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The largest possible sphere is carved out of a wooden solid cube of side 7 cm.

Introduction The Pantheon is one of the most iconic and best preserved ancient structures in Rome. With massive single stone columns raising the porch at the entrance, the immense open inner space created by the rotunda cylindrical, and of course the characteristic concrete dome and Open Oculus to begin, the Pantheon is rather the engineering wonder to see. However, the Pantheon as you see it today is not the Pantheon as it was when it was built for the first time. Neither is the first version of the Pantheon in that position. The Pantheon you see today is the third surrender of the “Church of every God” which had been adapted and modified through the centuries. This is only an example of a piece of the long history of the Pantheon that includes unique covesty, ingenious construction techniques and examples of remarkable Roman engineering. Due to this rich and often incomplete history, the history of Pantheon can be confused with confusion and mystery. Yet because of its breathtaking significance and wonder, the Pantheon has been the subject of many studies and analysis. While not all sources agree on every single point, the goal of this report is to try to sift the numerous sources of information to examine some of the stories, construction techniques and evolution involved in its history, in order to better appreciate the wonder This is the Pantheon. The Pantheon today (Photo by Author) Telescopic view of the interior of the Pantheon (Monlithic.org) History of the Pantheon is a breathtaking view just at first sight. Walk around a corner on a look similar to a typical Roman road and suddenly see the massive columns that invite you to domination dome. While it is beautiful to look and admire the dome, when you begin to analyze and break all the engineering involved with its construction, it becomes only more impressive. To put it in perspective, the Pantheon is still the world's largest non-reinforced concrete dome diameter, which means that there is no reinforcement structure in or around the concrete, as the strict one that would be used today. However, after almost 2000 years, it holds that record. The tallest building in the world changes every 10 to 20 years, but the Pantheon has kept its record for almost 2000 years. The one alone is a testament to the quality of Roman engineering techniques that went to create the Pantheon. After discussing some basic information in the next sections, I will present some information to expose some of these techniques and methods allowed for the creation and survival of Pantheon. Put into service while it is difficult to determine exactly who built the Pantheon, as, and when, it seems that there is a majority consensus on history as follows. In the year 117, Adriano began the tremendous feat that was the construction of the Pantheon. It was actually, rebuilding aOn the same site that the IL Two Pantheons where previously built. The first version, built by the emperor Marco Vipsanio Agrippa, is said to be a t-shaped building, built around 27 A.C. And burned in the fire of the year 80. Reconstructed from the emperor Domitian, the second Pantheon was struck by lightning and burned again in the year 110 (Parker, 2009). When Adriano decided to rebuild the Pantheon seven years later, the resulting plan included the ambitious dome of 43 meters in diameter. Modern Day Rome From Google Maps Location Currently in the Rome business district, Pantheon is located in Campo March (Campus Marzio), surrounded by restaurants and a public square, with Piazza Navona a few blocks westwards. At the time of Imperial Rome, as shown in the map above, the Pantheon was located in the personal property of Agrippa in the Campo Marzio, near the Nero Terme north and at the Terme di Agrippa to the south. Imperial Rome: the Pantheon is located in the upper left area (imgkid.com) design Although it is not clear who was the architect of the Pantheon, it is believed that it is not adriano in person, but rather than someone with More professional experience. Adriano, however, is given credit for the concept and great ambitious unique of the Pantheon (MacDonald, 1976). The Pantheon consists of three main parts, from a entrance portal with 16 monolithic columns that support him, from the cylindrical roundabout that walls the open interior space and the cement dome that thinters as it rises up to the ™ Oculo Open up high. The geometry and dimensions (in meters) of the Rotondae della Cupola (Martines, 2009) Plant views of the Pantheon (Jones, 2009) Meaning built on the place where Romolo, mythological founder of Rome, was ascended in heaven (Parker, 2009) The original Pantheon of Agrippa was designed for the glorification of Gens Iulia, one of the most noble patrician families of ancient Rome. In addition to the statues of Augustus and Caesar, members of Gens Iulia, the Pantheon of Agrippa also contained statues of many of the, including Mars and Venus. From a varied collection of divinities celebrated to the interior, it is believed that the Temple of Agrippa has taken its name from the Greek Â «Pantheonâ» which means more or less Â «all the gods» (Platner, N.D.). Cassius God, Roman Historic who published 80 volumes on Roman history in the early 2007 years, recognizes this commonly accepted interpretation and presents its ideas on the name of the Pantheon: Â «It has this name, perhaps because it has received among the images that They decorated the statues of many of the, including Mars and Venus; But my personal opinion on the name is that, due to its vaulted roof, it resembles the sky. Â «(Thayer, n.D.) According to Cassio God, this was not the original intention, as he describes further, Agrippa initially wanted to dedicate the Temple of Him to Augustus: Â« Agrippa, Its part, wanted to place a statue of Augustus even lÃ and give him the honor of having the structure that takes its name; But when the emperor would not accept norly honor, he placed a statue of the former Cesare and in the ancestral statues of Augustus and he. This was done, not from any revalità or ambition by Agrippa to make himself equal to Augustus, but from his fierce loyalty to him and his constant zeal for the public good; From here Augustus, until he censors him, he honored them more. " (Thayer, N.D.) The Pantheon of Agrippa stopped up to the 90's fire, and Domitian reconstructed the Pantheon in the same way and serve the same purpose as his predecessor. Adriano built the current Pantheon in 117 with the new cylinder and the design of the dome, but he held the same intention of a temple for all the gods. Adriano also preserved the original inscription of Agrippa on the portico of his new Pantheon: M Agrippa L F COS Tertivm Fecit (translating to: Marcus Agrippa, son of Lucius, three times consoles, built this). This was considered a more unperturbed thing to do; Write someone else's name on your building, but it was perhaps a way to give credit and remember the original concept of Agrippa for the Pantheon. This inscription caused confusion when trying to dating the building and the Pantheon manufacturer. But analyzing the stamps on the bricks that make up the rotunda, most of the historians feel confident that the current Pantheon was built by Adriano and not during the Kingdom of Agrippa, as the registration might seem to suggest (MacDonald 1976). Registration on the Pantheon porch (photo by author) Evolution of the Pantheon at a time just visible inscription on the Architrave recognizes the restoration of the Pantheon of Severus and Caracalla during the year 202 (Platner, N.D.). The Pantheon remained a temple to all the Romans until the fifth century, when in 609 the Emperor Phocas gave him to Pope Bonifacio IV, who consecrated him, dedicated him to Santa Maria and all the Christian martyrs, and renamed him Santa Maria Ad Martyres (Parker, 2009). This conversion into a Christian church is considered one of the main reasons that Pantheon resisted the test of time and was so well preserved. Together with other strong structural reasons as described below, the status of the Pantheon as Christian Church provided him with a more consistent and careful maintenance practice compared to other non-sacred or pagan sites that were left to be pierced and not maintained after the Fall of Rome and its long buoys (MacDonald 1976). Over the years since then and until now, the Pantheon has been altered, scavenged by, and used for various things. For example, the Byzantine Emperor Constans II robbed the Pantheon of his bronze tiles in 663, Pope urban VIII had two hundred tons of bronze from the porch removed to take eighty cannons Castel Sant'Angelo in 1620, and in 1620, 1620, century, twin towers where built over the porch and then removed in 1880. Pantheon was also used as a burial place for many significant Italians including; The artist Raphael in 1520 at the request of him, Victor Emmanuel II in 1878, the first king of Italy, and King Umberto I who was murdered in 1900 (MacDonald 1976). Today, Pantheon is open to the public to see and appreciate his wonder, for free. The tomb of Vittorio Emanuele (photo of author) The Christian altar in the Pantheon (photo by author) Analysis of the main sections of the Pantheon The Construction Foundation (Foundation) The Pantheon was built on a place that was naturally marshy, land of clay Unstable blue. This clay has crossed wet and dry four times a year due to the flooding of the Tiber River or changes in the water level. This has placed the potential to have a very problematic foundation because with a base so unstable, portions of the structure can settle or sink (Moore 1995). It is tolerable if the entire structure is established at a uniform rate and a uniform depth, but if different parts of the Foundation are established at different rates and depths, then the foundation could be stress that has not been designed for. If what could happen, the pantheon walls would be put under a great quantity of bending stress, and this could cause cement to cracks and fail in the shear. With such a massive structure like the Pantheon, it was important to make sure that the foundation was able to support all the weight of cement, brick and marble above it. The original design for the foundation of the Pantheon consisted of a 7.2 meter wide concrete ring, only about 1.2 meters wide than the walls he would support, and 4.7 meters deep in the ground ground. However, during a point in the final construction phases, the foundation cracked, so a second ring was then added to hold the first ring together. The second ring was 3 meters wide and led to a final concrete ring foundation of about 10.2 meters (Moore, 1995). Materials (foundation) The cement used to make the foundation is the Pozzolano cement, which consists of travertine aggregates in layers, held together by a mortar of lime and Pozzolano (Moore, 1995). The Roman cement consisted of three components: Moldy Moldy Lime, Pozzolana and Aggregation Pieces. The more often these materials were found in abundance and sent by relatively close to Rome the lime was made in limestone, consisting of calcium carbonate, which was heated to a furnace to suffer a chemical reaction and release gas into the limestone. After burning for days, the product in the furnace was a soft quicklime that, when mixed with water, becomes pasty and hardens as it dries. The second ingredient of the Pozzolano, is a volcanic ash that consists of a compound of amorphous silica. When mixed with liquid lime sewage, large holes in the molecular structure of Pozzolane are and expand to lock more pieces together. The last ingredient, rock aggregate is added or the concrete is placed directly on a layer of aggregate for additional mass and strength. The processes involved in creating and using concrete require a lot of chemistry; When you create a usable form of lime, when you mix the different amounts of the ingredients, then letting the concrete dry for the correct time, at the right thickness for the structure to form and harden properly. The Romans used a system of ratios to determine how to mix the best concrete using certain materials (Moore, 1995). It is quite humbly considering that the Romans knew nothing about molecular chemistry, their concrete was made through process and error, and yet they were able to invent concrete comparable to modern concrete, which is in terms of the types of materials used to make it, but not necessarily comparable to the modern superior strength of concrete. To build the foundation they initially dug circular trenches and lined them with wooden boards to create the concrete mould. They then compacted the concrete on layers of rock pieces and allowed it to dry (Parker, 2009). Compacting was a very important step, and Vitruvius showed how detailed it should be when he wrote that â˜˜˜˜˜ When stamping is finished it must be ... three quarters of its initial height “ (Moore, 1995). Compaction was important to make the concrete strong and resistant because a chemical reaction has to take place and the compaction of the concrete pushes the molecules closer by removing any extra air and water gaps. When approaching proximity and without extra water in the way in between, Pozzolan and Lime atoms can better bond by sharing electrons and this has created a resistant concrete (Moore, 1995). Structural Behavior (Foundation) This original design, in which the foundation was wider by about 1.2 meters wider than the 31.7 meter high walls it would support, which makes Moore suggests that the Romans might not have fully understood how much could happen and how much Foundation would be needed. The walls of Pompeii are another example of the economical use of the basic support by the Romans, because there is no distinguishable foundation for the 8-metre high and 5.5-metre thick wall. With the foundation of a structure that is probably the most vital element for longevity and stability, considering that the planned base of the Pantheon seemed to be a bit lean and built on top of wet clay, it is amazing that the structure has been stable until long has. Of course, they added more foundation after the first cracked ring, but it is uncertain what prevented the destruction of the structure, whether it is Lack of stress concentrations on the foundation, very strong concrete, and / or something else (Moore 1995). The design of the Rotunda walls (Rotunda) from the outside, the roundabout looks like a solid brick wall, but it is in fact more than this. There are openings in various various Rooms and passages throughout the Rotunda Wall. Also, while the wall seems to be made of bricks, the bricks are only a thin outer layer, most of the material in the walls is concrete, which provides the structural support and strength of the walls. The exterior of the walls was covered with white marble which hid all the brick and provided a cleaner prefix after construction. There are three frames between the walls that separate the wall into sections or levels (Macdonald, 1976). The walls contain arches of relieving interior and exterior which, together with 8 very large niches inside, divide the wall into a series of concrete piers. The interior of the Rotunda has a diameter of 43.4 metres, the same as the dome above, and is 31.7 metres high (Moore, 1995). The exterior of the walls is round. See the protrusions marking the frames just below the rectangular openings (photos by author) Construction (Rotunda) To build the roundabout, a repetitive cycle was used: the brick walls would be built lightly, the brick and mortar layering, then the aggregate would be positioned in a layer, the lime and the pozzolan mortar would be put on top, the concrete would be compacted, then let it dry. They built like this in 20 centimeters thick layers, adding relieving arches and leaving empty cavities as they moved. The lifting arches were made by erecting a temporary semi-circular wooden shape on the opening, laying a thin layer of mortar on the top to make a bed for the bricks, and then the bricks were stacked at the end on the shape. The bricks of the arches were bipedales, a Roman type of square bricks, which were about 60 centimeters long and wide, and about 2 centimeters thick. The lifting arches in the lower part of the Rotunda are a layer of thick bipedales, but are two or three thick layers in the upper sections. After the shape has been removed, the underlying void would be filled with bricks and concrete. There were also gluing courses, layers of bricks 2 thick bricks placed horizontally, up to the wall about every 1.1 meters on the wall, thought to be a way for builders to keep the level of the wall and straight as they built. (Moore 1995) To build the walls, the builders used scaffolding for very light wood tied together with rope. The scaffolding could be of three types: independent scaffolding standing alone and need not be supported by another structure, dependent scaffolding which was inserted into strategically positioned holes in the structure and was fully supported by the structure they were using the scaffolding to build and semi-dependent scaffolding which was a mixture of both; supported by both the land that from the built structure. The Pantheon builders probably used a combination of these. of scaffolding while they built the wall and the dome. See the images below for the visual explanation of the types of scaffolding (Moore 1995). Types of Roman scaffolding (Moore, (Moore,Materials (round) The concrete in the wall of Rotunda was the same type as described in the section of the foundation materials mentioned above. The layers of bricks as seen on the outside were built with the typical type of Roman brick. These bricks were made of burnt clay that undergoes a chemical reaction through the heating process, changing the chemical structure of the material. The bricks are heated at high temperature for about 2 hours to complete the chemical transformation. The colors of the bricks are determined by the temperature that is burned and the chemical composition, in particular the concentration of iron oxide, alumina and calcium. Below is a short breakdown of changes occurring in a brick during heating (Moore 1995). As bricks undergo chemical changes with heat. From Page 88 by David Moore "the Roman Pantheon" discussing the influence of heat in the brick manufacturing process, the bricks will be formed in standard forms as below screenshot shown; Bessales, Sesquipedales and Biedales. The different types of bricks would also be subdivided into the triangles, as shown by the lines through the bricks in the photo below, and this was made to provide various bricks of different sizes to satisfy certain works. The pieces of broken bricks were also used as part of the aggregate in the concrete walls of the Pantheon, an example of the common Roman practice of reuse and renomination of materials. Different sizes and standard Roman brick cuts (ACocella, 2014) In this photo you can see the layer of external bricks (low), exposed inner concrete (high central) and holes used to support scaffolding and painting during construction. (Photo by author) Structural behaviour (Rotunda) The rotunda walls hold the massive dome above and provides the interior space needed for public space inside. With all niches, cavities and alleviating arches to provide these characteristics, the walls of the Pantheon do not necessarily involve as a typical solid wall. The cavities and niches in the walls divide the round into what is essentially a series of eight concrete piers, where the concrete is more often, stronger and supports most of the load. The alleviating arches, frame the niches and cavities, are in place to deviate the load from the area near the structurally weak cavities in the docks. The arches transfer part of the load in vertical weight in a diagonal support reaction to the base of the arches in the Piers. The vertical component of this transferred load is directed through the pier and the ground, while the lateral thrust from the arches is directed towards the adjacent piers and arches. The lateral pushes in adjacent arches indicate opposite directions and substantially â€ œCancelâ€ each other, and why the archesPantheon are circular-shaped rotunda, all the forces distributed by the arches are fully supported and Â Â œ Gancancelledâ€ from the completed cycle (Lancaster, 2006) Cross section of the wall. See thicknessAreas against niches and cavities (Macdonald, 1976) A diagram of arches direct the load to the pillars (Lancaster, 2006) relieving arches in the brick walls of the Rotunda (Author's photo) relieving arches in the brick walls of the Rotunda (Author’s photo) Relieving arches in the brick walls of the Rotunda (Author’s photo) Rotunda’s softening arches also helped prevent and manage the regulation of the mortar while the walls dried during construction. Because of the shape of the arch and the way it redirects the load, the arches were able to move slightly and better absorb some of the effects of mortar settlement and also allowed them to build faster because they didn’t have to wait for the mortar to heal completely before moving to the next level (Lancaster, 2006). However, this did not stop all settlement and mortar creeping into the walls of the Pantheon. There is an interesting theory about the structure attached to the rear of the roundabout which suggests that the Pantheon faced some major settlement at some point during construction and they needed to improvise a way to remedy it. Attached at the rear of the Pantheon is a small structure, called Grottoni, which is a brick building consisting of 6 internal walls, 2 floors, vaults in the head and a bridge-like connection with the roundabout about 2/3 of the way up. The Grottoni does not seem to have served a ceremonial or utilitarian purpose, and along with the fact that it seems that the Grottoni was built quite quickly, there is a bit of mystery as to why it is there. Mark William Jone’s theory is that due to the clay foundation, portions of the walls of the Pantheon began to settle at significantly different rates, and this caused the walls to start to separate during construction. As a way to quickly fix this, they built the Grottoni to hold and support the walls against slope and collapse due to further settlements. Based on the cracks in the round walls and the dates printed on the bricks indicating when the Grottoni was built, Mark Williams Jones describes it as the most probable reason for the existence of the Grottoni: Ã¢Â¢ÂÂ¢Â | Whatever is exact causality, the very existence of the Grottoni and the way they were built undoubtedly speak of a crisis linked to structural difficulty or construction difficulty. Â” (Jones, 2009) the Grottons at the rear of the Pantheon (Author Photo) The porch at the entrance of the Pantheon is a large porch; An area covered by a triangular border structure supported by 16 monolithic columns (a single stone) above a slightly raised porch floor. The porch serves as a large entrance to the Pantheon and includes some rather interesting features, notably the columns. Construction (Portico) The column of the they were typical Roman column style, but they were larger than many columns used during this time, so it was their own business to create, carry and erect them. Most likely erected columnsThe typical Roman method described by Brian Sahotsky (ND): Ã ¢ â‚¬ "The raising of the columns used a variety of equipment, including cranes, lifting towers and other simple machines. In the tenth book on machines of Vitruvio, the author describes many cranes and processes that these machines are used to raise heavy loads during the completion of the temples and public works ", and also to upload and unload ships. He mentions that some of these machines are set to a vertical position in a stationary position, while some have revolving boomes. Vitruvius also describes a laminated wood instrument and support cords that looks like a fulcrum lever mechanism. Capstani on the ground floor would feed the strings through the pulleys to effectively tie the beams in the wood and pull the column from a horizontal position lying at the vertical position. Large wooden cranes, then raised the column in its place on each podium. Depending on the size of the loads, these cranes take the arms with single or double arms. The largest of loads would require reducer, including the use of capsuan to voltage arm arms. The most difficult and cumbersome of the loads would be managed by treadmill crane, as illuminated in a scene of Haterii relief (shown below). These cranes were depicted with a maximum of eight workers inside the tapis roulant bowels, which provide the necessary power to manipulate loads. Â, â‚¬ (Sahotsky, ND) As the columns could have been erected (Sahotsky, Nd) another method of lifting column (SAHOTSKY, ND) materials (porch) The columns of the Pantheon Portoco are organized in three files; 8 In the front row and then two rows of 4 columns behind them. The columns are all monoliths sculpted by the Egyptian granody. A stone very similar to granite, the granoderate is formed in the same way, with the underground magma of slow cooling, but the granoderototate has more soccer and sodium and is darker than granite. Even the rosette stone and the half dome of Yosemite are made of granoderate (national parks). Each column is 11.8 m high, 1.5 m in diameter and weighs about 60 tonnes. The columns were extracted in a single piece each from the mountain hails of the Egypt of Mons Claudianus. From there, they had to be transported to Rome through the Nile, the Mediterranean and the Tiber River by means of wooden sledges, barges and larger jars (Parker, 2009). The simple wooden trusses are now used below to support the roof of the pediment of the front, but once there was a bronze roof structure in the roof that has since been removed from Pope Urbano VIII. (MacDonald, 1976) Structural behavior (porch) When it is in place, these the columns were used to support the large triangular pediment above the entrance. The pediment is made of stone and supported by wooden beams inside. There was a bronze in the roof of the porch, he said to be in the form of capriates, but this implies that the ancient bronze had a greater structural force that can actually have had. TheIt was probably used only to cover wooden supports like those used now (MacDonald, 1976). The columns of the Pantheon porch serves the same functions as the largest number of other columns; They are supporting structures used to transfer the weight of the structure above, through compression, to the ground. As a fairly simple structure, the massive pantheon columns support beams that make up the lower part of the roof of the porch above. Although their functions are simple, the pure dimension of the columns and the fact that each of these single stones make the history and creation of the rather complex columns. The lower part of the pediment. Note The columns that support stone rays and arches, and wooden trusses holding the roof. (Photo of author) One last thing to note on the porch and the columns is the existence of a second scheme visible for a pediment on the intermediate block of the roundabout, slightly above the roof of the existing pediment. As seen in the picture below, this strange triangular contour, which reflects the shape of the current porch just below it, led to many speculations of why is there. Mark Wilson Jones (1987) offers a possibly explanation to this strange aesthetic; Originally expected to use even larger columns. Jones claims that the Pantheon was originally designed to have columns 50 Roman feet and 10-feet high Roman feet, but for some reason they were unable to use columns as designed. Therefore they had to use the 40 columns of the Roman foot and 8 Roman feet capitals that are currently in place. Whether it was a mistake during the quarry cut, the highest columns rolled, or some other reason, it is unknown because they had to use these courteous columns. The walls of Rotunda would already have built when they did this change of construction, so they had already done the outline for the designed pediment, hence the second highest outline that you can see today (Jones, 1987). This is an intriguing example of the engineering and adaptability of Roman engineering and another the unique challenges presented during the construction of the Pantheon who had to overcome. The reconstruction of the Pantheon may have looked, showing porch and statues (Hudelson, ND) the Pantheon today, see the second frame outlining the pediment planned above the existing pediment (Romesegway.com) the dome a half-circle perfect concrete Cofered in the internal concrete Which leads to the Oculus open to the sky, the dome probably the most definitive feature of the Pantheon. To build the dome he took a lot of planning and technique of Roman engineering, a work that repaid, while the dome is still today. Design (dome) The whole Pantheon is saturated with geometrically inspired design and the dome is a good example of this. The dome, a perfect from the inside, has a diameter of 43.3 meters and rests on top of the round walls which have an equal height. That means the Pantheon is is To theoretically keep a sphere of equal diameter to that of the dome, and the sphere is enclosed or defined by the size of the cylinder or cube that could be used to represent the Rotunda walls (MacDonald, 1976). This geometric report attracts the Vitruvian man of the Leonardo da Vinci mind, the ideal human form defined by a circle and a square. This circular and square design pattern is prevalent throughout the Pantheon, as also seen from the design of the tiles in the floor. Look at the images below for the visual explanation of these geometries. The theoretical sphere, cube and pantheon cylinder (toolonginthisplace.wordpress.com) leonardo da vinci vitruruvian man (leonardodavinci.stanford.edu) pantheon floor and hte circular circle and square geometry (photo of author) construction (dome) the dome is It was created by concrete poured using a system of internal and framework scaffolding. Once the rotunda wall is completed, the builders could start affixing wood platforms to the walls and start building the dome. The dome started from the top of the rotunda as a series of 7 concrete rings that are half of the dome down the width and diameter until it switches to a smooth circular line up to the diameter of 5.9 meters in diameter Oculus. The inside of the dome is flanked by 5 groups of speakers, rectangular spaces left out of the dome to save weight and material (Moore, 1995). To put the concrete for the dome, the manufacturers worked at levels, building wooden work platforms and shapes to shape the concrete. The rings have been laid and dried one above the other, so the shapes have been built the lay the circular dome while accumulating, creating special shapes for the speakers as they went. Below are some images on how this may have looked. They used the heaviest aggregate, mostly basalt, lower and lighter materials, such as pumice, high. This was done to lighten the weight of the dome while using the materials needed to provide sufficient support where necessary; At the bottom and save weight in which less load is supported; Near the top (Parker, 2009). When they arrived at the Oculus, it was not as simple as simply leaving an empty hole, the upper part of the dome is under compression, so they had to install a compression ring to prevent the collapsor oculus from the inside. The compression ring in the center of the dome is 5.9 meters in diameter of 1.4 meters thick. The ring is composed of 3 horizontal tiles rings, 2 thick bricks, set to a vertical position and one above the other. This brick ring and a bronze ring lining inside the oculus correctly distribute the compression forces at this point. (Moore, 1995) the dome was covered by a layer of bronze plates, but those were since removed and replaced with lead plates. In the photos below, you can see the step ring pattern seen in the outer base of the dome, the internal builder and some possible representations of how they could build the scaffolding and the painting for laying the domeof the dome. Geometry and dimensions (meters) of rotunda and dome. See the passage of the outside and the cover of the interior. (Martines, 2009) Figure of stepping rings and lead plates outside. (More 1995) figure of steppe rings and lead plates on the outside (More 1995) Possible scaffolding methods, see protruding form of crates: independent scaffolding (altereagle.com) Possible scaffolding methods: Delaying dependent (Moore, 1995) Materials (Dome) The dome of the Pantheon is made of cement, but it is not uniform in everything. Several cement mixtures have been used at different levels, while moving the dome, heavier materials lower to the base and lighter weight materials at the top near the top. Concrete was similar to what I described in the Materials Foundation section above, but they changed what kind of aggregate they used. They used heavier rocks like basalt and on top they used clearer rocks like pumice (Parker, 2009). Structural behaviour (Dome) Step rings provided most of the side push matting support from the dome. Adding enough mass to the base, where the force is concentrated, the rings act as a choke. These grinding rings are the reason why the dome does not look like a perfect circle midway from the outside, but rather more than a form of bowl. The reason why they varied the concrete weight of the dome at different levels was to make the dome lighter with cheaper material, while providing enough structural support. By weighing the dome less close to the top, but making the bottom of the dome heavier, it provided more support, at the bottom where it was necessary, for the lateral push from the load of the rest of the dome above (Lancaster, 2006). Other attempts to lighten the dome are seen in the dome's inner drawer and the dome's thinning from 7 meters to the base at 2 meters thick at the top. The 140 crates are rectangular slots left out of the dome to save some weight and material, but also add a scene of artistic perspective. Despite these many attempts to avoid excessive stress in the dome by reducing weight, the Pantheon dome is cracked in many places. Due to the fact that the concrete is dome-shaped, it is subject to tension by means of hoop stress and, as the cement performs more badly in tension than in compression, hoop stress has led to cracks in the dome and walls of the Pantheon. Pantheon cracking has been strongly documented and mapped and a design studio by Mark and Hutchinson has this to say about it: “Terenzio [an Italian superintendent of monuments documenting cracks in 1930] also identified fractures coming from the base of the rotunda to the top of the dome that he thought were brought from settlementFrom irregular cargo of the main wall, particularly near the entrance to the rotunda rather than find vertical vertical differential We only observed traces of side openings through the cracks-corresponding to the effect of the voltage of the circleÂ ». (MOORE, 1995) The slot occurs in the lower half of the dome, starting from the dome point where the stress changes from voltage compression. The cracks are in the southern direction, rather than sideways or horizontally and do not reach the oculus. Cracking creates an interesting situation in which the cracks create sections that act as series of arcs that share uncrowdered oculus as a common time key. While the dome is obviously still standing, the cracks contributed to the summit of the dome being collapsed about 60 centimeters. (Jones, 2009). According to Moore, a model has produced results showing that the maximum concrete bending stress in the dome is 18.5 psi and, using a similar Roman concrete sample from Libya, provided a traction resistance of 213 psi per The concrete. It therefore appears that the slots in the dome do not constitute an important problem, since the stresses are within a security limit, but the cracks are still monitored and discussed to add a protective steel band around the base to avoid dislocation during an event Like an earthquake. (Moore, 1995) The stresses in a spherical dome: the voltage in the lower part provokes southern slots from the base (Isler and Balz, 1980) mapping of cracks in the dome of the Pantheon. (Moore, 1995) The Pantheon and I didn't start with a idea what to write my essay, and I didn't know much about the Pantheon especially before this trip. However, after many conferences and tours, the Pantheon continued to tick into the discussions. That it was his marshy foundations, of the design of the dome, cracks, or of all the improvisation that took place with elements such as the columns too short or the additional structure to grottini in the back, I could not help but immerse myself In the depth and within the scope of the engineering genius who devoted himself to the design and construction of the Pantheon. But at the way of history and stories that can be read and listen, the only thing that strengthened my choice to study the Pantheon was the wonder that I tried seeing him in person, walking around, touching him and going inside . You walk behind a corner like any other Roman angle and then, Bam!, Pantheon is right there. The dimensions, the complexity and the appealing aesthetics are undeniably stunning. I had the opportunity to enter early one morning when it was raining, and it was unforgettable to see the rain fall through the oculus, apparently in slow motion, feel the rain hit the soil uncrowded and silent, and then take a deep breath To feel the great open space inside the Pantheon, the door of paradise. there is no available scale to climb up to that gate, but listening to music in the outside square, it is nice to imagine that there is one (see video below). Left: ScaleOne day while passing in front of the Pantheon (video of the author) right: this is the Pantheon. For me too. Thank you I would like to thank Steve Muench for guiding this program and Heta Kosonen for helping to make Engineering Rome a uricity and incredible experience. I have never been able to express my gratitude enough for all the hard work that has been done to start and manage this program, but I really appreciate the dedication and commitment to provide us with the opportunity to travel and know the Roman engineering. The people I met, the places I saw and the things I learned are indescribable memories that I will be happy to always have to do with the hard work and the good will of UW, of the civil engineering department, and the faculty that put together The program, in particular Steve, Heta and all those of the UW Center in Rome. I could never thank everyone, not enough, but I highly recommend this program to any student who is lucky enough to have the opportunity to participate. We hope that the roma engineering continues to prosper and then perhaps, as the more hearts touch and louder expand, there will be enough students to give everyone the praisions and thanks closest to what everyone really deserves, more than How much I can express alone, but never more than I really feel. MacDonald references, W. (1976). The Pantheon: Design, meaning and progeny. Copyright 1976 by William L. MacDonald Jones, M. W. (2009). The Pantheon and the phase of its construction. p.68-87. Recovered by UW Catalyst Engineering Roma Resources Page Martines, G. (2009) The Structure of the Dome. p.99-105 Posted on The Pantheon: From Antiquity to the Present (2015). Recovered by UW Catalyst Engineering Roma Resources Page Lancaster, L. C. (2006). In GraÃƒhof, Gerd Â «Heinzelmannâ», Michael Â «Wâ¤fler, Markus (edited by). Recovered by UW Catalyst Engineering Roma Resources Page Moore, D. (1995). The Pantheon. Recovered by Moore, D. (1995). The Roman Pantheon: The Triumph of Concrete. 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