

Crossed Arches in Thirteenth Century Armenian Architecture

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ABSTRACT: This work is on the formal-constructive theme of the crossed arches spreading in the historical Armenian regions during a period of big cultural and economic growth in order to have a wider and free inside space for civil meetings in connection with the church inside the monastic building. The typical domed space, not larger than 12 meters, was replaced by a new structural solution: a system of piers along the walls bearing two couples of parallel, usually pointed, arches. The meaning and the declination of this constructive form in Armenia distinguish it from the Iranian tradition of crossed arches in brick domes. The great variety of spaces covered by the system of crossed arches shows the ability of medieval builders who, starting from a structural problem, decline in various ways its formal potentialities. The highest concentration of this structural form is in the historical region of Lori-Tashir, under Bagratid power.

ARMENIAN STONE DOMED ARCHITECTURE: INTRODUCTION

The composition of the domed space is really remarkable referring to the medieval building tradition of the Armenian regions. In particular, master builders demonstrated an extraordinary ability in drawing inspiration from the surrounding building traditions – the Roman one, through Byzantine culture, the Hellenistic and the Iranian ones - the interest for the central spaces under the dome.

The experimentation on the dome in the design of churches probably started for liturgical reasons from the division between Armenian and Byzantine cults at the middle of the 5th century and the consequent definition of Armenian's own sacred ceremonial for the foundation of a church and the dedication of the site on which it was built. As some scholars proved, in many sacred texts some Armenian words as *gmbet* (dome) or *khoran* (canopy) are indifferently used meaning both the architectural spaces and the symbolic dimension of heaven. The conception of the dome for new Christian churches conducts to find new architectural forms in a sort of architectural metaphorical fight between the respect of liturgical precepts and the bent for the great value of the central space under the dome.

The Armenian medieval architecture was built with stone (a great variety of local easily workable tufa or more compact basalts) and developed a very peculiar building technique uniting freestone with a thick rubble-mortar core (see Fig.1). The implication of this constructive technique is: on the one hand, a specific monolithic structural behavior causing the absence of differential reactions of the structure but also the collapse of the building by big masses during the frequent seismic phenomena; on the other hand, an intense experimentation on the possibility of building a double nature for the two visible surfaces: outside, a sculptural approach through elementary solids hierarchically organized; inside, an absolute preference for curved spatial surfaces as roofing. The close examination of many religious buildings determines the understanding of some important structural aspects about the Armenian way of construction: while the principal resistant part is the concrete core for masonry, free-standing pillars, elements of transition (e.g. pendentives or squinches), drum, vaulting systems, the building technique and so the structural behaviour is more complex in the case of the arches supporting the dome; sometimes there is one really stereotomic arch and one or two superposed 'false' arches made by layers of thin ashlar and concrete - in this second type the arch remains a formal and symbolic element (see Fig.2).



Figure 1: The monolithic structural behaviour of Armenian stone architecture in some damaged monuments



Figure 2: A stereotomic arch of Ptghni church, sixth century A.D.

Figure 3: 'Surface stereotomy'

Vaults or domes are not stereotomic, their joint faces don't exist. Masons privileged the geometrical perfection of the visible surface of the entire architectural element more than the complete solid definition of every single ashlar. The attempt of dissimulating, as far as possible, the joints among the stone blocks, denying their tectonic value, is coherent with the building technique.

This thought recalls the typical approach of classical architecture in which the aims were the organicity of the work and the sculptural, monolithic appearance of its elements through the use of sophisticated systems of equipment for the cut-stone blocks. In this sense and for these reasons we can state that Armenian architects develop a sort of 'surface stereotomy' (see Fig.3). Although a typical problem of the successive stereotomic discipline in France, like the precise geometric shaping of the joint faces, was not faced by Armenian medieval stone-masons, their skilful constructive solutions both of 'developable' surfaces (like the semi-cones of the squinches) and of 'not developable' surfaces (like the hemispheres of the domes) widely demonstrate their advanced knowledge of Geometry, the same Geometry that will lay the foundations for the Renaissance codification of the stereotomic discipline.

THE CROSSED ARCHES AS THE CONSTRUCTIVE SOLUTION FOR THE DESIGN OF THE SO-CALLED GAVIT

The definition of spaces with crossed arches is somehow tied, in Armenia, to the construction, on the territory, of the system of the monastic buildings. They represented, in the Middle Ages, the principal sites of maintenance, development and transmission of the cultural patrimony: the illuminated manuscripts were preserved, copied and translated. These monasteries were generally composed by a group of churches and little chapels and by buildings with various functions, religious, in support of the worship, or civil, in support of the life of the monastic community. After the crisis of the eighth century, there was, in the following century, a new strengthening of some great Armenian families. Among these ones, the Bagratid dynasty ruled on the central and northern regions of Armenia. The renewal of the building activity concerned both urban churches and suburban monastic structures, in which, beginning from the tenth century, a new building type, the gavit, was introduced. It has generally a square plan with a system of wall pillars and four central free-standing pillars that support arches; the roofing structure is composed by a central bigger pseudo-dome, always open at its top, four smaller barrel-vaults around it along the east-west and north-south axes and four little flat vaults or four semi cloister-vaults at the four corners of the inside space. The need of a more unifying space leads the architects to abolish the isolated central pillars and to build arches crossing the whole space, from a wall to the opposite one. In some cases, the free-standing pillars still remain assuming a purely formal value losing their primary structural reason.

The architectural research for these spaces seems to recall the residential constructive experience in the conception of a directioned space characterized by a central lighting system and by the hierarchization of the roofing elements: the principal room, called *glxatun*, of these traditional houses has a masonry structure, walls and free-standing pillars, and a vertical succession of wooden beams in order to form a central hole for the direct light.

DIFFUSION OF THE SPACE WITH CROSSED ARCHES IN MEDIEVAL ARMENIA

The constructions with crossed arches individuated and documented by the researchers in the territory historically influenced by the Armenian culture are more than twenty and the drawing up of a diachronous table shows that all the experience were perpetrated within only one century composing an interesting baggage of experimentation on a theme, once more without defining a real temporal evolution. The most greater concentration of the spaces with crossed arches is in the historical region of Lori-Tashir, under the control of the Bagratid family up to the eleventh century; they commissioned the construction of many of these monasteries, subsequently modified by other branches of the same family, as the Zakarian and the Mamikonian, also through the addition of the gavit with crossed arches or other functional buildings. Few other spaces are built in the central regions of Kars and Aragatzotn, in the southern region of Syunik and in the eastern one of Karabagh. Even though it is difficult to reconstruct a definitive and univocal chronological order because of the uncertainties in the dating of many of these buildings, it is possible to point out the gavit of Surp Nsan church in the monastery of Haghbat as one of the first examples of structure with crossed arches, in which, nevertheless, the architectural complexity is already very high and the geometric solution is more precise and refined than in other spaces of the following years. In rare cases the space with crossed arches is contextually built with the rest of the monastic complex - as in the case of the gavit of Aljocvank, Bri Eghtsi and Bardughimeos vank - in other cases it is built some years after the completion of the principal buildings - as in the case of the library of Saghmosavank or the gavit of Ganjasar, Hyurekavank, Koranashat, Korakert monasteries and of Deghjunutivank - or after one or two centuries from the foundation of the monastery - as in the case of the gavit, refectory and library of Haghbat, of the gavit of Horomayr, Arakeloc in Ani, Makaravank, Nor Varagvank, Aratesvank, Neghutsivank, Horomosvank, Mshakavank, Ushi, or of the bell tower of Sanahin, of the refectory of Haghartsin and the library of Goshavank.

A work of classification follows the first chronological analysis; a synthetic composition of the geometric-constructive problem of the crossed arches could consider two different points of view: on the one hand, it is interesting to note contemporaneously the development, during one century, of a significative series of spatial potentialities, from which we can draw a table of possible solutions, that could be increased through new theoretical speculations; on the other hand, there is the problem of the construction of the crossed arches and of the more or less empirical definition of the coherent form for the chosen static system.

CLASSIFICATION OF CROSSED ARCHES ACCORDING TO GEOMETRIC-FORMAL CHARACTERISTICS

This particular type of construction could be classified according to two different criteria: the way in which the arches intersect one another; the architectural type to which this constructive theme is applied.

Crossed arches can be classified according to the different ways in which a couple of arches intersects the other one:

- arches crossing at the middle: there are only few buildings in which the arches intersect each other at their keystone. In the small gavit of Horomayr monastery the arches are two and they rise from the four corners of the inside quadrangular perimeter. The vaulting system is composed by four portions of cloister-vaults. In the gavit of Arakelots church in Ani the 'x'-shaped system of arches is repeated two times in order to create a rectangular plan. The arches don't bear vaults but vertical walls creating a horizontal plan closed by triangular plan vaults and a central square covered by rows of stalactites with a central hole for light. The gavit

of Aratesvank monastery has a rectangular plan: along the longer side each of the two arches on wall-pillars intersects one rampant arch rising from wall-pillars at the middle of the smaller sides. The solution adopted in Saghmosavank monastery is more anomalous: in this case, in fact, two parallel pointed arches are traced from the western entrance to the eastern altar - according to the direction of the longitudinal plan - and intersect another transversal arch at an intermediate point, next to the keystone, producing two systems of coverings with square base, the first one with an open hole - next to the entrance - and the second one with a cloister vault (see Fig.4).

- arches crossing at intermediate points: they are the main part of the preserved examples and they are characterized by the intersection at intermediate points, leaving the center free for the opening of the central vault and the penetration of zenithal light. This covering can be an open cloister-vault or a vault with muqarnas elements (see Fig.5).

One of the main geometric and constructive problem of the crossing of arches consists of the possible way of definition of the common keystone.

- The tectonic element of intersection can be simply given by the juxtaposition of the single ashlar belonging to the crossing arches; in this case, only two parallel arches are built completely and the other two are built into three different parts, producing a sort of casualness and many inaccuracies in the position of the joints of intersection.
- In the greater part of the cases the intersection is solved through the introduction of a specialized ashlar, with a complex stereotomic definition, that already contains in its form the four directions of the crossing arches so that the building technique results more precise and geometrically controlled (see Fig.6).

Very often in the point of confluence of the four directions the specialized ashlar has a very unusual element, a sculptured sphere of stone that seems to allude to the real knot, almost a stone transposition of the nail technically used for the connection of two wooden architectural elements.

CLASSIFICATION OF CROSSED ARCHES ACCORDING TO ARCHITECTURAL TYPES OR SYSTEMS

Crossed arches were introduced to solve a specific constructive and spatial need, but were contemporarily experimented in the design for other architectural types. There are:

- gavit with crossed arches: the architectural space is completely unified and the only hierarchy regards the covering system. For the central covering system Armenian master builders established many formal solution starting from two principal constructive techniques.



Figure 4: Arches crossing at the keystone

Figure 5: Some examples of arches crossing at intermediate points

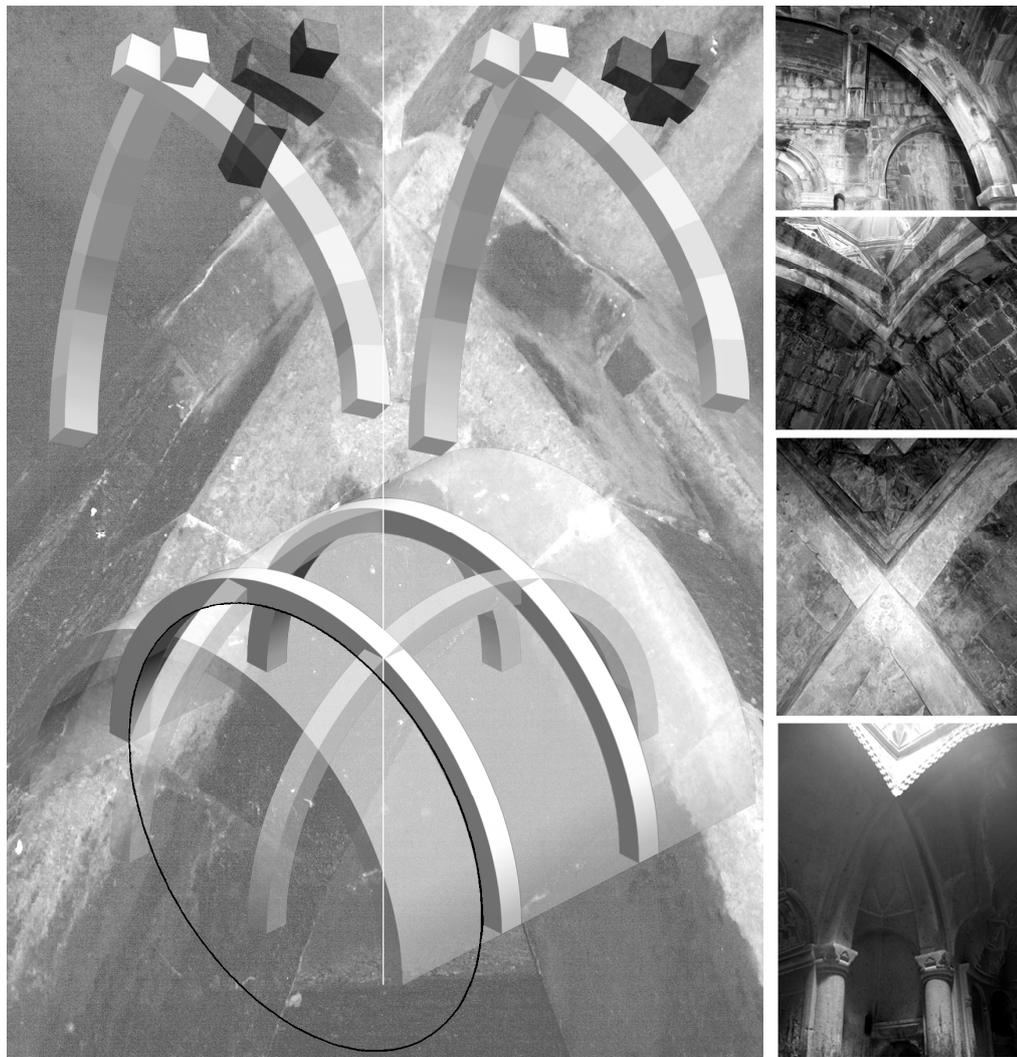


Figure 6: The solutions for the common keystone in Armenian crossed arches

This specific geometric problem is similar to that one for the principal dome in the churches, namely the transition from the central square plan defined by the intersection of the crossed arches to the smaller dimension of the circular or polygonal hole at the top. This problem generates principally two kinds of solution: the construction of thrusting or not thrusting structures on the system of the crossed arches. Besides the use of cloister vaults on polygonal base with the central hole, in the first hypothesis, another possibility requires attention: the construction of a second smaller system of two couples of crossed arches on the square base of intersection of the greater crossed arches; this solution is chosen for the gavit of Haghbat, Mshakavank and Bardughimeos vank monasteries. The central square plan produced by the intersection of these small arches is completely open. An important observation regards the complete aesthetical will that conditions the introduction of this constructive choice; the limited dimensions of this second order of crossed arches don't justify their use for structural reasons but persuade to hypothesize the interest of the architects for the repetition of them for formal and aesthetical reasons.

In the second case, the not-thrusting covering systems consists of overlapping more and more overhanging horizontal layers up to the dimensions of the hole at the top; usually these coverings are made of stalactites on square base. This stylistic element clearly is an evidence of the fruitful mutual architectural exchange with the Seljuk conquerors. Armenian masons used Turkish typical elements, as muqarnas, for the decoration of architectural elements, doors or façades, and for structural vaulting systems; Seljuks found in Armenia a very fertile field for the formation of their architecture, directly using the contribution of the autochthonous master builders for the building of their own architectural new types:

- refectories with crossed arches: the constructive theme is doubled to cover much wider, longitudinal space with zenithal lightning;
- small buildings with crossed arches: they are libraries or bell towers of the monastery in which the little dimensions don't imply the use of crossed arches as the only possible structure. The use of the same geometric-constructive system even in very small spaces denotes the assumption of the space under crossed arches as an aesthetical model of reference in the construction of many functional buildings inside the monastic complexes;

-domes with crossed arches: the intersection loses its original constructive reasons; it tightens itself in order to define and to pierce the building structure of the central covering of the gavit or of the dome for the church. This covering can be composed by two couples of arches, like in gavit; more usually the system has six arches rising from the vertices of a hexagon, so that they draw a sort of six-pointed star. An example is the central covering of the gavit of Khoranashat; two horizontal layers of plain triangular elements of transition produce a polygonal plan with many vertices; a virtual regular hexagon is traced on it and from it arches cross one another at intermediate points composing a further hexagonal base that constitutes the hole for the introduction of the zenith light in the inside space. The other free portions produced by the intersections are closed through little structures with a cylindrical surface of intrados. Also in this case the arches have their own structural function so that the little vaults closing the free portions are structurally autonomous from them.

ORIGINS AND INFLUENCES OF THE ARMENIAN CROSSED ARCHES IN EAST AND WEST

It is necessary to underline that this structural form precedes the formulation of the art of stereotomy, so it derives from an empiric but almost evolved knowledge more than from a true modern scientific approach. Armenian crossed arches have always a cylindrical form, so that the intersecting points produce a discontinuity. The Armenian experimentation comes back to the Persian one. Especially the last architectural type, the dome made by crossed arches, is similar to the tenth century Spanish domes in the Great Mosque in Cordoba or Toledo. In the seventeenth century Guarino Guarini will synthesize his knowledge of the Spanish crossed arches with the acquisition of the Renaissance French stereotomy to design a more sophisticated type of dome with crossed arches in which the intrados of each arch will be not cylindrical but a portion of a spherical surface, avoiding the problem of discontinuity.

CONCLUSIONS

Many scholars had stated the possible derivation of the Romanic or Gothic architecture from the Armenian building tradition. Surely the scientific limits of this kind of constructive technique are evident. But, on the other hand, the Armenian's culture was undoubtedly known in Western Europe thanks to some similar architectural elements built by the Turkish in Spain or other Mediterranean regions and to the cultural exchanges during the religious medieval Crusades.

The most fascinating aspect of the Armenian's experience in the field of religious building construction is the method according to which pure technical solutions become aesthetical and architectural forms through one of the finest sciences, Geometry.

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