



Sustainable reconstruction in Jacmel, Haïti Project “A Roof, A Future”

ARCHITECTURE & DÉVELOPPEMENT 's conceptual
and technical input





Haïti

RECONSTRUCTION OF A SUSTAINABLE HABITAT USING CONFINED STONE WALL TECHNOLOGY



Context

This project constitutes phase 2 of the "A Roof, A Future" programme. On 12th January 2010, an earthquake of magnitude 7 on the Richter scale, struck Haiti causing considerable damage. More than 200,000 people died and a further 1.3 million lost their homes. Several months after the immediate disaster-relief phase, A&D (in a technical role) partnered with Planète Urgence to implement a programme of reconstruction of rural habitats. The local context is integral to our approach to re-development, which utilizes stone gabion wall technology. The project should provide re-housing for 100 families in the Jacmel rural zone, La Montagne. The approach is based on a local farmer organization implemented since 2004 in the area, Opadel.

Objectives

- Provide a reliable and sustainable response to the housing and amenity needs of the most vulnerable people, through an integrated approach respectful of local development.
- Educate artisans and self-builders on simple hurricane and earthquake-resistant technologies. Provide accessible know-how on sustainable reconstruction, by introducing stone-wall gabion technology.
- Develop stone-wall gabion technology for self-help construction, with the aim of creating a new building sector that covers both rehabilitation of existing structures and new construction.
- Value the usage of local materials.
- Enable the local population to access a bioclimatic and economic habitat.

Approach

The project offers a global approach to reconstruction through provision of appropriate and accessible technology - which can be taken on by local entrepreneurs and craftsmen - and a new resource centre for habitats and sustainable, bioclimatic construction.

The project also includes prototype control buildings, construction 'schools', a workshop to produce building materials and two community hurricane refuges. Together with educating locals in self-help construction, this gives a new impetus to rural areas.

TECHNICAL OVERVIEW

july 2012 - nov 2013

Project roles

- Assistance to project promoters
- Education – construction schools
- Site supervision

Process

- A&D expert coach on the ground for 6 months
- Construction of prototype buildings as a teaching exercise
- Creation of a workshop, which prefabricates stone-gabion wall frames and cages
- Collaboration with the buildings' end-users
- Prefabrication of hurricane-resistant structures
- Technical supervision and provision of construction manuals

Expected results

- Initiate a local supply chain for stone-wall gabions
- Awareness of sustainable construction practices
- Improved habitat resilience to extreme weather
- Economical and environmental housing

The project in numbers

- **1** reproducible prototype house using stone-gabion wall technology
- **35m³** of stone per house
- **55** new **35m²** houses
- **60** tradesmen skilled in stone-gabion wall technology
- **4** km of galvanized steel wire per house
- Construction cost **85€/m²**

Personnel

- Ludovic JONARD, *Architect*
- Aurelio DOUAY, *Timber expert*
- Guy BESACIER, *Seismic engineer*

Project partner



Financing





STONE-GABION WALL TECHNOLOGY FOR A LONG TERM RESPONSE



Origins of the technique

The concept of and technical introduction of stone-gabion wall technology in the project "A Roof, A Future" stem from A&D's ongoing investment and technical research in post-disaster re-housing in Pakistan, since 2005. The main goals were to reduce production costs and environmental impact and to increase the socio-economic performance of reconstruction aid programmes. After a research and development stage involving the construction of two prototype houses in Morocco (2010), A&D developed for Planete Urgence a housing model combining wood and stone-gabion wall technology, which achieves exemplary and innovative construction performance.

An anti-seismic device

Stone-gabion wall technology utilizes the rigidity of a mass of stones and the flexibility of metal cages to create a structure whose natural frequency sits within the optimum 0.3s-1s range. The Laboratory of Civil and Mechanical Engineering at INSA, Rennes, used the computer code, Cast-3M – created by the CEA (Centre of Atomic Energy) - to numerically model and understand the behaviour of stone-gabion walls. Under Eurocode 8, stone-gabion wall buildings can resist earthquakes of magnitudes greater than 5.5 and a maximum ground acceleration of 3m/s² (Seismic Zone 4).

Using Local Resources

The most interesting aspect of this technology is the use of stones collected on site, thus benefitting from local materials and limiting the need for imported materials (and their associated transport costs and environmental impact). The site is dry, masonry is not required. Consequently, cement and its associated problems are avoided.

Self-help construction

Investment in the project by the beneficiary families is fundamental. Each family must collect 35-38m³ of stones that can be placed in the woven metal cages, which form the bedrock of the house. Construction of the walls (with no foundations) is very easy and requires 1 mason, 1 skilled worker and 3 beneficiaries. This technology is reproducible due to the simplicity of construction. It can therefore be appropriated by unskilled workers (self-help builders). The beneficiaries' financial contribution also guarantees their 'ownership' of the project. Due to their involvement from the start of construction, they know how to maintain the building into the future.

Development of a new supply chain

At the same time, the project aims to develop a local supply-chain by training craftsmen and teaching them alternative building techniques. The creation of building material workshops and a construction school ensures this training and knowledge transfer. This is the most delicate but also the most crucial aspect of the projects' long-term success.

TECHNICAL OVERVIEW

For an innovative response, adapted to post-crisis reconstruction situations

- Provide an immediate, sustainable and economically competitive response that goes beyond standard emergency housing.
- Value local resources and mobilise an unskilled workforce.
- Limit importation of expensive materials, logistics costs and the use of cement.
- Transfer and evolve stone-gabion technology – well known in rural and civil engineering fields – into the housing sector and develop seismic-resistant construction technologies.
- Include and train solo-entrepreneurs. Convince beneficiaries to become self-promoters and less dependent self-builders.

Advantages

- Dry construction, which is easily reproducible and requires little skill
- Modular plans and base building elements
- Seismic-resistant construction
- Low environmental impact

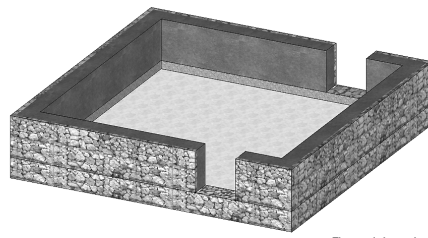
Key figures

- 150 cages per house
- 50 cages produced per day by 10 people
- 1 cage : 0,25m³
- 150 cages filled by 5 people in 6 days
- 270 kg of steel per house

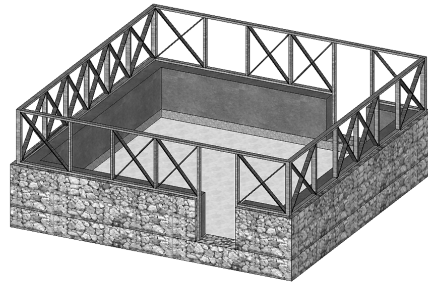


ARCHITECTURE & DÉVELOPPEMENT
ASSOCIATION DE SOLIDARITÉ INTERNATIONALE

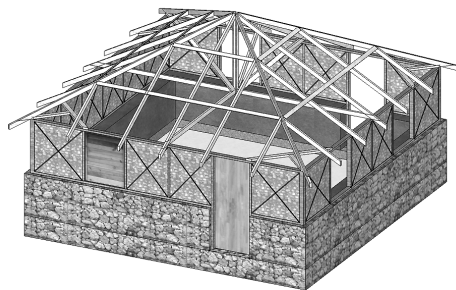
THE 7X7 HOUSE OF TIMBER AND STONE-GABION



Floor slab and stone-gabion walls



Braced timber frame



4 panelled seismic-resistant roof frame



Effective Architectural Design

A&D developed the model of a 4 to 5 person family house. The compact, rectangular plan facilitates arrangement of the stone-gabion cages and timber bracing structure, on which the anti-seismic roof sits. This assembly guarantees the stability of the structure in extreme weather and provides improved thermal comfort.

A quick and safe construction

- Construction of the walls (with no foundations) is very easy and requires 1 mason, 1 skilled worker and 3 beneficiaries. The site is dry, no masonry is required. The structural walls are comprised of cages filled with stones collected locally.

- The cages are fabricated from a woven mesh of galvanised steel. These are cut, folded and assembled as elements to form the containment for the walls.

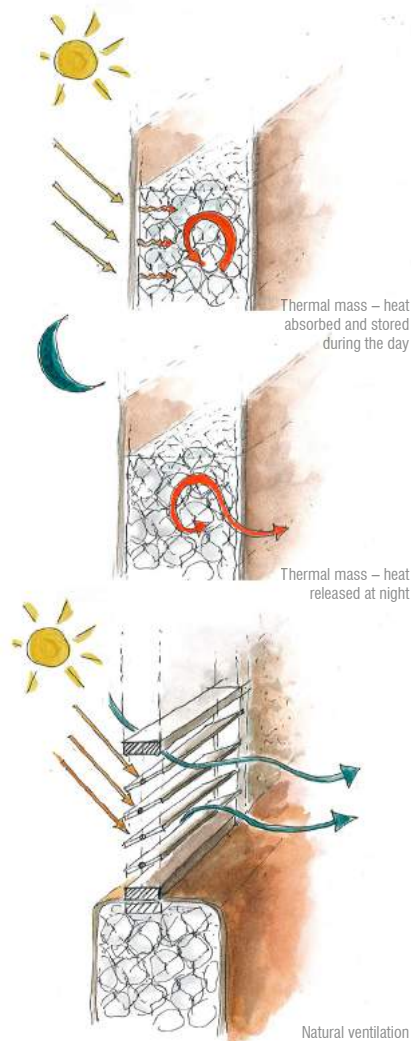
- The cages are filled in bulk, by hand to a height of 1.2m. The individual elements of the stone-gabion walls are linked together. The timber framing that sits above is inserted into these elements.

- The hurricane-resistant timber framing is bonded into the stone-gabion walls, forming a seismic-resistant assembly. The roof is of corrugated iron. The walls are finished with earth and lime.



ARCHITECTURE & DÉVELOPPEMENT
ASSOCIATION DE SOLIDARITÉ INTERNATIONALE

FOR A SUSTAINABLE, SAFE, ECONOMIC AND BIOCLIMATIC RESPONSE TO RECONSTRUCTION



An economical and sustainable building

The 35m² house - combining wood and stone-gabion wall technology and utilizing self-help construction - costs approximately €3000 (supply and installation). Compared with 18m² T-Shelters or standard construction costs in Haiti of €300/m² this is an excellent low-cost model for durable and comfortable housing. Combined with a simple architectural form, the stone-gabion wall technology is efficient to implement and reduces production times.

Hurricane and Seismic-resistant construction

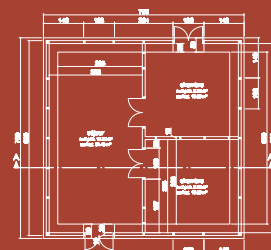
A light-weight timber frame is fixed above the seismic-resistant stone-gabion walls. This braced frame uses local construction techniques. The light-weight roof comprised of 4 panels also suits local typologies. Bonded to the walls, it forms a seismic-resistant assembly.

Sustainable and bioclimatic construction

The finished, stone-gabion walls provide the house with a good thermal performance. The 50cm deep walls comprise stones and voids with no other special apparatus. The stones and earth/lime finish provide good thermal mass and the air trapped in the voids improves the envelope's thermal resistance. Natural ventilation is provided through shutter openings and ventilation grilles with detachable wooden doors.

TECHNICAL OVERVIEW

7x7 house of timber and stone-gabion



The house in figures

- Habitable internal area : 35m²
- Stone-wall gabion bedrock
 - Stones: 35m³
 - Mesh: 200m²
 - Cages: 150 units
 - Wall finish earth/lime: 160m²
- Timber frame + infill
 - Timber frame: 0,5m³
 - Infill stones: 3m³
 - Wall finish earth/lime: 35m²
- Roof
 - Timber structure: 1,5m³
 - Sheet metal: 70m², 30 pieces
- Cost price: 3000€/house
- Value of beneficiaries' participation: 2000€/house
- Total Cost: 5000€/house
- Construction time: 5 weeks

Project partner



Financing





Acknowledgments

This project has been built by the A&D team as part of a technical assistance mission related to the "A Roof, A Future" phase 2 project (La Montagne, Jacmel, Haiti) on behalf of Planète Urgence, with the support of Fondation Abbé Pierre and Secours Catholique-Caritas France

Project contributors :

- Aurélio Douay, journeyman carpenter, technical coordinator
Training, stone-gabion wall implementation optimization, photos
- Guy Besacier, seismic engineer/architect
Recommendations and structural dimensioning
- Frédéric Potier, trainer-logistician
Stone-gabion wall technology transfer and optimization
- Silvia Gallo, architect
Technical monitoring, training material creation, writing and desktop publishing
- Ludovic Jonard, architect, project manager
Graphic design, coordination and technical supervision
- Anne-Lise Leymarie, architect
Training material creation, writing and desktop publishing
- Pauline Carriot, architect
Training material creation, writing and desktop publishing
- Estelle Collinet, architect
Training material creation, writing and desktop publishing

Contact in Haïti

Silvia Gallo sgallo@archidev.org

Contact in Paris

Ludovic Jonard ljonard@archidev.org

<http://www.archidev.org/>

The goal of 'stone-gabion wall' technology is to significantly reduce sensitivity to climatic risks and to provide a long-term housing solution at good value for money. These self-help housing projects do not claim to strictly comply with international seismic and high pressure regulations. However, they help raise awareness of better building practices for post-disaster reconstruction.

The "stone-gabion wall" technology for sustainable housing has been designed and developed by A&D since 2005. It is currently being implemented in Morocco, India and Haiti. Though not patented, this process is guaranteed only through A&D expertise and support during the implementation.



ARCHITECTURE & DEVELOPPEMENT
ASSOCIATION DE SOLIDARITE INTERNATIONALE