

STONE & CONCRETE MASONRY



MARCH 10TH, 2020

BACKGROUND



STONE MASONRY AND **CONCRETE MASONRY** ARE SIMILAR IN CONCEPT TO **BRICK MASONRY**. BOTH INVOLVE THE STACKING OF MASONRY UNITS IN THE SAME MORTAR THAT IS USED FOR BRICK MASONRY.

HOWEVER:

- WHEREAS BRICKS ARE MOLDED TO SHAPE, BUILDING STONE MUST BE WRESTED FROM QUARRIES IN ROUGH BLOCKS, THEN CUT AND CARVED TO THE SHAPES THAT WE WANT.
- WE CAN CONTROL THE PHYSICAL AND VISUAL PROPERTIES OF BRICKS TO SOME EXTENT, BUT WE CANNOT CONTROL THE PROPERTIES OF STONE.
- CONCRETE MASONRY UNITS, LIKE BRICKS, ARE MOLDED TO SHAPE AND SIZE, AND THEIR PROPERTIES CAN BE CLOSELY CONTROLLED.
- MOST CONCRETE MASONRY UNITS, HOWEVER, ARE MUCH LARGER THAN BRICKS, AND, LIKE STONE, THEY REQUIRE SLIGHTLY DIFFERENT TECHNIQUES FOR LAYING.

STONE CLASSIFICATIONS



IGNEOUS



METAMORPHIC

THREE TYPES:

- **IGNEOUS ROCK** IS ROCK THAT WAS DEPOSITED IN A MOLTEN STATE
- **SEDIMENTARY ROCK** IS ROCK THAT WAS DEPOSITED BY THE ACTION OF WATER AND WIND
- **METAMORPHIC ROCK** WAS FORMERLY EITHER IGNEOUS OR SEDIMENTARY ROCK. SUBSEQUENTLY, ITS PROPERTIES WERE TRANSFORMED BY HEAT AND PRESSURE



SEDIMENTARY

ASTM GROUPS



ASTM C119 (AMERICAN SOCIETY FOR TESTING AND MATERIALS) BREAKS DOWN DIMENSIONED STONE USED FOR CONSTRUCTION PURPOSES INTO 6 GROUPS:

- GRANITE
- LIMESTONE
- QUARTZ BASED
- SLATE
- MARBLE
- OTHER

GRANITE GROUP



GRANITE COUNTER TOP

GRANITE:

MOST COMMON IGNEOUS ROCK IN AMERICA. NON-POROUS, HARD, STRONG, DURABLE. WEATHER RESISTANT. MANY COLORS

BASALT:

ALSO DENSE AND DURABLE. USUALLY ONLY DARK GREY COLOR. MOSTLY USED AS RUBBLE. "BLACK GRANITE"



BASALT

LIMESTONE GROUP



CHOPPED LIMESTONE

LIMESTONE:

ONE OF TWO PRINCIPLE SEDIMENTARY ROCKS USED IN CONSTRUCTION

- FORMED LONG AGO FROM SKELETONS AND SHELLS OF MARINE ANIMALS
- COLORS – WHITE TO GREY, BUFF TO REDDISH
- POROUS AND SATURATED WITH QUARRY SAP (GROUNDWATER) WHEN EXCAVATED, EASY TO WORK. AFTER SEASONING (AIR DRYING), QUARRY SAP EVAPORATES AND STONE BECOMES MUCH HARDER AND FROST RESISTANT.
- DENSE LIMESTONES CAN BE POLISHED (SOMETIMES REFERRED TO AS MARBLES) BUT MOST TYPICALLY HAVE A SURFACE TEXTURE
- 3 CLASSIFICATIONS
 - CLASS I LOW DENSITY
 - CLASS II MEDIUM DENSITY
 - CLASS III HIGH DENSITY
 - ALL 3 SUITABLE FOR USE IN BUILDING

QUARTZ BASED GROUP



BROWNSTONE



BLUESTONE

SANDSTONE:

THE SECOND PRINCIPLE SEDIMENTARY ROCK USED IN CONSTRUCTION

- FORMED FROM ANCIENT QUARTZ AND SAND DEPOSITS
- COLOR VARIES SIGNIFICANTLY BASED ON MATERIAL THAT CEMENTS SAND
- TWO FAMILIAR FORMS
 - BROWNSTONE – WALL CONSTRUCTION
 - BLUESTONE – PAVING AND WALL COPINGS
- PRIMARILY FOUND IN NORTHEAST US
- WILL NOT ACCEPT A POLISHED FINISH

SLATE GROUP



SLATE ROOF

SLATE:

ONE OF TWO METAMORPHIC ROCKS USED IN CONSTRUCTION

- FORMED FROM CLAY
- DENSE, HARD, WITH PLANES OF CLEAVAGE WHICH EASILY SPLITS INTO SHEETS
- USEFUL FOR PAVING, SHINGLES, AND THIN WALL SHEETS
- COMES IN A VARIETY OF COLORS

MARBLE GROUP



MARBLE WALLS

MARBLE:

SECOND METAMORPHIC ROCK USED IN CONSTRUCTION

- RECRYSTALLIZED FORM OF LIMESTONE
- EASILY CARVED AND POLISHED
- COMES IN NEARLY EVERY COLOR AND OFTEN HAS PATTERNS OF VEINING
- PROPERTIES OF MARBLE VARY GREATLY DEPENDING ON THE ORIGINAL LIMESTONE IT CAME FROM, AND THE PROCESS BY WHICH IT WAS METAMORPHOSED
- FOUR STEP GRADING SYSTEM
 - GROUP A – UNIFORM AND FAVORABLE WORKING QUALITIES
 - GROUP B – LESS FAVORABLE WORKING QUALITIES, AND MAY HAVE SOME NATURAL FAULTS THAT REQUIRE STICKING AND WAXING
 - GROUP C – FURTHER VARIATIONS IN WORKING QUALITIES, AND POTENTIALLY MORE FLAWS WHICH REQUIRE ADDITIONAL WORKING
 - GROUP D – MAXIMUM VARIATION IN WORKING QUALITIES, AND HIGHEST NATURAL FLAWS. (MANY OF THE MOST PRIZED AND COLORFUL MARBLES BELONG IN GROUP D)

OTHER “MARBLE” THAT BELONG IN THIS GROUP INCLUDE LIMESTONE MARBLE, ONYX MARBLE, AND SERPENTINE MARBLE AMONG OTHERS, AND ARE NOT TRUE MARBLES

OTHER GROUP



TRAVERTINE FLOOR

INCLUDES:

- TRAVERTINE
- ALABASTER
- GREENSTONE
- SCHIST
- SERPENTINE
- SOAPSTONE



SOAPSTONE COUNTER

QUARRYING AND MILLING OF STONE



FIELDSTONE



RUBBLE



FLAGSTONE

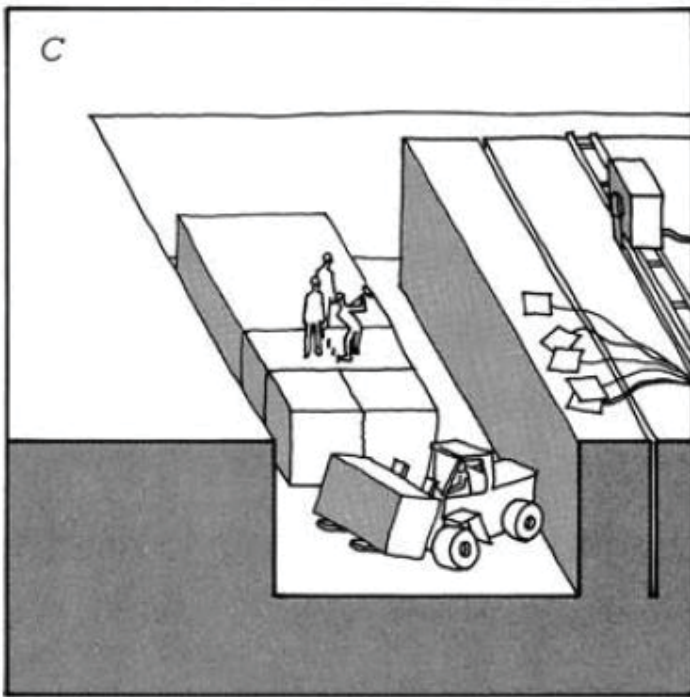
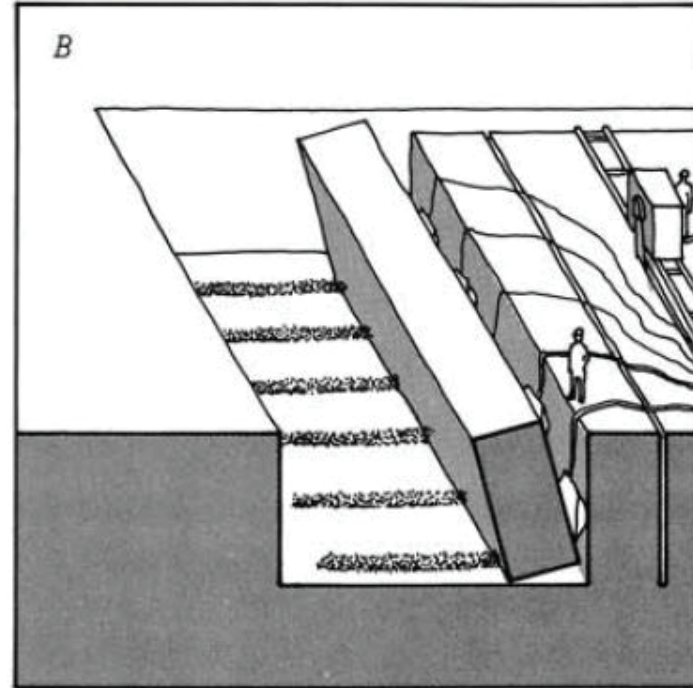
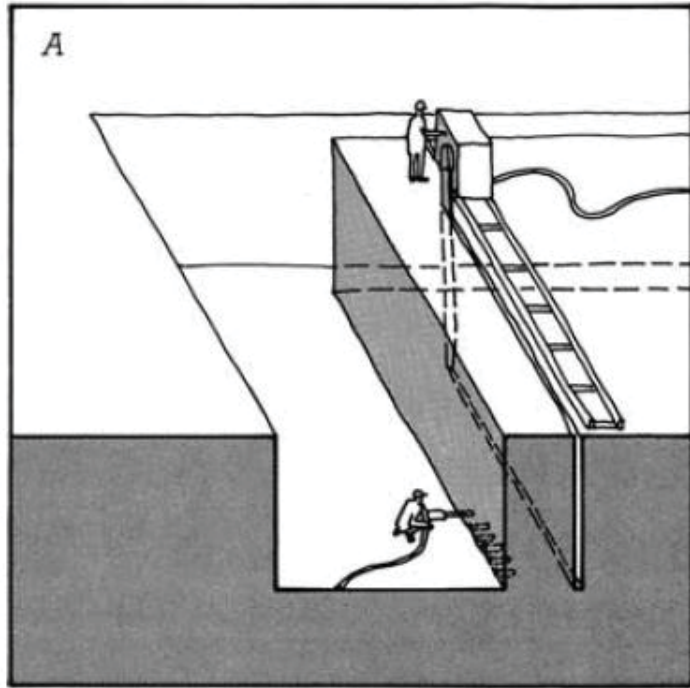


CRUSHED STONE

STONE FORMS:

- FIELDSTONE – ROUGH BUILDING STONE FOUND IN RIVERBEDS AND FIELDS. NO CUTTING.
- RUBBLE – IRREGULAR QUARRIED STONES THAT HAVE AT LEAST ONE GOOD FACE TO EXPOSE IN A WALL
- DIMENSION STONE – SEE LIST ABOVE. THESE ARE QUARRIED AND CUT TO SET DIMENSIONS.
- FLAGSTONE – THINS SLABS USEFUL FOR PAVING AND FLOORING
- CRUSHED STONE – USEFUL FOR DRAINAGE FILL OR AGGREGATE IN CONCRETE

QUARRYING AND MILLING OF STONE



HOW QUARRYING WORKS:

CRUSHED STONE (FOR ROADS):

[HTTPS://WWW.YOUTUBE.COM/WATCH?V=SWGALIKMPFC](https://www.youtube.com/watch?v=SWGALIKMPFC)

GIANT CHAINSAW (MARBLE):

[HTTPS://WWW.YOUTUBE.COM/WATCH?V=BSNSLRESF7Y](https://www.youtube.com/watch?v=BSNSLRESF7Y)

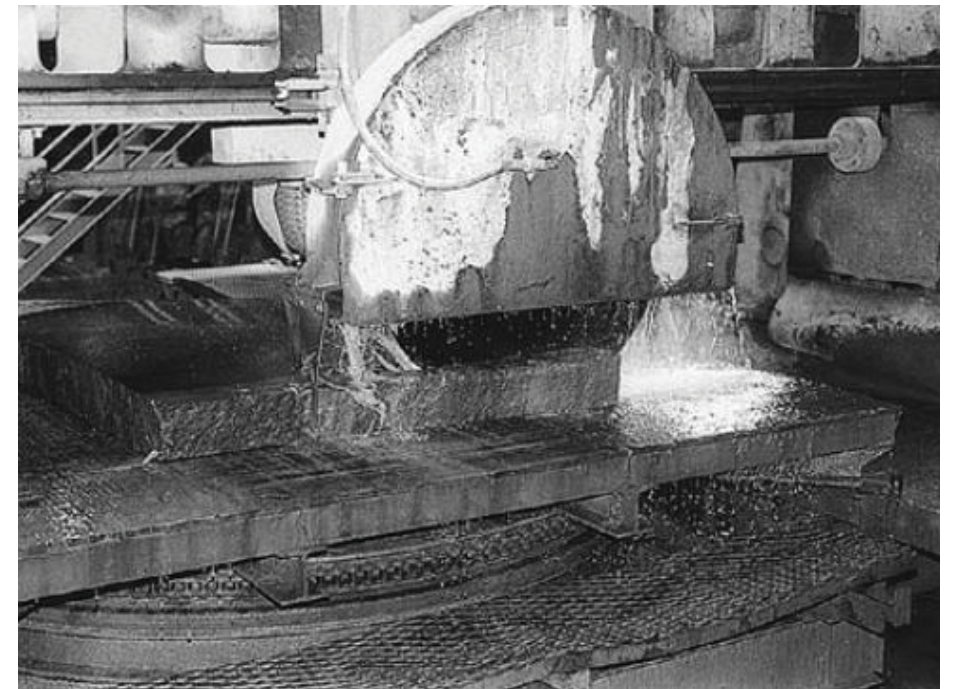
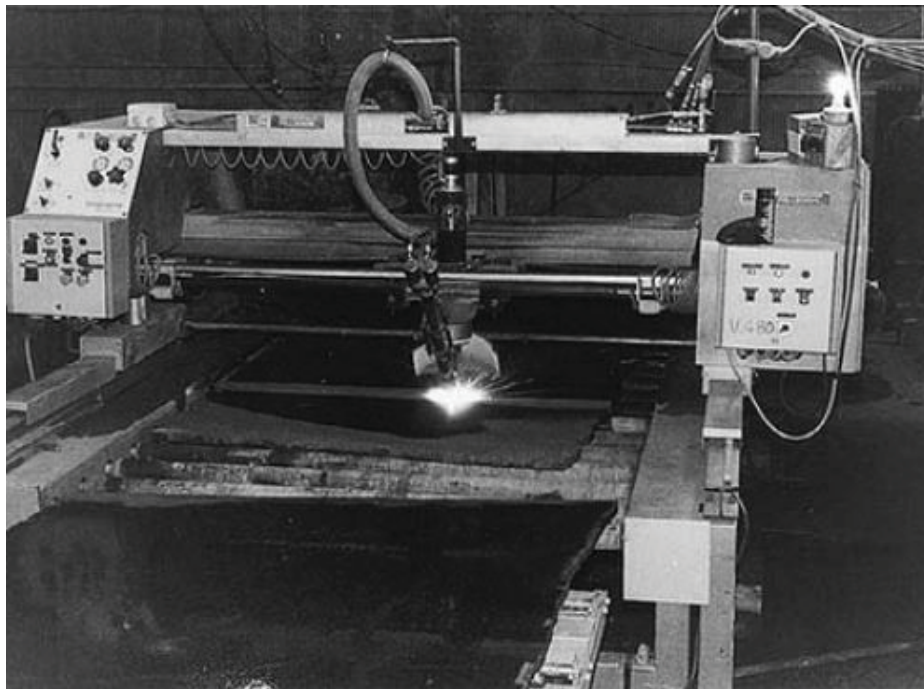
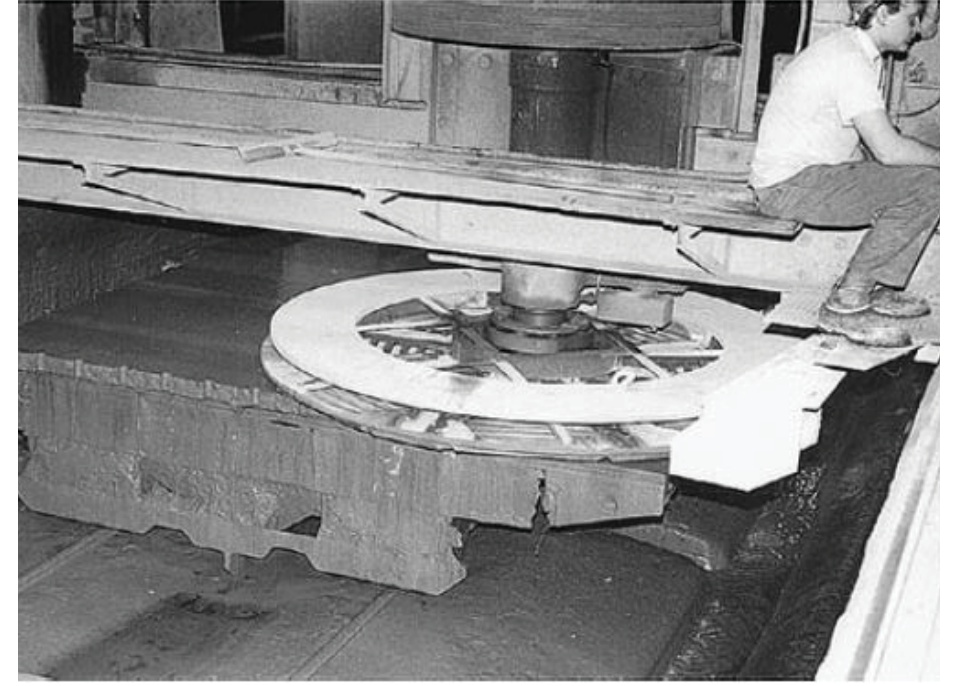
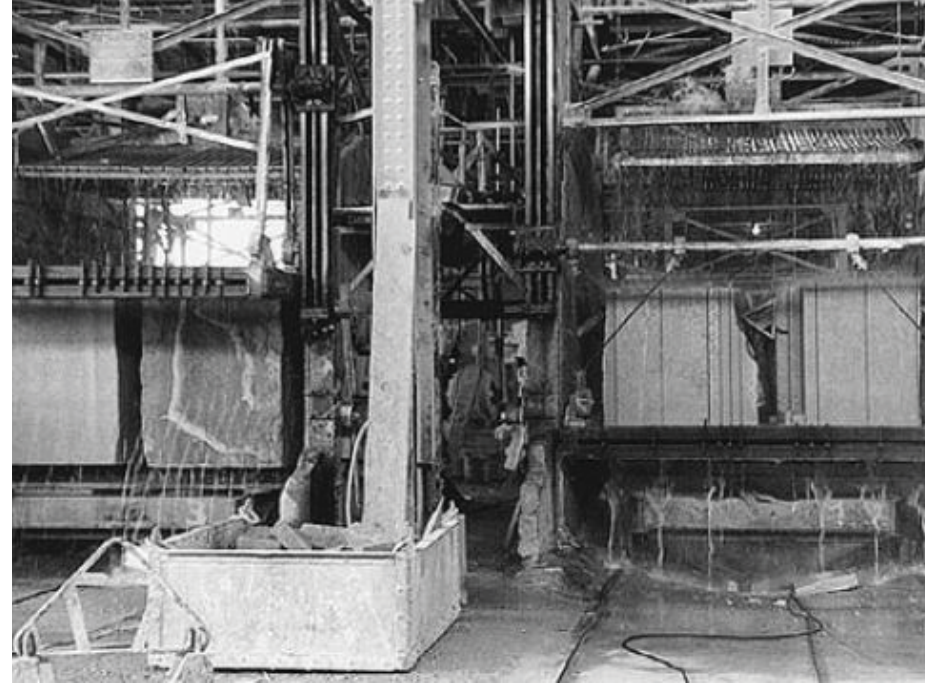
GRANITE SLAB PROCESS:

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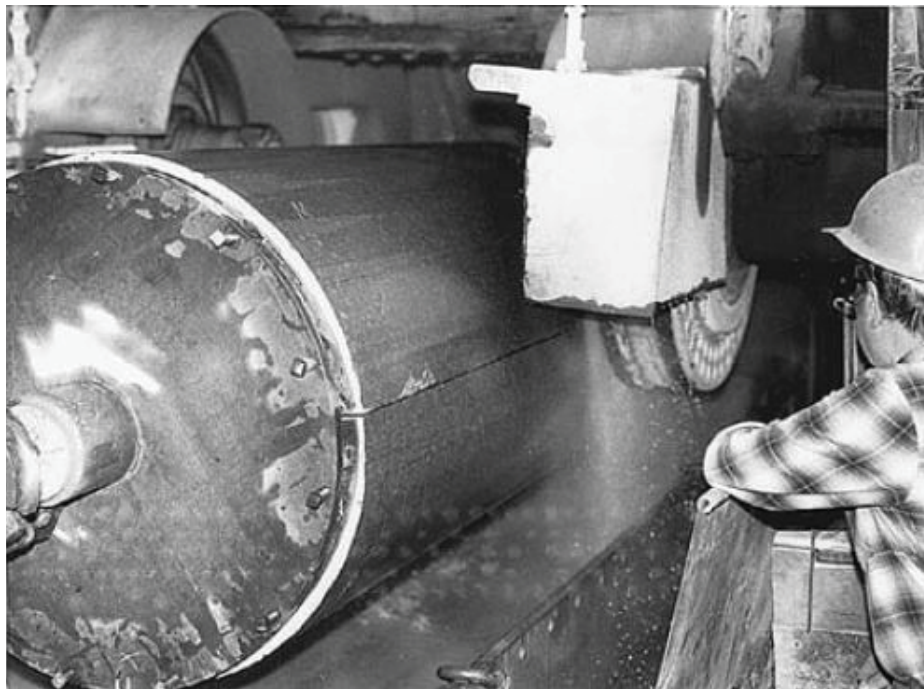
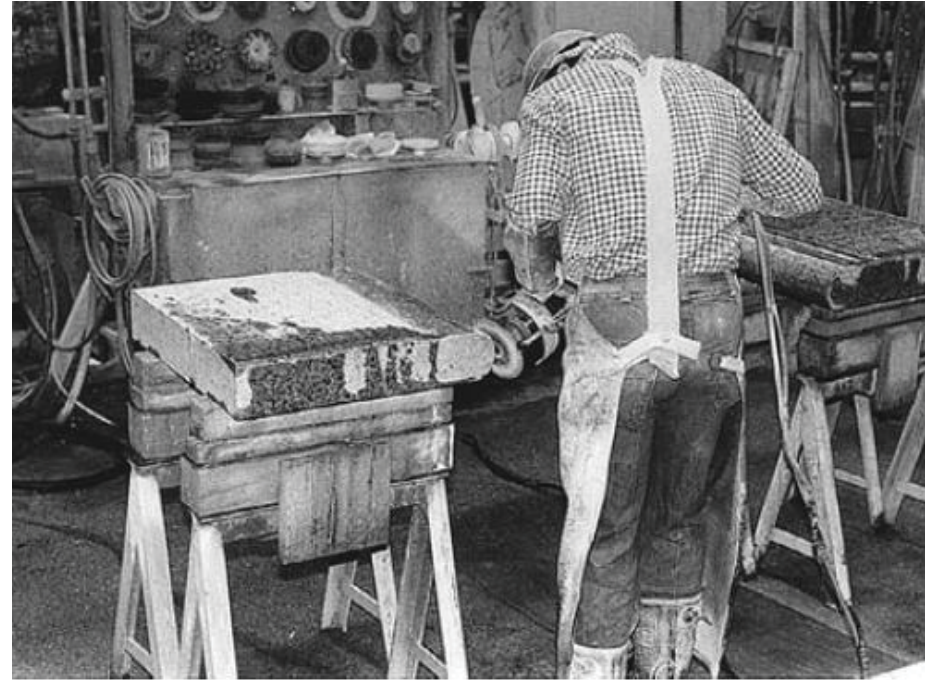
ITALIAN MARBLE (DIAMOND WIRE):

[HTTPS://WWW.YOUTUBE.COM/WATCH?V=_PCOPVYB7EQ](https://www.youtube.com/watch?v=_PCOPVYB7EQ)

QUARRYING AND MILLING OF STONE



QUARRYING AND MILLING OF STONE



QUARRYING AND MILLING OF STONE



RESULTS:

THIS 9-TON CORINTHIAN COLUMN CAPITAL WAS CARVED FROM A SINGLE 30-TON BLOCK OF INDIANA LIMESTONE.

ROUGH CUTTING TOOK 400 HOURS AND CARVING ANOTHER 500.

EIGHT OF THESE CAPITALS WERE MANUFACTURED FOR A NEW PORTICO ON AN EXISTING CHURCH.

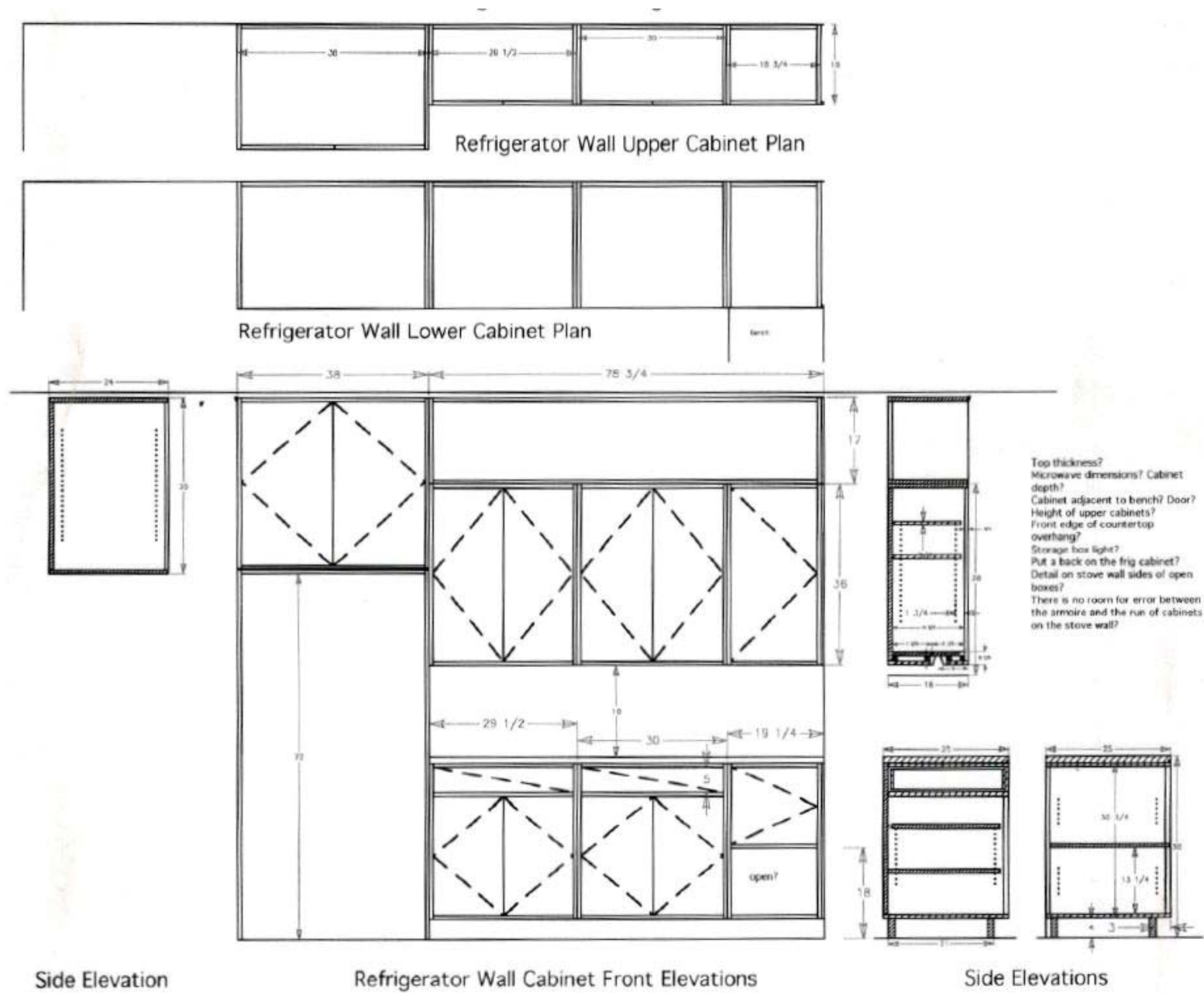
900 HOURS EACH X 8 = **7,200 HOURS**

30 TONS X 8 = **240 TONS OF RAW MATERIAL** (168 TONS OF WASTE)

QUARRYING AND MILLING OF STONE

SHOP DRAWINGS:

WHEN PREPARING STONE FOR A BUILDING, THE PRODUCER MUST CREATE SHOP DRAWINGS BASED ON THE ARCHITECT'S DRAWINGS FOR APPROVAL. ONCE APPROVED, THE STONES CAN BE CUT DOWN TO SHAPE AND LABELLED FOR INSTALLATION ON SITE



SHOP DRAWINGS

SELECTING STONE FOR BUILDING



NOT REAL MARBLE!!!!

CAN BE COMPLICATED

- NOT ALL COMMON NAMES REFER TO THE ACTUAL GEOLOGIC PROPERTIES. JUST BECAUSE SOMETHING IS CALLED “MARBLE” DOESN'T NECESSARILY MEAN IT'S REAL MARBLE
- NAMES CAN VARY FROM COUNTRY TO COUNTRY, REGION TO REGION, OR EVEN WITHIN REGIONS
- THE SOURCE OF THE STONE WILL IMPACT THE PROPERTIES OF THE STONE. STONES FROM UNKNOWN SOURCES SHOULD BE TESTED TO ENSURE THE STONE WILL PERFORM AS REQUIRED.
- STONE IS INTERNATIONAL. SOME OF THE SOURCES OF STONE ARE NOT EQUIPPED TO PROCESS IT TO CERTAIN STANDARDS. THIS RESULTS IN SHIPPING STONES AROUND A LOT. HOWEVER, WITH A GREATER AWARENESS AND DEMAND FOR SUSTAINABLE DESIGN, MORE OF AN EMPHASIS IS BEING PUT ON USING LOCAL QUARRIES AND MILLS

STONE MASONRY



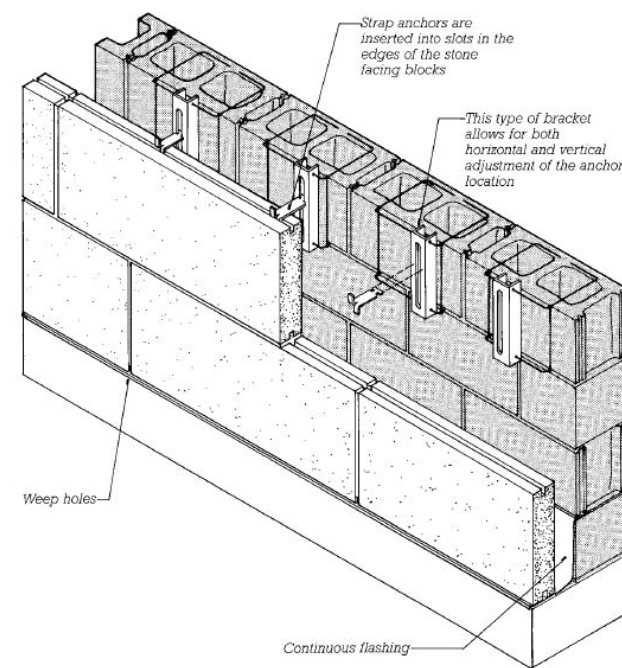
STONE MASONRY

PRIMARY STONE USES:

STONE MASONRY – LAID AND STACKED IN MORTAR, SIMILAR TO BRICK OR CMU

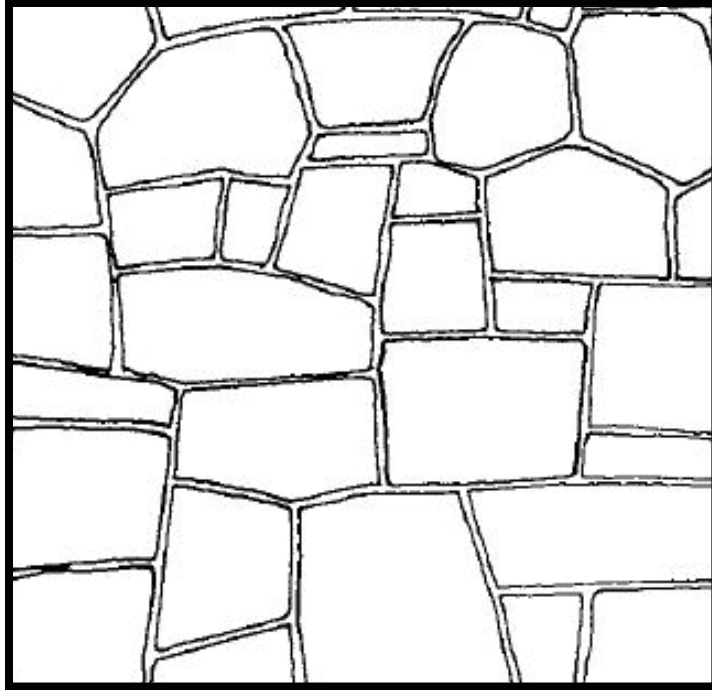
STONE CLADDING – MECHANICALLY ATTACHED TO STRUCTURAL FRAME OR WALLS AS A FACING

THIS CHAPTER FOCUSES ON MASONRY ONLY, NOT CLADDING

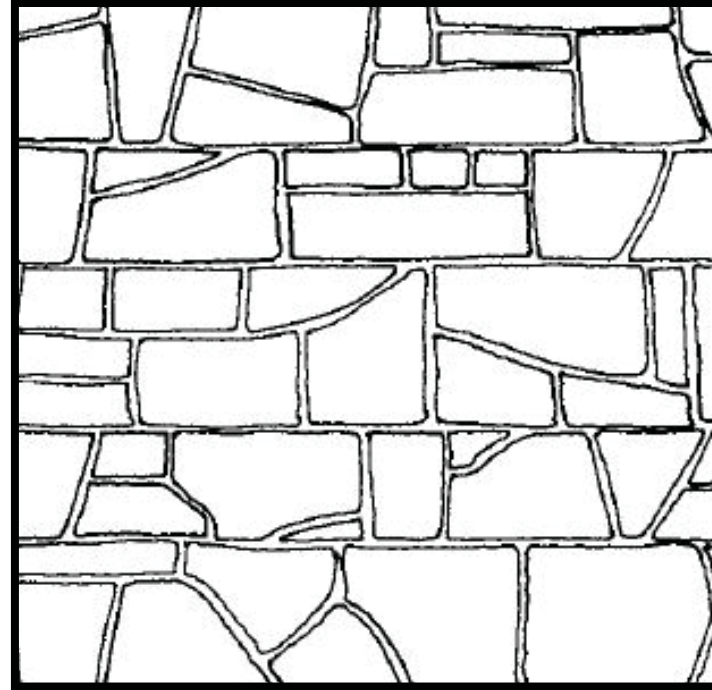


STONE CLADDING

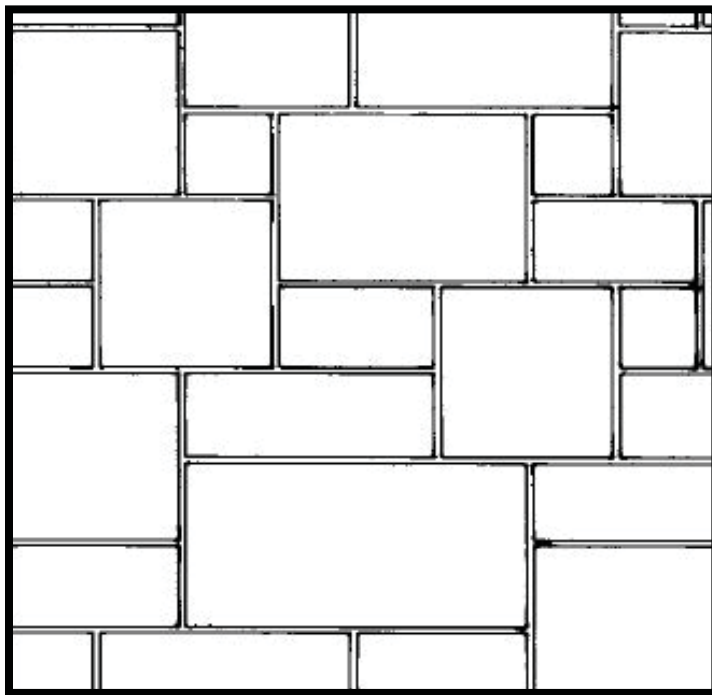
STONE MASONRY



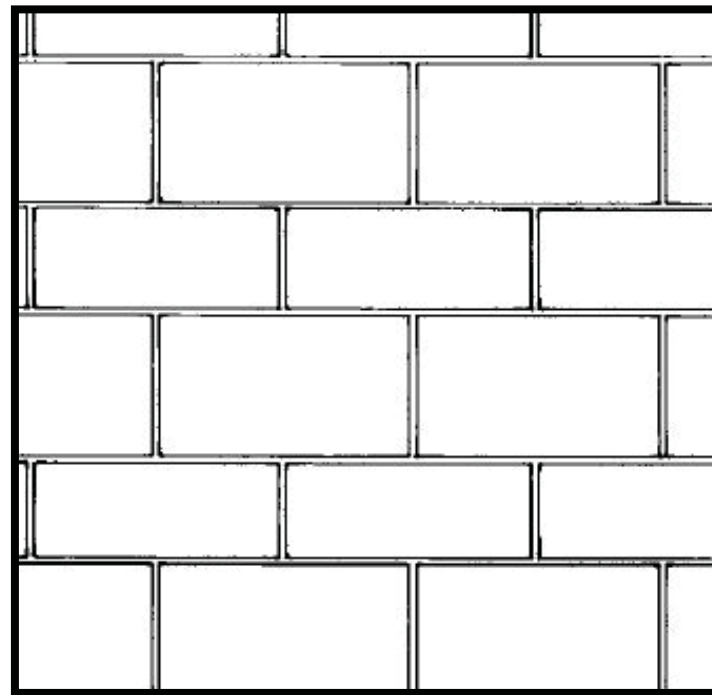
RUBBLE - RANDOM



RUBBLE - COURSED



ASHLAR - RANDOM



ASHLAR - COURSED

DISTINCTIONS / CLASSIFYING PATTERNS:

RUBBLE MASONRY

- USES UNSQUARED STONES
- CAN BE COURSED OR UNCOURSED
- LAID BY HAND SIMILAR TO BRICK

ASHLAR MASONRY

- USES SQUARED OFF STONES
- CAN BE COURSED OR UNCOURSED
- OFTEN THE STONES ARE TOO LARGE TO BE LIFTED BY HAND SO HOISTING EQUIPMENT IS REQUIRED
- VIDEO: [HTTPS://WWW.YOUTUBE.COM/WATCH?V=5TXy02COVSO](https://www.youtube.com/watch?v=5TXy02COVSO)

COURSED STONE MASONRY

- USES STRAIGHT HORIZONTAL JOINT LINES

RANDOM STONE MASONRY

- NO STRAIGHT JOINT LINES

STONE MASONRY



OTHER QUALITIES TO CONSIDER:

- “QUARRY BED” OR GRAIN SHOULD RUN HORIZONTAL BECAUSE THE STONE IS STRONGER / MORE WEATHER RESISTANT IN THIS DIRECTION
- STONE MASONRY IS OFTEN COMBINED WITH CMU FOR COST SAVINGS, QUICKER INSTALL, AND EASIER STRUCTURAL REINFORCEMENT
- POINTING MORTAR JOINTS CREATES GOOD WEATHER SEAL AT THE FACE OF THE STONE AND ALLOWS FOR COLORING TO MATCH OR COMPLIMENT THE STONE
- SOME STONES DETERIORATE IN ACIDS, SO SOME ENVIRONMENTS ARE NOT CONDUCIVE TO STONE INSTALL, AND CERTAIN CLEANERS SHOULD NOT BE USED ON STONE
- WHILE ALMOST EVERY CULTURE USES STONE, THE REGIONAL VARIATIONS HAVE DEVELOPED IN LARGE PART BECAUSE OF THE STONES AVAILABLE

STONE MASONRY

SUSTAINABILITY:

- STONE IS PLENTIFUL BUT FINITE
- QUARRYING STONE IS DISRUPTIVE TO THE IMMEDIATE VEGETATION AND WILDLIFE
- HABITAT RESTORATION CAN MITIGATE SOME OF THESE IMPACTS
- CAN USE RECYCLED MATERIALS IN CONCRETE FOR CMU
- STONE IS HEAVY AND DIFFICULT TO TRANSPORT
- THE CLOSER TO THE PROJECT THE BETTER
- FABRICATION USES LOTS OF WATER
- WATER FILTRATION AND RECYCLING CAN REDUCE WATER USE AND MINIMIZE POLLUTION TO WATER SYSTEMS
- A LOT OF STONE IS DISCARDED DURING QUARRYING AND FABRICATION
- RECYCLING THAT AS CRUSHED STONE FILL OR AGGREGATE CAN REDUCE OVERALL WASTE
- EMBODIED ENERGY OF STONE SHOULD BE CONSIDERED
- ON SITE WASTE OFTEN ENDS UP IN LANDFILLS, AND SHOULD BE REDUCED AS MUCH AS POSSIBLE
- THERMAL MASS POTENTIAL FOR HEATING AND COOLING STRATEGIES
- NONCOMBUSTIBLE, SO CAN BE USED FOR FIRE SEPARATIONS
- CONCRETE MASONRY HAS HIGHER THERMAL RESISTANCE THAN BRICK
- MOISTURE AND MOLD RESISTANT, AND REQUIRE VERY LITTLE MAINTENANCE
- CAN BE SALVAGED OR RECYCLED WHEN BUILDING IS DEMOLISHED
- PERMEABLE PAVERS ALLOW WATER TO RUN THROUGH AND REPLENISH GROUND WATER
- INTERLOCKING UNITS CAN BE EASILY DISASSEMBLED AND REUSED

CONCRETE MASONRY



SOLID BRICKS



HOLLOW

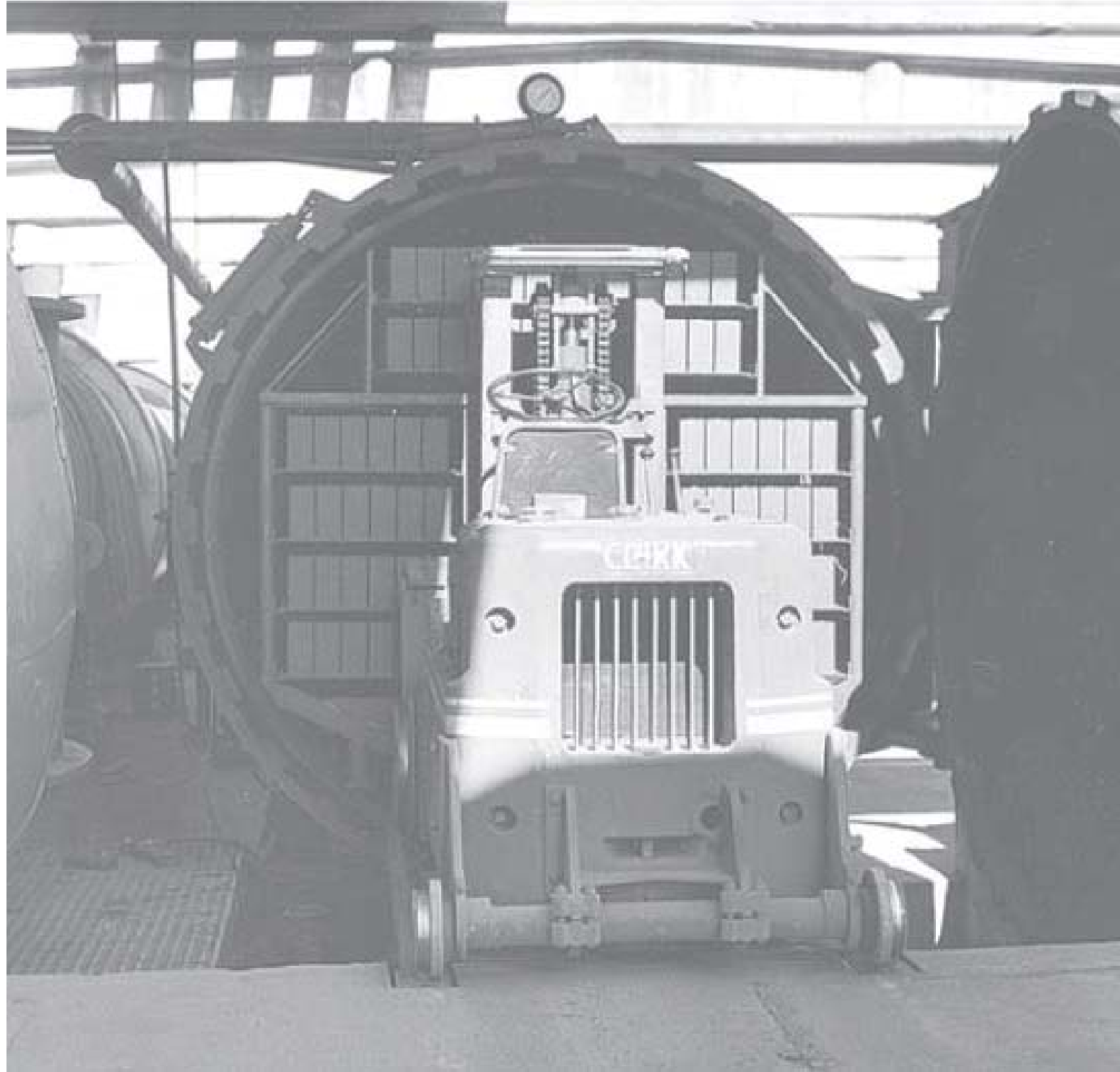
THREE BASIC FORMS:

- SOLID BRICKS
- HOLLOW CONCRETE BLOCKS
- LARGE SCALE SOLID BLOCKS



LARGE SCALE SOLID

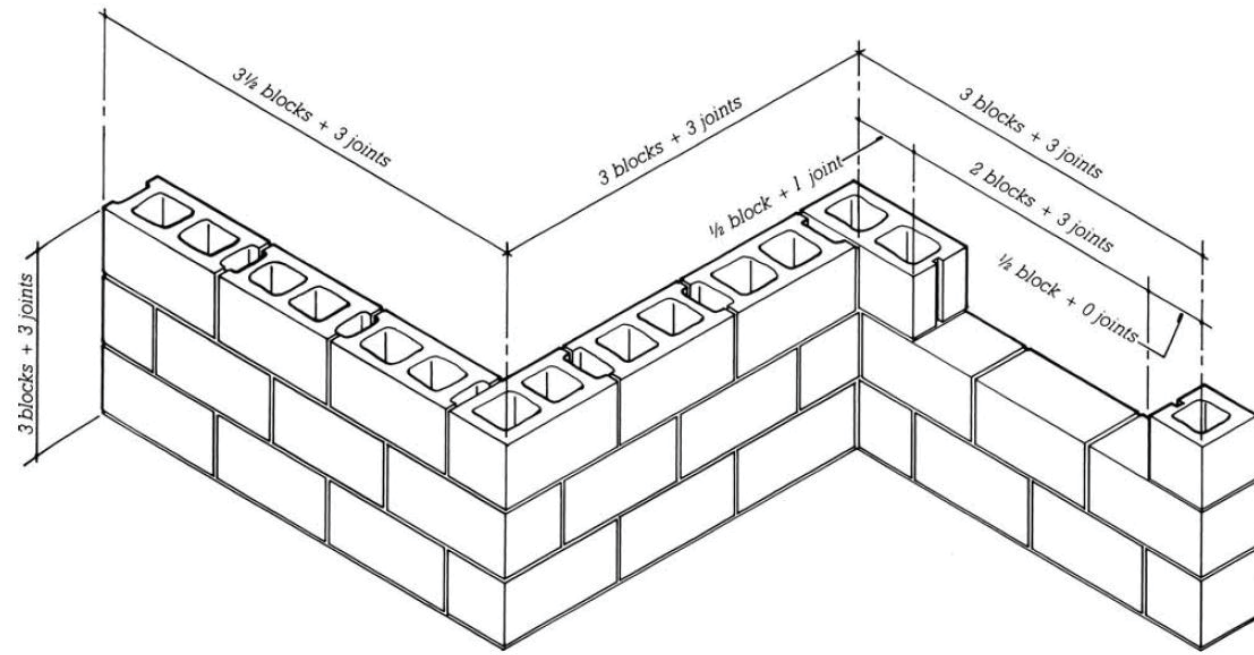
CONCRETE MASONRY



MAKING CMU:

- CMU MADE BY POURING CONCRETE MIX INTO METAL MOLDS AND THEN CURING
- COME IN A WIDE VARIETY OF SHAPES
- SINGLE-WYTHE EXTERIOR WALLS TEND TO LEAK IN WIND DRIVEN RAIN AND SHOULD BE PAINTED OR COATED

CONCRETE MASONRY



SIZING:

MOST COMMON CMU BLOCK IS 8 X 8 X 16 NOMINAL

- 7-5/8 X 7-5/8 X 15-5/8 ACTUAL DIMENSION
- LAID USING TWO HANDS
- DOUBLE CUBE SHAPE MAKES IT IDEAL FOR RUNNING BOND STRETCHERS, HEADERS, AND CORNERS (WHICH CAN BE EASILY REINFORCED)
- WHILE CMU CAN BE CUT, IT IS BEST IF THE BUILDING IS LAID OUT ACCORDING TO THE BLOCK MODULE
- THE 8 INCH BLOCK HEIGHT MATCHES 3 STANDARD COURSE OF BRICK, WHICH MAKES IT EASY TO MATCH BRICK AND CMU COURSING IN COMPOSITE WALLS

CONCRETE MASONRY

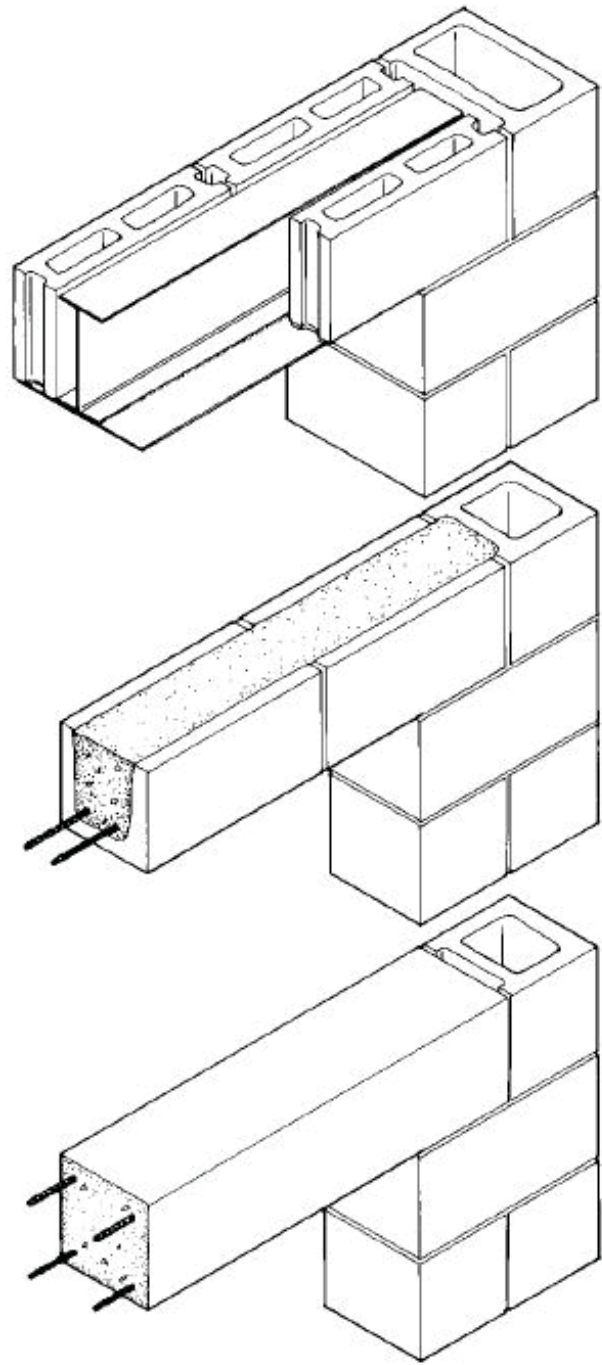


LAYING CMU:

- MORTAR IS IDENTICAL TO BRICK WALLS
- OFTEN REINFORCED WITH STEEL TO INCREASE LOADBEARING CAPACITY AND RESIST LATERAL FORCES
- HORIZONTAL JOINT REINFORCING IS USED BETWEEN COURSES
- IF HEAVIER REINFORCING IS NEEDED, BOND BEAMS CAN ALSO BE USED
- CELLS WITH REINFORCING SHOULD BE FULLY GROUTED TO LOCK REINFORCING IN PLACE
- OTHER CELLS CAN BE GROUTED FOR ADDITIONAL STABILITY
- LINTELS CAN BE STEEL OR REINFORCED BOND BEAMS

CMU IS TYPICALLY A BEHIND THE SCENES STRUCTURAL MATERIAL, BUT SPECIAL DECORATIVE BLOCKS CAN BE USED AS A FINISH MATERIAL

CONCRETE MASONRY



ECONOMY:

- CMU IS CHEAPER AND MORE VERSATILE THAN BRICK OR STONE
- BECAUSE OF THEIR SIZE, CMU GOES UP MUCH QUICKER THAN BRICK
- MUCH EASIER TO REINFORCE CELLS, SO IT'S A BETTER STRUCTURAL MATERIAL



OTHER TYPES OF MASONRY



OTHER TYPES OF MASONRY:

- STRUCTURAL GLAZED FACING TILES (CLAY)
- STRUCTURAL TERRA COTTA (CLAY)
- GLASS BLOCK
- AUTOCLAVED AERATED CONCRETE