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Data Article

Bioclimatic Prosthesis: Experimental dataset for a low-cost Trombe wall to existing social housing refurbishment for an intermediate valley (Chillán) city in the south of Chile

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ABSTRACT

This dataset is part of the article entitled "Design and experimental study of a low-cost prefab Trombe Wall to improve indoor temperatures in social housing in the Biobío Region in Chile" [1,2]. The dataset represents the outcome of experimental measurements during a 1-year monitoring campaign to assess the performance of an adaptable and low-cost prefabricated Trombe Wall (TW) with a vertical water storage system. The experiments include periods with mobile insulation during winter nights and external shading during summer which were added to test their effect on the thermal performance.

Temperature sensors were used to measure and compare the temperature in two test cells: one with and one without the TW. Following the National Chilean Standard [3], the experiment was done in the interior valley (Chillan), a Mediterranean climate (Csb), according to the Köppen climate classification [4].

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The two test cells were designed to represent the most used area of a social housing unit in combination with the most widely used type of window in north façades in the region. One test cell was built exactly as the social housing unit, while the second test cell included a low-cost Trombe wall. Five temperature sensors were installed in the test cells.

The thermal performance of the TW was monitored and analysed for the first time in Chile, providing insights in the thermal performance of the TW and proving the potential effectiveness of seasonal variations to improve winter and summer performances.

Specifications table

Subject	Renewable Energy, Sustainability and the Environment
Specific Subject area	Solar Energy and passive solar heating integration on dwellings, especially social housing, is a priority to struggle energy poverty.
Type of data	Tables Pictures Images Charts Graphs
How data were acquired	All the raw monitoring data were collected by using electronic temperature sensors in modules simulating social housing.
Data format	Raw and Analysed
Parameters for data collection	The experiment was done under real weather conditions for the winter of 2017 and the Summer of 2018 in Chillán City. A city of the Ñuble region in the south of Chile. The experiment consists of a measure of the Temperatures difference between two “houses” or test cells. One, as a case base and the other with the designed low-cost and prefab component integrated into the North façade.
Experiment description	The experiment was done under real weather conditions for the winter of 2017 and the summer of 2018 in Chillán City. This is a city of the Ñuble region in the south of Chile. The experiment consists of measuring the temperature difference between two test cells. One representing a Base Case and the other with the designed low-cost and prefab Trombe Wall integrated in the North façade. Both modules are identical and with an approximated interior volume of 4578 m^3.
Description of data collection	This is the first time that a complete monitoring campaign about a prototype of a low-cost Trombe wall thermal performance is done. Hourly data during almost one year of monitoring were collected. Every month the data were downloaded to provide security and to not exceed the memory capacity of the sensors. All these data were collected using High-resolution Temperature sensors. Different experimental measuring states were created in these test sites to test different scenarios in the city of Chillan (Central Valley of the south of Chile), in winter and summer 2017.
Data source location	Institution: Bioclimatic Prosthesis Research Group. City/Town/Region: Chillán/Ñuble Region, 36°61¨ South Latitude and 72°10 West Longitude. Country: Chile

(*continued on next page*)

Data accessibility	On a public repository, Mendeley and also provided with the article [9]. Repository name: Mendeley Mendeley Data, v2http://dx.doi.org/10.17632/jc2tmnfk4b.2 DOI: 10.17632/jc2tmnfk4b.2 https://data.mendeley.com/datasets/jc2tmnfk4b/2
Related research article	Agurto, L., Allacker, K., Fissore, A., Agurto, C., Troyer, F. De,. Design and experimental study of a low-cost prefab Trombe wall to improve indoor temperatures in social housing in the Biobío region in Chile. Sol. Energy 198, 704–721. https://doi.org/10.1016/j.solener.2020.02.003

Value of the Data

- The dataset experimentally demonstrates that it is possible to improve thermal comfort by means of a very cheap Trombe wall.
- Measurements show the first experience in which an experimental monitoring campaign was conducted in Chile, to measure the influence of a low-cost Trombe wall on the thermal performance. Such Trombe wall could be added to existing social housing as part of a refurbishment.
- In Winter, indoor thermal comfort hours were increased by 69% and 56% in the valley and coastal city, respectively. Energy savings calculated were 44% and 25%, respectively.
- The project's emphasis is to develop cheap solutions to foster the integration of solar systems in social housing in Latin America and especially in Chile.
- With this Trombe wall integration, the costs related to heating and ventilation of millions of families could be reduced, especially for existing houses.
- The data can moreover help validating simulation models to assess the thermal performance of Trombe walls.

1. Data description

The archive seeks to compile the hourly measurement data of the monitoring of the Trombe Wall placed in the Chilean city of Chillán. The excel file is composed of 13 spreadsheets compiling and analysing four monitoring periods: three periods in the Autumn/Winter of 2017 (W-01, W-03 and W-04) and a fourth period in the Summer of 2018 (S-01). The data moreover show the differences between the temperatures in the Base Module and the Module with the integrated Trombe Wall. The four monitoring periods are detailed in Table 1.

The content of every spreadsheet is as follows:

I. MONITORING PERIODS_CHILLAN:
II. SENSORS: Detailing the technical specifications from every sensor used during the monitoring campaign.

Table 1
Detailed description of the monitoring periods. Colors are used for easier comprehension.

CHILLÁN-Central Valley																		
Scenario	Season	Definitions	Date of beginning	Date of ending	Number of days for measurements	Amount of Hourly data collected	Amount of days finally monitorized	Existance of Shutter	Auxiliar Fan	Comparative with Module WITHOUT Prosthesis	Type of Holes/vents	SENSORS WORKING BY PERIOD						
												1	2	3	4	5	A	B
												001	135/003	007	103	T004	- -	101/005
W-01	Autumn	Prosthesis 01 + CLOSED VENT HOLES	30 of March 2017	31 of May 2017	65	1512	63,00	NO	NO	YES	Without Vent	NO	YES/NO	NO	NO	YES	NO	YES
W-03	Winter	Prosthesis 01 + OPEN VENT HOLES + Night Shutters with Insulation	14 of June 2017	16 of August 2017	64	1519	63,29	YES	NO	YES	Big : 100 mm diameter	YES	YES	YES	YES	YES	NO	YES
W-04	Winter	Prosthesis 01 + OPEN VENT HOLES + Night Shutters with Insulation + Auxiliar FAN	17 of August 2017	08 of September 2017	23	512	21,33	YES	YES	YES	Big : 100 mm diameter	YES	YES	YES	YES	YES	NO	YES
S-01	Summer	Prosthesis 01 + Prótesis 02 (Shadowing)	01 of February 2018	15 de March 2018	43	1032	43,00	NO	YES	YES	Big : 100 mm diameter	YES	YES	YES	NO	YES	NO	YES

1. RAW MONITORING MEASUREMENTS_2017: The raw data from the year 2017 (Winter), as in the direct way in which were downloaded.
2. RAW MONITORING MEASUREMENTS_2018: The raw data from the year 2018 (Summer), as in the direct way in which were downloaded.
3. Dynamic Table Period W-01 (Winter-01): Monitoring data during a period using Open Vent holes.
4. Dynamic Table Period W-03 (Winter-03): Monitoring data during a period using Open Vent holes and Night Shutters with Insulation.
5. Dynamic Table Period W-04 (Winter-04): Monitoring data during a period using Open Vent holes and Night Shutters with Insulation, including a small Auxiliary FAN.
6. Dynamic Table Period S-01 (Summer-01): Monitoring data in the Summer period, the TW is using a shadowing device.
7. One Winter week Chillán: representative week to illustrate the measurements.
8. Chillán Winter: Comparing Winter analysis in resume compilation for the whole Winter.
9. In Terms of Deltas 01: The measurements are analysed in terms of Temperature Differences (Deltas T°) between the two modules. Also, separating these points between Temperature differences during Night (blue points) and Day-time (red points).
10. In Terms of Deltas 02: For a better and deep understanding of the proposed prefabricated and Low-cost Trombe Wall, differences between the Base case and the module with the Solar device, are set in a Histogram graph.

2. Experimental design, materials, and methods

2.1. Research methods and experiment setup

The experiment consisted of building a test cell that replicated the current most commonly used social housing model, in compliance with regulations (national standards) [5] regarding space and building envelope.

2.2. Modules. References for sizing

The standard for spaces and furniture minimum space, called Chilean Standard N°49(VyU) 2011 [6] and General code for urban and construction standards (O.G.U.C. Art. 4.1.1.), were used to define the module dimensions (width, length, area and height). The Chilean thermal regulation from 2007 (nowadays in force) was used to define the thermal resistance of every component of the building envelope, including the window. For each of the two microclimates (coast and inland valley), two test cells were built, to easily measure and compare thermal comfort and energy use differences between the test cell with and without the TW.

The reference is a standard space representing a living room or a big bedroom of what current regulations [6] consider as appropriate space and considered as a minimum space. Based on these requirements, the module volume was determined. The module is roofed to water in a North-South descending direction. The average height of the interior volume is 2.4 m.

2.3. Distances between modules

To avoid shadowing of one test cell on the other in extreme days of the year (Solstices), the distance between and the exact location of the test cells were determined through a shadow analysis using Ecotect 5.5.

3. Materials

3.1. Sensors and measurements

Once the test cells were built and the TW attached to one of the test cells, the monitoring process started for both regional climates, coast and inland valley. During almost one year, from 30/03/2017 to 15/03/2018, the indoor temperatures were measured, analyzed, and compared to the average outdoor temperature. Temperature data were measured every ten minutes, recording six data per hour. For every test cell, the hourly based weather data were recorded in real-time. The reduction in thermal discomfort (too cold and overheating) was analyzed for a test cell with and without the use of the proposed Trombe Wall (BP_01).

3.2. Temperature comparison

To determine the improvement of the thermal performance, the temperatures in both the test cells with and without the Trombe Wall were measured simultaneously. A comfort range was set between 18 °C and 26 °C based on previous investigations in the same social and technical context [7].

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Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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