

The fundamental role of concrete in roman architecture history essay



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The development of concrete in Roman style architecture was of great use in producing many world famous, monumental buildings that are representative of the Roman era. Not only did concrete provide a unique scheme in the production of Roman architecture, it was also a convenient and functional tool when other raw materials were unattainable. In this essay, I will discuss the development of concrete, concrete's properties, surfacing techniques, concrete's ease of use and labour requirements, and the construction of the famous Pantheon as a prominent example of the immense benefits of concrete to the Romans.

Concrete was not invented by the Romans, but simply an adaptation of different mortar usages in earlier construction. MacDonald describes a mortar as, " materials of mixed composition in a semi-fluid state at the time of construction." Because Roman's didn't possess marble quarries like the Greeks, mortar became the practical alternative. Volcanic rock was the most common building material located in the Italian region, and was therefore, the most basic tool to create mortar, which would develop into useful concrete. As early as the 4th and 3rd centuries B. C., the observation of limestone walls with rock debris between each stone was made in Pompey. From this point onward, Roman concrete and mortar use became more and more prominent and by the late 3rd century B. C., Romans had improved the recipe of mortar to include lime and clay. When combined with different types of filling elements, also known as aggregates, as well as different types of facings, Roman mortars were able to create strong and dense walls. By the 1st century, the use of concrete is said to have been perfected by the Romans.

In order for concrete to become a useful building technology, the properties of concrete must be carefully examined. The Romans used concrete for a wide variety of purposes. Concrete has been used in Roman buildings as strong base foundations, as well as in the highest vaults. In order to give structure and substance to mortar, aggregates, or stones of different sizes mixed into the mortar, were used. Not only did aggregates give mortar structure and substance by increasing the mortar's mass, but they also helped to strengthen the building material. Aggregates were an essential part of concrete construction because they work together with mortar to defy crushing that can be caused by immense weights. This is clearly important when concrete was used as a foundation.

Different types of stone were used to produce aggregates dependent upon the use of the concrete. For strong solid base foundations, heavier rock materials were used. In these types of foundation, aggregate was often times two thirds of the volume of the entire fabric. For lighter concrete forms, including high vaulting, lighter rock materials (such as pumice) were used. Debris from destroyed structures was also a common form of aggregate, including buildings and sculptures.

Concrete is an indefinite, nearly fluid substance from the time that it is mixed to the time that it is set. Composed of lime, clay and aggregate, dry concrete is mixed with water, and this compound (opus caementicum) will harden into a solid mass. With this property in mind, Roman concrete construction was relatively simple. Generally wooden frames were set to pour the concrete mixture into and allow it to harden. Therefore, to produce

this type of Roman architecture, both a mortar substance and a frame were necessary.

Until Augustan times, the concrete used by Romans was a simple lime mortar. When limestone is burned, quicklime is produced. This quicklime is then slaked to produce calcium hydroxide, which is then mixed with sand. Once evaporated, calcium carbonate crystals are formed. These crystals are the fundamental bonding element of this basic concrete. Mixing more sand with the crystals increases the mortar's strength because the crystals bind to coarse surfaces. A great benefit of concrete use was fireproofing buildings.

By the late 2nd century B. C., a new kind of mortar came into existence that not only aided in fire proofing the structural design, but also in waterproofing it. Romans came across a type of volcanic ash near the city of Pozzuoli, Italy, which they used to create fine cement that reacts in a different manner than the simple lime mortar. This type of mortar is called pozzolana, and is also known as hydraulic cement. Pozzolana is composed of silicates and aluminates. When combined with lime, pozzolana forms a hydrated silicate of calcium. Comparatively, this combination of chemicals does not need to lose water through an evaporative process; it actually retains water into its structure. In doing so, pozzolana mortars can set in damp areas. This new found type of concrete was of great importance in waterproofing buildings. It helped to prevent decay and corrosion to buildings, allowing them to survive longer. Pozzolana is one of the most standard features of concrete in central Italy.

To further aid the waterproofing of concrete, different types of stone facings were developed. Facings were originally used to protect the surfaces of concrete. Typically, facings of stone and other material were set into wet concrete to create a strong casing when the concrete dried. Facings are of valuable importance in dating buildings, and there are several different types that evolved over the centuries. During the late 2nd Century B. C., Opus Incertum, or concrete faced with small irregular shaped stones, was commonly seen. Concrete faced with small four sided stones in a definite pattern, called Opus Reticulatum, is dated shortly after 100 B. C. Opus Testaceum, concrete faced with brick, was found throughout the early empire until the 4th century B. C. Opus Mixtum is concrete facing characterized by a combination of brick and stone in a decorative pattern, and dated from the same period as the former. Principally, concrete facings were both practical and decorative, used for protection as well as ornamentation.

For the Romans, using concrete in constructing buildings was just as convenient as it was practical. In terms of labour, the majority of workers necessary to complete any type of Roman structure did not need to be skilled or educated. Generally, the only highly skilled workers that were involved in the projects included the architect, the master masons and master carpenters. The tasks of mixing, carrying, hauling and pouring concrete were performed by rather unskilled labourers. This same demographic also fit into the category of creating forms into which the concrete would be poured. The timetables of such workers were scheduled around the drying of the concrete. It was certainly possible for Roman

architecture to be built of stone, but this type of work would require labourers to dress the stones to exact dimensions, a more challenging task than that of concrete use. Because of this fact, the ease of using concrete made it a more prevalent type of building technology.

Designed by Roman Emperor Hadrian, The Pantheon is a prime example of concrete use by the early Romans. Hadrian was known for advancement in the vaulted style, and The Pantheon exemplifies this style with its impressive concrete work. Work on The Pantheon began sometime between July of 118 A. D. and July of 119 A. D., and was completed between the years of 125 and 128 A. D. During the period of construction, concrete was used vastly. The Pantheon is built on a foundation of concrete, nearly 90 percent of the intermediate block and rotunda is made of concrete, and roughly 5, 000 metric tons of concrete make up The Pantheon's dome.

As in many concrete buildings, The Pantheon's construction was completed in levels, where different strengths of aggregate were used in each plane. The Pantheon is said to have five different layers of concrete with five separate types of aggregate. Naturally, the lowest level contains the densest and most cohesive aggregate. As the levels of concrete ascend, a lighter form of aggregate is used than the previous layer. The dome of The Pantheon is made of the lightest aggregate in the entire structure, pumice.

The Pantheon's major features were methodically configured. Carpenters were required to construct castings used to pour concrete for foundations. The rotunda walls were created by pouring a dense concrete and aggregate mixture into short, wide trenches. Once dried, more concrete was set atop

the original trench in layers, until the dome terrace was reached. At this point, the dome had to be poured.

The dome is one of the greatest features of The Pantheon. Again, the concrete that was used to create the dome was poured on to a wooden form built in a half sphere shape. The dome form was held in place with wooden struts and timber to allow a light aggregate concrete mixture to dry atop it. Castings of coffers, or sunken panels, were attached to the wooden form to create the dome's intricate detail. As the dome was being poured, circular brick dams in the form of step-ring buttresses formed the dome's exterior. Step upon step, concrete was poured until it reached the more nearly horizontal region of the dome, where tacky concrete was used. At the top most point, vertically set horizontal tiles finished the dome. As one of the greatest achievements of concrete work, The Pantheon represents the fundamental function of concrete in Roman Architecture.

It is obvious that concrete played an essential role in the construction of Roman buildings. The development and adaptation of concrete in the Roman world was the most practical means of construction. Not only was concrete an available source of building material, constructing with concrete was also an uncomplicated and efficient technique. Fire and water proofing of Roman buildings were just a few of the practical functions that concrete provided. Concrete's properties allowed for Roman architecture to survive throughout the centuries; because such a useful material was discovered and widely utilized, we are still able to view and study some of the world's most brilliant structures.