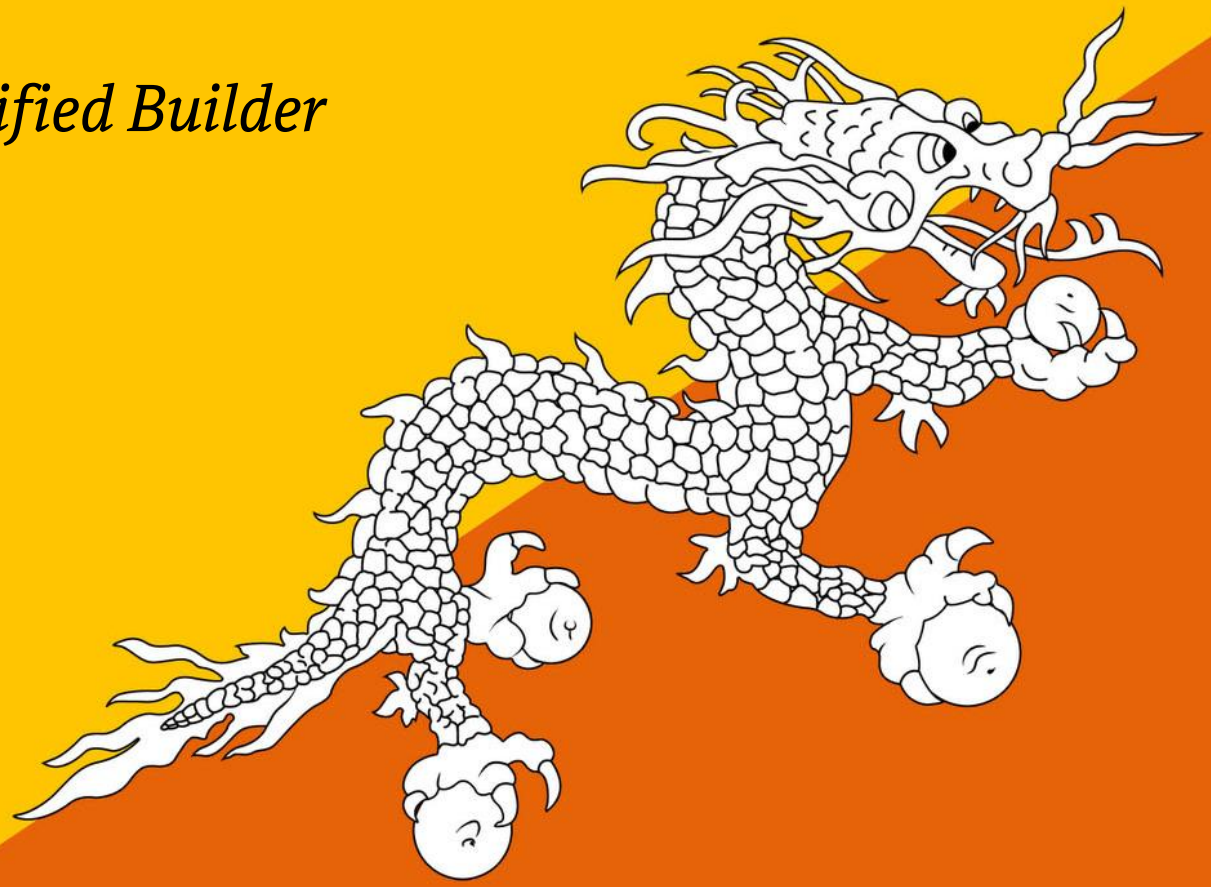
STRIVING TOWARD A HIGHER PURPOSE:

High Performance Building in the Land of the Thunder Dragon

Dan Whitmore *CPHC, PHIUS Certified Builder*
Indicator LLC

Cory Hawbecker *AIA, CPHC*
Holst Architecture



KARUNA IS THE SANSKRIT WORD FOR COMPASSION

The Karuna Foundation supports visionary organizations in developing nations working to both mitigate carbon emissions and help human populations and the ecosystems they rely on adapt to climate change.

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Jigme Singye Wangchuck School of Law's mission is to shape young students into lawyers who can navigate the modern global legal environment while remaining mindful of Gross National Happiness and Bhutanese culture and traditions.

DESIGN & TECHNICAL TEAMS

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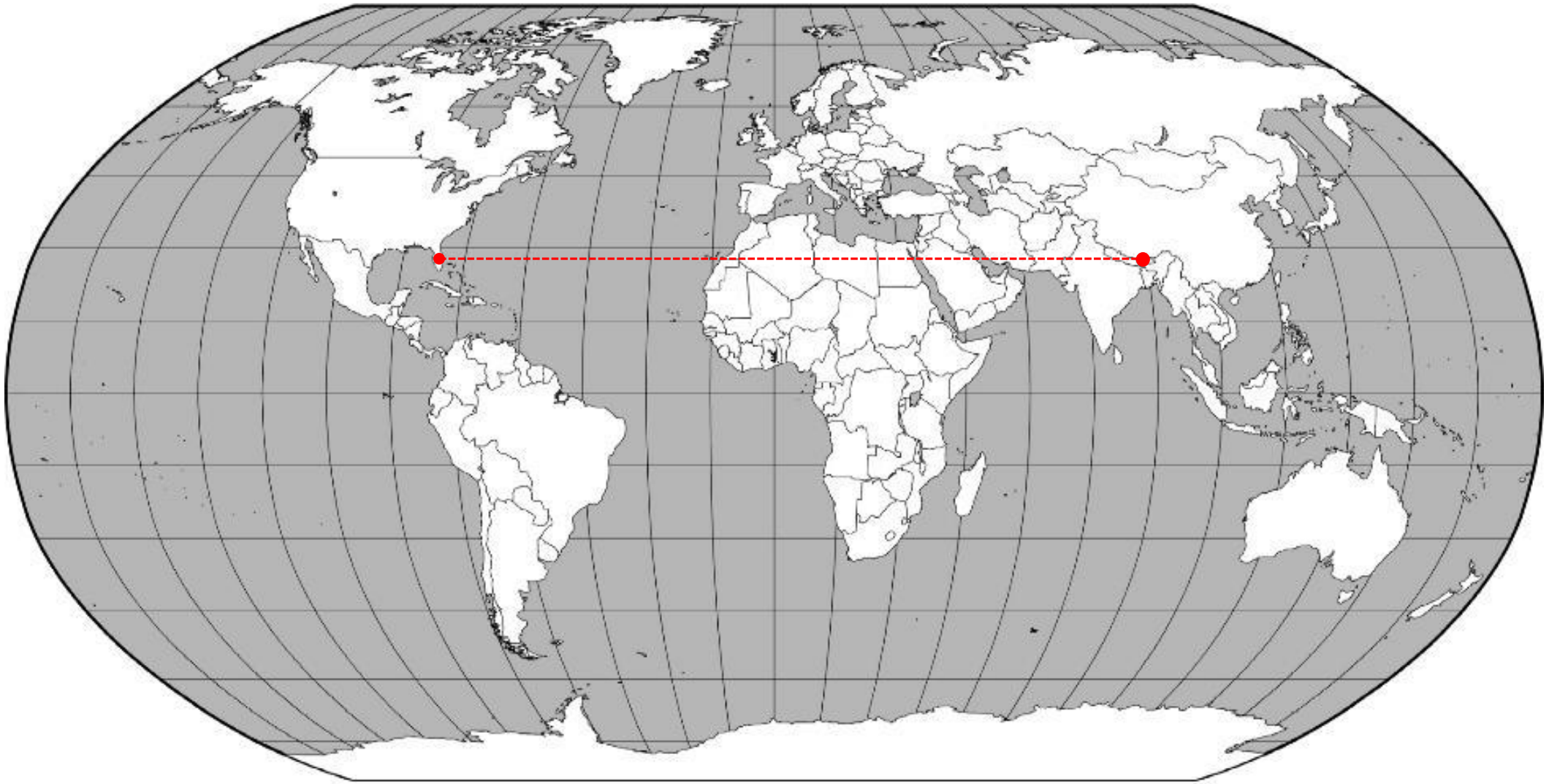


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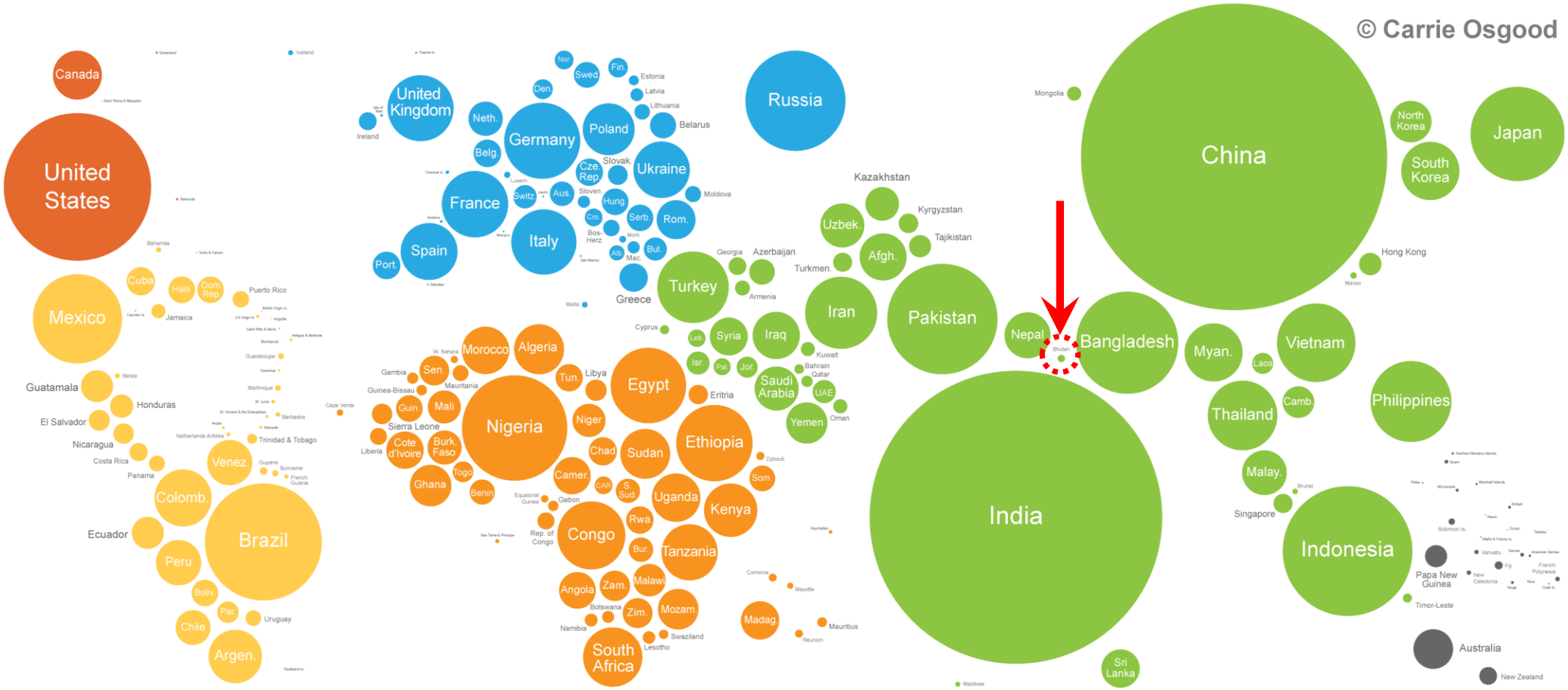
Joseph
COLVILLE RESERVATION
YAKAMA INDIAN RESERVATION
NEZ PERCE RESERVATION

Image: Michael Schmelling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Solomon Is.
Faulkland Is.

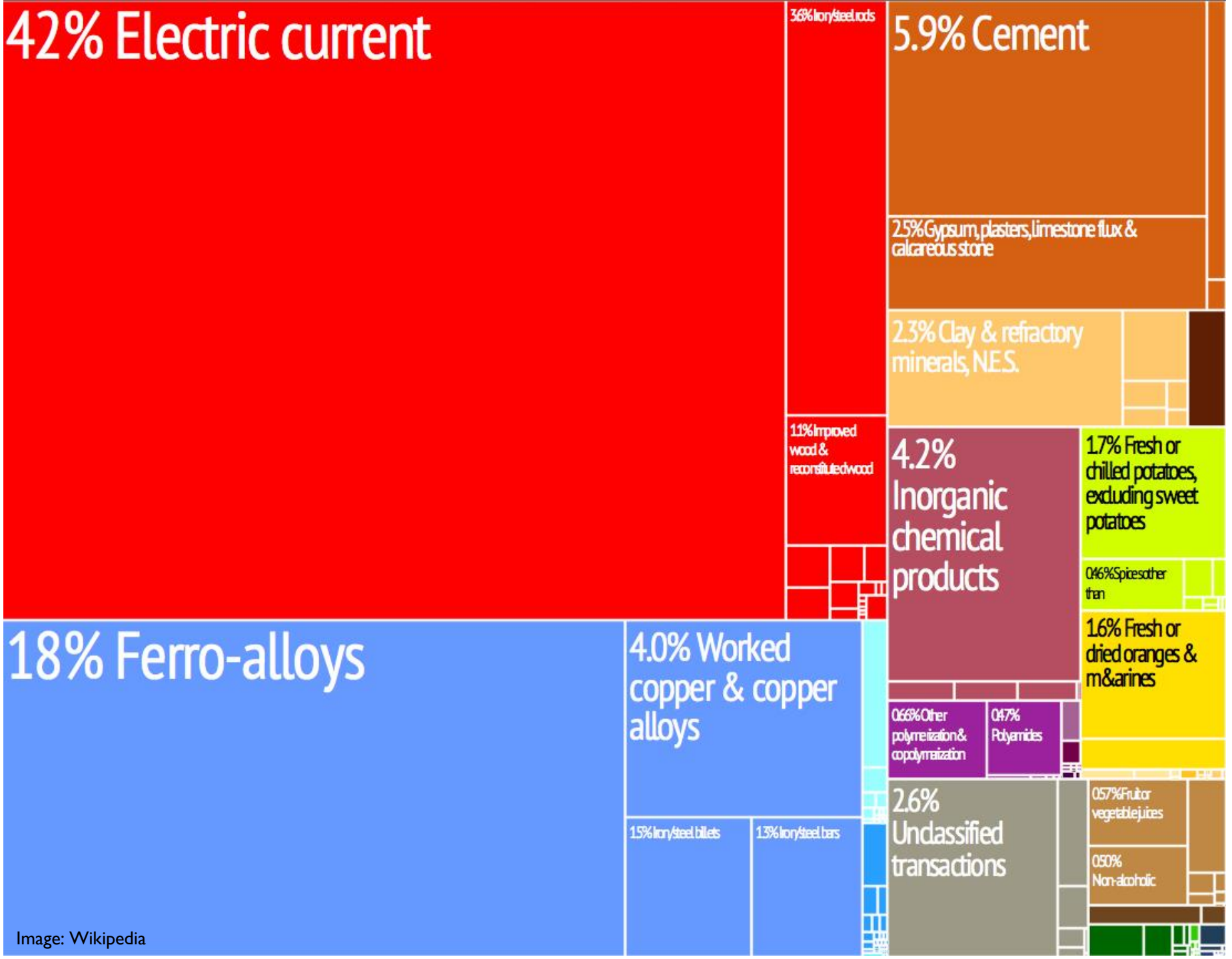
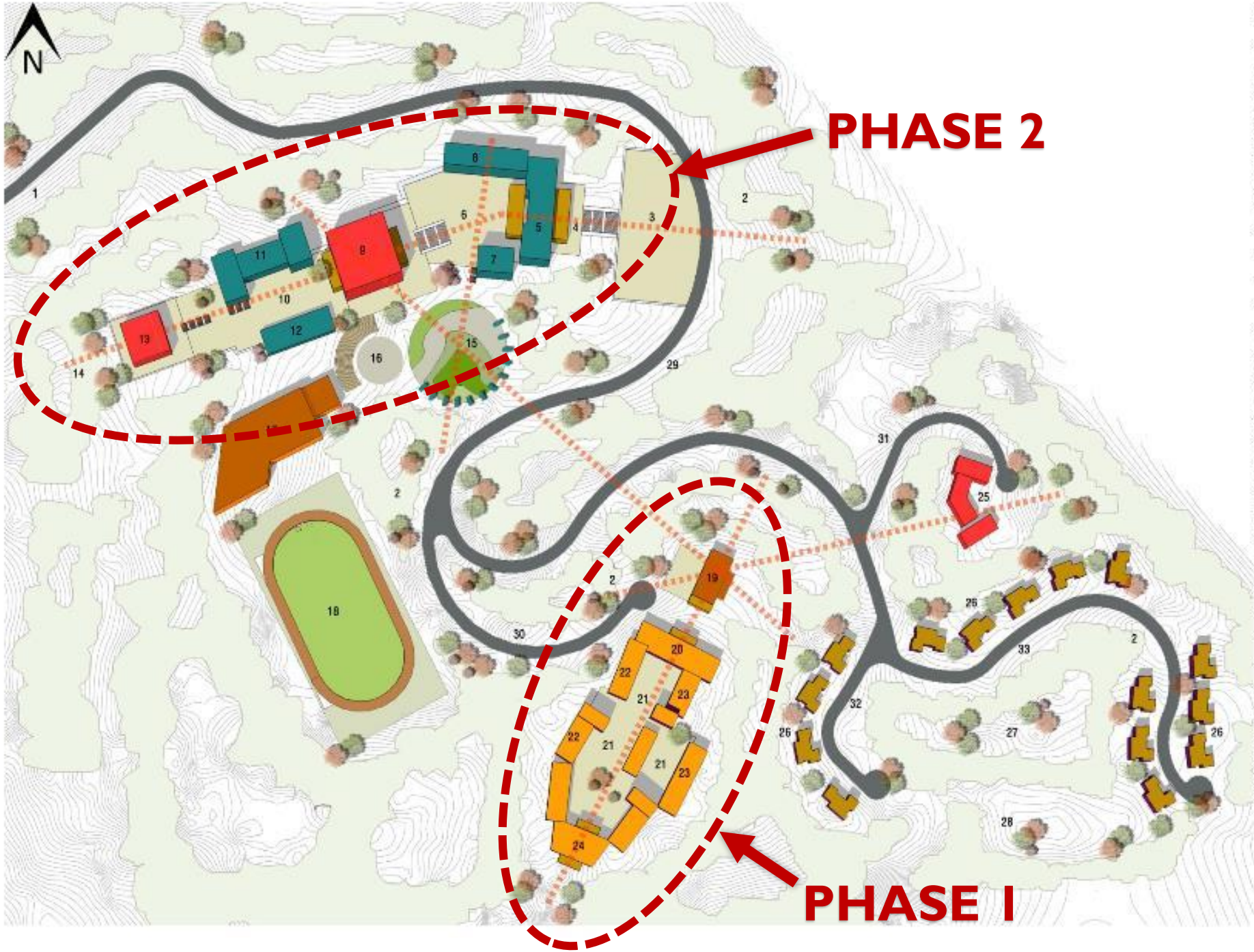


Image: Wikipedia

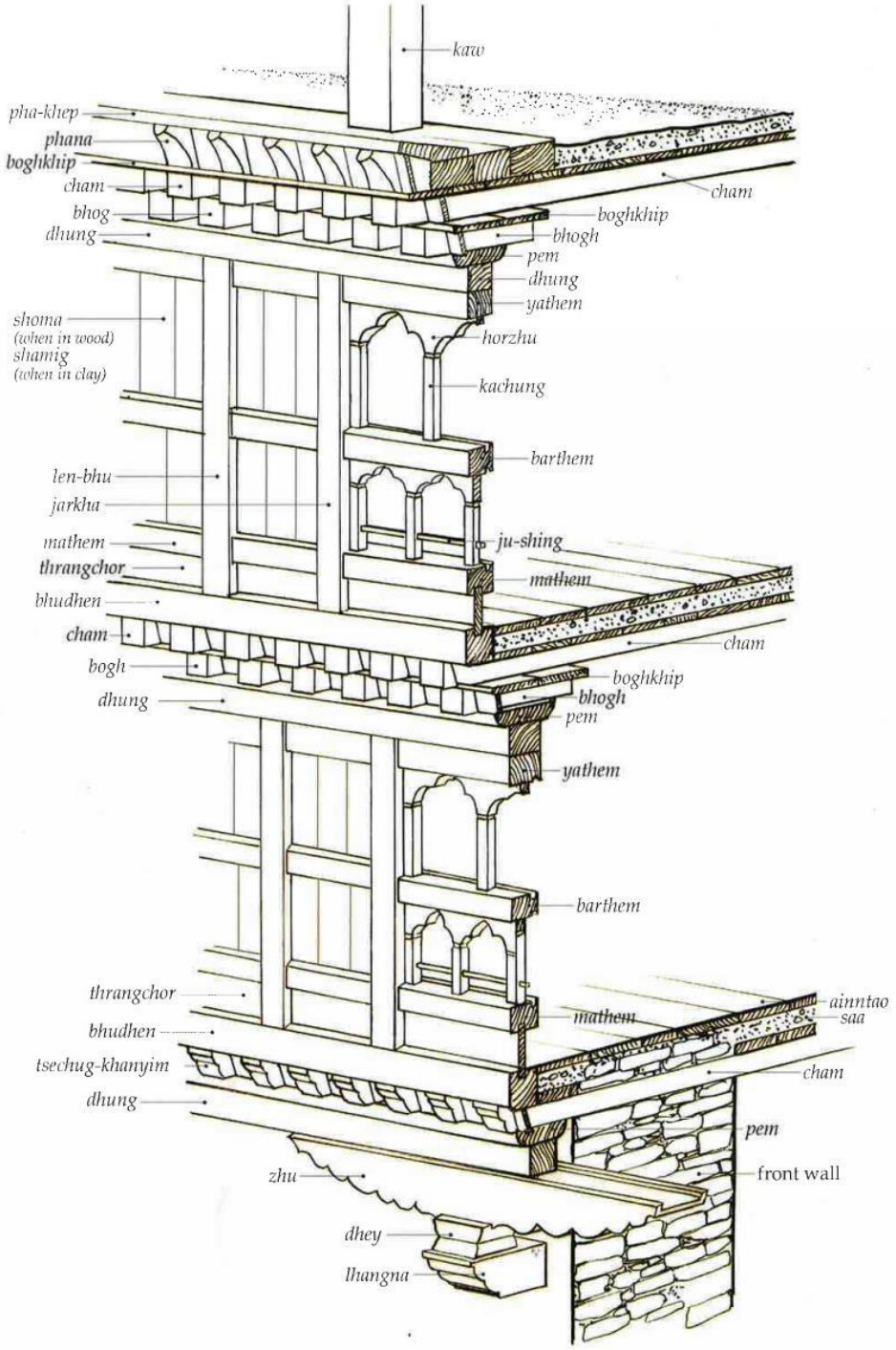

Image: Dan Whitmore



LEGEND

1 MAIN ENTRANCE
2 CAR PARK
3 CEREMONIAL ENTRANCE
4 GRAND STAIRS
5 ADMINISTRATIVE BLOCK
6 CENTRAL SQUARE
7 BOOK STORE/CAFE
8 LECTURE THEATRES
9 LIBRARY
10 ACADEMIC PLAZA
11 ACADEMIC BLOCK
12 ACADEMIC LOUNGE
13 LHAKHANG/MOOT COURT
14 EXISTING WOODS
15 VILLAGE COMMON
16 AMPHITHEATRE
17 MULTIPURPOSE HALL
18 SPORTS GROUND
19 DINING
20 RESIDENTIAL LOUNGE
21 RESIDENTIAL COURTYARD
22 STUDENT RESIDENCES
23 STUDENT RESIDENCES
24 STUDENT RESIDENCES
25 PRESIDENT;S MANOR
26 FACULTY VILLAGE
27 FACULTY GREEN
28 KNOLL/VIEW POINT
29 CAMPUS DRIVE
30 RESIDENCE DRIVE
31 MANOR DRIVE
32 KNOLL DRIVE
33 FACULTY DRIVE


SITE



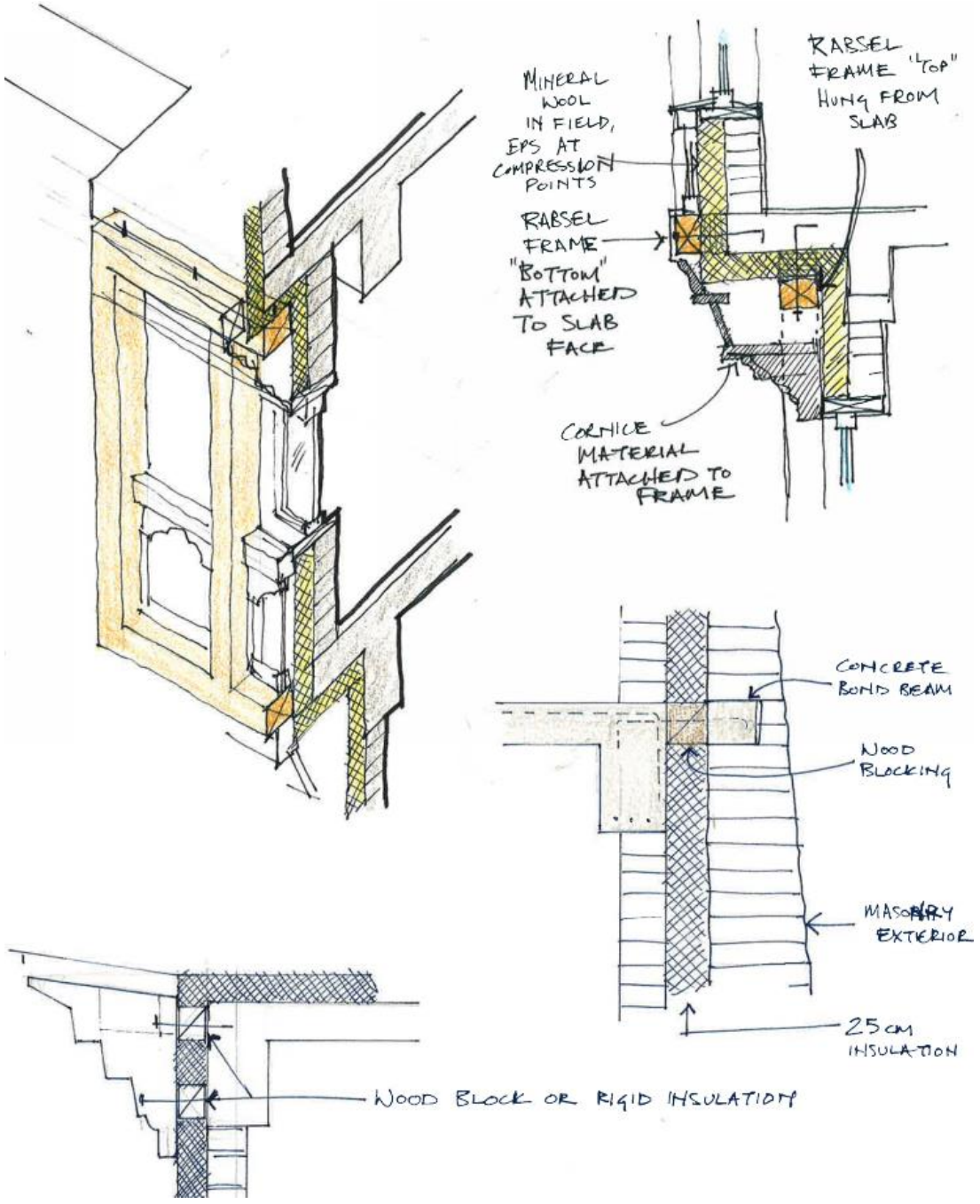
TRADITIONAL CONSTRUCTION METHODS

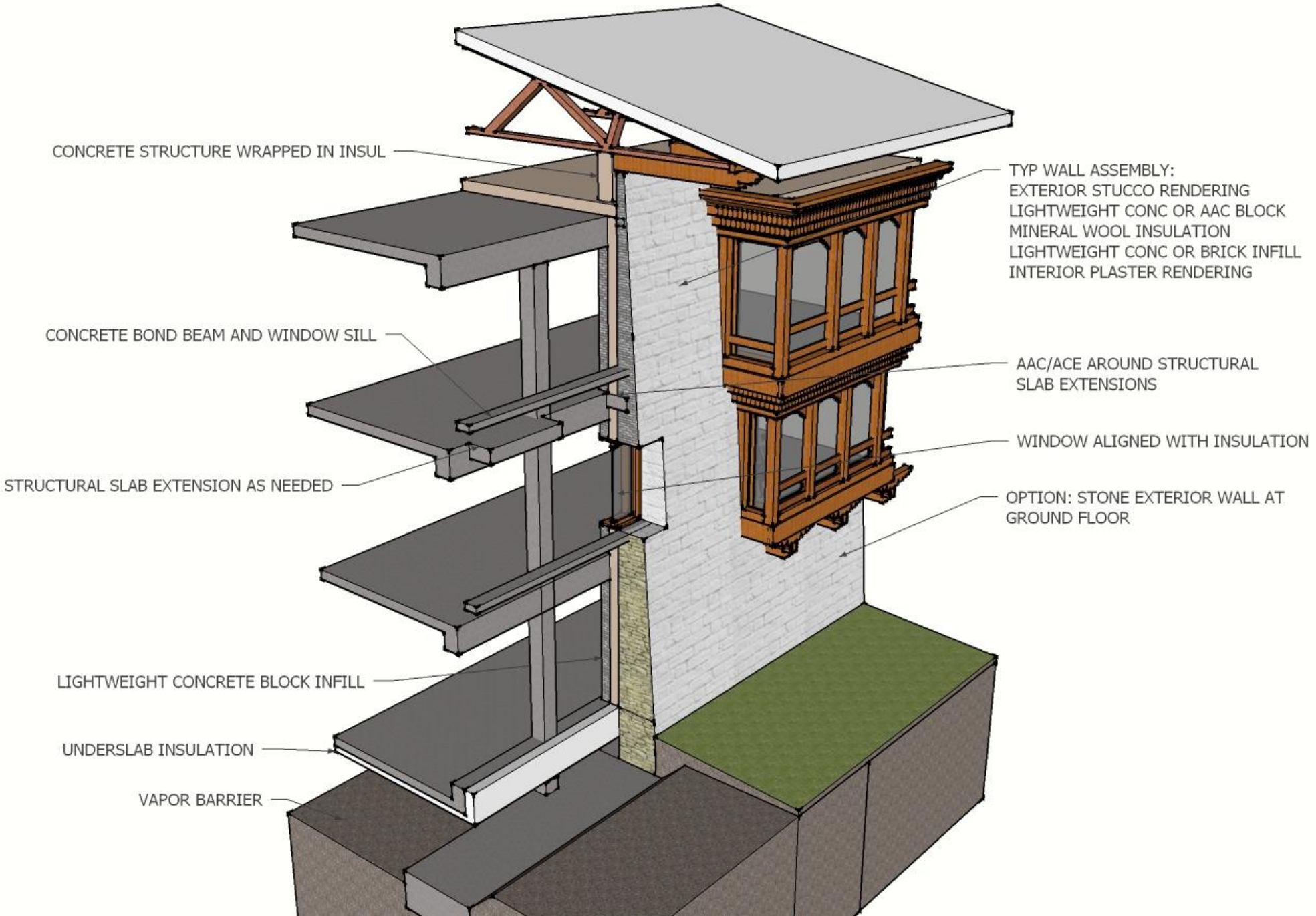
- Stone of primary structure
- Heavy timber wood floor and roof framing
- Structural elements are expressive
- Open attic
- Wood shutters, no windows
- No insulation
- No air-sealing
- No mechanical ventilation
- Biomass heating system
- High quality craftsmanship
- Built by Bhutanese

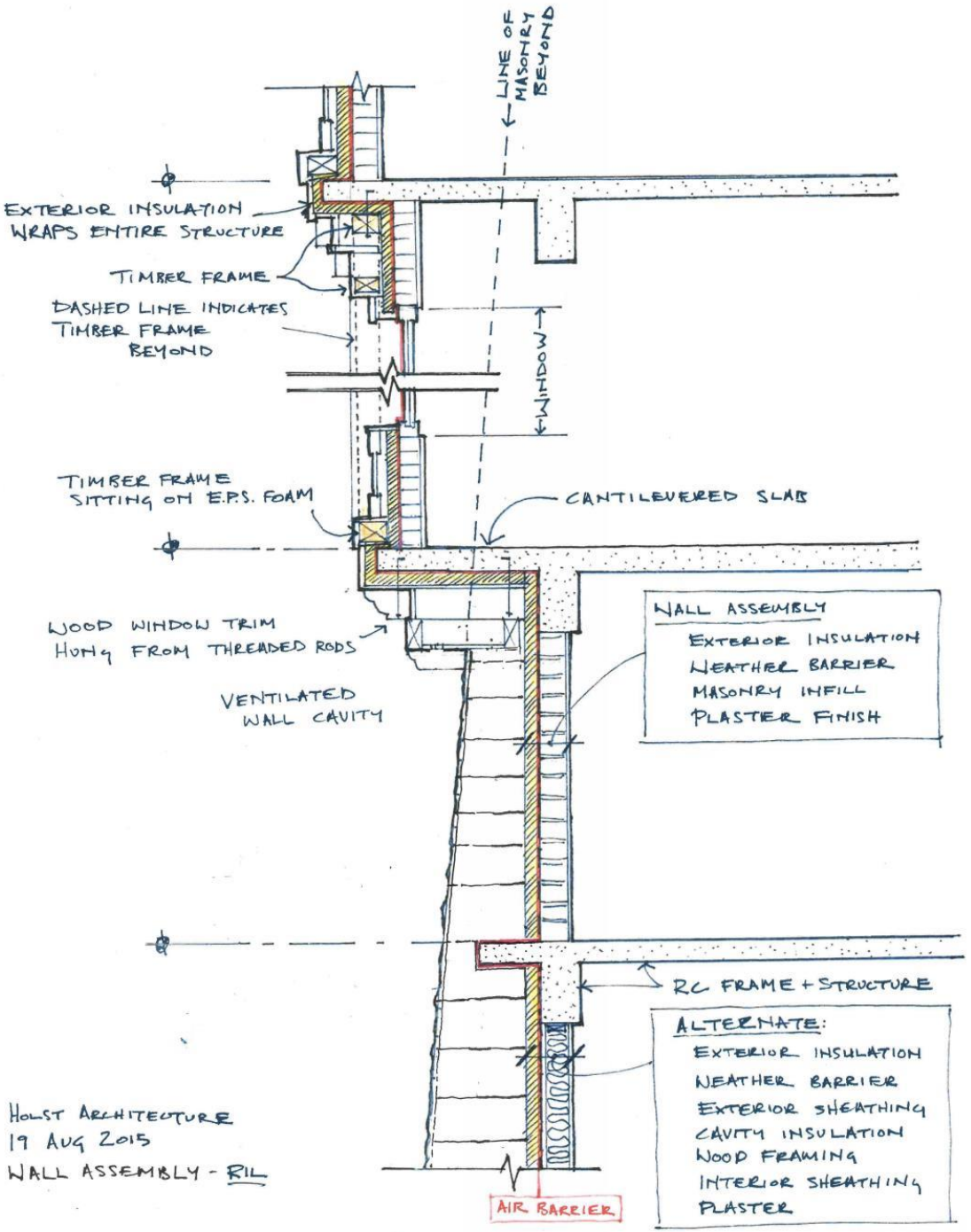
TYPICAL MODERN METHODS

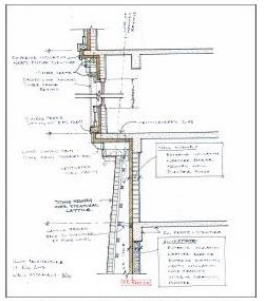
- Reinforced Concrete Frame
- Masonry infill walls with stucco rendering
- Structural elements are disguised
- Open attic (sometimes)
- Site-built single pane wood windows
- No insulation
- No air-sealing
- No mechanical ventilation
- Electric resistance heating
- Low quality craftsmanship
- Built primarily by migrant labor


21
MAN

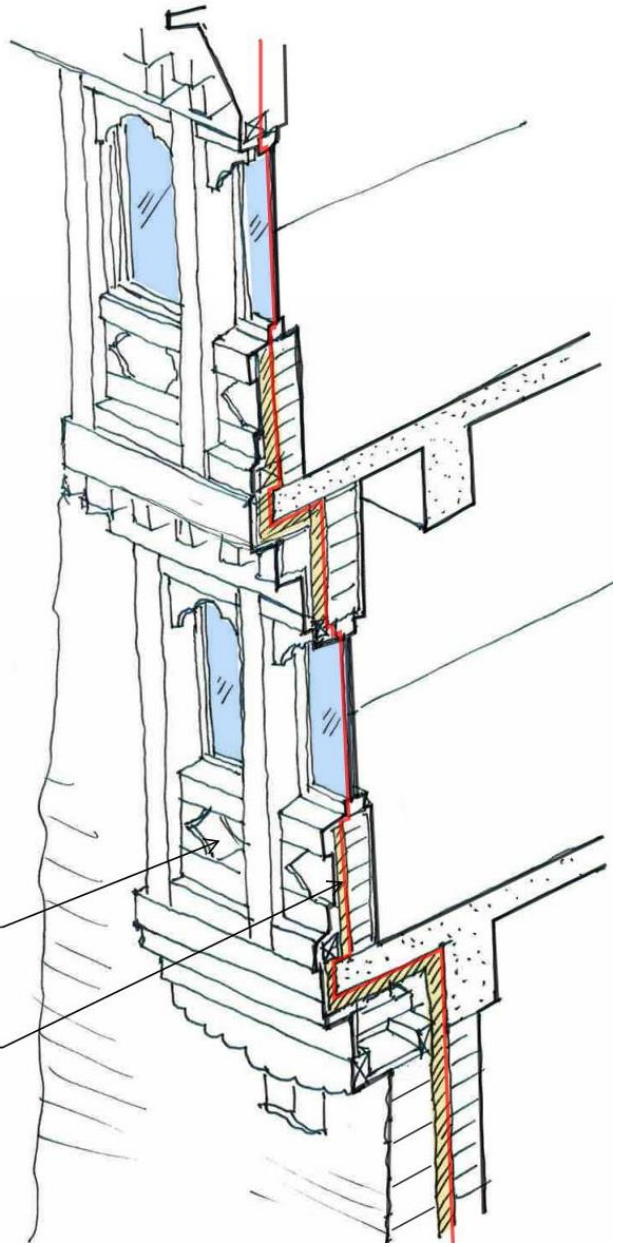

MINERAL WOOL IN FIELD, EPS AT COMPRESSION POINTS
RABSEL FRAME "BOTTOM" ATTACHED TO SLAB FACE
CORNICE MATERIAL ATTACHED TO FRAME
RABSEL FRAME "TOP" HUNG FROM SLAB
CONCRETE BOND BEAM
WOOD BLOCKING
MASONRY EXTERIOR
25 cm INSULATION
WOOD BLOCK OR RIGID INSULATION


CONCRETE STRUCTURE WRAPPED IN INSUL
CONCRETE BOND BEAM AND WINDOW SILL
STRUCTURAL SLAB EXTENSION AS NEEDED
LIGHTWEIGHT CONCRETE BLOCK INFILL
UNDERSLAB INSULATION
VAPOR BARRIER
TYP WALL ASSEMBLY:
EXTERIOR STUCCO RENDERING
LIGHTWEIGHT CONC OR AAC BLOCK
MINERAL WOOL INSULATION
LIGHTWEIGHT CONC OR BRICK INFILL
INTERIOR PLASTER RENDERING
AAC/ACE AROUND STRUCTURAL
SLAB EXTENSIONS
WINDOW ALIGNED WITH INSULATION
OPTION: STONE EXTERIOR WALL AT
GROUND FLOOR





REFERENCE SKETCH
FROM 19 AUGUST 2015

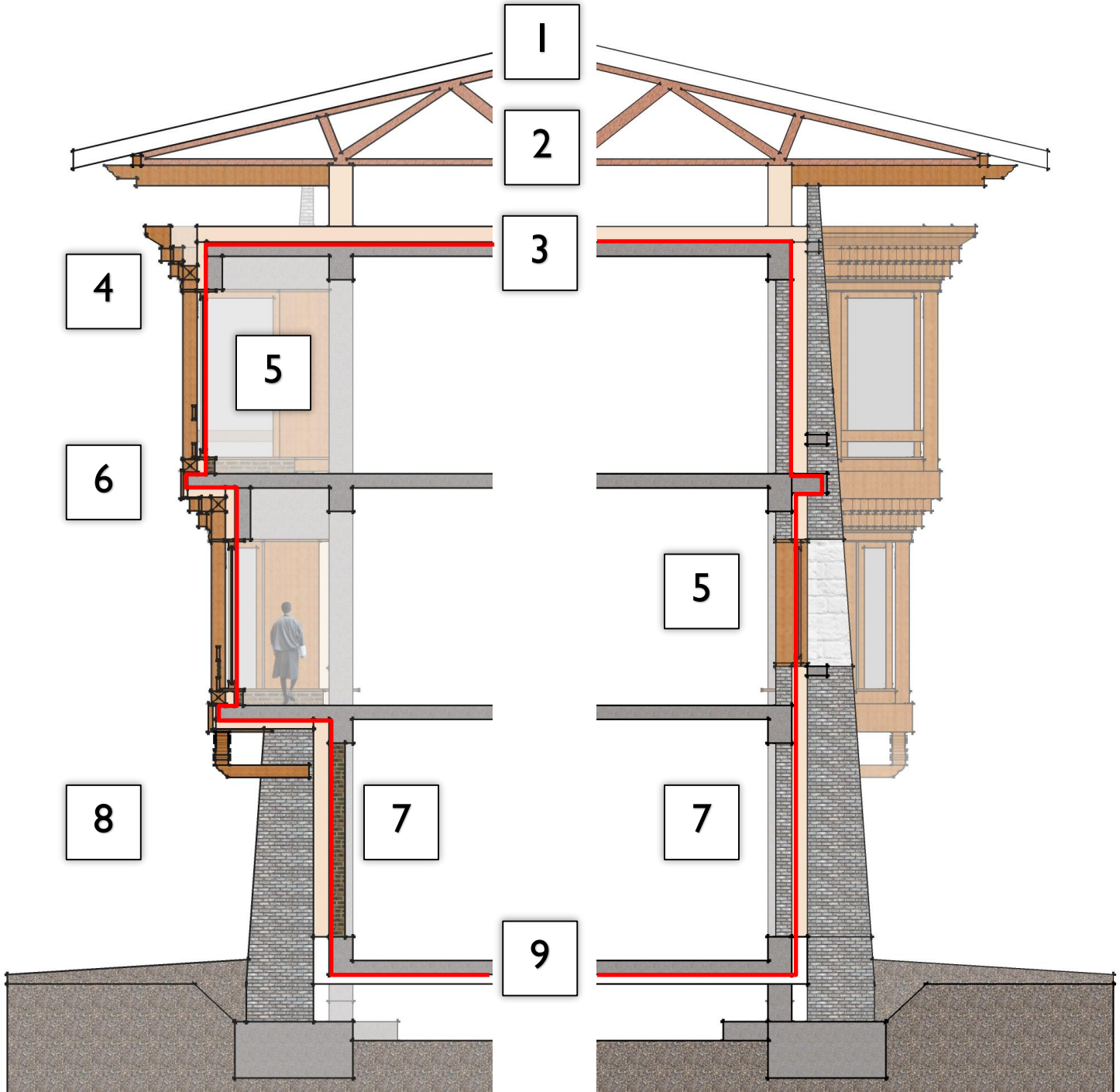


RECESSED INFILL PANEL, PAINTED DARKER TO MIMIC WINDOW

INSULATED MASONRY WALL REDUCES HEAT LOSS THROUGH ENVELOPE.

Air Barrier

1. Metal Roof
2. Open attic
3. Insulated concrete ceiling
4. Decorative elements
5. Double glazed windows
6. Cantilevered floor
7. AAC infill wall
8. AAC exterior masonry over 10 cm mineral wool
9. Insulated floor over crawlspace



Building geometry

Enclosed volume:	620,442.9	ft^3
Net-volume:	510,518.2	ft^3
Total area envelope:	52,254.2	ft^2
AV ratio:	0.1	1/ft
Floor area:	42,326.7	ft^2

	Air Tightness		Window Performance		Assembly R-Values (hr ft^2 F/Btu)			
	cfm/ft^2	ACH50	Avg U-Value (Btu/hr ft^2 F)	SHGC	Slab	Below Grade Walls	Walls	Roof
Standard Construction								
Partial Optimization								
Full Optimization								

	Air Tightness		Window Performance		Assembly R-Values (hr ft^2 F/Btu)			
	cfm/ft^2	ACH50	Avg U-Value (Btu/hr ft^2 F)	SHGC	Slab	Below Grade Walls	Walls	Roof
Standard Construction	1.2	7	0.72	0.85	1	2.5	37.5	1
Partial Optimization								
Full Optimization								

	Air Tightness		Window Performance		Assembly R-Values (hr ft^2 F/Btu)			
	cfm/ft^2	ACH50	Avg U-Value (Btu/hr ft^2 F)	SHGC	Slab	Below Grade Walls	Walls	Roof
Standard Construction	1.2	7	0.72	0.85	1	2.5	37.5	1
Partial Optimization	0.5	3	0.42	0.6	16	18	59	36.7
Full Optimization								

	Air Tightness		Window Performance		Assembly R-Values (hr ft^2 F/Btu)			
	cfm/ft^2	ACH50	Avg U-Value (Btu/hr ft^2 F)	SHGC	Slab	Below Grade Walls	Walls	Roof
Standard Construction	1.2	7	0.72	0.85	1	2.5	37.5	1
Partial Optimization	0.5	3	0.42	0.6	16	18	59	36.7
Full Optimization	0.18	1	0.34	0.48	16	18	59	36.7

	Annual Heating Demand	Heating Load	Site Energy
	kBtu/ft^{2}yr	Btu/ft^{2}hr	MWh/yr
Standard Construction	120	38.7	1613
Partial Optimization	38.6	14.4	603
Full Optimization	24	8.1	422

To Maintain 68°F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AAC BLOCKS
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LIGHTER
GREENER &
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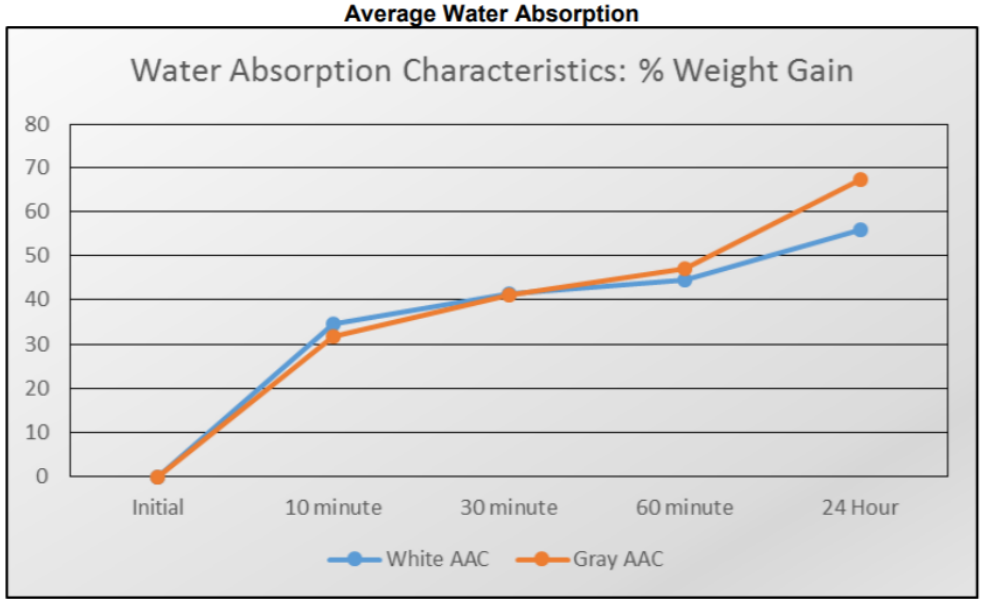
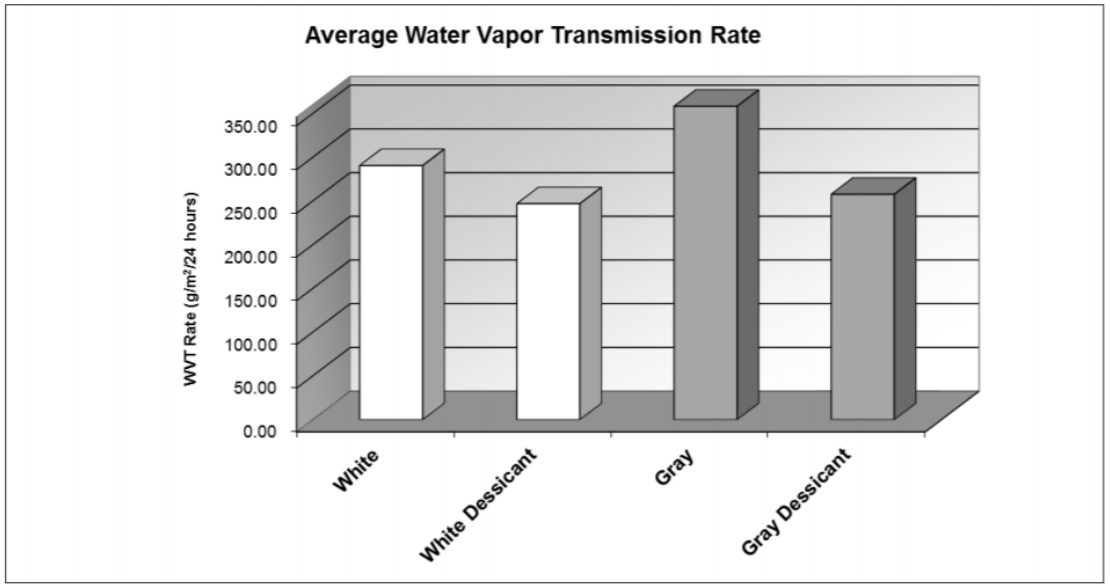
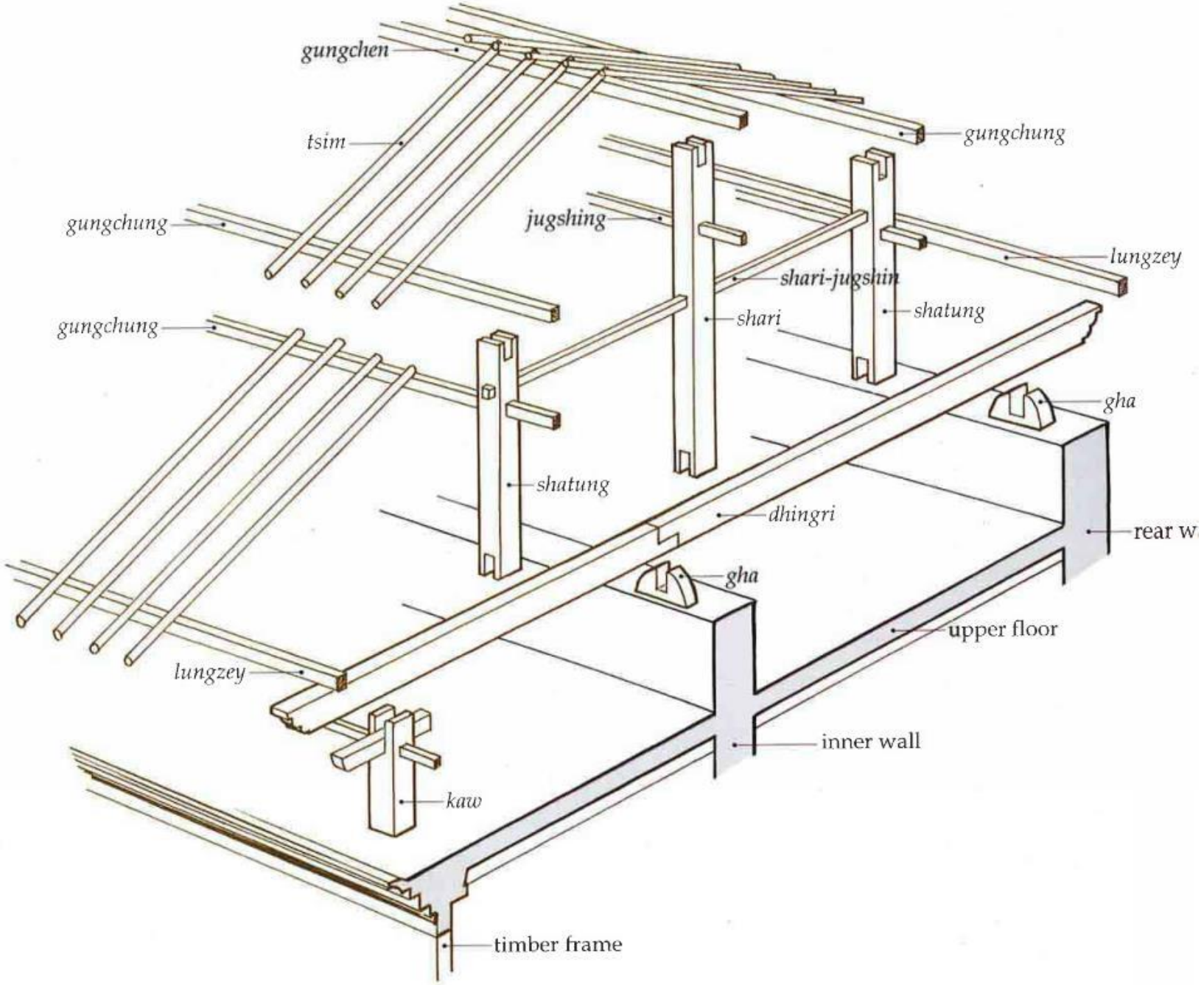
GRAPH: Water Absorption (ASTM C140 - Modified)



GRAPH: Water Vapor Transmission



	CASE	OUTER AAC ENDING MASS % WC	OUTER INSUL RH%	MID INSUL RH%	INNER INSUL RH%	INNER AAC ENDING MASS% WC
1% DRIVING RAIN	TOP MW 1% DR $3ACH_{50}$	81	100	85	76	1.3
	BOTTOM MW 1% DR $3ACH_{50}$	5.2	87	76	72	1.3
	TOP MW 1% DR $2ACH_{50}$	16	94	82	74	1.3
	BOTTOM MW 1% DR $2ACH_{50}$	4.6	85	75	71	1.3
	TOP MW 1% DR $1ACH_{50}$	13.3	94	82	74	1.3
	BOTTOM MW 1% DR $1ACH_{50}$	4.1	81	74	70	1.3
5 PERM VR	TOP MW 1% DR $3ACH_{50}$ 5 PERM VR	26.7	97	83	73	1.3
	BOTTOM MW 1% DR $3ACH_{50}$ 5 PERM VR	4.8	87	76	72	1.3
	TOP MW 1% DR $2ACH_{50}$ 5 PERM VR	13.4	94	82	74	1.3
	BOTTOM MW 1% DR $2ACH_{50}$ 5 PERM VR	4.2	82	75	71	1.3
	TOP MW 1% DR $1ACH_{50}$ 5 PERM VR	10.7	93	82	73	1.3
	BOTTOM MW 1% DR $1ACH_{50}$ 5 PERM VR	3.8	81	74	70	1.3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tsim
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gungchung
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jugshing
shari-jugshin
shari
shatung
shatung
lungzey
gha
dhingri
rear w
gha
upper floor
lungzey
inner wall
kaw
timber frame


PROJECT DANTAK
NATURE DOES NOT HURRY
YET EVERYTHING IS
ACCOMPLISHED
19 TF
60 RCC
ASHOK LEYLAND