
For

Kitsun Housing Co-op

Vancouver, BC

Prepared for:

IREDALE GROUP ARCHITECTURE

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Table of Content

1.0 Introduction
   1.1 Trombe Wall Definition
   1.2 Kitsun Housing Co-Op Existing Trombe Wall Condition
   1.3 Existing Trombe Wall Design Operation
   1.4 Current Issues Related To Trombe Wall System at Kitsun Housing

2.0 Proposed Solutions To Fix Existing Trombe Wall System
   2.1 New Paint Applied To Trombe Wall
   2.2 New Ventilation Fan Between Wall And Glazing
   2.3 New Air Openings To Second Floor
   2.4 New Retractable Overhang Canopy
   2.5 New Seal To The Double Glazing
   2.6 New Base Board Heaters
   2.7 New Transfer Air Fan On Second Floor
   2.8 New Circulation Fan Between Wall And Glazing
   2.9 Remove Skylid Control Cylinder

3.0 Conclusion

4.0 Appendix
1.0 INTRODUCTION

1.1 Trombe Wall Definition

“A Trombe wall is a special type of masonry wall used for thermal storage in passive solar building design. A typical Trombe wall consists of an 8- to 16-inch-thick masonry wall coated with a dark, heat-absorbing material and faced with a single or double layer of glass. The glass is placed from 3/4 inch to 6 inches from the masonry wall to create a small airspace. Heat from sunlight passing through the glass is absorbed by the dark surface, stored in the wall, and conducted slowly inward through the masonry. “

“Applying a selective surface to a Trombe wall improves its performance by reducing the amount of infrared energy radiated back through the glass. The selective surface consists of a sheet of metal foil glued to the outside surface of the wall. It absorbs almost all the radiation in the visible portion of the solar spectrum and emits very little in the infrared range. High absorbency turns the light into heat at the wall’s surface, and low emittance prevents the heat from radiating back towards the glass. Although not as effective as a selective surface, painting the wall with black, absorptive paint will also help the wall to absorb the sun’s heat. “

“For an 8-inch-thick Trombe wall, heat will take about 8 to 10 hours to reach the interior of the building (heat travels through a concrete wall at rate of about one inch per hour). This means that rooms remain comfortable through the day and receive slow, even heating for many hours after the sun sets, greatly reducing the need for conventional heating. Rooms heated by a Trombe wall often feel more comfortable than those heated by forced-air furnaces because of the radiantly warm surface of the wall, even at lower air temperatures. “

“Architects can use Trombe walls in conjunction with windows, eaves, and other building design elements to evenly balance solar heat delivery. Strategically placed windows allow the sun’s heat and light to enter a building during the day to help heat the building with direct solar gains. At the same time, the Trombe wall absorbs and stores heat for evening use. Properly sized overhangs shade the Trombe wall during the summer when the sun is high in the sky. Shading the Trombe wall prevents the wall from getting hot during the time of the year when heating is not needed. “
1.2 Kitsun Housing Co-op Existing Trombe Wall Conditions

The building is located at the intersection of W. Broadway and Vine St in Vancouver. The building was designed by Klaus Schmid of Atelier, with combined direct heat gain and Trombe Wall passive solar space heating system designed by Solar Applications around 1979.

The south residential units of the building have tempered double layer windows built outside of the concrete walls, with a space created between the wall and the glass. Each window consists of four glass panels, and one of the panels can be opened to provide access into the space for maintenance.

On the concrete wall of each unit, there is a window opening to provide direct sunlight into the townhouse, and there are two linear openings on the wall as well. The top linear opening is approximately 7 feet above the floor, and the bottom opening is about 1 foot above the floor. There are smaller windows on the perimeter walls, and small AC units are installed near the windows. Each residential unit also has a skylight on the top of south facing wall.
The general concept of the Solar Passive Trombe Wall is shown below.

[Diagram of Trombe Wall]

Fig. 2 General Concept of Trombe Wall

A Solar Passive Trombe Wall system consists of a thick concrete wall, which is usually painted black, a double layer glass built outside of the wall, and an air gap space created between the concrete wall and the glazing.

The function of the thick concrete wall is to absorb radiation heat from the sunlight. The wall is painted dark to increase its heat absorbing ability. The air space between the wall and glazing is heated up during the day, and the air flows towards the top of the Trombe Wall and then flows into the house. Air circulates naturally from the bottom opening to the top opening.

After whole day of heat absorbing, the concrete wall becomes a heat mass and contains a large amount of energy. During the night time, the heat gradually dissipates into the house. The Trombe Wall provides heating without any mechanical means.
1.3 **Existing Trombe Wall Design Intent at Kitsun Housing Co-op**

A sketch of existing Trombe Wall system of Kitsun Housing is provided on next page. (MSK-1) The Trombe Wall system at Kitsun building consists of a 300mm thick poured concrete wall for each unit (2.4 m wide by 4.8 m high). The concrete wall was painted black during the original construction. However, the walls were then painted white in the past due to malfunction of the Trombe Wall system in the summer.

A double layered glass was built outside of the concrete wall of each residential unit. The glazing consists of four tempered glasses, one of which can be opened for service access. During the site visit, the glass door was not locked, and the windows were not sealed properly. It is noted that air can move into the space between wall and glazing, and moisture can be contained inside this space.

There was automatic roller shade installed between the concrete wall and the glazing back in 1980s; however, the poor performance of the motorized roller shade caused a lot of problems for residents. The building had to remove the roller shadings, as most of them were not functioning in the first couple years.

Each residential unit has a skylight on the top of the south wall. The skylight is completed with automatic opening cylinder. The purpose of the cylinder is to sense the sunlight and initiate a mechanism to open the skylight. However, the skylight was not operating as it was supposed to since the beginning.

There are two linear air openings on the Trombe Wall. As discussed in previous section, they were supposed to provide natural air movement between the townhouse and the Trombe Wall. The building already blanked off these openings, as the Trombe Wall did not provide adequate heating or air ventilation in the past.

A transfer air fan was installed on the second floor, and its function was to transfer warm air from second floor to ground floor. The fan was turned off due to its high noise level.
1.4 Current Issues Related To Trombe Wall System at Kitsun Housing

Below are the current issues at the Kitsun Housing:

- During the summer season, the Trombe Wall is absorbing excessive heat from the sun and the townhouse becomes very hot. The original Trombe wall system consists of dark painted walls and automatic roller shade in the gap space. The malfunction roller shades were removed, and the Trombe wall was painted white to avoid excessive heat absorption.

- During the winter season, the Trombe Wall system does not providing sufficient heating to the townhouse units. The original design intent is to have natural air movement from bottom opening to top opening, when the air is heated by the sun. As the natural ventilation was not working properly in the past, no heated air was flowing to the townhouse.

- A transfer air fan was installed on the second floor of each townhouse. Air was supposed to be transferred from second floor to ground floor; however, due to its high noise level, the fan was turned off.

- There is a 1.2 m x 2.4 m 60° inclined skylight in each unit. Each skylight is complete a skylid damper which is supposed to opens and close automatically. However, the skylid was found malfunction and were controlled manually by hand.
2.0 PROPOSED SOLUTIONS TO FIX TROMBE WALL SYSTEM

In order to provide a better Trombe Wall System, the following solutions are available.

1. New paint to be applied to concrete wall
2. New ventilation fan to be added between wall and glazing
3. New air opening to be created to second floor
4. New overhang canopy to be added
5. New seal to be applied around the double glazing
6. New baseboard heaters to be installed
7. Replace transfer air fan on second floor
8. New circulation fan to be added between wall and glazing
9. Remove skylid control cylinder

The proposed solutions to fix the Trombe Wall System are shown on sketch MSk-2 below.
NEW KITSUN BUILDING SECTION

1. NEW PAINT APPLIED TO TROMBE WALL
2. NEW VENTILATION FAN
3. NEW AIR OPENING TO SECOND FLOOR
4. NEW OVERHANG CANOPY
5. SEAL THE GLAZING PROPERLY
6. NEW BASEBOARD HEATER
7. NEW TRANSFER AIR FAN
8. NEW CIRCULATION FAN
9. REMOVE SKYLID CYLINDER

TROMBE WALL ELEVATION

Project: KITSUN HOUSING CO-OP
Location: VANCOUVER, BC
Architect: IREDALE GROUP ARCHITECTURE

Dwg. No.: MSK-2
Issued: JAN 15, 2009
Scale: NS
Job No.: 3139
2.1 New Paint Applied to Trombe Wall

A new dark absorptive paint shall be applied to the concrete to help increase its heat absorbing capability. If budget allowed, applying additional selective surface will improve the performance. The selective surface has a metal foil glued to the outside of the wall. It is supposed to absorb all the sun radiation and has very little emittance; therefore, no heat is radiating back to the glass.

2.2 New Ventilation Fan Between Wall and Glazing

A new ventilation fan can be added at the bottom of the air gap space. The fan is ducted from the bottom air opening, and then ducted to the top of the space. During sunny days, the warm air naturally rises to the top of the air space. The fan will then draw the heated air to the townhouse through the bottom opening. The fan is controlled by a new thermostat.

The two existing linear openings shall be partially blanked off to provide better air movement path as shown on the sketch MSK-2. Each opening shall be provided with backdraft dampers as well.

2.3 New Air Opening to Second Floor

A new air opening can be added on the Trombe Wall. The new air opening shall be right above the second floor slab. When the air between Trombe Wall and the glass is heated up, the warm air shall move from the space to second floor through the opening.

2.4 New Overhang Canopy

Overhang canopies can be mounted outside of the double layered glass to decrease the solar heat gain from the sun in the summer.

Two canopies shall be constructed for each residential unit. A canopy shall be mounted on the top of Trombe Wall. This overhang prevents direct sunlight for the top half of the glazing. (Note: The sun light is about 23° from vertical axis in July.)

Another overhang canopy shall be mounted in the middle of the Trombe Wall near the mullion. The second canopy covers the bottom half of the double layered windows from sun radiation.

During winter season, the canopy shall not block the sunlight to the Trombe Wall, so that maximum sun radiation is absorbed by the Trombe Wall. The details of the canopy shall be reviewed and designed by the architect.

2.5 New Seal to the Double Glazing

During the site visit, it was observed that the glazing seal was peeled off and not installed properly. A new seal shall be applied around all double glazing windows. The operable glass door shall be sealed air tight when it’s at close position. A lock shall be installed as well, so that the door is not opened by unauthorized person.
2.6 New Baseboard Heaters

A new baseboard heater with thermostat shall be installed between the Trombe Wall and the double layer glazing. The function of the baseboard is to provide heating in winter season when Trombe Wall can not absorb enough radiation heat from the Sun. The baseboard is controlled by new thermostat.

In the past five years, Vancouver has an average of 21 sunny days between December and March. The following table shows the exact numbers.

*Sunny Days in Vancouver*

<table>
<thead>
<tr>
<th>Year</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>3</td>
<td>8</td>
<td>4</td>
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</tr>
<tr>
<td>2007</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>2006</td>
<td>2</td>
<td>2</td>
<td>12</td>
<td>7</td>
<td>23</td>
</tr>
<tr>
<td>2005</td>
<td>1</td>
<td>7</td>
<td>13</td>
<td>6</td>
<td>27</td>
</tr>
<tr>
<td>2004</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>9</td>
<td>20</td>
</tr>
</tbody>
</table>

During a sunny day, the Trombe Wall absorbs approximately 140,000 Btu of heat from 7 am to 6 pm, which is sufficient to heat up the townhouse in the night time. However, during a cold rainy winter day, the Trombe Wall can not absorb enough radiation heat. Therefore, a baseboard heater shall be installed to supplement the envelope heat loss, and also at the same time provide some radiation to the Trombe Wall, when there is no sun radiation available. Based on heat loss calculation, a 2 kW baseboard heater is required.

2.7 New Transfer Air Fan on Second Floor

A new quiet transfer air fan (sound level at 1 Sone) can replace the existing transfer air fan on second floor. The fan will help circulate warm air between ground and second floor, and is controlled by new thermostat.

2.8 New Circulation Fan Between Wall and Glazing

A new ventilation fan can be installed between the Trombe Wall and the double glazing. Its purpose is to increase the ventilation inside the space in summer time to help lower its temperature. The fan is controlled by a new thermostat. In addition, moisture level inside the space will be reduced.

Two new openings are required at the top and bottom of the side wall as shown on the elevation view on sketch MSK-2. The circulation fan is located at the high level and distracts warm air to outdoor. Each opening is complete with a motorized damper interlocked with each other. The fan operates when the temperature inside the space exceeds set point.

2.9 Remove Skylid Control Cylinder

Each of the existing skylights has a control cylinder that operates to open and close the skylid. These cylinders shall be removed as they do not operate properly. The skylids can be opened and closed manually by the tenant.
3.0 CONCLUSION

With the above mentioned modifications, the Kitsun Housing Co-op building shall have a better Trombe Wall system. In the winter season, the new heat absorptive paint shall increase the radiation heat absorbed by the Trombe Wall. If the system can not provide sufficient heating, the new baseboard heater provides additional heating to the townhouse.

The new ventilation fan in Trombe Wall shall move the warm air from the top of Trombe Wall to inside the townhouse. The new transfer air fan on second floor will increase the warm air circulation, while its noise level is acceptable to the tenants. In addition, the new linear opening on second floor shall increase the amount of warm air entering the tenant space. The new seal around the glazing will also avoid window leakage, and warm air can be kept inside the house.

In the summer season, the amount of heat absorbed by the Trombe Wall system shall be greatly reduced by the addition of two overhang canopies at each residential unit. Excessive heat and moisture will also be removed by the new circulation fan and wall openings. The skylight control cylinders will be removed, and tenants can open or close the skylight damper as desired.

Detailed design and specification shall be prepared during the design stage. The design shall be done to suit building owner’s construction budget and schedule. After modification of first residential unit, test results shall be reviewed to ensure the performance of the modified Solar Passive Trombe Wall System.
4.0 APPENDIX

Estimated costs for mechanical and electrical system are:

1. Exhaust fans and dampers including control: $7,500 / Suite
   - Ventilation Fan, Installation, Thermostat, Wiring, Ductwork, Dampers, and Control $2,000
   - Circulation Fan, Installation, Thermostat, Wiring, Ductwork, Motorized Dampers, and Control $3,500
   - Transfer Fan, Installation, Thermostat, Wiring, Sheetmetal, Damper and Control $2,000

2. Electrical baseboard heater: $3,000 / Suite
   - Electrical Baseboard Heaters, Thermostat, Wiring, Control, Installation and Electric Panel Connection