GLOBAL HOUSING TECHNOLOGY CHALLENGE INDIA

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

Ministry of Housing and Urban Affairs
Government of India

Azadi Ka Amrit Mahotsav

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RACHNA 2.0

RESILIENT, AFFORDABLE AND COMFORTABLE HOUSING THROUGH NATIONAL ACTION

Innovative Construction Technologies & Basics of Thermal Comfort

Training 37 – Green Finch Habitat

27-01-2023 & 28-01-2023

Presented by South Cluster CSB Cell

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Session 1: GHTC & Innovative Construction Technologies of LHPs

GIZ

GIZ is an international cooperation enterprise for sustainable development which operates worldwide, on a public benefit basis. GIZ is fully owned by the **German Federal Government**, GIZ implement development programs in partner country on behalf of the German Government in achieving its development policy objectives.

german cooperation
DEUTSCHE ZUSAMMENARBEIT

The focal areas of Indo-German cooperation currently are:

- ❑ Energy
- ❑ Environment, Preservation, and Sustainable Use of Natural Resources
- ❑ Sustainable Urban & Industrial Development
- ❑ Sustainable Economic Development

GIZ

Energy

We support our partners in developing framework conditions for the promotion of renewable energy, improved energy efficiency and rural energy access.

- Indo-German Energy Forum – Support Office
- Indo-German Energy Programme – Access to Energy in Rural Areas
- Integration of Renewable Energies into the Indian Electricity System
- Indo-German Solar Partnership – PVRT
- Promotion of Solar Water Pumps
- Indo-German Energy Programme – Green Energy Corridors
- Energy Efficiency in Buildings Programme
- Indo-German Energy Programme – Energy Efficiency

Sustainable Urban and Industrial Development

We support the development of urban and industrial areas to become cleaner, more liveable, inclusive, climate-friendly and resilient.

- Land Use Planning and Management
- Sustainable and Environment-friendly Industrial Production
- Support to Ganga Rejuvenation
- Integrated and Sustainable Urban Transport Systems for Smart Cities in India
- Sustainable Urban Development – Smart Cities
- Climate Smart Cities

MoHUA + GIZ

MoHUA
(Ministry of Housing & Urban Affairs)

Government of India

+

GIZ
(Deutsche Gesellschaft für Internationale Zusammenarbeit)

Government of Germany

Indo-German Energy Program (IGEN)

IGEN Program: Climate Smart Buildings

- **Thermal Comfort Action Plan**
- **Standard / Guidelines**

- **Implementation of GHTC India**
- **Establishment of Cluster Cells**

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RACHNA 1.0 & 2.0

GLOBAL HOUSING TECHNOLOGY CHALLENGE INDIA

RACHNA 2.0

RESILIENT, AFFORDABLE AND COMFORTABLE HOUSING THROUGH NATIONAL ACTION

Trainings & workshops on innovative construction technologies & Thermal comfort for Affordable Housing

IMPACT

- **75** TRAININGS
- **5142** Stakeholders trained
- **113** TRAINING DAYS
- **1199** Government Officials trained
- **1322** Practitioners trained
- **36000+** TECHNOGRAHIS ENGAGED
- **12** design COMPETITIONS ORGANISED
- **39** Expert trainers engaged
- 12 Academic Institutions involved
- **1638** Students trained
- **983** Construction workers trained

States & UTs across India covered **25**

29 Cities across India covered

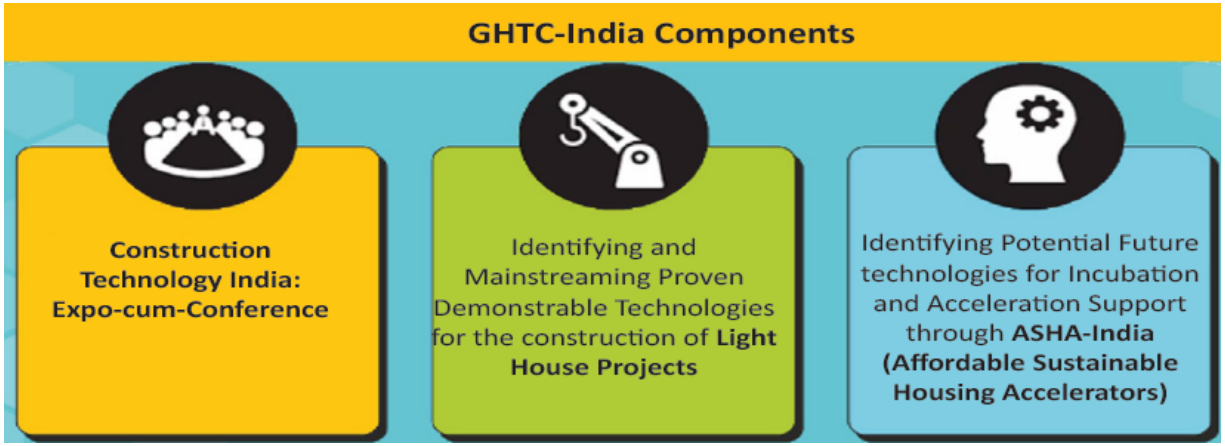
Global Housing Technology Challenge - India

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 geo-climatic conditions and desired functional needs.

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.

Hon'ble Prime Minister Shri Narendra Modi laid the foundation stone of these LHPs on January 1, 2021



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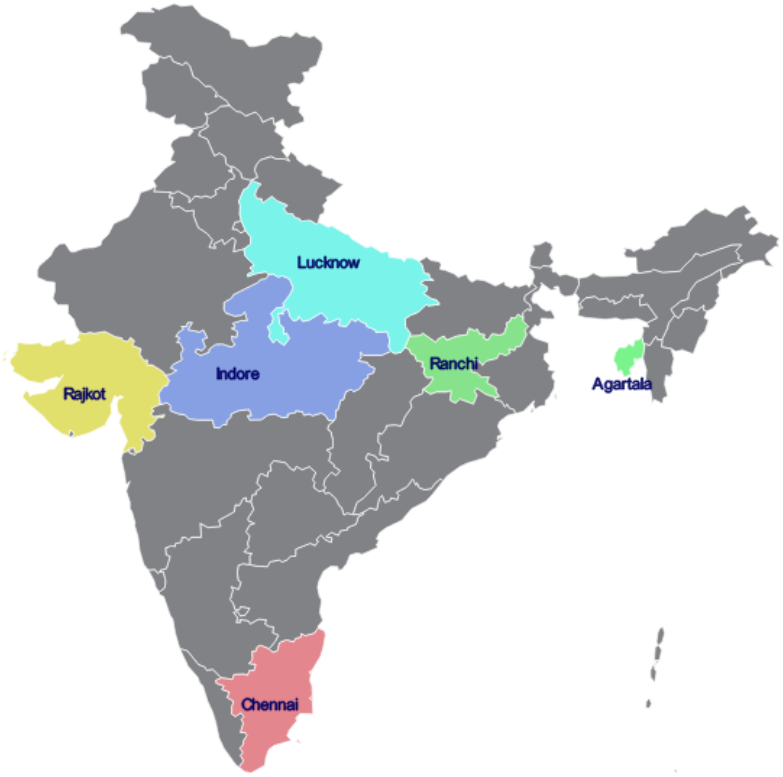
Light House Project

- **Model housing projects with approximately 1,000 houses built with shortlisted alternate technology suitable to the geo-climatic and hazard conditions of the region.**
- Demonstrate and deliver ready to live houses with speed, economy and with better quality of construction in a sustainable manner.
- **Period of construction is maximum 12 months from the date of handing over of sites to the construction agency after all statutory approvals.**
- LHPs shall serve as LIVE Laboratories for planning, design, production of components, construction practices, testing etc.
- **Site infrastructure development such as internal roads, pathways, common green area, boundary wall, water supply, sewerage, drainage, rain water harvesting, solar lighting, external electrification, etc.**
- **Incentives for early completion.**



Light House Projects

As a part of **GHTC- India**, six Light House Projects (LHP) consisting of about 1,000 houses each with physical & social infrastructure facilities is being constructed at six places across the country namely

1. Indore
2. Rajkot
3. Chennai
4. Ranchi
5. Agartala
6. Lucknow

These projects will showcase the use of the six distinct shortlisted innovative technologies for field level application, learning and replication. LHPs will demonstrate and deliver ready to live mass housing at an expedited pace as compared to conventional brick and mortar construction and will be more economical, sustainable, of high quality and durability. These projects shall serve as Live laboratories for all stakeholders including R & D leading to the successful transfer of technologies from the lab to the field

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Light House Project

Six Technology providers have been selected through a rigorous online bidding process for construction of Light House Projects (LHPs) at six different locations in six states.

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

LHP Indore

Prefabricated Sandwich Panel System

Number of Houses : 1024

- Factory made Prefabricated Sandwich Panel System is made out of cement or calcium silicate boards and cement mortar with EPS granules balls, and act as wall panels.
- These replace conventional brick & mortar walling construction practices and can be used as load-bearing and non-load bearing walling for residential and commercial buildings.
- Under this LHP, houses are being constructed using Prefabricated Sandwich Panel System with Pre-Engineered Steel Structural System.
- In this system the EPS Cement Panels are manufactured at the factory in controlled condition, which are then dispatched to the site. The panels having tongue and groove are joint together for construction of the building.

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LHP Indore - Video

LHP Rajkot

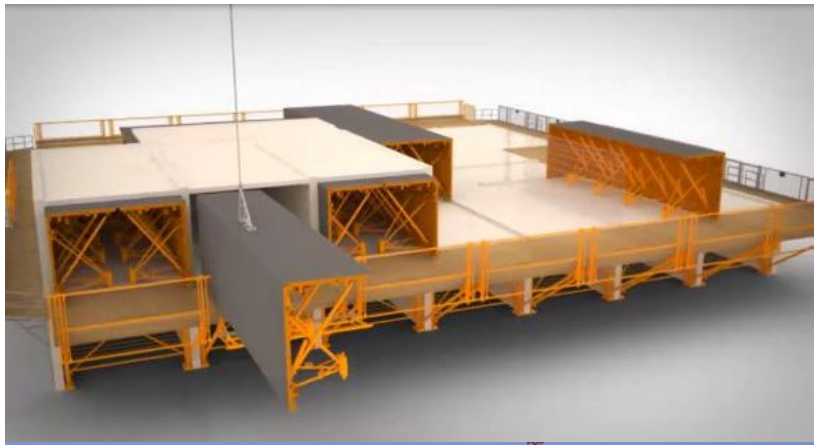
Monolithic Concrete Construction using Tunnel Formwork

- In 'TunnelForm' technology, concrete walls and slabs are cast in one go at site giving monolithic structure using high-precision, re-usable, room-sized, Steel forms or moulds.
- The system intends to replace the conventional RCC Beam-Column structure which uses steel/plywood shuttering.
- 'TunnelForm' system uses 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 an apartment.

Construction Process:

- Stripping of the formwork from the previous day.
- Positioning of the formwork for the current day's phase, with the installation of mechanical, electrical and plumbing services.
- Installation of reinforcement in the walls and slabs.
- Concreting

Number of Houses : 1144



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LHP Rajkot - Video

LHP Chennai

Precast Concrete Construction System – Precast Components Assembled at Site

- Precast concrete construction is a system where the individual precast components such as walls, slabs, stairs, column, beam etc, of building are manufactured in plant or casting yard in controlled conditions. The finished components are then transported to site, erected & installed.
- The construction process comprises of manufacturing of precast concrete Columns, Beams and Slabs in steel moulds.
- The reinforcement cages are placed at the required position in the moulds. Concrete is poured and compaction of concrete is done by shutter/ needle vibrator.
- Casted components are then moved to stacking yard where curing is done for requited time. These precast components are installed at site by crane and assembled together through in-situ jointing and/or grouting etc.

Number of Houses : 1152

Ground Floor Column Work in Progress - March 2021

First Floor Column & Beam Erection - May 2021

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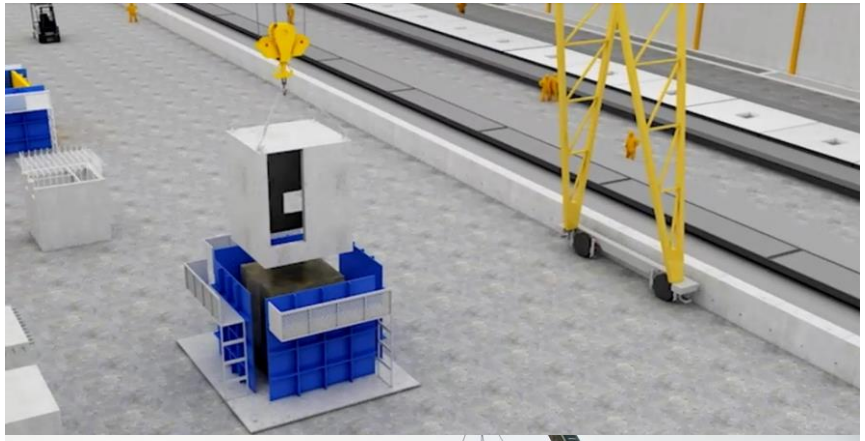
LHP Chennai - Video

LHP Ranchi

Precast Concrete Construction System – 3D Volumetric

- 3D Volumetric concrete construction is the modern method of building by which solid precast concrete structural modules like room, toilet, kitchen, bathroom, stairs etc. & any combination of these are cast monolithically in Plant or Casting yard in a controlled condition.
- These Modules are transported, erected & installed using cranes and push-pull jacks and are integrated together in the form of complete building unit.
- Factory finished building units/modules are installed at the site with the help of tower cranes. Gable end walls are positioned to terminate the sides of building.
- Pre stressed slabs are then installed as flooring elements. Rebar mesh is finally placed for structural screed thereby connecting all the elements together. Consecutive floors are built in similar manner to complete the structure.

Number of Houses : 1008



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LHP Ranchi - Video

LHP Agartala

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

- Light Gauge Steel Frame (LGSF) System uses factory made galvanized light gauge steel components. LGSF is used in combination with pre-engineered steel structural system for buildings above G+3 for longevity, speedier construction, strength and resource efficiency.
- The sequence of construction comprises of foundation laying, fixing of Pre-Engineered Steel Structural System, fixing of tracks, fixing of wall panels with bracings as required, fixing of floor panels, decking sheet, fixing of electrical & plumbing services and finally fixing of concrete walling panels with light weight concrete as infill.
- The other options of dry walling components such as sandwich panels with insulation material in between can also be used. Similarly, the floors can either by composite slab/deck slabs/precast hollow core slabs as per the need & requirements.

Number of Houses : 1000

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LHP Ranchi - Video

LHP Lucknow

PVC Stay In Place Formwork System

- Plant manufactured rigid poly-vinyl chloride (PVC) based polymer components serve as a permanent stay-in-place finished form-work for concrete walls. The formwork System being used acts as pre-finished walls requiring no plaster and can be constructed instantly.
- Construction is done in a sequential manner where at first, the Prefabricated PVC Wall panels and Pre-Engineered Steel Structural Sections as per the design are transported to the Site.
- Then, these Sections are erected on the prepared foundation using cranes and required connections. Floor is installed using decking sheet. Once the structural frame and floor is installed and aligned, wall panels are fixed on decking floor.
- The pre-fabricated walling panels having provisions of holes for services conduits, are fixed along with the reinforcement & cavities inside the wall panels are filled with concrete. Upon installment of wall panels, flooring and ceiling, the finishing work is executed.

Number of Houses : 1040

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LHP Lucknow - Video

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Session 2: Construction Process & Improving Efficiency

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Light House Project : CHENNAI

TECHNOLOGY SELECTED:

Precast Concrete Construction System – Precast Components Assembled at Site

AGENCY: **M/s B.G. Shirke Construction Technology Pvt. Ltd.**

No. of Towers: 12 **No. of Houses: 1128** **No. of Floors: 6**

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Light House Project : CHENNAI

Project Brief

Location of Project : Nukkampalayam 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.m

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

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 the Common area.
- Kota stone on Staircase steps.

Light House Project : CHENNAI

Description	Unit	Length	Width	Area
Hall	Sqmt	3.175	3.025	9.60
Kitchen	Sqmt	1.8	2.8	5.04
Bed Room	Sqmt	2.725	2.528	7.70
Bed Room Offset	Sqmt	0.9	0.2	0.18
Bath Room	Sqmt	1	1.4	1.4
W.C	Sqmt	0.9	1.55	1.395
Passage	Sqmt	1	1.2	1.2
Kitchen Opening	Sqmt	0.9	0.1	0.09
Door 1	Sqmt	1	0.15	0.15
Door 2	Sqmt	0.9	0.1	0.09
Door 3	Sqmt	0.75	0.1	0.075
Column Deduction	Sqmt			0.22
Total Carpet Area				26.78

Light House Project : CHENNAI

Precast concrete construction

- The construction process comprises manufacturing precast concrete Columns, Beams and Slabs in steel moulds. The reinforcement cages are placed at the required position in the moulds.
- Concrete is poured and compaction of concrete is done by shutter/ needle vibrator.
- Casted components are then moved to the stacking yard where curing is done for requited time and then these components are ready for transportation and erection at site.
- These precast components are installed at site by crane and assembled together through in-situ jointing and/or grouting etc.

Light House Project : CHENNAI

Special Features

- Nearly all components of building work are manufactured in plant/casting yard & the jointing of components is done In-situ leading to reduction in construction time.
- The controlled factory environment brings resource optimization, improved quality, precision & finish.
- The concrete can be designed as 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 resources.
- Helps in keeping a neat & clean construction site and dust free environment.
- Optimum use of water through recycling.
- Use of shuttering & scaffolding materials is minimal.
- All weather construction & better site organization.

Efficiency in Construction

LHP Chennai – 3S Precast system

- **Timeline** - Completed 1152 dwelling units & external infrastructure within 12 months amidst covid & heavy rains in Chennai
- **Reduced use of Natural Resources** - Concrete mixed with industrial by-product Ground granulated blast furnace slag (GGBFS) while also conserving natural resources. Optimum use of water through recycling & use of sprinkler for curing precast components.
- **Use of Recycled materials** - Concrete mixed with industrial by-product Ground granulated blast furnace slag (GGBFS). Usage of AAC blocks. Window glazing from Saint gobain with 18% recycled contents.
- **Use of Low Carbon technology** – Reduced timeline & labor aids to less carbon footprint during construction
- **Manpower management** – With less dependency on labors, construction works carried out during covid times with help of machineries.

Mainstreaming & replication of Technology

LHP Chennai – 3S Precast system

- **Cost of technology** - LHP technology of Chennai is 20% costlier than conventional technology. The cost of setting up a factory for casting elements will be null by the factor of scalability of the project or repetitive use of the precast moulds used.
- **Quality of construction** - LHP Chennai has 25% better quality than conventional construction due to factory made components reducing man made errors & unskilled labors.
- **Speed of construction** – 3 units per day was constructed at LHP.
- **Design flexibility** – Typical design can be completed at ease but flexibility of design is difficult as all components are precast.
- **Skilled labor requirement** – Almost 75% additionally skilled labors are required than the conventional construction technology.

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LHP Chennai – Process Video

Precast Concrete - Footing

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Precast Concrete – Stem Column

Precast Concrete – Back filling

Precast Concrete – Plinth beam

Precast Concrete – GF Column & Beam

Precast Concrete – FF Beam & Column

Precast Concrete – GF Roof slab

Precast Concrete – AAC Masonry

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Precast Concrete – Plastering

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Improved Efficiency & Defects

Earth

Soil Stabilization

Soil stabilization is a method of improving soil properties by adding and mixing other materials to it. Soil stabilization is a method of enhancing the shear strength parameters of soil and thus increasing the bearing capacity of the soil.

The following are some common soil stabilization methods

1. Mechanical Stabilization
2. Lime Stabilization
3. Cement Stabilization
4. Chemical Stabilization
5. Fly ash Stabilization
6. Soil Nailing for Vertical Force

Driven Piles

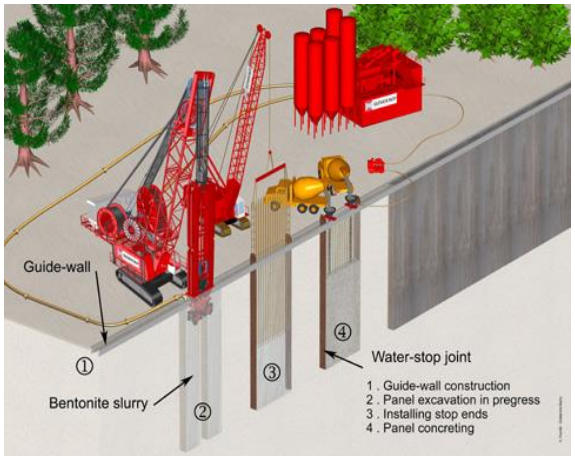
Driven piles, also known as displacement piles, are a commonly-used form of building foundation that provide support for structures, transferring their load to layers of soil or rock that have sufficient bearing capacity and suitable settlement characteristics.

Bored Piles are easier to build

Earth

Sand -Lime Pile

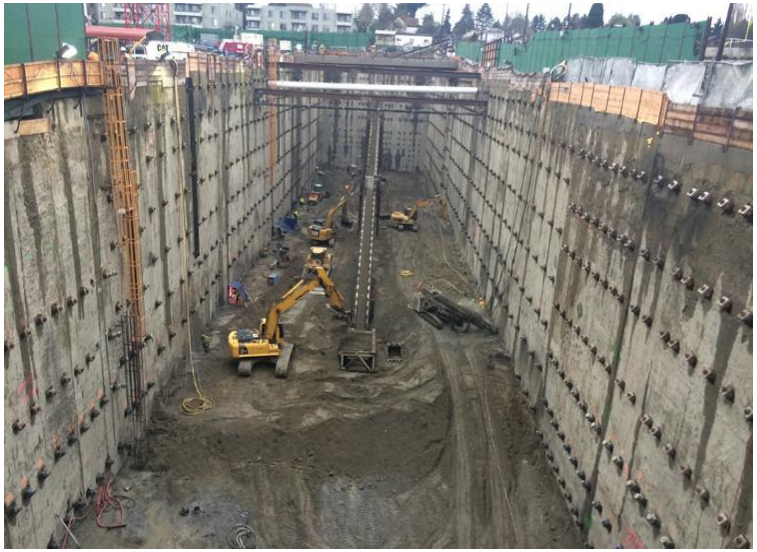
This method of pile is to improve the soft clay layer by using both partially replaced sand piles with/without confinement. This research is performed to study the effect of sand pile to improve the bearing capacity and to control the settlement.



Hardcore

'Hardcore' is the construction term used to denote 'engineered' infill material that is placed within the confines of a building foundation (after removal of any unsuitable ground layers) in order to support a ground-bearing floor slab.

Deep excavation needs protection by soil nailing. Diaphragm wall is another method to ease deep excavation.

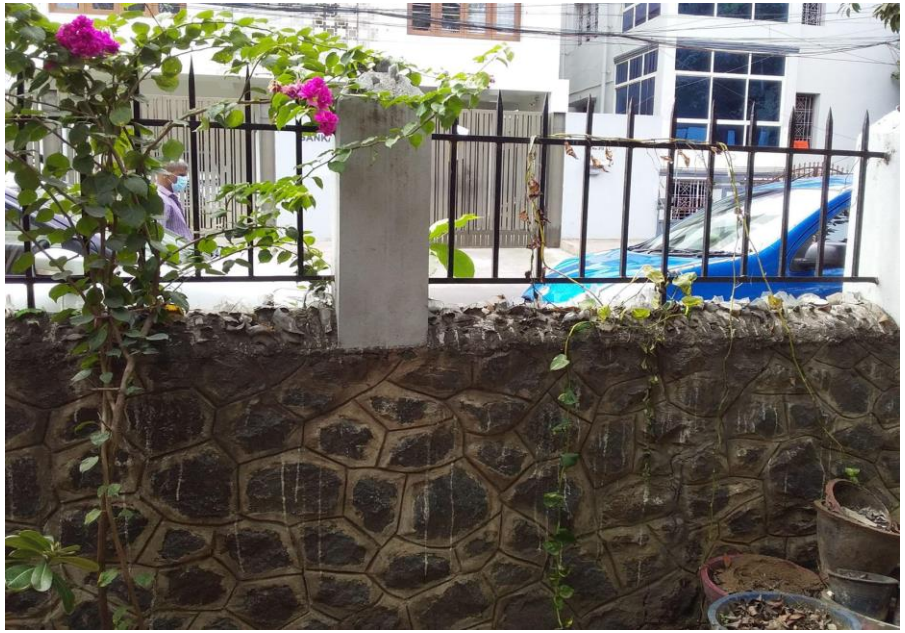


Stone

Based on the arrangement of the stone in the construction and degree of refinement in the surface finish, the stone masonry can be classified broadly in the two categories, Rubble and Ashlar masonry.

Random Masonry

In this category, the stones used are either undressed or roughly dressed having wider joints. This can be further subdivided as uncoursed, coursed, random, dry, polygonal and bint.



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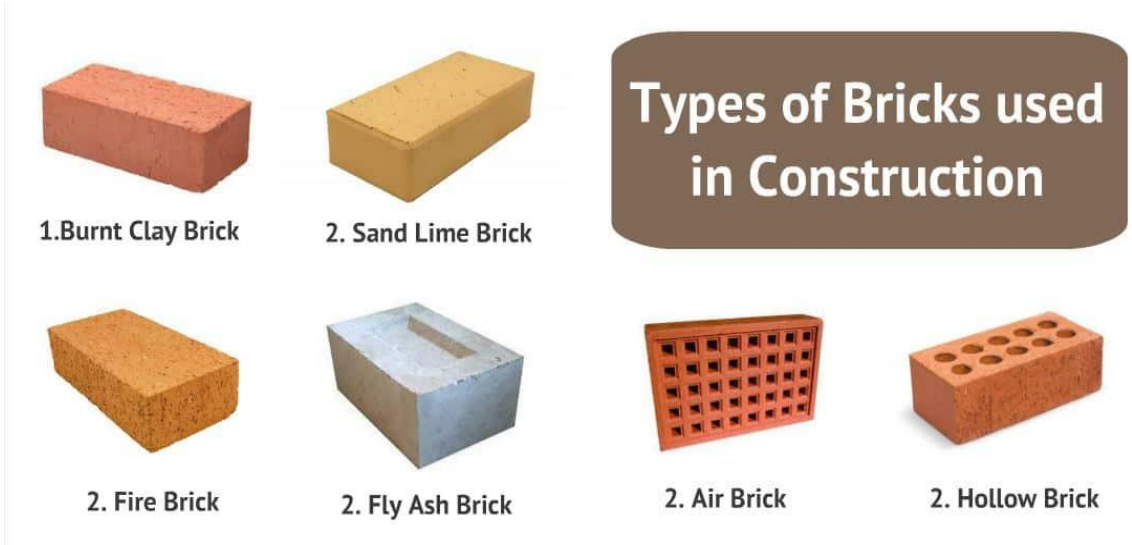
Brick



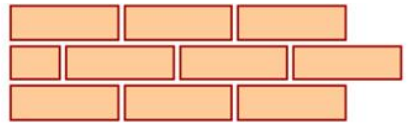
Brick

BONDS IN BRICK:

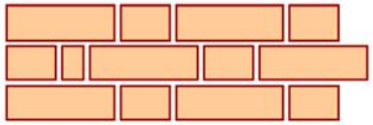
It is the method of arranging the bricks in courses so that the individual units are tied together and the vertical joints of the successive courses do not lie in the same vertical line. Bonds of various types are distinguished by their elevation or face appearance. If they are not arranged (or bonded) properly, continuous vertical joints will result. Bonds help in distributing the concentrated loads over a larger area.

TYPES OF BONDS

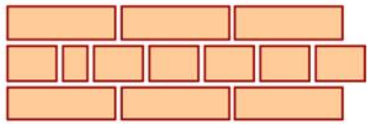
- Stretcher bond
- Flemish bond
- English bond
- Header bond
- Facing bond
- Double English cross bond
- Raking bond
- Zigzag bond
- Garden wall bond



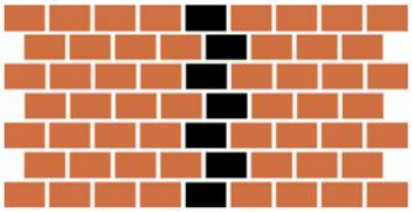
Stretcher bond



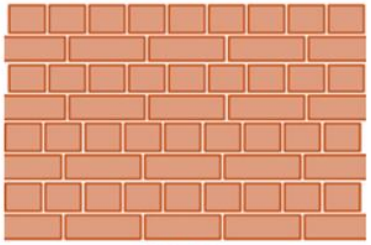
Flemish bond



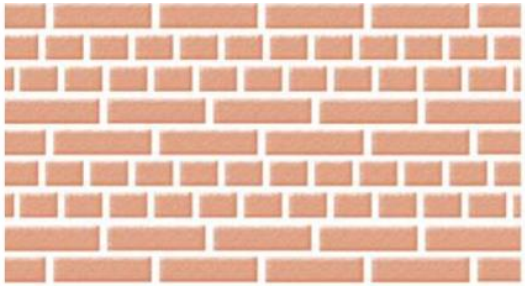
English bond



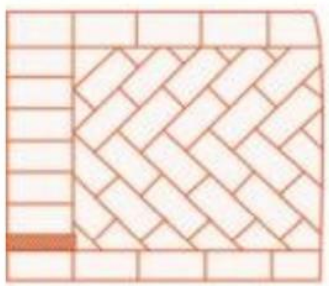
Header Bond



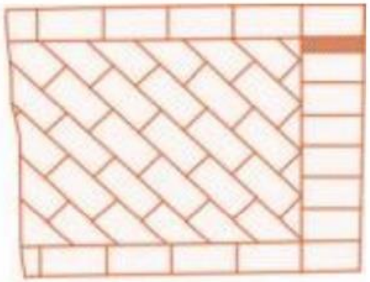
Facing Bond



Double English cross bond



Herring bone bond.



Diagonal bond.

Raking Bond

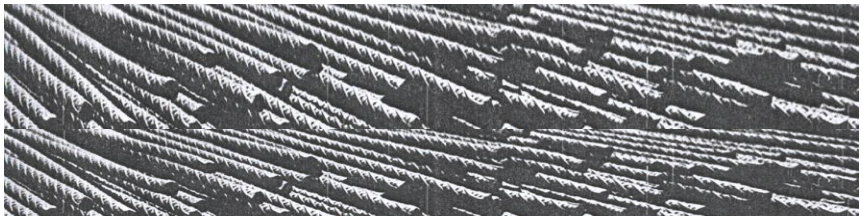
Steel

Reinforcement

Steel reinforcement are steel bars that are provided in combination with plain cement concrete to make it reinforced concrete. Hence these structures form steel reinforced cement concrete structure (R.C.C). Steel reinforcement is commonly called as 'rebars'. Surface is of regular shaped deformations.

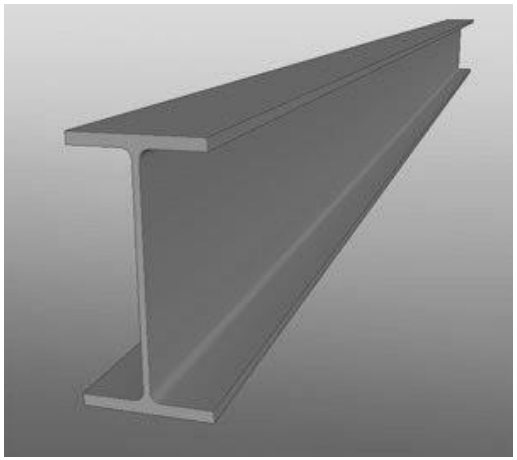
Cold twisted (CTD) or TMT bars are used.

GRIP BARS Developed by SERC and Produced by TISCO



Rolled Steel Joint

A rolled steel joist (RSJ) is a common type of beam used for structural steelwork. It is also known as an ‘I-beam’. A RSJ is a beam with an ‘I’ or ‘H’-shaped cross-section that comes in a variety of standard sizes. It is a very efficient form for carrying bending and shear loads in the plane of the web.They are formed by hot rolling, cold rolling or by extrusion.



Galvanized Iron

Galvanized iron or steel is the same as standard iron, the only difference is that it features a layer of zinc. The added layer of zinc helps to protect the iron from rust and corrosion. Without it, the iron will be exposed to moisture and oxygen from its surrounding environment.

PCC

- Plain cement concrete is the mixture of cement, fine aggregate(sand) and coarse aggregate without steel. PCC is an important component of a building which is laid on the soil surface to avoid direct contact of reinforcement of concrete with soil and water.
- The main reason of providing PCC is to provide a rigid impervious bed to RCC in the foundation before starting any RCC or masonry work directly on the excavated soil, PCC is done to form a leveled surface and to avoid laying concrete on soil directly so as to avoid mixing with soil and also to prevent soil extracting water from RCC thereby weakening it.
- Plain concrete is also used as a dense gravity provider in thick walls or in floors.

Concrete & Aercon Blocks

Concrete Blocks

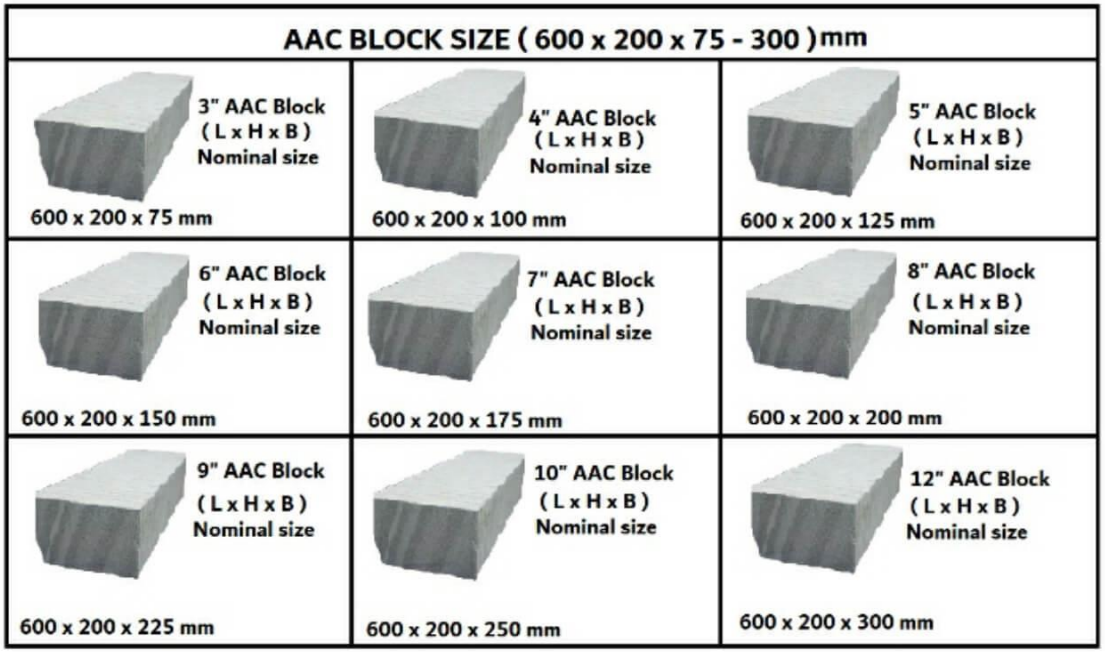
Concrete blocks are made from cast concrete (e.g. Portland cement and aggregate, usually sand and fine gravel, for high-density blocks). Lower density blocks may use industrial wastes, such as fly ash or bottom ash, as an aggregate.

These blocks come in a variety of dimensions and textures, from traditional smooth surfaces to fluted or rough finishes, as well as special units for corners or for beams with longitudinal reinforcements. The dimensions of these blocks range from the classic 8x8x16 inches (approx 19x19x39 cm) which is meant for structural use, to a size of 8x3.5x39 inches (approx 19x9x39 cm) for partitioning walls

Aerocon/ AAC Blocks

AAC blocks are a precast, foam concrete, sustainable construction material made from aggregates of quartz sand, calcined gypsum, lime, portland cement, water and aluminium powder.

Burnt clay blocks unlike bricks, these blocks have cavities and are manufactured through extension machine.



Compressed Earth Block

- A compressed earth block (CEB), also known as a pressed earth block or a compressed soil block, is a building material made primarily from damp soil compressed at high pressure to form blocks. Compressed earth blocks use a mechanical press to form blocks out of an appropriate mix of fairly dry inorganic subsoil, non-expansive clay and aggregate.
- If the blocks are stabilized with a chemical binder such as Portland cement they are called *compressed stabilized earth block* (CSEB) or *stabilized earth block* (SEB).
- **As compared to mud bricks, compressed earth blocks or CEB are solidified and compressed through chemical changes that take place as they air dry. Hence, the compression strength of the CEB usually exceeds those of typical mud bricks.**

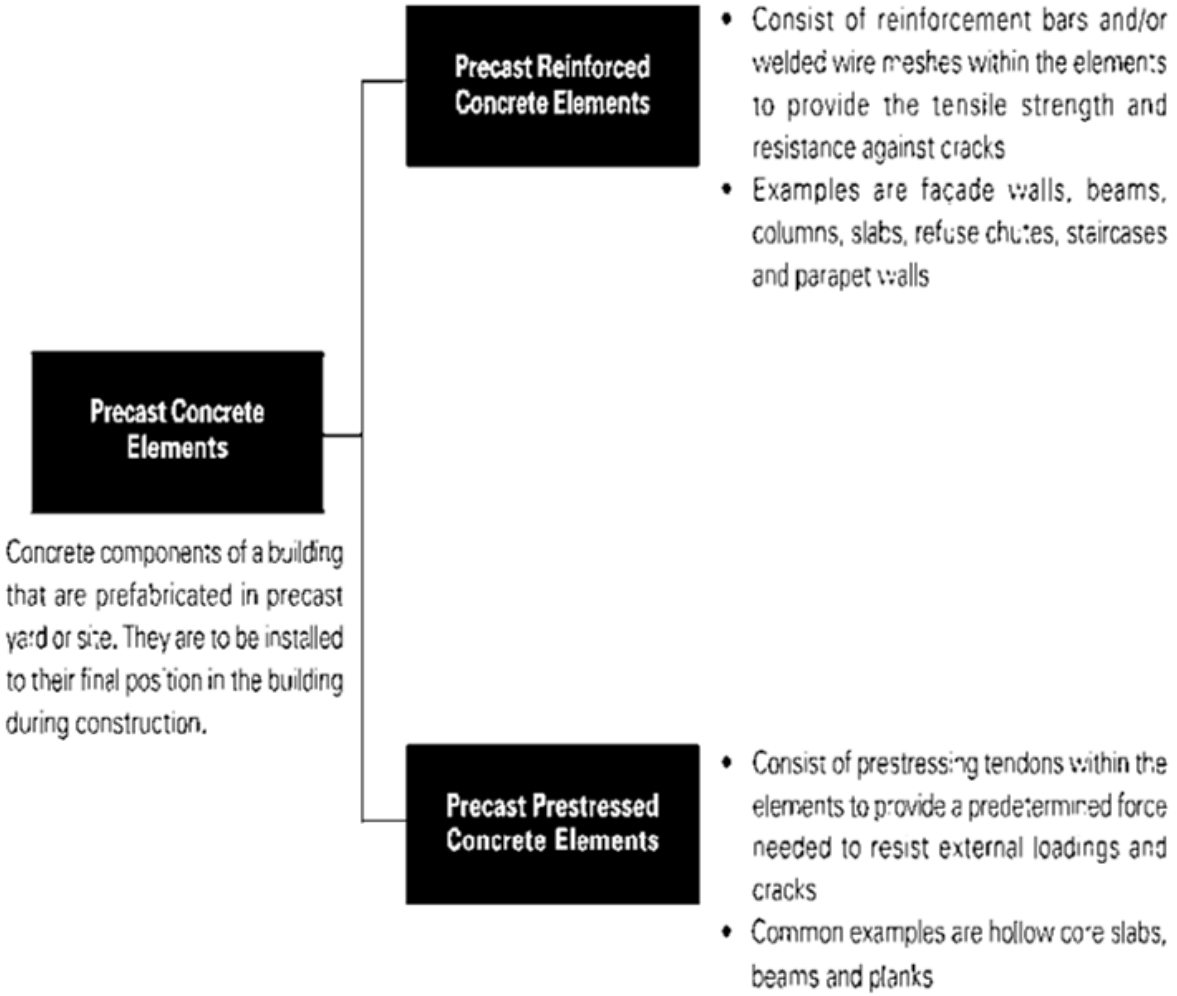
Precast Concrete

The precast concrete is transported to the construction site, lifted and positioned at the predetermined place.

TYPES OF PRECAST

Depending on the load-bearing structure, precast systems can be divided into the following categories:

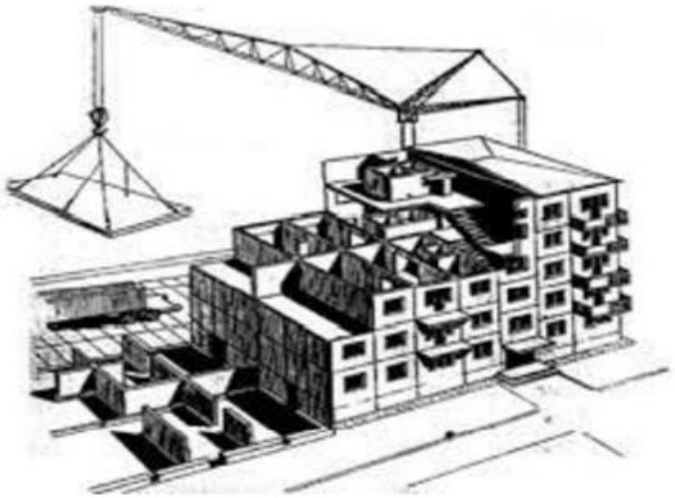
- Large-panel systems
- Frame systems
- Slab-column systems with shear walls
- Small elements
- Trusses
- Other Long Products
- Lift Slabs



Precast Concrete

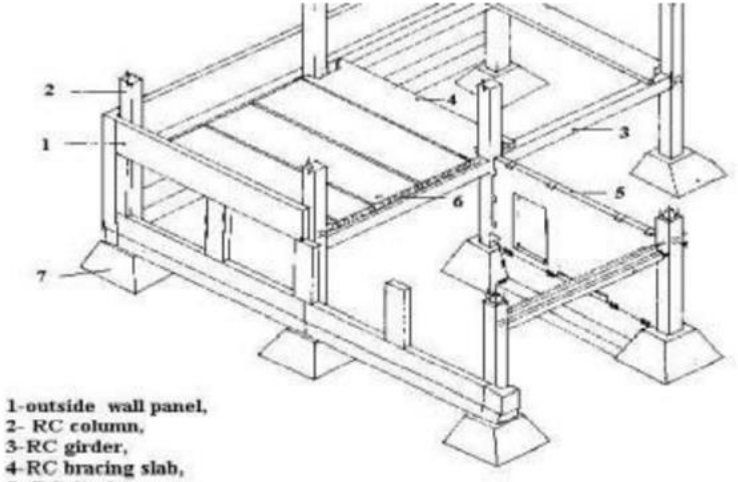
LARGE PANEL SYSTEMS

Large-panel system refers to multistory structures composed of large wall and floor concrete panels connected in the vertical and horizontal directions so that the wall panels enclose appropriate spaces for the rooms within a building



FRAME SYSTEMS

- In Frame system are constructed using linear elements or spatial beam, column.
- Precast beam-column sub-assemblages have the advantage that the connecting faces between the sub-assemblages can be placed away from the critical frame regions;
- The beam-column joints accomplished in this way are hinged



Precast Concrete

SLAB-COLUMN SYSTEMS WITH SHEAR WALLS

• These systems rely on shear walls to sustain lateral load effects, whereas the slab column structure resists mainly gravity loads.

• There are two main systems in this category:

➢ Lift-slab system with walls

➢ Prestressed slab-column system

LIFT –SLAB SYSTEM

• The load-bearing structure consists of precast reinforced concrete columns and slabs.

• Precast columns are usually two stories high.

• All precast structural elements are assembled by means of special joints.

• Reinforced concrete slabs are poured on the ground in forms, one on top of the other.

• Precast concrete floor slabs are lifted from the ground up to the final height by lifting cranes.

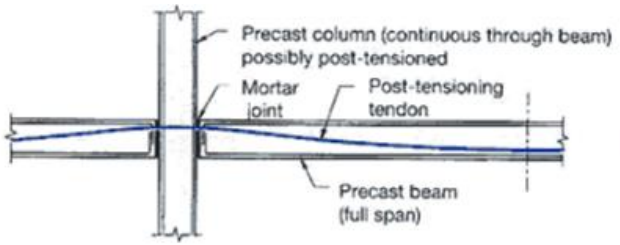
• The slab panels are lifted to the top of the column and then moved downwards to the final position.

• Temporary supports are used to keep the slabs in the position until the connection with the columns has been achieved.

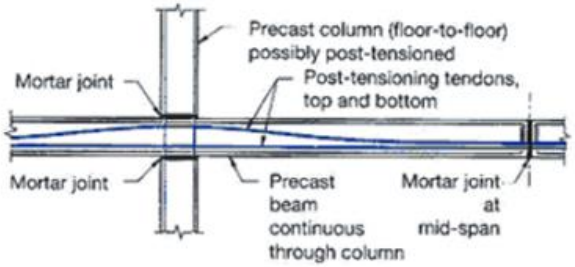
Precast Concrete

THE PRESTRESSED SLAB-COLUMN

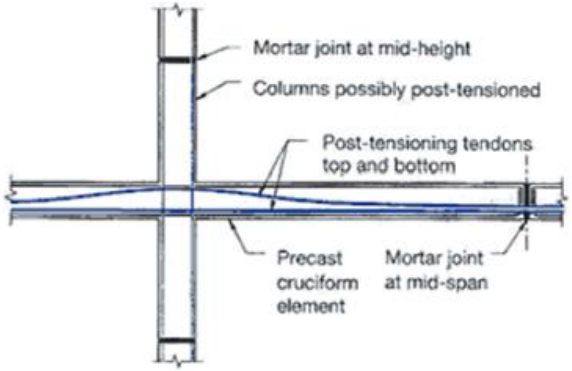
- System uses horizontal pre-stressing in two orthogonal directions to achieve continuity.
- The precast concrete column elements are 1 to 3 stories high. The reinforced concrete floor slabs fit the clear span between columns.
- After erecting the slabs and columns of a story, the columns and floor slabs are pre-stressed by means of prestressing tendons that pass through ducts in the columns at the floor level and along the gaps left between adjacent slabs.
- After pre-stressing, the gaps between the slabs are filled with in situ concrete and the tendons then become bonded with the spans. Seismic loads are resisted mainly by the shear walls (precast or cast-in-place) positioned between the columns at appropriate locations



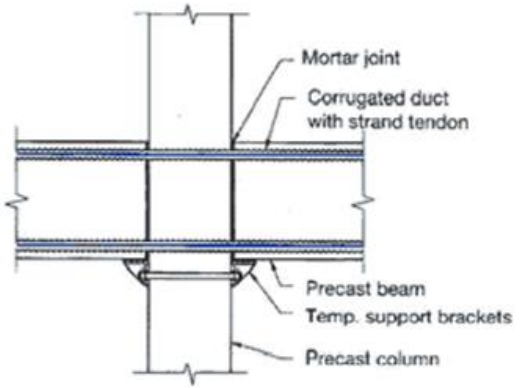
(a) Column Continuous Through Beam



(b) Beam Continuous Through Column



(c) Cruciform

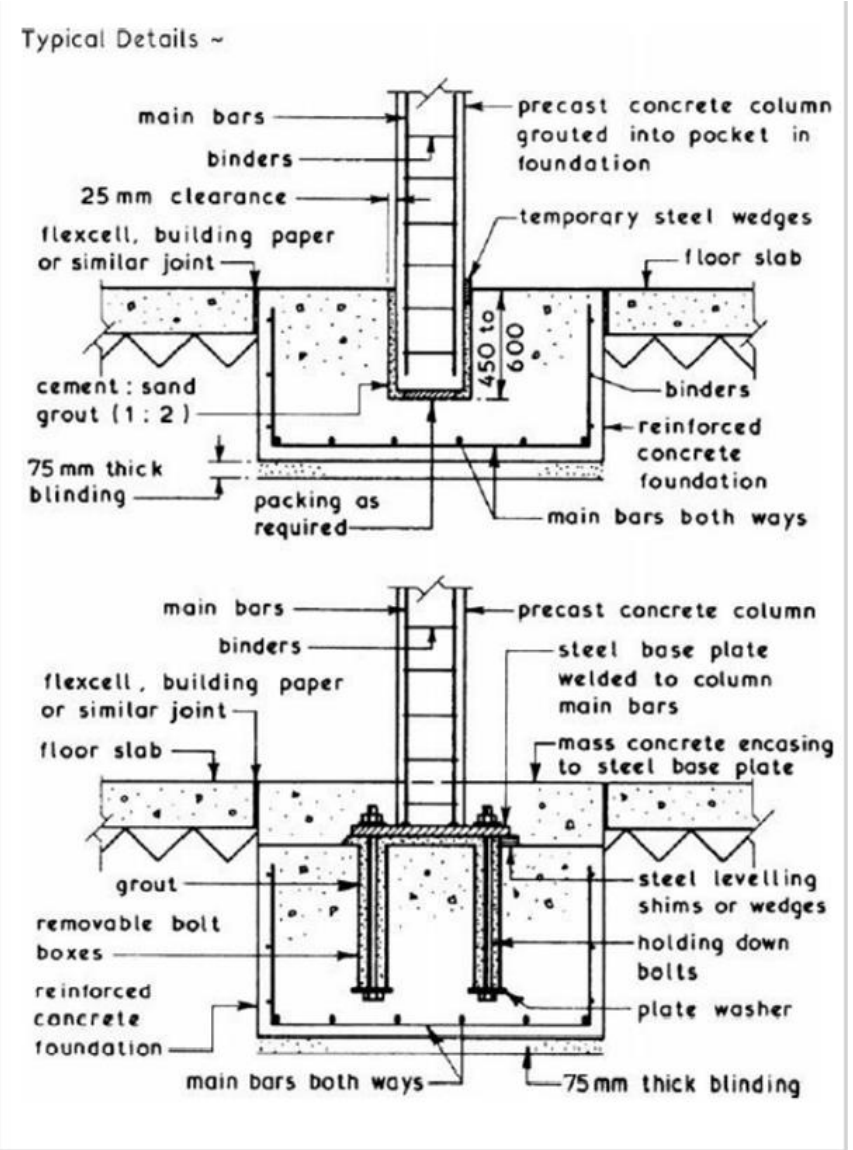


(d) Typical Connection Detail (adopted from [4])

Precast Concrete

FOUNDATION (STRUCTURAL COMPONENT)

- For light to medium loadings the preferred method of connection is to set the column into a pocket cast into a reinforced concrete pad foundation.
- Heavy column loadings are encountered it may be necessary to use a steel base plate secured to the reinforced concrete pad foundation with holding down bolts



LHP Precast System

PRE-CAST STRUCTURAL BUILDING COMPONENTS

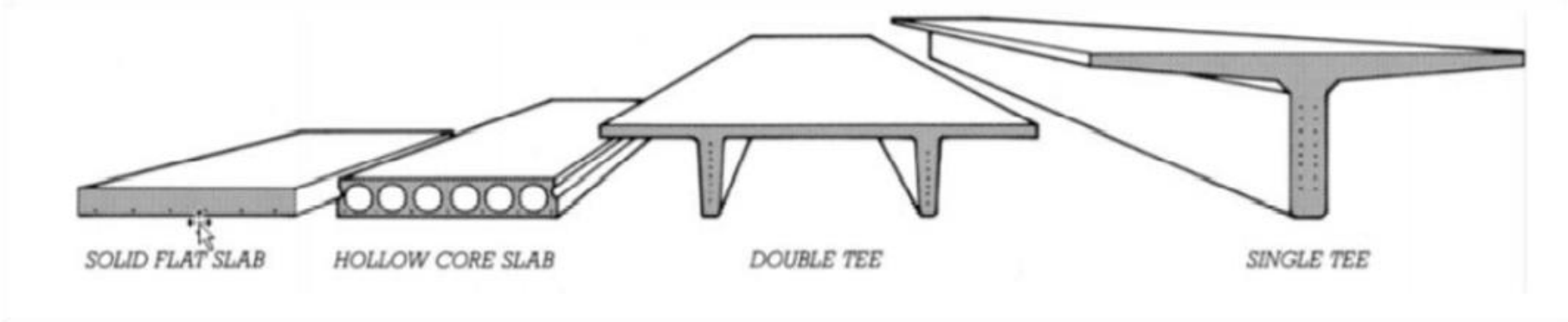
Structural Building Components	Non-Structural Building Components
Foundation	Door frames
Columns	Window frames
Beam walls	Parapet Jallee
Floor roofs	Parapet
	Paving
	Cupboard planks

Precast Concrete

FLOORS (STRUCTURAL COMPONENT) :

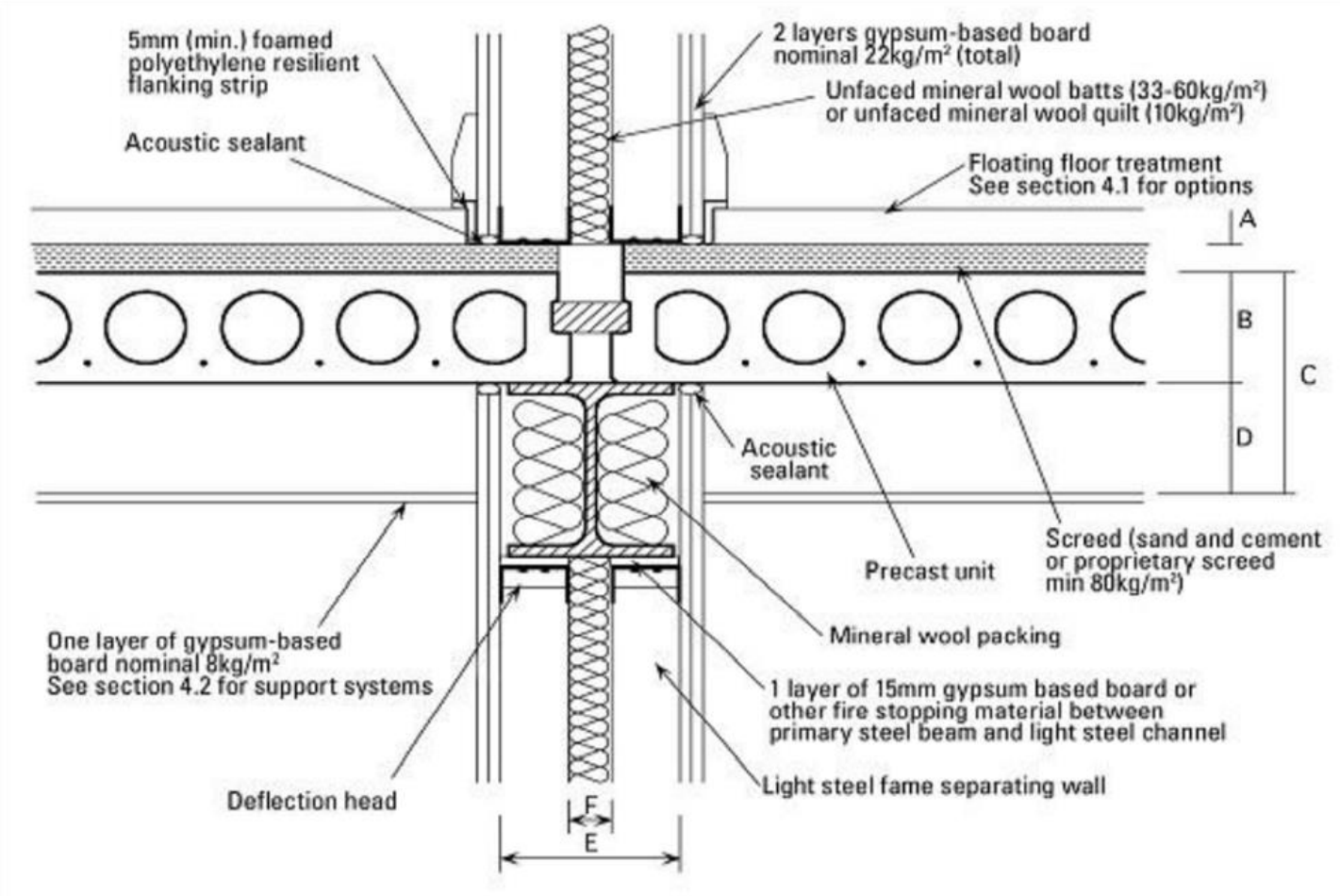
TYPES

- Precast reinforced concrete floor system
- Precast hollow floor unit
- Precast concrete plank floor units
- Precast concrete tee beam
- Plate floors
- Lift slabs



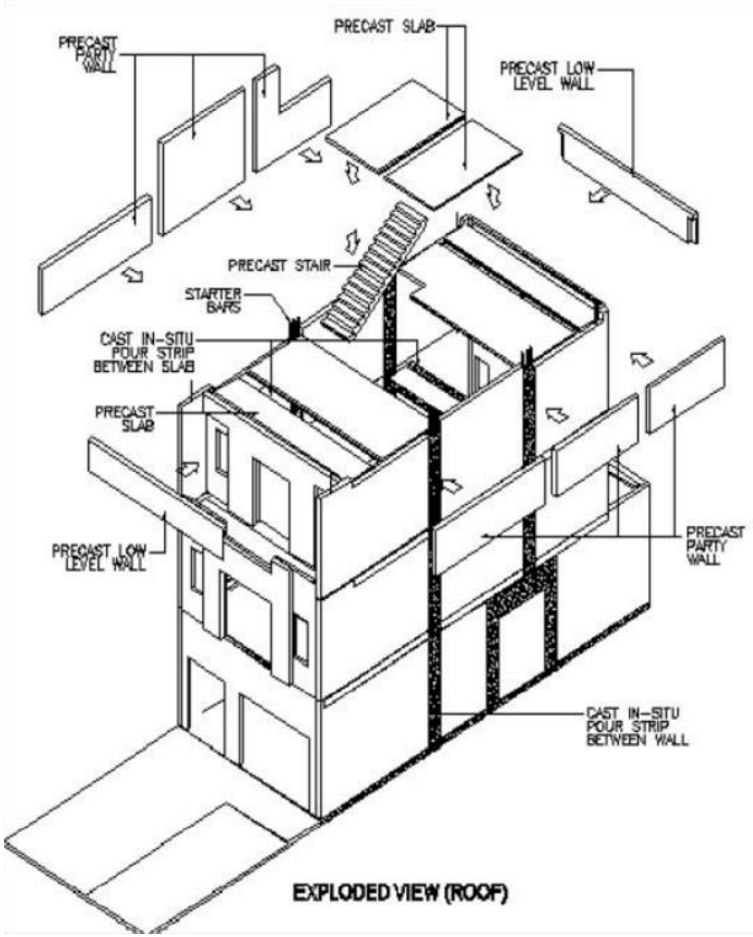
Precast Concrete

PRE CAST - FLOOR SLAB



Precast Concrete

ROOF STRUCTURAL COMPONENT



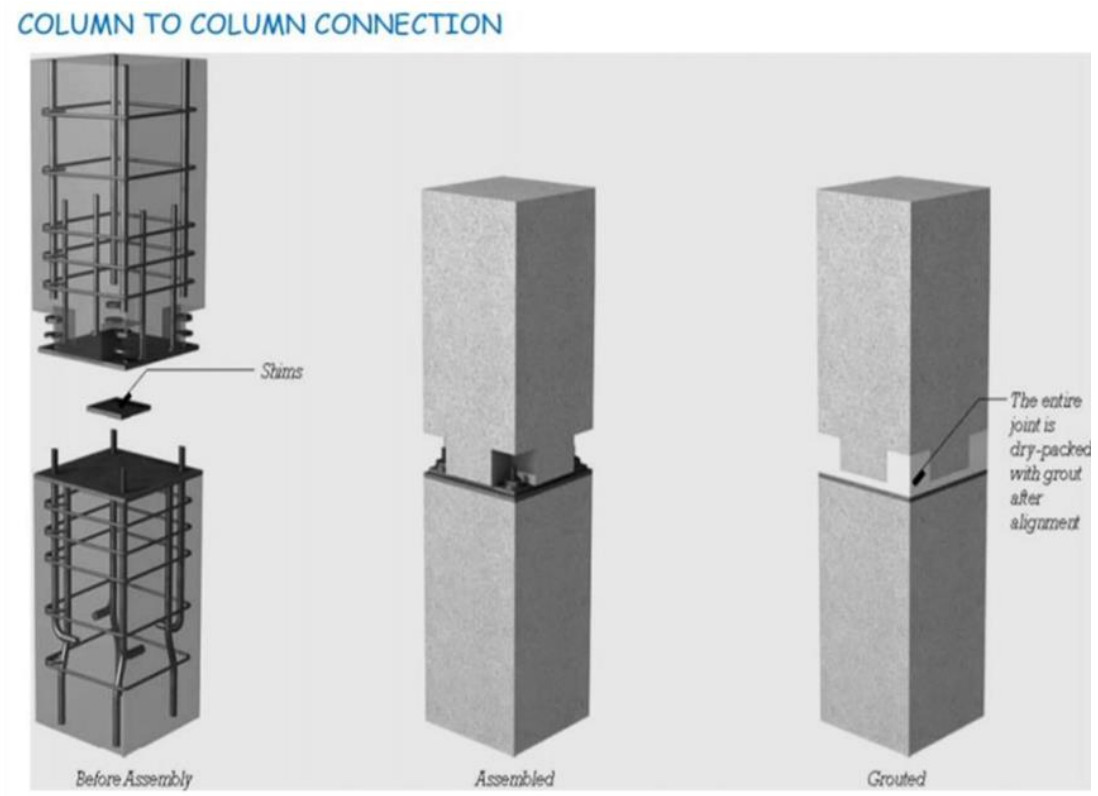
Precast pre-stressed slabs spanning between walls with composite in-situ topping for roof

Precast Concrete

COLUMNS
(STRUCTURAL COMPONENT)

• Column to Column Connection - precast columns are usually cast in one length. They are either reinforced with bar reinforcement or they are prestressed according to the loading conditions.

• If column to column are required they are usually made at floor levels above the beam to column connections and can range from a simple dowel connection to a complex connection involving in-situ concrete.

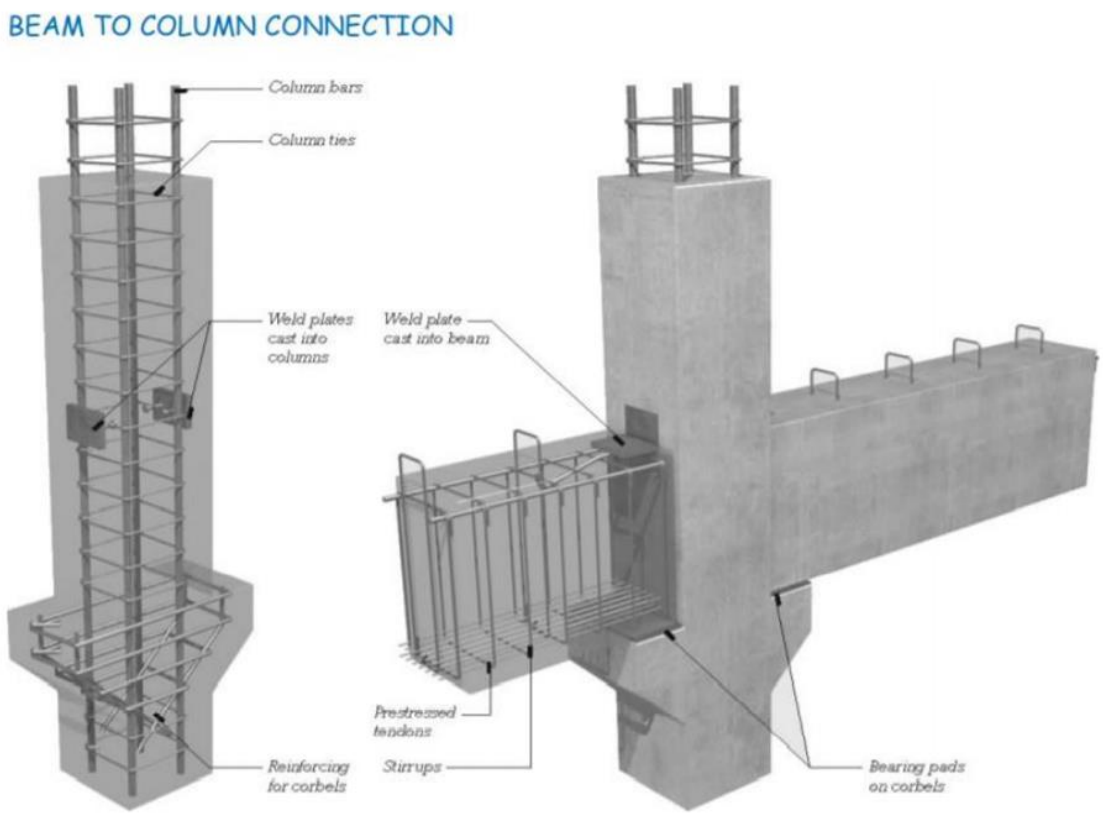


Precast Concrete

BEAMS (STRUCTURAL COMPONENT)

Beam to Column Connections - as with the column to column connections the main objective is to provide structural continuity at the junction. This is usually achieved by one of two basic methods:

- Projecting bearing haunches cast onto the columns with a projecting dowel or stud bolt to provide both location and fixing.
- Steel to steel fixings which are usually in the form of a corbel or bracket projecting from the column providing a bolted connection to a steel plate cast into the end of the beam



Precast Concrete

Installation

The on-site installation of precast components can be a high-risk activity involving the use of heavy plant, cranes and personnel working at height. Consideration should be given therefore to safeguarding against risks when receiving delivery, moving, and placing units.

Precasting can be carried out at a casting yard, in or near the site, or in a factory. A key aspect of determining whether to use site or factory precasting is transport costs. Factory work offers superior quality for obvious reasons, so if there is a factory close to the site, it makes sense to use it.

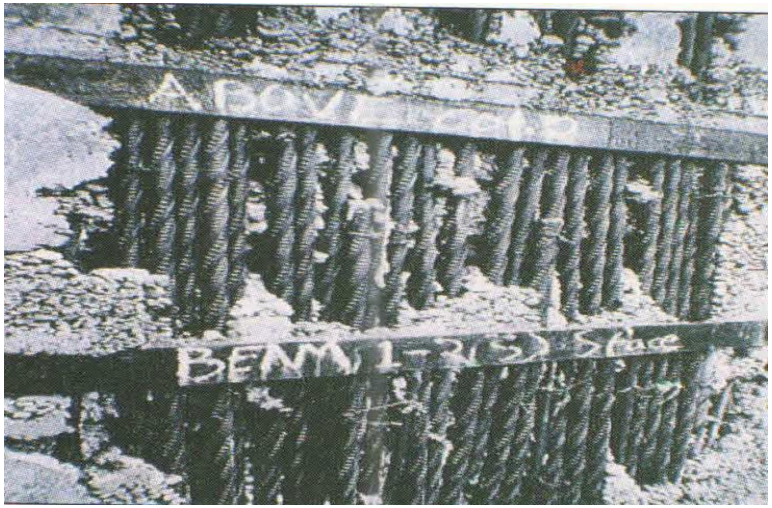
Transportation

- The precast concrete element will be unloaded on special racks placed in the storage area.
- The precast elements will be loaded and delivered on trailer with proper supports, blocking, cushioning, etc. to minimize or prevent damage during transit.

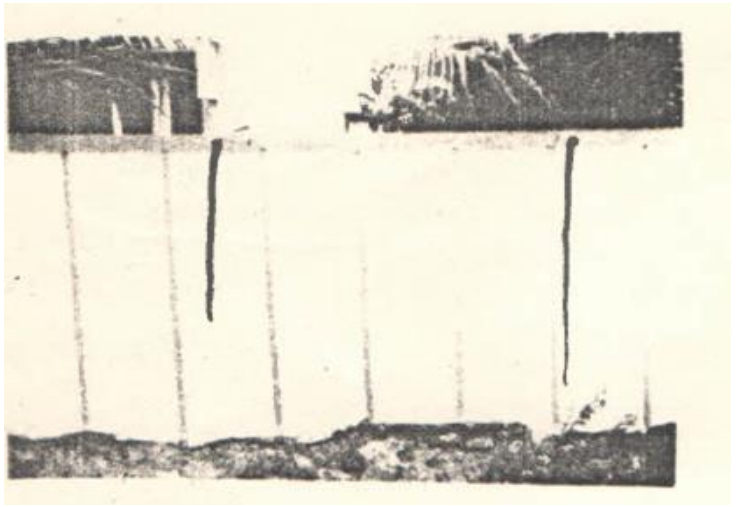
Defects

Why Defects are noticed?

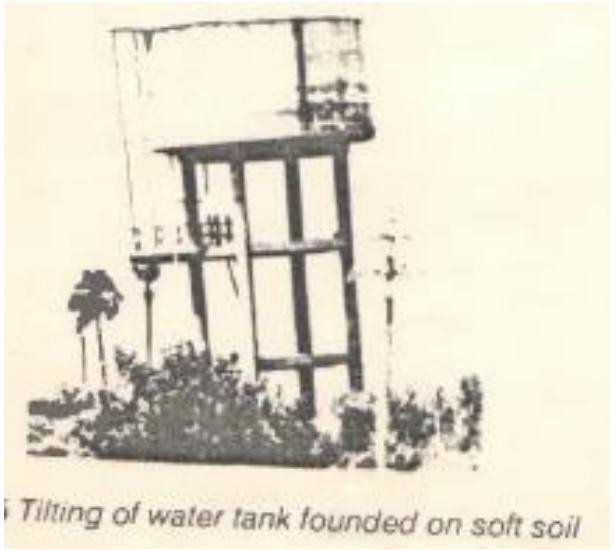
- Settlement of soil
- Cracks
  - Structural
  - Upward Pressure
  - Surface
- Cracks in concrete
  - Shrinkage
  - Temperature changes
  - Steel corrosion
  - Honey Combs



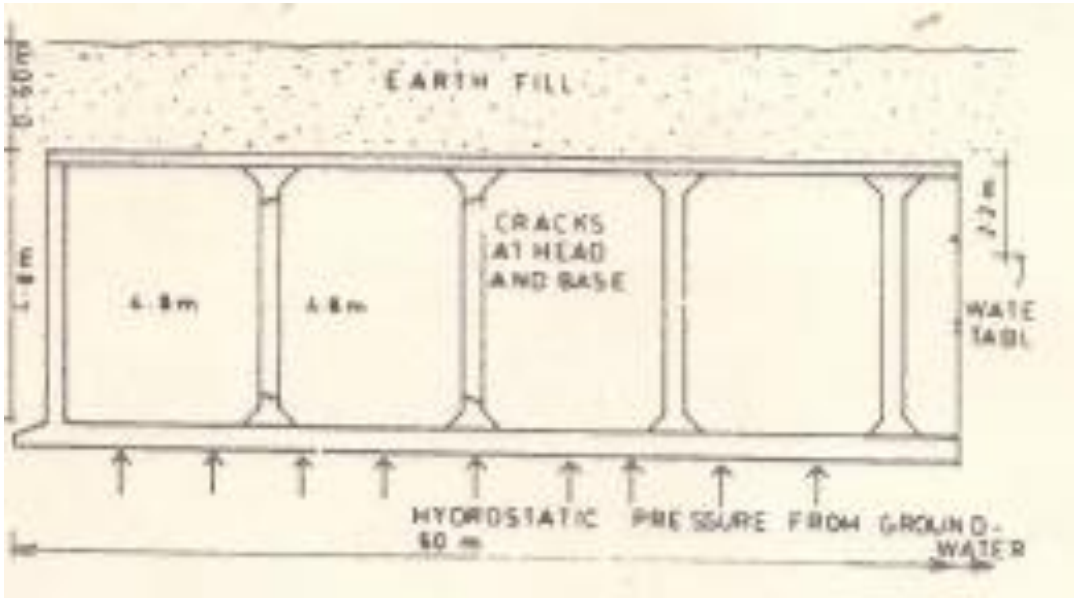
Incorrect planning & placing of reinforcement steel causes segregation concrete



Cracks in compound wall wider at top



Tilting of water tank founded on soft soil



GLOBAL HOUSING TECHNOLOGY CHALLENGE INDIA

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

Ministry of Housing and Urban Affairs
Government of India

Azadi Ka Amrit Mahotsav

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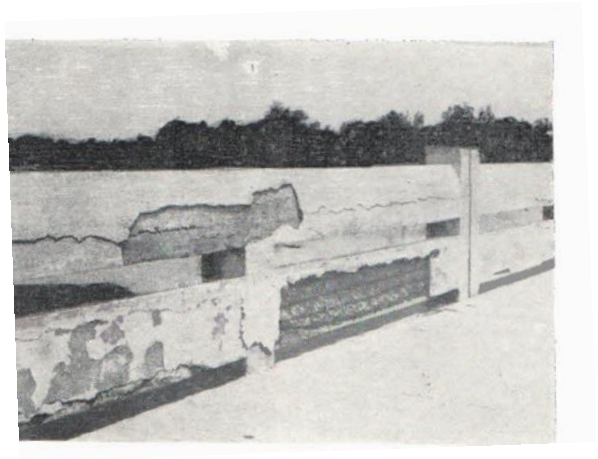
Defects

- Expansion Joints / Leakage
- Pavements
  - Settles
  - Abrasion
  - Water table below



Corrosion damage to railings of a bridge

Corrosion damage to an Exposed ceiling of shell Roof

- Cracks in concrete
  - Shrinkage
  - Temperature changes
  - Steel Corrosion

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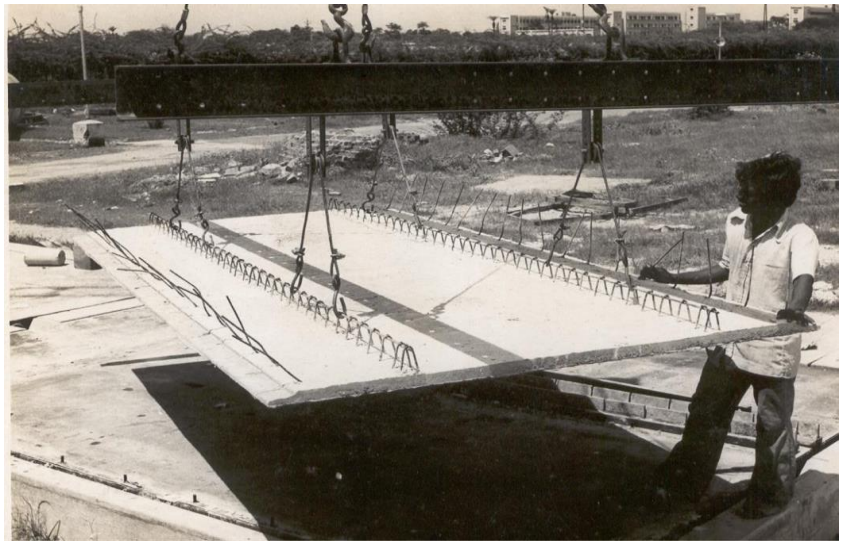

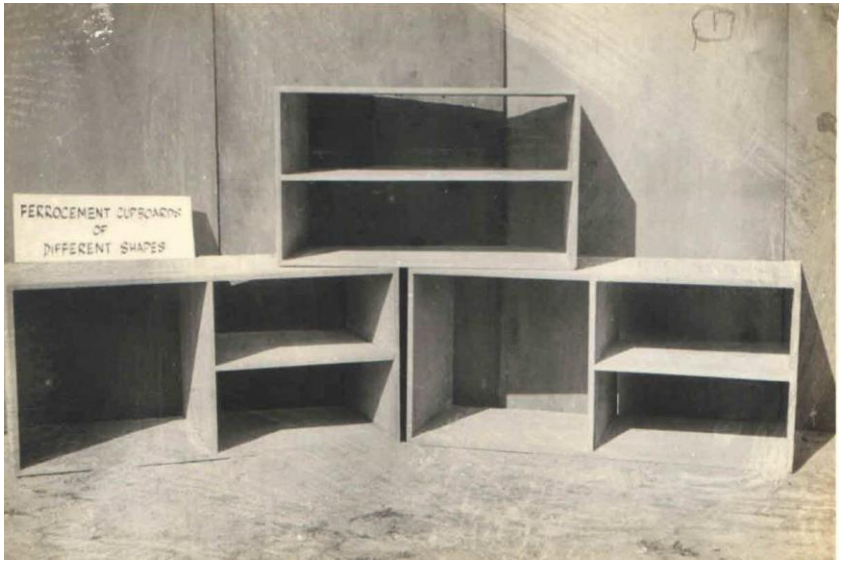

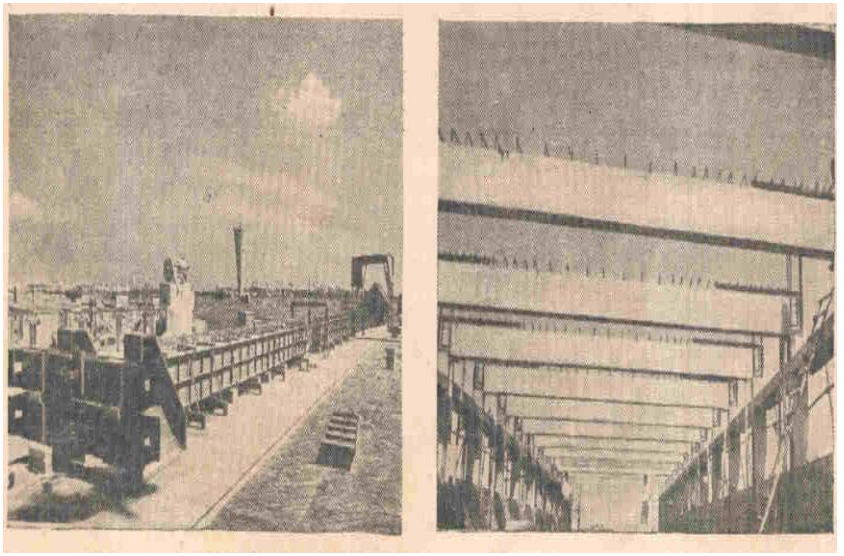

Prefabrication development over the years

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Construction Best Practices

Field testing of materials

- Thrust your hand into the cement. There should be cool feeling. (no heat of hydration, no setting)
- Open the bags - no lumps should be present
- Pinch of cement between fingers should give smooth feeling

Field testing of materials

- Sand is actually tasted and from its taste presence of salt is known
- Sand is rubbed against fingers - if fingers are stained, it indicates that sand contains silt or clay

Coarse Aggregate



Coarse Aggregate

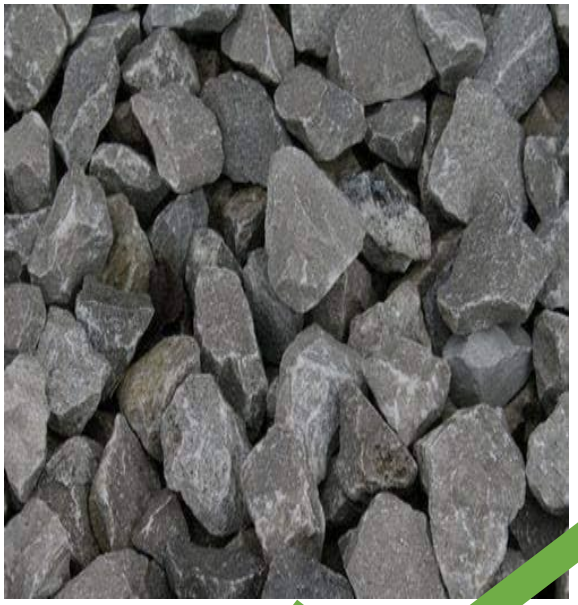
Materials retained on 4.75mm IS sieve.

5-20% passing the sieve are permitted

Coarse Aggregate

Flaky Aggregate

Elongated Aggregate



Coarse Aggregate

Proper stacking of Aggregate

Improper stacking of Aggregate

Coarse Aggregate

Result of improper sieving of sand & stacking of aggregate

Result of improper workmanship

Quality of water for construction

Quality of water for construction

Potable water (water fit for drinking) is generally considered for construction

Water suitable for mixing is suitable for curing also. But it should not leave objectionable stain or unsightly deposit on the surface. The presence of tannic acid and iron compounds is objectionable.

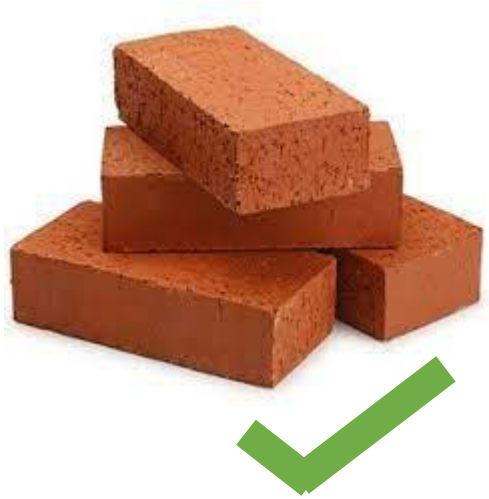
Quality of water for construction

Poor quality of concrete due to improper water cement ratio

Example for proper column concrete

Bricks

A good brick should have uniform red colour.



Foundation

GOOD PRACTICE IN CONSTRUCTION

Foundation concrete

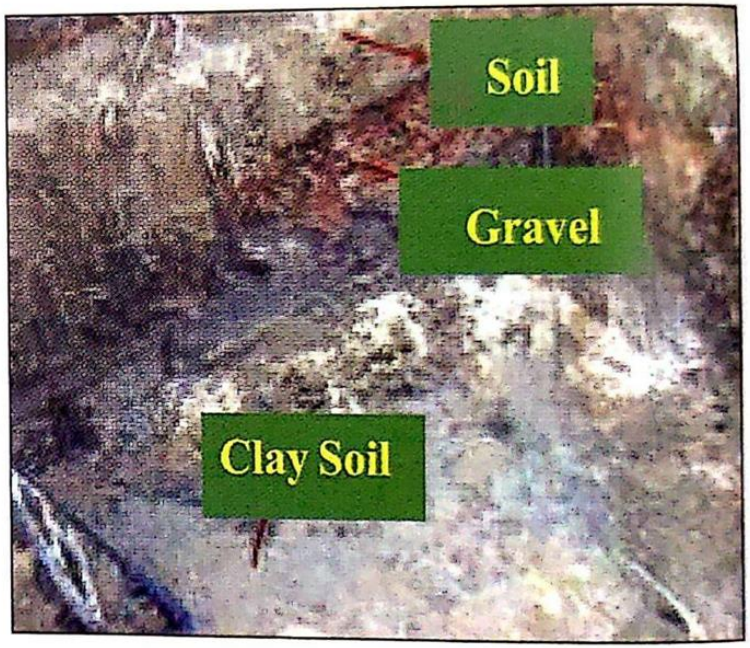
Existing well coming in the construction area.

Effective area has to be taken to fill well and proper design to be made for proceeding the wall

Foundation

Foundation should be avoided in the place where Existing well coming in the construction Area. In unavoidable cases the well should be filled with earth and proper consolidation layer by layer and proper design as to be made

Good Soil (Hard strata recorded in shallow depth)



Foundation

Proper way of laying footing

Column pedestal provided with proper cover

RR Masonry

Example of proper RR masonry

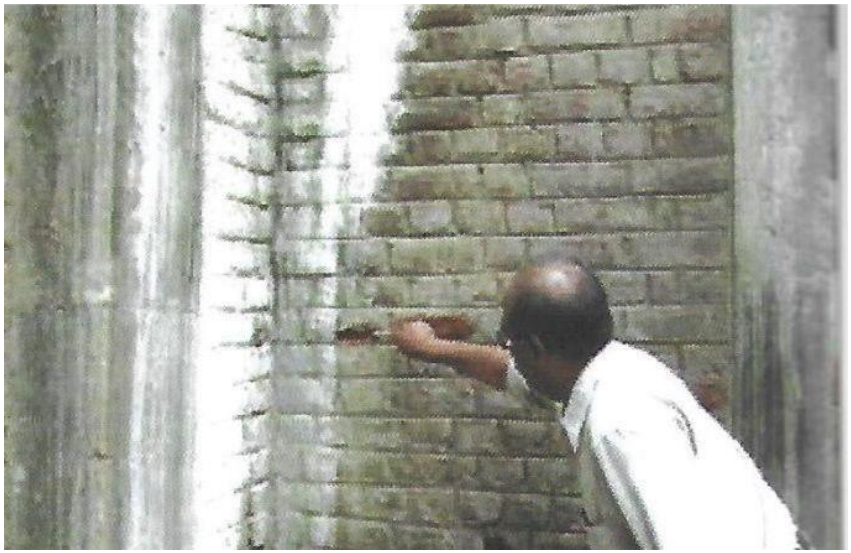
Brick Masonry

Improper marking of windows sill slab

Poor quality Brick

Example of proper brick masonry work

Brick Masonry



Result of bricks not soaked properly before using

Example of proper brick masonry work at hilly areas

Basement Filling

Improper filling

Improper basement filling

Basement Filling

Proper consolidation of layer by layer

Reinforcement

Method of positioning the foundation reinforcement

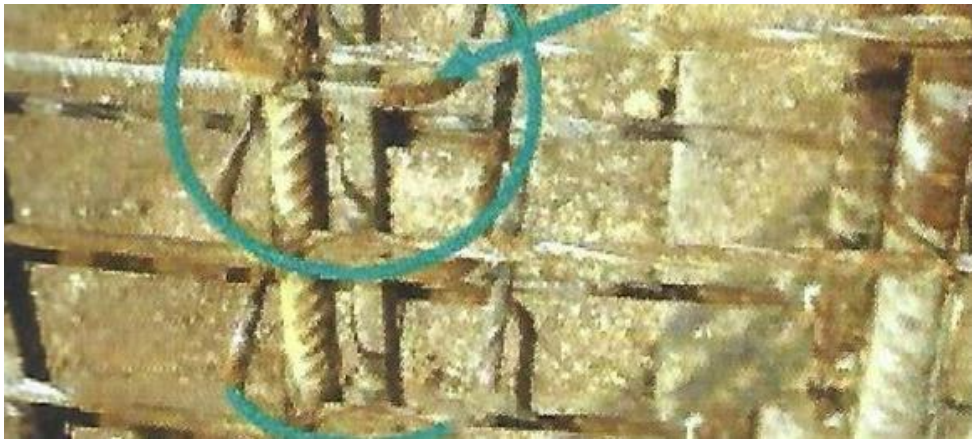
Method of proper fabricating reinforcement

Reinforcement

No cover on one side

Improper cover

Reinforcement



Stirrups not properly fabricated the corners do not tie with the main re-bars

Improper tying of stirrups

Improper work

Concreting

Poor quality of concrete due to improper water cement ratio

Poor quality concrete due to improper method of leaving beam rods in column & poor supervision

Concreting

Example for proper column concrete

Gunny bag curing for vertical members

Pond curing for roof slab

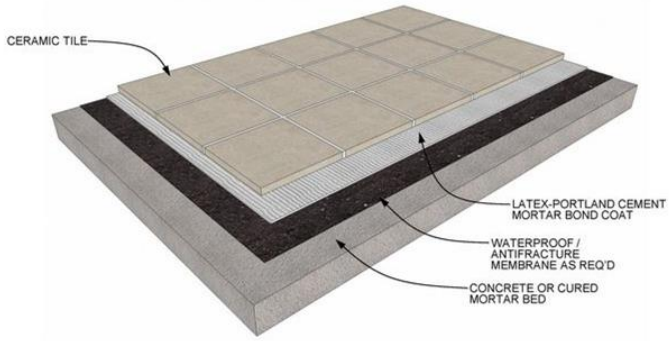
Plastering

Masons are also required to do plastering and floor finishing.

Plaster is made up using lime, cement, gypsum and their combinations

What are basic requirement of Finished plaster?

- ➔ Smooth even surface
- ➔ Free of cracks
- ➔ Flatness is measured as no projection/depression in a 3m square possibly with a 3mm tolerance



Plastering

Proper hacking of roof slab before plastering

Example for proper plastering in hilly areas

Plastering

Improper finishing of staircase steps without uniform tread and riser

Staircase steps with uniform tread and riser

Flooring & finishing

Proper laying of floor tiles after grout applying

Mosaic floor finish

Flooring & finishing

To ensure good plastering

- ➔ have coherent blend easy to work with
- ➔ curing by spray to ensure freedom from cracks
- ➔ Pre wetting of walls to reduce absorption of water from mortar

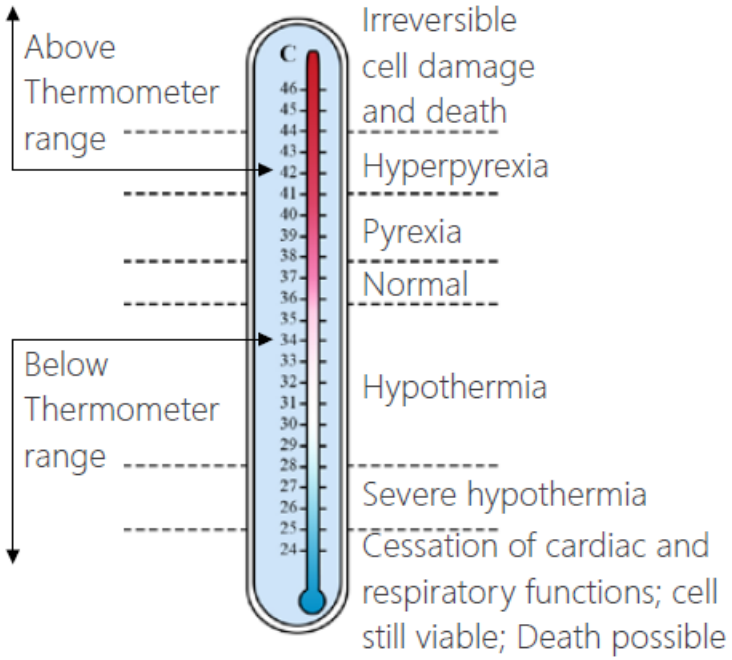
- Floor finishes are in concrete with smooth finish or broom finish.
- Finish in panels of 15m2 or less to avoid shrinkage cracks.
- Floor grinding or broom brushing are done on floor to ensure degrees of smoothness.

Flooring & finishing

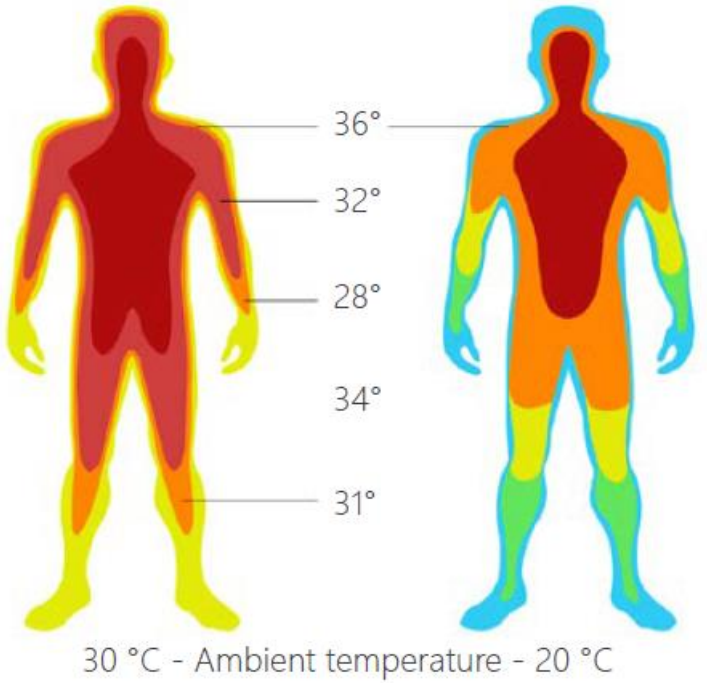
- Use appropriate tools to work with if the final floor finish is of Kota, Cuddapah, Stones, tiles, marble or granite slabs. The plaster finish should be rough to increase the bonding.
- Painting on plastered wall should be with appropriate paints externally or internally.
- On walls fresh with locked in moisture, membrane painting be avoided.
- Bubbles or Flakes will appear on membrane paints if locked in moisture escapes.

Thermal comfort

Thermal Condition of Human Body

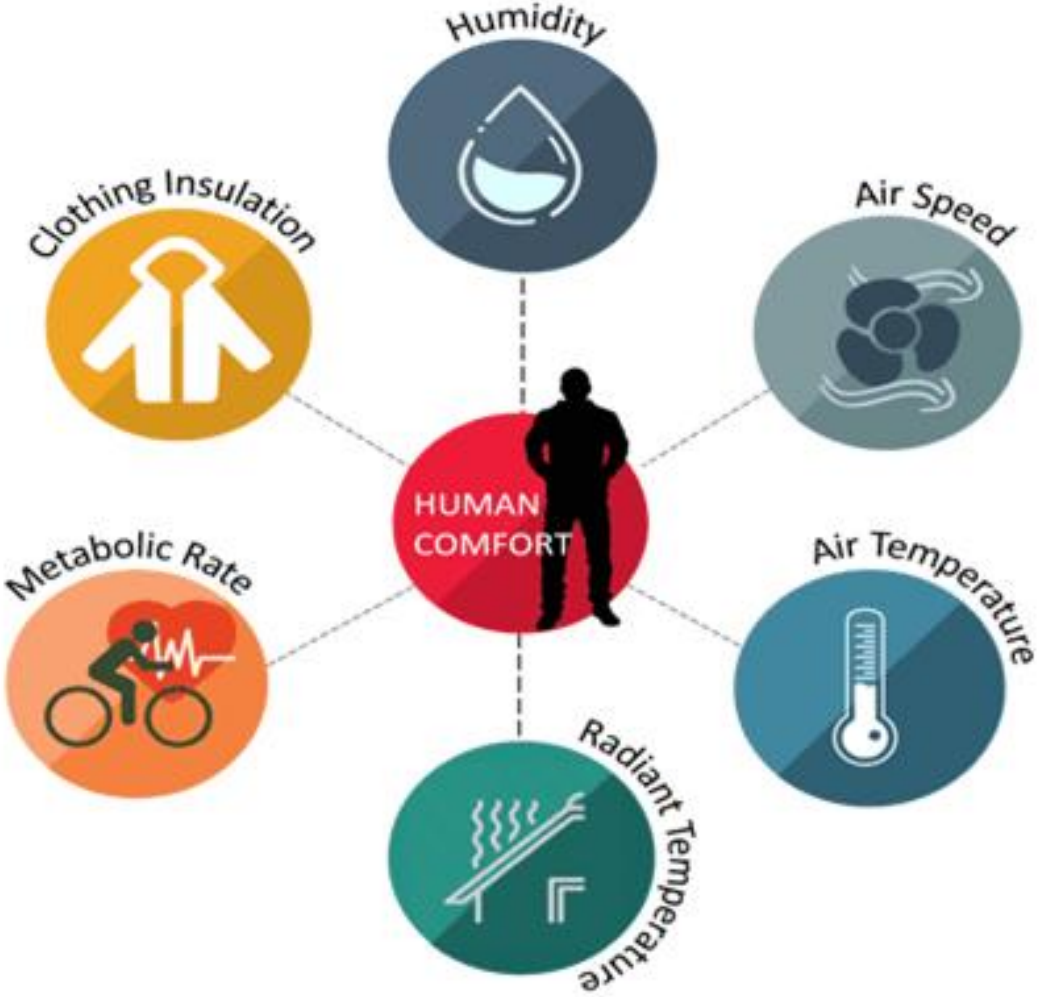


Comfort Band



Skin surface temperature

Thermal Comfort – Indices



Source: https://www.simscale.com/blog/2019/08/what-is-ashrae-55-thermal-comfort/

Thermal Comfort Indices – Metabolic Rate

Source: https://www.simscale.com/blog/2019/08/what-is-ashrae-55-thermal-comfort/

Thermal Comfort Indices – Environmental Factors

Problems due to High Humid Conditions

- ❑ Stuffy air
- ❑ Condensation on windows and walls
- ❑ Mold spots or water stains
- ❑ Musty smells
- ❑ Allergies
- ❑ Skin problems
- ❑ Swollen woods
- ❑ Moist fabrics

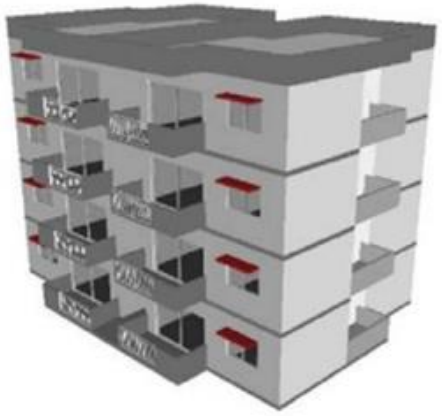
Problems due to Low Humid Conditions

- ❑ Dry air
- ❑ Allergies
- ❑ Vulnerable to Cold
- ❑ Infections
- ❑ Itchy & Dry Skin
- ❑ Damage to wood furniture & paints
- ❑ Increased static electricity
- ❑ Electronics damage

Passive Strategies & Building Materials

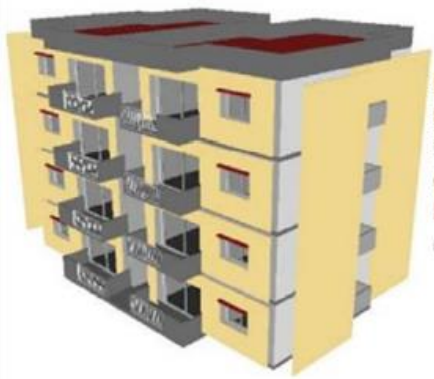
Initial Strategies

- Form and orientation
- Window-to-wall ratio
- Shading strategies
- Solar Heat Gain Coefficient (SHGC)
- Residential envelope transmittance value (RETV)
- Construction configuration
- Interaction between parameters



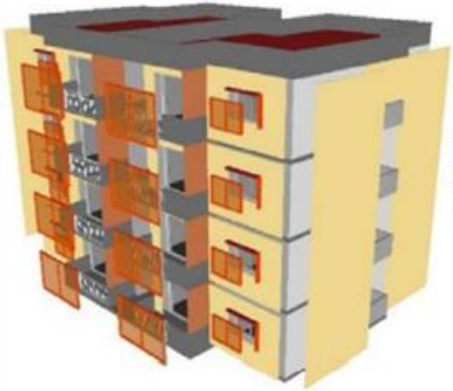
RETV- 21.0 W/m²
Business-As-Usual
Building Envelope

RETV value of typical affordable multifamily residential building



RETV- 18.0 W/m2
Building Envelope Details:
Better insulation in walls and roof (U-value)
High solar reflectance on roof (SRI)

RETV value after initial envelope optimization strategies



RETV- 15.0 W/m2
Better Windows (U Value, SHGC, VLT,
Building Envelope Optimization)

RETV value meeting ENS compliance after glazing related optimization strategies

GLOBAL HOUSING TECHNOLOGY CHALLENGE INDIA

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Pradhan Mantri Awas Yojana-Urban

Ministry of Housing and Urban Affairs
Government of India

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Thanks