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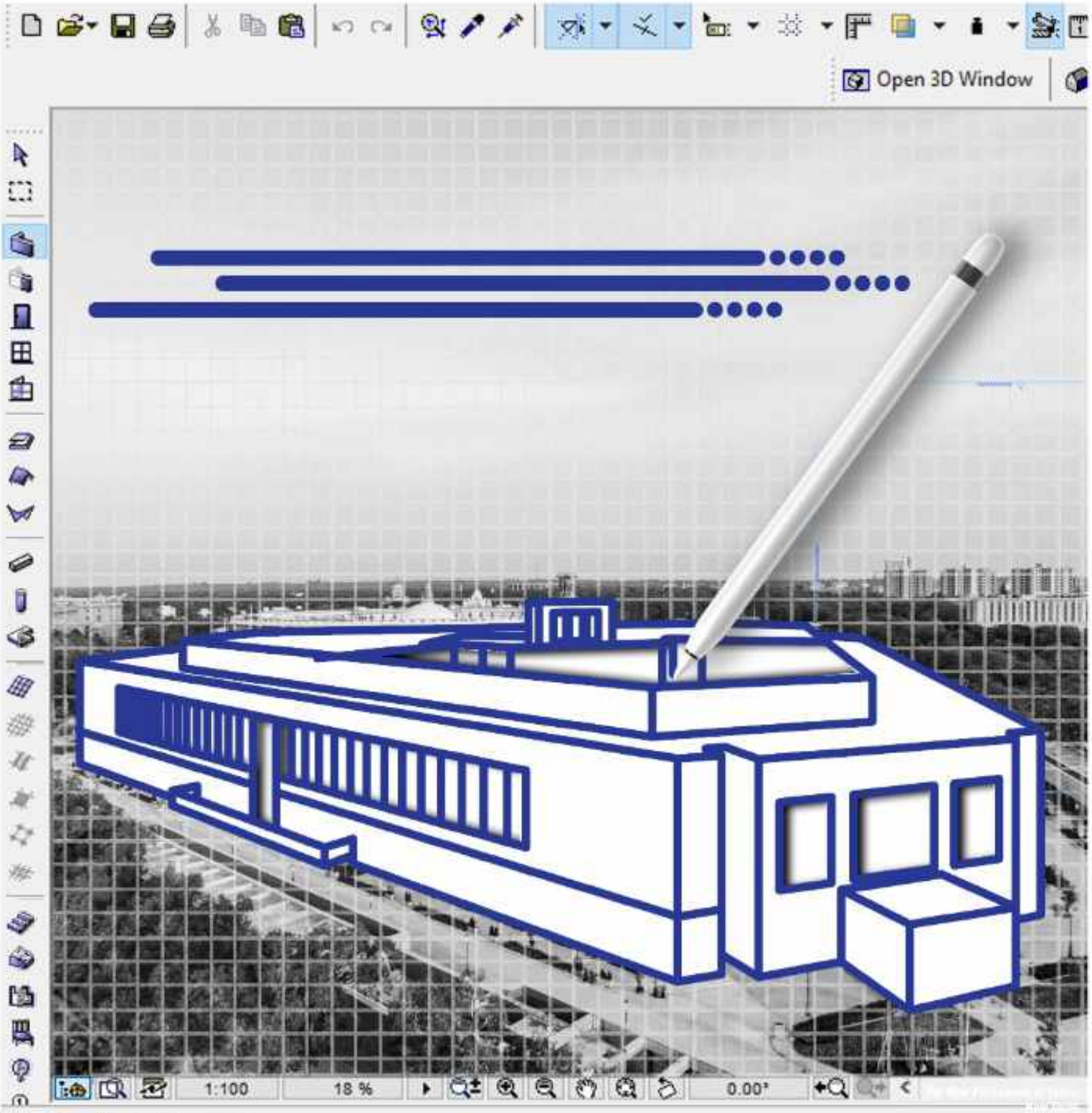
CPWD

Compendium of Papers
presented in Technical Seminar

Vigyan Bhawan, New Delhi :: **11th July 2023**



CPWD

COMPILATION OF TECHNICAL SESSION

July 11, 2023

Published under the Authority of
Director General
Central Public Works Department
Ministry of Housing and Urban Affairs

Rajesh Kumar Kaushal
Director General

सत्यमेव जयते
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Government of India

CPWD

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Message

The Use of Digital Technology is now making life easier in every spare of human being. Virtual Reality is now making way for visualization and adoption before the start of construction. Augmented reality is also used for monitoring and maintenance of critical infrastructure.

The CPWD is not far behind in using the digital technology and it is implementing ERP to automate its processes to ease out the procedures of the Public Works.

The theme of Technical Seminar 'CPWD-Digital in powering of Public Works' truly semblance the present scenario.

The construction related software's are boon for architectural, engineering and in- process construction activities. BIM is one of such software available in modern time which is accepted for creation of precise digital modelling of infrastructure and backed by government approval as ISO 19650 standard. BIM and other software tools are planning to be integrated with ongoing digital solutions in CPWD.

I place my gratitude to all the speakers who are attending this Technical Seminar and showcasing their Presentations. The topics covered in the seminar have variety of subjects ranging from ERP, use of BIM, software in visualizing and designing campuses, new construction technology-3D volumetric and pre-engineered building, case studies of rain water harvesting, carbon neutral Ladakh, usefulness of DC wiring, use high strength steel in PEB structures, applicability of tensile fabric in Dome and construction of water supply treatment plant for a city and use of building materials for sustainable environment, durability of structures and safety of users.

This compilation of Technical Presentations will go a long way in knowledge allowance and sharing industry experience in emerging building technology and materials among the technical fraternity of CPWD.

I congratulate Shri Dharmesh Chandra Goel, ADG (Tech.), Shri Prem Mohan, CE (CSQ) Civil, Dinesh K Ujjainia, SE(TAS) and his team for organizing this technical seminar and bringing out this publication.

Date: 11th July, 2023
New Delhi

(Rajesh Kumar Kaushal)
Director General, CPWD

Dharmesh Chandra Goel
Addl. Director General (Tech)

भारत सरकार
Government of India

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PREFACE

It is a matter of great pride for me to organize technical seminar on the occasion of 169th Annual Day of CPWD.

The subjects of Presentations are pertaining to digital initiatives, case studies, and technology and materials. The theme of this year Technical Seminar 'Digital empowering of public Works' convey the message about present trends and give glimpse of the future.

Shri Dinesh Kumar Ujjainia, SE (TAS) and his team has been in the helm of affaires for Technical Seminar and I wish to thankfully acknowledge their efforts and contribution in compilation.

The entire team is responsible for organizing this seminar but one person who stand out is Shri Devendra Kumar Sachan, Director (Tech. & PR) who repeatedly perused with presenters for submitting technical presentation to make this event effectively meaningful.

I also praise the efforts made by Shri S N Jaiswal, Shri Raghvendra, Shri Gian Chand, Shri Durga Ram Chowdhary and Shri Hemanta Panrui for their continues hard work and coordination with presenters. Smt. Sunita Baghla, Shri Sweekar Khanna and Smt. Manisha deserve special mention for their backend support and compilation of Technical Presentations.

I also wish to express my gratitude to all the participants who sent their technical presentations on digital initiatives, case studies, technology and materials which make possible for this compilation.

Date: 11th July, 2023
New Delhi

(Dharmesh Chandra Goel)
Additional Director General (Tech.)

CONTENTS

BUILDING INFORMATION MODELLING, A DIGITAL PROCESS OF MAKING VIRTUAL BUILDINGS

Sh. Sameer Jain, Primus Parterner Pvt. Ltd.

BRIEF INTRODUCTION TO BIM

BIM, or Building Information Modelling, describes a digital process that is useful across the various stages of design and construction of any infrastructure project. BIM in construction integrates several different tools and methods to drive efficiency, improve accuracy, reduce delays and save costs. The process of BIM is useful in creating and managing information on a construction project throughout its whole life cycle. BIM allows for real time collaboration of data, which increases precision, allows for better planning, procurement, adherence to laws. etc. This works by creating a digital description of every aspect of the infrastructure/ project, right from the planning stage to the post completion. This digital description includes a combination of information-rich 3D models and associated structured data such as product, execution, and handover information.

BIM allows real time collaboration for all stakeholders including AECO-Architecture, Engineering Construction and Operation industry, clients, etc. across the entire Project Life Cycle (PLC). This leadsto more efficient methods of designing, delivering, and maintaining physical built assets. The information contained within the models facilitates informed decision making and that means higherclarity, better communications, and, ultimately, better efficiency.

BENEFITS OF BIM

Infrastructure has become more complex, dynamic, and technologically innovative, especially in lightof rapid urbanization. BIM offers a means of transforming the relationships that exist between AEC, turning it into a more unified and productive unit. This technology enhances efficiency and effectiveness, while streamlining workflows.

BIM IN INDIA: CASE STUDIES

Autodesk's Navisworks Reduced Design Time in the Development of the Aurangabad Industrial City (AURIC)

The Aurangabad Industrial City (AURIC) is among India's first well-planned, greenfield industrial Smart Cities. It is one of the nodes of the highly prestigious Delhi-Mumbai Industrial Corridor. The city is being developed in an area of 10,000 acres, wherein the Bidkin Industrial Area (part of the Shendre Bidkin Industrial Area) spans 2,487 acres. It will have provision for high-growth industries with wide-ranging infrastructure services, convenient access, and will handle waste with minimum impact on the environment.

Project Challenges Foreseen

- Challenges in creating an efficient workflow
- Clash disputes
- Lack of coordination and collaboration causing delay in project design delivery
- Improper planning leading to excessive wastage on the construction site
- Continuously evolving design expectations leading to significant rework

Solution

Techture, one of the consultants on the Bidkin Industrial Area stretch of the AURIC city project, assisted in the project's BIM-enabled virtual construction, including the design of the roads, utilities, and highway structures. Working in close collaboration with Larsen & Toubro (L&T), the design-and-build contractor, Techture used Autodesk AEC solutions (Civil 3D, InfraWorks and Navisworks) to devise the project workflow and provide a clash-free design, along with reliable, accurate and quantitative planning data for the project. This facilitated high-quality design from the pre-construction stage, for water-based utility networks, roads and highway structures.

BIM's Value Proposition

- Dynamic clash detection and coordinated civil infrastructural modeling
- High-quality high-performing building and infrastructure design
- Project workflow optimization with integrated analysis, generative design, and visualization tools
- Easy design modifications with simulation tools
- Reduced rework and errors with 4D simulations
- Appropriate use of resources and saving on excessive wastage

> *Creating a federated and dynamic 3D Building Information Model (BIM) for AURIC city aided in better multi-party communication and a unified understanding through the 3D model. The infrastructure digitisation of roads, utilities and electrical assets improved quantity estimation and led to reduced timelines and increased cost efficiencies, by leaps and bounds.*
>
> ***VIRAJ VODITEL***
> ***Founder and Director***
> ***Techture***

Project Information

Name	Bidkin Industrial Area – First Industrial Smart City of India
Project Owner	Aurangabad Industrial Township Limited (AITL)
Design Consultants	AECOM, Techture
Contractor	Larsen & Toubro (L&T) Construction
Budget	INR 6535.92 Crore (USD 873 million)
Completion Year:	2020

BIM Use Leads to Improved Design and Construction Efficiency in Convention Centre Project

The India International Convention and Expo Centre (IICC) in New Delhi is a unique, multipurpose convention center developed under the smart city initiative of the Government of India with a vision to be an icon of India and to obtain a platinum certification from the Indian Green Building Council (IGBC). With a total area of 1,000,000 sq m, IICC is India's largest convention and exhibition complex with large exhibition halls, an auditorium, and multi-arena facilities.

Project Challenges Foreseen

- Expansive scale and complex nature of the project
- Difficulty in coordination between the ASMEP services
- Continuously evolving design expectations from the client
- Spatial coordination issues leading to delay in construction processes
- Software compatibility issues resulting in reworks
- Delays and breaks in workflow due to the COVID-19 pandemic

Solution

The BIM Engineers, one of the design consultants on the project, deployed the latest technological know-how in BIM to build the dynamic facilities of IICC. The consultants challenged the conventional method of designing the structure, by transitioning from in-silos data in AutoCAD to collaborative Revit models to efficiently control and develop the design and coordination process. By transitioning from CAD to BIM, the plan-to-design, design-to-construction, and construction-to-handover processes became more accessible and robust. The focus of the structural design was on sustainability – through developing the building envelope, general installations, energy efficiency, and control systems, among other things.

BIM's Value Proposition

- Improved collaboration for design coordination, and document management
- Early clash detection using Autodesk Navisworks
- Seamless spatial and built environment data exchange leading to minimal data losses
- Better time, cost, and quantity estimates
- Better control over site inventory and project plans
- Improved construction quality using value-engineered decisions using Autodesk Revit

> *Initially, this project was started using traditional CAD-based tools, and BIM was a lateral entry platform. However, using Autodesk Revit as one of the BIM solutions, we were able to bring design improvement and construction efficiency to this prestigious project, which will be a landmark for generations to come.*
>
> ***PALANIMUTHU KASINATHAN***
> ***Vice President***
> ***The BIM Engineers***

Project Information

Name	India International Convention and Expo Centre (IICC)
Project Owner	Government of India
Design Consultants	Lead Architect - CP Kukreja Architects, The BIM Engineers
Contractor	ARCOP, Larsen & Toubro (L&T) Construction
Budget	INR 29946.93 Crore (USD 4,000 million)
Completion Year:	2022

RELEVANCE OF BIM FOR CPWD

BIM is of utmost importance for CPWD due to its numerous benefits. Firstly, **BIM enhances the planning and design processes by providing a detailed and accurate project model**. This enables CPWD to identify potential issues and challenges early on, leading to more efficient and cost-effective projects. With improved coordination among stakeholders, including architects, engineers, contractors, and owners, BIM fosters seamless information sharing and collaboration, minimizing errors and reducing delays.

Secondly, **BIM streamlines the construction phase by allowing CPWD to create digital project mock-ups that simulate construction activities**. This digital visualization helps in identifying and addressing

potential problems, thus enhancing safety measures, and increasing productivity on construction sites. Additionally, BIM's digital asset library enables CPWD to effectively manage and maintain projects, reducing costs and improving operational efficiency. Lastly, **it will work to increase the capacity building of the officers to utilise the new age technology in the today's construction world.**

BIM could be beneficial to CPWD in the following ways:

1. Improved **planning and design**: BIM can be used to create a more accurate and detailed project model, which can help identify potential problems and issues early on in the planningprocess. This can lead to more efficient and cost-effective projects.
2. Improved **coordination**: BIM can be used to share information between different stakeholders in a project, such as architects, engineers, contractors, and owners. This can help improve communication and coordination, leading to fewer errors and delays.
3. **Improved construction**: BIM can be used to create a digital project mockup, which can be used to simulate construction activities and identify potential problems. This can help to improve safety and productivity on the construction site.
4. Improved **operation and maintenance**: BIM can be used to create a digital asset library of a project, which can be used to help with the process and maintenance of the project. This canhelp to reduce costs and improve efficiency.
5. BIM can help improve **project quality** by providing a more accurate and detailed model of the project. This can help identify potential problems and issues early on in the planning process, leading to more efficient and cost-effective projects.
6. BIM can improve **communication and coordination between different stakeholders** in a project. This can reduce errors and delays and improve the overall quality of the project.
7. BIM can help to improve **safety** on the construction site by providing a digital mockup of the project. This can be used to simulate construction activities and identify potential problems.
8. BIM can help to improve the operation and maintenance of projects by providing a **digital asset library** of the project. This can be used to help with the process and maintenance of theproject, which can reduce costs and improve efficiency.

CPWD - Need for the Common Data Environment and Building Information Model

BIM can be used in multiple ways in CPWD projects to reduce operational as well as construction cost. For example, BIM can be used to create a 3D model of a building. This model can then be used to simulate different construction scenarios, such as how the facility will withstand earthquakes or howit will be affected by changes in weather conditions. This can help identify potential problems early on in the planning process, saving time and money.

BIM can also be used to create a digital mockup of a building. This mockup can be used to train workerson how to construct the building, which can help improve the construction site's safety and productivity.

Finally, BIM can be used to create a digital asset library of a building. This library can store information about the building, such as its construction materials, maintenance schedule, and energy consumption data. This information can be used to help with the operation and maintenance of the building, which can help to reduce costs and improve efficiency. monitor electrical and mechanical equipment, Internet of Things (IoT) for data capturing form project sites and a layer of augmented reality, virtual reality and merging technology.

Additionally, CPWD is working on an ERP- a modular software system that integrates the main functional areas of an organisation's business processes into a unified system. CPWD's ERP system willbe driven by an online real time dashboard-based system for process monitoring, decision-making, coordination and control. It will comprise of six layers, including BIM. Incorporating BIM here will also help in real time and accurate project estimates, monitor electrical and mechanical equipment, Internet of Things (IoT) for data capturing form project sites and a layer of augmented reality, virtual reality and merging technology.

Given the numerous advantages of BIM for all infrastructure projects, especially in buildings, flyovers,site planning, etc., it should be implemented at a larger scale. In fact, while CPWD has already mandated in all projects over the worth of INR 150 cr., it may be suggested that this minimum value be reduced to INR 50crore for project optimization. Adequate awareness generation, capacity buildingand guidelines for adoption can help in the same.

PROPOSED AGENDA FOR PRESENTATION

During the BIM presentation, participants will engage in a comprehensive analysis of various aspects related to Building Information Modeling (BIM) and the BIMDCR platform. The workshop will begin with the understanding the concept of BIM and its advantages over traditional 2D methods. The necessity of implementing BIM will also be emphasized, followed by an introduction to Revit software.Attendees will gain practical insights into preparing a 3D BIM model using Revit, enabling them to grasp the intricacies of the software and its application in project development. Live demos will also be presented to help demonstrate and a create a better understanding of how the process works.

MAXIMIZING THE BENEFITS OF BIM THROUGH A SYSTEMATIC ADOPTION - CASE OF A PUBLIC PROJECT DELIVERY

Dr. V. Senthilkumar, Associate Professor, Civil Engineering Department
& Chairman, Engineering Works Division, IIT Palakkad

CONTEXT

Production, analysis, and management of millions of project data developed over the project life cycle areimportant for projects in which the area of development is extensive with several construction fronts opening simultaneously which is the case of the Indian Institute of Technology Palakkad's (IITPKD) permanent campus construction project. As a client organization, the Engineering Works Division (EWD) of IITPKD is mandated towards the quality execution of the multi-phased permanent campus construction Project spread over a developmental area of around 500 Acres with an estimated budget over 1000 Croresfor its first phase development. As one of the premier technical institutes in India, IITPKD strives for excellence in everything they do and so do the construction projects. During the inception of the project,the EWD of IITPKD needed a reliable solution that could streamline the processes, enhance collaboration,and improve overall project management during its multi-phased campus development exercise. One such aim of the institute is to work towards the digitization of campus construction documents and improve collaboration among the project stakeholders. The CPWD has been appointed as the PMC and the project was decided to be executed through EPC Mode3. Though the idea of complete digitalization through Building Information Modeling (BIM) and Common Data Environment (CDE) is not encouraged bythe stakeholders, the institute and the EWD team were insisting on the adoption of the same as the contractual mandate. However, given the absence of any standard guidelines/ standards/ sop's its adoption among the project stakeholders demanded a systematic adoption strategy. This executive summary shares the experience from the IITPKD permanent construction project while systematically adopting the BIM and allied technologies, during the project execution and its benefits.

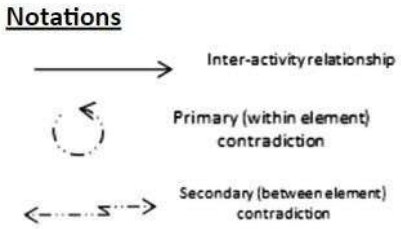
OVERVIEW OF BIM AND CDE ADOPTION AROUND THE GLOBE

BIM has been widely adopted in developed countries due to supportive government policies. However, the implementation of BIM in developing countries such as India is still rare. Many studies have been reported in the past towards the strategies and challenges associated with BIM adoption. The UK is considered a global leader in the adoption of Building Information Modelling (BIM). The UK government mandated BIM in April 2016 in every construction project which requires that all projects funded by central government be delivered with 'fully collaborative 3D BIM'. This has driven digital adoption in an industry which had traditionally been a laggard in this area, however the strategy has been rolled out formore than six years before its mandate leaving the ecosystem including its standards, capacity building etc., to be nurtured and so the Singapore government. Some countries such as UAE (Dubai Municipality) had given a brief amount of time during the year of 2014 and mandated the adoption of BIM. However, many developing nations are yet to mandate the adoption of BIM except for some of the projects with national importance without developing the ecosystem. Further, there is a lack

of understanding and research studies on BIM implementation in developing countries in contrast with the related studies in developed nations. Especially, the literature is lacking in understanding the influence of BIM adoption on institutional/ organizational climate while executing the project in developing countries such as India. Therefore, this executive summary focuses on addressing the impact of the various existing institutional aspects through activity theory as the lens in the Indian context.

There are many ways through which BIM implementation is advocated, some significant and classical strategies include 1. Government mandate 2. Industry ecosystem 3. Peer competition etc. In all these strategies towards implementation, the system-level changes within the implementation ecosystem playa major role in its success. Further, many theories have been reported in the literature for explaining complex systems such as technology adoption. In this case, the Activity theory is adopted to explain the theoretical account of the constituent elements of complex systems and their interactions. Using an actionresearch approach, the study aims to understand the interplay of information interfaces among various stakeholders through BIM adoption. The activity theory was used as a theoretical concept to illuminate and analyze the implementation issues of BIM. The findings show that BIM implementation undergoes a series of transformations due to the transformation of various elements of the organization and its changefrom the existing work practices. The study provides vital insights to practitioners to be aware that the BIM adoption could be localized while balancing the various elements of Architectural Engineering and Construction activity systems mentioned in the activity theory explained in the following section. This executive summary's insights further can help the project/ construction managers be better prepared with the shaping up of work processes to adopt BIM in a manner useful for the project by enhancing the implementation of the BIM and CDE.

SYSTEMATIC BIM IMPLEMENTATION USING ACTIVITY THEORY AS THE LENS



Technology adoption in any sector is primarily influenced by the 1. People 2. Process and 3. Technology/ Tool. The appropriate proportion of changes in these three aspects will enhance the success of any technology adoption as shown in Figure 1. Activity theory coined by Engestrom, (2000) further subdivides these aspects into six sub-elements as shown in Figure 2.

Figure-1: *Technology Adoption*

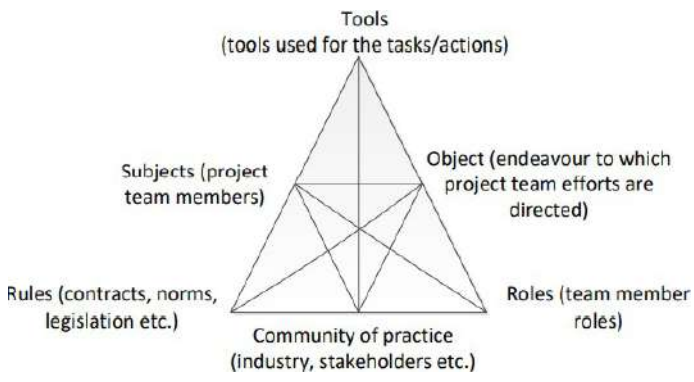


Figure-2: *Activity system (Engestrom, 2000)*

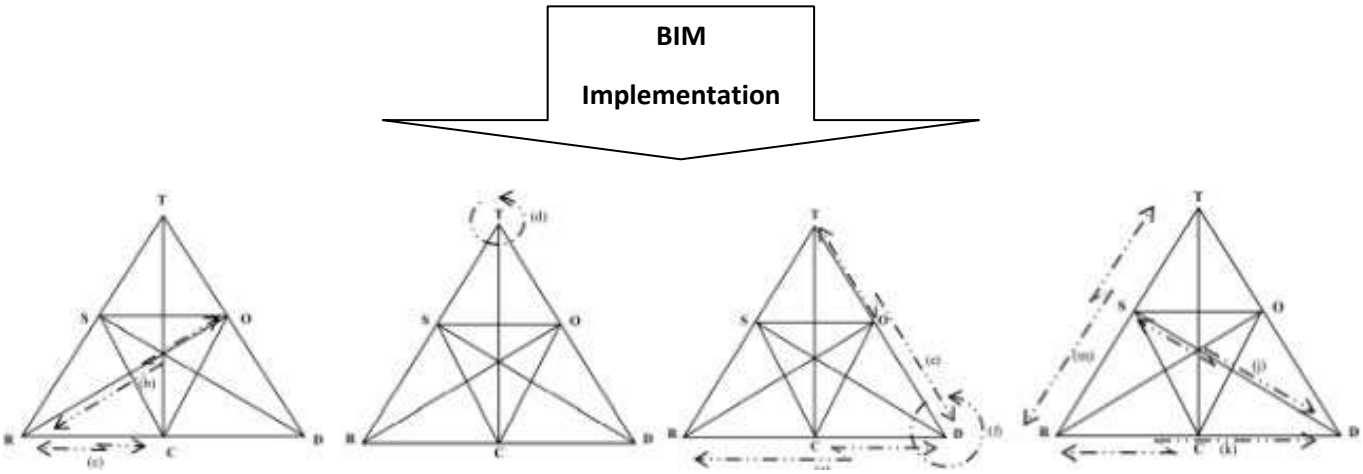


Figure-3: *Activity BIM-Induced Dysfunctions and Contradictions (Adeyemi, Senthilkumar and Root, 2020)*

To suitably conceptualize and clarify the nature of collaborative work practices among the project ecosystems which includes the BIM and CDE adoption, it is useful to employ the use of activity theory. According to Engestrom (2000), any work activity system comprises individual workers, tools they use tofacilitate their work rules that guide how they work, the purpose to which members of the workplace community direct their actions and the distribution of responsibilities between all the actors within the system as depicted in Figure 2. The inter-relationships among these work activity system elements may lead to translating the activity system in response to the context/climate it is attached to. These include the enquiry proposed by Mwanza (2002) viz, what sort of activity of interest? To what endeavour do actors direct their efforts? Who is involved in carrying out the activity? By what means are the subjects achieving the objectives? What norms and rules govern the performance of the activity? Who is responsible for what when carrying out the activity? What is the environment in which the activity is carried out? What is the desired outcome of this activity?

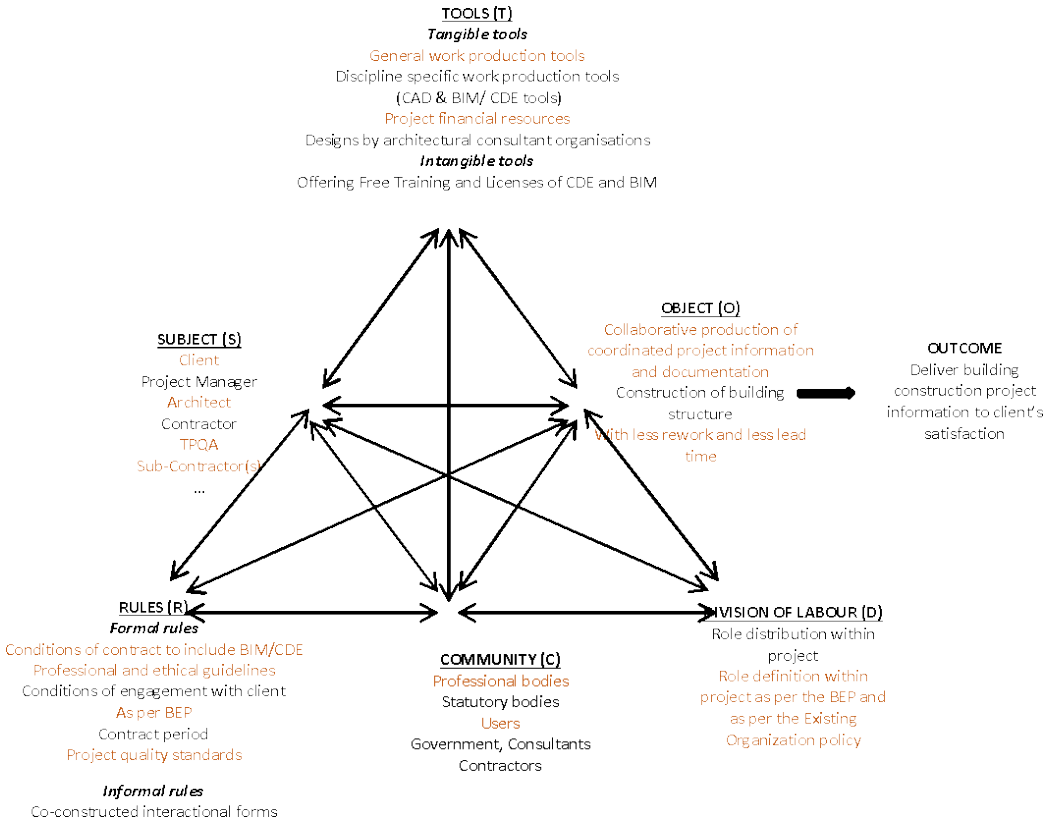


Figure-4: *Evolved Organizational Context Activity System Upon Impact by BIM Technology (A. AkintolaSenthilkumar. V and Root. S.D. 2019)*

The existing climate of the project organizations (CPWD's existing SOPs) is scrutinized to identify the potential translation of the activity system towards the digital transformation exercise initiated for this project by asking the answers to all the above-mentioned questions among all the stakeholder organizations involved in this project. As shown in Figure 3, the transformation induces primary, and secondary contradictions and inter-activity relationships within and between the organizations. That's when the standards and guidelines play a major role. In the absence of any organization-specific guidelinesand standards for the BIM and CDE implementation and to manage these contradictions & newly induced activity relationships due to the proposed BIM and CDE implementation, discussions were initiated by theIITPKD with all the project stakeholders. Though, there was initial resistance from the stakeholders to the proposed change in the activity system (workflow) due to the proposed digital transformation (workflow), as the existing work practices (SoPs), organizational rules and policies conflict with the proposed BIM and CDE implementation protocol. However, the IITPKD team decided to adopt the BIM and CDE in a Phased manner as the development and management of project information on a mission to develop a 12000- student capacity campus project spanning over a decade is challenging. The digital transformation at the engineering works division of the IIT Palakkad has been inevitable to generate, standardize, share, and archive millions and millions of this project information. CDE and BIM are the natural choices to achieve this objective.

Since there are no common standards and guidelines contextualized to the Indian context for BIM implementation, the Client organization decided to refer to the ISO1960 series of standards and related guidelines documents towards Digital Transformation in the campus construction Project. The standardsand guidelines of work protocols have been modified against the constraints posed by the existing work practices in the existing organizational and project context/Eco-system. After careful investigations of theexisting project work practices and proposed modifications to the work practices by the IITPKD (Client organization), the Implementation has been administered in a systematic and phased/integral manner among the project stakeholders. This executive summary only explains the sequential steps adopted to implement the digital transformation on the design collaboration, issue resolution, documentmanagement and quality management services of the Client's Greenfield Campus construction project.

As mentioned before, the transformation has been planned to be in a phased/integral manner and startedwith the adoption of CDE among the stakeholders to store their project documents through the CDE (BIM360 docs). However, this transformation left with delta change in the existing work practices. Figure 4 depicts the project context activity system for a typical development project in BIM implementation. For example, approval of any design document is done on the hard copy as per the existing system, however the same can be approved digitally with the use of CDE. The access of project data by different project stakeholders was another challenge as the conventional way of silo working won't allow the data sharing until it is finalized, whereas the BIM workflow may categorize the generated data/information aswork in progress, final, shared, published etc. Compromises on the standard implementations as per ISO19650 guidelines were made to embrace the CDE during the initial implementation among fewer stakeholders of the project. The objective of this first step of BIM and CDE implementation was to start with document management and make sure that all the project documentation has fool-proofed versioncontrol and thereby reducing the data/ information loss and reducing the searching time. Furthermore, the project demands access to different file types by different stakeholders such as. rvt, .nwc, .dwg,

.pdf,.doc, .jpg etc., this is another contradiction from the previous conventional practice, as not all the project stakeholders have the hardware and software supporting the particular file format but the CDE implementation rescued them all during such situations by allowing them to open all the file formats without having the necessary hardware and software installed in their local machine.

SYSTEMATIC IMPLEMENTATION STEPS

The first step of the digital transformation in the project activities was to secure the required number of licenses for the project stakeholders. This has been achieved as a mandate in the tender notice. The next step is to integrate these licenses into the main project CDE in line with the BIM Execution Plan (BEP), which is the project execution workflow as directed by the project administrator from the Client agency in consultation with the PMC (CPWD). The created campus construction project in BIM360 will act as thecommon data environment for all the stakeholders. Once this has been set up, the CDE acts as the common platform where all agencies can create, edit, modify, and manage different project-related documents in real time with respect to their access privileges. The third step of the implementation was to train the stakeholders, as most of the stakeholders had worked with conventional methods (paper-based) in their previous projects. IITPKD had arranged in-house training for all the stakeholder agencies

n using the CDE and BIM tools and getting familiarized with the program interfaces in an integral/phased manner in which, one delta changes towards the digital transformation exercise at a time with sufficient training. The fourth step of implementation includes the preparation of the project process protocol as per the developed BIM Execution Plan (BEP). For example, in the context of the site team of Third-Party Quality Assurance Agency (TPQA), the responsibility of quality management checklists was given to the TPQA and the TPQA has prepared and uploaded numerous inspection checklist templates for various construction activities in the CDE module using approved checklists from the PMC's and TPQA's quality assurance plan. Further, the TPQA has prepared a folder system for documents to be uploaded within their working space in the CDE interface and is compatible with the project workflow and requirements protocol spelt in the BEP. Meanwhile, IITPKD has created various roles, rules, workflow, and communities of practice to facilitate the objectives of the digitalization process. The following figures depict the incremental digital transformation efforts made in this project case.

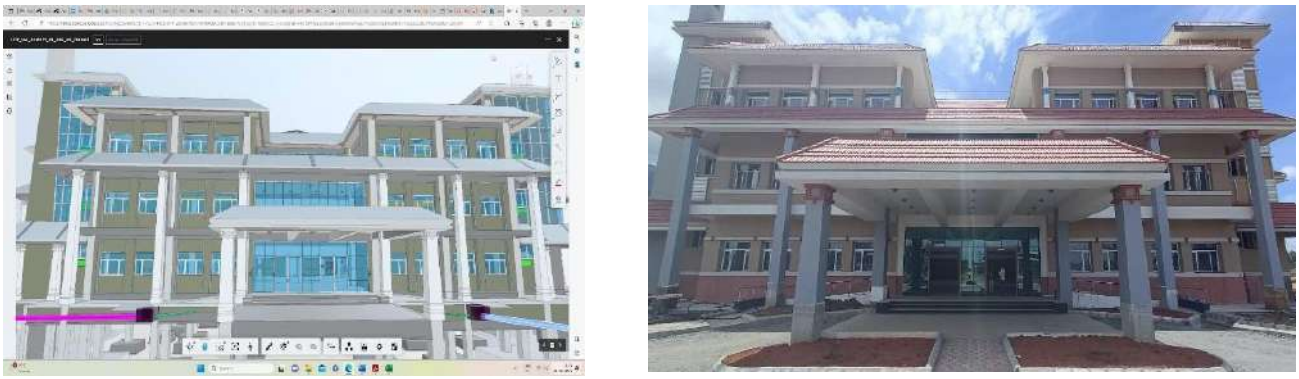


Figure-5: *Federated BIM Model and the Physical Building – Classroom Complex*

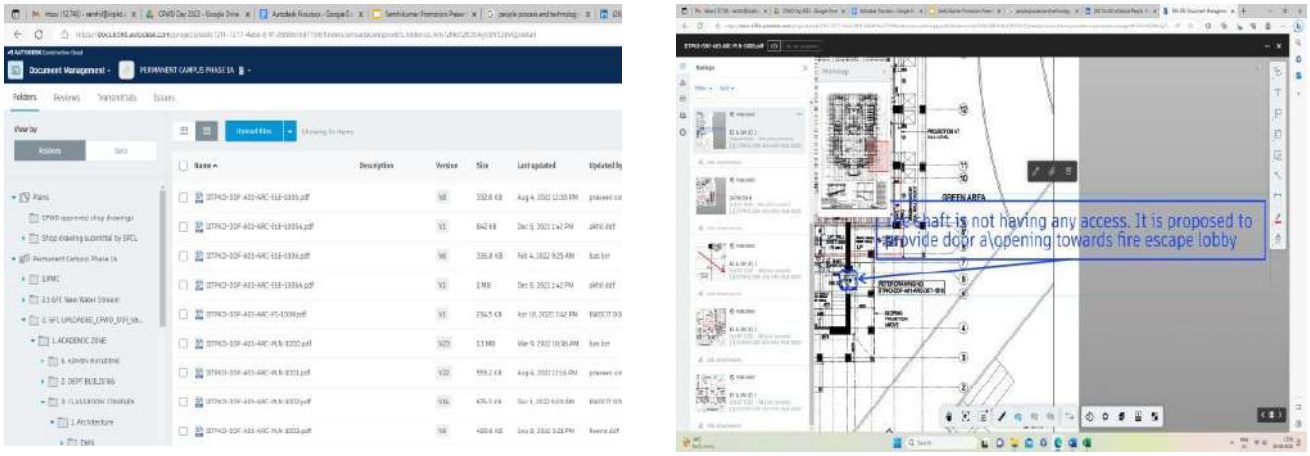


Figure-6: *CDE Folder Structure & Version and Markup for Design Collaboration*

Figure-7: *Design Issues report and Clash detection in BIM*

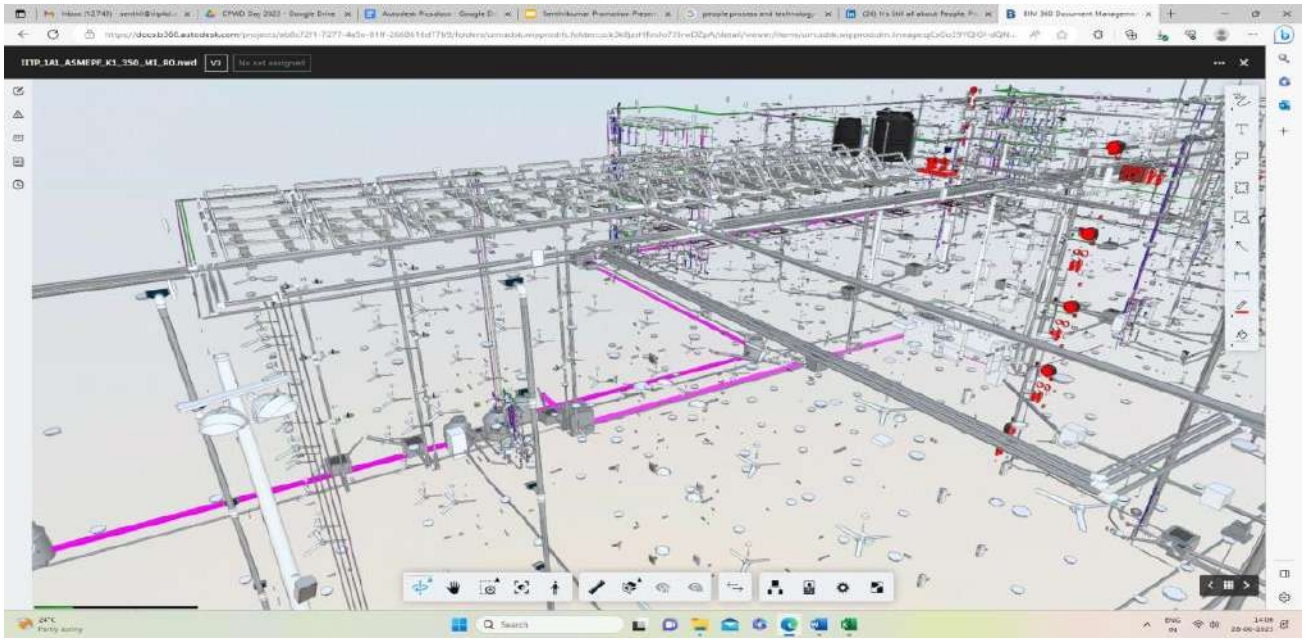


Figure-8: *Federated MEP - BIM Model of the Hostel Building*

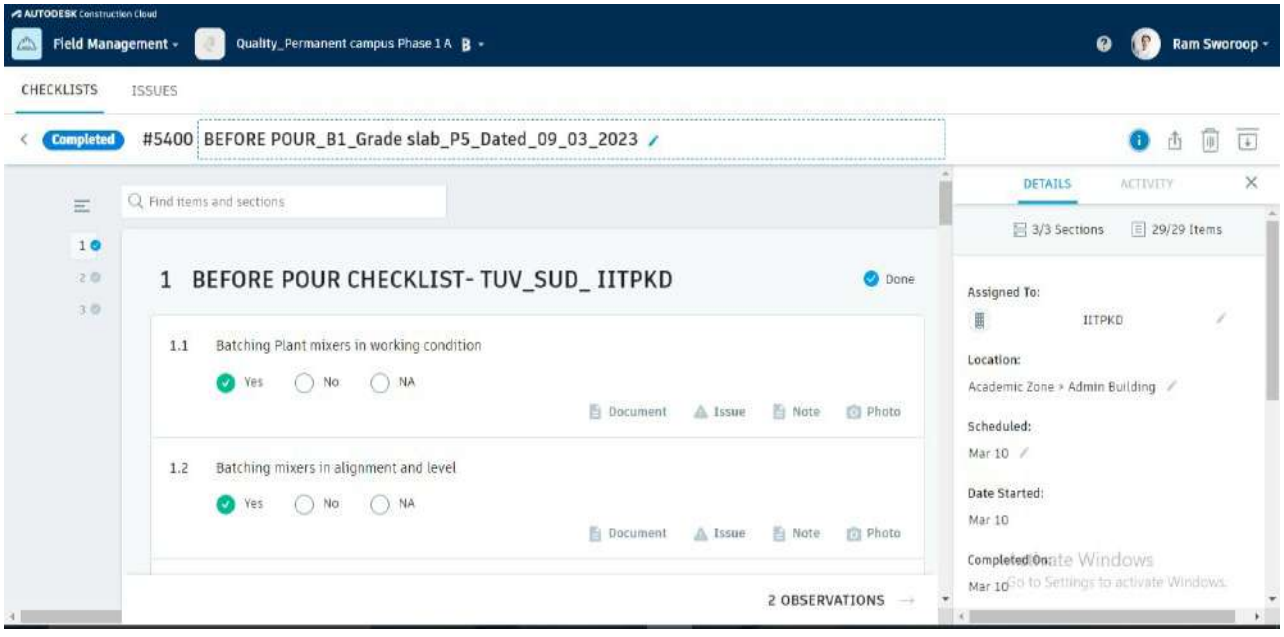


Figure-9: *Screenshot of the completed checklist*

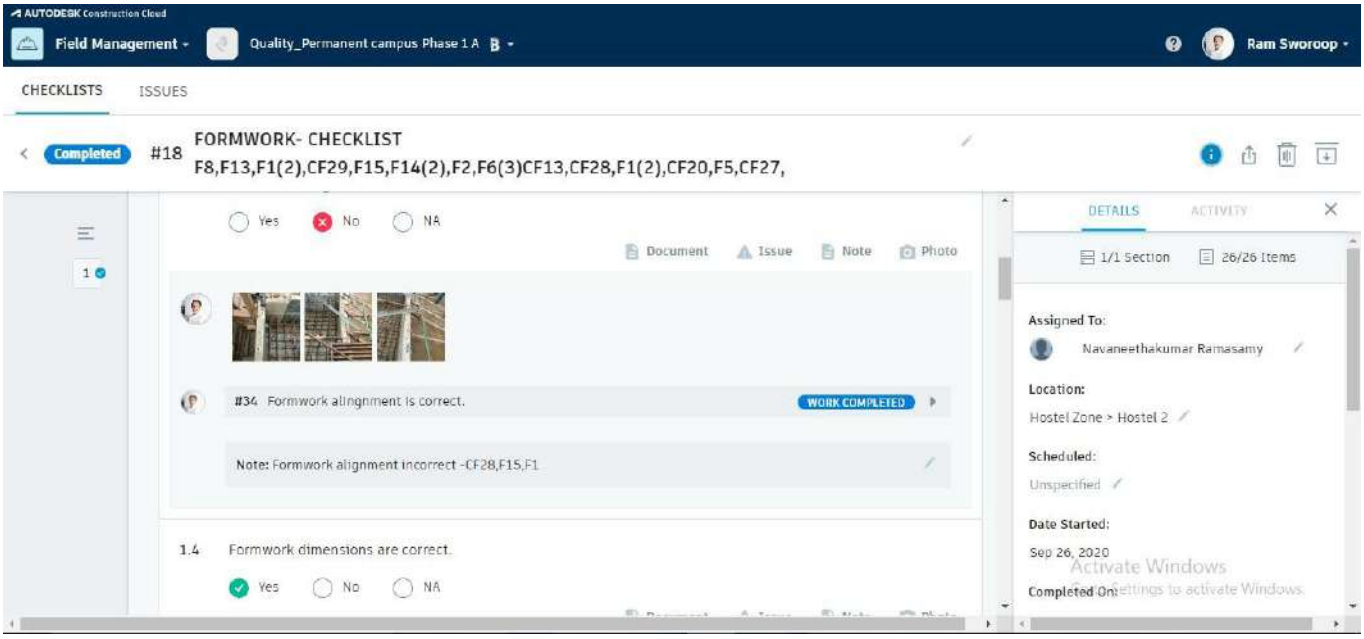


Figure-10: *Checklists attached with photos of non-compliance.*

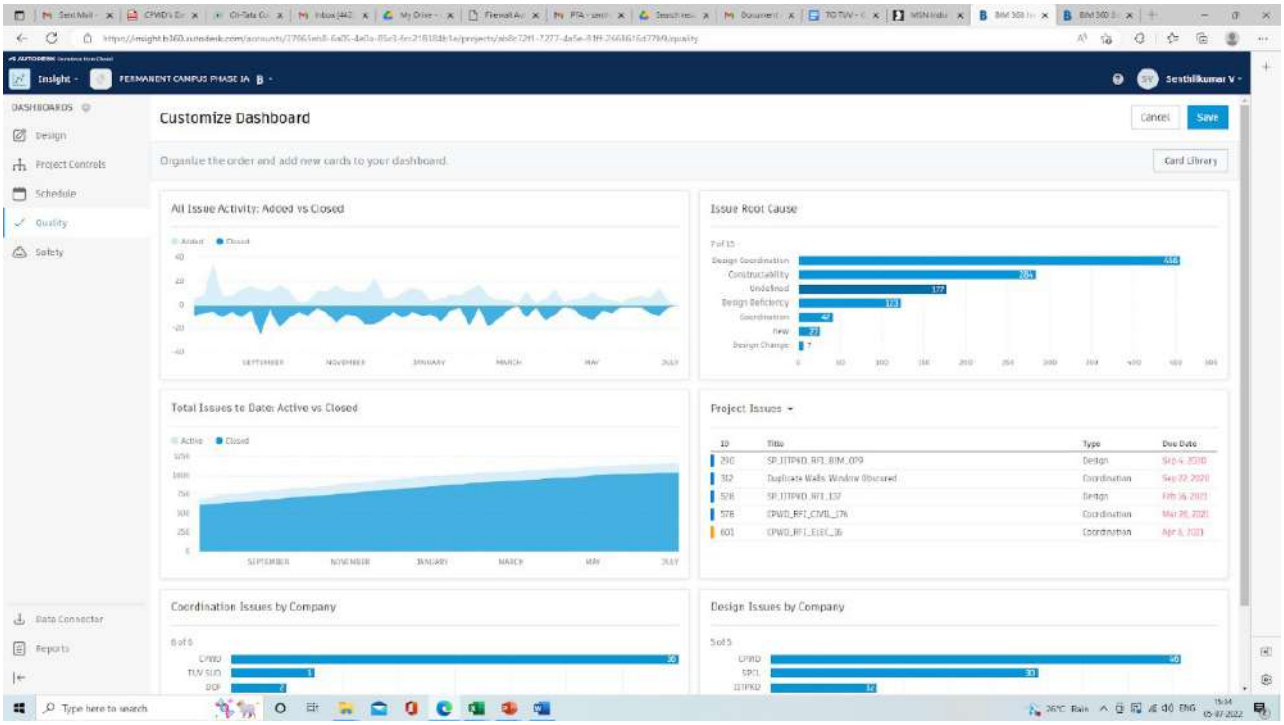


Figure-11: *Snapshot of the Project Insight in CDE*

BRIEF BENEFITS

With this initiative, more than 1300 site-related coordination issues/ RFI's are resolved before it initiates the site rework. Each of these RFI's underwent an average of 3 iterations and the average time taken for this process has been reduced by 1/3 over the conventional methods such as email communications. Furthermore, more than 8000 project documents such as models, reports, drawings, and specifications with all its older versions are digitally integrated and stored for future usage. In addition, more than 5000quality checklists with more than 3000 site-related quality issues have been generated and each of the quality management processes adopted with those checklists and rectifications related to the site-relatedissues and their resolution history were digitized. Around thousands and thousands of project meta datarelated to the approval date, issue resolution history, created party, annotations etc., has also

been stored in the CDE for further usage during its service life and dispute resolutions proceedings. All the project stakeholders get the latest data and details of any project component by getting an immersive project experience through their mobile phones/ipad without being installed with any BIM software through theCDE.

Summary

The adopted digital transformation using BIM and CDE in IITPKD project significantly helped to improve the conventional project management activities such as document management which includes the development of project information, communication, collaboration, design interface management, issue resolution, quality management which includes inspection, data collection, documentation, and reporting of quality and safety issues. The BIM models has significantly helped the project stakeholders in reducing their processing time, reporting delays, delays in sharing information among stakeholders and delays in decision-making. The elaborate reports generated from the CDE including photographs, mark-ups, videos,and drawings are easier to analyze and more effective than the conventional hardcopy reports. Further, the stored data in the CDE can easily be retrieved and analyzed for future issues during the service life ofthe structure. The errors and re-work in reporting have also been eradicated using the digital way of working. Conflicting or contradicting project data by different stakeholders have been eliminated in this project. The work and data flow for the project could be made sustainable, green, and economical using CDE. Altogether the efficiency of the site inspecting team had increased by approximately 60% inconducting inspections and reporting. However, a few challenges were also faced by the stakeholder's team while adopting this digital transformation, cost of deployment & training, uninterrupted connectivity, mobile phone/ tab ram speed while loading the rendered 3D BIM model etc. However, the overall ROI against the spending is worth adopting the tool. Dedicated value stream mapping of beneficiaries and costing of these Digital Transformation initiatives may discourage the typical front- loaded deployment cost and help to appropriately allocate the costing among various stakeholders. Overall, it is evident that the Client (IITPKD) along with the PMC (CPWD) and other stakeholders of the project, with the support and directions of the project Champion (Chairman, EWD) have adopted CDE and BIM effectively in the project management of the IITPKD permanent campus construction project in which the entire documentation was transformed into a complete Digital way. There are no specific ROI studies that have been performed in this project, however as per the project stakeholders, the value proposition to this digital transformation is already justified with more benefits to be realized in the future developmental phases.

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EMPOWERING INDIA'S INFRASTRUCTURE GROWTH: CPWD'S COLLABORATIVE 5D COMMON DATA ENVIRONMENT SOLUTION

Sh. Viraj Voditel, M/S Techture
Sh. Satyendra Prasad Gupta, Director (Dev.)-ERP, CPWD

INTRODUCTION

The Central Works Public Department (CPWD) plays a pivotal role in India's infrastructure development. With a vision of embracing Information Technology to manage resources intelligently, as part of CPWD ERP implementation e-NIRMIT, CPWD has successfully implemented a fully collaborative 5D Common Data Environment solution which is integrated with the ERP software. This innovative technological approach has revolutionized various aspects of CPWD's operations, including document management, issue management, CAD & BIM viewer, estimation, tasks, transmittals, transfer and position mapping administration, clash detection, scheduling and progress monitoring, and facility management. This solution has facilitated the successful onboarding of over 5,000 projects of varied cost and engaged more than 10,000 users across the nation. The software is developed under eNIRMIT vision of helping CPWD to leverage its vast organizational learning, accumulated over the past 167 years of its glorious history, for preparation of designs, estimates, tender documents and standards quickly and efficiently as per the requirements and enable the department to use modern IT tools for delivery of quality works and services on time.

DOCUMENT MANAGEMENT

The implemented software has transformed the traditional paper-based document management system into a streamlined and efficient digital platform. The implementation of this system has enabled CPWD to store, organize, and access project-related documents securely and conveniently on the Government of India empaneled Cloud. With a centralized repository, authorized personnel can easily retrieve drawings, specifications, contracts, and other critical documents, enhancing collaboration and reducing information asymmetry. The solution allows users to create Spaces within projects where users can organize the folders and store files as per their convenience. The solution ensures version control, document tracking, and quick retrieval, saving time and minimizing errors.

CAD AND BIM VIEWER

CAD and BIM viewer capabilities within the software have revolutionized the way projects are visualized and communicated. The solution supports more than 30 industry standard file formats where both 2D and 3D files can be viewed on the browser without the need to download or install any additional software packages. With advanced visualization tools, stakeholders can explore 3D models, identify clashes, and make informed decisions before the construction phase. The BIM viewer allows users to create issues, create and share custom views and layouts for easier communication. The BIM viewer is also used in Estimates, where users can open and view the files on the browser, take measurements and directly add it to estimates and BOQs.

2D & 3D ISSUE MANAGEMENT

The application is capable enough and valuable in managing issues throughout the project lifecycle. Users can now seamlessly create, track and monitor issues, tag relevant stakeholders, set deadlines, and ensure timely resolution. This streamlined approach fosters effective communication among team members and stakeholders, resulting in improved decision-making, faster issue resolution, and enhanced project quality.

4D SCHEDULING AND PROGRESS MONITORING

The software offers comprehensive scheduling and progress monitoring functionalities, enabling project managers to track project timelines, identify bottlenecks, and optimize resource allocation. Users can create gantt charts, identify Critical Path and plan the activities to adopt lean methodology and link it with the 3D BIM Models to achieve a 4D visualization. With Progress Monitoring and project tracking, users can also create catch-up plans and have revisions in the same project for better planning.

5D ESTIMATION

The portal incorporates comprehensive estimation functionalities, empowering engineers and estimators to generate accurate and detailed BOQs and cost estimates which can be derived from both 2D and 3D designs. By leveraging the power of digital estimation tools, CPWD can produce reliable project cost estimates, reducing uncertainties and enabling effective financial planning. The Estimation tool is integrated with SAP where all the Delhi Schedule of Rates (DSR) data and analysis of rates for resources and activities is synced. This allows users to create customized estimates as per regions, and this established system improves productivity.

TASKS AND TRANSMITTALS

Efficient task management is essential for project success, and the software provides a robust platform for organizing and tracking tasks assigned to various stakeholders. The system enables task delegation, progress monitoring, and timely updates, ensuring smooth project execution. Transmittals, including project-related communications, memos, and instructions, are seamlessly managed within the software, promoting effective information flow and accountability. This functionality allows users to collaborate with other stakeholders outside the Government that are part of different spaces and coordinate with them effectively.

PERSON-POSITION MAPPING ADMINISTRATION

The digital platform facilitates smooth workflow transitions when personnel are transferred or promoted, ensuring uninterrupted project progress. Person-Position mapping administration enables automation and handover of access control, and ensures that only the relevant stakeholders have access to the project at any given point of time.

BETTER INTEROPERABILITY

The developed solution has capability to integrate with other software offering a better interoperability. The solution is developed to integrate with SAP through which Enterprise Resource Planning, billing of subcontractors and Administrative tasks are easily done on the platform. Any changes in the SAP get reflected in the software and vice versa.

USE OF BIM IN PERMANENT CAMPUS OF IIT BHILAI

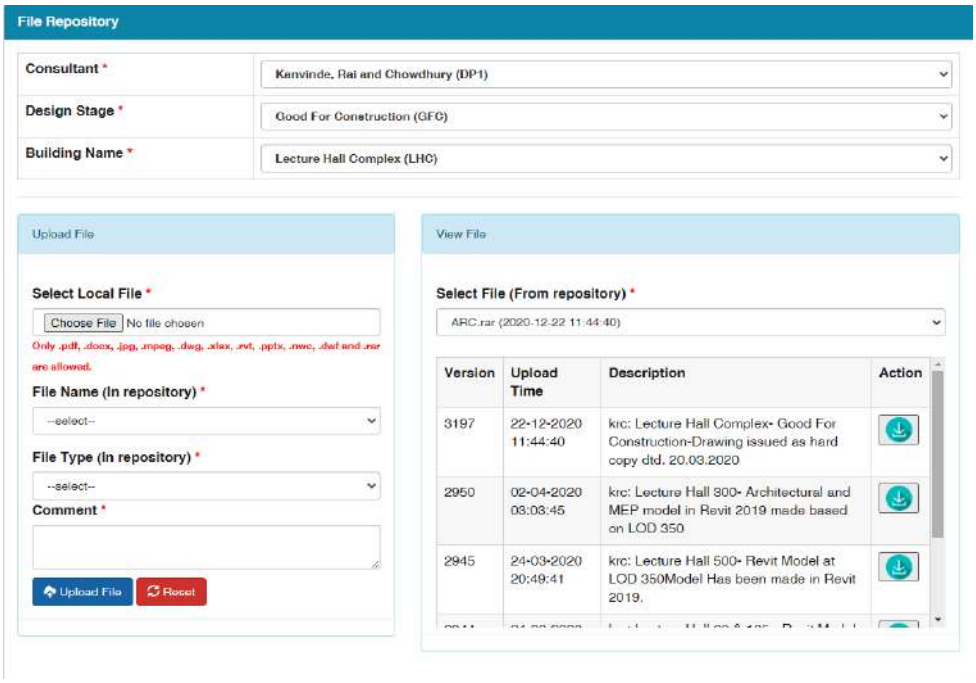
Sh. Anurag Kumar, SE & PD, CPWD

Indian Institute of Technology (IIT) Bhilai was established in the state of Chhattisgarh by Ministry of Human Resource and Development in the year 2016 in a temporary campus. The campus is expected to grow eventually to accommodate 12,000 students along with the desired faculty members, staff members and their dependents over a period of 20 years in multiple Phases. The work of first Phase i.e. Phase 1 Stage 1 of Permanent Campus construction was entrusted to CPWD in 2018. which will cater to 1200 students, 120 faculty members, 132 staff members and dependents of students, faculty and staff members.

NEW CONSTRUCTION TECHNOLOGIES IMPLEMENTED

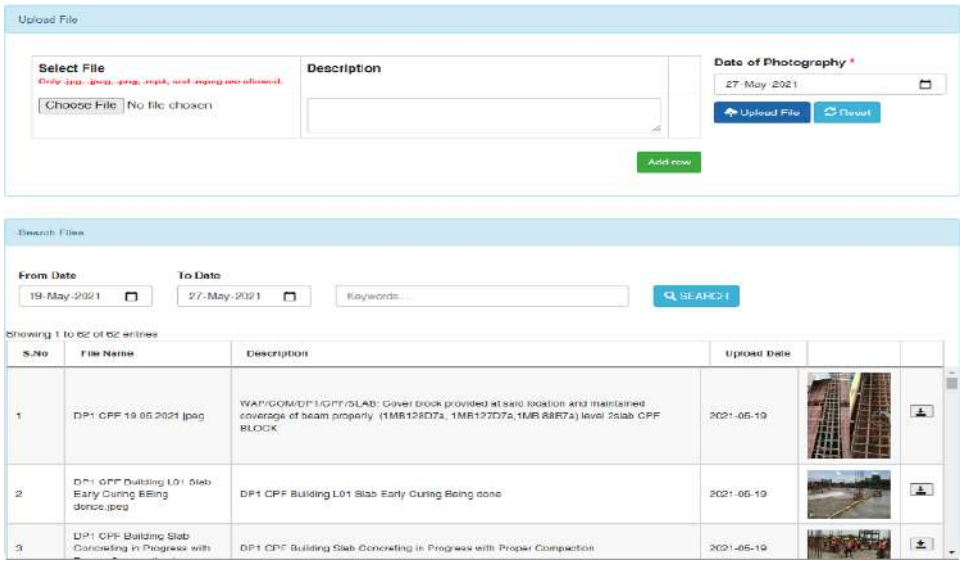
1. DRAWING DOCUMENT MANAGEMENT SYSTEM

This project required tremendous coordination among the client, consultants, CPWD and executing agency. This required handling of thousands of multidisciplinary drawings, being circulated and reviewed. To reduce the circulation time and improve coordination, an innovative cloud based drawing document management system for uploading all the documents related to Planning and execution was developed by IIT Bhilai. named as Drawing Document Management System (DDMS) and implemented by CPWD in this project.



Consultants upload all the GFC drawings related to Architecture, Structure, MEP, Landscape etc. on the DDMS portal which sends a notification through email to all the concerned (Authorized) persons and the drawings are available for review of all, at a glance. During construction, one can always login the portal and can refer the latest drawing for construction. Furthermore, all the drawings are documented with date which can be referred in future construction also and having very good control on Revisions and Versions of Drawings. Even during tendering all the tender drawings are downloaded by various bidders from this website.

2. CONSTRUCTION IMAGES DOCUMENTATION SYSTEM

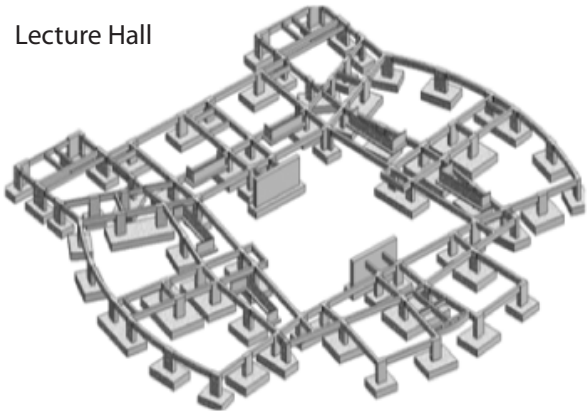


Cloud based system for daily monitoring of construction works at the site is implemented at IIT Bhilai project. Sites have been provided with IP Based cameras and daily photos are captured from site. These photos are uploaded on the portal on daily basis for effective monitoring of construction works. All Third party Quality control issues raised over this platform and rectification done are also uploaded besides regular site activities.

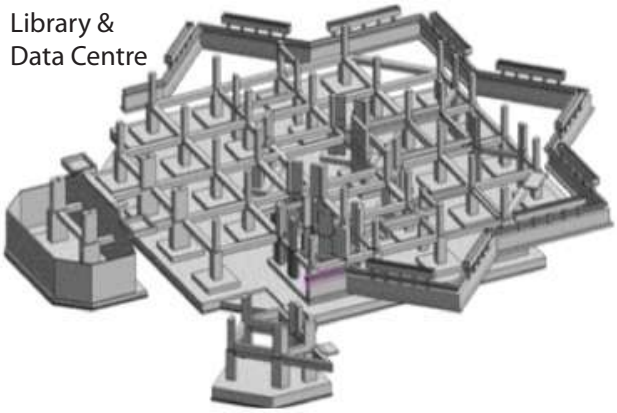
3. USE OF BUILDING INFORMATION MODELING (BIM)

The project envisaged construction of more than 21 buildings having Multi- Disciplinary services. The buildings have services like HVAC, Firefighting, MEP etc along with interconnected sewer & storm water network. Though conceptualized by the consultants on 2 D drawings but clashes among the services and structure can only be visualized in a 3 D view. Hence the concept of Building Information Model (BIM) was introduced in the project for avoiding clashes at a latter stage and saving cost and time. It also facilitates in development of shop drawings, Review by various stakeholders on BIM 360 platform, quantity confirmation of the BOQ during billing, Progress Monitoring, development of as built drawings and completion drawings.

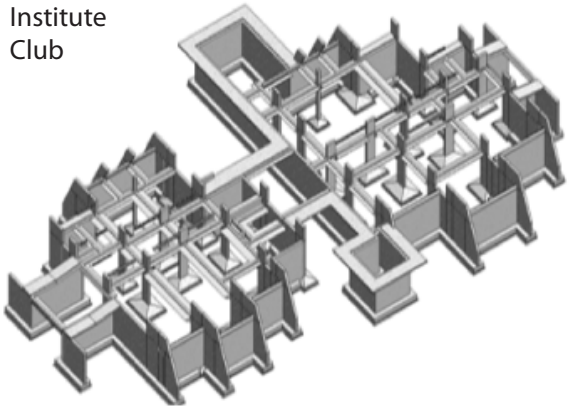
Lecture Hall



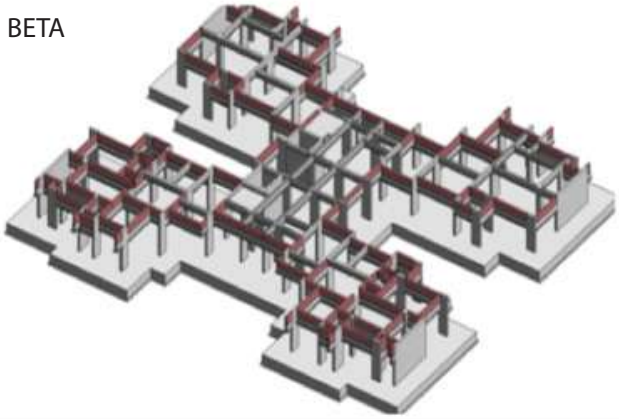
Library &
Data Centre



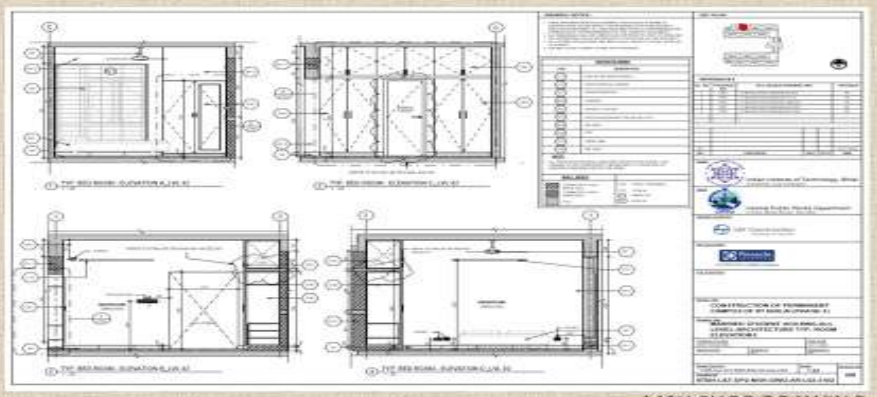
Institute
Club



BETA



DEVELOPMENT OF SHOP DRAWING GENERATION FROM BIM MODEL



NEW PARLIAMENT BUILDING SPECIAL FEATURES AND CHALLENGES IN DESIGN & CONSTRUCTION

Sh. P. Bhagat Singh, Chief Engineer, PCWZ

New Parliament building is constructed over a 9.5 acre plot of land immediately contiguous to the existing Parliament House at New Delhi. The Project was sanctioned for Rs 971 Cr by the Lok Sabha Secretariat on 15.06.2020 with a mandate of the Government of India to complete the Project as a Historic icon in the Capital of the Country and in a highly compressed time schedule.

The Project has several special features and is completed in the midst of various constraints and challenges, which are briefed out in this article

PROJECT BRIEF

- **Project Name** — **New Parliament Building**
- **Project management** — **CPWD (Central Public Works Department)**
- **Main Contractors** — **M/s Tata Projects Limited**
- **Consultants** — **M/s HCP DPM Pvt Ltd , Ahmedabad**
- **Project Configuration** — **B+GF+FF+SF (22m ht & 36.5 m ht up to crown)**
- **Start Date** — **14/01/2021**
- **Inauguration Date** — **28/05/2023**
- **Project Duration** — **28 Months**
- **Built Up Area** — **65,000 Sqm**
- **Plot Area** — **42,031 Sqm**
- **Sanctioned cost** — **Rs. 971 Cr**

Need for New Building

1) Capacity Expansion
2) Infrastructure modernization and
3) Seismic design considerations of the Structure

The present building will be appropriately retrofitted and meaningfully used in conjunction with the new facility.

Special Features

1. Iconic Building
2. Unique Structure
3. Longer design life of Structure
4. New Materials & Technologies
5. Highest degree of Security
6. Environmental Sustainability
7. MEP services

1. ICONIC BUILDING

The one and only kind of building in the country—The temple of democracy

Triangular Shaped Building comprising of Lok Sabha, Rajya Sabha & Courtyard.

THEME OF INTERIORS

Lok Sabha –Peacock (National Bird)

Lok Sabha

Rajya Sabha- Lotus (National Flower)

Rajya Sabha

Court Yard- Banyan (National Tree)

Court Yardv 2.Unique Structure

2. DESIGNED FOR SEISMIC ZONE V

- Foundation : Raft Foundation with varying thickness 1.5m to 2.65m
- LS RS Chambers:

- Semicircle with diameter of 57 m
- Beam depth upto 3.3 m
- Slab depth 250 mm
- Corbels of depth 6 m
- 12 columns size 5.58 m x 0.75 m
- Unsupported Columns Height 24 m
- above Ground floor slab

Chamber Foundation

Chamber Foundation

Centre Foyer below National Emblem

3. LONGER DESIGN LIFE OF STRUCTURE

- Designed for Higher degree of environmental exposure
- Grade of Concrete upto M60
- Self-Compacting Concretes
- Corrosion Resistant Steel
- Admixtures for durability
- (Integral Crystalline admixtures)

4. NEW MATERIALS & TECHNOLOGIES

- Self-Compacting Concretes
- with PPC or OPC+ Fly Ash
- Concrete Curing Compounds
- Reinforcement Couplers
- Fly ash Bricks
- Polymer Mortars and Ready mixed plasters
- Gypsum plasters
- Modular Form works of PERI, RMD Kwikform, Rapid shore
- Soil nailing for Slope protection
- CNC cut stone, wooden and Brass decorative
- Jalis , Furniture and Hand knotted Carpets
- Manufactured sand (No river sand)
- CLSM (Controlled Lean Strength Material)
- Stainless steel for plumbing and Copper pipes for Hot water supply

5. HIGHEST DEGREE OF SECURITY

- CCTV CAMERA (PTZ ,BULLET ,THERMAL)
- ACS Reader & Controller
- Biometric Cum Smart Card
- Full Height Double Door Security Electric Turnstile
- Boom Barrier ,Flap Barrier.
- Inbuilt Hydraulic bollards.
- Tyre Shredder
- Road Blocker
- DFMD
- HHMD
- XRAY Baggage Scanner
- Under vehicle Surveillance System
- Non –Lethal High Electrical Fencing system.
- Bullet proof Morchas
- CBRN protection

6. ENVIRONMENTAL SUSTAINABILITY

- Environment Friendly Construction practices
- Provisionally certified by IGBC as Platinum rated Green building and Targeted for GRIHA 5 Star rating

Noise Barrier & Mist Spray

Environment Friendly Construction practices

- 4 nos. of Anti-Smog guns
- Mist Spray system.
- Sensor based Air Monitoring Units (AMU) installed to monitor real time Ambient Air Quality (AQI).
- Automatic Air purification system /Smog Tower
- Noise Barriers 10m high
- 3 nos. of Sewage Treatment Plants of capacity 200 KLD, 100 KLD and 80 KLD (at NPB and KN) for treating waste water that is reused on site for construction activities.

- Gas based Gensets being used on site.
- Adherence to Ageing norms of vehicles and deployment of BS-IV and above Vehicles on site.
- Use of VFD in all Tower Cranes, Automatic Stirrup Machines and VRD in Welding, Bending and Grinding Machines
- Use of M sand (crushed sand in place of natural sand) for concreting.
- Use of Fly ash for M50 above concrete grade wherever OPC is being used.
- Use of LED Lights for reduced energy consumption.
- Use of Curing Compounds and Bio blocks in urinals to reduce water consumption.
- Provisionally certified by IGBC as Platinum rated Green building and Targeted for GRIHA 5 Star rating
- Locally available Sand stone and Lakha Red Granites
- Fly Ash Cements and Fly Ash bricks
- Rain water harvesting
- Water recirculation through STP
- Electrical Energy conservation measures
- Water and energy auditing for 2 years of Operation

Well being of Work force

- Accommodation given to all workers working for the project.
- Each gang of workers are provided with separate kitchen where all kitchens are equipped with IGL PNG connections.
- RO water is being provided to all the workers.
- Separate Urinals Latrines.
- Barber Shop, Canteen, grocery shop provided inside the camp.
- Food provided to all the new workers during quarantine period.
- During 2nd covid wave period all workers were provided with free grocery for 3 months.
- Different activities like Yoga session, carom competition.
- All workers are covered under workmen compensation policies.
- Workers are being paid on time.
- Vaccination for workers.
- skilled development training to workers
- Hospital Tie ups – BLK Max Super Specialty Hospital

7. MEP SERVICES

- 6.5 MW Capacity Substation with IP68 Bus ducts and 100% DG back Up
- UPS for Essential Services
- Centralized HVAC system with MERV Filters & UVGI system
- Lifts 23 Nos i/c Goods lifts
- STP (sewage Treatment Plant) with MBR (Membrane Bio Reactor) Technology
- CCTV and Access Control Systems
- Fire Fighting and Fire Alarm Systems (Clean agent system for Server rooms)
- IBMS (Integrated Building Management System)
- ICT (Internet and Intranet, Telecommunication) Net Work

- Video walls for information Display
- Special Security systems
- Language Interpretation and Broad Casting Services
- Fully Digital Multimedia screens for each MP, with Interpretation and Voting facilities
- Audio Visual and Public Address Systems
- High Performance Lighting systems
- Illuminated Signages
- Façade Lighting
- Hydro pneumatic Plumbing system, Sewerage network and Organic Waste Composter
- Irrigation System
- Acoustic Systems

CHALLENGES IN CONSTRUCTION

1. **Stringent time schedule for completion**
   - 28 months against minimum 36 months even with best bench marking performance
   - Fast Execution through
     - Deployment of 5000 work force in peak time
     - Deployment of huge Machinery
     - Use of large area of Centering, Shuttering
     - Parallel Off site procurement
     - Close Monitoring at High level
     - Effective handling of Covid Pandemic
     - Dedicated Project teams and
   - Efficient Project Management(Primavera, PMIS)
   - Quick Decision making
   - Conflict Management

- Owning of the Project at all levels

2. Working Constraints (Security, Logistics, Covid Pandemic)

- Security scanning all the time during construction
- Least Movement Space
- Covid wave 2 and 3
- Planning during Covid 1

3. Multiple Stake holders

- Lok Sabha Secretariat
- Rajya Sabha Secretariat
- PM Office
- MoHUA
- MoHA
- National Security Adviser
- Parliament Security Services
- Intelligence Bureau
- Delhi Police
- Special Protection Group
- Central Reserve Police Force
- National Informatics Centre
- MTNL
- Sansad TV
- NDMC
- Indraprastha Gas Limited
- Delhi Metro

4. Multifarious services

- As already listed above. About 20 services in the building.

5. Statutory authorities

- CPWD (Local Authority for Govt. buildings)
- DUAC (Urban Planning)
- UTTIPEC (Traffic impact)
- Central Vista Committee
- Heritage Conservation Committee (HCC)
- Delhi Fire Services
- Delhi Metro Rail Corporation
- IGL for Gas pipe line
- NDMC
- Ministry of Environment Forest department
- DPCC
- DFO/Tree Officer for Tress Transplantation

The Project of construction of a unique building like New Parliament Building in a record time , in spite of challenges and constraints , is an exemplary testimony to synergy of minds and actions of all those involved.

FROM BARREN LAND TO GREEN CAMPUS BY RAINWATER COLLECTION AT BHU BARKACHHA CAMPUS

Sh. Rajesh Banga, CE & ED, CPWD
Sh. Vinay Tiwari, EE cum SM, CPWD

ABSTRACT

Along with the urbanisation, the percentage of impervious land is increasing, leading to increased surface run off and lesser recharge of underlying aquifers. The simplistic traditional methods of rain water collection in landscapes offer benefits more than we can imagine. This is a case study where a large land which was once dry and barren with no source of water, has now turned into a green and habitable educational centre, simply by harnessing rain water. The transformation is a live lesson that the known practise of rain water collection needs to be at centre stage, when we are planning new campuses and urban centres.

The Banaras Hindu University is an internationally reputed temple of learning located in the holy city of Varanasi. To spread the fruits of knowledge and technology to the under privileged sections, the University in 1979 acquired another plot (2700 acre) at a place called Barkachha around 8 km south-east of Mirzapur town and set out to develop its South Campus.The area is in Vindhyan Range – a discontinuous chain of mountain ridges, highlands and plateaus and the soilis typically clay loam, sandy loam, and silty clay. The land terrain is mostly dry and rocky with no source of water. The areaconfronts acute water scarcity.

Transition from barren to green land – The developmental effort started in 2005. The hydrological planning of landform, watershed throughGIS studies, remote sensing and local surveys was carried out. Based on the studies, it was decided to construct earthen check dams, farm pond, bunds, Gabion Weirs, etc. in the campus to reap the benefit of rain water.

Original form - Dry landPresent landscape

A total of 9 no.Earthen Check dams, having holding capacity of each check dam as 2 lac KL - 3 lac KLhave been constructed. The construction is with local excavated earth mixed with stone boulders. The length of check dams varies around 150 – 200m and average water depthis about 2.5 – 3m. One large farm

pond having storage area 10,000 sqm with an average depth of 3-4 mand 2 nos. runoff water collection bandhis have also been made.

Check dam (near Vet. department) Check dam(near Academic blocks)

These bodies gradually started collecting rain water that would earlier go waste as runoff. Presently, the check dams retain store water in the period July -March. One check dam (near Vet department) retains water through the year.The water stored here is being used for irrigating farm land. At present 40 hectare area is being cultivated. Crops like, wheat, fodder, pulses etc. are grown with the check dam water. Fish farming is also being practiced in such water bodies. The 2 no. existing bore wells which were earlier dry, have also started yielding water. Over the years, the trees, vegetation have grown changing the face of the University.

Campus peripheral road

Cultivation of fodder with check dam water

Drinking water through rain collection: A dam was constructed at Lower Khajuri, a seasonal riverine about 2.5 km away from the campus. This reservoir has surface area of around 38 ha with an average water depth of about4 m. An intake well and pumping station has been established and the collected rain water is pumped to the campus. In the campus, raw water reservoir (4000 KL) and 2 MLD water treatment plant have been constructed. The treated water is stored in UG tank (400 KL) and 2 Overhead tanks (500 KL each, staging height 20m). In this manner, the Institute meets its drinking water requirements.

Lower Khajuri dam

Water treatment plant

Construction practises being adopted: The BHU and CPWD have been cautious while making new constructions and the storm water run-off from pucca aprons is beingchannelized through pipesto the nearby pond/ reservoir for its storage.

Check dam of newly constructed residential flats

Lesson for us: The country has launched the campaign "Catch The Rain" with the tagline "Catch the rain, where it falls, when it falls". Let us realise its true potential and keep this slogan at centre stage while we are planning new urban centres, campuses and developments.

USE OF HIGH STRENGTH STEEL IN PEB STRUCTURES – A COMPARATIVE STUDY

Sh. O P Tripathi, Additional Director General, CPWD
Sh. P K Naidu, CE & ED, CPWD

ABSTRACT

Presently Pre-Engineered Buildings (PEB) have become very popular for construction of Industrial buildings. The PEB design concept has helped in optimising structural design. The construction of PEB in place of conventional steel building (CSB) design concept resulted in many advantages as the members are designed as per bending moment diagram and thus reducing the quantity of steel. The limit state method (LSM) was introduced in IS-800-2007 and with this, design of PEB structures have become a reality using BIS codes of practice. Prior to this PEB design was not very advantageous with IS-800-1984 due to dependence on WSM and stringent deflection criteria specified therein. Designers were resorting to use of foreign codes such as American, British and Euro codes for design of PEB. Currently, use of E-450 grade steel is gaining popularity for its advantage to economise the structures. In this study the economy of PEB structures is discussed in terms of its weight comparison with reference to use of E-250, E-350 and E-450 grades of steel conforming to IS-2062.

INTRODUCTION

Pre-Engineered Buildings (PEB) are the buildings which are engineered at a factory and assembled at site. Usually, PEBs are steel structures. For primary structural members,built-up sections are used which are fabricated at the factory to the designed size, transportedto site and assembled at site with bolted connections. Historically, the primary framing structureof a pre-engineered building is an assembly of I-shaped members, often referred as I-beams. In PEB structures the I-beams are usually formed by welding the steel plates together to form the I-sections. Submerged Arc Welding (SAW) is used for such connections. Depth of membersare varied (tapered sections) according to the bending moment diagrams to achieve economy.Column free spans up to 60m can be installed with PEB concept. Cold formed members with cross sections of Z or C shaped are used for secondary members such as Purlins, Girts etc.,. PEBbuildings can save cost up to 33% compared to conventional Steel buildings. Use of tapered columns in PEB structures can result in further savings up to 8% in PEB structures. Use of American code (ASIC-2010) or Euro code (Euro-03) for design of PEB can bring down the weightof structures by 40 to 50% compared to design by using IS-800-2007 or British Code BS-5950.

This type of Structural Concept is generally used to build Industrial Buildings, Metro Stations, Warehouses, Air Hangers etc.

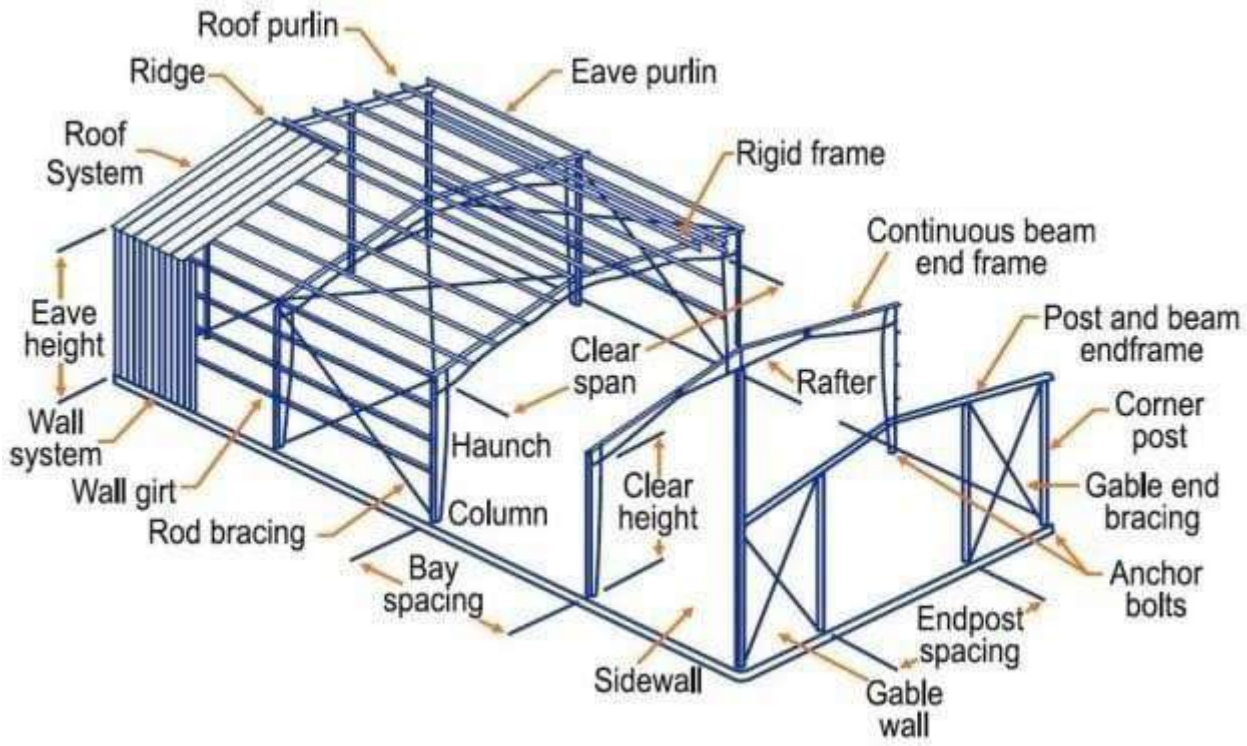


Figure-1 : *Various components of PEB Structure.*

The adoptability of PEB in the place of Conventional Steel Building design concept resulted inmany advantages, including economy & easier fabrication.

ADVANTAGES OF PEB

There are many advantages of Pre-Engineered Buildings, which are asfollows,

- **Lower cost** – Consumption of steel is very optimal due to design efficiency. On-site erection cost is also reduced due to reduction in structure weight.
- **Quality control –** Better quality control is possible as the entire structure is fabricated in a factory in controlled conditions. Very less skilled manpower is required at construction site & quick erection is possible as entire assembly is with nuts and bolts.
- **Minimizing time of construction** – Relatively PEB requires very less time for onsite activities as erection of structure requires few weeks only.
- **Low Maintenance-** Due to use of industrial quality paints over steel members and use of Galvanised secondary members the maintenance cost will be low as compare to conventional steel buildings.
- **Flexibility –** The PEB structure can be easily disassembled and shifted to an alternate location. It is also easier to extended the structure for any future extension requirements.

DISADVANTAGES OF PEB

Although PEB have many advantages in the field of Industrial structures but still there aresome demerits of Pre-Engineered Buildings, which are as follows,

- Rusting / Corrosion Sensitive, - If PEBs are built in corrosion prone areas and if the quality of paint used for coating of steel members is not of good quality, then it can damage the structure and thus reduces the service life of structure.
- Structure requires fireproof treatment which increases cost.

- Insulation Cost- Insulating the building to an agreeable benchmark will further add to construction costs.
- Skilled manpower is required for assembly and erection of structure.
- Appearance, Steel Sections can be unattractive when left exposed.

Components of PEB: PEB structures consists of the following main components:Main Frames consisting of Columns and rafters (Factory fabricated) Secondary frames consisting of Purlins & Girts (Galvanised cold rolled sections) Roof & Wall Bracings (Factory fabricated Hot rolled sections and/or Steel Tubes) Flange Bracings (Cold rolled sections) Sag Rods (Circular rods) Roof Claddings & Wall claddings (Colour coated Profiled Galvalume sheets)Gutters & Flashings. (Colour coated Plain Galvalume sheets)

Objective of the study: The objective of this study is to estimate the possible savings using HSS. A typical Air-hanger building being constructed for Hindustan Aeronautics limited near Bengaluru is designed by considering different grades of steel available in the market that conforms to IS-2062 and comparison is made. Staad Pro software is used for the structural analysis and design which is most widely used analytical tool for civil engineering. Indian standard code of practice IS -2062 classifies the steel plates into various grades basedon their ultimate strength or yield strength. The IS-800-2007 stipulates as many as 9 grades ofsteel with Yield strength ranging from 165Mpa to 450 Mpa. The mechanical properties of steellargely depend upon its chemical composition, rolling methods, rolling thickness, thermal treatment and stress history. Primary substances such as Carbon, Sulphur, Phosphorous, Manganese and Silicon influence the mechanical properties of steel. Of all these substances thecarbon has maximum influence. The present study focusses on three grades of steel commonlyused in steel structures.

Methodology: One Air hanger building of size 45 m X 48 m in plan and 10 m eves height isdesigned using Staad Pro software. Three Grades of Steel were considered in the design for comparison. E250 grade steel is generally not used in PEB designs (for economy considerations) and its use is generally limited to conventional Steel buildings. However, the same was also considered in the study for comparison purpose. The design work is done using Limit state method (LSM) as per IS-800-2007. The loads are adopted as per IS-875(Part-2)-1987 (Imposed Loads), IS-875(Part-3)-2015(Wind Loads), IS -1893-2016 (Seismic Loads).

Dimensions of the Hanger building:

Length – 48 m

Width - 45 m

Max Clear span – 45 mEves Height – 10 m Max height – 15 m

EOT crane – 5 Mt capacityRoof slope - 12 Degrees

Design Parameters:

Seismic Load:	Seismic Zone: II
	Structural system – Moment resisting frameZone Factor – 0.1
	Response reduction factor – 5
	Importance factor – 1.5 (IS-1893-Part-4-2015)Soil Type – Medium
Wind Load:	Basic Wind Speed: 33 m/s
	Internal pressure coefficient: 0.5
	Sections are considered as Plastic as per Tble-2 of IS-800-2007.Life Span – 50 Years

Load Combinations:

Limit state of Serviceability:

DL + LL

DL + WL/EL DL + LL + CL

DL + 0.8LL + 0.8CL + 0.8WL/EL

Limit state of Strength:

1.5(DL+LL)

1.5(DL+WL/EL)

0.9DL+1.5WL/EL

1.5 DL + 1.5 LL + 1.05 CL

1.5 DL + 1.05 LL + 1.5 CL

1.2 DL + 1.2 LL + 1.2 WL +0.53 CL

1.2 DL + 1.2 LL +0.6WL/EL+ 1.05 CL

1.2 DL + 1.05 LL +0.6WL/EL+ 1.2 CL

DL-Dead Load, LL- Imposed Load, WL- Wind Load, EL-Earthquake Load, CL- CraneLoad.

Deflection Criteria:

S. No.		Vertical	Horizontal
1	Main Frame	L/180	H/150
2	Main Frame with Crane	L/180	H/400
3	Crane Beam electric <50t	L/750	
4	Crane Beam electric >50t	L/1000	
5	Wind Column		H/120
6	Mezzanine Beam	L/240	
7	Purlin	L/150	
8	Girt	L/150	
9	Cantilevers	L/120	

Quantities of steel computed from design with different grades of steelare as under:

Grade of Steel	Steel take-off in MT	% reduction over base line case with E250
E 250	149.951	0
E350	132.457	11.67%
E450	119.045	20.61 %

CONCLUSIONS

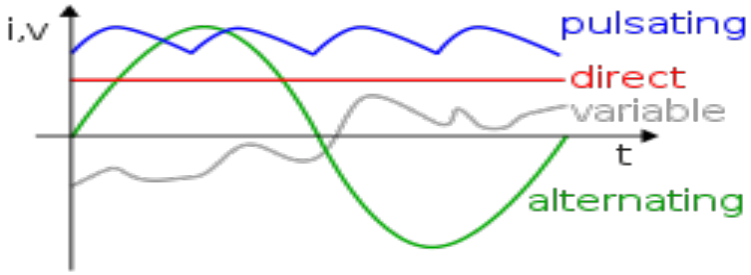
From the study it is clear that quantity of steel can be economised using High strength steel (HSS). Use of HSS results in reduction in size of structural members which in turn results in reduction in member weights and overall weight of PEB structure. This study indicates that 10.12% reduction in steel quantity can be achieved by using E450 grade steel in place of E350grade. Similarly, 20.61% reduction in steel quantity can be achieved by using E450 grade steel in place of E250 grade. E-450 grade steel offers better corrosion resistance and high strength to weight ratio. Only disadvantage is that E450 grade steel is not readily available in the market with the dealers and the material is available only on prior order and the suppliers take about 3 months'time to supply the HSS.

DC WIRING IN BUILDINGS

Sh. B. S. Reddy, CE & ED, CPWD

INTRODUCTION

- AC (Alternating Current) refers to the varying current& voltage generally at 415 V/ 230 V inside buildings.
- DC (Direct Current) refers to the unidirectional current at constant voltage inside the buildings.



THE EPIC BATTLE (*WAR OF CURRENTS*)

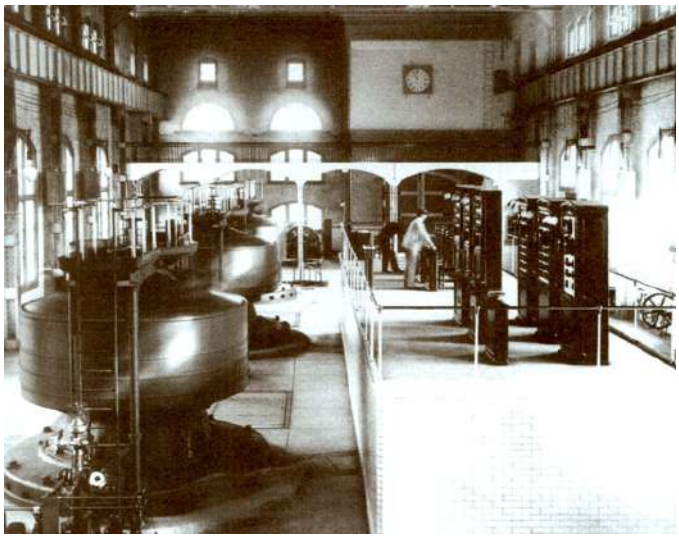
In the 1880s, Edison and Tesla became embroiled in a battle to establish the type of current that would best serve the electricity needs of the United States.

…Thomas Edison was advocating the use of DC
…Tesla (Tera electron volt Energy Superconducting Linear Accelerator) was for AC.

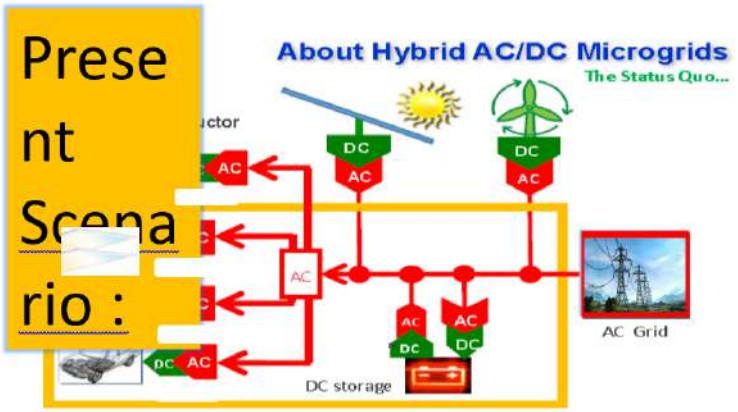
The winner was AC when Niagara Falls power station came online in 1896.

…. And the world never looked back again.

Edward Dean Adams Power Plant at Niagara Falls, 1896



PRESENT SCENARIO OF AC ELECTRICITY DISTRIBUTION :



4. *THE DEBATE STARTS AGAIN…..*

….***Trends*** in the energy industry are helping to fuel the debate about the advantages and disadvantages of direct current in buildings.

1. Growing deployment of distributed energy resources (DER) of DC such as Solar photovoltaics, etc
2. Energy storage in DC (Batteries), EVs
3. Increasing DC end use loads due to the proliferation of electronics and light-emitting diodes (LED fittings), brush less DC (BLDC) fans, etc.
4. More and more DC appliances like Computers, Mobile phones, TVs etc
5. Mushrooming Data Centres and Cloud Storages

5. BENEFITS OF DC SUCH AS

a) Improved energy efficiency

b) High component reliability

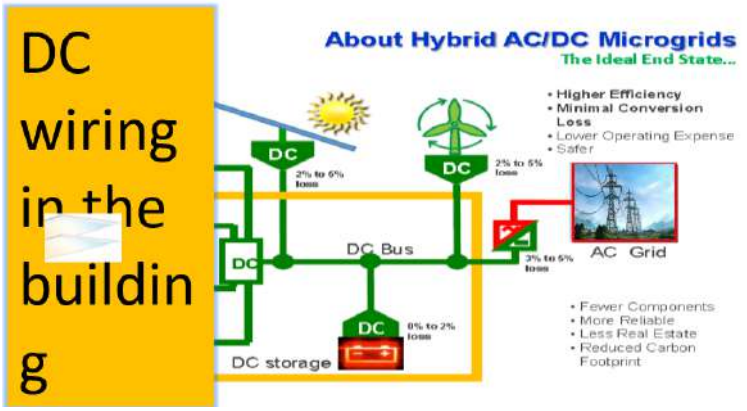
c) More flexible configurations

d) Reduced maintenance costs

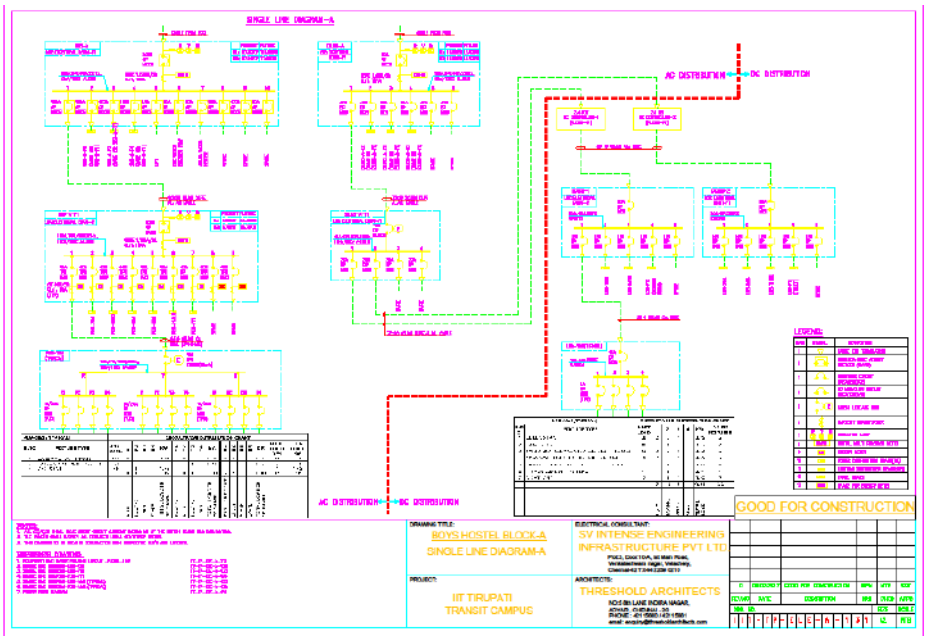
e) Negligible Harmonics

f) Ease of coupling of various sources without synchronization

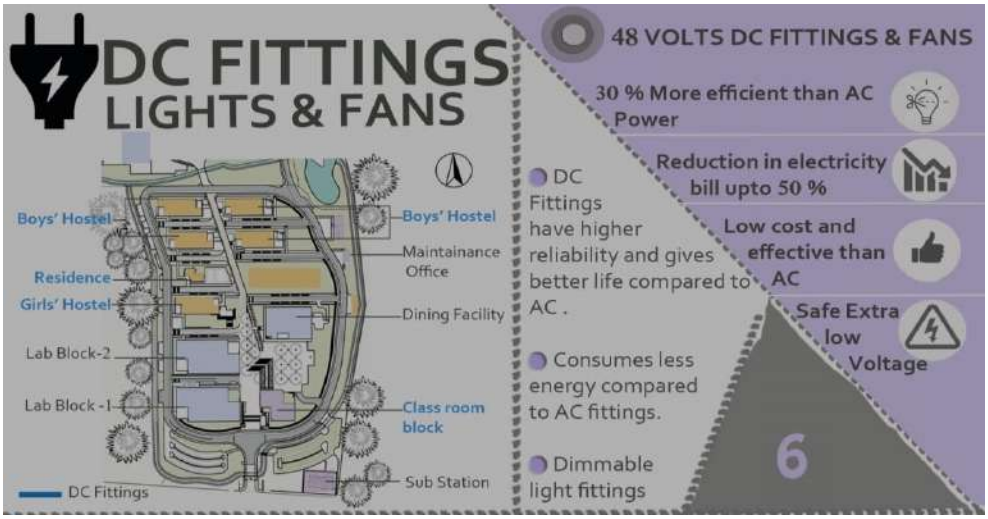
6. *DC DISTRIBUTION. THE FUTURE OF NEXT GENERATIONS*



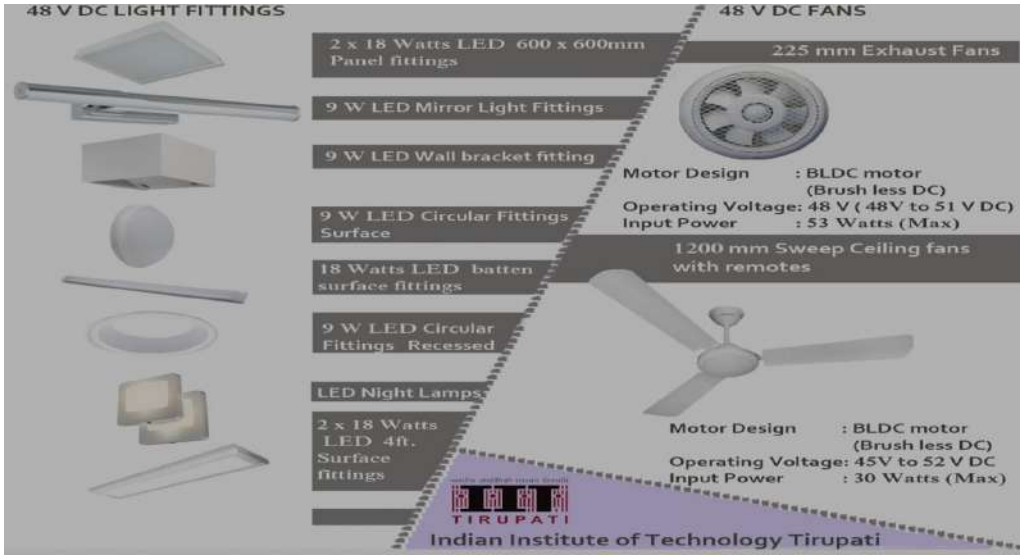
7. CASE STUDY IN IIT TIRUPATI: WIRING DIAGRAM IN A TYPICAL BUILDING



Case Study : Hybrid DC wiring done in Transit Campus at IIT – Tirupati



Case Study : Hybrid DC wiring done in Transit Campus at IIT – Tirupati



8. COMPARISIONS

AC	DC
AC can be transmitted long distances using step up transformers	Insignificant loss while transmitting over extra long distance at high voltages.
AC is easy to generate	Long life of equipment
More equipment for DC loads	Less equipment and less space; hence economical
Needs Synchronization between sources	Easy to couple as it runs on zero frequency.
Loss of conversion from AC to DC loads	More efficient as majority of equipment is DC based
	Regenerative sources are in DC generation
Load is capacitive, resistive or inductive: More losses	The load is resistive, less losses
Power factor 0 to 1.0	Unity power factor.
Can not be stored	Can be stored.
Skin affect of AC requires larger Xns.	DC travels through whole Xn area, less material
	Needs more substations to generate and transmit current

9. CONCLUSIONS AND CHALLENGES AHEAD

- Integrating DC in AC infrastructure
- Lack of DC standards
- Uncertainty with return on investment
- Supply/Demand for DC products
- Lack of sufficient pilot projects

CONSTRUCTION OF 129 MLD WATER TREATMENT PLANT – AN OVERVIEW

Sh. CR Nanda, CE, CPWD

CPWD was entrusted with construction of 129 MLD Water Treatment Plant for WATCO funded by Indian Oil Corporation under CSR scheme to supply water to Cuttack city. The project was sanctioned for Rs. 55.60 crore and completed with 50.00 crore with Rs. 5.60 crore savings. While preparing the estimate difficulty was faced to find technical details, specifications etc. for execution of such huge capacity WTP work. However, the above work was executed in active consultation with Water Corporation of Odihsa, Public Health Engineering Department. The design, sequencing, specification etc. are considered as per CPHEEO guideline.

The basic requirement suggested by the client is the capacity of treatment plant and final output water quality. The raw water is sourced from river Mahanadi and brought to site trough 1300 mm dia pipe line. The river water is normally high in turbidity and also carries other impurities. The treatment plant is designed to remove the impurities to acceptable level and finally stored in the clear water storage before pumping to public distribution system. The raw water quality and treated water quality is tabulated below.

The quality of raw water is as below :-

a)	PH	:	6.8 – 7.5
b)	Color	:	50 Pt.
c)	Turbidity	:	1500 mg/lt.
d)	TSS	:	2500 mg/lt.

As per CPHEEO guidelines the treated water fit for consumption of human being should have following parameters :-

a)	Color	:	Not greater than 5 Hazen units
b)	Turbidity	:	Not greater than 2 NTU (Nephelometre Turbidity Unit)
c)	Test/odure	:	Un-objectionable
d)	Free chlorine residual	:	Not less than 2 mg/lt. after 30 minutes of contact
e)	Appearance	:	Clear & sparkling
f)	Bacteriological Standards	:	No coli form

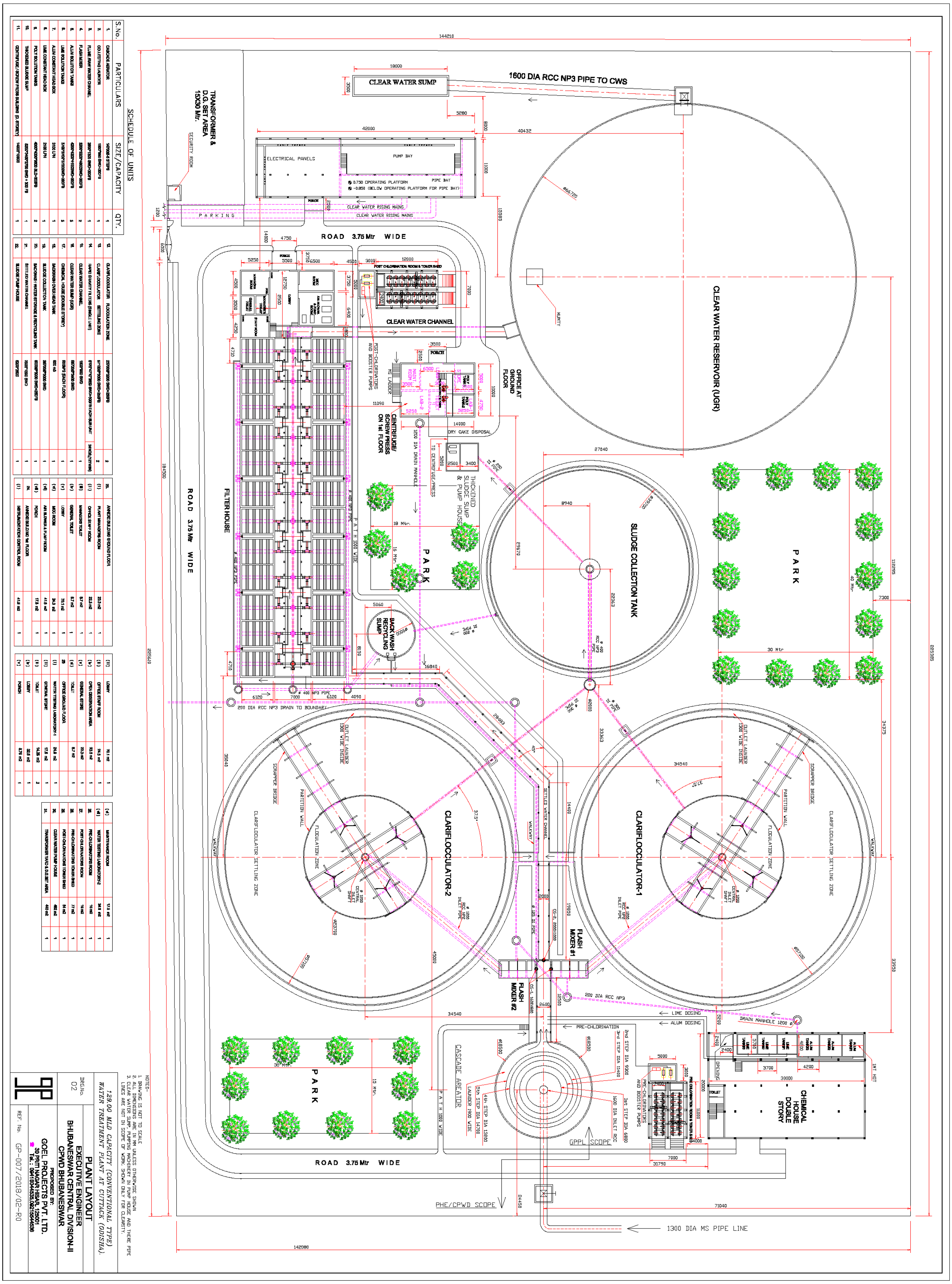
The WTP is hydraulically designed with following steps to achieve above :-

1. Aeration
    a) Chemical Dosing
    b) Alam & Lime.
2. Pre-Chlorination
3. Clarifloculator
4. Filtration
5. Post-Chlorination
6. Clear water storage
7. Pumping to public distribution system.

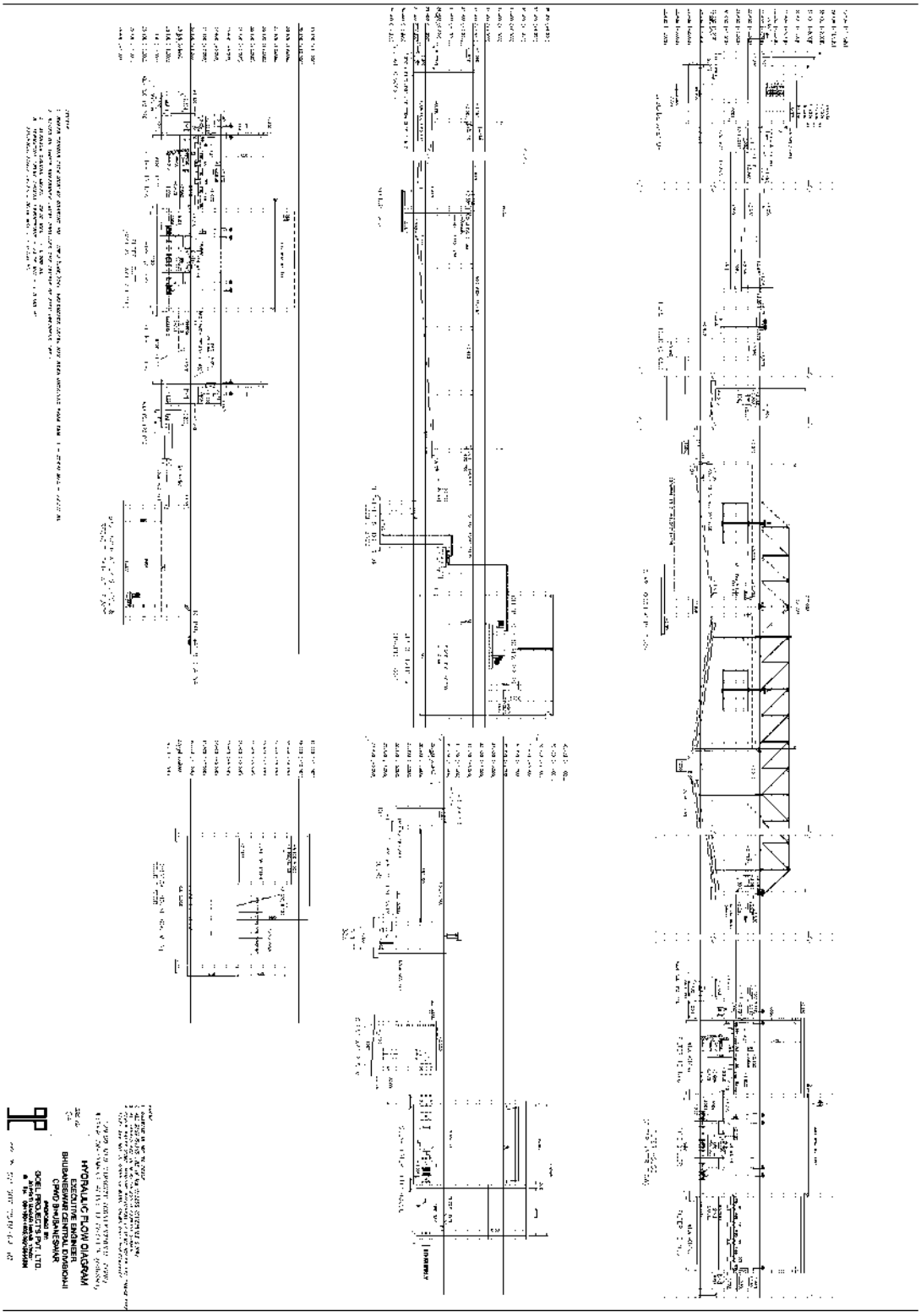
The above steps as per CPHEEO guideline are provided in the treatment plant. The lay-out plan of plant and cross-section details are shown in fig-1 and fig-2 respectively.

Details of individual components are as detailed below :-

1. **Aeration:-** Aeration is a process generally used for exchange of gases between water and atmosphere. By this process oxygen is added to water and carbon dioxide, hydrogen- sulfide are removed to minimize odure. By aeration minerals like manganese, iron are also removed. In the present plant aeration has been done through 5 step cascading aerator. Water is entered into aerator from the centre and flowing to lower level in sheet form. The diameter of aerator is varying from 6.8 metre at top to 14.7 metre at bottom with a fall of 0.3 metre on each step. After the aeration, water is collected on peripheral channel and moves forward through 2600 mm wide water channel to flash mixer.
2. **Chemical Dosing:** While moving through the channel, after aeration the next process in treatment is removal of turbidity and dissolved solids by sedimentation process. This has been achieved by adding alum and lime as coagulant. These chemicals are stored in chemical storage building and pushed to water channel through dosing pipes. The chemical house is a double storied building with floor area of 600 Sqm on each floor. The ground floor is used for storage of alum and lime. The dosing tanks, mixer and pumping arrangement are made in first floor. There are 3 alum solution tanks and 3 lime solution tanks are provided for the purpose. The chemicals lime and alum are fed to water channel @ 160 mg. per litre and 55 mg. per litre respectively to facilitate coagulation.


CLEAR WATER SUMP
1600 DIA RCC NP3 PIPE TO CWS
CLEAR WATER RESERVOIR (UGR)
TRANSFORMER & D.G. SET AREA 15X30 Mtr.
ROAD 3.75 Mtr WIDE
FILTER HOUSE
CLEAR WATER CHANNEL
SLUDGE COLLECTION TANK
PARK
BACK WASH RECYCLING SUMP
CLARIFLOCCULATOR-1
CLARIFLOCCULATOR-2
FLASH MIXER #1
FLASH MIXER #2
CASCADE AERATOR
CHEMICAL HOUSE DOUBLE STORY
PHE/CPWD SCOPE
GPPL SCOPE
1300 DIA MS PIPE LINE
SCHEDULE OF UNITS
PLANT LAYOUT
EXECUTIVE ENGINEER
BHUBANESWAR CENTRAL DIVISION-II
CPWD BHUBANESWAR
GOEL PROJECTS PVT LTD.
REF. No GP-007/2018/02-R0

(Fig-1)



(Fi-2)

3. **Clarifloculator:** After chemical dosing the water enters in to clarifloculator through flash mixture. There are 2 numbers of clarifloculator of 57.7 metre outer diameter. The central portion of 23.7 metre diameter is used for flocculation where vigorous mixing is done through motorized paddles. After the mixing in the flocculation zone, water moves to settling zone of the clarifloculator where settlement of particles takes place. The clear water is collected through peripheral channel and moves through settled water channel towards gravity filter. The sludge collected at the bottom of clarifloculator are removed and sent to sludge collection tank.

4. **Filtration:** After completion of coagulation and settlement of particles, cleaned water moves in to filtration area. There are 24 number of filtration beds of 28.83 sqm area each. Total filtration bed area is 692 Sqm. The water passes through filter 3 layered filter media and collected at the bottom of the pit. The filter media consists of 500 mm gravel followed by 500 mm sand and 250 mm anthracite coal at top. There is a back washing mechanism through water is also in position to remove chocked filter beds. Total process of filtration and back washing is automated and control by supervisory control and data acquisition (SCADA).

5. **Post-Chlorination:** After completion of the filtration, the clear water moves through clear water channel of 1800 mm width to underground clear water reservoir. While moving through the channel automatic sampling of water for various parameters are done to ensure quality of water. As per requirement, post-chlorination is also done at this stage to maintain required residual chlorination of 2 mg. per litre after 30 minutes of contact. The clear water reservoir is a huge structure to store 12000 cum water with 66.7 m dia.

6. **Pumping to Distribution System:** From clear water reservoir water is carried to clear water sump through 1600 mm diameter RCC pipe. The clear water is pumped to public distribution system through pumps of various capacity in pump house.

7. **Sludge:** From the bottom of clarifloculator, sludge with water moves to sludge collection tank. The sludge is pumped out from the tank to screw press unit where solid sludge cakes are formed. The cakes are used as manure for horticulture work.

In the total process of treatment of water it is designed in such a way that no pumping is required to lift water in any place. It is totally gravity driven. Also in the process, there is **zero** wastage of water. The water used for washing of filtration media and water obtained from sludge tank are back fed to flash mixer for recycling. The photograph of the plant is attached as fig-3

(Fig-3)

CENTRAL TENSILE FABRIC DOME AT IIT DHARWAD

Sh. Raghu Babu Sure, CE&ED, CPWD

A. SALIENT FEATURES

1. Central Lecture Theatre in IIT Dharwad Permanent Campus is provided with circular central court yard of 56 m diameter, one of the longest span tensile fabric structure in India.
2. The tensile structure is installed at 1.5m height from terrace floor level. Supports have been taken from existing RCC Columns along the periphery and there will not be any support at the centre of the structure.
3. Total Height of the tensile structure is **10m**, and the dome structure is separated by a conical structure at the centre.
4. Centre Cone is of **11.5m** Diameter and 3.5m Height from Dome top level.
5. Structure will be covered with both High and low translucent fabric.
6. The geometry of the tensile dome is designed and analyzed by computer form finding process in accordance with the structural and architectural views.
7. Structural design done by the consultant enaged by M/s B.G. Shirke Construction Technology Pvt. Ltd., Pune and got vetted by IIT Chennai.

B. LOAD DETAILS

1. Dead Load

- Dead load of the structure is considered as a self-weight in the Staad pro software
- Fabric Pre-tension forces have been arrived using ix-cube software and applied as nodal loads.

2. Live load

- Live load on the structure has been calculated as per IS:875 P-2 for curved roof and the value arrived as 73.5 kg/m^2

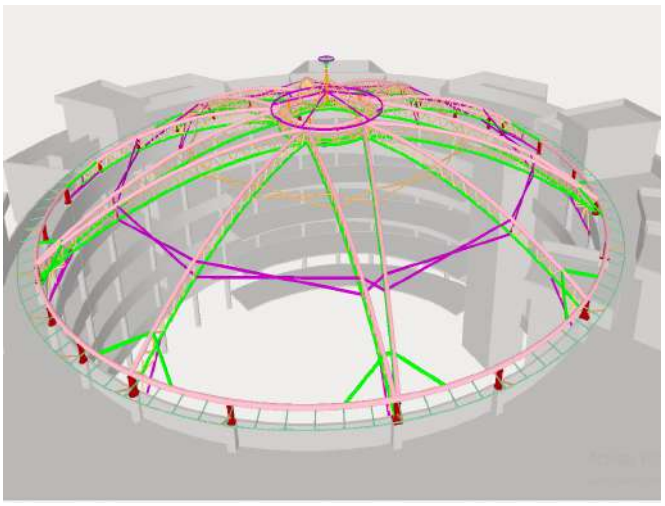
3. Wind load

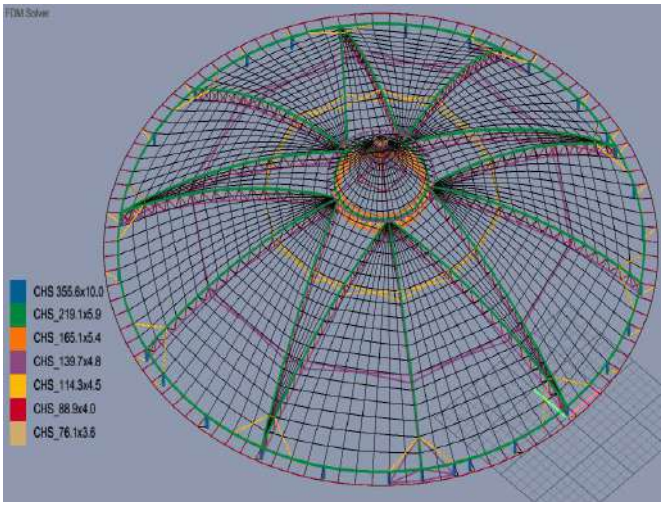
- Wind load is calculated with reference to the IS-875 part-3-2015, by considering
- Structure as curved roof and design wind pressure is arrived as 60 kg/m^2

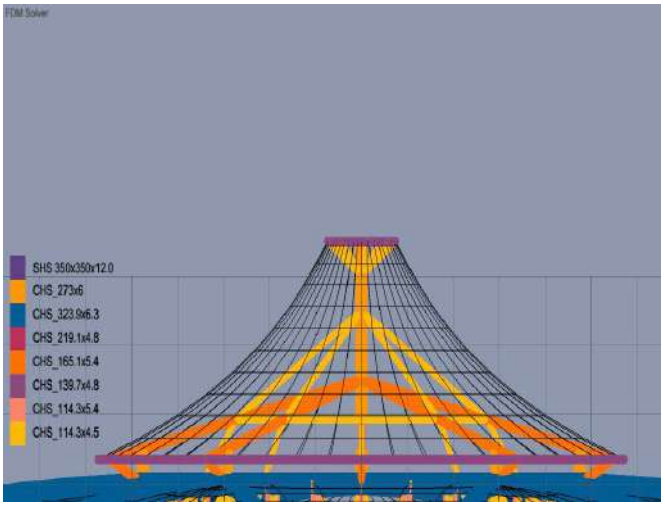
4. Load combinations

- Load combination for design strength and serviceability has been calculated separately as per IS standard and the structure is designed as per IS:800 – 2007.

C. CONCEPTUAL IMAGES





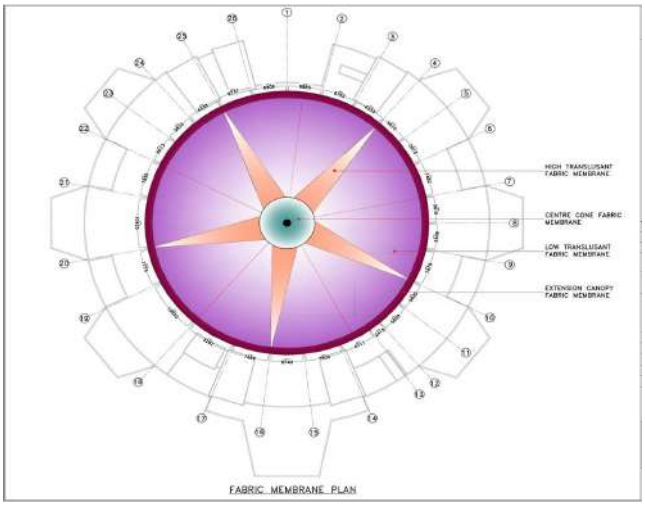


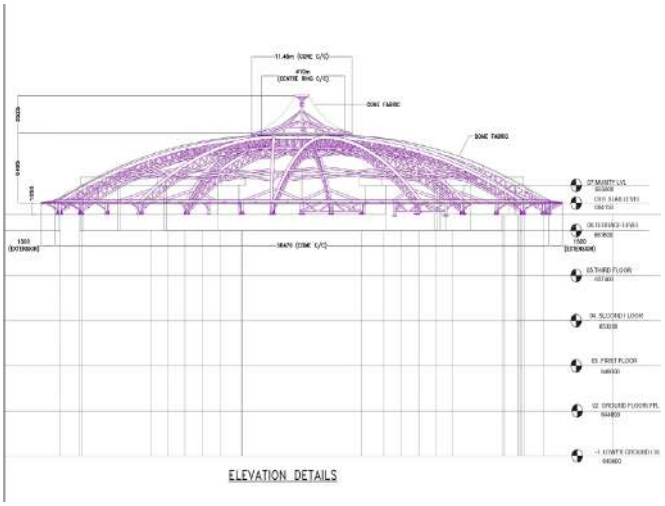
D. SPECIFICATIONS OF TENSILE FABRIC:

VALMEX® Product No. Material composition Finish			
Finish: Nanopolymered fluorinated lacquer system on both sides, protected against microbal and fungal attack, UV-protected, Titaniumdioxide (TiO2) front side primer.			
	Measurement methods/ Classifications Nanopolymered fluorinated lacquer	**Unit**	**FR 1000 Type III 7269 5256 attack, UV-protected, Tita**
Base fabric	DIN ISO 2076		Polyester Panama Weave P 2/2
Yarn count	DIN ISO 2060	dtex	1670
Low-wick yarn treatment	Methylene blue liquid method	mm	< 5
Total weight	EN ISO 2286-2	g/m^2	1050

Fabric thickness		mm	0.9
CMD ratio (Front:Back)			3:2
Mechanical properties			
Tensile strength (warp/ weft)	DIN EN ISO 1421/V1	N/50 mm	6000 / 5500
Elongation at break (warp/weft)	DIN EN ISO 1421/V1	%	24 / 32
Tear strength (warp/ weft)	DIN 53363	N	900 / 800
Adhesion	PA 09.03	N/cm	25
Crack resistance	DIN 53359 A	No. of folding	100,000 T - no cracks
Physical properties			
Light fastness	DIN EN ISO 105 B02		> 6
Cold resistance	DIN EN 1876-1	°C	-40
Heat resistance	PA 07.04	°C	+70
Fire resistance	Classification		DIN 4102-1:B1 EN 13501-1:B S2 D0 UNI 9177:CL2 BS 7837 California T19 NFPA 701 Test 2

E. REFERENCE IMAGES FOR TENSILE FABRIC





DSEO: THE FIRST BUILDING IN LINE WITH CARBON NEUTRAL LADAKH AND ASPIRING THE PM MANTRA OF PANCHAMRIT

Sh. Pradeep Gupta, Chief Engineer, CPWD
Sh. Ravinder Pal, Executive Engineer (E), CPWD
Sh. Arijit Ghosh, SAP Automation (India) Pvt. Ltd.

INTRODUCTION

Owing to the diverse and harsh topographical, geographical location and climatic condition of Ladakh, it becomes one of the most challenging locations for CPWD for creating national assets. These peculiar conditions do not exist in any other part of the country. Though there is presence of connectivity with nationalgrid as well as with the local hydel grid, but still there is acute shortage of primary energy in Ladakh.

In the cold climatic condition of Ladakh, there is need for space heating for at least 6-7 months in a year andneed for Domestic Hot water (DHW) round the year. During the winter period when the river freezes, the hydel power plants are shut down. Thus, the dual challenge emerges in the form of non-availability of electricity and non-utilization of the renewable energy as well as dependency over the fossil based space heating & fossil based electricity generation. This leads to emission of tremendous amount of carbon in theenvironment which is definitely not in the line of the vision of the carbon neutral Ladakh.

BUILDING DESIGN: THE BUILDING MUST ACT AS ITS OWN POWER HOUSE.

Buildings in Ladakh were erstwhile designed on the basis of the experimentations over the generations. Almost all of the office building across the UT of Ladakh are not only energy consuming but also energy in-efficient. The individual building should be designed in such a way that the building should at least generate that much amount of electrical energy that must suffice the electrical consumption of the building itself. Thus, buildings should act as the source of generation of electricity not as the sink of electricity. To make each building acting as own power house the two-stage strategy needs to be adopted. Firstly, the energy consumption of the building has to be reduced by incorporating the fundamentals of building physics & adopting energy efficient measures (like geothermal for space heating). Secondly, by generating the own electricity for the building.

DSEO: THE GAME CHANGER BUILDING

Central Public Works Department(CPWD) always a forerunner in innovation in public works, took the big step and introduce a new way to build in Ladakh, a science that could potentially change the way buildings in Ladakh are going to be built from now on.

DSEO is a first in many ways, it combines multi-dimensional interventions, all in hybridization and with singletarget to consume less energy and try to be NET ZERO.

Net Zero in Ladakh is a huge challenge, if the gear shift is not done. It's impossible to make Net Zero here with conventional methodology. The numbers just don't add up. That's why DSEO is game changer. the first.

BUILDING PHYSICS: INTEGRAL PART OF BUILDING

The first was to introduce Building Physics in Practice. The trick in any harsh climate is to- Decouple the building from the climate. Meaning whatever the cold or hot the ambient is, much inside. The first was insulation, requisite insulation on both sides of the wall brought the U Value (against suggested ECBC for Ladakh) to 60% better, the fresh air exchanged with only Mechanical Ventilation and heat recovery, there by dropping the electricity requirement for ventilation, while inserting 100% fresh air into the space, complying with EN13779 and ASHRAE 62.1 standards. The Thermal bridges were reduced and airtightness maintained as best.

With such detailed study and reduction of U Values for the Opaque assembly, the challenge was the transparent assembly, the glazing. Complying with the GRIHA 2019 Daylighting, we simulated the percentage, while reducing the exposure through glazing, finally 35% glazing complied with the GRIHA parameters for Daylighting. But our understanding and experience, tells us, apart from certification needs-the WWR % even lower is actually better for Ladakh

But we set out to smash the glass ceilings. We had to make it Net Zero, which meant crossing all standards and certifications available in India.

CPWD has targeted a performing and quantifiable building. Cross all standards.

With the Simulation software not having any Leh Specific weather file in the library, it had to be done with software with manual entry allowed for deducing the thermal load. The thermal load is the starting point for treating the climate inside. While building physics was the first intervention to reduce the thermal load, Lehhad a unique problem of treating cold inside.

GEOTHERMAL FIT THE BILL

The Fossil fuel had to eradicated, no boilers, no Kero heaters, no Diesel to be burnt, the options were literallylimited. The requirement was a site agnostic, 24/7 renewable and clean direct heat that required minimumelectricity to move the energy from one location to other.

Geothermal fit the bill. CPWD remains to be the first Government agency in India, who took up the challenge to distribute the heat in the building through geothermal exchange. The lithology of Leh Ladakh supports, shallow exchange of low grade heat that is sufficient to heat indoors.

With proper design and calculations the entire space heating and Domestic Hot Water was designed on Ground Source Heat Pumps. The Exchange loops can normally be 2 types horizontal and vertical. With afrost line of 1.5 meters, the horizontal exchange was a strict no no. That would not be enough heat to exchange in the cold Ladakh winters. It must be vertical exchange up to a depth where the temperature isstable and good for exchange.

CPWD follows the scientific process of getting the thermal conductivity test done before old timeline to ensure that the system can exchange energy for 25 years. It's a must. The Borehole the actual drilling is done. This test in short called TRT, ensures proper scientific data, extrapolated from the soil for a 25 years

exchangers buried in the ground, are the lifelines of the exchange. Hence any incorrect calculation shall either oversize or undersize the exchange, both can result in failure.

WHY IS GEOTHERMAL SO EFFECTIVE?

Why is Geothermal is so effective? Because it doesn't try to change the energy, it is the same thermal energy, that is stored in the soil deep at 100m around, therefore making it Renewable Heat. This renewable is the trick behind, decarbonizing heating/cooling.

It doesn't try to change the source and desired medium shifts the heat from one location to another,

through a liquid medium. With the ambient going down to minus -26 Deg C, it's a boon for the heating system to exchange arround 14-18 Deg C at a depth of 100-120 metres inthe ground. Where, at those temperatures where the Season Performance factor (SPF), in case of an electrical driven system could be barely touching 1.00 -1.25 or less , the Geothermal exchange can be easilyin the range of 4.00-5.00 , thus making it 4-5 times more efficient. This is real reduction of load of consumption.

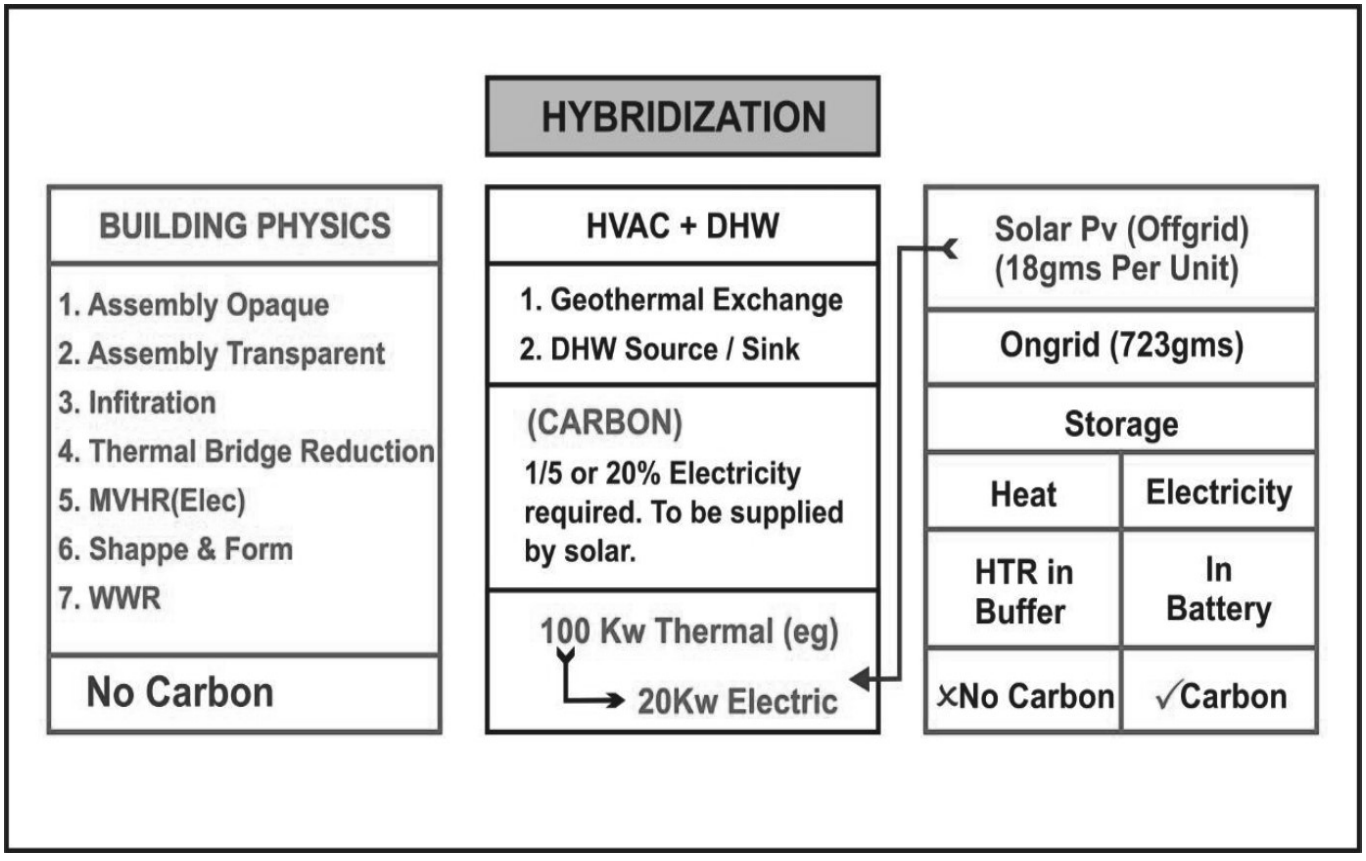
Adopting this , CPWD has been able to cut down from 200-250 watts per sq. mtr of electrical energy demand, now can expect around 20-25 watts per sq. mtr , a whopping 90% reduction in the building load forheating/cooling, thus the utility demand. And this is 90% reduction of carbon at grid to building level. Not only that 80-90% of the heating operation is carbon free, also it makes way for another carbon free operation the Solar PV.

Here is a small trick that could change the way the buildings were till today. The solar PV made on roof topwithout touching the grid is only 18gms/KWh carbon against a grid emission factor of 724 gms/ KWh of Carbon. Hence its makes finer sense to use the solar till the available production time to run the building on Solar as first choice energy source, this will also decarbonize the electricity operations to the extent of its consumption. When the sun goes down can the Grid come up to supply. This would ensure that the day inLadakh is not so grid dependent.

Inform when it's excess in the other benefit of this system is to store energy liquid the system, meaning when the heating/cooling is on stand by the available energy can produce for liquid form storage. This eliminates storage batteries to a large extent.

HYBRIDIZATION = RENEWABLE HEAT + RENEWABLE ENERGY (GEOTHERMAL + SOLAR)

If we need to clean the heating operation, in the Himalayas, decarbonize the heating then we must use multiple interventions and also be able to hybridize Renewable Heat and Renewable Electricity to make thatportion carbon free. This is hybridization of energy in buildings. The future will be only this. Only Renewableelectricity is not enough for a country like ours which has so many HDD and CDD.



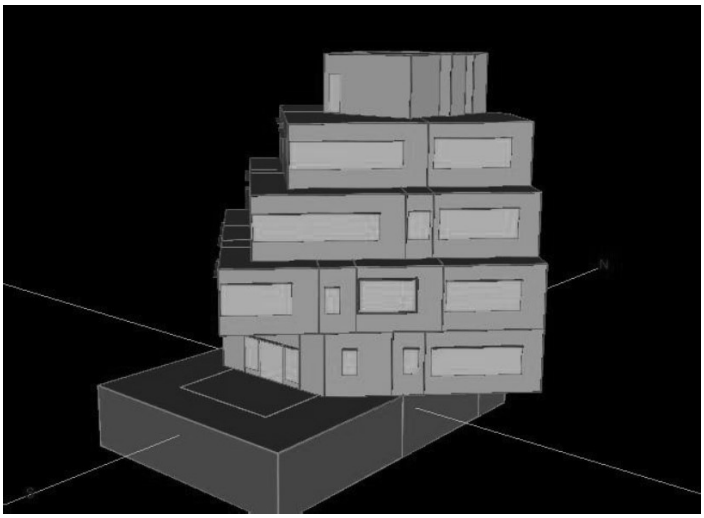
DESIGN SCORECARD : GREENER THAN THE GREENEST

EPI AND EUI DELIVERY

EUI		EPI	
KBTU	252949.7686	KWh	74135
gsf	11404.09	M2	1041.5
kbtu/gsf/a	22.18	KWh/m2/a	71.18

FINAL QUANTIFICATION

1. EPI = 71.18 Kwh/m2/year
2. EUI = 22.18 Kbtu/gsf
3. Carbon Emission = 1334.44 kgs or 1.313 (Imperial Tons)
4. Carbon Savings from Conventional: 32899.16 - 1334.44 = 31564.72 kgs (savings of Carbon)
5. % Reduction of Carbon - 95.94% reduced / saved



According to ECBC

EPI =201 as standard for Cold ClimatesECBC will be 21% less =158.79

ECBC Plus 27% less = 146.73

ECBC Super 45% less = 110.55

EPI for DSEO 71.18 Kwh/m2/year

DSEO Will be the *first* Building in line with Carbon Neutral Ladakh and in tune the PM mantra of PanchAmrit declared in the COP-26 of the UNFCCC. The key feature of the building makes this building unique that includes, Heating demand not attempted with fossil fuel, Diesel fired Boilers and combination ofnational grid 32899.16 kgs of emission brought down to 1334.44 kgs, This also decarbonizes the heating

/Cooling/DHW by going almost Off the grid, during BAU hours. This building holds the potential to be best building design in future and will set benchmark of energy efficiency.

WEAVING IDENTITY- DESIGNING OF IIIT RANCHI CAMPUS WITH PEOPLE, CULTURE & CONTEXT

Smt. Bratati Ghosh, Chief Architect, CPWD
Dr. Debarati Chakraborty, Architect, CPWD

INTRODUCTION

Renowned Architect Frank Gehry once said, "Architecture should speak of its time and place but yearn for timelessness." Designing the campus of IIIT Ranchi was a quest in creating a story of the local people, their culture, and ambitions – which would serve as a beacon in the annals of place making. The conception of every building in the site became a story telling journey that ultimately culminated in the creation of a place that would instil a sense of pride and identity to the people of the region.

Figure-1: *3D imagery of the administrative building and Research building block*

It took careful planning and broad participation to create a campus that accurately represents the IIIT Ranchi with its regional community, culture, and environment. The following important factors were considered while incorporating identity into campus design:

Research and comprehension: of the local context were the parts of the first step. This helped to better comprehend the state of Jharkhand's local culture, history, and surroundings. Engaging the neighbourhood's residents, including its students, teachers, and staff, to learn more about their needs, goals, and values. This information guided the design process and assist in developing a campus that blends in with its surroundings.

Involve the IIIT Ranchi and its people: Various workshops, focus groups meetings, and design charrettes were arranged to get suggestions and feedback from students, professors, and staffs of IIIT Ranchi. Their

participation promoted a feeling of pride and ownership in the campus, ensuring that it will accurately reflects their identity.

Embracing regional architecture and materials: Designing the campus using materials and features of indigenous architecture. Finding out about the regional building practises, materials, and architectural styles, and incorporating these components in the ambience generation, so that the campus shall develop a sense of community and better integrate with its surroundings.

ABOUT THE PROJECT

Indian Institute of Information Technology has been allotted a land of Area of around 207993.93 Sq. Mtrs /51.40 Acre at Sanga Village, Kanke, Ranchi. O/o ADG(Patna), CPWD has been entrusted with the design and execution of this trailblazing/pioneering project. The requisition (detail of requisition to be added in the presentation) was received in January 2020 followed by sanction of A/A & E/S on 12.03.2021. The project went into the category of EPC-I mode after the Conceptual Design drawings were done In-house and approved by the client.

The site has a Permissible FAR of 2.25 & Permissible Ground coverage of 50% as per Jharkhand Building by-laws 2016. Other by-laws pertaining to all the other local bodies such as fire department of Jharkhand or forest department were taken into consideration while developing the site. The site consists of two major activities- Academic and Residential will be developed in two phases. Phase 1: Administrative building, Academic building, Boys' & Girls' hostel, Director's residence, Registrar residence, Faculty Quarters, and allied services buildings. Phase 2: Boys' &Girls' hostel, Married scholar accommodation, Faculty quarters, Auditorium, OAT, Guest house and community center, commercial facilities.

ZONING AND BUILDING FOOTPRINT GENERATION BASED ON SITE FEATURES, CONTOURS, AND CLIMATE ANALYSIS

Technical analysis of site through software programs to assess the heat gain and loss in the building and heat island generation in the campus are mapped in this stage, along with contour analysis to show the building footprint generation location and zoning of different uses. Heat mapping of the entire campus including buildings, done to understand the pattern and density of vegetation to be proposed. The climatic condition of Ranchi is warm and temperate with sizeable amount of rain fall from June end to middle of September. Otherwise Ranchi withstand a dry warm climate. The landform of the site is undulating with a depression like a gorge at a central area creating the site interesting. To protect the natural drainage and the landform this gorge required to be conserved. The building blocks are mostly oriented in north south direction on the longer side although due importance has been given to their alignment with the contour and maximum focus on daylight in the interior.

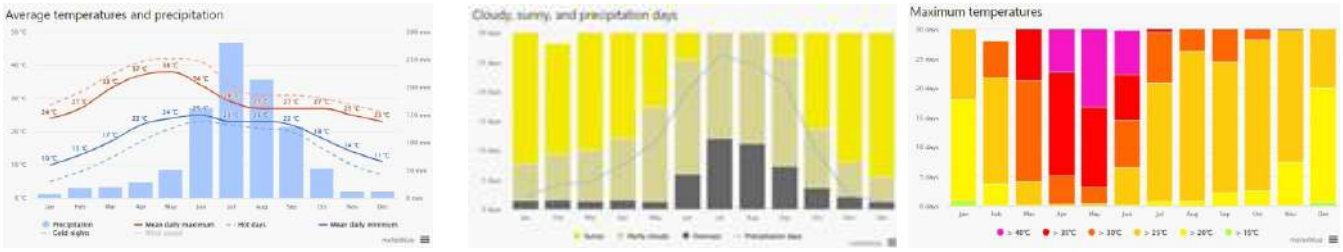


Figure-2: *Zoning based on contour analysis, & climatic analysis of sun path and wind direction of site*

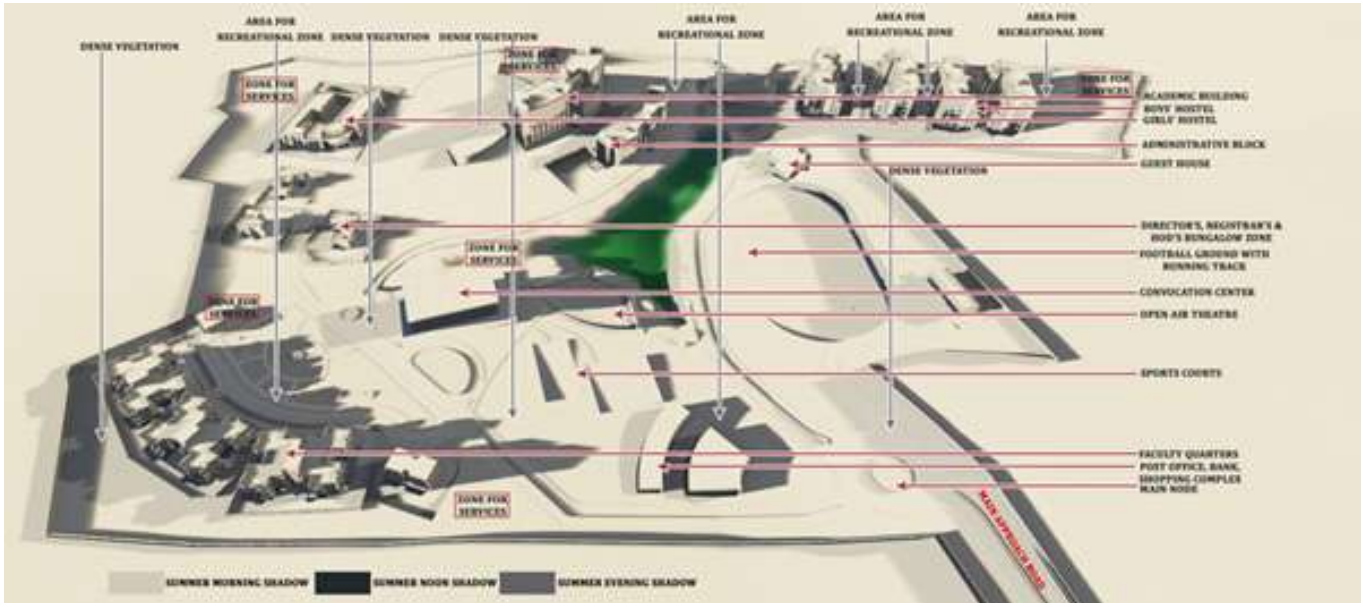


Figure-3: *3D Imagery showing building volume, vegetation & recreational area generation through shadow analysis*

Figure-4: *3D Imagery or birds' eye view of the entire site showing landscape design*

Land profile and existing water body has been designed inclusive, the design process shows how rediscover the beauty of nature, through its nature inclusiveness. The buildings are oriented keeping in mind the sunpath, heat mapping, wind patterns and drainage of the site.

AMBIENCE GENERATION OF THE SITE

Site planning for this campus is a careful blend of tradition and modernity that gives importance to physical features of the site. Water bodies are used to accentuate the buildings through careful formation of reflections. Academic and Administrative buildings are given due importance by placing them at an

altitude. Creation of an Ambiance conducive for students (local, national & international) to make them aware about art, culture, and education of the land of Jharkhand was the aphorism. Following were the broad points, taken care during the campus development planning.

Creating spaces for cultural expression: Creating areas that honour and accommodate the various cultural customs and activities that the IIIT Ranchi community engages in, including areas for drama, dance, music, and the arts so that kids can express and display their cultural background. These areas may be used as performance rooms, exhibition halls, or public gathering areas outside. The main road leading to the hilltop and other circulation spaces inside the site, depict stories of Birsa Munda and other renowned personalities of the state of Jharkhand and beyond, and about the institute of IIIT Ranchi and its endeavour to take the educational system of Jharkhand to its peak, through statues, plaques creating an identity of the place.

Figure-5: *3D Imagery showing development of decorative pathways with site out places, sculptures, plaques.*

Foster social interaction and collaboration: Designing public spaces that encourage social engagement can help students, instructors, and staff to communicate and collaborate. Creating welcoming spaces, which promote casual conversations, sharing of ideas, such as courtyards, plazas, or outdoor sitting. Creating small interactive gathering spaces, colloquially "पेड़कछिँव", for students, to enjoy a relaxing evening.

Figure-6: *3D Imagery showing group interaction places.*

Sustainable design and integration with nature: Integrating the campus with the surrounding environment and use sustainable design concepts. Using landscaping strategies that protect and accentuate already present natural features such as the natural water channel and hilly terrain and include gardens and green areas into the campus design. Additionally sustainable technology including efficient building systems, renewable energy sources, and rainwater harvesting etc. Were taken into consideration while designing the entire campus in macro scale and each building within it in micro scale.

Reflect local art and craftsmanship: The master plan or building design includes display of regional artwork and handiwork all over the campus to pay homage to the area's rich cultural heritage. By incorporating the creations of regional artists into the design through murals, sculptures, or installations, the campus will gain personality and authenticity while also assisting the regional arts scene. Buildings were envisioned to be one with nature, visibly by using murals/artworks flowing through walkways merging with wall surfaces culminating in a cultural flow.

Figure-7: *3D Imagery showing close up of building fascias painted with local artwork Sohrai and Khovar paintings.*

Prioritize inclusivity and accessibility: Considering inclusivity and accessibility when planning the campus was on priority. It was made sure that the campus to be barrier free and that there are ramps, lifts and accessible routes. The requirements of people with impairments, varied cultural backgrounds, and various learning styles were given due importance. Sincere efforts were given to create an inclusive environment where everyone is appreciated and welcomed.

CONCLUSION

The design of the IIIT Ranchi campus can become a representation of the local culture, values, and aspirations, creating a vibrant and inclusive environment for learning, collaboration, and personal growth.The campus located in a Composite Climate (Hot & Humid subtropical, dry winter climate) zone creates a micro climate within it to invite the visitors and enchanting them to tell a tale of the state and its nature & people and the glorious institute of IIIT, Ranchi.

INTEGRITY RISKS IN CONSTRUCTION PROJECT MANAGEMENT

Smt. Garima Bhagat, IRS, Sh. O.P. Tripathi, ADG CPWD, Prof K.N. Jha, IIT Delhi

BACKGROUND

As a core sector, construction has played a vital role in contributing to the economic and social development of human societies. In the Indian context, public works constitute a large slice of the total procurements in terms of both the number and value of tenders. The Infrastructure and Project Monitoring Division (IPMD), which monitors the implementation status of high-value infrastructural projects, has 1687 projects with an anticipated cost of US$340 billion on its monitor as of January 2021 (Ministry of Statistics & Programme Implementation 2021).

However, in recent years, integrity lapses have increasingly diminished its positive social images. According to Zou (2006), construction projects are vulnerable to corruption because of the volumes of money involved and the difficulty in monitoring spending processes. Large construction projects are complex, with multiple players at various levels, and corruption may occur at any level and at any project stage. Hence, its adverse ramifications are extensive, including project delays, cost overruns, defective works, low return on capital, lack of productivity, and an overall decline in project performance. Poor integrity outcomes also entail considerable economic loss to the construction sector. The annual loss from corruption in the global construction market is estimated to be approximately USD 340 billion, accounting for 1% of the global construction market value (roughly USD 3.2 trillion). Transparency International estimates that 10% of global infrastructure investment was lost through corruption annually.

In the Indian context, corruption in public procurement has emerged as one of the six significant sources of the generation of black money (Ministry of Finance 2012). Corruption in procurement manifests in varied forms such as bribery, fraud, extortion, embezzlement, favouritism, or collusion. Lately, it has morphed into new forms like money laundering through shell companies or influence peddling to state capture and organized crimes.

INTEGRITY RISKS IN PUBLIC CONSTRUCTION PROJECTS

While risk management is an established construction management domain, it has not yet assimilated integrity risks. Lasthuizen *et al*. (2005) define integrity as "the quality of acting in accordance with relevant moral values, norms, and rules". A risk that indicates an event or factor which impacts this, constitutes a vulnerability to corruption and qualifies as an integrity risk. Integrity risks permeate the entire project cycle, while their nature differs from stage to stage. So far, the thrust of procurement reforms has been around the tendering stage. However, this may be the proverbial 'tip of the iceberg'. Efforts are yet to be made to develop a stage-wise integrity risk assessment framework that covers risk identification, analysis, and evaluation across the distinct steps of the project. Without a stage-specific assessment, corruption could merely be displaced from one stage to another Hence, a risk-based approach that addresses the corruption vulnerabilities along the procurement cycle is immediately required (Beth 2007). Integrity risk management may be defined

as "an architecture and a coordinated set of activities and methods to identify, analyze, evaluate, treat, and monitor potential fraud and corruption-related risks to acquire reasonable assurance that the integrity of public institutions has been preserved"(OECD 2013). Such an approach would give a macro view of the integrity risks across the distinct project stages, facilitate their prioritization, and formulate stage-specific mitigation measures. The primary requirement for this is a risk mapping methodology for risk identification, assessment, and prioritization based on the perceptions of practitioners and experts. Procurement of works is a protracted process starting with planning, followed by design, tender solicitation, tender evaluation, contract award, and execution. Each stage in this process is handled by different players, is spread out spatially and temporally, and is exposed to different integrity risks. To effectively reduce corruption, a strategic stage-focused and rolling risk assessment must replace the generic handling of multiple irregularities strewn across the entire procurement process. Towards this end, it is proposed to undertake a stage-wise qualitative analysis of construction projects by identifying contemporary integrity risks along the dynamic flow of the project process.

IDENTIFICATION AND MAPPING OF INTEGRITY RISKS

A parallel combination of primary and secondary sources was used to identify major integrity risks in construction projects. Primary sources were tapped for a contemporary and cutting-edge analysis of the risks through a series of interactive workshops with project managers and other personnel directly involved in procurement and vigilance in large public organizations across India. Several discussions and face-to-face interviews were also held with officials in CVC/CTEO. Secondary source by way of extensive literature survey was utilized to identify the various integrity risks in works procurement. Along with academic works and reports of national and international bodies, many case studies with observations of the CVC were examined. Triangulation of the academic literature with direct collection of ground data about the current integrity risks in works procurement is a unique aspect of this study.

55 significant integrity risks in public construction were identified based on this process. Next, the integrity risks were mapped sequentially along the procurement cycle, which includes three main phases- pre-tendering (PRT), tendering (TP), and post tendering (PST). Each phase comprises distinct stages as per the activity involved. The stages under the pre-tendering phase are (i) Needs assessment (PRT1), (ii) Planning & budgeting (PRT2), (iii) Bid design (PRT3), and (iv) Choice of procedure (PRT4). The tendering phase comprises (i) Invitation to tender (TP1), (ii) Evaluation (TP2), and (iii) Award (TP3). The post tendering phase includes (i) Contract management (PST1) and (ii) Payments (PST2). A stage-wise integrity risk matrix is obtained by aligning the 55 risks across the respective project stage (Table 1).

Table 1: Stage-wise integrity risks in construction projects

Stage of procurement	Description of risk item
	Pre-tendering
Needs assessment (PRT1)	PRT1.1 Procurement not necessary/ no systematic estimation of demand[a]
	PRT1.2 Undue influence of external actors on decisions[a]
	PRT1.3 *Tailor-made* contract[a]
Procurement planning and budgeting (PRT2)	PRT2.1 Large project split to contract without bidding[b]
	PRT2.2 Administrative approval/ financial /technical sanction not taken to execute the work[c]
	PRT2.3 DPR is not prepared as per actual site requirements[c]
Bid design/ defining requirements (PRT3)	PRT3.1 Selection criteria for consultant are restrictive or not according to nature/ quantum of work[c]
	PRT3.2 Consultant not appointed through open competition/ appointed despite in- house facility available[d]

	PRT3.3 Updated standard bidding documents not used[c]
	PRT3.4 Selection criteria for contractor are restrictive or not according to the quantum/ nature of work[c]
	PRT3.5 Tender documents not approved by competent authority/financial vetting not done[c]
	PRT3.6 Role/ scope of consultant not clearly defined[c]
	PRT3.7 Selection criteria are ambiguous or subjective[a]
	PRT3.8 Ambiguity in nomenclature of items/ arbitrary quantities in estimates[d]
	PRT3.9 Consultant/ Contractor fee not linked to original contract value/upper ceiling of payment is not fixed[d]
	PRT3.10 Initiation of tender without availability of encumbrance- free land[e]
Choice of procedure (PRT4)	PRT4.1 Contractor appointed on nomination basis[c]
	PRT4.2 Non- competitive procedure invoked by abusing legal exceptions[b]
	Tendering stage
Invitation to tender (TP1)	TP1.1 Adequate and wide publicity not given to tender[c]
	TP1.2 Adequate time for submission of tender not given[c]
	TP1.3 Leak of confidential information before bid submission to few bidders[b]
Bid evaluation (TP2)	TP2.1 Contractors provide false certificates in bidding[b]
	TP2.2 Conflict of interest on part of decision makers[a]
	TP2.3 Evaluation is not carried out as per the criteria notified earlier[c]
	TP2.4 Conditions/specifications relaxed in favour of contractor to whom work is awarded[c]
	TP2.5 Negotiation on tender not done as per laid down guidelines[c]
	TP2.6 Decision on tender not given within bid validity period[c]
Award stage (TP3)	TP3.1 Lowest offer from consultant/contractor ignored on flimsy ground[c]
	TP3.2 Work order /supply order is not placed within justified rates[c]
	TP3.3 Consultant/contractor does not give performance guarantee in time[c]
	TP3.4 Bank guarantee submitted by bidder not verified[c]
	Post tendering stage
Contract management (PST1)	PST1.2 Work not executed as per the original sanction /design[c]
	PST1.3 Compliance with conditions regarding licenses, insurance policies/ renewals not being followed[c]
	PST1.4 Compliance with agreement conditions not fulfilled, including project milestones[c]
	PST1.5 All mandatory tests not being carried ou[t]c
	PST1.6 Proper record of hindrances not being maintaine[d]c
	PST1.7 Technical staff as per tender is not provided at site[c]
	PST1.8. Performance guarantee submitted is not renewed[c]
	PST1.9 Deviations, especially in high rated and high value items are not properly monitored and verified[c]
	PST1.10 Substitution of materials with inferior quality/ defective or different specifications[b]
	PST1.11 Site supervisor neglects duties or poor supervisio[n]b
	PST1.12 Sub-contractors engaged in a non-transparent way[e]
	PST1.13 Extension of Time (EOT) not granted on due verification of hindrances/ approval by a graded hierarchy structure[e]
	PST1.14 Necessary guarantees for water tightness etc. not taken[c]
	PST2.1 Payment of interest-free mobilization advances to contractors/recovery not linked to time[d]
	PST2.2 Late payment of invoices[e]
	PST2.3 Duplicate payment released for same expenditure under two different items[c]
	PST2.4 Contractors paid for that part of work which was not done by them[c]
	PST2.5 Escalation clause not applied correctly for admissible payment[c]

Payments (PST2)	PST2.6 Recoveries for taxes/duties not made before releasing payment[c]	
	PST2.7 Recoveries for land rent or equipment given to contractor not made[c]	
	PST2.8 Reimbursement of service tax, excise duty etc. is not done after obtaining actual proof of depositing[c]	
	PST2.9 Non- levy of penalties for violation of contract conditions[e]	
	PST2.10 Non- levy of liquidated damages for failure to meet timelines[e]	

Literature source: (a) Transparency International (2006), (b)Shan *et al*. (2015), (c)Tabish and Jha (2011), (d)CTEO (2002), (e) CVC (2020)

DELPHI SURVEY

Two rounds of Delphi survey with experts were conducted to obtain consensus regarding the top integrity risks with the highest impact. A purposive approach was adopted in selecting the panel experts who had to fulfil the following sampling criteria:

i. Extensive working experience in procurement anti-corruption and oversight management,

ii. Direct and current involvement in overseeing corruption in construction projects, and

iii. Having an in-depth knowledge of public construction procurement

Eleven experts in India who met all the criteria were selected and approached. The experts include senior officers working in the CVC of India, and Chief Vigilance Officers (CVOs) who are extension arms of the CVC across large public organizations. The responses obtained were subjected to statistical analysis. The consensus was measured in terms of the coefficient of variation ('v'), a measure of dispersion calculated by dividing the standard deviation by the mean. At the end of the second round of the Delphi process, 'v' ranged from (0.00) to (0.485). As 'v' less than 0.5 indicates a good consensus, there was no need for an additional round (von der Gracht 2012). Based on this, 30 top corruption risks out of the inventory of 55 risks were obtained.

EVALUATION THROUGH QUESTIONNAIRE SURVEY

The 30 top corruption risks identified above were evaluated by personnel of public organizations in different sectors of India through a questionnaire survey conducted between May to November 2022. The advantage of using a questionnaire while researching a sensitive subject like corruption is the anonymity offered (Owusu *et al.* 2021). 12 large public organizations in diverse sectors carrying out huge works procurements were identified using the project's database available from the CVC of India. This database was used to first approach the CVO of each organization, who was requested to circulate the questionnaire amongst personnel involved with public works projects. To ensure strict anonymity, the respondents were requested to submit the responses directly to the researchers by e-mail or post. 143 valid responses were received, including 119 by e-mail and 24 by post (Table 2).

Table 2: Profile of respondents

Attribute			Number of respondents	Percentage
Sector	**Category**	**Number of organizations**		
	Oil and petrochemicals	3	34	23.8
	Heavy manufacturing	1	8	5.6
	Highway/ border roads construction	2	14	9.8
	Railways	1	15	10.5
	Thermal power generation	1	13	9.1
	Power distribution	1	15	10.5
	Steel manufacturing	1	7	4.9

	Public works	1	22	15.4
	Coal mining and refining	1	15	10.5
Position	Top managerial level (General manager, Chief Manager, Executive Director)		51	35
	Middle managerial level (Dy General Manager, Senior Manager, Project Manager)		60	42
	Junior managerial level (Dy Manager, Assistant Director)		32	23
Years of experience	>20		67	47
	11-20		46	32
	6-10		23	16
	<5		6	4
Educational qualifications	Graduate (B.Sc., B. Com)		4	3
	Engineering graduate (B. Tech, B.E.)		71	50
	Postgraduate (MSc, MTech, MBA)		65	45
	PhD		3	2

FAILURE MODE AND EFFECTS ANALYSIS OF INTEGRITY RISKS

In this study, the Failure Mode and Effects Analysis (FMEA), an established risk analysis method, was adopted to assess the impact of integrity risks in public construction. FMEA sequentially involves defining the various failure modes and ascertaining their criticality through the occurrence rate, the magnitude of consequences, and ease of failure detection. Finally, the failure modes are classified to determine the priority of efforts. Here the possible failure modes, namely, the corruption risks, were identified per the qualitative methods described above. The survey was used to obtain the probability (P) of occurrence and severity (S) of the failure effect. The questionnaire used a Likert scale of 1-5 for the risk probability and severity ratings, 1 being very low and 5 being very high. The third element for FMEA, risk detectability, was obtained through a focus group workshop with the experts involved earlier in the Delphi survey. The risk detectability (D), i.e., the likelihood that control mechanisms in a public organization will capture, eliminate or mitigate the failure, was arrived at using the legend (Ochrana *et al*. 2015):

- 5- undetectable;
- 4- low likelihood of detection;
- 3- moderate probability of detection;
- 2- very likely that corruption will be detected; and
- 1- current processes, if implemented, will detect corruption.

The Risk Priority Number (RPN), which is a measure of the integrity risk impact, is obtained using the formula:

Risk impact (RPN) = probability (P) × severity (S) × detectability (D)…eq (1)

Table 3 displays the potential impact of the 30 top corruption risks identified and assessed in this study. A risk with a high RPN deserves higher priority in risk management and necessary corrective actions. The criticality of the risks is graded as:

- RPN ≥20 Critical risks that are most unacceptable;
- 15≤RPN<20 Very significant risks that are unacceptable; and
- RPN<15 Moderately significant risks that are undesirable.

Table 3: Evaluation of top corruption risks

Stage of procurement	Sub-stage	Description of risk item	Probability	Severity	Detection	RPN impact	Rank
Pre-tendering	***Needs assessment***	Procurement is not necessary/ no systematic need assessment done	2.03	3.5	**3**	21.27	
		Undue influence of external actors on procurement decisions	1.57	3.58	**3**	16.88	
		Tailor-made contract to suit a particular vendor	1.57	3.42	**3**	16.14	
	Planning/ budgeting	Large project is split to contract without bidding by lowering the contract value	2.28	3.96	**2**	18.06	
		Detailed Project Report is not prepared based on actual site requirements	1.84	3.76	**2**	13.84	
	Bid design	Selection criteria for the hiring of consultant are restrictive or not according to nature/ quantum of work	1.74	3.37	**3**	17.58	**16**
		Selection criteria for the hiring of contractor are restrictive or not according to nature/ quantum of work	1.61	3.90	3		**11**
		Role/ scope of the consultant not clearly defined	1.75	3.31	**3**	17.4	**18**
		Selection criteria are ambiguous or subjective	1.43	3.45	**3**	14.87	**22**
		Ambiguity in the nomenclature of items/ arbitrary quantities in estimates	1.92	3.62	**3**	20.82	**9**
		Tender is initiated without the availability of encumbrance- free land	2.33	3.85	**2**	17.97	**14**
Tendering	***Invitation to tender***	Confidential information is leaked before bid submission to a few bidders	1.48	3.79	**3**	16.87	**20**
	Bid evaluation	Contractors provide false certificates in bidding	2.16	3.79	**3**	24.6	**2**
		Conditions/specifications are relaxed in favour of the contractor to whom work is awarded	1.59	3.65	**2**	11.57	**28**

Post tendering	***Contract management***	Work is not executed as per the original sanction /design	1.81	3.64	**2**	13.21	**24**
		Compliance with conditions regarding licenses, insurance policies/ renewals are not followed	1.90	3.3	**2**	12.55	**26**
		Compliance with agreement conditions is not fulfilled	2.94	3.84	**2**		**5**
		All mandatory tests are not being carried out	1.95	3.8	**3**	22.25	**6**
		Proper record of hindrances is not being maintained	2.41	3.34	**3**	24.15	**3**
		Technical staff stipulated as per tender is not provided at the site	2.50	3.6	**2**	18.02	**13**
		Deviations, especially in high-rated and high-value items, are not properly monitored and verified	1.65	3.56	**3**	17.6	**15**
		Substitution of materials with inferior quality/ defective or different specifications	1.76	3.97	**3**	21.04	**8**
		Poor supervision by site personnel	2.27	3.97	**3**	27.04	**1**
		Sub-contractors are engaged in a non-transparent way	2.21	3.5	**3**	23.22	**4**
		Extension of Time (EOT) is not granted on due verification of hindrances	1.83	3.35	**2**	12.28	**27**
	Payments	Late payment of invoices	2.1	3.1	**2**	12.98	**25**
		Escalation clause is not applied correctly for admissible payment	1.59	3.0	**2**	9.54	**29**
		Recoveries for land rent or equipment given to contractor are not made	1.62	2.90	**2**	9.41	**30**
		Non-levy of penalties for violation of contract conditions	1.94	3.43	**3**	20.04	**10**
		Non-levy of liquidated damages for failure to meet timelines	1.72	3.38	**3**		**17**

CONCLUSION

Corruption in public construction is toxic and dysfunctional. Surprisingly, given its enormity, construction management research has not given it the deserved focus, especially in the Indian context. In practice, anti-corruption efforts in public projects have been mostly reactive and punitive. This research attempts

to set the stage for a risk management approach embracing integrity risks in construction projects. Qualitative methods are used to identify the corruption vulnerabilities and prepare a comprehensive inventory of stage-wise integrity risks. Quantitative assessment of these is done through a Delphi survey with a panel of top anti-corruption officers across major public organizations of India, followed by evaluation by practitioners in 12 large organizations.

This study captures the ground realities by involving position leaders and practitioners of public construction management. Despite the recent thrust on procurement reforms, as many as 20 critical risks were identified with an impact higher than 30, mainly in the pre and post- bidding stages. This underscores the need for a holistic strategy that looks beyond the tendering stage and addresses corruption across the entire project cycle. Transparency and technology emerge as the vital strategic interventions for the pre-bidding and post-bidding phases, with high ethical standards as the over-arching requirement. The integrity risk assessment presented here can be used as a standalone for risk management. It may also be integrated with data analytics for more rigorous integrity management in construction projects. Future studies can build on this foundation of integrity risk assessment for exploring stage-wise mitigation measures and their contribution to the integrity climate of an organization.

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NEW CONSTRUCTION TECHNOLOGY- 3D MODULAR PRECAST

Sh. Siddharth Sharma, M/s Megicrete

ABOUT TECHNOLOGY

An already established System for building construction in Europe, Singapore, Japan & Australia, 3D Modular Precast is the modern method of building in which solid precast concretestructural modules such as rooms, toilets, kitchens,bathrooms, stairs, etc., and any combination of these elements are cast monolithically in a controlled condition within a plant or casting yard.These modules, known as Magic Pods, are then transported, erected, and installed using cranes and push-pull jacks, and they are integrated together to form a complete building unit. Depending on the hoisting capacity, buildings of any height can be constructed using thistechnology.

MANUFACTURING PROCESS OF THE BUILDING MODULES/MAGICPODS

- High-strength steel, according to the structural design, is placed inside the 3D moulds.
- Electrical and plumbing lines are installed, and blockouts for doors and windows are also set up simultaneously.
- The pods are cast into their final shape using high-performance concrete. Stringent quality checks are conducted for each pod before they arepacked for shipping, ensuring that the construction project adheres to strict quality standards.
- The pods are then loaded and shipped, Taking care to follow the sequence of erection at the site.

CONSTRUCTION & INSTALLATION PROCESS

The sequential construction process for the projectbegins by preparing the designed foundation of the building while the manufacturing of precast concrete structural modules takes place at the factory. The factory-finished buildingunits/modules are then installed at the site using tower cranes. Gable end walls are positioned to terminate the sides of the building. Pre-stressed slabs are subsequently installed as flooring elements. Finally, rebar mesh is placed for the structural screed, connecting all the elements together. Consecutive floors are built in a similar manner to complete the structure.

ABOUT LHP RANCHI

7 Towers | 5.11 lac sft built up | 1008 Apartments | 30sqm carpet

Casting Line

MAGICRETE PRECAST
shaping your concrete

Installation

MAGICRETE PRECAST
shaping your concrete

NEW TECHNOLOGY: PRE-ENGINEERED BUILDINGS-ARRIVAL OF FUTURE

Sh. Akhelesh Kumar, Executive Director, Sam India Infrastructure LLP.

India is a fastest growing country. Therefore, the growth of Infrastructure needs to be maintained at its best and above the average pace of the competitive countries. For it, we need "New Technologies" to employ as the conventional ways of construction can not meet the rising expectations of the nation. This presentation will take you through two aspects, namely ;

1. Fastest Technology to build- Pre-Engineered Buildings
2. Increased Life cycle of these buildings

INTRODUCTION

- The concept of precast structures also known as prefabricated/ modular structures.
- The structural components are standardized and produced in plants in a location away from the building site.
- Then transported to the site for assembly
- The components are manufactured by industrial methods based on mass production in order to build a large number of building in a short time at low cost.
- Within some geographic industry sectors these buildings are also called Pre-Engineered Metal Buildings (PEMB)

WHY PRE-ENGINEERED BUILDING

Pre-engineered buildings becomes an obvious choice, because :

- Since we are a fast growing economy and facing shortage of skilled and semi-skilled labor near construction sites to complete the buildings in a specific time period.
- Pre-engineered buildings can be constructed at a rapid pace, most of the work can be done in the factory, While foundation is constructed at site.
- In India market of PEB is experiencing robust growth fueled by infrastructure development and increasing popularity in the industrial and commercial sectors.
- Under this government, the focus is on the infrastructure, speedy progress of the metro rail system and increasing emphasis on green building construction seems to be adding to the growth of PEBs.
- The use of new technology and endurance of the buildings, has now become a widely accepted phenomenon with proven benefits in the long run, in Indian environment.

HISTORY OF PRE-ENGINEERED BUILDINGS

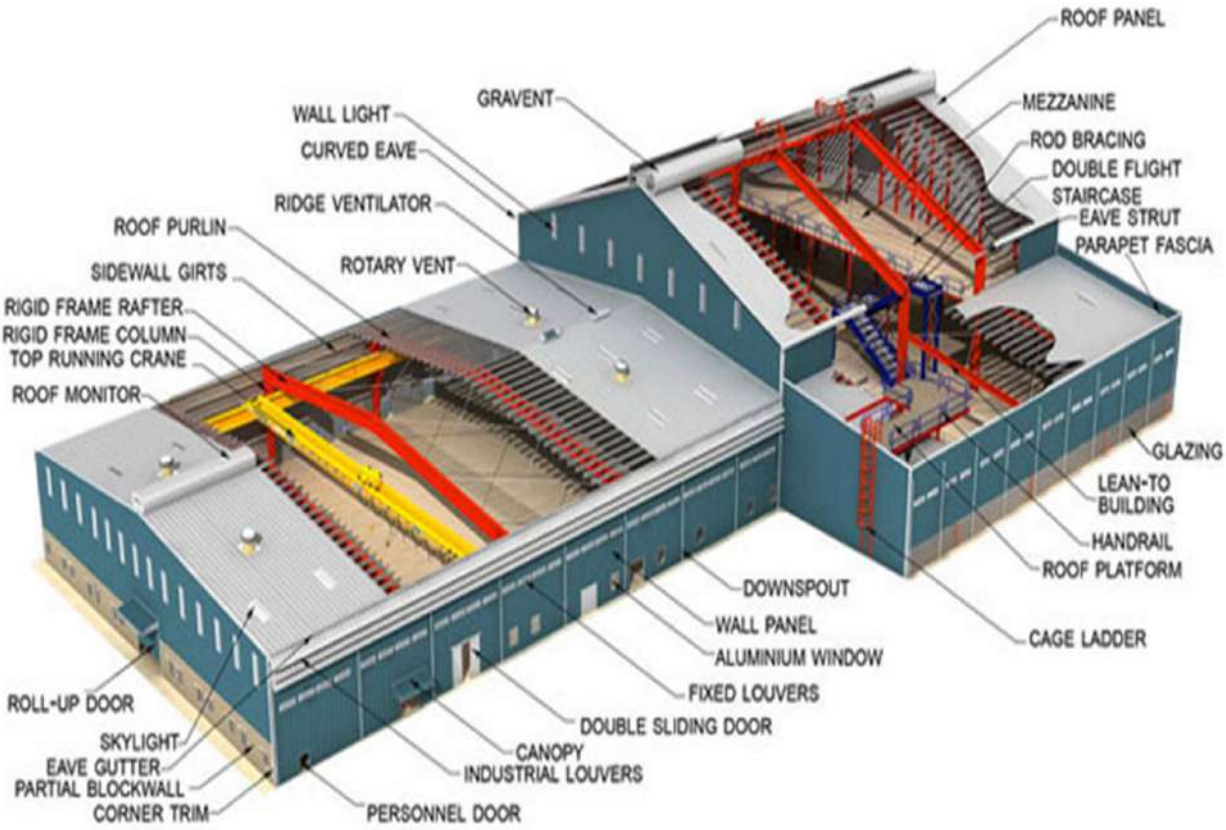
- During World War II, a need arose for structures such as barracks and maintenance facilities that could be containerized and shipped-ready to erect.
- During the 1960's, standardized engineering designs for buildings were first marketed as PEB's.
- Buildings during this time were still pre-fabricated as the market place adapted to the limited set sizes that were available.
- This configuration continued from 1950s into the mid-1980s. The advent of the computer to analyze and design structural members quickly has ultimately led to make-to-order process that exists today.
- Today, the metal building industry boasts a capability of producing buildings for virtually any low rise to high rise, non-residential as well as residential use.

Key features

- The assembly of building or their components at a location other than the building site.
- The method controls construction costs economizing on time, wages and material.
- Plant casting allows increased efficiency, high quality control and greater control on finishes.
- Prefabricated units may include doors, stairs, window wall etc.
- The speed of construction is increases since no curing period is necessary

Special Features

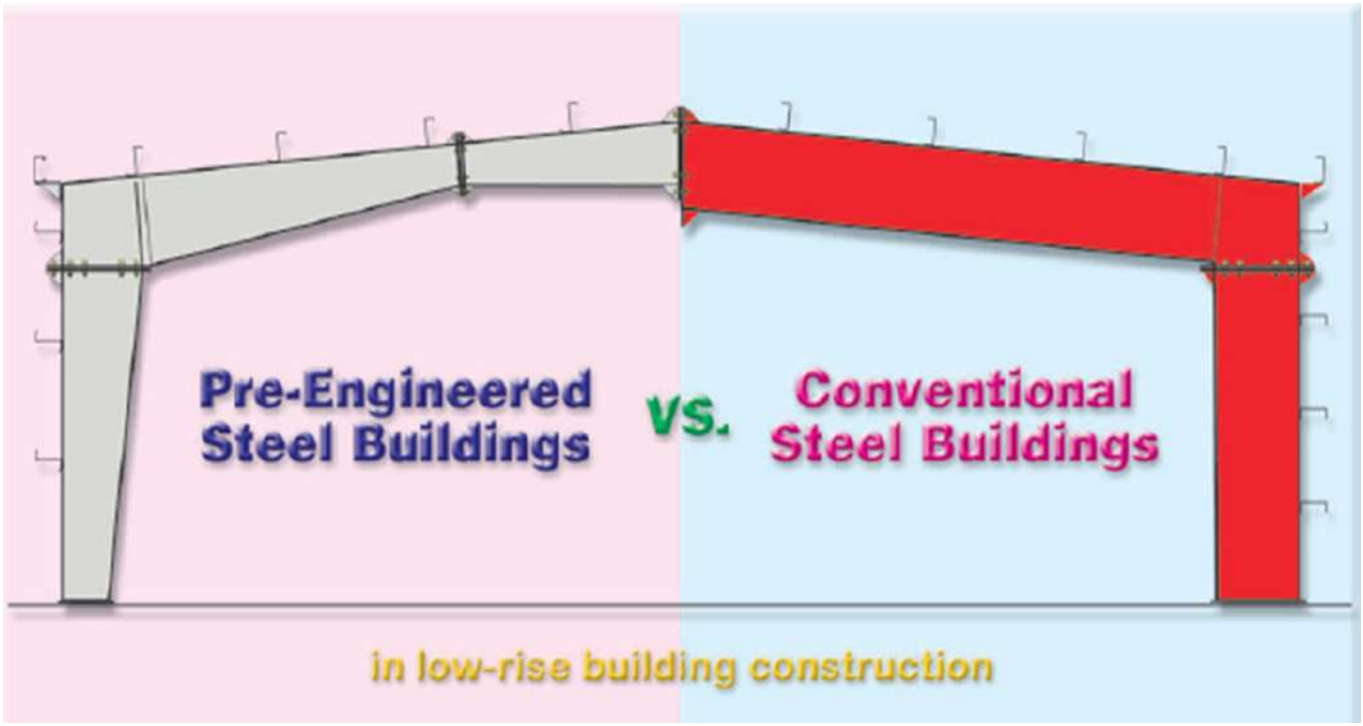
- Cheaper if Overall Cost to owner is considered, due to its residual value.
- PEBs are easier if future expansion is required, as the structural augmentation is possible
- The Life Cycle of steel buildings can be considered appx. 150-200 yrs., if foundation is made with enhanced life cycle.
- Structure weight is lighter than conventional buildings.
- Delivery is faster, can be manufactured at multiple locations.
- Buildings can be de-constructed and erected at some other place
- Good Residual value can be fetched even after using it for full of its life.



FOUNDATION

- For full value of the building, Long lasting foundation needed
- It is possible to use Pre-cast RCC foundation if building is symmetrical and big in size
- Precision in foundation work to be employed to avoid any delay due to mis-match

A Comparison



Property	PEB Building	Conventional Steel building
Structure weight	Pre Engineering building are on the average 30% lighter because of the efficient use of steel. Primary framing members are tapered built up section with the large depth in areas of higher stress	primary members are selected hot Rolled T section which are in many segment of the members heavier than that what is actual required by design ? members have constant cross-section regardless of the varying magnitude of the local stress along the member length
Design	Quick and efficient scenes PEB are mainly formed by standard section connection design, time is significantly reduced	Each conventional steel structure is design from scratch with fever design aids is available to the engineers
	Design shop detail sketches and erection drawings are supplied free of cost.	extension amount of consultant time is devoted to the alteration that have to be done
Delivery	Average 6 to 8 weeks	average 20 to 26 weeks
Foundations	simple design easy to construct and light	Extensive heavy foundation required
erection Simplicity	Since the connection of a compound is standard the learning curve of of erection For each subsequent project is faster	The connection or not normally complicated and differ from project to resulting in increase the time for erection of the building
erection cost and time	both cost and time of erection are accurately known based upon extensive experience with similar building	Typically , conventional Steel building are 20% more expensive than PEB in most of the cases erection cost and time are not estimated accurately

Advantage

- PEB is constructed using metal frames and structural components that need to be merely assembled together.
- Pre-engineered metal buildings are created using computerized designs. The process is faster and better.
- PEB structures are ideal for zones prone to tremor as they weigh lesser than all ordinary buildings or conventional metal buildings.
- As buildings are manufactured completely in the factory under controlled conditions, the quality is assured.
- As the complete building package is supplied by a single vendor compatibility of all the building components and accessories is assured.
- Based on the commercial requirements, the pre-engineered steel buildings can be expanded at low costs.
- Pre-engineered steel buildings cost lesser as their structural frames are built in large numbers whereas the components of the conventional building are developed for specific requirements and cost higher.
- Since all the connections of the different components are standard, the erection time is faster.

- Buildings can be easily expanded in length by adding additional bays. Also, expansion in width and height is possible by pre-designing for future expansion

Limitation

- Susceptible to Corrosion, If not properly maintained
- Low Thermal Resistivity, Steel is a metal, hence is a good at conductor of heat. Insulation needed for thermal comfort.
- Extra Fire Safety needed, this type of buildings becomes more susceptible to damage in fire due its conductivity.

Application of PEBs

- Industrial: Factories, workshop, Warehouse, Cold store, car parking sheds, Slaughter houses.
- Commercial: showrooms, distribution Centres, supermarket. Fast food Courts, Office buildings.
- Institutional: Schools, Hospital, Sports hall, Exhibition Halls.
- Agricultural: Poultry building Dairy Farms, Green houses, Grain storage
- Recreational: Gymnasiums, swimming pool, Indoor tennis courts.
- Aviation and Military: Aircraft hangers, Administration Buildings, Residential Barracks.

Probably, Future PE Buildings

CONCLUSION

- India is already a fastest growing market in the PEB construction segment at 9.5 % quite ahead of China with a growth rate of 8.5 %
- If the industry of Pre-Engineered steel buildings continues to grow at the current 33 % growth rate in India, then in a short span of 7-8 years India will be among the top 10 countries supplying steel in the world.

CONSTRUCTION CHEMICALS FOR COOL ROOF SYSTEMS

Sh. Harsha Kavi, Smt. Kanchan Vats,
M/s Fosroc Chemicals (India) Pvt. Ltd.

The infrastructure development has pickup its phase at urban areas. Lot of residential and commercial buildings constructions are phase up due to the this.

Energy demand is growing significantly worldwide to create thermal comfort in buildings. Air-conditioning is contributing to energy consumption at a massive scale in the residential and commercial sectors. The roof is one of the most critical components of the building envelopes, and it achieved maximum heat gain in summer, and it covered nearly 20–25% of overall urban surface areas.

In this respect, **cool roofs** are considered one of the sustainable solutions to maintain thermal comfort in buildings.

The cool roof systems reduced energy use in the buildings and a useful tool to mitigate Urban Heat Island (UHI) effect.

As the urban space getting scarce, it is inevitable that constructed spaces will go vertical, resulting in construction of high-rise structures.

Due to this heat transfer for inside the building will be faster will lead to Urban heat island.

This effect increases energy costs (e.g., for air conditioning), air pollution levels, and heat-related illness and mortality.

We need to mitigate this issue by using insulation system for the exposed roof areas.

- Landscape above the roof, roof guarding
- Insulation system to maintain proper U value inside the building
- Heat reflective coatings

PROPERTY OF WATERPROOFING MATERIAL

Any waterproofing material should have following properties-

- Bonded System
- Puncture resistance
- Tensile strength
- Crack bridging ability
- Elongation

- ❖ Bond strength with the concrete
- ❖ Water vapor permeability

Most of the cases, elongation property will be mis lead the over all concept of waterproofing.

There is a wide misconception regarding the elongation properties of waterproof membranes and their ability to bridge cracks that form post membrane application. This article endeavors to clarify the real meaning of elongation and elasticity in relation to bridging properties.

FLEXIBILITY & ELASTICITY

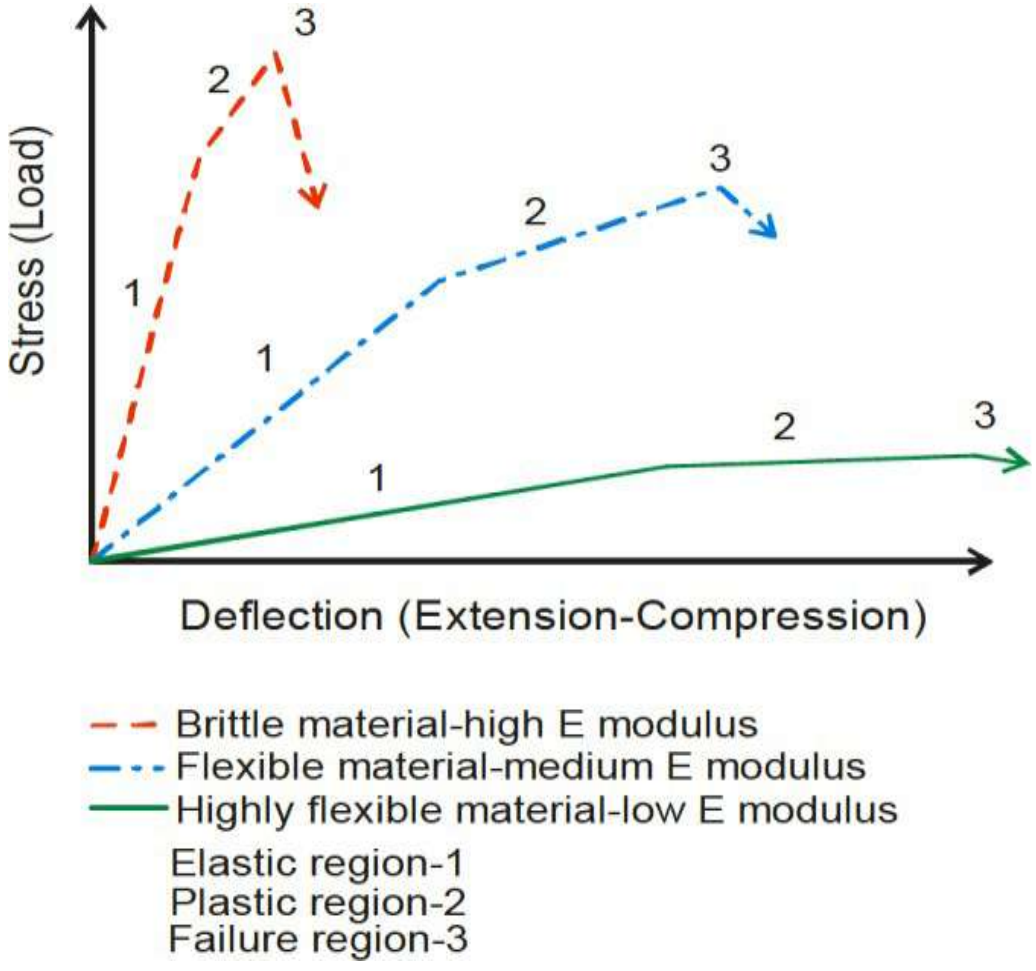
With membranes there are some important terms which control their properties. The terms include Elasticity, Elastic limit, Plasticity and Ultimate failure.

Elasticity - the ability of an object or material to resume its normal shape after being stretched or compressed, stretchiness. The E-modulus is defined as how much a sample deforms (strain) under a set of amounts of stress. An elastic material has a low E modulus, while a brittle material has a high E-modulus.

Elastic limit – is the maximum stress or force per unit area within a solid material that can arise before the onset of permanent deformation. The material always returns back to its original shape, deformation is reversible. Applied stresses beyond the elastic limit cause a material to yield or flow.

Plastic - Plasticity describes the deformation of a (solid) material undergoing nonreversible changes of shape in response to applied forces. The material will no longer return to it's original shape, and permanent deformation has occurred.

Ultimate failure - describes the breaking of a material at maximum applied stress.



The properties described are shown above. A high elongation Class III membrane would behave as the lowest graph (highly flexible), whilst a rigid epoxy Class I membrane would behave as the brittle material in the red dotted line.

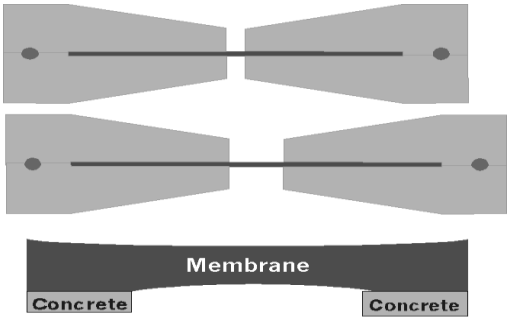
When a liquid membrane is applied to a concrete surface it is fully bonded to the substrate surface. Because of the elasticity and flexibility, the membrane has the ability to cope with broad span movements such as thermal expansion / contraction of the substrate as well as lateral flexing frequently experienced in construction projects. However, it needs to be recognized that the membrane is constrained on the side in contact with the rigid surface and this effectively alters the properties downward from the proof testing values.

It also needs to be that inclusion of a reinforcement matting material within the membrane causes a tradeoff between the reduced elongation, against an increase in tear resistance under increased stress. This is in part because to the matting properties, but also a consequence of the membrane being thicker, and therefore having more material to yield.

Within a structure there are two basic types of movement underlying an installed membrane and these are principally handled by two different mechanisms within the membrane coating. Free movement involves extensibility and deformability where the membrane is not restricted by being bonded to a rigid area of substrate, such unconstrained areas are over a bond breaker or bridging existing cracks. Restricted movement involves extensibility where the membrane is restricted by being fully bonded to the substrate.

The membrane's flexibility also allows it to cope with movement of cracks existing prior to the application of the membrane and the ability to cope with significant movement can be built into the application, by properly treating the crack with a bond breaker that extends the gap, where the membrane remains un-bonded to the substrate.

A membrane's elasticity or elastic modulus allows it to cope with small cracks such as hairline cracks that form as a result of plastic shrinkage of the concrete. It should be noted that when hairline cracks form after the application of the membrane, the membrane copes by necking or reducing its film thickness over the crack. As the crack gets larger the membrane gets thinner to a stage where it becomes ineffective as a waterproof membrane and eventually shears or tears to break completely across the crack.



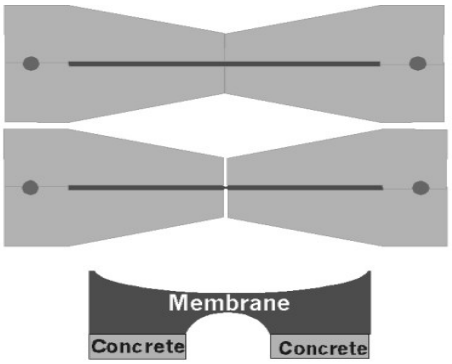
Enlarged section of membrane across developed crack showing minor necking of the membrane

Membrane 200% elongation
Original crack gap 2mm
Elongation across crack =
original gap + 200% x 2mm = 6mm
Minor Necking of Membrane

When the un-bonded gap at the membrane installation is 2mm, a membrane with 200% elongation will extend to 6 mm, should this degree of movement occur (2 x 200% = 4mm and 2+4=6mm).

There will be minor necking of the membrane across the gap as the membrane is stretched and the membrane may lose some waterproofing efficiency, however as the gap reduces again the membrane will recover because it has not exceeded it elastic limit.

In this example once the gap movement extends beyond the limits of the 200% elongation, the membrane will enter the plastic area and if the joint moves back again, will not go back to shape, and be compromised.



Enlarged section of membrane across developed crack showing severe necking of the membrane

Membrane 200% elongation
Original crack gap 0mm
Elongation across crack =
origininal gap + 200% x 0mm = 0mm

Cracks that form in concrete following application of the membrane, obviously have no membrane distance that is not bonded to the substrate.

In other words, there is no bond breaker to provide a section of unrestrained membrane.

The original gap is non-existent or 0 mm and regardless of the elongation properties of the membrane post application, cracks will result in damage to the membrane.

At 200% elongation – 200% of 0 mm is 0 mm.
At 500% elongation – 500% of 0mm is 0 mm.

(Though in truth, there will be a very small amount of movement before failure because the membrane does not have zero thickness).

ELONGATION AND ELASTICITY

When post application cracking occurs, the membrane will extend but the result will be serious necking of the membrane across the newly formed gap. This will seriously impair the properties of the membrane and the membrane will tear with small movements.

Post membrane application cracks are only accommodated by the elastic modulus of the membrane. In accommodating this crack the membrane reduces film thickness and the extent to which it will stretch without becoming ineffective as a waterproof membrane is limited.

FLEXIBILITY

The same applies where the surfaces move out of plain rather than simply extend. Where there is zero clearance the membrane stretches with the movement, necks and then fails.

Hairline cracking resulting from plastic shrinkage of the concrete can be accommodated, however more extensive cracking, such as structural building movement, will result in membrane fracture regardless of the elongation properties of the membrane.

Our Recommendations for cool roof system:

1. Roof Insulation - Fosroc Nitofoam 45
2. Heat Reflective Coating - Fosroc Nitoproof 725
   (Typical Roof System for energy efficient building is given on next page).

Item Description

Typical System Built up for Terrace Waterproofing

1 Terrace Waterproofing using hybrid Polyurea/polyurethane WH 200 coating with min. 25years service life

Providing and carry out waterproofing treatment to Terrace slab areas using environment friendly, zero VOC **Polyurea WH200**-Spray applied, 100 % solids, Fast Setting, hybrid Polyurea/polyurethane elastomeric waterproof coating having service life of minimum **25 years as per B.4.2.2 of BS EN 13251:2016 and BS EN 13252:2016** which becomes **tack free in 15 seconds & walkable in 10 mis**.

System includes concrete surface mechanical grinding to ensure a good bond between the coating and the substrate, proper surface preparation to remove loose dust, dirt, loose mortar, curing compound etc., carry out cementitious injection grouting at leakage points and construction joints using cement slurry modified with Cebex 100-Plasticised expansive grout admixture supplied in 225 gm pouch, application of polymer modified mortar for vatta at floor-wall junction & filling Construction joints, filling of annular space around rain water outlet using Conbextra GP2 - Non-shrink cementitious grout.

Further laying **Polyurea WH 200** waterproofing coating over prepared surface by applying primer **Nitoprime 31 –Epoxy** penetrating primer coverage @ 0.25 kg/m2, allow the primer to become touch dry, followed by application of **Fosroc Polyurea WH 200 @ 1.5 mm** thickness coverage @ 1.5 ltr/m2 must be applied utilizing plural heated high-pressure spray proportioning machine/spray gun such as those manufactured by WIVA/Graco spray proportioning equipment. Polyurea WH200 should be applied to achieve the required thickness of 1.5 mm over horizontal as well as vertical surfaces and terminated at a height of 300mm above FFL. The proportioning equipment utilized must be capable of supplying correct pressure and heat for the appropriate hose length on a consistent basis. **Polyurea WH200 exhibiting the following properties**.*Solids by Volume : 100%, Tensile strength ASTM D412 : >13 MPa, Tear Resistance ASTM D624C : 50 N/mm2, Shore D Hardness (ASTM D2240): 80, Elongation ASTM D412 : >450%, Abrasion (1kg,CS17 wheels) DIN EN ISO 5470 :19 mg /1000 cycles, Abrasion(1kg, CS 10 wheels,ASTM D 4060): 1.3 mg/1000 cycles,Abrasion(1kg, H22 wheels,ASTM D 4060): 117 mg/1000 cycles, Service temperature: -20^{0}C to +80^{0}C,Resistant to Fire (EN13501-1)-Class E, Moisture Vapour Transmission rate- ASTM E96*

2 PUF Insulation using NitoFoam 45

Providing and applying 50mm thick two component,HFC blown, free from CFC/HCFC polyurethane based sprayable rigid foam system, closed-cell type complying to IS 12432-3 (2002): Application of Spray Applied Insulation - Code of Practice, Part 3: Polyurethane/Polyisocyanurate [CHD 27: Thermal Insulation] & Type-1 foam as per Table-1 of ASTM D 7425. **NitoFoam 45** PUF hall be applied seamless in-situ over **Polyurea WH 200** coating using a plural-component proportioner with air purge or mechanical purge spray gun, ensure that **Fosroc Nitofoam 45** is applied evenly resulting in a smooth finish with no ridges with maximum thickness of PUF per layer is 25mm. **NitoFoam 45 should exhibit following properties**: *Compressive strength,ASTM D- 1621,kPa> 400, Elongation break 500-700%, Fire resistance; Class B2 fire rating, Tensile strength,ASTM D1623, kPa:>500, Adhesion to substrate,ASTM D4541, kPa:> 180, Thermal conductivity at 25Deg C as per ASTM C518, W/m K:≤ 0.023, Closed cell content,ASTM D2126/D2856 %:> 97, Water absorption,ASTM C272, %:< 1, Water Vapour Transmission,(ASTM C518/ ASTM E96), perm-inch, 0.92, Flash Points, ºC: Part A ISO > 200, Part B POLYOL > 65, Foam Density, kg/m3 ASTM D1622: 45 to 50, Gel Time approx. 13 seconds, Specific Gravity at 20°C 1.23.*

3 Sealer Coat over PUF insulation using single component pitch free PU coating

Providing and carry out sealer coat over **PUF** insulation using **Nitoproof 600PF**- Liquid applied single component pitch free polyurethane coating capable of bridging substrate cracks up to 2 mm which supplied in 25 kg drum. **Nitoproof 600PF** to be applied in two coats coverage @ 2.0 kg/m2 to achieve 1.5 mm thickness followed by laying of separation layer of 250 gsm non-woven geotextile layer before carry out protection screed etc. complete including all tools and tackles as per manufacturer's specification. **Nitocote 600PF** cured material shall be having *crack bridging of 2 mm, Elongation (ASTMD 412) – 400 %, Tensile Strength (ASTM D412) – 2.5 N/mm2, Recovery from Elongation (ASTM D412) – 95 %, 85% Solid Content, Tear Resistance (ASTM D624) – 15 Kn/m, Shore A Hardness (ASTM D2240) – 60, Water vapour transmission-*
0.6 g/m2/hr, Water Permeability @ 5 Bar (BS EN 12390)-Nil, Service Temperature – -40°C to 70°C, Flash Point > 70 °C, Viscosity-60p, Specific Gravity-1.4

Typical System Built up for Cool Roof

4 Protection Screed

Providing and laying PCC of M20 grade(min 75 mm thick finishing at the drain pipe)mixed with integral water proofing compound Conplast WL, including making control joints 3m x 3m Square,while the concrete is green & fill up with sealant Nitoseal PU50 later when the curing period of the concrete is completed, making angle fillet of 50mmX50mm using M20 grade concrete at the corners.

5 Heat Reflective Coating

Providing & applying one-component, cold applied water based, flexible protective & waterproofing coating **Fosroc Nitoproof 725** based on modified polyurethane hybrid technology & Class A fire rated as per ASTM E108. **Nitoproof 725** waterproofing coating shall be UV resistant colour stable with Solar Reflectance Index of **106 as per ASTM E1980.** Prior to applying **Fosroc Nitoproof 725** coating, surface shall be cleaned of any debris/ dust/latiance etc, any undulations shall be properly repaired using **Fosroc Nitomortar FC / FCB**. **Nitoproof 725** coating shall be applied using brush/roller/spray- **Keiser KP330 and KP230 or the Graco Mark V** over entire horizontal as well as vertical primed surface at a DFT of min. 0.8mm coverage @1.3Ltr/sqm. Primer shall be prepared by dilution in 1:1 by volume **Nitoproof 725** / clean water mixture & applied over preapred dry surface. Ensure primer to be dry to a tacky state before applying waterproofing coating as per manufacturers recommendations. **Nitoproof 725** shall exhibit following properties: *Tensile strength ASTM D412 : 1.75MPa, Elongation, ASTM D412 : >350%, Hardness, ASTM D2240 : 75 Shore A, Tear strength, ASTM D624 : 13N/mm, Adhesion to substrate ASTM D4541 / D7234: 1.9MPa concrete, Crack bridging, static/dynamic ASTM C836 : 2mm, UV resistance/colour stability 2000 hrs qUVA, ASTM D4587 : Pass, Resistance to water pressure: 10m, Water vapour transmission rate ASTM E96, 32Deg C/50%RH : 3.1g/m2/day (47.8gr/m2/day), Resistance to Fire : ASTM E108 Class A, Resistance to dynamic indentation ETAG 005 Part 1 : Pass, P3 at +90DegC, Resistance to mould growth ASTM D3273 : Pass, rating 10, Resistance to roots CEN/TS 14416 : Pass, Solar Reflectance Index ASTM E1980, White : 106, LEED compliance (v4.1 Heat island reduction SRI) : Pass, LEED EQc4.2 : Pass (VOC), BAAQMD Reg 8 Rule 3 : Pass (VOC)*

FIRE DOORS AND DOORSET SPECIFICATION AS PER IS 3614

Sh. Mahesh Kumar Singh, M/s Skakti Horman Pvt. Ltd.

GENERAL NOTE ON FIRE DOOR

Fire compartment is key to restricting the spread of fire and it is defined in terms of its fire rating in minutes. Fire doorset is an important component of compartmentation. The entire integrity of the compartment is compromised if the fire door used on the opening is not closing properly or not as per specification. To further the cause of safety in building fire door as a passive fire protection needs to be understood by everyindividual for rational use of fire doors.

As per the latest NBC -2016 all fire compartments shall be minimum 120minutes fire rating. For further information, please refer **(Annexure A)** summarized document on fire rating for various applications.

For any high rise building the fire separation assemblies like fire check doors shall be minimum 120minutes fire rated, refer clause 3.3.1 table 1 of NBC 2016

This paper on fire door will give you complete insight on the concept of fire door, do's and don'ts in selection of fire door. This will help you in evaluating products, checking quality and certification. As perthe national building code and fire door codes, given below parameters and precautions are to be taken bythe engineer in charge while writing the specification or carrying out the inspection of fire doors in any project

1. Definition of fire doors

As per definition, Fire Door means "Any combination of fire door, frame, hardware and other accessories that together provide a specific fire resistant rating to the opening in terms of stability, integrity and insulation properties when installed in the openings in fire separation walls. Fire dooris a component of fire door assembly.

2. Relevant code for fire doors

a. IS 3614: 2021 (Fire doors and doorset specification) – **Product standard Code**

b. IS 17518 Part1: 2022 (Fire resistance tests Door and shutter assemblies Part1) -**Testing Standard**

3. Types of fire doors

Fire doors shall be of two types

3.1 insulated fire door with 120minutes integrity and 30minutes insulation.

3.2 Un-insulated fire door with 120minutes integrity only.

4. Application

a. Insulated fire doors – for all exit staircase, exit pathway and refuge area (Ref: NBC2016 –Sec 2.22)

b. Un-insulated fire door – All other utility areas and non-egress shafts

5. Insulated fire door

5.1 Insulated fire doors shall have integrity of minimum 120minutes and 30minutes insulation. These doors tend to limit the spread of heat on the un-exposed side for the first 30minutes of fire, helping easy escape.

5.2 Insulated fire doors shall have intumescent seal on three sides of the shutter.

5.3 Minimum sheet thickness shall be 1.2mm for both frame and shutter. The material shall be galvanized steel with minimum 120gsm zinc coating as per IS277. MTC of the material bought tobe checked for manufacturing fire door. Use of CRCA or MS is not recommended, as the durabilitylife expectancy gets reduced due to various environmental conditions.

5.4 Material sheet thickness can be checked randomly for every lot of material supplied at site using Vernier. Paint needs to be removed in one corner of the frame or bottom of the shutter beforechecking the sheet thickness.

5.5 Vision panel –

a. The maximum size of the glass supplied on insulated fire door shall not be more than 0.06sq.mt.

b. Glass supplied shall be clear fire rated glass of minimum thickness 5mm. the glass shallremain clear for the entire duration of fire.

c. Wired, laminated or gel insulated glass shall not be used on fire doors.

5.6 Since the fire doors are performance oriented and mostly proprietary, it is important to give special attention to the infill material used inside the door. The minimum density of infill materialshall be 120kg/m3 and the shutter thickness shall be minimum 60mm.

5.7 Insist on checking the weight of the fire door against the tested door, this will give insight about any major deviations against the tested product and the supplies made.

6. Un-insulated fire door

6.1 Un-insulated fire doors shall have integrity of minimum 120minutes.

6.2 Minimum sheet thickness shall be 1.2mm for both frame and shutter. The material shall be galvanized steel with minimum 120gsm zinc coating as per IS277. MTC of the material bought tobe checked for manufacturing fire door. Use of CRCA or MS is not recommended, as the durabilitylife expectancy gets reduced due to various environmental conditions.

6.3 Material sheet thickness can be checked randomly for every lot of material supplied at site using Vernier. Paint needs to be removed in one corner of the frame or bottom of the shutter beforechecking the sheet thickness.

6.4 Vision panel –

a. The maximum size of the glass supplied on insulated fire door shall not be more than 0.12sq.mt.

b. Glass supplied shall be clear fire rated glass of minimum thickness 5mm. the glass shallremain clear for the entire duration of fire.

c. Wired, laminated or gel insulated glass shall not be used on fire doors.

6.5 Since the fire doors are performance oriented and mostly proprietary, it is important to give special attention to the infill material used inside the door. For un-insulated door industry practiceis to use honeycomb core with a minimum shutter thickness of 46mm.

6.6 Insist on checking the weight of the fire door against the tested door, this will give insight about any major deviations against the tested product and the supplies made.

7. Smoke seal vs. Intumescent seal

All fire door frames shall have mandatory fire rated smoke seal either inbuilt in the frame or face fixed using adhesive. This is applicable for both insulated and un-insulated fire doors including shaft doors.

a. Smoke seal stops the spread of smoke and works from the very first minute of fire accident.It is independent of the intumescent seal.

b. Intumescent seal is used to seal the gaps created between the frame and shutter, mostly in the case of wood based fire doors. Wood has the tendency to shrink when gets heated and may create larger gaps than recommended between frame and shutter, to seal this gaps intumescent seal is used. Intumescent seal works with higher temperature on the door as it has to melt and foam up. Intumescent seal is not a substitute or alternative for smoke seal.

8. Hardware for fire doors

8.1 All hardware used on fire doors shall be of similar fire rating. Test certificates of the individual hardware shall be submitted along with door test report / certificate, if the hardware is not partof the original specimen tested.

(Note- Any deviation on the fire rating of the hardware like locks, door closers, panic devices shall make the suppliedfire door invalid.)

8.2 Hardware like hinges of minimum size 100mmx 75mm x 3mm in stainless steel, pull handles may not require any test certificate. Refer 7.2.9 builder's hardware of IS3614: 2021

8.3 All fire doors should be self-closing except non egress doors like shafts.

8.4 All fire doors shall be self-latching (see latched and unlatched door), unless tested in un-latched condition

8.5 Fire doors on exits shall have panic device single point on a single leaf door and a combination of single point (active leaf) and two point (inactive leaf) in case of double leaf door

8.6 Door coordinator should be provided for double doors on fire exit doors to sequence the closingof inactive leaf followed by the active leaf.

8.7 Double doors shall have flush bolts on inactive leaf both top and bottom, not applicable for doors with panic bar.

8.8 Door closer are available in various spring sizes. It starts from spring size 2 to 7. Some are specific size like size 3 and some are variable like size 2-4 (which means can suit door weight and width from 750mm door width with 20kg to 1100mm door width with weight upto 80kgs)Selection chart for spring size is detailed below as for fire doors – door closer is one of the keycomponent as it has to be functional and should be able to close and latch the door, so that thereare no visible gaps. Chart for reference

Spring size	Max. door width	Weight of door
1	<750mm	20kgs
2	850mm	40kgs
3	950mm	60kgs
4	1100mm	80kgs
5	1250mm	100kgs
6	1400mm	120kgs
7	1600mm	160kgs

8.9 For insulated fire doors intumescent seal to be provided on three sides of the door leaf

9. Latched & Un-latched fire door

It is important to note that most of the doors are tested in latched condition, which means the latch which is operated by lever handle is engaged inside the strike plate of the frame. However, in projectsmost of the doors supplied are with deadbolt and pull handle (also referred as unlatched door). This isfor ease of operation.

Technically doors should be tested both in latched and un-latched condition to meet the project requirement. If the door is tested in latched condition, it should be seen that all doors supplied are withlatch and lever handle. If the door is tested in unlatched condition, i.e, with dead bolt and pull handle then the manufacturer can supply both latched and unlatched doors. The test report should qualify the test as latched or unlatched.

In unlatched doors (with dead bolt and pull handle) there is no positive latching and the door may throwopen because of the wind or air pressure. These types of doors require a higher spring strength of doorcloser to withstand the opposite pressure.

Make sure the door closer spring size is in line with the above chart.

10. Field of direct application

The door assembly cannot exceed the size it was originally tested and documented in the test certificate.However, if the test results are 20% higher than the intended test duration of 120minutes the followingshall apply only for un-insulated doors.

+15% in height or

+15% in width or

+20% in area

11. Special Conditions

Special care shall be taken in selection of right fire door and hardware for high risk building, like, hospitals as the mobility of the occupants will be very poor. Even the non-fire rated doors are recommended to have smoke seal to stop the spread of smoke.

All fire doors shall be self-closing and the door should be kept in closed condition. However, in reality it necessitates to keep the fire door open due to movement of people, wheel chair or stretcher. NBC andIS 3614: 2021 illustrates the use of such door closer with electro-magnetic hold open devices, or independent electro-magnetic hold open devices. These devices release the door in case of fire and thedoor closer will help in closing the door.

Swing door operators with sensors can also be an alternative solution for fire doors in such application.

12. Testing and Validity of reports

Fire doors shall be tested as per IS 17518 (Part 1): 2022 Manufacturer test report or certificate for bothfire door and hardware shall be **valid for five years from the date of issue** as outlined in IS 3614: 2021. Detailed test report should be submitted as part of the approval process before the order is processed. It is not required to test doors for specific projects if the material supplied is within the validity period of the test report or certificate.

13. Test report and certification

Fire doors and hardware has to be tested as a complete assembly with the right hardware in latched orun-latched condition. The test report shall detail the type of door as insulated or un-insulated fire door.Attention has to be given in making sure the test report submitted is from a

approved lab like CBRI orARAI (labs whose scope of testing includes fire doors). A detailed copy of the test report has to be submitted for verification.

Fire doors and hardware are also available with third party certification from International laboratorieslike warrington, Certifire, Exova, TBW and UL. International laboratories can be UKAS approved (United Kingdom accreditation services)

In India BIS has started licensing program for ISI marked fire doors. ISI marked fire doors should be preferred over non-ISI marked fire door.

Individual hardware test certificate for fire rating are acceptable if they are not tested as part of specimensample of fire door.

14. Content of the test report -

The test report submitted should be detailed copy covering the following information:

a) Name of manufacturer;

b) Type of fire door – insulated or un-insulated

c) A description of the assembly including fixing arrangements of fire door including drawing, exact sizes and components like thickness and the locations of fire door test assembly. The clearance and gaps between doors and frame shall also be fully recorded;

d) Hardware details with model number checked and verified to be in line with the standard

e) Fire Rating of the fire door mentioning insulation and integrity rating for door and glass separately

f) Furnace time/pressure chart and temperature curves actually attained during heating conditions

g) Time/temperature results and

h) Any other information about the performance

15 Labels on fire doors –

Fire doors shall have appropriate metal labels fixed permanently with screws or rivets on to the door leaf with the following information IS3614: 2021 sec 8.3

a. Name of the manufacturer

b. Type of fire door – Insulated or Uninsulated

c. Fire rating classification – ex, 120min

d. Serial number of the door –

e. Year of Manufacture

f. ISI marking if any

g. Testing laboratory and

h. Test report / Certificate number

16. Compliance Certificate –

Manufacturer compliance certificate shall be obtained for all supplies of fire doors in the prescribedformat as given in Annexure C of IS 3614: 2021.

For further information, please refer the standard for fire doors. A copy of the application of fire doorsbased on NBC is attached for your reference (Annexure A)

ACOUSTIC IN BUILDING ESSENTIAL REQUIREMENTS

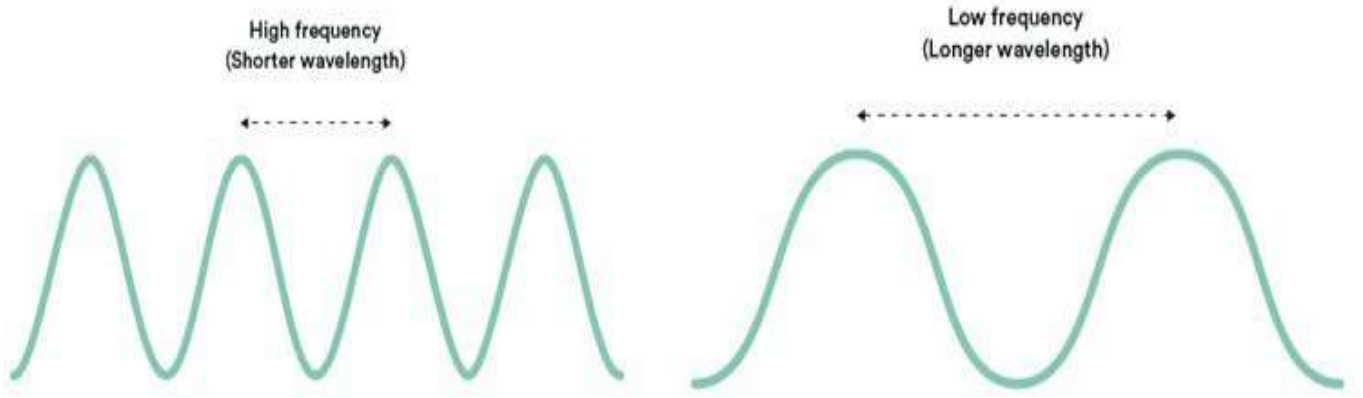
Sh. Mohit Munshi, M/s Koolpack & Allied Industries

WHAT IS SOUND?

Sound is defined as Oscillation in pressure, stress, particle displacement, particle velocity, etc., propagated in a medium with internal forces (e.g., elastic or viscous), or the superposition of such propagated oscillation. Auditory sensation evoked by the oscillation. Sound can be viewed as a wave motion in air or other elastic media. In this case, sound is a stimulus. Sound can also be viewed as an excitation of the hearing mechanism that results in the perception of sound. In this case, sound is a sensation.

FREQUENCY

Sound travels as waves of compressed air. A single wavelength is calculated by measuring the distance between one crest and the next. The wavelength determines the frequency of the sound. A sound frequency, measured in Hertz (Hz) likewise represents the speed at which a sound vibrates. It's this vibrational speed that determines the pitch of the sound. Sound that vibrates quickly has shorter wavelengths and a higher frequency, while sound vibrating more slowly has longer wavelengths and a lower frequency. The generally accepted standard hearing range for humans is 20 to 20,000 Hz, and most human speech occurs at frequencies between 500 and 2000 Hz. Frequencies below 20 Hz are felt rather than heard. Low frequency sounds include bass notes, while high frequency sounds include bells and cymbals.



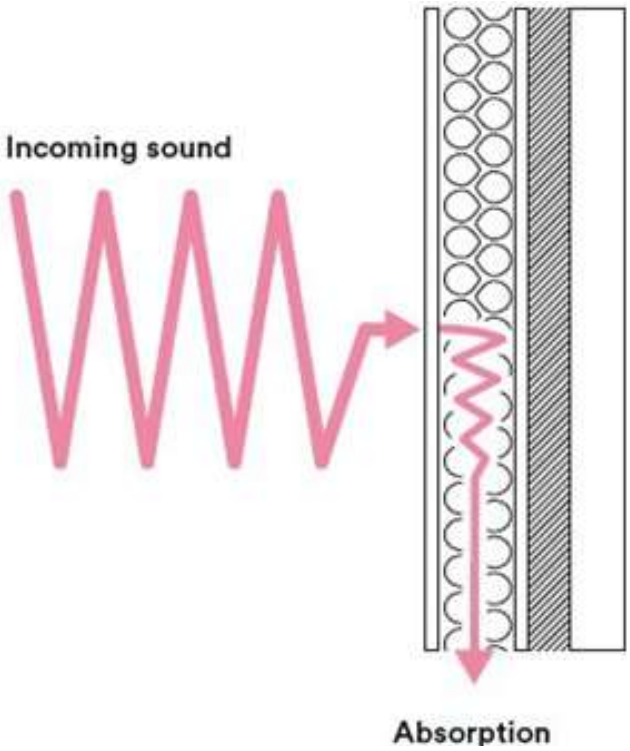
SOUND PRESSURE

The other key aspect of sound is sound pressure. The sound pressure level is commonly measured in decibels (dB),which represent the effective pressure of a sound relative to a reference value. Most human speech occurs at around 60 dB. Regular and prolonged exposure to sounds above 85 Db is considered hazardous to human health and wellbeing. Decibels are expressed on a non-linear logarithmic scale. In other words, making the sound pressure level 10 times higher corresponds to an increase in 10 dB. Do not confuse sound pressure with loudness, which is a subjective measure of sound.

COMMON SOUND WAVE BEHAVIOUR IN INDOOR SPACES

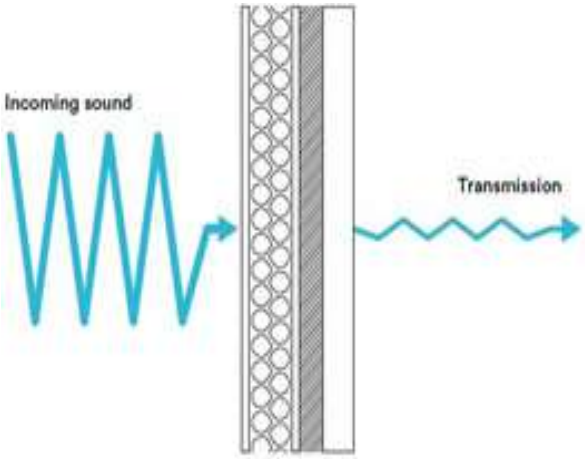
Absorption

Absorption occurs when a sound wave is absorbed by the object or material it encounters. A sound wave that is absorbed transforms into heat energy inside the object or material absorbing it. How much energy gets absorbed or continues to travel onward depends on the thickness and nature of the material. Too little absorption causes sound to reflect.



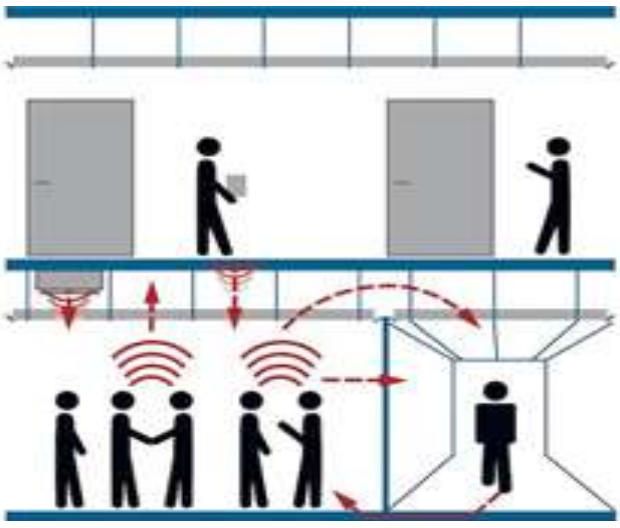
Insulation

Insulation takes place when a sound wave transfers from one material or medium to another, and then continues to travel out through the other side. How much insulation occurs depends on how well the acoustical impedances of the two materials match. Insulation becomes problematic when a sound originating from one room travels through the wall to be heard by the people next door.



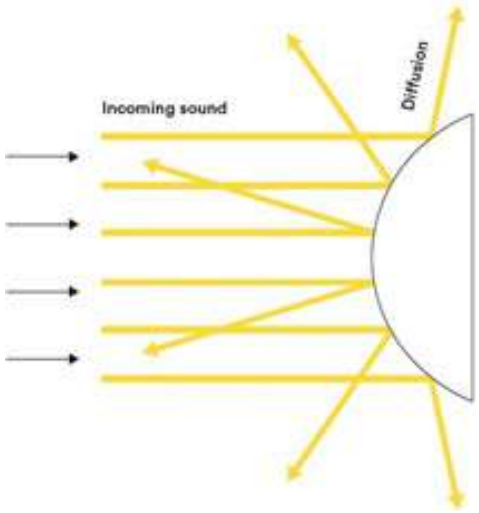
Isolation

Vibration Isolation is a technique used to stop transmission of vibrations from source to other mediums. The main reason of using this technique is to isolate the source from spreading extra vibrations, in directly blocking or reducing noise or sound emission.



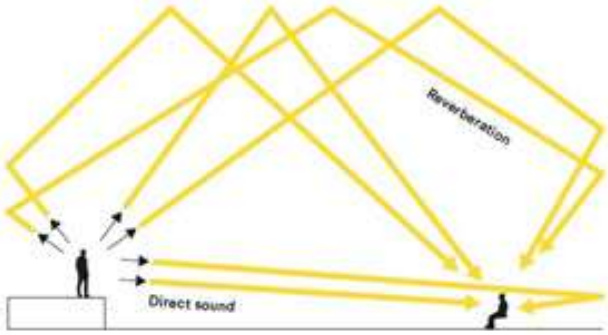
Diffusion

Diffusion typically occurs when the texture and hardness of the object or material is similar to the sound's wavelength. Exactly how the sound diffuses depends on the nature of the surface texture. Too much diffusion can make it difficult to localize where a sound is coming from. Diffusion occurs when a sound wave diffuses or scatters in different directions upon encountering an object or material.



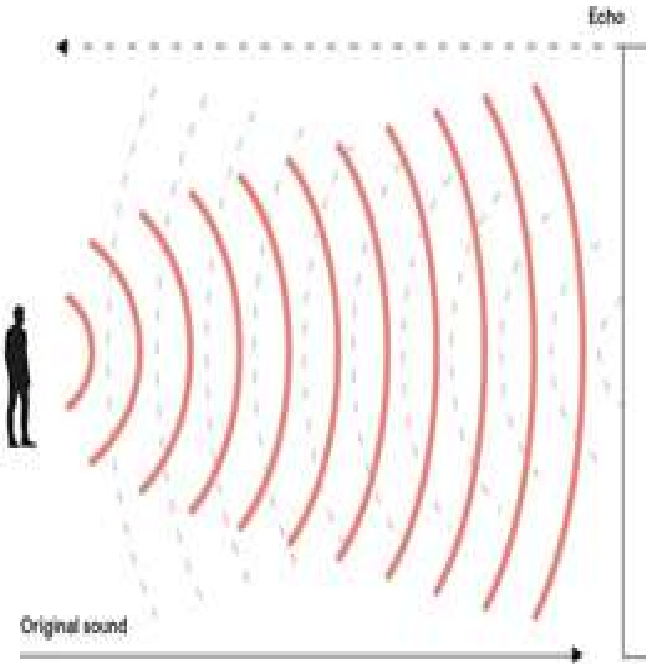
Reverberation

Reverberation is less optimal for speech, however. When it is too long, it can cause the sounds of individual words spoken consecutively to reverberate simultaneously. Reverberation is the lifetime or persistence of a sound wave in an enclosed space, measured from the time it first appears to the time it is no longer audible. As a sound wave travels around a space, interacting with different obstacles, it is reflected back and forth between surfaces with some of its energy being absorbed upon each impact until it completely 'dies out'. The more absorbent the room, the more quickly the sound diminishes.



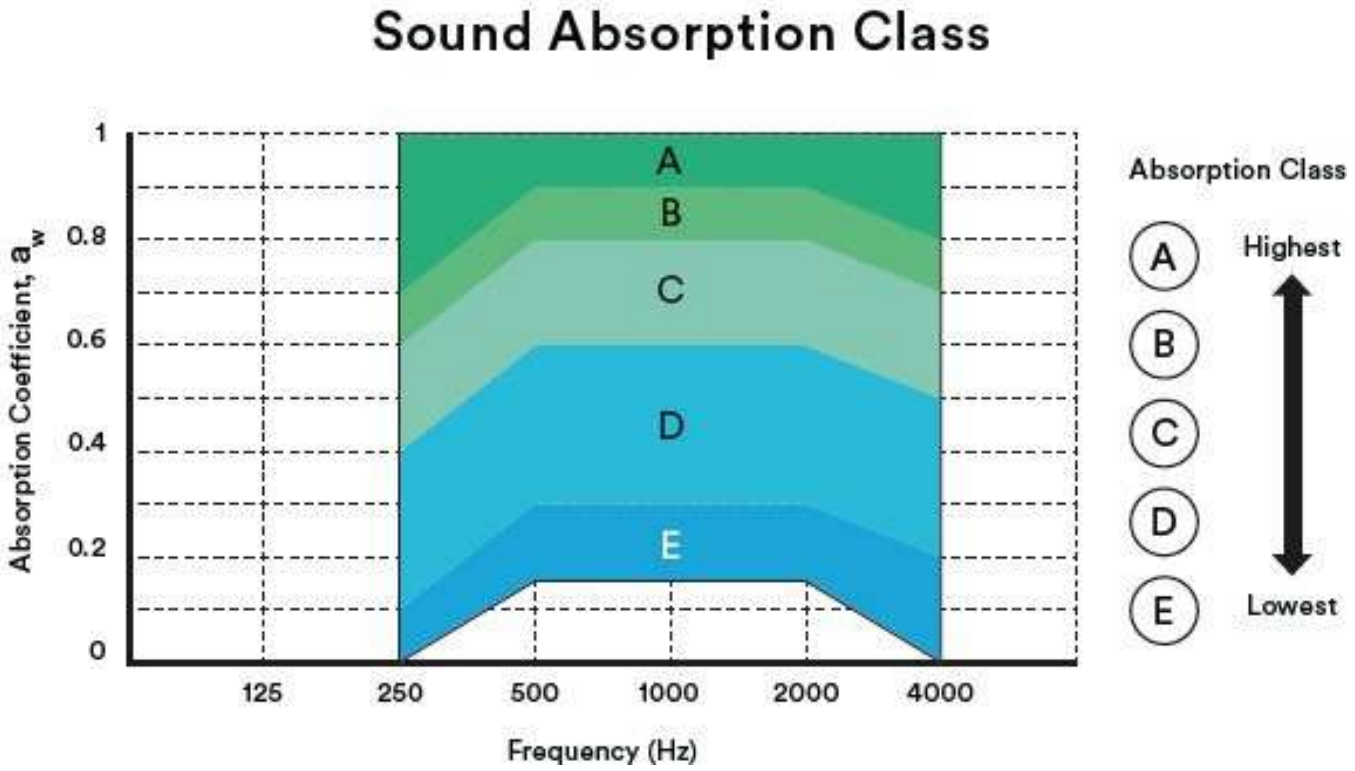
Echoes

Echoing indoors can make conversation difficult, and amplify distracting sounds. When reverberation time is long enough, an echo can occur. An echo is the distinct repetition of an original sound produced through the reflection of sound waves, which arrives at the listener following a delay. The length of the delay depends on the distances between the reflecting sound surface, the sound source, and the listener. One type of echo that is particularly problematic is a flutter echo. A flutter echo is the phenomenon of sound energy becoming trapped and reflecting repeatedly between two parallel surfaces, such as in a hallway.

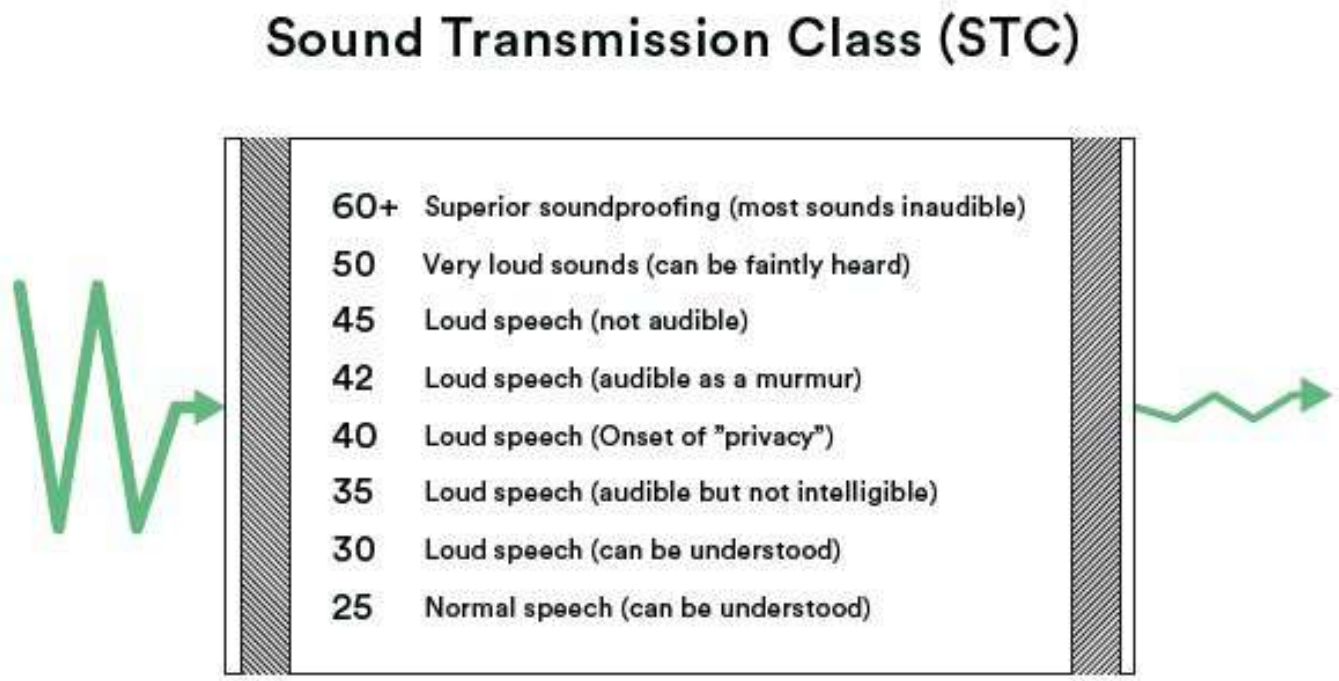


HOW TO MEASURE SOUND

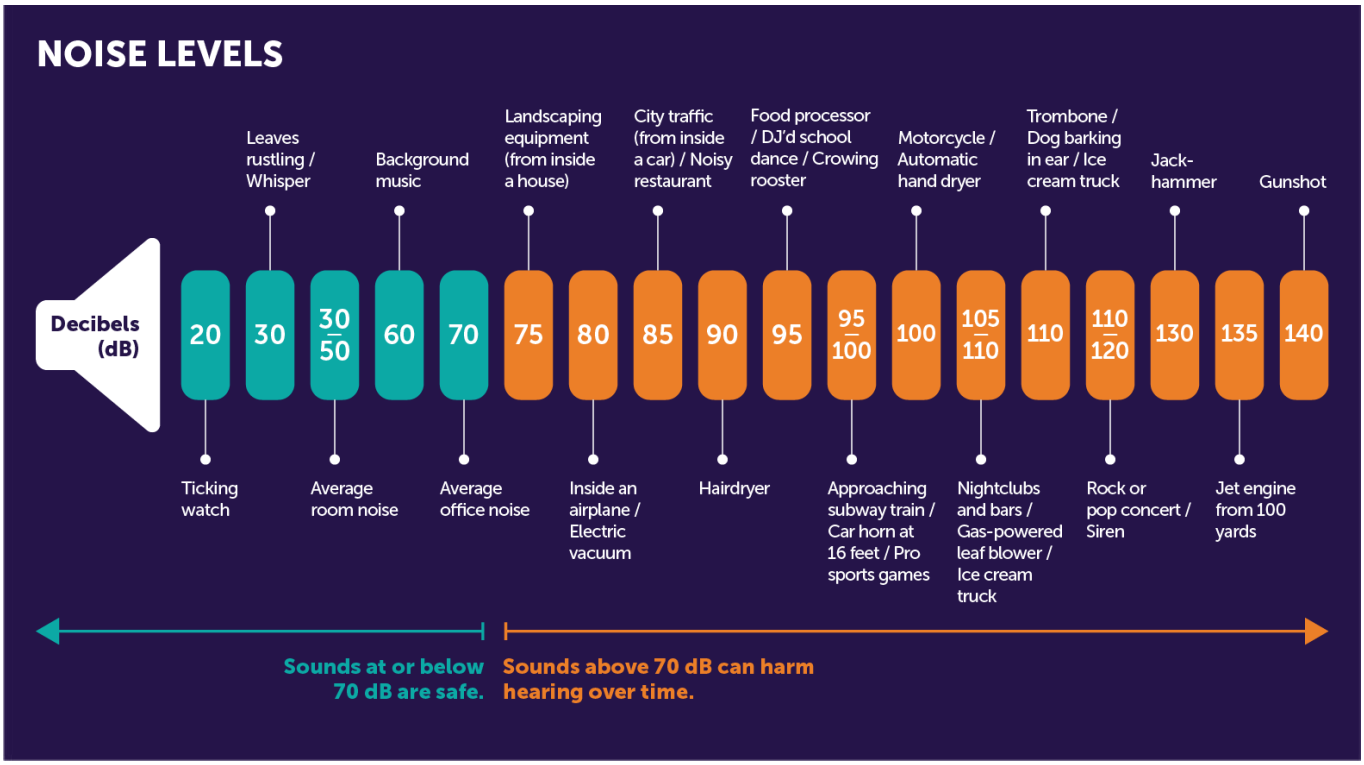
NRC - The term to measure the absorption value of the product is called NRC (Noise reduction Coefficient). Inother words, this is the capacity of the product to absorb the sound. NRC is the average absorption at all frequencies.



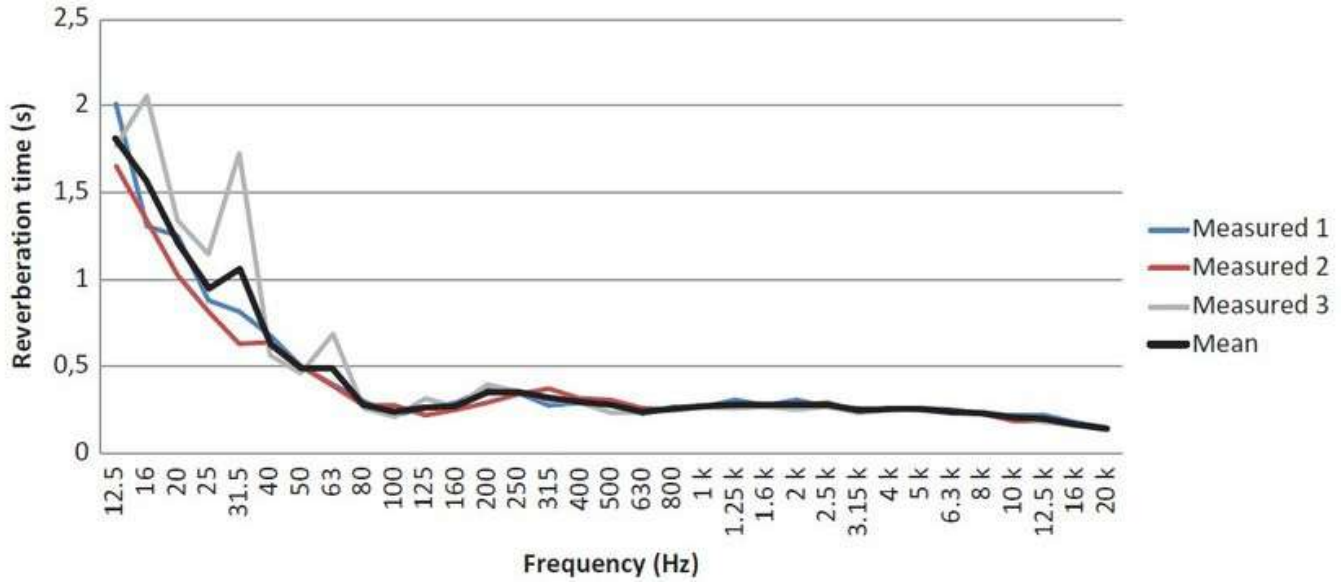
STC - The term to measure the blocking value of the product is called STC (Sound Transmission Class). In otherwords, this is the capacity of the product to block the sound. STC is the average blocking at all frequencies. In general Higher the STC the better will be the Insulation.



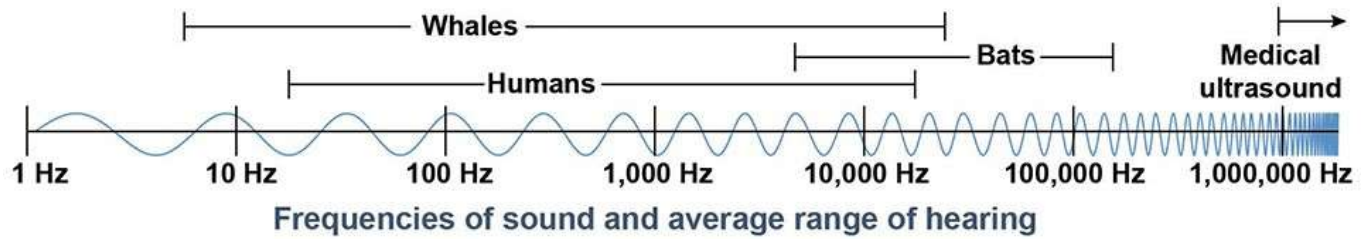
DB - Decibels is a term to measure noise level.



RT - Reverberation time is the time taken by sound energy to die down. Every place is having a different RT e.g-studio, Multiplex, Auditorium, Conference hall, Home Theater have different RT's & all sites have to be treateddifferently while doing acoustics.



HZ -Hertz is the term to measure frequencies.



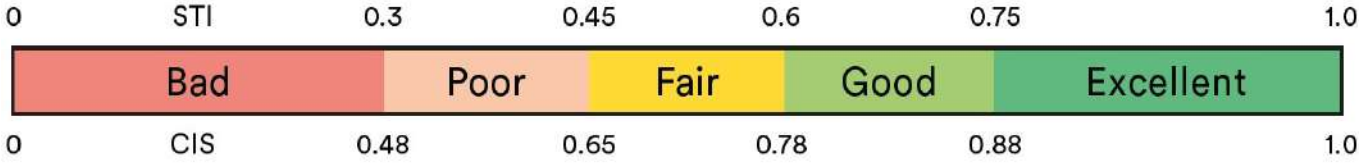
Frequencies of sound and average range of hearing

SPEECH INTELLIGIBILITY - is a measure of the quality of the transmission of speech.

Speech intelligibility is particularly important in public spaces where occupants need to be able to clearly hear andunderstand instructions, whether the instructions are coming from a person in the same room or via an electronicpublic address or voice alarm system. For instance, this could apply to classrooms, auditoriums, churches, conference rooms, concert halls, airports, trains stations and shopping centers. Speech intelligibility is calculated according to a standard index using acoustical measurements of speech and noise.

A number of factors influence speech intelligibility, including ambient noise level, reverberation time, the frequency response of a room, psychoacoustic masking effects, as well as the quality of any sound reproductionequipment being used to transmit sound in the space.

The Speech intelligibility index (SII) is represented on a numeric scale called the Common Intelligibility Scale (CIS).The value ranges from 0 to 1, or bad to excellent, and indicates the degree to which a space, aka transmission channel, degrades speech intelligibility.



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ESSENTIAL MEASUREMNTS FOR DIFFERENT SPACES

Maximum Noise Rating Level	Application
NR 25	Concert halls, broadcasting and recording studios, churches
NR 30	Private dwellings, hospitals, theaters, cinemas, conference rooms
NR 35	Libraries, museums, court rooms, schools, hospitals, operating theaters and wards, flats, hotels, executive offices
NR 40	Halls, corridors, cloakrooms, restaurants, night clubs, offices, shops
NR 45	Department stores, supermarkets, canteens, general offices
NR 50	Typing pools, offices with business machines
NR 60	Light engineering works
NR 70	Foundries, heavy engineering works

Note 1: These values should be regarded as minimum target values.
Note 2: Perceieved intelligibility relating to each category will also depend on the frequency response at each listening position.
Note 3: The SII values refer to measured values in sample listening positions or as required by specific apllication standards.

PARAMETERS TO CHOOSE THE BEST SOUND PROOFING PARTNER

TREATMENT OPTIONS

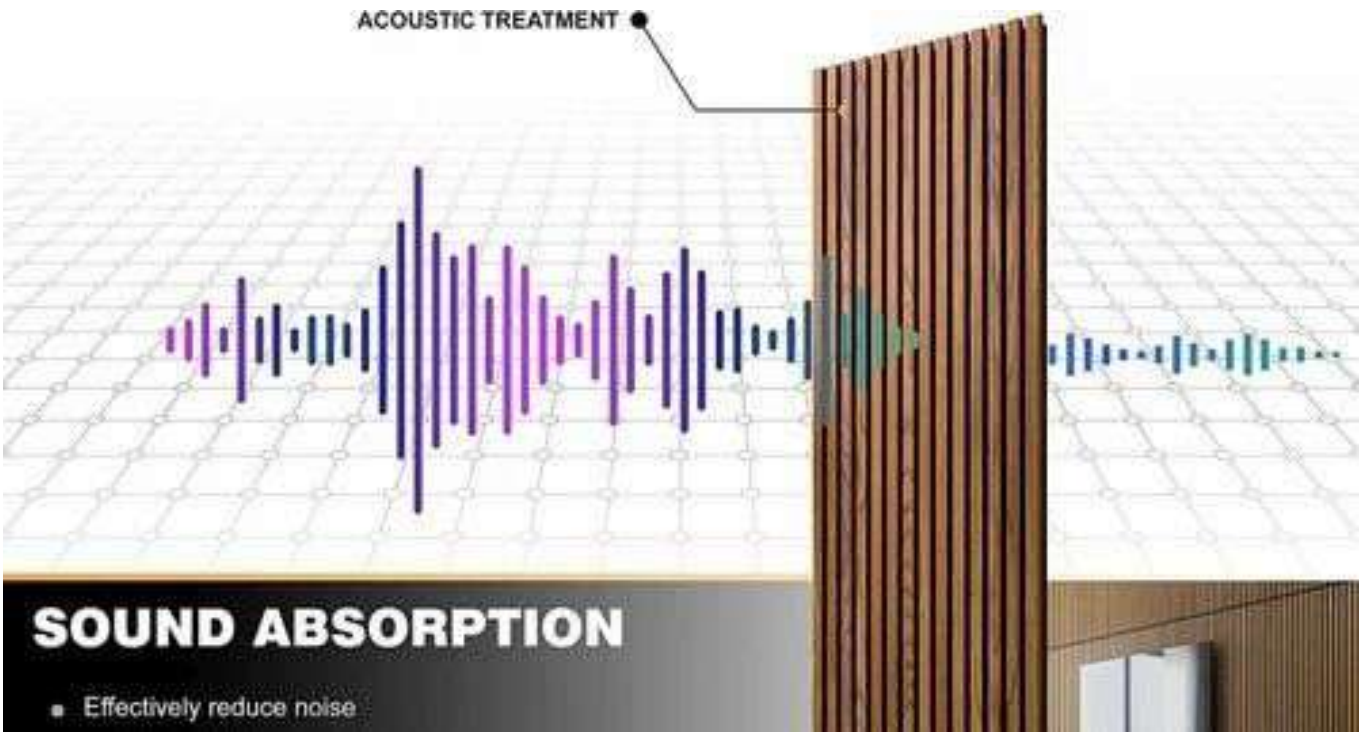
Absorption

Usage of Ceiling & Wall Panels of Different Material Finishes to Match Décor Seamless Gloss Absorptive Ceiling Treatments – ABSORPTION

Futuristic Wood Fiber Ceiling Treatments for Excellent Results – ABSORPTION

Fabric Designer Wall Cladding Treatment – ABSORPTION

Wooden Wall & Ceiling Treatments – ABSORPTION



Futuristic Wall Art Acoustic Panel Design – ABSORPTION

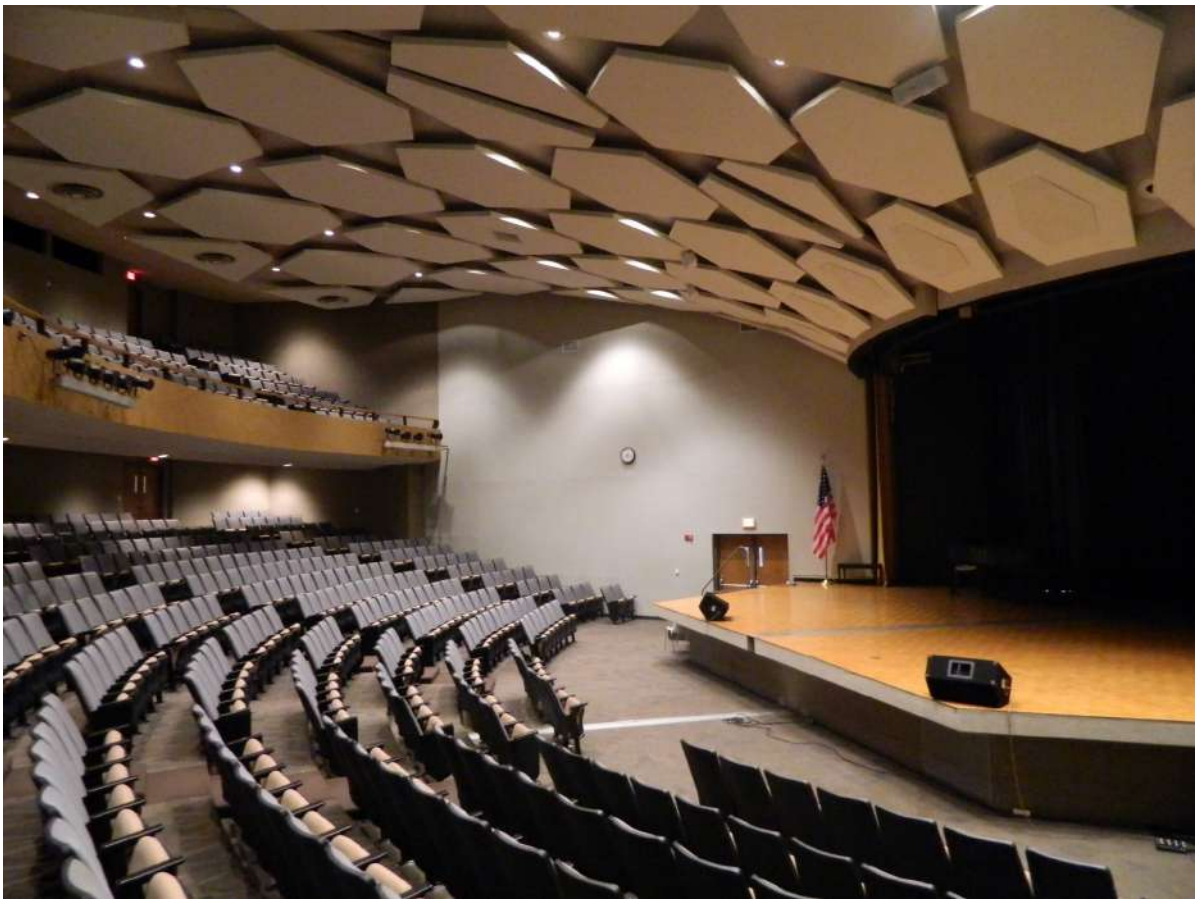
INSULATION

Dry Wall Partitions – INSULATION

Fabric Partitions – ABSORPTION + INSULATION

Acoustic Doors – INSULATION

Isolation & Diffusion



CONCLUSION-GOODACOUSTICDESIGNLEADSTOGOODADVANTAGES.....

In today's fast-paced world, where noise pollution poses a growing concern, the significance of optimal acoustic design cannot be overstated. Whether it's an office, school, concert hall, or personal living space, harnessing the benefits of sound optimization offers a myriad of advantages. In this article, we will explore eight key benefits derived from implementing optimal acoustic design, shedding light on how it enhances different environments.

1. Crystal-Clear Communication

One of the primary advantages of optimal acoustic design is its ability to enhance speech clarity. Whether

in classrooms, conference rooms, or auditoriums, effective communication relies on clear and intelligible speech. A well-designed acoustic environment minimizes echoes and disruptive background noise, ensuring that every word is easily understood. This fosters productive interactions, facilitates learning, and promotes effective teamwork.

2. Heightened Focus and Productivity

Unwanted noise distractions can significantly impede productivity and concentration levels in workplaces. Optimalacoustic design creates a peaceful atmosphere, reducing the negative impact of noise on employees. By minimizing external disturbances and controlling sound reflections within a space, individuals can better focus on their tasks, resulting in improved efficiency and overall job satisfaction.

3. Acoustic Design Enhances Learning Environments

In educational settings, optimal acoustic design plays a pivotal role in shaping students' learning experiences. Studies reveal that poor classroom acoustics can hinder comprehension and academic performance. On the other hand, optimized acoustics facilitate effective learning by enabling students to clearly grasp teachers' instructions, actively engage in discussions, and absorb knowledge more efficiently.

4. Elevating Musical and Artistic Performances

Concert halls, theaters, and performance venues greatly benefit from optimal acoustic design, as it directly impactssound quality and audience experience. Well-controlled room acoustics enhance the richness, clarity, and depth of musical performances, allowing musicians to showcase their talents while captivating the audience. Similarly, in theaters, it ensures clear dialogue intelligibility and an immersive theatrical experience.

5. Acoustic Design Promotes Health and Well-being

Noise pollution has been linked to various health issues, including stress, anxiety, elevated blood pressure, and sleep disturbances. Optimal design mitigates the adverse effects of noise, promoting better health and well-being. By creating tranquil and serene environments, it contributes to reduced stress levels, improved sleep quality, and enhanced overall comfort.

6. Safeguarding Privacy and Confidentiality

Spaces requiring privacy and confidentiality, such as meeting rooms and medical facilities, rely on optimal design for effective soundproofing. By utilizing sound-absorbing materials and techniques, sensitive conversations remainprivate and protected from eavesdropping. This fosters an atmosphere of trust, professionalism, and ensures the integrity of confidential discussions.

7. Complying with Building Regulations

Building regulations often encompass specific acoustic performance requirements for different settings. Adhering to these regulations through optimal design prevents legal and regulatory complications. By meeting recommended guidelines, designers and builders create spaces that fulfill necessary acoustic criteria, offering occupants a safe and comfortable environment.

AT HIMALYAN ACOUSTICS WE COMPLY WITH MAJOR FACTORS AS STATED ABOVE TO PROVIDE BESTSOUND PROOFING AND ACOUSTICS SOLUTIONS

HIMALYAN ACOUSTICS
company facts & brief history

OUR SERVICES – 360° Approach
services from our desk

HIMALYAN ACOUSTICS – *products have been used and installed at almost all sectors……*

HIMALYAN ACOUSTICS – *power packed lab certifications*

HIMALYAN ACOUSTICS – *quality certifications*

aphony **fibrette, gloss seamless & elegant**

Finish	Natural & Gloss
Core	Fibrette
Performance	0.89 – 1.00 NRC
Application	ceiling

NRC1 · Anti Fungal · Anti Bacterial Elegant · ISO Certified · Griha Certified · Termite Resistant · All Weather · Eco Friendly · Fire Resistance · Humidity Resistance

woodlot & microperforated

Finish	Laminate
Core	Acoustic MDF & Ply
Performance	0.85 – 0.88 NRC
Applicatin	wall & ceiling

ISO Certified · Griha Certified · All Weather · Eco Friendly · Fire Resistance · Humidity Resistance

acoustic drywall partition & door with vision panel

Finish	Laminate, Veneer, Fabric, Laquer Glass, Metal, Texture, Wall Paper, Paint & Himalyan Acoustic Products
Core	Sound Dampner, Iso & Acoustic wooden studs
Performance	Upto 45 to 65 STC
Application	Partition

ISO Certified | Griha Certified | All Weather | Eco Friendly | Fire Resistance | Humidity Resistance

stretch fabric, baffles & cloud

Finish	felt & fabric
Core	polyster & fibrette
Performance	0.9 – 1.00 NRC
Application	wall, ceiling, baffles & cloud

NRC1 | ISO Certified | Griha Certified | All Weather | Eco Friendly | Fire Resistance | Humidity Resistance

HIMALYAN ACOUSTICS – *introducing one of its kind.....*

Co2 adsorber (sound barrier & facade system)

acoustical **facades sound barrier (absorb air pollution)**

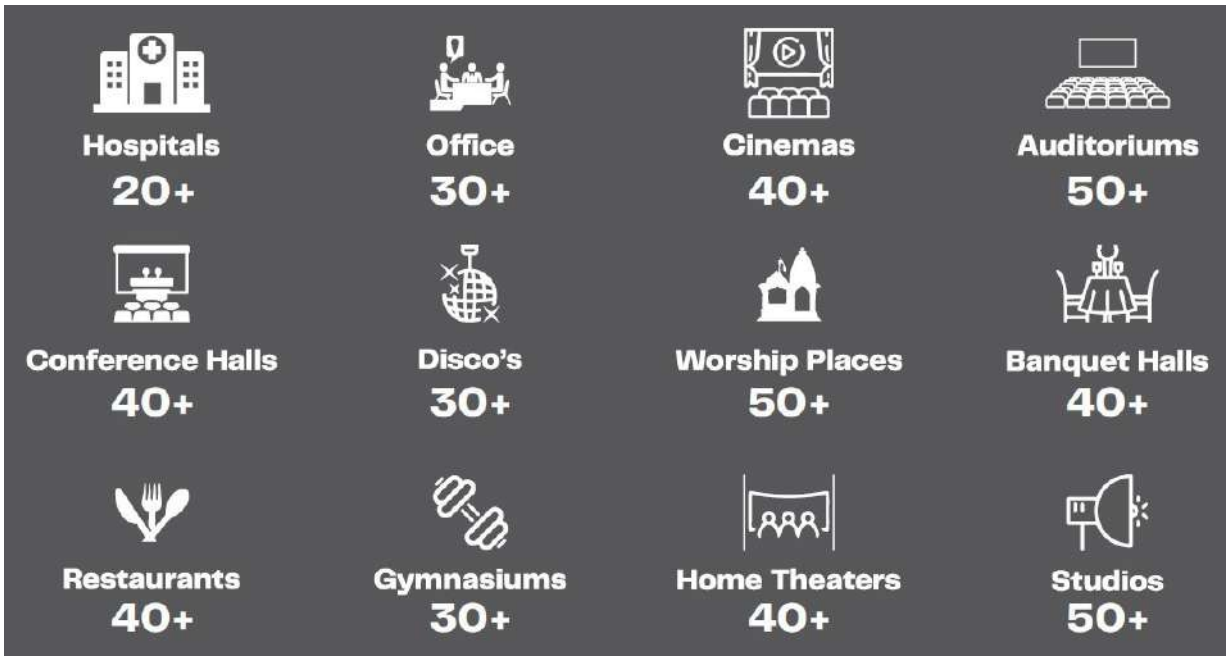
PRODUCT HIGHLIGHTS & BREIF FEATURES

1. Absorb Air Pollution
   a. Nitrogen Dioxide (No)
   b. Sulphur Dioxide
   c. Carbon Dioxide
2. Excellent Sound Isolation
3. Eco Friendly
4. Repaint able Maintenance
5. Traffic Noise Insulation
6. High Thermal Insulation
7. Fire Resistant
8. Termite & Vermin Resistant
9. Lightness
10. Workability
11. Weather and Water Resistant
12. Strength
13. Durability
14. Easy to Install
15. Carbon Monoxide

NRC1 · Carbon Adsorber · Anti Fungal · Anti Bacterial Elegant · Anti Pollution · ISO Certified · Griha Certified · Termite Resistant · All Weather · Eco Friendly · Fire Resistance · Humidity Resistance

S. No.	Parameters	Unit	Test Result without Acoustical Facades	Test Result with Acoustical Facades	Pollution Absorption Data	Pollution Absorption Percentage %	OSHA 34304:2011 Standards (Maximum Allowable Limit)	Test Method
1	Nitrogen Dioxide (No_2)	ppm	1.181	0.177	1.004	85.01	5	IS:5182 (P-6)
2	Sulphur Dioxide	ppm	0.117	0.03	0.087	74.36	5	IS:5182 (P-2)
3	Carbon Dioxide	ppm	1355	352	1003	74.02	5000	FL/SOP/GC25
4	Carbon Monoxide	ppm	1.5	1.25	0.25	16.67	50	FL/SOP/GC25

HIMALYAN ACOUSTICS – *Our achievements*



MODULAR WELDMESH FENCING SYSTEMS FOR PERIMETER SECURITY

Sh. Mahip Chamber
A-1 Fence Products Company Pvt. Ltd.

ADVANTAGES OF WELDED MESH FENCING FOR BORDER APPLICATIONS

The Indian defence started upgrading the borders and their establishments some 7-8 years ago. Over these years the anti-climb welded mesh made of 4 mm GI wires having a mesh size of 76.2x12.7 mm has proven to be a very robust fencing system for the application. Here's why

A] **Anticlimb** - the dense mesh makes it very difficult to climb as a person's fingers and toes don't go inside. The height of the system is close to 3 meters, and is topped up with a concertina coil.This makes crossing over from top also very difficult.

B] **Anti-cut** - the dense make ensures that the fence cannot be cut using ordinary tools easily. If one uses a hex-saw blade, it would take him a lot of time, more than 30 mins, to make a gap big enough for a human to pass through. This Delay make the fence very attractive

C] **Modular yet Anti-dismantle:** The entire fence has a modular design, which makes the assembly on site very easy. But there is always a risk of someone dismantling the fence as it is a complete

nut and bolt assembly. Thanks to the innovative design of the breakaway nuts, after the nut is completely tightened, the head break off. Once broken, it cannot be opened and becomes a permanent assembly. The entire fence panel also come in three equal parts, which is installed one on the top of other. This make transporting the panels to the installation site very easy. Also due to reduced weight, the fence can be installed without having to deploy a crane.

D] **Easy installation on slopes:** Due to the use of round poles, omega clamps and three independent small panels instead of one single big panel, installation on slopes and mild turns is possible without using an additional pole or creating a step.

E] **Transparent:** Despite the mesh being so dense, as the vertical wires are 76.2 mm apart, this fence has a superior visibility index. One can see the other side seamlessly. This helps the surveillance teams to monitor the borders and spot the intruders approaching the border when they are still very far away.

F] **Very low wind resistance:** The innovation of this fence is such that despite being so dense, due to the use of 4 mm wire, the block space is very little as compared to the open space. This is quite a difficult feat to achieve as it also has to be anti-climb at the same time. The fence is able to sustain even very high cyclonic wind speeds and hold it's ground

G] **Long life** - Due to the use of galvanized steel with superior thermoplastic coating on it, the fence had zero corrosion on it even after more than 5 years as observed by the long term test on samples erected on the Bhuj border. This is very important as the fence is a huge capital investment and if it has a small life, even if it is very secure it won't make practical sense to install these along the borders

MANUFACTURING PROCESS OF ANTI CLIMB WELDED MESH FENCE FOR BORDER APPLICATION

A] **Wire Straightening -** Medium Tensile wire are first passed through straightening machines to ensure that the weldmesh looks taut end to end

B] **Welding -** the welding of the mesh happens via a Special purpose welding machine which is fully automated and PLC controlled such that all the process parameters are tightly controlled.

C] **Trimming -** the protrusions at the end of the the welded mesh are trimmed using a trimming machine

D] **Surface preparation -** the weld mesh is then passed through a sand blasting machine to prepare the surface for coating. This step increases the surface area available for powder to stick on resulting in excellent adhesion.

E] **Powder coating -** The weld mesh, poles and accessories are then passed through the fully automatic powder coating conveyor based system having state of the art 10 tank pretreatment system and automatic guns.

F] **Packing and dispatch -** the mesh and poles are ten printed with batch number for traceability purposed and are packed as per SOP for dispatch to remote borders

IMPROVING THE OVERALL APPEAL OF WELDMESH FENCING AT THE BORDERS

Perimeter security is quite similar to cyber security in one aspect, the intruder keeps on improvising. It is like a virus and anti-virus relationship, our anti-virus requires frequent updates, as the anti-virus capable of blocking a virus today, might not be effective for the virus of tomorrow. Same is the case with the intruder at the border, they might not be able to cross today, but if we don't upgrade, they might figure out a way tomorrow. And hence, for they we must proactively plan to upgrade our border security and augment the strong physical fence with intelligent intrusion detection systems. We can do this by taking care of two main aspects:

A] Early warning - The more time we get, the easier it is to mitigate the threat. Using compact surveillance radars and seismic sensors, we can get an alert on a suspicious activity of the intruder much before they have actually reached the border. Seismic sensors can also be effectively deployed to track movement in unknown tunnels, as this cannot be stopped by the fence.

B] Final warning - Vibration sensors based on kinematic sensors technology or optical fiber technology can be deployed on the fence to detect the intrusion activity on its onset.

Such intelligent warning systems can greatly help in giving the right amount of time required by the Quick response teams to mitigate the threat.

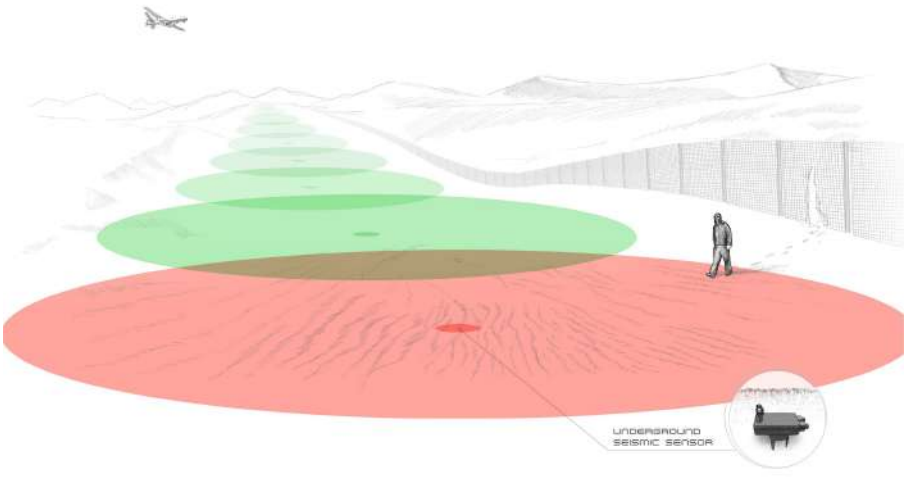


Illustration of Seismics Sensors deployed along the border as a part or Early Warning

Liminal-K Vibration sensor deployed on Border fence as a part of Final Warning

FROM SECURING BORDERS TO SECURING ASSETS

Weldmesh is finding increasing use for securing not just borders but also our regular assets like commercial, residential, industrial and institutional buildings. The advantages of welded mesh as an alternative to chainlink fence has resulted in its fast acceptance in the market, despite being slightly expensive on account of using more steel. Some of the key advantages are:

Bigger mesh, yet stronger - With chainlink, the maximum size we can go with without compromising its function is 75x75 mm. General size is 50x50 mm. We can scratch it to 100x100 mm, but here it looks flimsy and is very weak. However, with weldmesh, we can increase the mesh size to 50 x 200 mm and at the same time there is no need to compromise on strength. Bigger the mesh opening, minimal the design.

Horizontal and vertical mesh - Weldmesh has horizontal and vertical wires as opposed to chainlink which has diagonal wires. As most of the surface in a property are horizontal and vertical, chainlink spoils the visual balance and aesthetics

More secure - When you cut one wire of chainlink, the entire fabric looses its integrity and the tear becomes bigger and bigger. In weldmesh, the cut in wire gets contained at it's location. To intrude, at least a 400x400 mm box cut needs to be made, which has to be an intentional activity.

Flatness - Chainlink cannot match the Flat profile of the weld mesh panel, and this gives weldmesh a very clean, uniform and professional look.

Finish - As powder coating has a variety of colors and can have a gloss or a matte finish which is not possible in pvc coating, weldmesh has much superior finish than chainlink

Due to the above advantages, weldmesh is fast replacing chainlink in following applications:

- Main perimeter ground up demarcation fencing
- Main perimeter wall top demarcation fencing
- Internal demarcation for perimeters of parking area, gardens, walkways, swimming pools, transformers, DG sets etc
- Sports fencing of 6 m high
- In-building demarcation for warehouses, factory walkway etc
- Rooftop fencing on parapet

UNIQUE PRECAST CONCRETE PROJECTS WITH CPWD

Sh. Ketul Doshi, Fuji Silvertech Concrete Pvt. Ltd.

Fuji Silvertech is an Indo-Japan partnership precast with experience and trust. It is India's largest precast solutions provider. Fuji Japan brings state-of-the-art technology and 100 years of collective experience to combine with India's innovation capabilities, revolutionising the infrastructure. With a vision to instil pride in India by enhancing the infrastructure of the country, FUJI Silvertech demonstrates its commitment to quality, efficiency and precision.

With factories located at Bagodara, Gujarat and Aurangabad, Maharashtra, FUJI Silvertech has a total production capacity of approx. 6 Lakhs Tonnes per annum. FUJI Silvertech has an upcoming factory near Delhi NCR and is expanding operations nationally in all regions. FUJI Silvertech designs, manufactures, and dispatches precast solutions for various infrastructure segments including water and sewage, roads and bridges, railways, industrial and cable and power. FUJI Silvertech precast solutions are manufactured with high performance self-compacting concrete of M 50 and high strength steel. The major precast products by FUJI Silvertech include U shape drains and Cable ducts, Box culverts, Retaining walls, Segmental retaining walls, Noise barriers and building related products.

FUJI Silvertech has proudly devised unique solutions jointly with CPWD. Three such solutions are illustrated herein.

Precast Building Solution: The O P Tower

FUJI Silvertech jointly with CPWD, recently accomplished the installation of its building segment precast products. The Observation Point Tower (O. P. Tower) was a four storeyed building recently constructed using 272 numbers of precast products of 29 variations was installed in 24 days at the island of Lakhpatwari, Narayan Sarovar at Kutchh, Gujarat. The building was constructed for border security forces as a project from Central Public Works Department. The building consisted of a foundation storey which was filled and helped raise the height of the building and ground floor and two top floors for observation of border security.

The site which is on a 5 km wide island is situated at India Pakistan border and requires 25 km of travel in Arabian sea from Lakki nakka, Narayan Sarovar mainland of Gujarat. The site posed various challenges including accessibility, very poor soil with negligible load bearing capacity, high water tables and almost 2.4 m tide levels and highly saline and chemically corrosive environment, no existing infrastructure for power supply, housing or sanitation, difficulty in transportation of material, manpower and equipment and no means to carry out cast in situ construction. The site location is classified in high cyclone zone and high earthquake zone (Zone V) in BIS Standards.

Keeping all this in mind, a total precast solution was conceptualized and prepared by FUJI Silvertech which consisted of precast base slabs, precast raft footings, precast wall panels with couplers for foundation, precast wall panels with door and window openings as required for observation and precast slabs. The entire assembly was connected at site through bolted connection. The precast products manufactured at FUJI Silvertech's Bagodara facility in Gujarat had a zero mm tolerance and fitted perfectly

to close the box of the structure. Efforts were done by the CPWD at site to prepare a gabion wall and also to do ground improvement at site to bring the SBC to a desired value of 10 T/sq m. The wall panels and floor slabs were 200 mm thick to resist bullet penetration. Each and every product was less than 1.5 Tonne per product as advised for ease of handling, transportation and dispatch at site. The plinth level was maintained at more than 1.5 m above ground level as required. The foundation floor was bitumen painted to protect from corrosive environment attack.

FUJI Silvertech conceptualized, designed, manufactured, dispatched and provide complete installation support for construction of the O P Tower building. The building post installation faced one of the largest cyclones, cyclone Biparjoy on 15-17 June 2023. The towers were located right on the path of the very severe cyclone that had a sustained wind speed of 125 kmph and maximum wind speed of 140 kmph and a storm surge of 2 to 3 m above astronomical tide. The towers sustained the combined effect of the wind, tide and a minor earthquake and encountered no damage due to these harsh natural calamities proving the success and possibility of precast buildings in such zones.

Precast Bridge Solution

Prior to developing the building segment, FUJI Silvertech had provided a bridge solution at the Indo-Pak border at Lakhpat which is known to have very poor soil bearing strata; the solution consisted of precast box culverts with precast wing walls and precast parapet walls. Conceptual and detail drawings were developed by FUJI Silvertech in consultation with CPWD and the design and drawings were vetted by the National Institute of Technology, Surat. The modelling and analysis of these structures was then carried out using advanced tools for finite element method and the displacement and stresses were mapped.

The complete precast bridge solution components were dispatched to the site and installed in only 10 day's time. Fuji Silvertech is supplying Precast Box Culvert, Retaining wall and Parapet walls for last 6 years in this project. More than 200 minor bridges are completed and handed over. This was an achievement both in terms of project time and structural design at the location.

Precast Drainage Cum Fencing Solution

FUJI Silvertech is known to provide drainage solutions in more than 1000 projects across India. But a unique drain cum fencing solution was devised jointly with CPWD again at the Lakhpat location at Indo-Pak border. The political boundary called for both drainage and fencing at the same location. This was being done till now using Column – Beam arrangement.

To increase the life of this fencing drain, Fuji along with CPWD has devised a solution of Precast drain cum fencing. This is recently tested in the Cyclone Biparjoy with heavy flood situation. This fencing is sustained in totality withstanding water wind speed of 125 – 140 kmph and a flooded surge of 2 to 3 m above astronomical tide.

FUJI Silvertech drain lids were then so detailed precisely with zero tolerance to allow for installation of fencing poles to which the fence nets were connected. The possible assembly was tested for displacement and overturning due to large lateral loads through field test assembly. This was to check the probability of failure due to heavy wind loads. The lateral load carrying capacity was then externally certified before FUJI Silvertech proceeded to provide the complete solution.

Other government associations and projects of National importance

FUJI Silvertech is proud to be associated for projects of national importance by several government authorities in India. FUJI Silvertech for example has been instrumental in providing solution at important projects,

i) Border Roads Organisation, BRO, Himank, Leh - 218 Box culvert bridge solutions

ii) Dedicated Freight Corridor, DFCC – 600 km Drains, 350 Box Culvert bridge, 30 km Retaining walls of various heights 2 to 9.15 metre

iii) National High Speed Rail, NHSRCL – 300 km Noise barriers, 15 km Cable duct

iv) Central Vista, Parliament building – 5 km Cable trench

v) Vadodara Mumbai Express Highway, NHAI – 80 km Storm water drain, 8 km Box Culvert.

Some of the other notable projects where FUJI Silvertech has contributed are in the Narendra Modi Stadium at Ahmedabad, Shree Mandir Parikrama Project at Puri and Somnath temple at Somnath. FUJI Silvertech has supplied various infrastructure products in more than 1500 projects in last 7 years. FUJI Silvertech products are approved in several national, state and special government authorities such as Airport Authority of India, National Highways Authority of India, Department of atomic energy (BARC), NHSRCL, Indian Oil, DFCC, CPWD, PWD (MP), MIDC, GIDC, MCGM, R&B (Gujarat), Govt. of Telangana, Diu District Administration, Sports Authority of India, Somnath temple trust, IITs etc.

VISHWAKARMA AWAAS- THE WORKERS' COMMUNE IN IIT, TIRUPATI

Sh. B.V. Ramana Reddy, AVP, JMC Projects
Sh. Ramesh K. Garg, CE & ED, CPWD

The construction project site can be entrusted to safe hands if the layout and facilities are carefully and thoroughly designed, and if the same is implemented to accommodate the workforce. The workers' commune will serve as a "home" for numerous individuals who have arrived from different locations to support their families by working and earning at the construction sites. Therefore, it becomes crucial for everyone involved to meticulously plan and execute these measures.

Several significant factors have been considered, including the following:

- The size of the labour force required during various stages of the project
- The type of labour force required during the project
- The workforce's facility requirements
- The access and transportation arrangements for the workforce

PICTORIAL VIEW OF THE COMPLETED LAYOUT

LORD GANESH

FACILITIES AT THE WORKERS' HOUSING COLONY

CPWD along with other stakeholders displayed unwavering commitment in providing exceptional facilities for their workforce, which led to the meticulous planning of the workers' commune design and the subsequent establishment of Vishwakarma Awass

Some notable features of the workers' housing include:

1. Well-ventilated rooms- 484 Rooms - Housing approximately 2400 persons.
    a) Total Rooms - 484 **No's.**
        i. 4.0M X 3.0M – 432 No's.
        ii. 2.1M X 2.1M – 14 No's.
        iii. 3.0M X 2.25M – 10 No's.
        iv. 4.0M X 2.0M – 28 No's.
2. 39 Kitchens divided into Four blocks
3. Toilet Rooms-78 Numbers
4. Kitchens equipped with provision of Bio gas.
5. Sewage Treatment Plant- 150 KLD capacity.
6. RO Purified Drinking water-1000 LPH.
7. School (Crèche) for children with a Play area.
8. Well paved Walkways.
9. Solar street lights.
10. Dining Halls & Television sets for Entertainment.
11. Provisional stores with availability of all daily needs.
12. CCTV cameras for surveillance.
13. Ply Area
14. An OZONE Park with fountain.
15. Medical room with First Aid facilities
16. More than 2000 Saplings planted in total on various occasions.
17. The Hairdressing saloons.

ROOMS

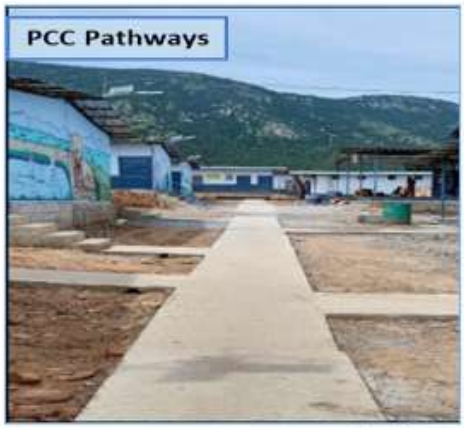
KITCHEN WITH BIO GAS

DRINKING WATER –RO & SEWAGE TREATMENT PLANT—150KLD CAPACITY

KIDS SCHOOL, PROVISIONAL SHOP & MEDICAL ROOM

PATHWAYS AND LIFE REFLECTING PAINTINGS

The Commune walls prominently showcase informative content regarding important topics such as avoiding food wastage, conserving water, practicing yoga, and promoting cultivation



SECURITY PERSONS, CCTV CAMERAS, AND SOLAR STREET LIGHTS- & MAINTENANCE

The workers' commune is enclosed by a compound wall on three sides, while the forest side is barricaded. It gives the appearance of a gated society with security personnel and eight closed-circuit cameras ensuring the security and safety of the premises..

The development of Ozone Park and Miyawaki Social Forest aims to provide individuals with the opportunity to observe and appreciate the beauty of nature while gaining an understanding of the significance of green belts in life.

SCOPE OF FIRE DOOR IN RESIDENTIAL, INSTITUTIONAL HEALTH CARE & COMMERICAL BUILDING AS PER NEW IS CODE 3614 : 2021

Sh. Rajeev Jha, Navair International Pvt Ltd.

Common practice:Minutes of Fire Protection

120	Exit stairways, Lift Lobby, Service Shaft
Refuge area and car parking compartment	120
120	Service Room Eng. Workshops Areas of high Hazard

HOTELS& RESIDENTIAL - Main entrance door -60 minutes

- Fire separation of open kitchen from serving area- 60 minutes

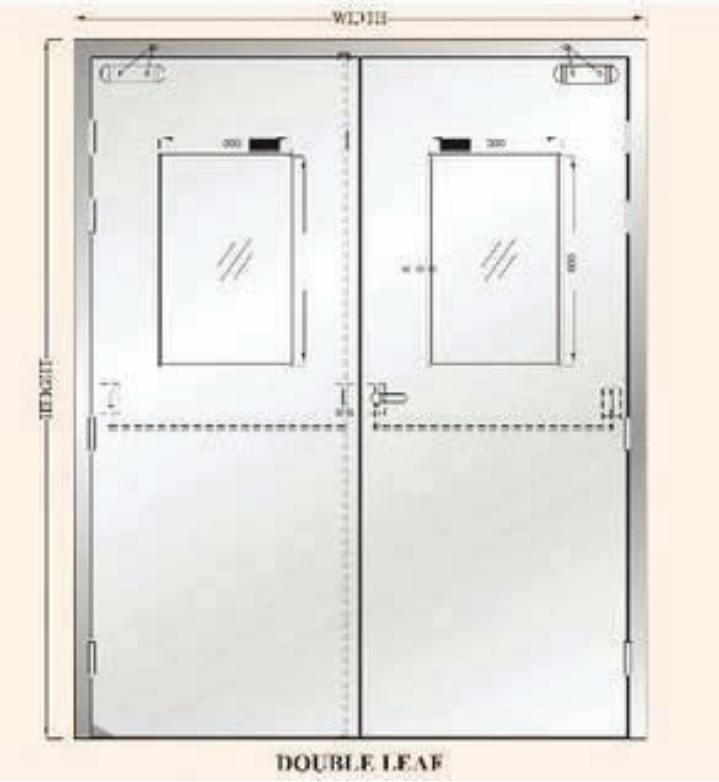
HOSPITAL -Area containing patient lacking-self preservation

Operation Theatre / ICU / Recovery Room/ Investigation room

Important Points:

- *No Rolling shutter &horizontal/vertical sliding* doors across corridors& Exit.
- Fire Doors required to swing along the direction of exit travel except for doors on individual small rooms, which may be permitted to swing in.
- For the purpose of fire protection, fire rated door and hardware supplied by two different agencies will be considered as non-fire rated in nature.
- Door frames do not necessarily require grouting to achieve fire rating. If needed, head frame members shall not be grouted with the grout mixture.

IS 3614-2021 : Key Points



- **Fire doors have been classified as insulated and uninsulated with criteria: 1) Integrity 2) Insulation**
- **Fire doors of two categories: Wooden – Upto 120mins integrity-120 mins. Insulation**

  Metal Door - Upto 120mins integrity-30 mins. Insulation

- ***Sizes* - Maximum door size for any hinged fire door compartment shall not exceed 7.2 m2 with the maximum permissible width of 2.4 m and height of 3.0 m. ***Size can be increased but not applicable for Insulated Door.**
- **All hardware to be used on fire rated door shall be components of a fire door assembly, supplied by the door manufacturer as a unit**
- **Validity: Time gap of testing should not exceed five years. However, in case of any material and design change, it should be tested and certified once again.**
- **Vision Panel: Maximum allowed glass size is 0.12 m2 (300mm x 400mm) for uninsulated door. For insulated doors the maximum glass shall not exceed more than 0.06 m2 (200mm x 300mm). The glass shall remain clear fire rated for the entire duration of intended test (for integrity) of the door assembly. Wired glass, not allowed, also interlayered glass or laminated gel glass, that becomes opaque and affects visibility shall not be used.**
- **Timber door set should be seasoned hardwood and moisture content should be upto 15%. Door frames should be supplied by the door manufacturer only.**

- For 120minutes rating-The minimum steel sheet thickness recommended for frames and shutter shall be 1.2 mm (18 gauge).
- Materials like resin bonded honeycomb paper core, mineral wool, ceramic wool and proprietary material may be used as infill, provided they satisfy the requirement of fire door rating.

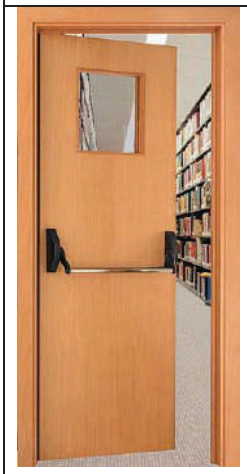
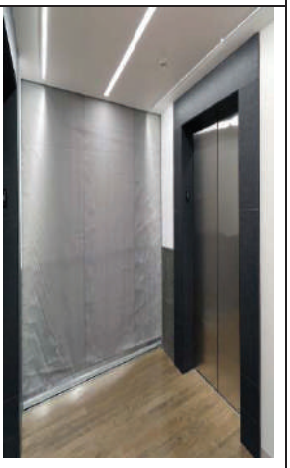
Polyurethane foam (PUF) as an infill material for fire doors shall not be permitted

- All fire doors are required to have smoke seal and intumescent seal as standard component of the door assembly
- All hardware used on fire doors shall be fire rated, and certified except Pull Handle and Hinges of size 100mm x 75mm x 3mm made out of stainless steel in SS 304 grade or above.
- Fire door shall not have the following hardware:
  1) Tower bolts 2) Aldrops 3) Slide bolts and 4) Chains with pad locks

Types of Fire Doors – size Limitations

Types of doors	Door width (mm)	Door Height(mm)	Vision panel
Insulated Fire Door (Wooden & Metal)	2400mm	3000mm	0.06 sqm (200mm x 300mm)
Un-Insulated Fire Door (Wooden & Metal)	3000mm	3000mm	0.12 sqm (300mm x 400mm)

NAVAIR PRODUCT RANGE

WOODEN Fire Door	METAL Fire Door	GLAZED Fire Door	Fire & Smoke Curtain
			
CBRI/IPRITI/NABL	CBRI/NABL/UL	CBRI/NABL/EXOVA	EXOVA
Upto 120 min	Upto 240 min	Upto 120 min.	Upto 240 min.

powering

Digitalisation

in public works

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