Design Description, Context and Features:

This 1-1/2 story Straw Bale House accommodates 3-6 people, and can be built in 4 phases. It consists of two rooms with dimensions of 4290 X 3530, a kitchen 2030 X 2300, a multi-purpose room 2030 X 2300, and a veranda 4670 X 2500. It features a usable attic for crop drying and storage. The total floor area including veranda but excluding attic is 65 m² (700 ft²).

Context: The design is shown on an unbuilt site in Khandbari in Sankhuwasabha district at an elevation of 950 meters, and is derived from the local architecture. Khandbari is the population center of an agricultural region that suffered moderate earthquake damage. However, this design is relevant in many regions of Nepal, at altitudes 500 to 3000 meters wherever rice, wheat, or barley are grown and bamboo is available. Similar social, climate, economic, material, and architectural contexts can be found in other earthquake-affected districts such as Gorkha, Dhading, Nuwakot, Sindhupalchok and Ramechhap.

The design uses local materials of stone, bamboo, straw (paral), wood, sand and clay-soil. The straw bale walls are highly insulating, keeping the interior warm in winter and cool in summer.

Building Components:

Foundation: stone masonry with mesh-reinforced cement plaster,
Walls: stacked straw bales (compressed straw blocks, see sheet 2) stiffened with thru-tied vertical bamboo, covered with mesh-reinforced clay or lime plaster, and with a wood top plate. Inexpensive nylon fishing net from Kathmandu or other population centers can be used for plaster mesh.
Attic Floor: bamboo truss chords and bamboo joists, split bamboo subfloor, light clay-straw floor
Roof: bamboo trusses and rafters, wood purlins, and CGI roofing

The earthquake-resistant design is based on a house design and construction method used by Pakistan Straw Bale and Appropriate Building (PASBAB) since 2007 which was shake-table tested at the University of Nevada, USA in 2009, and is consistent with the 2015 International Residential Code, Appendix S – Strawbale Construction. Architectural and material adjustments were made for the context of Nepal. Earthquake-resistant measures include shock-absorbing straw bale walls with through-tied bamboo stiffeners and mesh-reinforced plaster, a CGI roof diaphragm, and well-connected components from roof to foundation. A seismic analysis and the roof framing design were done in accordance with the Nepal National Building Code and the Indian Standard for Structural Design Using Bamboo.

Straw bale buildings have been constructed in all 50 U.S. states and over 50 countries worldwide, including every climate and in high seismic regions. Some buildings from the early years of its invention in the U.S. are over 100 years old.
Straw Bale House Design
Khandbari vicinity in Sankhuwasabha District

First Straw Bales Made in Khorang Sankhuwasabha District

Straw Bales Are Made with a Steel Compression Mould and Farm Jack

1. Cost of locally made compression mould approx. 12,000 Rs and imported jack approx. 6000 Rs
2. Can be shared by community or owned by a bale fabricator

Photos from Pakistan, courtesy of PAKSBAB

Straw Bale House Under Construction in Pakistan
Photo courtesy of PAKSBAB

* Cost of locally made compression mould approx. 12,000 Rs and imported jack approx. 6000 Rs
* Can be shared by community or owned by a bale fabricator

Photos from Pakistan, courtesy of PAKSBAB

1-1/2 Story Straw Bale House Design
Khandbari vicinity in Sankhuwasabha District

Nepal Engineers' Association Rural Housing Design Competition in collaboration with the Ministry of Urban Development and UNDP

1-1/2 Story Straw Bale House Design

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1-1/2 Story Straw Bale House Design
Khandbari vicinity in Sankhuwasabha District

Nepal Engineers' Association Rural Housing Design Competition in collaboration with the Ministry of Urban Development and UNDP

1-1/2 Story Straw Bale House Design
Khandbari vicinity in Sankhuwasabha District

Nepal Engineers' Association Rural Housing Design Competition in collaboration with the Ministry of Urban Development and UNDP

1-1/2 Story Straw Bale House Design
Khandbari vicinity in Sankhuwasabha District

1-1/2 Story Straw Bale House Design
Khandbari vicinity in Sankhuwasabha District
Nepal Engineers’ Association Rural Housing Design Competition in collaboration with the Ministry of Urban Development and UNDP

1½ Story Straw Bale House Design
Khandbari vicinity in Sankhuwasabha District

Date: 27 December 2015

CONSTRUCTION SEQUENCE - Showing Primary Building Components
No Scale

Side Elevation
1:50

Front Elevation
1:50

Section 'A'
1:50

Through-Tie Bamboo
At Every Other Course
Opposing Bamboo Stiffeners @ 60 CM O.C.
30x30x60 CM Strawbales in Running Bond
Wood Top Plate
Metal Connectors from Truss to Top Plate
Mesh on both sides of wall
Extra Band of Mesh at Top and Bottom of Wall (See Details)

Diagonal Bracing Between Trusses

Interior Plaster
2 Coats Clay Plaster w/ Lime Wash Finish
Finish Coat: Lime
1st Coat: Clay
Cement Plaster over Foundation

CGI Roofing and Roof Diaphragm
Split Bamboo Attic Subfloor
Light Clay Straw Earthen or Concrete Floor

Window Buck

1½” x 4” Purlins
26 Ga. CGI Roofing

Door Buck

1220

TRUSSES @ 1220 O.C.
Gable Vent Beyond Trusses @ 1220 O.C.

Builders Without Borders – Berkeley, CA, USA
MarAn Hammer, Architect
marAn@builderswithoutborders.org
1-1/2 Story Straw Bale House Design

Nepal Engineers’ Association Rural Housing Design Competition in collaboration with the Ministry of Urban Development and UNDP

Khandbari vidi�ality in Sankhuwasabha District

Date: 27 December 2011

1-1/2 Story Straw Bale House - Cost Estimate

<table>
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<th>Material</th>
<th>Quantity</th>
<th>Unit</th>
<th>Unit Cost - Rs</th>
<th>Total Cost - Rs</th>
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</table>

Unit Cost - Rs

1000

Total Estimated Cost

760,000

Note: Floor area incl. Veranda excl. attic. = 65.52 (1200 sq ft)

1000 x 65.52 = Rs 65,520