DESIGNER

HANDBOOK

STAINLESS STEEL FOR:

- WALL TIES
- STONE ANCHORS
- MASONRY FASTENING SYSTEMS

Stainless Steel
The Value Option®

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ACKNOWLEDGEMENT

The Specialty Steel Industry of North America (SSINA) wishes to acknowledge that this booklet was originally prepared by the American Iron and Steel Institute, Committee of Stainless Steel Producers. Many of the current SSINA stainless steel producers were represented on this committee.

In updating this handbook, the SSINA wishes to acknowledge the assistance provided by Hohmann & Barnard, Inc. of Hauppauge, New York.

INTRODUCTION

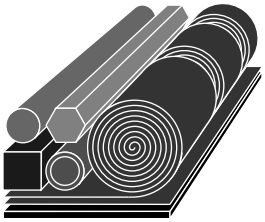
Masonry anchors have been used in building construction at least since the days of Greece and Rome when the widespread use of stone and marble gave a new significance to classical architecture. Today, with the modern trend towards high rise buildings, and the increasing use of stone and masonry, stone anchors have again assumed vital importance, and great care is exercised in their design and material selection. Because of the substantial factors of safety required, some authorities refuse to sanction the use of traditional steel anchors and in their place now specify only corrosion resistant anchors made of stainless steel.

The use of stainless steel anchors has grown steadily in recent years due to its excellent atmospheric corrosion resistance. An important consequence of this corrosion resistance is freedom from staining, thus avoiding the disfigurement of buildings which has been all too prevalent in the past. Other reasons for using stainless steels are:

- No paint or protective coatings to fail or maintain.
- Not affected by acids or alkalies used in concrete.
- Good fabrication characteristics.
- Not affected by high or low temperatures or other weather conditions.
- Available in a wide range of sizes, shapes, strengths, and types to meet almost any architectural or stone fastening need.
- Backed by many years of in-service experience in construction and architecture.
- Economically competitive with other corrosion resistant anchoring or fastening materials.

The information in this publication is intended for architects, designers, specifiers, stone contractors, and anchor manufacturers. Other publications on architectural and construction-related subjects are available from the Specialty Steel Industry of North America:

- Design Guidelines for the Selection and Use of Stainless Steel.
- Stainless Steel Fastening Systems.
- Standard Practices for Stainless Steel - Roofing - Flashing - Copings.



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WHAT IS STAINLESS STEEL?

The generally accepted terminology “stainless steel” applies to iron-base alloys that contain at least 10.5% chromium. Many people are familiar with chromium as a corrosion-resistant coating on the surface of chrome-plated automobile bumpers. In stainless steels, however, the chromium is added during the melting of the steel and forms a homogeneous mixture with the iron and other alloying elements, such as nickel, molybdenum, or titanium, which may be present to enhance fabricating and corrosion-resistant properties.

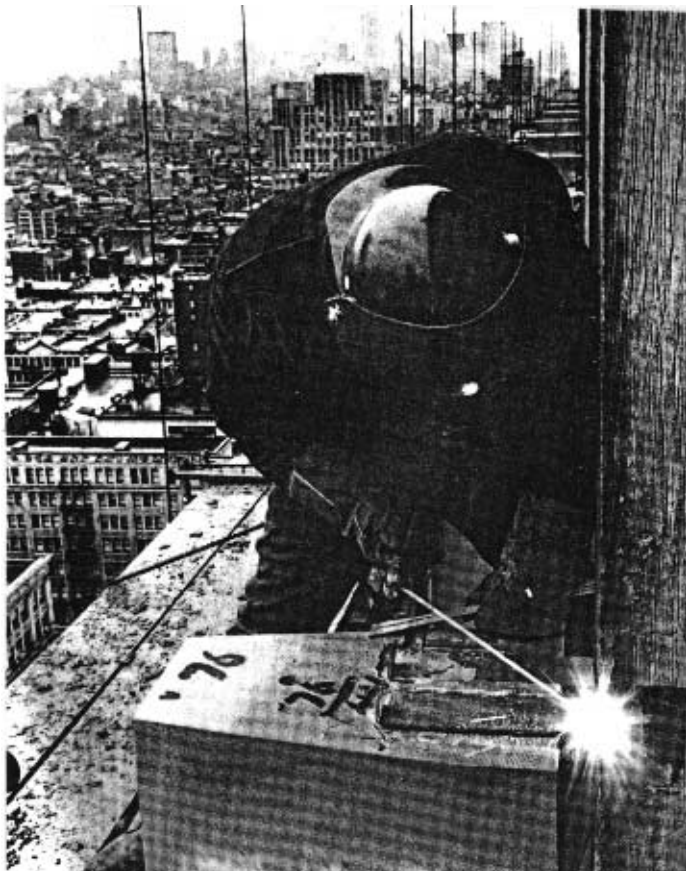
Currently there are over 50 stainless steel types originally designated by American Iron and Steel Institute (AISI) as standard compositions. These are usually identified by 200, 300, or 400 Series numbers, such as Types 301, 304, 316, and 410 — which are the types most frequently used in architecture and construction.

The Unified Numbering System (UNS) is another way in which stainless steels are identified. This is a five-digit number preceded by a letter, which in the case of stainless steels is the letter S. Type 304 is Type S30400 in UNS.

The terms austenitic, martensitic, ferritic, and precipitation hardening serve to identify categories of stainless steels on the basis of their metallurgical structure. The stainless steels classified under each heading tend to have similar characteristics with respect to corrosion resistance, hardenability, and fabricability.

Austenitic stainless steels (AISI 200 and 300 Series) are characterized as being nonmagnetic and having excellent corrosion resistance and good fabricating qualities. They cannot be hardened by heat treatment but can be hardened very effectively by cold working. The general-purpose alloy of this group is Type 304 containing approximately 18% chromium and 8% nickel, and it is frequently referred to as 18-8 stainless steel.

Martensitic stainless steels (AISI 400 Series) can be hardened by heat treatment and only slightly hardenable by cold work. They are strongly magnetic, resist corrosion in mild atmospheres, and have fairly good fabricating qualities. Type 410 is the general-purpose alloy of this group, containing about 12% chromium.



Two intermediate anchors are a split-tail design made from 1/4" thick stainless steel plate, 3" wide. Small-diameter stainless steel wire anchors serve to hold the limestone mullion until the anchors are welded to the structural steel.

Ferritic stainless steels (AISI 400 Series) are not hardenable by heat treatment and only slightly hardenable by cold working. They are magnetic, have good resistance to corrosion, and fairly good fabricating qualities. Representative is Type 430 with about 17% chromium.

Precipitation hardening applies to the category of stainless steels that are hardenable by a combination of cold working and a low-temperature heat treatment (900-1150°F or 482-621°C). They have good corrosion resistance and fabricating qualities.

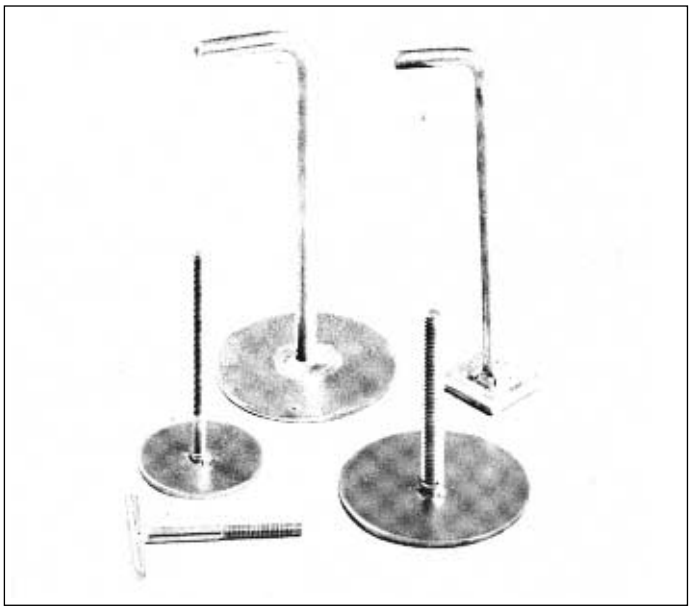
Duplex stainless steels have excellent pitting resistance and exhibit about twice the yield strength of austenitic grades.

THE ARCHITECTURAL STAINLESS STEELS

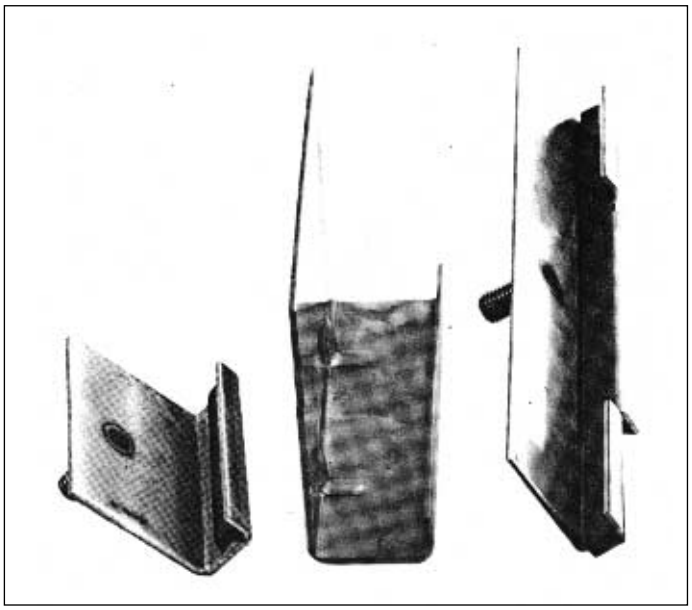
Type 304, the most widely used stainless steel, is preferred by architects because of its excellent corrosion resistance in rural, urban, and most industrial atmospheres. Type 304 is widely used for masonry and stone anchors.

Type 316 contains molybdenum in addition to chromium and nickel, so it has greater resistance to corrosion in all architectural atmospheres, including marine.

Type 301 stainless steel is a modification of Type 304, having slightly less chromium and nickel. This reduction is not enough to influence its corrosion resistance but does increase its work-hardenability. Type 301 can be cold rolled to very high tensile strengths, over 150,000 psi (1470MPa), and still retain considerable workability.



Coping and soffit anchors of stainless steel are designed to properly connect stones to steel frame. Threaded anchors permit close alignment. Threaded or bent rods are spot welded or arc welded to plates or Tee sections.



Stone anchor system of stainless steel for supporting thin stone veneer on building exteriors provides both strength and versatility. Threaded fasteners attach to prefabricated light-gauge struts, to permit wide range of vertical or horizontal adjustment.

Type 410 is a general-purpose martensitic stainless steel that is frequently used for fasteners. Its resistance to corrosion is not as good as Type 304, but it is satisfactory for many architectural applications. A thin rust film will form on the surface of Type 410, however, in marine atmospheres.

Most stone and masonry anchors used in the United States and Canada today are made of Type 304 stainless steels.

CONTACT WITH OTHER BUILDING MATERIALS

Concrete. Stainless steel can be used in contact with concrete without any reaction occurring between the two materials.

Since carbon steel rusts freely when embedded in a porous concrete cover, concrete cracking due to the pressure from corrosion products is likely and staining is inevitable. This threat has resulted in numerous applications of stainless steel masonry anchors, and the use of stainless is likely to increase with the growing use of precast concrete. Furthermore, the use of stainless steel threaded anchors or fasteners is advantageous since the fasteners can be readily undone if a component is damaged and needs to be replaced.

Mortar. Stainless steel is not attacked by mortars used in the building industry. Galvanized anchors are less reliable, because lime in mortars combined with water can dissolve the galvanized coating, allowing the iron to rust.

Natural Stonework and Brickwork. Stainless steel has no effect on these materials, and they in turn do not cause any attack on the stainless steel. In these circumstances, the non-staining benefit of stainless steel is particularly advantageous. For instance, the Indiana Limestone Handbook[1] contains a caution about the staining possibility of copper, bronze, and aluminum. These materials produce a metal oxide solution that when washed over the stone will stain the surface. While some of these stains can be removed, the suggested treatment requires the use of poisonous solutions, such as potassium cyanide. In addition, the need for periodic cleaning results in added expense.

Plastics. Stainless steels are compatible with plastic materials, and there is satisfactory service experience with stainless steels being embedded in epoxy and polyester resins. Stainless fasteners are frequently used with plastic and fiber glass panels.

Copper and copper alloys. Austenitic stainless steels and copper are compatible in all conditions of service, and stainless steel bolts have, in fact, been used successfully with architectural bronze cast-in place sockets for several years.

Aluminum. Although aluminum is a less noble metal than austenitic stainless steels in the electrochemical series and in theory would corrode if the two metals were brought into contact in the presence of an electrolyte, in practice it has been established that stainless steel can be used in conjunction with aluminum building components without attack taking place on the aluminum.

Carbon steels. The considerations are similar to those given for aluminum. The electrochemical potential is less between these two steels but some form of insulation may be necessary in severe environments. **Carbon steel fasteners should never be used to join stainless steel components.**

Zinc and galvanized steel. Zinc is less noble than the austenitic stainless steels and the same recommendations apply as those given for aluminum.

Stainless steel. Stainless steel fasteners are a natural choice with stainless steel building components. Where possible, a fastener of similar or superior corrosion resistance to the component should be used; e.g., a Type 304 screw with a door frame made from the same material.

TABLE 2

MECHANICAL PROPERTIES OF STAINLESS STEEL TYPES 302, 304, and 316 (ASTM A 666)			
Grade	Tensile Strength ksi (MPa) Min.	Yield Strength ksi (MPa) Min.*	Elongation % in 2" (50.8mm) Min.
Types 304 & 316 Plate, Sheet & Strip			
A	75(515)	30(205)	40
B	80(550)	45(310)	35
C	125(860)	75(515)	12
D	150(1035)	110(760)	7
Types 304 & 316 Bar			
A	75(515)	30(205)	40
B	90(620)	45(310)	40
C	115(710)	75(515)	15
D	125(860)	100(690)	7
Types 304 & 316 Wire (ASTM A 580)			
Annealed	75(515)	30(215)	35
Annealed & Cold Finished	90(620)	45(310)	35
Cold Worked	125(860)	100(690)	12

A = Annealed
B = Annealed & Cold Finished
C = 1/4-hard
D = 1/2-hard
*At 0.2% Offset

THE ADVANTAGES OF STAINLESS STEEL ANCHORS

These can be summarized briefly as

1. Economy
2. Corrosion Resistance
3. Strength

Stainless steel anchors cost less in the long run. When one considers the substantial cost of replacing anchors due to failure or of replacing stones because of staining, stainless steel is the most economical material over the full building lifetime. It is also reassuring for the owner to know that his building will not be plagued with falling stones.

The SSINA has a life cycle costing computer program available to use in comparing different types of materials over the full life cycle.

Nonstaining qualities of stainless steels are also reassuring to both architect and building owner. While stains can sometimes be removed from stone facings, the time and expense involved are far greater than the original cost of the anchors. And once staining begins, there is no reason to believe that it will stop with time.

Strength is an important benefit of stainless steels. In the annealed condition, yield and tensile strengths of stainless steels exceed those of other architectural metals. Also, in practice the austenitic (300 Series) stainless steels gain in strength when cold worked. Considerably higher strengths can therefore be obtained in anchors and fasteners, allowing some manufacturers to improve structural efficiency over other anchor or fastener materials, thus resulting in further economies.

ASTM A 666 provides minimum strength values for six types of austenitic stainless steels in four grades, A, B, C, and D. Grades A and B cover the annealed condition of different types, whereas Grades C and D cover stainless steels in the 1/4- and 1/2-hard tempers (Table 2).

In brief:

Grade A—30,000 psi (205MPa) minimum yield
Grade B—40,000 psi (275MPa) minimum yield
Grade C—75,000 psi (515MPa) minimum yield
Grade D—100,000 psi (690MPa) minimum yield

Stainless steels also have a modulus of elasticity nearly twice that of nonferrous metals used for anchors, which reduces elastic deflection.

STAINLESS STEEL FASTENERS

A full selection of stainless steel screws, bolts, studs, clips, and other fastening hardware is available for architectural and construction use.

The SSINA has a handbook available, "Stainless Steel Fasteners, A Systematic Approach to their Selection."

Special-purpose fasteners—such as welded studs, have been devised to suit the individual equipment and techniques of some fabricators. For this reason the architect or specifier usually allows fabricators to use alternative fasteners, subject to approval when shop drawings are submitted. The following guidelines will be useful for the designer and specifications writer:

1. When fasteners are to be exposed to outdoor atmosphere or damp conditions, Type 304 is usually specified. For highly corrosive atmospheres, consider using Type 316.
2. For indoor applications not subject to corrosive exposure, stainless steel fasteners in the 400 Series are frequently used, such as Type 410, and they are more economical than the 300 Series types. However, since 300 Series fasteners are more widely available in a greater variety of types and offer superior resistance to corrosion, they are becoming increasingly preferred for all architectural use—inside and out.
3. Lock washers, lock nuts, or some other locking device should be considered to prevent loosening of bolted connections due to vibration or thermal movement.
4. When using stainless fasteners at expansion joints, consider the use of nylon or Teflon* washers to assure free movement and prevent the possibility of buckling due to restriction of thermal expansion and contraction.

Stainless steel producers offer standard and proprietary modifications of the basic architectural alloys (Type 304) to improve their working properties for the manufacture of fasteners. Type 305, for instance, has a low work-hardening rate that makes it particularly suitable for cold heading and roll threading operations. Type 303, on the other hand, is a free-machining grade that is sometimes used for large fasteners produced by machining.

The SSINA has a handbook available; "Stainless Steel For Machining."

*Registered trademark, E. I. duPont de Nemours & Co., Inc.

STAINLESS STEEL ANCHORS

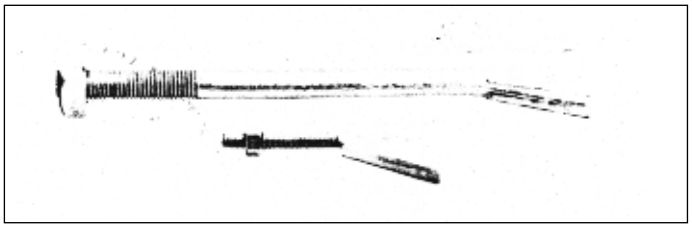
Metal anchors are used to connect masonry to a backing wall or frame. Masonry anchors provide connections which can resist compressive, tensile, and shear stresses.

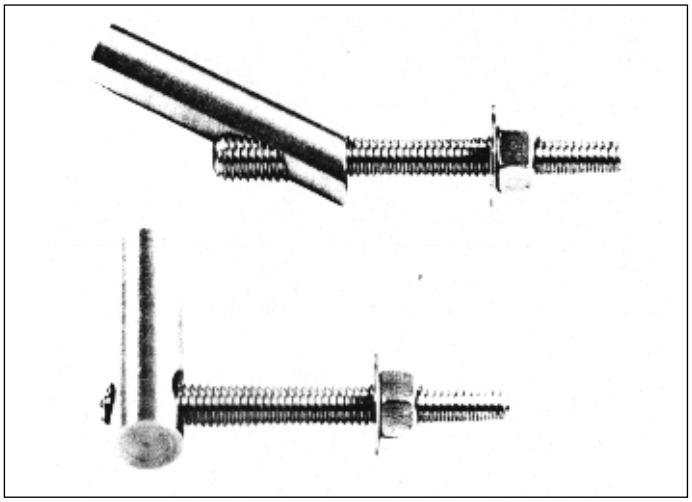
In stone masonry, many metals can cause staining, so austenitic chromium-nickel (18-8) stainless steel (ASTM A167, Type 304) is most commonly used.

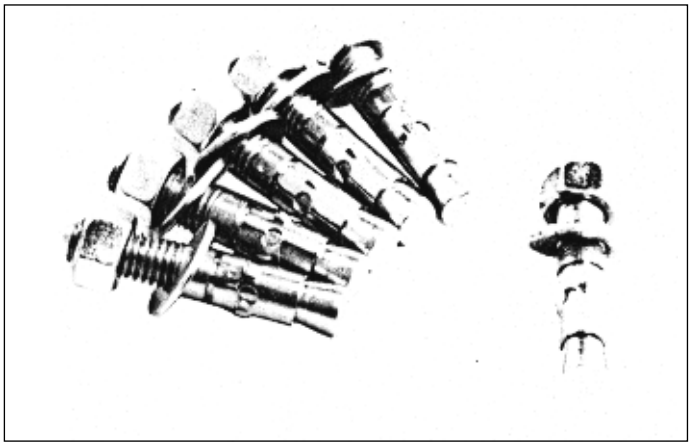
Anchor Types

Although architects can choose from hundreds of different anchors, such supports can be divided into two broad categories: anchors that are inserted into a kerf or slot cut into the edges of each stone panel, and anchors that are inserted into a hole drilled into the sides or rear of the stone panels. An anchor type should be selected only after careful analysis.

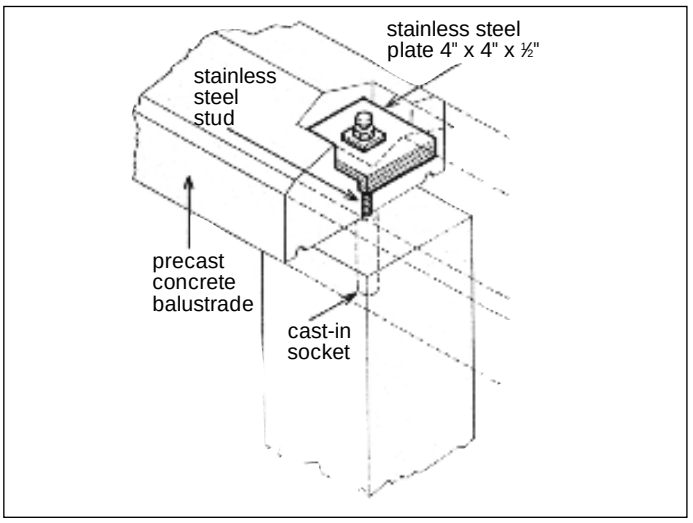
Several different anchoring systems are shown in the next few pages.



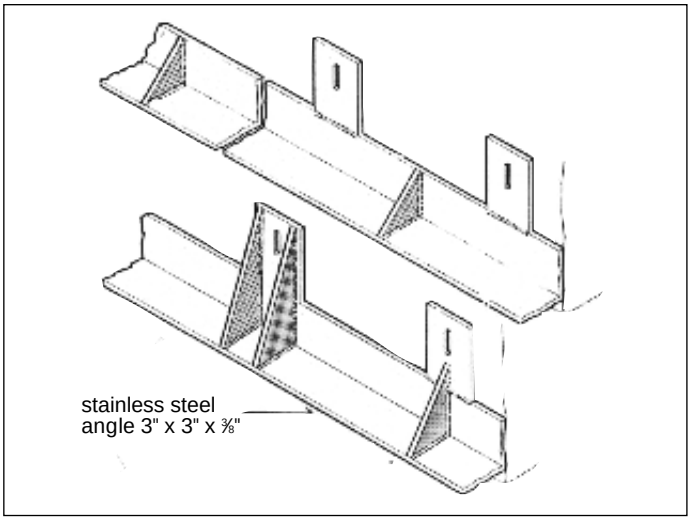




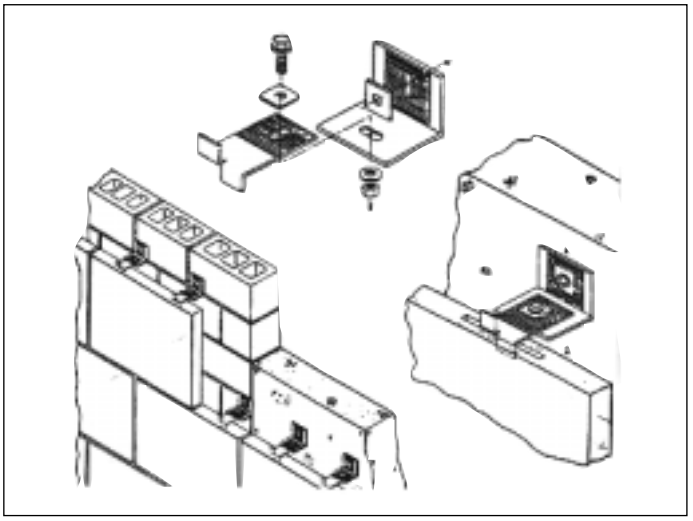
Lewis bolts (top photograph), threaded inserts for hanging stone (center), and anchor bolts (bottom) show variety of stainless steel fastening devices used in stone and concrete anchoring systems.



Stainless steel plate and stud used to attach a concrete handrail to a support post. This example illustrates the compatibility of stainless steel with other materials used in construction.



Gussetted angles fabricated by welding for use in brickwork above window openings. The nonstaining properties of stainless steels are particularly valuable in this type of application.



The interlocking, non-slip feature of using a serrated stainless steel can solve many jobsite anchoring problems.

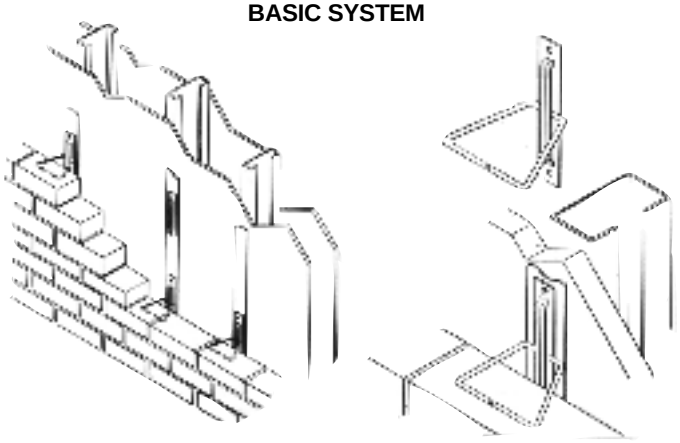
References

1. Indiana Limestone Institute of America, Indiana Limestone Handbook, January 1975.

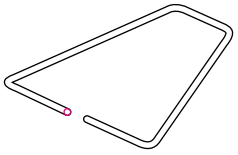
Stainless steel ties and anchors used for tying back in a brick and cavity wall.

All wire ties and dowels in contact with stone veneer should be fabricated from Type 304 stainless steel — ASTM A580. Diameter and length to be determined per anchoring condition.

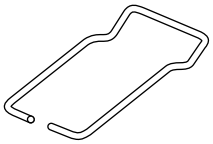
BASIC SYSTEM



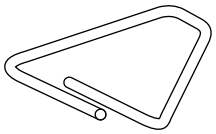
MASONRY WIRE TIES



Vee Tie

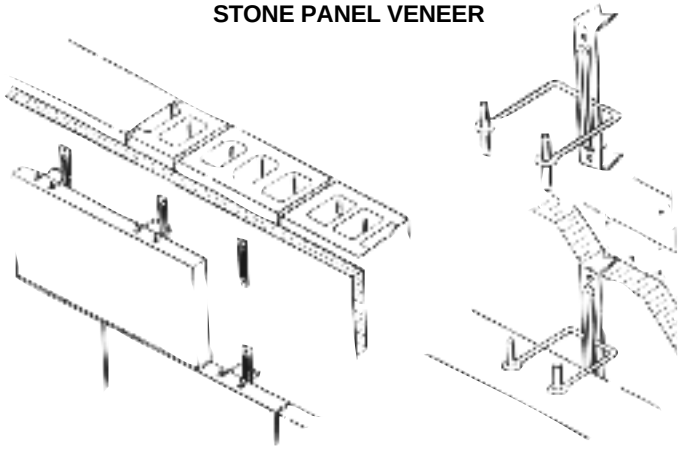


Box Tie W/Drip

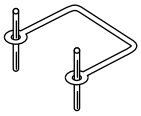


Byna-Tie®

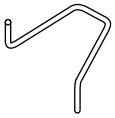
STONE PANEL VENEER



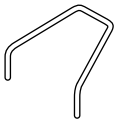
WIRE TIES FOR STONE VENEER



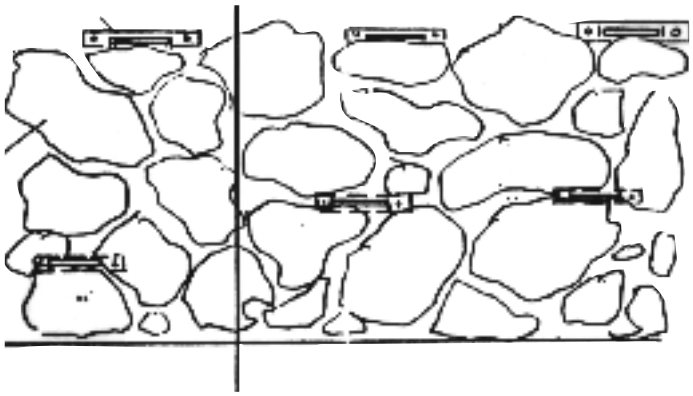
Rectangular
Eye & Dowel

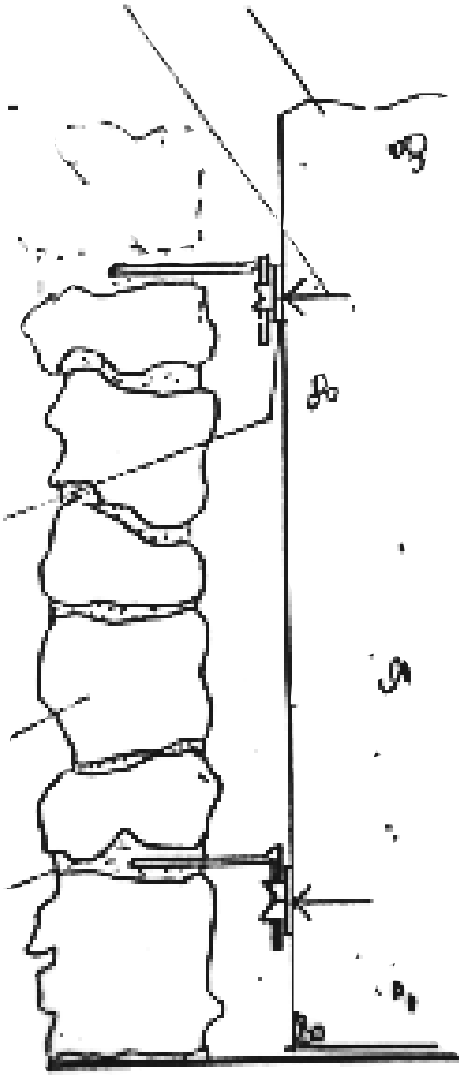


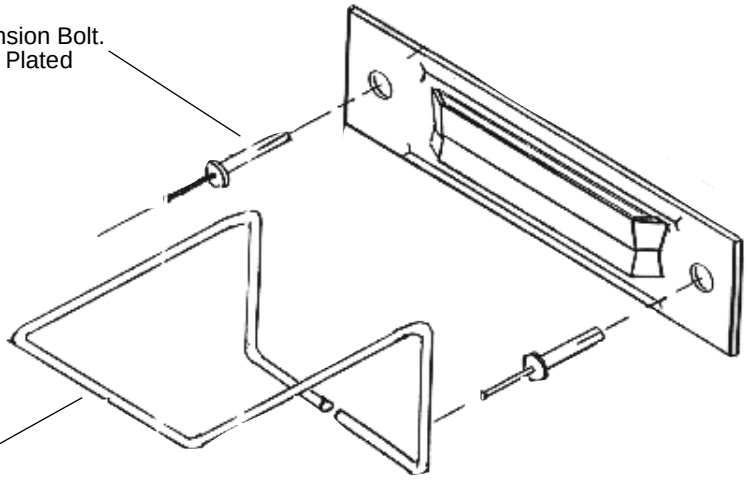
Modified
Vee Ties
#332



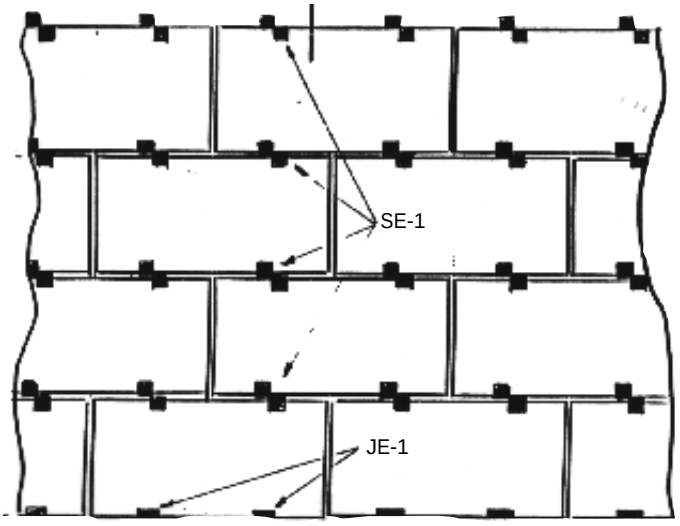
Stainless steel anchors for tying the stone front to the back wall.

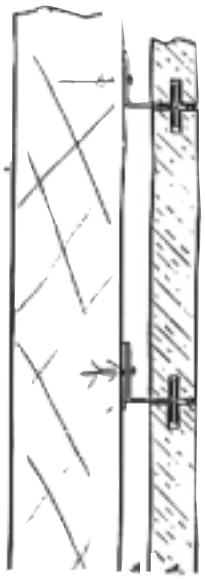


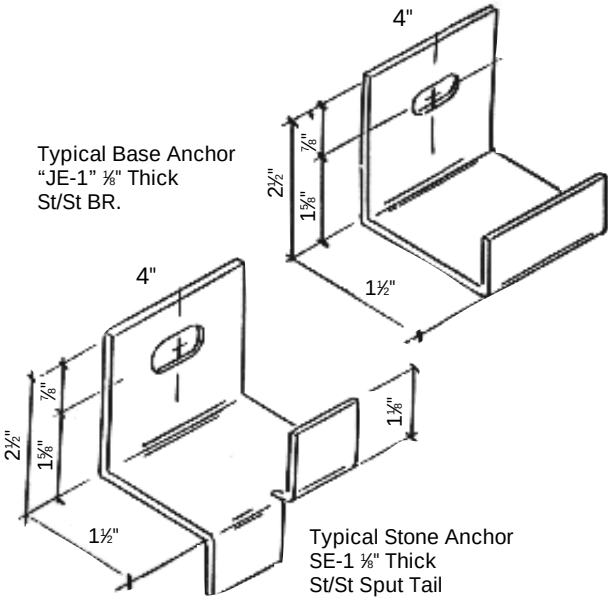


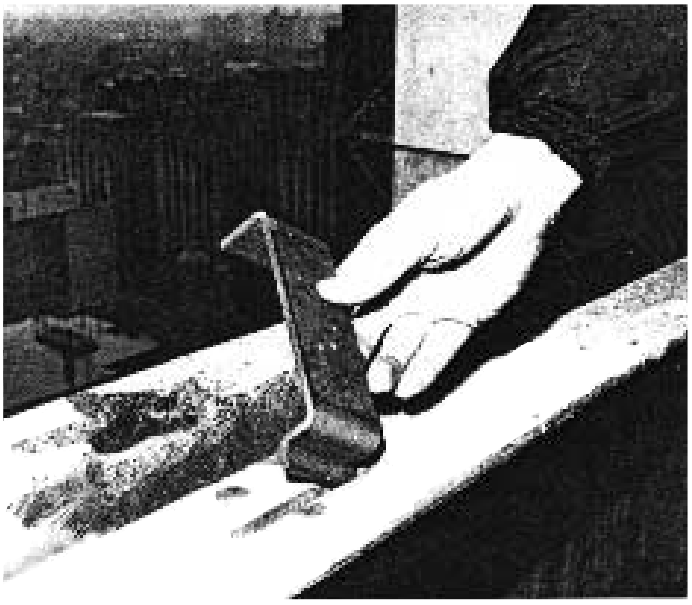


Stainless steel anchors for a 2" thick northern pink stone facade









Split-tail stainless steel anchors are shown here anchoring Rockport Granite to concrete block. The split-tail design serves to anchor upper and lower stones with one anchor.

The extra right-angle bend at one end of the stainless steel cramp allows this anchor to be installed between granite spandrel and the steel window frame member without any other type of fastening.