



TMMOB
İNŞAAT MÜHENDİSLERİ ODASI

ŞUBAT 2023 DEPREMLERİ SEMPOZYUMU

Şubat 2023 Depremlerinin İkinci Yılı

Earthen Architecture with Shotcrete Construction

Prof. Dr. Bilge İSİK,

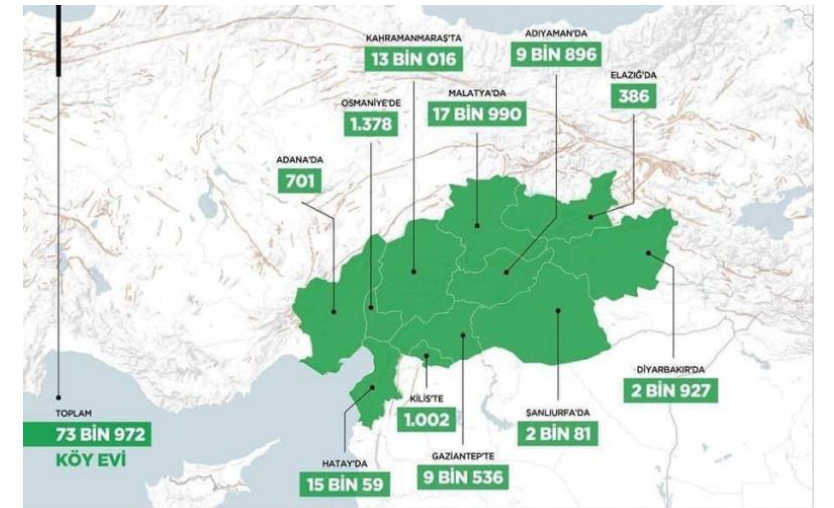
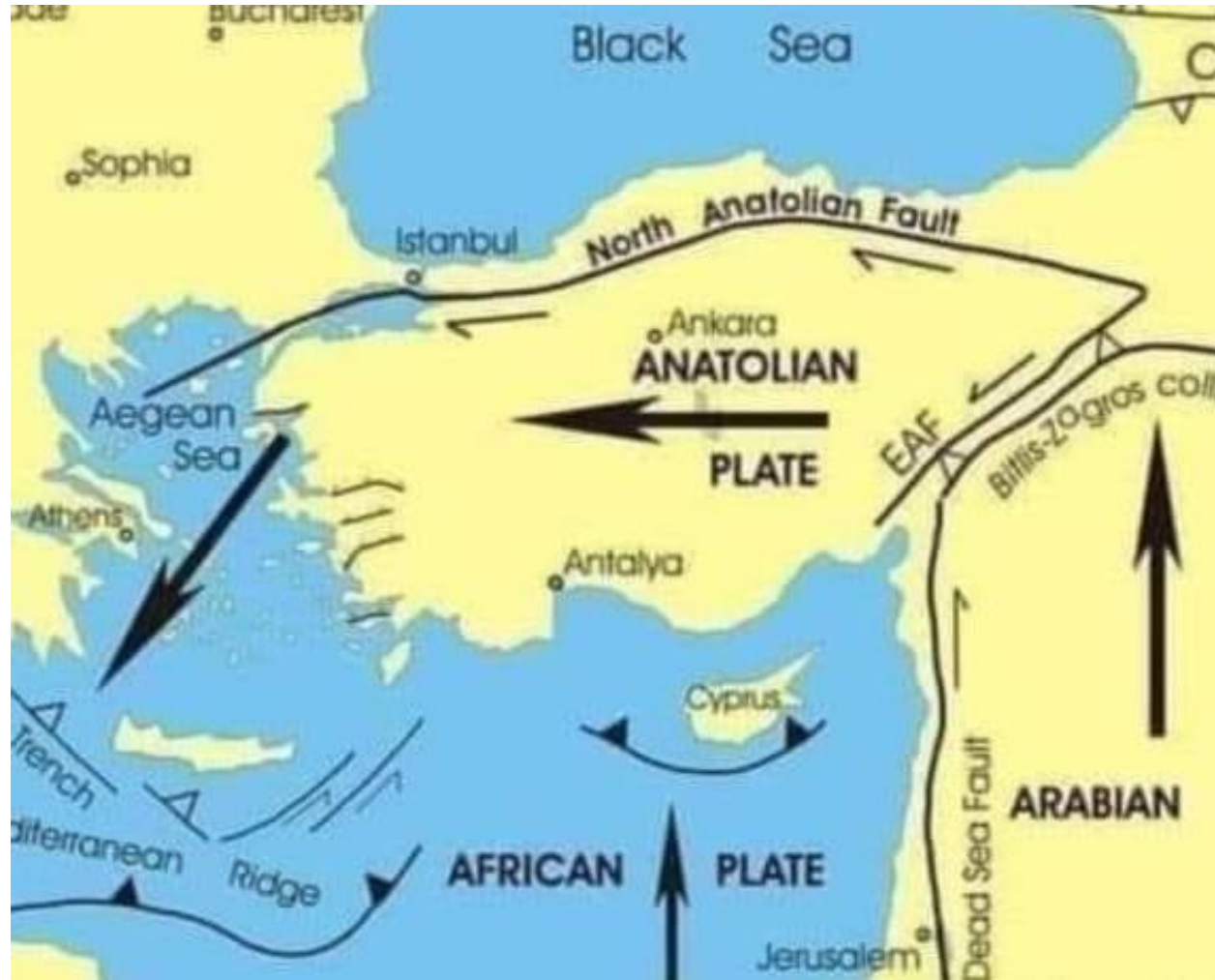
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Şubat 2023 Depremlerinin Yeniden Gündeme Getirdikleri;
Riskler, Önlemler ve Çözüm Önerileri

14 - 15 ŞUBAT 2025 - GAZİANTEP

ŞEHİTKAMİL KÜLTÜR VE KONGRE MERKEZİ



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1/3 World Population lives in Erthen Construction



2nd
century BC
Chinese
Tower



8th
century
AD
Morocco



Van Castle,
9th century
BC

Earthquake Safe Construction Technology must be known and applied



Historical Buildings are earthquake safe. Wall layers stones(strong) and bricks(low strength). Earthquake lateral force absorbed in low strength lateral areas.



The chocolate industry designs where the force will act and break.

Earthen Construction Today

Healty

Earthen wall provides natural humidity balance.
It provides natural air conditioning by balancing heat.
It protects human health (such as natural nutrition)

Sustainable

Energy Efficiency – uses less energy

Reduces fossil fuel use

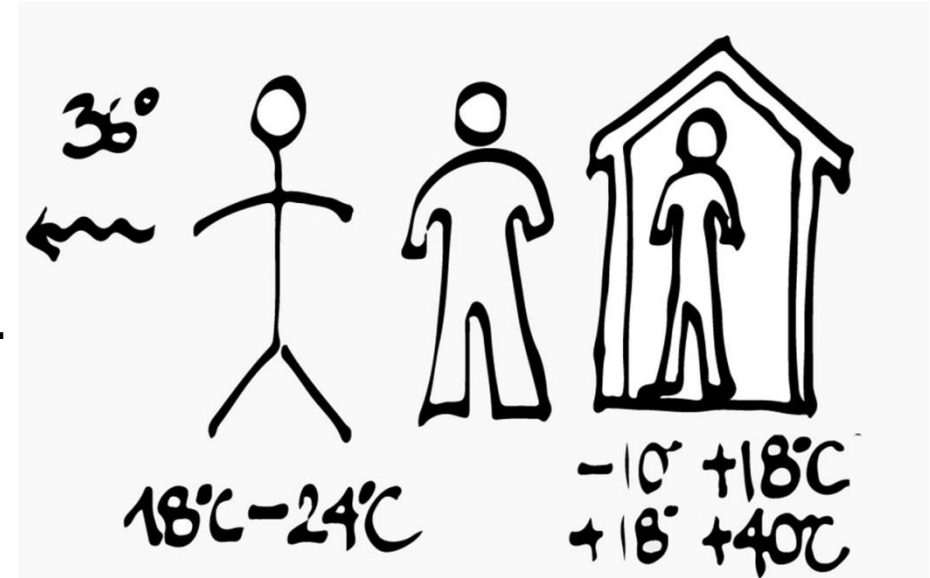
Does not pollute the natural environment – reduces plastic use

Protects family budgets and national budgets

Durable - Long-lasting

Contemporary – Industrialized Construction Technique

Earthquake Safe – Horizontal flexibility, energy dissipating

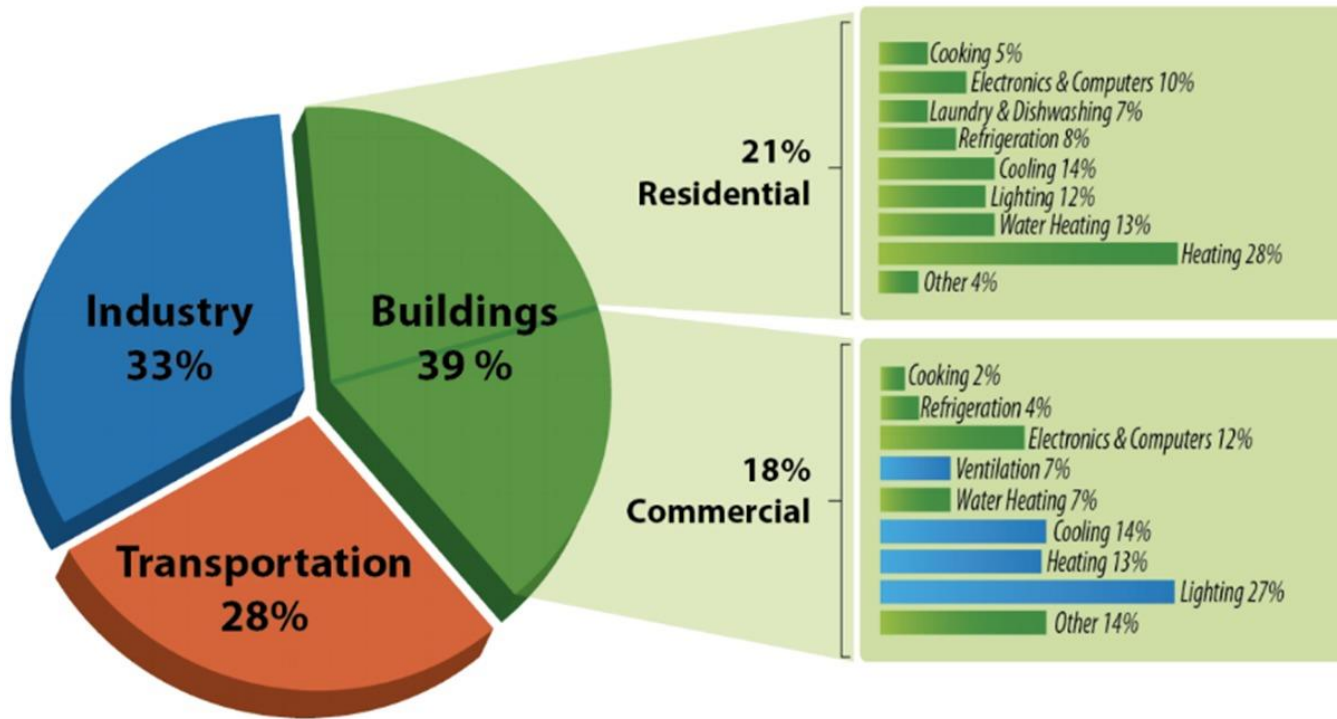




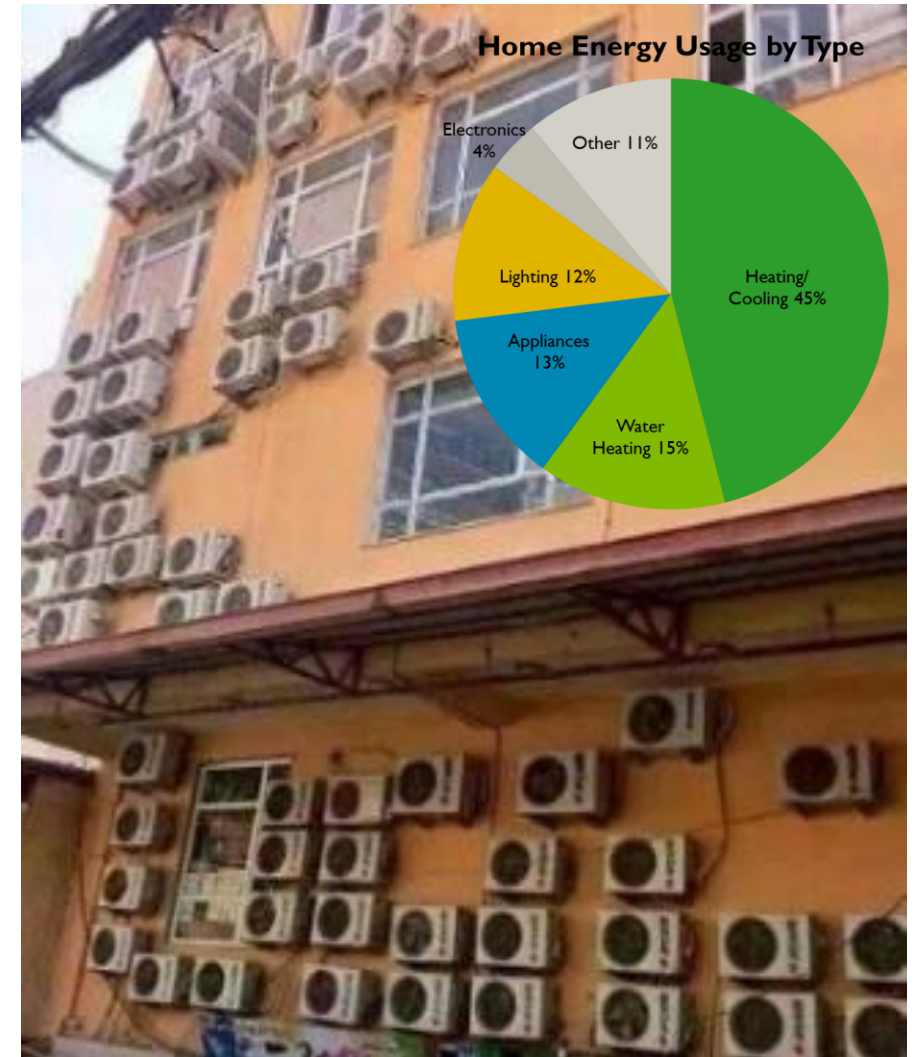
Earth Construction Creates Indoor Climate

- Heat
- Humidity

Energy Consumption in the U.S.



- The majority of the world's energy resources are used by the construction sector.
- Construction Sector energy use in **America 39%** in **Turkey 47%**





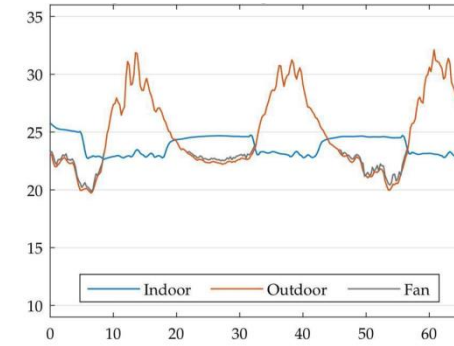
VAN Castle ; 3000 years ago

Gypsum-Lime Stabilization: Percentage

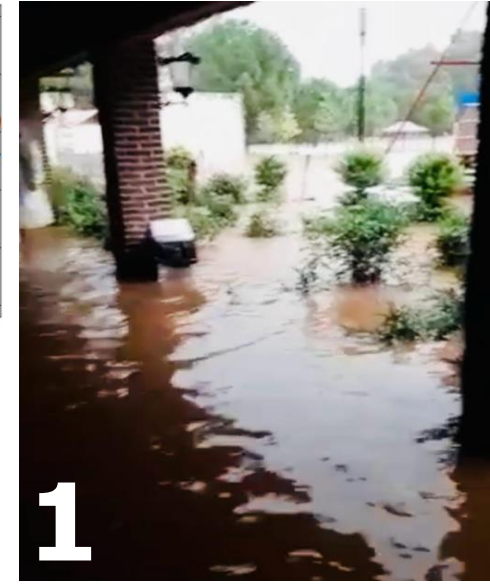
Content	% weight	Practical Dimensions
Soil	100	2 full wheelbarrow
Gypsum	10	4 full shovel
Lime	2 (time)	1 full shovel
water	18-20	1 bucket

Gypsum Stabilized Earth Property

- Water, Rain and Flood Resistance **(1)**
- Snow and Frost Resistance **(2)**
- Indoor climate performance
- Industrial Construction Technology



Measurement of internal and external thermal values



1



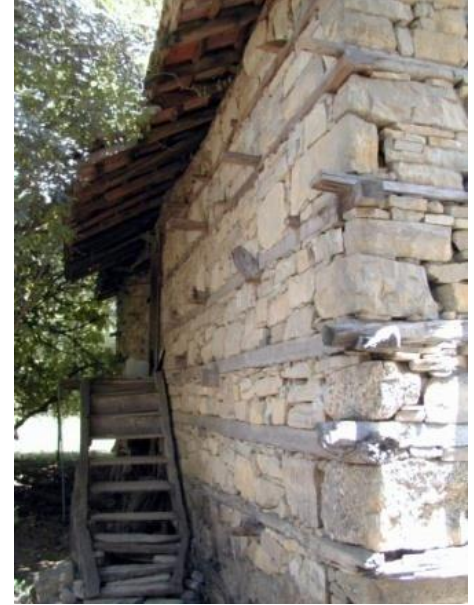
3

Earth construction without stabilization is damaged by water. **(3)**



2

Traditional Earthquake Safety



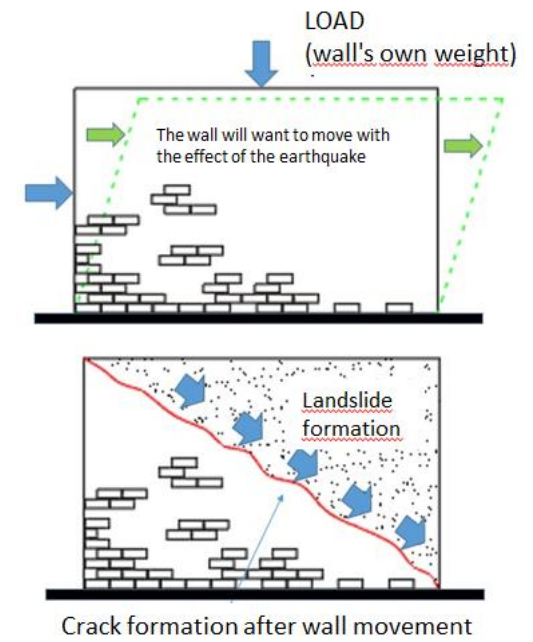
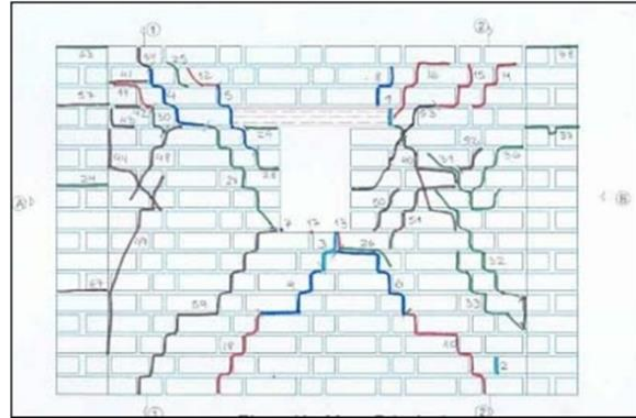
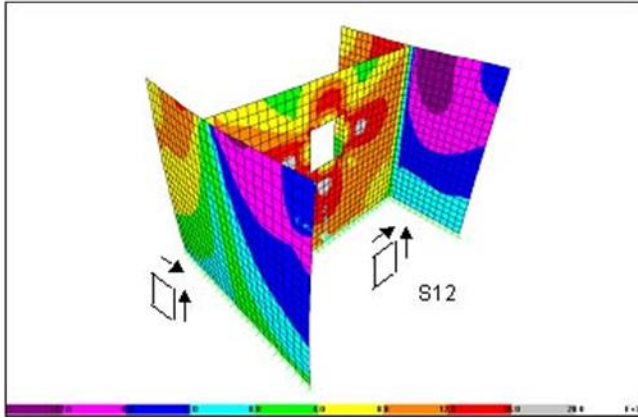
Historical earthen wall
Horizontal Layer in Türkiye
Horizontal layers in Lima

University of PUPC in Lima, Peru:
Labor test on earth wall
withoutt horizontal layer

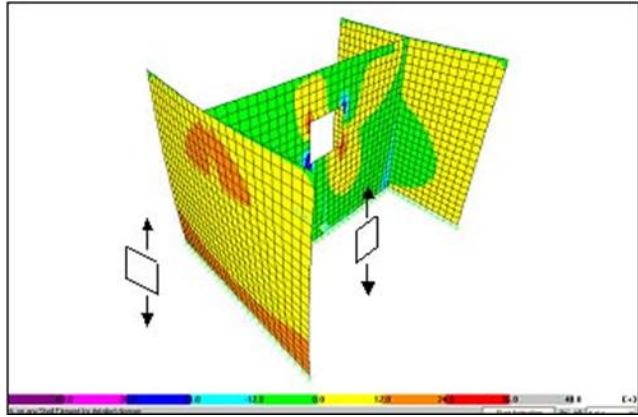


PUPC University
does not apply this
method

Horizontal force

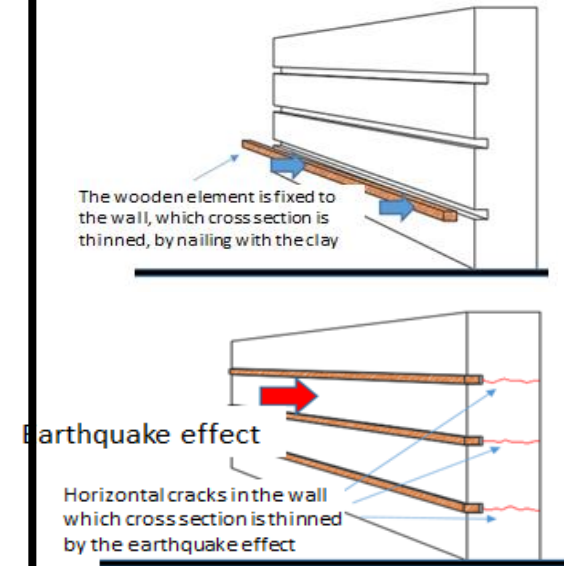


Vertical force

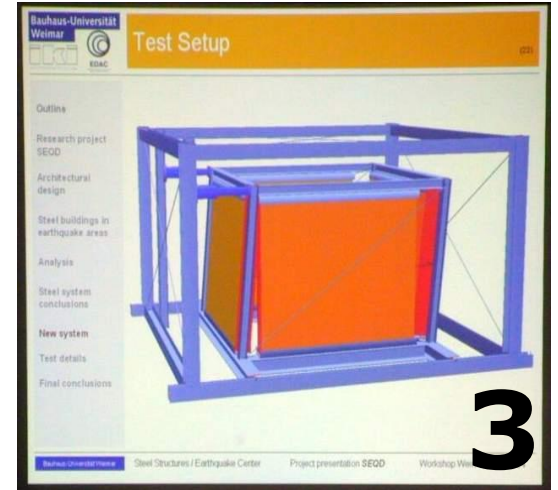


Peru - 2012 Nisan
M. Blondet, D. Torrealva, G. Villa García, F. Ginocchio, I. Madueño
 (Catholic University of Peru)

Load barring wall without horizontal flexible layer



1- Jan19-21 2005 EarthBuild, Sidney, International Conferences, Bamboo Reinforces



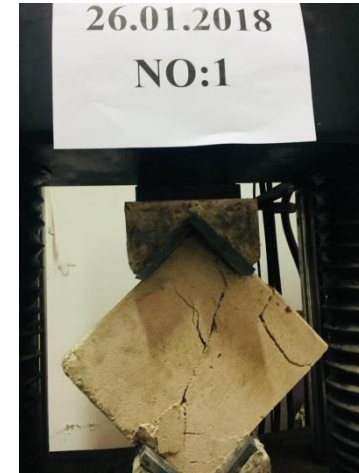
2- Australia, 19.01.2005 "EarthBuild Conference,"
M.Blondet,D.Torrealva,G.Villa García,F.Ginocchio,I.Madueño (Peru Catholic University)"Use of Industrial Materials in the Construction of Safe Adobe Houses in Seismic Zones"

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3 1-2 November 2004,
Germany, International
Conference / Workshop:
Bauhaus-Universität Weimar
Surface reinforcement

1 - Cross crack, ITU Laboratory test (2002)
Load barring wall without horizontal flexible layer

2 - Crack in horizontal layer, ITU Laboratory test.(2002)
Load barring wall with horizontal flexible layer





**Shaking Table
Test 2009 –
ANKARA
Disaster Affairs
Directorate
8 pieces 7
Richter scale
after
earthquake**

**Earthquake damage
with diagonal
fracture in an
unprepared
masonry building**

1. Lateral Flexible 2. Historical Building Stone + Brich horizontal flexible diagonal crack



EARTHEN INDUSTRIALIZED CONSTRUCTION TECHNOLOGY TODAY

Healty

Earthen wall provides natural humidity balance.
It provides natural air conditioning by balancing heat.
It protects human health (such as natural nutrition)

Sustainable

Energy Efficiency – uses less energy

Reduces fossil fuel use

Does not pollute the natural environment – reduces plastic use

Protects family budgets and national budgets

1. TRADITIONAL ADOBE

2. CONTEMPORARY EARTH CONSTRUCTION

Earthquake Safe

Durable – Long lasting

Fast Construction

2.1. Rammed Earth

2.2. Earth Block

Industrial Production

2.3. Shotcrete in wall form

CONSTRUCTION TECHNOLOGY

1. TRADITIONAL ADOBE Soil + Straw + Water

- Intensive labor
- Long production period
- Costly
- Production of a house: Entire summer period

Traditional Adobe (30% clay)- straw

- Kept in pool
- Shaped
- Laid on threshing floor
- Drying top-bottom
- Ready for construction

Wallwork + mortar + labor



CONSTRUCTION TECHNOLOGY

1. TRADITIONAL ADOBE

2. CONTEMPORARY EARTH CONSTRUCTION

2.1. Rammed Earth

Soil + %10 Gypsum + %2-5 Lime

Form compaction 45 m³
house walls –
4 workers production 11
days

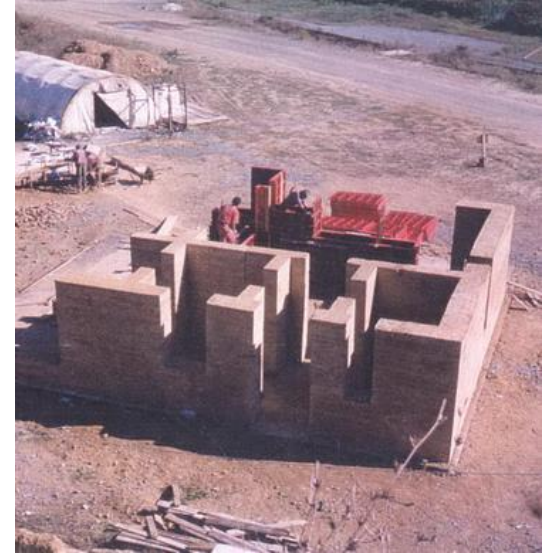
Gypsum Lime Soil (10% Clay)

- Dry mix
- Wet mix
- Ramming into mold

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2.1.RAMMED EARTH CONSTRUCTION

İTÜ Maslak, 1995 TÜBİTAK İNTAK TOKİ 622



CONSTRUCTION TECHNOLOGY

1. TRADITIONAL ADOBE

2. CONTEMPORARY CONSTRUCTION

2.1. Rammed Earth

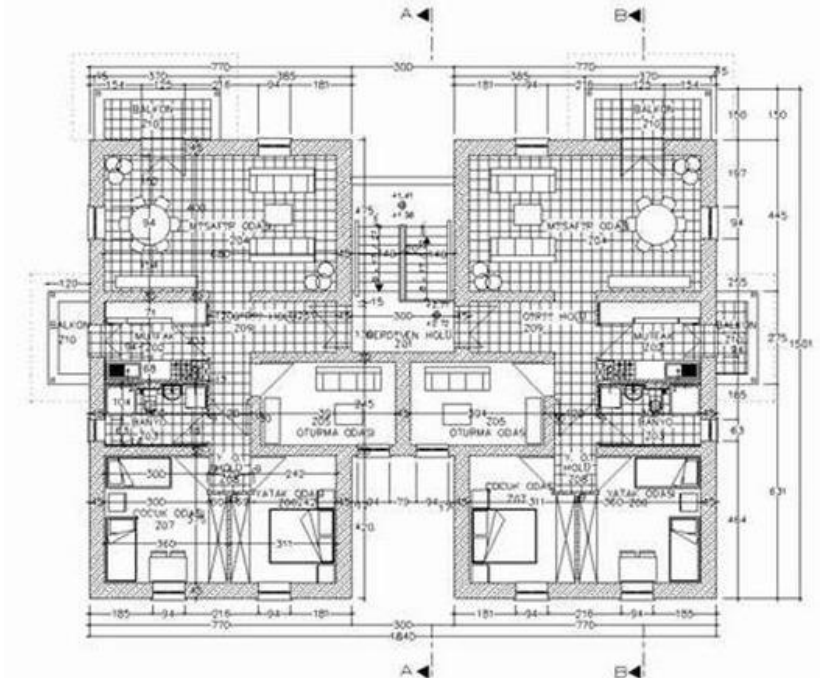
2.2. Earth Block Industrial Production

2.3. Shotcrete in wall form

2.2. INDUSTRIALIZED BLOCK PRODUCTION Earth+Gypsum 10%+Lime 2-5%



Urfa GAP Administration House 2000



2.3. SHOTCRETE Machine - Injection Earth + Gypsum + Lime



**ITU
Construction
Laboratory 1990**

**DELTA Company,
Owner Haluk
Yurttutan**



**Ankara
Disaster
Affairs 2009**

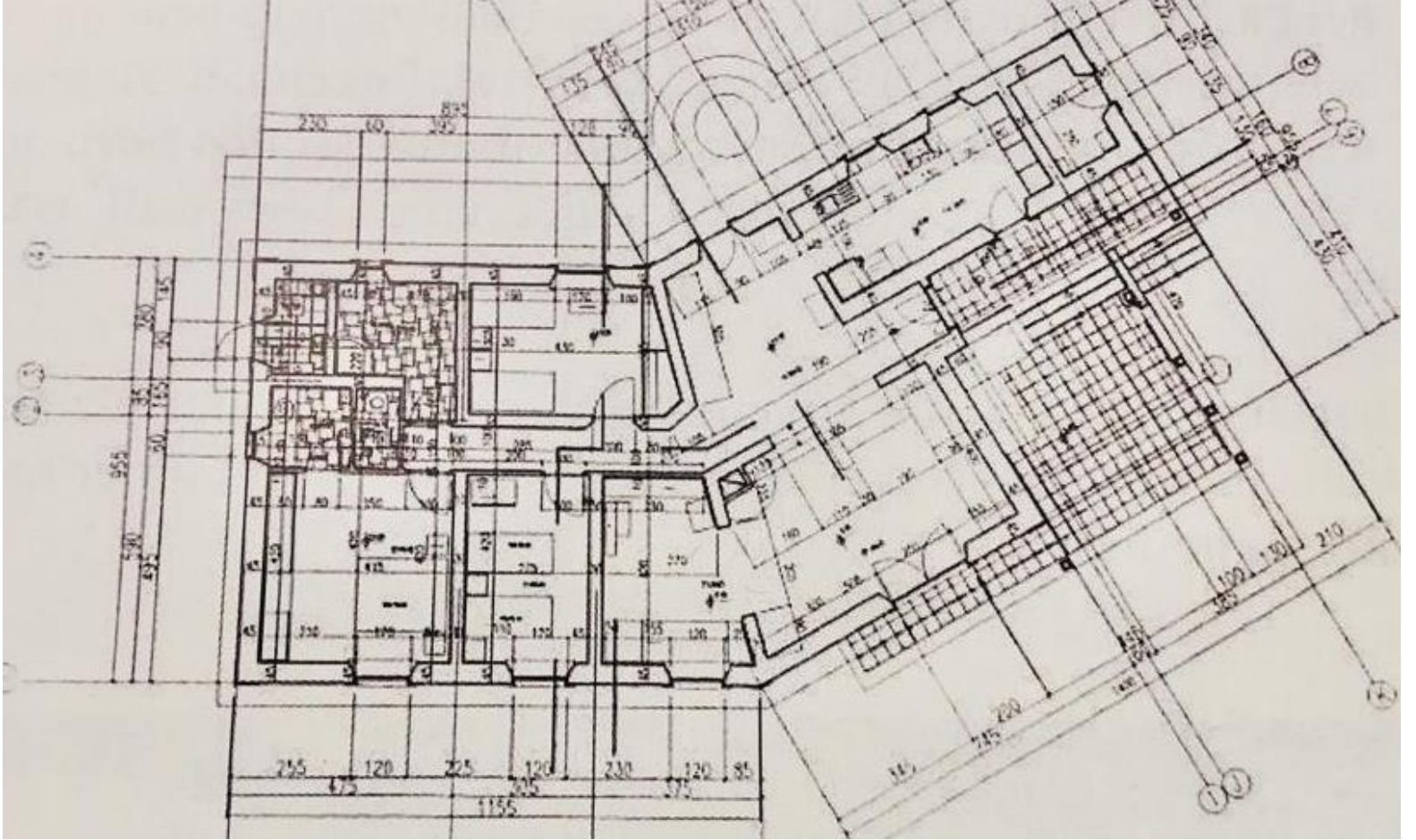


1997 - Altınoluk 180 m2

iç ekolojik yapılar inşaata uygun
dim ve alanda yapılabilir.
neksel kerpiç, suyla temasta
a da, yenilenen kerpiç üretimi
güne göre, toprağa alçı ve kireç
irak, sudan zarar görme
leniyor.



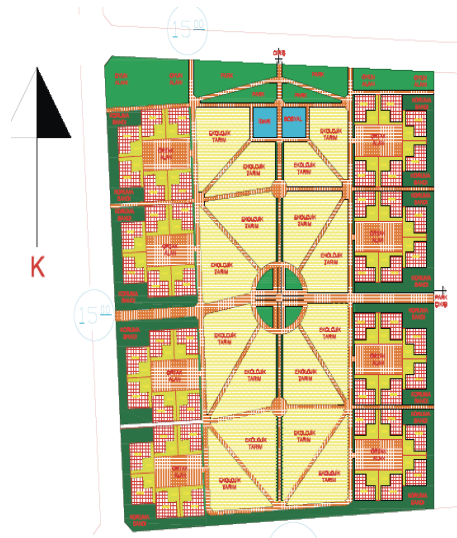
EARTH BUILDING SAMPLE



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EARTH BUILDING SAMPLE

2012- Viranşehir
Earth Building, Home
Owner Construction



EARTH BUILDING SAMPLE



2009 - Samsun, Earth Block filling project



EARTH BUILDING SAMPLE

2015 -
Gobeklitepe
Visitor Center,
Project: Kreatif
Mimarlık



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EARTH BUILDING SAMPLE

2015 - Köyceğiz BKM Film Plateau, About 2000 m2



EARTH BUILDING SAMPLE



**1994 - Cengiz Bektas
Saklikoy Horse Farm
Traditional Adobe Brick**



2012 - Kıbrıs Dilekkaya
Shot-Earth

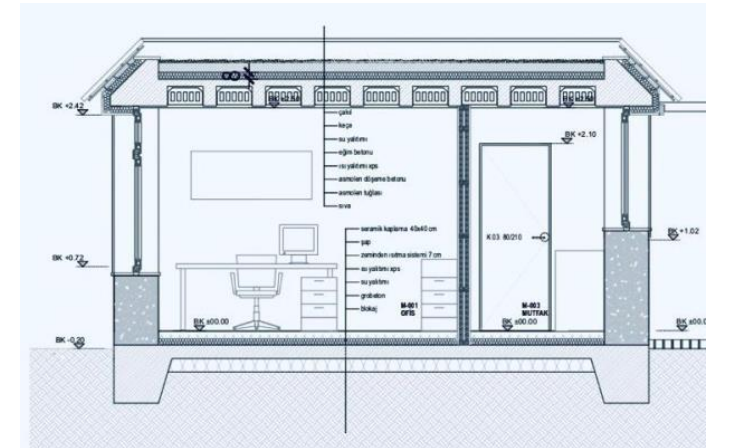
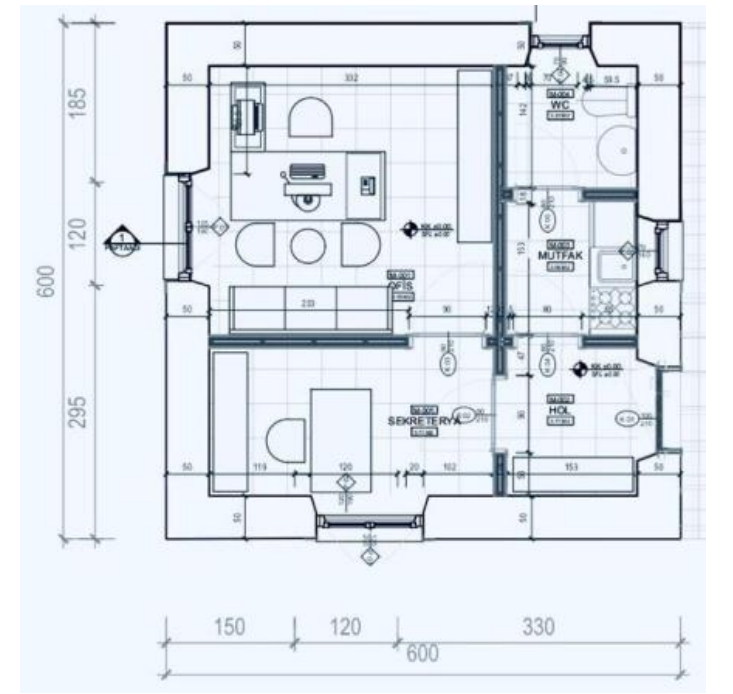
EARTH BUILDING SAMPLE



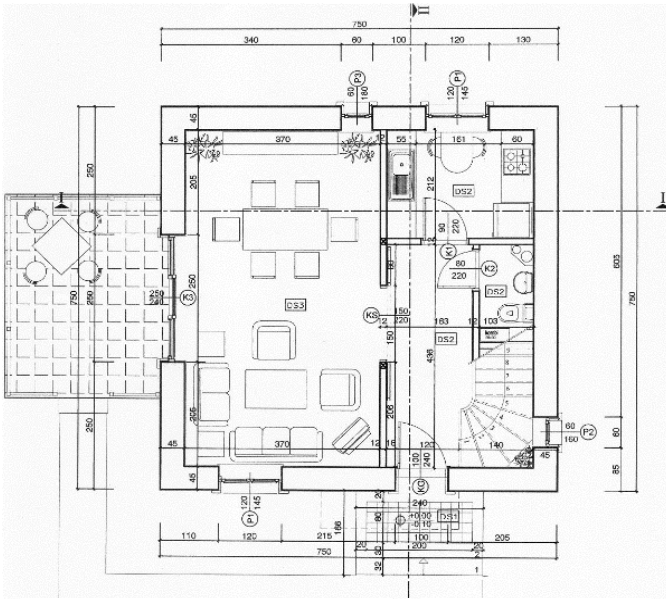
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2019 - Van, Muhtar Office

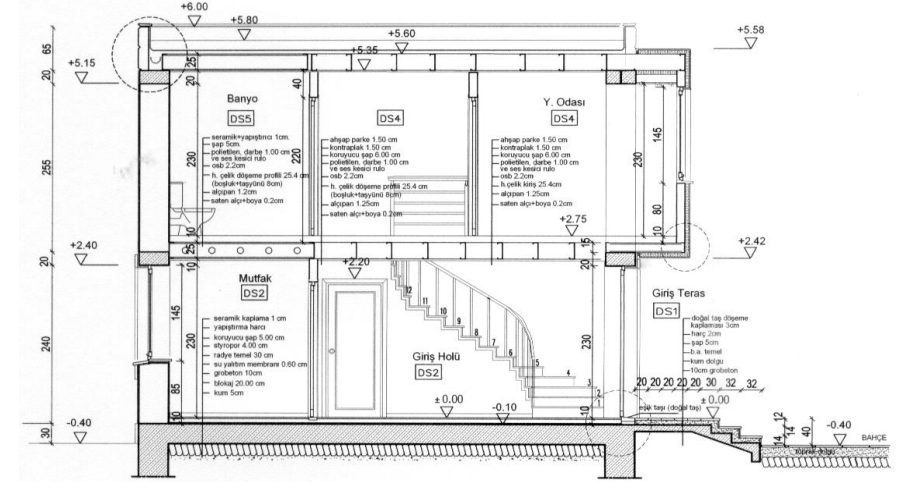
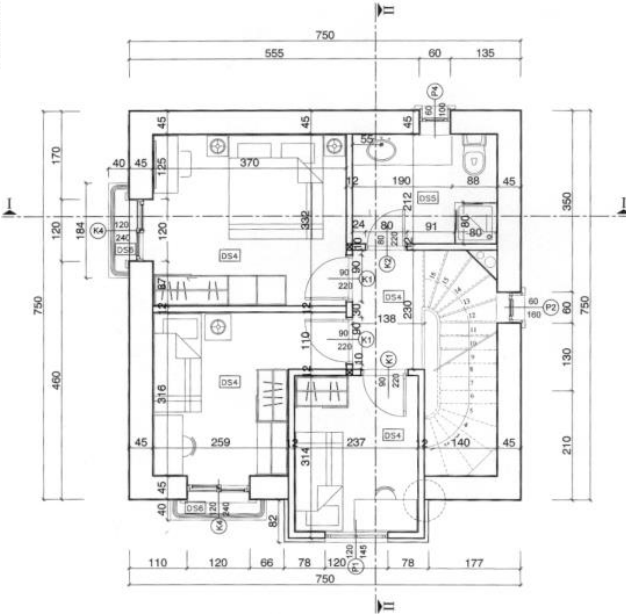
EARTH BUILDING SAMPLE



EARTH BUILDING SAMPLE



Plan 6 x 5 m= 30 m
Height 5x30= 150 m²
Thickness 0.5 = Wall 75 m³
Sprayed concrete feature 15
m³/hour 75m³: 15= 5
Building construction Duration 5
hours = one day



EARTH BUILDING SAMPLE

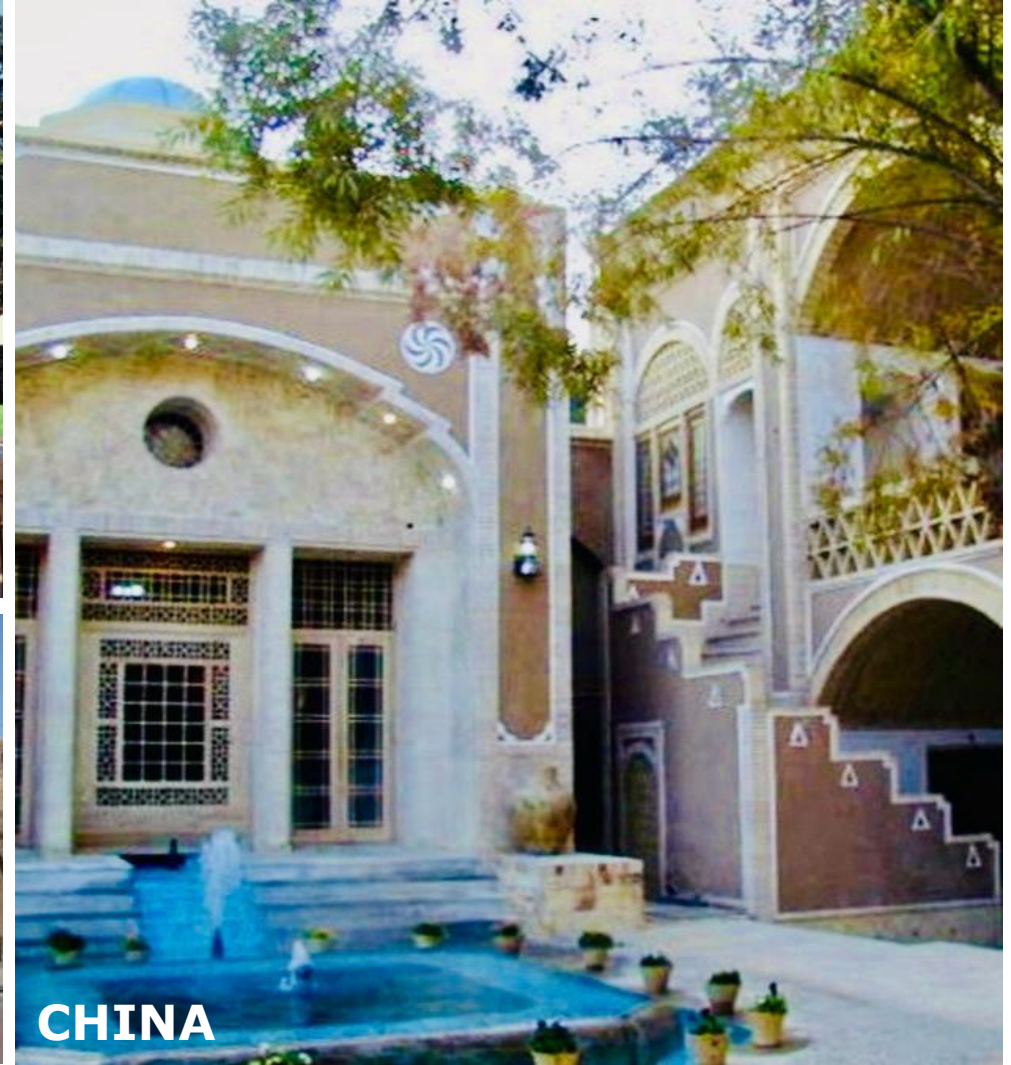
1995 - USA, NAPA Valley Villa
1995 - Australia, Villa



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EARTH BUILDING SAMPLE

CHINA
USA – NAPA Valley
MEXICA
IRAN



EARTH BUILDING SAMPLE



**HOSPITAL • ENTEBBE,
UGANDA**
**Architects: Renzo Piano
Building**
Area : 9695 m² Year : 2020



EARTH BUILDING SAMPLE



2022
Perma Doğa Anaokulu, Bahçeşehir



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