DESIGN AND CONSTRUCTION OF
TEMPORARY SHELTERS IN RUKUM WEST
USING BAMBOO, MUD AND PLASTIC SHEET

Presented by

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POST DISASTER SCENE

- EMERGENCY SHELTERS

POST DISASTER SCENE
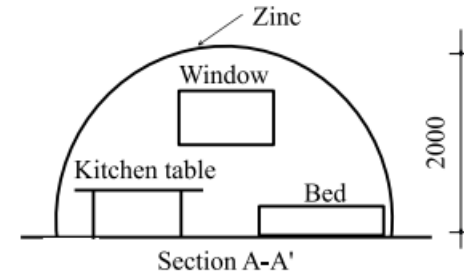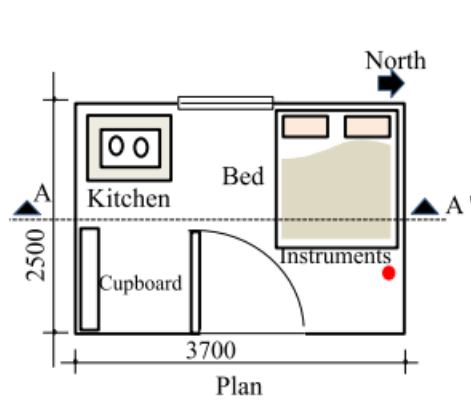
- TRANSITION SHELTERS

POST DISASTER SCENE
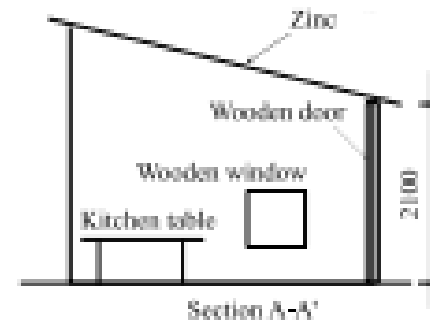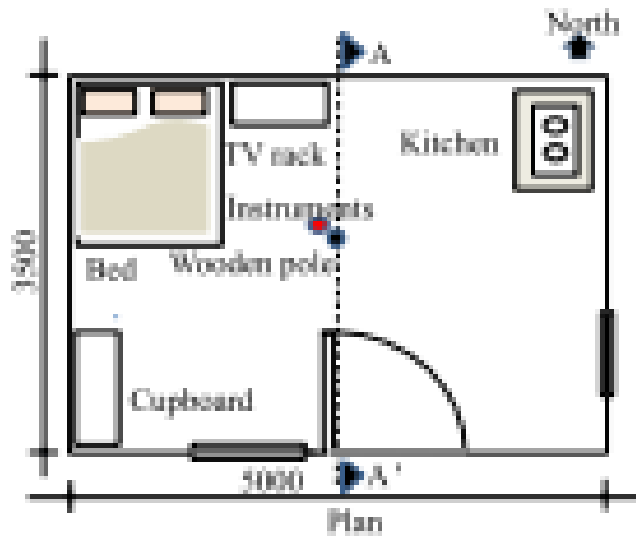
- PERMANENT HOUSING
- CONSTRUCTION IN BARPAK
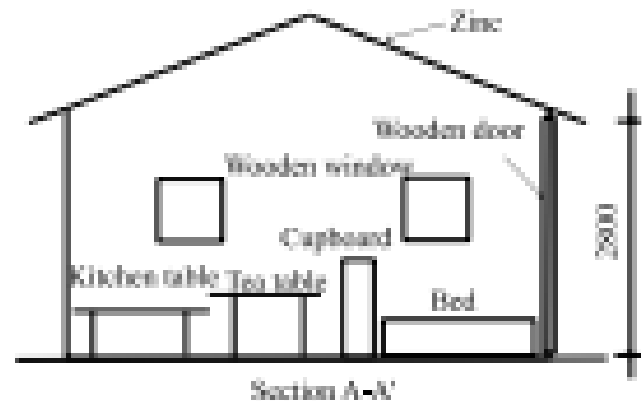
DESIGN AND CONSTRUCTION-2015 EARTHQUAKE: AREA 95 sq ft(Source: Rita et al, 2015)

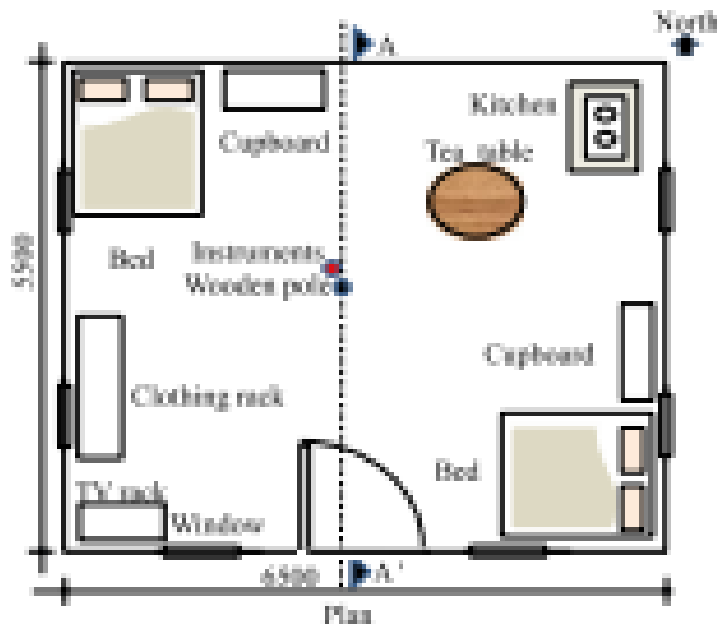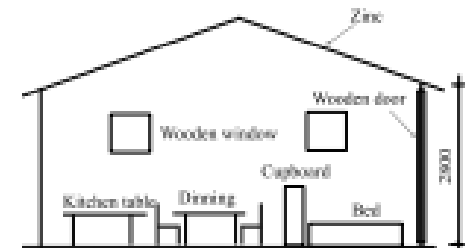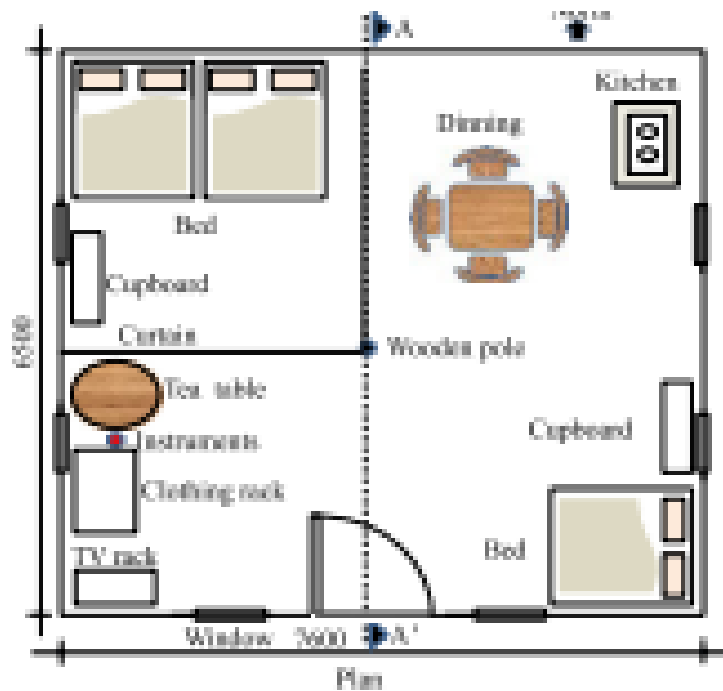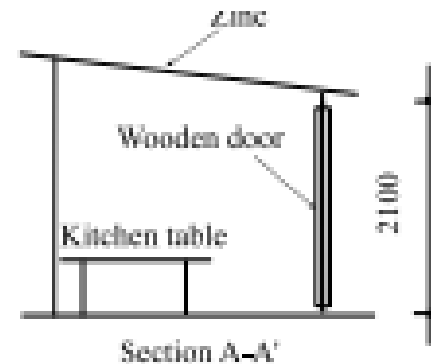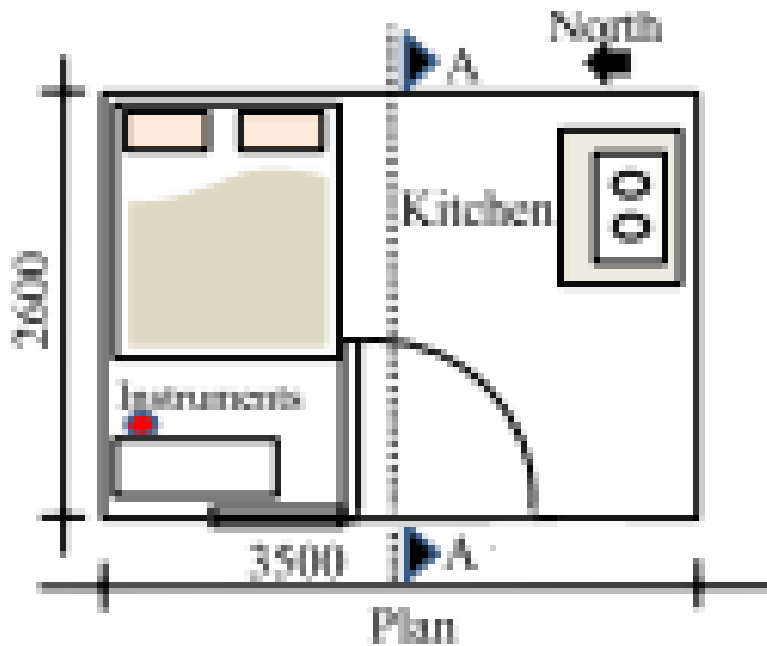# 2015 EARTHQUAKE: (Source: Rita et al, 2015)

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TEMPORARY SHELTERS

- COMMENTS
  - USE OF FOREIGN MATERIALS
  - COLD IN WINTER
  - HOT IN SUMMER
  - COMPARATIVELY COSTLY
  - COMPARATIVELY LONG TIME CONSUMED IN CONSTRUCTION

TEMPERATURE CALCULATION
SOURCE: Rita et al, 2015

Table 1
The size of investigated shelters, the number of people living and the materials used.

Shelter code	Depth [m]	Width [m]	Height [m]	No. of people	Density [Persons/m^2]	Wall [m]	Roof [m]		
							Internal	Middle	External
S1	5.0	3.5	2.1	4	0.23	Zinc sheet*	Thick clothes : 5×10^{-3} and CPF : 6×10^{-3}	Zinc sheet*	Straw : 6×10^{-2}
S3	3.7	2.5	2.0	4	0.43	Zinc sheet*	CPF : 6×10^{-3}	Zinc sheet*	Tarpaulin : 2×10^{-3}
S4	6.5	5.5	2.8	4	0.13	Zinc sheet*	Thick clothes : 5×10^{-3}	Zinc sheet*	None
S5	7.6	6.5	2.8	4	0.1	Zinc sheet*	Thick clothes : 5×10^{-3}	Zinc sheet*	None
S6	3.5	2.6	2.1	2	0.22	Bamboo : 8×10^{-3}, Mud plaster : 5×10^{-3}	CPF : 6×10^{-3}	Zinc sheet*	None

CPF : cellular polyethylene foam. Zinc sheet* [m] : 0.26×10^{-3}.

TEMPERATURE CALCULATION
SOURCE: Rita et al, 2015

TEMPERATURE CALCULATION SOURCE: Rita et al, 2015

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...iption of investigated shelters in terms of heat transmission coefficient, total heat loss coefficient and heat capacity estimated.

	Wall area [m²]	Roof area [m²]	Floor area [m²]	Total surface area (wall + roof) [m²]	U_i for wall [W/(m²K)]	U_i for roof [W/(m²K)]	Total heat loss coefficient [W/K]	Total heat loss coefficient per floor area [W/(m²K)]	Total heat loss coefficient per surface area [W/(m²K)]	$C\rho V$ [kJ/K]	$C\rho V$ per floor area, [kJ/(m²K)]
	35.7	17.5	17.5	53.2	5.6	1.2	220.9	12.6	4.2	1918	109.6
	11.6	15.1*	9.3	26.7	5.6	2.6	104.2	11.3	3.9	526	56.6
	67.2	36.3	35.8	103.5	5.6	3.8	514.3	14.4	5.0	4770	133.2
	79.0	49.7	49.4	128.6	5.6	3.8	630.1	12.8	4.9	5051	102.2
	25.6	9.1	9.1	34.7	4.4	2.8	138.1	15.2	4.0	1284	141.1

...shelter code. $C\rho V$ specific heat capacity. * Roof area is calculated for whole dome-shaped shelter.
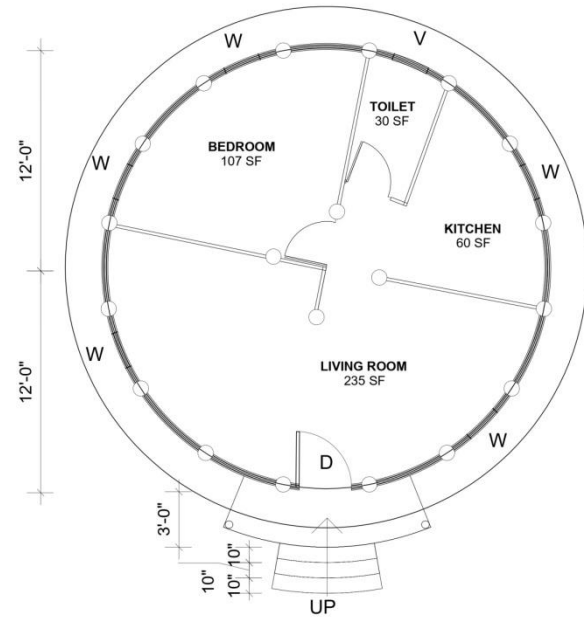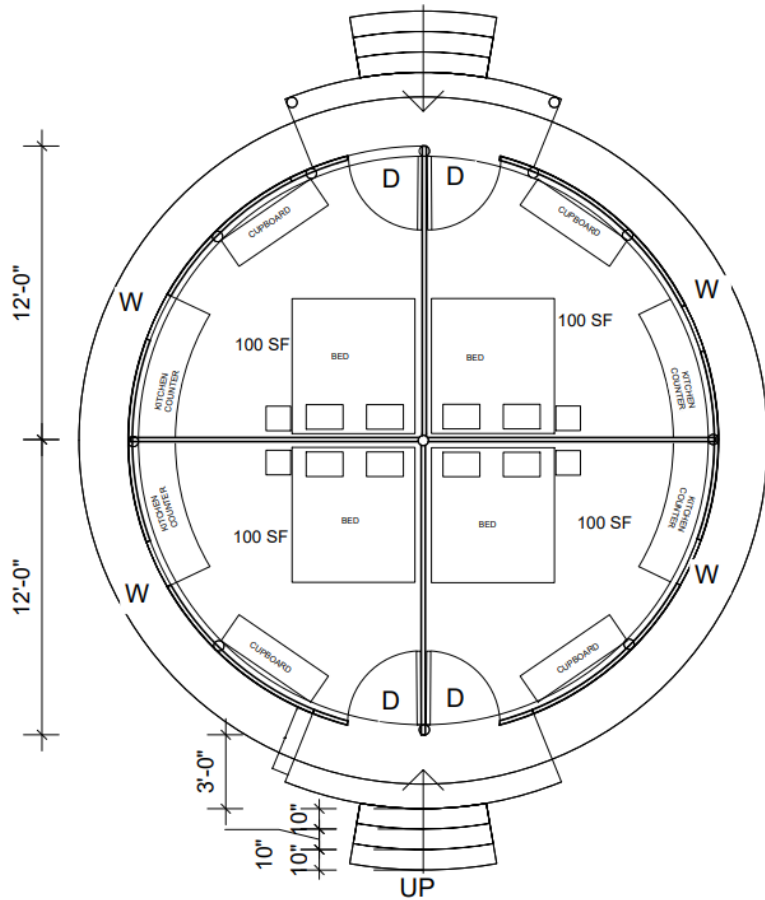
DESIGN AND CONSTRUCTION
using bamboo, mud and plastic sheet
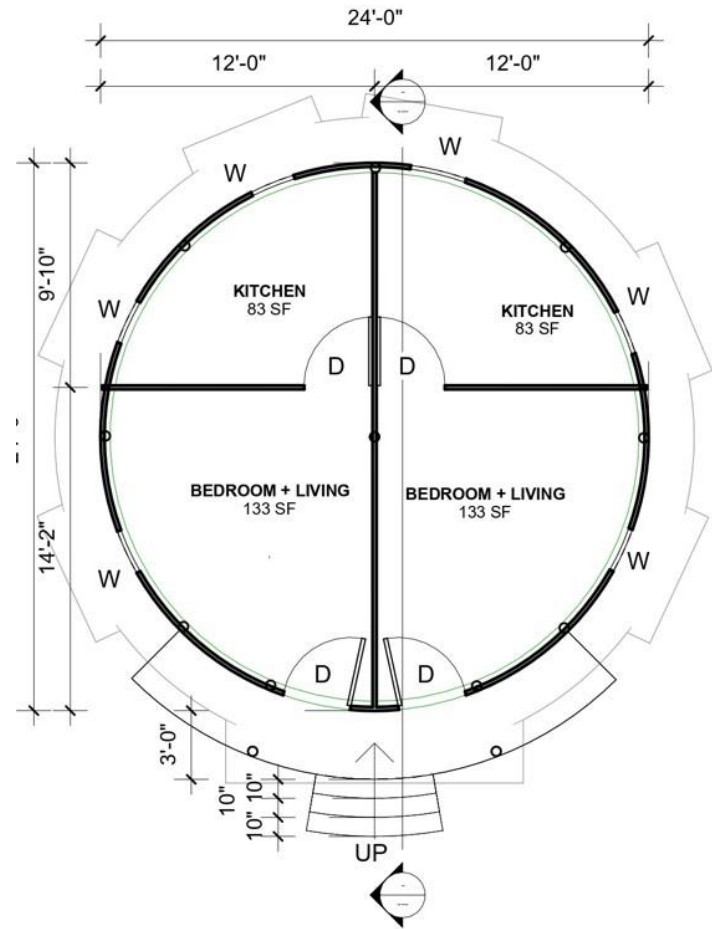
DESIGN AND CONSTRUCTION
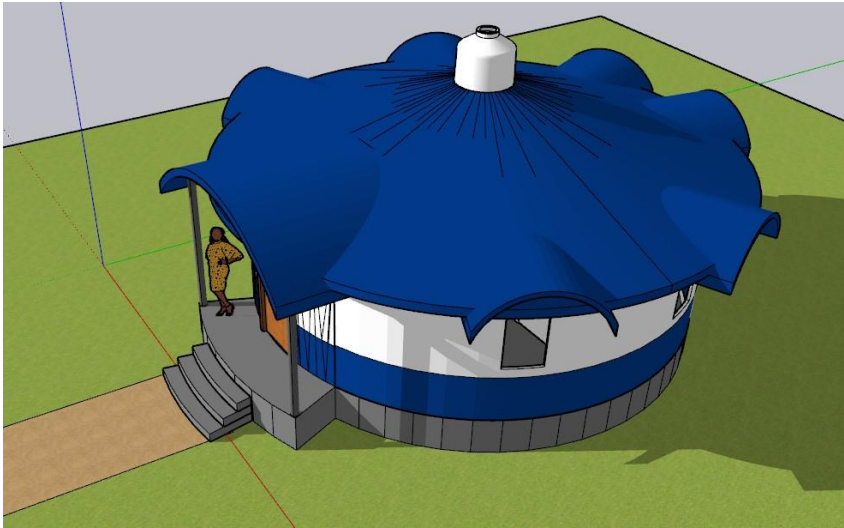
DESIGN AND CONSTRUCTION

GROUND FLOOR PLAN
(452.38 SQ.FT.)

DESIGN AND CONSTRUCTION
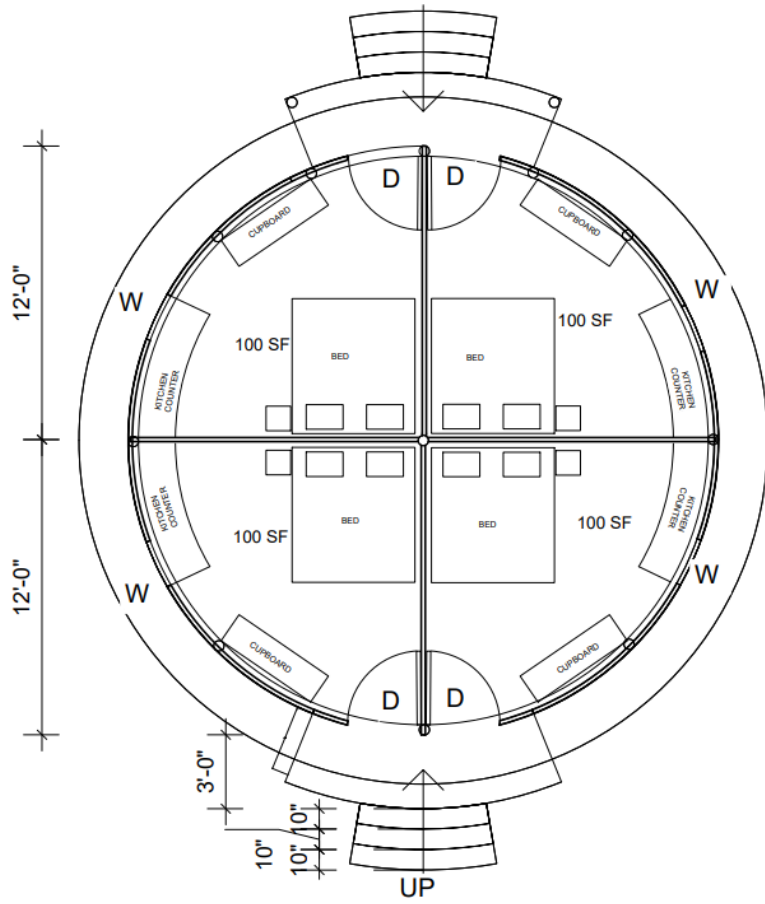
TEMPORARY SHELTERS

- USE OF BAMBOO AND , MUD IN FOUNDATION, SUPERSTRUCTURE AND ROOF

TEMPORARY SHELTERS

- USE OF SILPAULINE PLASTIC SHEET OF 120 GAUGE FOR ROOF COVERING

DOORS AND WINDOWS

- Made of bamboo

TEMPORARY SHELTERS

- MAINTAINENCE OF 3 INCH GAP IN WALLS
- GOOD INSULATION
- WARM IN WINTER
- COOL IN SUMMER
- THE TEMPERATURE SHOULD NOT GO BELOW 11(Degree Celsius)

CALCULATION OF THERMAL CONDUCTIVITY

Sn	Description	Conductivity/ W m^{-1} K^{-1}	Thickness/m	Resistance/m^2 K W^{-1}
1	15mm Mud plastered bamboo lath	4.4	.015	.003
2	75 mm Air Gap	0.18	.075	2.4
3	15mm Mud plastered bamboo lath	4.4	.015	.003
	Total			2.406
	Conductivity			1/2.406 = 0.41

The wall conductivity of shelter 6 was 4.4. Its wall is one tenth. Again it has a similar conductivity in roof. So, the temperature is likely to be more than 11degree celsius.

TEMPORARY SHELTERS

- MAINTAINENCE OF 3 INCH GAP IN ROOFS
- GOOD INSULATION
- WARM IN WINTER
- COOL IN SUMMER

TEMPORARY SHELTERS

- USE OF LOCAL MANPOWER AND ON HAND TRAINING
- USE OF LOCAL MATERIAL AND CONSTRUCTION TECHNIQUE LIKE BAMBOO AND MUD

- PROVISION OF WATER SUPPLY
- PROVISION OF ELECTRICAL LIGHTING

TEMPORARAY SHELTERS

- FIRE PROOF CONSTRUCTION DUE TO THE USE OF MUD PLASTER

- MOUSE REPELLENT CONSTRUCTION THROUGH THE USE OF POINTED BAMBOOS IN THE GAP

- EARTHQUAKE RESISTANT DUE TO LIGHT AND FLEXIBLE STRUCTURE

TIME TAKEN FOR CONSTRUCTION

- 8 WEEKS

- ONE SHELTER WAS COMPLETED IN 2WEEKS

- SEVERAL MISTAKES CAME INTO BEING BECAUSE OF FIRST CONSTRUCTION

- BUT IT CAN BE COMPLETED WITHIN ONE MONTH, OR ONE WEEK FOR ONE SHELTER IN FUTURE

COST INCURRED FOR CONSTRUCTION

- Material Cost
  - Bamboos-172 nos
    - 21,500 at 125 per no
  - Mud for plastering and filling
    - 6 tractors -12,000
  - Plastic Sheet – Rs 12,000
- Material Cost-11,375 per unit
- Labor Cost-29,400
  - 1 skilled, 4 unskilled for 7 days
- Miscellaneous-5000
- Total- 45,400
- The pilot project cost was high due to supervision, travel and other costs
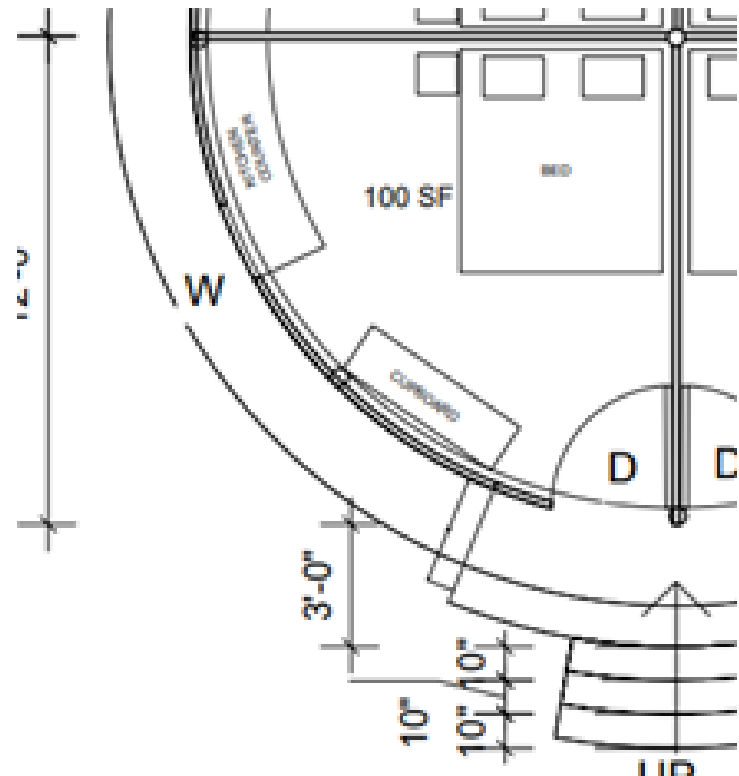
LIKELY IMPROVEEMENT FOR PERMANENT HOUSING

- It can be made permanent with few minor changes
  - For example putting ply wood instead of plastic sheet in doors and windows

DURABILITY

- This technology is used in Madhesh
- These houses are for permanent living
- I lived in such a house
- My own experience is its durability for at least 25 years and more
- But it should not be exposed in the open
- It should be plastered by mud plaster

DURABILITY

- The local technology is to dip it in a pool of water for a week

- It was not done because of its temporary nature

DURABILITY

- It can also be treated by the use of borax which is not very costly

HANDS ON TRAINING

- TRAINING HAS BEEN PROVIDED TO LOCAL PERSONS
- THEY CAN NOW BUILD ON THEIR OWN

HANDS ON TRAINING

- PLASTERING
- PAINTING

SUPPORTED BY

- NEPAL ACADEMY OF SCIENCE AND TECHNOLOGY

SUPPORTED BY

- LUMBINI INTERNATIONAL ACADEMY OF SCIENCE AND TECHNOLOGY

SUPPORTED BY

- KANTIPUR INTERNATIONAL COLLEGE

THANKS

Any questions?