INTRODUCTION

General

Several introductory remarks are unavoidable in a book with this purported coverage. In the first instance detailed ramification of any field of enquiry is now treated so extensively in journals or monographs that every effort must be made to limit or define as closely as possible the material to be considered here. And even then an almost unmanageable expanse will remain, together with inconsistent exclusions and inclusions. The delimitation is effective in three modes: nature, area and time. Briefly speaking the title Ancient Building Technology is to be understood as follows. Ancient here means from very first beginnings (origins) to the end of Late Antiquity (i.e. about 600 AD); as manifested geographically in the “Old World” of Europe and Middle East (i.e. not Africa south of the Sahara, or Further Asia/The Far East or the New World). Building is a gerund and so shares in the semantic field of both noun and verb—i.e. to assemble a substantial construction from component parts and so to make a building which (in English) is a structure enclosing space so that men or animals can enter it and use it for shelter—i.e. building is understood both as a process and a product. However in both instances consideration is limited to construction. There is no concern with design, the rational scheme which must be formulated to control the process of building. Finally technology here means the system of techniques used in the process of building construction. It does not (in the first instance) include the theoretical understanding of the principles which govern the techniques—i.e. the science of building, building science.

Again some amplification and justification of these standpoints is unavoidable. The origins of building are very difficult to establish and this is a question which could have important consequences on the nature of building. Equally it is not easy to set a terminal date for the present account. Building technology evolved (or changed) continually. At no date was there an overall cessation or regression of building technology. In fact it is social and political developments which make an end. The unity of the ancient world (including its building construction) broke up. Different cultural viewpoints prevailed in Western and Eastern Europe, while ever increasing areas of the Middle East soon passed under Arab control. These developments meant a fragmenting of a uniform tradition of building technology with consequent changes in its pattern.
The area considered is quite firmly delimited—that is for all later periods. For possible origins of building during the early history of mankind it is another matter. The area is bordered on the South by desert, on the West by ocean, on the North by snow and ice and on the East—alas! by no definite physical barrier. Throughout ancient times men passed backwards and forwards here between Europe and farther Asia. However a recognisably distinct history (and manner of building) obtained in the two regions. Certainly no influence in the technology of building penetrated into the Ancient World from the South, the West or the North—of course it is quite possible that technological influence from within the ancient world travelled beyond its boundaries into Africa or America, perhaps to some cultural effect, but this does not concern the present study.

The question of delimiting the nature of what comprises building technology is a much more vexed one, and cannot be passed over. There is a very material ambiguity in the word building. Unfortunately in English you can build many things beside buildings, e.g. railways, dams, power networks, etc. As a verb “to build” is synonymous with to construct; but not all constructions are buildings—i.e. the participle and the verbal (abstract) noun mean one (general) thing, while the concrete noun means another (special) thing. The product and the process are by no means aligned. And lest this should be thought pedantic, consider the following. Perhaps the most striking evidence of ancient building technology surviving today is from (imperial) Roman times. This is embodied above all in roads, bridges, viaducts, aqueducts, docks, breakwaters etc. None of these marvellous constructions are buildings according to the dictionary meaning of the noun in English. What is to be done here? Is the title to be understood in some such sense as Ancient Building and Engineering Technology? Or is the dictionary link with architecture (Architectural Building) to be maintained? In fact the latter course is adopted to keep the subject within manageable limits, and the technology employed elsewhere (i.e. on civil engineering projects) will be considered only if and in so far as it introduces novelties.

Also technology (technics, techniques) warrants further remarks. According to the general scope of the series, the title was originally presumed to imply something like Ancient Building Science and Technology. Reflection immediately indicated that considerations akin to modern Building Science, Strength of Materials etc., were not to be included. In the first place whatever notions of this nature existed in the ancient world are extremely difficult to determine, either from ancient sources or by observation and analysis of building remains. In fact the history of ancient science, which is a well established study, has very little to say about Ancient Building Science (viz the principles governing building construction). In the second place the writer disclaims the capacity to deal adequately with such scientific questions.
To resume the matter in brief, the scope of this study is the practical not
the scientific. It is the *fabrica* of Vitruvius, not his *ratio*. It deals with the tech-
niques of setting together the fabric of ancient buildings—comprising the man-
ual and mechanical operations involved; the materials, tools and equipment
used. Not the theory, if any, which lay behind these matters. Here another
generic limitation of subject matter is to be mentioned. Building is an impor-
tant factor in society. It is shaped by and shapes the pattern of society. Thus
apart from its technical constitution it has important social connections and
repercussions. Again to keep the study in reasonable bounds these things will
not be considered here *per se*—they will be mentioned only as may be required
to make sense out of the techniques employed.

In the face of all efforts to circumscribe the study, the fact still remains that
knowledge becomes so multifarious that it behoves anyone endeavouring to
cover such a wide field to state his own background. In speaking of building
technology in antiquity, the writer is proceeding from a basic elementary edu-
cation in history and in architecture obtained at the middle of the present cen-
tury, followed by a life long activity in excavating, recording and restoring
ancient building remains. He has had very little experience in modern build-
ing construction, and has no knowledge at all of modern advanced structural
analysis and properties of materials. The only justification for proceeding on
this narrowly restricted understanding is that it perhaps may not be too dis-
similar from that of many ancient builders whose constructions are discussed
in this book.

This statement gives onto the question of the background of those to whom
the book is addressed. The study presumes some general concern for and knowl-
dge of what is supposed to have transpired during the period discussed (Ancient
History). Likewise where things and processes can be accurately indcated by
terms currently employed in the building trades, these terms are used. Perhaps
something more may be added on this score. Recently studies of ancient build-
ing have been expressed (or recast) to avoid such terminology. This has involved
two patent disadvantages. It is virtually impossible to express these matters
clearly and concisely in other words; and since the terminology is widely known
(e.g. among householders) its avoidance raises a presumption that the writer
intends to refer to something else. On the other hand the book does not pre-
sume expertise in either the historical or the technological field—particularly
the latter. The book is certainly not addressed to those with the technological
acumen of builders of pyramids or Pantheons. Only it is hoped that such indi-
viduals will find nothing misleading in it.
The following résumé study deals with building material, which together with construction and structures, forms one of the three aspects of building, or equally one of the three factors which constitute the nature of a building. These considerations are theoretically separable, but in practice entirely inter-related. However it is possible to perceive that building materials have manifested a significance of their own in history. If man has made himself, he has done this in a significant measure by building; topically expressed here by his use of building materials. The earliest building required an understanding of the physical nature of materials (the properties of matter) and this knowledge was greatly increased by the practical experience of their use in building. Furthermore there was a parallel between the development of building and writing: the material man used for building he used for writing on (clay, stone). Indeed both building and writing were parallel ways of monumentalising man's existence and experience—thus both had utilitarian and transcendental functions.

It is evident that the primary structural materials: wood, earth, stone have outlasted much history. They have outlasted various changing modes in which they were used. And these modes in turn have outlasted the building styles in which they were embodied. In that sense primary building materials may be seen as "long durée" parameters of history (if there is any point in using that now fashionable term). Primary building materials certainly outlasted the Ancient World—but nothing lasts forever. Structural steel and ferro-concrete took over much during the 19th century and during the 21st century it is possible that entirely synthetic building materials may become predominant.

One or two specific historical instances are thrown up by such speculation. It may be of interest here to present them as questions (if any answers are forthcoming it can only be at the end of the complete study of Ancient Building Technology, not here). Mud brick was perhaps the most versatile of all building materials developed in the Ancient World. Used in the same manner it served to build unpretentious cabin shelters and the most imposing monuments (temples, palaces, ziggurats). This double destiny was fully established in Mesopotamia, ca 3000 BC. Then after some three thousand years an abrupt change occurred. Mud brick continued to be used as ever for domestic building but massive mud brick construction disappeared for great public buildings. There is also a strange parallel in a different material. Approaching the middle of the third millenium BC a style of monumental building in finely dressed heavy stone masonry appeared with the greatest éclat in Egypt. The technology involved was sophisticated and highly integrated. This mode of using stone together with the architectural style survived across the ages virtu-
ally unchanged. And then in the first centuries of the Christian era it dis­appeared entirely (at roughly the same date as the end of massive mud brick con­struction in Mesopotamia). What were the reasons for this great departure. Certainly not any shortcomings in the building materials and the modes of using them.

The particular problem in writing about ancient materials is to decide how to limit the scope of the treatment so as to avoid entering far (too far) into modern scientific theory. Obviously modern science can not be completely ignored. Often it affords a necessary rationalisation of ancient usage and cus­tom concerning materials. However the present age is one of continual change/advance in physical sciences and an enquiring disposition directed towards nature and behaviour of building materials soon leads to explanations quite beyond the mental capacity of the layman. More surprisingly, it soon leads to ques­tions which run of the mill academic scientists appear to be unable to explain cogently—"they are not treated in the syllabus". In short many such questions appear to be "open ended". What is to be done here? So far as any measure of generality can inhere in a rule, I have tried to limit reference to modern science to explanations which can be conveyed in common sense, plain lan­guage—i.e. I have endeavoured to avoid using mathematical symbols and for­mulae. This, of course, means that the book avoids as much as possible chemistry and chemical equations. This is not to say that I have tried to express the ancient builders' understanding of the nature and behaviour of the materials he used. It means that I have tried to explain matters only in such terms as would have been comprehensible to ancient builders.

Lest this should sound unduly retrogressive I draw attention to the follow­ing. I enquired about such things with a schoolboy friend who had become a distinguished civil engineer. To my surprise he denied all capacity to give any cogent explanation of the nature and behaviour of building materials. He said that the text books etc. on which his engineering education was based were "cookery books". And that his education was to enable him to make the cal­culations needed in his practice.

A different issue concerns existing manuals on ancient building, which all treat exhaustively of the materials of construction. These manuals are classics, the work of extremely able men, e.g. Clarke and Engelbach, Arnold (Egyptian); Nauman (Anatolia); Martin, Orlandos (Greek); Lugli, Adam (Roman). Additionally of very recent years several books have appeared which survey the develop­ment and use of materials in ancient civilisations, e.g. Shaw (Egyptian); Moorey (Mesopotamian). How is the present study to be adjusted with these works? Can it be anything other than a summary redaction, a digest of their contents? I have tried to avoid this by something of an analytic presentation. The fact
that the subject matter extends across all ages and regions favours comparison. And I have set out the treatment of materials according to a paradigm of nature, manufacture and use, so as to facilitate direct comparison between different modes of the one material, as also between different materials and between different building traditions.

Here an explanation must be offered of the effect of circumstances. The surcharge of publication is now such that it is impossible to keep to scheduled treatment of extended subjects. On commencement of the present volume it immediately became apparent that if the detail of coverage envisaged was to be maintained, the projected contents, Materials and Construction, would have to be broken up into two volumes. The present volume is thus restricted to a consideration of materials alone, leaving the technology of ancient building construction to be considered in the succeeding volume.

In endeavouring to cover the technology of building materials in antiquity the aim has been to say at least something about the principal materials from the beginning to the end of their involvement in building—that is to say from the physical nature of a substance to its incorporation into a structure. To deal with the beginning of this schedule was reasonably straightforward, as to speak of the nature and properties of materials and of their winning or manufacture. However, when considering the working of materials and their uses in building, no clear line of separation was found between this and questions of building construction. Thus if coverage of these latter issues appears in some instances to be incomplete, the reader may expect further information to appear in the succeeding volume dealing with building construction.

The present volume has been assembled while dwelling apart from archaeological centres, and thus the good offices of friends requires due acknowledgement. Fortunately several scholars concerned with ancient building live in the region of Avignon, and have conveyed information wherever possible—thus Professor O. Aurenche (Lyon); J.-L. Biscop (Paris and Villeneuve); J.-C. Bessac (Montpellier and Montpezat); P. Varènne and J.-L. Paillet (Aix en Provence). In making available a wide selection of photographs held by I.R.A.A. at Aix en Provence J.-L. Paillet tendered most unselfish help. These photographs included a notable collection made jointly by P. Varènne and J.-P. Adam, of Roman building in Pompeii, Rome and environs. Access to all this material was the more valuable since the writer’s own photographic collection had been destroyed by flooding.

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