Concrete Vaulted Construction in Imperial Rome: Innovations in Context

Lynne C. Lancaster

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CONCRETE VAULTED CONSTRUCTION IN IMPERIAL ROME

Concrete Vaulted Construction in Imperial Rome examines the methods and techniques that enabled builders to construct some of the most imposing monuments of ancient Rome. Focusing on structurally innovative vaulting and the factors that influenced its advancement, Lynne Lancaster also explores a range of related practices, including lightweight pumice as aggregate, amphoras in vaults, vaulting ribs, metal tie bars, and various techniques of buttressing. She provides the geological background of the local building stones and applies mineralogical analysis to determine material provenance, which in turn relates to trading patterns and land use. Lancaster also examines construction techniques in relation to the social, economic, and political contexts of Rome, in an effort to draw connections between changes in the building industry and the events that shaped Roman society from the early empire to late antiquity.

Lynne C. Lancaster is assistant professor of classics at Ohio University. An architect and archaeologist, she is a Fellow of the American Academy in Rome and has published in a variety of journals, including American Journal of Archaeology, Journal of Roman Archaeology, and Römische Mitteilungen.
CONCRETE VAULTED CONSTRUCTION
IN IMPERIAL ROME

INNOVATIONS IN CONTEXT

LYNNE C. LANCASTER
Ohio University
For Tom
I believe that in architecture, as in all art, the artist instinctively keeps the marks which reveal how a thing was done.

– Louis I. Kahn
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PREFACE

AS A STUDENT OF ARCHITECTURE AT VIRGINIA TECH traveling in Italy in 1985, I became fascinated with the ancient brick walls that had obviously inspired one of my favorite architects, Louis Kahn. He had visited Rome as a Resident at the American Academy in 1950, and later much of his work was designed around themes of brick arches. The arches in Roman architecture, and particularly the relieving arches inserted into solid walls, captured my imagination. I wondered what secret reasons the Romans had for scattering these elements throughout their buildings. At the time, I was inspired by what I saw as the Roman “honesty” in their use of materials, though I now realize they were probably not remotely interested in this modernist concept. (I have also come to admit that I like most Roman buildings as ruins much better than I would have liked them in their original state.) On my return from the study abroad program, I convinced my architecture professor, Dennis Kilper, to supervise an independent study project on Roman concrete construction, the final product of which would be an illustrated paper. In the end, it was based largely (if not exclusively) on information from Vitruvius and M. E. Blake, and the illustrations were never completed. In the present work, I hope to have remedied the shortcomings of that first project begun two decades ago.

I have been fortunate to work with people who have provided the intellectual grounding to tackle the problems that interest me. After graduating and then working as an architect for a couple of years, I decided to get a Master’s degree in classical archaeology. I went to Oxford University to study with Jim Coulton, whose sharpness of mind and interest in problem solving always enabled him to ask just the right question to guide me where I needed to go. As a bonus, two other scholars interested in architecture happened to be at Oxford at the time on postdoctoral fellowships, Janet DeLaine and Hazel Dodge. Margareta Steinby then came to All Souls for a year, and the architect, Sheila Gibson, who worked with John Ward-Perkins for many years, lived in Oxford. With this core group and others, we all presented our work at a series of architecture seminars where I had the benefit of studying with an intense group of scholars in my formative years. This was also a time when I was spending months at a time at the British School at Rome where I came to know Amanda Claridge, who has always both inspired and humbled me with her intimate knowledge of ancient Rome, and Andrew Wallace-Hadrill, who has been a constant supporter of my work. John Lloyd, a pottery and field survey expert, came to Oxford when I did and became a
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great influence on my archaeological education. His unexpected and much too early death was a blow, and to his memory I have dedicated Chapter 4 on amphoras.

This project on vaulting began at Trajan’s Markets. I knew that I wanted to study some aspect of the monument for my Master’s thesis, and when I went to meet with Lucrezia Ungaro, the person in charge of the Markets, for the first time in 1989, she suggested that I concentrate on the vaulting. Eventually the Master’s thesis was expanded into a doctoral dissertation on concrete vaulted construction from Nero to Trajan, the premise of which was to investigate the fifty-year period leading up to the construction of the Pantheon dome. This book, the proverbial “thesis book,” derives from that study, but the scope is much expanded. After completing the dissertation, I realized that some of the most interesting questions were those that dealt with the differences between the construction of the high empire and that of late antiquity. As a publication strategy I decided to concentrate first on publishing the detailed information I had collected on particular monuments, such as the Colosseum and Trajan’s Markets, so that I could refer to them later in a more general work on concrete vaulting. During the past decade, the book has been growing in the background as I familiarized myself with the radically different world of late antiquity in an effort to understand how the construction industry changed.

This book is more “interdisciplinary” than the dissertation, and I would not have been able to tackle some of the more technical issues were it not for help from other experts, especially in the fields of geology and structural engineering. In 1996, I attended a lecture in Rome on the rocks of ancient Rome by the geologist Marie Jackson, who has since helped tremendously with my geological education. The emphasis on geology throughout this book, as can be seen in the color plates, was generated from our early excursions together looking at Roman rocks. However, before long my initial chapter on building materials had grown to twice the length of any other chapter, and I realized that this was the topic of a separate work. The information presented here is a fraction of what I collected, and I hope to present a more detailed analysis of building materials in the future. Later, in 2001, I met another geologist, Fabrizio Marra of the Istituto Nazionale di Geofisica e Vulcanologia in Rome. His help and encouragement with the scoria analysis in Appendix 3 were invaluable, and he acted as my “cicerone,” taking me to explore abandoned pozzolana quarries. Finally, in the field of geology, I want to thank a group of scholars with whom I have worked on a mortar dating project and who have inspired me to pursue more actively interdisciplinary projects: John Hale (archaeologist), Jan Heinemier (physicist), Alf Lindmoos (geologist), and Asa Ringbom (art historian).

I have long been interested in the engineering aspects of ancient construction and had read structural studies on historical buildings by Robert Mark, Roland Mainstone, and Jacques Heyman. I could perform simple beam analyses from what I had learned in college, but I aspired to do thrust line analyses and discovered that I needed tutoring. In 2002, I received notice of the First International Congress of Construction History in Madrid, where Heyman was billed as the keynote speaker, so I decided to attend. In the end, we met and he very kindly agreed to read an early draft of what is now Chapter 8. He also introduced me to one of his former students who was an organizer of the conference, John Ochsendorf at MIT. With John’s help and many exchanges over e-mail and telephone, I learned how to make my own thrust line analysis, and I have presented the basic steps in Appendix 4 for anyone brave enough to have a go at it. Thus, I have been fortunate to meet experts in...
other fields whose broad visions and generous spirits have aided me in answering questions that I might not have otherwise asked.

Many people contributed to my thoughts and ideas about Roman construction through conversations and excursions. Margareta Steinby has been a constant source of information, inspiration, and support over the years. Mark Wilson Jones has offered many insights about the design process and has provided a refreshing counterpoint to my focus on construction. I have benefited greatly from Robert Coates-Stephens’s knowledge of ancient and medieval Rome. Peter Rockwell, a sculptor/scholar, taught me to carve a Corinthian capital when I was in Rome in 2001, an invaluable experience that provided me with a different perspective on the construction process. I also have benefited greatly from insights and on-site visits with Jim Packer to the Forum of Trajan and am grateful for his support of this project. Others with whom I have had enlightening conversations include: Jane Aiken, Larry Ball, Heinz Beste, Elisabetta Bianchi, Mario Como, Lucos Cozza, Clayton Fant, Shawn Graham, Michael Heinzelmann, Henner von Hesberg, Shawna Leigh, Giovanni Manieri Elia, Archer Martin, John Oleson, Bob Osterhout, Betney Robinson, Rabun Taylor, Bill Wallace, and Roger Wilson.

Two colleagues deserve special thanks for reading substantial portions of the manuscript and for sharing their own (often unpublished) research with me, Carla Amici and Janet DeLaine. I have had the great joy of engaging in many long conversations and on-site visits to monuments with each, and I consider them my closest intellectual companions. I also owe debts of thanks to others outside of my own area of expertise who have taken the time to read and comment on various chapters of early drafts of this manuscript (and are in no way responsible for any mistakes in the final one): Susan Martin on the building industry and legal issues; Ted Peña on the amphoras and trade; Marie Jackson and Fabrizio Marra on geology; and Jacques Heyman, Robert Mark, and John Ochsendorf on structural analysis. Finally, I am grateful to my former Ohio University student, Mandy White, for her careful reading of and insightful comments on the penultimate draft of this manuscript.

One complication for a project such as this one is the need for numerous permessi for various monuments around Rome, and many friends and colleagues have been instrumental in making the arrangements. Lucrezia Ungaro, Roberto Meneghini, and Riccardo Santangeli Valenzani of the X Ripartizione AA.BB.AA of the Comune di Roma have been wonderfully supportive colleagues in all my endeavors. I also am indebted to support I have received over the years from those at the Soprintendenza Archeologica di Roma including Irene Jacopi, Giangiacomo Martines, Cinzia Conti, and Maria Letizia Conforto. I owe special thanks to Rossella Rea, who is in charge of the Colosseum, for her encouragement of my work there. With regard to obtaining permessi, I am especially grateful to Maria Pia Malvezzi at the British School at Rome for arranging an often complicated schedule of visits and sometimes working her own miracles during the early research stages of this project. I also thank Anne Coulson of the American Academy for help in arranging permessi during my Rome Prize year in 2001.

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At a personal level I am grateful to a number of people who have helped me along the way: to my parents for supporting my education and to my grandmother for her long-term planning; to Charles Knight for giving me a construction job when I was an undergraduate; to Michael and Mariella Stannus, friends in Rome who have always been there for me in sickness and in health; to Bailey van Hook for her encouragement during hard times; and to Brian Rose for companionship in Rome and for hospitality in Cincinnati during research trips to the Blegen Library.

Finally, without my husband, Tom Carpenter, this project and my interest in archaeology would never have happened. From the beginning, he taught me the value of reason, evidence, and the positivistic approach and has been my most profound intellectual model. He has given generously from his own research schedule to help me with mine at every level—measuring, climbing, hashing me out of holes on a rope, reading too many drafts of this manuscript, serving as a sounding board, and at the end even helping me finish the illustrations as my deadline loomed. I also am grateful to his remarkable patience with me during emotionally tumultuous periods and during the past two years when I was married to my keyboard as I completed the text and illustrations. To him I dedicate this book.