Environmental Assessment and Preservation for Fujian Hakka Villages

ISISS 2011 Xiamen University

Minoru Ueda

MU Design Inc. Japan

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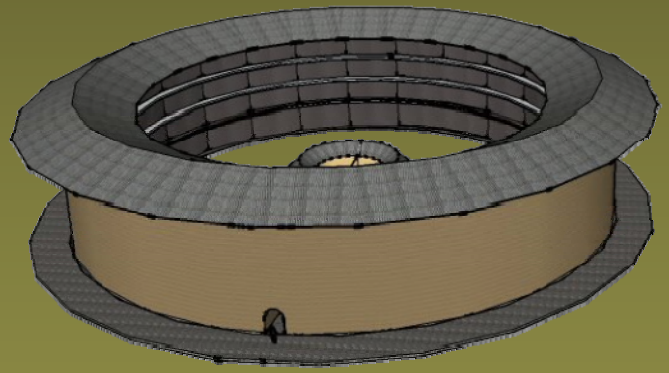
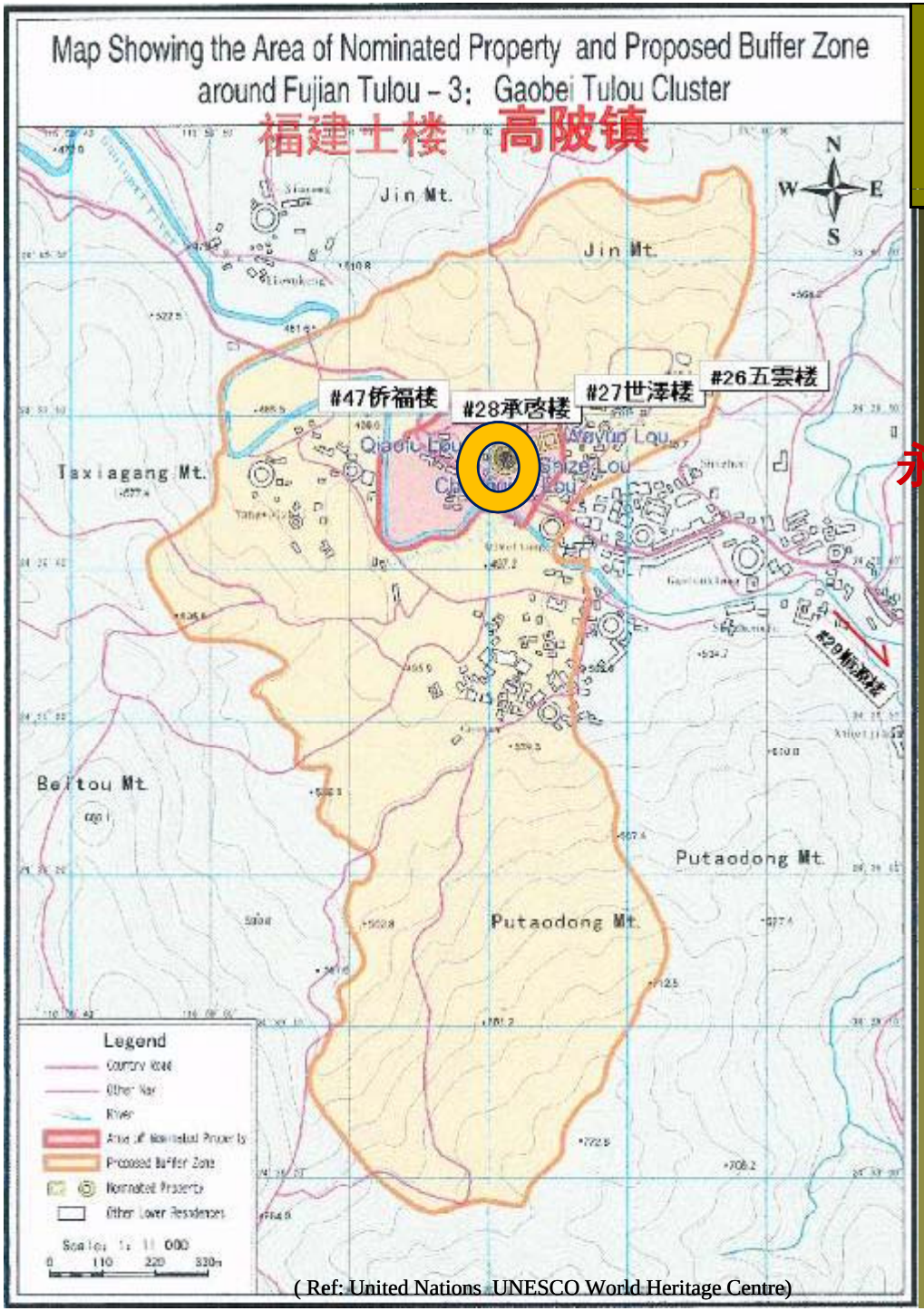


Minoru Ueda

MU Design Inc. Japan

1113-003 Gabei Tulou Cluster
高北土楼



(Ref: United Nations UNESCO World Heritage Centre)

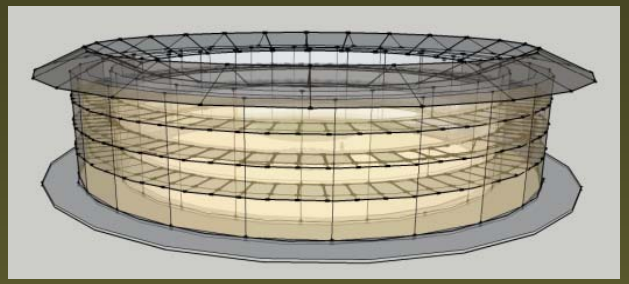
#28 承啓楼 Chengqi Lou (1709)

Cheng Qi Lou 承啓樓

Cheng Qi Lou 承啓樓
Structure 建築

- Typical Hakka Toulu – one of the largest
- 4 Story South Facing 4層樓朝南
- Area 878 m^2 面積平方米
- Diameter 62 m 直徑
- Height 15.8 m 建築高度

Cheng Qi Lou 承啓樓



- 150 km from Xiamen 150公里從廈門
- Altitude 515 m 高度
- Hot Summer/Mild Winter 炎熱的夏季/寒冷的冬季溫和
- Surrounding area agricultural 圍繞區域農業
- 40 Family 200people lives 四十家族 二百人

Local Climate 地域氣候

Gabei area 高北

- Temperature 溫度
- Humidity 濕度
- Insolation 日射量
- Wind 风向·风力
- Rain 雨量

- Hot Summer/Mild Winter 炎熱的夏季/寒冷的冬季溫和

- 700 Heating Degree Days 700的采暖度日數

Evaluating Environmental Impact
評估對環境的影響
Key Factors　關鍵因素

- Energy Utilization　能源利用
- Comfortability Index

Comfortability index					
	Temperature			Humidity	
	溫度			濕度	
ASHRE	20 – 27	℃		0 - 80	%
Chinese Indoor Environmental Standard	16 –24	℃		30 - 60	%

Data Loggers Installed
安裝數據採集器

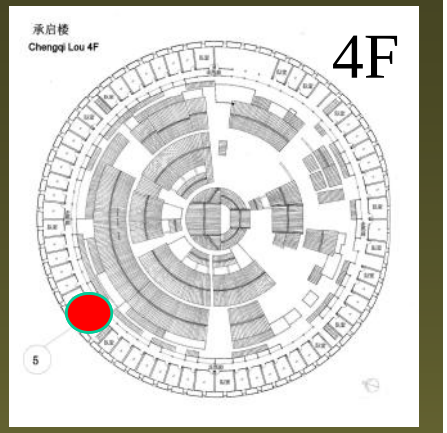
4F Bed Room

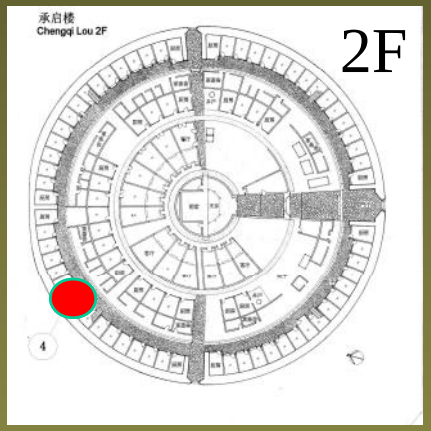
2F Storage

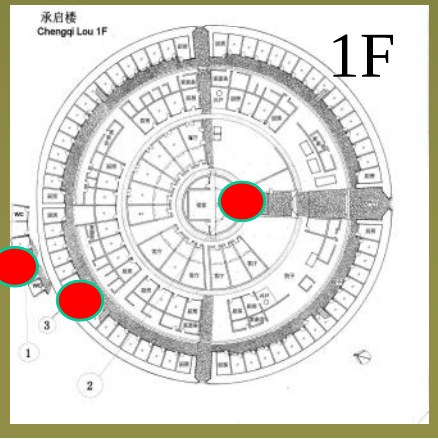
1F Kitchen

Courtyard

Outside



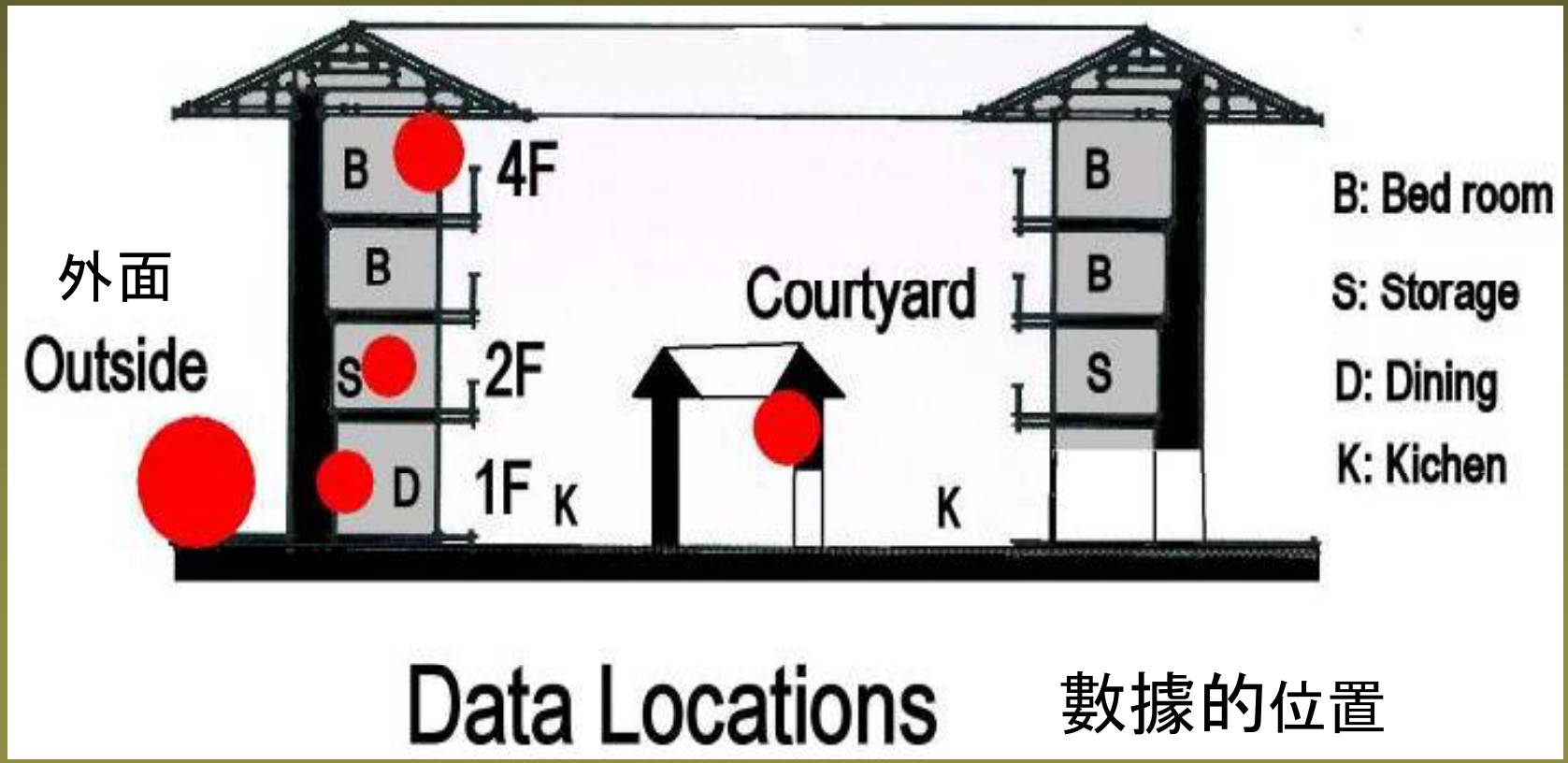




Reference: Drawings by Katayama and Tokyo Art University

Data Loggers Installed
安裝數據採集器

Data Collected 夏季的數據收集
June 28 – July 6, 2009



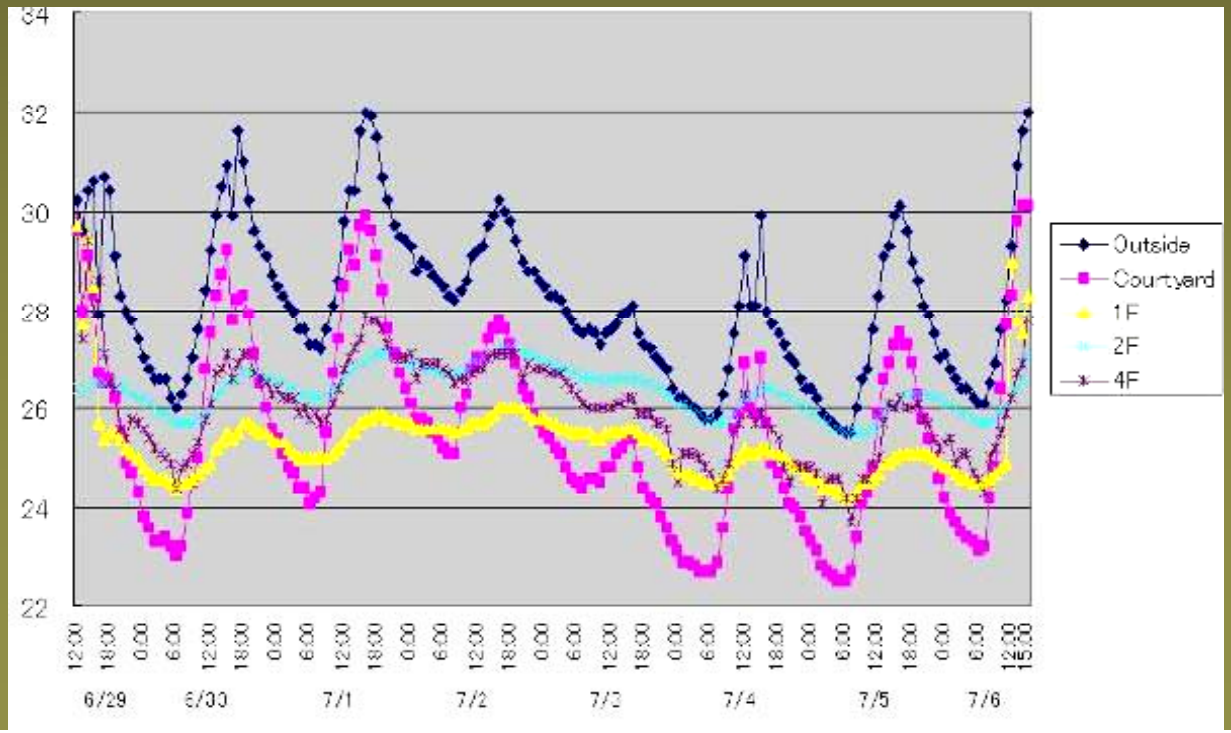
Data Loggers - Cheng Qi Lou 2009
數據記錄儀 -承啓樓

Monitoring Temperature and Humidity
監測溫度和濕度

Temperature Data 溫度數據

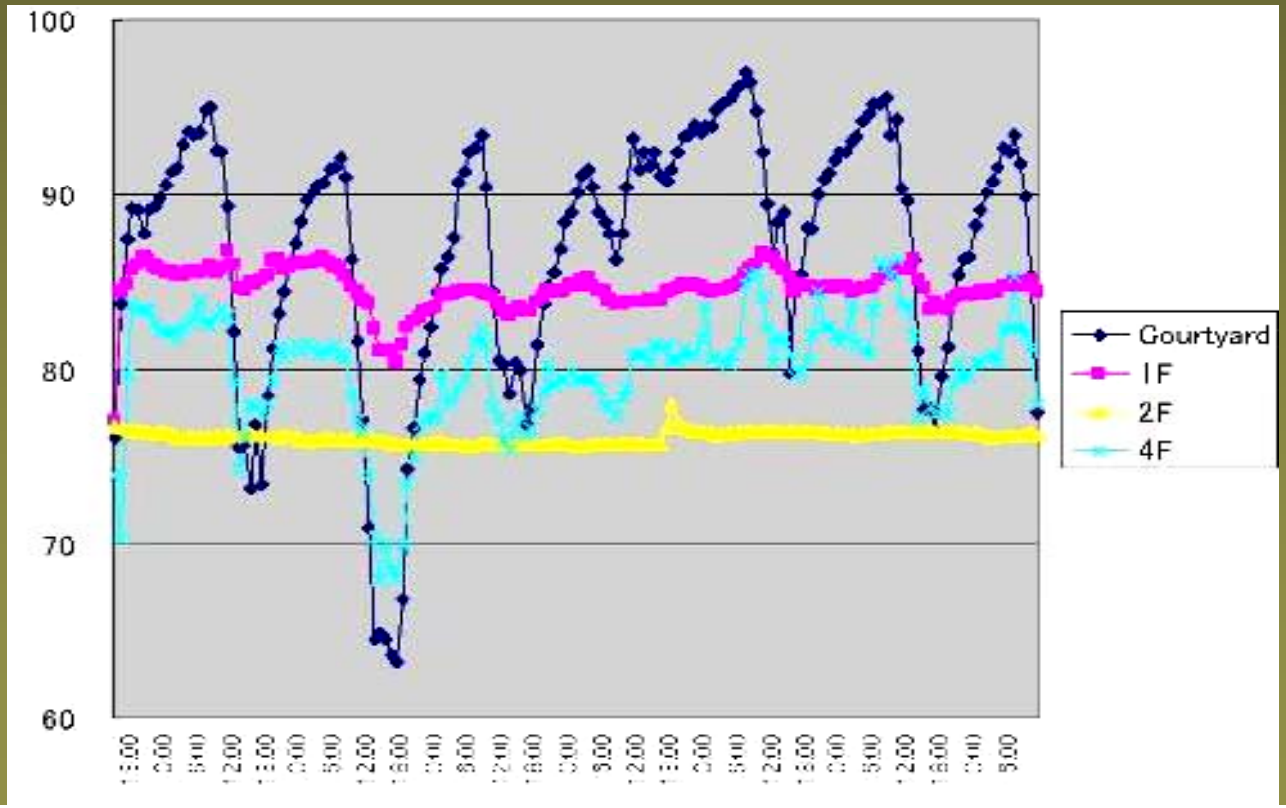
- External temp. variation 6.5^0 外部溫度變化
- 2 fl. temp. variation 1.7^0 溫度變化
- 1 fl. temp. variation <5.5^0 溫度變化

  Cooler - vaporization effect 散熱器 - 汽化效應



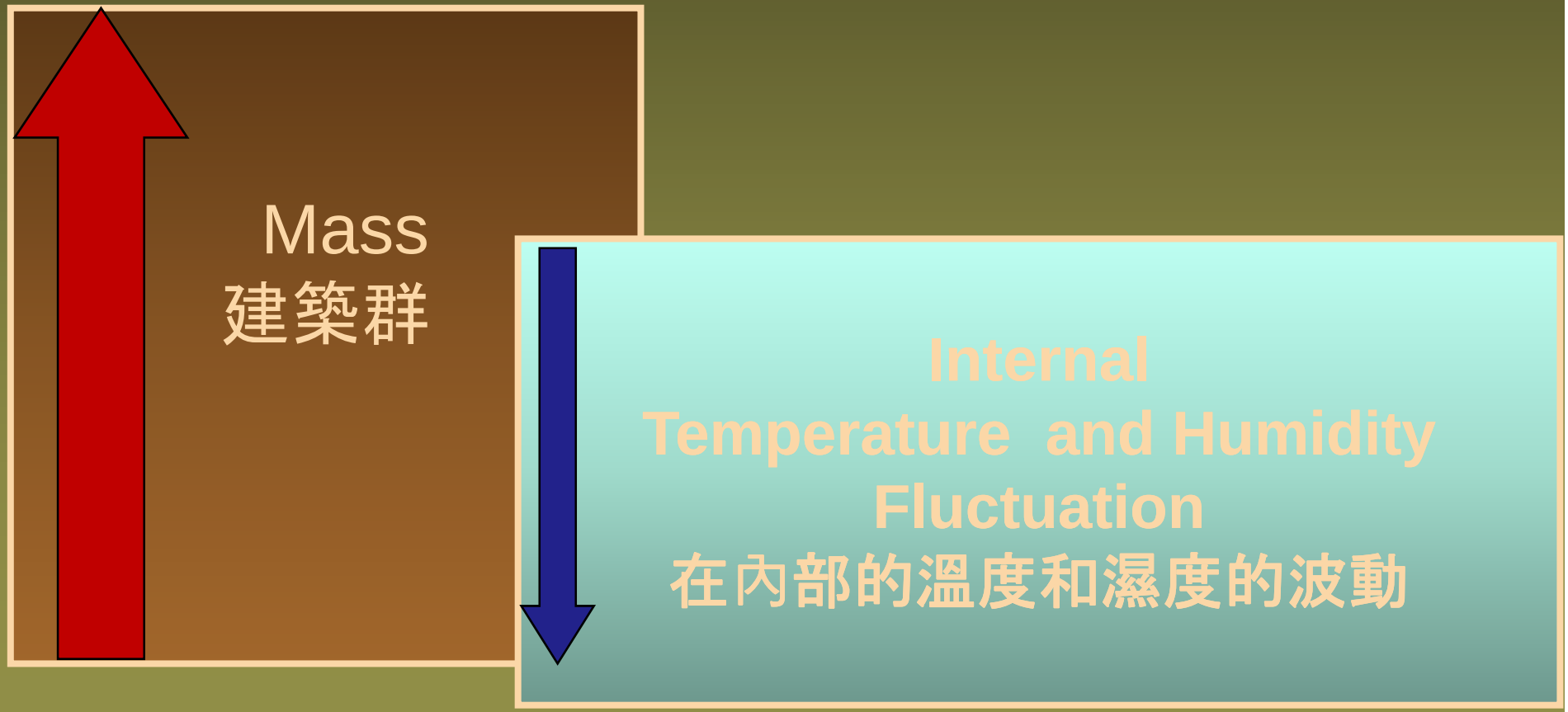
Relative Humidity Data　對濕度數據

- 2 fl nearly constant at 76% (± 2%)
- 1 fl relatively constant in 85% range
- 4 fl similar to external temp. but 7% lower



Massive Rammed Earth Walls
大規模的夯土土牆

Thermal Performance　熱性能



Massive Rammed Earth Walls
大規模的夯土土牆

- Cheng Qi Lou 承啓樓

Volume mass of earth - 3213 m^3 地球的大批量

26% of total building area 總建築面積

Smaller Toulu - similar wall thickness

Total volume mass / total space is even greater

Significant Thermal Battery Potential
顯著的熱電池的潛力

Historic Rammed Earth Structures
歷史撞向地球結構

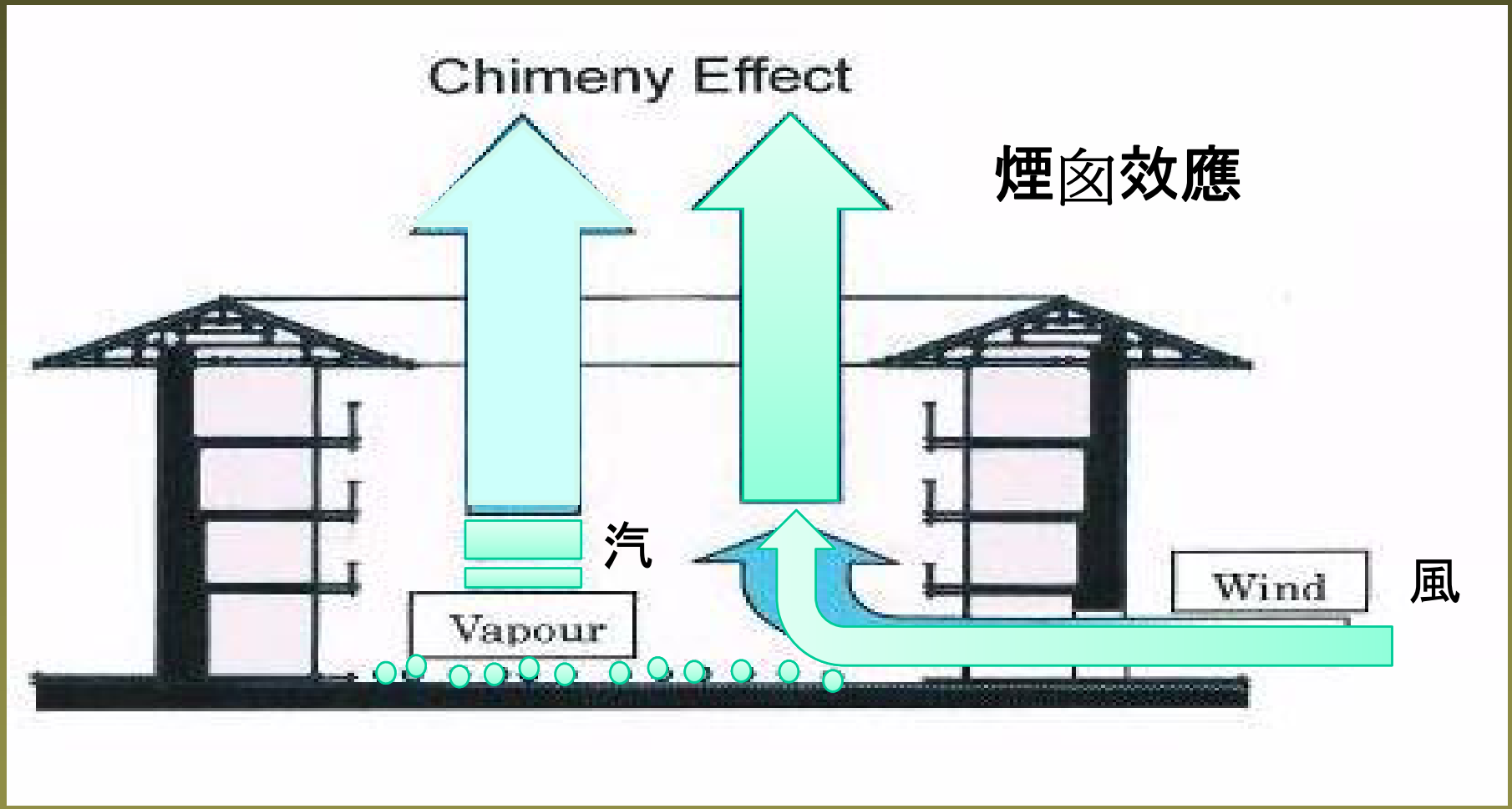
- Defense / Security 國防/安全

Sustainable Architecture 可持續發展的建築

- Protection from climate 從氣候保護
- Storage preservation 儲藏保鮮
- Use local materials 使用當地材料

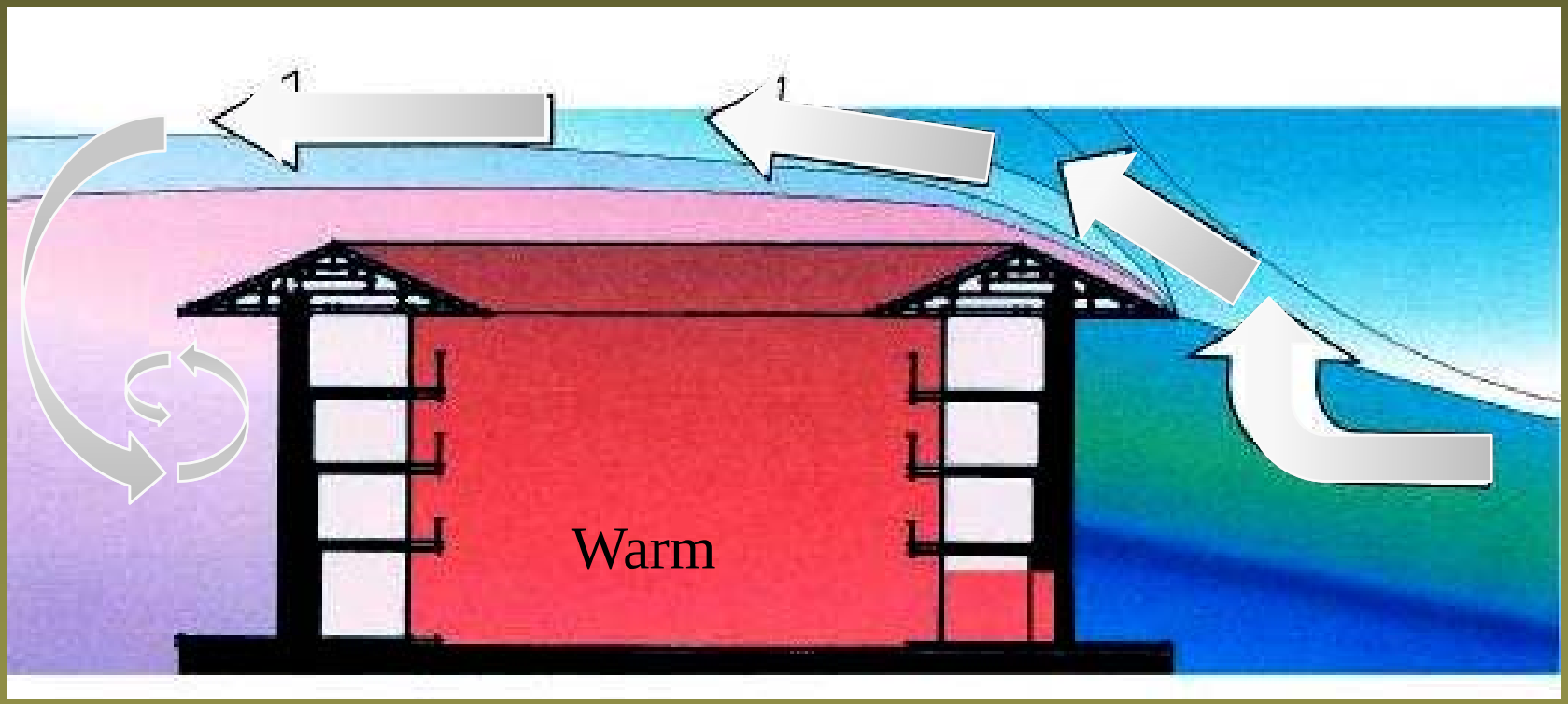
Natural Air Flow
自然空氣流動

Summer 夏天



Natural Air Flow
自然空氣流動

Winter - gate closed
冬季　閘門關閉



Improve Winter Heating Performance
提高冬季供暖性能

Prevent Heat Loss 防止熱損失

- External Insulation 外牆保溫
- Building perimeter 建築外圍

Environmental Performance Assessment
環境績效評估

- LEED (US)
- BREEAM (UK)
- CASBEE (Japan)

	LEED	CASBEE	BREAM
Indoor Air Quality	MAX		
Noise & Acoustics		MAX	MANY
Service Ability	N/A		
Energy	Simulations		Simulations
Rain Recycles		MAX	
Water Wastes		N/A	
Nox. LCCO2	N/A		
Heat Islands Effects			N/A
Flexibility	Exist		

LEED	CASBEE
Sustainable Sites	Q-3 Outdoor Environment on Site LR-3 Off-site Environment
Water Efficiency	
Energy & Atmosphere	LR-1Energy
Materials & Resources	LR-2 Resources & Materials
Indoor Environmental Quality	Q-1 Indoor environment
Innovation & Design	
	Q-2 Quality of Service

CASBEE Criteria

標準

CASBEE-Nice

Q-1 Indoor environment	Noise & Acoustics	LR-1Energy	Building Thermal Load
	Sound Insulation		Natural Energy Utilization
	Sound Absorption		Renewable Energy
	Room Temperature Control		Efficiency in Building Service System
	Humidity Control		ERR *
	Lighting & Illumination		HVAC System
	Air Quality		Ventilation System
	Ventilation		Lighting System
	CO_2 Monitoring		Hot Water Supply System
	Control of Smoking		Elevators
Q-2 Quality of Service	Provision of Space & Storage		Monitoring
	IT Innovation		Operational Management System
	Barrier-free Planning	LR-2 Resources & Materials	Water Saving
	Perceived Spaciousness & Access to View		Rainwater & Gray Water
	Space for Refreshment		Recycled Materials
	Décor Planning		Timber from Sustainable Forestry
	Durability & Reliability		Materials with Low Health Risks
	Earthquake-resistance		Reuse of Existing Building Skeleton etc.
	Seismic Isolation & Vibration Damping Systems		CFCs & Halons
	Interval for Exterior Finishes	LR-3 Off-site Environment	Air Pollution
	Interval for Main Interior Finishes		Noise, Vibration & Odor
	Interval for Plumbing & Wiring Materials		Wind Damage & Sunlight Obstruction
	HVAC System		Light Pollution
	Water Supply & Drainage		Heat Island Effect
	Electrical Equipment		Load on Local Infrastructure
	Support Method of Machines & Ducts		
	Communications & IT equipment		
	Story Height		
	Floor Layout		
	Floor Load Margin		
Q-3 Outdoor Environment on Site	Biotope		
	Townscape & Landscape		
	Local Characteristics & Outdoor Amenity		
	Thermal Environment on Site		

$$ERR^{*} = \frac{\text{Total amount of energy saved in the evaluated building}}{\text{Standard primary energy consumption for the evaluated building}}$$

Building Environment Efficiency Calculation (BEE)
建築環境效率計算

$$\frac{\text{Building Environmental Quality and Performance}}{\text{Building Environmental Load}}$$

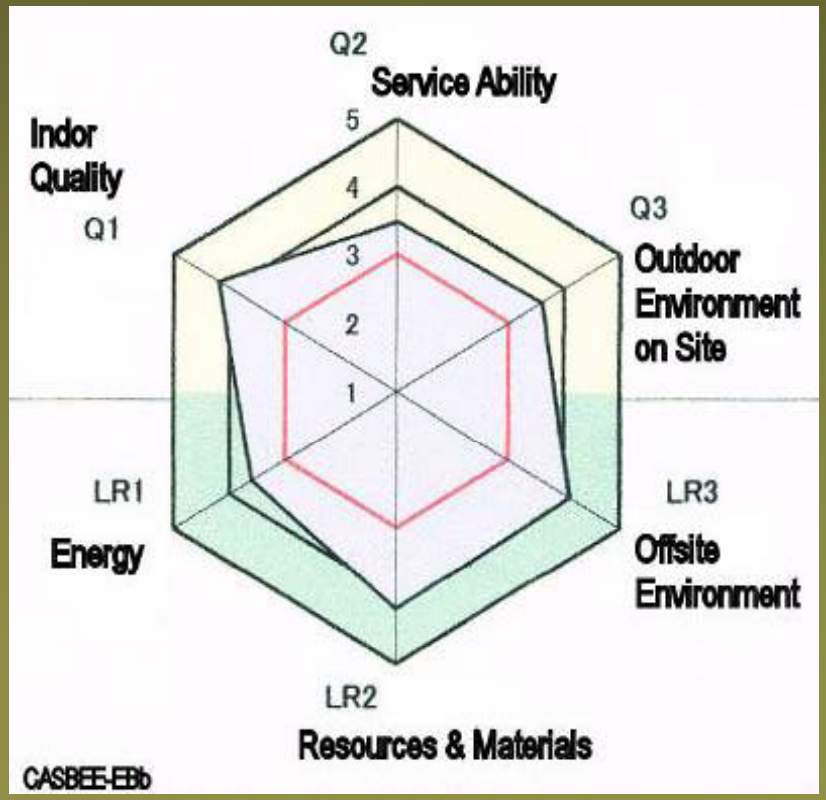
$$\frac{\text{建築環境的質量和性能}}{\text{建築環境負荷}}$$

$$BEE = \frac{\text{Q: Building environmental quality and performance}}{\text{L: Building environmental loadings}} = \frac{25 \times (S_Q - 1)}{25 \times (5 - S_{LR})}$$

Results
結果

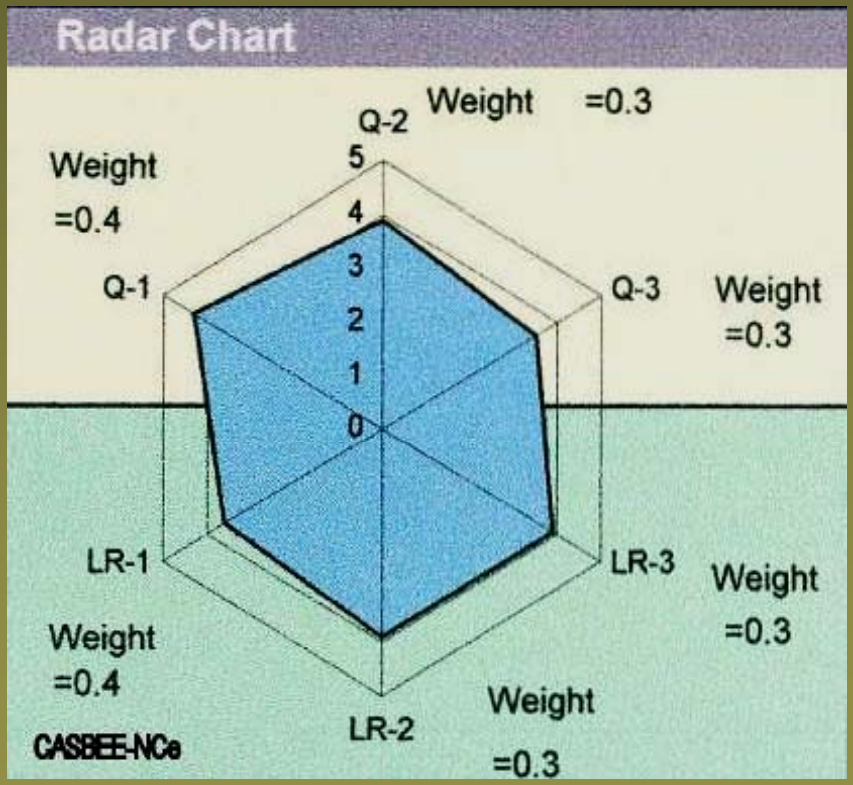
BEE = 2.7

Existing Building現有建築物



BEE = 2.9

New Construction新建築



Assessment of Chen Qi Lou
評估承啓樓

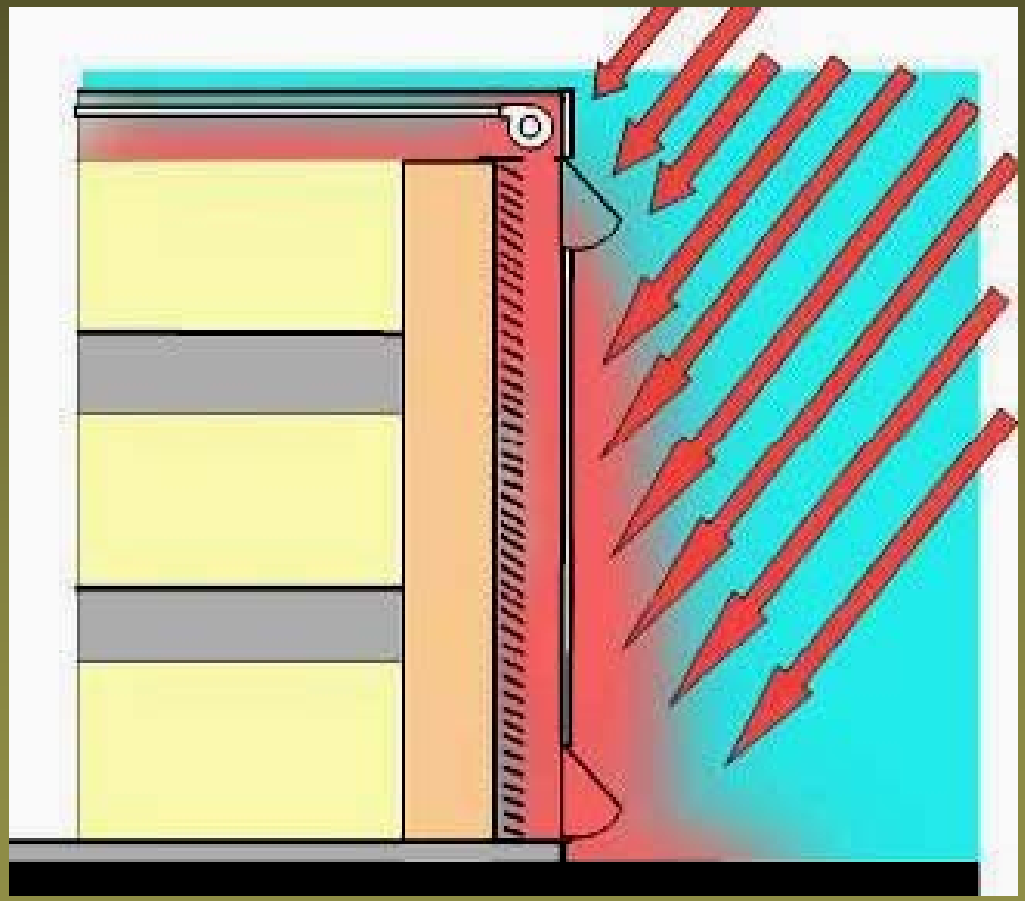
- Impressive Performance for a 383 year old building
- Efficacy of vernacular buildings 鄉土建築的療效觀察

Preserve

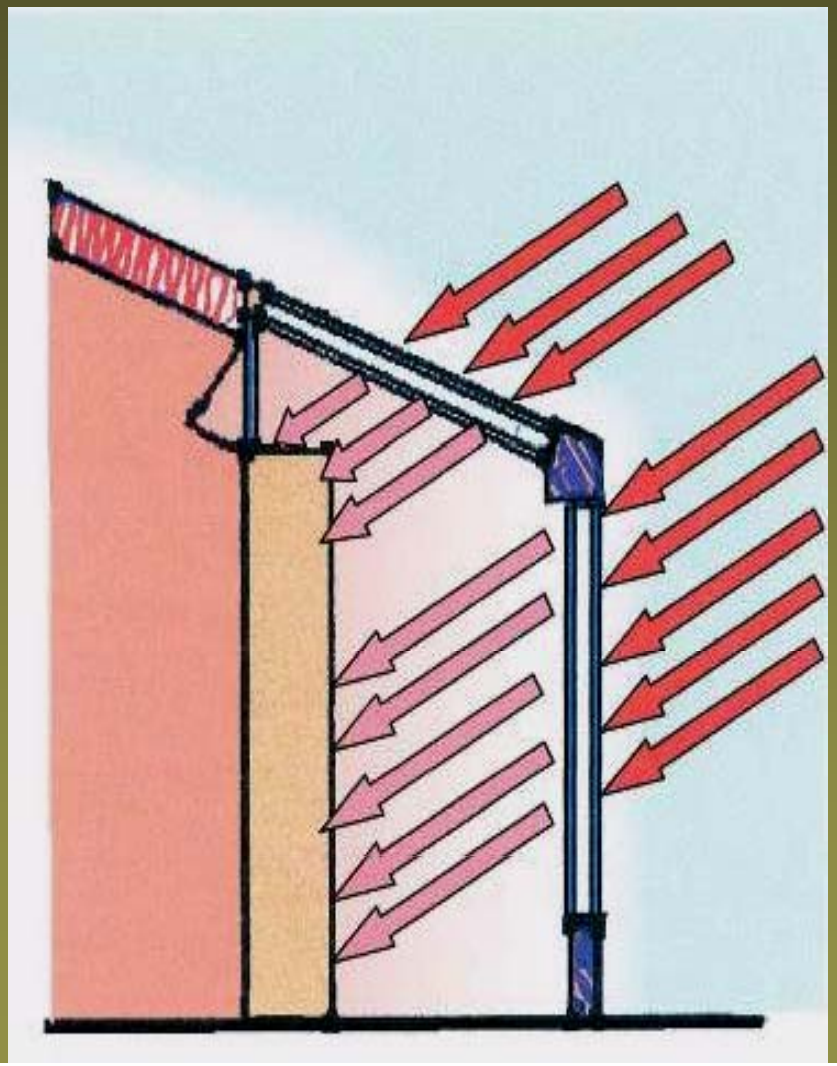
土楼维护 = Repair 修葺 + Revitalize 花样翻新

- 1) total water management upgrade
- 2) small energy efficient heating system
- 3) increased use of natural energy sources
- 4) more emphasis on the biotope and improvement in the outdoor environment.

Double Skin Window
雙層窗



Perimeter Window Zone
周邊窗戶區



Conclusion 结论

- Research for preservation and sustainable retrofit
- Work with villagers to preserve and retrofit buildings
- Establish research and demonstration center