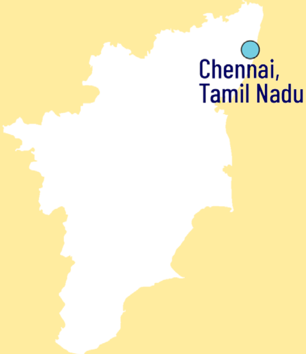
Ministry of Housing & Urban Affairs
Government of India

LIGHT HOUSE PROJECT
AT CHENNAI, TAMIL NADU



3D View of the Project

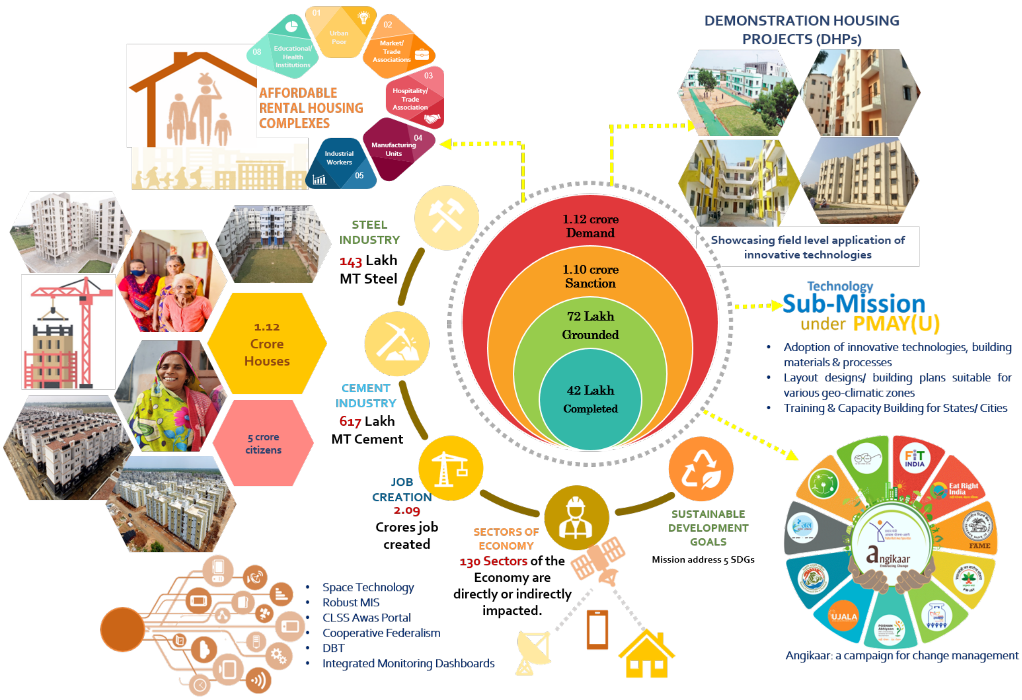
"The country is going to get a new technology to build houses for the poor and the middle class. In technical parlance, you call it the Light House Project. I believe these six projects are really like light towers. These six light house projects would give a new direction to the housing construction 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

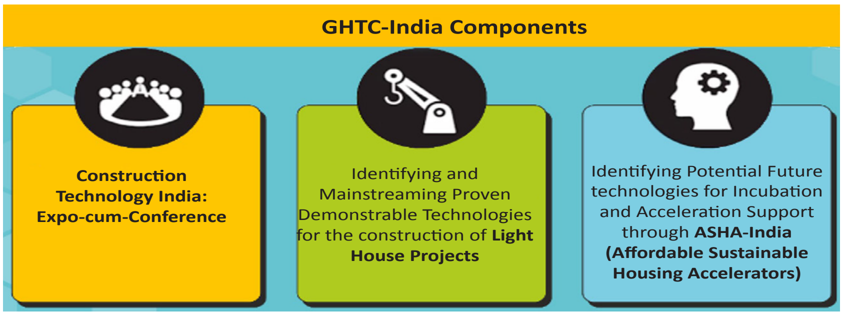
Alternate construction systems not only seek to reduce waste of energy, water and materials used during construction but also generate less construction & demolition waste after completion of the building. Well-designed buildings also help reduce the amount of waste generated by the occupants. When buildings 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

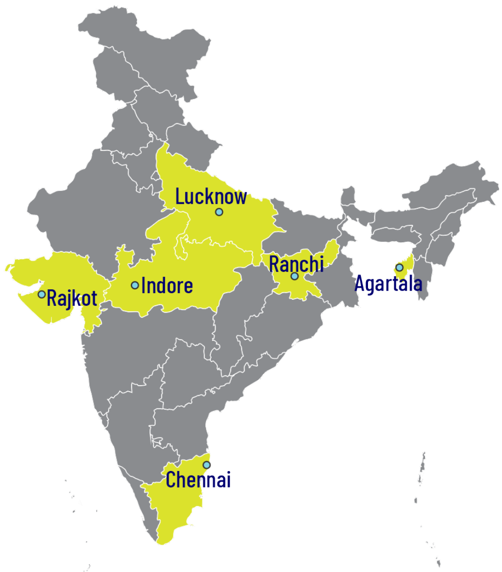
4.Prefabricated Sandwich Panel System

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 Chennai, Tamil Nadu

Project Brief	
Location of Project	Nukkampal Road, Chennai, Tamil Nadu
No. of DUs	1,152 (G+5)
Plot area	29,222 sq.mt.
Carpet area of each DU	26.78 sq.mt.
Total built up area	43439.76 sq.mt.
Technology being used	Precast Concrete Construction System - 3S System
Other provisions	Anganwadi, shops, milk booth, library and ration shop
Broad Specifications	
Foundation	RCC isolated footing
Structural Frame	RCC precast beam/columns
Walling	AAC Blocks
Floor Slabs/Roofing	RCC precast slab
Joinery & Finishing	Door Frame/ Shutters: • 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. Wall Finishes: • Weather Proof Acrylic Emulsion paint on external walls • Oil Bound distemper over putty on internal walls
Infrastructure	Internal Water Supply, Laying of Sewerage Pipe Line, RCC storm water drain, Provisions for Fire Fighting, Internal Electrification, 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, External Electrification, Water Supply System including underground water reservoir, Compound wall with Boundary Gates, Horticulture facilities, Rain Water Harvesting, Solid Waste Management.


58.72 AS PER FMB
26.76 AS PER FMB
119.93 AS PER FMB
12.04 AS PER FMB
EXISTING ROAD LEVEL AS PER SITE
37.60 AS PER FMB
136.45 AS PER FMB
234.43 AS PER FMB
8.44
39.50 AS PER FMB
132.33 AS PER FMB
18.0 M WIDE NUKKAPALAYAM ROAD
30 M. WIDE ROAD
PUBLIC PURPOSE-01 AREA-909.00 SQ.M
PUBLIC PURPOSE-02 AREA-877.30 SQ.M
POLICE STATION APROX. PLOT AREA -1312.19 SQM.
EXISTING GROND LEVEL AS PER SITE
LAYOUT PLAN

Layout Plan

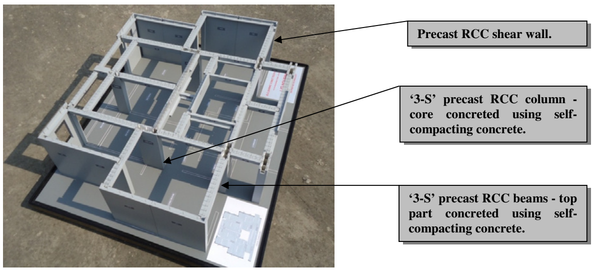
Block Plan

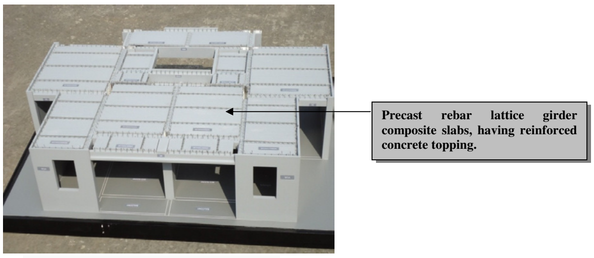
Unit Plan

Unit 3D View

Technology Details

A. INTRODUCTION





3S system incorporates precast dense reinforced cement concrete hollow core columns, structural RCC shear walls (as per design demand), T/L/Rectangular shaped beams, stairs, floor/roof solid Precast RCC slabs, lintels, parapets and chajjas. AAC blocks are used for partition walls. Hollow core columns are erected above substructure, over which beams are integrated in the column notches followed by erection of slabs. Structural continuity and robustness is achieved through wet jointing using Dowel bars/ continuity reinforcement placed at connections and filling the in-situ self-compacting concrete in hollow cores of columns. All the connections and jointing of various structural framing components is accomplished through insitu self-compacting concrete/ micro concrete/non-shrink grout as per design demand along with secured embedded reinforcement of appropriate diameter, length and configuration to ensure monolithic, continuous, resilient, ductile and durable behavior.

3S Prefab Technology completely eliminates the use of timber and forest produce of any category. On the contrary, use of flyash and GGBS enhances the sustainability. The thermal and acoustic insulation provided by the AAC block masonry, facilitates reduction in energy towards maintaining comfort level temperature within enclosed habitat space. Also, considerable reduction in dead load is achieved due to use of form finish precast components & AAC material resulting into better performance under seismic loads.

All the structural components are pre-engineered and manufactured in factories / site factories with objective quality control resulting into dimensional accuracy, correctness in spacing of reinforcement, uniform protective cover, full maturity of components and assurance on design strength due to use of design mix concrete having minimal water-cement ratio which ultimately results into durable structure.

B. BASIC MATERIAL REQUIREMENTS

i. RCC hollow columns & Beam

a. Concrete

Shall conform to appropriate grade based on environmental and structural requirements condition as per IS 456 : 2000

b. Reinforcement

Shall be of Fe 415 Grade or Fe 500 Grade as per IS 1786:2008

c. Precast RCC Slab or AAC Slabs of Grade 1 of Density 551-650 kg/m^3 of IS 6073:2006

ii. AAC Precast Block

Density 451-550 Kg/m^3 for internal wall, 551-650 Kg/m^3 for external wall as per IS 2185 (Pt. 3) :1984 or Precast RCC wall panels.

C. OTHER REQUIREMENTS:

I. EVALUATION OF STRUCTURAL REQUIREMENT OF JOINTS

a. Against vertical load

- Full Scale load test on assembly of precast elements by Tor Steel Research Foundation in India, Bangalore found it safe.

- Structural Design evaluation for HIG – II Buildings at Powai by Shri H.P. Shah; Stanford University found that based on the design concept, design calculation and detailing; the structure is safe against vertical loads, seismic loads and the wind loads.
- Scrutiny of design for S+24 type buildings by IIT Mumbai found it safe.
- Scrutiny of design details for Delhi project by IIT Roorkee found jointing & connections ensuring monolithic, durable & ductile behaviour.

b. Against seismic and wind load

A Test was performed by CBRI on full-scale building to establish behaviour of various joints under all design loads including seismic Zone IV. The experimental results on Full Scale Building Structure demonstrated the desired performance and behaviour of the 3S system under all loading condition as envisaged.

When designed for use in Zone V, independent verification may be needed.

II. DURABILITY

- Anticorrosive treatment given to reinforcement used in AAC slab panels for durability, was evaluated by CBRI, Roorkee with satisfactory results.
- Concrete and cover requirement are as per durability clause of IS 456 : 2000, to ensure adequate durability.

III. FIRE RESISTANCE PROPERTY OF BLOCK / SLAB AS DWELLING UNIT

AAC blocks / Slabs used will have fire rating as per the NBC norms for dwelling units.

IV. THERMAL BEHAVIOUR

Kvalue – 0.122 k cal/h/m^{o}c of AAC blocks.

V. ACOUSTIC COMFORT TEST

For 150/100 mm ACC Wall, Sound absorption is 38 – 40 db

VI. EASE OF FIXING SERVICES (ELECTRICITY & PLUMBING)

With pre-planning, electricity & plumbing services can easily be placed.

VII. AVAILABILITY OF PLANTS & MACHINERY

Plants & Machineries for production of Components available in Pune, Mumbai, Bangalore and Delhi. These can be setup at / nearby project site within shortest time.

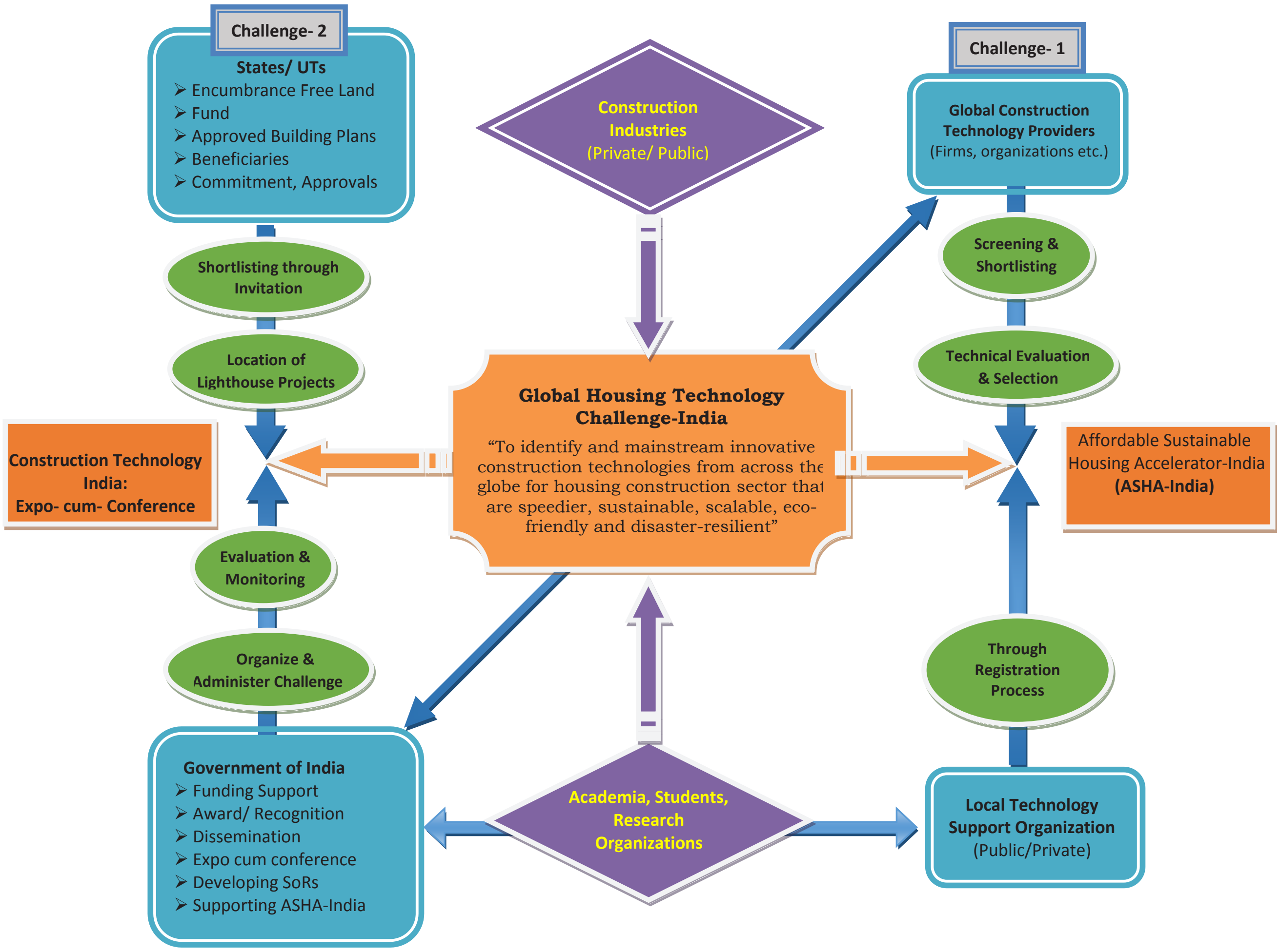
VIII. ECONOMY OF SCALE

- For a new plant to be setup, a minimum project of 2000 dwelling units may be needed.
- In places, where plant is already set up, smaller project may also be viable.

IX. ESSENTIAL REQUIREMENTS

- Precasting yard / factory set up is required with facilities such as Casting Yard, Computerised batching plant, Moulds, Transportation facility, Stacking yard for materials & components, Lifting and loading facility, Laboratory to test raw material & finished products, Water tank of enough holding capacity as required for 2 – 3 days, Service road, etc.
- Utmost attention is required for process engineering before taking up any field work. Close co-ordination between design crew, field staff and quality crew is essential.

Process Flow of GHTC-India



Notes:

Notes:

सत्यमेव जयते

The Joint Secretary & Mission Director (Housing for All)
Ministry of Housing and Urban Affairs
Government of India
Room No. 116, G-Wing, Nirman Bhawan, New Delhi
Tel: 011-23061419, Fax: 011-23061420
E-mail: jshfa-mhua@gov.in