Geodesic Structures

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Abstract: In this paper I would like to bring into attention the beauty of the dome-type structures as well as the geodesic sphere.
I will present examples of functional solutions following theoretic aspects, classifications, advantages and disadvantages, materials and techniques of execution.
In the end I propose a project for the refurbishing of the classic water castles.
Keywords: dome sphere geodezic watercastle.

1. INTRODUCTION

Building of a geodesic dome is based on the layout of an icosahedron into a sphere, following which each plane face is to be sectioned into a network of smaller triangles (figure 1) or hexagons (figure 2), which are subsequently projected onto the sphere. The edges of the triangles that were thus obtained are to be approximated to right line segments that are to form the geodesic network of the dome, in order to evenly undertake and distribute the mass of the structure.
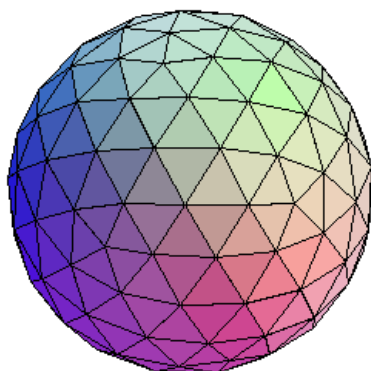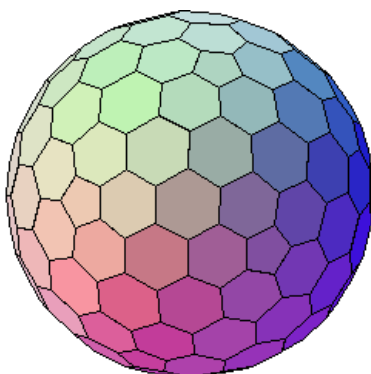

Fig. 1.Triangular geodesic sphere [1]

Fig. 2. Hexagonal geodesic sphere [2]

2. CLASSIFICATIONS

The classification of the geodesic dome is made according to the main polyhedron, according to the number and the type of the sub-divisions, the "latitude" where the geodesic sphere is cut in order to obtain the dome.

According to the type of triangulation of the main polyhedron, the geodesic domes are divided into classes:
-CLASS I parallel division to the side ;
-CLASS II perpendicular division on the side ;
-CLASS III any other type of possible triangulation.
The number of the segments into which is divided each line of the main polygon during the triangulation process is called frequency [3].

To make an icosahedron approximate a sphere more closely, the triangles making up the icosahedron are subdivided by splitting the edges of the triangle and then making the new split edges into more triangles. As in the figures 3,4,5, splitting each edge into n new edges yields n^2 new triangles. [4]
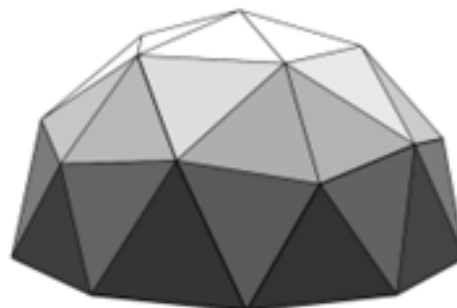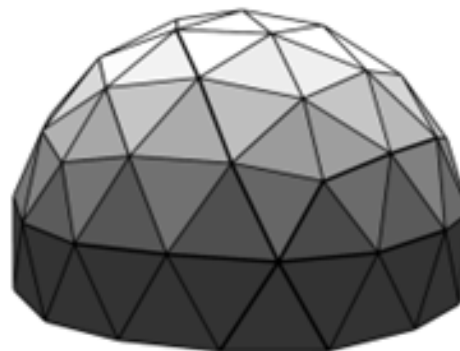

Fig. 3. A 2v geodesic dome

Fig. 4. A 3v geodesic dome

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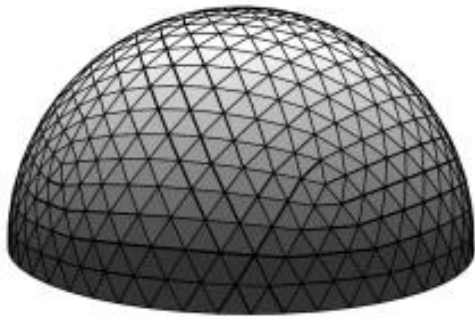
Fig. 5. A 10v geodesic dome

3. THE ADVANTAGES OF THE GEODESIC STRUCTURE

The force put into a corner of a triangle is directly transmitted to the base of the triangle. Since an icosahedron is made up of triangles, the force is distributed throughout the shape. The icosahedron can collapse from one of the joints between separate triangles bending, but that's still a very strong structure.

Dome-type homes are extremely energy-efficient due to the shape, and very resistant to natural disasters, strong winds or devastating earthquakes. Another quality of the dome-type homes is the low construction cost as compared to a regular home built on the same surface.

Specialized companies usually deliver kits to build up the dome-home, that the owner and a couple of friends can assembly with no cranes or other special machines. The structure is self-portent, which leads to multiple choices when it comes for interior subdivision. Warmth, light, noise are equally distributed.

Fig. 6. Dome house [5]

Nowadays, geodesic domes are known as being the most efficient building system, Anvelope /volume proportion being small.

Other advantages of the structure are its esthetics and the special attractiveness and this is why it is also recommended for public buildings and for touristic attractions, as well.

4.GEODESIC STRUCTURES IN ROMANIA

Such a dome was built in 1977 by eng. POP Liviu in Oradea. It is the botanical Greenhouse on the Aleea Strandului which now has become the Research Centre of the Oradea University.

Another recognized accomplishment is also the Botanical Garden [figure 7] in Jibou, built by the same engineer and designed by the architect Zisu Valentin, 1978.

Fig. 7. Botanical Garden in Jibou , SALAJ

5. GEODESIC STRUCTURES IN THE SUA

Expo 67 featured 90 pavilions representing Man and His World themes, nations, corporations, and industries including the US pavilion, a geodesic dome [figure 8] designed by Buckminster Fuller.

Two prominent buildings remain in use on the former Expo grounds: the American pavilion's metal-lattice skeleton from its Fuller dome, now enclosing an environmental sciences museum called **the Montreal Biosphere** and Habitat 67, now a condominium residence.

Fig. 8. Biosphere Montreal Expo

Fig. 9 Cinesphere Toronto

Cinesphere is the world's first permanent Imax movie theatre, built in 1971. Its design is of a triodetic-domed structure, akin to a Geodesic Dome, figure 9. The theatre is located on the grounds of Ontario Place in Toronto, Canada. In 2011, the original projection system was replaced with an IMAX GT 3D system and new NEXIOS playback system.

Fig. 10. University in Marquette

The Superior Dome, which opened as the "world's largest woodendome" on 1991, is a domed stadium on the campus of Northen   Michigan University in Marquette, USA. It is home to the Northern Michigan Wildcats football team, as well as a variety of campus and community events. The dome is 14 stories tall, has a diameter of   163.4 m, and covers an area of   21,000 m². It is a geodesic dome constructed with 781 Douglas Fir beams and 175 km of fir decking. The dome is designed to support snow up to 2.87 kPa and withstand 130 km/h winds. It has a permanent seating capacity of 8.000 though the building can hold as many as 16.000 people. The "Book of World Records-2010" listed it as the fifth-largest dome and largest wooden dome in the world, (fig. 10,11).

Spaceship Earth is the biggest geodesic dome, with a height of 55m, located near Orlando, Florida. Designed to face winds blowing up to 320km/h, it is built from a steel structure covered with aluminum

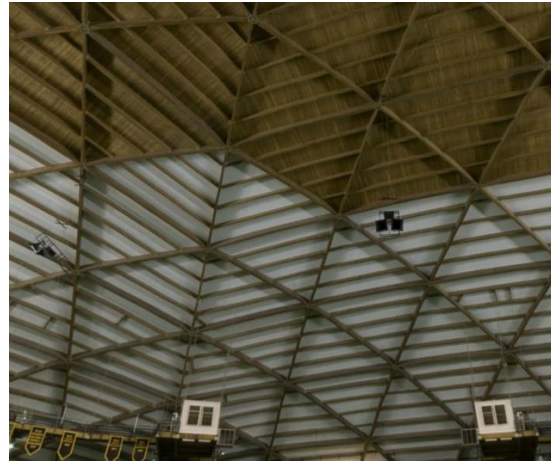panes and supported on 3 pairs of metallic legs 9m wide, that lift it to 4,5m above the ground. [6]

Fig. 11.Insied Dome

The structure of the geodesic dome consists of 1450 metallic bars covered with a waterproof neoprene. External closure is made of about 1000 triangular aluminum panes fixed by bolts on the metallic structure. The sphere has a diameter of 50m and a volume of 62.000 cubic meters, figure11.

The tourists visit the 17 interior levels on a 400m long dark corridor in spiral, with automatic transporting lanes or small boats. There is also a telecommunication system through optic fiber, a pneumatic system to remove the waste that are subsequently used   as fuel to produce the air conditioning. There is also a central security system that monitors 4000 critical points in case of fire or failure. The power is produced by 80.000 solar cells that provide 70 kW.

The contractor, Walt Disney, worked for 10 years with cu 600 engineers, 1.200 consultants and 5.000 workers for the amusement park that cost more than 1 billion $.
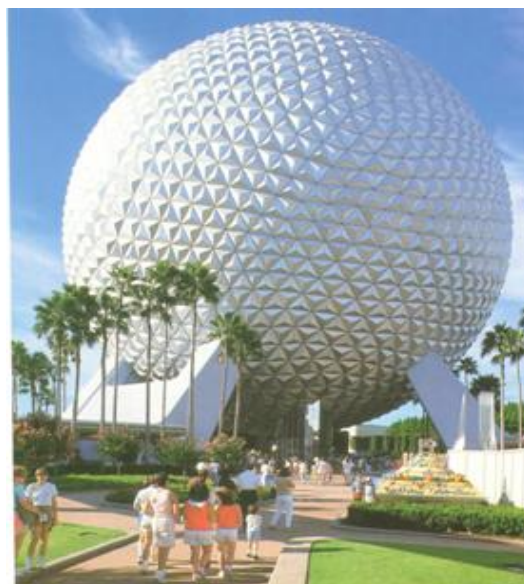

Fig. 11. Epcot Dome, Florida

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6. REFURBISHING OF THE WATERCASTLES IN ORADEA

The project for the refurbishing of the castles used as water tanks at height, came as a wish to reuse these investments dating since the 1975s, giving them both architectural and touristic values.

There are also concerns for cities like Bucharest, Arad, Timisoara and Braila but, due to financial or ownership obstacles, they could not be accomplished yet.

There are four water castles in Oradea, with a volume of 500 cubic meters and heights of about ~30m, not in use, one of them (figure 13) belonging to the Water Company. As its demolishing is not a safe solution because of the inhabited area, (see Medias), it is intended to be transformed into a touristic attraction and a Bellevue.
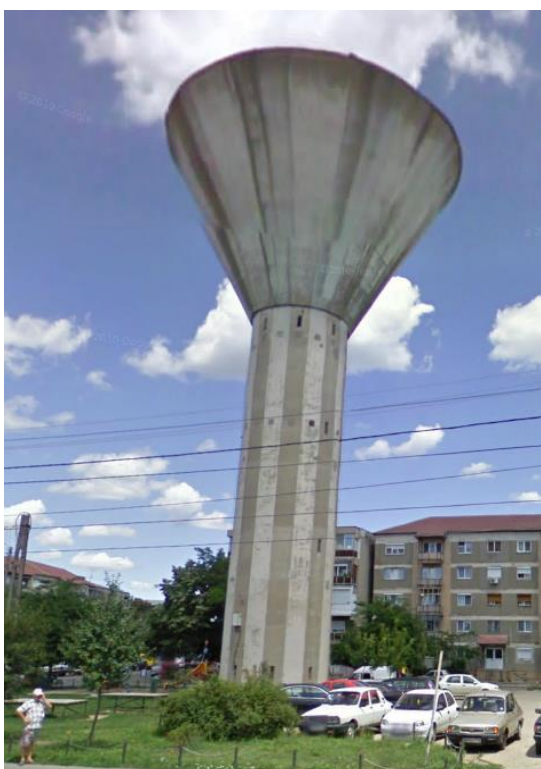

Fig. 13. Water castle Lacul Rosu Oradea

The tank will have a geodesic dome made of fiber glass on metallic structure, with a diameter of 12m.

According to an Agreement closed between the Faculty of Constructions and Architecture, the Water Company and Oradea City Hall, it is intended to attract European funds and to realize the project.

Fig. 14. Water castle in Kuweit

7.CONCLUSION

A sustained effort, is what is needed in order to bring a suplly of beautiness   to nowerdays environment, figure 14.

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