Concrete Masonry

- CMU Production
- Size and Application
- Performance
- Calcium Silicate Units
- Glass Units
- Natural Stone Units
- Autoclaved Aeriated Concrete Units

Ennis House
Frank Lloyd Wright
1924

Ennis House

- Los Angeles, Calif.
- Frank Lloyd Wright
- 1924
- Mayan Revival
- Textile Block

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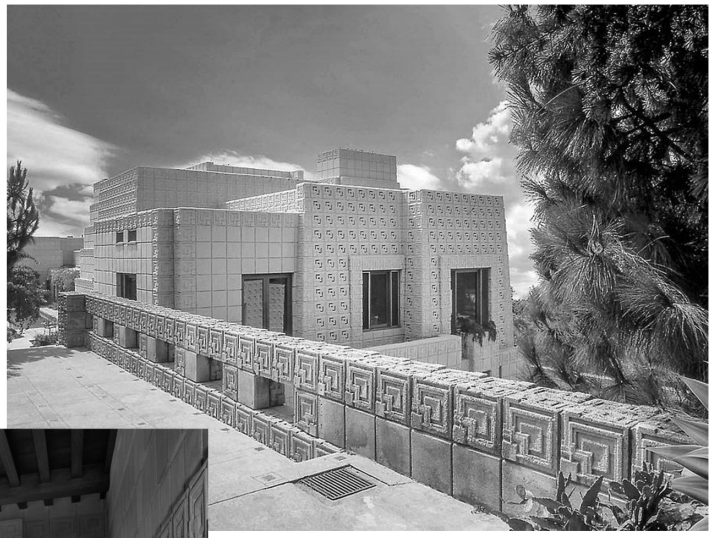
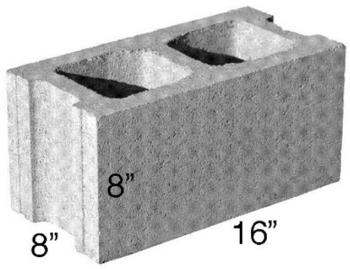


Concrete Masonry Units

Nomenclature

- Solid < 25% void Hollow > 25% void
- Net area is minus the voids
- Most are hollow – 50% to 60%
- Core is a void < 1.5 inches
- Frog is a depression
- Ears are extensions at ends



Sizes

- 8 inch grid
- 3/8 inch mortar joint

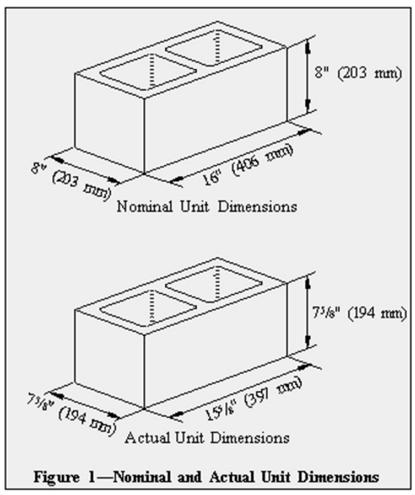
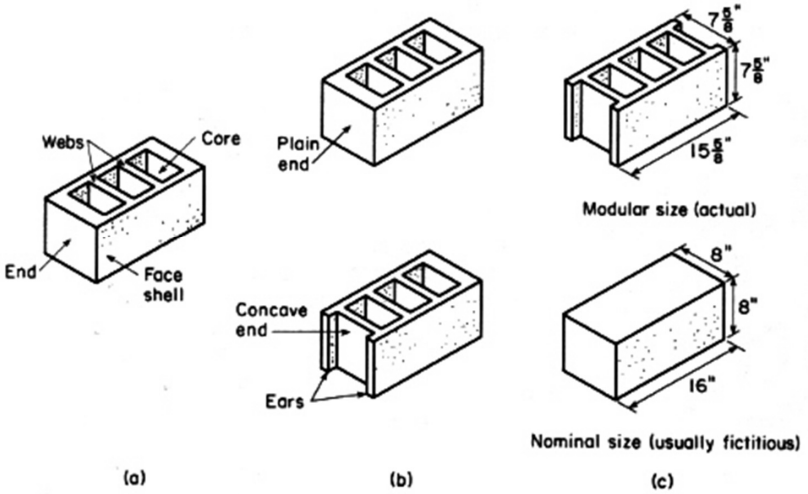


Figure 1—Nominal and Actual Unit Dimensions



Concrete Masonry Units
(CMU)

Concrete Masonry Units
(CMU)

- Cast (molds)
- Dried
- Autoclaved

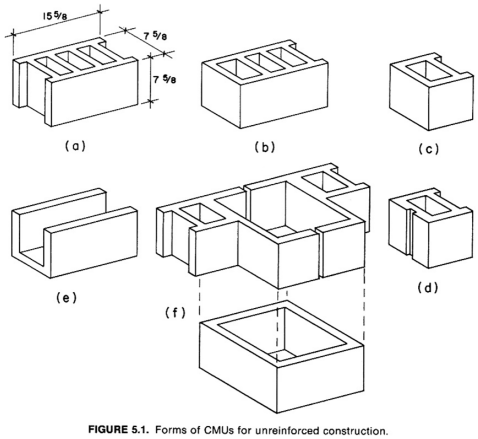
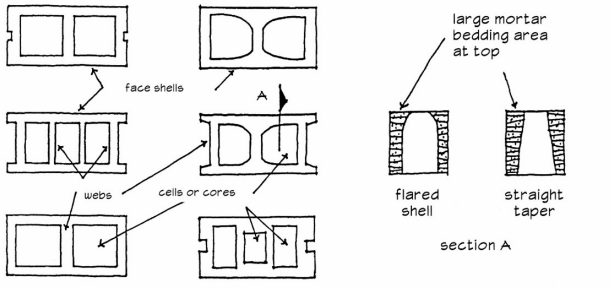
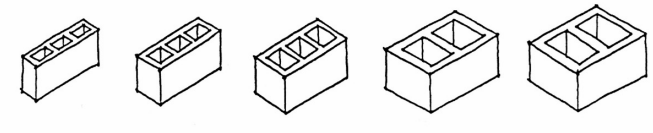


FIGURE 5.1. Forms of CMUs for unreinforced construction.

1.9.1 Standard Concrete Masonry Unit (CMU) Stretchers and Unit Coring



two-core and three-core concrete block



nominal dimensions
thickness x height x length

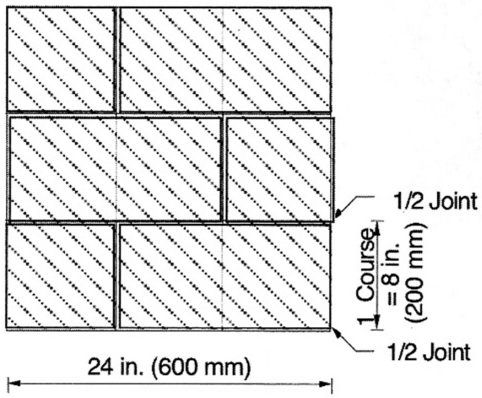
concrete block

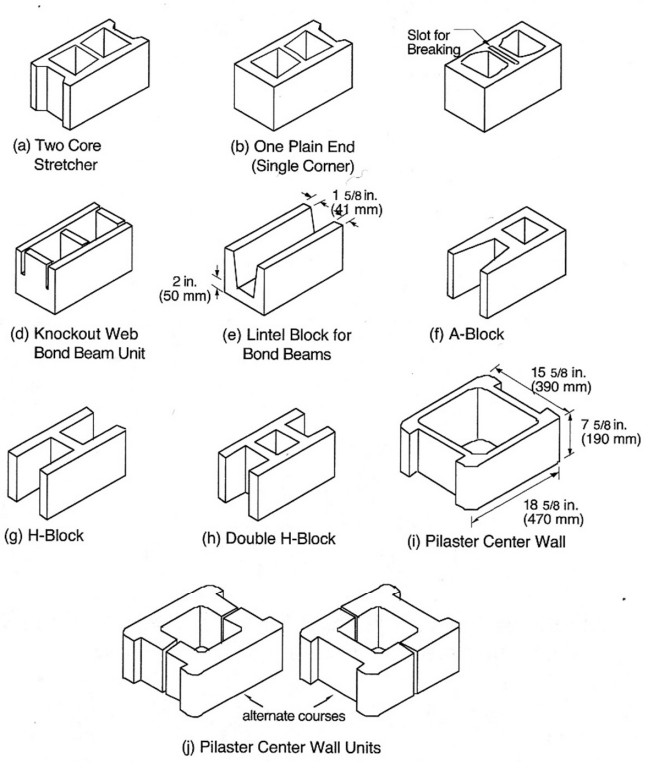
Concrete Masonry Units

Nomenclature

Sizes

- 8 inch grid
- 3/8 inch mortar joint





Note that (a) to (i) are shown in the 8 x 8 x 16 in. (200 x 200 x 400 mm) standard block size but other standard widths are available. Half block heights and other heights can be obtained.

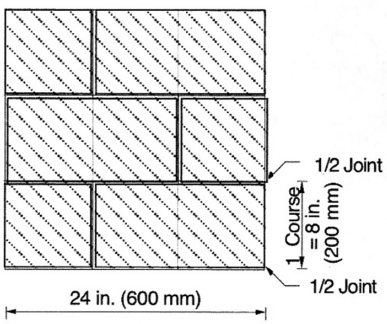
Figure 4.23 Typical concrete masonry units.

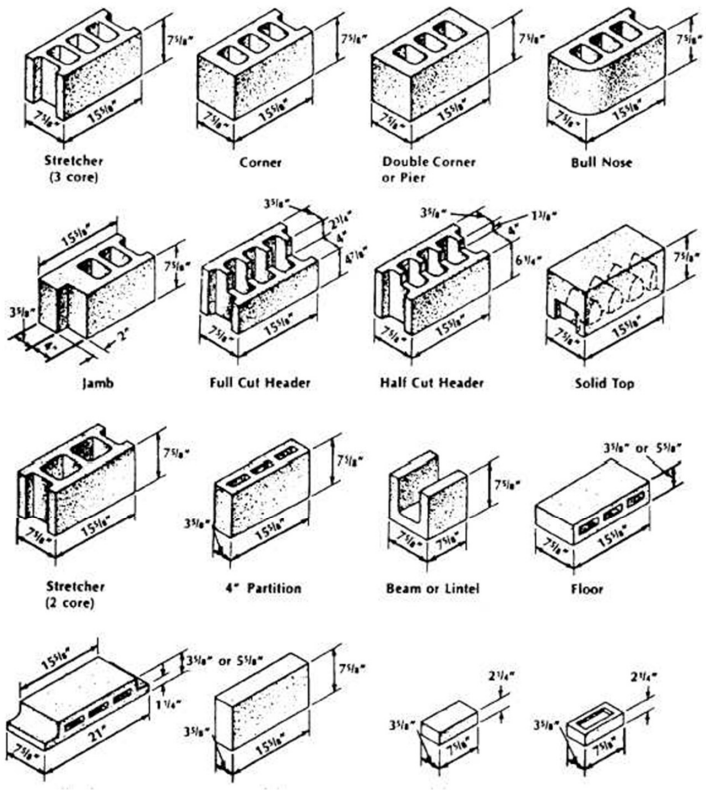
Concrete Masonry Units – CMU

Nomenclature

Sizes

- 8 inch grid
- 3/8 inch mortar joint





CMU

Nomenclature

Sizes

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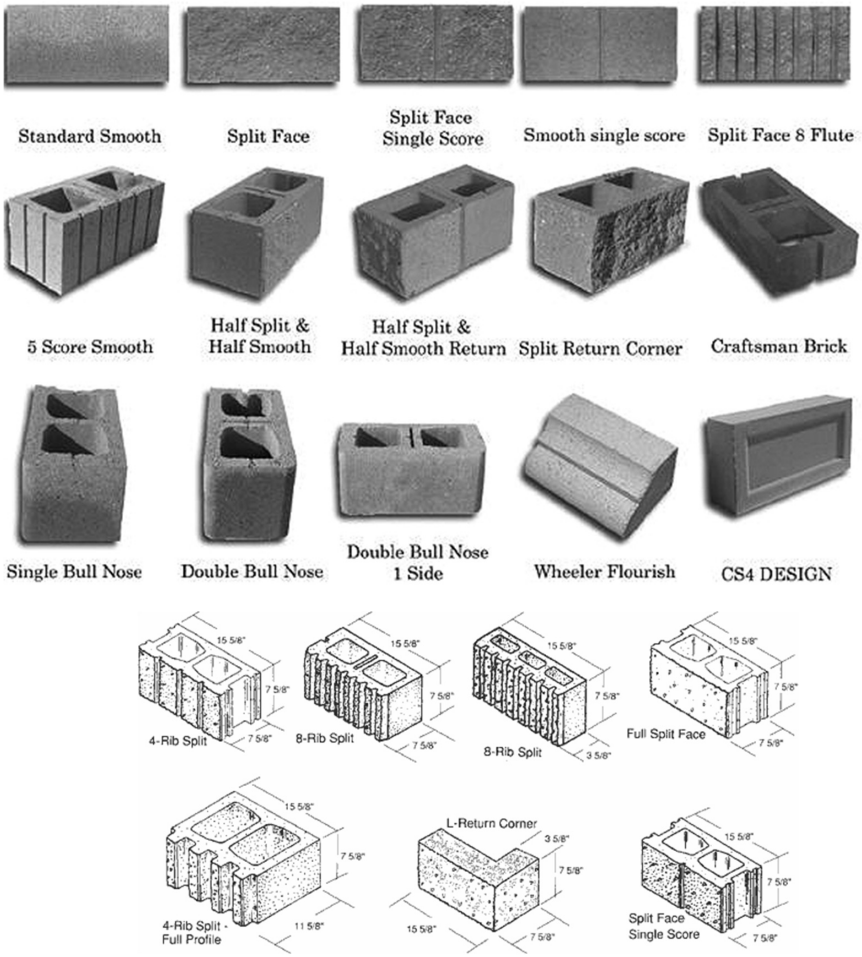
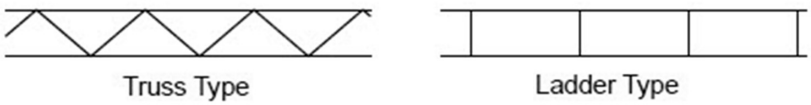
- 3/8 inch mortar joint



Concrete Masonry Units
(CMU)

- Reinforcing

Joint Reinforcing

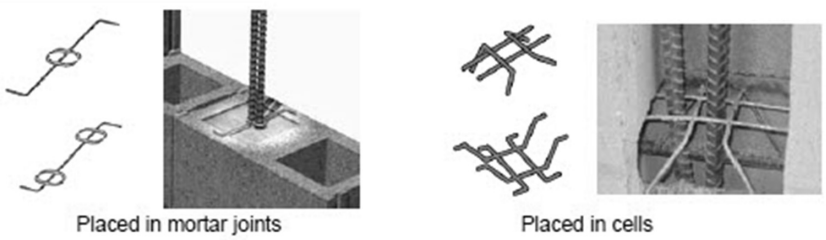


Truss Type Ladder Type

4.5 Horizontal reinforcement required for masonry not laid in running bond of $0.00028A_g$, placed at a maximum spacing of 48 in. o.c. in horizontal mortar joints or in bond beams.

$0.00028(7.625)(16) = 0.034in^2$ Use 9 gage (W1.7) at 16 in. o.c.

Rebar Positioners



Placed in mortar joints Placed in cells

Concrete Masonry Units 8

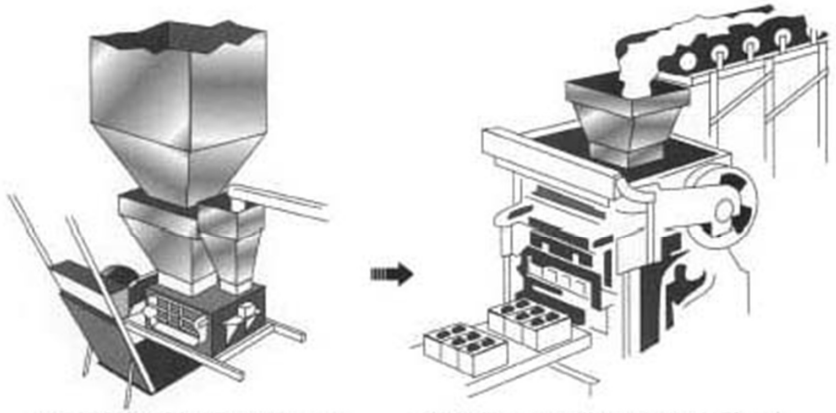
Clay Units – Manufacture

Ingredients

- Portland cement
- aggregate
- Water

- Blast furnace slag
- Fly ash

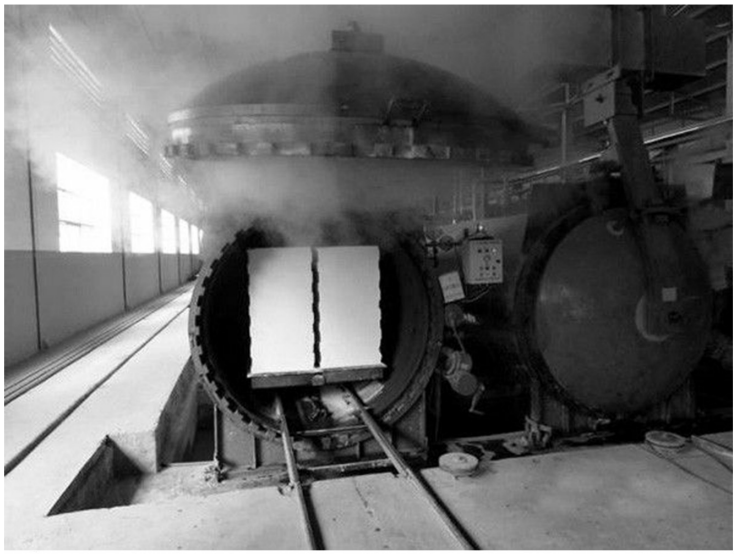
- Air entrainment
- Workability
- color



The weigh batcher is used to measure the proper amounts of each material.

The concrete comes off a conveyer and is forced into molds. The rotating brushes remove loose material.

CMU – Manufacture



Molding

- Zero slump
- Press molded
- Vibrated
- Steel molds – tapered for release
- 2000 units per hour

Curing

- Steam autoclave – 18 hrs

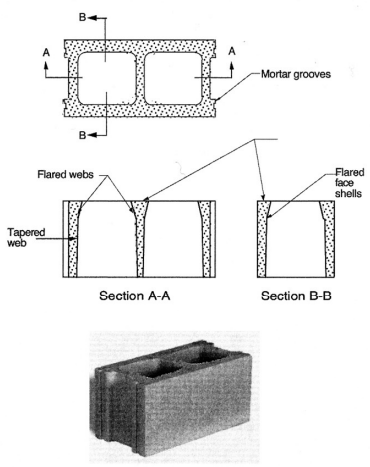


Figure 4.22 Variation in cell pattern and cell shape for a standard block. (Note the presence of taper and possible flare).

CMU – Strength

Classification
- Load bearing - CMU
- Non-loadbearing – facing
- Strength 2000 to 4000 psi

Tensile strength
- Modulus of rupture or split
- 10% to 20% of compression

Absorption lb/ft^3
- Related to durability
- And shrinkage
- 24 hour immersion
- No IRA test
- 3 unit average
- Individual

Table 4.3 Strength and Absorption Requirements for Concrete Masonry Units (ASTM C90 Standard)

Weight classification	Oven-dry density of concrete, lb/ft^3 (kg/m^3) Average of 3 units	Maximum water absorption, lb/ft^3 (kg/m^3)		Minimum net area compressive strength, psi (MPa)	
		Average of 3 units	Individual unit	Average of 3 units	Individual unit
Lightweight	Less than 105 (1,680)	18 (288)	20 (320)	2,000 (13.8)	1,800 (12.4)
Medium weight	105 to less than 125 (1,680 - 2,000)	15 (240)	17 (272)	2,000 (13.8)	1,800 (12.4)
Normal weight	125 (2,000) or more	13 (208)	15 (240)	2,000 (13.8)	1,800 (12.4)

Table 4.4 Strength and Absorption Requirements for Concrete Facing brick (ASTM C1634 Standard)

Density classification	Oven-dry density of concrete, lb/ft^3 (kg/m^3) Average of 3 units	Maximum water absorption, lb/ft^3 (kg/m^3)		Minimum net area compressive strength, psi (MPa)	
		Average of 3 units	Individual unit	Average of 3 units	Individual units
Lightweight	Less than 105 (1,680)	15 (240)	17 (272)	3,500 (24.1)	3,000 (20.7)
Medium weight	105 to less than 125 (1,680 - 2,000)	13 (208)	15 (240)	3,500 (24.1)	3,000 (20.7)
Normal weight	125 (2,000) or more	10 (160)	12 (192)	3,500 (24.1)	3,000 (20.7)

CMU – Performance

Durability
- Higher strength
- Lower absorption

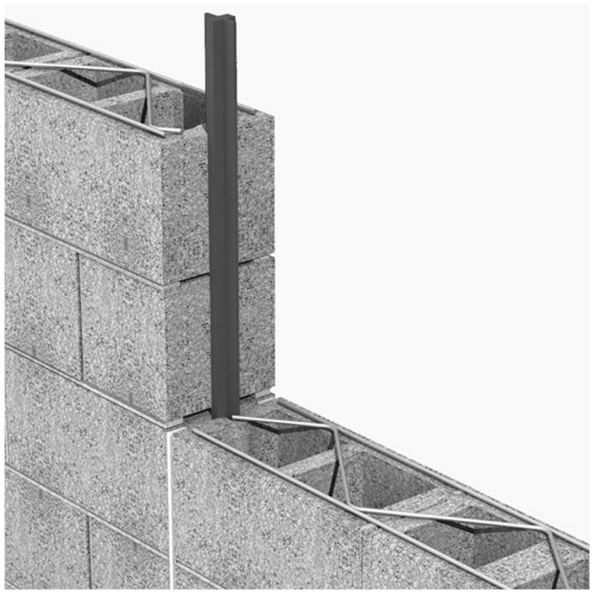
Expansion
- 5 x10^{-6} / ˚F (normal weight)
- 4 x10^{-6} / ˚F (lightweight)

Shrinkage
- Like cement
- Drying shrinkage – loss of water. Will regain if water is added, therefore usually not wet before use.
- Carbonation shrinkage – due to hydration over time – not reversible

Creep
- A bit less than concrete
- Lightweight CMU more than normal
- Mostly within the first year

Table 4.5 Typical Shrinkage of Concrete Masonry Products.

Product	Aggregate	Curing	Total Shrinkage, %
Block	Dense gravel Dense gravel Lightweight	Low pressure steam Autoclave Low pressure steam	0.02–0.05 0.01–0.04 0.04–0.08
Brick	Dense	Low pressure steam	0.02–0.05



Clay Units vs. CMU – Performance

Typical Values

Property		Clay Masonry	Concrete Masonry
Unit strength		$8000\ psi$	$2000\ psi$
Type N mortar	f'_m	$2440\ psi$	$1750\ psi$
	E_m	$1.70x10^6\ psi$	$1.58x10^6\ psi$
Type M or S mortar	f'_m	$2920\ psi$	$2000\ psi$
	E_m	$2.05x10^6\ psi$	$1.80x10^6\ psi$

Property	Clay Masonry	Concrete Masonry
Modulus of Elasticity, E_m	$700f'_m$	$900f'_m$
Shear Modulus, G	$0.4E_m$	$0.4E_m$
Coefficient of Creep	$\frac{0.7\ x10^{-7}}{psi}$	$\frac{2.5x10^{-7}}{psi}$

Calcium Silicate Units

Mainly in Europe and Australia

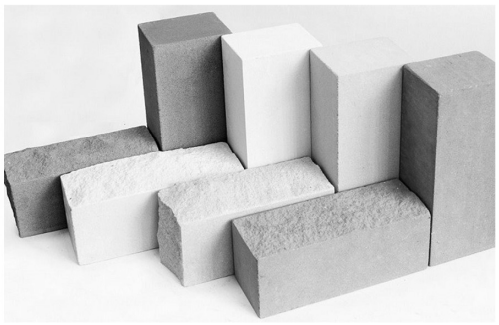
Formed and cured similar to CMU

- Mix of sand + hydrated lime
- Tightly grained
- Sizes follow bricks or other stone
- Generally 100% solid
- Compression by grade: 3500 to 8000 psi (or higher)

Table 4.6 Physical Requirements for Calcium Silicate Face Brick (from Ref. 4.34).

Brick grade	Minimum compressive strength (brick tested flatwise), psi (MPa), average gross area		Water absorption maximum, lb/ft^3 (kg/m^3)
	Average of 3	Individual	
SW	5500 (37.9)	4500 (31.0)	15 (240)
MW	3500 (24.1)	3000 (20.7)	18 (288)

Arriscraft (in US)



Natural Stone

Mainly non-loadbearing veneer

Three basic types

- Sedimentary
- Metamorphic
- Igneous

Table 4.7 Grouping, Common Names and Finishes of Building Stone (from Ref. 4.38).

Geological category	Common Name	Finishes
1. Sedimentary	Sandstone Limestone Dolomite	Smooth (machine finished by saw, grinder or planer) Machine tooled (with uniform grooves) Chat sawn (non-uniform) Shot sawn (irregular and uneven markings) Split face (concave-convex) Rock face (convex)
2. Metamorphic	Marble Serpentine Onyx Slate[1] Quartzite[1] Gneiss[2] Travertine[4]	Sanded Honed Polished Wheel abraded Bush-hammered Split face Rock face
3. Igneous	Granite Syenite Diorite[3] Gabbro Andesite Basalt	Sawn Honed Polished Machine tooled (4- or 6-cut, chiseled, axed, pointed, etc.) Flamed Sand finished Split face Rock face

[1] Slate and quartzite cannot be polished.
[2] Gneiss will take all of the finishes of marble and may also be flame finished.
[3] Diorite will not take flame finish.
[4] Travertine is actually a limestone but is classified with marbles for surface finishes. Travertine finishes include filled, partially filled, and unfilled.

Natural Stone

Mainly non-loadbearing veneer

Three basic types

- Sedimentary
- Metamorphic
- Igneous

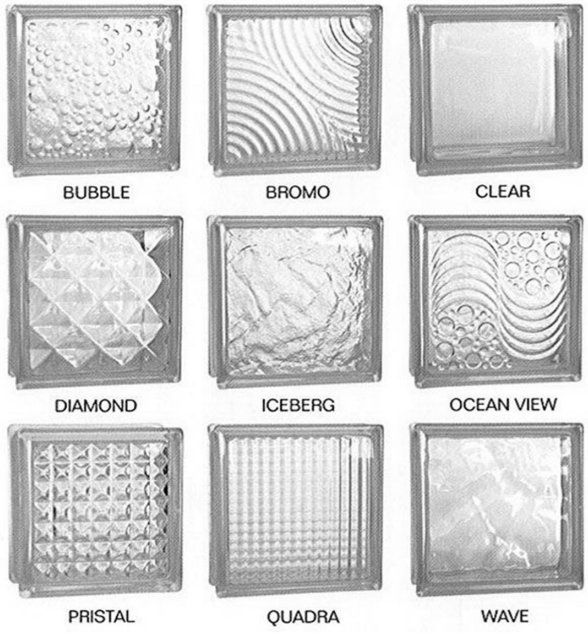
Table 4.8 Physical Requirements of Building Stone

Group of stone	Maximum absorption by weight, %	Minimum density, lb/ft^3 (kg/m^3)	Minimum compressive strength, psi (MPa)	Minimum modulus of rupture, psi (MPa)	ASTM standard
Limestone	12 7.5 3	110 (1760) 135 (2160) 160 (2560)	1800 (12) 4000 (28) 8000 (55)	400 (2.9) 500 (3.4) 1000 (6.9)	C568[4.39]
Sandstone	8 3 1	125 (2000) 150 (2400) 160 (2560)	4000 (27.6) 10000 (69) 20000 (139)	350 (2.4) 1000 (6.9) 2000(13.9)	C616[4.40]
Granite	0.4	160 (2560)	19000 (131)	1500 (10.3)	C615[4.41]
Marble	0.2	144 (2305) to 162 (2595)	7500 (52)	1000 (6.9)	C503[4.42]

Glass Block

Characteristics

- Non-loadbearing
- Interior of exterior
- Reduced UV transmission
- Natural daylighting
- Solar reflection
- Fire resistance
- Thermal insulation



Glass Block

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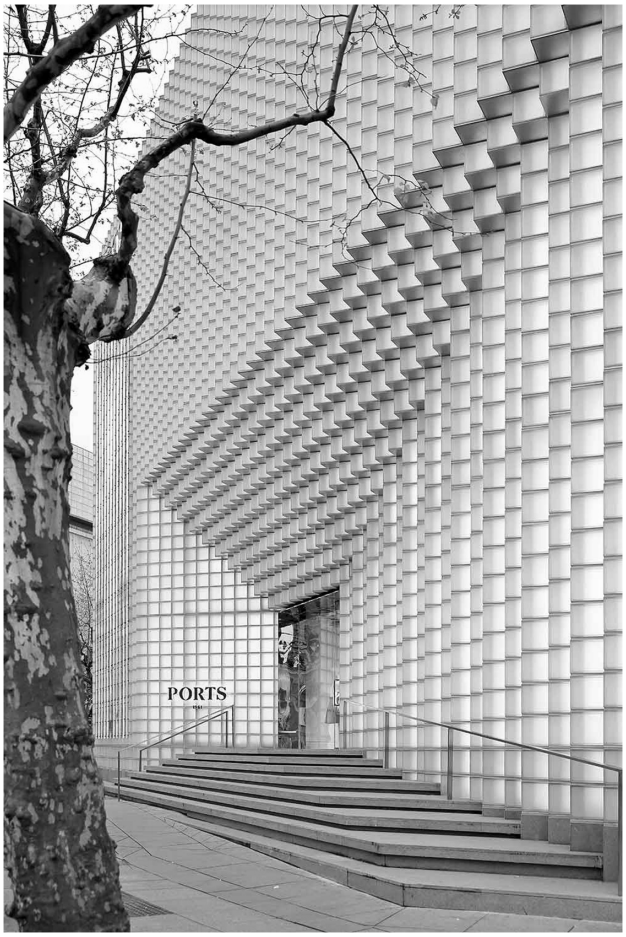
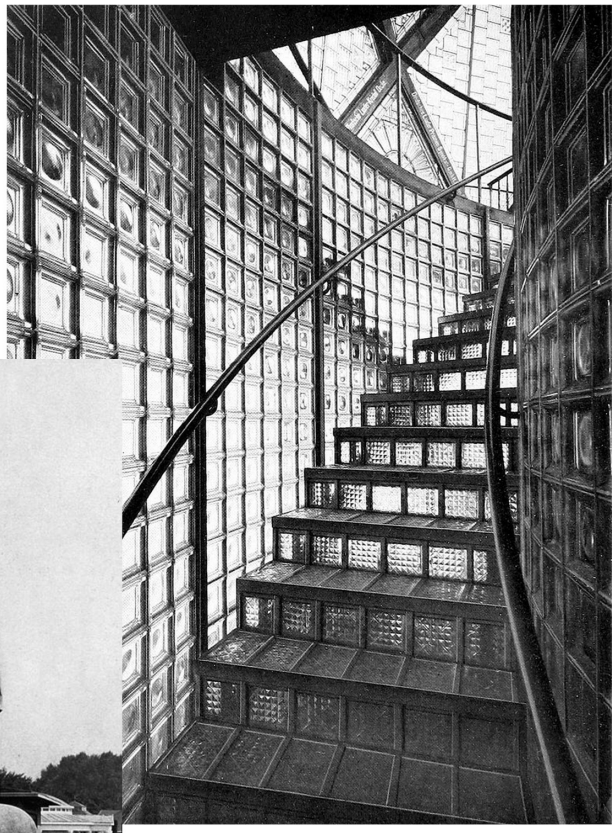
- Reduced UV transmission
- Natural daylighting
- Solar reflection
- Fire resistance
- Thermal insulation

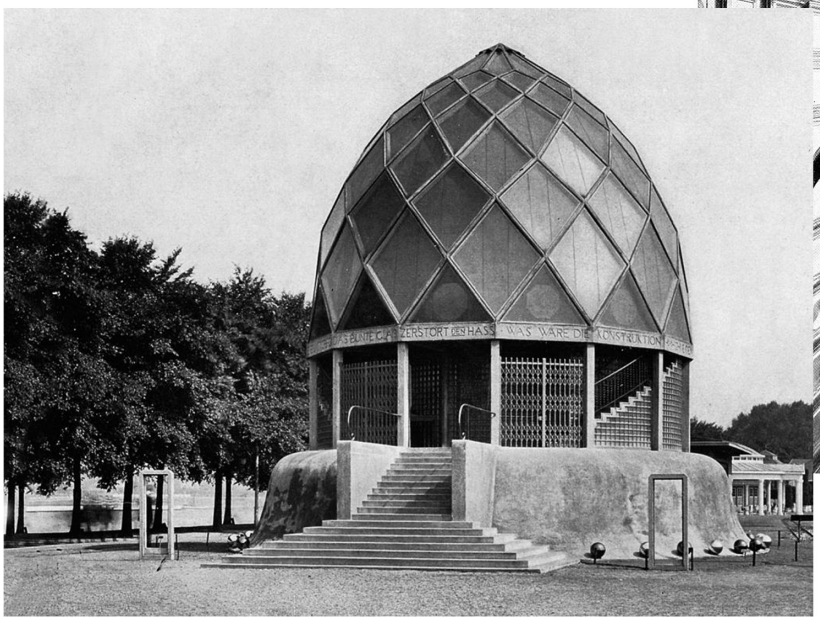
Ports – 1961 – Shanghai



Glass Block

- Bruno Taut
- Glass Pavilion
- Cologne Werkbund Exhibition
- 1914





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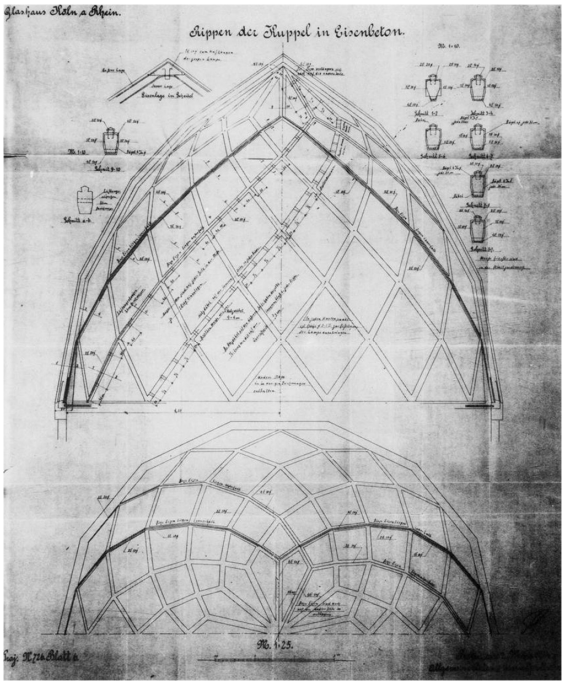
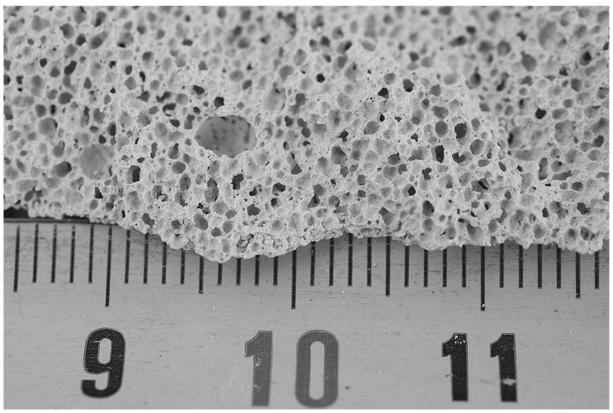


Aerated Autoclaved Concrete – AAC

Also called:
Autoclaved Cellular Concrete (ACC)
Autoclaved Lightweight Concrete (ALC)
autoclaved concrete
cellular concrete
porous concrete
Brand names:
- Aercon
- Hebel Block
- Ytong
- Aircrete
- Thermalite
- Magicrete
- BCA

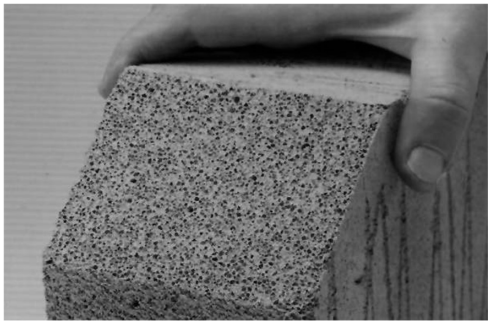


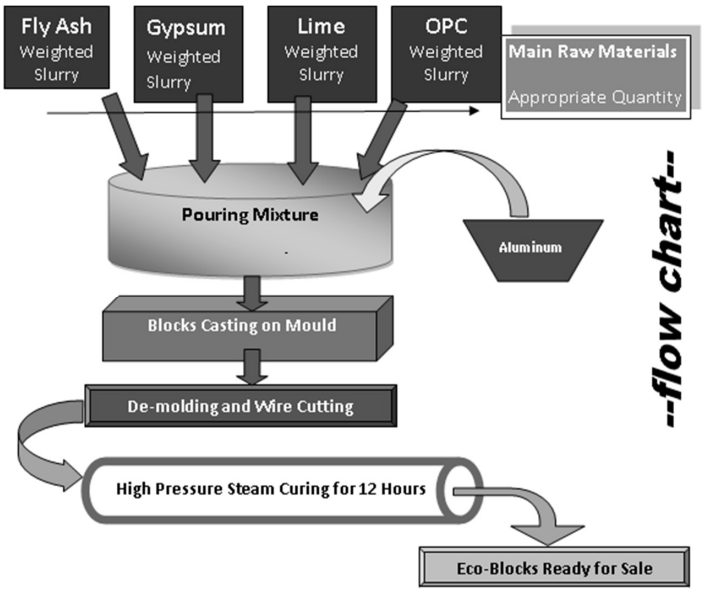
Cast and autoclaved in large slabs then cut to size
Lightweight, good thermal resistance,
transpires moisture, fireproof, sound insulation,
easily cut on site, erected as masonry

Autoclaved Aeriated Concrete
(AAC)

Used predominately in Europe
Developed by Dr. Johan Axel Eriksson in
- mid- 1920s in Sweden as "Ytong"
- since 1943, Hebel blocks in Germany
- Current largest production in China

Lighter weight
Better insulation value
Better fire resistance
Better moisture transmission
Larger blocks for faster erection
Can be shaped on site





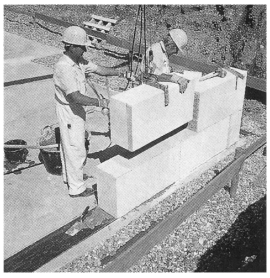
Autoclaved Aeriated Concrete
(AAC)

Density – 20 to 50 PCF (floats)

Compressive strength – 300 to 900 PSI

Allowable Shear Stress – 8 to 22 PSI

Thermal Resistance - 0.8 to 1.25 R/ IN



AAC Units

AAC Units

'Porenbeton'

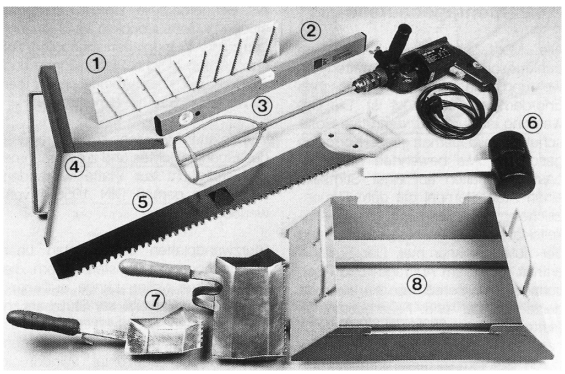
Dimensions	Standard (In)	Semi-Jumbo (In)	Jumbo (In)	O-Block (In)	U-Block (In)
Length	24	24	39-3/8	24	24
Height	8	16	24	8	8
Thickness	4 to 12	6 to 12	6 to 12	6 to 12	6 to 12
Class	AAC-2 and AAC-4				AAC-2
Thicknesses	4, 5, 6, 7, 8, 10 and 12 In				

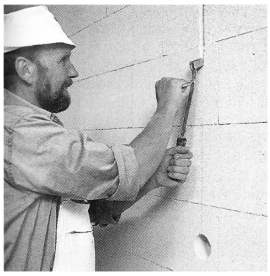
Autoclaved Aeriated Concrete
(AAC)

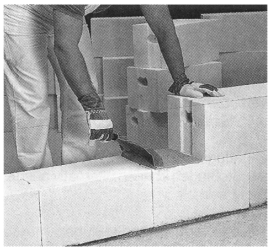
Easily shaped on site

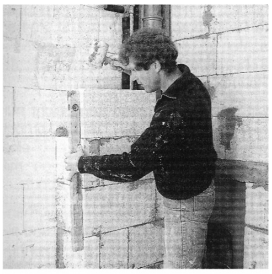
Thin mortar bed – 1/8" (1mm to 3mm)

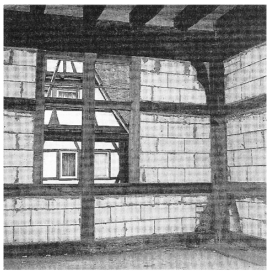
Tools for placement (below)

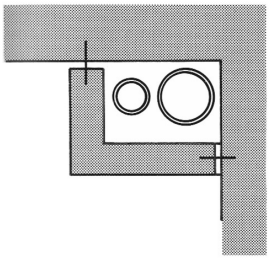








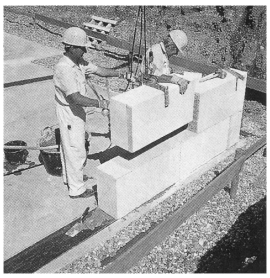


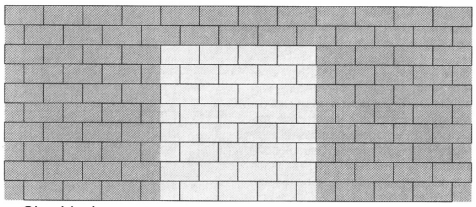


Autoclaved Aeriated Concrete
(AAC)

Larger blocks so faster layup – e.g. 8”x8”x24”

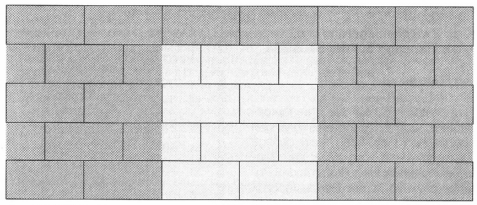
Panel layup with onsite crane





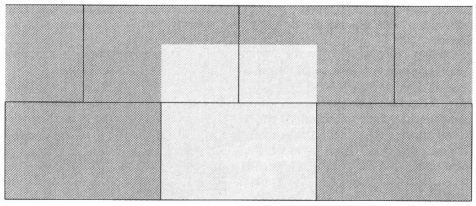
Clay block
32 blocks / m2
9.4” x 4.4”

Konventionelles Mauerwerk:
32 Steine 2 DF/3 DF für 1 m² Wand;
Steinmaß 240 mm x 113 mm x d



AAC block
8 blocks / m2
19.6” x 9.8”

Porenbeton-Plansteine:
8 Steine pro 1 m² Wand;
Steinmaß 499 mm x 249 mm x d



AAC panel
1.6 panels / m2
39.3” x 24.5”

Porenbeton-Planelemente:
1,6 Steine pro 1 m² Wand;
Steinmaß 999 mm x 623 mm x d

Autoclaved Aeriated Concrete
(AAC)

Finish with stucco

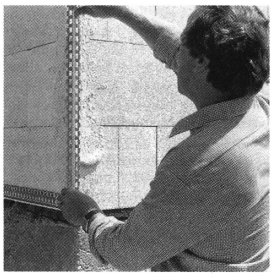


Abb. 2.4.4-1
Anbringen der Sockelabschluß- und Eckschutzschiene zur Sicherung der Mauerwerkskanten

Abb. 2.4.4-2
Auftrag des Grundputzes von Hand

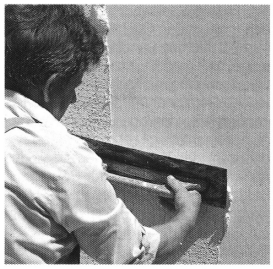


Abb. 2.4.4-3
Auftrag der Deckschicht

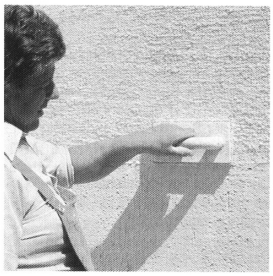


Abb. 2.4.4-4
Verreiben der Putzoberfläche mit Filzbrett oder Schwammscheibe