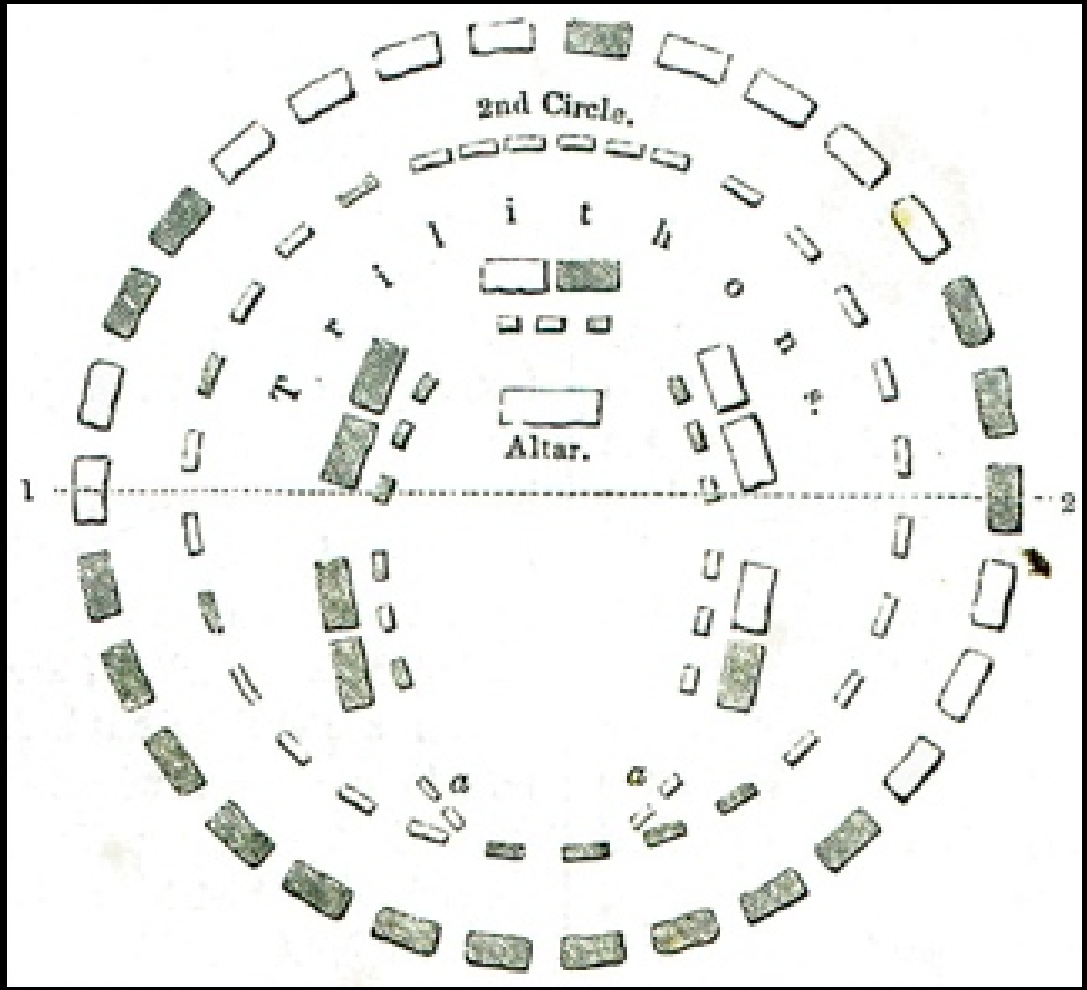
Stone: From Technique to Technology

Part One:
From Antiquity to the Romans

Technique vs Technology

Trial and Error vs Mathematics and Physics

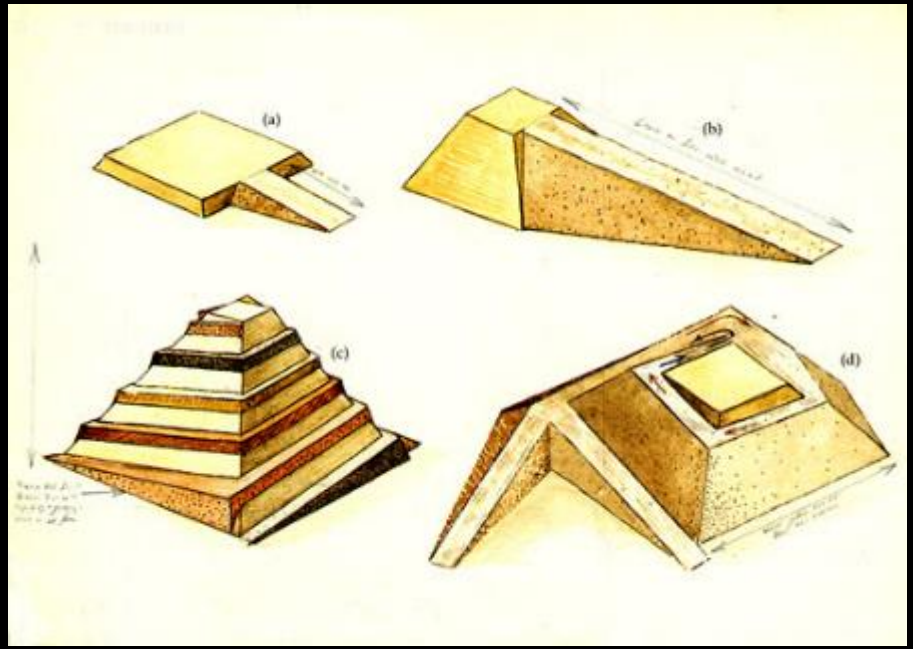

Stonehenge
Wiltshire, England
Circa 3000 BCE
Downloaded from Knowth.com


2nd Circle.
Altar.
1
2

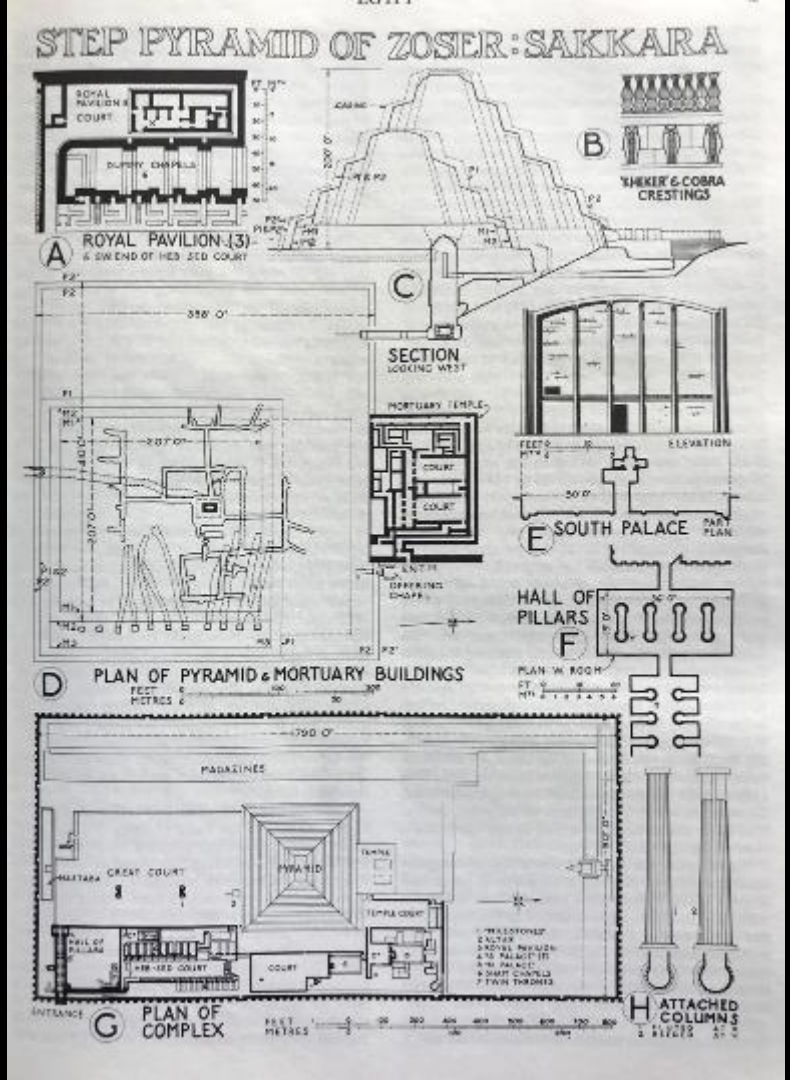
Law Code of Hammurabai
1750 BCE

If a builder build a house for a man and do not
make its construction firm,
and the house which he has built collapse
and cause the death of the owner of the house,
that builder shall be put to death.
If it cause the death of a son of the owner of the house,
they shall put to death a son of that builder.

ancient stone techniques


(a)
(b)
(c)
(d)

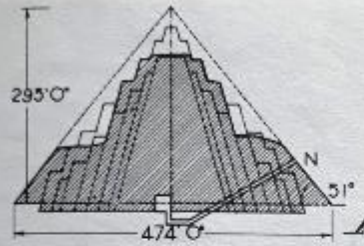
The Stepped Pyramid of Djoser at Saqqara
27th Century BCE



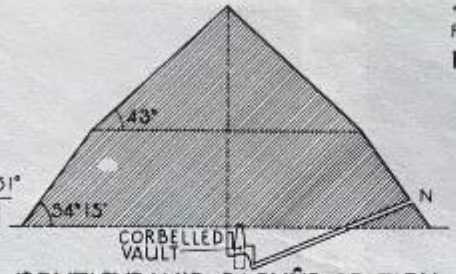
Plates from
"A History of Architecture"
By Sir Banister Fletcher

Pyramids at Giza
(Khufu/Cheops, Khafre/Chephren and Menkaure)
2580 BCE

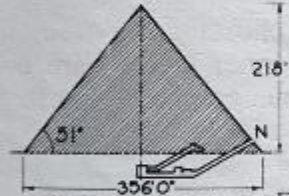
PYRAMIDS AND ATTENDANT BUILDINGS



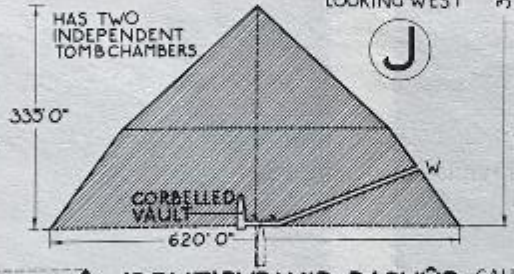
PYRAMID AT ME
H SECTION
LOOKING WEST



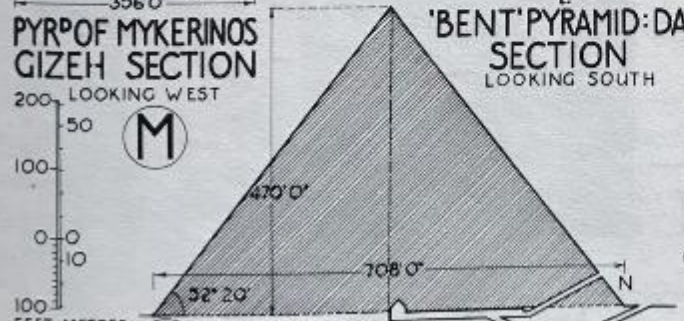
'BENT' PYRAMID: DASHÛR: SECTION
LOOKING WEST
J



PYR^D OF MYKERINOS
GIZEH SECTION
LOOKING WEST
M

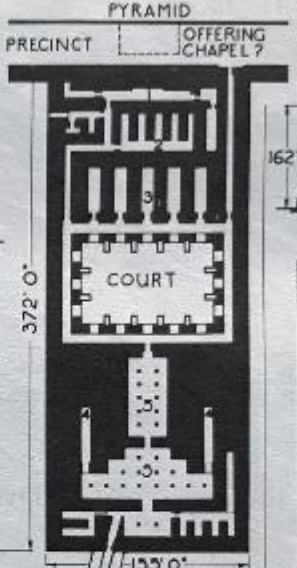


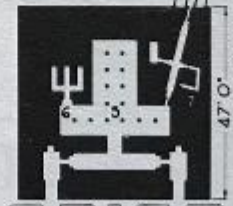
'BENT' PYRAMID: DASHÛR
SECTION
LOOKING SOUTH



K SECTION LOOKING WEST
PYRAMID OF CHEPHREN GIZEH

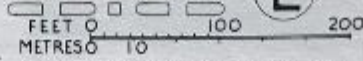
FEET METRES
SCALE FOR
ALL PYRAMID
SECTIONS





1 SANCTUARY
2 STORES
3 SHRINES
4 SERDABS
5 HALLS
6 2-STOREY CHAMBERS
7 UP TO ROOF

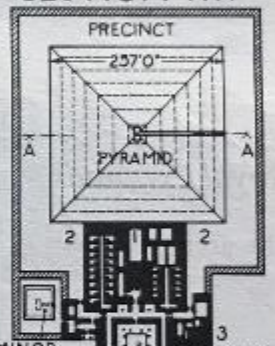
PLANS
L



MORTUARY TEMPLE & VALLEY
BUILDING ? CHEPHREN: GIZEH

DETAIL ? TOMB CHAMBER
LOOKING W

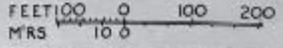
SECTION 'A A'



1 SANCTUARY
2 STORES
3 UP TO ROOF
4 LANDING

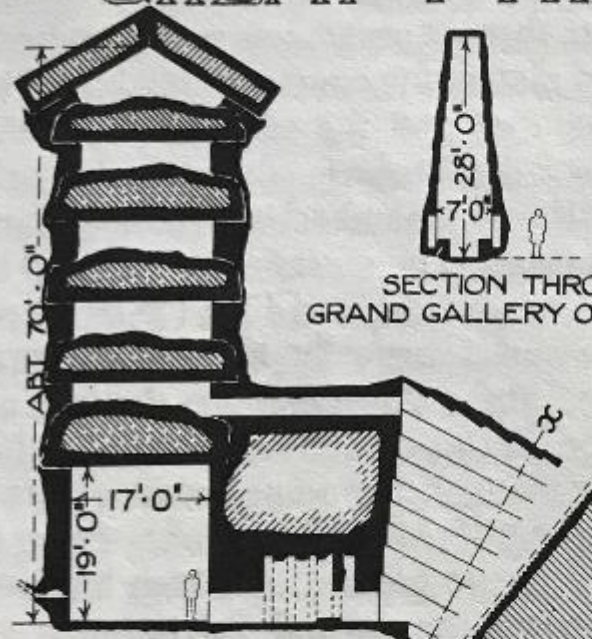
PLAN

N



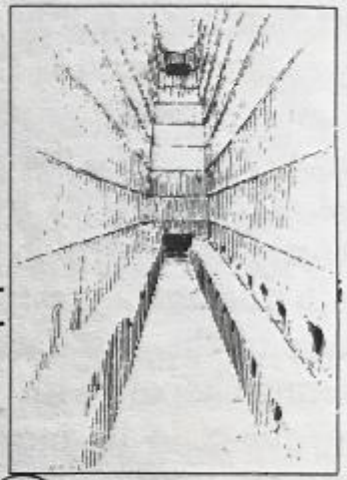
PYRAMID COMPLEX
? SAHURA : ABUSÎR

GREAT PYRAMID OF CHEOPS : GIZEH



SECTION THRO'
GRAND GALLERY ON X-X

C ENTRANCE AT z.



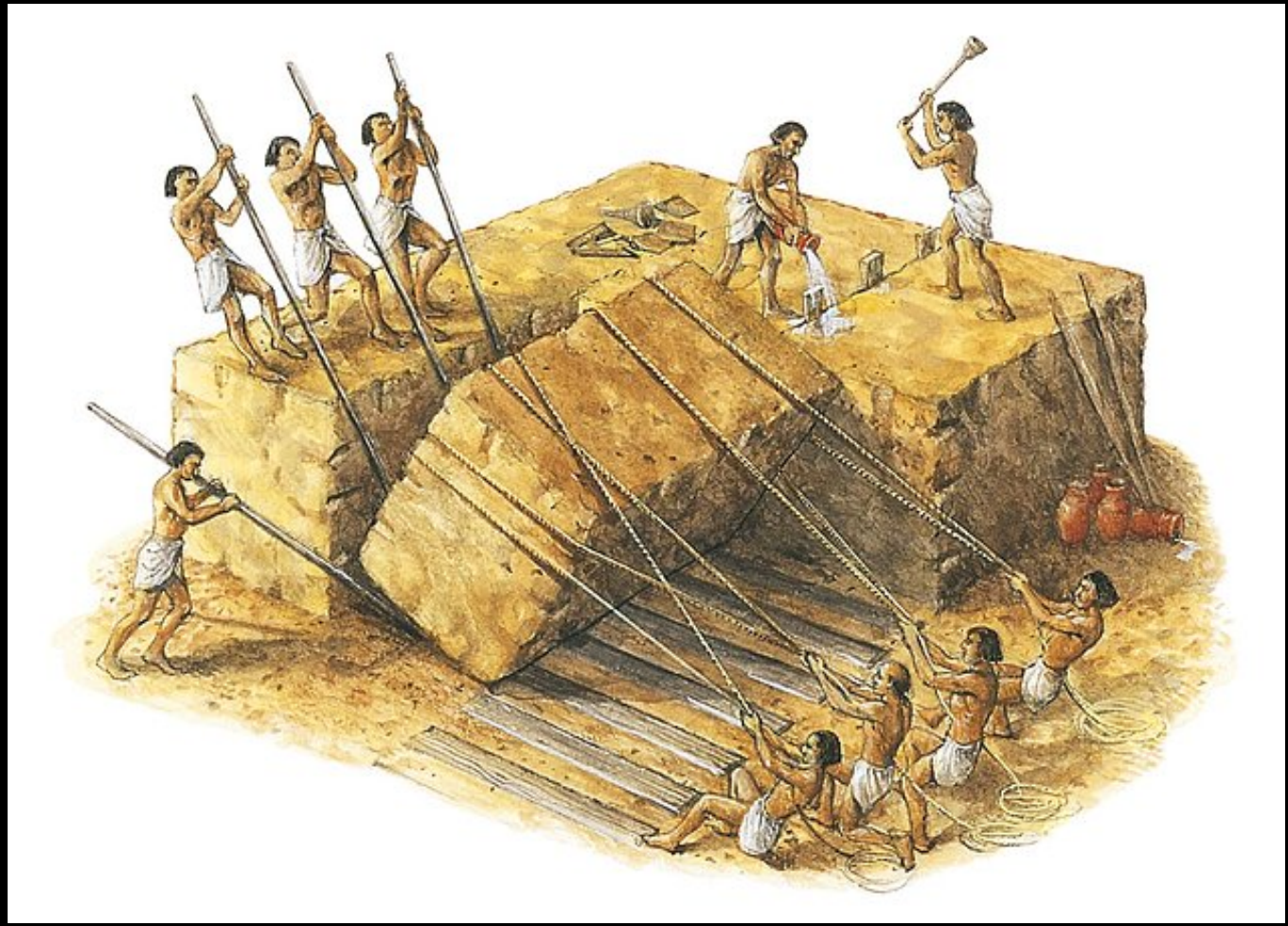
D GRAND GALLERY TO KING'S CHAMBER

A SECTION THRO' KING'S CHAMBER

B SECTION THRO' PYRAMID

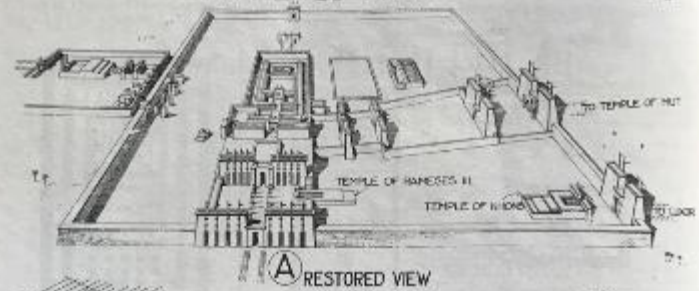
SUBTERRANEAN CHAMBER

E ROCKERS FOR RAISING STONES




Temple at Karnak
Thebes, Egypt
2050 BCE

GREAT TEMPLE OF AMMON: KARNAK



A RESTORED VIEW

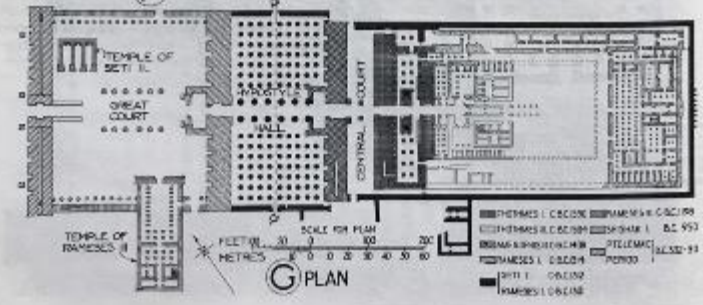
B THE CLEARSTORY
HYPOSTYLE HALL

C ENTRANCE PYLONS (AS EXISTING)

D ROOF APERTURES
LIGHTING INNER HALLS

E AUXILIARY LIGHT-HOLES
HYPOSTYLE HALL

F SECTIONAL VIEW OF HYPOSTYLE HALL ON a.-a.



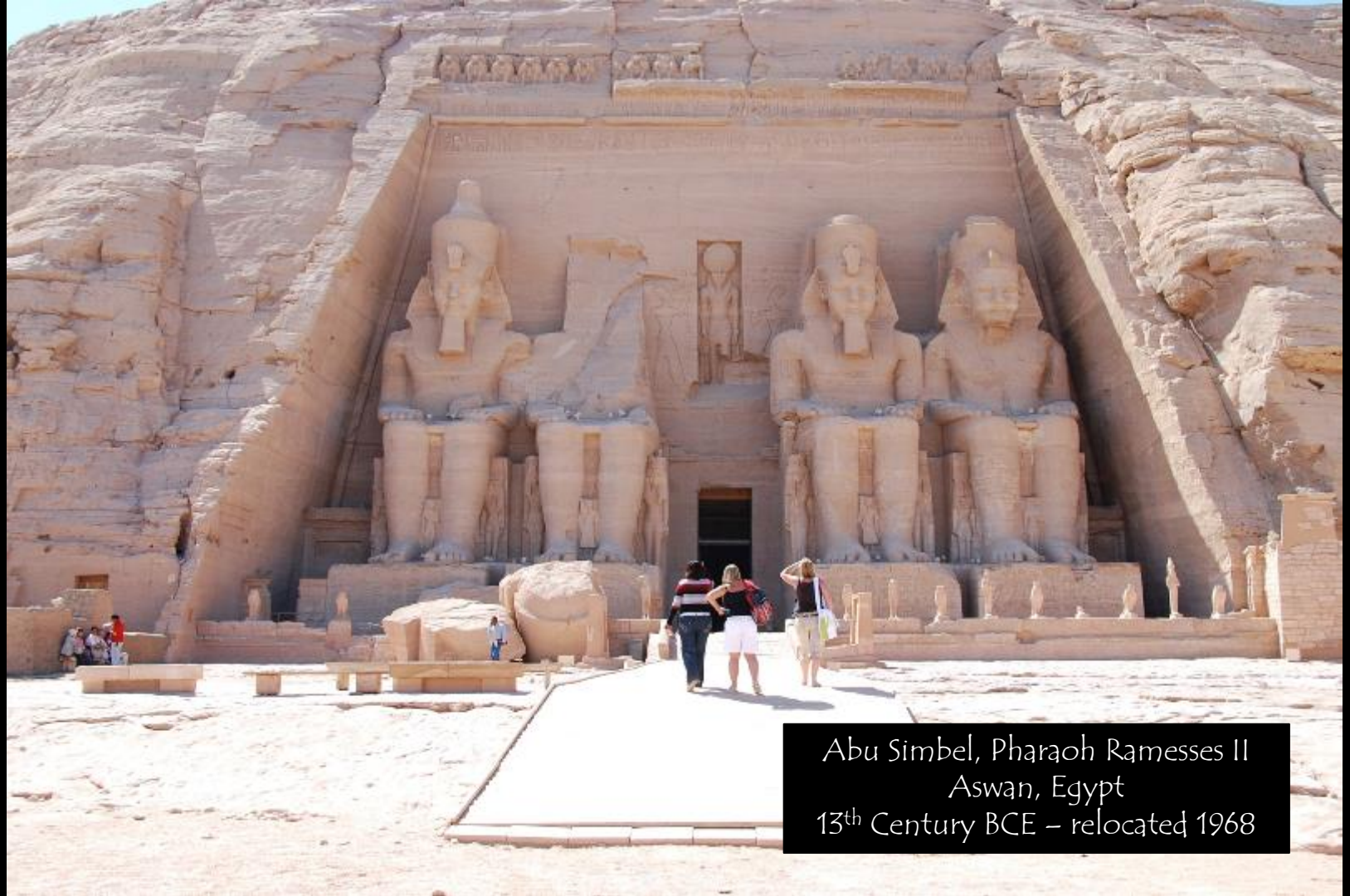
G PLAN

Hypostyle Hall

Where the roof is supported by a sea of closely spaced columns


STONE CANNOT SPAN!
IT HAS ZERO TENSILE ABILITY

Mortuary Temple of Hatshepsut
Valley of the Queens, Egypt
1479 BCE



Abu Simbel, Pharaoh Ramesses II
Aswan, Egypt
13th Century BCE – relocated 1968

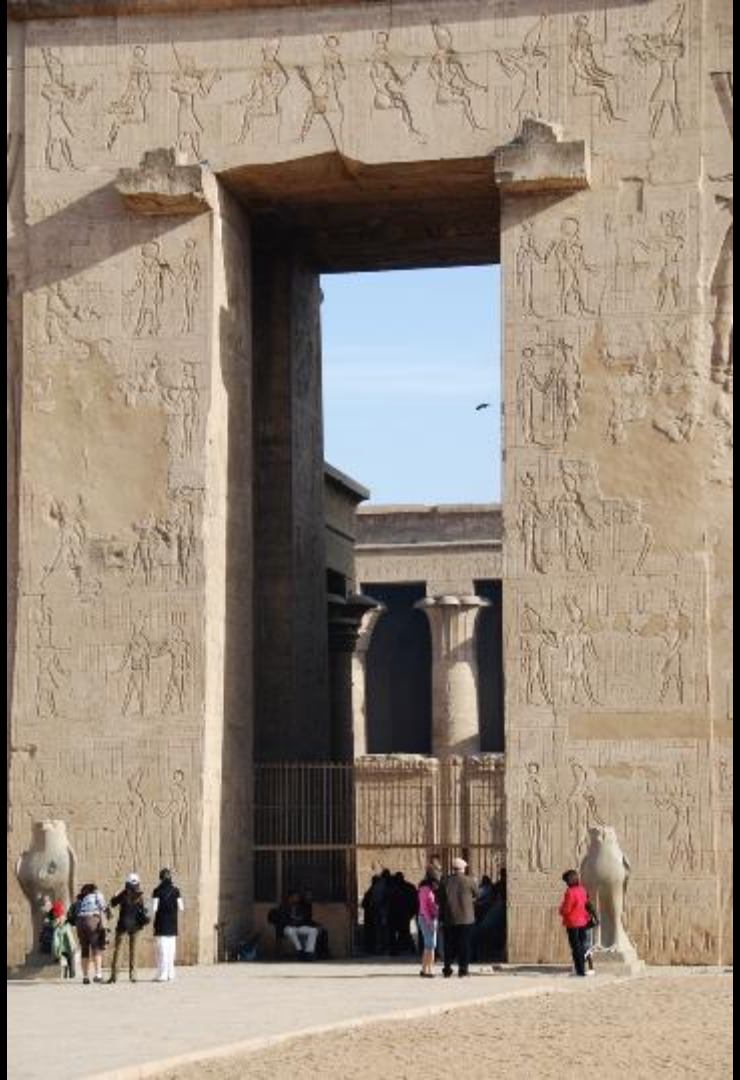

NO PHOTO INSIDE
THE TEMPLE

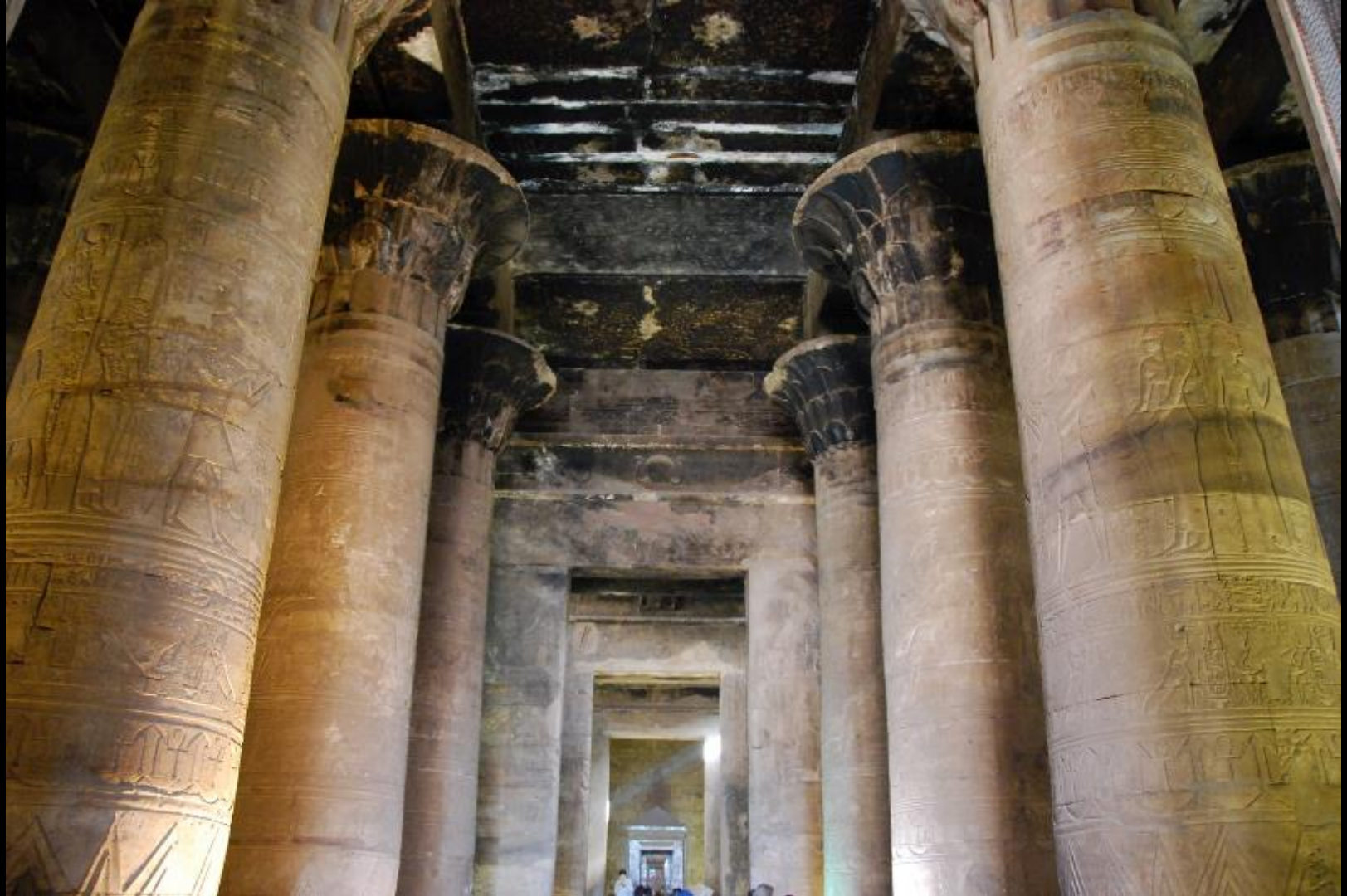
Tomb of Ramesses III
Valley of the Kings, Egypt
1155 BCE

Säulenkapitäle von Philae.

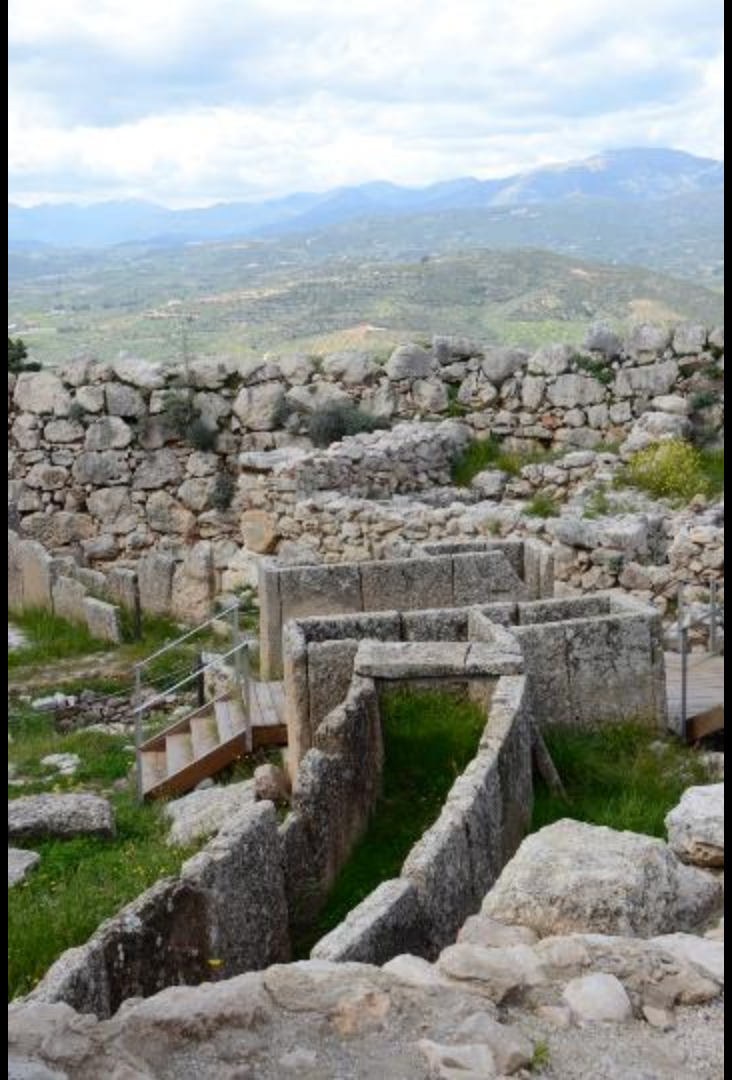
The Temple of Isis at Philae
Aswan, Egypt
380 BCE

The Temple of Horus at Edfu
Ptolemaic Kingdom
237 BCE





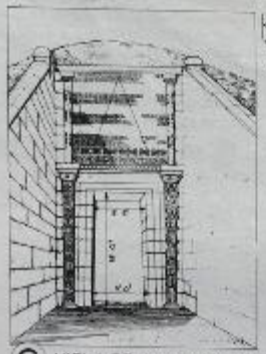

Lion Gate
Bronze Age Citadel
Mycenae, Greece
1250 BCE



TREASURY OF ATREUS: MYCENÆ

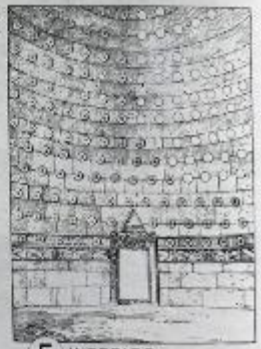
A SECTION

B PLAN



C VIEW OF DROMOS RESTORED

D PORTION OF SHAFT



E INTERIOR RESTORED

F FRAGMENT FROM FAÇADE

G FRAGMENT FROM FAÇADE

H SCULPTURE: GATE OF LIONS: MYCENÆ

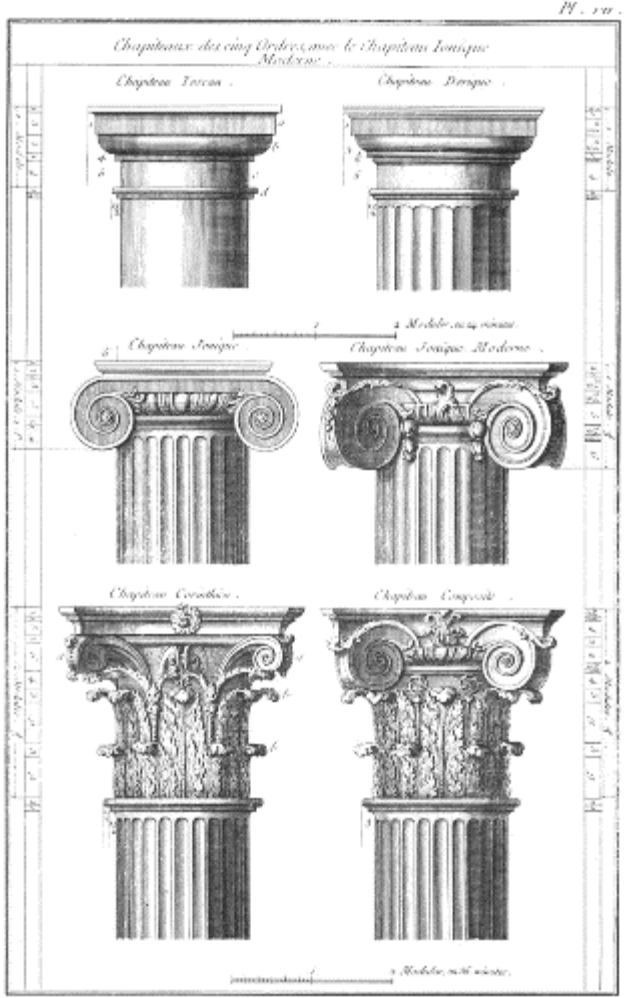

Great Wall of China
From 7th Century BCE

Classical Column Styles

Tuscan

Ionic

Corinthian



Architecture.

Doric

Ionic

Composite

ARCHITECTURE ORDERS:

A= comice (A1 pediment)
B= entablature (B1 frieze, B2 architrave)
C= column (C1 capital, C2 fluted or unfluted shaft, C3 entasis, C4 base)
D= stereobate (D1 stylobate)

Greeks

(man)

antefix
acroterion
triglyph
metope
drops
abacus
echinus
necking
A
A1
B
B1
B2
C
C1
C2
C3
D
D1

(woman)

volute
egg and dart

(girl)

abacus flower
acanthus leafs
A1
B1
B2
C1
C2
C4
torus
scotia
plinth

DORIC ORDER
sharp arrise
IONIC ORDER
fillets
CORINTHIAN ORDER

Roman

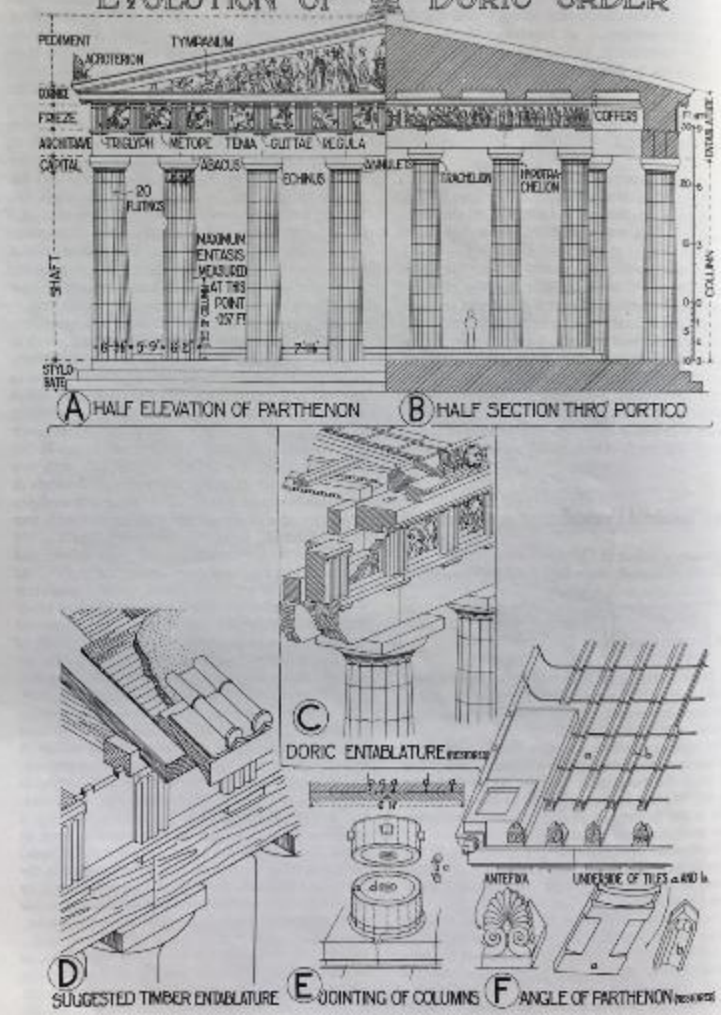
Paolo Villa:
composition of the didactic diagram, texts, graphic signs, modification of images (with: gimp and libreoffice).
First publication:
https://commons.wikimedia.org/wiki/File:GLI_ORDINI_ARCHITETTONICI_Greci_Etrusco_Romano_(scheda_didattica_di_Paolo_Villa_in_Commons_Wikimedia_org).pdf

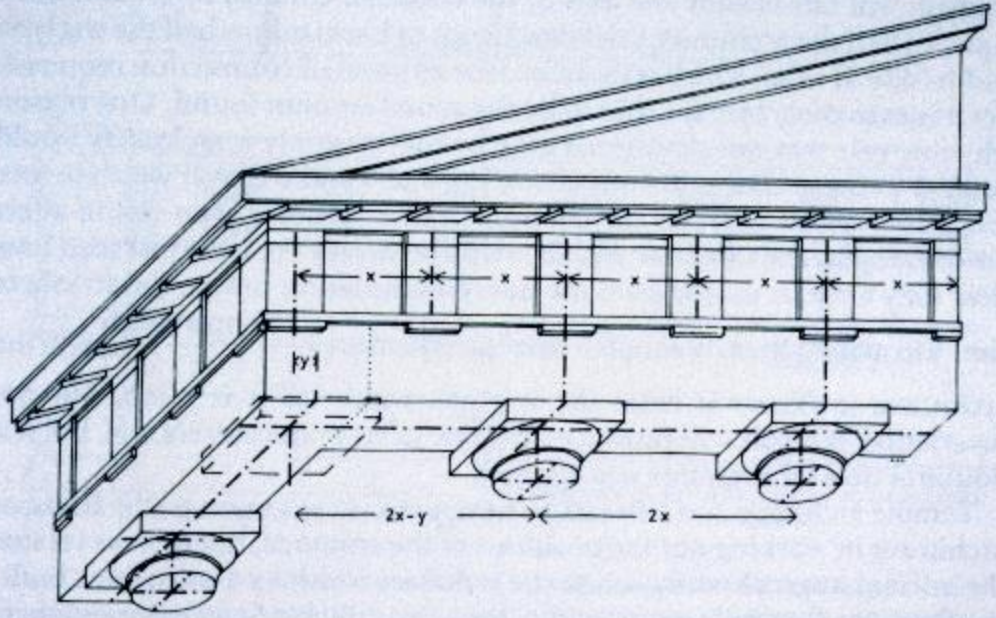
Etruscan

patera
bucranium

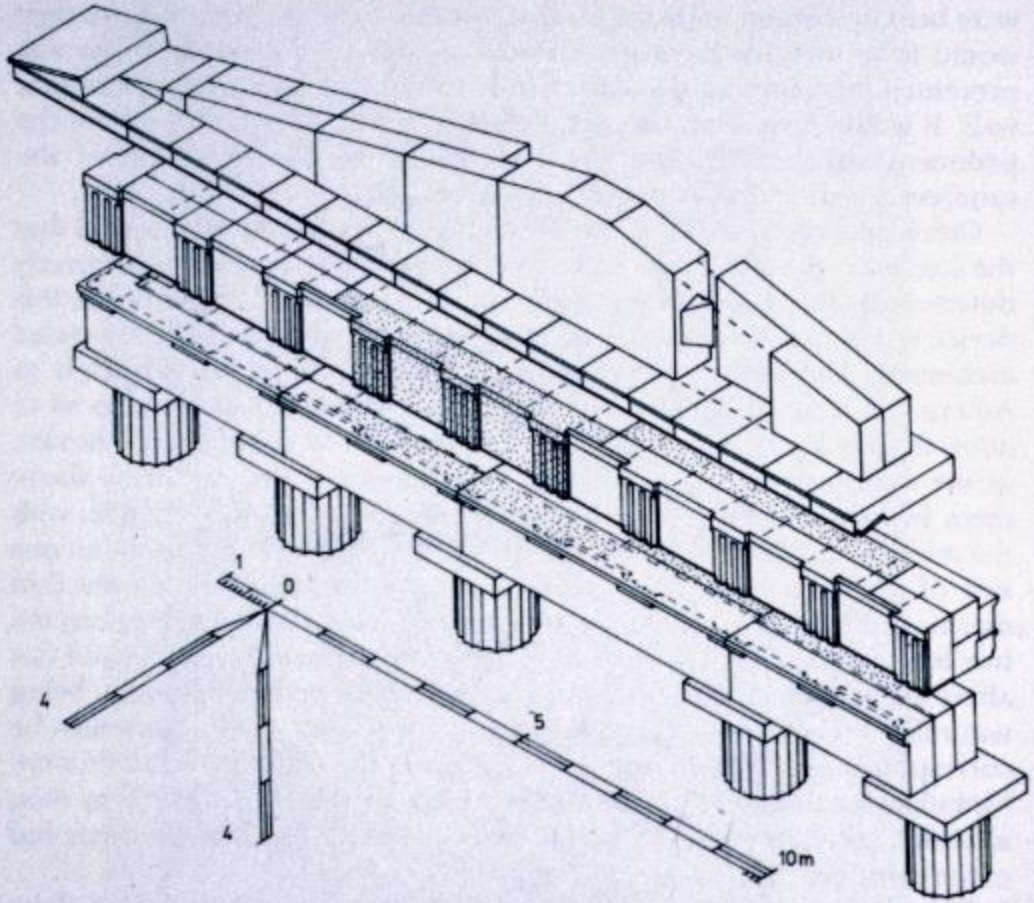
unfluted
TUSCAN ORDER

COMPOSITE ORDER

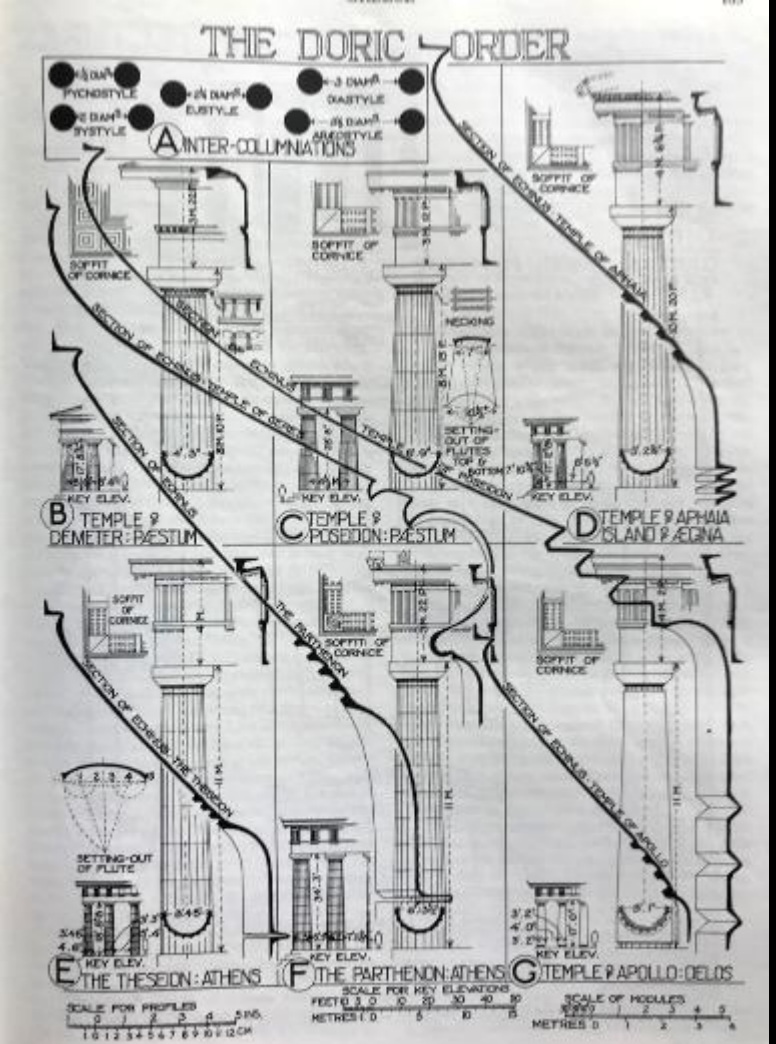




18 Angle contraction in the Doric order: elevation with oblique projection

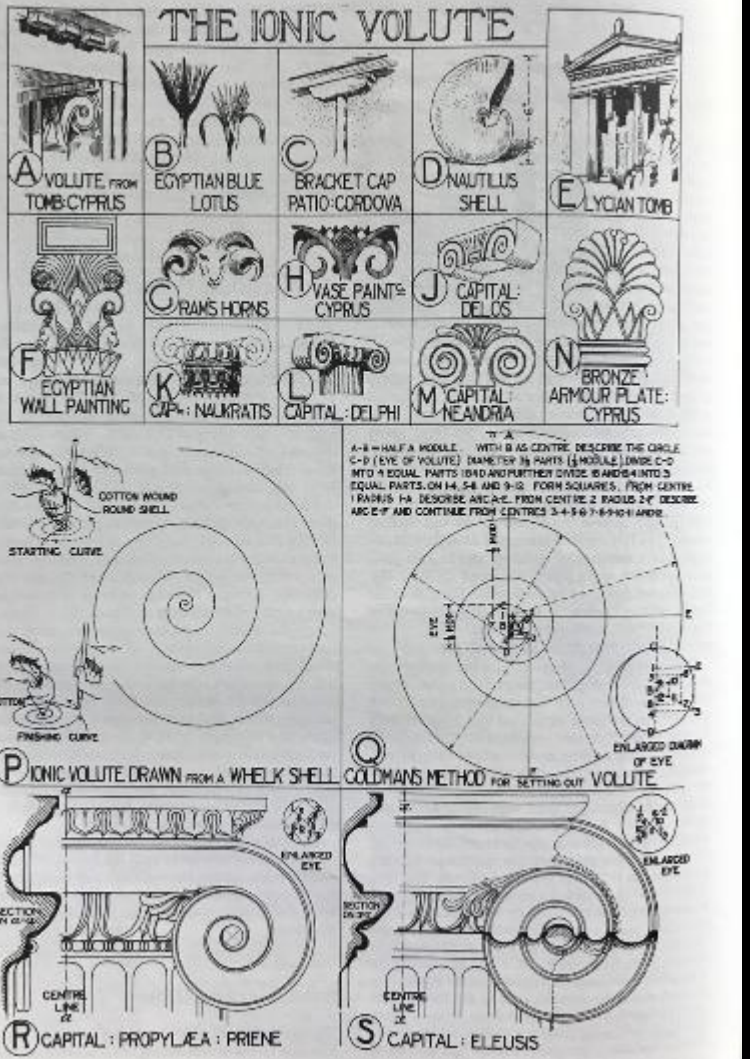


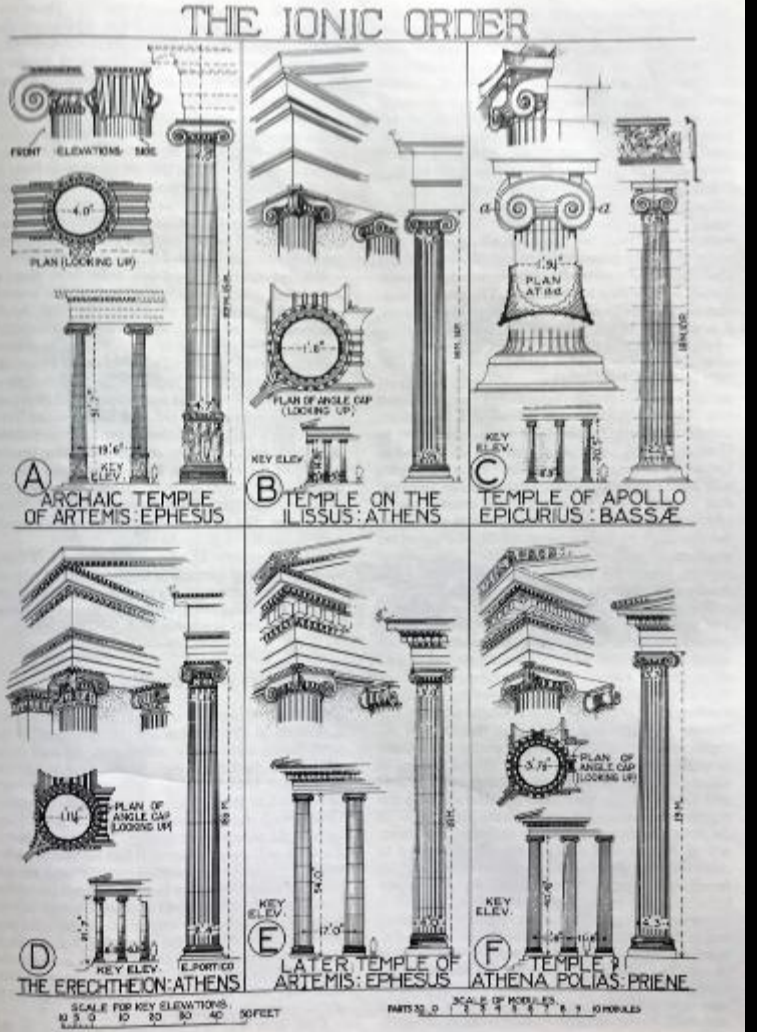
67 Propylaia at Athens, east façade (*c.* 437–432 B.C.): exploded isometric view showing cantilevered frieze beams


THE DORIC ORDER
PYCNOSTYLE
EUSTYLE
DIASTYLE
SYSTYLE
ARAEOSTYLE
A INTER-COLUMNIATIONS
SOFFIT OF CORNICE
NECKING
SETTING-OUT OF FLUTES TOP & BOTTOM
KEY ELEV.
B TEMPLE OF DEMETER: PAESTUM
C TEMPLE OF POSEIDON: PAESTUM
D TEMPLE OF APHAIA ISLAND OF ÆGINA
SECTION OF ECHINUS, TEMPLE OF APHAIA
SECTION OF ECHINUS, TEMPLE OF CERES
SECTION OF ECHINUS, TEMPLE OF POSEIDON
SECTION OF ECHINUS, THE PARTHENON
SECTION OF ECHINUS, TEMPLE OF APOLLO
SETTING-OUT OF FLUTE
E THE THESEION: ATHENS
F THE PARTHENON: ATHENS
G TEMPLE OF APOLLO: DELOS
SCALE FOR PROFILES
SCALE FOR KEY ELEVATIONS
FEET
METRES
SCALE OF MODULES
METRES


ΔΩΡΙΚΟΝ
DORIC


Temple of Apollo
Ancient Corinth,
Greece
550 BCE

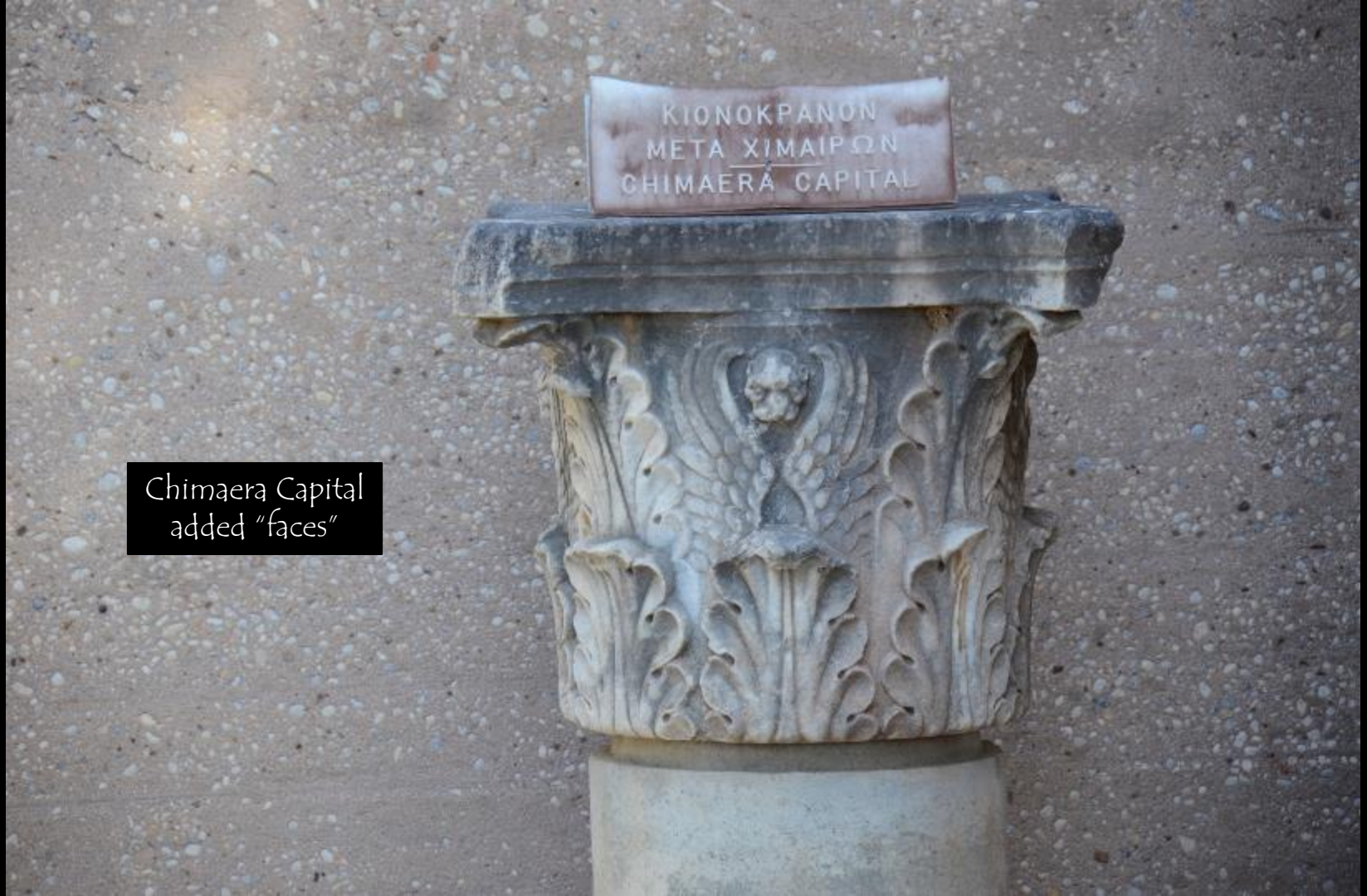

THE IONIC VOLUTE
A VOLUTE, FROM TOMB: CYPRUS
B EGYPTIAN BLUE LOTUS
C BRACKET CAP PATIO: CORDOVA
D NAUTILUS SHELL
E LYCIAN TOMB
F EGYPTIAN WALL PAINTING
G RAM'S HORNS
H VASE PAINTG CYPRUS
J CAPITAL: DELOS
K CAP: NAUKRATIS
L CAPITAL: DELPHI
M CAPITAL: NEANDRIA
N BRONZE ARMOUR PLATE: CYPRUS
COTTON WOUND ROUND SHELL
STARTING CURVE
COTTON
FINISHING CURVE
A-B = HALF A MODULE. WITH B AS CENTRE DESCRIBE THE CIRCLE C-D (EYE OF VOLUTE) DIAMETER ⅓ PARTS (¼ MODULE) DIVIDE C-D INTO 4 EQUAL PARTS (B-D) AND FURTHER DIVIDE IS AND B-4 INTO 3 EQUAL PARTS. ON 1-4, 5-8 AND 9-12 FORM SQUARES. FROM CENTRE 1 RADIUS 1-A DESCRIBE ARC A-E. FROM CENTRE 2 RADIUS 2-E DESCRIBE ARC E-F AND CONTINUE FROM CENTRES 3-4-5-6-7-8-9-10-11 AND 12.
EYE
ENLARGED DIAGRAM OF EYE
P IONIC VOLUTE DRAWN FROM A WHELK SHELL
Q COLDMANS METHOD FOR SETTING OUT VOLUTE
ENLARGED EYE
SECTION ON AT
CENTRE LINE OF
R CAPITAL: PROPYLÆA: PRIENE
S CAPITAL: ELEUSIS


THE IONIC ORDER
FRONT ELEVATIONS SIDE
PLAN (LOOKING UP)
KEY ELEV.
A ARCHAIC TEMPLE OF ARTEMIS: EPHESUS
PLAN OF ANGLE CAP (LOOKING UP)
B TEMPLE ON THE ILISSUS: ATHENS
PLAN AT a-a
C TEMPLE OF APOLLO EPICURIUS: BASSÆ
D THE ERECHTHEION: ATHENS
E.PORT.CO
E LATER TEMPLE OF ARTEMIS: EPHESUS
F TEMPLE OF ATHENA POLIAS: PRIENE
SCALE FOR KEY ELEVATIONS
SCALE OF MODULES

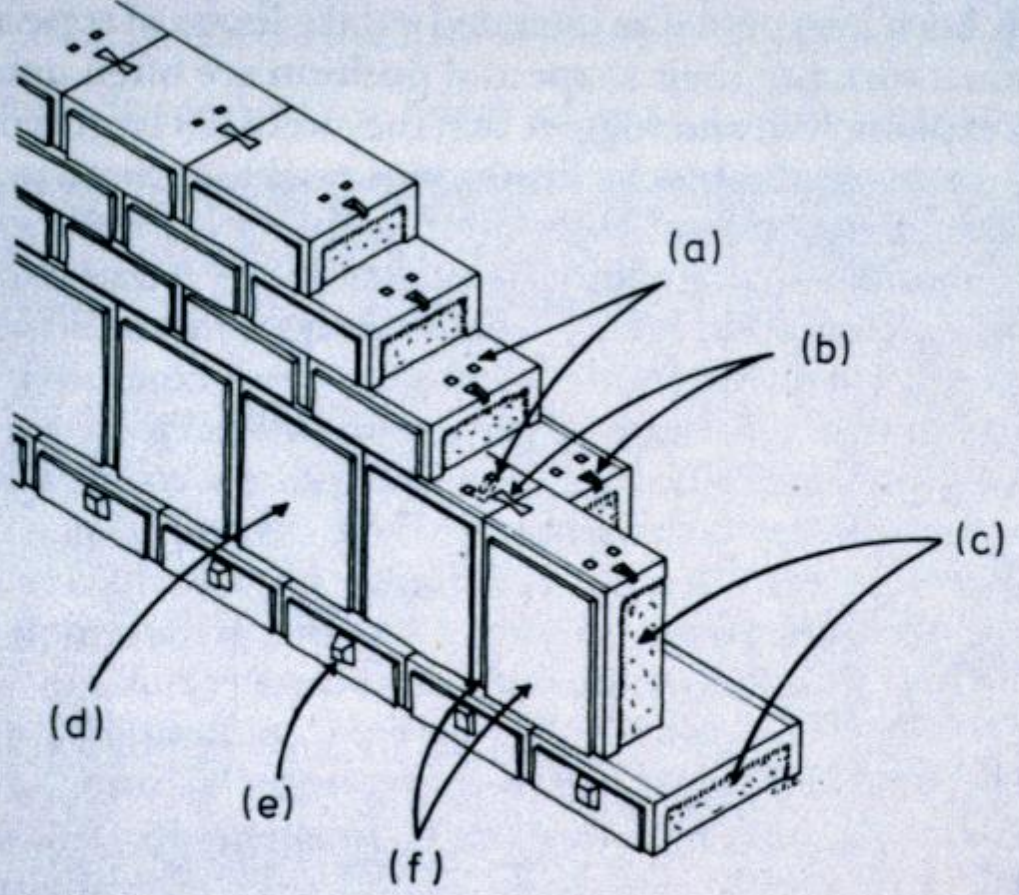

Corinthian Capitals


Composite Capitals = combination of Corinthian Acanthus leaves + Ionic volutes

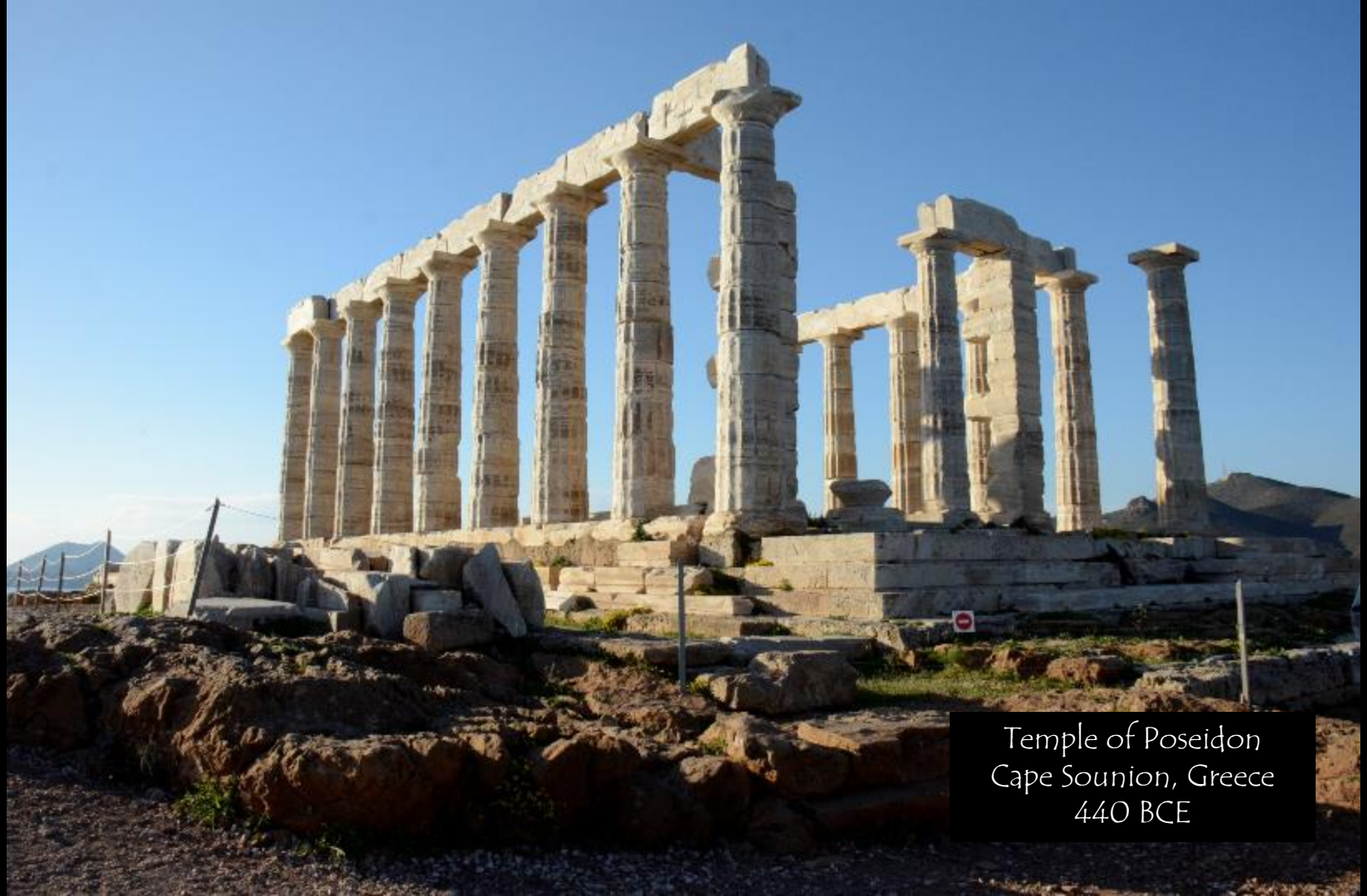
Early Corinthian capital



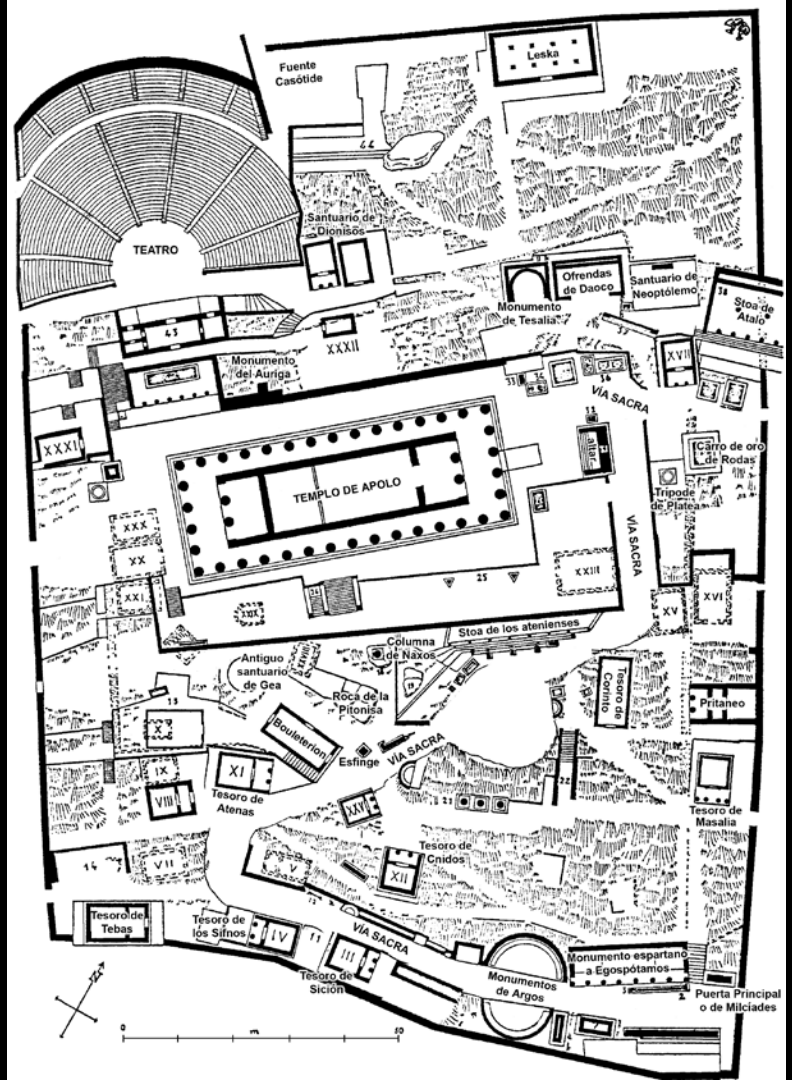
Chimaera Capital
added "faces"



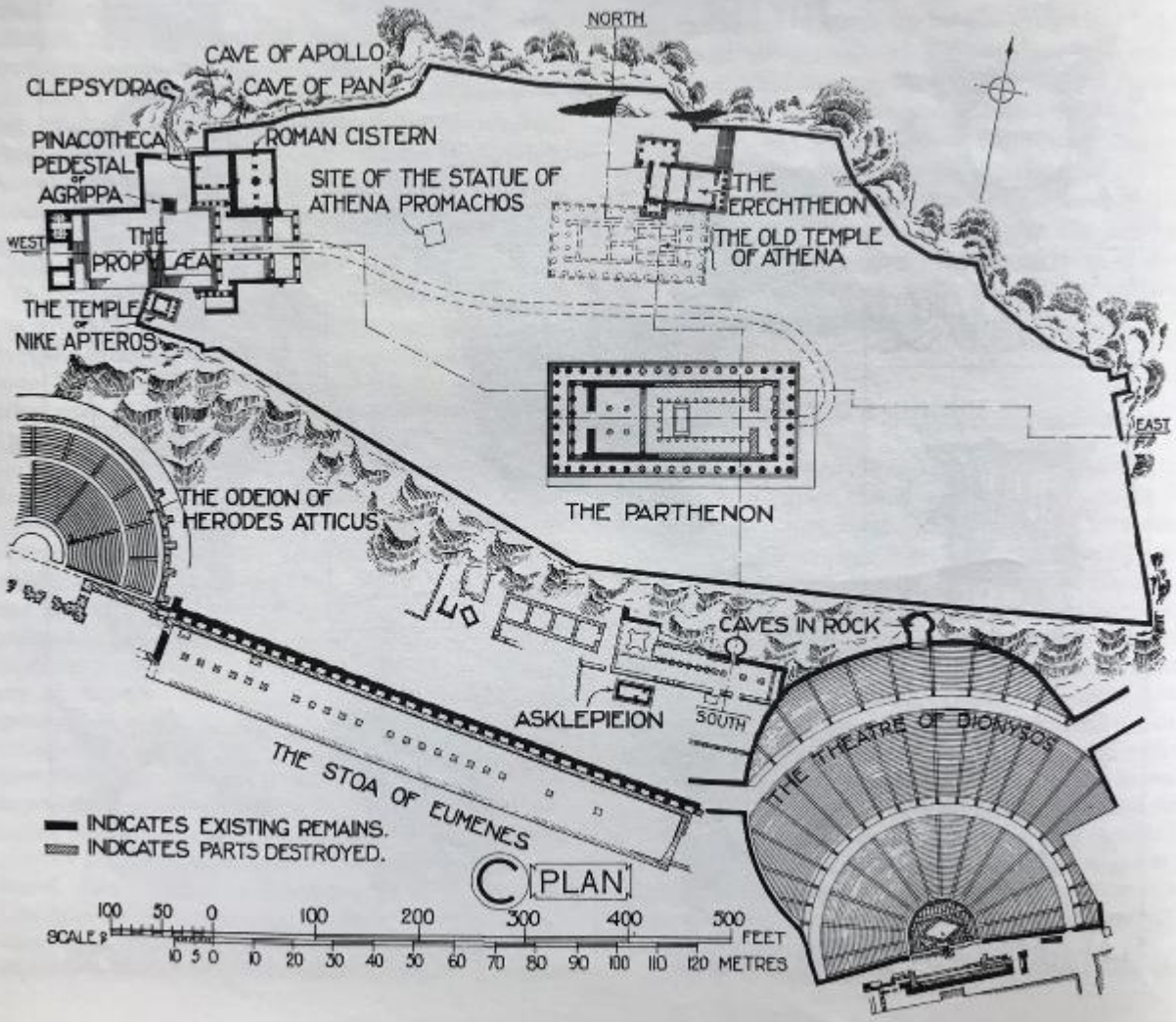
12 Features of early Greek monumental masonry: (a) U-shaped hole; (b) dove-tail clamp; (c) band anathyrosis; (d) orthostate; (e) handling boss; (f) preliminary dressing


Temple of Poseidon
Cape Sounion, Greece
440 BCE

Delphi Theatre
Greece
4th Century BCE


Fuente Casótide
Lesko
TEATRO
Santuario de Dionisos
Ofrendas de Daoco
Santuario de Neoptólemo
Stoa de Atalo
Monumento de Tesalia
Monumento del Auriga
XXXII
XVII
VÍA SACRA
XXXI
Carro de oro de Rodas
TEMPLO DE APOLO
Trípode de Platea
XXX
XX
XXI
XXII
XV
XVI
Stoa de los atenienses
Columna de Naxos
Antiguo santuario de Gea
Roca de la Pitonisa
Tesoro de Corinto
Pritaneo
Bouleterion
Esfinge
XI
Tesoro de Atenas
VIII
XIV
Tesoro de Masalia
Tesoro de Cnidos
XII
Tesoro de Tebas
Tesoro de los Sifnos
IV
III
Tesoro de Sición
Monumento espartano a Egospótamos
Monumentos de Argos
Puerta Principal o de Milciades
0
m
50


Acropolis
Athens, Greece
Circa 500 BCE


NORTH
CAVE OF APOLLO
CLEPSYDRA
CAVE OF PAN
PINACOTHECA
ROMAN CISTERN
PEDESTAL OF AGRIPPA
SITE OF THE STATUE OF ATHENA PROMACHOS
THE ERECHTHEION
THE OLD TEMPLE OF ATHENA
WEST
THE PROPYLÆA
THE TEMPLE OF NIKE APTEROS
EAST
THE PARTHENON
THE ODEION OF HERODES ATTICUS
CAVES IN ROCK
ASKLEPIEION
SOUTH
THE THEATRE OF DIONYSOS
THE STOA OF EUMENES
INDICATES EXISTING REMAINS.
INDICATES PARTS DESTROYED.
C PLAN
SCALE
100 50 0 100 200 300 400 500 FEET
10 5 0 10 20 30 40 50 60 70 80 90 100 110 120 METRES


The Parthenon
Acropolis
Athens, Greece
Circa 500 BCE

THE PARTHENON: ATHENS

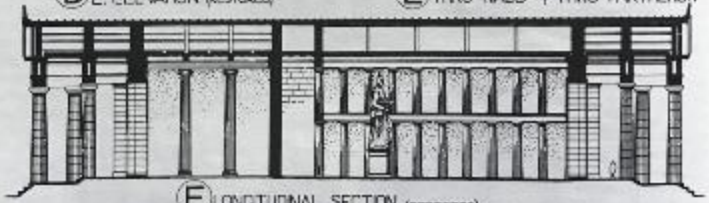
A SECTIONAL VIEW E. END

B E. FACADE (RESTORED)

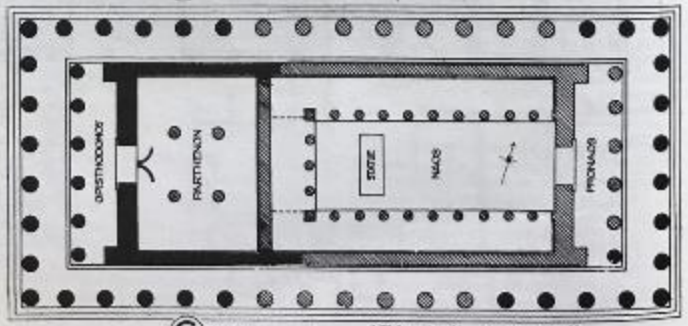
C N.W. ANGLE (RESTORED)

D E. ELEVATION (RESTORED)

E HALF TRANSVERSE SECTNS. THRO' NAOS + THRO' PARTHENON



F LONGITUDINAL SECTION (RESTORED)

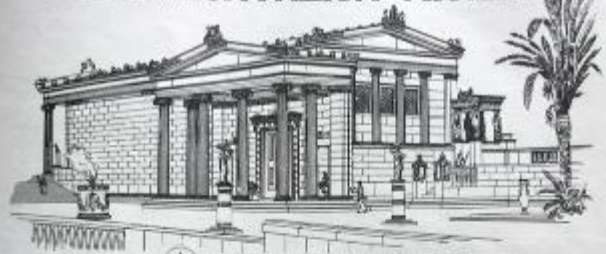


G PLAN (RESTORED)

FT-0 10 20 30 40 50 60
METRES 0 5 10 15


Erectheum
Acropolis
Athens, Greece
Circa 500 BCE

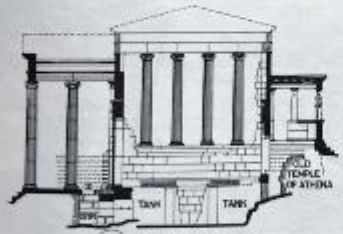
THE ERECHTHEION : ATHENS



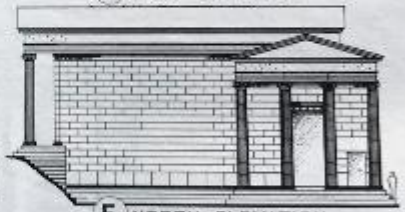
A VIEW FROM NORTH WEST

B EAST ELEVATION

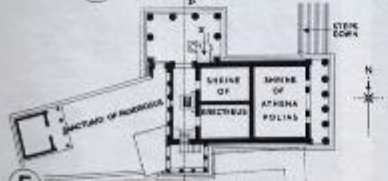
C WEST ELEVATION



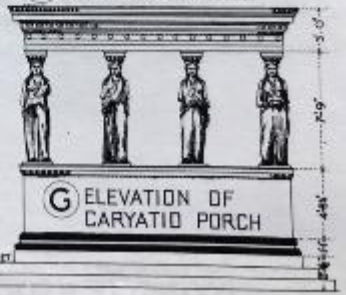
D SECTION A-A



E NORTH ELEVATION



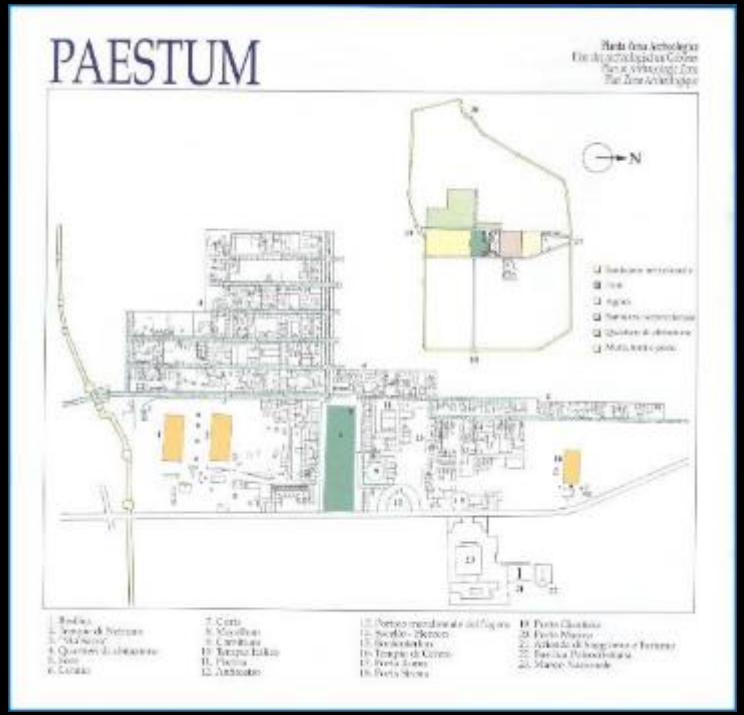
F PLAN

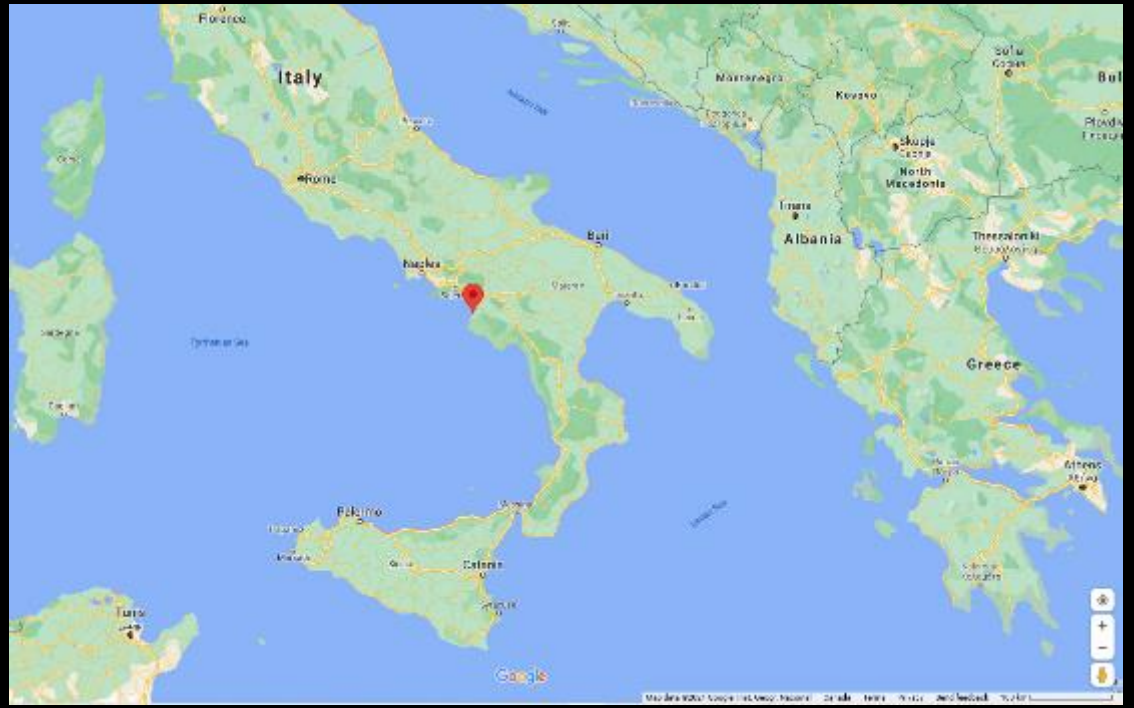


G ELEVATION OF CARYATID PORCH

SCALE FOR ELEVATIONS & SECTIONS

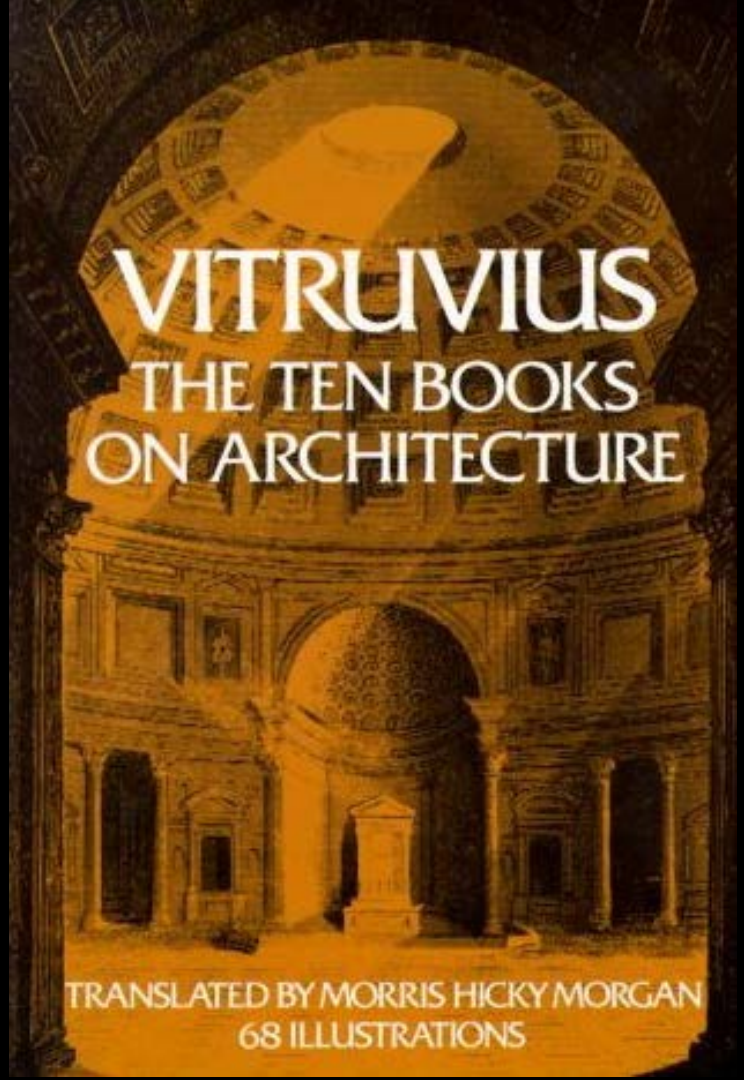
SCALE FOR PLAN


PAESTUM
N


Italy
Albania
Greece
Google

First Temple of Hera
Paestum, Italy
550 BCE

Second Temple of Hera
Paestum, Italy
450 BCE


VITRUVIUS
THE TEN BOOKS
ON ARCHITECTURE
TRANSLATED BY MORRIS HICKY MORGAN
68 ILLUSTRATIONS

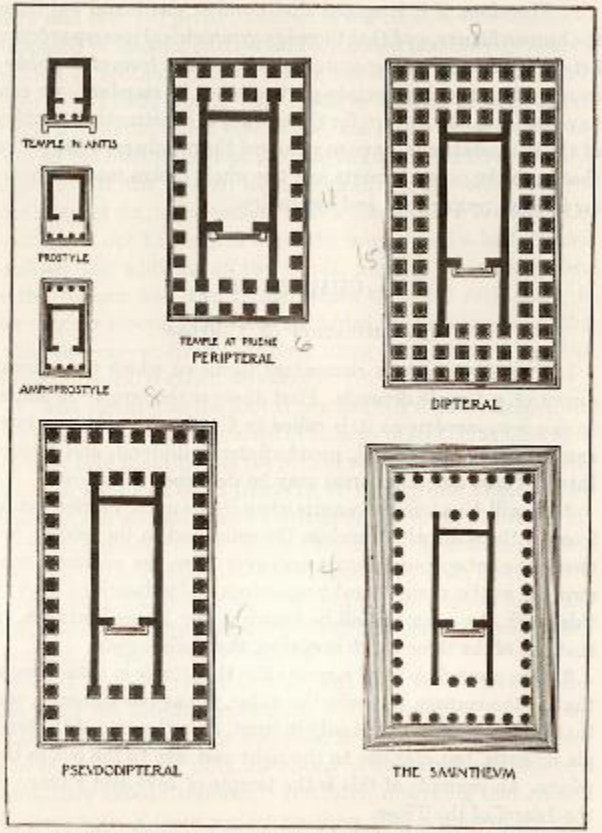
CHAPTER I

THE EDUCATION OF THE ARCHITECT

1. The architect should be equipped with knowledge of many branches of study and varied kinds of learning, for it is by his judgement that all work done by the other arts is put to test. This knowledge is the child of practice and theory. Practice is the continuous and regular exercise of employment where manual work is done with any necessary material according to the design of a drawing. Theory, on the other hand, is the ability to demonstrate and explain the productions of dexterity on the principles of proportion.

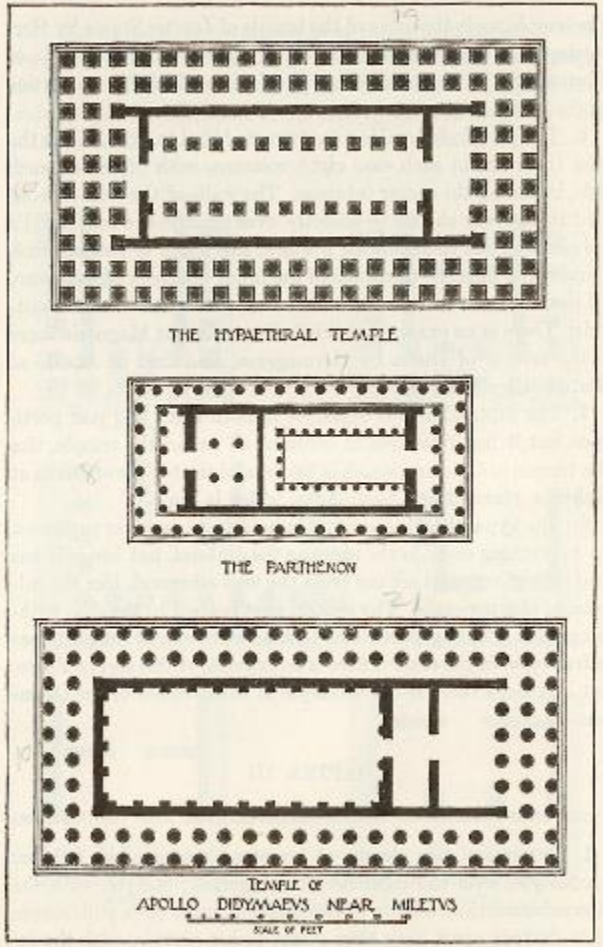
2. It follows, therefore, that architects who have aimed at acquiring manual skill without scholarship have never been able to reach a position of authority to correspond to their pains, while those who relied only upon theories and scholarship were obviously hunting the shadow, not the substance. But those who have a thorough knowledge of both, like men armed at all points, have the sooner attained their object and carried authority with them.

3. In all matters, but particularly in architecture, there are these two points: — the thing signified, and that which gives it its significance. That which is signified is the subject of which we may be speaking; and that which gives significance is a demonstration on scientific principles. It appears, then, that one who professes himself an architect should be well versed in both directions. He ought, therefore, to be both naturally gifted and amenable to instruction. Neither natural ability without instruction nor instruction without natural ability can make the perfect artist. Let him be educated, skilful with the pencil, instructed in geometry, know much history, have followed the philosophers with attention, understand music, have some knowledge of medi-



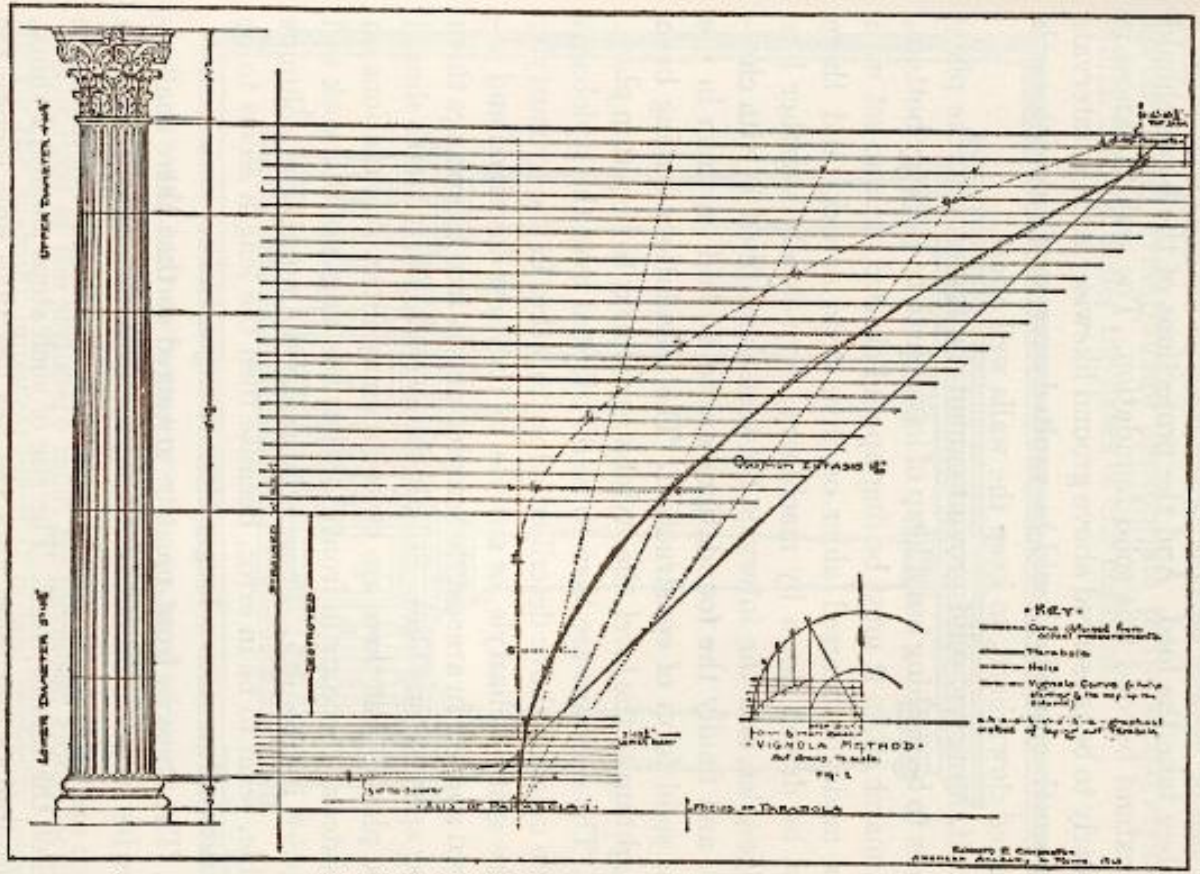
THE CLASSIFICATION OF TEMPLES ACCORDING TO THE ARRANGEMENTS OF THE COLONNADES

umns. Let the columns be so placed as to leave a space, the width of an intercolumniation, all round between the walls and the rows of columns on the outside, thus forming a walk round the cella of



THE HYPAETHRAL TEMPLE OF VITRUVIUS COMPARED WITH THE PARTHENON AND THE TEMPLE OF APOLLO NEAR MILETUS

1

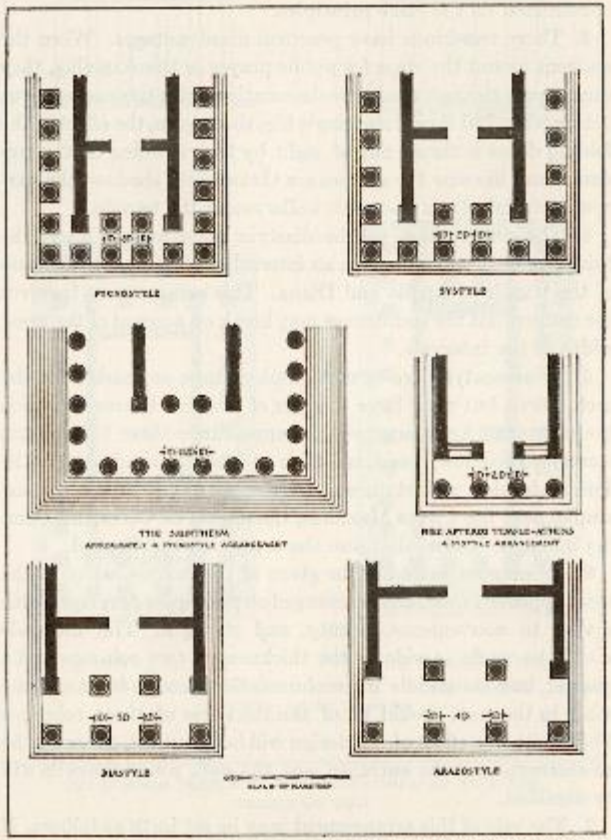


2

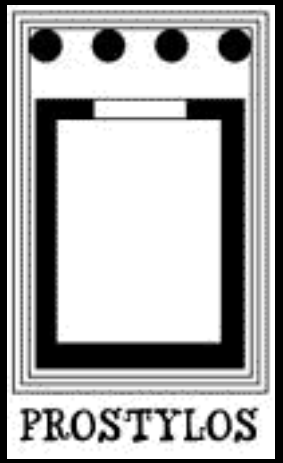
THE ENTASIS OF COLUMNS

1. The entasis as given by Fra Giocondo in the edition of 1511.
2. The entasis from the temple of Mars Ultor in Rome compared with Vignola's rule for entasis.

2. The pycnostyle is a temple in an intercolumniation of which the thickness of a column and a half can be inserted: for example, the temple of the Divine Caesar, that of Venus in Caesar's forum, and others constructed like them. The systyle is a temple in which



THE CLASSIFICATION OF TEMPLES ACCORDING TO INTERCOLUMNIATION

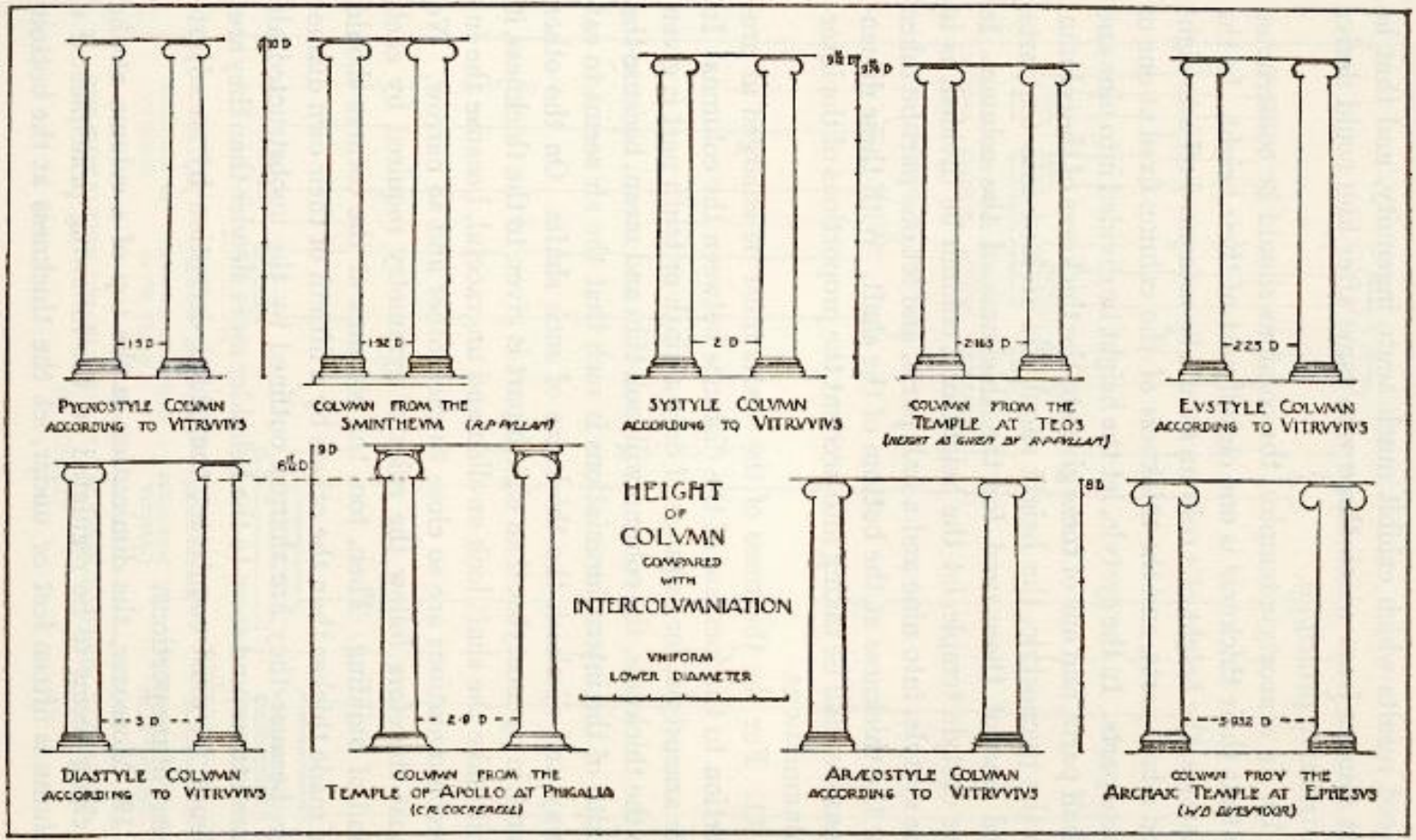



Temple of Portunus
Rome, Italy
3rd Century BCE

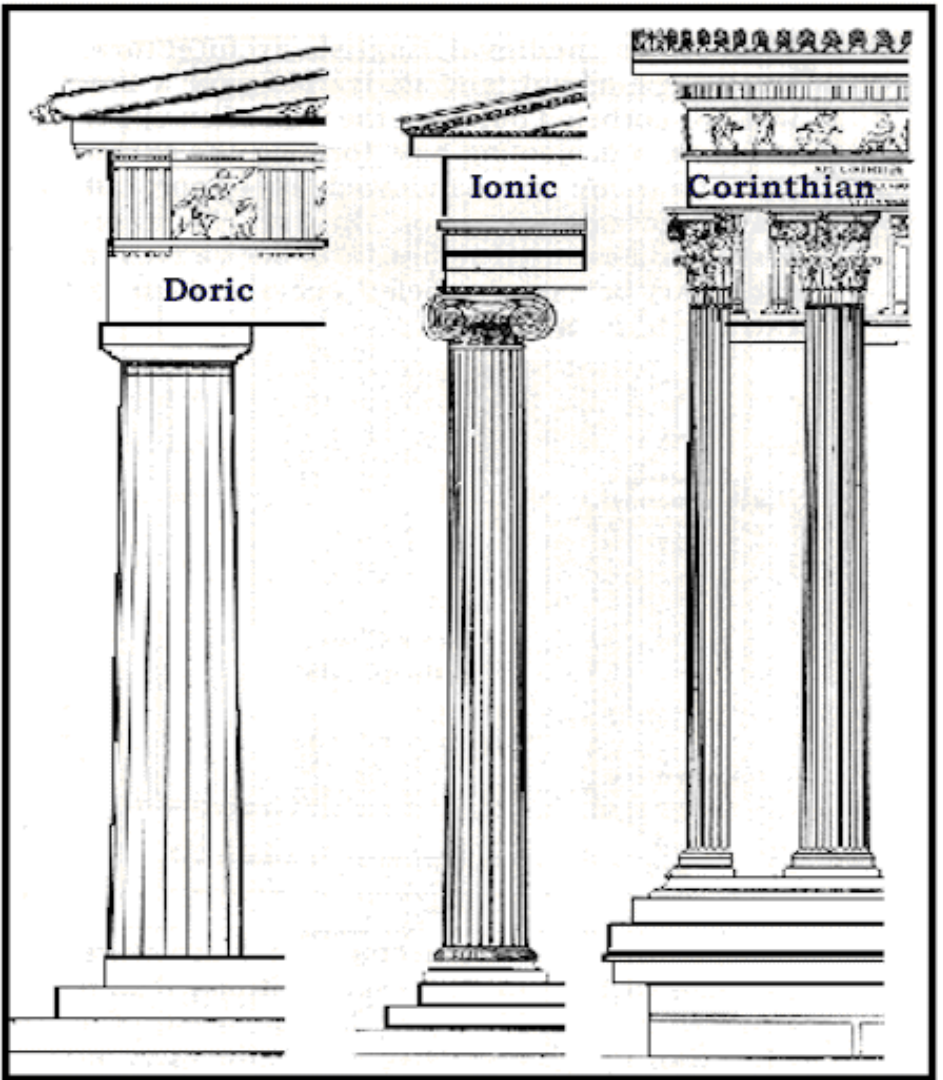
a COLUMN is a freestanding support

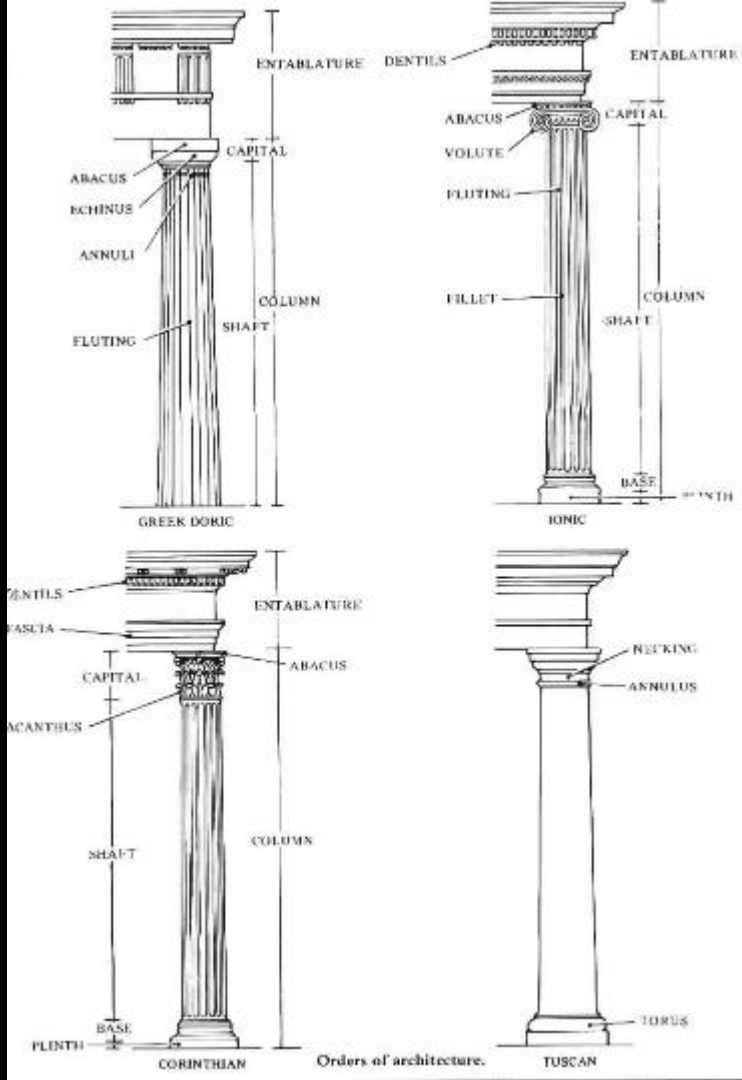
a PILASTER looks like a column
except that it is partially embedded
in the wall

Temple of Hercules Victor
Rome, Italy
2nd Century BCE



VITRUVIUS' RULES FOR THE DIAMETER AND HEIGHT OF COLUMNS IN THE DIFFERENT CLASSES OF TEMPLE COMPARED WITH ACTUAL EXAMPLES


Doric
Ionic
Corinthian


ENTABLATURE
CAPITAL
ABACUS
ECHINUS
ANNULI
COLUMN
SHAFT
FLUTING
GREEK DORIC
DENTILS
ENTABLATURE
ABACUS
CAPITAL
VOLUTE
FLUTING
FILLET
COLUMN
SHAFT
BASE
IONIC
ENTABLATURE
ABACUS
CAPITAL
ACANTHUS
SHAFT
COLUMN
BASE
PLINTH
CORINTHIAN
NECKING
ANNULUS
TORUS
TUSCAN
Orders of architecture.


Temple of Saturn
Roman Forum
497 BCE (contested)