

# Masonry Walls



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1

## Wood Frame Backup

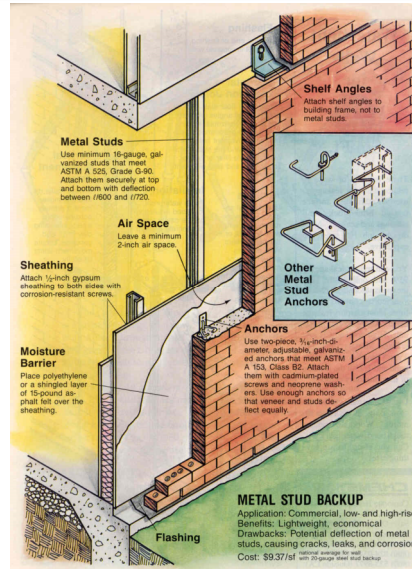


Brick Veneer Walls - Magazine of Masonry Construction, April 1989

2

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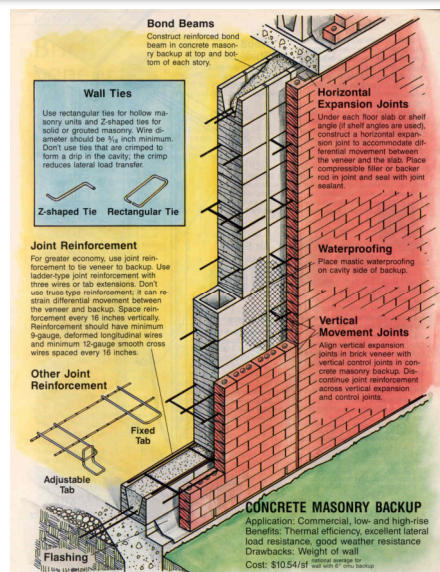
## Steel Frame Backup



Brick Veneer Walls - Magazine of Masonry Construction, April 1989

3

## Concrete Masonry Backup

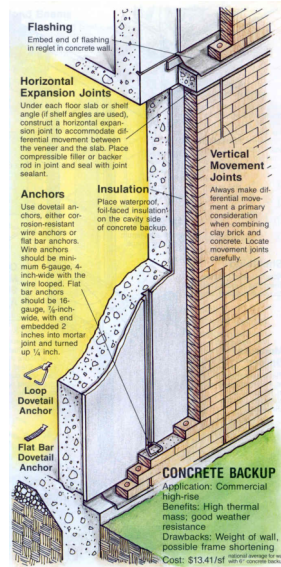


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## Concrete Backup



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5

## What is a wall?



***n.* – A vertical element with horizontal length to thickness ratio greater than 3, used to enclose a space**

MSJC 2005

6

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## Purpose of a Wall



**Keep the outside out and  
the inside in**

Lstiburek, PhD., Joseph , The Perfect Wall, [www.buildingscience.com](http://www.buildingscience.com)

7

## Masonry Wall Systems



**Reinforced/Unreinforced  
Loadbearing/Nonloadbearing**

- |                 |             |
|-----------------|-------------|
| ■ Single Wythe  | ■ Veneer    |
|                 | ■ Wood      |
| ■ Multi-Wythe   | ■ Steel     |
| ■ Solid         | ■ Masonry   |
| ■ Composite     | ■ Concrete  |
| ■ Non-Composite |             |
|                 | ■ Diaphragm |

8

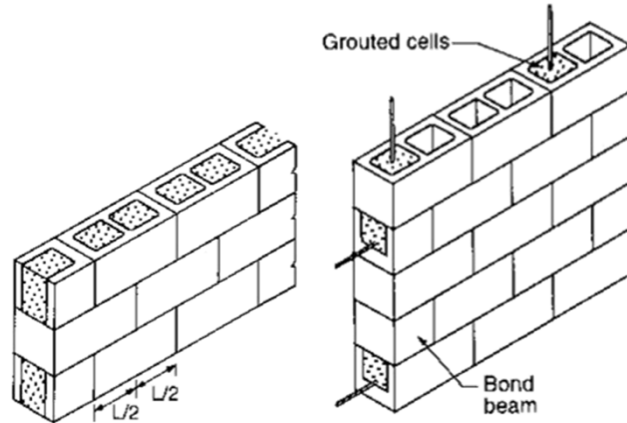
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## Single Wythe Wall



### Clay or Concrete Masonry Units

- Solid
- Cored
- Hollow



9

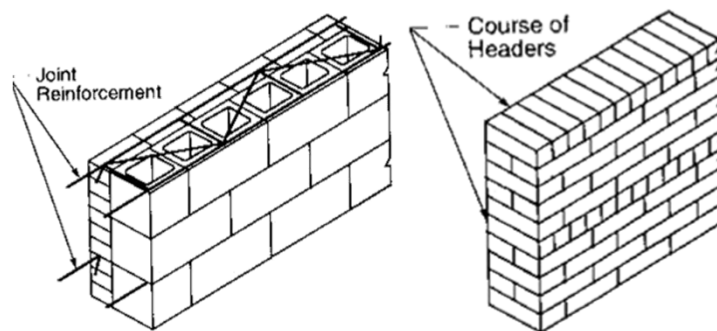
## Multi-Wythe Wall



### Solid Wall

### Clay and/or Concrete Masonry Units

- Ties, or
- Headers



10

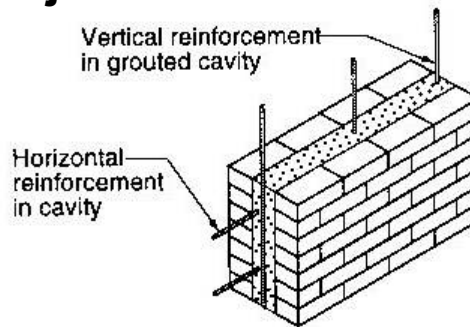
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## Multi-Wythe Wall Units



### Composite Wall Clay or Concrete Masonry

- Ties or headers, and
- Grouted collar joint



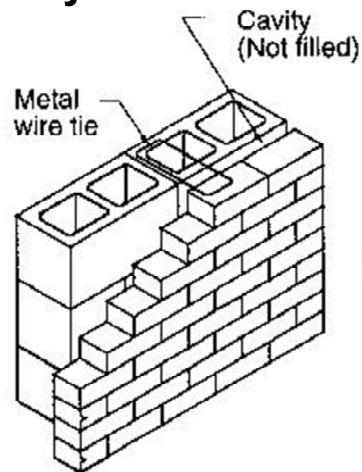
11

## Multi-Wythe Wall Units



### Non-Composite Wall Clay and/or Concrete Masonry

- Ties and
- Air space



12

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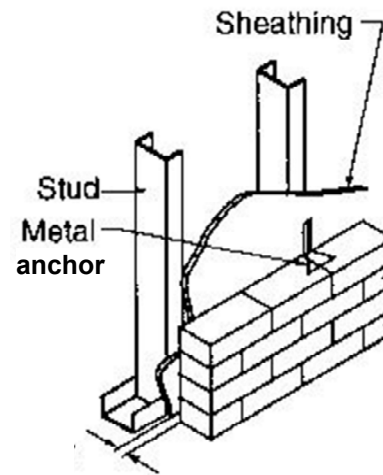
## Veneer Wall



### Clay, Concrete or Stone Masonry Units

#### Backup

- Wood
- Steel
- Concrete
- Masonry backup
- Bonded
  - Ties and
  - Air space



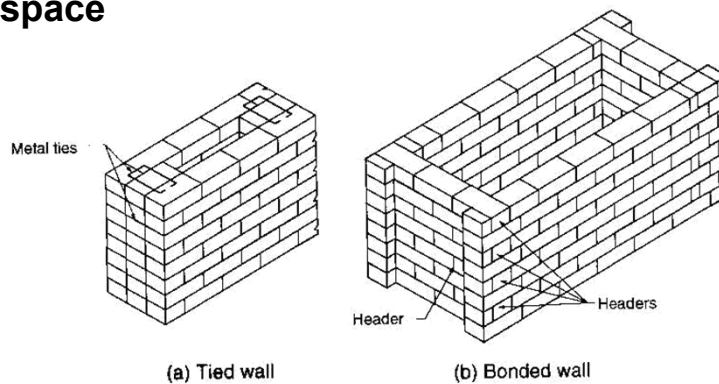
13

## Diaphragm



### Clay and/or Concrete Masonry Units

- Ties or headers, and
- Air space



14

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## Environmental Loads



**The exterior walls of buildings separate the internal and external environments and are thus subjected to environmental loads (both man-made and from nature)**

Masonry Structures Behavior and Design, 2<sup>nd</sup> ed.

15

## Environmental Loads



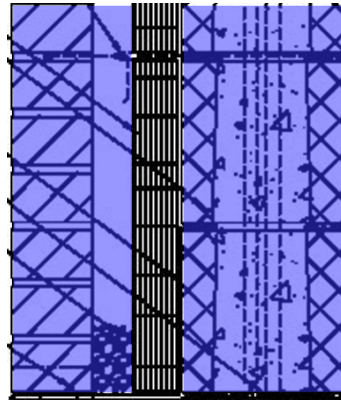
- Fire
- Thermal
- Water
  - Liquid
  - Vapor
- Air
- Sound
- Accidental Loads

16

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## Fire Resistance



17

## Fire Resistance



### Concrete Masonry

Table 3.1 – Fire resistance rating of concrete masonry assemblies

Aggregate Type	Minimum required equivalent thickness for fire resistance rating, in. <sup>A,B</sup>				
	1 hr	1 ½ hr	2 hr	3 hr	4 hr
Calcareous or siliceous gravel (other than limestone)	2.8	3.6	4.2	5.3	6.2
Limestone, cinders, or air-cooled slag	2.7	3.4	4.0	5.0	5.9
Expanded clay, expanded shale or expanded slate	2.6	3.3	3.6	4.4	5.1
Expanded slag or pumice	2.1	2.7	3.2	4.0	4.7

A. Fire resistance rating between the hourly fire resistance rating periods listed shall be determined by linear interpolation based on the equivalent thickness value of the concrete masonry assembly.

B. Minimum required equivalent thickness corresponding to the fire resistance rating for units made with a combination of aggregates shall be determined by linear interpolation based on the percent by volume of each aggregate used in the manufacture.

ACI 216.1/TMS 0216.1

18

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# Fire Resistance



## Clay Masonry

Table 4.1 – Fire resistance of clay masonry walls

Material Type	Minimum required equivalent thickness for fire resistance, in. <sup>A,B,C</sup>			
	1 hr	2 hr	3 hr	4 hr
Solid brick of clay or shale <sup>D</sup>	2.7	3.8	4.9	6.0
Hollow brick or tile of clay or shale, unfilled	2.3	3.4	4.3	5.0
Hollow brick or tile of clay or shale, grouted or filled with materials specified in 4.2.3	3.0	4.4	5.5	6.6

A. Equivalent thickness as determined from section 4.2.

B. Calculated fire resistance between the hourly increments listed shall be determined by linear interpolation.

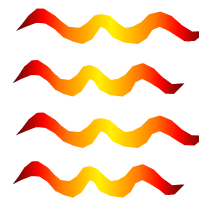
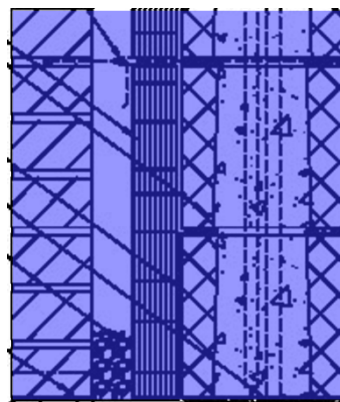
C. Where combustible members are framed into the wall, the thickness of solid material between the end of each member and the opposite face of the wall, or between members set in from opposite sides, shall not be less than 93 percent of the thickness shown.

D. For units in which the net cross-sectional area of cored brick in any plane parallel to the surface containing the cores shall be at least 75 percent of the gross cross-sectional area measured in the same plane.

ACI 216.1/TMS 0216.1

19

# Thermal Resistance



20

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## Thermal Resistance

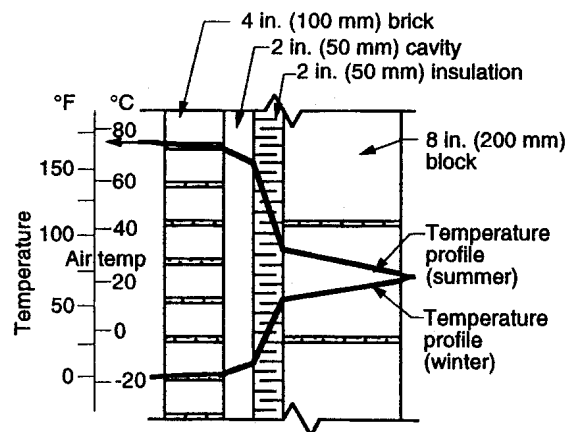


■ Outside Air Film	0.17
■ Clay Brick	0.44
■ 2" Air Space	0.97
■ 2" Rigid Insulation	10.00
■ 8" CMU Hollow (115 pcf)	2.10
■ <u>Inside Air Film</u>	<u>0.68</u>

**R-Value 14.36**

21

## Thermal Resistance



(a) Wall Section and Thermal Gradients

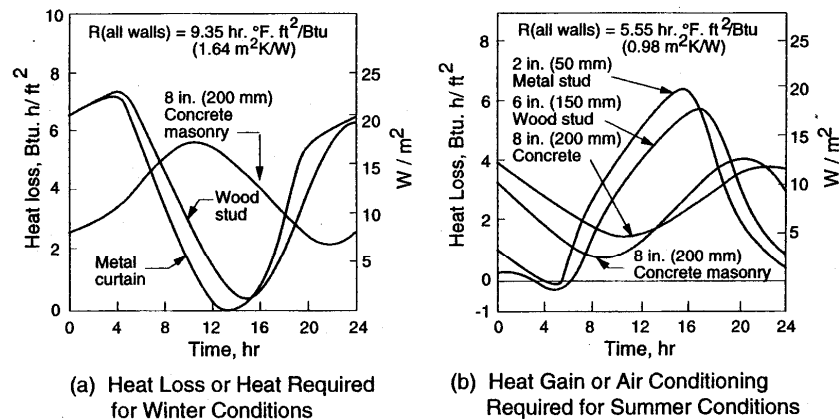
ASHRAE: As a general guide, the maximum effective temperature, or sol-air temperature (SAT) is usually in the range of 50 to 100°F above the air temperature, whereas the minimum is in the range of about 10°F colder than the ambient air temperature.

Masonry Structures Behavior and Design, 2<sup>nd</sup> ed.

22

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## Thermal Resistance



**Figure 14.10** Comparisons of heat loss and heat gain for buildings with walls of different masses (from Ref. 14.28).

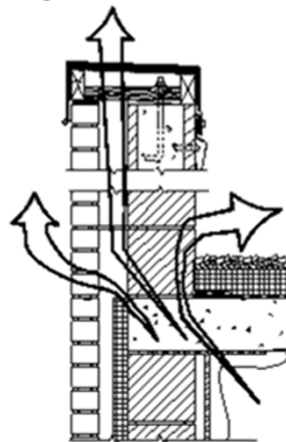
Masonry Structures Behavior and Design, 2<sup>nd</sup> ed.

23

## Thermal Resistance



### Thermal Bridging



**A thermal bridge allows heat to “short circuit” insulation**

NCMA TEK 6-13A

24

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# Thermal Resistance

**Thermal Bridging**

The diagram illustrates two cross-sections of a slab edge detail. The 'Typical Slab Edge Detail' on the left shows a concrete floor slab on a steel deck, with a steel beam below it. Heat loss is indicated by red arrows pointing through the steel beam. The 'Preferred Slab Edge Detail' on the right shows the same assembly but with insulation added around the steel beam, reducing heat loss.

Labels for Typical Slab Edge Detail:

- INTERIOR FINISH ON UNINSULATED FURRING
- INSULATION
- CONCRETE FLOOR SLAB ON STEEL DECK
- VENER
- STEEL BEAM WITH FIRE-PROOFING
- WALL TIE
- CONCRETE MASONRY
- AIR SPACE
- FLASHING
- STEEL SUPPORT ANGLE
- STEEL SHELF ANGLE

Labels for Preferred Slab Edge Detail:

- INTERIOR FINISH ON UNINSULATED FURRING
- CONCRETE FLOOR SLAB ON STEEL DECK
- VENER
- INSULATION
- STEEL BEAM WITH FIRE-PROOFING
- WALL TIE
- CONCRETE MASONRY
- AIR SPACE
- FLASHING
- STEEL SUPPORT ANGLE
- STEEL SHELF ANGLE

NCMA TEK 6-13A

25

# Water – Liquid

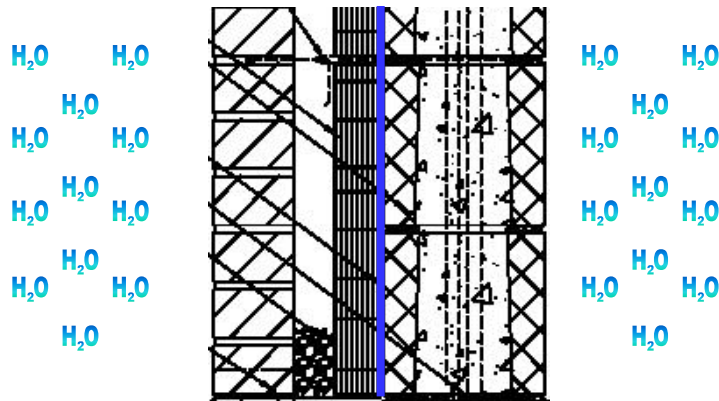
- Flashing & weepholes
- Effective drainage cavity

The diagram shows a cross-section of a wall with a window or door opening. Water is shown penetrating the wall and entering the cavity. The diagram highlights the need for flashing and weepholes to ensure effective drainage of the cavity.

26

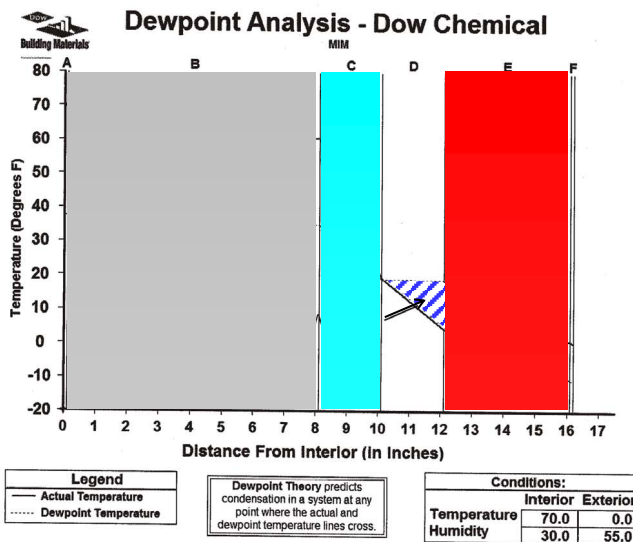
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## Water – Vapor



27

## Winter

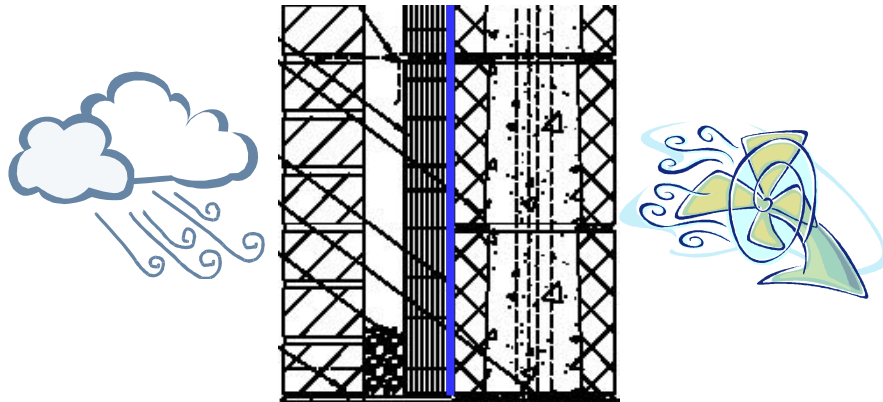


Loadbearing Masonry's Bottom Line, The Story Pole, Jan/Feb 2008

28

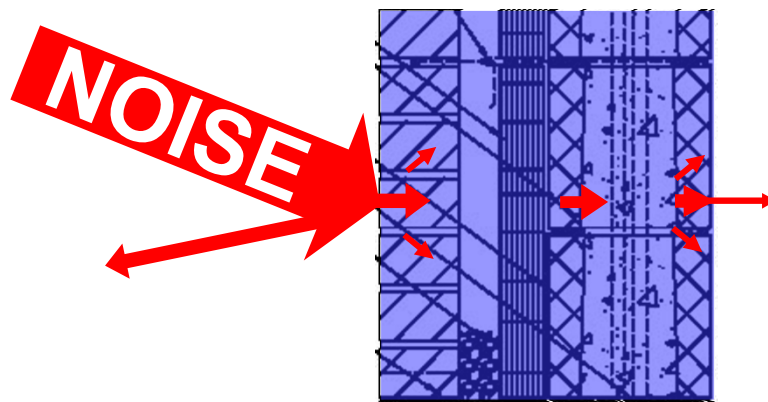
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## Air Flow



29

## Sound



30

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## Sound



### ■ Sound **Transmission?**

- the sensation perceived by the human ear resulting from rapid fluctuations in air pressure usually created by a vibrating object

### ■ Sound Transmission Class (STC)

- a single number rating calculated in accordance with ASTM E413 using values of sound transmission loss

Masonry Structures Behavior and Design, 2nd ed., TMS 0302-00

31

## Sound



### ■ Sound Absorption

- Sound level within a room can be lowered by use of materials that absorb sound energy rather than reflecting it back into the room

### ■ Sound Absorption Control

- Involves minimizing sound reflections, so that noise generated within a space is not echoed back into the space

Masonry Structures Behavior and Design, 2nd ed., NCMA TEK 13-2A

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## Accidental Loads



- Violent changes in air pressure
  - High explosives
  - Service system explosions
- Impact
  - Vehicles
  - Aircraft
  - Crane
- Fire
- Tornado
- Hurricane
- Severe subsidence or erosion of foundation
- Hail and snow in areas not normally exposed to them