



SUITABLE STADIUM ROOF COVERING MATERIALS FOR NIGERIAN CLIMATE

INTRODUCTION

Long gone are the days when the objective was to pack as many people as possible into a stadium, most of them in standing areas, without any cover against the climatic elements of sun, rain, snow etc. In recent decades, there has been a shift towards designing stadia with every sense of comfort. This has been driven primarily by the introduction of stricter safety regulations, but also by a greater recognition of the fact that spectators should be able to enjoy watching events in comfort. Mohammed Khalid Omar R. (2016) Khalid Department of Architecture Engineering University of Sharjah. Increasing stadium comfort by providing seat tiers should also be appreciated by the provision of cover to provide the needed comfort. This however is lacking in Nigeria, as only very few stadia have roof covers over the spectators.

Modern stadiums should be designed so that all spectators are safe and comfortable and have a perfect view of the pitch and also without any shadow casting over the pitch, for a better view and camera coverage. Sitting in a stadium event is regarded as more comfortable than standing if cover is provided, Lord Justice Taylor (1992) final report.

SHADOW CASTING OVER THE PLAYING PITCH

Over the years it has been observed that stadium roof covers made of opaque materials cast shadows on the playing pitch, this shadow casting causes distortion and confusion to the player in the pitch it equally causes poor video recording to the media personnel's. In solving this shadow casting effect an option of using transparent roofing material has been recommended by FIFA. The world football governing body which works perfectly.

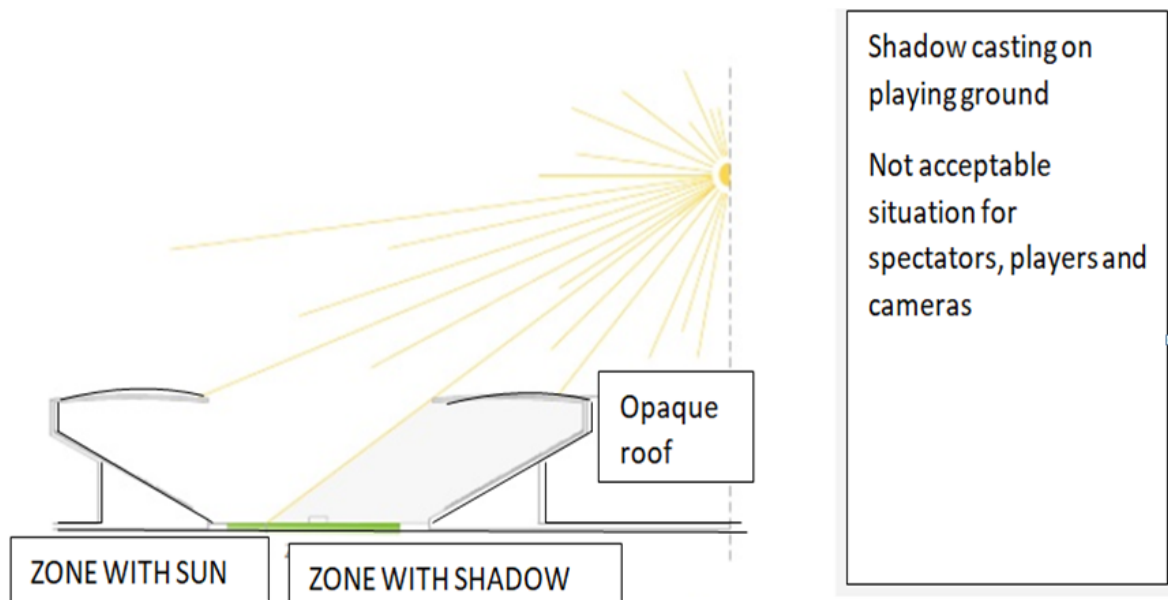


Fig1. Shadow casting on the field of play with an opaque roofing material

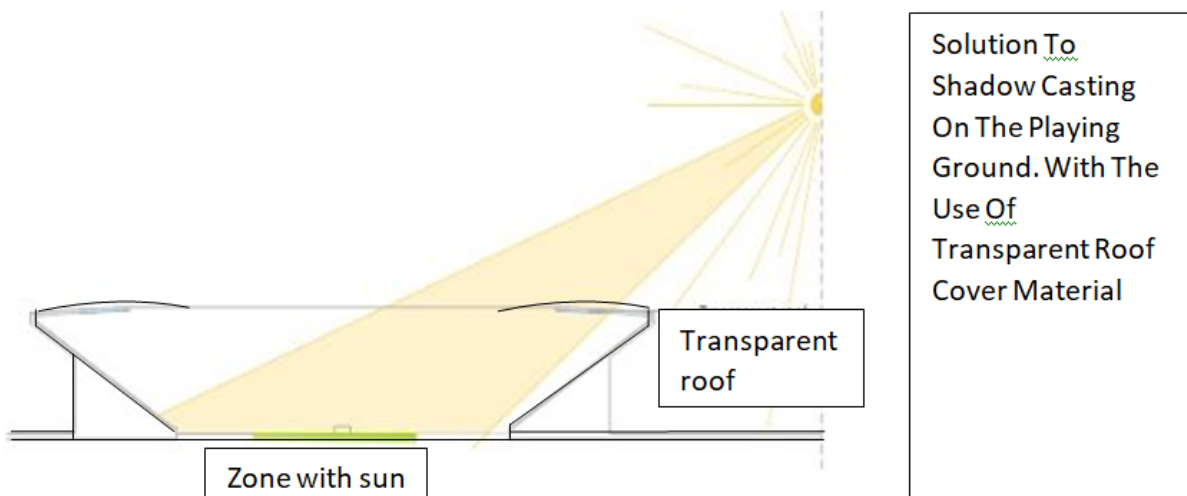


Fig2. The sun rays passing through a transparent roof cover onto the field of play.

Football Stadia is usually oriented with the goal posts facing the North and South, to avoid the players and goal keepers having to face the sun rays directly. Furthermore, due to the movement of the sun from the east, through the south, to the west, this gives reasons why most stadiums locate their main stand in the west in order to back the sun in the evening time, which is mostly the time for stadium match events. Though the pattern is expected to vary with seasons and as regards to the stadium location.

In addition, translucent or transparent roof covering materials gives the advantage of reducing shadow casting on the stadium pitch, it also reduces the radio and television transmission

interferences, and also the growth of the stadium natural grass. Though Glass is said to be the most transparent medium, but in the case of roof cover discussed in this study, polycarbonate and GRP both could provide the highest of about 85% light transmission, while PVC coated polyester fabric and PTFE coated glass fibre fabric can also provide transmission of light to a certain recommendable extent. A list of an example of translucent roofs in major stadiums includes, Watford stadium, wembley (England) stadium and the munich stadium (Germany).



Fig3. Watford Stadium with translucent PVC. Vaulted shell roof cover. Source; internet

MATERIALS FOR ROOF STRUCTURAL ELEMENTS

In providing a cover for an arena or a stadium, it comprises of two separate elements attached together, one providing the support while the other provides the needed shelter or cover. These elements or components include.

ROOF STRUCTURAL ELEMENTS:

This is the structural support that holds and supports the roofing system, the roof structure helps to transfer load from the roof top to the ground or to some other element that then transfers the load to the ground, e.g column, beams, trusses etc. Material for roof structural elements includes:

- **TIMBER:** timber could be used for structural support, however care should be taken that they are properly treated with preservatives against insect attack. Coating should also be done for protection against fire and the spread of flames. Softwood is more recommendable as it has some ability to resist both tensile and compressive forces. An important demerit of timber is its creep, when first loaded timber deforms elastically and over a period of time its deformation increases. Timber have varying degree of durability depending on the species. Its starts decaying if the moisture content is above 22% In the case of spanning a long distance the use of timber could pose a difficult task.

- **CONCRETE:** being able to be molded into shapes is a major advantage of concrete, a wide range of shapes, forms, textures and finishes could be produced, and concrete is also known to be economically cheap. Concrete demands less maintenance, it provides good protection for steel and other metal materials against corrosion. Concrete could be made with light weight aggregate to reduce its weight. It provides a great resistance to fire. Concrete for roof structures are better pre-cast and brought to the site than being poured in-situ, to ensure better quality and high standard of finishing.
- **STEEL:** where a cantilevered roof form is being proposed, steel is most likely to be used. Care should be taken that the steel be coated to prevent corrosion. Steel will require a long-term maintenance programme because the coated material could have a limited life. Steel has the advantage of being light weight, however this could be disadvantageous to areas where wind uplift is possible e.g coastal areas.
- **ALUMINIUM:** Aluminium in alloy form is a viable material and is used mainly where a high strength to weight ratio is required. However, because of its expensive price its use in roof structure is greatly substituted with steel.
- **STAINLESS STEEL:** stainless steel is another expensive roof structural material which have been successfully used for stand that have a cable-stayed roof construction. Because of its high cost it stainless steel it rarely used.

It is therefore very realistic to see today's roofed stadia, with their arrays of 3dimensional or specials forms as the forerunners of completely roofed, weather-controlled cities. A good example is the San-Silo Stadium in Italy.

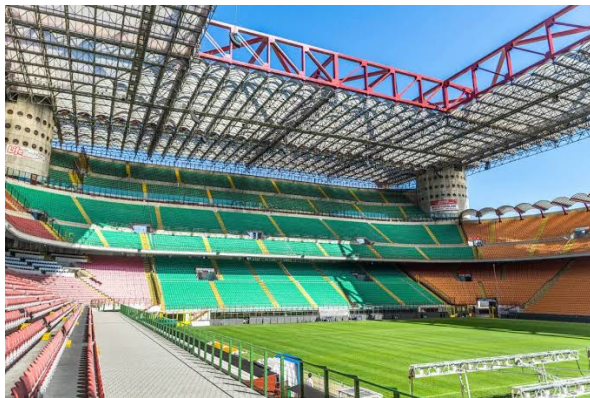




Fig4. San-Silo Stadium with a special roof structures, source; internet

MATERIALS FOR STADIUM ROOF COVER

In seeking for right material for roofing of a stadium, the following properties of lightweight, toughness, water-tight, durability, incombustible, transparency, aesthetics, cost-effectiveness and the ability to withstand the effect of weather conditions and the ultra-violet rays of the sun should be at the front line of consideration. Roof cover, this is simply the material used to cover the roof which provides the needed shelter of covering over the stands. This material could be attached either below or above the roof structure.

A look at the various materials used for stadium covering which includes metals, concrete, timber, plastics and fabrics in variety of shapes.

- **METALS SHEETING:**

this material is very cheap and easy to use, and one of the commonly used stand covering, it has a high strength to weight ratio and accepted as being incombustible in this case. The two most commonly used metal covering are aluminum and steel metals

- I. **ALUMINUM:**

aluminum is said to be lighter in weight than steel, though is almost indistinguishable from steel from a distance. Aluminum has a built-in resistance to atmospheric attack because of the inert-oxide film in its surface that inhibit corrosion or rust. Aluminium sheet is supplied in plain or mill finish. Colour finishes can also be obtained. Plain finished aluminium will require treatment to prevent discolouration by oxidation. Aluminium is also affected by electrolytic corrosion when in contact with other metals or concrete and chemical corrosion when in contact with wood which is frequently wetted, like being exposed to rainfall. This therefore requires separation

membrane at contact point with other materials. However in the case of roofing a stadium with aluminium, aluminium sheet does not allow the passage of light through it, thus not transparent.

II. STEEL:

steel in this case is galvanized (zinc-coated) or painted to prevent corrosion or rust. Steel can also come in different colours. However metal materials will provide the needed resistance against atmospheric attack, is also durable, water tight and incombustible, but will record very poor also in being transparent, such it will cast shadow over the playing field.

• **CONCRETE:**

For roofing purposes concrete can be pre-cast in slab or shell form, and used to span between primary structural elements, but the weight of concrete makes it very difficult to span a reasonable distance. Though concrete may be cost effective if made in curved forms and cast in a light weight aggregate. It requires little maintenance and is good in resisting atmospheric attacks. It can also incorporate decorative features, but it also has the tendency to compress and stretch when heated. However, its weight and non transparent properties prove a great demerit for use in stadium covering.

• **TIMBER:**

Safety being a major concern, timber therefore is greatly discouraged for stadium covering due to its high combustibility level and durability. However, flame resistant coating could be used to reduce the spread of flames on timber, but with the effect of atmospheric weather conditions these coating could be washed away leaving the timber materials vulnerable to flame. Though it has the great merit of being light weight, timber roof cover will still not give the needed transparency to avoid shadow casting.

• **PLASTIC:**

Plastic for covering of stadium can take various forms which includes; acrylic (Perspex, PVC or polycarbonate. Though it could be more expensive but is translucent, waterproof, corrosion free and durable. Plastic can withstand relatively large deformation without showing any structural damage. And has high impact resistance. PVC plastic becomes brittle with much exposure to the atmospheric attack like the ultra-violet ray of the sun. However Polycarbonate is considered durable under ultra-violet sun rays. Acrylic on its disadvantages catches fire easily, unless the edges are protected.

Glass Reinforced Plastic (GRP) is also feasible roof covering material; however it becomes brittle and less translucent with age and much exposure to the ultra-violet sun light.

- **FABRICS**

Fabrics are also used as roof cover materials in tensile structures the two main types of structural fabrics suitable for use in the roofing of a stadium includes

- I. PVC coated polyester fabric**

- II. PTFE (Teflon) coated glass fabric.**

PVC coated polyester fabric is easy to handle but very poor in terms of durability, it would be required to be changed after about fifteen years, because of its degradation in the effect of ultra violet sun light. PVC coated polyester demands much maintenance with age as it will collect dust and becomes stick, This proves a great challenge to the Nigerian climate, as the effect of dust in Nigeria during the dry seasons is much. PVC coated polyester fabric also tends to slacken or loosen, causing material sag with time. However, the PTFE coated glass fibre fabric has a reasonable long life, It is proved to be strong against the Ultra Violet sun rays, it is also easy to maintain as it could be made clean with just a little rain fall. This property of cleaning with rain wash proves it's adaptability to the Nigerian climatic condition. The Teflon coated fabric also has similar character with PTFE coated glass. However, these two materials are more expensive when compared to other roof covering materials. But, it would be wise if the whole life cost of the stadium should be considered, before reaching the final conclusion on which of the roof covering material to be used. Consideration should also be given to the particular locations. Materials vulnerable to degrade in quality with the effect of the ultra-violet sun light should be avoided in area with intensive sun light.

CONCLUSION

The aim of ensuring safety and comfort in the stadium and the drive for higher capacities have caused an exploration for improved materials and construction techniques in stadium design. Modern technology, have made it possible for a large vertical distance of more than 40 meters to be spanned, to be able to have roof covered arena of thousand of millimeters. The limit to the span of stadium roofing form could be determine by various factors, though there is no limit given theoretically, but the world largest cantilevered stadium spanned about 48meters which is the Husky Stadium, Seattle USA. Barcelona stadium Camp-Nou has a span of 38meters. Spanning about 50m could also be possible. The shapes of stadia have varied widely according to the variety of uses for which they were built. Several outstanding stadiums have been built. Modern technology, including that developed in the aerospace industry, already possesses techniques for covering spans of hundreds of feet. Such is the potential of the modern stadium design concept as completely roof covered stadia have been built e.g. Docklands cricket stadium Australia. However, Nigeria as a country is expected to have passed what we currently have as an international stadiums, as we could only boast of one or two stadiums of an international standards. Nigerians should also note that good sports stadium infrastructure is what gives the advantage of acceptance nod to hosting an international sports events like the world cup. With the quality and number of stadia in Nigeria, the dream of hosting the FIFA world cup will always be a mirage, as we do not have the good number of improved stadia for the local league, not to talk of hosting the African Nations cup, nor the FIFA world cup.

RECOMMENDATIONS

Stadium design is said to be very technical and so various bodies have provided some codes and requirements. These requirements are mostly provided by associations or football governing bodies at different levels: continental, national or local league levels as guide to qualification, before being accepted in such league or tournament. The world overall governing body for all soccer activities is FIFA, this body overseas football activities at the global level. In Africa, Confederation of African Football (CAF.) oversees Football Soccer events in Africa, while the NFF takes charge at the National level in Nigeria. These bodies ensure regulation of sports

activities, and also declare a stadium qualified to host sports events under their specific jurisdiction.

A careful attempt has been made in this research work to highlight the way forward for an active sports stadium infrastructural development in Nigeria, especially as regards to stadium roof cover.

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