

Zeitschrift: IABSE reports = Rapports AIPC = IVBH Berichte
Band: 83 (1999)

Artikel: Combining aesthetic and structure for the Large Domes in Isfahan
Autor: Mirtalaei, Kamal / Nahvi, Reza / Farshad, Mehdi
DOI: <https://doi.org/10.5169/seals-62841>

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Combining Aesthetic and Structure for the Large Domes in Isfahan

Kamal MIRTALAEI
Ass. Professor
Isfahan Univ. of Tech.
Isfahan, Iran

Mehdi FARSHAD
Professor
Mosalla, Masjed
Isfahan, Iran

Hossein SEIFOLLAHI
Civil Engineer
Mosalla, Masjed
Isfahan, Iran

Reza NAHVI
Civil Engineer
Mosalla, Masjed
Isfahan, Iran

Naser SAGHAFIAN
Industrial Engineer
Mosalla, Masjed
Isfahan, Iran

Ali KEYVANI
Civil Engineer
Mosalla, Masjed
Isfahan, Iran

Abstract

Isfahan Cultural Center comprises a building complex of 150,000 m². Several types of building are being constructed among which a number of special structures exist. The architectural and structural design requirements for these special structures are the main subject of this paper. Since the complex is located in Isfahan, a very famous old city with several beautiful and ancient buildings, it was necessary for the proposed design to be harmonious with the existing situation. In general, the arch and dome-shaped forms were used in the most important parts of the building with special attention to the application of new material and technology. Both concrete and steel structures were utilised in the complex for the following two important special structures.

1. **Main Court (Praying Hall):** The architectural design required a column-less roof over 9,600 m² (160m x 60m) area of the court. The structural system for this large area had to comply with both architectural appearance and structural performance. The architects suggested a dome-shaped roof which normally have a circular or square plan. The rectangular area of the court was therefore divided into two 60m x 60m squares and two 20m x 60m rectangles (one between and one outside the squares). The covering system for square parts of the plan were two spherical domes supported on four edge beams. The maximum rise from the corner supports of the edge beams and spherical dome are 12 and 20 meter respectively. The corner supports are themselves located 15 meters above the ground level to give a 35m height for the top of the dome. The roof for the other rectangles (20m x 60m) is a type of tire-shaped structure supported on the edge beams of the adjacent spherical domes. As for the structural material, the first decision was the use of reinforced concrete shell but due to a number of parameters including: a) very large formwork surface, b) a large amount of scaffolding, c) special problems encountered for a cast-in-situ thin shell concrete placement and curing and finally the construction time, it was decided to use a steel structure for this part of roof system. Two alternatives were considered for this structure: space truss or space frame (both in dome shaped). The required structural depth for space truss was about 3 meters with a rather unpleasant and congested bar elements, while a space frame required a shallow depth (600mm) consisting of curved steel box sections. To provide a suitable harmony and agreement between these steel frame grids and the existing traditional architecture of Isfahan, different shapes were surveyed and finally a famous symmetrical design was adopted from an existing eight-hundred-year old mosque in the city. The frame elements have the same shape and design of the old mosque (Fig 1).
2. **Concrete Shell Roofs:** The praying hall is surrounded with a total area of 8,400m² consisting of 21 square chambers each covering an area of 400m² (20m x 20m). The structural engineers proposed a concrete-shell spherical dome for each unit. The design was changed later from a spherical to an ellipsoid dome to provide a more attractive appearance. The main design problem for the dome was that the plan area to be covered was a 20-meter square while the horizontal cross-section of the dome was a circle. The optimum solution was then to use four elliptical edge beams on the sides of the square. The shell is a half ellipsoid with small and big diameters of 20 and 28 meters respectively. The

shell thickness at most parts is 100mm and near the edge connection 150 mm . Each 20m x 20m chamber consists of three stories and the mentioned ellipsoid concrete shell covers its third floor (Fig 2).

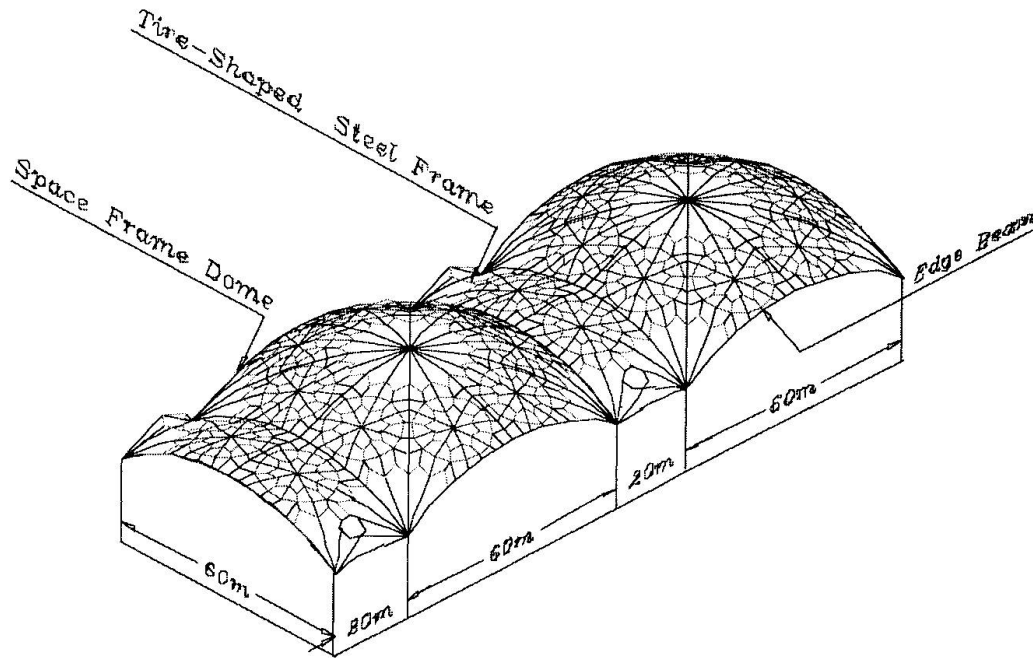


Fig. 1 Steel grid dome roof for the praying hall

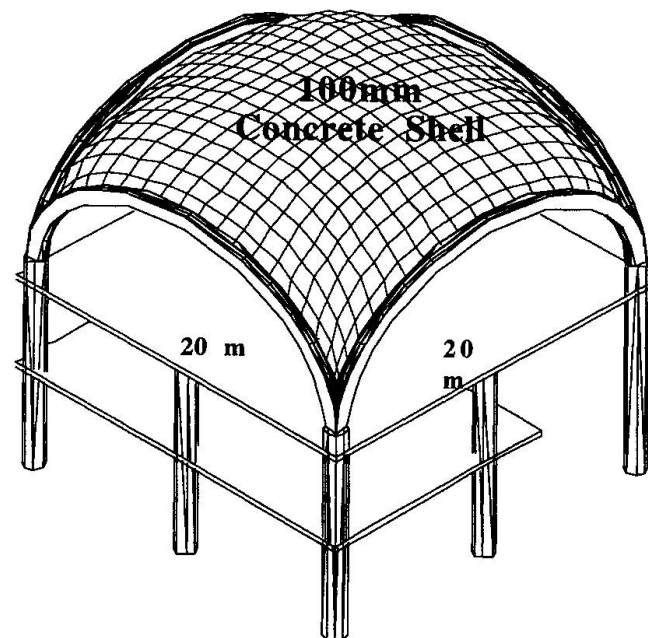


Fig. 2 A three-story 20m x 20m chamber unit with its ellipsoid 100mm concrete shell roof