A Study on Architectural Plans of Dome

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Abstract* – *Concepts such as meditation center, amusement park, actually designed for iconic monuments like Dome, Taj Mahal, Lotus Temple, etc., commercial mall, residential or office building. The shape, design and technology itself will become internationally attracted building. The shape of the building is star shaped. The building will stand on single point of conical arms of star attached to the sphere making it look like a star. The external shell of the life star building will revolve around the structure from outside and the elevation will look as if the whole building is revolving on one single point. The technology used to make the building stand on one single point will be based on magnetic field and gravitational energy in balance with wind, rain and sun habbits. The life star building structure can be built in structural steel , Reinforced Cement Concrete , etc. This building will make use of maximum solar panels instead of glass where ever required for exterior facade taking care the aesthetics of elevation of the building. Landscape designing includes rain water harvested in underground drainage sprinklers.

Keywords: Building, Architecture, Life, Star

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1. INTRODUCTION

A dome (from Latin: domus) is an architectural element that resembles the hollow upper half of a sphere. The precise definition has been a matter of controversy. There are also a wide variety of forms and specialized terms to describe them. A dome can rest upon a rotunda or drum, and can be supported by columns or piers that transition to the dome through squinchesor pendentives. A lantern may cover an oculus and may itself have another dome.

Domes have a long architectural lineage that extends back into prehistory and they have been constructed from mud, snow, stone, wood, brick, concrete, metal, glass, and plastic over the centuries. The symbolism associated with domes includes mortuary, celestial, and governmental traditions that have likewise developed over time.

Domes have been found from early Mesopotamia, which may explain the form's spread. They are found in Persian, Hellenistic, Roman, and Chinese architecture in the Ancient world, as well as among a number of contemporary indigenous building traditions. Dome structures were popular in Byzantine and medieval Islamic architecture, and there are numerous examples from Western Europe in the middle Ages. The Renaissance architectural style spread from Italy in the early modern period

Advancements in mathematics, materials, and production techniques since that time resulted in new dome types. The domes of the modern world can be found over religious buildings, legislative chambers, sports stadiums, and a variety of functional structures.

Fig 1 The dome of St. Peter's Basilica in Rome

2. ETYMOLOGY

The English word "dome" ultimately derives from the Latin *domus* ("house") from ancient Greek δόμος (dómos), which, up through the Renaissance, labeled a revered house, such as a *Domus Dei*, or "House of God", regardless of the shape of its roof. This is reflected in the uses of the Italian word *duomo*, the German/Icelandic/Danish word *dom* ("cathedral"), and the English word *dome* as late as 1656, when it meant a "Town-

House, Guild-Hall, State-House, and Meeting-House in a city." The French word dosme came to acquire the meaning of a cupola vault, specifically, by 1660. This French definition gradually became the standard usage of the English dome in the eighteenth century as many of the most impressive Houses of God were built with monumental domes, and in response to the scientific need for more technical terms.

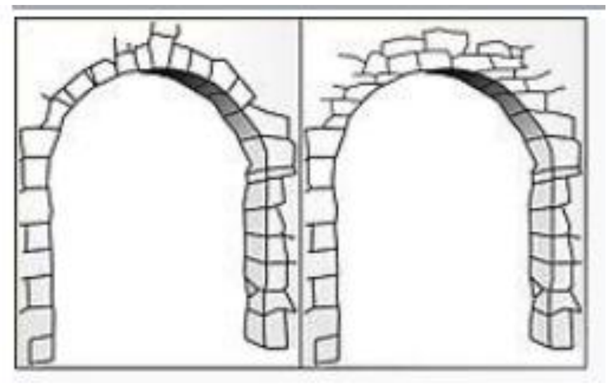

Fig 2 Comparison of a generic "true" arch (left) and a corbel arch (right)

A dome is a rounded vault made of either curved segments or a shell of revolution, meaning an arch rotated around its central vertical axis. The terminology used has been a source of controversy, with inconsistency between scholars and even within individual texts, but the term "dome" may be considered a "blanket-word to describe an hemispherical or similar spanning element." A half-dome or semi-dome is a semi-circular shape often used, especially in apses.

Sometimes called "false" domes, corbel domes achieve their shape by extending each horizontal layer of stones inward slightly farther than the lower one until they meet at the top. A "false" dome may also refer to a wooden dome. "True" domes are said to be those whose structure is in a state of compression, with constituent elements of wedge-shaped voussoirs, the joints of which align with a central point.

The validity of this is unclear, as domes built underground with corbelled stone layers are also in compression from the surrounding earth. The Italian use of the term finto, meaning "false", can be traced back to the 17th century in the use of vaulting made of reed mats and gypsum mortar.

As with arches, the "springing" of a dome is the level from which the dome rises. The top of a dome is the "crown". The inner side of a dome is called the"intrados" and the outer side is called the "extrados". The "haunch" is the part of an arch that lies roughly halfway between the base and the top.The word "cupola" is another word for "dome", and is usually used for a small dome upon a roof or turret. "Cupola" has also been used to describe the inner side of a dome.

Drums, also called tholobates, are cylindrical or polygonal walls with or without windows that support a dome. A tambour or lantern is the equivalent structure over a dome's oculus, supporting a cupola.

3. INTERNAL FORCES

A masonry dome produces thrusts down and outward. They are thought of in terms of two kinds of forces at right angles from one another. Meridional forces (like the meridians, or lines of longitude, on a globe) are compressive only, and increase towards the base, while hoop forces (like the lines of latitude on a globe) are in compression at the top and tension at the base, with the transition in a hemispherical dome occurring at an angle of 51.8 degrees from the top.

The thrusts generated by a dome are directly proportional to the weight of its materials. Grounded hemispherical domes generate significant horizontal thrusts at their haunches.

Unlike voussoir arches, which require support for each element until the keystone is in place, domes are stable during construction as each level is made a complete and self-supporting ring. The upper portion of a masonry dome is always in compression and is supported laterally, so it does not collapse except as a whole unit and a range of deviations from the ideal in this shallow upper cap are equally stable. Because voussoir domes have lateral support, they can be made much thinner than corresponding arches of the same span. For example, a hemispherical dome can be 2.5 times thinner than a semicircular arch, and a dome with the profile of an equilateral arch can be thinner still.

The optimal shape for a masonry dome of equal thickness provides for perfect compression, with none of the tension or bending forces against which masonry is weak. For a particular material, the optimal dome geometry is called the funicular surface, the comparable shape in three dimensions to a catenary curve for a two-dimensional arch. The pointed profiles of many Gothic domes more closely approximate this optimal shape than do hemispheres, which were favored by Roman and Byzantine architects due to the circle being considered the most perfect of forms. Adding a weight to the top of the pointed dome, such as the heavy cupola at the top of Florence Cathedral, changes the optimal shape to perfectly match the actual pointed shape of the dome.

The outward thrusts in the lower portion of a hemispherical masonry dome can be counteracted with the use of chains incorporated around the circumference or with external buttressing, although cracking along the meridians is natural. For small or tall domes with less horizontal thrust, the thickness of the supporting arches or walls can be enough to resist deformation, which is why drums tend to be much thicker than the domes they support.

4. ZONE OF TRANSITION

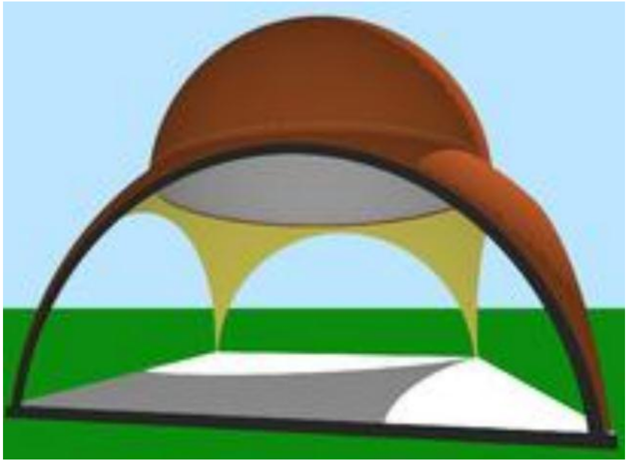

Fig 3 A compound dome (red) with pendentives (yellow) from a sphere of greater radius than the dome

A compound dome (red) with pendentives (yellow) from a sphere of greater radius than the dome. An example of quadrangular to circle transition .The mosque of Isfahan international conference center. When the base of the dome does not match the plan of the supporting walls beneath it (for example, a dome's circular base over a square bay), techniques are employed to bridge the two. One technique is to use corbelling, progressively projecting horizontal layers from the top of the supporting wall to the base of the dome, such as the corbelled triangles often used in Seljuk and Ottoman architecture. The simplest technique is to use diagonal lintels across the corners of the walls to create an octagonal base. Another is to use arches to span the corners, which can support more weight. A variety of these techniques use what are called "squinches". A squinch can be a single arch or a set of multiple projecting nested arches placed diagonally over an internal corner. Squinches can take a variety of other forms, as well, including trumpet arches and niche heads, or half-domes.

The invention of pendentives superseded the squinch technique. Pendentives are triangular sections of a sphere, like concave spandrels between arches, and transition from the corners of a square bay to the circular base of a dome.

The curvature of the pendentives is that of a sphere with a diameter equal to the diagonal of the square bay. The precise definition of "pendentive" has been a source of contention among academics, including whether or not corbelling is permitted under the definition and whether or not the lower portions of a sail vault should be considered pendentives.

Domes with pendentives can be divided into two kinds: *simple* and *compound*. In the case of the *simple dome*, the pendentives are part of the same sphere as the dome itself; however, such domes are rare. In the case of the more common *compound dome*, the pendentives are part of the surface of a larger sphere below that of the dome itself and form a circular base for either the dome or a drum section.

5. ACOUSTICS

Because domes are concave from below, they can reflect sound and create echoes. A dome may have a "whispering gallery" at its base that at certain places transmits distinct sound to other distant places in the gallery.

The half-domes over the apses of Byzantine churches helped to project the chants of the clergy. Although this can complement music, it may make speech less intelligible, leading Francesco Giorgi in 1535 to recommend vaulted ceilings for the choir areas of a church, but a flat ceiling filled with as many coffers as possible for where preaching would occur.

Cavities in the form of jars built into the inner surface of a dome may serve to compensate for this interference by diffusing sound in all directions, eliminating echoes while creating a "divine effect in the atmosphere of worship." This technique was written about by Vitruvius in his Ten Books on Architecture, which describes bronze and earthenware resonators. The material, shape, contents, and placement of these cavity resonators determine the effect they have: reinforcing certain frequencies or absorbing them.

Materials

The earliest domes in the Middle East were built with mud-brick and, eventually, with baked brick and stone. Domes of wood allowed for wide spans due to the relatively light and flexible nature of the material and were the normal method for domed churches by the 7th century, although most domes were built with the other less flexible materials.

Wooden domes were protected from the weather by roofing, such as copper or lead sheeting. Domes of cut stone were more expensive and never as large, and timber was used for large spans where brick was unavailable.

Roman concrete used an aggregate of stone with a powerful mortar. The aggregate transitioned over the centuries to pieces of fired clay, then to Roman bricks. By the sixth century, bricks with large amounts of mortar were the principle vaulting materials. Pozzolana appears to have only been used in central Italy. Brick domes were the favored choice for large-space monumental coverings until the Industrial Age, due to their convenience and dependability. Ties and chains of iron or wood could be used to resist stresses.

The new building materials of the 19th century and a better understanding of the forces within structures from the 20th century has opened up new possibilities. Iron and steel beams, steel cables, and pre-stressed concrete have eliminated the need for external buttressing and enabled far thinner domes.

Whereas earlier masonry domes may have had a radius to thickness ratio of 50, the ratio for modern domes can be in excess of 800. The lighter weight of these domes has not only permitted far greater spans, but also allowed for the creation of large movable domes over modern sports stadiums. Experimental rammed earth domes were made as part of work on sustainable architecture at the University of Kassel in 1983.

Symbolism

According to E. Baldwin Smith, from the late Stone Age the dome-shaped tomb was used as a reproduction of the ancestral, God-given shelter made permanent as a venerated home of the dead. The instinctive desire to do this resulted in widespread domical mortuary traditions across the ancient world, from the stupas of India to the tholos tombs of Iberia. By Hellenistic and Roman times, the domical tholos had become the customary cemetery symbol.

Domes and tent-canopies were also associated with the heavens in Ancient Persia and the Hellenistic-Roman world. A dome over a square base reflected the geometric symbolism of those shapes. The circle represented perfection, eternity, and the heavens. The square represented the earth.

An octagon was intermediate between the two. The distinct symbolism of the heavenly or cosmic tent stemming from the royal audience tents of Achaemenid and Indian rulers was adopted by Roman rulers in imitation of Alexander the Great, becoming the imperial baldachin. This probably began with Nero, who’s "Golden House" also made the dome an essential feature of palace architecture. The dual sepulchral and heavenly symbolism was adopted by early Christians in both the use of domes in architecture and in the ciborium, a domical canopy like the baldachin used as a ritual covering for relics or the church altar. The celestial symbolism of the dome, however, was the preeminent one by the Christian era. In the early centuries of Islam, domes were closely associated with royalty. A dome built in front of the mihrab of a mosque, for example, was at least initially meant to emphasize the place of a prince during royal ceremonies. Over time such domes became primarily focal points for decoration or the direction of prayer. The use of domes in mausoleums can likewise reflect royal patronage or be seen as representing the honor and prestige that domes symbolized, rather than having any specific funerary meaning.

6. CONCLUSION

Domes built with steel and concrete were able to achieve very large spans. In the late 19th and early 20th centuries, the Guastavino family, a father and son team who worked on the eastern seaboard of the United States, further developed the masonry dome, using tiles set flat against the surface of the curve and fast-setting Portland cement, which allowed mild steel bar to be used to counteract tension forces. The thin domical shell was further developed with the construction by Walther Bauersfeld of two planetarium domes in Jena, Germany in the early 1920s. They consisting of a triangulated frame of light steel bars and mesh covered by a thin layer of concrete. These are generally taken to be the first modern architectural thin shells. These are also considered the first geodesic domes. Geodesic domes have been used for radar enclosures, greenhouses, housing, and weather stations. Architectural shells had their heyday in the 1950s and 1960s, peaking in popularity shortly before the widespread adoption of computers and the finite element method of structural analysis.

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