SECTION V

specifications, technotes, glossary, index

I. SPECIFICATIONS FOR CUT INDIANA LIMESTONE

This section, describing production, should be used with Section II when mortar is the joint closer, or with Section III when sealants are used. If no coursed or rough ashlar is involved (see Section VI), no further specifications are required for limestone in standard masonry buildings.

1. work included

The work under this contract shall include all labor and material necessary to furnish and satisfactorily install the Cut Indiana Oolitic Limestone in accordance with the drawings and as hereinafter specified.

2. description of stone

All limestone specified or shown on drawings shall be Indiana Oolitic Limestone, as quarried in Lawrence, Monroe, and Owen Counties, Indiana. Stone shall be

_____
(Specify grade & color)

and shall have a _____ finish.
(Specify finish)

3. samples

The supplier or fabricator shall submit three (3) samples, ___ x ___″ (specify size), for approval by the architect. The samples shall in general be typical of the grade, color and finish specified. This sample and the standards established by the Indiana Limestone Institute shall form the basis of the contract agreement.

4. standard practice

The architect reserves the right to approve the material supplier for cut stone before this portion of the work is awarded. Stone and workmanship quality shall be in accordance with **Industry Standards and Practices** as set forth by the Indiana Limestone Institute of America, Inc., Bedford, Indiana. The stone supplier shall be a member in good standing of that organization.

5. cutting and setting drawings

The cut stone supplier shall prepare and submit to the architect for approval, complete cutting and setting drawings for all of the cut Indiana Limestone work. Such drawings shall show in detail the sizes, sections, and dimensions of stone, the arrangement of joints and bonding, anchoring and other necessary details. All jointing as shown by the architect on the contract drawings shall be followed, unless modifications are agreed upon in writing, or indicated upon the approved shop drawings. If the contract drawings do not show the intent of the jointing, it will be the fabricator's responsibility to establish the jointing in accordance with industry standards and practices. The general contractor shall furnish all field dimensions necessary for fabrication.

The cutting and setting drawings shall be based upon and follow the drawings and full size details prepared by the architect except where it is agreed in writing or shown on the approved shop drawings that changes be made. Each stone indicated on the setting drawings shall bear the corresponding number marked on an unexposed surface.

Provision for the anchoring, dowelling, and cramping of work, in keeping with standard practices, and for the support of stone by shelf angles and loose steel, etc., when required, shall be clearly indicated on the cutting and setting drawings.

6. carving and models

All carving shall be done by skilled carvers in a correct and artistic manner, in strict accordance with the spirit and intent of the approved shaded drawings, or from models furnished or approved by the architect.

7. cutting

All stone shall be cut accurately to shape and dimensions and full to the square, with jointing as shown on approved drawings. All exposed faces shall be dressed true. Beds and joints shall be at right angles to the face, and joints shall have a uniform thickness of 3/8″ unless otherwise shown or noted on drawings.

Reglets for flashing, etc., shall be cut in the stone where so indicated on the drawings.

Molded work shall be carefully executed from full size details supplied by architect, and must match satisfactorily at joints. All exposed arrises shall be in true alignment and slightly eased to prevent snipping.

8. repairing damaged stone

Repair of stone is an accepted practice and will be permitted. Some chipping is expected; repair of small chips is not required if it does not detract from the overall appearance of the work, or impair the effectiveness of the mortar or sealant. The criteria for acceptance of chips and repairs will be per standards and practices of the industry unless other criteria are mutually agreed upon by the limestone supplier and the architect.

9. back-checking and fitting to structure or frame

Stone coming in contact with structural work shall be back-checked as indicated on the approved shop drawings. Stones resting on structural work shall have beds shaped to fit the supports as required.

Maintain a minimum of 1″ between stone backs and adjacent structure. (**Note**: many bolted connections will require more space than this; 2″ space may be more desirable. Large-scale details should illustrate and control these conditions.)

10. cutting for anchoring, supporting, and lifting devices

Holes and sinkages shall be cut in stones for all anchors, cramps, dowels and other tie-back and support devices per industry standard practice and/or approved shop drawings. However, expansion anchor holes shall be drilled at jobsite by mason or erector to facilitate alignment.

No holes or sinkages will be provided for contractor's handling devices unless arrangement for this service is made by the contractor with the stone supplier.

Note: It is not recommended that Lewis pins be used for stones less than 3 1/2″ thickness.

11. cutting and drilling for other trades

Any miscellaneous cutting and drilling of stone necessary to accommodate other trades will be done by the cut stone fabricator only when necessary information is furnished in time to be shown on their shop drawings and details, and when work can be executed before fabrication. Cutting and fitting, due to jobsite conditions, will be the responsibility of the general contractor.

Incidental cutting such as for window frame clips, etc., which is normally not considered to be the responsibility of the stone supplier, will be provided only by arrangement by the contractor with the stone supplier.

12. loading and shipment

The cut Indiana Limestone shall be carefully packed for transportation with exercise of all customary and reasonable precautions against damage in transit. All cut stone under this contract shall be loaded and shipped in the sequence and quantities mutually agreed upon by the general contractor or erector and the material supplier.

13. unloading and storage at jobsite

All stone shall be received and unloaded at the site with necessary care in handling to avoid damaging or soiling.

Stone shall be stored clear of the ground on nonstaining skids (cypress, white pine, poplar, or yellow pine without an excessive amount of resin). Chemically treated wood should not be used. DO NOT use chestnut, walnut, oak, fir, and other woods containing tannin.

Stone shall be covered with waterproof paper, clean canvas or polyethylene.

II. SETTING CUT INDIANA LIMESTONE (WITH MORTAR)

This section describes the setting and further handling of limestone where mortar joints are used. In conjunction with Section I, no further stone sections are necessary for specifying hand-set cut stone.

14. work included

The work under this contract shall include all labor and materials necessary for the satisfactory installation of cut Indiana Limestone in accordance with the provisions set out herein.

15. setting mortar

Setting mortar shall be ASTM C-270 Type N (indicate other type if desired) composed of (select:) one part portland cement, one part mason's lime, and six parts sand mixed with potable water (or:) one part masonry cement and two and three-fourths part sand mixed with potable water.

16. pointing mortar

Pointing mortar shall be composed of one part (white or other) portland cement, one part hydrated lime, and six parts white sand passing a #16 sieve.

17. expansion joints

Joints shall be adequate to allow for thermal and structural differential movement. Filler material for these joints shall be nonstaining.

18. weeps

Plastic or other weep tubes, or felt wicks, shall be placed in joints where moisture may accumulate within the wall, such as at base of cavity, continuous angles, flashing, etc., or as shown on architectural drawings.

19. stone anchors and attachments

Provide anchors and attachments of type and size required to support the stonework fabricated from the following metals for conditions indicated below:

Stainless Steel, AISI Type 304 or 316, for anchors and expansion bolts embedded within the stone.

Hot-Dip Galvanized Steel as follows:

Galvanized malleable iron for adjustable inserts embedded in the concrete structure.

For anchor bolts, nuts and washers not in direct contact with stone; comply with ASTM A 307, Grade A, for material and ASTM C 153, Class C, for galvanizing.

For steel plates, shapes and bars not in direct contact with stone; comply with ASTM A 36 for materials and ASTM A 123 for galvanizing.

For expansion bolts not in direct contact with stone use zinc plated or cadmium plated bolts with stainless steel expansion clips.

For steel angles supporting limestone; comply with ASTM A 36 for materials and ASTM A 123 for galvanizing. Supports protected with one shop coat of zinc-rich or other rust-inhibiting paint, and one job coat of similar, compatible paint, may be used at the discretion of the architect.

20. dampproofing for stain prevention:

Where indicated on drawings, coatings of either (a) cementitious waterproof stone backing or (b) bituminous dampproofing shall be applied on backs, beds, and joints of all stones used at grade. Dampproof all adjacent concrete surfaces on which limestone will rest, including concrete or cmu haunches and ledges, as well as support angles.

A. Dampproof unexposed surfaces of stone to at least 1′-0″ above grade.

B. Dampproof joints only to within 1″ of finished surfaces when using bituminous or asphaltic solutions.

C. Stones extending below grade shall be dampproofed as above, and in addition shall be dampproofed to the level of grade on their face surfaces which are covered.

D. Cementitious coatings must be allowed to cure before treated stone is set. Due care must be exercised in handling all dampproofed stone to avoid chipping or off-setting.

21. setting

A. All Indiana Limestone shall be set accurately in strict accordance with the contract and shop drawings.

B. When necessary, before setting in the wall, all stones shall be thoroughly cleaned on all exposed surfaces by washing with fiber brush and soap powder, followed by a thorough drenching with clear water.

C. All stone joint surfaces not thoroughly wet shall be drenched with clear water just prior to setting.

D. Except as otherwise specially noted, every stone shall be set in full beds of mortar with all vertical joints slushed full. Completely fill all anchor, dowel, and similar holes. Unless otherwise noted, all bed and joint widths shall be 3/8″.

E. Lead or plastic setting pads shall be placed under heavy stones, column drums, etc., in same thickness as joint, and in sufficient quantity to avoid squeezing mortar out. Heavy stones or projecting courses shall not be set until mortar in courses below has hardened sufficiently to avoid squeezing.

F. Joints can be tooled when initial set has occurred, or raked out 1″ and pointed later. If pointed with sealant, the raked depth and sealant applications shall conform to manufacturer's instructions. (See p. 25.)

G. Projecting stones shall be securely propped or anchored until the wall above is set.

H. Only the ends of lugged sills and steps shall be embedded in mortar. Balance of joint shall be left open until finally pointed.

I. All cornice, copings, projecting belt courses, other projecting courses, steps, and platforms (in general, all stone areas either partially or totally horizontal) should be set with unfilled vertical joints. After setting, insert properly sized backup material or backer rod to proper depth, and gun in sealant. (See p. 25 and the following specification section for more information on sealant joints.)

J. In cold weather, International Masonry Industry All-Weather Council recommendations for setting from 40 degrees to 20 degrees F shall be followed, except that no additives shall be used in the setting mortar, and below 20 degrees F all work shall be done in heated enclosures.

22. protection of finished work

A. Receipt, storage, and protection of cut stonework prior to, during and subsequent to installation shall be the responsibility of the mason contractor.

B. During construction, tops of walls shall be carefully covered at night, and especially during any precipitation or other inclement weather.

C. At all times, walls shall be adequately protected from droppings.

D. Whenever necessary, substantial wooden covering shall be placed to protect the stonework. Nonstaining building paper or membrane shall be used under the wood. Maintain all covering until removed to permit final clearing of the stonework.

23. cleaning

The stone shall be washed with fiber brushes, mild soap powder or detergent and clean water or approved mechanical cleaning process.

Special consideration and protection shall be provided when brickwork is cleaned above the limestone. Strong acid compounds used for cleaning brick will burn and discolor the limestone.

Use of sand blasting, wire brushes or acids will only be permitted under special circumstances, approved by architect.

III. ERECTING CUT INDIANA LIMESTONE (WITH SEALANT JOINTS)

This section is used in conjunction with Section I, when the primary joint closing material will be sealant in lieu of mortar. One of these combinations (Section I with either Section II or III) is usually the only specification required for hand-set cut stone applications in standard or traditional masonry construction. (Users may wish to refer to ILI Technote on Joint Sealants for Indiana Limestone.)

14. work included

The work under this contract shall include all labor and materials necessary for the satisfactory installation of cut Indiana Limestone in accordance with the provisions set out herein.

15. joint sealants

A. Joint Sealant (specify type)

1. Multicomponent polysulfide or polyurethane as per Federal Specification TT-S-00227e (Com-NBS) Amendment-3, October 9, 1970, Type II, NonSag, Class B and A.S.A. Specification A116.1 (1967).

2. One part polysulfide meeting Interim Federal Specification TT-S-00230c, Type II (Com-NBS) Amendment-2, October 9, 1970.

3. One part acrylic polymeric sealant as per U.S. Federal Specification TT-S-00230c, Type II (Com-NBS) Amendment, October 1, 1970. (Use of acrylics should be limited to those joints where anticipated movement is minimal.)

4. One or two parts Silicone as per Federal Specifications TT-S-001543 (Com-NBS) Amendment.

5. One part Hypalon Sealant as per U.S. Federal Specifications TT-S-00230 (Com-NBS), February 2, 1970, Type II, Class B.

6. One part Polyurethane as per Federal Specification TT-S-00230c, Type II.

B. Primer, when required, shall be nonstaining and nonacidic, and shall be used as recommended by manufacturer of sealant in writing to architect, having been tested before for staining and durability on samples of actual surfaces to be sealed.

(If primers are required, *they should be applied to the confines of joint surfaces* after stone is installed into the wall. In some instances it may be advisable to apply primer to the stone before the stone is installed into the wall. Application procedures should be as recommended by manufacturer of the sealant, in writing, to the architect.)

C. Backup materials and preformed joint fillers shall be nonstaining, compatible with sealant and primer, and of a resilient nature, such as closed cell resilient foam, sponge rubber, or of a supporting type, such as closed cell rigid foam, cork or non-impregnated fiberboard. Materials impregnated with oil, bitumen or similar materials shall not be used. Size and shape shall be as indicated by joint detail in drawings.

Sealant shall not adhere to backup material and shall be as recommended by sealant manufacturer in writing to architect.

D. Bond breakers, when required, shall be (polyethylene tape)—(other) as recommended by manufacturer of sealant in writing to architect.

E. Solvents, cleaning agents and other accessory materials shall be nonstaining to Indiana Limestone and shall be recommended by sealant manufacturer in writing to the architect.

16. expansion and control joints

Joints shall be adequate to allow for thermal and structural differential movement. Filler material for these joints shall be nonstaining and compatible with the sealing compound.

17. weep systems

Plastic or other weep tubes, or felt wicks, shall be placed in joints where moisture may accumulate within the wall, such as at base of cavity, continuous angles, flashing, etc., or as shown on architectural drawings.

18. stone anchors and attachments

Provide anchors and attachments of type and size required to support the stonework fabricated from the following metals for conditions indicated below:

Stainless Steel, AISI Type 304 or 316, for anchors and expansion bolts embedded within the stone.

Hot-Dip Galvanized Steel as follows:

Galvanized malleable iron for adjustable inserts embedded in the concrete structure.

For anchor bolts, nuts and washers not in direct contact with stone; comply with ASTM A 307, Grade A, for material and ASTM C 153, Class C, for galvanizing.

For steel plates, shapes and bars not in direct contact with stone; comply with ASTM A 36 for materials and ASTM A 123 for galvanizing.

For expansion bolts not in direct contact with stone use zinc plated or cadmium plated bolts with stainless steel expansion clips.

For steel angles supporting limestone; comply with ASTM A 36 for materials and ASTM A 123 for galvanizing. Supports protected with one shop coat of zinc-rich or other rust-inhibiting paint, and one job coat of similar, compatible paint, may be used at the discretion of the architect.

19. dampproofing for stain prevention:

Where indicated on drawings, coatings of either (a) cementitious waterproof stone backing or (b) bituminous dampproofing shall be applied on backs, beds, and joints of all stones used at grade. Dampproof all adjacent concrete surfaces on which limestone will rest, including concrete or cmu haunches and ledges, as well as support angles.

A. Dampproof unexposed surfaces of stone to at least 1′-0″ above grade.

B. Dampproof joints only to within 1″ of finished surfaces when using bituminous or asphaltic solutions.

C. Stones extending below grade shall be dampproofed as above, and in addition shall be dampproofed to the level of grade on their face surfaces which are covered.

D. Cementitious coatings must be allowed to cure before treated stone is set. Due care must be exercised in handling all dampproofed stone to avoid chipping or off-setting.

20. setting procedures and conditions

A. All Indiana Limestone shall be set accurately in strict accordance with the contract and shop drawings.

B. When dictated by the condition of the stone prior to setting, all Indiana Limestone shall be thoroughly cleaned with fiber brushes and soap powder before erection. Otherwise, stone shall be cleaned after erection. Power cleaning systems which will not harm stone or joints may be used.

C. Limestone shall be set on concrete, clip angles or continuous angles bedded in mortar. Lead setting pads or other setting shims, buttons, or sheets of resilient, low-durometer material approved by the architect may be used in lieu of or in combination with mortar. Where load-bearing joints occur between stones (that is, joints without concrete or steel support areas), similar bedding materials shall be used to support the load and to maintain joint width. Unless otherwise noted, all bed and joint widths shall be 3/8″.

D. Mortar joints shall be raked back sufficiently to accept backup material or bond breaker plus sealant bead. Apply no sealant directly against mortar.

E. Fill all anchor slots, dowel holes, and other sinkages with mortar, lead wool, sealant, approved shim or other material.

21. workmanship, installation

A. General

1. Use contractors specializing in the application of sealants and apply in conformance with manufacturer's written directions.

2. Sealant contractor shall examine all other work surfaces and joint dimensions to receive the work of this section and report to the general contractor all conditions not acceptable.

3. All joint surfaces shall be neatly pointed or tooled to provide the contour as indicated on drawings.

4. For application of sealant when air temperature is below 40 degrees F or above 95 degrees F, consult sealant manufacturer for recommendations.

B. Preparation

1. Thoroughly clean all joints, removing all foreign matter such as dust, oil, grease, water, surface dirt, and frost. Sealant must be applied to the clean joint surface or primer.

2. Stone should be cleaned where necessary by grinding (sand-water) blast-cleaning, mechanical abrading, or a combination of these methods as required to provide a clean, sound base surface for sealant adhesion.

(a) Loose particles present or resulting from grinding, abrading, or blast-cleaning shall be removed (by blowing out joints with oil-free compressed air or vacuuming joints) prior to application of primer or sealant.

3. All joints to receive sealant shall be as indicated on architectural drawings. Do not seal joints until they are in compliance with drawing, or meet with the approval of the architect.

(a) Joints to receive sealant and backing shall be a minimum of 3/8″ wide by no more than 3/8″ deep, unless otherwise approved.

(b) Depth of the sealant may be equal to the width in joints up to 1/2″ wide. For expansion and other joints 1/2″ to 1″ wide, depth shall not be greater than 1/2 the applied sealant width. For joints exceeding 1″ in width, depth shall be 3/4″ maximum or as directed by sealant manufacturer. For joints exceeding 2″ in width, depth shall be as directed by sealant manufacturer.

4. Joints to receive sealant, backup material or preformed joint filler shall be cleaned out and raked to full width and depth as required by sealant contractor or others.

5. Joints shall be of sufficient width and depth to accommodate specified backup material or preformed joint filler, and sealant. Limestone shall be free of water repellents and other surface treatments. If there is a question that surface treatment may be present, contact sealant manufacturer for test for adhesion before proceeding with the sealant work.

C. Application

1. Install backup material or joint filler, of type and size specified, at proper depth in joint to provide sealant dimensions as detailed. Backup material shall be of suitable size and shape so that, when compressed (25% to 50%), it will fit in joints as required. Sealant shall not be applied without backup material and, if necessary, bond breaker strip. Use specified bond breaker strip between sealant and supporting type backup material. Bond breaker strip shall be used in all joints where sufficient depth for backup does not exist. (**Note:** Closed-cell polyethylene may cause gas bubbles in sealant bead if compressed in excess of 25%.)

2. Apply masking tape, where required, in continuous strips in alignment with joint edge. Remove tape immediately after joints have been sealed and tooled as directed.

3. Prime surfaces, where required, with primer as recommended by sealant manufacturer.

4. Follow sealant manufacturer's instructions regarding mixing, surface preparation, priming, application life, and application procedure.

5. Apply, tool, and finish sealant as required. When tooling white or light colored sealants, use (clean water-wet or dry) tool or tooling solution recommended by sealant manufacturer.

6. Clean adjacent surfaces free of sealant or soiling resulting from this work as work progresses. Use solvent or cleaning agent, nonstaining to limestone, as recommended by sealant manufacturer. All finished work shall be left in a neat, clean condition.

22. protection of finished work

A. Receipt, storage, and protection of cut stonework prior to, during, and subsequent to installation shall be the responsibility of the general contractor.

B. During construction, tops of walls shall be carefully covered at night, and especially during any precipitation or other inclement weather.

C. Whenever necessary, substantial wooden covering shall be placed to protect the stonework. Nonstaining building paper or membrane shall be used under the wood. Maintain all covering until removed to permit final clearing of the stonework.

23. cleaning

The stone shall be washed with fiber brushes, soap powder and clean water or approved mechanical cleaning process.

Special consideration and protection shall be provided when brickwork is cleaned above the limestone. Strong acid compounds used for cleaning brick may burn and discolor the limestone.

Use of sand blasting, wire brushes or acids will only be permitted under special circumstances, approved by architect.

IV. SPECIFICATIONS FOR UNITS PREASSEMBLED WITH THERMO-SETTING RESIN

This section describes the fabrication of preassembled stone panels. It may be used by itself, in those cases where no hand-set stone is required. If a more complete description of the milling process is desired, this section may be used with Section I. Typically, the joints within preassembled stone units are closed with adhesive. Joints between units are closed with sealant. Refer to Section III.

14. work included

The work under this contract shall include all labor and material for furnishing the assemblies of Indiana Limestone in accordance with the drawing and specifications, using high-strength adhesives and mechanical connections when required.

15. stone

Units shall be constructed of Indiana Limestone quarried in Lawrence, Monroe, and Owen Counties, Indiana. Stone shall be _____
(Specify grade & color)

and shall have a _____ finish.
(Specify finish)

16. adhesive

The adhesive shall be a two-component epoxy consisting of epoxy resin, hardener, inert mineral filler and thixotropic agent. The filler content shall not exceed 50% of the total composition by weight.

17. qualifications

The adhesive used shall meet the following minimum requirements after a 7–day cure at 75 degrees F:

18. samples

Two sample units of stone bonded together with adhesive shall be submitted showing stone and joint quality. Samples shall be 6″ long, 3″ wide, 3/4″ thick, bonded together on the large face, at right angles. No fabrication or assembly shall begin until approval of sample is obtained.

Property	Value	Test Method
Tensile Bond Strength*	Cohesive failure in stone	ASTM C-321
Tensile Elongation	2.5%	ASTM D-638
Tensile Strength	3,500 psi	ASTM D-638
Compressive Double Shear*	400 psi	MMM G-650A
Compressive Strength	6,000 psi	ASTM D-695
Shore “D” Hardness	75	ASTM D-1706
Water Absorption (24 hours)	0.50%	ASTM D-570

***Note**: These tests represent bond strength. Other tests are made on the adhesive only.

Note: Accepted industry practice allows 1/8″ adhesive joints.

19. drawings

The stone fabricator shall submit to the architect for approval detailed drawings showing the epoxy joint construction he proposes to use, including mechnical anchoring.

20. shop assembly requirements

A. Stone must be dry and free from grease, oil, dirt, loose particles, and efflorescence. Clean compressed air should be employed to blow stone dust from the pores of the stone. Artificial heat is recommended for the removal of moisture from the stone which has not had the opportunity to dry following fabrication. No

moisture should be observed creeping into areas to be bonded following the removal of artificial heat.

B. Units shall not be assembled when the stone temperature and the surrounding air temperatures are below 50 degrees F or above 95 degrees F. Assembly of units below 50 degrees F is permitted when the temperature of the stone units and the adhesive is raised by artificial heating to a temperature above 50 degrees F. After the units have been joined, artificial heat should continue to be applied to the stone adjacent to the joint area to give the adhesive the curing temperature above 50 degrees F. Approved clips, frames, expansion bolts, and other mechanical connections are installed during this process in strict accordance with approved shop drawings.

C. Adhesives shall be mixed in parts by weight or parts by volume in strict accordance with manufacturer's instructions, with strict compliance to the manufacturer's recommendations on the "pot life" of the adhesive.

D. Upon joining the stone members together, use suitable clamps or bracing to maintain proper alignment until the adhesive sufficiently hardens.

E. Assembled limestone units shall not be moved until the adhesive has cured sufficiently to assure that there will be no joint slippage. Curing shall continue until tests indicate that the adhesive has reached the required hardness (Shore D). When stones are pressed together, the adhesive will ooze out of the joint. On exposed joints, in a textured finish, it is recommended that the excessive adhesive be removed after the adhesive has taken on its initial hardening. The extra adhesive can then be scraped away with a putty knife. Any excessive adhesive on smooth finish is best removed after complete hardening with the use of power sanders.

21. transportation and storage

Extreme care shall be taken to insure that the assembled units are free of any torsional stress during transportation, handling, and storage.

22. erection

A. The stone fabricator shall make provisions for the employment of the necessary lifting methods of the assembled units, in cooperation with the erector. Such lifting devices as clamps, slings, Lewis pins, etc., shall be furnished by the erector.

B. All assembled units of Indiana Limestone shall be erected in strict accordance with the contract and the shop drawings.

V. PERFORMANCE SPECIFICATIONS

The use of a performance specification implies the need for expertise beyond that which typically exists in the office of the designer or specifying authority. In the case of stone cladding, such an expert is an experienced skin-and-connection design engineer. Specifiers should determine, based on preliminary designs, whether such skills are needed. Need will be determined by one or more of the following: knowledge of the performance records of the contemplated systems, materials or connections; complexity of the cladding and/or connection system; unusual or extreme loading conditions; unusual frame or structural configuration.

If it is determined that no such need exists, DO NOT USE THIS SECTION. One of the earlier sections of this specificiation, describing conventional methods and materials with known or easily predictable performance records, will prove more economical and effective.

If such need is seen to exist, contract documents should make clear who is responsible for providing the engineering services, and the extent of the services expected. Such services may include design of the stone cladding, its thicknesses and its connections, and the supervision of any necessary testing of small-size specimens and scale or full-size mockups. The experience and capacity to produce satisfactory designs and supervision should be assured.

SECTION 04400—STONEWORK

PART 1—GENERAL

1.1 related documents:

Related documents include but are not limited to Drawings, Specifications, and General Provisions of the Contract; ASTM C-568, Standard Specification for Limestone Building Stone; ASTM C-97, Test Methods for Absorption and Bulk Specific Gravity of Building Stones; ASTM C-99, Test Method for Modulus of Rupture of Building Stone; ASTM C-170, Test Method for Compressive Strength of Building Stone; *Indiana Limestone Handbook*, latest edition; *Contractors Handbook on Indiana Limestone*, latest edition; *ILI Technote on Safety Factors*; and other applicable ILI Technotes.

1.2 summary:

1.2.1 Extent of limestone work is indicated on drawings and schedules.

1.2.2 General: Provide Indiana Limestone cladding in accordance with the contract documents. The work shall include the following:

Limestone facade panels.

Limestone preassembled units.

Limestone copings, sills, soffits, lintels, and miscellaneous features.

Steel support and retention connections for stonework, including necessary shims.

Secondary structural steel framing for stonework where not shown or not sized on structural drawings.

Mockups.

Installation of stonework.

1.2.3 Related Work Specified Elsewhere:

Exterior stone paving (sitework).

Unit masonry.

Sealants.

Secondary steel framing for stone support and anchorage as shown and sized on structural drawings.

Interior stone and paving and exterior stone paving.

1.2.4 Installation of preset concrete inserts

1.2.5 Installation of preset masonry inserts

1.3 system description:

1.3.1 General: Design, fabricate, and install stonework to withstand normal loads from wind, gravity, movement of building structure, and thermally induced movement, as well as to resist deterioration under conditions of normal use including exposure to weather, without failure.

1.3.2 Performance Requirements—General: The cladding requirements shown by the general stone details are intended to establish basic dimensions of units or modules, plus profiles and sight lines for the stonework. Within these limitations, the contractor shall be responsible for the design of the stonework, and shall request approval of, and make whatever modifications and additions to the details as may be required to fulfill the performance requirements. The visual concept shall be maintained as shown, including profiles and alignment of components.

The requirements for the stone support and anchorage as shown by the details are intended to establish the basic intent of the stone anchorage system. The contractor shall be responsible for the design of the support and anchorage system and shall request approval of, and make whatever modifications and additions to the details as may be required to fulfill the performance requirements. Final shapes and locations shall be as designed by a registered professional engineer.

Engineering Calculations: This engineer shall be a registered professional engineer experienced in cladding design to design the cladding support and retention system. The system shall include all items required to connect the stone cladding to the structure (or secondary framing) as shown and detailed on the structural and architectural drawings. The cladding engineer shall be registered in the state of _____ and shall prepare engineering calculations for the justification of all principal stonework, units, fasteners, and anchorage components for compliance with the criteria established in the performance requirements of this section. The calculations shall be submitted to the architect for review and approval. After review, revisions, and final approval, the cladding engineer shall certify a record copy of the calculations with professional engineer's stamp or seal. Based on the design loads, material properties, and safety factors (all as defined in this section), the calculations shall include, as a minimum, the following information:

Stone loads, stresses, and safety factors.

Support and anchorage loads, stresses, safety factors, design loads, and allowable loads.

Stone thicknesses.

Support and anchorage sizes.

Drawings of all support and anchorage items in sufficient detail for fabrication and for the detailing and completion of the shop drawings as prepared by the stone fabricator. The cladding engineer shall review all stone shop drawings prepared by stone installer or fabricator.

1.3.3 Performance Requirements—Stone:

Physical Properties: The Indiana Limestone physical properties shall meet or exceed the values listed in the Indiana Limestone Institute of America, Inc. *Handbook* (ILIA), latest edition.

Safety Factors—Stone: Safety factors for Indiana Limestone shall be not less than as listed in the *Technote on Safety Factors*, as published by ILIA.

Connections and Attachments for Limestone: Support and Retention Steel: All steel shapes, plates and straps shall be designed to carry the design loads with safety factors and allowable stresses in accordance with the American Institute of Steel Construction, Inc. (AISC) except that steel supports carrying gravity loads shall be stressed not more than 50% of the yield stress in bending.

Connections into the Stone: Expansion bolts, straps, hooks, anchors, and other devices shall be designed to carry the design loads with safety factors not less than listed in ILIA *Technote on Safety Factors*.

Attachments to the Structure: Connections and attachments to the structure or secondary framing shall be designed to carry the design loads with safety factors or allowable stresses in accordance with the following:

Welds: Structural Welding Code (AWS D1.1 and AISC).

Expansion Bolts: Per ICBO evaluation report for the specific bolt to be used. If an ICBO report is not available, use not less than the following:

Safety Factors:

Into 4,000 psi concrete—4 to 1

Into grouted CMU—6 to 1

The combined load factor for combined tension and shear shall satisfy the ILIA *Technote on Safety Factors*.

Bolts: AISC.

Concrete Embedded (Cast-in) items: PCI or manufacturer's recommendations, whichever is more conservative. The safety factor shall be not less than 4 to 1 based on concrete failure.

Design Loads: All cladding and cladding attachments shall be designed to carry the following design loads with safety factors not less than specified in this section:

Wind Loads: (Latest Edition) UBC (or applicable code or wind tunnel test results).

Seismic Loads: Per code where applicable.

Vertical Loads:

Dead Loads: Actual computed weight of cladding.

Live Loads: (Latest Edition) UBC (or applicable code).

Provisions for Fabrication and Erection Tolerances: Design, detail and fabricate connections to provide allowance for fabrication tolerances, erection tolerances, and structural deflections.

Concrete structural fabrication and erection tolerances are specified in Division-3 section "Concrete Work."

Structural steel fabrication and erection tolerances are specified in Division-5 section "Structural Steel."

Control of Corrosion: Prevent galvanic and other forms of corrosion by insulating metals and other materials from direct contact with non-compatible materials, or by suitable coating.

1.4 submittals:

1.4.1 Product Data: Submit manufacturer's technical data for all stone, stonework accessories, and other manufactured products required.

1.4.2 Shop Drawings: Submit cutting and setting drawings indicating sizes, dimensions, sections and profiles of stones; arrangement and provisions for jointing, supporting, anchoring, and bonding stonework; and details showing relationship with, attachment to, and reception of, related work. The drawings shall include the details as developed by the cladding engineer as defined in the performance requirements section.

Include large scale details of decorative surfaces and inscriptions.

1.4.3 Samples: Submit the following samples:

Limestone samples in form of sets of three, consisting of stones not less than 12″ square. Sample sets will show a range of variations in color and grain to be expected in completed work.

Sealant samples for each type and color of joint sealant required.

1.4.4 Data for Limestone Cladding: For limestone cladding, submit the following data which has been signed and stamped by a qualified professional engineer registered in _____ who thereby
NAME OF STATE
certifies preparing or supervising the preparation of the data to comply with the performance requirements and recognized engineering principles and practices:

Engineering calculations as defined in the performance section.

Connection details as defined in the performance section.

1.5 quality assurance:

1.5.1 Single Source Responsibility for Stone: Obtain limestone from a single quarry source with resources to provide materials of specified consistent quality. The fabricator and the quarry shall have sufficient capacity to quarry, cut, and deliver the stonework on schedule. Both fabricator and quarry must be members in good standing of Indiana Limestone Institute.

1.5.2 Single Source Responsibility for Mortar Materials: Obtain mortar ingredients of uniform quality and from one manufacturer for each cementitious and admixture component and from one source or producer for each aggregate.

1.5.3 Single Source Responsibility for Other Materials: Obtain each type of stone accessory, sealants and other materials from one manufacturer for each product.

1.5.4 Information on Drawings and in Specifications establishes requirements for both aesthetic effects and performance of the limestone cladding. Aesthetic effects are indicated by dimensions, arrangement, alignment and profiles of components and assemblies as they relate to sight lines and relationships to one another and to adjoining work. Performance is indicated by criteria that is subject to verification by either preconstruction or field test, if applicable, or by inservice experience.

Do not modify intended aesthetic effects, as judged solely by architect, except with architect's approval and only to the extent exclusively needed to comply with performance requirements. Where modifications are proposed, submit comprehensive explanatory data to architect for review and approval.

1.5.5 Installer Qualifications: Engage an installer with not less than 10 years experience and who has successfully completed stonework similar in material, design and extent to that indicated for this project. Submit list of completed projects; include project names, addresses, and names of architects and owners.

1.5.6 Preconstruction Tests: Contractor shall obtain material tests as noted below:

Preconstruction Testing Service: Contractor shall employ and pay qualified independent testing laboratories to perform preconstruction testing indicated.

Test limestone for compliance with physical property requirements for Limestone Building Stone, Type II, as listed in ASTM C-568. Conduct tests using specimens randomly selected from, and representative of, actual materials proposed for incorporation in the work.

The following test reports shall be submitted:

ASTM C 99	Modulus of Rupture
ASTM C 170	Compressive Strength

1.5.7 Field-Constructed Mockup: Prepare mockups for the stonework if applicable. Purpose of mockups is further verification of selections made for color and finish under sample submittals and establishing standard of quality for aesthetic effects expected in completed work. Build mockups to comply with following requirements.

Locate mockups on site where indicated or, if not indicated, as directed by architect.

Build mockups containing elements typical of the stonework in this project. The extent of the mockup shall be defined by this section.

Erect mockups only after notifying architect when construction will begin.

Retain mockups during construction as standard for judging completed stonework. When directed, demolish mockups and remove from site.

Option: Acceptable mockup may be incorporated into the work.

1.5.8 Qualifications for Welding Work: Qualify welding operators in accordance with AWS "Standard Qualification Procedure."

Provide certification that each welder employed in the work is qualified for welding processes involved by having satisfactorily passed AWS qualification tests and, if applicable, by undergoing recertification. Retesting for recertification shall be contractor's responsibility.

1.6 delivery, storage and handling:

1.6.1 Deliver masonry materials to project in undamaged condition.

1.6.2 Store and handle stone and related materials to prevent their deterioration or damage:

Do not use pinch or wrecking bars on stonework.

Lift with wide-belt type slings where possible; do not use wire rope or ropes containing tar or other substances which might cause staining.

Store stone on non-staining wood skids or pallets, covered with non-staining, waterproof membrane. Place and stack skids and stone to distribute weight evenly and to prevent breakage or cracking of stones.

Store cementitious materials off the ground, under cover and in dry location.

1.7 project conditions:

1.7.1 Protect stonework during erection as follows:

Cover top of walls with non-staining waterproof sheeting at end of each day's work. Cover partially completed structures when work is not in progress. Extend cover a minimum of 24″ down both sides and hold securely in place.

Prevent staining of stone from mortar, grout, sealants, and other sources. Immediately remove such materials from stone without damage to the stonework.

Protect base of walls from rain-splashed mud and mortar splatter by means of coverings spread on ground and over wall surface.

Protect sills, ledges and projections from droppings of mortar and sealants.

1.7.2 Cold Weather Protection: Comply with the following requirements.

(Part 1.7.2 should be part of the specifications in those projects where mortar is used in setting, and where freezing weather is a possibility.)

Remove ice or snow formed on stonework beds by carefully applying heat until top surface is dry to the touch.

Remove stonework damaged by freezing conditions.

Perform the following construction procedures while stonework is progressing:

Temperature ranges indicated apply to air temperatures existing at time of installations.

In heating mortar materials, maintain mixing temperatures selected within 10 degrees F (6 degrees C); do not heat water for mortar to above 160 degrees F (71 degrees C).

Mortar: At 40 degrees F (4.4 degrees C) and below, produce mortar temperatures between 40 degrees F (4.4 degrees C) and 120 degrees F (49 degrees C) by heating mixing water and, at temperatures of 32 degrees F (0 degrees C) and below, sand as well. Always maintain temperature of mortar on boards above freezing.

At 25 degrees F (-4 degrees C) to 20 degrees F (-7 degrees C), heat both sides of walls under construction using salamanders or other heat sources and use windbreaks or enclosures when wind is in excess of 15 mph.

At 20 degrees F (-7 degrees C) and below, provide enclosure and auxiliary heat to maintain an air temperature of at least 40 degrees F (4.4 degrees C) for 24 hours after setting stonework and heat stones so that they are above 20 degrees F (-7 degrees C) at time of installation.

PART 2—PRODUCTS

2.1 materials, general:

2.1.1 Comply with referenced standards and other requirements indicated applicable to each type of material required.

2.1.2 Provide stone from a single quarry for each grade, color, and finish of stone required.

2.1.3 Make quarried blocks available for inspection by architect.

2.2 limestone:

Limestone Building Stone Standard: ASTM C 568.

2.2.1 Classification: Category II (Medium Density).

2.2.2 Variety: Indiana Limestone.

2.2.3 Finish of Exterior Limestone Cladding: As follows:

Finish Indiana Limestone cladding to match standard finish of Indiana Limestone Institute, Inc. designated below.

(Finish name—insert here)

(OR)

Finish Indiana Limestone to match approved samples and/or mockups of Indiana Limestone.

2.2.4 Furnish Stone in accordance with approved samples and jobsite mockup for type, variety, grade (if applicable), color, and other characteristics relating to aesthetic effects.

2.2.5 Indiana Limestone Grade and Color: Provide color indicated below in accordance with grade and color classification established by Indiana Limestone Institute, Inc. (ILI).

(Quality and color names)

2.3 mortar and grout materials:

2.3.1 Portland Cement: ASTM C 150, Type I except Type III may be used for cold weather construction. Provide gray or white cement as needed to produce mortar color required.

2.3.2 Hydrated Lime: ASTM C 207. Type S.

2.3.3 Aggregate: ASTM C 144; and as indicated below:

For joints narrower than 1/4″ use aggregate graded with 100 percent passing the No. 8 sieve and 95 percent the No. 16 sieve.

2.3.4 Water: Clean, non-alkaline and potable.

2.4 stone anchors and attachments:

2.4.1 Provide anchors and attachments of type and size required to support the stonework fabricated from the following metals for conditions indicated below:

Stainless Steel, AISI Type 304 or 316, for anchors and expansion bolts embedded within the stone.

Hot-Dip Galvanized Steel as follows:

Galvanized malleable iron for adjustable inserts embedded in the concrete structure.

For anchor bolts, nuts and washers not in direct contact with stone; comply with ASTM A 307, Grade A, for material and ASTM C 153, Class C, for galvanizing.

For steel plates, shapes and bars not in direct contact with stone; comply with ASTM A 36 for materials and ASTM A 123 for galvanizing.

For expansion bolts not in direct contact with stone use zinc plated or cadmium plated bolts with stainless steel expansion clips.

For steel angles supporting limestone; comply with ASTM A 36 for materials and ASTM A 123 for galvanizing. Supports protected with one shop coat of zinc-rich or other rust-inhibiting paint, and one job coat of similar, compatible paint, may be used at the discretion of the architect.

2.4.2 Dovetail Slots: Where required, furnish dovetail slots, with filler strips, of slot size required to receive anchors provided, fabricated from 0.0336 (22-gage) galvanized sheet steel complying with ASTM A 446, G90.

2.5 preassembled units—Indiana Limestone:

Performance Requirements: Performance requirements defined elsewhere in this section apply to the preassembled units.

2.5.1 Adhesive: The adhesive shall be a two-component epoxy consisting of epoxy resin and hardener.

Adhesive Properties: The adhesive used shall meet the following minimum requirements after a 7-day cure at 75 degrees Fahrenheit.

Property	Value	Test Method
Tensile Bond Strength*	Cohesive failure in stone	ASTM C-321
Tensile Elongation	2.5%	ASTM D-638
Tensile Strength	3,500 psi	ASTM D-638
Compressive Double Shear*	400 psi	MMM G-650A
Compressive Strength	6,000 psi	ASTM D-695
Shore “D” Hardness	75	ASTM D-1706
Water Absorption (24 hours)	0.50%	ASTM D-570

*__Note__: These tests represent bond strength. Other tests are made on the adhesive only.

2.5.2 Samples: Two sample units of stone bonded together with adhesive shall be submitted showing stone and joint quality. Samples shall be 6″ long, 3″ wide, 3/4″ thick, bonded together on the large face, at right angles. No fabrication or assembly shall begin until approval of sample is obtained.

Industry practice permits 1/8″ thick adhesive joints.

2.5.3 Drawings: The epoxy joint construction including mechanical anchoring and framing shall be shown on the shop drawings.

2.5.4 Shop Assembly Requirements: Stone shall be dry and free from grease, oil, dirt, loose particles, and efflorescence. Clean compressed air should be employed to blow stone dust from the pores of the stone. Heat is recommended for the removal of moisture from the stone prior to applying epoxy. No moisture should be observed creeping into areas to be bonded following the removal of heat.

Units shall not be assembled when the stone temperature and the surrounding air temperatures are below 50 degrees F or above 95 degrees F. Assembly of units below 50 degrees F is permitted when the temperature of the stone units and adhesive is raised by heating to a temperature above 50 degrees F. After the units have been joined, heat should continue to be applied to the stone adjacent to the joint area to give the adhesive the curing temperature above 50 degrees F. Approved clips, frames, expansion bolts, and other mechanical connections shall be installed in strict accordance with approved shop drawings.

Adhesives shall be mixed in parts by weight or parts by volume in strict accordance with manufacturer’s instructions, with strict compliance to the manufacturer’s recommendations on the “pot life” of the adhesive.

Upon joining the stone members together, suitable clamps or bracing shall be used to keep the stone in proper alignment until the adhesive sufficiently hardens. Process shall include any and all shims needed to insure proper alignment.

Assembled limestone units shall not be moved until the adhesive has cured sufficiently to assure there will be no joint damage. Curing shall continue until the adhesive has reached the required hardness. When stones are pressed together, the adhesive shall flow out of the joint. On exposed joints, in a textured finish, it is recommended that the excessive adhesive be removed after the adhesive has taken on its initial hardening. The extra adhesive may be scraped away with a putty knife. Any excessive adhesive on smooth finish may be removed after complete hardening with the use of power sanders.

All dowels, anchors, expansion bolts, bearing plates, and other steel items in direct contact with the stone or contained within the stone shall be stainless steel AISI Type 304 or 316. Frames, plates, and other steel shapes not in direct contact with the stone shall be ASTM A-36

hot-dipped galvanized after fabrication per ASTM A-123. Bolts not in contact with the stone shall be ASTM A-325 or equal and shall be galvanized or plated with zinc or cadmium.

Fabricate and assemble structural framing in shop to comply with AISC *Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings*, including "Commentary" and Supplements thereto as issued, and as indicated on final shop drawings.

Weld or bolt connections to comply with the following requirements:

Install high strength threaded fasteners to comply with AISC *Specifications for Structural Joints using ASTM A-325 or A-490 bolts* approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation (RCRBSJ).

Weld connections to comply with AWS D1.1 *Structural Welding Code—Steel*.

2.5.5 Transportation and Storage: Extreme care shall be taken to insure that the assembled units are free of torsional stress during transportation, handling, and storage.

2.5.6 Erection: The stone fabricator shall make provisions for the employment of the necessary lifting methods of the assembled units, in cooperation with the erector. Such lifting devices as clamps, slings, etc., shall be furnished by the erector.

2.6 stone accessories:

2.6.1 Setting Shims: Lead, stainless steel, or plastic shims, non-staining to stone, sized to suit joint thicknesses and bed depths of stonework involved without intruding into required depths of joint sealants.

2.6.2 Concealed Sheet Metal Flashing: Fabricate from stainless steel or other material complying with requirements specified in Division-7 Section "Flashing and Sheet Metal," in thicknesses indicated but not less than 0.015″ thick.

2.6.3 Plastic Tubing Weeps: Medium density polyethylene, outside diameter of 1/4″ and of length required to extend between exterior face of stone and cavity behind.

2.7 elastomeric sealants:

Refer to Section 07900.

2.8 mortar and grout mixes:

2.8.1 General: Do not add mixtures including coloring pigments, air-entraining agents, accelerators, retarders, water repellent agents, anti-freeze compounds, or calcium chloride, unless otherwise indicated.

2.8.2 Mixing: Combine and thoroughly mix cementitious materials, water and aggregates in a mechanical batch mixer; comply with referenced ASTM standard for mixing time and water content, unless otherwise indicated.

2.8.3 Setting Mortar: Comply with ASTM C 270, Proportion Specification, for types of mortars and applications required below, unless otherwise indicated:

Set Indiana Limestone with Type N mortar.

2.9 stone fabrication:

2.9.1 General: Fabricate stonework in sizes and shapes required to comply with the requirements as shown on approved shop drawings.

2.9.2 Comply with recommendations of the Indiana Limestone Institute of America, Inc. (ILI) as published in the *Indiana Limestone Handbook* (latest edition).

2.9.3 Cut and drill sinkages and holes in stones for anchors, fasteners, supports and lifting devices as indicated or needed to set stonework securely in place; shape beds to fit supports.

2.9.4 Cut stones to produce pieces of thickness, size and shape indicated or required and within fabrication tolerances recommended by ILI.

2.9.5 Thickness of Exterior Stone Cladding:

Provide stone thicknesses required to comply with performance requirements but not less than shown on architectural drawings. Use tables in *Indiana Limestone Handbook* as a guide to size requirements.

2.9.6 Control depth of stones and back-checks to maintain a clearance between backs of stones and surfaces or projections of structural members, fireproofing (if any), backup walls and other work behind stones.

2.9.7 Cut joints (bed and vertical) straight and at 90 degree angle to face, unless otherwise indicated.

2.9.8 Quirk-miter corners, unless otherwise indicated; shall provide for cramp anchorage in top and bottom bed joints of corner pieces.

2.9.9 Cut stones to produce joints of uniform width and in locations indicated.

Joint Width: _____

2.9.10 Contiguous Work: Provide chases, reveals, reglets, openings and similar features as required to accommodate contiguous work.

2.9.11 Fabricate molded work, including washes and drips, to produce stone shapes having a uniform profile throughout their entire length and with precisely formed arrises slightly eased to prevent snipping, and matched at joints between units.

2.9.12 Carve and cut decorative surfaces and inscriptions to conform with shaded drawings or models approved by architect. Use skilled stone carvers experienced in the successful performance of work similar to that indicated.

2.9.13 Finish exposed faces and edges of stones to comply with requirements indicated for finish under each type and application of stone required and to match approved samples and field-constructed mockups.

PART 3—EXECUTION

3.1 examination:

3.1.1 Require installer to examine surfaces to receive stonework and conditions under which stonework will be installed and to report in writing any conditions which are not in compliance with requirements. Do not proceed with installation until surfaces and conditions comply with requirements indicated in specifications or elsewhere for execution of other work which affects stonework.

3.2 preparation:

3.2.1 Advise installers of other work about specific requirements relating to placement of inserts, flashing reglets and similar items which will be used by stonework installer for anchoring, supporting and flashing of stonework. Furnish installers of other work with drawings or templates showing locations of these items. General contractor or concrete contractor will provide drawings to locate weld-plates and embeds for connection of stone skin or its system.

3.2.2 Clean stone surfaces which have become dirty or stained prior to setting to remove soil, stains and foreign materials. Clean stones by thoroughly scrubbing stones with fiber brushes followed by a thorough drenching with clear water. Use only mild cleaning compounds that contain no acid, caustic or abrasives.

3.3 setting stone, general:

3.3.1 Execute stonework by skilled mechanics, and employ skilled stone fitters at the site to do necessary field cutting as stones are set.

Use power saws to cut stones; for exposed edges, produce edges which are cut straight and true. Mallet and chisel cutting will be permitted provided craftsmen are skilled in their use.

3.3.2 Contiguous Work: Provide chases, reveals, reglets, openings and other spaces as indicated for accommodating contiguous work. Close up openings in stonework after other work is in place with stonework which matches that already set.

3.3.3 Set stones to comply with requirements indicated on drawings and final shop drawings. Install anchors, supports, fasteners and other attachments indicated or necessary to secure stonework in place. Shim and adjust anchors, supports and accessories to set stones accurately in locations indicated with uniform joints of widths indicated and with edges and faces aligned according to established relationships and indicated tolerances.

3.3.4 Dampproofing for stain prevention: Where indicated on drawings, coatings of either (a) cementitious waterproof stone backing or (b) bituminous dampproofing shall be applied on backs, beds, and joints of all stones used at grade. Dampproof all adjacent concrete surfaces on which limestone will rest, including concrete or cmu haunches and ledges, as well as support angles.

A. Dampproof unexposed surfaces of stone to at least 1′-0″ above grade.

B. Dampproof joints only to within 1″ of finished surfaces when using bituminous or asphaltic solutions.

C. Stones extending below grade shall be dampproofed as above, and in addition shall be dampproofed to the level of grade on their face surfaces which are covered.

D. Cementitious coatings must be allowed to cure before treated stone is set. Due care must be exercised in handling all dampproofed stone to avoid chipping or off-setting.

3.3.5 Construction Tolerances: Set stones to comply with the following tolerances:

Variation from Plumb: For lines and surfaces of columns, walls and arrises, do not exceed 1/4″ in 10′, 3/8″ in a story height or 20′ maximum, nor 1/2″ in 40′ or more. For external corners, expansion joints and other conspicuous lines, do not exceed 1/4″ in any story or 20′ maximum, nor 1/2″ in 40′ or more.

Variation from Level: For grades indicated for exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines, do not exceed 1/2″ in any bay or 20′ maximum, nor 3/4″ in 40′ or more.

Variation of Linear Building Line: For position shown in plan and related portion of columns, walls and partitions, do not exceed 1/2″ in any bay or 20′ maximum, nor 3/4″ in 40′ or more.

Variation in Cross-Sectional Dimensions: For columns and thickness of walls from dimensions indicated, do not exceed minus 1/4″, nor plus 1/2″.

NOTE–The tolerances in this section are masonry industry setting tolerances and are provided for the convenience of the specifier. As a production industry, the Indiana Limestone industry can not and does not control them.

3.3.6 Provide expansion joints, control joints and pressure-relieving joints of widths and at locations indicated or required.

Sealants, expansion, and other joints are specified in Division 7 Section "Joint Sealers."

Use no mortar or shims in expansion joints.

3.4 setting stonework with sealant joints:

3.4.1 Support stonework on gravity supports, and insert anchors for lateral loads, of type and number indicated on final shop drawings, and complying with requirements indicated for material and performance.

3.4.2 Attach anchors securely to stones and to backup surfaces.

3.4.3 Attach framing for stone support system to structural frame of building at connection points indicated by welded or bolted field connections complying with the following requirements:

Install high strength threaded fasteners to comply with AISC *Specifications for Structural Joints using ASTM A 325 or A 490 bolts* approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation (RCRBSJ).

Weld connections to comply with AWS D1.1 *Structural Welding Code Steel*.

Provide joints to exclude water or permit its escape to exterior of building. Provide weeps at locations where water could accumulate due to condensation or other causes.

For galvanized surfaces of assembled framing, comply with ASTM A 780 for cleaning field welds, bolted connections and abraded areas and application of galvanizing repair paint.

For shop-painted surfaces, clean field welds, bolted connections, and abraded areas, immediately after erection. Apply paint to exposed areas using same material as used for shop painting.

3.4.4 Fill anchor holes with non-staining mortar or sealant.

Where dowel holes occur at pressure-relieving joints, provide compressive material above and below dowels.

3.4.5 For stones supported on clip or continuous angles, set stones on non-corrosive and non-staining shim material in sufficient area to support the load. Mortar may be used in lieu of shims provided that setting pads are provided to maintain joint sizes if stone weight squeezes out mortar.

Place setting buttons of adequate size, in sufficient quantity, and of same thickness as indicated joint width, to prevent mortar from squeezing out and to maintain uniform joint widths. Hold buttons back from face of stone to provide space for backer rope and sealant.

The joint between bottom of relieving angles and top surface of stones below angles shall be free of mortar or shims to avoid load transfer.

3.4.6 Install concealed flashing at continuous shelf angles, lintels, ledges and similar obstructions to the downward flow of water so as to divert such water to the exterior.

3.4.7 Keep cavities open where unfilled space is indicated between back of stone veneer and backup wall; do not fill cavities with mortar or grout.

3.4.8 Place weepholes/vents in joints where moisture may accumulate including base of cavity walls, above shelf angles and flashing. Locate weepholes/vents at intervals not exceeding 2′ and those serving as vents only, at intervals not exceeding 5′ horizontally and 20′ vertically.

3.4.9 Where mortar is used in setting stones on anchors or elsewhere, rake out mortar from joints to depths adequate to receive sealants and sealant backings

3.4.10 Embed ends of lugged sills on shims or mortar; leave balance of joint open until final sealing.

3.4.11 Set the stonework with open vertical joints for installation of joint sealants. Use no shims or spacers in vertical joints.

3.5 installation of joint sealants:

Specified in Section 07900.

3.6 adjusting and cleaning:

3.6.1 Repairing Damanged Stone: Repair of stone is an accepted practice and will be permitted. Some chipping is expected; repair of small chips is not required if it does not detract from the overall appearance of the work, or impair the effectiveness of the mortar or sealant. The criteria for acceptance of chips and repairs

will be per standards and practices of the industry unless other criteria are mutually agreed upon by the limestone supplier and the architect.

3.6.2 Remove and replace stonework of the following description:

Stones so damaged that repair is impossible, either structurally or aesthetically.

Defective joints.

Stones and joints not in conformance with approved samples and field-constructed mockups.

Stonework not complying with other requirements indicated.

3.6.3 Replace in manner which results in stonework conforming to approved samples and field-constructed mockups, complying with other requirements and showing no evidence of replacement.

3.6.4 Clean stonework using clean water and stiff bristle fiber brushes. Do not use wire brushes, acid type cleaning agents, or other materials or methods which could damage stone. Mechanical or pressure cleaning methods may be used if approved by architect. Protect limestone when adjacent brick is being acid-washed.

3.7 protection:

Provide final protection and maintain conditions, in a manner acceptable to fabricator and installer, which ensures stonework being without damage or deterioration at time of substantial completion.

VI. SPECIFICATIONS FOR ASHLAR STONE VENEER AND SAWED STONE TRIM

This section can be used alone when the project requires only coursed or rough ashlar. It should be included with other sections in those projects where such stone use is in addition to cut stone.

1. work included

The work included in this section shall include all labor and material for the furnishing and setting of all interior and exterior Indiana Limestone ashlar veneer and sawed stone trim in accordance with drawings.

2. stone

A. General. Stone shall be (coursed ashlar) (webwall) (drywall)—specify—Indiana Limestone quarried in Lawrence, Monroe, and Owen Counties and produced by a member of the Indiana Limestone Institute.

B. Color. The stone shall be (unselected for color) (all buff) (all gray) (____% buff and ____% gray)—specify.

(use following for coursed ashlar only)

C. Finish. The face surface of the stone shall be (split face) (shot sawed) (chat sawed)—specify.

D. Dimensions.

1. Bed thickness shall be between 3″ and 4″.

2. Course heights shall be furnished in the following percentages: 15%—2 1/4″; 40%—5″; 45%—7 3/4″. (Specify other percentages and rises.)

3. Stone lengths shall be random, varying between 1′-6″ and 4′-0″, and shall be jointed at the job to lengths conforming to approved jointing pattern.

(use following for webwall and drywall only)

C. Finish. The face surface of the stone shall be rough broken.

D. Dimensions.

1. (Webwall only) Bed thickness shall be between 2″ and 6″.

(Drywall only) Bed thickness shall be _____ (specify: between 3″ and 4″ when used as veneer; random, varying between 4″ and 2′-0″ when used as full-thick or retaining wall).

2. (Webwall only) Exposed faces shall vary from 1/2 to 3 sq. ft.

(Drywall only) Exposed stone edges shall vary between 2″ and 6″ high.

E. Sawed stone sills and coping. These items shall be (specify color) Indiana Limestone sawed or otherwise dimensioned to the sizes shown on drawings, and anchored as shown or as detailed in large scale sections.

(following applies to all types)

3. setting stonework

A. Stone shall be set in strict accordance with approved profile and jointing pattern. Joints shall be _____″ wide (specify).

B. Stone shall be anchored with non-corrosive wall ties spaced not over 18″ horizontally and 24″ vertically.

4. mortar

Mortar shall (be as specified for other masonry units) (conform to Type _____ (specify), ASTM C-270 requirements) with final color to be approved by architect.

5. handling and storage

All Indiana Limestone shall be shipped, unloaded and stored in such a manner as to avoid excess breakage and stain. Stone shall be stored at the job on planks, pallets, or timbers, clear of soil and soil splash.

6. cleaning

Finished stonework shall be washed clean and free of dirt, mortar and other objectionable accumulations. Remove mortar droppings and smears as work progresses. Final cleandown shall include brushing with fiber brushes and mild soap or detergent, and rinsing with clear water. Use no acids without prior approval. Protect stonework from rundown or splash when using acid on adjacent materials.

notes on ashlar stone

Coursed or random ashlar is defined as "Semi-Dimensional," having exact course heights and bed thickness, furnished in random lengths for jobsite fitting.

These products are used to best advantage when the variations of grain and natural characteristics are allowed to complement the stone color and jointing pattern.

Sawed or split stone is usually furnished between 3 1/2″ and 4″ thick. The individual fabricator will produce only one dimension, but stones from various fabricators will not exceed 4 ″unless otherwise specified.

Where greater than standard course heights are required, they should be specified as 10 1/2″, 13 1/4″, and 16″. These heights will work out well with the standard heights, but the changes in percentages will have to be specified. Standard heights are also available in other percentages, such as 50% 2 1/4″, and should be specified when desired.

When sawed or split ashlar is used in a random pattern, it is suggested that no vertical joint in the pattern be higher than the highest course height being used, no horizontal joint be more than three stones long, and that no two stones the same height be placed end to end.

ILI Technotes

Safety Factors

The following safety factors are intended as general guidelines for determining maximum design loads and stresses in Indiana Limestone, and in anchors and supports for Indiana Limestone. These values represent the minimum safety factors which the Institute considers to be good practice for most applications. The designer must always use judgment based on the specific application to determine proper safety factors. Proper safety factors may be more conservative than the values suggested in this bulletin, depending on the specific condition under consideration.

The physical properties of Indiana Limestone should be determined by lab test for the specific stone to be furnished. In lieu of lab tests, the minimum properties as listed in the Indiana Limestone Handbook*, "Performance Tables," may be used to determine maximum allowable working stresses.*

Safety Factors

STONE STRESSES

1. Stress Modes—Bending

1.1 Gravity Loads

Stone stressed in bending due to gravity loads: Use not less than 8 to 1 safety factor applied to the modulus of rupture to determine maximum allowable extreme fiber stresses.

1.2 Lateral Loads

Stone stressed in bending due to lateral loads (wind loads or seismic loads): Use not less than 8 to 1 safety factor applied to the modulus of rupture to determine maximum allowable extreme fiber stresses. A stress increase of 1/3 is permissible when the building code for the project permits this increase for other building materials. This provides a safety factor of not less than 6 to 1 for lateral load bending stresses.