BIOPHILIC PATTERN AND APPEARANCE OF LEPENSKI VIR HABITATS

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ON ARCHITECTURE – PHILOSOPHY OF ARCHITECTURE

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ARCHAEOLOGICAL SITE OF LEPENSKI VIR

- Lepenski Vir was discovered in the 1960s.
- The greatest merit for this discovery has an archaeologist Dragoslav Srejović.
- The site is estimated to be about 8,000 years old.
- Its discovery includes the remains of habitat floors.
- It is located on the Serbian side of the Danube in Djerdap.
- Djerdap UNESCO Global Geopark is included (with site Lepenski Vir) in Global Geopark Network list in 2020.

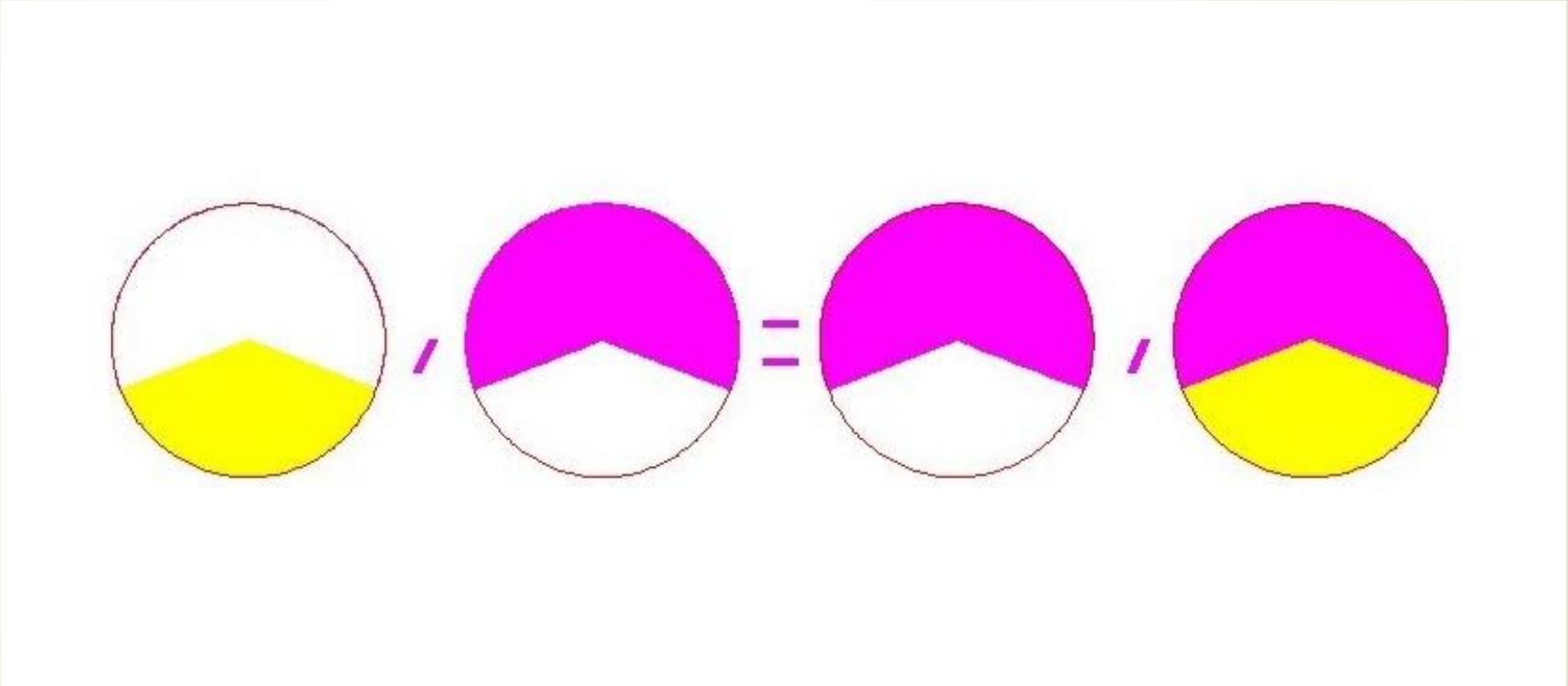
THE AIM OF THIS PRESENTATION

- **Designing one of the possible habitat models of Lepenski Vir.**
- The biophilic pattern could be the role model for conceptual design of Lepenski Vir habitats.
- Natural forms and natural patterns are some of several paramount strategies in biophilic design.

BACKGROUND – SOMETHING ABOUT BIOPHILIA AND BIOPHILIC DESIGN

- Sami Meira: „Hierarchically organized relationships in nature are based on the Fibonacci sequence and the golden ratio as mathematical patterns.
- If we apply this ratio to a circle, this is the golden angle (about 137.5°).
- This is the approximate angle in the leaves, where sunlight is most efficiently used.“

THE GOLDEN ANGLE: φ≈137.5°
THE GOLDEN RATIO IN A CIRCLE WITHOUT NUMBERS (PICTURE-FORMULA)



WHY THE AUTHOR USES A LEAVES AS BIOPHILIC PATTERN?

- The leaves are structured for optimal light capture for maximal photosynthetic activity.
- The golden angle is indeed optimal for usage of solar energy for:

1. photosynthesis,
2. phillotaxis (the arrangement of leaves on a stalk).

- This angle gives maximum influx of solar energy into plants.

PATTERN: AN IVY LEAF (HEDERA HELIX)

- An ivy leaf can serve as a pattern for the biophilic design of the ground plane of Lepenski Vir habitats because:

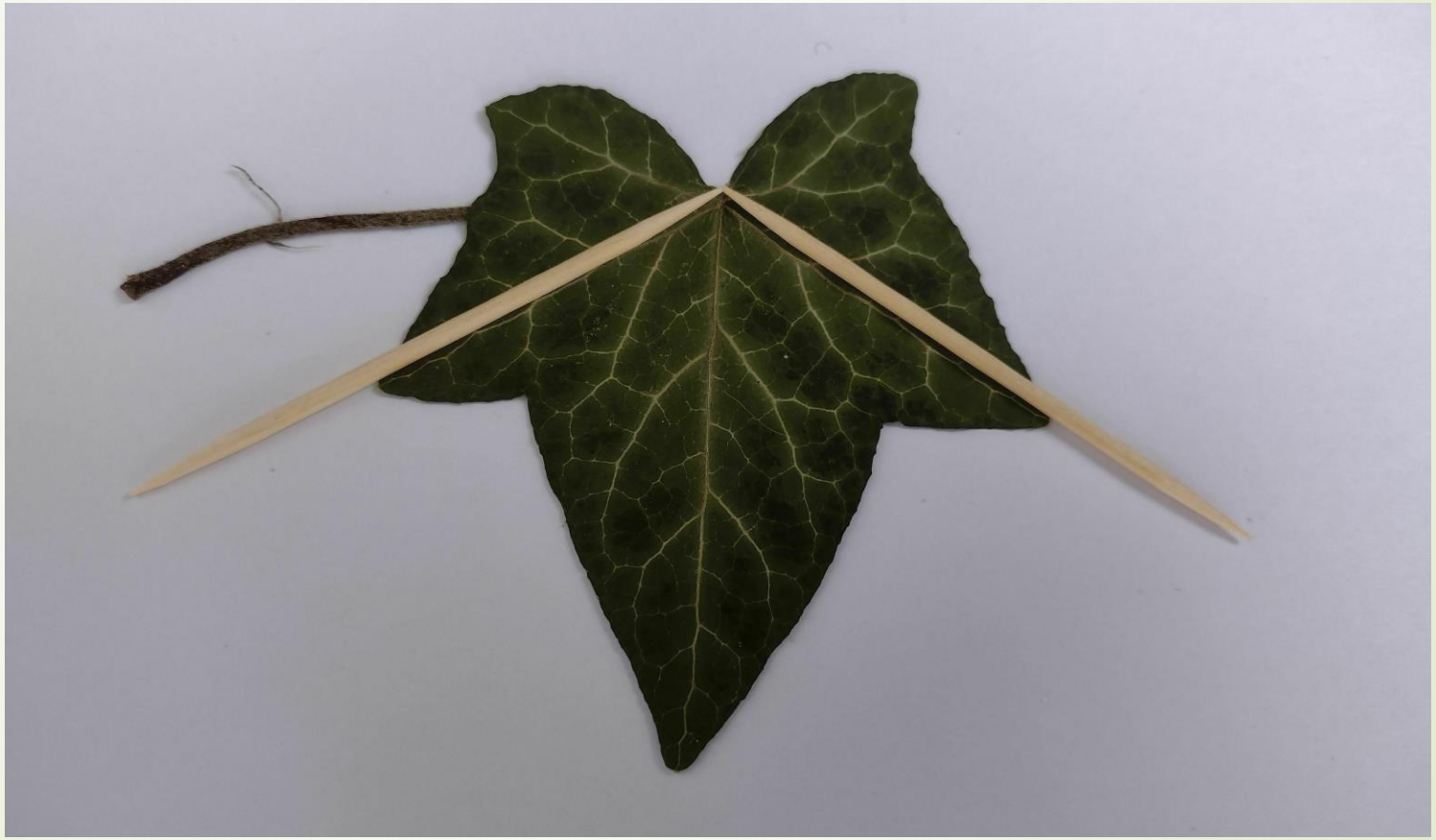
1. An ivy is a survivor from the Tertiary period in geology and it is very old, resilience and flexible plant,

2. It exists in National Park Djerdap,

3. People know its property well: it symbolizes fertility and eternity life in some myths and civilizations,

4. The remains of the architecture of Lepenski Vir are the remains of the energy-efficient architecture, which the author has written about before.

AN IVY LEAF (HEDERA HELIX), ITS VEINS AND THE PLACE OF GOLDEN ANGLE



APPLY OF THE GOLDEN ANGLE IN ENERGY EFFICIENCY

- Professor Branislav Todorović: „HVAC engineers estimate conduction heat loads in winter due to the influence of different intensities of solar radiation on the walls of the room, which are oriented towards individual parts of the world with the addition of Zs.“
- The angle of 135°, which includes orientation of S, SE and SW walls, has Zs = - 0.05.
- This angle is an approximate value of the golden angle.

WHY WERE THE LEPENSKI VIR HABITATS BUILT IN THIS MANNER?

- The remains of the Lepenski Vir's architecture (about 8,000 years old) indicate to recognizable measures aimed at increasing energy efficiency in buildings implemented in the design and construction of habitats and settlements at this site.
- The role of the Sun and solar radiation at the site is very important to understand the purpose of this architecture.

WHY WERE THE LEPENSKI VIR HABITATS BUILT IN THIS MANNER?

- Dragoslav Srejović: “Architecture of Lepenski Vir corresponds only with the morphology of the city of the far future.”
- We may conclude, based on the remains of the architecture, that the purpose of such construction was to ensure thermal stabilty and comfortable conditions in them, taking into consideration energy efficiency in buildings.
- The remains of architecture in Lepenski Vir are the remains of an energy-efficient architecture.

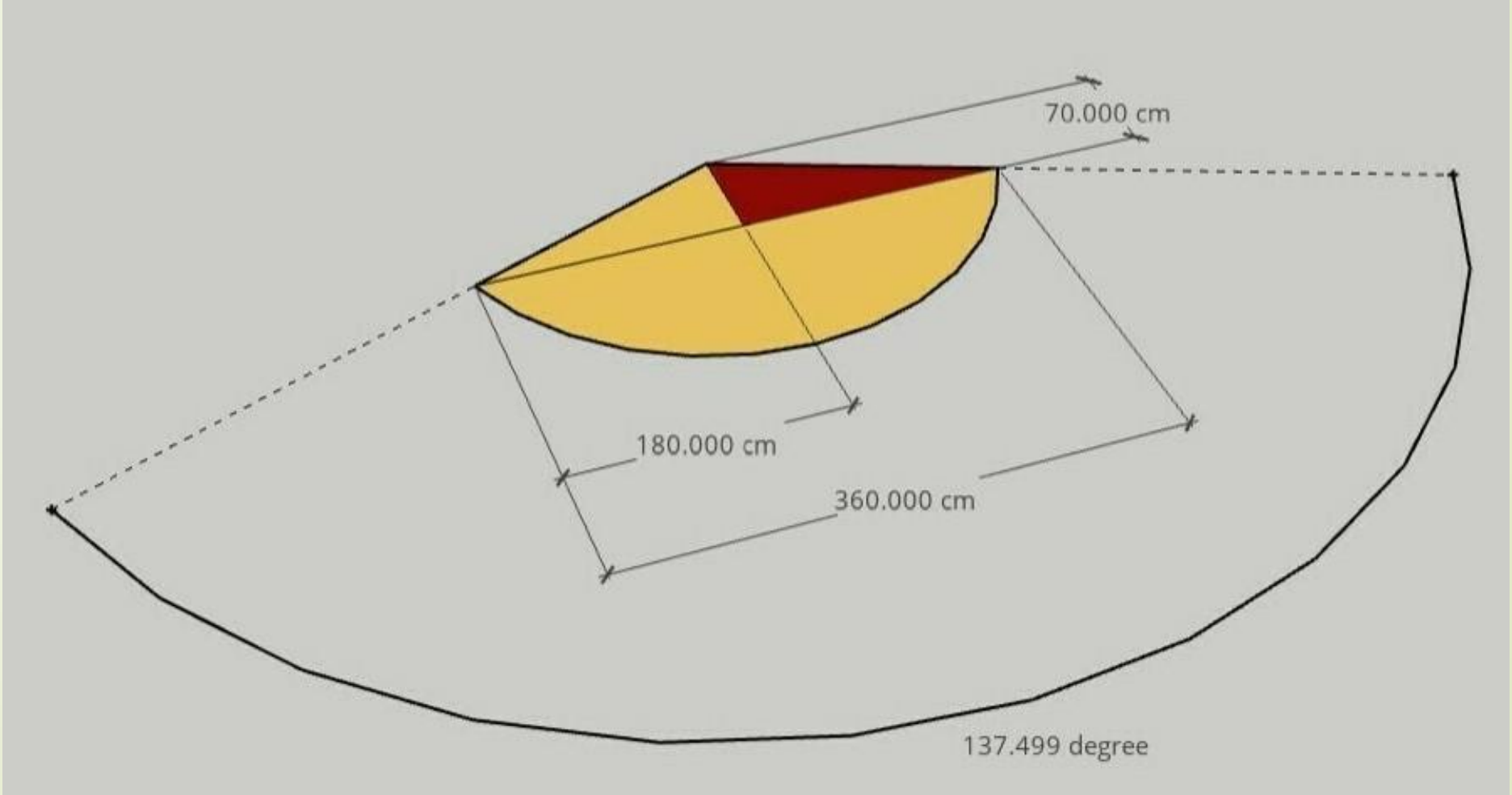
DESIGNING ONE OF THE POSSIBLE HABITAT MODELS OF LEPENSKI VIR

- It will be develop in several steps (phases) and starts from a horizontal base-line at the entrance with an initial measure of 360.
- Digging in the earth behind the base-line and backfilling in front of it are included in all steps for foundation.
- After building the foundation, we can continue with construction of the skeleton.
- Further, the methods of construction of the Lepenski Vir habitat will be presented.

STEP 1: AN APPROXIMATE GOLDEN ANGLE CONSTRUCTION

- The right-angled triangle with legs 180 and 70 contains half of golden angle with relative error less than 0.1‰.
- The golden angle was got as double right-angled triangle with legs measure 18 and 7.
- This construction was possible in prehistory.
- It’s a golden angle with very high precision for building house.

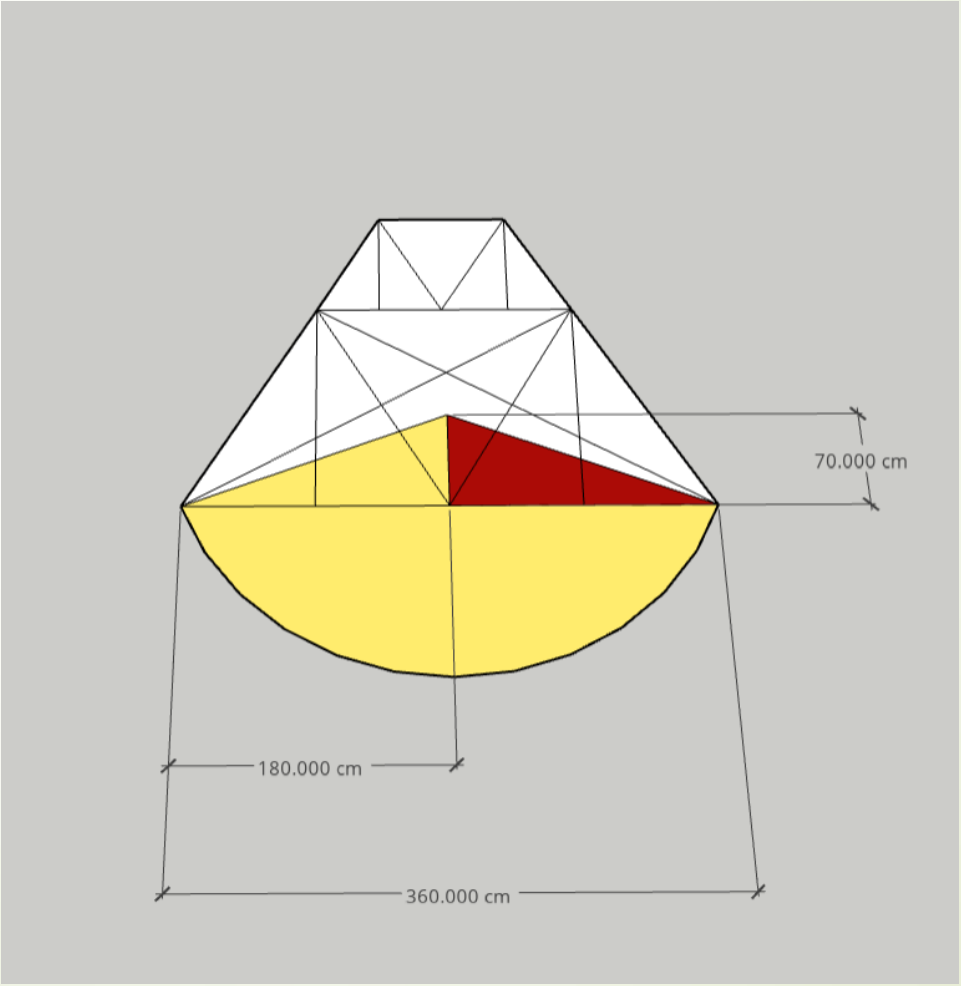
STEP 1: AN APPROXIMATE GOLDEN ANGLE CONSTRUCTION (φ=137.507764...)



STEP 2: FURTHER BUILDING OF THE FOUNDATION

- The part of basis behind the base-line can be obtained if we construct equilateral triangles in two rows.
- The first row has equilateral triangles 180 in size;
- The second row there has equilateral triangles 90 in size.
- With such a construction, we can obtain the point of the orthocentre of the unfinished horizontal equilateral triangle measuring 360.
- The construction starts from the base-line and from the inside, as D. Srejović suggested.

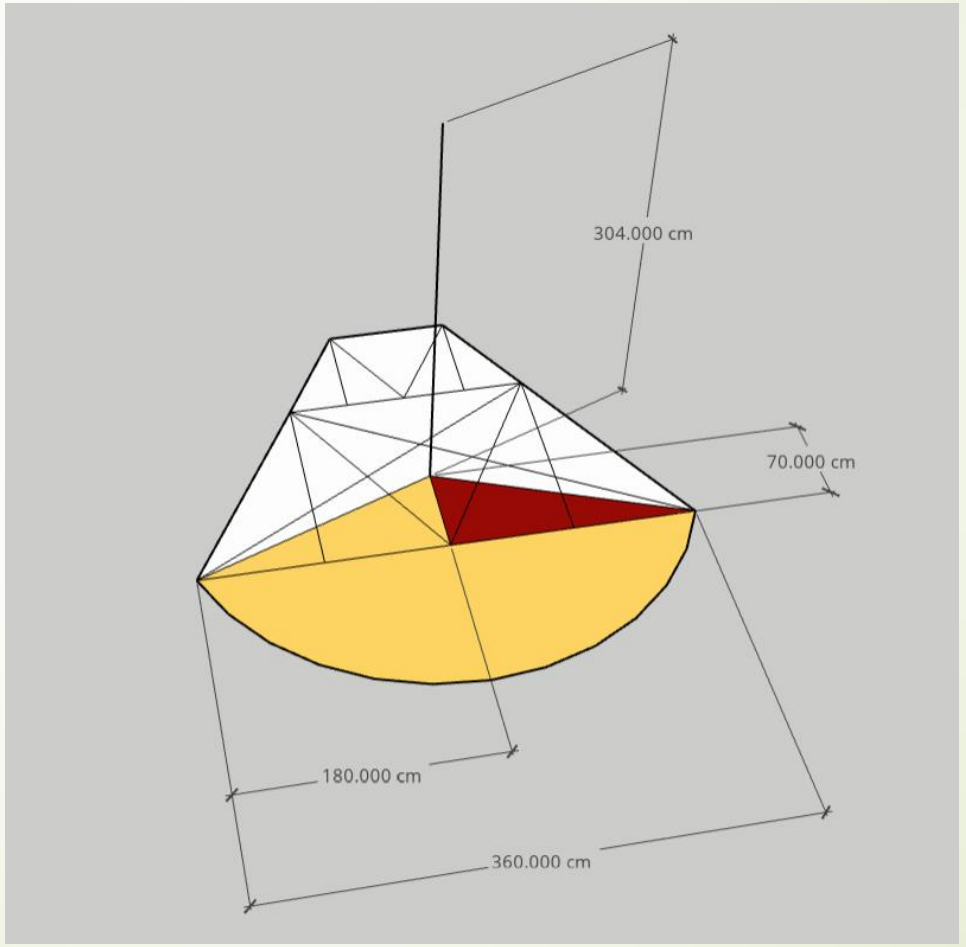
STEP 2: FURTHER BUILDING OF THE FOUNDATION



STEP 3: THE AUXILIARY VERTICAL STICK

- Now we are ready to install the auxiliary vertical stick.
- It prepares the third dimension of the Lepenski Vir habitat.
- The bottom of the stick is in the centre of the golden angle.
- This stick is strictly vertical.
- The height of this stick is obtained so that the top of stick is also the top of inclined equilateral triangle which includes the base-line of the foundation.

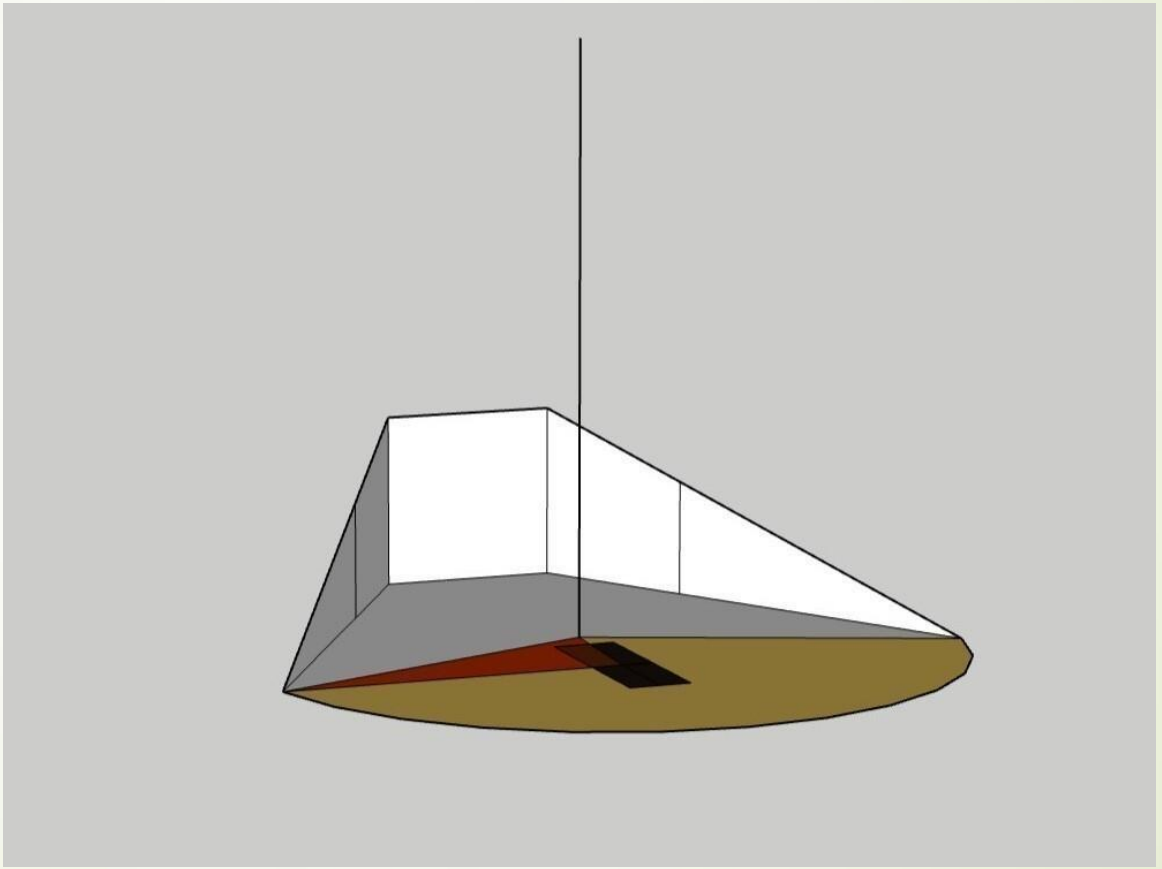
STEP 3: THE AUXILIARY VERTICAL STICK



STEP 4: DIGGING IN THE GROUND AND THE BACKSIDES

- The settlement has a steep hinterland.
- D. Srejović stated that the back side of habitat was dug in the ground up to 1 m (the House 34).
- The author assumes that the back side is an dug square 90 in size (like a quarter of 360) and that it was a part of the habitat.
- The square measuring 90 could be constructed with deviations because the site is located in a steep hinterland.
- Deviations are possible in the construction of individual habitats in relation to the slope of the terrain and include deviations in shape and size.

STEP 4: DIGGING IN THE GROUND AND THE BACKSIDES



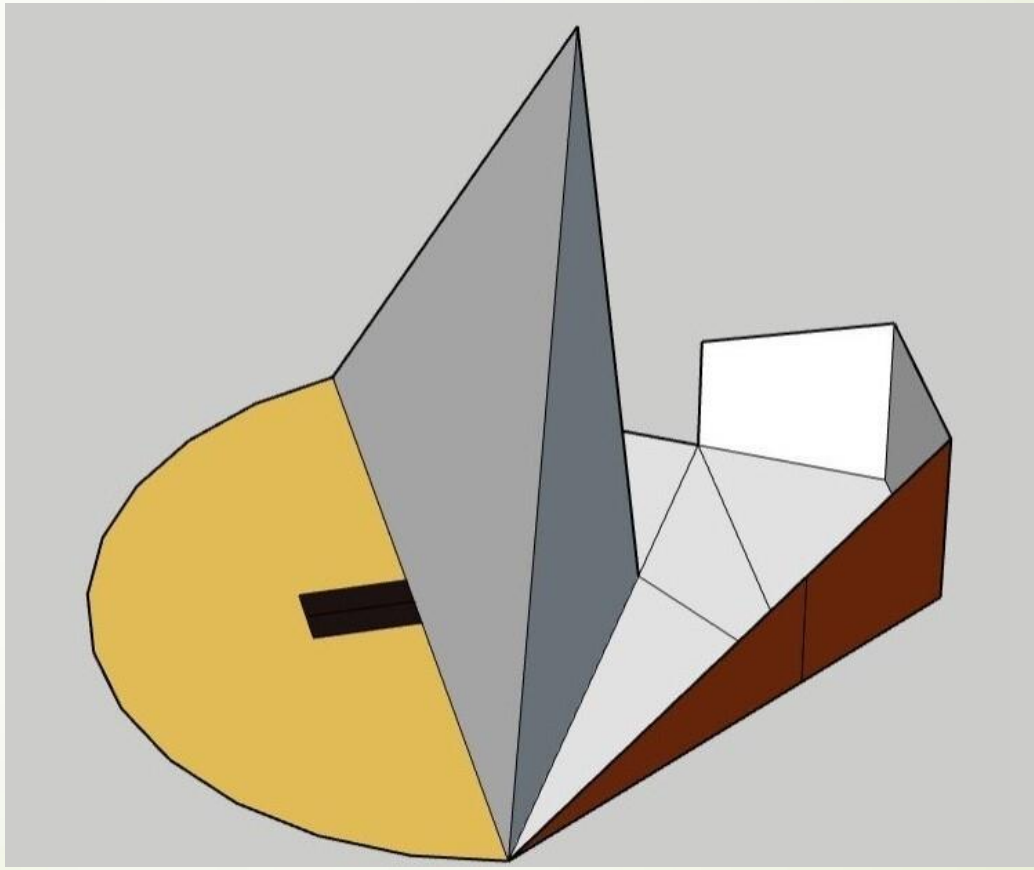
STEP 5: THE FIRST PART OF THE SKELETON

- The first next step is a skeleton construction of three sticks.
- The apex of that is the top of the strictly vertical stick from the centre of the golden angle (from step 3).
- The two sticks 360 in size are at front and are the part of inclined equilateral triangle that includes the base-line.

STEP 5: THE FIRST PART OF THE SKELETON

- The third stick has its bottom in the orthocentre of the unfinished horizontal equilateral triangle measuring 360 (from step 2).
- The apex of third stick is the top of the auxiliary vertical stick (from step 3).

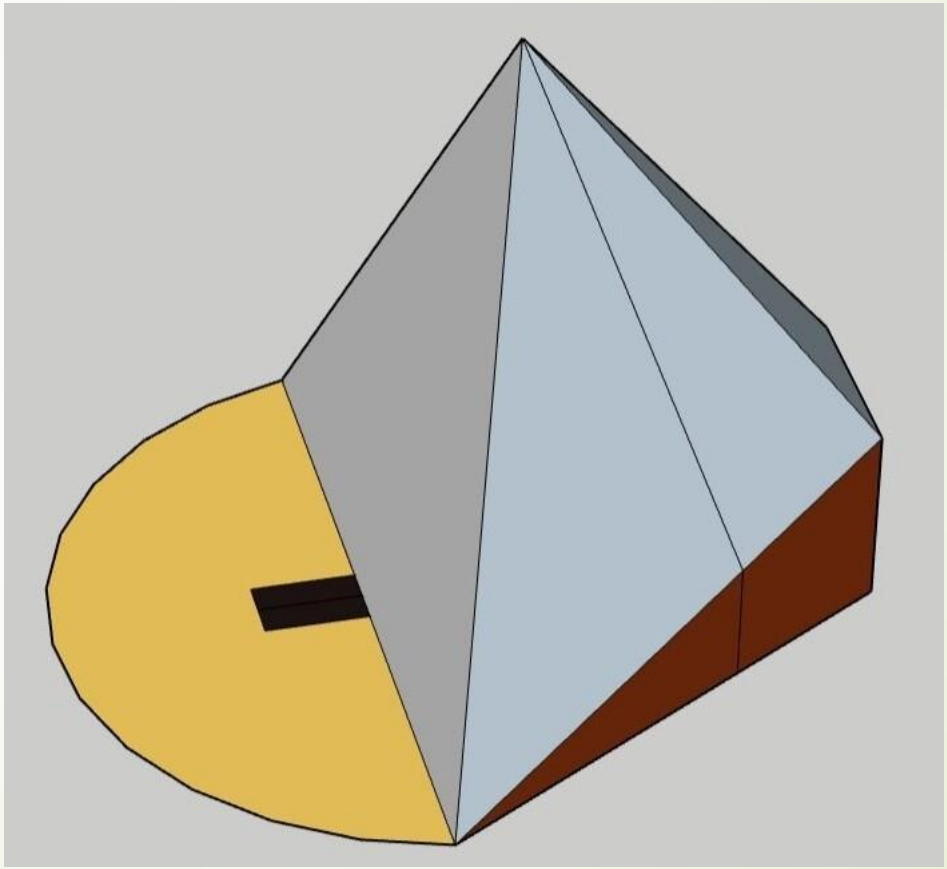
STEP 5: THE FIRST PART OF THE SKELETON



STEP 6: THE SECOND PART OF THE SKELETON

- The second part of the skeleton was made of sticks from the apex.
- It is the starting point for lateral edges of the pyramid-shaped skeleton.
- The endpoints of these lateral edges are characteristic points on the ground.
- The second part of the skeleton is behind the base-line.
- The front view of the second part of the skeleton is equilateral triangle 360 in size.

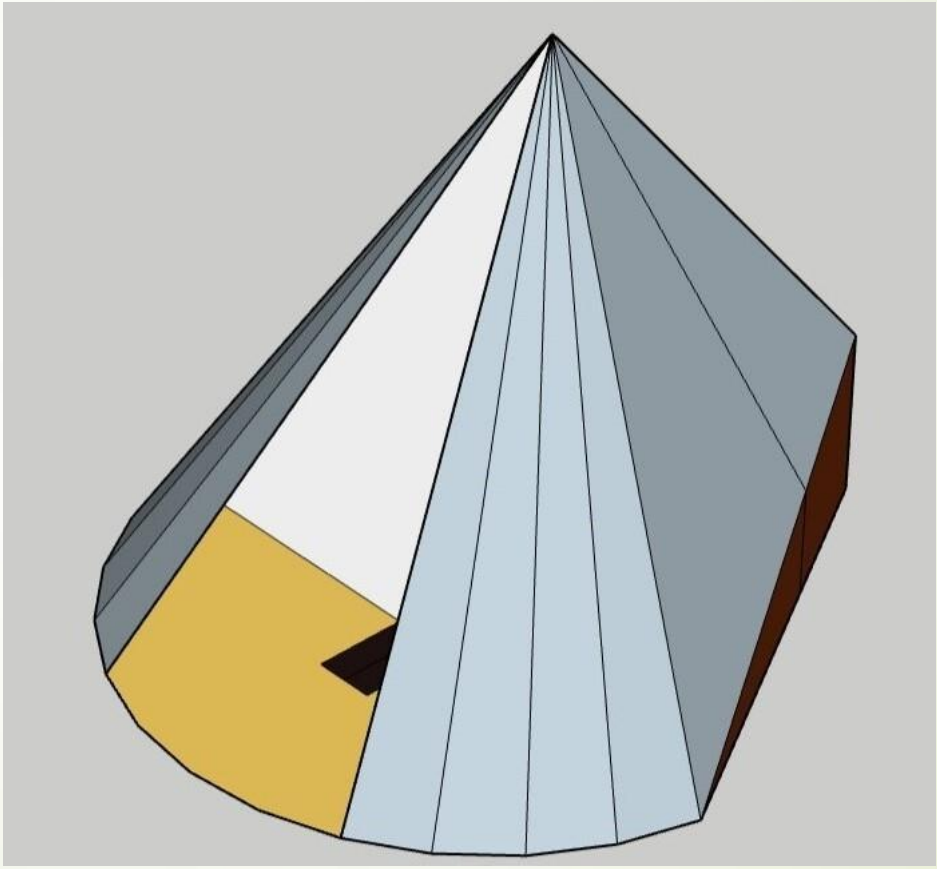
STEP 6: THE SECOND PART OF THE SKELETON



STEP 7: THE THIRD PART OF THE SKELETON

- The third part of the skeleton can be obtained by connecting the top of the habitat with the arc of the previously constructed golden angle (from step 1).
- This top is the apex of the upright cone or pyramid.
- These rods can be at 15° arc spacing.
- The entrance to the habitat is 60° and it is without sticks at the entrance.

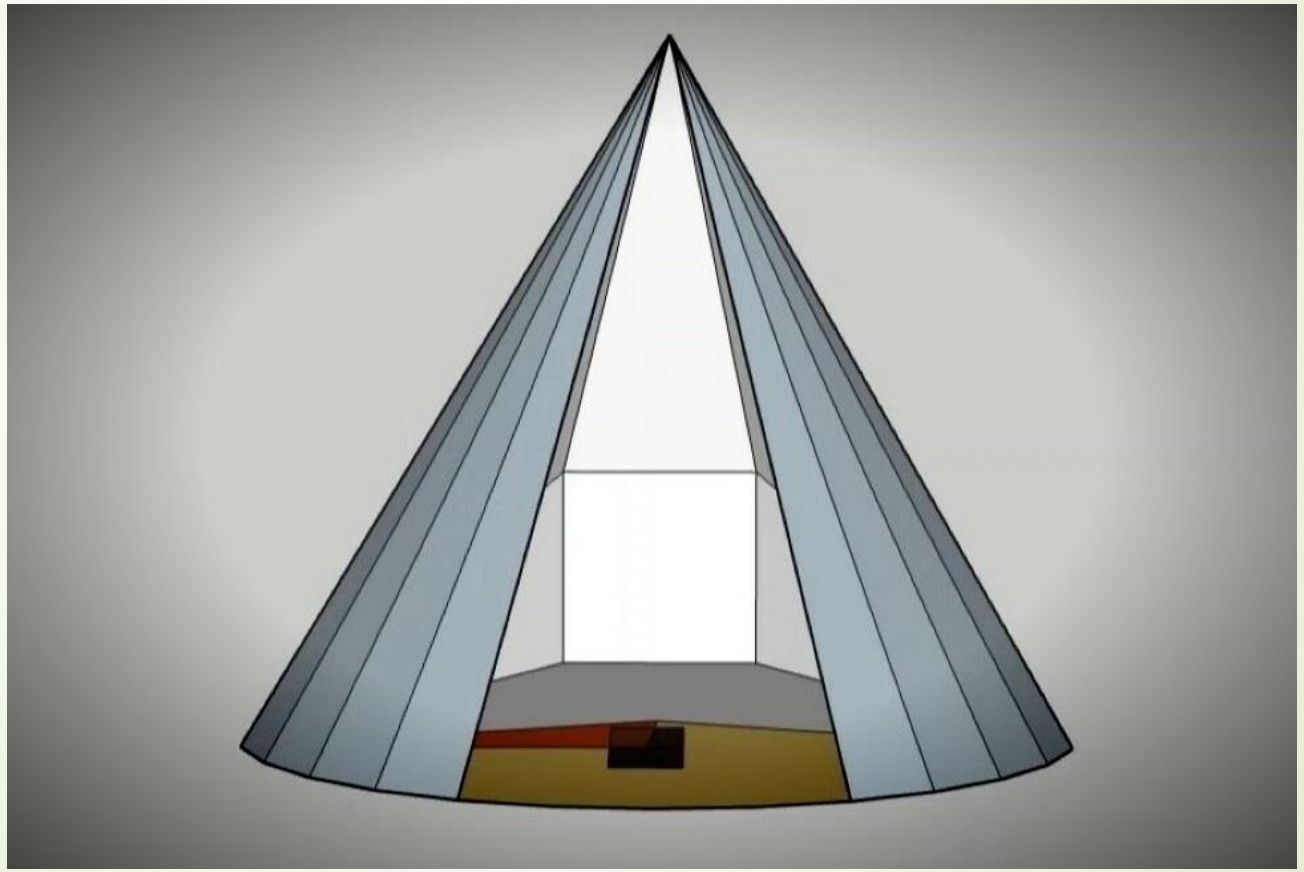
STEP 7: THE THIRD PART OF THE SKELETON



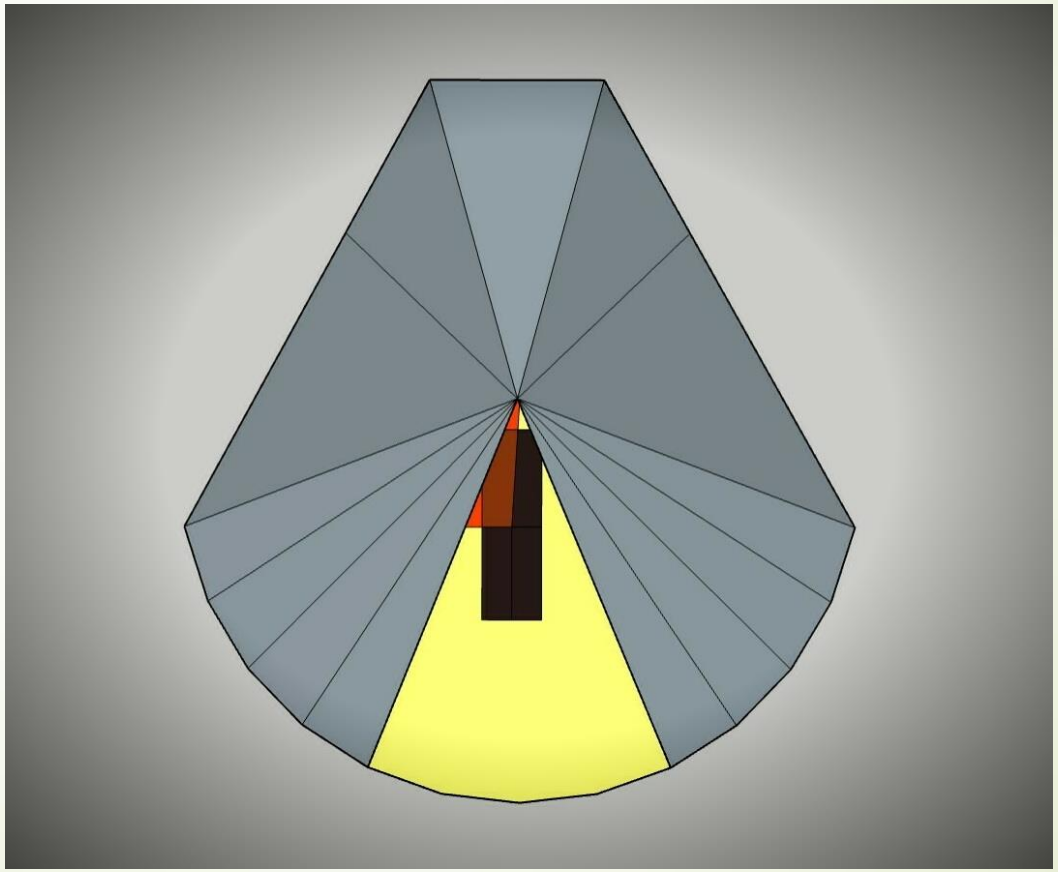
STEP 8: FINAL APPEARANCE ONE OF THE POSSIBLE HABITAT MODELS OF LEPENSKI VIR

- The final appearance of Lepenski Vir habitat could be obtained by carefully removing the auxiliary vertical stick and the stick from the orthocentre of the unfinished horizontal equilateral triangle.
- It enables better functionality of the hearth and increases usability of the living space.

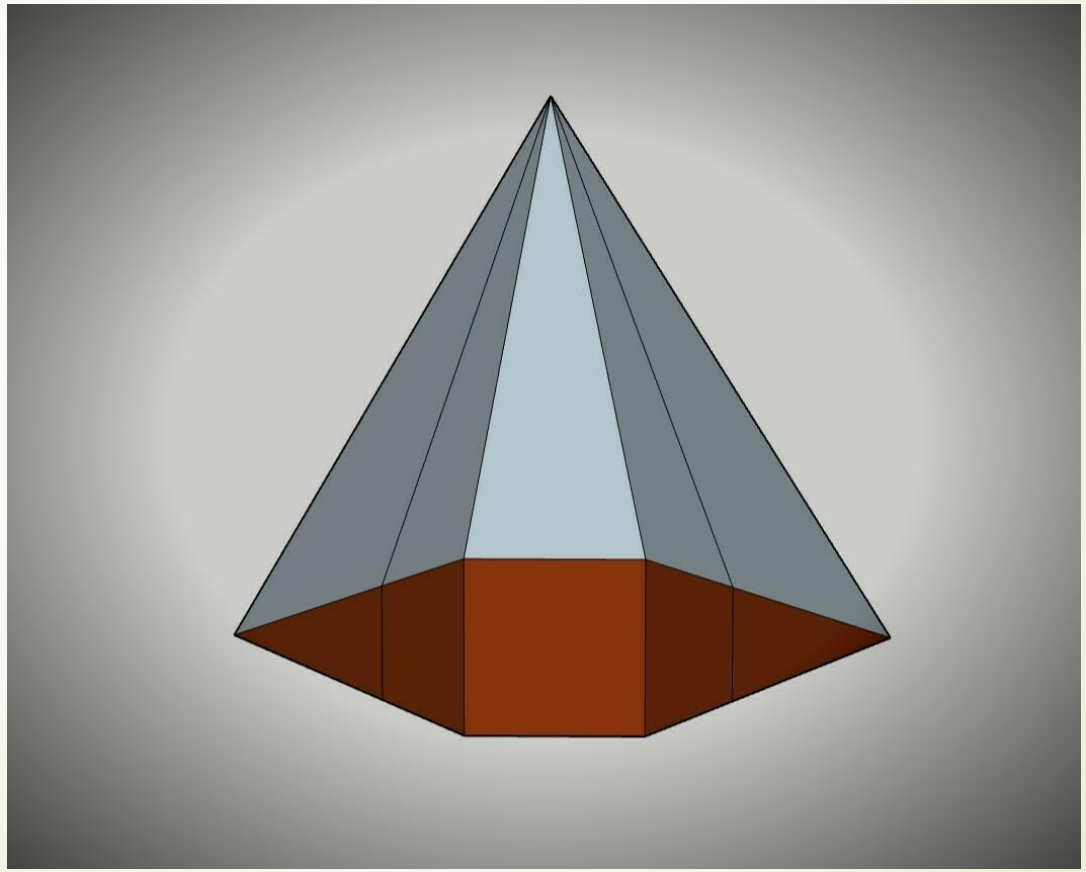
STEP 8: ONE OF THE POSSIBLE HABITAT MODELS OF LEPENSKI VIR – THE FRONT VIEW



STEP 8: ONE OF THE POSSIBLE HABITAT MODELS OF LEPENSKI VIR – THE TOP VIEW



STEP 8: ONE OF THE POSSIBLE HABITAT MODELS OF LEPENSKI VIR – THE BACK VIEW



HOW IS POSSIBLE TO CONSTRUCT THE TOP OF THE LEPENSKI VIR HABITAT?

- National museum in Požarevac (Serbia):

Archaeologist Dragan Jacanović materialized prehistoric building techniques with wooden sticks, rope and net.

CONCLUSION

- The resulting appearance is based on the answers to the question: „Why were the Lepenski Vir habitats built in this manner?“
- Its remains are remains of energy-efficient architecture.
- The role of the Sun and solar radiation on the site is very important to understand the purpose of this architecture.
- That is the reason why was choosen the biophilic pattern and the golden angle in this construction.

CONCLUSION

- An ivy leaf (Hedera helix) was chosen as a pattern for the biophilic design of the ground plane of Lepenski Vir habitats.
- This is not a reconstruction of a specific individual habitat of Lepenski Vir, but each habitat is a variant of this model, depending on the terrain configuration.
- Deviations from this conceptual desing model are possible in the construction of individual habitats and include deviations in shape and size.

CONCLUSION

- The first step is an approximate golden angle construction.
- The golden angle and basic size of 360 was used in the geometry and mathematics of the Lepenski Vir habitat.
- Approaches to the architecture of Palladio, Wright, Fuller and others are important for this biophilic pattern and appearance of the Lepenski Vir habitat.

CONCLUSION

- The architecture of Lepenski Vir was the architecture of the golden angle.
- This archaeological site is very important for understanding of sustainable development on the planet in the light of energy efficiency in buildings, saving of energy, reduction of greenhouse gas emissions, and prevention of effects of climate changes and global warming in the contemporary age.

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THANK YOU FOR ATTENTION!

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