CONFINED STONE WALL (CSW)
A sustainable option for a better and safer reconstruction in rural Nepal

TRIBHUVAN UNIVERSITY
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Architecture & Développement

• International NGO based in Paris
• 20 years of experience
• Over 100 projects on 4 continents
• Core group of senior experts
• Task force of volunteers

Competences:
Technical expertise, advisory, design & project management, participatory construction, hands-on trainings, supervision, monitoring and evaluation.
Mission statement

• To create processes compatible with a holistic & sustainable approach, taking into account social, economic and environmental concerns

• To improve the quality of the built environment in emergency, post emergency and development contexts

• To promote the social role of professionals in the construction sector
CSW program background

Pakistan (2005) : First idea after the Batagram earthquake
Morocco (2010-2012) : 4 prototype modules in 2 locations
Haiti (2012-2013) : Post disaster reconstruction - 60 houses + income generation program
Morocco (2015 – 2017) : thermal and cost efficiency water/sanitation, class room
Nepal (2016 – 2017) : demo house + seismic tests
Post disaster Social Center for women and children (Morocco, 2011)
Pre-school in the desert (Morocco, 2012)
Post disaster rural housing scheme (HAITI, 2013)
Model units in a eco friendly campus (Morocco, 2015)
CONFINED STONE WALL (CSW)

STONES + WIRE MESH CAGES + MUD PLASTER

A SAFE AND PERMANENT BUILDING

CSW - CONFINED STONE WALL
PHASE 1 : FOUNDATIONS

No specific foundations: the structure sets on a layer of burried CSW that can be protected with a waterproof and anti-termite barrier. This allows for building in a diversity of sites, even on unstable soils.
PHASE 2 : WALLING

The **cages are manufactured on site** in a workshop equipped with a table for weaving hot galvanised steel wire. **Walls are built continuously** by piling up wire cages and filling them with raw stones.
PHASE 3 : OPENINGS

A **first frame** is placed into the CSW wall for each opening. A secondary frame is then inserted to attach doors and windows openings.
CSW - CONFINED STONE WALL
PHASE 4 : FLOORING

The flooring structure is placed on a wooden tie band, embedded into the upper row of cages.

Joist are stiffened with spacers. They bind all the floor together with the bearing wall and create a diaphragm structure (action box)
PHASE 5 : ROOFING

CSW allows for many types of roofing structures and can be adapted to locally available or recycled materials.
Trusses are designed to connect to the floor and allow more habitable space.
CSW - CONFINED STONE WALL
Walls are **plastered on both sides** to protect the wiremesh and isolate from humidity, cold and insects. The plaster composition is adapted to **available material** and vernacular building practices.
SIMPLE TO IMPLEMENT

**Dry technique** (no water, no cement)

No need for **complex tools**

Participatory construction with **unskilled labour**.

Building process that reduce **errors in workmanship**.
ADAPTABILITY

Simplicity, modularity and efficiency allow for diversity of geographic contexts

Typology flexibility (distribution of modules and partitions as needed)

Adapted to rural or suburban areas, for individual housing or for small community facilities

Formal diversity that respects vernacular architecture

Suitable for backward areas (social-economic isolation, logistic difficulties, technical precariousness)
SOCIO-ECONOMIC IMPACT

Construction performance
Recycled and local materials, sound technology, no mechanisation, easy monitoring

Owner driven process
High in-kind contribution of beneficiaries: Stone collection, cage manufacturing, filling and assembling of components

Social and economic insertion
Local production/supply chain, income generation programmes

Community dynamics
Participatory project, housing cooperatives, easy replication, familiar technology

Cost efficiency
Lox cost material, high intensive labour, non contractors or middle-men
BIOCLIMATICAL FEATURES

Added value of locally available materials
Rocks, earth, lime,

Energy efficiency
High thermal capacity, passive solar conception, reduced need for heating. Reduction of energy precariousness, increased comfort

Low environmental footprint
Recycled material, low grey energy, limited CO² emissions

CSW has a large thermal inertia and a resistance of around 0.60 m².K/W (equivalent to brick wall + 10cm styrofoam panel)
SEISMIC PERFORMANCE

CSW achieves static and dynamic structural integrity with interrelated concepts of architectural design (action box) and CSW absorption/properties (energy dissipation by friction).

CSW technology combines the hardness from stones and the ductility of steel. The result in a seismic context is at first rigidity and then plasticity.
SEISMIC BEHAVIOUR

Initial studies show CSW system can withstand high seismic activity, yet further studies are needed to certify the properties.

Numeric Finite Elements Modelisation with Cast 3M calculation code from CEA (Commissariat Energie Atomique, France)
Nepal 2016 – 2017 : CSW as an alternative for owner driven reconstruction?

- Demonstration unit with TU
- Extended tests
- Compliance with Building Code and DUDBC standards

**Academic / Corporate / NGO partnership**

- Dissemination
- Pilot projects
- Hands-on trainings
- Income generation activities (wire mesh)
CSW HOUSE: Proposal for DUDBC

Layout

This model is under process of approval, dimensions and specifications are merely informative

Facades
THE CSW PROGRAM IN NEPAL

Designed and implemented by:

In Partnership with:
Engar PVT LTD
Tribhuvan University

Funded By:
Thank you!