

Approach to the wall of Adobe from its thickness, structures and cost

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ABSTRACT: Chile presents an interesting building tradition related to adobe; indeed this material has defined the typical housing style of the nation from its colonial period. This building system have been traditionally based on walls of approximately 60 centimetres and supported by the compression force of the roof. Contemporary Chilean architecture has forgotten the material due to the handmade condition of the constructive system and the incapacity to satisfy the present structural requirements in a seismic country, relegating these practices to a few locations in rural zones. An innovating constructive system tries to modify this situation. By means of the combination of squares and steel meshes, the structure of walls, ceilings and floors are assembled, which are filled with adobe, releasing the material of any structural effort, allowing any thickness. However, wall thickness determines the thermal properties of the adobe constructions (especially in terms of thermal inertia and insulation) in the internal environment of dwellings. Simulations by means of the software TAS have been made to study the thermal behaviour of different wall thicknesses in different Chilean climates, which has demonstrated a good performance in terms of thermal lag, buffering temperature variations. Finally, this study explores different thicknesses of adobe walls to establish a balance between thermal performance and final cost.

Key words: Adobe, thermal inertia, wall thickness, costs

1. INTRODUCTION:

The Adobe has accompanied the construction history of Chile, long before the conquerors arrived to America the Atacameños and the Diaguitas knew the kindness of thermal construction on soil. Soon the Spaniards would bring its own constructive techniques towards the material and the would be for long used in its establishment.

Subsequent to the traditional technique of wide walls structured by the weight of the the roof , the new requirements of density and height of

the city forced to structure the walls with Adobe with wood skeletons, this system demonstrated its advantage as far as the slenderness, space saving and the elastic capacity to respond to an earthquake.(1)

Although the thermal faculties of Adobe are well known within the country, such as the saving of energy in the season of heating and the fresh air in summer seasons (3), the experiences with earthquakes has not been good specially in the north of Chile, is therefore next to the little plasticity of the material to construct great lights and free bays

characteristic of the contemporary spaces, have been. the reasons for which this traditional material has been left behind.

The incorporation of outstanding technologies and specialized design has given a new form to see Adobe, by a steel skeleton the building is structured leaving the Adobe like a non structural element. Due to the above mentioned the seismic problem is resolved, since the steel properly structured works very well in a telluric episode. On the other hand the structured steel beams allows great lights with free bays of great dimension, which gives a compatibility with the contemporary concepts of space in terms of the plasticity that the steel gives to Adobe. This system gives to Adobe wall the thickness that the design determines, leaving behind the previous. sizing requirements

The Mediterranean weather of the central valley of Chile presents a considerable thermal

oscillation between the day and the night. The Adobe accumulates the heat during the day and it liberates it during the night, this phenomenon allows a constant temperature at the interior the house.

The thickness of wall determines and establishes the amount of thermal mass for the optimal development of this phenomenon and the thermal requirements of each space.

The study determines then the optimal thickness of the wall of Adobe to give a suitable thermal work in the Mediterranean weather restablishing a criterion between thermal benefits and the construction cost by vertical square meter.

2. METHODOLOGY

2.1 Constructive System.

The system this based the technique of folding the steel mesh, the fold gives rigidity to the mesh, giving it slenderness and avoiding the flexion and the buckling. Every certain uniformed space is reinforced in vertical sections with iron supports properly welded.

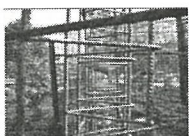
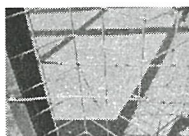


Figure 1: Folding the steel mesh (1)

The folded mesh is fixed, and reinforced by a structure of profiles steel, beams and



pillars properly seated to the foundations unite skeleton and mesh constructing the skeleton of the wall.

Figure 2: Reinforced by a structure of profiles (1)

The Adobe prepared with enough fiber adds to the strucural steel, the mud is applied by the technique of the stuccoed one, adapting like a amorphous mass to the characteristics that the structure imposes.



Figure 3: Technique of the stuccoed one (1)

The Adobe can be applied in two ways, manual and with a pressure machine

commonly used to constructed the concrete walls of pools. At the opposite side of the adobe an application of a OSB plate works out as a unilateral mould, which receives a strong application of the mud by pressure.



Figure 4: Pressure

2.2 Thermal analysis metallic.

For software analysis effects we have modeled a box of 3 x 2.4 meters. It is considered constructed in its four perimeters walls by Adobe and concrete slab on the roof. A window of 130cm. x 150 cm is considered Oriented to the west.

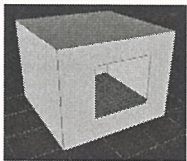


Figure 5: Box of 3 x 3 x 2.4 meters

VOLUME CUALITY

Total Area	46.8	m.2
Floor Area	9	m.2
Volume	21.6	m.3
Perimeter	22.6	m.2

THERMAL PROPERTIES

Confront Band	Coger Band	18	C°
	Upper Band	27	C°
Occupancy	N°	1	U.
	Sedentary	70	W.
Internal Gains	Sensible Gain	5	
	Laten Gain	2	
Infiltration	Rate Air Chage	0.5	
	Wind Sensitivity	0.25	
Hours Of Operation	Weekdays	24	
	Weekends	24	
Desing Conditions	Clothing	1	

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Once applied the mass, Adobe is levelled with iron supports of Acma mesh that builds vertical and horizontal sections that form squares. With this the wall is constructed and ready to recived the outer shell that can be made by stucco with the same mud or another material. (1)

Figure 5: Levelled with iron supports of Acma mesh (1)
machine (1)

Software 3 thicknesses different from quinch

Humidity (%) 60
Air Spendo. 5 m/s
Lighting Level 300 Lux

Weather Utilized

For the evaluation of the model Los Angeles, California, USA has been choosen because of the latitude that results from its homology with the South Hemisphere.

2.2.1 -Mass Determination of thermic RammedE. (CYMAPS QUICKMAPS)

Thickness	Termal LAG
500 mm.	12.12 ¹
300 mm.	10.3 ²
100 mm.	8.48 ³

¹ Collected data of Software Ecotect version 5.5

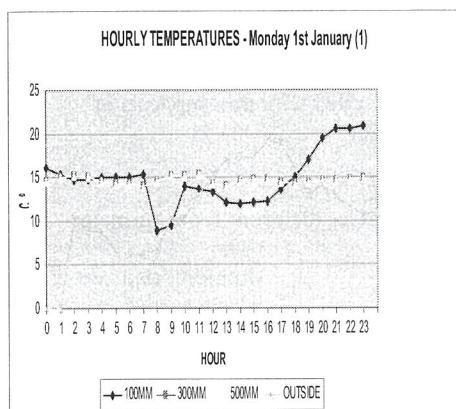
² Collected data of Software Ecotect versión 5.5

³ Calculated data with software CYMAPS QUICKMAPS³

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2.2.2- Hourly Temperatures

Coldest day (Peak)
Monday 1st.Janury



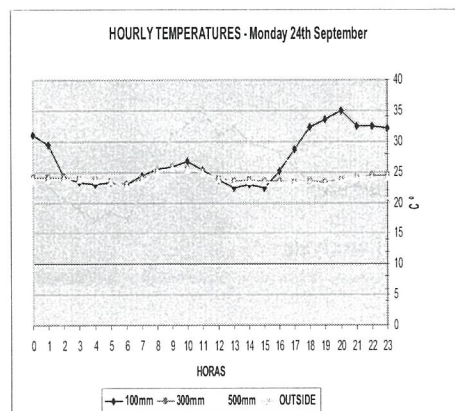
Thermal oscillation
internal Differential

Coldest day (Peak)

Thickness mm.	Min. c°	Máx. c°	Dif. c°
100	8.9	20.8	11.9
300	14	15.4	1.4
500	14	15.4	1.4

The thicknesses 300 and 500.mm has a very silimar thermal behavior during the coldest day of year. In addition the Thermal Differential is 1.4 C° in both cases, the variations are always very close to the comfort band established between 18 and 27 C°. The thickness of 100mm. presents thermal oscillation of 11.9 C° extremely superior to the previous ones, shows greater vulnerability in relation to the temperatures outside. In this case it moves away from the band of comfort during most hours calculated.

Hottest Day (Peak)
Monday 24st.September



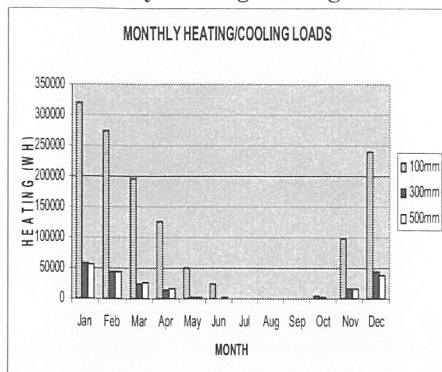
Thermal oscillation
internal Differential

Hottest Day (Peak)

Thickness mm.	Min. c°	Máx. c°	Dif. c°
100	22.5	35	12.5
300	22.8	25.7	2.9
500	22.8	25.7	2.9

The thicknesses 300 and 500 mm has a very silimar thermal behavior during the hottest day of the year. In addition the Thermal Differential is 2.9 C° in both cases; the variations are always vry close to the comfort band. The thickness of 100mm. it presents a thermal oscillation of 12.5 C° extremely superior to the previous ones, shows greater vulnerability in relation to the temperatures outside, In this case it approaches to the comfort band during some of the calculated hours.

2.2.3 Monthly Heating/Cooling Loads



The thicknesses 300 mm and 500 mm have a similar heating demand during the year de 214.624 (Wh) y de 201.626 (Wh) respectively. The thickness of 100mm. presents a heating demand of 1332.314 (Wh) extremely superior to the previous cases. This demonstrates the inefficiency of the 100mm wall made of adobe in relation to the inclemencies of the weather during the year. The demands of cooling are in 0 at the three thicknesses, giving an excellent behavior of the material in relation at high temperatures.

Table I: Heating and cooling demand for the prototype for different thickness.

Thickness mm.	Heating (Wh)	Cooling (Wh)
100mm	1332.314	55.100
300mm	214.624	0
500mm	201.626	0

3.3 - Costs

After cubing and studying the costs of construction of the wall in its different thicknesses, we have concluded that the difference is not considerable since the final numbers are similar, this variable doesn't determine the desition of the thickness of the wall.

. The previous desition centers the criteria of the election only in the thermal factors, and at structural behavior of the wall according to the amount of mass of adobe.

3. CONCLUSIONS

This investigation demonstrates that regulating the thickness of the wall, the thermal behavior of marimates can be occupied to reduce the demands of heating, and to completely annul the demands of cooling of the Houses with Merditeranean weather during the year.

The previous is caused by the high thermal inertia that is a characteristic of marimates, that allows inner temperatures with reduced thermal oscillation an aproximation to the comfort band.

The 500 thickness and 300mm. Behave in a similar way reason why they have been considered equals under the thermal criteria. The thickness of 100mm. has demonstrated its thermal insufficiency.

The thickness of 300 mm has equal efficiency that the one of 500mm in thermal terms. To have less mass in a wall is better in constructive and structural terms.

According to comparative analysis of the results that the study throws 300mm has been selected for being the thickness that has a suitable thermal behavior with the smaller thickness.

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