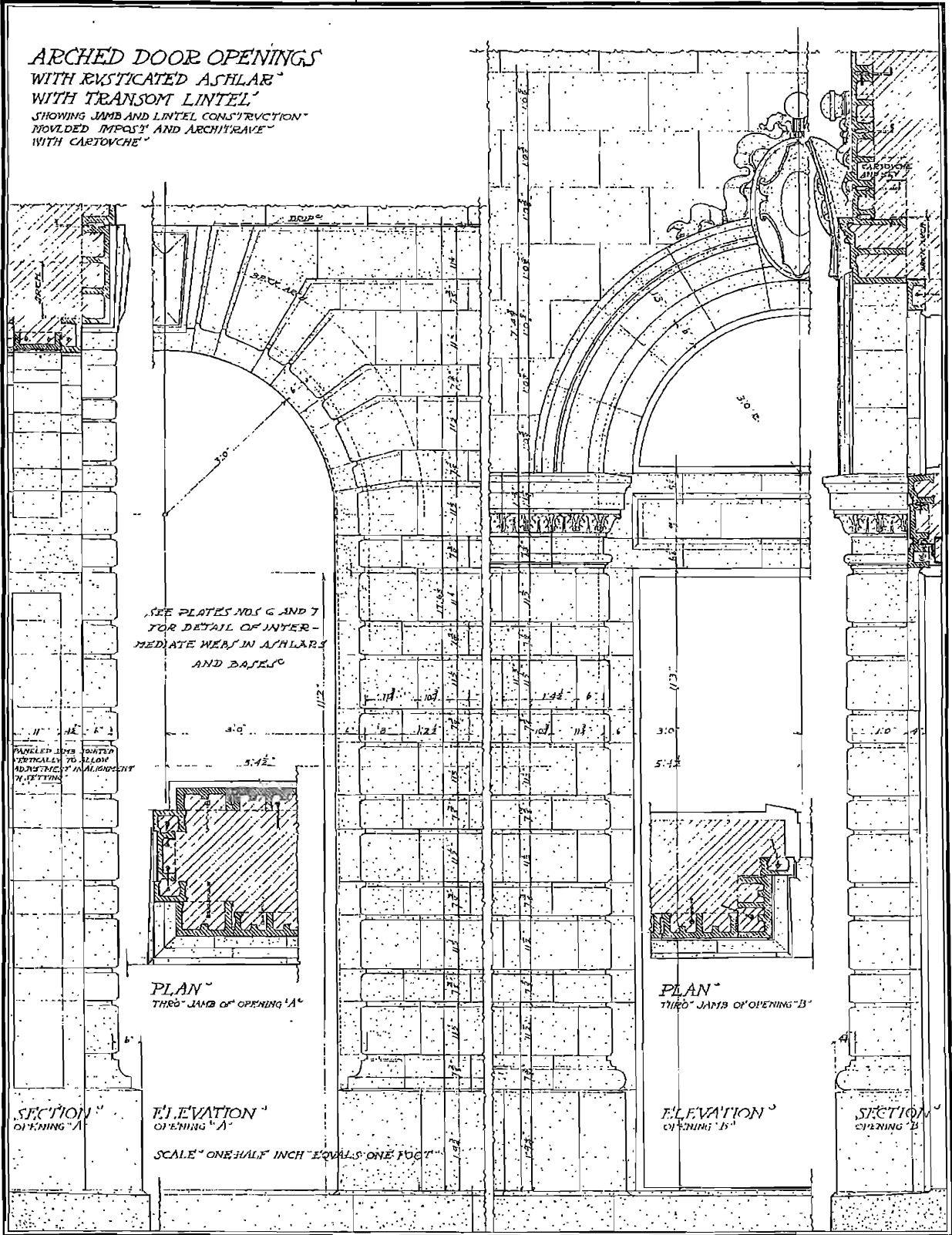
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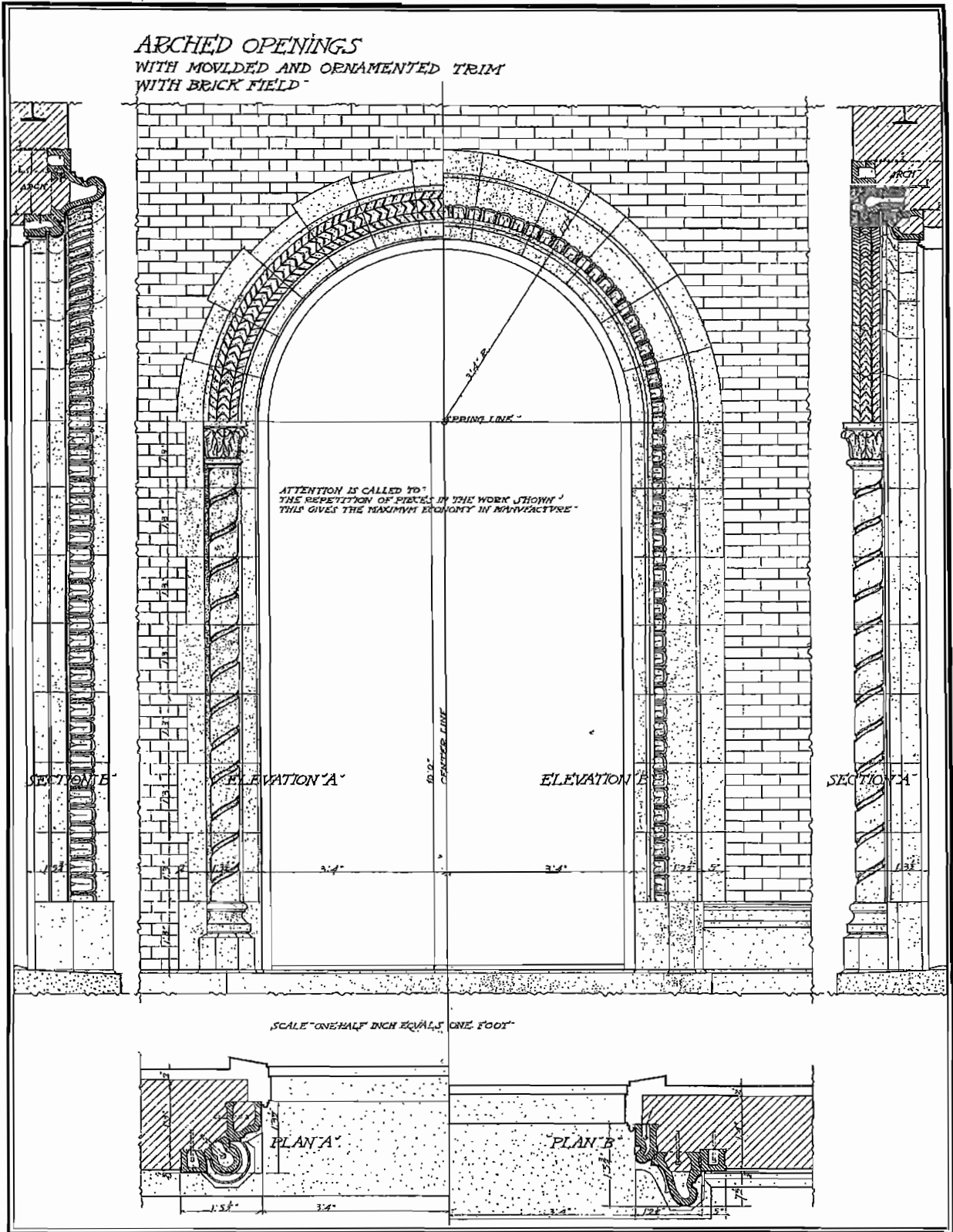
TERRA COTTA STANDARD CONSTRUCTION



▲ ▲ ▲ ▲ TERRA COTTA · STANDARD CONSTRUCTION · ▲ ▲ ▲ ▲

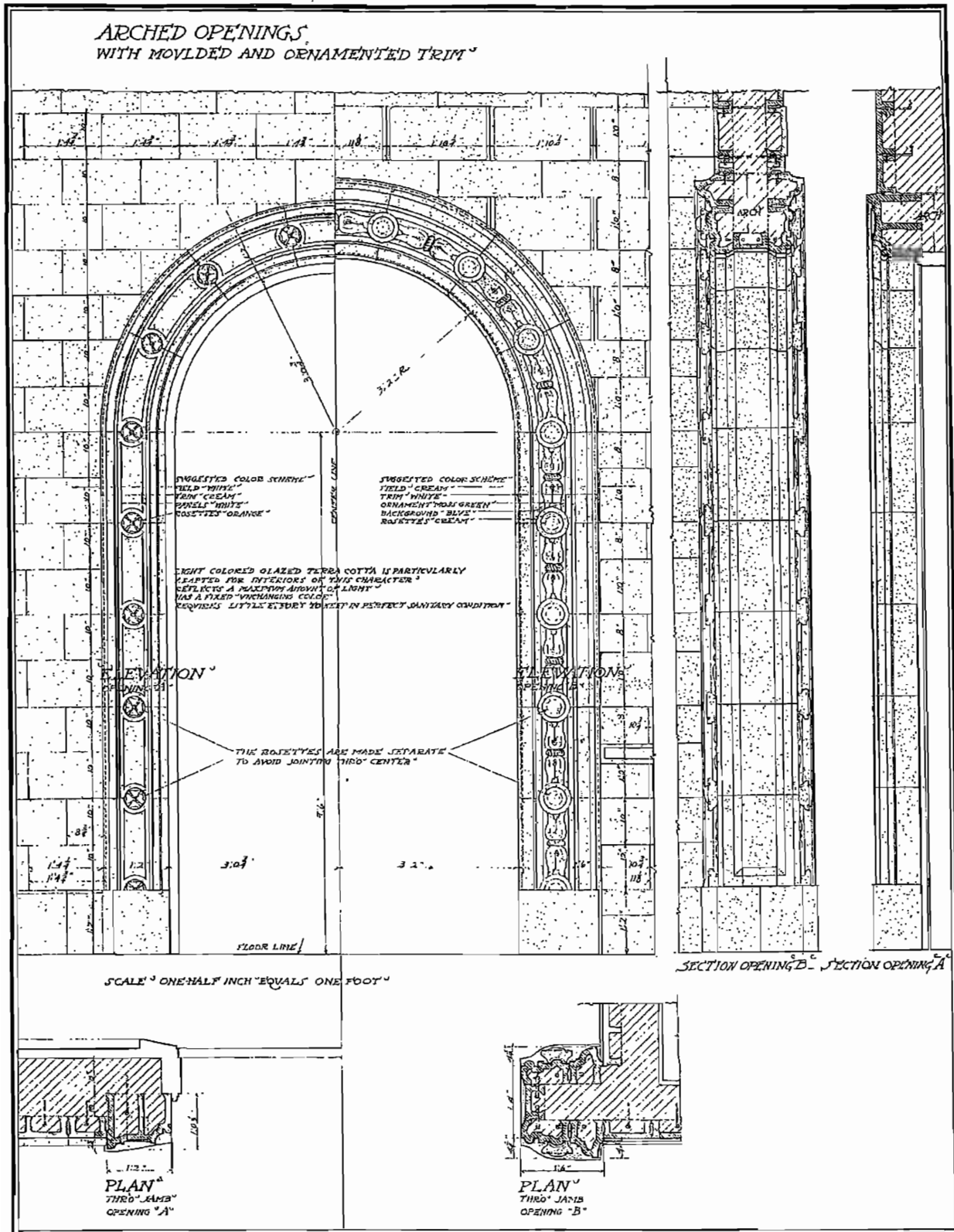


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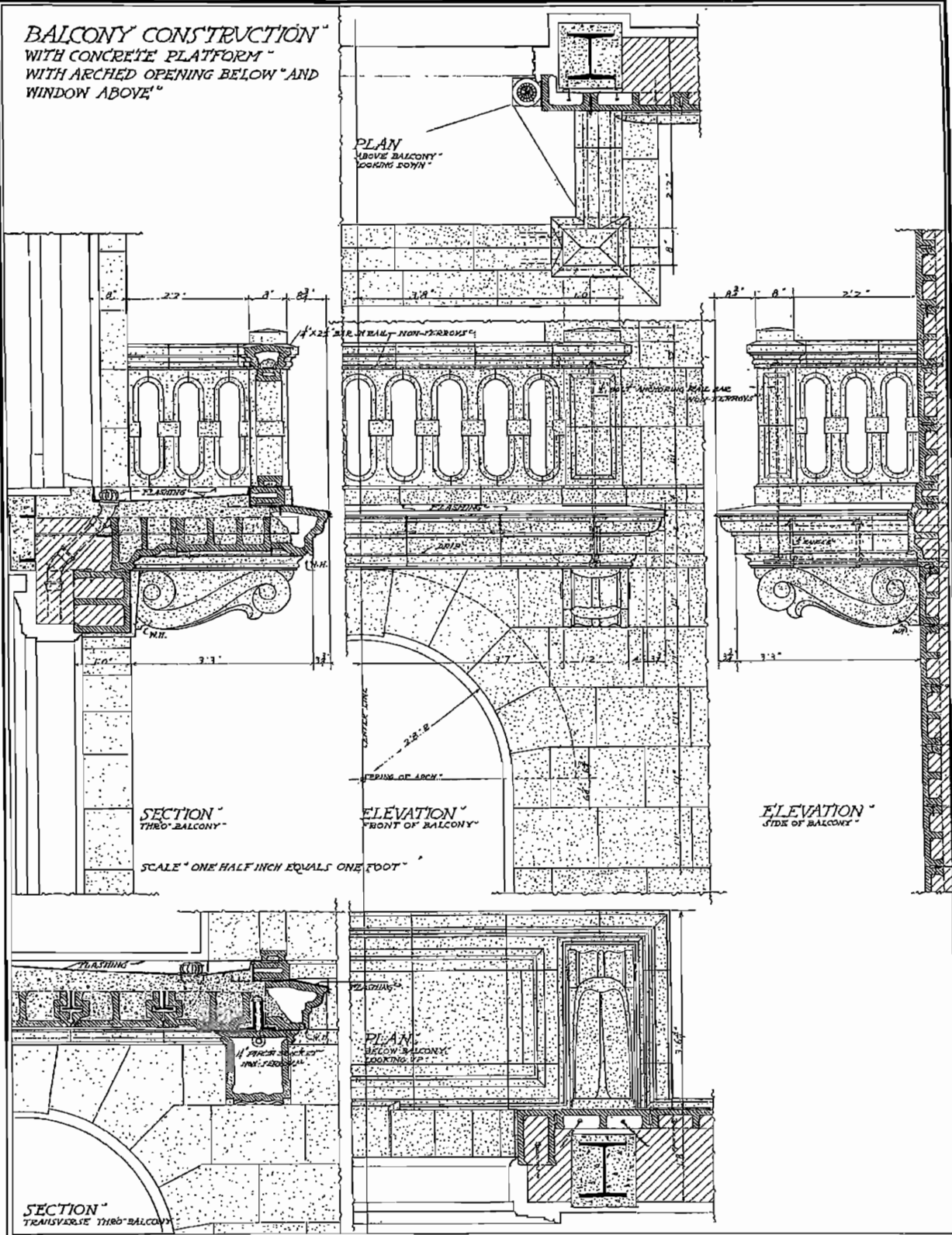
NATIONAL TERRA COTTA SOCIETY · V · S · A · · PLATE NO · 10

TERRA COTTA STANDARD CONSTRUCTION



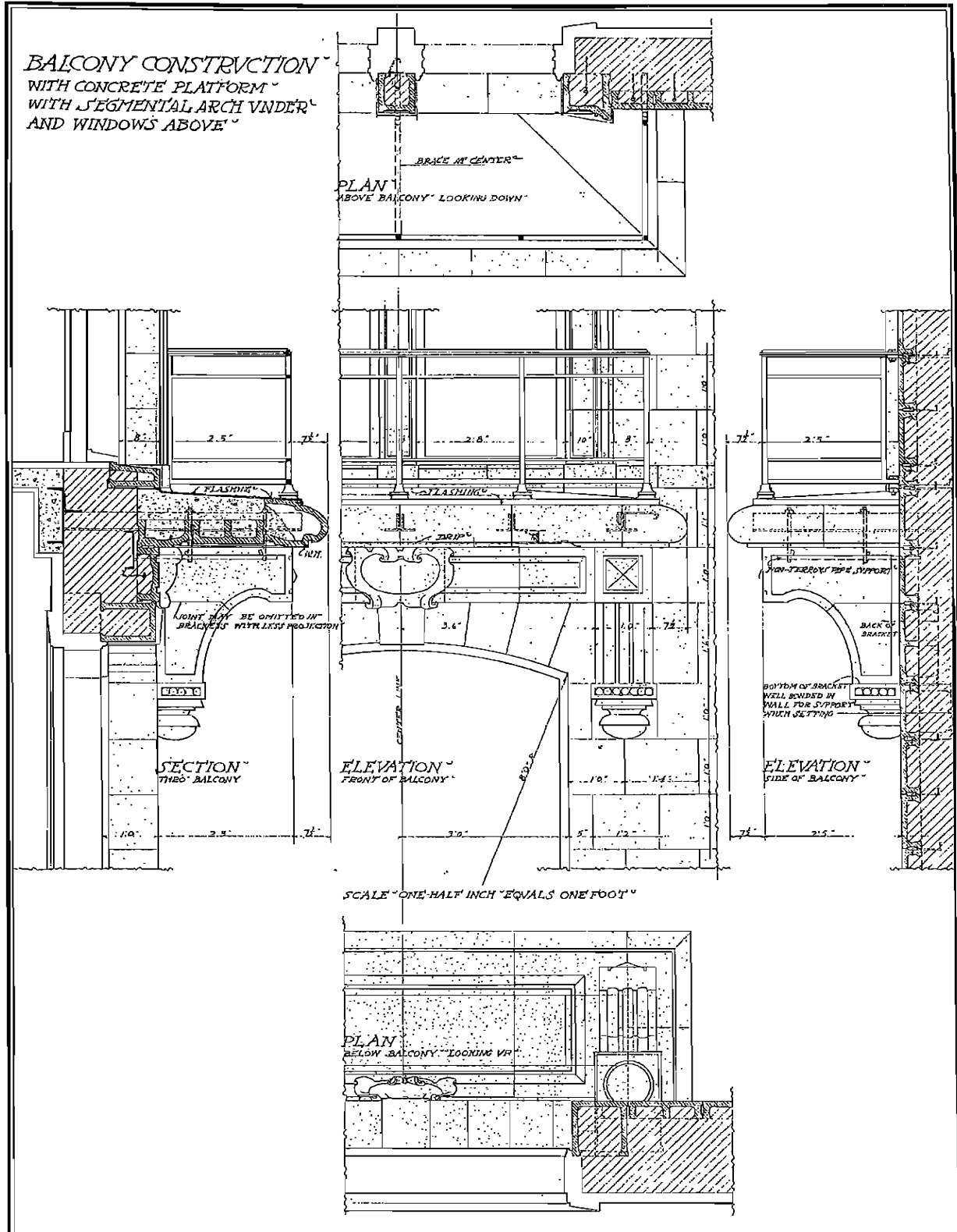
▲ ▲ ▲ ▲ TERRA COTTA ▲ ▲ STANDARD CONSTRUCTION ▲ ▲ ▲ ▲

BALCONY CONSTRUCTION
WITH CONCRETE PLATFORM
WITH ARCHED OPENING BELOW AND
WINDOW ABOVE

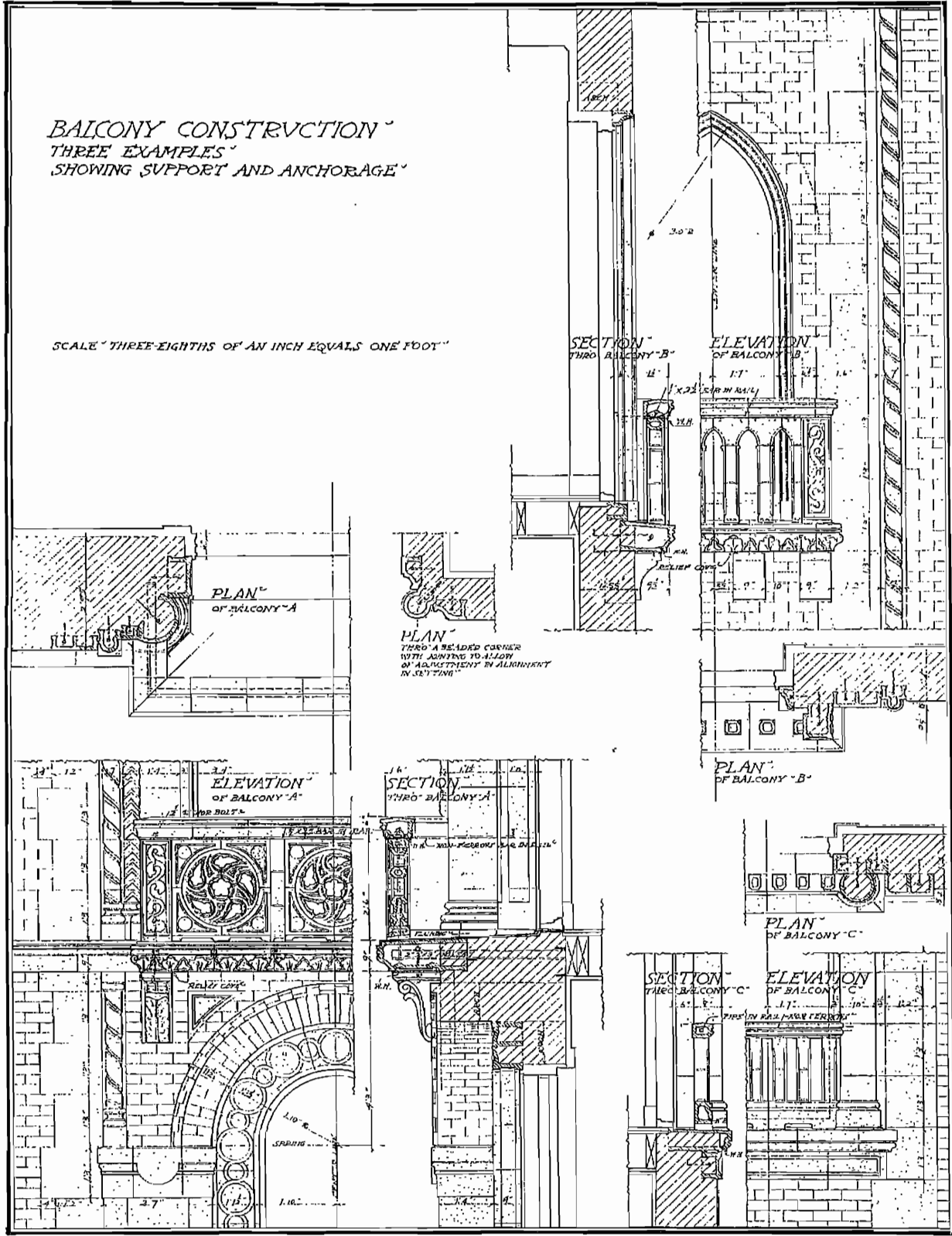


SCALE " ONE HALF INCH EQUALS ONE FOOT "

TERRA COTTA STANDARD CONSTRUCTION

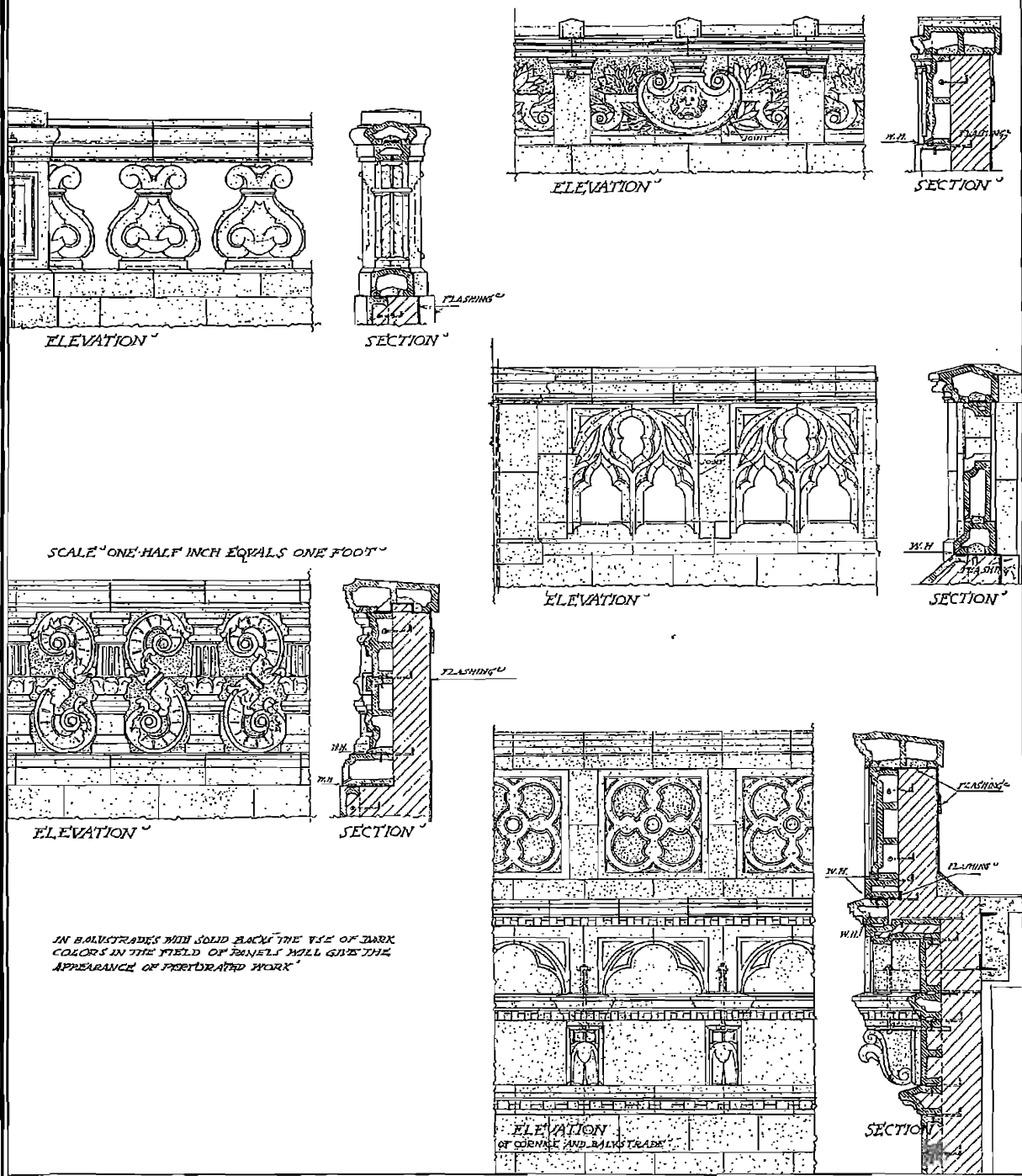


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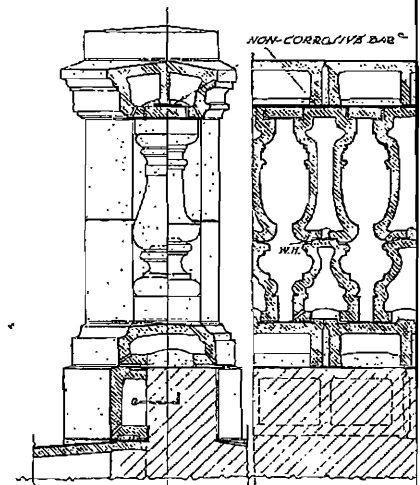
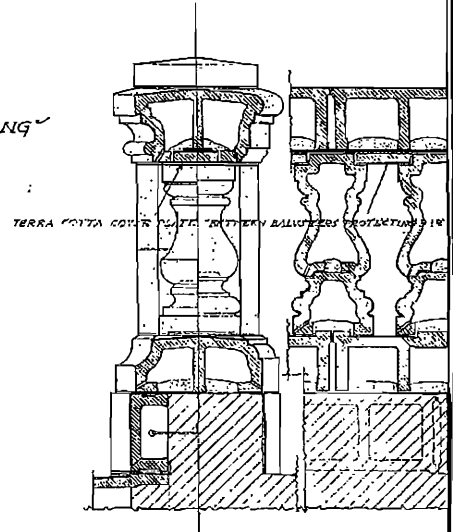
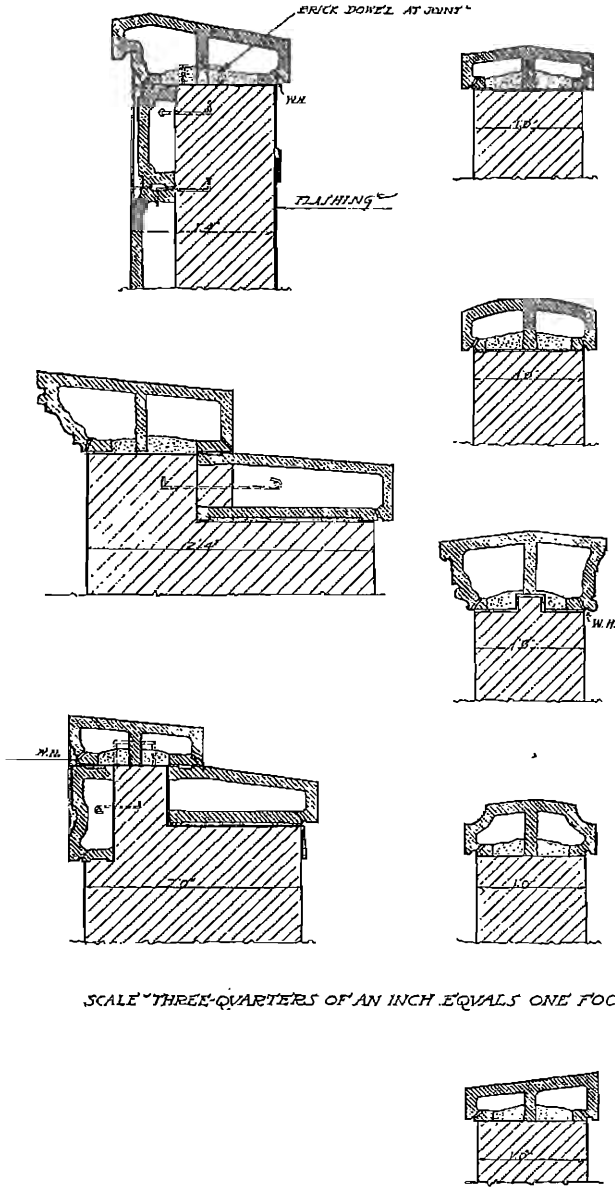
▲ ▲ ▲ ▲ TERRA COTTA ▲ ▲ STANDARD CONSTRUCTION ▲ ▲ ▲ ▲

BALUSTRADES
PARAPETS



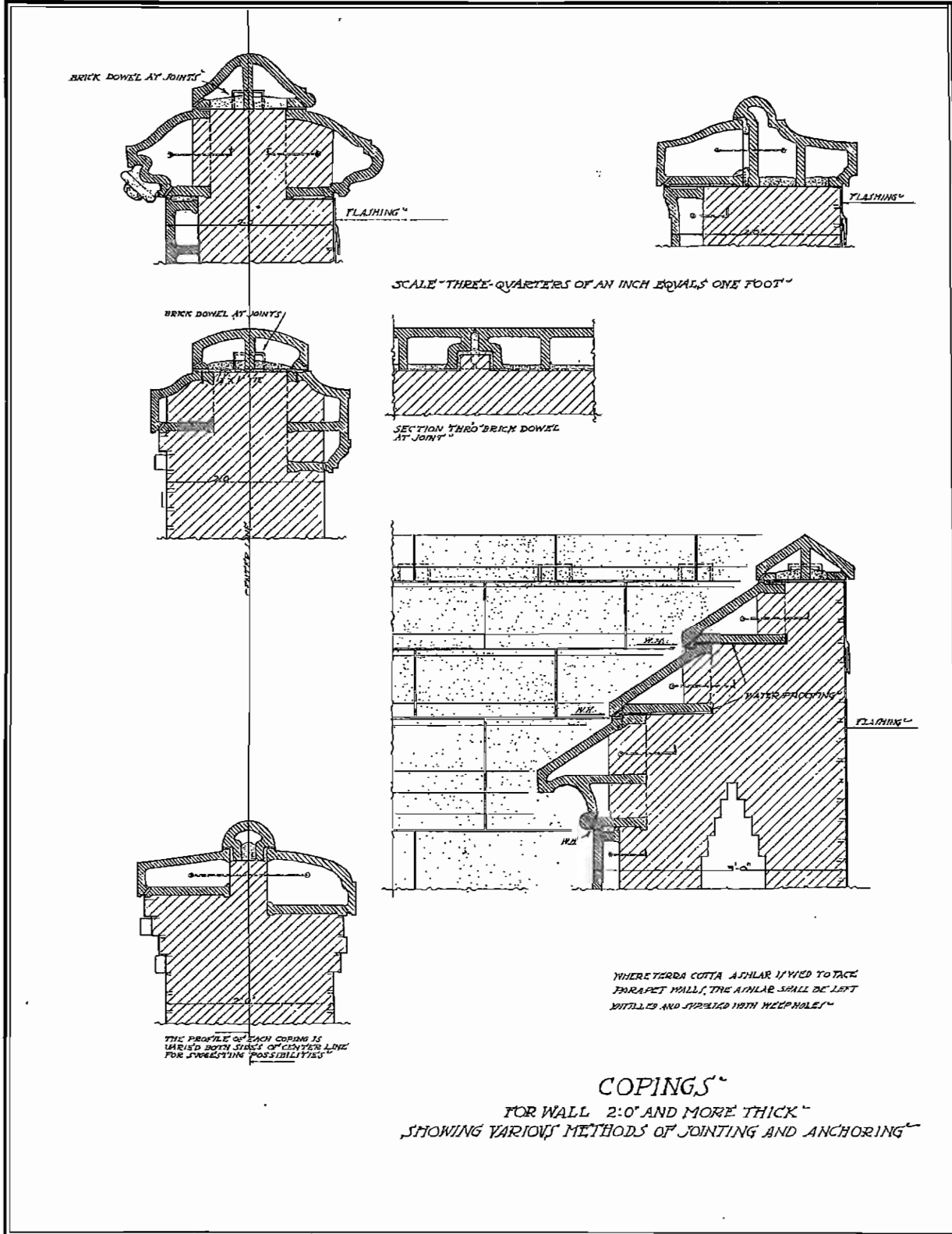
TERRA COTTA STANDARD CONSTRUCTION

WALL, COPINGS AND BALUSTRADES
SHOWING VARIOUS METHODS OF JOINTING AND ANCHORING



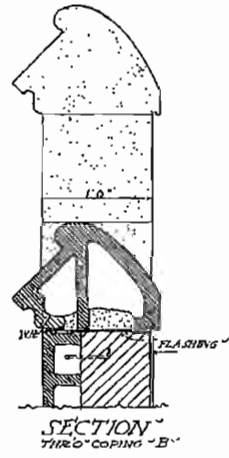
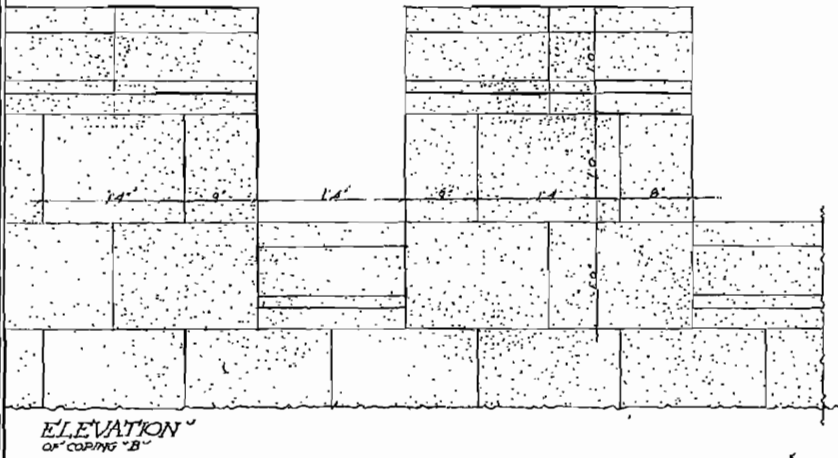
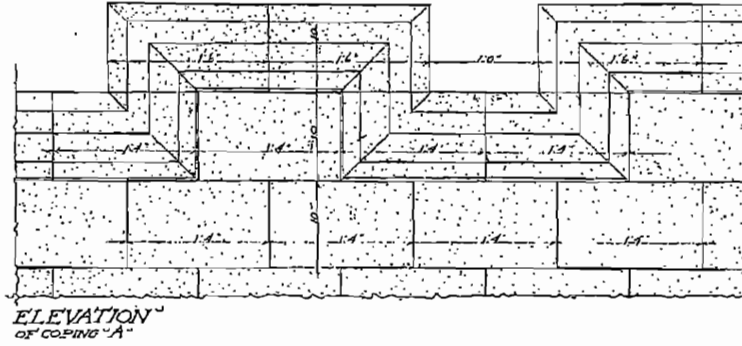
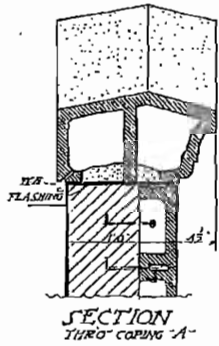
WHERE TERRA COTTA ASHLAR IS USED TO FACE PARAPET WALLS, THE ASHLAR SHALL BE SET UNFILLED AND SUPPLIED WITH WEEP HOLES

▲ ▲ ▲ ▲ TERRA COTTA ▲ ▲ STANDARD CONSTRUCTION ▲ ▲ ▲ ▲

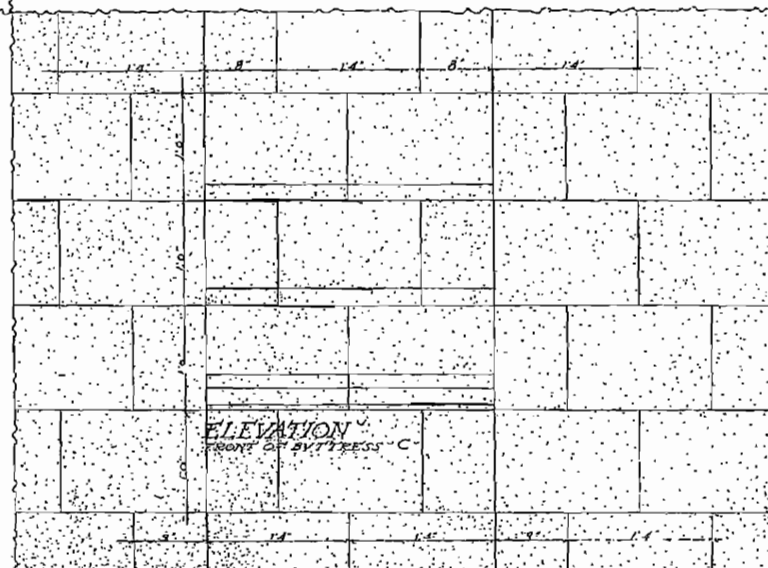
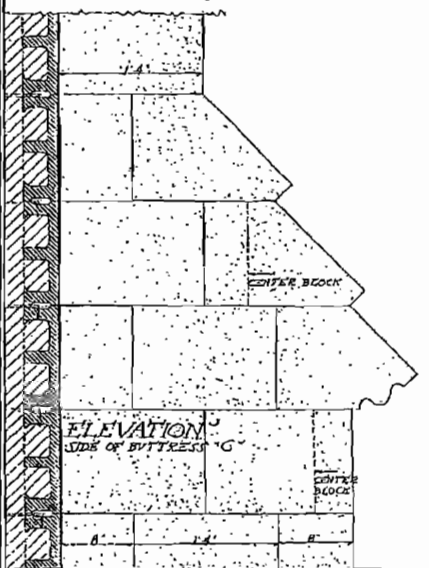


▲ ▲ ▲ ▲ TERRA COTTA ▲ STANDARD CONSTRUCTION ▲ ▲ ▲ ▲

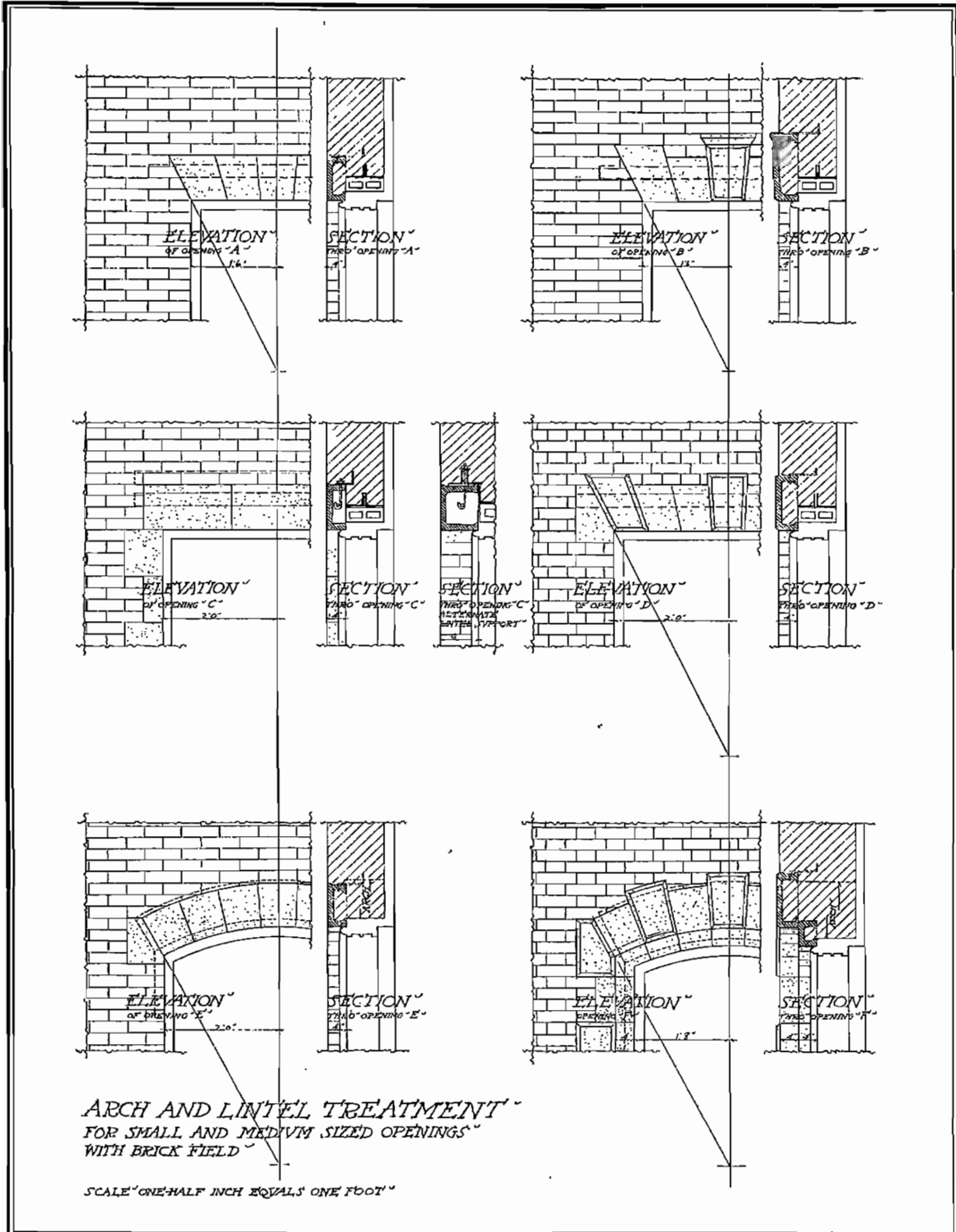
BATTLEMENTED COPING AND SET-OFFS



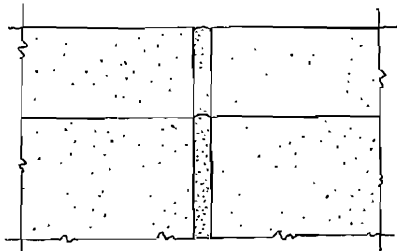
SCALE THREE-QUARTERS OF AN INCH EQUALS ONE FOOT



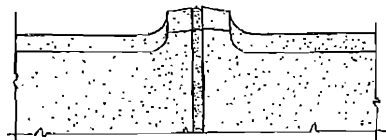
▲ ▲ ▲ ▲ TERRA COTTA ▲ ▲ STANDARD CONSTRUCTION ▲ ▲ ▲ ▲



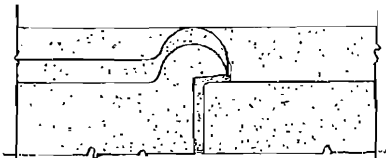
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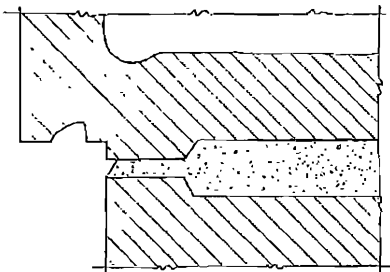
"STANDARD FLUSH JOINT" RECOMMENDED AS SUPERIOR TO THE OLD STYLE RAISED AND ROLL JOINTS, SHOWN BELOW



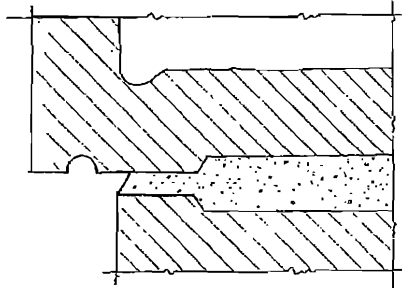
OLD STYLE RAISED JOINT



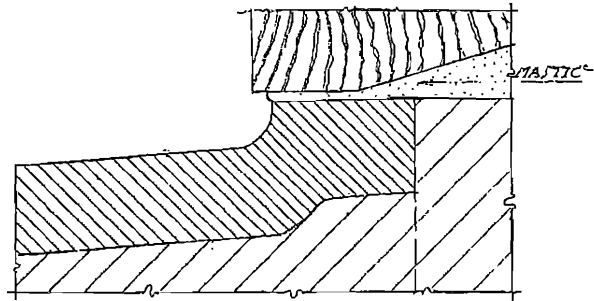
OLD STYLE ROLL JOINT



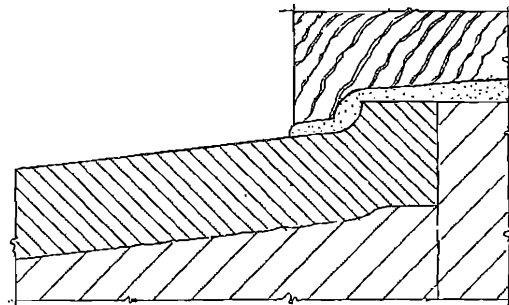
TYPICAL DRIP DETAILS



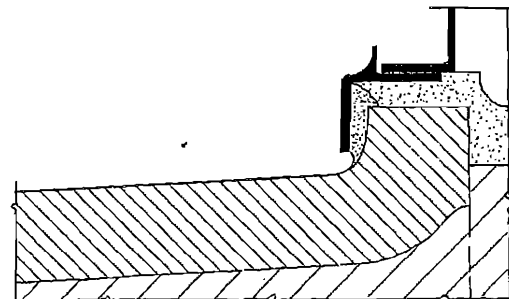
SCALE HALF AND QUARTER FULL SIZE



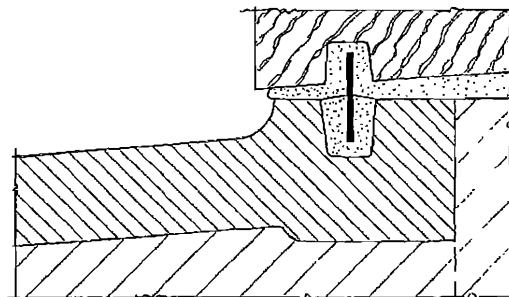
WOOD OR HOLLOW METAL SILLS



TUCK UNDER SILL

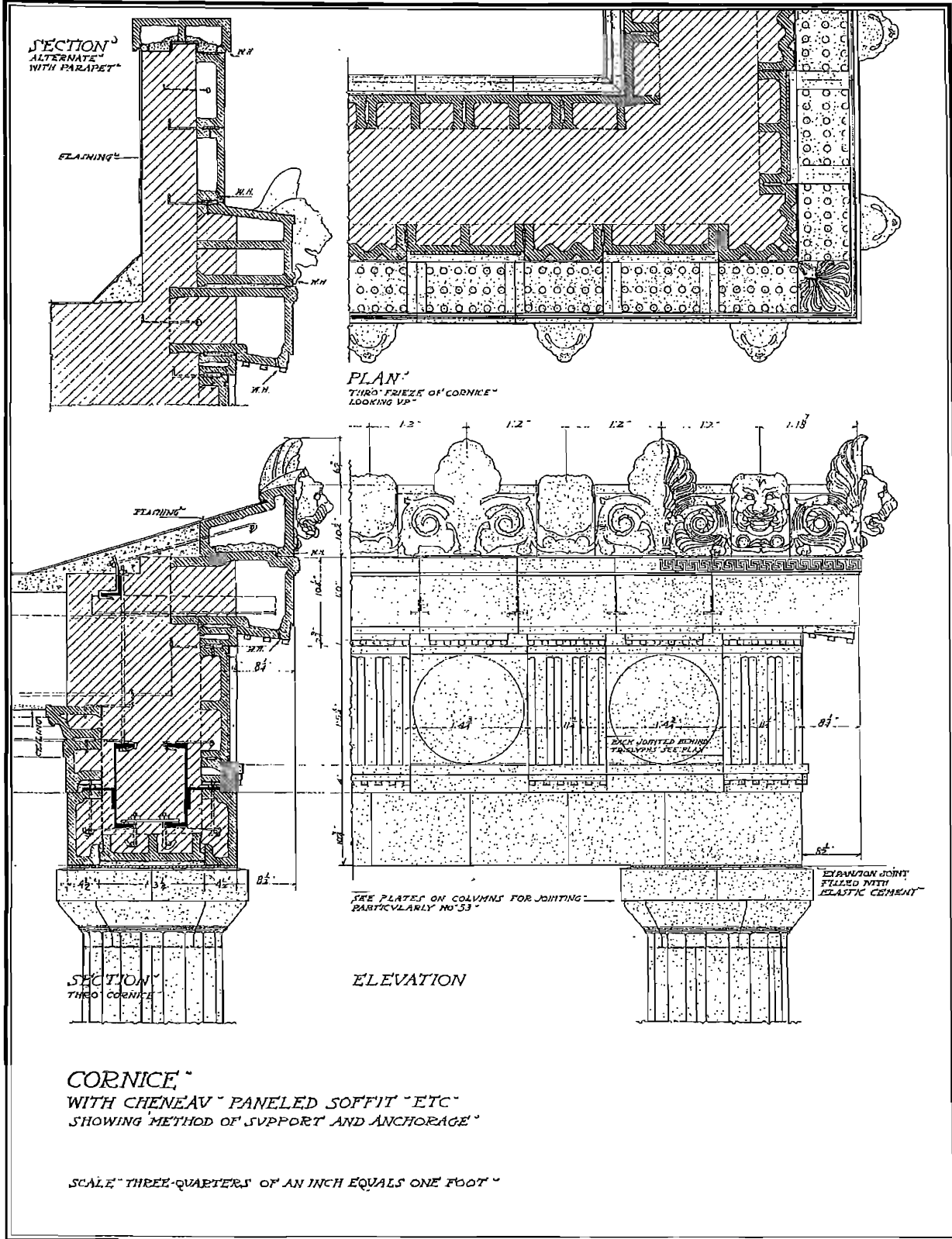


SILL FOR SOLID METAL FRAMES



SILL WITH NON-FERROUS WATER BAR

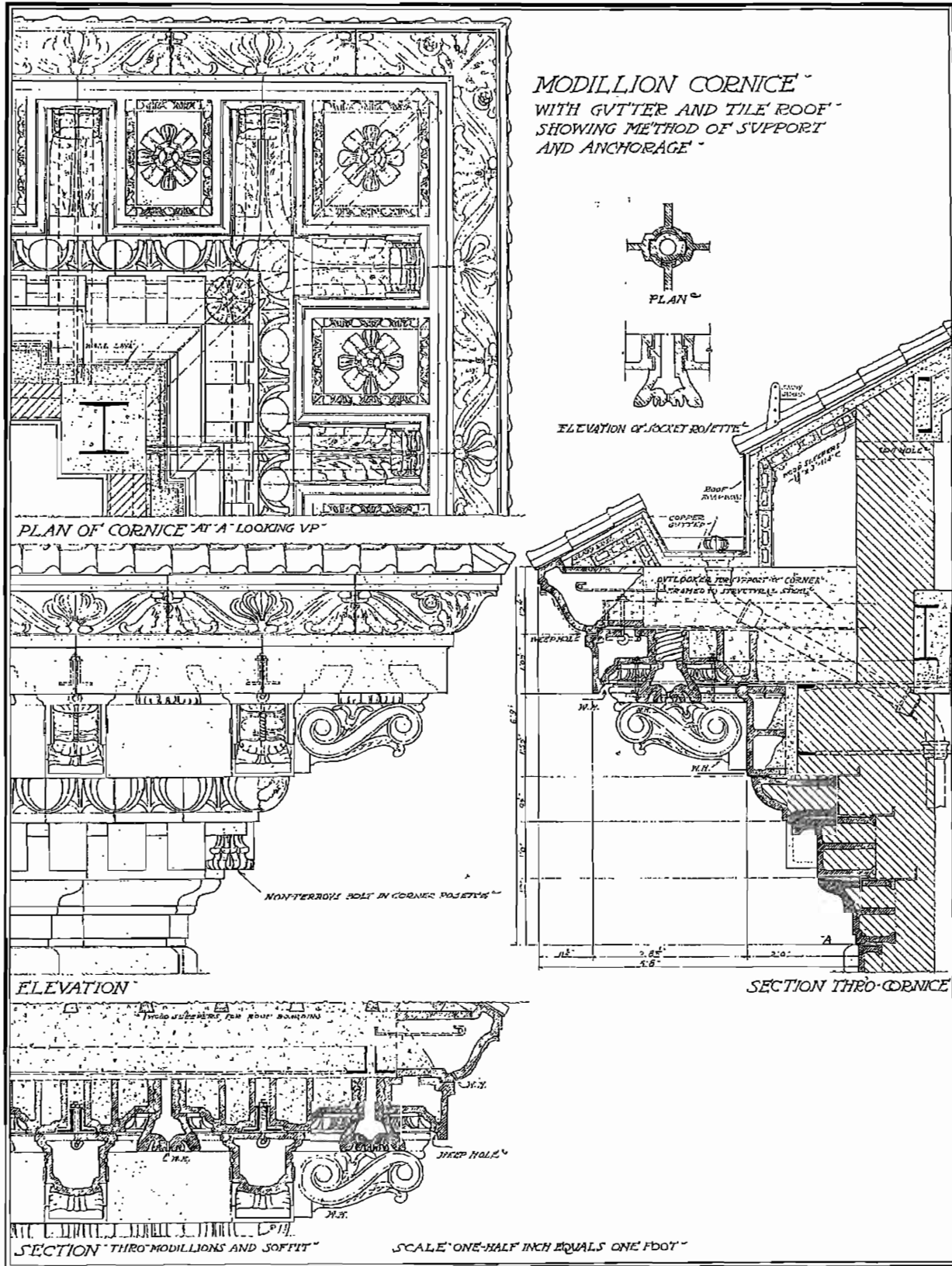
▲ ▲ ▲ ▲ TERRA COTTA ▲ ▲ STANDARD CONSTRUCTION ▲ ▲ ▲ ▲



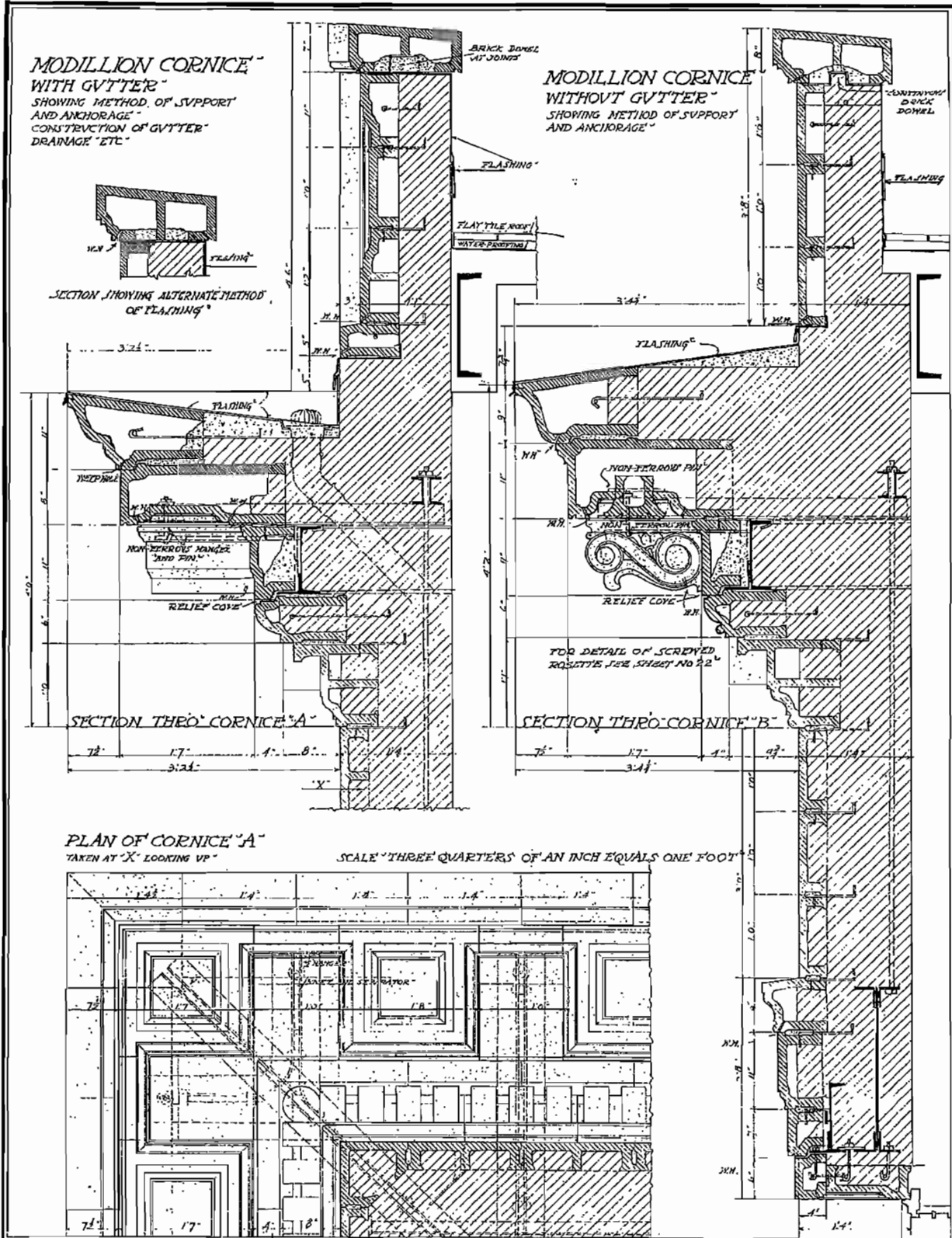
CORNICE
WITH CHENEAV PANELED SOFFIT ETC
SHOWING METHOD OF SUPPORT AND ANCHORAGE

SCALE THREE-QUARTERS OF AN INCH EQUALS ONE FOOT

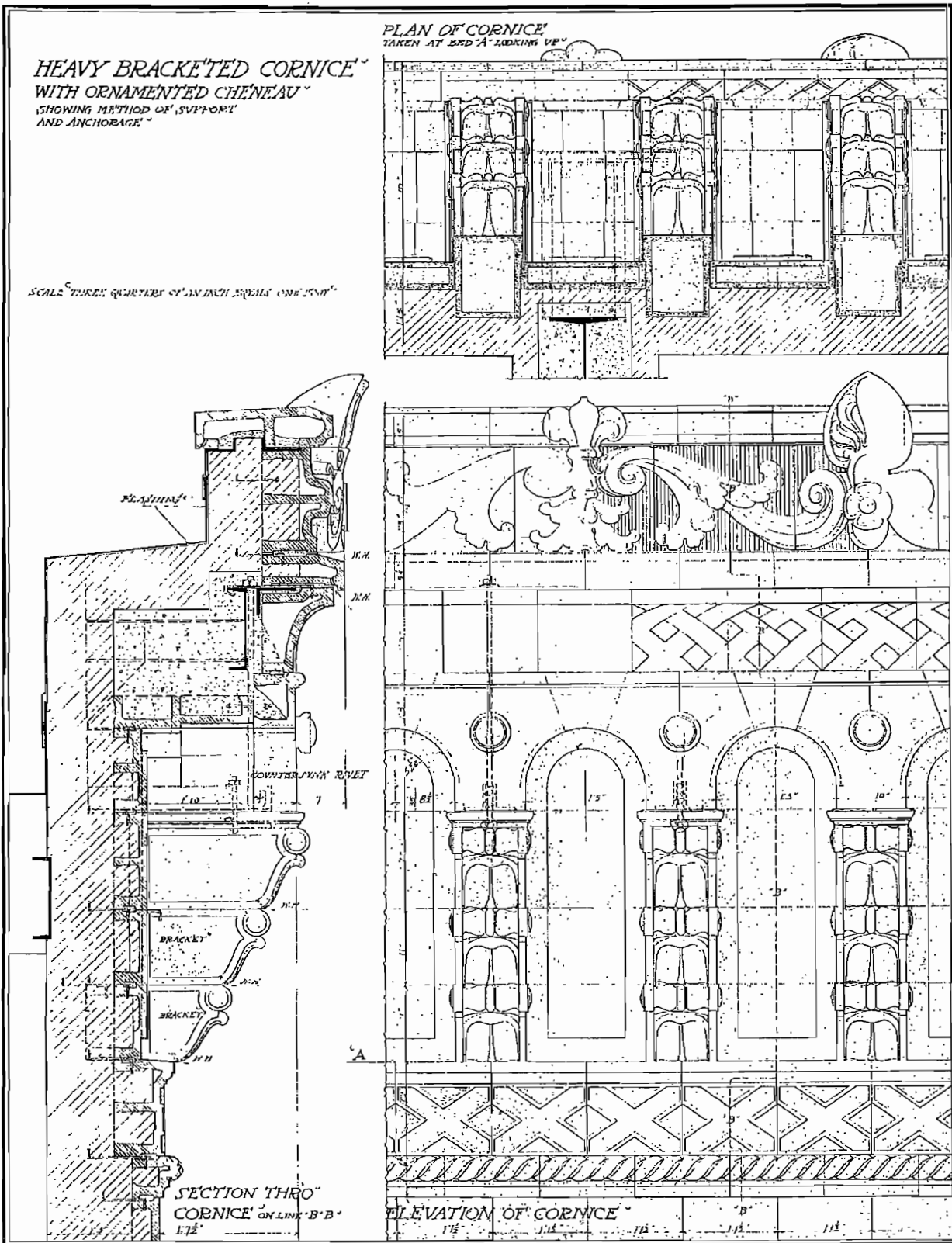
TERRA COTTA STANDARD CONSTRUCTION



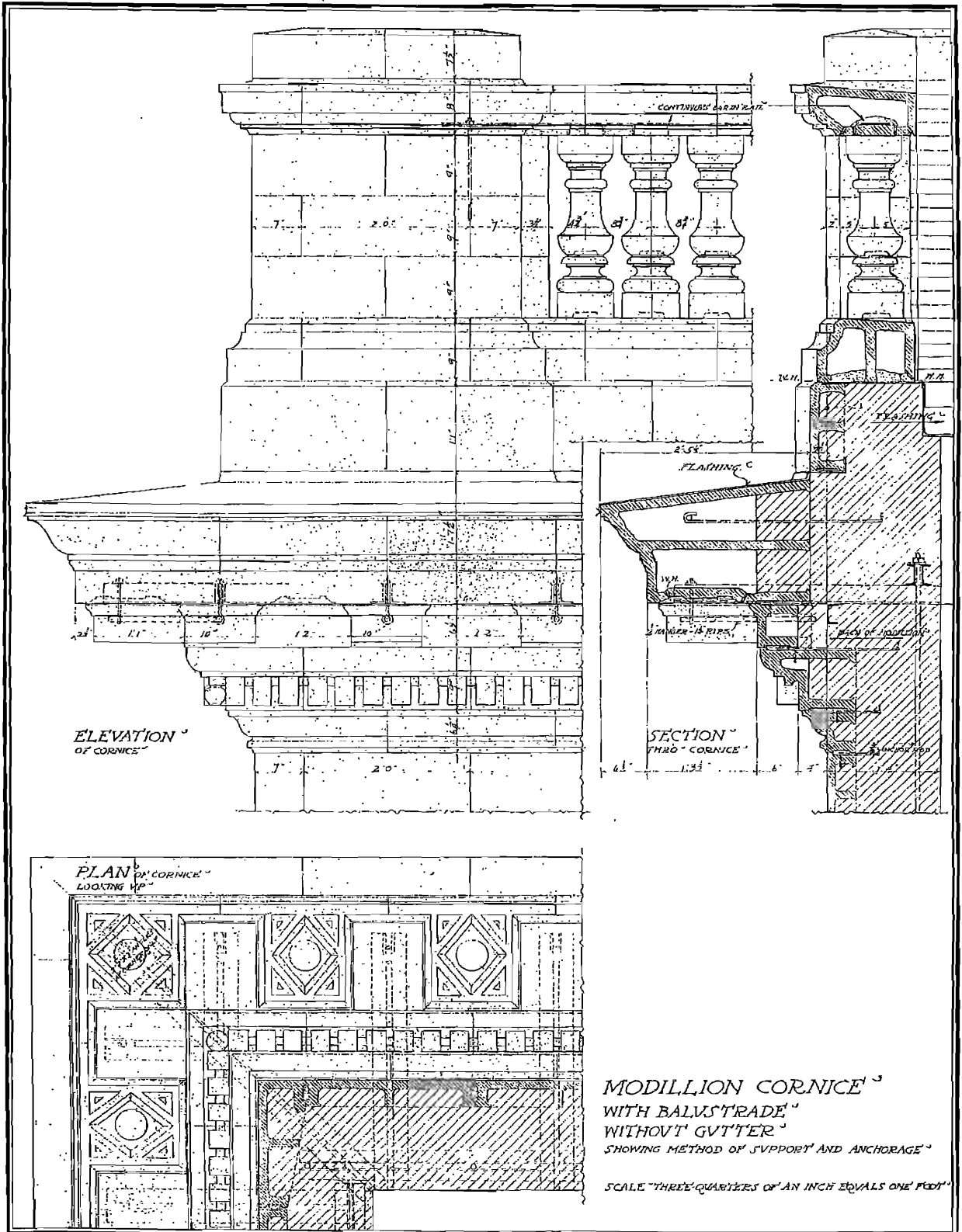
TERRA COTTA STANDARD CONSTRUCTION



▲ ▲ ▲ TERRA COTTA STANDARD CONSTRUCTION ▲ ▲ ▲

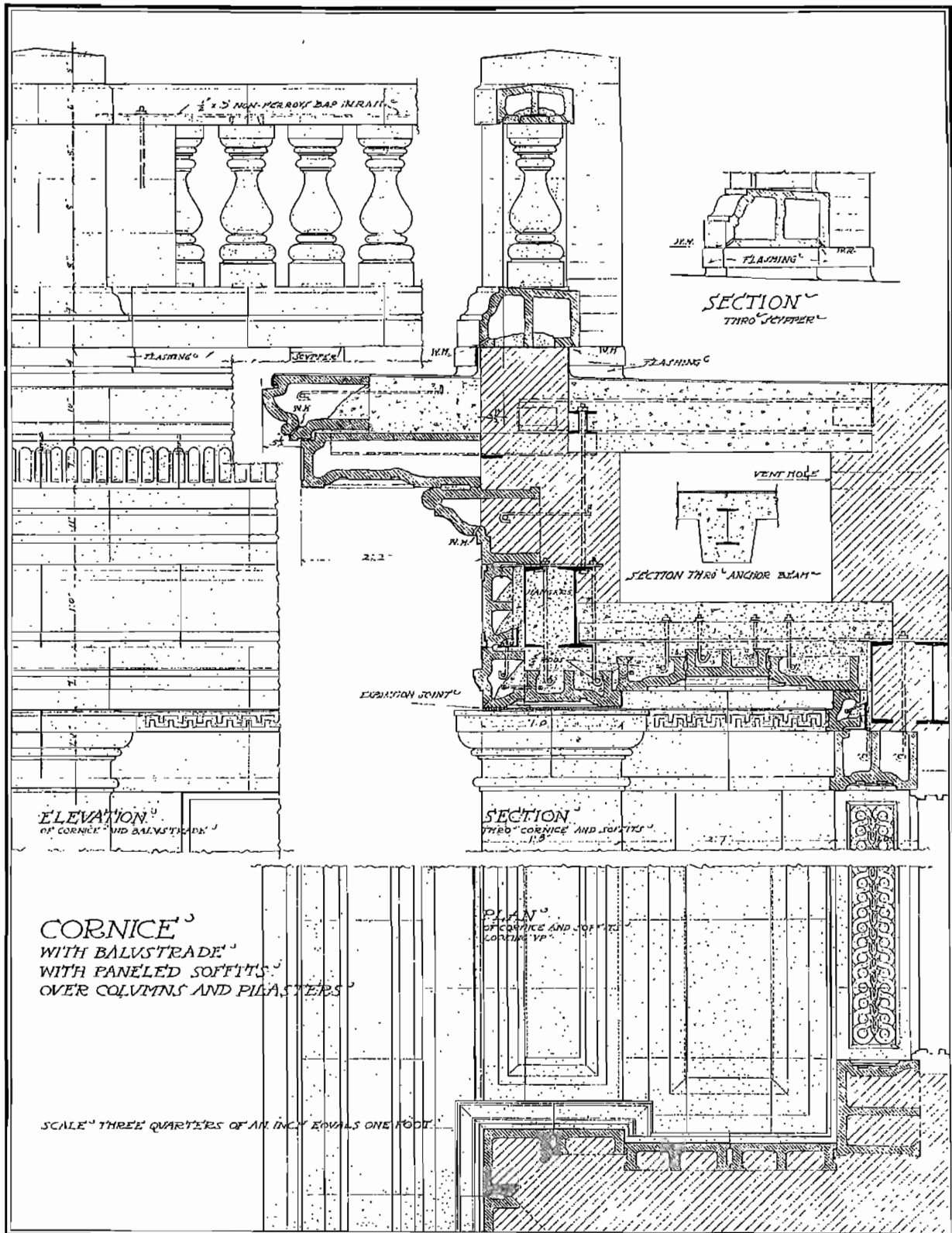


▲ ▲ ▲ TERRA COTTA STANDARD CONSTRUCTION ▲ ▲ ▲

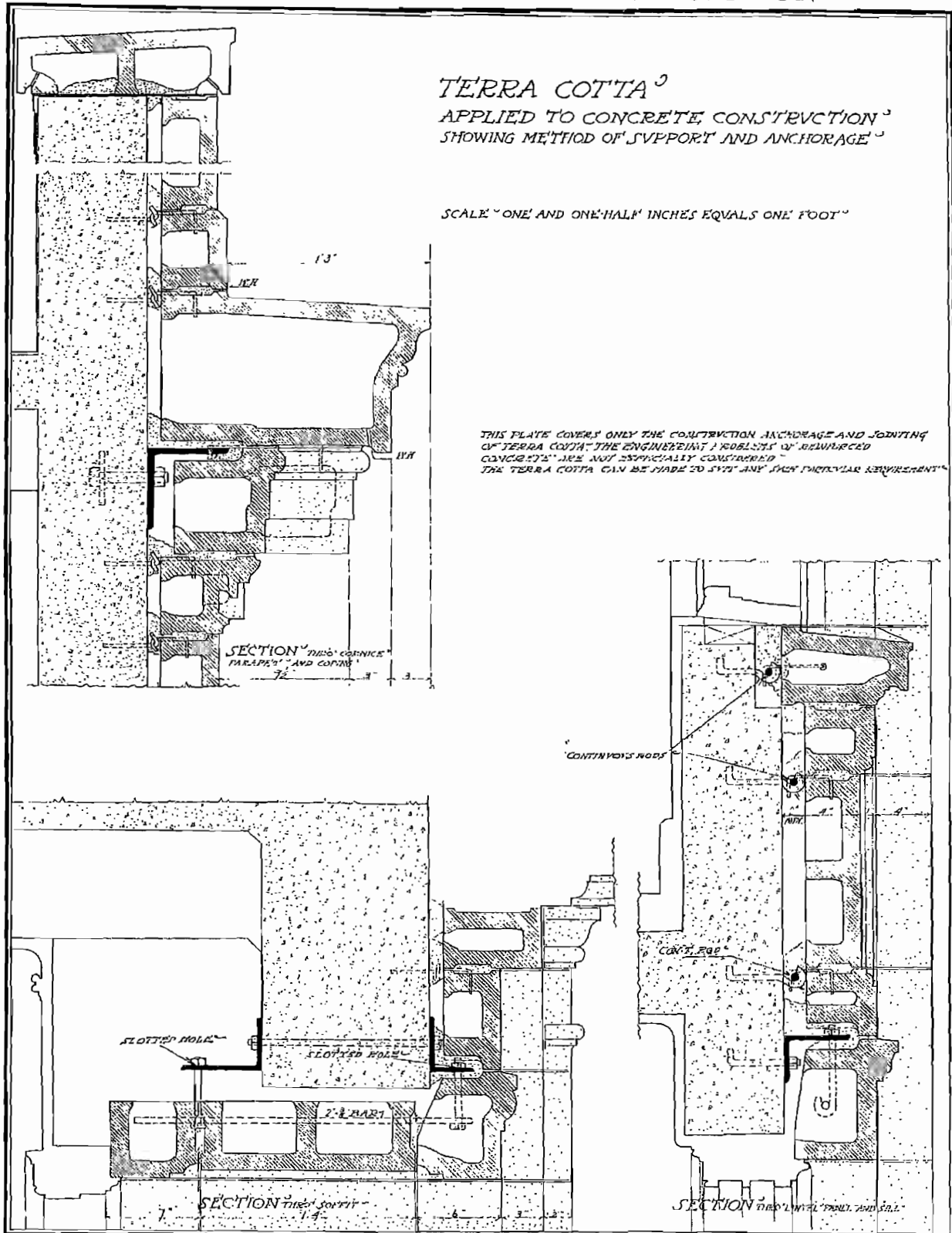


MODILLION CORNICE³
WITH BALUSTRADE⁴
WITHOUT GUTTER⁵
SHOWING METHOD OF SUPPORT AND ANCHORAGE⁶
SCALE THREE-QUARTERS OF AN INCH EQUALS ONE FOOT⁷

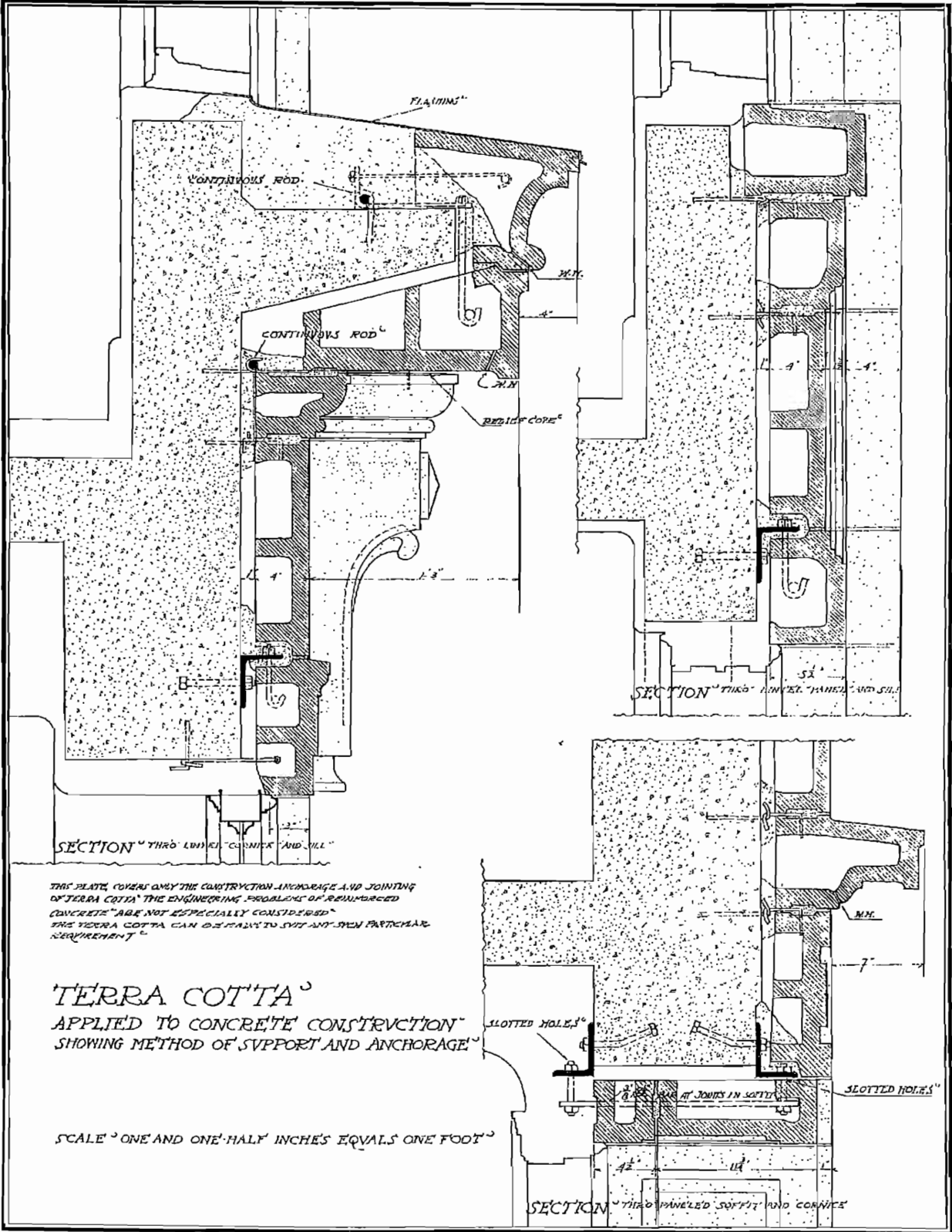
*** TERRA COTTA *** STANDARD CONSTRUCTION ***



*** TERRA COTTA *** STANDARD CONSTRUCTION ***



*** TERRA COTTA *** STANDARD CONSTRUCTION ***

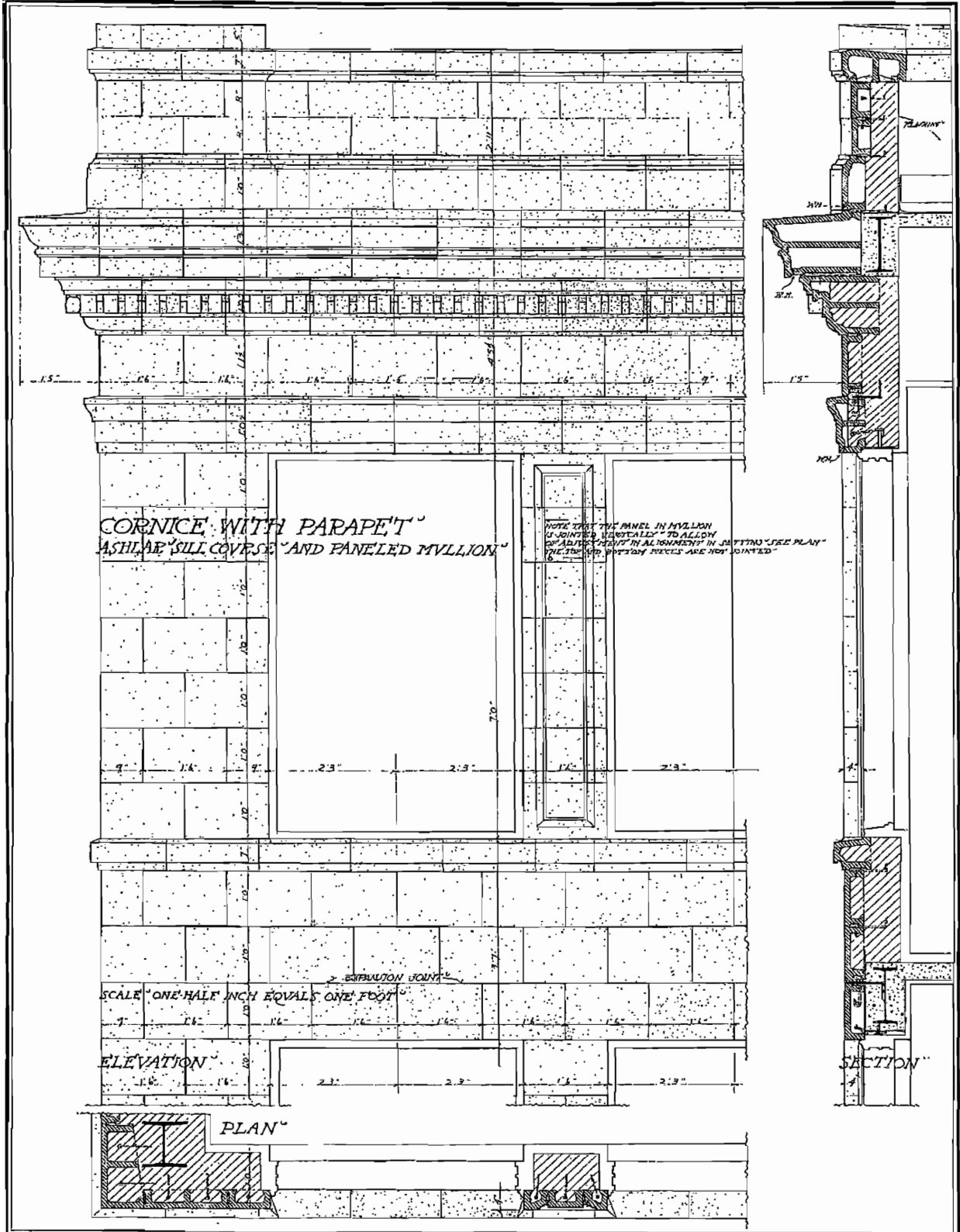


THIS PLATE COVERS ONLY THE CONSTRUCTION, ANCHORAGE AND JOINTING OF TERRA COTTA. THE ENGINEERING PROBLEMS OF REINFORCED CONCRETE ARE NOT ESPECIALLY CONSIDERED. THE TERRA COTTA CAN BE FOUND TO SUIT ANY GIVEN PARTICULAR REQUIREMENT.

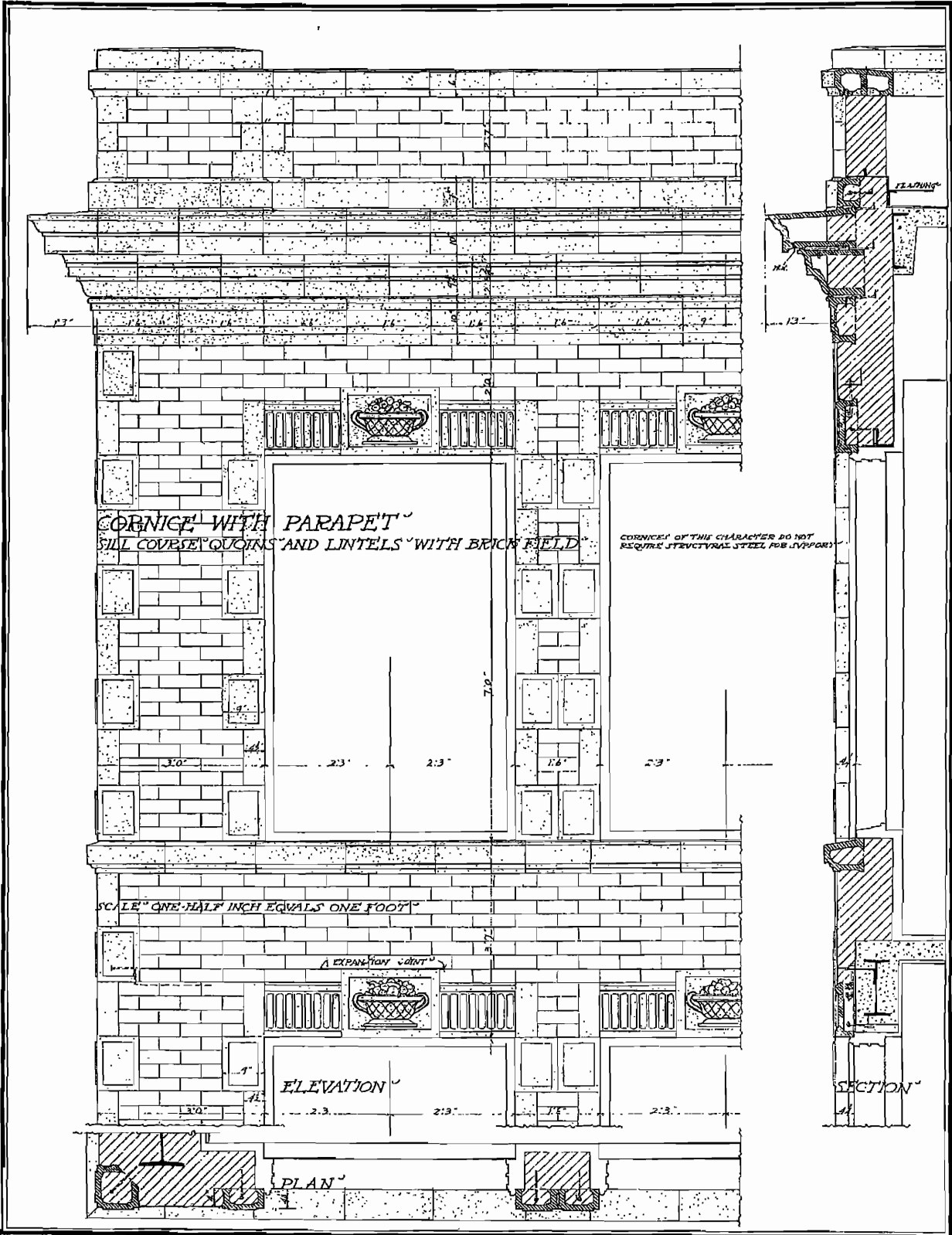
TERRA COTTA
 APPLIED TO CONCRETE CONSTRUCTION
 SHOWING METHOD OF SUPPORT AND ANCHORAGE

SCALE ONE AND ONE-HALF INCHES EQUALS ONE FOOT

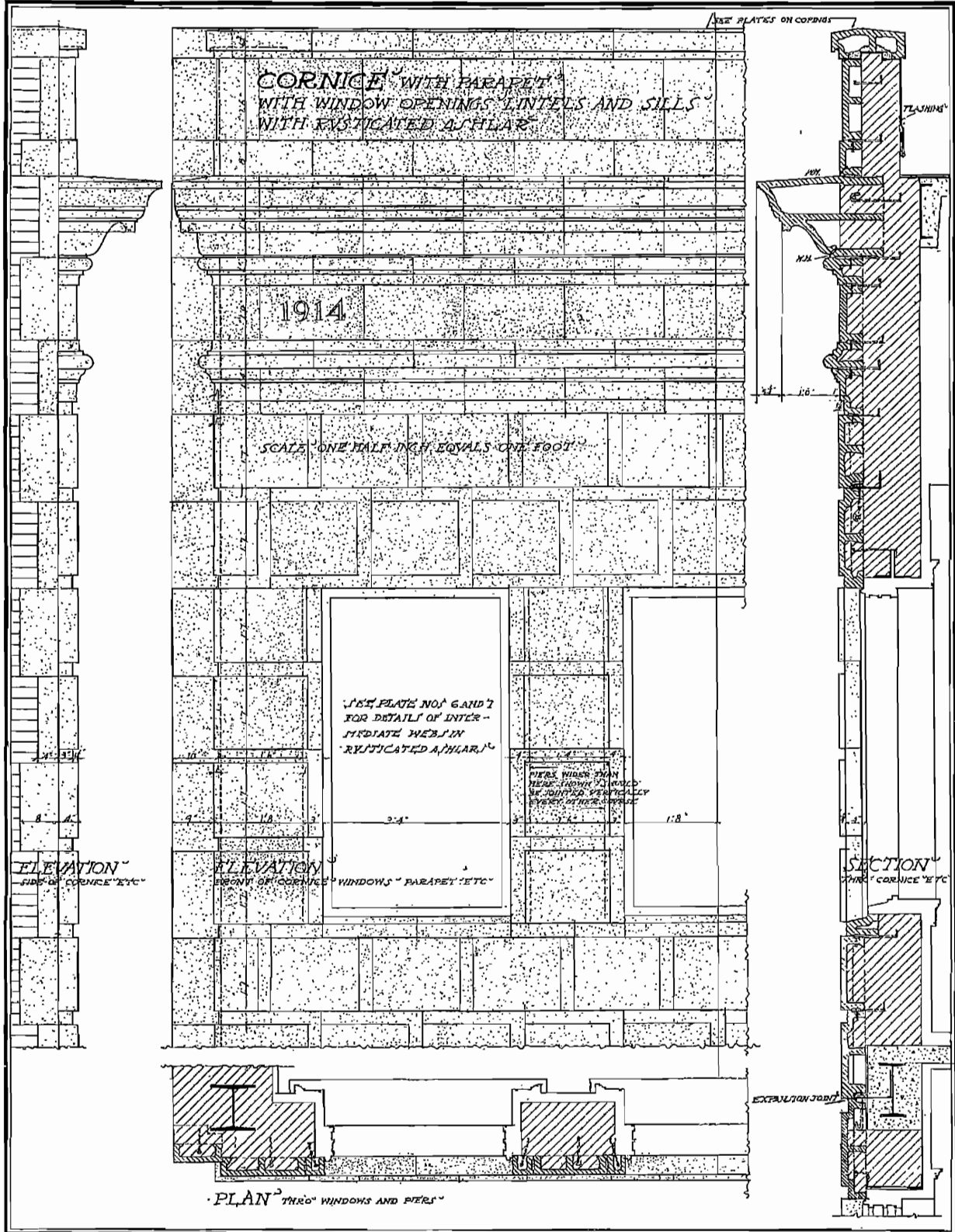
▲ ▲ ▲ TERRA COTTA ▲ STANDARD CONSTRUCTION ▲ ▲ ▲ ▲



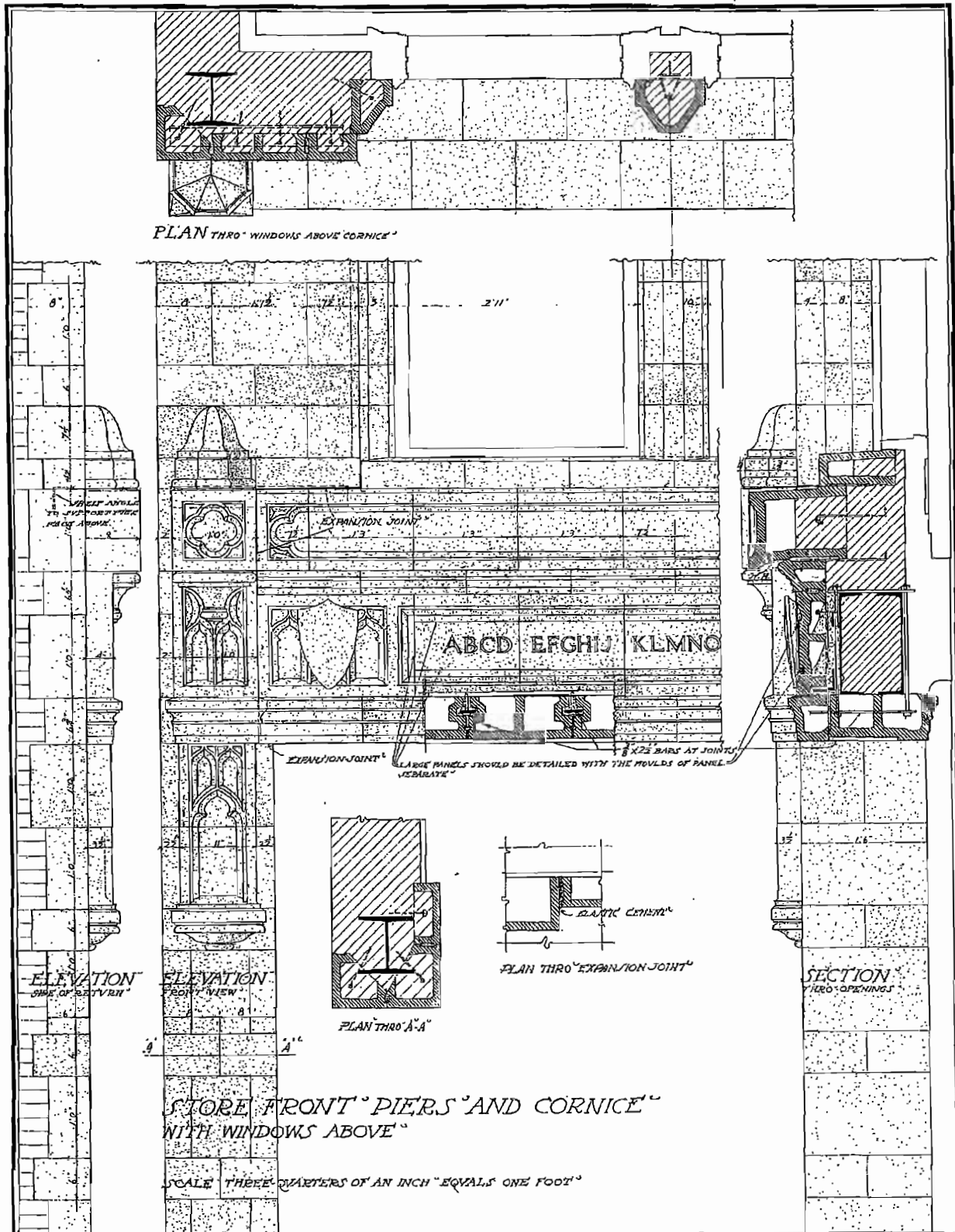
▲ ▲ ▲ ▲ TERRA COTTA ▲ ▲ STANDARD CONSTRUCTION ▲ ▲ ▲ ▲



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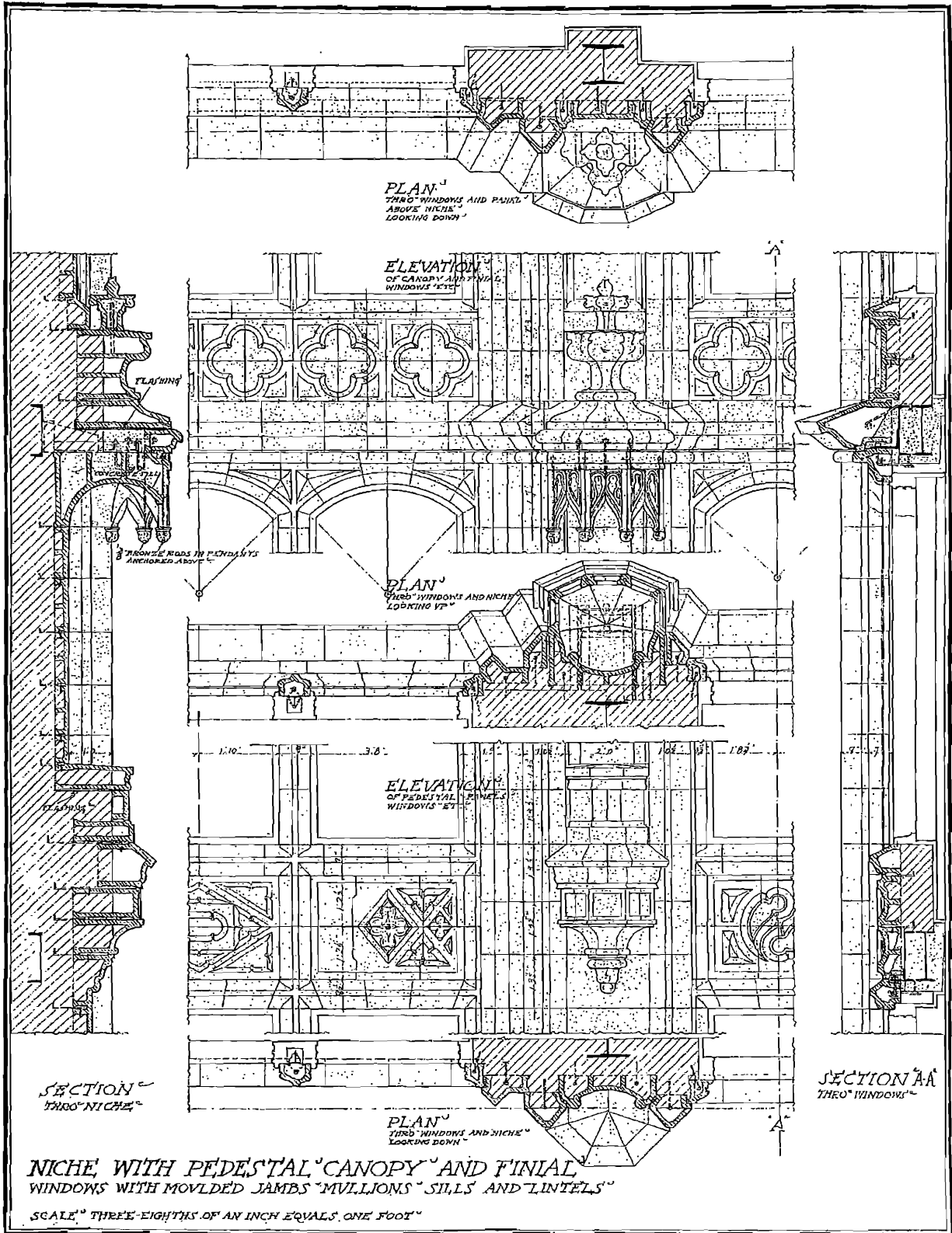
TERRA COTTA STANDARD CONSTRUCTION



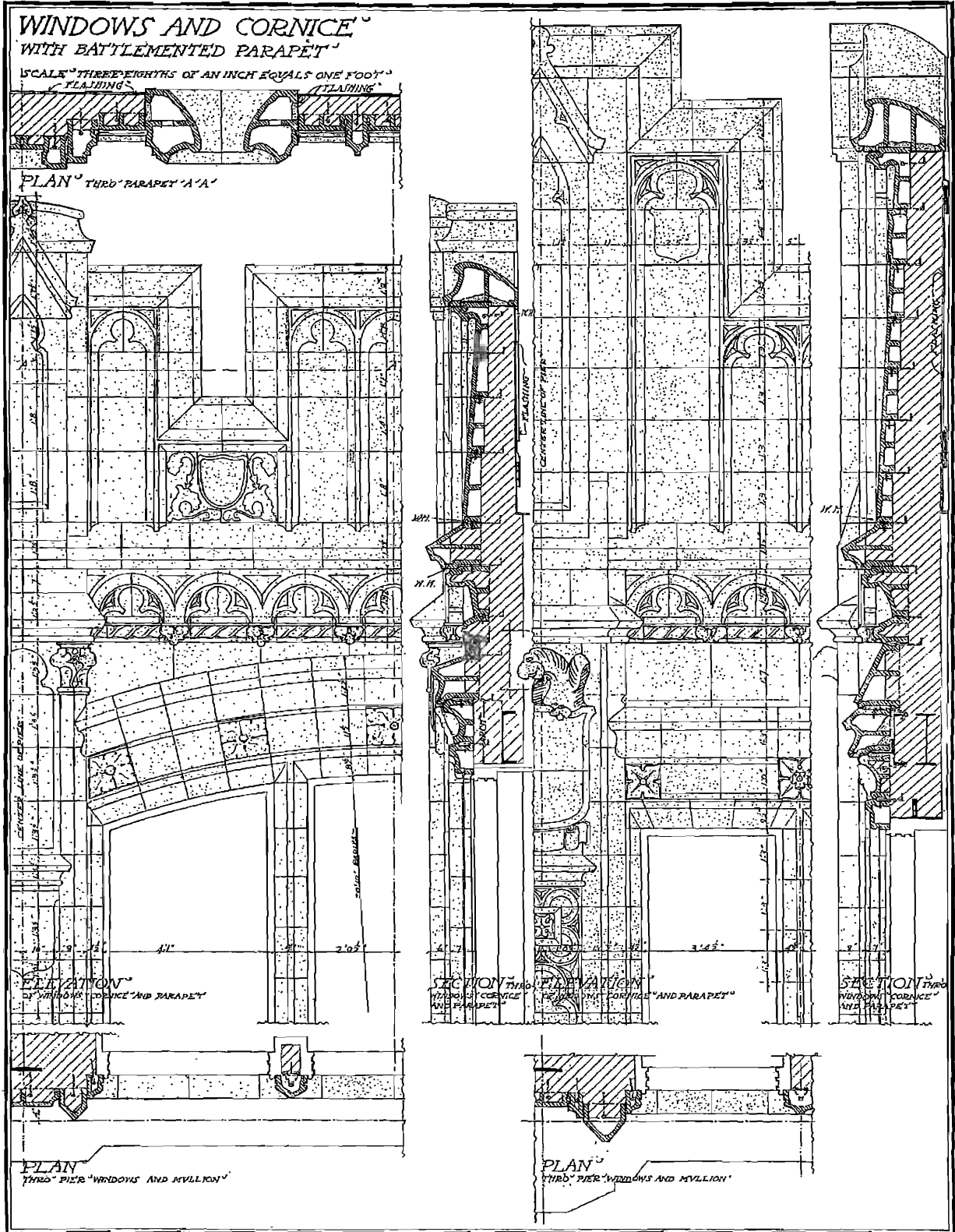
STORE FRONT PIER'S AND CORNICE WITH WINDOWS ABOVE

SCALE THREE QUARTERS OF AN INCH EQUALS ONE FOOT

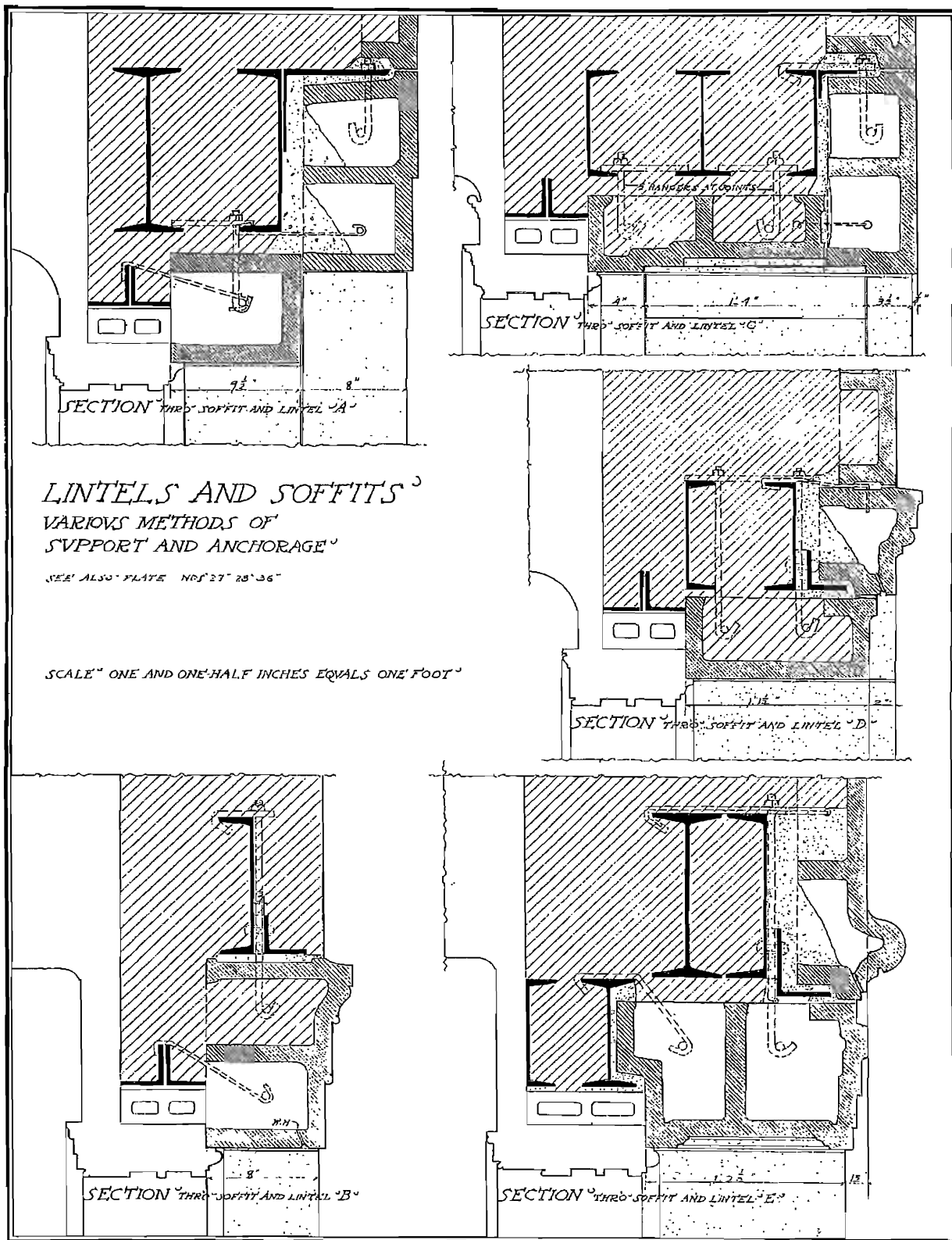
*** TERRA COTTA STANDARD CONSTRUCTION ***



TERRA COTTA STANDARD CONSTRUCTION



▲ ▲ ▲ ▲ TERRA COTTA ▲ ▲ STANDARD CONSTRUCTION ▲ ▲ ▲ ▲



LINTELS AND SOFFITS
VARIOUS METHODS OF
SUPPORT AND ANCHORAGE

SEE ALSO PLATE NOS 27 28 36

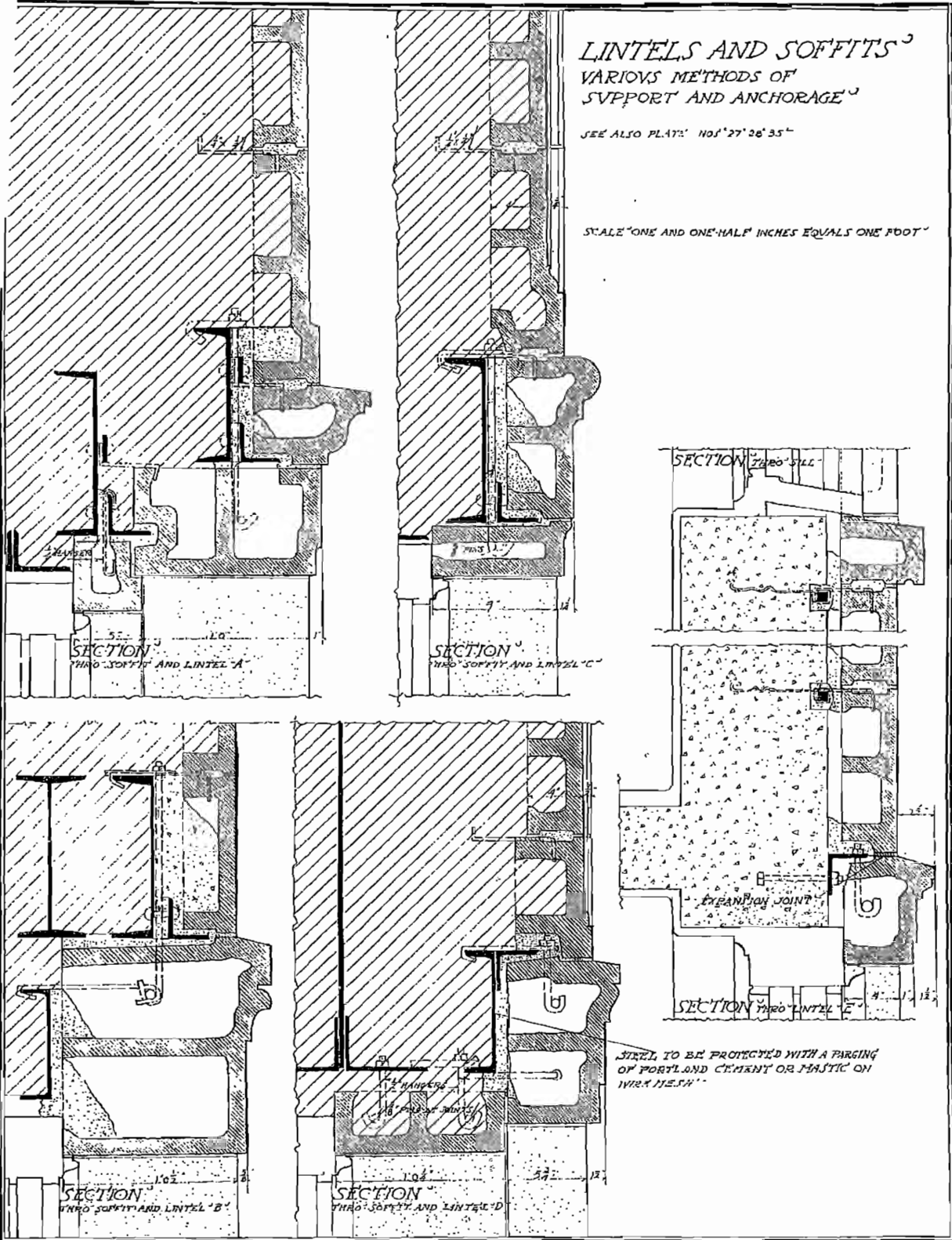
SCALE ONE AND ONE-HALF INCHES EQUALS ONE FOOT

TERRA COTTA STANDARD CONSTRUCTION

LINTELS AND SOFFITS
VARIOUS METHODS OF
SUPPORT AND ANCHORAGE

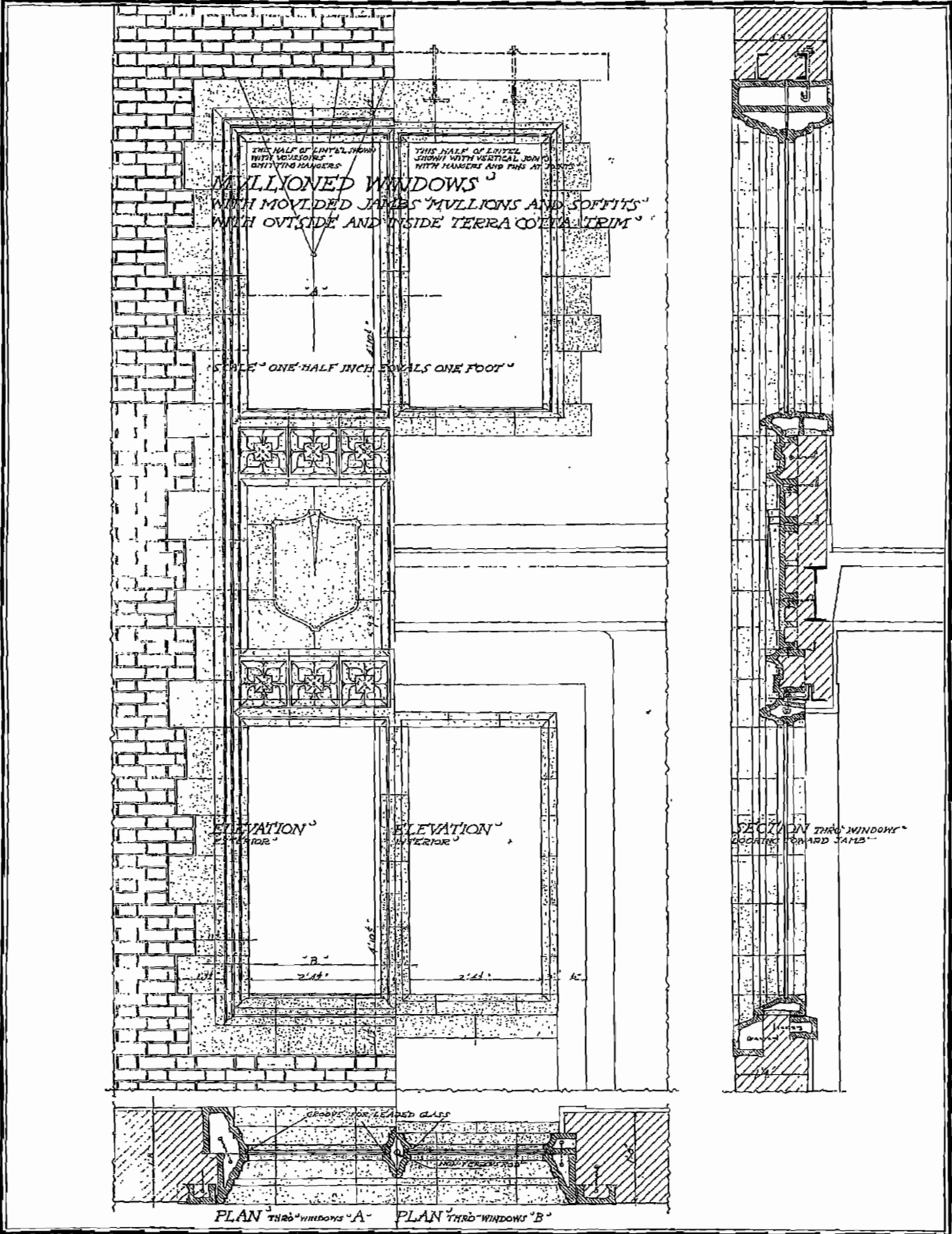
SEE ALSO PLATE NOS 27 28 35

SCALE ONE AND ONE-HALF INCHES EQUALS ONE FOOT

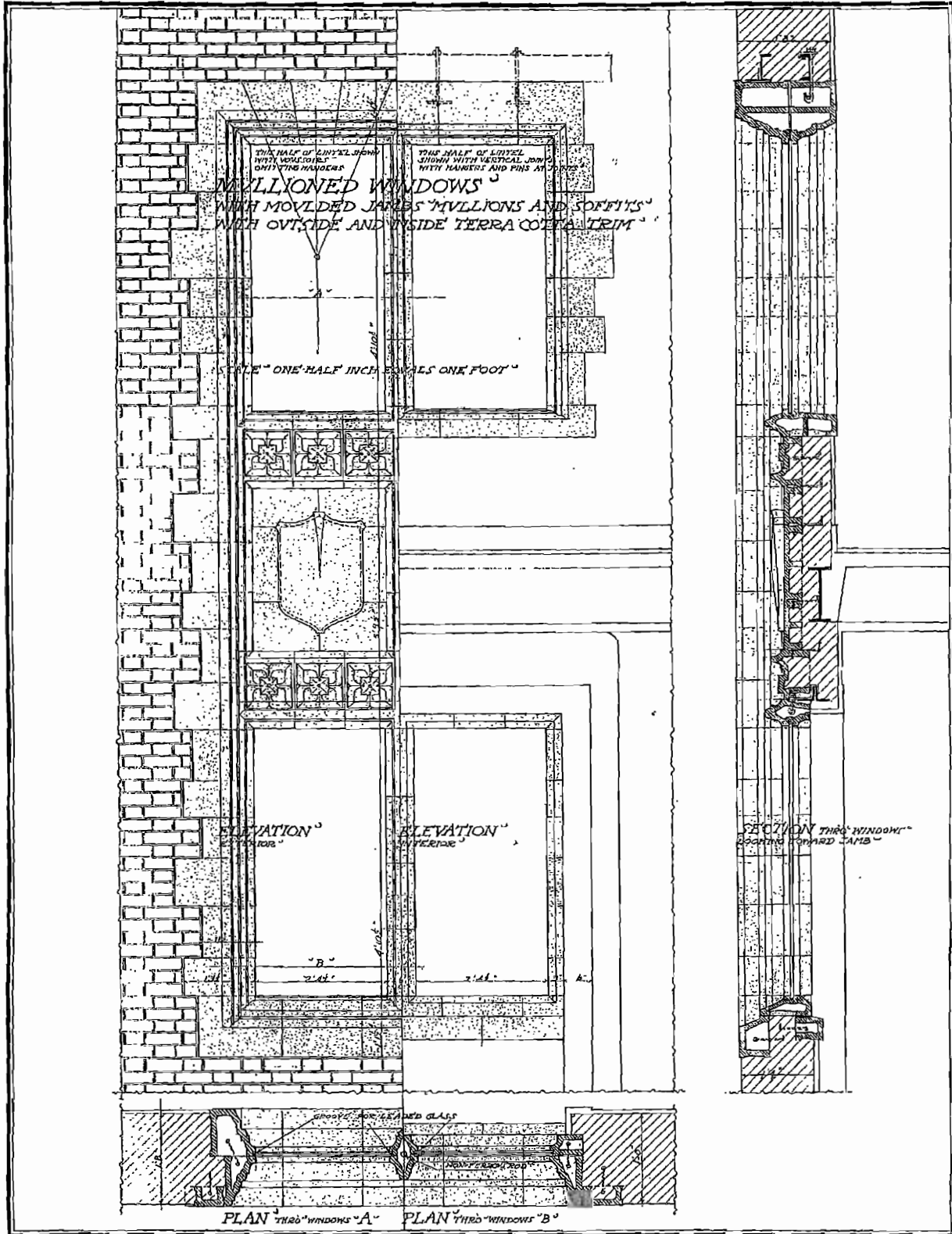


STEEL TO BE PROTECTED WITH A FARGING
OF PORTLAND CEMENT OR MASTIC ON
1/4" X 1/2" X 1/4"

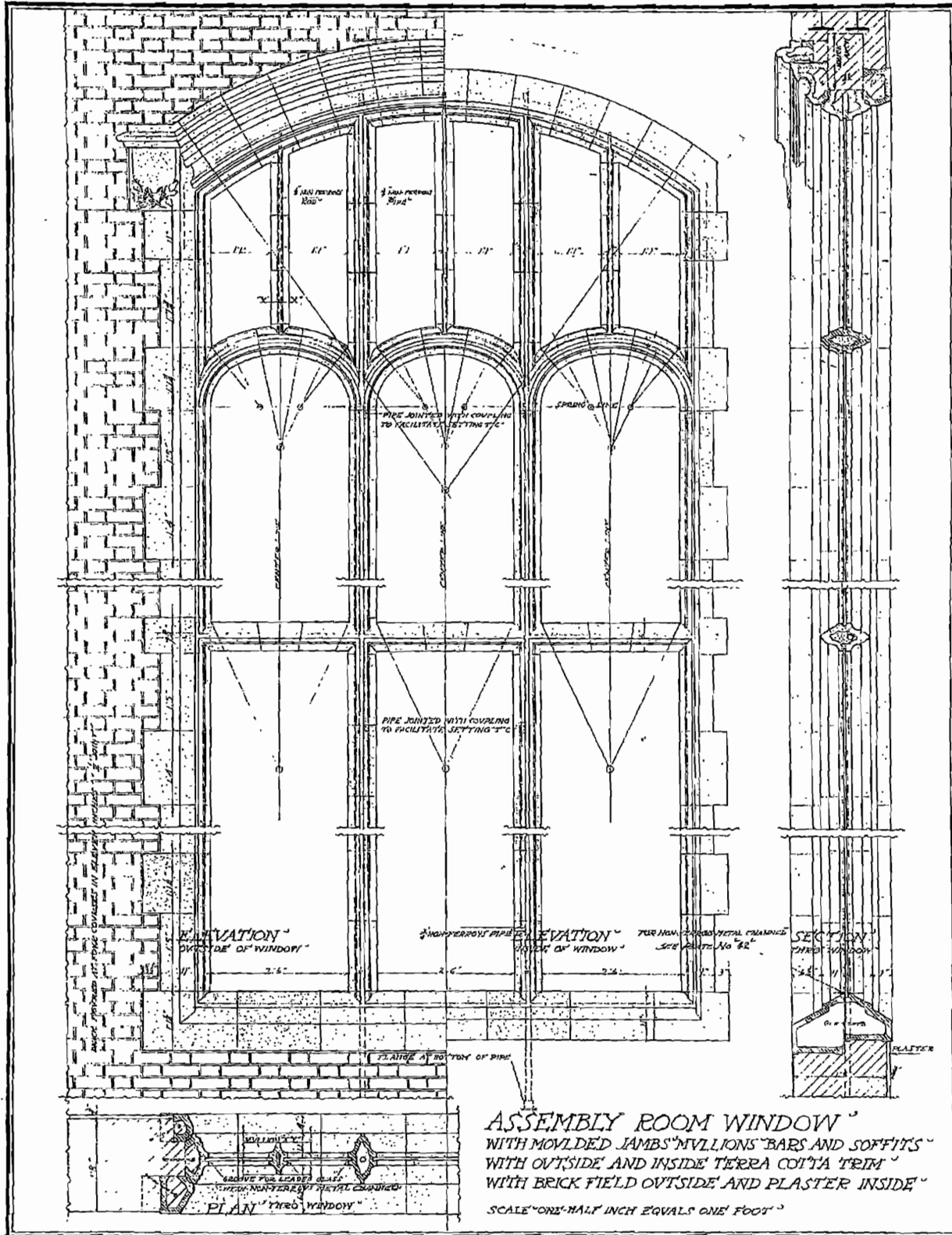
▲ ▲ ▲ ▲ TERRA COTTA ▲ STANDARD CONSTRUCTION ▲ ▲ ▲ ▲



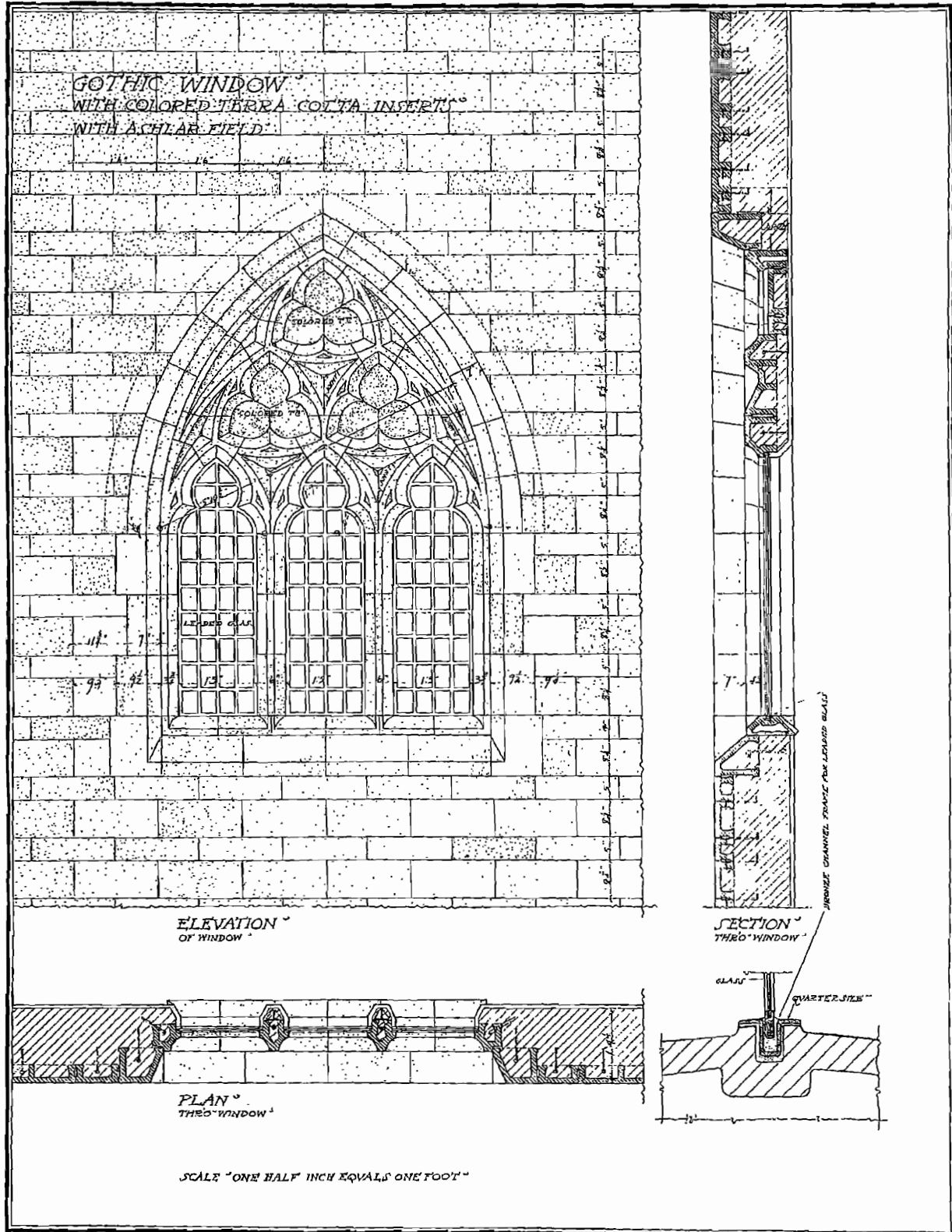
▲ ▲ ▲ ▲ TERRA COTTA STANDARD CONSTRUCTION ▲ ▲ ▲ ▲



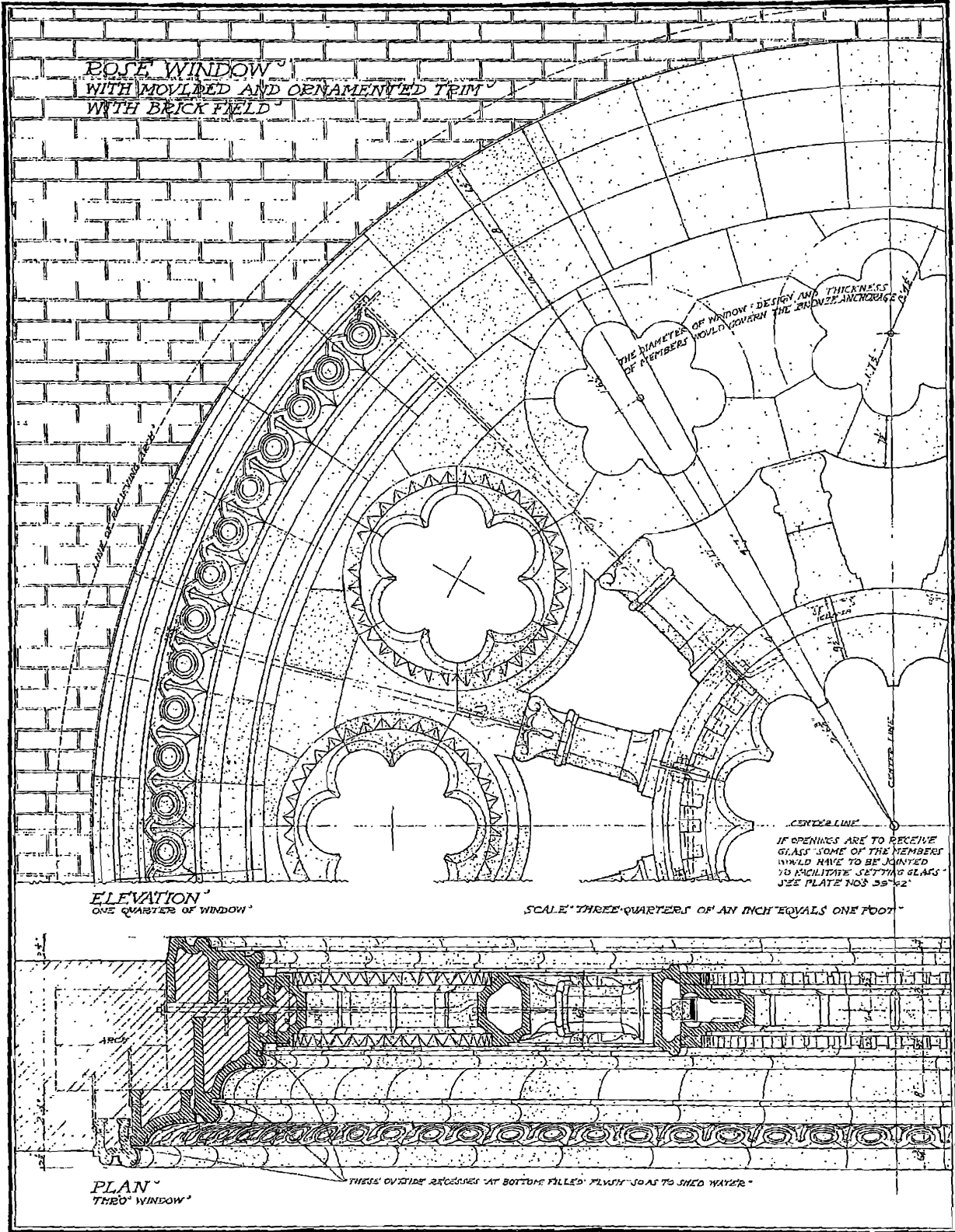
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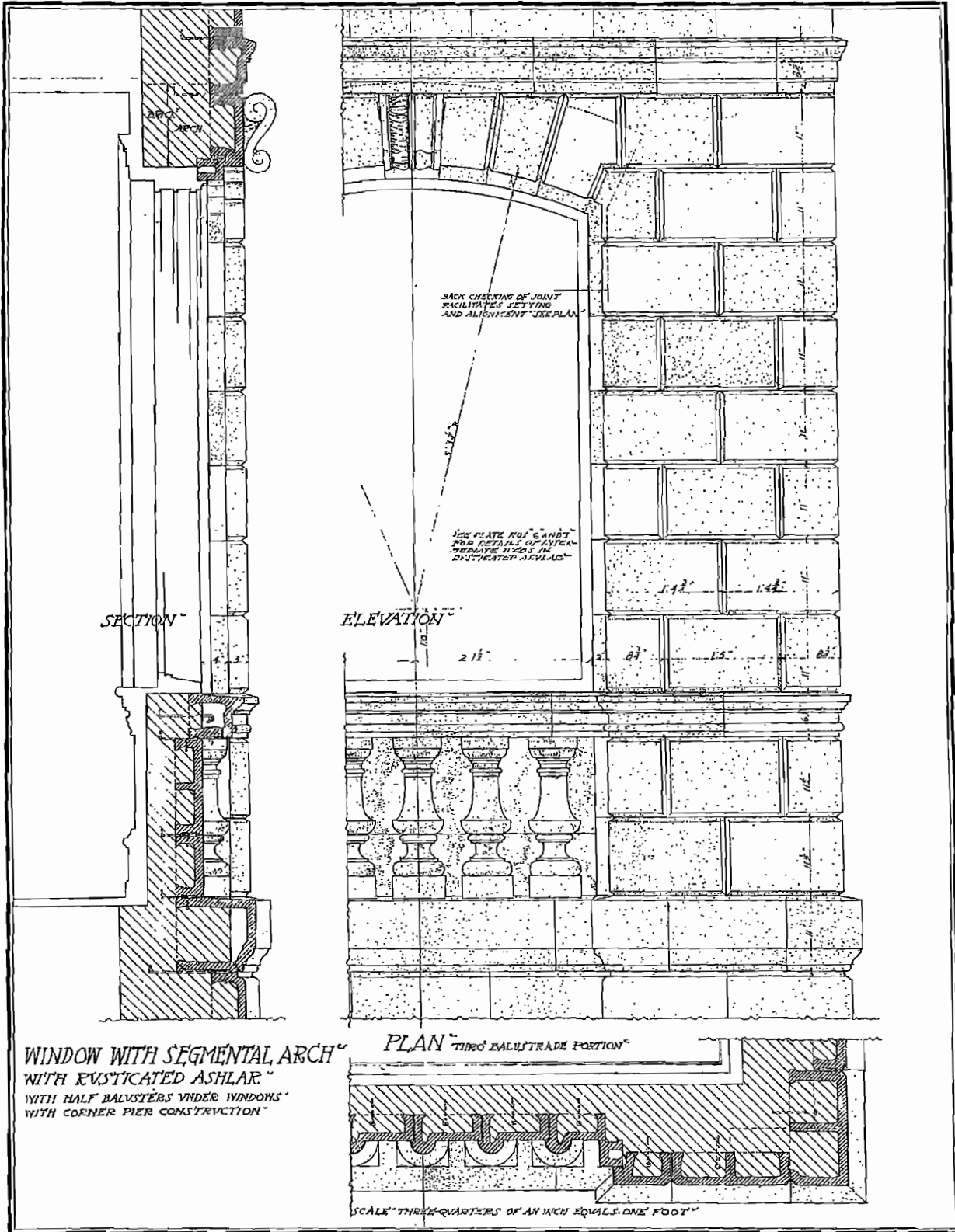
TERRA COTTA STANDARD CONSTRUCTION



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• • • • TERRA COTTA • • STANDARD CONSTRUCTION • • • •

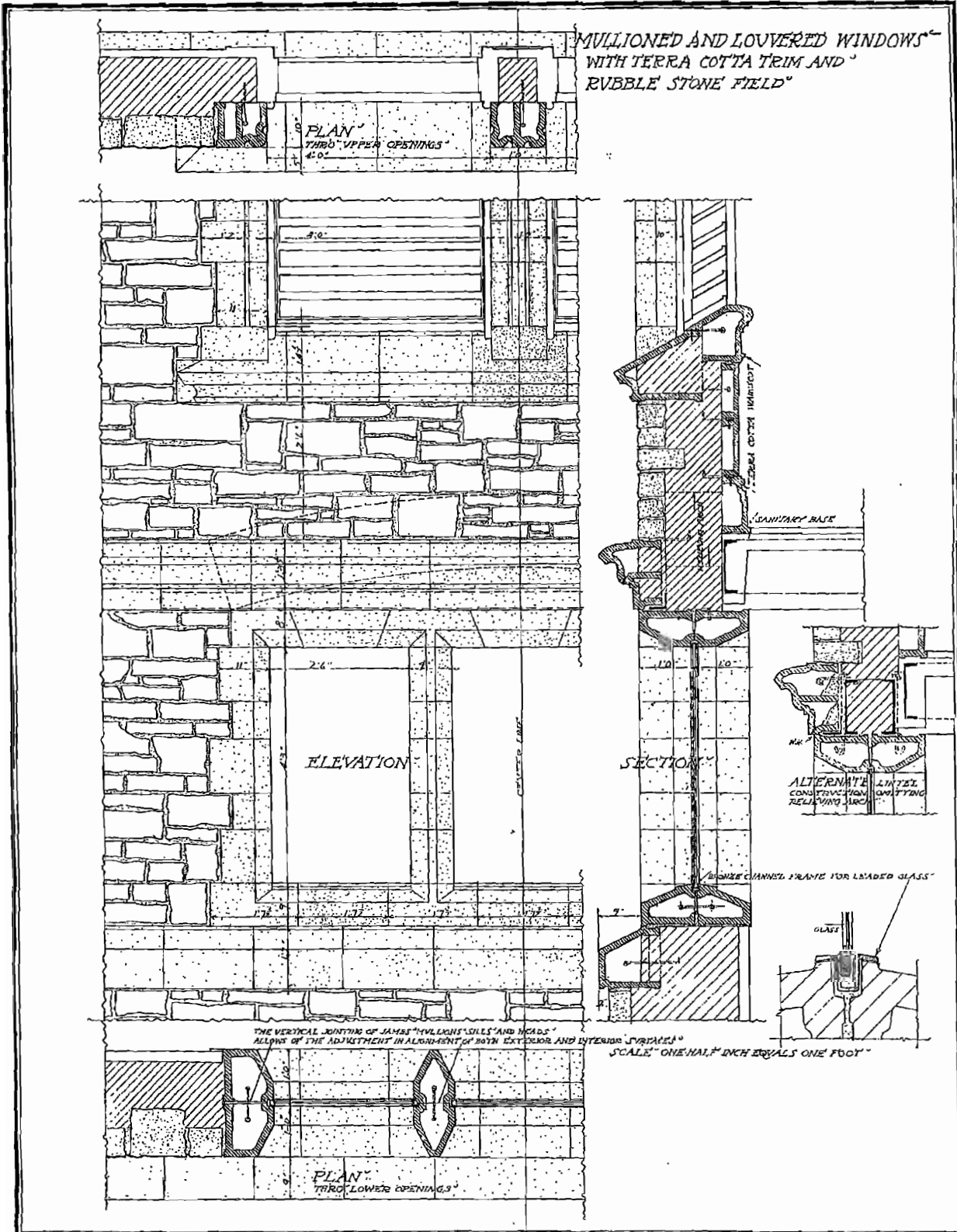


WINDOW WITH SEGMENTAL ARCH
WITH RUSTICATED ASHLAR
WITH HALF BALUSTERS UNDER WINDOWS
WITH CORNER PIER CONSTRUCTION

PLAN - THIRD BALUSTRADE PORTION

SCALE - THREE-QUARTERS OF AN INCH EQUALS ONE FOOT

▲ ▲ ▲ TERRA COTTA STANDARD CONSTRUCTION ▲ ▲ ▲



TERRA COTTA STANDARD CONSTRUCTION

WINDOW
WITH MOULDED JAMB AND SILL
WITH INTERIOR TERRA COTTA WAINSCOT

THE VERTICAL JOINTING OF MOULDED JAMBS (PARTLY
CONCEALED BY BACK CHECKING) AS SHOWN, PERMITS
OF ADJUSTMENT IN ALIGNMENT IN SETTING

PLAN

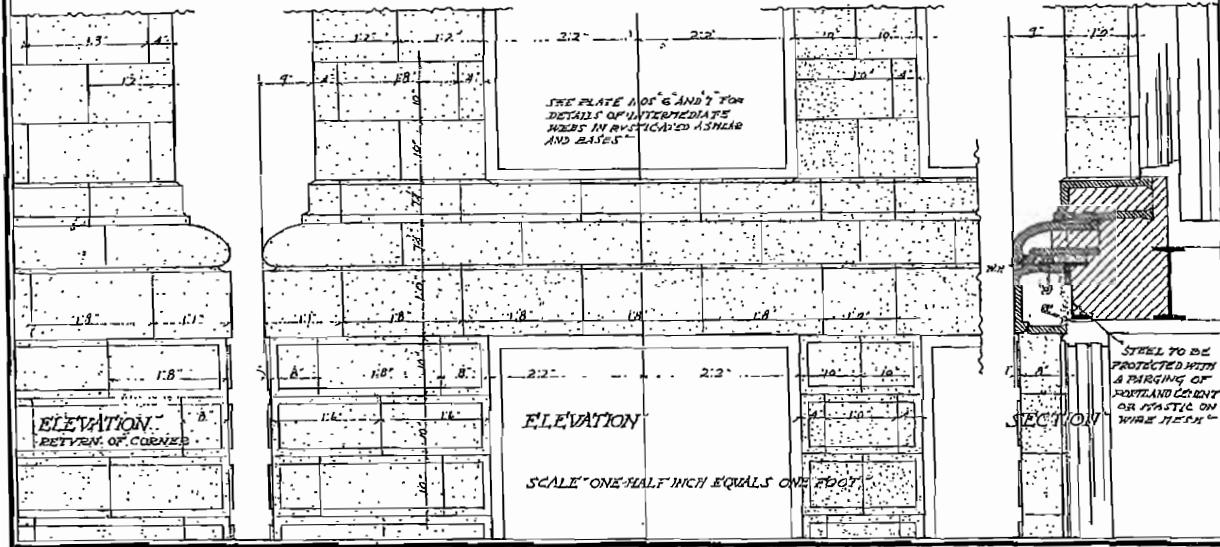
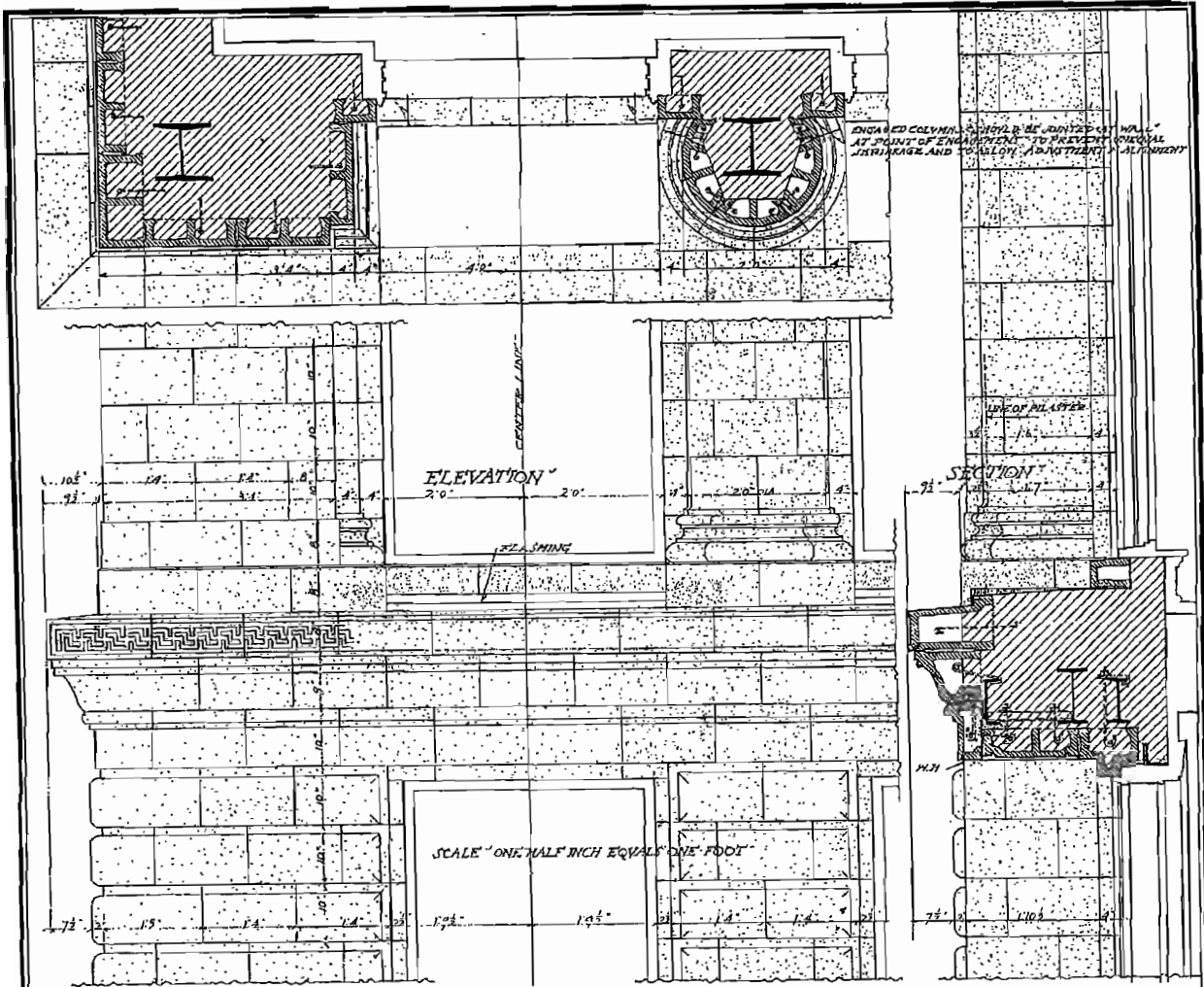
ELEVATION

SECTION

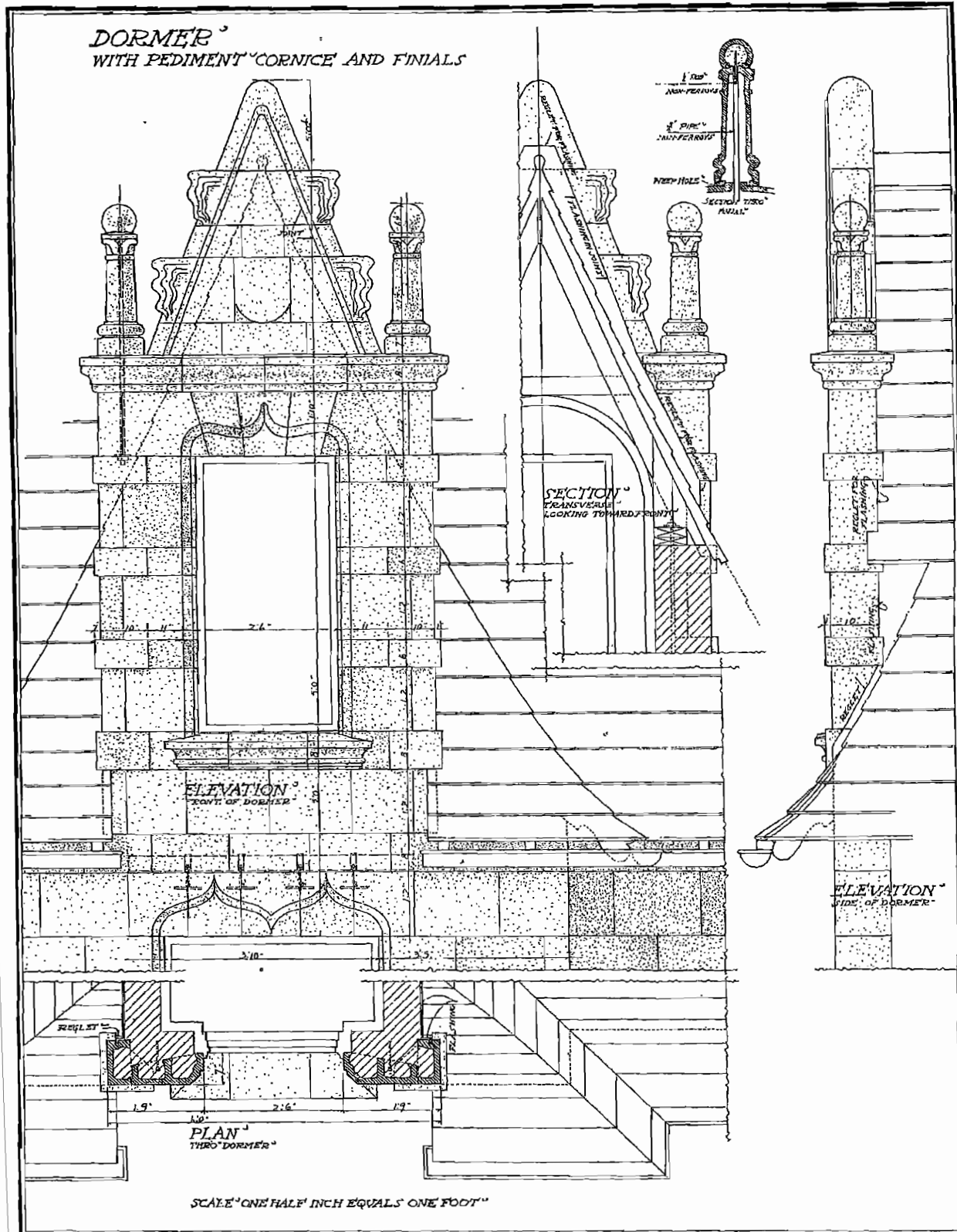
FOR NON-CORROSIVE
CHANNEL LEE PLATE (NO. 45)

SCALE "THREE QUARTERS" OF AN INCH EQUALS ONE FOOT

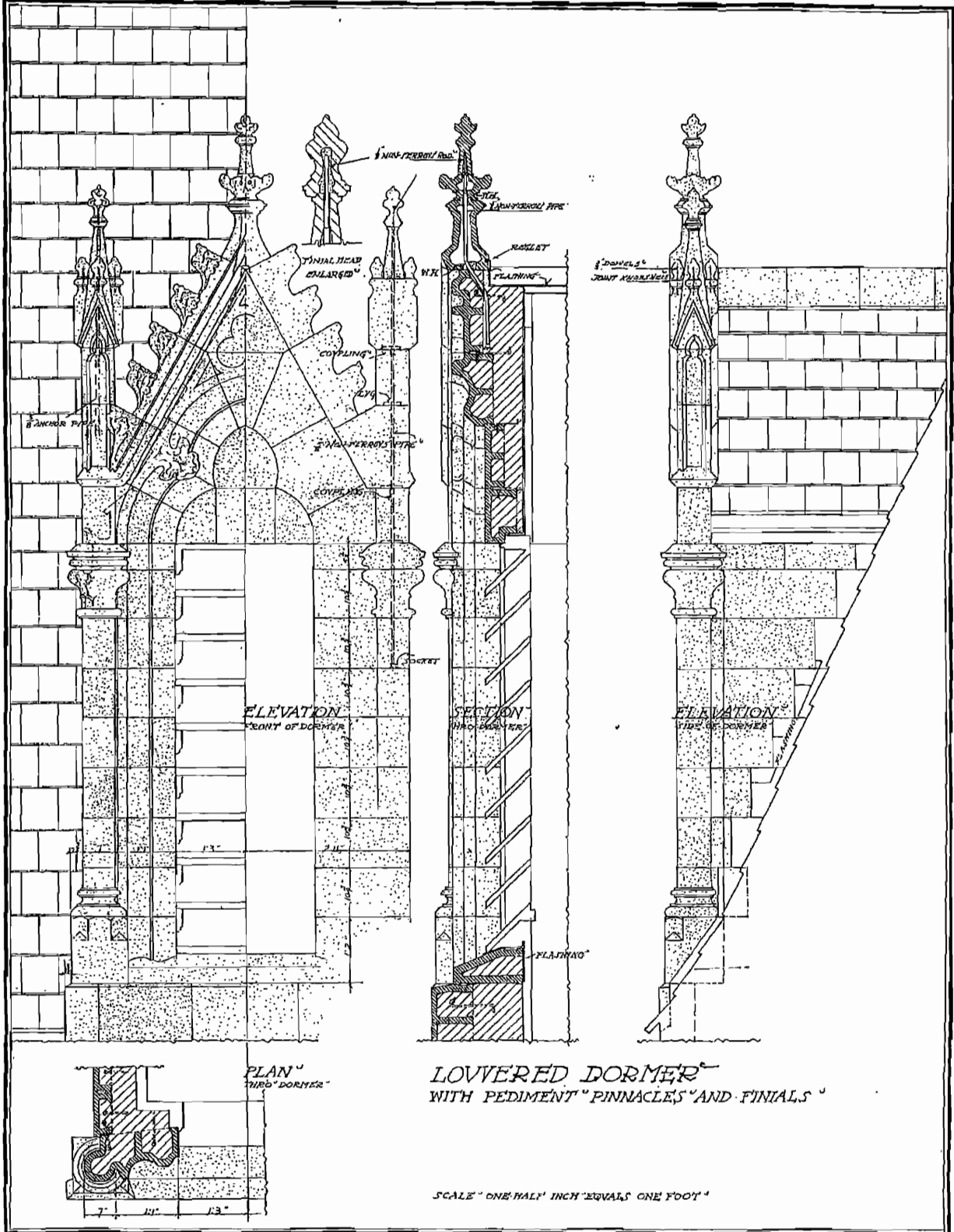
TERRA COTTA STANDARD CONSTRUCTION



• • • • TERRA COTTA • • STANDARD CONSTRUCTION • • • •

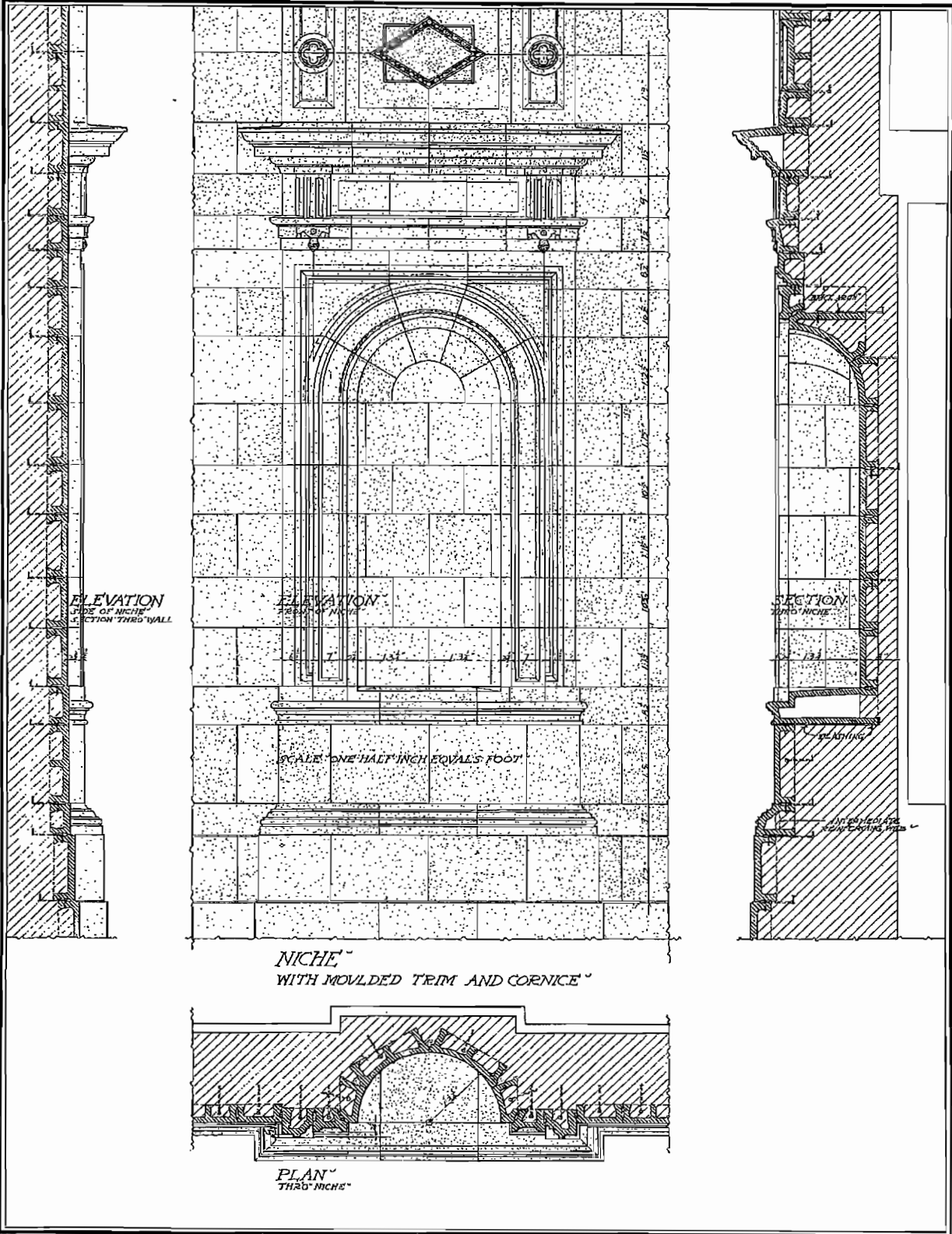


▲ ▲ ▲ TERRA COTTA STANDARD CONSTRUCTION ▲ ▲ ▲



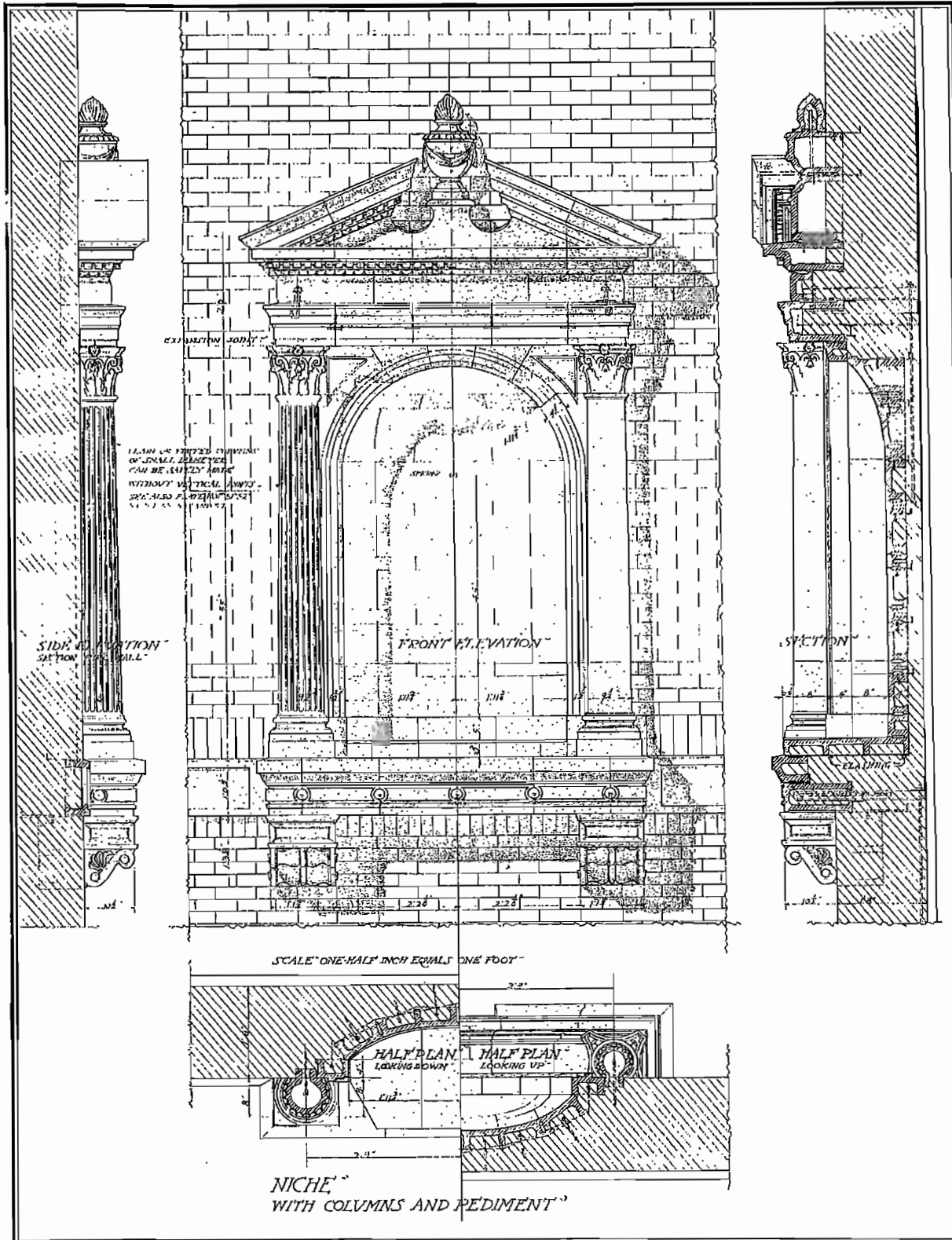
NATIONAL TERRA COTTA SOCIETY · V · S · A · · · PLATE NO · 47

TERRA COTTA STANDARD CONSTRUCTION

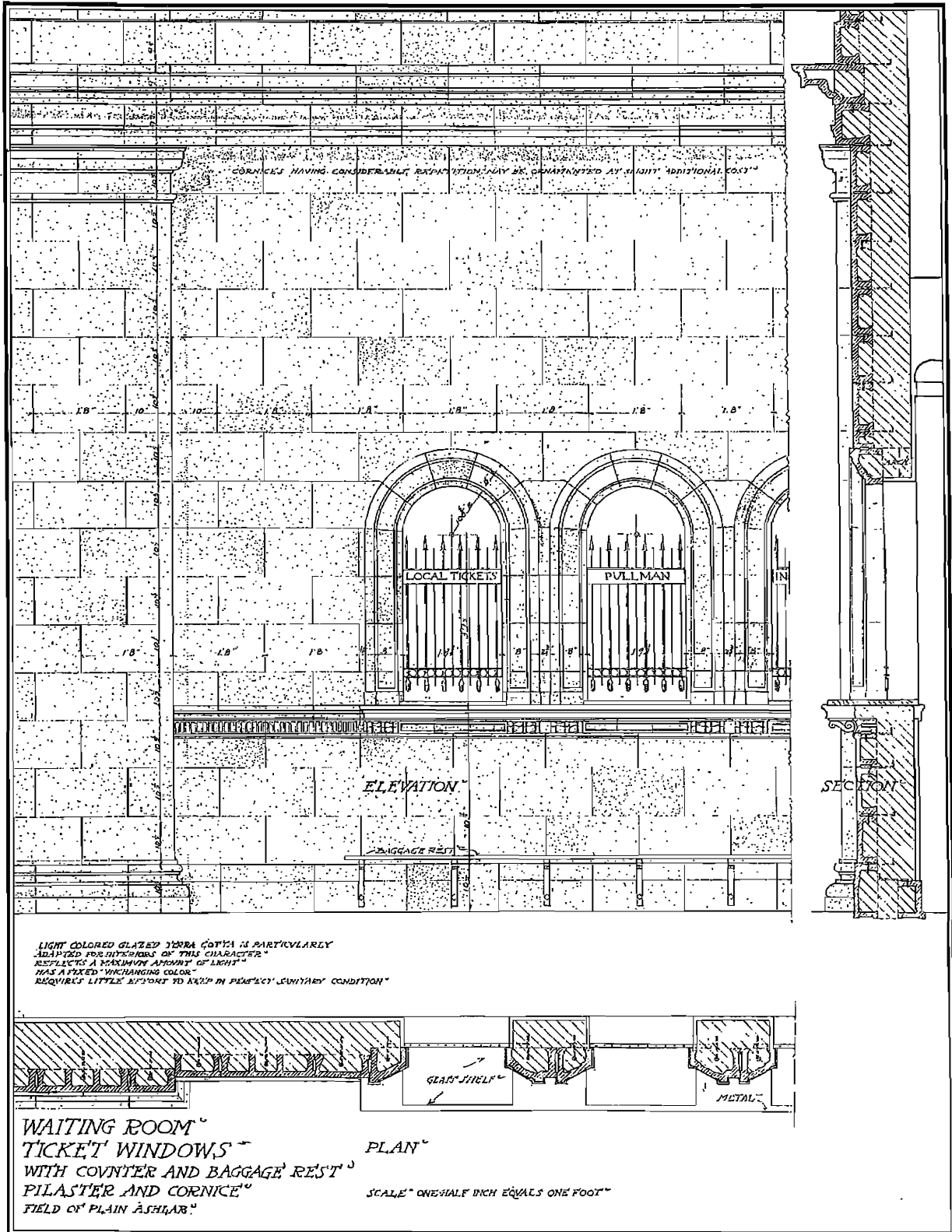


NICHE WITH MOULDED TRIM AND CORNICE

TERRA COTTA STANDARD CONSTRUCTION

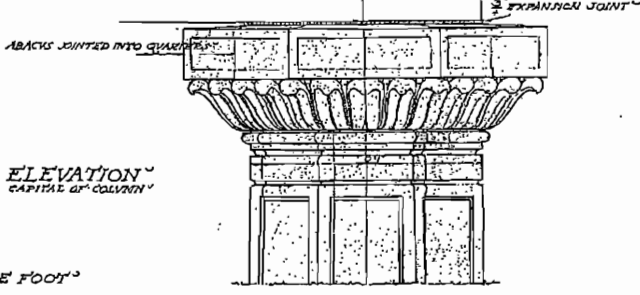


▲ ▲ ▲ ▲ TERRA COTTA ▲ ▲ STANDARD CONSTRUCTION ▲ ▲ ▲ ▲



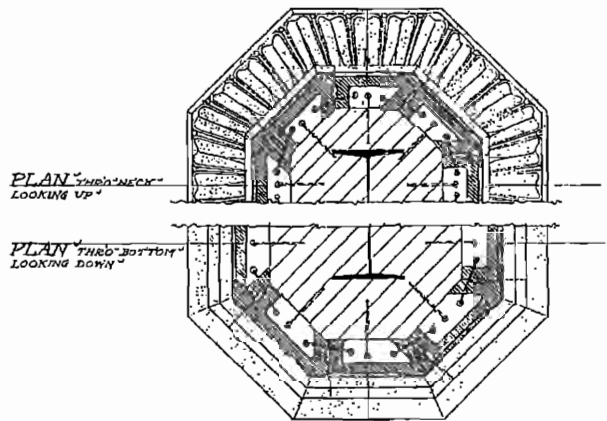
▲ ▲ ▲ ▲ TERRA COTTA ▲ ▲ STANDARD CONSTRUCTION ▲ ▲ ▲ ▲

OCTAGON COLUMN³
WITH CAPITAL AND BASE³



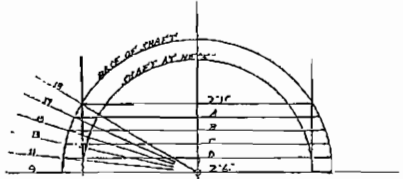
ELEVATION³
CAPITAL OF COLUMN³

SCALE " THREE-QUARTERS OF AN INCH EQUALS ONE FOOT "



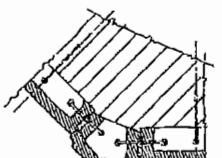
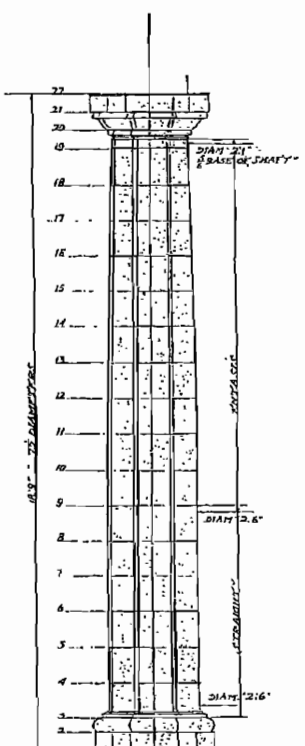
PLAN THROUGH NECK³
LOOKING UP³

PLAN THROUGH BOTTOM³
LOOKING DOWN³



DIAGRAM³ OF METHOD FOR OBTAINING ENTASIS OF SHAFT³
LAY OUT ACCURATELY TO FULL SIZE OF COLUMN³
A, B, C AND D CAN THEN BE ACCURATELY MEASURED³
GIVING THE DIAMETERS AT " 11 " 13 " 15 " AND " 17 "

THE CHAFFY AS JOINED TENDS TO CONCEAL THE VERTICAL JOINTS PERMITS CLOSE FITTING AND ALLOWS OF ADJUSTMENT IN ALIGNMENT IN SETTING.



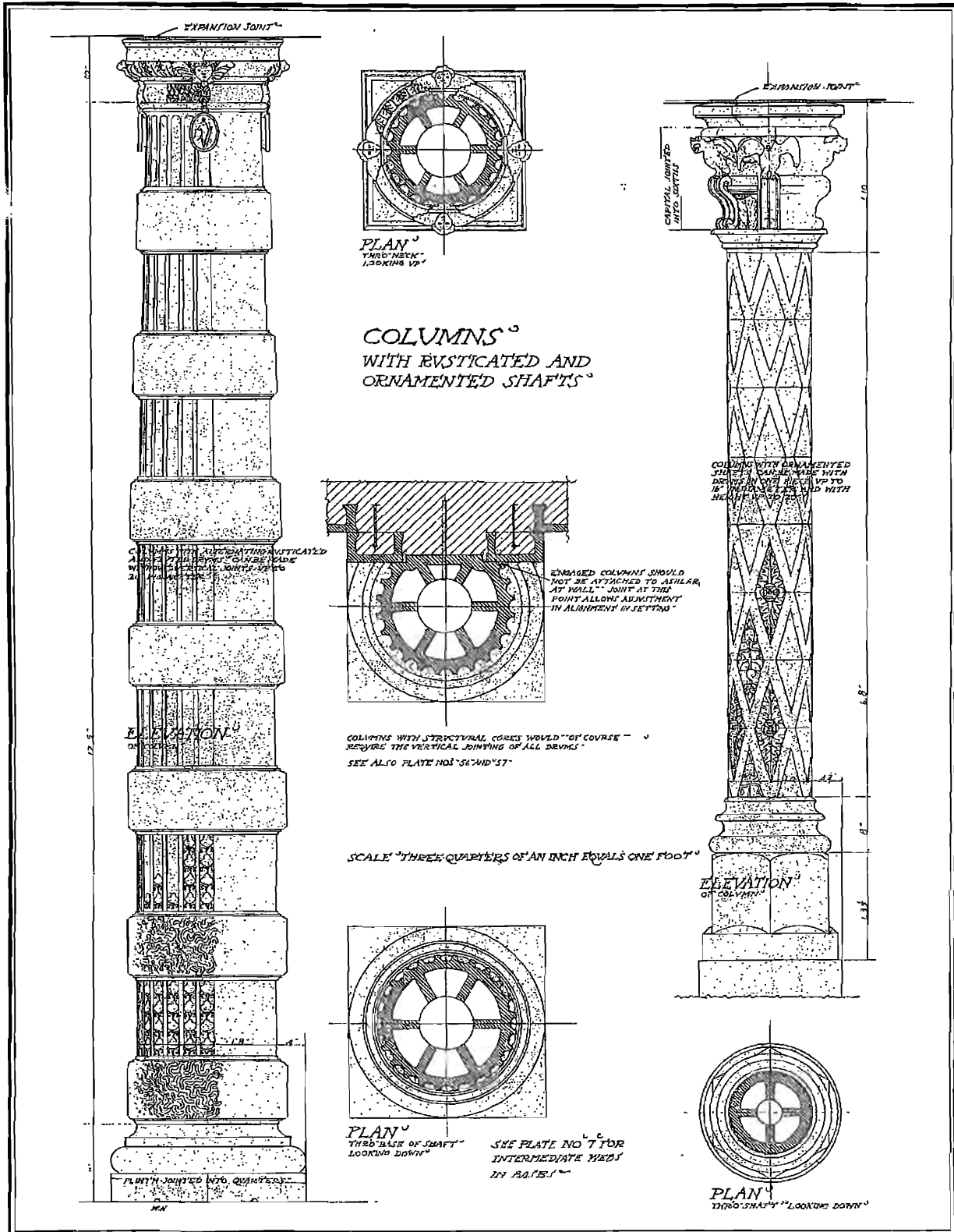
THE MOLDDED CORNERS OF LARGE COLUMNS SHOULD BE JOINED SEPARATELY.

SEE PLATE NO 1 FOR INTERMEDIATE NEEDS IN BASES.

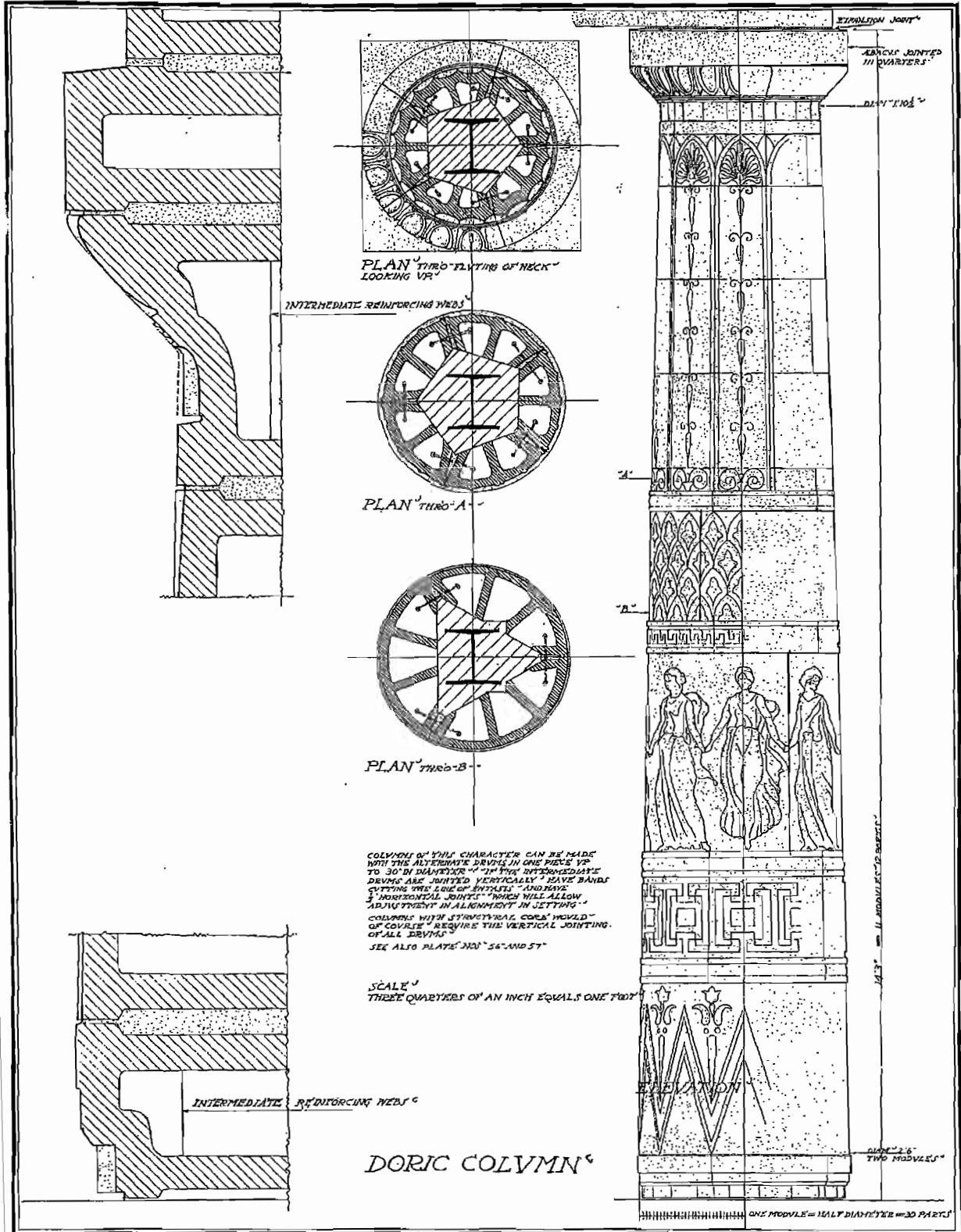
ELEVATION³
BASE OF COLUMN³

SCALE " ONE-QUARTER OF AN INCH EQUALS ONE FOOT "

▲ ▲ ▲ ▲ TERRA COTTA ▲ ▲ STANDARD CONSTRUCTION ▲ ▲ ▲ ▲



TERRA COTTA STANDARD CONSTRUCTION



PLAN thro' FLATTING OF NECK LOOKING UP

INTERMEDIATE REINFORCING WEBS

PLAN thro' A-A

PLAN thro' B-B

COLUMNS OF THIS CHARACTER CAN BE MADE WITH THE ALTERNATE DRUMS IN ONE PIECE UP TO 30" IN DIAMETER. IF THE INTERMEDIATE DRUMS ARE JOINED VERTICALLY, HAVE BANDS CUTTING THE EDGE OF ENTABLATURE AND HAVE 2 HORIZONTAL JOINTS WHICH WILL ALLOW ADJUSTMENT IN ALIGNMENT IN SETTING. COLUMNS WITH STRUCTURAL CORE WOULD OF COURSE REQUIRE THE VERTICAL JOINTING OF ALL DRUMS. SEE ALSO PLATE NOS 56 AND 57.

SCALE: THREE QUARTERS OF AN INCH EQUALS ONE FOOT

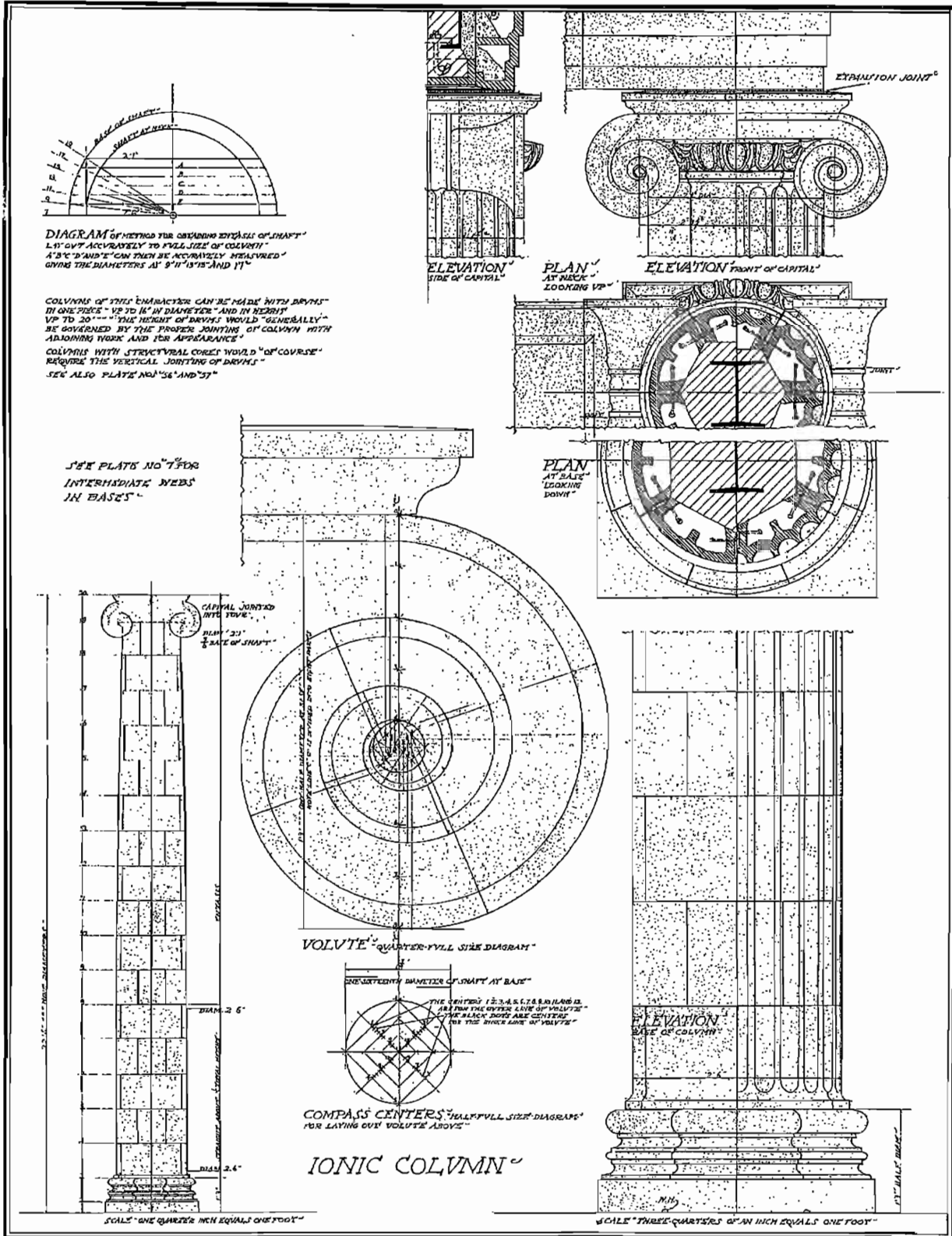
INTERMEDIATE REINFORCING WEBS

DORIC COLUMN

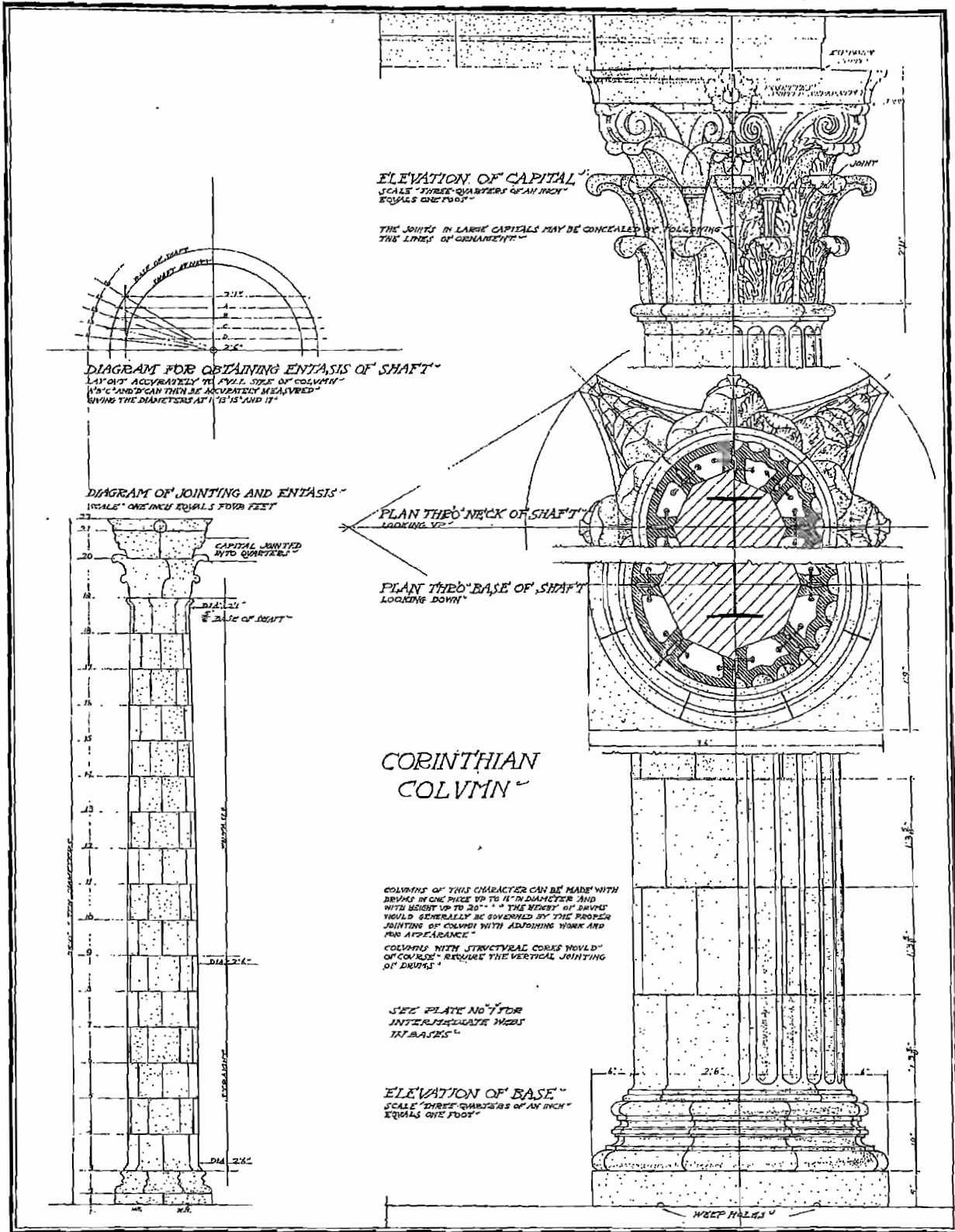
ELEVATION

ONE MODULE = HALF DIAMETER = 30 PARTS

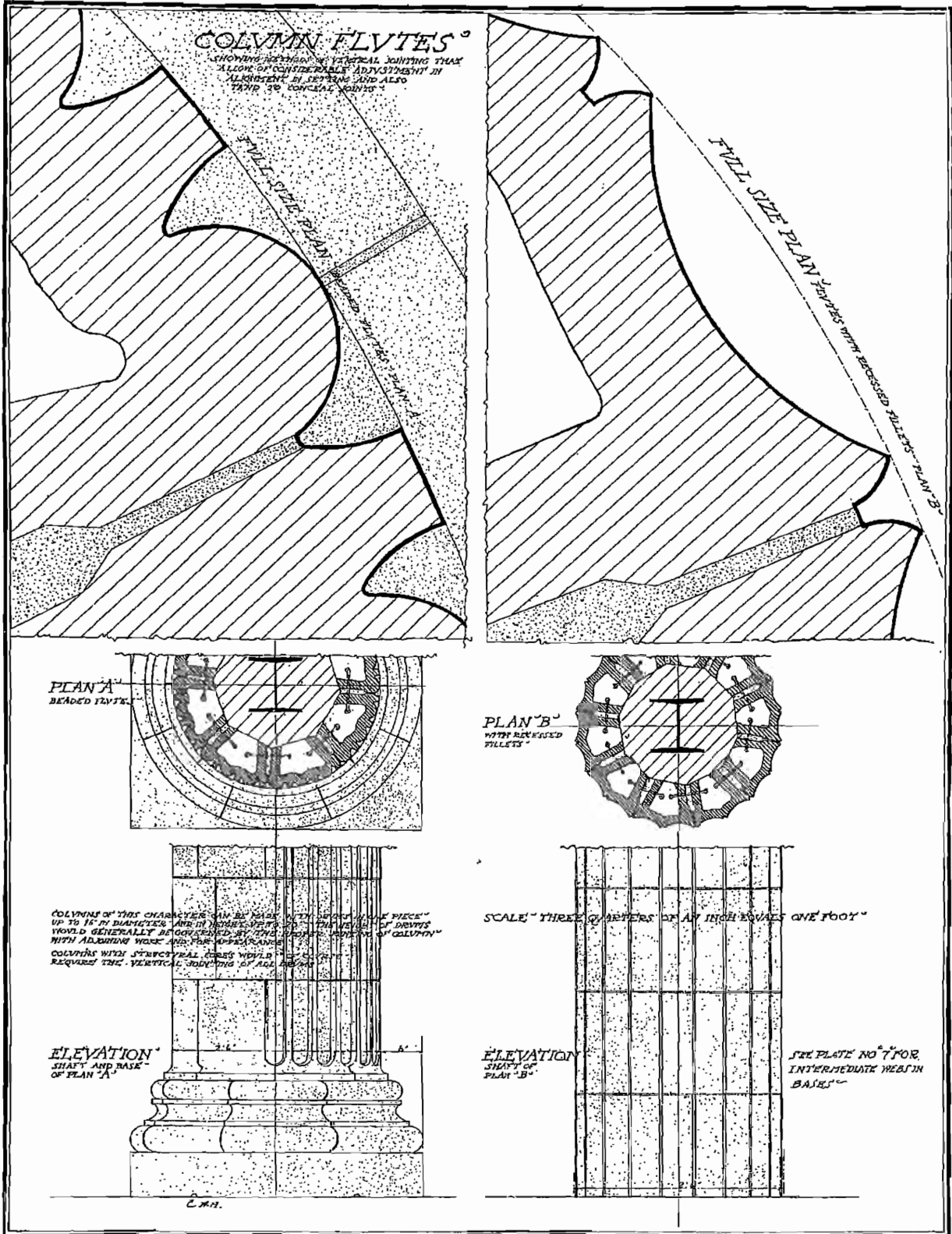
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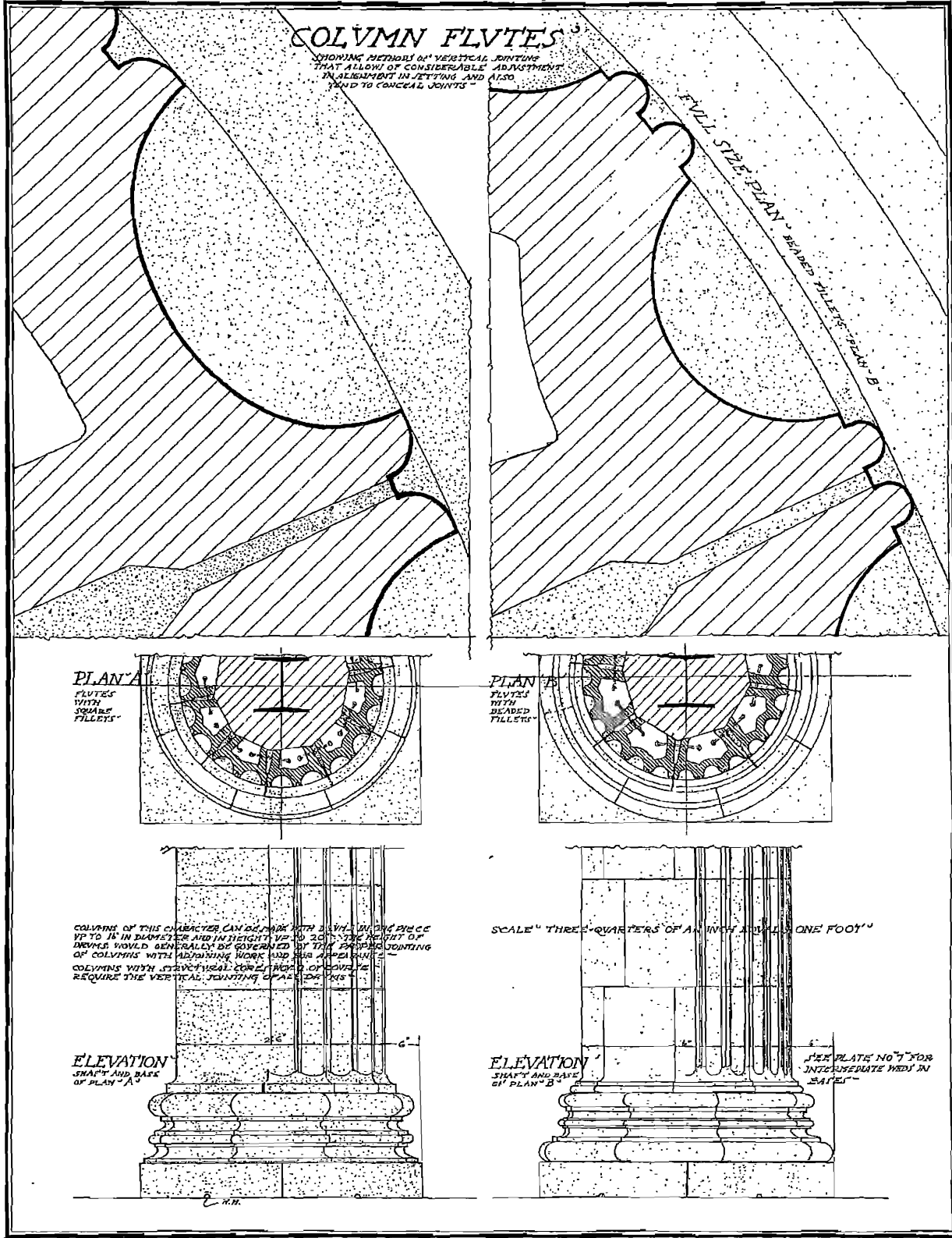
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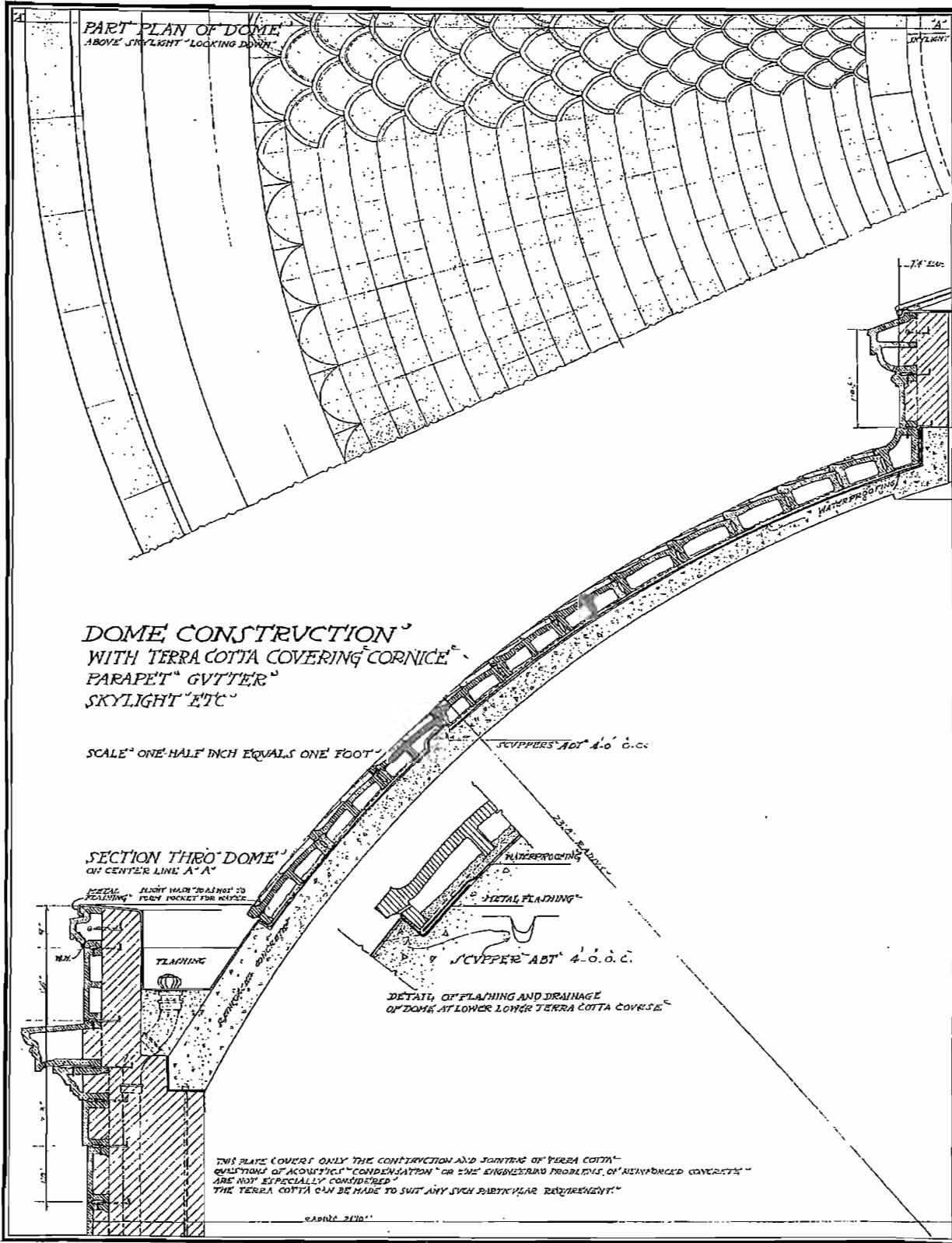
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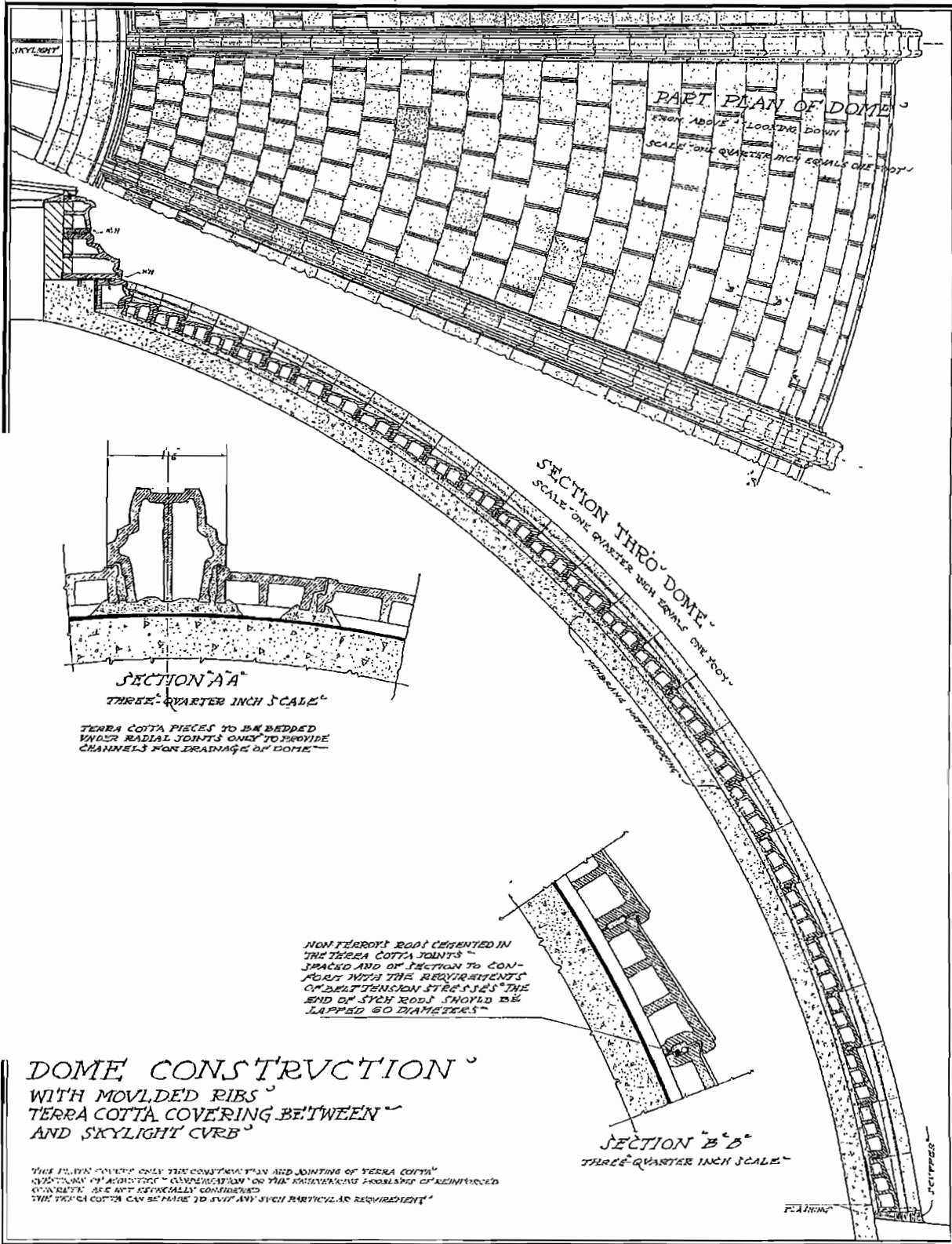
TERRA COTTA STANDARD CONSTRUCTION



TERRA COTTA STANDARD CONSTRUCTION



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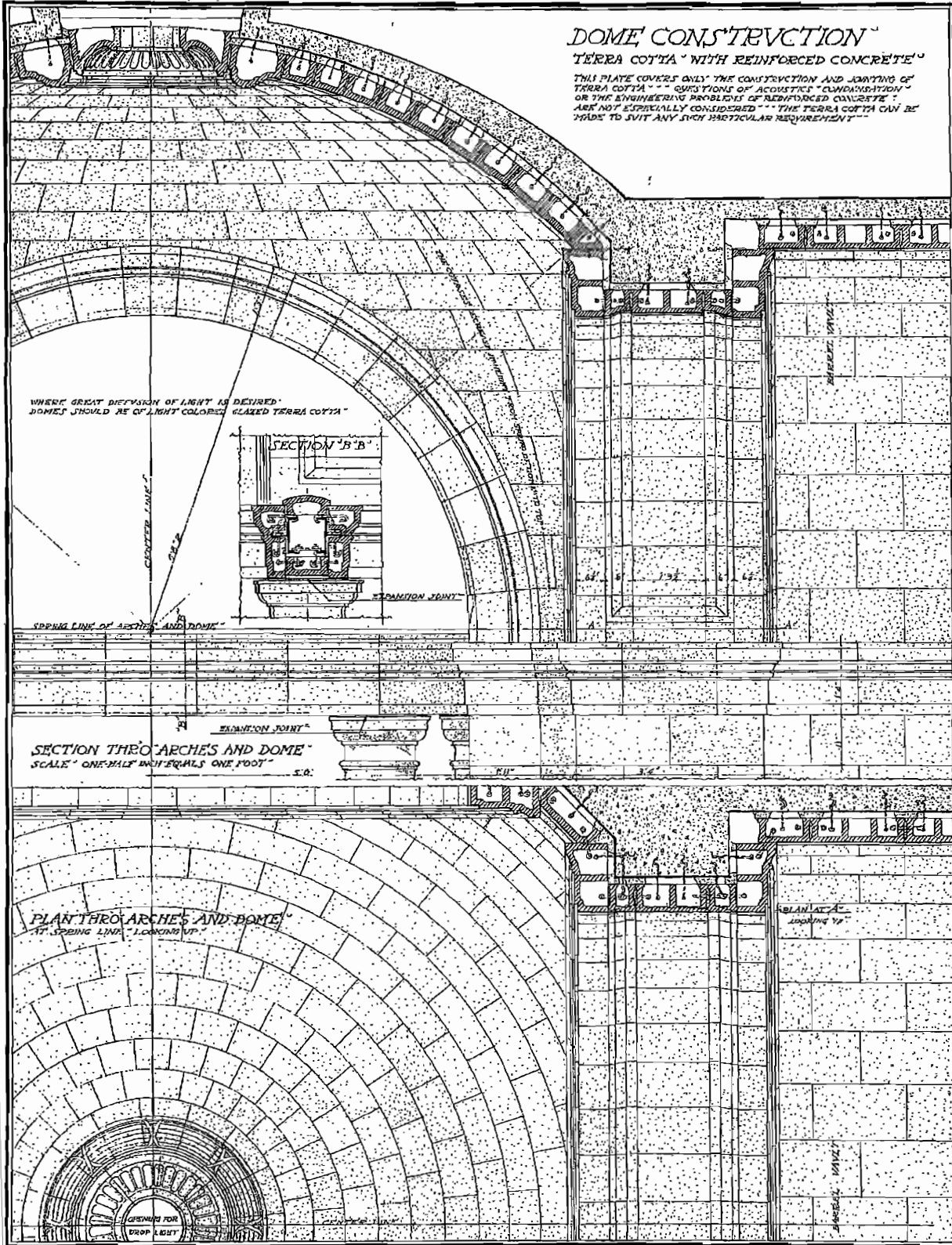


TERRA COTTA STANDARD CONSTRUCTION

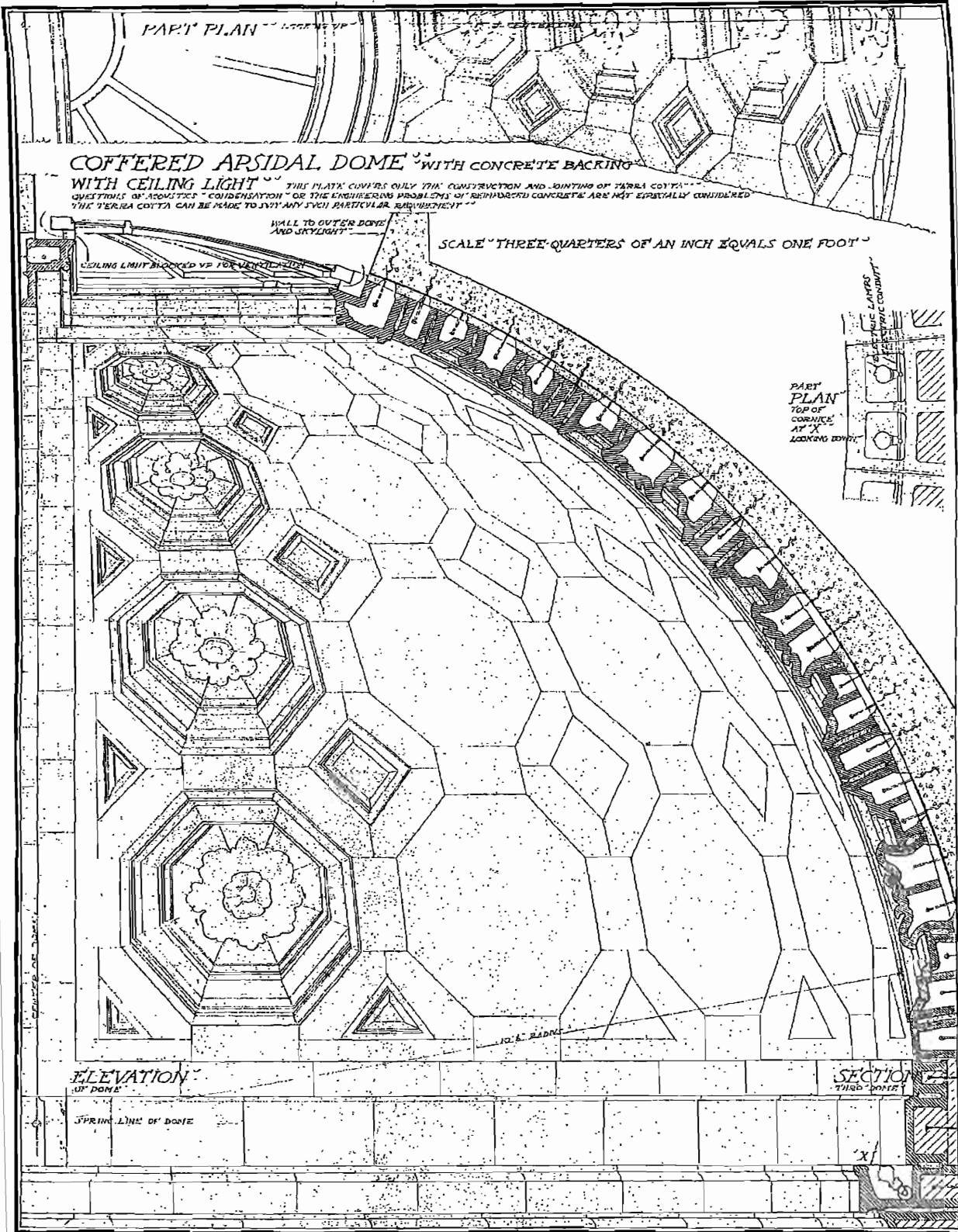
DOME CONSTRUCTION

TERRA COTTA WITH REINFORCED CONCRETE

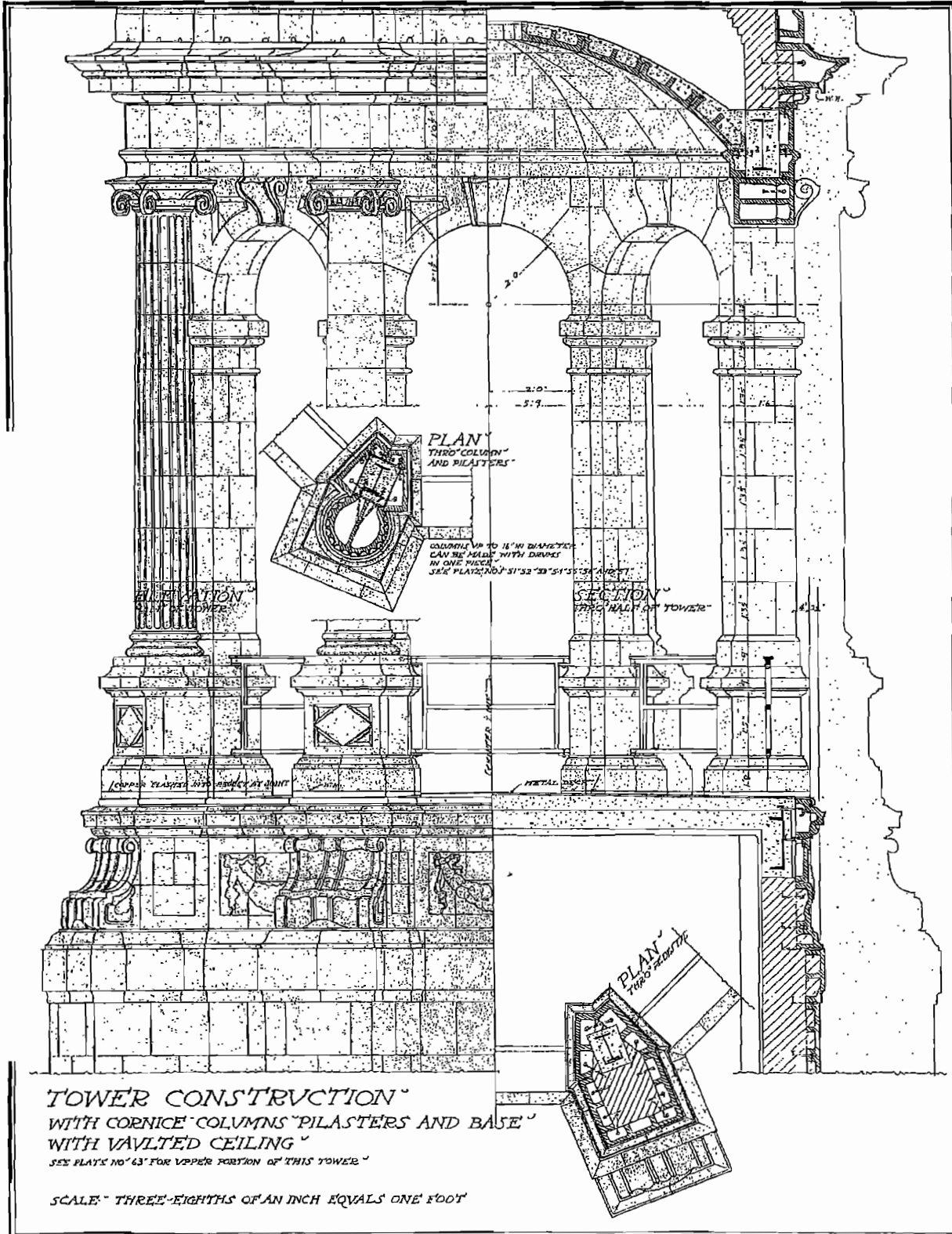
THIS PLATE COVERS ONLY THE CONSTRUCTION AND JOINTING OF TERRA COTTA... QUESTIONS OF ACOUSTICS... CLIMATIZATION... OR THE ENGINEERING PROBLEMS OF REINFORCED CONCRETE... ARE NOT ESPECIALLY CONSIDERED... THE TERRA COTTA CAN BE MADE TO SUIT ANY SUCH PARTICULAR REQUIREMENT...



TERRA COTTA STANDARD CONSTRUCTION



▲ ▲ ▲ TERRA COTTA STANDARD CONSTRUCTION ▲ ▲ ▲

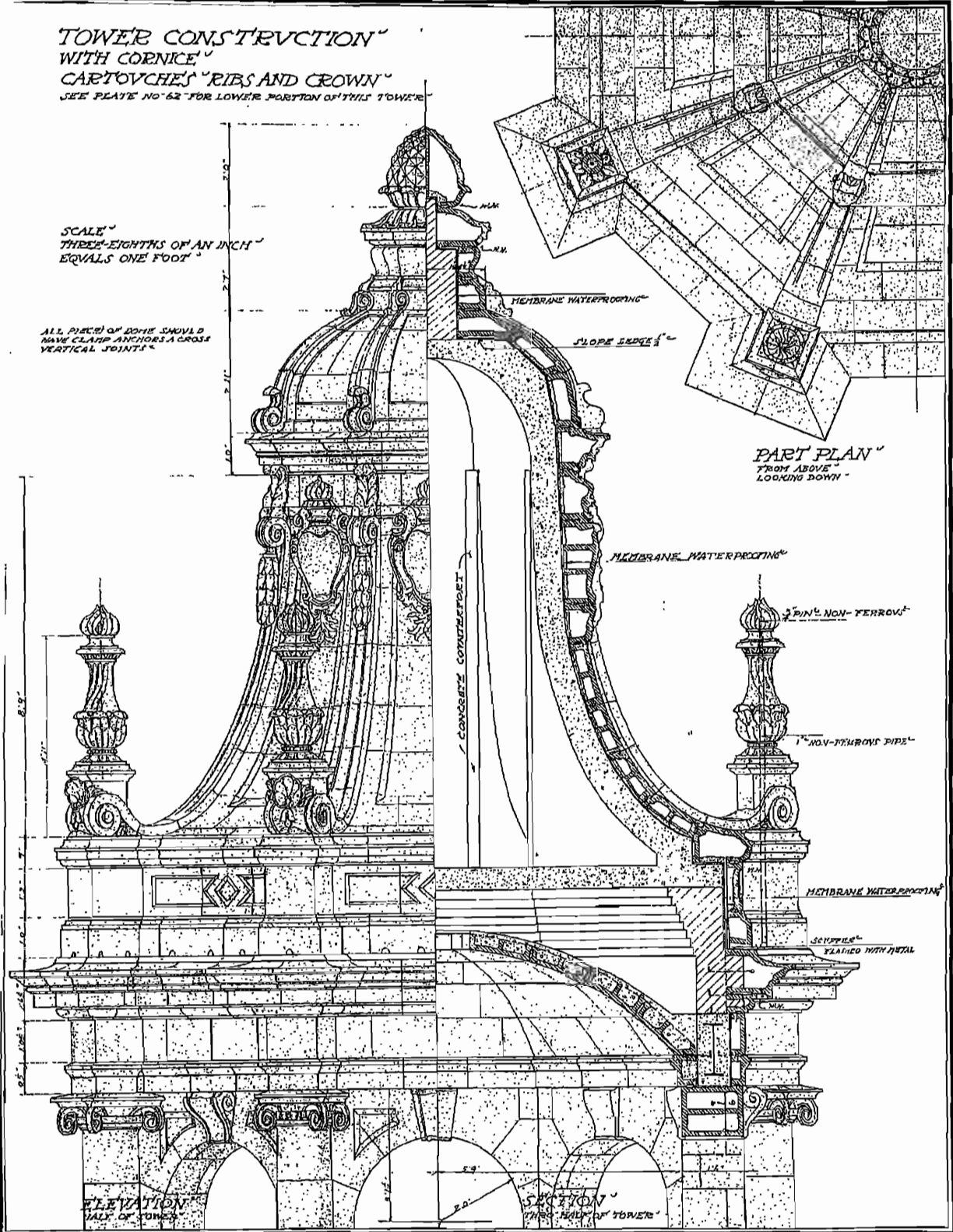


TERRA COTTA STANDARD CONSTRUCTION

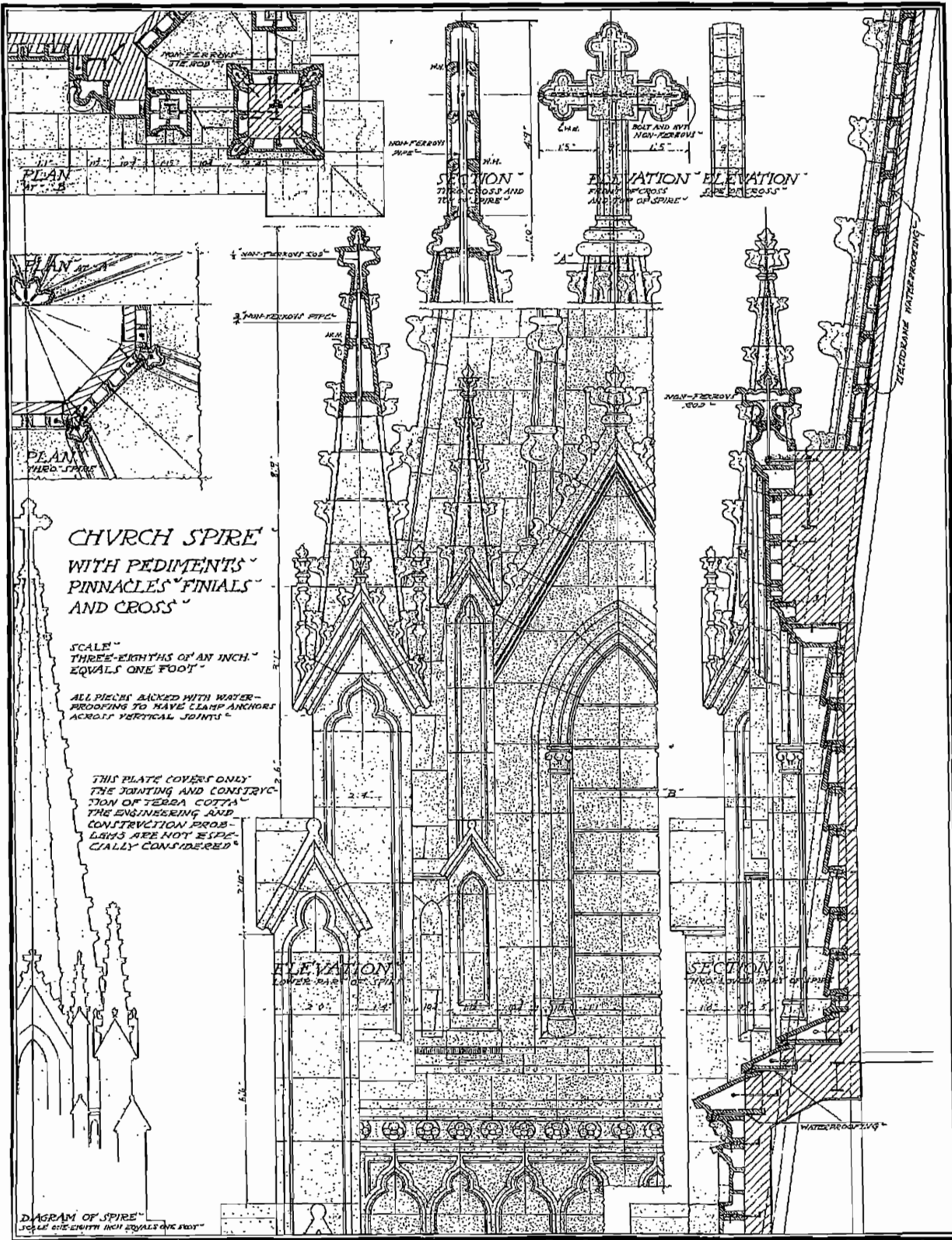
TOWER CONSTRUCTION WITH CORNICE CARTOVCHES RIBS AND CROWN SEE PLATE NO 62 FOR LOWER PORTION OF THIS TOWER

SCALE THREE EIGHTHS OF AN INCH EQUALS ONE FOOT

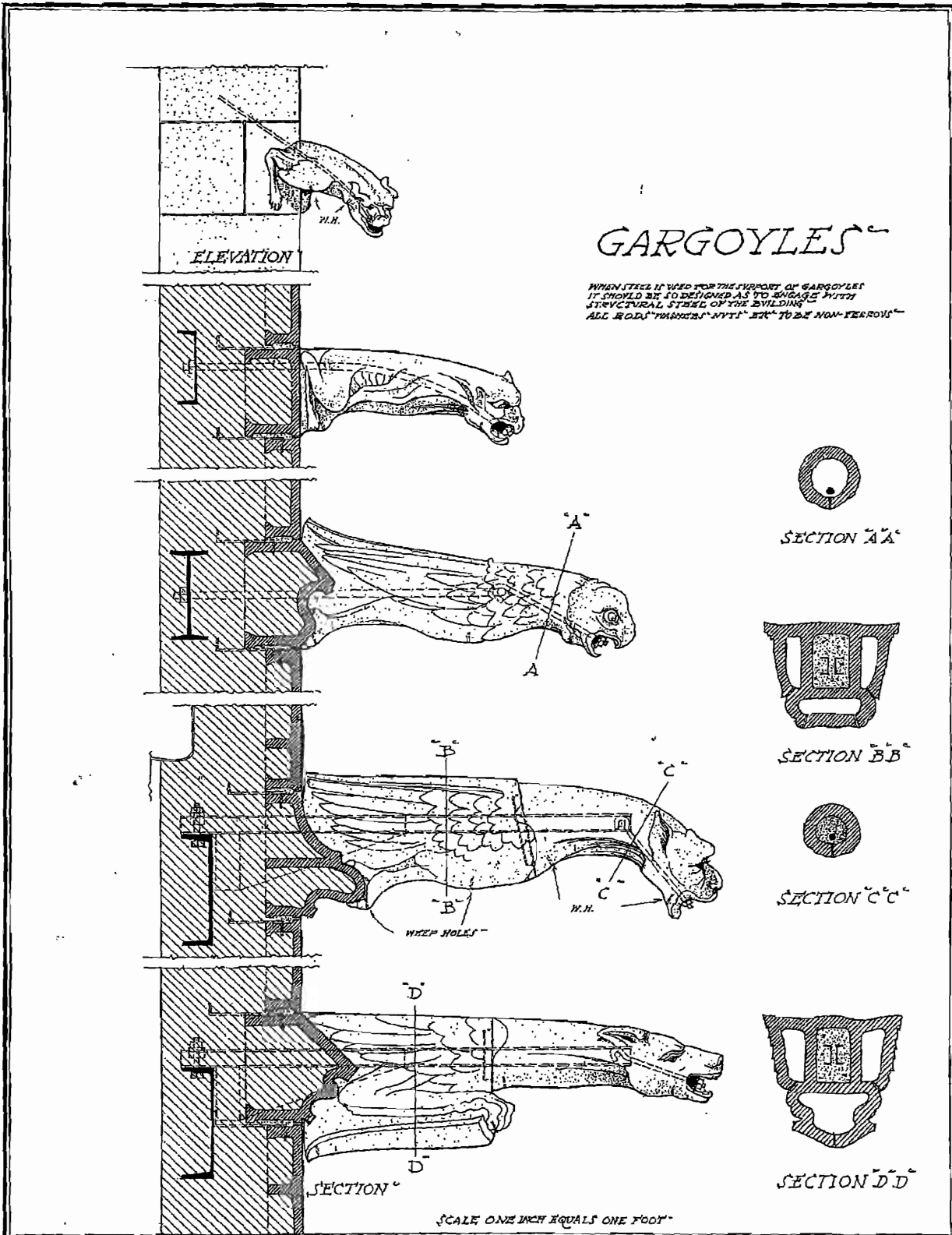
ALL PIECES OF DOME SHOULD HAVE CLAMP ANCHORS A CROSS VERTICAL JOINTS



TERRA COTTA STANDARD CONSTRUCTION



TERRA COTTA STANDARD CONSTRUCTION

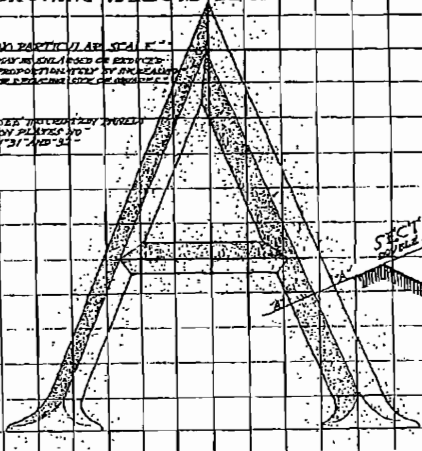


TERRA COTTA STANDARD CONSTRUCTION

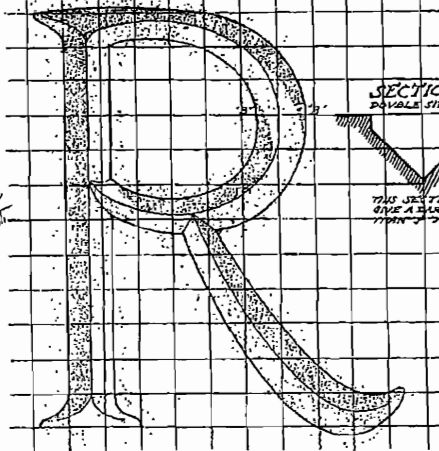
LETTERING
SHOWING VARIOUS SECTIONS " BOTH INCISED AND RAISED "

NO PARTICULAR SCALE
MAY BE OBTAINED OR REPRODUCED
WITHOUT PERMISSION BY ARCHITECTS
OR ENGINEERS FROM THE SOCIETY

ALL DIMENSIONS BY
BY PLAYER NO
"31" AND "32"

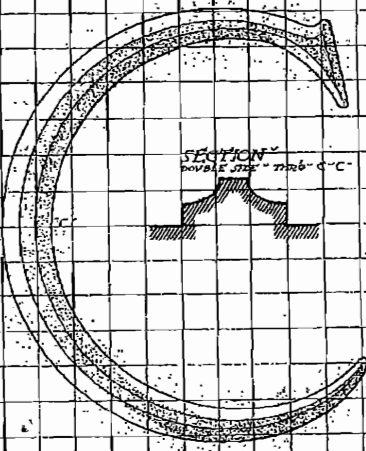


SECTION
DOUBLE SIZE THIRD "A-A"

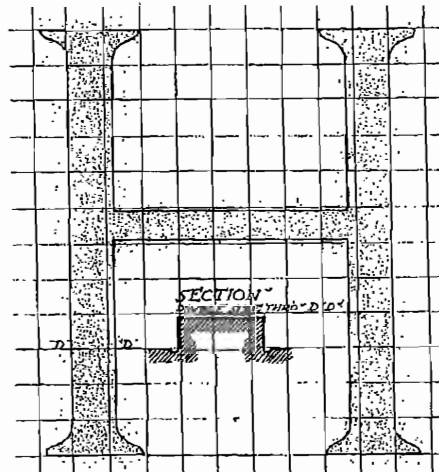


SECTION
DOUBLE SIZE THIRD "B-B"

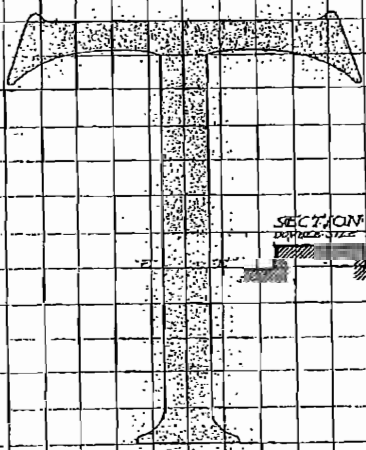
THIS SECTION WILL
GIVE A DARKER SHADOW
THAN "A"



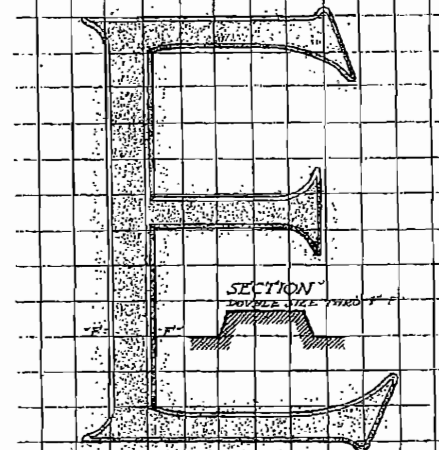
SECTION
DOUBLE SIZE THIRD "C-C"



SECTION
DOUBLE SIZE THIRD "D-D"



SECTION
DOUBLE SIZE THIRD "E-E"

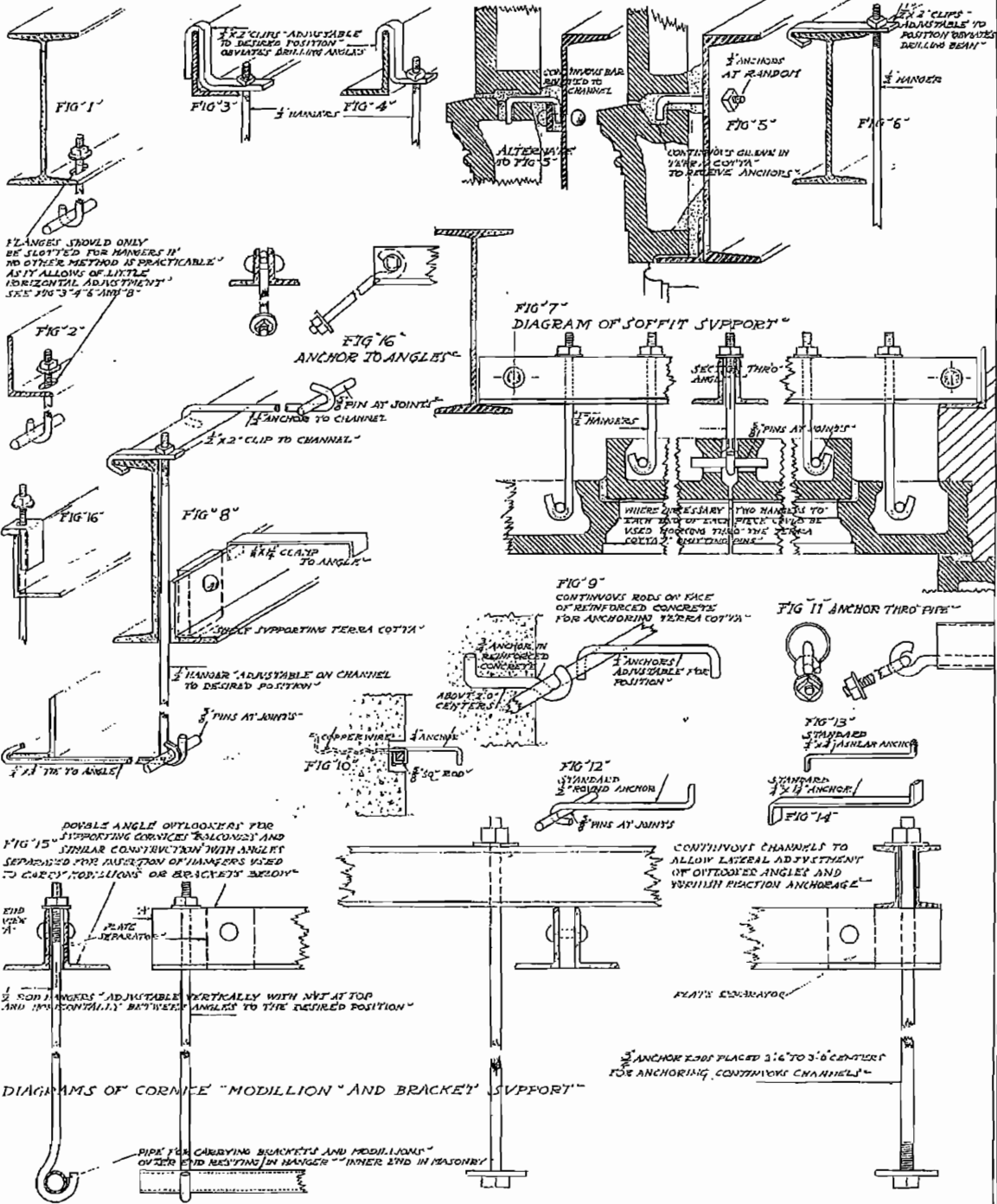


SECTION
DOUBLE SIZE THIRD "F-F"

TERRA COTTA STANDARD CONSTRUCTION

DETAILS OF ANCHORS HANGERS STRAPS CLAMPS ETC USED IN SETTING TERRA COTTA

STRUCTURAL STEEL WHEN ERECTED FREQUENTLY VARIES FROM EXACT FIGURED DIMENSIONS FOR THIS REASON ALL SUPPORTS FOR TERRA COTTA INCLUDING ANGLES ROBS ANCHORS ETC SHOULD BE DESIGNED SO AS TO PERMIT OF EASY ADJUSTMENT TO THE REASONABLE REQUIREMENTS OF CONSTRUCTION WHEN THE MATERIAL IS BEING SET



▲ ▲ ▲ ▲ **TERRA COTTA** ▲ ▲ **STANDARD CONSTRUCTION** ▲ ▲ ▲ ▲

Standard Specification

for the

Manufacture, Furnishing and Setting of Terra Cotta

Adopted by NATIONAL TERRA COTTA SOCIETY

NOTE—The Architect or Specification Writer will find it convenient to follow the Short Form Specification beginning with Section 63.

The Short Form incorporates all the provisions of the Standard Terra Cotta Specification, but eliminates the necessity of mentioning them in detail.

Reference to the Glossary, Sections 50-62, will supply the surface finish, ceramic finish, and color data necessary to specify surface and color correctly.

The Corollary Clauses, Sections 85, 86, explain the setting option between mason and manufacturer.

Sections 87-91 under Corollary Clauses explain the specifications for flashing, sheet metal, structural steel, structural concrete and rough carpentry. These specifications form a part of the Terra Cotta Specifications, although the materials are supplied and set in place by different contracting parties.

A—GENERAL INFORMATION

Drawings and Schedules

1. The Terra Cotta manufacturer shall be furnished with all drawings, details and other information necessary for the manufacture of Terra Cotta, including drawings for all classes of work with which the Terra Cotta engages.
2. Wherever Terra Cotta is required to match in contour, color, finish and surface treatment, existing Terra Cotta, as for example in connection with alterations or additions to existing work, the Terra Cotta manufacturer shall be furnished with the required profiles and samples of the original work, and other needed information.
3. The Terra Cotta manufacturer shall, before proceeding with manufacture, submit to the architect for his correction and approval, shop drawings showing jointing and construction of the Terra Cotta and provision made for all flashing and counter flashing. These drawings must conform as nearly as practicable to the architect's drawings, but shall be in accordance with good Terra Cotta structural practice.
4. All pieces of Terra Cotta shall be numbered. The Terra Cotta manufacturer shall provide two copies of the completed scale shop drawings to be used for setting and showing the piece numbering of the Terra Cotta, and the size of the joints to be used for setting the various portions of the work clearly indicated. These drawings shall be designated as the setting drawings.
5. The Terra Cotta manufacturer shall furnish, as promptly as possible, a schedule of all special anchors, hangers, etc., necessary to secure and support the Terra Cotta in a manner approved by the architect.

B—MATERIAL

Quality Tests

6. **Note**—In view of the researches now being conducted by the National Bureau of Standards at the instance of the National Terra Cotta Society, it seems inadvisable to attempt, at this time, to write either quality clauses in terms of crushing strengths, densities and elasticity, or specifications for tests. Clauses descriptive of the desirable physical characteristics and of tests to prove compliance of the material with such physical requirements will be prepared as soon as the necessary data are available and inserted in a later edition of this standard specification.

Modeling

7. All ornament shall be artistically modeled by the Terra Cotta manufacturer's staff artists. (Or, models made to Terra Cotta shrinkage scale will be furnished to Terra Cotta manufacturer, without cost to him, securely crated for shipment f. o. b. modelers' studio at).
8. Photographs in duplicate of all ornament shall be submitted to the architect for his approval or correction, or, if he so desires, he may inspect all modeling at the factory. Such approval or inspection by the architect shall be made promptly. No ornamental work shall be burned until modeling has been approved.

Surface Finish, Ceramic Finish and Color

9. The surface finish, ceramic finish and color of all exposed surfaces of Terra Cotta shall be as indicated by the architect's drawings or as specified. For surface and ceramic treatments, see Glossary of Terms relating to Terra Cotta, which is hereby made a part of this specification.
10. The ceramic finish shall be applied to the Terra Cotta in such a manner as thoroughly to coat the exposed surfaces.

Samples

11. The Terra Cotta manufacturer shall submit samples of the color or colors of the ceramic finish to the architect for his approval, and all Terra Cotta shall conform without marked variation to the sample or samples approved.

NATIONAL TERRA COTTA SOCIETY V.S.A SPECIFICATION

▲ ▲ ▲ ▲ **TERRA COTTA** ▲ ▲ **STANDARD CONSTRUCTION** ▲ ▲ ▲ ▲

C—DESIGN AND STRUCTURE

- 12. *Ends, Walls and Partitions* Walls shall not be less than one inch thick and partitions shall be of such thickness and so spaced as to perform their proper functions with regard to form and structure. Each piece of Terra Cotta shall be provided with the necessary anchor holes and hand holes and shall be so formed as properly to engage the structure. Beds generally shall be not less than 4" deep.
- 13. *Washes, Weep Holes and Drips* Projecting courses, cornices and heavy ornamental detail may have washes, drips and weep holes, where shown on the approved shop drawings.
- 14. *Preparation for Flashing* Where so shown the washes of all projecting cornices and other exposed horizontal surfaces shall have provision made for flashing. All surfaces where the wash pitches inward toward the structure and stops against superimposed work; all balcony floors, and all gutter grades shall have provision made for flashing.
- 15. Raggles shall be provided to receive gutter linings and flashings when the joints cannot be used for the purpose. Raggles shall be not less than 3/4" deep.
- 16. All capping courses, copings and sills except of the "slip" type, shall have stools and lugs at intersections with vertical surfaces.
- 17. *Joints* All joints shall be straight and true and of an approximate uniform width of 1/4". All Terra Cotta shall be laid out at the factory to test it for uniformity of joint widths and over-all dimensions. Where necessary to secure accurate dimensions and uniform joint widths, the material shall be sized straight and true.

D—TRANSPORTATION, STORAGE AND PROTECTION

- 18. *Shipment, Delivery and Care* Unless otherwise specifically agreed, all Terra Cotta shall be furnished by the manufacturer f. o. b. cars factory, with freight allowed to destination. All Terra Cotta shall be carefully packed in hay, straw, excelsior or other suitable material.
- 19. *Replacements* If any pieces of Terra Cotta are damaged in transit, the manufacturer shall be immediately notified in writing by the setting contractor and proceed with the remaking of the pieces. The responsibility for the cost of such replacements shall be determined by the point of delivery fixed by the contract under which the Terra Cotta is delivered. If the point of delivery is beyond the immediate control of the manufacturer, the setting contractor shall assume responsibility for the necessary proof of damage.

E—ERECTION

- 20. *Handling* The setting contractor shall receive the Terra Cotta on arrival at the freight yards and shall transfer it without damage from the cars to the building. When the Terra Cotta manufacturer delivers on trucks at the building the setting contractor shall unload and store the Terra Cotta. Terra Cotta shall be stored under cover, not in contact with the ground, stacked without inflammable packing on wood laths or strips, so as to protect it from injury.
- 21. *Mechanics* All Terra Cotta shall be set by mechanics experienced in the handling and setting of the material.
- 22. *Cutting and Fitting at the Building* Notice of errors in the manufacture of the Terra Cotta shall be given to the manufacturer immediately upon discovery. Cutting or fitting due to such errors shall be done by the Terra Cotta manufacturer or shall be paid for by him if he fails to do the necessary cutting or fitting promptly upon receipt of notice.
- 23. Other necessary cutting and fitting of the Terra Cotta that may be required at the building, including all fitting around anchors, steel and iron work and reinforced concrete, shall be done by the contractor for setting Terra Cotta.
- 24. *Supporting Metal Work and Anchors* *In Connection with Structural Steel:* Beams, channels, angles, T's, plates and fabricated members for supporting Terra Cotta and which are not secured to the structural steel by rivets or short bolts, as shown on the architect's drawings, together with all anchors, hangers, bolts, clips, straps, rods and pins for securing Terra Cotta, shall be furnished and set by the contractor for setting Terra Cotta.
- 25. *In Connection with Structural Concrete:* The contractor for structural concrete shall furnish and set all supporting metal work imbedded in the concrete and all steel angles and continuous rods. All such metal work shall conform to the requirements of the setting drawings prepared by the Terra Cotta manufacturer.
- 26. All other loose iron such as clamps, hangers, clips, straps, and pins shall be furnished and set by the Contractor for setting Terra Cotta.
- 27. All anchors, hangers, bolts, clips, straps, rods and pins for securing Terra Cotta shall be of wrought iron or non-corroding soft steel.
- 28. Anchors, hangers, bolts, clips, straps, rods and pins for securing the Terra Cotta, except where otherwise shown or specified, shall be of the following minimum sizes:

▲ ▲ ▲ ▲ TERRA COTTA ▲ ▲ STANDARD CONSTRUCTION ▲ ▲ ▲ ▲

- 29. Anchors:—(a) For ashlar or courses balanced on the wall, shall be $\frac{1}{4}'' \times \frac{1}{4}''$ or $\frac{1}{8}'' \times \frac{5}{8}''$, or No. 6 gauge galvanized wire.
- 30. (b) For projecting courses not balanced on the wall, shall be not less than $\frac{5}{8}''$ round or square bars of equal cross section.
- 31. Hangers shall be $\frac{5}{8}''$ diameter round bars or other shapes of equal cross section area.
- 32. Clips and straps shall be $\frac{3}{8}'' \times 2''$.
- 33. Pins shall be $\frac{1}{2}''$ diameter round bars.
- 34. Continuous rods on concrete wall faces to which Terra Cotta ashlar is clipped, shall be $\frac{5}{8}''$ diameter round bars which shall be secured to the masonry with $\frac{1}{2}''$ diameter round anchors placed not more than 2' 0" on centers.
- 35. All steel or iron supporting metal work shall be clean and thoroughly protected with two coats of pure red lead and linseed oil paint, asphaltum applied hot, or other approved protective compound.

Protection of Supporting Metal Work

- 36. Metal work of every description, supporting Terra Cotta, shall be imbedded thoroughly in the masonry backing and when not so imbedded, metal work shall be protected against corrosion by encasing with cement mortar or in cement mortar masonry.
- 37. When the back of a Terra Cotta course comes in contact with iron or structural concrete in such manner as to prevent the encasing of supporting iron from the rear, an opening shall be made in the top to admit of the placing of the encasing mortar as required above.

Mortar

- 38. All cement used for setting mortar shall be of a standard brand of Portland cement fulfilling the requirements both physical and chemical of the standard specifications for Portland cement adopted by the American Society for Testing Materials.
- 39. All sand used for setting mortar shall be clean, sharp and well graded in size.
- 40. All mortar for setting and pointing shall be composed of one volume of Portland cement to three volumes of sand. Hydrated lime, not to exceed 9 pounds to the sack of cement, shall be added.
- 41. The sand and cement and lime, if any, shall be thoroughly mixed dry before any water is added. The use of retempered mortar shall not be permitted.

Setting

- 42. All Terra Cotta shall be set true to a line and carefully laid in a solid bed of mortar. All rebates in bed and cross joints from front to back and top to bottom, shall be filled solid with mortar leaving no voids. Each piece of Terra Cotta shall be tamped into place, excess mortar cut off and struck with a jointer or trowel. All sills, wall copings and other capping courses, shall be set in a thick bed of mortar and well pounded down so that the mortar fills all spaces around bottom of webs of Terra Cotta.
- 43. All Terra Cotta projecting courses shall be so set that the arris casting a shadow shall be true to line.
- 44. When the Terra Cotta work is of such scope or character that the proper handling and setting of the Terra Cotta require special skill and knowledge, the Terra Cotta manufacturer shall, if required by the contract, furnish a competent Terra Cotta setter to assist in the sorting, selecting and handling of the Terra Cotta, to co-operate with the setting contractor, to assist him when cutting or fitting of the Terra Cotta is necessary, to advise as to interpretation of setting drawings and to help generally in securing rapid, efficient progress during the setting of the Terra Cotta. For such service the setting contractor shall pay such setter full time at his regular wage rate. When the furnishing of such a competent setter involves traveling expenses, the setting contractor shall pay the same and also make an allowance for his board.
- 45. When the services of such a competent setter are not required under the contract, the Terra Cotta manufacturer may, at his own option and expense, send such a representative to the work who shall perform the above services, and the setting contractor shall co-operate with and aid and facilitate the performance of such services by such representative.

Pointing

- 46. All joints in Terra Cotta shall be pointed and struck as the setting progresses except in freezing weather. In freezing weather and when re-pointing is necessary, all joints shall be raked or cut out to a depth of $\frac{1}{2}''$ and the pointing mortar driven into the joint and struck with a jointing tool.
- 47. All joints in overhanging Terra Cotta, balustrades, parapets and free standing features shall have joints raked out one-half ($\frac{1}{2}$) inch, and pointed with an approved elastic cement.

Protection

- 48. All uncompleted walls including Terra Cotta and backing shall be protected by waterproof covering at night and at any time when liable to injury from storms or freezing. (Note:—All other protection required for projecting courses, jambs of openings, etc., is provided for under the work of other trades.)

▲ ▲ ▲ ▲ TERRA COTTA ▲ ▲ STANDARD CONSTRUCTION ▲ ▲ ▲ ▲

Short Form Specification

for

The Manufacture, Furnishing and Selling of Terra Cotta

For Incorporation in the Architect's Specifications

To be used in connection with Standard Specifications and the Standard General Conditions of the American Institute of Architects.

63. (Note to architect:—The Standard Specification does not state who shall set the Terra Cotta, who shall provide wood centering, scaffolding, hoists, cover boards and protection (except tops of walls against weather). It does not include any cement or concrete work in connection with forming gutter grades and washes on projecting courses and features, or the furnishing or setting of sheet metal flashings and gutter linings. It does not include the furnishing and erection of metal supporting members which are riveted or bolted with short bolts to the structural steel or structural concrete. It requires the architect to show on his drawings the sizes and arrangement of rolled or fabricated structural shapes used for supporting Terra Cotta. (See notes on corollary clauses at end of this specification for the work of other trades to take care of such omissions.)

GENERAL CONDITIONS

- 64. The general conditions of the American Institute of Architects, Third Edition, shall form a part of this specification and contract and all work shall be subject to the provisions thereof.
- Work Included* 65. The work included in the contract comprises the manufacture, (and) delivery (and selling) of all Terra Cotta in accordance with the contract drawings and these specifications.
- 66. All (here insert a complete description of work) shall be of Terra Cotta.
- Work Not Included* 67. The following items are not included as a part of the contract for furnishing (and selling) Terra Cotta.
 - (a) Masonry backing. See specifications for (.....).
 - (b) The furnishing and erection of metal supporting members which are riveted or bolted with short bolts to the structural steel. See specifications for (.....).
 - (c) Cement or concrete grading for gutters, washes, floors, etc. See specifications for (.....).
 - (d) Furnishing and setting sheet metal. See specifications for (.....).

MATERIALS AND WORKMANSHIP

- 68. All Terra Cotta work under this contract, except as hereinafter specified, shall be executed in strict conformity with the Standard Specification for the Manufacture, Furnishing and Setting of Terra Cotta, adopted by the National Terra Cotta Society; which Standard Specification is hereby declared and made a part of this specification with the same force and effect as if written herein in full.
- Surface Finish, Ceramic Finish and Color* 69. All Terra Cotta (Note:—If several textures or finishes are to be used give location of each) shall be
 - 70. (1) *Unglazed:* Surface Finish of flat members shall be
 - (a) *Smooth.*
 - (b) *Tooled or Drove.*
 - (b1) Eight lines to the inch.
 - (b2) Six lines to the inch.
 - (c) *Light irregular drag or combing.*
 - (d) *Heavy irregular drag or combing.*
 - (e) *Special.* (Note:—Special surface finishes like "bush-hammered," "pitted," "vermiculated," etc., should be described.)
 - 71. The surface finishes of mouldings and curved surfaces generally shall be (Note:—Unless otherwise specified these surfaces are generally made smooth.)
 - 72. (2) *Unglazed Granite Colors:* Surface finishes of flat members generally shall be (a, b, c, d, e). The surface finish of mouldings and curved surfaces generally shall be (Note:—Unless otherwise specified these surfaces are generally made smooth.)
 - 73. (3) *Lustrous or Full Glazed or Enameled:* Surface finish shall be (Note:—Unless otherwise specified these surfaces are generally made smooth.)
 - 74. (4) *Mat or Dull Glazed or Enameled:* Surface finish shall be (See Note 3).

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- 75. (5) *Lustrous or Full Glazed or Enameled Granite*: Surface finish shall be (See Note 3).
- 76. (6) *Mat or Dull Glazed Enameled Granite*: Surface finish shall be (See Note 3).
- 77. The color of the Terra Cotta generally shall be (.....) as per approved sample or samples.
- 78. (7) The Terra Cotta comprising (....described here in detail....) shall be (two, three, four) color polychrome. Colors (....specify where....) shall be blended.
- 79. (8) The surface finishes of (....specify where....) shall be fire gilded with (mat or lustrous) gold glaze.
(Note:—Sections 1, 2, 3, 4, 5, 6, are alternates. If there is no polychrome work or no fire gilding omit sections 7 and 8. Sections a, b, c, d, e, are alternates for surface finish.)

Delivery 80. The Terra Cotta manufacturer shall furnish and deliver (f. o. b. cars factory with freight allowed to destination) (on trucks at the site of the building) (and set) all the Terra Cotta as indicated on the drawings or as here described.

Setting 81. All Terra Cotta shall be set by the (Terra Cotta manufacturer), (mason....). For such anchors and metal work as are to be furnished by the setting contractor see Standard Specification.

(Note to architect:—If the Terra Cotta manufacturer is to set his material include the following clause in the Terra Cotta specification. See also suggested clauses at end of this specification to take care of these omissions and for incorporation in the specifications for the work of other trades.)

82. "Hoisting service, storage space, setting mortar delivered on the scaffold, outside and inside scaffolds, runways and platforms, water, temporary light and removal of refuse, shall be furnished to the Terra Cotta manufacturer free of charge by the (....mason contractor....)."

Terra Cotta Seller (Note to architect:—If the work is of such scope or character that the proper handling and setting requires special skill, the following clause may be inserted: "The Terra Cotta manufacturer shall furnish at the expense of the setting contractor a competent Terra Cotta setter to assist in the sorting, selecting, handling and setting of the Terra Cotta.")

Joints 83. (The Standard Specification does not require any joints to be rubbed. If rubbed joints are to be required it should be so stated here.)

84. (The Standard Specification requires all joints to be approximately 1/4" wide. If joints of a different width are desired it should be so stated here.)

Suggestions for Corollary Clauses

85. 1.—If the Terra Cotta is to be set by the Terra Cotta manufacturer, a clause similar in purport to the following should be included in the general requirements relating to masonry or brick work:

86. "Terra Cotta will be furnished and set by the Terra Cotta manufacturer. Hoisting service, storage space, setting mortar delivered on the scaffold, outside and inside scaffolds, runways and platforms, water, temporary light and removal of refuse shall be furnished to the Terra Cotta manufacturer, free of charge, by the (mason contractor)." A provision should also be included to the effect that the (mason contractor) shall construct the brick (concrete) backing for the Terra Cotta and "The backing shall proceed simultaneously with the setting of Terra Cotta. Each piece of Terra Cotta shall be backed up solid with brick and mortar, so as to make a perfect bond and homogeneous mass between wall lines. This backing shall extend beyond the wall line when necessary to structural stability. If concrete is used it shall not be stronger than a 1 to 9 mixture." Also a provision under which the (mason) contractor shall place all concrete or cement grading for gutters, washes and balcony, loggia or other floors.

87. In the case of parapet walls specifications should state that flashing if used shall be carried through the wall, or if flashing be not used the back of the parapet wall shall be damp-proofed and the water-proofing carried through the wall.

88. 2.—In the specifications for sheet metal work there should be included a clause similar in purport to the following:

"The washes on all cornices and other exposed surfaces, where shown or specified, shall be covered with () which shall be turned up against vertical surfaces (cap flashed) and cemented into the raggles provided for the purpose in the Terra Cotta."

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89. 3.—Structural Supports.
Under "Structural Steel," a clause similar in purport to the following should be included:
"Beams, channels, angles, T's, plates and fabricated members for supporting Terra Cotta, and which are secured to the structural steel with short bolts or rivets, shall be furnished and erected by the contractor for (structural steel)."
90. Under "Structural Concrete" a clause similar in purport to the following should be included:
"Steel beams, channels, angles, T's, plates, fabricated brackets and outlookers and other members, bolts, rods, wires, anchors, and sleeves for supporting Terra Cotta, which are imbedded in the structural concrete, also shelf angles and continuous rods attached to structural concrete shall be furnished and set by the contractor for structural concrete, in strict accordance with setting drawings prepared by the Terra Cotta manufacturer."
(For information as to the sizes and character of bolts, rods, anchors, etc., see section E paragraphs 24 to 35 inclusive on "Supporting Metal Work and Anchors" of Standard Specification for the Manufacture, Furnishing and Setting of Terra Cotta. Such supports should be clearly shown on the drawings.)
91. 4.—Under "Rough Carpentry" or other suitable division of work, there should be included a clause providing that the contractor shall furnish, set and maintain all centering, cover boards, boxing and protection for Terra Cotta, and remove the same upon completion of the work.

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