

Finite Element Analysis of Soccer Stadium under Dynamic Loads

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Abstract— The stadium is the heaviest structure in sports category, made up of concrete and steel structure. The stadium is also a critical structure with many critical structure elements combination, the behavior of these components under the dynamic loading is the part of analysis and designing the stadium which can withstand under high pressure loads and hence which can be economical. The dynamic loads and lateral loads like “wind load, seismic loading, heat of hydration”. The basic aim behind the analysis of the stadium is to know reaction when the whole structure is acted against the forces.

We have shown the “performance results of our implementation” which we have done. The finite element method for stadium gives the accurate results for huge structure by contracting into small and giving the accurate results. The results are stimulated in MIDAS GEN.

Keywords— mode shapes, heat of hydration, critical section, wind loading, midas gen, slanted column.

I. INTRODUCTION

Before planning the any structure the site plan and the locations are planned. This help to know what type of designed is required for the structure. The site planning and the locations help is finding the seismic zone of the area and the past history it has been. The football stadium is proposal for Raipur city capital of Chhattisgarh, the city is come under zone II of seismic table, but still the stadium is designed for higher zone. The stadium is designed for the capacity of 14,240 people. The max height of the stadium from ground floor is 12.12 m. the grand stand is the most important part of the stadium which is made up of concrete, over which the truss of 13.9 m is resting. The stadium dimension is 138.81 x 107.22 m; it also has four large exit doors.

The Midas Gen is under top 5 structural design software for finite element, the software is user friendly and ease to use. Many and all important structure in the world are designed using the Midas Gen. The software is of finite element method and give accurate results for all types of cases.

II. LITERATURE REVIEW

A.H den Hollander[1]. It is seen that by the design concept the structural feasibility of a portable stadium is proven. A roof structure and a detailed foundation should be included in a further research. A further financial feasibility study should be done, to prove if a portable stadium can compete with fixed stadium and portable grandstands from a financial point of view. Carlos Alberto Medeiros[2]. Grandstand shall be design to withstand crowd-included vibration during sports and non-sports events, such as pop rock concerts, The dynamic loads may be lead to panic spectators or collapse of the grandstand structures. If the dynamic excitation from spectators, engaging in a rhythmic motion, is near natural frequency of the structure may to cause resonance, that is displacement amplification. Christots Gkologiannis, Fortis Zoulas[3]. It is observed that main structural element of the new football stadium of Panathinaikos F.C in Greece have been presented , with emphasis on the steel roof and its interaction with the underlying reinforced concrete pylons. Appropriate decisions that had to be made at the conceptual design stage, in order to minimize the interaction of the steel roof with the pylons and the ten structurally independent grandstand structure during eventual seismic events, have been described. The resulting mechanisms of resisting both horizontal and vertical loads have been outlined. The main connection between primary structural members, posing several challenges in order to comply with the previously mentioned structural functions have been shown. Dr S. M. Doran[4]. The safety of viewing facilities is the responsibility of the management of the facility. It has been noted that information on design and performance of existing grandstands and not necessarily reliable. It is however clear on the value of such a database in underpinning public safety in the use of grandstand structures and as basic information when developing future guidance. Kourosh Kayvani[5]. The long span nature and architectural of the arc required it to be designed to be as efficient, slender and lightweight as possible. The structural implication of this slenderness is a unique level of interaction between the overall buckling of the arch and the local buckling of the individual chords. Extensive nonlinear buckling analyses were conducted considering a range of expected geometrical

imperfection in the arch in its erected form. An automated design procedure was developed which took advantage of the similarity in the geometry of the arch nodes and effectively dealt with variability of loading conditions. Separate moving roof panel models were superimposed onto the global fixed roof model to assess the behavior of the panels due to the movement of the fixed roof structure and the warping stiffness of the panel was also assessed. Zwarts and Jansma[6]. It is noted that the absence of sufficient double curvature of the grandstand leads to a limited structural stiffness. The roof structure is of structural importance to the total structure and limits horizontal movement of the grandstand structure. With respect to functionality, the idea of the lotus stadium is the most natural shape that arises due to the optimal sight lines. However the natural shape regarding function does not make this design the most natural shape in a structural way.

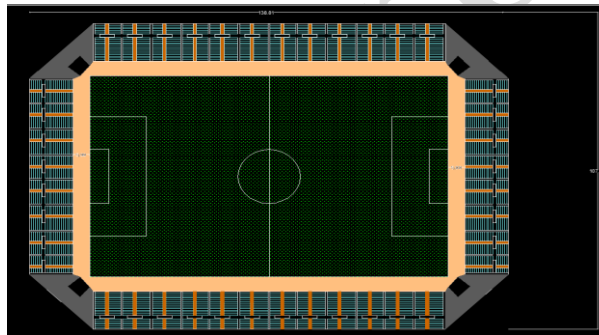
III. PLANNING AND DESIGNING

A. Site plan

The proposed site plan is in the Raipur city in the new Raipur area. The site is an open area and rest of it are under construction. The location selected for the soccer stadium is accessible from all around and it is near by all facilities like airport, hotels and hospitals. The zone of the area is II

B. Planning

The soccer field dimension is 105 x 68 m and overall dimension are 138.81 x 107.22 m which is rectangular in shape. The grandstand is the most crucial part for the stadium, the height for the grand stand is 12.12 m from the ground level, the slope angle for the grand stand is 27 (degree) which can be calculated by the give formula.



$$C = \frac{D(N+R)}{D+T} \quad R =$$

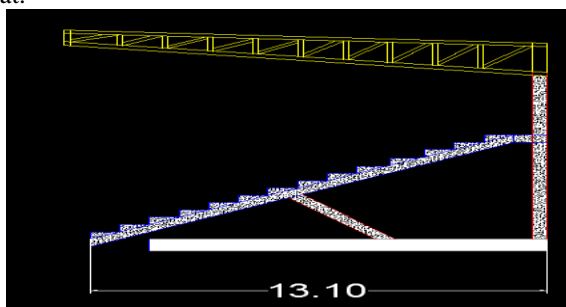
Where C = the c value

D = the horizontal distance from each individual position

N = the rise height of each individual row of seat

R = the vertical height between the person eye level and the point of focus.

T = the depth of each individual row of seat.





The grand stand components are “(1) Column,(2) Alligator beam, (3) Rectangular beam, (4) Seating deck L shaped, (5) Alligator tapered beam, (6) Floating block”.

C. Designing

Here two columns are designed the dimension of both columns are 450 x 600 mm and 450 x 450 mm. The big column is the main key for the truss and whole structure. The beam for the grandstand is 300 x 450 mm and the slab Thickness is 850 mm. The alligator beam is of rise 440 mm and tread of 580 mm. The plates are used while deigning the alligator beam.

D. Data

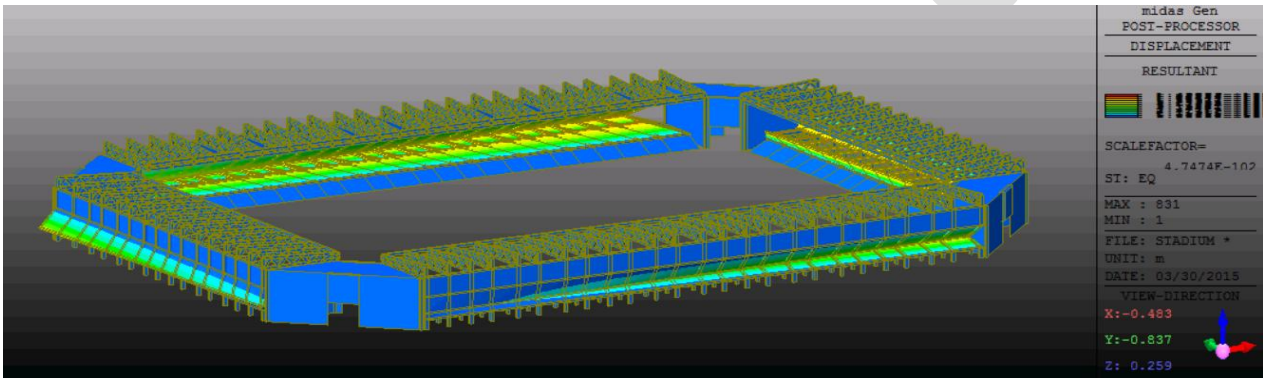
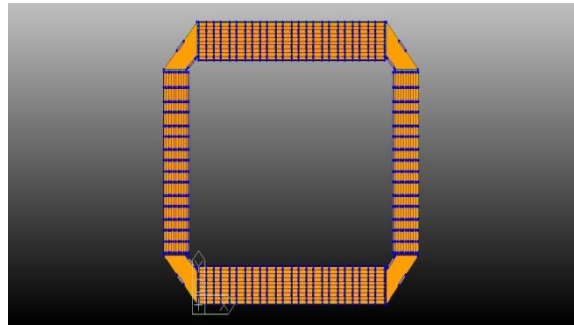
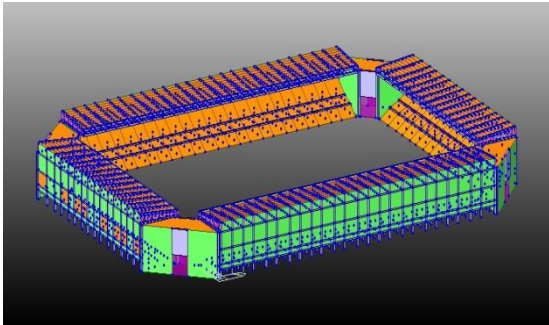
Column 1	450 x 450 mm
Column 2	450 x 600 mm
Slab	850 mm
Concrete	M 30

E. Loads Combinations

- gLCB1 DL(1.500) + LL(1.500)
- 2 gLCB2 DL(1.200) + LL(1.200) + WL(1.200)
- 3 gLCB3 DL(1.200) + LL(1.200) + WL(-1.200)
- 4 gLCB4 DL(1.500) + WL(1.500)
- 5 gLCB5 DL(1.500) + WL(-1.500)
- 6 gLCB6 DL(0.900) + WL(1.500)
- 7 gLCB7 DL(0.900) + WL(-1.500)
- 8 gLCB8 DL(1.000) + LL(1.000)
- 9 gLCB9 DL(1.000) + WL(1.000)
- 10 gLCB10 DL(1.000) + WL(-1.000)
- 11 gLCB11 DL(1.000) + LL(0.800) + WL(0.800)
- 12 gLCB12 DL(1.000) + LL(0.800) + WL(-0.800)
- 13 gLCB13 DL(1.500) + LL(1.500)
- 14 gLCB14 DL(1.200) + LL(1.200) + WL(1.200)
- 15 gLCB15 DL(1.200) + LL(1.200) + WL(-1.200)
- 16 gLCB16 DL(1.500) + WL(1.500)
- 17 gLCB17 DL(1.500) + WL(-1.500)
- 18 gLCB18 DL(0.900) + WL(1.500)
- 19 gLCB19 DL(0.900) + WL(-1.500)
- 20 gLCB20 DL(1.000) + LL(1.000)
- 21 gLCB21 DL(1.000) + WL(1.000)
- 22 gLCB22 DL(1.000) + WL(-1.000)
- 23 gLCB23 DL(1.000) + LL(0.800) + WL(0.800)
- 24 gLCB24 DL(1.000) + LL(0.800) + WL(-0.800)
- 25 RC ENV_STR
 - + gLCB13(1.000) + gLCB14(1.000) + gLCB15(1.000)
 - + gLCB16(1.000) + gLCB17(1.000) + gLCB18(1.000)
 - + gLCB19(1.000)
- 26 RC ENV_SER
 - + gLCB20(1.000) + gLCB21(1.000) + gLCB22(1.000)
 - + gLCB23(1.000) + gLCB24(1.000)
- 27 LCB27 DL(1.500) + LL(1.500)

IV. RESULTS

Under the load combination of live, dead and wind load the following results were obtain which leads to show that the deformation occurred at the critical section which is the entry gate opening and the grand stand near by.



V. CONCLUSIONS

The designed stadium with its dimensions for column, beam and slab and the total height is stable and analysis done for both time history and response spectrum. The graph shows that the frequencies for the structure is high and the max values are 140.69 rad/sec and the minimum value is 74.75 rad/sec.

Table 1 frequency data

Frequency (rad/sec)	1	2	3
	74.759	136.5	140
		7	.069
	114.86	139.0	149
		6	.61

The frequency is high and value reached this much because the structure (stadium) is shorted heighted and if the building is short the frequencies will be high and if the structure is tall the frequency will be small.

Response spectrum values the max value is 113.26 and the minimum value is 36.58

Table 2 acceleration data

Frequency (rad/sec)		
1	84.759 7	24.8 984
2	36.581 4	49.0 616
3	40.086	49.6 193
4	100.25 51	59.9 913
5	107.08 26	71.5 822
6	109.36 94	74.4 926
7	110.25 47	75.5 884
8	112.39 06	78.7 932
9	113.77 23	80.1 272
10	113.26 36	81.0 011

From the above results the maximum value obtained was the edge at the gate opening with highest value of deformation. Hence the critical section is at the joint of the gate which should be designed by caution. The main failure region is the same. This concluded that the slanted column can be used for Grandstand load to make it more simpler.

References

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