TECHNOLOGY INNOVATION AND ITS PRACTICAL APPLICATION - AN INDIAN CASE

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1.0 BACKGROUND

Civil Engineering is as old as mankind. Indian Civilization is one of the most ancient civilizations of the world. There is vivid description of majestic and graceful Temples, Palaces, Gardens, Cities & similar civil engineering structures in our epics like Ramayana, Mahabharata showing India as a nation always capable of creating wonders. Architectural and engineering capabilities are evident in a vast number of Engineering & Architectural marvels situated all over the Country. Historically, India has produced many structures which are unparalleled to this day. The heritage temples and the Taj Mahal bear testimony to the technological innovations and high skill of workmanship. In the post independence period, India has embarked upon a high level of development activity which involves creation of social and physical infrastructure for the economic growth and improving the quality of life of people. Central Public Works Department is a proud participant in this glorious tradition for more than 130 years. The tradition of constructing monuments continues and Parliament Library Building is the latest which combines grace and elegance of heritage buildings with the latest in modern construction techniques.

The Parliament Library which is presently located in Parliament House, started functioning with about 15,000 volumes in the year 1952. With the current information explosion and ever growing need a separate building is needed to cater for expanding information service and introducing the latest library management techniques. Sansadiya Gyanpeeth, the Parliament Library Building now conceived, will be a mutli-dimensional institution developed as an Information Management Centre. It will be equipped to meet the basic requirements of a modern library having a stack area for storing 3 million volumes of publications.

Central Public Works Department (CPWD) has taken up construction of Parliament Library Building which, once constructed , will be a pride and prestige of the Engineers of this era.

The design of the Parliament Library building is based on a low key architectural expression signifying sagacity, even spiritual elegance, rather than competing with the seat of power, the Parliament. The relationship between the proposed Library Building and the Parliament House is that of Guru (Royal Teacher) and King and this is precisely why Parliament Library Building is physically lower in height than Parliament House. The Project presents monument in stone and glass work and involves number of new technologies in its planning and construction.

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2.0 ARCHITECTURAL FEATURES :

i)	Plinth Area	:	55,000 Sqm. i/c 8,000 sqm parking
ii)	Structure	:	RCC framed structure with 2 Storeyes above ground + 2 Storeyes underground & Parking in three storeyes Underground.

(iii) Three open courtyards - systematically placed around Central built form.

(iv) Green terrace garden.

(v) Total 12 Domes of varying diameters and differing geometrical patterns and structural arrangements. The domes are made of composite construction with a steel frame work over which precast concrete bubbles are placed. The steel frame for these domes is jointed with cast steel joints which reduces drastically the extent of welding involved , apart from presenting a sleek appearance. The central (focal) dome shall be fully glazed while the other domes are partly glazed, to varying degrees.

(vi) Glass block paving all around the building at ground floor level to provide diffused light in the basements.

(vii) Exterior of building is finished similar to the finish provided in the Parliament House.

2.1 SALIENT FEATURES : -

i) Building has been conceived as Multi-Dimensional institution to be developed as information management center, to meet the requirements of all types of information, facts, briefs, backgrounds, articles & research notes.

ii) Stack area for housing 3 million volumes

iii) Equipped with latest concept in stacking system like mobile or rolling stacks on rails.

iv) Central Air-conditioning.

v) Passenger and goods lifts and Dumb-waiters.

vi) Automatic Fire Alarm and Fire Fighting system with sprinkler, manual fire fighting system & talk back system.

vii) Sound system including public address and car calling.

viii) Sub-station equipment, Generating set.

ix) Door frame metal detector system.

x) CCTV for Display and Surveillance.

xi) Automatic car control in Parking area having capacity for 286 Cars.

xii) 35 mm Film Projection System for Auditorium having seating capacity of 1100 persons.

xiii) Video Projection for Auditorium & Committee Rooms.

xiv) Stage Lighting with automatic front-of-house lights for Auditorium.

3.0 FOUNDATION SYSTEM

3.1 BACKGROUND :

The building has two basements involving deep foundation over a large area, The soil is sandy silt to silty sand with presence of rock at a depth varying 1 to 14 M. The type of rock varies from quartzite to stand stone. Ground water table is generally at 4 M below ground level rising during rainy season even upto ground level.

(i) Diaphragm wall :

On account of proximity of Parliament House, restricted area and high water table, open excavation was ruled out. It was decided to provide diaphragm wall along the outer periphery of the building followed by curtain grouting the rock mass below the diaphragm wall. By providing this wall it was possible to do excavation in the area confined within the diaphragm wall without requiring any additional space. Further as path of the underground water flowing from outside towards the foundation pit increases substantially by providing curtain grouting, the amount of de-watering required gets reduced tremendously.

To construct the diaphragm wall, RCC guide walls were first constructed. Thereafter a rectangular trench having depth equal to the depth of the wall panel was made and the sides were stabilized using Bentonite slurry. Reinforcement cage was lowered in the trench and concreting done under water using tremie pipe. The provision of trumpet pipe to facilitate providing of inclined rock anchors and grout curtain pipes was made in the reinforcement cage. A ring beam was provided to connect the Diaphragm wall panels at the top. RCC guide walls were then dismantled.

(ii) Rock Anchors :

The diaphragm wall rests on rocky strata and for its lateral stability Inclined permanent Rock Anchors are provided.

Due to high water table, there will be large hydrostatic upthrust acting on RCC base raft. To counter-balance this upthrust, the raft was held down with the help of vertical permanent rock anchors.

(iii) Earth Work

Nearly 2,00,000 cum excavation including 90,000 cum. in rock was carried out. Because of proximity of heritage buildings including the Parliament House use of explosives was prohibited. Even controlled blasting was not permitted. Diverse methods had to be adopted to excavate. These included :

(i) Pavement Breakers
(ii) Hydraulic Rock Splitters
(iii) Hydraulic Krupp Hammers
(iv) Jack Pushing of Rocks
(v) Manual Cutters
(vi) Pre-heating and Splitting.

4.0 SUPERSTRUCTURE :

This building has been provided with extensive stone work used as cladding either on brick wall or on circular columns. Circular columns have been cladded with 50mm thick sand stone quadrants made to circular shape and held together by S.S. rings at the top and bottom independent of RCC column. Circular quadrants were made from the solid stones manually as well as by using lathe machines specially designed for the purpose. For other areas stone cladding has been achieved by making the cladding monolithic with brick wall and in case of RCC faces stainless steel anchor fasteners have been used.

For the desired aesthetics and acoustics, roofing has been provided with hand crafted sand stone jalis backed with acoustical lining. A wide range of flooring patterns have been evolved using combination of stones from various parts of the Country including Granite, Marble, Kotah stone etc. On account of this graceful and elegant flooring no carpet is to be used anywhere except the Auditorium.

5.0 DOMES :

5.1 BACKGROUND :

There are twelve domes at roof level with diameter varying from 14 metres to 35 metres having varying geometry. The central dome is a stainless steel and glass dome, three domes are partly glazed and the remaining eight opaque. The main feature of the domes are their cast joints; connection details between the steel ring beam and dome structure; steel structure & precast concrete bubbles, support details for bubbles on the steel dome and support system for supporting the ring beam on the existing RCC columns.

5.2 STRUCTURAL SYSTEM :

The basic structural system for the domes have been conceived with tubular arc type trusses, shaped to form skeletal dome shaped roof arranged in a Hexagonal/ Octogonal pattern formed by steel frame covered with pre cast high performance fibre reinforced concrete bubbles. Thus the structural system is of composite construction made up of steel frame work, over which concrete bubbles are placed.

5.2.1 Brief Description of Structural System for various Domes

5.2.1.1 **Auditorium Dome-** The structural system is a grid of two way space trusses made of structural steel. Neoprene Pad bearing supports resting over concrete ring beam are used at all support points.

5.2.1.2 **Core /VIP Dome –** Structure is single layered grid lying on a spherical surface in hexagonal /octoganal & square pattern of twin tubes. The whole structure rests on a steel ring beam. The ring beam rests on columns through supporting system having 65 mm thick neoprene bearing which provides sliding support condition. This is a compression structure.

5.2.1.3 **BPST, AV, Services , Library & Museum Dome -** The structure is double layered grid with top layer on a spherical surface in octagon and square pattern of twin tubes. Bottom layer consisting of network of tension rods, the top layer and bottom layer are connected through diagonal rod and struts in form of smaller tube. The ring beam rests on columns through supporting system having 65 mm thick neoprene bearing which provides sliding support and free support condition, the top layer resisting large compression force and bottom layer resist large tensile force.

5.2.1.4 **Focal Dome : -** Stainless steel structure of focal dome is petals shaped space structure consisting of purlin and rafter tubes connected with ladder and stablised with tension tie system.

For skylight of Focal and VIP domes, double glazed hermetically sealed glass panels consisting of heat strengthened, heat reflective, laminated safety glass were used.

5.2.2 JOINTING OF STRUCTURAL MEMBERS :

In order to avoid extensive in-situ welding, cast steel bolted joints were adopted. Such extensive casting has been done for the first time in the Country for structural purposes. The casting has been done in cast steel as well as in stainless steel matching with structural members of the respective domes. These cast members have been connected with high strength friction grip bolts.

High Performance Fibre Reinforced concrete bubble domes spanning 5 M have M50 concrete 40 mm thick shell and consist of 53 grade cement, condensed silica fume, ground granulated blast furnace slag , steel fibres.

5.2.3 TESTING :

The cast steel joints/ welding have been extensively tested by DPT (Dye Penetration Test) , Ultrasonic , Radiographic examinations and cutting across members for visual inspection .

i) Testing of castings - 100 % cast steel joints have been tested by Ultrasonic testing method. 0.5% of the casting have been cut across the section for dye penetration testing of sections. In addition to above one percent cast steel joints have also been tested by radiographic examination.

ii) All the welded joints have been tested by dye penetration testing (DPT) method . 10% of the joints have been examined by radiographic examination and 1% of the welded joints have been mechanically tested.

6. ELECTRICAL & MECHANICAL SERVICES :

The power consumption shall be around 5 MW and the building has its own Electric Substation with 9 Nos. dry type Transformers. The Air Conditioning of the entire building is by means of 5 Nos. Centrifugal Chilling machines with a total capacity of 2750 Refrigeration Tons along with 3 Nos. electric boilers of capacity 1 MW each so as to provide comfort conditions throughout the year. The lighting is also on emergency supply through 2 Nos. diesel generating sets of capacity 1 MW each. For security purposes closed circuit TV surveillance system has been provided along with Door Frame Metal Detectors and X-Ray Baggage Scanners at entry points. State of the art services in the Auditorium include Simultaneous Interpretation System , 35 mm Film Projection with Dolby Digital Surround Sound, Stage Lighting with Scanner operated Front of House Lights, Video Projection with Xenon illumination system giving an output of 10000 Ansi Lumens, Sound Reinforcement System of exceptional quality etc.

7. ISO-9002 (Quality Control)

Befitting the status of the project, the project team has worked towards establishing and maintaining a quality assurance system in planning and construction of Parliament Library Building. The Parliament Library Project Team have been conferred w.e.f. 01.09.96 to 31.08.99 and re-conferred w.e.f. 01.09.99 to 31.08.2002 with the internationally acclaimed **ISO-9002** Certification for **"Construction Services"** by Bureau of Indian Standards, who are accredited by Raad Voor Accreditatie, Netherlands. The Parliament Library Project Team is the first Civil Engineering Government Organization in the Country to be conferred with this certification by BIS.

8. CONCLUSIONS :

By adopting technological innovation and its practical application it has been possible to construct a monumental building which is matching in grandeur with Parliament House and yet provided with all modern amenities. Extensive use of natural finishes with stones are not only aesthetically pleasing but reduce the burdens of maintenance also. Usage of treated glass and glass blocks imparts natural light in basement for conserving energy. Innovative techniques made it possible to excavate toughest rock even without blasting in a reasonable period of time. The use of cast steel joints has drastically reduced the in-situ welding in the dome structure and made the structure more elegant and aesthetically pleasing. The building has been constructed on the theme of heritage to high-tech. Use of natural stone and craftsmanship makes it heritage building The building is now complete and is shortly to be dedicated to the Nation.

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