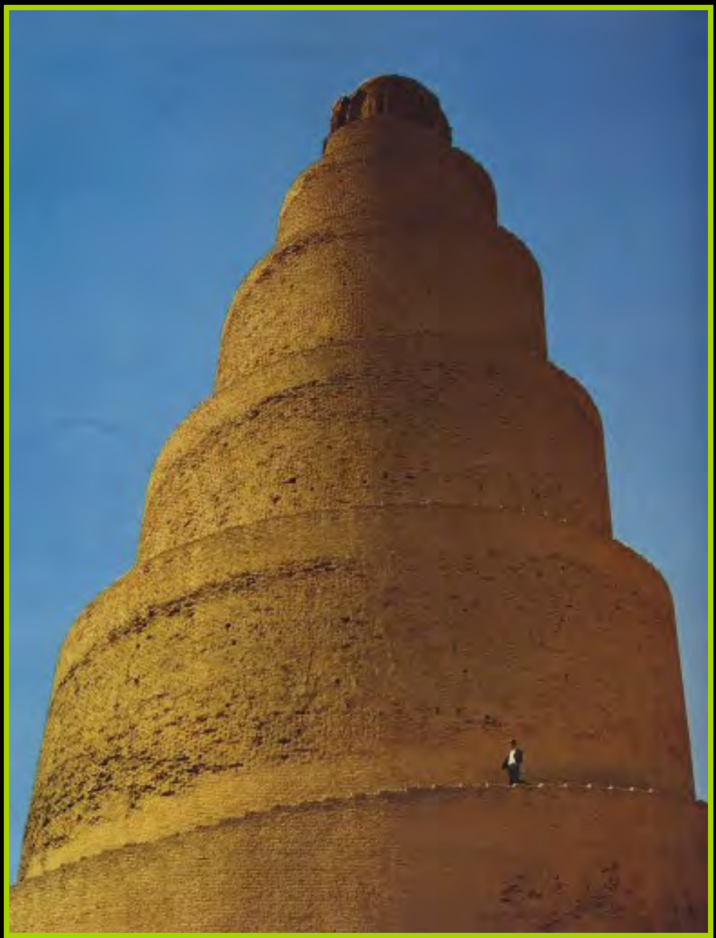
Construction Technology 1 (AES 24501)

Intro to Basic Materials:

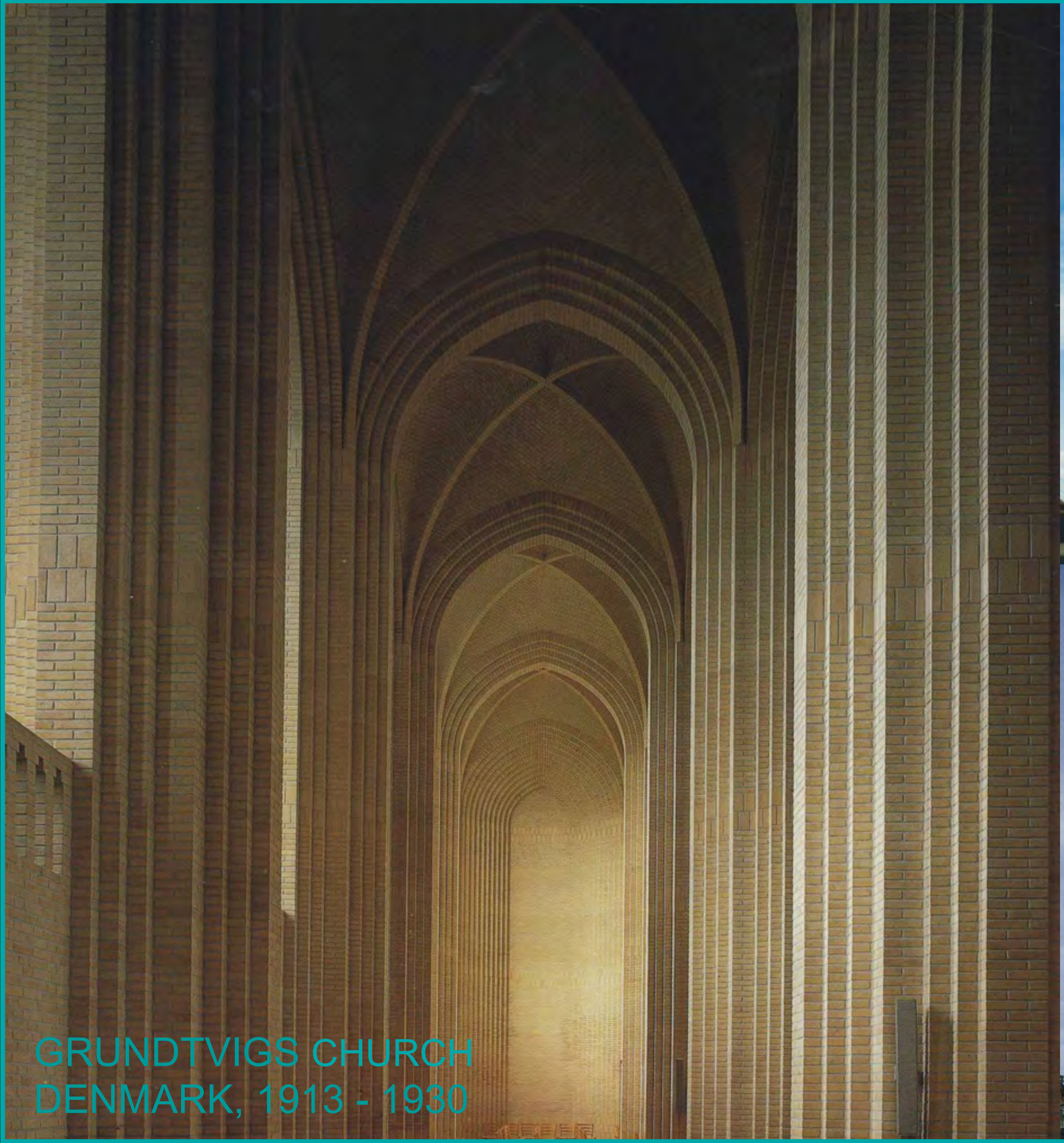


MASONRY MATERIAL

MINARET 'al-MALWIJA'
SAMARRA, IRAQ, ~860

GREAT WALL (MING DYNASTY)
CHINA, 1368 - 1644

MONADNOCK BUILDING
CHICAGO, 1889 - 1891

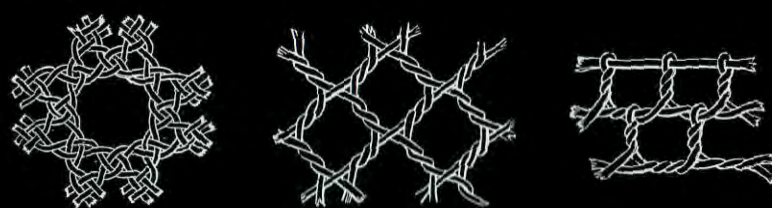


GRUNDTVIGS CHURCH
DENMARK, 1913 - 1930

→ *TYPOLOGY OF HUMAN PRODUCTION METHODS:*

G. Semper:
"Style in the Technical and Tectonic Arts -
or Practical Aesthetics" 1860-1863
(after G.Klemm: "General Cultural History of Mankind", 1843-1851)

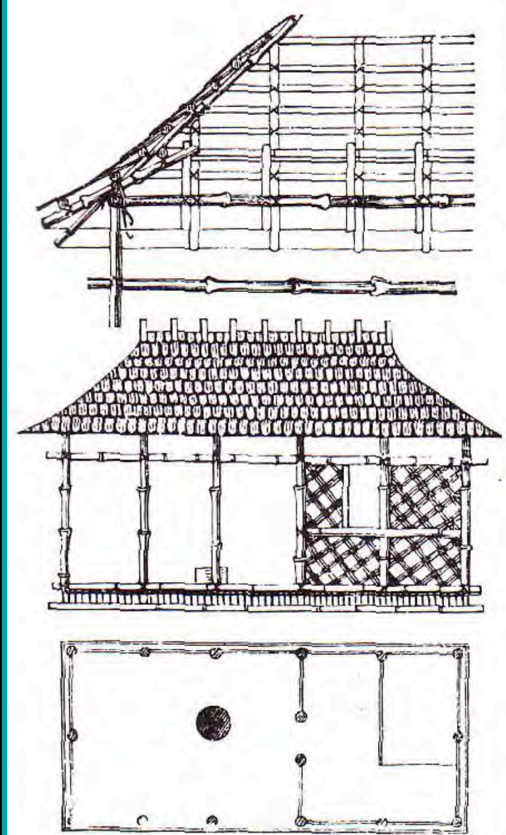
<u>Four 'ORIGINAL' Methods of Production:</u>



-WEAVING
-POTTERY
-TECTONICS (TIMBER CONSTRUCTION) → <u>'FILIGREE'</u>
-STEREOTOMY (MASONRY CONSTRUCTION) → <u>'SOLID'</u>

"The 'KNOT' (as representation of a technical solution) is the oldest technical symbol and…

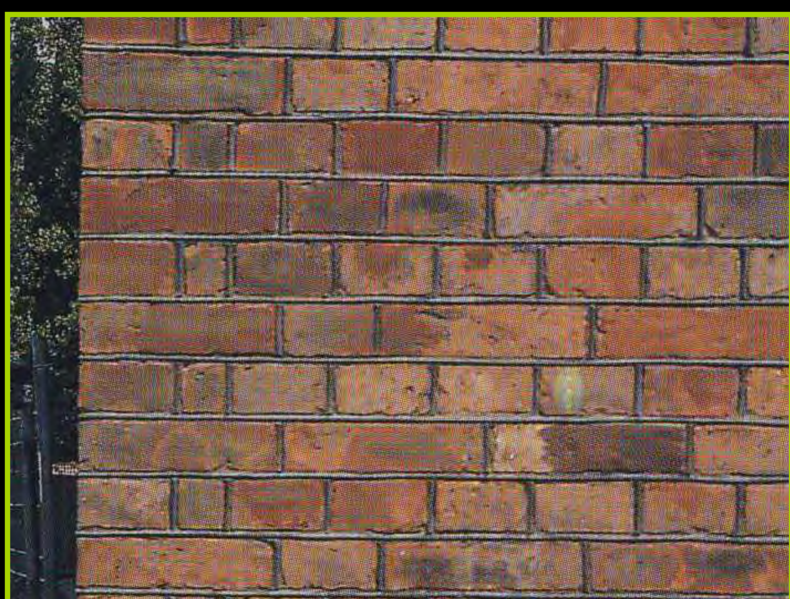
*the prime motif of human '**tekhne**' (craft,…) because a structural necessity (the connection of 2 elements) becomes an aesthetic, meaningful image."*

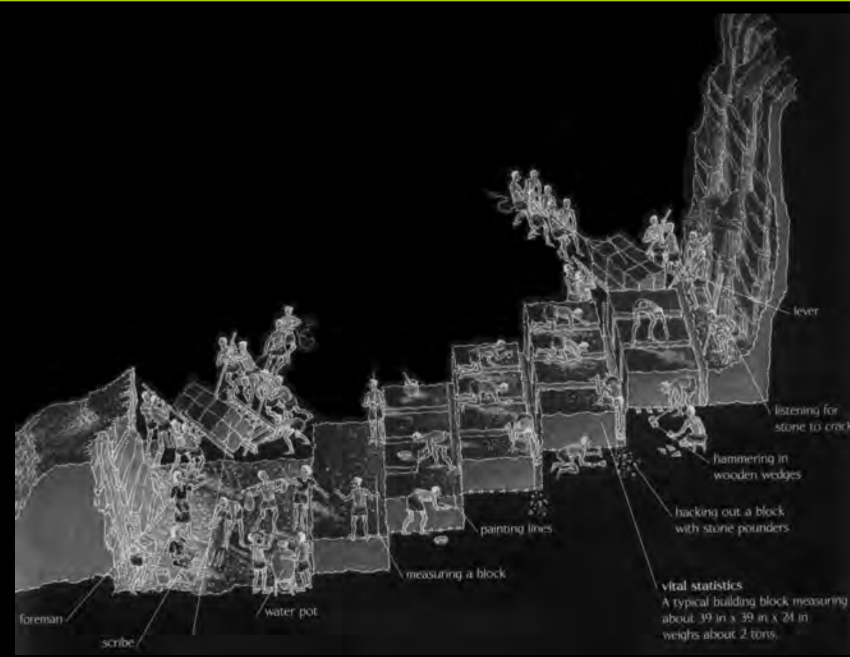


Gottfried Semper, illustration from *Der Stil in den technischen und tektonischen Künsten*, 1860–1863. The Caribbean hut in the Great Exhibition of 1851.


"PREFAB"
THE FIRST PREFABRICATED
BUILDING SYSTEM OF HUMANKIND!

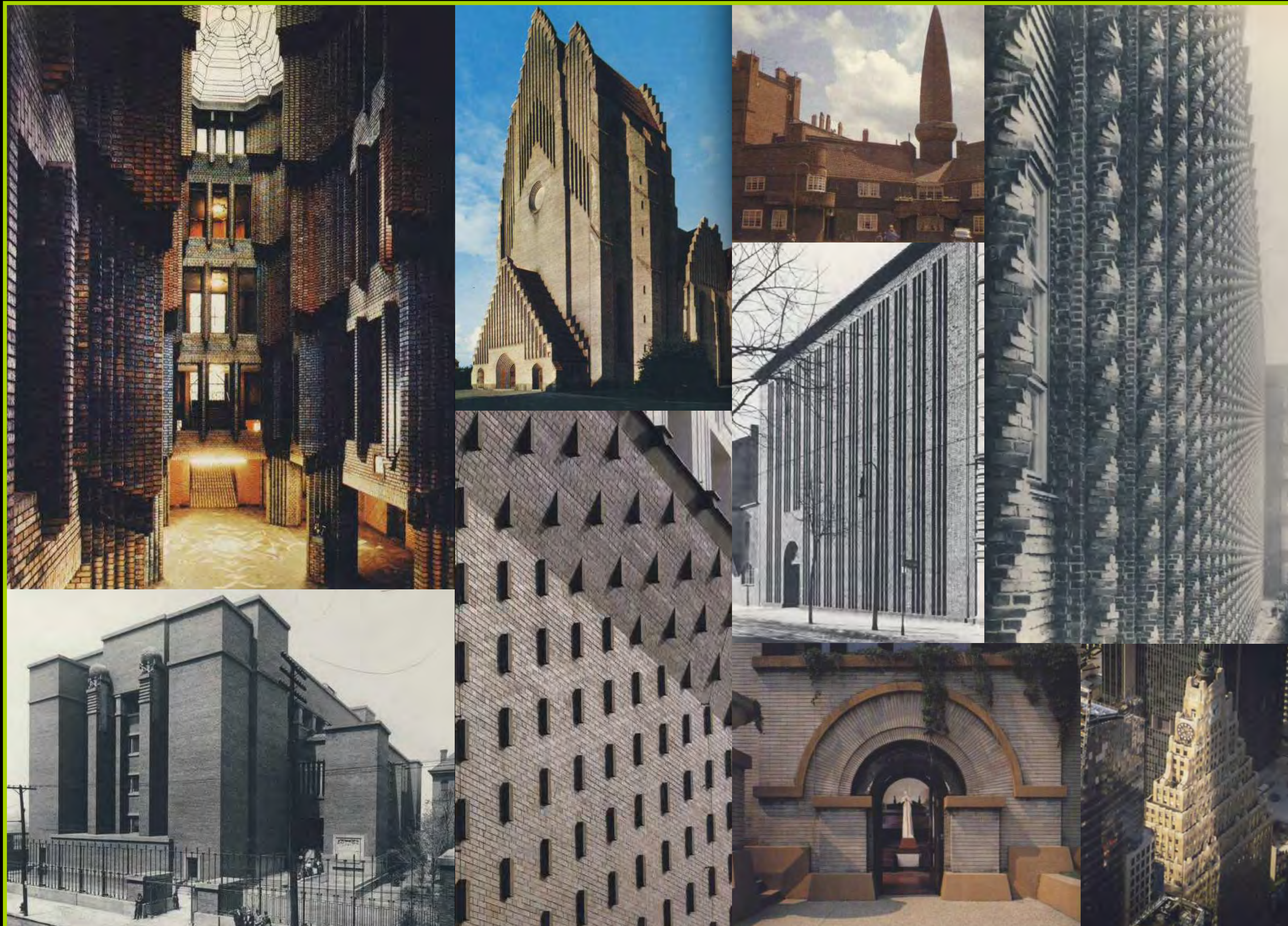
→ *MASONRY*




lever
listening for stone to crack
hammering in wooden wedges
hacking out a block with stone pounders
painting lines
measuring a block
vital statistics
A typical building block measuring about 39 in x 39 in x 24 in weighs about 2 tons.
water pot
foreman
scribe

→ *MASONRY BONDS*

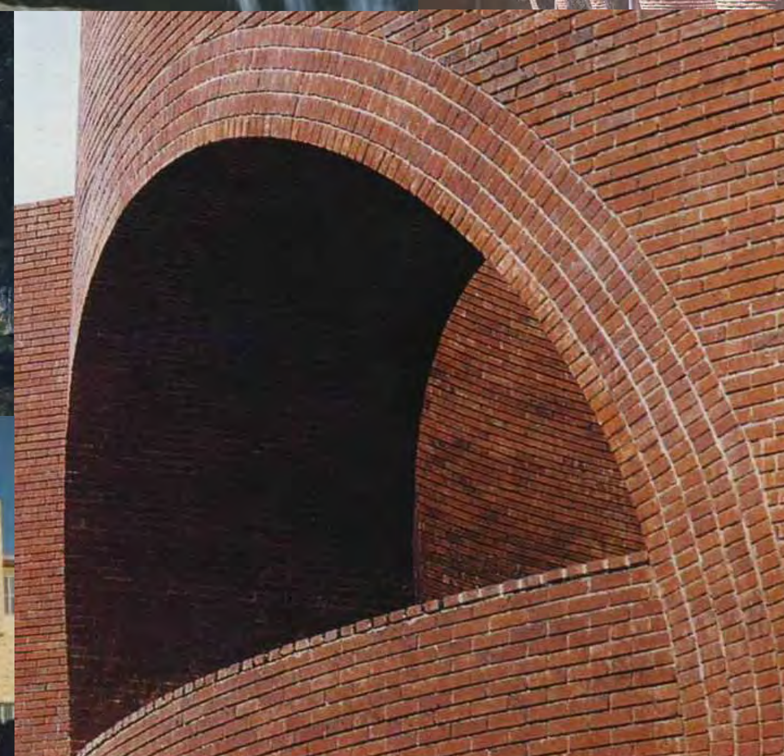
1900 - 1920



1920 - 1950







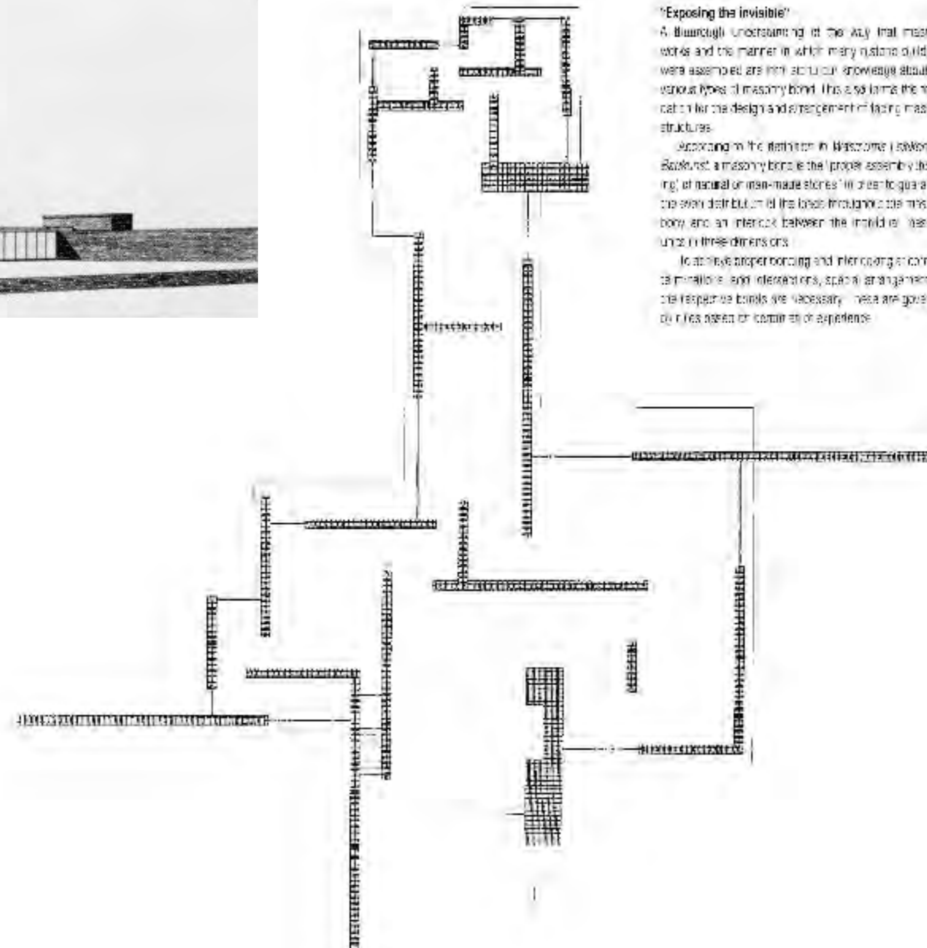
TODAY

→ *MASONRY BOND*

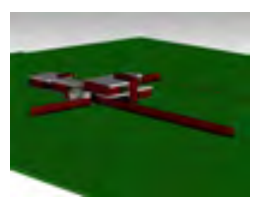
"The brick is a different master.
How ingenious: a small, handy,
usable format for every purpose.
What logic there is in the bonding.
What spiritedness in the joints.
What wealth there is in even the
simplest wall surface. But what discipline
this material demands."

Ludwig Mies van der Rohe

→ MASONRY BOND: EXAMPLE



"Exposing the invisible"



Mies van der Rohe:
"Brick Country House",
1923

→ MASONRY BOND: PRINCIPLES

(HERE: 'ENGLISH BOND')

1 EXACT HORIZONTAL COURSES

2 REGULAR ALTERNATION OF 'STRETCHER' AND 'HEADER'

3 MAXIMAL AMOUNT OF 'HEADERS' IN THE CORE

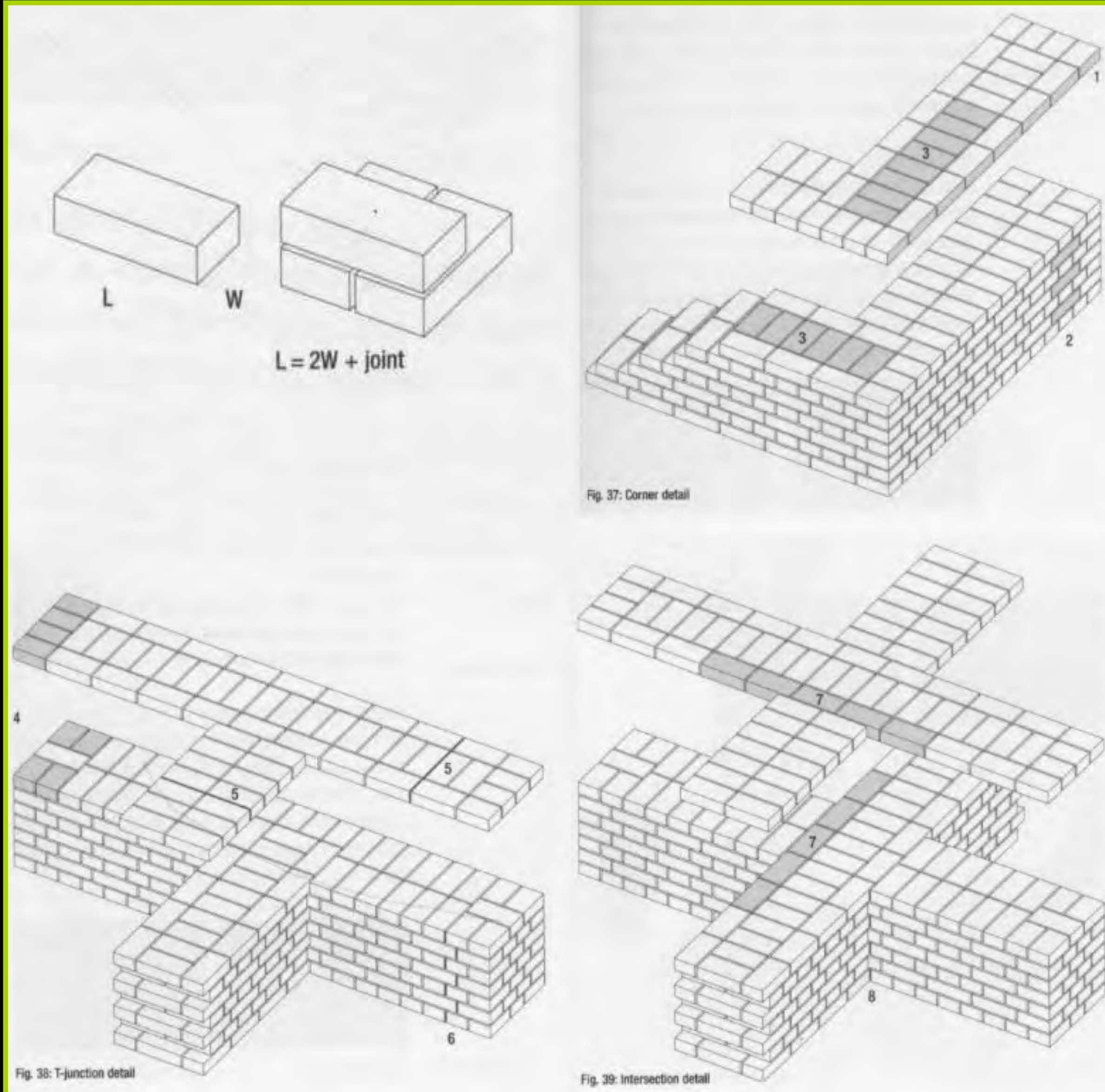
4 MAXIMAL AMOUNT OF FULL BRICKS; '<u>CLOSERS</u>' (3/4 BRICKS) ONLY WHERE NECESSARY

5 HEAD JOINTS SHOULD CONTINUE THROUGH THICKNESS OF WALL

6 HEAD JOINTS OF TWO SUCCESSIVE COURSES: OFF-SET BY 1/4 TO 1/2 OF LENGTH OF UNIT

7 CORNERS+INTERSECTIONS +BUTT JOINTS: CONTINUE STRETCHER COURSE

8 INTERNAL CORNER: THE HEAD JOINTS OFF-SET IN SUCCESSIVE COURSES.



→ *BASIC BRICKWORK TERMINOLOGY:*

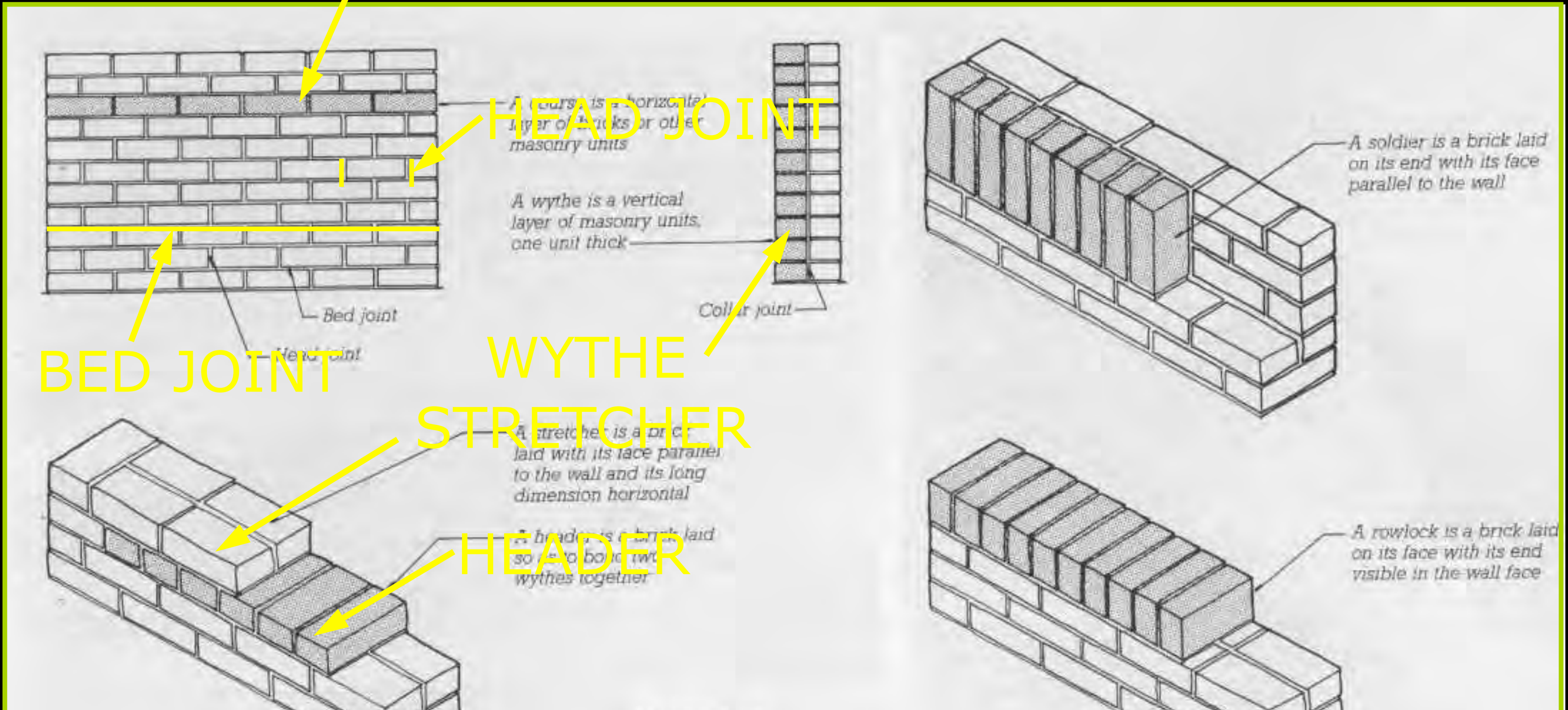
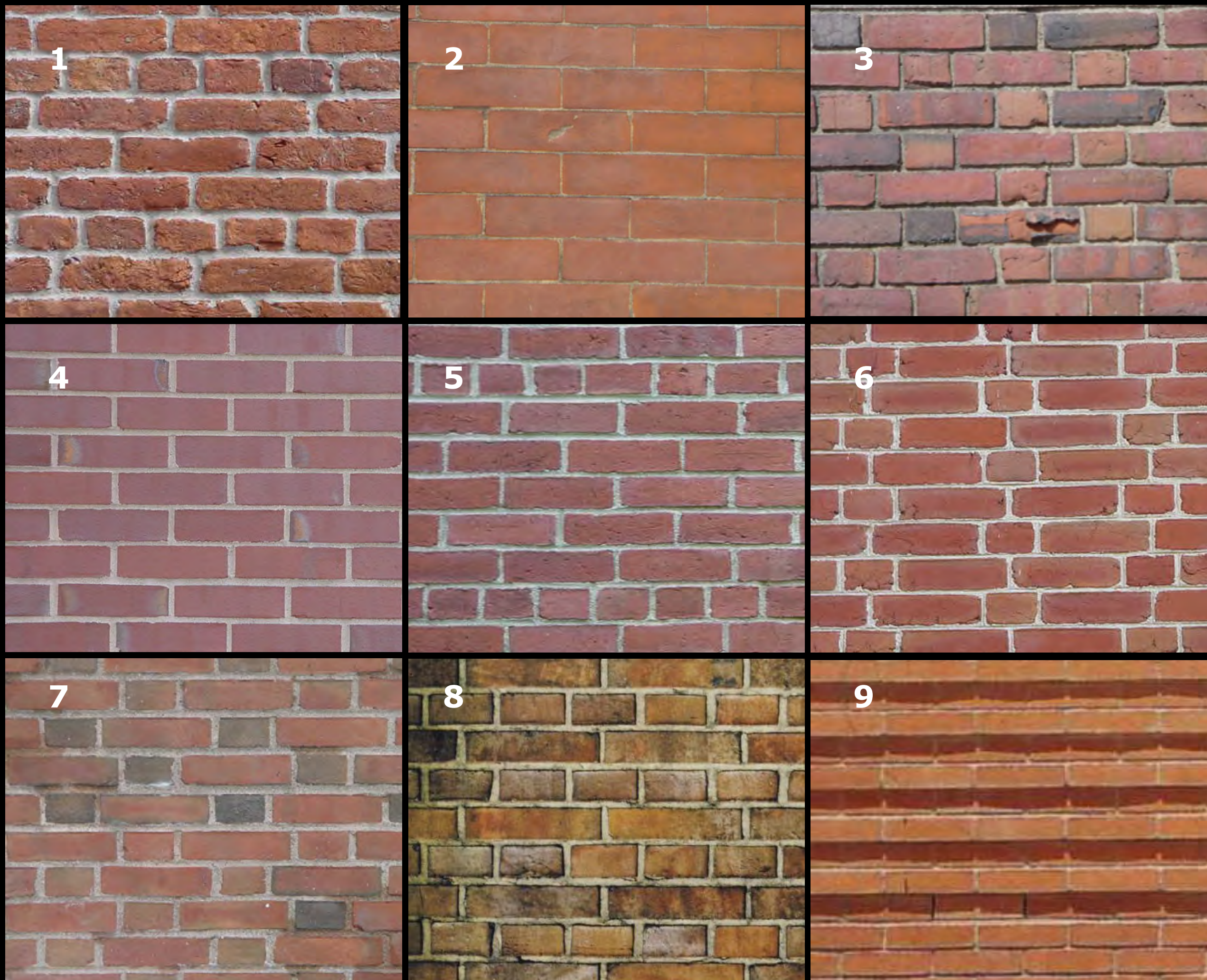
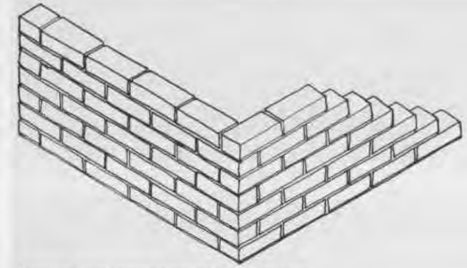


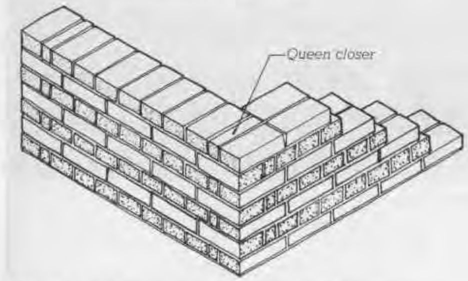
Figure 8.17
Basic brickwork terminology.

→ ‘A BRICK WALL IS ONLY AS STRONG AS ITS BOND!’

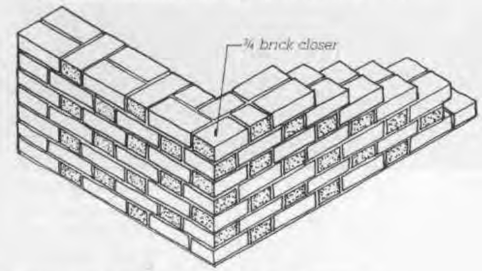




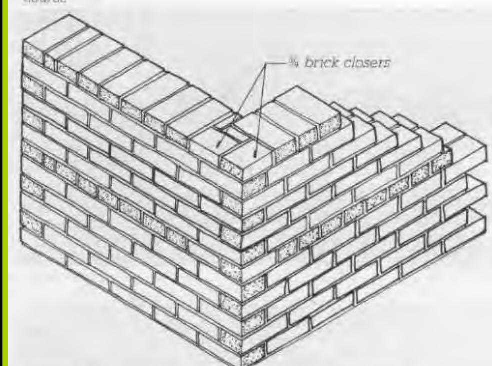
Running Bond consists entirely of stretchers



English Bond alternates courses of headers and stretchers



Flemish Bond alternates headers and stretchers in each course

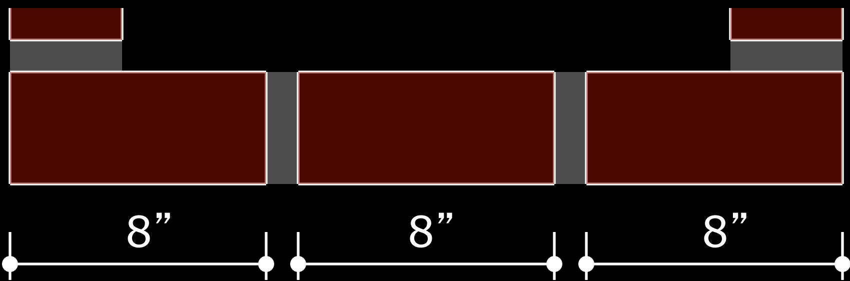


Common Bond (also known as American Bond) has a header course every sixth course

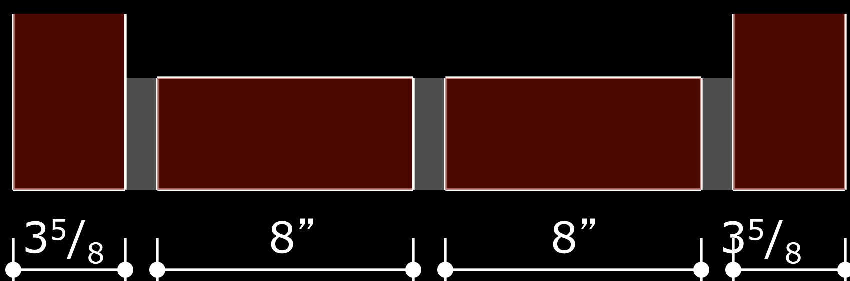
WHY DO WE SEE SO MANY RUNNING BONDS NOWADAYS ?

→ PLANNING WITH BRICK:

DIMENSIONING



1st COURSE: 3x $8''$ + 2x $^3/_8{}''$ = $24\,^3/_4{}''$



2nd: 2x $8''$ + 2x $3\,^5/_8{}''$ + 3x $^3/_8{}''$ = $24\,^3/_8{}''$

→ BRICK DIMENSIONS OF DIFFERENT COURSES NOT NECESSARILY SAME:

- → ‘MAIN’ COURSE FOR GEOMETRICAL CONCEPT
- → DOUBLE-CHECK 2nd COURSE
- → COORDINATE WINDOW/DOOR OPENINGS
- → NO MATERIAL CHANGES FOR BRICK !

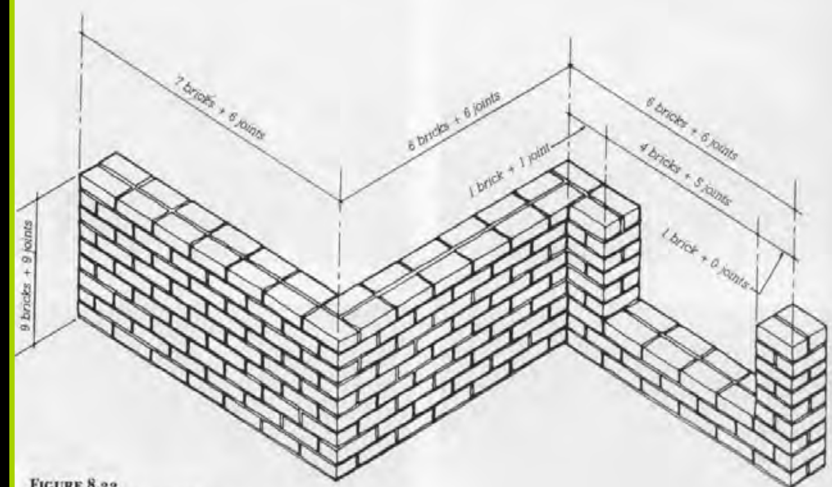
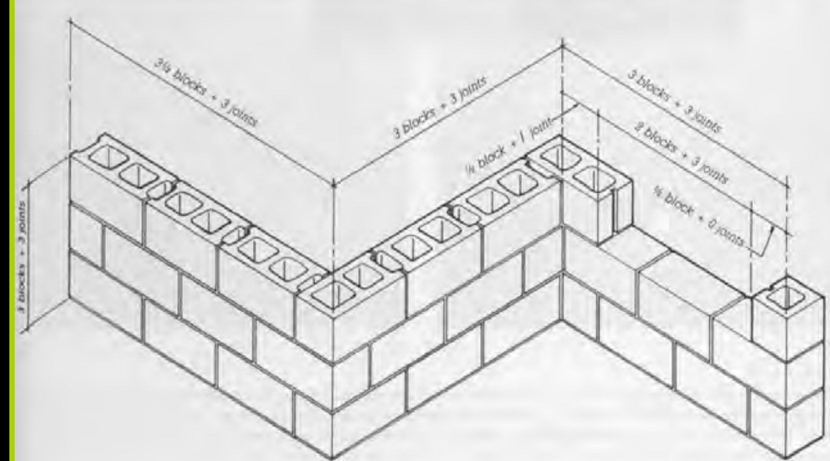


FIGURE 8.22
Dimensions for brick buildings are worked out in advance by the architect, based on the actual dimensions of the bricks and mortar joints to be used in the building. Bricks and mortar joints are carefully counted and converted to numerical dimensions for each portion of the wall.

FIGURE 9.25
Concrete masonry buildings should be dimensioned to use uncut blocks except under special circumstances.



→ *ALVAR AALTO: EXPERIMENTAL HOUSE, MUURATSALO 1952-54*

→ *FABRICATION*

<u>TUNNEL KILN:</u>

1800 – 2400 °F

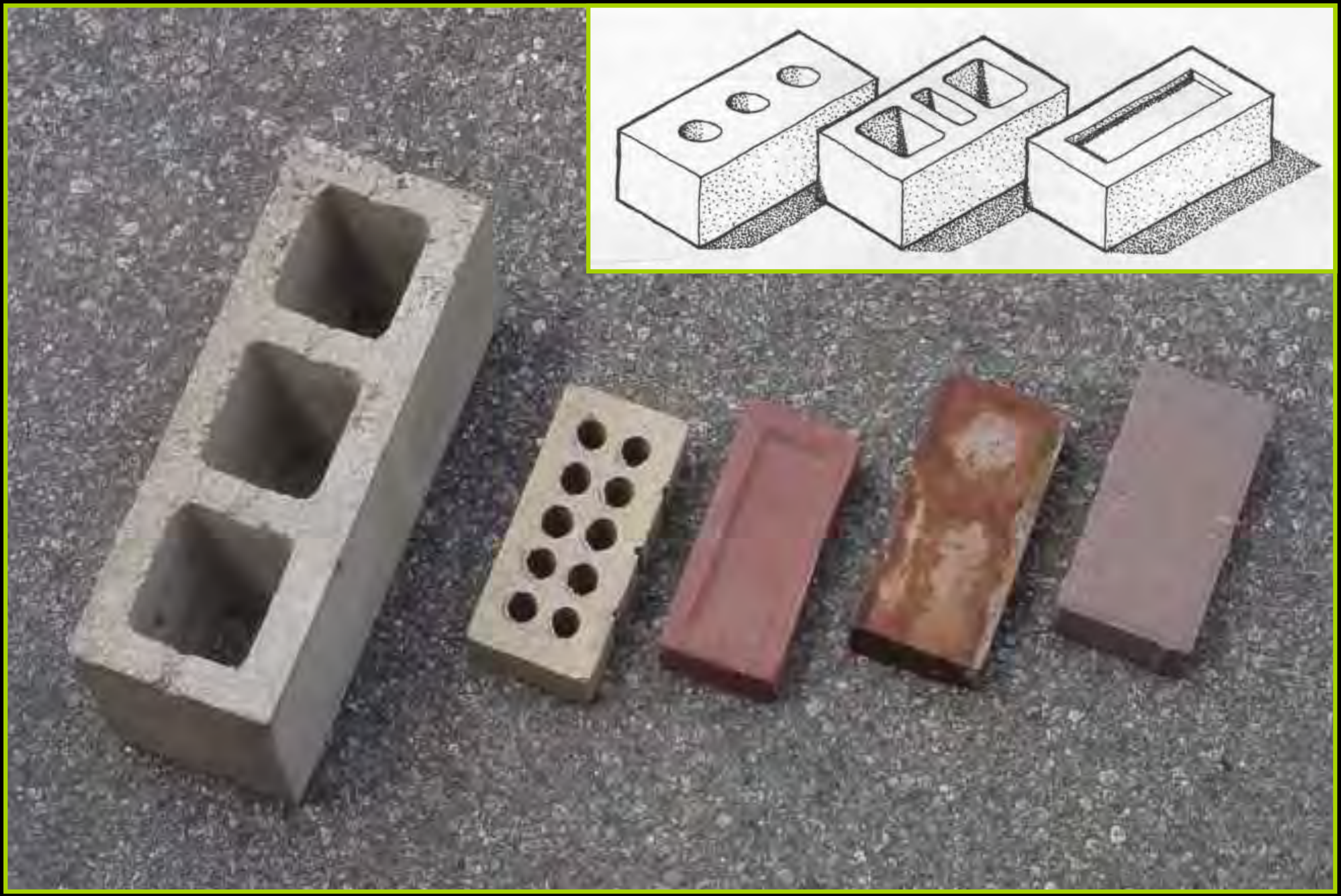
~1-2 hours

→ 'A BOND NEEDS A MODULAR SYSTEM !'

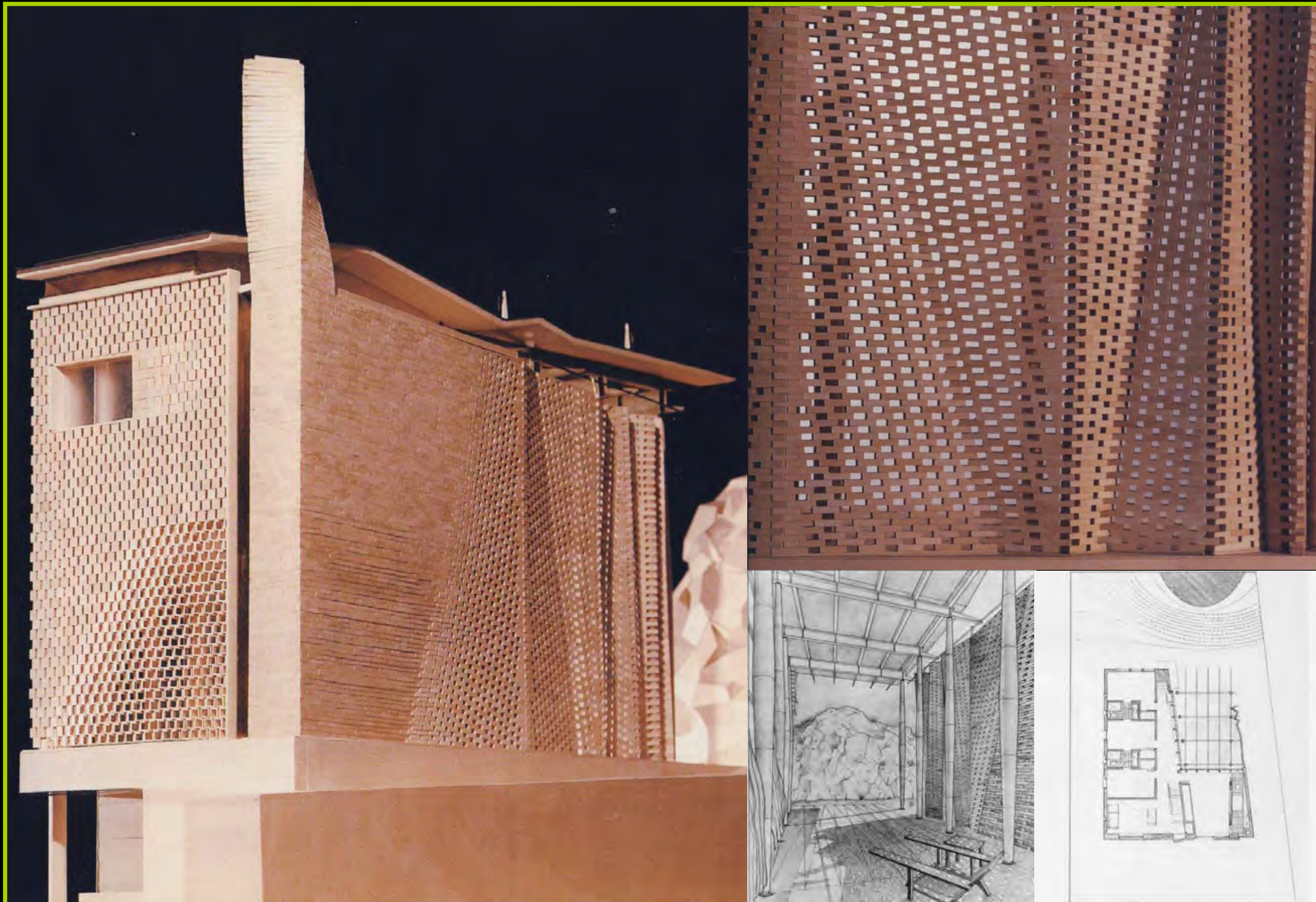
Standard Brick Sizes

Unit Name	Width	Length	Height
Modular	$3\frac{1}{2}$″ or $3\frac{5}{8}$″ (90 mm)	$7\frac{1}{2}$″ or $7\frac{5}{8}$″ (190 mm)	$2\frac{1}{4}$″ (57 mm)
Standard	$3\frac{1}{2}$″ or $3\frac{5}{8}$″ (90 mm)	8″ (200 mm)	$2\frac{1}{4}$″ (57 mm)
Engineer Modular	$3\frac{1}{2}$″ or $3\frac{5}{8}$″ (90 mm)	$7\frac{1}{2}$″ or $7\frac{5}{8}$″ (190 mm)	$2\frac{3}{4}$″ to $2\frac{13}{16}$″ (70 mm)
Engineer Standard	$3\frac{1}{2}$″ or $3\frac{5}{8}$″ (90 mm)	8″ (200 mm)	$2\frac{3}{4}$″ (70 mm)
Closure Modular	$3\frac{1}{2}$″ or $3\frac{5}{8}$″ (90 mm)	$7\frac{1}{2}$″ or $7\frac{5}{8}$″ (190 mm)	$3\frac{1}{2}$″ or $3\frac{5}{8}$″ (90 mm)
Closure Standard	$3\frac{1}{2}$″ or $3\frac{5}{8}$″ (90 mm)	8″ (200 mm)	$3\frac{5}{8}$″ (90 mm)
Roman	$3\frac{1}{2}$″ or $3\frac{5}{8}$″ (90 mm)	$11\frac{1}{2}$″ or $11\frac{5}{8}$″ (290 mm)	$1\frac{5}{8}$″ (40 mm)
Norman	$3\frac{1}{2}$″ or $3\frac{5}{8}$″ (90 mm)	$11\frac{1}{2}$″ or $11\frac{5}{8}$″ (290 mm)	$2\frac{1}{4}$″ (57 mm)
Engineer Norman	$3\frac{1}{2}$″ or $3\frac{5}{8}$″ (90 mm)	$11\frac{1}{2}$″ or $11\frac{5}{8}$″ (290 mm)	$2\frac{3}{4}$″ to $2\frac{13}{16}$″ (70 mm)
Utility	$3\frac{1}{2}$″ or $3\frac{5}{8}$″ (90 mm)	$11\frac{1}{2}$″ or $11\frac{5}{8}$″ (290 mm)	$3\frac{1}{2}$″ or $3\frac{5}{8}$″ (90 mm)
King Size	3″ (75 mm)	$9\frac{5}{8}$″ (240 mm)	$2\frac{5}{8}$ or $2\frac{3}{4}$″ (70 mm)
Queen Size	3″ (75 mm)	$7\frac{5}{8}$″ or 8″ (190 mm)	$2\frac{3}{4}$″ (70 mm)

→ CORED, FROGGED, HOLLOW, SOLID BRICKS



→ I.E. REINFORCED WALLS: *OFFICE da: BRICK SCREEN HOUSE*



→ 'CMU' - WALLS: STRUCTURAL: REINFORCED TYPE

→ *'MORTAR BONDS!'*

- ASSIMILATES/CUSHIONS IRREGULARITIES OF BRICK
- BEARING TRANSFER
- SEAL AGAINST CLIMATE: WIND+WATER
- ADHESION BONDS UNITS INTO SINGULAR MONOLITHIC STRUCTURE
- <u>CONTENTS:</u>
  PORTLAND CEMENT
  HYDRATED LIME
  AGGREGATE (SAND)
  WATER
- PROPRIETARY FORMULATIONS
- COLOR / COLORS
- TYPES N / M / S / O
- CURING BY HYDRATION (NO USE AFTER $2^{1}/_{2}$ HOURS)
- CHEMICAL ADDITIVES FOR LONGER WORKABILITY

FIGURE 8.5
Mortar types as defined by ASTM C270.

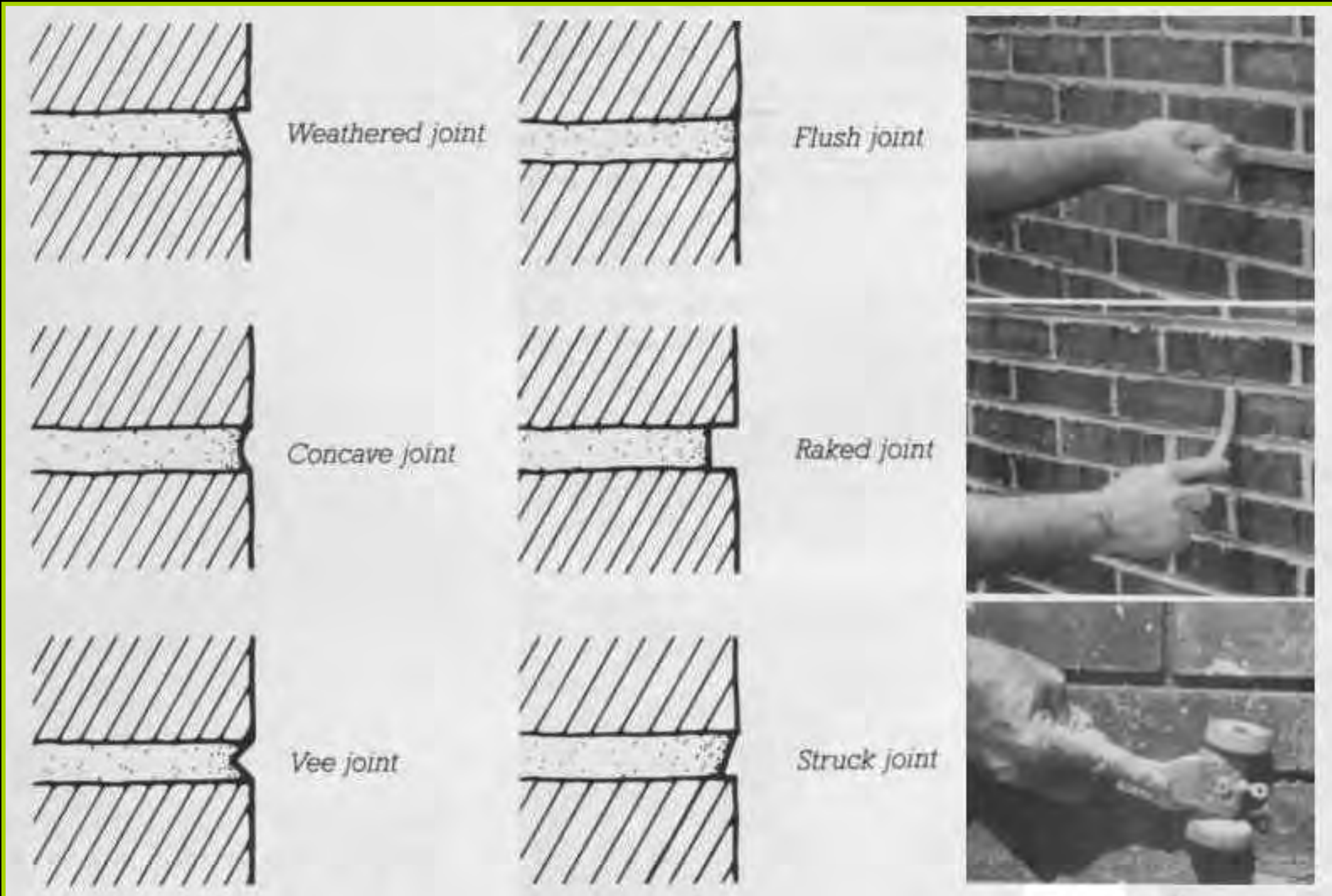
Mortar Type	Description	Construction Suitability	Minimum Average Compressive Strength at 28 days
M	High-strength mortar	Masonry subjected to high lateral or compressive loads or severe frost action; Masonry below grade	2500 psi (17.25 MPa)
S	Medium high-strength mortar	Masonry requiring high flexural bond strength but subjected only to normal compressive loads	1800 psi (12.40 MPa)
N	Medium strength mortar	General use above grade	750 psi (5.17 MPa)
O	Medium low-strength mortar	Nonloadbearing interior walls and partitions	350 psi (2.40 MPa)

FIGURE 8.6
Some typical formulas for mortar types M through O.

Mortar Type	Parts by Volume of Portland Cement	Parts by Volume of Masonry Cement	Parts by Volume of Hydrated Lime	Aggregate Measured in a Loose, Damp Condition
M	1 1	1 (Type II) —	— ¼	Not less than 2¼ and not more than 3 times the sum of the volumes of the cements and lime used
S	½ 1	1 (Type II) —	— over ¼ to ½	
N	— 1	1 (Type II) —	— over ½ to 1¼	
O	— 1	1 (Type I or II) —	— over 1¼ to 1½	

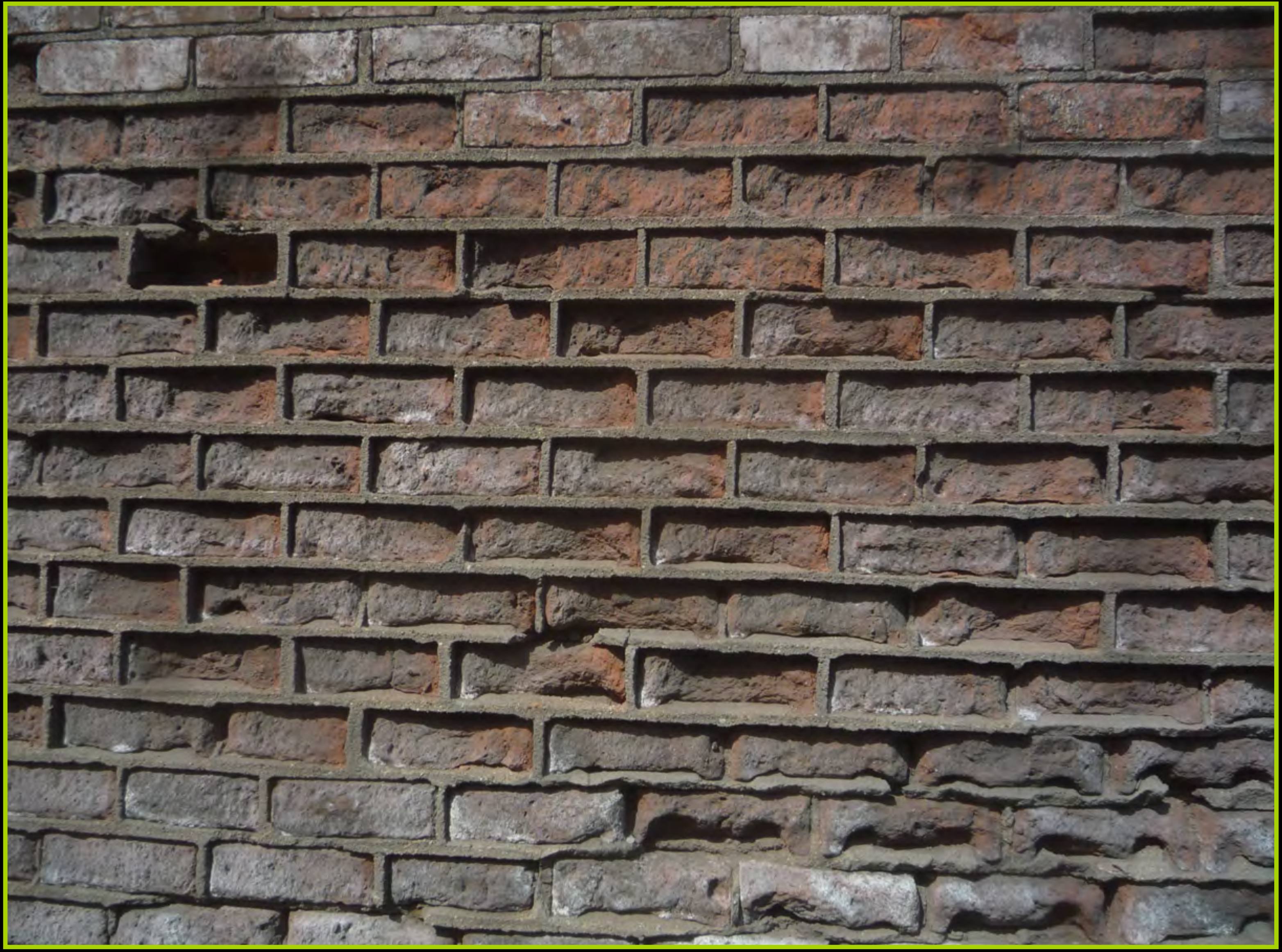
THE MORTAR JOINT ACCOUNTS FOR 'TOLERANCES' /ADJUSTMENT IN ASSEMBLY PROCESS!

→ MORTAR JOINT CHOICES:

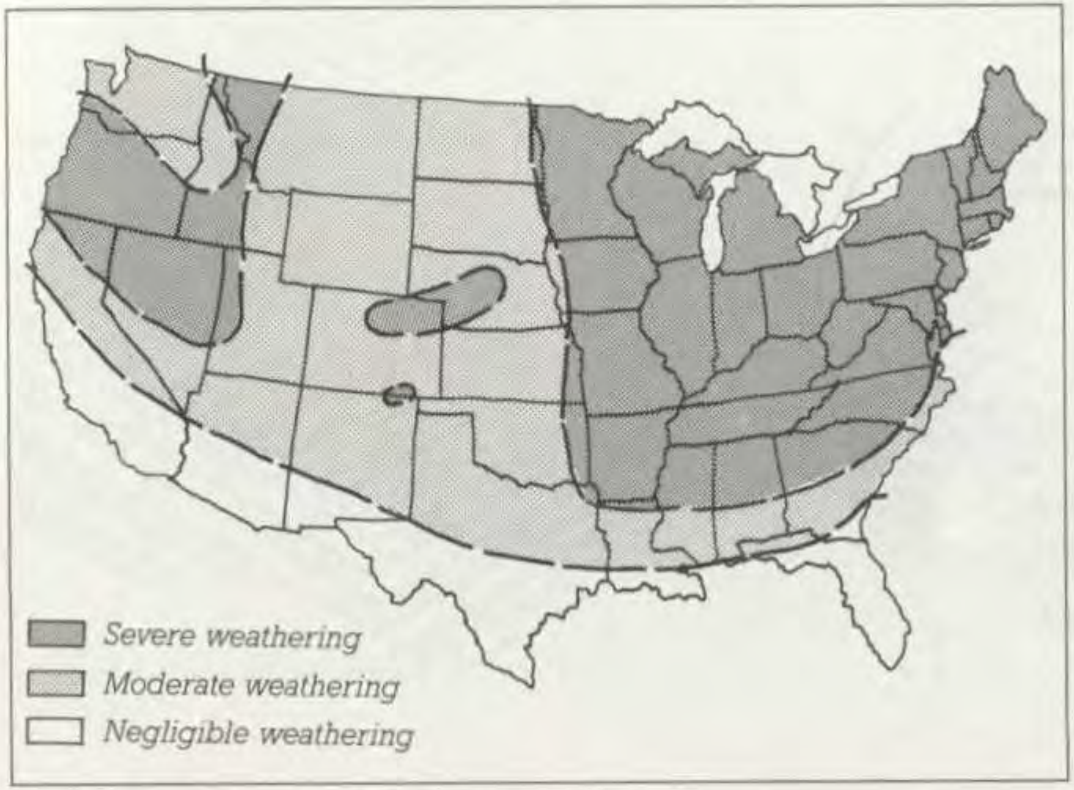


→ GROUT PROBLEMS ('EFFLORESCENCE' … and 'POINTING')

→ GROUT PROBLEMS



→ DURABILITY (PRODUCTS)



Grades for Building and Facing Bricks	
Grade SW	Severe weathering
Grade MW	Moderate weathering
Grade NW	Negligible weathering

Types of Facing Bricks	
Type FBX	High degree of mechanical perfection, narrow color range, minimum size variation per unit
Type FBS	Wide range of color and greater size variation per unit
Type FBA	Nonuniformity in size, color, and texture per unit

Brick Specs

Extruded

Glen-Gery manufacturers many sizes of extruded brick in a multitude of shades and textures to accommodate the visual requirements of most projects. The more popular extruded brick have a nominal

Molded

Machine molded brick, as manufactured by Glen-Gery Corporation, are available in natural colors and sand finish textures which are suitable for any building type. There is some intended irregularity to

Handmade

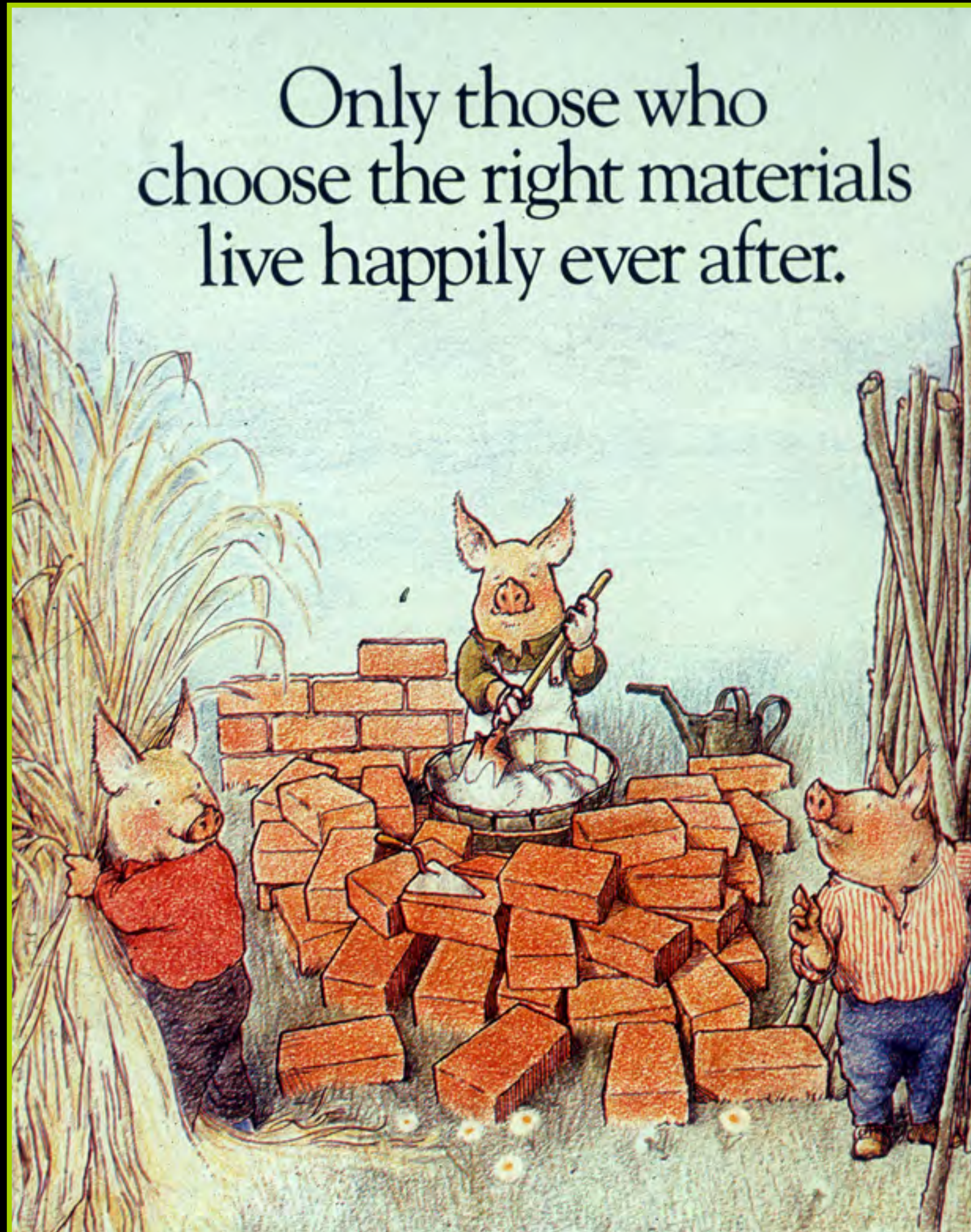
Adapted from the ancient art of hand molding brick, this series of brick

Glazed

Glen-Gery's Hanley Plant manufactures many sizes of glazed brick in a variety of shades to accommodate the visual requirements for most projects. The glazed brick have a nominal four inch bed depth of thickness. Glazes are

Claycoat

→ *REPAIRS: (LOCAL LAW 11, FAÇADE INSPECTIONS)*


Only those who
choose the right materials
live happily ever after.

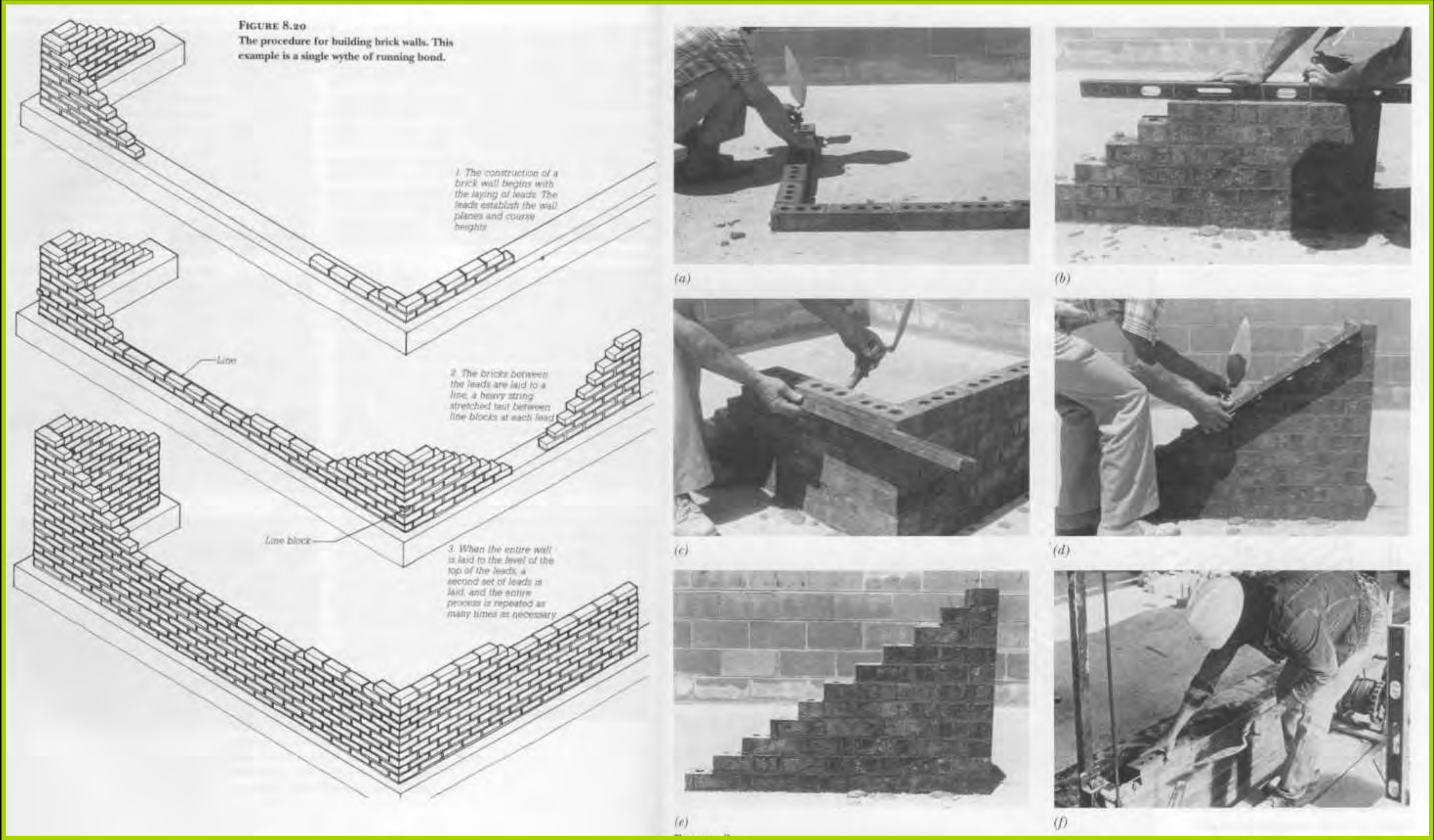
→ *BRICK AS A BUILDING SYSTEM:*
(ADVANTAGES - DISADVANTAGES)

- **FLEXIBILITY/EFFORT**
  - PLANNING
  - WORKING
- **LABOR/SPEED OF CONSTRUCTION**
- **VERSATILITY / GEOMETRY**
- **TRANSPORTATION**
- **SUSTAINABILITY**
- **INSULATION QUALITY**
- **POROSITY/WATER PENETRATION**
- **RAW MATERIAL AVAILABILITY**
- **MATERIAL COSTS**
- **BUILDING MAINTENANCE**
- **SPANNING**
- **BEARING CAPACITY**
- **FIRE RESISTANCE**
- **WEIGHT / ‘DEAD LOADS’**

MONADNOCK BUILDING, Burnham & Root, 1884-1891

→ *INSTALLATION:*

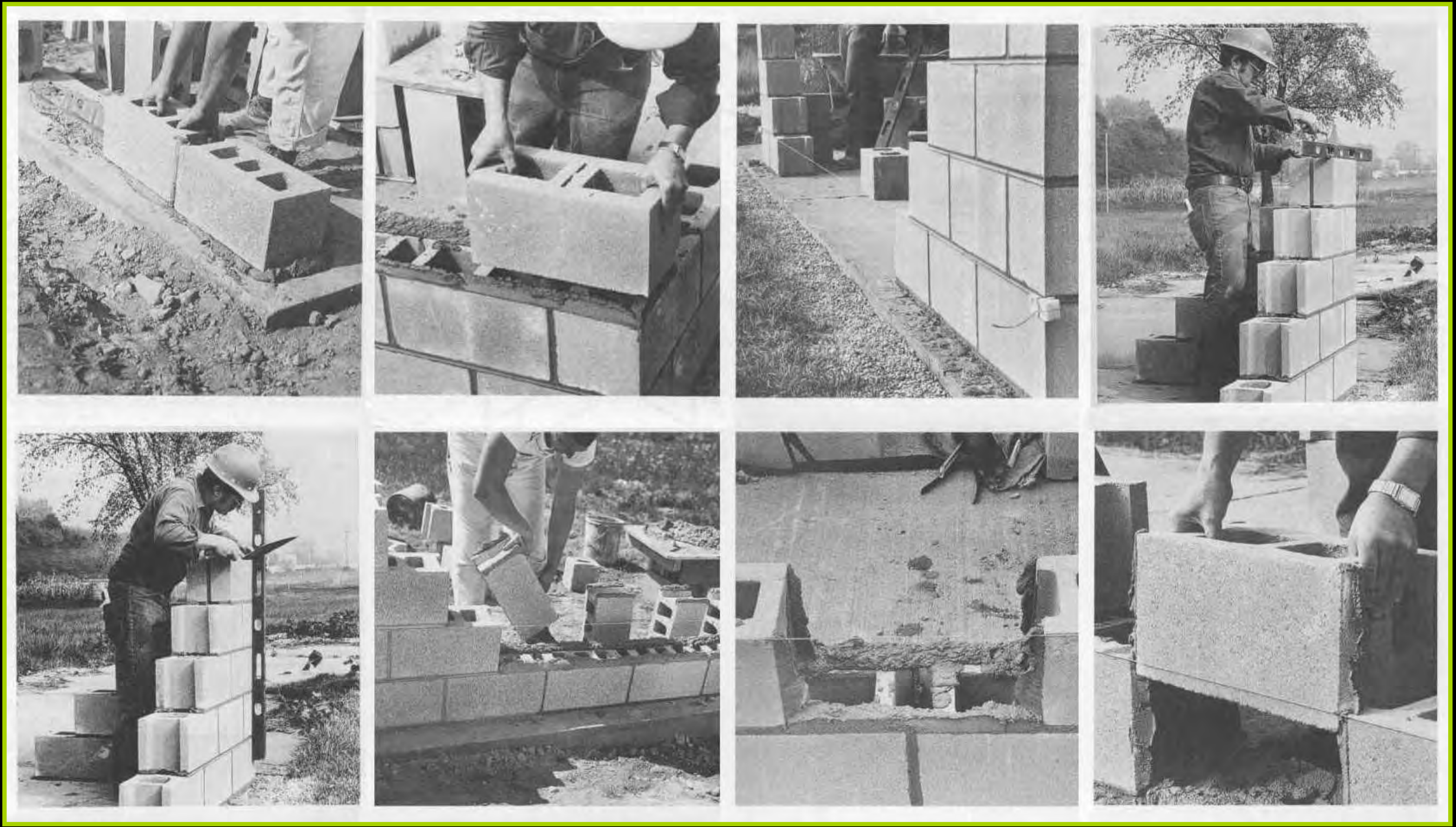
- → BRICK HELD WITH ONE HAND!
- → FOUNDATION MARKS; START ‘LEADS’ ON CORNERS, IN MORTAR BED.
- → EACH COURSE MUST BE LEVEL, STRAIGHT, PLUMB.
- → FILL-IN BETWEEN COMPLETED ‘LEADS’ W/ STRETCHED LINE.




4/22 MASONRY TRAINING @ IMI
team IMI
UNION MASONRY CRAFTWORKERS
CONTRACTORS & CONSULTANTS

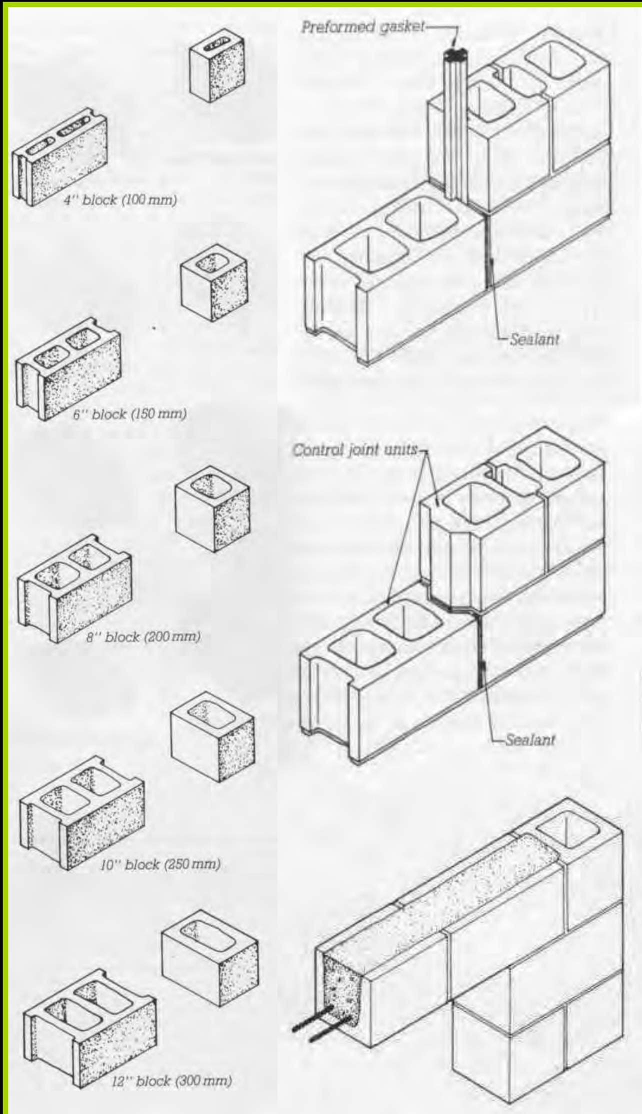
→ *INSTALLATION:*

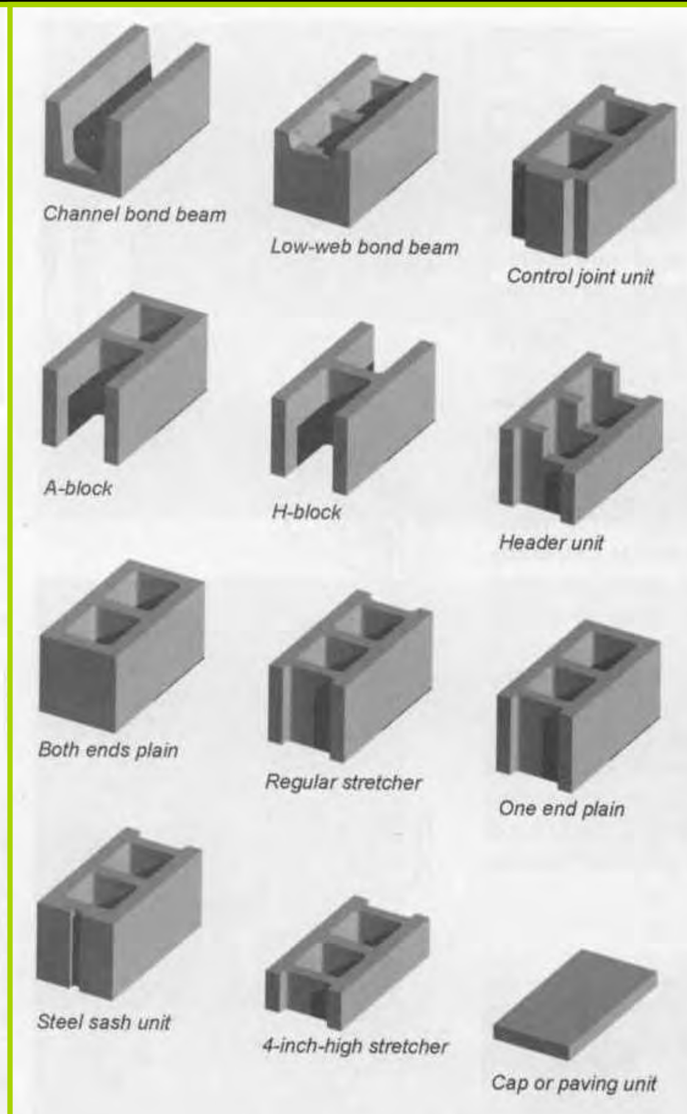
→ 'CONCRETE MASONRY UNIT' HELD WITH TWO HANDS!
→ FOUNDATION MARKS; START 'LEADS' ON CORNERS, IN MORTAR BED.
→ EACH COURSE MUST BE LEVEL, STRAIGHT, PLUMB.
→ FILL-IN BETWEEN COMPLETED 'LEADS' W/ STRETCHED LINE.

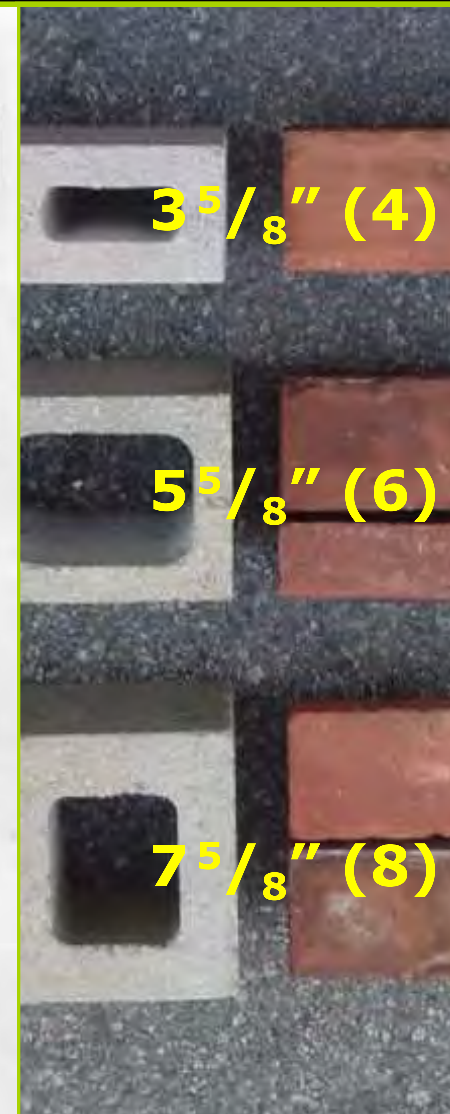


→ *'CMU' - TYPES:*

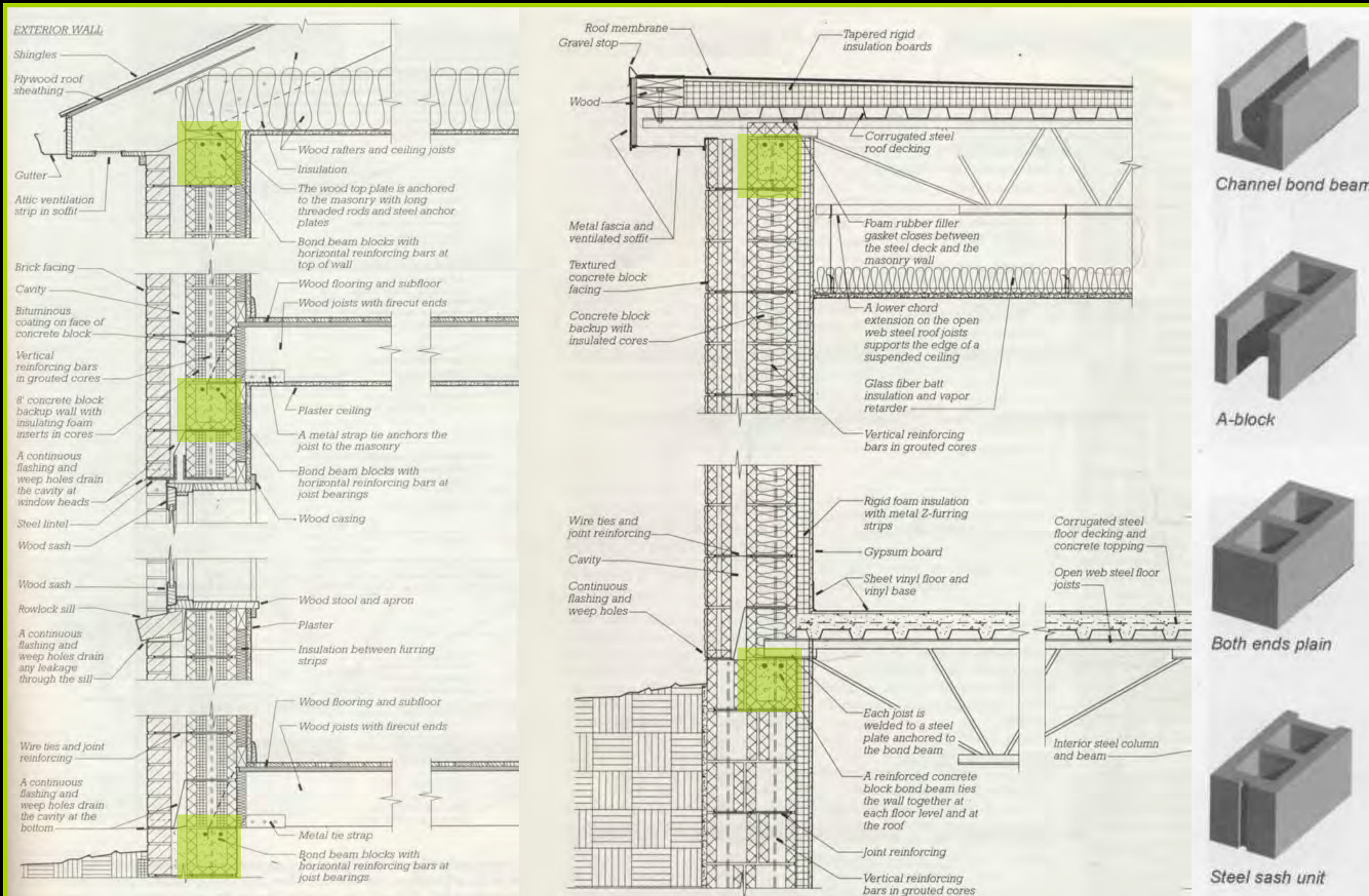
CMU: H= 7 $^{5}/_{8}$" (8), L= 15 $^{5}/_{8}$" (16)







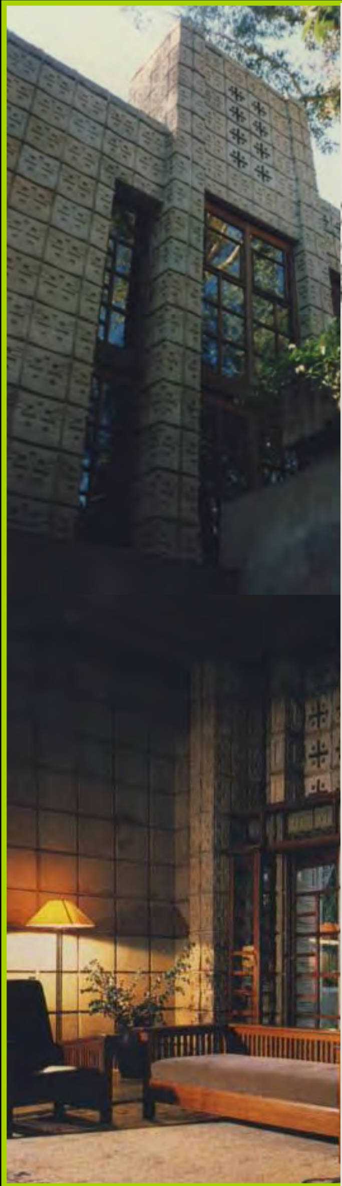
→ 'BOND BEAMS':

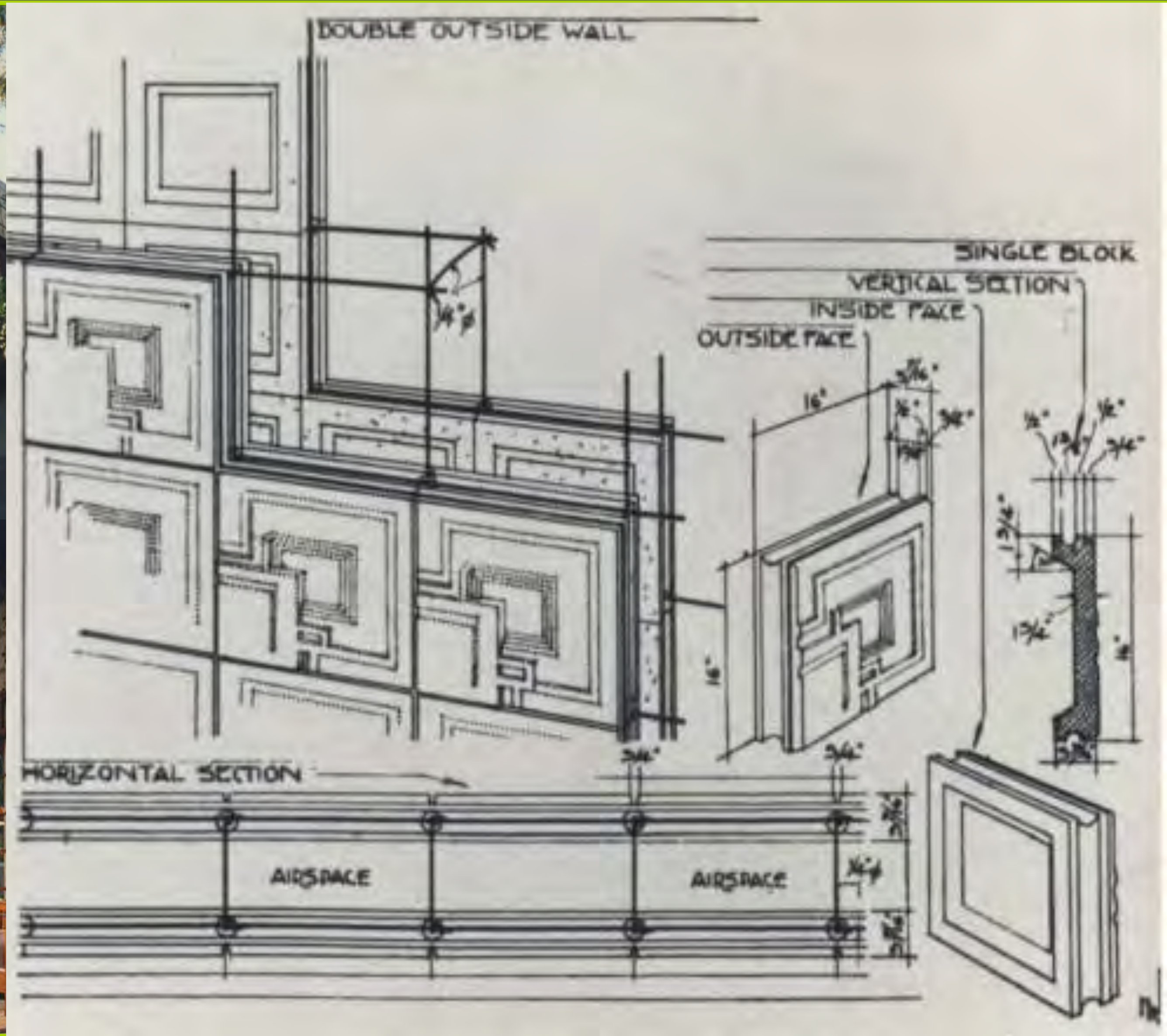


EXTERIOR WALL
Shingles
Plywood roof sheathing
Gutter
Attic ventilation strip in soffit
Wood rafters and ceiling joists
Insulation
The wood top plate is anchored to the masonry with long threaded rods and steel anchor plates
Bond beam blocks with horizontal reinforcing bars at top of wall
Brick facing
Cavity
Bituminous coating on face of concrete block
Vertical reinforcing bars in grouted cores
8' concrete block backup wall with insulating foam inserts in cores
A continuous flashing and weep holes drain the cavity at window heads
Steel lintel
Wood sash
Wood flooring and subfloor
Wood joists with firecut ends
Plaster ceiling
A metal strap tie anchors the joist to the masonry
Bond beam blocks with horizontal reinforcing bars at joist bearings
Wood casing
Wood sash
Rowlock sill
A continuous flashing and weep holes drain any leakage through the sill
Wood stool and apron
Plaster
Insulation between furring strips
Wood flooring and subfloor
Wood joists with firecut ends
Wire ties and joint reinforcing
A continuous flashing and weep holes drain the cavity at the bottom
Metal tie strap
Bond beam blocks with horizontal reinforcing bars at joist bearings
Roof membrane
Gravel stop
Wood
Tapered rigid insulation boards
Corrugated steel roof decking
Metal fascia and ventilated soffit
Foam rubber filler gasket closes between the steel deck and the masonry wall
Textured concrete block facing
Concrete block backup with insulated cores
A lower chord extension on the open web steel roof joists supports the edge of a suspended ceiling
Glass fiber batt insulation and vapor retarder
Vertical reinforcing bars in grouted cores
Rigid foam insulation with metal Z-furring strips
Wire ties and joint reinforcing
Gypsum board
Cavity
Sheet vinyl floor and vinyl base
Continuous flashing and weep holes
Corrugated steel floor decking and concrete topping
Open web steel floor joists
Each joist is welded to a steel plate anchored to the bond beam
Interior steel column and beam
A reinforced concrete block bond beam ties the wall together at each floor level and at the roof
Joint reinforcing
Vertical reinforcing bars in grouted cores
Channel bond beam
A-block
Both ends plain
Steel sash unit

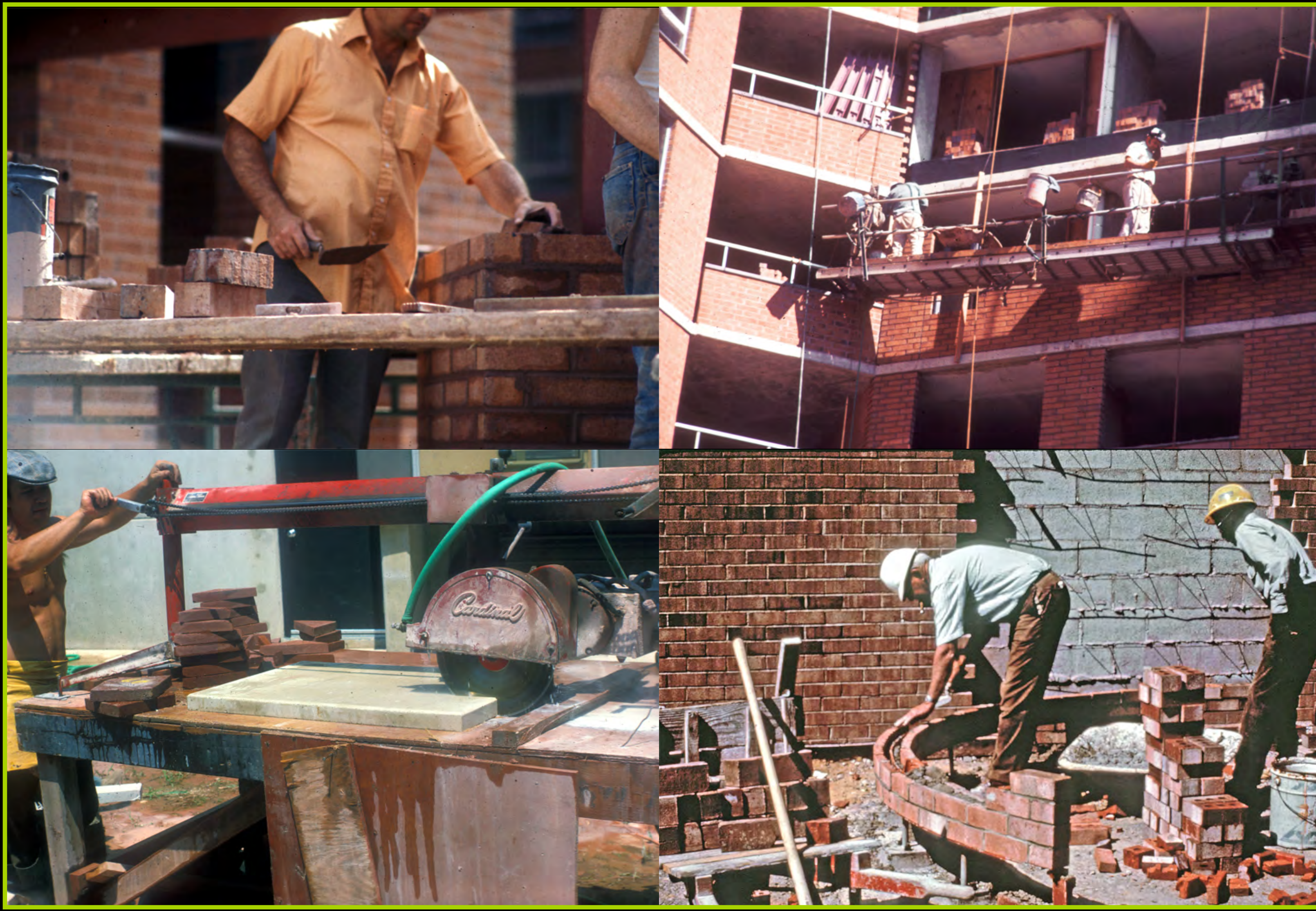
→ CASE STUDY: A. VILLAREAL: ' SISTEMA ARDE ' / TANDACASA, 1996-98

→ CASE STUDY: F.L.WRIGHT, MILLARD HOUSE, 1923; ‘TEXTILE BLOCK’

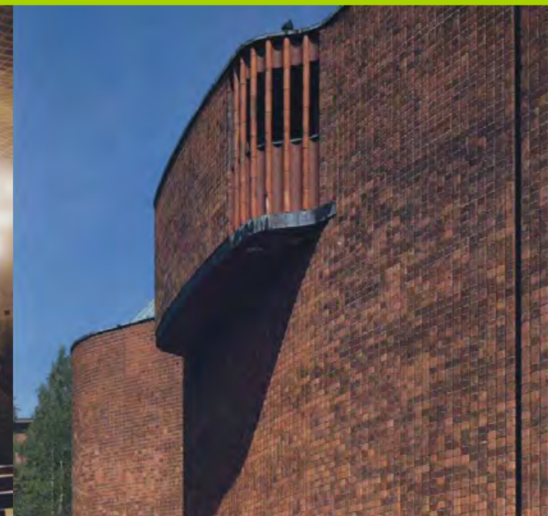




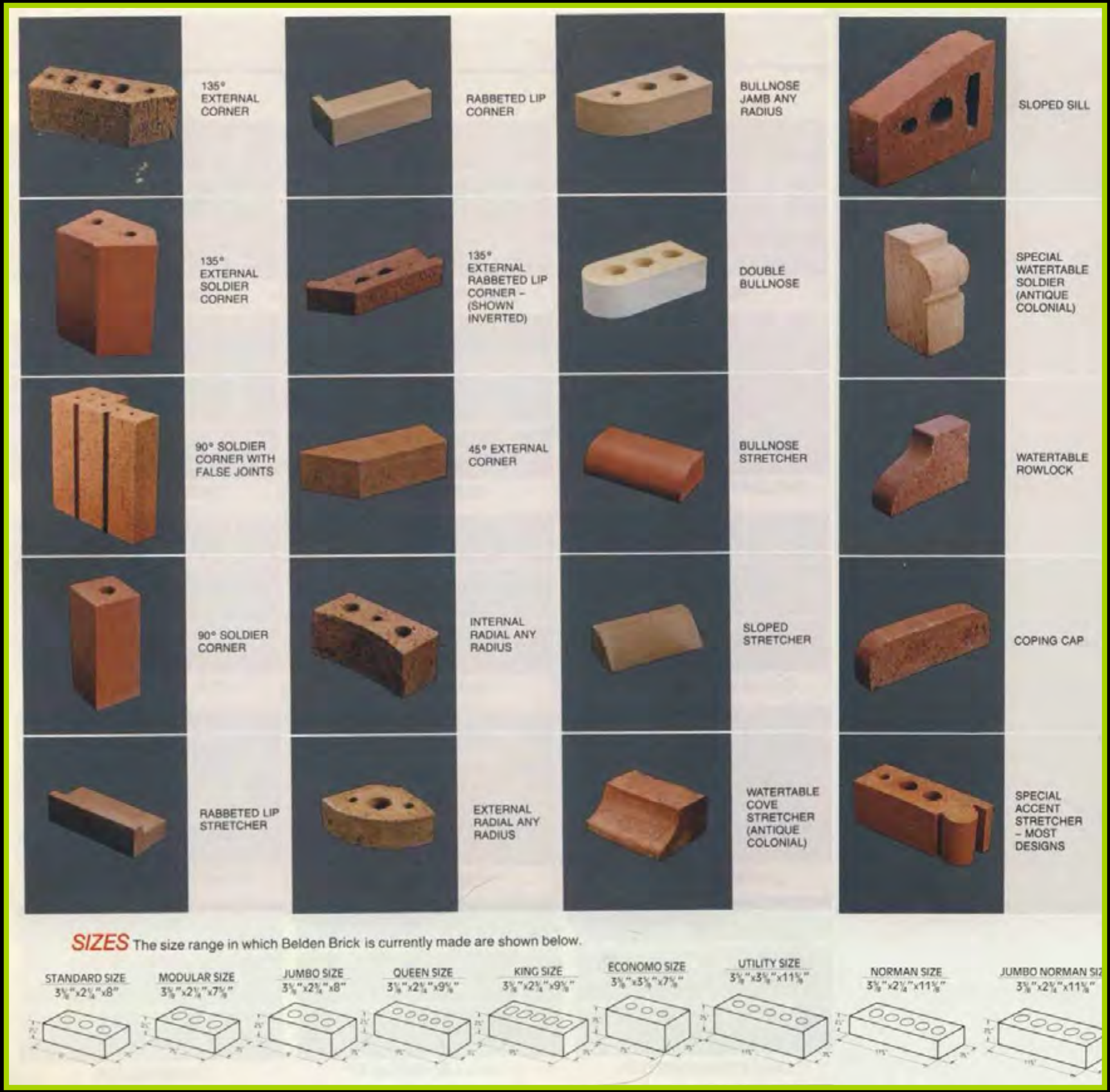
→ FLEXIBILITY / EFFORT (WORKING WITH BRICK)

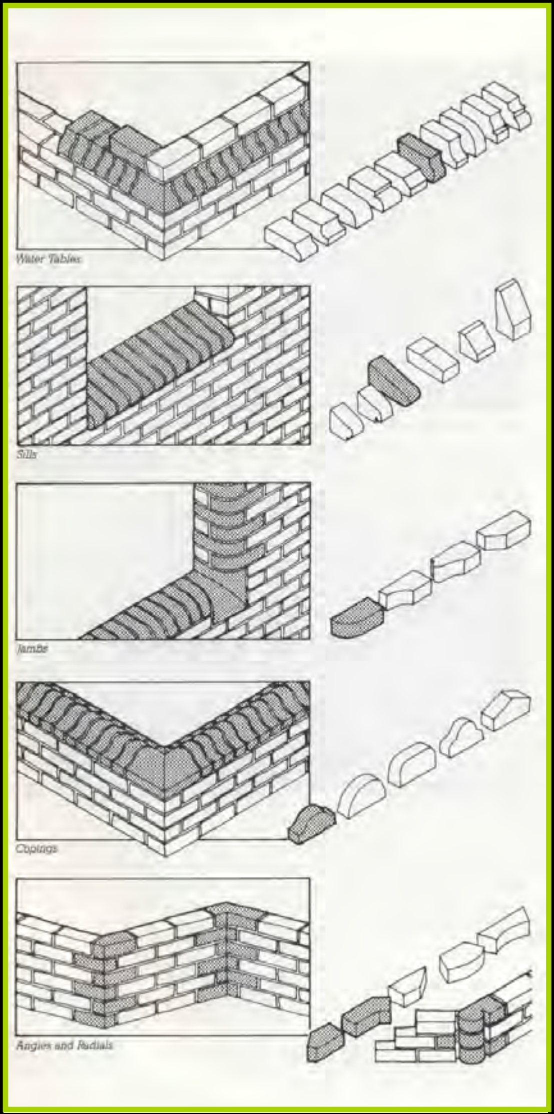


→ *VERSATILITY / GEOMETRY (“FORM MAKING”)*

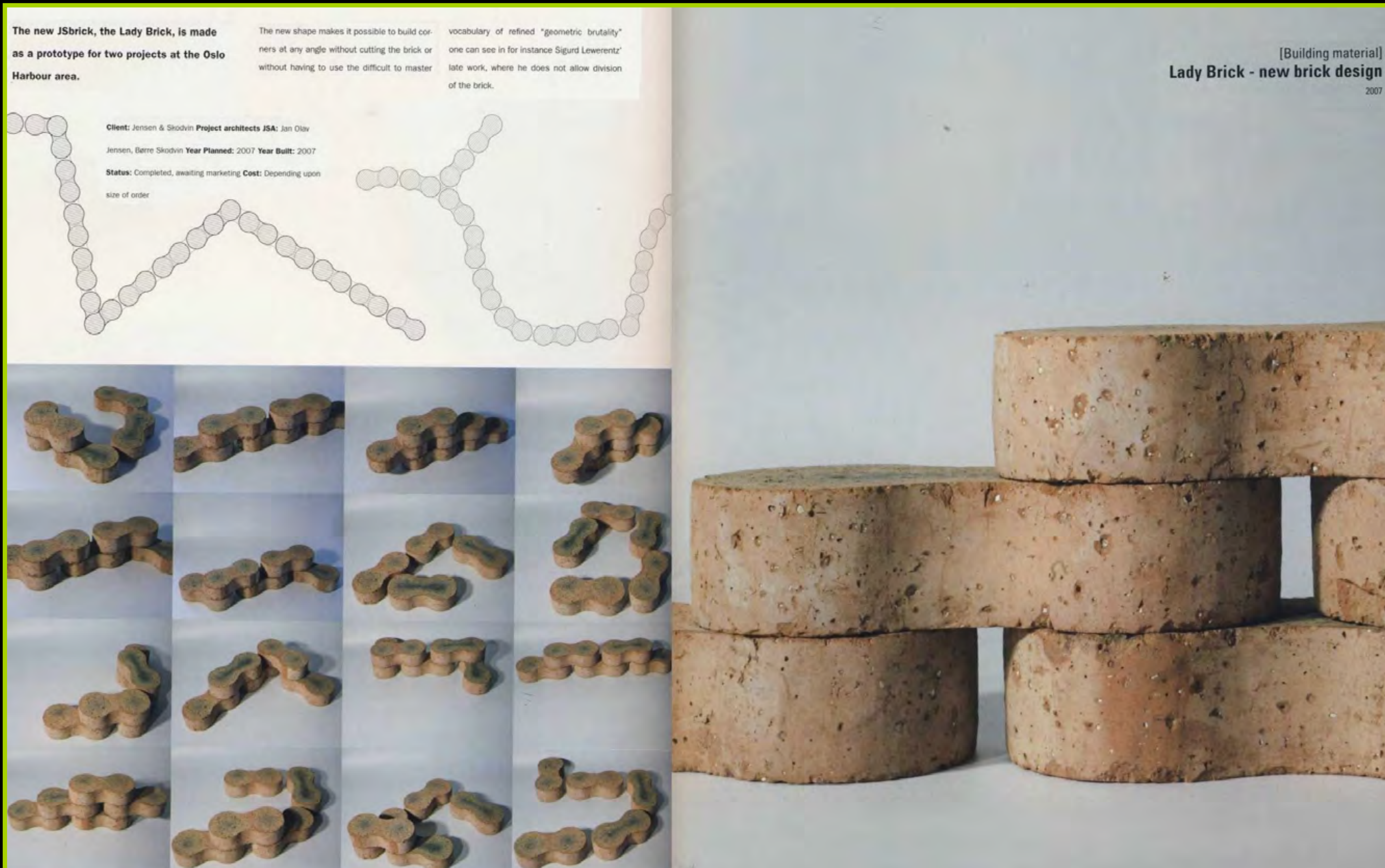




→ VERSATILITY / GEOMETRY *(PRODUCTS)*





→ *VERSATILITY / GEOMETRY* *(PRODUCTS)*



[Building material]

Lady Brick - new brick design

2007

The new JSbrick, the Lady Brick, is made as a prototype for two projects at the Oslo Harbour area.

The new shape makes it possible to build corners at any angle without cutting the brick or without having to use the difficult to master vocabulary of refined "geometric brutality" one can see in for instance Sigurd Lewerentz' late work, where he does not allow division of the brick.

Client: Jensen & Skodvin **Project architects JSA:** Jan Olav Jensen, Børre Skodvin **Year Planned:** 2007 **Year Built:** 2007 **Status:** Completed, awaiting marketing **Cost:** Depending upon size of order

→ TRANSPORT (PRODUCTS)

→ EMBODIED ENERGY (MATERIAL PROPERTIES)

EMBODIED ENERGY (EE)

THE ENERGY CONSUMED IN

- MANUFACTURING,
- ITS TRANSPORT,
- ITS INSTALLATION,
- ITS MAINTENANCE,
- ITS DEMOLITION

OF CONSTRUCTION MATERIAL, MEASURED IN GIGAJOULE

(GJ)→ 'CARBON FOOTPRINT'

Example: options for wall cladding

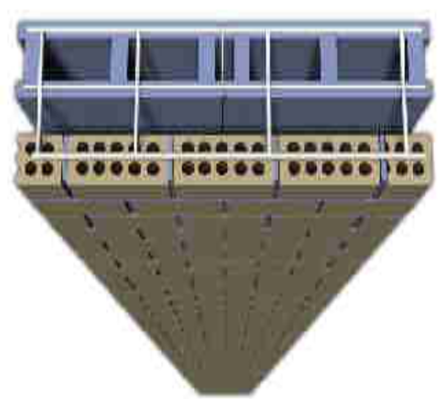
The level of embodied energy (EE) in a 3000 x 3000 mm (10ft x 10 ft) bay of a facade was calculated for each option. Since thermal insulation has been omitted from the calculations, the U-value of each construction is not considered here. For each cladding panel option, it was assumed that each panel would be supported by a floor slab/perimeter beam both top and bottom. Components within each panel were sized accordingly. Like the structural options, levels of embodied energy were calculated based on the weight of each material used in the assembly multiplied by the EE value for each.

The wall configuration with the lowest embodied energy is the timber framed wall. The highest are the aluminium framed curtain walling and the facing brick cavity wall. When steel is used for framing solution, the embodied energy of the curtain walling drops to approximately half the level of aluminium.

Among the options for opaque walls with a 1 metre square window, levels of embodied energy are relatively similar between timber and reinforced concrete but the brick cavity wall has almost 5 times the embodied energy of the timber framed wall.

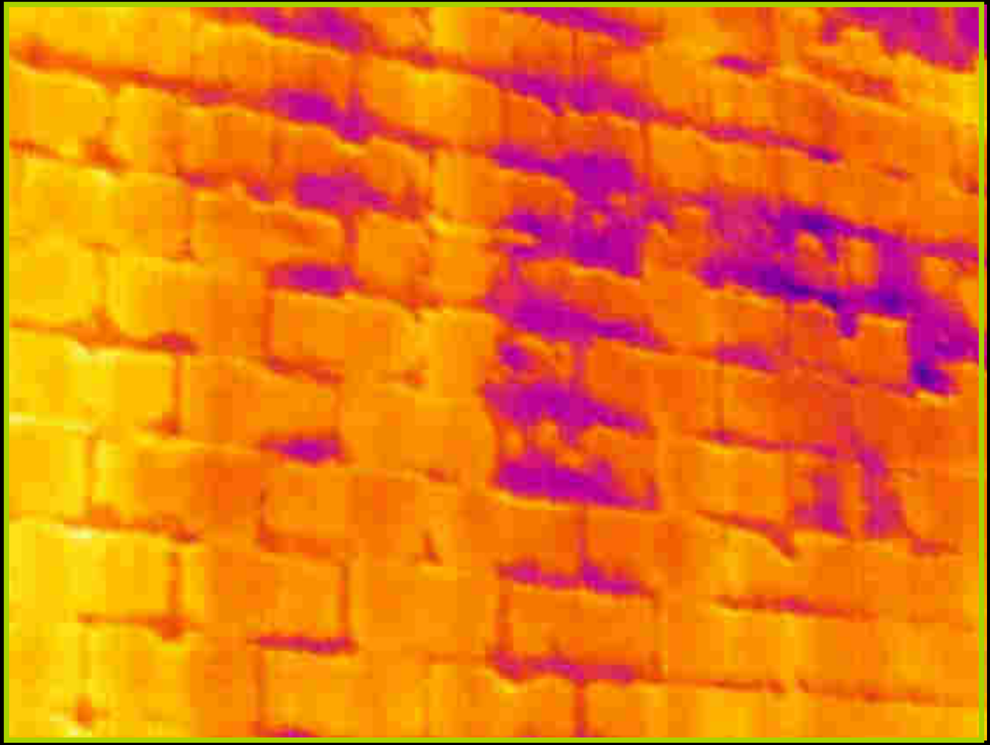
Embodied energy values used	GJ/tonne
1) Aluminium alloy	200
2) Synthetic rubber	150
3) Structural steel	26.8
4) Steel used in windows	31
5) Float glass	15
6) Softwood	13
7) Plasterboard	2.7
8) Facing bricks	11.7
9) Mortar	0.84
10) In situ concrete structure above ground	1.09
11) Steel reinforcement	26.8
12) Plywood	17
13) Concrete block	1.31
14) Wall insulation	35
15) Plastic	150

	GJ/m^2
1) Timber framed wall+double glazed window	0.48
2) Timber framed curtain walling	0.82
3) Reinforced concrete panel+dg window	0.70
4) Facing brick cavity wall+double glzd. window	2.33
5) Facing brick cavity wall with steel shelf angle	2.54
6) Aluminium framed curtain walling	2.48
7) Steel framed curtain walling	1.26
8) Bolt fixed glazing	0.80



SOURCE: INSTITUTION OF STRUCTURAL ENGINEERS UNITED KINGDOM

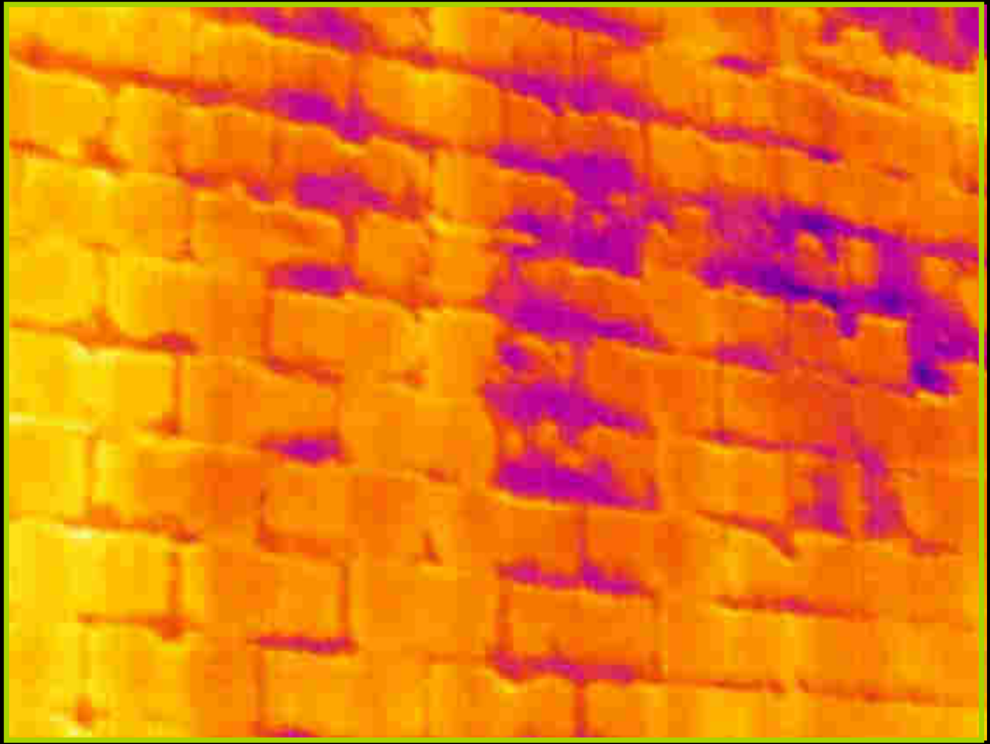
→ INSULATION VALUE *(hr sq.ft.°F/BTU) or (m^2 K/W)*

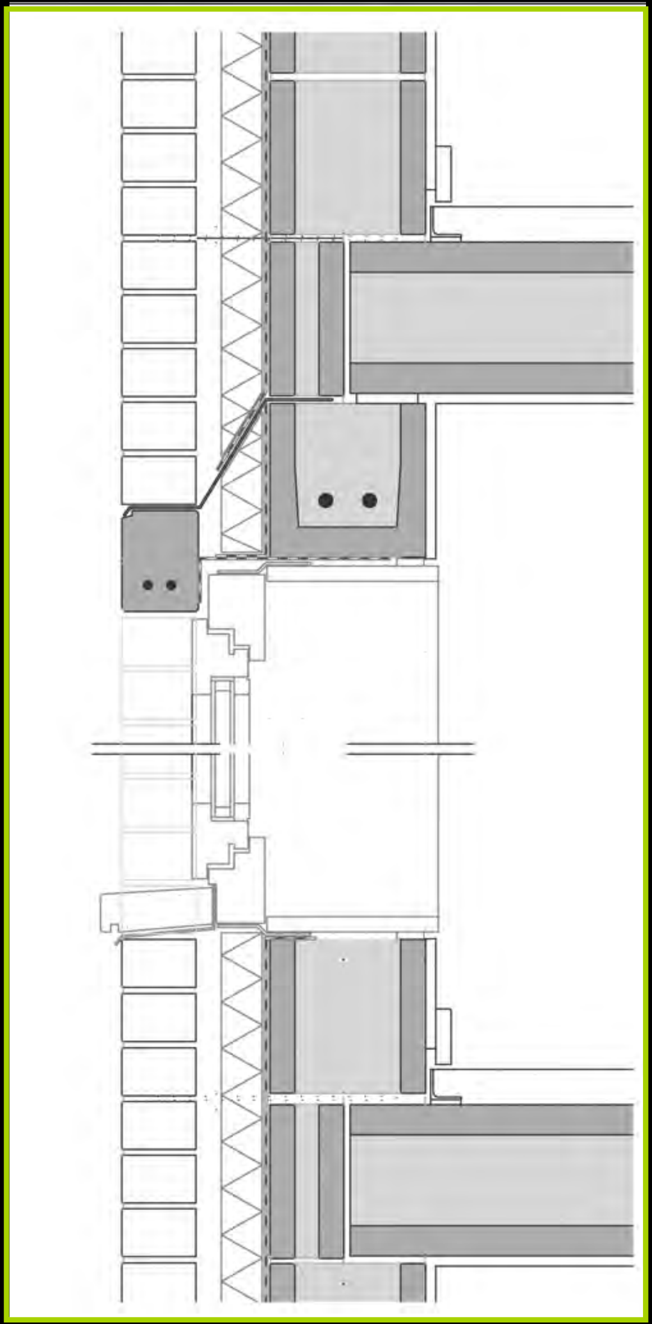


R-Value Table
Insulation Values For Selected Materials

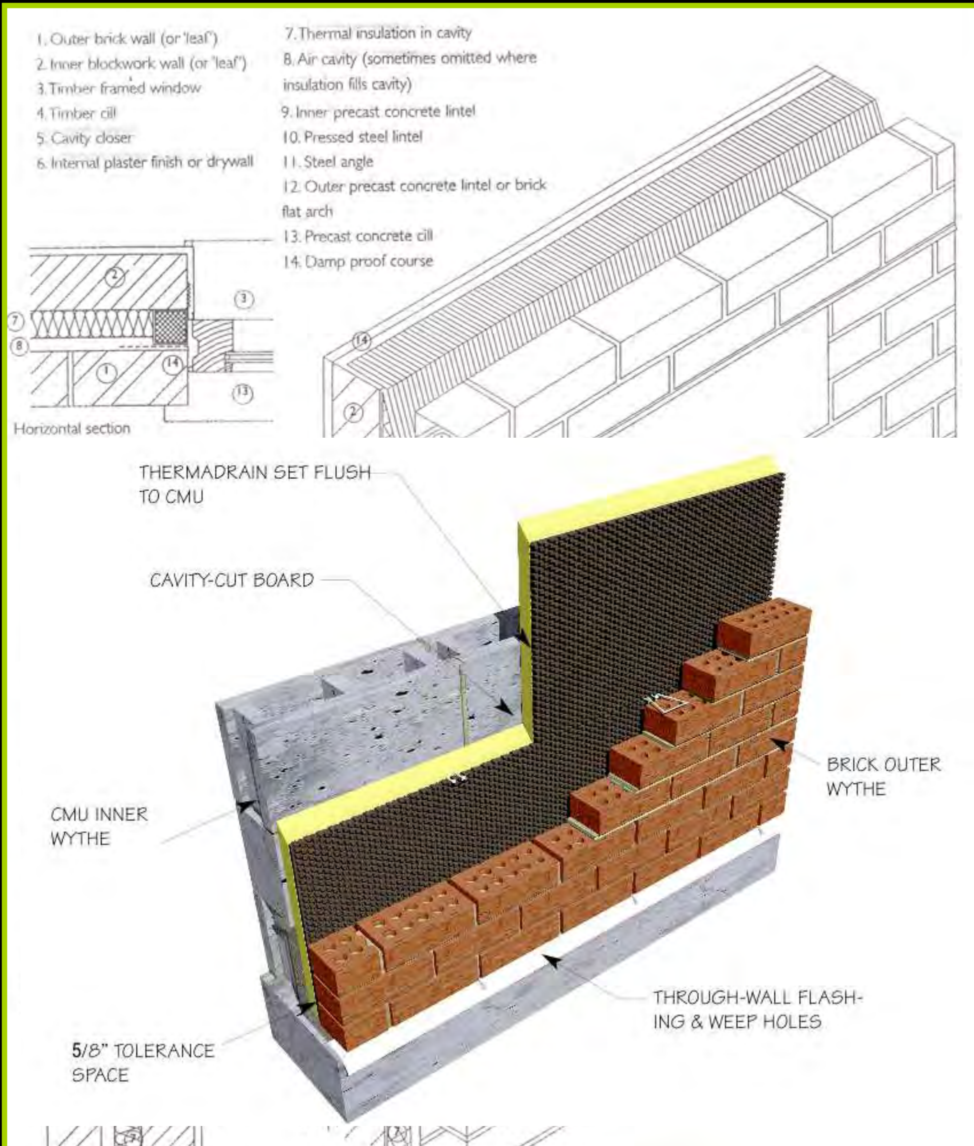
R-Value Table

Material	R/ Inch	R/ Thickness
Insulation Materials		
Fiberglass Batt	3.14	
Fiberglass Blown (attic)	2.20	
Fiberglass Blown (wall)	3.20	
Rock Wool Batt	3.14	
Rock Wool Blown (attic)	3.10	
Rock Wool Blown (wall)	3.03	
Cellulose Blown (attic)	3.13	
Cellulose Blown (wall)	3.70	
Vermiculite	2.13	
Autoclaved Aerated Concrete	3.90	
Urea Terpolymer Foam	4.48	
Rigid Fiberglass (> 4lb/ft3)	4.00	
Expanded Polystyrene (beadboard)	4.00	
Extruded Polystyrene	5.00	
Polyurethane (foamed-in-place)	6.25	
Polyisocyanurate (foil-faced)	7.20	
Construction Materials		
Concrete Block 4"		0.80
Concrete Block 8"		1.11
Concrete Block 12"		1.28
Brick 4" common		0.80
Brick 4" face		0.44
Poured Concrete	0.08	
Soft Wood Lumber	1.25	
2" nominal (1 1/2")		1.88
2x4 (3 1/2")		4.38
2x6 (5 1/2")		6.88
Cedar Logs and Lumber	1.33	





→ INSULATION VALUE *(hr sq.ft.°F/BTU) or (m^2 K/W)*



R-Value Table

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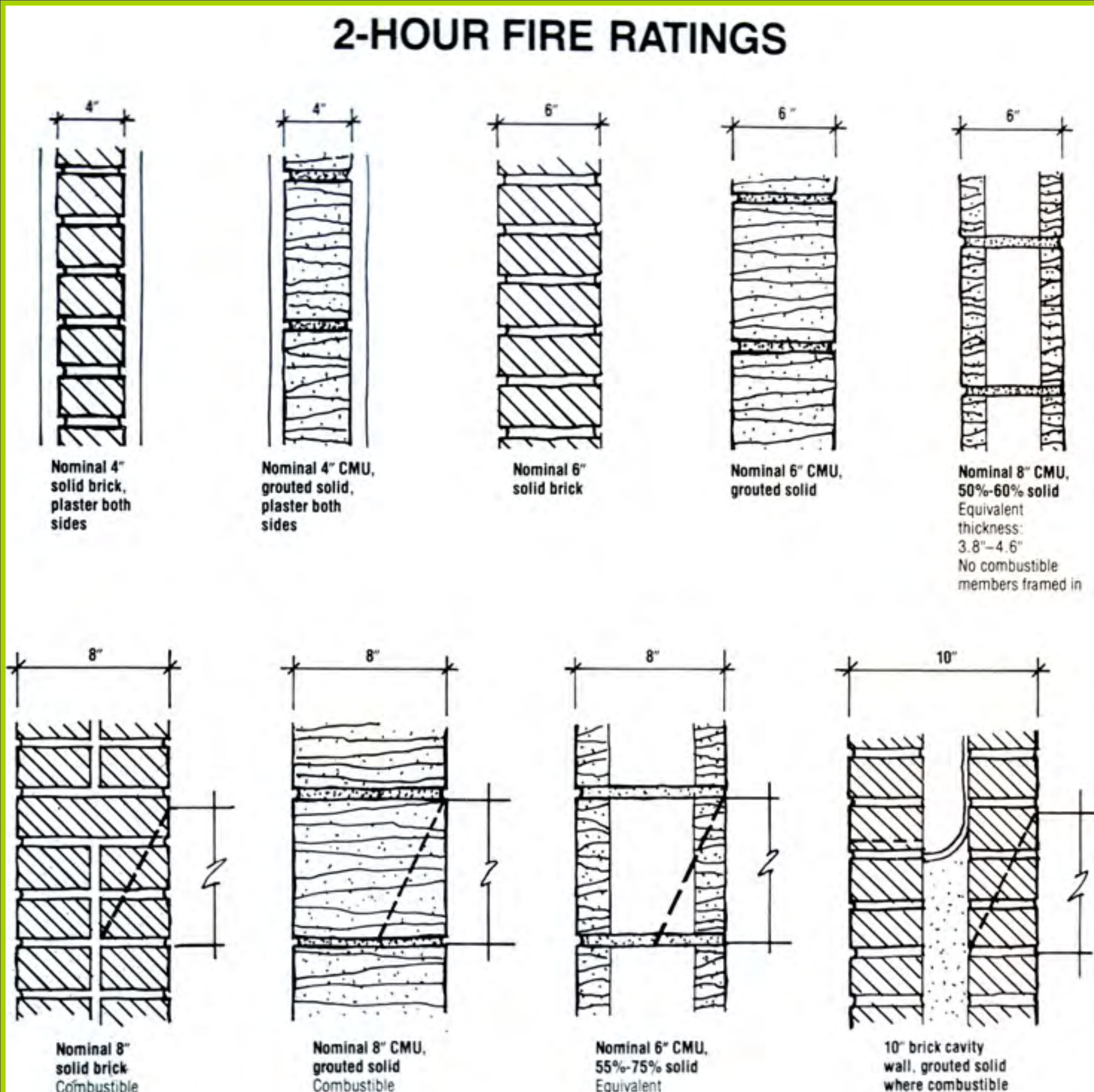
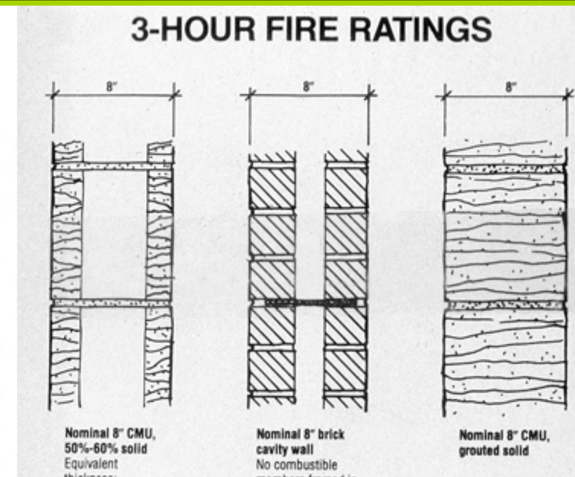
2x4 (3 1/2")		4.38
2x6 (5 1/2")		6.88
Cedar Logs and Lumber	1.33	

→ *FIRE RATINGS*





→ *HOW TO SPAN BRICK:* LINTELS

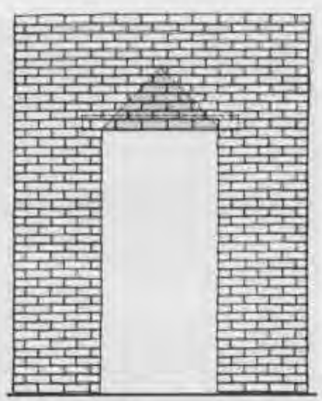
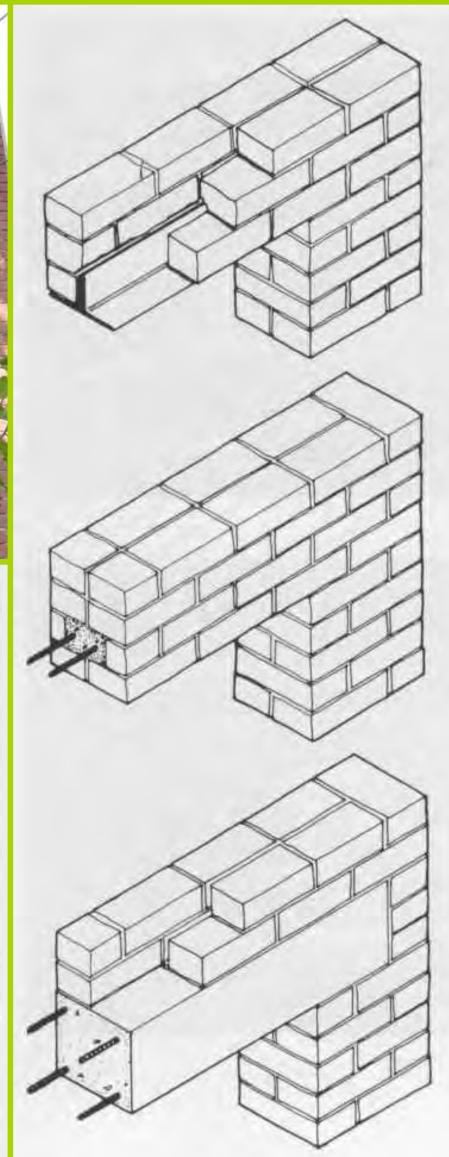


FIGURE 8.26
Because of corbelling and arching action in the bricks, a lintel is considered to carry only the triangular area of brickwork indicated by the shaded portion of this drawing. The broken line indicates a concealed steel angle lintel.



→ 'OPUS CAEMENTITIUM'

R.Moneo: Museo de Arte Romano, Merida

Prefabrication and *opus caementitium*

The impressive building housing the Museum of Roman Art in Mérida, which is built on part of the largest Roman settlement in Spain, Augusta Emerita, consists of a series of massive arches and flying buttresses plus solid walls.

The concrete was poured between two slender leaves of hard-fired bricks with a very flat format; the finished wall thickness is equal to twice the brick (i.e. leaf) width plus the distance between the leaves. The concrete forms the core of the wall and binds the two leaves together. For their part, these leaves form the "attractive" surface and can be regarded as permanent formwork, which has to withstand the pressure of the wet concrete during casting and provide stability. But without the concrete core the masonry would be totally inadequate for the structural requirements of this building.

Fig. 86: View during construction showing the "clay pipes"
Rafael Moneo: Museo de Arte Romano, Mérida (E), 1986

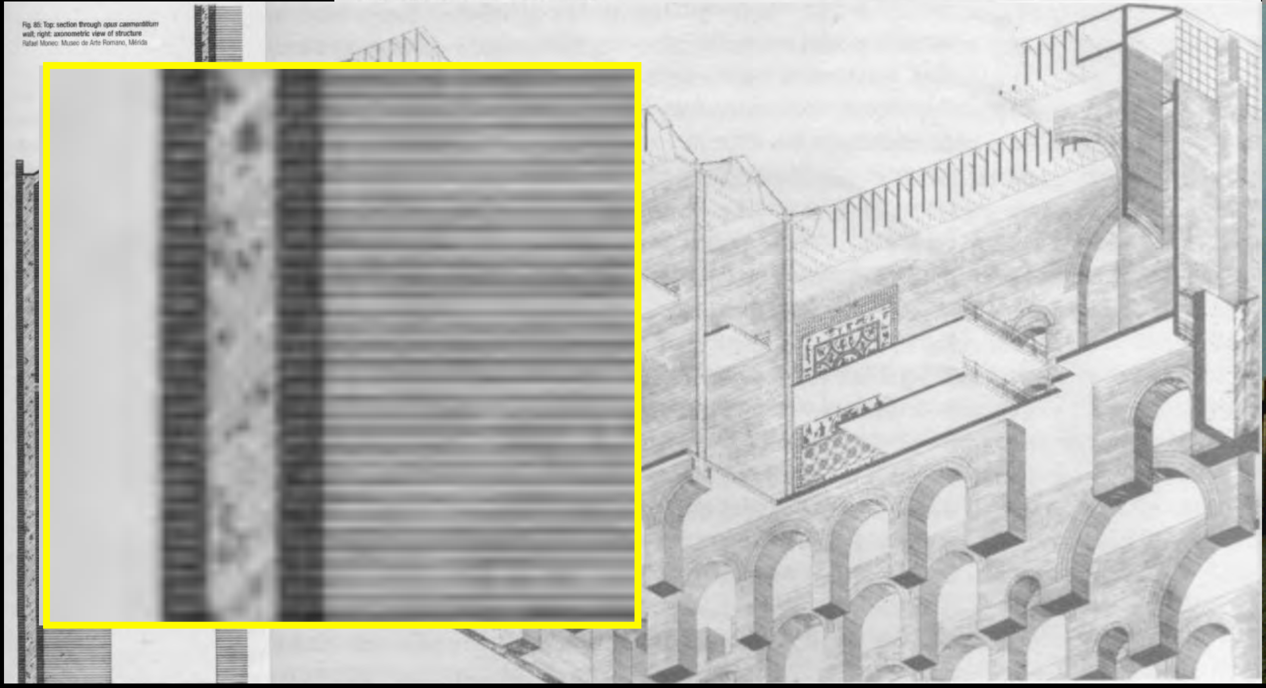
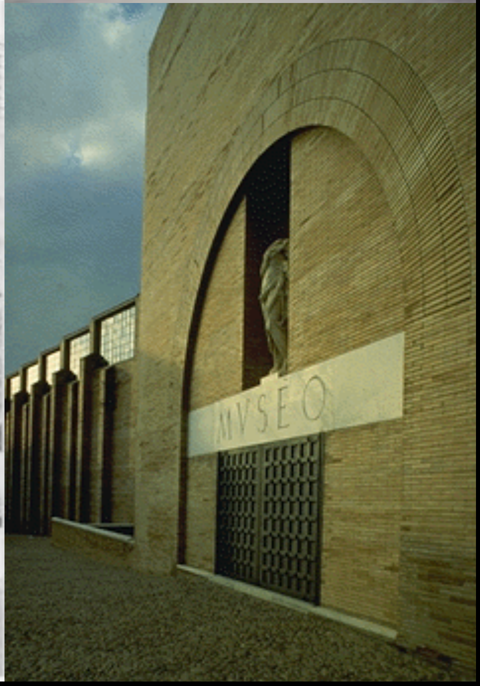
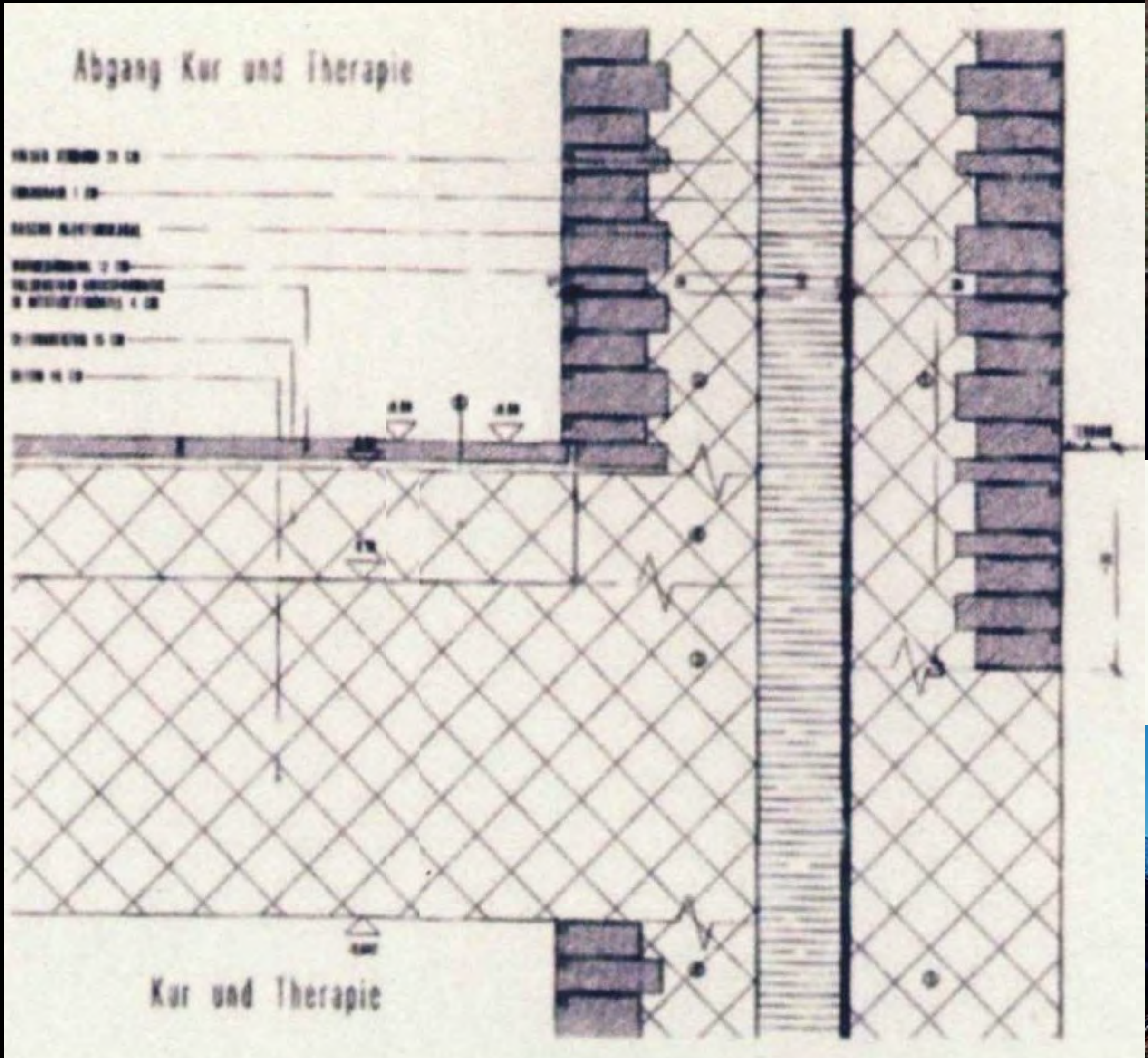


Fig. 85: Top: section through *opus caementitium* wall; right: axonometric view of structure
Rafael Moneo: Museo de Arte Romano, Mérida



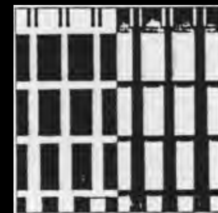
→ 'OPUS CAEMENTITIUM'

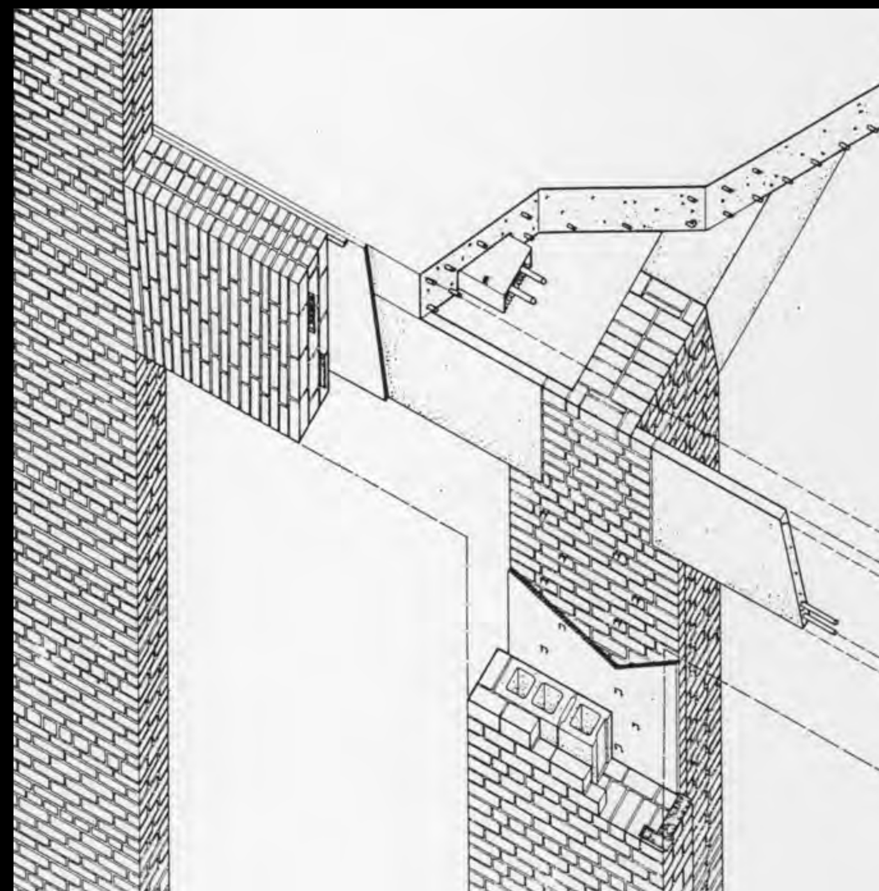
Peter Zumthor: Vals Bath, Switzerland 1990



→ 'TRUE LINTEL' AS DESIGN IDEA

Louis Kahn: Exeter Library, New Hampshire 1971





→ CORBELLING

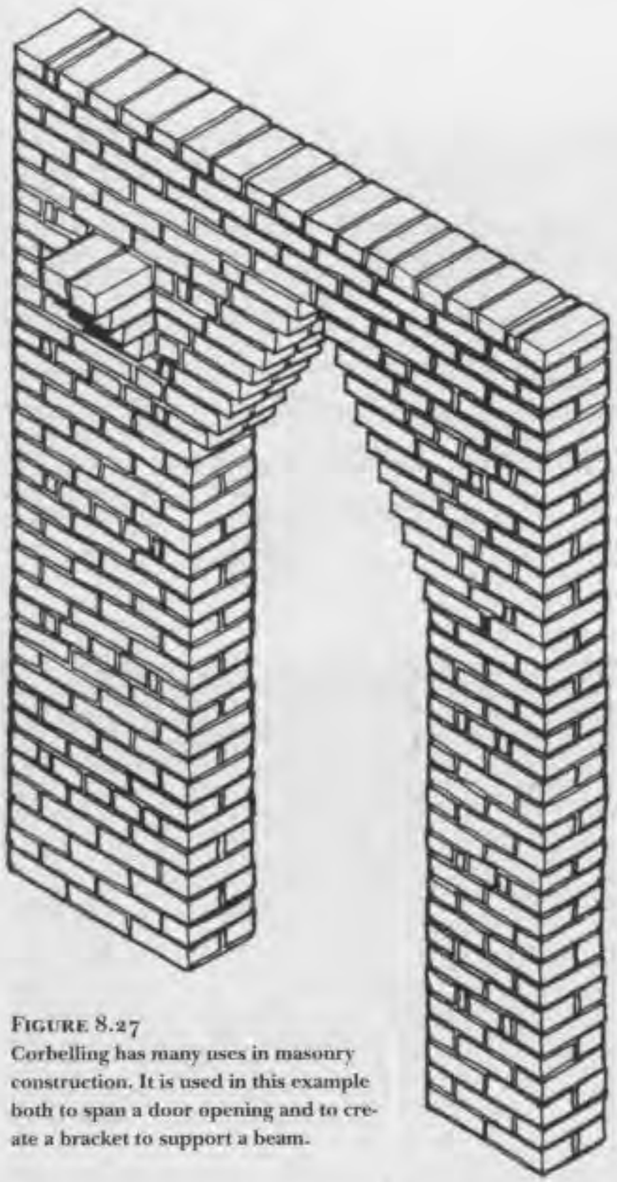
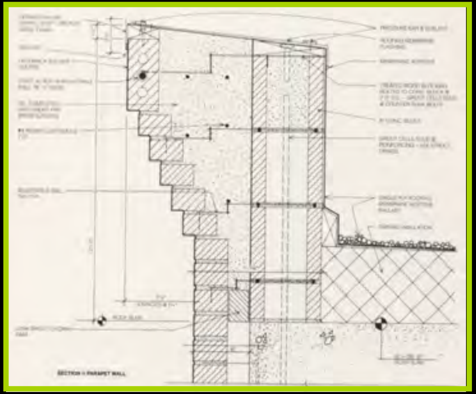


Figure 8.27
Corbelling has many uses in masonry construction. It is used in this example both to span a door opening and to create a bracket to support a beam.

→ *CORBELLING*



→ CORBELLING: “FALSE ARCHES” - “FALSE VAULTS”

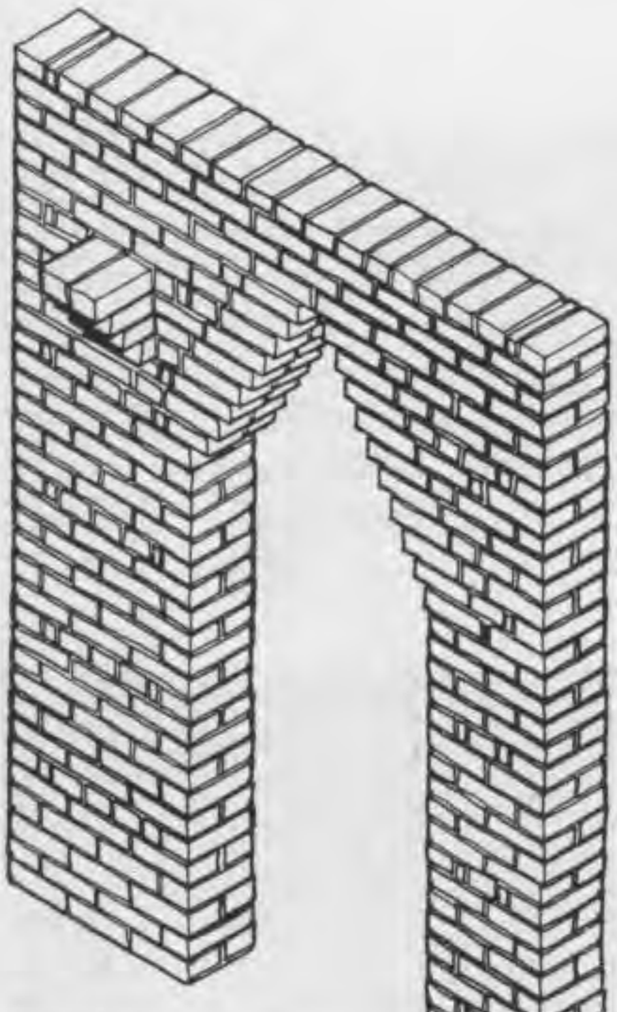
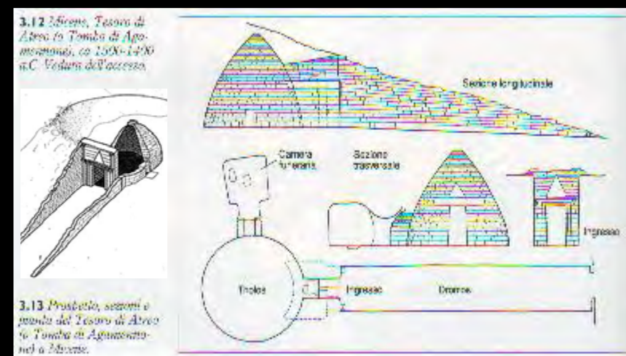


FIGURE 8.27
Corbelling has many uses in masonry construction. It is used in this example both to span a door opening and to create a bracket to support a beam.

“FALSE”

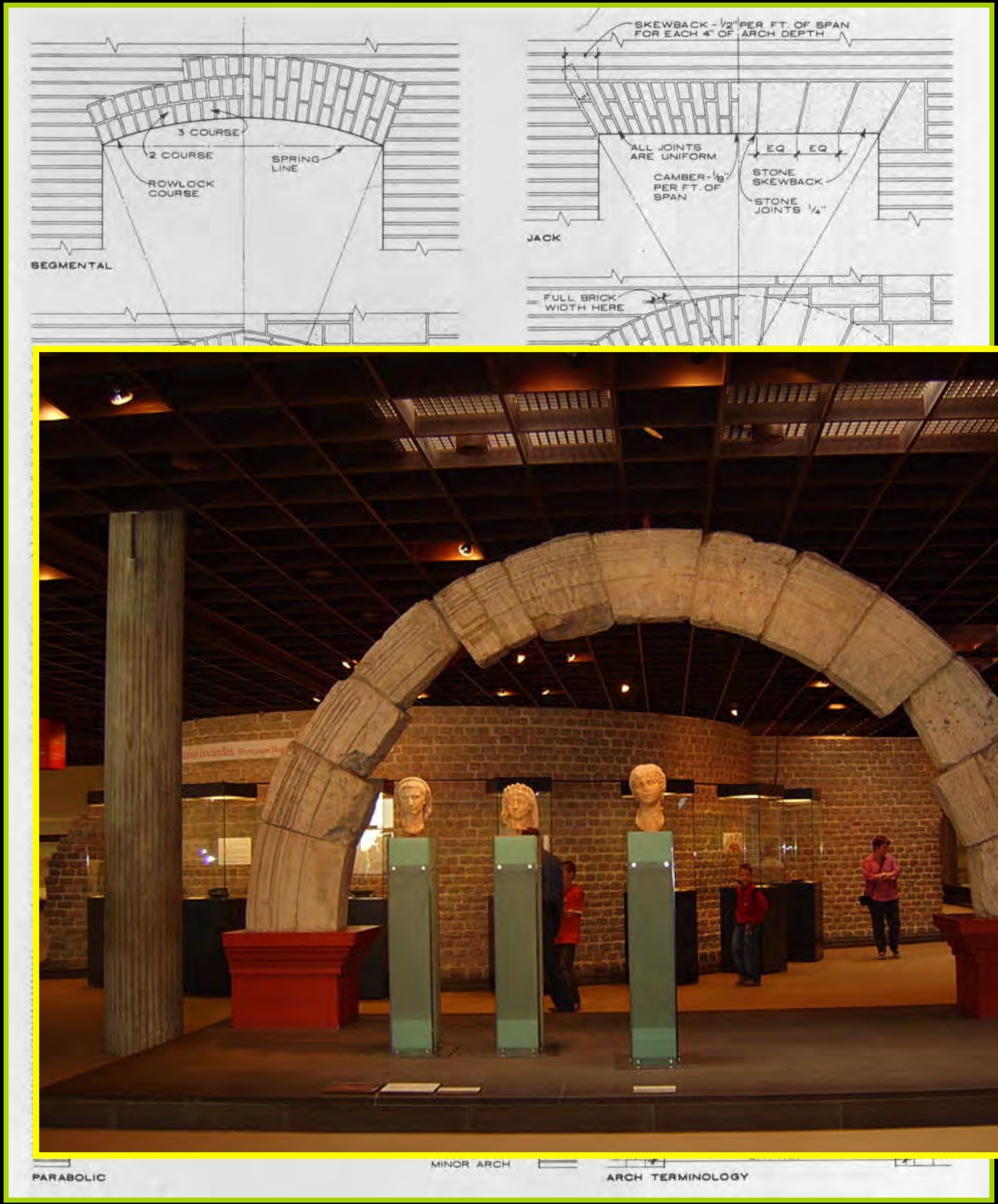


‘TREASURY OF ARTEUS”, MYCENAE, GREECE ~1200 B.C.

→ 'TRULLI' CONSTRUCTION

→ ARCHES

'OLYMPIC STADIUM', ATHENS, ~300 B.C.



"TRUE"

→ *STONE: MASONRY, too …*

→ *STONE: MASONRY, too …*

→ *STONE: MASONRY, too …*

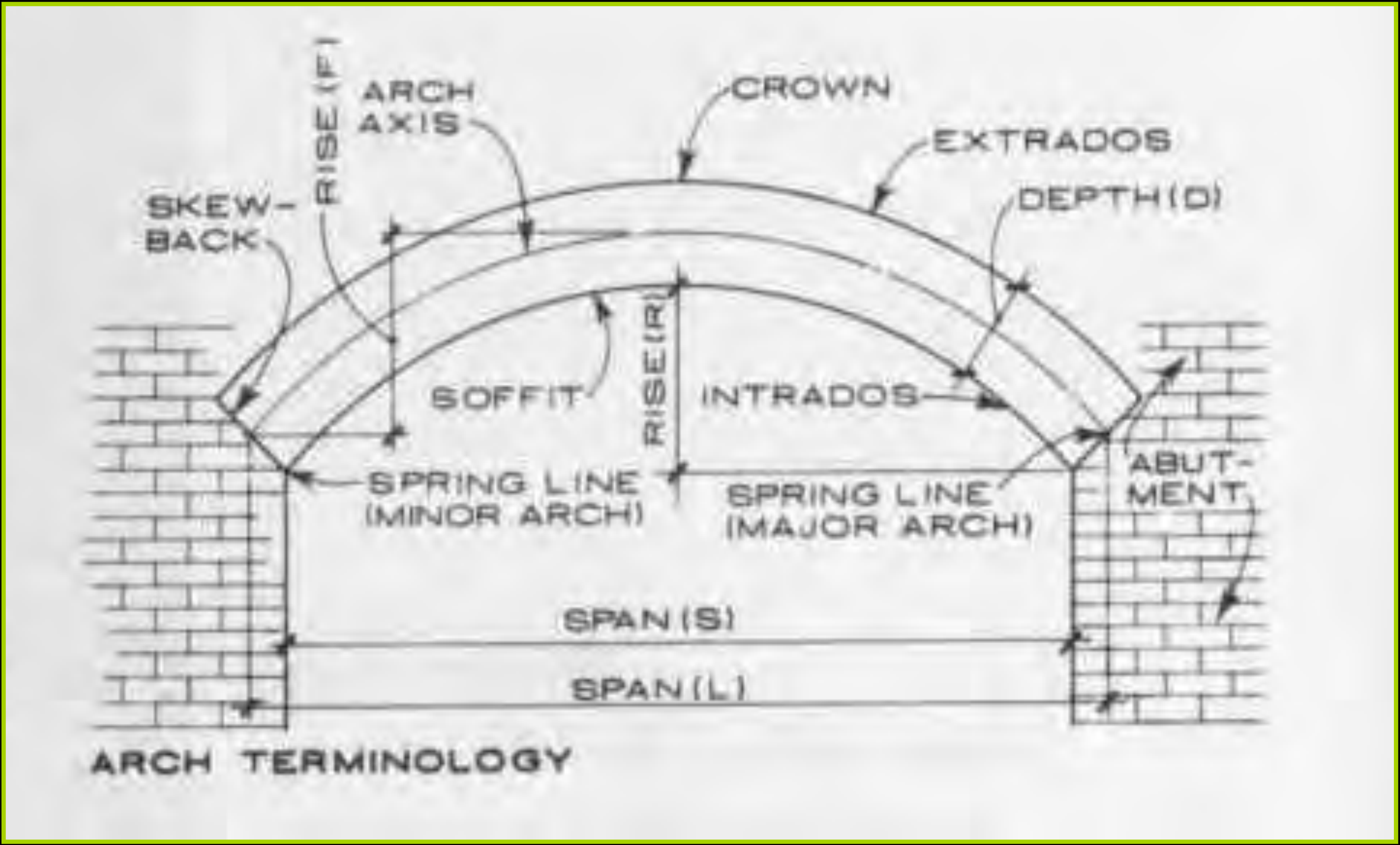
→ *STONE: MASONRY, too …*

→ STONE FABRICATION:

→ *NATURAL STONE:*

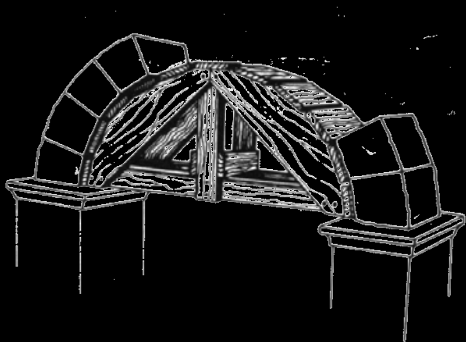
ANTON GARCIA-ABRIL: MUSIC ACADEMY;
SANTIAGO DE COMPOSTELA, SPAIN 2002

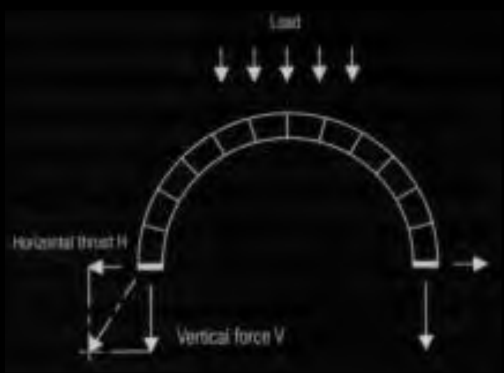
→ ARCHES: TERMINOLOGY

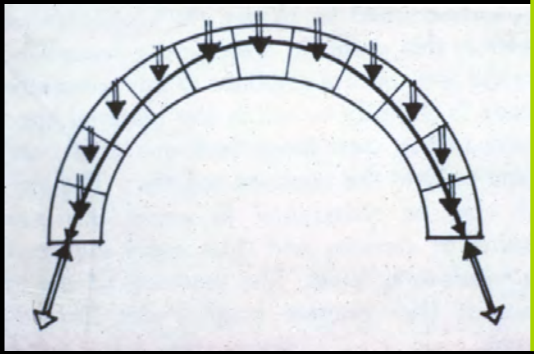


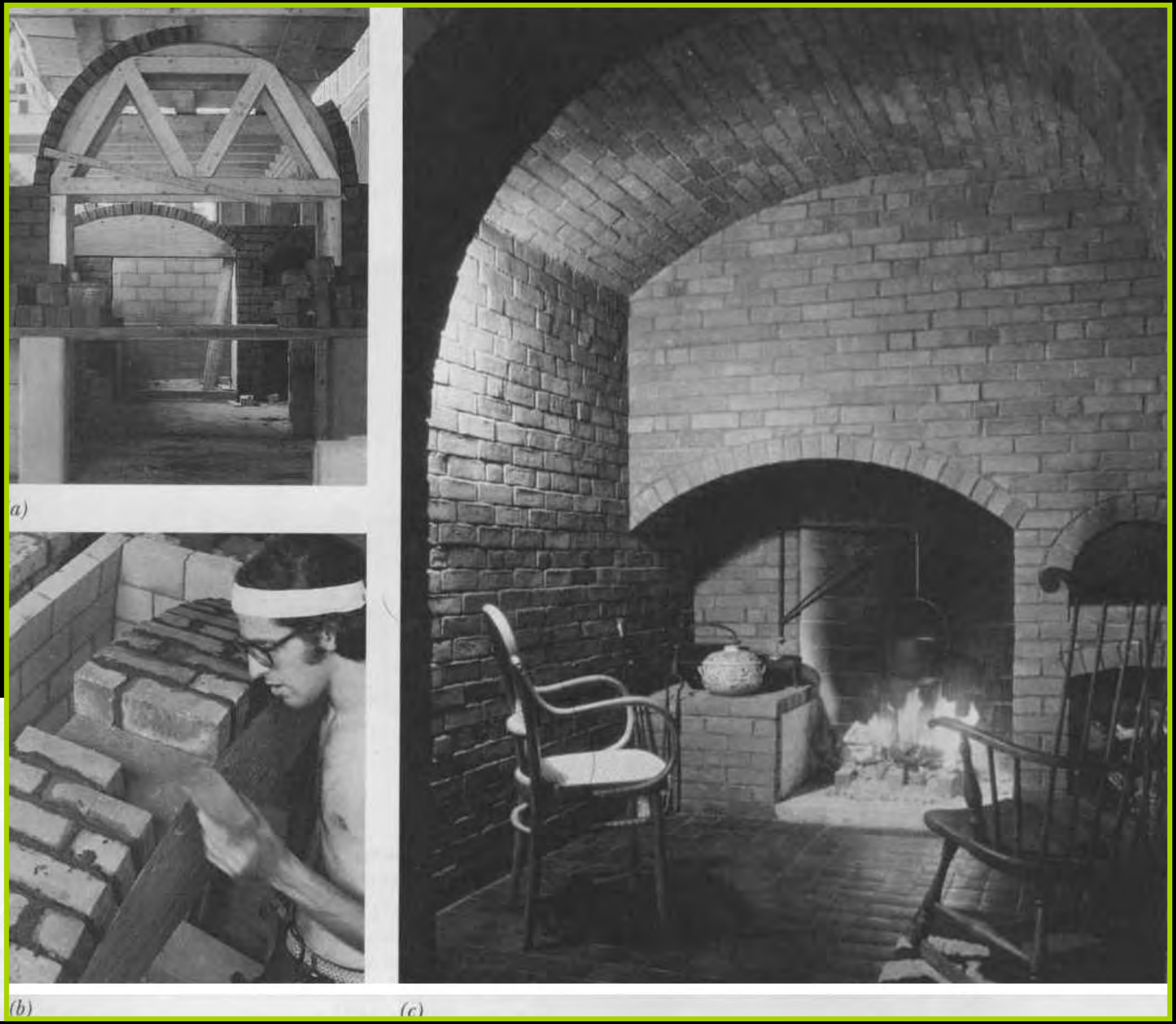
→ *CONSTRUCTING AN ARCH*

CENTERING



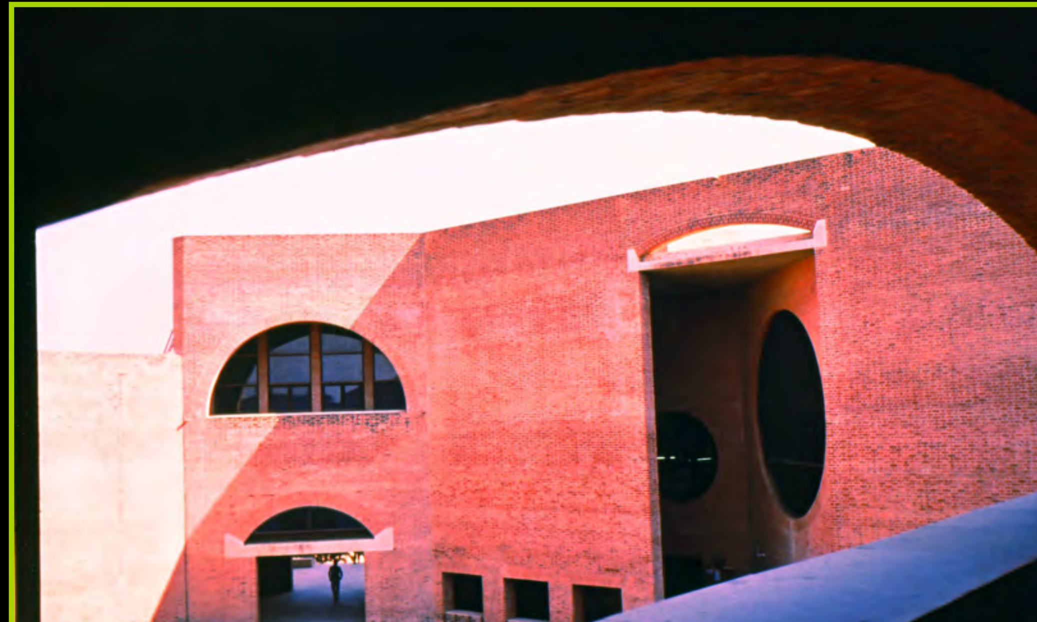


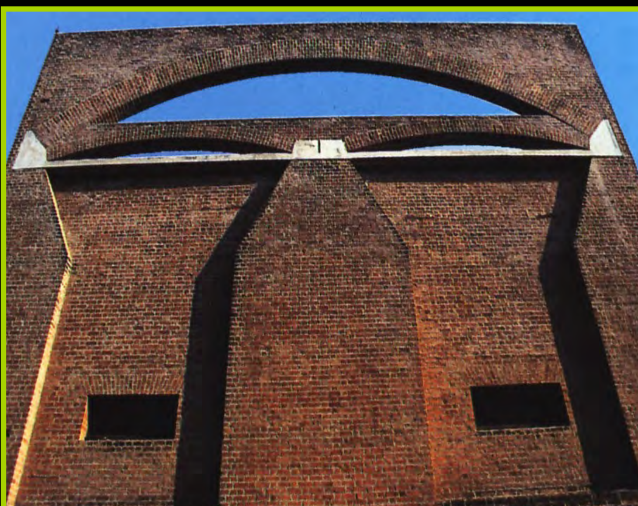




→ ARCHES: LOUIS KAHN'S 'DIALOGUE WITH BRICK':

"You say to brick, 'What do you want, brick?' And brick says to you, 'I like an arch.' And you say to brick, 'Look, I want one too, but arches are expensive and I can use a concrete lintel over you, over an opening.' And then you say, 'What do you think of that, brick?' Brick says, 'I like an arch.'" L. Kahn, 1973



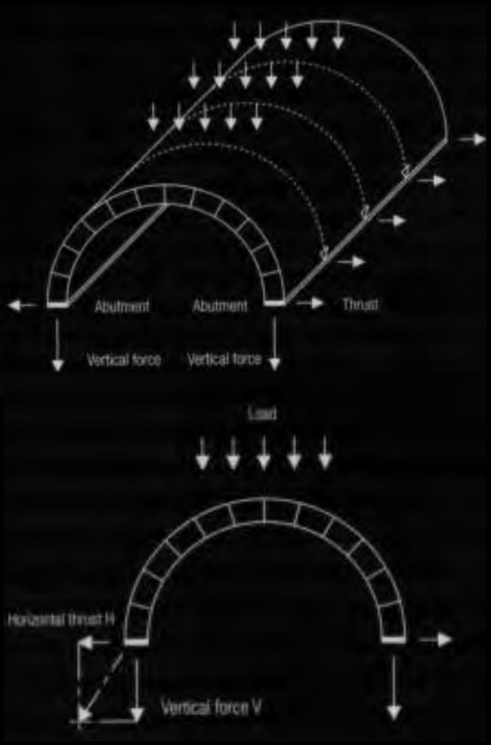


LOUIS I. KAHN: INDIAN INSTITUTE OF MANAGEMENT, AHMEDABAD, INDIA 1962 - 1974

→ ARCHES, CONTEMPORARY:

→ *CONSTRUCTING AN ARCH*

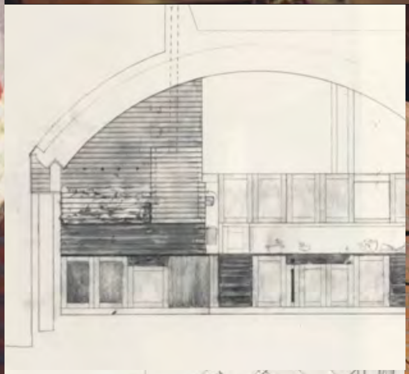
→ *CONSTRUCTING A VAULT*



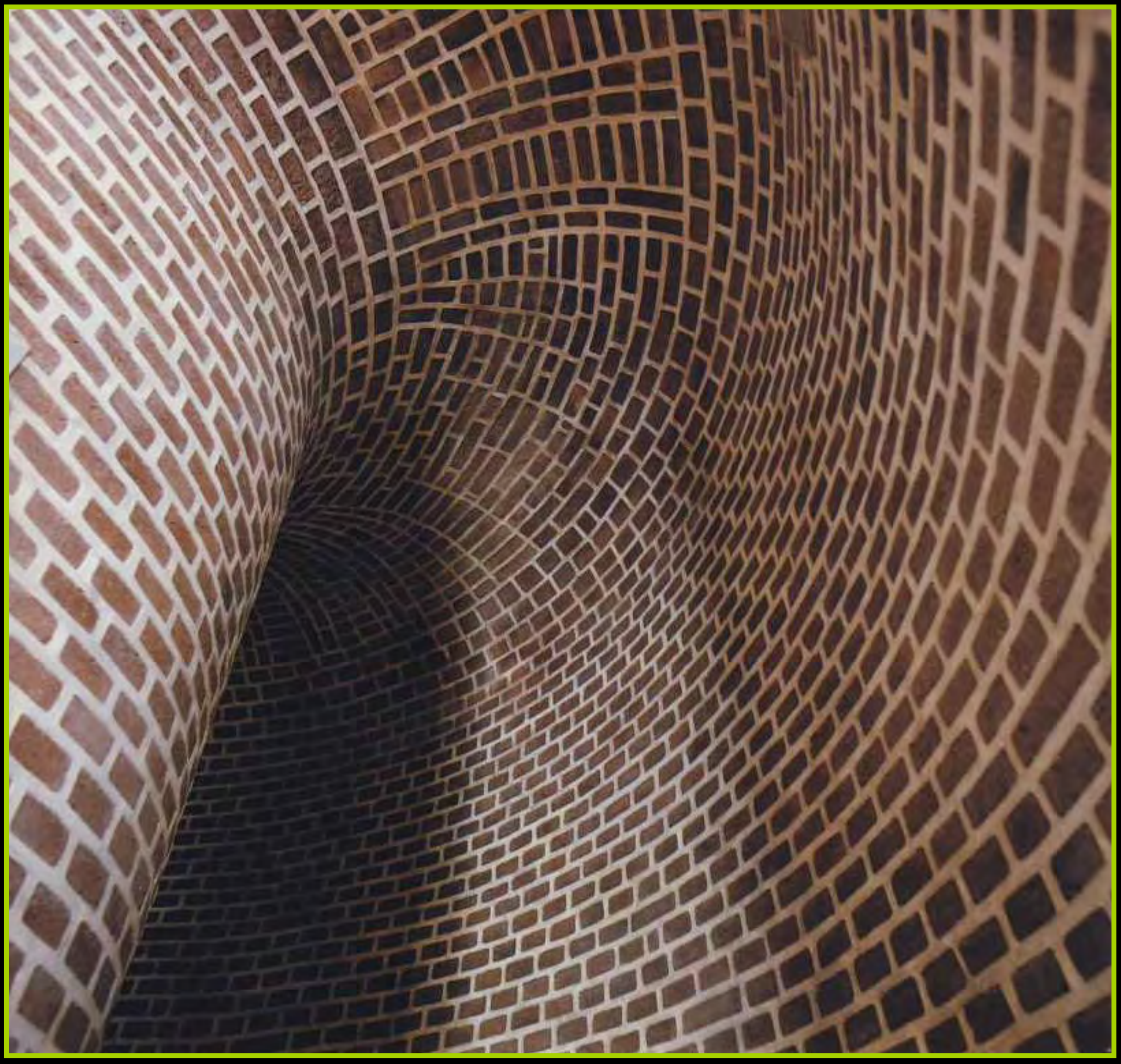
→ *VAULTS, CONTEMPORARY*

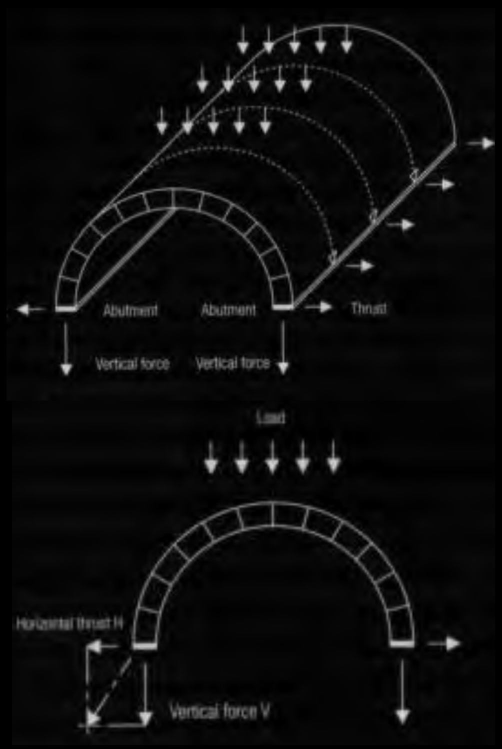
J.JENSEN + B.SKODVIN, HOUSE
WORMDAL, OSLO NORWAY 1991





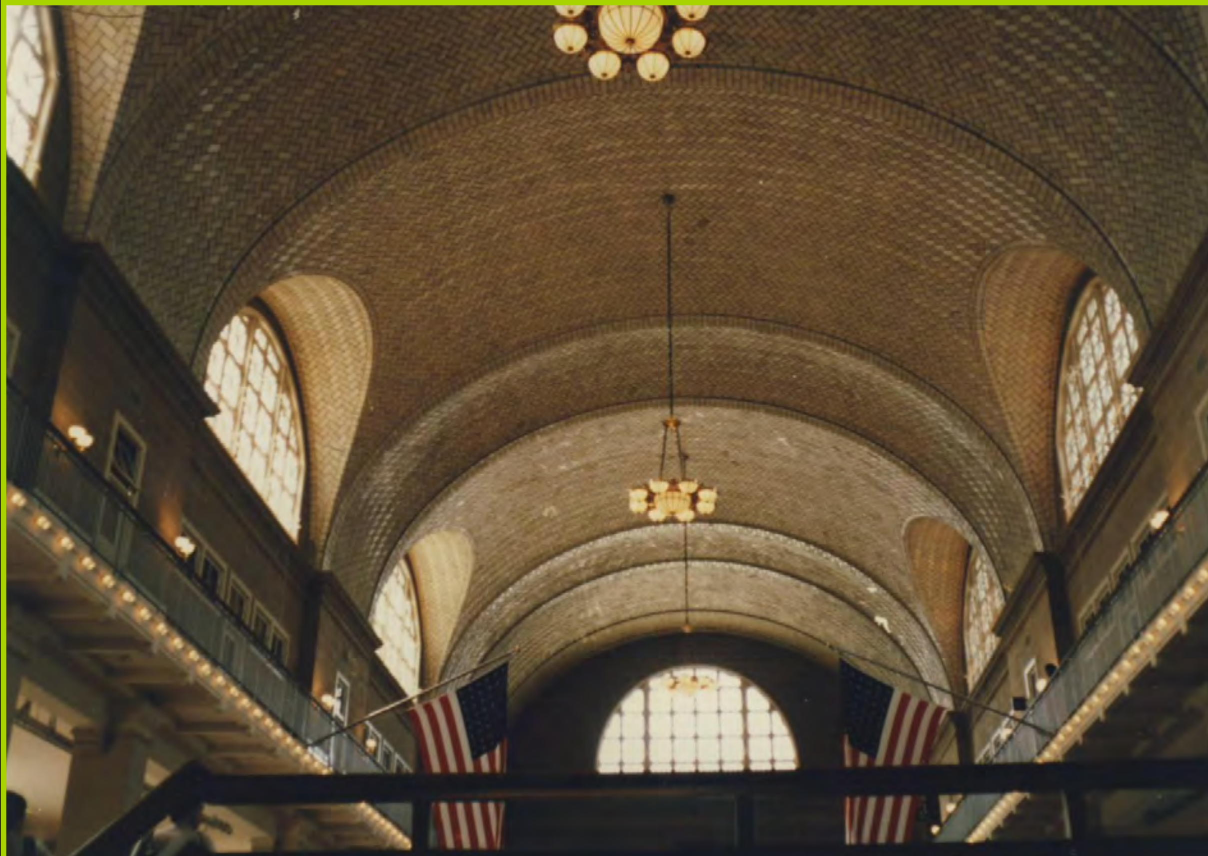
→ *CONSTRUCTING A CIRCULAR VAULT*

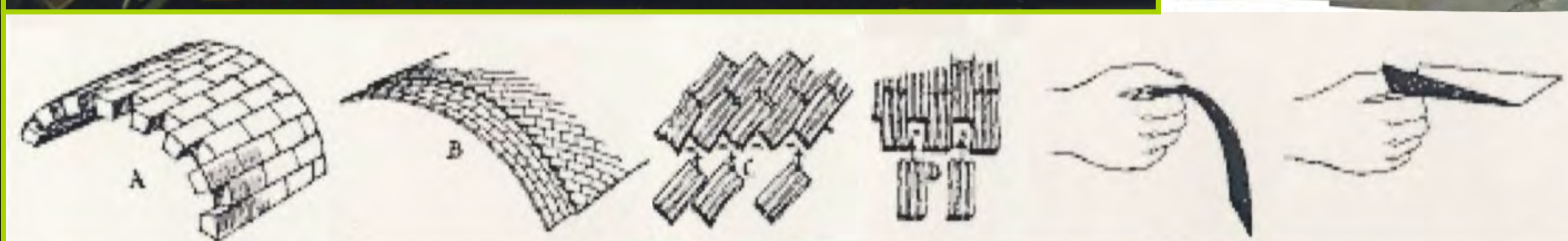




J.PLECNIK, PRAGUE CASTLE 1923

→ TIMBREL VAULTING: ‘THE GUASTAVINO SYSTEM’





→ TIMBREL VAULTING: ‘THE GUASTAVINO SYSTEM’

→ *VAULTING:*

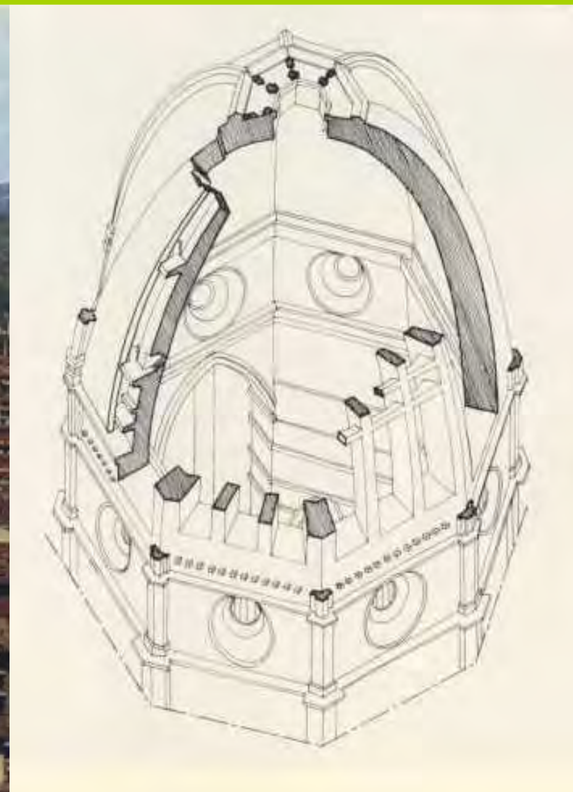
(a)

(b)

FIGURE 8.34
(*a*) Masons in Mauritania, drawing on thousands of years of experience in masonry vaulting, build a dome for a patient room of a new hospital. The masonry is self-supporting throughout the process of construction; only a simple radius guide is used to maintain a constant diameter. The dome is double with an airspace between to insulate the room from the sun's heat. (*b*) The walls are buttressed with stack bond brick headers to resist the outward thrust of the domes. (*Courtesy of ADAUA, Geneva, Switzerland*)

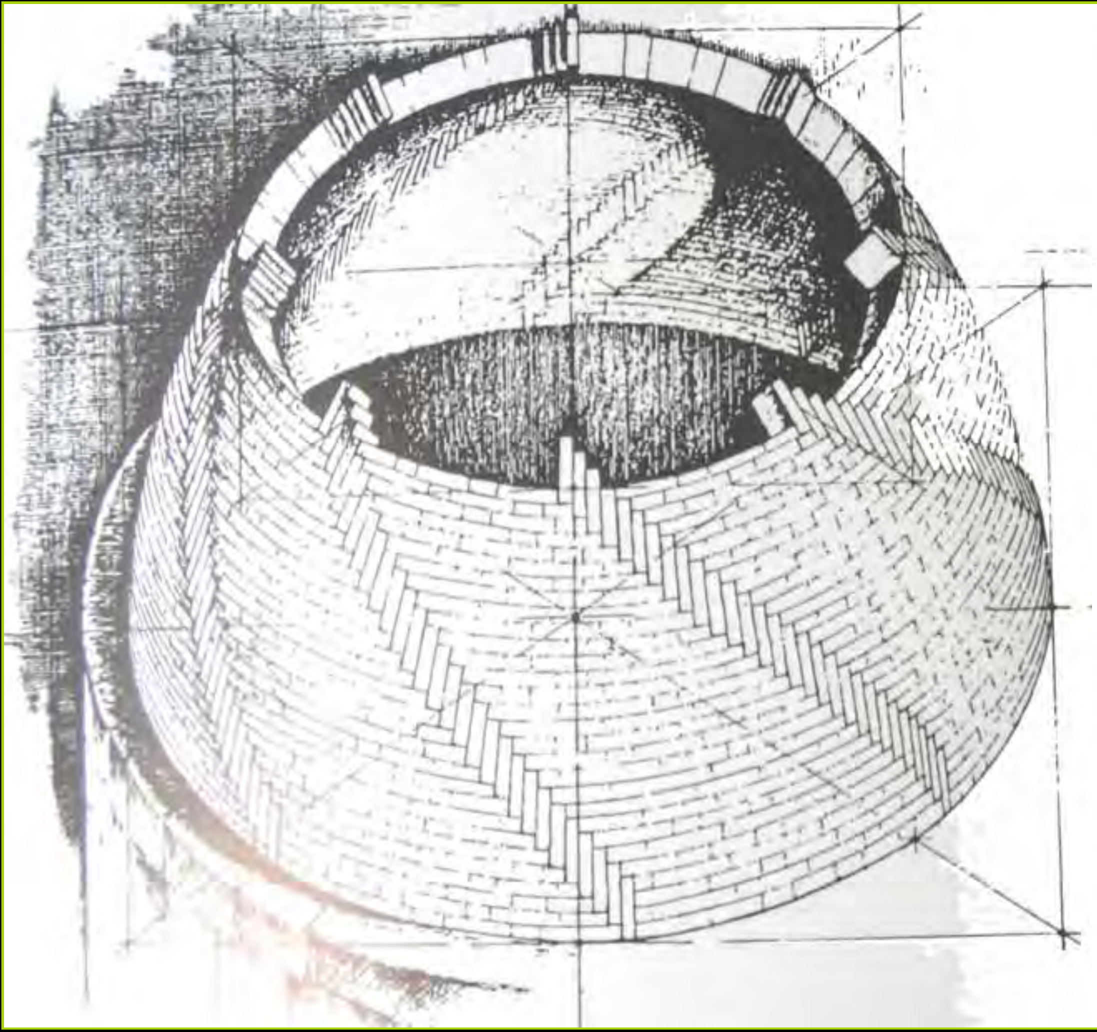
→ *DOMES, VERNACULAR, WORLDWIDE:*

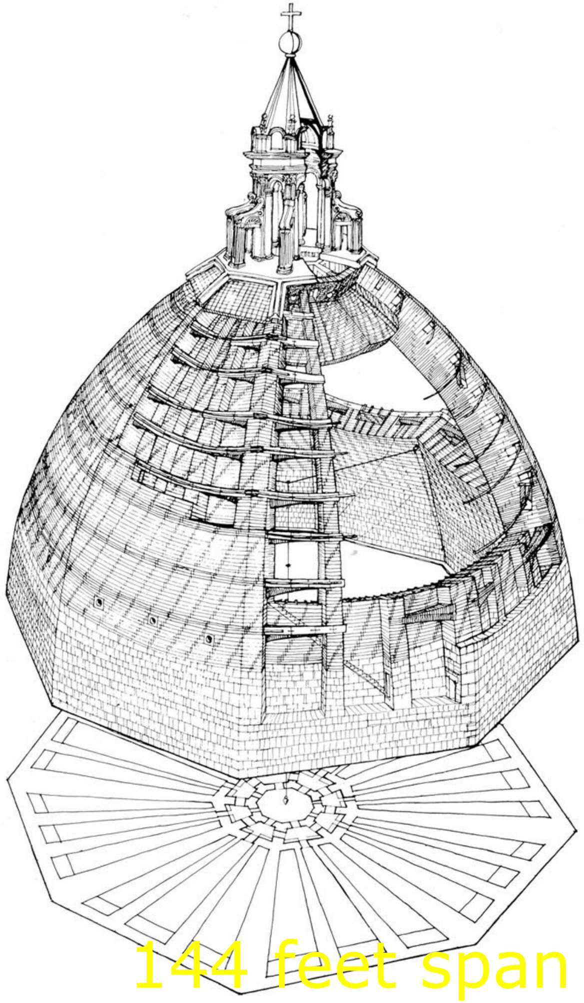
→ *CONSTRUCTING AN ARCH WITHOUT FORMWORK:*



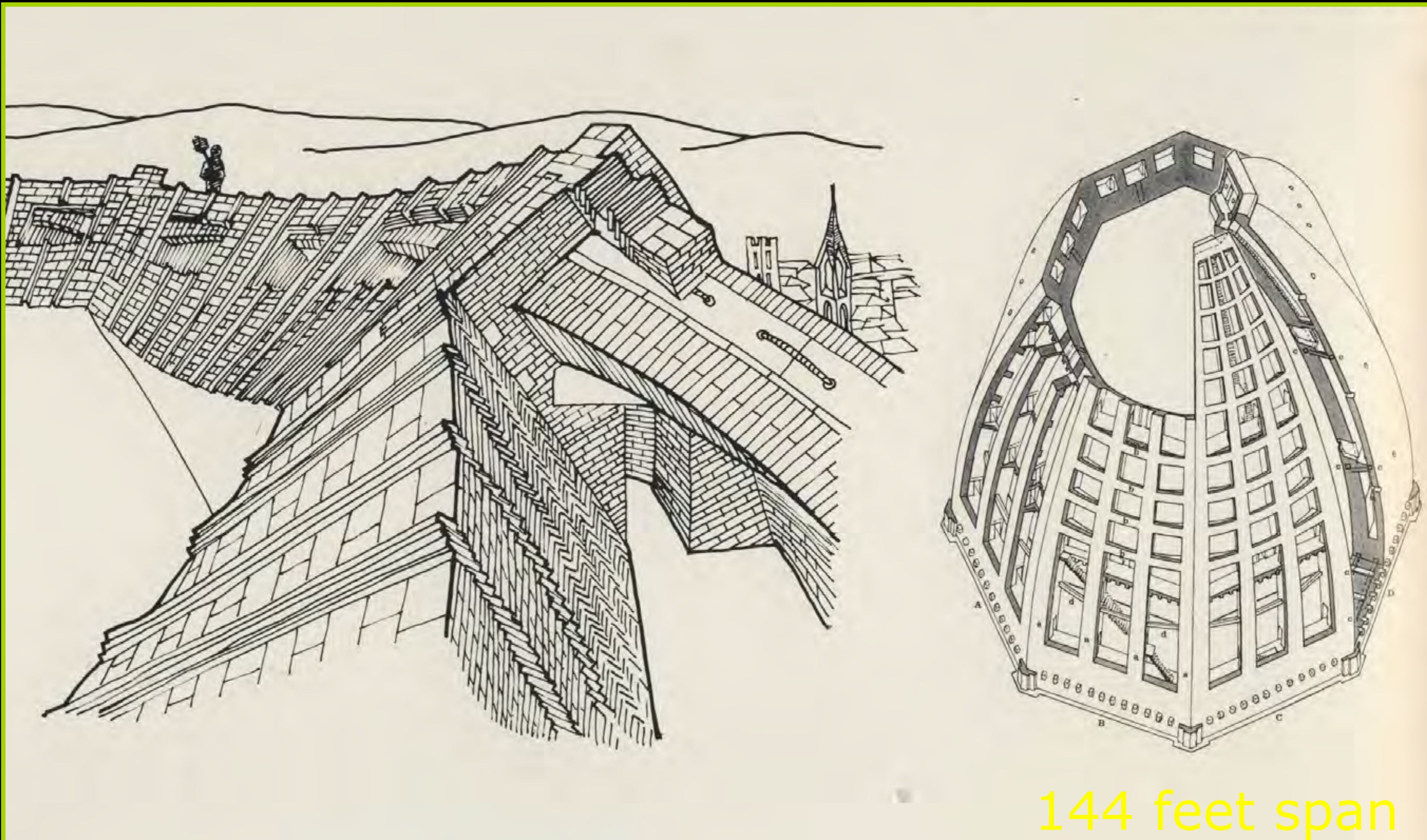
<u>FILIPPO BRUNELLESCHI:</u> CONSTRUCTION OF 130 FEET DIAM. DOME IN TWO LAYERS, WITH DIFFERENTIATION OF STRUCTURE AND INFILL (IN HERINGBONE PATTERN), STEEPER ANGLE OF DOME (NOT ROUND), BUILT IN 1420-1446

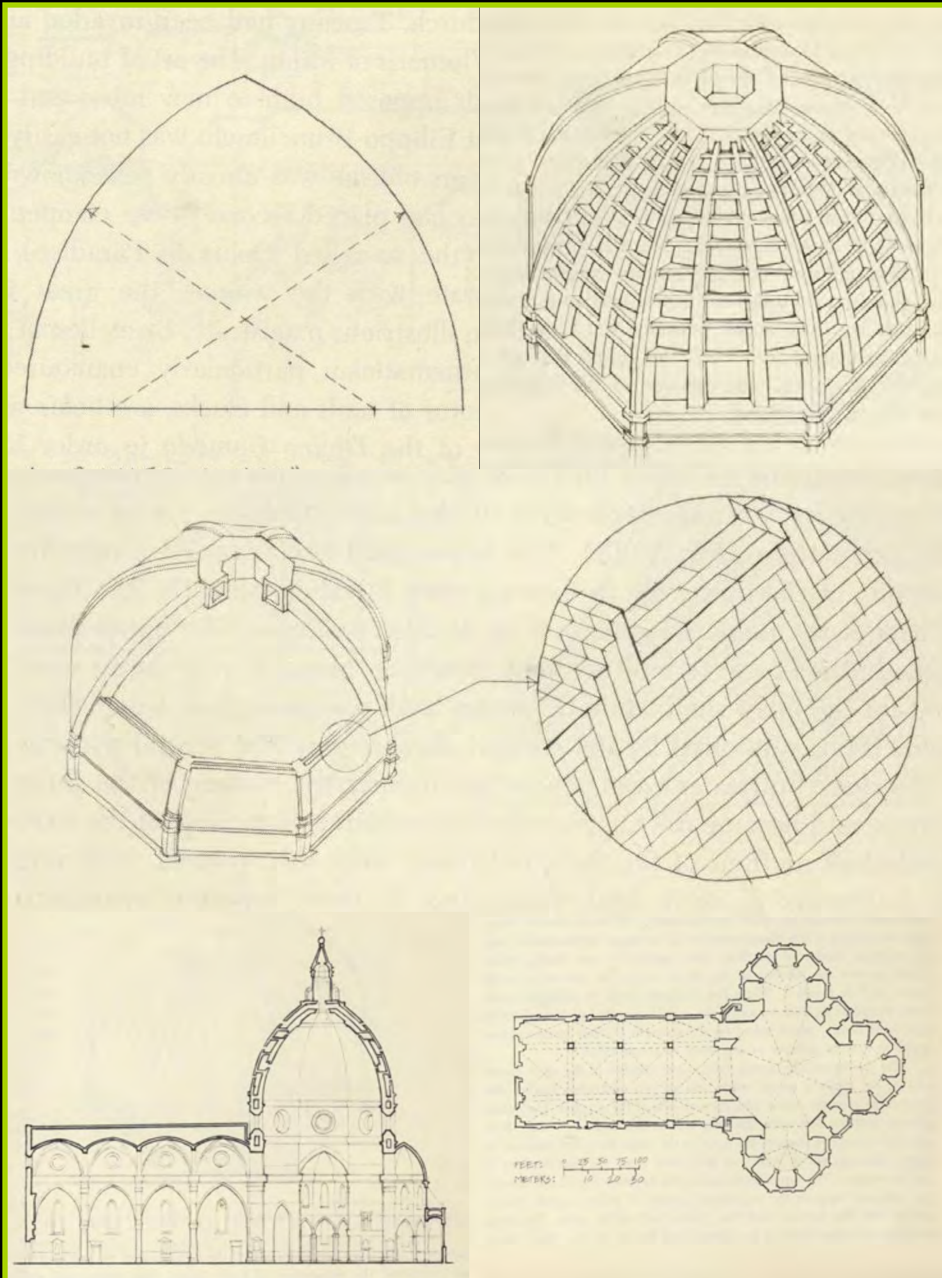
→ *CONSTRUCTING AN ARCH WITHOUT FORMWORK:*

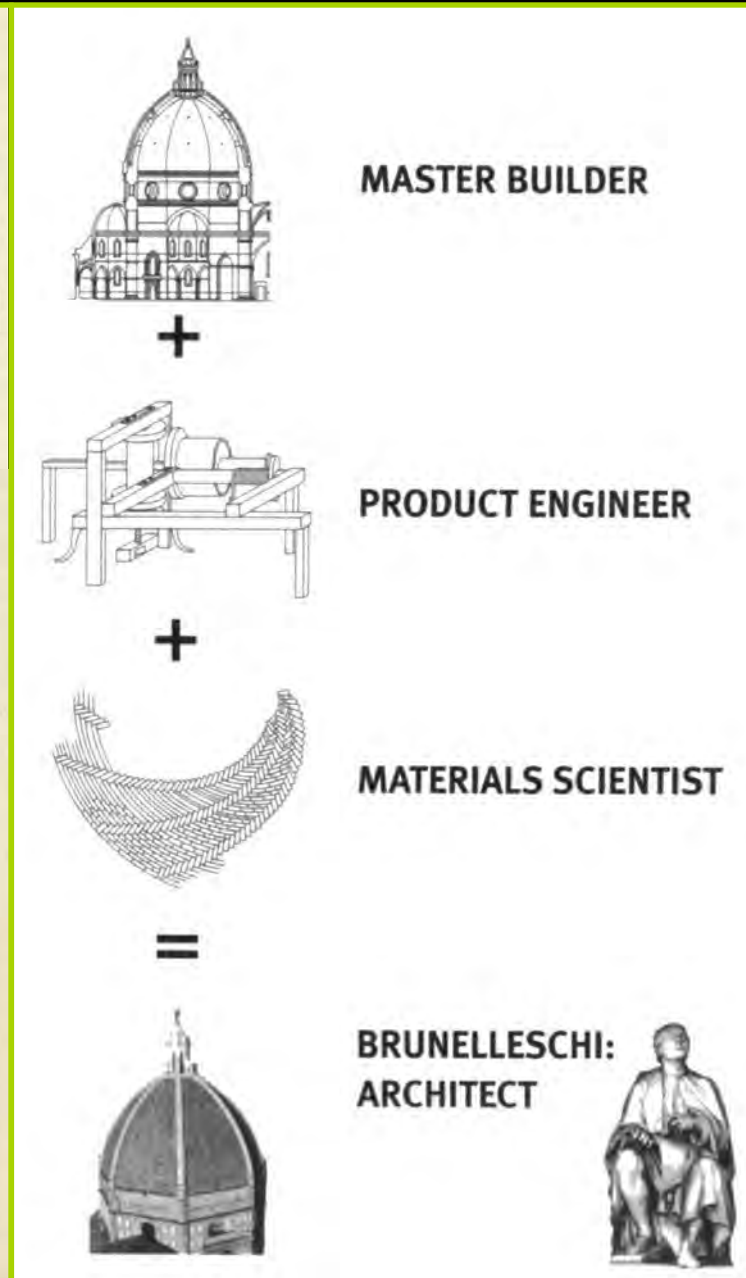




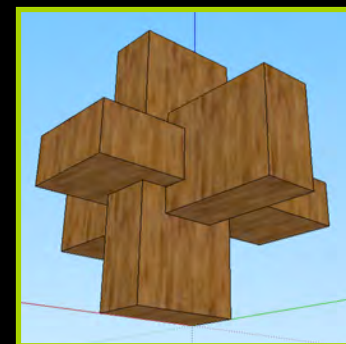
→ *CONSTRUCTING AN ARCH WITHOUT FORMWORK:*

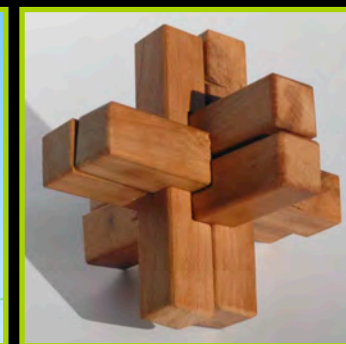


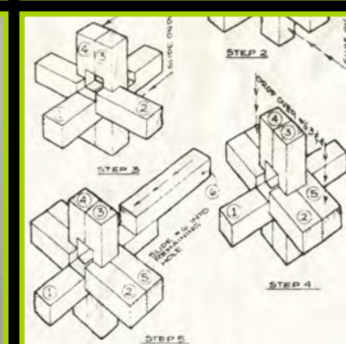




MASTER BUILDER
+
PRODUCT ENGINEER
+
MATERIALS SCIENTIST
=
BRUNELLESCHI:
ARCHITECT






STEP 2
STEP 3
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STEP 5