

The use of mortars in ancient buildings: foundations, walls, vaults

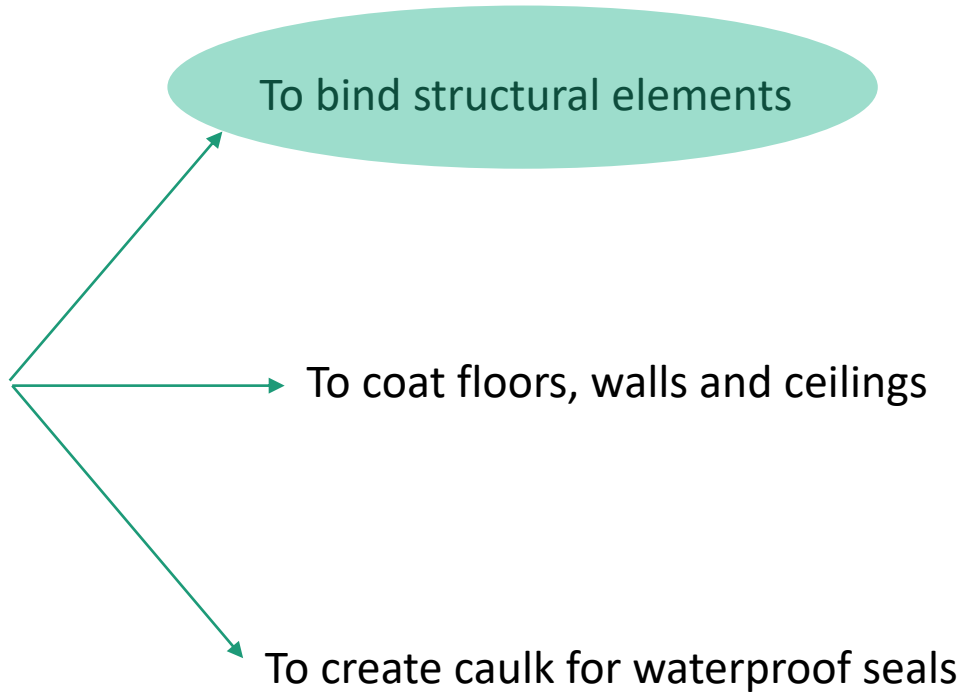
The main uses of mortars

The 3 main uses of mortars in building contexts

To bind structural elements

To coat floors, walls and ceilings

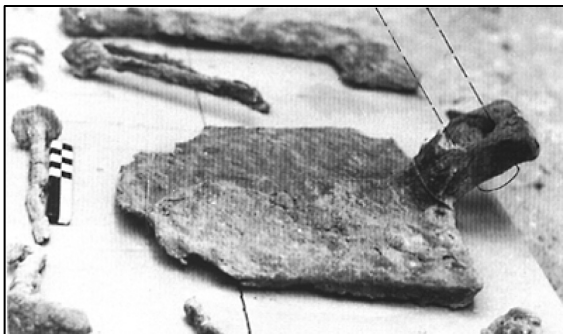
To create caulk for waterproof seals



The preparation of mortars



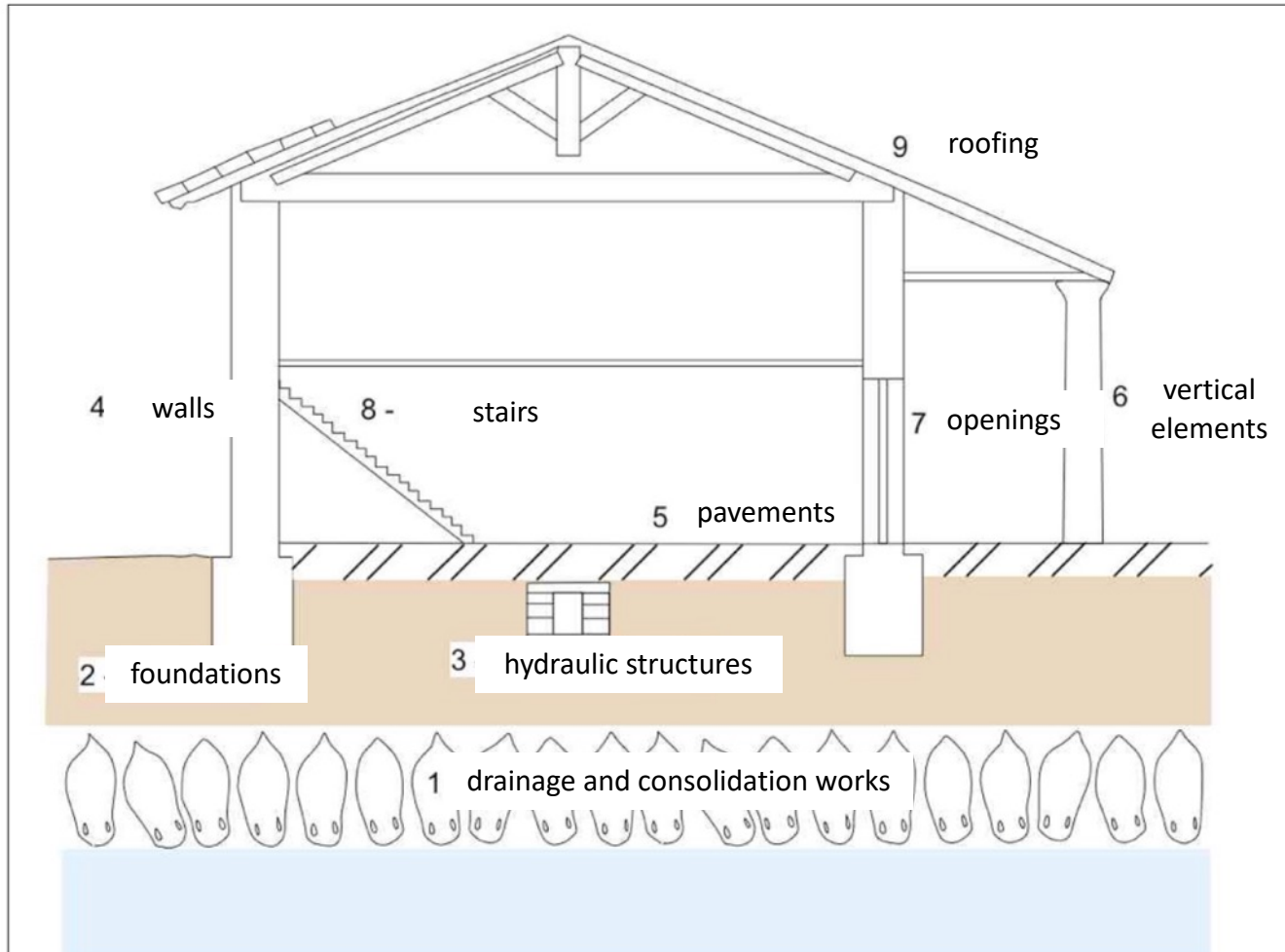
Amphora with its narrow top intentionally broken, used to carry lime, found at Pompeii



Mixing hoe, found at Pompeii



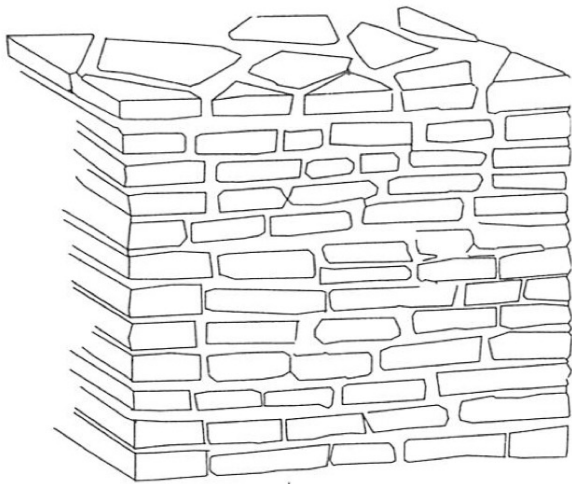
The main constitutive parts of a building



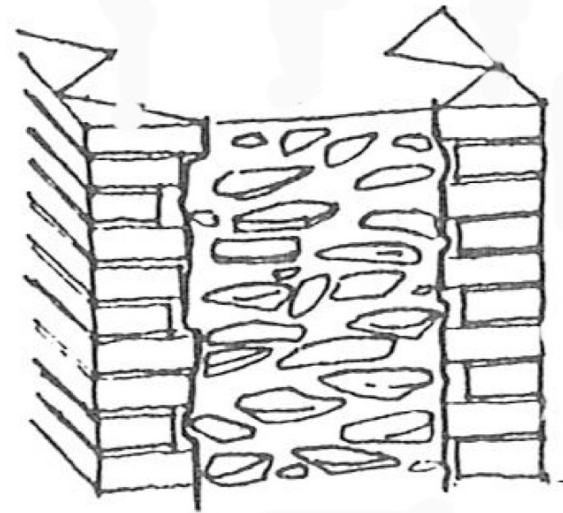
The use of mortars

How was mortar used?

To fill the joints
between stones or bricks

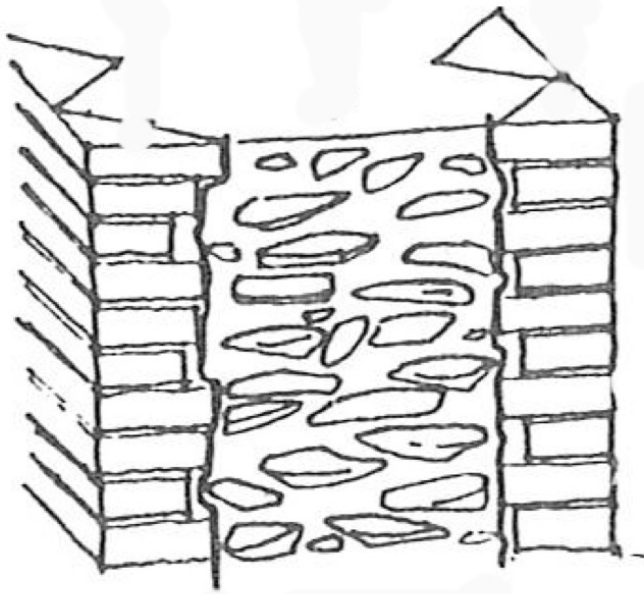


Mixed with stones
in the core of the walls



Opus caementicium

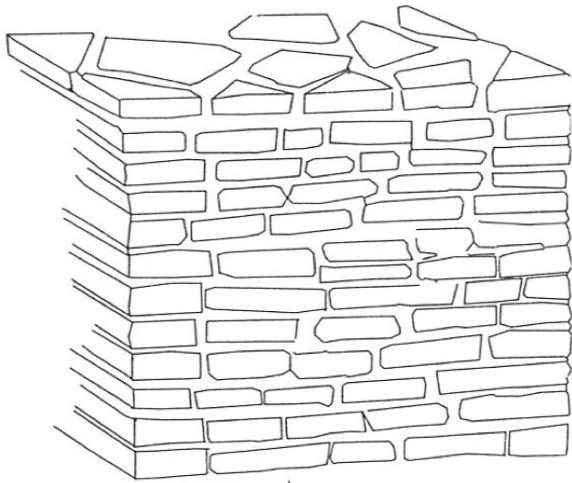
The opus caementicium



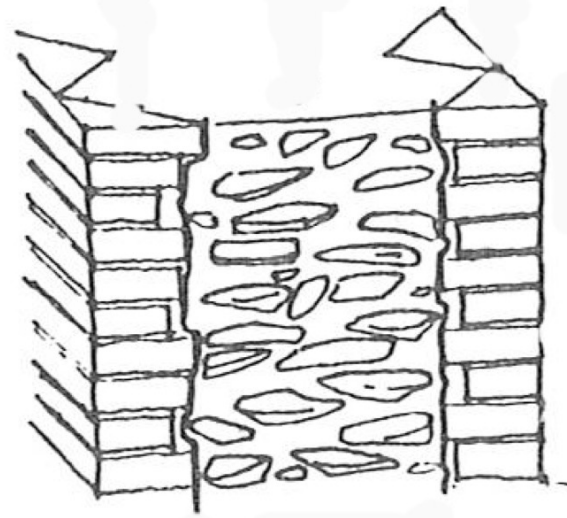
*‘A third way called εμπλεχτον in use among the peasants, is carried out by dressing the facings and filling the middle with mortar and rubble material [ita uti sunt nata, just as they are born], putting in here and there bonders [in the form of headers going into the wall]; our builders, who wish to get on quickly, take care with the erection of the facings and strengthen the middle with **stone chippings mixed with mortar**, thus forming **masonry in three layers**, two being the facings and one in the middle being the core.’ (Vitruvius, 2, 8)*

The use of mortars

homogeneous
structure



three layers
structure



The opus caementicium

Opus caementicium

Uniform mix
of mortar and stones

Alternated courses
of mortars and stones,
tamped to ensure bonding



The opus caementicium

Opus caementicium vs
modern concrete



In *opus caementicium* mortar and stones are **mixed in the wall**

Modern concrete is a mixture **prepared in advance**

Walls with a core in opus caementicium



Peltuinum, calcestruzzo con ciottoli e malta di graniglia

Walls with a core in opus caementicium



Walls with a core in opus caementicium



Capri, faro, calcestruzzo con prevalenza di laterizio

The use of opus caementicium: walls

Opus incertum facing



- ❖ **Masonry made of irregularly shaped stones arranged in an irregular manner (*opus incertum*)**

The shape of the stones depends on natural crushing or on the shape of the quarry bench.

The shape of the stones is unsuitable for bearing lateral thrusts: frequent masonry stasis is necessary to distribute the loads over the entire section of the structure (e.g. brick layers)

Chronology: 3rd c. BC – 1st c. BC



*The facings of walls with an *opus coementicium* core*

Opus incertum facing



The use of opus caementicium: walls

Opus reticulatum facing

- ❖ **Masonry of truncated pyramid blocks with oblique arrangement (*opus reticulatum*)**

Advantages: standardisation of material, regularity of components, speed of production and installation.

Chronology: end of the 2nd c. BC – 2nd c. AD



The use of opus caementicium: walls

Opus reticulatum facing



Structurarum genera, sunt haec: reticulatum, quo nunc omnes utuntur; et antiquum, quod incertum.

There are two kinds of masonry: the reticulate which everyone uses today and the old one which is called uncertain.

[Vitruvius, II, 8]

The use of opus caementicium: walls

Opus reticulatum facing outside central Italy



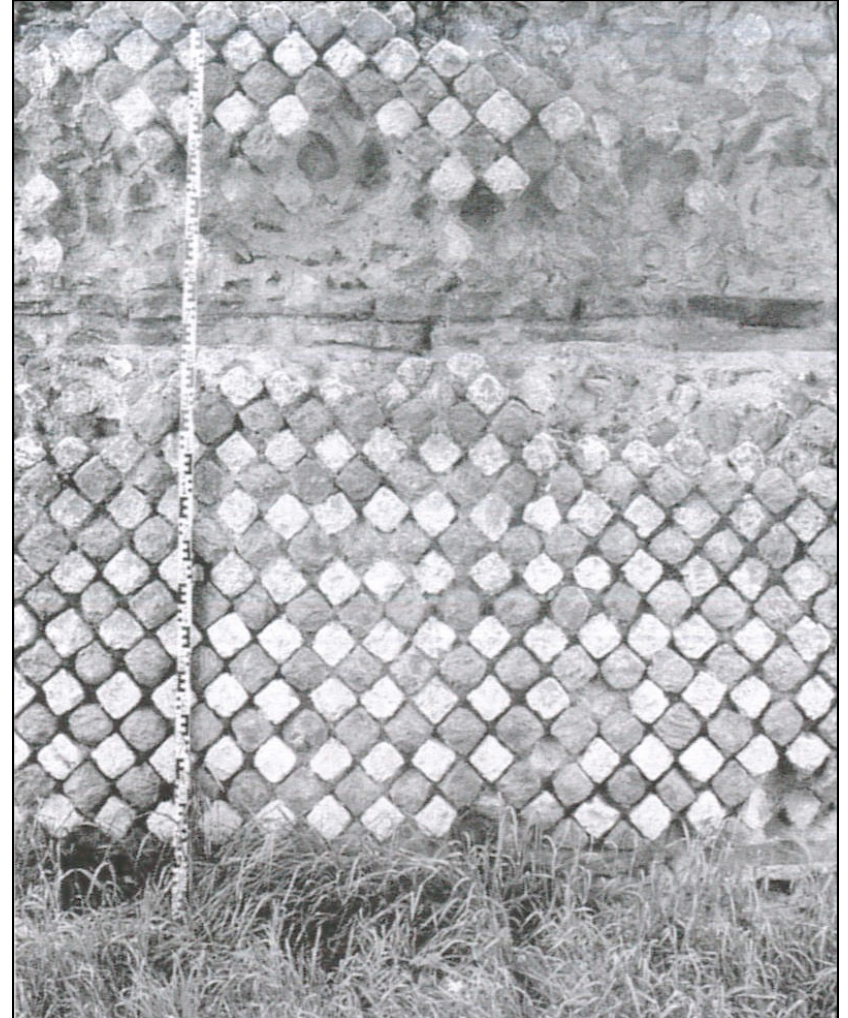
The use of opus caementicium: walls

Opus reticulatum facing



The use of opus caementicium: walls

Opus reticulatum facing



The use of opus caementicium: walls

Opus reticulatum facing



Cuma, the so-called Temple of Jupiter on the Acropolis, Julian-Claudian period

The use of opus caementicium: walls

Opus vittatum facing

- ❖ **Masonry of squared decimetric blocks, more or less regularly arranged in regular horizontal courses (*opus vittatum*)**

Chronology: end of the 1st c. BC – 1st c. AD



The use of opus caementicium: walls

Opus vittatum facing



The use of opus caementicium: walls

Opus vittatum facing outside central Italy: Gaul



The use of opus caementicium: walls

Opus vittatum facing outside central Italy: northern Italy



The use of opus caementicium: walls

Opus mixtum facing

❖ **Mixed masonry**

The elevations are made of different materials (**stone and brick**).

Regular planes to control horizontality and distribute loads over the whole surface by means of layers of bricks (several courses).

Need to proceed in horizontal planes to guarantee greater homogeneity of the structure and in some cases to ensure the link between the core and the facing.



The use of opus caementicium: walls

Opus mixtum facing



The use of opus caementicium: walls

Opus mixtum facing



The use of opus caementicium: walls

Opus mixtum facing



The alternation of block and brick courses can vary within the same building, as on this tomb from the Eastern Necropolis at Ostia.

The use of opus caementicium: walls

Opus mixtum facing



Whereas in the *opus mixtum* constructions in Italy the brick courses are only elements of the facings, the Gallo-Roman builders used this material to great benefit in making true **horizontal bonds connecting the two faces of the walls**. Thus the three separate parts, consisting of facings and core, were united at intervals, for instance the walls of a building fixed by the floor levels. In many cases, these brick courses corresponded to one shuttering in height or one day's work and their intervals followed the gaps between successive levels of scaffolding, as is evident from the positions of the putlog-holes.

The use of opus caementicium: walls

Opus mixtum facing outside central Italy



The use of opus caementicium: walls

Opus testaceum facing



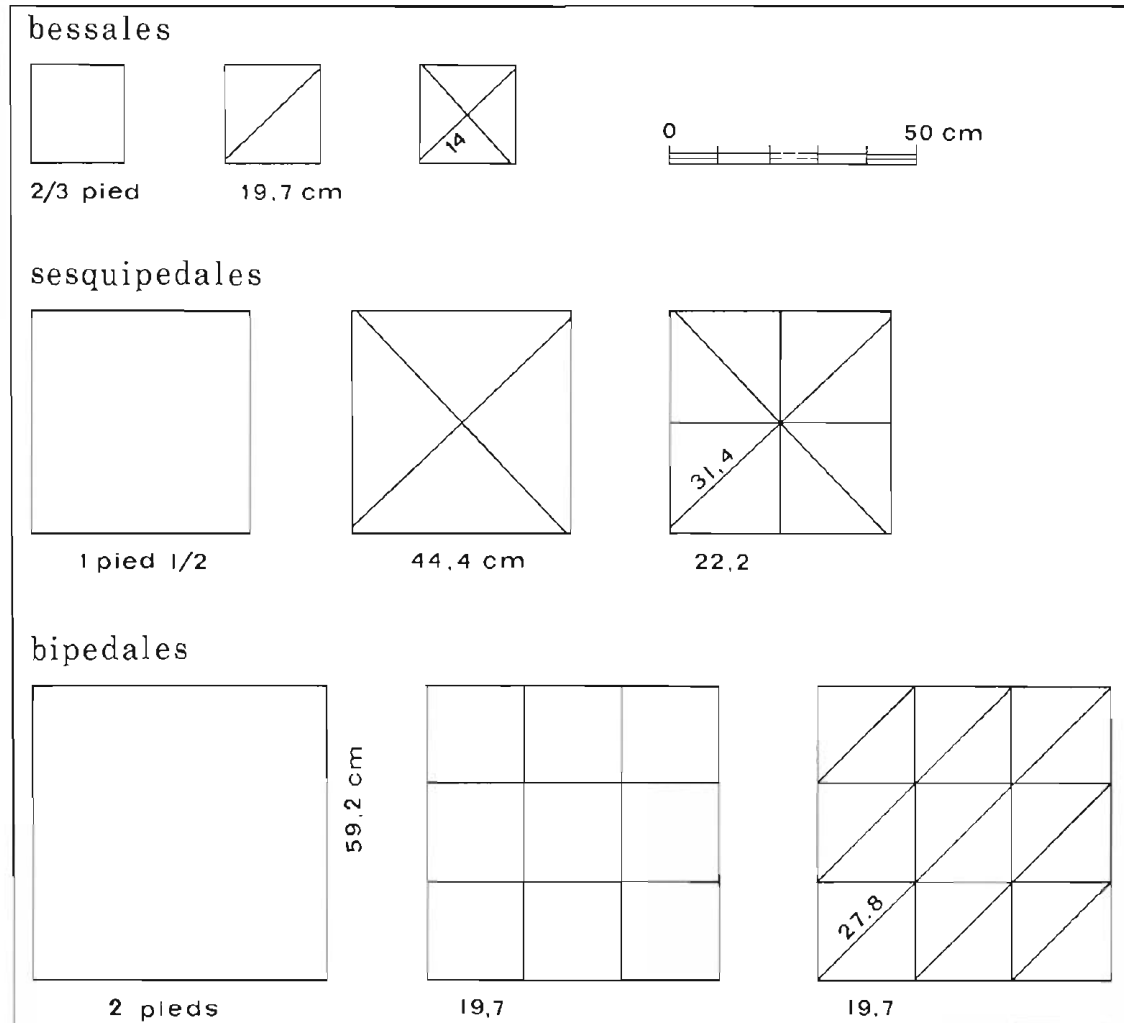
❖ **Masonry of fired bricks arranged in regular horizontal courses (*opus testaceum*)**

Chronology: from the 1st c. AD onwards



The use of opus caementicium: walls

Opus testaceum facing



The use of opus caementicium: walls

Opus testaceum facing



The use of opus caementicium: walls

Opus testaceum facing

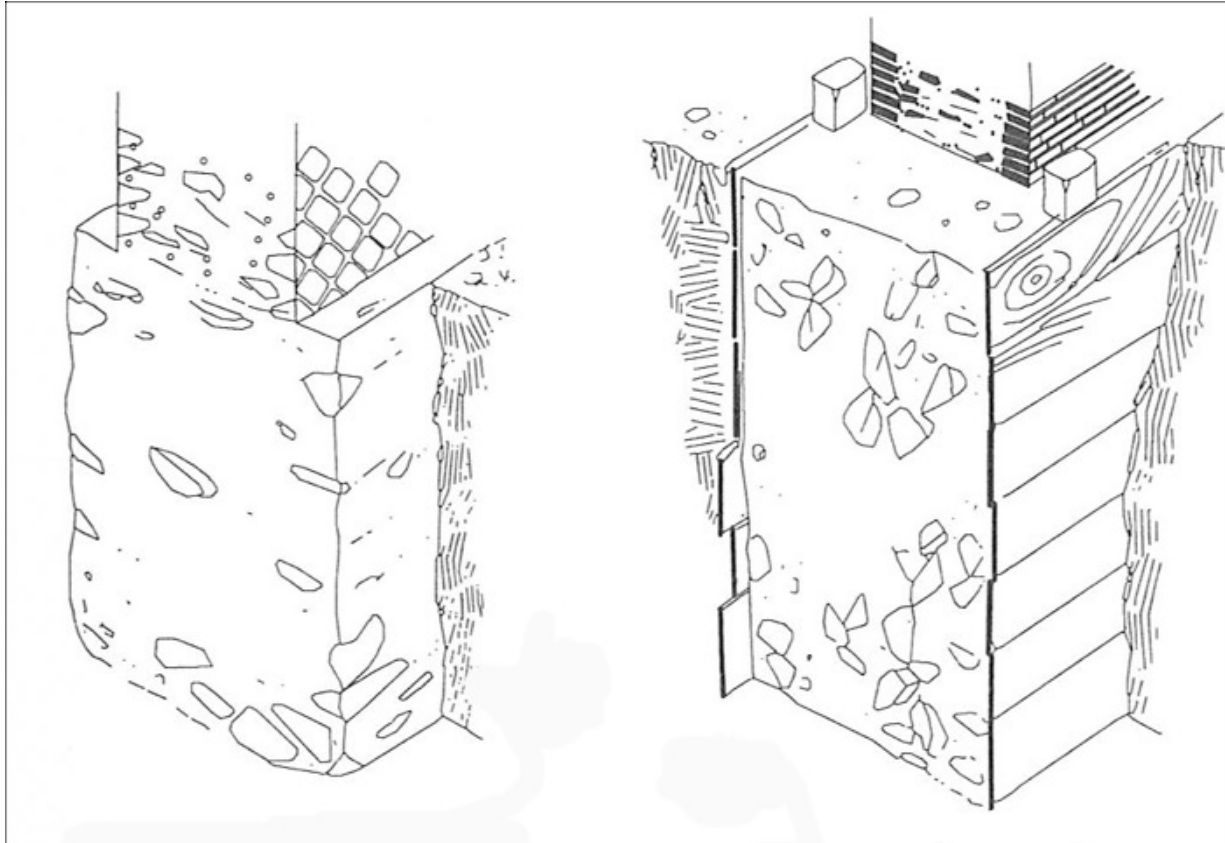


The use of opus ca

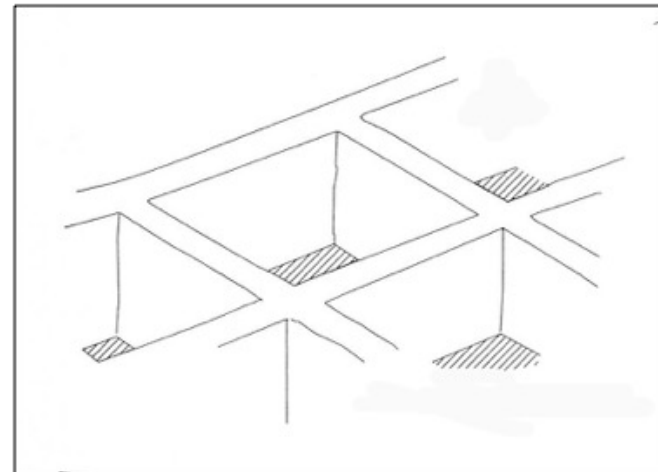
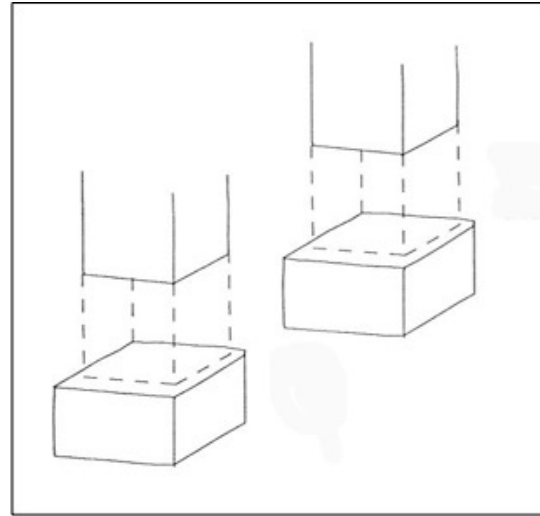
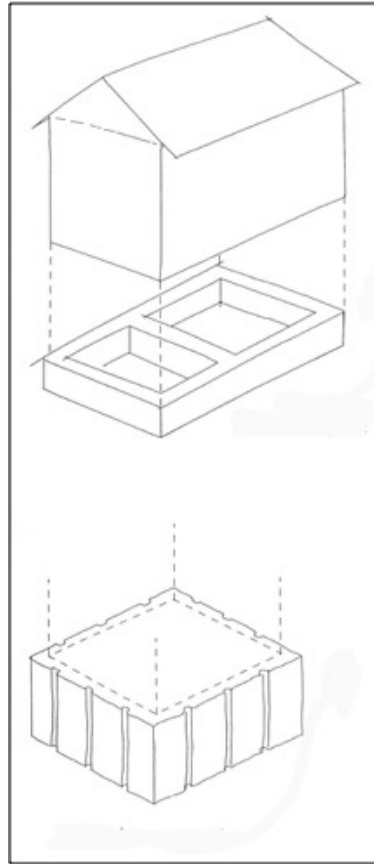
Opus testaceum facing



The use of opus caementicium in foundations

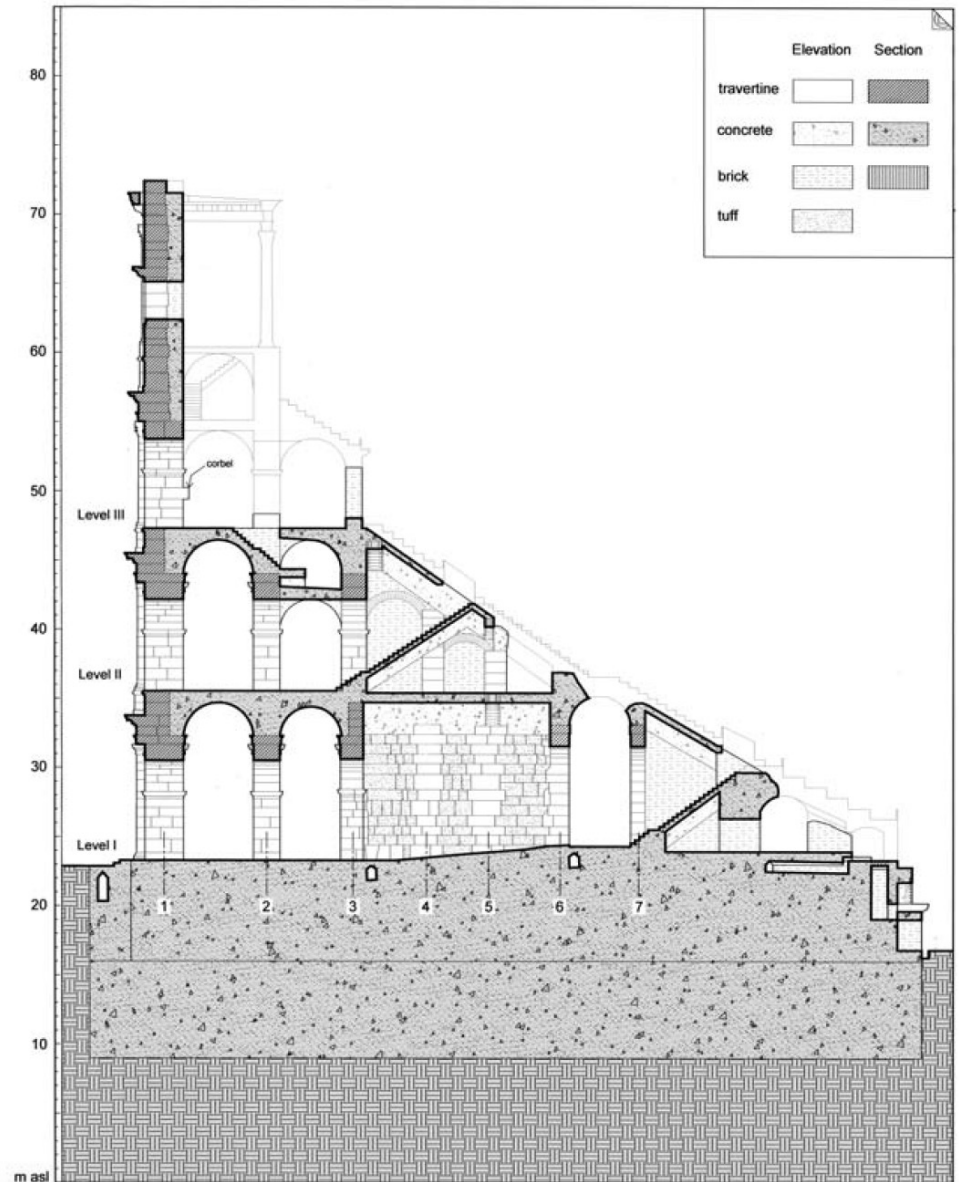


The use of opus caementicium in foundations



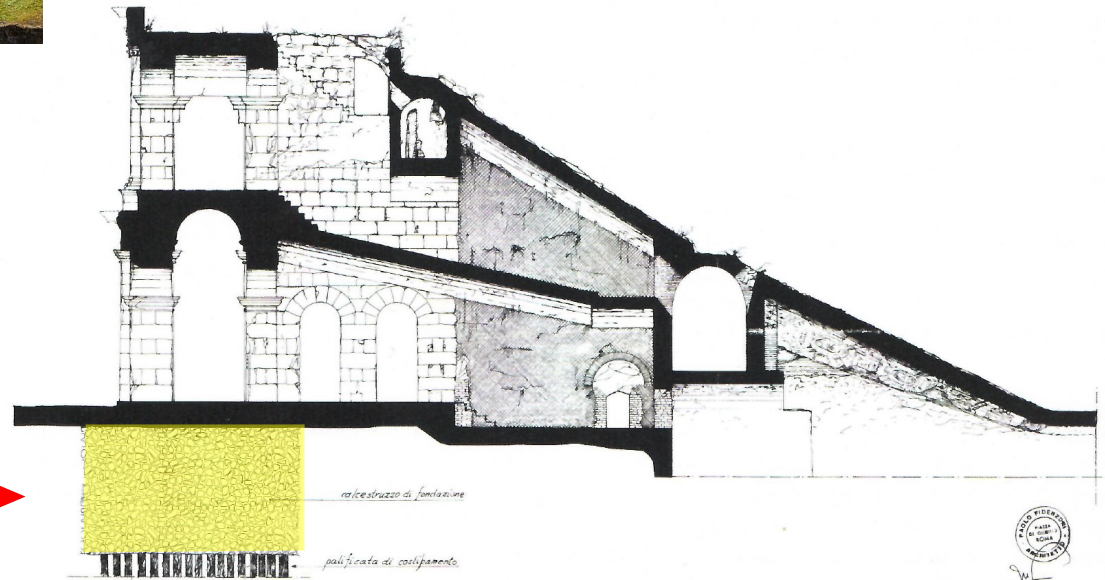
The use of opus caementicium in foundations

The foundations of the Colosseo (1st c. AD)



The use of opus caementicium in foundations

The foundations of the Marcellus's theater (1st c. BC)



Concrete platform

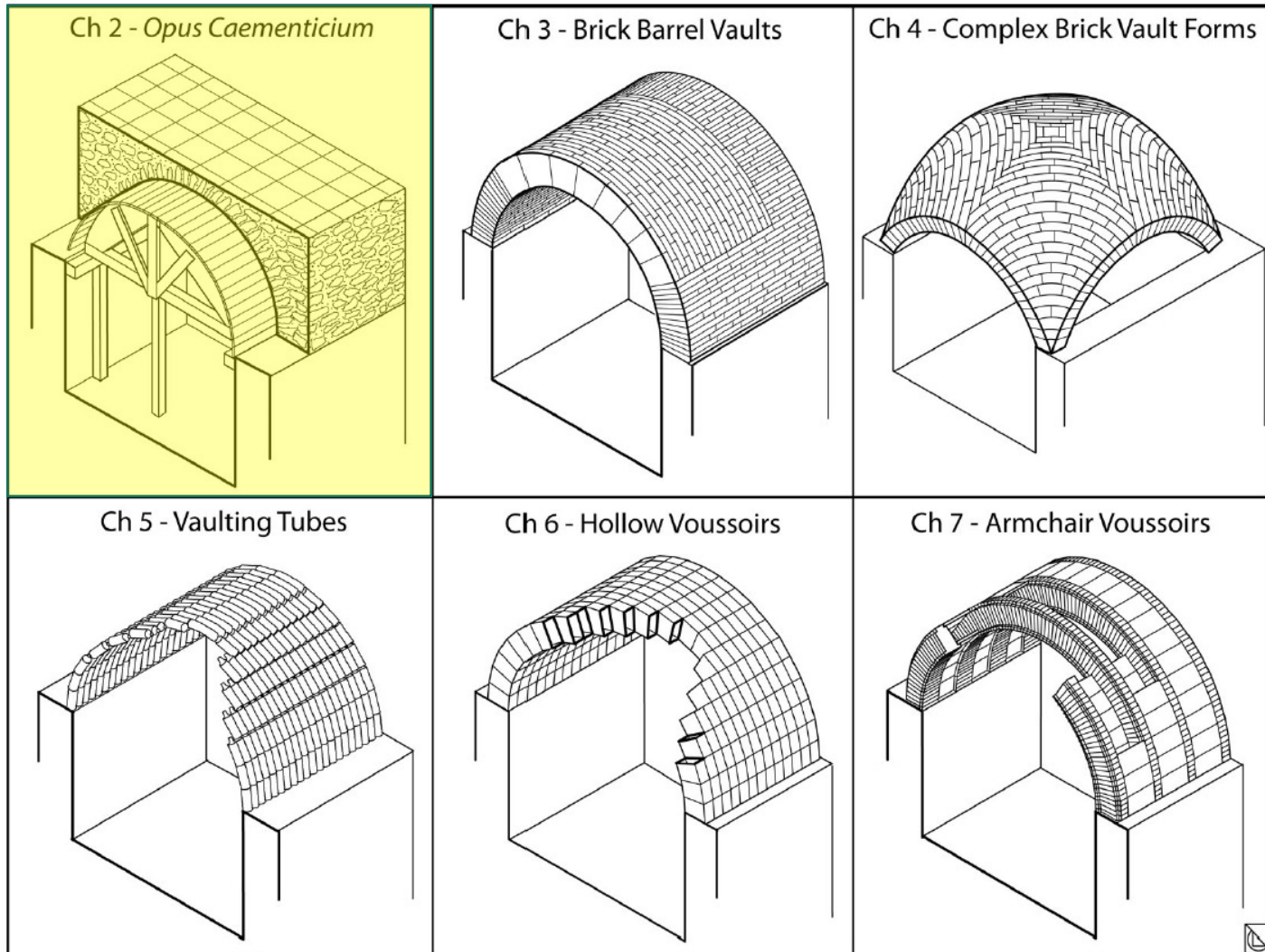


ricostruzione di fondazione

pali ficati di consolidamento

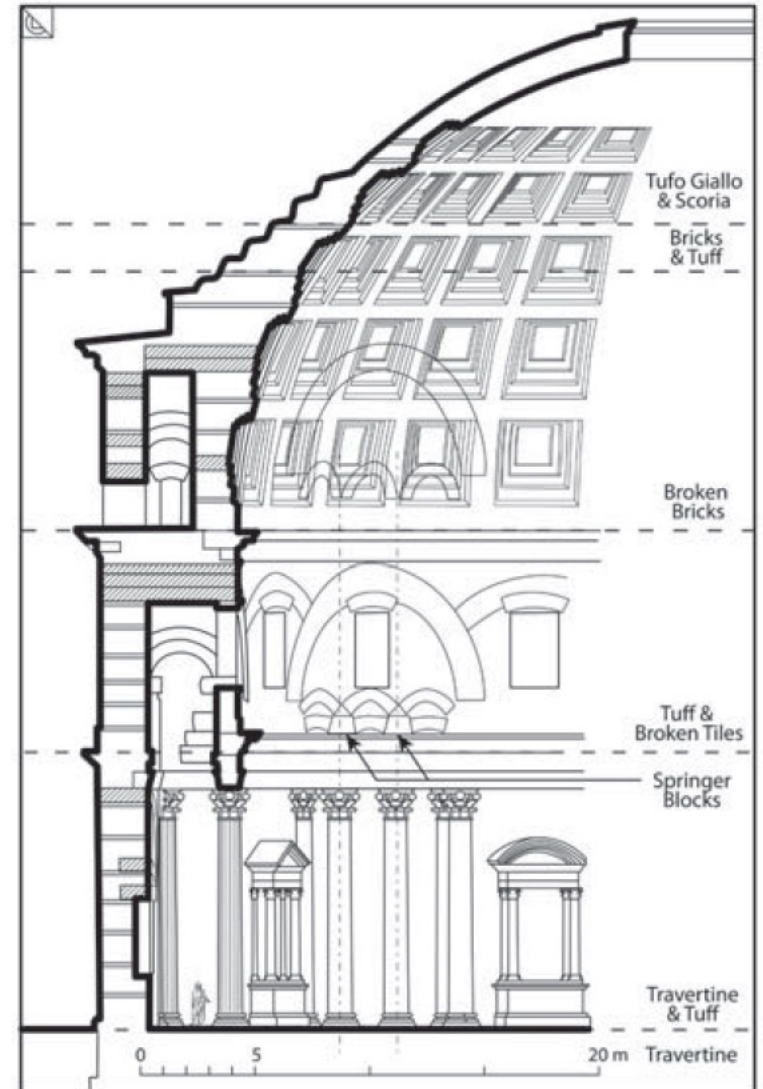


The use of opus caementicium in vaults

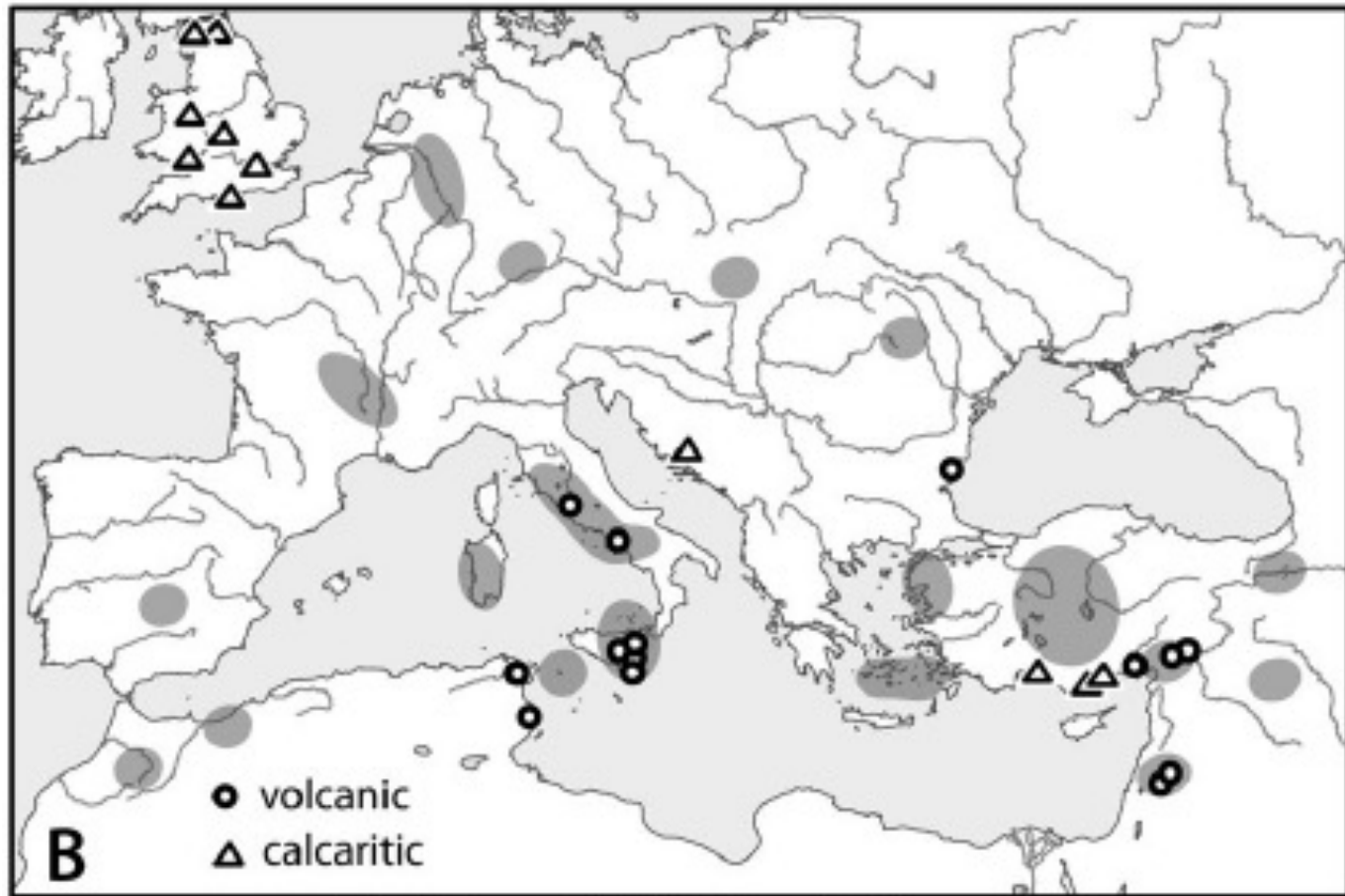


The use of opus caementicium in vaults

The Pantheon (112-124 AD)



The use of opus caementicium in vaults



Vaulting with lightweight *caementa*

The use of *opus caementicium* in vaults

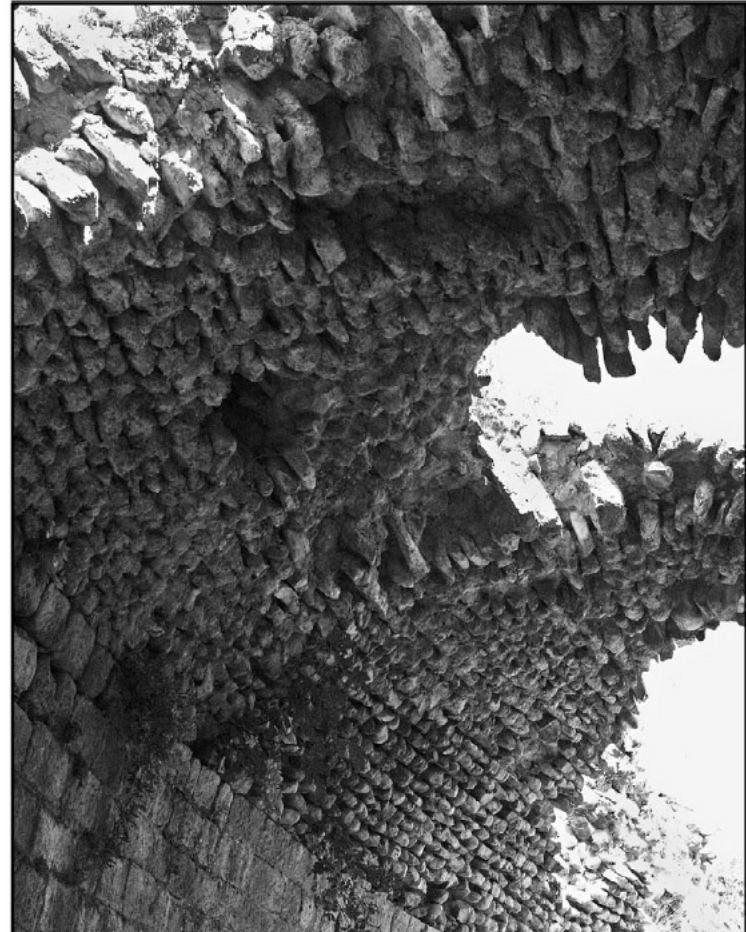


13. Examples of radially laid *caementa* combined with courses of radially laid brick. A: Substructures of the Palace of Diocletian at Split, Croatia (early fourth century CE). B: *Praefurnium* for *caldarium* of the Imperial Thermae at Trier, Germany (early fourth century CE). Note vertical tubes in vault for ventilation. The iron tie bars are modern. (Color image: WebFig. 6).

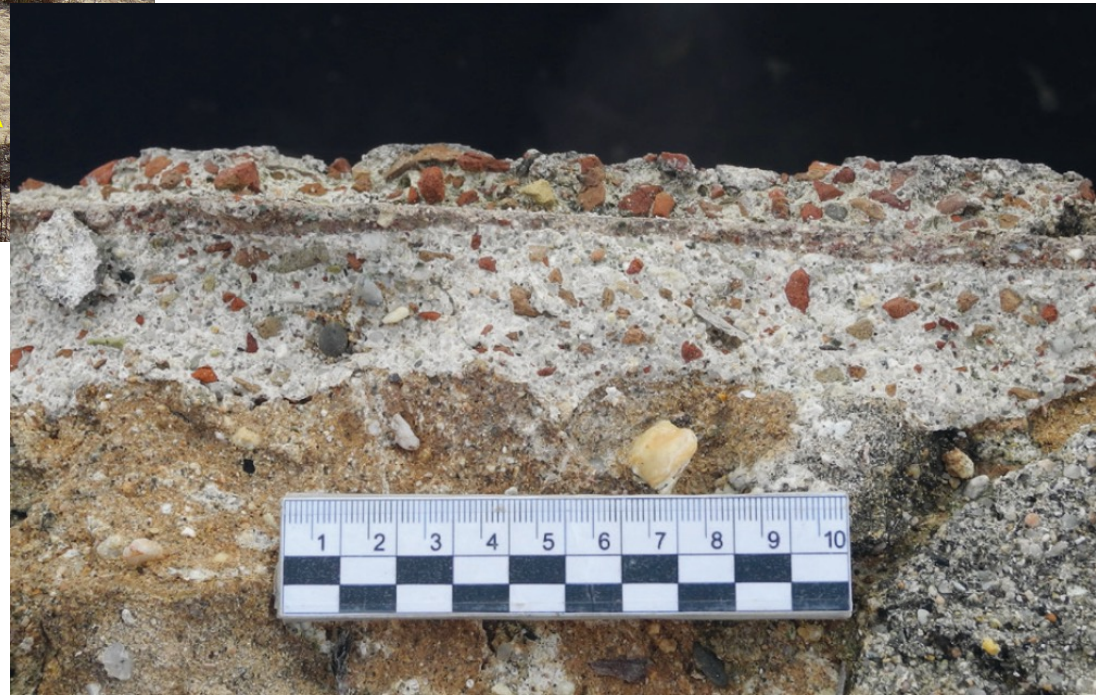
The use of opus caementicium in vaults



The use of opus caementicium in vaults



The use of mortar for coating structures



The use of mortar for coating structures

