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Adhered Masonry Veneers

A Modern Approach
to Wall Systems

By Peter Loughney

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Masonry veneers are divided into two major categories, anchored veneers and adhered veneers. Most of us are at least familiar with anchored masonry veneers, defined by the TMS 402-11/ACI530.1-11/ASCE 5-11 code as: “Masonry veneer secured to and supported laterally by the backing through anchors and supported vertically by the foundation or other structural element.” However, the other method, adhered masonry veneers, defined by TMS 402-11/ACI530.1-11/ASCE 5-11(TMS402), as: “Masonry veneer secured to and supported by the backing through adhesion”, has a rich history and is broader in application than generally realized.

Richard P. Goldberg, Architect AIA, CSI, provides a brief history of thin cladding systems going back to 2700 B.C. when ceramic tiles were used to decorate graves of Egyptian Pharaohs. The oldest known exterior cladding is the Dragon of Marduk sculpture for the Istar Gate in Mesopotamia dating to 604 B.C. By the 13th century, ceramic tile was used extensively on the exteriors of prominent buildings throughout the Middle East. The influ-

ence of Islamic architecture spread through Spain and Italy by the 16th century, and has since become a familiar decorative and functional exterior cladding. In the 1950s, the invention of modern stone cutting equipment coupled with the invention of new adhesive products by the newly formed LATICRETE International, made direct adhesive attachment of ceramic tile, natural stone and thin brick to modern building façades practical and economical.

Design

Requirements for the design and construction of adhered masonry veneers can be found in the 2012 *International Building Code* (IBC) and the TMS 402 code, as well as its companion Specification TMS 602-11/ACI 530.1/ASCE 6-11 (TMS 602). For residential application requirements refer to the *International Residential Code* (IRC). Many jurisdictions may have local code requirements which should be considered as well. Adhered veneers fall within the scope of Chapter 14 of the IBC which requires compliance with provisions contained in IBC Section 1405.10 and with provisions contained in TMS 402, sections 6.1 and 6.3; and in accordance with manufacturer’s instructions.

In addition to the code requirements noted above, all adhered masonry veneers require a backing system. Acceptable options per the IBC include: concrete, masonry, steel framing or wood framing. Structural design requirements for these wall systems are found in IBC Chapters 19 -23.

Note that the design of metal and wood framing systems may require extra vigilance with respect to allowable deflection limits, stud spacing, and protection requirements for framing in contact with masonry or concrete, sheathing exposure ratings, general fastener requirements and fastener requirements and patterns for sheathing.

Detailing

Within Section 1405.3 are directions for vapor retarder requirements for the interior of frame walls for Climate Zones 5,6,7,8 and Marine Zone 4 (defined in Chapter 3 of the *International Energy Conservation Code*). Designers of frame systems in these zones should carefully review this section, and may wish to consider having a condensation analysis performed before completing the final design.

IBC Chapter 14 also contains requirements related to weather protection. While concrete and masonry wall systems are granted an exception to the weather resistant exterior wall envelope requirements, IBC provisions for metal and wood framing systems are quite specific:

1403.2 Exterior walls shall provide the building with a weather-resistant exterior wall envelope.

The envelope is required to provide flashing and to be designed in such a manner as to prevent the accumulation of water within the wall assembly by providing a water-resistive barrier behind the exterior veneer and a means of draining water that enters the wall assembly to the exterior. Protection against condensation must be considered as well.

A potentially overlooked IBC provision for water-resistive barriers over wood based sheathing is included in Section 2510.6. Although Chapter 25 contains requirements for Gypsum Board and Plaster, Section 2510.6 specifically includes wood-based sheathing. Water-resistive barriers over wood must also be vapor-permeable with a performance at least equivalent to two layers of Grade D paper. The section also states individual layers are further required to be applied independently in such a manner as to provide a separate continuous plane. Any flashing intended to drain to the water-resistive barrier is directed between the layers.

Flashing requirements at the foundations are addressed in Section 1405.10. An acceptable flashing material installed from 1 inch below the plate line to 3½ inches above is required. The top of the flashing is to be lapped over by the water-resistive membrane coming down from above. For exterior stud walls, clearances from contact with horizontal exterior surfaces are called out; from earth, 4 inches, from paved areas 2 inches and from exterior walking systems supported by the same foundation ½ inch.

TMS 402 Design & Detailing

Design and detailing requirements for masonry veneers, both anchored and adhered, are addressed in Chapter 6 of the TMS 402 code. Provisions in this chapter also cover dimension stone for adhered applications, but not for anchored stone veneer which is considered a Special System.

General design requirements include:

- design and detailing of a backing system that will resist water penetration,
- flashing with weep holes at least $\frac{3}{16}$ inches in diameter spaced no less than 33 inches on center, and
- the design and detailing must accommodate differential movement.

Specific design options are found in TMS 402 Section 6.3. There are two options, alternative design of masonry veneer and prescriptive requirements for adhered masonry veneer. The alternative method allows designer professionals more latitude in material size and thickness, but requires more research and engineering to ensure the backup systems is adequate.

Prescriptive requirements include: unit size, wall area limitations and backing. The unit size of adhered masonry veneers is limited to:

- 2 $\frac{5}{8}$ inches in thickness (maximum),
- 36 inches in any face dimension,
- no more than 5 square feet in face area, and
- the unit weight shall not exceed 15 psf.

These requirements are intended to reduce difficulties in handling and installation, and to assure a good bond. Wall area limitations are not restricted in height, length or area, except as necessary to control differential movement stresses between veneer and backing. Permitted backing systems include masonry,



Material may require a thorough cleaning to ensure adequate bond between the veneer and backing.

concrete or metal lathe, and Portland cement plaster applied to masonry, concrete steel framing or wood framing.

Adhesion is critical in adhered systems and is addressed in TMS 402, Section 6.3.2.4. Shear strength between the adhered units and the backing is critical to the performance of the system and for public safety. Minimum shear strength of 50 psi, based on the gross unit surface area, is required when tested in accordance with ASTM C482. There is an exception to the test. Under the TMS 602 Specification, 1.4C, if the veneer is placed in accordance with Article 3.3C (see the Construction section that follows), the test is not required.

Construction, Inspection & Testing

Construction, inspection and testing requirements are included in the TMS 602 Specification which is referenced in the TMS 402, IBC and IRC.

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Summary of code and specification provisions for adhered veneers.

Design Provisions
IBC Section 1405.10
TMS 402 Sections 6.1 and 6.3
Manufacturer's instructions (in addition to the code requirements)
Backing Systems
IBC Section 1405.10 – acceptable backing systems
IBC Chapters 19 – 23: specific requirements for design of the backing system selected
Detailing
Flashing – IBC Sections 1403.2, IBC Section 1405.10
Vapor Retarders – IBC Section 1405.3
Weather Resistance, Water-resistive barriers – IBC Section 1403.2, IBC Section 2510.6 (wood only)
Construction, Inspection & Testing Requirements
TMS 602



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Substantial differences in thicknesses are found in these two natural stone units, even though they are from the same batch.

Article 3 of the TMS 602 specification covers execution, or installation in the field. Adhered masonry veneer requirements are found in Article 3.3C 1-4. This article describes the installation process:

- Apply a neat paste of Portland cement to the back of the unit and to the backing.
- Apply a Type S mortar to the back of the unit and to the backing.
- Tap the unit into place completely filling the space behind the unit so that a small amount of mortar is forced from behind at the edges.
- The mortar on the back of the unit should be no less than 3/8-inch thick nor more than 1/4-inch thick.
- Tool when thumbprint hard.

In addition, both the TMS 402 Code and the TMS 602 Specification have an accompanying commentary which will prove invaluable to designers and installers alike. The commentary contains narrative, figures and diagrams, and references that will provide additional valuable information and insight into development of specific requirements and how they may be met. Careful review of the commentary is recommended. The *Table (page 15)* shows a summary of the code and specification requirements for adhered veneer.

Additional Considerations

In many applications, drainage mats will provide improved drainage, a capillary break and may help to prevent deterioration of the backing system. Drainage mats will generally be found outside the water-resistive barriers, but will need to be behind the metal lathe and scratch coats so the adhered veneer has a solid backing.

Continuous insulation layers may be desirable or even mandatory to meet requirements of the *International Energy Conservation Code*. Insulation layers are generally found attached directly to masonry or concrete backup walls.

For frame walls, there is typically a backer sheathing layer, an air/moisture/vapor barrier and then the continuous insulation. Beyond this, a water-resistive barrier and any drainage mat layers would be installed followed by metal lathe and scratch coat.

Lessons from the Field

A clear understanding of the manufacturer's instructions is imperative. Products are constantly being improved and modified, and manufacturer's instruction are regularly updated and improved. Be sure you have the latest instructions. If questions remain, contact the manufacturer or the technical representative for your area.

Original designs do not always survive to the construction phase. Bid day alternates, value engineering and last minute supply issues often result in substantial differences between original designs and built installations. While this often results in cost savings or schedule improvements, care must be taken to ensure that these design modifications still meet the design intent, and that all elements of the systems are compatible and will perform at the required level. Failure of one system component can result in less than satisfactory performance of the building envelope or worse, resulting in a public safety issue.

An adhered veneer application is only as good as the bond between the backing and the veneer. Masonry products often have dust on the outer surfaces from cutting or grinding during production or it may accumulate during shipping and handling. Additionally, backer systems can become dust covered or contaminated during installation or from being exposed on a construction site for any significant length of time. Manufacturer's installation instructions may include cleaning recommendations to remove any release agents that may be present resulting from the production process. In most cases, it is best for the installer to assume at least some cleaning or scarifying will be required in the field.

Mockup panels are used to demonstrate to the owner, design professional and CM spell out what to expect of the final installation. Mockup panels should represent the full range variances in size, color and shape or any other distinguishing features that might be found in the specified material. Installers may wish to order and inspect enough quantity of material prior to constructing the mockup panel to ensure that an accurate representation of the final installation is provided. All concerns and issues regarding the final appearance should be resolved before approving the mockup panel.



In any good masonry design, one must account for movement of the veneer and the backing. Cracks resulting from movement are unsightly and can be both difficult and expensive to repair.

Panels showing the full system: structural backing, water-resistive barriers, insulation, drainage mats, flashing, weeps, scratch coats, setting beds, veneers with grouting and tooling; completely cleaned and sealed, if required, will provide the greatest amount of information to all parties concerned. They can also serve as a good training reference when the full installation crew arrives on-site.

Movement control is essential in all masonry design, and adhered veneers are no exception. The TMS 402 Code requires that design professionals show, on the project drawings, provisions for dimensional changes resulting from elastic deformation, creep, shrinkage, temperature, and moisture. (1.2.2h) Movement control methods can vary considerably depending on the selected backup structural system and selected veneer. Movement control is particularly important in seismic regions.

Conclusion

Adhered masonry veneers have offered a popular alternative to anchored systems for a wide variety of applications. Modern systems date back to the early 1960s and successful examples, both large and small, can be found in nearly any town or city.

Considerable direction is provided by both the IBC and the TMS 402 Codes, and by manufacturer's instructions and product specifications, for design professionals to complete successful designs and detailing. The TMS 602 Specification and manufacturer's instructions provide direction to contractors and inspectors to guide installation in the field. ■

References

Direct Adhered Ceramic Tile, Stone and Thin Brick Façades, Technical Design Manual. Richard P. Goldberg, Architect AIA, CSI, ©LATICRETE International, Inc. 1998, P.10-12