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

GLOBAL HOUSING TECHNOLOGY CHALLENGE INDIA

Ministry of Housing & Urban Affairs
Government of India

स्वच्छ भारत
एक कदम स्वच्छता की ओर

LIGHT HOUSE PROJECT
AT LUCKNOW, UTTAR PRADESH

3D View of the Project

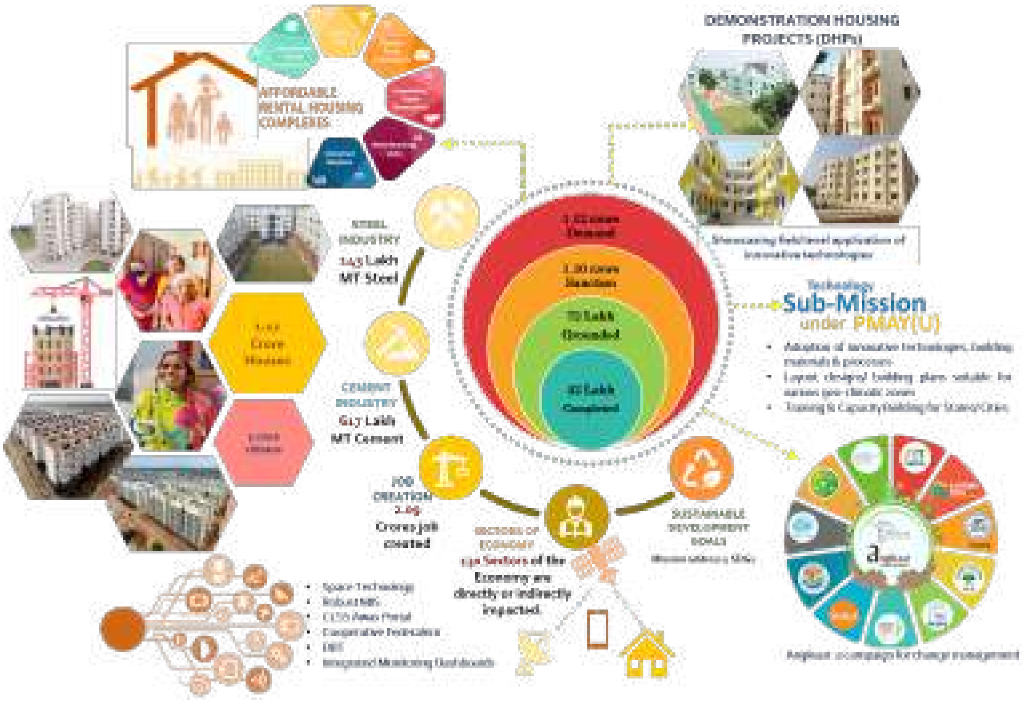
"The country is going to get a new technology to build houses for the poor and the middle class. In technical parlance, you call it the Light House Project. I believe these six projects are really like light towers. These six light house projects would give a new direction to the housing construction in the country. The coming together of states from the east-west, north-south and every region of the country is further strengthening our sense of cooperative federalism. These light house projects will be constructed through modern technology and innovative processes. This will reduce the construction time and prepare the more resilient, affordable and comfortable homes for the poor. In a way, these projects will be incubation centres and our planners, architects, engineers and students will be able to learn and experiment with new technology."

Narendra Modi
Prime Minister of India
1.1.2021

1. Background

The Ministry of Housing and Urban Affairs (MoHUA) is implementing Pradhan Mantri Awas Yojana-Urban (PMAY-U) Mission, one of the largest public housing programs in the world, with a goal of providing all weather pucca houses to all eligible urban families by 2022. Against an assessed demand of 1.12 crore houses, so far over 1.08 crore have been sanctioned; out of this over 72 lakh have been grounded for construction and nearly 42 lakh have been completed and delivered to the beneficiaries.

Under PMAY(U), a Technology Sub-Mission (TSM) has been set up with an aim to provide sustainable technological solutions for faster & cost-effective construction of houses suiting to geo-climatic and hazard conditions of the country". TSM promotes adoption of modern, innovative & green technologies and building material for faster and quality construction of houses. It also facilitates for preparation and adoption of layout designs and building plans suitable for various geo-climatic zones.



The Country being in development phase, massive construction activities are undergoing and planned in all the States/UTs for creating affordable shelters & related infrastructures. Traditionally, houses in the country are constructed using conventional technology as in-situ reinforced cement concrete (RCC) frame & burnt clay brick masonry. With the massive construction requirement & taking into consideration the important factors such as fast depleting natural resources, achieving Sustainable Development Goals (SDGs) & international commitments to reduce Carbon Dioxide emissions, there is urgent need to find alternate, sustainable and resource efficient solutions.

Globally, there has been technological advancement in the area of building materials and fast track prefabricated/pre-engineered construction practices. However, the use of alternate construction technologies in our country is in a limited extent so far. Hence, there was a need to look for new emerging, disaster-resilient, environment-friendly, cost-effective and speedy construction technologies which would form the basis of housing construction in India. Hon'ble Prime Minister envisaged a paradigm shift through technology transition using large scale construction under PMAY(U) as an opportunity to get the best available construction technologies across the globe.

In the light of above, MoHUA initiated Global Housing Technology Challenge India (GHTC-India) in January, 2019 which aimed to identify and mainstream globally best available proven construction technologies that are sustainable, green and disaster resilient through a challenge process which could bring a paradigm shift in construction practices for housing sector.

2. Construction Scenario in India

Housing for All by 2022 is the firm resolve of the Government to provide pucca shelter to each household of India and is a humble beginning towards building New India. The number of housing units that need to be constructed are huge. There is a requirement of 11.2 million dwelling units in urban areas by 2022. Also, construction sector is emerging as third largest sector globally to take India towards $5 trillion economy.

Conventionally, houses are built with traditional materials, i.e., burnt clay bricks, cement, sand, aggregates, stones, timber & steel. Sand and aggregates are already in short supply and due to irrational mining, it is banned in number of states in India. Burnt clay bricks use top fertile soil as raw material and also, its production makes use of coal, a fossil fuel. Cement and steel are also energy intensive materials and produced from natural resource, i.e., limestone rock and iron ores respectively. Further, the construction requires clean drinking water which is already in short supply even for drinking.

The way out is:

i. To make use of alternate materials which are based on renewable resources & energy
ii. Optimize the use of conventional materials by bringing mechanization in the construction
iii. Utilize agricultural & industrials waste in producing building materials.

In conventional method, the materials are gathered at the site and then construction takes place by laying bricks layer by layer to construct walls and pouring concrete over steel cages (reinforcement) to make floors, vertical members, i.e., columns and horizontal members i.e. beams through a labour intensive process with little control on quality of finished product. Also, this construction process is slow paced. Further, in being cast in situ construction, there is ample wastage of materials and precious resources and at the same time there is enormous dust generated polluting the air. Therefore, there is need to bring construction methodologies which impart speed to the construction, bring in optimum use of materials, cut down wastages and produce quality product.

In today's context, a few more terms have become significant with construction and need to be dovetailed with future construction practices. These are sustainability, climate responsiveness and disaster resilience. The construction industry poses a major challenge to the environment. As per the UN Environment Programme (UNEP), more than 30% of global greenhouse gas emissions are building related and emissions could double by 2050 on a business-as-usual scenario. As per report of the Green Rating for Integrated Habit Assessment (GRIHA), globally, buildings consume about 40% of energy, 25% of water and 40% of resources. In addition, building activities contribute an estimated 50% of the world's air pollution, 42% of its greenhouse gases, 50% of all water pollution, 48% of all solid wastes and 50% of all CFCs (chlorofluorocarbons) to the environment.

Further, disasters due to natural hazards i.e. earthquakes, cyclones, floods, tsunamis and landslides have been happening with ascending frequency and effects. Every year due to faulty construction practices and bad performance of built environment during disasters, there are not only heavy economic losses but also losses of precious lives of humans leaving irrevocable impact on human settlements and therefore, disaster-resilient construction is also paramount.

In view of the above, it is obvious that construction sector requires a paradigm shift from traditional construction systems by bringing innovative construction systems which are resource-efficient, environmentally responsible, climate responsive, sustainable, disaster-resilient, faster, structurally & functionally superior. These kinds of systems are being practiced world over successfully and have shown their versatility through the passage of time.

3. Innovative Construction Technologies: Salient Features

i. Resource Efficiency

A conventional building tends to focus on the use of basic materials namely cement, bricks, sand, aggregates, steel which are based on natural resources. Also, there is over dependence on fossil fuels for production & transportation. These natural resources are finite and cannot be replenished quickly. Also, their extraction and manufacturing have direct and indirect consequences on environment & energy requirements and pose danger to our planet in terms of greenhouse gas emissions, land & air pollution etc. Therefore, natural resources are to be used efficiently which is one of the key features of alternate construction systems as they employ industrial techniques to produces building components and use cement, steel and other aggregates optimally. The other feature of alternate construction systems is to make use of renewable resources.

ii. Structural Design Efficiency

The alternate systems follow the path of optimization. Right from the concept & design stage, the building components, including structural configuration, is designed in a manner to optimize the performance. The performance-based design instead of prescriptive design philosophy is the key for design efficiency while dealing with these alternate construction systems.

iii. Disaster Resilience

The alternate construction systems are designed to be resilient in terms of natural hazards as it entails performance-based design of buildings.

iv. Cost & Payoff

The most criticized issue about alternate construction systems is the price. The stigma is between the knowledge of up-front cost vis-à-vis life cycle cost. The cost of a building is defined as follows:

Total Cost = Initial construction cost + Running cost during life of building + disposal cost
(This is also known as life-cycle cost)

Most of the time, the criterion in selection of technology is cost per m^2, which is initial cost and can be incongruous if green aspects are to be considered. The buildings with alternate systems may cost 10-15% higher initially as of now (It can also be questioned as today these systems require initial push but once mainstreamed the initial cost will also be equivalent to cost of conventional construction) but will be less by couple of times over the entire life of the building. During the life span of a building, the financial payback will exceed the additional initial cost of using alternate systems several times. And broader benefits, such as reductions in greenhouse gases (GHGs) and other pollutants have large positive impacts on surrounding communities and on the planet.

v. Energy Efficiency

Alternate construction systems often include measures to reduce energy consumption, i.e., the embodied energy required to extract, process, transport and install building materials and the operating energy to provide services such as heating and power for equipment. The buildings with alternate systems use less operating energy, embodied energy. These buildings will have a lower embodied energy than those built primarily with brick, mortar, concrete, or steel.

vi. Water Efficiency

The conventional construction systems primarily are cast-in-situ reinforced concrete systems which require large quantity of potable water for curing and most of the time, the water of curing go waste. The new systems employ better techniques of curing such as pressurized curing, chemical curing etc. which help in conserving the water during construction.

vii. Material Efficiency

Building materials are typically considered to be sustainable if they are based on renewable/waste resources and can be reusable and recyclable. Most of the alternate construction systems either make use of industrial waste, renewable resources, energy efficient building materials or optimize the use of basic raw materials, i.e., cement, sand, aggregates, steel consumption. For example, The Glass Fiber Reinforced Gypsum (GFRG) panels make use of phospho-gypsum which is a by-product of fertilizer plant, sandwich panels make use of EPS beads which are energy efficient.

viii. Indoor Environmental Quality Enhancement

The Indoor Environmental Quality refers to providing comfort, well-being, and productivity of occupants. Indoor Air Quality seeks to reduce volatile organic compounds, or VOCs, and other air impurities such as microbial contaminants. The alternate systems employ construction materials and interior finish products with zero or low VOC emissions during the design and construction process which enhance indoor air quality. Also, well- insulated and tightly sealed envelope reduce moisture problems which often leads to dampness.

ix. Operation & Maintenance Optimization

The construction systems identified are based on factory made building components which are manufactured with high precision under strict quality control and therefore, more durable, requiring no or minimum maintenance. The alternate technologies are industrial products having SOPs for building's Operations and Maintenance (O&M).

x. Waste Reduction

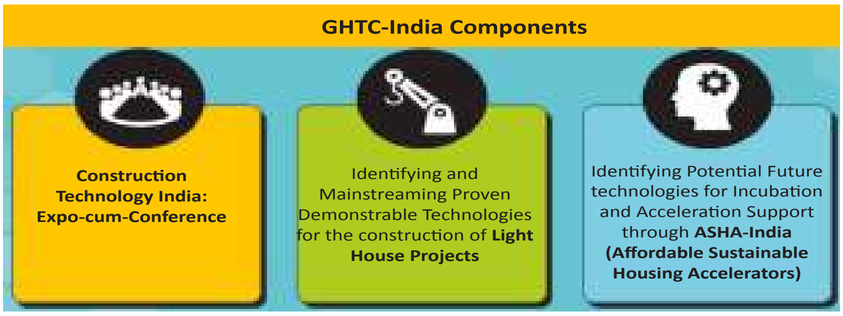
Alternate construction systems not only seek to reduce waste of energy, water and materials used during construction but also generate less construction & demolition waste after completion of the building. Well-designed buildings also help reduce the amount of waste generated by the occupants. When buildings reach the end of their useful life, they are typically demolished and disposed to landfills. In case of alternate systems, most of the deconstructed components can be reclaimed into useful building materials.

End-User Benefits
• Improved structural & functional performance
• Safer and disaster resilient house
• Better quality of construction
• Low maintenance, minimum life cycle cost
• Speedy construction resulting in early occupancy
• Cost-effective and environment-friendly
• Better fire resistance & thermal efficiency
• Less air pollution and waste generation

4. Global Housing Technology Challenge-India

MoHUA has initiated the Global Housing Technology Challenge-India (GHTC-India) which aims to identify and mainstream a basket of innovative construction technologies from across the globe for housing construction sector that are sustainable, eco-friendly and disaster-resilient. They are to be cost effective and speedier while enabling the quality construction of houses, meeting diverse geoclimatic conditions and desired functional needs. Future technologies will also be supported to foster an environment of research and development in the country. GHTC-India aspires to develop an eco-system to deliver on the technological challenges of the housing construction sector in a holistic manner.

Construction Technology India (CTI) – 2019: 1st Biennial Expo-cum-Conference was inaugurated by Hon'ble Prime Minister on 2nd March 2019. He also declared the year 2019-20 as the 'Construction Technology Year' to promote new and alternate technologies at a large scale in the country. The Expo brought together multiple stakeholders from across the world involved in innovative and alternative housing technologies for exchange of knowledge and business opportunities and master classes.



MoHUA, through a Technical Evaluation Committee (TEC), shortlisted 54 innovative proven technologies suiting different geo-climatic conditions that could be considered for demonstration through actual ground implementation of six Light House Projects (LHP) in six different States/UTs of PMAY(U) regions across the country. These 54 technologies were further categorized into following six broad categories:

1. Precast Concrete Construction System - 3D Precast volumetric

2. Precast Concrete Construction System - Precast components assembled at site

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

4. Prefabricated Sandwich Panel System

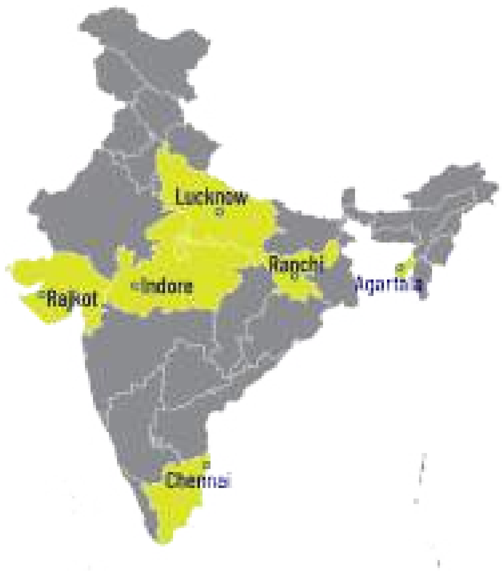
5. Monolithic Concrete Construction

6. Stay In Place Formwork System

The details of the shortlisted 54 technologies are available at https://ghtc-india.gov.in.

5. Light House Projects

Six distinct innovative technologies have been selected from among 54 globally best technologies that participated in GHTC-India for constructing six Light House Projects (LHPs) of about 1,000 houses each with allied infrastructure at Indore, Rajkot, Chennai, Ranchi, Agartala and Lucknow.



Hon'ble Prime Minister Shri Narendra Modi laid the foundation stone of these LHPs on January 1, 2021 and Hon'ble Governors, Hon'ble Chief Ministers of six states along with State Ministers joined the event from the LHP sites through video conference. The LHPs are model housing projects comprising of nearly 1,000 houses at each location with allied services are being constructed for showcasing use of the best of new-age technologies, materials and processes in the construction sector.

The houses are being constructed using the innovative technologies shortlisted under GHTC-India suitable to the geo-climatic and hazard conditions of the region and will be completed in challenges mode within 12 months time. LHPs will pave the way for a new eco-system where globally proven technologies will be adopted for cost effective, environment-friendly and speedier construction.

LHPs will serve as Live Laboratories for different aspects of transfer of technologies to field application, such as planning, design, production of components, construction practices, testing, etc., for both faculty and students, builders, professionals of private and public sectors and other stakeholders involved in such construction.

Details of six Light House Projects are as given below:

Location	DUs (Storeys)	Technology	Construction Agency
1. Indore, Madhya Pradesh	1,024 (S+8)	Prefabricated Sandwich Panel System	M/s KPR Projectcon Private Limited
2. Rajkot, Gujarat	1,144 (S+13)	Monolithic Concrete Construction using Tunnel Formwork	M/s Malani Construction Co.
3. Chennai, Tamil Nadu	1,152 (G+5)	Precast Concrete Construction System – Precast Components Assembled at Site	M/s B. G. Shirke Construction Technology Pvt. Ltd.
4. Ranchi, Jharkhand	1,008 (G+8)	Precast Concrete Construction System – 3D Volumetric	M/s SGC Magicrete LLP
5. Agartala, Tripura	1,000 (G+6)	Light Gauge Steel Structural System & Pre-engineered Steel Structural System	M/s Mitsumi Housing Pvt. Ltd.
6. Lucknow, Uttar Pradesh	1,040 (S+13)	PVC Stay In Place Formwork System	M/s JAM Sustainable Housing LLP

Light House Projects : Salient Features

- LHPs are model housing project with approximately 1,000 houses built at each location with shortlisted alternate technology suitable to the geo-climatic and hazard conditions of the region.
- Constructed houses under LHPs will include on site infrastructure development such as internal roads, pathways, common green area, boundary wall, water supply, sewerage, drainage, rainwater harvesting, solar lighting, external electrification, etc.
- Houses under LHPs are designed keeping in view the dimensional requirements laid down in National Building Code (NBC) 2016 with good aesthetics, proper ventilation, orientation, as required to suit the climatic conditions of the location and adequate storage space, etc.
- Convergence with other existing centrally-sponsored Schemes and Missions such as Smart Cities, Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Swachh Bharat (Urban), National Urban Livelihood Mission (NULM), Ujjwala, Ujala, Make in India were ensured during the designing of LHPs at each site.
- The structural details were designed to meet the durability and safety requirements of applicable loads including earthquakes, cyclone, and flood as applicable in accordance with the applicable Indian/International standards.
- Cluster design may include innovative system of water supply, drainage and rainwater harvesting, renewable energy sources with special focus on solar energy.
- The period of construction will be maximum 12 months. Approvals were accorded through a fast track process by the concerned State/UT Government.
- For the subsequent allotment of constructed houses under LHPs to the eligible beneficiaries in States/ UTs, procedures of existing guidelines of PMAY (U) will be followed.

Light House Project at Lucknow, Uttar Pradesh

Project Brief	
Location of Project	Avadh Vihar, Lucknow, U.P.
No. of DUs	1,040 (S+13)
Plot area	20,036 sq.mt.
Carpet area of each DU	34.51 sq.mt.
Total built up area	48,702 sq.mt.
Technology being used	Stay In Place Formwork System with pre-engineered steel structural system
Other provisions	Community Centre, Shops
Broad Specifications	
Foundation	RCC raft foundation
Structural Frame	Pre-engineered steel structural frame
Walling	Stay In Place PVC Formwork System
Floor Slabs/Roofing	Cast in-situ deck slab
Joinery & Finishing	Door Frame/ Shutter: • Pressed steel door frame with flush shutters • PVC door frame with PVC Shutters in toilets. Window Frame/ Shutter: • uPVC frame with glazed panel and wire mesh shutters. Flooring: • Vitrified tile flooring in Rooms & Kitchen • Anti-skid ceramic tiles in bath & WC • Kota stone Flooring in Common area. • Kota stone on Staircase steps.
Infrastructure	Internal Water Supply, Laying of Sewerage Pipe Line, RCC storm water drain, Provisions for Fire Fighting, Internal Electrification, Internal Road & Pathway (CC Road and Bituminous Road), Providing Lifts in building blocks, Landscaping of site, Street light with LED lights, Solar Street Light System, Sewerage Treatment Plant, External Electrification, Water Supply System including underground water reservoir, Compound wall with Boundary Gates, Horticulture facilities, Rain Water Harvesting, Solid Waste Management.

Project Layout Plan

Block Plan

Unit Plan

Technology Details

A. INTRODUCTION

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. The hollow Novel Wall components are erected and filled with concrete, in situ, to provide a monolithic concrete wall with enhanced curing capacity due to water entrapment, as the polymer encasement does not allow the concrete to dry prematurely with only the top surface of the wall being exposed to potential drying. The polymer encasement provides crack control vertically and horizontally for the concrete, and provides vertical tension reinforcement thus increasing the structural strength of the wall. The resulting system is unique and provides substantial advantages in terms of structural strength, durability enhancement, weather resistance, seismic resistance, design flexibility, and ease of construction. Steel dowels are necessary to anchor the wall to the concrete foundation.

This System is suitable for residential and commercial buildings of any height from low rise to high rise. In order to achieve speedier construction, strength and resource efficiency, the composite structure with Pre-Engineered Steel Structural System as structural members is being used in the present project.

B. SIZE OF PANELS

PVC Wall Forms have been developed in various cross-sectional sizes as per project requirement. The common sizes are 64mm, 126mm, 166mm & 206mm. However available Novel System types are as follow:

Novel	Wall Thickness	
	Overall (Nominal)	Concrete Core
N64	64 mm	60 mm
N126	126 mm	120 mm

- N64 walls are erected individually and not preassembled, except for headers and sills.
- Pre-assembled walls sections are used for walls over 4300 mm (14’) high
- The height of walls made with the Formwork vary according to the requirement.
- N126 walls less than 4300 mm (14’) high are erected individually except for walls of unique projects and for headers and sills.

C. MANUFACTURING PROCESS IN THE PLANT

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. The raw material is fed into the screw barrels of the extruders & heated in the barrels to molten form, where the temperature is electronically controlled. The extruded profile is cut to designed length, labelling of the components takes place in the coring, cutting, foaming or assembly areas, and the stay in place sections are ready to move for erection at site.

D. CONSTRUCTION & INSTALLATION PROCESS

Prefabricated SIP Wall panels and Hot Rolled Sections are transported to site. PEB HR Sections are erected on ready foundation prepared in conventional manner using cranes and required screws and connections.

- Floor slab is erected using decking sheet. Once the structural Frame and floor is installed and aligned; SIP Wall panels fixing start with box connector at a corner or a T-intersection and the two adjacent panels as per design on decking floor. Temporary bracing and steel reinforcing bars shall be installed as the wall erection proceeds. SIP Wall panels with provisions of holes for services conduits are reinforced with minimum amount of reinforcement.
- 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 cores to allow easy flow of the poured concrete between the components.
- Cavities inside the wall panels are filled with concrete which imparts the required hardness to SIP Wall panels.
- Upon installment of SIP wall panels, flooring and Ceiling Finishing work is executed.
- Other services accessories, instrument and equipments are installed at the final stage.

E. 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 very aesthetic finished surface in different color options
- The system provides substantial advantages in terms of structural strength, durability enhancement, weather resistance, seismic resistance, design flexibility, and ease of construction.

F. LIMITATIONS

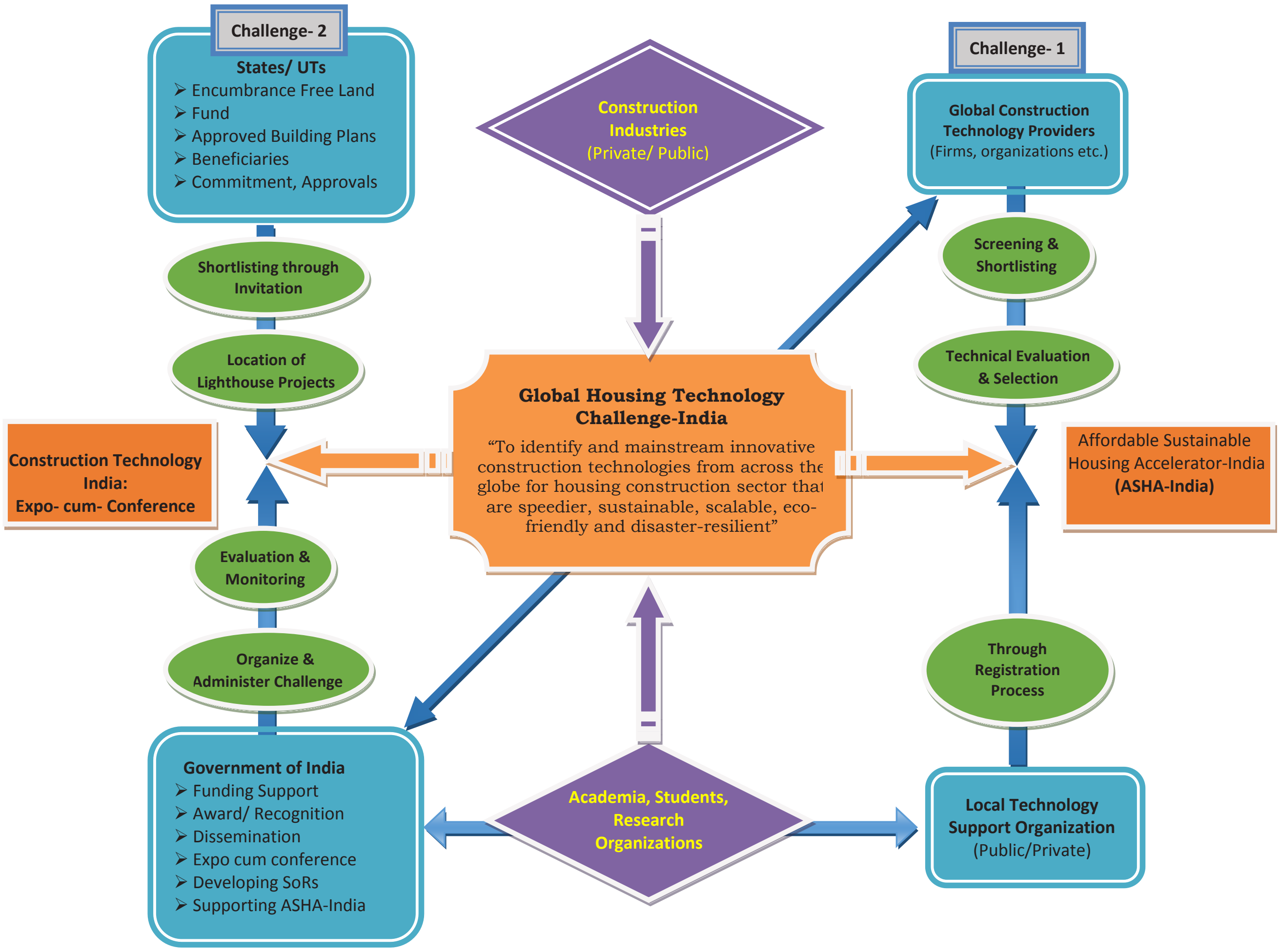
Limitations for using Novel System on the basis of performance, safety, geo-climatic Conditions:

- 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.

G. CERTIFICATION

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

Process Flow of GHTC-India



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