V–11. Masonry Veneer Design Under the Uniform Building Code

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ABSTRACT

Masonry Veneer has been used for ages, since before B.C. (Before Codes). Some of the items passed on from father to son and so on and so on and so on have been necessarily codified for modern use. One example is the Uniform Building Code, Chapter 30 VENEER. It is rather well set up on a rational basis, especially so for a code, i.e., it is both performance and prescriptive oriented. Its outline and structure can be clarified for effective use by a simple Commentary on the various items, i.e.:

1. *There is a listing of General type limiting factors.*
2. *There are two types of Veneer, Adhered and Anchored.*
3. *The Design Criteria is 50 psi for Adhered and twice the weight for Anchored.*
4. *In lieu of design one may use certain Standard time proven specification methods such as*
   a. *Mortar bonded*
   b. *Paste bonded*
   c. *Masonry and Stone (5" maximum thick) anchored*
   d. *Stone (10" maximum thick)*
   e. *Slab Type units*
   f. *Terra Cotta*

Discussion of the items, details and methods can clarify and simplify the use under the well outlined codification. It can also help to avoid difficulties or embarrassing failures. (like the examples shown)

Masonry veneer has been a construction technique for many years, dating from before modern codes. There are now many codes that govern veneer installations but the Uniform Code has developed a rather sound design control, perhaps because of developing under the threat of hazard of earthquakes. However, in spite of its excellent provisions it has been misinterpreted frequently and must be read very carefully. It represents a subject that has required much explanation, such as that done by the Masonry Institute of America, who published clarifying brochures on it. This paper is intended to clarify the Uniform Building Code Veneer design provisions for greater ease of use. It is the basis for an explanatory slide program for further education.

Masonry Veneer, rich legacy from antiquity, has come to us in many forms, from many places through the ages, as a way to add love, life, and beauty to drab structures. There were many sources, e.g., Mycenae . . . from *long* before Christ, Greece . . . from *shortly before* Christ, Romans . . . *before* and *after* the time of Christ, Byzantines,—The Blue Mosque, and others, in which they demonstrated such a high skill in color, texture, and shading. Then there was the Renaissance, with its magnificent temples of worship, which lead into our modern age, in which we now need, and have codes and laws for control of all building methods. Hammarabi also had this need, and provided a simple performance code some 5000 years ago. Our modern Uniform Building Code, with its police enforcement, is more complex. However, by knowing and following these codes we benefit by the beauty of masonry along with its durability.

Of course we do not now require that our veneer survive for 3000 years, but we do like its permanence, low maintenance, and resistance,—Resistance to:

Time
Weather
Fire
Earthquakes
Termites (Its not on their diet)
Rodents—we do not see rat holes in brick walls

Also we like it for its economical solutions to the architects' functional and aesthetic problems.

The present codification of Veneer in the Uniform Building Code makes it one of the more reasonable codes. The purpose of this presentation is to clarify and emphasize some of the provisions so it may be used more easily and authoritatively. Briefly, in principle, it provides for performance by design, as well as for use of traditional prescriptive methods. It imposes certain general type limits, and certain General design items.—Then it classifies or defines the two types of Veneer—Adhered and Anchored,—and provides for use of traditional alternate Standard methods.

Outline

General Limits
General Design
Types
  Adhered
  Anchored
Standards

It states the specific design criteria for each—50 psi for Adhered—and twice the weight for Anchored. Having thus provided for engineered design and use, it then states "In lieu of design one may use time-proven methods that are listed in the Standards Volume."

This is a commendable code provision, that is, the alternate of either *Performance* or *Prescription.* The design profession is thus given the excellent option of freedom to design and detail an installation to a performance requirement, or to simply use a satisfactory specification method, without design, on a prescriptive basis. Many other jurisdictions have adopted similar provisions, some with local improvements or variations, e.g., Los Angeles City, Los Angeles County, San Francisco and other Codes.

So much for generalities, lets now talk about the specifics of The Uniform Building Code:—a long way from Hammarabi. (See Figure 1) The *scope* states that all veneer shall comply with the Code, and it exempts Wainscotes which are not more than 4′ high, and interior or bathroom tile. This is because they would not be a hazard to life or to "Building and Safety."

One of the General type limitations imposed is that Veneer shall not be supported by wood over 25′ above the ground. This is in recognition that wood shrinks in time with moisture changes, (and with termites)—But the veneer does not deflect, and the greater the height the greater the differential between the two,—and hence the greater the hazard. The *practical limit* imposed, 25′, is about the maximum height of a one-story store with parapet, or office, or a two-story flat, or office, and it has been found to be a generally satisfactory construction. For heights greater than 25′ special design and details may be provided to accommodate them.

There are *definitions* of terms to help keep the language clear. And there is freedom of choice of support and materials—whatever can do the job!

Masonry
Concrete
Cement plaster

Of course, the anchors must be permanent. (See Section 3003)

Veneer is specifically *non-structural* in that it does not carry building load.

One paragraph states that "Consideration shall be given for differentials due to movement, temperature, shrinkage, creep and deflection."—It is a simple statement but a potent one, full of meaning.

Let's note a drawing of the elevation of a marble veneered building to show what happened due to deflection of the support. A building with a pre-stressed thin flat slab floor supported veneer. The structure was strong, although the slab could deflect, while doing its job safely. But the 5′ deep spandrels of the veneer could not deflect similarly,—so the anchorages pulled apart—and some slabs fell into the street! Yes, the effect of differential movements can be serious! (See Figure 2.)

Another serious item is touched on lightly in that statement in Section *3004* ". . . temperature changes,—shrinkage . . . ." This brings up the important subject of expansion joints. For example, an Adhered Veneer where a dark surface exposed to the sun may become up to 100° hotter than the shielded base and will expand—while a fresh concrete backing is shrinking, as in paving. This results in a doubled shearing force in the cushion zone—tending to destroy bond. Some calculations indicate that control joints to relieve such stress should be not more than 12′ to 16′ apart, though some practice has indicated that 16–20′ is a satisfactory spacing. (See Figure 3) Yes, there is a great deal of meaning in that simple requirement. We reiterate, the design criteria for an Adhered Veneer assembly is simply—*develop 50 psi,* and for an Anchored Veneer assembly is simply *develop twice the weight.*

These requirements are probably greater than might seem necessary but they are to provide extra safety in view of the fact that there may be large indeterminate temperature changes and volume changes and building movements,—and methods of installation may be imperfect—and the extra safety is not costly. . . . Also the hazards to public life and safety may be great, since veneer is so frequently installed above public ways.

There are some additional General type requirements, for example: *Exterior veneer* must provide a weather proof covering. *Unlimited* area is permitted except as required to control expansion and contraction. The *unit size* is arbitrarily limited in recognition of the practical difficulty of satisfactory installation of large size units. There is an exception for very lightweight units, however, beause large units may be installed easily in a workmanlike manner if the material is extremely lightweight.

Section 3006 permits the use of the traditional specification type of provision in the Standards volume, "in lieu of design."

Now let's discuss *Anchored Veneer.* Section 3006(b) provides that the stiff unbending masonry veneer will not be subjected to the distress that would be caused by flexible or deflecting supports. Such differentials between the two may impose excessive stress on the anchorages.

"Supported at not more than 25′ and at not further than 12′ apart above that."—Normally this might be considered as at story heights.

One must check the design deflection of the support and of the veneer. This shall not be more than 1/500 of the span.

And now ". . . in lieu of design" use one of the old proven standard methods that have worked for years. Let's show some of these successful methods that are specified—which may be shown on blueprint details: Section 30.103 for Adhered Veneer. . . . .The key to this method is the note in the lower right hand corner, i.e., clean moist surfaces of unit and backing, with neat cement paste coating, mortar applied to each, and units pressed into place. (See Figure 4, Method 1)

No. 1 is a similar method but with thin portland cement paste as the bonding agent, consequently the units must be precise in thickness. "Paste applied to units and to the true surface of the backing. Then units pressed or tapped into place." (Figure 5, Method 2) (The paste may be dryset material)

The general requirements we mentioned above and showed on the drawing for *anchored veneer* are summarized or reiterated in this table.

GENERAL

- Design criteria, 2 × wt.
- Backing, any Code acceptable material

- Carries no load other than itself
- Units not too big to handle
- Corrosion resistant ties
- Support that will not settle nor deflect
- The height limit of 25′ for veneer supported by wood

Some detail methods are, *Anchored Veneer*—for masonry units up to 5″ thick anchored to *concrete or masonry*. Note the alternate of spot bedding shown in the lower half of the drawing, in lieu of solid fill. (See Figure 6.) Also 5″ thickness anchored to *studs*. This might be considered as similar to half of a two wythe solid grouted wall, with ties anchoring to the studs.

Others are listed. There is Stone Veneer, up to 10″ thick, anchored to Concrete, Masonry, or to Wood or Steel Studs. And Veneer of Slab Type units, such as marble, attached to Concrete or Masonry or to studs. There are modifications of that code provision for installaion of Marble.

And then the old reliable, ornate and beautiful Terra Cotta, so very widely used in the past era. (See Figure 7.)

Ornate Griffins were installed by W.L. Dickey in 1925. (See Figure 8.)

The installation of veneer tied to studs has been a very effective use of Veneer. It provides the dignity, the beauty, the low maintenance and the permanence of brick, with low weight imposed on the structural beams, columns and footings. However, especially in a multi-story construction, the connections of the veneer–stud assembly to the structure must be carefully detailed to provide support perpendicular to its plane, while permitting story to story drift parallel to its plane. (See Figure 9.) One simple detail is a bolt or strap serving as a strut tie. It is stiff enough to serve as a short strut for earthquake or wind against the face. But it is long enough to be flexible, to permit one floor to drift in the direction of the wall plane relative to the adjacent floor. This, of course, requires that the wall areas be free to move, and hence must be well caulked at joints that provide for such motion. Another method is the use of bolts in slotted holes. These, however, require extreme care in construction to assure motion in the right direction without binding. (See Figure 10.)

These veneer methods are shown in brochures on drawings for installation:

on masonry
on studs with a cement plaster
on studs with a "true" surfaced plaster

Another increasingly important factor in construction is the installation of *insulation*. (See Figure 11.) It is protected here by the weatherproof durable veneer exterior face, while conserving precious energy. One item that is not listed in the UBC—but is not prohibited,—has been used in many successful installations. It is the thin set method included in ANSI specifications. ANSI 118 is for the modified portland cement material and ANSI 108 is for the installation method. The thin set cement contains a water retention agent to prevent excessively rapid drying or water loss. The cement may hence be applied in a thin layer, ridged with a comb type trowel, and the units pressed into place.

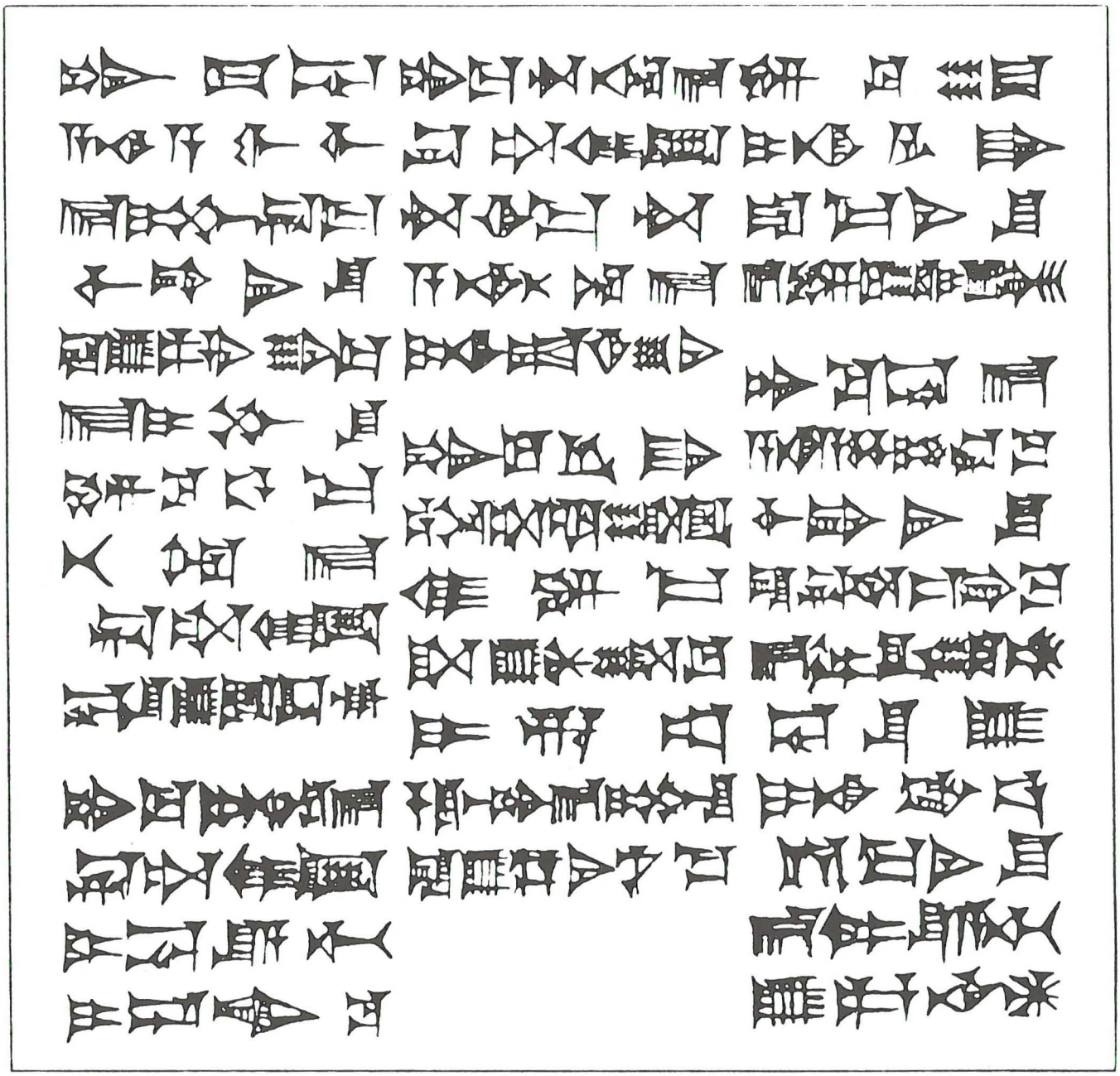
One method of providing the mortar joint between units is with a cake frosting decorator, which is more correctly known as a grout bag, to keep the surface clean rather easily. This is especially important with *brick* veneer because mortar bonds so well into the pores of clay brick. This emphasizes an important point. The best way to *clean* it is to KEEP IT CLEAN, *not* to CLEAN IT later. However, if mortar does dirty the surface and is not removed promptly, light sandblasting may be used to remove it. This must be done carefully or the dense surface of the brick and the tooled surface of the mortar joints will be removed, exposing cracks and permitting leaks.

In summary, the Veneer Chapter of the UBC may be used to design installations to fit specific needs quite easily and effectively.

Any of the masonry materials may be used
A few general type limits must be observed, under UBC and many types of veneer may be used, effectively
Adhered Veneer—designed to develop 50 psi or:
Anchored Veneer—designed to support twice the weight of veneer *or:*

Certain proven traditional standard methods may be used
Adhered by mortar
Adhered by cement paste
Units anchored to concrete or masonry
Units anchored to studs
Anchored stone
Slabs anchored to concrete or masonry
Slabs anchored to studs
Marble type tied veneer
or Ceramic Veneer
and the old Terra Cotta

Masonry Veneer is a successful tool easily used by the Architect, Engineer, Designer or Builder to satisfy his client.—As it has done for centuries, it will continue to serve man's need for beauty, combined with utility.



FROM THE CODE OF HAMMURABI (2200 BC)

IF A BUILDER BUILDS A HOUSE FOR A MAN AND DOES NOT MAKE ITS CONSTRUCTION FIRM AND THE HOUSE COLLAPSES AND CAUSES THE DEATH OF THE OWNER OF THE HOUSE—THAT BUILDER SHALL BE PUT TO DEATH. IF IT CAUSES THE DEATH OF A SON OF THE OWNER—THEY SHALL PUT TO DEATH A SON OF THAT BUILDER. IF IT CAUSES THE DEATH OF A SLAVE OF THE OWNER—HE SHALL GIVE TO THE OWNER A SLAVE OF EQUAL VALUE. IF IT DESTROYS PROPERTY—HE SHALL RESTORE WHATEVER IT DESTROYED AND BECAUSE HE DID NOT MAKE THE HOUSE FIRM HE SHALL REBUILD THE HOUSE WHICH COLLAPSED AT HIS OWN EXPENSE. IF A BUILDER BUILDS A HOUSE AND DOES NOT MAKE ITS CONSTRUCTION MEET THE REQUIREMENTS AND A WALL FALLS IN—THAT BUILDER SHALL STRENGTHEN THE WALL AT HIS OWN EXPENSE.

Figure 1.

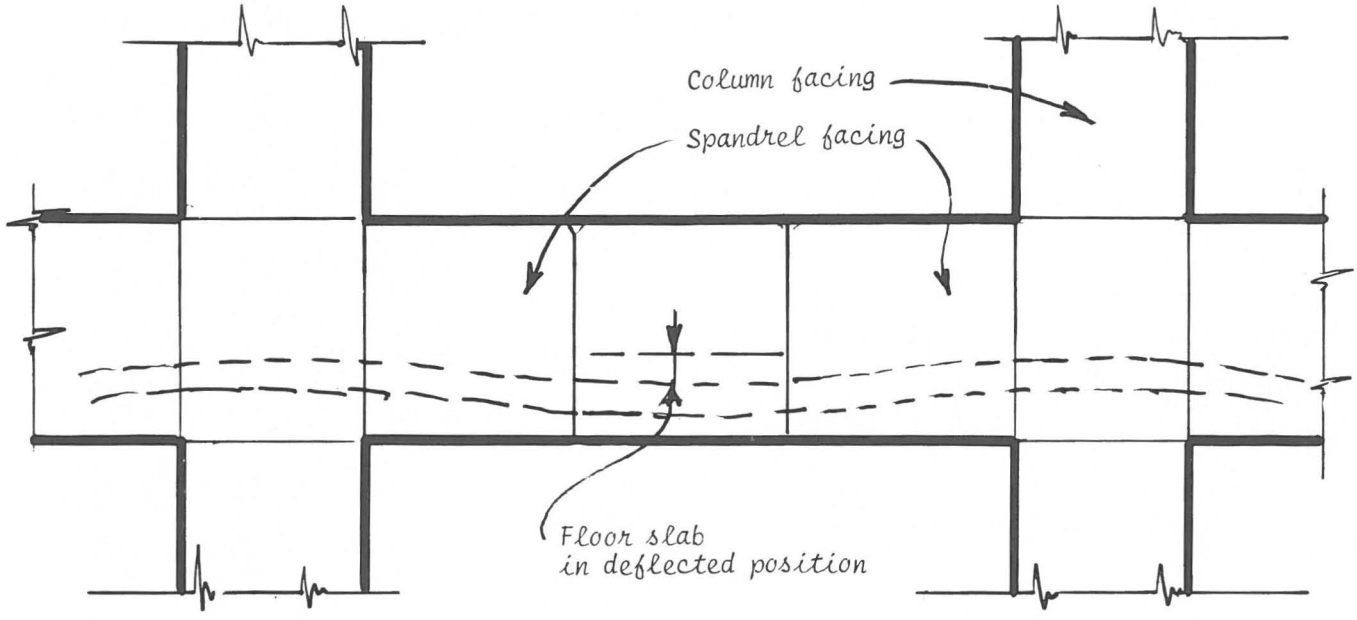
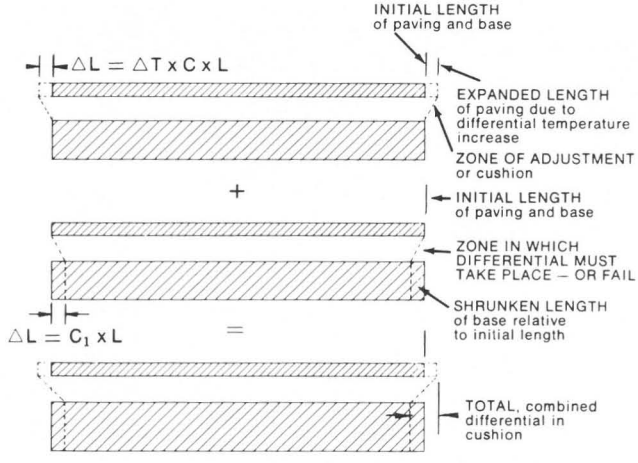


Figure 2.



This shows the cumulative differential effect of paving expansion and base shrinkage. This results in a double shearing stress and tendency to force curvature. Both these factors will have an additional tendency to destroy bond between the surface paving and the base, with consequent possibility of distress.

The advantage of close spacing of expansion joint is the reduction of stress accumulation.

Figure 3.

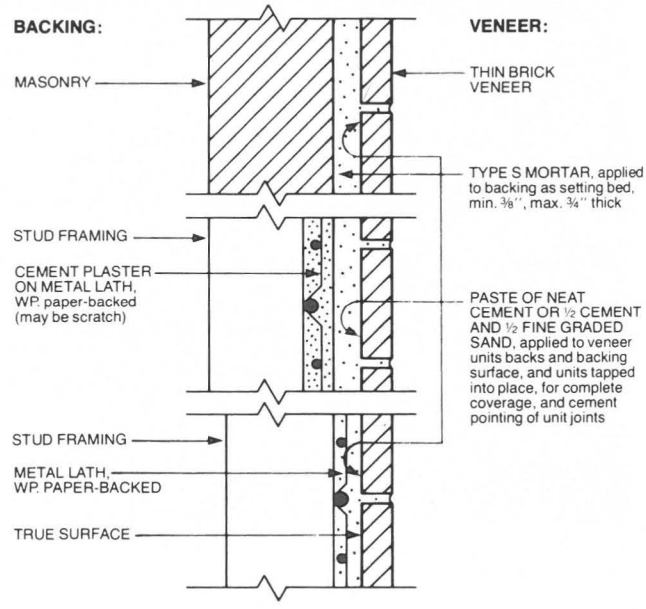


Figure 4. Method 1—Adhered Veneer

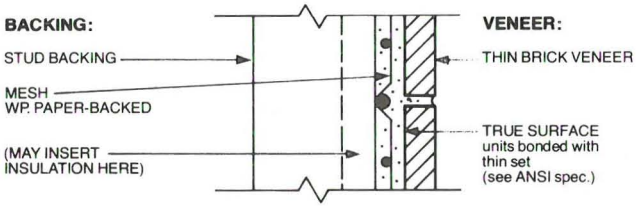


Figure 5. Method 2—Adhered Veneer

Figure 7.

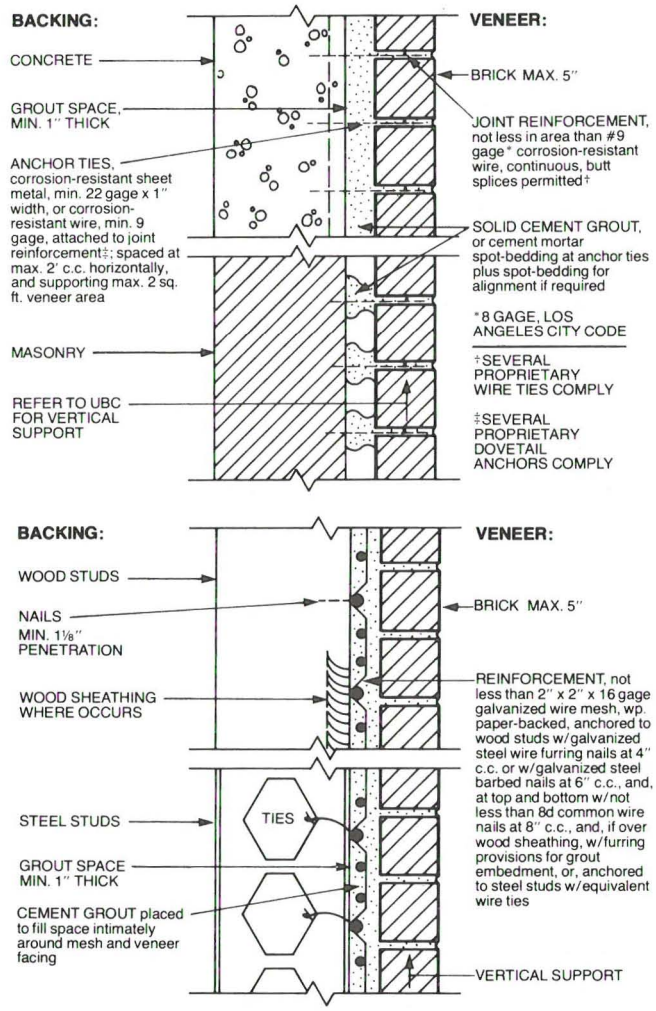


Figure 6. Anchored Veneer

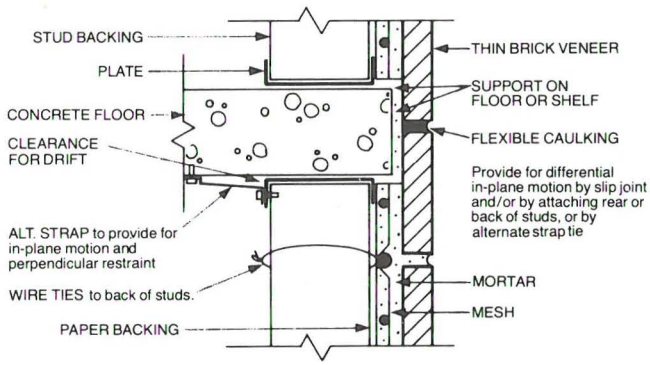


Figure 9.

Figure 8b.

Figure 8a.

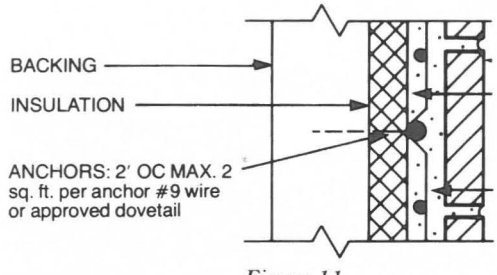


Figure 11.

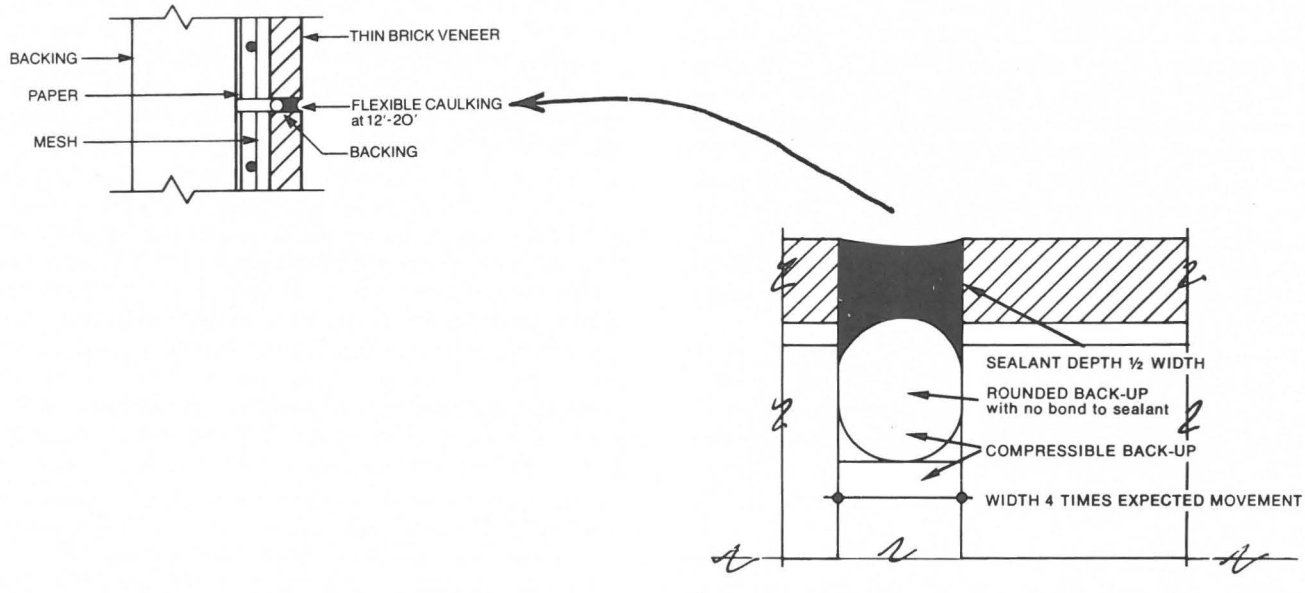


Figure 10.