Eco friendly construction practices and materials

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Structure of presentation

- Significance and impact of SBM (sustainable building materials)
- Concepts and Attribute Matrix
- Base analysis criteria ; -life cycle - l*ive-phases of SBM*

  -Embodied energy analysis

  -Life cycle cost analysis
- Evaluation matrix - sustainable guidelines wrt practices and efficient techniques
- Policy intervention/ DC rules

Significance

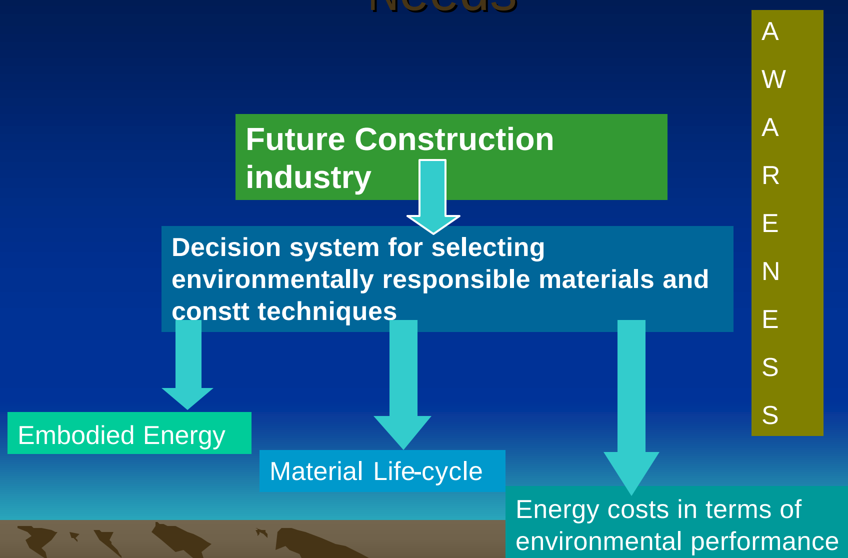
- Phenomenal growth of construction industry that depends upon depletable resources.
- Huge quantities of waste and byproducts generated every year.
- E.G. Fly ash –70-75 million tons/yr,

  Blast furnace slag – 10 million tons/yr
- Perennial pressures on land and environment.
- Degree of environmental impact

Needs

- Need for the intensive efforts on –
- Standardization of energy efficient production processes,
- Reuse of production wastes
- Basis to analyze a material in terms of its “sustainable quotient”
- Scale its ‘Environmental friendliness’

Needs



Concepts

- Sustainably managed materials are - environmentally preferable/sustainable quotient
- have a mitigated degree of adverse impact on environment and human ecosystem when compared with equivalent products for the same application

Sample characteristics

Life Cycle

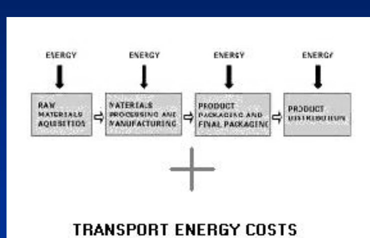
Sustainable Building Materials

Energy input Vs Waste output

Characteristic
Regional availability
Rcyclability
Reusability / Salvaged
Durability and Life Span
Life cycle cost impact
Energy Efficiency

Resource Efficiency
Certified Wood
Non toxic
Material Cost
Savings
Material Reduction

Embodied energy "content"



- Scalar total of energy input required to produce a product and transporting them to the building site.

- **Quotient of environmental "friendliness"**
- **More processed, more environmentally expensive a material becomes**

Energy consumption

- Annual household primary energy consumption varies widely over a range of 4-16GJ per capita
- Large proportion of low energy rural construction (which is zero energy based) to the high energy urban construction (high-energy intensity based construction)
- Perennial shift of patterns in energy consumption from the traditional low-energy to high-energy urban and the sustainable building construction goals for the future.

Energy intensity

- **Energy intensity in manufacture of building materials**

Average Delivery Radius>100 kms adds to 10-15% to the total Energy costs of the delivered materials

Category of Materials	*Energy Intensity (Range)*
High Energy	> 5 GJ/Ton
Medium Energy	0.5 – 5 GJ/Ton
Low Energy	< 0.5 GJ/Ton

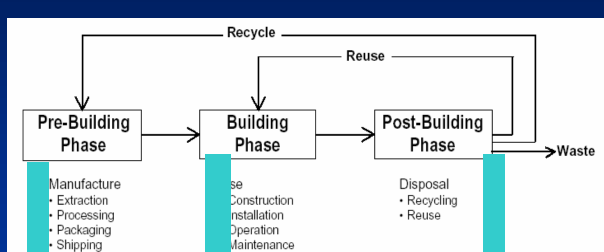
Mode Of Transport	*Energy Intensity*
	INDIA
Road - Truck	2.85MJ/Ton/km
Railways	0.9MJ/Ton/km
Water – Sea Inland	0.09MJ/Ton/km 0.9MJ/Ton/km

Energy intensity

Very High Energy	
Aluminum	200-250
Stainless Steel	50-100
High Energy	30-60
Steel	12-25
Glass	5-8
Cement	8-10
Plasterboard	
Medium Energy	3-5
Lime	2-7
Clay Bricks and Tiles	1-4
Gypsum Plaster	
Concrete :	0.8-1.5
In Situ	0.8-3.5
Blocks	0.1-5
Precast	
Low Energy	<0.5
Sand, aggregate	<0.5
Fly-ash	<0.5
Blast Furnace slag	

- Energy costs estimated on the basis of energy intensity
- the gross energy requirement to manufacture unit weight.
- Mixture of electrical and thermal costs
- Primary energy + transportation energy

Building Material Life cycle



Most potential for causing environmental damage

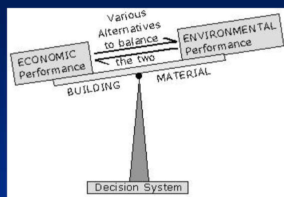
Wise selection

Material waste generated on constt site, can be recycled

Use & maintenance-emission potential

Disposal of resulting waste once usefulness of bldg is over

Life cycle cost analysis



$$LCC = I_c + R_c + E_c + W_c + OMR_c - S_c$$

where:

I_c = Initial investment cost
R_c = Replacement cost
E_c = Energy cost
W_c = Water cost
OMR_c = Operation, Maintenance & Repair cost
S_c = Salvage cost (for reuse or resale)

- to assess the cost effectiveness of a material i.e. the present value of the total cost of the asset over its operating life
- including initial capital cost, operational cost and
- the salvage cost in case of ultimate disposal of the asset at the end of its useful life over a study period.

Guidelines for material selection

Minimize resource quantity

- Build less,
- materials which ensures reduction of scrap materials , find alternatives to reduce the thickness of walls, storey heights in tendon with the intended function and performance.

Maximize use of renewable materials

- wood, plant fibres, geotextiles and other resources

Guidelines for material selection

Selection of low energy materials & standard constt systems,

- reducing the embodied energy costs involved in the whole life of the building
- use of lime-pozzolana/ gypsum mortars/plasters in place of cement mortars, soil or stabilized soil blocks or sand-lime blocks over burnt clay bricks, light weight concrete blocks over dense concrete blocks

Select materials based on their life cycle costs

- At the initial capital investment review the life cycle cost requirements or the "avoided future costs" for the material for O&M requirements.

Guidelines for material selection

Maximize the use of regional/locally manufactured products

- Best fit options as per the climate suitability and specific construction requirements for that particular region
- allow significant reduction in transportation (with delivery radius <100 kms) contribute to low embodied energy consumption and life cycle costs

Materials with reusable & recyclable potential

- Use materials, which are manufactured from waste or recycled materials, products which can be reused.

Whole Energy Analysis of a Building

Type Of Housing	Total Energy Req. - MJ	MJ/Unit
House 1: Made primarily with manufactured materials– cement, sand, bricks, iron, stone, windows/doors	126 690	1583
House 2: Made with local materials – adobe walls, cgi sheet on timber roof	47 224	590

▪Structure sub-system – highest energy consuming for all Building types

▪While other components depend on Building type

▪Single family residential/industrial –site work is the second largest energy sub-system

Cement/Concrete

- Most energy intensive industry causing resource depletion, significant green-house gas emissions etc.
- Using about 4.2 X 10^9 GJ of total world primary energy consumption ,equal to the cost of 25% of finished cement construction.
- Need for a policy intervention or inclusion in the DC rule to reduce annual household primary energy consumption in structural system/building fabric.

Eco-housing Pune
Low environmental impact materials

DC rule :Use of industrial by-products in structural concrete –

- Minimum 25% replacement of cement by weight of fly ash or ground-granulated blast furnace slag in absolute volume of structural concrete used in the overall structure, meeting the equivalent strength requirements.
- *The fly ash used shall confirm in quality and specifications to IS 3812: 1981, percentage replacement of cement with fly ash in concrete shall not exceed the acceptable limits and exposure conditions confirming to IS 456: 2000.*

Low environmental impact materials

- **Environmental impact**

1. Utilizing almost zero energy industrial waste to replace energy intensive material.
2. Reduction in the use of high-energy materials such as cement, concrete, steel etc by absolute volume when compared with equivalent products for the same application.
3. Effective savings in the primary grade raw materials, cumulative embodied energy, labour and capital investments.

Low environmental impact materials

Best practices

- Use ready mix concrete or high volume flyash concrete for construction (commercially available by L&T, ACC) or use PPC concrete for construction (commercially available by ACC suraksha, Lafarge cement, L&T cement, Jaypee Buniyad, Prism Champion etc, PPC must meet the requirements of IS 1489: 1991)
- Light weight aggregates/autoclaved concrete, demolish concrete as secondary material

Low environmental impact materials

DC rule: Use of industrial by-products in non-structural/infill wall system-

- Use of industrial waste based bricks/blocks (for e.g. fal-G stabilized mud blocks, fly ash-sand lime bricks, lato blocks, non load bearing precast solid/hollow flyash based concrete blocks, flyash based light weight aerated concrete walling blocks etc), which utilize a minimum 15% of industrial waste such as fly ash, blast furnace slag etc by absolute volume, for 100% non-structural infill wall system.

Low environmental impact materials

- **Best practices-**
- Use of flyash based bricks/blocks such as fal-G products, fly ash based light weight aerated concrete blocks,lato blocks, clay red mud burnt bricks etc.
- Precast aerated/cellular/autoclaved concrete blocks
- Precast walling technologies such as composite ferrocement system, extruded structural clay joist and filler blocks, zipbloc system, alker system, precast reinforced fal-G brick/tile panels etc.

Resource efficient interiors

- **Embodied Energy Analysis :Wood - 0.34GJ/m3+ transport energy costs**
- **Need to minimize the use of wood as a natural resource.**
- **Can be formed as an eco-responsive measure**

Resource efficient interiors

- Minimum 50% of the total quantity of all interior finishes and products used in each of the category should be low energy finishes/materials/products which minimize wood as natural resource or utilize industrial waste by using composite wood products, rapidly renewable materials/products or resource efficient finishes
  - i. Sub-assembly/internal partitions
  - ii. Interior wood finishes/panelling/false ceiling
  - iii. Flooring
  - iv. Doors/windows, frames
  - v. In-built furniture/cabinetry

Resource efficient interiors

- **Environmental impact-**
- Although the total energy content of wood is very low as compared to other energy intensive building materials such as steel and concrete, it overuse exhausts domestic wood sources and intensifies deforestation on account of lack of practices such as sustainable tree farming or replantation.
- **Best practices-**
- Use composite wood products such as hardboards, blockboards, lumber-core plywood, veneered panels, particleboards, medium/low density fibreboards, made from recycled wood scrap from sawmill dusts or furniture industry bonded with glue or resin under heat and pressure.

▪Fibrous gypsum wall boards

▪100% post industrial recycled content product

▪Demountable Systems

▪Used for partitioning and non-structural interior use, which allows changes to internal plans without significant demolition and resource wastage.

▪Terrazzo/finished concrete flooring

▪60% recycled content, sizing flexibility, adhesives used should be non toxic, non voc emitting

Low VOC finishes

- **Zero/Low VOC paints** –
- Use only low VOC paints, 100% of all paints used in the interior of the building must be certified as containing zero or less than 150 grams/litre of VOCs per gallon.
- **Environmental impact –**
- Wide varieties of volatiles are released through oxidation by both solvent- based and water-based paints which can be injurious to lung health and can be odorous.
- **Best practices**
- Water based acrylics (Asian paints) should be preferred over solvent based oil paints Latex paints are available with recycled content but not in much use in India.

Discussions…..