STRAW BALE WALLS

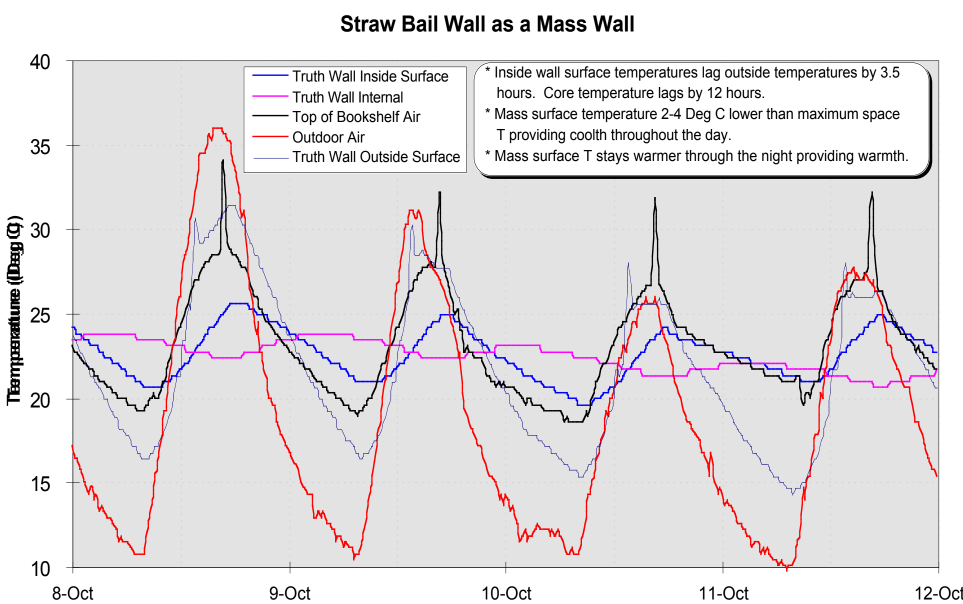
The straw bale walls are one of the more interesting design features of the Real Goods Solar Living Center. Constructed of 2' thick rice straw bales covered with a 3" thick layer of pise, the construction provides a wall with a high thermal resistance and thermal mass - ideal for passive cooling. Outside surface temperatures compared between walls were found to track each other closely; the inside surface temperatures tracked each other as well. A total of seven temperature sensors were placed in or on the surface of the walls. Shown below are the three temperature sensors placed on the truth wall along with inside and outside air temperatures. The steps particularly noticeable in the internal wall temperature line are due to the 0.3°C resolution of the data loggers.

All the characteristics of a thermally massive wall can be seen in the data. The diurnal variations in the mass temperature are smaller than those of the indoor air temperature which in turn are smaller than those of the outdoor air temperatures. The core temperature of the wall varies less than the surface temperatures which is in line with the high insulation value of the straw. The cooler mass temperature in the afternoon provides cooling while the warmer mass temperature in the evening allows the wall to release heat built up during the day into the cool outside and to a lesser extent into the indoor air. The core of the straw wall has a 12 hour lag with the inside air temperature resulting in a warm wall at night and a cool wall during the day when cooling is needed. The fact that the inside wall surface temperature tracks the inside air temperature closely suggests that the mass is thermally coupled to the indoor air - a prerequisite for thermal mass to be successful.

The data suggests that the straw bale wall is working as thermal mass. An estimate of the amount of cooling is not possible given the limitations of the field methods. There were several unsolicited comments from the employee surveys suggesting that they felt the walls created a pleasant cooling effect. This combined with the data suggests that the straw bale wall as a thermal mass design feature was successful.

Though 2' thick straw bale walls are advertised to provide a thermal insulation value of R65, the heat capacity of straw bales is not as well publicized. The data collected presented the opportunity to estimate this value. Using a spreadsheet model of the mass wall, the pise was assumed to have thermal properties similar to lightweight concrete. Assuming R65 for the composite wall, the thermal insulation of the straw bale alone could be estimated. The model fitted to the measured data suggests that the volumetric heat capacity of the straw bales is on the order of 0.0093 Btu/ft^3°F. This value will vary depending on moisture levels, the type of straw, and how densely the straw is baled. Another variable is the surface roughness of the pise which will affect the heat transfer to the air. This value can be used in lieu of better information, but there is a high degree of uncertainty associated with the estimate, perhaps ±40%.

The relatively high heat capacity and low thermal resistance of the pise and the low heat capacity and high thermal resistance of the straw bales suggest that the thermal characteristics of a straw bale wall can be tuned. Within the significant design constraints, the thickness of the pise and straw bales could be varied to change the amount of mass and its lag time.



Graph 3 – Straw Bale / Pise Wall as a Mass