INNOVATIVE, ARCHITECTURE AND STRUCTURAL ASPECTS OF WAR MUSEUM WITH TWISTED 72° PLAN AREA ON EACH FLOOR

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Abstract: This paper presents the conceptual design and structural solution/analysis of a war museum, characterized by a unique rotational architectural form. The museum is composed of five distinct special Volumes, each rotated at 72°, relative to the preceding one, cumulatively forming a Complete 360° spiral sequence. Unlike conventional stacked floors systems, the floors are radially offset, so that each segment begins at the terminus of the previous, creating a dynamic and continuous spatial journey. This configuration, not only narrates the thematic progression of way through different floors, including history, Arms and ammunations display, gallantry awardees, and immersive light & sound shows. - but also offers significant opportunities for energy-efficient design. The twisted form optimizes natural day-light penetration, facilitates passive ventilation, and enhances shading, thereby reducing energy consumption. The paper discusses the innovative, structural solutions adopted to address the complex load of paths and torsional stresses, induced by the rotation and offset arrangement. The integration of architectural creativity. with sustainable design principles, aims to create a museum environment that is both experimental and environmentally responsive. This study is expected to inspire Architects, structural Engineers and building performance specialists interested in the fusions of symbolic architectural forms with energy - conscious building design. This project will be typical construction of innovative structure to the budding Engineers and Architects too.

Index Terms **- Innovative architectural geometry, structural design methodologies, rotational geometry, sustainable design, climate-responsive strategies**

1. INTRODUCTION

Architecture beyond its functional and aesthetic roles; Serves as a Powerful medium for storytelling, especially when memorializing complex human experiences such as war museums, dedicated to war, often navigate a delicate balance between commemoration, education, and emotional engagements. This paper explores a noval architectural approach to designing a War Museum, where the form itself becomes an expression of narrative as: Each floss twisted 72 degrees from the one below, producing a dynamic and evolving a vertical structure. The cumulative twist is not only a structural gesture but also a metaphor for the chaos, transformation and complexity associated with warfare.

The design is structured around six- Integrated aspects, each contributing to a holistic visitor experience:

1.1. Innovative architectural structure: The 72-degree twist provides a sculptural and symbolic form, representing the fragmentation and unpredictability of war, It also introduces new perspectives at every level, inviting visitors to engage physically and emotionally.

1.2. Typical structural design: While the form is unconventional, the Structural system aims to remain feasible through a reinforced concrete core; radial beams, and Cantilevered floor plates. The paper discusses how traditional structural logic is adopted to accommodate the twisting geometry.

1.3. Thematic Floors: Each of the five major floors are dedicated to a specific aspect of war- ranging from historical context and strategy to humanitarian impact - creating a chronological and emotional Journey through spaces.

1.4. Display of Arms & Ammunition: Dedicated galleries are designed with secure adaptable display system, integrating lighting and materials. that enhance visitors understanding of historical weaponry and military technology.

1.5. History of Gallantry awarded Warriors: A key highlight includes a memorial floor that honors decorated soldiers. Biographical installations, digital archives and interactive exhibits help narrate their stories of courage.

1.6. Light & sound show: The museum culminates in a performance space designed for multimedia shows, using light, sound and projections to reenact historical monuments and evoke emotional resonance.

The proposed design is conceptual but grounded in realistic architectural and structural strategies. Computational modelling and Visualization tools such as Rhino, Grasshopper and sketch-up are used to explore the twisted geometry and space planning. Structural analysis focuses on load. paths, stability under rotation, and material considerations. This paper is intended to inspire architects, structural Engineers, and museum planners by illustrating how a strong architectural concept, supported by thematic clarity and structural logic compelling and meaningful cultural landmarks. If demonstrates the potential of form-driven story telling in public architecture and suggests how conceptual design can -evolve into practical applications

The paper deals in details regarding methodology adopted, the data selected, use of sun- path, effect of Earthquake reduction method, bearing capacity of soil, use of material in detail. Section wise breakdown is shown for design Concept structural analysis, drawings, the floor wise plans, technical content related to structural and architectural analysis.

2. RESEARCH METHODOLOGY

The design methodology adopted for the war museum involved a multi-layered approach, integrating historical research, special storytelling, architectural form making and user experience design. The following key steps define the process.

2.1. Research & concept Development: An in-depth study of war history, particularly national conflicts and their special impacts, informed the narrative structure of the museums. Case studies of existing war museum globally, such as the imperial War Museum (London) and Hiroshima Peace Memorial Museum (Japan), helped in considering understanding Curatorial strategies and spatial organization.

2.2. Sile Analysis: A comprehensive site analysis was conducted to evaluate the topography, accessibility & climate, Sun-path, Wind direction, and surrounding context. These factors influenced the orientation, form and programmatic layout of the building.

2.3. Form Exploration: (Twisted Geometry) The twisted 72-degree form was derived through parametric design explorations using digital modelling tools like Rhino and Grass Chopper. The twist is Symbolic representing the distortion of peace, during times of war, and simultaneously achieving as a dynamic sculptured landmark in the Urban fabric.

2.4. Program & Special Zoning: The five floors are organized thematically, representing a Chronological journey as: Ground floor: Reception, orientation, Admin and Management office, Kitchen and Dining area, and temporary exhibits; First floor: Origins & early conflicts; Second floor: Major wars and resistances; Third floor: Post war reconstruction and peace building; Fourth floor: Reflection spaces, archives and memorial gallery; Fifth floor: Used as a light and sound system.

2.5. Materials and structural strategy: For this museum, Reinforced Contrale, M-20 and M-25 were recommended. Being a complex geometry of structure, it was carefully designed for torsional stress. Effect of earthquake for Zone III was also taken into account. The bearing capacity was taken as 20 t/m2. This bearing capacity was available at adequate depth of 6-7 m.

2.6. Sustainability and Environmental Responses: Passive design strategies like natural Ventilation, daylighting through skylights, green roof were integrated to enhance environmental performance. Solar panels and water recycling systems further reduce buildings ecological footprints.

2.7. User Experience and Accessibility: Universal design principles were applied to ensure accessibility to each floor; guided pathways contemplation zones are interspersed to support varied Visitors engagement levels.

3. STUDIES AND FINDINGS

3.1. Site Introduction: National War Museum at Princess Park:

The National War Museum at Princess Park Complex is a strategically important institutional establishment within New Delhi's heritage-sensitive Central Vista area, covering 10.71 acres at the 'C' Hexagon of India Gate (28°36'46"N, 77°13'46"E) between Tilak Marg and Copernicus Marg, officially sanctioned by the Union Cabinet in October 2015. The site, situated in the Lutyens' Bungalow Zone (LBZ)—a heritage area aspiring for UNESCO status and listed on the World Monuments Fund's 2002 Watch List—is surrounded by significant early twentieth-century imperial architecture, such as Hyderabad House, Baroda House, and Patiala House. This necessitates that modern architectural interventions thoughtfully integrate with established Lutyensian design principles while incorporating innovative responses. The site is semantically and symbolically appropriate for a museum devoted to post-independence military heritage and the operations of the Indian armed forces since 1947 because of its historical resonance as the site of Prime Minister Jawaharlal Nehru's hoisting of the Indian Tricolors on August 15, 1947. Although Lutyens spatial philosophy is preserved, development is restricted by strict regulatory parameters (35% maximum ground coverage, 1.20 FAR, 26-meter permissible height) that allow for roughly 51,928 square meters of built-up area. This is enough for extensive museological programming (exhibition galleries, multimedia auditoriums, research facilities, restoration laboratories). The museum is positioned as a key hub within India's national cultural infrastructure thanks to its outstanding connectivity infrastructure, which includes major arterial roads, the Central Secretariat Metro Station, and an integrated underground passage to the 40-acre National War Memorial precinct. By addressing the creative architectural and structural design strategies needed to balance modern museum practices,

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heritage conservation principles, and the museum's unique twisted 72° plan configuration within limited development parameters, this study establishes methodologies applicable to institutional architecture that is sensitive to heritage in similar urban contexts.

Figure 1. Location of Site

3.2. Site Analysis:

Climate Profile: Delhi's temperatures fluctuate greatly throughout the year, ranging from -2.2°C to 48.4°C. With an annual mean of 24.5°C, summer highs peak at 40°C (May–June) and winter lows fall to 13°C (December–January). The average annual rainfall is 800 mm, with the highest amount occurring in August. The monsoon months (July to September) see the highest humidity, which ranges from 40 to 80%.

Ventilation and Wind: The predominant wind direction is from north-west to south-east. Cross-ventilation is made possible and summer heat gain is reduced when buildings are oriented optimally, which is between 30 and 45 degrees to the wind.

Topography and Soil: Site exhibits undulating terrain (higher north, descending south-east). Soil: clay-silt-sand composition with calcareous nature. Net safe bearing capacity: 23.0 T/sq.m (adequate for 26m height). Hydrogeology: Groundwater depth: 10m (monsoon), 8-9m (post-monsoon). Water quality: fresh up to 40m depth; TDS 1-45 mgL (suitable for non-potable use).

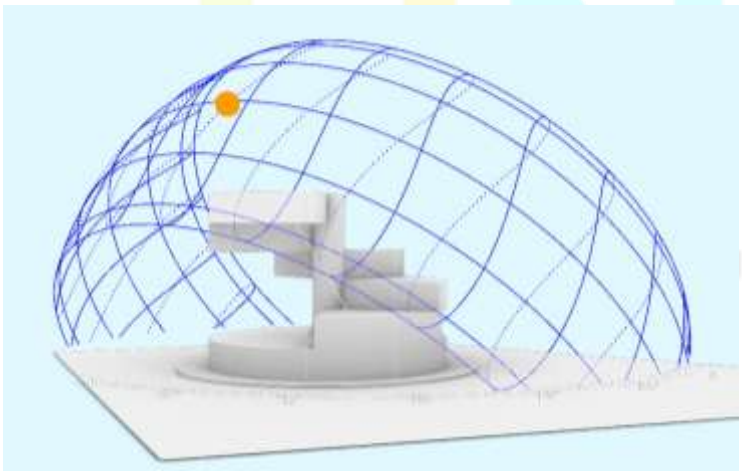

Figure 2. Sunpath of site

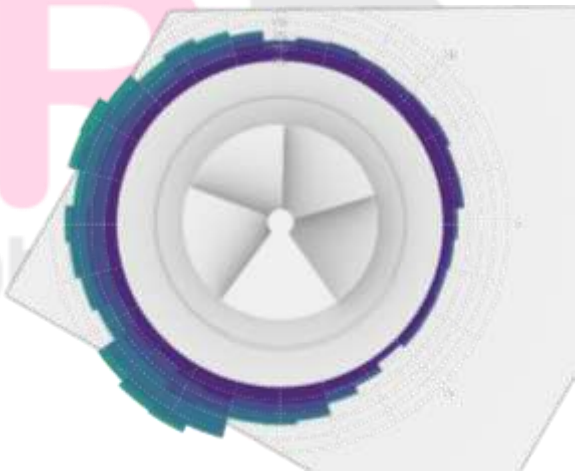

Figure 3. Wind direction

3.3. Form Evolution and Planning:

The architectural form of the National War Museum is fundamentally shaped by a unique concept: each floor is rotated 72 degrees relative to the one below it, creating a dynamic, spiraling vertical sequence that spans five levels and 360 degrees. In order to translate symbolic themes of conflict and transformation into built form, this rotational approach was developed through parametric explorations using digital modeling tools. In addition to creating a striking visual impression, the spiral gesture tells the story of the visitor's journey. It moves smoothly from ground-level operations, including reception, administration, dining, and temporary exhibits, up through themed galleries that focus on the causes of conflict, major wars, postwar reconstruction, and memorial areas, and ends on the top floor with an immersive light and sound experience. (see uploaded floor plans: ground to fifth floor).

Functional and narrative dimensions are combined in the spatial planning process. Each gallery zone is radially offset to provide new views at every turn and guarantee that circulation follows a continuous, natural path. Features like green roof segments and central voids in the plans demonstrate how the unique arrangement of cantilevered floor plates and a central structural core not only addresses torsional stresses and maintains overall stability, but also allows for optimal natural light penetration and passive ventilation. As a result, the changing form serves as a spatial metaphor and actively enhances daylighting, energy efficiency, and user experience, showcasing the harmonious fusion of sustainable practices, planning logic, and architectural creativity in a landmark public monument.

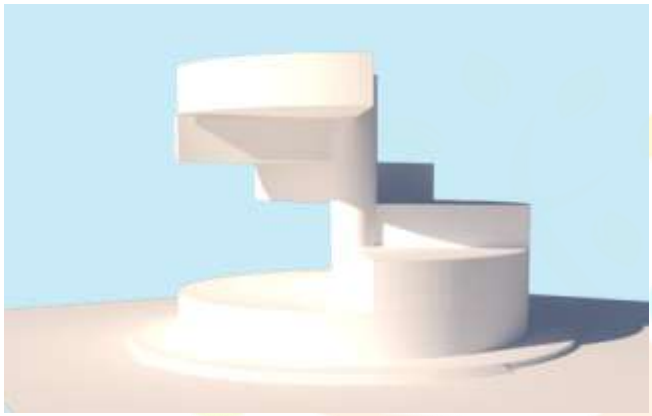

Figure 4. Form Development

Figure 5. View of the Structure

Figure 6. Site plan

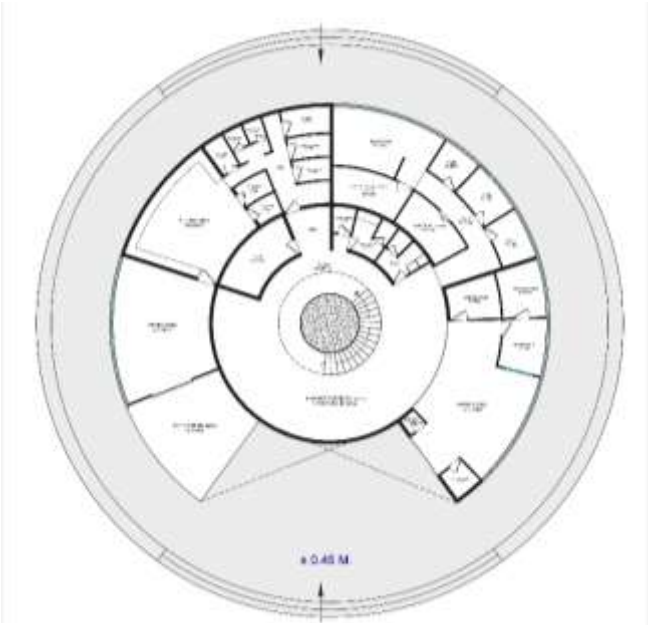

Figure 7. Ground floor plan

Figure 8. First floor plan

Figure 9. Second floor plan

Figure 10. Third floor plan

Figure 11. Fourth floor plan

Figure 12. Fifth floor plan

3.4. Materials and Structural strategy:

High-performance glass and locally sourced stone are examples of facade elements that balance daylight penetration and thermal insulation, minimizing heat gain during hot summers while providing adequate winter warmth.

Structural Aspect: The structure was designed for the following conditions:

- Load: The design of column, beam, and slab were considered for dead load, live load, floor finish, seismic load, earthquake load.
- I.S. Codes: For concrete design, IS code IS-456:2000 was adopted. For steel structure, IS-800:2007 was considered. Earthquake Zone III, the seismic design was carried out in accordance with **IS 1893 (Part 1)**, and the structure was designed to satisfy all Zone III requirements.
- Concrete Design: For concrete R.C.C. structure, M-25 was taken into account.
- Steel Design: For the design of steel structure, a cantilever Warren truss type structure was considered.
- In R.C.C. design, Fe-415 was taken into account. For the design of R.C.C. floor slab, live load 3 kN/m² and floor finish load 1.0 kN/m² were adopted.
- Design of all the five floors is the same (for beam, slab etc.).
- Each floor is provided with five hybrid concrete cantilever beams. The warren truss was embedded in the main cantilever beam to resist/transfer the load.
- Similarly, five radial beams were resting on main cantilever hybrid composite beams (see Fig).
- The floor slab will act as a curved two-way continuous slab.
- Foundation: Local soil is available at an adequate depth with a bearing capacity of 20 t/m². The foundation was designed considering base isolation forces.
- Software Used: Analysis and design were carried out using STAAD-Pro.

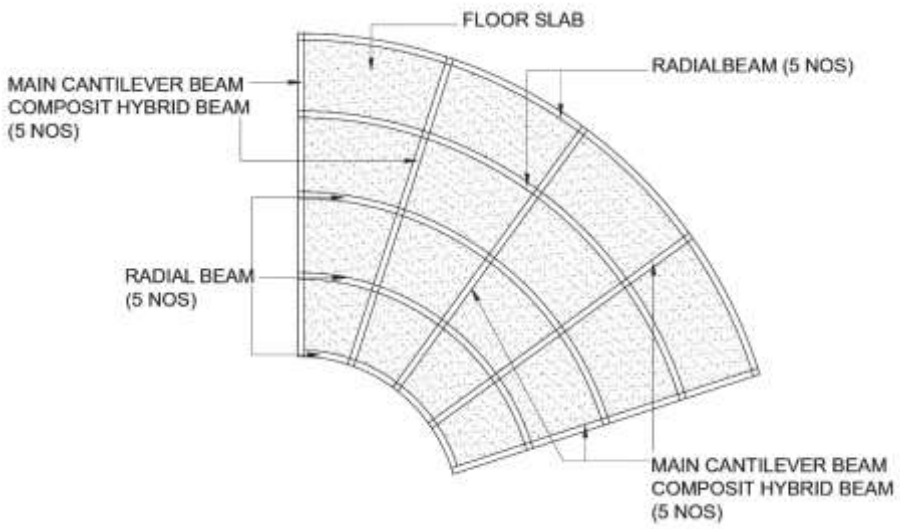

Figure 13. Typical structural plan

3.5. Sustainability and Environmental Responses:

The spatial and formal planning integrates sustainable features: from passive design solutions, the rotated floor plates maximize natural daylighting, cross-ventilation, and optimize solar orientation. Green roofs further enhance insulation and help with the management of stormwater runoff in Delhi's monsoon seasons while enhancing biodiversity. Solar panels provide renewable energy to the museum, along with water recycling systems that aim to conserve the resources of the resource-scarce neighbourhood, meeting both the needs of ecological responsibility and municipal demand. The strategic use of shading through overhangs and louvered systems serves to reduce heat gain during peak months, while envelope designs also work to limit cooling loads. The building form and orientation take advantage of prevalent north-west to south-east winds, which aids in natural ventilation and reduces operational energy use.

4. CONCLUSION

The war museum is not merely a structure, but it is an embodiment of collective memory, national sacrifice, and silent aftermath of conflict. The architectural decision to incorporate 72° twist is more than a visual gesture. It becomes a metaphor for the distortions of lives during war, and the complex narrative of history that must be navigated, not ignored.

Spanning five floors, each level unfolds like a chapter in a historical manuscript - moving visitors from confrontation to contemplation. The integration of light, voids, and material texture transforms spatial experience into emotional resonance. Every passage, ramp and gallery is curated to echo the rhythm of remembrance. While architectural Symbolism drives the aesthetic, structural clarity ensures its realization. Although this discourse primarily explored architectural language, future expansions will integrate structural innovations that support and enhance the spatial intent.

This museum stands as a typical architectural marvel & a complex structural challenge, offering rich learning for both, practicing engineers & building professionals. It invites, inter-disciplinary collaboration, pushing boundaries of conventional design & Construction.

In an era where built environments are often reduced to utility, this project aspires to restore architecture power as a Vessel of meaning - on that does not Just a house memory but awakens it. An innovative planning and structural design of such twisted structure is a guideline to budding Engineers, Architects and builders also.

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