How BIM Brings LEED V4 Certified Sustainable Design (Green Building) to Construction?

LEED (Leadership in Energy and Environmental Design) – the most extensively used green building rating system in the world provides a framework to craft efficient and cost-saving solution. Consequently, the construction companies started implementing this universally acknowledged symbol of sustainability in their work process. However, a number of challenges are faced by Architecture, Engineering & Construction (AEC) firms for bringing LEED V4 (the newest version of LEED) to construction. Building Information Modeling Technology helps to meet the criteria of LEED Credit Categories in a construction project, resolving the challenges of Environmental Factors, Water Scarcity, Resource Management, Long Material Lead Time, Benchmarking Energy Usage, Accurate Structural Analysis and Extending Design to Fabrication Workflow for MEP trades. This article focuses on how Pinnacle Infotech, the Global BIM Service Provider implemented Green Building Design through BIM, saving cost of an entire project.


Challenges in Bringing Sustainable Design to Construction for a World Class Production Facility - Jaipur, Rajasthan, India

1. **Environmental Factors** – BIM Professionals faced complication in bringing Sustainable Design (Green Building) to Construction. Pinnacle wanted to ensure that the workforce get a
healthy work environment & don’t have to struggle due to extreme heat (>45 degree centigrade) and humid conditions of Jaipur while working in the production center.

2. **Water Scarcity** - Jaipur experiences severe water scarcity, receiving 600 millimeters precipitation/year (average), during monsoon (June-September).

3. **Resource Management** – It was challenging to manage a resource of more than 300 people, working at the same construction site.

4. **Long Material Lead Time** - It was challenging to extract accurate quantities of materials with long lead time. In order to meet the criteria of Sustainable Design to Construction, maximum materials were imported from Germany, USA, Japan, Thailand & China. (Lead time is the time between concept plan & completion of production - order placement, material sourcing, manufacturing & final delivery.)

5. **Benchmarking Energy Usage** – Creating Designing Opportunities for Energy Efficiency across the Buildings was challenging for this project.

6. **Accurate Structural Analysis**

7. **Extending Design to Fabrication Workflow - MEP**

**Challenges Resolved through BIM**

1. **BIM Achieved Sustainability Goals, Minimizing Environmental Impact** - Through BIM Technology, Sustainable design (green building) was brought to construction by planning through façade design during pre-construction stage. Shop drawings produced from Revit Model were shared with multiple vendors & stakeholders, leading to smooth, flawless construction. Architect used Revit Design Options to visualize Concept Design, Plans and Sustainable Designs. 3DS Studio Max was used for this project to get clear idea of the color, room sitting positions, material visualization and aesthetics.

2. **Water Efficiency, Valuable Criteria for LEED** - In design stage, Pinnacle calculated Rain Water Harvesting report through BIM model for reducing water usage.

3. **4D Scheduling/Virtual Simulation through Navisworks Manage** helped Pinnacle make proper planning & DPR (planned vs. actual) for more than 300 labors to work at a time on the same construction site, enabling smooth construction.

4. **Extracted Accurate BOQ from Design Development Stage Model to Import Material in Time**, avoiding material surplus/shortage at site.

5. **Energy Analysis - Understanding Energy Performance with Revit** - Benchmarking energy usage across buildings with Revit Solar Study & Thermal Analysis while designing opportunities for energy efficiency aided cost savings & improved building performance. HVAC systems including equipment capacities, efficiencies, airflows, and fans were modeled and designed, supporting documentation upload in LEED. Energy modeled, reflected architectural, lighting & HVAC with relevant plans. Building model was simulated with actual orientation, rotating 90,180 & 270 Degrees, providing an average result for Base-case Energy consumption.
Understanding Sun’s position & how it changes with respect to building being designed over the course of a day or through different seasons in a year helped Pinnacle visualize shadows & assess building’s performance in terms of natural light & heating requirements. Revit Architecture simulated Sun path for better understanding the impact of Sun in relation to project & surrounding context. It helped visual representation of Sun’s movement across the sky at geographic project location, providing a greater understanding of shading & overshadowing issues with interactive control of Sun’s position.

6. **Structural Analysis with BIM** - Revit model was created by Pinnacle’s BIM Professionals, collaborating with StaddPro. Structural Analysis helped in:
   
   - **Testing Effects** - Structural Load, Wind Load Simulation and Live Load Calculation were performed verifying IS compliance. Moreover, comprehensive element analysis was performed (columns, beams & floors) for risk-free project delivery.
   - **Validating Design** – Design was validated for constructability, performance & maintenance of wood, steel & concrete - column size, structural openings, beam depths & clashes. Furthermore, BIM was used for structural design (conceptual to construction), detailing & prefabrication.
   - **Calculating Material Quantity** - Quantity Takeoff, Estimation and Coordination were done through BIM, enhancing productivity & constructability analysis.

7. **BIM Extended Design to Fabrication Workflow – Optimizing MEP with Revit** - Intelligent BIM model helped Pinnacle design building systems with greater efficiency. The Model provided project stakeholders get a clear idea of design intent, enabling them to modify the design and achieve desired outcome, minimizing the risk of costly changes later. Design options were simulated & analyzed to develop cost-effective solutions.

**Design Analysis Includes:**

**Mechanical Ducting:** Load Analysis & CFM Calculations, Sizing Ducts & Terminals, Air Balancing, ESP Calculation & Pressure Loss Reports, Designing Equipment Capacities, Optimize Duct Routing, Damper Selection & Placements, Piping, Sizing & Layouts

**Electrical:**

- **Lighting & Small Power:** Power & Lighting Circuit, Ensuring Lighting Illumination, Voltage Drop Calculation & Cable Sizing, Load Balancing & Calculation, DB & Panel Schedule, Providing Wire & Conduit Sizes, Earth Fault Loop Impedance for each circuit, Energy Analysis Layouts
- **Cable Tray Routes (MV & LV):** Providing Accumulative Voltage drop calculations, Cable tray sizes & routes, Electrical Single Line Diagram Creation, Short Circuit Current Calculation

- **Firm Alarm:** System Connection & Equipment/Fixture Schedule, Layout & Looping Fire Alarm Speakers, Providing Control Modules for Fans, Motorized Dampers & Pumps, Monitor Module for FHC & HRFHC

**Plumbing:** Assigning Fixture Units, Layout Generation & Pipe Flow Calculations, Pipe Sizing & Pressure Drop Calculations, Designing Drainage, Rain Water & Storm Drain, Pump Head Calculation & Pump Selection

**Return on Investment**

**Implementing Green Building Design through BIM Saved Cost for Pinnacle’s Jaipur Project**

Implementing Green Building Design through BIM Process saved **14% of the overall cost** of Pinnacle’s Jaipur project. The Building System’s CFM (HVAC System Air Flow) & Capacity appeared to be high. Baseline System seemed much efficient when the fans were auto-sized by the simulation software. The High CFM & Capacity of the proposed system were revisited prior to model revision. BIM solution played a vital role in sustainable design & design optimization, coordination and construction management.

**Money Saved from BIM Implementation for the Project-** 1368117 USD total cost saved for the construction project, out of which 219624 USD for Labour, 229624 USD for MEP items, 269623 USD for Dismantling, 279623 USD for Rework, 369623 USD through BBS/Reinforcement Validation & Design Changes

**Time Saved from BIM Implementation for the Project-** 180 total man days saved from BIM implementation, out of which 60 Man Days for Civil Items including concrete, steel reinforcement, shuttering, finishing, interior items and facade, 30 man days for dismantling including Civil, MEP & Labor and 90 Man Days for rework.

**Concluding Thought:** Innovative BIM facilitated aesthetics modifications to reflect the architectural heritage of Jaipur. Choice of glass, exposed brick, local ‘Ita’ sandstone & the form of building with courtyard reflected rich traditions of the region in the building. Now, the building gets enhanced day light, ensuring unhindered external views for the occupants.

**Jaipur Production Facility Snaps**
Company Website: https://www.pinnaclecad.com/

Company Logo:

Company Twitter Handle:

https://twitter.com/Pinnacle_AEC

Company LinkedIn URL:

https://www.linkedin.com/company/pinnacle-infotech

Link: