Build earthquake-resistant houses
Change construction practices permanently

SEISMIC RETROFIT OF HOUSING:

HOW TO BEGIN PERMANENT RECONSTRUCTION AS SOON AS THE RUBBLE IS GONE

Gordon Goodell
Director of Engineering
Build Change

Shelter Meeting 13a
26 April, 2013

Build Change

HOMEOWNER-DRIVEN PERMANENT HOUSING RECONSTRUCTION AND RETROFITTING

Elizabeth Hausler Strand, Ph.D.
Founder and CEO

Shelter Meeting 12b
October 31, 2012

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USAID
FROM THE AMERICAN PEOPLE

BUILDING BACK HOUSING IN POST-DISASTER SITUATIONS – BASIC ENGINEERING PRINCIPLES FOR DEVELOPMENT PROFESSIONALS: A PRIMER

January 2012

This report was produced for review by the United States Agency for International Development (USAID). It was prepared by Build Change for International Resources Group (IRG).

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USAID
FROM THE AMERICAN PEOPLE

Seismic Retrofit of Housing in Post-Disaster Situations – Basic Engineering Principles for Development Professionals: A PRIMER

DRAFT

December 2013

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Site Hazard Mitigation in Post-Disaster Situations – Basic Engineering Principles for Development Professionals: A PRIMER

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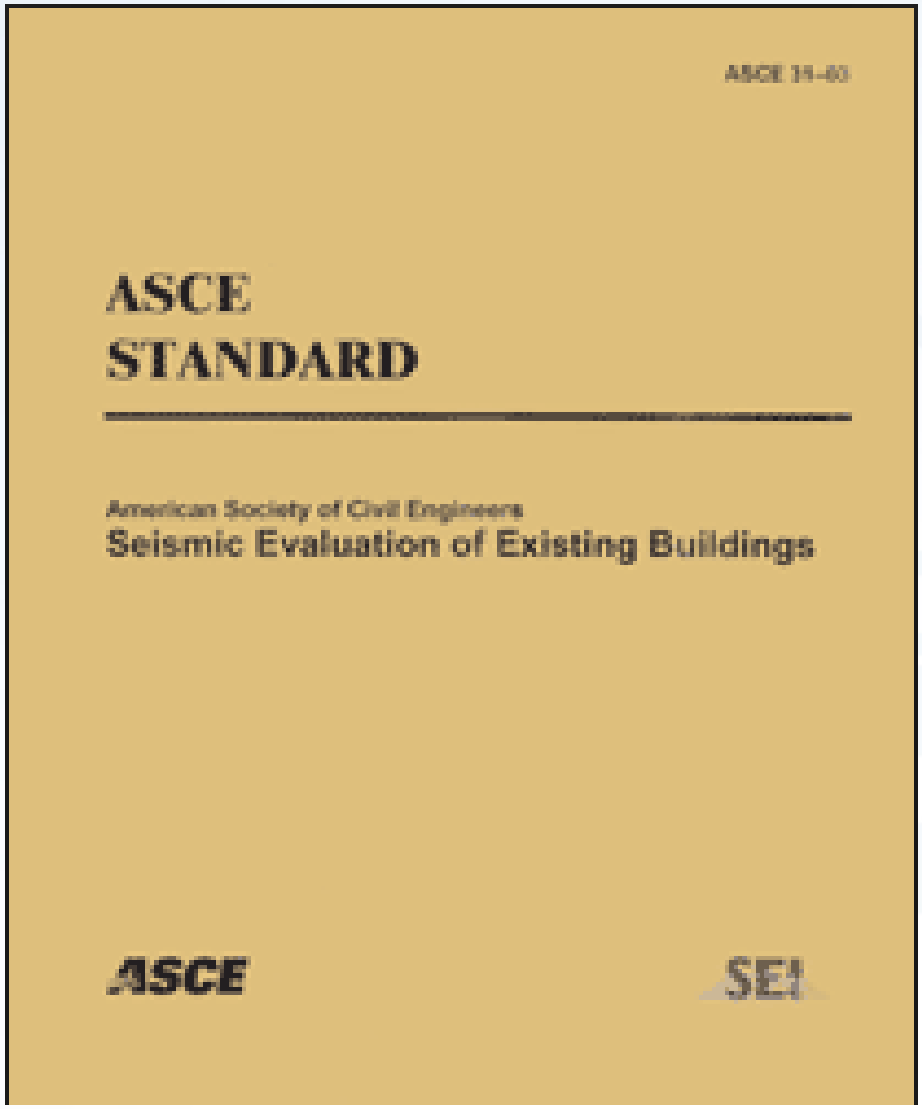

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COST (Materials and Labor) *as of 10/23/2012*

COST (US$)	Villa Rosa (Canape Vert)	Ti Sous (Carrefour)
RETROFITS		
Red Tag Cost/m^2	$99/$m^2$	$84/$m^2$
Yellow Tag Cost/m^2	$40/$m^2$	$56/$m^2$
NEW BUILDS		
New Build Cost/m^2	$219/$m^2$	$182/$m^2$
Avg Cost Per Bldg	$3,507	$3,423

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"**Haiti's Homeless: Is 'Transitional' Housing the Solution?**," Desvarieux, J., Time, 16 July, 2010.

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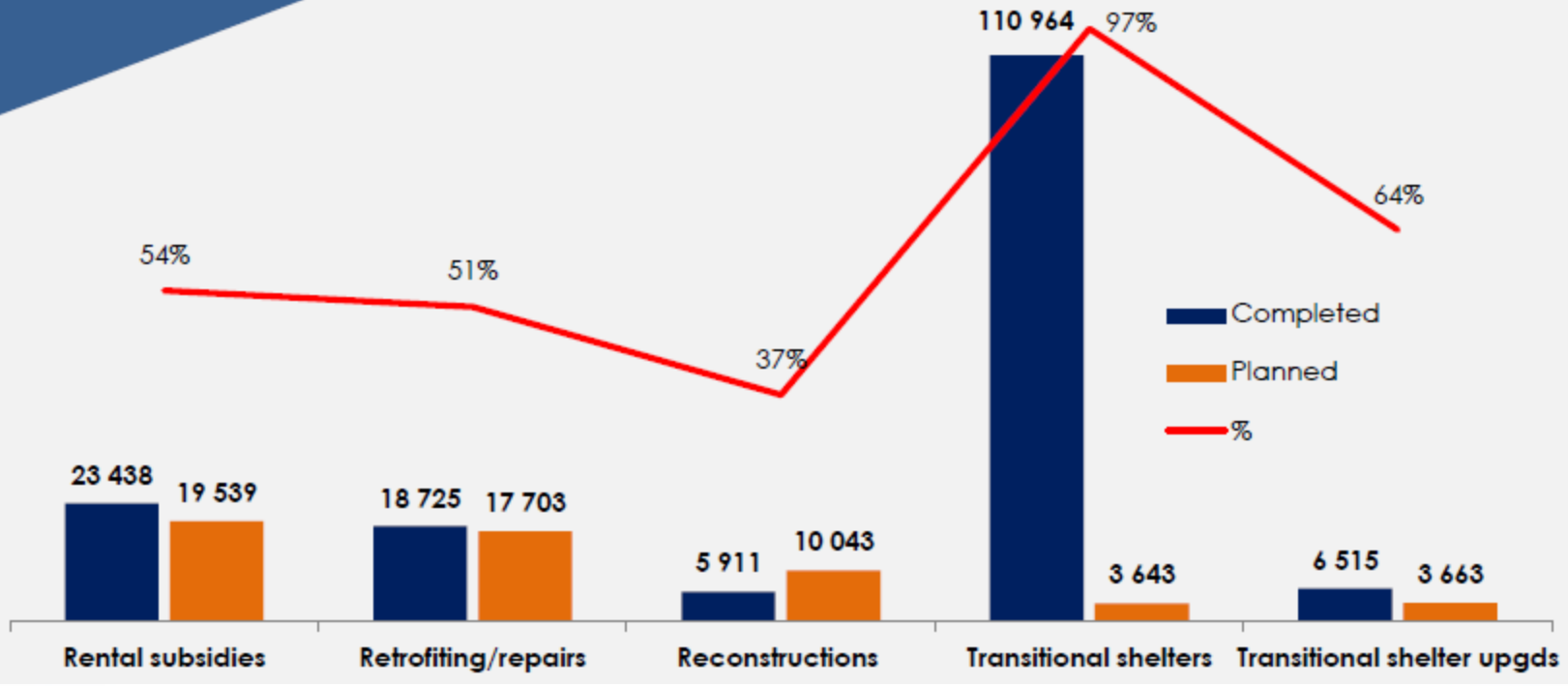
IASC Inter-Agency Standing Committee
HAITI E-SHELTER/CCCM CLUSTER

II. RETURN SOLUTIONS

2.1 Reconstruction activities – November 2012

(Information Unit, Cluster)



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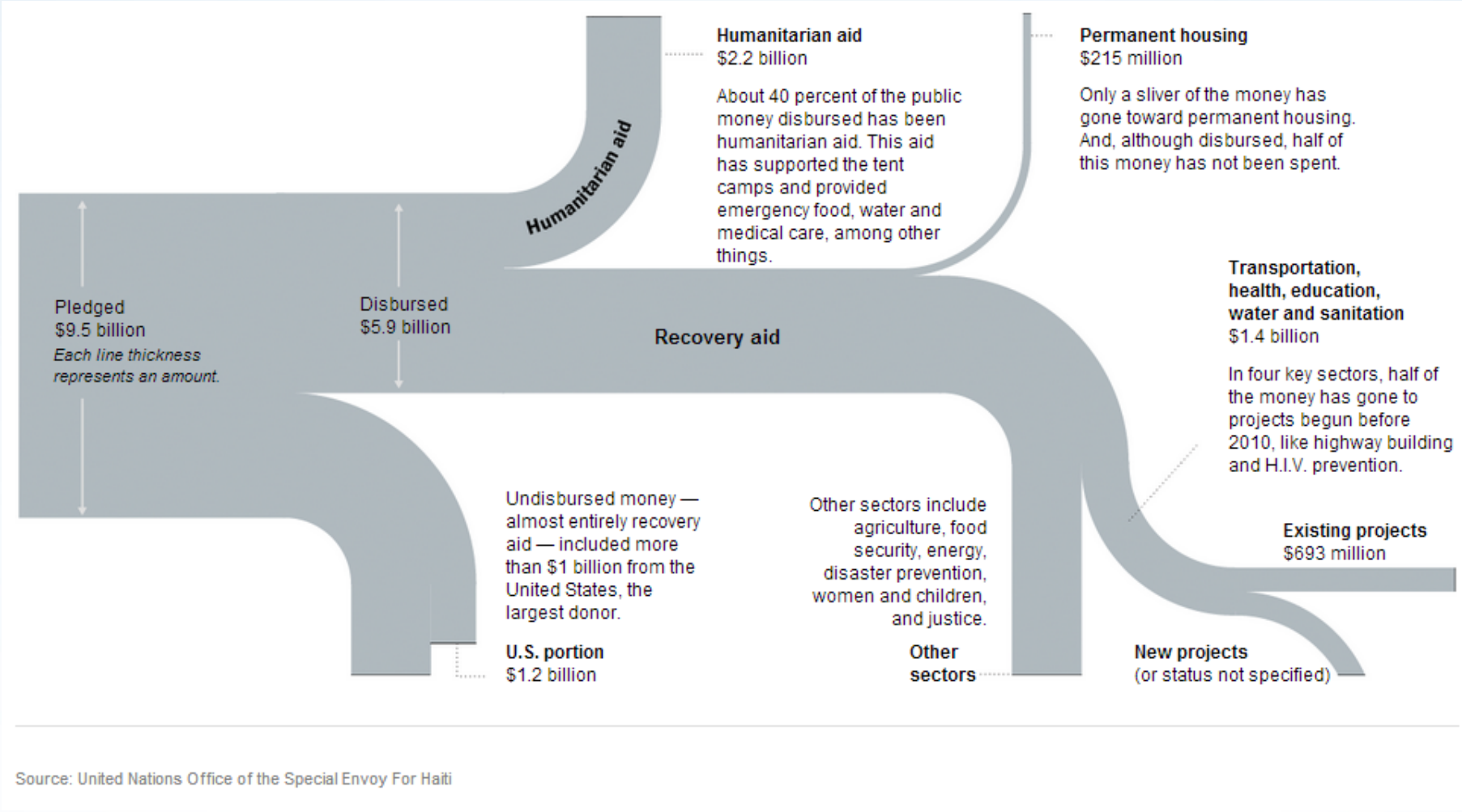

"Rebuilding in Haiti Lags After Billions in Post-Quake Aid," Sontag, D., NY Times, 23 Dec, 2012.

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HAITI 3-YEAR CASE STUDY ($US), JANUARY 2010 – DECEMBER 2012

International funds disbursed:	5.9 billion
Funds to humanitarian aid:	2.2 billion
Funds to shelter (tents, T-shelters, rent subsidies):	1.2 billion
Funds to T-shelters (110,964):	500 million
Average cost per T-shelter:	4,506
T-shelter funds spent in Haiti:	100 million
Funds to recovery aid:	3.7 billion
Funds to permanent shelter:	215 million

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Cordain No.: _____ Homeowner: _____ Homeowner telephone: _____

BC Engineer: _____ Boss: _____ Boss Telephone: _____

D0.2

Repair of wall to roof connection

Method

1a Remove loose and flakey masonry using chisel and wire brush
1b Roughen underside of slab using chisel
2 Mix dry-pack (Cement:Sand 1:2). Add just enoght water so that you can form a ball of mortar that sticks together.
3 Pack gap with mortar using a hammer and wooden dowel to completely fill joint.

Checklist

1	Surface Preparation	Implemented correctly ?	Date	Photo #	If step not correctly implemented, following advice given:	Advice followed?	Date	Photo #	Action taken if advice not followed:
a	All loose and flakey material has been removed	Yes / No				Yes/No			
b	Roughen underside of slab using chisel	Yes / No				Yes/No			
2	**Mortar Mixing**	**Implemented correctly ?**	**Date**	**Photo #**	**If step not correctly implemented, following advice given:**	**Advice followed?**	**Date**	**Photo #**	**Action taken if advice not followed:**
a	Use mortar 1:3 mix	Yes / No				Yes / No			
b	Use clean, fine river sand	Yes / No				Yes / No			
c	Use clean water (not salty or muddy)	Yes / No				Yes / No			
d	Use Type 1 Cement	Yes / No				Yes / No			
e	Mix on a clean, concrete or asphalt surface, not on dirt	Yes / No				Yes / No			
f	Turn over 3 times or until color is uniform	Yes / No				Yes / No			
g	Add just enoght water so that you can form a ball of mortar that sticks together.	Yes / No				Yes / No			
3	**Implementation**	**Implemented correctly ?**	**Date**	**Photo #**	**If step not correctly implemented, following advice given:**	**Advice followed?**	**Date**	**Photo #**	**Action taken if advice not followed:**
a	Use hammer and wooden dowel to pack mortar into joint	Yes / No				Yes / No			
b	Joint completely filled	Yes / No				Yes / No			

Homeowner Signature: _____ Date: _____

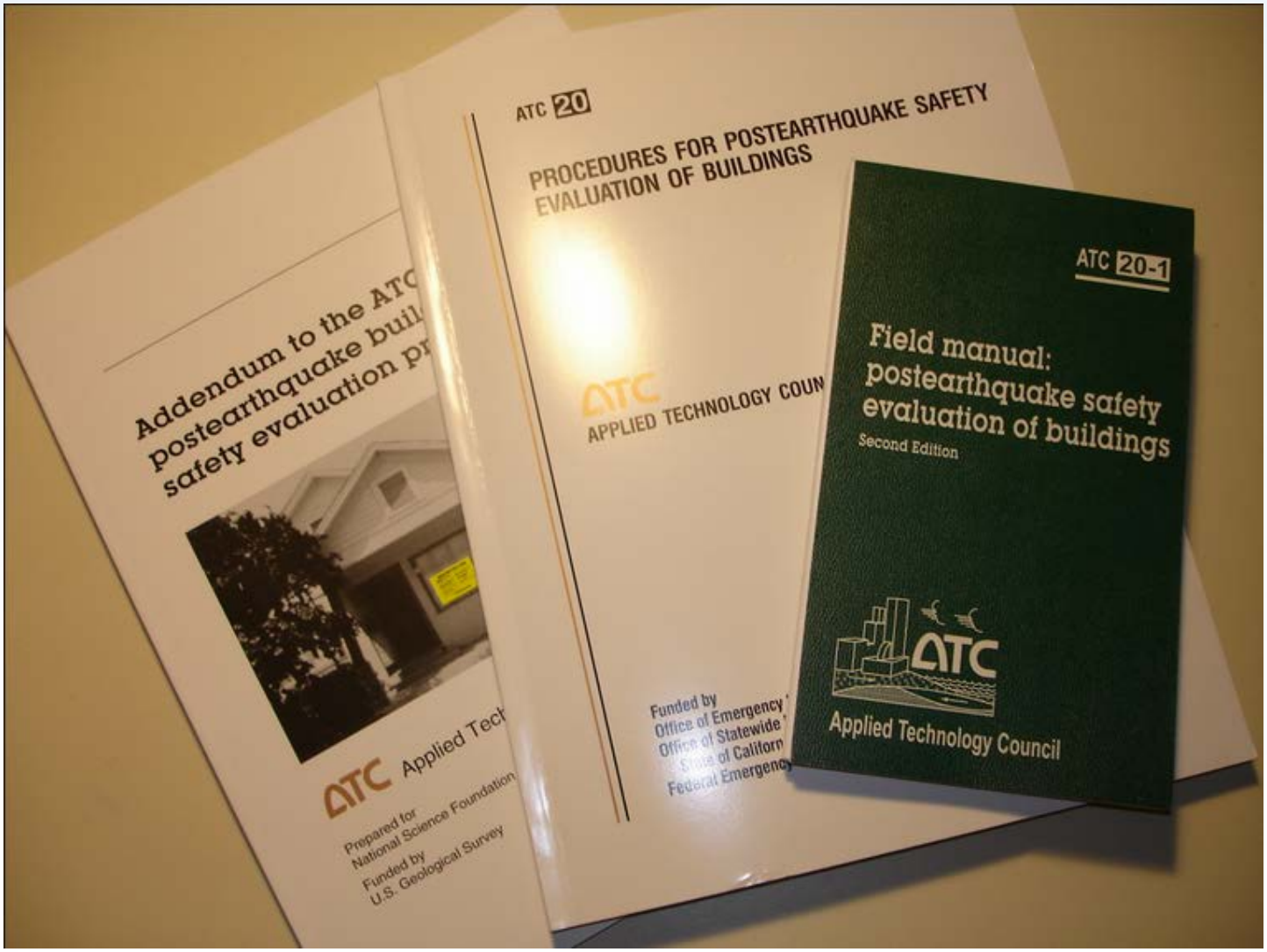
BC Engineer Signature: _____ Date: _____

BC Team Leader Signature: _____ Date: _____

Overall Assessment: Meets Minimum Standard?

Yes / No

Comments:



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Seismic Evaluation Checklist: Low-Rise Haitian Masonry Construction
Unreinforced, Confined, or Infill Masonry

		MASONRY WALLS	NOTES
4.4	**Transverse** Story C-NC-N/A 3 2 1 **Longitudinal** Story C-NC-N/A 3 2 1	WALL AREA PERCENTAGE: The provided Wall Area Percentage shall be greater than the required Wall Area Percentage at each level and in each direction. Note the Wall Area Percentage provided and required on the right, and C, NC, or N/A in the column to the left.	**Wall Area Provided and Required** **Transverse** Story Required Provided 3 2 1 **Longitudinal** Story Required Provided 3 2 1

	# Stories in Building			
Level	1-Story	2-Story	3-Story	Notes
3	-	-	4.7	For buildings with heavy floors and roofs having concrete slabs, concrete joists, and masonry void forms.
2	-	4.6	8.1	
1	4.0	6.9	9.6	
3	-	-	3.0	For buildings with light roofs made of sheet metal and wood framing.
2	-	3.0	5.2	
1	3.0	4.0	6.9	

Assumptions:

Sds = 1.05g, for other design ground motion values ratio accordingly.

URM construction. For compliant CM or IM construction use 50% of these values, 1.5% minimum..

"Average" quality construction. For poor quality construction increase by 50%.

Concrete block strength is 4.8MPa. See Manual for adjustment to other strengths if required.

Building Evaluation, increase by one third for evaluation of a proposed Retrofit Design.

Block is typical 15cm, between 50% to 60% solid, and not plastered. For other thicknesses and net solid area ratios adjust the required WAP accordingly.

5.0		BUILDING CONFIGURATION	NOTES
5.1	C NC N/A	TORSION: Walls are located on all exterior sides of the building, or within 25% of the plan dimension at the wall location, including L-shaped and T-shaped plans. Alternatively the estimated distance between the center of mass and the center of rigidity shall be less than 20% of the maximum building width in either plan dimension.	
5.2	C NC N/A	ADJACENT BUILDINGS: If floor and roof slabs of adjacent buildings are not vertically aligned, then the contact distance shall be greater than 3 cm for single story structures, 6 cm for two-story structures, and 9cm for 3-story structures. If floors and roof slabs are aligned the item is compliant.	

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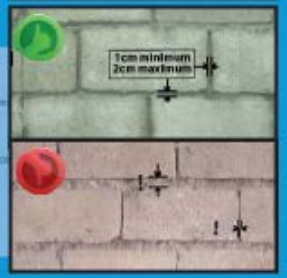
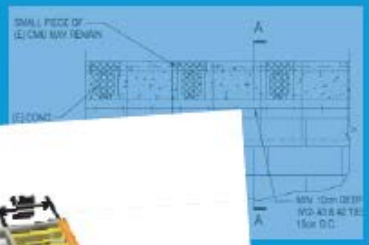
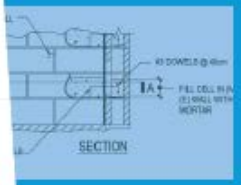
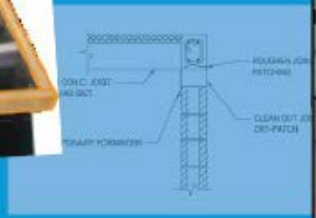
GUÍA FOTOGRÁFICA DE REFORZAMIENTO

Ayuda visual en la ejecución de refuerzos anti sísmicos









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Thank you. Please contact any of us at Build Change.

Gordon Goodell

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Build Change so far:

15,000 people trained in earthquake-resistant construction

20,000 earthquake-resistant homes built or retrofitted

80,000 people safer

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The Tech Awards Laureate 2008

CGI Commitment Maker 2010

echoing green social change starts here

Kingdom Foundation

ASHOKA

HILTI FOUNDATION

DRAPER RICHARDS FOUNDATION

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Imogiri, Central Java, after 27 May, 2006.

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Lesson #3: Donor-driven models make projects more expensive.

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Lesson #7: Homeowners will contribute their own funds.

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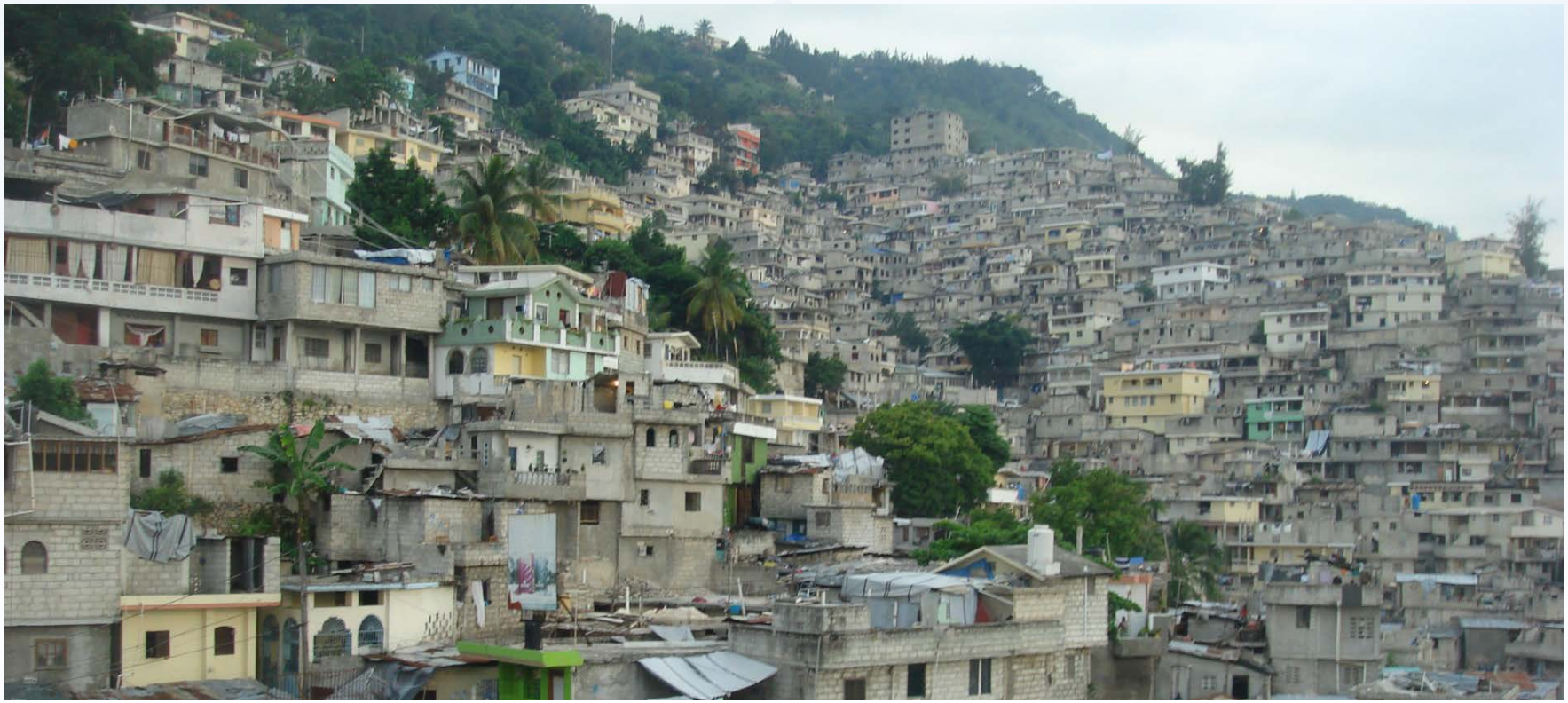
Lesson #7: Homeowners will contribute their own funds.

Lesson #10: Retaining walls must be addressed in steep, urban environments.



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Lesson #12: A horizontal ring beam should always be provided, even for a sloped lightweight roof.

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Lesson #13: Train workers, not just contractors.

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Lesson #16: SME blockmakers can make 10 MPa blocks.