A STRANGE OBSESSION, A MONUMENTAL ACHIEVEMENT

MOST PEOPLE WOULD BE HAPPY TO RETIRE AFTER 40 YEARS WORKING IN FAR-FLUNG CORNERS OF THE WORLD. NOT DAVID MOORE. THERE WAS A MYSTERY TO BE SOLVED; A MYSTERY THAT WAS 2,000 YEARS OLD.

David Moore, P.E., is the author of the definitive work on Roman concrete, entitled *The Roman Pantheon: The Triumph of Concrete*. The following interview with Moore and his son John Moore, Ph.D., his sometime editor and site manager for **www.roman-concrete.com**, details his decade-long quest to solve the mysteries of Roman concrete. It was a quest begun by Moore following an epiphany at the Pantheon—an epochal event in the life of the author that happened almost by chance.

CONSTRUCTOR: What sparked your interest in Roman Concrete?

David Moore: I had just retired from an engineering career of some 40 years, and was passing through Rome from a post in Saudi Arabia. Our hotel clerk suggested a visit to the Pantheon to see the world's oldest engineering marvel. With a brief walk, my wife and I were soon facing this ancient building: A complete large round structure with modern-looking brick on the walls, covered by a 143-foot-diameter dome. A brochure said it was 1,800 years old and made with Roman concrete. The convex shape of the tile floor inside, along with other building refinements, cast doubt on its age, to my mind.

Steel reinforcing rods were not used in Rome at that time to hold the massive dome together. Something was askew, I thought.

Besides, the Portland cement of our modern concrete was invented only some 200 years ago, so what was the material that held this building together? Any modern engineer knows that only Portland cement makes concrete, but the ancient Romans had this hard gray "stuff" to make the Pantheon. Scholars call the "stuff" Roman concrete or ancient concrete, but, I asked myself, "What do they technically know about concrete chemistry?"

Now, I had time, so I intended to return home and read about the Pantheon in my rocking chair. Big mistake.

How did your investigations into the Pantheon's structure lead you to examine ancient concrete?

David Moore: First, a researcher must ask the right questions to get a logical answer: "What materials did the Romans use, and what were their processes?"

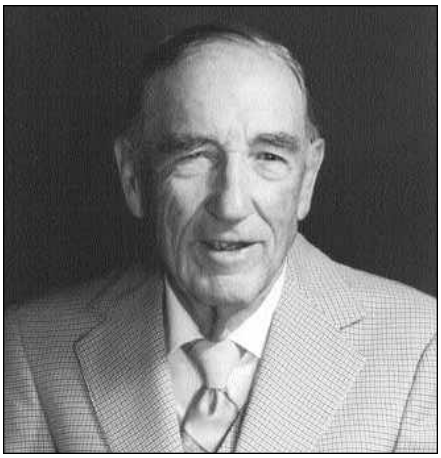
Many scholars on the subject have said the Romans used lime and pozzolan to make their concrete. They were right, but they didn't read the works of ancient writers such as Vitruvius and Pliny and interpret the ingredients along with their formulas. It's tough reading and doesn't make much sense to a non-engineer. For example, what is Vitruvius' "pit sand," and what do "having beaten the walls" and "beaten with iron bars" mean?

It turns out that "pit sand" is pozzolan, and "beaten with iron bars" simply means compaction with a special tool. Perhaps more scholars should take engineering courses to better understand the writings of the ancients.

Did you start your research thinking you would write a book?

David Moore: No! I did not want to reinvent the wheel. I wanted to read a book that would tell me the science of the ancient concrete and how it was tied to that of modern concrete. But there was none. The idea of writing a technical book is not appealing; it is hard work. Eventually, pages copied from journals and books became my supporting data in exploring the mystery. My notes were few and random.

Finally, I realized I needed some kind of outline to get a direction. I organized the data into what eventually became chapters, which were revised many times.



***David Moore, P.E.**, has more than 40 years of wide-ranging civilian and military experience. Moore is most recently the author of* The Roman Pantheon: The Triumph of Concrete, *a book detailing the construction techniques and materials used to build the Pantheon in Rome more than 1,800 years ago, as well as identifying the chemical composition of the ancient concrete used in the structure.*

Meanwhile, I kept hoping to find the definitive work on Roman concrete to save me all the hard work, but I never found it.

How long did it take you to finish your research and reach your conclusions about the Pantheon and Roman concrete?

David Moore: About 10 years. I thought it would never end, and many times I believed I'd failed in my task. It was simply too complicated to get all the science together for proof that the professionals would believe. One time on Guam, I asked a scientist from the Stanford think-tank why someone hadn't written a book on ancient concrete, mentioning I had 10 years credit to the task.

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His quick reply was, "I think you have your answer."

How long did it take you to write and self-publish your book?

David Moore: Finishing the rough chapters lasted more than a year, but I had help in editing the material. Frank King, Ph.D., a Cambridge (England) historian, encouraged me, and Billings Brown, Ph.D., a retired professor of chemistry, helped me with the chemical formulas. Other academics were also supportive. Amazingly, none criticized. Rich Thurman, the former editor of University of Utah publications, said I needed to personalize the draft, and I did. I sent copies to publishers, who replied that readers were not interested in an ancient concrete story. It would not make money.

So I asked my grand-nephew, who owns an office supply and Internet firm in Pinedale, Wyo., to publish it at his cost, and I would take no royalties. Hopefully, a few might be interested in and make use of the information I gathered.

How has your son, John Moore, helped you during this process?

David Moore: John is a Ph.D. in engineering and has an excellent command of the fundamentals of many engineering disciplines, including that of concrete practice. In fact, he has revised my book on the Pantheon, which is in the final editing stage. He has made it more definite in its assemblage and added more interesting material. Plus, John has ably answered my e-mails for me during my long siege of sickness, so I am indeed proud and welcome his contribution.

How did you first begin assisting your father in this project?

John Moore: Around the time my father was having trouble getting his book published, I was learning website development, and I thought his material would interest people on the Web. In order to post it on the Web, I had to read and understand it. My background isn't construction engineering. It's mechanical and software engineering, but the more I read, the more interested I became.

Why a website on Roman concrete and the Pantheon?

David Moore: This is John's contribution. Websites are a part of his professional domain, so he knows them well.

Also, John came to believe, as I do, that the knowledge of ancient concrete was seriously lacking in our libraries and wished to share it with the world. We hope it will advance science as others become interested in the subject.

What in particular captured your interest about the Pantheon?

John Moore: I'm interested in how people construct things, not just buildings, but everything. I think that if we can understand how people made wonders like the Pantheon, it will help us understand how to make things better in our day and age. There is something very special about a building that is still standing after 1,800 years! How did the Pantheon constructors do that? We can't do that today!

How has that curiosity influenced your own research and made it different from your father's?

John Moore: I have just started my research, so I guess I'm still figuring that out. If I can help out my father in some way, then that's great. Mostly, I see my current role as editor and publicist of my father's work to help others enjoy it as much as he has.

What kind of visitors do you typically get? Students? Researchers? Professionals?

John Moore: The majority are high school or college students who have an assignment to write about Roman history or Roman architecture. They type in "Roman concrete" or "Pantheon" into their search engine and—***voila!***—they get our website, romanconcrete.com, almost every time.

The questions are split about half-and-half between Roman concrete and the Pantheon. A number of serious researchers have e-mailed us, and we've built up a correspondence with a number of people in construction engineering. I enjoy corresponding with with them, and they seem to appreciate the contribution my father has made. Then, of course, we get the e-mail messages that read something like, "i hav to writ a term papr by next fri. pls tell me everything you know about roman concrete." Usually, the person doesn't even bother to give their name. I can guarantee that those e-mail messages don't get nearly as much attention as those that make some effort to tell us what they are interested in, what kind of assignment it is, what school they go to, what research they have already done, and what specific questions they have, showing they have made some effort to understand the material before e-mailing us.

***John E. Moore, Ph.D.**, principal engineer for the Systems and Process Engineering Group of Northrop Grumman Information Technology, has helped his father, David Moore, in his quest for knowledge about the Pantheon and Roman concrete by editing his father's draft copy and setting up and maintaining a website dedicated to the subject: www.romanconcrete.com.*

How do you think research on Roman concrete, and yours in particular, should be used by the construction community?

David Moore: Excellent question. On the pages of the technical chapter of my book are details governing the processing of strong concrete. You see, the underlying principles in both modern and ancient concrete are fundamentally the same. In studying the Romans' concrete practices and drawing lessons from their experience and expertise, we may also be able to make a modern concrete that will last 1,800 years.

—Interview **By Stephani Miller**, *CONSTRUCTOR's former editorial assistant*

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