

## Rehabilitation and Upgrading of Major Dhyan Chand National Stadium

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## Summary

This paper specifically reports on overview of stadium, concept of structural system, design of roof over VIP gallery, foundation design for MDC New Delhi. For the Commonwealth Games 2010 (CWG-2010) it was realized that the nature of facilities to be offered to the athletes, the spectators and even the viewers on TV have changed, seating capacity was increased, to 20,000. Any modifications to the stadium have to confine themselves to the overall envelope, both structural and architectural, particularly the facade on the Central Vista. As regards structural engineering efforts, additional space was created under the VIP area and the open gallery for spectators, which were situated on earthfills, by adopting a structural, tiered, frame arrangement and also the 22 m long cantilever roof system that covered the seating requirements and complied with the height restrictions. The mast lighting for the arena, violating the height restrictions of any structure in the area was addressed innovatively along with Integrated solution.

Keywords – Central Vista, Open Gallery, VIP Gallery, Roof Structure, RC Members, Grand Stand, CWG-2010. MDC

## 1. Introduction

The stadium was first constructed in 1933-34. During 1950-51 this was extended for the first edition of Asian Games and also used during the Asian Games in 1982. Major Dhyan Chand National Stadium is located at the eastern periphery of the Central Vista area near India Gate, New Delhi. This was venue of Hockey for 2010 Common Wealth Game. For CWG-2010, it was realized that the facilities to be offered to the athletes, the spectators and even the viewers on TV have changed with enhanced seating capacity. Any changes to the “look” of the area was prohibited particularly to the facade on the side of the Central Vista. There was limited freedom on the other side away from the Central Vista.

To upgrade entire stadium to International stadium, new Open and VIP gallery is restructured creating space for various facilities. Rehabilitations were carried out on heritage building without altering the heritage status as per latest standard. The main design concept of the stadium were an Open Stadium, accumulate all international facilities to the spectators and athletes, Column free VIP seating galleries.

## 2. Structural Concept And Design

**RC Structure of Open and VIP gallery** - The VIP and Open galleries are separated by seismic joints so that ponding during earthquake is eliminated. Elastic analysis is carried out to find the forces of the structural elements. Grillage Modeling of Flat slab is done with beam elements taken along the column strip. Bracket system for stub column is developed near outer masonry wall to not to disturb the balancing lateral force on main existing Wall.

**Grand Stand** - The seating tiers, involves two stage analysis and constructions. RC precast Tiers are fabricated at the yard and hauled to its position. In 2nd stage, concrete is poured on top of Tiers and at supports to get the final continuous seating tier.



**Roof Over V.I.P. Gallery** -The roof of V.I.P. gallery of MDC stadium has been designed in steel considering faster mode of construction. The V.I.P. roof is 163m long, 43m average width having 22m cantilever length, and 13m height. The roof girder is connected with the R.C.C. column with anchor bolt anchored into the flared column top encased into the steel casing to withstand tension. The girder is modeled with finite element plates and is analyzed as framed structure. Sections are checked for different stages of construction following Indian standard.

**Design of Foundation**-The Yamuna river bank being very close to the stadium, the water table encountered near ground, during construction continuous dewatering system was continue during . Below ground structure is designed as water retaining structure by limiting the stress in steel and crack width 0.2mm for service stage loading. A plane frame model with grillage beam element along with RC wall was developed for foundation system and forces had been verified with plate elements. The stiffness of the spring is computed based on the subgrade modulus of the soil to represent the contribution of soil interaction.

### 3. Structural Design criteria

The main design criteria of stadium, is as follows-

- Structural member shall have sufficient strength and capacity to avoid excessive deformation and limiting the cracking to 0.3mm during service load.
- Yielding of some RC member during major earthquake is allowed with proper detailing.
- Structure is designed based on strong column and weak beam philosophy so that first hinge due to seismic loading may not occur in the column.
- The roof girder is designed within elastic limit which could also be maintained during environmental loading.

### 4. Design Loads and Combination

**Normal Load** - The dead load of structures considered was self weight in addition to finishes. A load of 100 kg/sqm along with wall load is applied on all floors and roof to hang the services. The Live Load of 300kg/sqm for offices, 400kg/sqm for corridor and staircase, 500kg/sqm for car parking and 75 kg/sqm for roof is considered as per IS 875. The grand stand live was decided to be taken as 500kg/sqm as all code of standard are silent.

**Seismic Load** - As per all national and international code of practice, where public congregates, require a higher structural performance than ordinary buildings. The stadium was designed with importance factor 1.5, Zone factor 0.24, Response reduction factor 5 and structural damping of 5% as per IS: 1893, corresponding ductile detailing to prevent the joint rotation is done as per IS13920.

**Wind load** - The wind load was predominantly governs the design of steel roof over VIP gallery. The basic wind speed 47m/s and Risk coefficient for 100 year of return period is considered as per criteria given in IS875 part-3.

**Load combinations** - Above primary load cases combined with the factors for Normal, Seismic and wind conditions as per Indian Standard IS: 456, IS: 1893, to confirm the structural safety and stress level of structural components.

### 5. Conclusion

As the look of existing stadium was to be retained with limited scope of changes to the building retaining the *Aura*, the remodeling and up-gradation of the existing stadium with state-of-the-art facilities has been a challenging task.

Finally the stadium was completed by the end of year 2009 by overcoming all constrains. The stadium has now *State-of-the-Art* facilities. After successful completion and handing over of the stadium to Sports Authority Of India, Major Dhyan Chand National Stadium was utilized for the purpose at first for World Cup Hockey Tournament in January 2010 and then for Hockey Events of Commonwealth Games, Delhi- 2010.