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DESIGN AND MODELING OF JNTUA CRICKE STADIUM USING ARCHICAD 24 and LUMION 10

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ABSTRACT:

Stadiums are more than just facilities for organized sport; they offer a gathering site for people with shared interest, provide economic benefits to the surrounding community, and most importantly represent the advancements in architecture and engineering. When stadiums were first developed, their main focus was to provide enclosure for players to play and little attention was given to spectators. Under this project I would like to design and model the cricket stadium for our JNTUA campus by using the architectural software i.e. archicad24 and lumen10, and the entire analysis is done StaadPRo, ground plan designed in AutoCAD all with international standards

INTRODUCTION: Since their earliest existence in ancient Greek and Roman civilizations, stadiums have been regarded as architectural masterpieces and focal points in their surrounding cities. "Stadiums are amazing buildings. They can help to shape our towns and cities more than almost any other building type in history and at the same time put a community on the map". the design and development is an exciting challenge for all the architects and engineers involved. The Roman Colosseum is the first architecturally and structurally designed building that resembles modern-day stadiums

After a few centuries of minimal improvements in stadium development, the industry made huge advancements starting in the 19 th century. 0nce sports were properly defined and strict guidelines were set in place, architects had specific constraints to drive their designs. With new technology and an increased understanding of engineering capabilities, designers began producing one-of-a-kind stadiums that would be remembered for years to come. Throughout this thesis stadiums will be pointed out for their success and important contributions to the field of stadium design Throughout the thesis show, stadium designs have become more complex as well as more imaginative, in terms of architecture, structural systems, and materials used The latest trend is the incorporation of moving roofs which are becoming the norm and are being implemented in new construction as well as stadium renovations With the option of having a fully roofed facility and a field with natural grass, "stadiums have been evolving from one-sport stadiums to multi-use venues, and have additionally needed to meet the demands of the new era of media involvement.

The purpose of this thesis is to design a cricket stadium for the college of JNTUA as an engineering achievement. In order to accomplish this, the report is broken into nine major chapters. The first three chapters deal with the history of cricket stadiums and their existence in India in the 20th century. Following this, a second set of three chapters discusses the design considerations and factors that drive stadium designs. This includes major decisions like the basic use of the stadium, as well as smaller details like the type of steel that is needed. Once these factors are introduced, the thesis focuses on structural systems, specifically those geared towards the roof. The roof of the stadium is often the most complex and awe-inspiring thus requiring the most detail and imagination. Here I am introducing the description of the software's.

Archicad is a software tool for architects working in the architecture-engineering-construction (AEC) industry for designing buildings from the conceptual phase all through to the construction phase. It is a BIM software developed by GRAPHISOFT, enabling architects to work in a BIM (Building Information Modeling/Management) environment As we know this software was design for architectural design in 1982 and later it was also introducing in 1984 for BIM design which means its proves itself for giving detailed information about modeling of different type of building structures or architectural structures through its designing process so it has now good impact on architectural design industries.

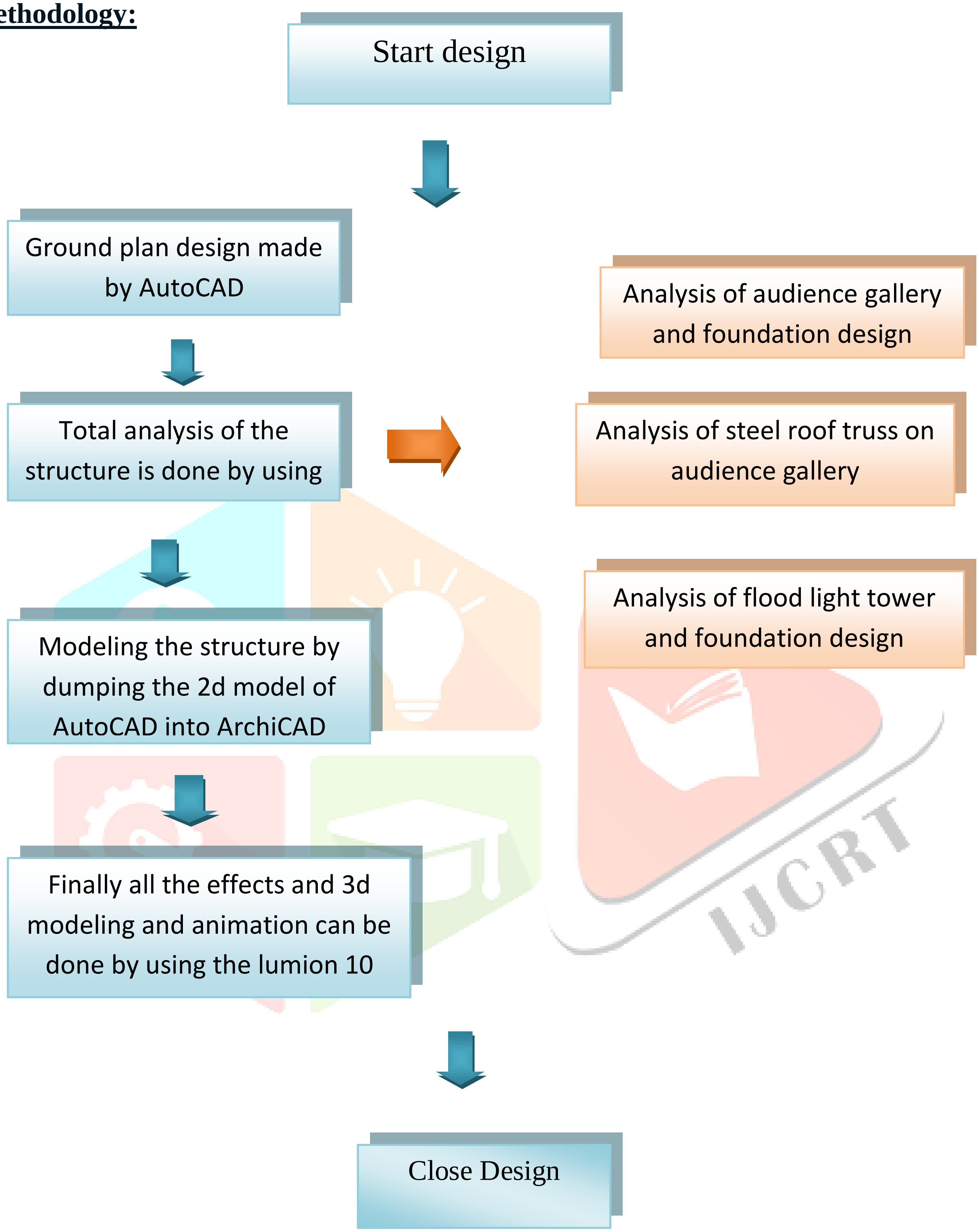
It has a very user-friendly working interface which you can customize in different theme according to your suitability. We can easily design a conceptual base design in it by using customizing and easily modified geometrical objects, you can use pull and push modeling quickly in this software, multiple object extrude also possible in it.

Lumion 10 builds on the tradition of making 3D rendering a stress-free part of architectural workflows. Simply imagine how you want to show your design and Lumion 10 can help you quickly bring that vision to life. As an architect, you're trained to experience design in a truly immersive and incredible way Something as flat as a 2D floor plan can exist in your mind as a lively, fully colored and detailed scene. You can feel the space around you: the sensation of flow through a room, the mood influenced by the wall and floor materials, the light in the evening. Lumion is designed to be effortless, transparent and stress-free. Backed by more than 10 years of development, Lumion comes complete with everything you need for placing your design in its local context. You can dress a model with materials. Furnish interiors and exteriors. Apply lighting and shadow. If you can envision it, you can create it in Lumion. With Lumion Pro, there's no limit to how you can show your exterior, interior, landscape or urban design.

AutoCAD is a software application used for drafting and design. CAD itself is called Computer Aided Design, it was first released in December 1984 by Autodesk Before AutoCAD was introduced, most commercial CAD programs ran on mainframe computers or minicomputers, with each CAD operator (user) working at a separate graphics terminal. AutoCAD is used in industry, by architects, project managers, engineers, graphic designers, city planners and other professionals. It allows you to draw and edit digital 2D and 3D designs more quickly and easily than you could by hand. The files can also be easily saved and stored in the cloud, so they be accessed anywhere at any time.

STAADPro is the name itself known as structural analysis and design. It is one of the most popular software used for analyzing and design civil structures like buildings, bridges, dams, stadiums, towers etc. it allows civil engineering individuals to analyze structural designs in terms of factors like force, load, displacements, etc. report generation, steel and concrete is also can be available by using this STAAD Pro software. Foundation design is also feature to design foundation for the respective structure.

Methodology:



DESIGNING OF AUDIENCE GALLERY:

Audience Gallery is a place or venue for (mostly) outdoor sports or other events and consists of a field or stage either partly or completely surrounded by a tiered structure designed to allow spectators to stand or sit and view the event. In this particular design here I am accommodated the rise of each step is 1feet and in the same way the tread is all of 2 feet length. The lengths are provided for the gallery for the sake of audience comfort. Here I accommodate about more than 4 square feet for each audient to experience the comfortable movement. By providing this much of area to every audient the capacity of audience gallery is about three thousand. If the area allotted to each audient is may decrease we can increase the capacity of the stadium. If we can provide the sitting chairs of 1.5 square feet we can increase the capacity up to 7000 audience.

Analysis of Audience Gallery

B E A M D E S I G N R E S U L T S:

M29 Fe415 (Main) e415 (Sec.)

SIZE: 304.8 mm X 457.2 mm COVER: 25.0 mm

SUMMARY OF REINF. AREA (Sq.mm)

SECTION	0.0 mm	762.0 mm	1524.0 mm	2286.0 mm	3048.0 mm
TOP REINF.	266.70 (Sq. mm)	266.70 (Sq. mm)	0.00 (Sq. mm)	266.70 (Sq. mm)	266.70 (Sq. mm)
BOTTOM REINF.	266.70 (Sq. mm)	266.70 (Sq. mm)	266.70 (Sq. mm)	266.70 (Sq. mm)	297.89 (Sq. mm)

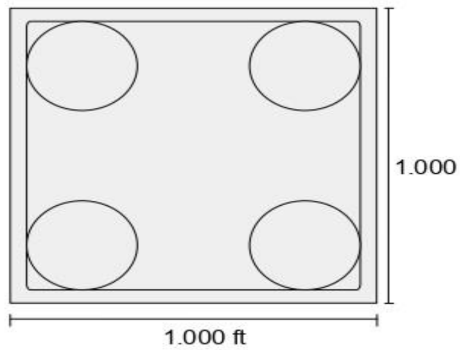
SUMMARY OF PROVIDED REINF. AREA

SECTION	0.0 mm	762.0 mm	1524.0 mm	2286.0 mm	3048.0 mm
TOP REINF.	4-10í 1 layer(s)	4-10í 1 layer(s)	4-10í 1 layer(s)	4-10í 1 layer(s)	4-10í 1 layer(s)
BOTTOM REINF.	4-10í 1 layer(s)	4-10í 1 layer(s)	4-10í 1 layer(s)	4-10í 1 layer(s)	4-10í 1 layer(s)
SHEAR REINF.	2 legged 8í @ 165 mm c/c	2 legged 8í @ 165 mm c/c	2 legged 8í @ 165 mm c/c	2 legged 8í @ 165 mm c/c	2 legged 8í @ 165 mm c/c

STAAD.Pro Query Concrete Design

Beam no. 29

Design Code: IS-456



Design Load

Load	2
Location	End 1
Pu(Kns)	-0.460000
Mz(Kns-Mt)	0.190000
My(Kns-Mt)	0.180000

Design Results

Fy(Mpa)	415
Fc(Mpa)	29
As Reqd(mm²)	743.000000
As (%)	0.866000
Bar Size	16
Bar No	4

C O L U M N D E S I G N R E S U L T S:

M29 Fe415 (Main) Fe415 (Sec.)

LENGTH: 3048.0 mm CROSS SECTION: 304.8 mm X 457.2 mm COVER: 40.0 mm **

GUIDING LOAD CASE: 1 END JOINT: 2 SHORT COLUMN

REQD. STEEL AREA : 164.50 Sq.mm.

REQD. CONCRETE AREA: 20562.71 Sq.mm.

MAIN REINFORCEMENT : Provide 8 - 12 dia. (0.65%, 904.78 Sq.mm.)

(Equally distributed)

TIE REINFORCEMENT : Provide 8 mm dia. rectangular ties @ 190 mm c/c

SECTION CAPACITY BASED ON REINFORCEMENT REQUIRED (KNS-MET)

Puz : 1894.87 Muz1 : 50.96 Muy1 : 33.58

INTERACTION RATIO: 0.99 (as per Cl. 39.6, IS456:2000)

SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS-MET)

WORST LOAD CASE:

1 END JOINT: 2 Puz : 2115.48 Muz : 97.98 Muy : 61.60 IR: 0.52

==

C O L U M N D E S I G N R E S U L T S

M29 Fe415(Main) Fe415 (Sec.) LENGTH: 3657.6 mm

CROSS SECTION: 304.8 mm X 304.8 mm COVER: 40.0 mm **

GUIDING LOAD CASE: 1 END JOINT: 27 TENSION COLUMN

REQD. STEEL AREA : 743.22 Sq.mm.

REQD. CONCRETE AREA: 92159.80 Sq.mm.

MAIN REINFORCEMENT : Provide 4 - 16 dia. (0.87%, 804.25 Sq.mm.)

(Equally distributed)

TIE REINFORCEMENT : Provide 8 mm dia. rectangular ties @ 255 mm c/c

SECTION CAPACITY BASED ON REINFORCEMENT REQUIRED (KNS-MET)

Puz : 1452.05 Muz1 : 32.32 Muy1 : 32.32

INTERACTION RATIO: 0.10 (as per Cl. 39.6, IS456:2000)

SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS-MET)

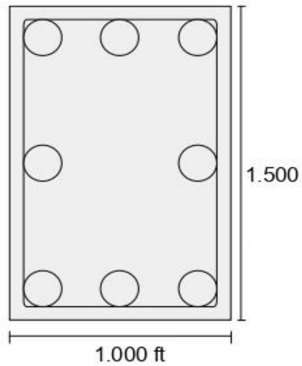
WORST LOAD CASE: 1

END JOINT: 27 Puz : 1470.24 Muz : 34.10 Muy : 34.10 IR: 0.13

STAAD.Pro Query Concrete Design

Beam no. 60

Design Code: IS-456



Design Load

Load	1
Location	End 2
Pu(Kns)	115.000000
Mz(Kns-Mt)	2.960000
My(Kns-Mt)	0.660000

Design Results

Fy(Mpa)	415
Fc(Mpa)	29
As Reqd(mm²)	70.000000
As (%)	0.649000
Bar Size	12
Bar No	8

************** CONCRETE TAKE OFF **************

(FOR BEAMS, COLUMNS AND PLATES DESIGNED ABOVE)

NOTE: CONCRETE QUANTITY REPRESENTS VOLUME OF CONCRETE IN BEAMS,

COLUMNS, AND PLATES DESIGNED ABOVE.

REINFORCING STEEL QUANTITY REPRESENTS REINFORCING STEEL IN BEAMS AND

COLUMNS DESIGNED ABOVE.

REINFORCING STEEL IN PLATES IS NOT INCLUDED IN THE REPORTED QUANTITY.

TOTAL VOLUME OF CONCRETE = 46.1 CU.METER

BAR DIA (in mm)	WEIGHT (in New)
8	9860
10	3141
12	13943
16	6780
20	147

*** TOTAL= 33872

HERE I AM DESIGNED FOR THE SPAN OF 40 FEET LENGTH

ACTUAL WEIGHT OF THE STRUCTURE OF THIS SPAN IS = 142124.234 KG OF RCC

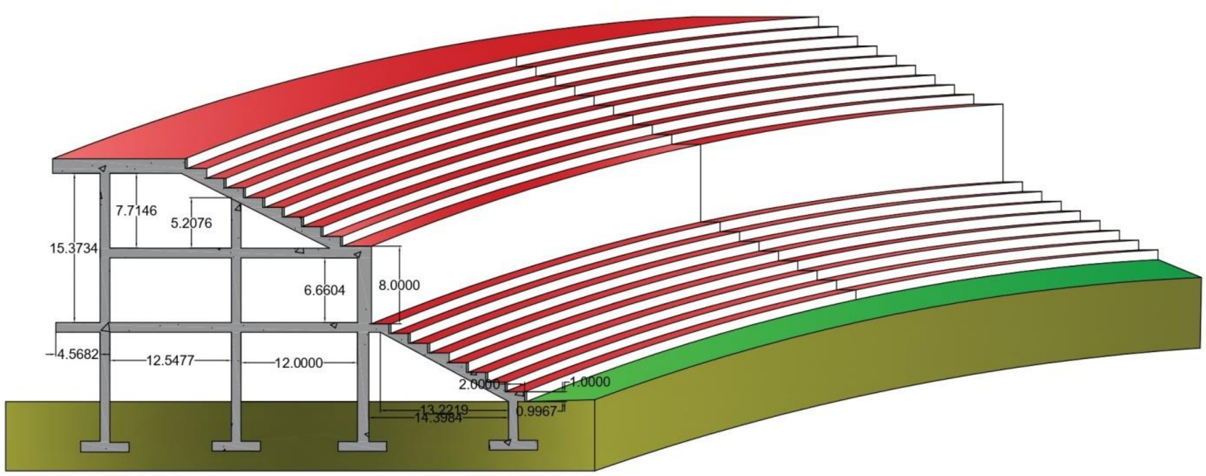


Fig. 40 feet length cross section design

3. DESIGNING OF AUDIENCE GALLERY ROOF TRUSS

The cricket stadium Superstructure is basically divided into two major components first one is the reinforced concrete frame structure around the ground and a roof which is made up of steel on the reinforced concrete framed structure which is used for the protection of the audience from the climatic challenges like sun and rain. The hipped roof end is usually laid at the end of the pre-lock-up stage of the Structure, which then becomes a closed, monolithic structure. The roof truss is a Steel or wooden frame of the roof which carries the loads from the roof covering. It is the angle of inclination of the roof truss that determines the degree of water drainage (e.g. on high roofs snow will not accumulate). The structure of the roof truss should be thoroughly considered, as its type will determine the ability to accommodate any additional attic space in the future. The purpose of the roof truss, as the primary load-bearing element of the roof structure, is to transfer loads to the main supports.

4.DESIGNING OF FLOOD LIGHT TOWER

When it comes to cricket lighting, LED lights are the preferred choice. Cricket lighting helps ensure that the stadium is well illuminated so that the players can play the sport with ease. It provides complete coverage to the entire field and does not leave any room for dark spots. The reason why LED spotlights are commonly used is because they are more durable and energy-efficient as compared to other light sources. They are bright enough to light up even the biggest of sporting venues for cricket

4.1 Analysis of flood light tower design:

P R O B L E M S T A T I S T I C S

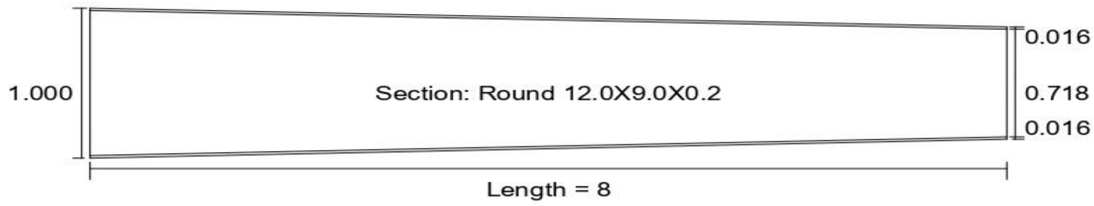
NUMBER OF JOINTS 6 NUMBER OF MEMBERS 5
NUMBER OF PLATES 0 NUMBER OF SOLIDS 0
NUMBER OF SURFACES 0 NUMBER OF SUPPORTS 1

SOLVER USED IS THE OUT-OF-CORE BASIC SOLVER

ORIGINAL/FINAL BAND-WIDTH = 1/ 1/ 12 DOF
TOTAL PRIMARY LOAD CASES = 2,
TOTAL DEGREES OF FREEDOM = 30
TOTAL LOAD COMBINATION CASES = 0 SO FAR.
SIZE OF STIFFNESS MATRIX = 1 DOUBLE KILO-WORDS
REQRD/AVAIL. DISK SPACE = 12.0/ 59737.6 MB

STAAD.Pro Query Property

Beam no. 2



Unit : kg - ft

Physical Properties

Ax	0.043	Ix	0.008
Ay	0.000	Iy	0.004
Az	0.000	Iz	0.004
Depth	0.875	Width	0.875

Material Properties

Elasticity(kip/in2)	28999.971	Density(kip/in3)	283 E-6
Poisson	0.300	Alpha	6 E-6

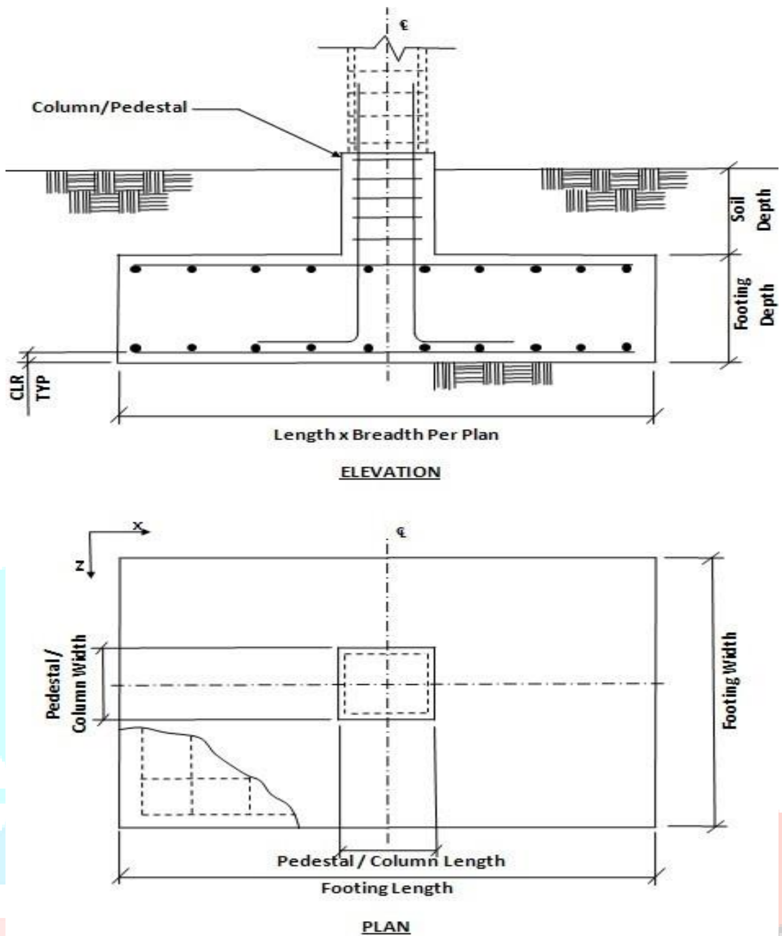
4.2 Foundation Design of Flood Light tower

Isolated Footing Design (IS 456-2000)

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
1	1	1.100 m	1.100 m	0.305 m

Footing No.	Footing Reinforcement				Pedestal Reinforcement	
-	Bottom Reinforcement(M_Z)	Bottom Reinforcement(M_X)	Top Reinforcement(M_Z)	Top Reinforcement(M_X)	Main Steel	Trans Steel
1	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	N/A	N/A

Isolated Footing 1



Design Type : Calculated Dimensions

Footing thickness (Ft) : 305.00 mm

Footing Length – X (Fl) : 1000.00 mm

Footing Width – Z (Fw) : 1000.00 mm

Eccentricity along X(Oxd) : 0.00 mm

Eccentricity along Z (Ozd) : 0.00 mm

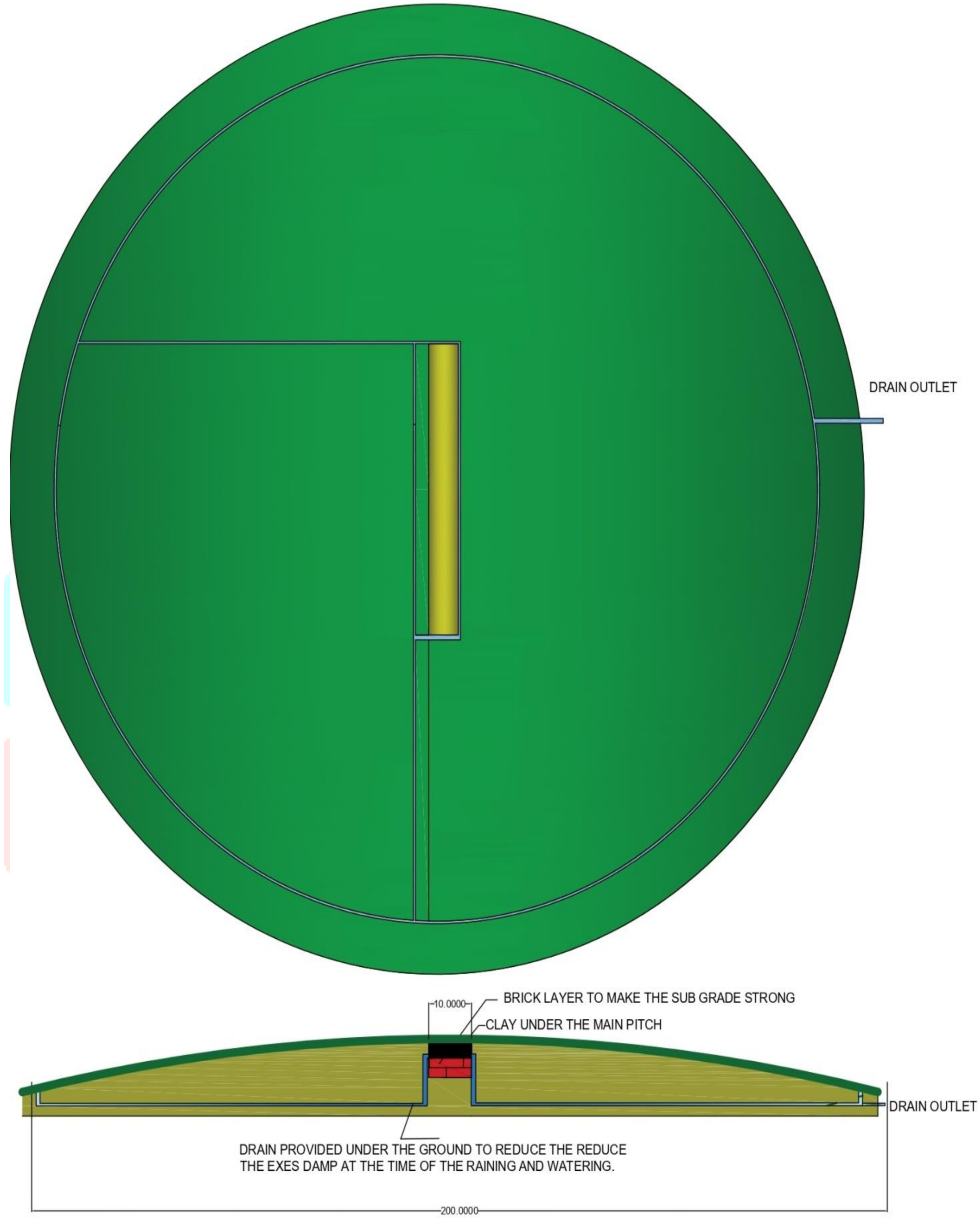
Column Dimensions

Column Shape : Rectangular

Column Length -X (Pl) : 0.381 m

Column Width - Z (Pw) : 0.381 m

SUBGRADE DESIGN OF PITCH AND GROUND



Material Estimation

description	Number of units	Total volume/weight
Volume of concrete for 40 feet length of the structure	1	82.2 cubic meters
For footing 4*4 square feet.	16	16 cubic meters
Total volume of concrete		96.2 cubic meters
8mm diameter bars for slab construction	1	9.6 tons
6 number of 12 mm diameter bars for columns	16	36 numbers of 40 feet length =0.270kg/feet * 40*36 = 0.38 tons
For footing mat required 8mm dia bars 4 numbers for each mat	16	64 members of 40 feet length= 0.120 kg/feet *40*64 = 0.307tons
Total weight of steel required		10 tons
For a single truss member required 18 lengths of 20 feet one inch hallow square pipe	4	80 members
For join the one truss to another we required 10 feet length 1 inch hallow square pipe	4	3*4 =12 members of 20 feet length
Total 1 inch square pipes required		100 lengths
7*15 Square feet of Teflon roof sheets		7 numbers
Total perimeter of the stadium with outer radius of 150 feet is [150*2*3.142=942.6 feet]. Here we are estimating for 40 feet length so, [942.6/40=23.565] it require 24 times of the above estimated materials to construct the entire stadium.		

Modeling by using ArchiCAD

After the 2d model design using AutoCAD dump the entire Structure into ArchiCAD. Here by using this software we are able to design the 3d model using layer by layer format. From 0^{th} level of ground to entire 3dimentional structure is can be modeled here. The following are the pictures show the entire structure of stadium:

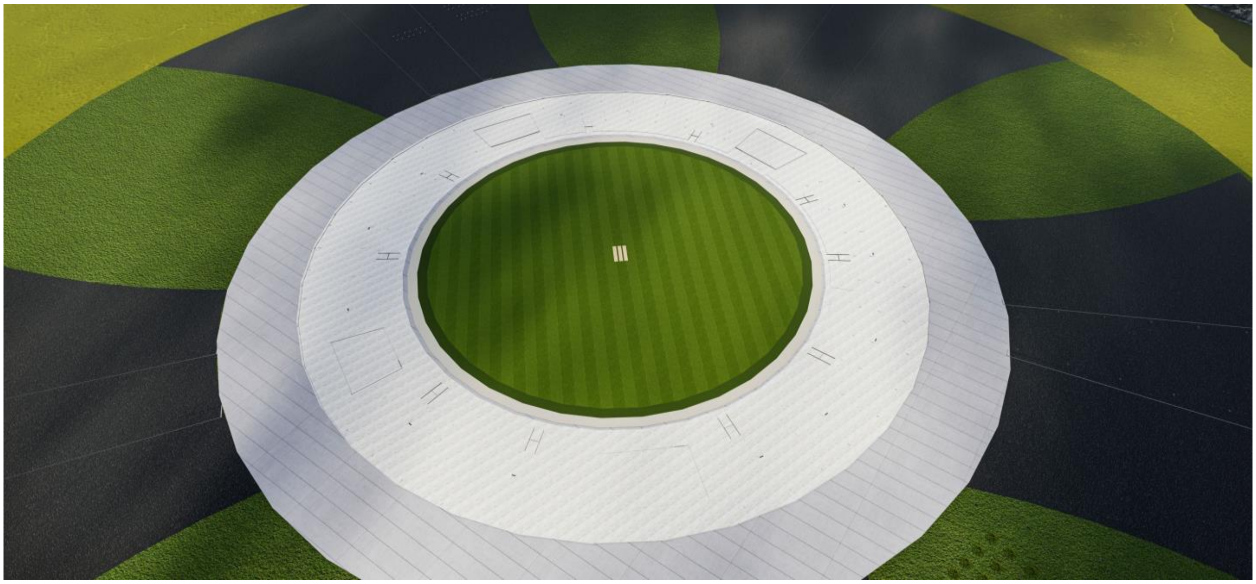


Fig1. base level of cricket stadium

Fig. base level with flooring

Fig. structure with walls

Fig. structure without truss

fig. structure with roof

3D animated view by using lumion 10

After 3d modeling done by using ArchiCAD, the entire structure takeoff into lumion 10 where all the external features are added. The features like colors, lighting effects, paints, special effects, animation are done. By this software we can get finished structure look, all the type of architectural materials are available to assign to the structure. We can create a visual wonder by using this software. The following are the pictures before 3d animated view.

Fig. final view of stadium

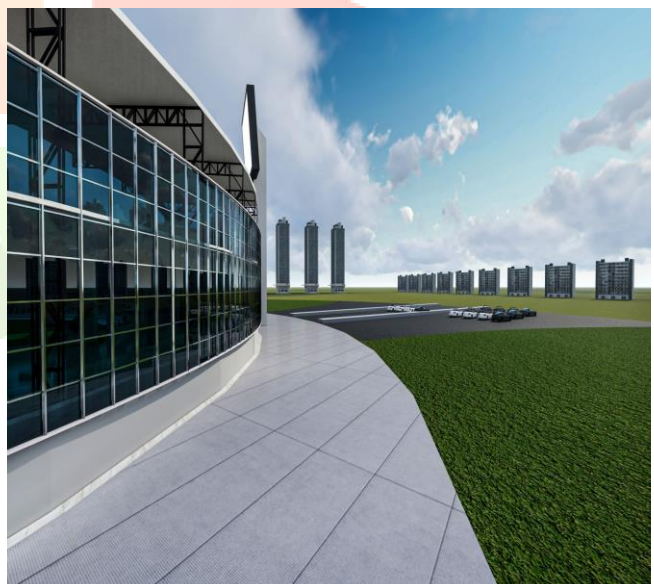


Fig. parking lot for JNTUA Cricket Stadium

This is the link which shows the final 3D animated video of the JNTUA Cricket Stadium.

https://drive.google.com/file/d/18eq-p8XUKRidSXf-y9Swx8Y0P0-kq-J2/view?usp=share_link

Conclusion

This designing and modeling of the stadium gives the challenge to structural and architectural engineers. We can use this stadiums for multipurpose also. By constructing this type of structures may used for the present and feature generation also, by providing them a good environment to play the games and sports, this may gives them better recreation reflects for their good physical and metal health.

A variety of contributing factors has brought Stadium design to the forefront of structural engineering and architectural design. With the advancements in television broadcasting more and more people are directly exposed to sports and with that the culture has greatly evolved. While in the 21th century there were concerns that the public would prefer watching sport competitions from the comfort of their living room and also from stadium lively, the true fans realized that there are no substitutions for attending events in person at the stadium. Coupled with the global competition to build the tallest structure, the longest bridge or the most advanced and innovative stadium, stadium design has attracted the most innovative minds to produce the next generation of stadium. The desire to widen the consumer base and improve the overall experience for the spectators while addressing the players' needs as well as the arena owners' has forced the designers to think outside the box and introduce design elements which were never before considered in the scope of stadium design. The recent idea of pulling the natural turf playing surface out of the arena allows designers to reduce the size of the operable roof and thus gain substantial savings.

With a new way of supplying natural grass with sunlight, designers can put more focus on elaborate stationary roofs without having to think about roof mechanical systems. This kind of innovative approach opens the design to a whole new era in stadium design one that is not confined by prior designs. While countries and cities are still vying to build the tallest building, stadiums, recreation centers etc the challenge of being home to the largest and most advanced stadium is rapidly gaining momentum. Stadiums built around the world provide a source of tremendous pride to the hosting country and an innovative platform for the engineers who are eager to challenge themselves. The benefits to the design field will be felt well beyond stadium design and it will affect structural engineering and overall design approach throughout the construction industry. "Sporting design has not merely come of age; it may well be ready to take center stage. If the nineteenth century may be defined as the age of railways, why not sport and leisure in the twenty-first"

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