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Roman Concrete is NOT Better Than Today's Concrete!

Perhaps you saw the news release posted in early July 2017. The headline says it all: "Why 2,000 Year-Old Roman Concrete Is So Much Better Than What We Produce Today." It gets worse: "Battered by sea waves for 2,000 years, these [harbour structures] are still around while our modern concoctions erode over mere decades. Now scientists have uncovered the incredible chemistry behind this phenomenon, getting closer to unlocking its long-lost recipe. As it turns out, not only is Roman concrete more durable than what we can make today, but it actually gets stronger over time."[1]

That last part shouldn't have been too startling to any concrete technologist. Roman concrete was made with a cementing material made with volcanic ash and hydrated lime, plus sand, volcanic rock, and water. Modern concrete is made with portland cement, often including supplementary cementitious materials similar to volcanic ash, sand, many types of rock, and water. When continuously exposed to water, both Roman and modern concretes get stronger over time. That's because water will eventually reach any of the cementing material that hasn't yet hydrated, forming new calcium silicate hydrates in the concrete matrix.

All of the "can-you-believe-this" hoopla in several similar articles is based on a study published in *American Mineralogist*. In the study, researchers drilled cores from several remnants of Roman marine structures that had been fully or partially immersed in seawater. Thin sections from the cores were examined using X-ray microdiffraction and Rayman spectroscopy to learn more about the structure of crystals in the cementing medium.[2] The researchers hypothesized that the cement in Roman concrete grew aluminous tobermorite over thousands of years, after the initial reaction of volcanic ash and hydrated lime had ceased. Now they want to "reverse engineer" the products studied so modern concretes can grow aluminous tobermorite to achieve Roman concrete durability in marine structures.

We need to pause here, and note two facts that might explain the long-term performance of the Roman structures without any need for reverse engineering.

- Roman concrete structures contained no reinforcing steel. Gjørv said it best: "...it is not the disintegration of the concrete itself but rather chloride-induced corrosion of embedded steel which poses the most critical and greatest threat to marine structures."[3] Without reinforcing steel corrosion damaging the concrete, the service life would be expected to be longer.
- The structures were in a sub-tropical climate. That means no cycles of freezing and thawing—a common cause of concrete deterioration.

Finally, there's a logical flaw in the study called "survivor bias." It occurs when researchers concentrate on Roman concrete structures that made it past 2,000 years, and overlook those that did not, probably because of lack of visibility. As an example, during World War II, researchers from the Center for Naval Analysis conducted a study of damage done to aircraft that returned from missions. In order to minimize loss of aircraft, they recommended that armor be added to areas that showed the most damage. A statistician noted that the study considered only the aircraft that had survived their missions—the aircraft that had been shot down were not present for the damage assessment. The holes in the returning aircraft, then, represented areas where a bomber could take damage and still return home safely. He proposed that the Navy reinforce areas where the returning aircraft were unscathed, since those were the areas that if hit could cause the plane to be lost.[4]

According to David McRanney: "When failure becomes invisible, the difference between failure and success may also become invisible."[5] Based on this observation, a different approach could be used to test the hypothesis that the presence of aluminous tobermorite was responsible for longevity of Roman concrete marine structures. Use information from ancient historians to locate sites of Roman marine structures that are now invisible. Then search the ocean floor at those sites to find remnants of Roman concrete. Examine the remnants for presence of aluminous tobermorite. If it's found, the hypothesis may be incorrect, and a better one is needed. And if no aluminous tobermorite is found, it helps to support the researchers' theory, but still doesn't prove that Roman concrete was better than modern concrete, for reasons I've already mentioned.

References

1. www.sciencealert.com/why-2-000-year-old-roman-concrete-is-so-much-better-than-what-we-produce-today July 2017
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4. https://en.wikipedia.org/wiki/Survivorship_bias
5. https://youarenotsosmart.com/2013/05/23/survivorship-bias/