

AFFORDABLE CONSTRUCTION: ADOBE AND COMPRESSED EARTH BLOCKS BASED ON LOCAL MATERIALS, the case of Kabul

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STAGE 01 (Kabul brief)

Earth has been used for thousands of years in Kabul and it is still the main construction material:

- around 70% of single dwellings are earth made houses- most of them were built unplanned and unlawfully,
- Low-income people completely rely on earth made buildings,
- Kabul has medium climates with 4 seasons (hot summer and cold winter)
- One of the main assets of earthen materials is its role in moisture buffering and controlling temperature, which can be related to phase change processes occurring within the pores,
- Earth is able to keep indoor air humidity between 40% and 60%,
- Earth is locally available, environmentally friendly + economic. Earth construction presents less embodied energy and better thermal insulation compare to concrete buildings.

Traditional techniques:

- Adobe, rammed earth, wattle and daub are the main traditional technics – Kabul
- Adobe produces manually using wooden formwork and CEB and CSEB produced using manual press,

Erosion is the main problem with earth construction!

- Stone/concrete foundations, roof overhang and wall plaster are traditional technics to prevent erosion,
- **Martin Rauch** uses ceramic or lime plaster layer to control wall erosion.

Affordable Housing

- Government needs 41704 cheap shelters each year-affordable housing policy,
- Only (5-10 %) build by Government and private sector.

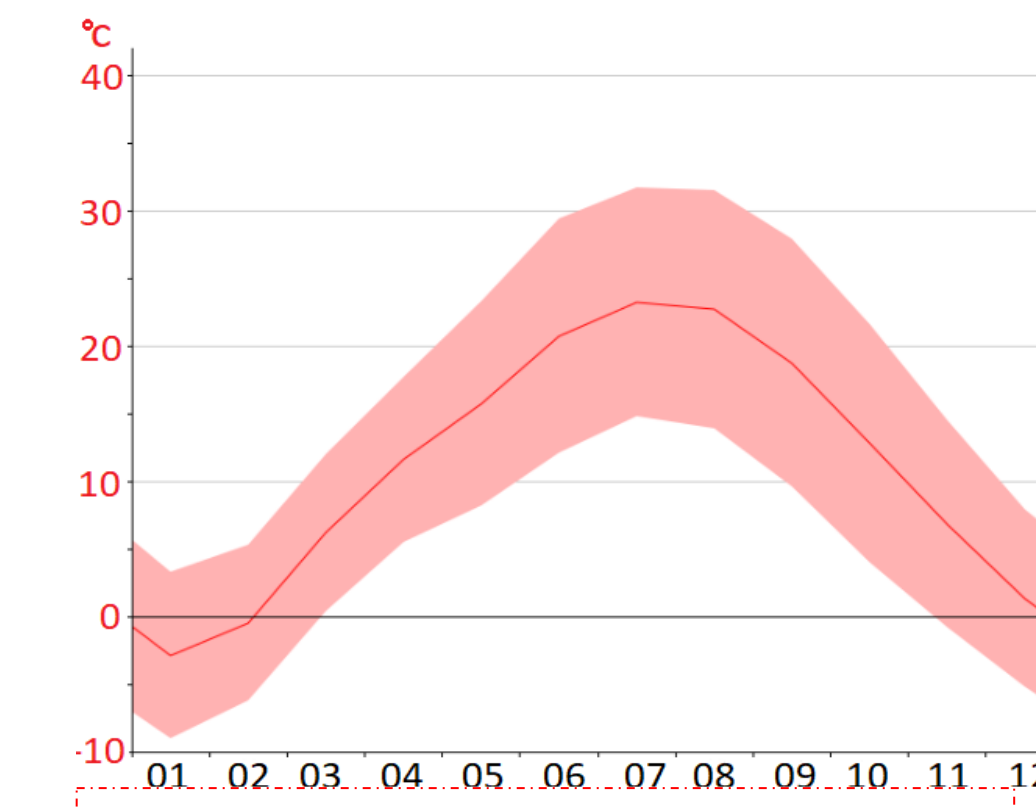


FIG1. Monthly weather – Kabul



PIC 1. Traditional adobe production method



PIC 2. Adobe, CEB and CSEB production at KPU



PIC 3. Adobe house with stone foundation and soil-straw plaster ,

STAGE 02 (Soil selection in Kabul region)

- Three places were studied: Experiments show, Deh-sabz and Arghandi are good soil respectively for adobe, CEB+CSEB production, while Bandi-e-Ghazi soil seems poor quality and has a lot of sand and gravel.
- According to X-RD, patterns of Deh-sabz and Arghandi soils are similar, mainly constituted by calcite and quartz, (Heating treatment shows presence of chlorite (clay minerals)).
- Wet sieve analyses define soil sand ratio as following: Deh-sabz, 98:2; Arghandi, 93.69:6.31; Band-e-Ghazi ,31.22:68.78.

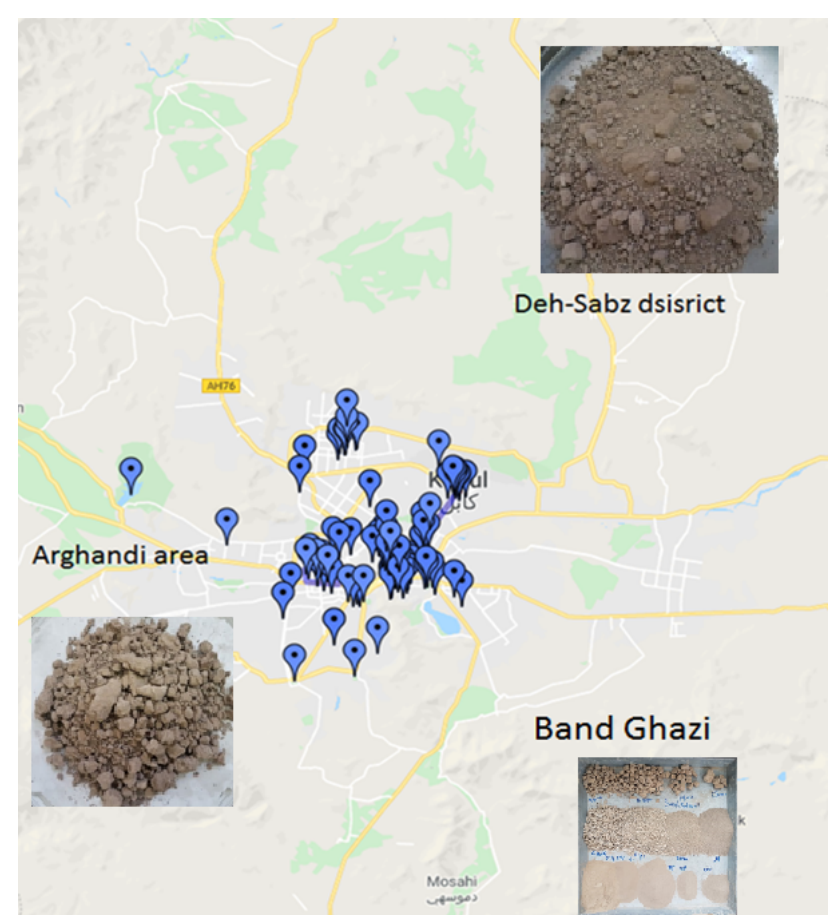


FIG 2. Kabul Map: Deh-Sab, Arghandi and Band Ghazi area. Source, Google map

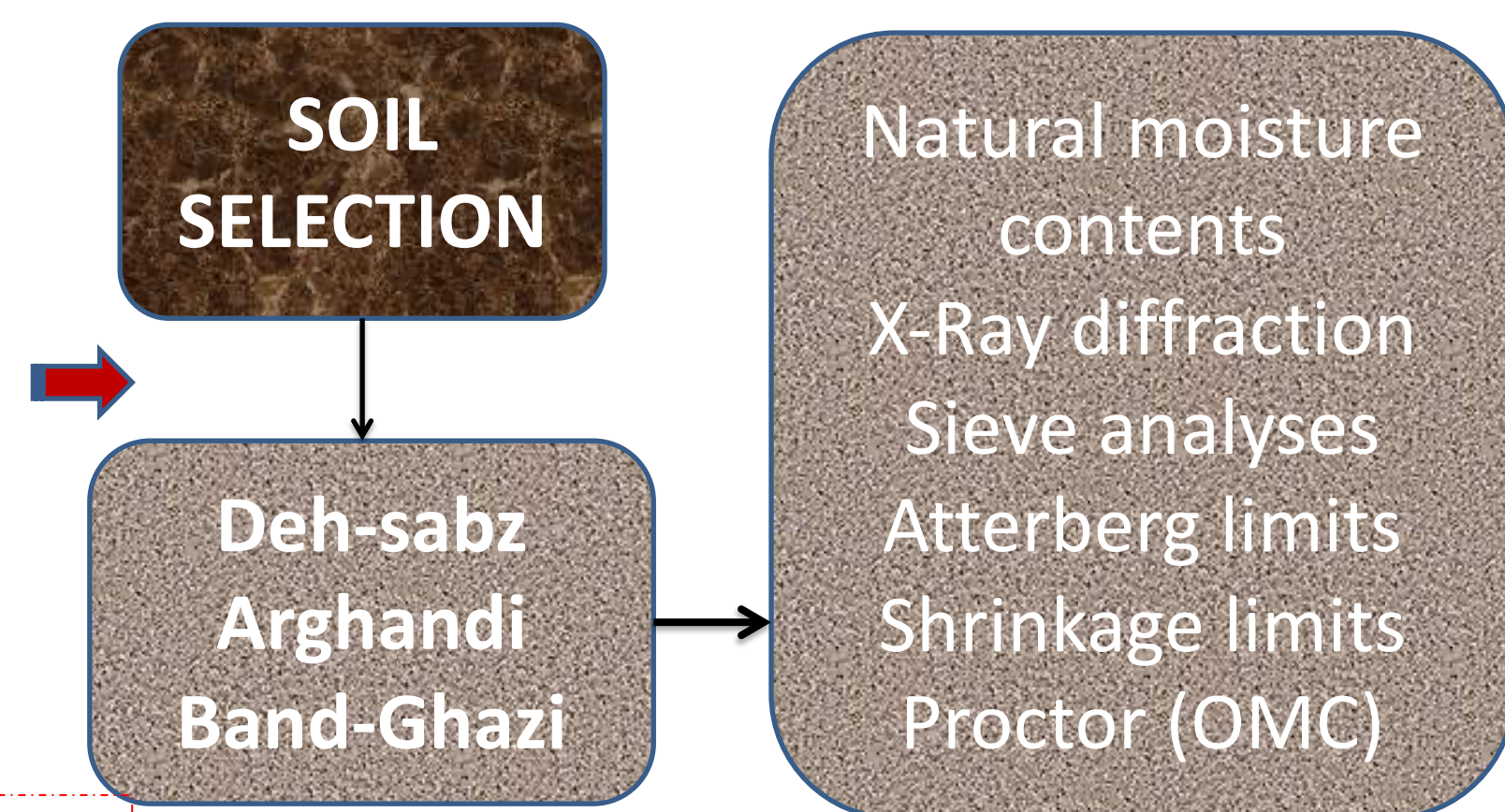


FIG 3. Soil selection and treatments

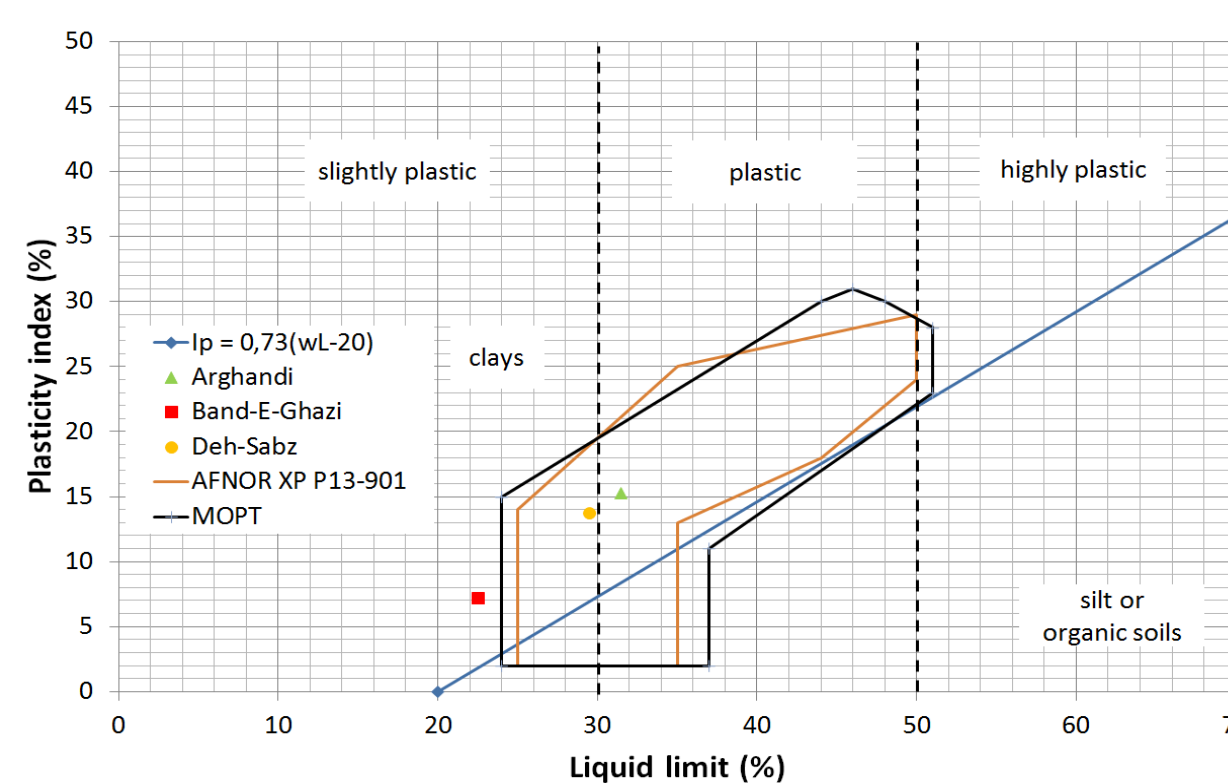


FIG 4. AFNOR 2001; CRATerre-Eag 1998; MOPT 1992 Moyenne

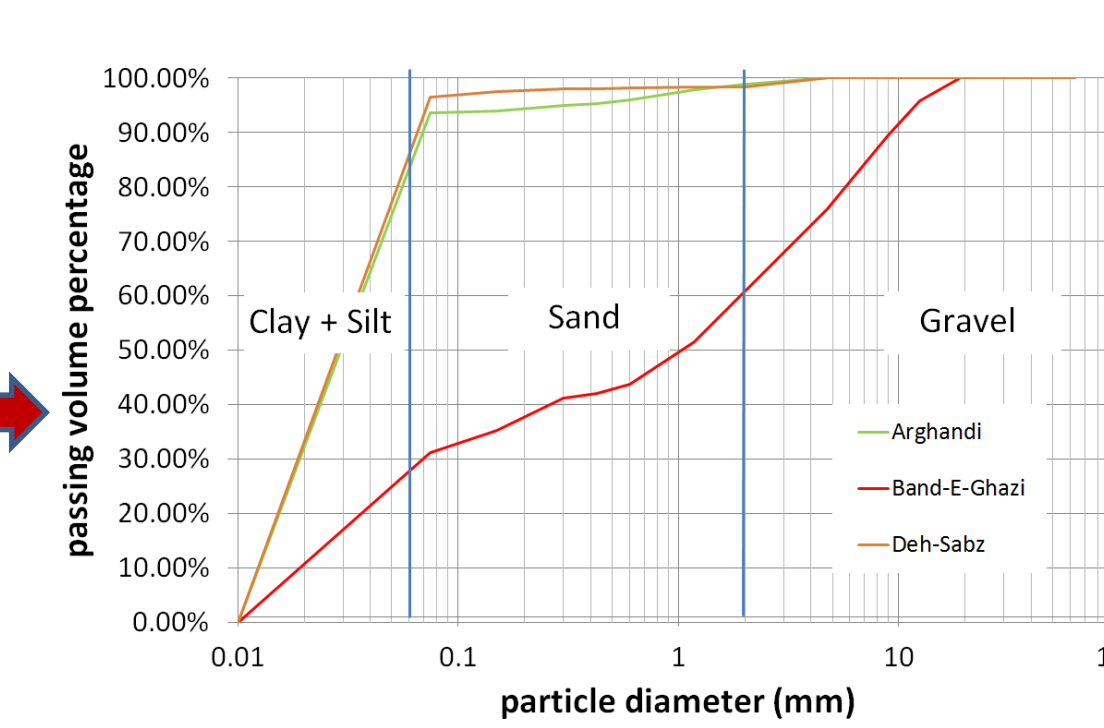


FIG 5. Wet sieving analysis

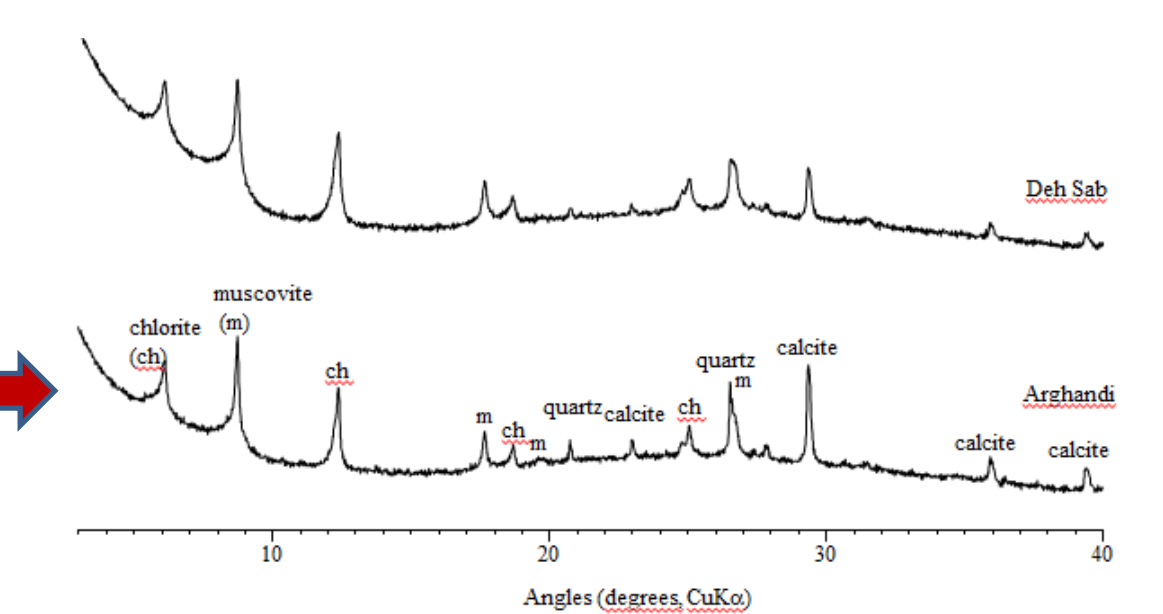


FIG 6. X-R diffractograms of the < 2µm fraction of the samples mainly composed of limestone and quartz

STAGE 03 (Block production and test results):

Note

- The tests results indicate that:
- Deh-sabz has the best 3-points bending and compressive strength,
- Arghandi and Band-e-Ghazi are 2nd and 3rd respectively.
- Water absorption results is quite good and is less than 8 % for adobe, CEB and CSEB,
- Traditional method of water absorption used, there was not direct contact between block and water except for CSEB which has direct contact as shown in the picture.

No	SOIL LOCATION	ADOBE				CEB				CEB + 1% Straw			
		Adobe		Adobe+1% Straw		CEB		CEB + 1% Straw		CEB + 1% Straw		CEB + 1% Straw	
		Compressive strengths/dry	Compressive strengths/dry	3-point bending/dry	3-point bending/dry	Compressive strengths/dry	Compressive strengths/dry	3-point bending/dry	3-point bending/dry	Compressive strengths/dry	Compressive strengths/dry	3-point bending/dry	3-point bending/dry
1	Deh-sabz	2.69	3.744	2.47	2.67	0.97	0.97	3.62	5.73	0.78	1.05	5.33	6.63
2	Arghandi	2.33	2.56	2.35	2.49	0.81	0.99	3.28	4.63	0.788	0.82	4.26	4.49
3	Band-e-Ghazi	1.27	2.38	1.64	1.57	0.5	0.53	3.94	3.97	0.22	0.36	2.06	3.67

TAB 1. 3-Point bending and compressive strength results for DEH-SABZ, ARGHANDI and BAND-E-GHAZI SOILS



PIC 4. Traditional water absorption method for ADOBE, CEB and CSEB

STAGE 04: Affordable housing strategy:

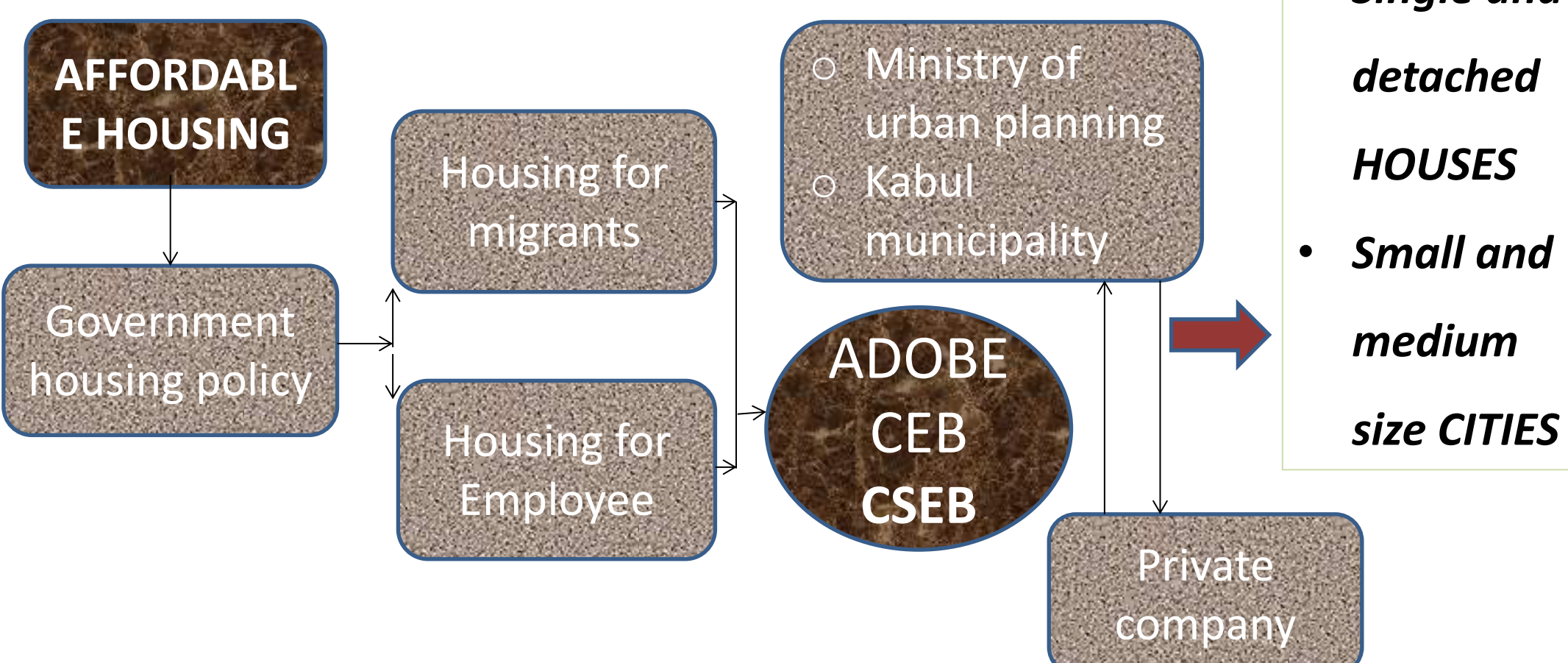


FIG 7. Proposed model for AFFORDABLE HOUSING

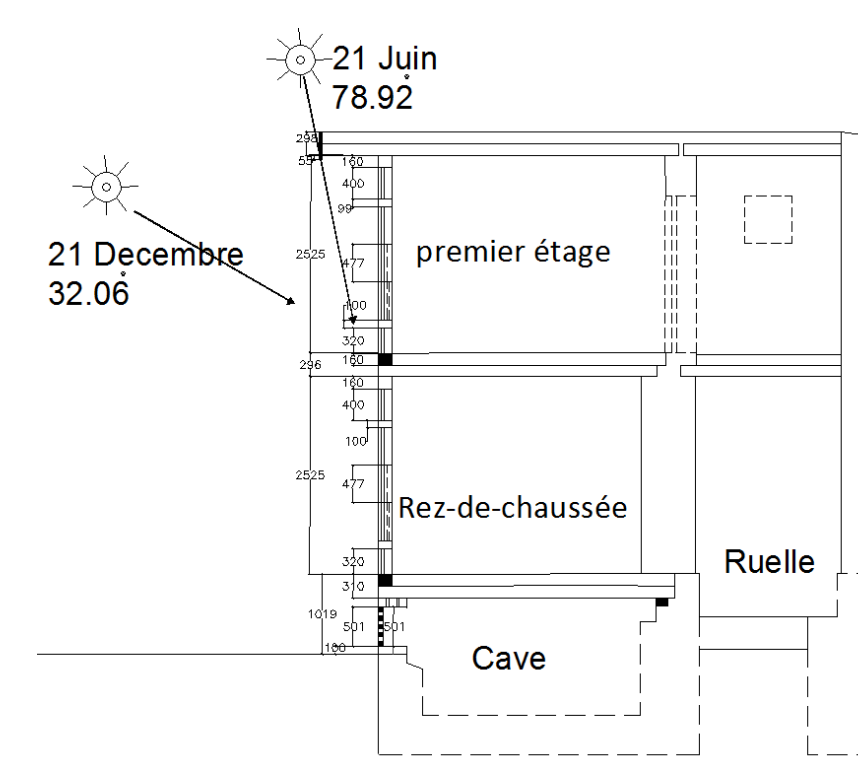


FIG 8. Bioclimatic and vernacular approach



FIG 9. Ministry of Urban Development and Land (MUDL) model for affordable housing

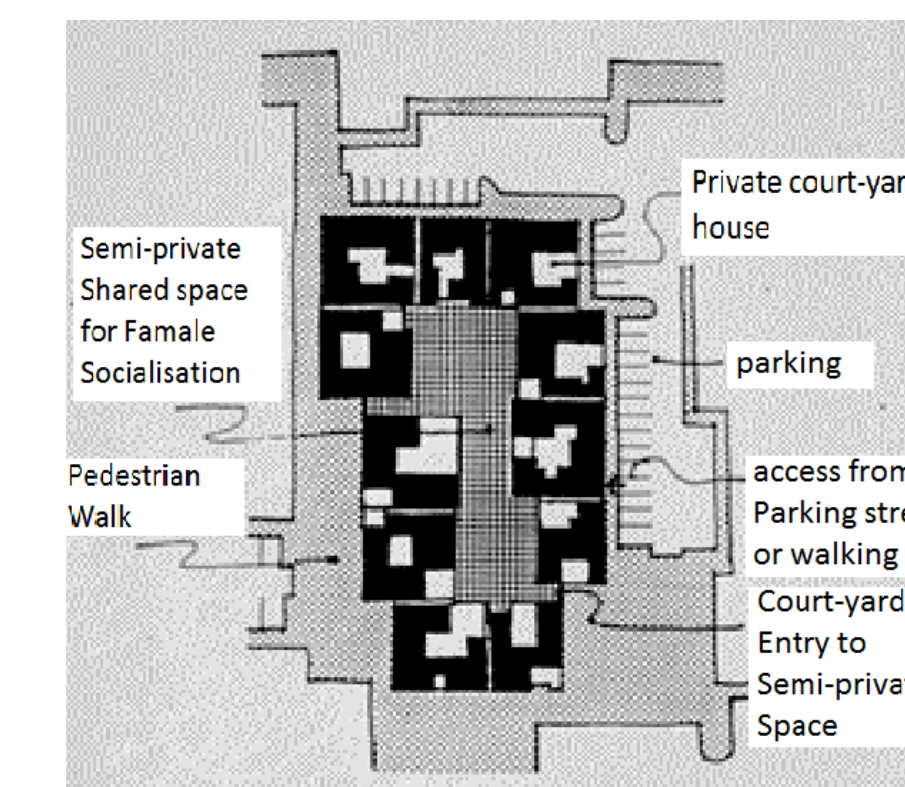


FIG 10. Architect B. Kazimi proposed shared cluster of residential courtyards with semi-private space for contemporary application.

Note: It is easy to criticize MUDL design in term of: Energy use, Shared walls, Roof overhand, Density, modern materials. Kazimi model: seems better, especially for social life especially for women. **However**, for affordable housing, and land usage, seems somehow expensive, Even Vernacular approach seems quite responsive compare to MUDL.

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