**[Did the late Romans just forget how to make concrete?!](https://www.reddit.com/r/AskHistorians/comments/gntlr8/how_did_the_late_romans_just_forget_how_to_make/?rdt=55395)**

Dr. Garrett Ryan (u/toldinstone), 2020.

I've had the pleasure of talking about Roman concrete several times on AskHistorians. This is an edited and slightly expanded version of an older answer:

**Building techniques never die. They just become irrelevant...**

First, some background on Roman concrete. Concrete is best understood as a type of mortar. Mortar (the stuff that holds courses of bricks or blocks together) is typically composed of water, sand, and lime. There are variations - the Chinese, famously, made mortar by mixing lime with sticky rice - but in the Classical Mediterranean, the water, sand, and lime formula was always standard.

Roman concrete differed from Roman mortar by virtue of its "secret ingredient" - the volcanic ash known as pozzolana, which was used in place of regular sand. This was really just a case of good geological luck on the Romans' part: Rome happened to be located near large deposits of pozzolana (later, even larger deposits would be discovered on the Bay of Naples). Roman masons quickly discovered that mortar made with pozzolana was much stronger that mortar made with regular sand. And so concrete was born.

It should be noted here that not all Roman concrete was made with pozzolana. Most Italian concrete was, and pozzolana was occasionally shipped to (coastal) cities in other parts of the Empire (Herod the Great had a batch brought all the way to Caesarea in modern Israel). But there were deposits of volcanic ash with similar properties in the provinces (above all in the Greek islands). Roman builders eventually discovered, moreover, that a fairly good concrete could be made by using crushed terracotta in place of pozzolana.

Contrary to what you might think, the Romans were seldom adventurous builders. Roman architects received no formal training and had no way of mathematically modelling forces or stresses or other things likely to cause the collapse of buildings and careers. As a result, they tended to be very conservative in their use of building materials. At first, they only used concrete to save time when building thick walls: instead of making the wall of building four or five brick courses thick, they simply built brick facings and filled the interior of the wall with a mixture of rubble and concrete.

Sometime in the first century BCE, the Romans discovered that concrete made with pozzolana could harden underwater - in fact, thanks to chemical reactions the Romans knew nothing about, saltwater actually strengthened the material, forming nearly unbreakable mineral bonds. So in the waning days of the Republic, Romans began to build "artificial harbours" like the famous example at Caesarea Maritima. But the great days of concrete architecture still lay ahead.

Only in the mid-first century CE, under the stimulus of imperial funding and imperial demands, did concrete begin to be used to create the spectacular vaults and domes that are the greatest achievement of Roman architecture. The revolutionary moment came in the reign of Nero, when the architects Severus and Celer (about whom we know nothing) created an impressive series of concrete rooms for Nero's infamously decadent Golden House. These represented the culmination of nearly a century of experimenting with vaults, primarily in the large, imperially-sponsored bath buildings. Once Severus and Celer showed what concrete could do, the creative floodgates, for the first time in Roman architectural history, were truly open.

The next century and a half witnessed the construction of the most famous Roman monuments: the Colosseum (supported by a colossal concrete foundation), the Pantheon (crowned by a spectacular concrete dome), the Baths of Caracalla (roofed by an awesome series of concrete vaults and domes), the Basilica of Maxentius in the Roman Forum (likewise vaulted) and so on.

Concrete was also used in the provinces, but always on a much smaller scale. The basic reason was simple: the Roman emperors, by an incredible margin the wealthiest men in the Empire, seldom sponsored building projects outside Rome. In large provincial cities like Alexandria or Antioch or Ephesus, very impressive building projects were undertaken. But these were financed by the benefactions of wealthy citizens (often working in concert); and provincial notables, for all their wealth, could never create anything on the scale of the concrete-crowned projects in Rome. As a result, provincial concrete tended to be used more conservatively. This was not solely a matter of scale - in the Greek east, for example, a well-established tradition of fine masonry ensured that stone, not concrete, was often used in domes - but without imperially-sponsored scale or imperially-sponsored funding, the use of concrete had a fairly limited scope.

Once the emperors stopped paying for large-scale construction projects, concrete largely reverted to what it had been before the Roman architectural revolution: a useful filler for thick walls. Roman concrete was not forgotten in the early Middle Ages, at least not in Byzantium: Procopius (*Buildings*, 1.11-18-20) mentions Justinian using Roman hydraulic concrete to build a new harbour in Constantinople. But after this, aside from a few mentions in Isidore of Seville's *Etymologies* (e.g. 15.8.1), concrete virtually vanishes from the literary record.

The domes of Justinian's Haghia Sophia, the last great product of Roman engineering, were made of brick bedded in concrete. But after Justinian, the troubles that overtook the Eastern Empire (like those that had destroyed the imperial order in the west a century earlier) virtually ended monumental building for centuries. And in those centuries, concrete vaults and domes became, like so much else across the former Roman world, mementos of a vanished past.

On the techniques of laying and modelling Roman concrete, I refer you to [my video on the Pantheon](https://toldinstone.com/the-pantheon/).