Appropriate Materials for Sustainable Housing

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GOALS:

- Sustainability
- Cradle to Cradle design
- Source reduction
- Innovation
- Viability

Aspects of Green Technology

- Energy
- Green Building
- Green Chemistry
- Green Nanotechnology

Challenges

Source of images: Internet

Climate change | Energy shortage | Urbanization | Infrastructure

Some Solutions to these Challenges

Green Building Materials and Technologies

Construction Industry – Challenges

Climate Change (Green House Gases Emissions)

Need to reduce "greenhouse" gas emission to combat global warming

- **6-7% of the world CO_2** emissions from cement production
- **One ton of cement produces ~0.9 ton of CO_2**
- Cement production is **highly energy intensive process.**

Conservation of Natural Resources

- 3 billion tons of limestone
- 13 billion tons of aggregates

Construction – the largest consumer of non-renewable resources

The increasing cost of energy and rapid depletion of Natural resources have forced us to think about Green building strategies. Successful green building depends on the appropriate building form, design of energy efficient systems and the specifications of environmentally sustainable Materials.

Traditional Building Materials & Technologies

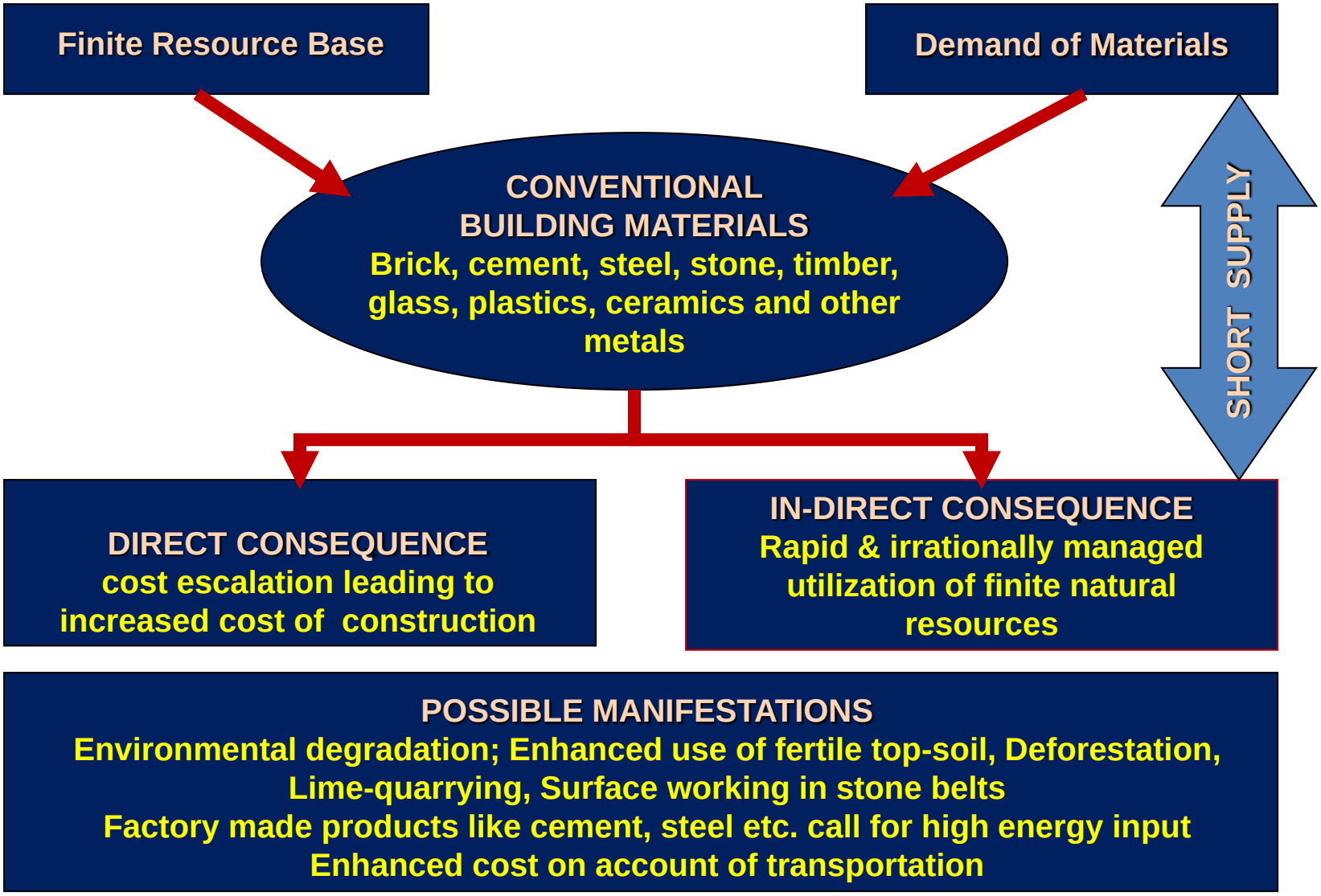
- **USE OF LOCAL SOILS : Mud, Cob, Adobe, Baked Bricks, Stone, Roofing (Mangalore) Tiles, Bamboo, etc.**

- **Indian architecture has been the most enduring evidence to technological achievements when one talks of culture, civilization, etc.**

- **The cultural diversity manifest itself in variety of basic materials and construction systems, and**

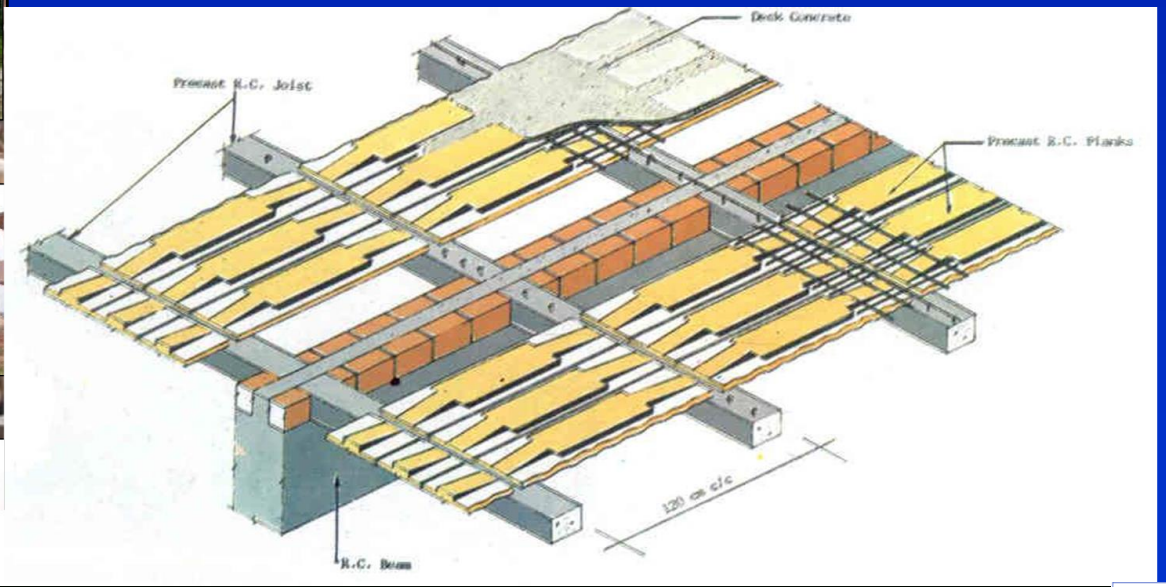
- **Each region has developed unique ways of using local building materials which are energy efficient & sustainable.**

Conventional Building Materials



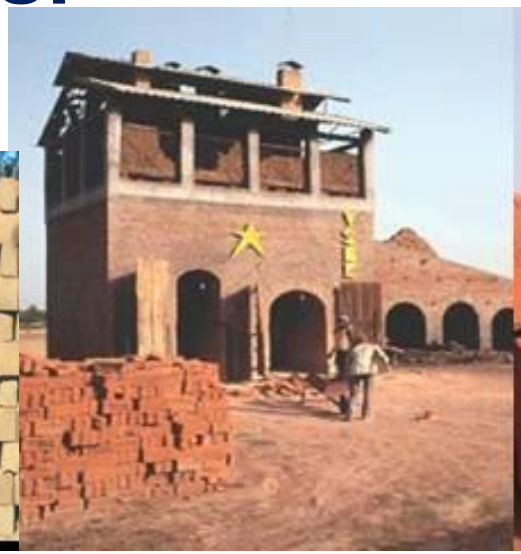
Due to shortage of conventional materials, new materials & technologies emerged and are being used in the construction.

Green Materials and Technologies for Building Sector - Present



Technology solutions:

Walling



CLAY FLY-ASH BRICKS

Developed by	National standard framed
CBRI, Roorkee	IS 13757: 1993

Being produced by various Building Centres and private entrepreneurs.

FLY-ASH SAND LIME BRICKS

- By mixing of lime and Fly-Ash in the presence of moisture, Fly-Ash sand lime bricks are made.
- After reactions between lime and Fly Ash, calcium silicate hydrates are produced which are responsible for the high strength of the compound.
- Bricks are manufactured with the help of hydraulic press and are dried in the autoclave.
- These bricks are suitable for use in masonry like burnt clay bricks and have various advantages over the clay bricks.

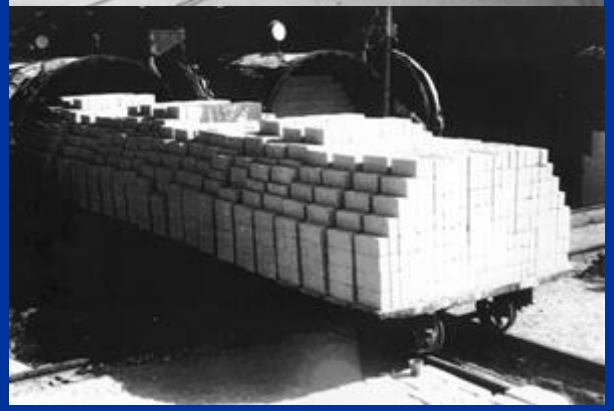
FLY- ASH + SAND + CEMENT / LIME BRICK

RAW MATERIALS : FLYASH , SAND, CEMENT, OR LIME

A substitute of burnt clay bricks, Uniform shape and size

Production, capacity : 10000 – 12000 brick per day

Fly Ash Lime Bricks



Developed by	National Standard
CBRI, Roorkee	IS 12894:2002

Hollow and Solid Light Weight Concrete Block

Developed by	National Standard
CBRI, Roorkee	IS 2185: (Pt 2)1983

Number of machines developed. Very popular walling technology. Being produced by various Building Centers and private entrepreneurs.

Solid Cement Concrete Blocks

Developed by	National Standard
CBRI, Roorkee	IS 2185

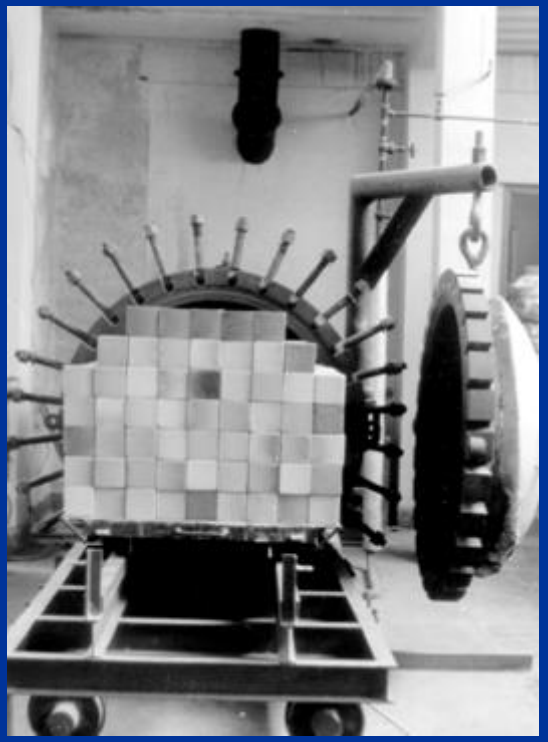
Number of machines developed. Very popular walling technology. Being produced by various Building Centers and private entrepreneurs.

Precast Concrete / Stone Masonry Blocks

Developed by	National standard framed
CBRI, Roorkee	IS 12440: 1985 IS 14213: 1994

Good options where stones are available. Being produced with good exterior textures.

Sand Lime/ Calcium Silicate Bricks



Developed by	National Standard
CBRI, Roorkee	IS 12984:1990

Sand Lime/Calcium Silicate Bricks are being manufactured by large no. of private entrepreneurs

Embodied Energy of Walling Systems

Per Cubic Meter in 1:6 Cement Mortar

Type of Masonry	Unit	Embodied Energy
Burnt Clay Brick (229 x 114 x 76mm)	Cum.	2696.10 MJ
Clay Fly Ash Brick (229 x 114 x 76mm)	Cum.	1696.10 MJ
Stone Concrete Block (300x200x150 mm)	Cum.	1352.45 MJ
Sand Lime Brick (229 x 114 x 76mm)	Cum.	1841.10 MJ
Cement Concrete Aerated Block (400 x 200 x 200 mm)	Cum.	833.85 MJ

PRECAST RC PLANK AND JOIST SYSTEM

- The size of precast RC plank is 30cm wide, 6cm thick, 130 cm long; precast RC joists 15 cm x 15cm and up to 4.2m long.
- The components are produced on casting platform at construction site.
- As soon as the walls reach the floor/roof level, the components are created, and partly filled with concrete to form the floor\ roof.
- This results 20% saving in overall cost, 25% in cement and 10% in steel as compared to conventional R.C. slab floor/roof.

Precast RC Planks and Joints

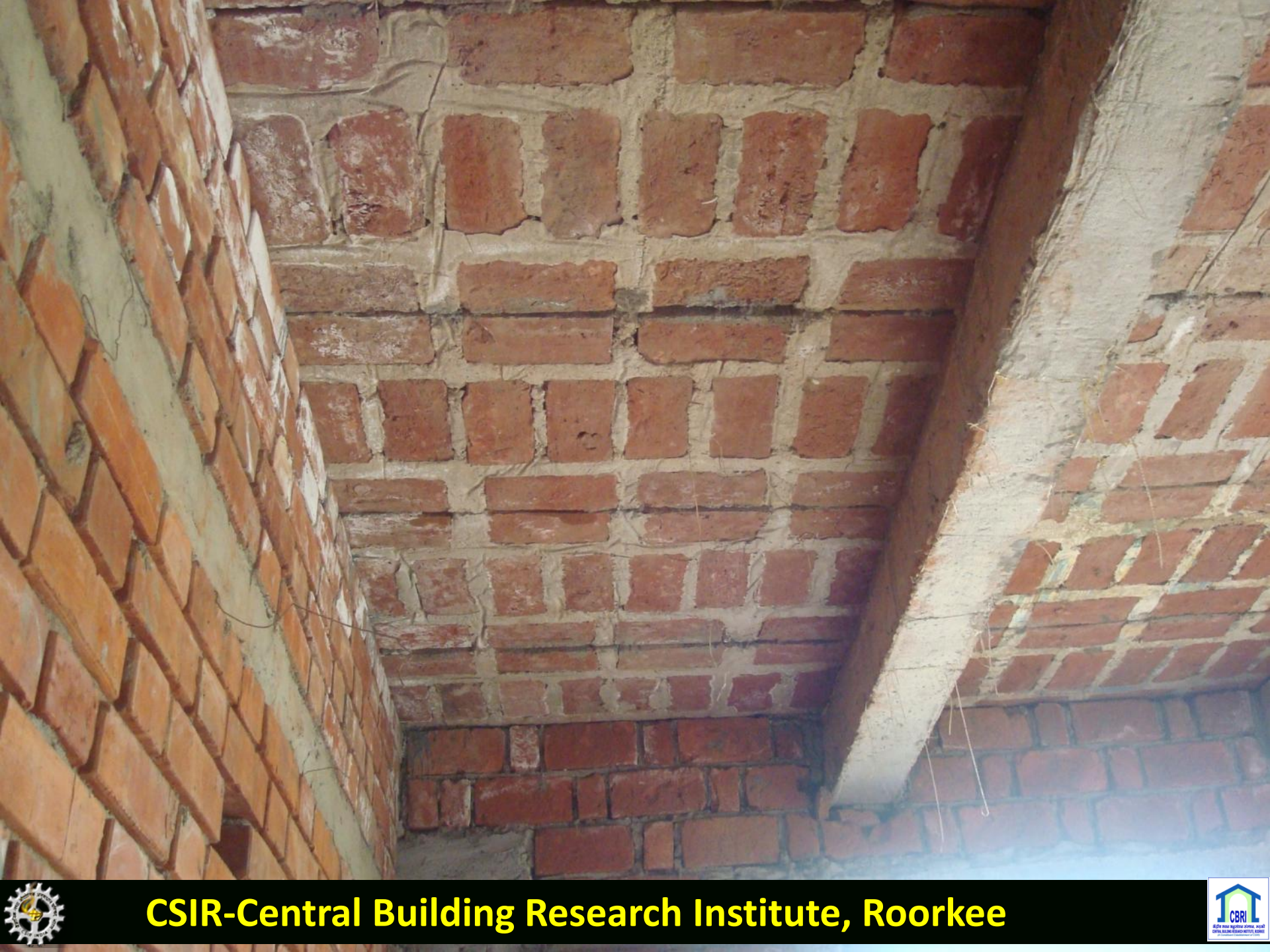
Developed by	National standard framed
CBRI, Roorkee	IS 13990:1994 (SP) IS 13994:1994

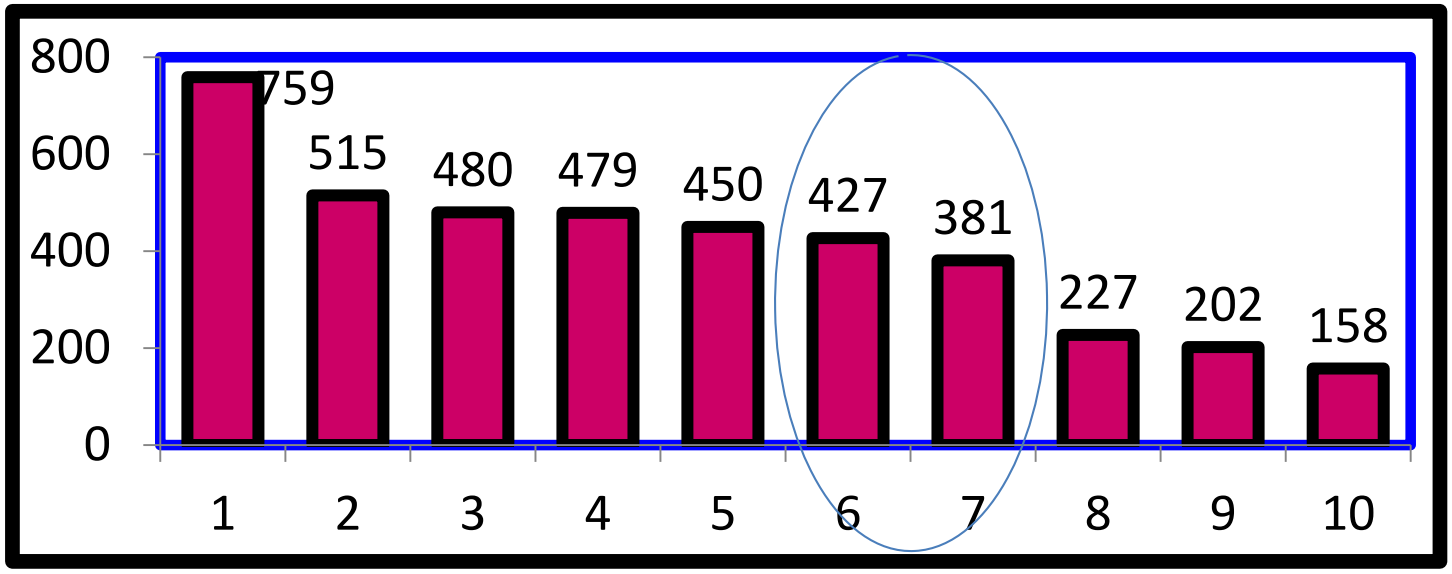
Extensively used for cost-effective housing. Machine available. Being produced by various Building Centers.

Prefabricated Brick Panel for Floor/Roofs

Developed by	National Standard
CBRI, Roorkee	IS 14142: 1994 IS 14143: 1994

Building Centres are capable of casting. It could be cast at site. Found to be good option where bricks are cheaper.





Embodied Energy (MJ per sqm.) of different Roofing Systems

1	RCC slab	6	Brick panel roof
2	Jack- Arch roofing system	7	R C. Plank and joist roof
3	R.B. slab roofing system	8	Mangalore tile roof
4	Corbelled Brick Arch roofing	9	Ferro Cement Channel
5	R.B.C. slab roof	10	Micro concrete Tile Roof

Embodied Energy of RC Planks & Joists and Brick Panel System is low and are Energy Efficient.

Materials and Technologies for Future

Construction and Demolition Waste

Renovation

Construction

14.5 Million Tonnes

C & D Waste

Refurbishment

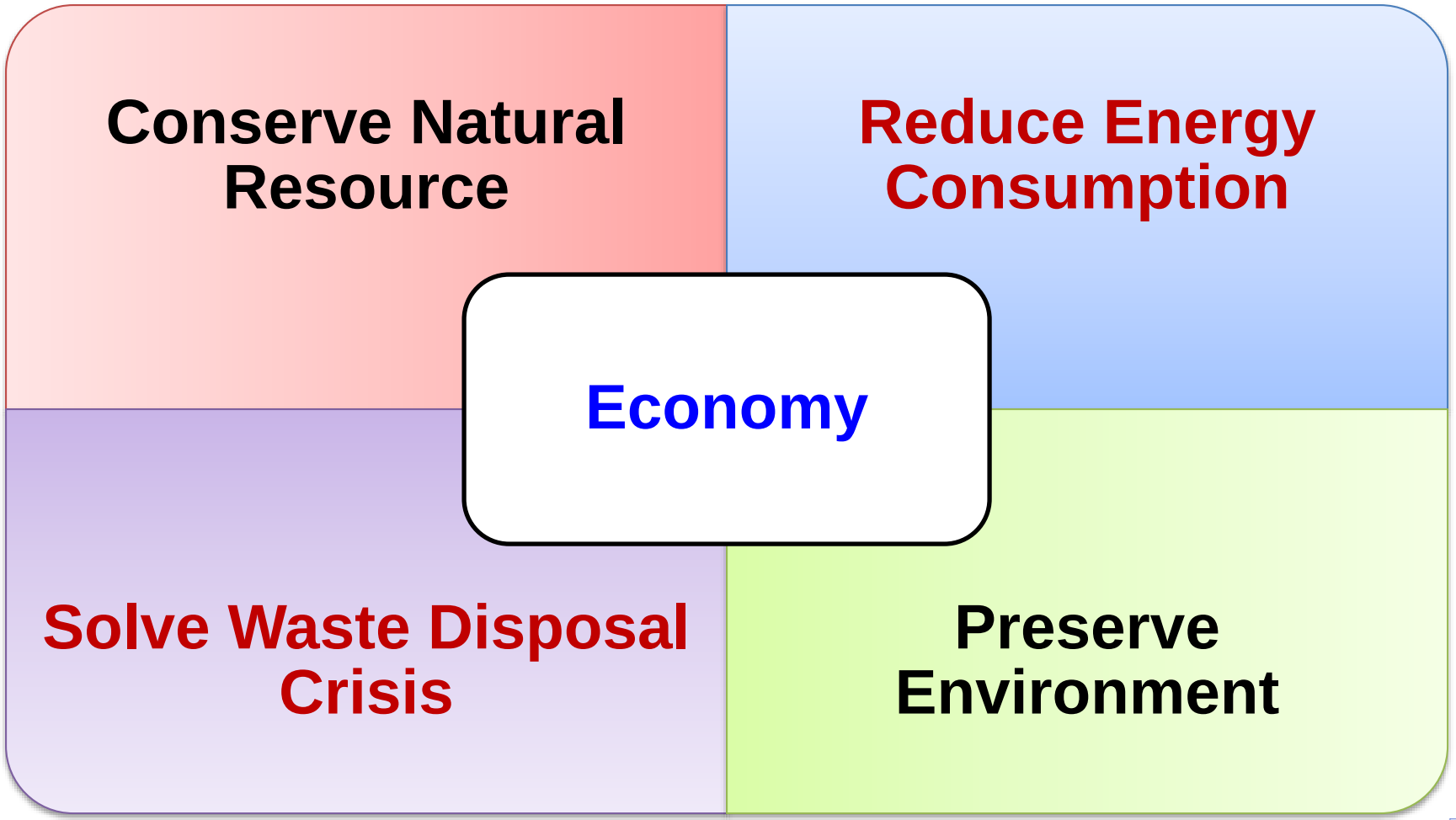
Demolition

Excavation

Site Clearance

Source
CPCB

Benefits of reuse of C&D waste



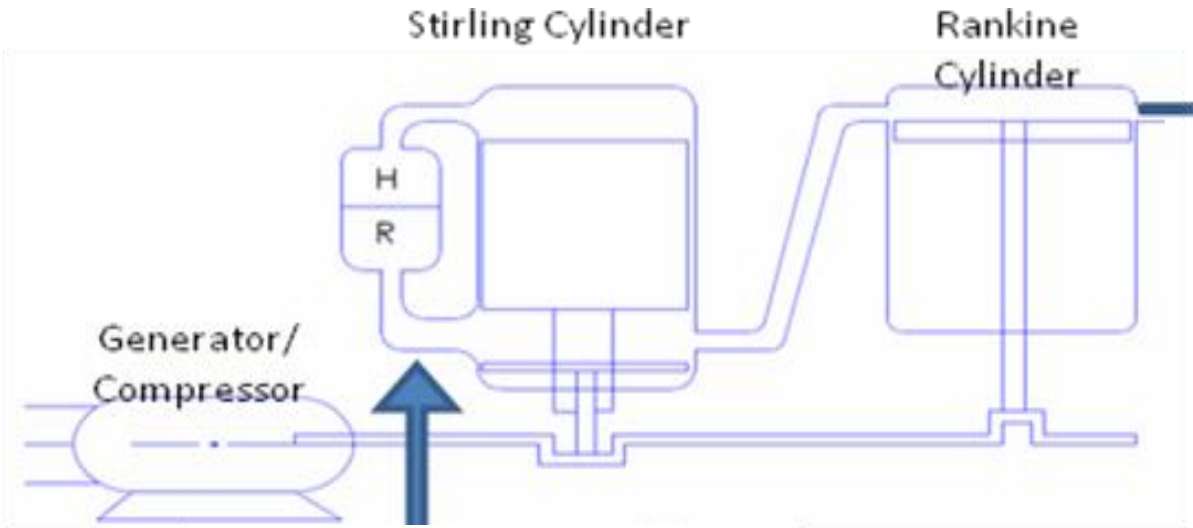
Green Retrofitting

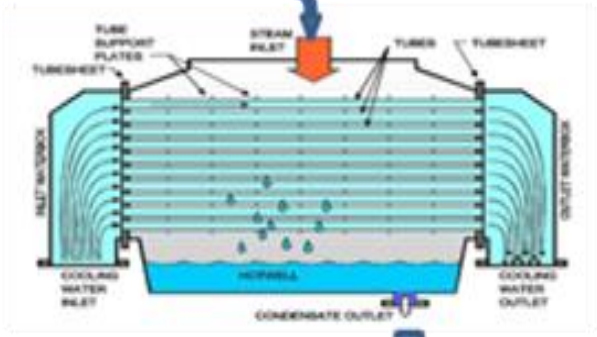
Green Retrofits - are any kind of upgrade(s) at an existing building that is wholly or partly occupied:

- **To improve energy & environmental performance,**
- **To improve the comfort,**
- **To reduce water use, and**
- **To improve quality of space in terms of natural light, air quality, and noise etc.**

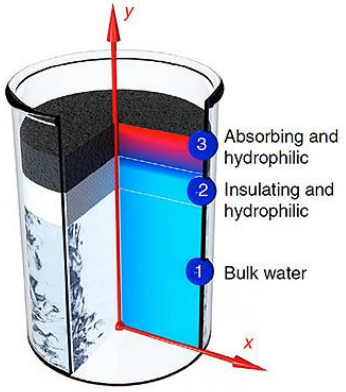
Financially viable with payback guarantee

Novel Solar AC





Novel Solar Collector



Novel Thermodynamic Cycle for AC/Power Generation

Materials & Technologies: Future

- Multi-functional Coatings
- Nano – Technology based materials / components
- Recycled Aggregates
- Cement – free Concrete
- Bio – Concrete
- PCM based materials
- Solar Air Conditioners
- Building Components from waste.
- Pervious Concrete
- Wood Alternatives

Materials & Technologies: Future

- **Building Integrated Photo Voltaic (BIPV)**
- **Net-zero Buildings**
- **Bio – mimetic**

Future Green Technology:

- Technology that brings cleaner conventional energy such as clean coal technology

- Focus on alternative energy and renewable energy.

- Technology that helps to generate, transmit and distribute electric power more efficiently.

Contd....

- **Technology that facilitates planning, building and operation of sustainable, efficient and healthy buildings which give occupants comfort, convenience and service.**

- **This includes having improved efficiency in energy and water use, low impact materials that are sourced locally, recycled, and green featured.**

Issues before Construction sector

Conservation of Natural Resources: Use of alternative building materials

Energy Conservation: Energy Efficient process, technology & Material

Reduction in Green House Gas Emission: Use of innovative approaches

THANK YOU....