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## **A Mini Review of Roof Structure Technologies for Stadiums based on Cortical Layer**

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### **Abstract**

recently, with increasing of interest of all people especially young people and teenagers to sports in Iran in parallel the tendency of investors both in governmental and private parts is increased ,and in this part the special places and spaces of sport was not departed , and billion Rials (Iran's currencies) is paid for making some places for sport or equipped the old building .In this part football stadium are very important , on the one hand , the grass of playground need water and light but the shade of sits of fans make some problems for the grass , but on the other hand , in Europe , in most stadium they have made roof for stadium and in some cases they are equipped with moving roof for making more comfortable place for roof .The aim of this research is the review of technology of making the roof in stadium .This research is the over viewing of present essay .Today's it is used from cortical layer technology from material ETFE which is very useful for stadium because of special characteristics.

**Keywords:** stadium, roof structure, technology.

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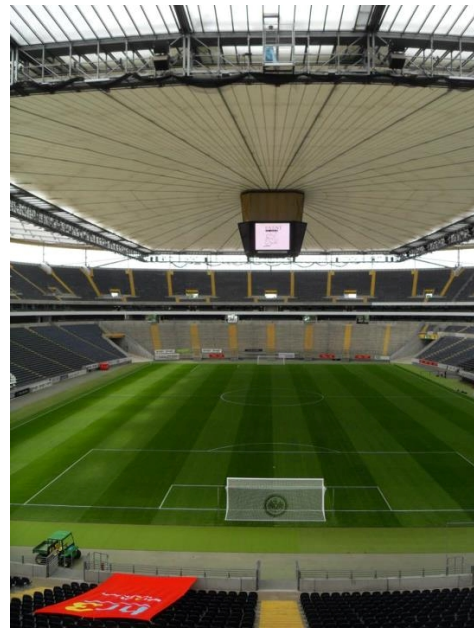
## Introduction

Today's, sport as a social symbol is improved with gradual changes and evolution, so the presence of improved facilities and suitable subtraction is essential (1). This case itself is caused the increase intendency of governmental and private parts for investments. But from the one hand, control process and heed of certain standards in making the stadium is concerned less. Determine of standards or proper models are one of the important stages in control process (2). These standards are consisting of 4 groups (2):

- a) Historical standards,
- b) Engineering standards,
- c) Subjective standards,
- d) External standards.

Besides, when we talk about stadiums, the first name which crystalline in our mind is "Coliseum (Amphitheatre)", the place of gladiators' battles and maritime simulated. The first stadium in history had 50000 capacities and it was multi stadium and the roof was of the thick cloth (canvas) and also ropes for protection the fans in front of the water and bad weather (3). As we know, today's all European stadiums are equipped with roof and in some cases with movable roof in order to make more comfortable place for fans (picture 1). The grass in stadium needs light and water and the shade of roof makes some problems .In this case and also if

this cover is inscrutable in front of the ultraviolet ray, it will make much more cost for officials. So, the aim of this research is the reviewing of technology of making roof in stadiums (3).



Picture 1. *Removable roof with central cube video.* Commerzbank Arena/ Frankfurt/ Capacity: 51500 people (4).

## Materials and Methods

This research is the kind of reviewing and it was done according to librarian studies and over viewing essays and presence of books.

## The Technology Related to the Roof

The Process of evolutionary technology of roofs is as follow (3):

### A) Bracing Membranes

1. The roof consist of two concrete curved bowed which and for their weights, the cable made some tension which these roofs also should tolerate the weights of cables.

2. The stable system with less cost which suits for circle roofs. In this roof, a group of vertical cables connect the central tension steel ring to external concrete ring. The cover of roof is consist of a lot of pre making concrete slabs wedge which by ending hook is connected to vertical cables and finally this roof is solid and less swing. Drainage this roof is done with pumping of rain by pumping the external edge of the roof.

### B) Roofs based on Air

1. Balloons roofs or bubbles which is made of weaved plastic for pools, tennis saloons and other places also used .they can be flatted with a little compression and can make some shapes such as stable ovals .Addition compression equal to psf3 till psf6 is enough to make them stable. For entrance to these structures, they use battalions doors, even the doors is used a lot, the decrease of pressure is a little .the decrease of pressure alternatively controlled by pressure grade and compensated, big domes oh the radar sets is working in this way which they are made by very thin plastic layer which don't make any disorder in transferring the receiving and sending electromagnetic .The balloon used as concrete frame in igloos which was designed

by "Salvadori". Steel straight net is over the balloons which concrete layer with some thickness by machine is spread on it. This kind of concrete is called "gunite". When the concrete will be solid, they will empty the inside air and it will be moved to other place.

2. Parabolic Hyperbolic Horse saddle Roofs, [this kind of roof was used in Mexico City stadium (picture 2)]. This roof is made of steel pipe which is in length in straight begetter. Disorder flexural in the edge of layer related with local flexural in pipes in oval roofs (4).



Picture 2. *Parabolic Hyperbolic Horse saddle Roofs.* Mexico City stadium/ Estadio Azteca (5).

## The New Technology of Stadiums' Roof Making

The most part of the roof in some stadiums has anti-air and anti-water cortical cover. this cover is on the subsidiary members with curved steel pipe and among upper chords and for shaping the horse saddles in the side of this chords is stretched tightly, another

chords stretched between lower chords which is used as closed the view of stadium (3, 6) (picture 3).



Picture 3. *A View of the Allianz Arena's replica/ Munich/ Construction: 2005-2002/ Capacity: 69901 people (7).*

As for making 2 layers, both layers should guarantee the transferring of light .the layer from roof should be open able till the pressure balance is made between two layers. Transferring of sound is also important .The speakers are placed in spaced situations and finally the mechanical strength of layer should be also guaranteed (6-8). According to picture 3 Alianz Arena the designers (Jacques Herzog, Pierre de Meuron) were not followed the ancient model as before. They said that making stadium is not just engineering work but also cultural characteristics. The inspiration for the design of the stadium was not architecture based on tensile structures and truss systems or not the idea of building a suspension bridge but it was based on picture collage of football players showing in a

Baroque theater. The roof cover (which has area about 37600 m<sup>2</sup> covering) and external view of stadium which is united is the cover consists of ETFE system (glassical tissue) which is put as diamond mass. This system consists of some lightening elements which such as big LED that can be change in different colors.

This system is adjusted according to the team which have play on the playground such as FC Bayern München that they are red and white, and white and blue for München 1860 club that they have blue cloths; the color are changed by the digital controlled transmission system that they push colored gas into the ETFE [Ethylene Tetra Fluoro Ethylene has the well keep clean characteristic and not combustibile; and recently it has been extended such as network membrane; and it is ideal for use in dual system. Its permeability against pressure is showed that higher layer are not exposed to excessive load (6-8)] diamond (6, 7). The internal edge of roof is fixed in the base and the steel structure is covered by glass (picture 4) (3, 6, 8).

In the blowy layer some cortical ingredients with Aluminium dressing was based to the steel structure. The cover of the roof can absorb the heat expansion although there is needed some expansion seam in the view. In the rain time, the extra water is gathered in the holes, the special system of gathering additional water will prevent the additional weight on the system. with bring

the lower edge about 0/02 mm from the surface of ground can be prevent from disturbance, although if any damage is happen it can be compensate .the material ETFE also is resistance in front of the fire.

And also it is resistance in front of the ultraviolet ray but nearly all waves can go through it and reach to the playground and as a result it helps to keep the grass of playground (6, 8).



Picture 4. *ETFE Diamond-shaped masses and established bases on steel structure covered with glass display at the Allianz Arena (6-8).*

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