The History of Masonry Construction

Types of masonry:
Brick
(concrete) Block
Stone

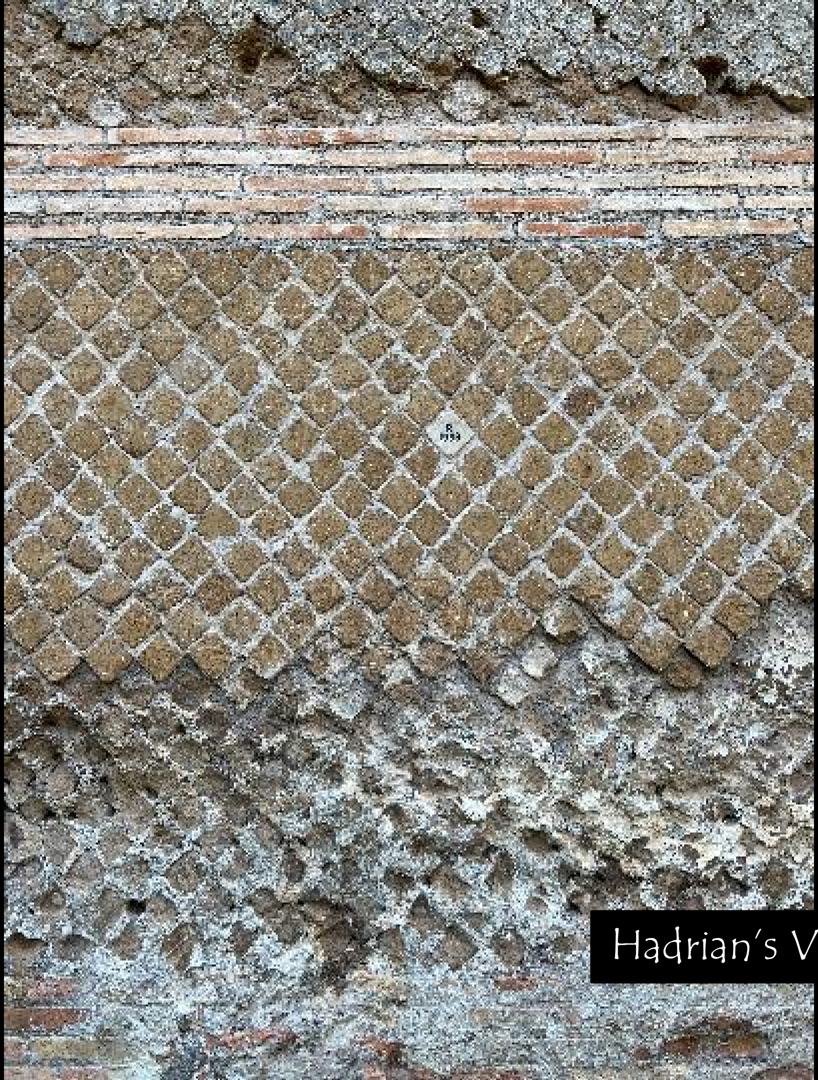
STONE units are usually CUT to shape

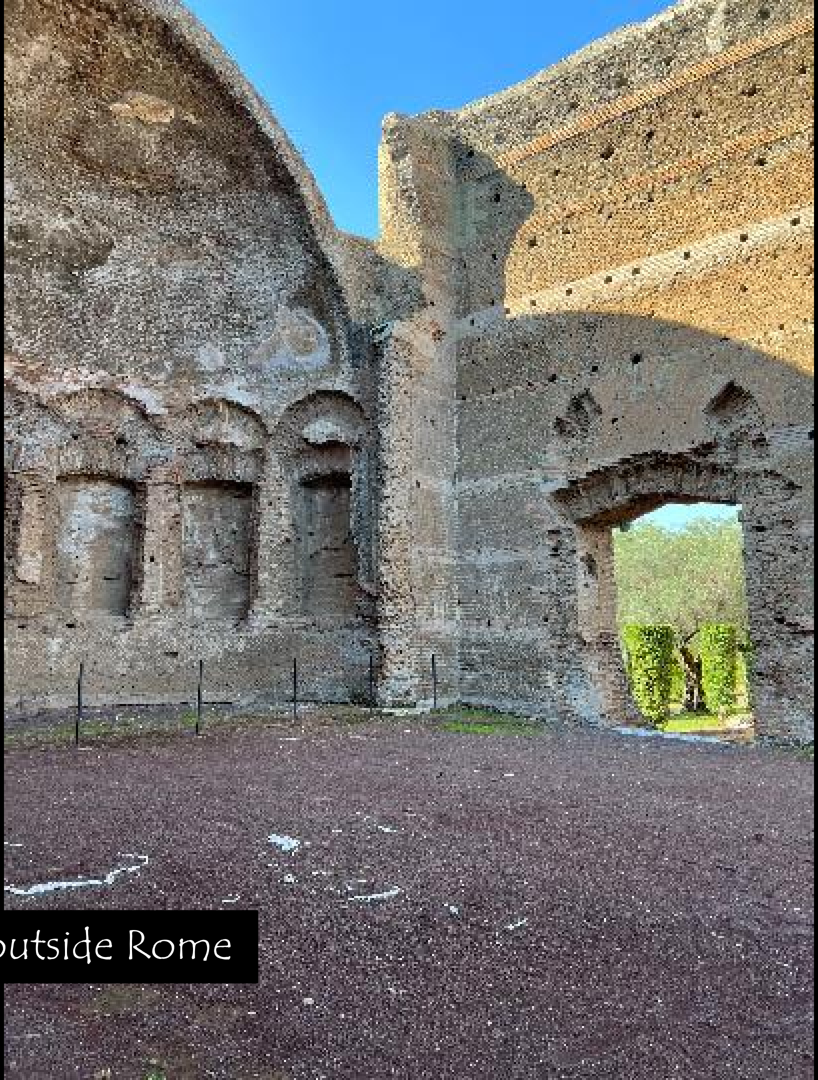
BRICK units are usually formed or extruded and need to be FIRED to harden them

CONCRETE BLOCK is extruded and needs to dry/cure to get its strength

TERRACOTTA units are formed and fired and often glazed

Pompeii,
Italy
69 CE





Hadrian's Villa outside Rome

Aqua Claudia and the Anio Novus as Part of the Porta Maggiore
Rome, Italy
200 CE

Giant Wild Goose
Pagoda
Xian, China
752 CE

ADOBE Construction
mud/clay + straw
left to dry in the sun

Masonry is usually laid in
COURSES
That is, a row of units

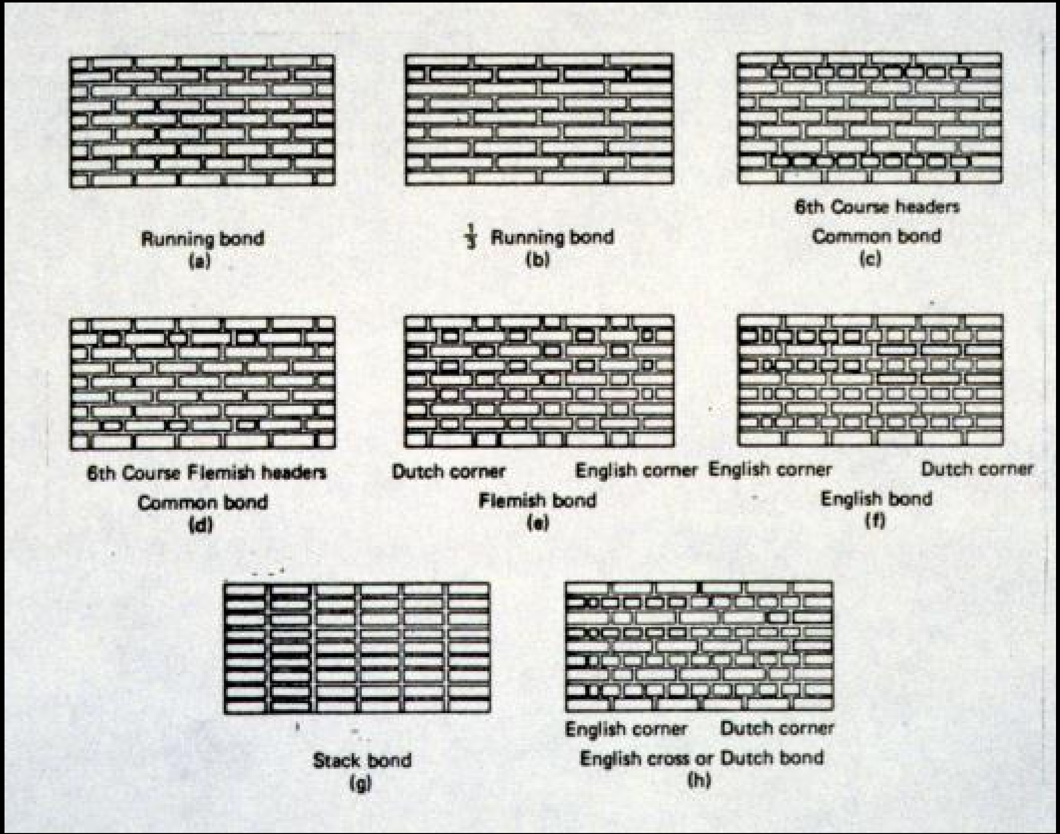
(note the spelling of course)

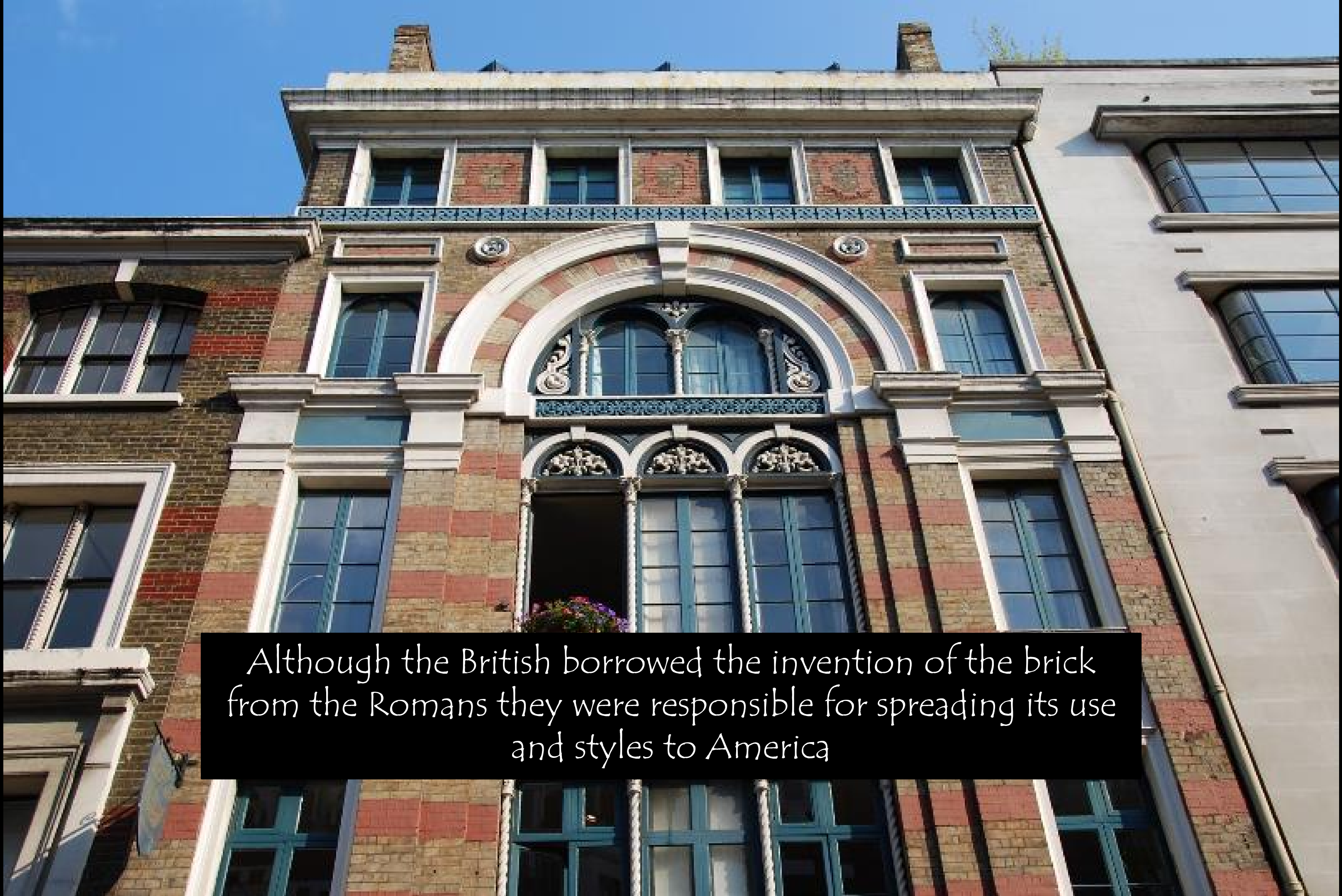
A single thickness wall
of masonry is called a

WYTHE

A SOLID Load Bearing Wall of Brick
is normally made of at least
2 WYTHES of brick
bonded down the middle with mortar

Brick is laid in various BOND patterns there must be sufficient overlap for structural performance





Although the British borrowed the invention of the brick from the Romans they were responsible for spreading its use and styles to America


R

St. Pancras Railway Station
London, England
George Gilbert Scott, William Henry Barlow
1868


The re-creation of a masterpiece
STATION
KING'S CROSS ST. PANCRAS STATION

Westminster Cathedral
London, England
John Francis Bentley Architect
1903
Byzantine Revival Style


DOMINE·IESU·REX·ET·REDEMPTOR
PER·SANGUINEM·TUUM·SALVA·NOS

British Georgian Style
Architecture
1714-1830


10

Various Historic
Newport, Rhode Island, USA


NEWPORT
COMMUNITY
CHURCH


Serv


Monticello
Charlottesville, Virginia
Thomas Jefferson
1772

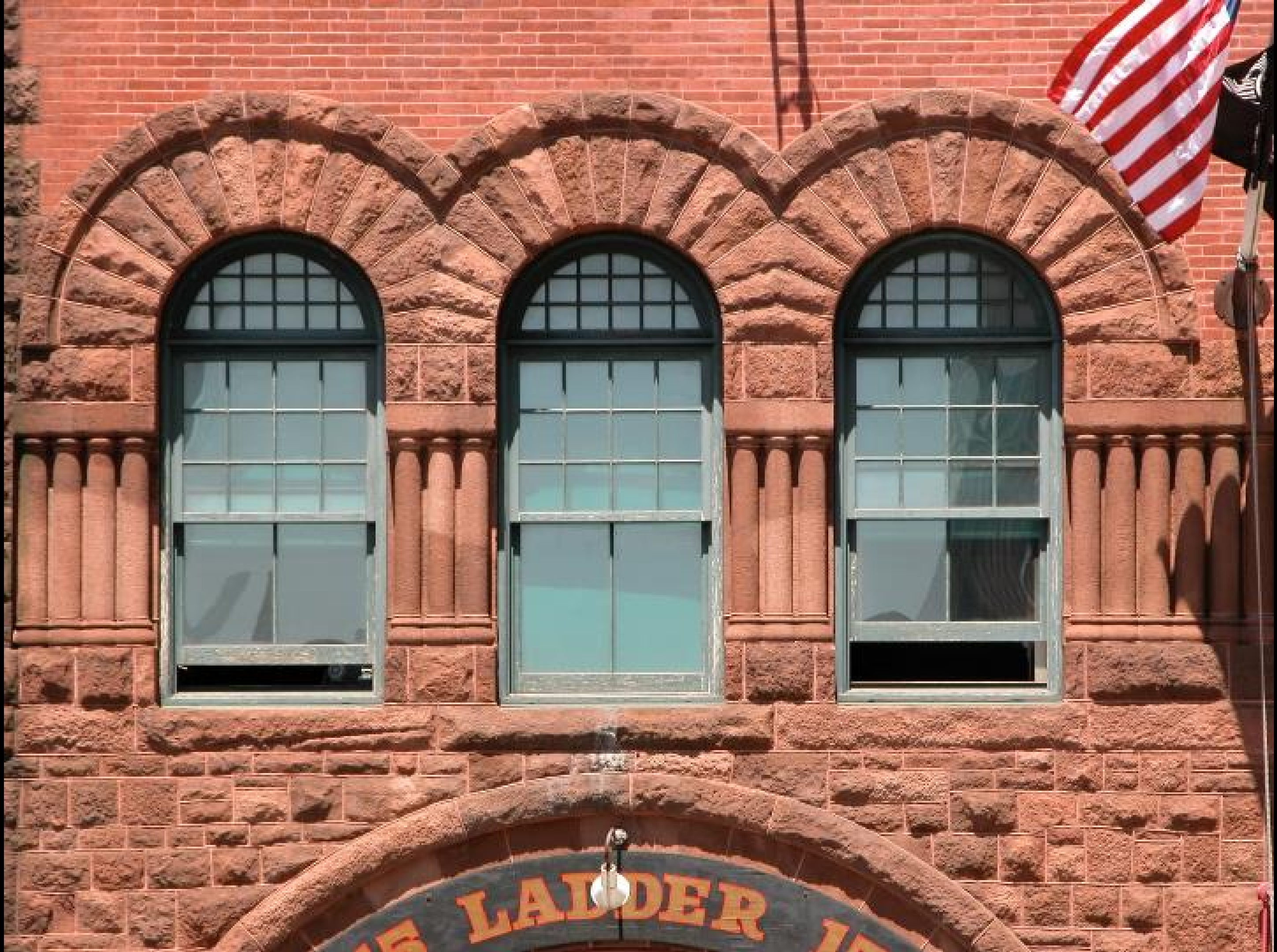
University of Virginia
Charlottesville, Virginia
Thomas Jefferson and Stanford White
1826

Boston sees the direct influence of British masonry styles as one of the earliest settled parts of America


FOR SALE


PARKING


BOSTON


LADDER


CLAFLIN BUILDING


Boston Public Library
Boston, Massachusetts
McKim Mead and White Architects
1852


THE PUBLIC LIBRARY OF
OF CITIZENS
CHOOSING TO PARTICIPATE


THE PEOPLE
DEDICATED


EXIT

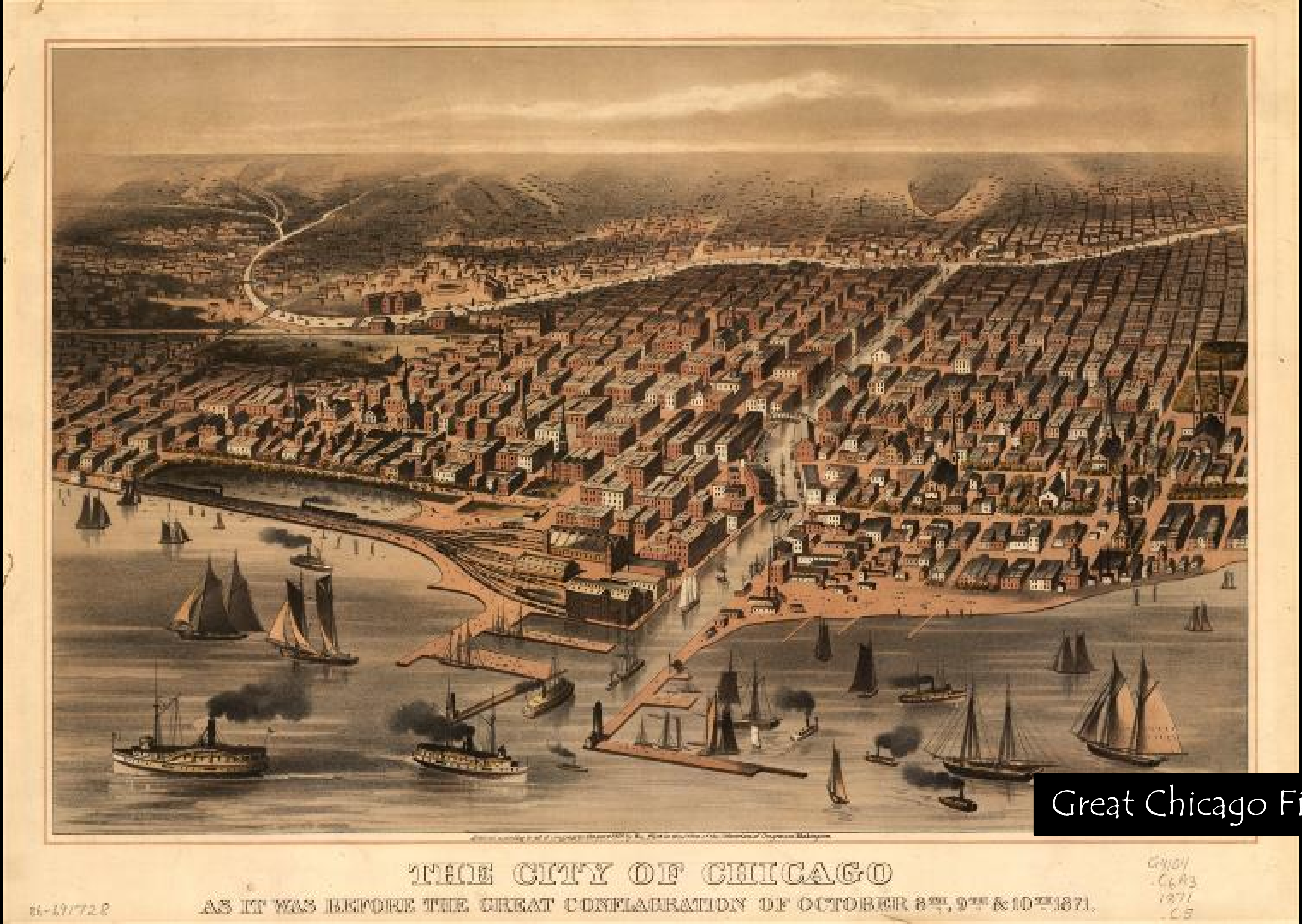
Brick masonry became the "go to" material in North American cities


TRAIL
WEST
BOOTS•HATS
APPAREL
TRAIL WEST

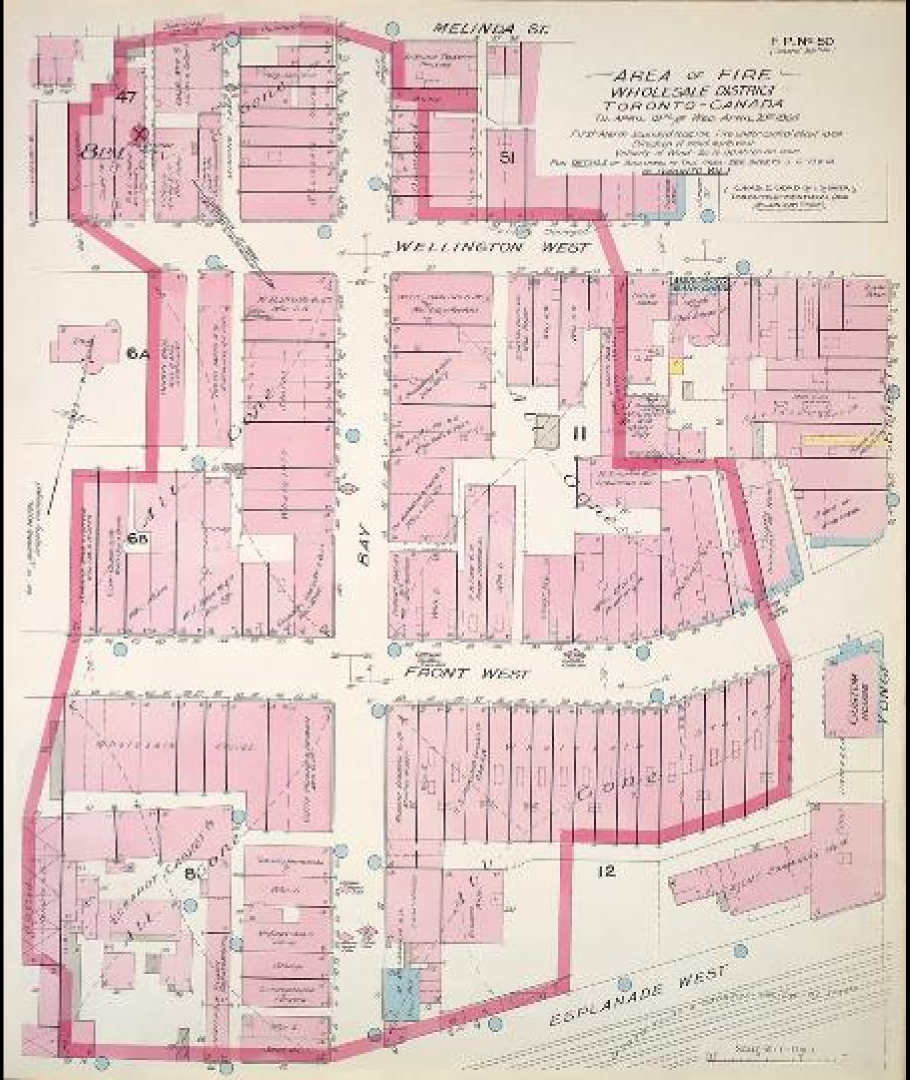

CE
J
COTTON-EYED
JOE
OF
NASHVILLE
GIFTS FASHIONS RECORDS
COTTON EYE JOES


EVERGREEN
BRICK WORKS
Bringing together nature, culture and community
evergreen.ca

Many urban areas switched from wood construction to solid masonry late 1800s/early 1900s after some disastrous urban fires



Great Chicago Fire 1871



https://www.toronto.ca/explore-enjoy/history-art-culture/online-exhibits/web-exhibits/web-exhibits-significant-events/the-great-fire-of-1904/

Toronto Fire 1904

Various Historic
Buffalo, New York


VISITOR CENTER
617
MAIN
CEPA GALLERY
PRESERVATION

Electric Tower
Buffalo, New York
1912

Terra Cotta cladding

Buffalo City Hall
Buffalo, New York
Dietel & Wade; Sullivan W. Jones
1931

Prudential (Guaranty) Building
Buffalo, New York
Louis Sullivan and Dankmar Adler
1896


PRUDENTIAL (GUARANTY) BUILDING
ARCHITECT. LOUIS H. SULLIVAN,
CALLED THE FATHER OF MODERN
AMERICAN ARCHITECTURE EARLY
ALL-STEEL FRAME OFFICE BLDG.
WITH FINE TERRA COTTA VENEER
BUILT IN 1895
BUFFALO HOLDING CORPORATION
BUFFALO & ERIE COUNTY HISTORICAL SOCIETY
1966


PRUDENTIAL


GUARANTY
Main Entrance
Located on
Pearl Street
All Exits are Monitored
and Videotaped

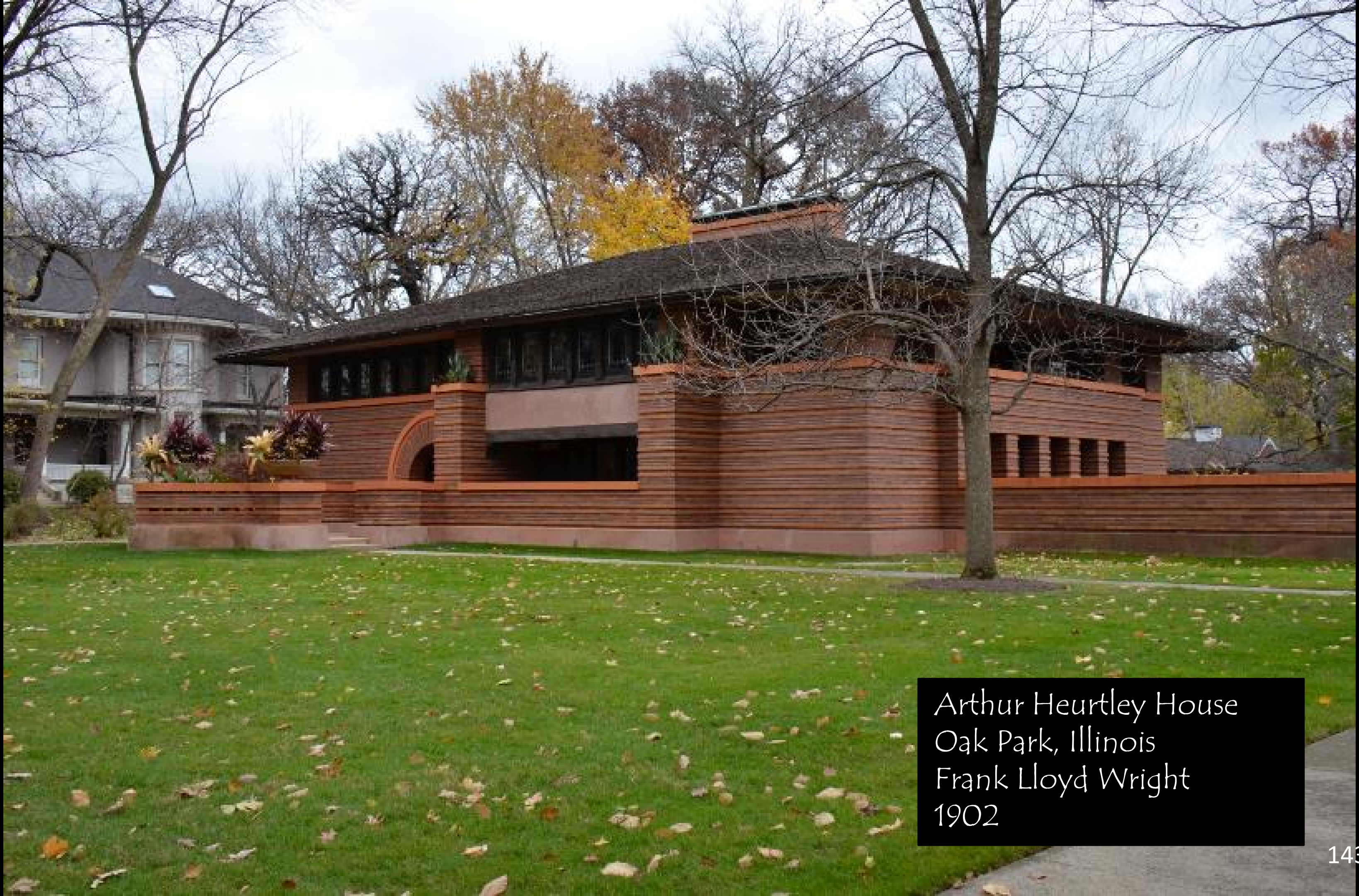
Unreinforced masonry proved incapable of resisting seismic forces leading to disuse in active areas

Great Kanto Japan Earthquake 1923

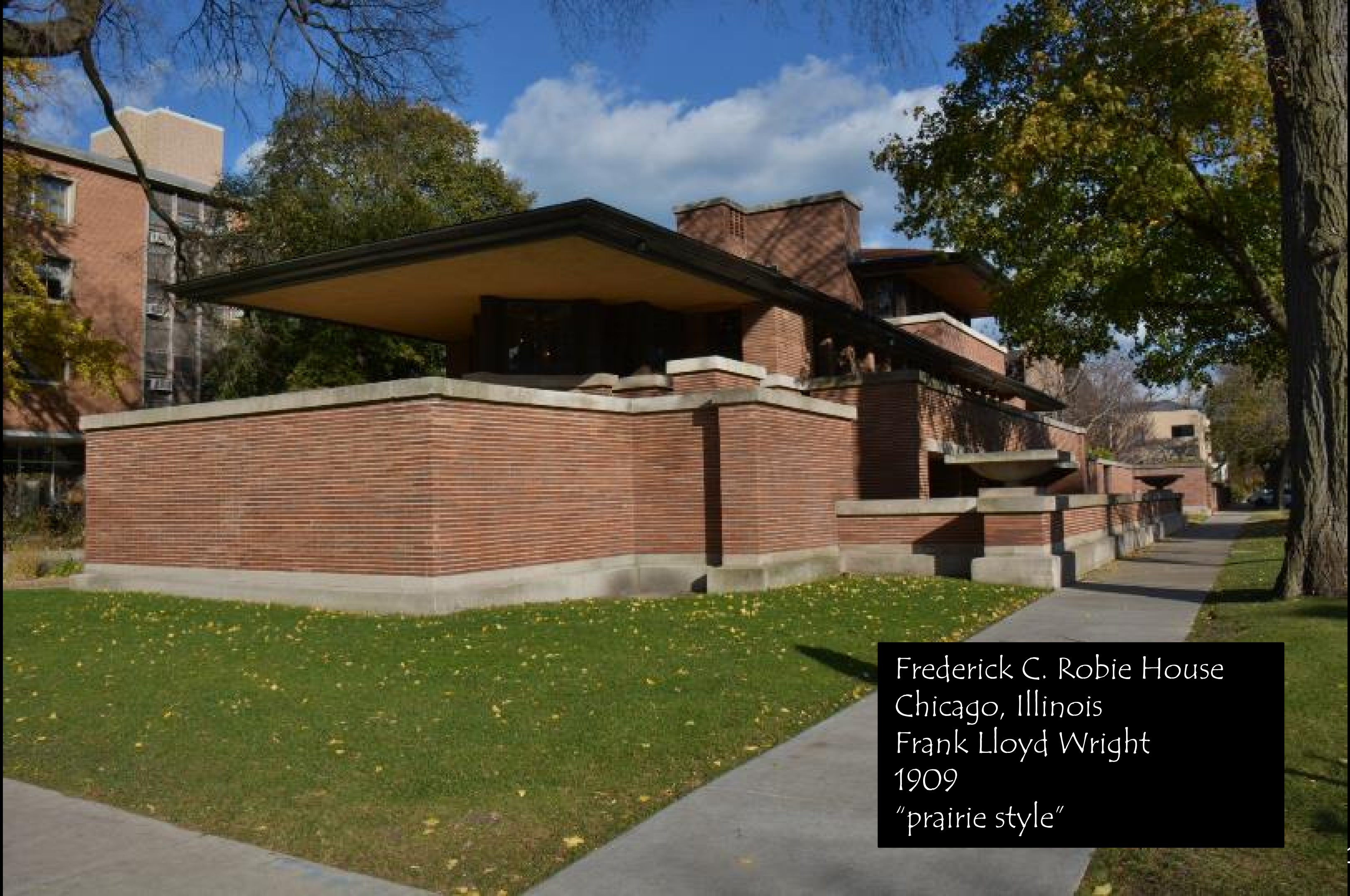
Frank Lloyd Wright Home and Studio
Oak Park, Illinois
1909


HAMMER STILL TO CHEER
THE ARTIFEX

Nathan Moore House
Oak Park, Illinois
Frank Lloyd Wright
1895

Arthur Heurtley House
Oak Park, Illinois
Frank Lloyd Wright
1902



Frederick C. Robie House
Chicago, Illinois
Frank Lloyd Wright
1909
"prairie style"


living room


EXIT

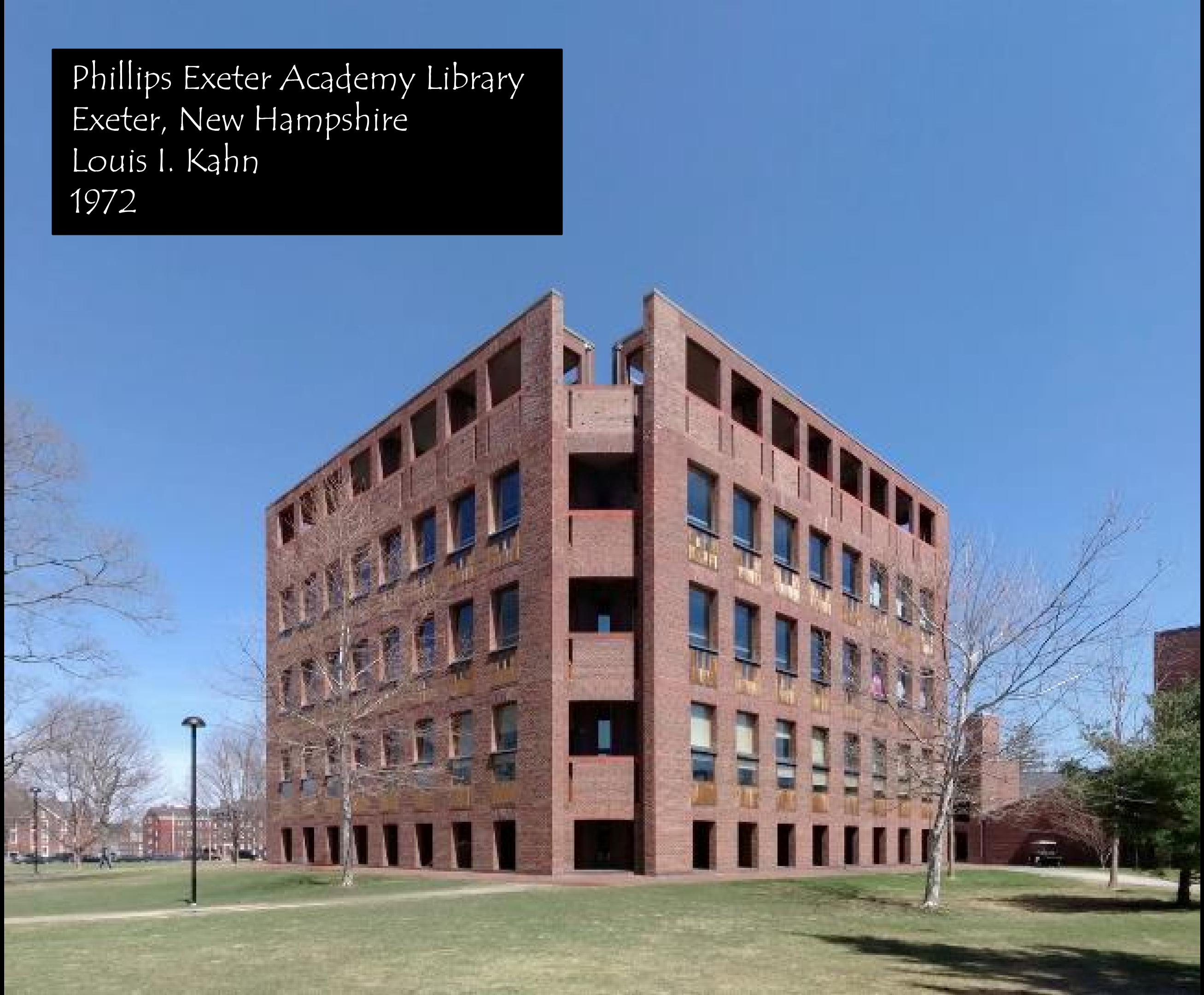
V C Morris Gift Shop
San Francisco, California
Frank Lloyd Wright
1948


ALLERY
140

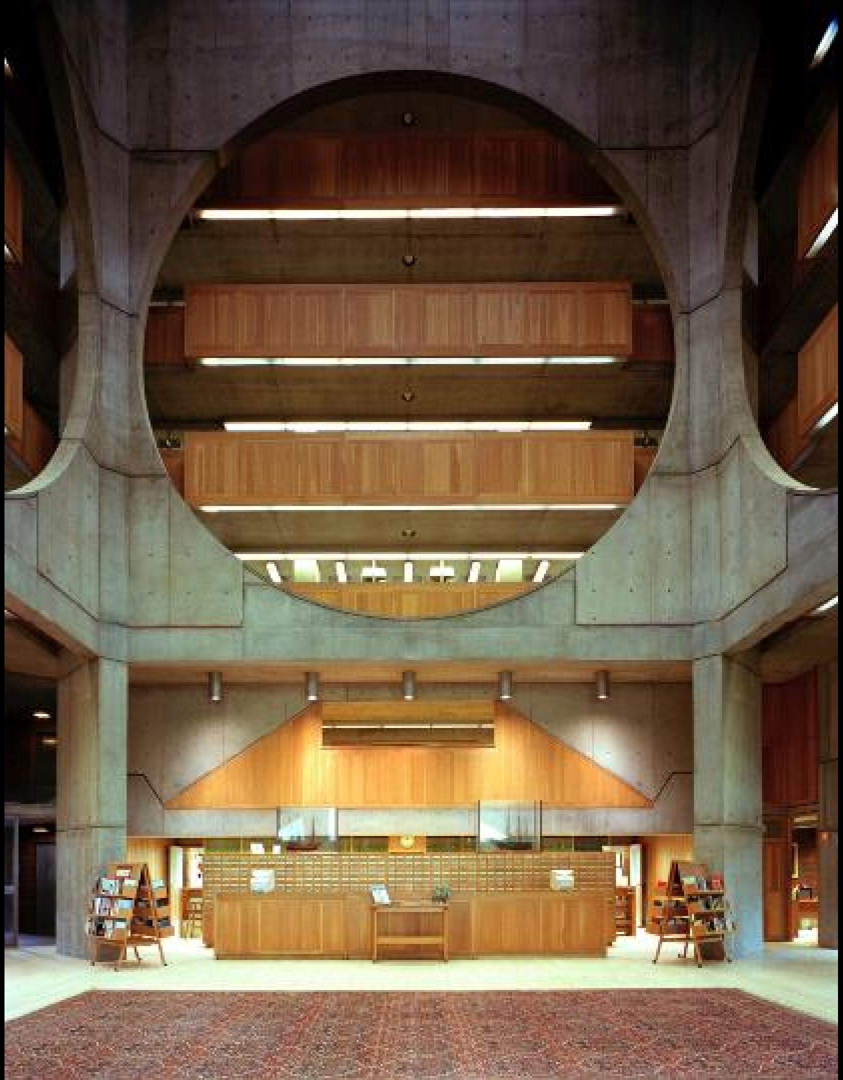
MIT Chapel
Cambridge, Massachusetts
Eero Saarinen
1955

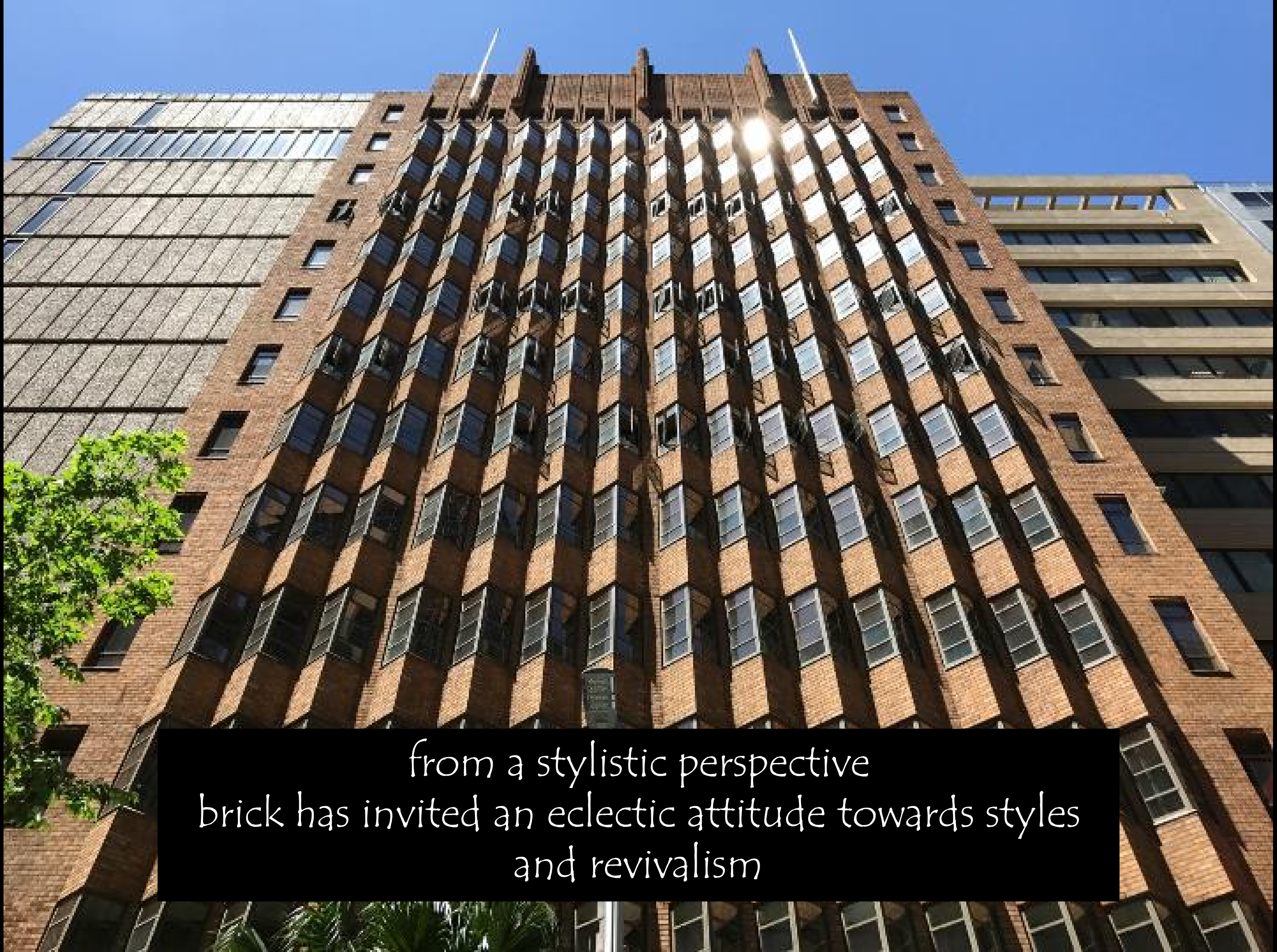

Rothko Chapel
Houston, Texas
Philip Johnson
1971


CHAPEL

Phillips Exeter Academy Library
Exeter, New Hampshire
Louis I. Kahn
1972





from a stylistic perspective
brick has invited an eclectic attitude towards styles
and revivalism

Palmer Museum of Art
Penn State University
State College, Pennsylvania
Charles W. Moore
1990

"post modern"

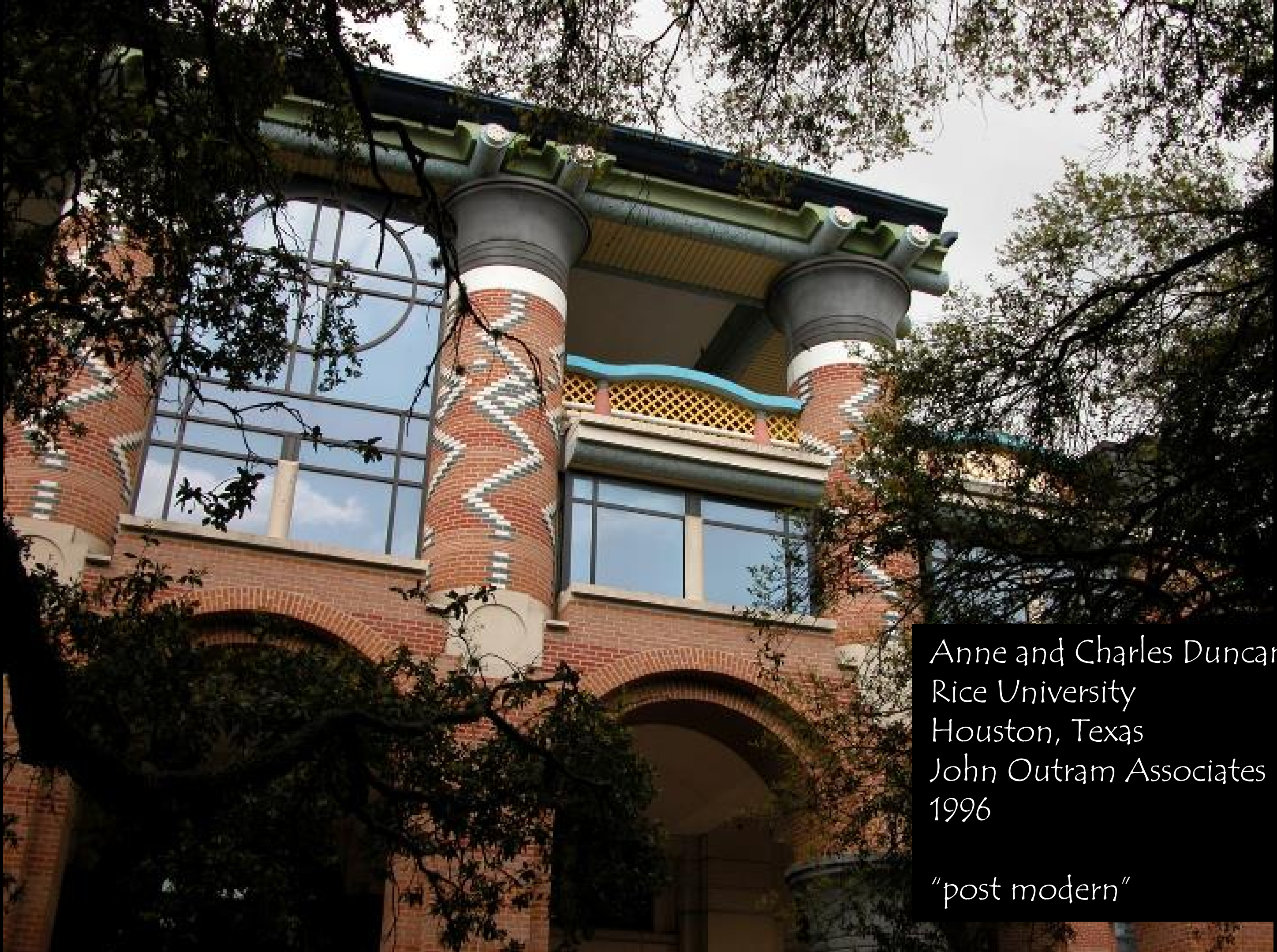
Brown College
Rice University
Houston, Texas
Michael Graves
2002

Not very good wall detailing! Fat mortar joints, no rain screen, easily absorbs water, not good for us up north.

Herring Hall
Rice University
Houston, Texas
Cesar Pelli Architect
1984

"post modern"


Cesar Pelli & Associates
Architects

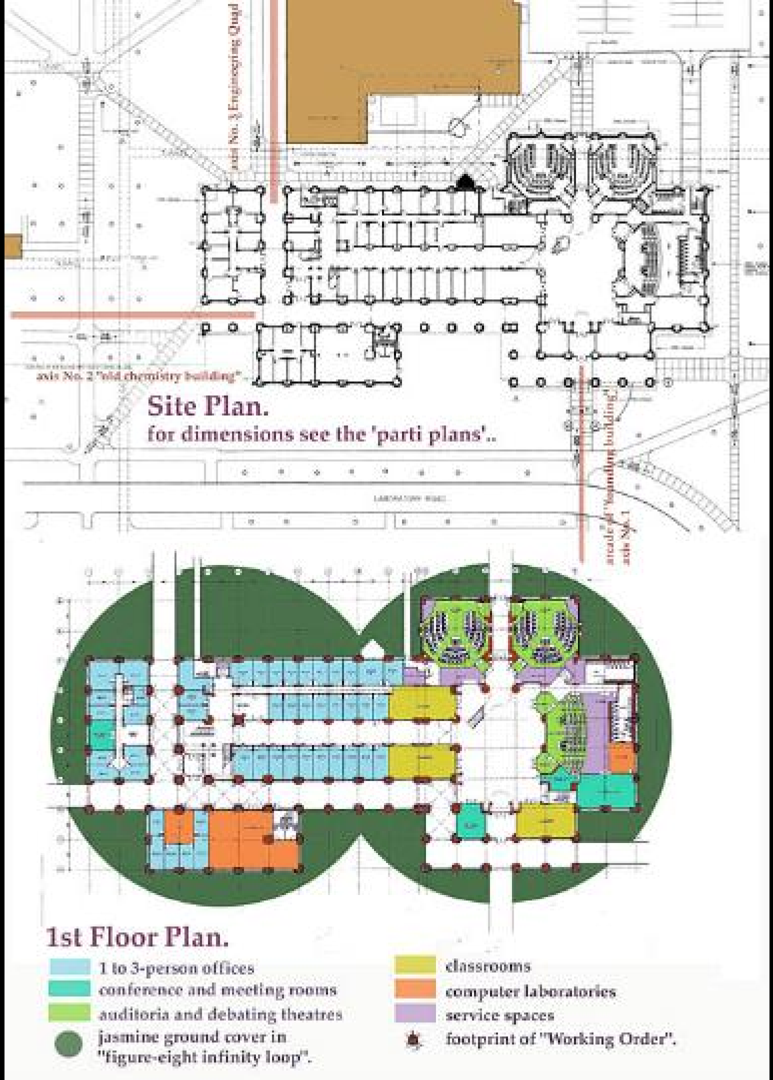


Anne and Charles Duncan Hall
Rice University
Houston, Texas
John Outram Associates
1996

"post modern"

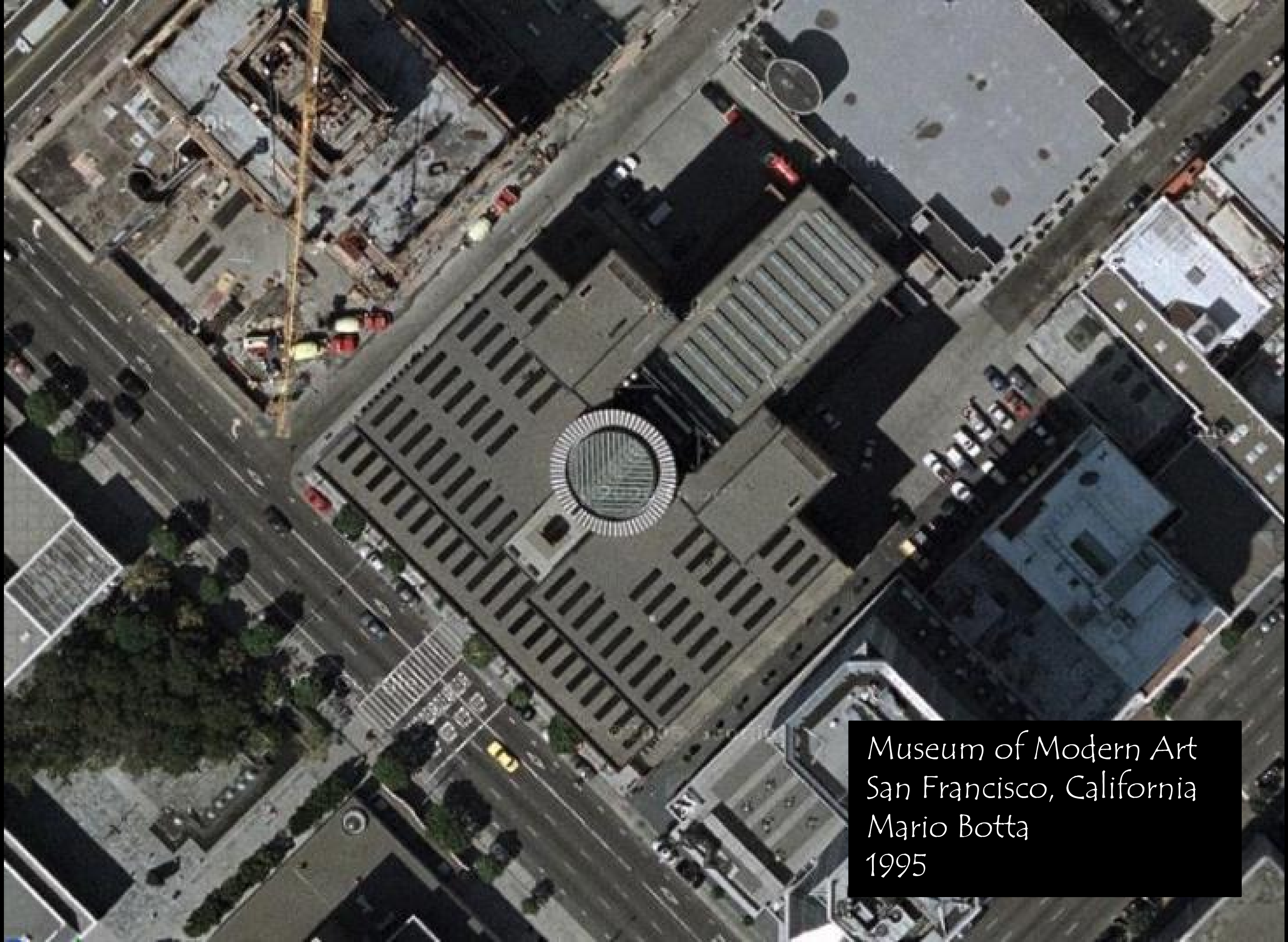
Long Section on East West axis

Scale: Working Order "Hypostyle Module is 18'8" c/c.
'Working Column' diameter is 6'0",
Corridor through 'Walking Order' is 4'0".

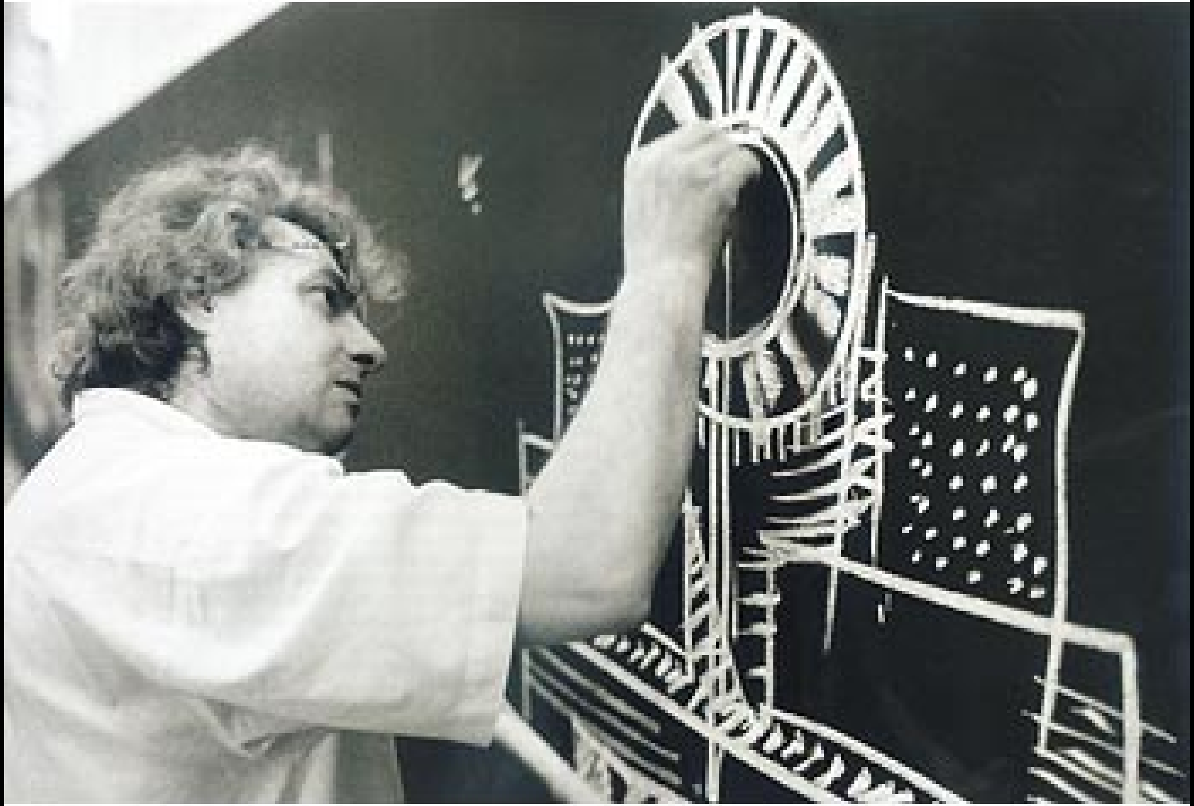


axis No. 2 "old chemistry building"
Site Plan.
for dimensions see the 'parti plans'..
1st Floor Plan.
1 to 3-person offices
conference and meeting rooms
auditoria and debating theatres
jasmine ground cover in "figure-eight infinity loop".
classrooms
computer laboratories
service spaces
footprint of "Working Order".

brick can be made as large precast panels and hung from the building to make a rain screen saving time laying brick at height (scaffolding issue) in inclement weather

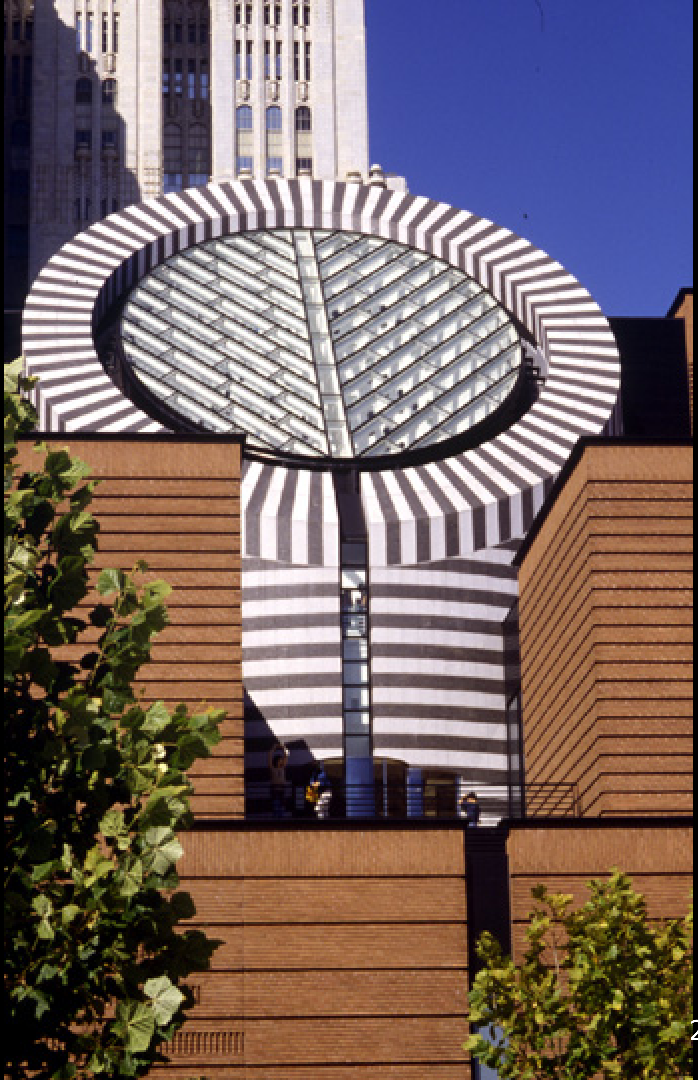


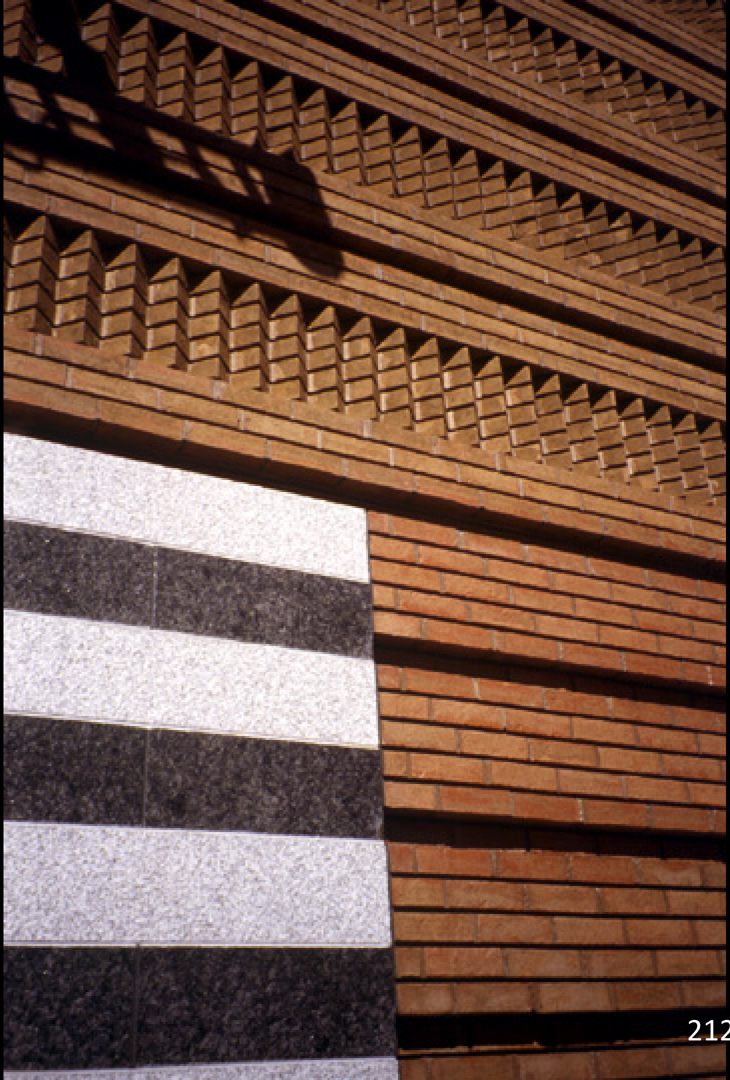
Museum of Modern Art
San Francisco, California
Mario Botta
1995



2


Think
outside
the






Millennium Science Complex
Penn State University
State College, Pennsylvania
Rafael Vinoly Architects
2011


SCIENCE COMPLEX

Dr Chau Chak Wing Building
Sydney, Australia
Frank Gehry
2015

Different detailing is ESSENTIAL in cold climates!

Do NOT copy details from warm or temperate climates as they need not be concerned with creating a rain screen in the same way

Ray and Maria Stata Center
MIT University
Cambridge, Massachusetts
Frank Gehry
2004

"deconstructivist"

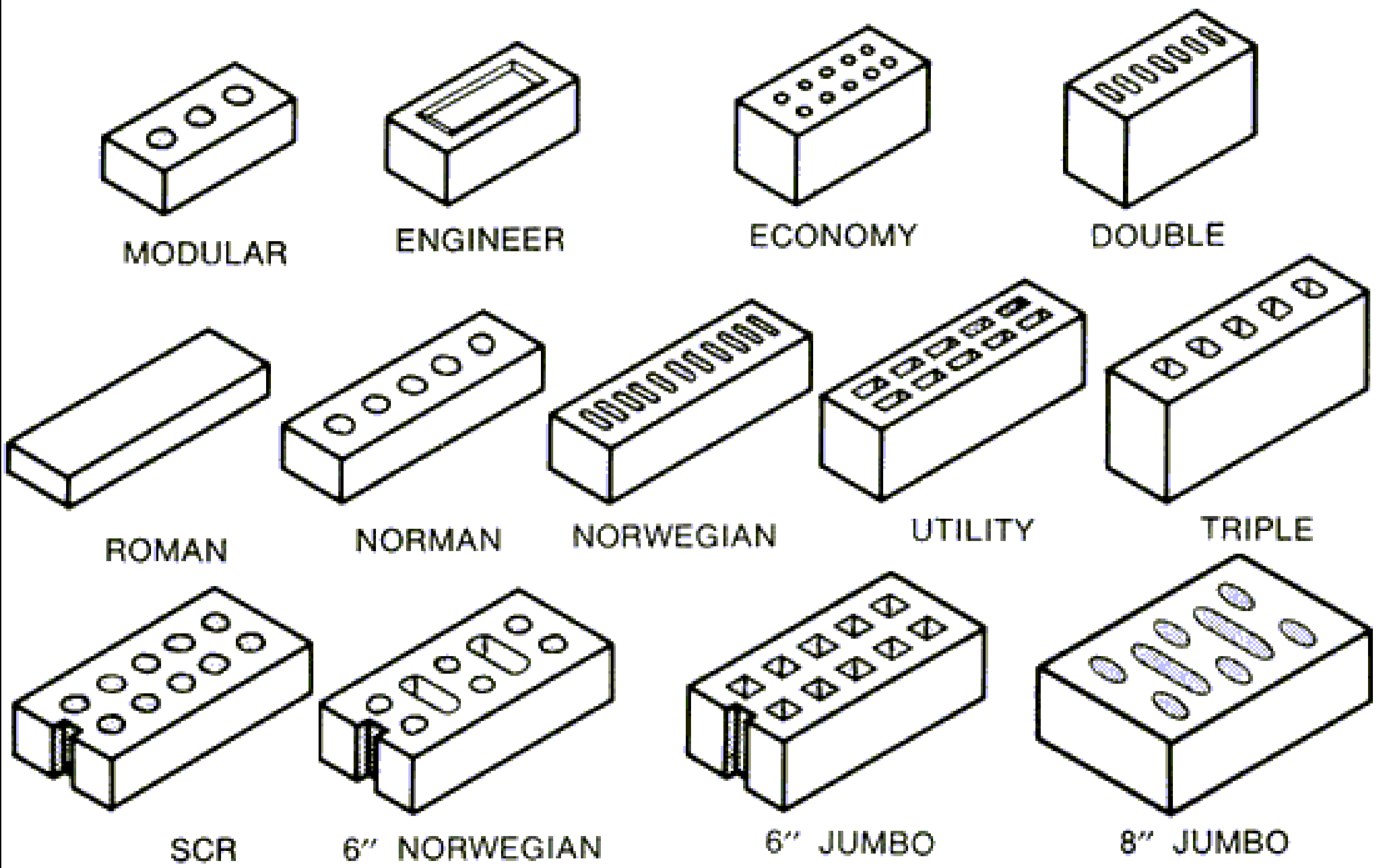

PMG

Hydro Block Housing
Toronto, Ontario
Jack Diamond Architect
1978

University of Waterloo COOP Education Building
Suffering from efflorescence

The Details of Brick and Concrete Block Construction

Brick Construction


MODULAR
ENGINEER
ECONOMY
DOUBLE
ROMAN
NORMAN
NORWEGIAN
UTILITY
TRIPLE
SCR
6″ NORWEGIAN
6″ JUMBO
8″ JUMBO

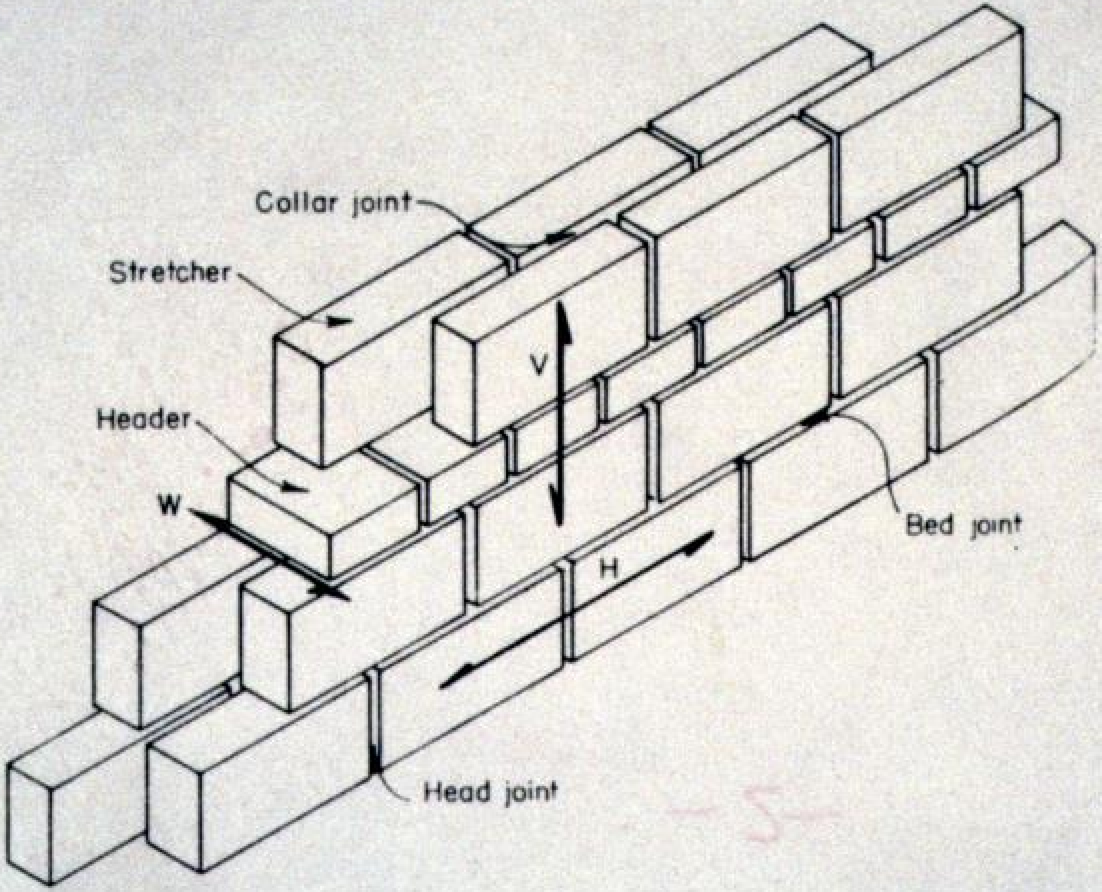
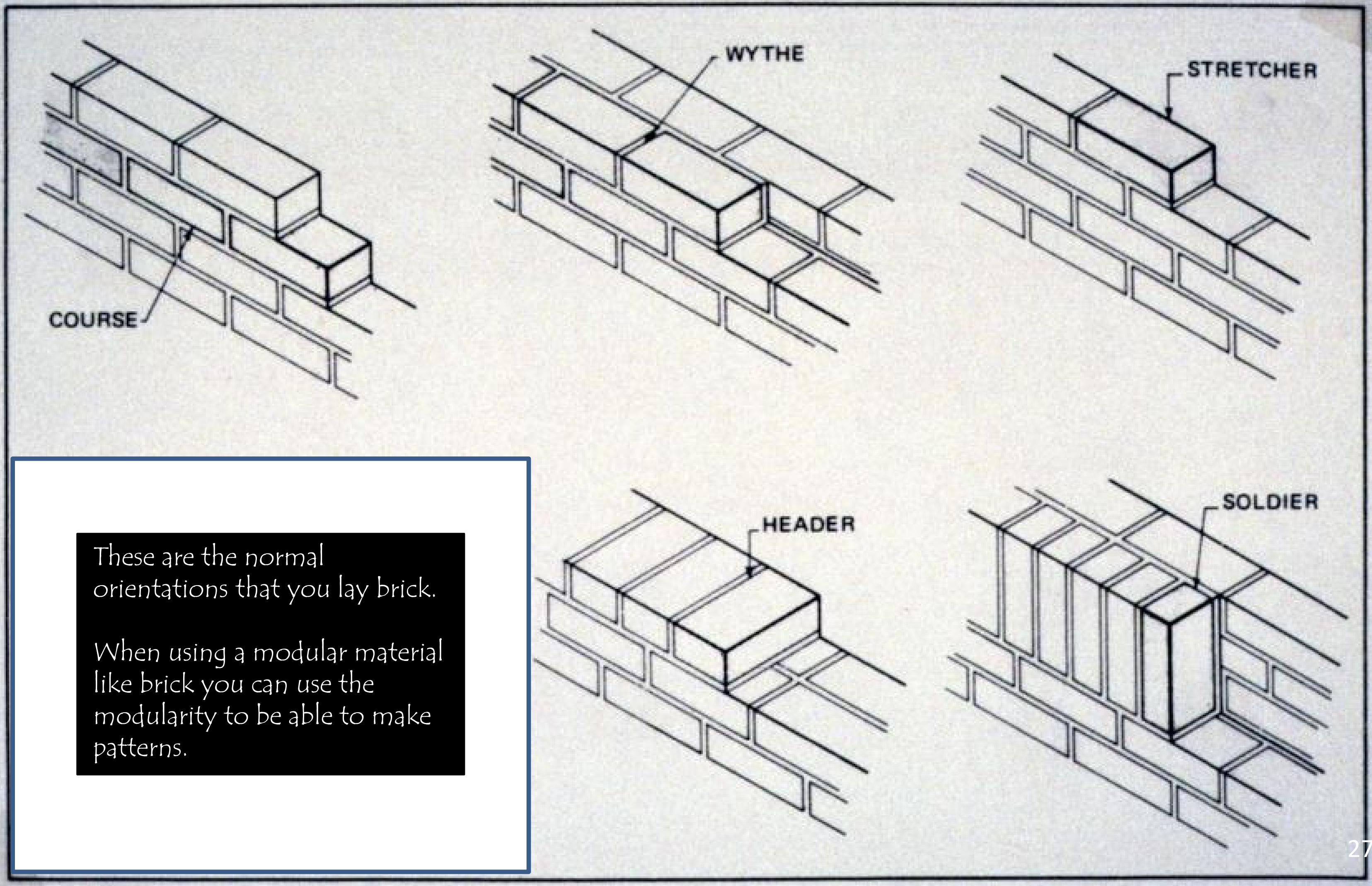
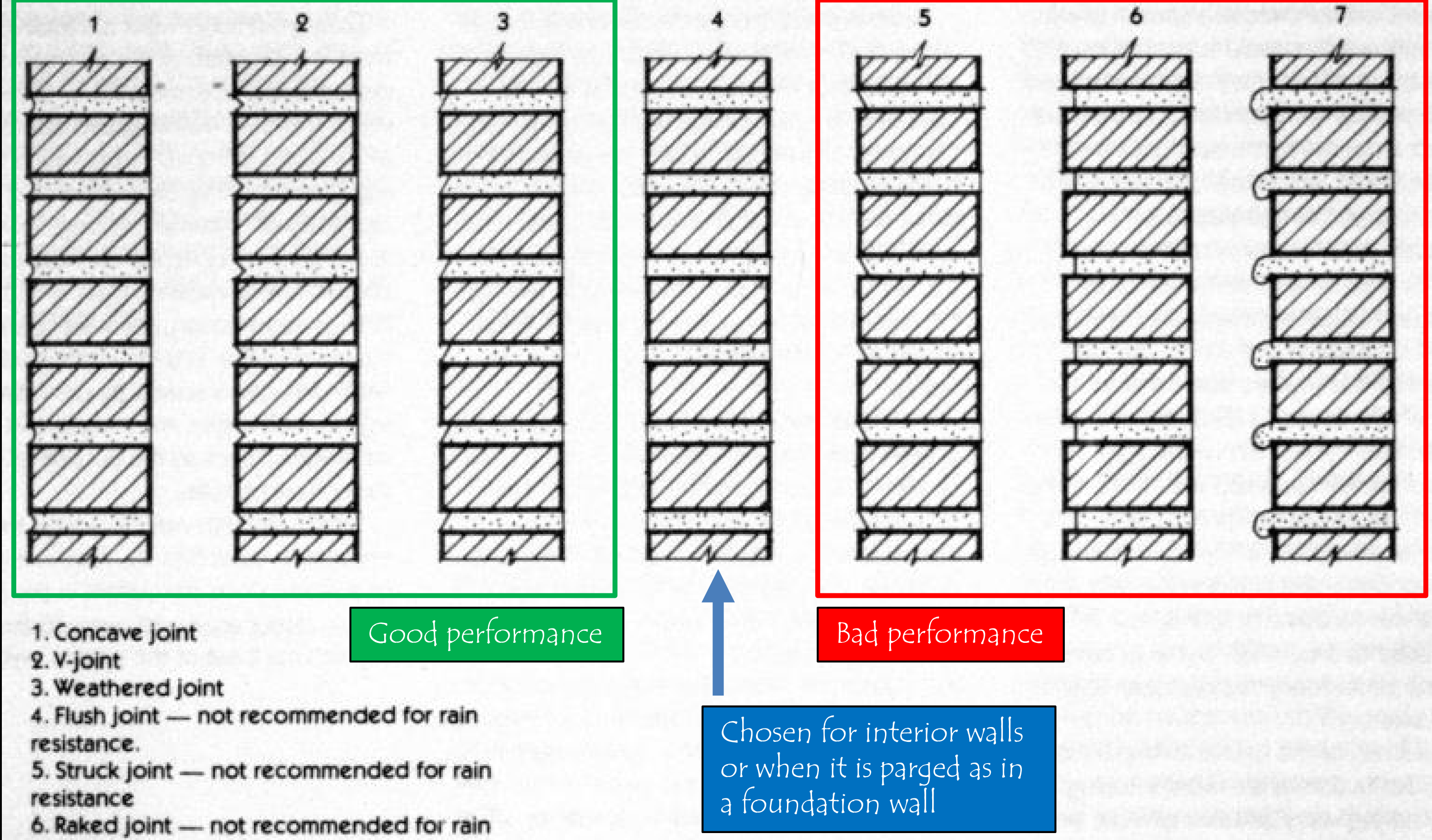


Fig. 4-2. Basic terms and bonding directions.



These are the normal orientations that you lay brick.

When using a modular material like brick you can use the modularity to be able to make patterns.

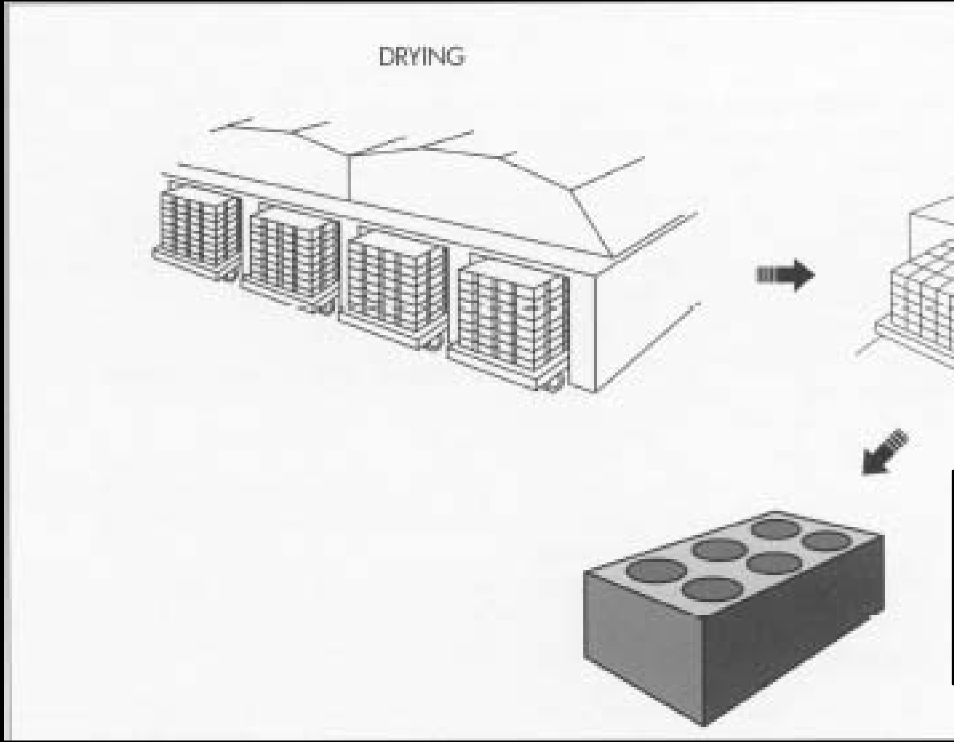


1. Concave joint
2. V-joint
3. Weathered joint
4. Flush joint — not recommended for rain resistance.
5. Struck joint — not recommended for rain resistance
6. Raked joint — not recommended for rain resistance
7. Extruded — not recommended for rain resistance

Fig. 13 Types of mortar joint treatment

Basic brick laying tools

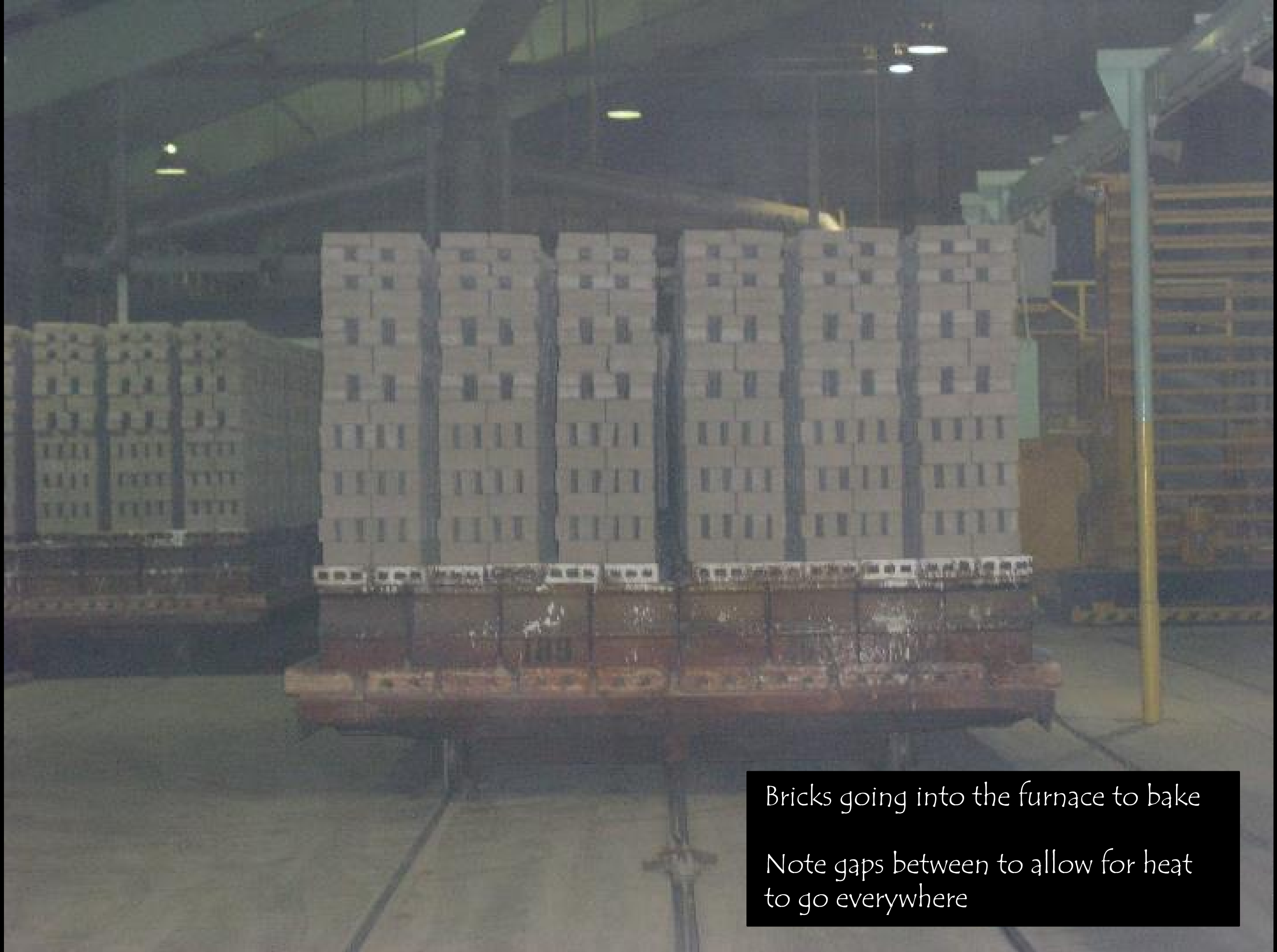
Device used to break the bricks when a part brick is needed



The clay is a wet material that only gains strength when it is fired

Has CO_2 implications

The extruded bricks are cut/sliced with a "wire" which can leave (nice) patterns on the face of the bricks

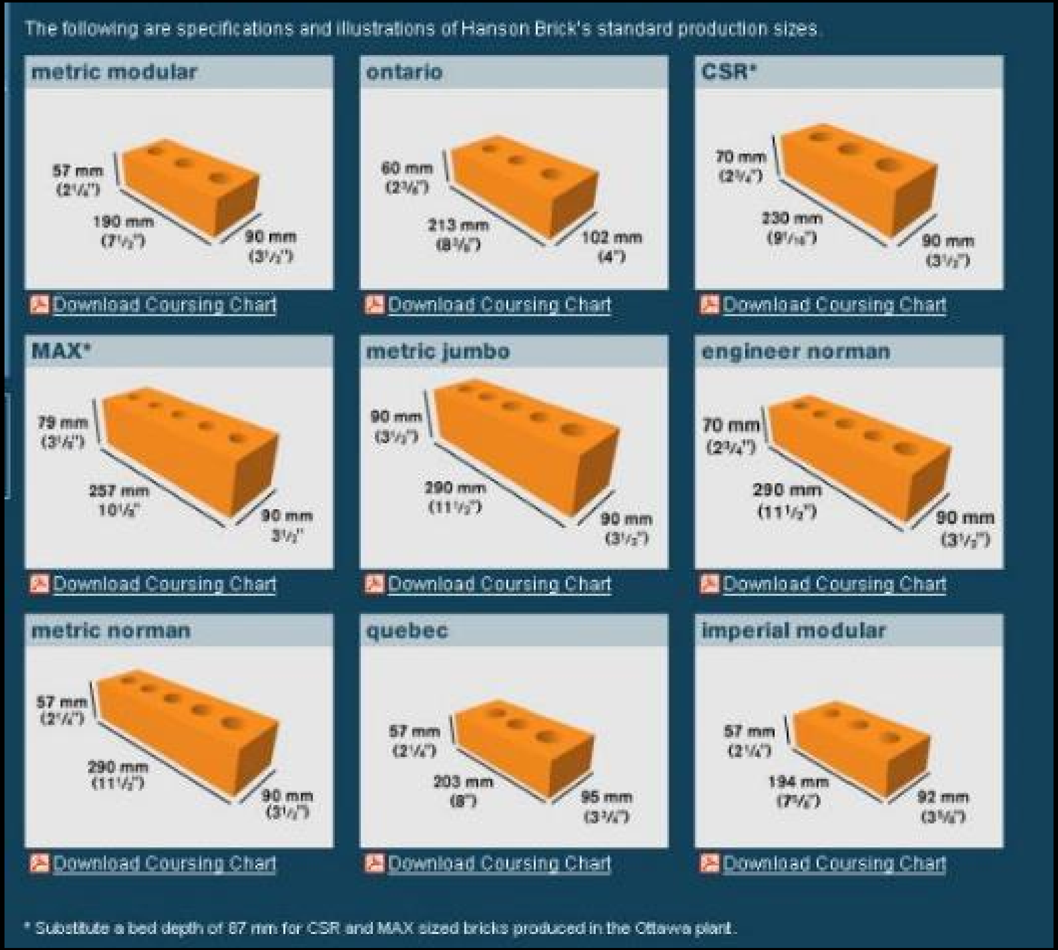


Bricks going into the furnace to bake

Note gaps between to allow for heat
to go everywhere

Bricks bundled ready for shipping

The "holes" in the stacks allow the load to be picked up with a forklift truck – more sustainable than using wooden pallets.



The industry uses a selection of standard sizes for bricks.

Coursing charts are available through the manufacturers to help with your detail drawings to determine opening sizes to avoid excessive cutting.

BRAMPTON BRICK

COURSING CHART
IMPERIAL MODULAR BRICK

(7 5/8" Length x 2 1/4" Height x 3 5/8" Bed Depth)
(194mm Length x 57mm Height x 92mm Bed Depth)

VERTICAL COURSING
always one brick + one joint in the table below

No. of courses	3/8" joint	1/2" joint	10 mm joint
1	0' 2 2/3"	0' 2 3/4"	67 mm
2	0' 5 1/2"	0' 5 1/2"	133 mm
3	0' 8"	0' 8 1/4"	200 mm
4	0' 10 2/3"	0' 11"	267 mm
5	1' 1 1/3"	1' 1 3/4"	333 mm
6	1' 4"	1' 4 1/2"	400 mm
7	1' 6 2/3"	1' 7 1/4"	467 mm
8	1' 9 1/3"	1' 10"	533 mm
9	2' 0"	2' 3/4"	600 mm
10	2' 2 2/3"	2' 3 1/2"	667 mm
11	2' 5 1/3"	2' 6 1/4"	733 mm
12	2' 8"	2' 9"	800 mm
13	2' 10 2/3"	2' 11 3/4"	867 mm
14	3' 1 1/3"	3' 2 1/2"	933 mm
15	3' 4"	3' 5 1/4"	1,000 mm
16	3' 6 2/3"	3' 8"	1,067 mm
17	3' 9 1/3"	3' 10 3/4"	1,133 mm
18	4' 0"	4' 1 1/2"	1,200 mm
19	4' 2 2/3"	4' 4 1/4"	1,267 mm
20	4' 5 1/3"	4' 7"	1,333 mm
25	5' 6 2/3"	5' 8 3/4"	1,667 mm
50	11' 1 1/3"	11' 5 1/2"	3,333 mm
100	22' 2 2/3"	22' 11"	6,667 mm

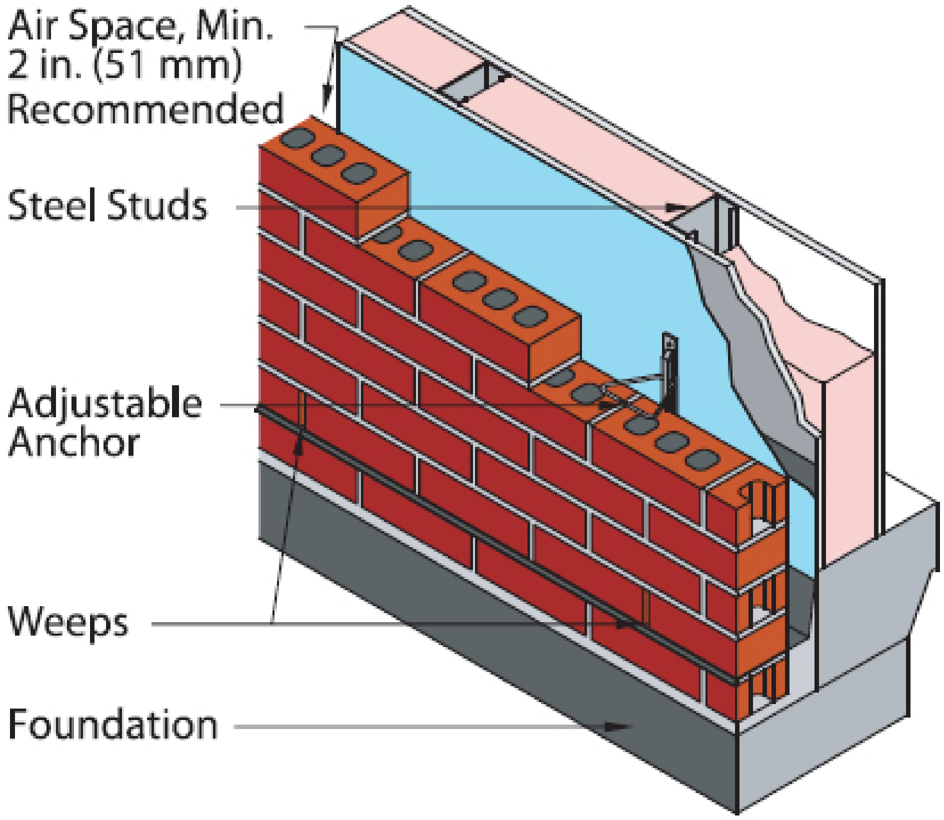
HORIZONTAL COURSING

3/8" joint	1/2" joint	10 mm joint
0' 8"	0' 8 1/8"	204 mm
1' 4"	1' 4 1/4"	408 mm
2' 0"	2' 3/8"	612 mm
2' 8"	2' 8 1/2"	816 mm
3' 4"	3' 4 5/8"	1,020 mm
4' 0"	4' 3/4"	1,224 mm
4' 8"	4' 8 7/8"	1,428 mm
5' 4"	5' 5"	1,632 mm
6' 0"	6' 1 1/8"	1,836 mm
6' 8"	6' 9 1/4"	2,040 mm
7' 4"	7' 5 3/8"	2,244 mm
8' 0"	8' 1 1/2"	2,448 mm
8' 8"	8' 9 5/8"	2,652 mm
9' 4"	9' 5 3/4"	2,856 mm
10' 0"	10' 1 7/8"	3,060 mm
10' 8"	10' 10"	3,264 mm
11' 4"	11' 6 1/8"	3,468 mm
12' 0"	12' 2 1/4"	3,672 mm
12' 8"	12' 10 3/8"	3,876 mm
13' 4"	13' 6 1/2"	4,080 mm
16' 8"	16' 11 1/8"	5,100 mm
33' 4"	33' 10 1/4"	10,200 mm
66' 8"	67' 8 1/2"	20,400 mm

73.5 Imperial Modular Brick covers one square meter
6.8 Imperial Modular covers one square foot
Metric dimensions are rounded

Veneer as Rainscreen:

- Creates equal pressure on both sides of the veneer
- Vented to allow for air pressure equalization
- Drain holes at bottom to allow water to escape
- Flashing at base to direct water



Brick Veneer/Steel Stud Wall

Back up wall can be steel stud or wood stud

If steel stud the insulation performance is severely compromised so you need to put a LOT of rigid insulation in the cavity (more than you see on this image!)

COMPONENTS OF THE ASSEMBLY | *Building Technology – BVCM*

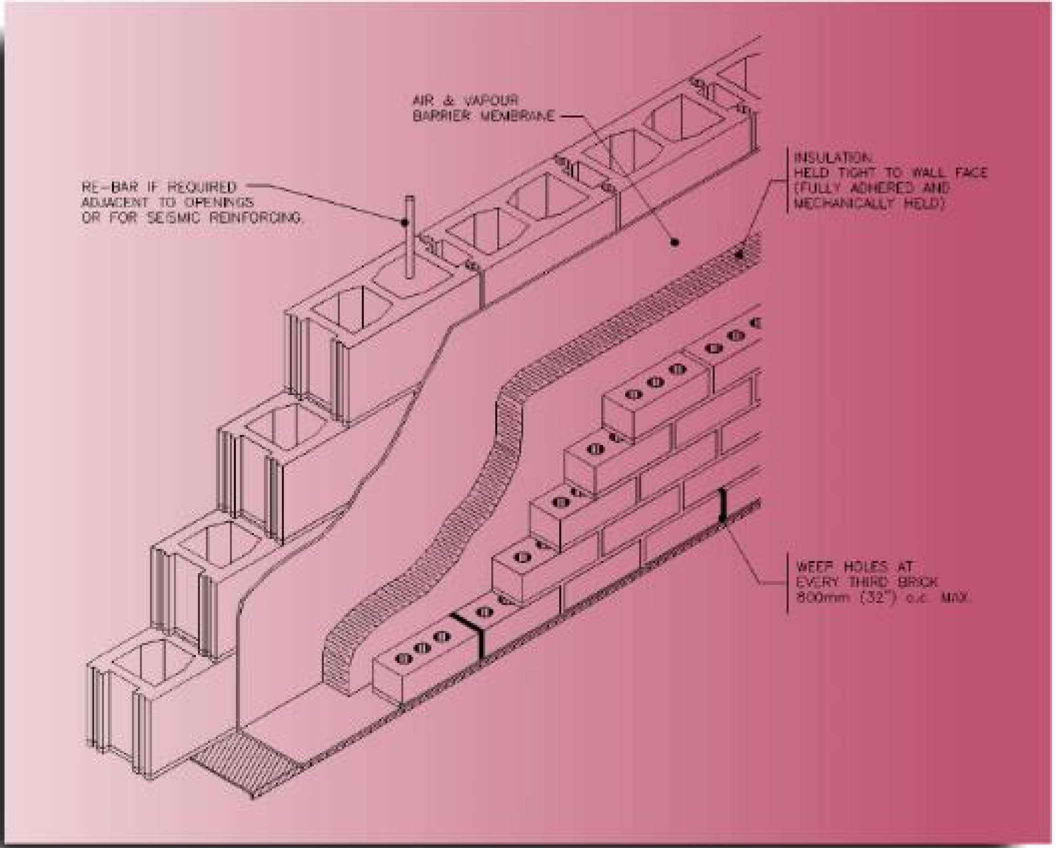


Figure 2.2: *Typical BV/CMU Drainage Wall*

For many commercial and institutional buildings, concrete block is the go to material for the back up.

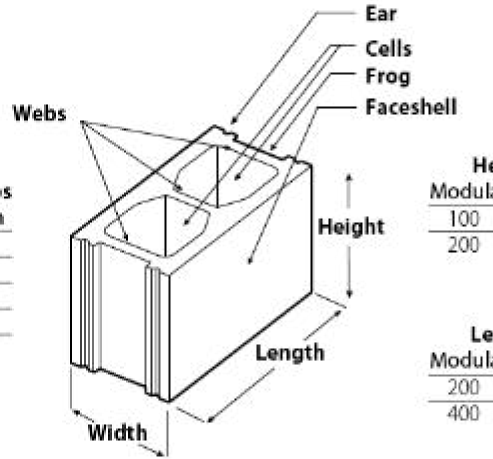
Here the insulation will be a rigid type that is placed in the cavity, with a 25mm air space between the insulation and the brick veneer to allow for drainage

Concrete Block Construction

Concrete block can be used as a
LOAD BEARING
wall as a single WYTHE depending on the height
and thickness of the units

Figure 3.1: Typical Concrete Block Masonry Unit (Hollow Unit, with Flanged Ends) (Ref. 2)

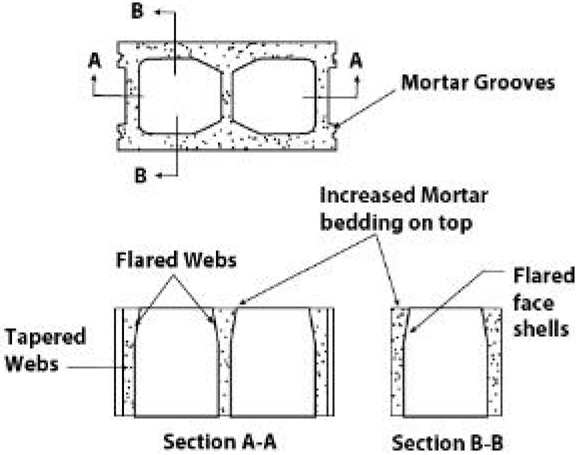
Modular	Width Actual	Faceshell mm	Webs mm
100	90	20	20
150	140	25	25
200	190	30	30
250	240	35	35
300	290	35	35



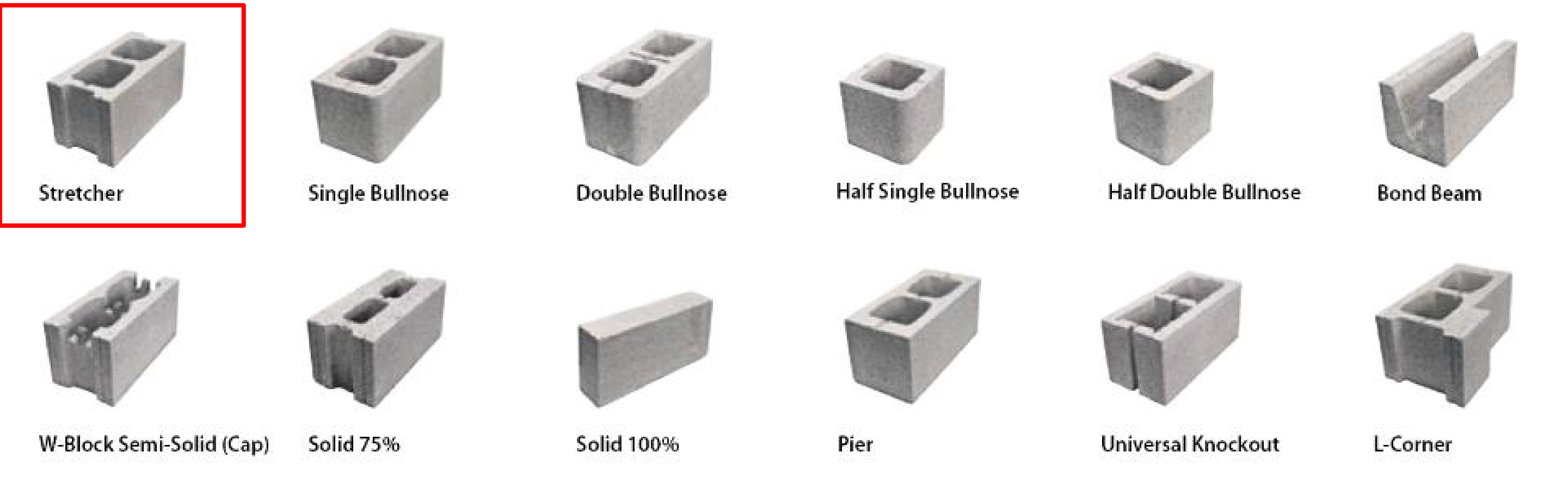
Height Modular	Height Actual
100	90
200	190

Length Modular	Length Actual
200	190
400	390

Figure 3.2: Typical Concrete Block Masonry Unit (Hollow Unit, with Flanged Ends)

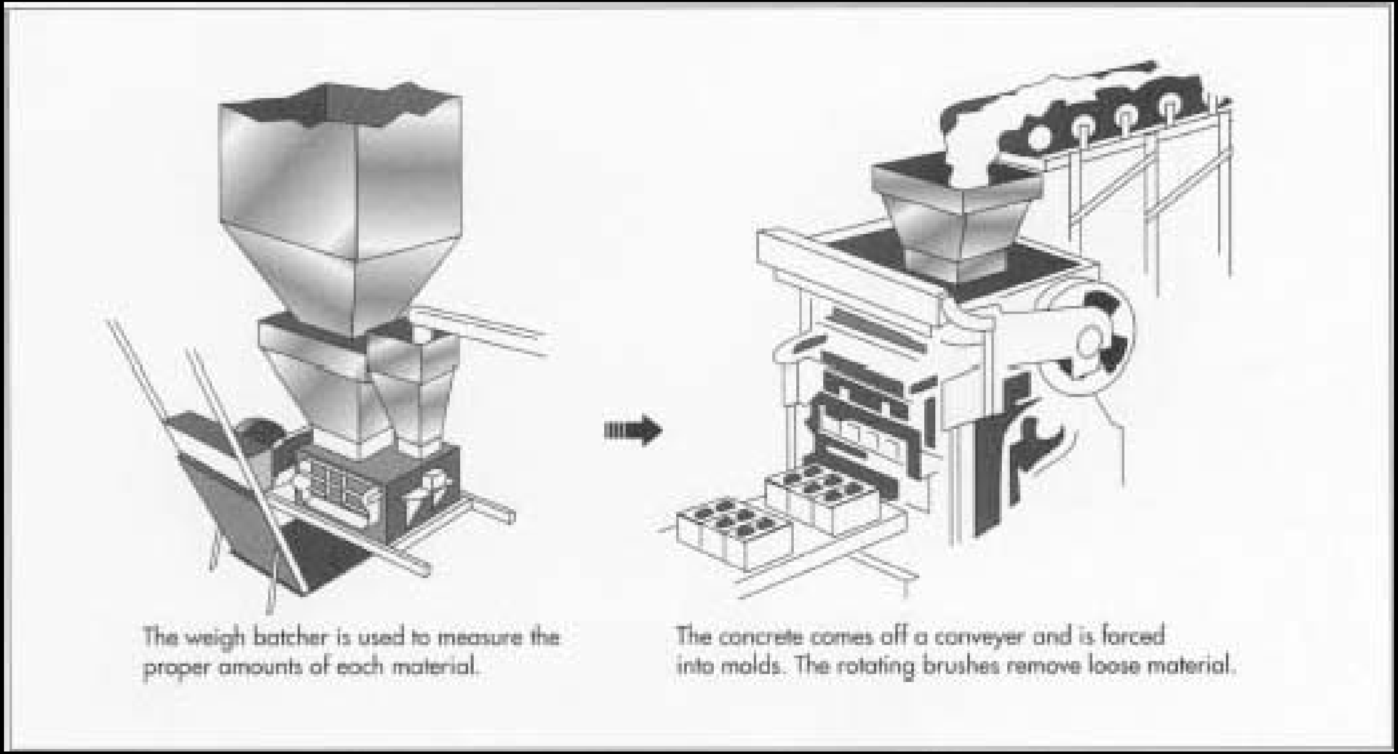


Most common shape



A range of shapes is available to accommodate corner and lintel conditions.

Concrete blocks are made from concrete! But a smoother material needed so no large aggregates.

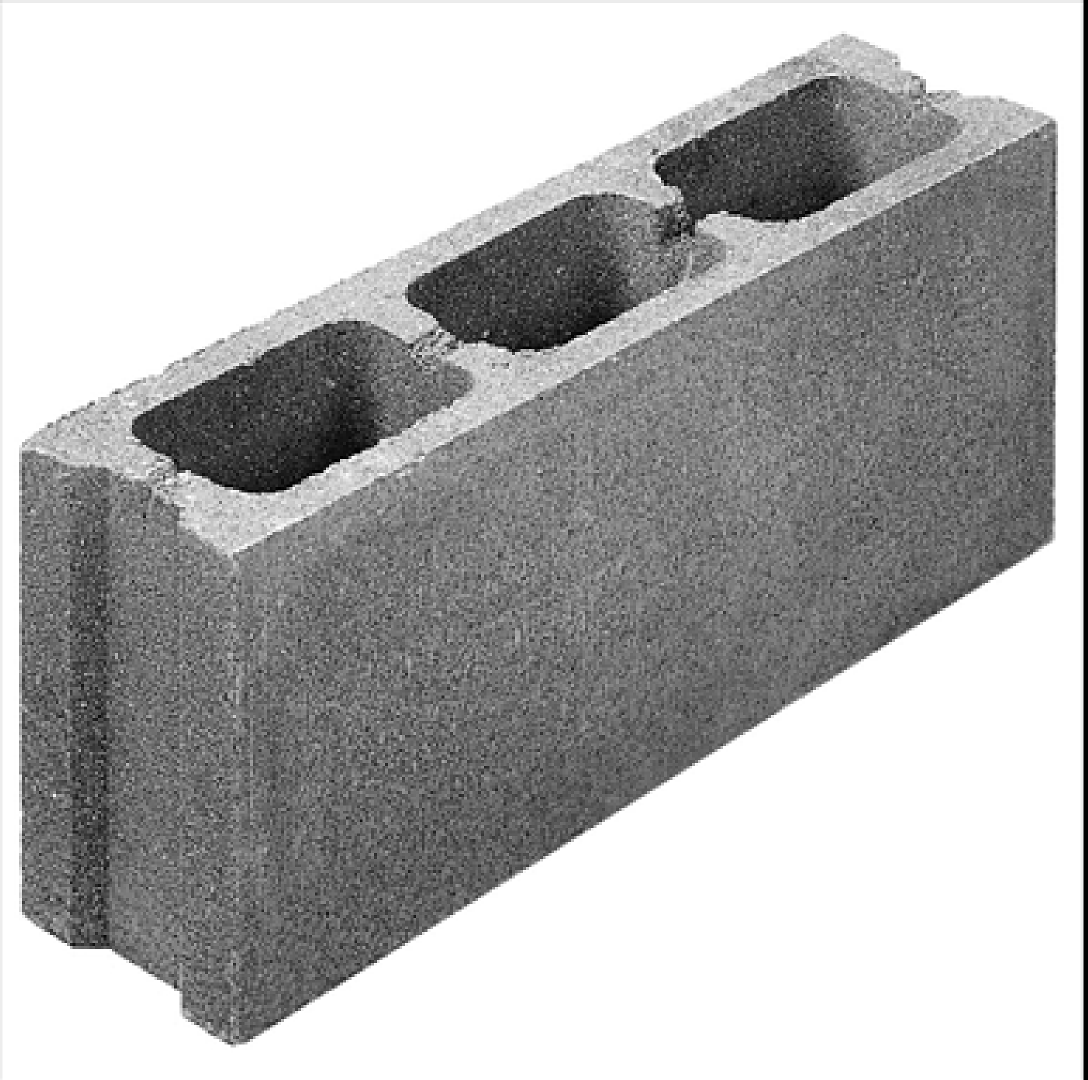


Some production devices are fairly crude but get the job done.

Modern production facilities have equipment that allows for fast production and high volumes.

Mortar joints are 10mm making the module 200 x 400mm

The surface texture is pretty porous. When used as a foundation this means you need to parge it with cement to make it ready to take your bituminous dampproofing materials.

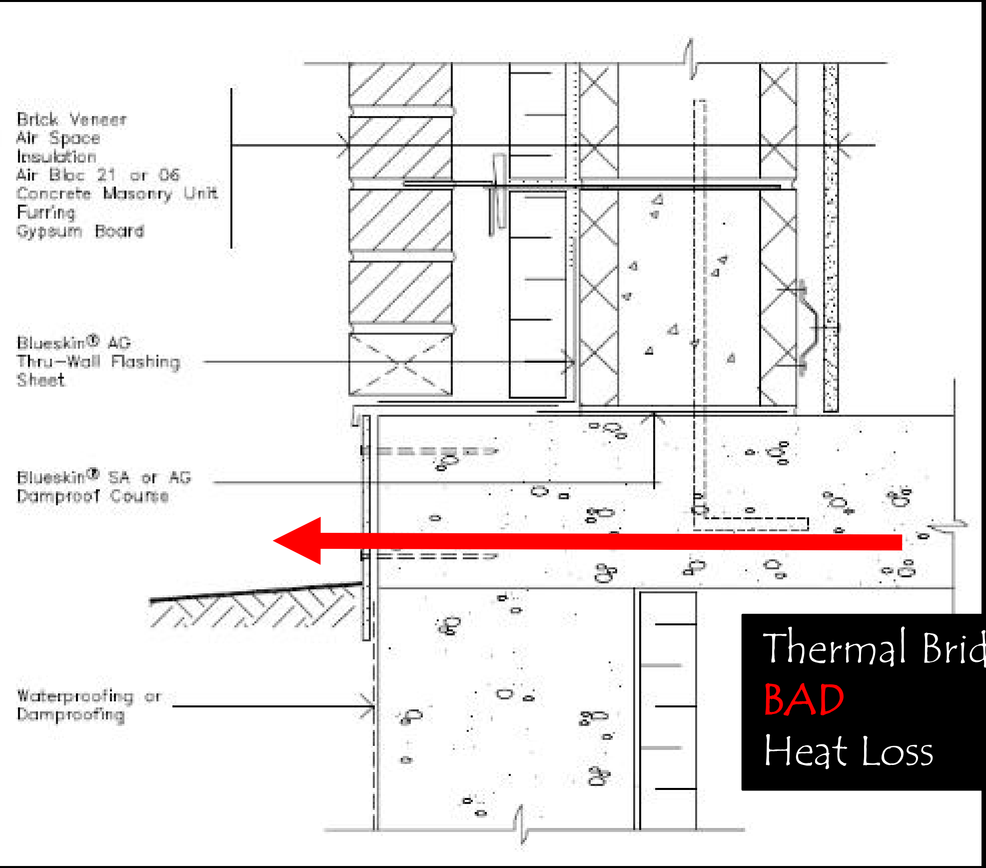


Various standard thicknesses are available

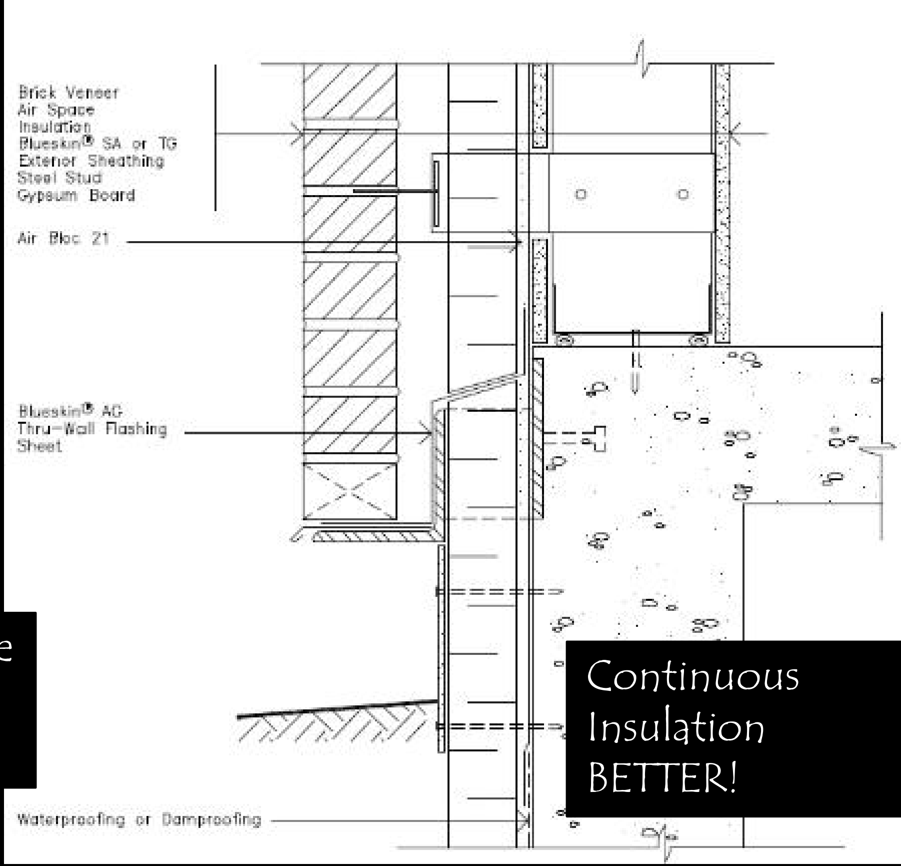
Thinner ones for interior non load bearing partitions

Limit of load bearing is the 190mm thick one due to the weight and not wanting to make the job too hard on the masons.

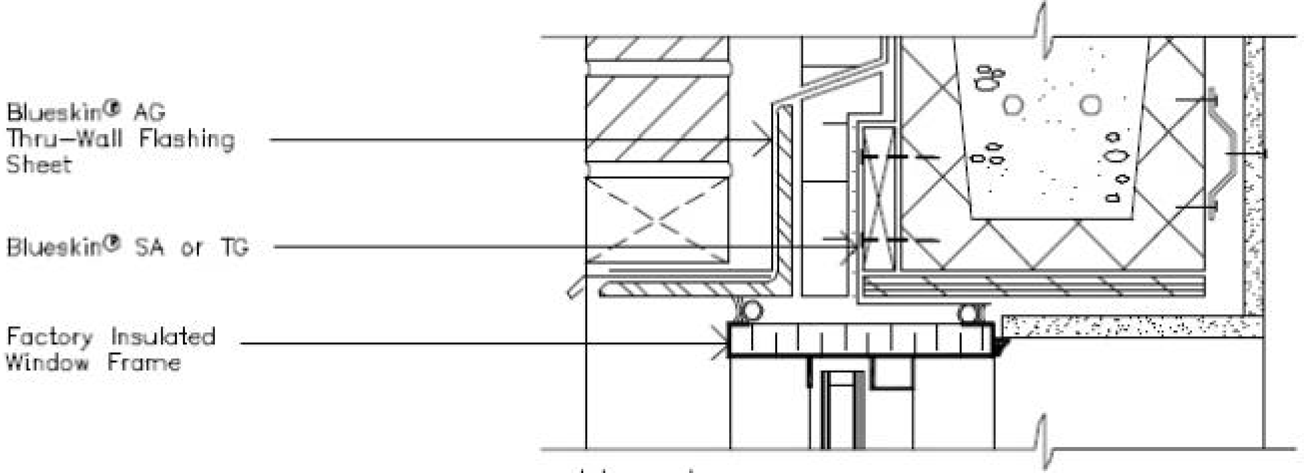
Blocks with sharp corners are used for piers or end conditions.



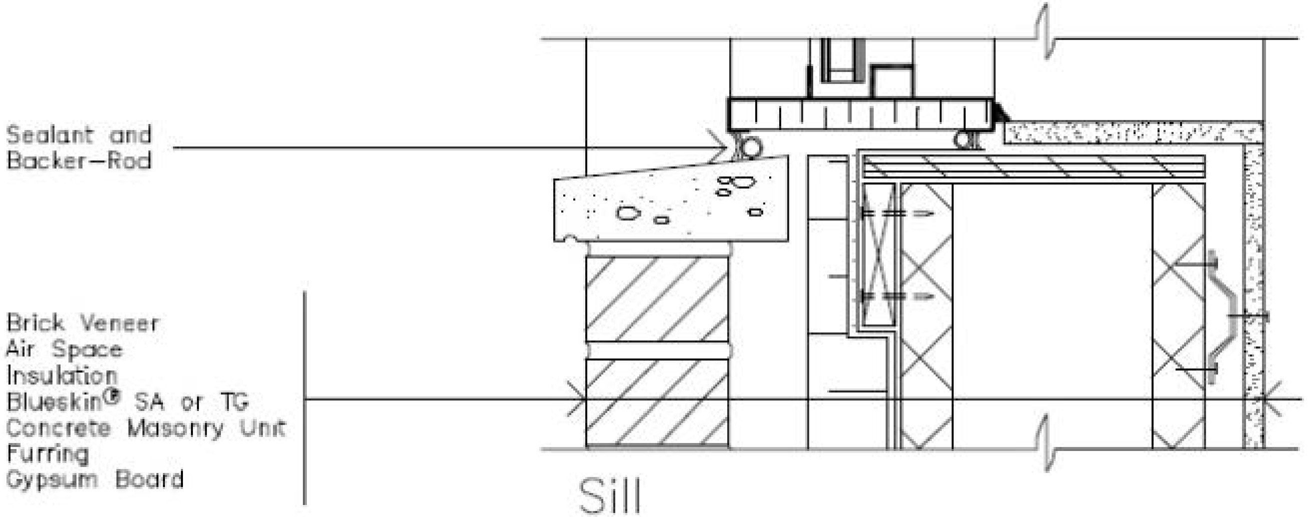
Thermal Bridge
BAD
Heat Loss



Continuous
Insulation
BETTER!


Blueskin® AG
Thru-Wall Flashing
Sheet
Blueskin® SA or TG
Factory Insulated
Window Frame

Head


Sealant and
Backer-Rod
Brick Veneer
Air Space
Insulation
Blueskin® SA or TG
Concrete Masonry Unit
Furring
Gypsum Board

Sill

The following images are for your information and were not included in the lecture.

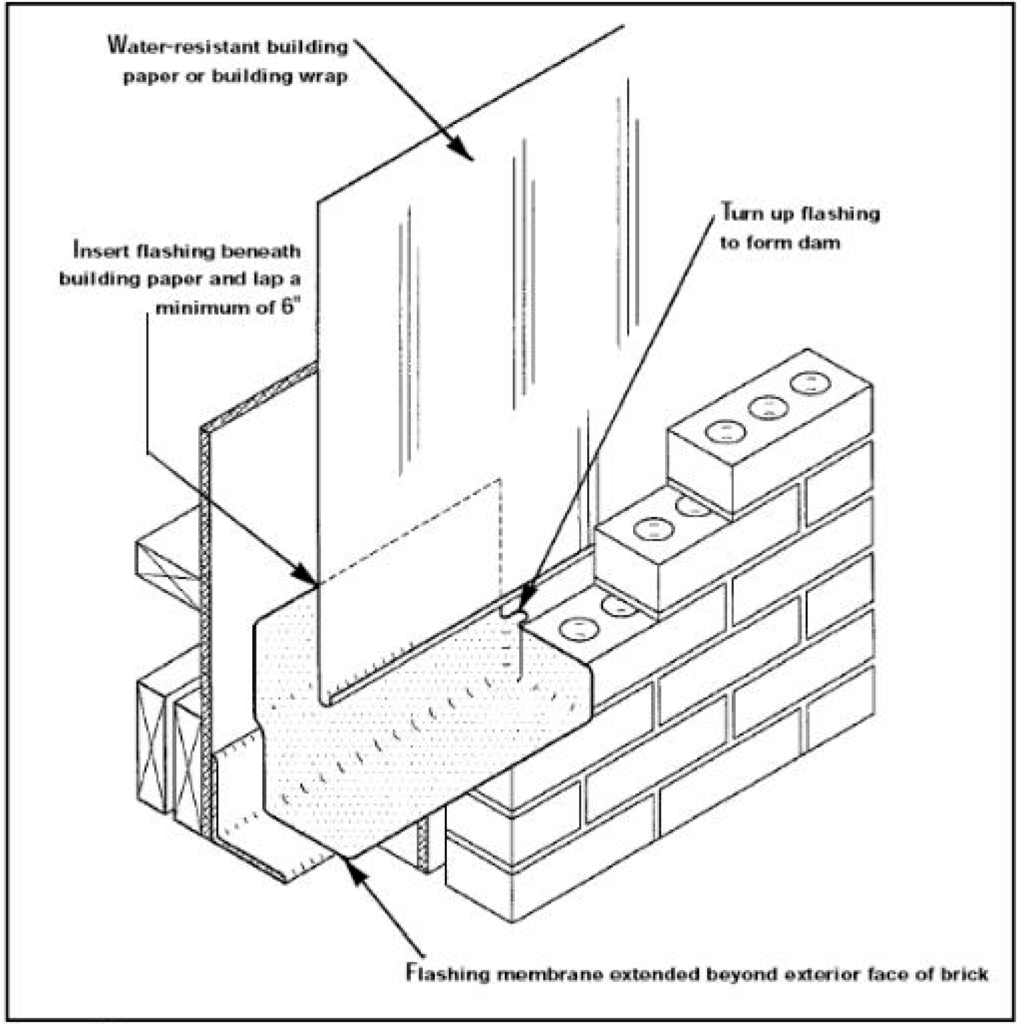
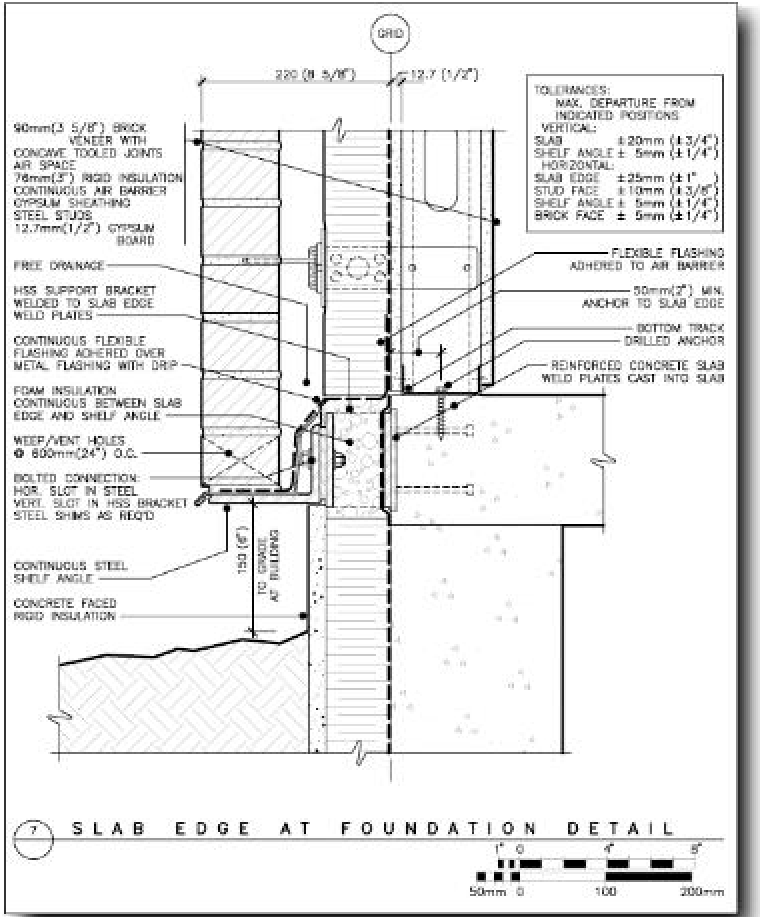
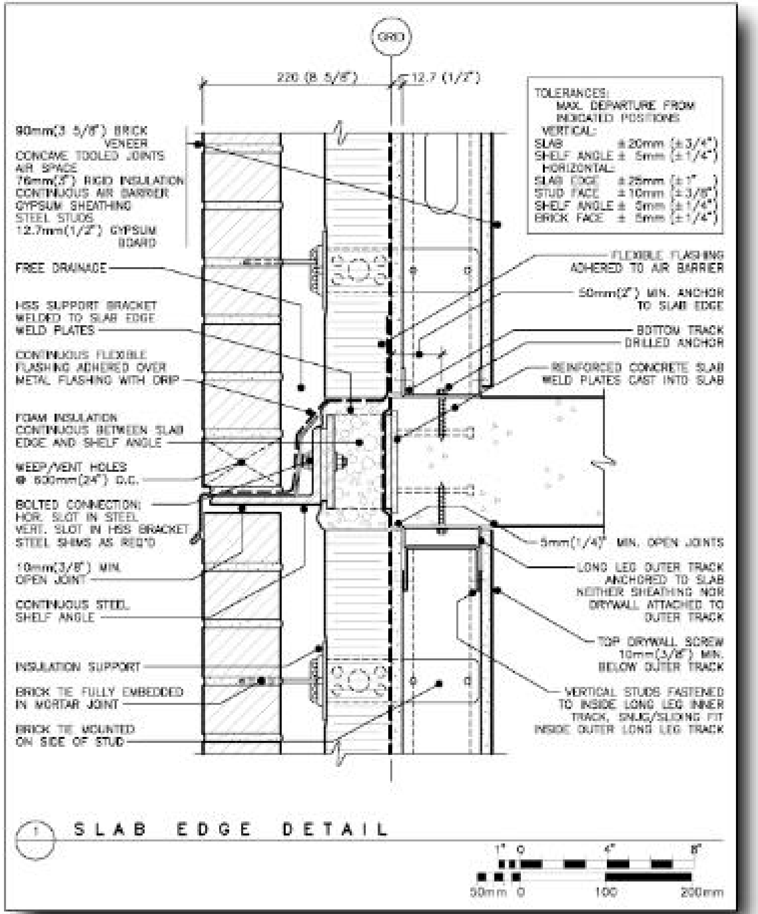


Figure 3. Isometric of flashing above opening

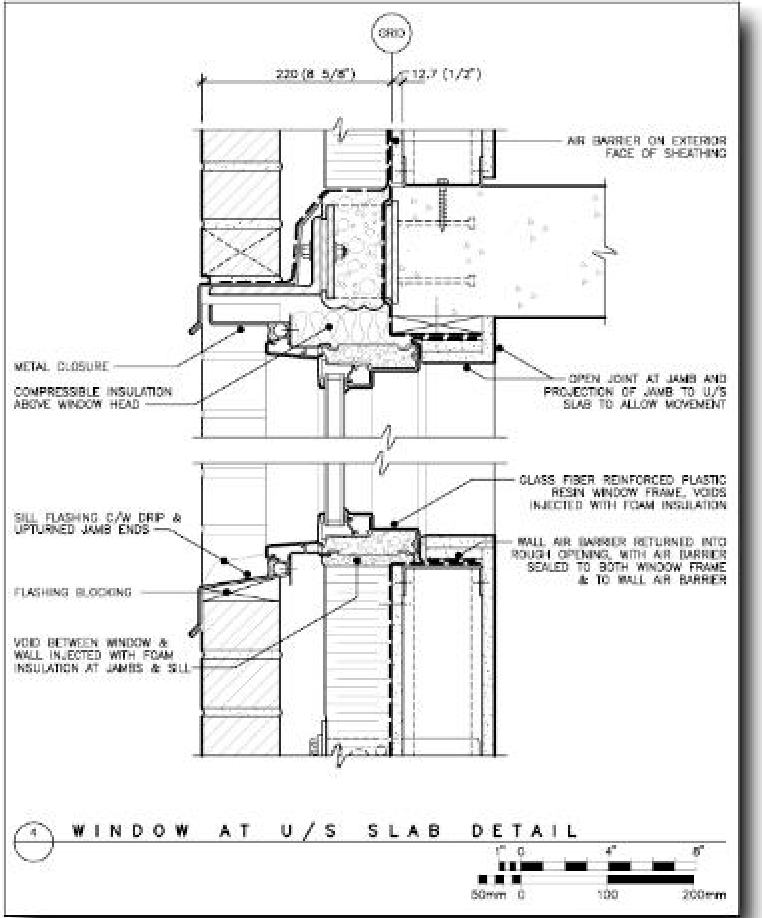
Steel Stud Back Up Wall



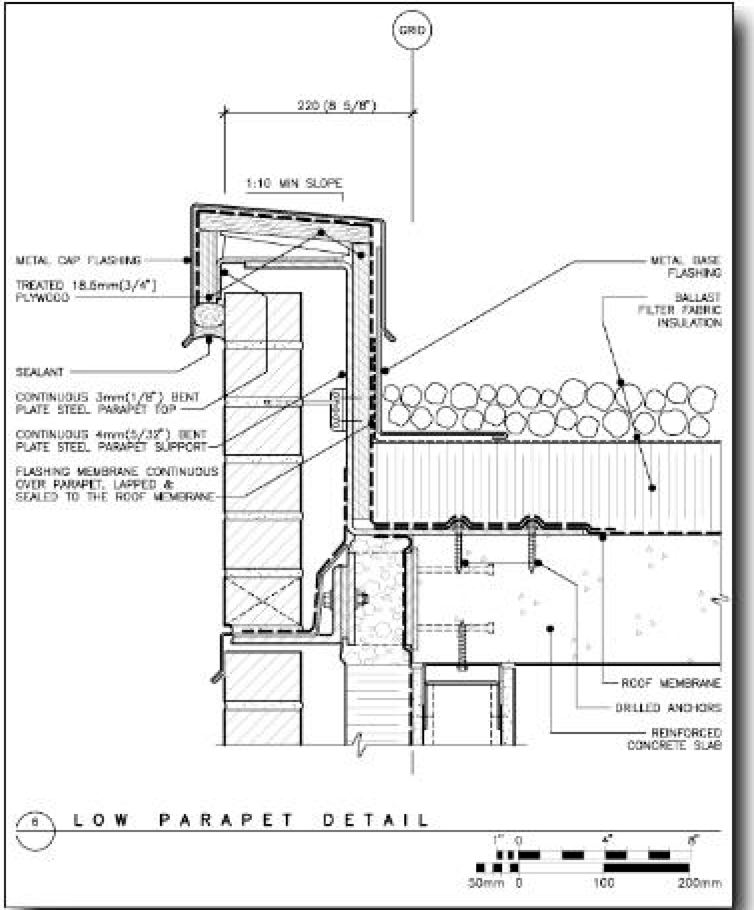
Detail 7: Slab Edge at Foundation



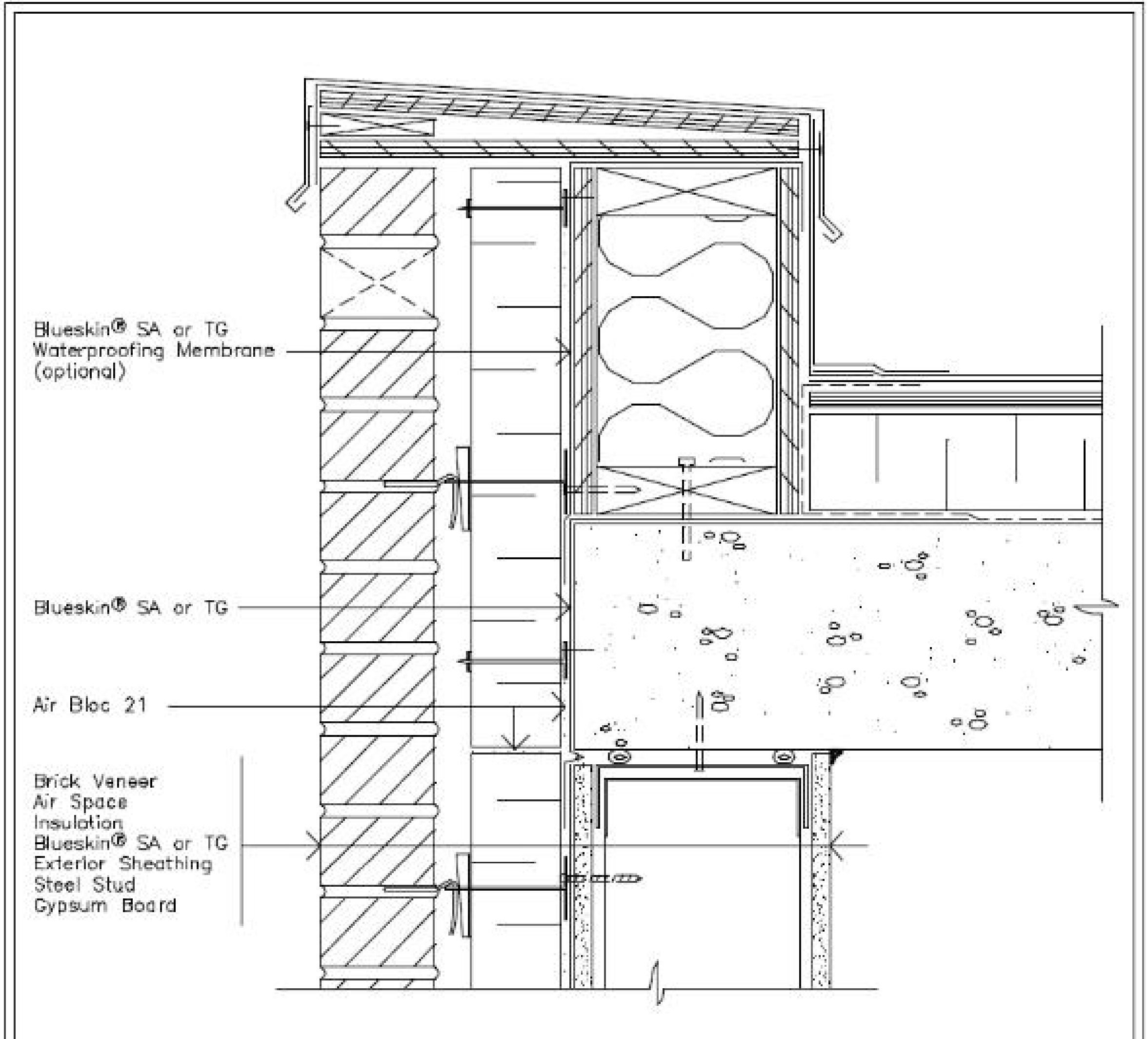
Detail 1: Slab Edge

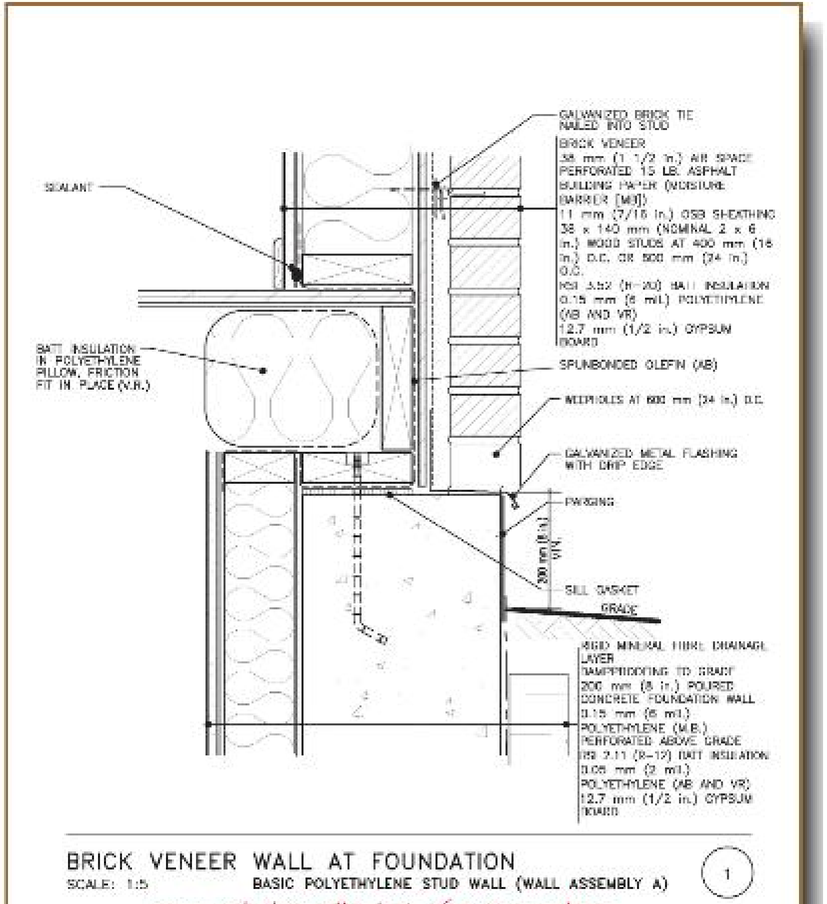


Detail 4: Window at U/S Slab



Detail 6. Low Parapet


Blueskin® SA or TG
Waterproofing Membrane
(optional)
Blueskin® SA or TG
Air Bloc 21
Brick Veneer
Air Space
Insulation
Blueskin® SA or TG
Exterior Sheathing
Steel Stud
Gypsum Board

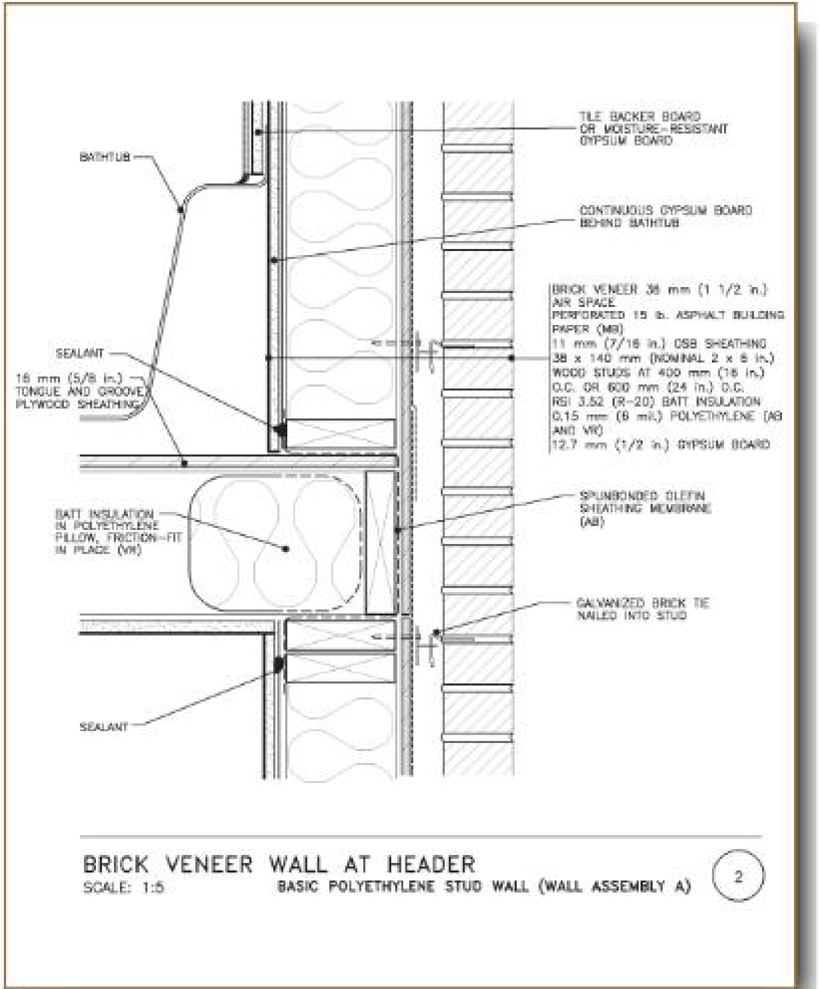


issue with this wall is lack of cavity insulation
adding requires alteration to foundation wall
width in order to also support the brick veneer

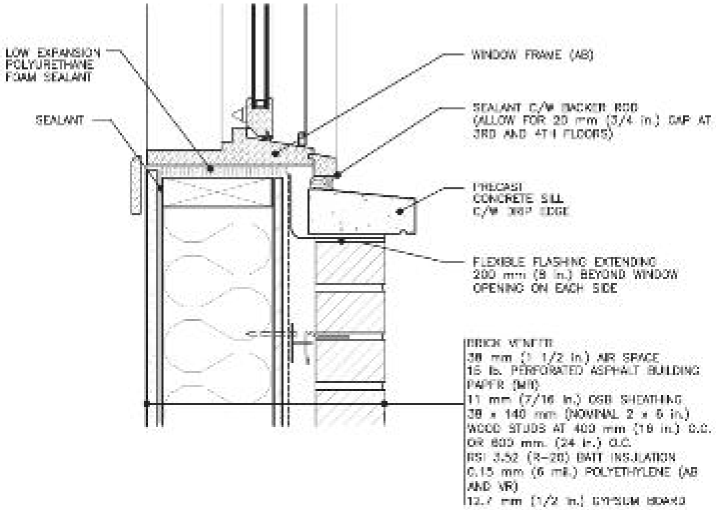
Detail 1: Brick Veneer Wall at Foundation

Wood Frame Back Up Wall

When you do your final project, please be sure to add 38mm of rigid insulation in the cavity.



Detail 2: Brick Veneer Wall at Header



the rough framed opening is always larger than the window
in order to allow the placement of shims that allow the carpenters
to ensure that the windows are plumb and square

WINDOW OPENING
SCALE: 1:5

(WALL ASSEMBLY A)

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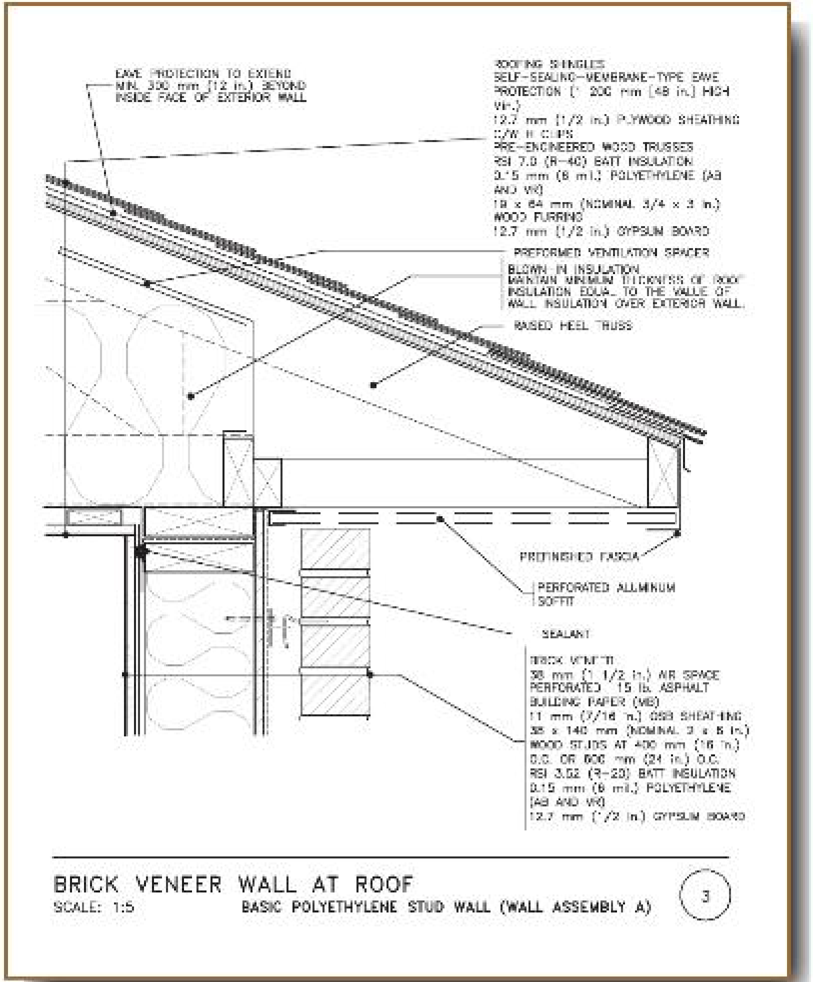
Detail 17: Window Opening, A



Detail 3: Brick Veneer Wall at Roof