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MODULAR TESSELLATION AND ARCHITECTURE. SERGIO LOMBARDO'S STOCHASTIC TILES AND THEIR APPLICATION IN REAL ARCHITECTURES.

Abstract
The application of Sergio Lombardo's stochastic tiles in a real architecture was here considerate. The investigation of the history of use of modular tessellation in architecture shows the innovated character of Lombardo's work. The examples of the use of his stochastic tiles in recent or in progress architectural projects represent a test of the Eventualist Theory and his application in the architectural field.

Relationships with tradition

Sergio Lombardo's stochastic tiles represent a real innovation in the millennia-old history of modular tessellations used in architecture to cover flat surfaces.
Modular tessellation, in architecture, generally aims to reduce building elements to the minimum, in order to produce them more easily and several times. It is an interesting aesthetic problem that of obtaining even more complex and non-repetitive patterns, through placing side by side a minimum number of modules for saturating the planes.
The very long tradition of modular tessellations, that presumably began with the Egyptians, had such a development in the Middle-East civilizations that solutions were found that are sometimes of an exceptional complexity and using a very small number of basilar, elementary modules. Nevertheless, this mainly happened, as the evolution of the same principle of symmetry, linked to the original, unique and perfect shape of the circle (Issam El-Said And Ayse Parman, 1976).
Every surface can in fact be measured and divided by tracing circles of equal dimensions that can also be divided into other circles (fig. 1); fragments of them, obtained by intersecting them with radii, diameters and chords, again from their respective centres, can be highlighted by chromatically differentiated painting-in and thus ori-

ginate endless patterns.
The colouring-in of the elements derived from the circle, in bi-cromia B/W or in polycromia, can generate compositions of single geometric figures that can be very asymmetric and far from the regular images of the beginning.
This tradition was later developed in the Roman, late-Roman and Byzantine times, through the epic of the Cosmati, reaching an incredible acme between the 13th and the 14th century in its countries of origin (Iran and Iraq) and in Western Europe, under the Arab rule. It is in this period that have been realised the masterpieces of Isfahan in Iran and the ones in Spain (Alhambra in particular) (fig. 2), and in all the other countries touched by the Arab rule (France, and Southern Italy); this became as a prelude to the developments of the Renaissance and the subsequent great flowering of the Italian majolica floors.
Almost all the complex graphical compositions of the Islamic tradition are obtained through six primary polygonal tiles which are decorated by lines crossing them (called "Girih" tiles) and connecting the midpoints of each side, with particular angles that are chosen in such a way that the lines can run as straight lines once the tiles are placed one next to the other (fig. 3).
The saturation of the plane in the Islamic tradition and in the ones that have drawn upon it, always takes place through regular or "periodic" tessellations, i.e. tessellations that can be super-imposed on each other by being put through simple translations.
Nor did our composing exercises, and their codifications realised during the Enlightenment in the 18th century and founded on the square and the semi-square, actually introduce particular innovations or exceptions to this structuring. The arguments and the illustrations that Father Sébastian Truchet presented in his treatise in 1704 (fig. 4, 5) did not introduce irregular or random combinations, and certainly nothing that can be defined as stochastic (Truchet Sebastian, Père, 1702). Similarly Father Dominique Douat, in his 1722 re-writing of Truchet's studies (Douat Dominique, Père, 1722), added several examples of compositions, which do not reject the overall symmetry, although they represent a surprising anticipation of images that can be found only in the Western kinetic and optical art of the Fifties (fig. 6).
We have to get to the 20th century, when the geometrical structures and the chromatic variations of Russian and European Abstract Art (the Futurists, the Suprematists, the experimentations of the Vkhutemas and the Bauhaus, of De Stijl, of Mondrian and others) opened the way to new aesthetic scenarios. The drawings and the graphic works, even when composed of asymmetrical elements, or in an asymmetric pattern, will always remain within the realm of balanced asymmetries and of overall harmonic equilibriums. Mainly this takes place still in the context of subjective creative processes without introducing, at least for what is known, relevant changes in the field of minimal modular tessellations.
The endless combining possibilities of Father Truchet's "squares divided in half in two colours" were, perhaps for the first time, read from a random perspective only

in 1958 with the work "Répartition aléatoire de *triangles* suivant les chiffres pairs et impairs d'un annuaire de téléphone" [*The random ordering of triangles following the odd and even numbers of a telephone book*] by Francois Morellet who used black and white half-squares to compose his drawing which definitely loses its repetitive arrangement (fig.7).

It is interesting to mention the experimentations that were undertaken by the Italian architect Gio Ponti, who, at the beginning of the 50s, probably for the first time in the production of ceramic tiles, drew on some traditional modular solutions which are structured on the diagonal with patterns that leave open the possibility of combination during the phase of placement, thus generating overall drawings that are varied and randomly determined.

Ponti himself presents it as "one of the first attempts to have a geometric abstract drawing which leaves it to the subsequent combination the possibility to create different and personalised drawings. The name itself SERIE MULTIPREF (Ponti Gio', 1950) wanted to be an answer to a necessity – prefabrication- and at the same time to leave space for imagination and creation for the user and final consumer" (fig. 8).

This long tradition found further original developments and elaborations in recent times thanks to the contribution given by modern maths which allowed the enrichment of existing tessellations with others that are irregular or "aperiodical", i.e. tessellations that cannot be super-imposed by simple translation. Fundamental are the famous studies made by Penrose (Penrose R. 1974) (fig. 9) and their following developments by De Brujin (De Brujin, N.G. 1981) (fig. 10). Moreover, very recent studies discuss the primacy of modern mathematicians on their Islamic predecessors (Peter J. Lu and Paul J. Steinhardt, 2007).

Many, therefore, were the patents in the 20th Century trying to produce combination games, all later abandoned or let lapse, probably because they were not able to produce drawings that activated truly stimulating processes of interaction with the viewer (Robert J. Krawczyk, 2011).

Interesting, however, is the description of the construction process coming from A.F.Loewy's patent of 1991, that is somehow close, as we will see, to Sergio Lombardo's experimentations: "*Each module is made in the following manner. Assume that the regular polygon has n sides. First, one chooses a set of points on one of the sides of the polygon, the points being distributed symmetrically around the midpoint of the side. Then, one duplicates this arrangement of points on each of the remaining sides. Next, one connects pairs of points with lines, such that every point is connected to one line. The lines can be straight or curved, but they must be continuous. The lines are drawn such that the resulting pattern is not symmetrical around any imaginary straight line joining any pair of vertices of the polygon. Finally one can optionally fill in some or all of the spaces defined by pairs of lines, or by one or more lines and one or more sides of the polygon, with colour or with some other design element*" (A.F.Loewy, 1991) (fig. 11).

Sergio Lombardo's Stochastic Tessellations

The stochastic tiles which Sergio Lombardo devised at the beginning of the Nineties, presented at the Venice Biennal in 1993 and published in *Rivista di Psicologia dell'Arte* in 1994 (Lombardo S. 1994) (fig. 12), hold innovative elements not only from the perspective of the graphic image but also from the perspective of the work's relation with the viewer and, as we will see, from the perspective of the building optimization in architecture. Already in 1966, the artist had worked with tiles, realising the work *Superquadro* [Super-painting], by randomly arranging traditional tiles decorated with a two diagonal stripes (fig. 13).
Lombardo's tiles are made with six types of tiles which were already present in the tradition.
The deformation of the tiles' black fields according to stochastic parameters originates new drawings of tiles that are at different levels of complexity, depending on the amount of points extracted for the deformations (5, 10, 20, etc.) and it keeps with the combinational possibility of the single traditional modules, which is guaranteed by the portions of the black-coloured sides, in proximity of the edges.
Composing a certain number of single modules, for the saturation of a plane, according to different orientations of the same drawing or by placing side by side tiles with different patterns, causes several graphic compositions.
Such a procedure can be planned in predetermined sequences, or can take place without a pre-established procedure. In the latter case too the result will be a drawing of the whole.
In the context of the Eventualist aesthetic theory, developed by Lombardo himself starting from 1987 (Lombardo S. (1987), the drawings obtained through the above described procedure become, in the viewer's perception, a stimulus towards a frenetic interpretative process and determine an interpretative range which varies from viewer to viewer depending on the respective unrepeatable individual experiences.

Application in architecture. The Tufello project.

The first application realised within an architectural project is represented by a set of 26 floors in two tenement blocks in Rome, in the Tufello district, conceived by the author, Claudio Greco, in 1998 and realized in 2001 (Greco C. 2001).
In response to an open call published by the *Istituto Autonomo delle Case Popolari di Roma* [The Autonomous Institute of Social Housing in Rome] a proposal was presented for the recovery and redevelopment of 24 towers with 5 floors, at that time without elevators and clustered in two complexes in the Tufello district in Rome. The available budget and the relatively conserved condition of the buildings made it possible to install of 24 new tower-elevators and the necessary enlargement of the entrance halls.
We had then to insert new architectonic elements in an established complex with a simple and sober architectural quality, for which the residents, who had lived there

for more than thirty years, had already developed a noticeable level of appreciation and emotional attachment.
Inserting a new technological component was consequently faced, taking into account the original characteristics, which had by then become familiar to the residents.
It was chosen to realise an architectonic element that could simultaneously insert itself into the existing architectural environment, through the shape of a regular parallelepiped and by drawing on existing decorative elements (red brick or the structural vertical and horizontal white elements) in order to induce an acceptance in the residents (*the tower is the same as the houses*). But, we also wanted to present new elements of distinction, in order to support the originality of the project, respecting the canonic restoration diktats; these elements were devised through some limited formal variations or by changing the coating material, but always within tradition, i.e. the coloured and variable mosaic induces a sense of further affective appropriation (*my tower is different from the others*), because perception becomes closer the closer you get to the tower.
Inside the new entrance hall, an extension of the existing one, it was decided to insert a decorative element in the space comprised between the elevator and the stairs, to increase the quality of the modest council houses (fig 14).
It was decided to realise a square design of tiles to be inserted into a Trani marble floor and made of coloured marble chips in cement, similar to the existing one, according to the consolidated tradition of social housing buildings in Rome.
Following the logic used for defining each individual tower, it has been chosen in this case too to realise a floor design that was of the same kind in all the towers and made with a material typical of the vernacular tradition, (cement chips) (for *acceptance*) but different for each tower (for the *affective appropriation*).
The use of the Lombardo's stochastic tiles was in fact coherent with the architectural principles at the basis of the intervention; it actually represented a further examination.
Regarding the possibilities listed in this article, presenting the experiments, in accordance with Sergio Lombardo, two types of traditional primary drawings were chosen, selecting two opposed types out of the six from the original published experiment.
For the stochastic deformation, a set of 10 points was randomly picked, chorded with straight or curved lines, according to the two primary types, thus obtaining the four tiles:
The floors, originally in black and white, have been changed to black and another colour (blue, yellow and green) that was already present in the external mosaics, in order to have a visual link between the floor indoors and the decorative element outdoors, for each of the towers (*yellow tower-black/yellow floor*).
The tiles were made by using traditional materials and a traditional technique, using manual processes, in keeping with the overall nature of the restoration project.
Moreover, the handmade fabrication retains the familiar quality of the floor, even in association with the unusual graphic image, and it allows the removal of all the

elements of refusal and disturbance in the perception of the users. More modern and unfamiliar materials would have had this effect (resin, marble-resins, etc.).
For realising the 26 floors, several architectural choices have been made, randomly and without any aesthetic aim, and selecting a prefixed set of combinations.
Specialised workers managed the process of laying the floors, with the order to "not follow any rule" thus "without a plan".
The floor layering had then made randomly without any type of criterion (fig. 15)
The floors have been accepted and appreciated by the residents, even if their drawing appeared to be strongly abstract, thus corroborating the aesthetic theory devised by Lombardo.

S.Felice Church flooring project (2014-2015)

The restoration program of the Church S. Felice in Guglionesi (Campobasso) will become an opportunity to realize a new Sergio Lombardo stochastic floor in a real architectural contest. This will be tanks to the commitment of the Soprintendente of the Molise Region, arch. Carlo Birrozzi.
The aim of the Soprintendente, was to suggest, with this prototype, a renewal of the tradition in a contemporary and cultural sense, in opposition of a fake continuity with the past or an unconditional opening to the new.
In this new project the choice is to use, as floor, modular tassellation realized in a multi-coloured ceramic materials, in continuity with the tradition, but with a new contemporary pattern, obtained with a controlled stochastic process by Sergio Lombardo.
The new floor will occupy the entire central area (the"navata") till the border consisting in the steps of the elevating areas of main and lateral altars. This will be according with the conceptual geometrical idea of a pattern drawn on to an infinitive toroidal surface.

The type of tile is selected in the 2013 series, with four colours (light yellow, black, light green, violet), variation of the four of the most popular colours used in the Italian tradition of tiling.
The monumental character of the S. Felice Church, make the insertion of the contemporary floor more problematic then in the previous case of Tufello's project entrances floors.
The impact of the high innovative pattern and composition of shapes and colours with the traditional architectural elements and space, will probably produce a range of high differentiated reactions between art history critics and between people visiting the church.
Once done the stochastic floor, there will be a new opportunity of further investigate the Eventualist theory registering and analyzing observers interpretations.

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1- The architectural choices are made by Claudio Greco and the tiles production will be made by Rita Rivelli ("Studio Forme" Roma).

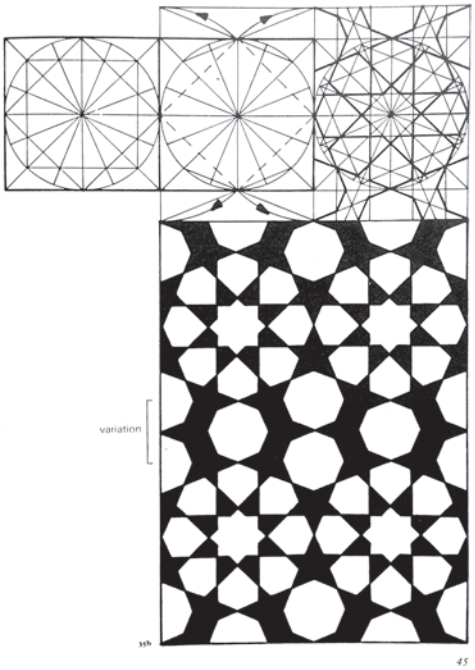


Fig. 1

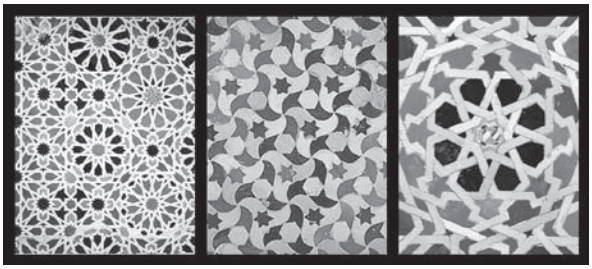
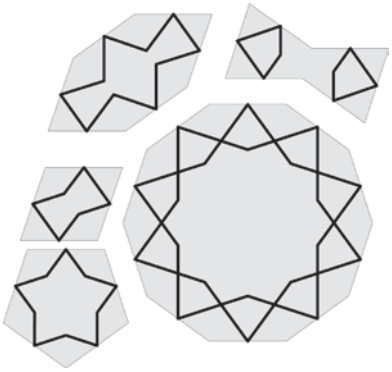


Fig. 2



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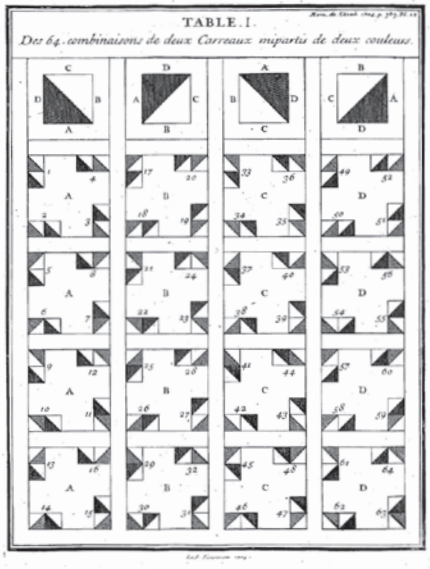


Fig. 4

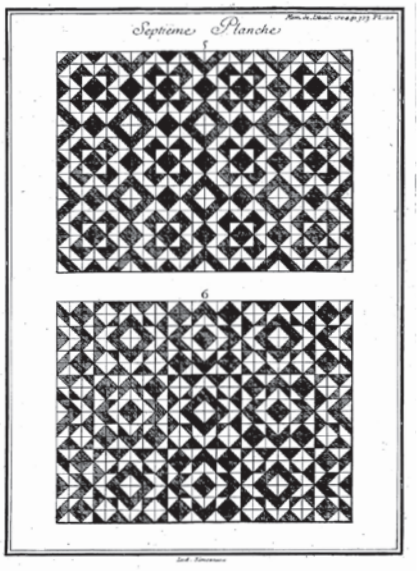
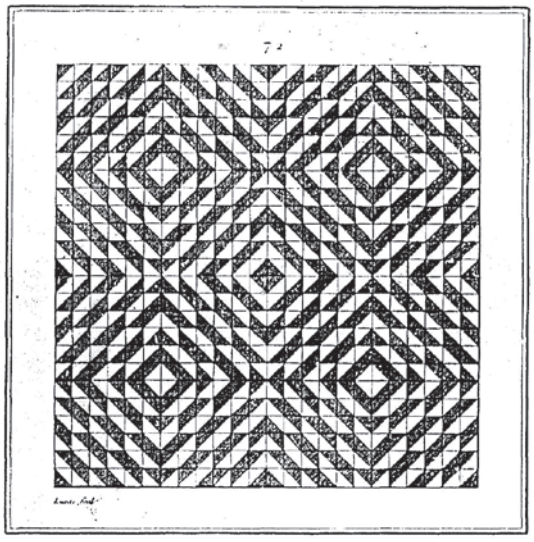


Fig. 5



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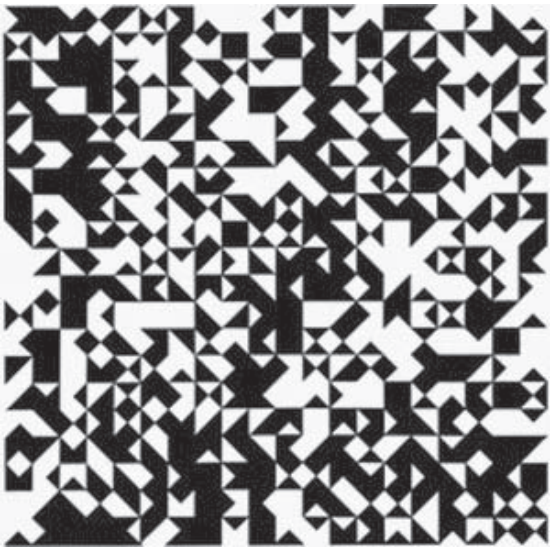

Fig. 7

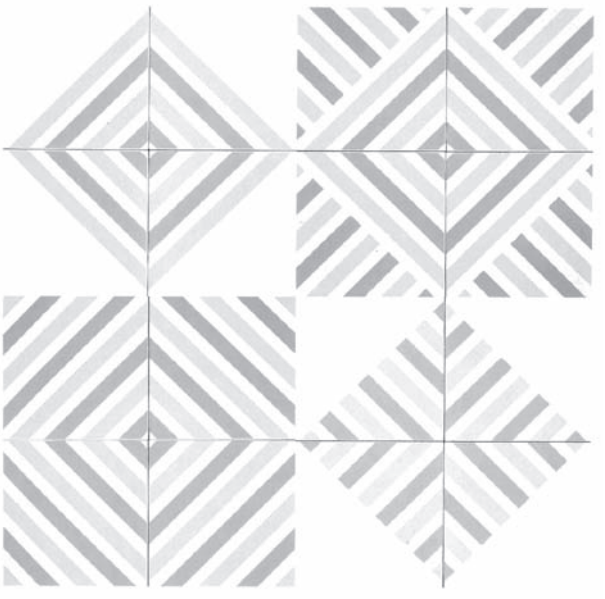

Fig. 8

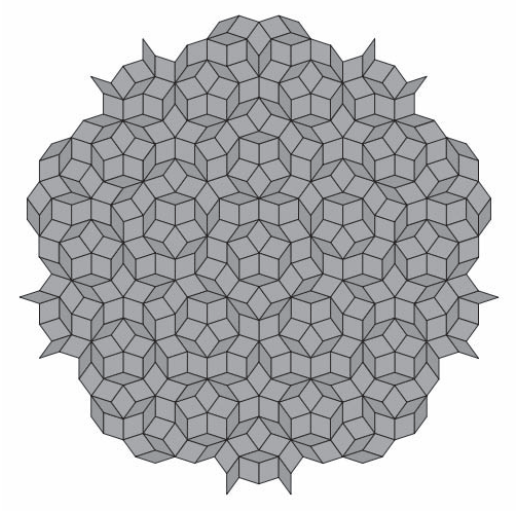

Fig. 9

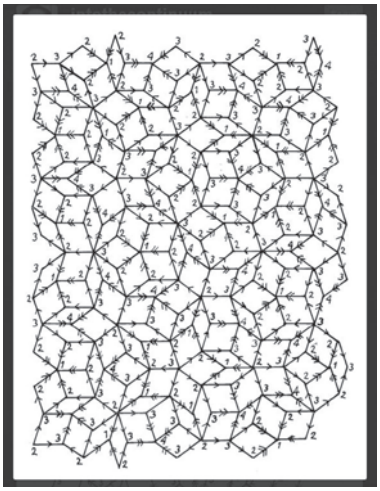

Fig. 10

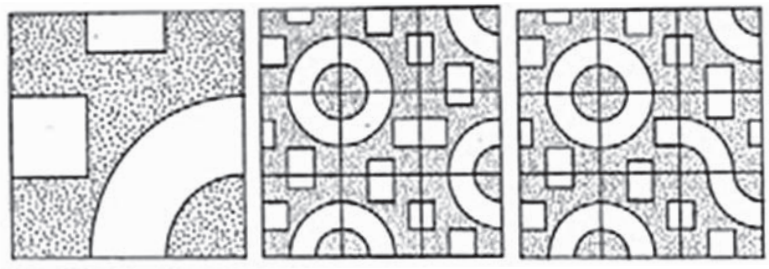

Fig. 11

Fig. 12

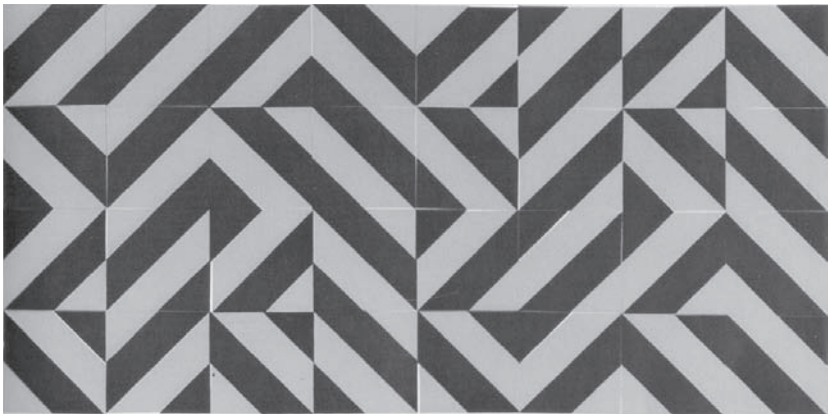

Fig. 13

Fig. 14

Fig. 15

Fig. 16

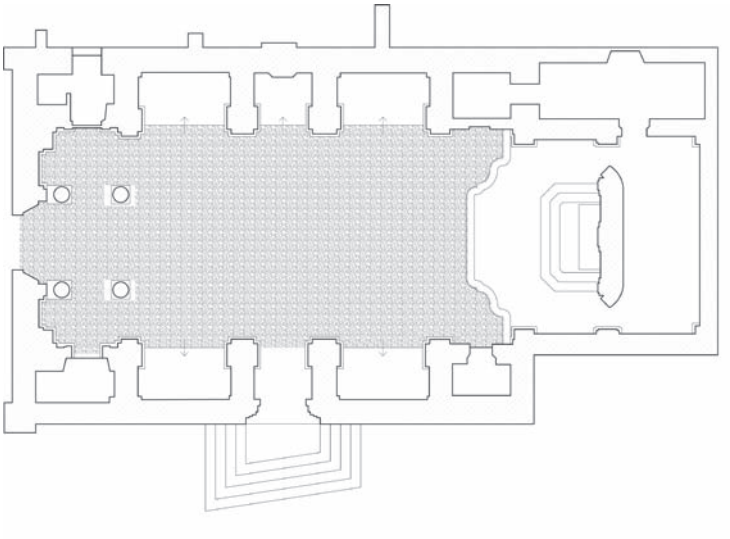

Fig. 17

Fig. 18