



## **Photographic Report** | Second Phase of Post Earthquake Reconstruction Effort + Training of Earthquake Banding Team | Bhattedanda, Dhulikhel, Nepal

28th April to 6th May

Prepared on 15/5/17 by Adriano Pupilli Architects for



HEALTHABITAT O/S LTD and

Rotary



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WORLD COMMUNITY  
SERVICE



The banding team left to right: Raj Kumar, Surya, Hori, Surya Tamang, Som, Prem

## Background

This is a photographic report documenting phase two of the post 2015 earthquake reconstruction effort in Bhattedanda Village, Dhulikhel, Nepal.

This effort is focussed on the strengthening of existing stone and mud housing types found in the village using a system of reinforced concrete banding and pillars at strategic points of vulnerability.

Phase two also involved the training of a local five person banding team and supervisor Surya Tamang. I would like to take this opportunity to personally thank the Banding Team (left), Surya Tamang, Prem Lama, The Village Development Committee and Bishnu Shresta for their hospitality, hard work and considerable talents during my one week stay.

The following report is structured into three main parts:

## Process | Findings | Actions





Foundation trenches being dug



Stone laid into foundation trenches



Cutting steel reinforcement for band no.1 at foundation level



Bending 4' x 4' L rods connecting straight steel runs in first band



1mm wire ties to hold rods together



3mm wire ties to form steel reinforcement ladder

# Process





3"x1" timber formwork for banding laid in place for 3"x1" cross pieces



Concrete is batched onsite....



First placing concrete into the 4" core holes



Then filling the rest of the band formwork



Steel trays are used to transport the concrete



The completed first band at foundation level : 6 bags cement used to this point

## Process





Attempt to make clumps when concrete band set did not bind to band adequately



At H2 (Bambo) the clumps were poured while the band was wet, this is best practice



The stone mason team supplied by the householder laying the first two feet of wall



"Hold pass" being installed in the window and door frames



Door installed taking care to ensure 4' offset from any outside walls, allowing for L reinforcement



L reinforcement being threaded over vertical reinforcement

## Process





2' band level, vertical rod core holes being poured



4" core hole pipe being lifted as concrete filling in hole



Core hole being poured, also "hold pass" concrete anchor to door jamb tie shown poured below...needs to be allowed for in materials



2' L band troweled on to 3" using sand and cement mortar mix



Stones being laid while mortar wet to maximise grab between stone and cement



10 bags of cement used to this point

# Process





Stone up to 3' laid



Concrete mix being poured into 4' band core holes



Gradual lifting of pipe as concrete is poured prevents it getting stuck



Mortar mix being poured at T and L junctions



Completed L, T and cores...clumps to follow

## Process





Clumps shown on wet mortar L's and T's -  
photos by Surya Tamang



Bamboo scaffolding in place and stone masons  
progressing to 6' band



Concrete lintel laid over door







Trenches for foundations dug before arrival



Stone installed prior to arrival



Checking trench and footing dimensions on arrival to site



Widening the footings to 2 1/2'



Checking depth is 2'



Width of 2' accepted as partially existing

# Process





First band being poured



Unskilled labour assisting with a human conveyor belt passing concrete from batching to band



Manual batching of the cement by the householder



Filling 4" PVC pipes with concrete



Then pouring of the band - 8 bags cement used to this point



The completed foundation band with stone masons commencing laying of stone

## Process

House 2 | Bambo

Final Report | 10





Stone being laid while the band is wet to maximise grab between stone and cement



It proved difficult to coordinate stone mason team with the banding team



Local mud placed onto stone to secure the next course



Clumps installed when it was realised time would not permit the masons from completing the first layer of stone before the concrete set



Mud from excavated footings being used to build the walls with minimal waste



# Process





Door supplied and located by the household following simple rule of allowing a 4 1/2' offset from outside face of stone work to door jamb



Checking for 4 1/2' offset minimum, allowing for T reinforcement



Stone mason team building up first 2' level of wall



Banding team setting up L and T reinforcement at corners and cross walls



Banding team pouring mortar to L's and T's



Banding team came up with a new way to hold formwork in place using bent steel bar

# Process





Stone masons progressing following completed 2' banding - photos this page by Surya Tamang the next week



Stone reaching 4' in places



## Process





Pre-arrival excavation of footings



Stone foundations on arrival



Issues found with junctions at cross walls and corners not dug to allow for 4" pipe and rod



Household requested to dig down for vertical rod and footing depths and widths re-checked



Cement bags issued to household and stored onsite



Placing cogged vertical bars into holes and replacing stone around tightly





Stone laid into footing trenches, purchased by the household due to insufficient stone onsite



Batching concrete for band 1



Banding team installing reinforcement and formwork for band 1



Banding team bending the L's for band 1



Pouring concrete into band 1 formwork



Completed band before clumps laid

# Process





Photos sent by Surya Tamang the next week



Doors being supplied and located in the plan by the householders





The initial banding team briefing by Bishnu Shrestha and myself on day 1



Cutting and straightening 3mm tie wire roll ready for use onsite



Angle grinder was essential for cutting 10mm steel reinforcement bar - gloves and protective eyewear were also essential



Using a concrete power pole in the village to bend the steel for L's and T's in a consistent fashion



Closing 3mm wire ties securely around the 10mm rod to prevent it slipping out of place



Completed component of L and T reinforcement ladders

## Process

Training the Banding Team





The banding team from left to right: Raj Kumar, Surya, Hori, Surya Tamang, Som, Prem



Bending the loops takes 3 guys



Pre-bent loops for all 3 house site prepared in one central place due to availability of space and power for the angle grinder



Securing the 3mm tie wires



Completed L and T reinforcement ladders

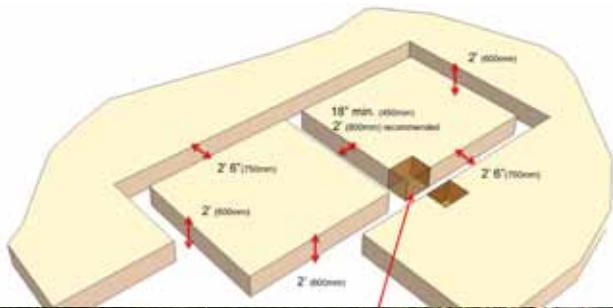


Bishnu explaining the different configurations of L and T bands

# Process

Training the Banding Team





Check foundation trench depths and alignment of vertical rod core holes at cross walls



Sand and cement clumps at 1' spacing to be applied to wet concrete or mortar in every case



Ensure 3x 3mm wire at L's and T's



Secure the 3mm wire ties well around the steel bar to prevent it slipping out



Avoid mortar bed depth exceeding 3" at T's and L's



Ensure 4" pipe and vertical rods are located at all door jambs during the first stone course

## Findings

Key Things to Check





Unskilled labour paid by the project results in high cost and less funds for the reinforcing



Cogs to bottom of verical rods tested on all sites and works welll, material efficient and is simple to work around



1 1/4"x3" pine formwork for banding made offsite by carpenter Triratna. Nails better then brackets as no screw drivers not available onsite.



Construction manual in poster format was useful during start-up of a project to get the banding team and stone masons across the scope



Use of detergent tested to increase runniness of mortar but deemed unnecessary



Prefabrication of steel elements in central location

## Findings

Experiments this Phase





Explore options to expand the re-construction system to cement & stone and brick options as discussed during village meeting



Develop instruction manual poster



Update construction manual for 4" pipe and 3" mortar bed

<b>Corner vertical reinforcement 10mm dia deformed bar (min)</b>	
	<b>Number of bars</b>
Vertical bar reinforcement right angle corners	4
Vertical bar reinforcement T junction corners	2
Vertical bar reinforcement for doors (1 bar each side of the door)	4
<b>Total volume of concrete for vertical rods</b>	
<b>Earthquake bands</b>	

Update calculator to boost shortage of cement: particularly focusing on loss of concrete into cracks of stone at 4" pipes and mortar beds

#### CHECKLIST

Yes/No	Description
<input checked="" type="checkbox"/>	Item 1
<input type="checkbox"/>	Item 2
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Develop a stage by stage checklist as a tool to be used by the banding team to ensure key things to check are completed



Add "hold passes" and window/door lintels to cement calculation