

Veneer and Cavity Walls

Definitions
Behavior
Support

Lübecker Dom



Lübeck, Germany



Lübeck Innenstadt

Lübeck, Germany



Holstentor

University of Michigan, TCAUP



Masonry

Slide 3 of 27

Lübeck, Germany



Burgtor

University of Michigan, TCAUP

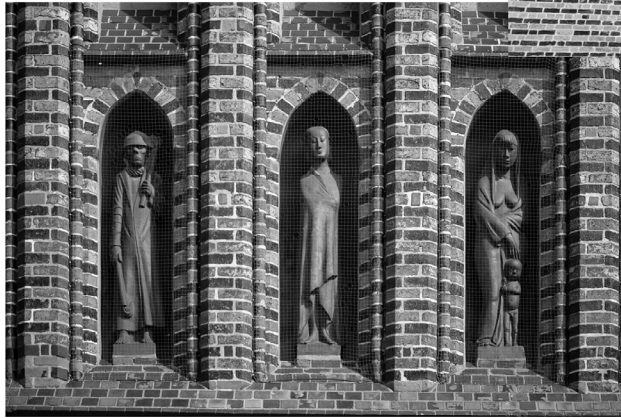


Lübecker Dom,
1173 - 1230

Masonry

Slide 4 of 27

Lübeck, Germany



Ernst Barlach

- Ernst Barlach
- 1870-1938



The Avenger, 1914



- Ernst Barlach
- 1870-1938



Der Schwebende (floating angel), 1927-1937 Güstrow Cathedral



The Singing Man, 1928

Masonry Veneer Walls

“Fake” walls

- Also called “veneer”
- Real brick
- Very thin 3/8” to 1”
- Applied with glue to wall board
- “Grout” squirted in



Masonry Veneer Walls

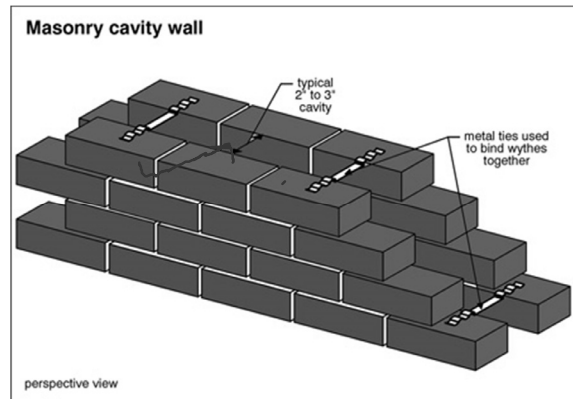
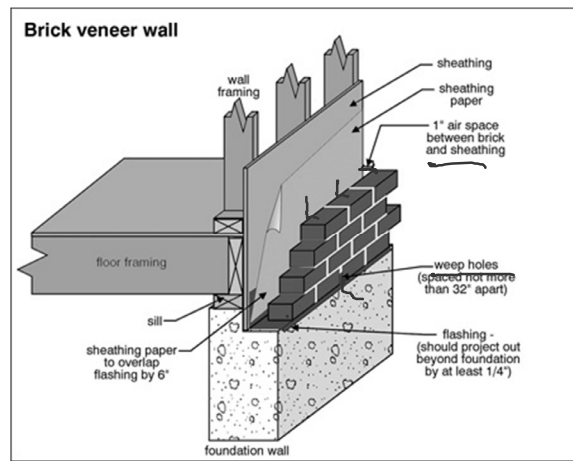
Veneer vs. Cavity Walls

Veneer

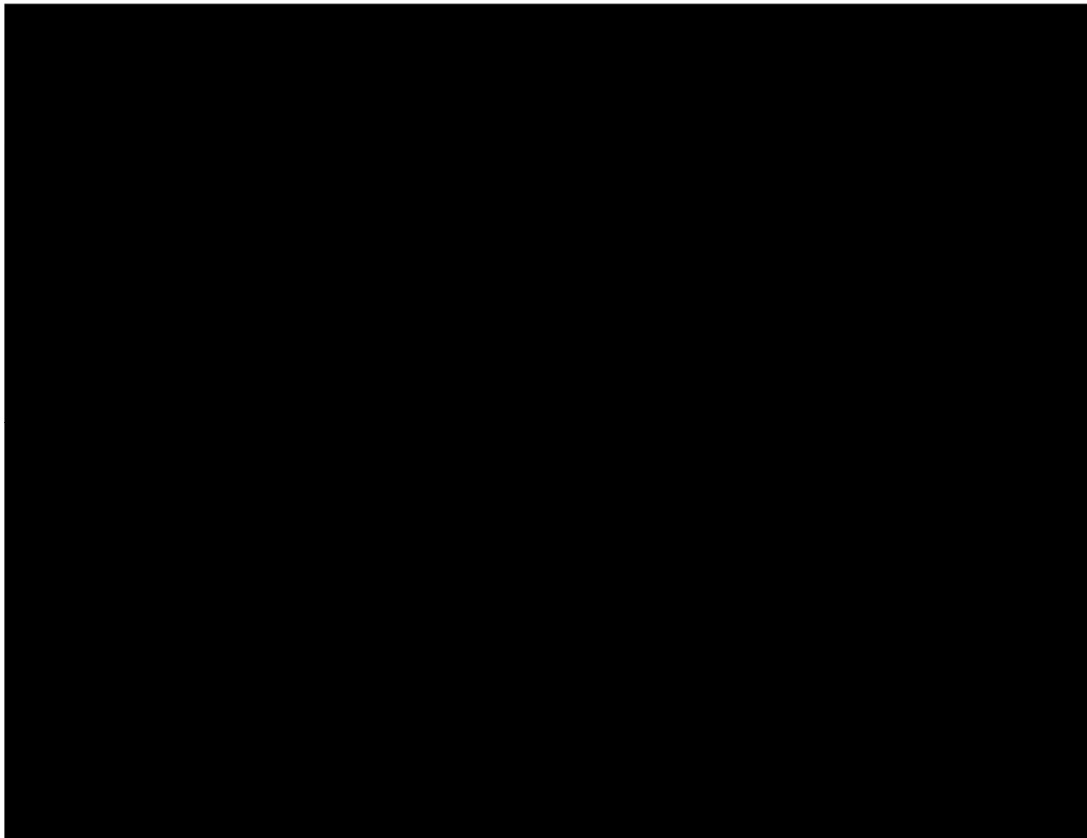
- Exterior facing
- Structural backing
- Anchored by ties
- Barriers to rain
- Non-loadbearing but carry wind, earthquake and selfweight

Cavity

- Similar to veneer
- Two wythes
- Both wythes carry load
- Joined by ties
- Insulated cavity
- Drainage

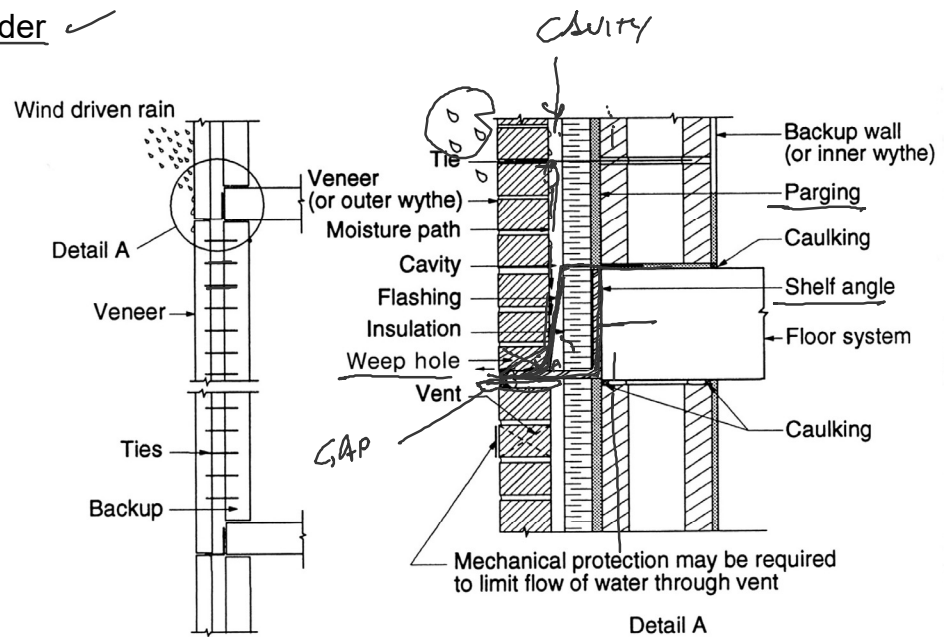


Veneer layup



Veneer Walls

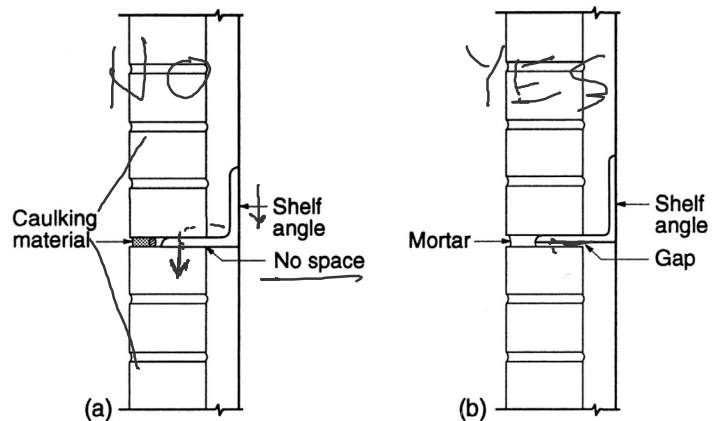
- Shelf Angle
- Cavity
- Backup wall (inner wythe) *STRUCTURAL*
- Ties and anchors ✓
- Weep holes and vents
- Compartment divider ✓
- Movement joints
- Flashing
- Air barrier



Veneer Walls

Horizontal and Vertical Movement

Thermal expansion loads need also to be considered.



Spalling of brick veneer at shelf angle.

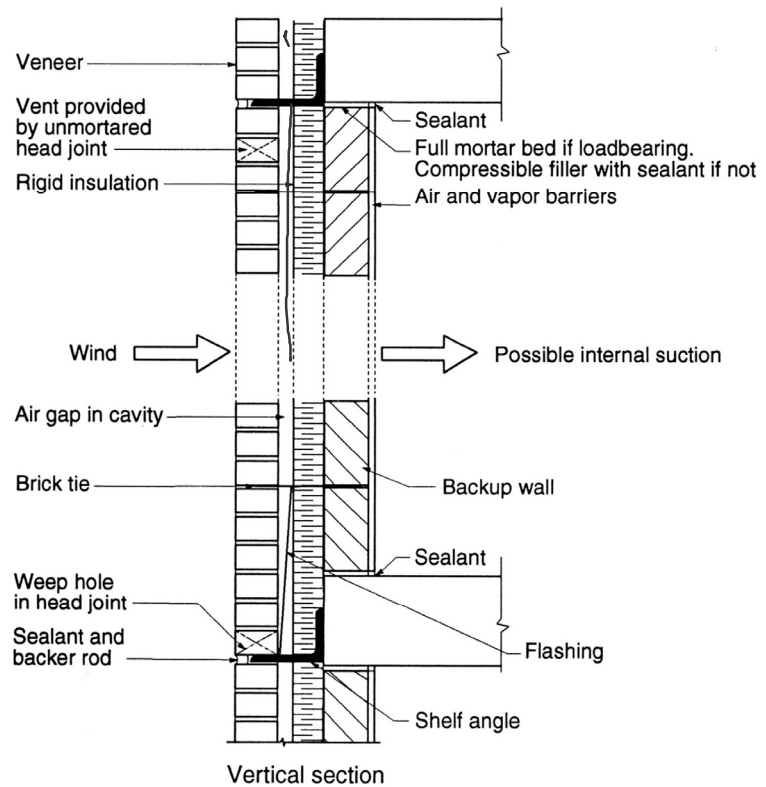
Veneer Walls

Rain Penetration:

- Air space
- Airtight backup wall
- Clean cavity
- Open weep holes
- Properly positioned flashing
- Quality materials

Results:

- Corrosion of ties ✓
- Poor air circulation ✓
- Mold
- Efflorescence
- Freeze cracking ✓
- Wet insulation
- Rotting wood
- Staining



Veneer Walls

Stage One - Outer Wythe Prevent water penetration

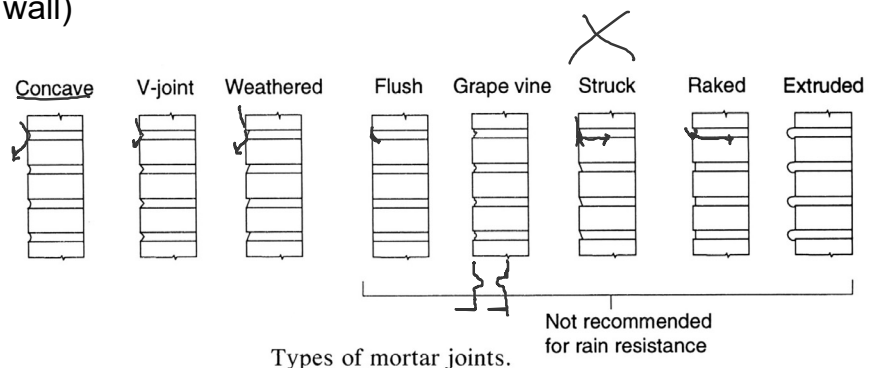
- Roof overhang ✓
- Gutters
- Drips under window sills
- Tooling ✓

Water penetration by:

- Gravity drainage
- Capillary action
- kinetic energy (hitting wall)
- Air flow



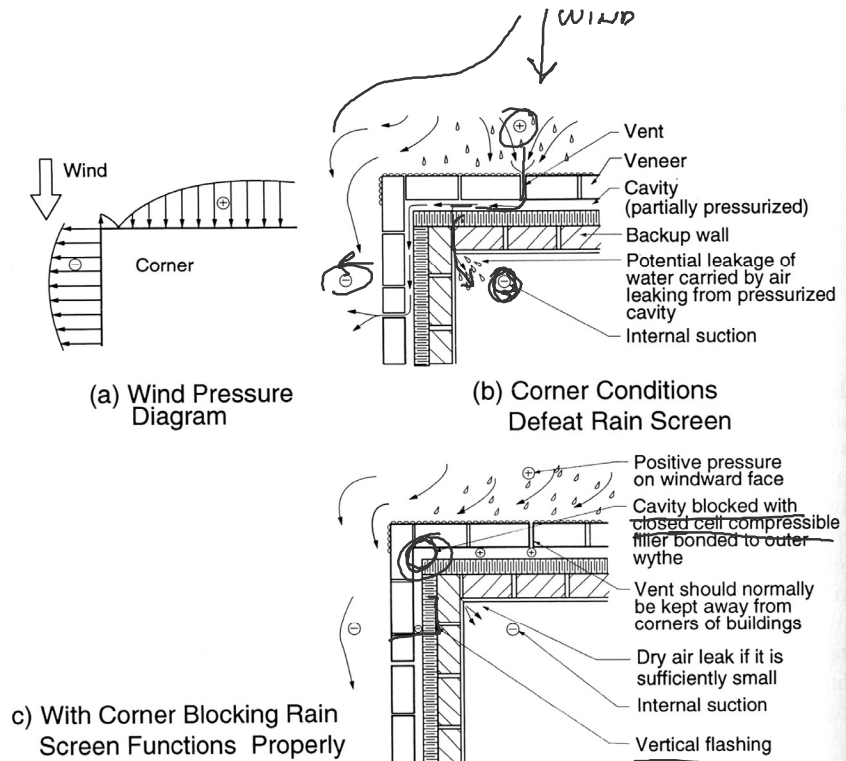
Tooling of mortar joints (concave type)



Veneer Walls

Stage Two

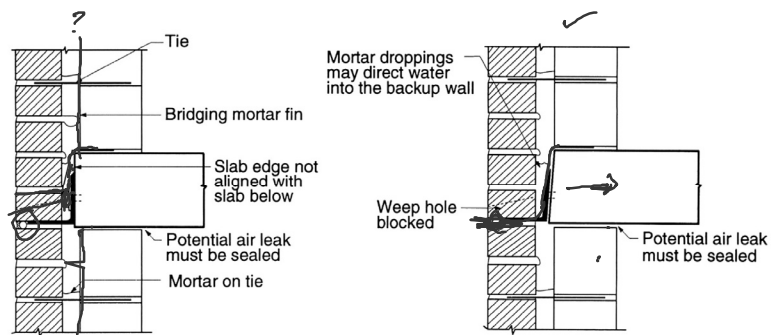
- Equalize air pressure
- Weep holes and vents
- Adequate air space
- Limit air flow
- Cavity blockers
- Vert. - Closed-cell foam
- Horiz. - shelf angle
- Spacing like movement joints



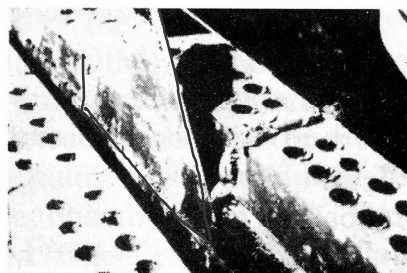
Veneer Walls

Stage Three

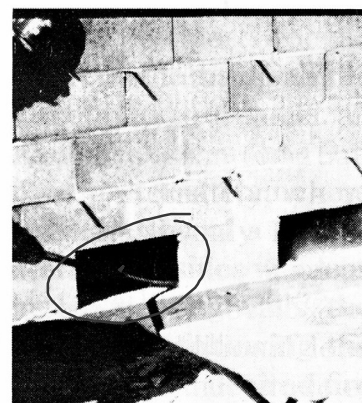
- Drainage system
- Air space cavity 1 1/2 to 2 in.
- Free of material (mortar)
- Clear weep holes
- Waterproof inner wall
- Membranes or parging



a) Wood strip to remove mortar droppings



b) Smearing the back with mortar



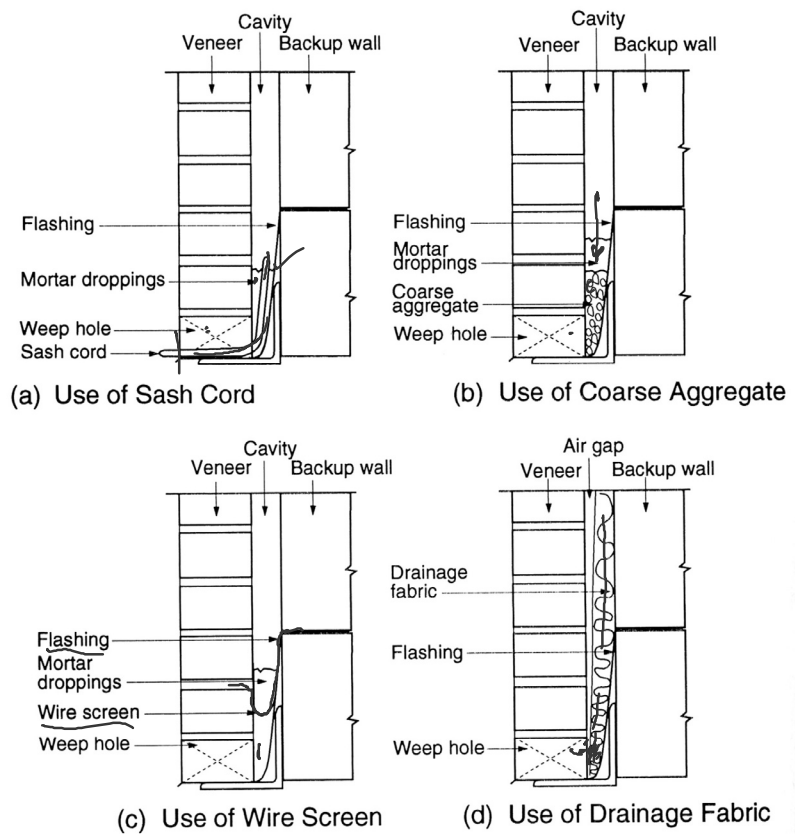
c) Leaving units out at the bottom for cleaning

Veneer Walls

Stage Three

- Drainage system
- Air space cavity 1 ½ to 2 in.
- Free of material (mortar)
- Clear weep holes

Keeping the drainage path open in cavity walls



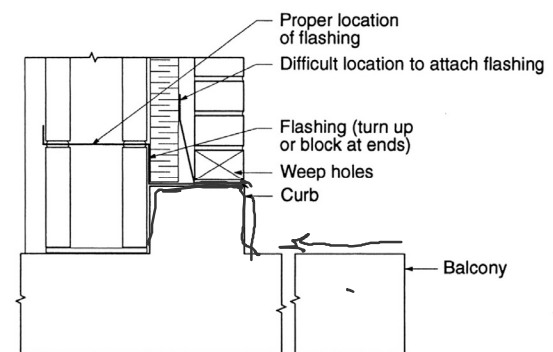
Methods for keeping drainage path open in cavity walls

Veneer Walls

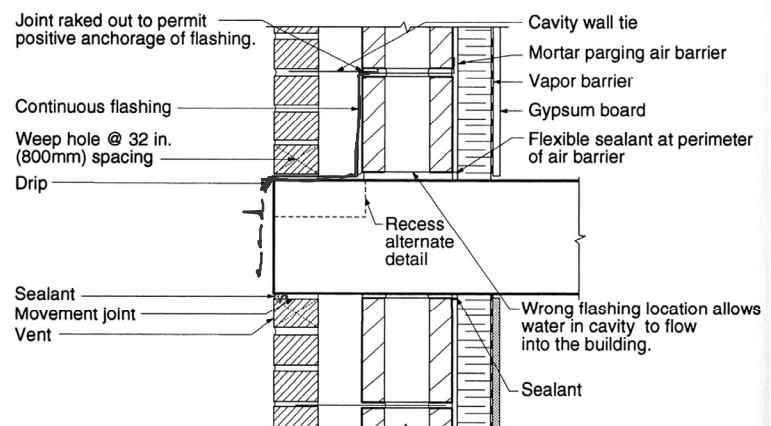
Additional precautions to prevent rain penetration

Sloped sills and slabs on balconies or windows

Built with curb



(a) Support of Veneer at a Balcony

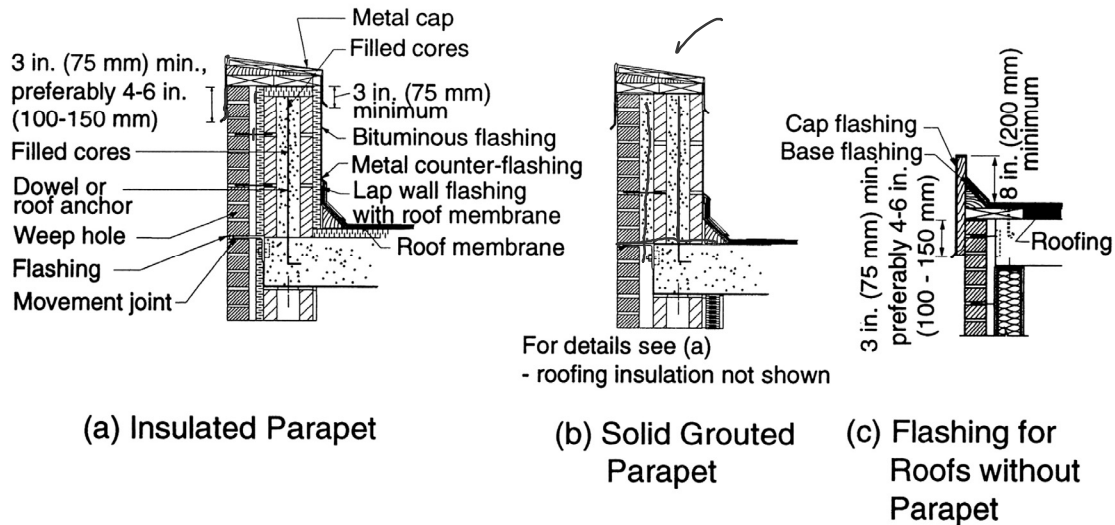


(b) Veneer Supported on the Floor Slab

Veneer Walls

Parapet walls:

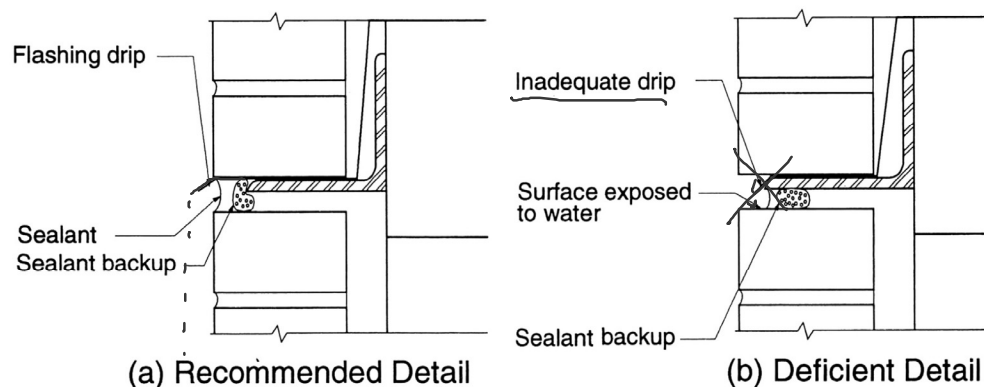
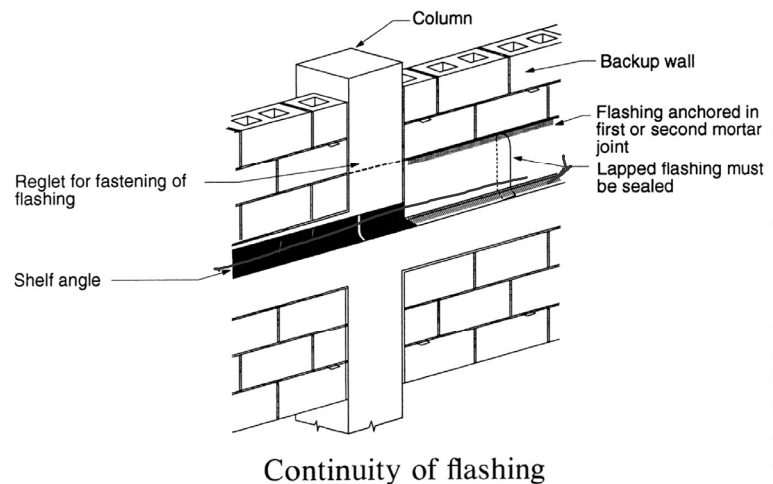
- Higher wind load
- Use air barriers or parging
- Use solid grouting to prevent freezing
- Locate vents away from corners and away from drainage paths



Veneer Walls

Flashing:

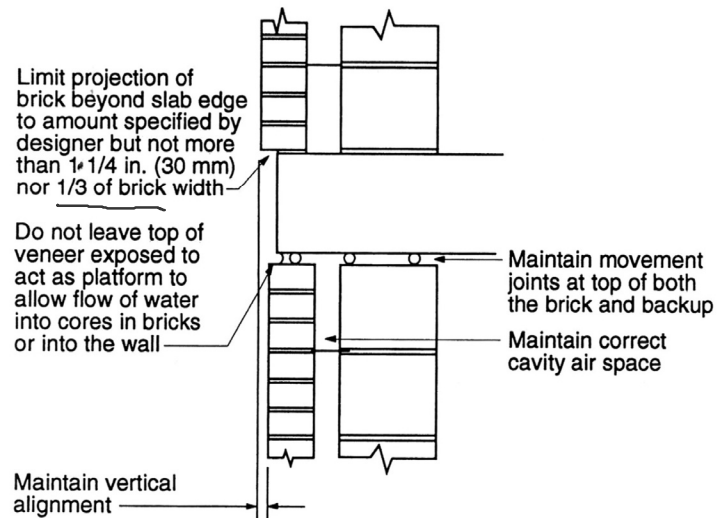
- Must be continuous
- Pass completely through veneer
- Form a drip edge at exterior
- Sealant positioned to allow for drainage



Veneer Walls

Support of Veneer:

- Limit overhang
- Maintain movement joints

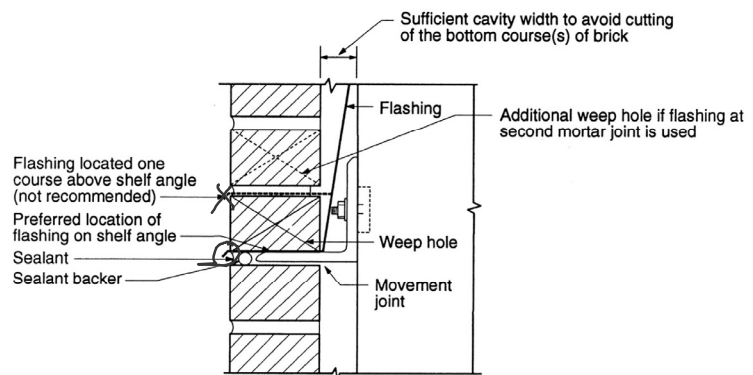


Requirements for veneer supported on concrete slab

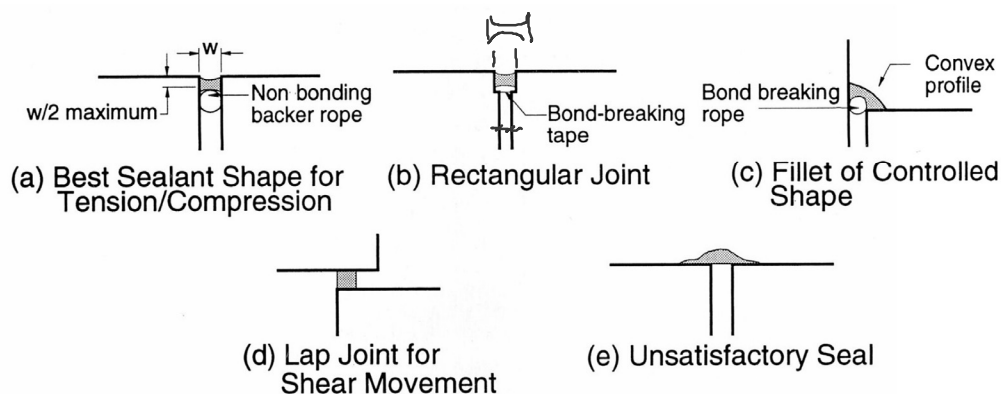
Veneer Walls

Support of Veneer:

- Position flashing to miss bolts
- Limit use of sealant
- Use foam sealant backer
- Use “dog bone” shape seal
- Deformation of seal < 25%
- Make joint wider to accommodate deformation (b)



Flashing detail to avoid shelf angle bolt

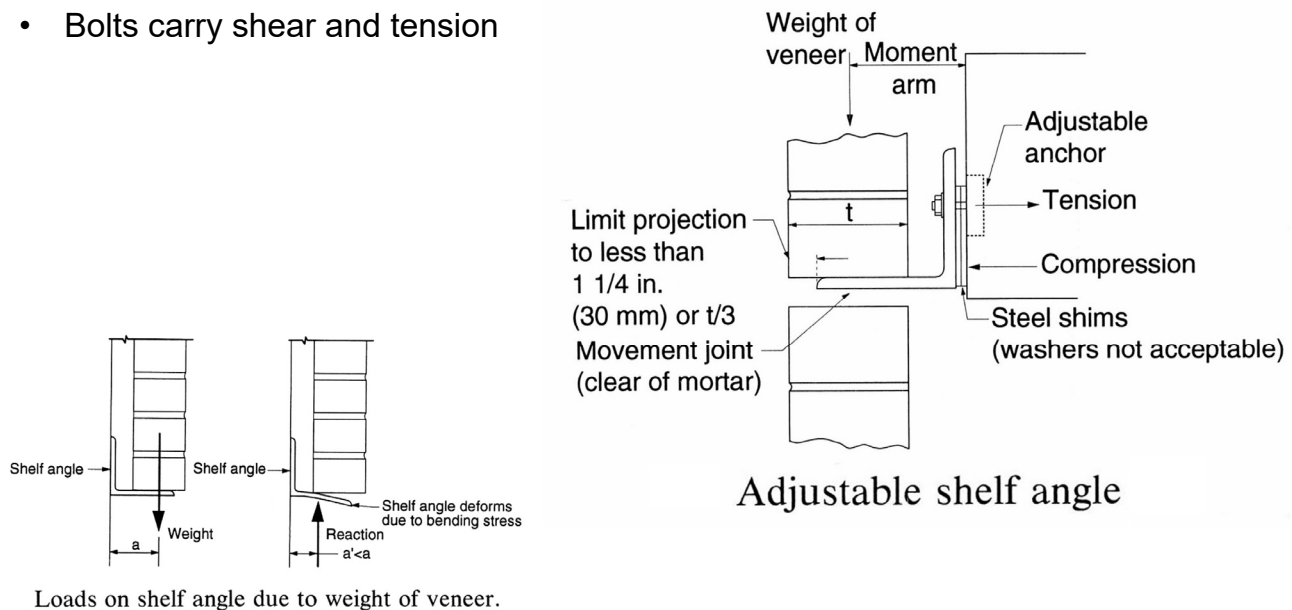


Sealant shapes and bond breakers

Veneer Walls

Shelf Angles:

- Adjustable vs. non-adjustable
- Support with full shims (not washers) to prevent rotation
- Bolt holes must match mortar joints
- Bolts max. 4 ft o.c.
- Bolts carry shear and tension



Veneer Walls

Shelf Angle Anchor Design

Given:

9 ft high veneer wall

Weight = 36 lb/ft²

Supported on shelf angle

Bolted 4 ft o.c.

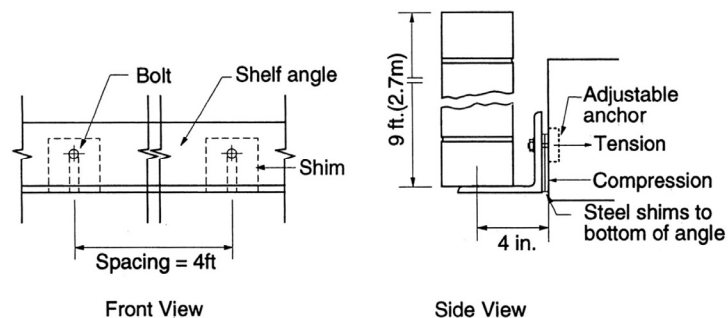
C.L. of brick is 4" from slab

Find:

Anchor bolt required

Use A325 bolt

Allowable tension = 44 ksi



$$M = (\text{veneer weight per unit length}) \times (\text{anchor bolt spacing}) \times (\text{moment arm between center of veneer and edge of slab}).$$

$$= (36 \text{ lb/ft}^2)(9 \text{ ft})(4 \text{ ft})(4 \text{ in.}) = 5184 \text{ in.-lb}$$

$M = \text{force} \times \text{moment arm}$

$$M = A_s F_s j d$$

giving

$$A_s = M / F_s j d$$

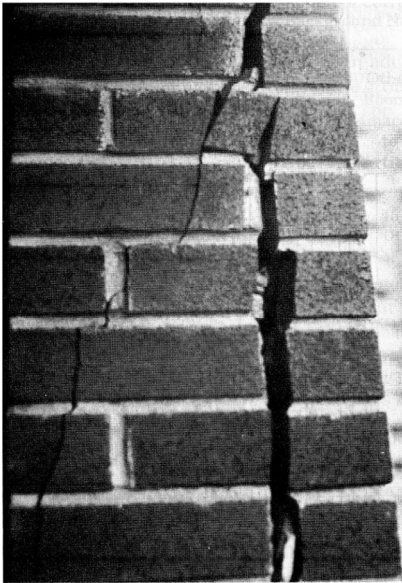
$$A_s = 5184 \text{ in.-lb} / (44000 \text{ psi} \times 7/8" \times 4") = 0.034 \text{ in}^2$$

$$\text{A-325 } 1/2 \text{ bolt Area} = 0.182 > 0.034 \text{ OK}$$

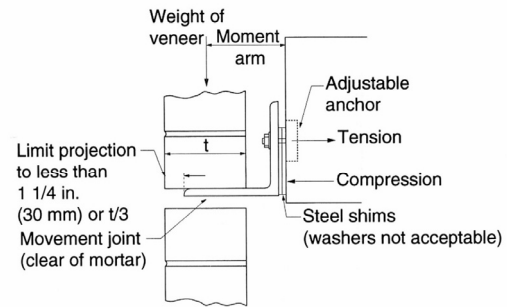
Veneer Walls

Shelf Angle Details:

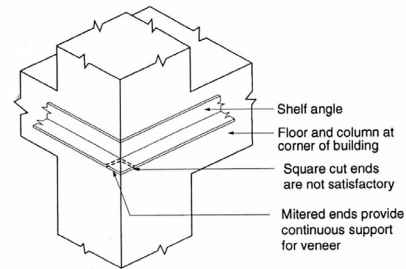
- Limit projection to $t/3$
- Continuous support at corners
- Mortaring corners causes cracking



Cracking of brick veneer at corners of buildings.



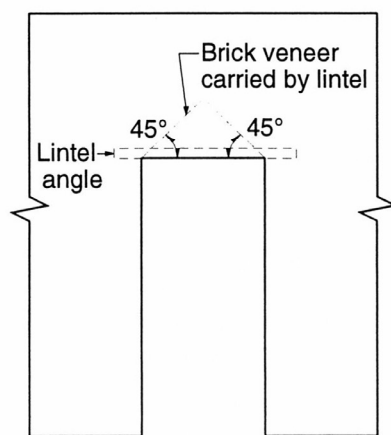
Adjustable shelf angle



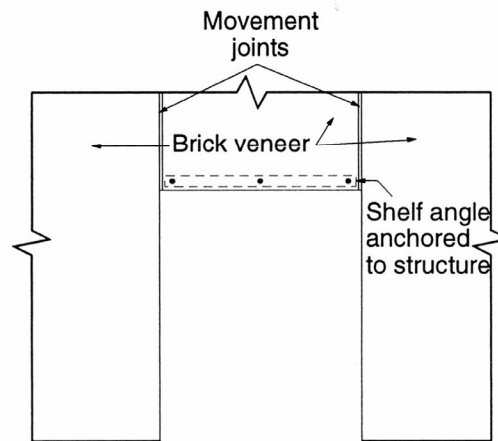
Veneer Walls

Shelf Angle Details:

- Used as lintel



(a) Lintel Angle Over Opening.



(b) Separate Shelf Angles For Support of Veneer Over Openings.

Support of veneer over openings

Veneer Walls

Flashing Material:

- Durability to last life of wall
- Strength – during construction
- Ease of installation
- Low vapor transmission

Material	Advantages	Disadvantages and Limitations	Installed Costs	Minimum Thickness
Stainless steel 2D, -dead soft, annealed	hard, impervious, strong, very durable	difficult to form and join, stiff, poor bond to mortar, labor intensive	100%	0.015 in.
Cold rolled copper	impervious, flexible, durable, easily formed and rolled	damaged by excessive flexing, stains surfaces where water runs off	90%	16 oz.
Lead coated copper	see copper; does not stain surfaces	see copper; requires care in soldering	95%	16 oz.
Aluminum	fairly durable, can be formed, corrosion resistant (except in the presence of lime)	high thermal coefficient, easily cracks at bends, cannot be field sealed, corroded by time	60%	0.032 in.
Galvanized steel	hard, impervious, easily formed and jointed, low thermal coefficient	subject to early corrosion	80%	26 ga
Lead	easily formed and joined, reasonably corrosion resistant	easily torn, affected by lime mortar, creeps	75%	2#
Zinc	easily formed and joined	creeps, destroyed by corrosion, cracks easily in cycling (cold weather)	80%	0.018 in. +
*Bitumen/fabric/copper	easy to form and join, good bond to mortar	easier torn than metal	50%	5 oz. (copper)
*Neoprene	easily formed and bonded, reliable, flexible	can be punctured, strength limited, requires protection	55%	0.045 in.
*PVC	easily formed and joined, impervious when new	aging deterioration and hardening, easily punctured and cut, weak	25%	0.040 in.
*Built-up bituminous glass/cotton fabrics	effective when intact, easy to form	easily damaged, weak, needs multiple plies, cracks in recycling	35%	0.040 in. +

* Requires metal flashing for drip edge. (Neoprene thickness can be reduced if reinforced.)

+ Added by the authors.