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Philosophische Fakultät
Archäologisches Institut
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Modulprüfung: 3D Documentation and Modelling

Puente del Diablo.
Creating a 3D Model of an Aqueduct Bridge in Cinema4d

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1. Abstract

This is an academic report on the 3D Modelling Project to complete the Modulprüfung 3D Documentation and Modeling for the WS 2023/24. The tasks consist of a part in 3D modelling (software: Cinema4d) for the purpose of creating a 3D print of an aqueduct, this report, 1-page summaries on SfM and RTI, as well as documenting the modelling process in form of a blog and finally burning everything on CD-Rom. The given reference material includes a square 3D Model with a terrain model and a long rectangular cuboid, to show the intended scale and position of the expected model. This report reports on the modelling process, as well as the ethical and theoretical implications of 3D reconstructions in general and how they apply to this project. In the conclusion part, the author will also acknowledge the weaknesses of the final product and summarize what was learned.

2. Introduction

3D data and 3D models have become a natural part of archaeology. Nowadays, no excavation is conducted without a total station, and on-site made drone imagery for SfM (structure-from-motion) as well as LIDAR scans are frequently seen, too. Such computational technologies are essential to modern archaeology and are taken (almost) for granted. This global, transformative trend has started decades ago and has led researchers to criticize a potential over-reliance and lacking consciousness in the employment, already in the 2000's.[1]

In the frame of the Master degree's study program "Digital and Computational Archaeology" at University of Cologne, students attend classes on a wide range of 3D methods relevant today. The employed softwares often present themselves as easy-to-use push-button-solutions. While this leads potentially to faster and more accurate archaeological data and documentation, it comes with its own challenges, which require special awareness. In the case of SfM, those include the creation of 'primary' 3D data through photographs. As students quickly realize, the SfM process creates large amounts of data and requires a lot of digital storage. This is especially valuable where no sufficient documentation has been done before, such as ongoing excavations or generally less researched and remote areas. But this is not always necessary. Depending on the intended purpose of the 3D data and resulting models, it is well possible to extract the required information from existing plans and publications, as shown with this course on 3D modelling. Based on 2D plans and drawings created decades or even centuries ago, 3D

[1] Huggett 2004, p. 81-92

modelling can create 3D content for various purposes, such as visualization, education and reconstruction. However, contrary to, i.e. SfM software, the spatial data is created manually, meaning the human agent has a lot more control and ability to shape and manipulate the final construct. This poses a great target area for various biases, spread of misconceptions and critique from fellow researches. As the scientific field encountered such challenges more regularly, it has led to the creation of overarching guidelines, like the Sevilla Principles[2] and the London Charter[3]. Thanks to those, it has become easier for researchers to produce more consciousness and coherent documentation alongside their data and is pretty much the goal of this report, too.

3. Considerations on Ethics and Theory of 3D Reconstruction

We could just start sculpting around and create purely fictional pillars, arches and so forth and make it look like a famous aqueduct bridge. Because the given task does not specify what kind of aqueduct is wanted, not even that it should be supported by a bridge with supporting arches or from which time period. But if this model gets 3D printed and will sit in the collection of an institute, possibly for decades, information probably gets lost over time and there is a chance that either nobody will understand the identity of the building or worse, may take it as an authentic reconstruction of an actual building, which in a way it is. For many years prior, "the main criticism raised in the literature is 3D reconstruction's tendency to mislead the end-user through highly realistic imagery".[4]

The purpose of the 3D print beyond being part of a "student collection", should be specified.[5] The wide range of theoretical and ethical Implications of 3D reconstruction, and in a wider sense virtual archaeology as a whole, have been discussed extensively and for decades in academic research, so it is difficult to point to specific publications.[6] Most notable are "The

[2] Link in the sources
[3] Link in the sources
[4] Barratt 2021, p. 18
[5] Compare Sevilla Principle 2:
"Prior to the development of any computer-based visualisation, the ultimate purpose or goal of our work must always be completely clear."
Also 4.2.2.:
"In addition to clarifying the main purpose of computer-based visualisation, more specific objectives must always be defined in order to obtain more precise knowledge of the problem or problems to be resolved."
[6] I find these Implications to not limiting themselves to 3D reconstructions but also applying to various other forms of Digital Archaeology and even pre-Digital Archaeology.
For an overview of the history of virtual archaeology and some theory and best practices, see for example: Remondino 2014, 113-127.

Sevilla Principles" and the "London Charter for computer-based visualisation of cultural heritage", because they represent the resulting and universally applicable guidelines (despite their age) for 3D reconstructions in Archaeology. Following are some brief explanations of some typical, theoretical and ethical implications, based on those and how they apply to this project.[7]

3.1. Theoretical implications

Interpretation Bias:

Reconstructions in archaeology of any kind, involve interpretation of archaeological "features", meaning the underlying data is always fragmented or incomplete. There is always a human who has to filter and fill in the gaps. This is usually combined with a spatial gap between the production of data in fieldwork and the publication, leading to the stereotype of the archaeologist, who argues alone in front of their data. It's caused by a lack of circulation of the data before publication.[8] This predicament combined with humans usually having different of biases, unwarily so, may lead to biases in the final representation of ancient remains. In this project, I assumed that the green long block in the Reference Material expected me to model an aqueduct bridge, so my vision was indeed biased to begin with.

We see that a lot in physical reconstructions in ancient roman sites. In the last century, the advent of tourism, a better understanding of ancient architecture and concrete as a versatile, cheap and strong building material inspired the imagination and lust for reconstructing monumental roman architecture. One such example could be the Nymphaeum Traiani in Ephesus. It was "reconstructed" despite a lot of its superstructure is missing and not even to the correct height, producing a sorry image of confusing dimensions and incorrect arrangements. Adding pain to injury, the concrete is not easy to remove and changes are therefore hardly possible.[9] This point leads into the next implication:

Accuracy vs. Speculation:

Every reconstruction needs to find a balance between accuracy and the inevitable speculation involved in filling gaps in the archaeological record. This may raise questions about the validity and reliability of reconstructions. In this project, I used a schematic plan of the layers of stone slabs as the main source for my model. It does not show any kind of detail (like decorations) or

[7] It's noteworthy that these often apply to all kinds of reconstructions, not just virtual 3D models.
[8] Remondino 2014, p. 117
[9] Quatember 2011, p. 167

true to life variations. However, this aqueduct bridge is designed and constructed very uniformly with little to no decorations, as far as I'm aware. So, I would argue that accuracy and speculation are actually well balanced.

Temporal Validity:

As time passes and more research is conducted, the underlying archaeological record and conclusion can change. Earlier reconstructions are rendered obsolete or inaccurate. This implication is similar to interpretation bias.

3.2. Ethical Implications

Authenticity of Representations and Ownership of Cultural Heritage:

Ethical concerns may arise about the credibility of reconstructions when compared to the original sites, as well as their portrayal of ancient cultures and peoples. For example, in my 3D model of the Puente del Diablo, I used plans to model ('sculpt' would also be fitting), an aqueduct bridge that crossed a valley. This valley, however, did never contain a river like the reference terrain model did. Also note how architectonical features of pillars sitting in rivers are missing. This aqueduct bridge couldn't exist in reality. But it may look convincing to someone. My 'reconstruction' took a real building of a different nations cultural heritage and misplaced it, in what looks like a terrain of a real site. Collaboration with stakeholders would improve this situation. Perhaps they could provide more accurate data than is available online. The Institute of Archaeology of the University of Cambridge should be contacted and asked for the purpose of the reconstruction. The "student collection" implies education but what can a 3D print show, that can't be seen in images, with this purpose in mind? This question should have been clarified beforehand.

3.3. Presenting 3D Reconstructions and 3D Prints

Transparency and Communication:

With the established implications and referenced guidelines above, and the scope of this fictional project in mind, transparency is of critical importance. It needs to be stated in some way or form, what the purpose of the model is and how it deviates from reality. As a first step, I would recommend a good label somewhere on the print, with key information. It should already point to the fictive nature. Then, for a presumed database of the collection, a short info text should be delivered, which summarizes the project and contains links to access the full documentation and files online (as will be done on GitHub and Sketchfab later on).

Label example:

Fictional 3D Model of an Aqueduct Bridge

Bridge is based on “Puente del Diablo”, Tarragona, Spain

Fictional location

Made by: Lorenzo Canals in 2024

Contact info, Institution, etc.

Documentation:

Firstly, the documentation should be accessible online and the different platforms should cross-reference each other. It should be comprehensive, equipped with sources, methodologies, and assumptions underlying the reconstruction. This is for the purpose of verification by other scholars. Secondly, some contextualization would be helpful, like the real localization of the terrain model and the real location of the bridge, along with photographic evidence. Some of which is provided in this documentation.

4. Reconstruction process

The following chapter is a summary of the reconstruction process, following the order in which things were done and ideas were had.

4.1. Reference Material and initial Considerations

Since the target audience is in the field of academics and the purpose is appears to be educational, it makes sense to attempt to balance the “Accuracy vs. Speculation” scale more in favor of accuracy. Higher accuracy comes at a cost of efficiency[10] though and time was short for this exam project.

The reference model implies that the aqueduct is supposed to bridge over a valley and optionally a river or ancient river bed. “Optionally” because despite the image we typically have of an aqueduct in our mind, not all of them cross rivers and wide valleys. Essentially, an aqueduct is a water canalization and only in special situations, Romans deemed bridges worth building. But

[10] Sevilla Principle 6

I assumed this to be the expected model architecture. The quick way to get a list of candidates, is the "List of Aqueducts in the Roman Empire"[11] on Wikipedia. Based on those requirements and the seemingly large size of the 3D print, two specific aqueduct bridges come to mind:

First the Pont du Gard in France, which is probably the most iconic roman aqueduct. It's also known to be the tallest and among the best preserved. It was built in the 1st century AD, crosses a river and has very wide and near circular arches, of various positions and dimensions, meaning it requires a lot of handwork in modelling. So, I decided against it.

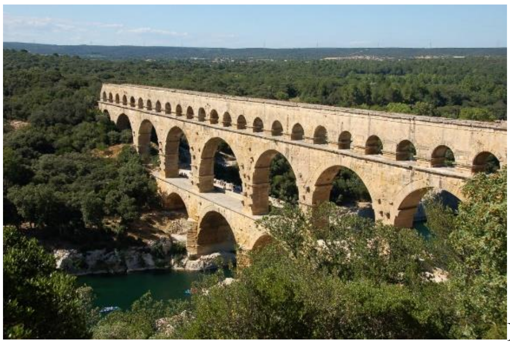


Fig.1: Pont du Gard

My second option is found in Spain and called the Aqüeducte de les Ferreres, or Pont del Diable (Catalan). It is one of the most famous *arcuationes* (latin name for this kind of bridge) in all of Spain and was built in Augustean times.[12] The architectural design is overall very uniform and the construction style is *opus quadratum*. That should make modelling easier.


Fig. 2: Puente del Diablo bottom pillar

[11] https://en.wikipedia.org/wiki/List_of_aqueducts_in_the_Roman_Empire; see also: http://www.romanaqueducts.info/index.html
[12] E. Lopez 2016, p. 164-166

It crosses a valley, meaning the pillars are set on the ground and rectangular in shape, unlike river crossing bridges, that (sometimes) appear with wedge-shaped piers, like for example the Ponte Sant' Angelo in Rome (Fig. 3). Furthermore, the bridge has what I call a double gallery in the center and single gallery at maximum height besides it.

Fig. 3: Ponte Sant' Angelo with wedged piers

In fact, a 3D model of the Tarragona aqueduct can already be found online but it appears to be SfM based and of very low quality, recognizable by the many distortions and badly filled areas in the extremities.[13] It's also pay-walled and does not carry any literature references, that would document anything about it.

4.2. Distortion and Scaling of the Reference Material

There aren't many elevation or section plans published for this aqueduct bridge and after my initial research, it seems there currently exists no really accurate or recent stone-true plan. Instead, the archaeological literature did what happens often. It copies, scales and reprints old plans (doing all that in the pre-digital era), resulting in some amount of distortion. Also, old plans are typically hand drawn and based on hand measures, so anything outside of a "Steinplan" could be just a scaled sketch. In the referred publication,[14] it seems like the old French plan ("alzado y planta")[15] has some compression in the height axis, which could also be a product of me scanning the paper pages. It also fails to represent the steps in the pillar. This can be seen much better in the authors 2D plan ("detalles de la estructura en alzado y seccion

[13] https://sketchfab.com/3d-models/acueducto-puente-del-diablo-tarragona-8bd99b4e80c1418c92f748da82390be8
[14] Casado 2008, p. 29-52. The first edition of this book was from the 1980's.
[15] Casado 2008, p. 34

vertical”), which respects the roman units and appears to be scaled correctly. Therefore, the old French depiction is from here on considered as less accurate and is only good for estimating the scale of the pillars besides the double gallery in the center. In the end, I scaled the Spanish schematic based on pillar width and height of the lower gallery, and assumed, that ‘roundness’ and radius of the arches are more correctly reproduced here.

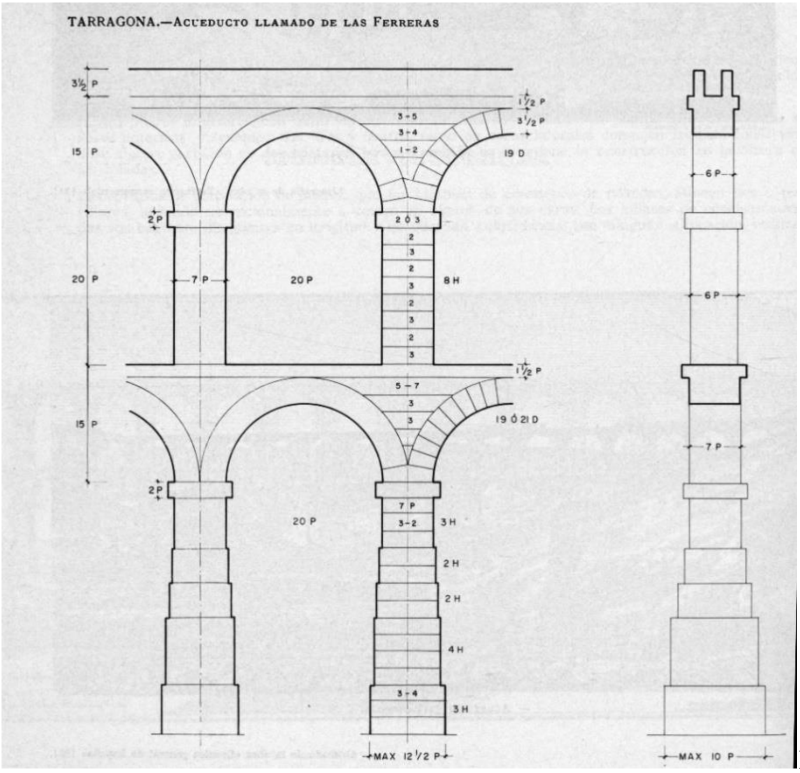


Fig. 4: Schematic Elevation plan

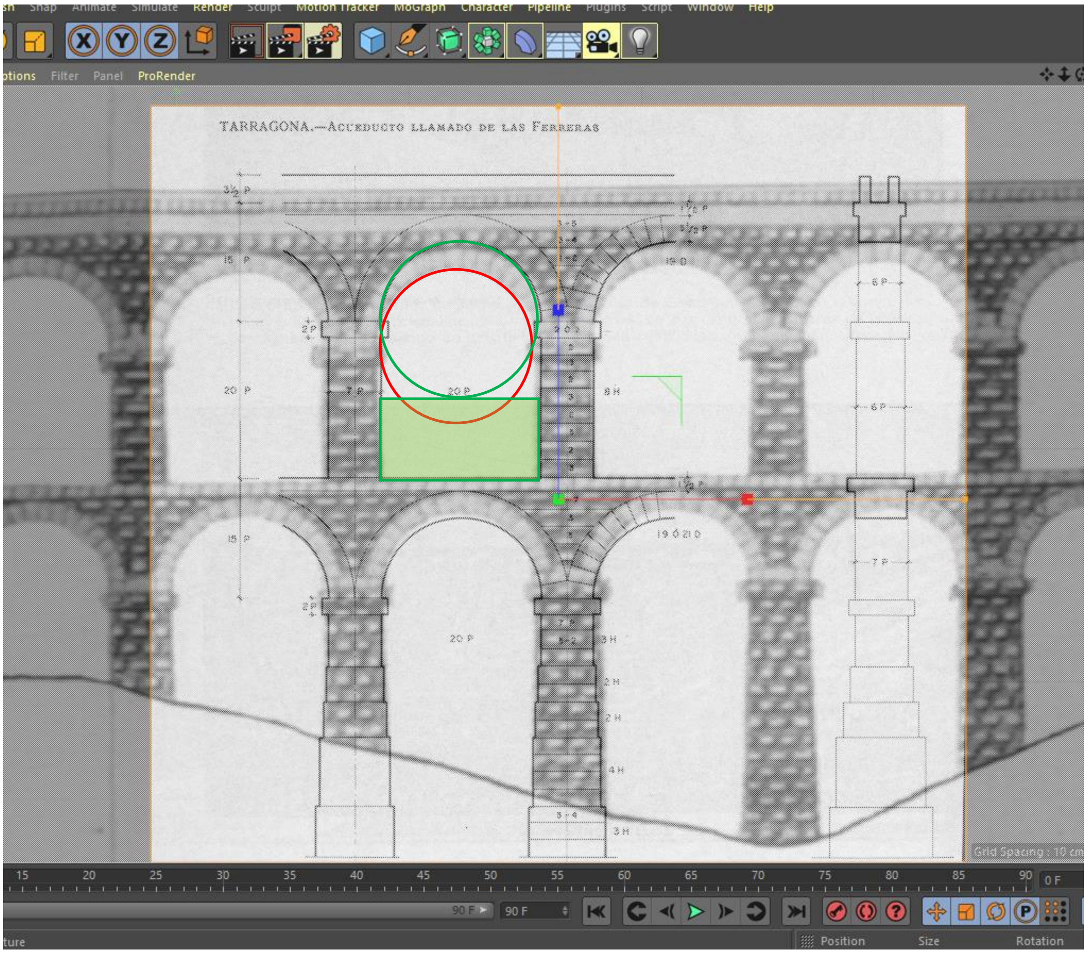


Fig. 5: Distortion between Plans

4.3. The Modelling Approach and Considerations on 3D Printing

A choice that presents itself now, is whether to use box or spline modelling. In my opinion, the spline can create more complex shapes when modelling based on 2D images but increases the handy work when dealing with simple geometries, like the rectangular ashlars found here.

Thanks to the overall uniformity, symmetry and lack of architectural decorations (which seems unsurprising on a utility building outside of urban spaces), box modelling seems to be the better approach, at least for the pillars. The surfaces of cubes can be easily extruded and stretched to match the existing plans, while providing more uniformity and simplicity than spline modelling could in the same amount of time. With a few boxes a bottom pillar is quickly done. The layers seen in the background image represent the actual block height and indicates how many blocks were used per layer.

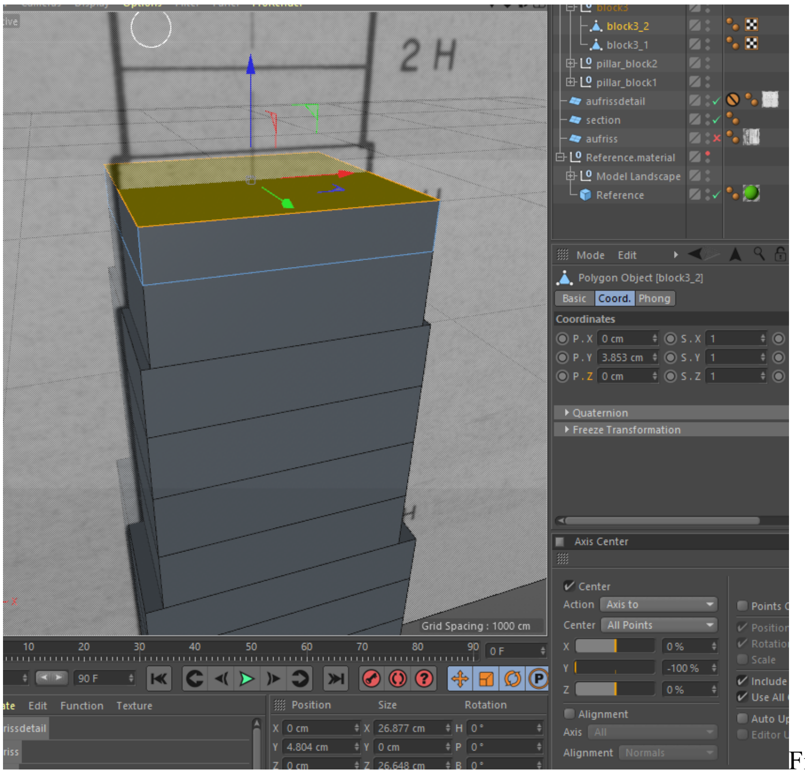


Fig. 6: Box Modelling

Noteworthy is the use of "Snapping" to assure that the individual blocks are actually touching each other, or else the 3D print may run into issues. From experience I'd expect errors like layer shifts or bad layer adhesion, resulting in a failed print. This is very frustrating as such small oversights are time consuming to fix afterwards. Furthermore, the use of box modelling and the relative simplicity helps with avoiding mesh holes (imo), which confuse slicer programs and will create unusable gcode.

One more question that arises from the use of such a standardized schematic plan is the possible lack of 'realism', or rather it misses certain details like architectonical decorations (ornaments, beveling, irregularities, etc.) that make it feel believable and alive. The resulting boxes may even look too simplistic. I would argue, that since the archaeological documentation does not reliably record any of that, e. g. in form of a LIDAR, or SfM generated point cloud, we could only hope to 'fictionalize' the missing details. One fix to this could be the recreation of the bossage visible on photos. Later on, I came up with an easy way to do this. However, what already can be said is that bossage does not appear on every block and it's generally debatable when it is a style element and when it is simply a sign of unfinished work. The arches (Fig. 2) appear with their bossage removed. It will need extra consideration and explanation why and where bossage was recreated, when it isn't even well documented.

From the perspective of 3D printing, it depends on the print scale and the purpose of the model. If I create bossage and the model will be printed at a small scale, they may not even appear because they disappear between layer heights and my even introduce other issues like stringing, at least in my experience with cheap FDM printers. Also, if the purpose is to show students what bossage looks like, I believe a separate model based on, for example, an SfM point cloud, of a single pillar, printed on a larger scale, would make far more sense. In that scenario the purpose would be teaching of architectural details. I would assume the model only serves to visualize the main components of an aqueduct bridge.

4.4. Modelling the Center Gallery

The pillar width is also easy to model, since the plan provides both front and sides. Thanks to that and the remarks in the text[16], I understand the alternation of the ashlar layers. If one layer has only two blocks, the next one above will have three. Same on the sides. This prevents continuous vertical gaps. On the photos we can easily see, that albeit the layer height is uniform, the block width is often random. So, I just used the tool 'plane cut' to slice the surface polygons of the boxes randomly, by hand. This menu can be opened by a right click. There, I also found the function 'inner extrude'. This slices surfaces inside and creates a look similar to a painting frame, and when extruded, a bossage. With multiple surfaces selected simultaneously, this was very efficiently done (Fig. 8). The dimensions were pure guesses but still look quite convincing. I varied the offset of the bossage top surface from cube to cube so they don't look too similar, just like in real life. Most of the time, this method worked very well.

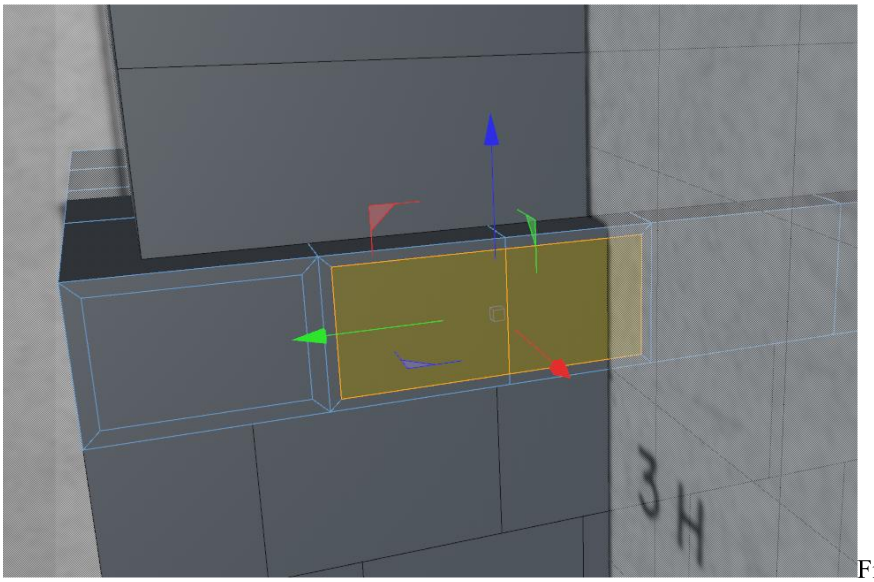


Fig. 7: Inner Extrude

[16] Casado 2008, p. 15

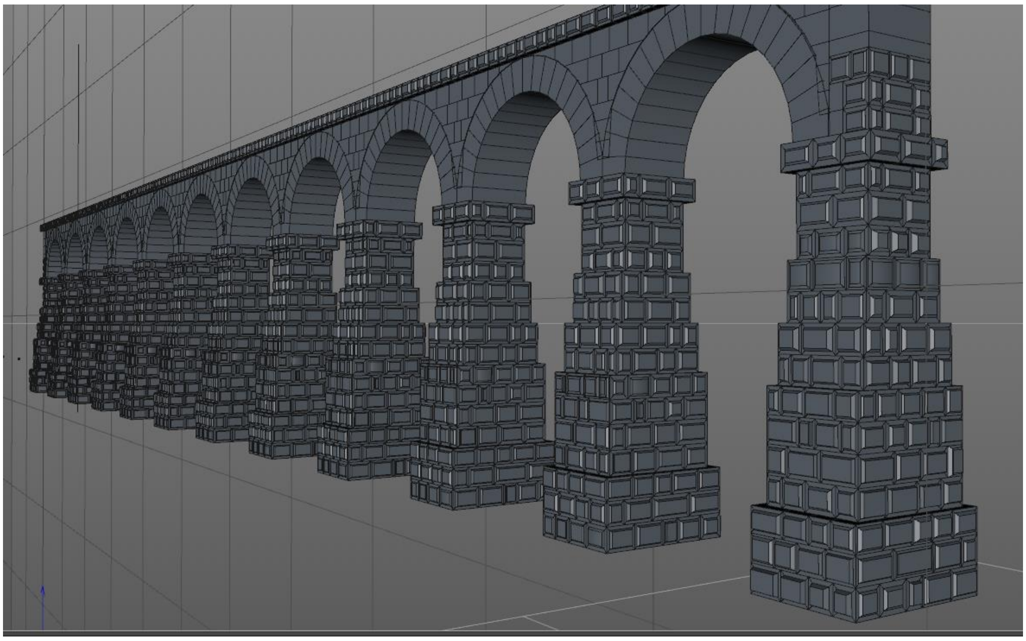
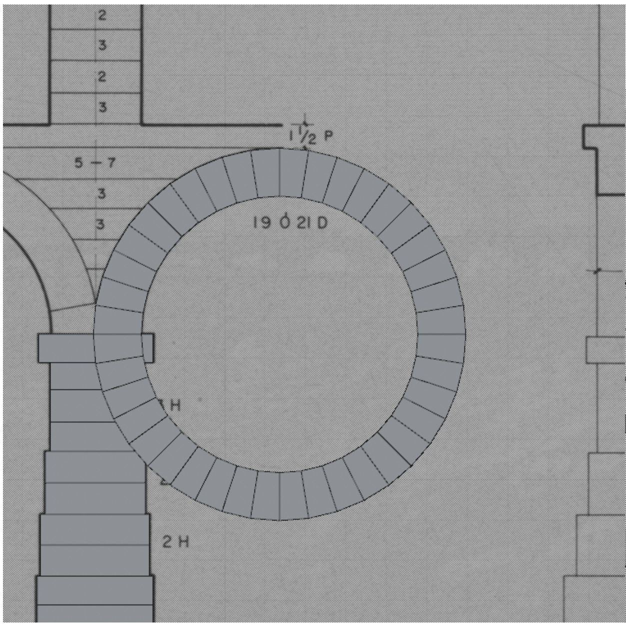


Fig. 8: Bottom Gallery

For the arches I decided to create two cylinders with the seemingly correct number of segments (40 for the whole circle, 10 for each quarter) and an estimated radius by laying it over the plan. With a Bool object, the inner cylinder subtracted from the outer cylinder and created a tube. This tube only needed to be cut and the surfaces adjusted to better meet the blocks as they appear on plans and photos.



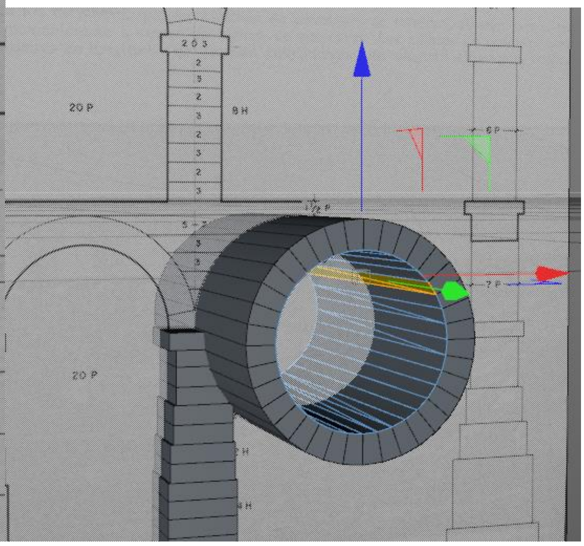


Fig. 9: Arch Modelling, Fig. 10: Tube

The filling material between arches was first created as simple cubes, with the intent of using another bool object to simply subtract the arch from those cubes but that didn't work very well and I'm not quite sure why, so that's why there are these seemingly out of place double lines where arches meet. The number of capstones per arch were counted from photos. The Center-

Top-Gallery was done in the same fashion, except I paid more attention to the filler material in between archer and extruded surfaces more carefully, so that it'd follow the shape of the arches exactly. Noteworthy is how the two second arch blocks are larger and meet in the center. No plans accurately reproduced this, so I guessed based on photos.[17]

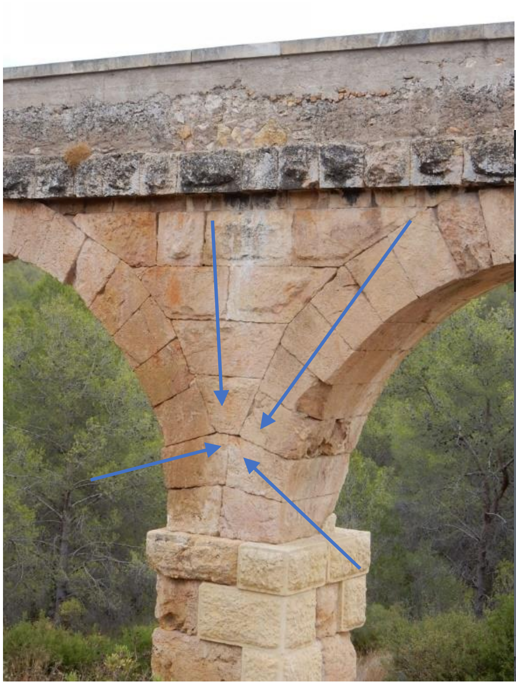
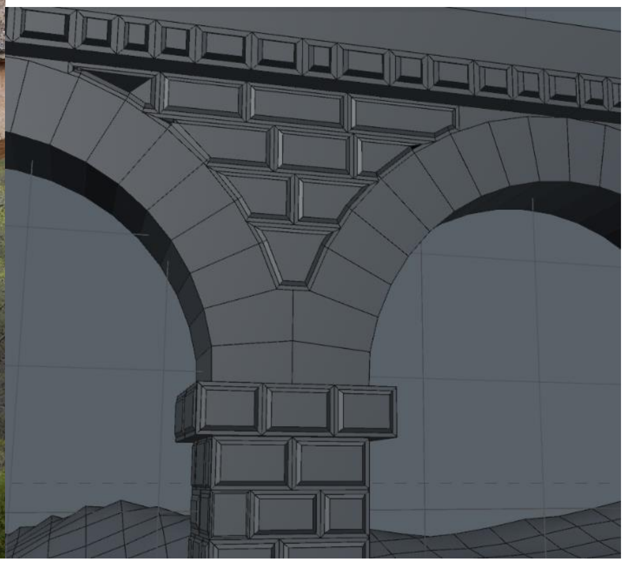


Fig. 11: Arches Meeting Point, Fig. 12: Arches Meeting Point in the 3D Model

Note how the bossage is generally less elevated in this area. This has been respected.

4.5. The Side-Galleries

The parts beside the double stacked gallery are referred to as side galleries. The arches here are simple continuation of the same arches found in the top gallery and didn't need to be modelled again. Or rather, this was my assumption based on the used plans.[18] Counting the number of stones on photos gave further reason to accept this assumption. For the long pillar I could find neither accurate plans[19] nor good photos, so I simply reused bottom and top pillars and filled the missing section with more cubes form the top pillar. This way, a plausible uniformity is maintained. The available photos show the side-gallery pillars to be in the soil, already at the level of the capstone of the bottom gallery

[17] Casado 2008, p. 31 also notes this.
[18] As I found out later, it is actually mentioned in the text: Casado 2008, p. 31. More on that below.
[19] Closest thing: Casado 2008, p. 31

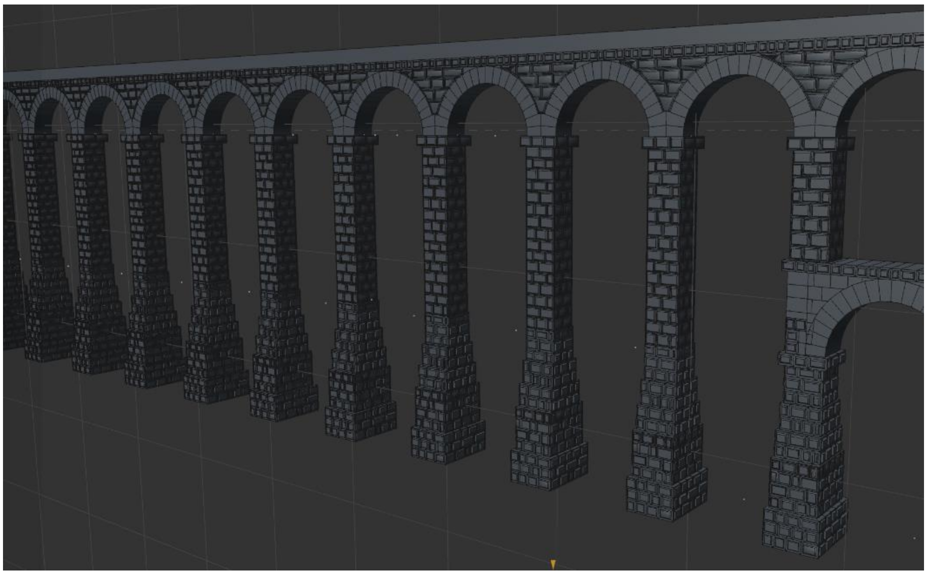


Fig. 13: Side Gallery 3D Modell

Fig. 14: Photo of Side Gallery

4.6. Cutting the Model, Positioning in the Terrain

Originally, I modelled the entire length of the bridge. Soon I realized though, it wouldn't fit into the given reference terrain model because of its length. So, I had to cut some arches off. Also, I felt like the double gallery should be over the lowest part of the valley, as it is in real life. To cut the model I simply created vertical planes off the sides of the reference model, then closed the holes.

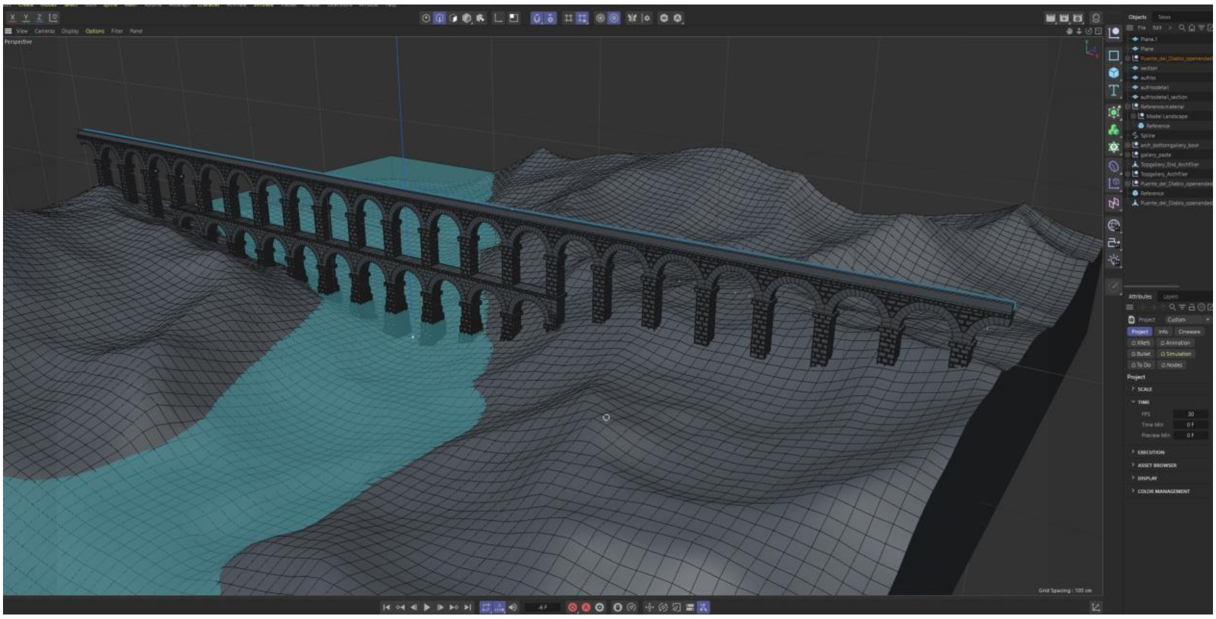


Fig. 15: Positioned 3D Model.

4.7. Textures and Renders

At this point of the module exam, time was short, so, a quick and efficient solution was needed for textures. I could not find in the literature the exact building material, but I believe it to be limestone. It is a very porous stone and appears on photos with a sandy to orange or ochre color tone. I used the only limestone material Cinema4d had to offer and changed the color a bit towards orange.

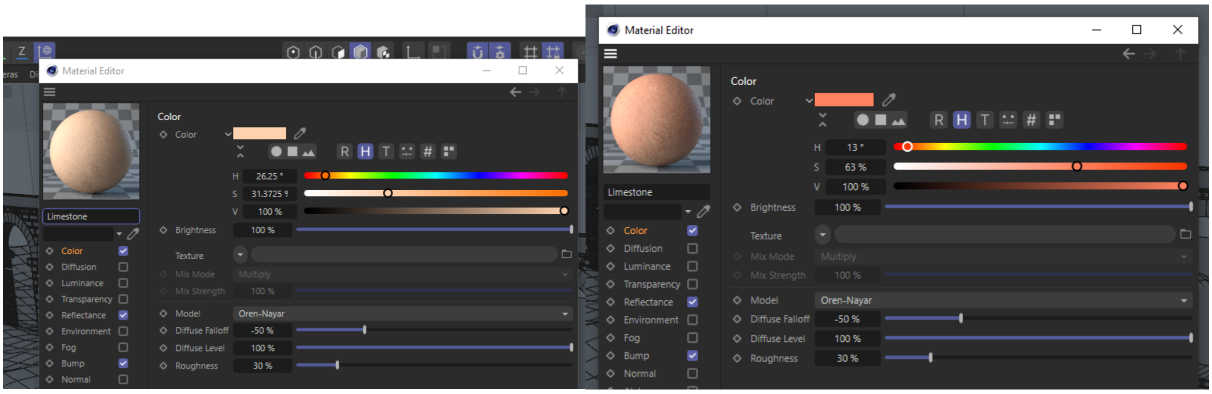


Fig. 16: Textures 1st Attempt

Finally I added a ‘physical sky’ and let the program make some renders, with the settings from the course tutorials.

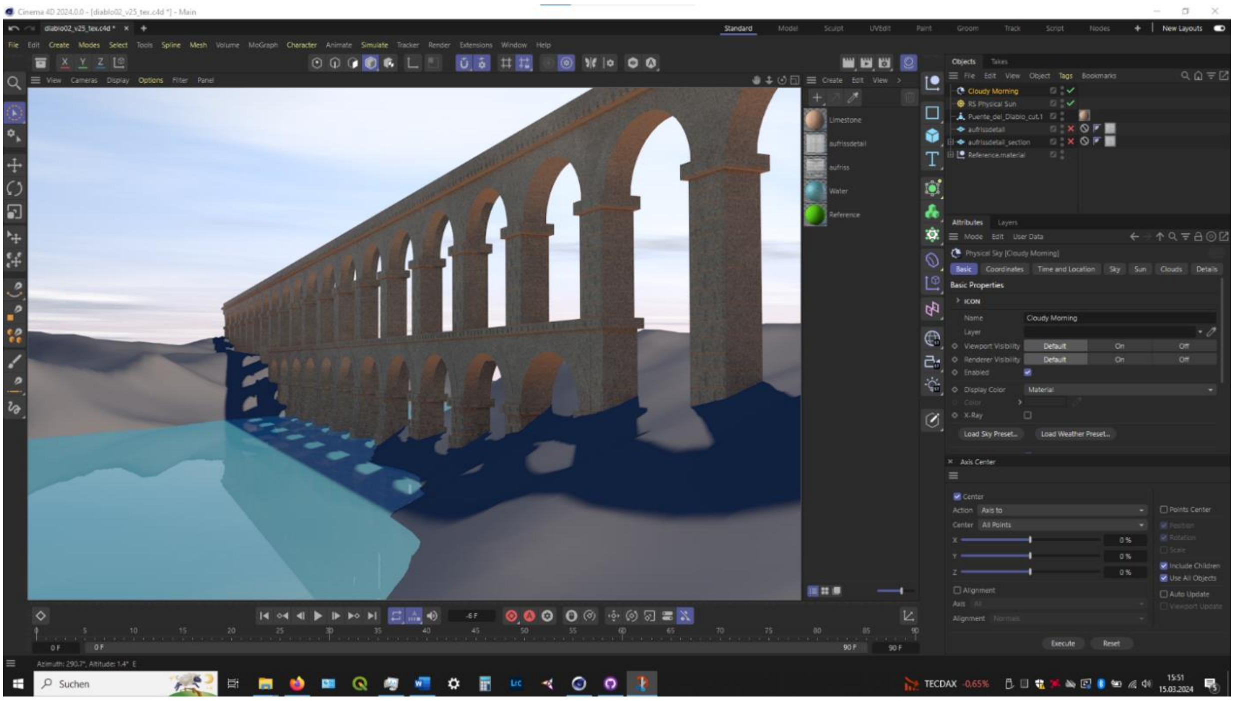


Fig. 17: Viewport Render

4.8. Accessibility: GitHub and Sketchfab, or: Where the Hell are my Textures?

In order to adhere to the referred guidelines and the exam requirements, I opted to upload my files publicly as a GitHub project and use the wiki section for the blog posts. This was fairly quickly done, as I already had the desktop app installed and could directly ‘push’ local folders on my PC. Real issues came only with Sketchfab. Sketchfab, unsurprisingly, does not support the proprietary .c4d files. So, 2-3 clicks later, I had created an .fbx file, which I reopened in Cinema4d. The result was this:

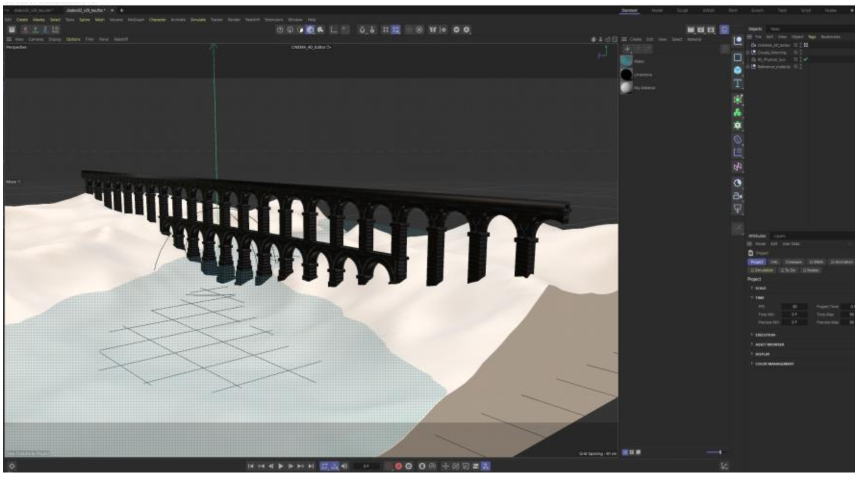


Fig. 18: OBJ without Texture

The used material appeared all black, but it seemed to be saved inside the new file. After hours of trouble shooting and research, one piece of the puzzle seemed to be the object "tags" in the object manager. After I added those and adjusted the viewport settings, I could finally see the texture in the viewport window, unrendered for the first time.

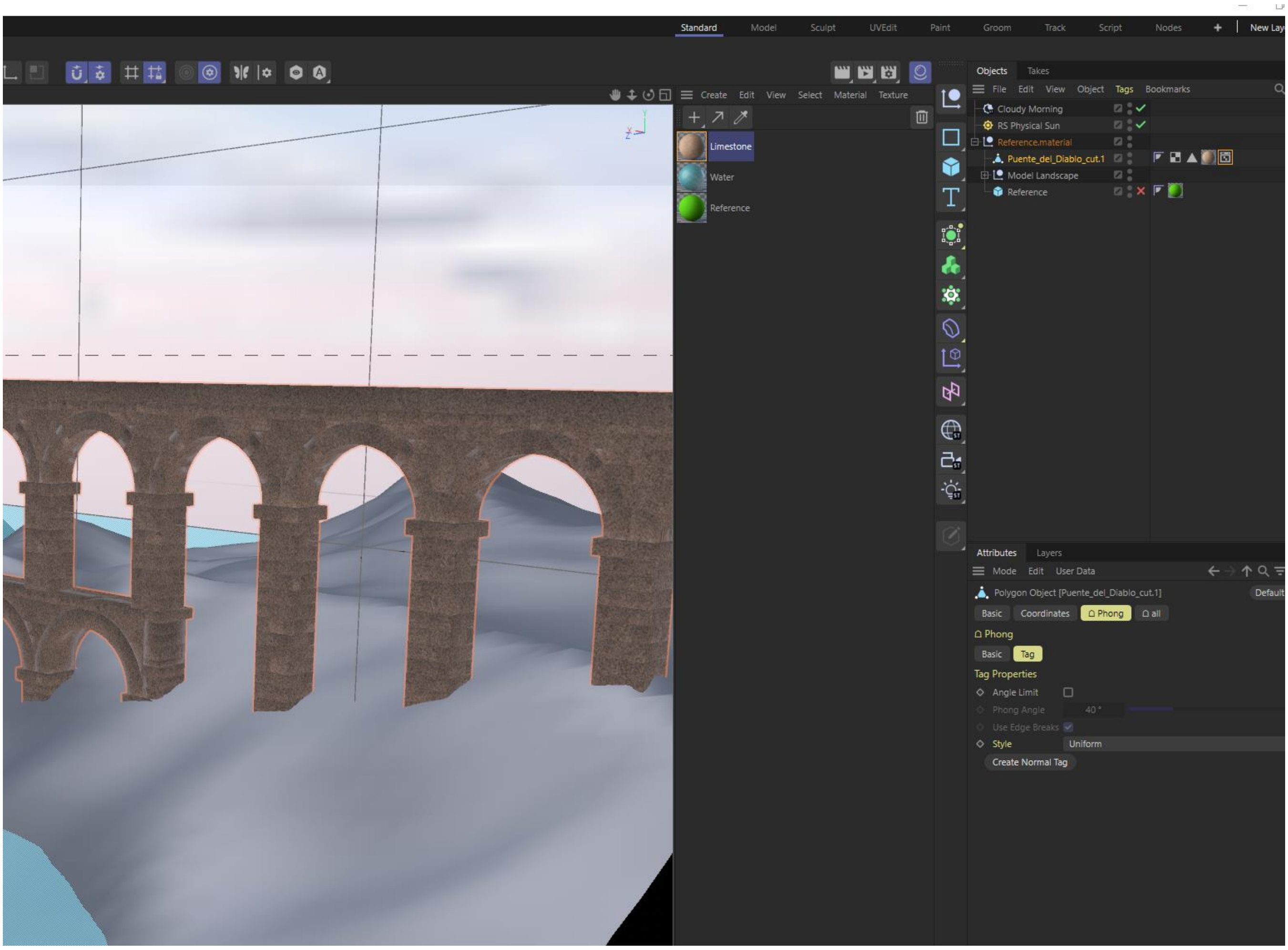


Fig. 19: Unrendered Texture

Then I re-exported and still no texture. For a change I tried .obj, with the same result. Several hours later, I found a possible 2nd piece of the puzzle: "Baking". Objects, as well as textures can or may need to be "baked" into the model, as far as I understood. The exact processes and best settings remain a mystery to me, but on one attempt, the program made this curious image:

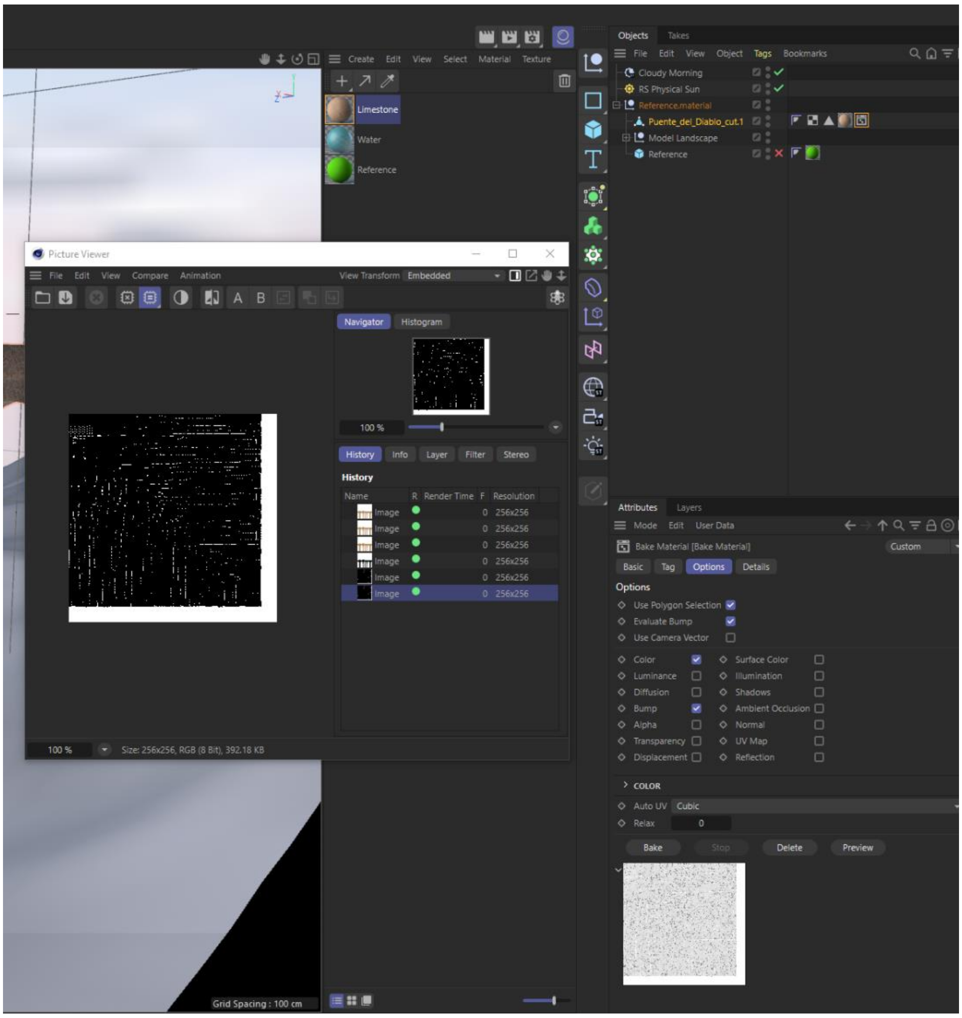


Fig. 20: Baking Texture

After wasting more hours and attempts, I found a video on YouTube.[20] Apparently, .obj exports are notoriously problematic in C4D and the main issue are missing file paths in the .mtl file. In the video they edit the .mtl manually and add the texture file paths. But my texture is a material that was already in Cinema4d, so it was never in the “tex” folder to begin with. How do I copy a texture from the program library to a custom folder? Before wasting more time by researching this rabbit hole, I decided to quickly create my own texture with a free texture[21] found online. This one was not as “orangy” like in the photos, but the newer blocks that seem to stem from restoration efforts, look rather yellowish-sandy. So, I copied it to the tex folder. Export again and this time as .obj with “consolidate textures” and sure enough 2 files appeared. 1st obj, 2nd .mtl. And just like in the video, the .mtl did not include file paths. But for testing I opened the

[20] https://www.youtube.com/watch?v=hbY0WUwqXt4
[21] https://www.freepik.com/free-photo/rough-beige-stucco-surface_1038543.htm#query=limestone%20texture&position=14&from_view=keyword&track=ais&uuid=47219718-606b-40f8-bd21-dc1336c4c699

obj as is in Cinema4d, and it came textured. Then I uploaded both .obj and .mtl together in Sketchfab and somehow it just worked right away. At least the model finally had a texture. More surprises awaited on the back side of the model.

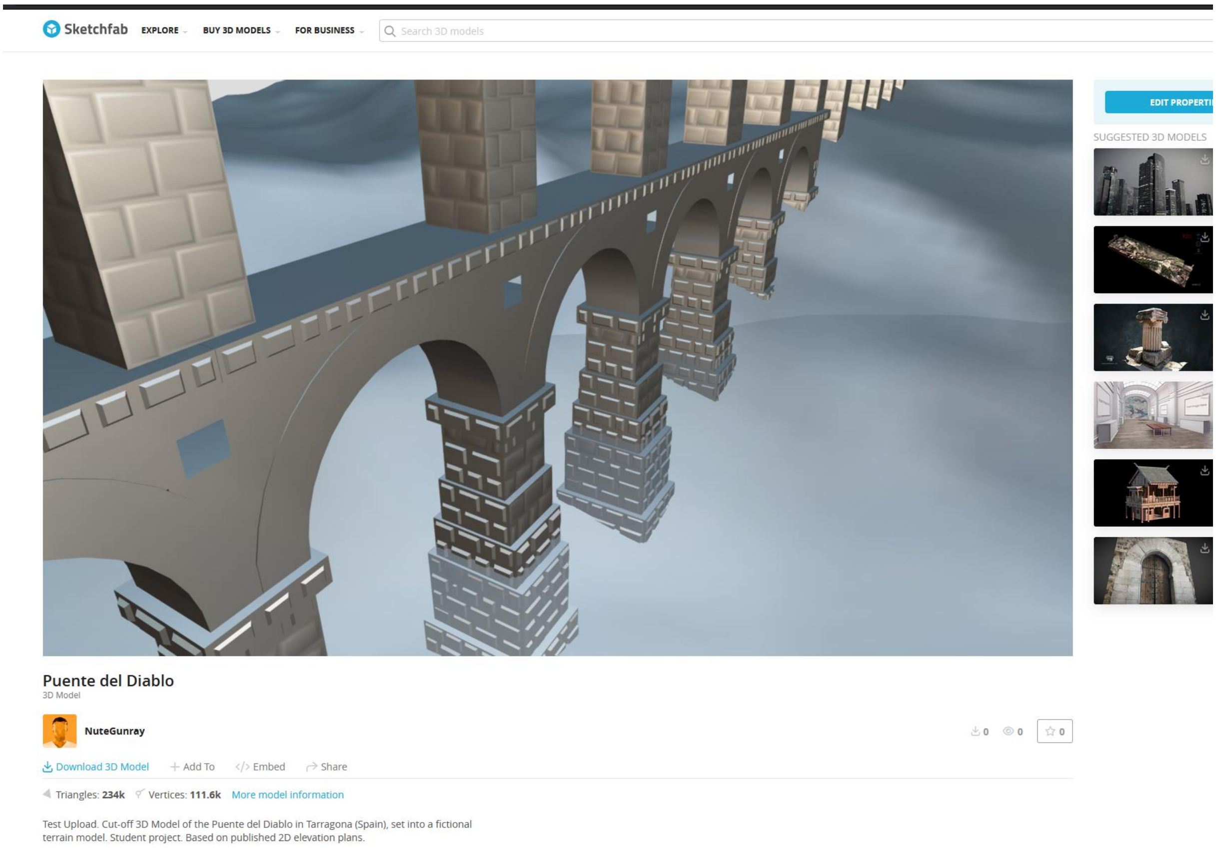


Fig. 21: Holes in the OBJ Model on Sketchfab

In the process of exporting the model into a different file format, new holes appeared, that were closed surfaces originally. I fixed those by remodeling the entire area between arches and finally, after many long hours, the 3D model was finally done.

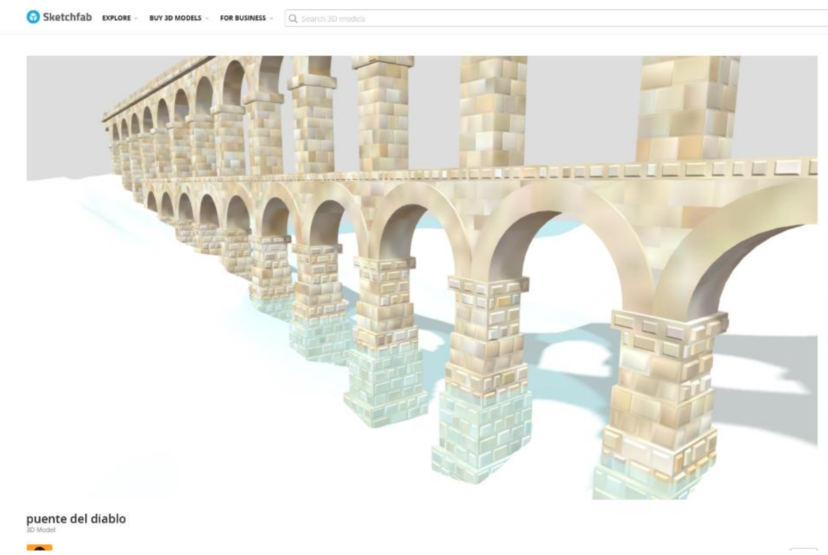


Fig. 21: Fixed and textured Model on Sketchfab

Except for the bossage. Somehow those became very distorted and washed out in some parts, but at this point, no more fixing was possible.

5. Conclusion & Acknowledgement of Flaws

This report has shown, following the given exam tasks, how 3D modelling could be used to digitally and remotely reconstruct a piece of roman architecture, without capturing any new 3D data. Accordingly, and within the given scope, some (!) theoretical and ethical implications of this projects' reconstruction have been discussed. The result is the central part of a still *in situ* aqueduct bridge, set within a fictional location, which can now all be downloaded from Sketchfab & GitHub and is ready for 3D printing. Even though the purpose of this model was not clearly defined, there are some scientific use cases. It could be used to show students the general appearance of *arcuationes*, the typical design of aqueducts in Augustean Tarraconnensis[22] and maybe some technicalities of 3D printing. Beyond this, the author is rather skeptical about the scientific usefulness of this model in its current state, also because of the following flaws.

Even though this *arcuatio* is probably not suited to stand in water, at least it respects terrain elevation. This realization came to me actually only at the point of positioning the model, so I tried to at least explain this issue thoroughly in this report. Also, the scaling is eyeballed.

Another such potentially fatal realization is the fact, that the Spanish literature actually describes the arches of the top gallery to be made of 8 blocks per half-arch plus a keystone, but because of time constraints and language barrier I missed that in my earlier research and couldn't fix this in time. Same probably applies to the building material. I couldn't find it in the literature but that was probably because of time and language constraints. This as an example why collaboration with stakeholders or circulation of the data before publication would be helpful, because it could have helped collecting more data and reference material, and the analysis and interpretation thereof. Probably, there are more such unnoticed inaccuracies. One approach to defuse this issue of lacking circulation is the publication of the files on GitHub, but this is in itself a premature form of publication, which may be for the worse.

Considering the theoretical implications mentioned above, the biggest flaw of this model is the lack of clarification, meaning it is not obvious from the 3D model which parts are original, speculative, reconstructed or repaired in later times, or even missing entirely.[23] For example, the archaeological research has found the inclination of this aqueduct,[24] but it's not included in

[22] Casado 2008, p. 41
[23] For a good example of distinction between reconstruction and archaeological remains, see: Patay-Horváth 2014, p. 20
[24] 4m/km. E. Lopez 2016, p. 164-166

this model. The design and cover of the water channel were not considered either. On the other hand, if the purpose and expectation wasn't specified to begin with, how well can a 3D model be rated scientifically? We must not forget that a model always serves a specific purpose and can only represent a certain part of reality. The purpose here was a simple, yet dimensionally realistic reproduction of a real building and its main features. This has been accomplished.

At last, a short comment on the used software:

Cinema4D is a proprietary and closed-source software. It was surprisingly hard to find useful tutorials and forum posts that had dealt with simple issues before. For scientific purposes, Blender, which is also far wider spread, could have been a better choice.

6. Literature, Sources, Links

Link to GitHub Repository (Blog posts in the wiki section)

https://github.com/LC1567/puente-del-diablo-3D-model

https://github.com/LC1567/puente-del-diablo-3D-model/wiki

3D Model on Sketchfab

https://skfb.ly/oSqIK

Archaeological Publications

Barrett 2021

R. P. Barratt, Speculating the Past: 3D Reconstruction in Archaeology, in: E. M. Champion (Hrsg.),Virtual Heritage. A Guide (London 2021), 13-23

Casado 2008

C. F. Casado, Acueductos Romanos en España (Madrid 2008)

Huggett 2004

J. Huggett, Archaeology and the new technological fetishism. Archeologia e Calcolatori 15, 2004, 81-92

Lopez 2016

E. Sanchez Lopez–J. Matinez Jimenez, Los Acueductos de Hispania. Construcción y abandono (Madrid 2016)

Patay-Horváth 2014

A. Patay-Horváth, The virtual 3D reconstruction of the east pediment of the temple of Zeus at Olympia – an old puzzle of classical archaeology in the light of recent technologies, DAACH 1 (2014), 12-22

Remondino 2014

F. Remondino – S. Campana, 3D Recording and Modelling in Archaeology and Cultural Heritage

Rheinholdt 2013

C. Rheinholdt, Rez. Zu: U. Quatember, Das Nymphaeum Traiani in Ephesos, 118-142, (Wien 2011), Forschungen in Ephesos XI 2. Gnomon 85, 2013, 167-172

Online Sources (all last accessed at 15.03.2024)

Roman Aqueducts Website

http://www.romanaqueducts.info

Wikipedia List of Roman Aqueducts

https://en.wikipedia.org/wiki/List_of_aqueducts_in_the_Roman_Empire

Sevilla Principles

https://www.cipaheritagedocumentation.org/wp-content/uploads/2018/12/L%C3%B3pez-Menchero-Grande-The-principles-of-the-Seville-Charter.pdf

7. Image credits

Fig. 1: Pont du Gard

https://upload.wikimedia.org/wikipedia/commons/0/02/Pontdugard.jpg

Fig. 2 : Puente del Diablo bottom pillar

http://www.romanaqueducts.info/aquasite/tarragona/index.html

Fig. 3: Ponte Sant' Angelo with wedged piers

https://www.google.de/maps/@41.9022446,12.467981,33a,35y,246.19h,79.31t/data=!3m1!1e3?hl=de&entry=ttu

Fig. 4: Schematic Elevation plan

Casado 2008, p. 38

Fig. 5: Fig. 5: Distortion between Plans

Casado 2008, p. 34, 35, 38

Fig. 6, Fig. 7, Fig. 8, Fig. 9, Fig. 10,
Authors Screenshots

Fig. 14: Photo of Side Gallery
Casado 2008, p. 41

More Authors Screenshots:
Fig. 15: Positioned 3D Model.

Fig. 16: Textures 1st Attempt

Fig. 17: Viewport Render

Fig. 18: OBJ without Texture

Fig. 19: Unrendered Texture

Fig. 20: Baking Texture

Fig. 21: Holes in the OBJ Model on Sketchfab

Fig. 21: Fixed and textured Model on Sketchfab

8. Deckblatt und Erklärung

DECKBLATT FÜR HAUSARBEITEN
- Archäologisches Institut -

Vom Studierenden auszufüllen:

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Kursnummer /-titel: 3D modelling and reconstruction in Archaeology

Modulkennung-/titel: Modulprüfung: ja [x] nein [ ]

Name Dozent/in.: Hageneuer, Sebastian

Titel der Hausarbeit: Puente del Diablo. Creating a 3D Model of an Aqueduct Bridge in Cinema4d

Erklärung

Hiermit versichere ich, Canals
Name, Vorname

19.04.1995
geboren am

dass ich die vorliegende, an diese Erklärung angefügte Hausarbeit selbstständig und ohne die Benutzung anderer als der angegebenen Hilfsmittel angefertigt habe. Alle Stellen der Hausarbeit, die wörtlich oder sinngemäß aus veröffentlichten Schriften entnommen wurden, sind als solche unter Angabe der Quelle kenntlich gemacht.

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Note: ____________________

Unterschrift Prüfer/in: ____________________ Datum: ____________________

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