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

SPECIAL NOTICE

It is a violation of the Professional License Law to alter any drawing in anyway, unless acting under the direction of a Licensed Professional Engineer. The altering consultant shall affix his/her seal and the notation “Altered” followed by his/her signature and date of alteration.

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

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John A.Fidler RIBA, IHBC, Intl Assoc AIA, FRICS, FSA, FIIC, FAPT, Principal of John Fidler: Preservation Technology in LosAngeles J 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.The late Prof Martin Weaver [Columbia University]. and all the other Engineers and Architects who have contributed to this bulletin.

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

CINTEC
REINFORCEMENT SYSTEMS

SECURING THE PAST FOR THE FUTURE


CINTEC
REINFORCEMENT SYSTEMS
Salient Points for use of Cintec Reinforcement Systems
CINTEC TERRA COTTA SOLUTIONS
Email: solutions@cintec.com
www.cintec.com

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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 Engineer of Record.

Salient Points for Use of Cintec Reinforcement Systems

Cintec's anchoring and reinforcement system "Presstec" grout is **CEMENTATIOUS.** This all natural, proprietary grout is of high strength with no additives and very good bond capacity (65 psi). See MSDS sheet Page 16.

Cintec's anchoring and reinforcement system can be **INSTALLED IN WET OR DUSTY CONDITIONS**. This is very important, as many sites do not provide "ideal" installation conditions with respect to moisture, dust presence or precision hole creation and the failure of the installer to create these ideal conditions may lead to anchoring failure with other systems. The presence of water or dust or even less than exact hole diameters is of no consequence – in fact, Cintec anchors and reinforcement can and have been successfully installed under water.

Cintec's anchoring and reinforcement system can only be **INSTALLED BY CINTEC TRAINED AND CERTIFIED** installers. As part of our quality control, extensive training of all installers is mandatory by Cintec personnel. Cintec product is only available to the project via Cintec Reinforcement Systems thus eliminating the possibility of contractors obtaining product independently and installing with less than qualified people.

Cintec's anchoring and reinforcement system has been **TESTED TO BE FIREPROOF.** A major and common application of Cintec anchors is for seismic upgrading and as such the fireproof characteristics of this product are critical. Often, earthquakes result in fire and any anchoring system not fireproof and resistant to high heat conditions could easily result in anchoring failure and possible human injury or death.

Cintec's anchoring and reinforcement system is **PULLOUT CAPACITY ENGINEERED** to required load capacity. All Cintec anchors and reinforcements are custom made and project specific to address required capacities. We do not use a "one size fits all" approach in selection and manufacturing of anchoring solutions. Please visit the engineering aid section following for extensive information and design criteria.

Cintec's anchoring and reinforcement system has been **TESTED TO 150 FREEZE/THAW CYCLES.** Public Works and Government Services Canada (PWGSC) commissioned and paid for thorough testing of Cintec product for Pull Out and Freeze Thaw by the University of Manitoba – Structural Department. As a result, Cintec product is "sole sourced" on many federal projects.

Cintec's anchoring and reinforcement system provides both **ADHESIVE AND MECHANICAL** attachment. Unlike other systems that offer only one or the other attachment system, Cintec's patented system provides adhesive attachment through it's grout bonding and mechanical through it's expandable sock system.

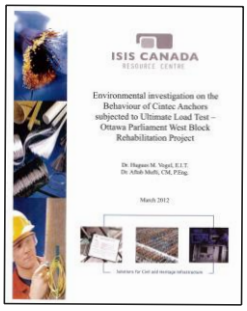
Cintec's anchoring and reinforcement system has been **TESTED TO RESIST SEISMIC** action. As stated earlier, seismic upgrading of structures – worldwide is a major and common application of the Cintec system.

Cintec's anchoring and reinforcement system **DOES NOT RESULT IN BRITTLE FAILURE.** Although very important, this factor is often overlooked in anchoring solutions. Simply stated, brittle failure is experienced in systems that hold… then fail. Cintec's progressive failure (by design) allows for release when critical loads are reached but not instant total failure. A rough analogy might be the difference between a blow out versus a slow leak in a car tire.

For more information see ENGINEERS GUIDE available at www.cintec.com

CINTEC - GENERAL SPECIFICATIONS

- ✓ Cintec's anchoring and reinforcement system "Presstec" grout is **CEMENTATIOUS**.
- ✓ Cintec's anchoring and reinforcement system can be **INSTALLED IN WET OR DUSTY CONDITIONS**.
- ✓ Cintec's anchoring and reinforcement system has been **TESTED TO BE FIREPROOF.**
- ✓ Cintec's anchoring and reinforcement system is **PULLOUT CAPACITY ENGINEERED** to required load capacity.
- ✓ Cintec's anchoring and reinforcement system has been **TESTED TO 150 FREEZE/THAW CYCLES.**
- ✓ Cintec's anchoring and reinforcement system provides both **ADHESIVE AND MECHANICAL** attachment.
- ✓ Cintec's anchoring and reinforcement system has been **TESTED TO RESIST SEISMIC** action.
- ✓ Cintec's anchoring and reinforcement system **DOES NOT RESULT IN BRITTLE FAILURE.**



The ISIS Canada Research Network (ISIS) was established in 1995 under the leadership of Dr. Sami Rizkalla to advance the civil engineering profession in Canada to a world leadership position through the use of advance composite materials and the application of structural health monitoring (SHM) to civil infrastructure, such as bridges. The Network—headquartered at the University of Manitoba—comprises 14 Canadian universities (five of them western), 30 principal investigators (engineering professors), 185 researchers and 50 to 75 government and industry partners.

Pull Out / Freeze Thaw Testing of Cintec Reinforcement System.

In 2012 Public Works and Government Services Canada (PWGSC) commissioned the ISIS Canada Research Network to extensively test the Cintec Reinforcement System as reassurance of the products suitability for use in it's seismic upgrades and restorative efforts with respect to its structures. Cover Left

The main objective of the study outlined by PWGSC was to evaluate the performance of Cintec anchors in a material similar to the one found in the outer wythe of the West Block building, while accounting for the influence of weather conditions in the Canadian climate. The objective translates into two major benchmarks for the program:

[1] **CONDITIONG** – subject the samples to weathering criteria listed in the relevant North American Standards with consideration for other international standards.
[2] **TESTING** – evaluating the pullout behaviour of anchors in both control and conditioned samples under static loads.

Successful test results were responsible for the following comments made by the testing principals.

"This ductile behaviour provided by the Cintec repair technique is strongly advantageous because it provides ample warning of impending failure while sustaining a surcharge comparable to the capacity of the anchor." **

"this damage is contained in the vicinity of the rod as well as at the top of the grouted hole. It does not extend towards the interface to affect the bond between the fabric sock and the stonework. The result underlines another advantage of the Cintec anchorage system for rehabilitating structures similar to the West Block building on Parliament Hill." **

"the Cintec rehabilitation technique is resilient despite the consideration of thermal weathering." **

** Dr Hugues M. Vogel, E.I.T & Dr. Aftab Mufti, CM, P.Eng.

CONSTRUCTING EXCELLENCE
bre

BRE is a world leading multi-disciplinary building science centre with a mission to improve the built environment through research and knowledge generation. Building a better world together.

Fire testing of Cintec's remedial cavity wall ties.

"In the latest test in our fire test rig with a static dead load on each tie of 1.3 kN 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." *

* R. C. de Vekey - Head of Masonry Structures Section, Structural Design Division, Geotechnics and Structural Group

JRC
EUROPEAN COMMISSION

JOINT RESEARCH CENTRE (JRC) is the European Commission's science and knowledge service which employs scientists to carry out research in order to provide independent scientific advice and support to EU policy. Located in Ispra, Northern Italy it is firmly established as one of Europe's leading research campuses.

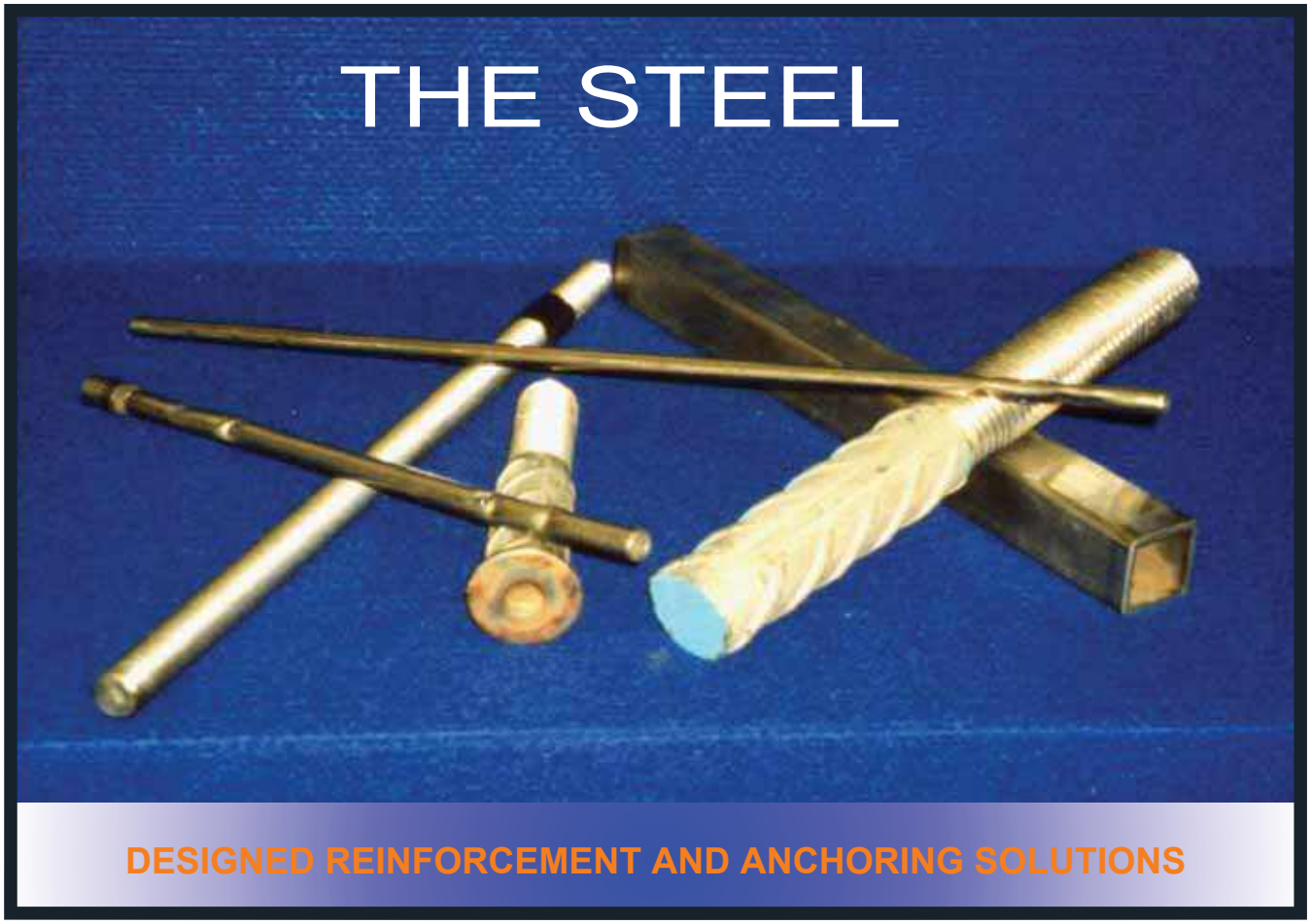
Seismic Testing of Cintec Reinforcement System.

Physical testing aimed specifically at seismic loading has taken place in the reaction wall laboratory of the Joint Research Centre in Italy.

Pseudo-dynamic and cyclic tests were carried out on a full-scale model of part of the cloisters of the São Vicente de Fora Monastery, in Lisbon - Portugal. The research was aimed at characterizing the non-linear behaviour of stone block structures under earthquake loading and also at assessing the effectiveness of retrofitting Cintec anchors.

The retrofitted model demonstrated that the continuous bond Cintec anchors performed far better than pre-compression ties.

It was apparent that observed cracking was 'better distributed' within the structure. The tests provided strong evidence for the 'applicability and effectiveness of such a kind of retrofitting in terms of deformation capacity and strength of the model.'

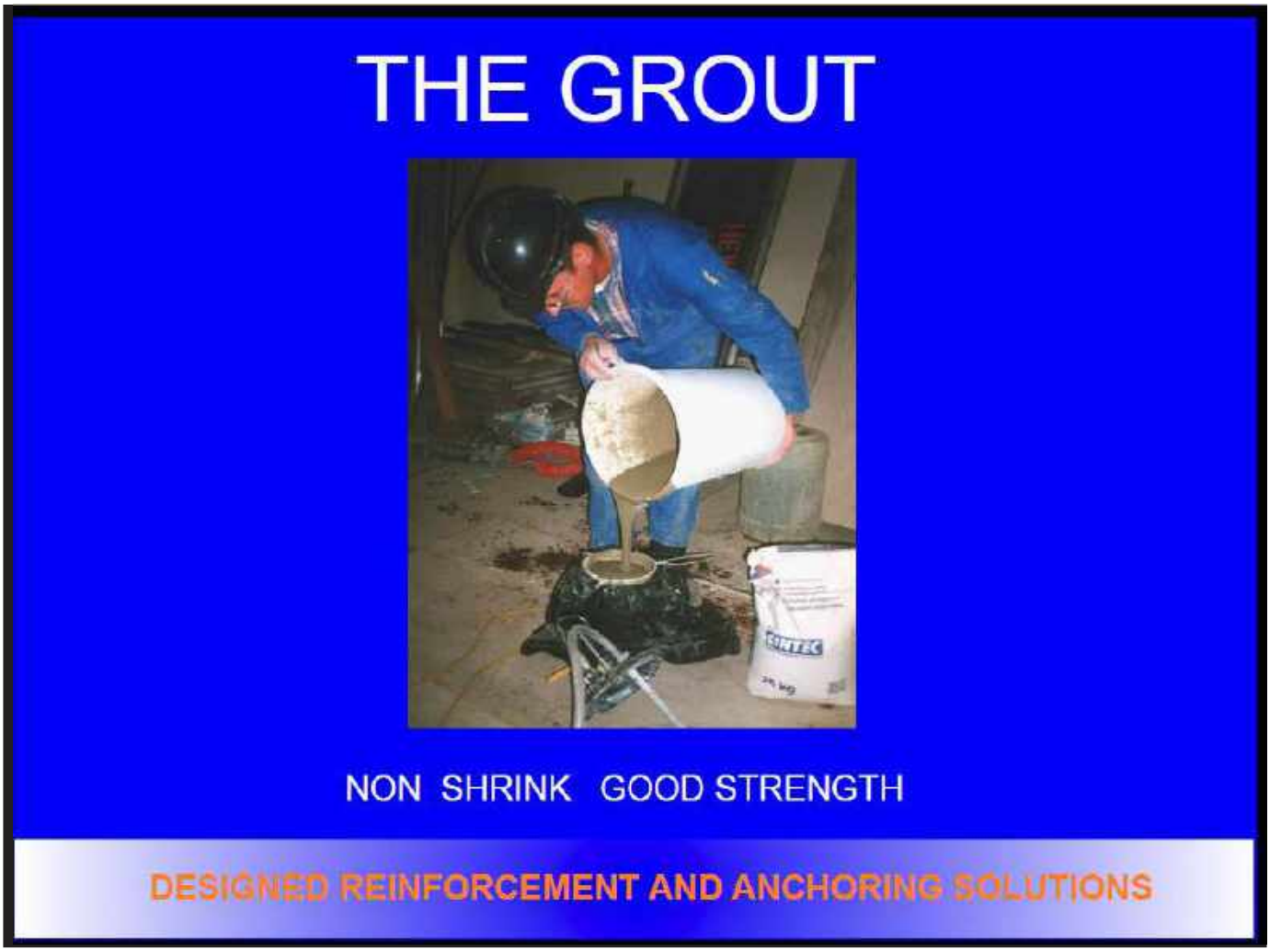


The anchor or reinforcement consists of three components - steel, sock and grout. The first is the reinforcing bar which comes in a variety of forms such as solid, hollow, round or square. Steel configuration is determined by project requirements such as load and application. It is, in most cases, stainless-steel Type 304 but we also use Type 316 for greater corrosion resistance and Type 2205 where higher strengths are needed. Cintec manufactures to the specific requirements of the project and therefore may use other types of stainless steel as well.

For more information see ENGINEERS GUIDE available at www.cintec.com

The second component of the Cintec Reinforcement System is the sock.The sock is a woven polyester sleeve that can expand horizontally but not longitudinally. Redundant to the process once inflated and the grout has set, the sock is critical in the installation procedures to contain and retain the grout. Wetting the sock, prior to inflation, “conditions” it to allow the bonding grout milk to flow through yet traps the micro cement particles and prevents uncontrolled grout flow. This facilitates an even expansion along its entire length for bonding with substrate where contact is made and expansion of system into voids when possible. Manufactured by Cintec, to stringent standards, this proprietary sock is available in 1” to 12” diameter and unlimited length.

For more information see ENGINEERS GUIDE available at www.cintec.com



The grout is the third component of the Cintec Reinforcement System and is a specially engineered Mineral Bound Injection Grout with no artificial additives. This cementitious grout consists of very fine particles (micro cement) that can be injected over considerable distances. It is non shrink, non expansive and impervious to absorption when set. The patented grout is manufactured in Germany to Cintec standards. Stringent mixing and injection procedures are provided as part of Cintec's Quality Control program and must be implement by Cintec certified installers only. Use of any other grout,in the Cintec Reinforcement system, that has not been pre-approved by Cintec is not allowed and voids any warranty.

For more information see ENGINEERS GUIDE available at www.cintec.com

PRESSTEC ©GROUT BOND QUICK CALCULATION

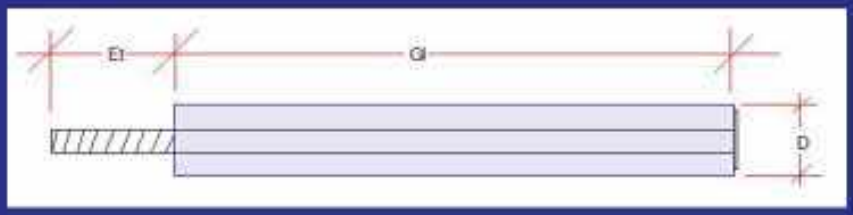
GROUT - PRESSTEC 2000 ©

TYPICAL MEAN VALUES

	1 DAY	7 DAY	28 DAY
TENSION	835 psi / 5.75 Mpa	1060 psi / 7.3 Mpa	1150 psi / 7.9 Mpa
COMPRESSION	6550 psi / 45 Mpa	8840 psi / 61 Mpa	9625 psi / 66 Mpa

APPROXIMATLY 70% AFTER 24 HOURS

PULL OUT BOND STRENGTH



Bond capacity = π X D X L X 65lbs

Where D is core hole diameter Gl is grouted length and 65lbs is bond per square inch

Assume: D is 2 inch , Gl is 6 inches

Therefore: 3.14 X 2 X 6 X 65 **2,450 lbs bond pull out for this anchor**

DESIGNED REINFORCEMENT AND ANCHORING SOLUTIONS

For more information see ENGINEERS GUIDE available at www.cintec.com

MOCK-UP of CINTEC ANCHOR or REINFORCEMENT

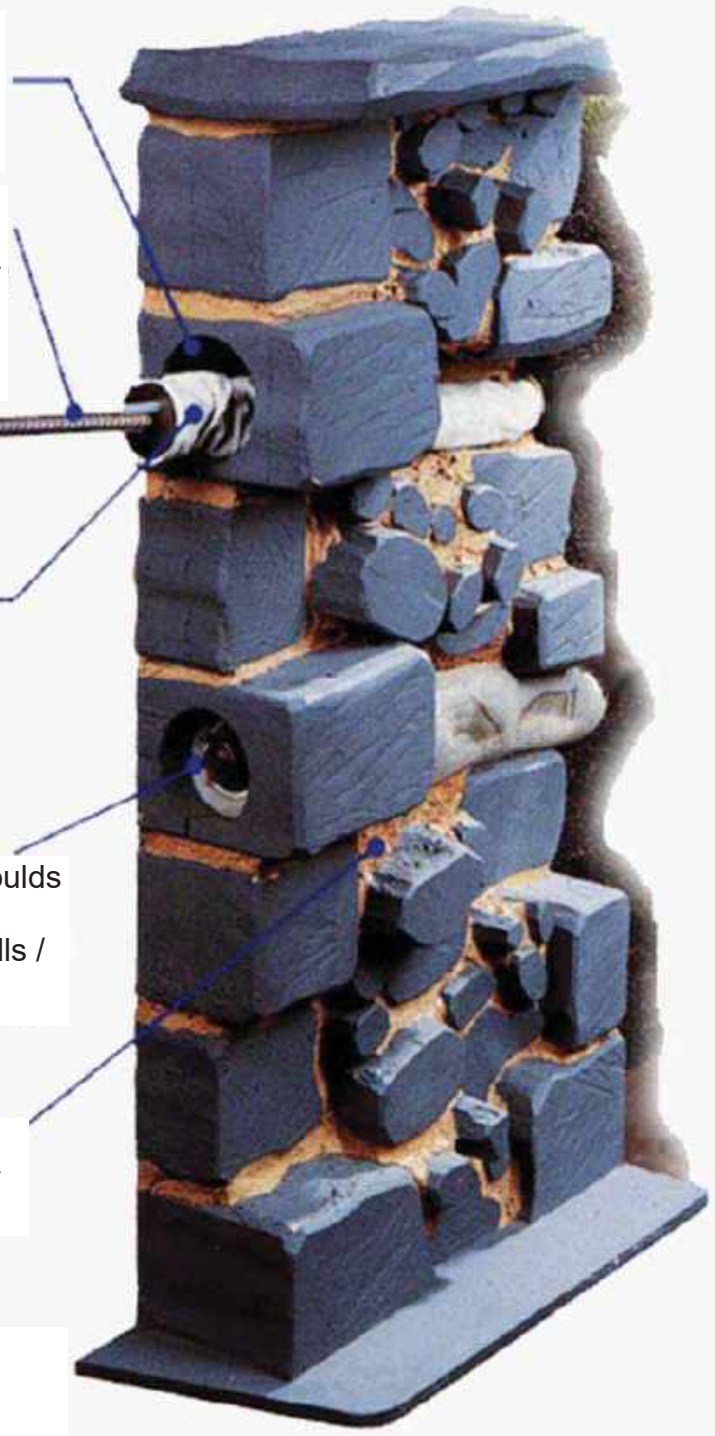
Drilled hole usually double, or greater, than body diameter

Main body available as square or circular hollow section or solid bar profile of various stainless steel materials

Woven polyester sock contains and retains Presstec© grout around anchor body and allows bonding to substrate

Grout injection (40 psi +/-) moulds anchor / reinforcement to the shapes and spaces within walls / structure

Inner wall substrate – in this case rubble fill but often other material



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IN-SITU CINTEC ANCHOR or REINFORCEMENT

ACTUAL PHOTO

The Cintec Reinforcement System attaches in two ways. When the sock, containing grout milk, is able to come in contact with the substrate it adheres with a bond strength of 65 psi. When the expanded sock is not able to contact the substrate then the low injection pressure causes the sock (grout) to expand horizontally into the void resulting in a mechanical attachment. The high compressive grout strength (9,000 psi) ensures an attachment with progressive failure rather than brittle failure potential.

For more information see ENGINEERS GUIDE available at www.cintec.com

All Cintec anchors are custom made. Whatever the Engineer / Architect / Contractor requires to satisfy project needs is what we manufacture. Configuration is determined based on load requirements, application and site conditions. This customization ensures that specific project needs are satisfied as opposed to a compromised solution selection based on “off the shelf” availability.

For more information see ENGINEERS GUIDE available at www.cintec.com

CALCULATION OF ANCHOR DESIGN

Determine application: Is the anchor to act as a:
A - Stitching anchor for brick or masonry (usually CHS but may be SRT for higher loads)
B - Wall reinforcing anchor (usually SRT but may be HSS or other configuration)
C - Wall anchor used for attaching to something i.e.: header, beam etc. (usually SRT but end treatments can be defined by Engineer/ Architect)

Determine loads to be placed on the anchor.
A - Shear
B - Tensile
C - Bending Moment
D - Pull Out (bond failure)

Substrate capacity will usually be less than designed anchor capacity.

Wall (substrate) thickness must be determined as anchor lengths are predicated on this information. Stitching anchors are usually 4” [100 mm] less in length than total wall thickness (embed length). Anchors used for attaching are usually wall thickness less 2” [50 mm] (embed length) plus the amount of protrusion needed for end treatment.

Page 63-66 – Locate stainless steel configuration (CHS, HHS or SRT) and pick size from table so that all values equal or exceed determined loads.

Page 86 – Hole diameter selected from table based on style and diameter of steel to be used. (Note length limitations)

Page 75- 82– Using the embed lengths and hole diameter previously found locate corresponding Pull Out Strength. Straight extrapolation for longer lengths is acceptable. If pull out is less than needed, diameter of cored hole may be increased.

The above is a good general determination of anchor needs. I should also caution you that any load other than direct tension pull out should be looked at by a Cintec engineer. A second opinion never hurts.

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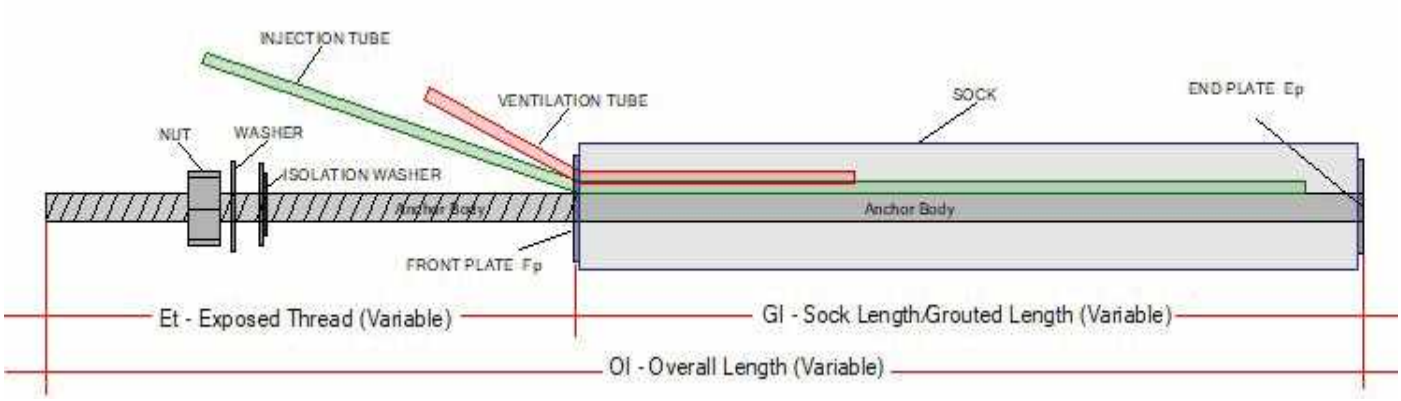
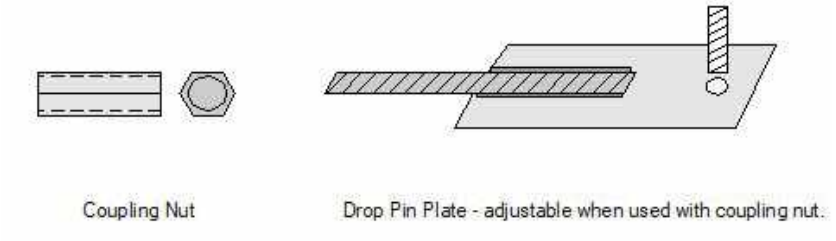
Cintec Generic SRT



Accessories



CINTEC TERMINOLOGY

Accessory - end treatment that can be attached to an anchor

Anchor Body - the steel part of the anchor. Usually stainless steel and may be hollow, solid round, square, or other configuration.

Nut - hexagonal with same ID as body and usually of same material.

Plate (End) - on most anchors. Usually 1/2" smaller diameter than the core/ sock diameter. Has hole in centre the size of body so it can be welded / thread-locked in place.

Plate (Front) - on some anchors. Usually 1/2" smaller diameter than the core/ sock diameter. Has hole in centre the size of body so it can be welded / thread-locked in place. May also have "port (s)" to accommodate injection / ventilation / other tubes.

Sock - polyester , woven tube usually size matched to the core hole diameter... but NOT always

Tube (Injection) - tube that is glued in place and used to INJECT the anchor sock. It is the longest tube if two or more tubes are present and identified with a sticker with green writing.

Tube (ventilation) - also called "emergency" allows air in system to escape and can also be used if absolutely necessary to inflate anchor. It is glued in place and is the shortest tube if two or more tubes are present and identified with a sticker with red writing.

Washer - also called flat or fender washer.

Washer (Isolation) - also called bonded washer, used to prevent galvanic action between dissimilar materials

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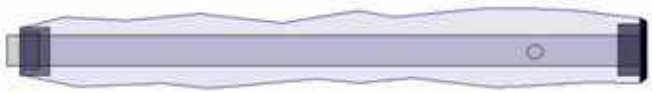
WHAT "TYPE" TO USE

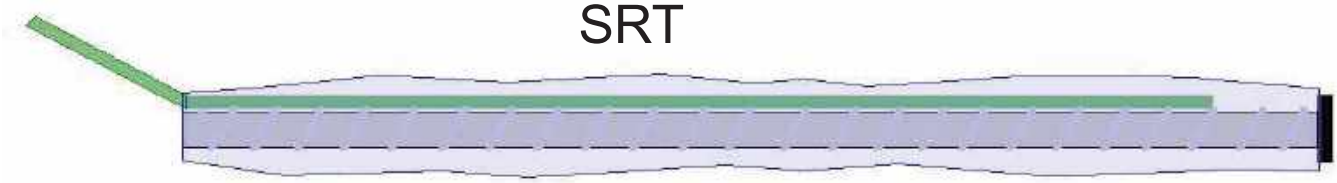
CHS



CHS (Circular Hollow Section)

Often referred to as a **STITCHING ANCHOR**. Stainless Steel 304 / 316. Body diameter of 3/8" (10mm) or 1/2" (12mm). They are typically installed perpendicular to wall face. Used primarily to consolidate exterior to interior masonry wall faces as well as multi-wyth brick. Installation in a ¾" (20mm) or 1" (25mm) hole, respectively, with a length of no more than 39" (1000mm). Typically installed in a Domino 5 pattern. Various end treatments are possible for specific project requirements and applications.

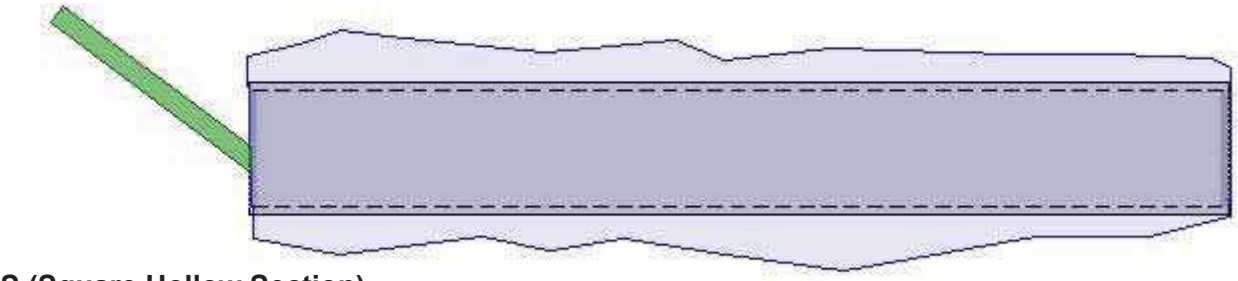
SRT



SRT (Solid Rod-Threaded)

Inplane or Reinforcement run parallel with the structures face and may be installed vertically, horizontally or on an incline. Stainless Steel 304 / 316 /2205 and 17-4PH are commonly used but other grades may be used per project requirements. Possibly the most widely used of the Cintec Reinforcement System, it's primary purpose is in strengthening, cladding stabilization and seismic upgrading. Body diameter of ¼" (6mm) to over 2 ½" (65mm) with sock / core hole diameters of ¾" (20mm) to 12" (300mm). No length restrictions - longest to date 147' (4500mm). This "type" of reinforcement may be **Post Tensioned** using a 2 sock system. Application and purpose dictates sizing and various end treatments are possible for specific project needs.

SHS



SHS (Square Hollow Section)

Moment Resisting, this body configuration is used where increased moment capacity is required while keeping the overall diameter of cored hole to a minimum. Stainless Steel 304 / 316 are commonly used but other grades may be considered per project requirements. It's primary purpose is as a support member and to transfer loads for applications such as shelf angles and joist attachment. Body diameter of 3/4" (20mm) to over 4" (100mm) with sock / core hole diameters of 1 1/2" (38mm) to 12" (300mm). No length restrictions. Application /purpose dictates sizing and various end treatments are possible for specific project needs.

For more information see ENGINEERS GUIDE available at www.cintec.com

PATENTS

Since 1965 Cintec has strived to become the world leader in the design and manufacture of project specific designed cementitious anchoring and reinforcement systems. PATENS have been obtained worldwide and addition patents have been applied for and are pending. A partial list of Patents / Patents pending includes, but is not limited to: 2245121, 2764006, 0090895, 5216857, 116188, 1210495, DE19609914, 3608775, DE2315859.

THE SOCK

The fabric sleeve is specially woven polyester based tubular sock with expansion properties to suit the diameter of the bore hole and substrate. The mesh of the sock is designed to contain the aggregates of the mixed grout, while still allowing the cement enriched water (milk) to pass through the sock both sizing and bonding to the substrate. The sock is manufactured in sizes from 20mm to 300mm in diameter and is adjusted to suit each individual application.

THE GROUT

Presstec grout is a cementitious grout, a factory produced mix with graded aggregates and other constituents which when mixed with water produce a pumpable grout that exhibits good strength with no shrinkage. Presstec is made in accordance with the following DIN standards, which are comparable to ASTM standards. The Grout does not contain any resin binders.
DIN EN 197-1. DIN EN 196. DIN EN 932. DIN 4226. DIN EN 933.
DIN EN 1097. DIN EN 1367. DIN 18555. & DIN 18557

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WARRANTY

Cintec warrants that for a period of 12 months from the date it sells a product it will, as its sole option and discretion, refund the purchase price, or replace such product if it contains a defect in material or workmanship. Absence of Cintec receipt of notification of any such a defect together with a copy of the original invoice within this 12-month period shall constitute a waiver of all claims with regard to such product.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANT-ABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

Acceptance of order: Acceptance is limited to the express terms contained herein, and terms are subject to change by Cintec without notice. Additional or different terms proposed by customer are deemed material and are objected to and rejected, but such rejection shall not operate as a rejection of the offer unless it contains variances in the terms of the description, quantity, price or delivery schedule of the goods.

Indemnification: Cintec shall in no event be liable for, and customer hereby agrees to indemnify Cintec against all claims related to, special, direct, indirect, incidental, consequential, or any other damages arising out of or related to the sale, use, or inability to use the product by an approved contractor and or installer for the said project the product was designed for. Customer hereby agrees to indemnify Cintec for any costs, including attorney's fees, incurred by Cintec as a result, in whole or in part, of any violation by customer of any Federal, Provincial or local statue or regulation, or of any nationally accepted standard. It shall be customer's sole responsibility to comply with all applicable laws and regulations regarding the handling, use, transportation, or disposal of products upon taking possession of same.

Cintec's anchoring and reinforcement systems can only be **INSTALLED BY CINTEC TRAINED AND CERTIFIED** installers.

For more information see ENGINEERS GUIDE available at www.cintec.com

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:

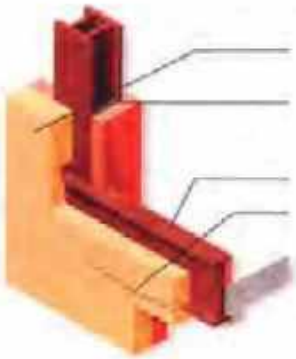
The source of moisture must be determined and rectified to mitigate further corrosion of the anchors and original iron work. Serious consideration should also be given to stabilizing the original iron work and anchors which will continue to rust and jack even if no longer performing any structural service.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

CINTEC TERRACOTTA SOLUTIONS WHAT IS TERRA-COTTA ?

Cathodic Protection

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

How Historical Steel-Framed Buildings Fail



1- Moisture permeates through stone to reach steel.
2- Poor quality mortar traps moisture against steel creating perfect corrosion conditions.
3- Steel beams corrode and expand.
4- Expansion caused by corrosion displaces or fractures stone.

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 TerraCotta. either fractured or with a poor glaze condition. It is only meant to stabilize sound TerraCotta 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 TerraCotta 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 sacked area via a number of flood holes.
- El cemento ce 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.
- Cuándo 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.
- Aproximativement 15 secondes más tarde el ancla esta totalmente llena de concreta micro fina que produce una fijación mecanica. Entre tanto 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 ensaqos efectuados sobre una construcción de materiales homogéneos por laboratorios independientes compilaron resultados más allá de 3000 lbs sobre la tensión axial.

CINTEC

DESIGNED ANCHOR SYSTEMS FOR THE CONSTRUCTION INDUSTRY

CINTEC TERRA COTTA SOLUTIONS

Technical Bulletin No.2

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 ½" 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

CINTEC TERRA COTTA SOLUTIONS

Fire Rating

Cintec anchors are fire resistant

Building Research Establishment
Garston Watford WD2 7JR
Telephone 0923 894040 Telex 923220 Fax 0923 664010

Direct line 0923 66
GTN 3532

Mr. 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

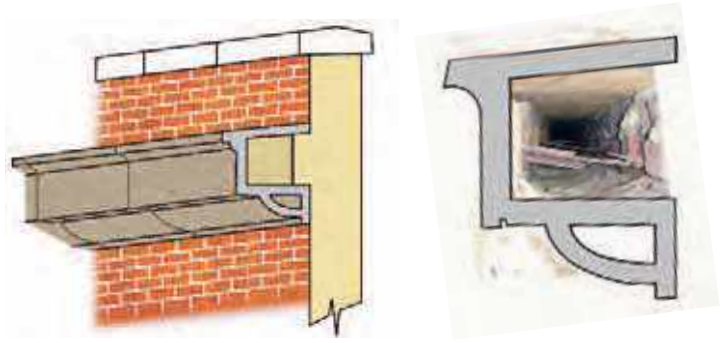
Head of Masonry Structures Section, Structural Design Division, Geotechnics and Structures Group

See Cintec's website for 2 hour laboratory testing results.
www.cintec.com

NB: Cavity lock systems are now known as Cintec International Limited

CINTEC TERRA COTTA SOLUTIONS

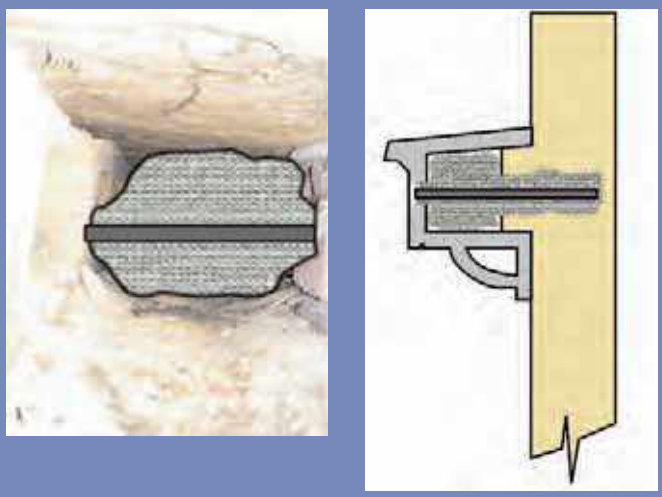
Inside Detail on Terra Cotta Repairs and Stabilization



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.

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 ⅝th" Dia body 3" Dia sock set into 1½" Dia hole subject to field conditions and requirements.

CINTEC TERRA COTTA SOLUTIONS

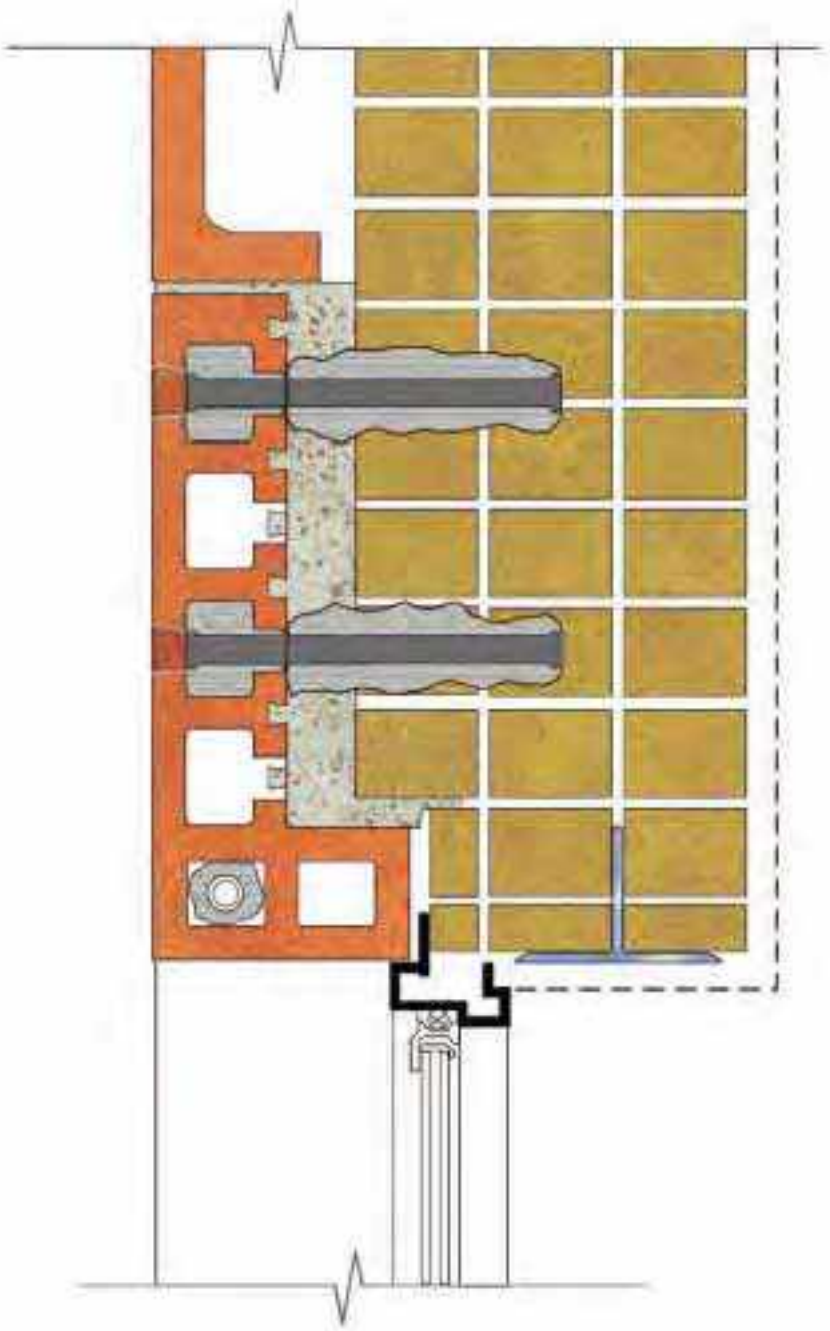


PLATE 1

FIXING TERRA COTTA CLADDING TO BRICK BACK UP

CINTEC TERRA COTTA SOLUTIONS

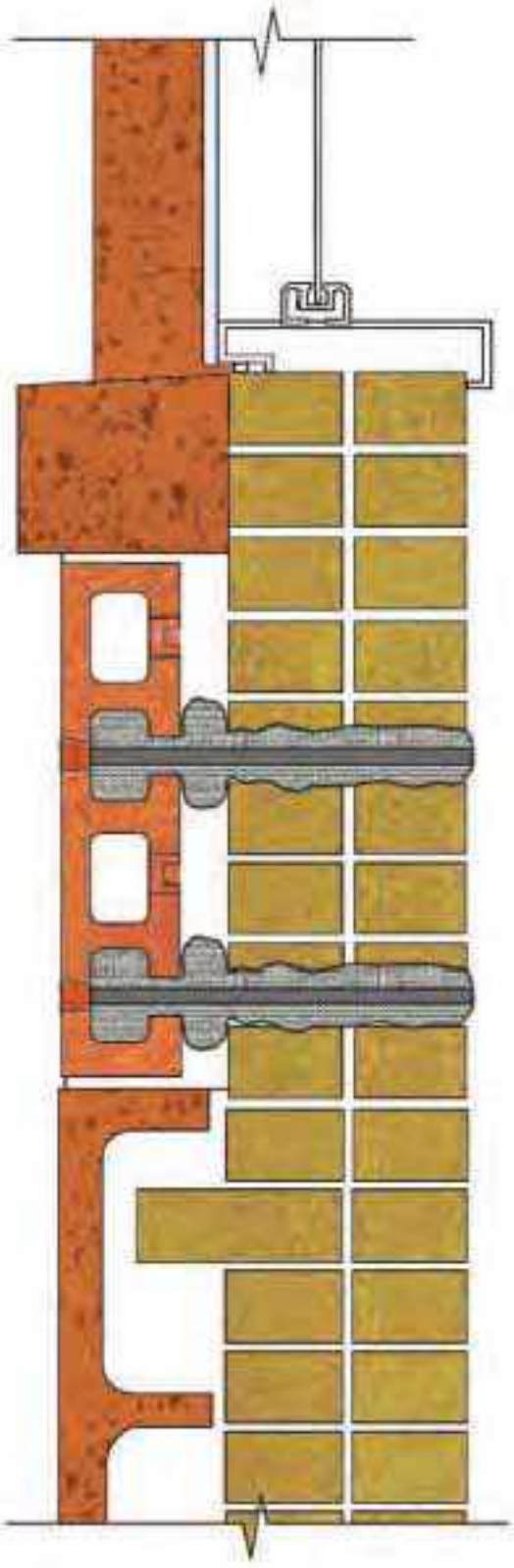


PLATE 2

FIXING TERRA COTTA CLADDING TO BRICK BACK UP WITH AIR GAP

CINTEC TERRA COTTA SOLUTIONS

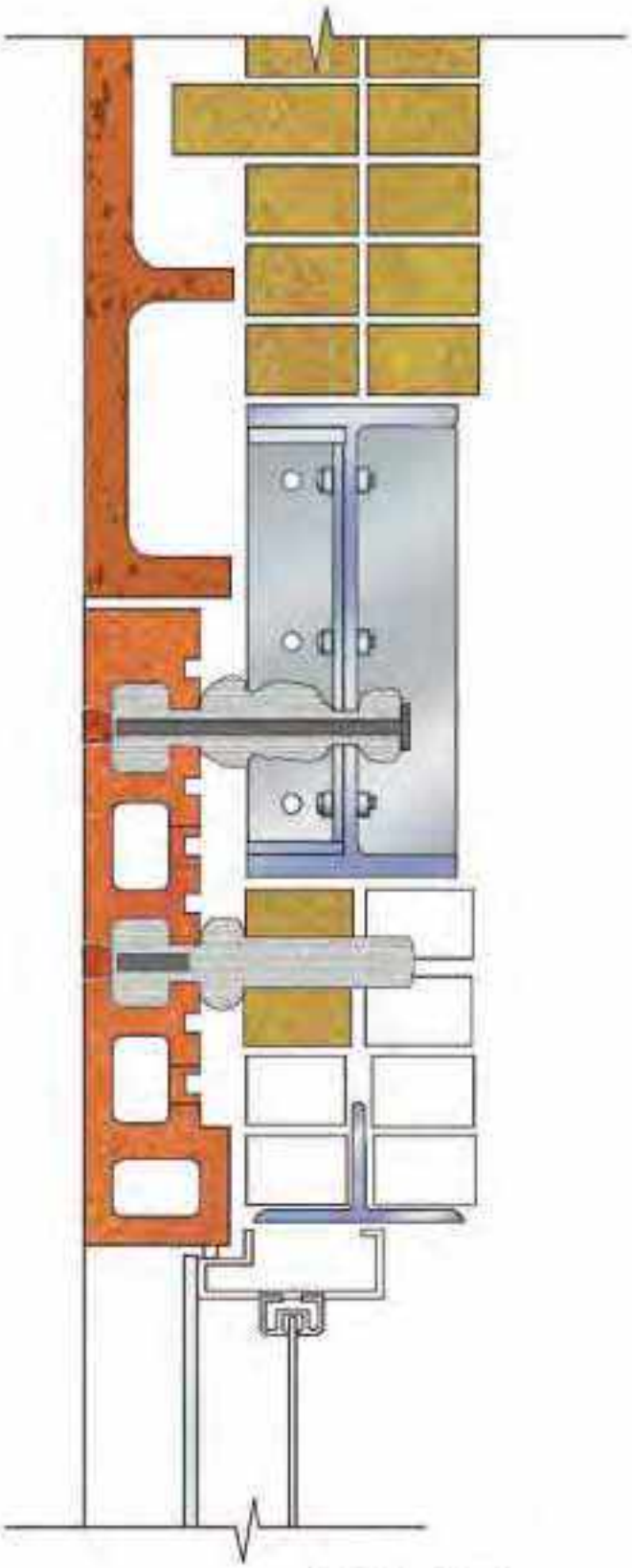


PLATE 3

FIXING TERRA COTTA CLADDING TO STEEL SPANDREL AT WINDOW HEAD

CINTEC TERRA COTTA SOLUTIONS

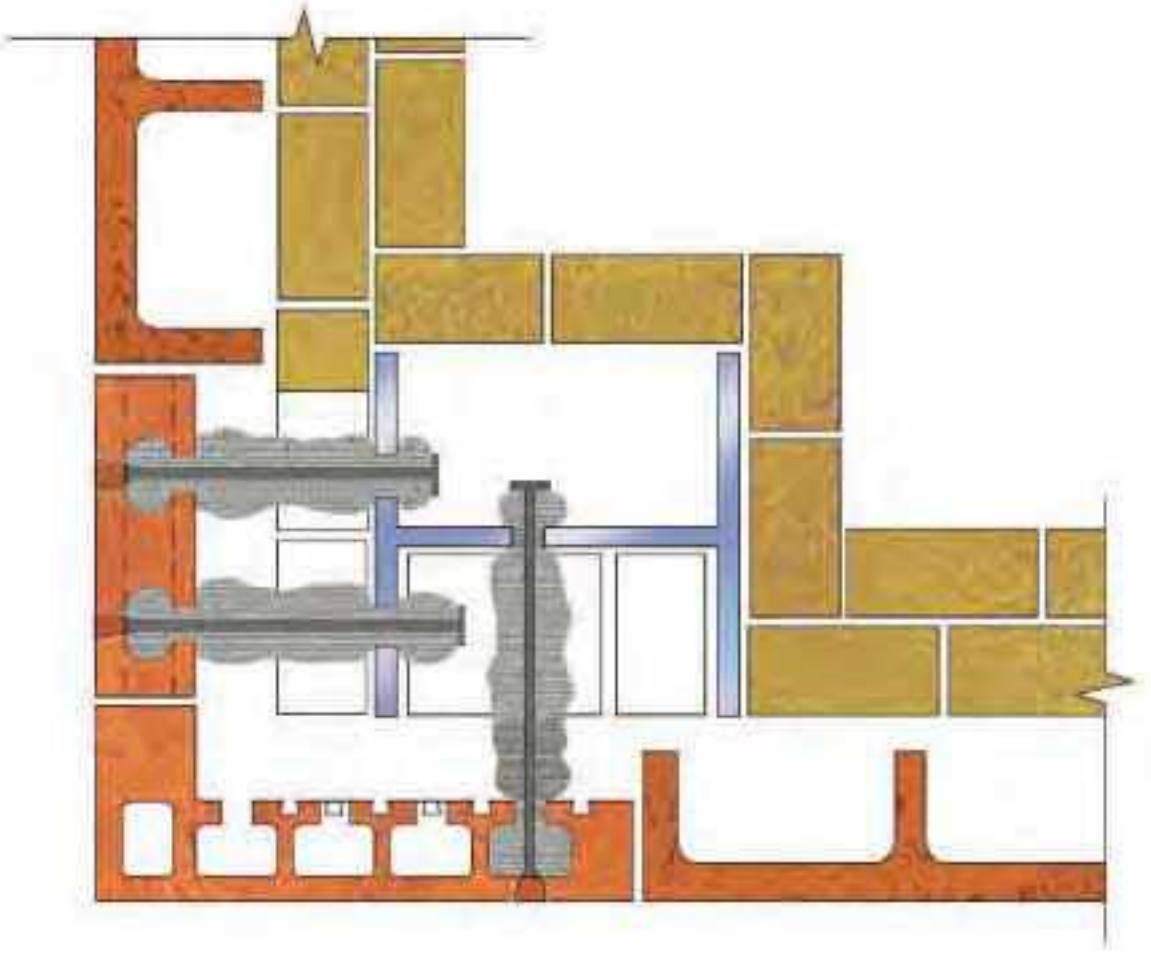


PLATE 4
FIXING TERRA CLADDING TO A STEEL COLUMN

CINTEC TERRA COTTA SOLUTIONS

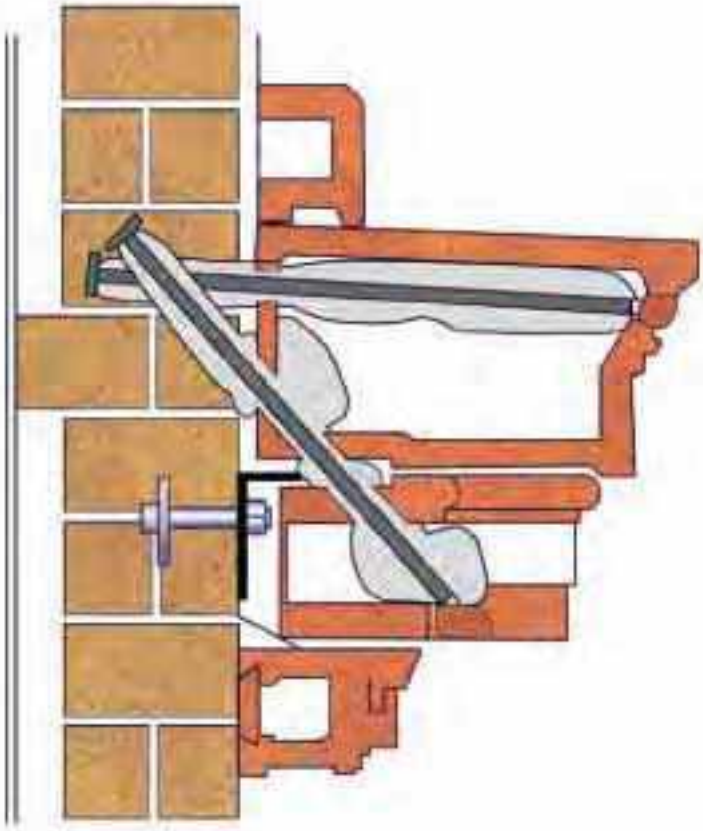
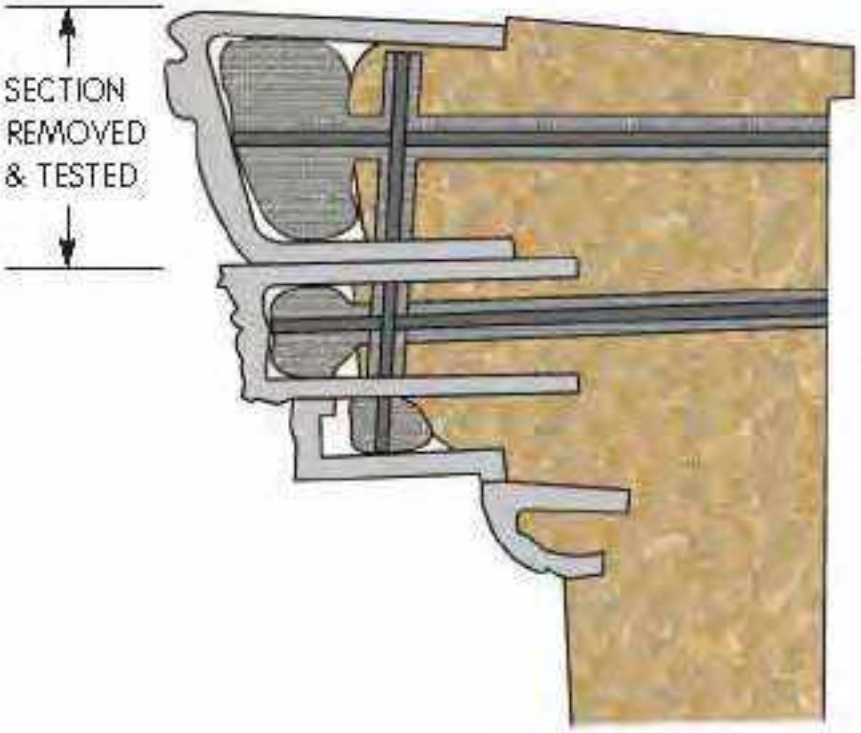
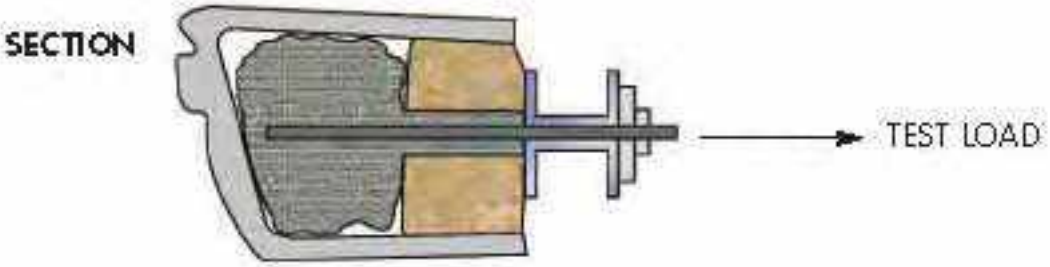


PLATE 5
FIXING TERRA COTTA CORNICE TO BRICK PARAPET

CINTEC TERRA COTTA SOLUTIONS



CINTEC
SOLUTION
AS BUILT



FULL SCALE TESTING

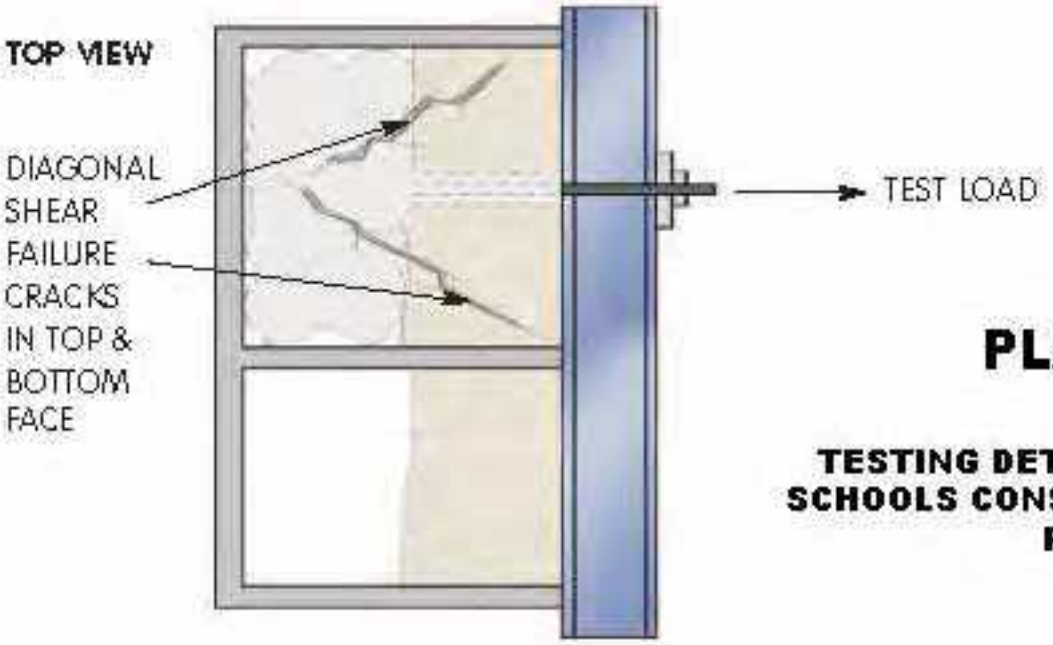


PLATE 6

TESTING DETAILS FOR NEW YORK SCHOOLS CONSTRUCTION AUTHORITY PS 230 K

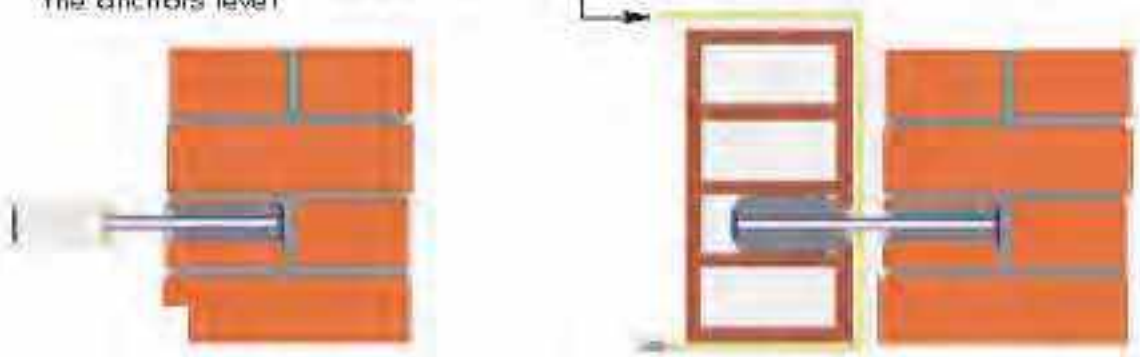
CINTEC TERRACOTTA SOLUTIONS

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 jigging to keep the anchors level

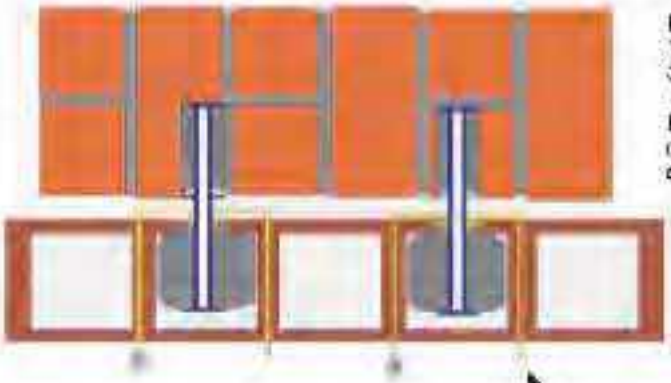
The Terra Cotta is set in place and fitted carefully over the outer end of the anchor and inflated with the flexible injection tube positioned through an existing mortar joint



SECTION

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

SECTION



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

EMBEDDED DEPTH
dependent on load and cavity size

CONTROL SOCK

PLAN

INJECTION tube

PLATE 7

Fixing New Terra Cotta to existing back up wall

CINTEC TERRA COTTA SOLUTIONS

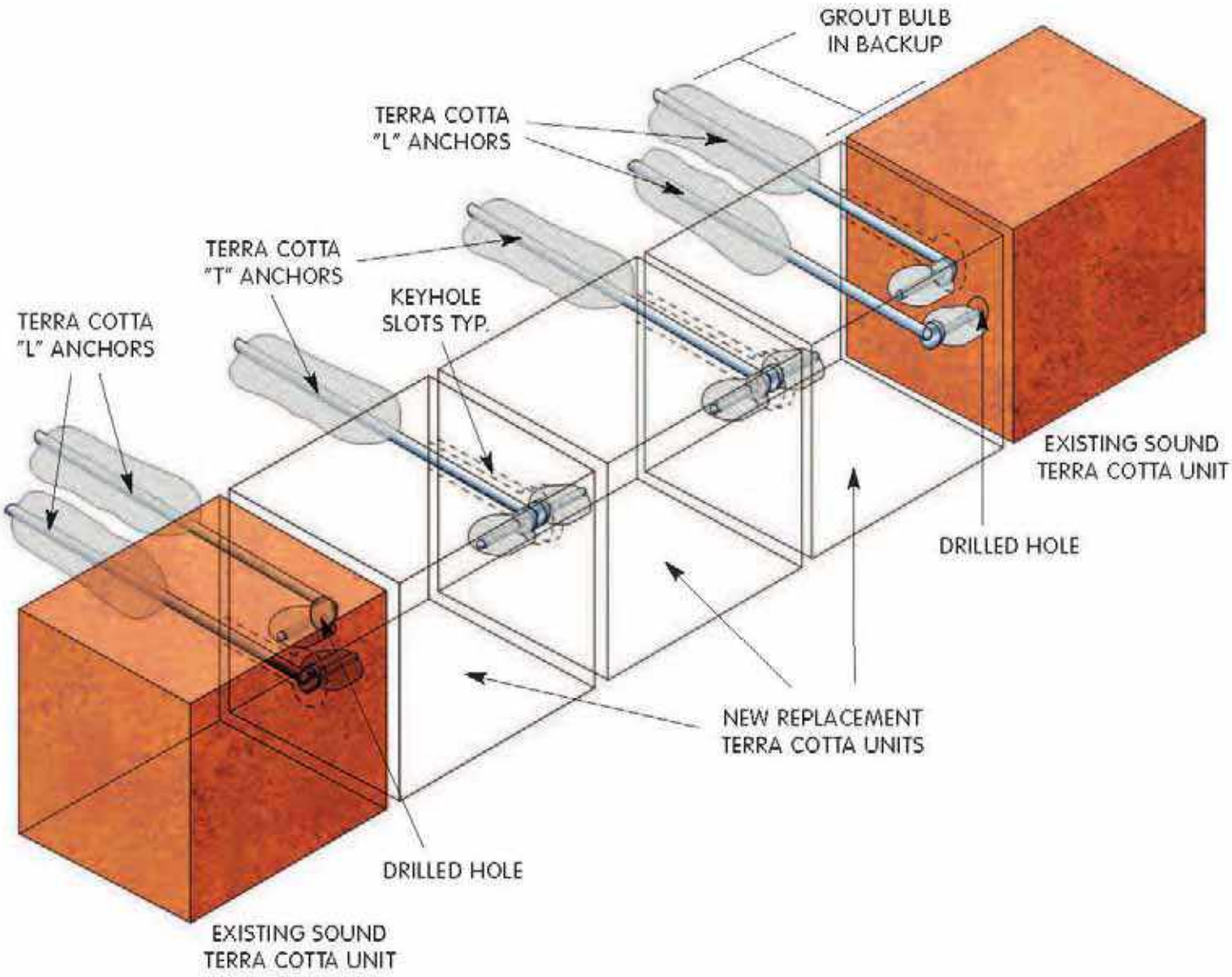


PLATE 8

INSERTING NEW TERRA COTTA UNITS BETWEEN EXISTING UNITS

The Property

This "recognized iconic asset" to the New York City Skyline is located in midtown Manhattan and was built as a Beaux-arts style building in 1929. The property strategically straddles Park Avenue at 46th Street and offers a direct connection to Grand Central Station. It was acquired (2007) for One Billion One Hundred and Fifty Million USD.

The Problem:

By 2009, the building had begun to show its age. At the top of the building some of the twenty-six east and south facing Terra-Cotta columns [with the base starting at the 26th floor and extending past the 34th floor] had begun to show cracking and in some areas had began to shed large pieces of stone. The building owners/management had inquired as to replacement cost of these Terra-cotta Brackets and had been quoted prices exceeding 16 Million dollars. By employing the Cintec method of repair, the owner was able to save more than 15 million Dollars effecting by repairs for just over 1million dollars.

The Solution:

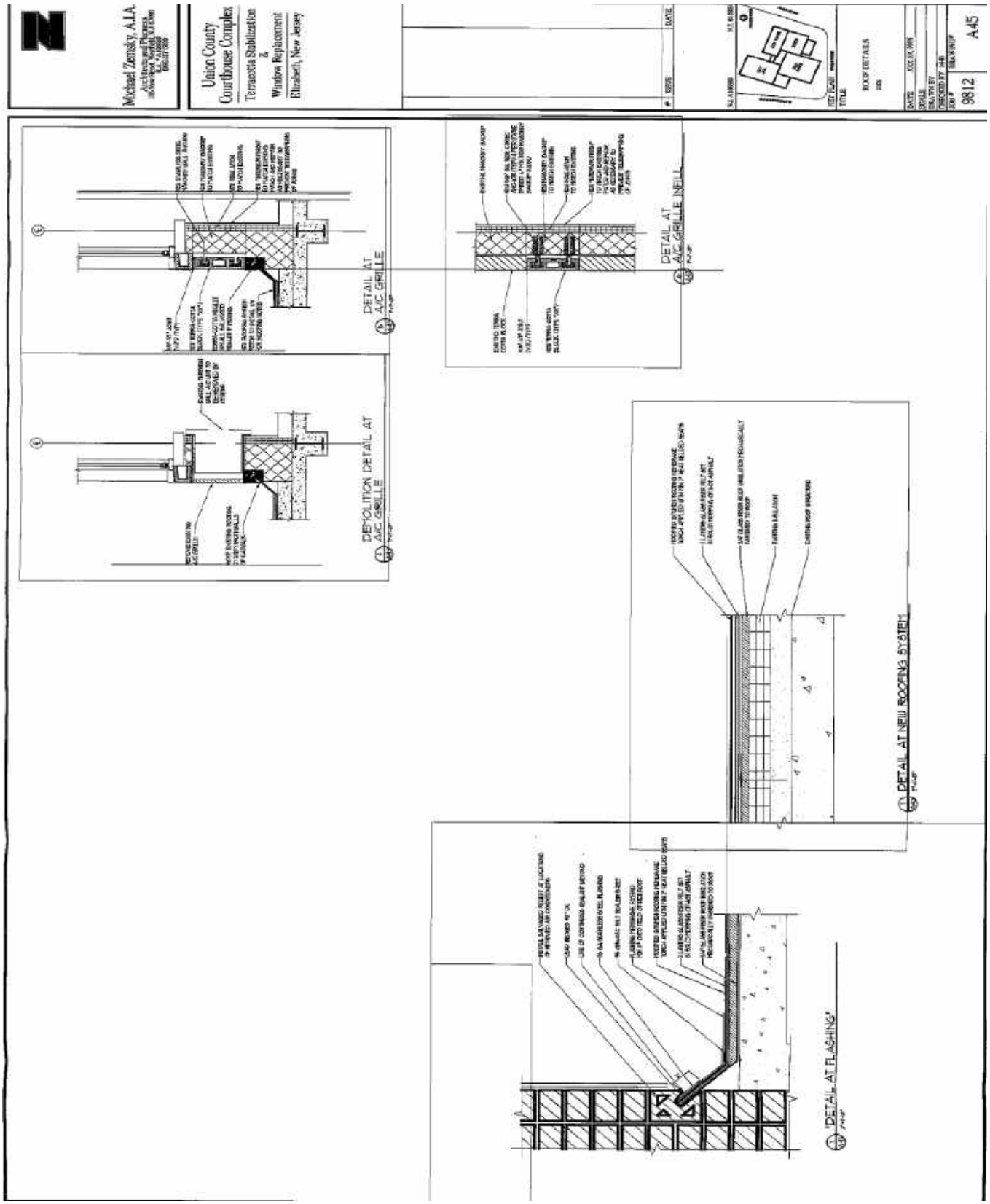
Cintec in North America was contacted by Thornton Tomasetti Engineering Corporation to find a solution to this issue, working together Cintec North America and Tomasetti Engineering Corporation formulated a plan. Through exploratory probes and use of a borescope it was assessed that the structure behind the columns (staked brick) was sound, given this assessment it was decided that all that would be needed would be to attach the Cintec Anchoring System to the backup and tie it to front face of stone that was sound in order not only to strengthen the attachment to face but to create additional points of contact in the stone face brackets that were sound. This was achieved by drilling oversized holes through the face of the stone and recessing the anchor 1" from face of stone to accommodate a finish patch, thus creating an invisible repair. The ability to tie the face of the original Terra-cotta panels to the back up wall saved the integrity of the landmark building.

Savings:

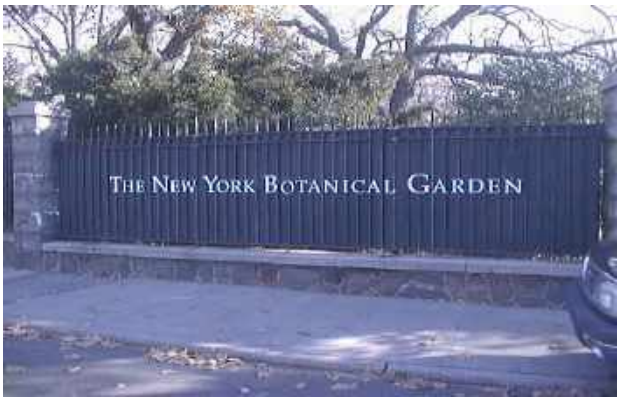
By affecting, this repair method as opposed to fiberglass replacement and demolishing landmark terracotta brackets and columns, the owner was able to save more than 15 Million dollars and effect repairs in less than a quarter of the time needed to replace brackets. The General Contractor on this project was United Restoration Corp who worked closely with Cintec North America, Thornton Tommasetti (Engineer of Record) and Arteco Design Corp (Driller/Installer) to complete this project with minimal issues and maximum savings.

General Contractor	Engineer of Record	Specialist Masonry Contractor
United Restoration Services of NY	Thornton Tomasetti	Arteco Design & Restoration
295 Greenwich St, Ste 341	24 Commerce Street, 8th Fl	8 Bogart Place
New York, NY	Newark, NJ	Yonkers, NY
10007	07102	10708
Tel: 212-431-1261	Tel: 877-993-9737	Tel: 914-793-9424

Union County Courthouse complex NJ. Typical Architect detail

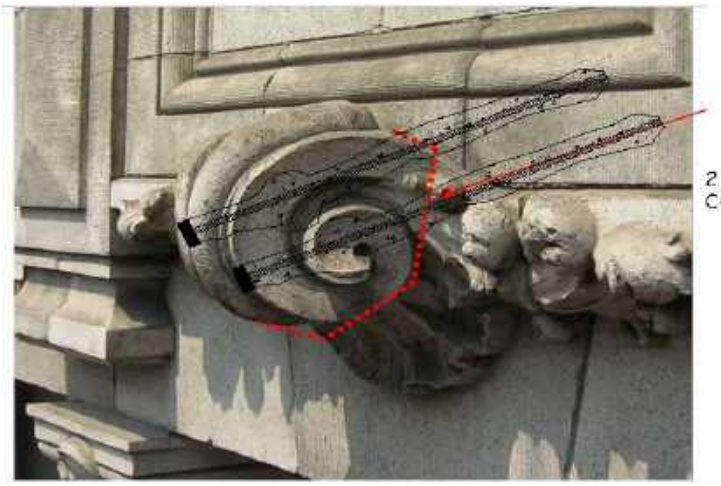


Attaching Flag Pole intoTerra-Cotta



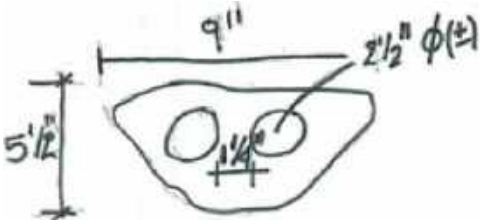
Charleston Presbyterian Church, Charleston West Virginia

Typical Details for attaching Terra-Cotta Ornaments N.Y

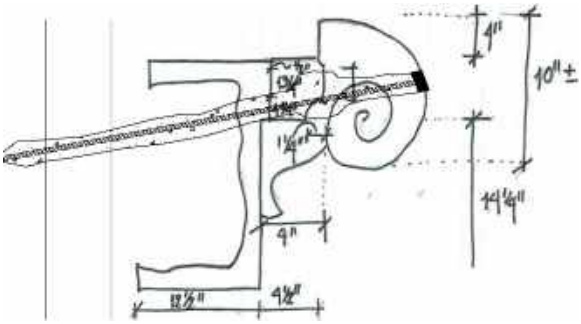


Overview of existing terra cotta ornament at the 9th floor to be pinned

Wood block

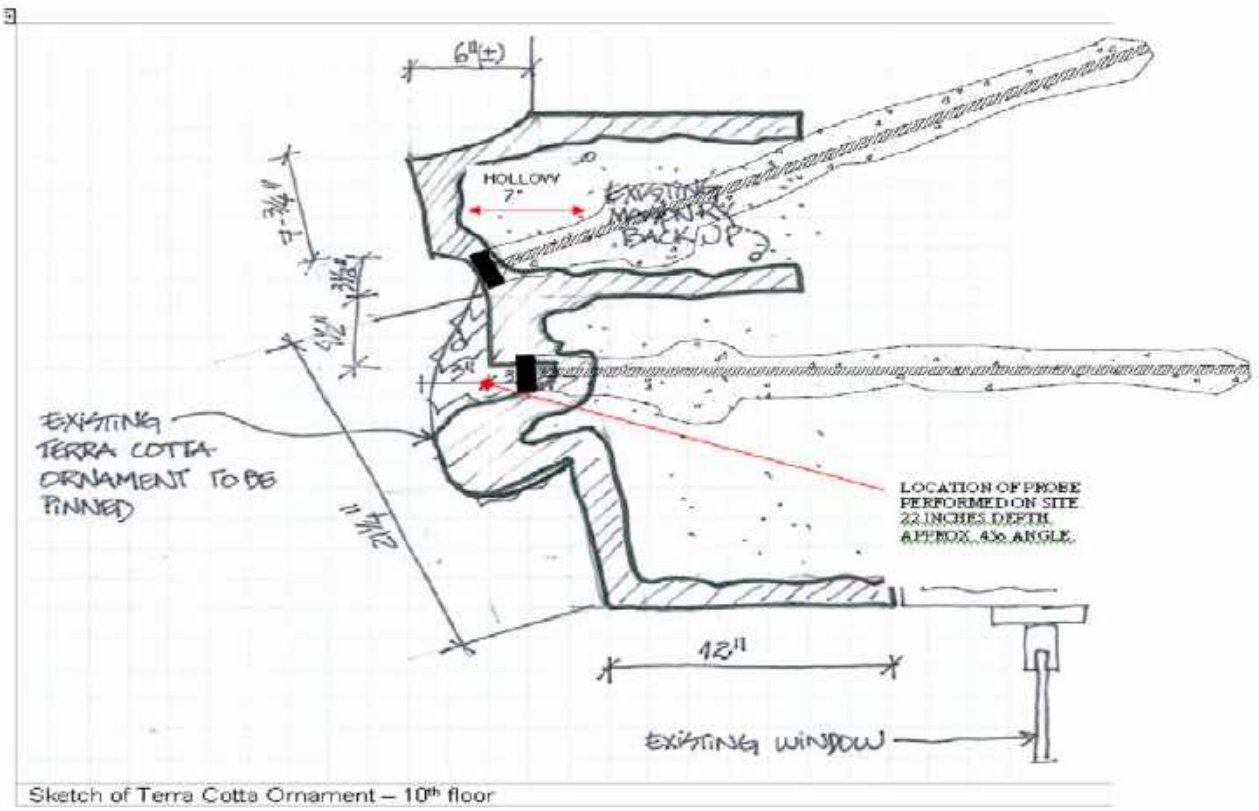


View of location where Loose ornament was removed. Wood block s = 10", embedment of wood blocks = 5-1*!2"*



1sketch of section of 9th floor Terra-Cotta Ornament

Typical Details for attaching Terra-Cotta Ornaments N.Y

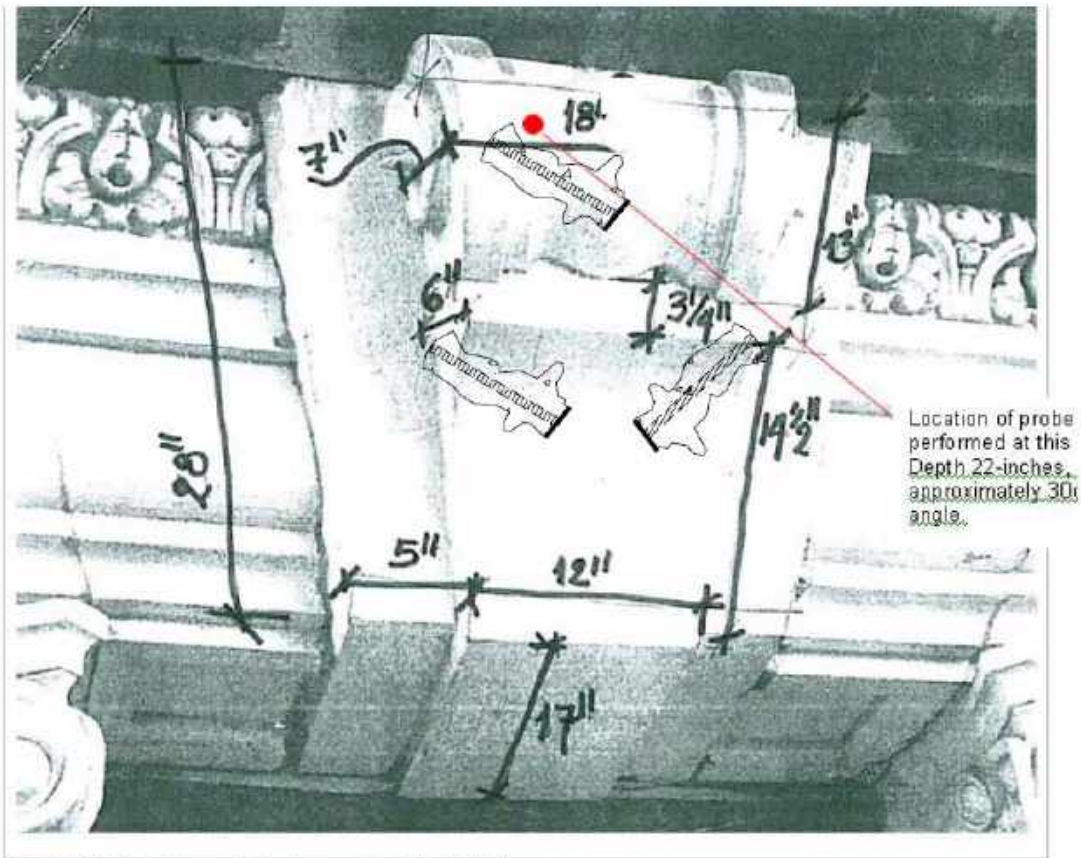


Sketch of Terra Cotta Ornament – 10th floor

Sketch of Terra-Cotta Ornament 10th Floor

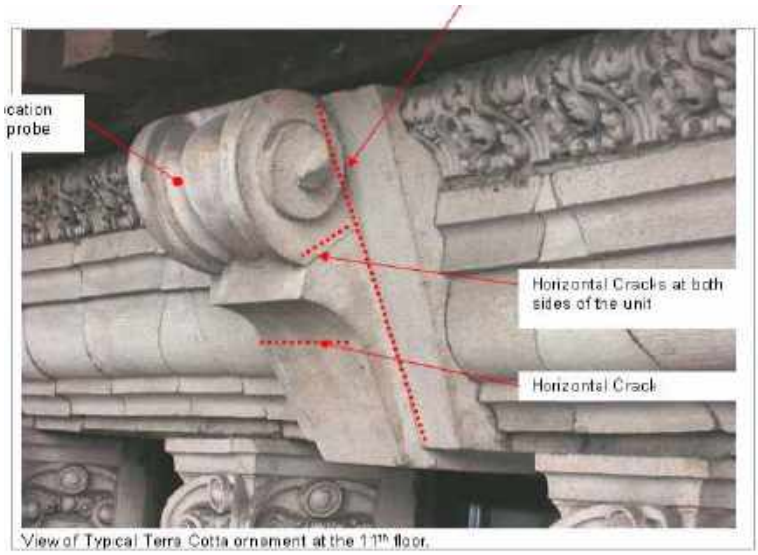

10th Floor Terra Cotta Ornament

Typical Detials for attaching Terra-Cotta Ornaments N.Y

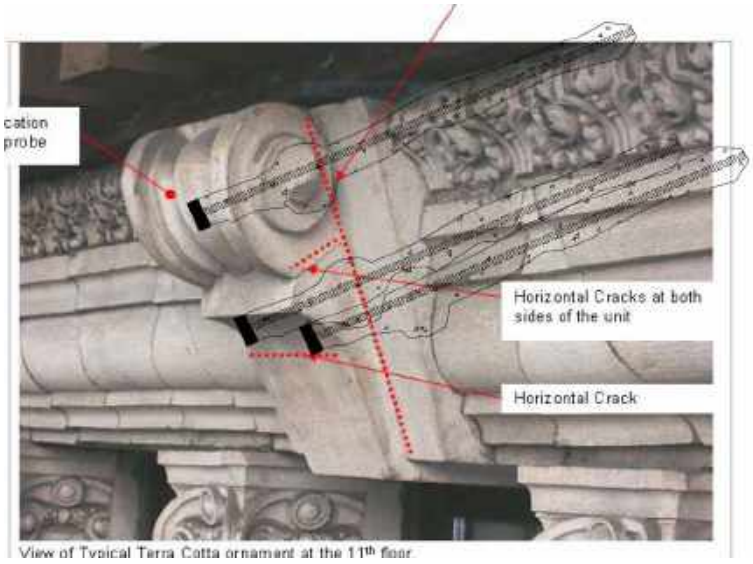


Photo/sketch of Terra Cotta Ornament at the 11th floor.

Sketch of Terra-Cotta Ornament 11th Floor

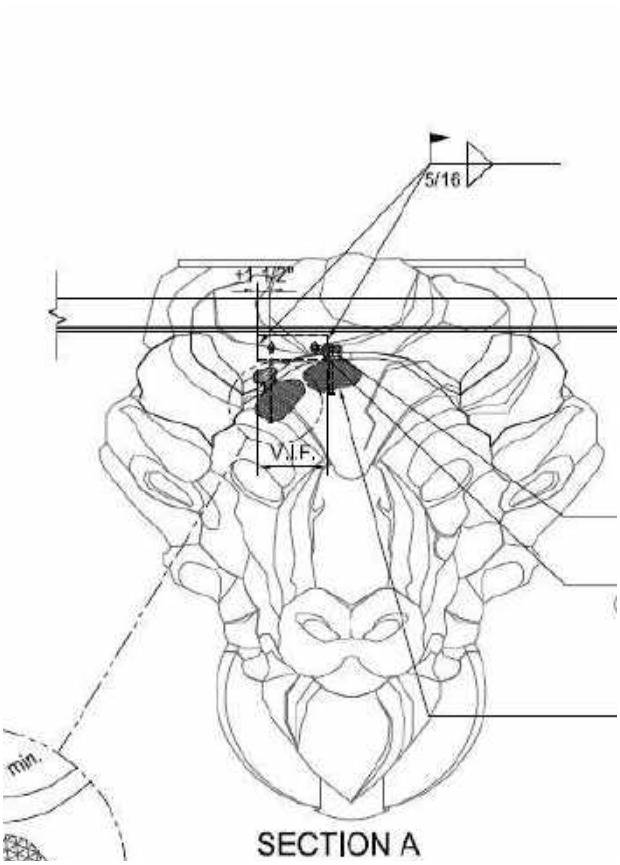


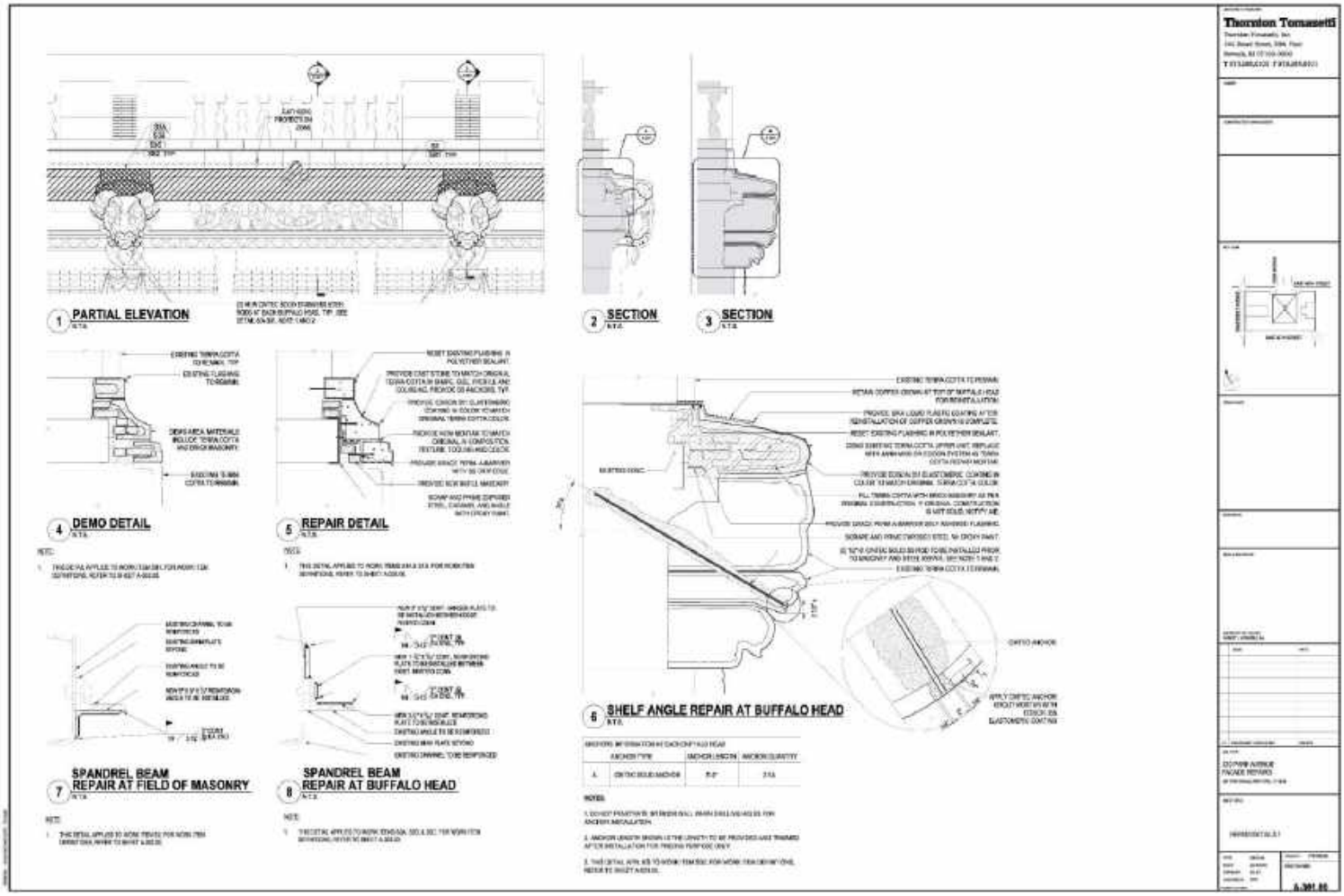
View of Typical Terra Cotta ornament at the 11th floor.



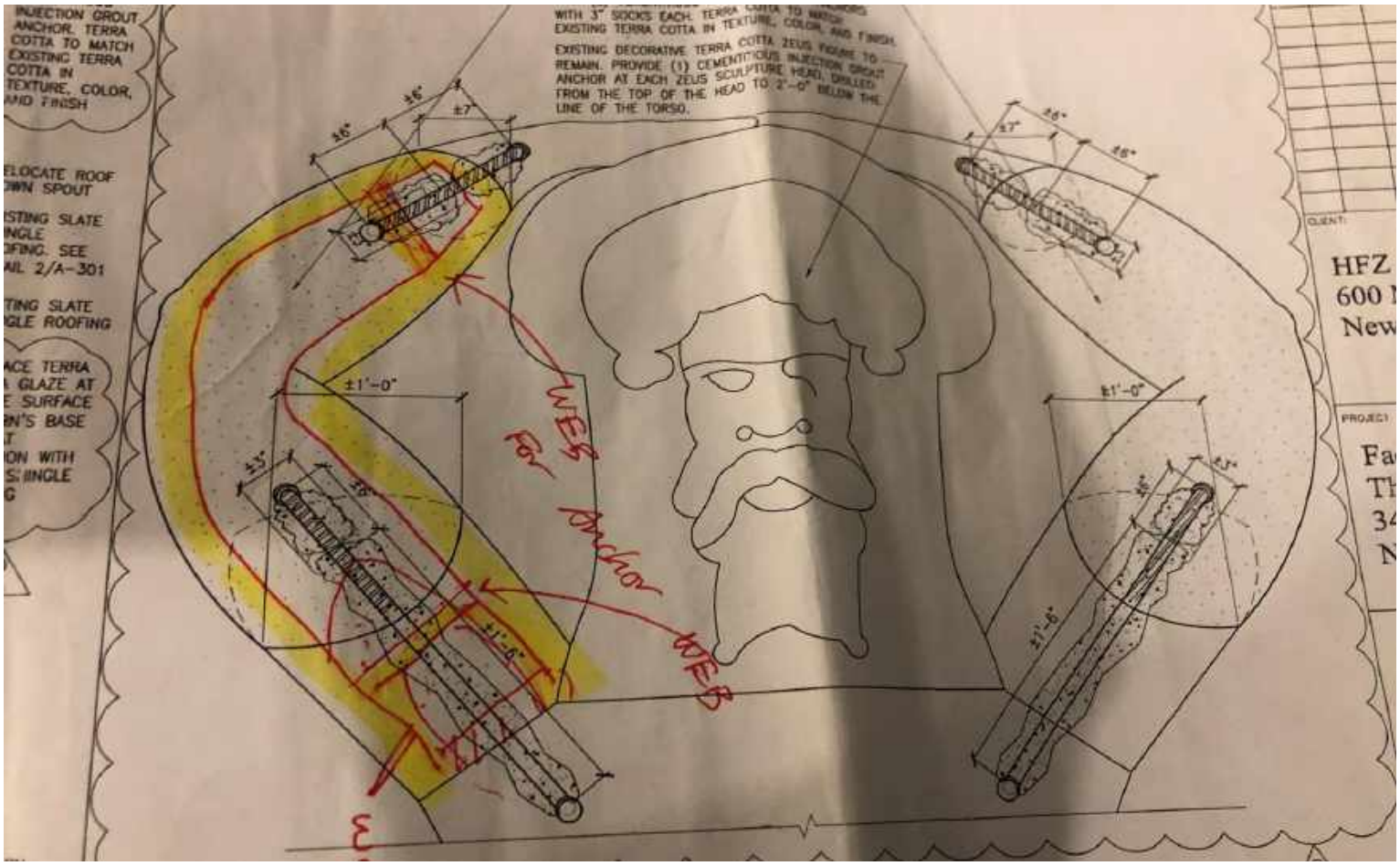
View of Typical Terra Cotta ornament at the 11th floor.

Details for Buffalo Head Terra-Cotta Ornaments, NY

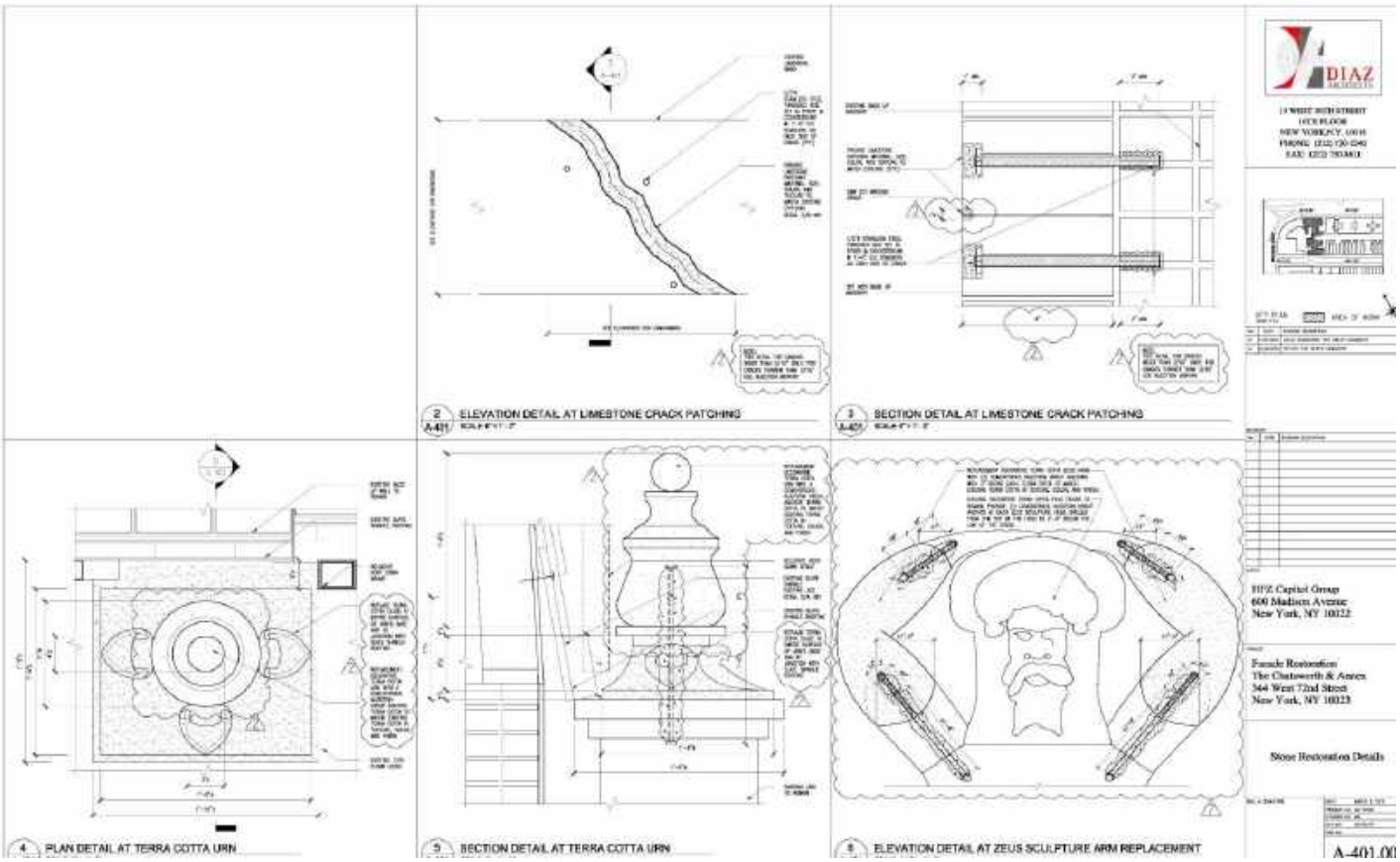


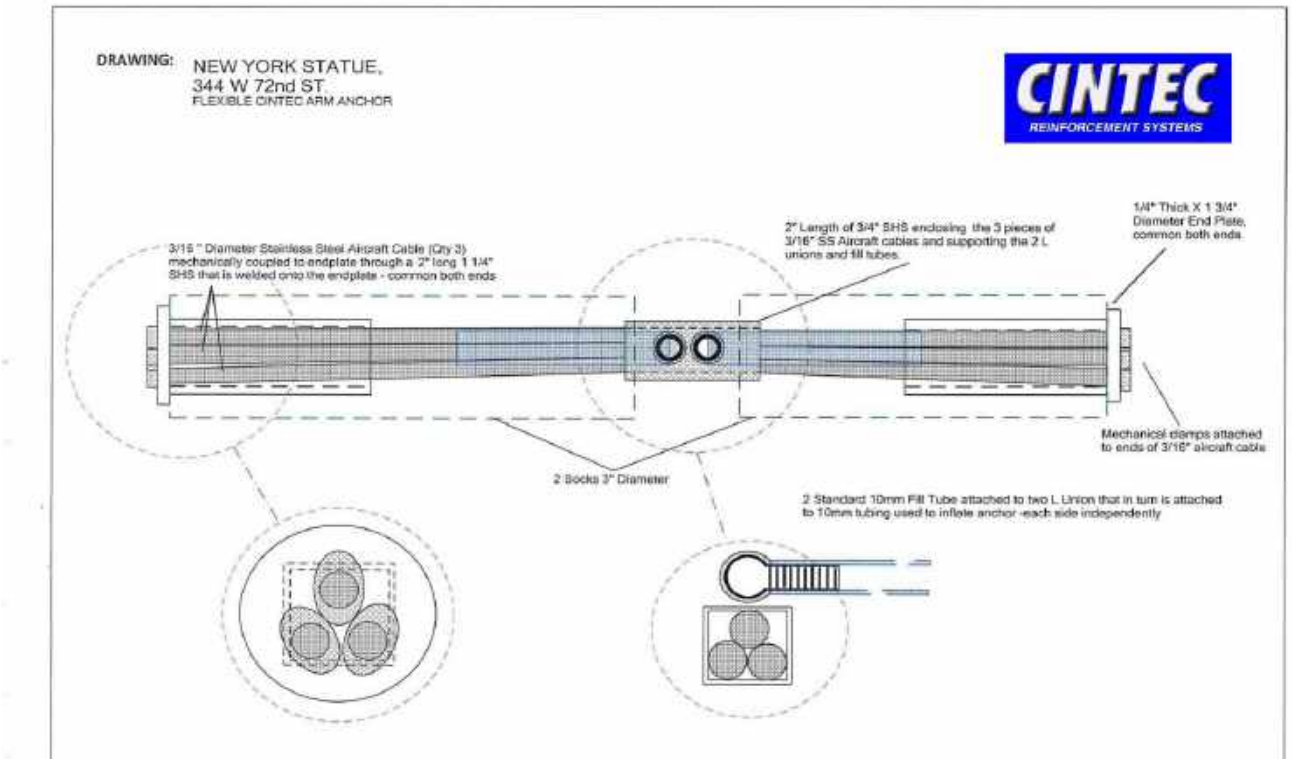


Details for Sculpture Arm Terra-Cotta Ornaments, NY



Details for Sculpture Arm Terra-Cotta Ornaments, NY





National Bank of Commerce Building, 922, Walnut Street, Kansas City, Missouri

The National Bank of Commerce Building, located at 922-924 Walnut Street, Kansas City, Missouri, is a sixteen-story granite, Brazilian brick and terra-cotta commercial building. Designed by Chicago architect Jarvis Hunt in 1906-07 and constructed in 1907-08 by George A. Fuller Company, Kansas City.

The main facade faces east. The symmetrically-placed entrances are situated behind three prominent arches, crowned by a denticulate balustrade and supported by elaborately carved moulded scrolls with volutes and garlands. Smaller similarly designed brackets, positioned at the top centre of each arch, visually resemble keystones.

The photo shows the anchor extending through the plate girder and past the attached terra cotta. The inflated anchors is 3.5” in diameter extending out of a 2.5” hole. The picture below shows this wall condition. This attachment approach secures the scrolls directly to the plate girder with a nut and washer which is recessed into the drilled hole in the face of the granite.

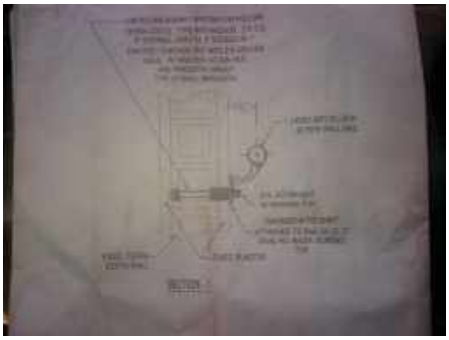
During an exterior examination of the main entrance it was discovered that the granite scrolls were showing some tendencies of later movement. The solution was to install three Cintec anchors evenly spaced the height of the granite scrolls. The scrolls are about 7 feet tall. Three 2.5” holes were drilled in the granite scrolls through an eye plate and a 4”x3”x5/16” plate girder plus through the terra cotta attached to the plate girder. Photo below shows the two holes drilled into the granite scrolls.

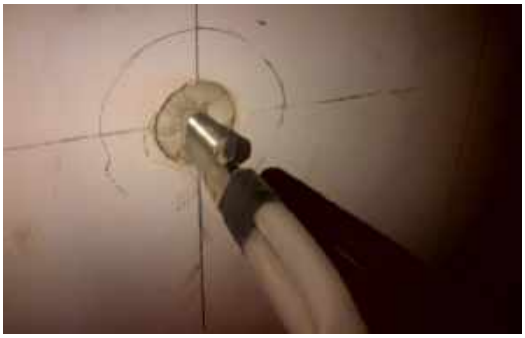
Owner:	Tower Properties Co, Kansas City, MO
Contractor:	Chamberlin Contracting, INC
Engineer of Record:	Structural Engineering Associates, Inc

New England Power Building, 441 Stuart St, Boston, Massachusetts

The New England Power Building is 11 stories tall and was built in 1927 of typical construction methods of the period. Which included using terra cotta tile as wall back up through the building including interior hallways. During the interior restoration it was discovered that the handrails were not properly attached to the terra cotta back up walls.

To solve the attachment situation a Cintec anchor 3/8" stainless steel threaded rod 7" long with a 5" sock was installed in a 2.5" hole with 1" of exposed thread was allowed for the attachment of the hand rail. The shop drawing below gives you a cross section of the design. The Cintec anchor inflates with Cintec grout to fill the terra cotta cell to give a 100% positive wall contact which controls wall pull out and prevents the anchor body from crushing the terra cotta and the original wall plaster.





Installed anchor in the wall

Two of the four anchors installed in the wall, note the exposed thread for attaching the handrail.

Owner: Synergy Investments, Boston, MA

Contractor: Ryan Iron Works, Inc

Cintec repair details base upon

TERRA COTTA

· STANDARD · CONSTRVCTION

NB: The diameter of the steel shown is for illustration purposes only. Site conditions/ application may dictate otherwise. The EOR must check and advise. In general the ends of the Cintec Anchors should not extend past the face of the Terra-Cotta untis.

Cintec anchor type A

CINTEC STAINLESS STEEL (304) M10 ANCHOR

3/8"th dia body
2" diameter sock
Set into a 1½"
diameter hole

Cintec anchor type B

CINTEC STAINLESS STEEL (304) M16 ANCHOR

5/8"th diameter body
3" diameter sock
Set into a 1½"
diameter hole

NATIONAL
TERRA COTTA SOCIETY
19 WEST 44th STREET U·S·A NEW YORK, N. Y.
1927

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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. H. 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

A brief synopsis of the manufacture of Terra Cotta

Drawings — 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.

Models and Moulds — 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.

Decoration — 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.

Clay — 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.

Pressing — 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.

Color — 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.

Firing — 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.

Fitting — 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.

Shipping — 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.

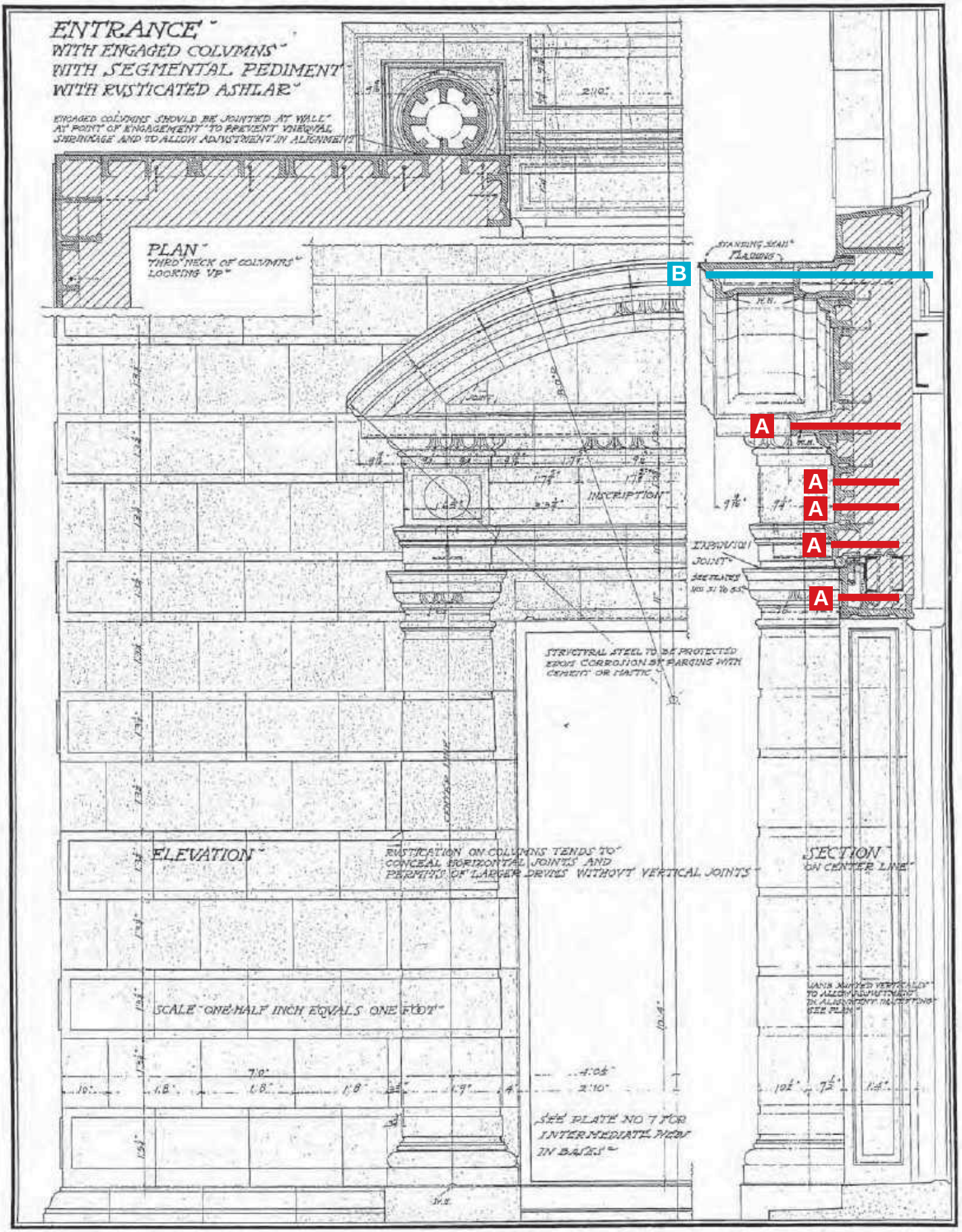
Erection — The appearance of erected Terra Cotta is greatly affected by inaccurate setting and defective pointing of the mortar joints. As the individual pieces of Terra Cotta have been carefully fitted and numbered to correspond with the erection drawings, the PIECES MUST BE ERECTED IN ACCORD WITH THE NUMBERS THEREON if satisfactory results are to be secured.

Time — 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.

Specification and Contract — 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



NATIONAL TERRA COTTA SOCIETY · U·S·A · · · PLATE NO·1

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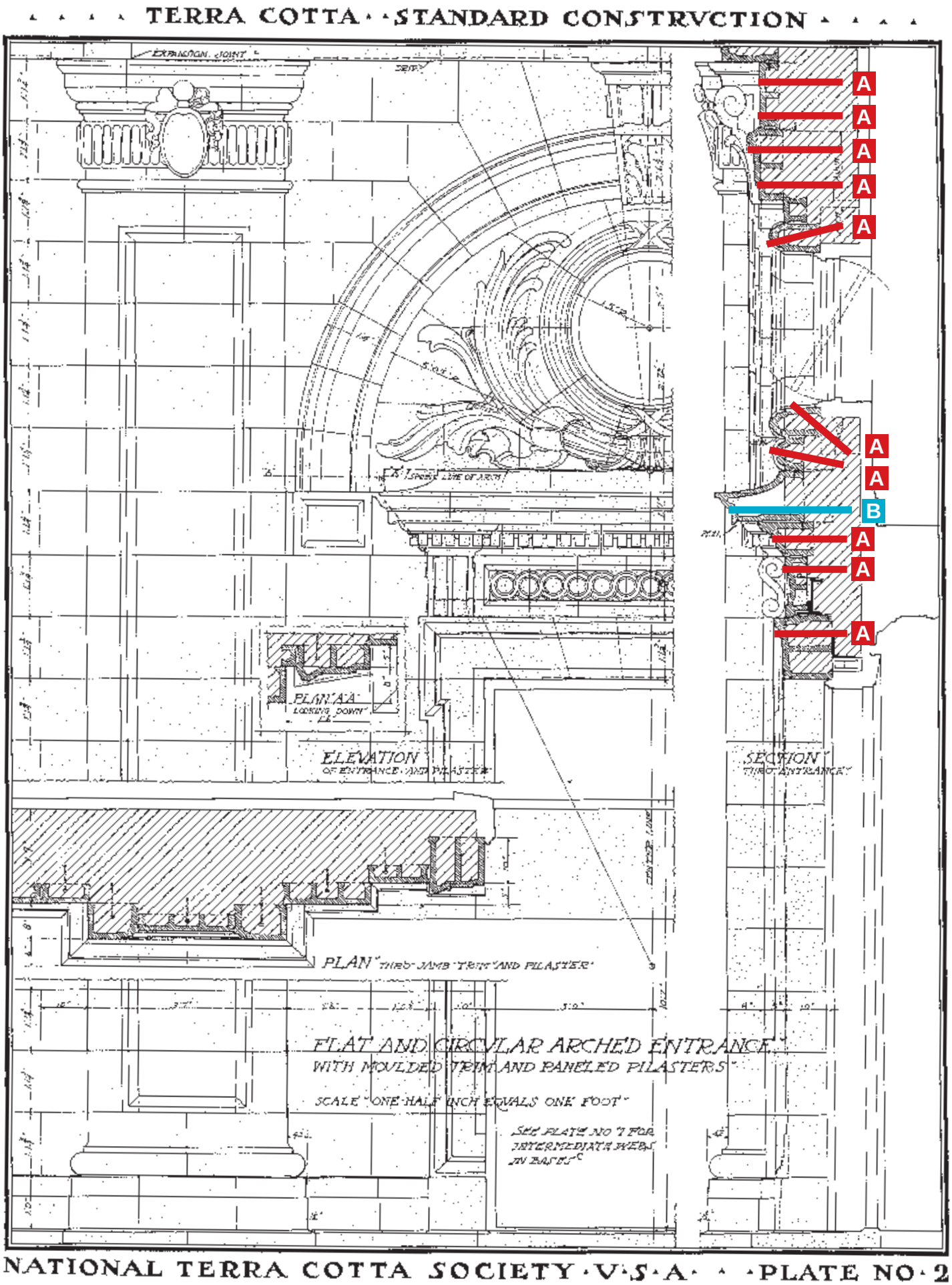

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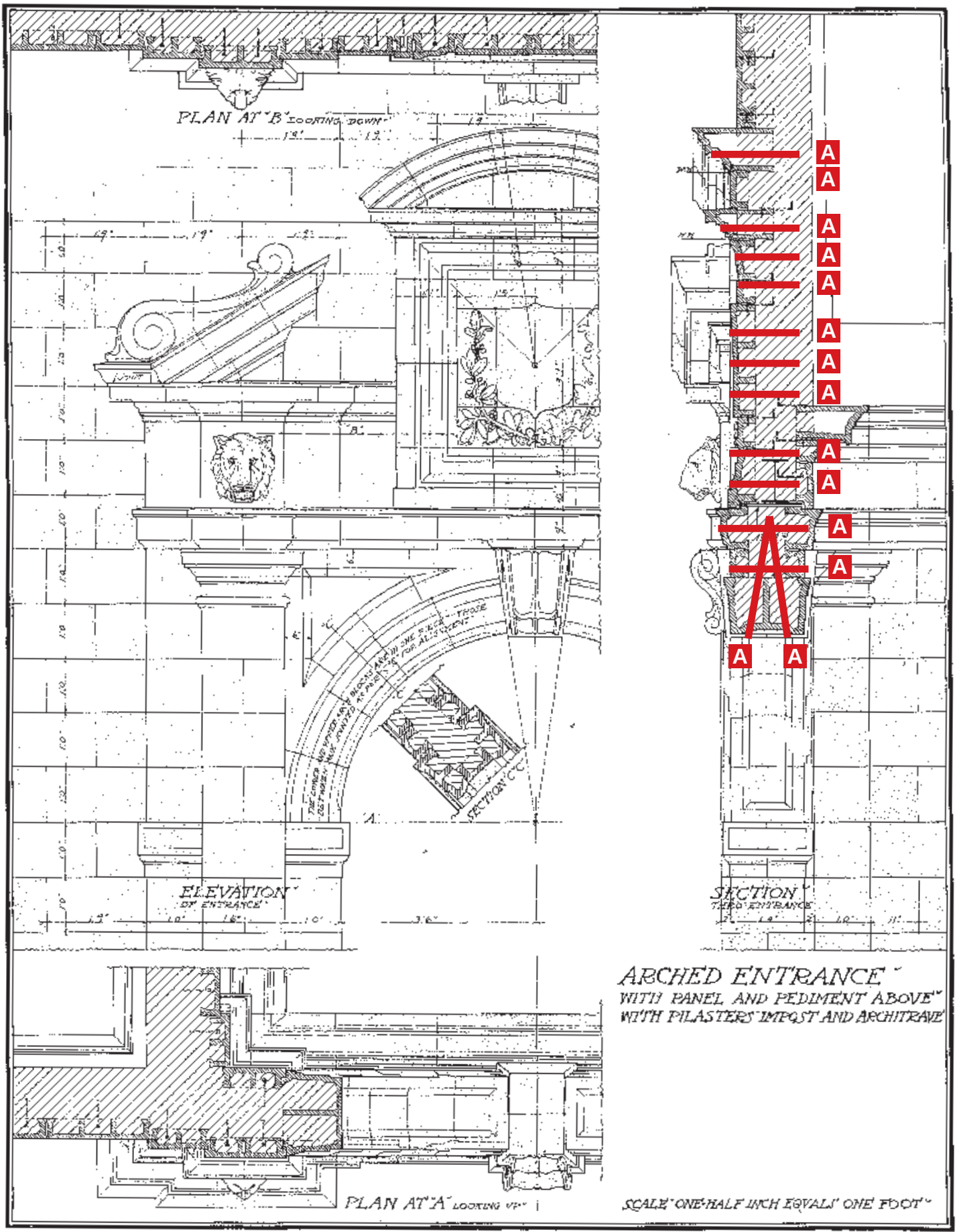
TERRA COTTA · STANDARD CONSTRUCTION



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

SCALE ONE-HALF INCH EQUALS ONE FOOT

NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·3

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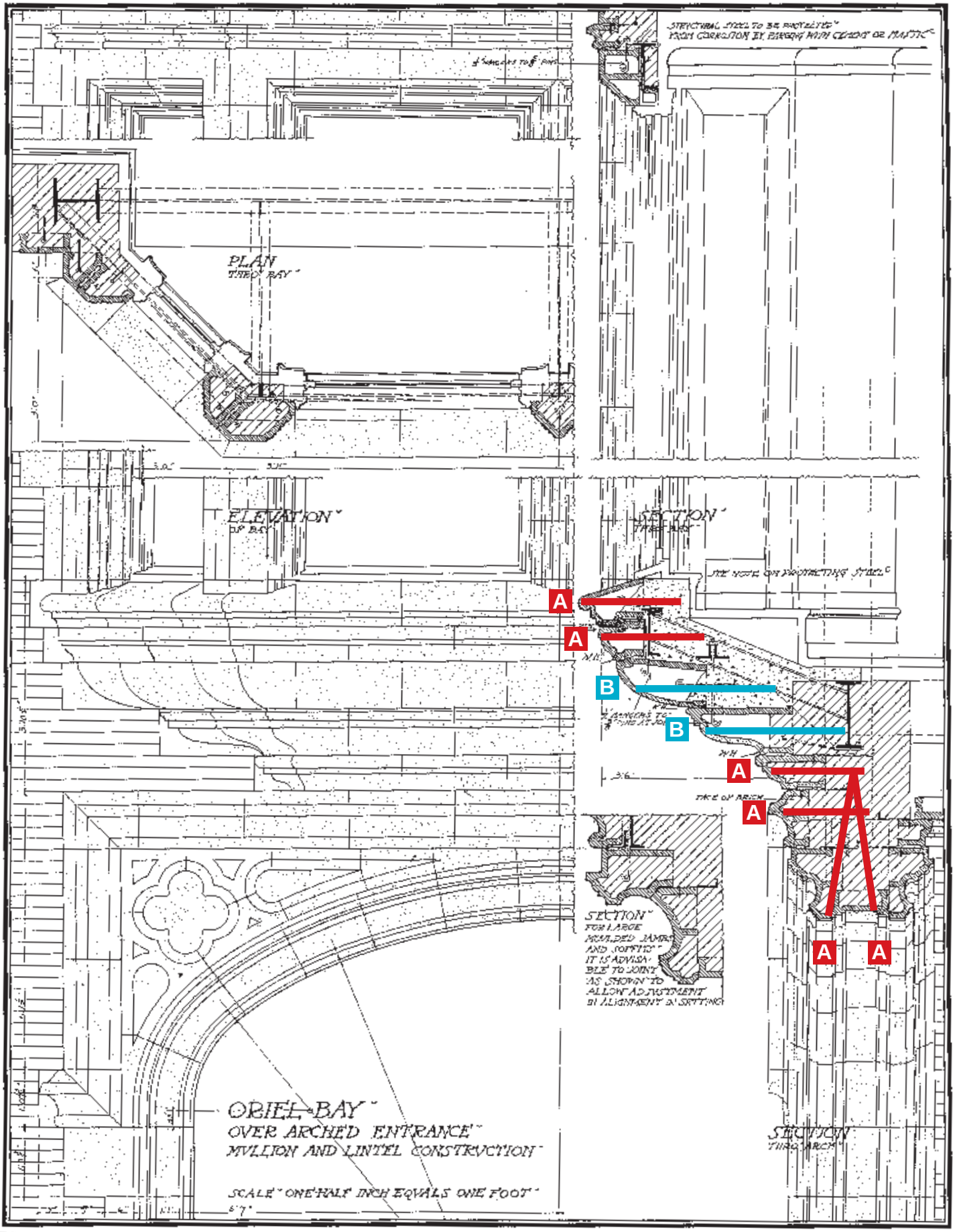
E.O.E

TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO · 4

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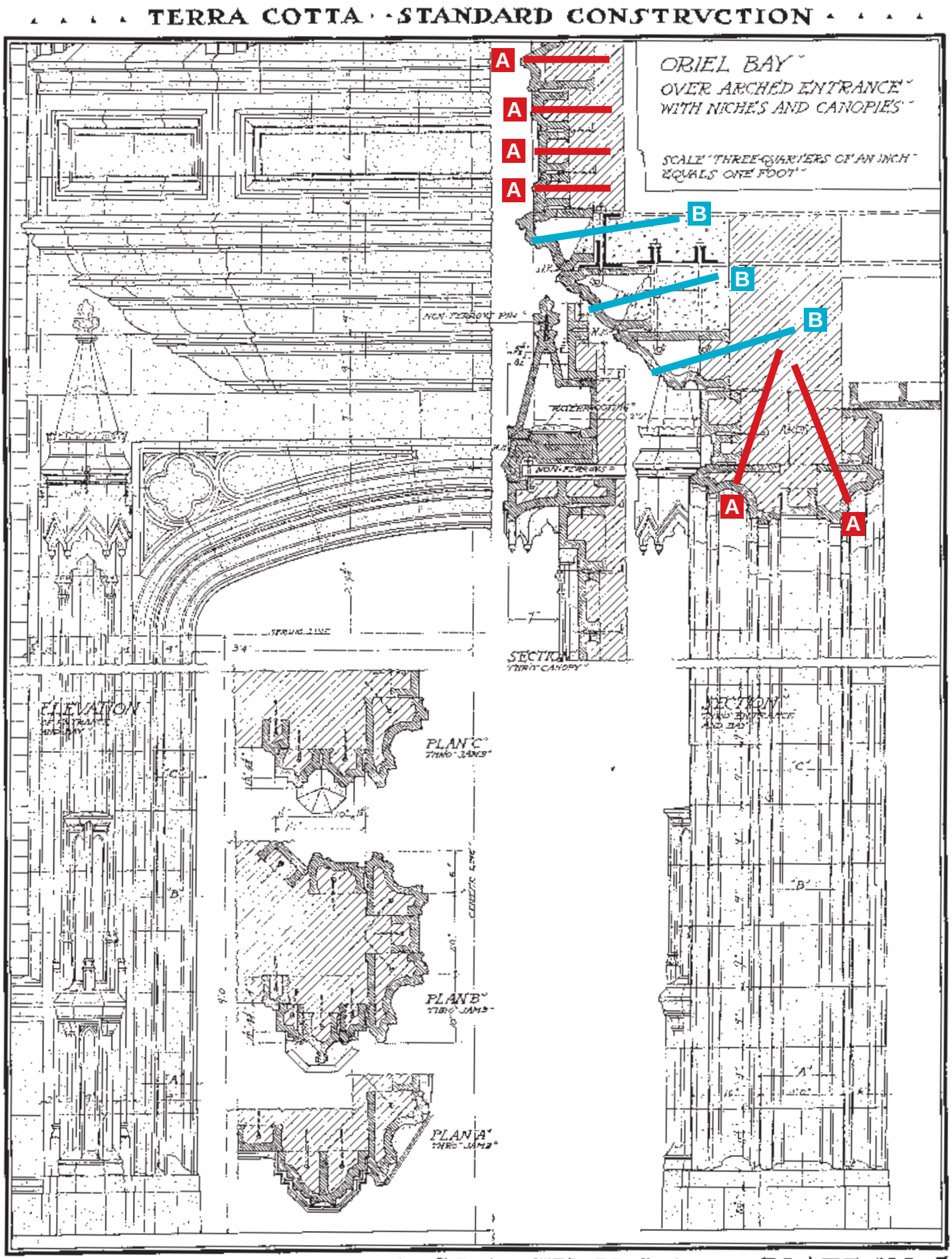
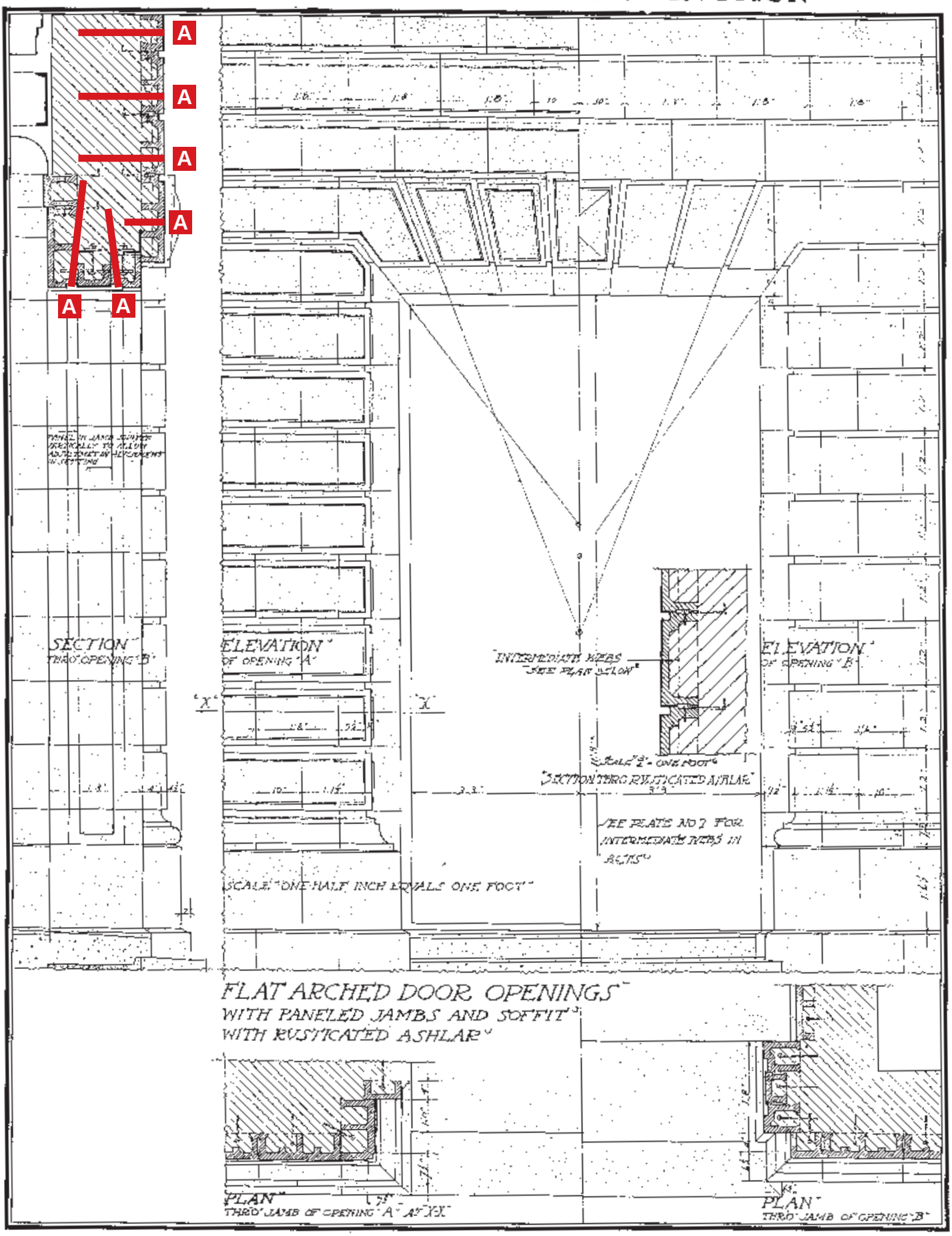
E.O.E

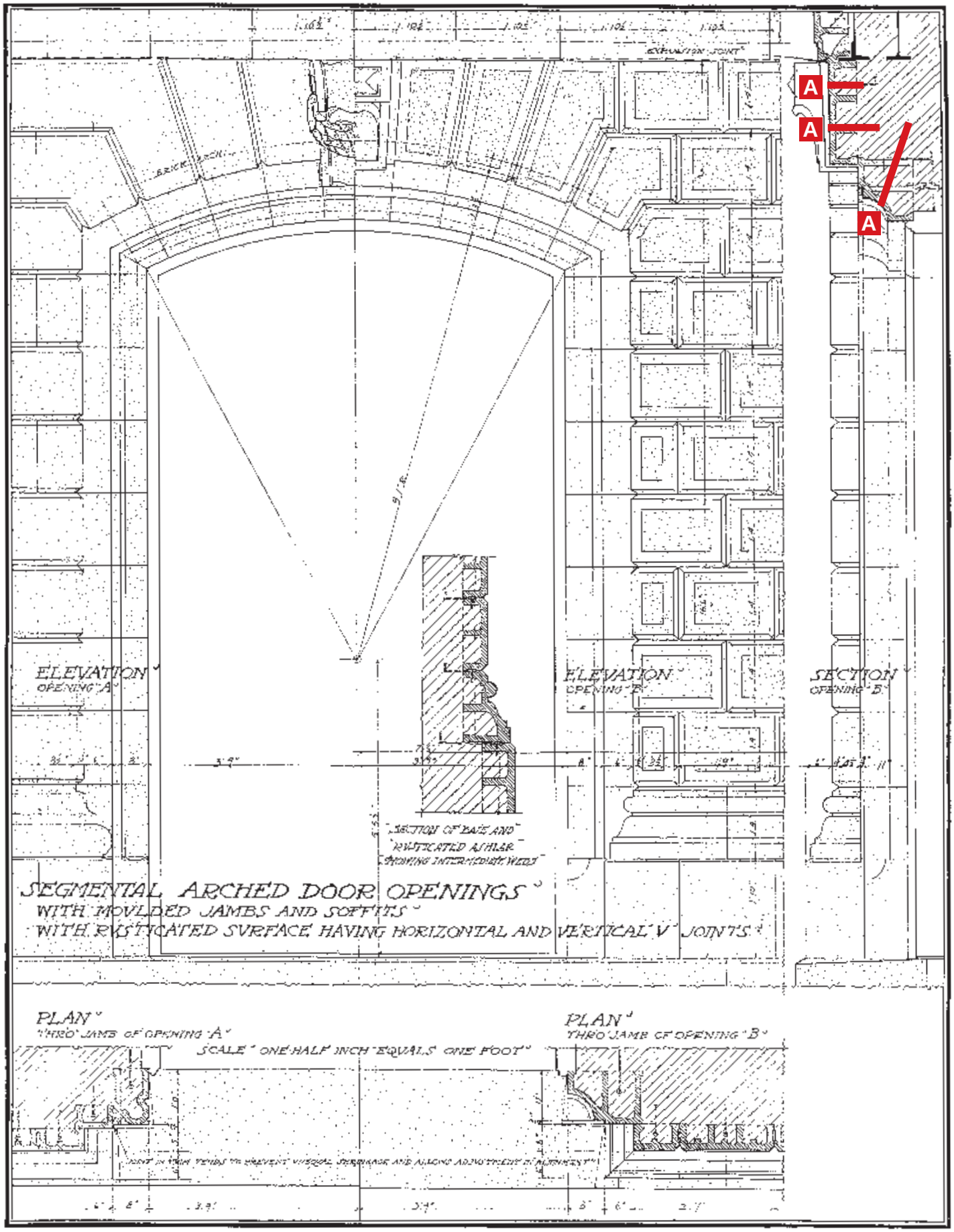

TERRA COTTA · STANDARD CONSTRUCTION
ORIEL BAY
OVER ARCHED ENTRANCE
WITH NICHES AND CANOPIES
SCALE THREE-QUARTERS OF AN INCH EQUALS ONE FOOT
A
A
A
A
B
B
B
A
A
NON-FERROUS PIN
SECTION
ELEVATION
PLAN C
PLAN B
PLAN A
SECTION
NATIONAL TERRA COTTA SOCIETY · U·S·A · · · PLATE NO·5

TERRA COTTA · STANDARD CONSTRUCTION



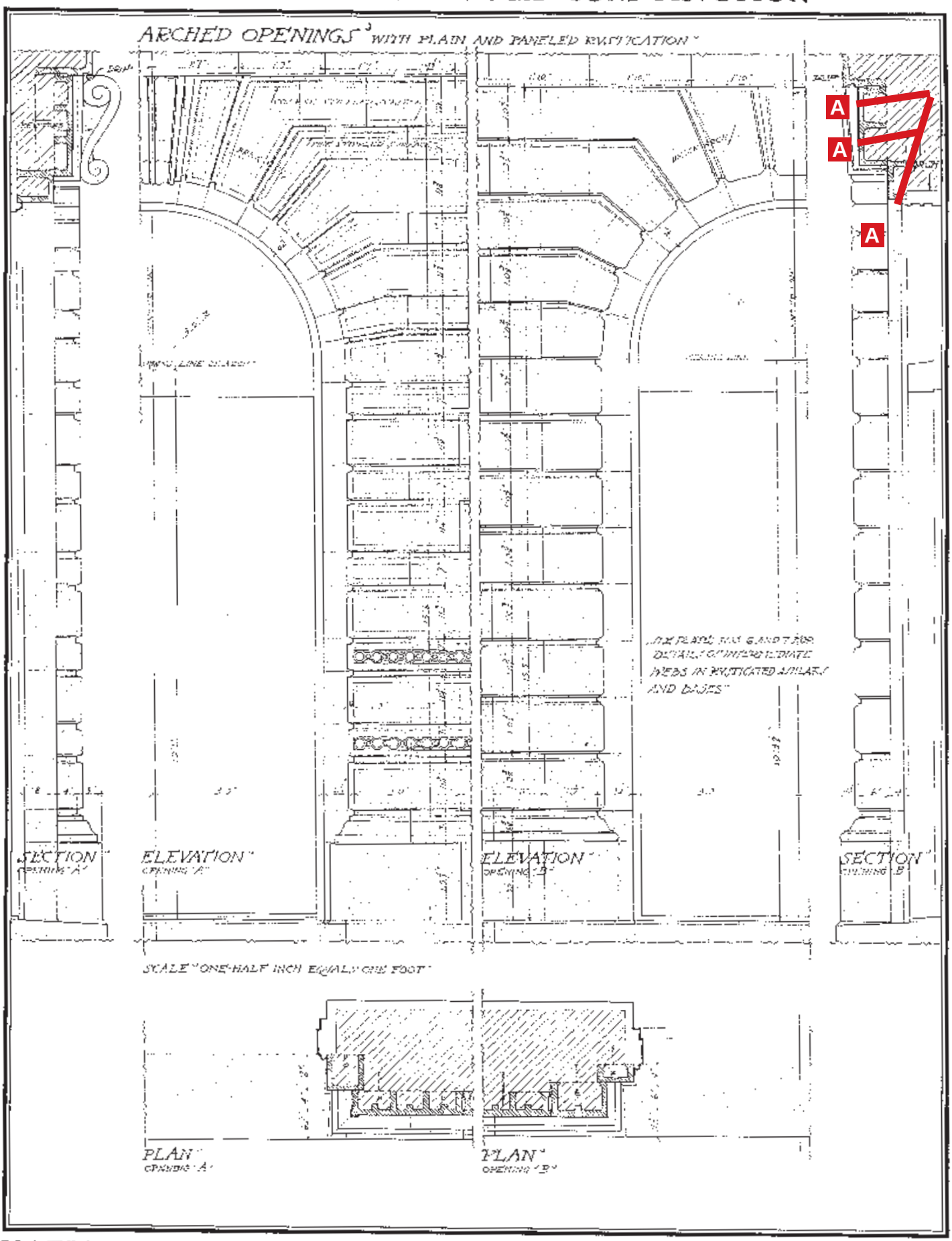
NATIONAL TERRA COTTA SOCIETY · U · S · A · · PLATE NO · 6

TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·7

TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · V · S · A · · PLATE NO · 8

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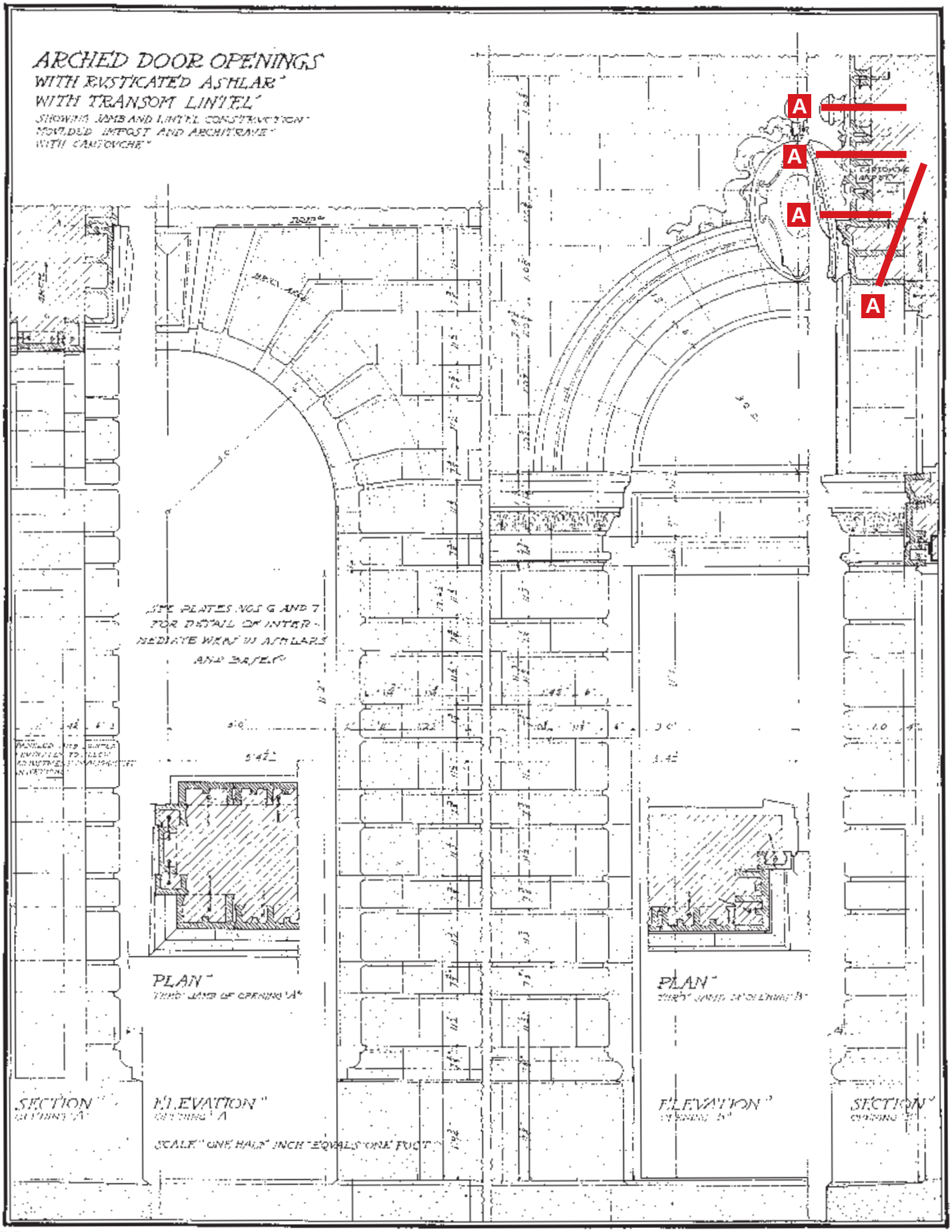
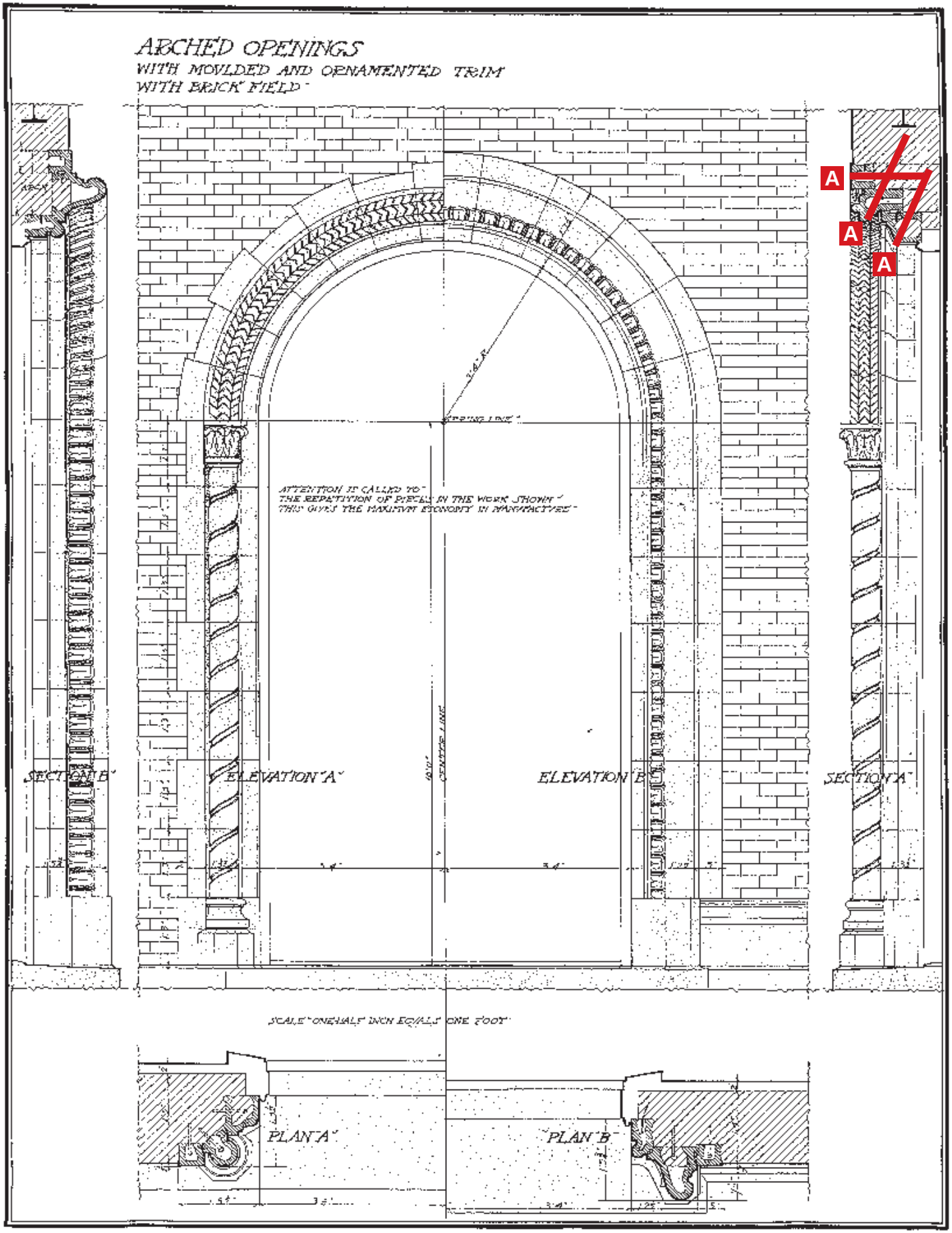
E.O.E

TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U·S·A · · · PLATE NO · 9

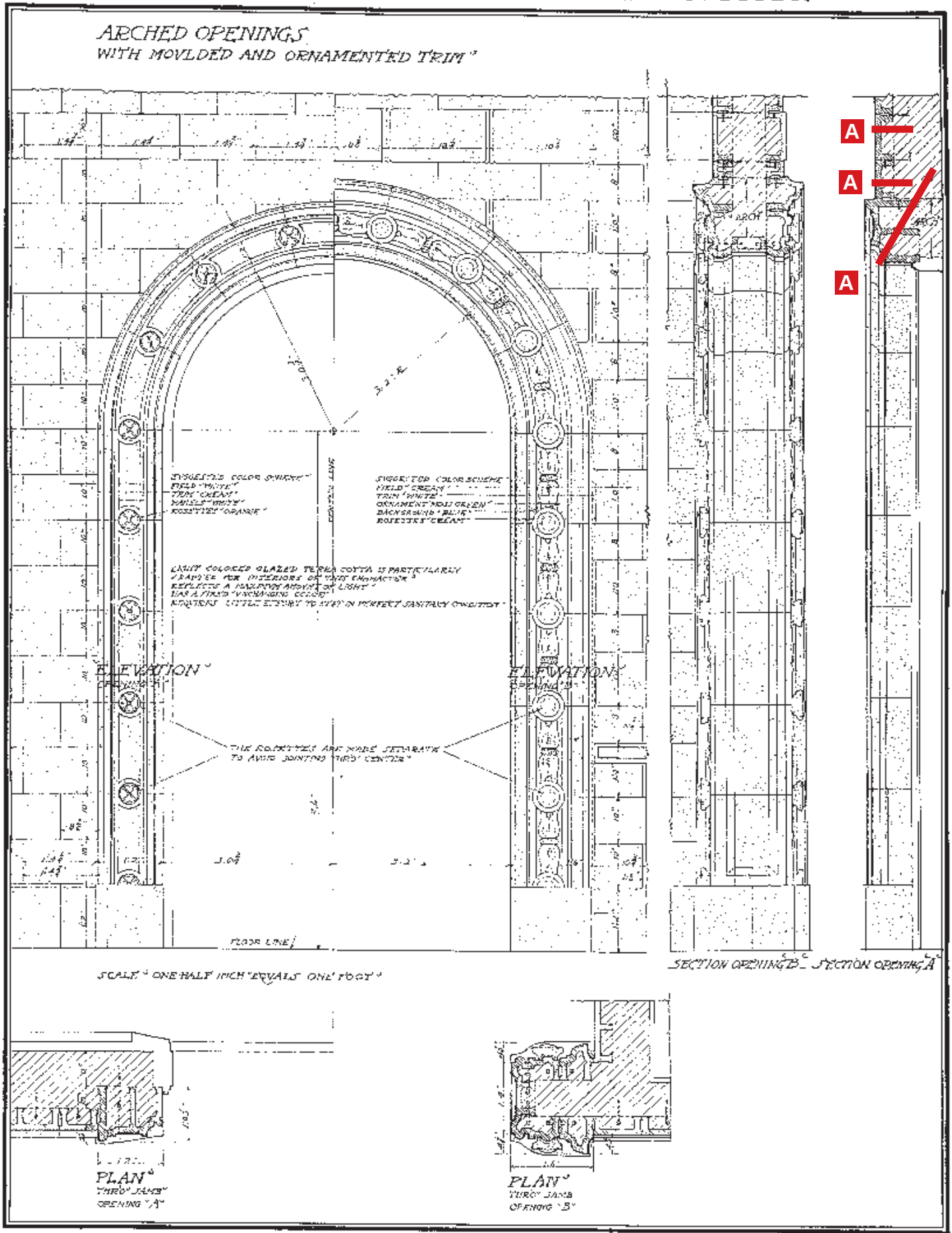
TERRA COTTA · STANDARD CONSTRUCTION



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

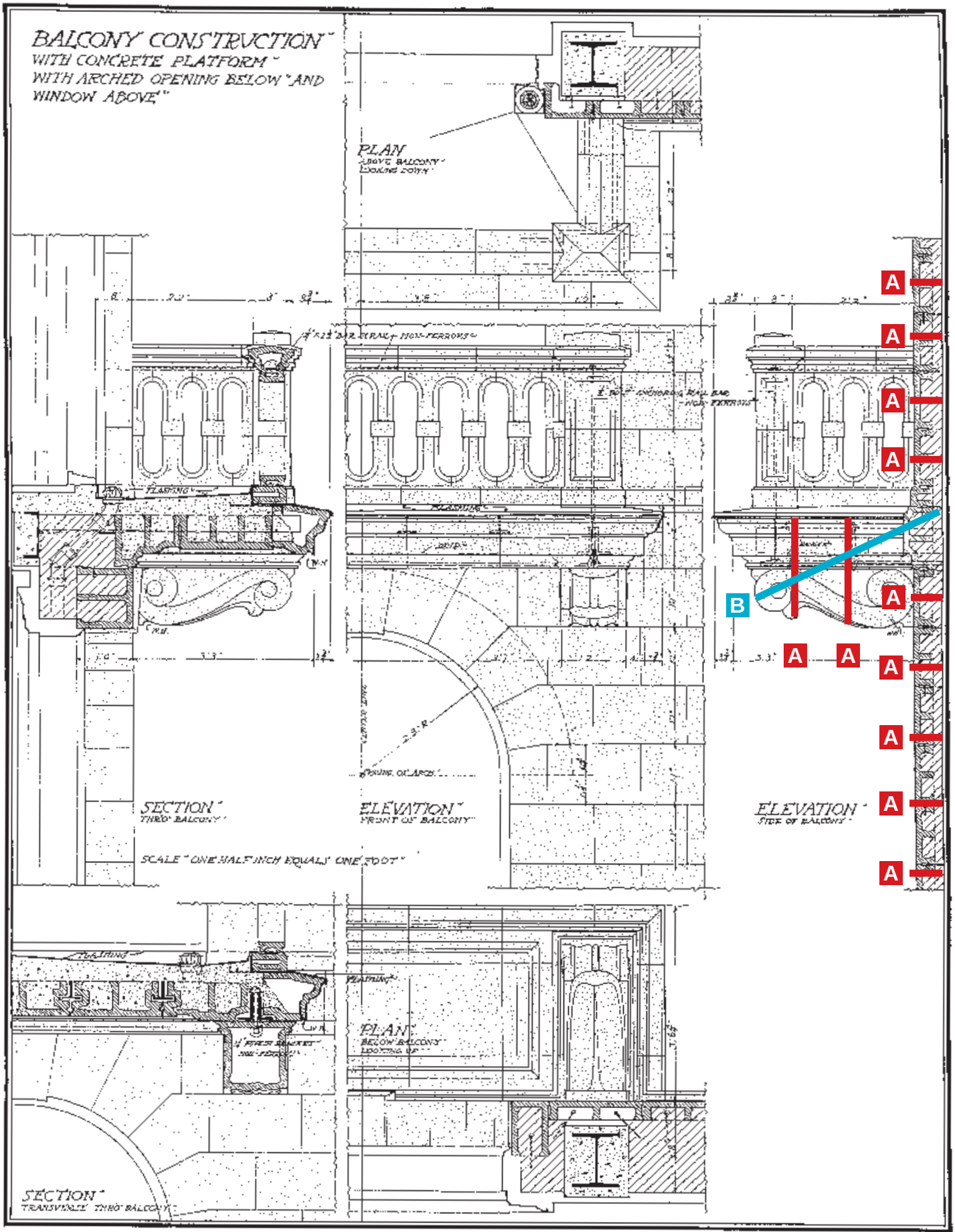
1

TERRA COTTA STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY U.S.A. PLATE NO. 11

TERRA COTTA · STANDARD CONSTRUCTION



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

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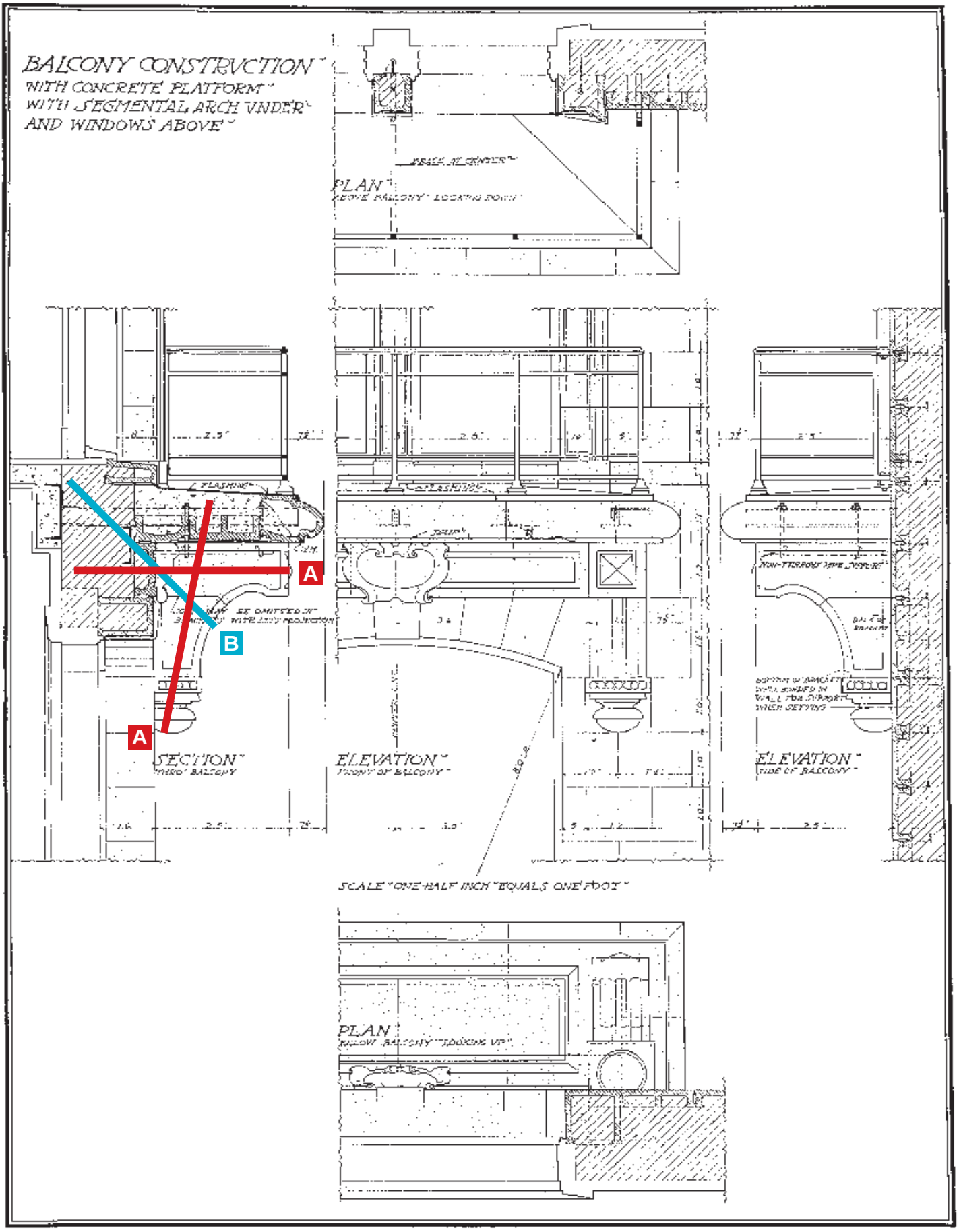
E.O.E

TERRA COTTA STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY V.S.A. PLATE NO. 13

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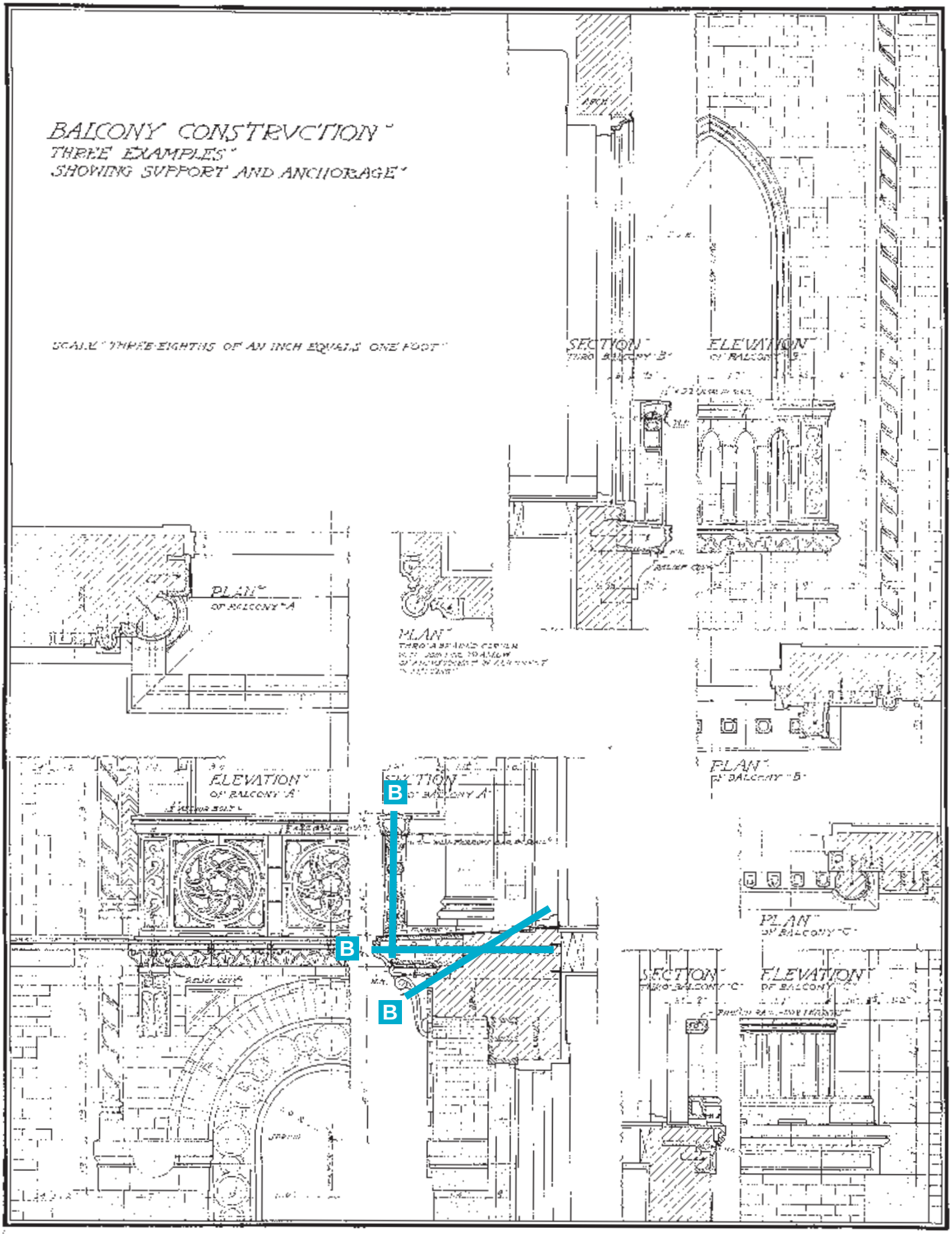
E.O.E

TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO · 14

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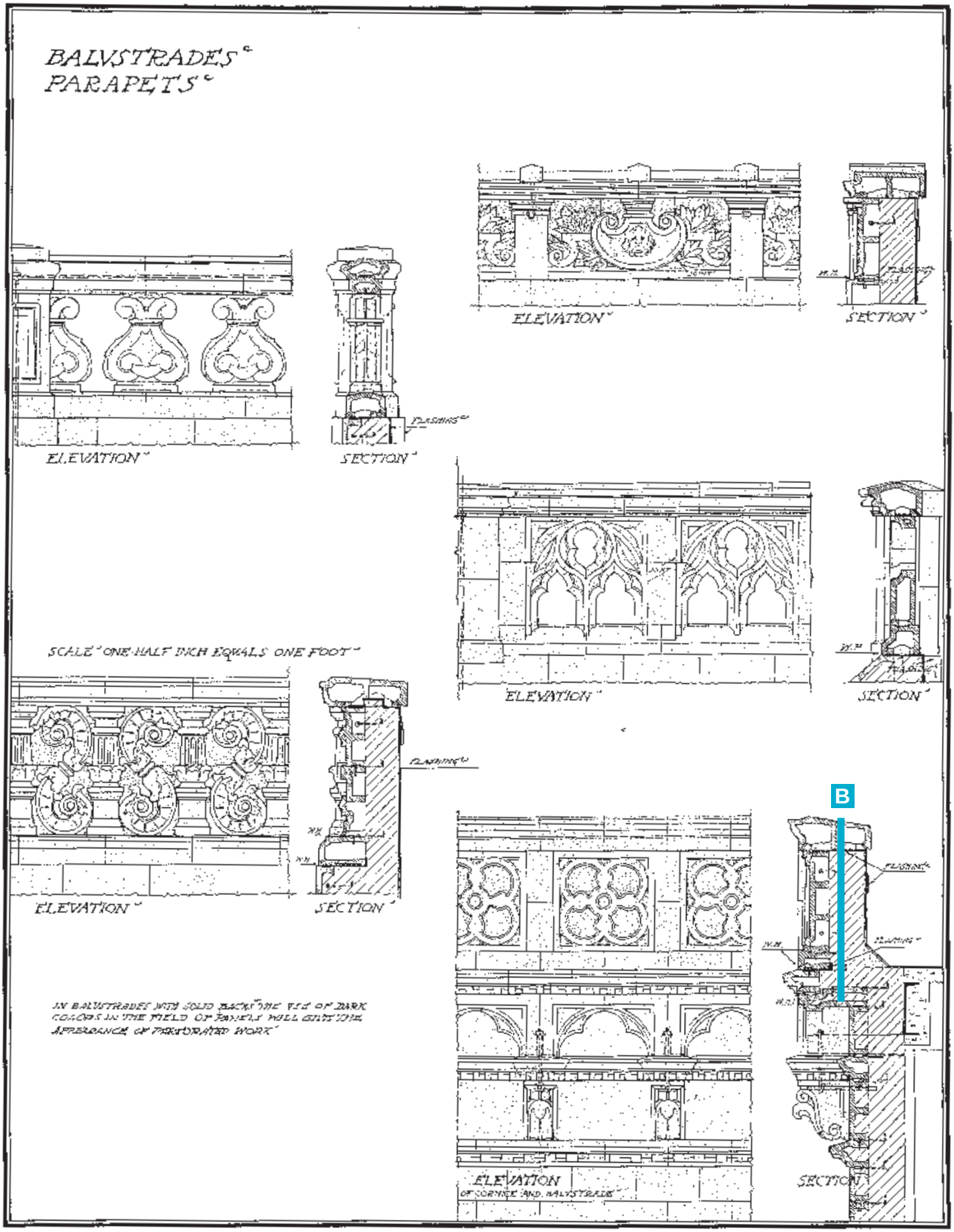
E.O.E

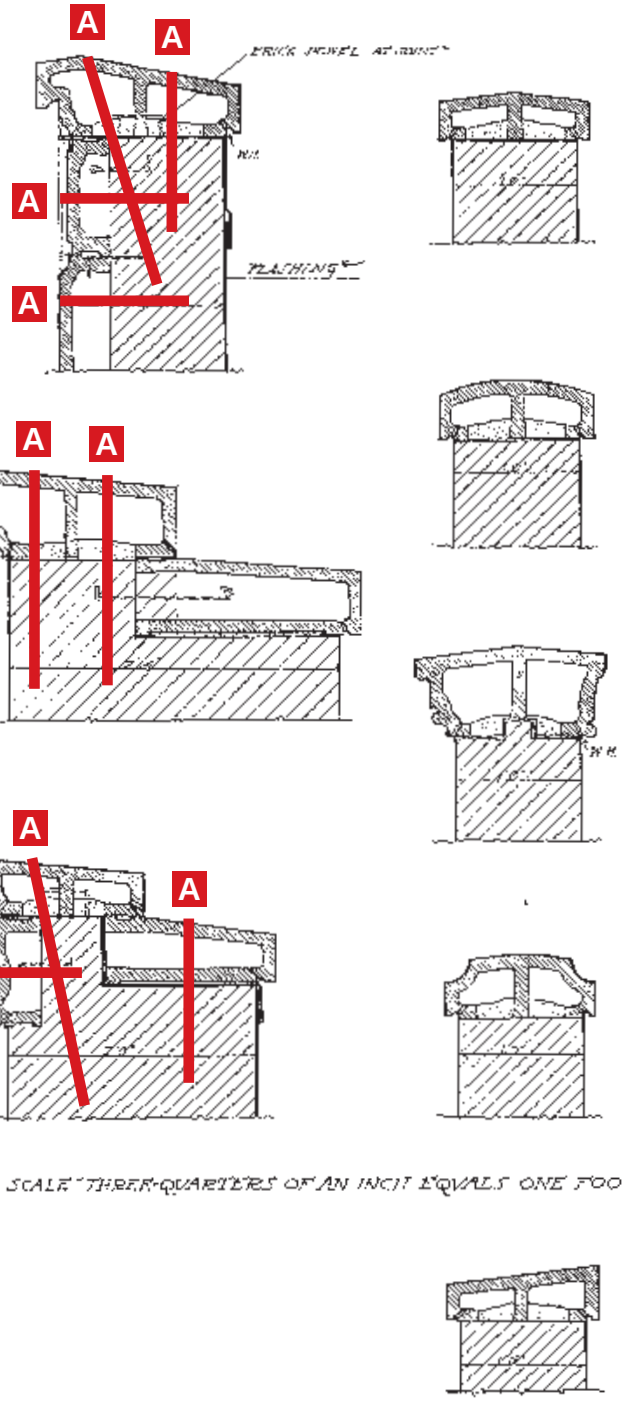
TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U · S · A · · PLATE NO · 15

TERRA COTTA · STANDARD CONSTRUCTION

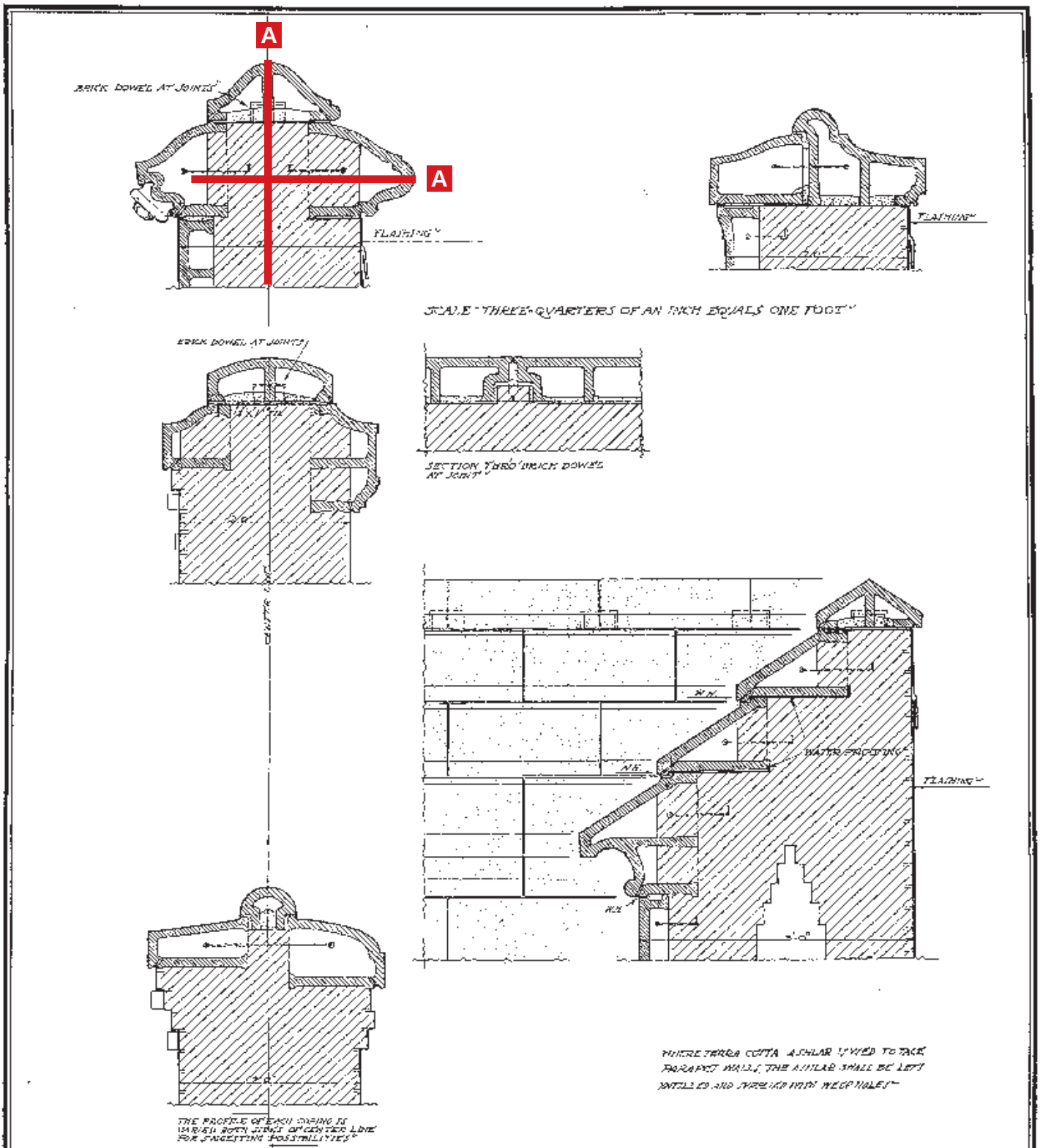
WALL COPINGS AND BALUSTRADES
SHOWING VARIOUS METHODS OF JOINTING AND ANCHORING



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

NATIONAL TERRA COTTA SOCIETY · V · S · A · · PLATE NO · 16

TERRA COTTA · STANDARD CONSTRUCTION



COPINGS

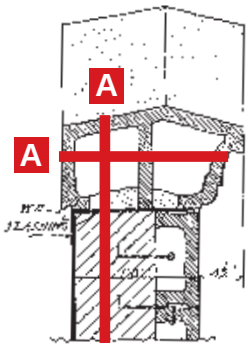
FOR WALL 2'-0" AND MORE THICK

SHOWING VARIOUS METHODS OF JOINTING AND ANCHORING

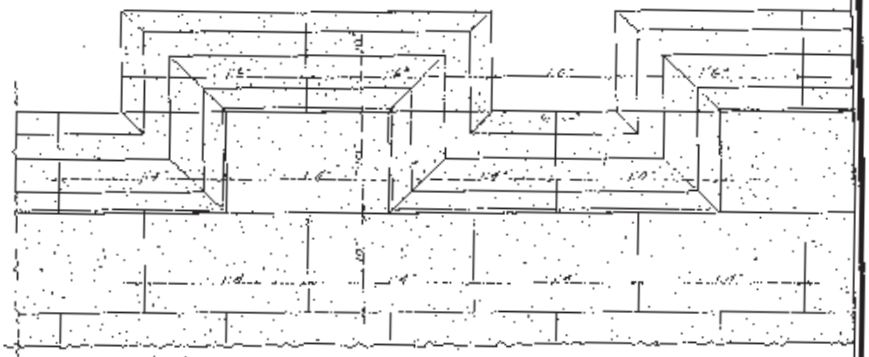
NATIONAL TERRA COTTA SOCIETY · V · S · A · · PLATE NO · 17

TERRA COTTA · STANDARD CONSTRUCTION

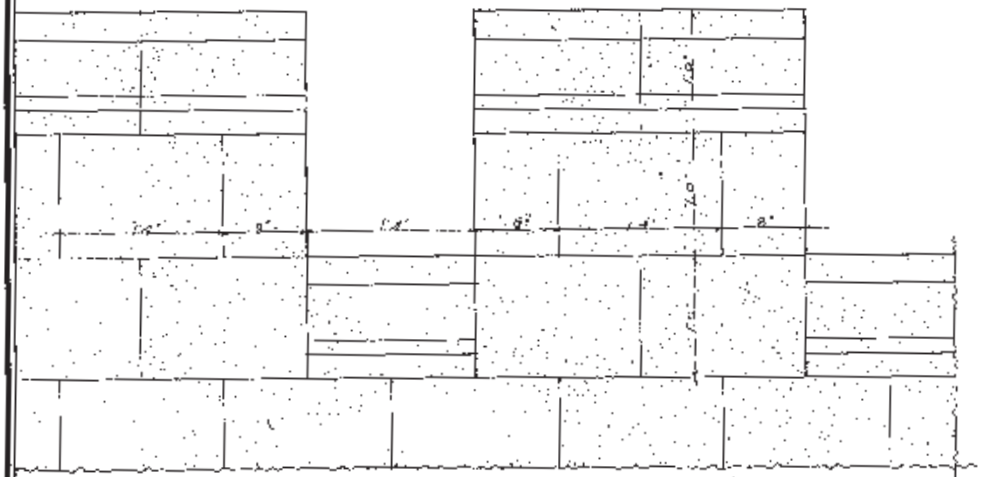
BATTLEMENTED COPING AND SET-OFFS



SECTION THRO' COPING "A"



ELEVATION OF COPING "A"



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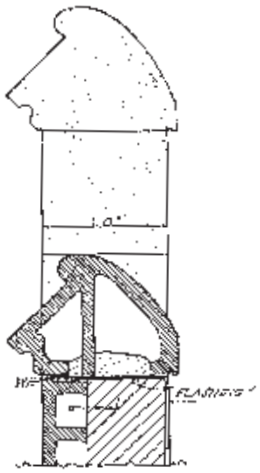
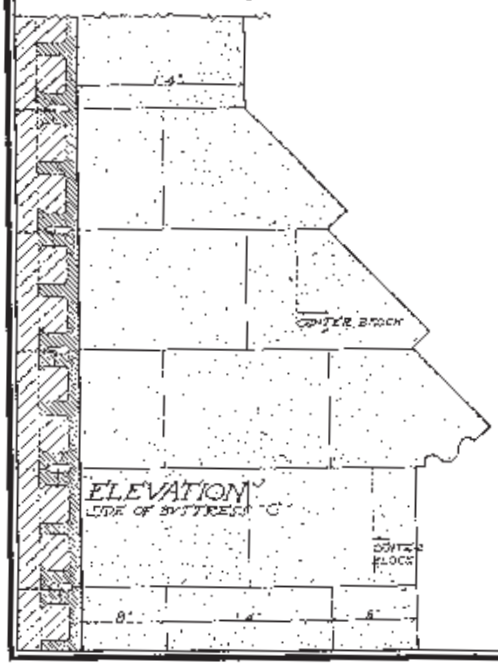
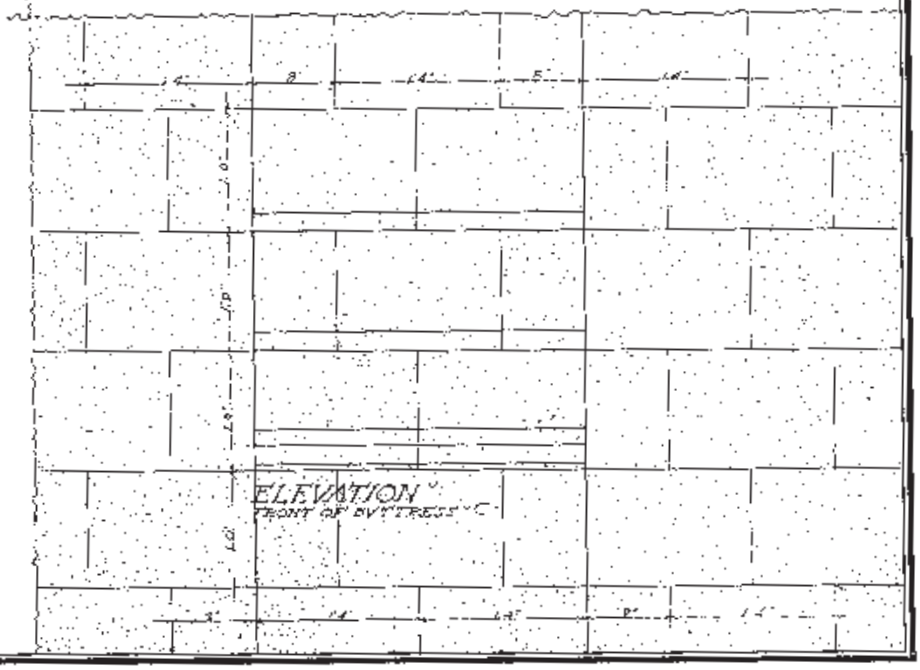


SECTION THRO' COPING "B"

SCALE "THREE QUARTERS OF AN INCH EQUALS ONE FOOT"



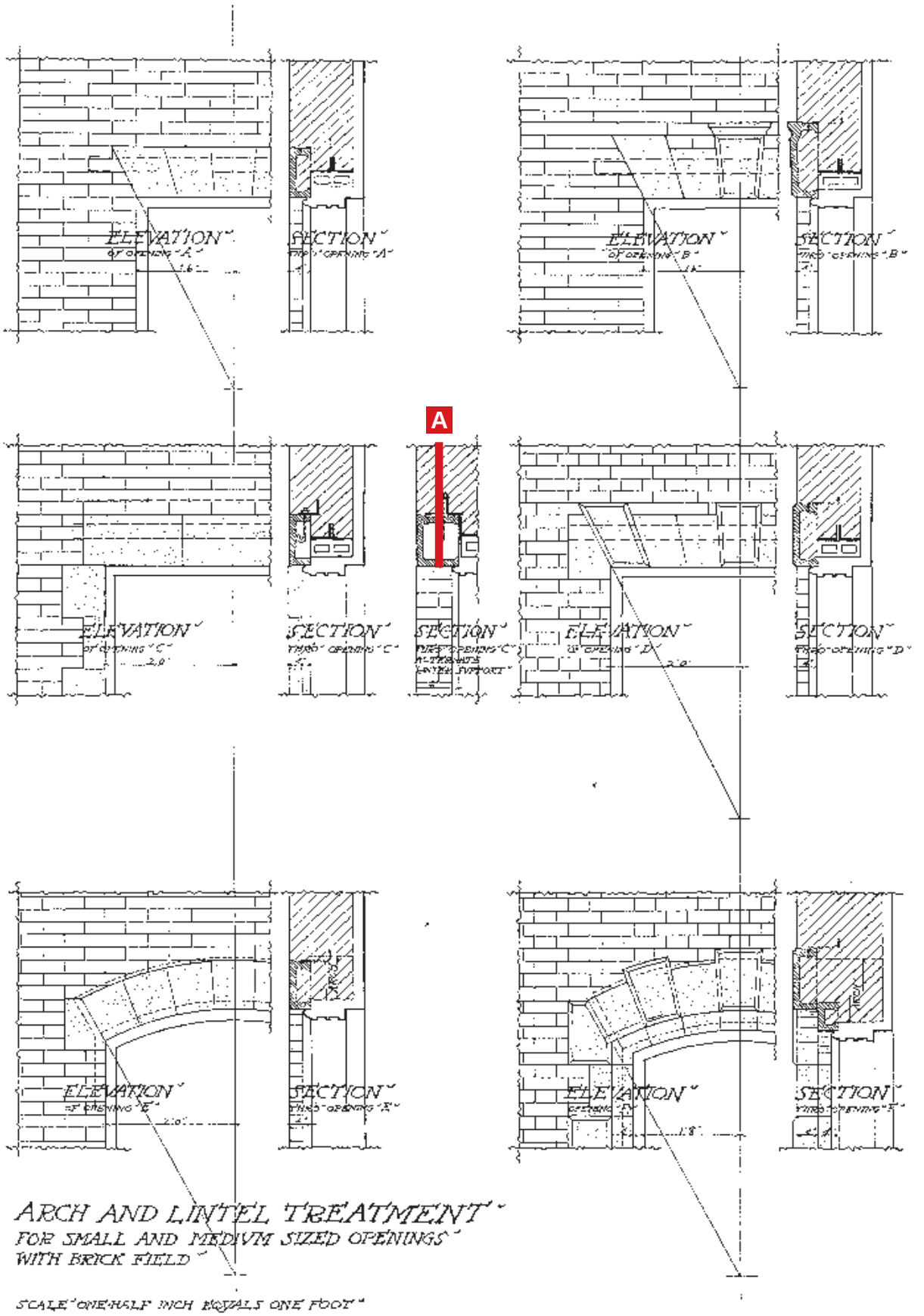
ELEVATION SIDE OF BUTTRESS "C"



ELEVATION FRONT OF BUTTRESS "C"

NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·18

TERRA COTTA · STANDARD CONSTRUCTION

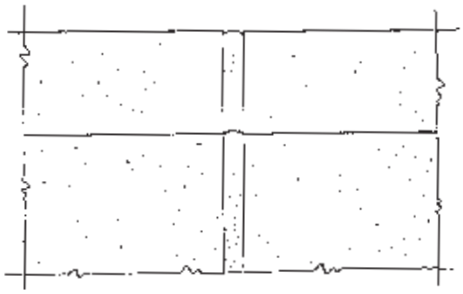


ARCH AND LINTEL TREATMENT
FOR SMALL AND MEDIVM SIZED OPENINGS
WITH BRICK FIELD

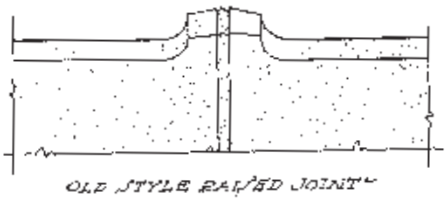
SCALE ONE-HALF INCH EQVALS ONE FOOT

NATIONAL TERRA COTTA SOCIETY · V · S · A · · PLATE NO · 19

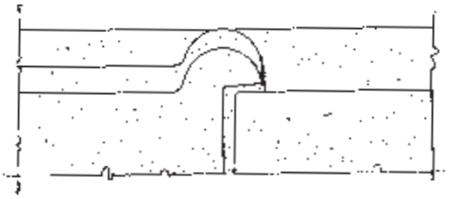
TERRA COTTA · STANDARD CONSTRUCTION



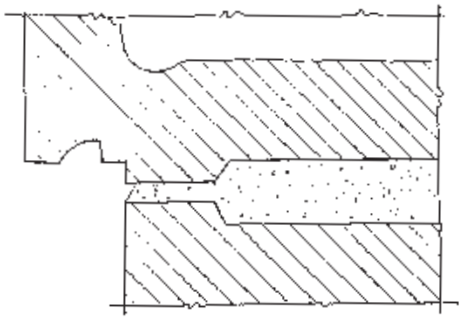
"STANDARD FLUSH JOINT" RECOMMENDED AS SUPERIOR TO THE OLD STYLE RAISED AND ROLL JOINTS SHOWN BELOW



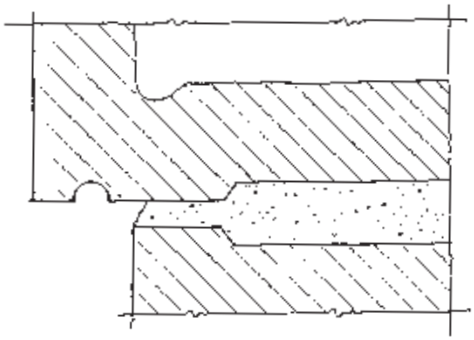
OLD STYLE RAISED JOINT



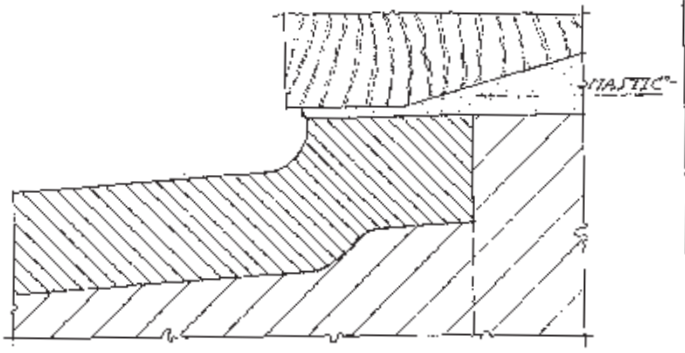
OLD STYLE ROLL JOINT



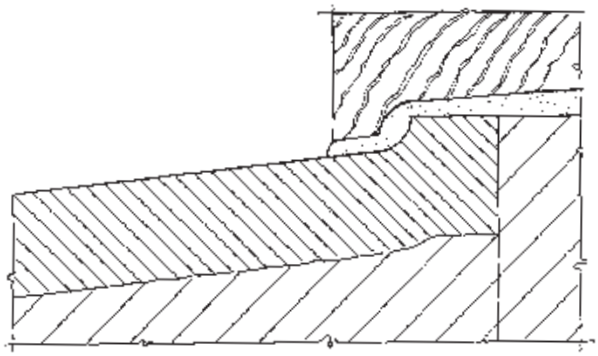
TYPICAL DRIP DETAILS



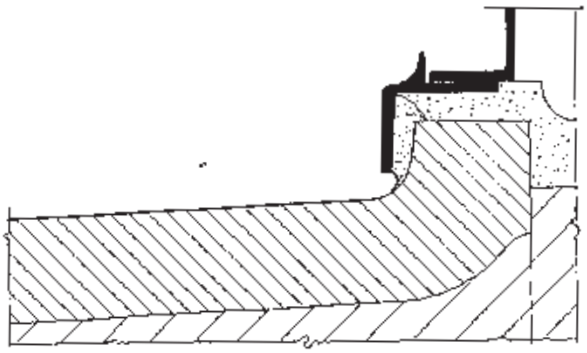
SCALE HALF AND QUARTER FULL SIZE



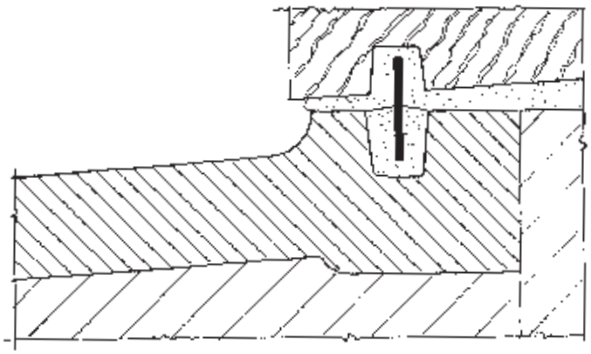
WOOD OR HOLLOW METAL SILLS



TUCK UNDER SILL



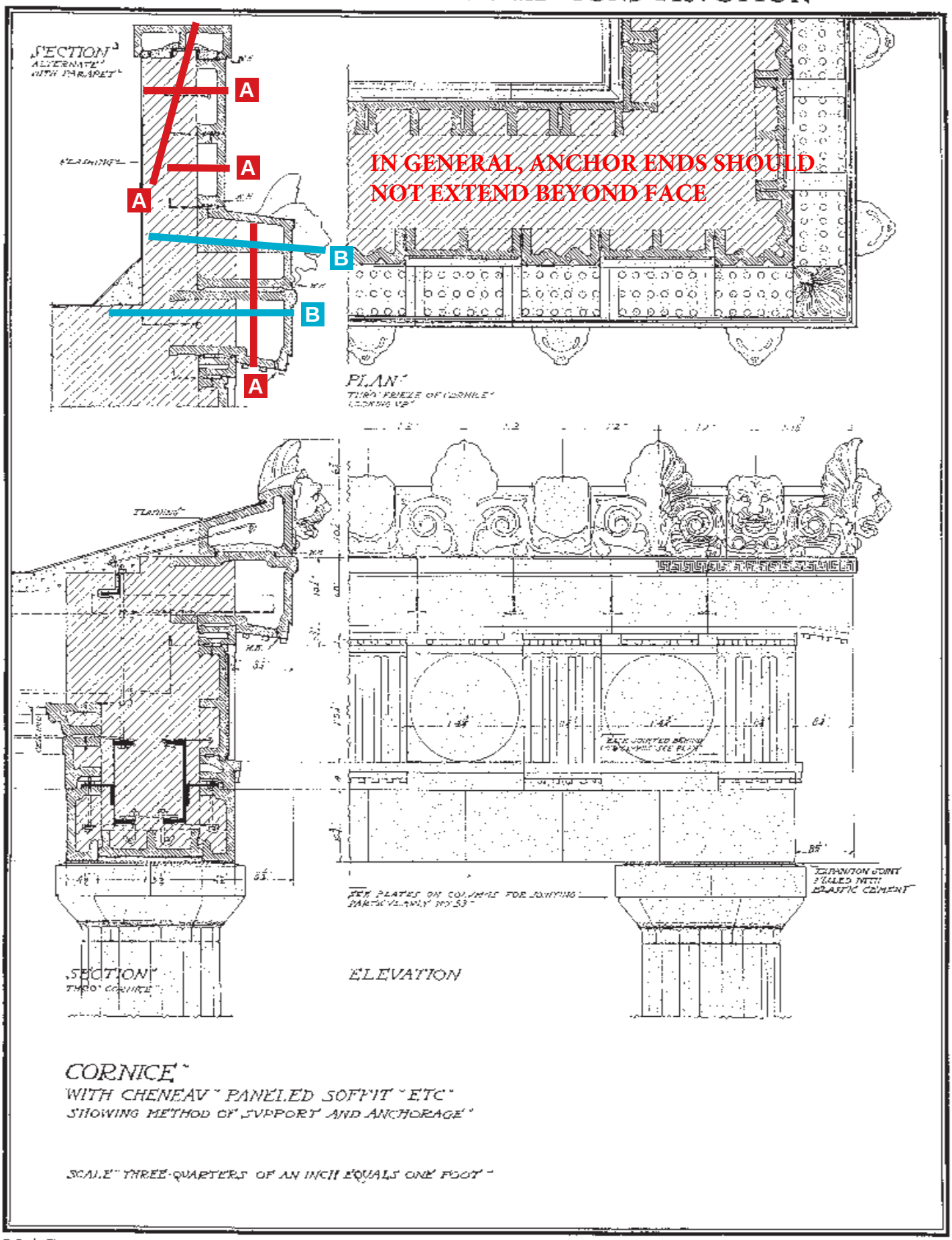
SILL FOR SOLID METAL FRAMES



SILL WITH NON-FERROUS WATER BAR

NATIONAL TERRA COTTA SOCIETY · U · S · A · · PLATE NO · 20

TERRA COTTA · STANDARD CONSTRUCTION



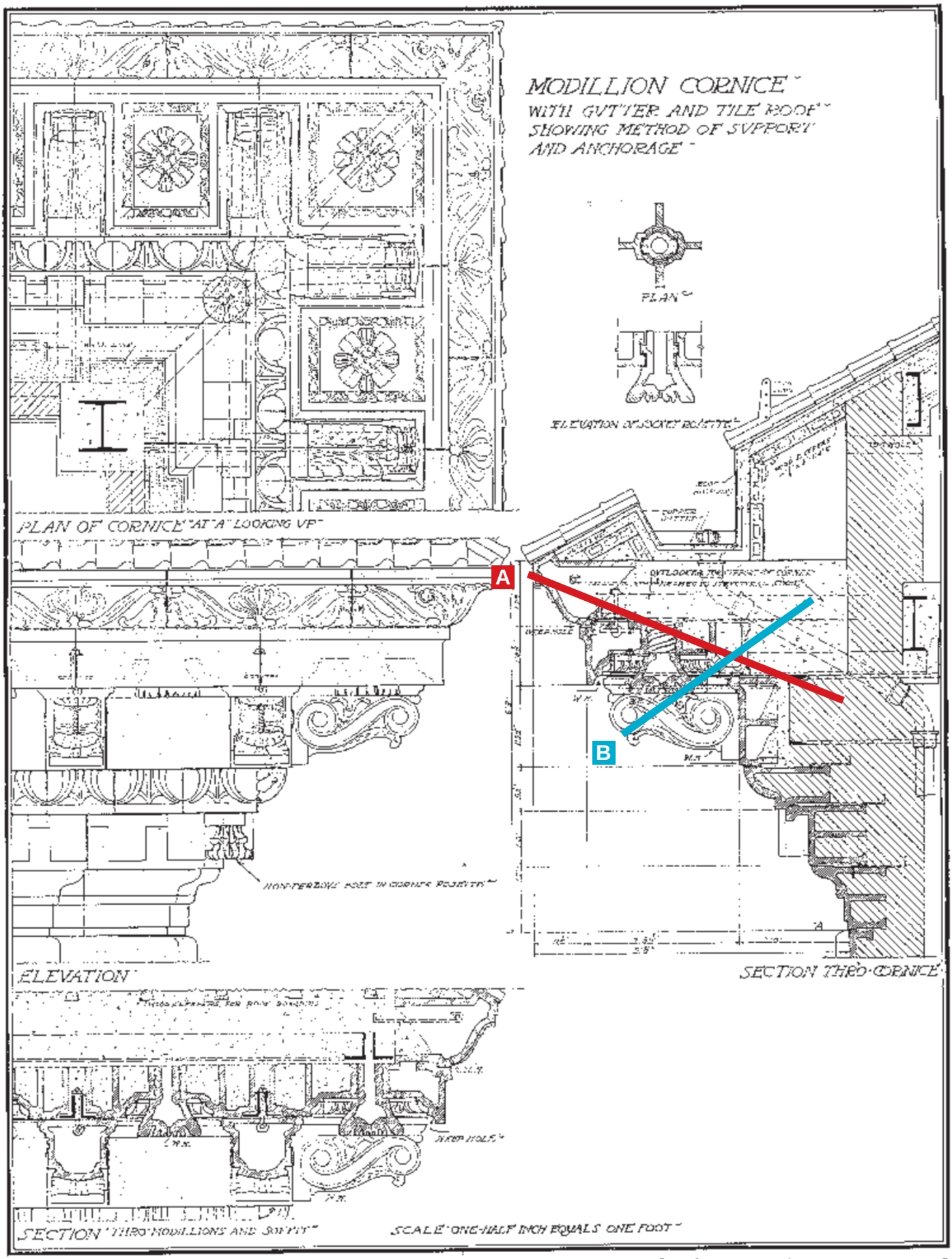
CORNICE
WITH CHENEAU, PANELED SOFFIT, ETC.
SHOWING METHOD OF SUPPORT AND ANCHORAGE.

SCALE: THREE-QUARTERS OF AN INCH EQUALS ONE FOOT.

NATIONAL TERRA COTTA SOCIETY · U.S.A. · PLATE NO. 21

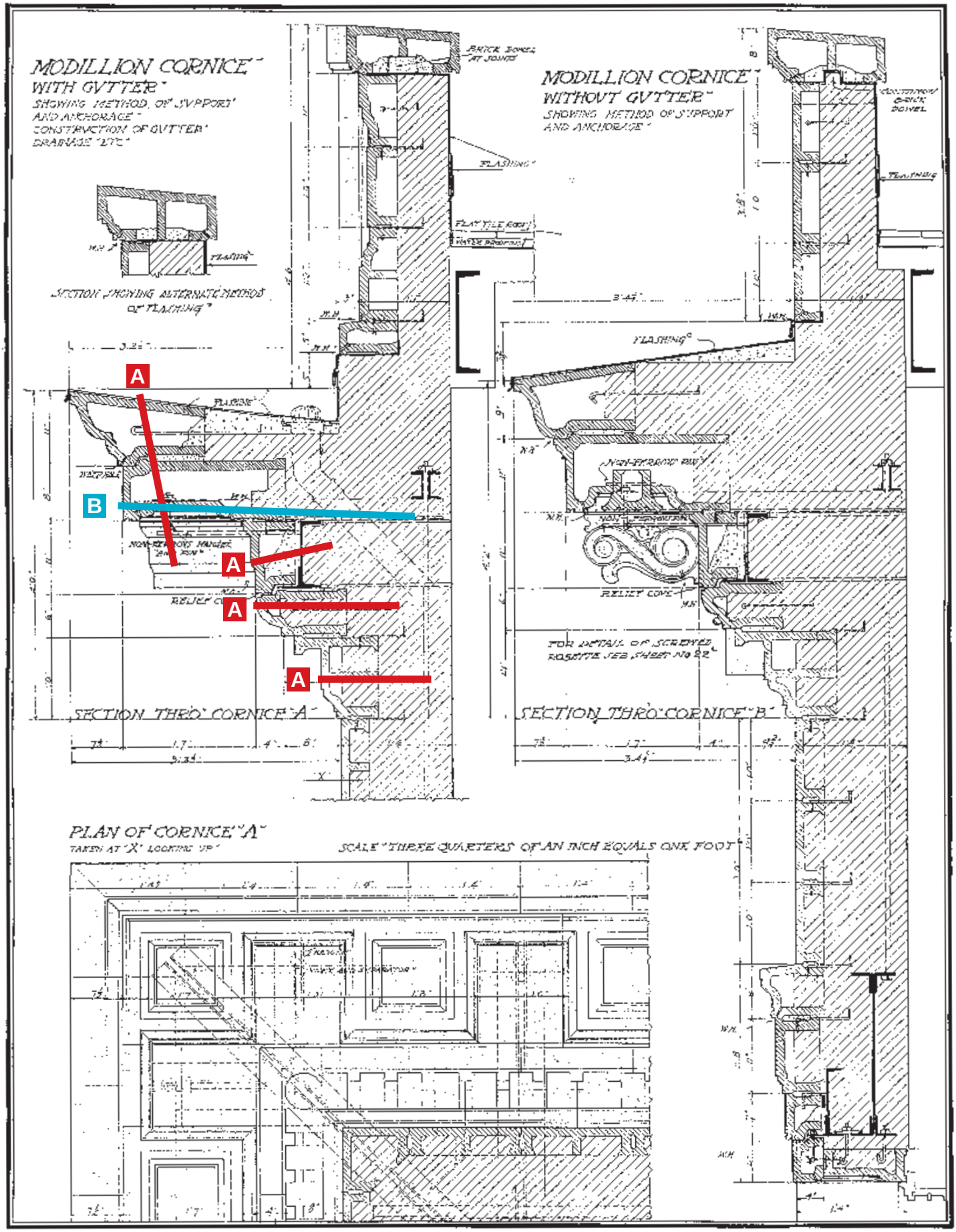
This manual provides general information for use in preliminary selection of a Cintec anchor.
Final designs must be prepared by Cintec and approved by the project Architect or Engineer of Record.

TERRA COTTA · STANDARD CONSTRUCTION



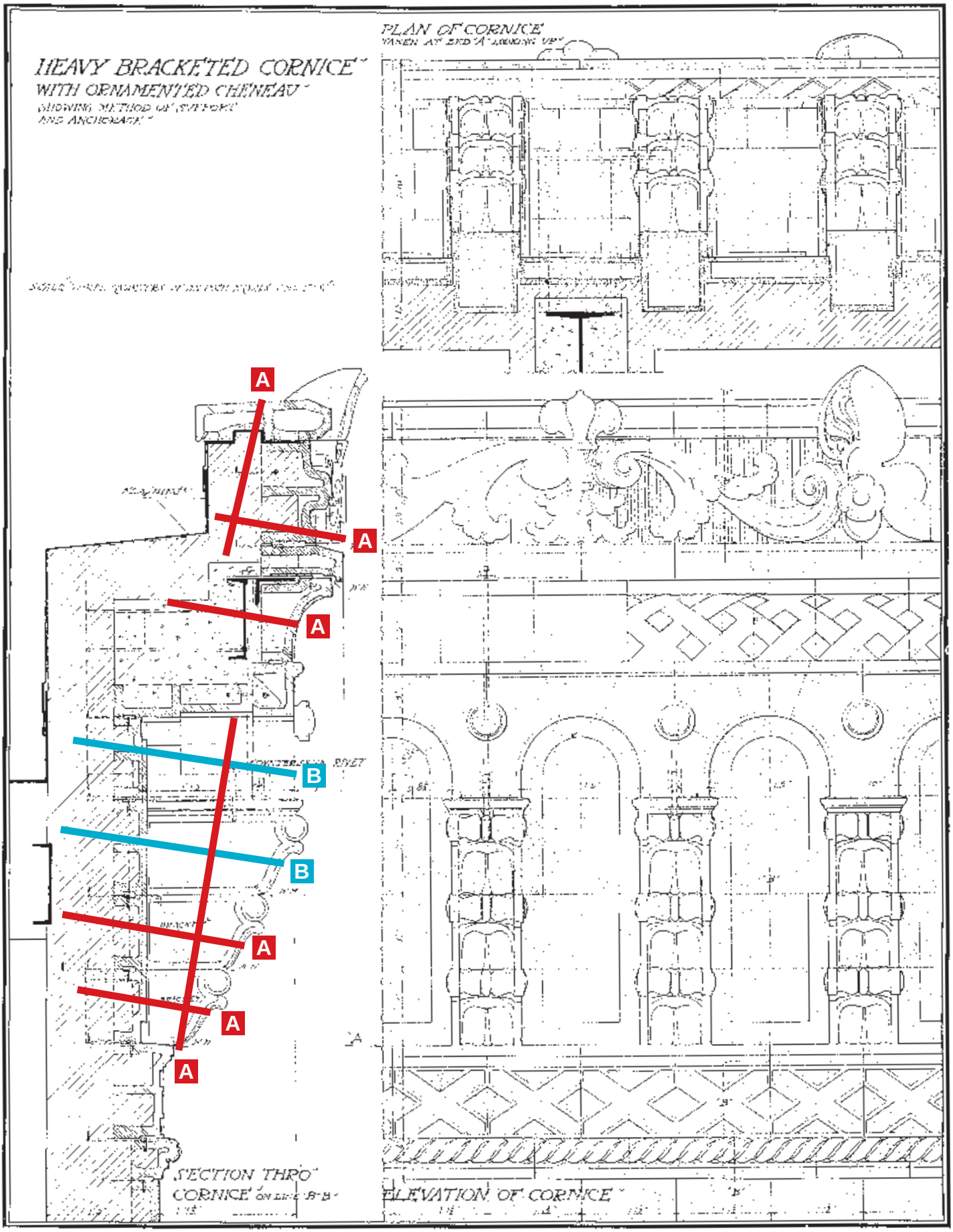
NATIONAL TERRA COTTA SOCIETY · V · S · A · PLATE NO · 22

TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·23

TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO · 24

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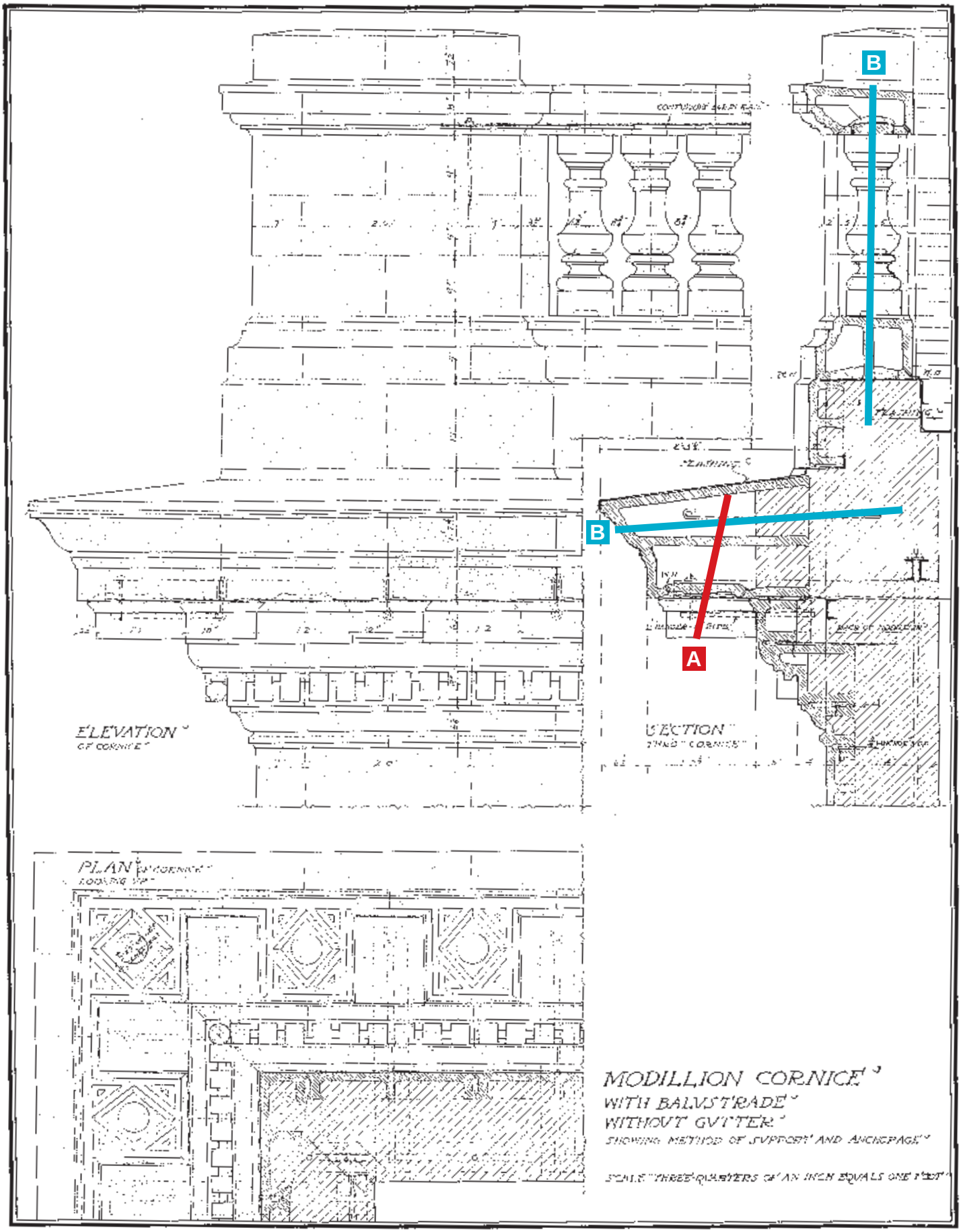
E.O.E

TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U · S · A · · · PLATE NO · 25

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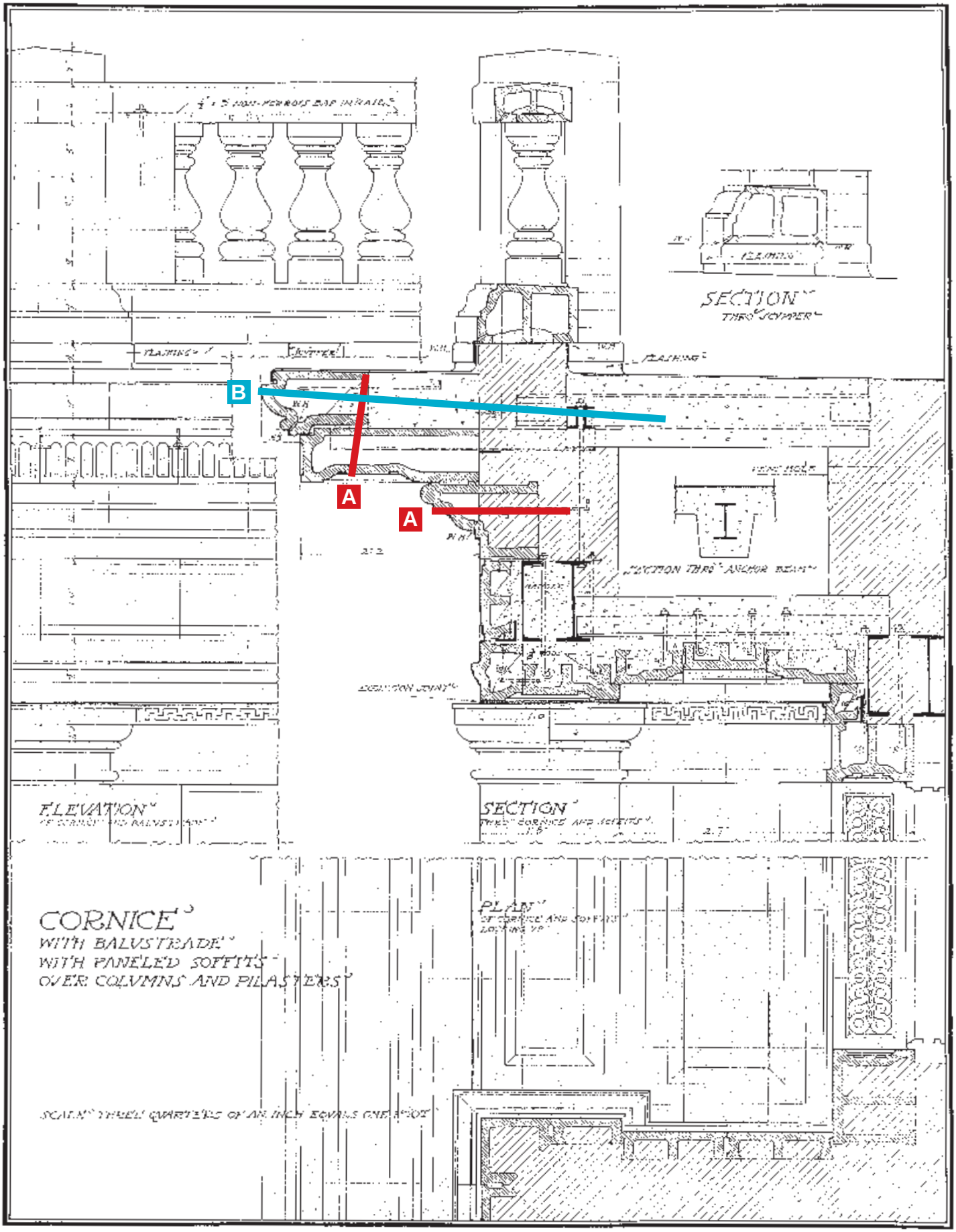
E.O.E

TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO · 26

This manual provides general information for use in preliminary selection of a Cintec anchor.
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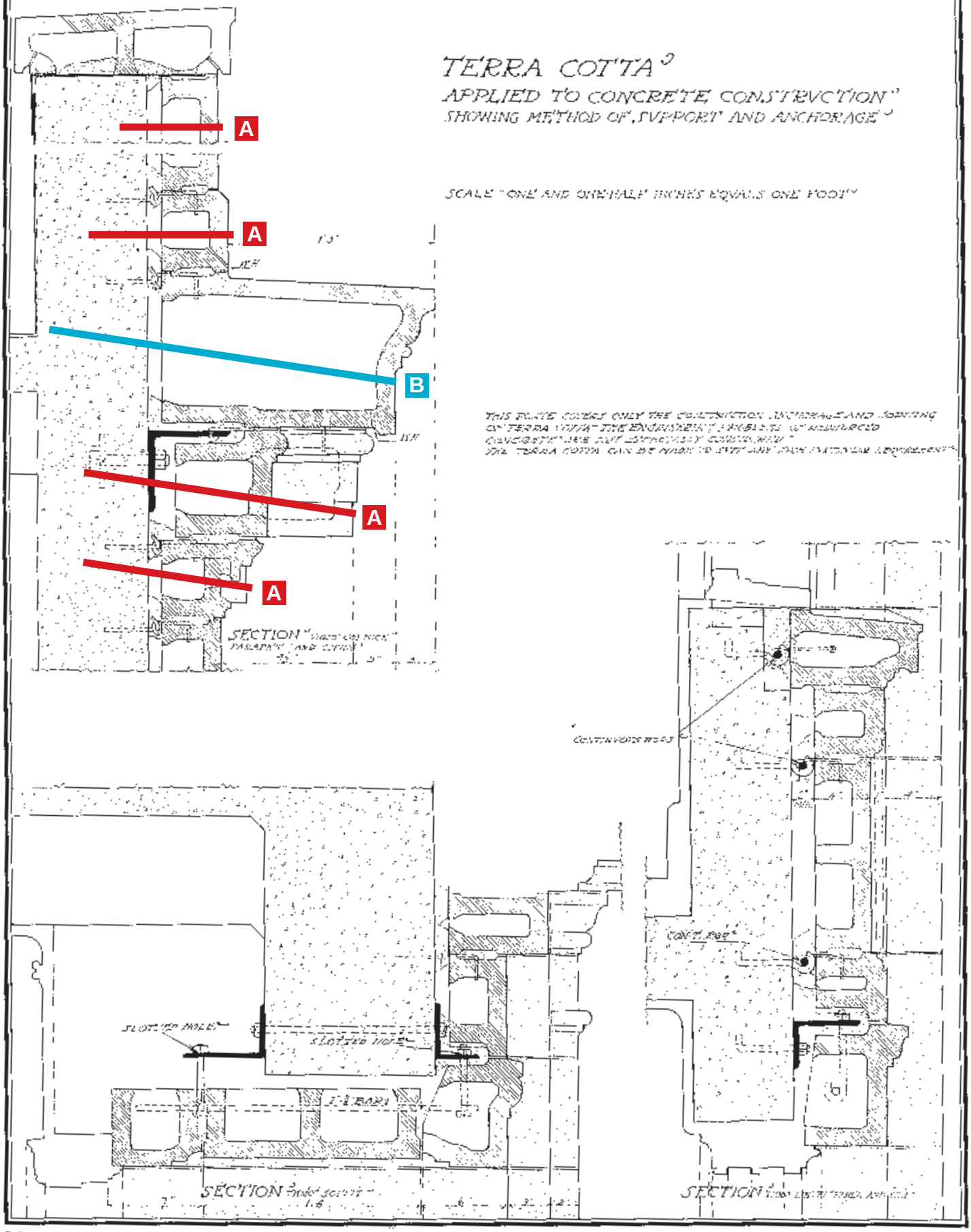
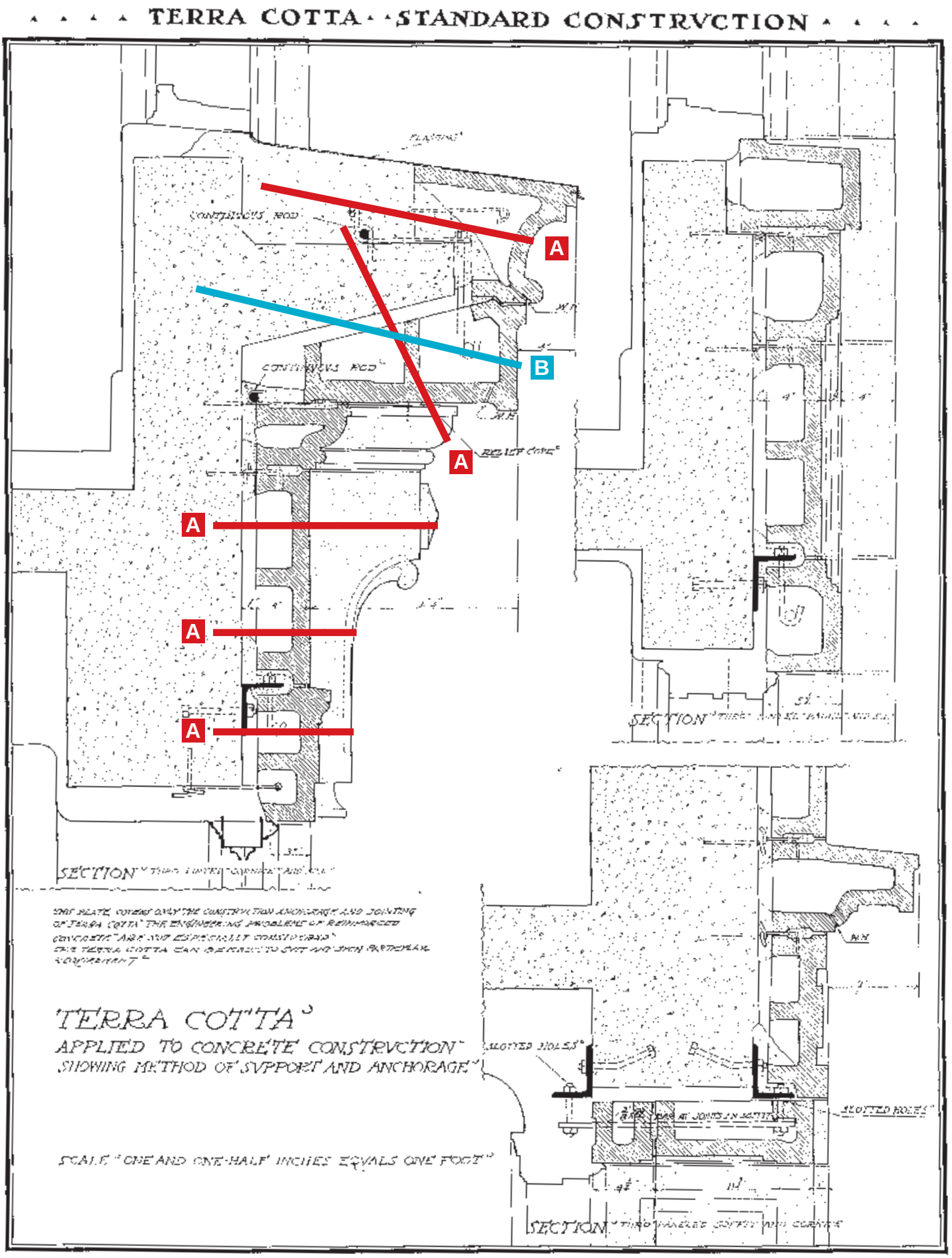
E.O.E

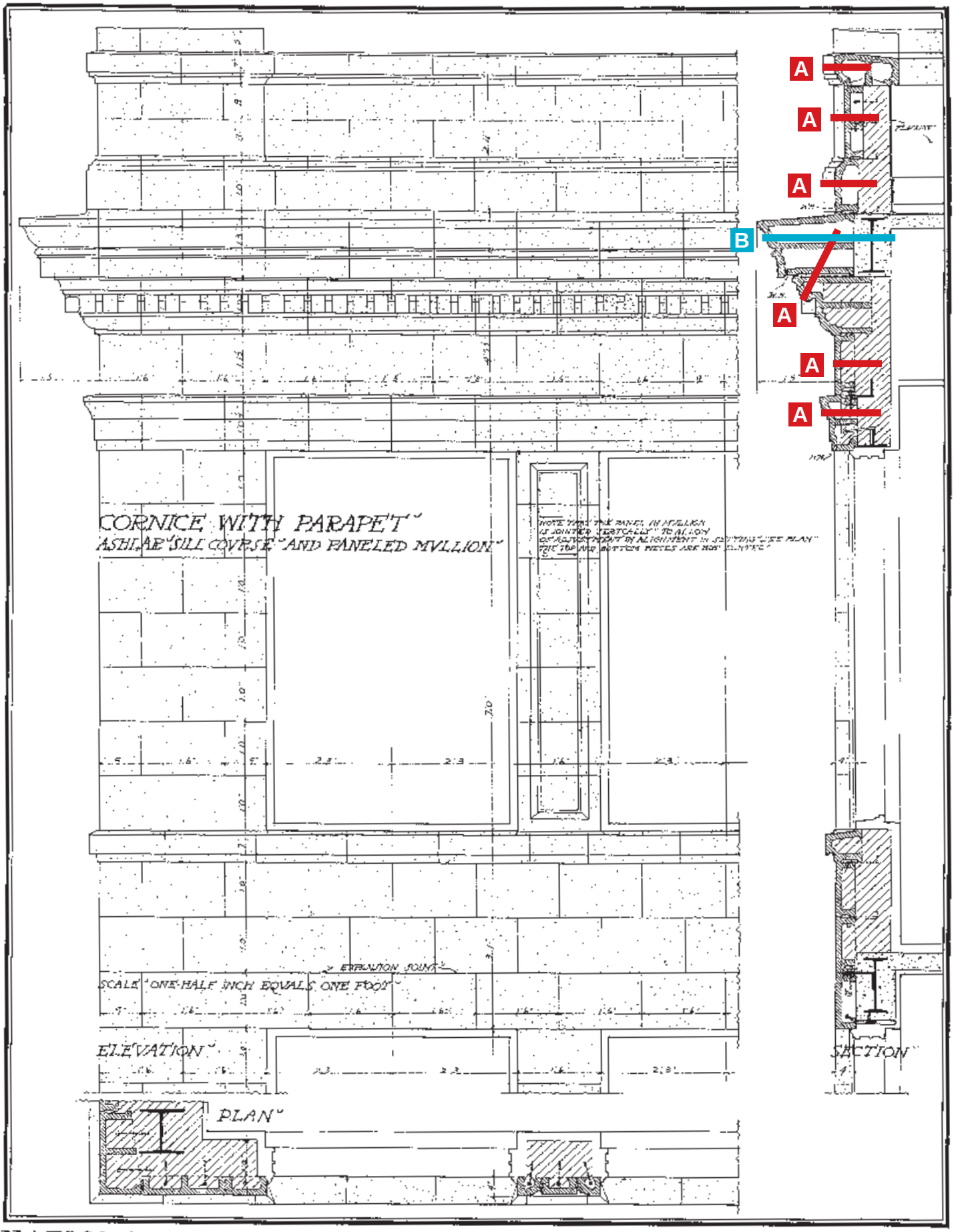
TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·27


TERRA COTTA · STANDARD CONSTRUCTION
A
B
A
A
A
A
SECTION
SECTION
SECTION
TERRA COTTA
APPLIED TO CONCRETE CONSTRUCTION
SHOWING METHOD OF SUPPORT AND ANCHORAGE
SCALE ONE AND ONE-HALF INCHES EQUALS ONE FOOT
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO· 28

TERRA COTTA · STANDARD CONSTRUCTION

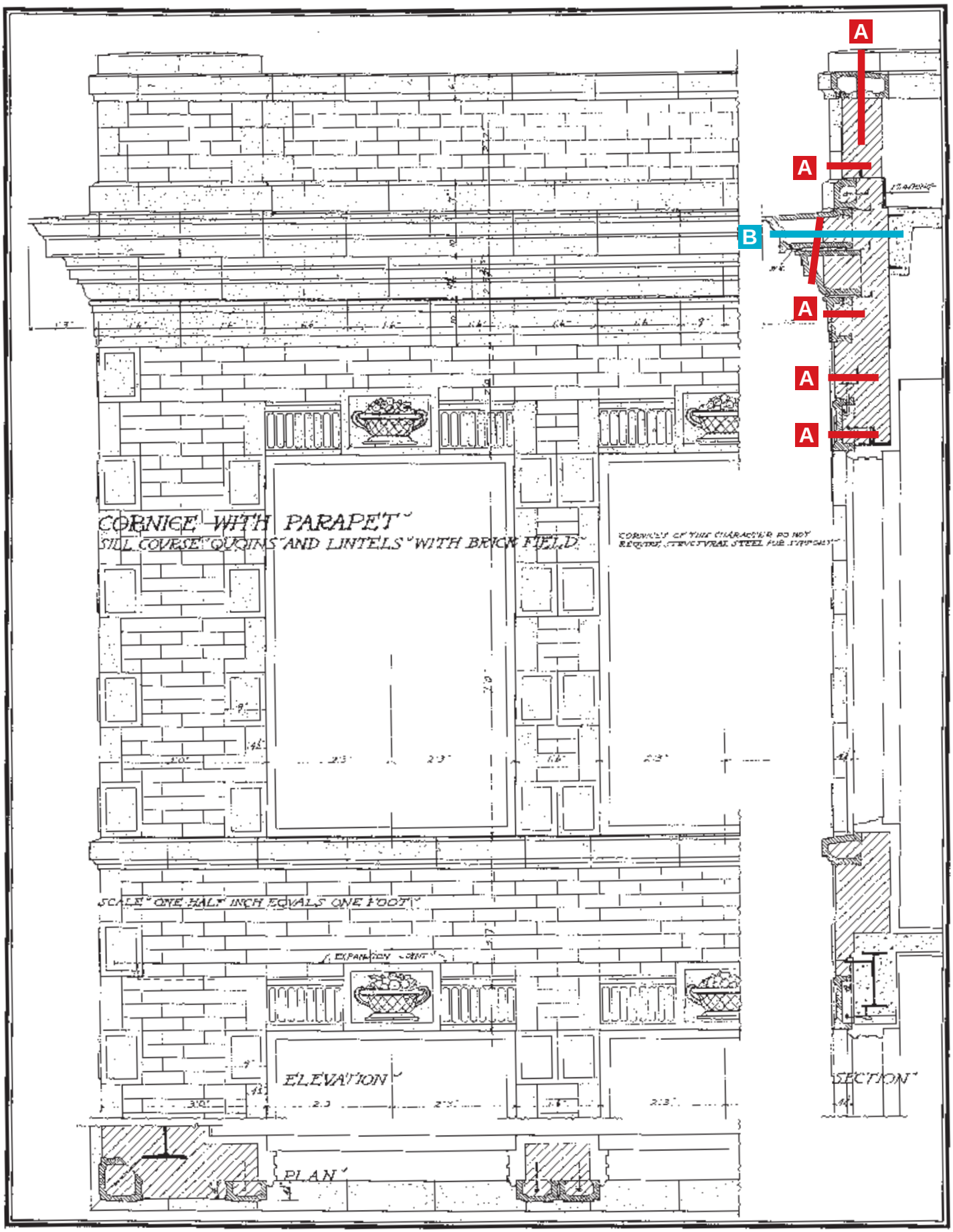


NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO · 29

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.

E.O.E

TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO· 30

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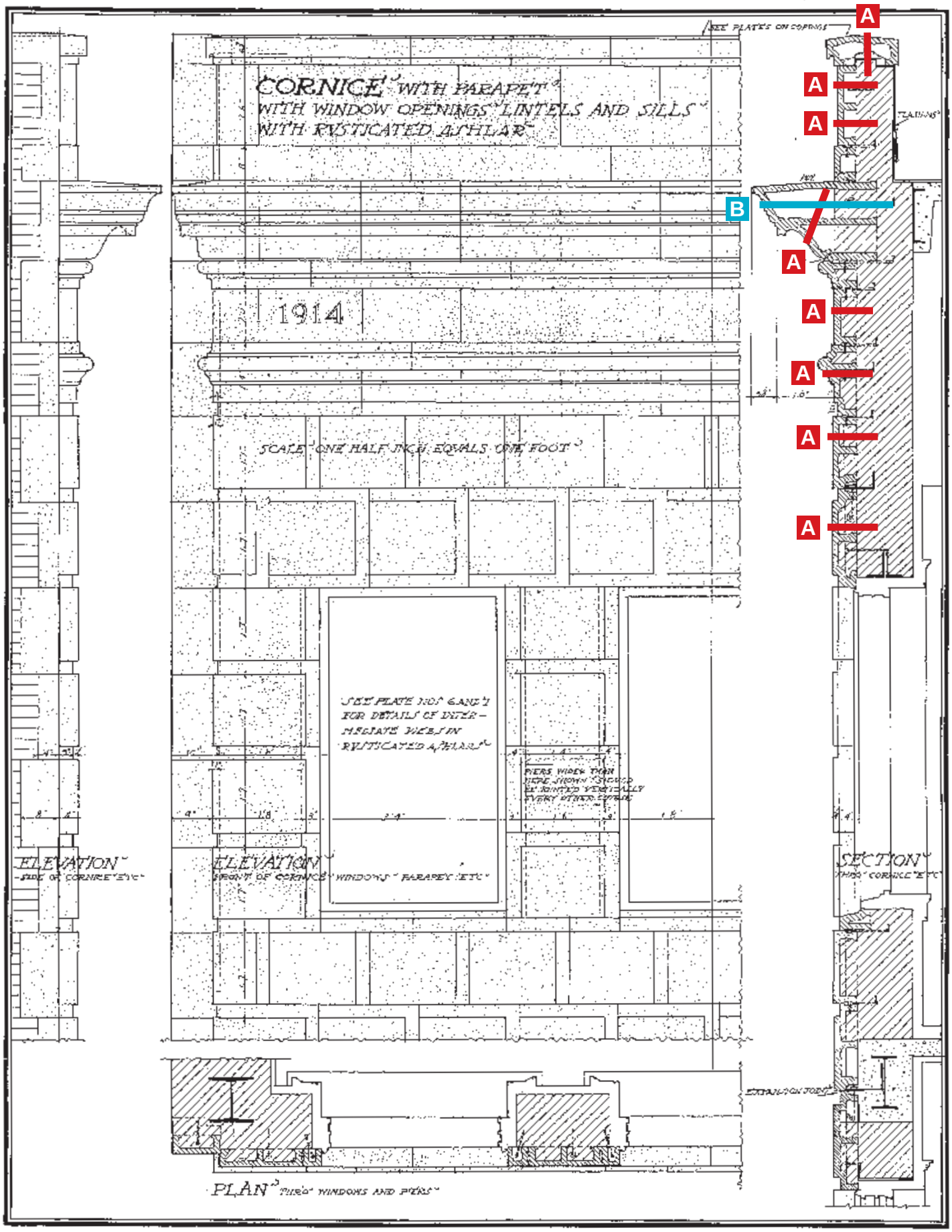
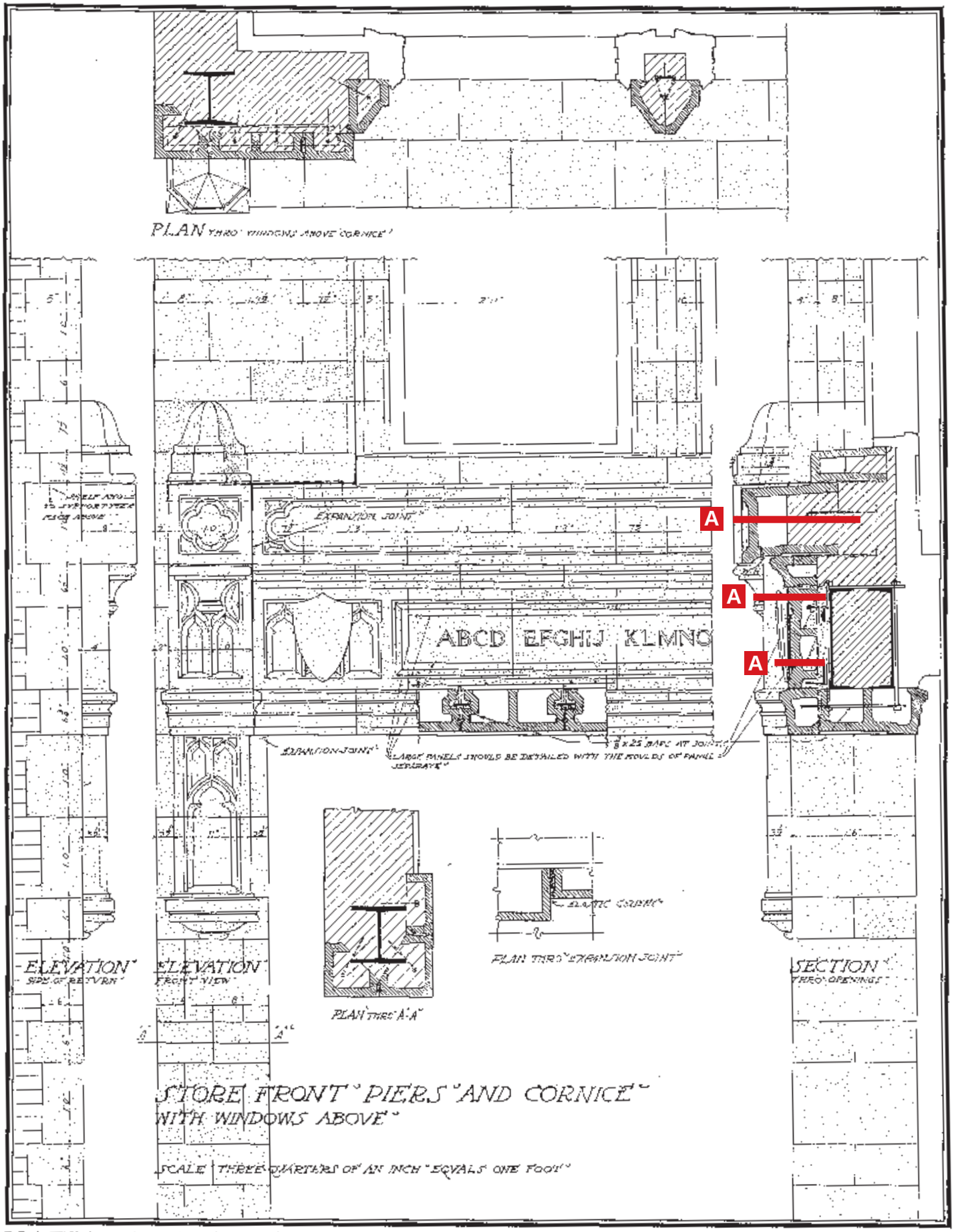
E.O.E

TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·31

TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·32

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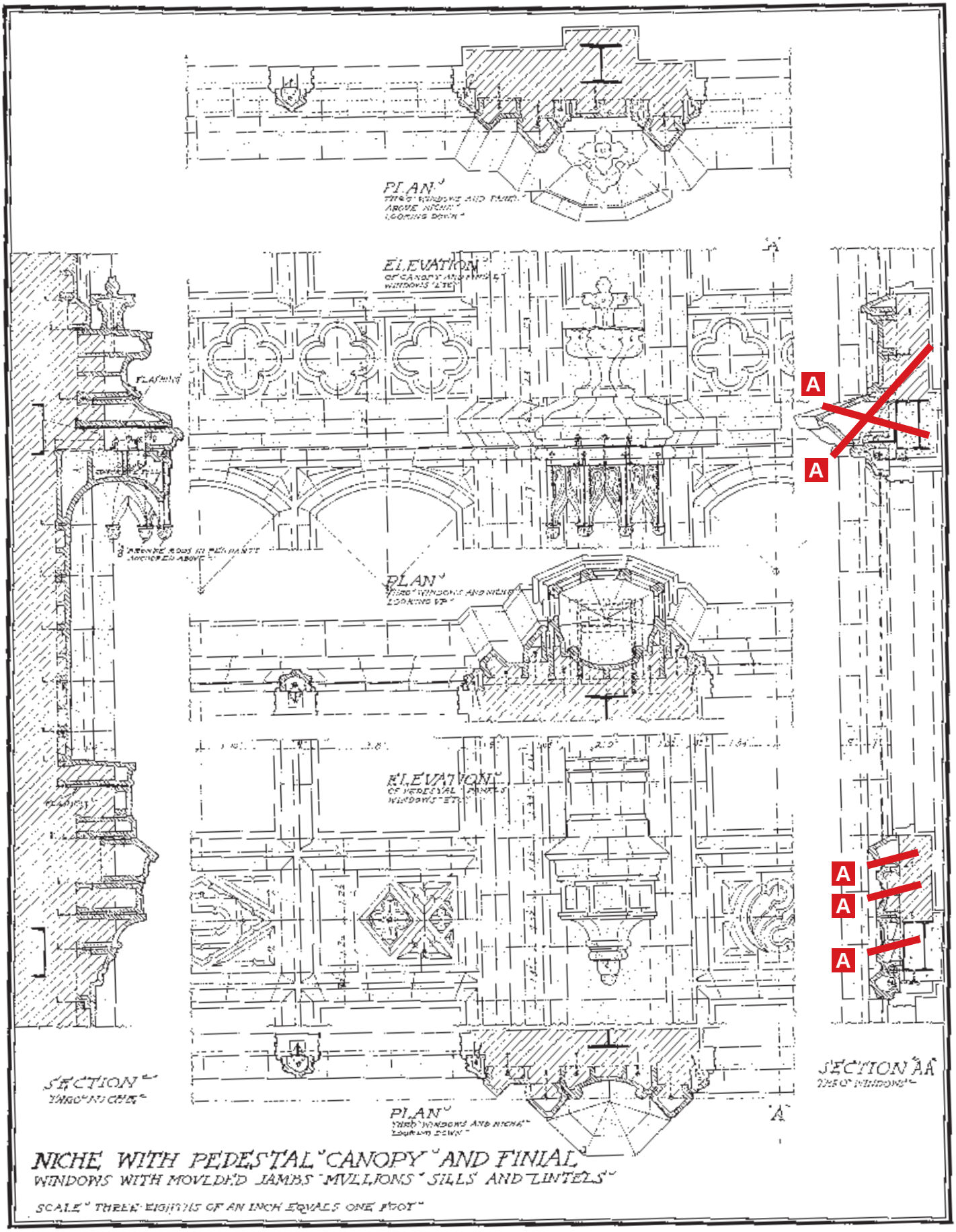
E.O.E

TERRA COTTA · STANDARD CONSTRUCTION

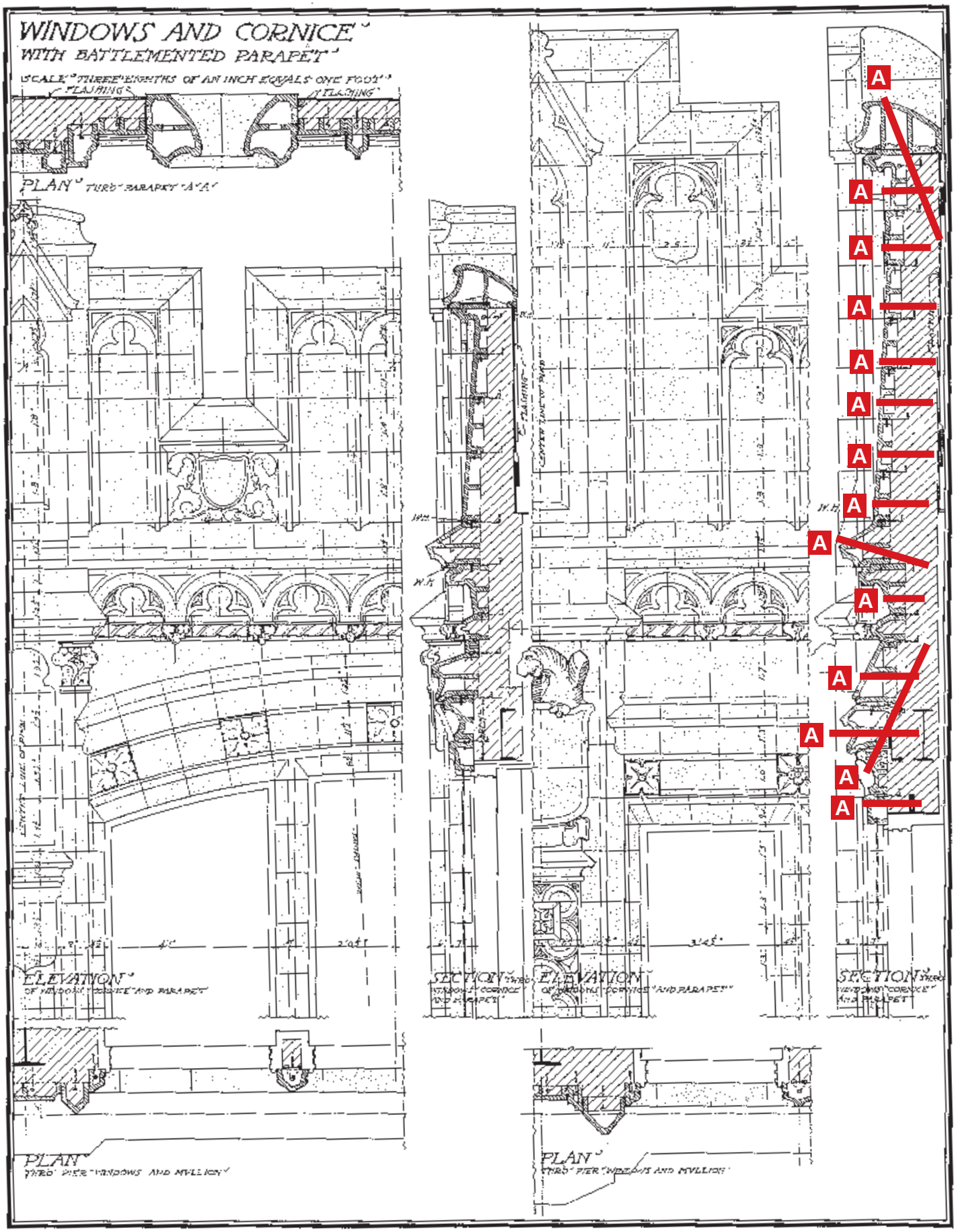


NICHE WITH PEDESTAL "CANOPY" AND FINIAL
WINDOWS WITH MOULD'D JAMBS "MULLIONS" SILLS AND LINTELS"

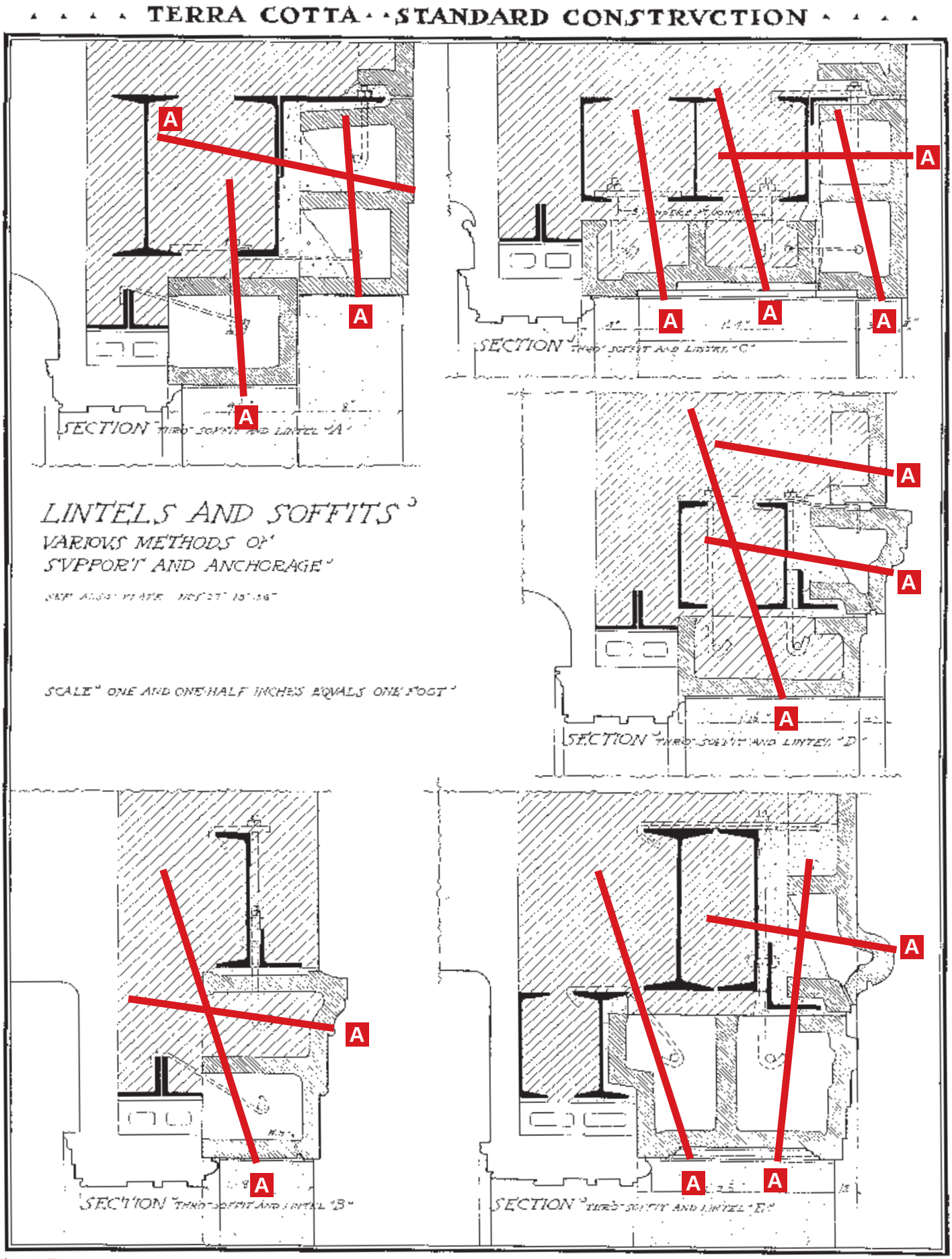
SCALE" THREE EIGHTHS OF AN INCH EQUALS ONE FOOT"

NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO · 33

TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·34



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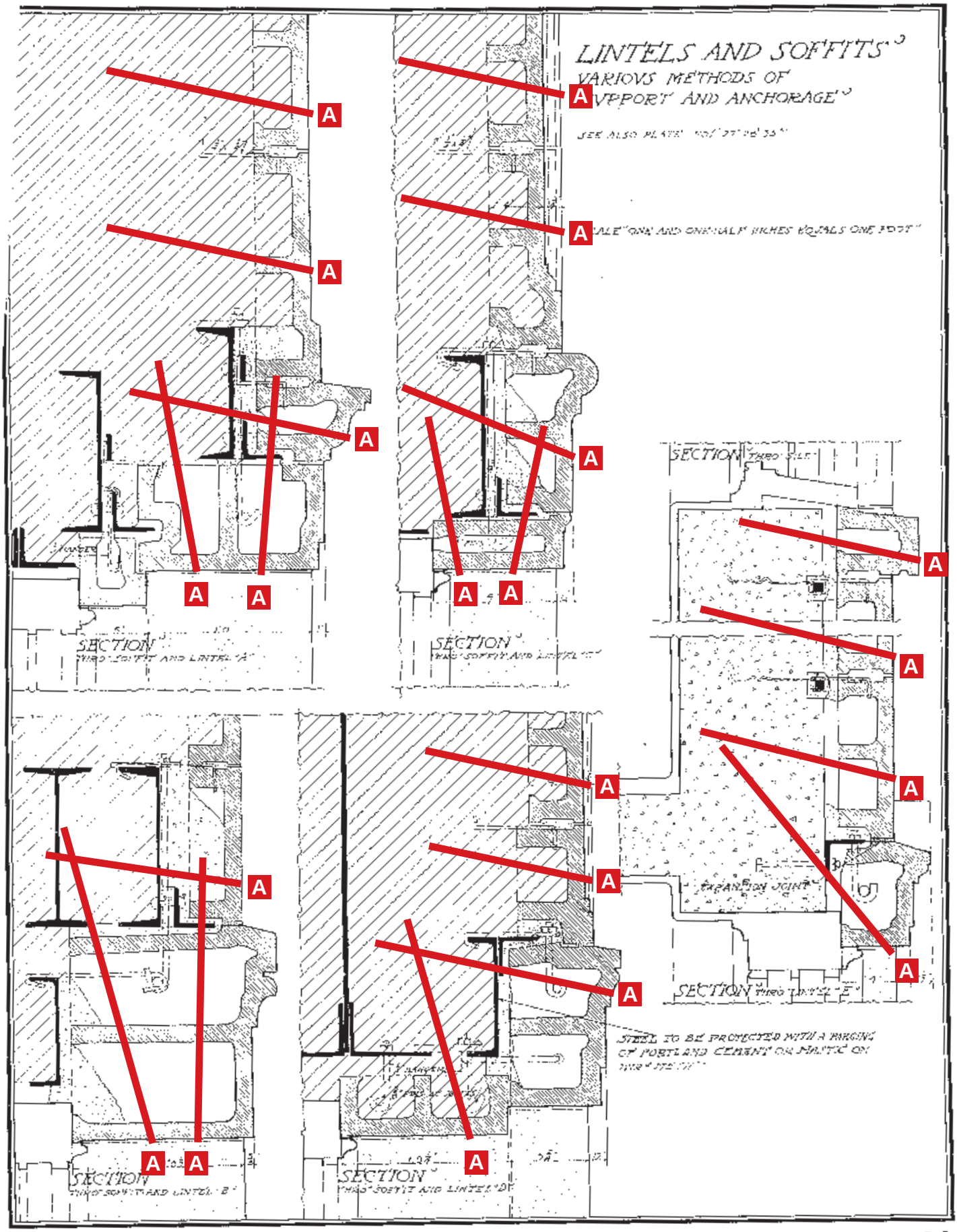
TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO· 36

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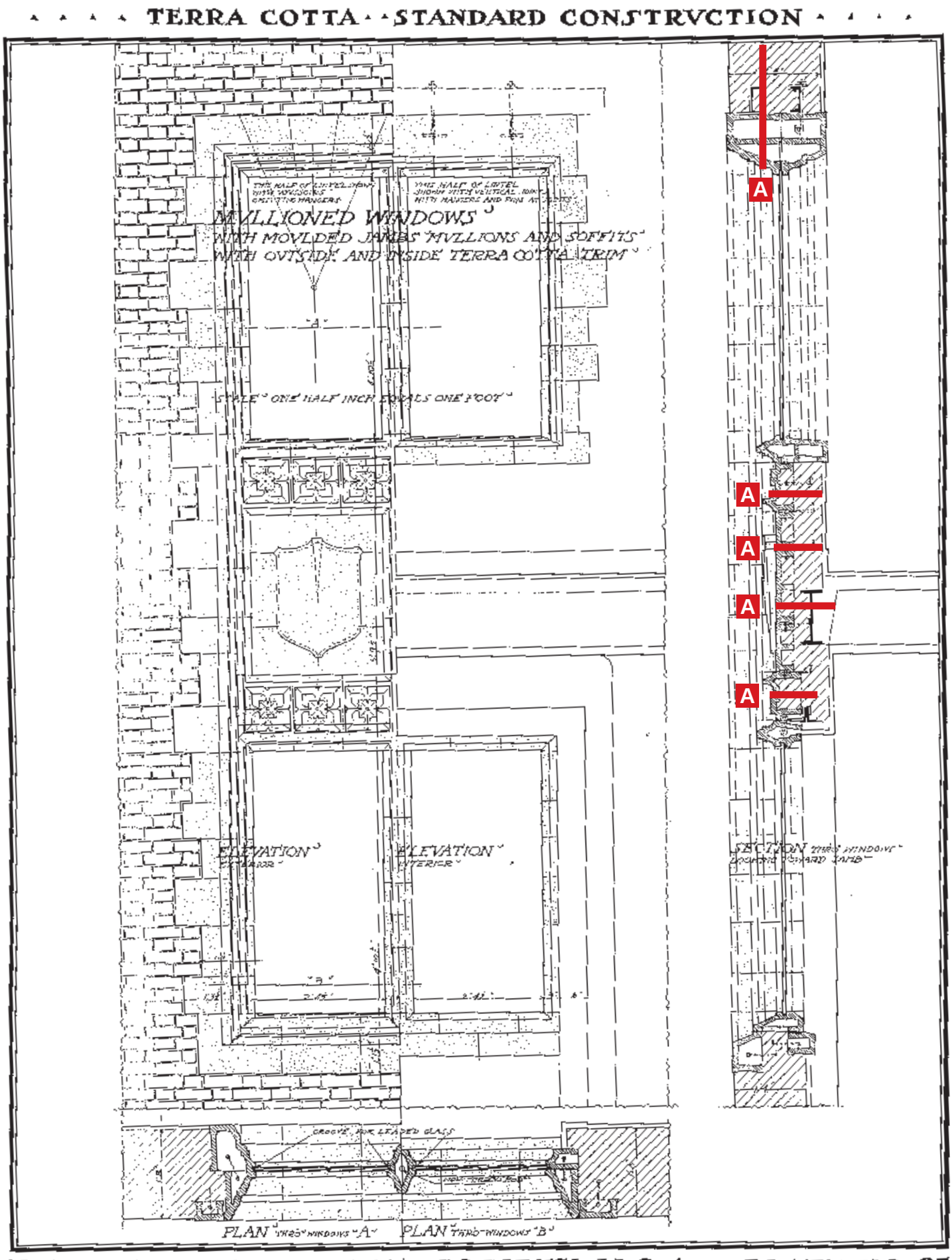
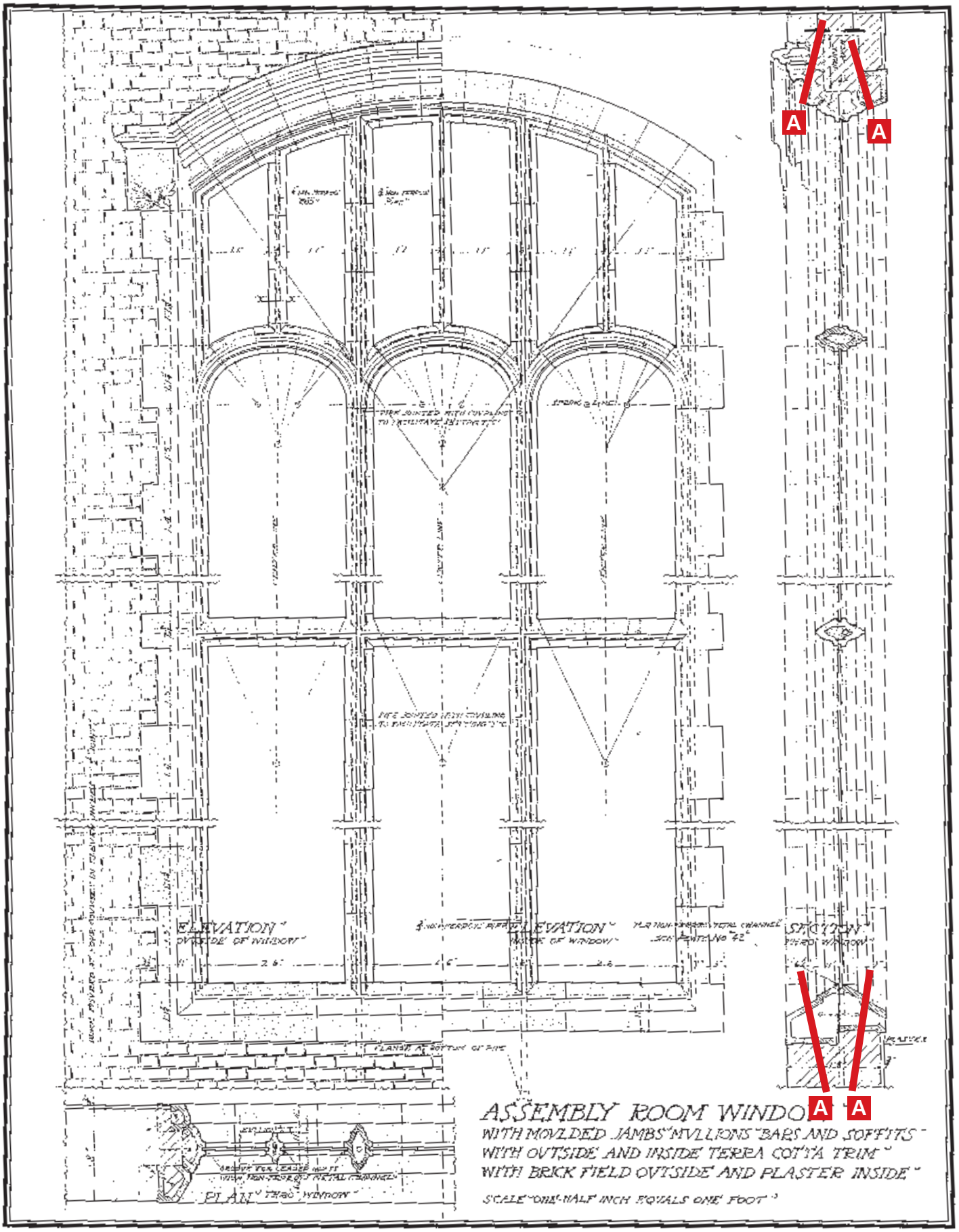
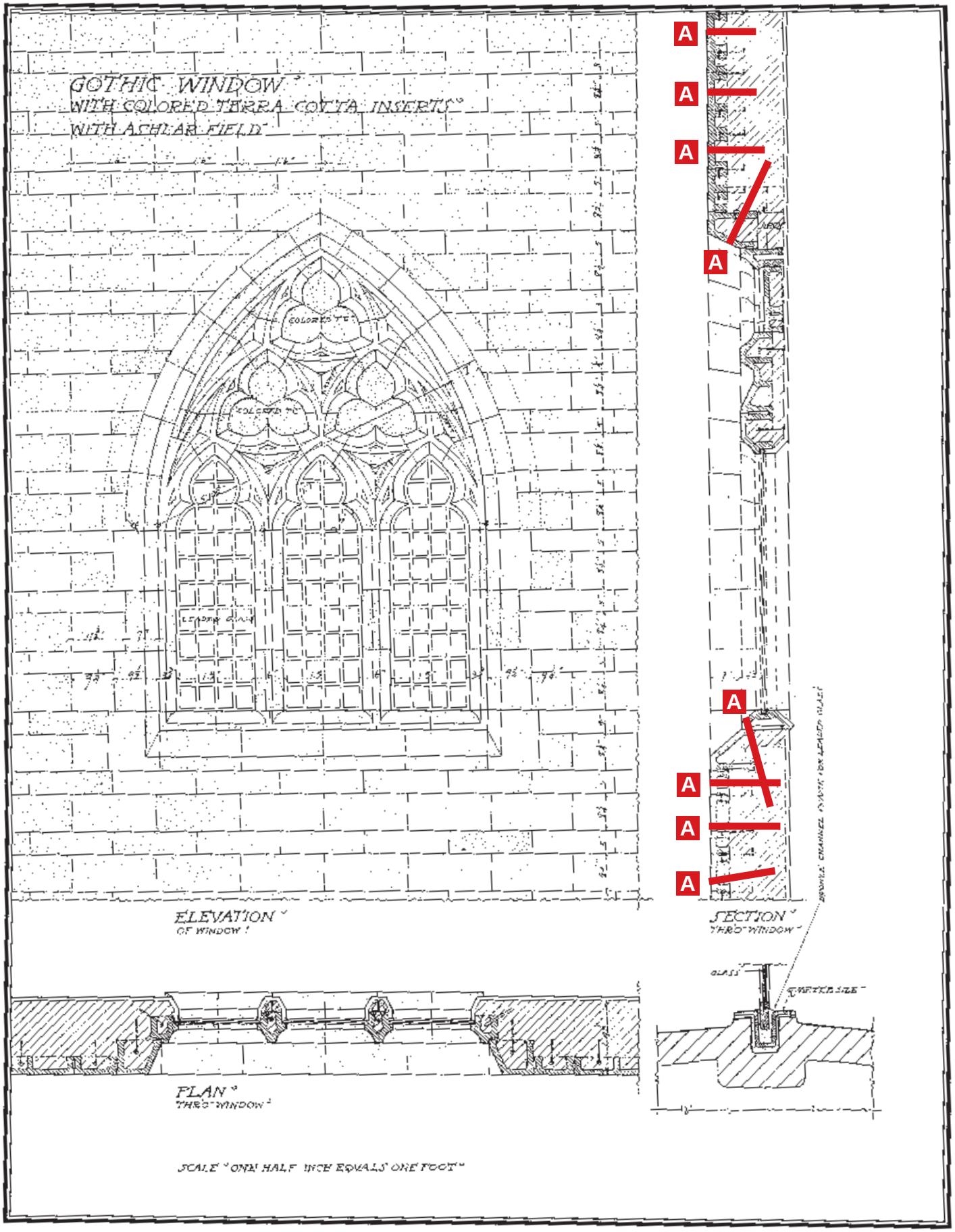

TERRA COTTA · STANDARD CONSTRUCTION
MULLIONED WINDOWS
WITH MOULDED JAMBS MULLIONS AND SOFFITS
WITH OUTSIDE AND INSIDE TERRA COTTA TRIM
SCALE ONE HALF INCH EQUALS ONE FOOT
ELEVATION
ELEVATION
SECTION
A
A
A
A
PLAN
PLAN
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·37

TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·38

TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·39

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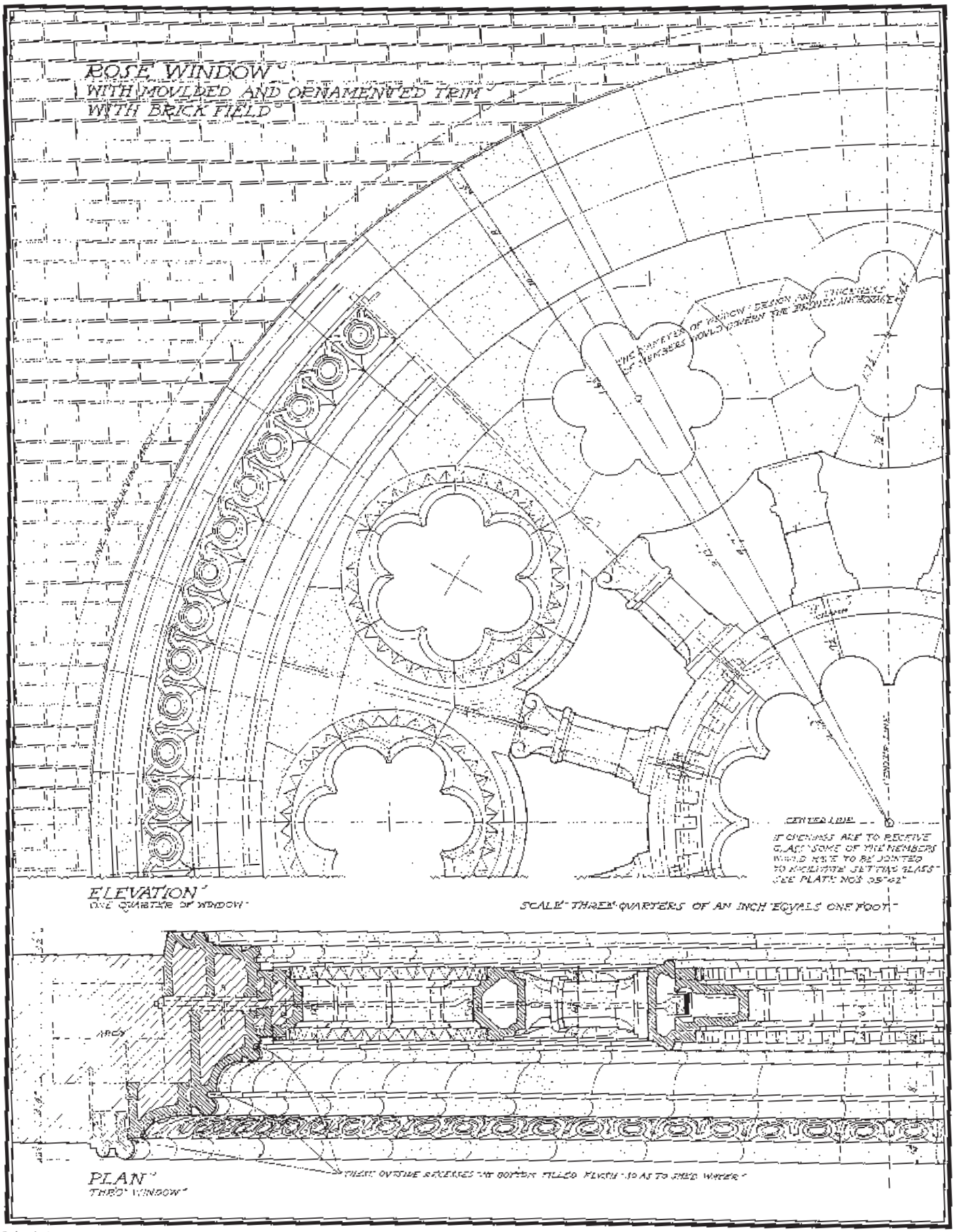
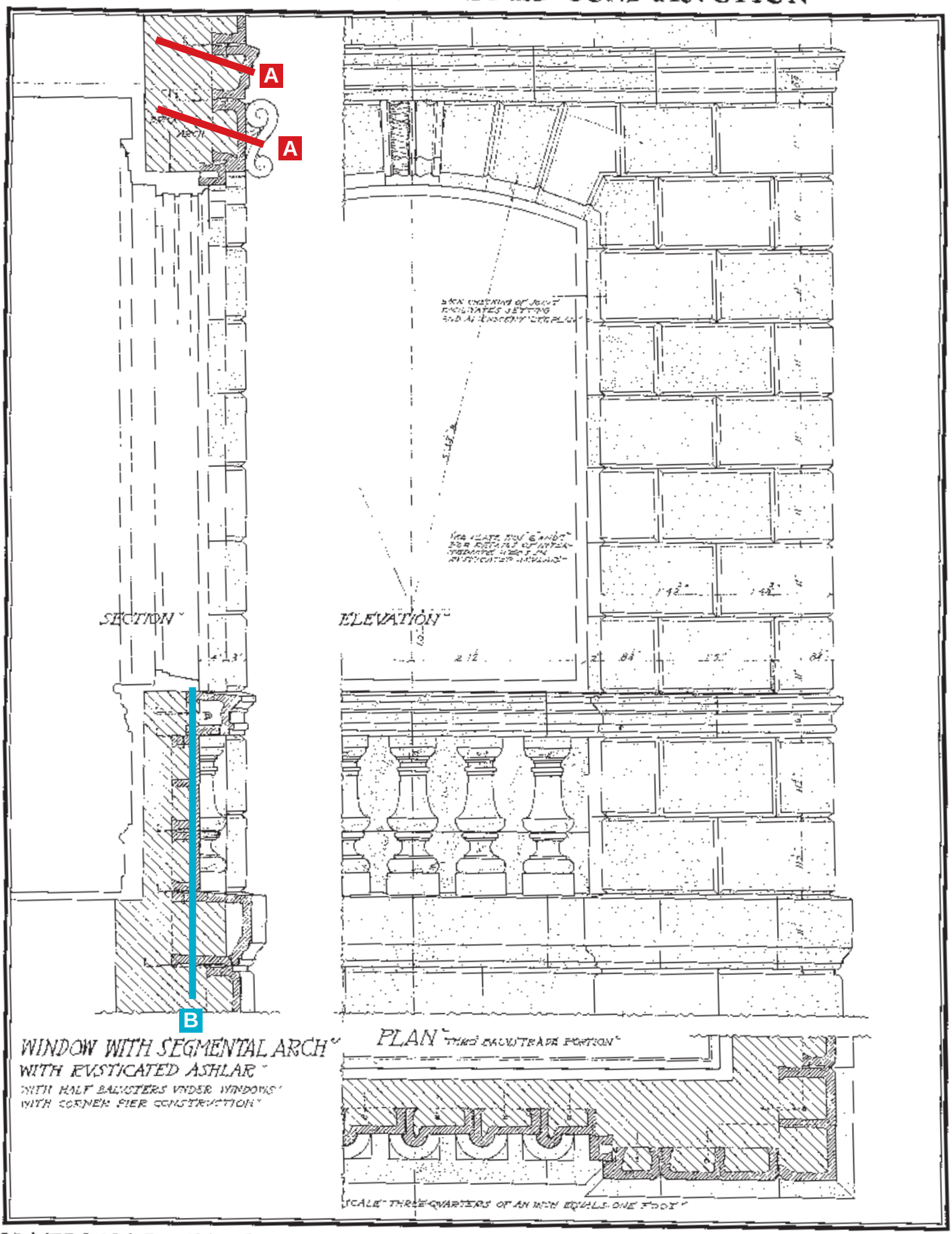
E.O.E

TERRA COTTA · STANDARD CONSTRUCTION



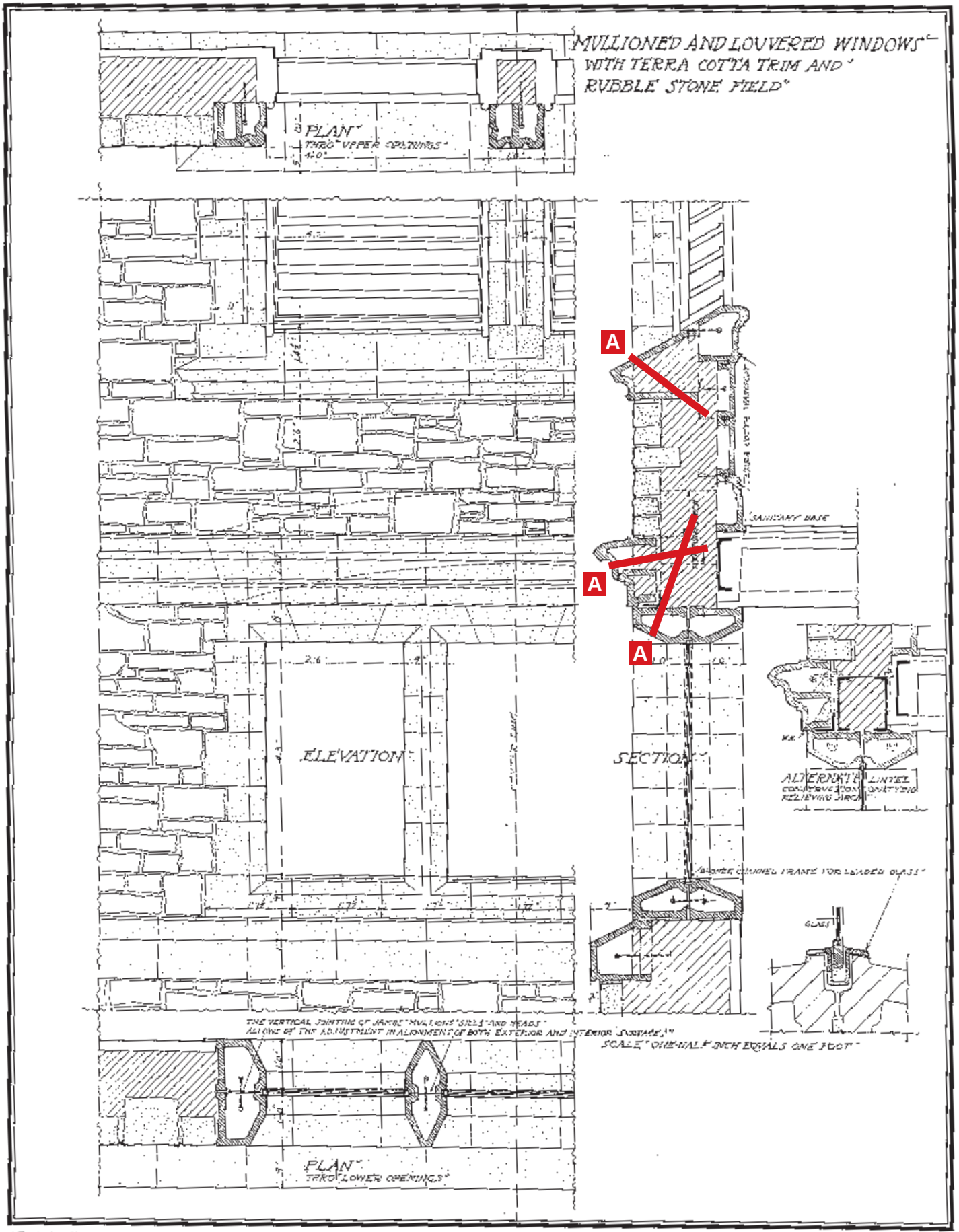
NATIONAL TERRA COTTA SOCIETY · V·S·A · · PLATE NO·40

TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·41

TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · V · S · A · · · PLATE NO · 42

This manual provides general information for use in preliminary selection of a Cintec anchor.
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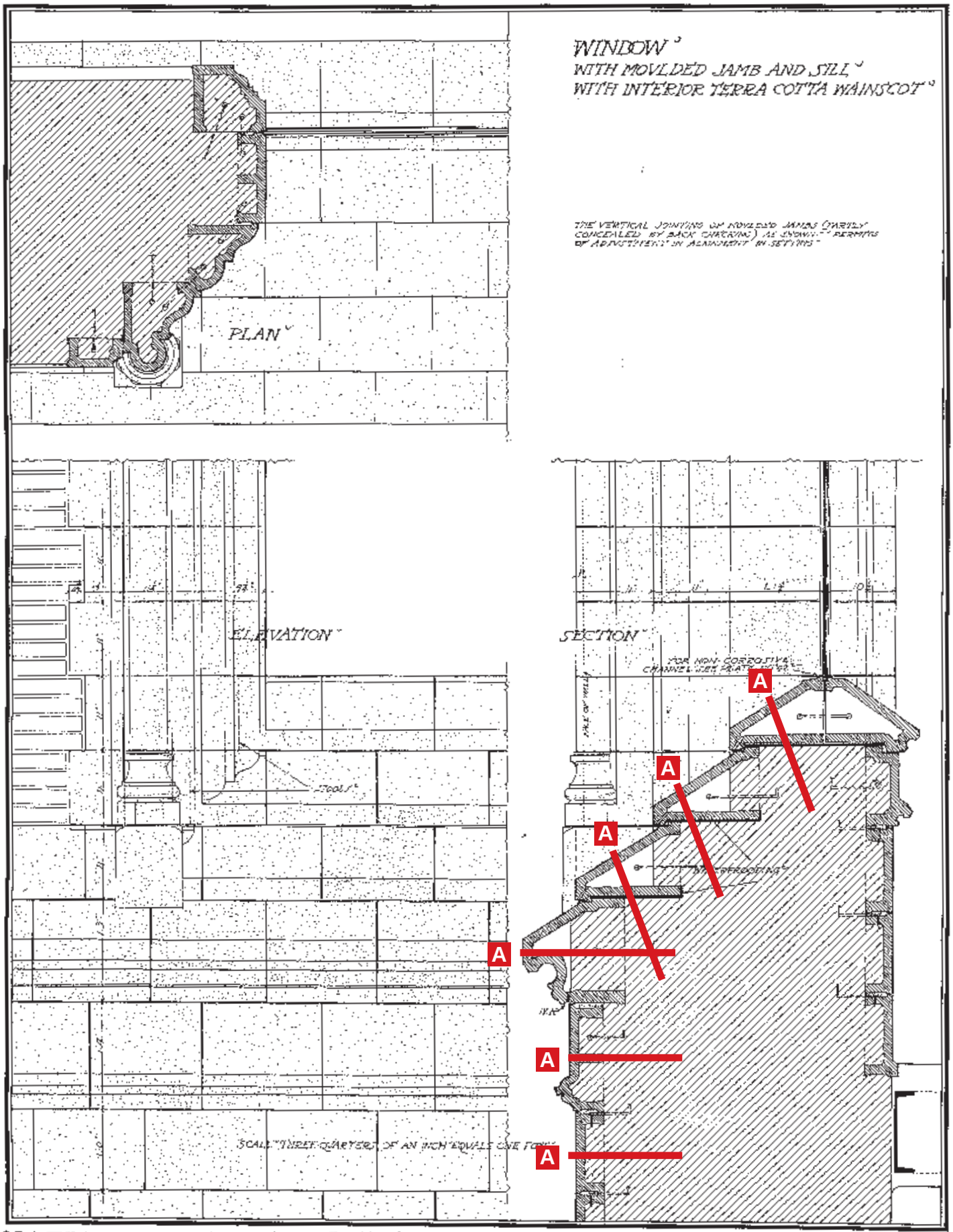
E.O.E

TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO · 43

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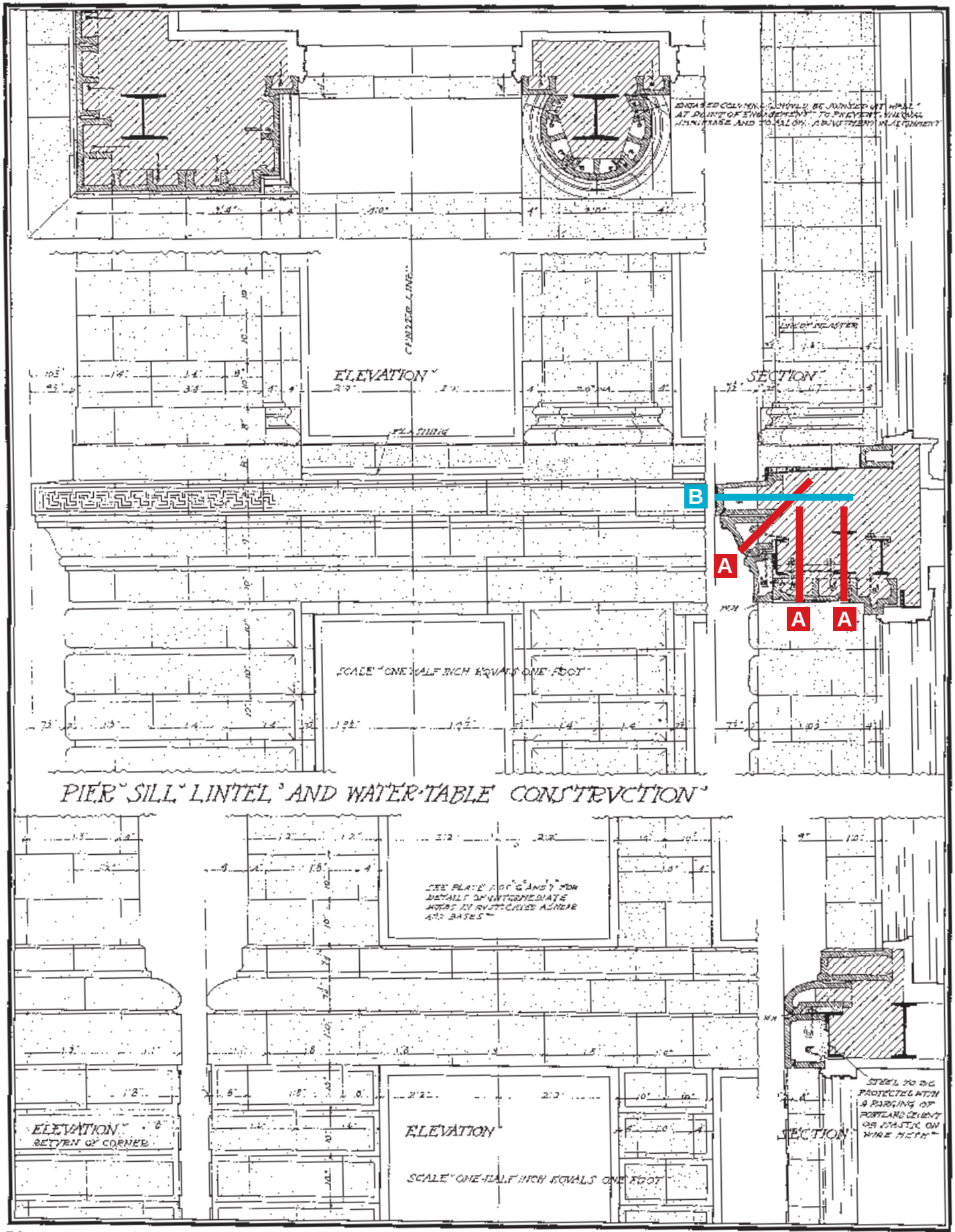
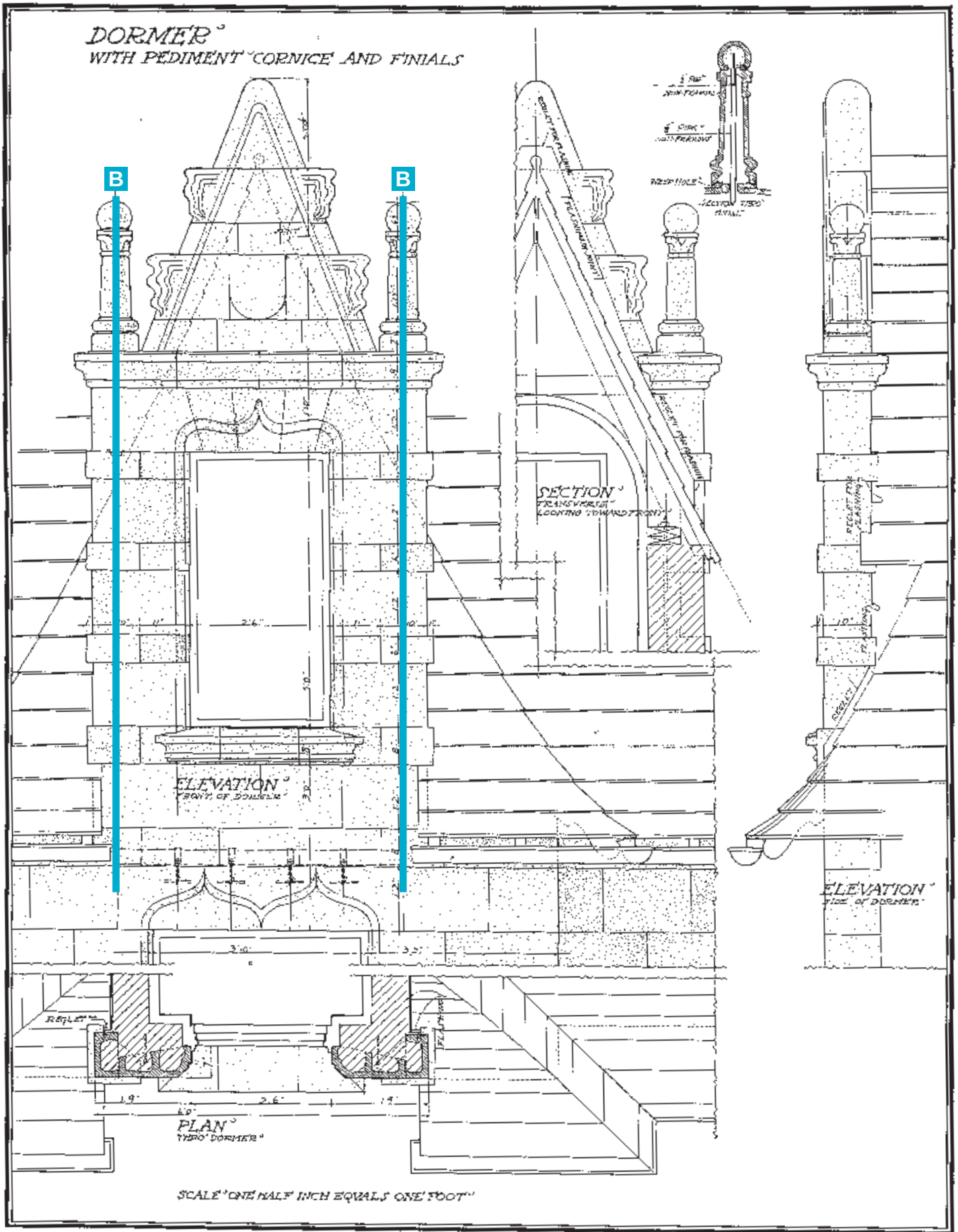
E.O.E

TERRA COTTA · STANDARD CONSTRVCTION



NATIONAL TERRA COTTA SOCIETY · V · S · A · · PLATE NO · 44

TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·46

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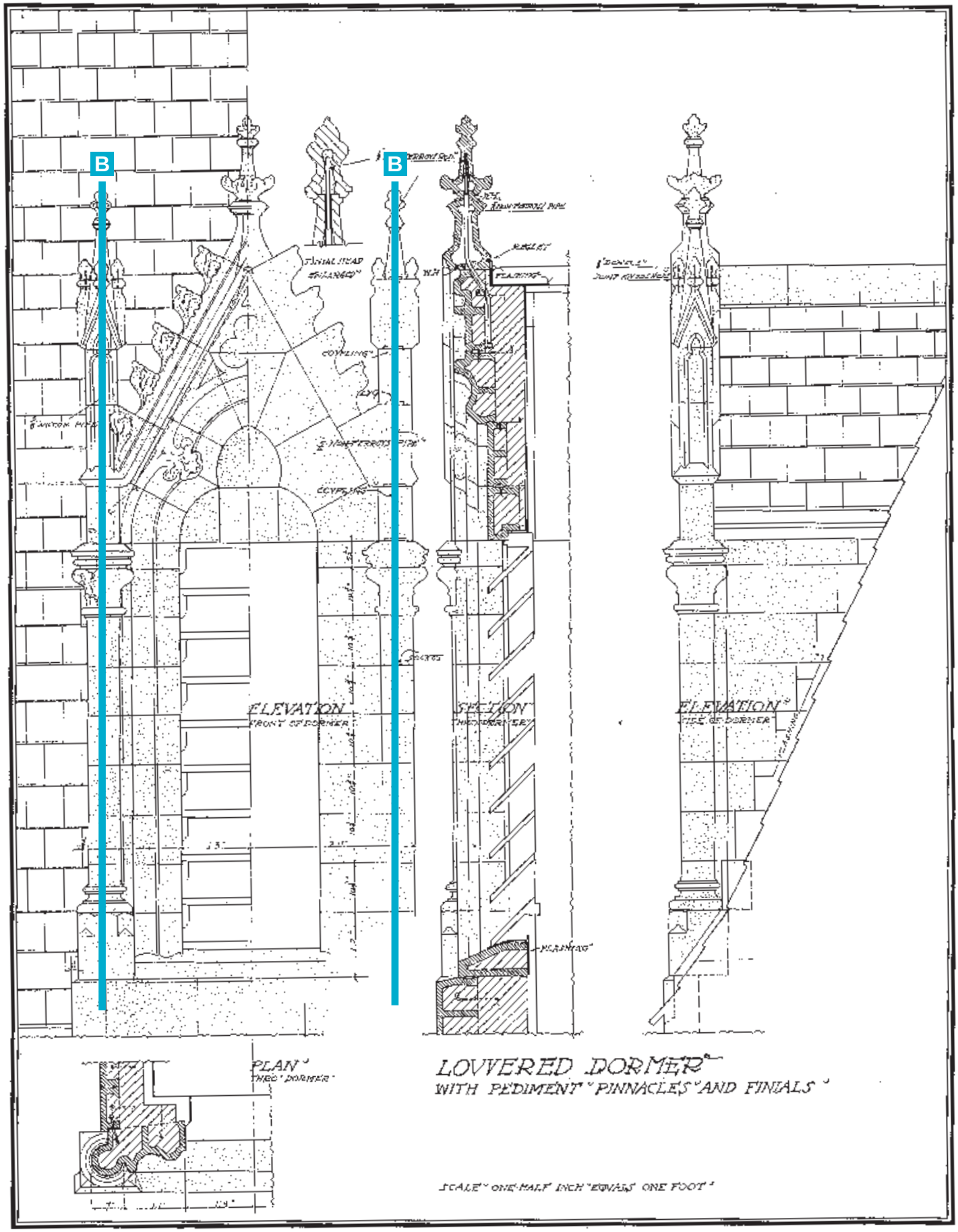
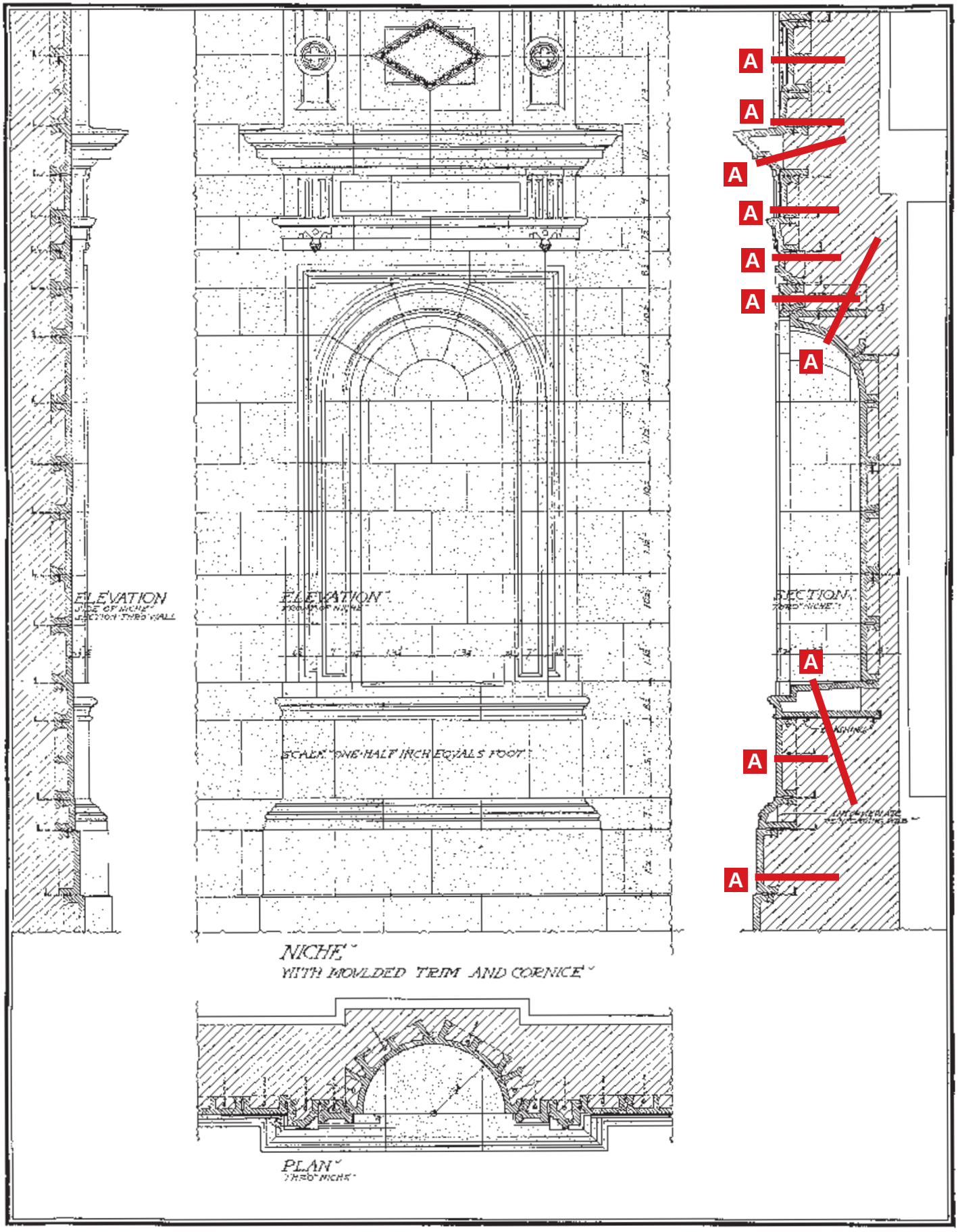
E.O.E

TERRA COTTA · STANDARD CONSTRUCTION



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

TERRA COTTA · STANDARD CONSTRUCTION



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

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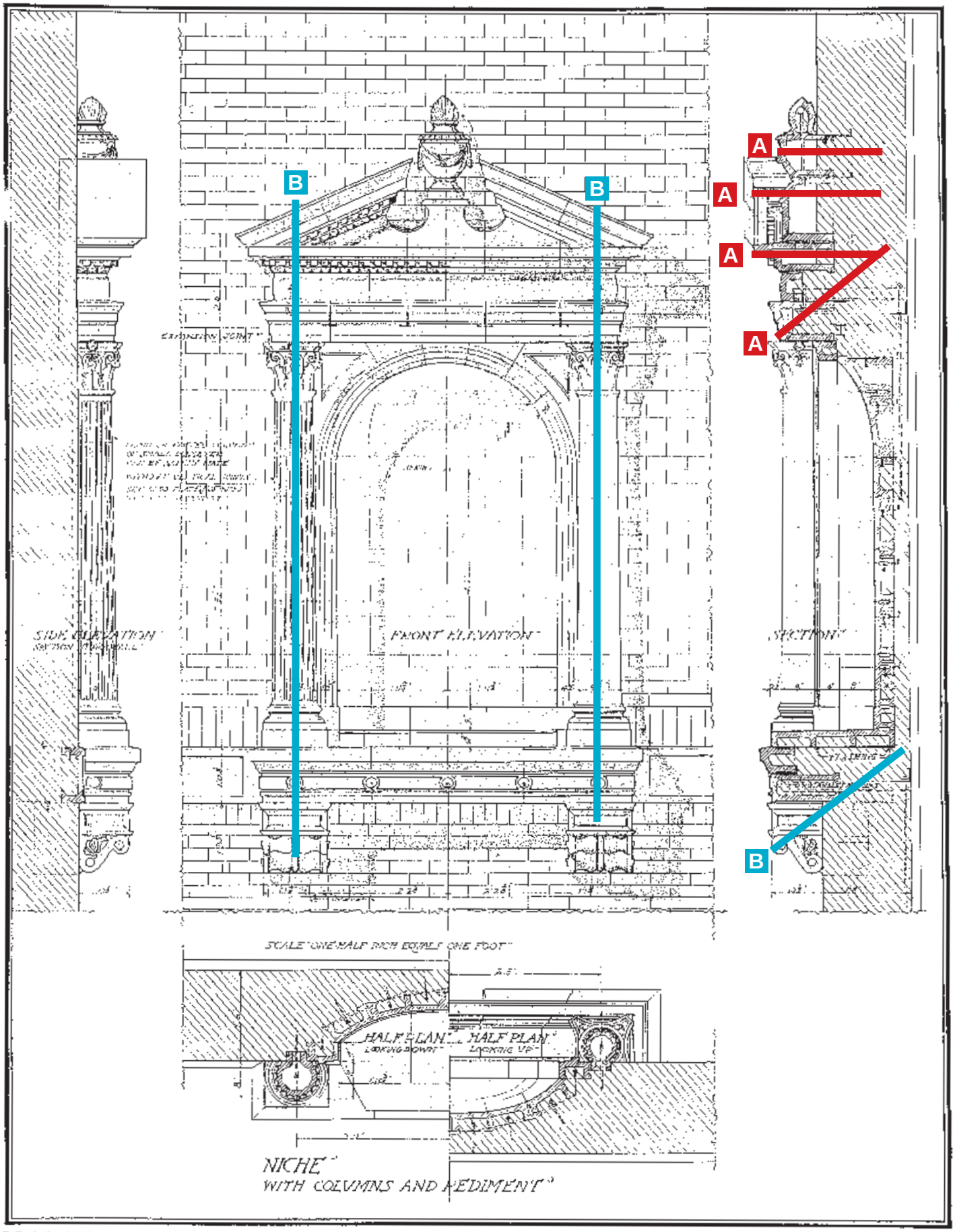
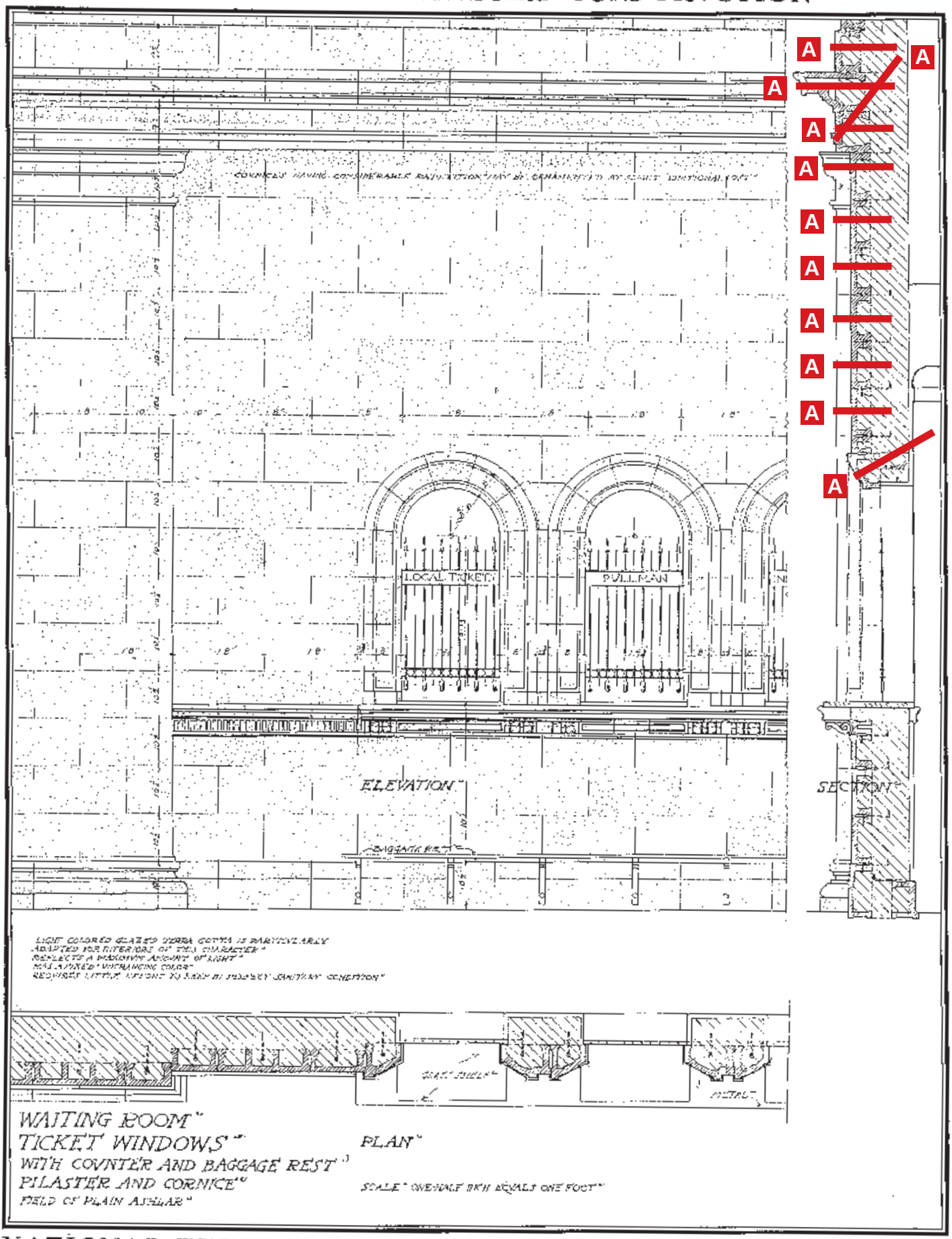
E.O.E

TERRA COTTA · STANDARD CONSTRVCTION



NATIONAL TERRA COTTA SOCIETY · V · S · A · · PLATE NO · 49

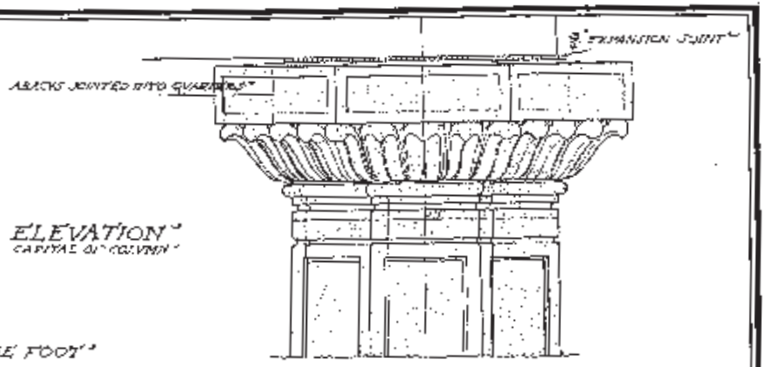
TERRA COTTA · STANDARD CONSTRUCTION



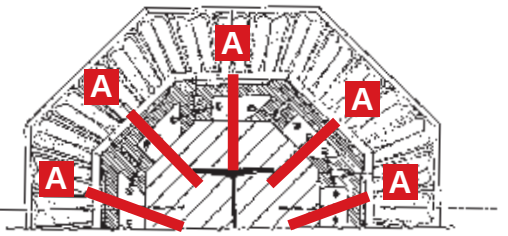
NATIONAL TERRA COTTA SOCIETY · U · S · A · · PLATE NO · 50

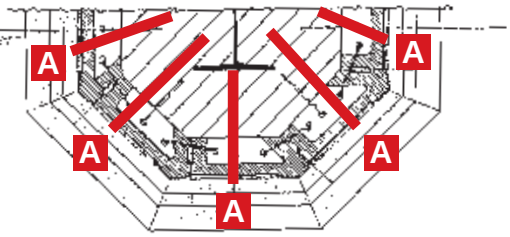
TERRA COTTA · STANDARD CONSTRUCTION

OCTAGON COLUMN WITH CAPITAL AND BASE



SCALE THREE QUARTERS OF AN INCH EQUALS ONE FOOT





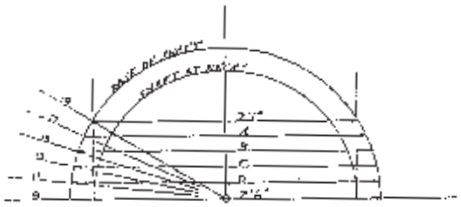
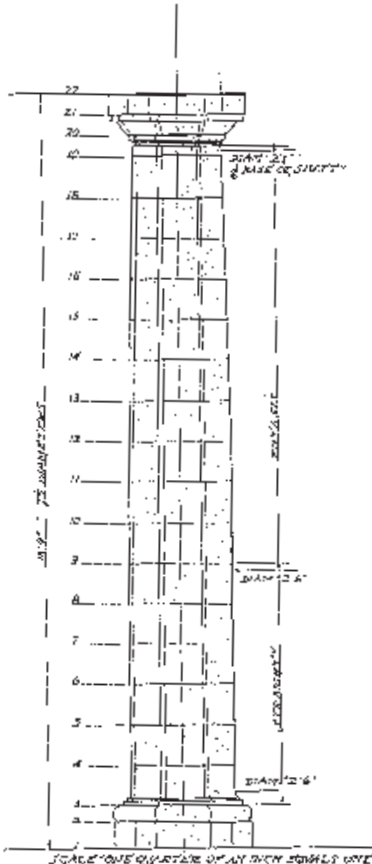
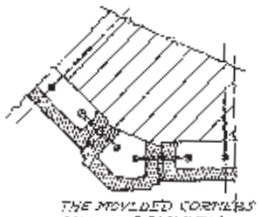


DIAGRAM OF METHOD FOR OBTAINING ENTASIS OF SHAFT
LAY OUT ACCURATELY TO FULL SIZE OF COLUMN
A B C AND D CAN THEN BE ACCURATELY MEASURED
GIVING THE DIAMETERS AT

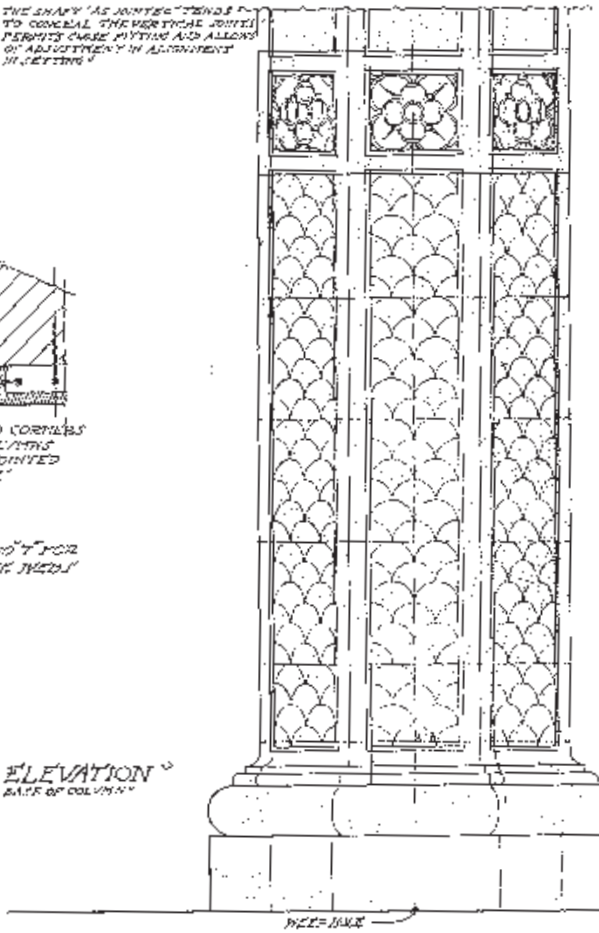
THE SHAFT IS JOINTED TENDS TO CONCEAL THE VERTICAL JOINTS PERMITS EASE FITTING AND ALLOWS OF ADJUSTMENT IN ALIGNMENT IN SETTING





THE MOULDED CORNERS OF LARGE COLUMNS SHOULD BE JOINTED SEPARATELY

SEE PLATE NO 7 FOR INTERMEDIATE MEDIUM SIZED BASES



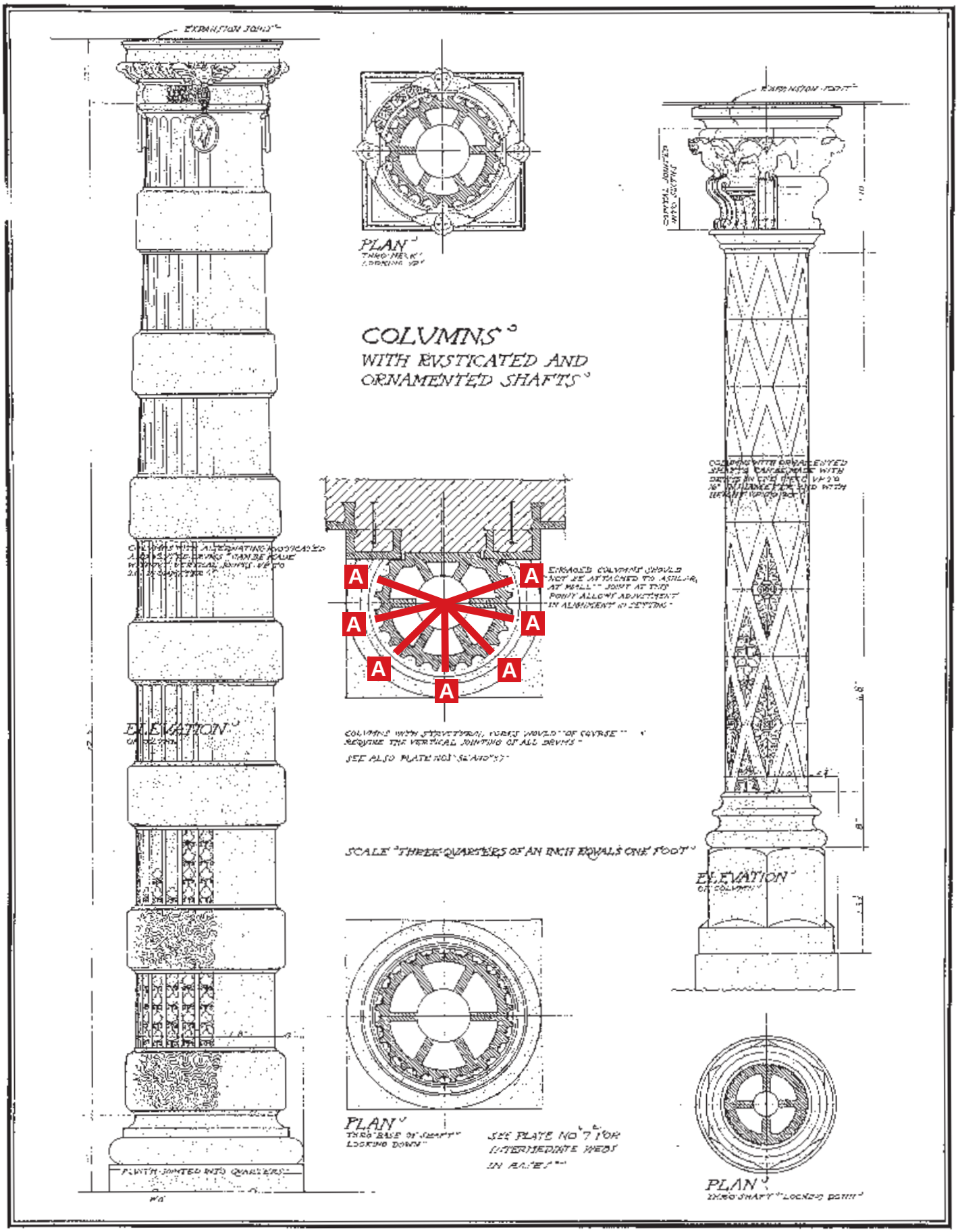
ELEVATION
BASE OF COLUMN

SCALE ONE QUARTER OF AN INCH EQUALS ONE FOOT

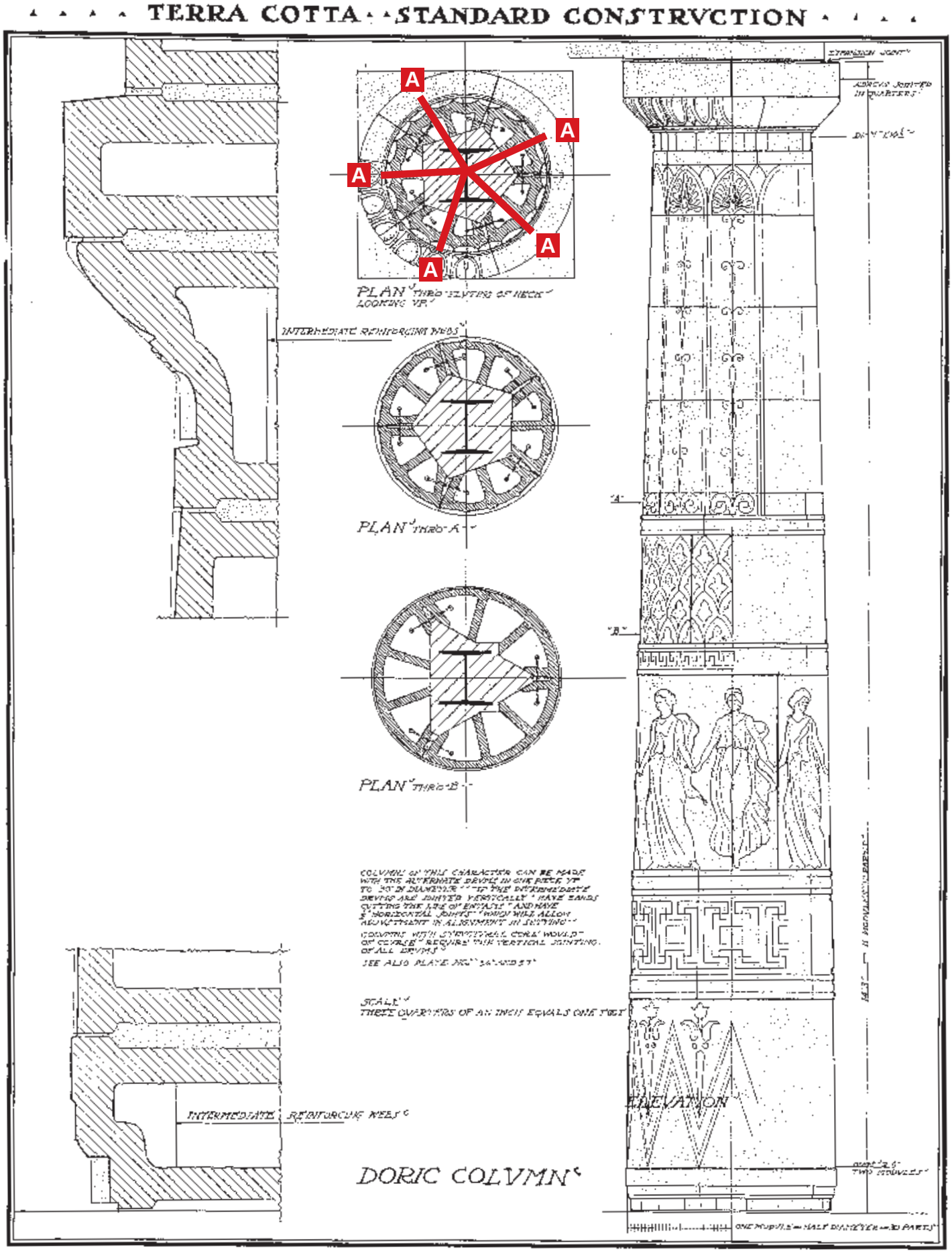
NEEDHAM

NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·51

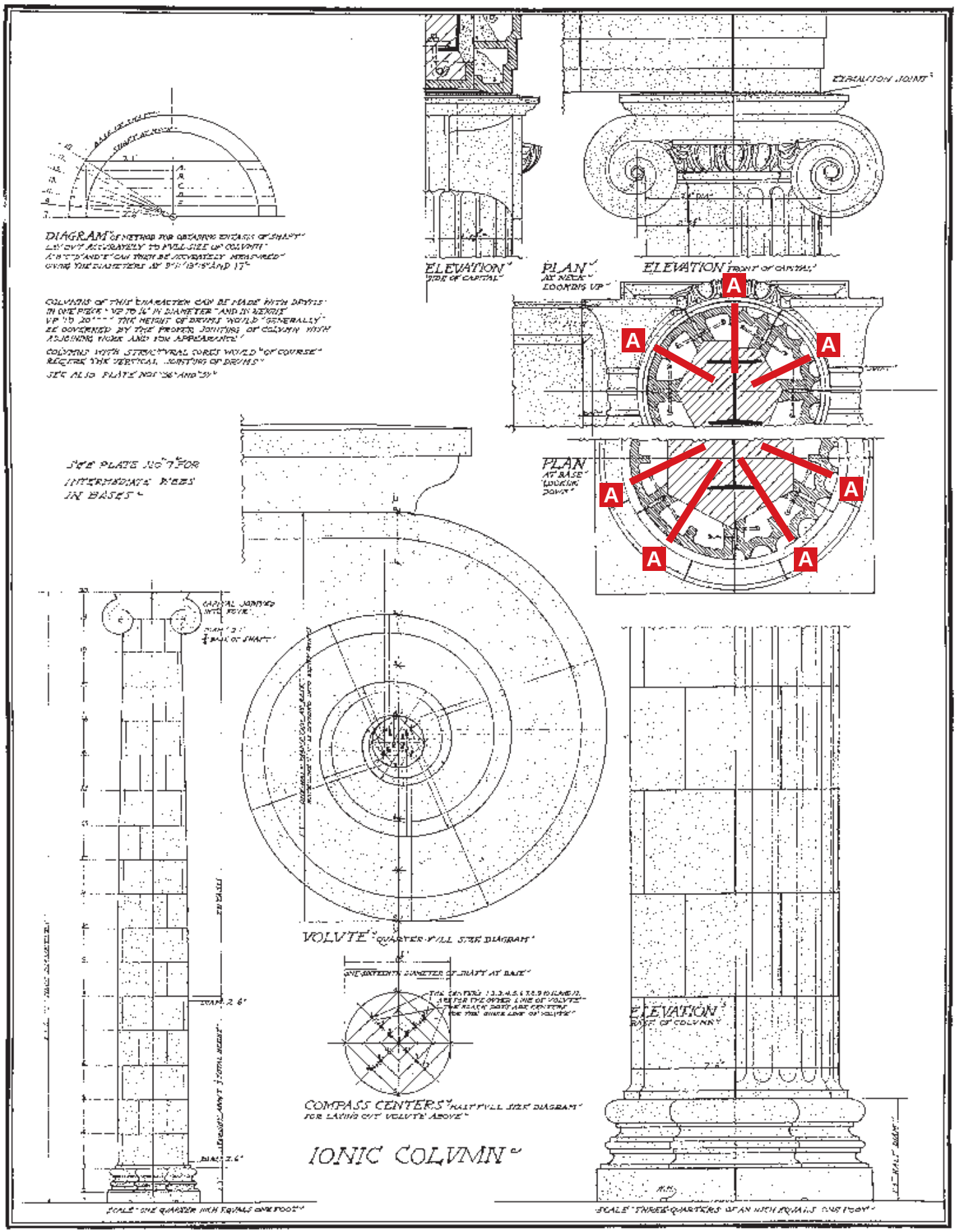
TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·52


TERRA COTTA · STANDARD CONSTRUCTION
A
A
A
A
PLAN THRO SETTING OF NECK LOOKING UP
INTERMEDIATE REINFORCING WEBS
PLAN THRO A
PLAN THRO 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 JOINTED VERTICALLY HAVE SAND CUTTING THE LINE OF ENTASIS AND HAVE A HORIZONTAL JOINT WHICH WILL ALLOW ADJUSTMENT IN ALIGNMENT IN SETTING
COUNTRY WITH CYLINDRICAL CORE MOULD OR COREGE REQUIRE THIN VERTICAL JOINTING OF ALL DRUMS
SEE ALSO PLATE NO 54 AND 57
SCALE
THREE QUARTERS OF AN INCH EQUALS ONE FOOT
INTERMEDIATE REINFORCING WEBS
DORIC COLUMN
ELEVATION
NATIONAL TERRA COTTA SOCIETY · U · S · A · · PLATE NO · 53

TERRA COTTA · STANDARD CONSTRUCTION

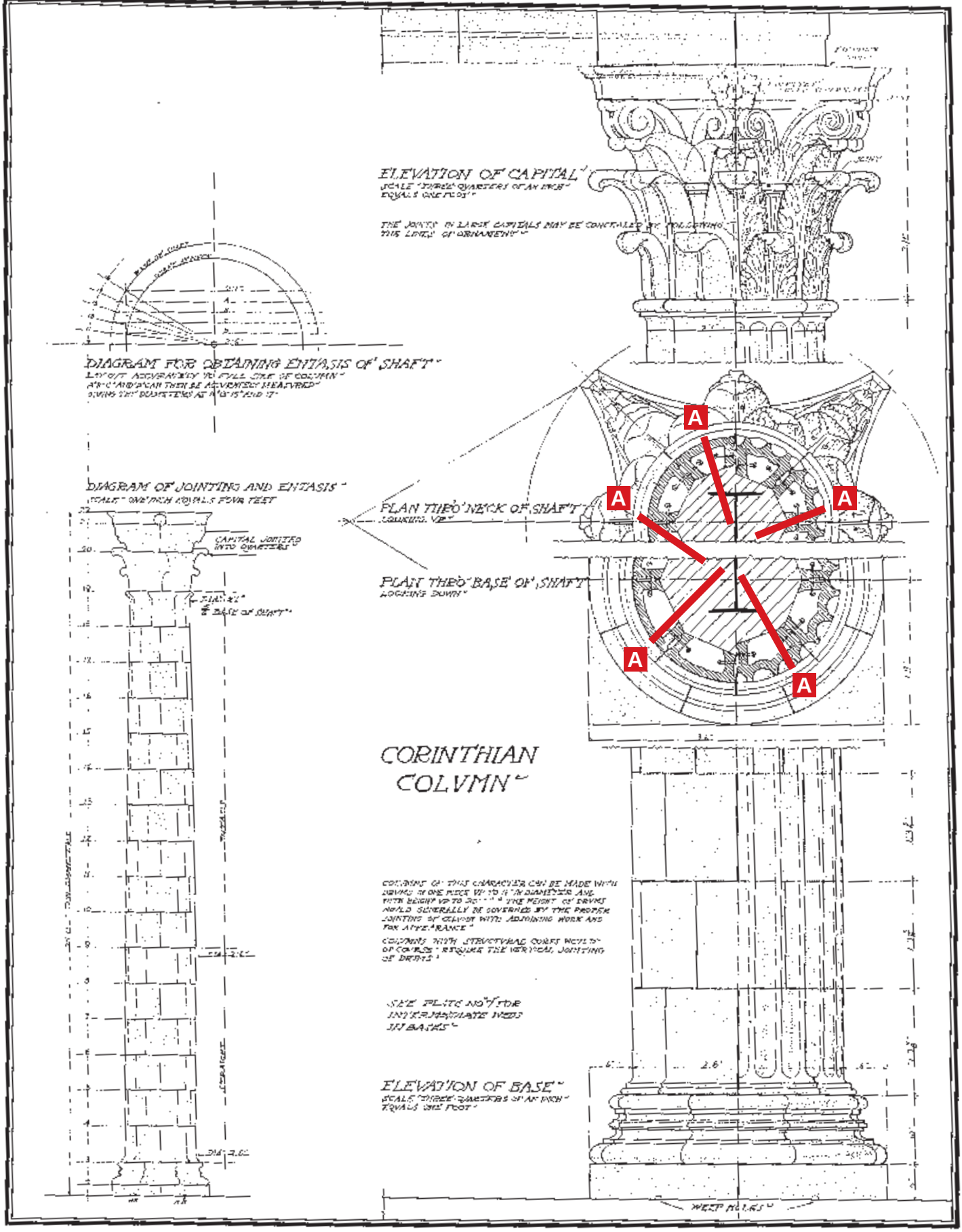


NATIONAL TERRA COTTA SOCIETY · V · S · A · · PLATE NO · 54

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.

E.O.E

TERRA COTTA · STANDARD CONSTRUCTION

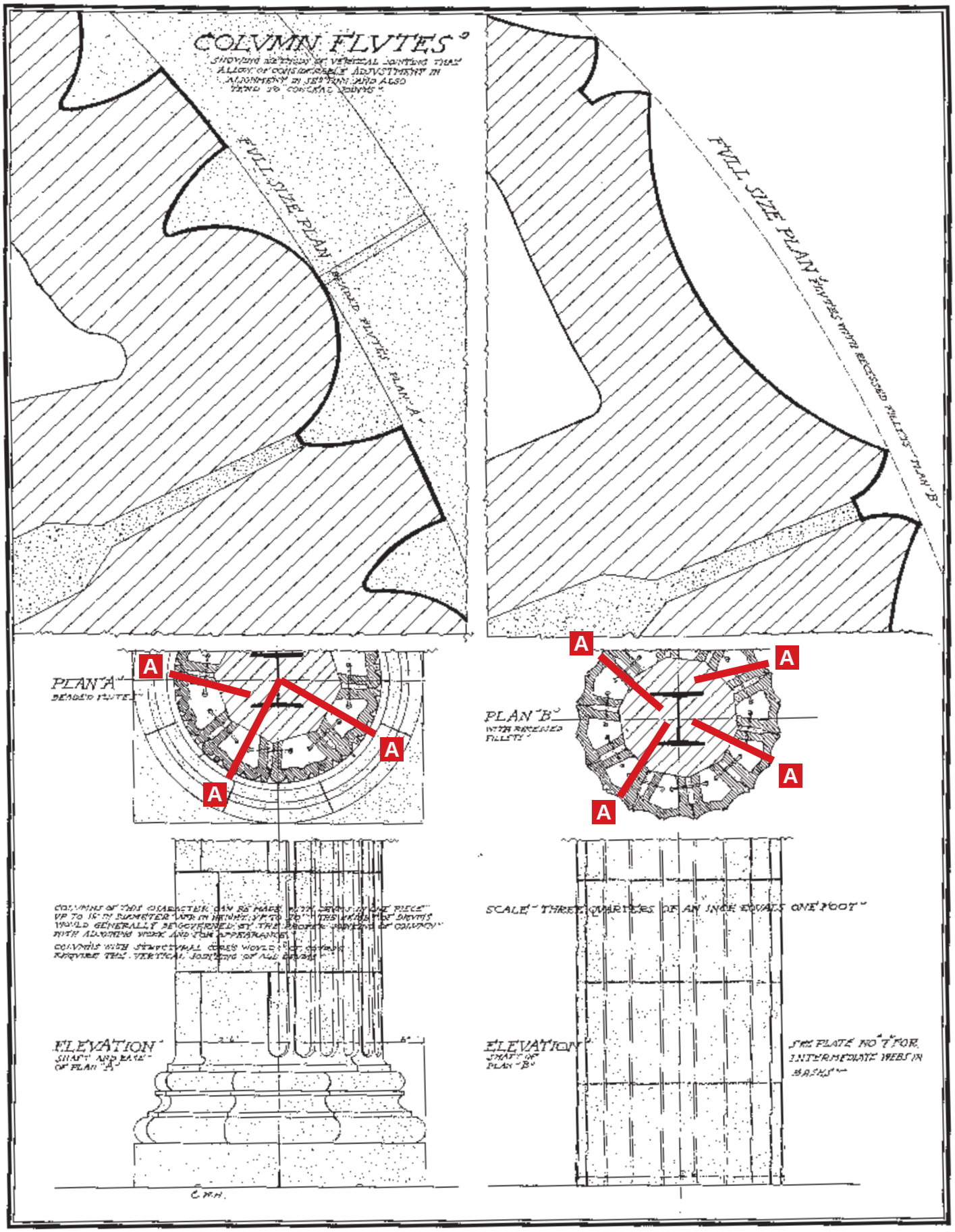


NATIONAL TERRA COTTA SOCIETY · V · S · A · · PLATE NO · 55

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.

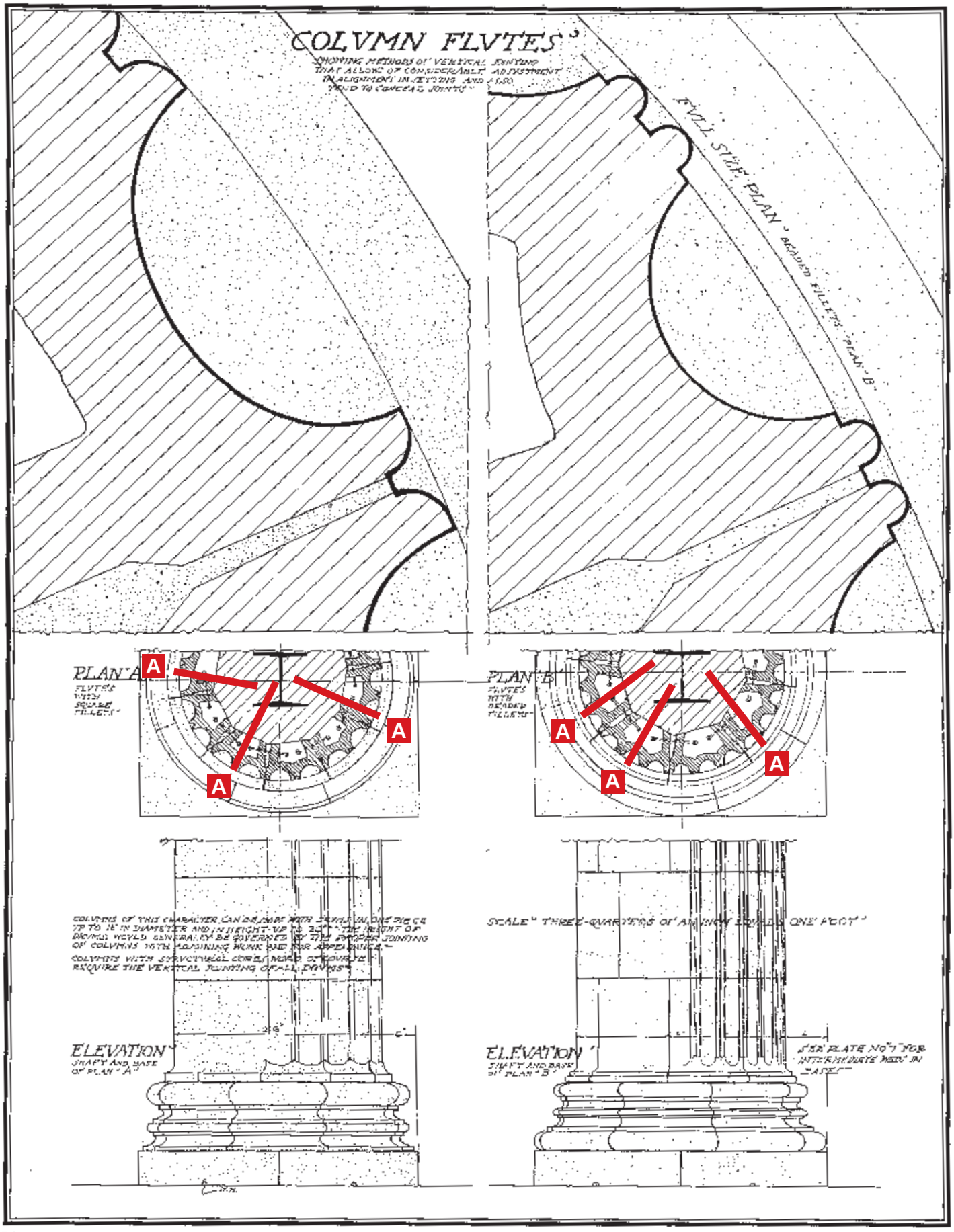
E.O.E

TERRA COTTA · STANDARD CONSTRUCTION



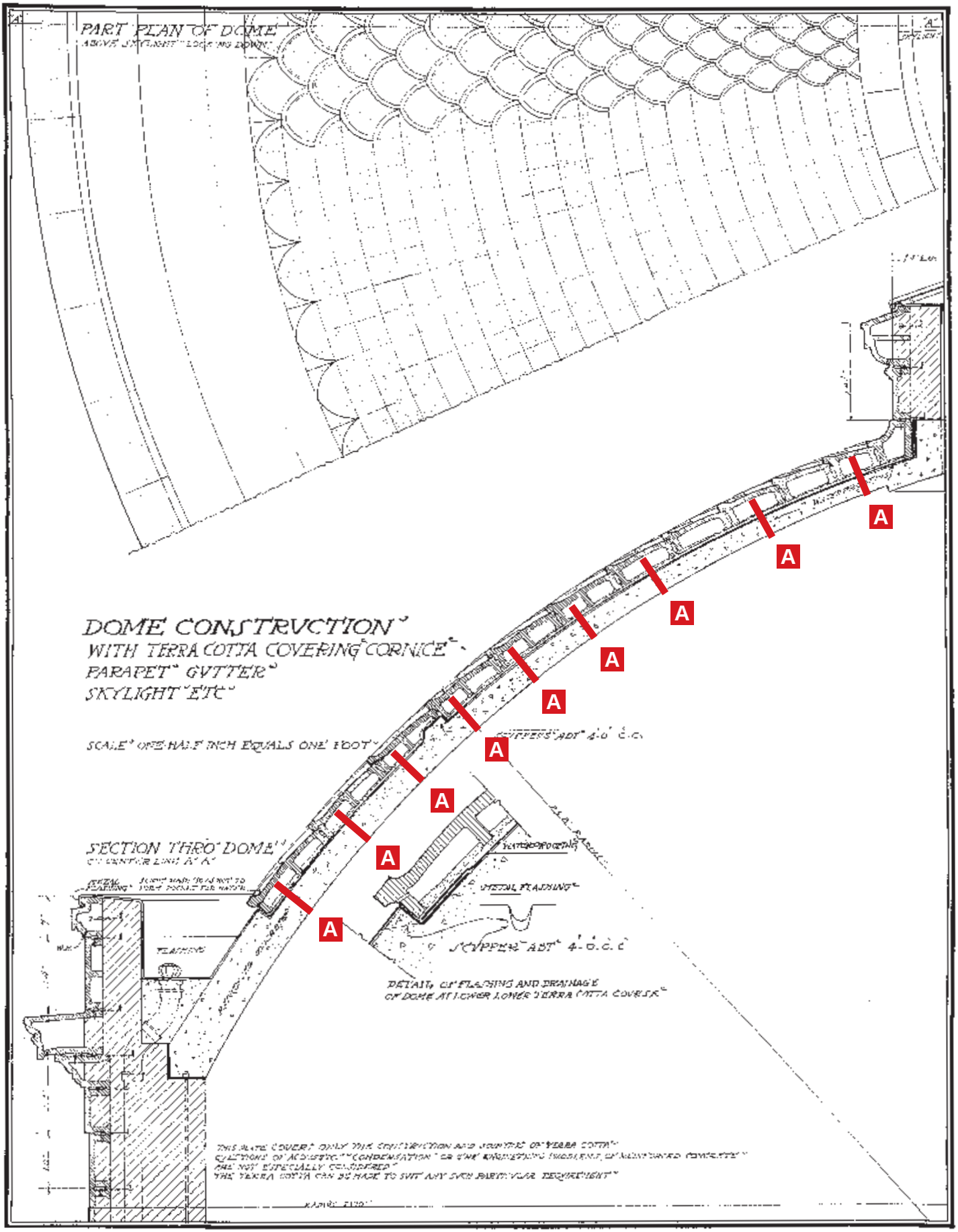
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·56

TERRA COTTA · STANDARD CONSTRUCTION



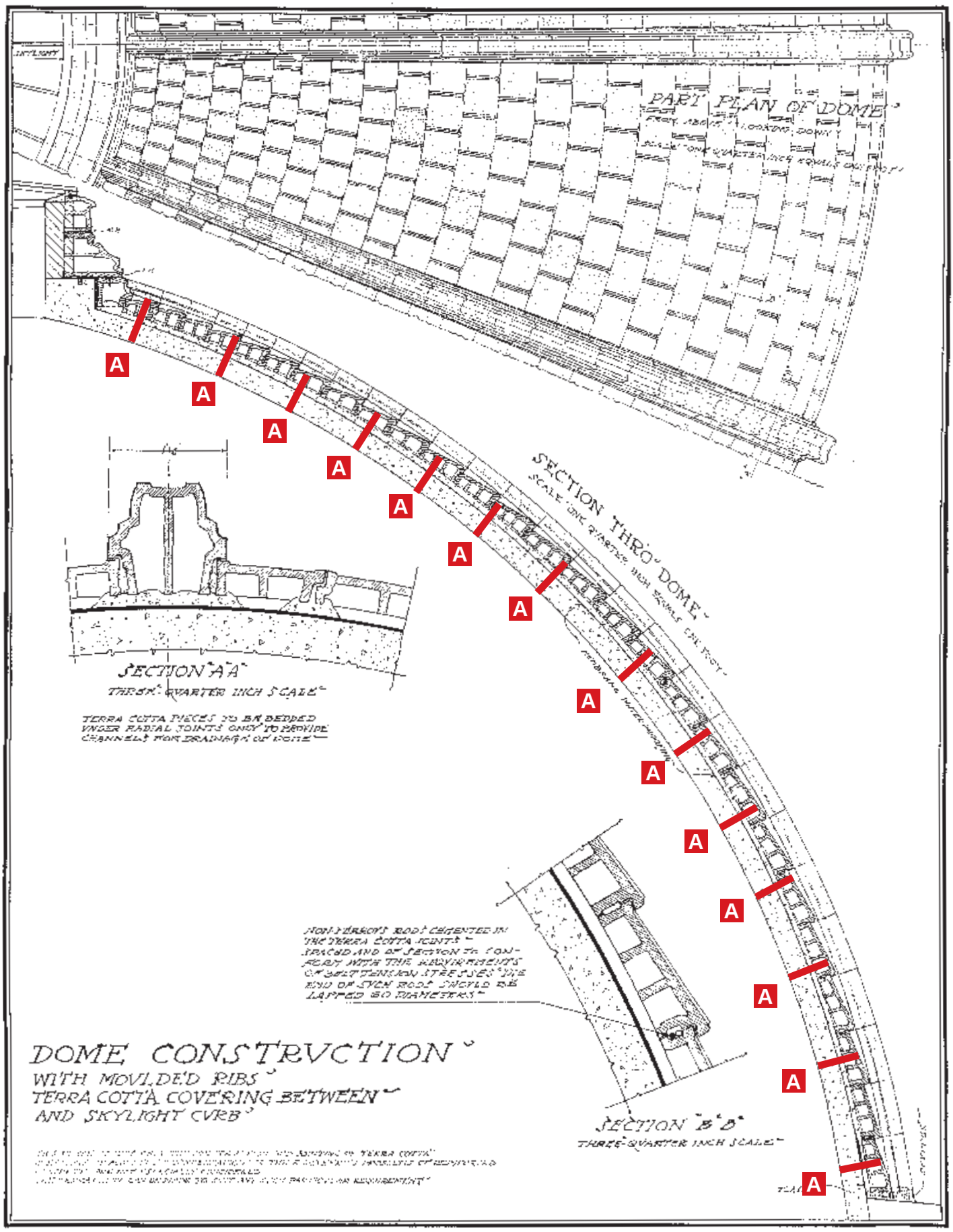
NATIONAL TERRA COTTA SOCIETY · V · S · A · · PLATE NO · 57

TERRA COTTA · STANDARD CONSTRUCTION



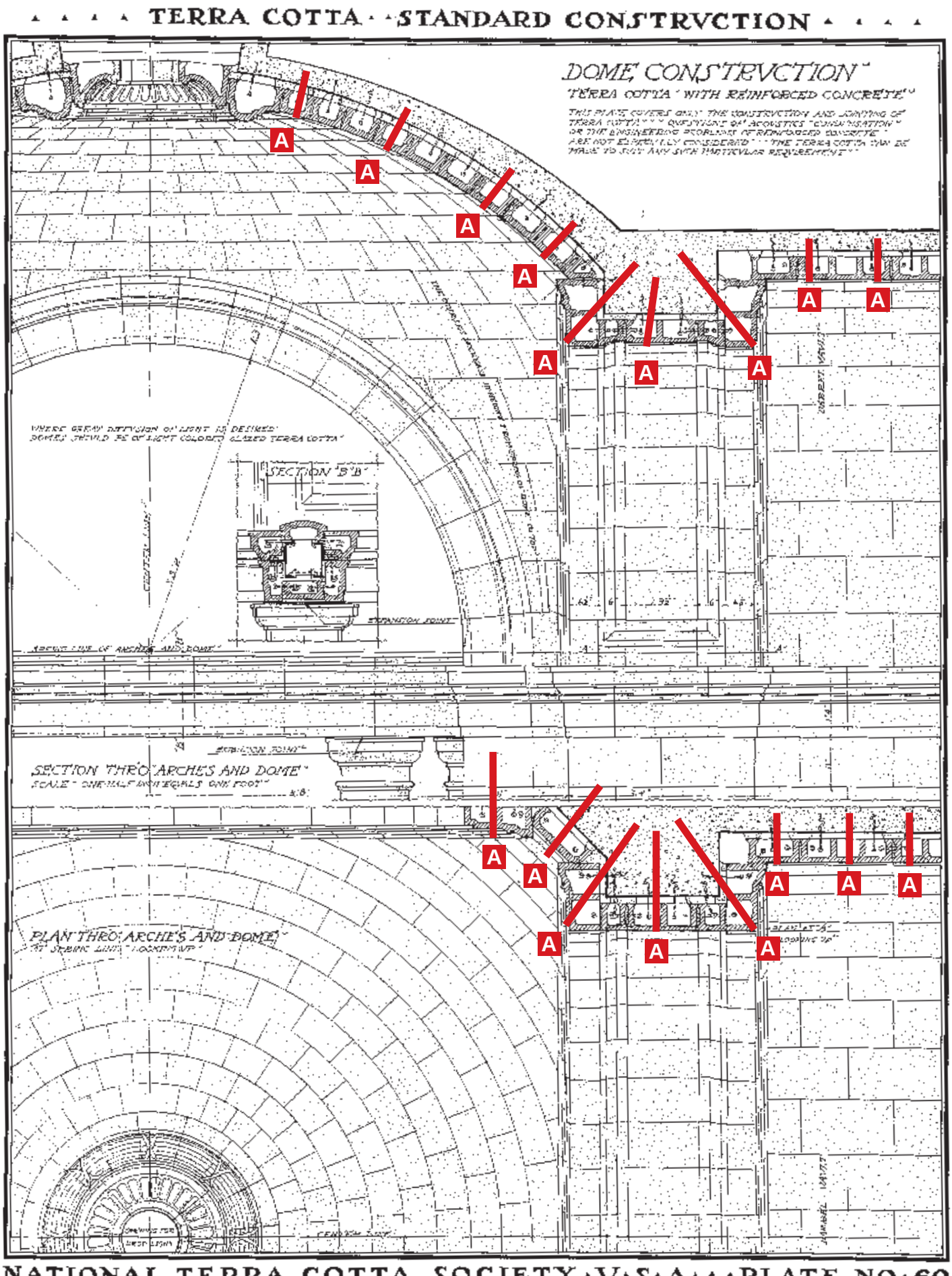
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·58

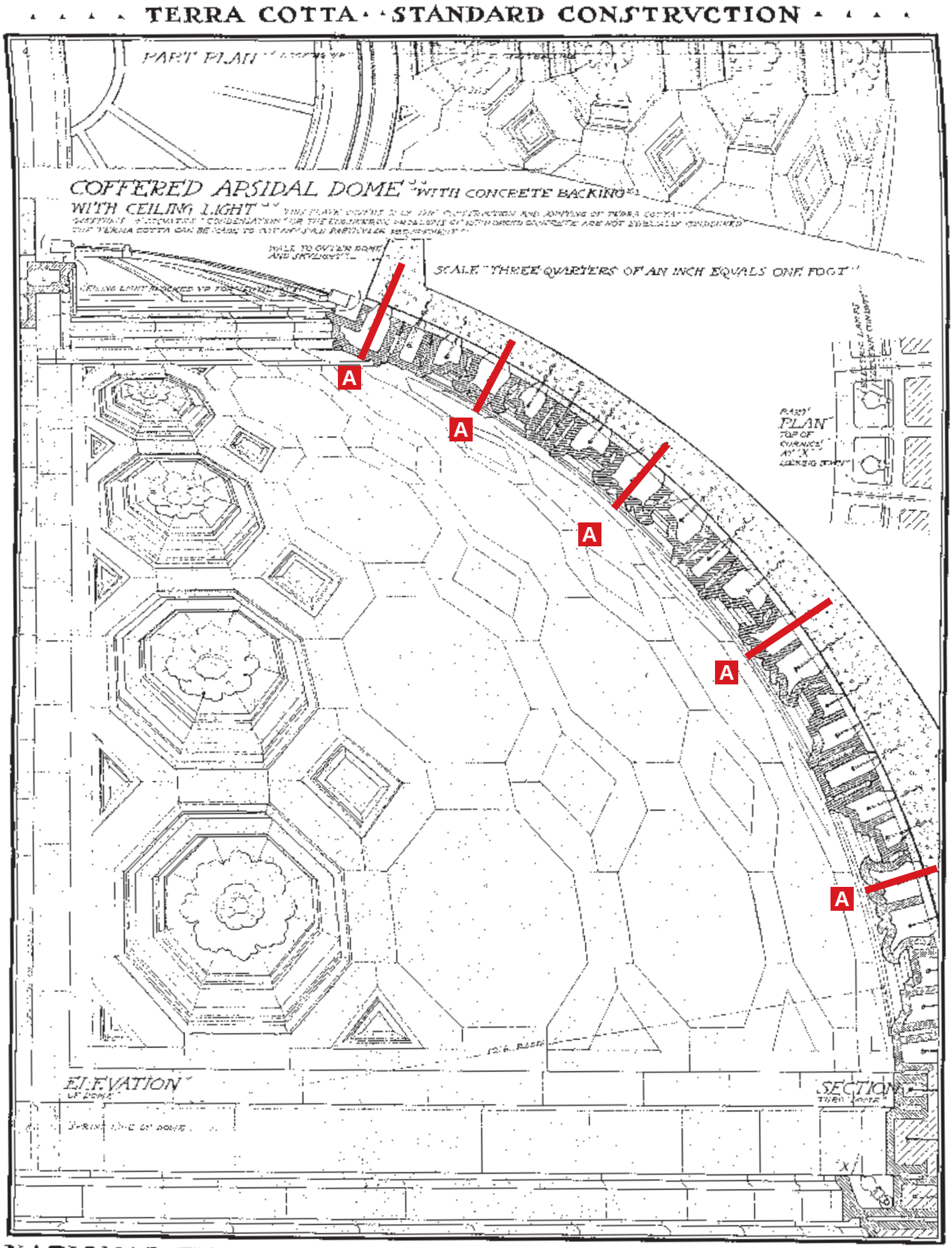
TERRA COTTA · STANDARD CONSTRUCTION

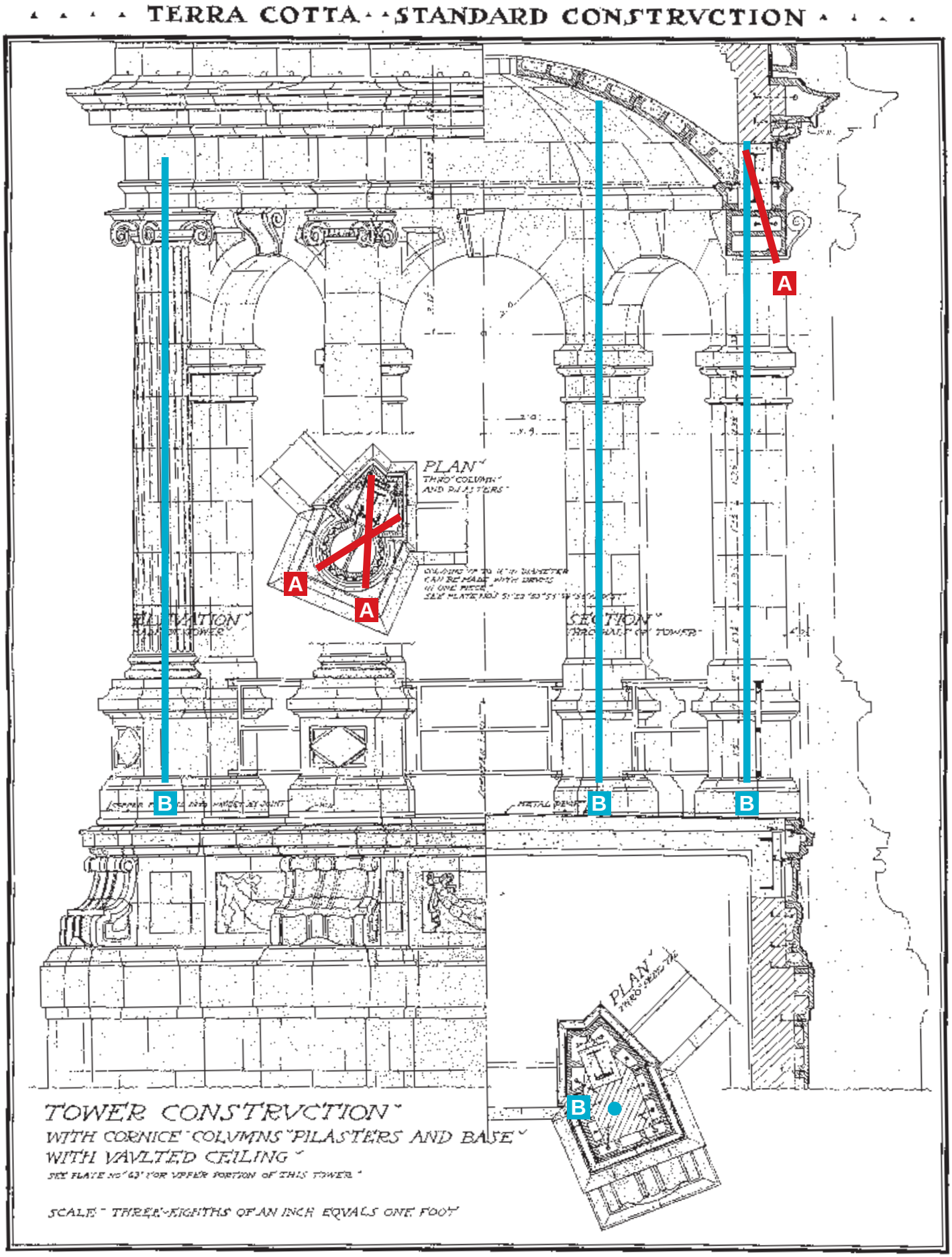


DOME CONSTRUCTION
WITH MOULDED RIBS
TERRA COTTA COVERING BETWEEN
AND SKYLIGHT CURB

NATIONAL TERRA COTTA SOCIETY · U · S · A · · PLATE NO · 59


TERRA COTTA · STANDARD CONSTRUCTION
DOME CONSTRUCTION
"TERRA COTTA" WITH REINFORCED CONCRETE
SECTION "B"B"
SECTION THRO' ARCHES AND DOME
PLAN THRO' ARCHES AND DOME
A
NATIONAL TERRA COTTA SOCIETY · U · S · A · · PLATE NO · 60

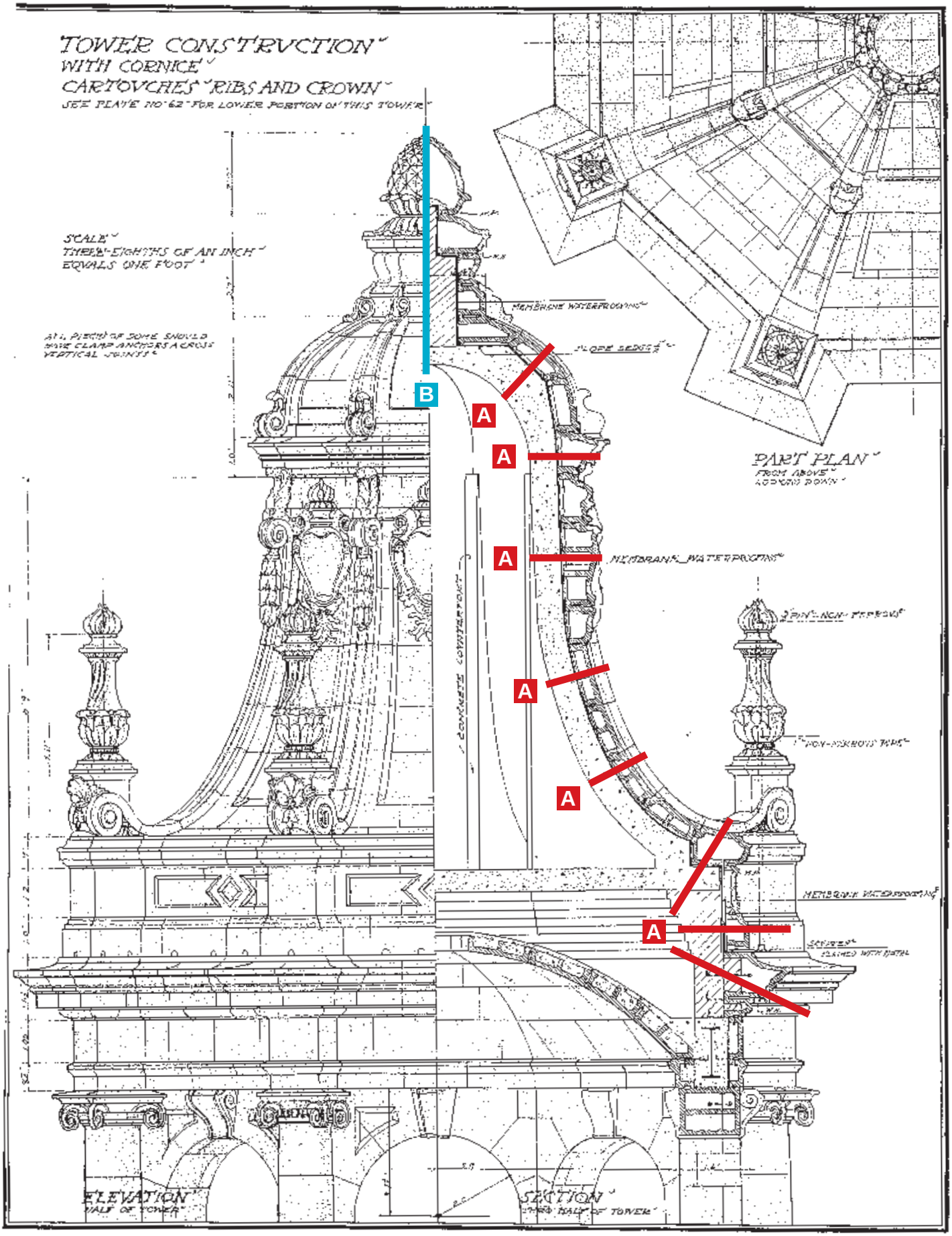

TERRA COTTA · STANDARD CONSTRUCTION
PART PLAN
COFFERED APSIDAL DOME WITH CONCRETE BACKING
WITH CEILING LIGHT
SCALE THREE QUARTERS OF AN INCH EQUALS ONE FOOT
A
A
A
A
A
PART PLAN
ELEVATION
SECTION
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·61



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.

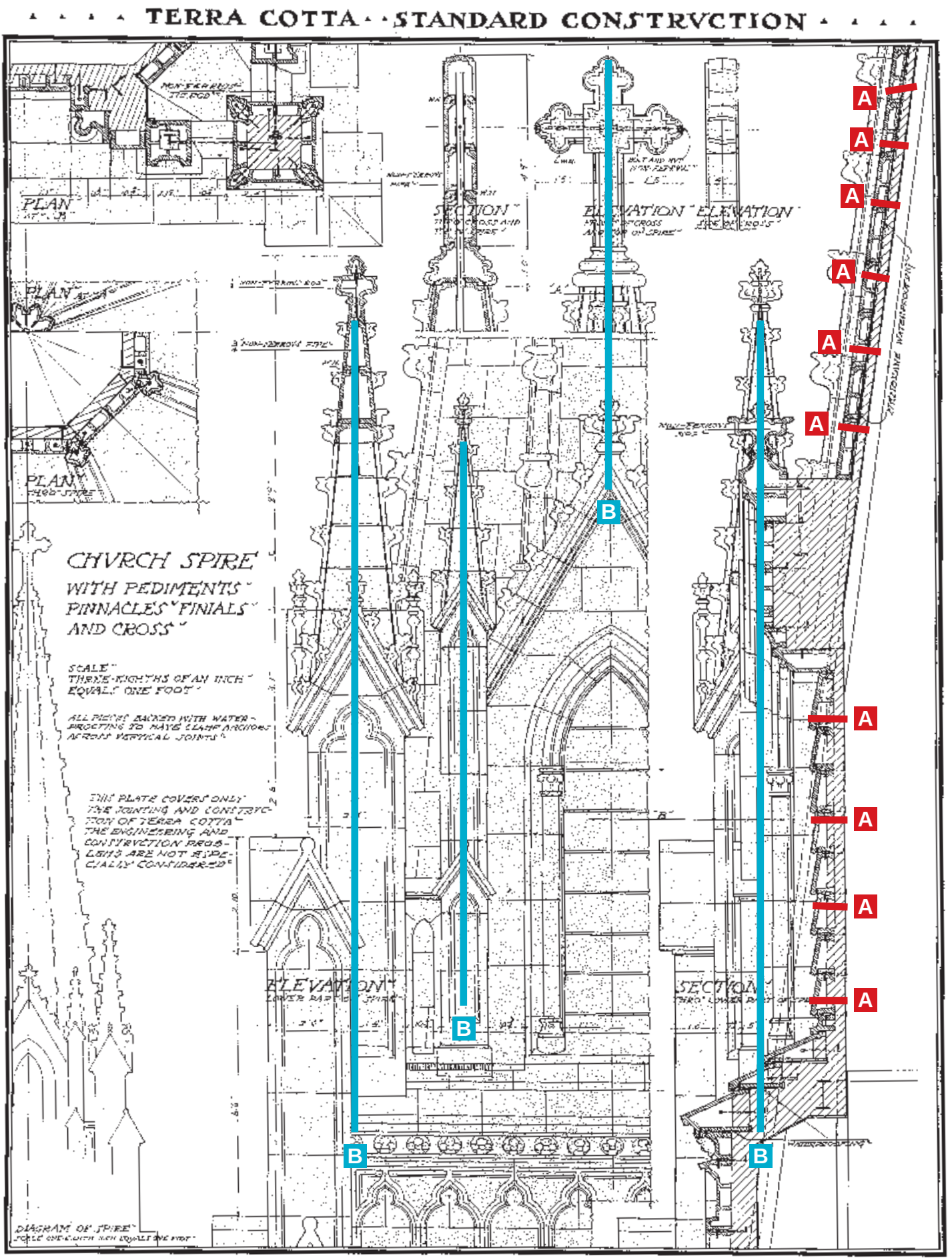
E.O.E

TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · V · S · A · · PLATE NO · 63

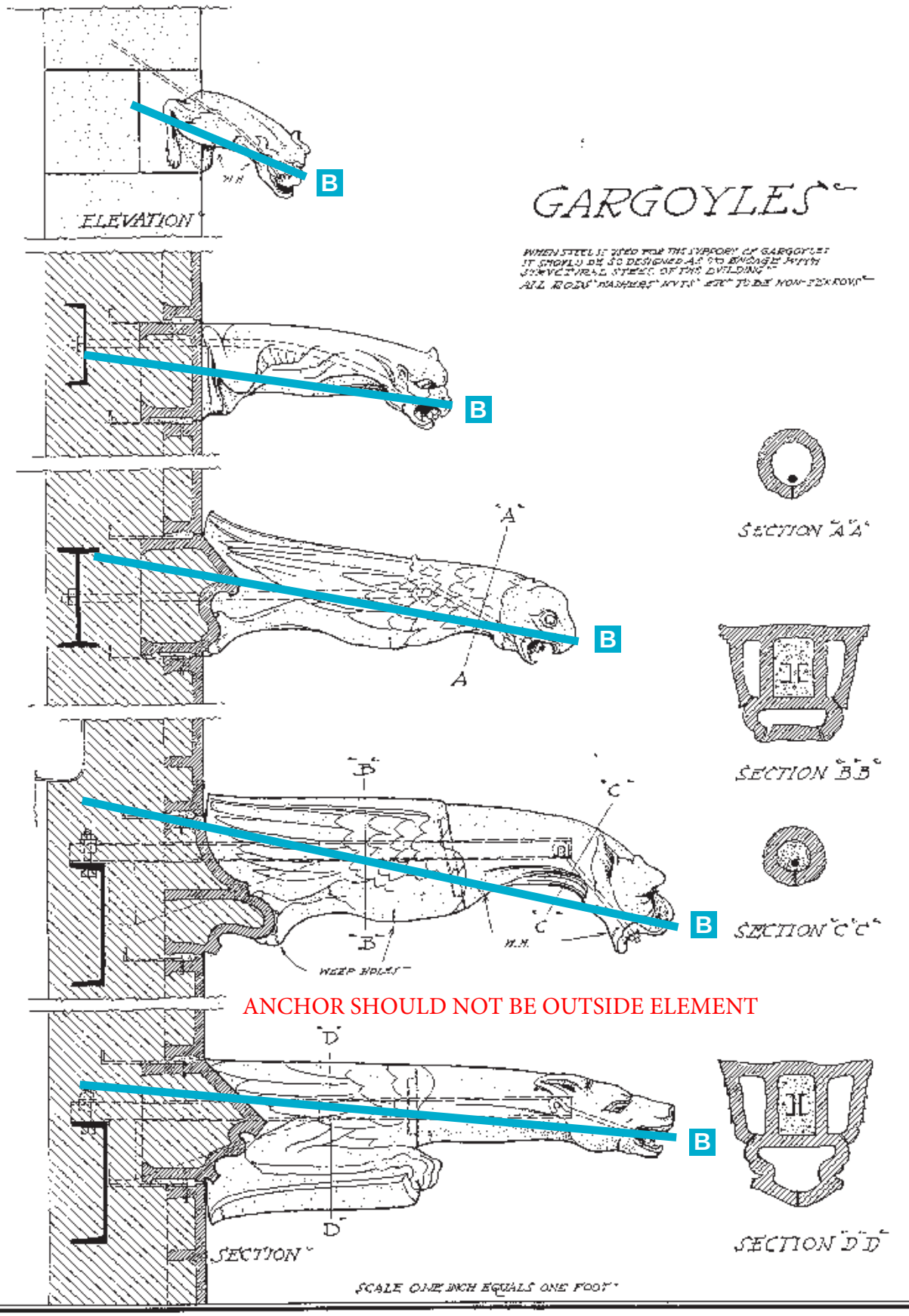
This manual provides general information for use in preliminary selection of a Cintec anchor.
Final designs must be prepared by Cintec and approved by the project Architect or Engineer of Record.



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.

E.O.E

TERRA COTTA STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · V · S · A · · PLATE NO · 65

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.

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)

VERSATILE CONSULTING & TESTING SERVICES, INC.

Integrity Is What This Firm Is Built On

240-02 66th Avenue
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.

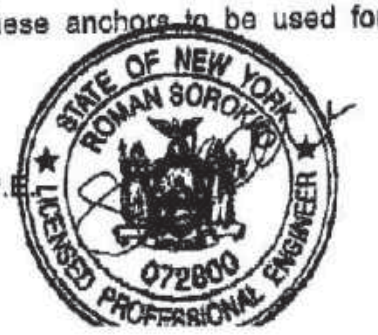
I was also directed to generate an engineering calculation in order to confirm the adequacy of the anchors to the design purpose – to secure the terra cotta blocks attached to the exterior surface of the parapet wall (as per as per Item 04525 – Terra Cotta Restoration and Repair, Paragraph 2.2 Anchors).

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 incompliance 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 PLARTE

ANCHOR DESIGN - COMBINED BENDING AND SHEAR

STATE OF NEW YORK
ROMAN SOROKKO
072800
LICENSED PROFESSIONAL ENGINEER

OPTION 1
CANTILEVERED DESIGN
(CONSERVATIVE)

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

Engineered Grout Injection Anchors by:

CINTEC AMERICA INC.

Tel 613 225 3381 Fax 613 224 9042 E-mail: rlr@cintec.com

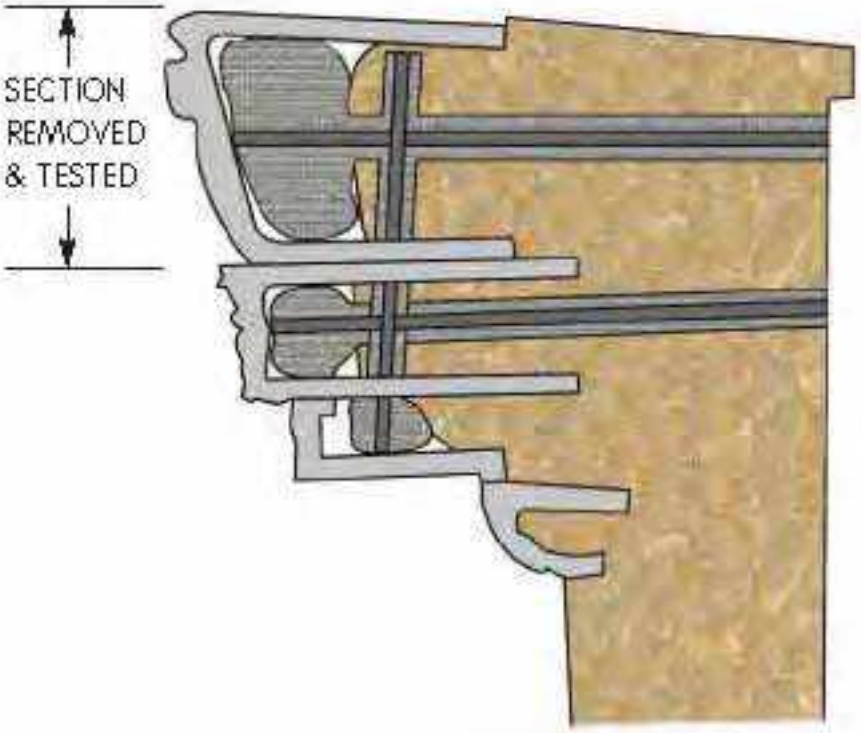
Product Engineering By: JOKINEN ENGINEERING SERVICES

Tel 905 333 1079 Fax 905 333 3699 E-mail: eric.jokinen@sympatico.com

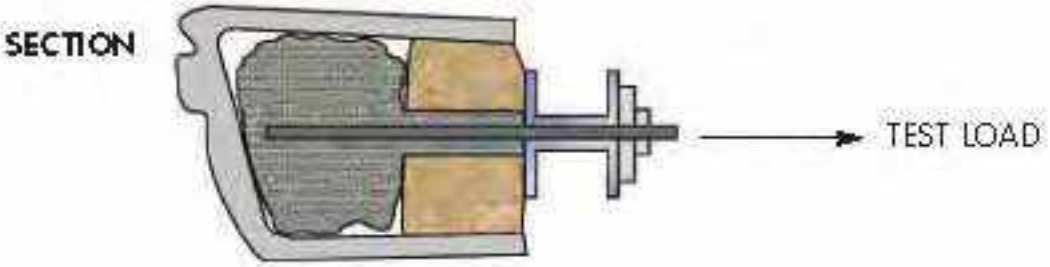
Project #:
By: AZ
Date: JANUARY 2001

SK 2A DRWG #:
0 REV. #

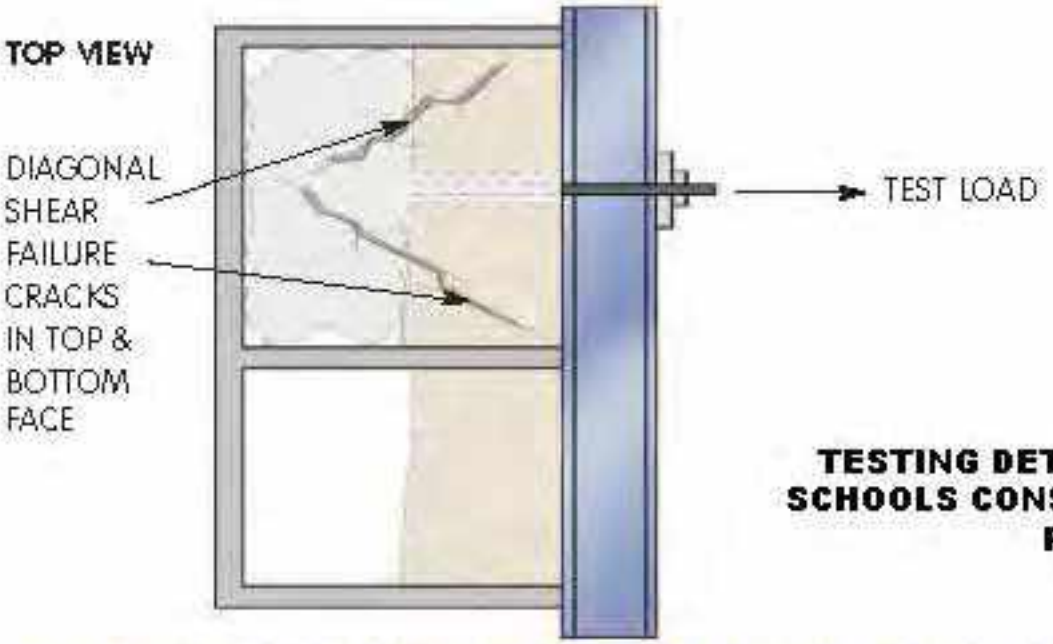
CINTEC TERRA COTTA SOLUTIONS



CINTEC
SOLUTION
AS BUILT

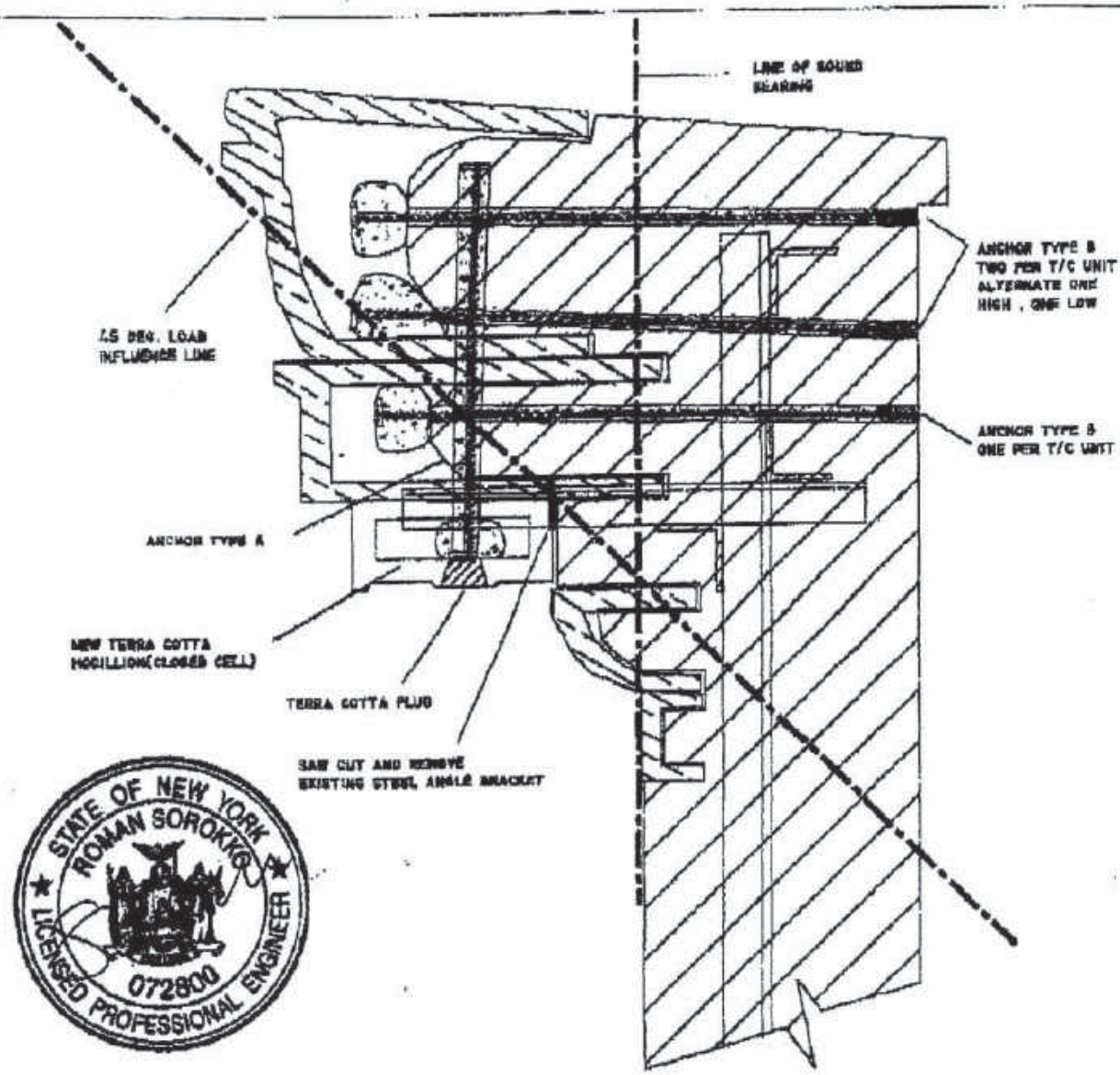


FULL SCALE TESTING



TESTING DETAILS FOR NEW YORK SCHOOLS CONSTRUCTION AUTHORITY PS 230 K

VERSITATILE CONSULTING & TESTING SERVICES JULY 2001



STATE OF NEW YORK ROMAN SOROKIG 072800 LICENSED PROFESSIONAL ENGINEER

Project Name PS 230 & PS 258

Location BROOKLYN, NEW YORK

Consultant: TAMS CONSULTANTS, INC.

CORNICE STABILIZATION
MODILLION REPLACEMENT ONLY

Engineered Grout Injection Anchors by:

CINTEC AMERICA INC.

Tel 613 225 3381 Fax 613 224 9042 E-mail: cin@cintec.com

Product Engineering By: IOKINEN ENGINEERING SERVICES

Tel 905 333 1079 Fax 905 338 2650 E-mail: eric.iokinen@sympatico.com

JES C129

Project #:

By: AZ

Date: Dec 14/2000

SK 1 DRWG #: | 1 REV. #

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 PLARTE

ANCHOR DESIGN - COMBINED PULL-OUT AND SHEAR

STATE OF NEW YORK
ROMAN SOROKKO
072800
LICENSED PROFESSIONAL ENGINEER

OPTION 2
CORBELLED DESIGN
(LESS CONSERVATIVE)

Project Name PS 230 & PS238
Location BROOKLYN NEW YORK
Consultant: TAMS CONSULTANTS

Engineered Grout Injection Anchors by:

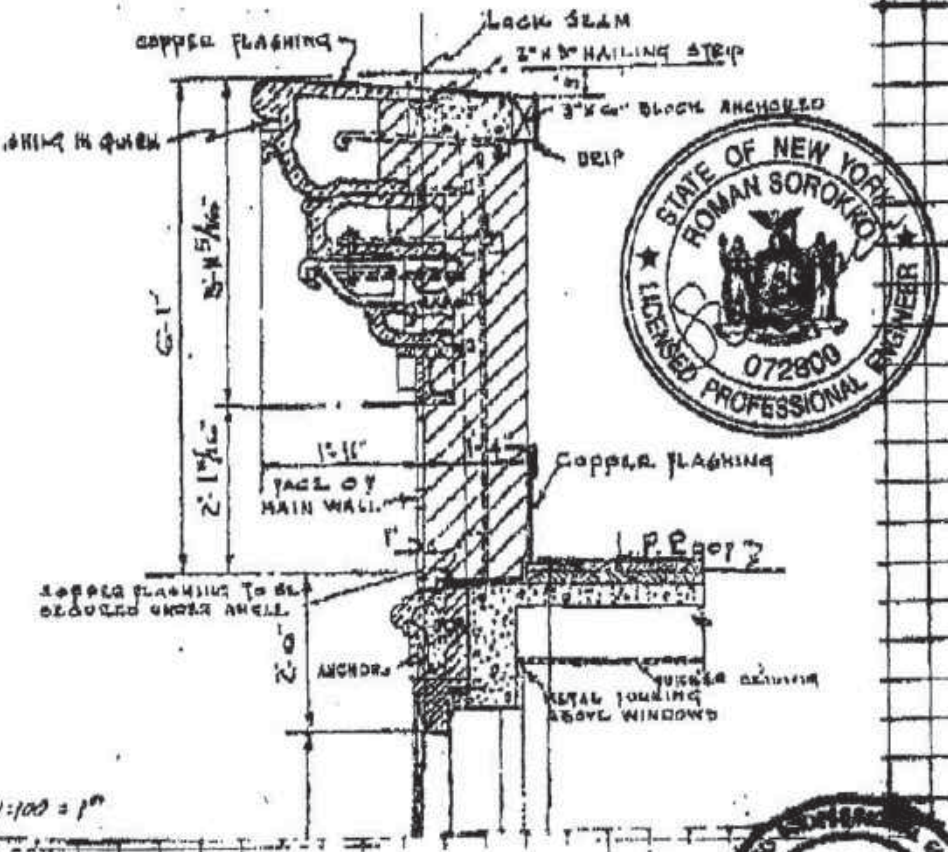
CINTEC AMERICA INC.

Tel 613 225 3381 Fax 613 224 9042 E-mail: rir@cintec.com

Product Engineering By: JOKINEN ENGINEERING SERVICES

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

Project #:	
By: AZ	
Date: JANUARY 2001	
SK 2B	0
DRWG #:	REV. #



EXISTING CONDITION

Project Name PS 230 & PS 238

Location BROOKLYN, NEW YORK

Consultant: TAMS CONSULTANTS, INC.

DESIGN CALCULATIONS

CORNICE / PARAPET

Engineered Grout Injection Anchors by:

CINTEC AMERICA INC.

613 225 3381 Fax 613 224 9042 E-mail: dr@cintec.com

Product Engineering By: JOKINEN ENGINEERING SERVICES

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

Project #:

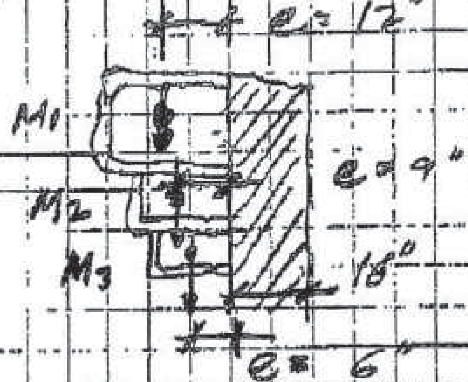
By AZ

Date: Dec 14/2000

JES C129

DE 1 DRWG #:

0 REV. #



(L)

M1: 2' x 1.5' x 2.5 @ 100PCF = 750#

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

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

MATL: ANSI 304 SS } STEEL
F_y = 29,000 PSI }

f'_c = 5000 PSI GROUT

f'_b = 300 PSI BRICK SUBSTRATE

STATE OF NEW YORK ROMAN SOROKKO LICENSED PROFESSIONAL ENGINEER 072809

ERIC P. [illegible] PROVINCE OF ONTARIO

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

DESIGN CALCULATIONS
CORNICE & PARAPET

Engineered Grout Injection Anchors by:
CINTEC AMERICA INC.
613 225 3381 Fax 613 224 9042 Email: rlr@cintec.com

Product Engineering By JOKINEN ENGINEERING SERVICES
Tel 905 333 1079 Fax 905 333 3659 E-mail: eric.jokinen@sympatico.com

JES C129

Project #:
By: AZ
Date: Dec 14 2000
DRWG #: DE 2
REV. #: 0

OPTION 1: CANTILEVER DESIGN (CONSERVATIVE)

BLOCK M1: 750#/2 ANCHORS

12"

16"

2 anchors / block

1/2 x 1/2 x 6 Anchor body A = 0.531 in²

#SS Sb = 0.266 in³

Shear

V = 750/2 = 375 #

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

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

$f_b = \frac{M}{S} = \frac{4500}{0.266} = 16917 < 0.66 F_y$

STATE OF NEW YORK
ROMAN SOROKKO
LICENSED PROFESSIONAL ENGINEER
072800

PROFESSIONAL ENGINEER
FEB 2 0 2001
ERIC P. JOKINEN
PROVINCE OF ONTARIO

Project Name PS 230 & PS 238

Location BROOKLYN, NEW YORK

Consultant: TAMS CONSULTANTS, INC.

DESIGN CALCULATIONS

Engineered Grout Injection Anchors by:

CINTEC AMERICA INC.

613-224-9361 Fax 613-224 9042 E-mail: rin@cintec.com

Product Engineering By: JOKINEN ENGINEERING SERVICES

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

JES
C129

Project #:

By: AZ

Date: Dec 14/2000

DE 3 | 0

DRWG #: | REV. #

OPTION 1: CANTILEVER (CONSERVATIVE)

BLOCK M1 (cont'd)

CHECK BAG ON BRICK

ASSUME 3" ϕ DIA HOLE

BAG ON ½ CIRCUMF

EMBEDMENT = 1'-2" = 16" - 2" = 14"

$S_b = \frac{3 \times 3.14}{2} \times \frac{14^2}{6} = 154 \text{ in}^3$

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

Moment about centroid of brick bag area

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

$f_{brick} = \frac{7125}{154} = 46 \text{ psi}$

$f_{bag} = \frac{375}{66} = 6 \text{ psi}$

$f = 52 \text{ psi} < 300 \text{ psi Allowable}$

STATE OF NEW YORK ROMAN SORGIVO 072800 LICENSED PROFESSIONAL ENGINEER

FEB 2 0 2001

ERIC P. JOKINEN

Project Name: ES 230 & FS 238

Location BROOKLYN, NEW YORK

Consultant: TAMS CONSULTANTS, INC.

DESIGN CALCULATIONS

Engineered Grout Injection Anchors by:

CINTEC AMERICA INC.

613 225 1381 Fax 613 225 9042 E-mail: ric@cintec.com

Product Engineering By: JOKINEN ENGINEERING SERVICES

Tel 905 333 0079 Fax 905 333 5659 E-mail: eric.jokinen@sympatico.com

JES: C129

Project #:

By: AZ

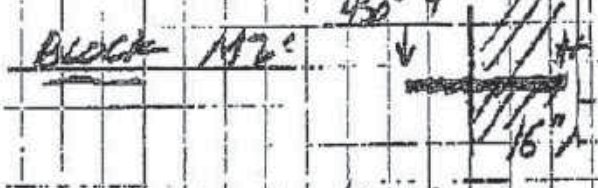
Date: Dec 14/2000

DRWG #: DE 4

REV. #: 0

OPTION 1 : CANTILEVER

BLOCK M2 :



TRY 1 ANCHOR/BLOCK

1/2 x 1/2 x 6 in 3" HOLE - EMBED 14"

M_c = 450 x 9 = 4050 < M_c (BLOCK 1) ∴ OK

M_{BRG} = 450 x (9+7) = 7200 in-lb ≥ M_{br} (BLOCK 1)

∴ OK

USE SAME DESIGN AS

BLOCK 1 EXCEPT 1 ANCHOR/BLOCK

BLOCK M3 IN TENSION

f'_c = 100 #/in² 1/2" ϕ THREAD A_{net} = 0.11 in²

P_{allow} = 0.11 x 2000 x 0.6 = 1900 # OK

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

P_a = 3060 # OK

END OPTION (1)

STATE OF NEW YORK ROMAN SOROKIO LICENSED PROFESSIONAL ENGINEER 072600

ER 2-8-2001 ERIC JOKINEN PROFESSIONAL ENGINEER PROVINCE OF ONTARIO

Project Name PS 230 & PS 238

Location BROOKLYN, NEW YORK

Consultant: TAMS CONSULTANTS, INC.

DESIGN CALCULATIONS

Engineered Grout Injection Anchors by:

CINTEC AMERICA INC.

613 225 3381 Fax 613 224 8042 E-mail: dr@cintec.com

Product Engineering By: JOKINEN ENGINEERING SERVICES

Tel 905 333 1079 Fax 905 333 3659 E-mail: eric.jokinen@sympatico.ca

Project #:

By AZ

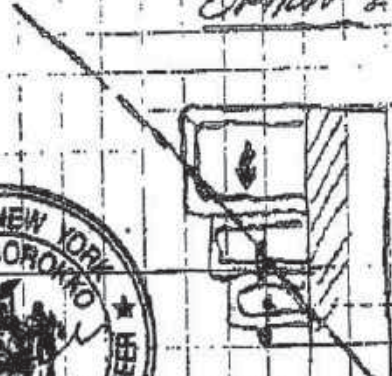
Date: Dec 14/2000

IES C129

DRWG #: DE 5

REV. # 0

OPTION 2: CORBELLED



$\Rightarrow$ $P = M_1 + M_2 + M_3$

$= 750 + 450 + 100^{\#}$

$= 1300^{\#}$

$e = 12"$ (CONSERVATIVE)

$M_c = 12 \times 1300 = 15600$ in-lb

$P = \frac{M}{d} = \frac{15600}{16} = 975^{\#}$ PULLOUT ON 1 ANCHOR

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

STEEL: $P_a = 0.75 \times 28000 \times 0.6 = 4350^{\#} < 975^{\#}$

BOND: $P_a = 1.5\pi \times 12" \times 65 \times 1 = 3673^{\#} < 975^{\#}$

$\therefore$ OK

BLOCK M3 HANGER (AS OPTION 1 DESIGN)

STATE OF NEW YORK ROMAN SOROKKO LICENSED PROFESSIONAL ENGINEER 072860

Project Name: PS 230 & PS 238

Location: BROOKLYN, NEW YORK

Consultant: TAMS CONSULTANTS, INC.

DESIGN CALCULATIONS

FEB 2 0 2001

ERIC JOKINEN

PROFESSIONAL ENGINEER PROVINCE OF ONTARIO

Engineered Grout Injection Anchors by:

CINTEC AMERICA INC.

613 225 3581 Fax 613 224 9042 E-mail: ric@cintec.com

Product Engineering By: JOKINEN ENGINEERING SERVICES

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

Project: JES C129

By: AZ

Date: Dec 14/2000

DRWG #: DE 6

REV. #: 0

OPTION 2: CORBELLED

CHECK SHEAR IN ANCHORS @ PARAPET EXT. FACE

3 - 3/4" ϕ THRD ROD DOWELS

$V_{allow} = \frac{0.25 \times 29000 \times 0.4}{1.23} = 2180\#/anchor$

> 1300# TOTAL ROD

∴ OK

ADD OPTION (2)

STATE OF NEW YORK
ROMAN SOROKKO
072600
LICENSED PROFESSIONAL ENGINEER

LICENSED PROFESSIONAL ENGINEER
SEP 20 2001
ERIC P. JOKINEN
PROVINCE OF ONTARIO

Project Name PS 230 & PS 258

Location BROOKLYN, NEW YORK

Consultant: TAMS CONSULTANTS, INC.

DESIGN CALCULATIONS

Engineered Grout Injection Anchors by:

CINTEC AMERICA INC.

Tel 613 225 3781 Fax 613 224 9042 E-mail: cinc@cintec.com

Product Engineering By: JOKINEN ENGINEERING SERVICES

Tel 905 333 1079 Fax 905 329 3659 E-mail: eric.jokinen@sympatico.com

JES
C129

Project #:

By: AZ

Date: Dec 14/2000

DE 7 | 0

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

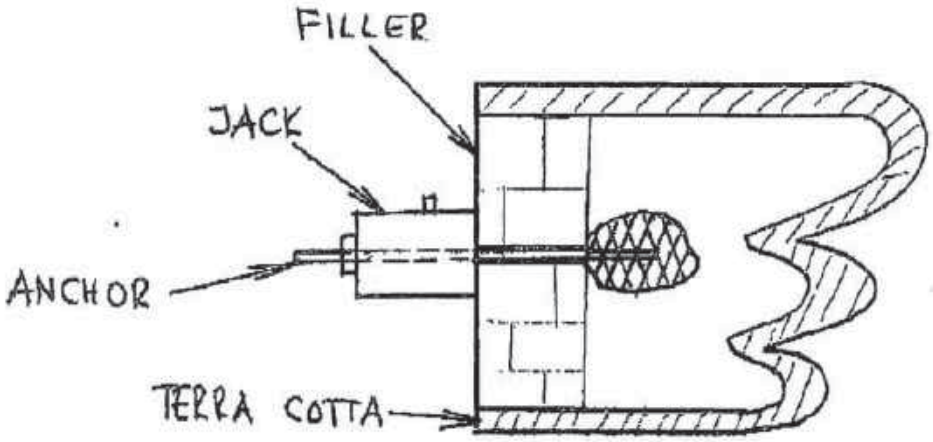
One June 18, 2001 the anchors Type A and Type B were installed by the representatives of Cintec America Inc. This installation was also a part of the Contractor's training program. Two Type A anchors (1/2" in diameter) designated for the testing were placed into the pies of terra cotta which was previously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

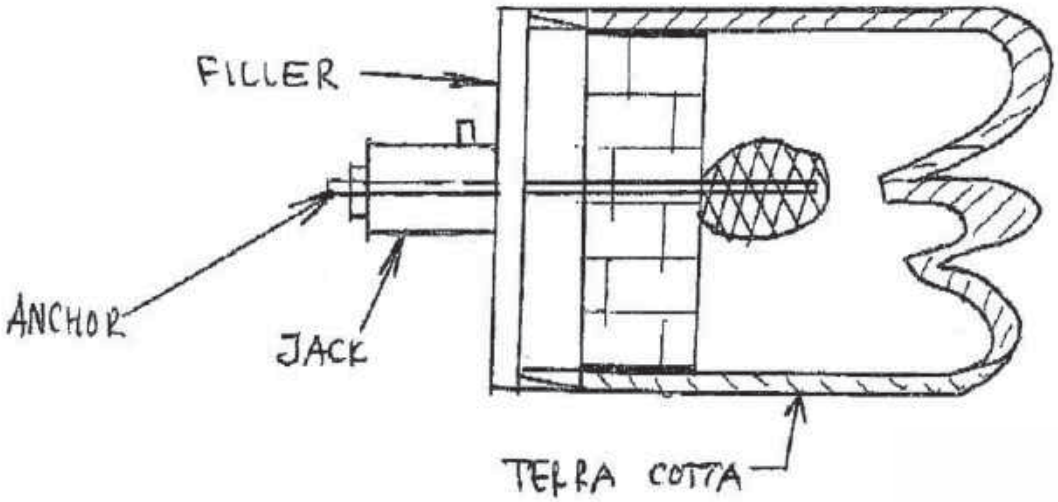


Under this format the Type A anchor was loaded up to 4,690 lbs or 2.3 tons (equivalent of 1,000 psi reading). The load was gradually applied in steps of 100 psi increment.

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.

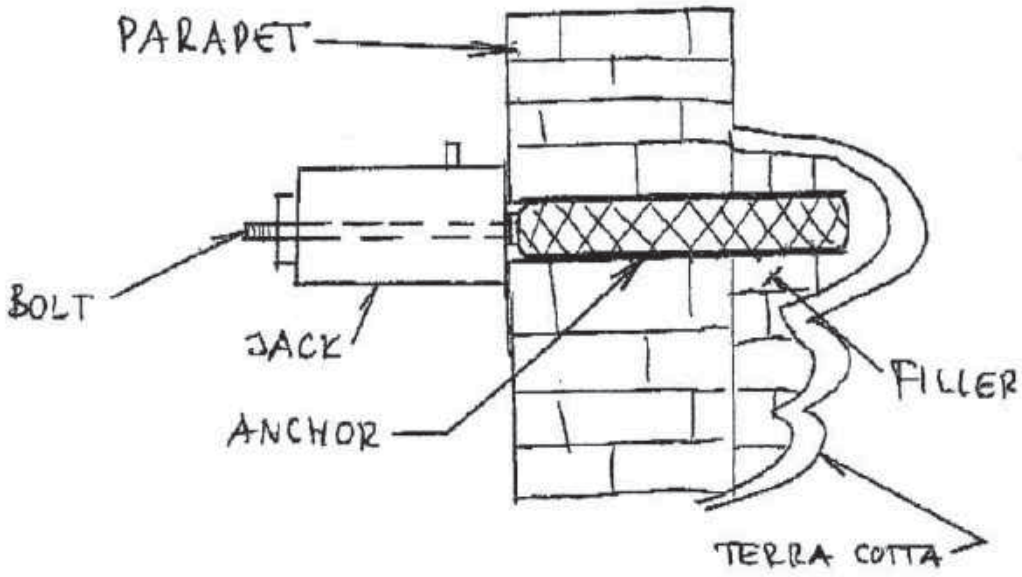
The second Type A anchor was loaded similar to the TEST No. 2 – pull out forces were applied to the joint between the terra cotta and the masonry filler.

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, ¾" 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

A Study of a Terra-Cotta Building
By Professor Martin E. Weaver, AADipl

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.

A Study of a Terra-Cotta Building
By Professor Martin E. Weaver, AADipl

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 top and 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 cracqueleure 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 cementious 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.

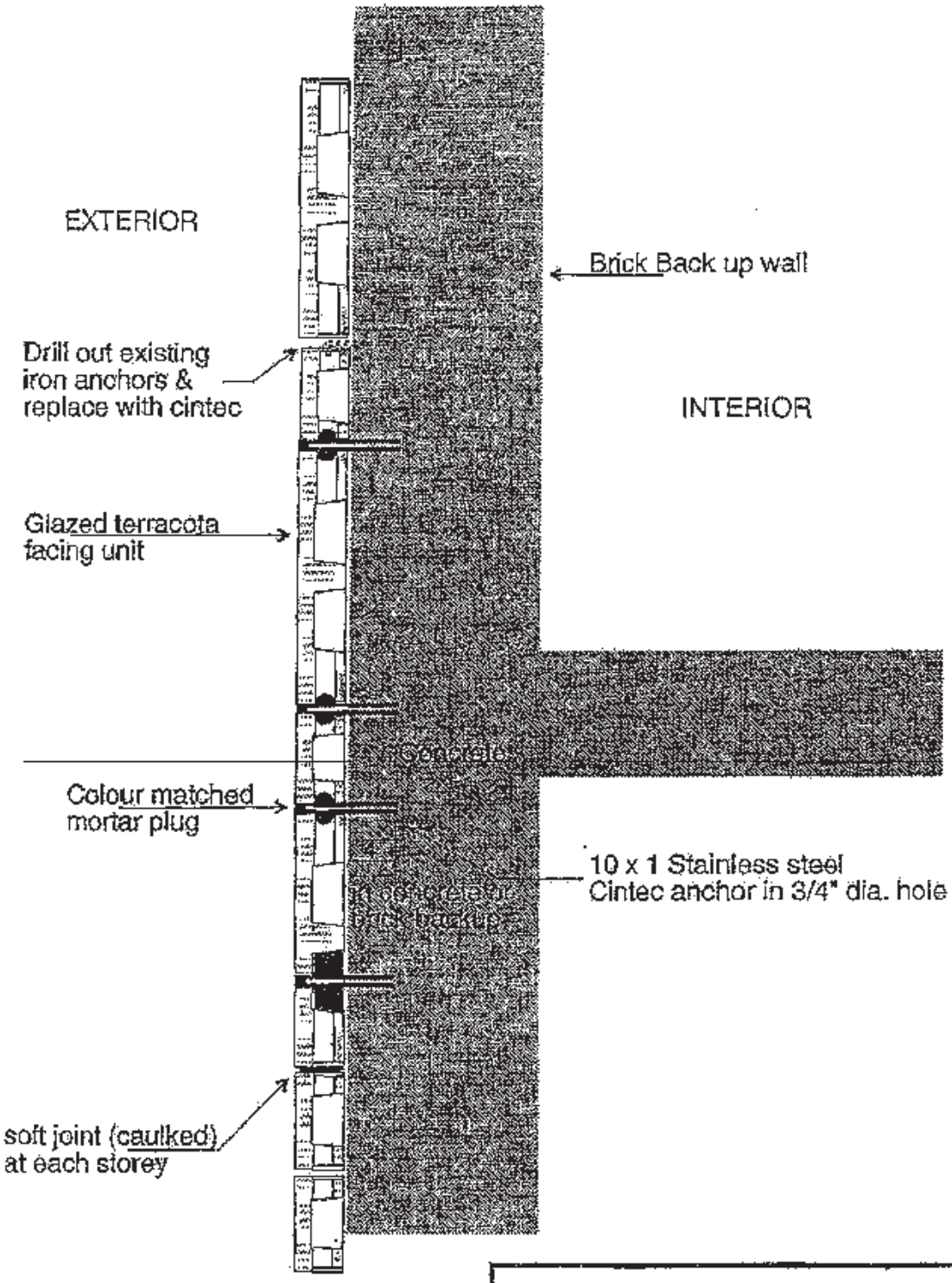
Spall damage should be repaired by careful cutting out and the insertion of matching Indiana Limestone Dutchmen. Cleaning of the limestone should be by means of nebulous spray washing and limited use of neutral, non-ionic detergents such as Triton X100. Following appropriate testing and the establishment 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.



UMA Engineering Ltd. Engineers & Planners		
Typical Terracota Anchoring Detail		
DRAWN BY NO	JOB NO.	SHEET NO. 9
DESIGNED BY EJ	SCALE	
CHECKED BY	DATE	

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BUILDING WITH STONE
MASONRY CLEANING & RESTORATION
STOREFRONTS & COMMERCIAL FACADES
BIRD CONTROL
PLAQUES & SIGNAGE
PUBLIC ART & SCULPTURE
EXTERIOR CORNICES

PLUS

TILE ROOFING

CONSERVING A TERRA-COTTA CORNICE

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.*

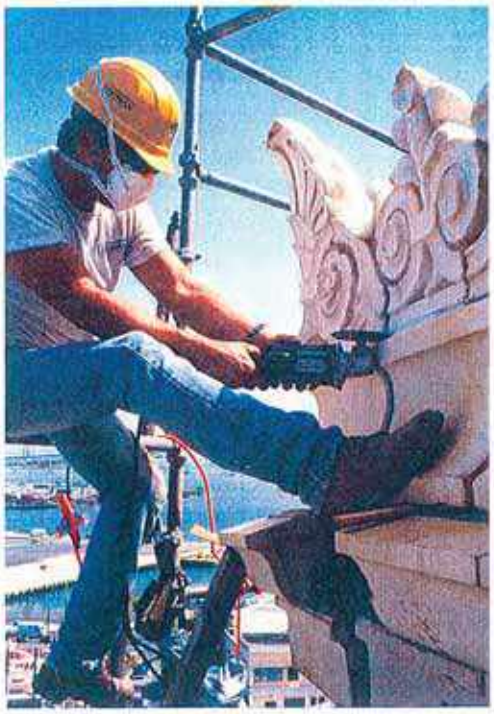
Conservation Solutions, Inc., was contracted by the government of Puerto Rico to assist Pablo Quinones of OPQ & Associates in the investigation of the main terra-cotta cornice at the base of the dome of San Juan's Capitol Building.

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

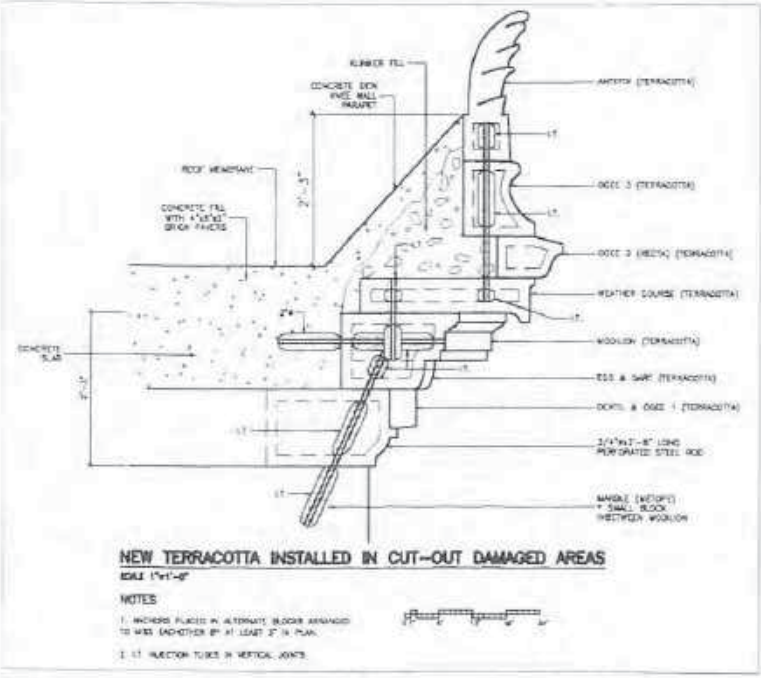


A worker is seen here cutting the mortar joints between the terra-cotta blocks in preparation for the disassembly of the cornice.

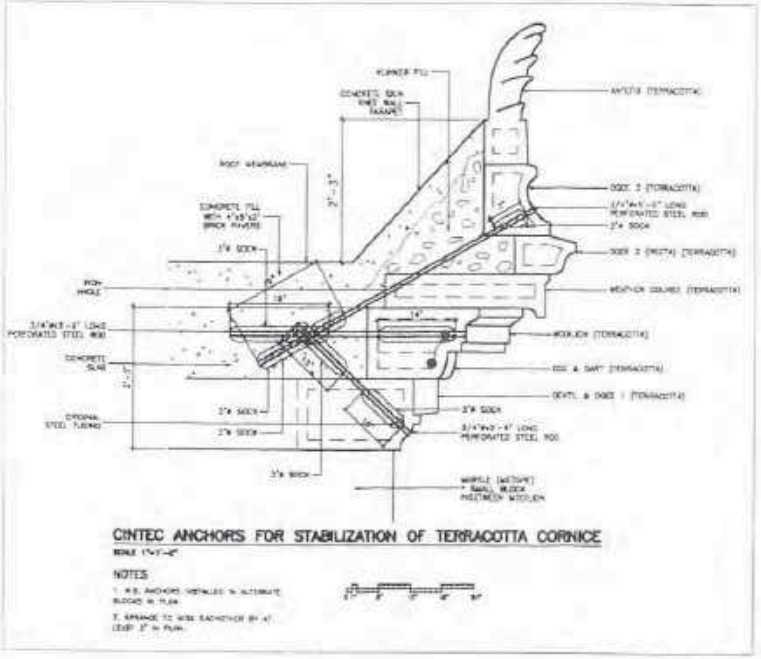
Puerto Rico's Capitol Building, or "El Capitolio," in San Juan, was completed and inaugurated in 1929. A major port city, San Juan faces the Atlantic Ocean to the north. This marine environment was a major factor in the dangerous corrosion of the anchoring system of the building's terra-cotta cornice.

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.

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 316 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 of the cornice's upper level, we found that the cornice was backed-up by 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 Sonkiss is President and Head Conservator of Conservation Solutions, Inc., Baltimore Heights, MD. The firm specializes in the conservation of historic structures, monuments, sculpture, and fountains in such materials as metal, stone, and terra-cotta.

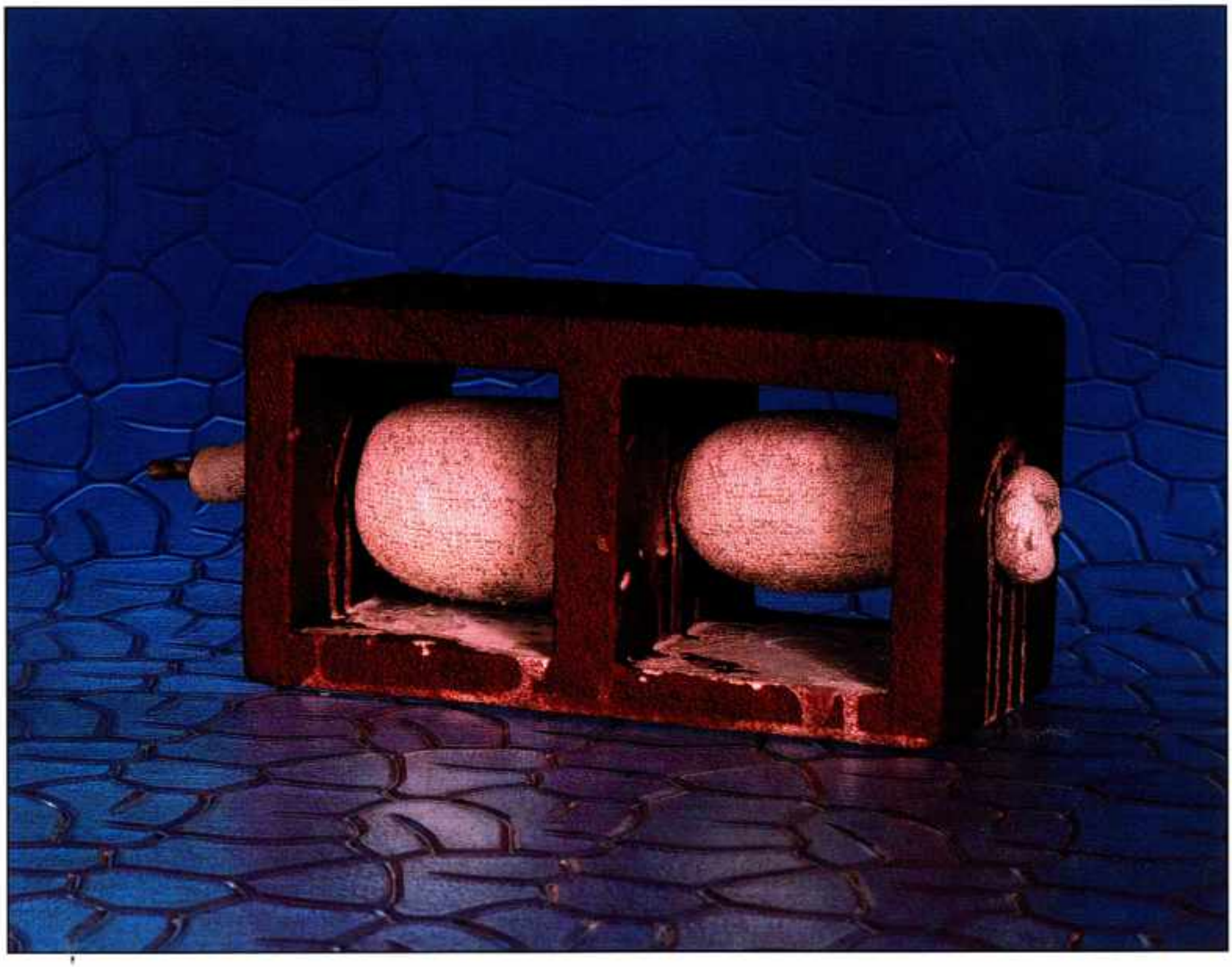
CI/SfB | Us/Ca | Xt 6

CINTEC

ENHANCED FIXING TECHNOLOGY FOR TERRA-COTTA AND HOLLOW MASONRY UNITS

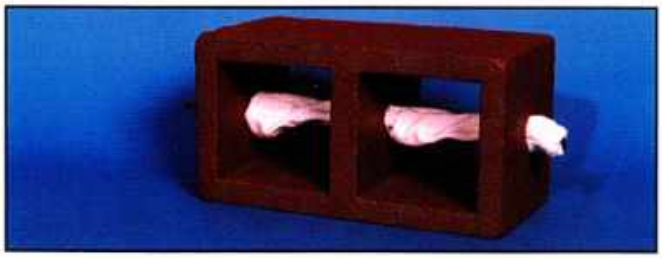
NOUVELLE TECHNOLOGIE D'ATTACHEMENT POUR TERRE CUITE ET ÉLÉMENTS CREUX DE MAÇONNERIE

NUEVA TECNOLOĠIA DE FIJACIÓN DE CERÁMICA Y UNIDADES DE MAMPOSTERÍA EN HUECO



CINTEC

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 PRESSION 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 GAINE PAR DE NONBREUSES OUVERTURES D'ÉCOULEMENT.

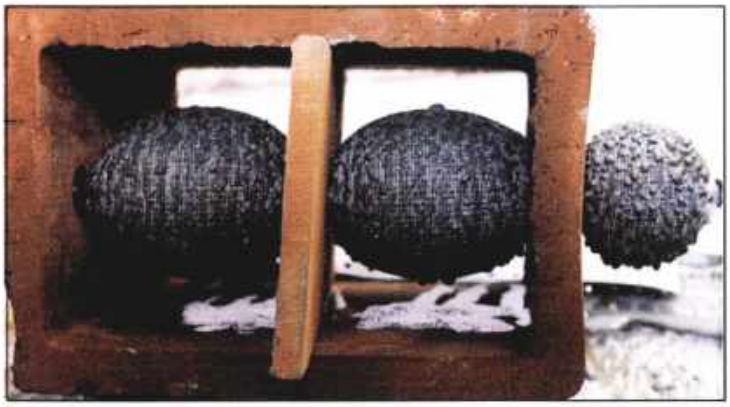
EL CEMENTO ES BOMBEADO EN LA SECCIÓN HUECA DE ACERO PARA POSTERIORMENTE FLUÍR A TRAVERS DE NUMEROSOS AGUJEROS HACIA EL FORRO.

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

CINTEC

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.

DOUBLE FIXING CAPACITY.
LA CAPACITÉ D'ANCRAGE EST DOUBLÉE.
DOBLE CAPACIDAD DE FIJACION!!!

IN TESTS CARRIED OUT BY AN INDEPENDENT LABORATORY ON A BUILDING OF SIMILAR MATERIAL, AXIAL PULL RESULTS IN EXCESS OF 3000 LBS. WERE ACHIEVED.

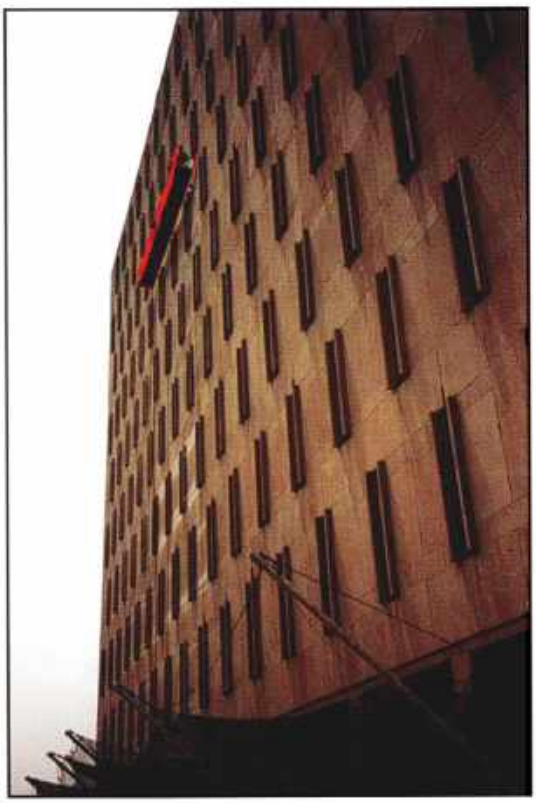
LES ESSAIS EFFECTUÉS PAR UN LABORATOIRE INDÉPENDENT SUR UN BÂTIMENT DE MATÉRIAU SIMILAIRE ONT RÉVÉLÉ DES RÉSULTATS DÉPASSANT 1300 KG SUR LA TENSION AXIALE.

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 DISPOSICIÒN, MEDIANTE SOLICITUDE.

INTERNATIONAL PROJECTS
PROJETS INTERNATIONAUX
PROYECTOS INTERNACIONALES

CINTEC



THIS DESIGNED ANCHOR SYSTEM WAS USED IN THE ESSEX COUNTY NEW COURT HOUSE & JAIL NEWARK, NEW JERSEY, USA. FOR FURTHER INFORMATION CONTACT OUR TECHNICAL DEPARTMENT.

CE SYSTÈME D'ANCRAGES ÉTUDIÉS A ÉTÉ UTILISÉ AU NOUVEAU PALAIS DE JUSTICE ET PRISON DU CONTÉ D'ESSEX, NEWARK, NEW JERSEY -E.U.. POUR TOUS RENSEIGNEMENTS SUPPLÉMENTAIRES, CONTACTER NOTRE DÉPARTEMENT TECHNIQUE.

ESTE SISTEMA DE ANCLAS DE DISEÑO FUE UTILIZADO EN EL PALACIO DE JUSTICIA DE NEW JERSEY.

PARA MÁS INFORMACIÓN, CONTACTAR CON NEUSTRO DEPARTAMENTO TÈCNICO.

CINTEC
REINFORCEMENT SYSTEMS

United States

Cintec America Inc.
200 International Circle, Suite 5100,
Hunt Valley, Maryland
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Tel: 1 410 761-0765

E-mail: solutions@cintec.com

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Tel: (1) 613 225-3381
Fax: (1) 613 224-9042
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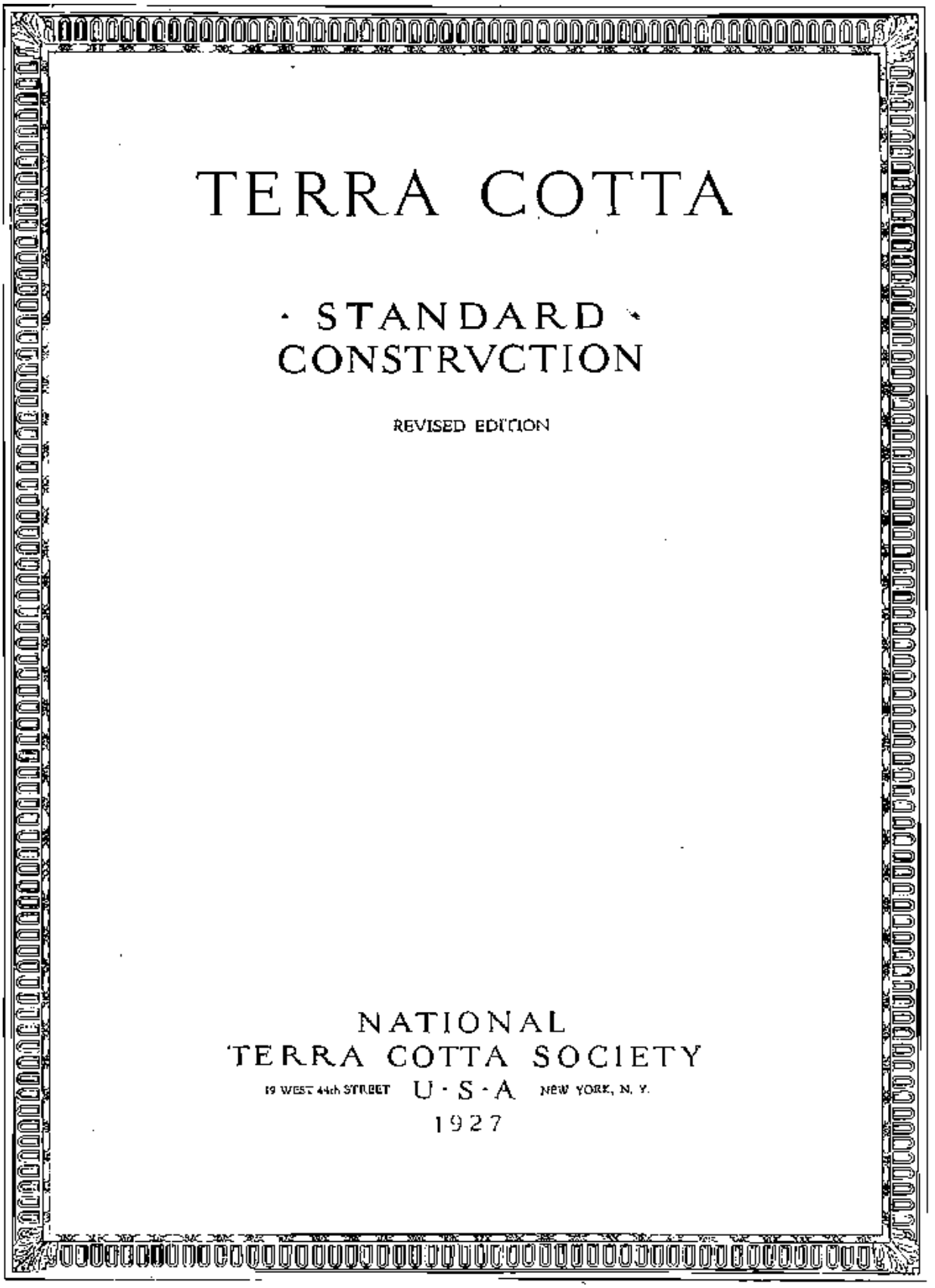
Tel: +44 (0) 1633 246614
Fax: +44 (0) 1633 246110
E-mail: hqcintec@cintec.co.uk

www.cintec.com

PRESS CLUB OTTAWA, CANADA

The following [pages 147- 227] original drawings have been left without notations for use by others



TERRA COTTA

· STANDARD · CONSTRVCTION

REVISED EDITION

NATIONAL
TERRA COTTA SOCIETY
19 WEST 44th STREET U · S · A NEW YORK, N. Y.
1927

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. H. 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

A brief synopsis of the manufacture of Terra Cotta

Drawings — 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.

Models and Moulds — 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.

Decoration — 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.

Clay — 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.

Pressing — 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.

Color — 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.

Firing — 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.

Fitting — 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.

Shipping — 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.

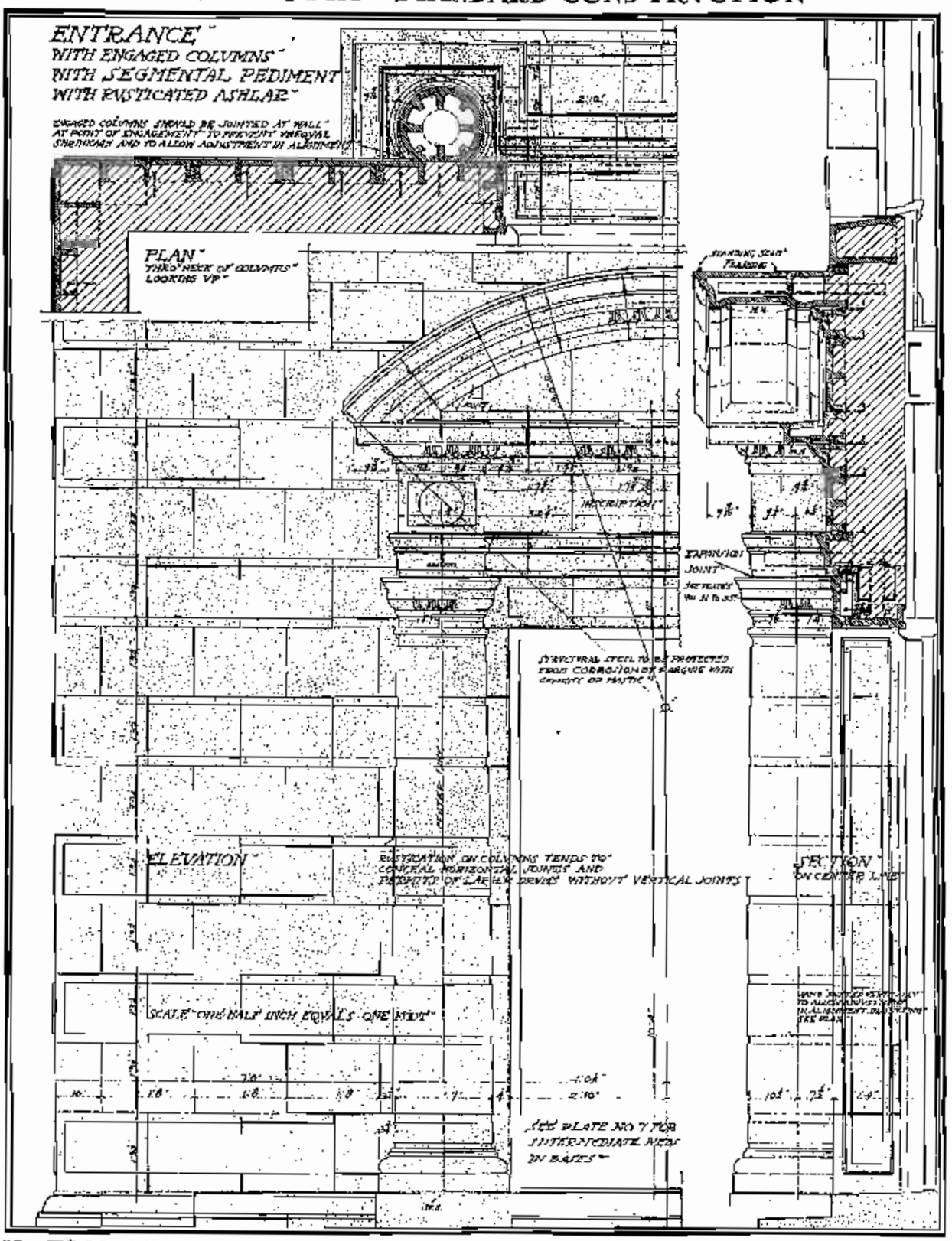
Erection — The appearance of erected Terra Cotta is greatly affected by inaccurate setting and defective pointing of the mortar joints. As the individual pieces of Terra Cotta have been carefully fitted and numbered to correspond with the erection drawings, the PIECES MUST BE ERECTED IN ACCORD WITH THE NUMBERS THEREON if satisfactory results are to be secured.

Time — 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.

Specification and Contract — 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.

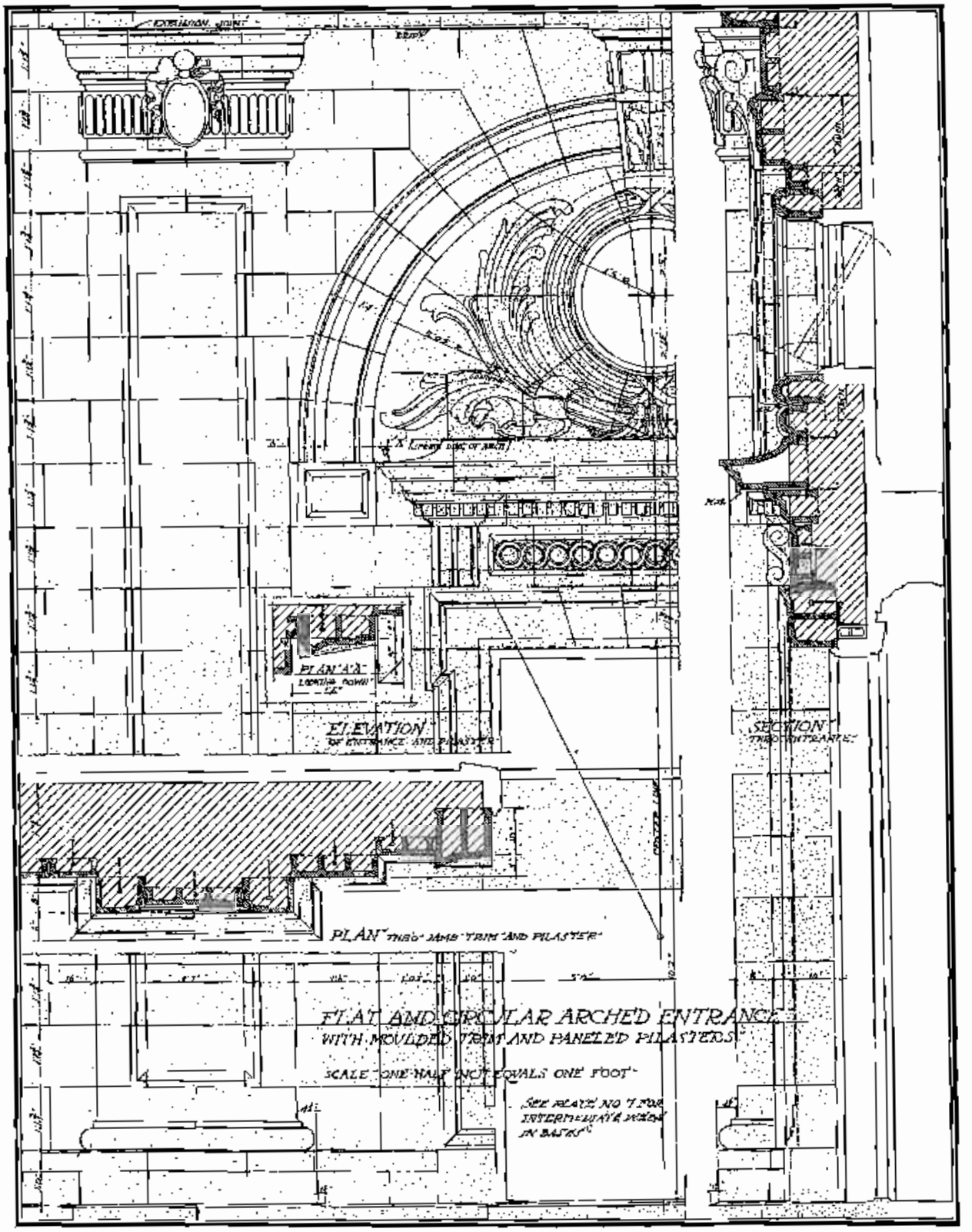
Terra Cotta factories are conveniently located in the Eastern, Central and Western sections of the United States (see list in back of this volume). All of the Society's membership will be glad to have any architect or designer interested in the processes of manufacture of Terra Cotta visit their plants.

TERRA COTTA STANDARD CONSTRUCTION



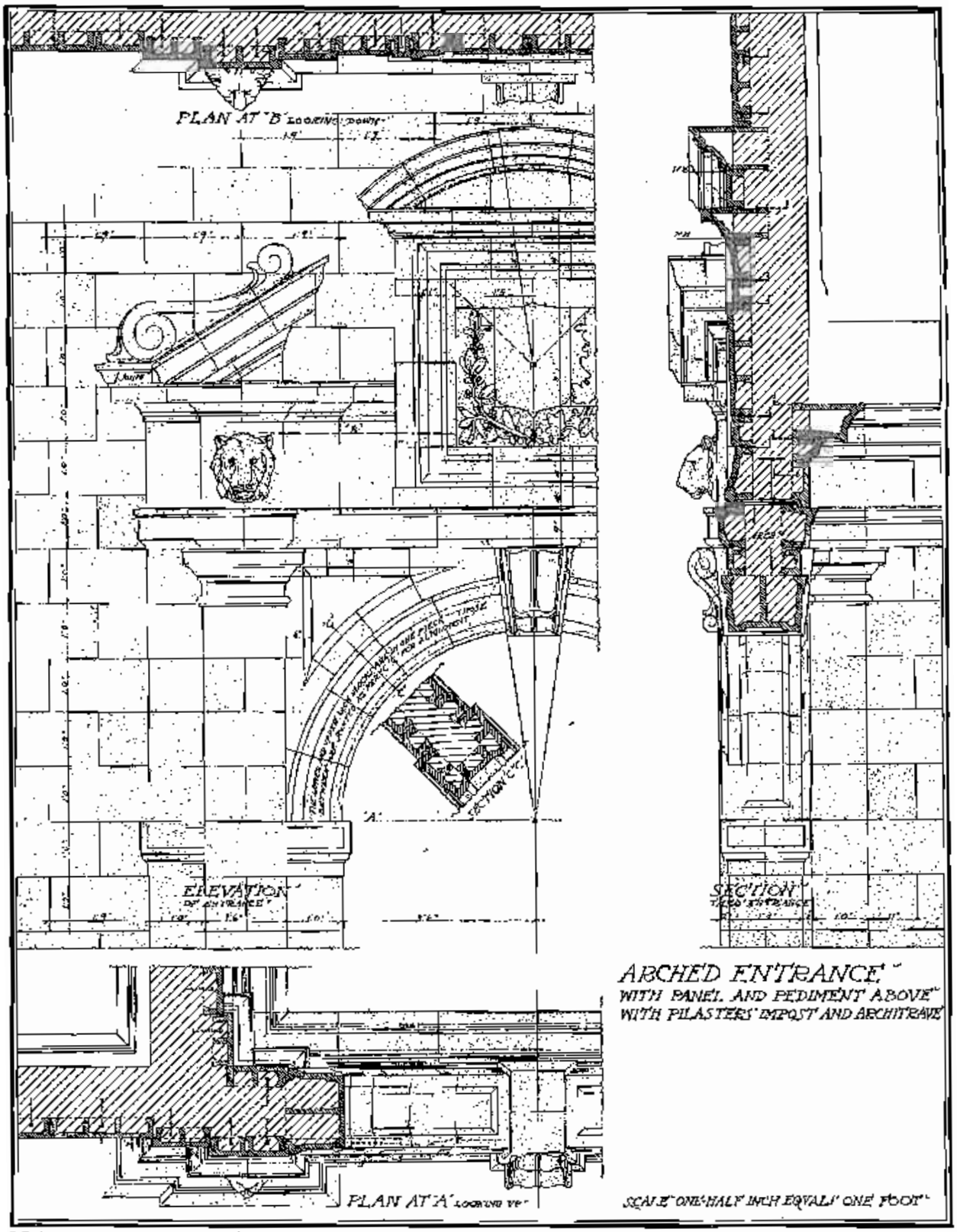
NATIONAL TERRA COTTA SOCIETY U.S.A. PLATE NO. 1

TERRA COTTA STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY U.S.A. PLATE NO. 2

TERRA COTTA · STANDARD CONSTRUCTION

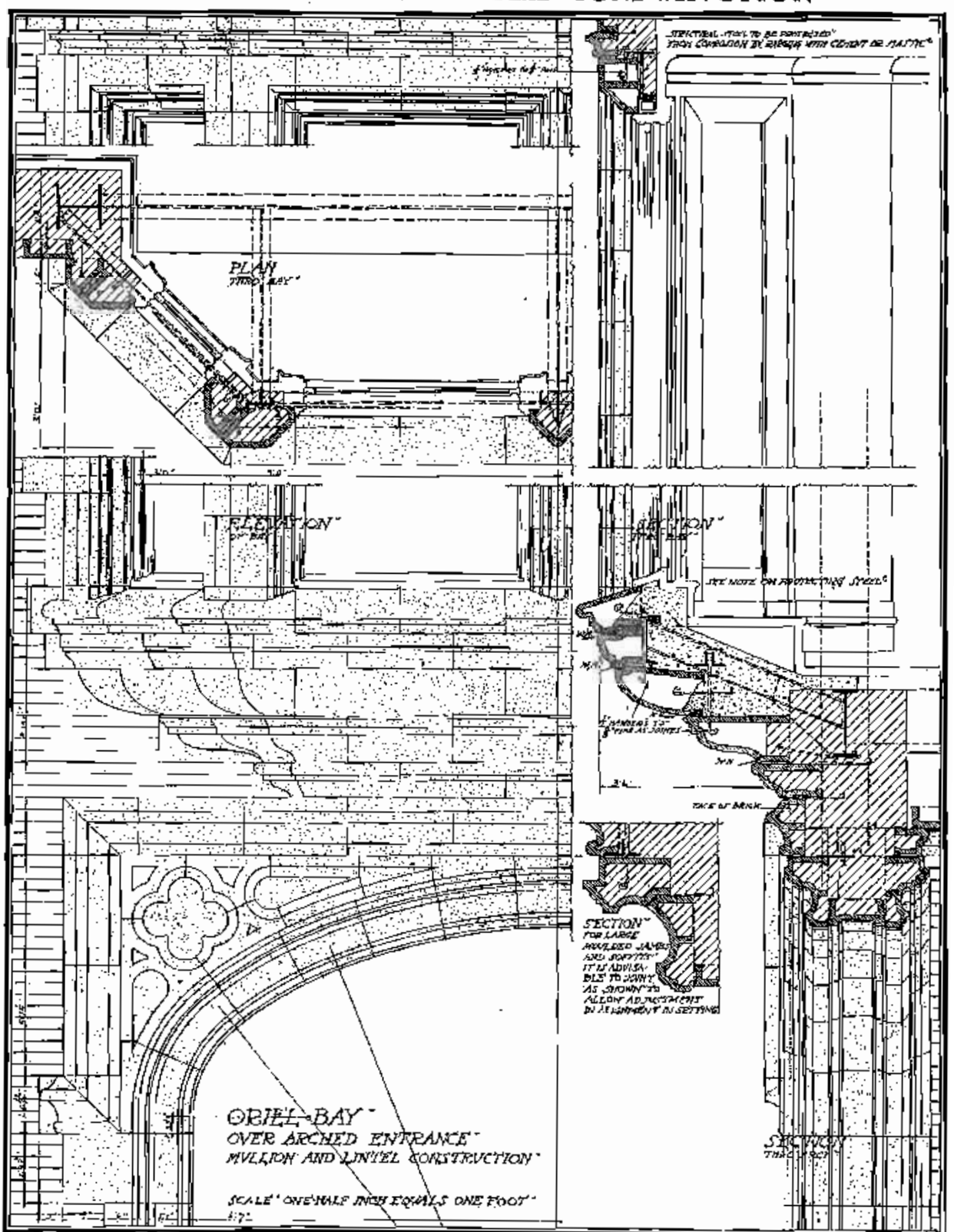


ARCHED ENTRANCE
WITH PANEL AND PEDIMENT ABOVE
WITH PILASTERS IMPOST AND ARCHITRAVE

SCALE ONE HALF INCH EQUALS ONE FOOT

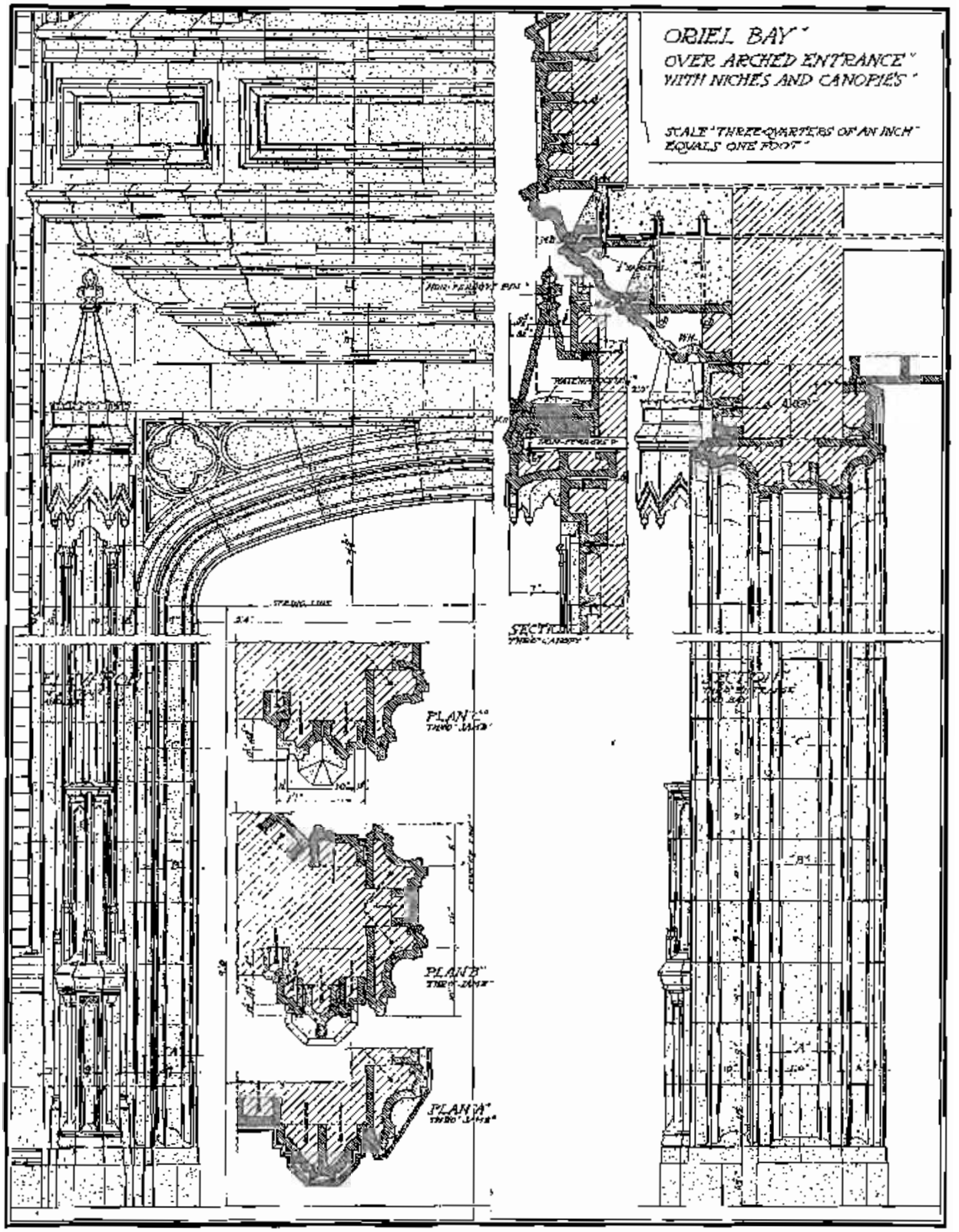
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·3

TERRA COTTA · STANDARD CONSTRUCTION



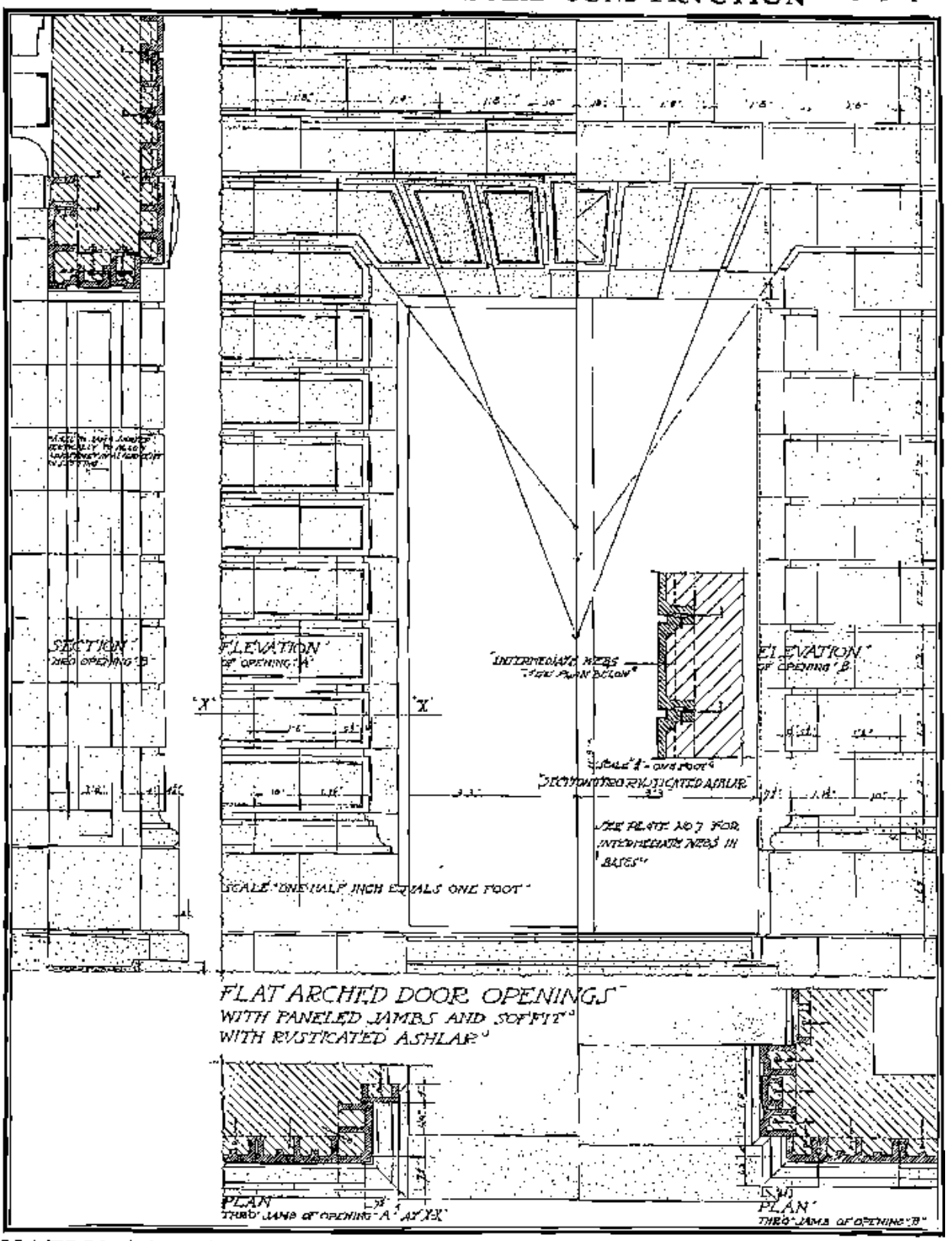
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO· 4

TERRA COTTA · STANDARD CONSTRUCTION



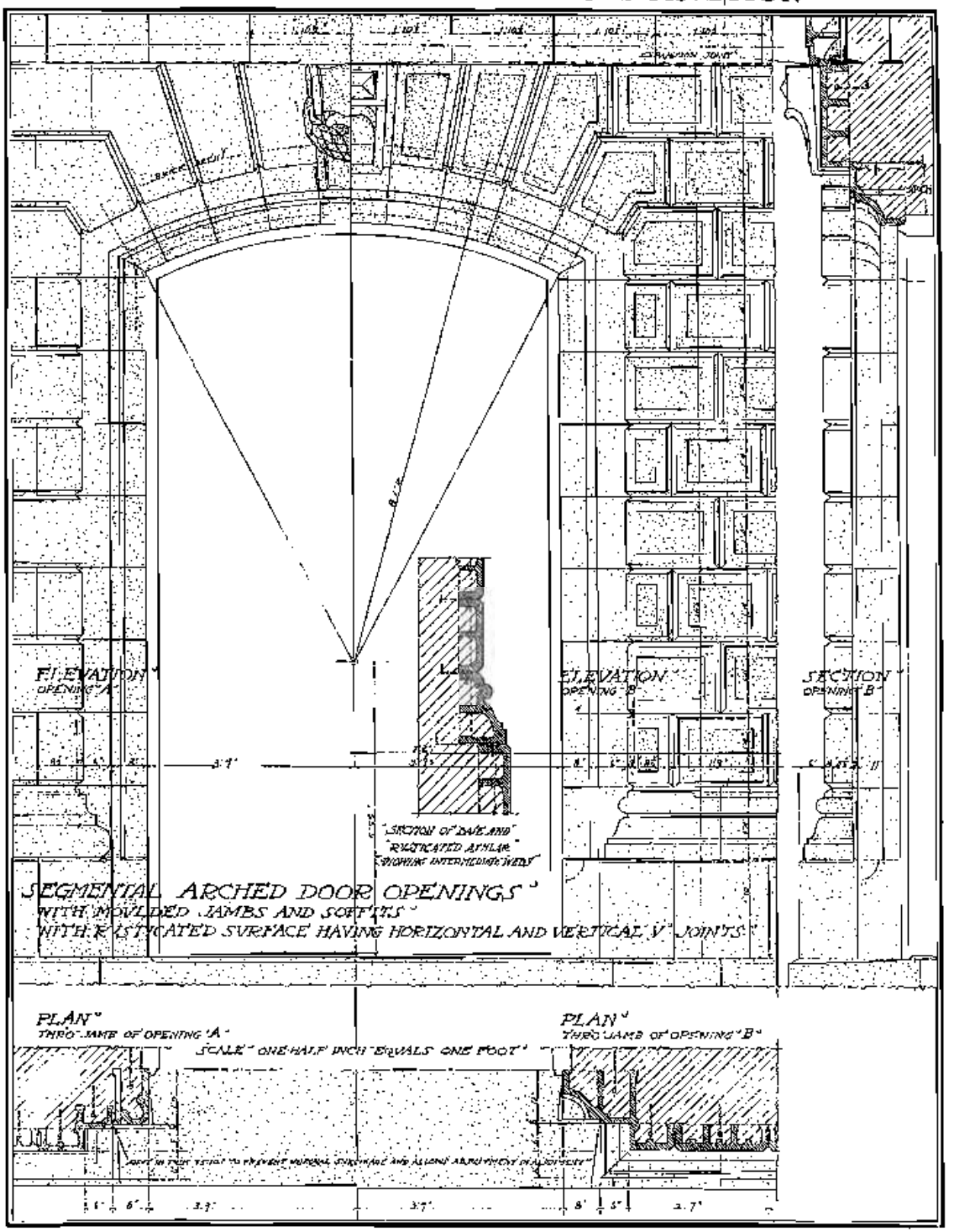
NATIONAL TERRA COTTA SOCIETY · U·S·A · · · PLATE NO·5

TERRA COTTA · STANDARD CONSTRUCTION



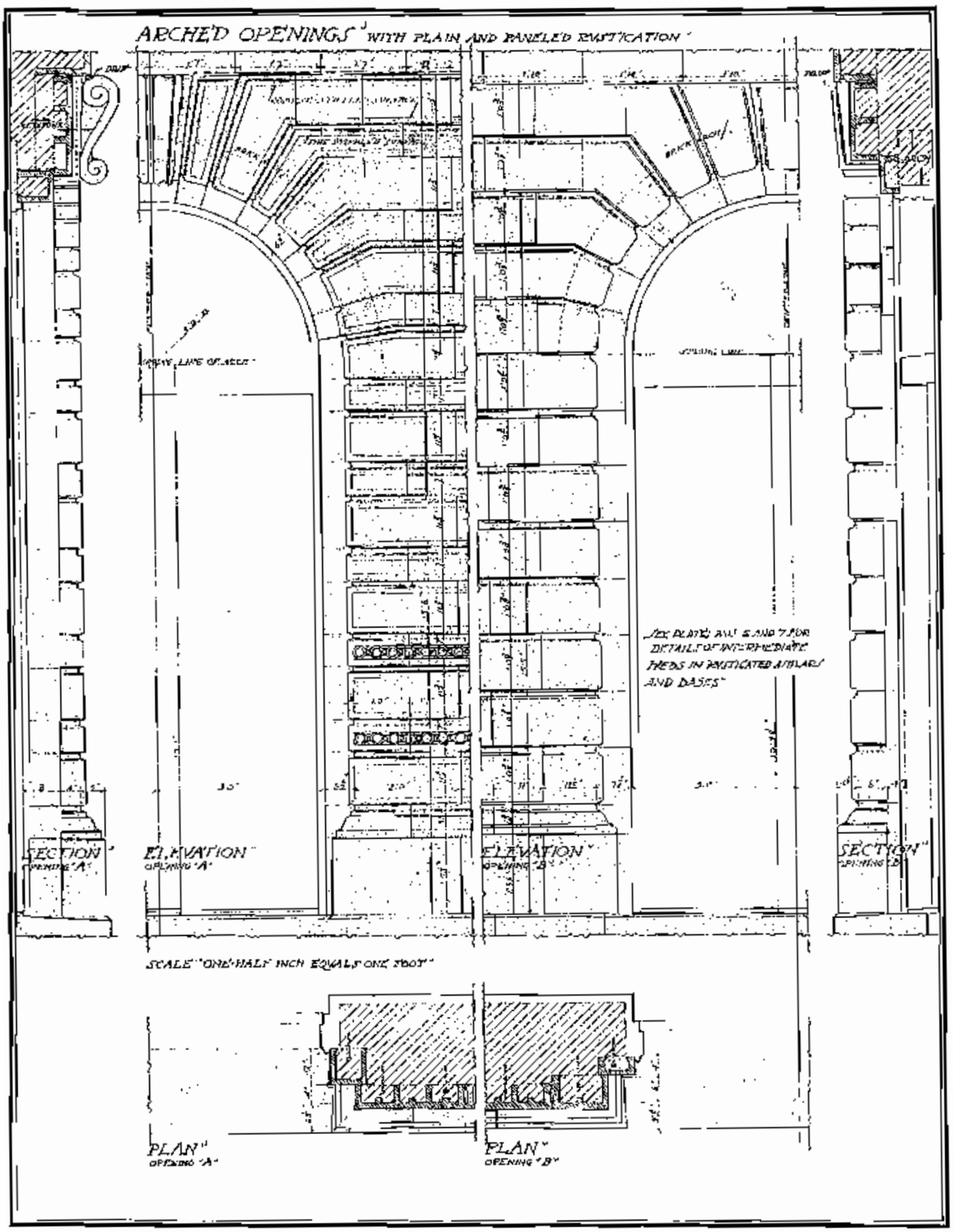
NATIONAL TERRA COTTA SOCIETY · U · S · A · · PLATE NO · 6

TERRA COTTA STANDARD CONSTRUCTION



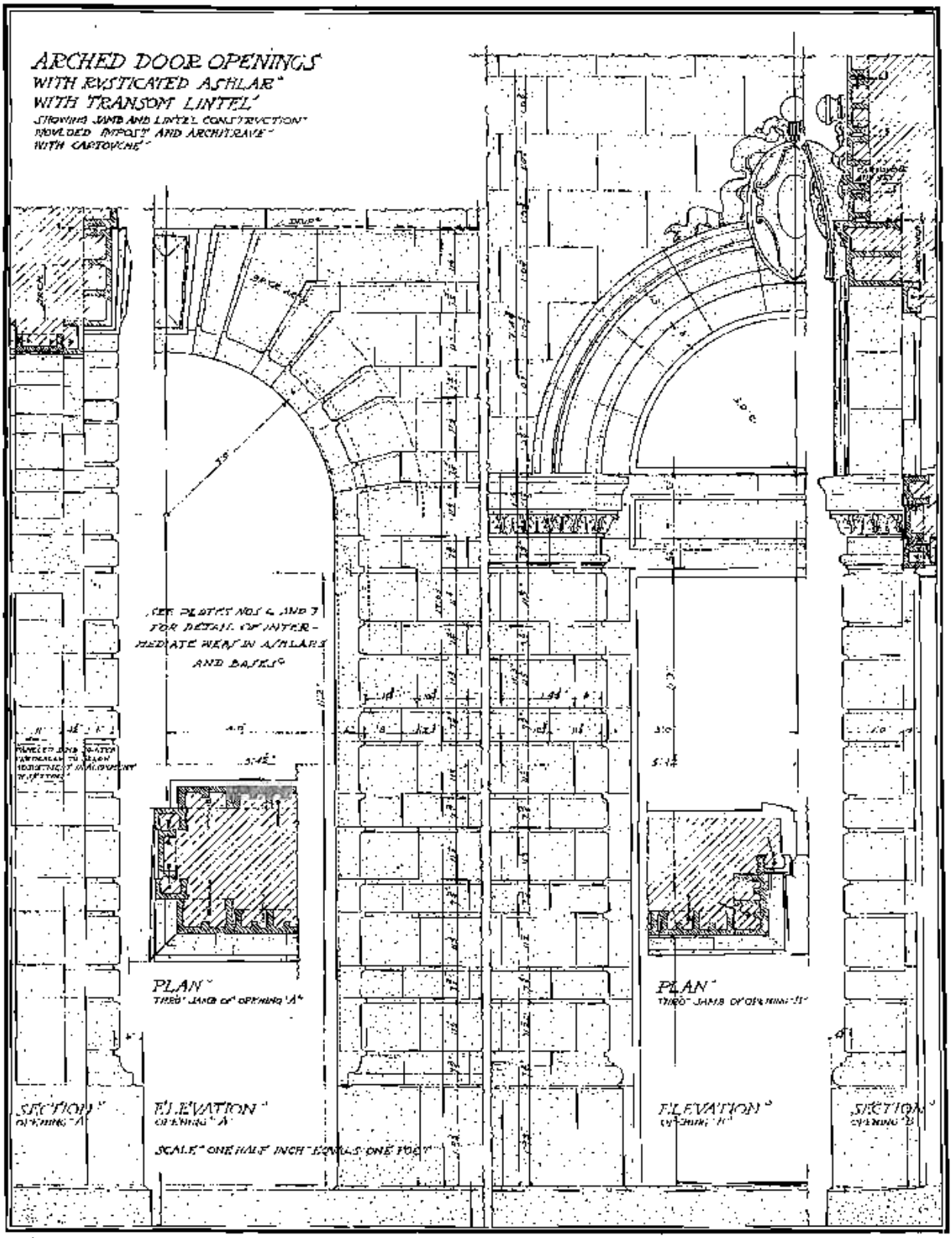
NATIONAL TERRA COTTA SOCIETY U.S.A. PLATE NO. 7

TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·8

TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U·S·A · · · PLATE NO·9

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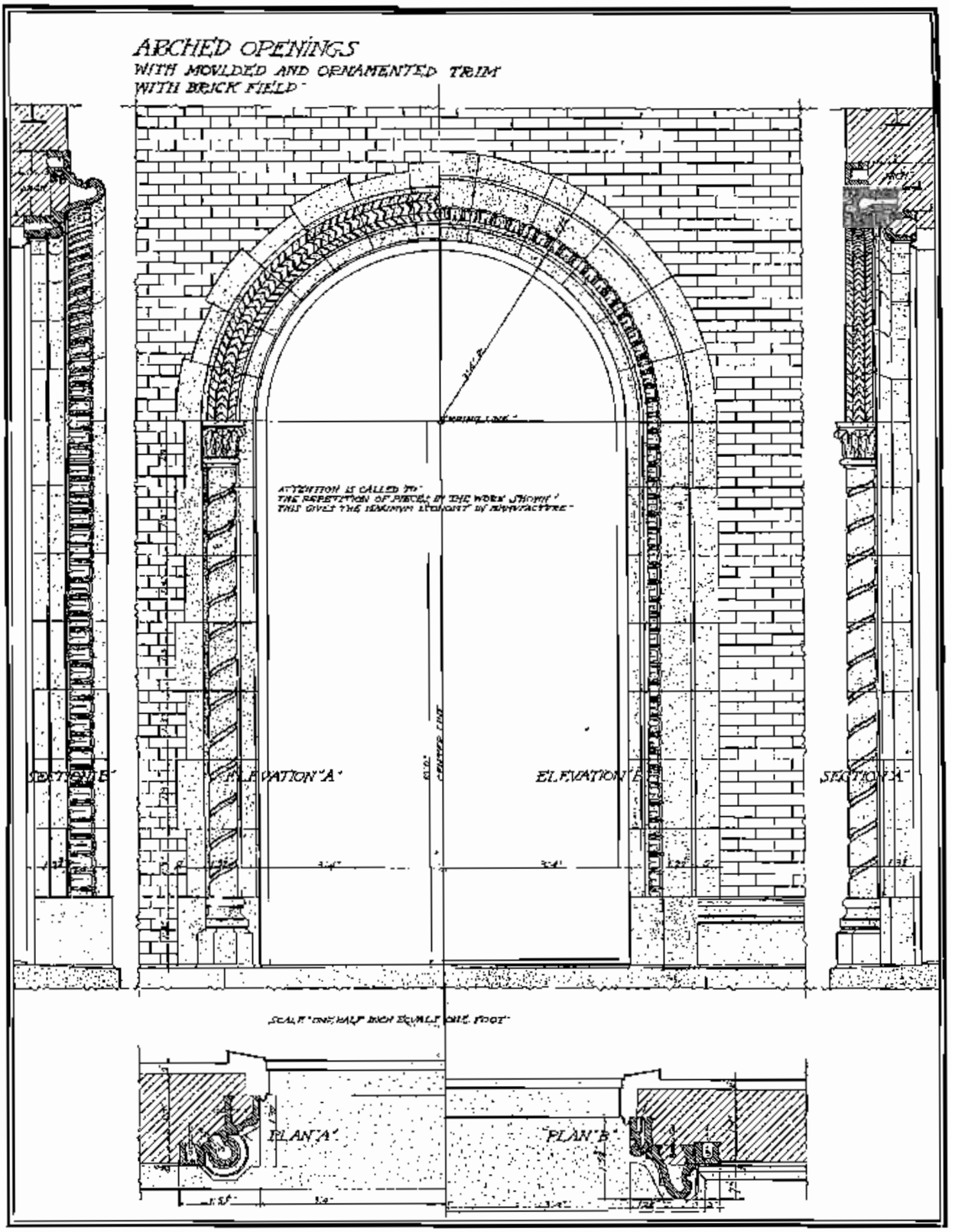
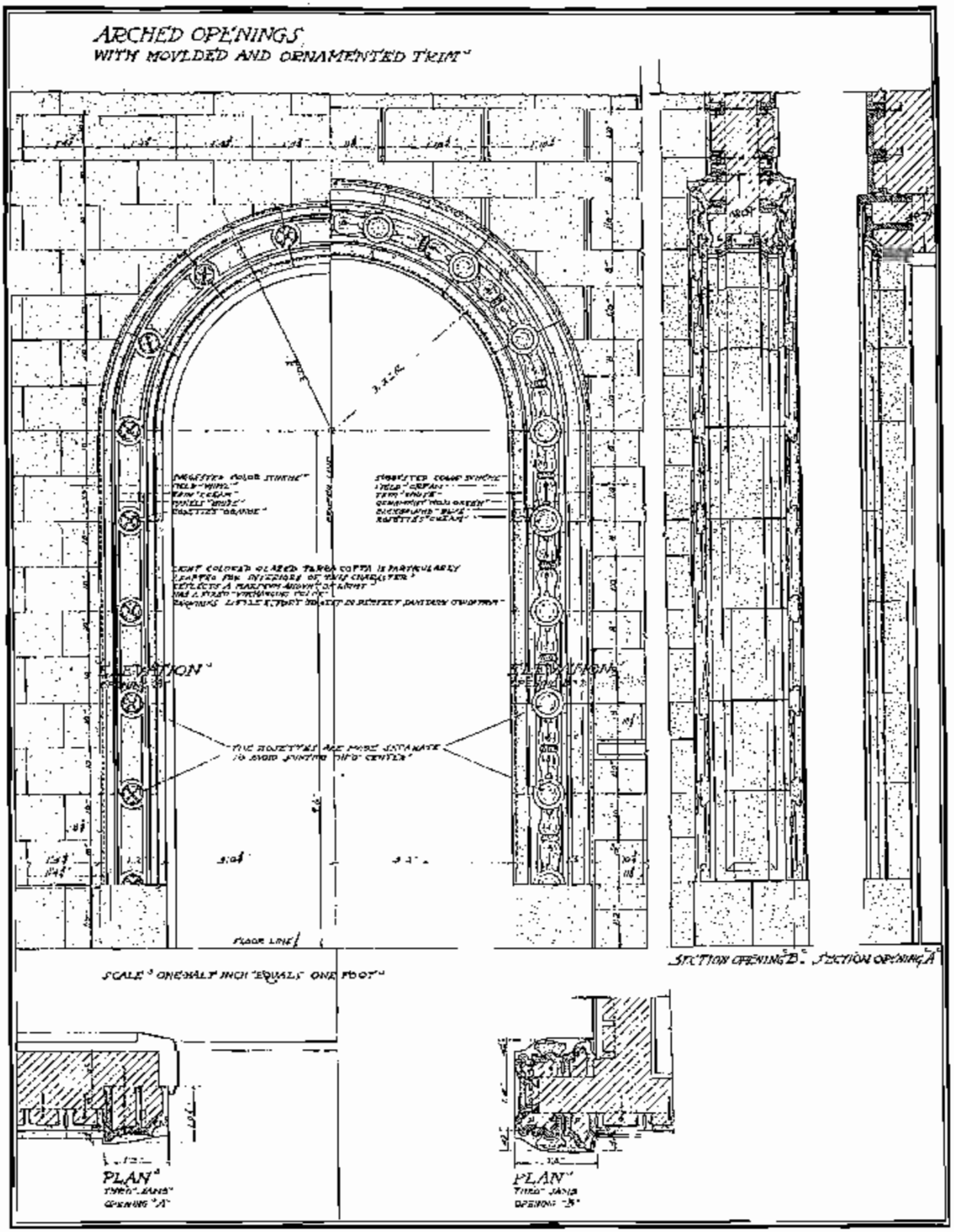


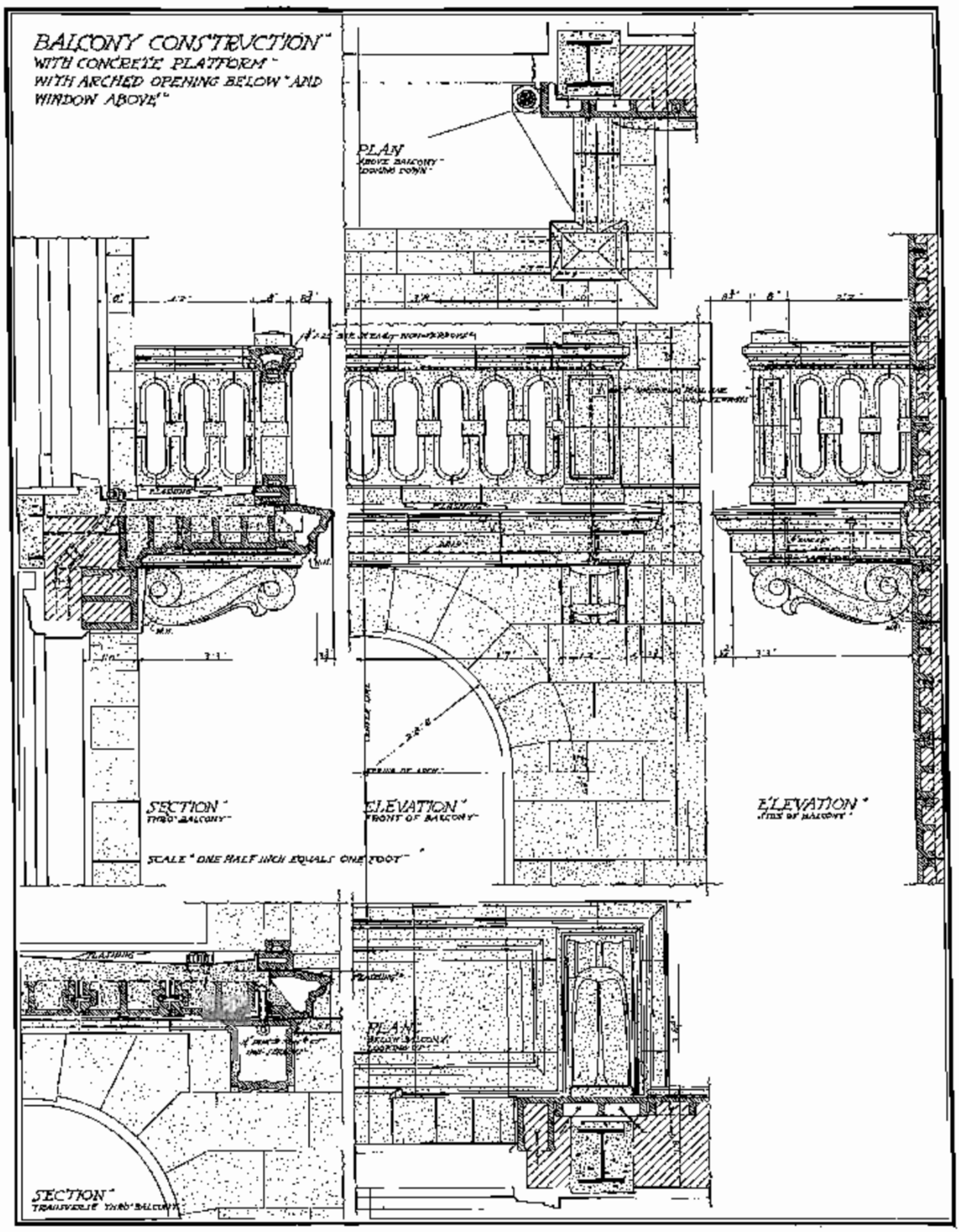
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO· 10

TERRA COTTA STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY U.S.A. PLATE NO. 11

TERRA COTTA · STANDARD CONSTRUCTION



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

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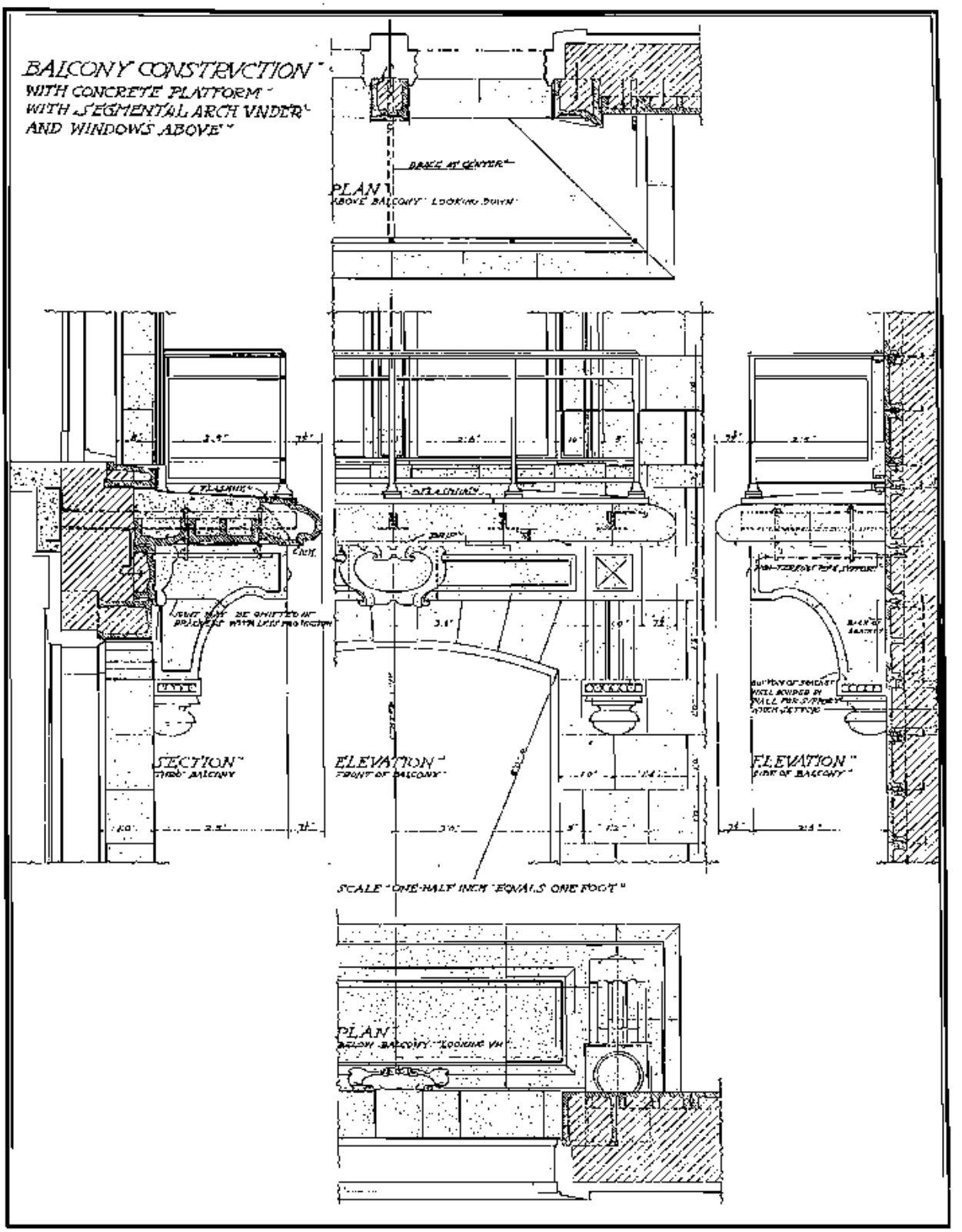
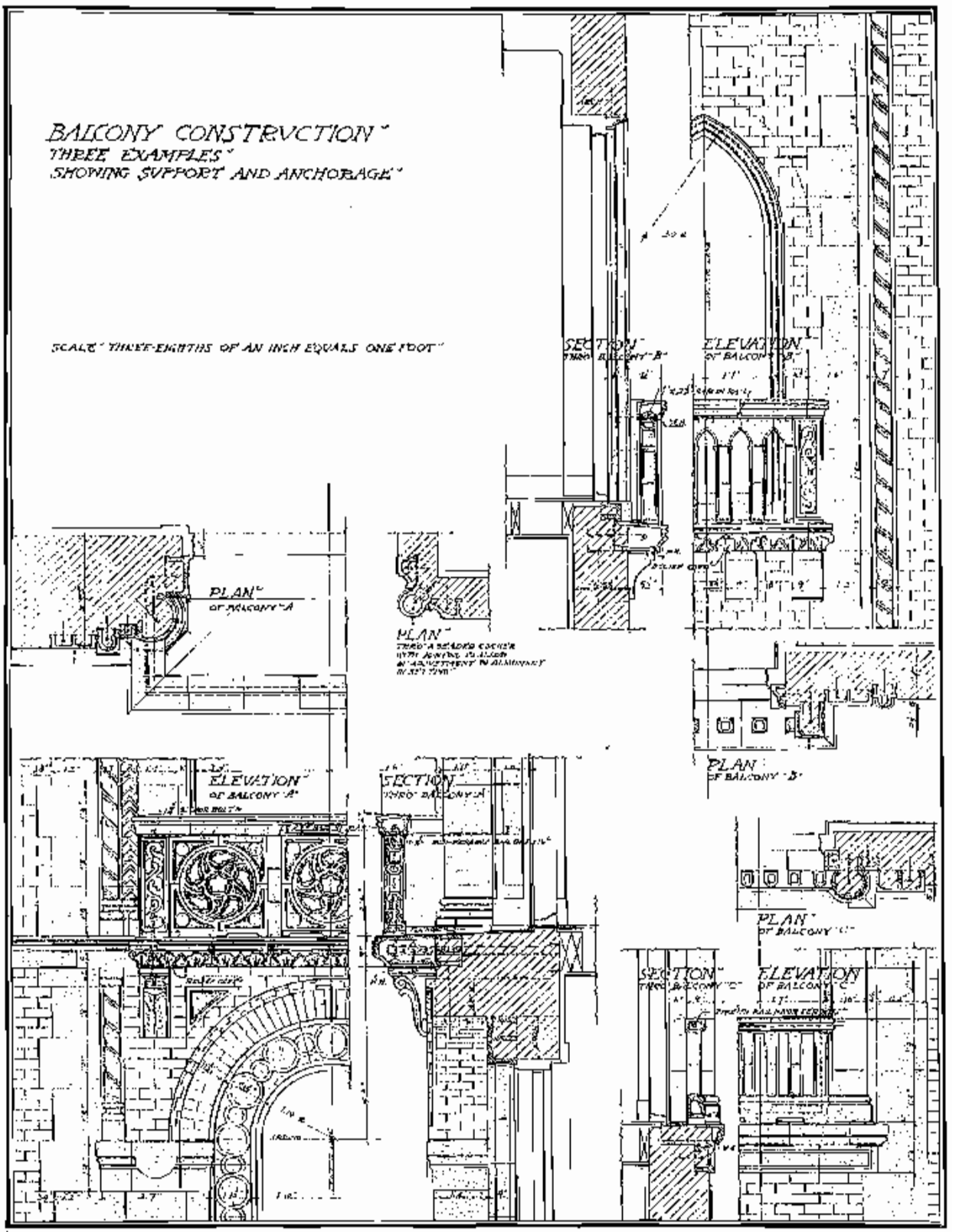


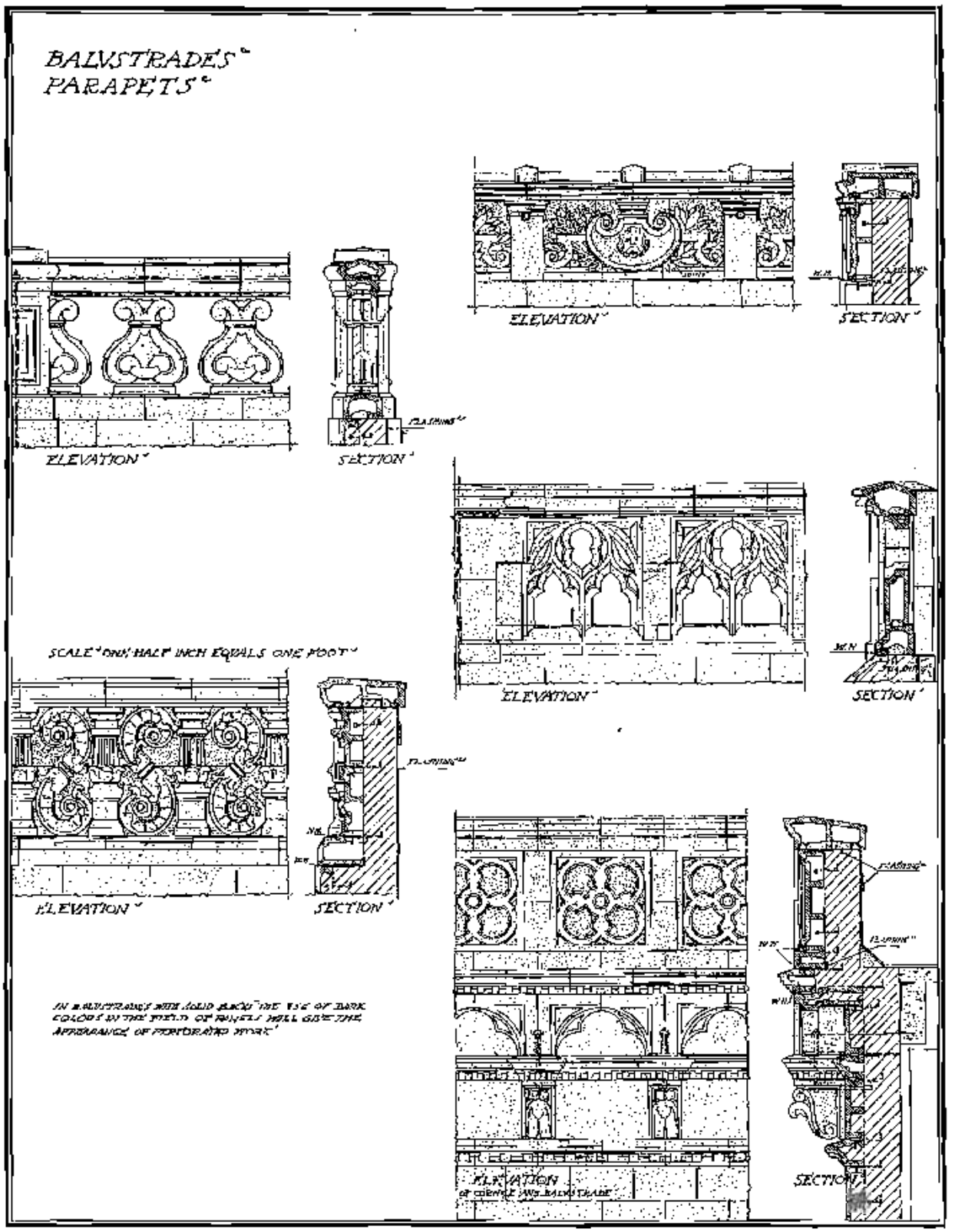
NATIONAL TERRA COTTA SOCIETY U.S.A. PLATE NO. 13

TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO· 14

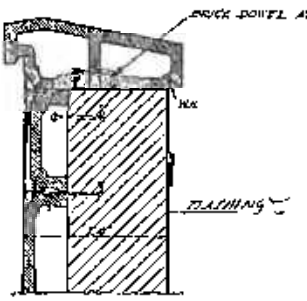
TERRA COTTA · STANDARD CONSTRVCTION

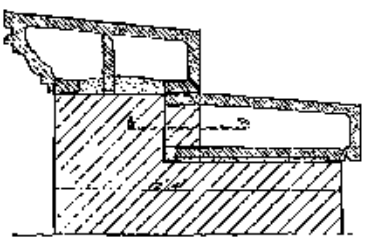


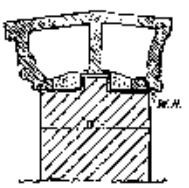
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·15

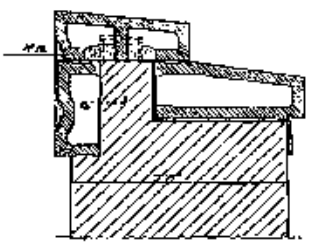
TERRA COTTA · STANDARD CONSTRUCTION

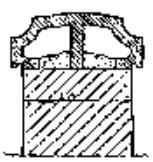
WALL COPINGS AND BALUSTRADES
SHOWING VARIOUS METHODS OF JOINTING AND ANCHORING

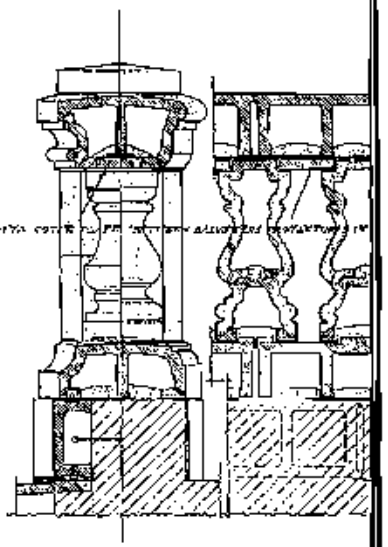


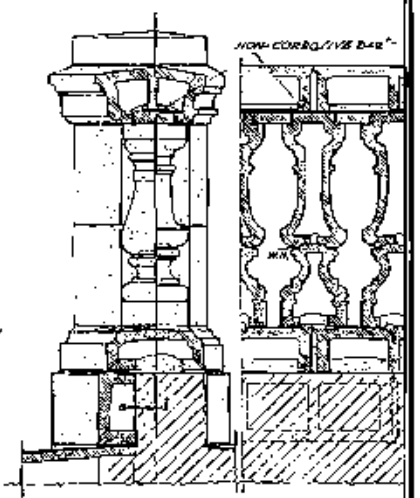






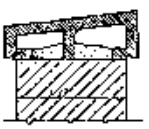






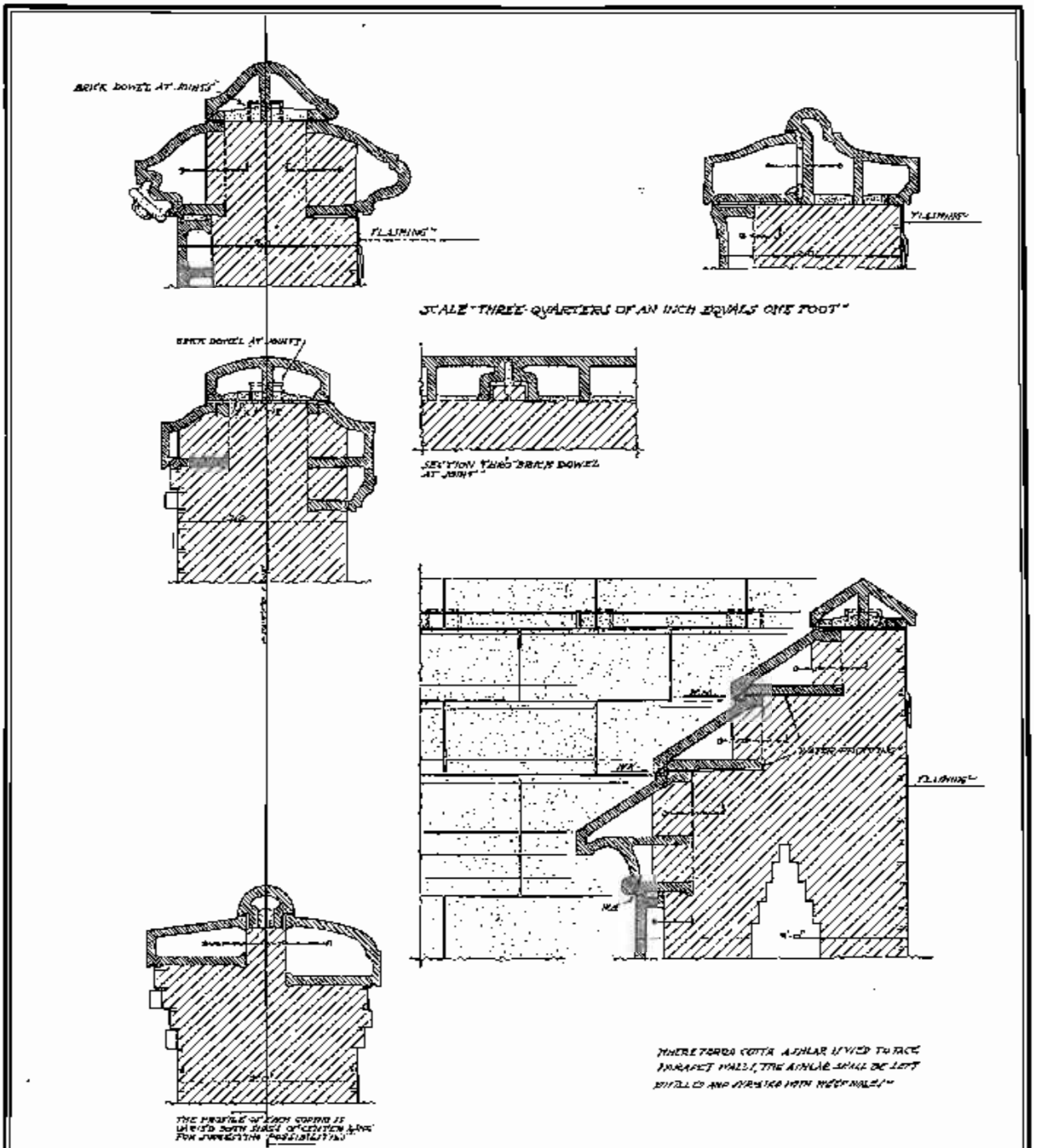
WHERE TERRA COTTA ASHLAR IS USED TO FACE PARAPET WALLS, THE ASHLAR SHALL BE LEFT HOLLOW AND SPORTED WITH WEEP HOLES

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



NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·16

TERRA COTTA · STANDARD CONSTRUCTION



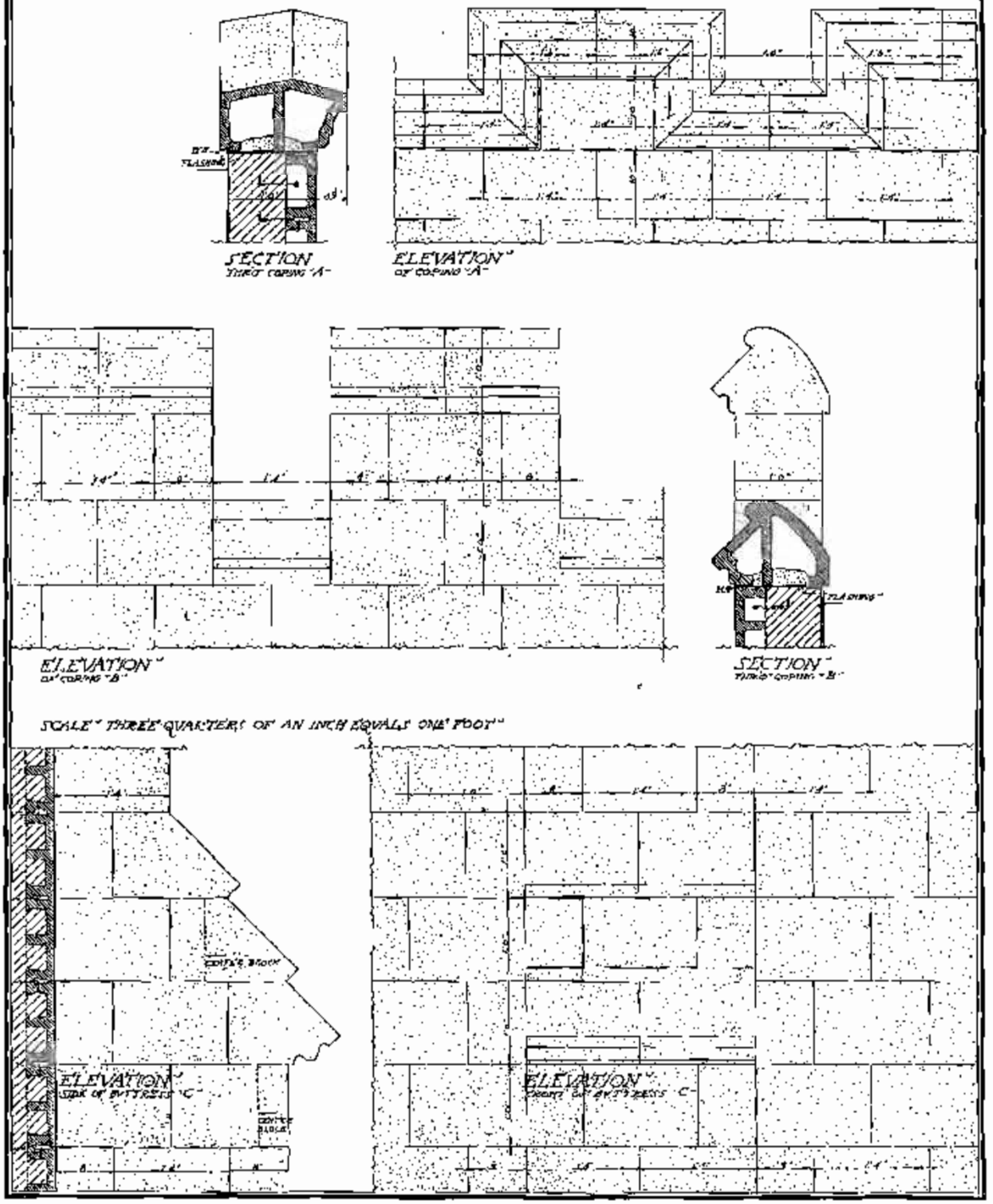
COPINGS

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

NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO· 17

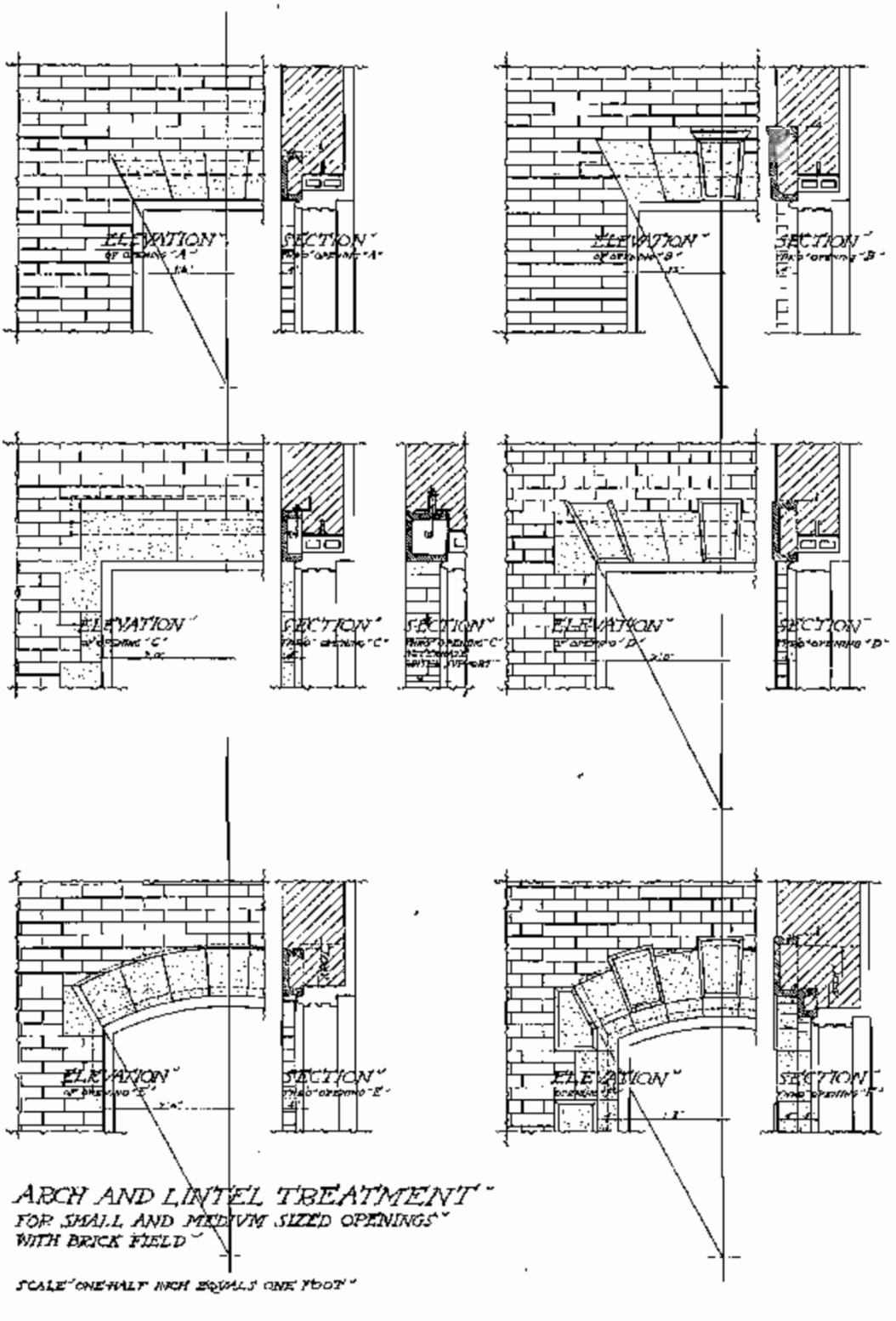
TERRA COTTA · STANDARD CONSTRUCTION

BATTLEMENTED COPING AND SET-OFFS



NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO 18

TERRA COTTA · STANDARD CONSTRUCTION

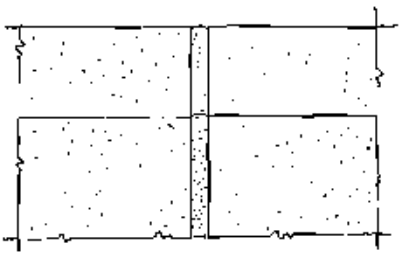


ARCH AND LINTEL TREATMENT
FOR SMALL AND MEDIUM SIZED OPENINGS
WITH BRICK FIELD

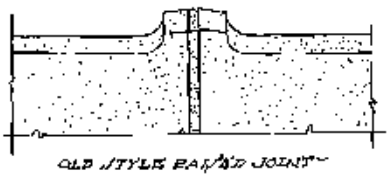
SCALE ONE-HALF INCH EQUALS ONE FOOT

NATIONAL TERRA COTTA SOCIETY · U.S.A. · PLATE NO. 19

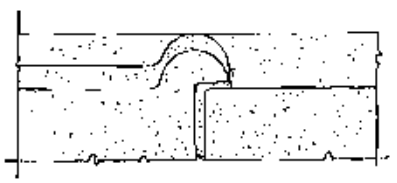
TERRA COTTA · STANDARD CONSTRUCTION



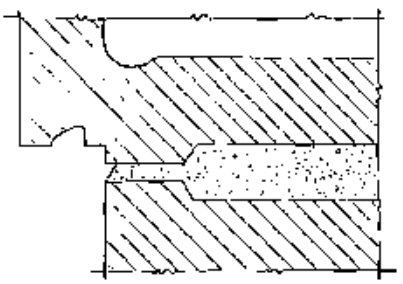
"STANDARD FLUSH JOINT" RECOMMENDED AS SUPERIOR TO THE OLD STYLE RAISED AND ROLL JOINTS SHOWN BELOW



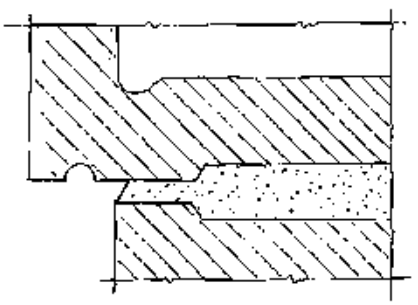
OLD STYLE BANDED JOINT



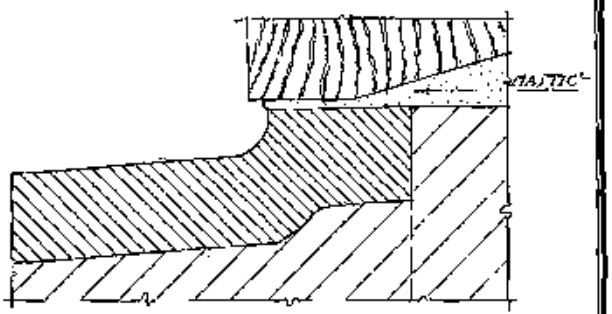
OLD STYLE ROLL JOINT



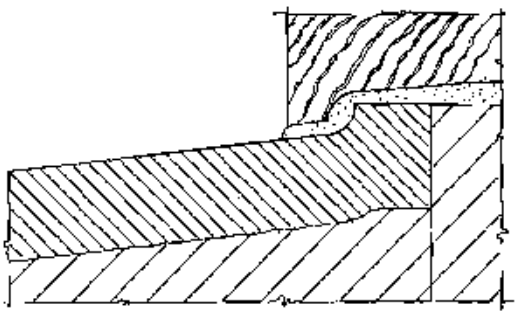
TYPICAL DRIP DETAILS



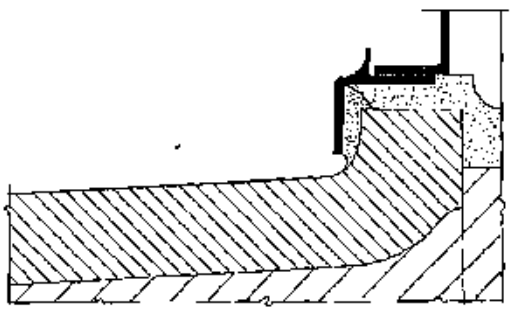
SCALE HALF AND QUARTER FULL SIZE



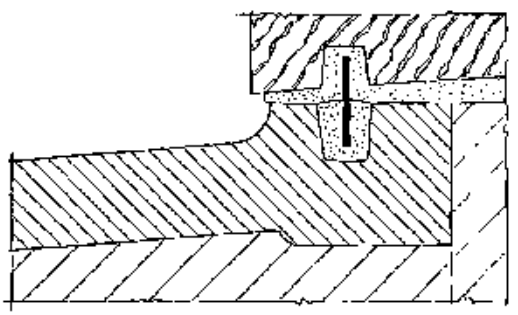
WOOD OR HOLLOW METAL SILLS



TUCK UNDER SILL



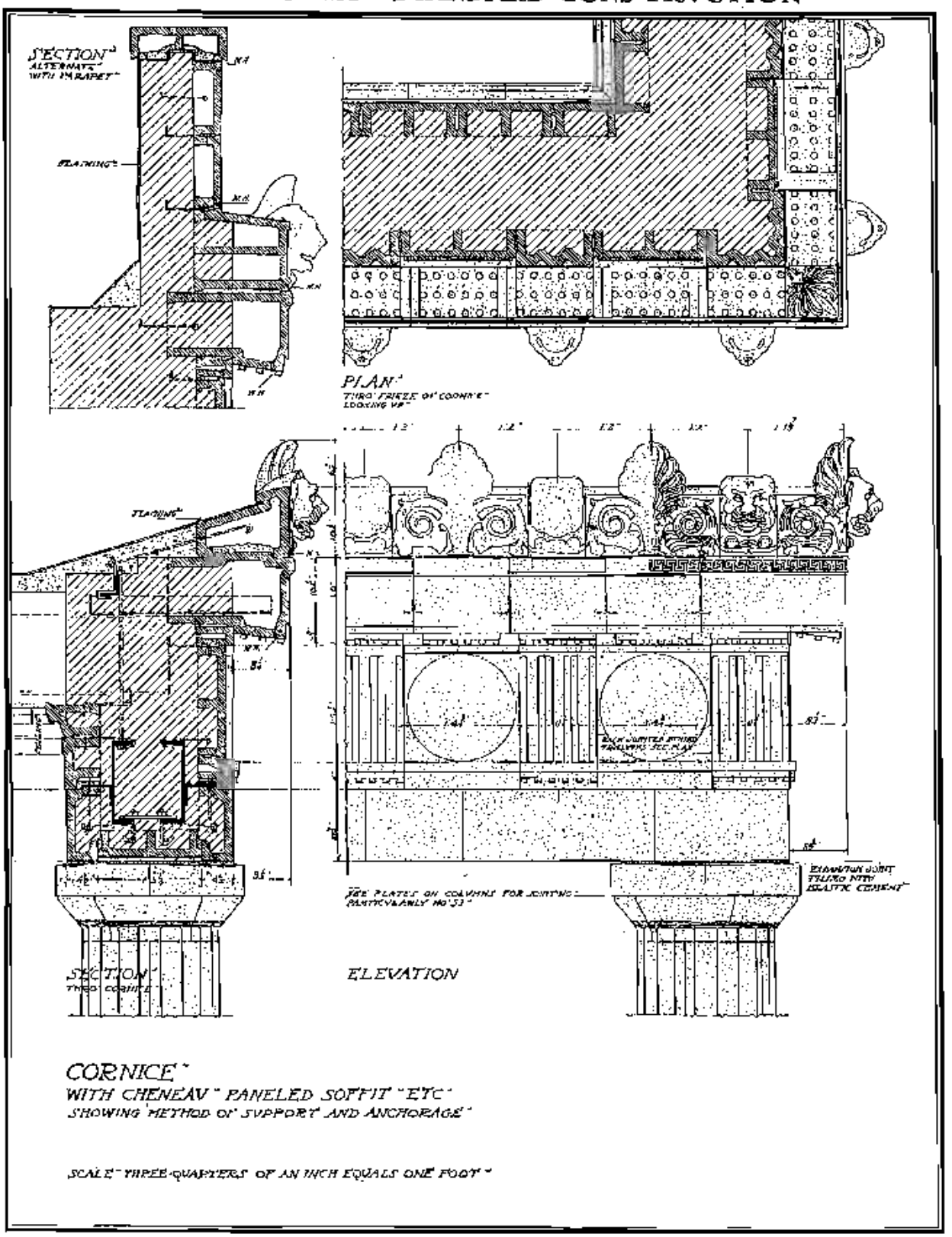
SILL FOR SOLID METAL FRAMES



SILL WITH NON-FERROUS WATER BAR

NATIONAL TERRA COTTA SOCIETY · U·S·A · PLATE NO·20

TERRA COTTA · STANDARD CONSTRUCTION

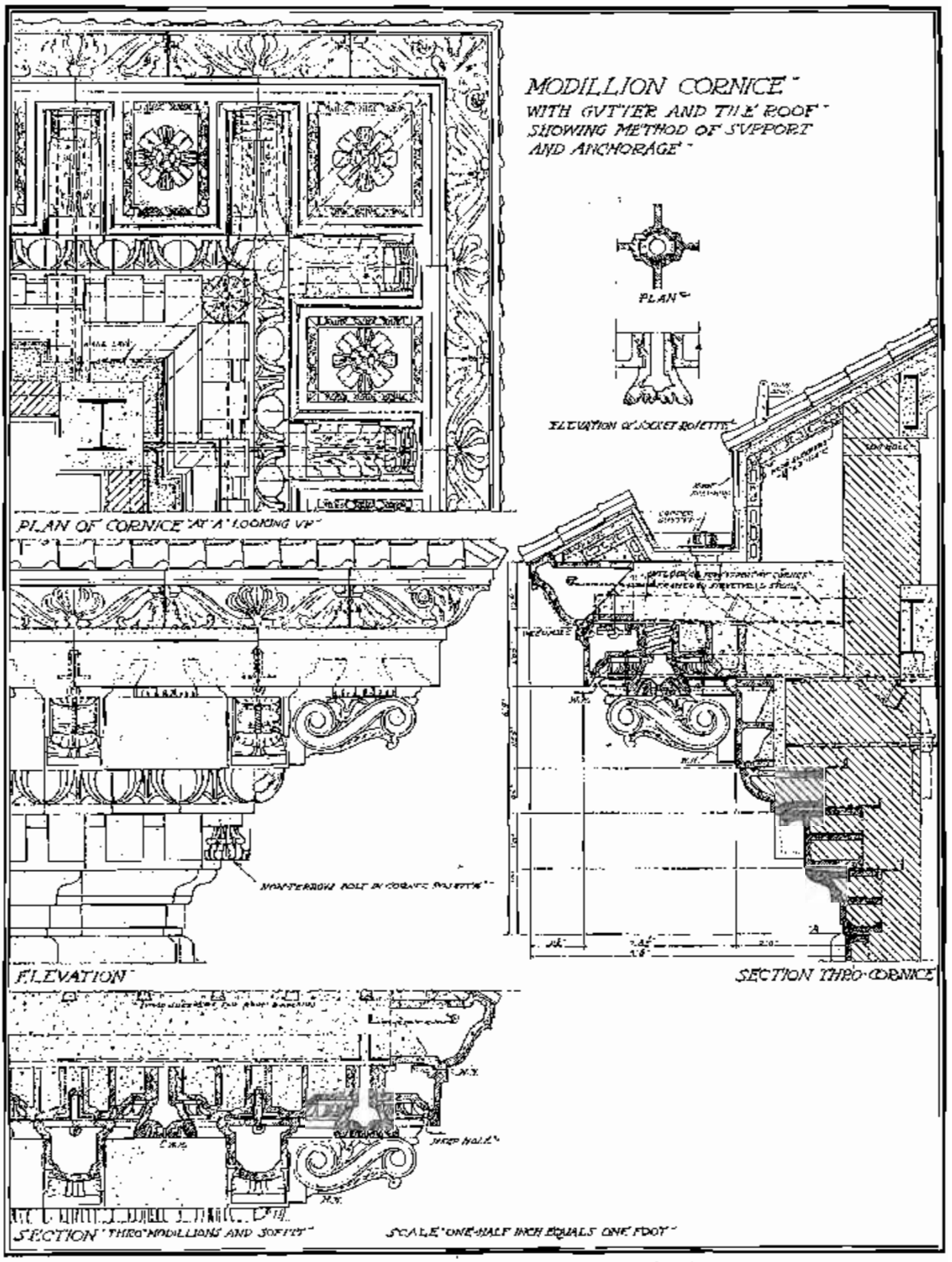


CORNICE
WITH CHENEAU · PANELED SOFFIT · ETC ·
SHOWING METHOD OF SUPPORT AND ANCHORAGE

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

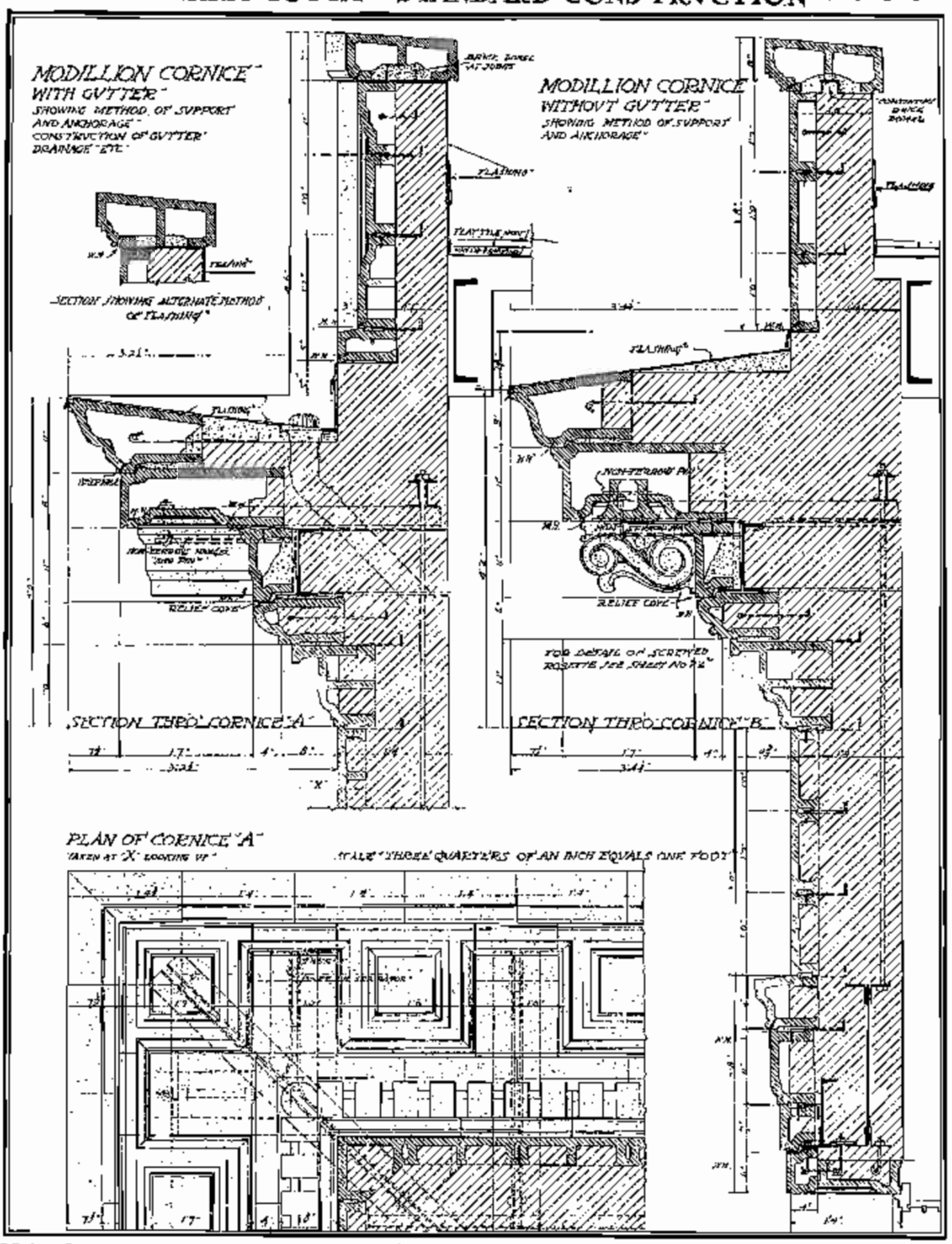
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO · 21

TERRA COTTA STANDARD CONSTRUCTION



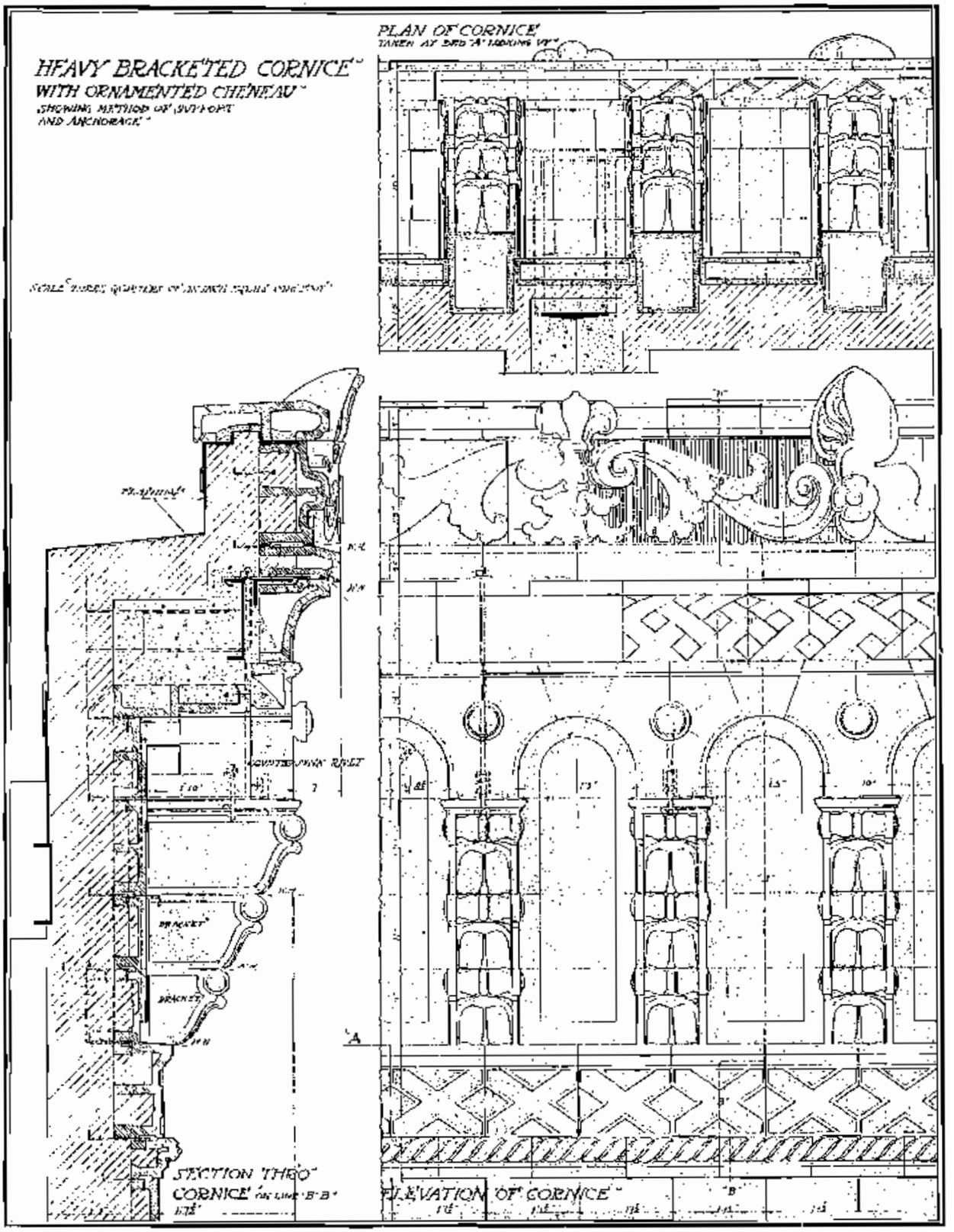
NATIONAL TERRA COTTA SOCIETY U.S.A. PLATE NO. 22

TERRA COTTA · STANDARD CONSTRUCTION



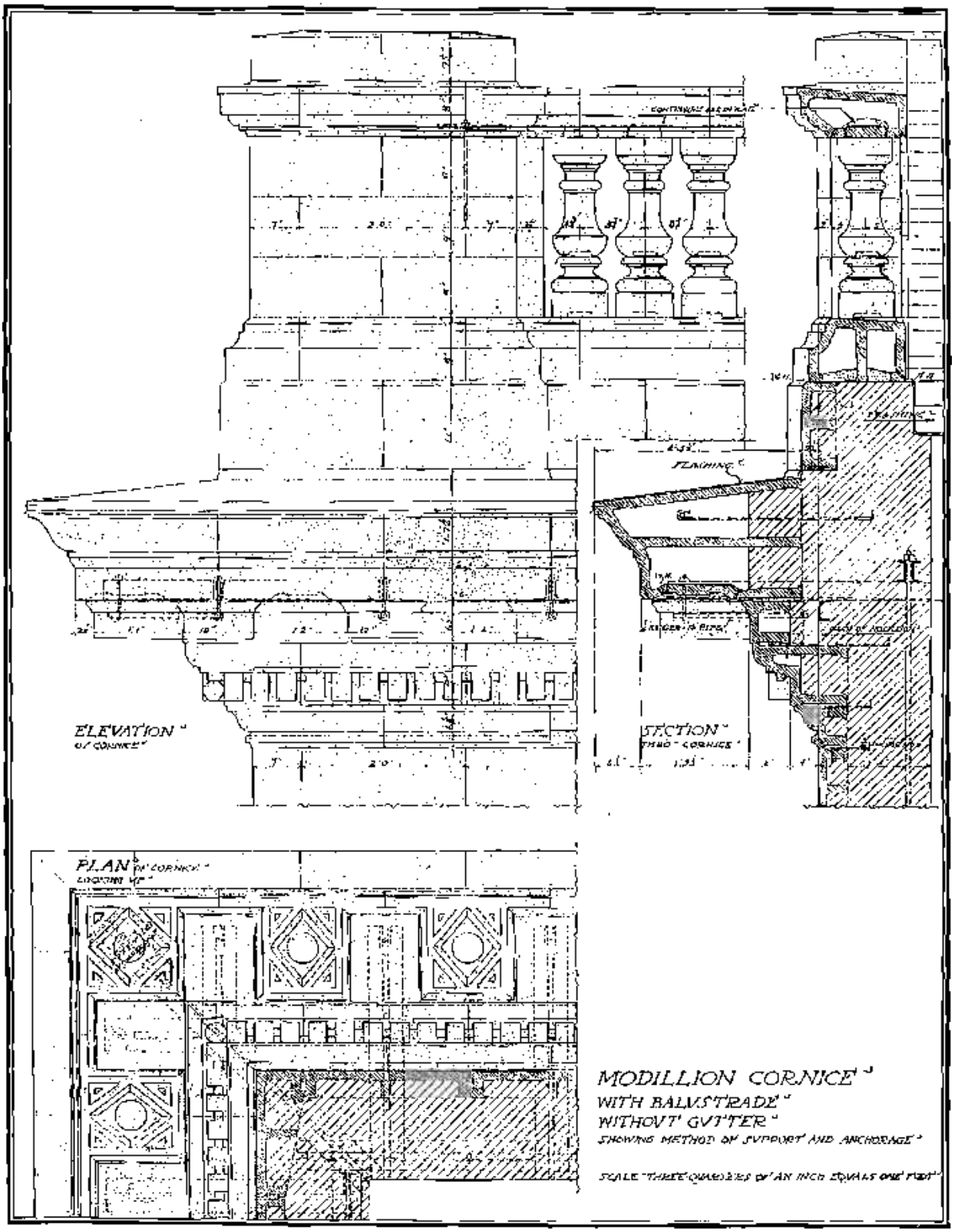
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·23

TERRA COTTA · STANDARD CONSTRUCTION



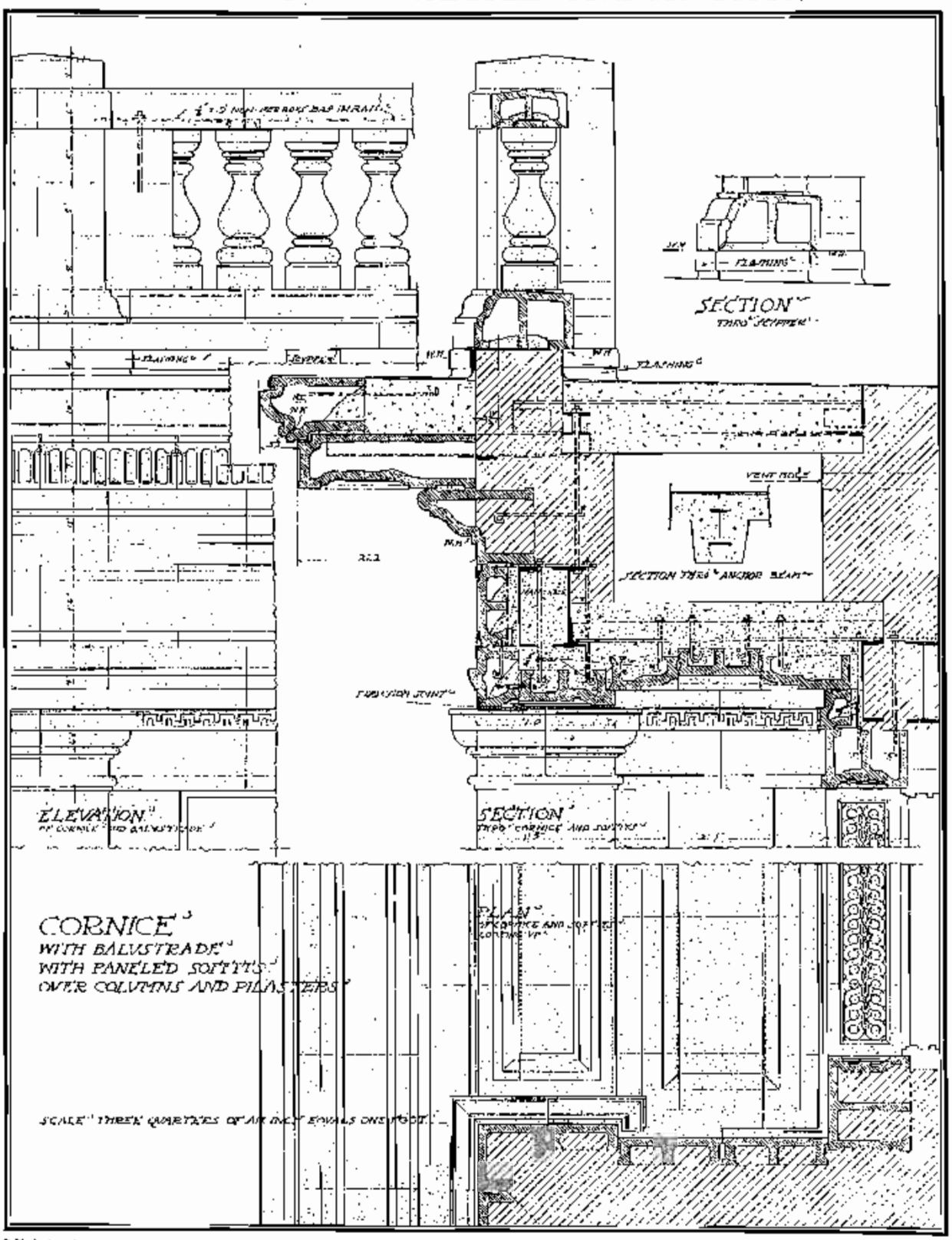
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO· 24

TERRA COTTA · STANDARD CONSTRUCTION



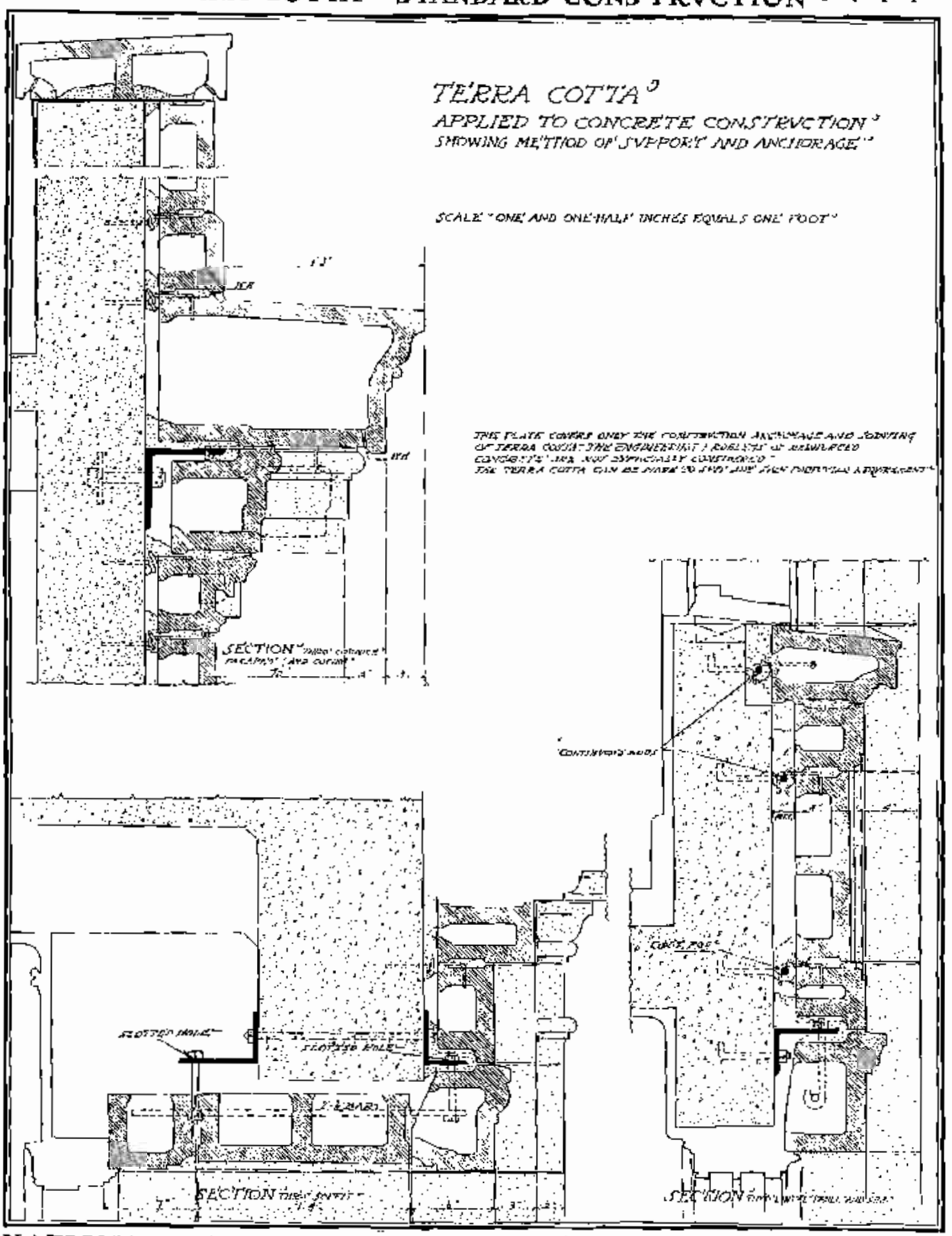
NATIONAL TERRA COTTA SOCIETY · U · S · A · · · PLATE NO · 25

TERRA COTTA · STANDARD CONSTRUCTION



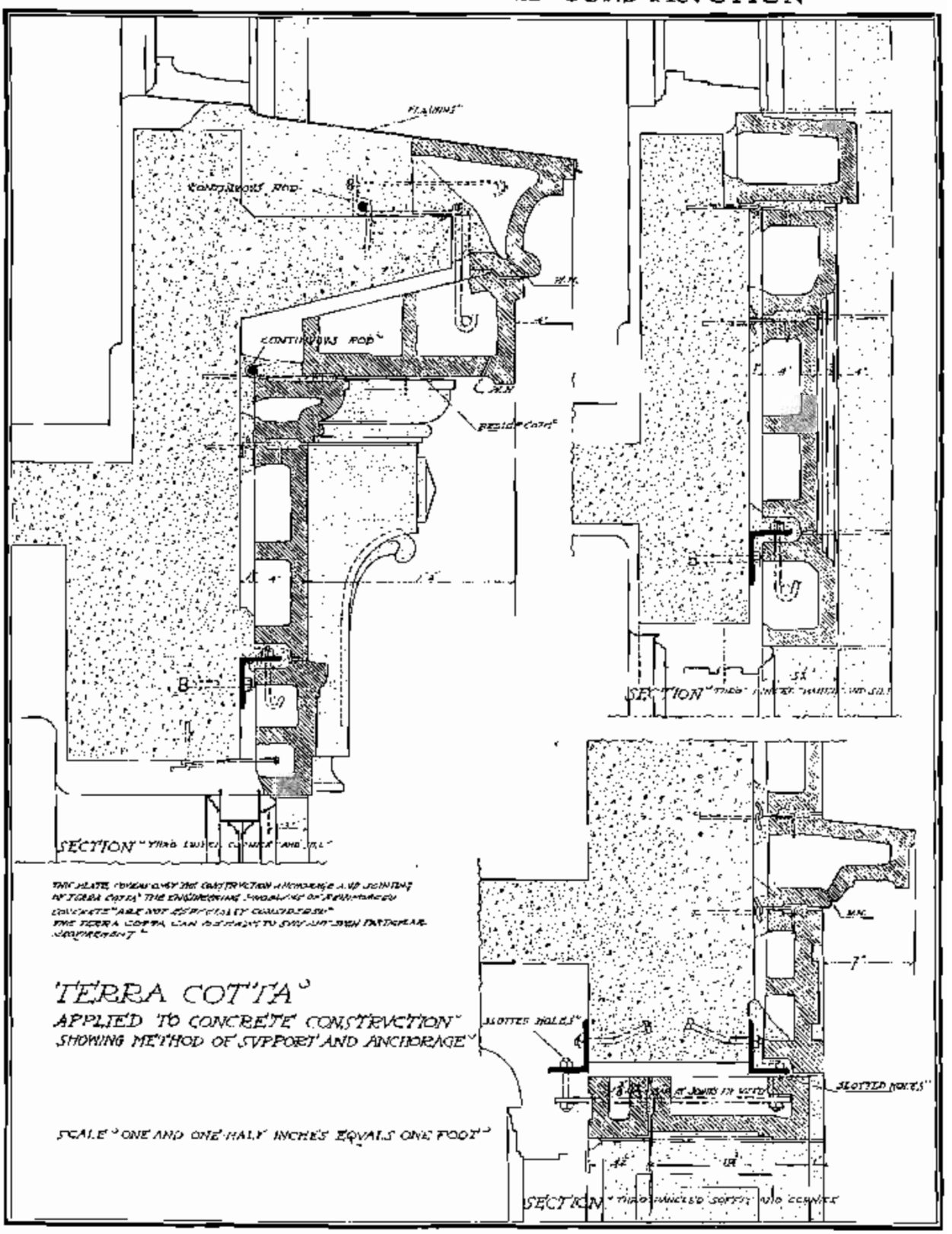
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO· 26

TERRA COTTA · STANDARD CONSTRUCTION



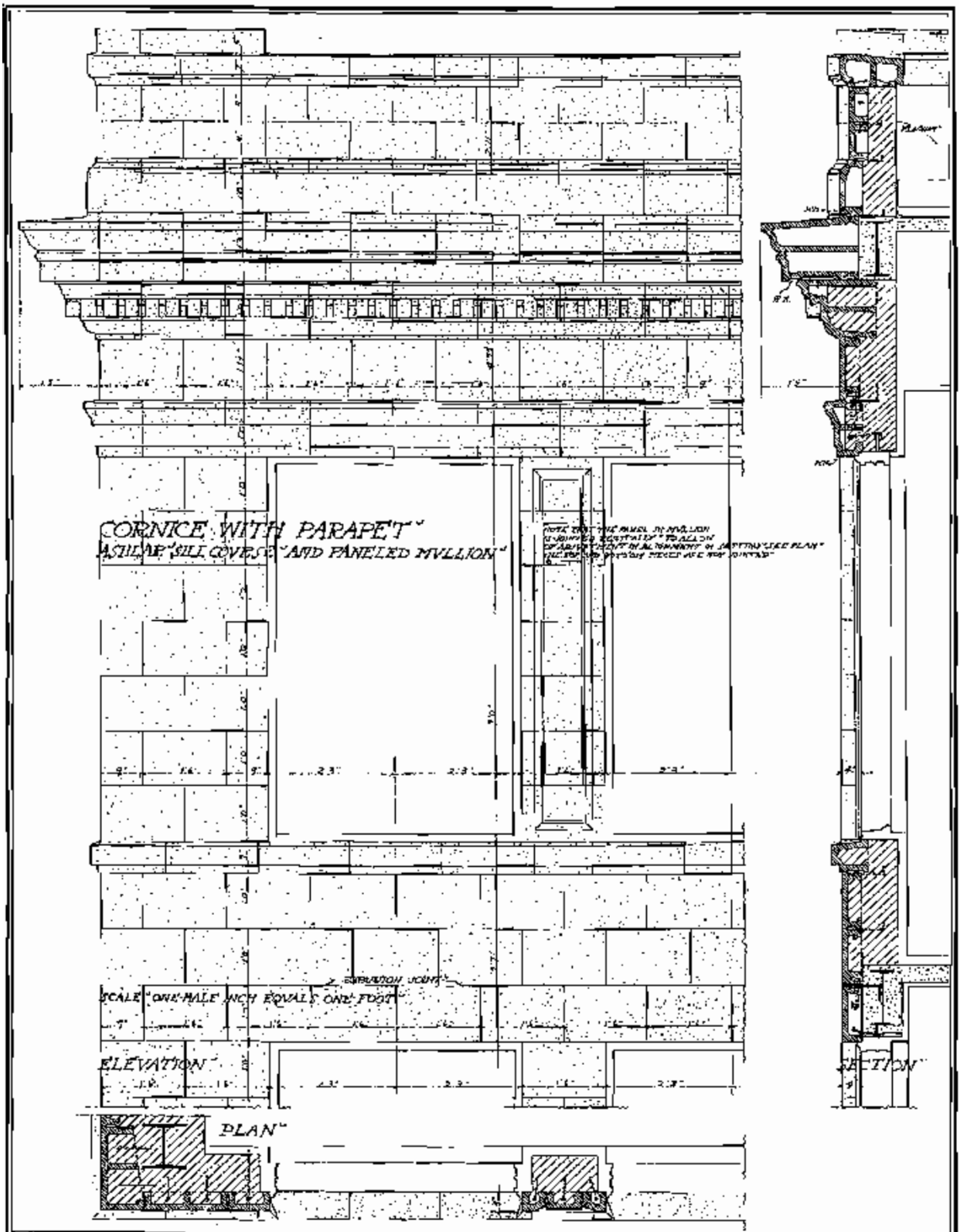
NATIONAL TERRA COTTA SOCIETY · U.S.A. · PLATE NO. 27

TERRA COTTA · STANDARD CONSTRVCTION



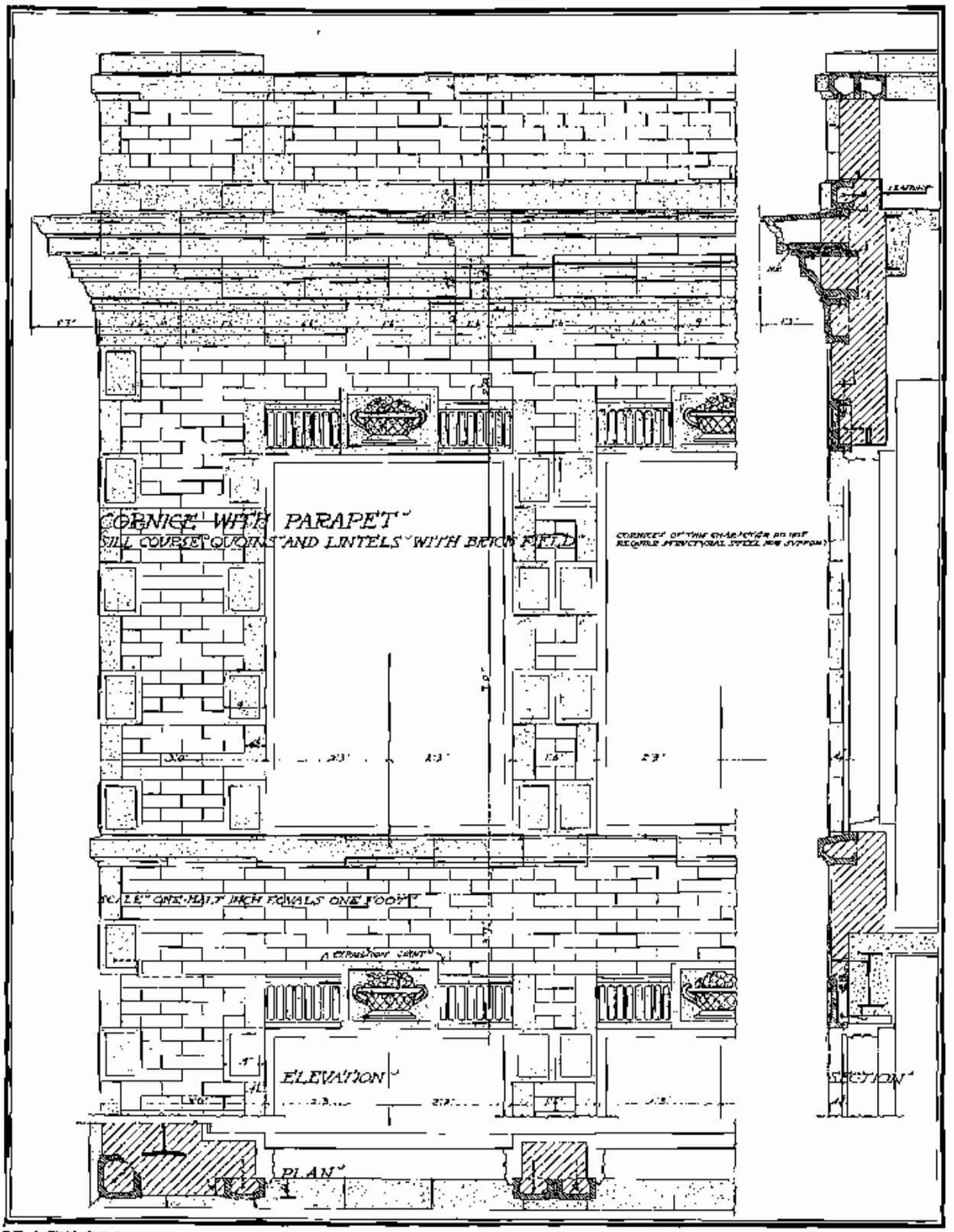
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO · 28

TERRA COTTA · STANDARD CONSTRUCTION



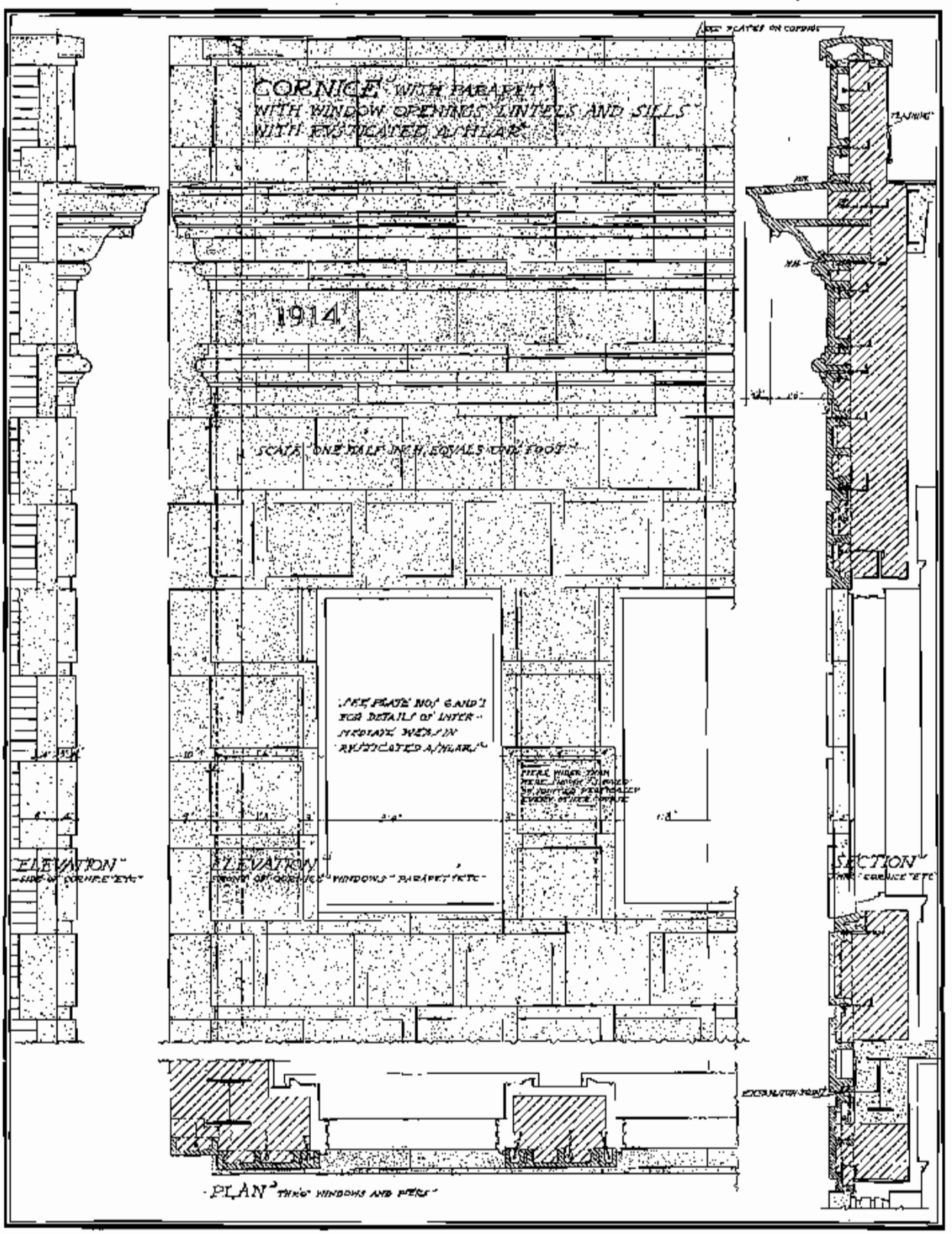
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·29

TERRA COTTA · STANDARD CONSTRUCTION



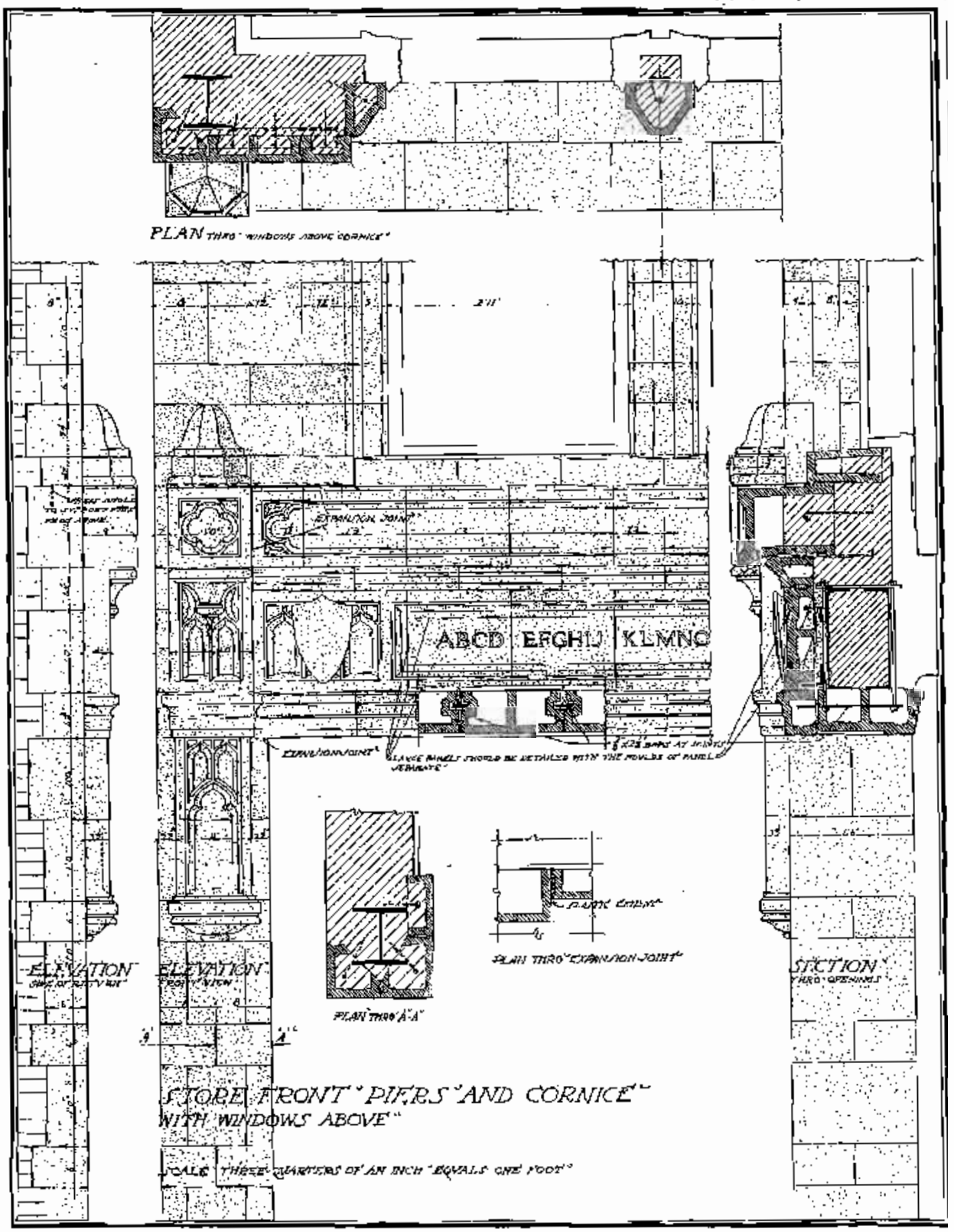
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO· 30

TERRA COTTA · STANDARD CONSTRUCTION



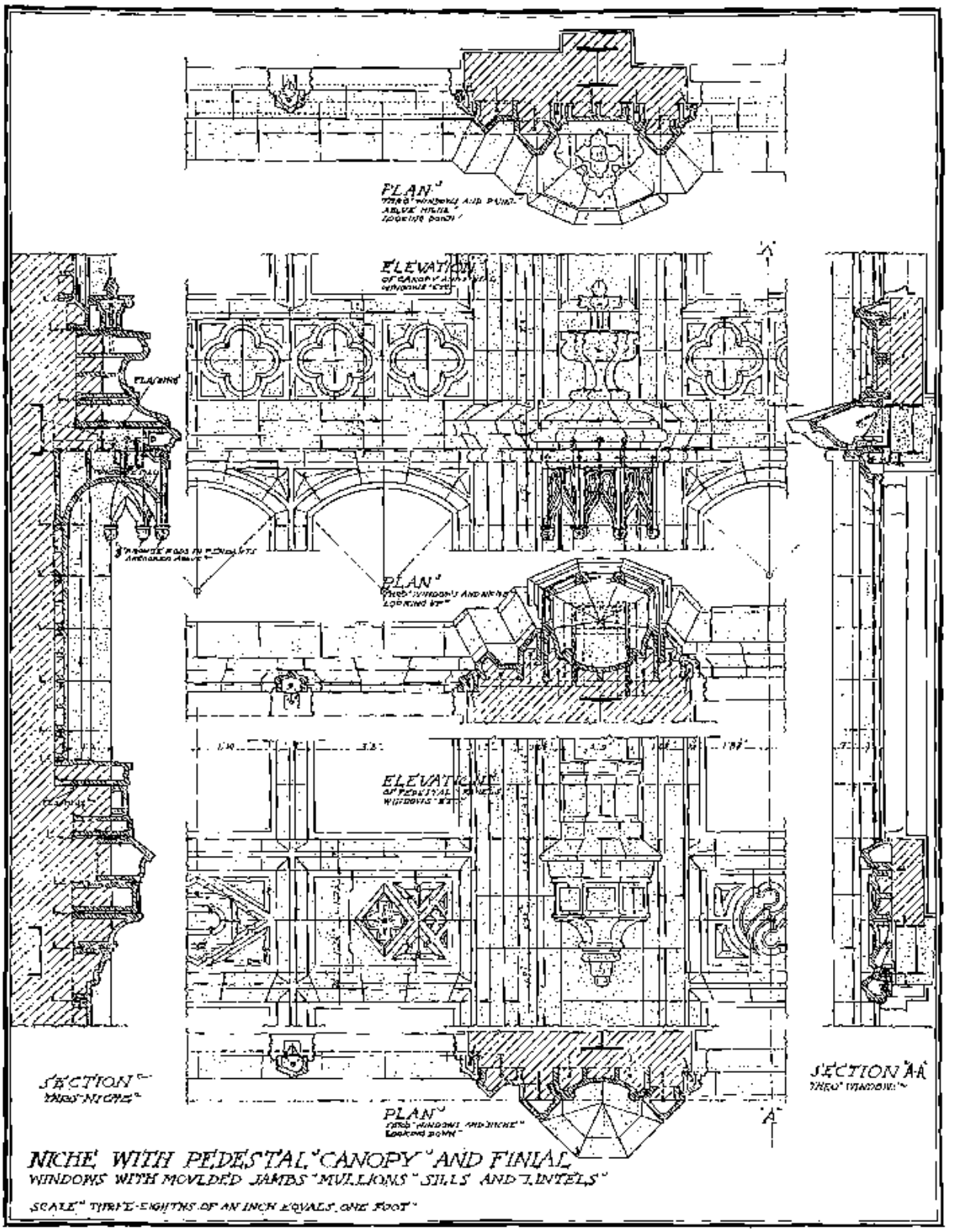
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·31

TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·32

TERRA COTTA · STANDARD CONSTRUCTION

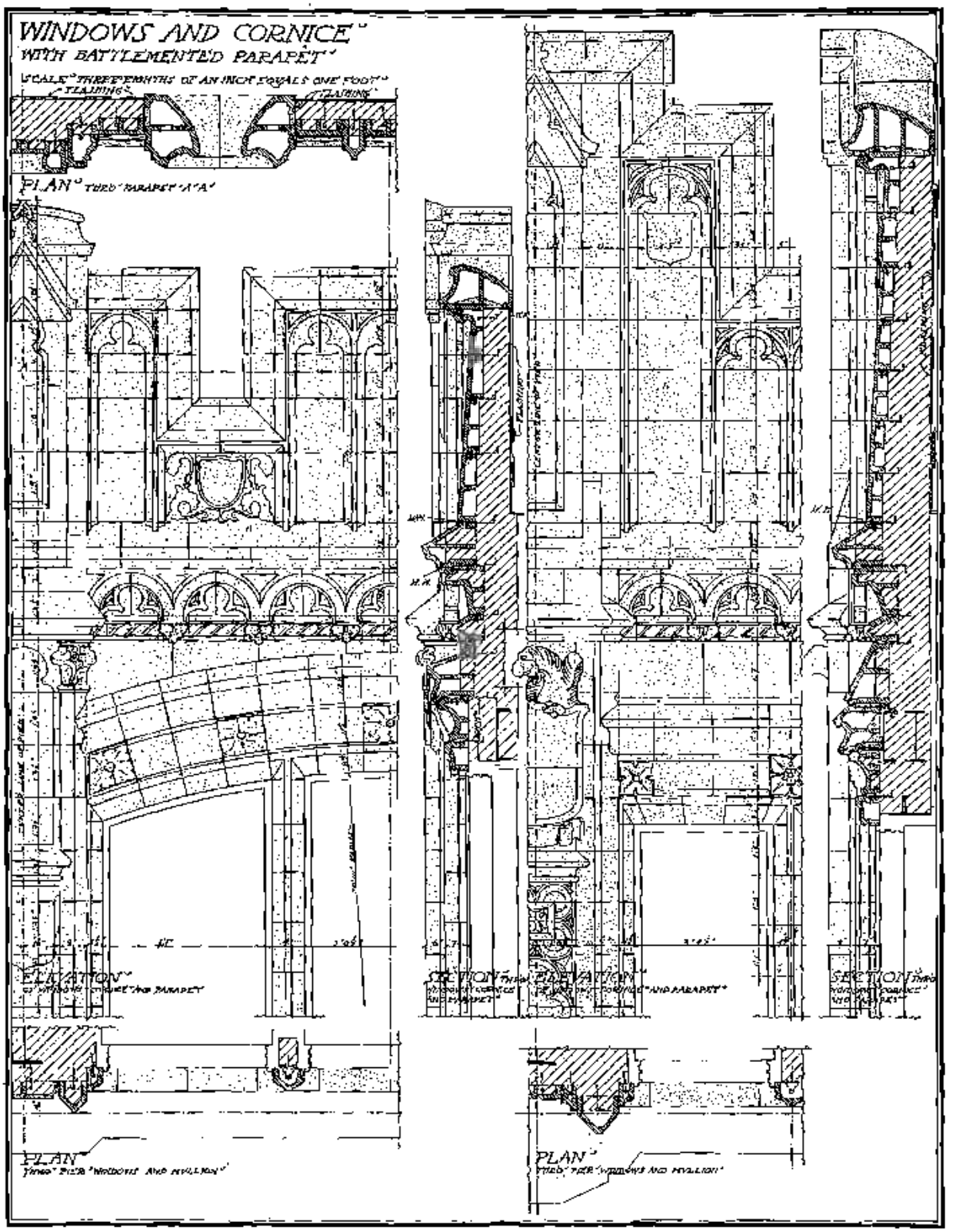


NICHE WITH PEDESTAL, CANOPY AND FINIAL
WINDOWS WITH MOULDED JAMBS, MULLIONS, SILLS AND LINTELS

SCALE, THREE-EIGHTHS OF AN INCH EQUALS ONE FOOT

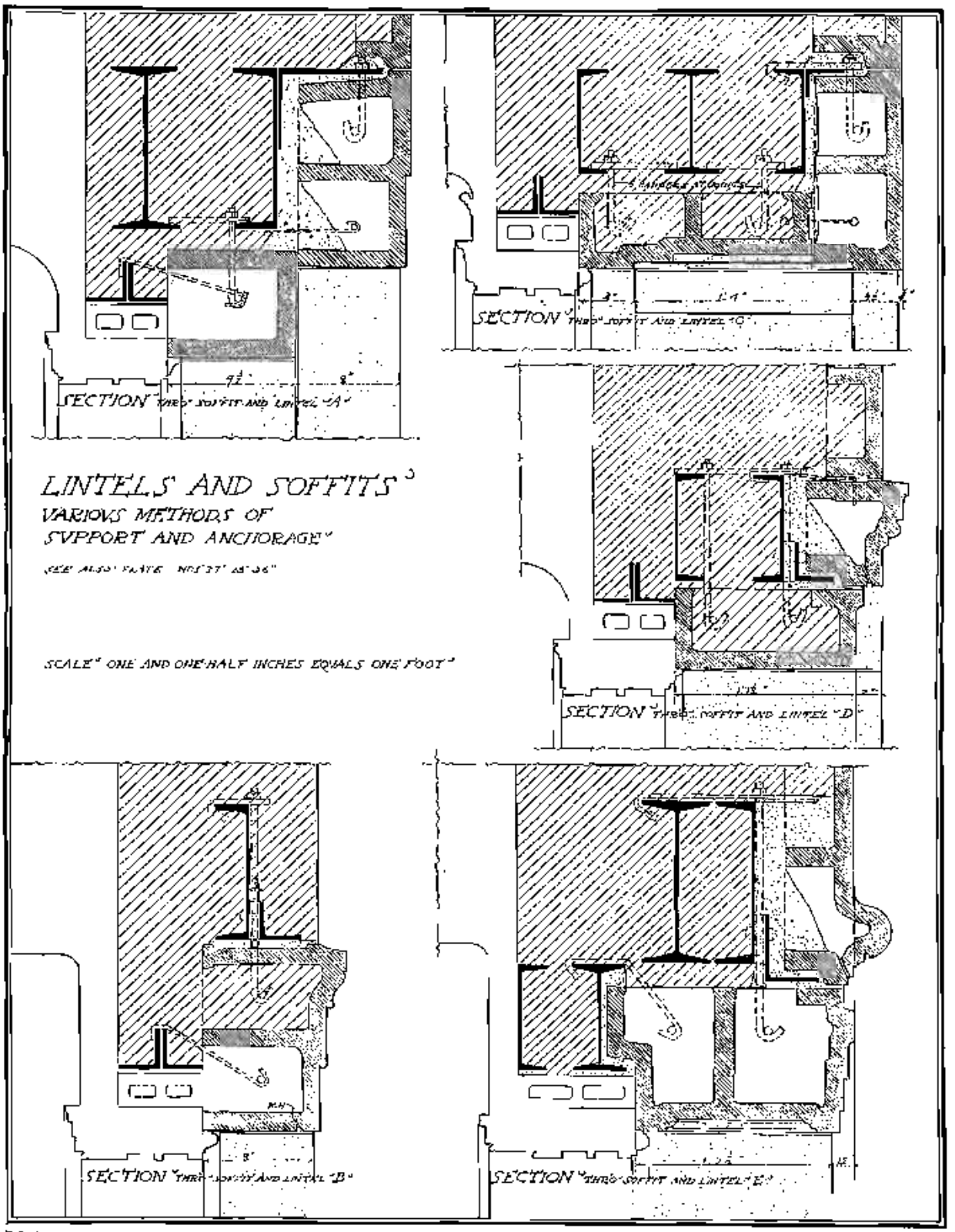
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO · 33

TERRA COTTA · STANDARD CONSTRUCTION



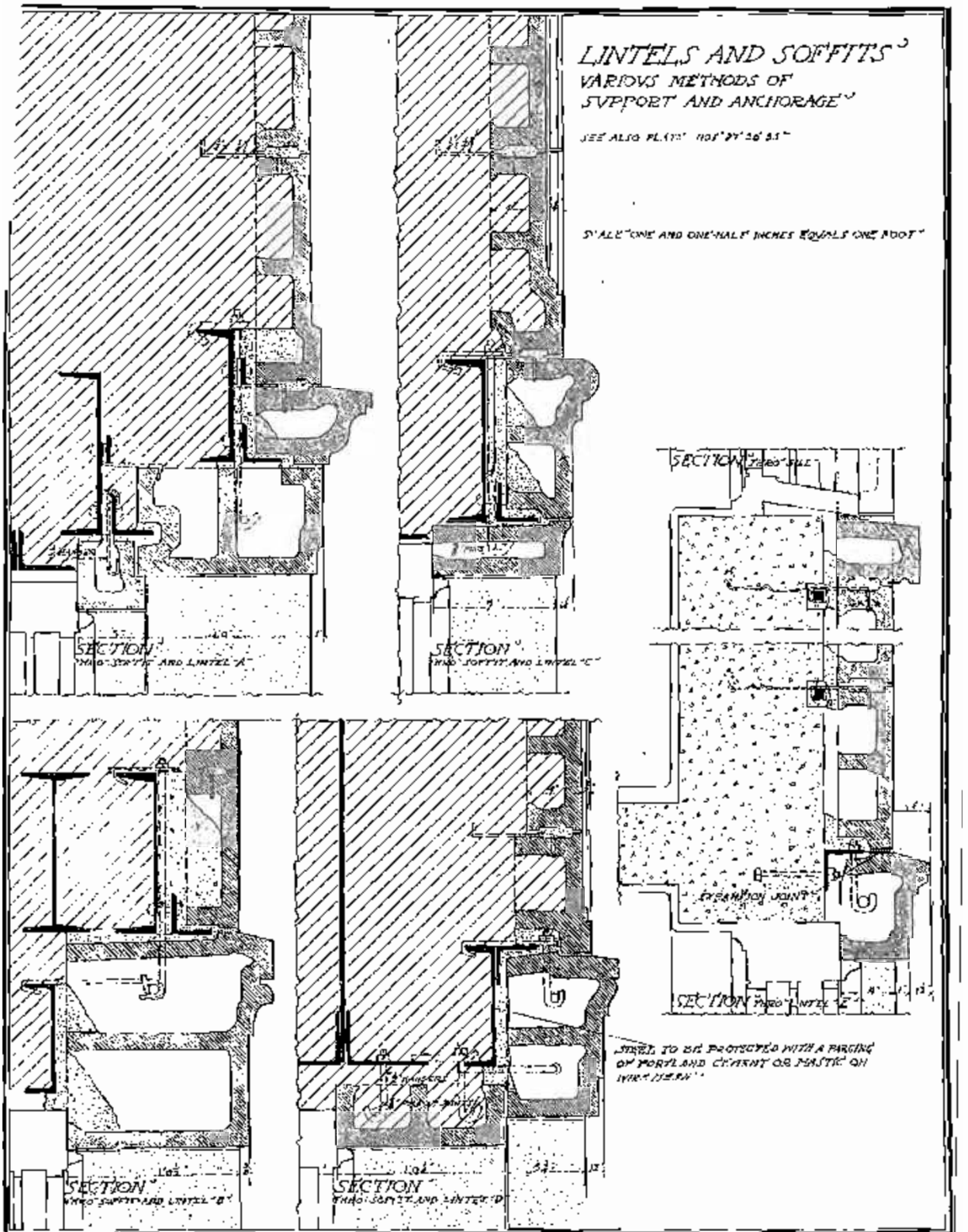
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·34

TERRA COTTA · STANDARD CONSTRVCTION



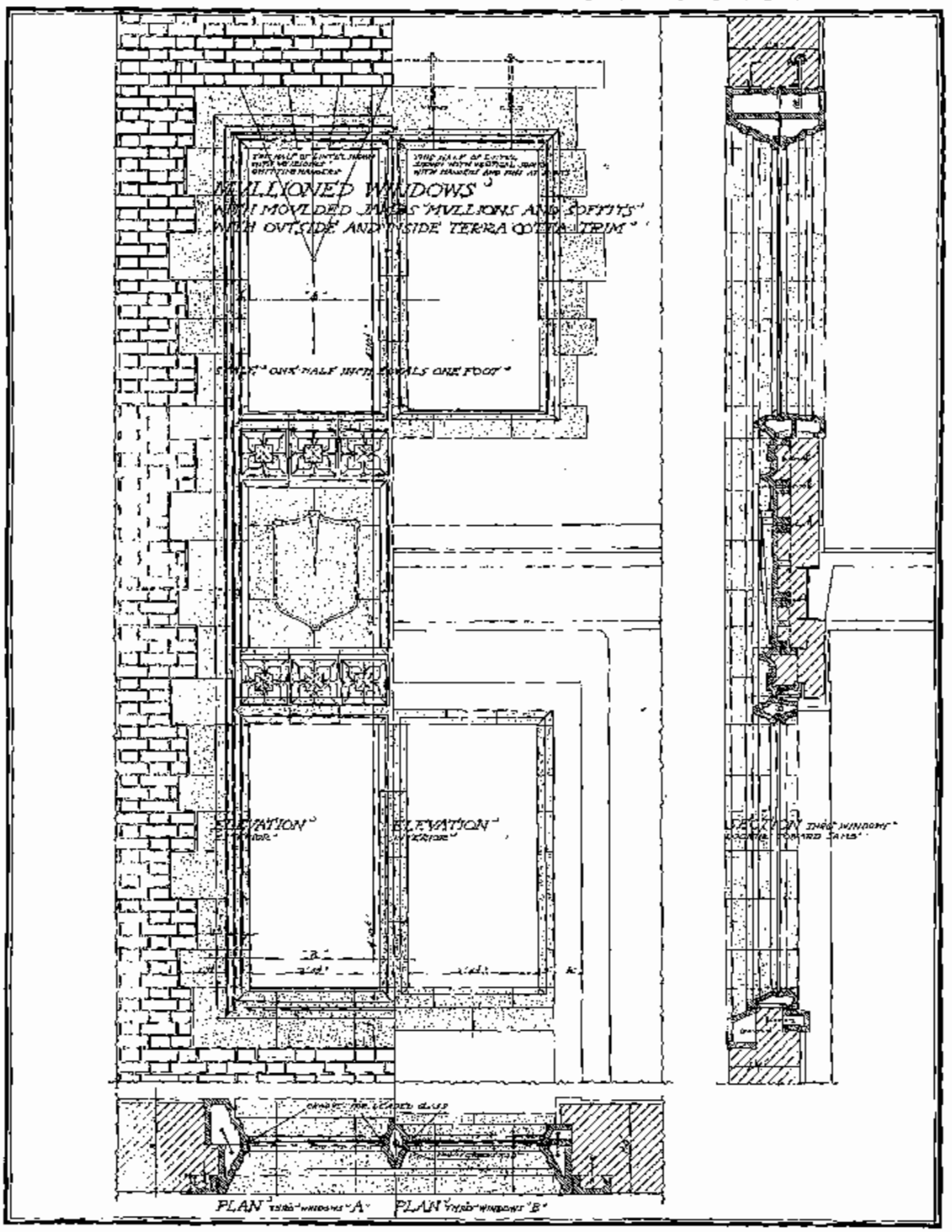
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·35

TERRA COTTA · STANDARD CONSTRUCTION



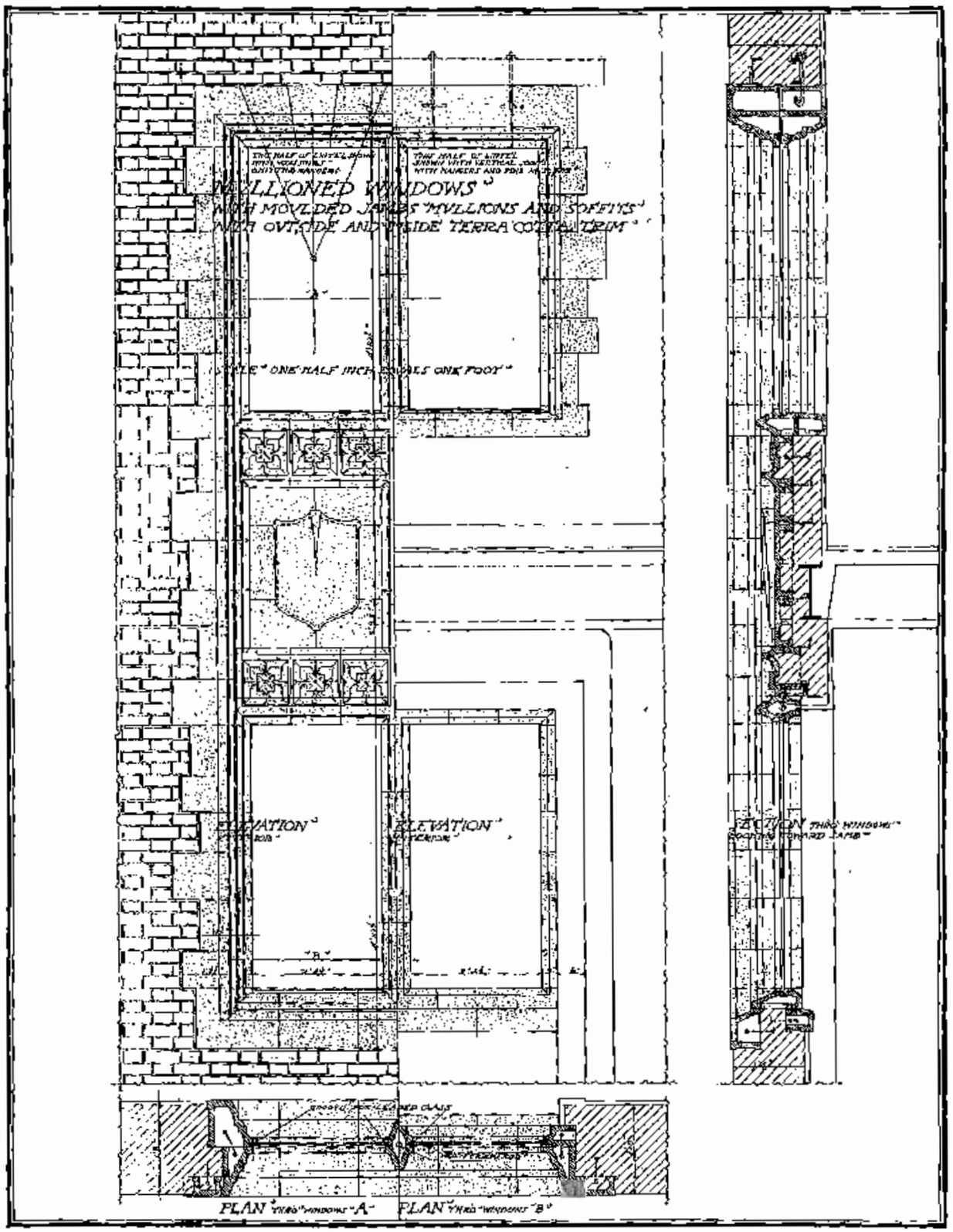
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·36

TERRA COTTA · STANDARD CONSTRUCTION



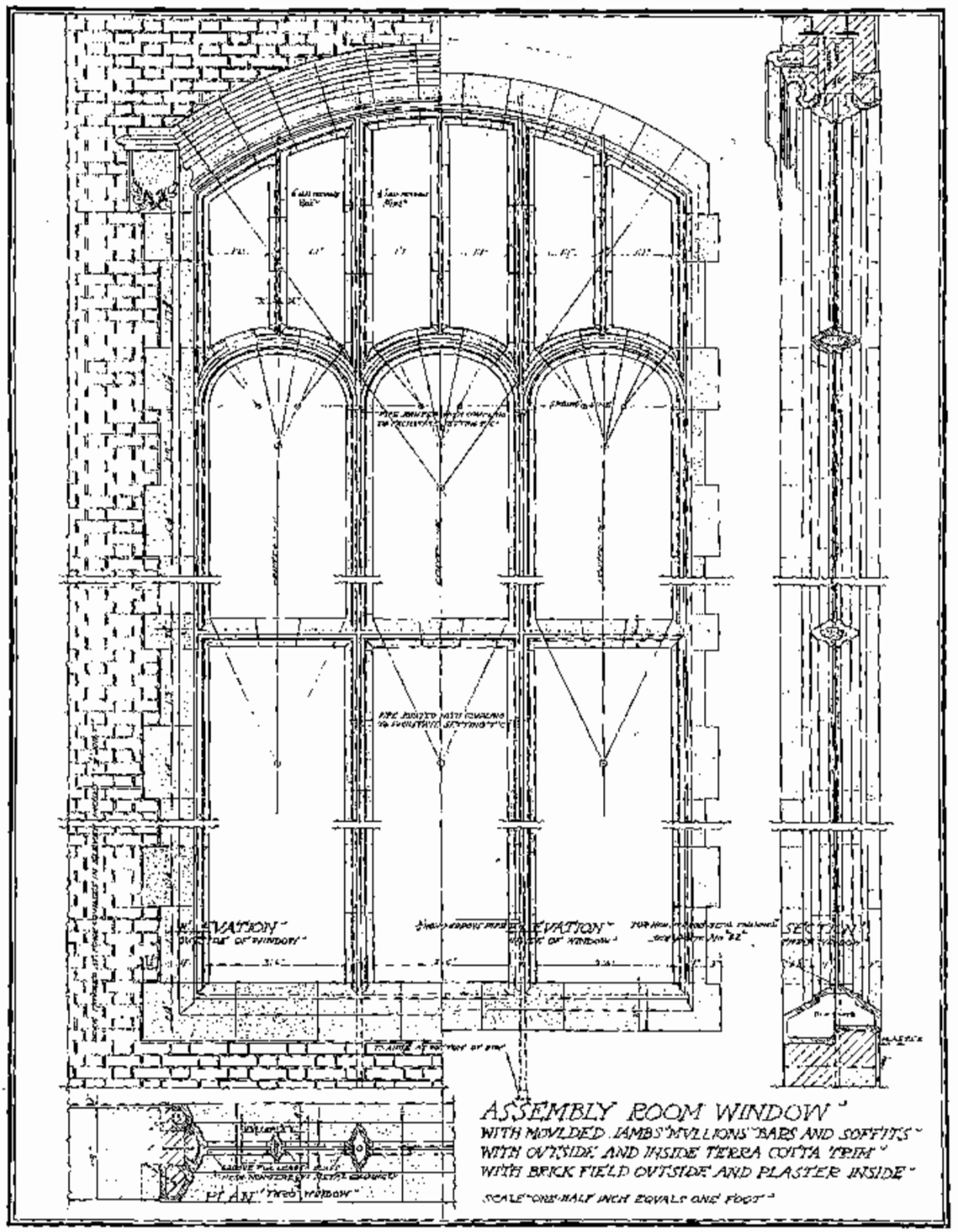
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·37

TERRA COTTA · STANDARD CONSTRVCTION



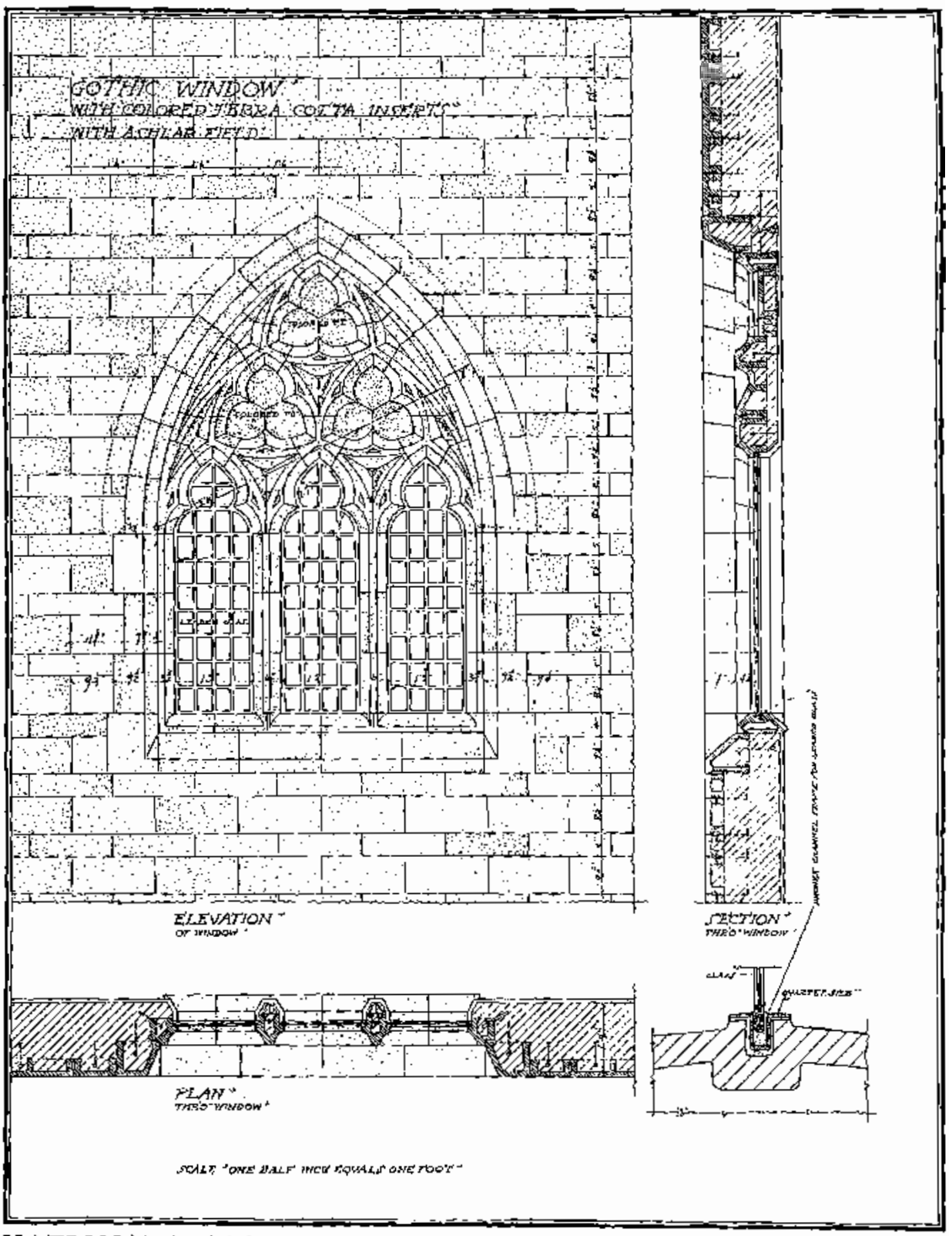
NATIONAL TERRA COTTA SOCIETY · V·S·A · · PLATE NO·37

TERRA COTTA · STANDARD CONSTRUCTION



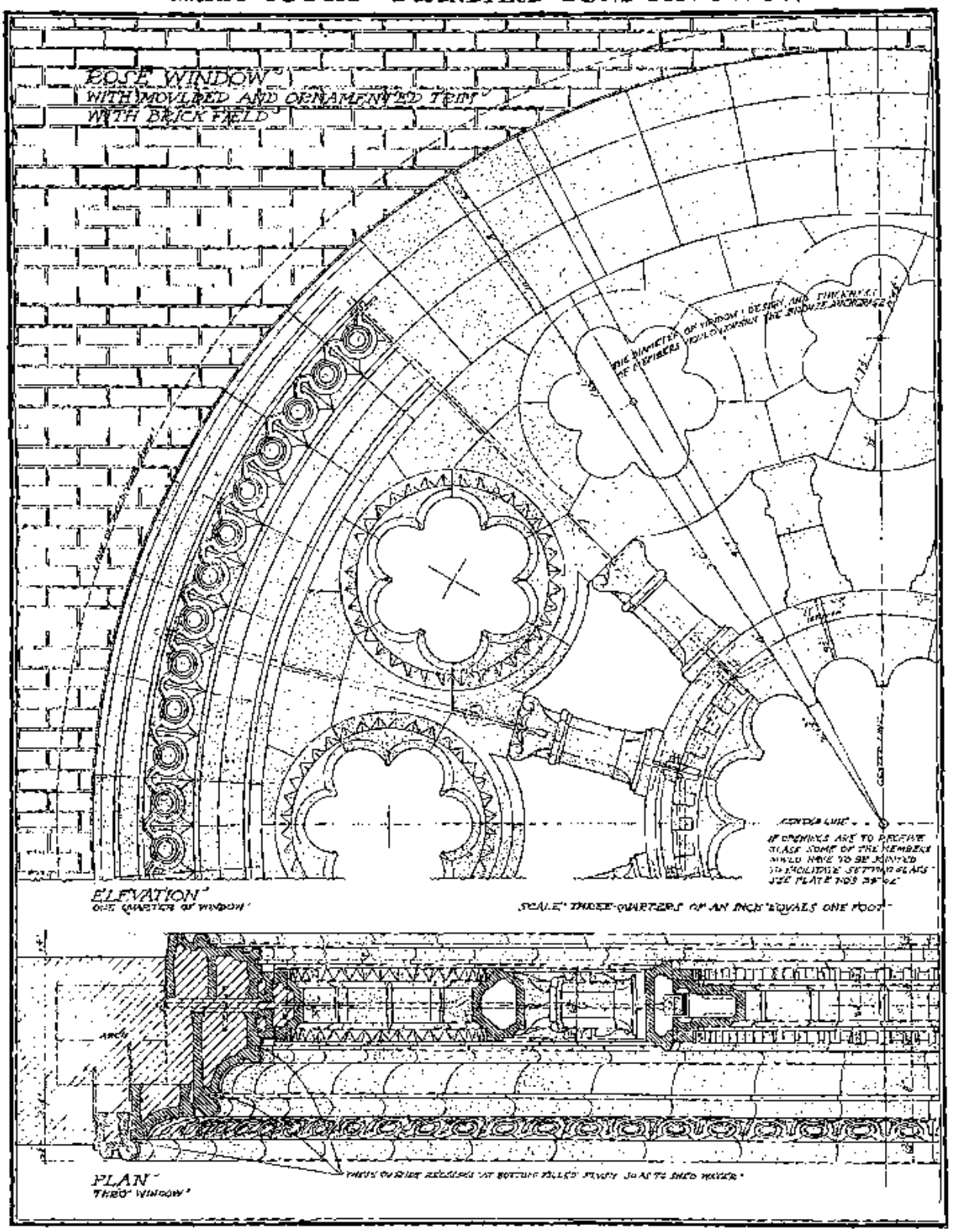
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·38

TERRA COTTA · STANDARD CONSTRUCTION



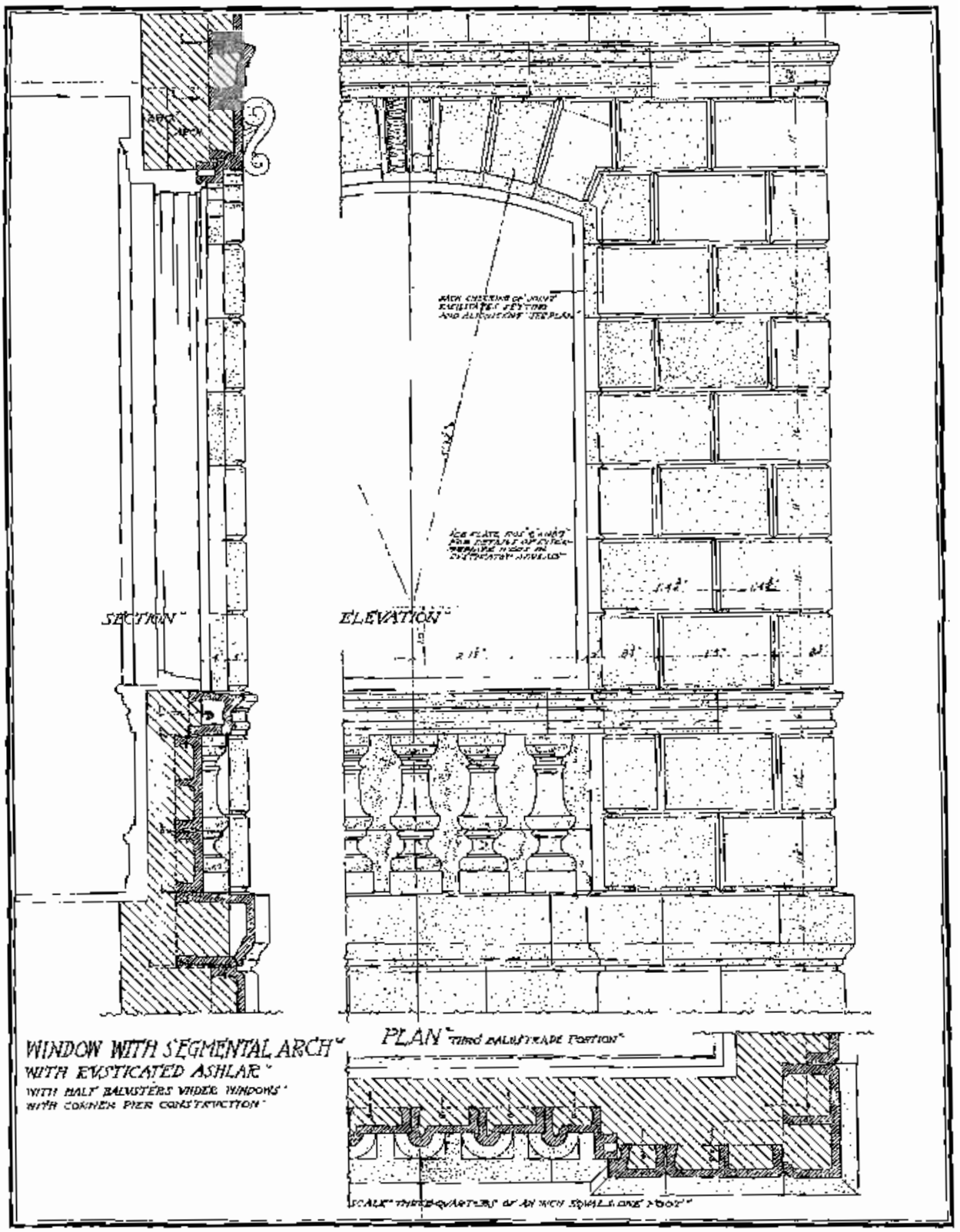
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO · 39

TERRA COTTA · STANDARD CONSTRUCTION



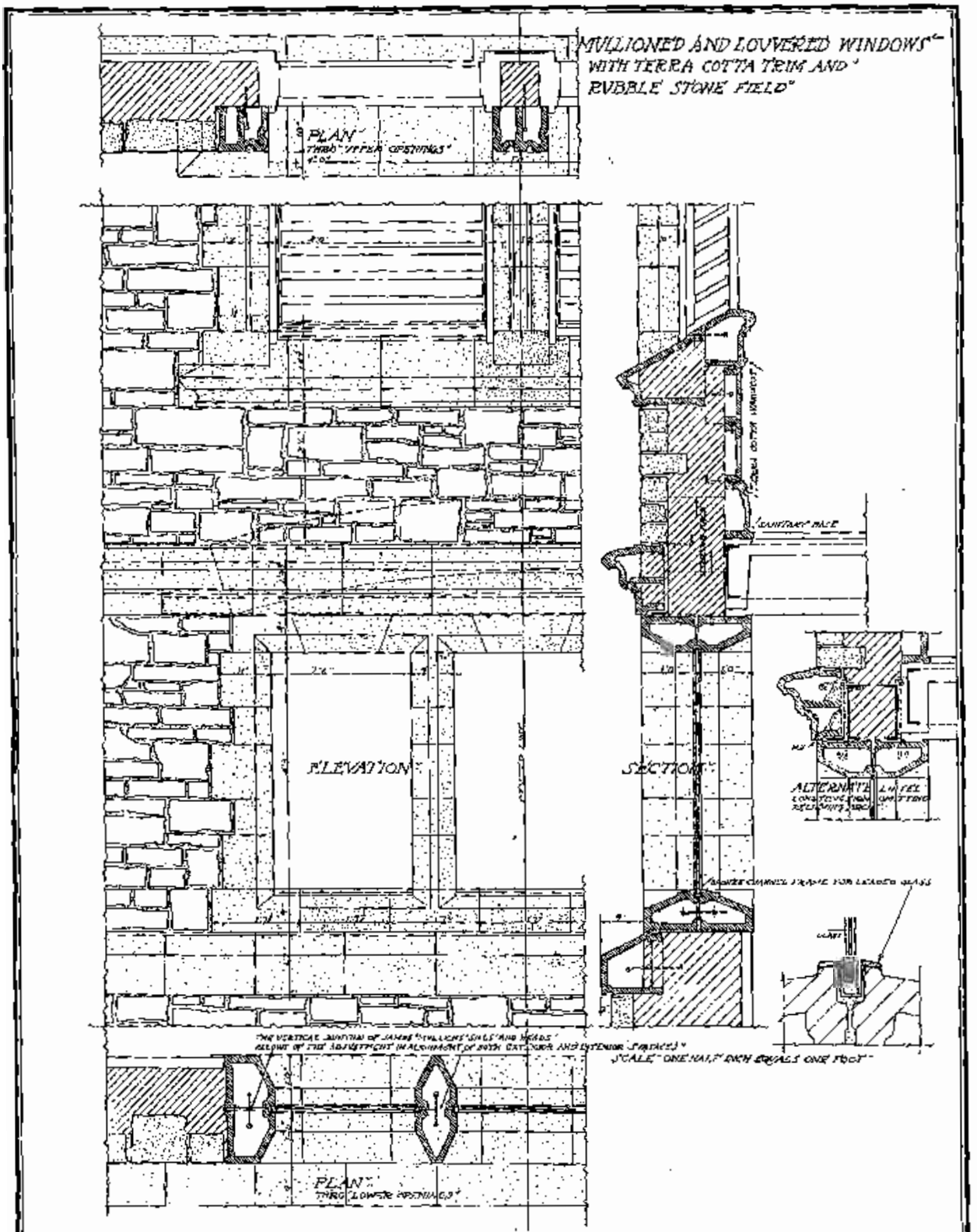
NATIONAL TERRA COTTA SOCIETY · U · S · A · · PLATE NO · 40

TERRA COTTA · STANDARD CONSTRVCTION



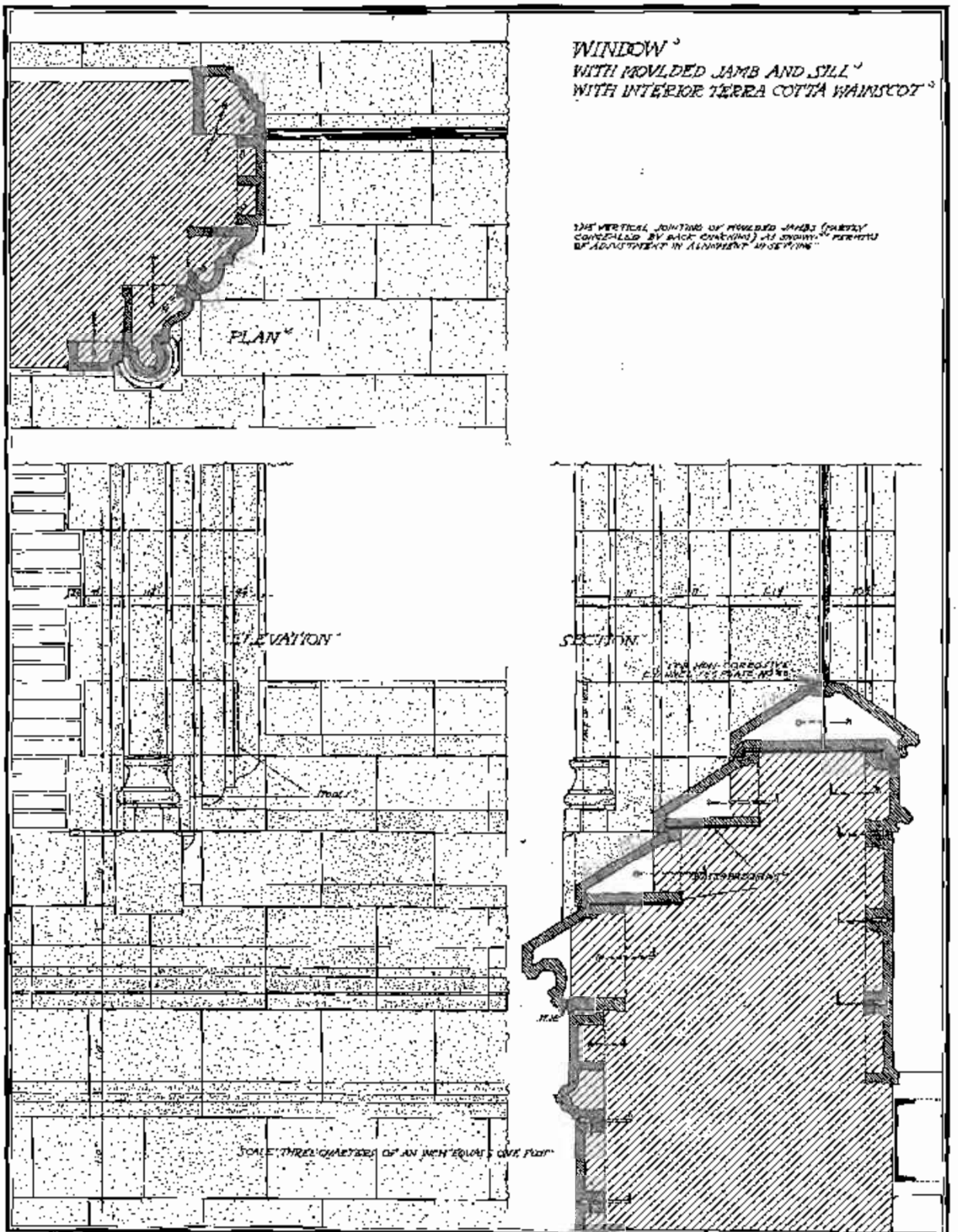
NATIONAL TERRA COTTA SOCIETY · V · S · A · · PLATE NO · 41

TERRA COTTA · STANDARD CONSTRUCTION



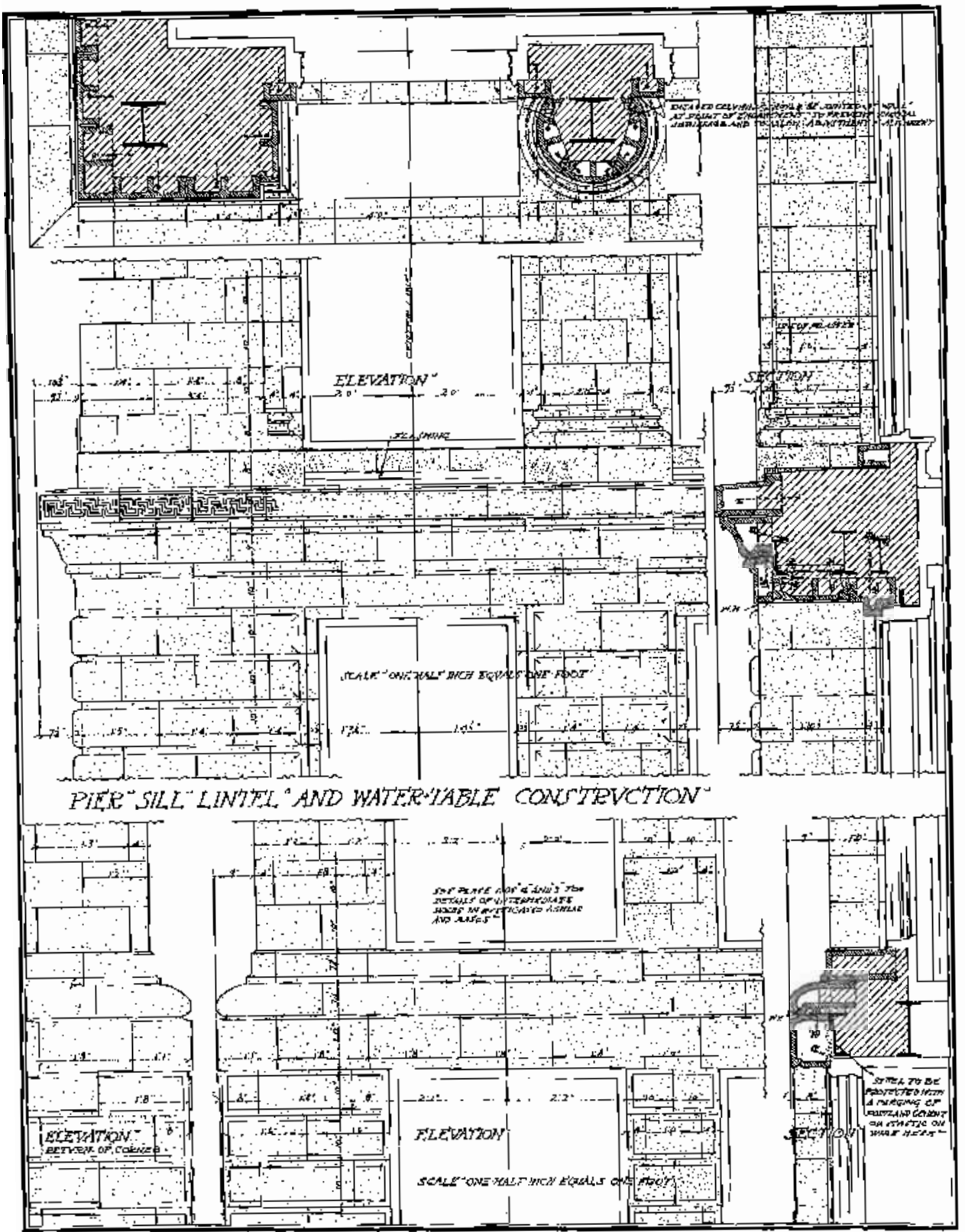
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO· 42

TERRA COTTA · STANDARD CONSTRUCTION



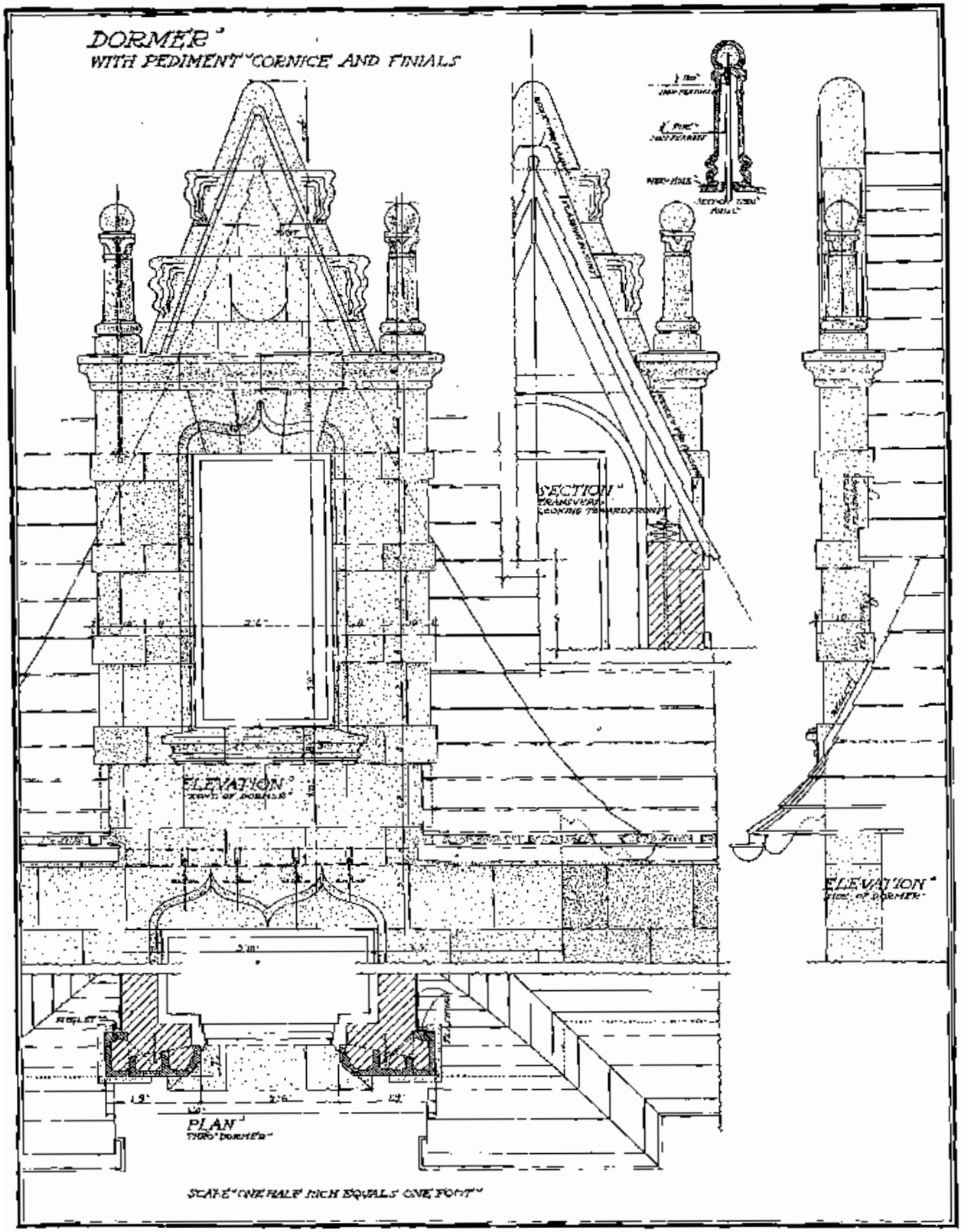
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO · 43

TERRA COTTA · STANDARD CONSTRVCTION



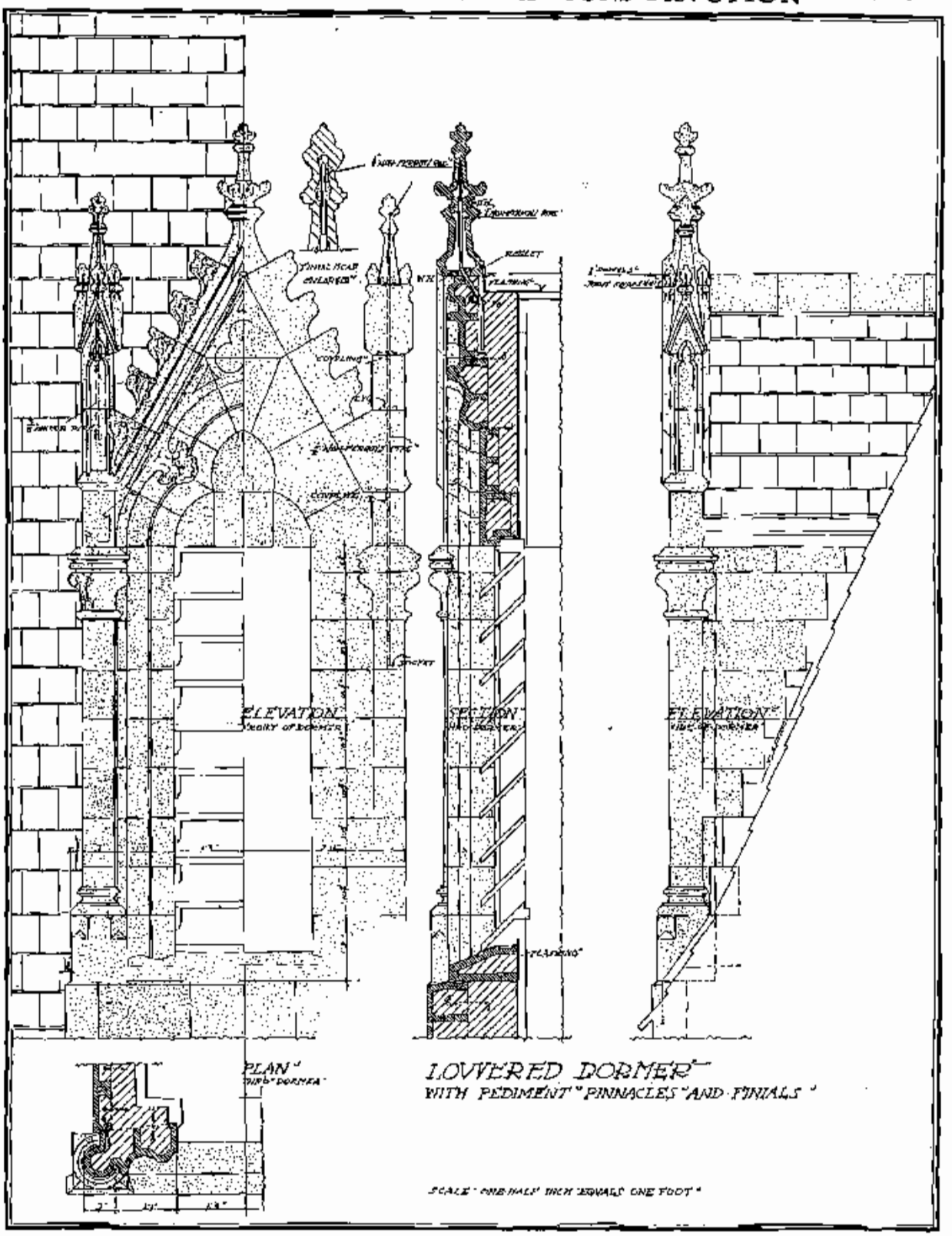
NATIONAL TERRA COTTA SOCIETY · V · S · A · · PLATE NO · 44

TERRA COTTA · STANDARD CONSTRUCTION



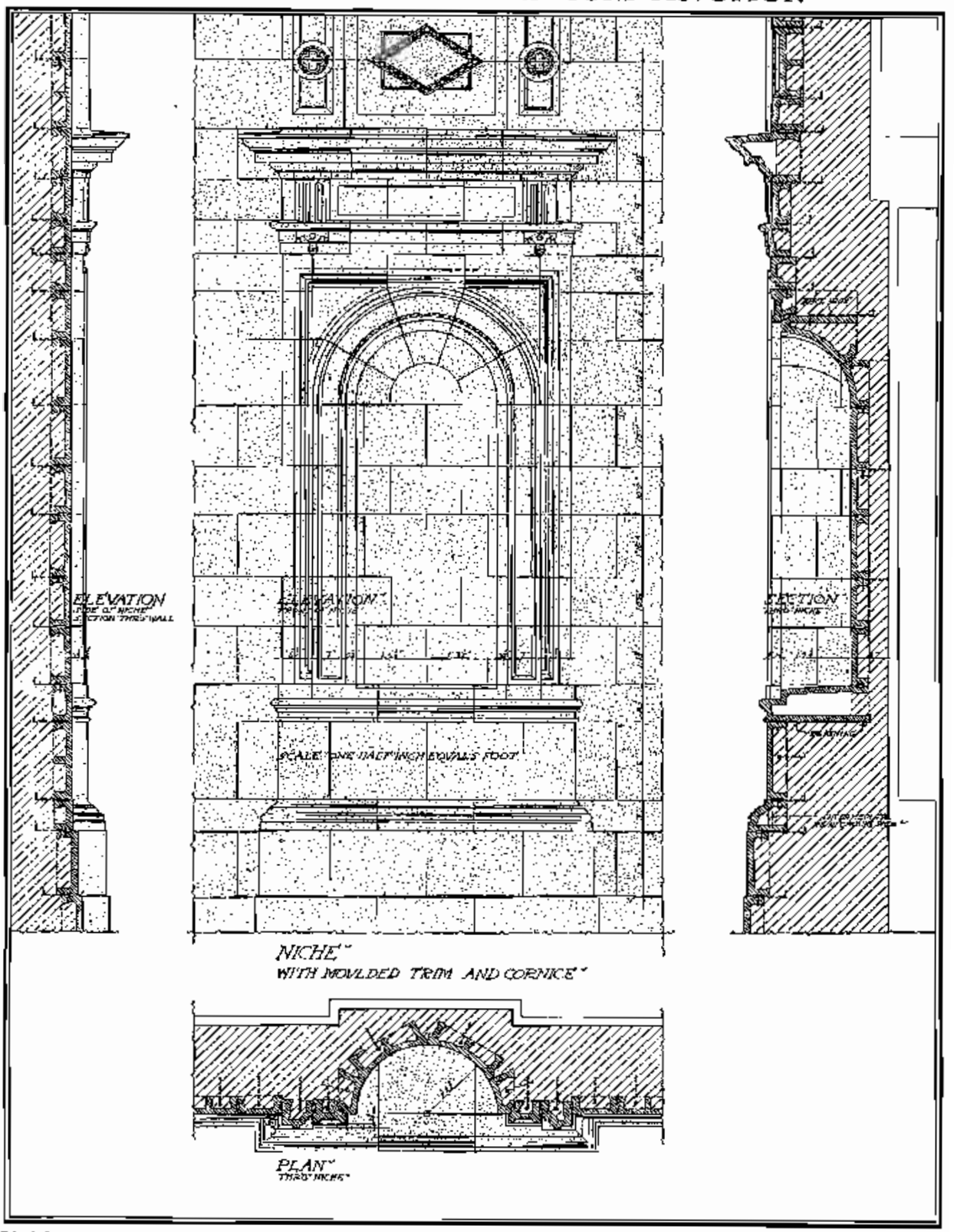
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·46

TERRA COTTA · STANDARD CONSTRUCTION



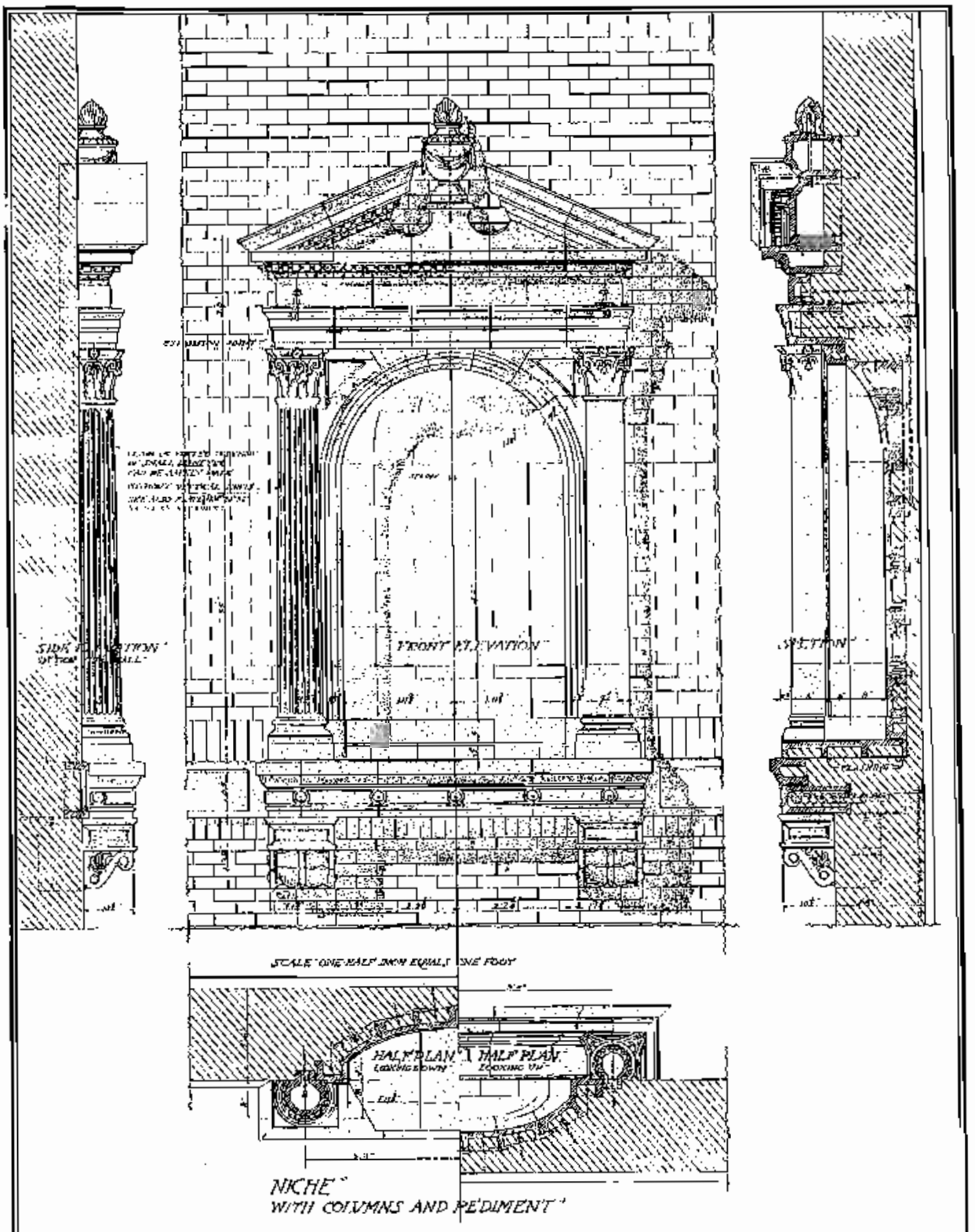
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO · 47

TERRA COTTA · STANDARD CONSTRUCTION



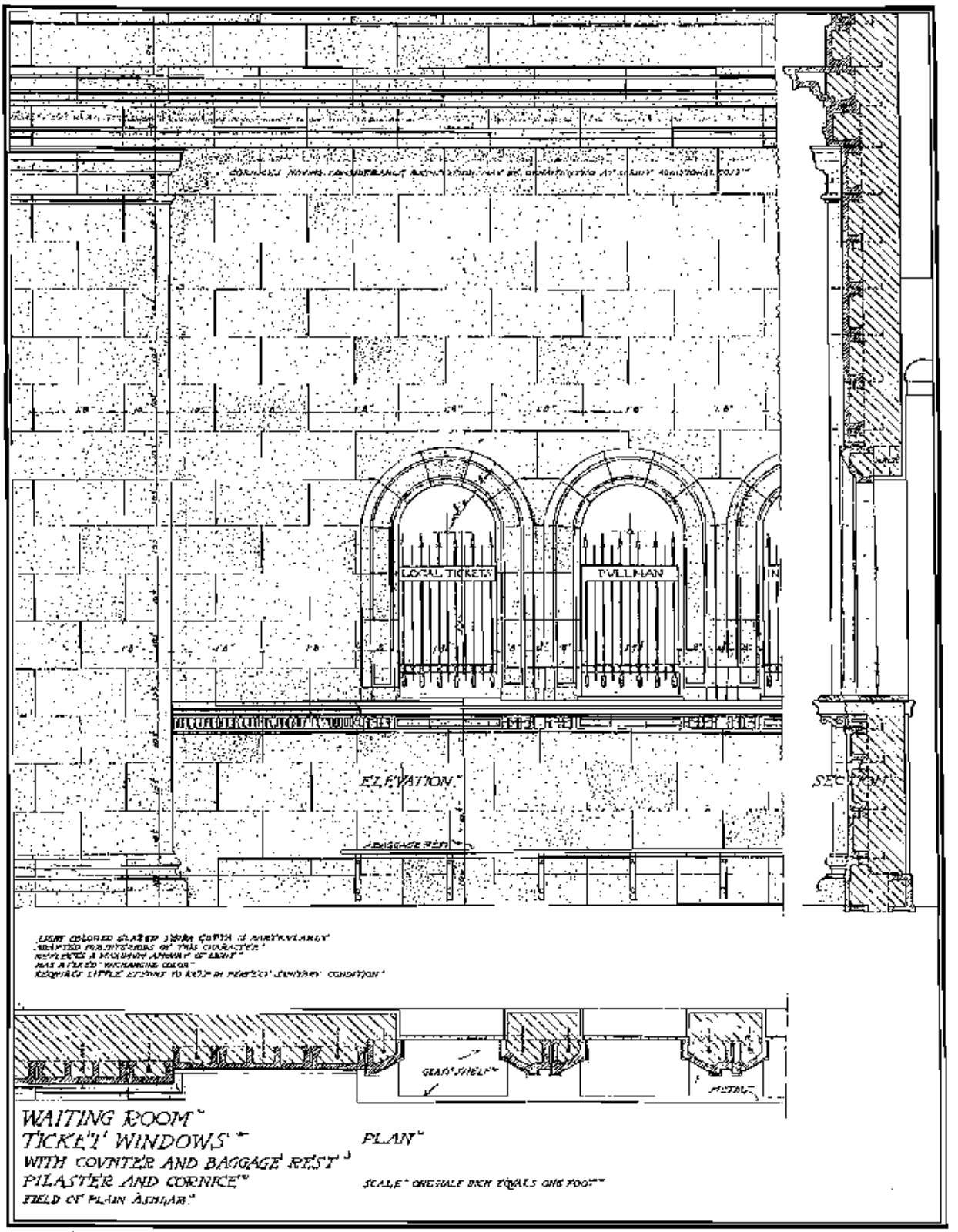
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO · 48

TERRA COTTA · STANDARD CONSTRVCTION



NATIONAL TERRA COTTA SOCIETY · V · S · A · · PLATE NO · 49

TERRA COTTA STANDARD CONSTRUCTION

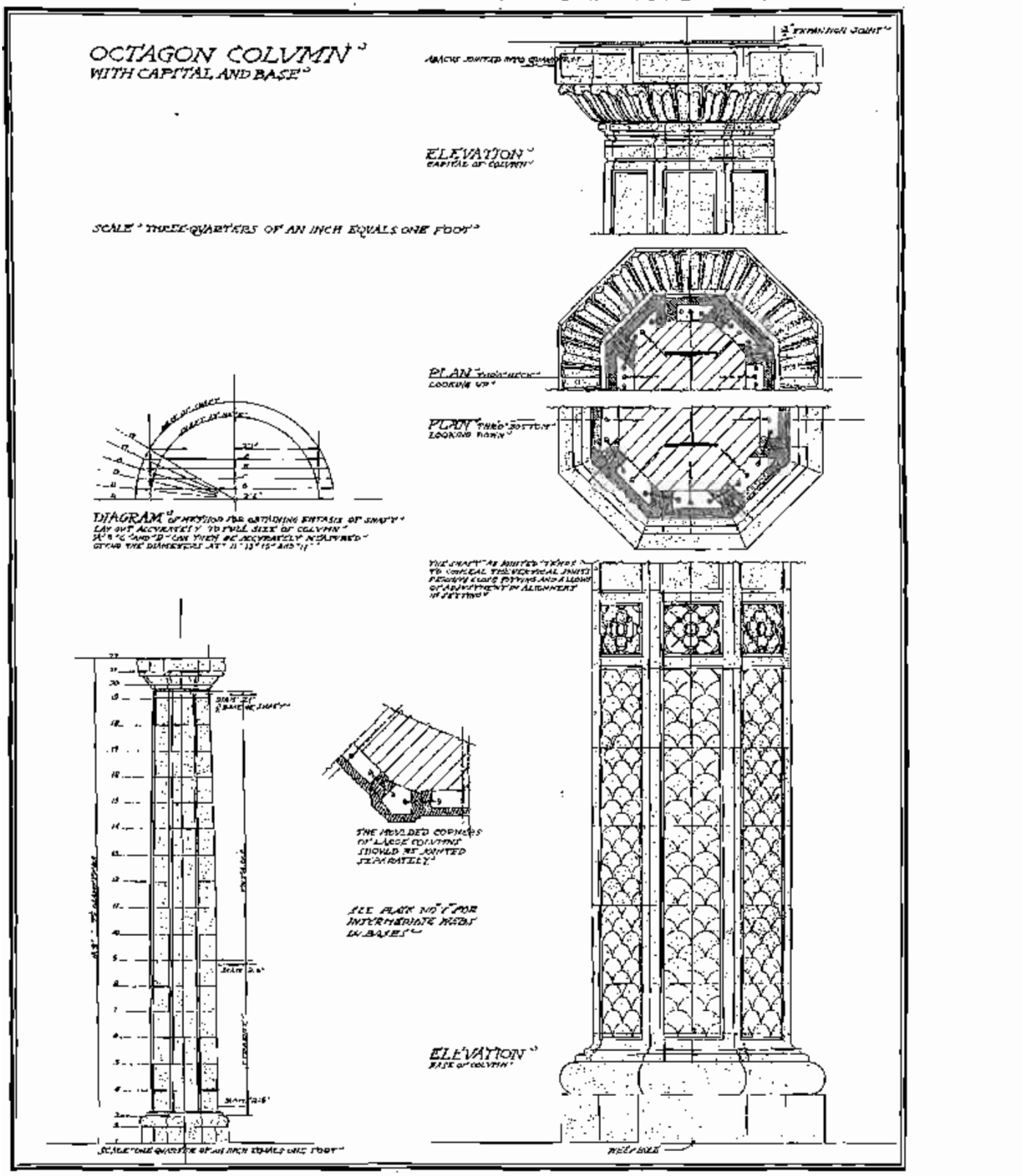


WAITING ROOM
TICKET WINDOWS
WITH COUNTER AND BAGGAGE REST
PILASTER AND CORNICE
FIELD OF PLAIN ASHLAR

SCALE ONE HALF INCH EQUALS ONE FOOT

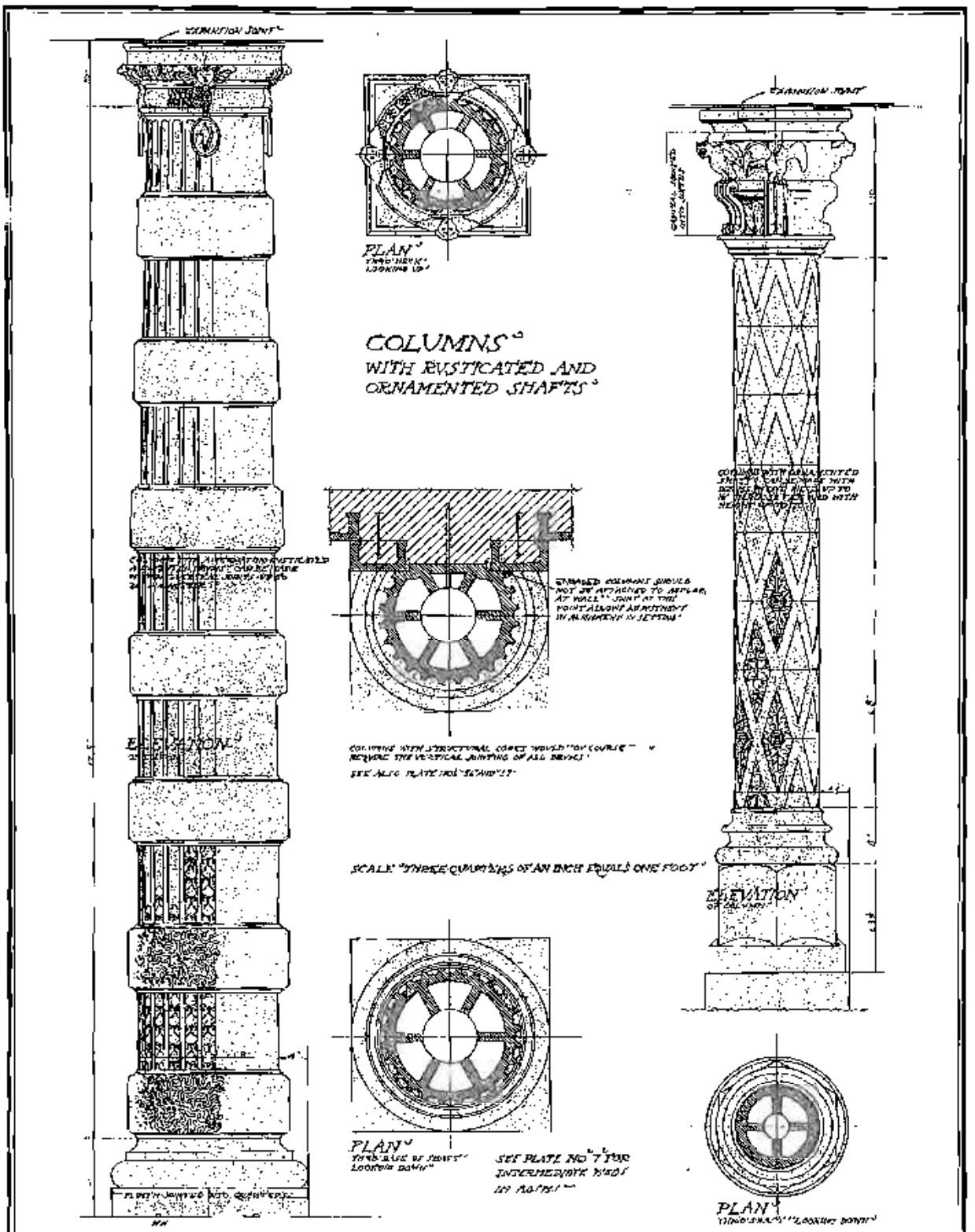
NATIONAL TERRA COTTA SOCIETY U.S.A. PLATE NO. 50

TERRA COTTA · STANDARD CONSTRUCTION



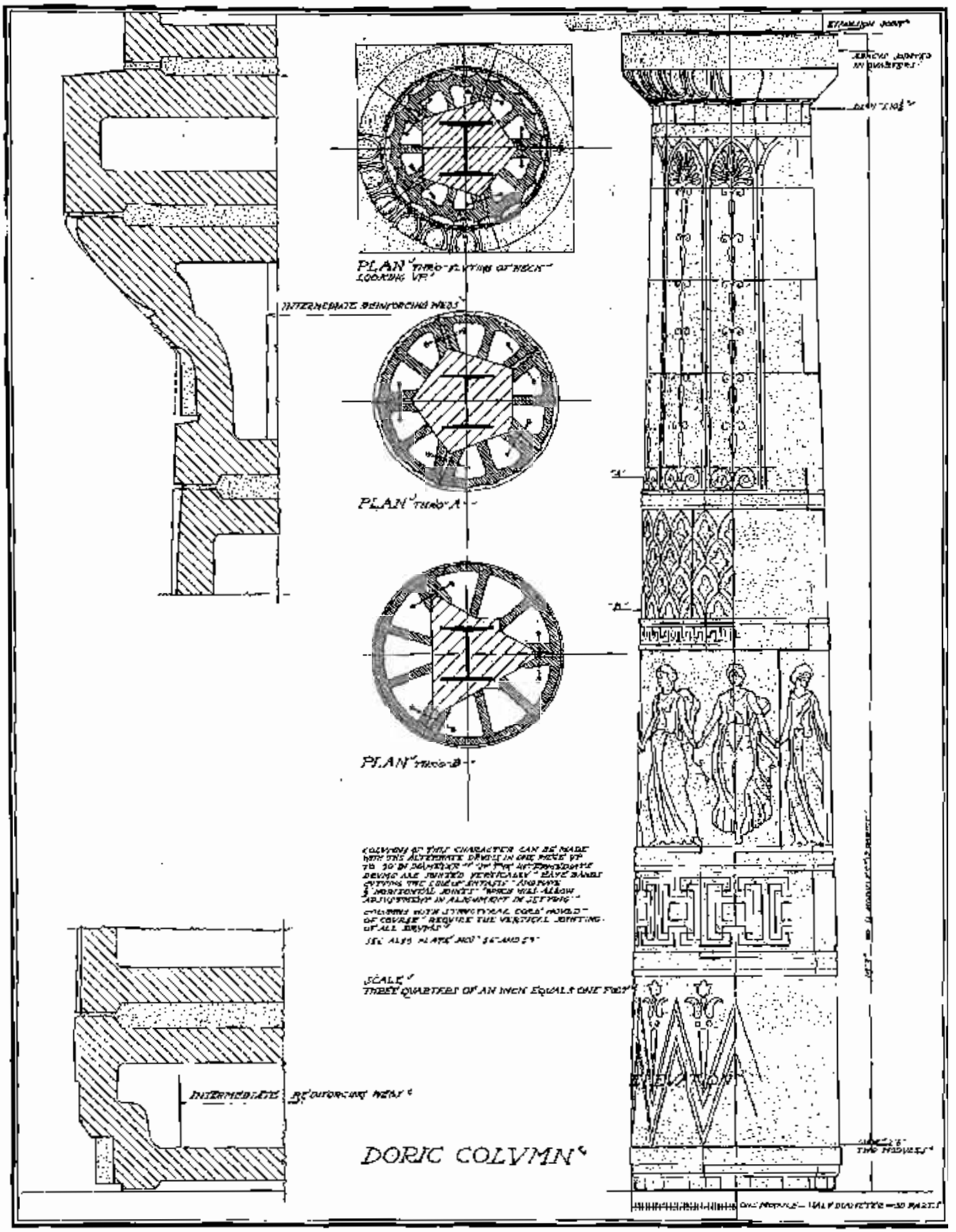
NATIONAL TERRA COTTA SOCIETY · U.S.A. · PLATE NO. 51

TERRA COTTA · STANDARD CONSTRUCTION



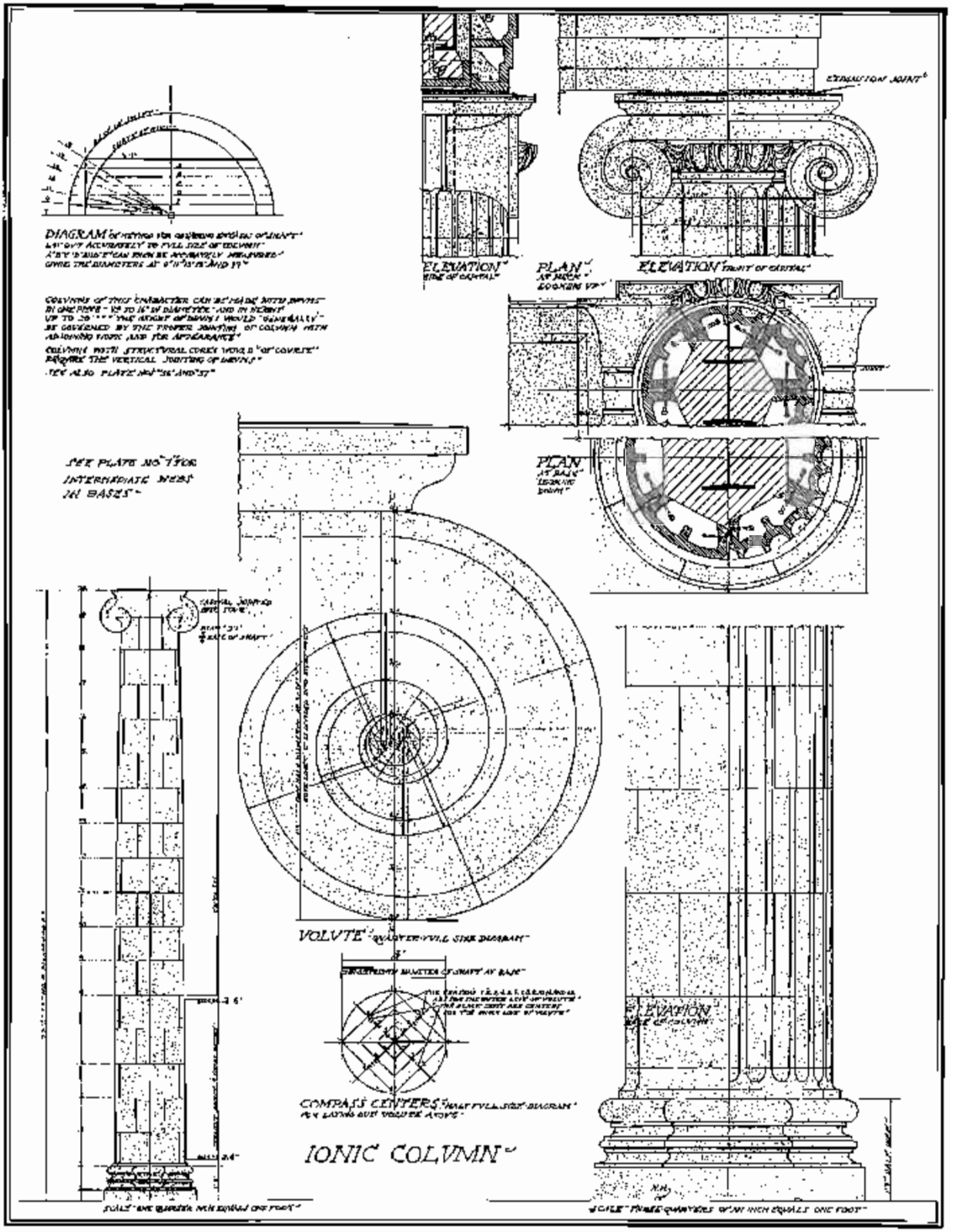
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·52

TERRA COTTA · STANDARD CONSTRUCTION



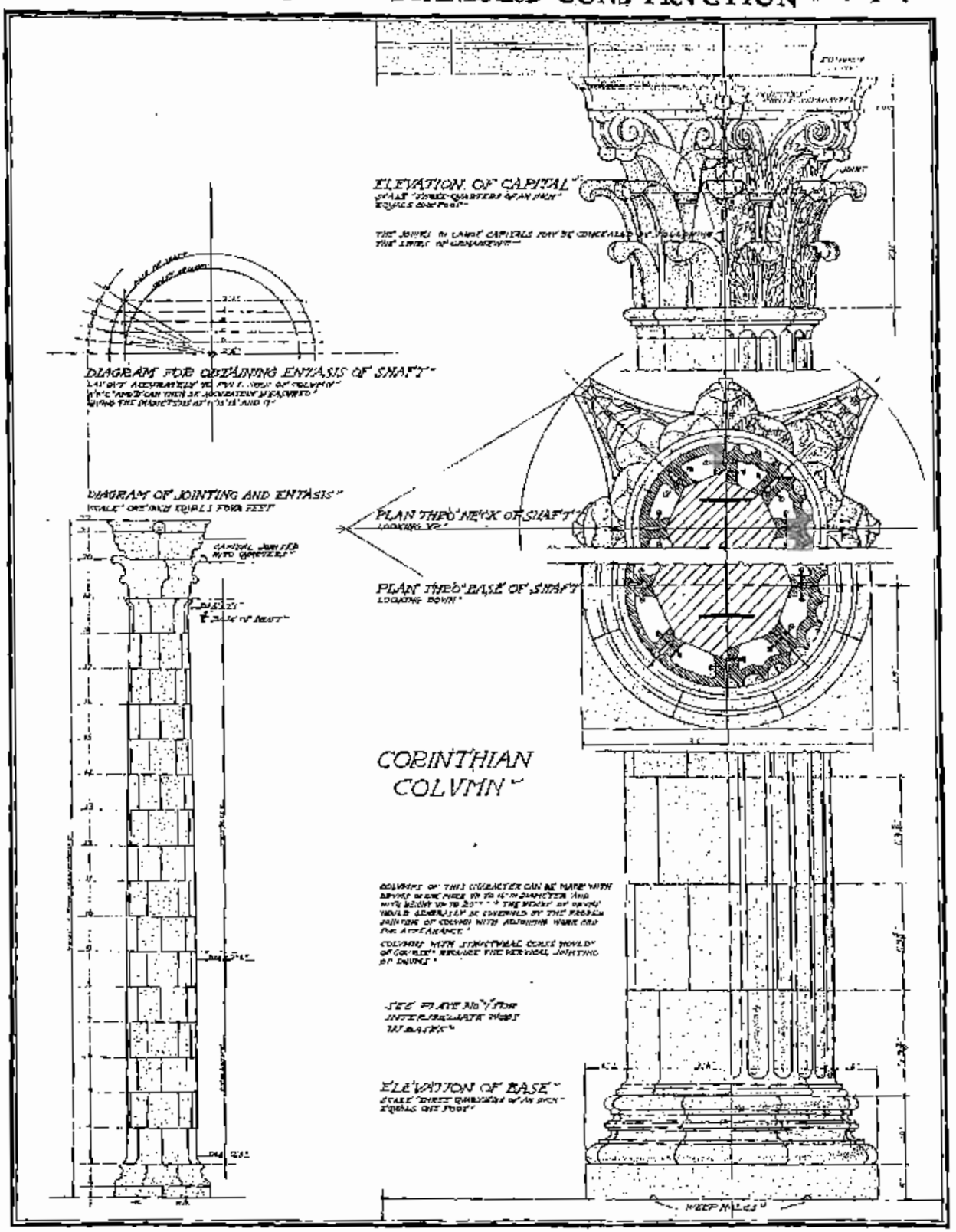
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·53

TERRA COTTA · · STANDARD CONSTRUCTION



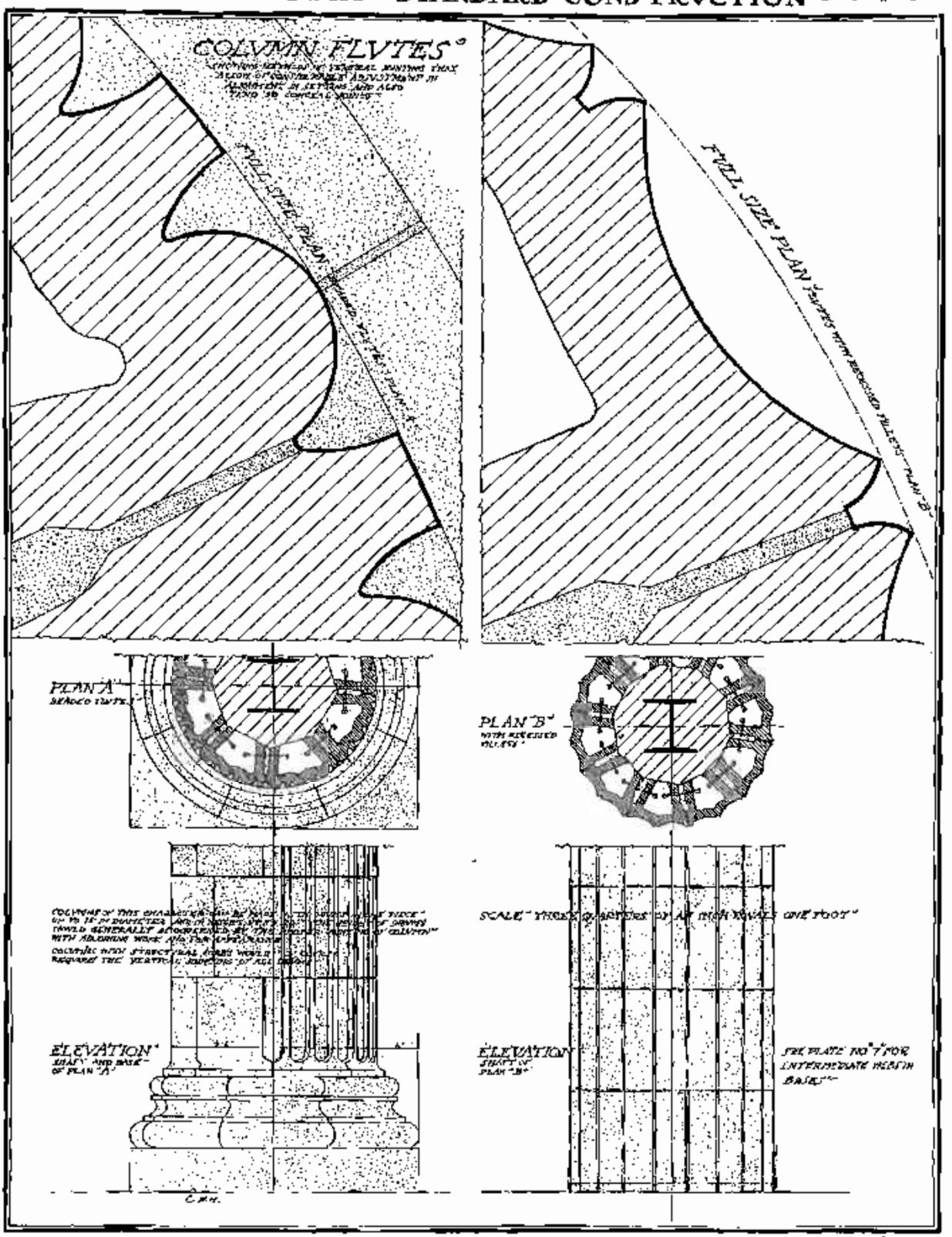
NATIONAL TERRA COTTA SOCIETY · U · S · A · · PLATE NO · 54

TERRA COTTA · STANDARD CONSTRUCTION



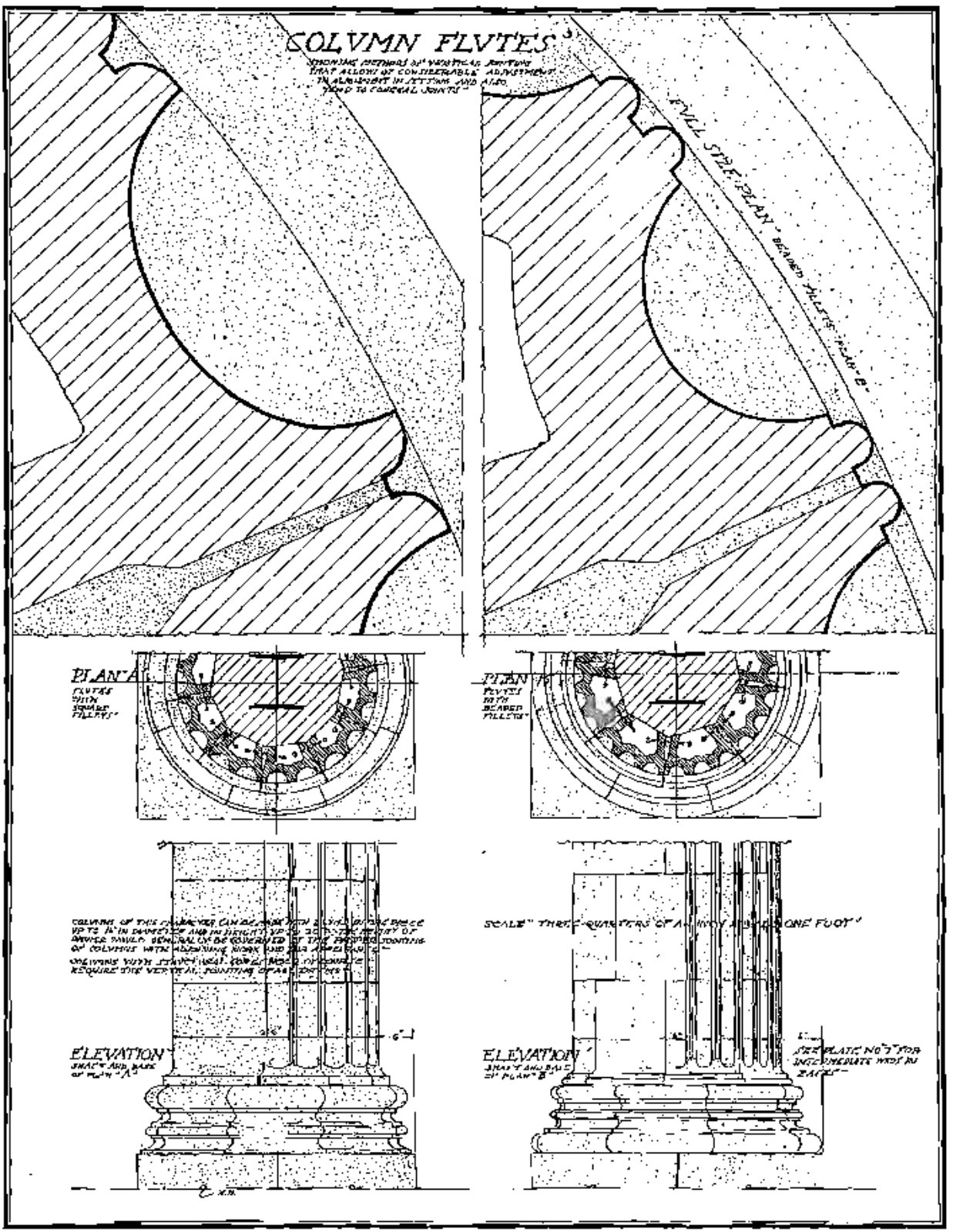
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·55

TERRA COTTA · STANDARD CONSTRUCTION



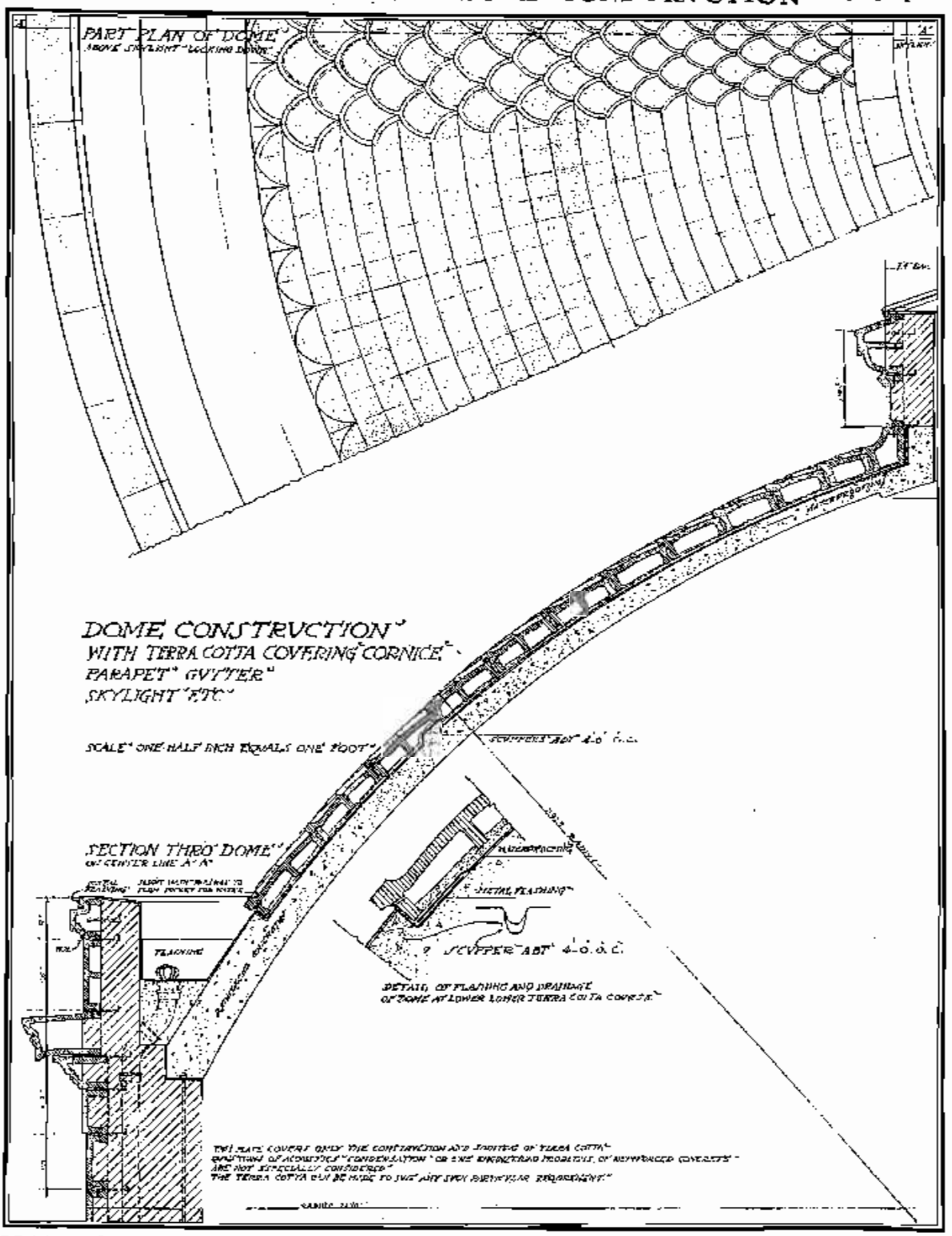
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·56

TERRA COTTA · STANDARD CONSTRUCTION



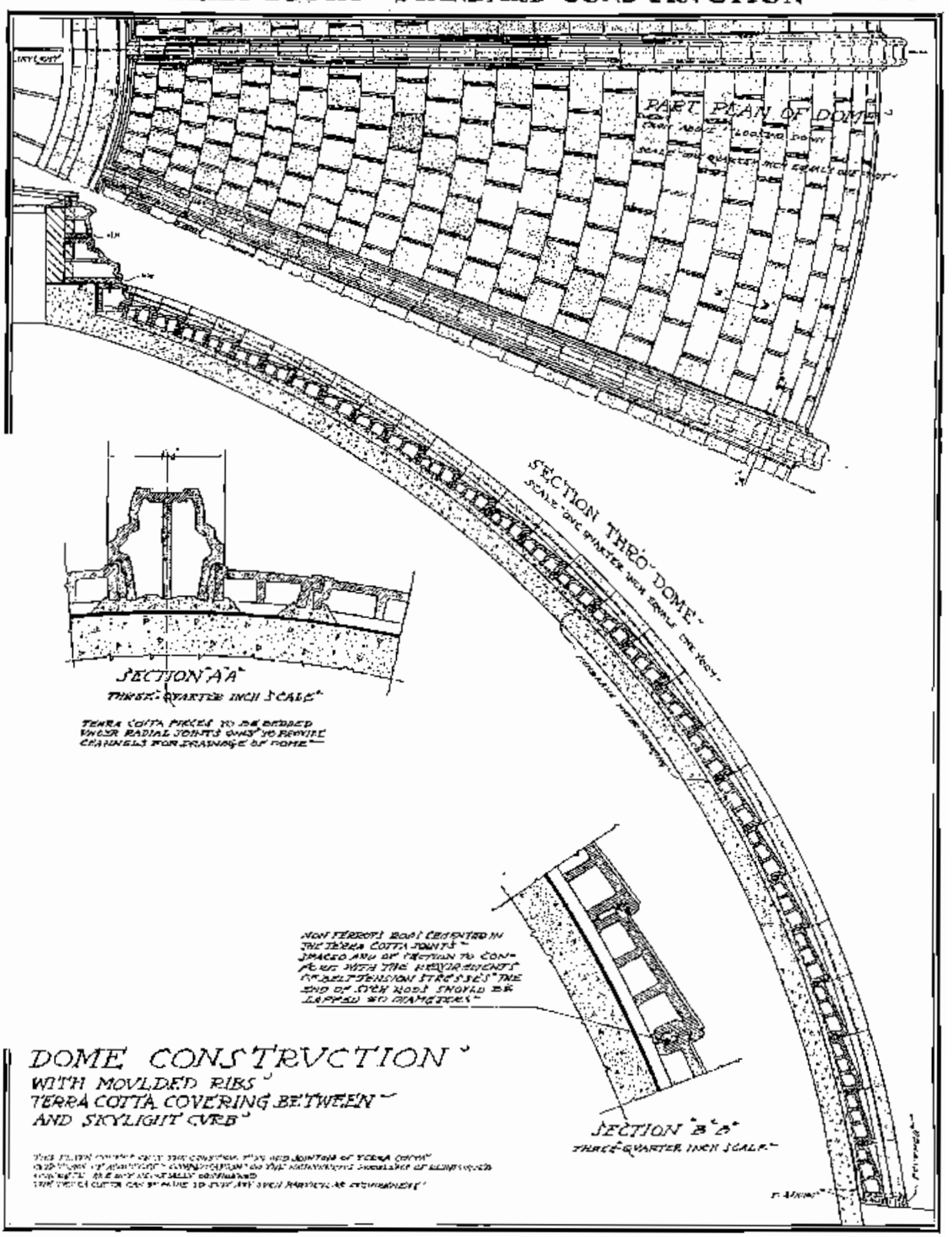
NATIONAL TERRA COTTA SOCIETY · V · S · A · · PLATE NO · 57

TERRA COTTA STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY U.S.A. PLATE NO 58

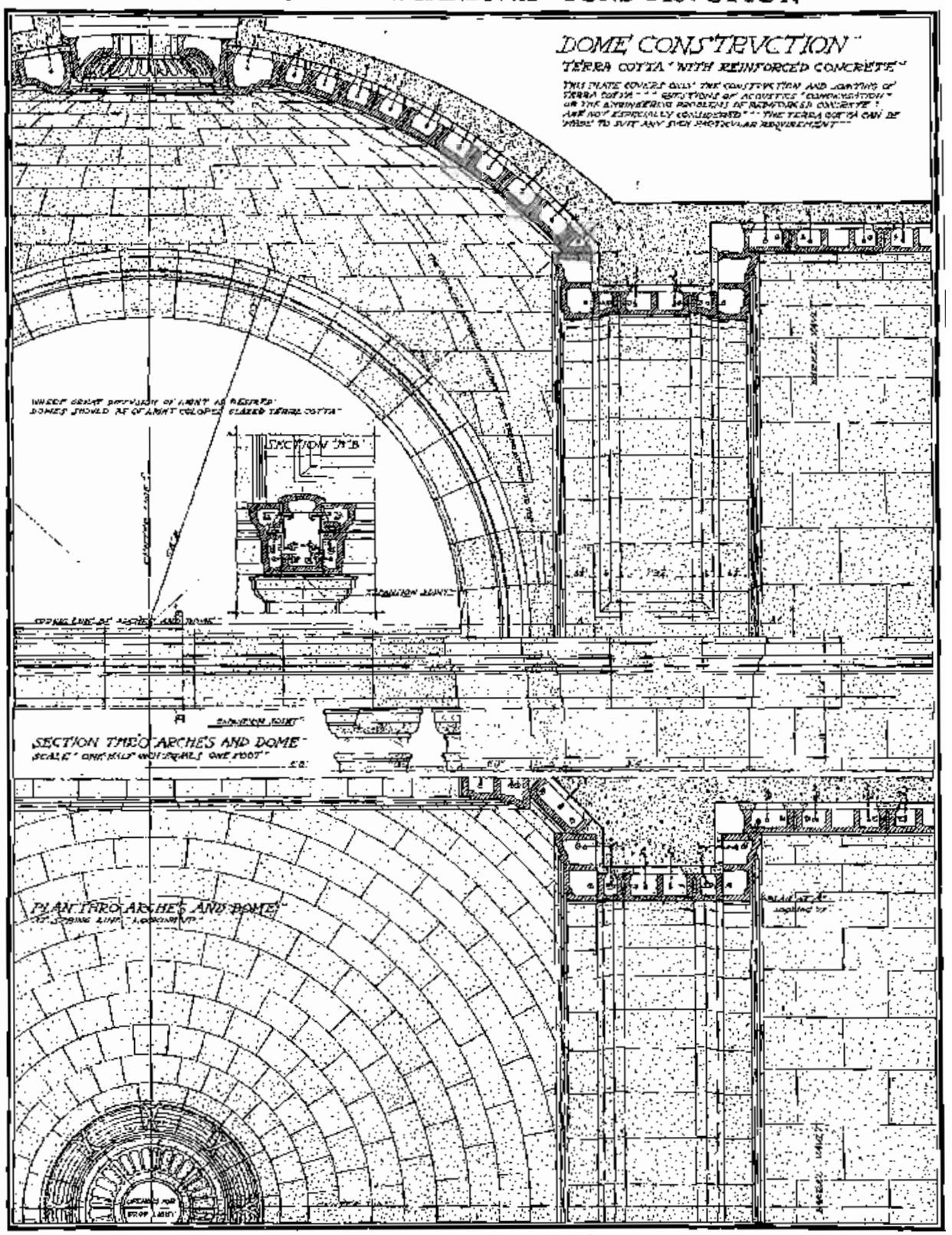
TERRA COTTA · STANDARD CONSTRUCTION



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

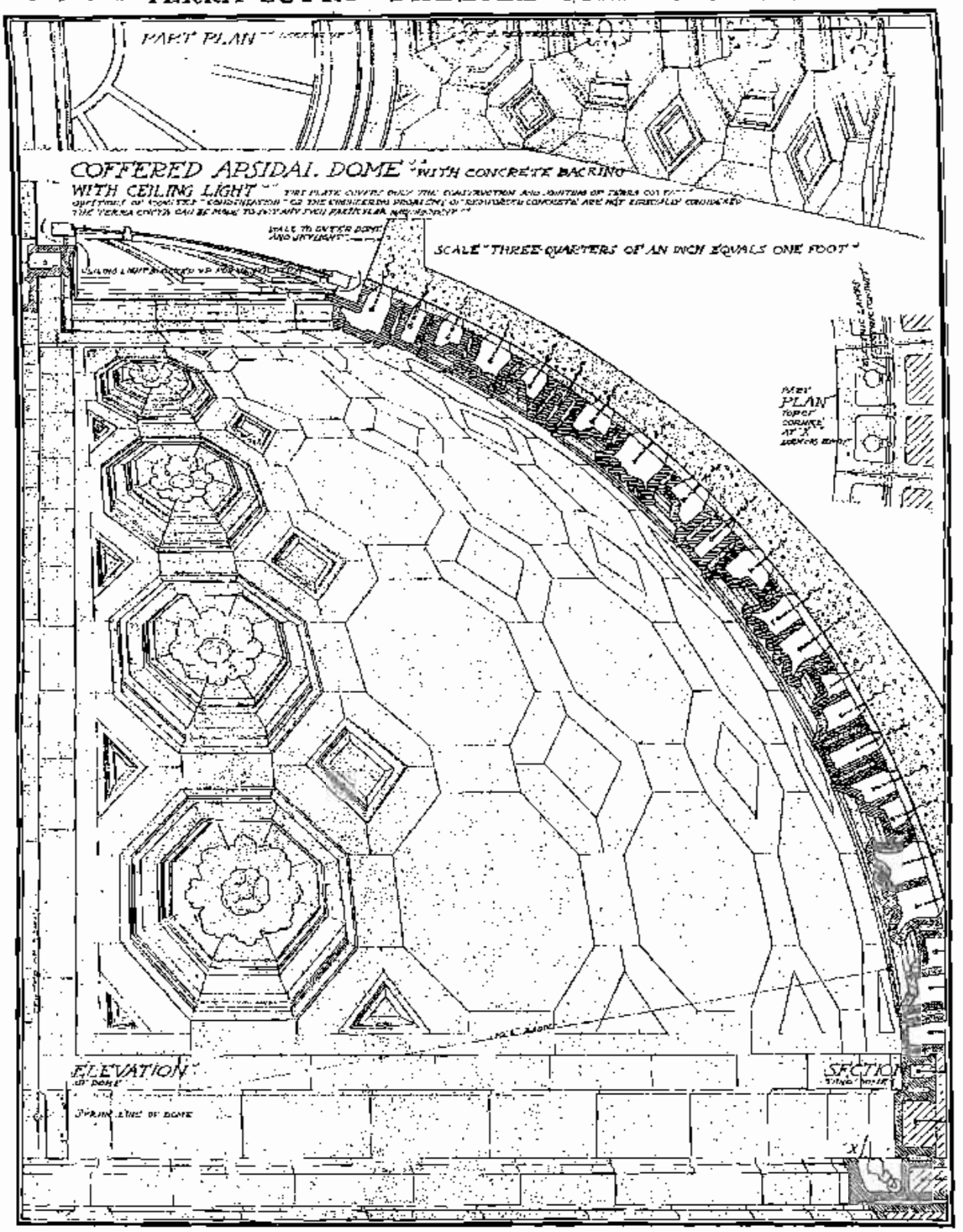
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·59

TERRA COTTA · STANDARD CONSTRUCTION



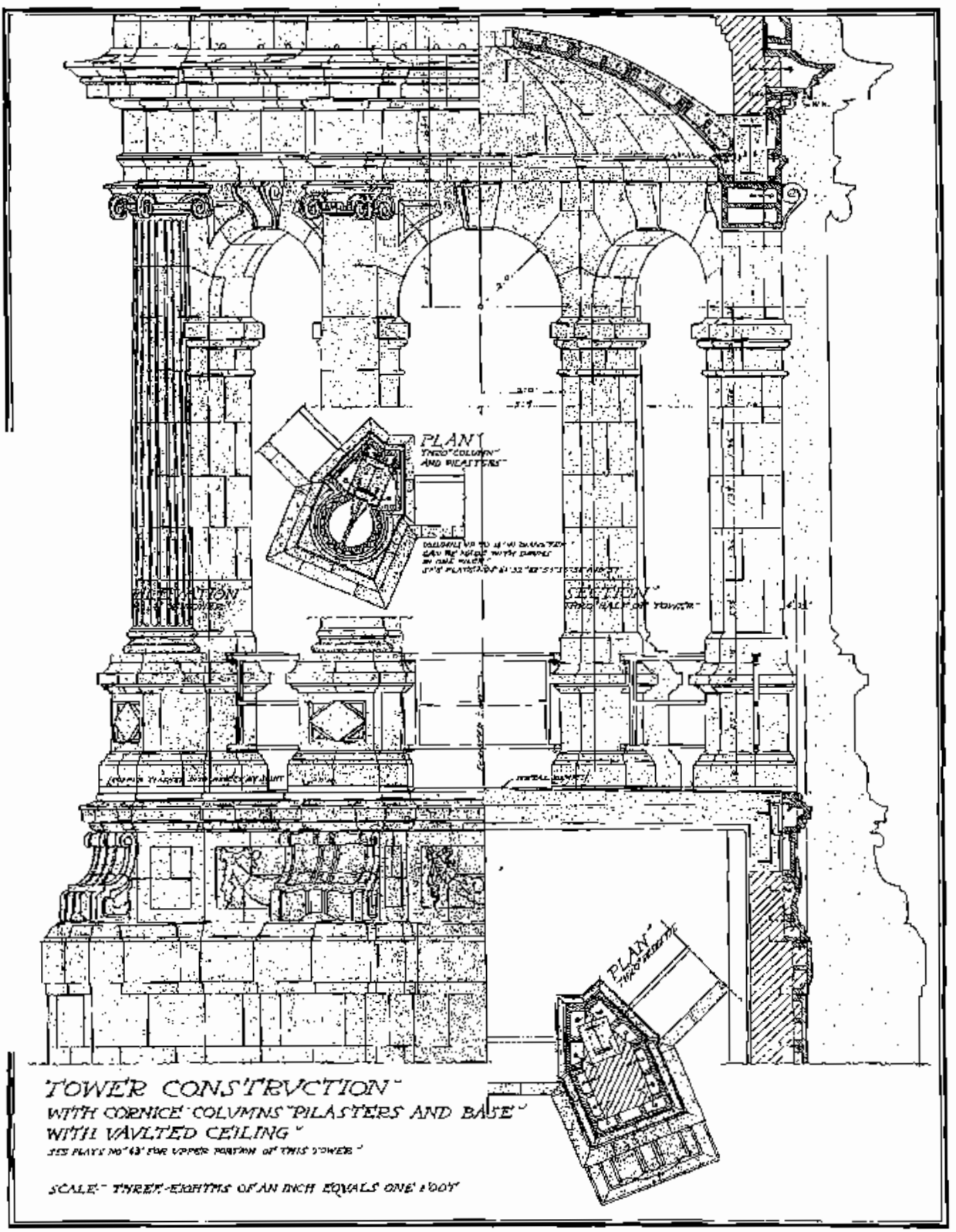
NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·60

TERRA COTTA · · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U · S · A · · · PLATE NO · 61

TERRA COTTA · STANDARD CONSTRUCTION

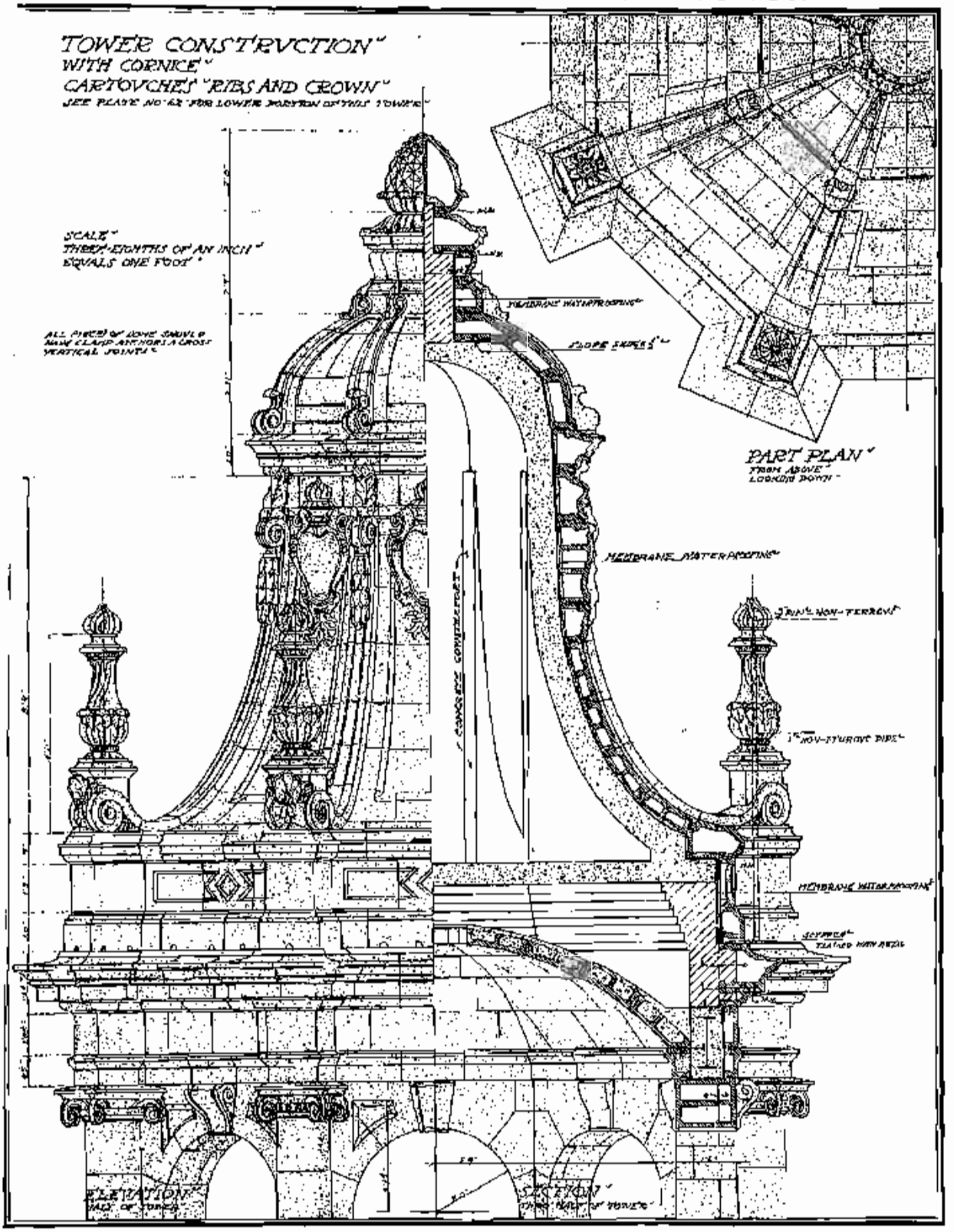


"TOWER CONSTRUCTION"
WITH CORNICE "COLUMNS "PILASTERS AND BASE"
WITH VAULTED CEILING"
SEE PLATE NO "63" FOR UPPER PORTION OF THIS TOWER"

SCALE" THREE-EIGHTHS OF AN INCH EQUALS ONE FOOT

NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO · 62

TERRA COTTA · STANDARD CONSTRUCTION



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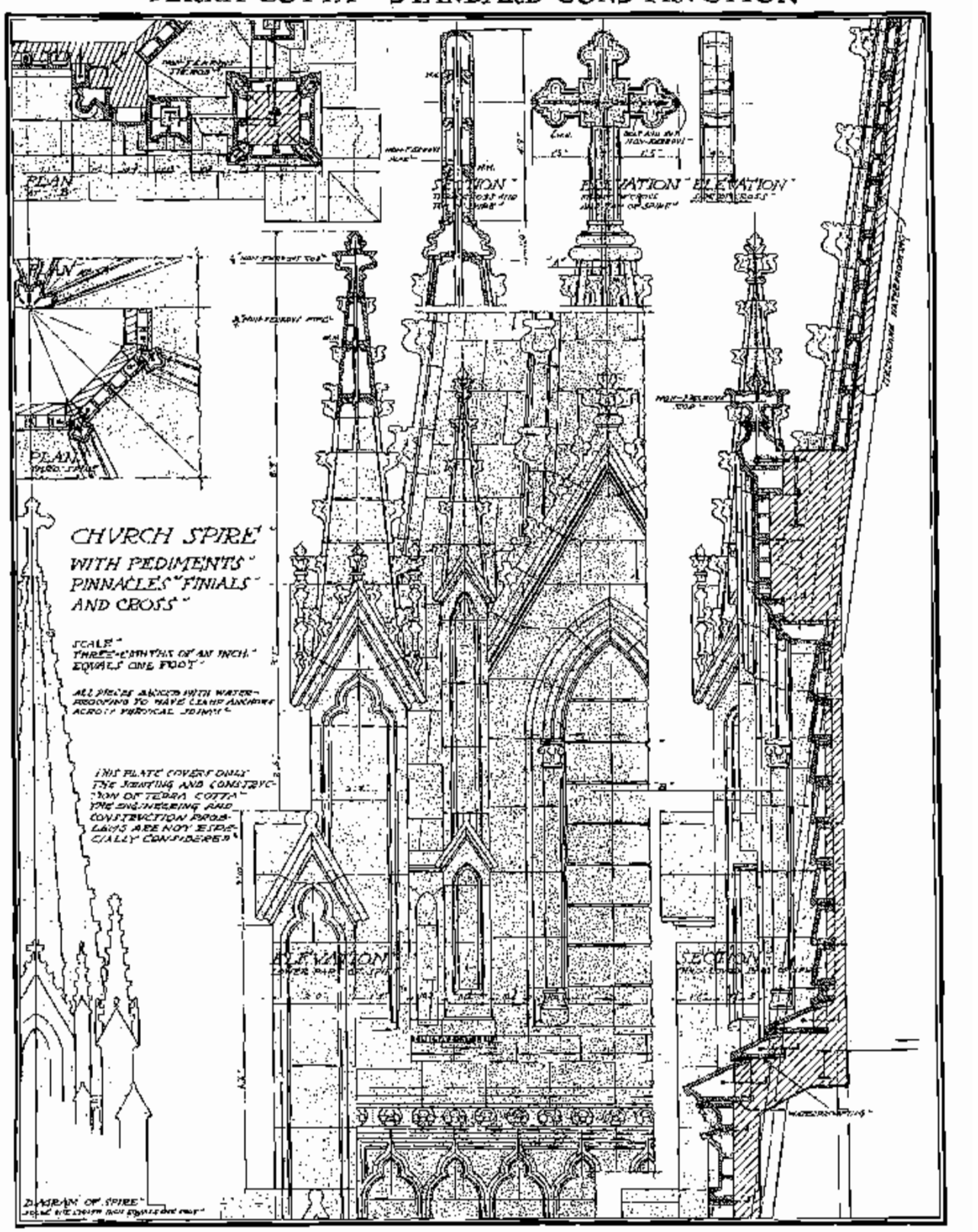
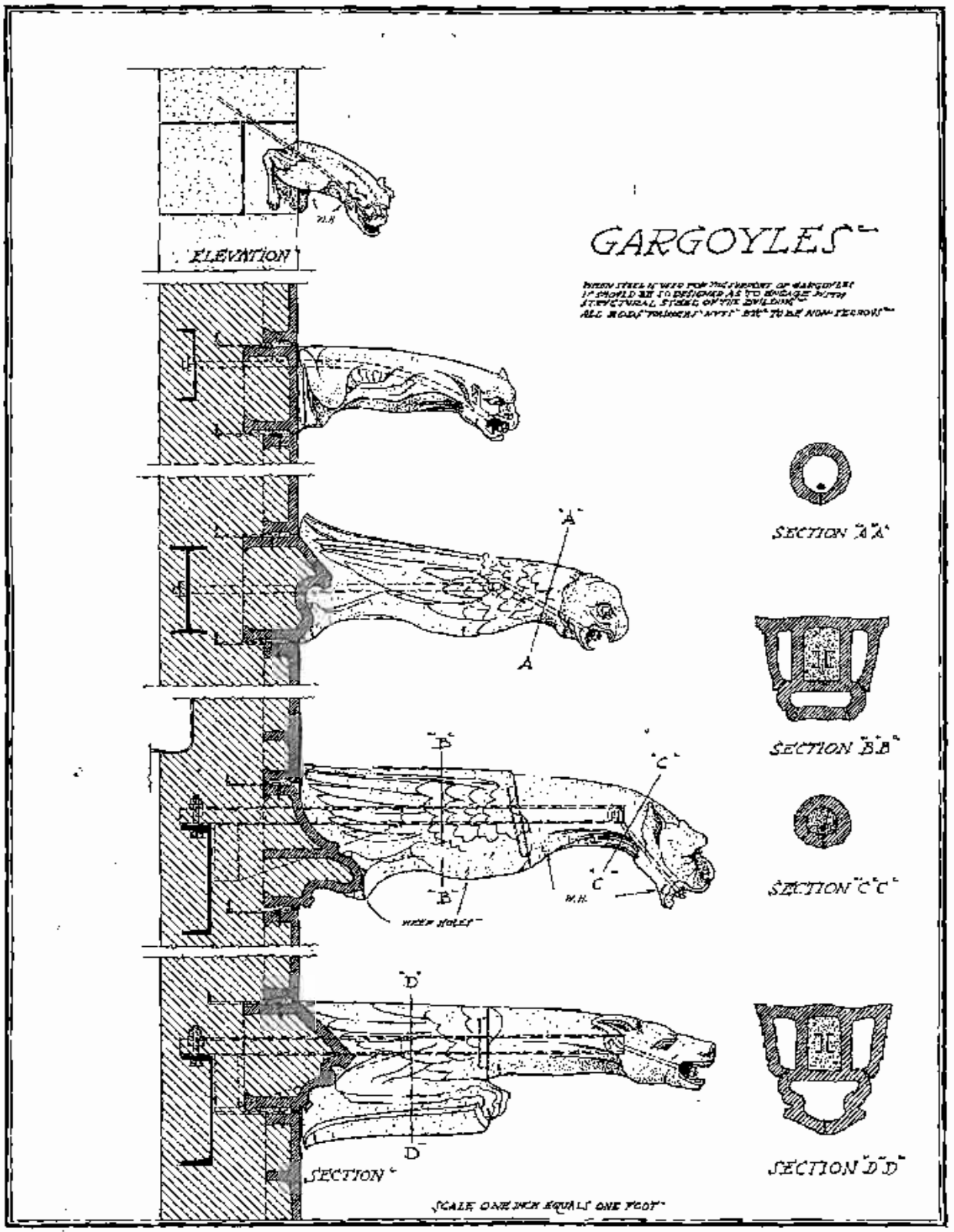
TERRA COTTA · STANDARD CONSTRVCTION



NATIONAL TERRA COTTA SOCIETY · V · S · A · · · PLATE NO · 64

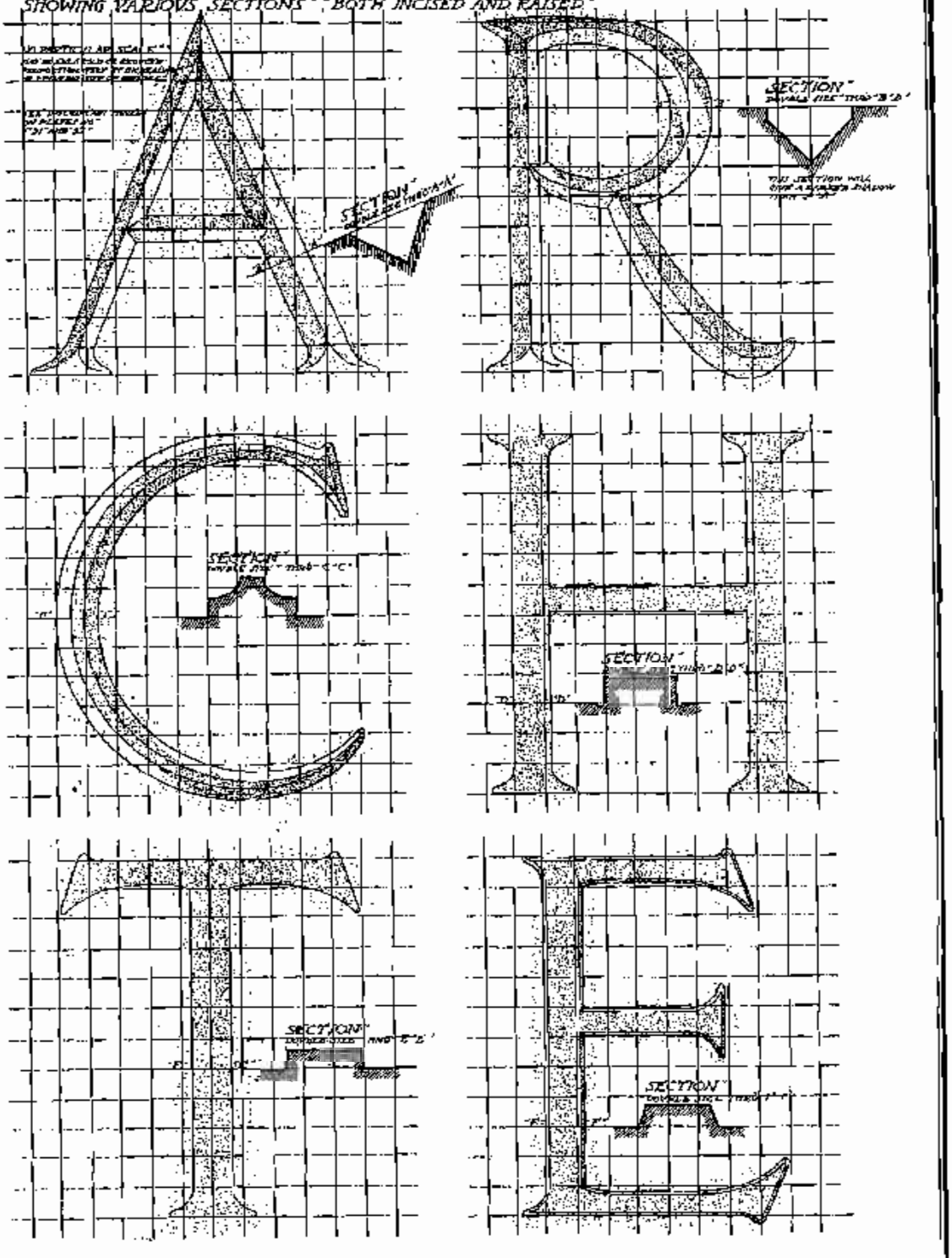
TERRA COTTA · STANDARD CONSTRVCTION



NATIONAL TERRA COTTA SOCIETY · V · S · A · · · PLATE NO · 65

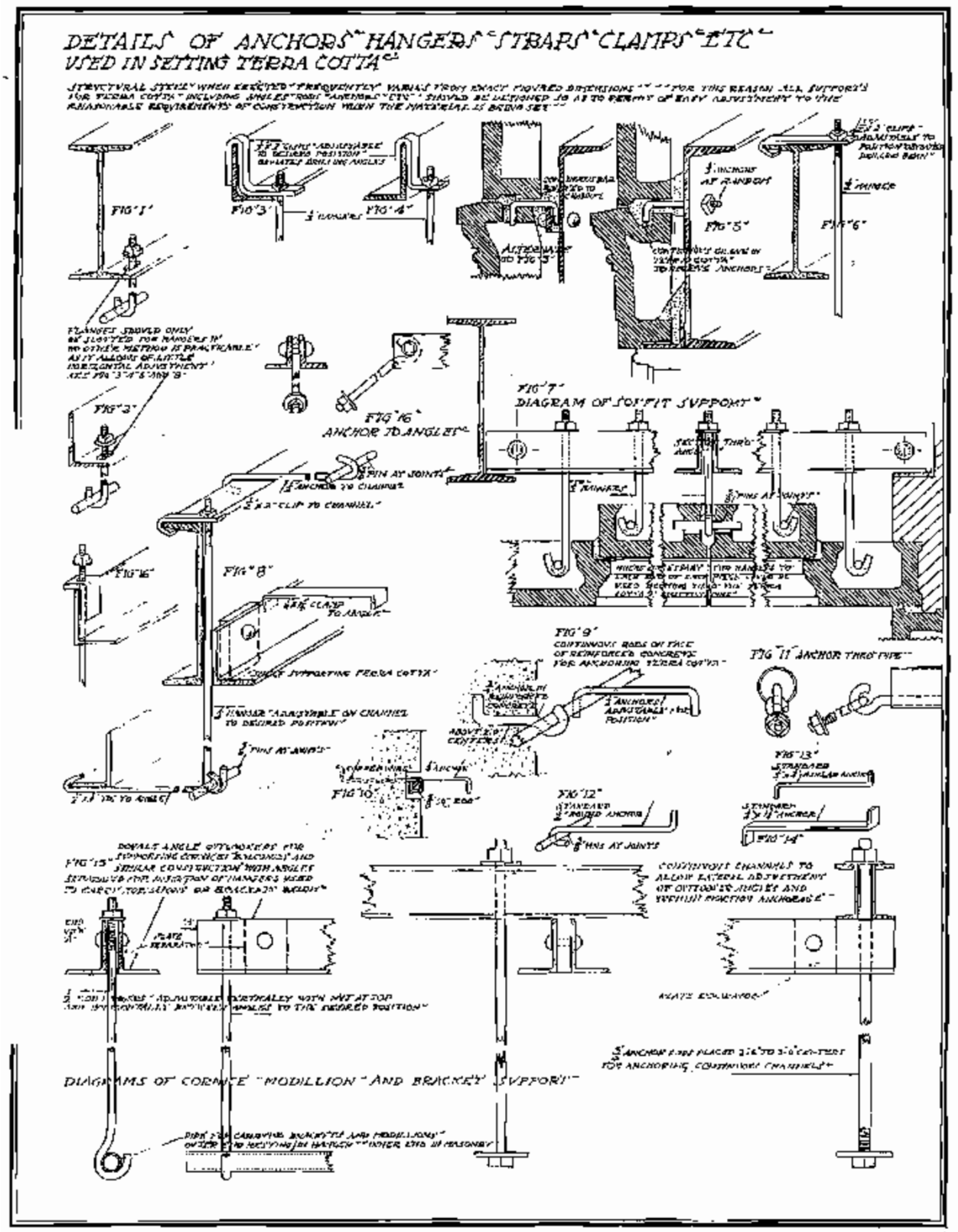
TERRA COTTA · STANDARD CONSTRUCTION

LETTERING
SHOWING VARIOUS SECTIONS "BOTH INCISED AND RAISED"



NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO·66

TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U.S.A. · PLATE NO. 67

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 68.

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.

C—DESIGN AND STRUCTURE

Ends, Walls and Partitions

12. 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 ¾" deep.

Washes, Weep Holes and Drips

13. Projecting courses, cornices and heavy ornamental detail may have washes, drips and weep holes, where shown on the approved shop drawings.

Preparation for Flashing

14. 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 ¾" deep.

16. All capping courses, copings and sills except of the "slip" type, shall have stools and lugs at intersections with vertical surfaces.

Joints

17. All joints shall be straight and true and of an approximate uniform width of ¼". 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

Shipment, Delivery and Care

18. 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.

Replacements

19. 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

Handling

20. 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.

Mechanics

21. All Terra Cotta shall be set by mechanics experienced in the handling and setting of the material.

Cutting and Fitting at the Building

22. 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.

Supporting Metal Work and Anchors

24. *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 shelf 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:

29. Anchors:—(a) For ashlar or courses balanced on the wall, shall be ¼" x ¼" or ⅛" x ⅝", or No. 6 gauge galvanized wire.

30. (b) For projecting courses not balanced on the wall, shall be not less than ⅝" round or square bars of equal cross section.

31. Hangers shall be ⅝" diameter round bars or other shapes of equal cross section area.

32. Clips and straps shall be ⅜" x 2".

33. Pins shall be ½" diameter round bars.

34. Continuous rods on concrete wall faces to which Terra Cotta ashlar is clipped, shall be ¼" diameter round bars which shall be secured to the masonry with ⅛" 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 openingshall 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 retempared 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 ½" 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 (½) 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.)

Short Form Specification

for

The Manufacture, Furnishing and Setting 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.

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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 setting) 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 setting) 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 "high-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).

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 (....describe 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 Setter

(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 ¼" 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."

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 J; 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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1927

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