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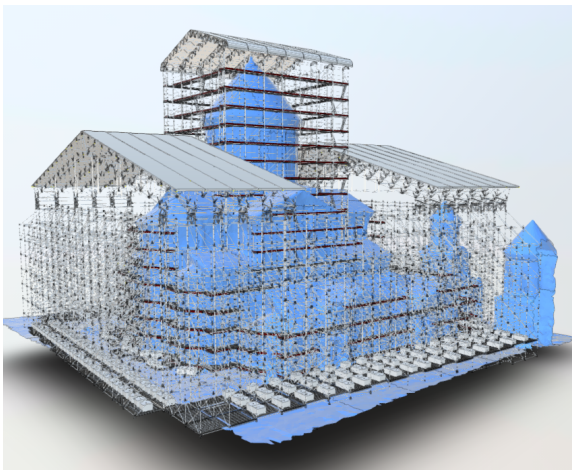
Safeguarding and conservation of Gelati Monastery
World Heritage Property, Georgia

Agreement between LEPL "National Agency for Cultural Heritage Preservation of Georgia" and "ReStruere ltd, Florence University spin-off"



Hangar Phase
Temporary roofing for the implementation of final works

Deliverable H.1.A
Executive summary of activities and report of Phase H.1.1
(Supervision of the conception and design of the temporary hangar structure, needed for the next implementation steps of the final works)

February 26th, 2023

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On the cover, in addition to a photo of Gelati Main Church, there is a picture which represents an elaboration of the structure proposed by Layer Company on February '23 (see pag.5).

Content Index

Definition of the Terms

AGSS: "Associazione Giovanni Secco Suardo".

GET: "Georgian Expert Team". It is the team in charge of carrying out the activities in Georgia related to the safeguard project of Gelati Monastery, World Heritage Property.

LC: "Layher Company".

MCSY: "Ministry of Culture, Sport and Youth of Georgia".

MCT: "Microclimate Consultancy Team". It is the team in charge of carrying out the activities relating to microclimatic issues.

NACHP: "National Agency for Cultural Heritage Preservation of Georgia".

RS: "ReStruere Team".

RET: "Restoration Expert Team". It is the Italian Restorers Team. The Team in charge of carrying out the restoration of frescoes and paintings, joined with Georgian Restorers.

WHC: "World Heritage Center".

Executive summary of activities related to the supervision of the conception and design of the temporary hangar structure, from October 2022 to February 2023

On October 16th 2022 ReStruere (RS) communicated the need to start relations with the Company that will take care of the design and construction of the Hangar Structure, necessary for the implementation of the roof refurbishment works through the letter "*Articulation of the expected works for the Safeguarding of Gelati Monastery (draft)*". The National Agency for Cultural Heritage Preservation of Georgia (NACHP) has promptly contacted Layher Company (LC), as the world leading manufacturing company of scaffolding systems and temporary works solutions, characterised by the implementation of numerous interventions for the protection of Cultural Heritage, proposing a collaboration for the "Safeguarding and Conservation of Gelati Monastery, World Heritage Property, Georgia" (21.10.2022).

LC responded positively to NACHP's letter via the email from Eng. Viktor Klein who confirmed LC's interest in supporting the Gelati project. Eng. Klein informed the Agency that they had already received a request regarding this project from UNESCO and International Relations Unit in Georgia in February 2021 and that they invested a lot of time and energy in the project but they didn't receive any response from UNESCO and International Relations Unit.

Eng. Klein provided the Agency with the preliminary drawings of the proposed project and the Agency promptly provided ReStruere with the documents, consisting in particular of:

- Draft proposal, isometric view, St. George Church scaffolding project (pdf file);
- Draft proposal, isometric view, Virgin Church scaffolding project (pdf file);
- temporary link for the 3D model view, St. George Church scaffolding project;
- temporary link for the 3D model view, Virgin Church scaffolding project;
- Lahyer Company Profile (pdf file);
- Brochure regarding the FW System (pdf file);
- Photographs of past Layher projects in the protection of historical buildings (jpg files);
- Email correspondence between Lahyer and International Relations Unit in Georgia, from February to April 2021.

A fundamental remote meeting occurred on November 16th 2022 among RS, the Ministry of Culture, Sport and Youth (MCSY), NACHP and LC. During the meeting, some main issues related to the design of the Hangar Structure and connected scaffolding system were discussed with a very positive outcome.

During the meeting, different issues were discussed, in particular:

1. Type of structure
2. Actions to consider in the structural calculation
3. Weight issues
4. Delivery, production, and transportation
5. HS Installation

For a detailed description of the meeting please refer to Annexe 1 - "*Minute of the first remote discussion table for the Hangar Structure, needed for the final works on Gelati Monastery* (16.11.2022)". Following the meeting, the Georgian Expert Team (GET) and LC shared emails with detailed technical information and technical drawings, as agreed.

RS described these first steps and has formally enshrined the collaboration with LC in the letter, dated December 8th 2022, "HANGAR PHASE - Temporary roofing for the implementation of final works - beginning of the collaboration with Layher Company" (see Annexe 2)

An important step was made on the occasion of the Joint WHC/ICOMOS/ICCROM Advisory Mission that was held from November 28th to December 2nd 2022, with the presence, in Gelati, of the Teams RS, Associazione Giovanni Secco Suardo (AGSS), Microclimate Team (MCT) and Restoration Expert Team (RET). During the Advisory Meeting, the Advisory members had the opportunity to speak with the various Teams, explore the construction site, and enter into the merits of the initiatives taken and what was planned for safeguarding the Monument. On that occasion, there was the opportunity to share with the Advisory members, as already highlighted in the latest reports, the initiative to involve LC in order to create a Hangar Structure to allow safe and easy implementation of the works.

For an excerpt of the mission description please refer to § 2 (Phase E.1.3 - Technical support for submitting the summary of the implemented works to WHC) of "*Deliverable E.1.B - Executive summary of activities and reports of the phases E.1.2 (Monitoring of the evaporation) and E.1.3 (Technical support for submitting the summary of the implemented works to WHC)*", Ugo Tonietti and Sara Stefanini, December 29th, 2022.

For a detailed description of the mission, please refer to "*Executive Summary on the mission carried out at Gelati Monastery and Tbilisi (Georgia) from November 27th until December 2nd 2022 in occasion of the joint World Heritage Centre (WHC)/ ICOMOS/ ICRROM Advisory Mission to the World Heritage Site by Ugo Tonietti and Giulia Misseri*", Ugo Tonietti and Sara Stefanini, December 29th, 2022.

On December 16th 2022, RS sent an email to MCSY, NACHP, GET and LC in order to take stock of the situation after the joint WHC/ICOMOS/ICCROM Advisory Mission, in particular referring to:

1. Type of structure
2. Actions to consider in the structural calculation
3. Weight issues
4. Delivery, production, and transportation
5. HS Installation
6. Project timelines
7. Project Costs

RS proposed scheduling a second online meeting in which it would be possible to clarify how to address the individual points, define what the various teams need and how to achieve it, in order to define a path useful for achieving the objective (see Annexe 3). The second remote meeting was held on January 13th 2023 and delved into issues related to the hangar structure solution for covering also the dome of the Main Church. In particular, it was agreed that LC should look for a different solution than the one proposed for the scaffolding support structure with regard to the support system for the dome cover; LC would have looked for alternatives presenting the best possible solution. Other topics covered during the meeting were: additional scaffolding on the gable sides; dimensions and type of material of the constituent elements of the structure; the need on the part of LC to have information relating to topographic data (to compare/adapt to their previous drawing), wind load, snow load, seismic data in the monastery area.

After the meeting, GET shared with LC the file with the topographic plan of the site and building elevations (DWG) and the building design codes "Construction Climatology (PN 01.05-08)" (Annexe 5) and "Earthquake Engineering (PN 01.01-09)", mandatory for Georgia. Furthermore, upon LC's request, GET committed to sending the 3D model in the near future.

On February 7th 2023, RS received from the MCSY the preliminary "*REPORT of the Joint World Heritage Centre/ICOMOS/ICCROM Advisory mission to the World Heritage property "Gelati Monastery" (Georgia) 28 November – 2 December 2022*".

The Report very clearly recommends "immediately carry out a project for the placement of an overall protective coverage of the monument, including the cupola" in order to allow:

1. the "process of evaporation to happen in the other arms of the Church", in addition to the West Arm, subject of the pilot intervention[1];
2. "further interventions on the site";
3. "different monitoring activities that would inform those interventions".

As a fundamental precondition to monitoring activities in the Main Church, the report suggests the following criteria for the design of the new protective roofing:

- The overall coverage of the monument, including the dome, so that every possible area on its exterior and interior is accessible (in conjunction with the completion of the metal scaffolding in the interior of the building).
- Ensuring the strength of the construction under difficult weather conditions (snow, rain and wind). Preferably, it should be reinforced by iron beams-elements capable of lifting heavy loads (snow), inclined for removing rainwater quickly, connected to each other by wind-resistance cross-links (X), and anchored to point bases of concrete.
- The protection of the facades of the monument from the weather conditions.
- The protection of the workers on the monument under different climatic conditions, and ensuring access for the repair of the open joints of the structural stones of the building (e.g. vertical banners – metallic elements be placed on the sides, protecting the monument and the workers from side winds and rainwater).
- Ensuring lighting for the workers, by placing transparent sections. The solution of strong plastic sheets to cover side luminaires, fixed on a suitable metal frame, should be examined.
- The protection of any archaeological finds (underground channels, etc.) in the areas where the roof supports are placed.
- The long-term maintenance of the protection roof in situ.

In the report, it is stated very clearly that the realisation of the project for the placement of overall protective coverage of the monument must be carried out as soon as possible, as a prerequisite for the realisation of the other actions to be undertaken for the protection and preservation of the Gelati Monastery.

During February 2023, the exchange of material and information between LC, RS and GET continued. In particular, LC revised the initial project by adding the cover for the dome and proposing an initial estimate of the costs. In the email dated February 15th 2023, from LC to the MCSY and NACHP, a new 3D model was submitted containing a technical solution for the structure depending on some previous evaluations shared during the online meeting carried out on 13th January.
The main innovation concerned the need to also cover the dome and the drum of the church finding structural solutions reliable but also capable of not damaging the monument. LC asked RS and GET about the capacity of the old building to accommodate a load of about 16 tons (depending on the scaffolding system) on each Arm.
RS and GET started immediately to evaluate such hypotheses.
RS discussed this issue by sharing with GET a document that deemed inappropriate to load with such heavy weight the Arms and (subsequently) the masonry vaults, suggesting some changes to the design with the aim of removing the loads from the vaults of the Arms, distributing them better and looking for ways to reduce them.

[1] Please see "Deliverable E.1.A - Executive summary of activities and report of the phase E.1.1 (West Arm covering removal. Supervision of the implementation of the emergency temporary covering)", December 29th 2022, by RS, for a description of the intervention on the West Arm.

Together with GET some ideas and suggestions, also illustrated with simple drawings and elaborated in remote meetings, have been studied and transmitted to LC on February 23rd, accompanied by a document who explained the reasons for the variants and evaluating the recovery of the idea of using part of the windows of the drum (as already discussed in the online previous meeting, but discarded at first) to better support the scaffolding as well as a sort of work plan including the need to remove the dome cover to make it possible to intervene on all the underlying pitches (Annexe 4).
In summary, three different alternatives have been evaluated. Two of these seek to modify the solution proposed by LC in a fairly slight way and consist in trying to distribute the loads acting on the Arms over several layers, creating a structure (in one case made by steel) with the purpose of creating a sort of bridge over the Arms, while maintaining a light collaboration for them. The third option is more radical and seeks to completely resolve the issue of excessive load transfer on the Arms. It proposes to maintain a steel hangar structure around the dome that rests directly on the ground. This is a more challenging design.
Naturally, these suggestions only represent possible research directions that only LC experts will be able to relate to the system of which the Company is the custodian.

The design of this important structure is, at this stage, a work in progress but the fundamental lines, that will characterise it, have been, from our side, outlined, and are now shared. On this issue, the LC engineers, with whom RS and GET maintain constant contact, are basically at work now. The involved Teams are also thinking about how, if possible, to reduce the costs. Unfortunately, it has to be remembered that some time was lost because of the need to wait for (and to interpret) the WHC report after the November-December on-site mission.
Some forthcoming steps will have to be devoted to the assessment of loading actions and the site situation. RS plan to account for these completion phases of the temporary roofing structure design in the deliverable that will be drawn up at the end of the structure implementation phase.

Annexe 1

Minute of the first remote discussion table for the Hangar Structure, needed for the final works on Gelati Monastery

Date and Place: 16.11.2022, 10:00 am – 1:00 pm (GMT+4), Georgia, Italy & Germany.

Remote (via Zoom) attendees:

Mr Kaha Sikharulidze – First Deputy Minister of Culture, Sport and Youth (MCSY)
Mr Nikoloz Aznaurashvili – Director-General of the National Agency for the Cultural Heritage Preservation (NACHP)
Ms Salome Jamburia - Senior Specialist for International Relations Department (MCSY)
Ms Tamar Ketiladze - Head of the UNESCO and International Relations Unit (NACHP)
Mr Tariel Kiparoidze – Chief Architect, Georgian Expert Team (GET)
Mr Lasha Shartava – Architect, Georgian Expert Team (GET)
Mr Ugo Tonietti – Architect, President of ReStruere (RS)
Mr Arash Boostani - PhD Engineer, ReStruere (RS)
Ms Sara Stefanini - PhD Architect, ReStruere (RS)
Mr Viktor Klein - Sales manager, Layher Company Export Department (LC)
Mr Waldemar Trumpf - Engineer, Layher Company Technical Department (LC)

Summary of the meeting

Mr Sikharulidze opened the meeting. Welcoming remarks and greetings were exchanged.

Mr Klein presented the Layher Company and the preliminary solution proposed for the temporary protective Hangar Structure (HS).

After the presentation, a discussion took place among the participants. Below are the main issues addressed and shared by those present at the meeting

I. Type of structure

The LC proposed that the HS that will cover St George Church can be simpler and lighter, being made up of an aluminium structure.

In the LC proposal, the HS that will cover the Virgin Church, considering the span to cover, should be built with the steel-made “FW type” structure agreed upon amongst the participants.

The facade scaffoldings are separate structures and can be made of aluminium for the Virgin Church.

Both Hanger Structures will be covered by tarpaulin, whose lifetime depends on weather conditions (snow load, wind, UV, temperature etc.). In the experience of LC, most of the projects that use tarpaulins have a duration of 1-3 years. In the case of the restoration of the Church of the Holy Sepulcher in Jerusalem, Layher Keder tarpaulins were intact approximately after 8-9 years. Anyway, it will be possible to easily renew the damaged tarpaulins.

Due to structural stability, LC prefers to have one HS covering the entire Virgin Church. The facade scaffoldings can be installed in different steps of the implementation works and be used for both Churches at different times.

Based on RS request, the dome of the Virgin Church must be protected separately by a lightweight Layher roof construction. At the moment, the preliminary HS design doesn't cover the dome. LC prefers not to add extra load to the proposed solution. LC will plan a Layher Keder roof structure similar to the proposed one for St. George Church. In that case, LC has to design a new adjustable base for the support scaffolding on the roofing areas to be able to cover the main dome of the Virgin Church.

Finally, to clarify all the details and optimize the LC solutions for the outside facade scaffolds, LC will send the .dwg files of the scaffolding structures and, together with RS and GET, will examine and optimize each section.

II. Actions to consider in the structural calculation

In the preliminary HS, LC considered the wind and snow actions. RS underlined that the design should take into account also the seismic risk in the construction region. LC will check their preliminary structural calculation and take into consideration this issue in the final structural calculation.

III. Weight issues

The total weight of the HS is about 155 tons (without wall tarpaulins and the ballasts). Regarding the weights of the ballasts, LC has done the first layouts and preliminary structural calculations; in the final version, they will present their recommendation regarding the ballasts.

RS requested complete data regarding the load distribution on the ground for base preparation and studies prior to installation of the HS.

It would be useful for LC to receive technical requirements such as the loading capacity of the working platforms, the optimal width of the working area and other details. These details will be discussed and shared in the team's (LC, RS, GET) future communications.

IV. Delivery, production, and transportation

LC confirmed that: the main elements (99%) are standard parts available in LC stock. According to the current situation, only 3 items are special parts with a production time of approximately 6-8 weeks.

The transportation time from Layher to Georgia with standard trucks (13,5m long) via Turkey is approximately 2 weeks. Considering the total weight (approx. 150 tons), about 12-14 trucks will be needed for transportation to Georgia.

The Georgian authorities' request for smaller trucks. Since the elements are not longer than 4 meters, the LC confirmed the possibility of this request.

V. HS Installation

Following the request by the Georgian authorities for the erection of the scaffolding system, the local capacity (including the labor and skilled laborers and machinery) will be used under the supervision/ training of the LC specialists.

Considering the nature of the project (Safeguarding of the Cultural Heritage), and taking into account that the duration of the HS presence on site could be difficult to estimate, RS suggested foreseeing a long period of time.

Note: We agree to organize a new meeting after the conclusion of the WHC mission on site.

Annexe 2

HANGAR PHASE - Temporary roofing for the implementation of final works - beginning of the collaboration with Layher Company (December 8th 2022)

RESTRUERE
STRUCTURE AND RESTORATION

December 8th 2022

Subject: **HANGAR PHASE - Temporary roofing for the implementation of final works - beginning of the collaboration with Layher Company**

Dear National Agency for Cultural Heritage Preservation of Georgia,

Following up on the document "Articulation of the expected works for the Safeguarding of Gelati Monastery (draft)" by ReStruere and dated 16.10.2022, National Agency has contacted the Layher Company proposing a collaboration for the "Safeguarding and Conservation of Gelati Monastery, World Heritage Property, Georgia" (21.10.2022).

The Layher Company has been identified as the world's leading manufacturing company of scaffolding systems and temporary works solutions, characterized by the implementation of numerous interventions for the protection of Cultural Heritage.

On October 24th, Eng. Viktor Klein confirmed Layher's interest in supporting the Gelati project. Eng. Klein informed the Agency that they already received a request regarding this project from UNESCO and International Relations Unit in Georgia in February 2021 and that they invested a lot of time and energy in the project but they didn't receive any response from UNESCO and International Relations Unit.

Eng. Klein provided the Agency with the preliminary drawings of the proposed project and the Agency promptly provided ReStruere with the documents, consisting in particular of:

- Draft proposal, isometric view, St. George Church scaffolding project (pdf file);
- Draft proposal, isometric view, Virgin Church scaffolding project (pdf file);
- temporary link for the 3D model view, St. George Church scaffolding project;
- temporary link for the 3D model view, Virgin Church scaffolding project;
- Lahyer Company Profile (pdf file);
- Brochure regarding the FW System (pdf file);
- Photographs of past Layher projects in the protection of historical buildings (jpg files);
- Email correspondence between Lahyer and International Relations Unit in Georgia, from february to april 2021;

An important remote meeting occurred on November 16th 2022 among ReStruere, the CSY Ministry, the National Agency and the Layher Company.

Below the participants of the meeting: Mr Kaha Sikharulidze, First Deputy Minister of Culture, Sport and Youth; Mr Nikoloz Aznaurashvili, Director-General of the National Agency for the Cultural Heritage Preservation; Ms Salome Jamburia, Senior Specialist for International Relations Department; Ms Tamar Ketiladze, Head of the UNESCO and International Relations Unit; Mr Tariel Kiparoidze, Chief Architect of the Georgian Expert Team; Mr Lasha Shartava, Architect of the Georgian Expert Team; Mr Ugo Tonietti, Architect and President of ReStruere; Mr Arash Boostani, PhD Engineer, ReStruere; Ms Sara Stefanini, PhD Architect, ReStruere; Mr Viktor Klein, Sales manager, Layher Company Export Department; Mr Waldemar Trumpf, Engineer, Layher Company Technical Department.

The content of the fruitful meeting has been reported in "Minute of the first remote discussion table for the Hangar Structure, needed for the final works on Gelati Monastery" drafted by Restruere and shared with all participants.

The days after the meeting, Eng. Klein provided some additional information and documents:

- Draft proposal, Front and top view, of the proposed covering system (pdf file);
- Abacus of elements and the total weight (pdf file);
- Scaffolding, instructions for assembly and use (pdf file);
- FW system, instructions for assembly and use (pdf file);
- Keder roof XL, instructions for assembly and use (pdf file);
- Draft proposal, 3D model, St. George Church scaffolding project (DWG file);
- Draft proposal, 3D model, Virgin Church scaffolding project (DWG file);

Restruere considers this beginning of the professional relationship with Layher, and the first proposals exchanged regarding the technical solution, to be positive and reliable. Restruere pledges to continue the partnership with Layher, closely working with the Georgian authorities and Georgian expert team.

Ugo Tonietti

President of ReStruere LTD

Annex 3

Email from ReStruere (December 16th, 2022)

Dear all,
(Georgian Ministry of Culture, Sport and Youth (MCSY) and National Agency for Cultural Heritage Preservation (NACHP), Layher Company (LC), ReStruere (RS), Georgian Expert Team (GET),

We would like to resume the path started and dedicated to the design of the temporary structure necessary for the implementation of the consolidation and safeguarding works on the Gelati Monastery.

As you know, during the week between November and December, the UNESCO World Heritage Center (WHC) and its Advisory Bodies (ICOMOS & ICRROM) field mission took place. It was carried out firstly in Gelati and then in Tbilisi. The report of the joint WHC/ICOMOS/ICCROM Advisory Mission, on the activities carried out and those planned, is expected at the end of January '23, but from the talks that have taken place, we think we should expect encouragement to continue along the path undertaken in the substantive questions.

During our first online meeting (16 November 2022), we discussed some main issues related to the design of the Hangar Structure (HS) and connected scaffolding system. The opinion of ReStruere is sincerely positive on what was presented as a preliminary study by the LC. Therefore, it is essential to put ourselves in a position to complete the punctual definition of the project and outline a time schedule to be able to implement it.
Below we summarize the most important issues that have to be deepened, following the minute of our last remote meeting.

1. Type of structure
On this point, we are basically in agreement (as regards the Nativity of the Virgin Church – the Main Church: the facade scaffolding made of aluminium as a separated structure from HS made in FW type steel; while for St. George church, everything can be made up of an aluminium structure, if that doesn't raise the price too much).
We also agree to have one HS covering the entire Virgin Church. The facade scaffoldings can be installed in different steps of the implementation works and be used for both Churches at different times.
Finally, we agree to postpone the definition of the coverage of the dome (LC will plan a Layher Keder roof structure similar to the proposed one for St. George Church).

2. Actions to consider in the structural calculation
Bearing in mind that the permanence of the temporary structure is not perfectly defined, it will be appropriate to contemplate the exposure of the HS also to possible seismic actions and wind forces.
To this end, it will be useful for the Georgian experts to present the data that LC deems necessary and any reference to local regulations on the subject.

3. Weight issues
Strictly connected with the previous item, a clear load distribution on the ground for base preparation has to be provided. For this purpose, several aspects have to be evaluated and analysed.

3.1 Does the Layher Company have the necessary data with respect to the topography, the shape of the rock, and the mapping of areas of archaeological interest? Are stratigraphic investigations on the ground necessary to clarify some geological and geotechnical aspects?

3.2 In order to identify the load capacity of the working platforms (together with the optimal width of the working area etc.) it will be useful to remember that the structure to be designed will have to allow for the removal of all tiled roofs, the current filling of the under roofs and the installation of new solutions for covering and protecting the monument. To such a task, we have to add also, at least on the four wings of the church, materials suitable for their structural consolidation.

3.3 With reference to the installation procedures, an exchange of opinions and data will be useful to understand which and how many devices for moving the structural elements are necessary and if there are constraints in adopting them. For example, could two cranes placed on opposite sides of the monument be used if only one crane were to have difficulty moving the expected weights?
A specific working table should be activated on these issues.

4. Delivery, production, and transportation and **5. HS Installation**
On these points, we can follow what was exposed in the minute of the previous meeting.

6. Project timelines
This is a crucial issue that affects the entire design process. We have to take into count that we are lucky to have a preliminary project already defined but several details need to be still solved.
We need to discuss work program to understand its feasibility and highlight its critical issues.
Due to the suffering conditions exhibited by the monument, it needs that interventions to make it safe from meteoric infiltrations, but also for structural consolidation and protection of the valuable architecture, be implemented quickly.

7. Project Costs
Indeed, when the main HS performances are defined in detail, the issue of the Project costs will have to be addressed.

Proposal for the second online meeting:
In light of these considerations and if you agree, we think to organize the second online meeting in the week of December 26th to 30th, in which we can clarify how to address the individual points, define what the various teams need and how to achieve it, in order to define a path useful for achieving the objective.

Best regards,

Ugo Tonietti (for ReStruere)

Firenze, 16 December 2022

Annex 4

Letter and drawings transmitted to Layher Company (February 23rd, 2023)

Suggestions resulting from the examination of the proposal received from Layher Company on 15th February and concerning the technical solution for the cover protection of the main church.

Looking at the preliminary design and concentrating on the issues underlined by the same Company, we can share these considerations:

1) Actually, the way in which loads of 1/4 of the support structure of the scaffolding (necessary for the works on the dome) are transferred to the roof of each Arm is of concern.

This is for two reasons: on the one hand because the weight is considerable, due to the pitches on which it will rest (weak material) but especially since such weight will be transferred to the ancient vaulted structure); on the other hand, for the way in which this weight is transferred. In fact, it will be necessary to spread the load or to reduce it.

In our opinion, we have to think of a slightly different solution, capable of shifting the transfer of loads as much as possible to the vertical elements outside the arms, but then from them, as far as possible, directly to the ground. We can act by making the structure straddling the roof of each arm stiffer (and more "structure"). The drawings attached (as PDF) can better explain this concept (we suggest three hypotheses, starting from the softer one to finish with a more demanding one).

- A first solution is characterized by adding only some diagonal rods to the current scaffolding (we add extra diagonal elements to strength the structure to reduce the deformation of the middle elements to have a better load distribution on the pitches).
- A second one is based on the use of steel profiles in order to obtain, in a more effective way, the same purpose.

For both of these proposals the idea is to create a little bridge over the Arms.

Naturally, the leaning on the roof will remain (even if the legs of the structure could rely on a wooden element with a distribution function). Still, most of the load will be transferred to the outside (and, in any case, it will be better to load more heavily on the lower pitches).

Something similar has to be repeated for the structure that can connect the cover protection to the soil.

- A third solution represents a more complex and robust choice.

The main character of the third solution is to crate dome shelter without supported by the main church structure. The trusses above the church Arms (East and West) are lifted up by 1.50 m and middle trusses are lifted gradually to reach the dome cover. For that, it is necessary to install additional scaffolding buttresses from the North and South sides as well. Due to the increased surface area, we wonder how it will perform under wind loads and we are curious about if it is possible for the tarpaulin to stretch from the inner /bottom/ side of the trusses.

With these proposals, we only wish to provide a research direction. In fact, it is not easy, for us, to perfectly understand how they could be composed with the remaining part of the structure (and only Layer's engineers have the right know how on the matter).

2) Another important issue is connected to the need to carry out the works on the church at different times, since the scaffolding for the dome cannot allow the intervention of some lower pitches. This fact obliges us to decide how to proceed with the work plan. Keeping in mind the recommendations of the UNESCO World Heritage Centre on the need to cover the whole building, and trying to minimize the violation of this principle, we think it is necessary to plan the works as follows.

We can install all the cover protection on the church. Then we can open the four Arms to allow the evaporation of humidity, leaving a roof strip of about 1.5-2.00 meters near the base of the drum for each Arm, with the existing cover. Relying on such strips, we can follow the installation of the scaffolding for the dome, starting the works on the dome. After completing the works on the dome, we have to dismantle the scaffolding around the dome. Then we can work in all the different pitches of the Main church.

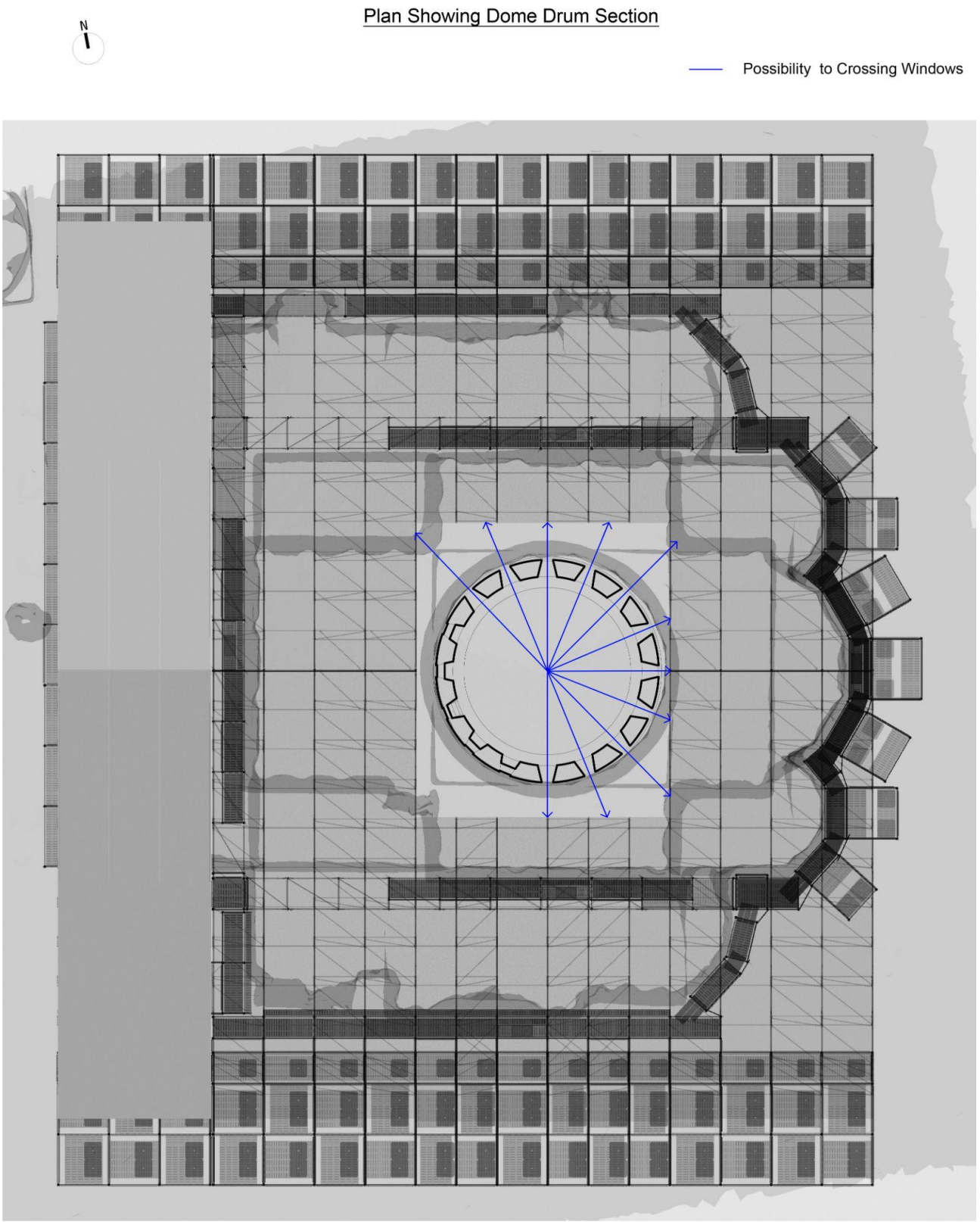
As regards the possibility of shifting in different and separate parts (four parts, following Layher suggestions) protection cover, in order to reduce the costs, we have to follow the World Heritage Centre and its Advisory Bodies mission report on Gelati Monastery. The report is mandatory in prescribing a total protection structure to allow simultaneous activities on the monument (which could represent a useful condition).

3) Thinking about how to reduce the loads on the old masonry and roofs, loads that depend on the Layher protecting cover, we thought again about the situation of the drum. Reflecting on it, only five windows are filled with brickwork. Other openings are protected by windows with wooden frames. It could be appropriate to understand if it could be possible to use some of the openings of the drum in order to connect the scaffolding with the drum (by some beams, but only one with a diameter extension), also transferring a little part of the load. Of course, this solution has to be carefully evaluated to avoid any type of damage and if it could really represent a help.

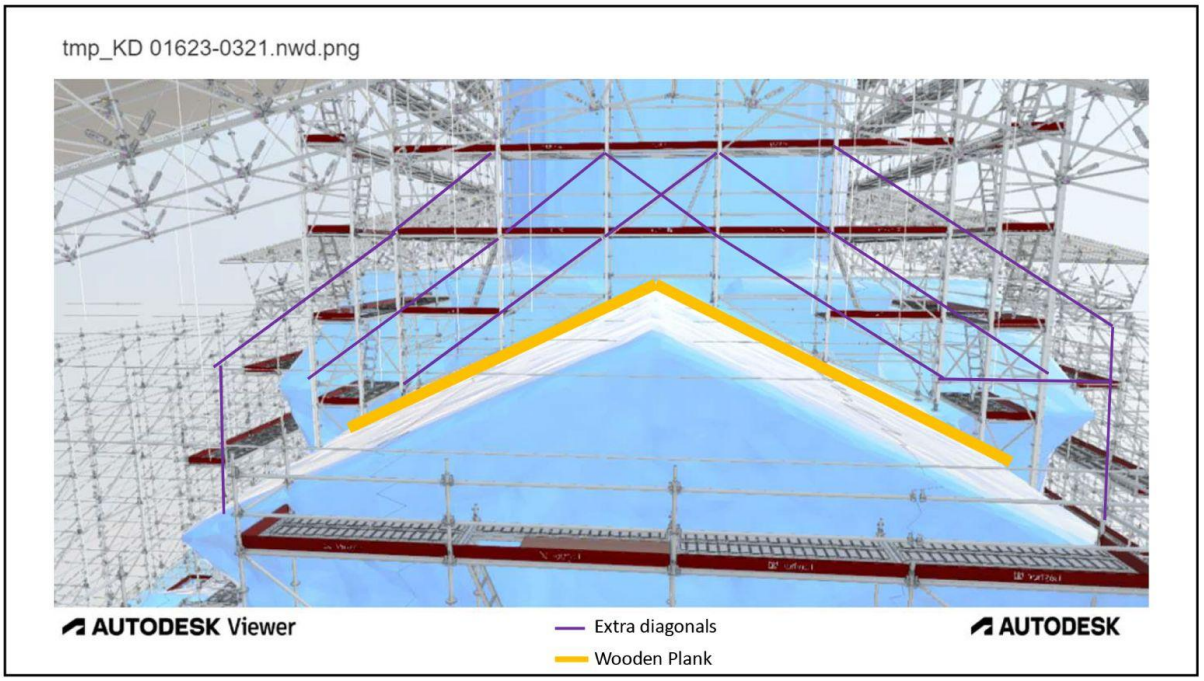
Thank you for your attention.

Best regards,
Ugo, Lasha and Arash

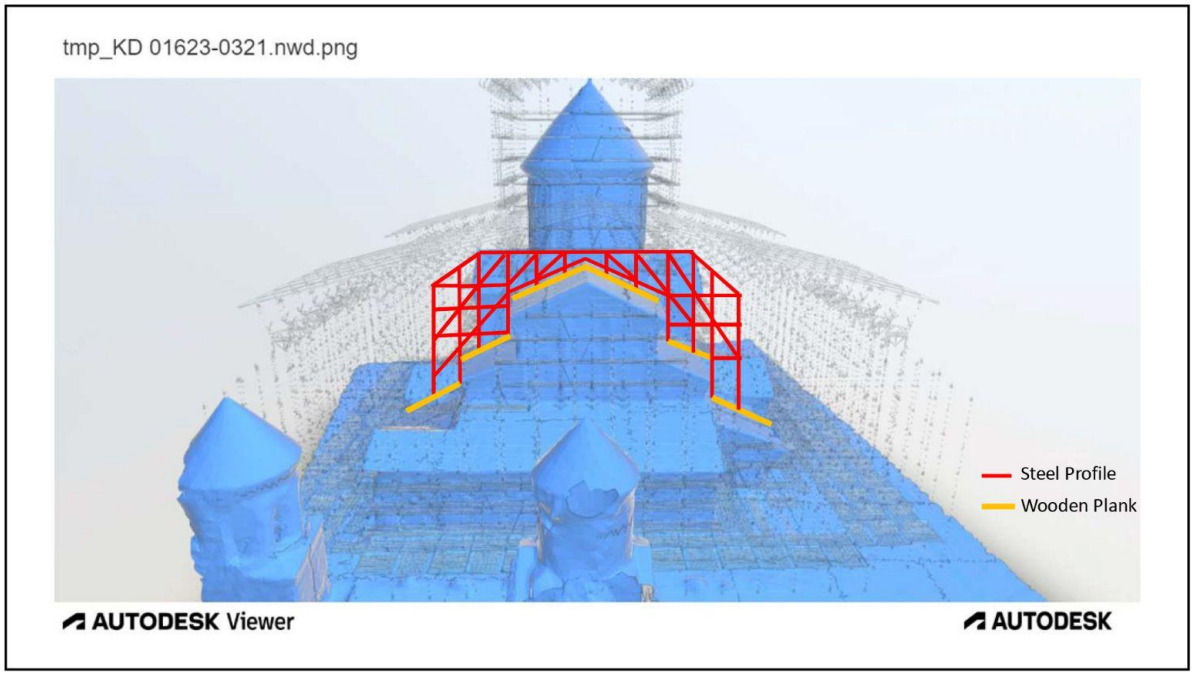
Dome Drum Plan



Option 1

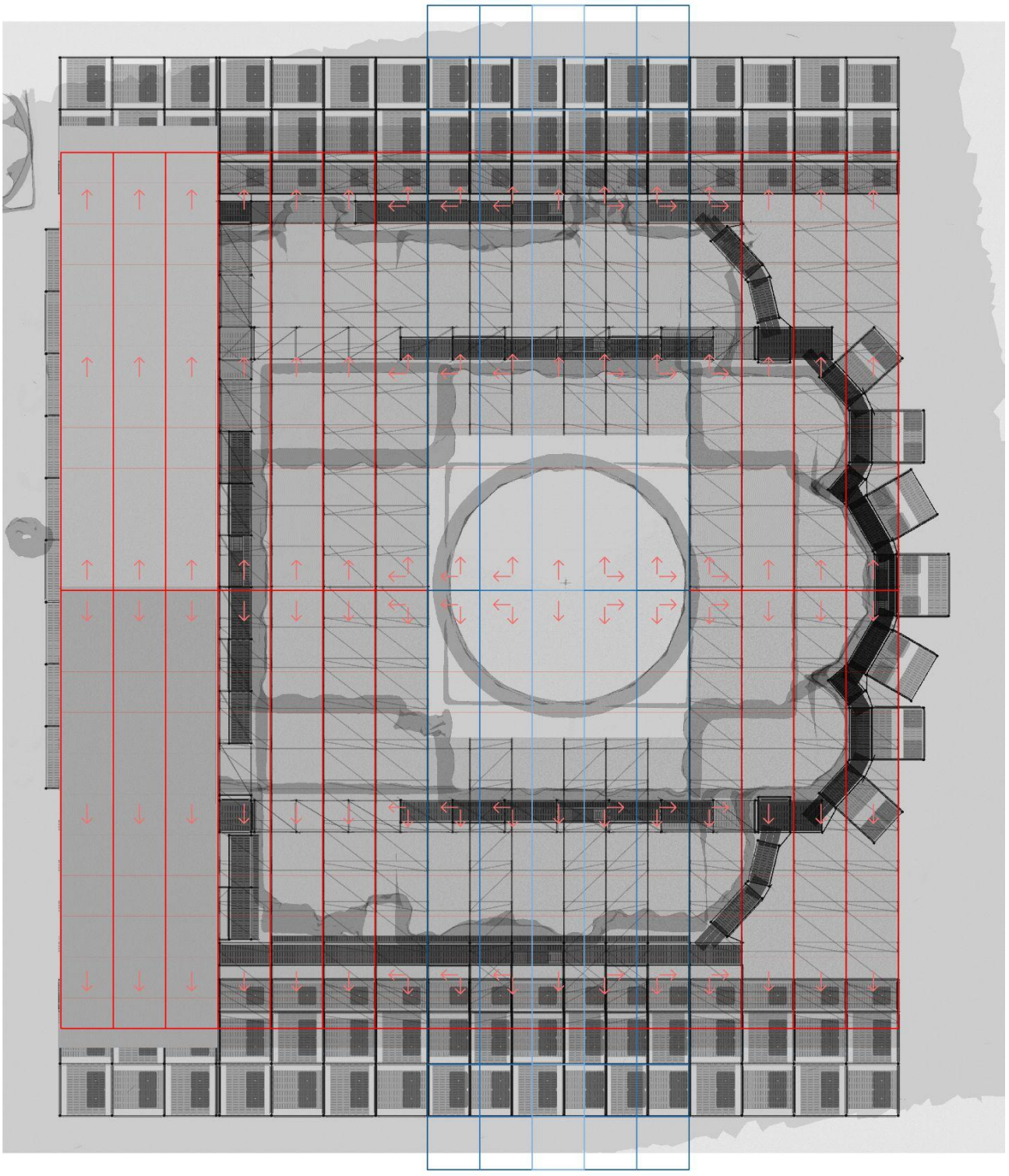


Option 2



Option 3

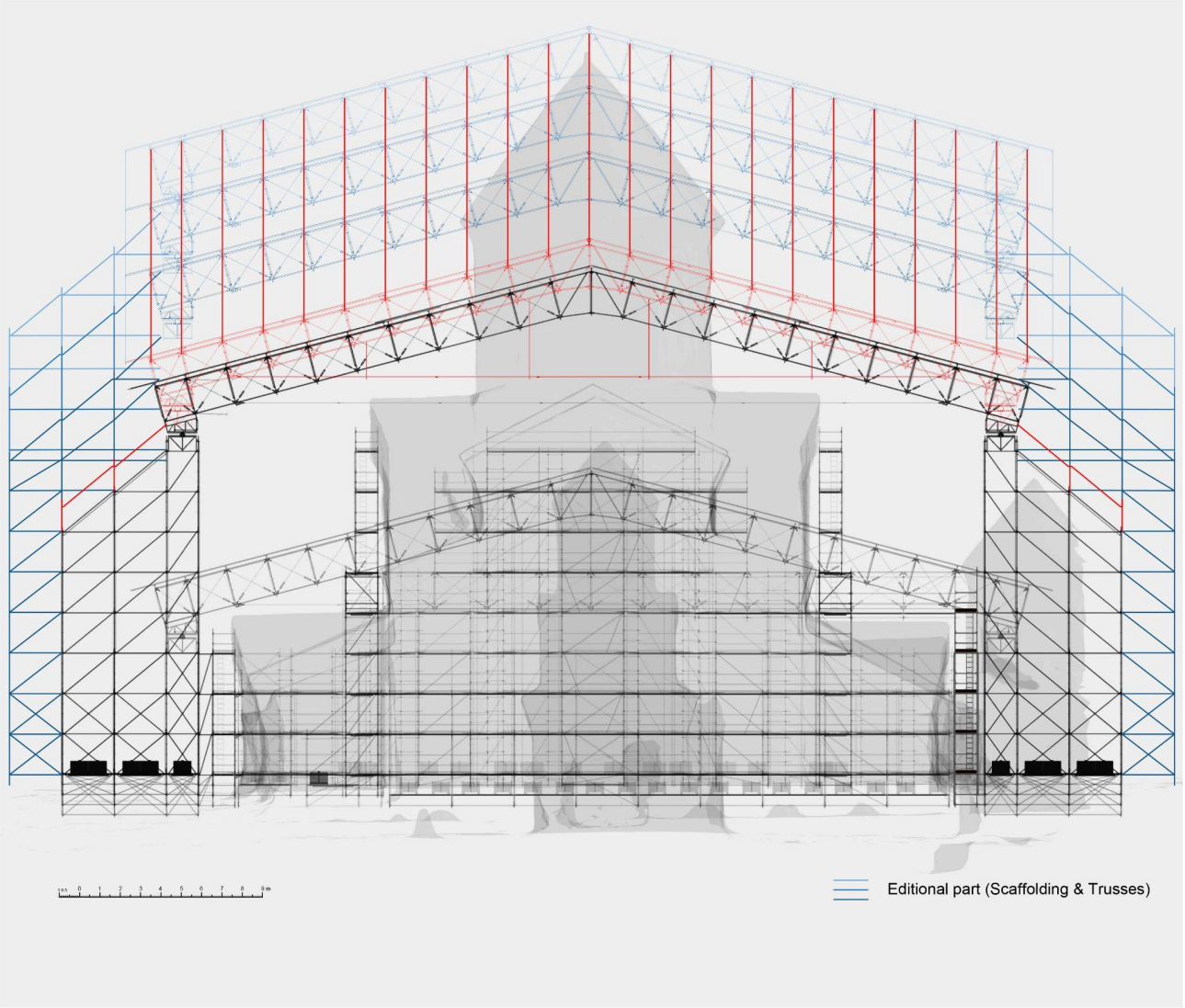
Roof Plan - Option 3



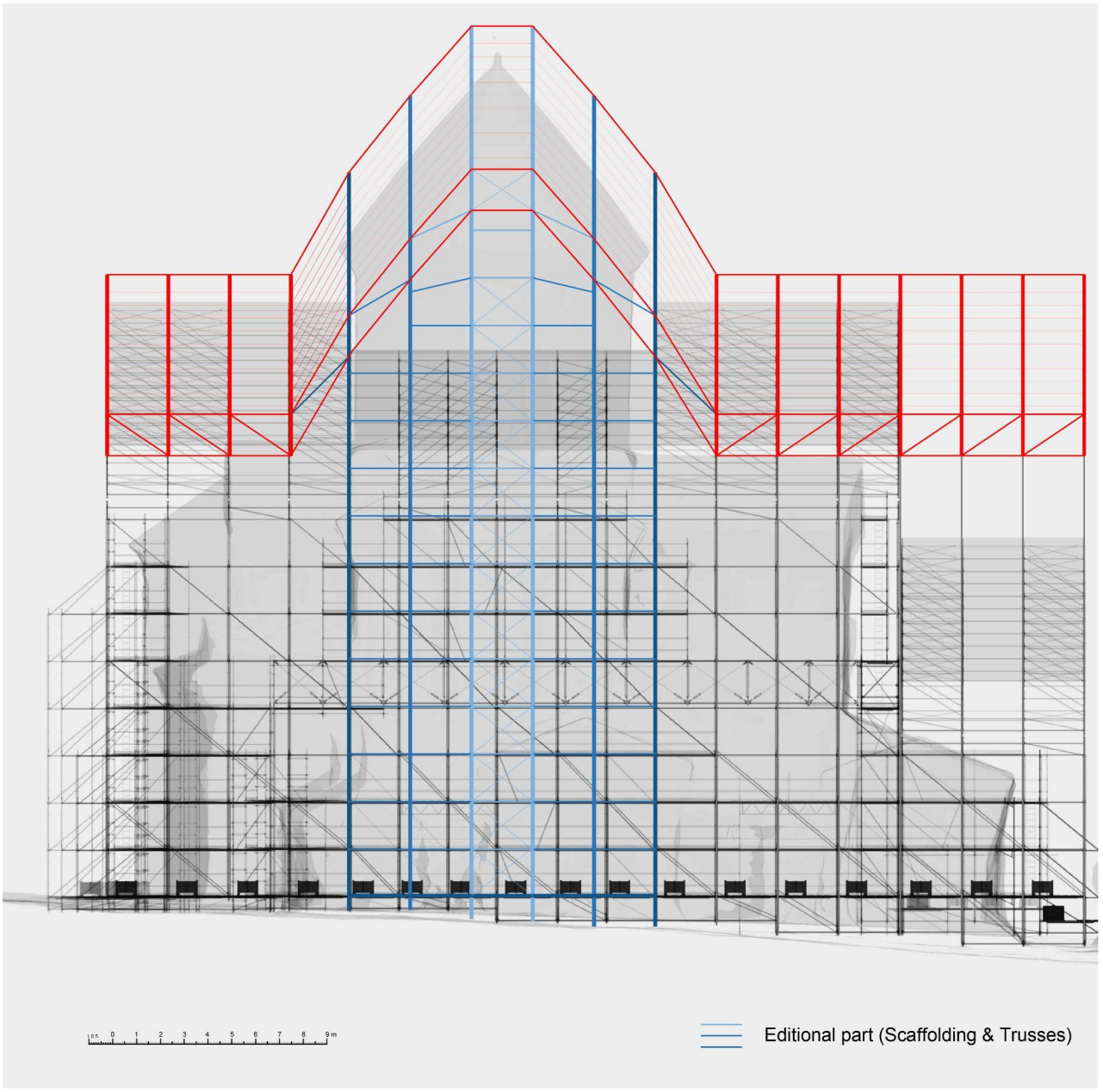
Editional part (Scaffolding & Trusses)

Slope Direction (Down)

East Facade - Option 3



North Facade - Option 3



Data from the “Construction Climatology” (PN 01.05-08)

Settlement Coordinates

№	Name of the Settlement	Coordinates			Barometric pressure (hPa)
		N	E	Altitude above sea level (m)	
146	Kutaisi	42°16'	42°38'	116	990
-	Gelati	42°17'	42°45'	400	-

Amount of precipitation

N	Name of the Settlement	Amount of precipitation per year, mm	Daily maximum of precipitation, mm
146	Kutaisi	1394	166

Snow cover load

N	Name of the Settlement	Snow cover weight, kPa	Number of days of snow cover
146	Kutaisi	0,50	26
-	Gelati	≈ 1,00	≈ 30
Snow cover load, kPa – weight of snow cover per 1 m² of horizontal surface in kN.			

Normative values of wind pressure

N	Name of the Settlement	w0 Once in 5 years, kPa	w0 Once in 15 years, kPa
146	Kutaisi	0,73	0,85
Normative value of wind pressure is determined by the 10-minute averaged value of wind speed at a height of 10 meters, which can be repeated once in 5 years (or in another given interval)			

Wind characteristics																								
N	Settlement	Maximum wind speed possible once every 1,5,10,15,20 years, m/s					Repeatability of wind direction (%) January/July								Average, maximum and minimum wind speed, m/s		Repeatability of wind direction and stille (%) per year							
		1	5	10	15	20	N	NE	E	SE	S	SW	W	NW	January	July	N	NE	E	SE	S	SW	W	NW	Stille
146	Kutaisi	31	35	37	38	39	10/8	19/4	25/10	18/4	2/2	5/9	14/54	7/9	7,4/1,7	3,6/1,1	9	13	21	10	3	5	29	10	13

Data from the “Earthquake Engineering” (PN 01.01-09)

Seismic Data (Seismic hazard map addition, Annex-2)					
#	Settlement	Region	Municipality	A - The seismic nondimensional coefficient Design peak acceleration (g)	Seismic Intensity (MSK64 Scale)
1001	Gelati	Imereti	Tkibuli	0.14	8