Building a Dream Home Using Tires

(used tires, baled not shredded)

Jon & Laura Hagar

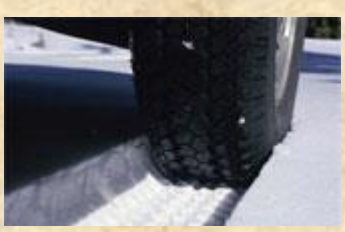
Designers & Builders of first of a kind tire bale house

First tire bale house designed, built & lived in (that we know of) in the world

http://www.hagartirebales.com

So what's our story. . .

- What we did & Why
- Biomimicry -- huh?
- What we implemented
- It's a systems view
- Our data
- Show-n-tell-pictures
- Our lessons learned
- FAQs



Tires...good on cars

But, what to do with millions
of tires stuck in landfills
that are environmental & fire hazards

Why not build houses with those used tires &

make those tires work for something again?

What is a tire bale house and Why would anyone build one?

- **What is a tire bale house?**
  - **A house built using bales of used tires as the foundation and structural support which provides a thermal mass**
  - **<u>Tire bales are not the same as Earthship technology</u>**
    Here's a comparison to Dennis Weaver's Earthship outside Montrose Colorado
    Dennis' house--3,000 tires + >350,000 aluminum cans in 8,500 sf
    Ours --17,000 tires + >1,000 cans + >1,000 plastic jugs, bottles, plates + >200 wine bottles in 2,700 sf
- **Why would anyone build this kind of house?**
  - **This is one solution to "going green" and to have a lesser environmental impact**
  - **It offers one solution in building technology that also makes use of human trash**
  - **We wanted to demonstrate the technology & provide a proof of concept**
  - **We wanted a showcase of possibilities**

What does a tire bale look like?

Tires in a landfill or baled in the walls of a home?

Photo courtesy www.eagle-equipment.com/enviroblock.html

~100 used tires
compressed under ~35,000 lbs
pressure into a bale form
~ 5.5 x 5.5 x 2.5 feet
and weighs approx. 1 ton
held together by 5 steel bands
and can be stacked like bricks

We ask the big questions . .

- Why not turn used tires into something useful?
- Why not use something so prolific in our world?
- Why not re-use society's trash instead of creating something "new" all the time, which creates more waste in the waste stream?
- Why not?

What is Thermal Mass?

- Thermal mass is equivalent to solid material's ability to heat itself in sunlight
- Our home heats itself just like the hillside it sits on does
- Thermal mass is a benefit of passive solar design
- Instead of paying a utility company to heat our home, why not use what is available & free?

Surrounding earth + tire bales + concrete/slab + total building structure = Our Home's Thermal Mass

Thermal Mass provides <u>non-mechanical heat storage and regulation</u>

Biomimicry -- huh? What's that?

- ***"NATURE DOES NOT BUILD WITH COLUMNS AND BEAMS, BUT WITH LAWS OF GROWTH. ITS CONSTRUCTIVE LOGIC IS THE SAVING OF ENERGY, ADAPTABILITY AND FLEXIBILITY***"

  Lessons of Biomimicry taken from

  -- http://www.cerveraandpioz.com/bionic_megacities_v.htm

Check out their definition of "bionics"

- Biomimicry Institute defines it best. https://biomimicry.org/what-is-biomimicry/
- "Biomimetic" (drawing on nature in design) architecture (http://www.bbc.com/earth/story/20150913-nine-incredible-buildings-inspired-by-nature)

Biomimicry – Model, Mentor, Measure

- Biomimicry (from *bios*, meaning life, and *mimesis*, meaning to imitate) is a design discipline that seeks sustainable solutions by emulating nature's time-tested patterns and strategies, e.g., a solar cell inspired by a leaf.
- The core idea is that Nature--imaginative by necessity--has already solved many of the problems we currently are facing.
- **Model**: Biomimicry is a new science that studies Nature's models and then emulates these forms, processes, systems, and strategies to solve human problems – sustainably.

  Mentor: Biomimicry is a new way of viewing and valuing nature. It introduces an era based not on what we can extract from the natural world, but what we can learn from nature.

  Measure: Biomimicry uses an ecological standard to judge the sustainability of our innovations. After 3.8 billion years of evolution, Nature has learned what works and what lasts.
  - Thermal mass – Think large animals
  - Solar – Ever see a bird or animal sunning?
  - Natural cooling – termite mounds
  - Recycle – everything in nature tends to recycle what it finds "naturally" – think nature's fertilizer
  - Natural products – clay, silicon, earth, sun

What We Implemented

- Tire Bales as foundation and structural support, Thermal mass, as well as recycled tire materials
- Tires and other human “trash”
- Natural products: clay, silicon (glass), earth, sun
- Natural “beetle killed” wood








What We Implemented (cont.)

- **Natural products (beetle killed wood ceilings)**

What We Implemented (cont.)

- **Solar and natural heating/cooling**

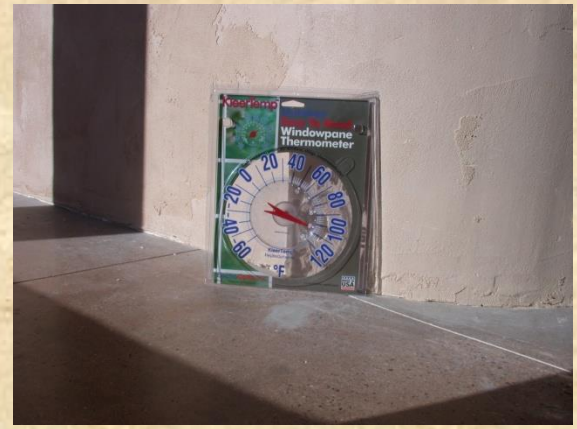
All images taken on same day in Feb. within minutes of each other in the sunshine
Outside AIR temp was ~40 degrees, 90 degrees in the sunshine
Sunny day: outside temp of 5 degrees, inside temp 80 degrees

Master bedroom

Note air temp of
77 degrees
on tire bale wall

Window next to front door

Hall outside master bath



Living room within 2 feet of concrete floor

Window across from kitchen

What We Implemented (cont.)

- **Thermal Mass**

(Who cleans all those windows?)

A solid material's ability to heat itself in sunlight providing <u>non-mechanical</u> heat storage and regulation

30 (plain glass) windows facing south, east & west plus glass front door

- Back (motorized)windows "vent" heat if house gets too hot

It's a Systems View

- **Our house when viewed as a whole system with "green" built in**
  - **Is not viewed as green by some governmental agencies (USGBC), companies and publications**

- **Architecture – ours is different but it has "smart" home features** (motorized blinds and windows, etc.)
- **Subsystems**
  - **Photo Voltaic Arrays**
  - **On-demand hot water**
  - **Long lasting materials – tire bales, stucco, polished concrete…**
- **What could we have done differently?**
  - **Made the house 25-feet deep to meet passive solar gain guidelines**
  - **Located the garage elsewhere (studied wind direction more thoroughly before setting design)**
  - **Be more direct and demanding of our plumbers**
  - **Done away with parapit walls (no true value there—aesthetics only**
  - **Changed roof design to include more south windows higher for more solar gain**

Solar Array

We added a solar array in July 2010 to reduce our electrical footprint

This array cut our electric bill by 2/3 (when our heavy equipment is not plugged in) & pays us a small dividend each month for the energy we feed back in to the grid

Plans are to add 1 (maybe 2) more PV arrays in 2018

Wind machines have also been considered

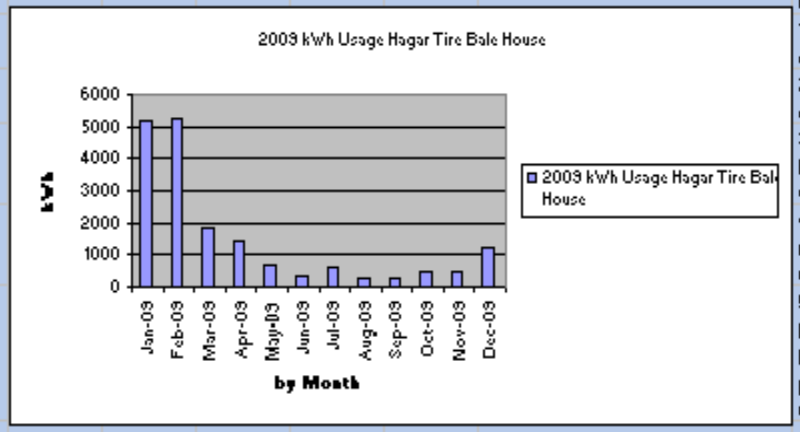
Our Data

- 17,000 tires in 170+ bales
  - Thermal mass
  - Bales in walls and foundation
- Tire bales were “free” although hauling them was not (tire bales paid for by recycle fees to State of Colorado from tire installers)
- Primary heat source: solar, secondary heat source: wood stove, backup heat source: baseboard HydroSil (sealed oil) electric heaters (a requirement of building codes)
- + 30% – wood recycled or “low impact” engineered products
- 2,700 Sq ft -- all living areas have solar heat
- 8,270 ft elev.
- Length ~120 feet with 35 windows (22% ratio)
- 53 can lights for interior lighting (mix of CFLs & LED lights)
- Each living area (bedrooms, living & office) has a string of LED rope lights
- Dec/Jan/Feb lows can be sub zero
- Inside temps average 64+ degrees year round
- Analysis ongoing

Data: 2009 Energy Bills

2009 living in house full time

Jan-09	5175	1186
Feb-09	5234	10406
Mar-09	1829	4641
Apr-09	1429	-2566
May-09	679	
Jun-09	371	
Jul-09	616	
Aug-09	298	
Sep-09	268	
Oct-09	461	
Nov-09	476	
Dec-09	1210	
2009 usage (excludes Jan&Feb)**		**7637** **
Jan-10	1967	



Hagar:
Factors for solar sizing:
1) House construction (ceiling not totally enclosed) until Dec. 2009
2) Electric baseboard heat, heat tape, heavy equipment not plugged in daily
3) Triple cell blinds installed west end mid Feb.2009, styrofoam used in east end windows
4)All 2009 figures may not be totally representative of typical kWh usage due to utility billing errors
5) Utility bills are approximately 30 days behind (i.e., March bill is actually for February) and bills are not for consistent periods (could be 20 days vs. 30 or 31 days usage)

EPA estimate of household kWh usage for family of 4 in 2012 was 2,394 kWh
Peruse our presentation to IEEE Green Technologies 2013 Conference to see a data comparison of our household electrica; usage compared to 3 other types of structures in pur county (see next slide).

Accompanying Data

- Floorplan of our house
- Presentation to IEEE Green Technologies Conference 2013
  YOU MUST ASK FOR REPRINT PERMISSION
- Comparison of Electric Use with other types of structures in our county
  (see IEEE presentation file above)
- Pictures during build (later in this file)

ASK FOR PERMISSION TO USE ANY PICTURES FOUND ON THIS WEB SITE

Construction Images…from 2005



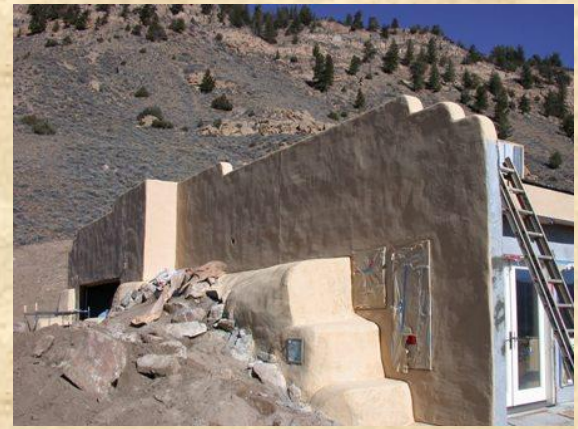






2006 images….

2007 Images



2008 Images





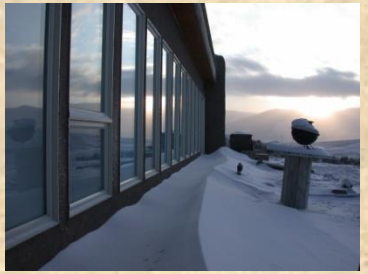




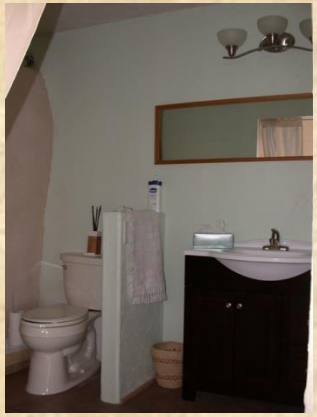





2009 Images



2010 Images



Miscellaneous Images

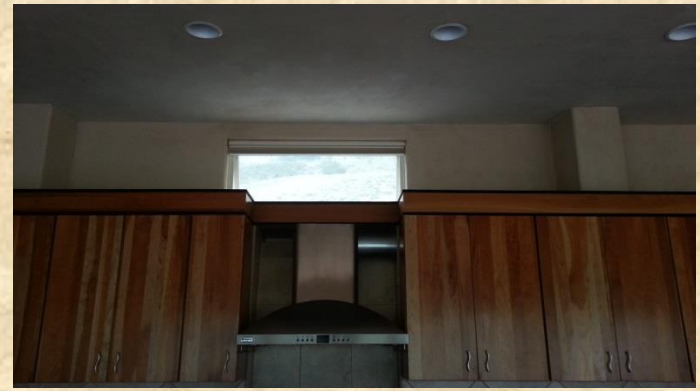
Wave in ceiling

Shoji screens aide in bathroom ventilation

Curved, partial glass block walls
on bathrooms provide light into spaces without using electricity

Sunlight warms floor Winter 2017

Miscellaneous Images



Upper windows allow “stovepipe” venting

Wood stove burns beetle-killed wood for supplemental heat

Grey gravel & flagstone adds to thermal mass

Miscellaneous Images

Looking through some of our windows in winter

Issues and Lesson Learned

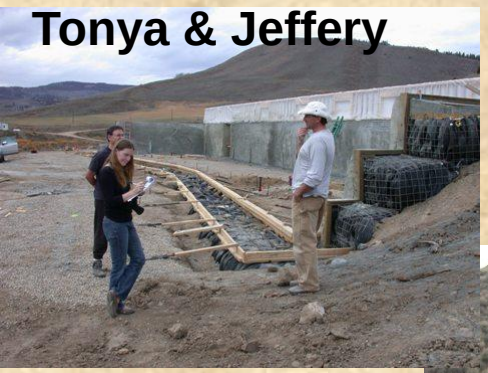
- Many engineering ideals to be “solved” still
  - Use a Civil Engineer to “work” with Build Dept.
- Banking and Mortgage industry are “clueless”
- Another 1-2 Solar arrays coming – moving toward a net zero footprint
- Could have been built with less expense
- Building takes longer than you ever plan for it to
- *Be Agile*... plan more, be more specific with contractors, be more insistent with contractors
- The amount of money paid had nothing to do with the quality of workmanship
- A few hiccups during building (plumbing); a few things we would have designed differently (garage location versus wind, added higher windows to South for more solar gain, parapit walls don’t add true value—simple aesthetics)

Thanks to Friends & Volunteer Laborers


Family


Bobby
& Judy


Leonard Jones, P.E.


Tonya & Jeffery


Dr. Art & Trisha

& many others…

From there to here….

- Series of pictures to demonstrate “stacking of tire bale walls to green stucco” http://www.flickr.com/photos/26217766@N05/
- Our blog https://hagartirebales.wordpress.com/

Our grand experiment

Why not tire bales…?

Home About Engineering Apps Inquiry Resources Contact

Tire Bales

Finished Tire Bales

In 2003 the State of Colorado generated over 4 million waste tires, and currently there are over 30 million waste tires in inventory in the state as reported by the RMA. Tire Bales are a key product in the tire recycling process with a wide variety of uses.

Specifications of Tire Bales

Tire Bales are a solid compressed block of waste tires. Each bale is made up of 100-120 passenger and light truck tires. One Tire Bale weighs an average of 2,000 lbs. - one ton. The dimensions of the bale are 60 inches wide, 50 inches long and 30 inches high.. There are 5.9 gauge steel wires that hold the Tire Bale together. Each Tire Bale can sustain 375,000 lbs. of pressure before any failure occurs.

Agriculture

One of the largest markets for Tire Bales in Colorado is the agricultural sector. Tire Bales are a very versatile product that can serve a number of purposes. One of the primary uses for Tire Bales are windbreaks. This product makes for a durable long-term lasting portable windbreak. Material storage bins are also a very popular use for this product.

C-DOT

The Colorado Department of Transportation has approved Tire Bales in 2005 for highway construction. Tire Bales have been used in many road and bridge projects, including Texas, New Mexico and New York. The success rate for the Bales in these applications has been exceptional.

From Front Range Tire http://www.frtirerecycle.com/tire_bales.htm where our tire bales came from

Summary

- First of a kind
  - Four more tire bale houses in Colorado as of 2013
  - Proof of concept
  - Built on ideals similar to Earthship technologies
  - Show place of possibilities
- Learning….still & every day
- Provide “engineering” for future users
- Many ideals, no one answer to all issues