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THE SARIDAG MONASTERY'S "KHOROL TOONO" AND GEOMETRICAL MODELING OF A GER

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The article presents the results of a study on modeling the main dimensions of a ger components of that time, based on the measurements of a "khorol toono" found in the Saridag Monastery, using a model of the basic measures of a so called Undur Gegeen Zanabazar's "canon ratio of a ger".

Keywords: *Saridag monastery, khorol toono, canon ratio of a ger, modeling, module, Mongol ger's constant*

Bogd Undur Gegeen Zanabazar I expanded his ger in 1654 and built a monastery, called Ribogejaigandanshadublin on the slopes of Khentii Mountain, which was completed in 1680 [1].

The monastery was plundered and destroyed during the Khalkha-Oirat riots in 1687 [1]. At the end of the 19th century, A.M. Pozdneev [2], a tourist, left information about his visit to the monastery; and during 1915-1916, a research team led by P.A. Witte identified the monastery as a major research object and put it into scientific use [1].

Almost 100 years later, from 2013-2018, the National Research Department of the Institute of History and Archeology of the Mongolian Academy of Sciences, headed by S. Chuluun, excavated, researched and analyzed the ruins of the Saridag Monastery in Erdene soum, Tuv aimag [3]. In September 2019, according to the results of a survey, rare relics found on the ruins of the monastery were exhibited at the National Historical Museum. For example, one of them is ger's "khorol toono", the top of the ger (Figure 1).

We have reconstructed the toono's structure from this artifact and conducted research to determine the design and size of the ger components of that time.

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Figure 1 - “Khorol toono” found in Saridag monastery.
National Historical Museum, Ulaanbaatar, 2019

1 About Undur Gegeen Zanabazar’s “canon ratio of a ger”, which is the basis for modeling the main dimensions of the Mongolian ger

Between 1700 and 1706, the Undur Gegeen returned to its homeland from Dolnuur and remodeled the canon ratio of the Mongolian ger (Figure 2) [4]. Undur Gegen Zanabazar, using his knowledge of the Canon ratio of Buddha creation, redeveloped the concept of the canon ratio of the Mongolian ger, bringing it to the level of a classic work that preserved the traditions of the indigenous nation. He used the distance between the holes *(zet)* in the outer circle *(muur)* as the basis (design) for other parts’measurements [5].

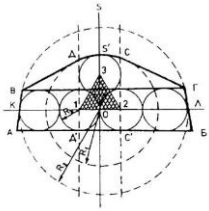

Figure 2 - Undur Gegeen Zanabazar’s “canon ratio of a ger”
(Source : Daajav.B “History of Mongolian Architecture”, series III.
Canon ratio of Mongolian Architecture, 2006.)

The main goal of Undur Gegeen's work was to find the dimensions of the main structural parts of the ger in order to make the configuration details related to the canon ratio of a ger, and to make a "Template" in order to pre find the distance between the wall cross points (udeer).

Another change introduced by Undur Gegeen was the transformation of the toono’s top (tsamkhraa) into a Buddhist symbol, the Khorol. We are confident that one of the khorol toonos of that time is the one found in the ruins of the Saridag monastery or “Nomiin Khuree”.

2 Determining the sizes of the structural wooden parts of the Saridag monastery's ger

In 1967, B. Daajav considered that it is important to find the length "module" that can be used for all measures of the Mongo-lian ger structural components. He found that the distance be-tween the axes of the holes in the outer circle (holes for unis' points) is 4-6 cm and used it as the ger's "module" [2]. We have carefully selected the "modular" size of the ger, re-constructed the structure and size of the toono, using the Undur Gegen Za-nabazar's Canon and then determined the size and parameters of the ger in the following way as follows. It should be noted that when Undur Gegeen Zanabazar called the distance between the axis of the holes and the graphic design as Canon, B. Daajav called it a 'module'.

The toono found in the Sarydag monastery: There are two main pairs of sticks with rings for forming the inner circle and the additional circle in-side the outer circle, crossed perpendicu - larly in the center of the khorol toono's top, which are strictly fixed to the outer circle. Each main stick is the size of: $l \times b \times c = 182 \times 10 \times 4{,}5$ cm.

The inner circle's diameter of the toono's top equals to 1/3 of the outer circle's diameter. The outer circle's diameter is 190±0,5 cm.

There are 4 additional sticks with three rings for each with diameter of 2 cm, through which are fixed to the inner circle and to the additional circle inside the outer circle.

Each additional stick has the size of; $l \times b \times c = 61 \times 10 \times 3$ cm (Fig-ure 3).

Research on gers used in the past and present: Table 1 shows the survey results made on the 8th Bogd Jebtsundamba's leopard skin ger, gers in Um-nugovi, Dornod, Khentii, Uvarkhangai provinces, gers in Ulaanbaatar and museum exhibits in order to establish how the Canon was inherited.

а) в)

Figure 3 - a) The Canon of the Saridag Monastery's toono; it's a graphic model; b) The Canon of the ger, it's graphic model made on the basis of Saridag Monastery's toono measurements and drawn by the method of Undur Gegeen's graphic model of ger (researcher's source)

The ratio M÷ m is set for each ger.

M - The distance (distance 1) between two adjacent unis' axes and the 2 points formed by the intersection of the wall head with the corresponding circumference (cylinder);

m - The distance (distance 2) between two adjacent unis' axes and two points formed by the intersection of the outer circle of the toono with the corresponding circle (cylinder);

We have determined the measurements of the ger using the data of the Saridag Monastery's toono in the following way:

Diameter of the toono d Saridag =190 cm;
Length of the toono's outer circle PSaridag =2r =596 cm.
Hence the base diameter of the ger is D Saridag= 760 cm and
the Length of the base circle is P Saridag =2R =2387,6 cm.

The Saridag's toono is quite large, so we have considered the Distance 1 of Saridag Monastery's ger m= Ptoono ÷ Nuni = 5,5 cm; however Undur Gegeen Zanabazar's Canon and B.Daajav's module the Distance 1 was determined as 4-6 cm.

NSaridag = PSaridag ÷ 5,5 cm 108
Number of unit of Saridag's ger:
NSaridag = 108
Distance 2 of Saridag's ger M:
M= PSaridag÷ NSaridag = 22 cm
Constant number of the ger's wooden structure is Mm = 4.

Table 1 - Measurement research to determine how the Canon is inherited

Location	*Owner*	*Date*	*The size of the ger*							
			Diameter of the ger	*Diameter of the toono)*	*Number othef uni \ (N uni)*	*Door width, heigh*	*Hiegh of the support (bagana)*	m Distance 1	M Distance 2	$\frac{M}{m}$
The ger with 4 walls										
Ulaanbaatar	*Bogd Khaan's Palace Museum*	*1893*	*4900 mm*	*1240 mm*	*88*	*1100 x 1240 mm*	*2250 mm*	*44 mm*	*175 mm*	***3.9***
Umnugobi province, Nomgon soum	*Dechin*	*Before 1940*	*3520 mm*	*880 mm*	*65, Length 1380 mm*	*1280 mm*	*1700 mm*	*42,5 mm*	*170 mm*	***4***
Dornod provinc, Matad soum	*Dolgoriin Dash*		*4950 mm*	*1180 mm*	*65, Length 1950*	*1040 mm*	*2100mm*	*57 mm*	*239, 1 mm*	***4,1***

The ger with 5 walls										
Khentee province, Umnudelger soum		*Before 1940*	*5640 mm*	*1270 mm*	*81, Length 2260 mm*	*1000 x 1340 mm*	*2560 mm*	*54,6 mm*	*218,6 mm*	***4,0***
Khentee province, Bayan-ovoo soum			*4600 mm*	*1108 mm*	*81, Length 1900 mm*	*1000 X 1220 mm*	*1970 mm*	*42,9 mm*	*178,3 mm*	***4,1***
The ger with 6 walls										
Ulaanbaatar	*"Tumen tsagaan ger"LLC*	*Since 2005*	*7300 mm*	*1820 mm*	*96*	*1800x 1200 mm*	*294 mm*	*59,5 mm*	*238,7 mm*	***4,0***
The ger with 7 walls										
Uvurkhangai province,Kharkhorin soum	*"Bat-Ulzii design" LLC*	*Since 2010*	*8500 mm*	*2120 mm*	*111*	*2125x 1400 mm*	*342 mm*	*59,9 mm*	*24 0,5 mm*	***4,0***

Conclusion

Given the time when the Saridag Monastery's khorol toono was created and could be used, there is every reason to believe that it had been created by the Undur Gegeen Zanabazar's Canon.

Based on the 19 details and parts of the khorol toono, a graphic model was created, and the dimensions and parameters could be determined. We have found that the ger created by Undur Gegeen's Canon is in line with the gers that have been developed to this day.

Using the Undur Gegeen's reconstructed graphic model of the toono, we have made the variation of the ger with this toono, its measurements and parameters.

We have established the constant number of the gers (the constant of the ger's wooden structure), created by the Undur Gegeen's Canon is equal to $n = M \div m = 4$. This number is considered to be a key factor in determining the size and parameters of the ger's wooden structures.

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