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Sustainable Development of Thermally and Acoustically Efficient Structural Walls Incorporating Solid Waste Materials

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Nearly everything we do leaves behind some kind of waste:

- Households create ordinary garbage.
- Industrial and manufacturing processes create solid and hazardous waste.

The Office of Solid Waste (OSW) regulates all this waste under the Resource Conservation and Recovery Act (RCRA).

Industry

Batteries

Cement Kiln Dust

Construction & Debris

Crude Oil & Natural Gas

Fossil Fuels Combustion

Industrial Waste

Medical Wastes

Mining

Mineral Processing

Used Oil

Recycling

Buy Recycled

Electronics Recycling

Hazardous Waste Recycling

Household Hazardous Waste

Jobs Through Recycling

Materials & Waste Exchanges

Recycling Measurement

Reduce/Reuse/Recycle

Current Building Practice in USA

Currently, the building practice for wall assemblies used for construction recommends:

light weight construction

wood or steel studs

butt or blown-in insulation

exterior structural skin

internal vapor barrier

both internal and external finishing

The Need for Sustainable Walls

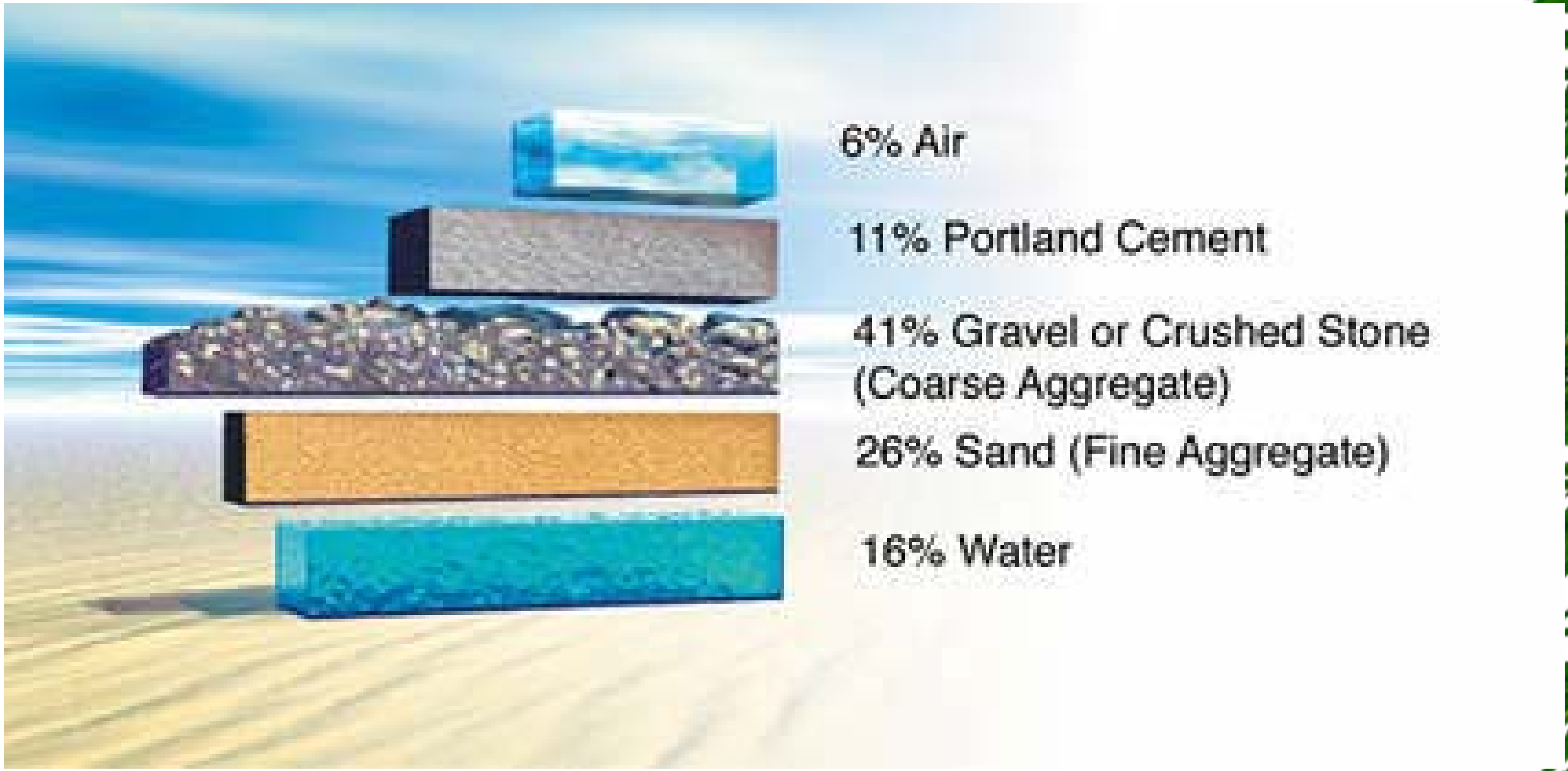
With the substantial increase in the cost of energy as well as the prices of traditional building materials, including concrete and wood, alternative sustainable building practices are needed to find more thermally efficient, sound proof, moisture and insect resistant and affordable walls for construction.

Definition of the Problem

The United States is facing two major problems:

- Substantial increases in fuel prices
- Current practices in waste disposal, particularly land-filling and incineration, that contribute to a number of environmental problems

Cement & Concrete Basics



Research Objective

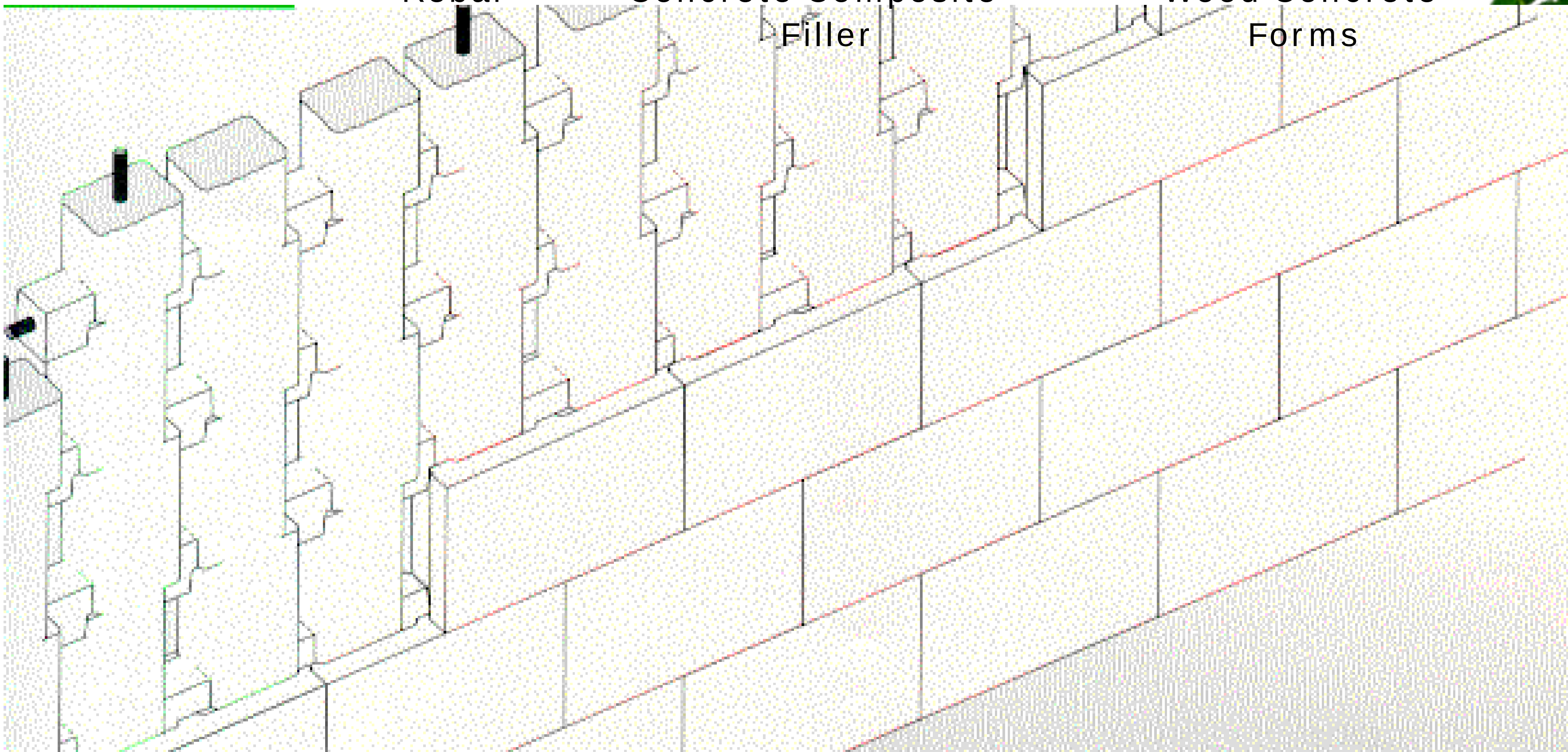
The main objective of this study was to determine the technical and economic feasibility of using different forms of non-hazardous solid waste materials such as **wood**, **glass**, **plastic**, **spent foundry sand**, **fly ash**, and **fiberglass**, generated from different sources, to construct thermally and acoustically efficient composite walls

Pine Wood Pallets

Solid Waste Materials Used in this Study

- Mineralized Wood Chips (from pine wood pallets)
- Granulated Plastic from Milk Jugs
- #1A Air-Entrained Portland Cement
- Granulated Waste Fiberglass & Glass
- Pozzolanic Fly Ash, ASTM Class C
- Spent Foundry Sand, #60 Grain Fineness

Sustainable High-Performance Cost-effective Structural Wall Incorporating Solid Waste By-product



Wall Composition

Wood-Concrete Forms (Blocks) made out of:

- Mineralized Wood Chips.
- #1A Air-Entrained Portland Cement.
- Others: Granulated Waste Fiberglass.
- Pozzolanic Fly Ash, ASTM Class C.
- Spent Foundry Sand, #60 Grain Fineness.

Wood-Concrete Forms (Blocks) Materials

Original Faswall® composition:

85% wood + 15% cement

Modified Compositions:

Fiberglass replacing wood in 5% increments to a maximum substitution of 20%.

Fly ash & spent foundry sand independently replacing cement in 1% increments to a maximum substitution of 5% in combination with fiberglass substitutions.

Concrete Filler Materials

The possibility of using granulated plastic, glass, and fiberglass waste materials to partially substitute for the fine aggregate (sand) in concrete was evaluated

Portland cement was mixed with the aggregates to produce cementitious concrete composites. Four volume fractions of each of the waste aggregates were used (5,10,15, and 20%) to produce concrete mixtures

Wood-Concrete Forms (Blocks) & Concrete Filler Materials Testing

C 39-94, standard test method for **compressive strength** of cylindrical concrete specimens

C 293-94, standard test method for **flexural strength** of concrete using simple beam with center-point loading

C 496-90, standard test method for **splitting tensile strength** of cylindrical concrete specimens

C 192-90a, standard practice for making & curing concrete test specimens in the laboratory

Results of Wood-Concrete Forms (Blocks)

Generally - increasing fiberglass substitution increases the mechanical properties of the composite

Generally - increasing fly ash & spent foundry sand in combination with fiberglass further enhances the mechanical properties up to about 3% substitution; above this point strength tends to fall off

Results of Cementitious-Concrete Filler Materials

Increasing the volume percentage of plastics aggregate-substitute led to a slight reduction of the compressive, splitting tensile, and flexural strengths. The stiffness values remained unchanged

Increasing the glass volume percentage aggregate-substitute did not change significantly the compressive and splitting tensile strengths. The values of the modulus of rupture and elasticity remained unchanged except the 20% glass substitute was higher than the control specimen

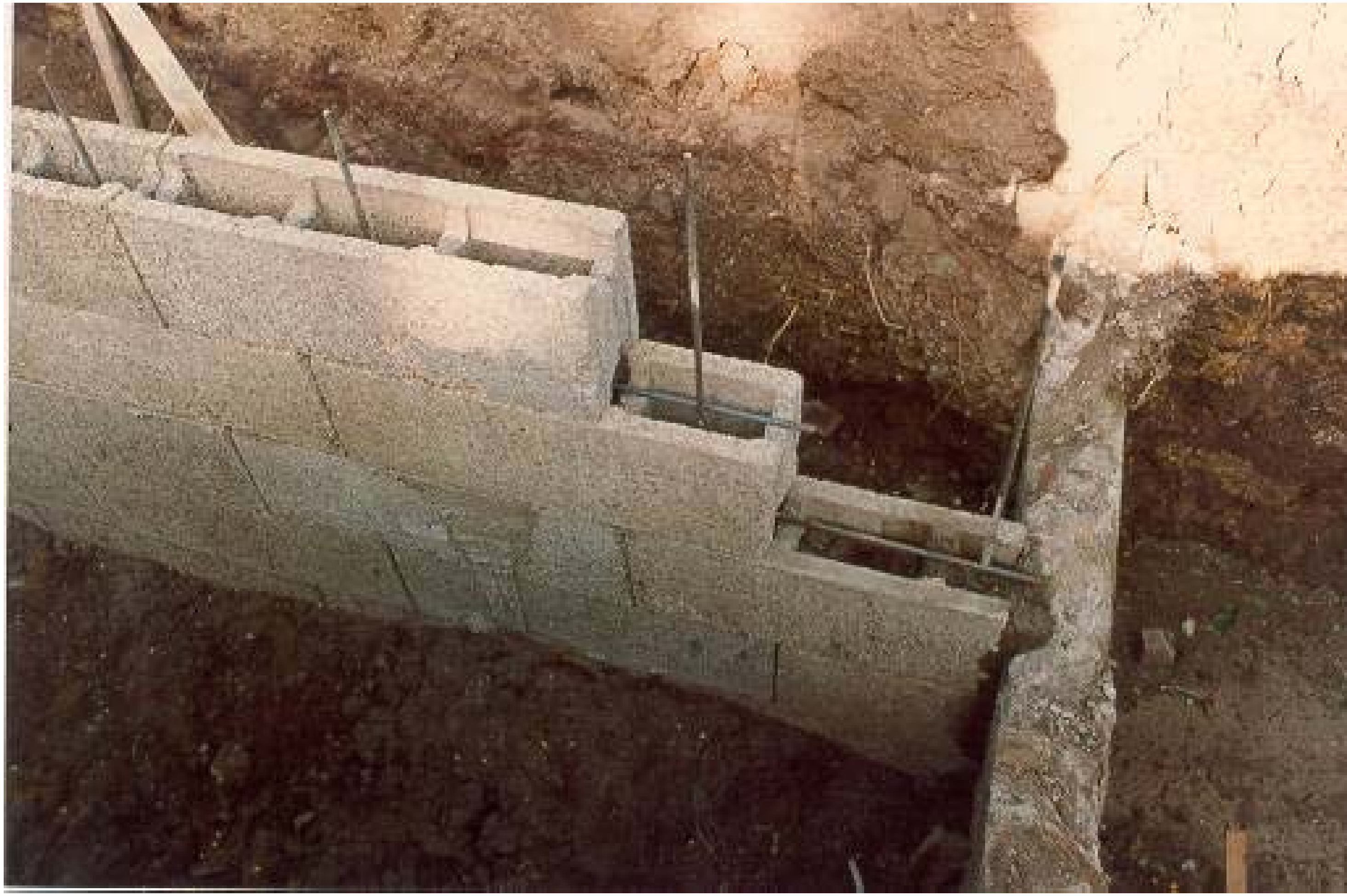
Results of Cementitious-Concrete Filler Materials

Increasing the volume percentage of fiber glass-substitute reduced:

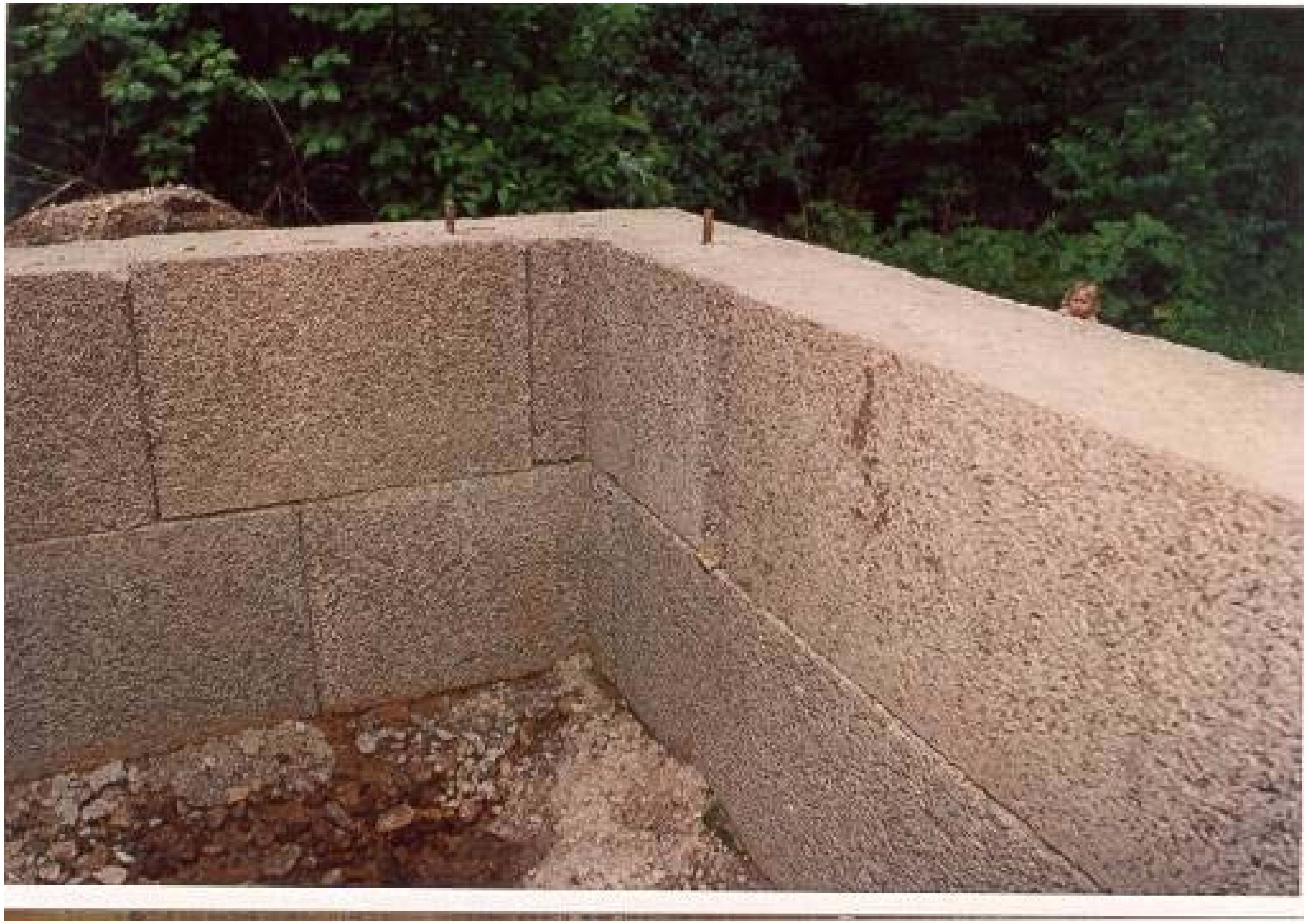
- Compressive strength
- Splitting tensile strength, and
- Flexural strength

The stiffness values increased

Constructing a Wall – Laying the forms and rebars on the footer



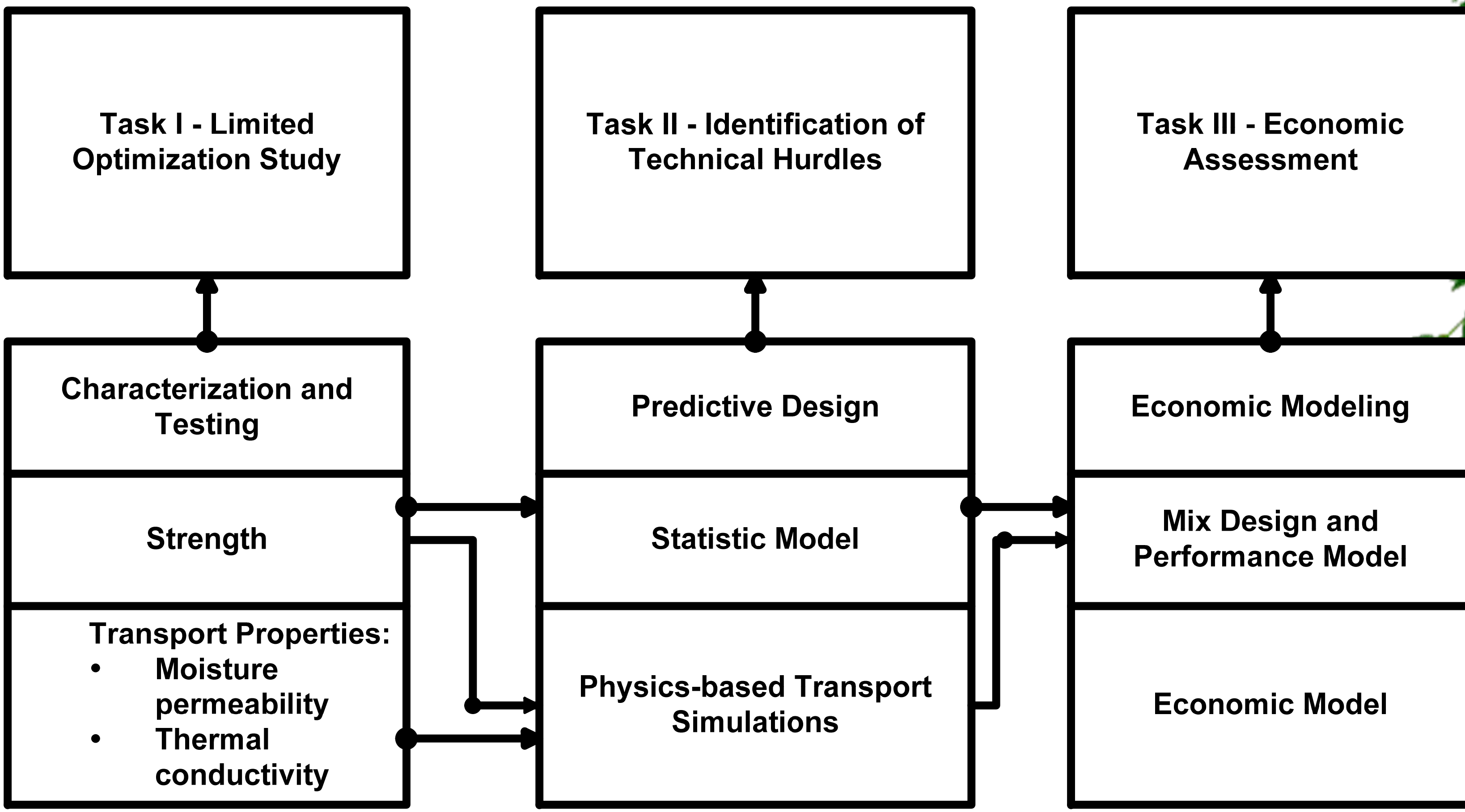
Filling the forms with concrete filling materials



Drilling holes for pipes and passages for utilities

Two Story Apartment Building

Research and development strategy for sustainable development of structural walls Incorporating solid waste materials



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