प्रधान मंत्री आवास योजना-शहरी
Pradhan Mantri Awas Yojana-Urban

GLOBAL HOUSING TECHNOLOGY CHALLENGE INDIA

Ministry of Housing and Urban Affairs
Government of India

Azadi Ka Amrit Mahotsav

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giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Light House Projects : LIVE LABORATORIES

WEBINAR SERIES: Volume 3 – International Perspective

e-Learning sessions on innovative techniques in new age construction

Aug – Sep 2023

Volume 3 -Session #03 on Light House Project Indore, Madhya Pradesh

Theme – International Perspective Innovative Technologies and Practices in LHPs

Date: 04.09.2023, Monday| Time: 15:00 – 17:00

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Light House Projects : Live Laboratories
Webinar Series

Emerging Construction Systems for Mass Housing

bmtpc

Building Materials & Technology Promotion Council
Ministry of Housing & Urban Affairs
Government of India

PMAY (U) Achievement (provisional)

[as on 28th August, 2023]

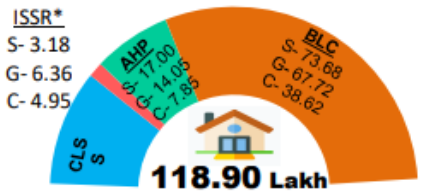
Overall Sanctions for 1.19 crore Houses

Construction of Houses (Nos in lakh)

Demand	Sanctioned	Grounded*	Completed*
112.24	118.90	113.17	76.45

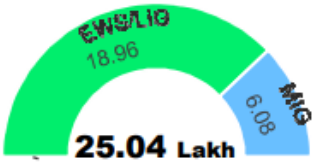
Financial Progress (₹ in Cr)

Committed	Released	Expenditure	UC Received
1,99,944	1,49,499	1,42,680	1,42,494

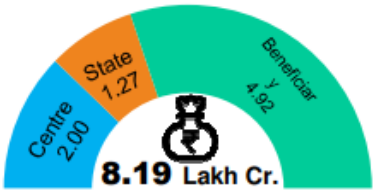


Houses in verticals (Nos in Lakh)

S- Sanctioned G- Grounded C- Completed



Beneficiaries under CLSS (in lakh)



Investment Approved (Rs in Lakh Cr.)

Interest Subsidy under CLSS (Rs in Cr.)

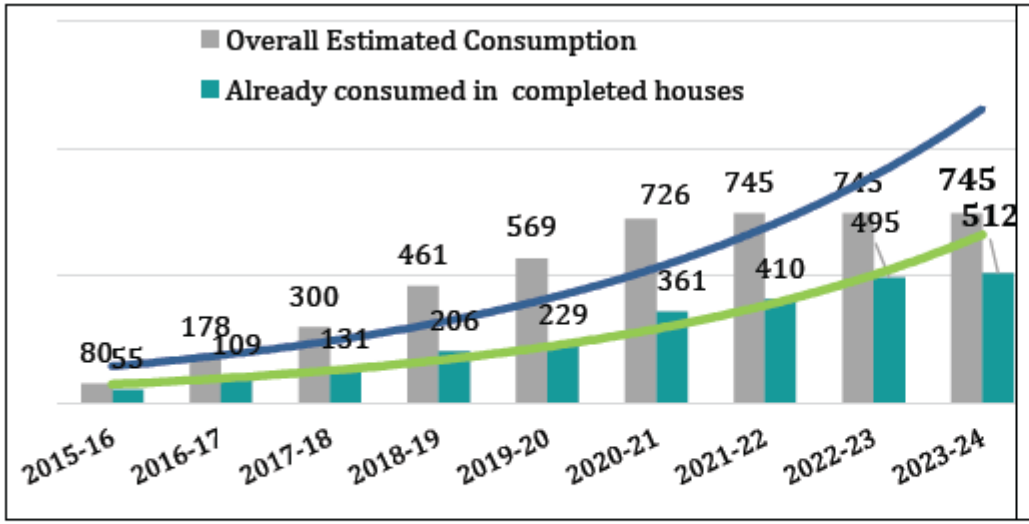
16 lakh houses are being constructed using New Technologies

16 lakh houses are being constructed using New Technologies

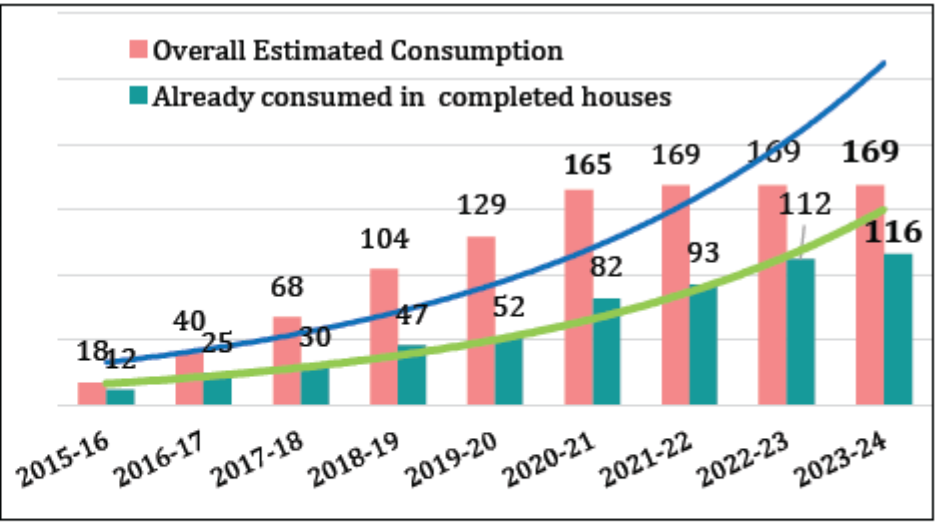
Generation of Employment

Details	Direct	Indirect	Total
Person days (Nos in Cr.)	259	587	**846**
Jobs (in lakh)	93	210	**303**

Cement Consumption (Lakh MT)



Steel Consumption (Lakh MT)



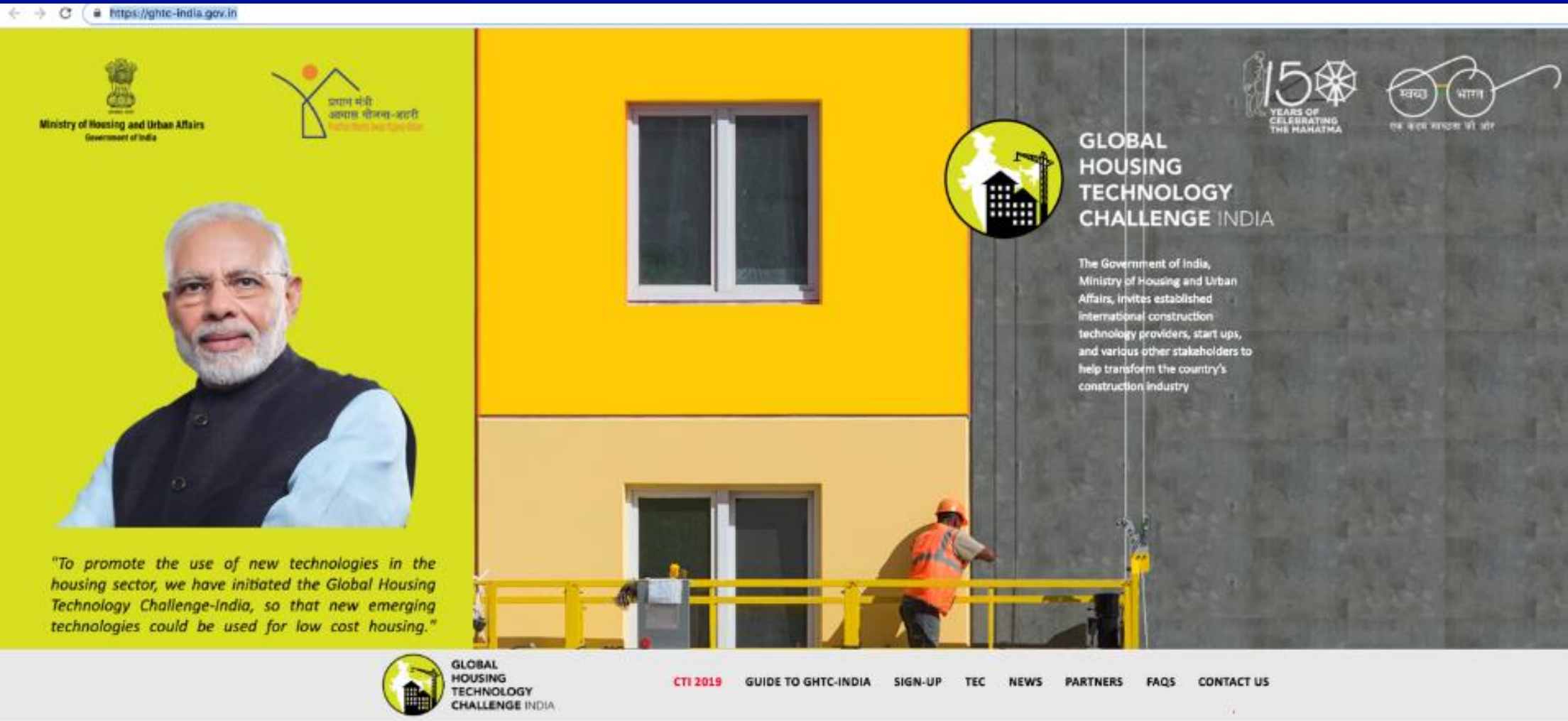
* *includes incomplete works of earlier NURM.*

सबका सपना, घर हो अपना

स्वच्छ भारत
एक कदम स्वच्छता की ओर

GLOBAL HOUSING TECHNOLOGY CHALLENGE INDIA

Global Housing Technology Challenge - India (GHTC-I)



https://ghtc-india.gov.in/

Global Housing Technology Challenge - India (GHTC-I)

Categories	Technology	Tech. Providers
1	***Precast Concrete Construction System - 3D Precast volumetric***	4
2	***Precast Concrete Construction System – Precast components assembled at site***	8
3	***Light Gauge Steel Structural System & Pre-engineered Steel Structural System***	16
4	***Prefabricated Sandwich Panel System***	9
5	***Monolithic Concrete Construction***	9
6	***Stay In Place Formwork System***	8
	Total	**54**

GLOBAL HOUSING TECHNOLOGY CHALLENGE INDIA

Light House Projects under GHTC-India

Location	Technology	Houses
	Prefabricated Sandwich Panel System	1,024
	Monolithic Concrete Construction System	1,144
	Precast Concrete Construction System-Precast Components Assembled at Site	1,152
	Precast Concrete Construction System-3D Pre-Cast Volumetric	1,008
	Light Gauge Steel Structural System & Pre-Engineered Steel Structural System	1,000
	Stay in-place Formwork System	1,040

- GHTC-India was launched to identify and mainstream innovative proven construction technologies from across the globe which are Cost-effective, Climate & Disaster Resilient, Sustainable and Green.
- Shortlisted Technologies will showcase 6 Light House Projects (LHPs) in 6 States through challenge process as **Live Laboratories.**
- **3S** Mantra of Skill, Scale & Speed for superior quality of construction

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स्वच्छ भारत
एक कदम स्वच्छता की ओर

GLOBAL HOUSING TECHNOLOGY CHALLENGE INDIA

Light House Projects

Hon'ble Prime Minister laid the foundation stone of six LHPs on 01.01.2021

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Conventional Construction Systems

business as usual approach

The prevalent construction systems in India are:

Load bearing Structure

In this system, walls are constructed using bricks/stone/block masonry and floor/roof slabs are of RCC/stone/composite or truss. It is cast in-situ system and called load bearing system as load of structure is transferred to foundation and then to ground through walls.

RCC Framed Structure

In this cast in-situ system, the skeleton of a structure is of RCC column and beam with RCC slab. The infill walls can be of bricks/blocks/stone /panels. The load of the structure is transferred through beam and column to the foundation.

Conventional Construction Systems	Alternate Construction Systems
Slow	Fast
Maximum Use of Natural Resources	Optimum use of Resources
Waste Generation	Minimum Waste
Air/Land/Water Pollution	Minimum Pollution
Labour Intensive	Industrialized System
Prescriptive Design	Cost-effective Design
Unhealthy Indoor Quality	Better health & Productivity
Regular Maintenance	Low Life Cycle Cost
Energy Intensive	Energy Efficient
Cast-in-situ Poor Quality	Factory Made Quality Products
High GHG Emissions	Low GHG Emissions
Unsustainable	Sustainable

3D Precast Volumetric Construction

- Replacing cast in situ RCC structural frame with factory made structural components – 3D
- Customized factory made volumetric construction i.e. the entire module (room)

3D MONOLITHIC VOLUMETRIC Construction

Courtesy :

Global Housing Technology Challenge - India (GHTC-I)

1 Precast Concrete Construction System – 3D Volumetric

1	Pre-cast concrete system with columns, beams, walls, slabs, hollow core slabs & also 3D Volumetric components	Katerra
2	Vertical structural modules cast in Plant/Casting yard are assembled together through casting of floor panel. The unit is transported & installed at site.	Moducast Pvt. Ltd
3	3D Modular casting using steel mould and high performance concrete of building modules in factory. These pods are transported to the construction site & assembled	Magicrete Building Solutions,
4	Modules with 3D Volumetric Precast concrete unit, various units make on house	Ultratech Cement Ltd,

Light House Project (LHP) at Ranchi, Jharkhand

(Technology: Precast Concrete Construction – 3D Volumetric Construction)

No. of Dwelling Units : 1008 Nos. (G+8)
No. of Block / Tower : 7 Blocks
Units in each Block / Tower : 144 Nos.

Light House Project: Ranchi, Jharkhand

Construction Agency	M/s SGC Magicrete LLP
Technology Used	Precast Concrete Construction System – 3D Volumetric
No. of Houses	1,008
No. of Towers	07 (G+8)
Technology brief	• A latest technology where precast concrete **structural modules** like room, toilet, kitchen, bathroom, stairs etc. & any combination of these are cast monolithically in casting yard under controlled condition. • These Modules are **transported and installed** using cranes & push-pull jacks and integrated together at site to form a complete building unit.

Construction Process

1 **Casting of structural modules & slabs in the casting yard**

2 **Placement of modules at site** using cranes

3 **Placement of pre cast floors on already erected structured modules**

4 **Step 2 & 3 are repeated like Lego Blocks to complete a Tower**

Precast Concrete Construction System – 3D Volumetric

Advantages

- Upto 90% of the building work including finishing is complete in plant/casting yard leading to significant reduction in construction & occupancy time
- The controlled factory environment brings resource optimization, improved quality, precision & finish
- The required concrete can be designed using industrial by-products such as Fly Ash, Ground granulated blast furnace slag (GGBS), Micro silica etc. resulting in improved workability & durability, while also conserving natural resources. In this project Ground granulated blast furnace slag has been used in concrete.
- With smooth surface it eliminates use of plaster
- The monolithic casting of walls & floor of a building module reduces the chances of leakage
- The system has minimal material wastage (saving in material cost), helps in keeping neat & clean construction site and dust free environment
- Use of optimum quantity of water through recycling
- Use of shuttering & scaffolding materials is minimal
- All weather construction & better site organization

2D Precast Concrete Construction

- Replacing cast in situ RCC structural frame with factory made structural components – 2D planar elements
- Customized Factory made beams, columns, wall panels, slab/floors, staircases etc.

Concrete components prefabricated in precast yard or site and installed in the building during construction

2

Precast Concrete Construction System – Precast components assembled at site

1	Precast Large Concrete Panel (PLCP) System with structural members (wall, slab etc.) cast in a factory/ casting yard and brought to the building site for erection & assembling	Larsen & Toubro
2	Pre-cast Concrete Structural system comprising of pre-cast column, beam, precast concrete / light weight slab, AAC blocks/ infill concrete walls.	B.G. Shirke Construction Technology Pvt. Ltd
3	Optimal Pre-cast concrete System through structural Analysis, design & equipment support	Elematic India,
4	Precast concrete construction system using precast walls with precast plank floor	PG Setty Construction Technology Pvt Ltd,
5	Precast components comprising of beams, coloumns, staircase, slab, hollow core slab etc. manufactured in plant & erected on site	Teemage
6	Pre-cast sandwich panel system & Light weight Pre cast Light Weight concrete slab	Nordicflex
7	Prefabricated Interlocking Technology (without mortar) with Roofing as Mechnized Precast R.C. Plank & Joist system	Adalakha Associates Pvt. Ltd
8	Large Hollow wall prefab concrete Panel (lightweight, interlocking, concrete panel) using factory produced large standard hollow interlocking concrete block	William Ling,

Light House Project (LHP) at Chennai, Tamil Nadu

(Technology: Precast Concrete Construction System-Precast Components)

No. of Dwelling Units : 1152 Nos. (G+5)
No. of Block / Tower : 12 Blocks
Units in each Block / Tower : 96 Nos.

Light House Project: Chennai, Tamil Nadu

Construction Agency	M/s B.G. Shirke Constriction Private Ltd.
Technology Used	Precast Concrete Construction System - Precast Components Assembled at Site
No. of Houses	1,152
No. of Towers	12 (G+5)
Technology Brief	• Individual **precast building components** (columns & beams, slabs, stairs etc.) are manufactured in the **casting yard** under controlled conditions. • Finished components are then transported to site, erected & assembled through in-situ concreting **(wet jointing).**

Construction Process

1 **Manufacturing** of Pre-cast building components (columns & beams, slabs, stairs etc.) in casting yard

2 **Transportation & Erection** of Pre- cast beams & columns at site

3 **Placement** of pre-cast slabs & **Assembly** through in-situ concreting (wet jointing) with beam and columns

4 **Infill walls** constructed using Autoclaved Aerated Concrete (AAC) Block masonry along with **services** (electricity, plumbing) followed by plastering

Precast Concrete Construction System-Precast Components Assembled at Site

Advantages

- Quality of construction is enhanced significantly due to pre-casting of components by using sophisticated moulds and machineries in factory like environment, assured curing, assured specified cover to reinforcement, proper compaction of concrete results in to dense and impermeable concrete etc. Thus lesser maintenance cost during lifetime of project.
- Inbuilt eco-friendly method of construction in terms of more off-site works in controlled factory like environment results in to significant reduction in wastage of water, natural resources, air pollution and noise pollution.
- Safety of workforce achieved automatically as most of the works are carried out at ground floor in factory like environment, which ultimately enhances the work efficiency and quality.
- Wooden shuttering material is completely avoided and wastage of other construction materials reduced significantly; which results in to conservation of scarce natural resources like soil, sand, aggregate, wood etc.
- Advance procurement of major construction materials, advance pre-casting of structural components and assured completion of work within stipulated completion period will save cost towards escalation & early returns on investments, thus Substantial cost benefit to the client.

PRE-ENGINEERED STEEL STRUCTURAL SYSTEM

- Replacing cast in situ RCC structural frame with factory made steel (hot rolled) structural system

Steel skeleton with Aerocon panel infills

LIGHT GAUGE STEEL STRUCTURAL SYSTEMS

- **Replacing cast in situ RCC structural frame with factory made light gauge steel (cold rolled) structural system**

GLOBAL HOUSING TECHNOLOGY CHALLENGE INDIA

Global Housing Technology Challenge - India (GHTC-I)

3

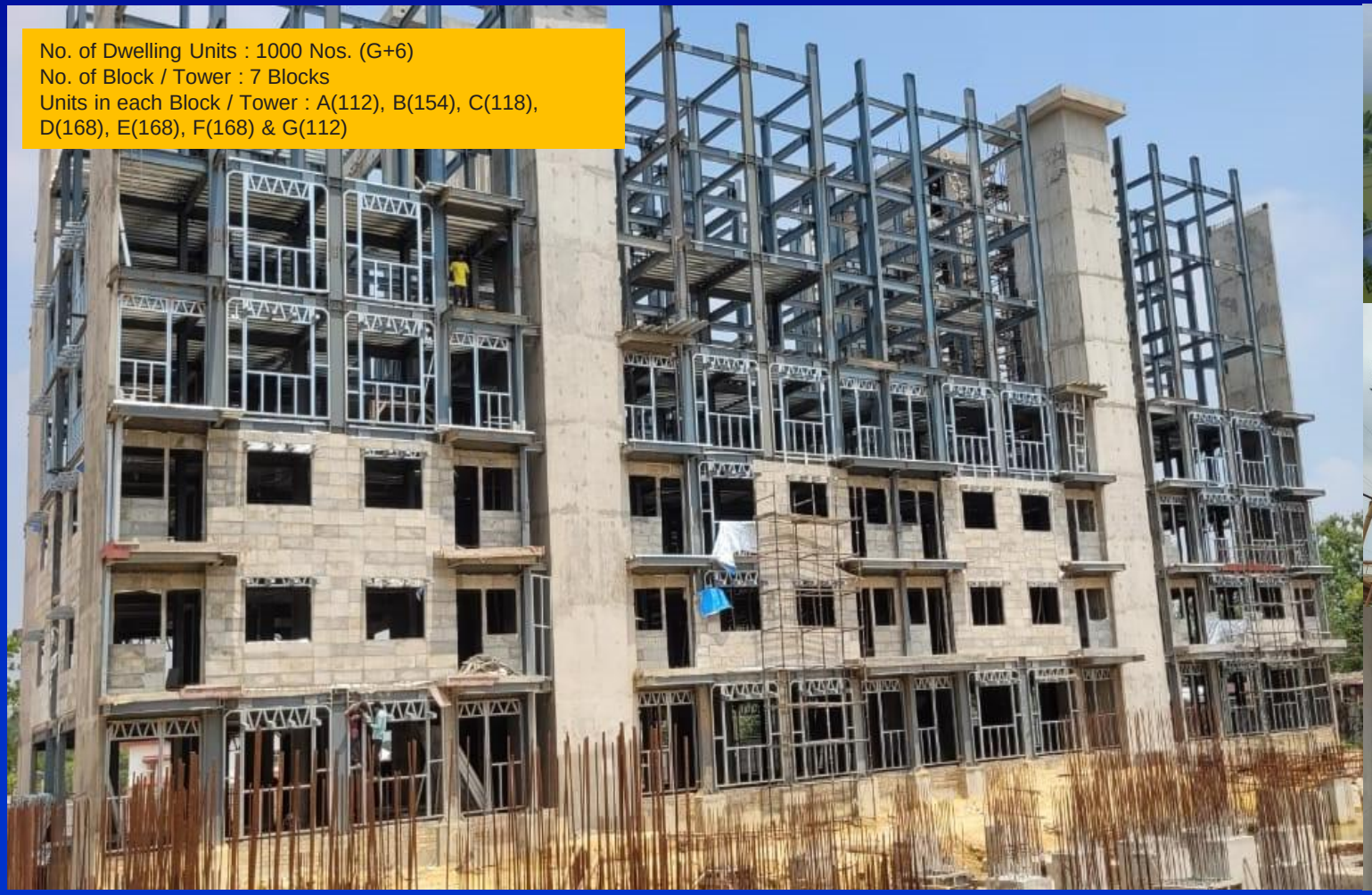
Light Gauge Steel Structural System & Pre-engineered Steel Structural System

1	LGS Framing with various walling & roofing options	Mitsumi Housing Pvt. Ltd,
2	LGS Framing with various walling & roofing options	Everest Industries Ltd,
3	LGS Framing with various walling & roofing options	JSW Steel Ltd.,
4	LGS Framing with various walling & roofing options	Society for Development of Composites
5	LGS Framing with various walling & roofing options	Elemente Designer Homes
6	LGS Framing with various walling & roofing options	MGI Infra Pvt. Ltd.,
7	LGS Framing with various walling & roofing options	RCM Prefab Pvt. Ltd,
8	LGS Framing with various walling & roofing options	Nipani Infra and Industries Pvt. Ltd.,
9	LGS Framing with various walling & roofing options	Strawcture Eco
10	LGS Framing with various walling & roofing actions	Visakha Industries Ltd.
11	Prefabricated steel structural system with Dry wall system as AAC panels, PUF panels etc	RCC Infra Ventures Ltd.
12	Hot rolled steel frame with speed floor	Jindal Steel & Power Ltd.
13	Hot rolled steel section with AAC Panels as floor & slab	HIL Ltd.
14	AAC wall and roof panel system to provide integrated solution. AAC products are reinforced and used in both load and non-load bearing applications	Biltech Building Elements Ltd
15	AAC Panels are Wire mesh/ steel reinforced for use as wall & slab. Appears to be non load bearing panels to be used with structural framing.	SCG International India Pvt Ltd
16	Precast Light Weight Hollow-core wall Panel is a non-structural construction material with framed structures.	Pioneer Precast Solutions Private Limited

Light House Project (LHP) at Agartala, Tripura

(Technology: Light Gauge Steel Structural System & Pre-Engineered Steel Structural System)

No. of Dwelling Units : 1000 Nos. (G+6)
No. of Block / Tower : 7 Blocks
Units in each Block / Tower : A(112), B(154), C(118), D(168), E(168), F(168) & G(112)



Light House Project: Agartala, Tripura

Construction Agency	M/s Mitsumi Housing Pvt. Ltd
Technology Used	Light Gauge Steel Framed (LGSF) System with Pre-engineered Steel Structural System
No. of Houses	1,000
No. of Towers	07 (G+6)
Technology brief	• This system uses factory made galvanized **Light Gauge Steel** wall components in combination with pre-engineered steel structural system for structure • The light gauge steel wall sections are **assembled at site** which are then cladded with concrete panels on both sides and filled with light weight concrete.

Construction Process

1 **Customised steel columns & beams** manufactured in the factory are erected at site

2 **Erection** of factory made **LGSF panels** and **Fixing** of Precast concrete panels for walling

3 **Filling of light weight concrete** between the wall panels

4 **Deck slab installation** in already erected steel structure & **Concreting with services**

Advantages:

Light Gauge Steel Frame (LGSF):

- Due to light weight, significant reduction in design earthquake forces is achieved. Making it safer compared to other structures.
- Fully integrated computerised manufacturing of LGSF sections provide very high precision & accuracy.
- Speedier
- Structure being light, does not require heavy foundation
- Structural elements can be transported to any place including hilly areas/ remote places easily
- Structure can be shifted from one location to other with minimum wastage of materials.
- Steel used can be recycled multiple times
- The system is very useful for post disaster rehabilitation work.

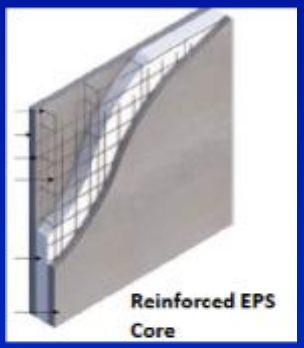
Advantages:

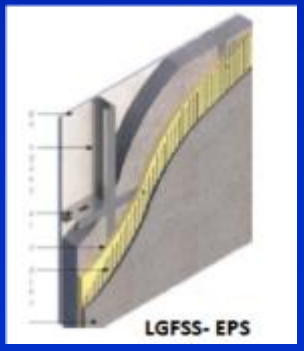
(Hot Rolled Steel):

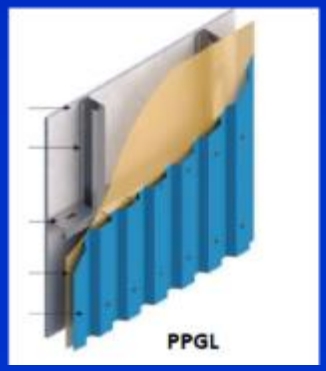
- The building system offers flexible design option with diverse layout possibilities/ architecture.
- Helps achieve very fast installation with various dry wall options
- Steel structures are pre-fabricated, manufactured under controlled factory environments. This ensures quality and durability of the component.
- All steel structures are 100% recyclable
- It is highly advantageous in building and infrastructure projects with long spans

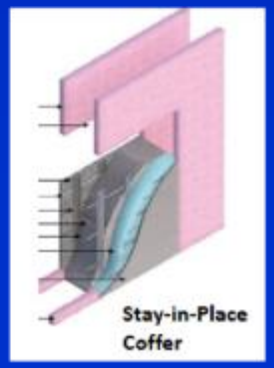
PREFABRICATED SANDWICH PANEL SYSTEMS

- **EPS Core Panel Systems**
- **Other Sandwich Panel Systems**
  - **Fibre cement board**
  - **MgO Board**
  - **AAC panels**









- **Replacing brick and mortar walls with dry customized walls made in factory**

SINGLE

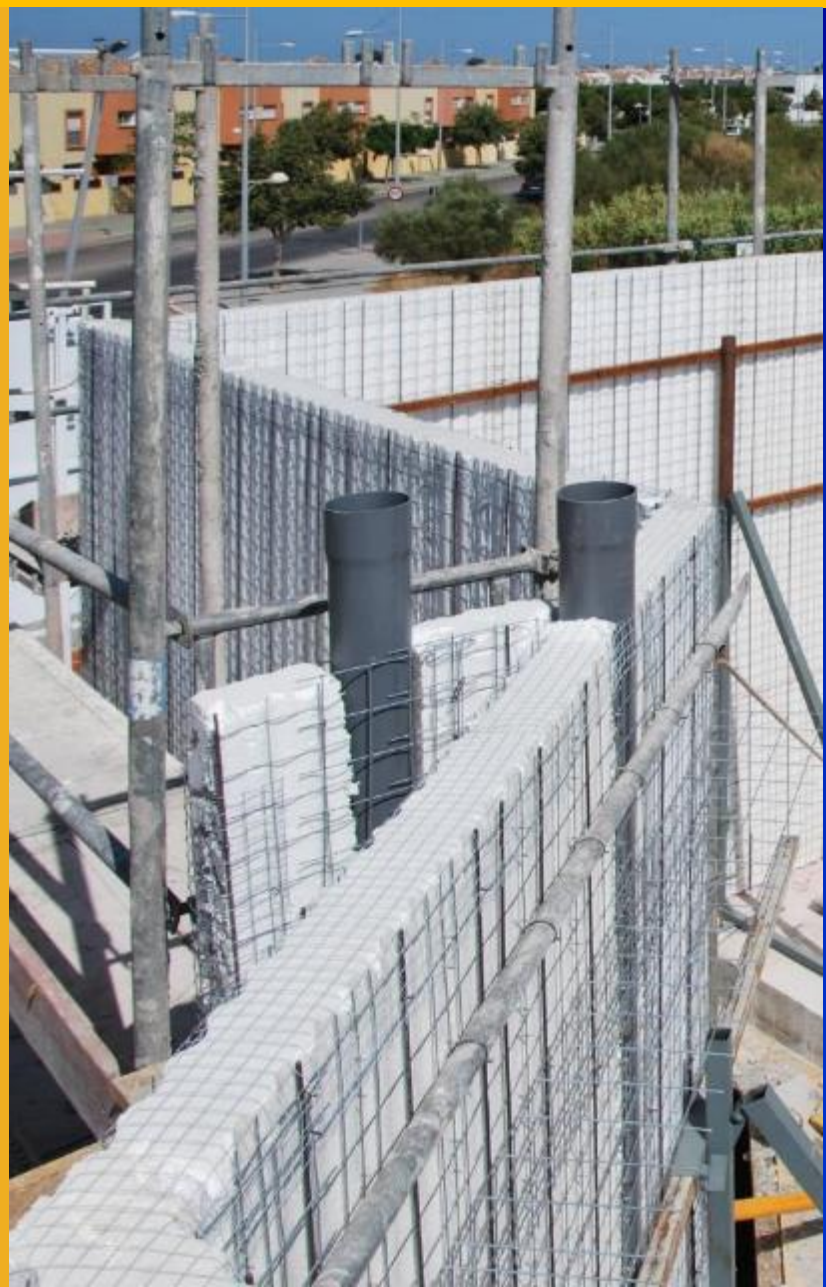
DOUBLE

Global Housing Technology Challenge - India (GHTC-I)

4

Prefabricated Sandwich Panel System

1	Reinforced Expanded Polystyrene sheet core Panel with sprayed concrete as wall & slab	Worldhaus
2	EPS Cement sandwich Panel: wall & slab with EPS Cement sandwich Panel to be used with RCC or Steel structural frame. Load bearing upto G+1 storey	Bhargav Infrastructure Pvt.Ltd
3	EPS Cement sandwich Panel: wall & slab with EPS Cement sandwich Panel to be used with RCC or Steel structural frame. Load bearing upto G+1 storey	Rising Japan Infra Private Limited
4	Reinforced Expanded Polystyrene sheet core Panel with sprayed concrete as wall & slab	Bau Panel Systems India Pvt Ltd,
5	Reinforced Expanded Polystyrene sheet core Panel with sprayed concrete as wall & slab	BK Chemtech Engineering
6	Reinforced Expanded Polystyrene sheet core Panel with sprayed concrete as wall & slab	MSN Construction
7	Reinforced Expanded Polystyrene sheet core Panel with sprayed concrete as wall & slab	Beardshell Ltd.
8	Pre-fab PIR (Poly-isocyanurate) based Dry Wall Panel System" as non-load bearing wall	Covestro India Pvt. Ltd.,
9	Sandwich panels as wall & slab	Project Etopia Group



Light House Project (LHP) at Indore, M.P.

(Technology: Prefabricated Sandwich Panel System & Pre-Engineered Steel Structural System)

No. of Dwelling Units : 1024 Nos. (S+8)
No. of Block / Tower : 8 Blocks
Units in each Block / Tower : 128 Nos.

Light House Project: Indore, Madhya Pradesh

Construction Agency	M/s KPR Construction Pvt. Ltd
Technology Used	Prefabricated Sandwich Panel System with Pre-Engineered Steel Structural System
No. of Houses	1,024
No of Towers	08 (S+8)
Technology brief	• The **factory-made Prefabricated Sandwich Panel System** comprises of core cement mortar with EPS granules balls sandwiched between calcium silicate boards on both sides. • These panels are being used in combination with **pre-engineered steel structural system as a dry wall construction** in this project.

Construction Process

1 **Customised steel columns & beams** manufactured in the factory are erected at site

2 **Deck slab installation in already erected steel structure**

3 **Concreting** of deck slabs with reinforcement along with **services**

4 **Factory made Prefabricated sandwich panels** are installed as infilled walls along with services

Rising EPS (Beads) Cement Panels

- Rising EPS (Beads) Cement Panels are patented panels from M/s Rising Japan Infra Pvt. Ltd. These are lightweight composite wall, floor and roof sandwich panels made of thin fiber cement/calcium silicate board as outer and inner faces with a core of EPS granule balls, adhesive, cement, sand, fly ash and other bonding materials in mortar form.
- The core material in slurry state is pushed under pressure into preset molds. Once set, it shall be moved for curing and ready for use with RCC or steel framed structure.
- These panels are presently manufactured by the firm in China and now plants are operational in Pune & Nagpur.

Advantages

- The system is dry walling system, brings speed in construction, water conservation (no use of water for curing of walling components at site).
- The sandwich panels have light weight material as core material, which brings resource efficiency, better thermal insulation, acoustics & energy efficiency
- Being light in weight, results in lower dead load of building & foundation size.

MONOLITHIC CONCRETE CONSTRUCTION

- Replacing cast-in-situ Formwork with factory made customized formwork systems
- Formwork material is Aluminium / composites / steel having 100 to 500 repetitions
- Assembly line construction i.e. placing the formwork, pouring the concrete, moving the formwork to upper level

Global Housing Technology Challenge - India (GHTC-I)

5

Monolithic Concrete Construction

1	Aluminium formwork system for Monolithic Concrete construction	Maini Scaffold Systems
2	Aluminium formwork system for Monolithic Concrete construction	KumkangKind India Pvt. Ltd
3	Aluminium formwork system for Monolithic Concrete construction	S-form India Pvt. Ltd.,
4	Aluminium formwork system for Monolithic Concrete construction	ATS Infrastructure Ltd.
5	Aluminium formwork system for Monolithic Concrete construction	Innovative housing & Infrastructure Pvt. Ltd
6	Aluminium formwork system for Monolithic Concrete construction	MFS formwork Systems Pvt. Ltd.
7	Aluminium formwork system for Monolithic Concrete construction	Knest Manufacturers LLP
8	'Tunnel form' construction technology, an cast in situ RCC system, based on the use of high-precision, re- usable, room-sized, steel forms or moulds for monolithic concrete construction	Outinord Formworks Pvt. Ltd.
9	Aluminium formwork system for Monolithic Concrete construction	Brilliant Etoile

Light House Project (LHP) at Rajkot, Gujarat

(Technology: Monolithic Concrete Construction System)

No. of Dwelling Units : 1144 Nos. (S+13)
No. of Block / Tower : 11 Blocks
Units in each Block / Tower : 104 Nos.

Light House Project: Rajkot, Gujarat

Construction Agency	M/s Malani Construction Co.
Technology Used	Monolithic Concrete Construction using Tunnel Formwork
No. of Houses	1,144
No. of Towers	11 (S+13)
Technology brief	• **Reinforced Concrete walls and slabs** are cast monolithically in single pour (one go) using Tunnel Form work. • It is a customized engineered steel formwork consisting of **two half shells** which are placed together and then **concreting** is done to form a room size module. Several such modules make a house.

Construction Process

1 **Customised Tunnel Formwork** (mould) of steel manufactured in the factory

2 **Placement of Tunnel formwork** in already erected reinforcement cage for walls at site

3 **Placement of slab reinforcement & Concreting** of walls & slabs together in one go along with **services** (electricity,

4 **Infill walls** constructed using Autoclaved Aerated Concrete (AAC) Block followed by plastering

Advantages

- Facilitates rapid construction of multiple/ mass modular units (similar units)
- Results in durable structure with low maintenance requirement
- The precise finishing can be ensured with no plastering requirement
- The concrete can use industrial by-products such as Fly Ash, Ground granulated blast furnace slag (GGBFS), Micro silica etc. resulting in improved workability & durability, while also conserving natural resource
- Being Box type structure, highly suitable against horizontal forces (earthquake, cyclone etc.)
- The large number of modular units bring economy in construction

STAY-IN-PLACE FORMWORK SYSTEM

- Replacing cast-in-situ Formwork with factory made formwork systems
- It is sacrificial formwork or lost formwork means formwork is left in the structural system to later act as insulation or reinforcement cage

6

Stay In Place Formwork System

1	Expanded-Steel Panel reinforced with all- galvanised Steel Wire-Struts serving both as the load- bearing steel structure and as the stay-in-place steel formwork filled with EPS-alleviated concrete	JK Structure
2	Factory made prefab Glass fibre reinforced Gypsum cage panels suitable for wall & slab with reinforcement & concrete as infill as per the requirement	FACT-RCF Building Products Limited
3	Structural Stay In Place Galvanized Steel formwork system for walling with the same bottom single layer formwork for slabs/ in-situ slab	Coffor Construction Technology Pvt.Ltd
4	Factory produced PVC Stay in place formwork with concrete & reinforcement in walling units with cast insitu RCC Slab	Joseph Jebastin (Novel Assembler)
5	Fully load bearing walls with 150 mm monolithic concrete core sandwiched inside two layers of EPS as walling The forms are open ended hollow polystyrene interlocking blocks which fits together to form shuttering system	Reliable Insupack
6	Ready to use Stay in place polymer formwork, light weight, with flooring slab (combination of ferro cement and natural stone) placed on RCC precast joists)	Kalzen Realty Pvt. Ltd
7	Fast Bloc, Insulated Concrete Form (ICF), acts as formwork for concrete and rebar, Co1oumn/post and beam construction, creating an strong skeleton in the walls.	Fastbloc Building Systems
8	Formwork system "Plaswall with Two fibre cement boards (FCB) & HIMI (High Impact Molded Inserts) bonded between two sheets of FCB in situ and erected to produce a straight-to finish wall with in-situ concrete	FTS Buildtech Pvt.Ltd

Light House Project (LHP) at Lucknow, U.P.

(Technology: Stay in-place Formwork System & Pre-Engineered Steel Structural System)

No. of Dwelling Units : 1040 Nos. (S+13)
No. of Block / Tower : 4 Blocks
Units in each Block / Tower : A(494), B(130), C(208) & D(208)

Light House Project: Lucknow, Uttar Pradesh

Construction Agency	M/s Jam Sustainable LLP
Technology Used	Stay in Place PVC Formwork with Pre-Engineered Steel Structural System
No. of Houses	1,040
No. of Towers	04 (S+13)
Technology brief	• Poly-vinyl Chloride (PVC) based permanent stay-in-place form work acting as pre finished walls filled with concrete which requires no plaster and paint • These pre finished walls are used in combination with Pre-Engineered Steel Structural System

Construction Process

1 **Customised steel columns & beams** manufactured in the factory are erected at site

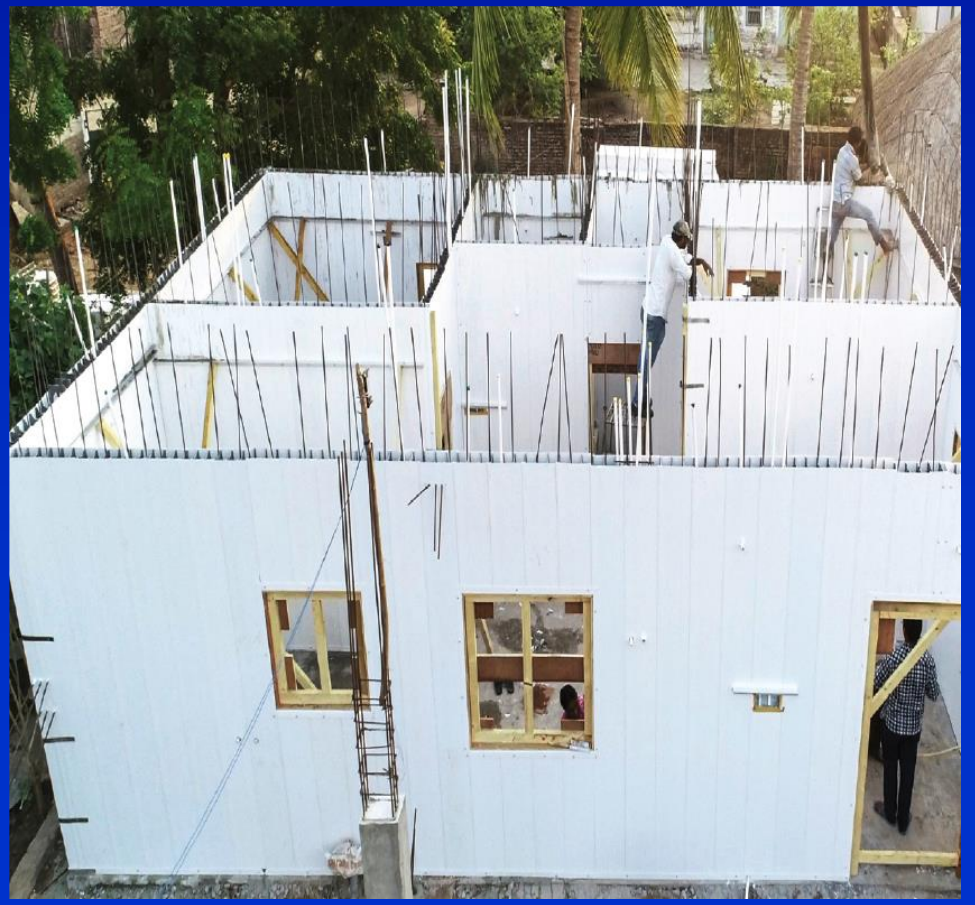
2 **Deck slab installation** in already erected steel structure & **Concreting with services**

3 **Factory made prefinished PVC Wall forms** are installed as infilled walls along with services

4 **Filling of infill walls with concrete**

Stay-In-Place PVC Wall Forms

- This is a prefinished wall formwork from M/s Novel Assembler Pvt. Ltd. comprising of rigid Poly-Vinyl Chloride (PVC) based polymer components that serve as a permanent stay-in-place durable finished form-work for concrete walls.



- The extruded components slide and interlock together to create continuous formwork with the two faces of the wall connected together by continuous web members forming hollow rectangular components. The web members are punched with oval-shaped cores to allow easy flow of the poured concrete between the components.
- The hollow Novel Wall components are erected and filled with concrete, in situ, to provide a monolithic concrete wall.

Stay in Place PVC formwork System

Advantages

- Having formwork already as part of system, the construction of building is faster as compared to conventional buildings. The formwork needs some support only for alignment purpose.
- The formwork consists of rigid PVC components, which do not corrode, chip or stain & resistant to UV, bacteria, fungi etc., thus ensuring long life of the structure.
- The polymer content used in manufacturing of formwork is up to 55% recycled content and are further recyclable, making it an eco-friendly material.
- The form work system has specific advantage for use in coastal areas as due to polymer encasement it offers higher durability.
- With concrete as filling material, the curing requirement of concrete is significantly reduced, thus saving in precious water resources.
- The formwork system does not have plastering requirement & gives a aesthetic finished surface in different color options.
- The system provides advantages in terms of structural strength, durability enhancement, weather resistance, flexural strength, thermal insulation and ease of construction.

Conventional Construction Systems	Alternate Construction Systems
Slow	Fast
Maximum Use of Natural Resources	Optimum use of Resources
Waste Generation	Minimum Waste
Air/Land/Water Pollution	Minimum Pollution
Labour Intensive	Industrialized System
Prescriptive Design	Cost-effective Design
Unhealthy Indoor Quality	Better health & Productivity
Regular Maintenance	Low Life Cycle Cost
Energy Intensive	Energy Efficient
Cast-in-situ Poor Quality	Factory Made Quality Products
High GHG Emissions	Low GHG Emissions
Unsustainable	Sustainable

Emerging construction systems help to build

SAFER structures

Sustainable Buildings

- 30%-50% reduction in energy use
- 40% reduction in water use
- 35% reduction in GHG emission
- 75% reduction in waste

E Economical - low life cycle cost, better quality

R Resilient - disaster-resistant, structurally superior

Adoption of New Technologies by States

AHP houses in Pune, Maharashtra using Precast Construction Technology

- Around **16 Lakh houses** are being built using innovative technologies under PMAY(U) & other state schemes.

State	Technology
Andhra Pradesh	EPS, Monolithic and Steel Technology
Chhattisgarh	Monolithic and Precast Technology
Gujarat	Monolithic, Precast (Waffle-crete)
Kerala	Glass Fibre Reinforced Gypsum (GFRG)
Maharashtra	Precast (3S) & Monolithic Technology
Odisha	Precast concrete construction
Jharkhand	Global Tender floated
Tamil Nadu	Precast Concrete Technology
States like Assam, Karnataka, Madhya Pradesh, Telangana & Uttarakhand have also expressed interest in Technology neutral bidding process	

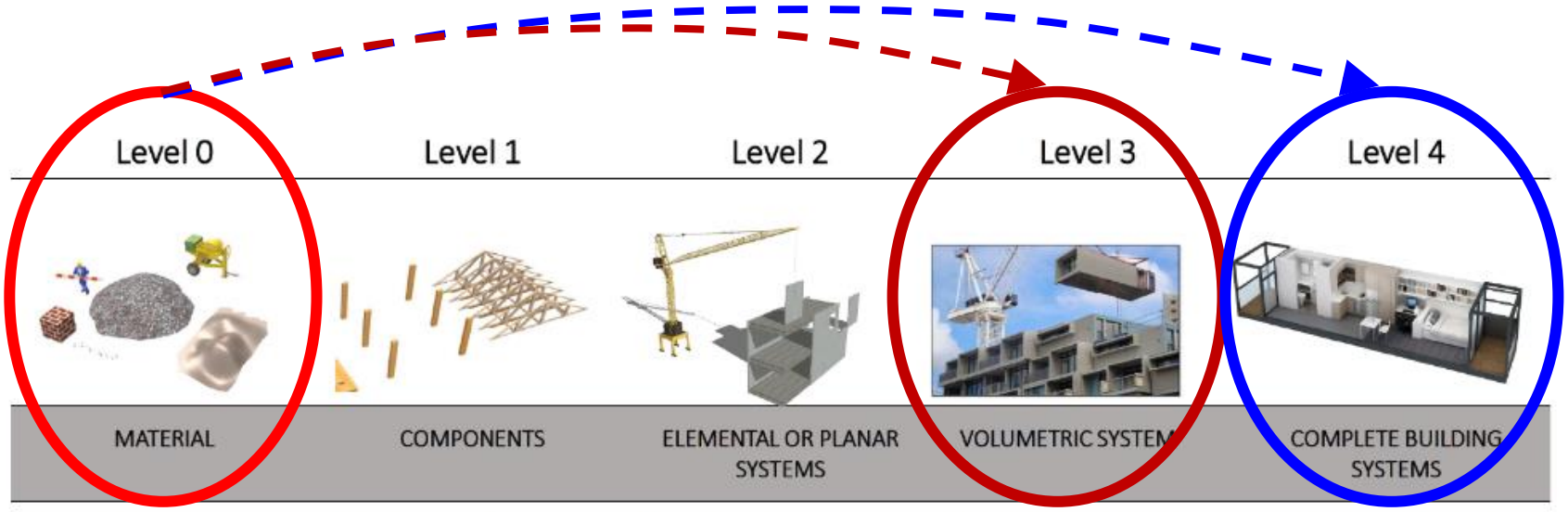
54
Alternate technologies Identified

54
technologies approved by CPWD

34
SoRs issued for alternate technologies by CPWD (27+7)

Looking Back / Rear view

Levels of Construction Technology



Level 0	Level 1	Level 2	Level 3	Level 4
Basic materials for site-intensive construction ✓ Involves more Labour ✓ Time consuming	Manufactured components ✓ Fabricated in Factory ✓ Can't be build On-site ✓ Assist in construction speed & quality	Linear or 2D components ✓ Series of Pre fabricated elements assembled to form the shell ✓ Requires on-site work	3D components in the form of modules ✓ Volumetric, forms a completed part of the building ✓ Involves more than one trade in the factory	Modular components - fully finished and delivered to site ✓ Finished interior & exterior surfaces ✓ Less on-site work

Source: Gibb., A.G.F., *Off-site Fabrication—Pre-Assembly, Pre-Fabrication, and Modularization*

Courtesy : hoMission Abode All

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"Creating Enabling Environment for Affordable Housing for All"

Light House Projects : LIVE LABORATORIES

WEBINAR SERIES: Volume 3 – International Perspective

e-Learning sessions on innovative techniques in new age construction

Aug – Sep 2023

Volume 1 - Session #04 on Light House Project
Lucknow, UP

Date: 18.09.2023, Monday| Time: 15:00 – 17:00

प्रधान मंत्री आवास योजना-शहरी
Pradhan Mantri Awas Yojana-Urban

GLOBAL HOUSING TECHNOLOGY CHALLENGE INDIA

सत्यमेव जयते

Ministry of Housing and Urban Affairs
Government of India

स्वच्छ भारत
एक कदम स्वच्छता की ओर

LIGHT HOUSE PROJECT AT LUCKNOW

GHTC-India Category

Stay in Place Formwork System

Technology:

Stay In Place Formwork System with Pre-Engineered Steel Structural System

CONTENTS

- Six Light House Projects
- LHP at Lucknow
- Technology being used
- Structural Elements
  - Foundation
  - Structural System
  - Floor/ Roof Slab
  - Wall Panels
- Stay in Place PVC Formwork System
- Design Basis
- Construction Sequence
  - Foundation
  - Structural System
  - Floor/ Roof Slab
  - Wall Panels
  - MEP
  - Finishing
- Other Infrastructure Items

Summary of Six Light House Projects (LHPs)

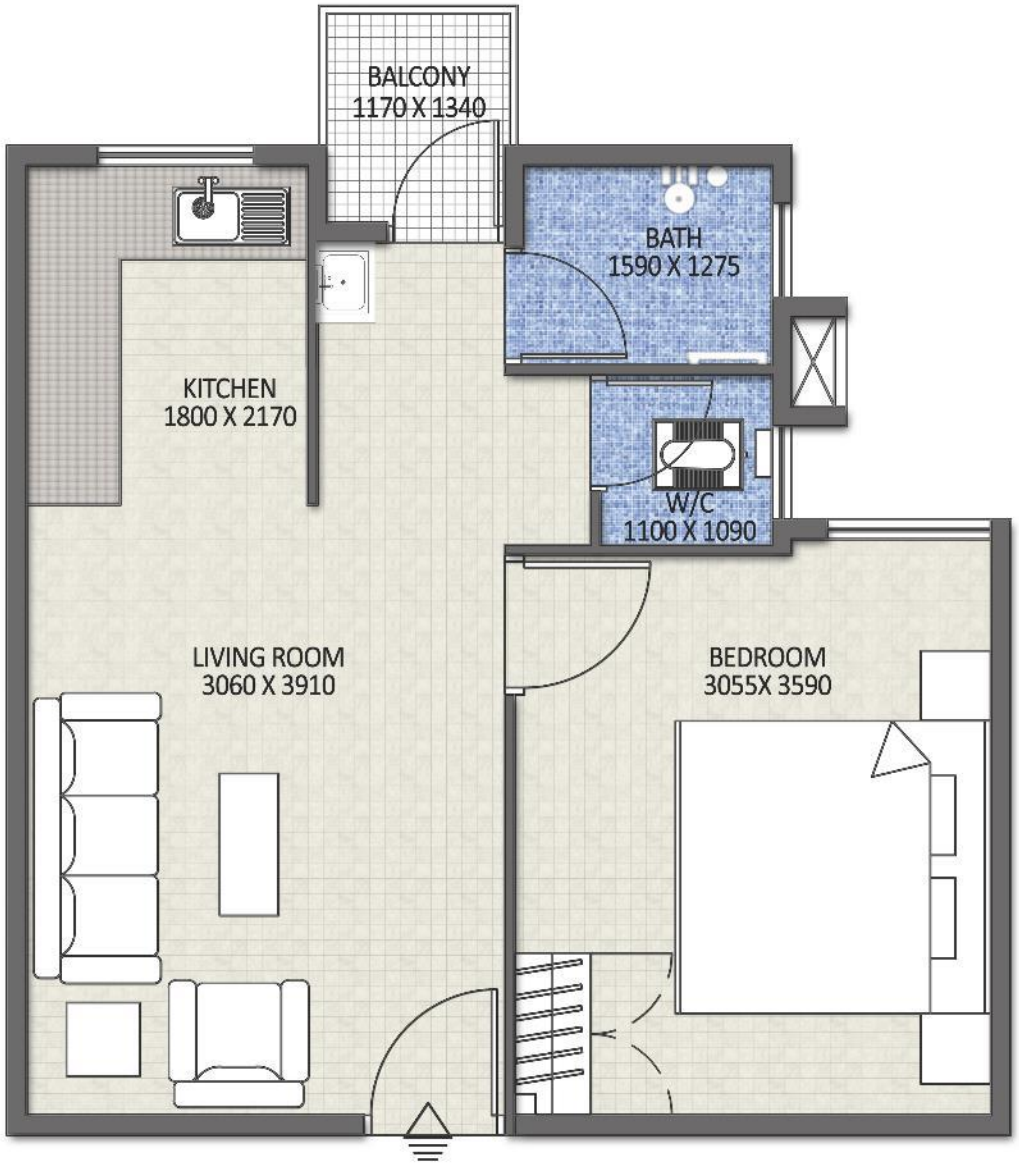
LHP Location			Chennai (Tamil Nadu)	Rajkot (Gujarat)	Indore (Madhya Pradesh)	Ranchi (Jharkhand)	Agartala (Tripura)	Lucknow (Uttar Pradesh)
Sl. No	**Particulars**	**Units**						
1	Name of Technology	Name	Precast Concrete Construction System-Precast Components	Monolithic Concrete Construction using Tunnel Formwork	Prefabricated Sandwich Panel System	Precast Concrete Construction System – 3D Volumetric	Light Gauge Steel Frame System (LGSF) with Pre-Engineered Steel Structural System	Stay in Place Formwork System
2	No. of Houses	No.	1,152	1,144	1,024	1,008	1,000	1,040
3	No. of Floors	No.	G+5	S+13	S+8	G+8	G+6	S+13
4	Plot Area	Sqm	33,596	39,599	41,920	31,160	24,000	20,000
5	Per House Carpet Area	Sqm	26.58	39.77	29.04	29.85	30.00	34.50
6	Project Cost	INR (in Cr)	116.27	118.90	128.00	134.00	162.50	130.90
7	Per House cost (with infrastructure)	INR (in Lakh)	10.09	10.39	12.50	13.29	16.25	12.58

- There are 4 blocks in Stilt + 13 configuration with 1040 houses along with basic and social infrastructure.
- Ground coverage of the project is 23% and FAR achieved is 2.41.
- Organized green space is 13%.

Typical floor plan (Block C & D)

- 16 dwelling units at each floor of building block C &D with provision of lifts and staircases.

- Typical Dwelling Unit plan



Each dwelling unit consists of one living, one bed room, a kitchen, a toilet and a balcony. The carpet area of each unit is 34.51 Sq.mt. The sizes of individual rooms & service areas conform to NBC norms.

Other special features:

- Green rating as per GRIHA
- Use of renewable resources:
  - Rain water harvesting
  - Solar lighting
- Solid waste management
- STP with recycling of waste water
- Fire fighting services as per NBC norms

Prevalent Construction Systems → **Technology being Used**

Load bearing Structure

RCC Framed Structure

Steel Frame Structure

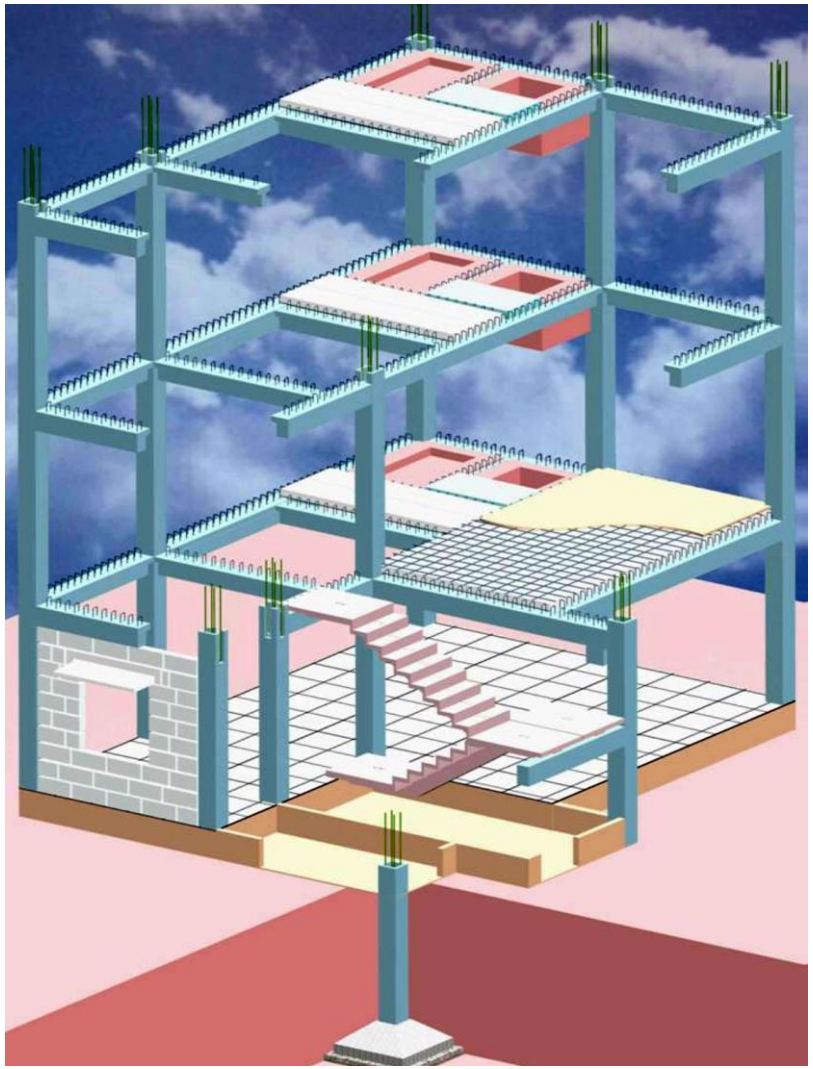
Stay In Place PVC Formwork System

The stay in place form work system is unlike the temporary shuttering adopted in conventional systems, as it stays permanently as an integral part of the structure.

In order to meet structural requirements, Hybrid system comprising of **Stay In Place PVC Formwork System with Pre-Engineered Steel Structural System** has been adopted in the present project.

Structural Elements

- Foundation
- Structural System
- Floor/ Roof Slab
- Wall Panels



Source: M/s B.G.Shirke

Foundation

- Conventional as per geo-technical investigations, bearing capacity, soil strata, water table, etc.
- Raft foundation with RCC column upto plinth height.
- RCC plinth beam and grade slab at plinth level.

Structural system

- Pre-Engineered Building system comprising of built-up fabricated I sections for beams and columns

Floor/ Roof Slab

- The floor/ roof is deck slab which comprises of deck sheet, reinforcement with concrete screed

Wall Panels - Stay in Place PVC formwork System

- The formwork components are manufactured from extruded polyvinyl chloride (PVC).
- The extrusions consist of two layers, the substrate (inner) and Modifier (outer).
- The two layers are co-extruded during the manufacturing process to create a solid profile.

Stay in Place PVC formwork System

- Typical manufacturing plant for production of PVC formwork

- **Typical Wall Panel Dimensions**

Application	Novel	Wall Thickness		Weight of Panel with concrete
		Overall (Nominal)	Concrete Core	
External Wall	N126	126 mm	120 mm	8.5 kN/m
Internal Wall	N64	64 mm	60 mm	4.25 kN/m

- Width of the individual panel components = 300 / 250 mm.
- Height is as per the requirement. In LHP at Lucknow, it is full storey height about 3 mtr.

Technical Specification Sheet

PRODUCT SPECIFICATIONS

PROFILES	110MM, 150MM, 200MM AND 250MM
PVC THICKNESS	2.6 MM
LIFE EXPECTANCY	MINIMUM 50 YEARS
HEIGHT	ALL PANELS CAN BE ORDERED TO CUSTOM HEIGHTS MINIMUM 1.0M – MAXIMUM 8.0M STOCK HEIGHTS: 2.8M, 3M, 3.3M, 3.6M, 3.8M, 4.0M, 4.6M, 5M, 6M.

	CONCRETE VOLUME (M^3 /M^2)	PRODUCT WEIGHT (KG/ M^2)	FIRE RATING (MINUTES MINIMUM)
110MM PROFILE	0.101	14.7	90
155MM PROFILE	0.146	15.8	180
200MM PROFILE	0.188	16.8	≥ 240
250MM PROFILE	0.2404	17.8	≥ 240

PANEL WIDTH	300 MM
PVC DENSITY	1,300 KG/ M^3
FINISH	GLOSS WHITE, WATER RESISTANT
UV STABILITY	NOT AFFECTED BY EXPOSURE TO SUNLIGHT EITHER IN STORAGE OR AS FINISHED PRODUCT
SPECIFIC PPE	NONE REQUIRED. GLOVES ARE NOT ESSENTIAL, BUT ON SITES WHERE MANDATORY, GLOVES WITH RUBBER FINGERS AND PALM INFILL WILL REMOVE RISK OF SLIPPING.
MSDS	READILY AVAILABLE
ORDERING LEAD TIME	STOCK HEIGHTS DELIVERED TO MAJOR CAPITAL CITIES WITHIN SEVEN DAYS FROM ORDER. CUSTOM HEIGHT PANELS WITHIN FIVE WEEKS.
SHIPPING AND FREIGHT	WE OFFER DELIVERY AT COST, OR YOU CAN ARRANGE YOUR OWN
PAYMENT TERMS	COD OR 30-DAY ACCOUNT UPON APPLICATION

CERTIFICATIONS AND COMPLIANCE

CODE, SPECIFICATION OR STANDARD	CERTIFIED BY
AS1530.3 - IGNITABILITY, FLAME PROPAGATION, HEAT RELEASE AND SMOKE RELEASE	CSIRO
AS/NZ3837:1998 - HEAT & SMOKE RELEASE RATES	CSIRO
BCA PARTS A2 & C1 - HEAT & SMOKE RELEASE REQUIREMENTS	CSIRO; SGS-CSTC; MURTAGH BOND STRUCTURAL ENGINEERS
BCA PART F5 – ACOUSTIC PERFORMANCE, SOUND TRANSMISSION AND INSULATION	RUDDS CONSULTING ENGINEERS
GREEN BUILDING COUNCIL OF AUSTRALIA – GREEN STAR OFFICE DESIGN	CETEC

Stay in Place PVC formwork System

Stay in Place PVC formwork System

- The rigid poly-vinyl chloride (PVC) based form work system serve as a permanent stay-in-place durable finished form-work for concrete walls.
- The extruded components slide and interlock together to create continuous formwork with the two faces of the wall connected together by continuous web members forming hollow rectangular components.
- The web members are punched with oval-shaped cores to allow easy flow of the poured concrete between the components.

Performance Appraisal Certificate No.: 1044-S/2019 has been issued to M/s Novel Assembler Pvt. Ltd, Mumbai by BMTPC.

Advantages

- Having formwork already as part of system, the construction of building is faster as compared to conventional buildings. The formwork needs some support only for alignment purpose.
- The formwork consists of rigid PVC components, which do not corrode, chip or stain & resistant to UV, bacteria, fungi etc., thus ensuring long life of the structure.
- The polymer content used in manufacturing of formwork is up to 55% recycled content and are further recyclable, making it an eco-friendly material.
- The form work system has specific advantage for use in coastal areas as due to polymer encasement it offers higher durability.
- With concrete as filling material, the curing requirement of concrete is significantly reduced, thus saving in precious water resources.
- The formwork system does not have plastering requirement & gives a aesthetic finished surface in different color options.
- The system provides advantages in terms of structural strength, durability enhancement, weather resistance, flexural strength, thermal insulation and ease of construction.

Limitations

- Stay in Place PVC Forms Walls need pre-planned & installed MEP/Services for concealed network.
- Door and Window position shall not be changed after pouring of concrete.
- Erection of panels shall be under supervision of trained staff.

Being first time mass scale field implementation of new technology the Light House Project at Lucknow is on

Design & Build Basis

Agency:

M/s JAM Sustainable Housing LLP, Ahmedabad

Technology Provider:

M/s Novel Assemblers, Mumbai

Design Basis

- Structural Frame as RC Steel Hybrid structure
  - Sub-structure up to the plinth level in RCC
  - Superstructure is using HR Steel built-up I sections with lift wells in RCC Shear wall
- Safe Bearing capacity: 13.3 T/m^2, depth of foundation 2.5 m
- Raft foundation as per IS:2950 (Part-1)-1981 (reaffirmed 2008)
- Wind speed: Very High damage risk zone with basic wind speed (V_b=50m/sec)
- Design wind speed:

$$V_z = V_b.k_1.k_2.k_3.k_4$$

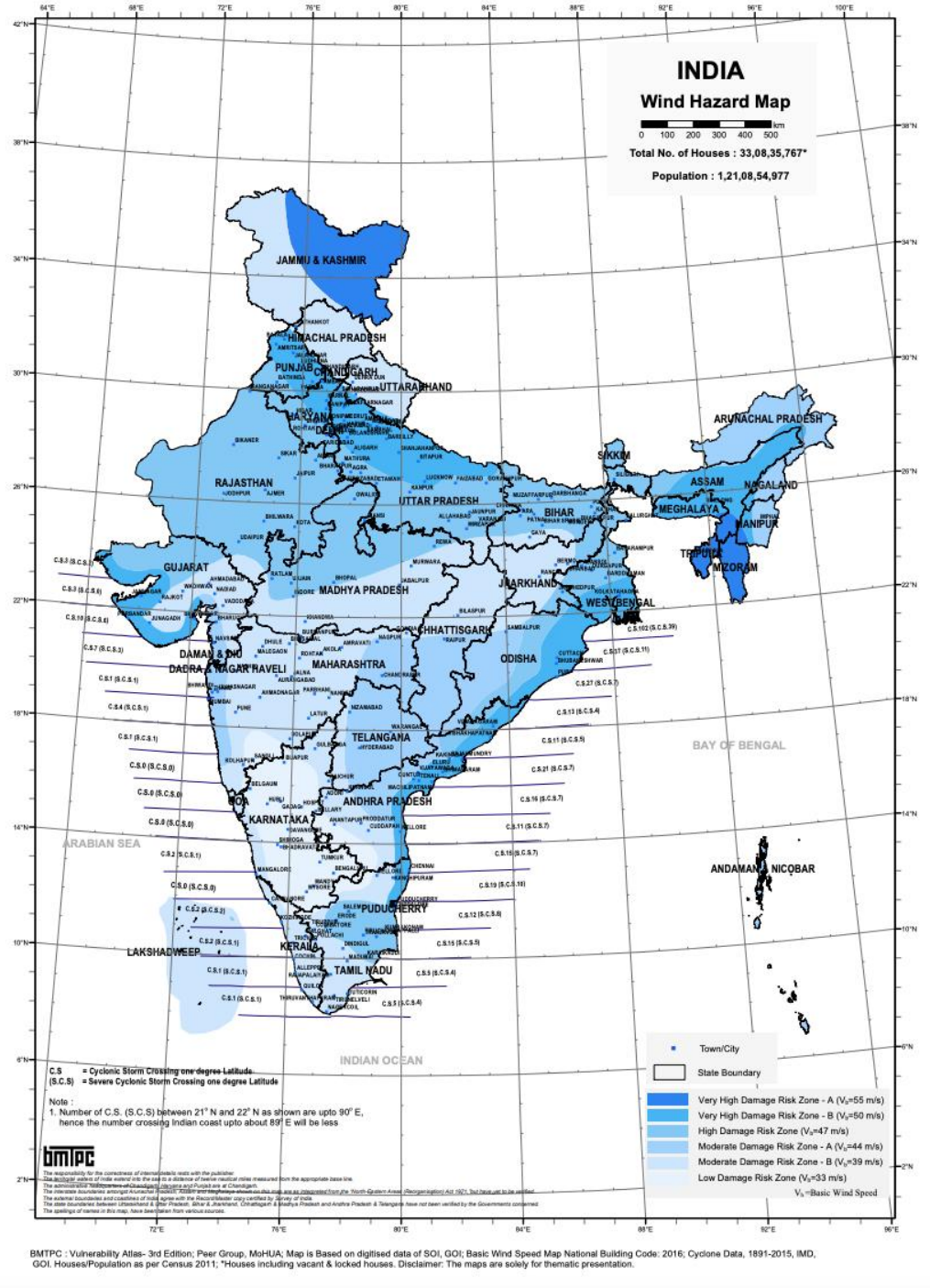
k_1 (Risk Coefficient)=1

k_2 (Size factor)=as per height

k_3 (topography factor)=1

k_4 (importance factor)=1

- Wind Pressure (P_z) = $0.6.Vz^2$
- Wind pressure is converted into design wind pressure and then distributed at each storey as wind force.



BMTPC : Vulnerability Atlas- 3rd Edition; Peer Group, MoHUA; Map is Based on digitised data of SOI, GOI; Basic Wind Speed Map National Building Code: 2016; Cyclone Data, 1891-2015, IMD, GOI. Houses/Population as per Census 2011; *Houses including vacant & locked houses. Disclaimer: The maps are solely for thematic presentation.

Design Basis

- Earthquake : Zone-III as per Seismic Zoning Map of India IS: 1893 (Part-1):2016
  - Designed as dual system with ductile RC structural walls and few special moment frames in structural steel in both direction, Response Reduction Factor=5 (Table-9 iv of IS: 1893 (Part-1):2016), Z=0.16,I=1.2, R=5, Damping Ratio=5%.
  - Design Horizontal Seismic Coefficient (A_h)

$$A_h=(Z/2).(S_a/g).(I/R)$$

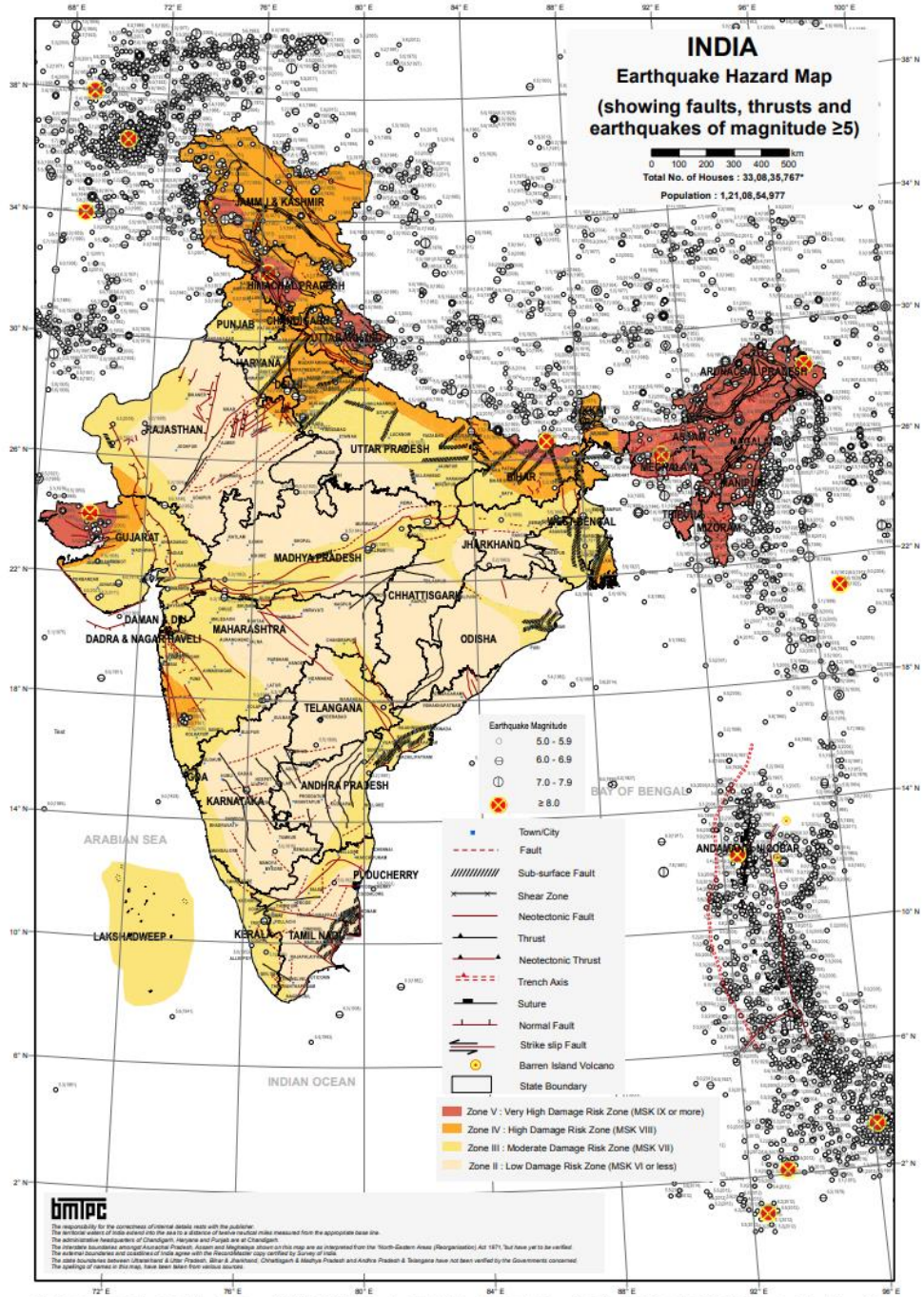
S_a/g is design acceleration coefficient for different soil types corresponding to natural period (T) of building

  - Design Lateral Force (V_B)

$$V_B=A_h.W$$

W is seismic weight of building

  - Linear dynamic analysis shall be done to obtain the design lateral forces with steel columns as fixed for SMRF frames and pinned for ordinary frames.
  - Rigid diaphragms in horizontal direction at floor levels as per Cl.7.6.4 of IS:1893(Part-1):2016.
- Expansion joints as per Cl.3.10.3.2 of IS:800-2007 to cater for thermal and seismic forces.
- Design has been carried out as per IS 456-2000, IS 800-2007 and NBC-2016.



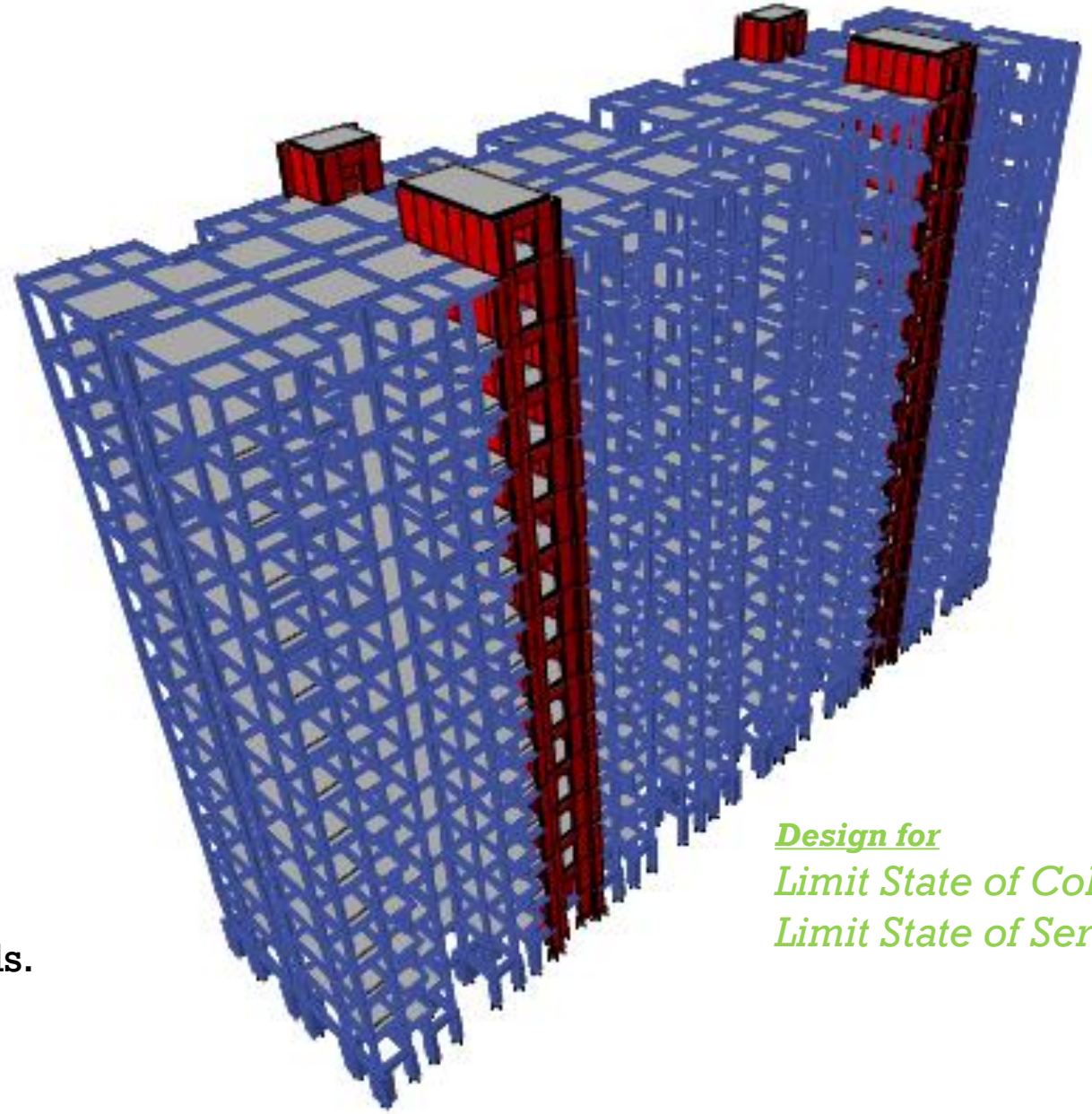
BMTPC : Vulnerability Atlas - 3rd Edition : Peer Group, MoHUA, GOI; Map is Based on digitised data of SOI; Seismic Zones of India Map IS 1893 (Part I): 2002, BIS; Earthquake Epicentre from IMD; Seismotectonic Atlas of India and its Environs, GSI; Houses/Population as per Census 2011; *Houses including vacant & locked houses. Disclaimer: The maps are solely for thematic presentation.

STRUCTURAL ANALYSIS & DESIGN

- 3D Model of typical tower with PEB Structure

- Load Combinations :
  - 1.5 (DL+LL)
  - 1.2 (DL+LL±EL/WL)
  - 1.5 (DL±EL/WL)
  - 0.9DL ±1.5EL/WL

(EL/WL implies Earthquake/Wind Load in +X, -X, +Y, and –Y, directions . Lateral forces shall be considered acting from all directions but one at a time.)



- Steel structural system can be easily modeled in the CAD software such as STAADPRO, ETABS, SAFE, SAP, ABACAS and others for detailed structural analysis.
- 2D/ 3D Static and dynamic linear and non-linear analysis can be carried out using these softwares.
- The softwares can also be used for structural design as per Indian Standards.
- AUTOCAD for drawings

Design for

Limit State of Collapse

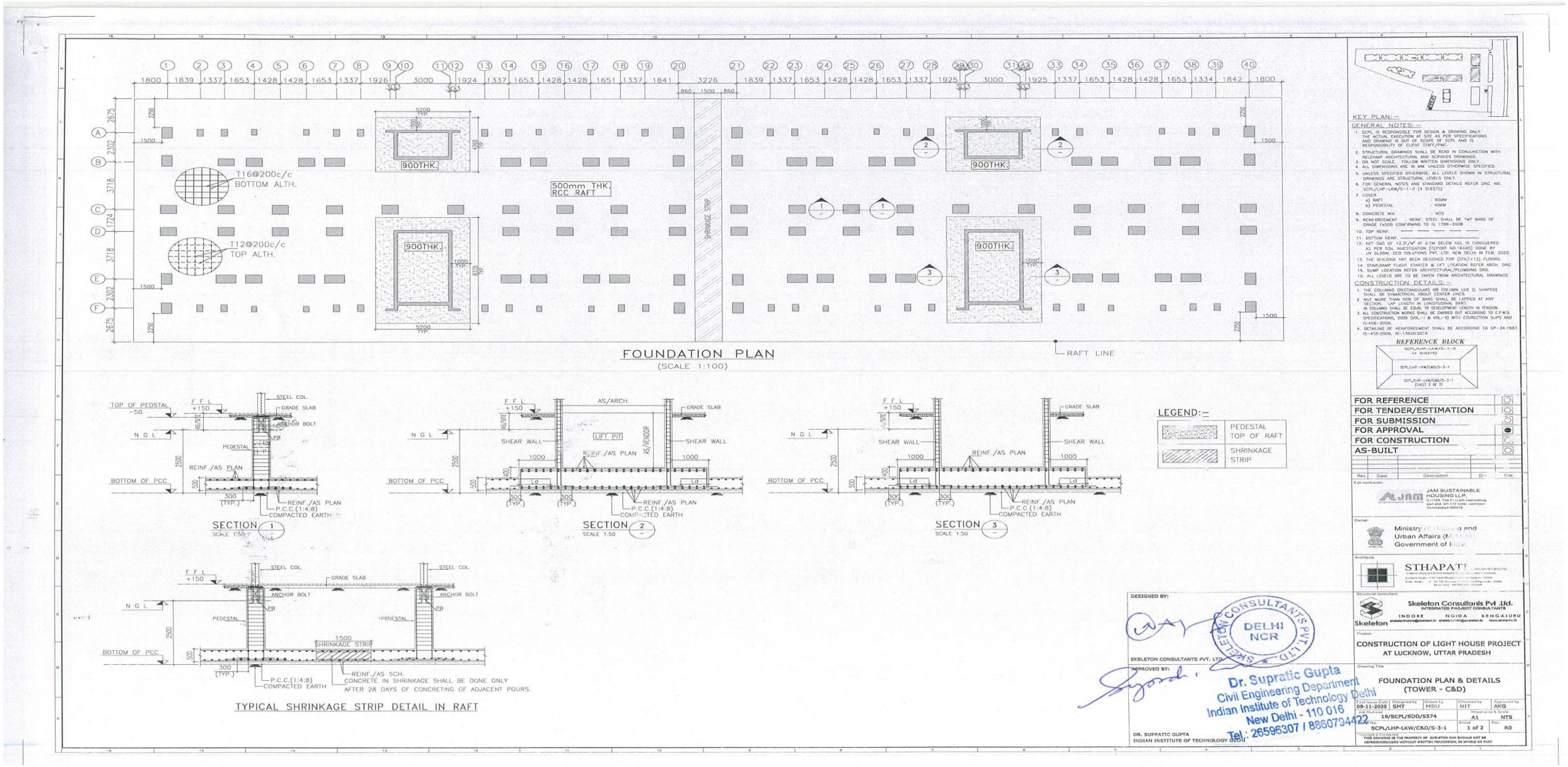
Limit State of Serviceability

Construction Sequence

- Sub-Structure: Foundation
- Super-structure: Structural system
  Floors
  Wall Panels
- MEP: Plumbing & Electrical
- Finishing

FOUNDATION

Structural Drawings



FOUNDATION

Concrete & Reinforcement Steel Specifications

Item	Concrete Grade
Raft foundation, Plinth beam, Grade slab, Column upto Plinth level	M25
Shear walls, Water tank, Sewage Treatment Plant (STP)	M30

- Mix design for concrete and all Concrete work shall conform to IS 456-2000 & Liquid retaining structures shall conform to IS 3370:2009
- Reinforcement Steels are to be TMT bars of Fe 500 as per IS 1786-2008.

Concrete mix design (IIT Delhi)

Cement Name	Conc. Grade	Water	Cement	Fly Ash	Sand	Coarse Aggregate		Plasticizer	Slump		Comp. Strength (MPa)		Fly Ash/ Cementitious Material	Water/ Cement ratio
						10 mm	20 mm		Initial	After 1 hour	7 Day	28 days		
JK	M-30	160	319	137	692	415	623	0.65%	145	110	32.5	39.4	30%	0.35
	M-25	160	287	154	694	416	625	0.60%	160	140	24.7	32.2	35%	0.36
Ultra Tech	M-30	160	319	137	692	415	623	0.65%	135	120	33.1	42.0	30%	0.35
	M-25	160	287	154	694	416	625	0.60%	160	150	23.2	33.5	35%	0.36

28 days Target Strength: M30 38.25 MPa

28 days Target Strength: M25 31.65 MPa

Design Slump range for the above mix: 100 – 150 (Pumpable)

Fly Ash content of 30% as a proportion of Cementitious Material in case of M30 Grade Concrete and 35% in case of M25 Grade Concrete is being used in the project, making the concrete **green and sustainable,** therefore, conserving natural resources i.e. lime stone.

FOUNDATION

- Reinforcement and shuttering for raft foundation

FOUNDATION

- All building blocks have Raft foundation with 500 mm thick M-25 Concrete. **An additional thickness of 400 mm has been constructed around staircase and lift well.**

FOUNDATION

- Columns of M25 Grade Concrete are being cast upto plinth height over already laid cured raft.

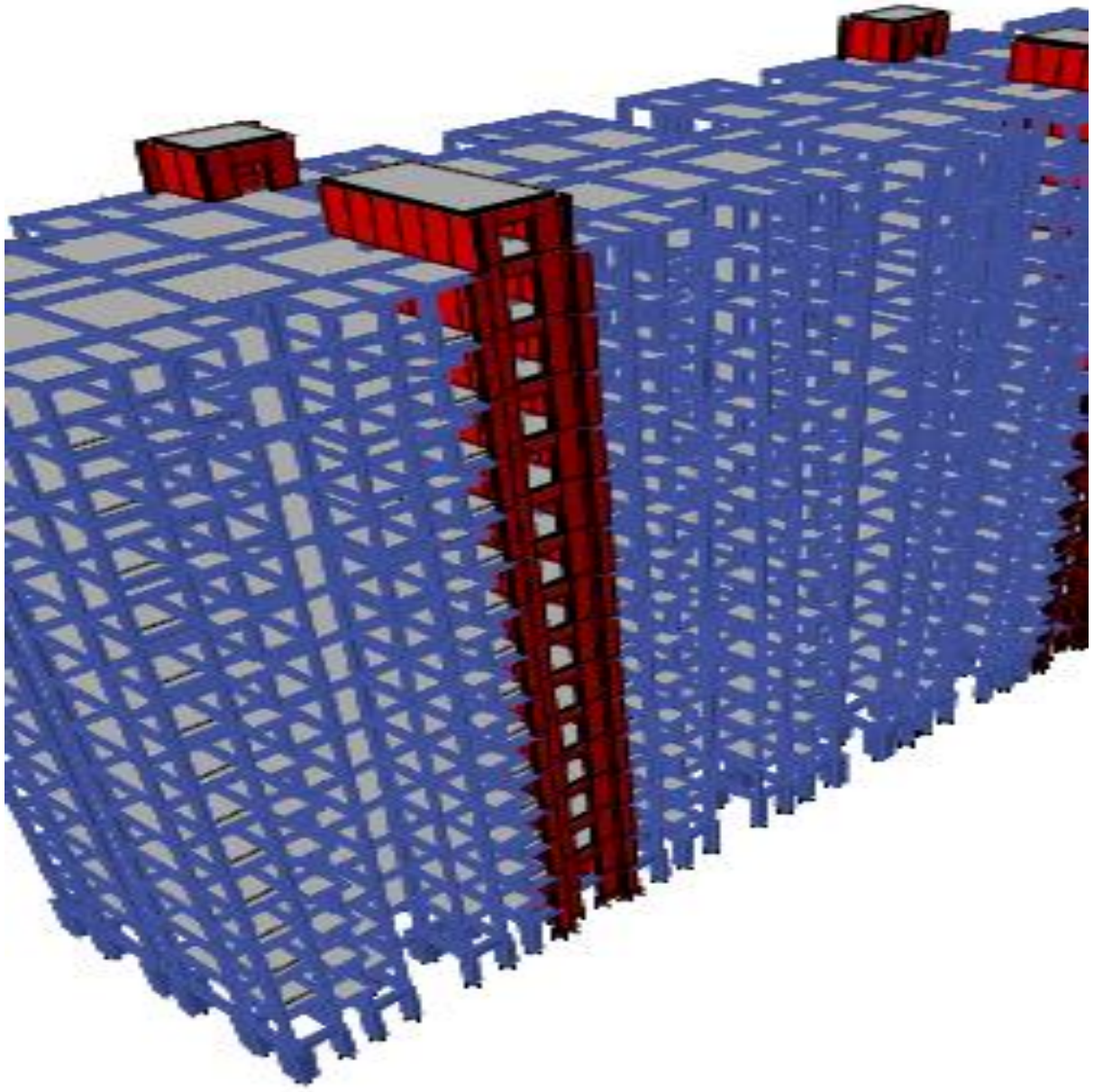
FOUNDATION

- Plinth beam shuttering work along with reinforcement cage
- Fixing of anchor bolts with templates over which factory made built up columns with base plate will be erected.

FOUNDATION

- Anchor bolts have been cast with concrete at plinth level over which factory made built up columns with base plate will be erected.
- The reinforcement laying & shuttering work is in progress for shear wall construction of lift & staircase portion.

Plinth beam and shear wall casting

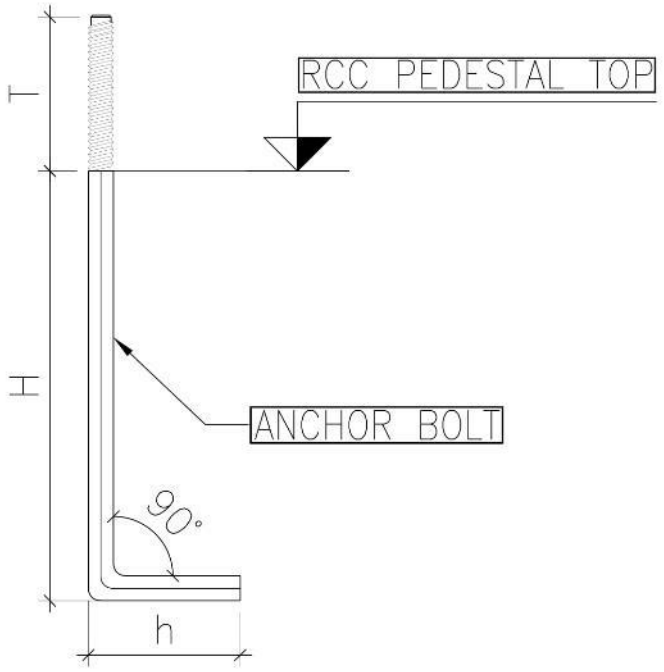


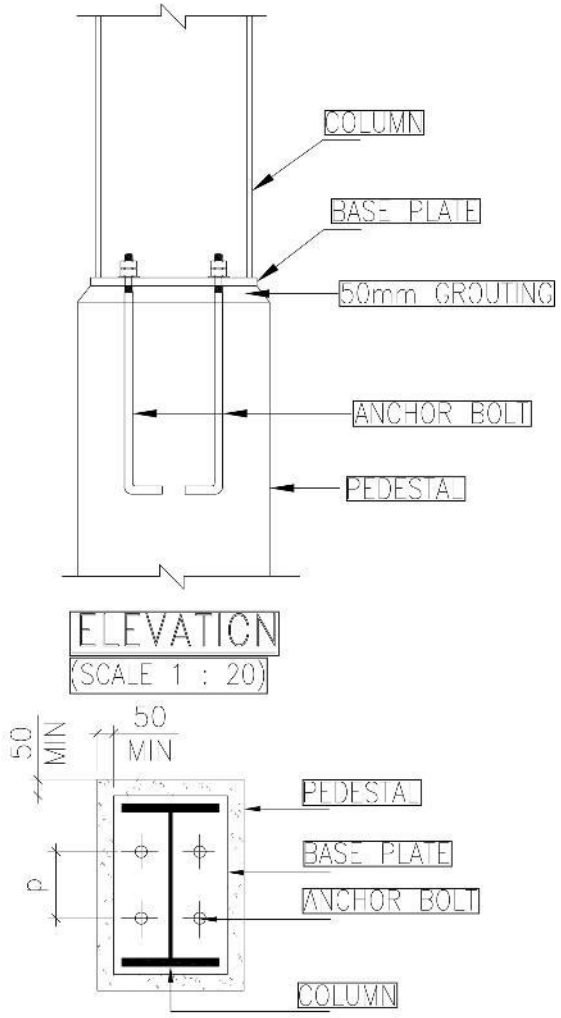
STRUCTURAL SYSTEM

In the present lecture, the structural system and other details are being explained through drawings, sketches and text.

STRUCTURAL SYSTEM

- Connection details of built up steel column at plinth level (Stilt) with foundation (plinth beam)





Dia (mm)	H (mm)	h (mm)	T (mm)
16	400	100	100
20	500	100	100
24	600	100	150
27	700	100	150
30	800	100	150

Anchor bolt schedule

a) Typical anchor bolt detail

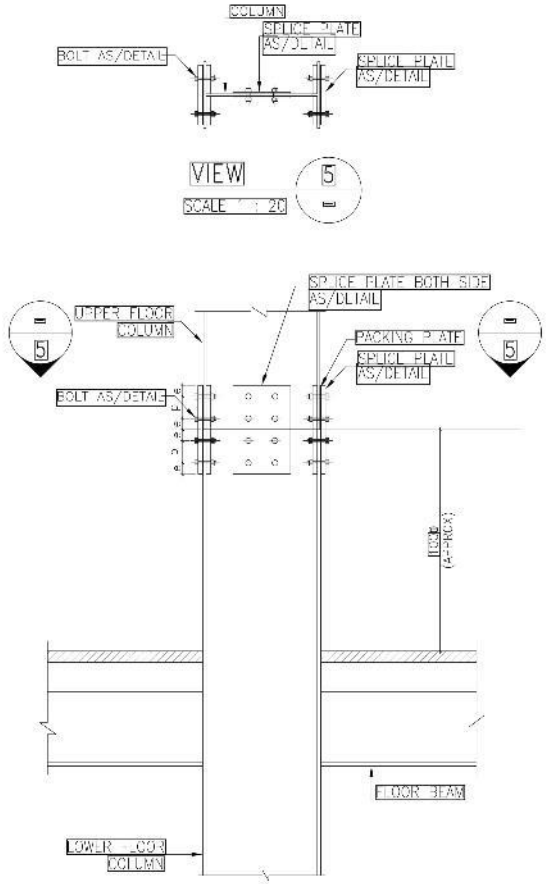
Anchor bolt is inserted below plinth level upto height H and projected above plinth up to height T

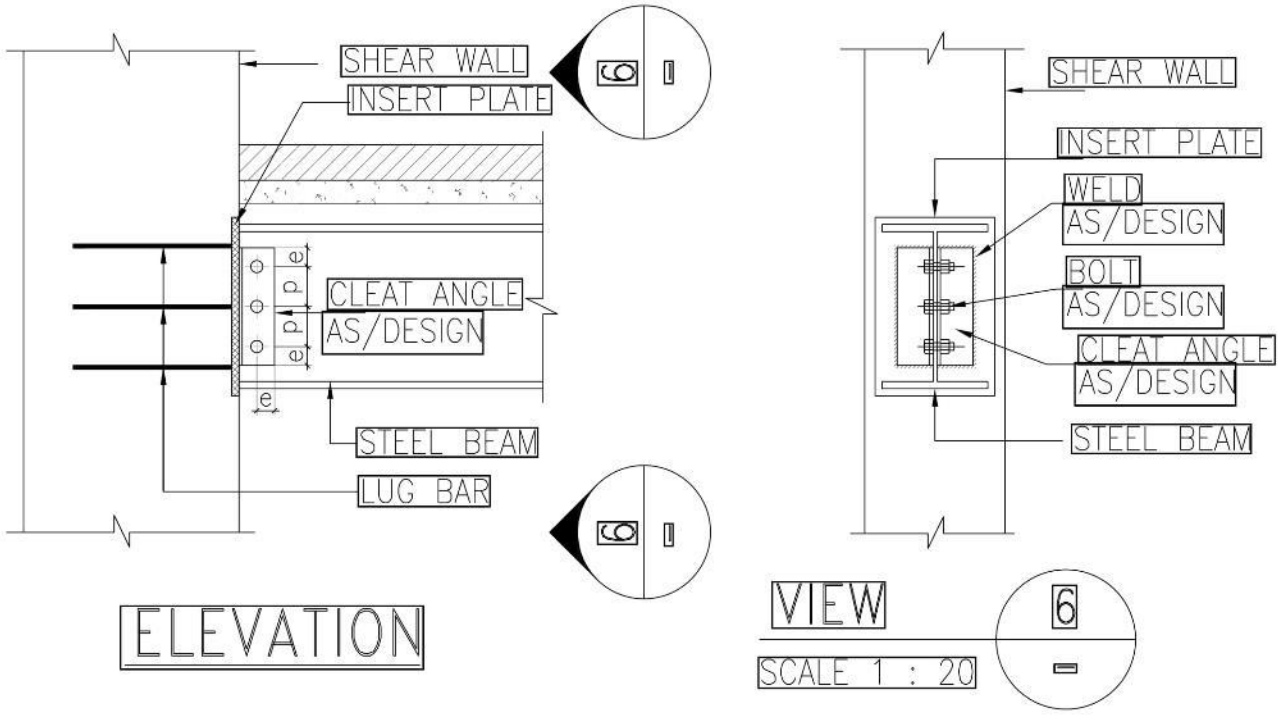
b) Typical base plate detail

The built up steel I column is being fixed with anchor bolts and base plate

STRUCTURAL SYSTEM

- Column-Column Connections





a) Column Splice detail

Columns are being spliced through nut & bolts connection along with plates both in web and flange portion

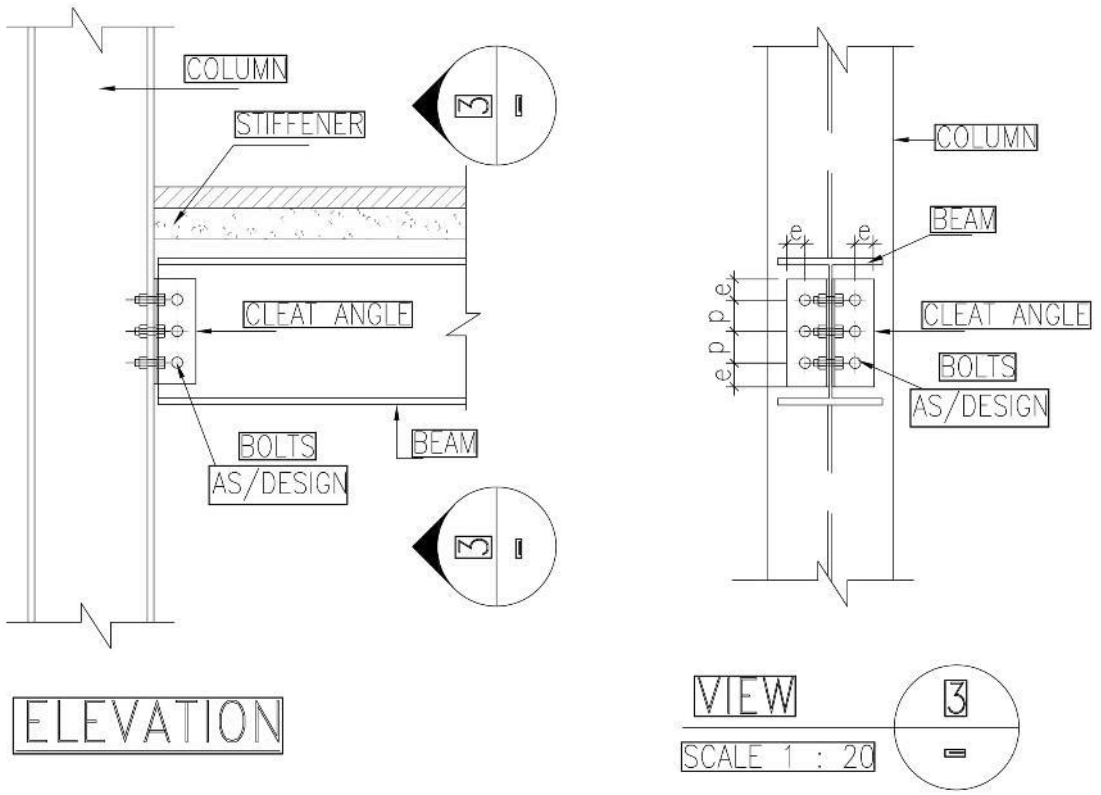
A typical length of column being fabricated for the project is of 6m.

b) Shear wall to steel beam connection

Insert plate along with lug bar are cast during the casting of shear walls and steel beam is connected to the wall with bolted connection through insert plate

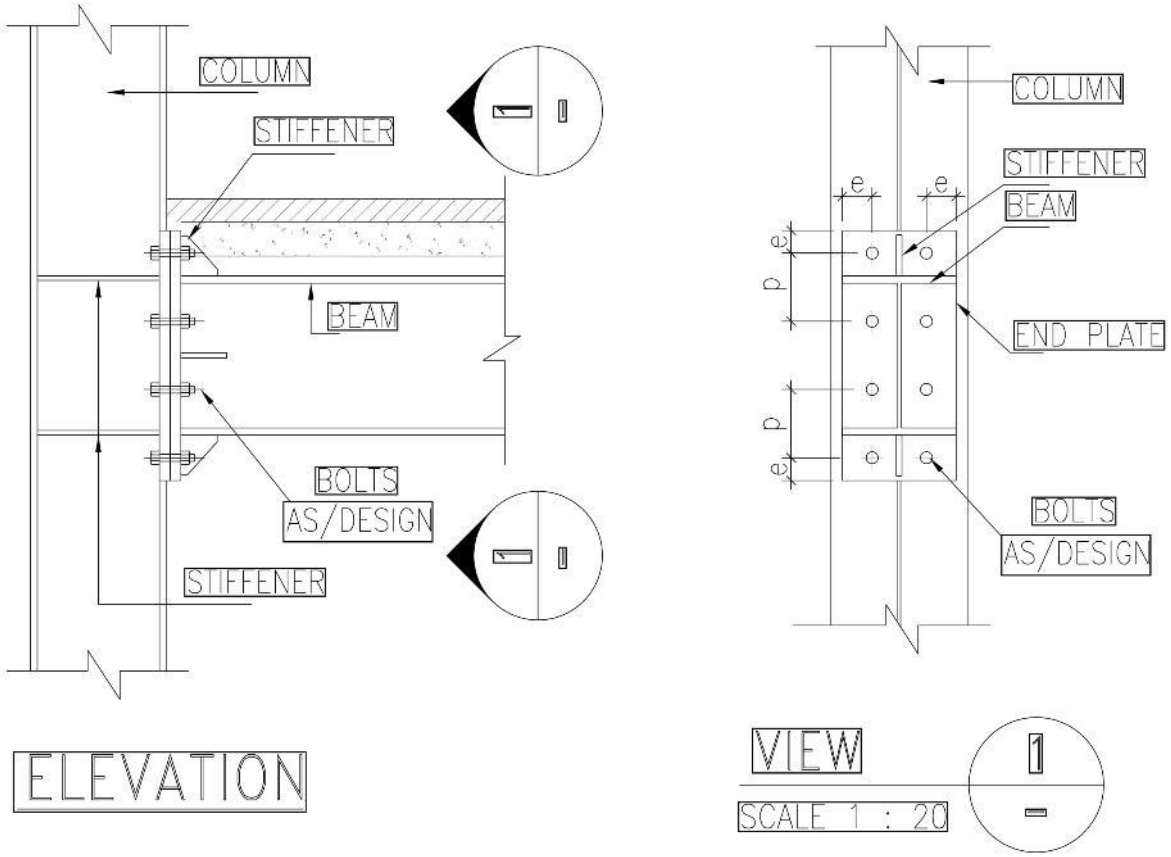
STRUCTURAL SYSTEM

- Typical beam column shear and moment connections



a) Typical beam to column flange shear connection

Steel beam is being connected to the column through cleat angle connected to the web portion of beam



b) Typical beam to column flange moment connection

The steel beam is being connected to column through plates on flange & web portion

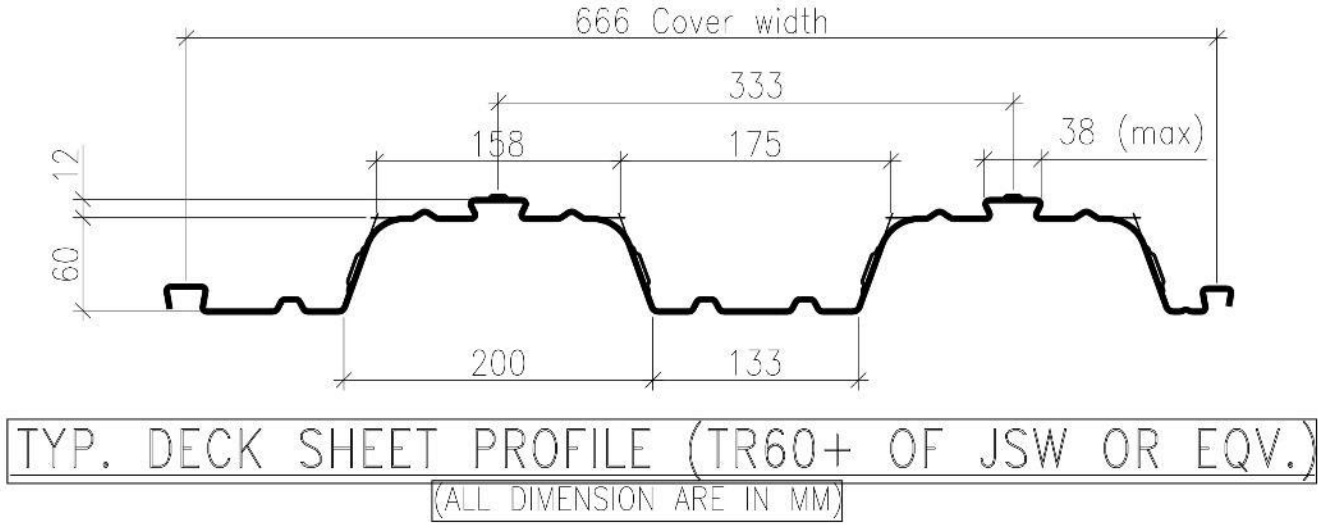

Erection of steel columns

Erection of steel columns & beams

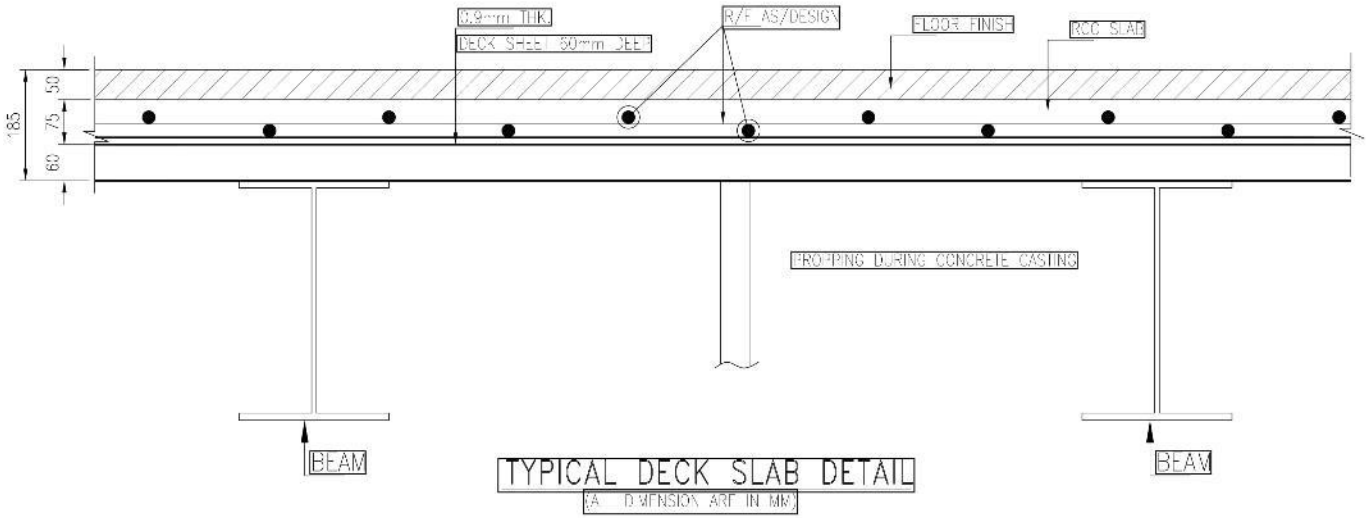
FLOORS

- Floor slab details : Deck slab

  - After erection of steel beams and column (PEB Structure), steel deck sheet of thickness 0.9 mm are placed with required bearing on the beams.
  - Concrete screed of 75 mm is poured on the deck sheet in M25 with reinforcement as per structural design.
  - Structural design for reinforcement is as per IS 456-2000.
  - Generally, nominal reinforcement is provided in concrete screed of deck slab to take care of shrinkage & cracking.



a) Typical deck sheet profile



b) typical deck slab detail

Placing of deck slab and reinforcement


Concrete on deck slab

Wall Panels

Construction & Installation Process with Stay in Place PVC formwork System in the LHP

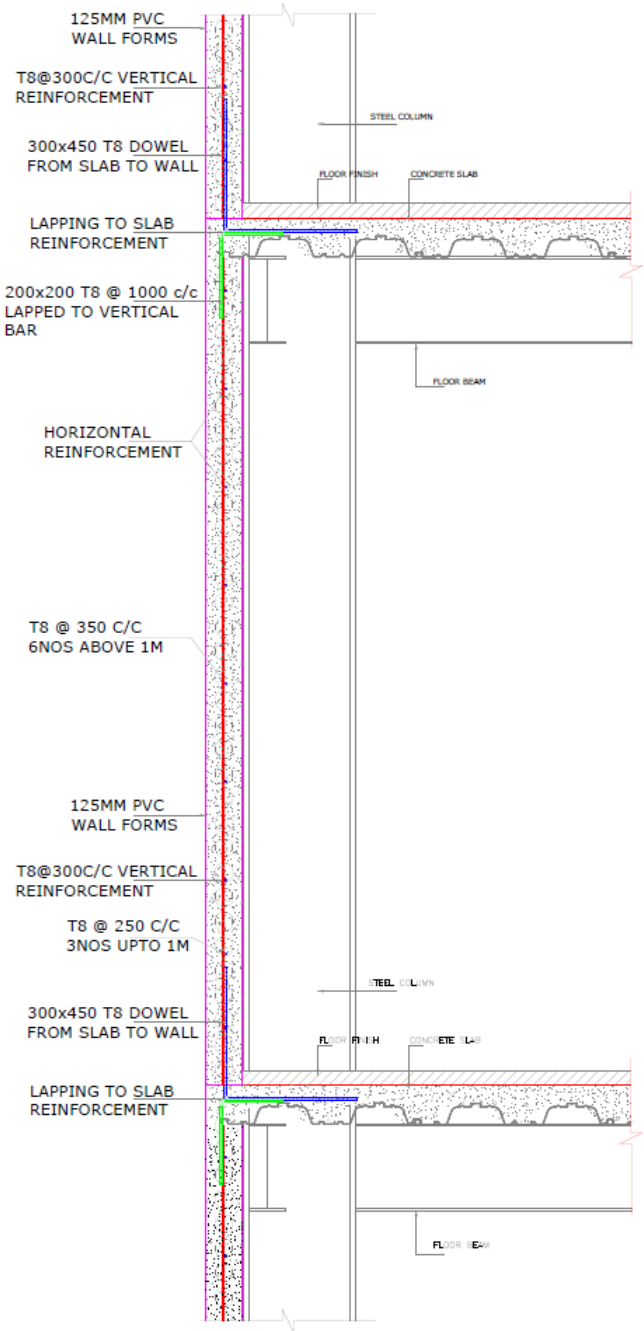
Construction is done in a following sequential manner:

1. Transportation of Prefabricated PVC Wall panels and Steel Sections as per the design to the site.
2. Erection of built up sections for structural frames on RCC foundations using cranes and connections as designed (connection details already explained)
3. Installation of decking sheets on structural frame at floor level followed by pouring of concrete screed with nominal reinforcement
4. Fixing of PVC wall panels on decking floor, once the structural frame and floor is installed and aligned.
5. Putting the reinforcement as per requirement on the already fixed PVC wall panels and filling the cavities with concrete.
6. The wall panels have provisions of holes for services conduits where services such as water supply, electricity are laid before filling the cavities.
7. Upon installment of wall panels, flooring and ceiling, the finishing work is executed.

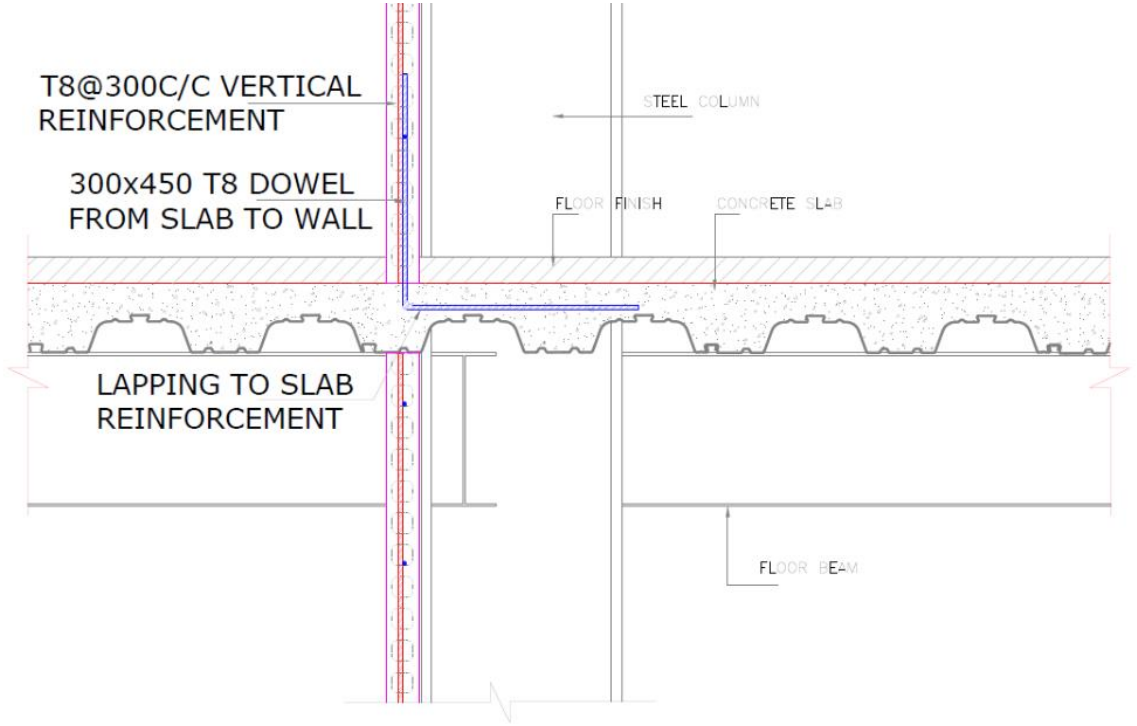
Wall Panels

PVC Wall to Steel Frame Connection

Structural integrity and monolithic behavior of wall and structural frame is achieved in this technology through dowel bars.



EXTERNAL WALL REINFORCEMENT DETAIL



INTERNAL WALL REINFORCEMENT DETAIL

Wall Panels

- Typical view of PVC wall panels and steel frame construction

Fixing of Wall Profiles

Concreting in Wall Profiles

Services, Doors, Windows

SERVICES

- Services lines are fixed inside the wall panels prior to concrete pour
- Openings are cut in the walls for electrical and plumbing interfaces

DOORS, WINDOWS AND CONCRETING

- Capping panels are fixed on edges of doors & windows before fixing wooden frames to gain strength for concrete pour. The frames are removed once concrete is set. No gaps to be left in between panels.
- Water proofing/hydrophilic sealant installed to cover all gaps and prevent concrete leak
- All corners, doors, windows, stop ends are adequately braced
- Metal strip on external wall corners and aluminum angles on top third of walls
- Screws on window panels and bottom connectors
- Self Compacting Concrete shall be poured by boom pump with a 50mm dia. end hose
- Pour shall not be done more than 1 mt. at any point to ensure panels can withstand concrete pressure

MEP

- The plumbing and electrical services are incorporated as done in conventional method of construction i.e. chasing and filling

OTHER INFRASTRUCTURE ITEMS

- The external infrastructure includes
- Laying of Sewerage Pipe Line,
- RCC storm water drain,
- Provisions for Fire Fighting
- Bituminous Internal Road & Paver blocks for Pathway,
- Providing Lifts in building blocks,
- Landscaping of site,
- Street light with LED lights,
- Solar Street Light System,
- Sewerage Treatment Plant (STP),
- External Electrification,
- Water Supply System including underground water reservoir,
- Compound wall with Boundary Gates,
- Horticulture facilities,
- Rain Water Harvesting,
- Solid Waste Management.

A view of block (A) with shear wall and PEB structure

View of LHP project site


BED ROOM
(3055 X 3940)

Status of the Project in terms of important components of Building work,

As on September 17, 2023

S. No.	Components of Building work	Completed/Total Requirement
1.	Erection of Steel Structural Framing comprising of Built-up columns and beams	For 1004 DUs/1040 DUs (About 96% of total requirement of about 3600 Tons)
2.	Construction of Shear wall concrete (Staircase & Liftwells)	About 98% of the total requirement
3.	Installation of PVC Wall forms in number of DUs	968 DUs/1040 DUs

Live status of LHP site can be accessed at

https://ghtc-india.gov.in

CONTACT US:

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Maulana Azad Road, Nirman Bhawan,
New Delhi - 110011
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ska@bmtpc.org
Call Us at: +91-11-23063266

प्रधान मंत्री आवास योजना-शहरी
Pradhan Mantri Awas Yojana-Urban

GLOBAL HOUSING TECHNOLOGY CHALLENGE INDIA

Ministry of Housing and Urban Affairs
Government of India

आज़ादी का अमृत महोत्सव

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Webinar Series

LIGHT HOUSE PROJECT AT INDORE

GHTC - India Category:

Prefabricated Sandwich Panel System

Technology:

Prefabricated Sandwich Panel System with Pre-Engineered Steel Structural System

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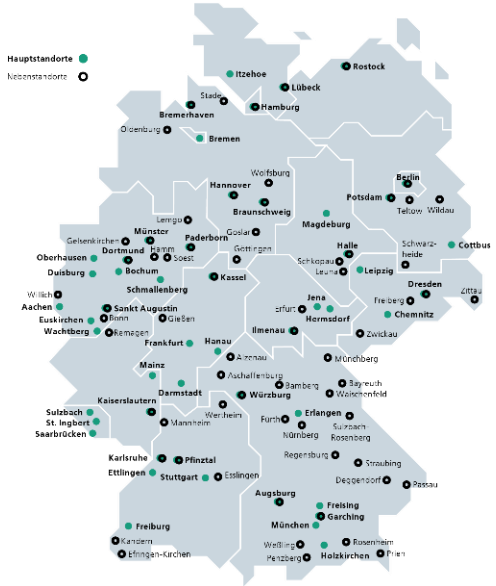
INTRODUCTION

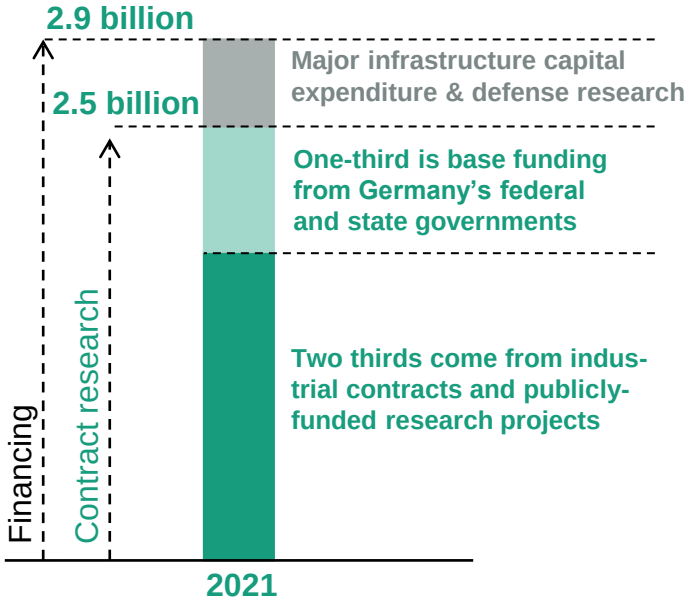
Fraunhofer Society On Applied Science

Applied research with a focus on key future-relevant technologies and the commercialization of findings in business and industry. A trailblazer and trendsetter in innovative developments.

> 30,000 employees

76 institutes and research units





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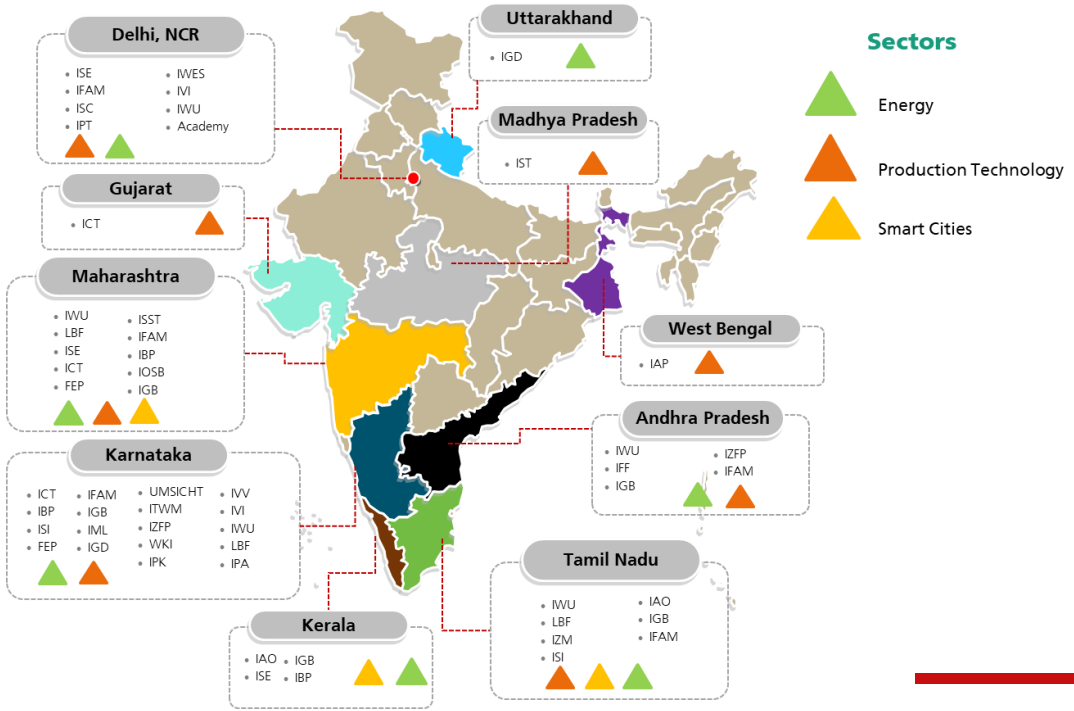
Fraunhofer Society – Presence in India

Present since 15 years

- 56 Institutes
- Revenue € 50 M in last 10 years

Focus areas:

- Production Technology
- Renewable Energy
- Smart Cities
- Artificial Intelligence
- Electromobility
- Clean Tech and Sustainability



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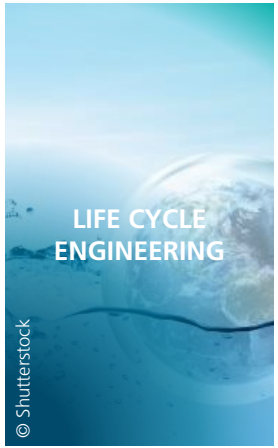
Fraunhofer Institute For Building Physics IBP

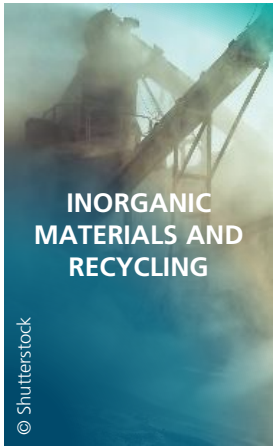
€ 20.5 M
External income

SOURCES OF FUNDS

- **45%** Industry / trade associations
- **38%** Federal / state governments
- **17%** EU / Other

Departments Today





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Light House Projects And Technograhi Programme

Development of short video E-modules on LHP technologies

- field application
- merits and limitations
- thermal comfort
- energy efficiency parameters
- durability

Technograhi Platform
https://bmtpc.org/LatestTopicsDetails.aspx?mid=196

Sharing of International knowledge, experience and best practices on the LHP construction technologies

- Expert Lectures
- Video tutorials
- **Webinars**/in-person conference virtual/real* site visits

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Light House Projects And Technograhi Programme

Chennai

Precast Concrete Construction System – Precast components assembled at site

Rajkot

Tunnel Formwork for Monolithic Construction

Lucknow

Stay in Place Fromwork System

Indore

Prefabricated Sandwich Panel System

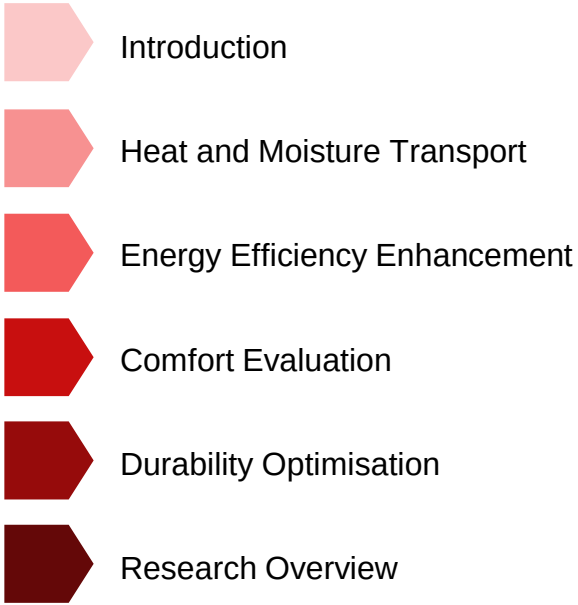
Ranchi

Precast Concrete Construction – 3D Volumetric

Agartala

Light Gauge Steel Structural System & Pre-engineered Steel Structural System

Technograhi Platform
https://bmtpc.org/LatestTopicsDetails.aspx?mid=196



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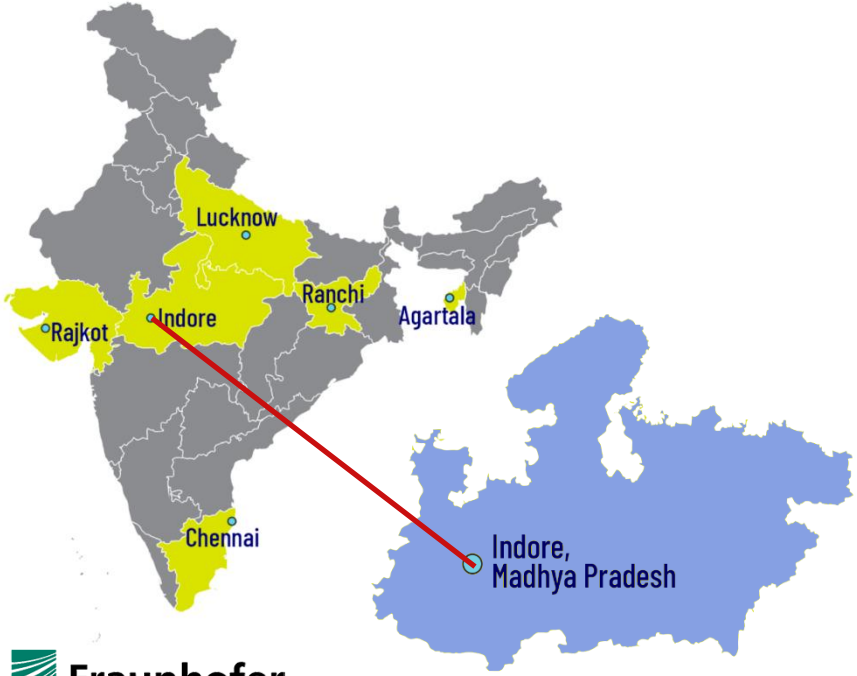
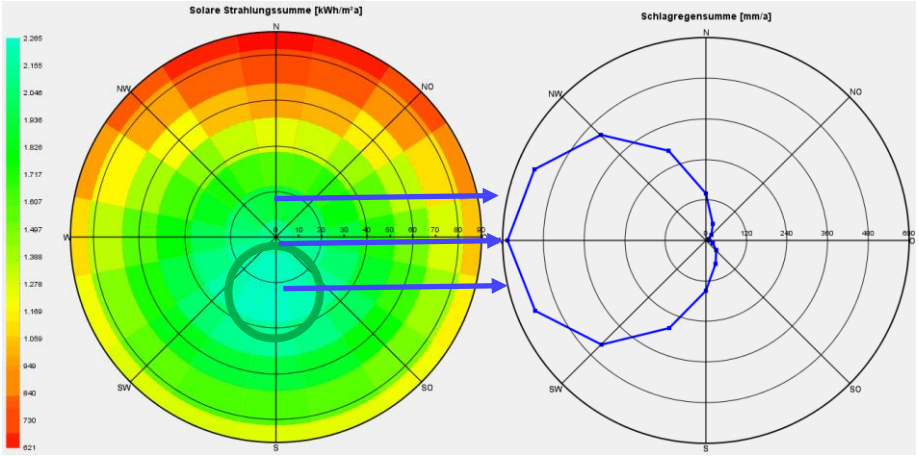
Location And Climate: Indore

- Altitude: 563 m
- 22,72 ° North 75,80 ° East



- Mean temperature: 24,9 °C
- Mean rel. Humidity: 52,8 %
- Normal-rain-sum: 617,2 mm/a



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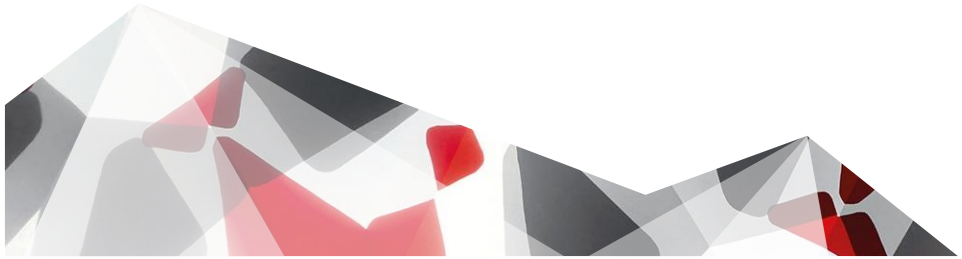
Structural System

- Pre-Engineered Steel Frame Structural System and Prefabricated Sandwich System
- The Sandwich Panel System involves factory-made wall panels replacing conventional ones
- Panels can be used for loadbearing or non-loadbearing applications
- Structural design: Basic structure made of concrete, clad inside and outside with calium silicate panels

Building made with Prefabricated Sandwich Panel System
Source: https://gihc-india.gov.in/Login/SearchLHPStatus

Analysis And Research

Heat And Moisture Transfer



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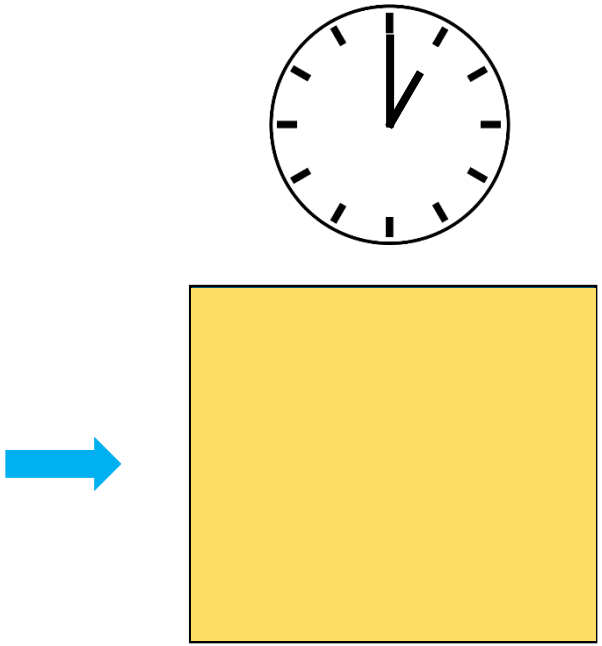
How To Measure Ventilation In Buildings?

$n_L =$ indicates how often the room air volume is completely exchanged within one hour



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Ventilation Options For The Light House Project in Indore.

Possible complete air exchange of the apartment in: 3-120 minutes

Window position	
No window and no door open	✓
Window tilted	✓
Window half open	✓
Window completely open	✓
Window and opposite door completely open	✓

Possible air change: n_L= 0 - 40

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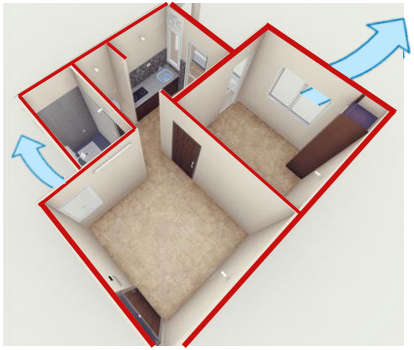
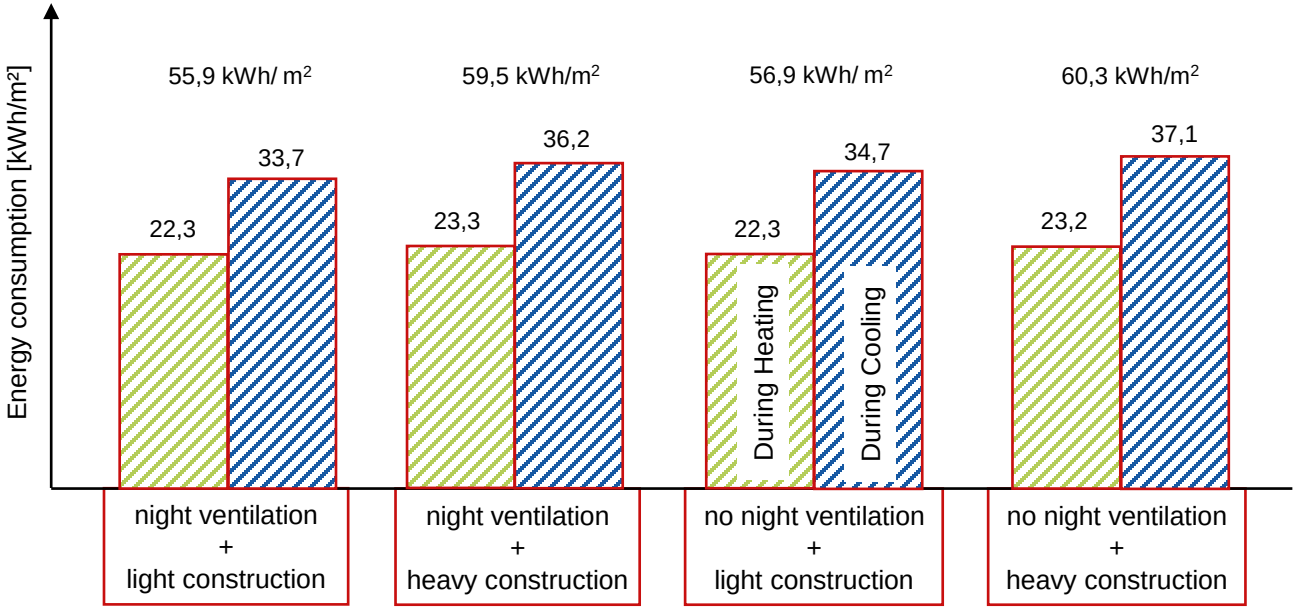
Energy Balance – Using Night Ventilation And Light and Heavy Materials





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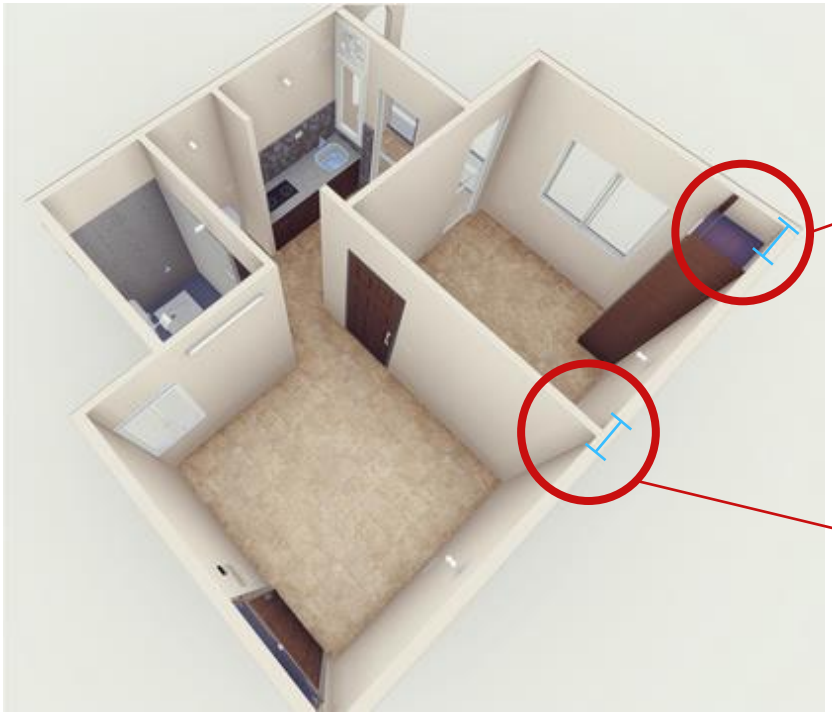
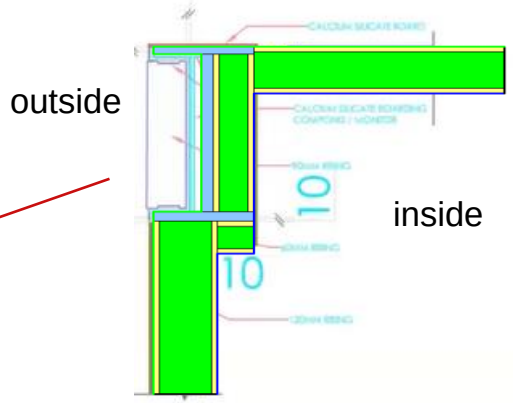
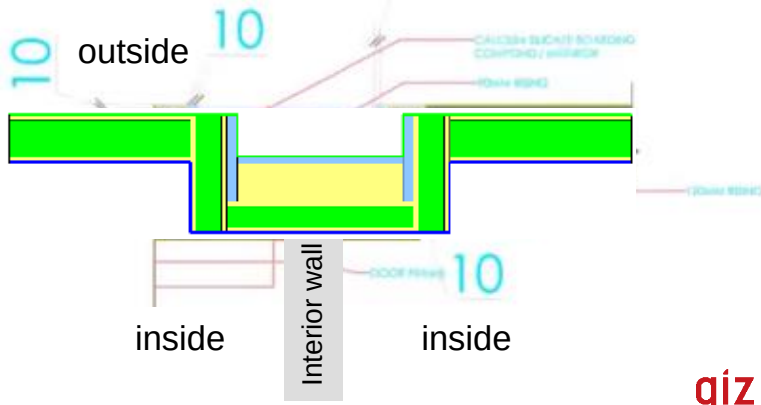
Thermal Bridges – Examples From Indore







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Thermal Bridge

Thermal bridges are localized areas in the heat-transferring envelope of a building, where an increased heat flow occurs compared to "normal" wall constructions.

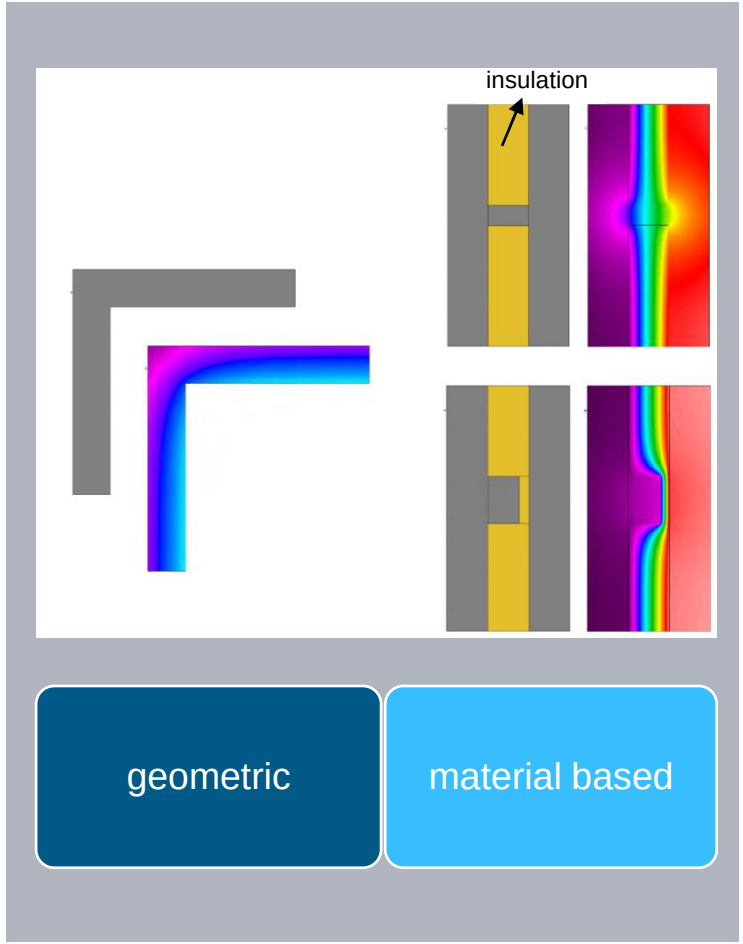
Kinds of thermal bridges

- Geometric thermal bridges
- Material based thermal bridges

$$H_T = U \cdot A \cdot \Delta\theta$$

$$H_{TWB} = Q_{wb} + U \cdot A \cdot \Delta\theta$$

U	U-value [W/m²K]
H_T	Heat flux ($^{d_i}/_{\lambda_i}$) [W]
A	Area [m²]
$\Delta\theta$	Temperature difference [K]
Q_{WB}	Thermal bridge heat flux [W]



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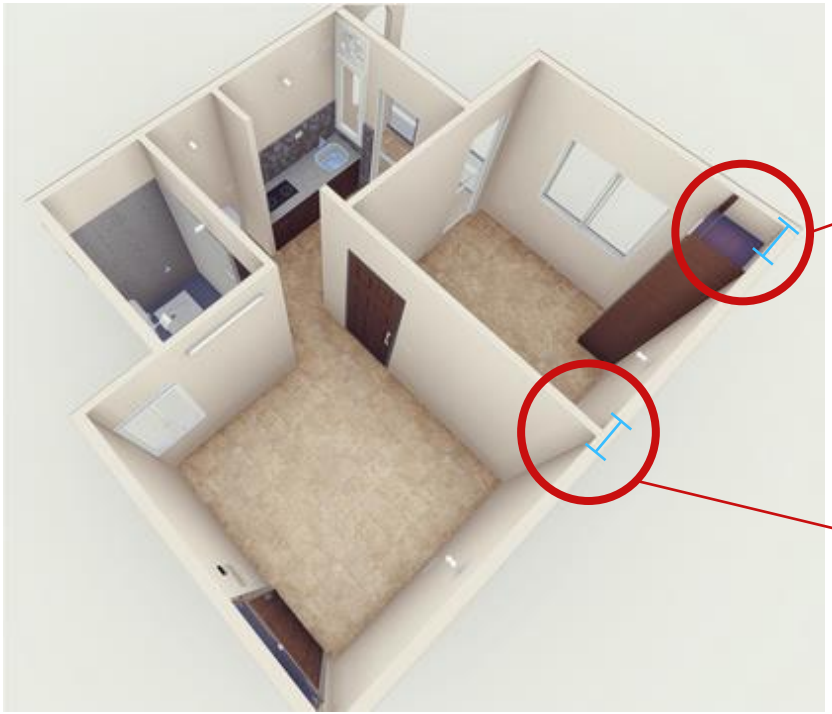
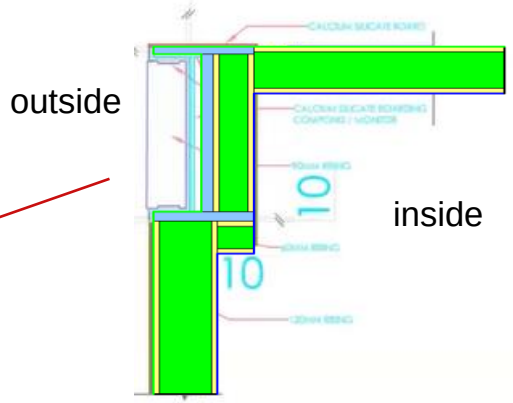
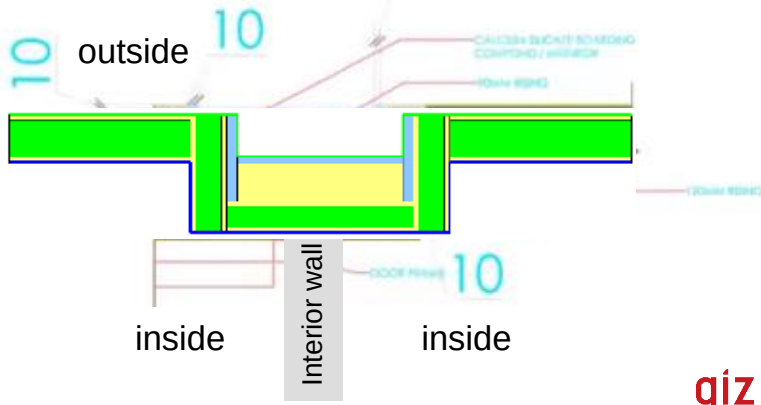
Thermal Bridges – Examples From Indore







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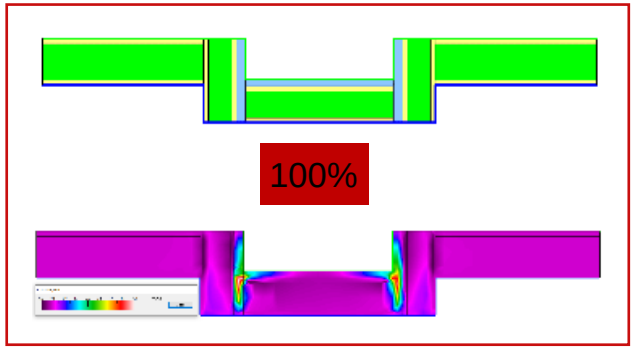
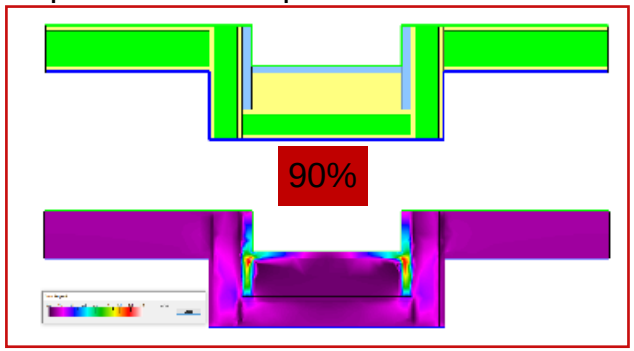
Improvements To Structural Thermal Bridges: Heat Transfer

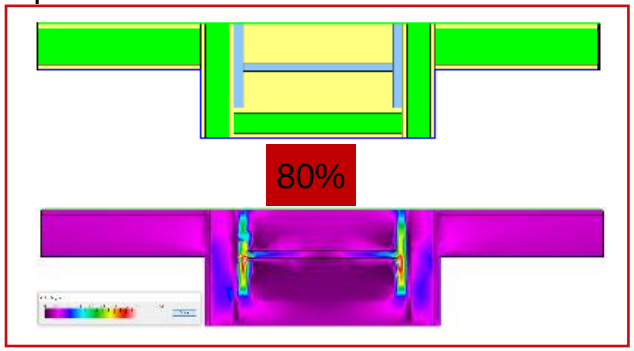
Reference version



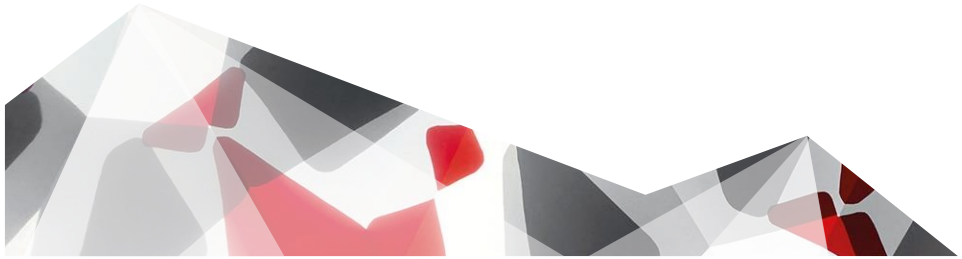
Improved interior part



Optimised version



THERMAL COMFORT IN BUILDINGS



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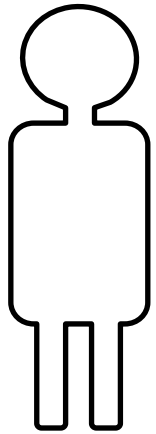
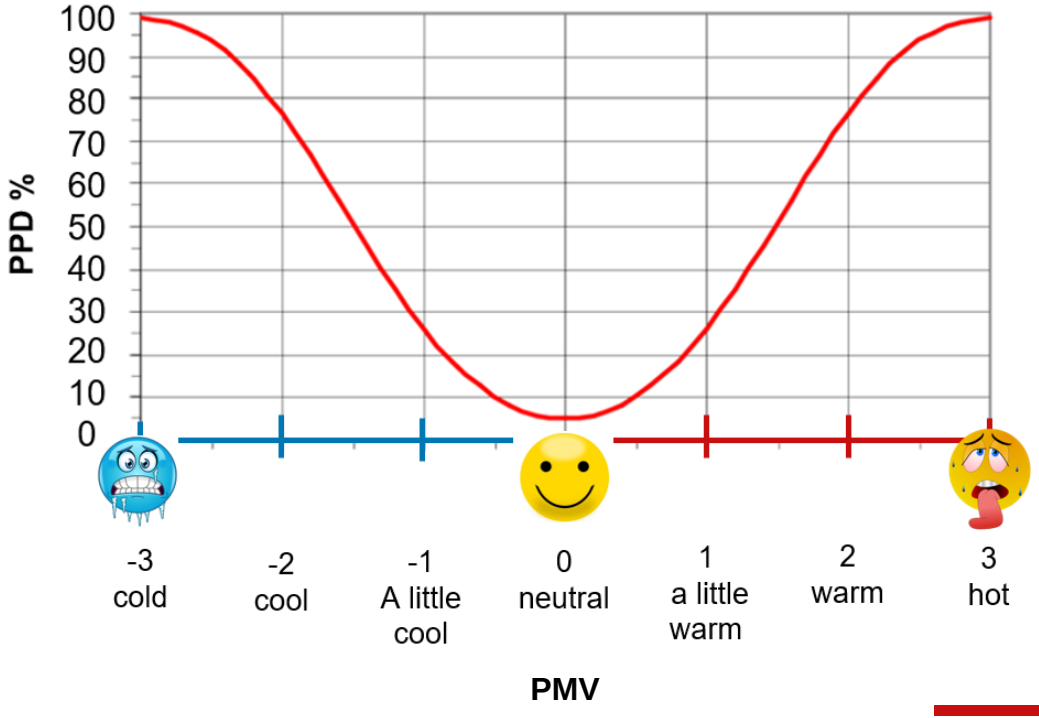
Predicted Mean Vote (Fanger)

7-level scale for evaluating temperature sensation

Inputs for Energy Balance

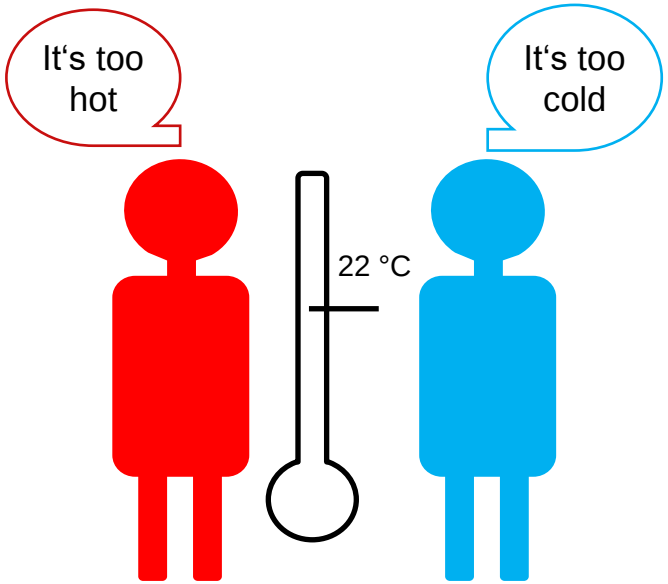
Metabolic Rate
Clothing Insulation
Air Temperature
Air Velocity
Mean Radiant Temperature
Relative Humidity

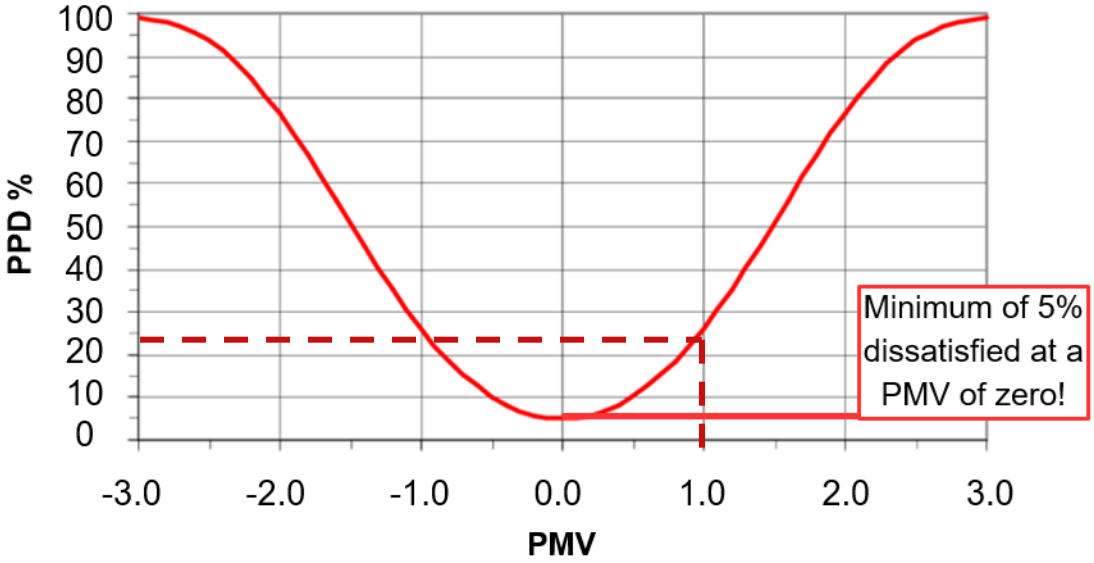




Predicted Percentage of Dissatisfied (PPD)

As function of the Predicted Mean Vote (PMV) (Fanger)





ENERGY EFFICIENCY ENHANCEMENT SIMULATION DEMONSTRATION WITH

IDA ICE

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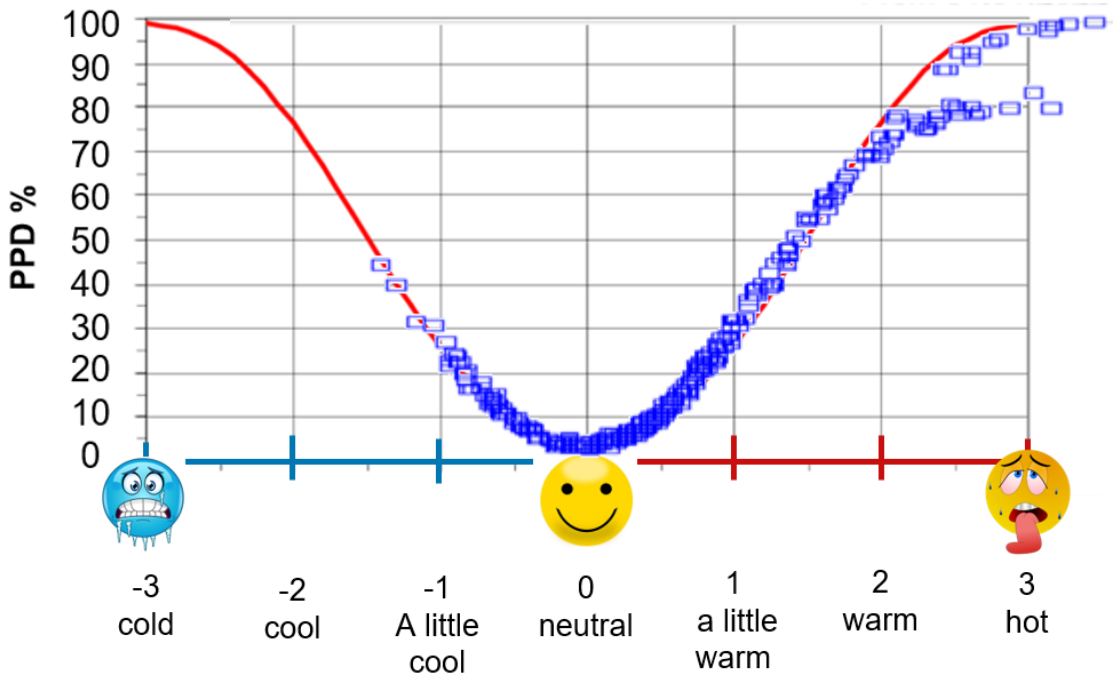
PMV and PPD in Indore

As function of the Predicted Mean Vote (PMV) (Fanger)



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LIFE-CYCLE-ANALYSIS

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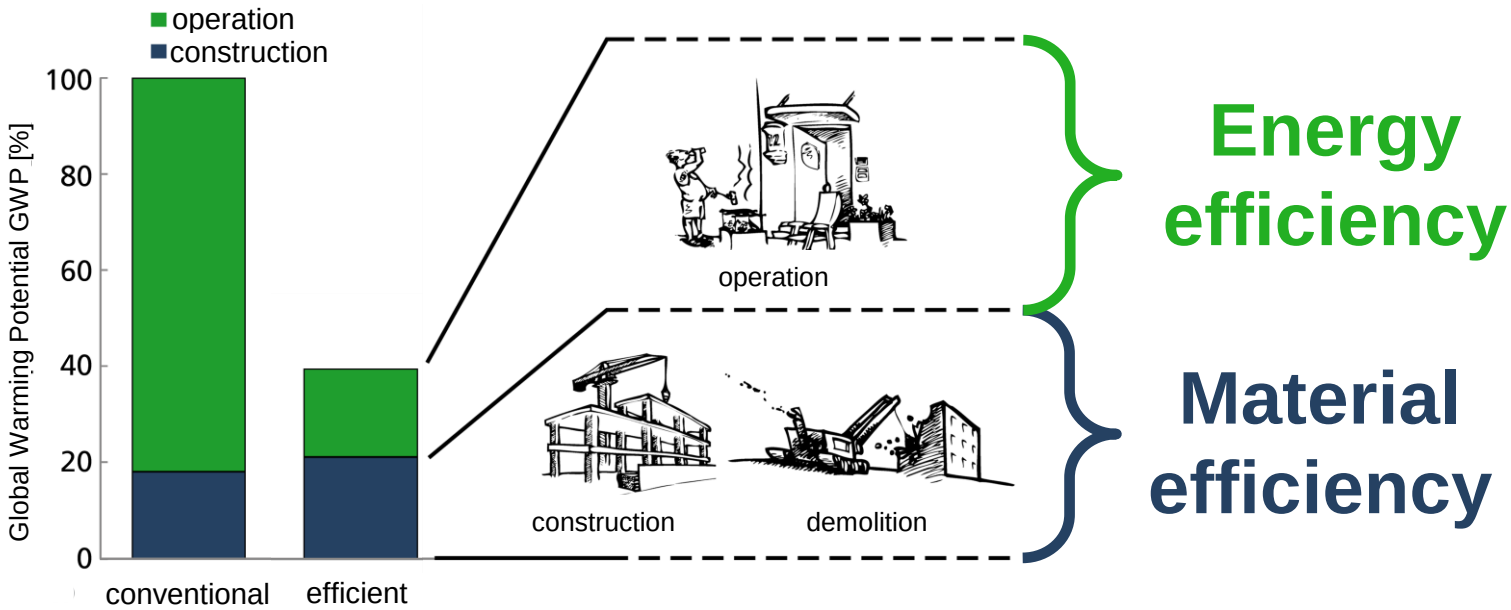
Relevance Of Life-Cycle-Analysis



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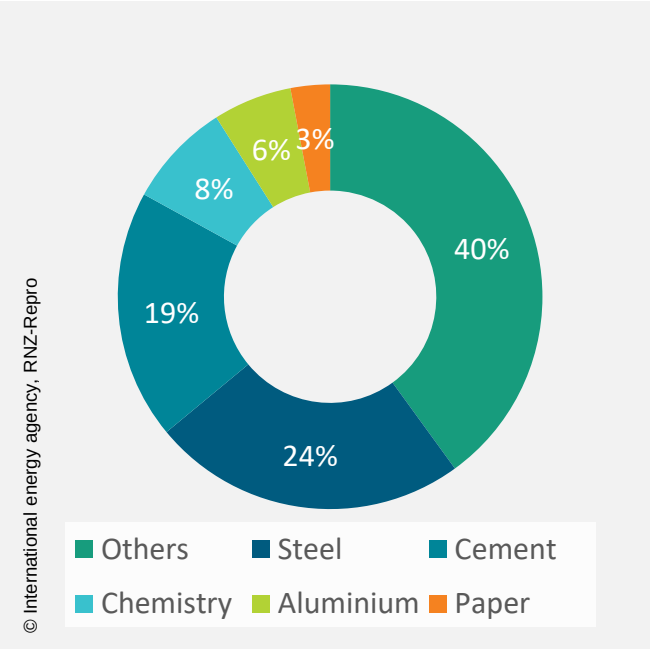
Industrial CO_2 Emission

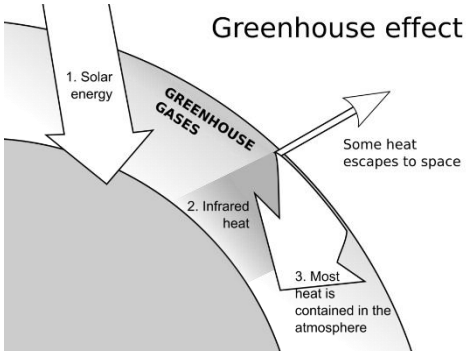


Global CO_2-Emissions	▪ 2019: 36.4 bn t/a ▪ 2050: 43.1 bn t/a
Worldwide	▪ Industry: 14.8 bn t/a ▪ Cement: 2.8 bn t/a
Germany	▪ Cement: 20 Mio. t/a

What Is the Global Warming Potential (GWP) ?

Factors of Global Warming Potential

- Ability to absorb infrared radiation
- Radiation absorption spectrum
- Lifetime in the atmosphere



The main greenhouse gases

Greenhouse gases	Chemical formula	Pre-industrial concentration	Concentration in 1994	Atmospheric lifetime (years)***	Anthropogenic sources	Global warming potential (GWP)*
Carbon-dioxide	CO_2	280 ppmv	358 ppmv	50-200	Fossil fuel combustion Cement production Land use conversion	1
Methane	CH_4	700 ppbv	1720 ppmv	12-17	Fossil fuels Rice paddies Waste dumps Livestock	21**
Nitrous oxide	N_2O	275 ppbv	312 ppmv	120-150	Fertilizer industrial processes combustion	310
CFCs	CFC12	0	503 pptv	102	Liquid coolants Foams	125-152
HCFCs	HCFC-22	0	105 pptv	13	Liquid coolants	125
Perfluorocarbon	CF_4	0	110 pptv	50000	Production of aluminium	6500
Sulphur hexa-fluoride	SF_6	0	72 pptv	1000	Production of magnesium	23900

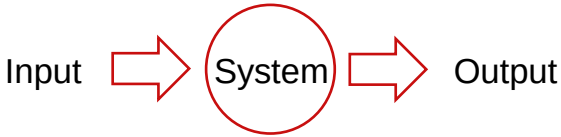
Note: pptv= 1 part per trillion by volume; ppb= 1 part per bilion by volume, pomy= 1 part per million by volume

* GWP for 100 year time horizon. ** includes indirect effects of tropospheric ozone production and stratospheric water vapour production. *** On page 15 of the IPCC SAR. No single lifetime for CO2 can be defined because of the different rates of uptake by different sink processes.

Source: own graphics, content from the IPCC radiative forcing report; Climate change 1995, The science of climate change, contribution of working groupe 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge press university, 1996.

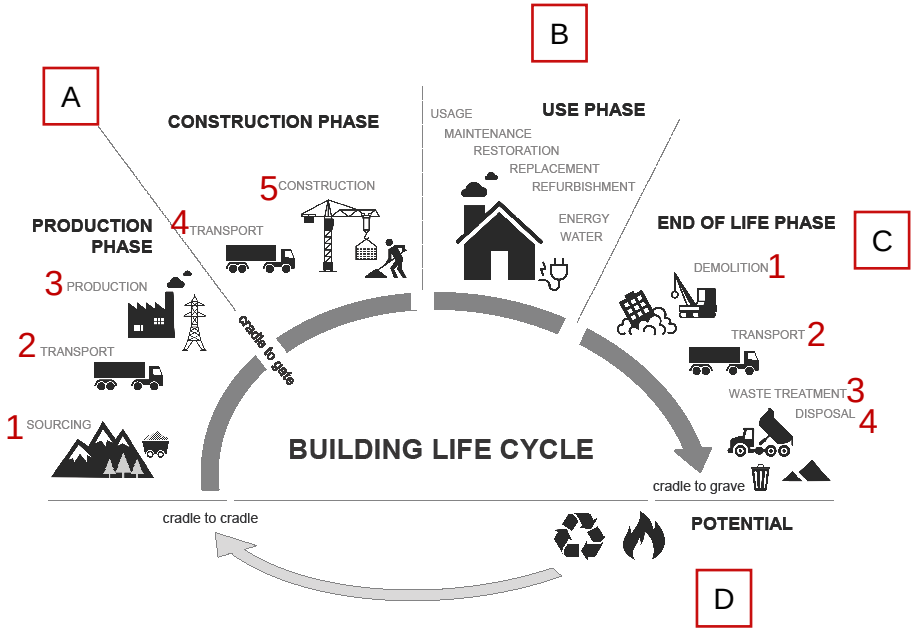
Usecase Scenarios Of The GWP – Life-Cycle-Analysis (LCA)

Balancing theory



LCA Definition

“the LCA is the compilation and assessment of the input and output flows and the potential environmental effects of a product system in the course of its life cycle.”



[The Noun Project; CC BY 3.0 US]

LCA Phases

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Calculation Example Of The Global Warming Potential

$$GWP_i = a_{1,i} * GWP_{a1,i} + a_{2,i} * GWP_{a2,i} + \ldots + a_{N,i} * GWP_{N,i}$$

GWP_i …GWP-Potential for the status i of the building
$a_{n,i}$ …Gross- quantity of the products, which are being used in phase i
$GWP_{an,i}$ …GWP-Potential for the product in phase i

House Characteristics	Size	Unit
Size	10 x 10	m
Height	6	m
Wall Size	240	m2
Wall Thickness	0,20	m
Wall Volume	48	m3

Wall Materials	Thickness [m]	Size [m2]	Volume [m3]
Plaster (Gipsum)	0,01	1	0,01
Insulation (Mineralwool)	0,09	1	0,09
Concrete	0,09	1	0,09
Plaster (Gipsum)	0,01	1	0,01
∑	0,20		

Material	A1-A3	A4-A5	B	C1-4	GWP (A1-C4) [kg CO2-Equ.]	%-Part
Plaster (Gipsum)	1,19	0,00	0,00	0,16	1,36	5,13
Insulation (Mineralwool)	3,02	0,46	0,00	0,14	3,62	13,67
Concrete	18,72	0,48	-0,86	1,80	20,15	76,08
Plaster (Gipsum)	1,19	0,00	0,00	0,16	1,36	5,13
∑	24,13	0,93	-0,86	2,27	**26,49**	100,00

TOTAL GWP [kg CO2-Equ.]

6357,19

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Software To Calculate LCA / GWP

Databases

ecoinvent

GaBi

ELCD

Ökobaudat

Databases are based on national Data and can therefore not be transferred to other countries!

LCA Tools

Umberto NXT

Caala

Legep

Generis

eLCA

Further Reads, Links

Technograhi Platform

https://bmtpc.org/LatestTopicsDetails.aspx?mid=196

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Ministry of Housing and Urban Affairs
Government of India

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