Bales in My Roof...A Costly Decision?

by Scott E. Pegg - Toronto, Ontario, Canada

When envisioning, dreaming and ultimately designing what was to become a very unique masters thesis project, I found myself not only drawn to bale construction but nearly addicted to its use. Although we know bales aren't magic, I couldn't help but think that if they are so wonderful for wall use, why not for other things as well? I had read about people using bales for roof insulation and what seemed like the clear ecological decision quickly became part of my design. Was it the right decision?

I am often extremely critical of design features, such as living roofs, that seem to carry so many negative environmental implications I wonder if the motivation is to find truly sustainable alternatives or purely aesthetic appeal and personal gratification. A very beautiful, productive and insulating living roof often comes at the expense of thick petrochemical EPDM type membranes, tubs of contact adhesive, splicing compound, caulking and an undoubtedly beefed-up super structure to keep the ground-like roof way up in the air.

My building is the first code-approved, loadbearing SB structure in Ontario using earthen plasters. Adding adobe flooring, a rubble trench/gabion foundation and off-grid living lead me to proudly hang my building permit at the end of the road. While nearly giving my very open and progressive building inspector a heart attack with this building system, I decided to push him a bit further by including bale insulation in the pre-engineered trussed roof system.

Once the excitement of having a building permit for this unconventional building system subsided, I began to more closely look at the implications of my decisions. As an environmental economist by training, I engaged in a cost-benefit analysis of the ecological, economic, and 'hassle factors' of my roof system. It was critical for me, as someone advocating the importance of sustainable building, to look beyond what seemed to be quite innovative and "cool" to what made pragmatic and accountable, ecological and economic sense. My fear of this matter-of-fact assessment was the creation of a "sensible" building that looks like all the other stamped-out boxes that dominate my region, lacking the spirit and uniqueness that seems so natural with bale building.

So, here I am, trying to reconcile my decisions from a very technical perspective, knowing full well the importance of creating buildings that feel good, nurture our spirit, and feel connected to our surroundings. Comparing ecological and economic costs to the implicit benefit of a building that feels right and exhumes a strong sense of place is where any kind of practical reconciliation exercise stalls and is certainly where economists ought to give up trying to equate numbers with the "value" of our natural surroundings and social well being.

For this kind of decision, I have no theory for reconciliation. When examining the appropriateness of roof insulation, I do. As a buried, entirely utilitarian element of any code-approved building system, roof insulation is in itself pragmatic, entirely functional and, I would argue, has no aesthetic value as we can not see or feel it. We do, however, see and feel the financial and comfort effects if it does not perform well. For such a building decision, I feel comfortable relying on a economic and ecological cost-benefit analysis to make my decision, realising full well that reconciling economic savings at an ecological cost, for instance, moves the decision to an objective, ethical level. We economists are so limited!

Table #1-Bale Roof Insulation

Material	Amount req'd	Cost* Each	Total Cost	Material Used
Trusses	24	$97.92	$2350.00	70 Cubic Feet of Lumber
Bales	190	$3.75	$7.13	3 Tons of Bales
Strapping/bales	1024 ft 1x4	$0.19	$195.00	24 cubic feet of lumber
Roxul Ins.	643 sq ft	$0.36	$2.13	11 bags of mineral fibre
Total			$3489.00	81 cubic feet of lumber

Table #2-Blown Cellulose Insulation

Material	Amount req'd	Cost* Each	Total Cost	Material Used
Trusses	16	$101.94	$1631.04	47 Cubic Feet of Lumber
Blocking	3 sheets 1/2" ply	$22.00	$66.00	4 cubic feet of lumber
Cellulose Ins.	44 bags	$17.55	$772.00	0.65 tons recycled newspaper
Machine Rental			$50.00	electric power
Total			$2519.04	51 Cubic feet of Lumber

**All figures in Canadian dollars*

Tables #1 and #2 depict the design for the bale-insulated roof. Trusses are spaced at 15in(38cm) centres to allow a standard two-string bale to be placed on edge between trusses. To keep the bales from sliding down the scissor trusses and to keep them raised above the bottom chord, 1x4in(19x89mm) rough strapping is used. To help remedy the inevitable gaps in the bale insulation between the trusses, and to comply with fire prevention requirements, Roxul (mineral wool) insulation would be installed between the bottom cords, below the strapping and bales.

Table #1 outlines the cost (both financial and lumber use) for the bale-insulated roof. The hassle factor is another story. As my site was on the side of a hill, materials were generally carried up by hand, and I had not imagined the difficulty of lifting 190 bales atop my roof for installation. Fitting irregular bales to create a uniform layer of straw would have been arduous to say the least. Dealing with 15in(38cm) centres would mean lots of cutting and fitting of the Roxul insulation between the lower cords of the trusses. In

short, what looks slick on paper may have become a nightmare on the construction site.

Table #2 goes through the same costing as the bale roof, but for using blown cellulose insulation instead. The largest savings (both financially and lumber use) came with the reduced number of trusses needed. The trusses used in the bale roof had the capacity to be installed on 24in(61cm) centres, but reducing the centres to 15in(38cm) just compensated for the additional weight of the bale roof. With a rented blowing machine (supplied with the materials), and open soffits, blowing the insulation is a snap and even has a pretty sizable fun factor. Make sure you are wearing a really good respirator to keep the fibres out of your lungs.

So, in the case of my building design, insisting on bales in the roof would have cost nearly 40% more and used nearly 60% more lumber, causing me to scrap the bale idea. The cellulose insulation gives me a toasty warm R-60, whereas the bale option would have been a less continuous R-45 or so at best. Recycled shredded newspapers and a toss of borax treatment formed an arguably natural insulation material. Once my steel roof was installed, and the interior site milled rough pine ceiling carefully hammered in from below, what started out to be a quest for bales being used in every which way possible turned into a sound realisation that in the case of ceiling insulation, it just did not make much sense.

I would even go so far as to say that an insistence on using bales for roof insulation in my application would have been inconsistent with my values and objectives. When true accounting is attempted, a bale roof would not have been justifiable beyond satisfying my own passion for innovation and achieving a high coolness factor. Using a conventional product in this case actually improves the sustainability and connectivity of my home, as hard as such wisdom is for me to accept.

Now I have a roof structure with the same roof insulation as one of the largest suburban developers in the region uses. Thank goodness my decision to do so didn't have any negative bearing on my place feeling wonderful, connected and nurturing.

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Scott Pegg's building is the first code-approved, loadbearing structure to use earthen plasters in "strictly-by-the-book" Ontario.

The Pallet Truss: A Low Cost Alternative Roof Structure

by Alfred von Bachmayr - Tesuque, New Mexico

In the past several years, I have been working in the border area around El Paso/Juarez and have been amazed at the number of uses people have devised for wooden shipping pallets. I have seen everything from full houses to an incredible variety of fencing designs, furniture, and even kids' toys. I realized that the low cost and availability of pallets makes them a reliable and versatile resource. At the same time, I was struggling with what seems to be a universal challenge—low-cost structural members for roofs that allow for thick roof insulation. The typical 2x4 or 2x6 (38x90 or 38x140mm) rafters work structurally in some areas with low live loads, but the joist depth does not allow for sufficient roof insulation. The idea of a truss made from pallet parts seemed like it could be the answer to these challenges.

With the help of some local carpenters, I began trying different truss configurations and joint connections. We looked for pallets that had full length 2x4(38x90mm) members and avoided pallets that had been cut out to allow the fork lifts to access them from all sides. After several prototypes we developed a simple way to construct trusses that also proved to be structurally sound. I had a structural engineer model the truss in a computer and give me the required number of nails for each joint. We decided to use glue at each joint to achieve the extra capability needed, and the nails were put in from both sides to tighten the joints. Any configuration of truss could be developed, assuming the length of the pallet parts is not exceeded in the design.

The first challenge was to find a way to disassemble the pallets. Pulling the nails was almost impossible without destroying the parts. We found that by cutting the nails with a reciprocating saw, using 8-9in (20-23cm) metal cutting blades, the pallets would come apart quickly with no damage to the parts. We then had to create a way to standardize the construction of the trusses so they were dimensionally stable and consistent in strength. For this, we built a jig out of 2x4 rails nailed to plywood or OSB that mirrored the shape of the outline of the truss (Fig.1). We drew all the parts on the jig so everyone knew exactly where all the parts went to