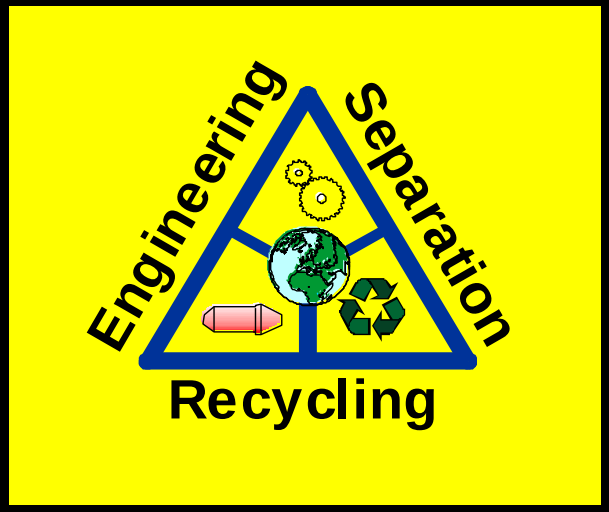
The Rice Hull House



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The Straw Bale House

After moving my company from Belgium to Texas back in the summer of 1997, I became thoroughly fascinated with straw-bale construction. The idea of taking an agricultural waste material and building from it a super-insulated structure made a lot of sense. I then set about constructing two strawbale structures in

The Straw Bale House

Texas: a residence of 2,200 ft^2, and a three story office building of 12,000 ft^2.


Residence
Photo of a Strawbale Wall


Same Wall with Stucco


Interior


Interior


Office Building


Office Building


Texas Wild Flowers

From Straw to Rice Hull

But upon relocating my company from Texas to south Louisiana, I began to doubt the suitability of the strawbale method in a hot and humid climate. Tiny cracks in a stucco finish can allow moisture to accumulate within a strawbale wall, and the only way to avoid this would be to adopt the well-proven method of

From Straw to Rice Hull

cladding an exterior wall with siding or panels. But how to attach siding or panels to bales of straw? They demand studs, and to situate studs against a strawbale wall is an illogical duplication of methods. So then, why not create a large wall cavity and fill it with shredded straw? Here in Louisiana, there is an abundance

From Straw to Rice Hull

of rice straw, but shredding straw is an unnecessary and expensive procedure, especially when the rice industry presents to us another agricultural by-product that demands no preparation whatsoever and is available throughout the year at a 12% moisture content: the rice hull.

Rice Hulls

Rice hulls are unique within nature. They contain approximately 20% opaline silica in combination with a large amount of lignin. This intimate blend of silica and lignin give rice hulls some fairly amazing properties.

Rice Fields

Rice Fields

Class A Insulation Material

ASTM Testing

Recent ASTM testing conducted R&D Services of Cookville, Tennessee, have conclusively demonstrated that rice hulls, in their raw and unprocessed state, without the addition of any chemicals, constitute a Class A or Class I insulation material. Let us briefly review these test results.

Design Density Test

The first test conducted by R&D Services was a Design Density Test. The initial densities of the rice hulls were 7.729 and 7.488 lb/ft^3. After 24 hours of vibration, these two samples increased to 9.972 and 9.807 lb/ft^3 respectively.

Critical Radiant Flux Test

Three samples were tested according to test method ASTM E 970. The average CRF was 0.29 W/cm^2, the standard deviation was 0.015, and the coefficient of variation was 0.05. All three samples easily passed this test.

Smoldering Combustion Test

Three sample were tested according to test method ASTM C 739, Section 14.

Sample 1 showed a weight loss of 0.07%,

Sample 2 showed a weight loss of 0.03%,

Sample 3 showed a weight loss of 0.03%.

All three sample passed this test.

Odor Emission Test

The rice hulls were tested according to test method ASTM C 739, Section 13. There was no perceptible odor associated with the rice hulls, and therefore, they easily passed the odor emission test.

Moisture Vapor Sorption Test

Rice hulls were tested according to test method ASTM C 739, Section 12. The sample showed a gain in weight of only 3.23% and easily passed this test.

Corrosiveness Test

The rice hulls were tested according to test method ASTM C 739, Section 9. At the end of this test, the aluminum, copper and steel showed no holes or perforations. The rice hulls once again easily passed this test.

Thermal Resistance

The rice hulls were tested according to test method ASTM C 518.

Length of Time	R-per-inch
8.6 hours	2.549
120.0 hours	3.024
90.3 hours	2.926
92.0 hours	2.946

Resistance to the Fungal Growth

The rice hulls were tested according to test method ASTM C 1338. Three samples of rice hulls were inoculated with five specific fungal species and left to incubate over 28 days. Once again the rice hulls easily passed this test.

Surface Burning Characteristics

The ASTM E84 Standard Test for Surface Burning Characteristics of Building Materials (ANSI 2.5, NFPA 255, UBC 8-1, UL 723) was conducted by Omega Point Laboratories of Elmendorf, Texas. The results here were amazing. US building codes require a Fire Spread Index of 25 or less. The FSI for rice hulls

Smoke Development Index

was 10. US building codes require a Smoke Development Index of 450 or less. The SDI for rice hulls was 50. Rice hulls, therefore, are a Class A or Class I insulation material. The United States produces over 1.2 M metric tons of rice hulls annually, and often times, they are available free-of-charge.

A Blanket of Hulls

Now that we have found an agricultural waste material that serves as a wonderful insulation material, let us then wrap our proposed house in a blanket hulls. For this we need large floor, wall and roof cavities created by means of floor, wall and roof trusses.

Floor, Wall & Roof Trusses

The floor truss is a 12-inch open-web truss called a spacejoist or posi-strut. The walls are composed of 12-inch wall trusses, and the roof is constructed out of conventional roof trusses. It is important that the floor joist be an open web, otherwise a back pressure is created when blowing hulls into floor cavities.

Floor Cavity

The spacejoist with OSB at the bottom and sub-flooring at the top creates a 12-inch floor cavity. It is important not to situate a rice hull house on a concrete slab, since a concrete slab, in a hot and humid climate, is a magnet for condensation that demands often times the unnecessary use of air-conditioning.

Pier & Beam

Not long ago most houses in Louisiana were situated several feet off the ground (the pier & beam construction method) as the best line of defense against flooding, condensation, mold, mildew and termites. Floor joists in the style of a space-joist or posi-strut are strong, lightweight and inexpensive.

Floor Truss

Floor Truss with OSB Underneath

The Wall Truss

For the wall truss, we propose two 2x4's with their outer edges pulled 12 inches apart and held together by three plywood gusset plates situated at top, middle and bottom. Such wall trusses spaced 16 inches on center constitute a formidable defense against hurricane-force winds.

The Wall Truss

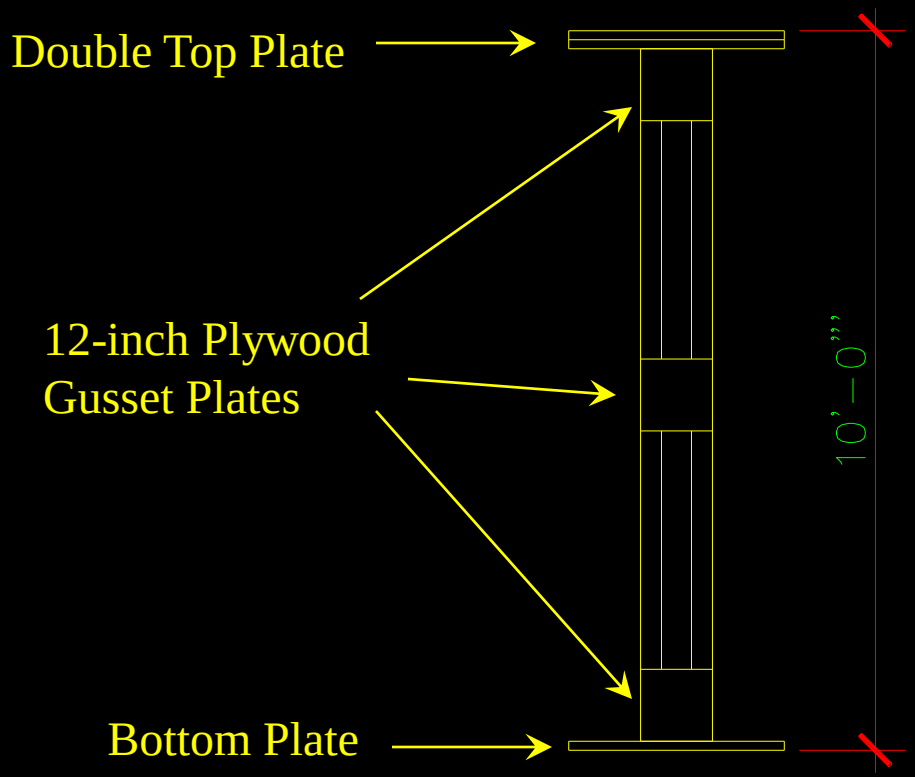


Photo of Wall Truss

Wall trusses are fabricated in a jig for quick and easy installation on site.

They are light-weight, and their open design minimizes thermal bridging.

4-Foot Wall Section

Exterior Wall

The exterior wall consists of 4x10’ fiber-cement panels. No OSB is required.

These panels can be mounted far more quickly than lap siding.

They can be clad with battens to give a board & batten look. Or the stucco style panel can easily give an authentic bousillage look.

4-Foot Wall Section

4-Foot Wall Section

With 5/8 Sheetrock

Difference in Cost

The cost to construct the 10-foot high walls of a 1,152 ft^2 structure using 12-inch wall trusses is approximately $500 more than constructing the walls of the same house using ordinary 2x4 studs. Any imperfections in the 2x4's used to make the wall trusses are corrected by the 12-inch gusset plates.

Easy Electrical Installation

Since there is a 5-inch gap between the two studs of a wall truss, it is not necessary to drill holes in studs to install electrical lines. This gap breaks the transfer of heat and sound through the wall, and the truss itself behaves as a single unit allowing a wall to withstand much greater wind loads.

Insertion of Rice Hulls

The insertion of rice halls into a floor, wall or roof cavity can be done at times by hand or by means of a blower. At first we thought that a standard cellulose insulation blower would work, but in no way could it handle rice hulls. In the end, we were obliged to construct a far more powerful rice hull blower.

By Hand

Rice Hull Blower

Radiant Barrier Foil

But the cheap and easy insulation of this rice hull house is not enough. The high temperatures created by radiant energy from the sun must also be avoided. The attic of this rice hull house, therefore, is covered with a radiant barrier foil that blocks up to 97% of the radiant energy from the sun. The radiant barrier foil is placed

Roof Construction

face-down directly over the roof trusses. Afterwards, horizontal 1x4's are fastened to the roof trusses, followed by corrugated metal sheets. Once again, no OSB is used. The attic is then filled with 12 to 16 inches of rice hulls. Soffit and ridge vents dissipate any heat that might build up in this attic space.

Super-Windows

The windows of this rice hull house are super-windows constructed by companies such as FiberTec of Canada. The fiberglass frames of these windows have a R-value of 10, and there are two layers of glass with a Heat Mirror TC88 film sandwiched in between.

Heat Mirror TC88 + Krypton

This heat mirror film serves as a radiant barrier to reflect radiant energy from the sun and to keep in radiant energy during the winter. The glass is filled with krypton gas, giving a middle-of-glass R-value of 7.10. The doors of this rice hull house are also made from fiberglass, and they, together with the windows, are

Fiberglass Doors and Shutters

are equipped with operable shutters. The proposed Rice Hull House is a traditional pier-and-beam structure situated at least 2 feet above ground. This greatly reduces termite and flood risk, and simplifies plumbing and AC installation. In this way, we also avoid the horrible problems associated with the

No Condensation

the condensation of water vapor on a concrete slab. Even without air-conditioning, in the hot and humid climate of south Louisiana, condensation on floors, walls and ceilings does not occur in a rice hull house.

Operable Shutters

The Wood Stove Option

Fire wood is perhaps the cheapest source of winter heat available in Louisiana, and we can easily find modern wood stoves that burn with efficiencies as high as 75%. Louisiana is being over-run by the invasive Chinese Tallow tree, and this tree could be cut into small cubes or chunks for easy drying and handling.

Jotul F 602

This small Jotul stove costs less than $600 and would be ideal for heating a Rice Hull House.

A fan situated above this stove would distribute hot air to every room in the house.

A Water Source Heat Pump

A water source heat pump is the most efficient way to cool a house. Water will hold five times more heat than an equal weight of air, and its heat carrying capacity does not vary with temperature. Ground water temperatures in Louisiana average about 69°F, and water exits the heat pump at about 79°F: a rise of only 10°F.

An Earth-Coupled Heat Pump

In general, a minimum flow of about 3 gpm of water is required per ton of heating and cooling. A simple way to make the heat exchange is to drill a 4-inch hole with a 1-inch pipe running down into the ground and looping back up to the surface. In this closed loop, no water is actually pumped out of the ground.

A 250-Foot Hole

In general, one 250-foot hole is required for every ton of heating and cooling. The cost to drill and grout this hole and to install a dual 1-inch pipe is approximately $650. A small supplemental heat exchanger coupled to the main unit provides hot water; that is, it transfers heat from within the home to the hot water tank.

An Approximate 50% Reduction

According to the DOE, about 73% of the energy used in a residential structure is devoted to heating, cooling and water-heating, and an earth-coupled heat pump can reduce this energy demand to 24%. The difference here is an amazing 49%: all free from the earth without using a drop of water!

Same Price

A water source heat pump does not cost more than a conventional air source heat pump. No noisy condensing units are located outside the residential structure. In a super-insulated rice hull house of 1,152 ft2, a one-ton water source heat pump is all that is required.

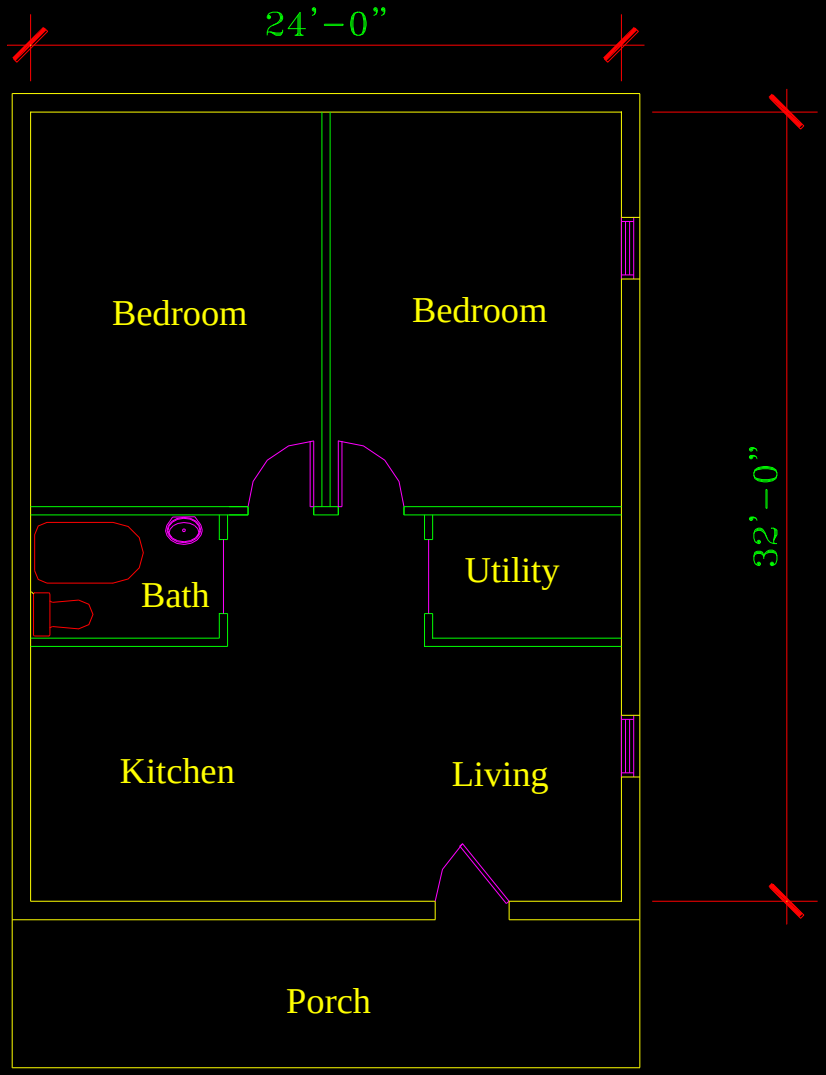
Rectangular Layout

The most economical house form is a rectangle about 28 feet in width. This maximizes floor space while minimizing the size of the roof assembly. The design is wide enough to accommodate two rooms in width, yet narrow enough to be spanned by a single roof truss without support from interior walls.

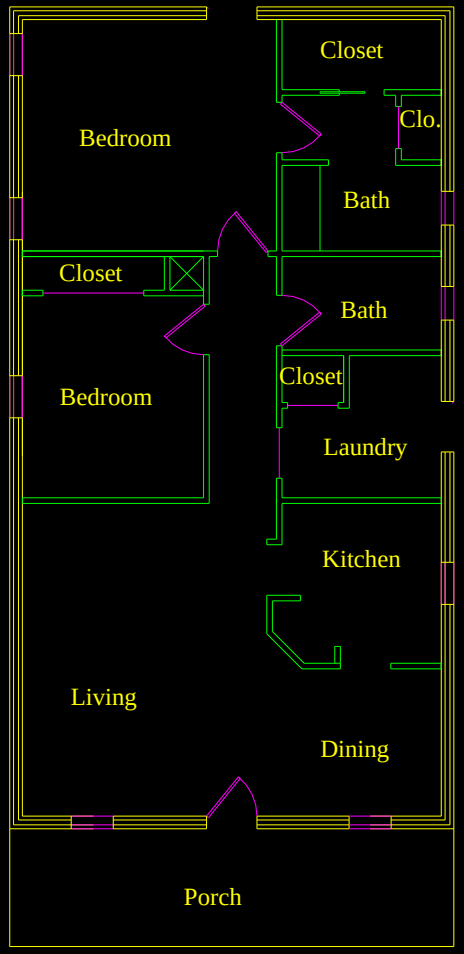
Interior Floor Space

This gives the architect a lot of freedom in laying out interior floor space. The length of this rectangle may extend to 48 feet or more. Such a simple layout, with no bends or turns, results in a thoroughly uniform method of construction, greatly reducing labor and other site costs.

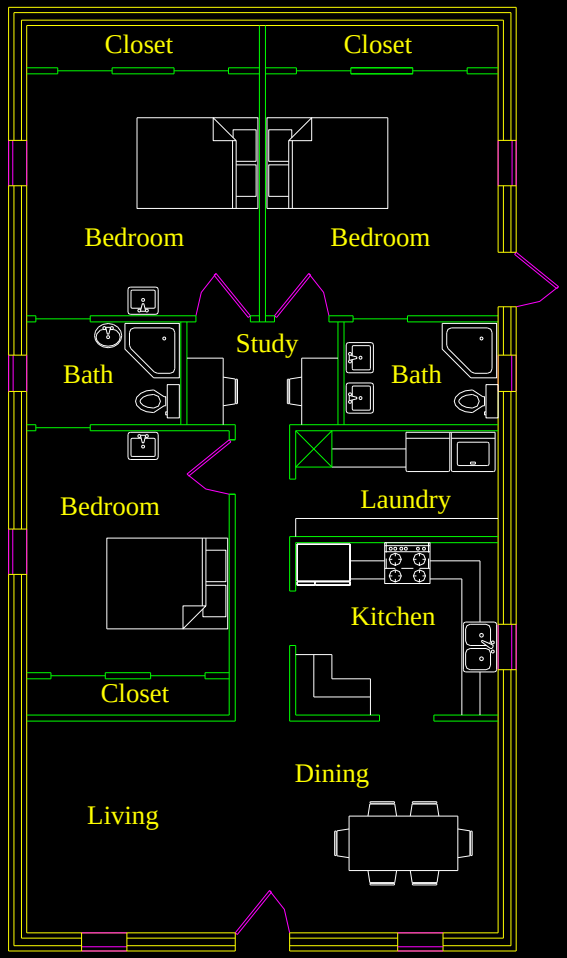
Two Bedroom



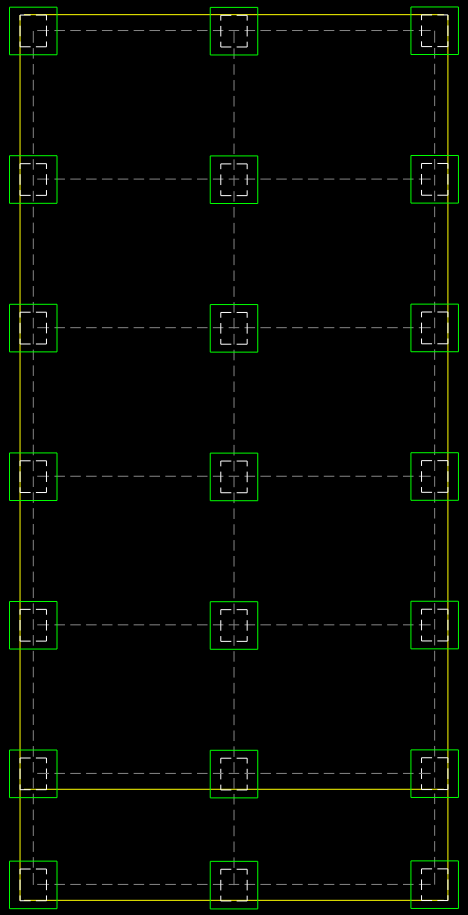
Two Bedroom

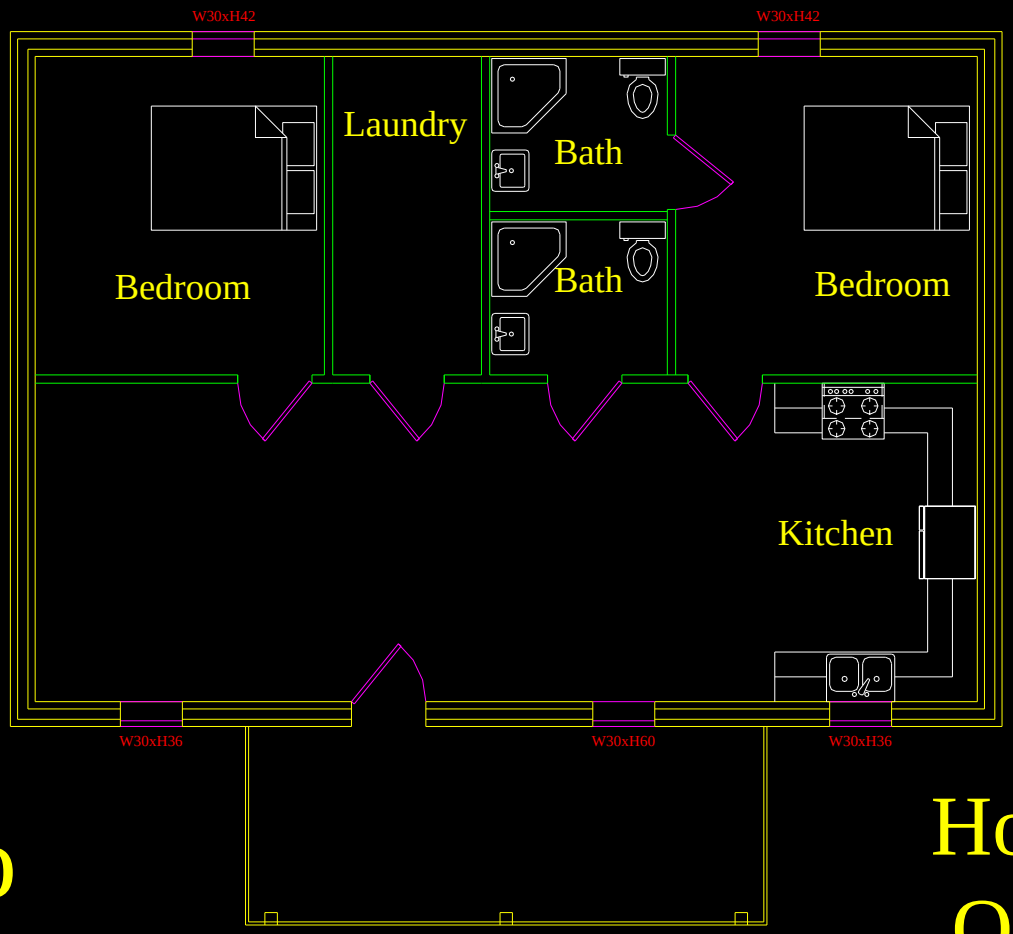

Closet
Clo.
Bedroom
Bath
Closet
Bath
Closet
Bedroom
Laundry
Kitchen
Living
Dining
Porch

Three Bedroom



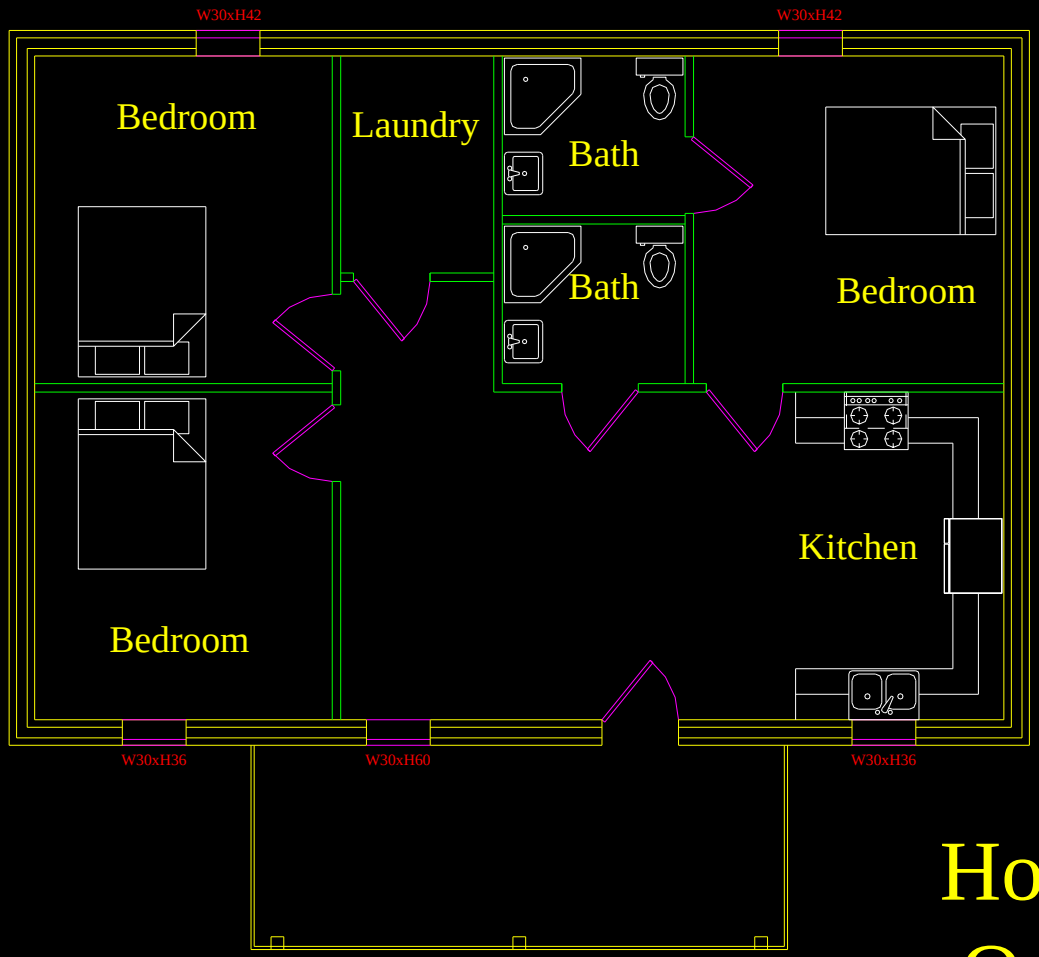
Concrete Pads





Two Bedroom

Horizontal Orientation



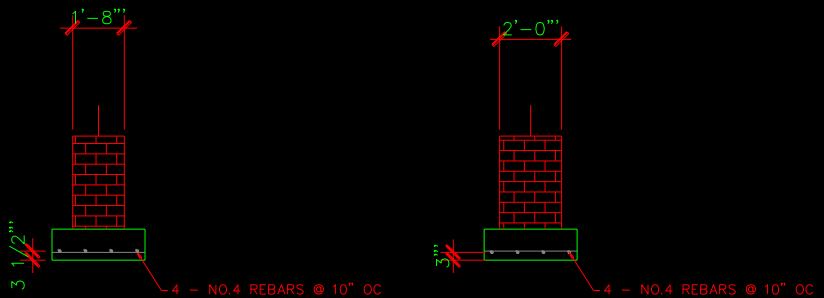
Three Bedroom

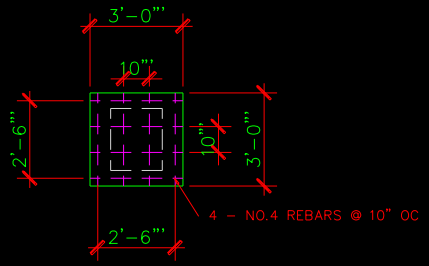
Horizontal Orientation

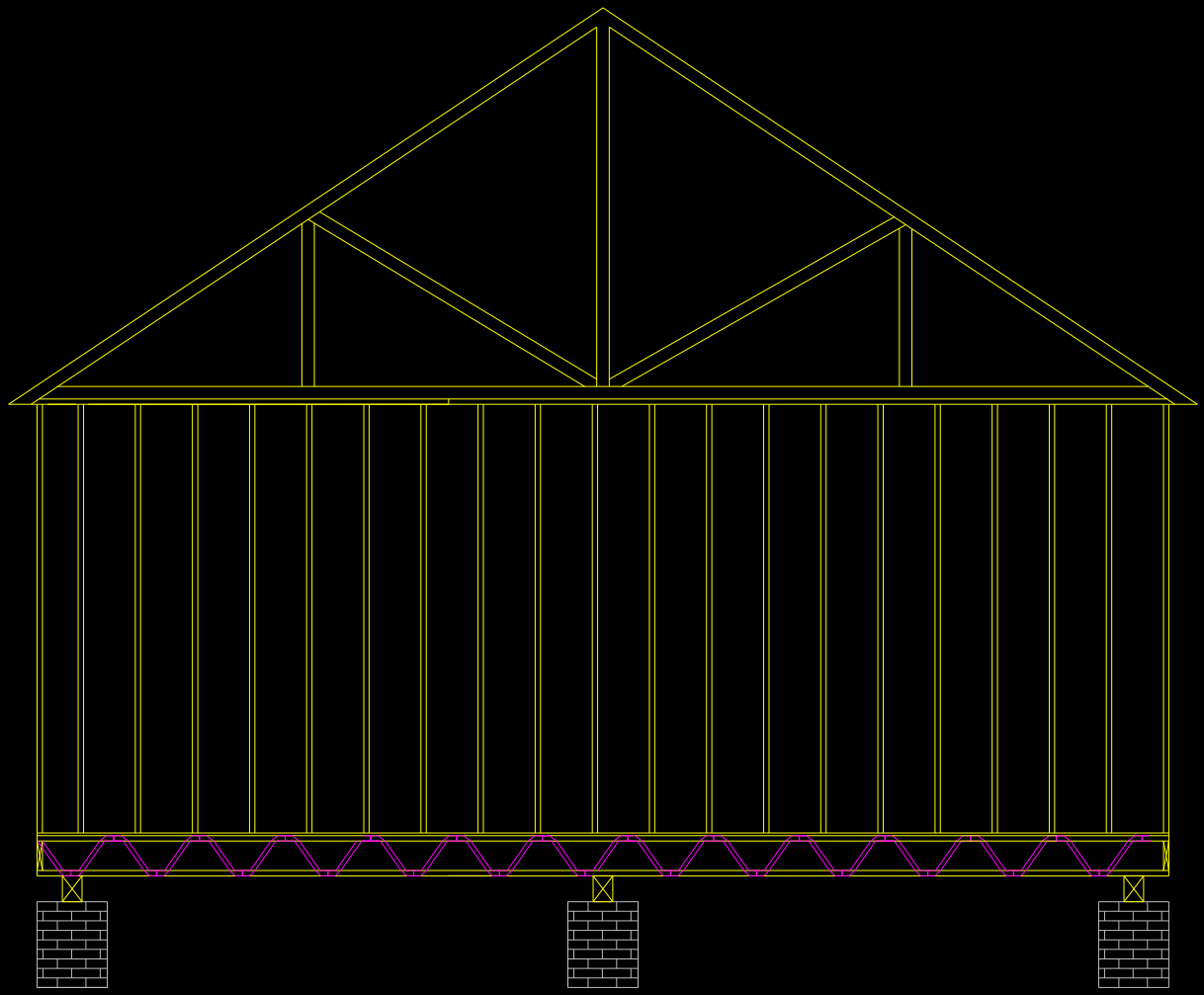
Pier Detail

TOTAL CONCRETE = (3')(3')(1')(21) / 27
= 7 CUBIC YARDS

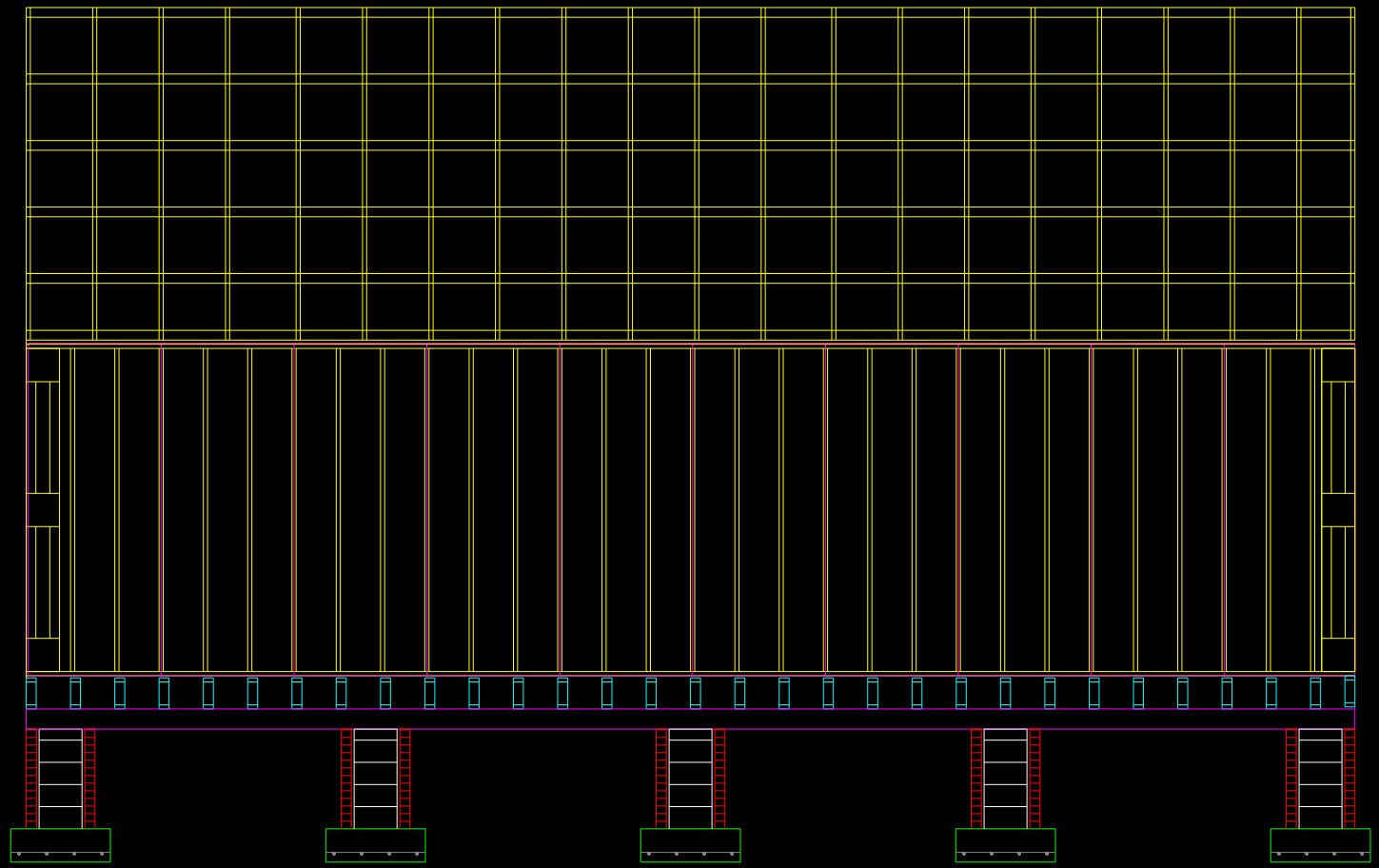
TOTAL STEEL = (24' per pad)(21 pads)
= 504 LF OF NO.4 REBAR
= 337 LBS OF NO.4 REBAR







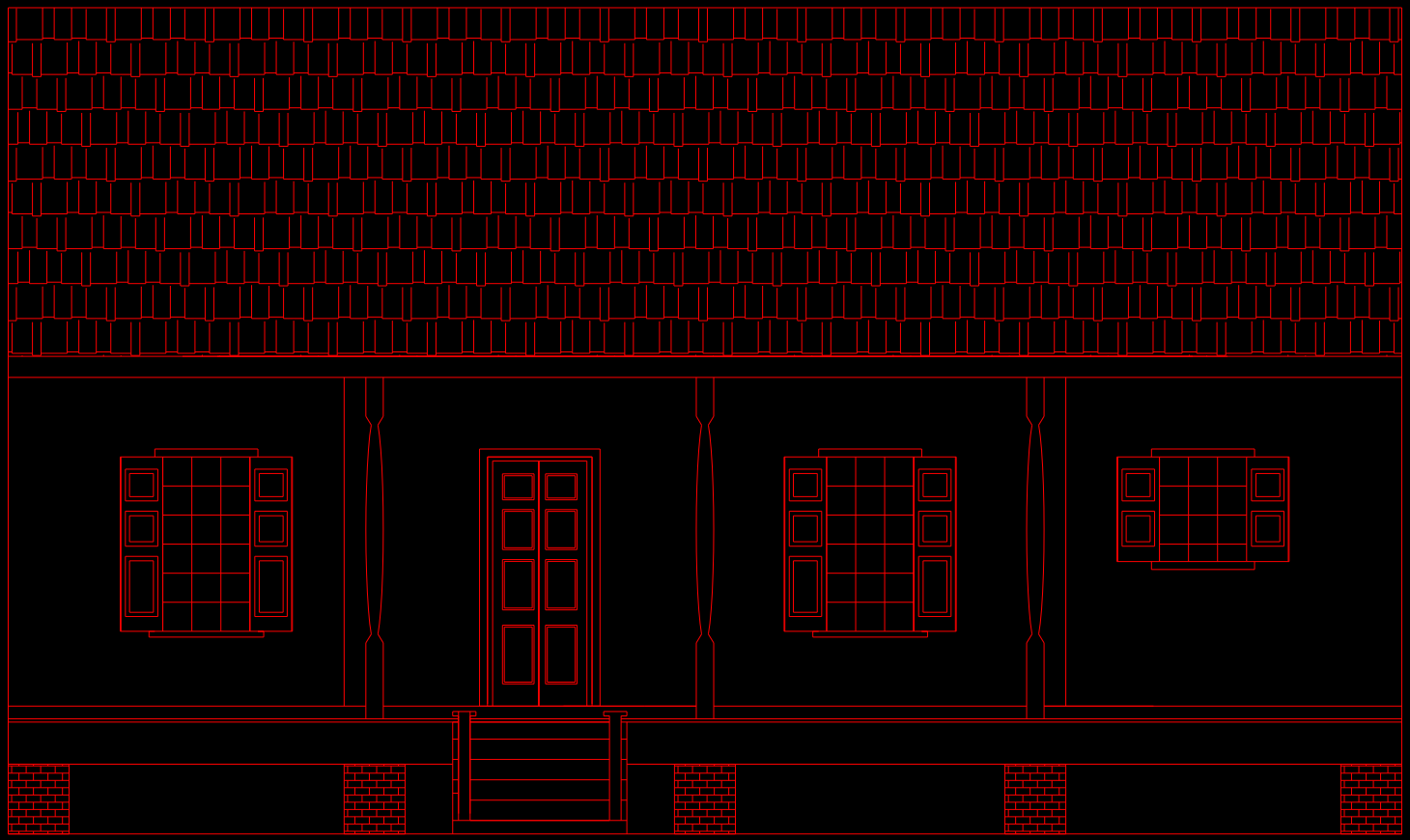
Vertical Orientation



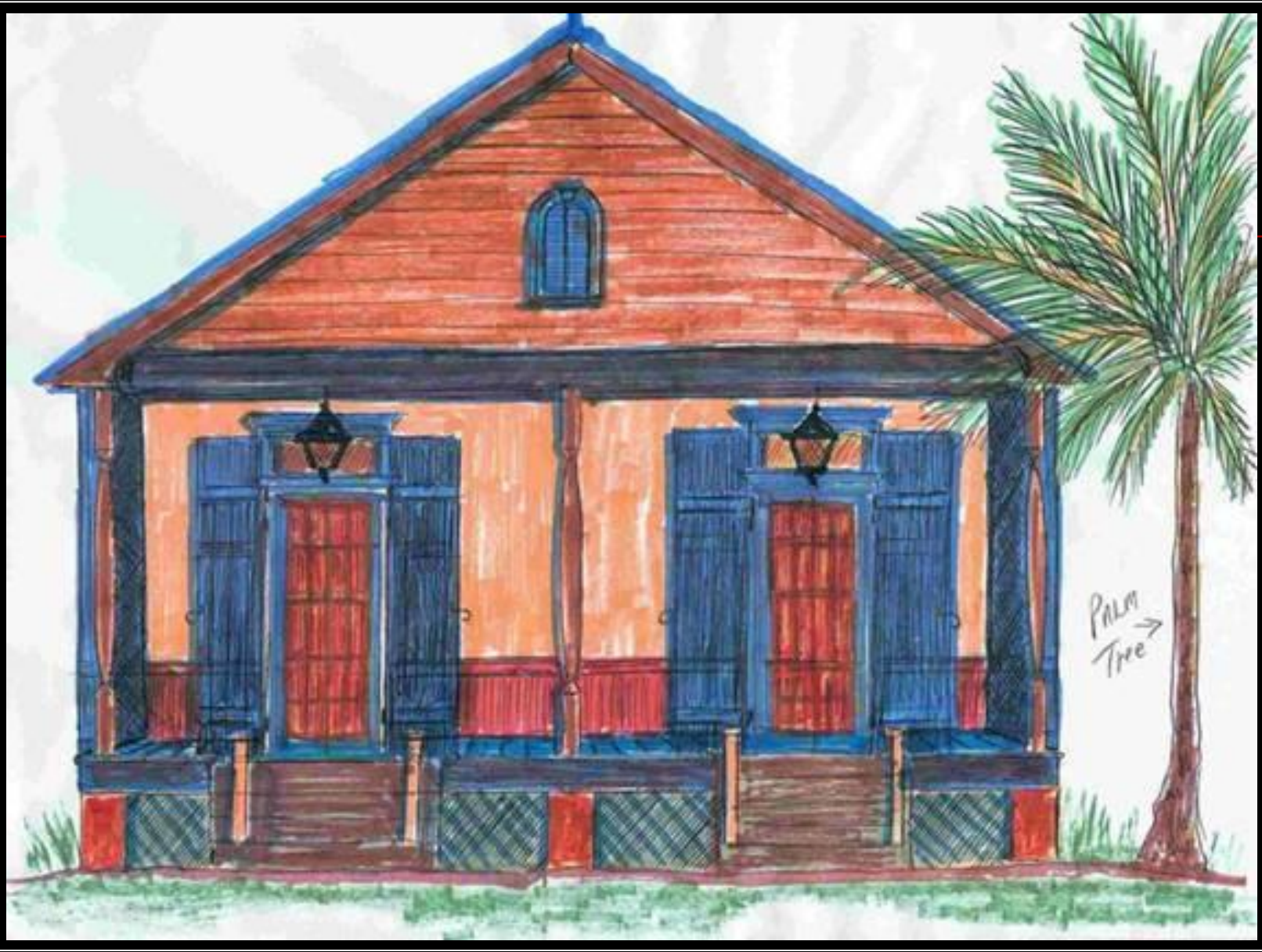
Horizontal Orientation

Vertical Orientation

Horizontal Orientation



40 Feet Wide – 28 Feet Deep



by John Lafleur

by John Lafleur

From Rent to Ownership

Many families in Louisiana pay over $300 per month in rent for a two to three bedroom house, and they face utility bills that average over $300 per month: well over $600 per month for both rent and utilities.

A super-insulated Rice Hull House can be financed through the Rural Housing Service

From Rent to Ownership

in conjunction with a local bank. A Rice Hull House costing $45,000 would involve a monthly house note ranging from $166 to $268 per month depending on the level of income of the purchasing family. To this, we must add about $40 per month for utilities. Therefore, the total cost of house note and utilities would

From Rent to Ownership

range from $200 to $300 per month, less than half the current price. Depending on their level of income, many families would qualify to receive grants up to $7,000 to be applied to the purchase of their homes.

Workshop & Job Training

A workshop, equipped with a Mitek Klincher, can be set up for the fabrication of the floor, wall and roof trusses. This workshop would also feature job training and sweat equity programs.

The Mitek Klincher

The Mitek Klincher, with 30 ft overheard suspension track, and walk-through jig, sells for less than $16,000.

All floor, wall and roof trusses can be fabricated in this workshop, and the house can be framed in a day or two.

Replacing Substandard Housing

Architecturally these super-insulated rice hull houses would be indistinguishable from houses built over a 150 years ago, and they could replace every sub-standard house or trailer in the area. Home ownership would be made available to everyone who truly seeks it. The cycle of poverty rooted in a perpetual rent situation

The Rice Hull House

would be broken. Home owners would accumulate wealth, and young people would receive job training. All labor would be locally sourced, and all income generated would stay within the area. At the same time, the environmental benefits of such a concept are enormous.

The Rice Hull House Program

In conclusion, this rice hull house program offers quality housing, pride of ownership, financial security, jobs and job training to a large number of people. Residential energy consumption would be reduced five-fold, and no other building program could ever do as much to preserve and enhance the multifaceted and

The Time is Now

unique culture of south Louisiana. Every family needs a home, and when, in many cases, it is far cheaper to live in a brand new super-insulated rice hull house than to remain in a sub-standard house with utilities bills that continuously rise, year after year, then the simple technology presented here merits careful consideration.

The First Rice Hull House

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