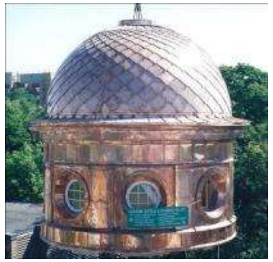
Historical Innovations

Sustainable Home Construction
Business Concept Brief
June 2020

Presented by Rob Andrushko
President and Founder


Rob Andrushko: President and Founder



Construction Industry Experience:

- 22yrs in historical restoration & new construction, religious buildings and high end homes
- Tradesman: Slate Roofing, Copper Smith, Masonry Restoration
- Site Supervisor: Experience in large projects in excess of $11Mil
- Estimating
- Project Management and Training Director


Education:

- Bachelor of Business Admin and Bachelor of Arts Major in Philosophy, Memorial University
- Specialization in Environmental Ethics
- Command and Staff College: Army Operations Course
- Tactics School: Tactical Operations Course & Infantry Dismounted Company Commander Course


Military Experience:

- 15 years experience, Infantry Officer, 8+ years as a Company Commander
- Command up to 450 X staff and soldiers at the division training center Meaford, ON
- 2018-2019 posted as Officer Commanding Leadership School in Petawawa
- Specialist Instructor in the Road 2 Mental Resiliency and other specialized programs

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Problem

Climate change is the challenge of our generation. Growing evidence is driving international consensus for action to limit global warming. Buildings consume up to 40% of global energy use and contribute up to 30% of global greenhouse gas emissions – they are a key piece of the puzzle towards a low-carbon future.

Challenge

- Affordable, durable and ecologically sustainable buildings
- Extreme efficiency with superior longevity
- Reduction and capture of CO2
- Elimination of fossil fuel dependence – NetZero – Off Grid
- Use of renewable resources and reduction of harmful materials
- Reduce the cost to build sustainable homes and communities
- Sustainable development with reduced environmental impact
- Reduction of specialized trade
- Develop buildings to last centuries not decades

Assumptions

- Few industry competitors have longevity and efficiency of the building envelope as a business criteria.
- Demand for sustainable and extraordinarily efficient homes is high in an underserved market.
- Consumers are demanding durability and efficiency.
- Energy costs will rise in the future.
- Passive House standards, NetZero or similar stringent efficiency standards will become common place.

Historical Innovations Mission Statement

We construct extraordinarily efficient sustainable buildings.

Historical Innovations Value Proposition

Historical Innovations will provide homeowners elegant buildings that lower their carbon footprint, easily meet NetZero, reduce operating costs and last centuries not decades.

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Performance Oriented Building Envelope: THE SEARCH FOR THE IDEAL WALL SYSTEM

- **Sustainable:** ecologically responsible, aligned with the planet, contributes to superior indoor air quality
- **Economical:** able to reduce housing costs, easy to source materials
- **Simple:** leverage low skilled labour in its construction, able to scale production
- **Enduring:** lasts not just decades, but centuries, non-organic/ non-degradable material
- **Responsible:** A manifest solution to our generations biggest challenge…climate change
- **Practical:** Possible to build now with current technology
- **Durable:** fireproof, sound proof, waterproof
- **Adaptable:** can take any shape
- **Elegant:** homeowners will desire it
- **Validated:** homeowners will trust it

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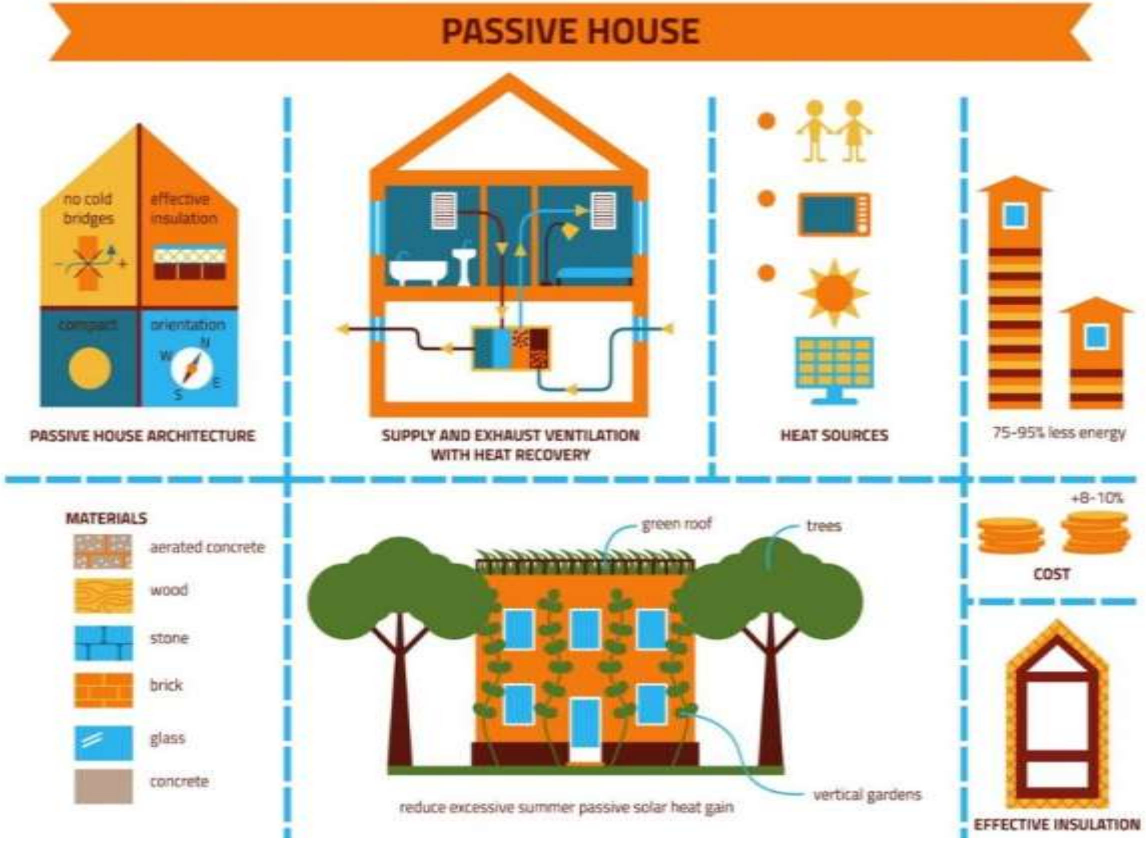
Performance Oriented Building Envelope: PASSIVE HOUSE

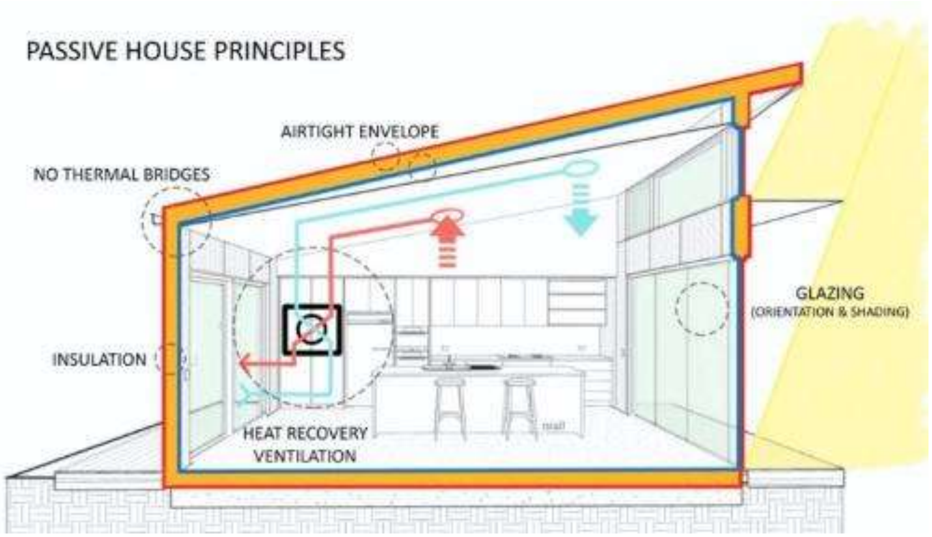
Passive House (German: Passivhaus)

- Voluntary standard for energy efficiency. Developed from research into NRC Saskatchewan Conservation House (1977).
- Reduces building's ecological footprint. Results in ultra-low energy buildings, requires minimal energy for heating/cooling.
- Standard not confined to residential properties; several office buildings, schools, and commercial units have met the standard.
- Passive design is not an attachment or supplement to architectural design, but a design process that integrates with architectural design. Although it is principally applied to new buildings, it has also been used for refurbishments.



https://www.ecohome.net/guides/1418/the-principal-designer-of-the-house-that-inspired-the-global-passivhaus-movement-reflects-on-the-project-that-started-it-all/

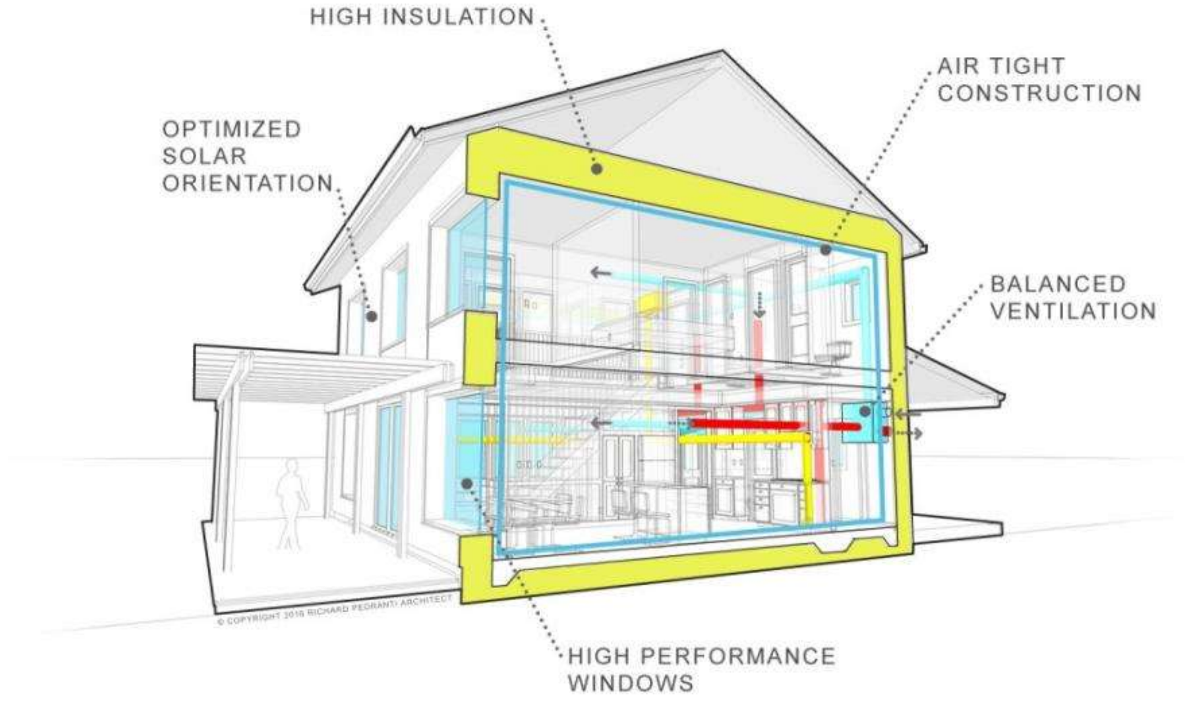
Performance Oriented Building Envelope: Path to NetZero



Passive House buildings consume up to 90 percent less heating and cooling energy than conventional buildings.

Energy Performance

- **Space heat demand max. 15 kWh/m2a OR heating load max. 10 W/m2**
- **Pressurization test result at 50 Pa max. 0.6 ACH (both over-pressure and under-pressure)**
- **Total Primary Energy Demand max. 120 kWh/m2a**



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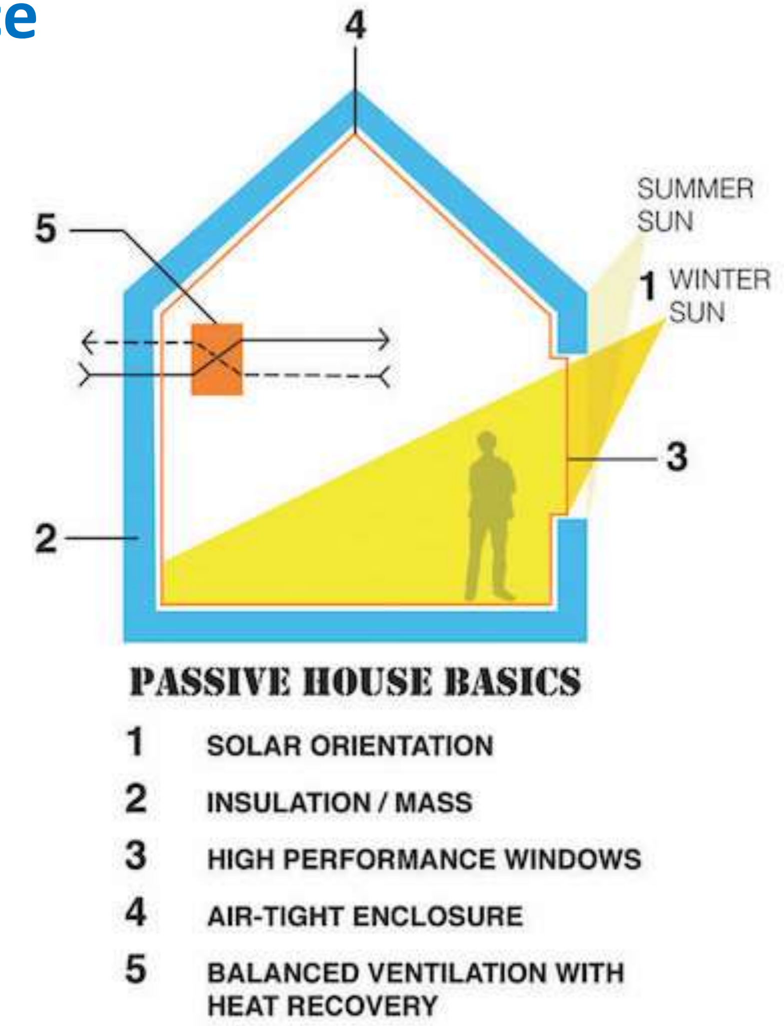
Performance Oriented Building Envelope: Efficient Design Leads to Efficient Performance

Superior Building Envelope

- No thermal bridging
- Superior insulation
- High performance windows
- Airtight construction, less than 0.6 ACH (blower door test) High performance ventilation
- +Thermal mass within the building envelope



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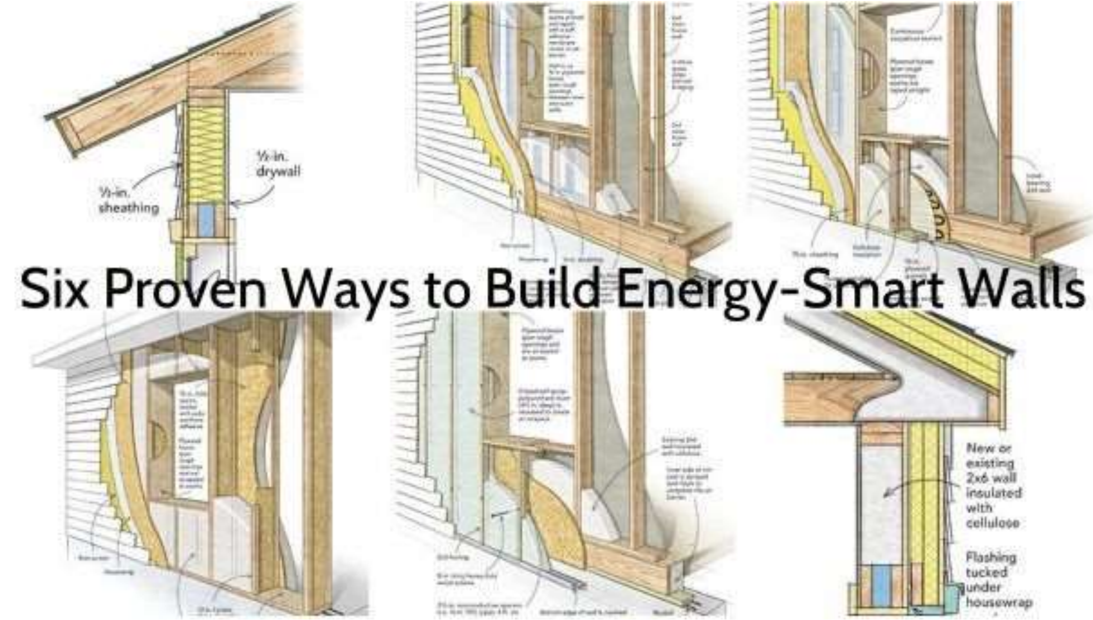
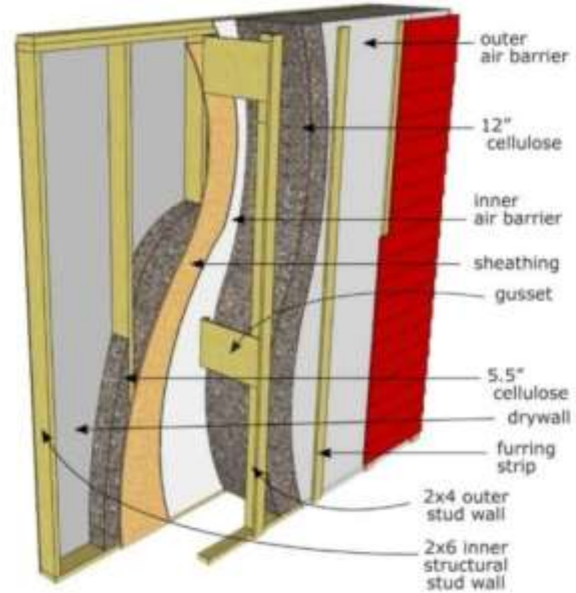
The Building Envelope: Setting the Foundation for Efficiency

How do we get there?
How much time, money and material to do it?





Pros of existing solutions:

- Real and measurable improvement over current min code standards
- Can reach Passive House standards
- Familiar to builders

Cons of existing solutions:

- Expensive 15-25% increase in costs
- Complex, relies on too many layers, each prone to failure
- Specialized manufactured materials and skills to install
- Time consuming and manufactured material oriented
- Materials are not ecologically aligned with the planet and our lives (Chemicals/Offgasing). Long term performance unproven

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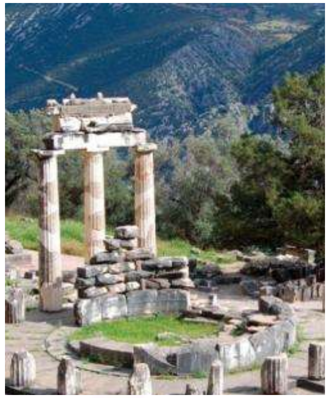
The Building Envelope: Understanding our Past

Stone? Lasts Forever!

But HOW DID THEY DO IT?















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The Building Envelope: Buildings of “Stone” stand the test of time.

Impossible with todays technology?

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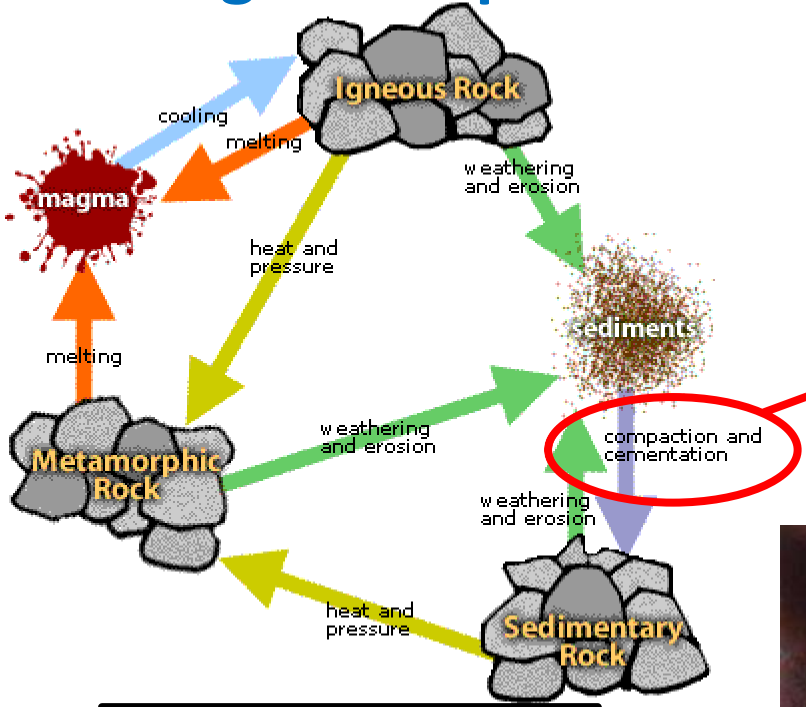
Looking to the past for answers to the future: How does nature create stone?



THE ROCK CYCLE

Geological process to create sedimentary stone

COMPACTION AND CEMENTATION

WHAT IF THERE IS A WAY TO SPEED THIS UP?

What if the civilization that was smart enough to build those pyramids and other monoliths were not dumb enough to try and lift those big heavy stones?

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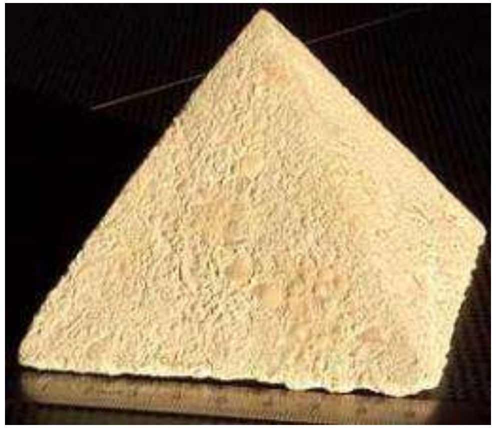
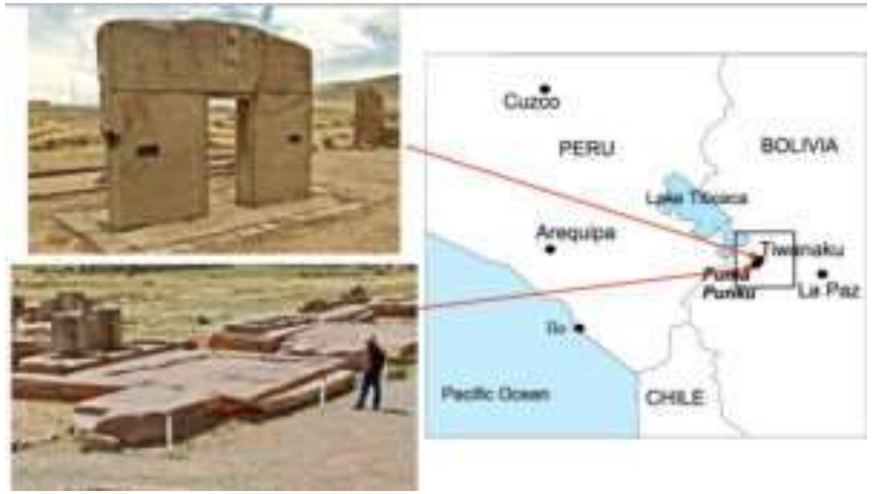
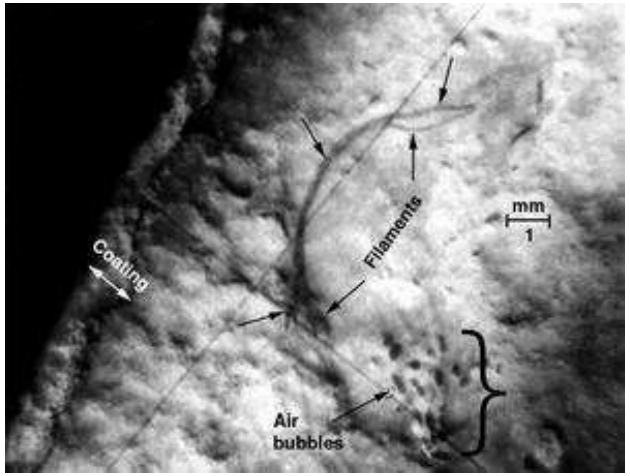
Looking to the past for answers to our future: Scientifically Proven Theory of Pyramid and other Monolithic Stone Construction

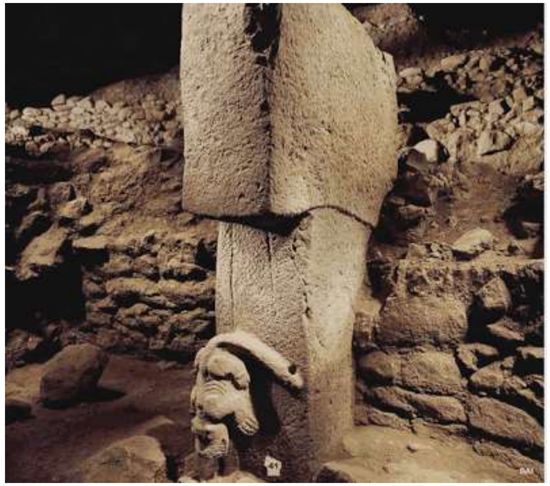
GEOPOLYMER INSTITUTE

https://www.geopolymer.org/archaeology/









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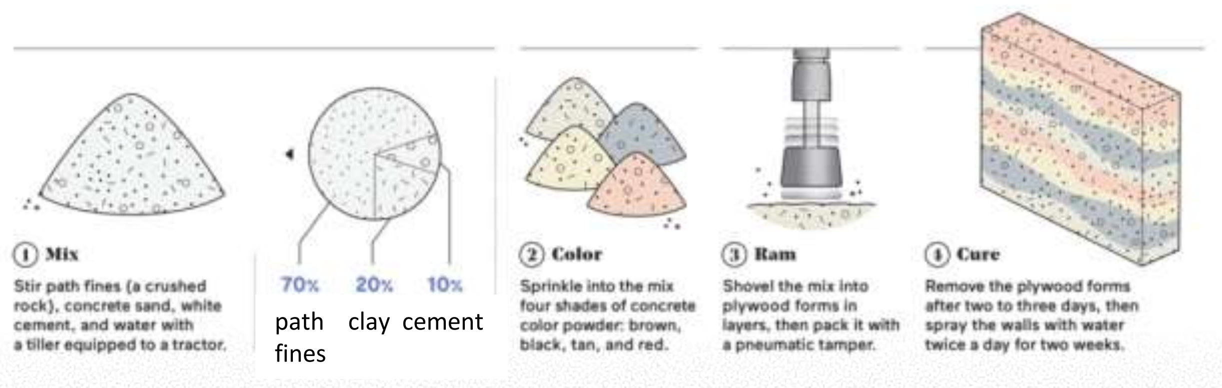
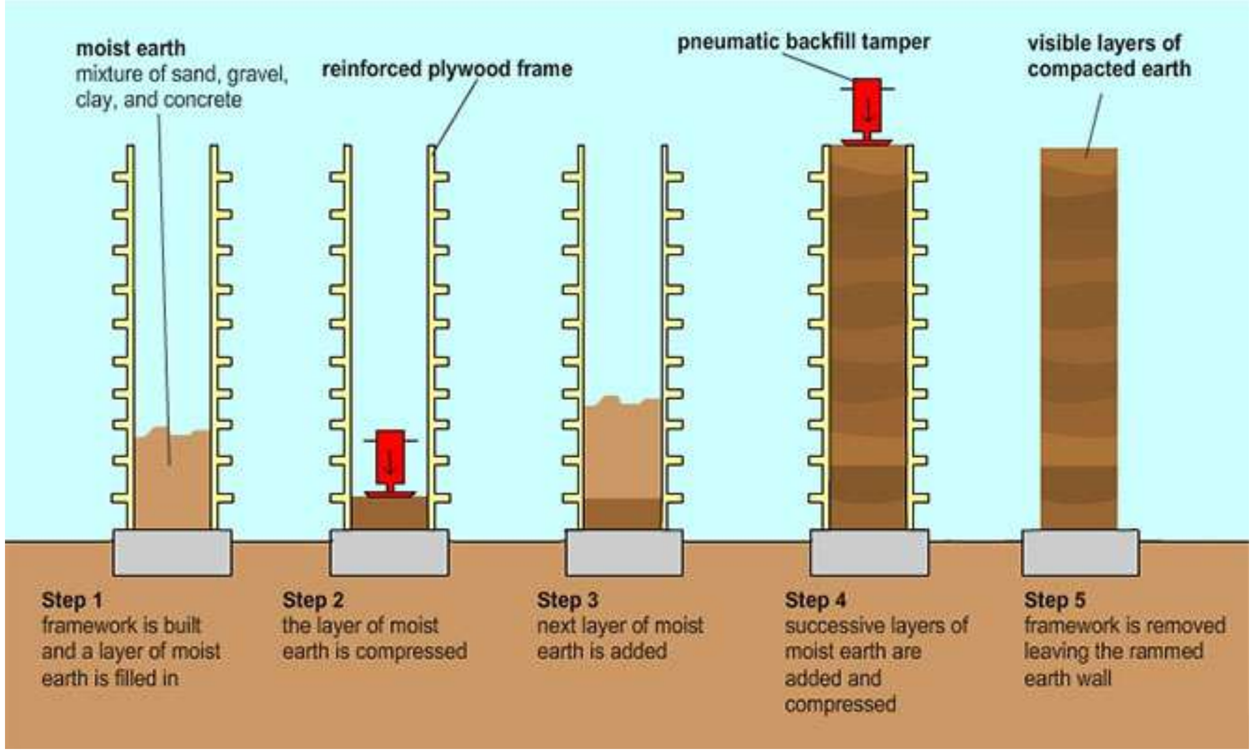
Monolithic Stone Creation: Master Masons Or Master Mold Makers?

Man made formed stone: Rammed Earth

Pise (French) – Arde (Germanic) – Tapia (Spanish) - *hāngtǔ* (夯土) (Chinese)

A Recipe for Rammed Earth: 4 stage process for earthen walls





Making rammed earth involves compacting a damp mixture of sub soil that has suitable proportions of sand, gravel, clay, and stabilizer (cement) into a formwork (an externally supported frame or mold). Historically, additives such as lime, animal blood, volcanic ash and other binders were used to stabilize it.

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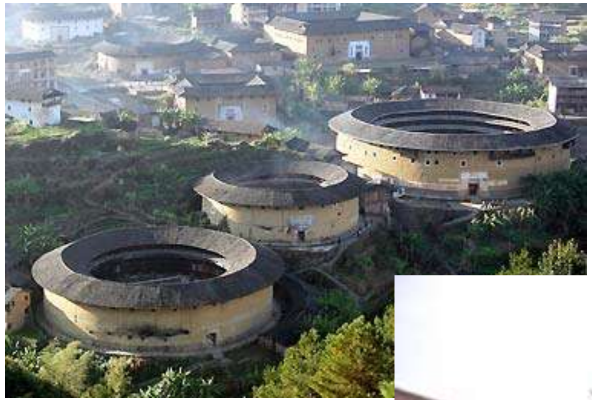
Rammed Earth: Examples throughout the world, many dating 100s - 1000s of yrs old

France



China

Spain

Yemen

France

Yemen

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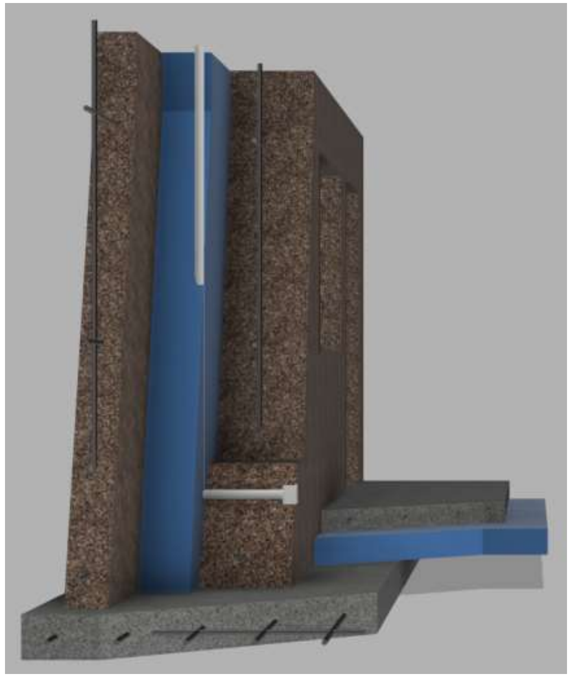
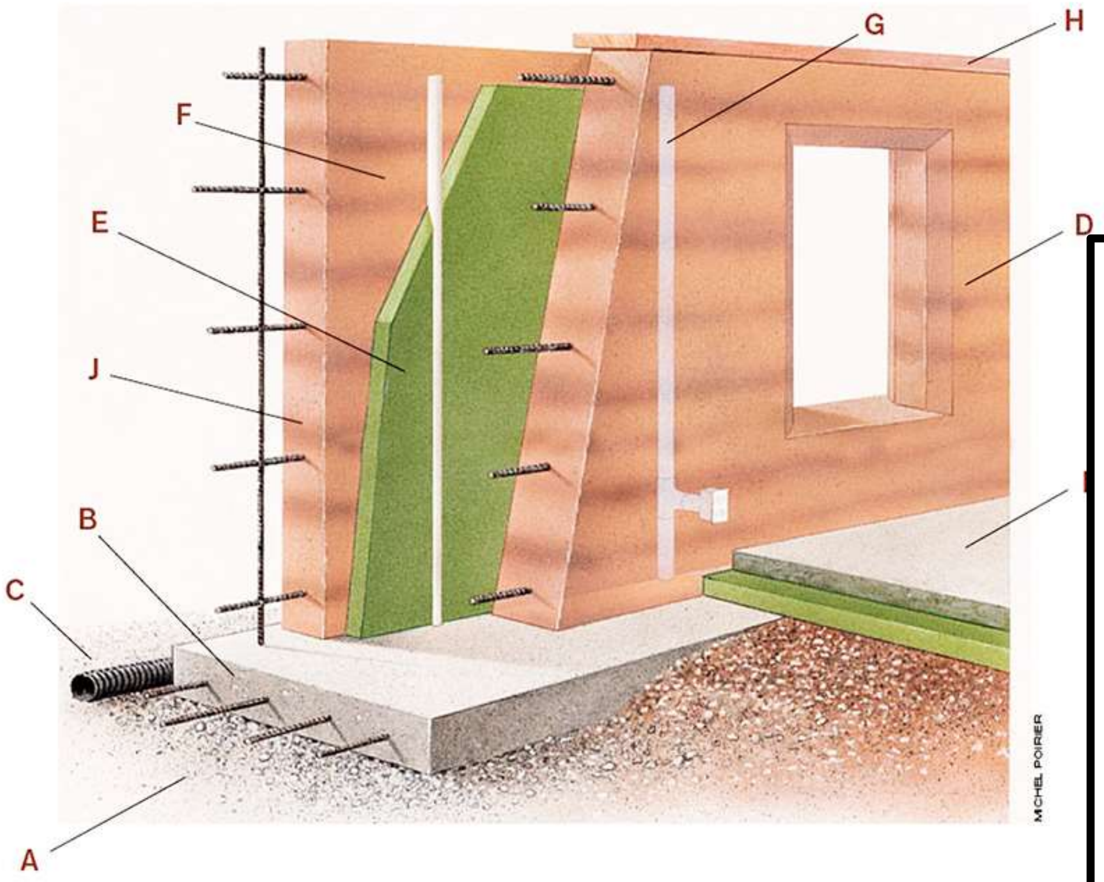
The Ideal Building Envelope: Monolithic Insulating Stone Walls

Stabilized (Cement binder)
Insulated (Rigid EPS/XPS Foam)
Rammed (Compacted into Molds/Forms)
Earth (60% sand/gravel, 20% clay, 5-10% cement)





Strength of SIRE
20mPa – 30mPa
2,900psi – 4,350psi

Stabilized Insulated Rammed Earth Cutaway

A. Rubble trench – 4 inch bed of drain rock
B. Reinforced concrete footing – up to 6 feet wide
C. Drain pipe
D. 12 inch interior rammed earth wall, reinforced with steel rebar
E. R50 to R80 continuous rigid foam insulation
F. 8 inch Exterior rammed earth wall, reinforced with steel rebar
G. EMT pipe to function as electrical conduit
H. Wooden or concrete top plate, anchored to wall, ready for roof
I. Interior floor
J. 1” of rammed earth is an effective vapour barrier

Rammed Earth: Testing and Standards from Other Jurisdictions

Monolithic Insulating Stone Walls are a *structural sandwich core wall system* typically 24” to 36” thick
Local soils combined with 5% - 9% cement are compacted on either side of a hidden insulation core
Stabilized with compacted earth and rebar, with rigid insulation hidden in the centre of the wall (rebar is used in seismic zones). *no sealants, siding or drywall required*

Building Code Standards from other jurisdictions:

- Australian Earth Building Handbook
- California Historical Building Code
- Chinese Building Standards
- Ecuadorian Earthen Building Standards
- German Earthen Building Standards
- Indian Earthen Building Standards
- International Building Code / provisions for adobe construction
- New Mexico Earthen Building Materials Code
- New Zealand Earthen Building Standards
- Peruvian Earthen Building Standards

<u>ASTM Standards</u>
ASTM C1364 Specification for Architectural Cast Stone
ASTM D2487 Practice for Classification of Soils for Engineering Purposes
ASTM E2392 - 05 Standard Guide for Design of Earthen Wall Building Systems
ASTM 1633 Standard Test Methods for Compressive Strength of Molded Soil-Cement Cylinders

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Rammed Earth: Sustainable and Ecologically Responsible

Rammed Earth Wall Embodied Carbon &Energy

Wall type: 2.4 m (8ft) high	Material embodied energy from I.C.E. in MJ/kg	Weight to volume ratio of material*	Volume of material in sample 1000sf/92.9m2 building	Sample building embodied energy	Material embodied carbon from I.C.E. in kgCO2e/kg	Sample building embodied carbon	Notes
Lowest Impact							
Solid rammed earth wall, 300mm (12in), no stabilisers							
Rammed earth	0.083 (Aggregate, general)	1601 kg/m3	49.6 m3 79,410 kg	6,591 MJ	0.0052	413 kg	Option 1 does not include insulation
Totals				6,591 MJ		413 kg	
Highest Impact							
Double wythes 200mm (8in) each, 150mm (6in) rigid foam insulation between wythes							
Rammed earth with 5% cement stabiliser	0.68 (Cement stabilized soil @ 5%)	1601 kg/m3	66 m3 105,666 kg	71,853 MJ	0.024	2,536 kg	
Reinforcing bar	17.4 (Bar and rod, average recycled content)	1 kg/m	156 m 156 kg	2,714 MJ	1.4	218 kg	
Rigid foam insulation	88.6 (Expanded polystyrene)	24.8 kg/m3	24.8 m3 615 kg	15,252 MJ	3.29	2,023 kg	
Totals				89,819 MJ		4,777 kg	

Transportation: Earth transportation by 35 ton truck would equate to 74.6-99.3 MJ per kilometer of travel to the building site
*Typically from engineeringtoolbox.com

Endeavour Center Embodied Carbon Evaluation 2017

Use of Geopolymer binder will offset Carbon burden

Rammed Earth: Factors Impacting Strength

Rammed Earth mix composition/design, compaction, water addition and admixtures are all factors in final wall strength

	Rammed Earth	Stabilized Rammed Earth	Non-Standard Insulated Rammed Earth	Historical Innovations Stabilized Insulated Rammed Earth
Compressive Strength	1mPa – 3mPa 145psi – 435psi	3mPa – 7mPa 435psi – 1,015psi	3mPa – 20mPa 435psi – 2,900psi	20mPa – 30mPa 2,900psi – 4,350psi
R-value (static)	R6	R6	R18 – R25	R33 & UP
R-value (dynamic)	R9 – R13.5	R9 – R13.5	R38 – R56	R50 – R74
Erosion Resistance	A garden hose erodes this	Garden hose resistant	Widely variable	2,500psi pressure washer resistant
Quality Control Protocol	Unlikely	Possible	Unlikely	Yes
Risk of efflorescence	Possible	Possible	Possible	Unlikely
Curing Protocol	No	Possible	Possible	Yes
Air barrier detailing	No	No	Possible	Yes
Pre-build soil optimization	No	Unlikely	Minimal	Yes
Vapour drive barrier	No	No	Unlikely	Yes
Engineer and Building Permit friendly	No	Yes	Unlikely	Yes
Large project capability	Possible	Possible	Unlikely	Yes
Standards & Specifications	No	Yes	Variable, Self -monitored	Yes

Rammed Earth: How the strength of an insulated rammed earth wall can vary when constructed

Depending on how a rammed earth wall is built, these factors can **dramatically affect** overall **strength** and **durability**:

- Too much or little moisture – 40% difference, best to worst
- Hand tamping or wrong tampers – 50% difference
- Curing – 50% difference
- Mixing – 75% difference
- Pneumatic tamping or wrong tampers – 25% difference
- Control of lift depth – 50% difference
- Material management – 30% difference
- Consistency of soils used – 25% difference

Rammed Earth Formwork: Modular, Flexible, Rapid Assembly

The Old Way

Rammed earth technique developed by Mrinmayee Bangalore
Earth is rammed in a smaller blocks of 2 feet length, using formwork which can easily be installed and shifted to adjacent sections of the wall

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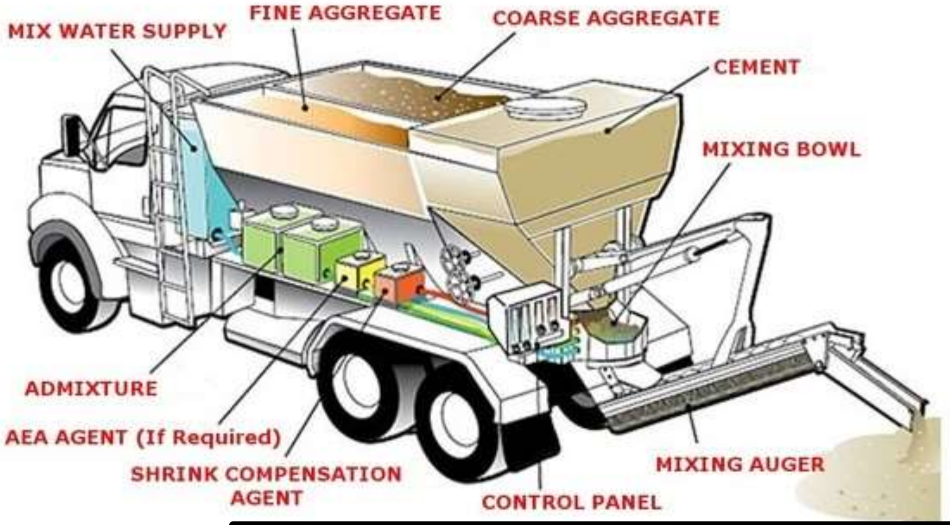
The New Way

Rammed Earth Material Handling and Mixing: Speed, Volume, Reach

Volumetric Mixer for high production



Hydraulic Mixing Buckets for medium production

Telehandlers for longer reach

Paddle Mixer for low production

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Rammed Earth Compaction: Manual, Pneumatic, Automated (future)

The Old Way




The New Way





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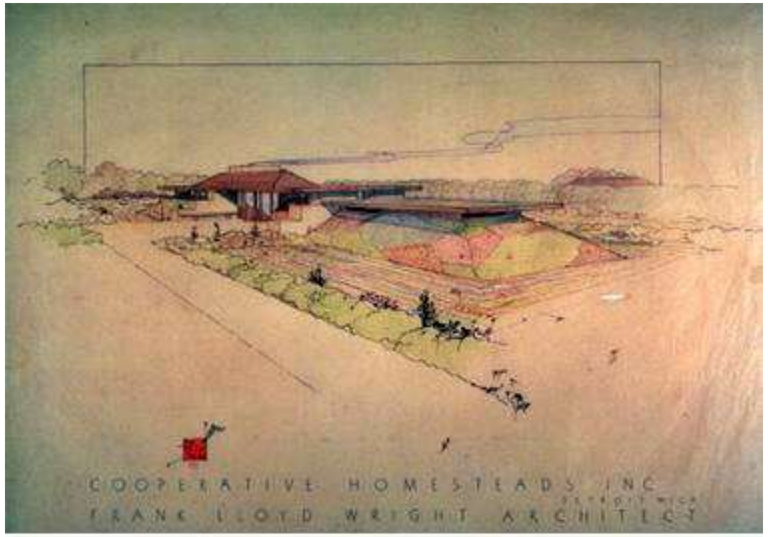
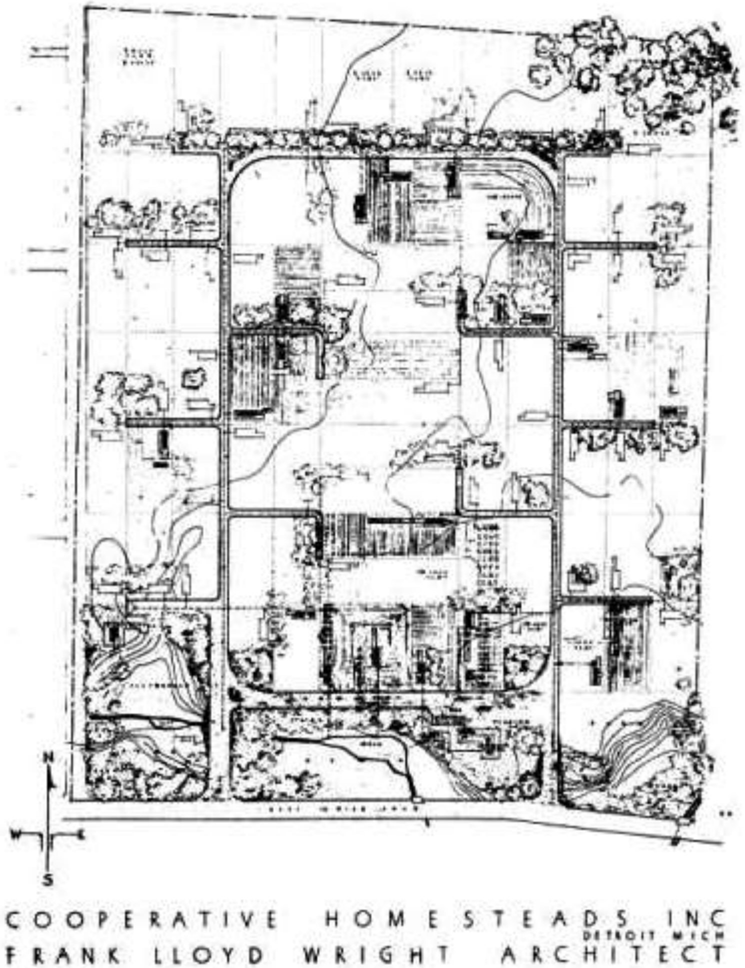
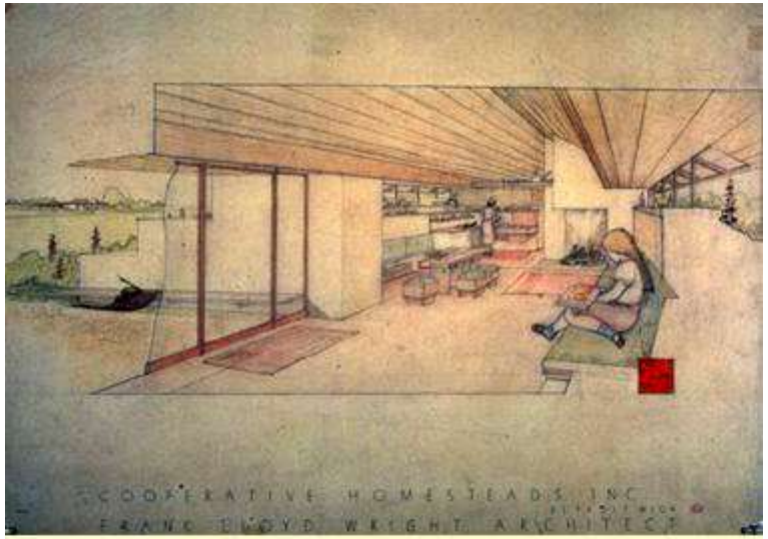
Local Rammed Earth Example: St. Thomas Anglican Church (Shanty Bay, Ontario)

Built of rammed earth or *pisé de terre* or simply *pisé* between 1838 and 1841 by local craftsmen. The axe marks on the hand hewn wooden forms used for the rammed earth are still visible. Its steep pitched roof, lancet windows and entrance tower are typical of Gothic Revival churches. It was consecrated on February 27, 1842, and is still an active Anglican church.

Rammed Earth Affordable Alternative: Frank Lloyd Wright







In 1941 Frank Lloyd Wright began the Cooperative Homesteads project in Madison Heights, Detroit Michigan. The homes were to cost $1,400 and to keep the costs low they utilized berm and rammed earth construction. It is said that the would be occupants for the houses were drafted during World War II and construction ceased.

Rammed Earth Possibilities: Affordable Housing on Speculation

Historical Innovations Vision Statement

To establish ourselves as a leader in ecologically responsible, affordable and sustainable real estate development. To become the recognized industry leader in Stabilized Insulated Rammed Earth sustainable home construction. Through innovative and proven construction techniques we will empower our team of earth craftsmen to ensure outstanding quality in earth masonry that will immortalize their dedication in the architectural history of North America. Our homes and buildings will provide value and energy cost reduction through superior thermal insulation of the building envelope and use of renewable resources throughout construction.

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Redefining Sustainability

Elegance
Artistic
Timeless
Durability
Indestructible

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Many examples around the world
30% of the human population lives in a earth borne structure

Modern Day Monoliths

Creating stone in the shape we need it
Will last forever
Multi-generational buildings

Historical Innovations: Business Model

- Provide outstanding quality, highly efficient, rare and highly aesthetic homes.
- Develop strategic alliances with would-be competitors, establish opportunities to provide other builders with SIRE.
- Develop and train our own specialized construction leaders and tradesmen.
- Become known as a proven solution to climate change.
- Build strong team cohesion by developing a powerful corporate culture of hard work, passion, enthusiasm, dedication and intrinsic value in our work.
- Refine the business model so that it can be duplicated in many jurisdictions.
- Market our buildings longevity and efficiency as a permanent multi-generational affordable home.
- Maintain a low overhead, order only what is required for each project.
- Build long term relationships with developers, become the preferred choice for large scale residential developments.



Historical Innovations: The next bound

Next steps

- Proof of concept

- Design
- Estimation/Securing of Financing
- Prospecting and Sourcing Materials
- Procurement of Equipment
- Demonstration Project
  - Partnership with Industry Professionals
- Validation: Material /Performance Testing – **NRC**
- Seed Funding

Long Term Goals

- Economies of Scale
- Automation of mixing and material handling
- Automation of Tamping
- Geopolymer Binders vs Portland Cement

Potential

- Northern and Remote Communities Development
- Architectural Building Elements
- Roads and Barriers
- Pre-Fabricated Construction

Questions?