# The Influence of Ancient Indian Spatial Concepts on the Geometry of Kangju Architecture in Central Asia, Uzbekistan and Kazakhstan

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## Abstract

A number of unusual cross-shaped buildings exist in Central Asia. A significant number of these monuments is concentrated in the middle reaches of the Syr Darya River, within the territory of the present-day Uzbekistan and Kazakhstan. In historical scholarship, this region is traditionally identified with the ancient state of Kangju (Kang, Kangha). Their form is atypical of the architectural tradition of the region and reveals similarities with the ancient Indian mandalas. However, there is no clarity about these cross-shaped buildings. In this context, this article examines the cross-shaped buildings of Kangju, analysing them in the context of ancient cultural contacts between Central Asia and India. It ascertains the possible influence of ancient Indian spatial concepts of Vastu-vidya and the Śulba Sūtras on Kangju architecture.

The study employs a comparative-analytical method within a case study approach. The primary data were obtained through a review of relevant scholarly sources, field observations, and interviews. In addition, a geometric method was applied to identify the principles of geometric construction and proportional relationships of the investigated buildings.

Based on a geometric analysis of these structures, it is concluded that the architecture of Kangju is closely connected with ancient Indian architectural traditions. Construction of these buildings has involved a specific system of knowledge related to geometry and architecture. An anthropometric system of measurement, known from the ancient Indian texts, has been applied in the buildings under consideration. Special importance has been attached to the spatial orientation of the structures. These factors, together with the identified module, help conclude that the religious buildings in Kangju most likely relied on knowledge derived from the ancient Indian treatises on geometry, such as Vastu-vidya and the Śulba Sūtras.

**Keywords:** Kangju, Uzbekistan, Kazakhstan, cross-shaped buildings, ancient Indian treatises, mandala.

## Introduction

Unusual cross-shaped buildings have been discovered at various times in Central Asia. They are located in the territory of Uzbekistan and southern Kazakhstan and are dated by researchers to the ancient and early medieval periods. Such sites as Shashtepa and Mingurik are situated within the Tashkent oasis. Setalak 1 is located in the Bukhara oasis. In the Fergana Valley, Bilovurtepa, Ark-tepe, and Tepe 5 have been identified. In southern Kazakhstan, monuments such as Ak-tobe 2, Chol-tobe, Kzyl-Kainar-tobe, and Kultobe have been discovered. However, there is also an area beyond Central Asia where cross-shaped buildings are found—Shahr-i Qumis in Iran, identified with the ancient city of Hecatompylos.

From the 4th century BCE to the 4th century CE, the state of Kangju (Kang, Kangha) existed in this territory. Researchers associate the cross-shaped buildings of the middle reaches of the Syr Darya River with the state of Kangju (Smagulov & Yerzhigitova, 2017; Filanovich, 2010; Bogomolov & Ilyasova, 2010; Torgoev, Kulish & Torezhanova, 2020). Kangju is known from Chinese sources. The Avesta mentions the country of Kangha (Kang), which is also identified with Kangju (Filanovich, 2010).

Some scholars have proposed hypotheses regarding connections between the state of Kangju and ancient India. For example, Suleimanov (2004) argues that historical and cultural ties existed in antiquity between the Syr Darya basin and Northern India. In turn, the ancient Indian epic Mahabharata mentions the Kanka people (Ancient Authors on Central Asia, 1940).

A major challenge for scholars has been determining the function and origin of the unusual cross-shaped buildings of Kangju. The question of their function was addressed in another work by the author, which concluded that these were religious structures (Nurulin, 2025). The present study focuses on the problem of the origin of the cross-shaped buildings of Kangju. The unusual layout of these structures for the architectural tradition of Central Asia suggests the presence of external cultural influence. This study is the first to develop a theory concerning the influence of ancient Indian architecture on the architecture of Kangju.

The aim of this study is to determine the origin of the cross-shaped buildings of Kangju and to substantiate their connection with ancient Indian spatial concepts.

The objectives of the study are as follows.

- To conduct a geometric analysis of the cross-shaped buildings of Kangju;
- To identify a unified module common to all cross-shaped buildings of Kangju;
- To compare Kangju architecture with the principles of constructing religious buildings described in the ancient Indian treatises Vastu-vidya and the Śulba Sūtras.

## Theoretical Framework

This study examines several theoretical concepts, such as “vernacular architecture”, as well as “mandala-shaped buildings”, “cosmograms”, and “cross-shaped buildings” of Kangju in the context of “ancient Indian spatial concepts” of “geometry”, which are grounded in the “historical connections” between Ancient India and Kangju. The theoretical framework of the study is based on a discussion of previous scholarly works addressing the problem of the origin of Kangju architecture. At the core of these concepts lies the importance of understanding the genesis and formation of the architecture of Kangju and Central Asia as a whole.

## Ancient Indian Spatial Concepts: Vastu-vidya and the Śulba Sūtras

In India, texts related to geometry and architecture have been known since ancient times. They emerged during the Vedic period, approximately between 1500 and 1000 BCE (Vibhuti Chakrabarti, 1998). Such treatises include Vastu-vidya, the Śulba Sūtras, and the Gṛihya Sūtras.

According to Chakrabarti (1998), Vastu-vidya, or ancient Indian knowledge of architecture, is first mentioned in the Rigveda and continues to exist in the works of architects and restorers. Vastu-vidya of the 6th century BCE to the 6th century CE has survived in the form of fragments that were incorporated into later versions of this body of knowledge (Chakrabarti, 1998). The treatise Vastu-shastra is considered part of this tradition. This Hindu system of architectural planning is mentioned in the Vedas and the Mahabharata. Vastu-vidya

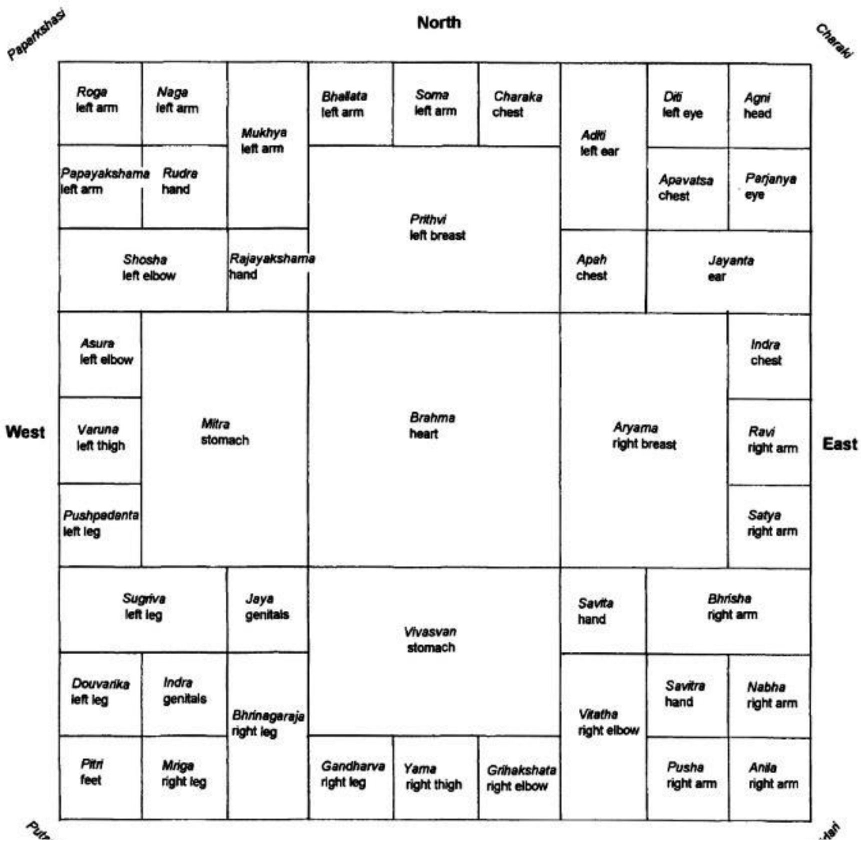


**Fig. 1:** Paramasaayika Mandala
Source: Chakrabarti, 1998

or Vastu-shastra is associated with the construction of dwellings and temples, and the texts consistently describe the construction process (Chakrabarti, 1998).

Ancient Indian Brahmana texts of the 8th–5th centuries BCE, as well as the Śulba Sūtras and Gṛihya Sūtras of the 5th century BCE, address issues related to the construction of temples and sacrificial altars (Bulatov, 2009). According to Price (2001), the Śulba Sūtras are part of Vedic literature in which numerous geometric properties and constructions are described. The Śulba Sūtras discuss the construction of platforms and altars of various shapes. The simplest of these are square, while more complex forms include those shaped like a falcon, a chariot wheel, or a tortoise (Price, 2001).

## Cross-shaped Buildings or Mandala-shaped Structures of Kangju

The term cross-shaped buildings in the context of Kangju architecture is used in the works of many scholars (Filanovich, 2010; Suleimanov, 2000; Khasanov, 2004; Ternovaya, 2008; Baipakov, 2010; Smagulov & Yerzhigitova, 2017; Torgoev, Kulish, & Torezhanova, 2020; Nurulin, 2025).

Alongside the term cross-shaped buildings, this study introduces the definition mandala-shaped structures. According to the Great Russian Encyclopedia, the word mandala is translated from Sanskrit as “circle” and represents a symbolic diagram of the universe. According to Chakrabarti (1998), the Vastu Purusha Mandala is a grid that facilitates the generation of the design of a future building (Fig. 1 & 2).

In scholarly works devoted to the architecture of cross-shaped buildings in Central Asia, the terms mandala and cosmogram are used interchangeably. According to the architect Gurevich (1985), the plan of Shashtepa is associated with a proto-Indian cosmogram. Bulatov (2009) examines this monument from the perspective of ancient Indian canons of altar and temple construction described in the Brahmana texts (8th–5th centuries BCE), the Śulba Sūtras, and the Gṛihya Sūtras (5th century BCE). According to Filanovich (2010), circular layouts with a cross or a square can be regarded as cosmograms. Nurulin (2012) suggests that the layout of Shashtepa is connected with a mandala. According to Nazilov (2022), cosmogonic concepts are embedded in the layouts of these structures.

**Module**

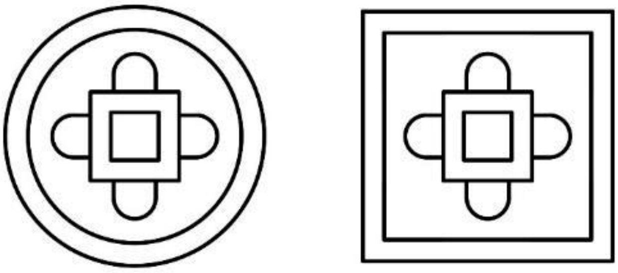

**Fig. 2:** Schematic representations of ancient Eastern mandalas
Source: Author

According to Nurulin (2013), the central squares of Shashtepa and Mingurik are dimensionally related. The author identifies a module applicable to both structures. When a grid consisting of 4×4 cells is superimposed on the square of Shashtepa, the size of one cell is calculated as 5.32 m. This dimension fits three times along the side of the square of the Mingurik building. Thus, it was revealed that Mingurik was constructed according to a 3×3 grid. It should be noted that at this stage the research results had not yet been compared with ancient Indian spatial concepts.

## Anthropometric Measurement System in Vastu-vidya

Ancient Indian treatises on geometry describe a system of units of measurement based on anthropometry. According to Vibhuti Chakrabarti (1998), in the anthropometric measurement system of Vastu-vidya, the smallest unit is equal to the phalanx of the middle finger, approximately 1.9 cm, and is called angula. The next unit of measurement is vitasti, which equals 12 angulas. Two vitastis equal a cubit called hasta. Four hastas form a danda (rod), approximately 1.8 m in length, which clearly corresponds to human height. According to Bulatov (2009), this same unit is equal to vyama – the "square of celestial fire" – which also corresponds to human height. According to Price (2001), the Śulba Sūtras use the units angula and purusha. Angula equals 1.9 cm, while purusha is approximately 228 cm, corresponding to the height of a person with arms raised upward.

## Vastu Purusha Mandala

According to Vibhuti Chakrabarti (1998), special Vastu Purusha Mandalas are used in Vastu-vidya for the construction of temples, dwellings, and cities. These mandalas are grids composed of squares arranged as 1×1, 2×2, 3×3, and so on. The Vastu Purusha Mandala is superimposed onto the selected site after determining the orientation of the structure. This mandala symbolizes the cosmic being Purusha. The center of the mandala is usually left open, as it is occupied by Brahma.

According to Vibhuti Chakrabarti (1998), the simplest mandala is sakalla, consisting of a single square and symbolizing the four cardinal directions. The pechaka mandala consists of four squares arranged in a 2×2 grid and was used for domestic worship and other public buildings. The pitha mandala comprises nine squares arranged in a 3×3 grid. It symbolizes the four cardinal directions and divine governance and is used in temples to organize sanctuaries, halls, and circumambulatory galleries. The mahapitha mandala consists of sixteen squares arranged in a 4×4 grid, with Brahma occupying the central position and other deities placed along the perimeter. The upapitha mandala is composed of twenty-five squares arranged in a

5×5 grid. The ugrapitha mandala consists of thirty-six squares arranged in a 6×6 grid. The sthandila mandala comprises forty-nine squares arranged in a 7×7 grid. The manduka mandala (8×8, 64 squares) and the paramashaika mandala (9×9, 81 squares) are used for dwellings and temples, respectively (Fig. 3).

## Geometric Problem of Square Construction in the Śulba Sūtras

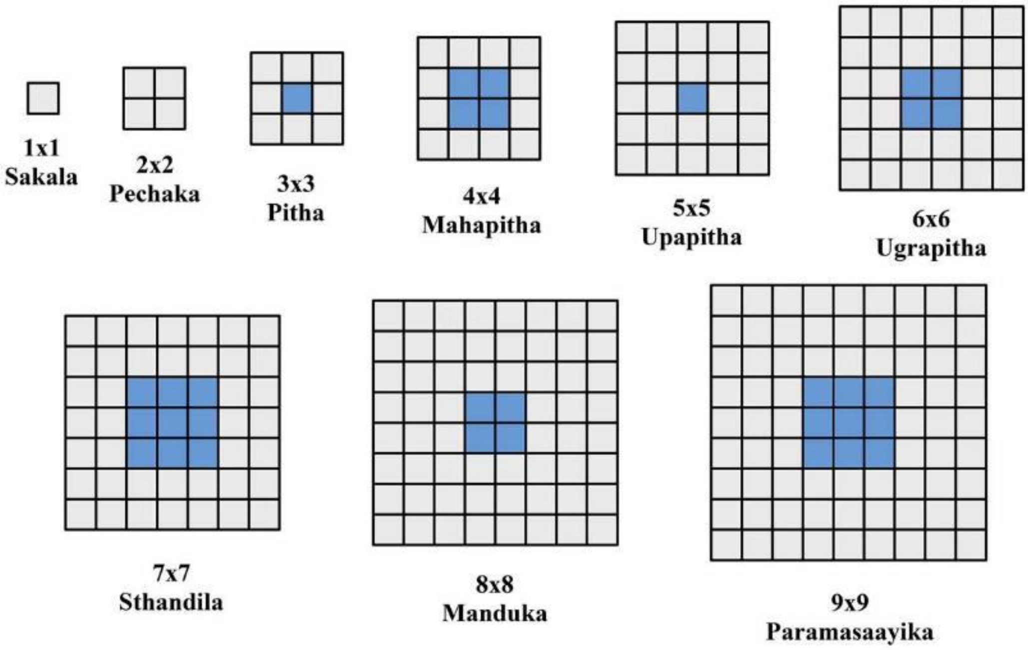


**Fig. 3:** Vastu Purusha mandalas
Source: Author's compilation based on an image by Jusbir Mundi

According to Price (2001), in the Śulba Sūtras, the construction of geometric forms begins with drawing an east–west line, which serves as an axis of symmetry. The construction of a square starts from a point located on this east–west line. A circle is then drawn with this point as its center. The intersection of the line and the resulting circle produces two new points. Connecting these points forms a north–south line perpendicular to the east–west line. Thus, four points appear on the circle, which serve as the centers of future circles. Next, four circles are drawn with radii equal to that of the original circle, with their centers located on the circumference of the central circle. As a result, a four-petaled cross is formed. The intersections of these circles create four points, the connection of which forms a square (Fig. 4).

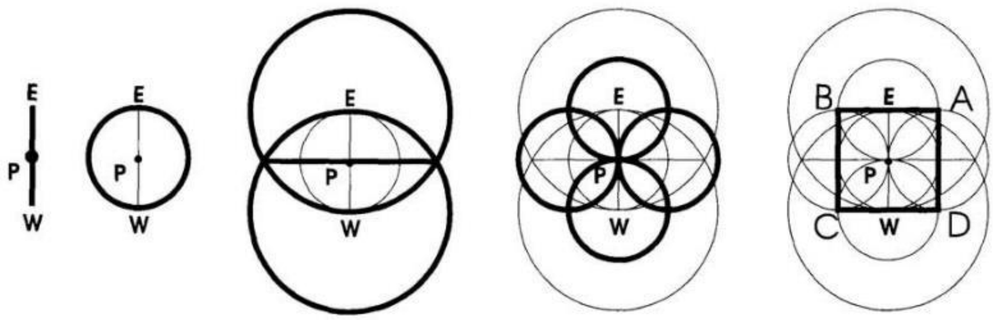


**Fig. 4:** Square construction in the Śulba Sūtras
Source: Price, 2001

## Review of Literature

The problem of the influence of ancient Indian spatial concepts on the geometry of Kangju architecture in Central Asia, with the development of a theoretical framework, is in fact being posed for the first time in this study. However, various researchers have addressed individual aspects of this issue. Let us consider the main studies related to this topic.

Akishev (1984), in his study of the culture and art of the Saka tribes of Central Asia, identifies a connection between the Avestan tradition and Vedic culture. Highlighting the cosmological aspects of the worldview of the peoples of Central Asia, the scholar attaches particular importance to the sacred geometry of works of art and architecture, as well as to their spatial orientation. According to the architect Gurevich (1985), the plan of Shashtepa is associated with a proto-Indian cosmogram. This conclusion is based on the similarity between the composition of the monument (a square within a circle) and a mandala. One of the leading theorists of Central Asian architecture, Bulatov (2009), is the author of the concept of geometric harmonization of Central Asian architecture. In his research, the author examines the Shashtepa monument from the perspective of ancient Indian canons of altar and temple construction described in the Brahmana texts (8th–5th centuries BCE), the Śulba Sūtras, and the Gṛihya Sūtras (5th century BCE). However, this position is not supported by a developed theoretical and evidential framework.

Suleimanov (2004) argues that early medieval cross-shaped buildings embody a cosmogram model. Ternovaya (2008) presents arguments in favor of linking cross-shaped buildings with cosmograms. According to Filanovich (2010), circular layouts with a cross or a square can be regarded as cosmograms. It is likely that the scholar, in reaching this conclusion, relies on the external similarity between the cross-shaped buildings of the Tashkent oasis and mandalas. Nurulin (2012) suggests that the layout of Shashtepa is connected with a mandala. Later, Nurulin (2013) points to the identified module of 5.32 m common to the two monuments, Shashtepa and Mingurik. However, its origin and significance remained unclear at that time. According to Nazilov (2022), cosmogonic concepts are embedded in the layouts of cross-shaped buildings. Here, the scholar's fundamental position is clearly visible, according to which the construction of any buildings in antiquity involved the principle of architectural sacralization.

However, not all authors interpret the layout of Kangju cross-shaped buildings as a cosmogram. For example, Baipakov (2010) associates these structures with a solar symbol. Filanovich (2010) uses the terms solar layouts and cosmograms interchangeably. At the same time, some scholars either do not address this topic at all (Smagulov & Yerzhigitova, 2017) or completely reject the symbolism of the layouts of Kangju cross-shaped buildings (Torgoev, Kulish, & Torezhanova, 2020).

A review of the main viewpoints on this issue shows that most researchers perceive a certain symbolism in the layouts of cross-shaped buildings, based on a cosmological model. Relying on the unusual layouts of individual monuments, scholars associate them with cosmograms or mandalas. However, such assertions are most often based on external similarity and are not supported by a solid theoretical or evidential foundation.

## Research Methodology

This study employs the case study method, which makes it possible to examine specific cross-shaped monuments of Kangju as representative examples and to investigate the principles of their spatial layout and geometric organization. This method facilitates an in-depth analysis of Kangju architecture, which is essential for understanding its origins. Within the case study framework, a comparative-analytical method is applied to analyze Kangju architecture and to establish its connection with ancient Indian treatises on geometry. The data collection methods used include the following.

- Case study,
- Comparative-analytical method,
- Literature review,
- Observations,

- Interviews,
- Geometric method.

To obtain data, various theoretical research methods were applied. The literature review covered previous studies, archaeological reports, monographs, and journal articles. Sources related to the history and theory of Central Asian architecture, as well as ancient Indian treatises on geometry, were primarily identified through the electronic resource Academia.edu and the author's personal library. During the research, numerous sources were identified that address the problem of the origin of Kangju architecture, as well as issues related to the geometry of ancient Indian architecture.

In addition, an interview was conducted with the respected local archaeologist Margarita Filanovich. This scholar was selected because she headed the Tashkent Archaeological Expedition for many years and directly studied the Tashkent monuments examined in this research. The interview was conducted in person.

The geometric method was also applied to identify the principles of geometric construction and proportional relationships in the plans of Kangju cross-shaped buildings. Together, these methods provide a more comprehensive understanding of the problem of the origin of Kangju architecture.

The methods employed create a solid foundation for researchers interested in Kangju architecture and the problem of its origins.

## Case Studies


**Fig. 5:** Kangju and India
Source: Author's compilation based on Google Earth

In historical retrospect, the region of Central Asia in the middle reaches of the Syr Darya River, where the majority of cross-shaped buildings have been identified, is associated with the ancient state of Kangju (Kang, Kangha), which existed from the 4th century BCE to the 4th century CE. The unique cross-shaped form of these buildings makes it possible to unite them into a single typology. This circumstance allows researchers to associate cross-shaped buildings with the state of Kangju (Smagulov & Yerzhigitova, 2017; Filanovich, 2010; Bogomolov & Ilyasova, 2010; Torgoev, Kulish, & Torezhanova, 2020). The name Kangju is known from

Chinese sources. In the Avestan tradition, this country was called Kangha (Kang) and was first identified by Bartold with the middle reaches of the Syr Darya River (Filanovich, 2010).

In the context of this study, the observations of certain scholars regarding connections between the state of Kangju and the Indian subcontinent are of particular interest. During the Classical and early medieval periods, contacts were established between Central Asia and northwestern India. This is confirmed by archaeological evidence: Buddhist monasteries, temples, and stupas have been discovered in southern Central Asia (Bulatov, 2009). By comparing the toponym Kang, associated with the middle reaches of the Syr Darya, with the Indian Ganges, Suleimanov concludes that historical and cultural connections existed in antiquity between the Syr Darya basin and Northern India (Suleimanov, 2004). It is also known that in ancient India there was a people called the Kanka. In the ancient Indian epic Mahabharata, the great sacrificial ritual ashvamedha is described, in honor of which offerings were made by the Saka, the Tokharians, and the Kanka (Ancient Authors on Central Asia, 1940) (Fig. 5).

In Central Asia, ancient and early medieval cross-shaped buildings are mainly concentrated within the territories of present-day Uzbekistan and Kazakhstan (Fig. 6, 7).


**Fig. 6:** Cross-shaped buildings of Kangju
Source: Author's compilation based on Google Earth

## Tashkent Oasis

Shashtepa, dated to the 2nd century BCE, and Mingurik, dated to the 1st century CE (Filanovich, 2010), are located within the modern city of Tashkent. Shashtepa is a circular building in plan with an inscribed central square volume. Four rectangular towers are attached to the central square. Mingurik is a square structure with semicircular towers attached to its sides.

## Bukhara Oasis

Setalak 1, dated to the 3rd–4th centuries CE (Suleimanov, 1983), is located in the Bukhara oasis. The building is a square structure with semicircular towers along its sides. The cross-shaped structure is located within an outer square.

## Fergana Valley

Bilovurtepa, dated to the 1st–2nd centuries CE (Zadneprovsky, 1985), Ark-tepe, dated to the 2nd–3rd centuries CE (Gorbunova, 1994), and Tepe 5 (Gorbunova, 1985) are located in the Fergana Valley. Bilovurtepa has a circular form with an inscribed cross-shaped building. Ark-tepe is represented by a cross-shaped structure with a stepped configuration. Tepe 5 is a square structure in plan with semicircular towers attached to its sides. The corners of the central square of Tepe 5 are also articulated by semicircular towers.

## Southern Kazakhstan

Ak-tobe 2, dated to the 1st–4th centuries CE (Maksimova, 1968), Chol-tobe and Kzyl-Kainar-tobe, dated to the 1st–4th centuries CE (Mershchiev, 1970), and Kultobe, dated to the 1st–3rd centuries CE (Smagulov & Yerzhigitova, 2017), are located in southern Kazakhstan. Ak-tobe 2 is a cross-shaped structure enclosed by an outer oval wall. Chol-tobe and Kzyl-Kainar-tobe have the form of a four-petaled cross enclosed by a rectangular wall. The Kultobe structure is also represented in the form of a four-petaled cross.

## Iran

Shahr-i Qumis is located outside Central Asia. This monument is situated in Iran and is dated to the 1st century BCE (Hansman & Stronach, 1974). This area is identified by scholars with the ancient city of Hecatompylos. Shahr-i Qumis has a circular form with an inscribed square and rectangular towers attached to its sides.

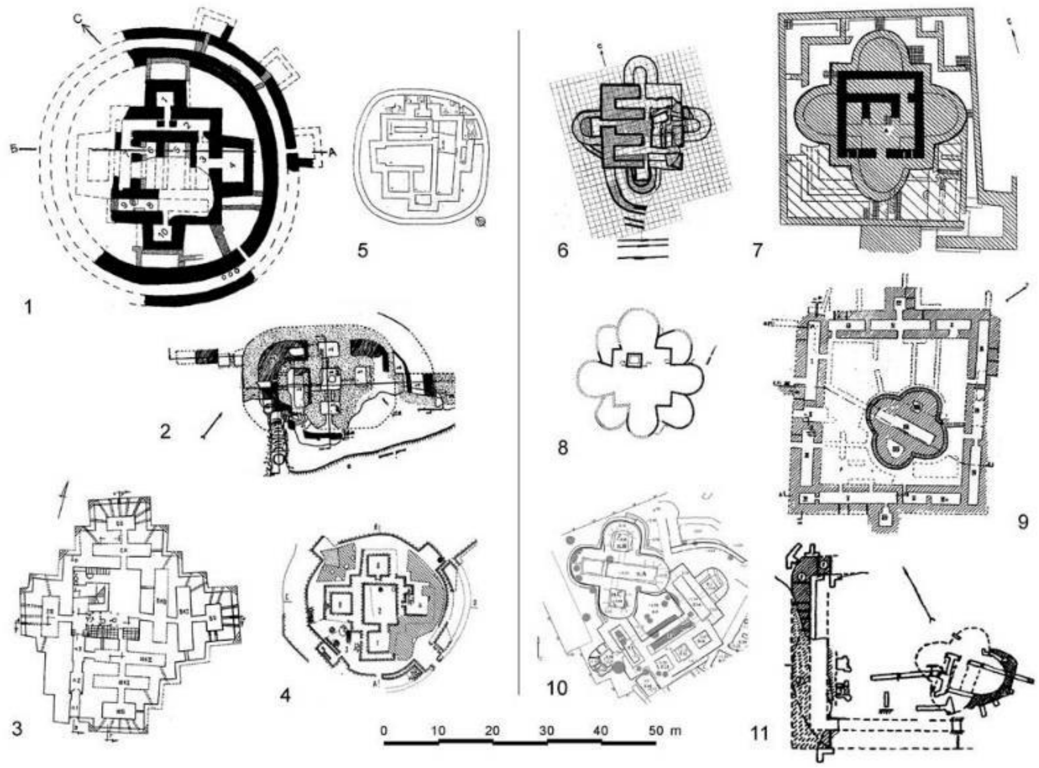


**Fig. 7:** Typology of cross-shaped buildings:
1. Shashtepa. Source: Filanovich, 2010; 2. Ak-Tobe 2. Source: Maksimova, 1968; 3. Ark-Tepe. Source: Gorbunova, 1994; 4. Bilovurtepe. Source: Zadneprovskiy, 1985; 5. Shahr-i Kumis. Source: Stronach, 1973; 6. Mingurik. Source: Filanovich, 2010; 7. Setalak 1. Source: Suleimanov, 1983; 8. Tepe 5. Source: Gorbunova, 1985; 9. Chol-Tobe. Source: Mershchiev, 1970; 10. Kul-Tobe. Source: Smagulov, 2017; 11. Kzyl-Kainar-Tobe. Source: Mershchiev, 1970

## Findings

The central problem of this study concerns the origin of the cross-shaped buildings of Kangju. The layout of these structures, which is uncharacteristic of the architectural tradition of Central Asia and resembles ancient Indian mandalas, suggests the presence of external cultural influence. In this regard, Kangju architecture is examined in the context of ancient Indian spatial concepts.

## Application of Ancient Indian Spatial Concepts to the Geometry of Kangju Architecture: Vastu-vidya and the Śulba Sūtras

A study of the cross-shaped buildings of Kangju demonstrates that particular attention was paid to their planning and construction. If their cultic character is taken into account (Nurulin, 2025), the use of specialized knowledge of geometry and astronomy in their construction becomes understandable. In particular, the orientation of the towers of the Shashtepa monument, directed toward the sunrise and moonrise on specific days, may indicate the application of astronomical knowledge (Nurulin, 2016). Special attention was also paid to the orientation of cross-shaped buildings relative to the cardinal directions. Careful preparation of the construction sites for these cross-shaped structures is also known (Filanovich, 2010). All these principles of constructing ancient Kangju cross-shaped buildings clearly find parallels in the ancient Indian tradition of erecting religious and civic structures.

In the ancient Indian tradition of Vastu-vidya, the construction of cities, religious buildings, and dwellings was a highly significant process requiring deep knowledge of mathematics, geography, geology, and astronomy. Construction began with the selection of a site based on natural and climatic conditions, as well as testing the soil for density. Astronomical calculations related to the position of the sun were also carried out (Vibhuti Chakrabarti, 1998). Each stage of construction was overseen by a specific specialist. All construction processes were directed by the Sthapati, the chief architect. Measurements were carried out by the surveyor Sutragrahin, whose main tools were a rope and a rod—a special staff approximately equal to human height. The main construction work was performed by the carpenter Takshaka, a master skilled in working with various materials such as wood, stone, and clay. Finishing work was carried out by another specialist, the Vardhaki. These craftsmen were associated with the four faces of the creator god Brahma (Vibhuti Chakrabarti, 1998).

In this context, Kangju architecture is examined from the perspective of the application of ancient Indian spatial concepts.

## Application of the Mandala Concept to the Cross-shaped Buildings of Kangju

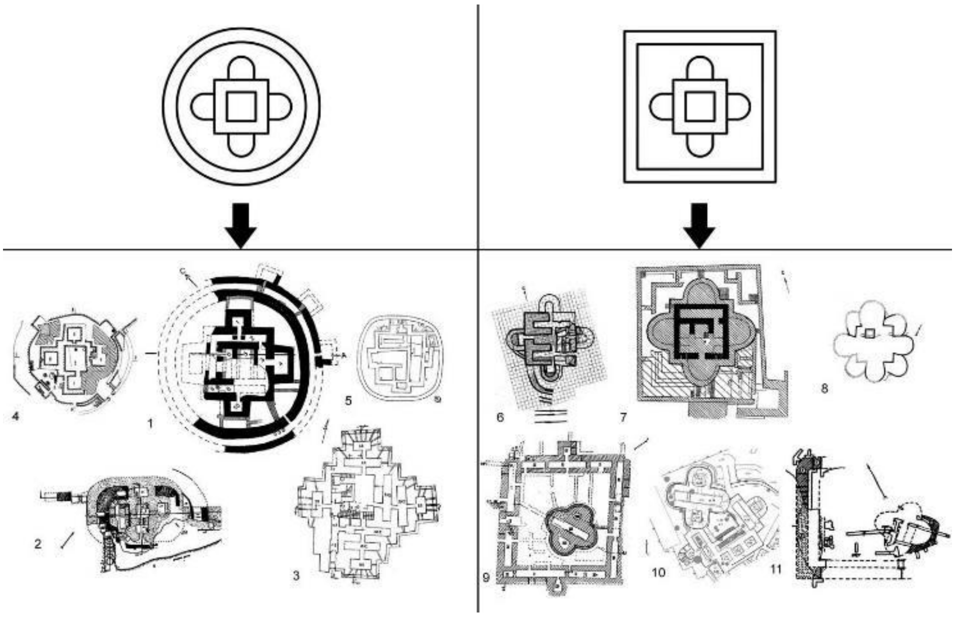

**Fig. 8:** Comparison of two types of mandalas with Kangju architecture:
1. Shashtepa; 2. Ak-Tobe 2; 3. Ark-Tepe; 4. Bilovurtepe; 5. Shahr-i Kumis; 6. Mingurik; 7. Setalak 1; 8. Tepe 5; 9. Chol-Tobe; 10. Kul-Tobe; 11. Kzyl-Kainar-Tobe
Source: Author

In scholarly discourse, the term cross-shaped buildings has become firmly established with regard to Kangju architecture. However, it is evident that these structures should more accurately be described as mandala-shaped structures. Their plans are based on various combinations of the circle and the square. Such layouts developed over several millennia within Indo-Iranian cultural contexts and reached a complete form in Buddhist stupas and temples, as well as in the temples and architectural-sculptural structures of Kangju (Nurulin, 2025). Researchers have long noted that, for example, the plan of Shashtepa is based on a mandala (Gurevich, 1985; Bulatov, 2009; Filanovich, 2010; Nurulin, 2012; Nazilov, 2022).

In Buddhism and Hinduism, mandalas are known in the form of specific compositions based on the combination of a circle and a square. The most widespread type is a mandala consisting of a double circle with an inscribed square, with rectangular or semicircular towers attached to its sides. This type of mandala is precisely replicated by the religious buildings of Shashtepa, Ak-tobe 2, Bilovurtepa, and Shahr-i Qumis. Ark-tepe can also be attributed to this type, although it is not enclosed by an outer circle.

Another type of mandala consists of a square with semicircular towers attached to its sides and enclosed by an outer square. Religious structures such as Mingurik, Setalak 1, and Tepe 5 were built according to this model. Somewhat different in form are the religious architectural-sculptural structures of Kultobe, Chol-tobe, and Kzyl-Kainar-tobe. In plan, these monuments take the form of a four-petaled rosette inscribed within a square. However, they are derivatives of buildings of the Mingurik type (Fig. 8).

## Application of the Module to the Cross-shaped Buildings of Kangju

The module previously identified for the monuments of Shashtepa (4×4) and Mingurik (3×3), equal to 5.32 m (Nurulin, 2013), is also applicable to other cross-shaped buildings of Kangju (Fig. 9, 10 & 11).

- **4×4.** Shashtepa was constructed according to a 4×4 grid. In the Ark-tepe building, the use of the 5.32 m module is evident throughout the structure. The central square is built on a 4×4 grid, while each of the stepped towers attached to the sides of the square corresponds to three and two grid cells, respectively.
- **3×3.** Mingurik was built on a 3×3 grid. The central square of Setalak 1, using the same 5.32 m module, is also composed of a 3×3 grid. The central square of Shahr-i Qumis is likewise constructed on a 3×3 grid.
- **2×2.** Bilovurtepa and Tepe 5 were built on a 2×2 grid. It has been established that the four-petaled rosettes of Chol-tobe and Kultobe are based on a 2×2 square oriented diagonally relative to the rosette. This square forms the compositional basis, fixing the four corner points of the structures. It is evident that further construction of the circles completing the composition proceeded from these points. It should also be noted that the annex attached to the cross-shaped building of Kultobe was likewise constructed using the same module. The rectangle of this annex corresponds to a 4×2 grid, and its tower-like projection fits within three consecutive grid cells.
- **7×7.** The entire Setalak 1 complex, enclosed by a square wall, fits within a 7×7 grid. During the study, it was established that the courtyard of the Chol-tobe complex fits within a 5×5 grid, while the width of the double wall enclosing the entire complex equals one grid cell measuring 5.32 m. This means that the entire Chol-tobe complex was constructed according to a 7×7 grid.

## Application of the Ancient Indian Anthropometric Measurement System to Kangju Architecture

Considering the anthropometric units of measurement known from the ancient Indian treatises Vastu-vidya and the Śulba Sūtras—angula (finger) (1.9 cm), vitasti (12 angulas), hasta (cubit) (2 vitastis), and danda (rod) (4 hastas) (Vibhuti Chakrabarti, 1998)—the identified module of 5.32 m can be converted into the ancient Indian anthropometric system.

If 1 angula equals 1.9 cm, then 5.32 m corresponds to 280 angulas, or 12 hastas (cubits). It is likely that a larger unit, the danda (rod), approximately 1.8 m in length and corresponding to human height, was used in the cross-shaped buildings of Kangju. This means that the 5.32 m module equals three dandas.

Based on the above, it becomes clear that in the construction of cross-shaped buildings—particularly the religious structures of Shashtepa, Mingurik, Setalak 1, Ark-tepe, Chol-tobe, and others—a special object in the form of a rod (danda) was used. In laying out the territory into grid cells, an enlarged module equal to three dandas was applied.

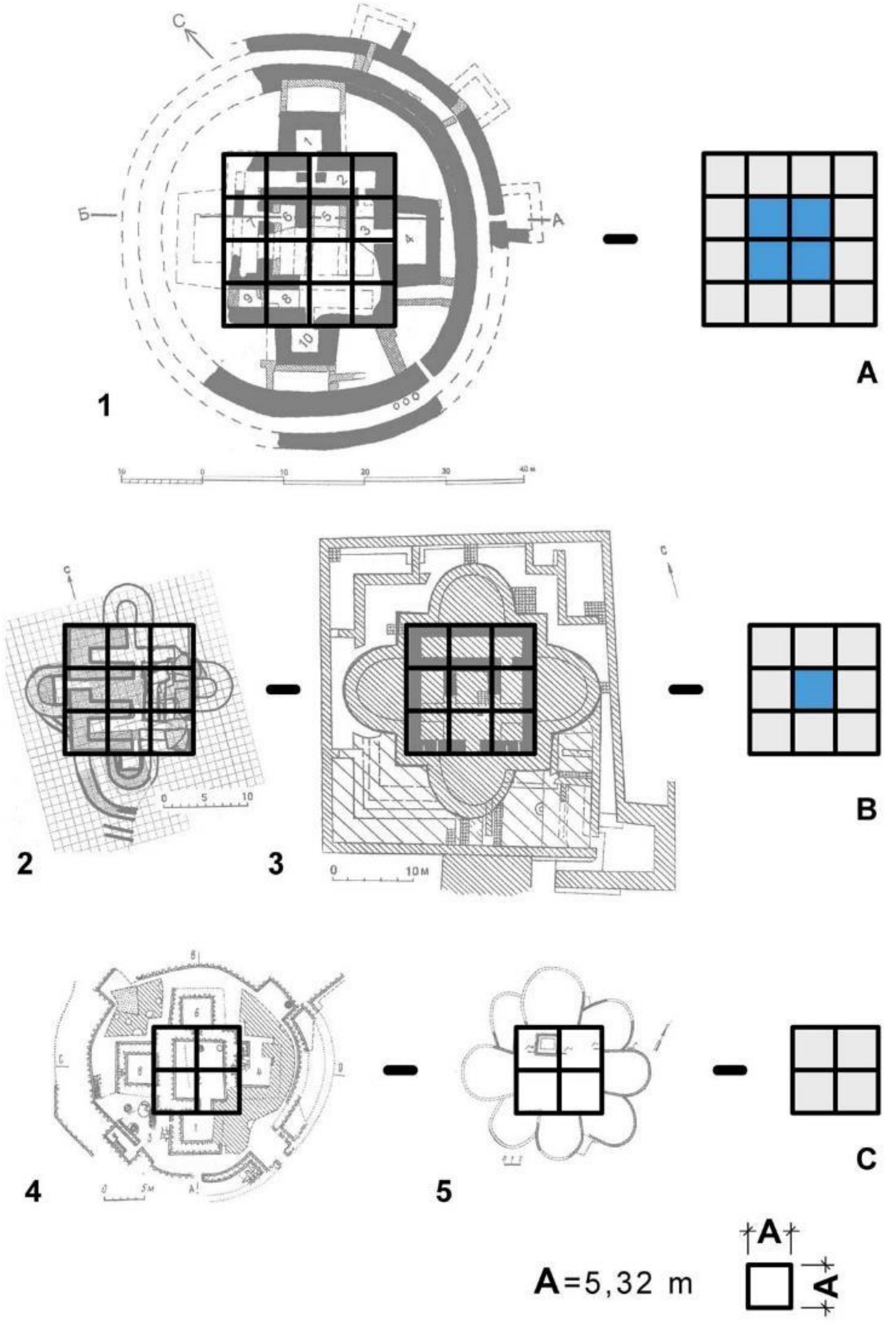


**Fig. 9:** Geometric analysis of Kangju buildings. Modular grid with a cell size of 5.32 m: (A) Mahapitha mandala: 1. Shashtepa; (B) Pitha mandala: 2. Mingurik, 3. Setalak 1; (C) Pechaka mandala: 4. Bilovurtepe, 5. Tepe 5
Source: Author

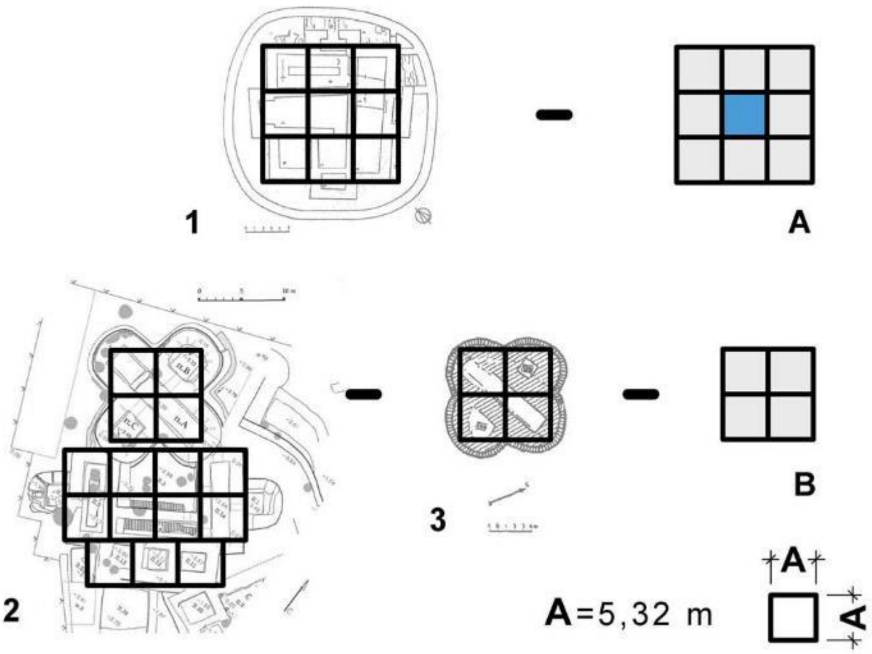


**Fig. 10:** Geometric analysis of Kangju buildings. Modular grid with a cell size of 5.32 m:
1. Shahr-i Kumis and the Pitha mandala; 2. Kultobe and the Pechaka mandala; 3. Chol-Tobe and the Pechaka mandala
Source: Author

## Application of the Vastu Purusha Mandala Concept to the Geometry of Kangju Architecture

An analysis of the geometric structure of Kangju cross-shaped buildings shows that their spatial organization corresponds to various types of Vastu Purusha Mandalas described in the ancient Indian tradition of constructing religious and civic buildings. The application of a modular grid makes it possible to identify several stable schemes corresponding to specific types of mandalas (Fig. 9, 10, 11).

- **Mahapitha Mandala (4×4).** The central building of Shashtepa is a square that fits within a 4×4 grid, comprising 16 padas. This corresponds to the mahapitha mandala. The central square of Ark-tepe was constructed according to the same principle, also based on a 4×4 grid of 16 padas. This indicates that Ark-tepe was built on the basis of the mahapitha mandala.
- **Pitha Mandala (3×3).** Mingurik was built as a square with a 3×3 grid consisting of 9 padas, corresponding to the pitha mandala. The central square structure of Setalak 1 is also built on a 3×3 grid of 9 padas. As in the Mingurik building, the pitha mandala underlies the layout of Setalak 1. Shahr-i Qumis likewise consists of square cells arranged in a 3×3 grid, which also corresponds to the pitha mandala.
- **Pechaka Mandala (2×2).** Bilovurtepa, based on a square structure, is divided into a 2×2 grid consisting of four cells. These four squares form the pechaka mandala. The central square of Tepe 5, composed of a 2×2 grid, was also built on the basis of the pechaka mandala. The cross-shaped plan of Kultobe likewise incorporates a 2×2 square at its core, corresponding to the pechaka mandala. The four-petaled building of Chol-tobe, which is based on a 2×2 square, was constructed according to the same pechaka mandala principle.
- **Sthandila Mandala (7×7).** As noted above, the central square building of Setalak 1 is based on the pitha mandala. Petal-like towers are attached to this square, forming a cross-shaped composition, which is enclosed by a square wall. Applying the same module to the remaining parts of the structure results in a 7×7 grid. This corresponds

to the sthandila mandala. Similarly, the four-petaled monument of Chol-tobe, based on the pechaka mandala, is enclosed by a double square wall forming a courtyard. The square courtyard fits within a 5×5 grid, while the entire structure forms a 7×7 grid, corresponding to the sthandila mandala.

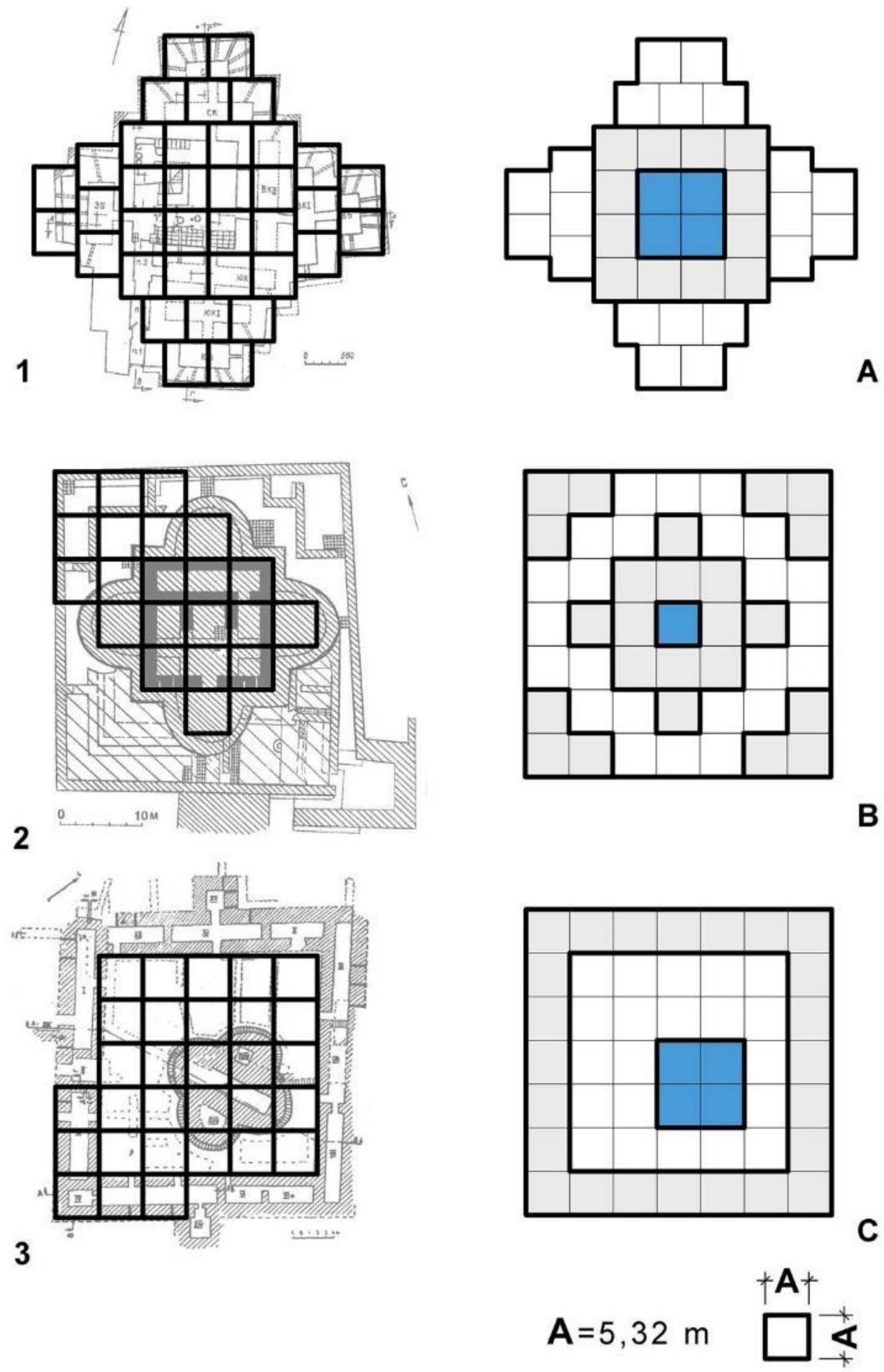


**Fig. 11:** Geometric analysis of Kangju buildings. Modular grid with a cell size of 5.32 m: 1A. Ark-Tepe and the Mahapitha mandala; 2B. Setalak 1 and the Sthandila mandala; 3C. Chol-Tobe and the Sthandila mandala.
Source: Author

## Application of the Geometric Problem of Square Construction from the Śulba Sūtras to the Four-petaled Structures of Kangju

The Chol-tobe structure has an unusual form: in plan, it appears as a four-petaled rosette. A geometric analysis of the plan of Chol-tobe shows that a central square forms the basis of this composition. By drawing circles with centers on the sides of this square and diameters equal to the side of the square, a four-petaled cross is obtained. The same principle underlies the construction of another monument, Kzyl-Kainar-tobe, which also has the form of a four-petaled rosette. This seemingly simple form conceals an elegant solution to a geometric problem that requires specific knowledge of geometry. The plans of Chol-tobe and Kzyl-Kainar-tobe display a construction similar to the geometric problem described in the Śulba Sūtras for constructing a square with respect to the cardinal directions (Fig. 12).

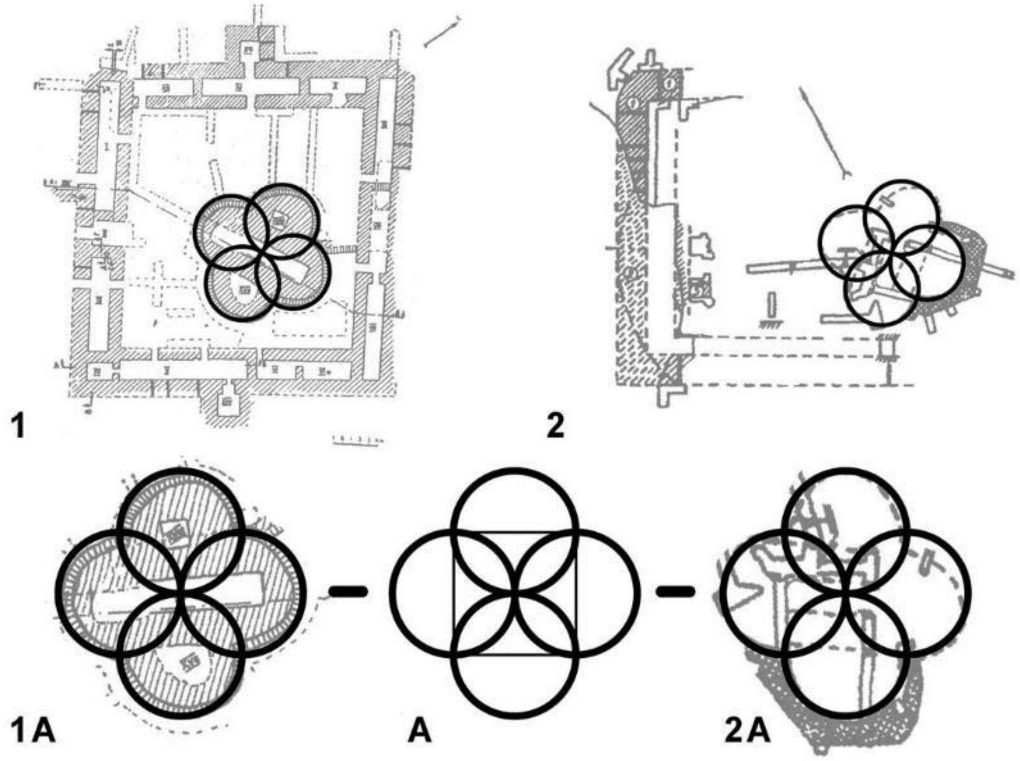


**Fig. 12:** Geometric analysis of Kangju buildings. Four-petaled structures of Kangju and square construction according to the Śulba Sūtras:
Chol-Tobe; 2. Kzyl-Kainar-Tobe.
Source: Author

## Application of the Principle of Orientation in Vastu-vidya to Kangju Architecture

A study of the cross-shaped layouts of Kangju shows that particular importance was attached to the orientation of these structures relative to the cardinal directions. Of the ten monuments examined, half are oriented with their corners aligned to the cardinal directions, while the other half are oriented with their sides aligned to the cardinal directions. It should be noted that not all monuments are oriented strictly according to the cardinal directions; some exhibit slight deviations from the north–south axis (Table 1).

- **Orientation by corners to the cardinal directions.** The central square structure of Shashtepa, surrounded by a double ring wall, is oriented strictly by its corners toward the cardinal directions. Accordingly, the towers attached to the sides of this square are oriented toward the northeast, northwest, southeast, and southwest. Ak-tobe 2 exhibits the same corner-based orientation. Moreover, this monument inherited the structural scheme of Shashtepa, with a central square, towers on its sides, and a surrounding ring wall (in a modified form). Shahr-i Qumis has a plan similar to that of Shashtepa and is likewise oriented strictly by its corners to the cardinal directions. The Chol-tobe structure was built with a slight deviation but is also oriented by its corners to the cardinal directions.

- **Orientation by sides to the cardinal directions.** The Bilovurtepa building is oriented strictly with its sides aligned to the cardinal directions. Kultobe is also oriented by its sides to the cardinal directions. Ark-tepe shows a slight deviation from the cardinal axes. Special attention should be given to the monuments of Mingurik and Setalak 1, which share similar planning solutions. Both monuments are oriented with their sides aligned to the cardinal directions but with a deviation of 16°. This indicates a connection between these two monuments.

**Table 1.** Orientation of Kangju Religious Buildings
Source: Author

| No | Name of the site | Orientation by corners to the cardinal directions | Orientation by sides to the cardinal directions | Accuracy |
|---|---|---|---|---|
| 1 | Shashtepa | + | | Exact |
| 2 | Ak-tobe 2 | + | | Exact |
| 3 | Shahr-i Qumis | + | | Exact |
| 4 | Chol-tobe | + | | With deviation |
| 5 | Kultobe | | + | With deviation |
| 6 | Bilovurtepa | | + | Exact |
| 7 | Ark-tepe | | + | With deviation |
| 8 | Mingurik | | + | With deviation |
| 9 | Setalak 1 | | + | With deviation |
| 10 | Tepe 5 | + | + | |

An interesting case is presented by the Tepe 5 structure, which occupies an intermediate position between orientation by sides and by corners relative to the cardinal directions. With such an orientation, it is difficult to determine whether the object is oriented by its sides or its corners.

The examined examples demonstrate that special attention was devoted to the orientation of Kangju cross-shaped buildings. This would have been possible only through the application of a specialized system of knowledge. In ancient Indian architectural texts, particular importance is attached to the spatial orientation of buildings and altars. The orientation of structures is associated with the rising and setting of the sun. Sunrise and sunset on the days of the summer and winter solstices mark four points known as chatussrakti, which are positioned diagonally relative to the cardinal directions (Bulatov, 2009). In Vastu-vidya, building orientation is determined using a gnomon. To establish the east–west axis, the shadows cast by the gnomon in the morning and evening are marked, and the resulting points are connected. A perpendicular drawn to this line indicates the north–south direction (Vibhuti Chakrabarti, 1998). This method is largely applicable to the Shashtepa building (Fig. 13).

It is likely that the initial stage of construction described in ancient Indian treatises—based on orienting buildings relative to sunrise and sunset—formed the basis for the construction of Kangju cross-shaped buildings.

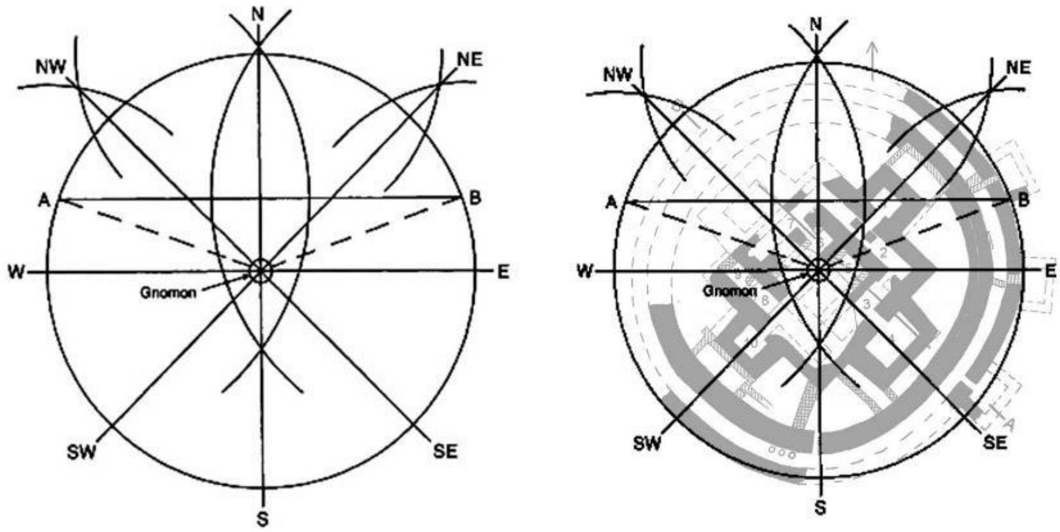


**Fig. 13:** Orientation of Kangju buildings relative to the cardinal directions, using the Shashtepa temple as an example. Determination of the principal directions using a gnomon in Vāstu-vidyā
Source: Mayamata, 1985; Vibhuti Chakrabarti, 1998. Shashtepa plan: Filanovich, 2010
Compiled by the author

## Interview

During the interview, general information was obtained concerning the attribution of cross-shaped buildings to ancient Kangju. The discussion also addressed the view that the planning structure of Kangju cross-shaped monuments is unique and reflects the worldview of ancient societies, based on the sacralization of architecture.

## Discussion

The results obtained indicate a deliberate application of geometric principles rather than accidental form-making in the cross-shaped buildings of Kangju. The spatial organization of these structures can be interpreted as a reflection of specific worldview and cosmological concepts. The data derived from comparing Kangju cross-shaped buildings with ancient Indian mandalas, as well as from the identified module and orientation, are consistent with ancient Indian spatial concepts.

In contrast to the conclusions of Torgoev, Kulish, and Torezhanova (2020), who consider cross-shaped buildings exclusively from a functional perspective, the results of the present study demonstrate their symbolic significance. The findings support the statements and hypotheses of Gurevich (1985), Suleimanov (2004), Ternovaya (2008), Filanovich (2010), and others that Kangju cross-shaped buildings embody the model of a cosmogram (mandala).

In particular, the results of this study confirm Bulatov's (2009) assertion that the cross-shaped building of Shashtepa should be examined from the standpoint of ancient Indian canons of altar and temple construction. The research makes it possible to reinterpret Kangju cross-shaped buildings as structures constructed according to the mandala principle. The conclusions obtained complement existing studies devoted to the monuments of Central Asia and, in particular, to the architecture of Kangju.

## Conclusions

The aim of this study was to identify the influence of ancient Indian spatial concepts on the geometry of Kangju architecture in Central Asia. The layout of cross-shaped buildings, which resembles ancient Indian mandalas, made it possible to examine these structures from the perspective of ancient Indian treatises on geometry. The study has established that Kangju architecture is closely connected with ancient Indian spatial concepts (Vastu-vidya and the Śulba Sūtras).

The geometric analysis of monuments such as Shashtepa, Mingurik, Setalak 1, Bilovurtepa, Ark-tepe, Tepe 5, Ak-tobe 2, Chol-tobe, Kzyl-Kainar-tobe, Kultobe, and Shahr-i Qumis demonstrated that ancient Indian spatial concepts influenced the geometry of Kangju architecture in Central Asia.

The identified module of 5.32 m is applicable to all the examined cross-shaped religious buildings of Kangju. It was established that Kangju cross-shaped buildings are subject to a specific planning system based on a modular grid (2×2, 3×3, 4×4, etc.), as evidenced by the subdivision of spaces within these structures. Clearly, this system is based on the texts of Vastu-vidya and reflects the ideas of Vastu Purusha Mandalas. This circumstance allows the cross-shaped buildings of Kangju to be defined as mandala-shaped structures.

In turn, the identified module of Kangju cross-shaped buildings indicates the application of an anthropometric system of measurement known from ancient Indian texts. In particular, it was established that an enlarged module equal to three dandas (rods) was used in the construction of these buildings.

The application of the geometric problem of square construction described in the Śulba Sūtras to the four-petaled buildings of Kangju, such as Chol-tobe and Kzyl-Kainar-tobe, showed that the principles of ancient Indian spatial concepts were employed in the planning and construction of these monuments.

Special importance was also attached to the spatial orientation of buildings. Using the example of the Shashtepa monument, which is oriented strictly by its corners toward the cardinal directions, it became clear that a gnomon was used in the construction of this structure to mark the principal points of sunrise and sunset. This indicates the application of building orientation principles known from the texts of Vastu-vidya.

All of this leads to the conclusion that knowledge derived from ancient Indian treatises on geometry, such as Vastu-vidya, the Śulba Sūtras, and others, was applied in the construction of Kangju religious buildings. This, in turn, points to ancient connections between Kangju—particularly the territory of the middle reaches of the Syr Darya River—and Ancient India.

A strong aspect of this study is the application of a geometric approach, which made it possible to identify patterns that had not previously been addressed in studies of this type. The use of the case study method also ensured an in-depth examination of specific monuments within their historical and cultural context. Another advantage of the study is the comparison of the architectural forms of Kangju cross-shaped buildings with the principles described in ancient Indian treatises, which constitutes a novel contribution.

A limitation of the study is that the examination of a limited number of monuments does not allow the findings to be fully extrapolated to the entire architecture of the region; however, it provides a foundation for further comparative research. The application of the comparative method does not exclude the influence of local building traditions not reflected in ancient Indian spatial concepts. These circumstances do not diminish the significance of the results obtained but indicate the need for further research on this topic.

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**Ethical Standards:** The authors declare that the research was conducted following standard ethical practices and that it did not impinge upon the rights of individuals or animals.

**Conflict of Interest:** The author declares that the results of this study do not involve any conflict of interest.

**Availability of Data:** The author declares that the data used in this study are available for verification upon request.

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