

CONCRETE SHELLS FOR AN ECLECTIC CHURCH

MIRCEA MIHAILSCU, IOAN TĂNĂSOIU, GHEORGHE MIRCEAN, DELIA DRĂGAN,
- Technical University of Cluj, str. C-tin. Daicoviciu nr. 15, 3400, Cluj-Napoca.

Abstract

An outstanding Greek-Roman church, now in erection stage, was designed trying to bring into agreement, some old and new forms.

More precisely the intention was to harmonise in the frame of a modern conception the traditional cylinder shape of the ancient orthodox basilica with the modern expression of the hyperbolic paraboloid shell, nowadays frequently promoted in the catholic churches.

The projected edifice has in plane a latin cross form, its center being covered - instead of the usual dome - with a congruence of four hyperbolic paraboloids, joined at their top along horizontal lines by triangular trusses, which serves as sky lights too. The other two edges of each HP shell provided with great slope, are strengthened by struts.

The wings of the church horizontal cross form are covered with circular cylinder shells; one of which, at the entrance, being twofold longer than the others.

The principal church roof was made of twisted inscribed precast sandwich concrete panels, while the edge struts were also designed of precast concrete box segments.

The entire central envelope, accomplished of HP shells, is supported on four abutements only, placed on the corners of the quadratic covered surface. The abutements conceived to undertake the trust induced in any possible directions by the envelope, are joined together with prestressed concrete ties.

The paper gives many details concerning the computer analysis as well as the building process itself.

1. Preamble.

The church represents essentially, the meeting place of those, who faithfully, try to rise towards the Almighty, the Creator of this World, Who, without cease, watches that the laws of nature should be observed.

In the persecution time of the Cristians, churches were esoteric places for initiates, hidden in building basements, or caves, the space being restricted and dark.

After the triumph of Christianity, churches, some of them, representing large hierarchie organisations: dioceses, bishoprics, patriarchates, became symbols of the community's power to manifest its faith.

Thus the impulse towards the great, the unequalled, was born, expressed along the centuries through magnificent edifices: St. Sophia Cathedral, Gothic Churches, St. Peter's Basilica. Nowadays usually, new style cathedrals have been built within dioceses (Tokio, Paris St.Evry).

In this respect, an outstanding Greek-Roman church, now in the erection stage, was designed with the idea of compelling into agreement some old and new forms.

More precisely, the intention was to harmonize in the frame of a modern conception, the traditional cylinder shape of the ancient orthodox basilica, with the modern expression of the hyperbolic paraboloid shell, frequently promoted in the catholic churches (Fig .1) .

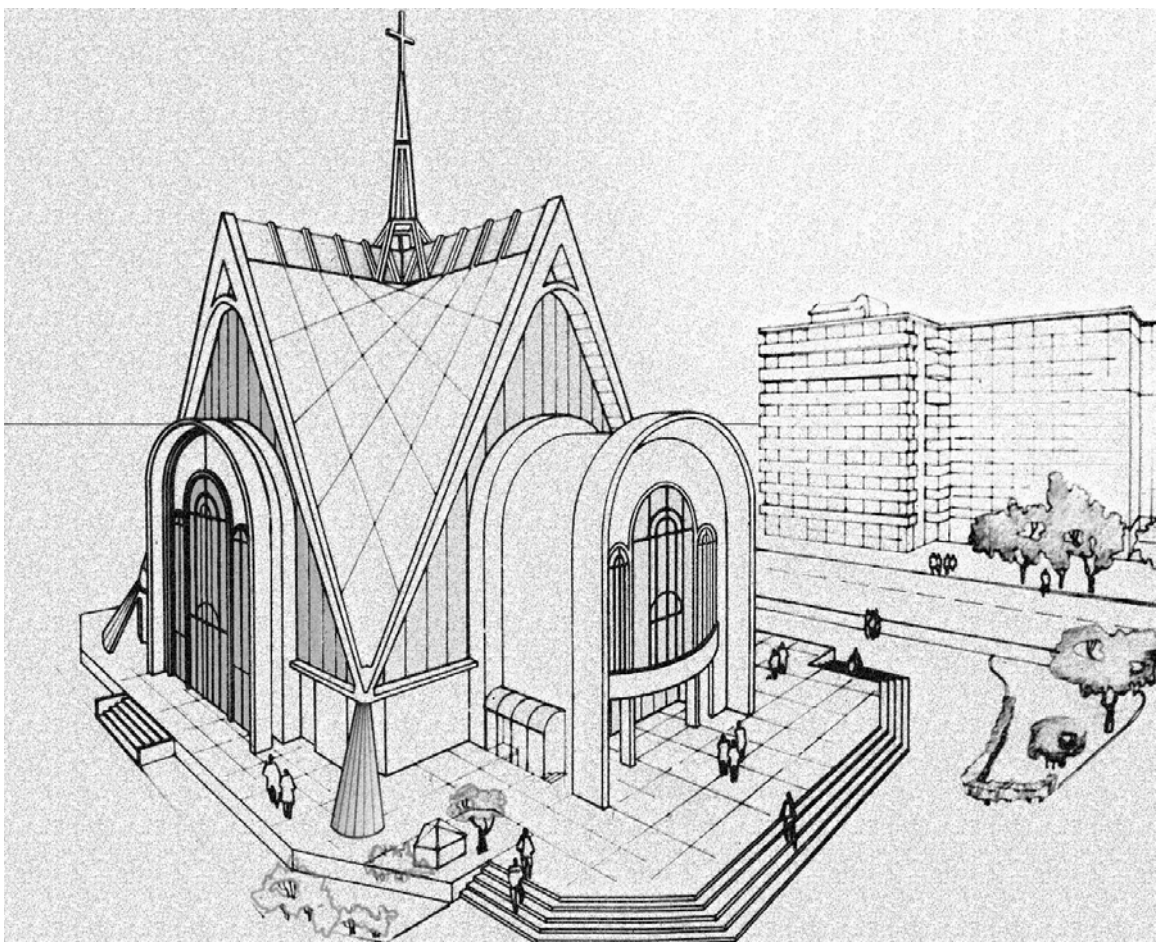


Fig.1

2. Description

The designed edifice has in the horizontal plane, a Latin cross form, its central area being covered-instead of the usual dome- with a congruence of four hyperbolic paraboloid shells, joined together, along their upper horizontal generatrices, by triangular trusses, serving as skylights too (Fig 2). The other pair of boundary generatrices, both with the greatest slope, are strengthened by struts.

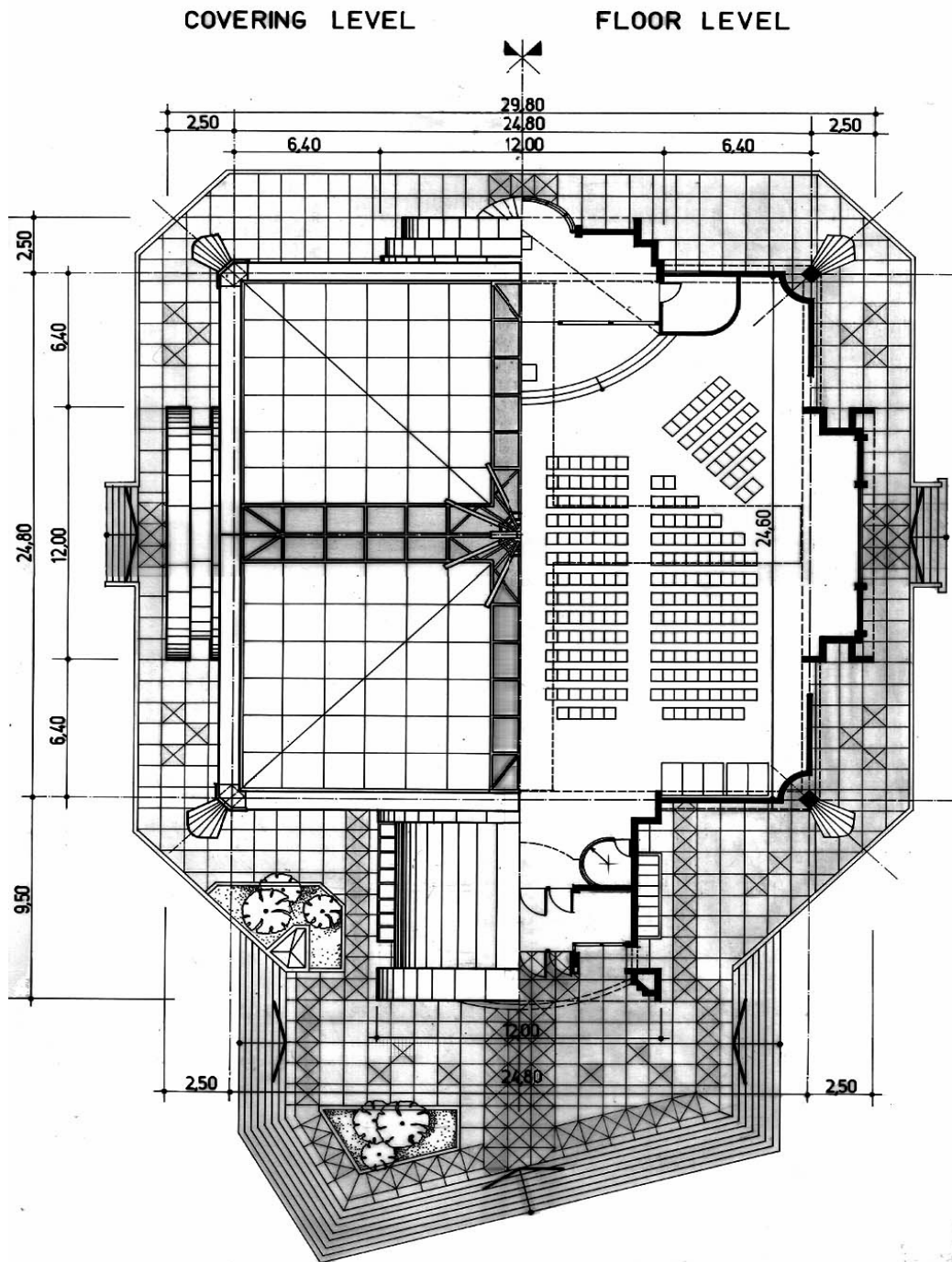


fig. 2

The wings of the horizontal cross form were covered with circular cylindrical shells, supported by compact walls. One of these bodies, placed at the entrance is twice longer than the others.

The entire hyperbolic shape covering is made of 144 precast concrete, twisted sandwich panels, of various sizes, from: 1,75x1,75 m to 3,50 x 3,50 m (Fig. 3).

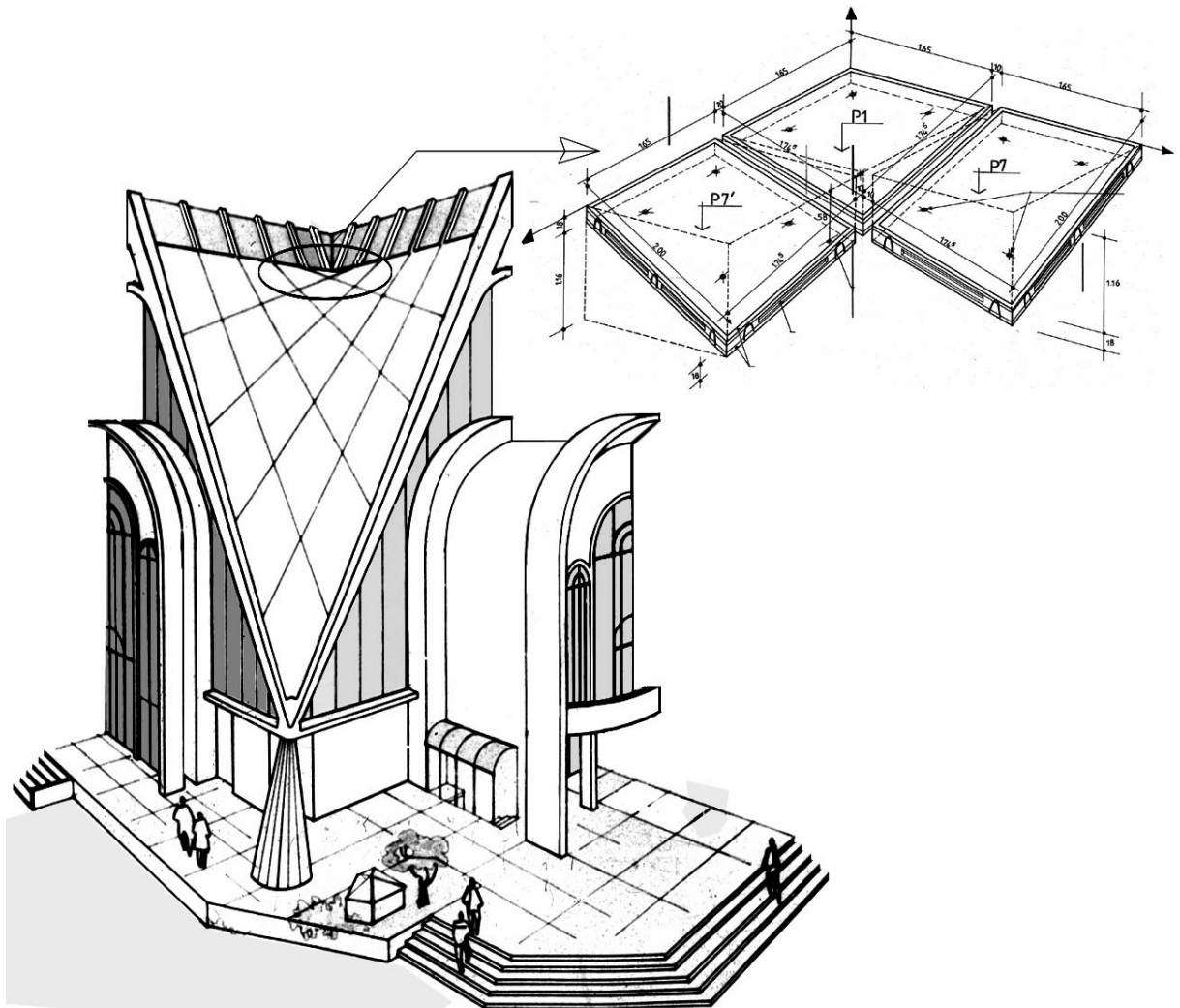


Fig.3.

The edge struts are also made of precast concrete: the segments of five types, have their cross section in a variable box form.

The abutments, which undertake the envelope thrusts, acting in many possible directions, were drafted in a fan shape. They are joined together with concrete prestressed ties perimetrically placed - to the covered area. The church foundations were built on 30 bored piles of almost 10 m length.

3. Structure analysis

The central covering, made of four HP shells, joined together by two orthogonally disposed metal trusses was analysed through a program based on the Finite Element Method assumptions concerning plane triangular elements. Fig.4 shows the axial efforts induced in the middle surface of the structure, due to a symmetric loading, while Fig.5 depicts the state of the same axial efforts durring a seismic action.

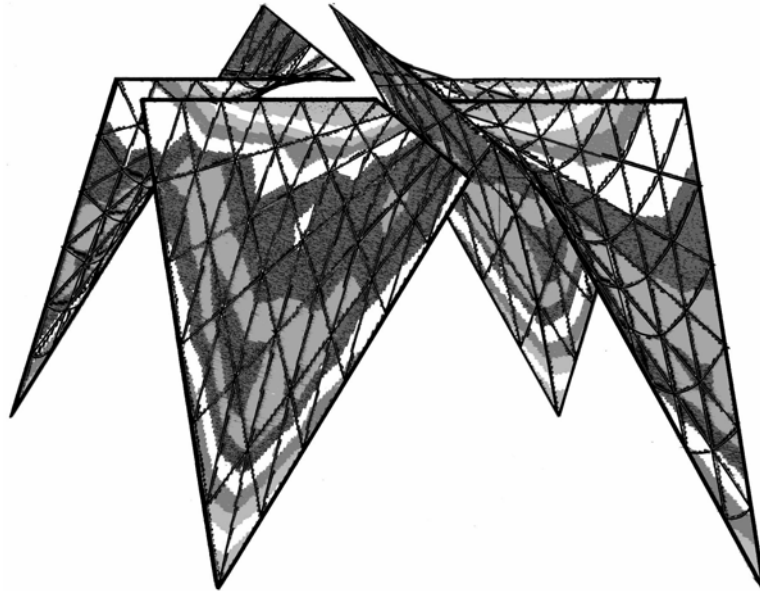


Fig .4

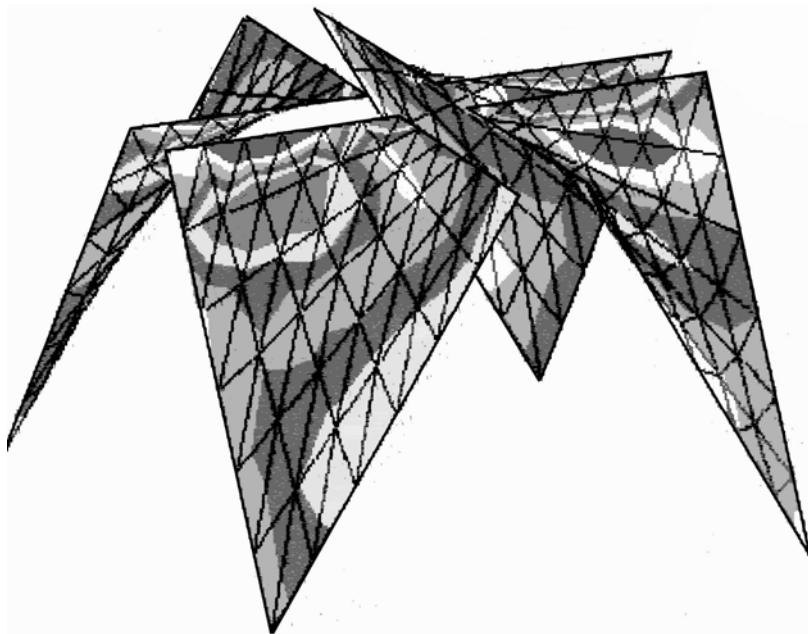


Fig. 5

4. Main details

A special care has been taken in order to avoid secondary stresses, provoked by rigid connections unable to allow the structure respiration at temperature variations and eventually to small foundation displacements. In this respect the contacts between abutments and shell corners were provided with hinges, this detail appearing in fig.6. For the same reason, the connection between the HP shells and the neighbourhood metal trusses were achieved through bolts allowing small displacements (Fig.7).

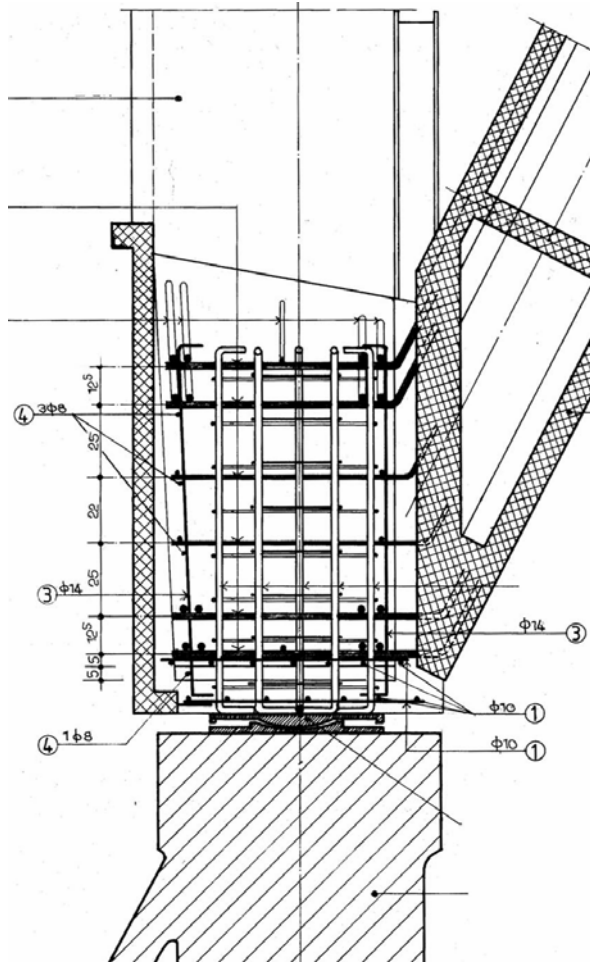


Fig. 6

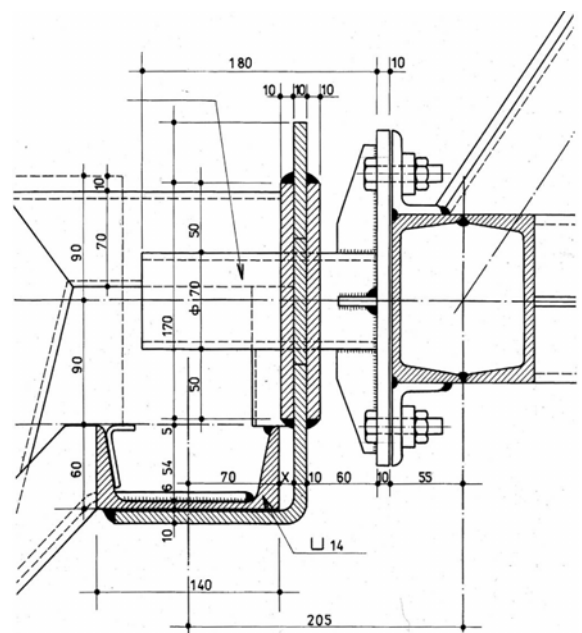


Fig. 7

5. Concrete precasting

It must be stressed, that by precasting the concrete not only economy, easier feasibility, better quality of concrete by curing it in the plant and a faster execution, were achieved, but also the possibility of avoiding shrinkage effects. This phenomenon could had been very important, in the case of pouring the concrete in situ, due to the fact that in order to increase the durability,

the cement content were fixed at 470 kg/m³ and 500 kg/m³. The concrete mixture for the sandwich precast plates was:

- white gravel from 0 to 16 mm	1660 kg/m ³
- P normal cement gris	320 kg/m ³
- P cement white	150 kg/m ³
- water	225 l/m ³

The concrete mixture for the struts and pilars was:

- white gravel from 0 to 16 -	1650 kg/m ³
- P cement gris	300 kg/m ³
- P cement white	200 kg/m ³
- water	220 l/m ³

The water proffing of the apparent concrete is provided by crystallisation with XYPEX

6. Assembling method

The assembling was conceived to be achieved on a shoring Peri system extended to the central surface, in order to erect at first the central covering.

The lateral cylindrical shells will be poured in situ.

All the concrete remains apparent having a white natural color. Many measures were taken in this respect.

7. Acknowledgement

The authors wish to express their gratitude and thanks to the parochial priest Liviu Boitos, who has proved to be very diligent in promoting this cathedral form, as well as in procuring funds for building it up.