A Day at the Centre for the Acropolis Studies

The Construction Of An Ancient Greek Temple

The ancient Greek temple was not in itself a place of worship but more a city's offering to a specific deity or deities. Worship took place around the building and not inside it. As a result, the temple developed as a structure concerned more with external appearance than with interior form.

As a rule, entrance to the temple was made from the east face. Specialists have long argued over the exact orientation of Greek temples. It is possible that they faced the direction in which the sun rose on the feast day of the particular deity.

The area in front of the temple's east entrance was reserved for the assembly of the faithful and constituted a kind of square with altars for sacrifices and various votive offerings, usually sculptures. Here one would also find stelae bearing inscriptions of civic laws, decrees or general texts that had to be made public.

The temple's interior was left dark; the only light came from the entrance when the door was open.

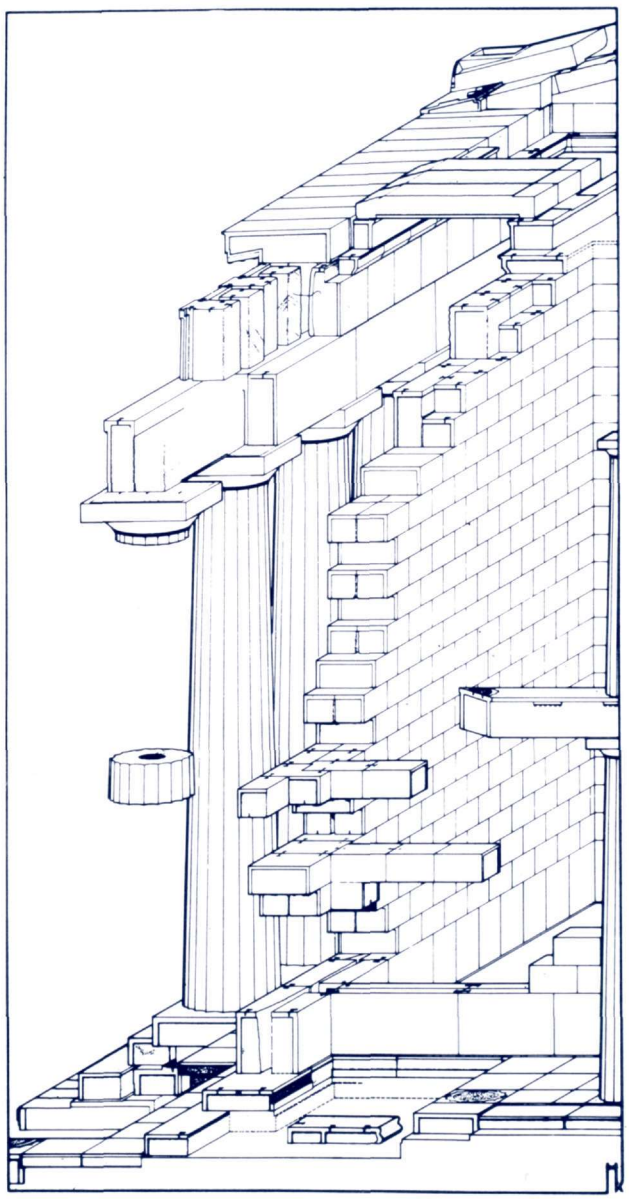
Compared to the later stone temples, the construction of the first temples was far more simple: a wooden frame supporting clay-brick walls with a base of small stones was usually the rule.

By 620 B.C., we already find the application of dressed blocks in temple construction. In the 6th century B.C. this becomes the norm with the result that the use of wood and clay was eclipsed, at least in the more important monuments.

The forms of the wooden temples were retained in that of both orders of stone temple.

A morphological analysis, especially of the Doric temple, indicates that the whole building came very close to the wooden prototype carefully copying even the smallest details in stone, such as the nails used to join the wooden members together. Here we have a kind of 'petrified wooden structure'.

It seems, however, that the forms that were coppied in the new medium of stone on the one hand could be expressed through the new material, on the other they had an aesthetic or artistic value in themselves. At the same time it appears that quite a few new morphological features were added.

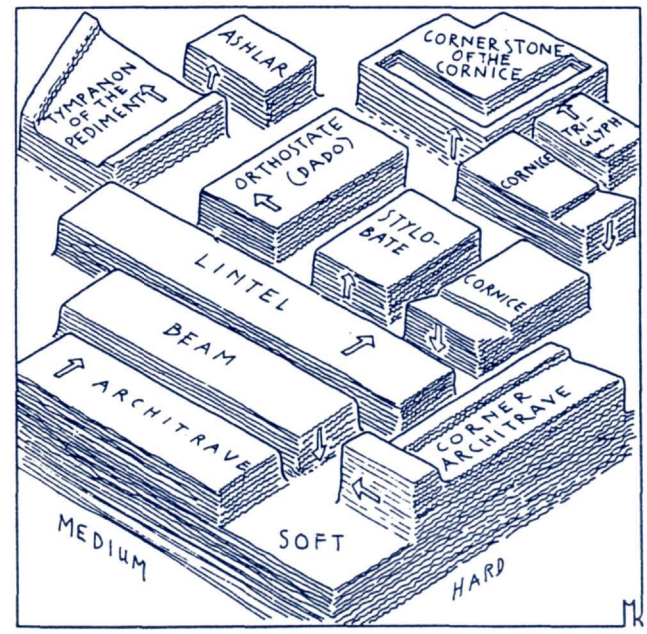


The way in which public projects were planned and realized in Ancient Greece is mainly known to us from Athens.
The Assembly of Citizens ('Ecclesia of Demos') appointed directly the architect in charge for the project as well as a small (five members?) committee that would oversee the works. The committee in which the architect participated had a secretary and occasionally a treasurer. The architect prepared the plans as well as exact specifications of the project; however, he could be replaced by other architects who would supervise the construction that could last many years. Subsequently the committee assigned parts of the project to contractors or individual craftsmen.
The projects were assigned in the Voulé (Parliament) which were responsible for controlling public funds and prosecuting the offenders.
The committees consisted of Athenian citizens. They were of short duration (yearly?), but they had great responsibility and some power since they delegated the projects directly to groups of craftsmen.
We can understand the manner of the work of the committees with the help of the texts that have survived engraved on stylae (the 'building inscriptions').
These texts are concerning the erection or the repair of ancient buildings; they defined the obligations of contactors and craftsmen, and included descriptions, accounts, committee reports and additional items, all in great detail. These texts, engraved on marble stylae were displayed in public areas so as to make the above information available to all citizens, since great sensitivity prevailed in common matters.
The building inscriptions of the Erechtheion for example provide a lot of information, with names of on-site personnel, individual job descriptions and relevant costs. This way, we learn that of the 107 workers and craftsmen, 24 were Athenian citizens, 42 metics, 20 slaves and 21 unknown. Many of the slaves belonged to the craftsmen and worked side by side with their masters on the project, moreover, if they did the same work they received the same wages.
The architect and his secretary received a yearly salary. All the others were paid with daily wages or by the item.
The architect was responsible for the faithful following of given specifications and for the maintaining of a superior standard of workmanship.
Architects built plans and miniature models of the buildings, as well as prototypes which the craftsmen would copy. Unfortunately, very little is known to us about ancient Greek arcitectural plans. Furthermore, we have very little information about the technical systems used for measurements and for high precision drawings, necessary for the ancient constructions.

Ch.B.

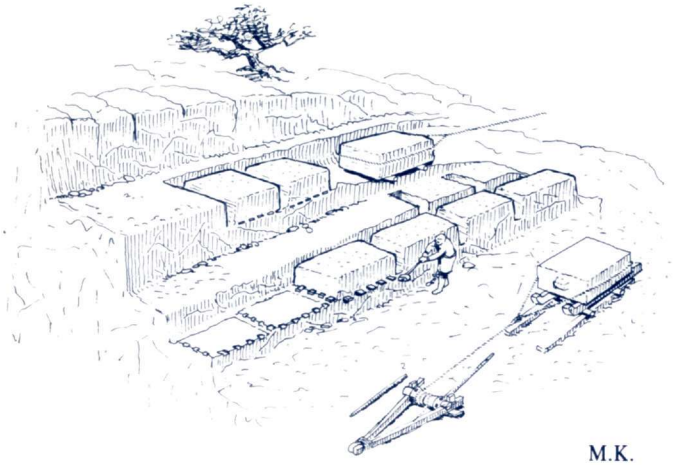
The construction of ancient temples consisted in their being assembled from the largest possible hewn blocks. These stones, the 'Architectural Members' have a simple geometric form and are joined together 'dry' that is without the use of mortar.
The selection of different stones depended mainly on the current character of the architecture, ideals, finance but also from the distance of the site from the quarry. (The marble of the Parthenon was cut from the location Spilia on Mount Pentelikon, 16 km from the Temple).
The size of the stones depended principally on the nature of the quarry, the methods of cutting out the stone, and the economics of cutting and transporting the material.

The mechanical qualities of the marble, and in particular its hardness, varied according to the three different directions of the texture of the stone. A certain orientation was demanded in the layers and folds of the material to accord with the block's position and the type of preparation work along its



surfaces. Criteria for this orientation were the direction and orientation of the stone's profile, of the

channels made during quarrying and of the cutting surfaces. Naturally, certain architectural members bearing sculptured details (metopes, frieze, cymatia, etc.) demanded marble of a higher quality.
Quarrying of the marble was not simply difficult and heavy work but also necessitated unbelievably sharp judgment in planning the stages the material would go through during quarrying and subsequently during its production into structural elements in their initial, half-worked form.



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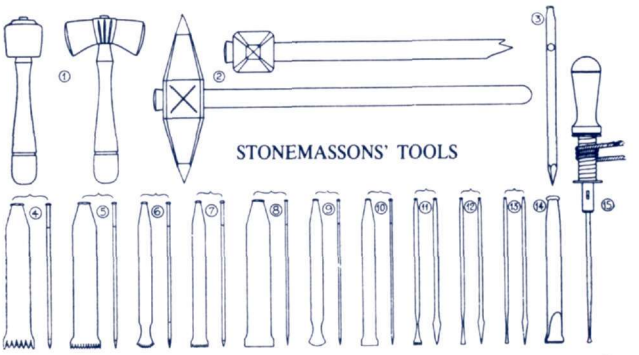
In an ancient Greek quarry, the stone was usually cut out in stages. Deep cuts were made in the sides of the stones, and heavy hammers were used to drive iron wedges through the cuts thus splitting off the stone.
Transportation of the stones was very expensive. Special care was taken so that only the absolutely necessary weight is transported.
Thus each piece of marble was cut to the dimensions needed to fashion them into any particular architectural member. Aditional thickness was left around the marble and remained unworked to protect the final surface from possible damage.
The marble blocks were removed from the quarry by means of sledge-like vehicles 'eschares' which slid on a paved downward-sloping road; ropes rewinded around posts firmly planted in the ground helped in gradually lowering the load.

The transportation of the un-worked stone blocks from the quarry to the workshop was executed with a four-wheel cart drawn by many pairs of mules or oxen. Especial care was shown for the proper upkeep of the roads on which this transport was made.
The loads were taken up to the Acropolis on ramps with the help of special hoisting systems using animal power.

A strict systematic programme ensured that the half-worked architectural members reached the workshops not only in the order in which they would be needed during construction but also in accordance with the time demanded for their preparation for insertion.

In the classical era the intermediate and consequently 'unfinished' stages of the work were done with incredible care, precision, and elegance, giving them a certain 'completeness'. In addition to the mentality of the Greeks for the 'completeness' of half finished works, unstable political and economic conditions forced works to be interrupted for whole decades, and many monuments were forever left unfinished. (Propylaia).



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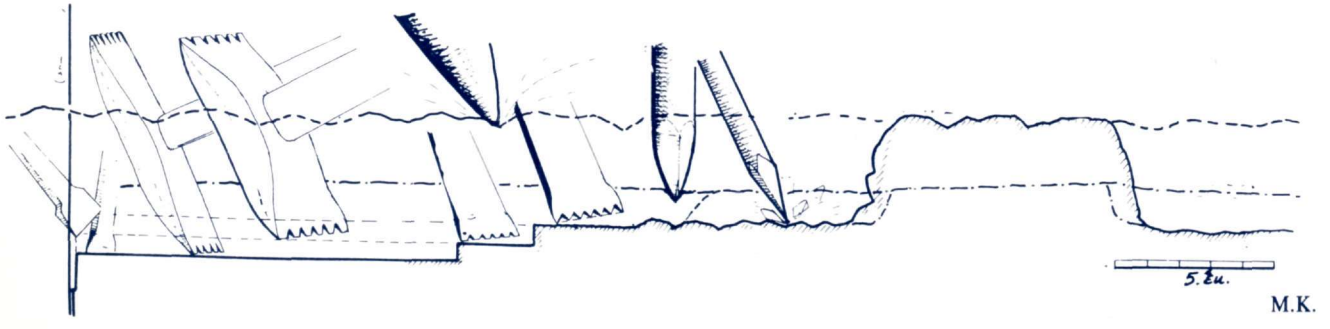
1 hammer 2 pick 3 pointed chisel 4 coarse toothed chisel 5 medium toothed chisel 6 toothed gauge 7 fine toothed chisel 8 flat chisel 9 flat gauge 10 fine flat gauge 11 and 12 fine gauge 13 purich 14 cutter 15 auger

The stone cutting tools the ancients used remain identical and are used today in the same manner.
The dressing of a surface was done according to the



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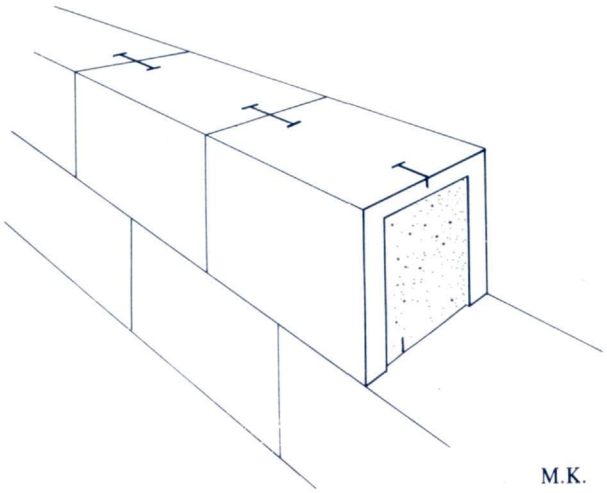
position of the stone in the structure, i.e., whether it was a vertical or horizontal sufrace, and whether or not it was to be seen or joined to another stone. Surfaces in horizontal joints were completely worked to give perfect contact over their entire area.
For the horizontal curving they used a variety of fine toothed chisels with the parallel use of precise rules this way constantly controlling and guiding the sculpting. The variety and shapes of the marks left on the stones are characteristic.



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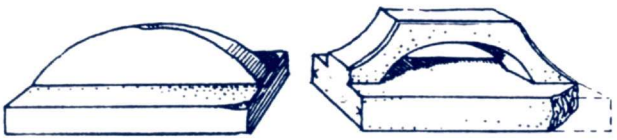
Vertical surfaces were smoothed to make contact in a marginal band 5-15 cm. wide (anathyrosis), while the rest of the surface was left at a deeper level rough. Initial preparation of the blocks' contact bands was made in the workshop with a toothed chisel; however, the final working of the bands occurred during the blocks' placing in the building when trial joins were made followed by smoothing of any remaining irregularities with a float.



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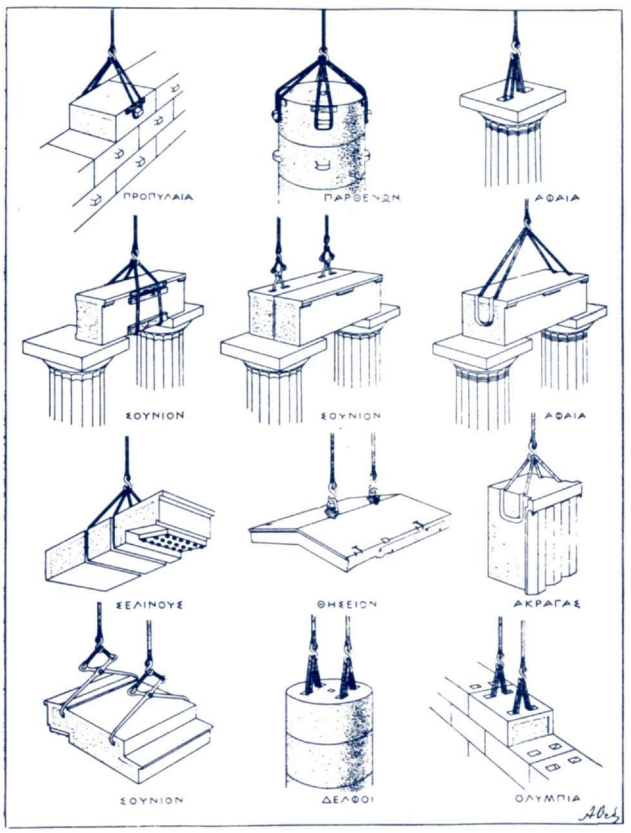
The result of the unsurpassed skill of the ancient craftsmen was a perfect matching of the stones, 'Harmonia' as they called it. At the Parthenon many joints are estimated to be less than $^{1}/_{100}$ mm. wide. It is characteristic of such perfect joints in marble that often when a crack develops in one stone it extends to the neighboring stones as if there were no joint between them.

The stones were transported and positioned by one or a combination of the following means: cranes,



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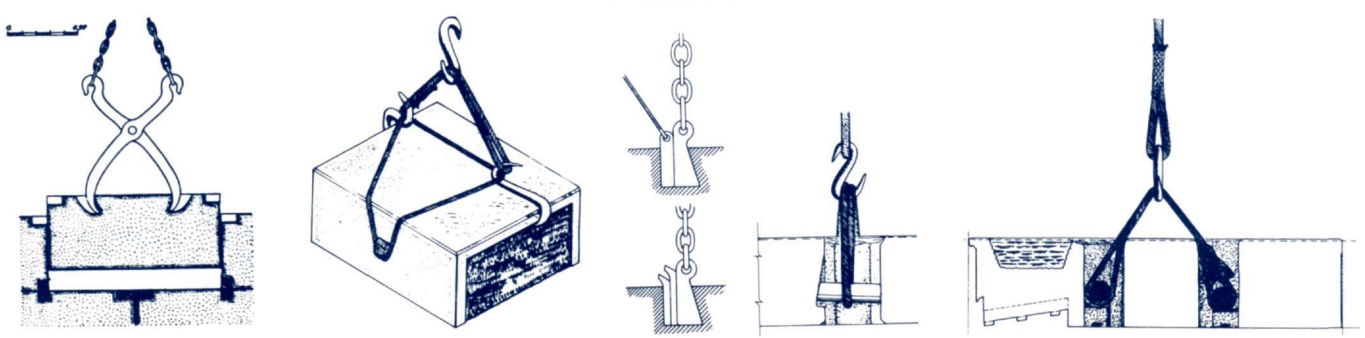
sledges wooden rollers, levers of wood or steel. Stones were fastened for hoisting in several ways; with plain ropes carefully placed to protect the edges; with ropes which had been attached to special horizontal grooves; with ropes and hooks fastened to lifting bosses (small projections of excess marble to be removed after hoisting) with steel chains and

PARTHENON



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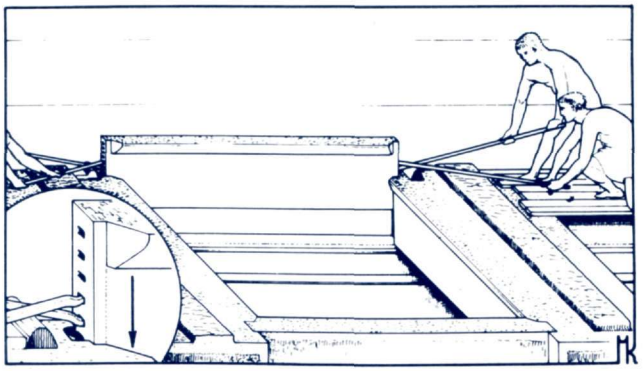
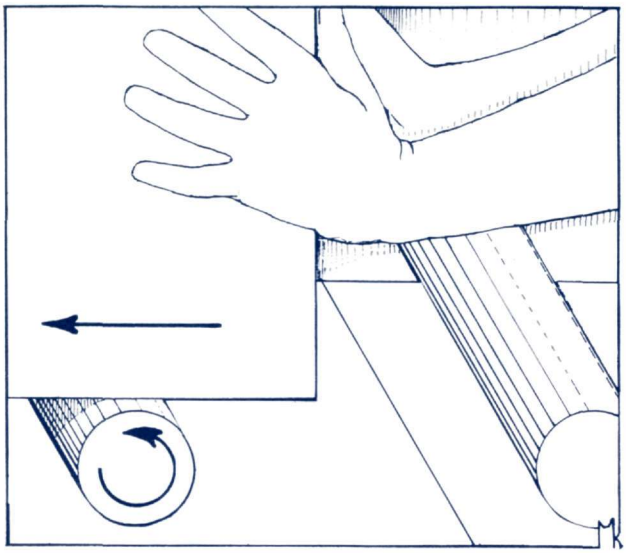
hooks fastened in special holes in the stone; with lewis and wooden 'anchors' fixed in large vertical holes in the stone.

During construction of walls or of any structure consisting of horizontal courses of stones (e.g., foundation, frieze, cornice, etc.) each level was usually finished before the stones of the next were set



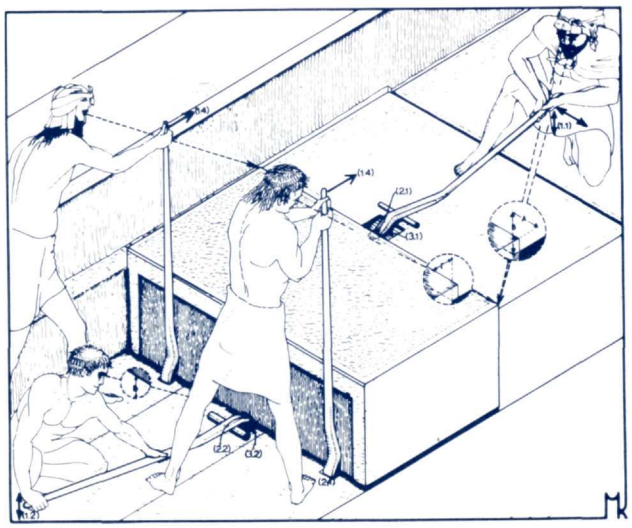


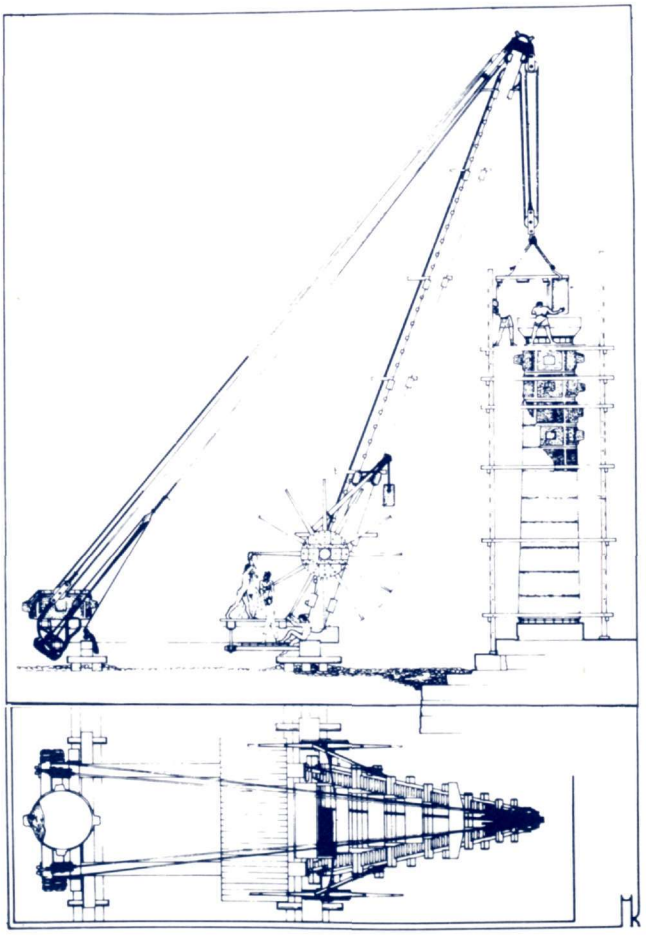
the level, gradually nearing each other until the final stone (kataphrage) was put in place, usually from above, with the use of levers.

Certain architectural members such as column drums, capitals, and the sculptures on the pediments were naturally put in place directly with a crane or some other hoisting system.

The architectural members of the ancient Temples were joined together without the use of mortar. The enduring stability of an ancient structure is not due to the use of mortar, but to the combination of

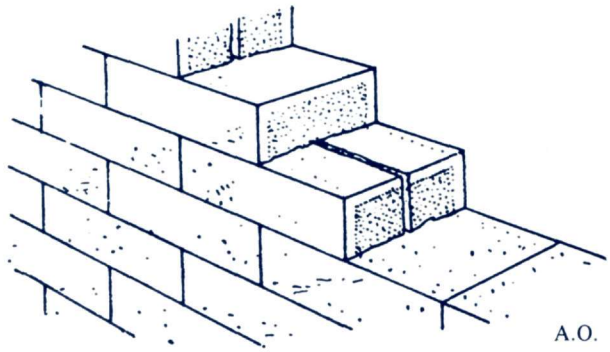
in place. Thus it was possible to hoist the stones at one or two places along the wall, and then to place them on rollers and to transport them horizontally to their final positions;





The stonemassons then with the use of levers positioned the stones.
The stones were laid starting from the two ends of

the perfect contact of the stones 'dry', with the forces of friction which were very strong due to the great weight of the structural elements. The careful arrangement so that vertical joints of successive



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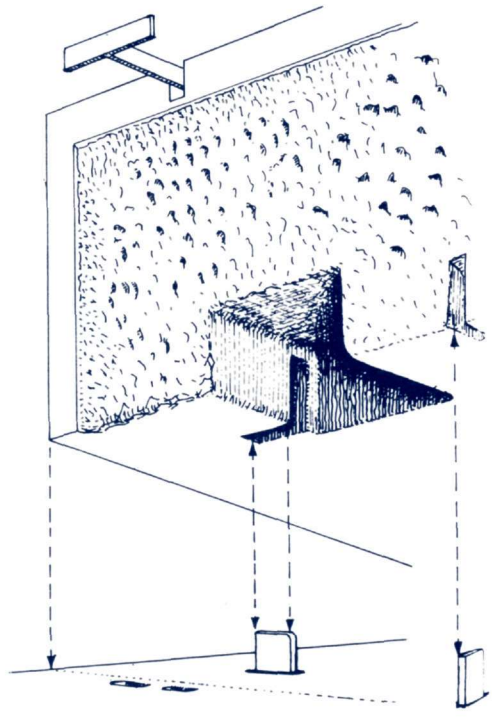
courses do not coincide, that is the interweaving of the blocks together with the forces of friction kept the construction coherent.
The resistence of the structure during an earthquake



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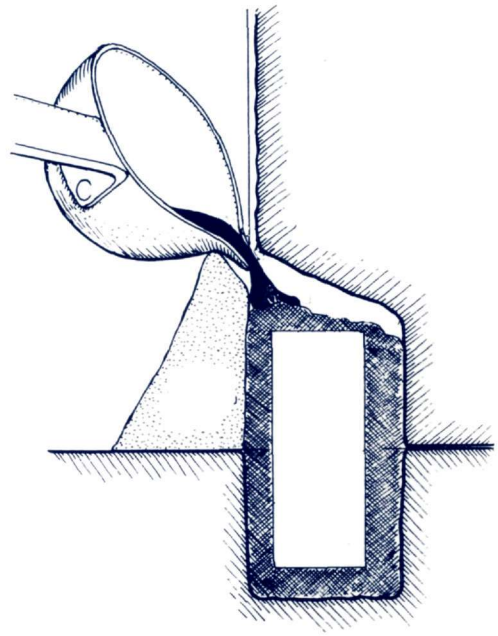
was secured not only through the interweaving of the blocks but also with the fastenings usually made of iron. For the horizontal connections different shapes of clamps were used, but most often those shaped like a double 'T' and for the vertical joints small rectangular dowels called 'gomphoi'. It should be noted that for the Parthenon the dimensions of these connectors were chosen so that under extreme loads the connectors would break, not the marble.

The cuts to receive the clamps were made in the shape of the clamps but perceptably larger so that molten lead could be poured around the connectors. The lead made for a more complete bond between the clamp and the stone, and because of its softness,



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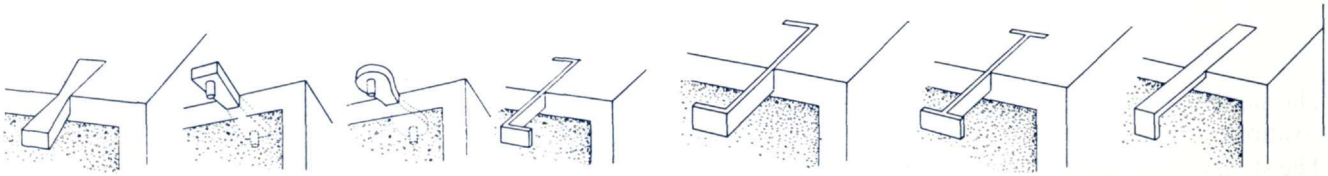
absorbed part of the vibrations and energy of an earthquake, and at the same time protected the iron from the environment and oxydation. The random and assymetrical placement of the clamps within the joints is a result of the search for their ideal location in the veins of the marble. Today, the irregularity of their placement serves as important evidence in the archaeologist's search for the ancient order and arrangement of stones fallen or moved from ancient structures.



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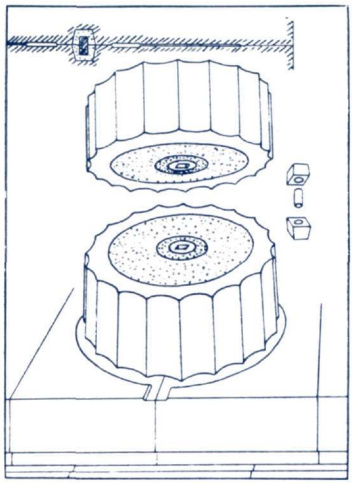

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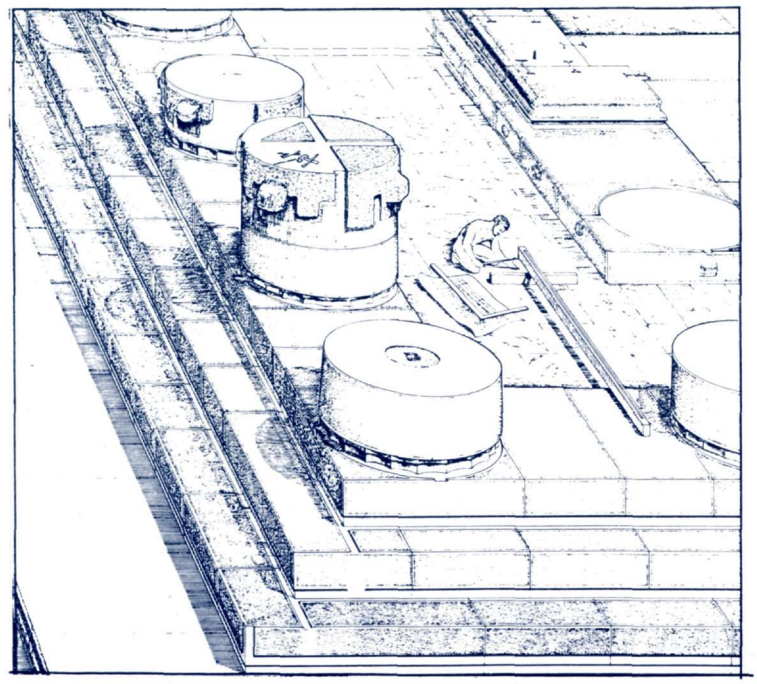
The columns of the Parthenon consisted of 10 to 12 column drums of varied height. The drums were unconnected, and the stability of the column was ensured by their weight contact alone. The square holes we see in the centers of column drums would have received rectangular pieces of wood, not metal, called 'embolia'. In the embolia stood a round pin of harder wood, the 'polos', which would have aided the centering of the drums, and possibly even their slight rotation for better contact.
Metal clamps between the drums of columns occur only in later monuments, such as the Olympeion.
Color and painted decoration were part of ancient architecture, completing a monument's visual effect. The present golden hue of the marble is due to age. But when the buildings of the Acropolis were under construction their appearance was different, since newly cut Pentelic marble has a blinding snow-white brilliance. Because of this, different colours were used to cover the white surfaces. The precise allocation of all the colors is not known. However, the table below shows how some colors were used:
bases, columns, and architrave: off white.
taenia: red with a golden meander.
regula: dark blue with golden anthemia.
mutule: blue.
triglyphs and background of metopes: alternate blue and red.
background (tympanum) of pediments and background of frieze: blue.
mouldings, astragaloi, coffer stabs, antefixes: combination of red, blue, yellow, green and gold.
sculpture: polychrome with gilded bronze fittings.

M.K. C.H.



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Study of ancient Greek temples provides us with much information on the chronological sequence of construction work. In many cases, duration of construction was long mostly due to various adverse factors. Here building work was undertaken to at least complete that part of the temple most needed for its use, namely the cella. Later, the external columns would be added beginning with those of the main side. When rapid completion of building work was envisaged construction began with the colonnade and continued with the cella. The fact that the Parthenon was built within eight years makes it certain that the colonnade and the cella were built at the same time with only a slight difference in the progress of the height. This same method has, after all, been established as that used in the construction of the first marble Parthenon, the older Parthenon. The wall-base of its cella was already in place when construction of the columns had not yet progressed higher than the second or third drum. The same applied for the construction of its inner columns. The chronological sequence of construction work to the Parthenon is as follows:

Quarrying of Piraeus stones for the massive foundations. Cutting of horizontal bearing surfaces on the sloping rock (stepped foundation) and building of the foundations (greatest height about 11 m.). Concurrent quarrying of Pentelic marble for the crepis columns and walls. Transportation, preparation and positioning of marbles for the crepis. Provision of large wooden beams for the construction of high scaffolding used in the erection of the columns. Positioning of the first drums. Interuption and destruction of work due to the Persian invasion (480 B.C.).

Recommencement of the works (447 B.C.) after modification of the older plan. Provision of new poros stones for the widening of the old foundations. Dismantling of the already assembled marble members. Removal of the destroyed marbles. Supplementation of the various amounts of marble needed from the Mount Pentelikon quarries. Construction of the new crepis. Building of the cella crepis. Provision of wood and construction of scaffolding and strong hoists. Erection of the columns and walls. The column drums were positioned with a thick unworked outer layer. The walls were also built with unworked outer surfaces; the cella floors were laid. Metopes and column capitals were prepared immediately on the beginning of work for the columns. The column capitals were positioned after one to two years. Positioning of architraves, triglyphs and metopes. Parallel preparation of coffer slabs and marble tiles. Positioning of the cornice. Positioning of the blocks of the Ionic frieze in the form of simple rectangular blocks. Positioning of the wall-cornices.

Beginning of carving work on the frieze on the building itself. Positioning of the coffered ceilings. Construction of the roof and painting of the ceiling. Execution of flutes on the columns, removal of the unworked protective covering surfaces of the walls and dismantling of the scaffolding. Positioning of doors and intercolumniar railings. Laying of floors of the colonnade. Removal of the unworked surfaces of the orthostates, the floors and the crepidoma. Completion of the work for the large statue of Athena. Dedication of the temple in 438 B.C. Progress in the preparation of the pedimental sculptures. Positioning of the pedimental sculptures and the acroteria.

M.K.