

# Building the Nation – Sustainable Technology & Innovation in Infrastructure Development

*By*  
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## Revolutionizing Road Infra with Modern Equipment, Technologies, Sustainable Materials and Policy Guidelines

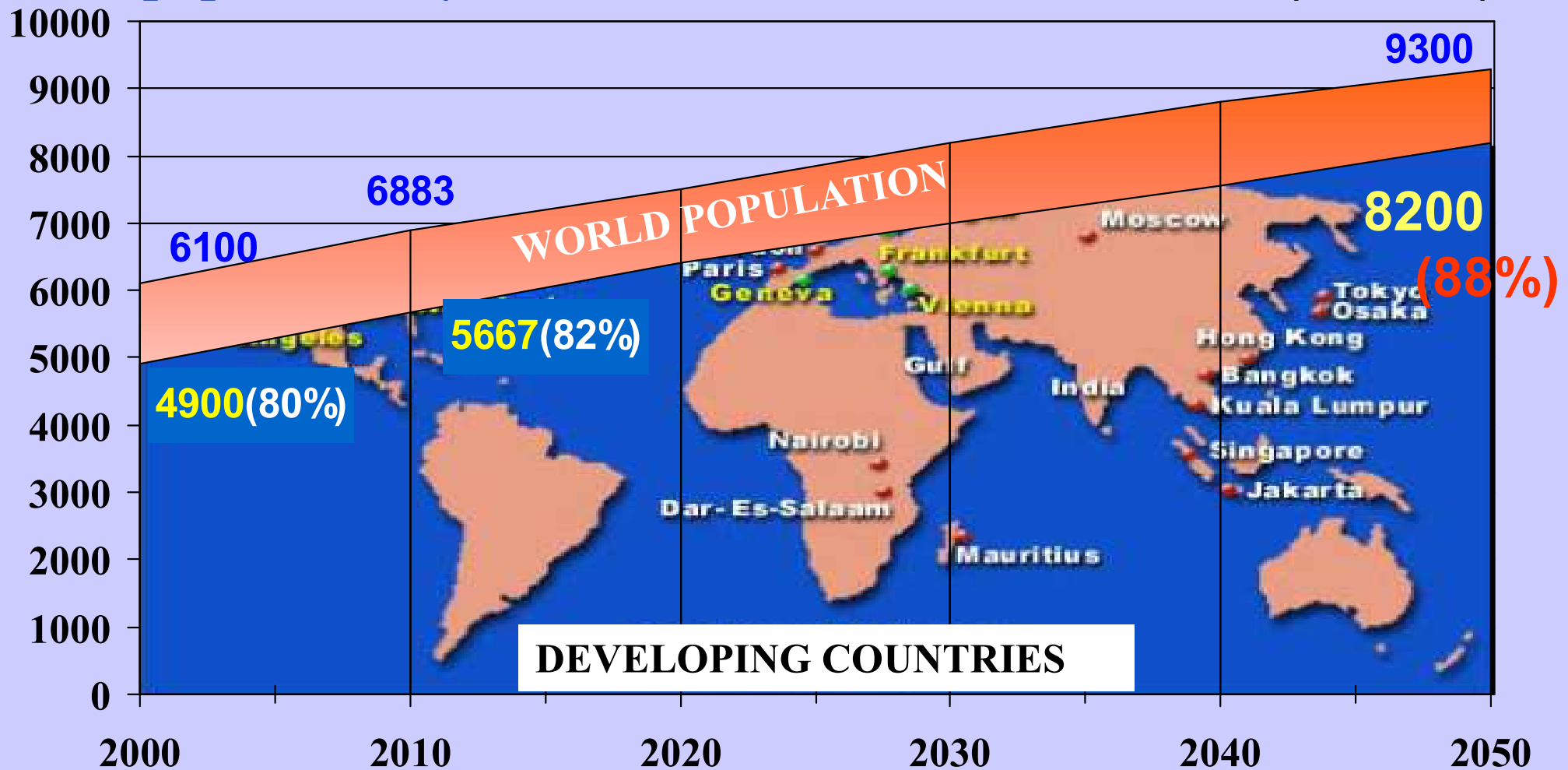
Manekshaw Centre, New Delhi

29<sup>th</sup> February 2024



# World Population Trends

Population in developing and lesser developed countries to be 88% of total population by 2050  
(in millions)



Source: UN Population Division; WORLD POPULATION PROSPECTS

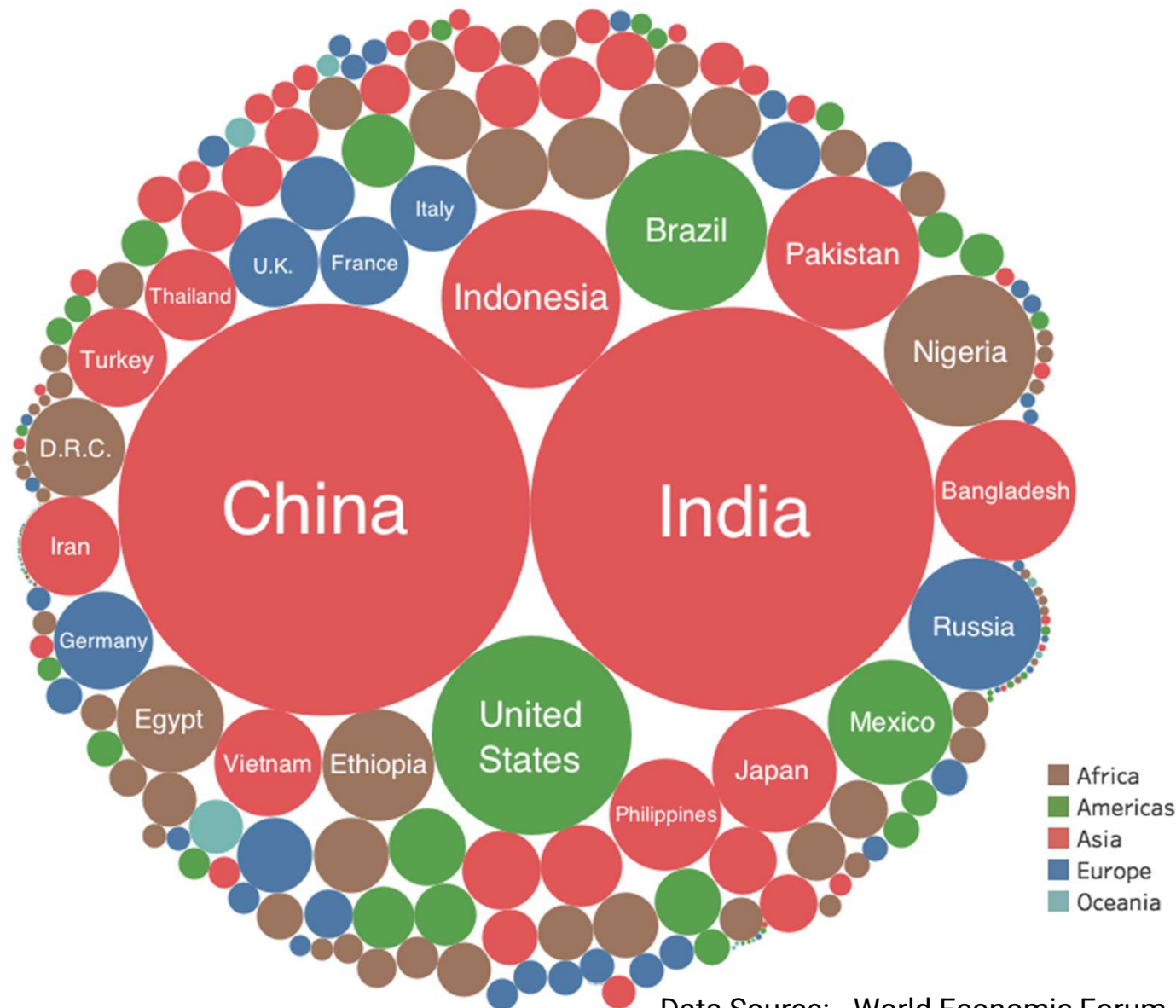
Population Reference Bureau: WORLD POPULATION DATA SHEET

# World Population Trends

Countries by Population Size

**World Population  
crossing 8 Billion**

**1.4 Bn + China**  
**1.4 Bn + India**  
**1.4 Bn + Africa**



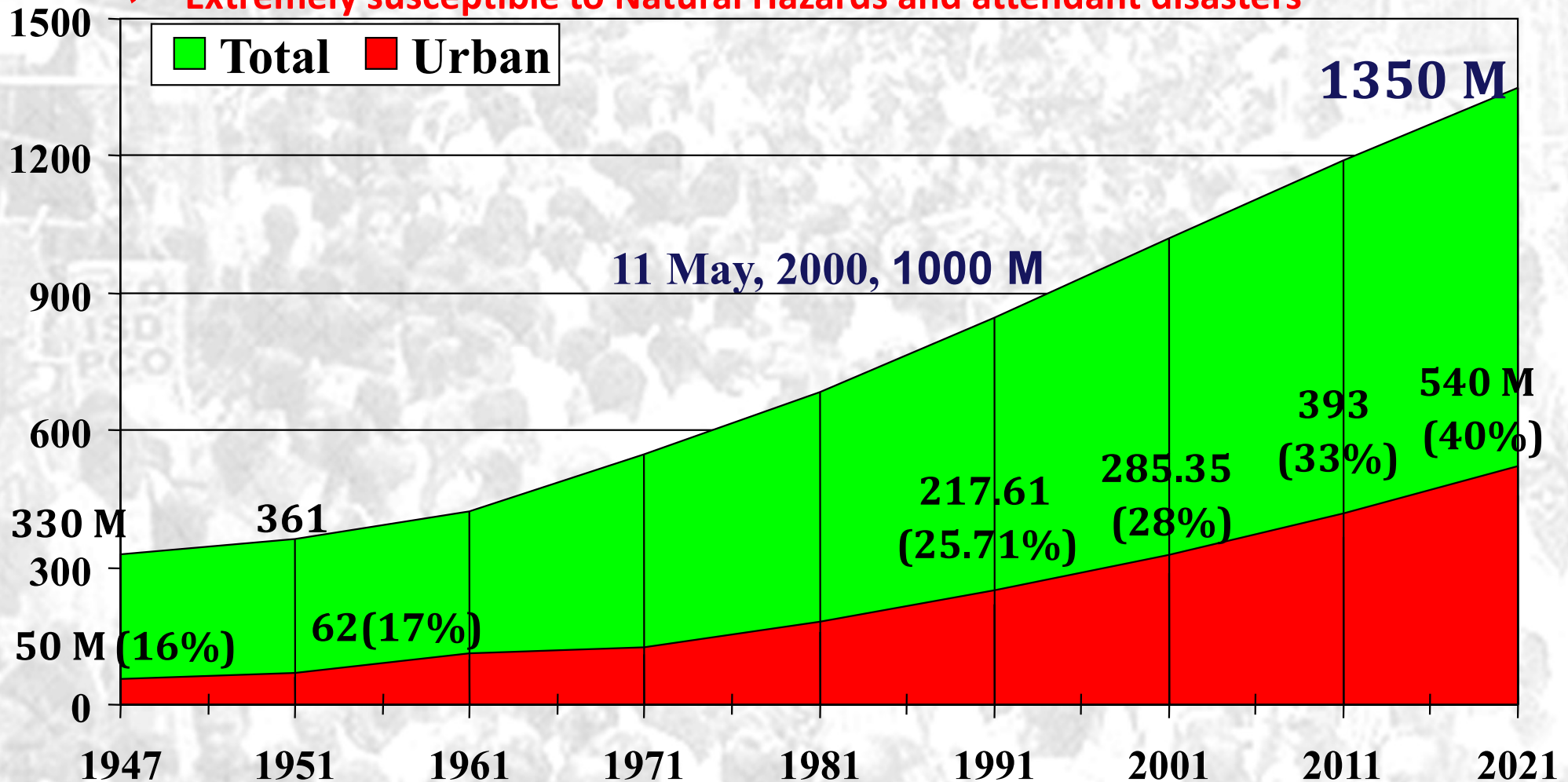
Data Source: - World Economic Forum

# Urbanisation Scenario in India

Decadal Growth Rate of Population (1991-2001) **Urban: 31.13% Rural: 17.97%**

✓ 350 Million getting added in 2 Decades

✓ **Extremely susceptible to Natural Hazards and attendant disasters**



# India Core Infrastructure Needs

## **Modernisation / Upgradation of Highways**

National Highway Development Projects

4 / 6 Laning of 14,279 km

2 Laning of 2000 km Road

1000 km of Express Highways

# India Core Infrastructure Needs

## **Indian Railway Network**

Modernisation and Expansion

High Speed Trains / Container Trains / Freight Corridors

To Transport 750 MT of Freight

6.5 billion people in a year with 5% Growth each year

# India Core Infrastructure Needs

## **Civil Aviation Sector**

Worlds Second Largest Commercial Aircraft Market

Passenger Traffic Growth 20% per annum

Modernisation / Expansion of Airports

# India Core Infrastructure Needs

## Ports Sector

6400 km - Coastline

Ports provide the Crucial Transport Infrastructure

13 Private / Captive Ports with  
Annual capacity of 47,500 MT on way

23 More needed for 90,000 MT

National Maritime Development Programme



# India Core Infrastructure Needs

## **Energy Sector**

Additional Power Generation

To Meet the Growing Economy needs

1,08,000 MW Power Generation

Harnessing Renewable Energy

# India Urban Infrastructure Needs

## **Sectors of:**

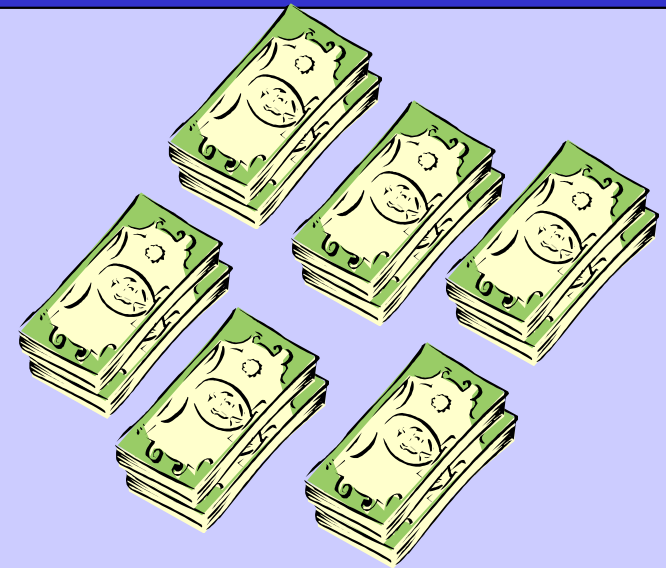
Water Supply,  
Sanitation, Sewerage, Drainage,  
Solid Waste Management,  
Roads and  
City Transportation Network

**GATI SHAKTI for Infrastructure Thrust –  
INR 100 Lakh Crore**

# Increased Emphasis on Partnership Modes for Infrastructure Sector

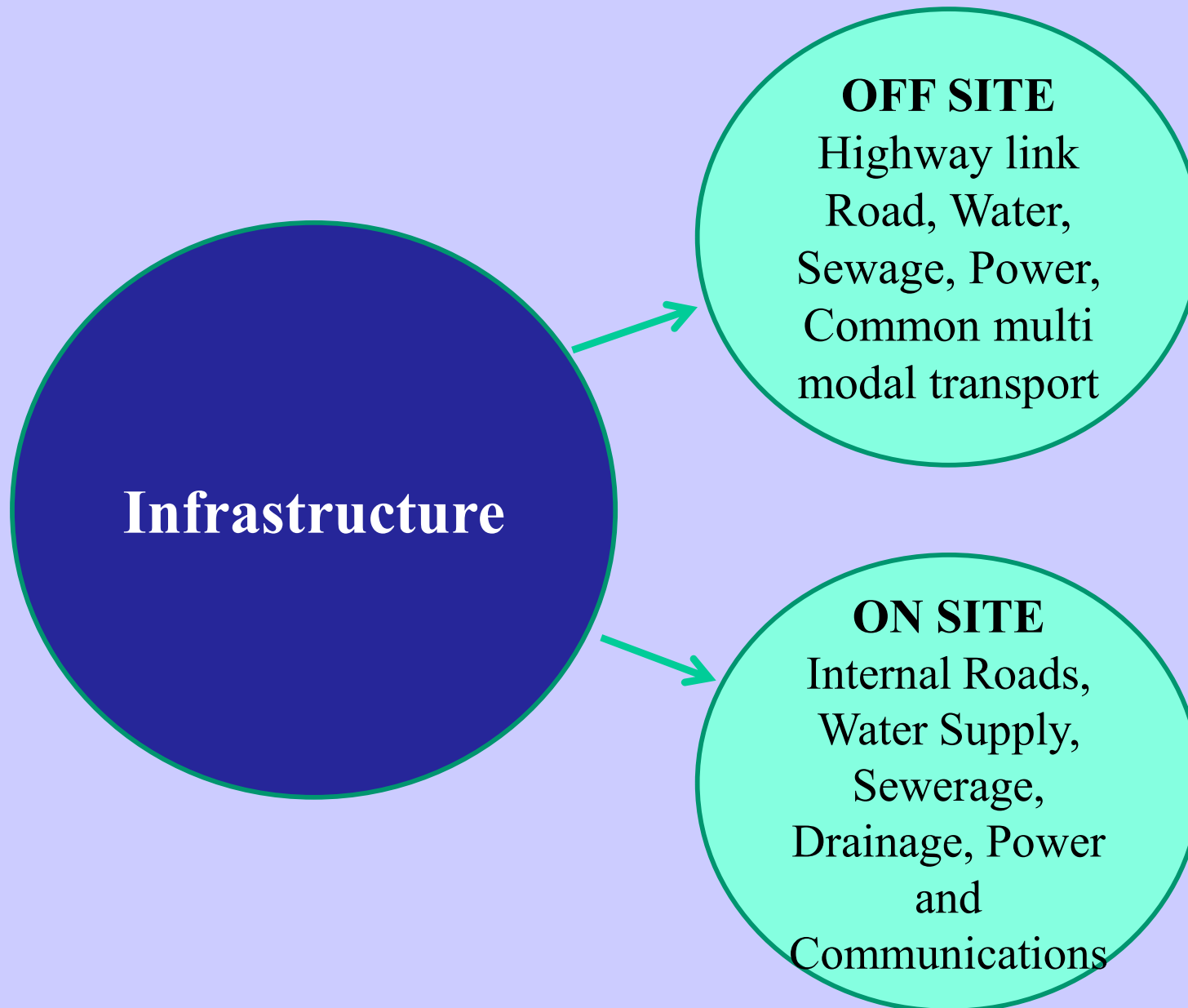
The imperative need for Private Sector Participation for:

- EXTENDED RESOURCES
- STATE-OF-THE-ART TECHNOLOGIES
- EFFICIENT PROJECT MANAGEMENT / MAINTENANCE



VS

# Integrated Townships



# Construction Sector as Growth Engine

- The above would indicate the massive construction needs of India for Housing, other buildings as well as infrastructure development in the Urban / Rural Sector as well as Core Sectors
- The Construction Industry spend has registered quantum jump – nearly 10% of GDP
- Second largest employment sector after Agriculture. Rs. 1 crore investment produces 100 man years of employment – over 5 crores of construction workers
- Providing employment to 10 lakhs engineers of all disciplines.
- Over 250 industries contribute growth opportunities (Cement, Steel, etc)
- Building the Nation for the additional New India of 40 crores population

# Imperatives for Promoting Safer Buildings/ Construction

With a view to ensure that the massive financial resource investments for housing and other public asset buildings and infrastructure are safe, strong, durable and perform well during life cycle, it is essential that these are:



**Flood protected**



**Cyclone  
Typhoon resistant**



**Earth Quake  
Resistant**



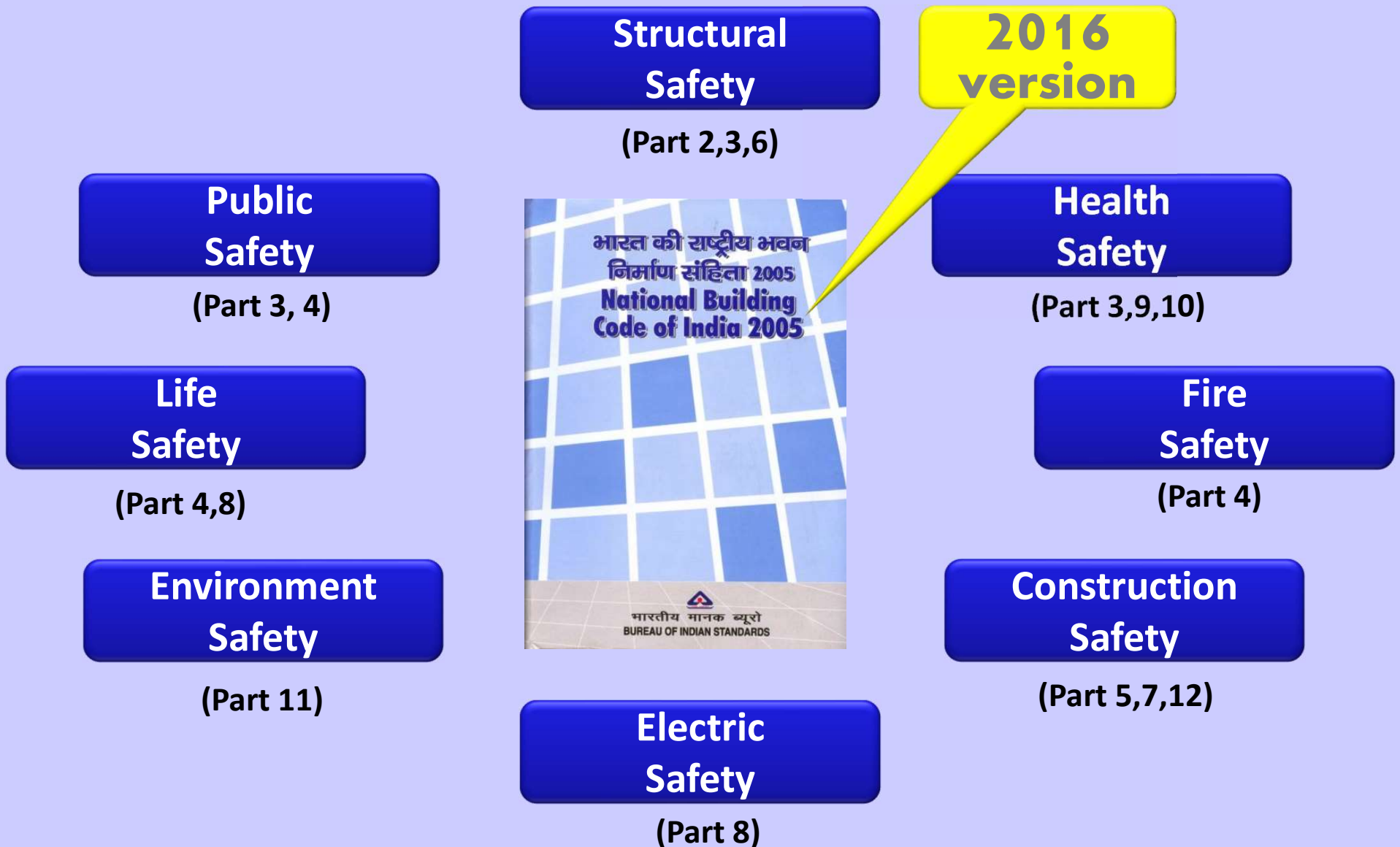
**Land slide protected**



**Sea erosion protected  
Tsunami protected**

# NBC of India 2016

Built around the philosophy of creating and maintaining Safe Built Environment for people and property by ensuring:

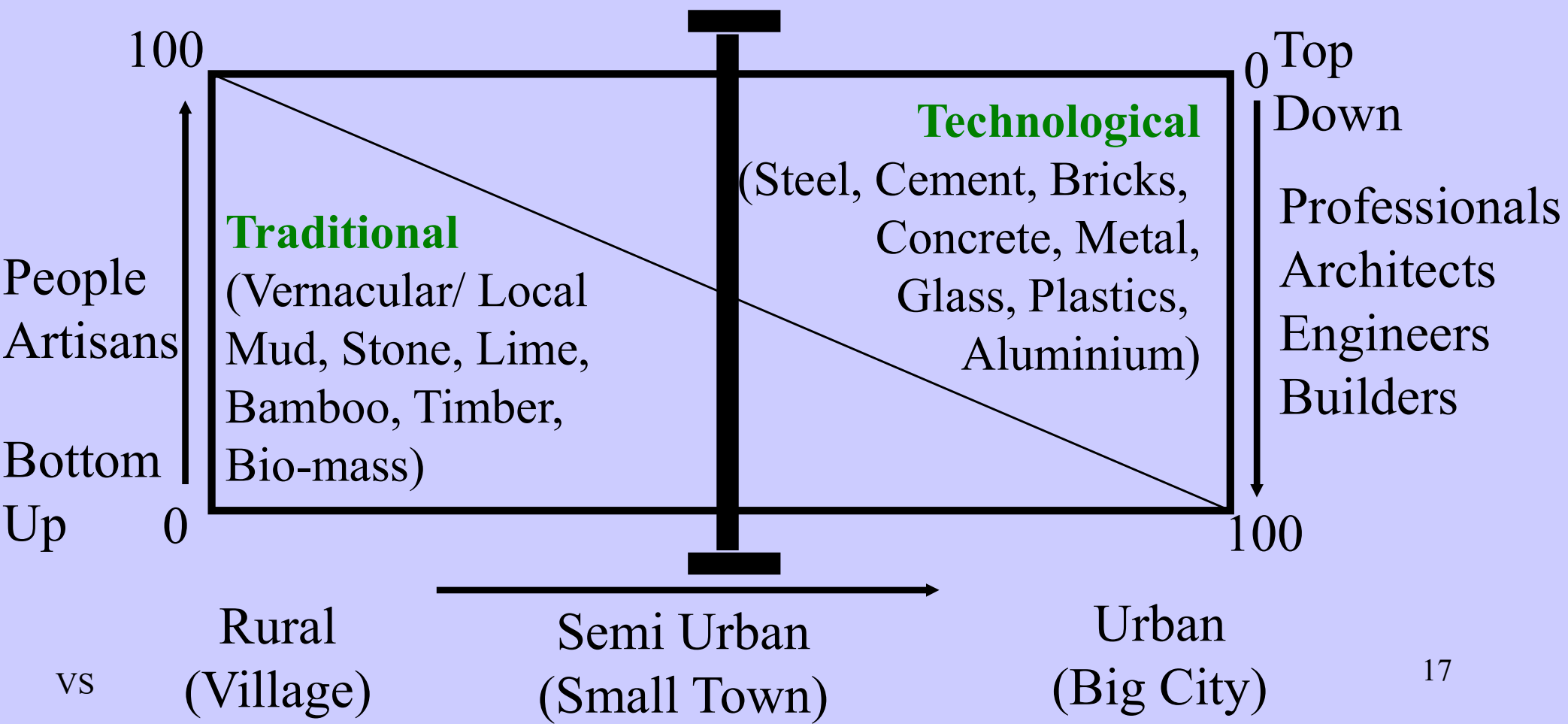


# Construction Systems in India

- **Vernacular systems**
- **Conventional systems**
- **Industrialized systems**
- **Alternative systems**

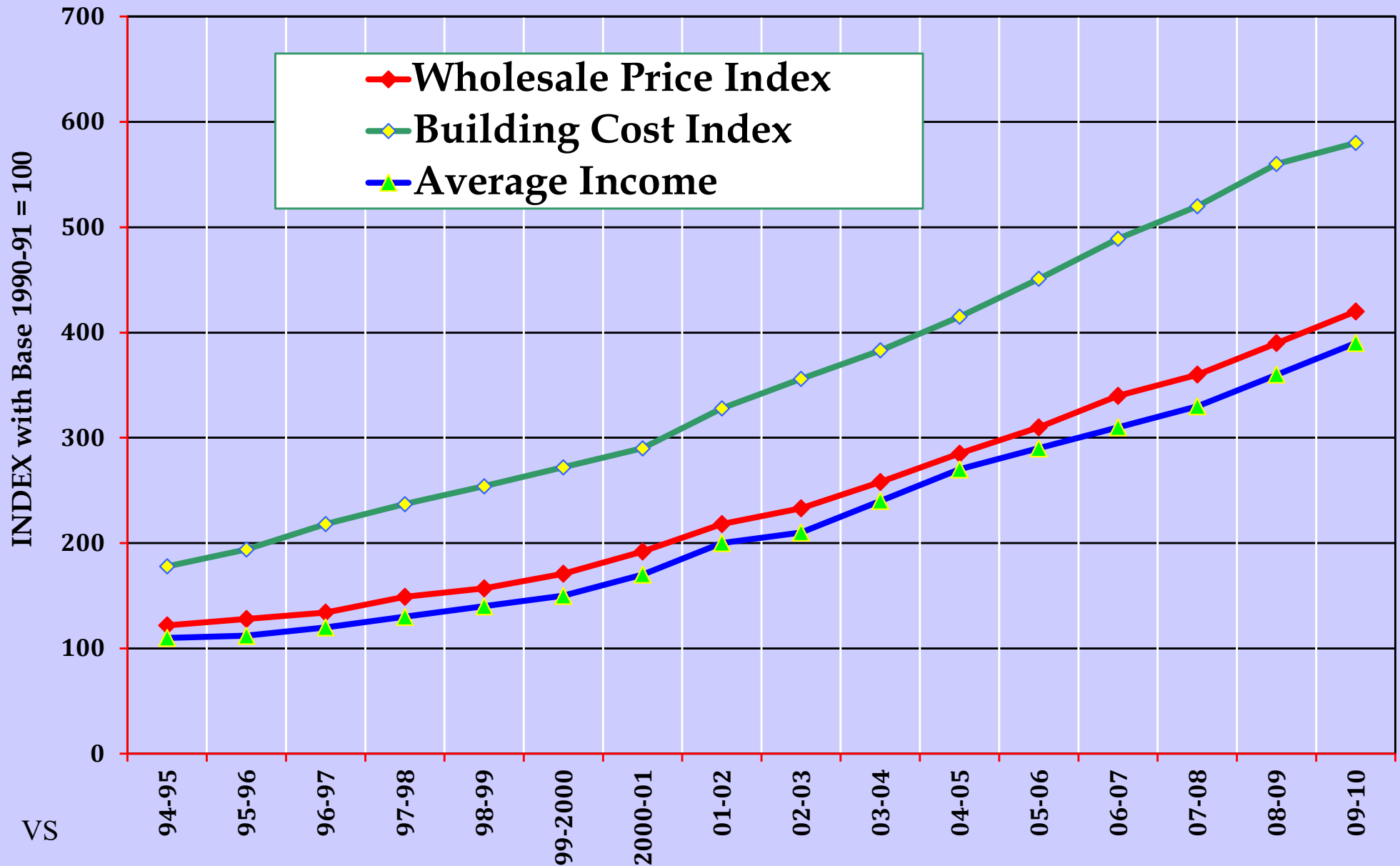


# Appropriate, Intermediate, Cost Effective, Disaster Resistant and Sustainable Technologies



# Status of Construction Industry

Cost of construction goes up at rates 50% more than inflation



# Salient Indicators

**Aims to reduce the cost of construction and at the same time not sacrifice any element of safety or serviceability of the house over the life cycle.**

There is need for adoption of :

- strong,
- durable,
- functional,
- aesthetic,
- environment friendly,
- ecologically appropriate,
- energy efficient
- affordable and adaptable
- cost-effective materials
- appropriate technologies in construction.

# Utilisation of Industrial Wastes

Item	Source	Application in Building Material
Fly-ash	Thermal power stations	Portland pozzolana cement, bricks, lime pozzolana mixture, lightweight aggregate, cellular concrete
Phospho-gypsum	Hydro-fluoric/ phosphoric acid, Amm.Phosphate Fertiliser Plants	Gypsum plaster, fibrous gypsum boards and blocks, cement clinker, as a solid retarder and for making super sulfate cement
Red mud	Aluminium extraction plant	Building bricks and tiles, light-weight structural blocks, roofing sheets and as additive to concrete
Blast furnace slag	Steel plants	Portland blast furnace slag cement, super sulfate cement, as an aggregate in concrete, as substitute for sand, Light weight concrete
Limestone waste	Limestone quarry	Masonry cement and activated lime pozzolana mixture
Lime sludge	Sugar, ferti-lizer, calcium carbide paper, acetylene	Portland cement, masonry cement, sand lime bricks, building lime pozzolana mixture

# Utilisation of Agricultural Wastes

Item	Source	Application in Building Material
Rice husk	Rice mills	As fuel and in production of rice husk binder, fibrous building panels, bricks
Bagasse	Sugar Industries	Manufacture of insulation boards, wall panels, etc
Banana leaves/ stalk	Banana plants	Building boards, fire resistant fibre board
Coconut husk	Coir fibre Industry	Building boards, roofing sheets, insulation boards, building panels, as a lightweight aggregate
Groundnut Shell	Groundnut oil mills	Building panels, building blocks, chip boards, roofing sheets, particle boards
Jute Stick	Jute Industry	Chip boards, roofing sheet
Cinder vs	Thermal power stations/ railways	Lime cinder mortar, concrete building blocks, bricks from black cotton soil

# Waste as Resource



# Innovation in Concrete as Construction Material

**High Performance Concrete**

**Self-compacting Concrete (SCC)**

**High Volume Fly Ash Concrete (HVFA)**

**High Performance Lightweight Concrete**

**Self-curing, Shrinkage-free concrete**

**The Use of Mineral Admixtures**

**Condensed Silica Fume (CSF)**

**Durability Enhancing Products**

**Hydrophobic Concrete Waterproofing System**

# Innovations in New Construction Materials

**Recycled Aggregates**

**Lightweight Aggregates**

**Corrosion Inhibitors for Reinforcement**

**Advanced Composite Reinforcement**

**Application of Nano Technology**



# Innovative form work Systems

**As against conventional timber / bamboo options for scaffolding and form work use:**

- Doka
- PERI
- RECKLI
- Destil
- Meva
- Cometal
- Destil
- Paschal
- Mivan

# Use of Equipments and Machineries

- ❑ **Use of FRACO Climbing Platforms – for external plastering, painting, tiling, glassing**
- ❑ **Rope suspended Cradle / Platforms**
- ❑ **Innovative and Intelligent Construction Equipment for all Infrastructure activities**
  - **Delivery**
  - **Trained Certified Manpower**
  - **Leasing options & Financing**

# Prefabricated Construction

## - Future Trends

**For massive needs in housing and building construction could opt for prefabricated construction systems with:**

- Production at controlled environment
- Assured Quality
- Timely completion (30 – 40% time saving)
- Less dependence on large labour force needed for conventional construction
- Large working period – even during monsoon
- Scaffolding and form work cost elimination
- Progressive shift from *open* to *closed* systems
- Transformation needed from use of **partial precast elements** to **full industrialised system** of prefabricated construction

# Beyond Safety Consideration is the Climate Change Response

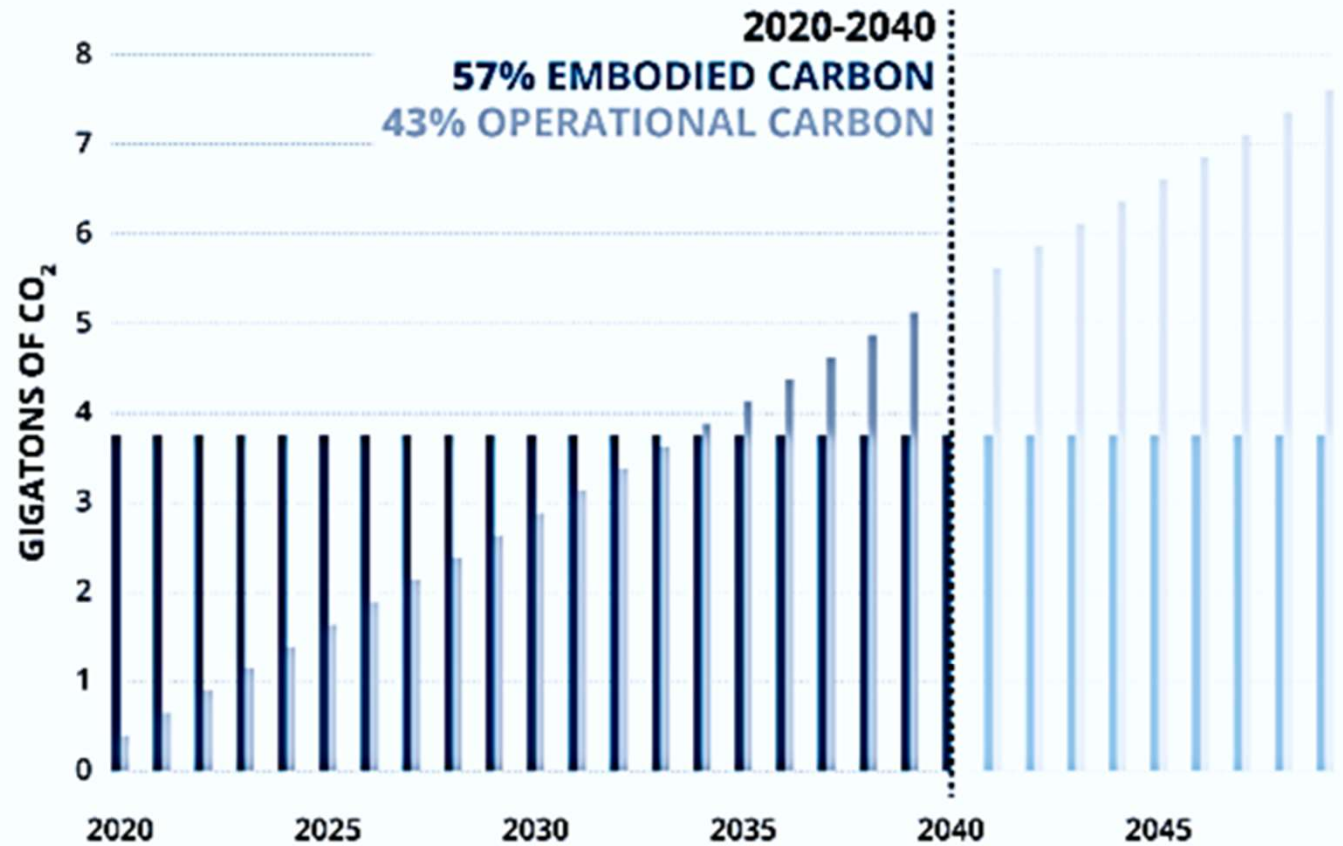
While the present Regulatory frame work deal with Built Environment for the three dimensional spaces and connected spatial development, these do not touch on:

- Environment
- Ecology
- Energy Consumption
- Quality of Life
- Sustainable Development
- Life Cycle Assessment
- Carbon Footprint Reduction

# CO<sub>2</sub> Emissions from Building Sector

Responsible for 39% Global CO<sub>2</sub> Emissions

### Total Carbon Emissions of Global New Construction *with no building sector interventions*



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Data Sources: UN Environment Global Status Report 2017; EIA International Energy Outlook 2017

# Two Decades of Green Building Journey

Before 2015

Stakeholders leading by example

Based on Manufacturer Declarations



Green Buildings

Launch of GreenPro

Few initial takers

Endorsed by IGBC systems



Post 2016

Expansion of IGBC Ratings

Demand Created by Green Projects



Green Built Environment

2018

Net Zero

Raise the Bar  
GEN Certified



2023

Low Carbon Construction

7,800 Certified Products



Net Zero India



How Green Products are different?

*Ecolabelled Cement products have reduced per tonne emissions ranging from 2 to 10 % than the defined baselines.*

## Green Cement

Mandatory Requirements	
Fly Ash requirements in PPC	25% to 35%
Slag Content in PSC	40% to 70%
Additive Content in CC	30% to 65%

kg of CO <sub>2</sub> Emission per Tonne of Cement		Reduction in CO <sub>2</sub> Emission
Baseline	FY 2021 – 22 (Performance)	
750	539.5	28.1%
750	629.5	16.1%
750	660.8	11.9%
540	246.7	54.3%

Project sample

### Kg of Carbon Emissions:

- AAC blocks (9 inch) : 80 kg CO<sub>2</sub> / CuM
- Clay Brick : 250 kg CO<sub>2</sub> /CuM

Mandatory Requirement -  
steel billet should be in  
accordance with the IS  
1786:2008 standards

❖ **Cement and Steel comprise around 50% of total cost value of materials**

Improved Product Performance



Reduced Slag Generations  
by promoting  
reuse and  
recycling  
waste



Reduced  
carbon  
emissions



Improved Efficiency of Products



High Tensile  
strength



Elongation  
values



Highly Anti  
Corrosive



Oxidation  
Resistant

**TMT Rebars  
Green Steel**



# Pervious Concrete

## Site Information

- **Concrete Pavement Area : 6000 m<sup>2</sup>**
- **Rainfall Intensity : 102 mm**
- **Runoff Coefficient**
  - **Conventional : 0.95**
  - **Pervious Concrete : 0.6**



System Parameters	Unit	Conventional Concrete	Pervious Concrete
Rainwater Runoff	m <sup>3</sup>	581.4	367.2
Percolation Pits Required for Ground Water Recharge (Dia 150 mm & Depth 6 m)	m <sup>3</sup>	323	204
<b>Increase in rainwater harvesting (%)</b>	<b>%</b>	<b>-</b>	<b>37%</b>

Percolation rate:  
200 to 500 litre /  
minute / m<sup>2</sup>

**Reduction in investment for rainwater harvesting system**

# Green Construction Chemicals

- **Admixtures**
- **Adhesives & Sealants**
- **Grouts**
- **Protective Coatings**
- **Water Proofing Coatings**



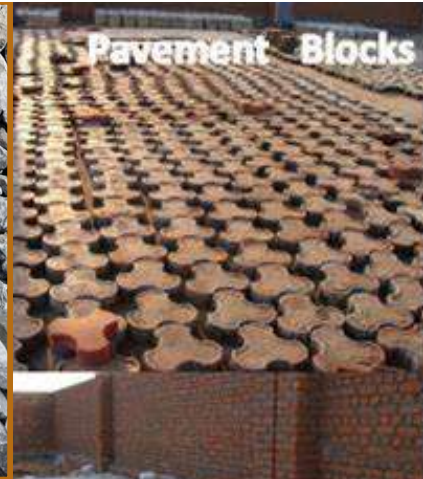
Parameter	Conventional Construction Chemicals	Green Construction Chemicals
<b>Volatile Organic Compounds (g/L)</b>	> 50	17
<b>Concentration of Heavy Metals</b>		
Lead (mg/L)	Total concentration is relatively high (> 0.1% or 1000 PPM)	0.1
Mercury (mg/L)		0.01
Arsenic (mg/L)		0.2
Cadmium (mg/L)		2
Chromium (mg/L)		2
<b>Use of Sustainable Materials</b>	Nil	20 – 35%

**To enhance health & wellbeing of building occupants**

# Demolition Waste to Reuse Construction Material



Recycled Aggregate  
Crushing Stone Aggregate



Pavement Blocks



Particle Boards



Coarse sand





## Embodied Carbon of Ecolabelled Building Materials

S No	Material	Unit	Conventional Products	Average Value of Ecolabelled Products
1	Blended Cement	kg of CO <sub>2</sub> /MT	550	475
2	Autoclaved Aerated Concrete Block	kg of CO <sub>2</sub> /MT	350	310
3	Ready Mixed Concrete (RMC)	kg of CO <sub>2</sub> /MT	190	115
4	Float Glass	kg of CO <sub>2</sub> /MT	> 400	335
5	Steel TMT Rebar	MT of CO <sub>2</sub> /MT	2.2	1.95

**\* Average value of GreenPro Ecolabelled Companies**

# Carbon Footprint of New Materials Vs Recycled Materials

Material	GHG From New Production (CO <sub>2</sub> e/kg)	GHG From Producing Recycled Materials (CO <sub>2</sub> e/kg)	Difference (%)
Steel	2.4	0.3	87
Aluminum	11.0	0.4	96
Glass	0.9	0.5	41
Plastic	2.1	1.3	37
Paper	1.1	0.7	37
Organic waste	0.07	0.05	27

<https://8billiontrees.com/about/>

# Elements for Promoting Safer Construction in Built Environment

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Three critical elements for action areas to promote safer construction are in creating:



**Awareness**



**Appreciation**



**Application**

# Thrust Areas

- ✓ **EDUCATION**
- ✓ **ENGINEERING**
- ✓ **ENFORCEMENT**

# Innovative Techno-financing regime

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- All building / infrastructure constructions by public, private, corporate, co-operative, community, joint and individual sectors receiving funds from many sources to adopt **innovative techno-financing regime** without exception.
- Such contributors including government / Budget funds / financial institutions (DFIs / HFCs) and Banks to insist on disaster resistant construction and **incorporation of disaster resistant features** as a precondition for providing funds / mortgage / project loans for projects.
- Reserve Bank of India being regulator for Banks and National Housing Bank being regulator HFC's have instructed for mandatory safety compliance as per NBC for funding.
- **Fixing the Insurance premium / tariff to be linked to the incorporation of disaster resistant features in construction.**
- Provision for inspection and **periodic technical audit** and retrofitting.



# Need for safe and durable construction delivery – for desired quality

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- It becomes therefore imperative to ensure the right construction practices and delivery system
- This can only be done with a large cadre of trained artisans(masons/carpenters/ bar benders, tile / sheet layers, plumbers, electricians, welders) – National Network of Building Centres, Nirmiti Kendra / Nirman Kendra and Skill India initiatives have made some impact.
- The availability of manpower, material, machinery and management linked with money flows become an imperative focus for ensuring the **techno legal** and **techno-financing** regimes.

# Operation & Maintenance and Asset Management

- Creating safe assets for disaster mitigation is important (CAPEX)
- Equally important is to evolve appropriate maintenance and asset management strategies and actions (**OPEX**) for ensuring safe and long term life and continuous functional performance of the infrastructure / buildings – **to combat obsolescence, decay and disfunctioning**
- Calls for inspection systems at periodic intervals and carrying out non-structural / structural upkeep, maintenance and repairs and **“Unsafe” buildings and infrastructure to be retrofitted**
- **Including Periodic Renewal Clearances – against “Safety concerns”**
- **Part 12 of NBC provides for the same**



# IMS (Integrated Management System)

- ISO 9001
- ISO 14001
- OHSAS 18001

**Need commitment to Environmental Initiatives from whole team**







Leads to.....

**Building the Nation.**

.....each one of you

joining the movement

.....with efficiency, economy and productivity

**Thank you**