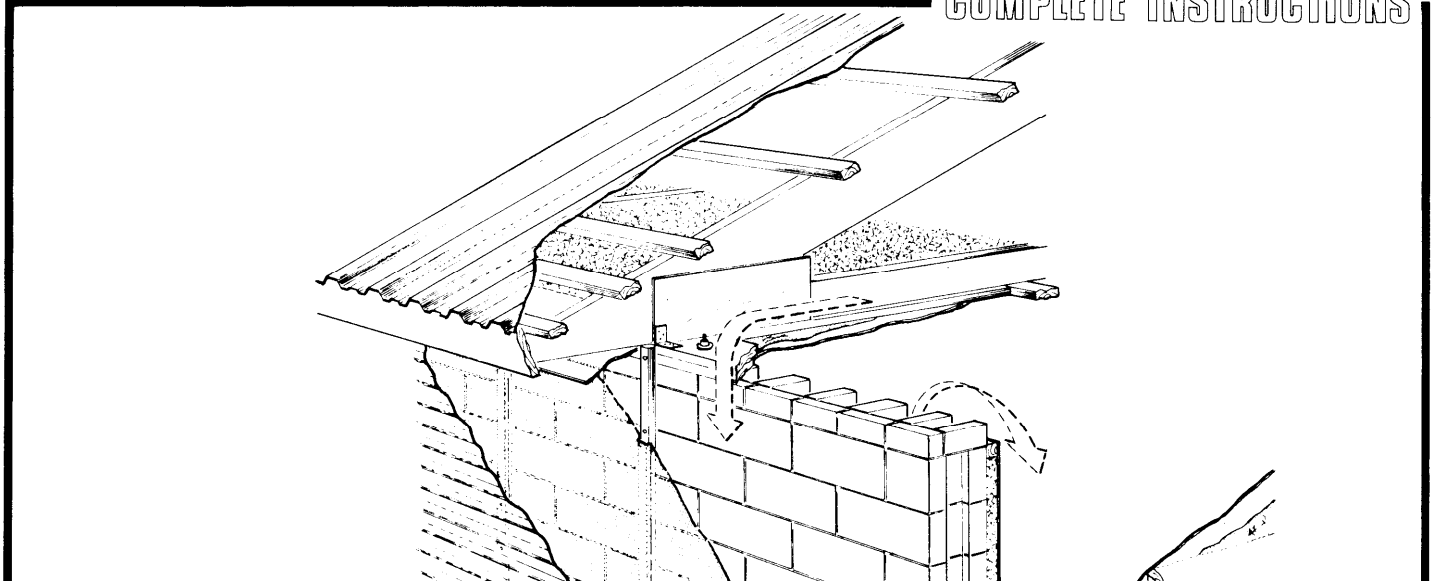
9732

SOLAR VENTILATION WALL WITH HEAT STORAGE

COMPLETE INSTRUCTIONS



The Canada Plan Service prepares detailed plans showing how to construct modern farm buildings, livestock housing systems, storages and equipment for Canadian Agriculture.

This leaflet gives the details for a farm building component or piece of farmstead equipment. To obtain another copy of this leaflet, contact your local provincial agricultural engineer or extension advisor.

SOLAR VENTILATION WALL WITH HEAT STORAGE

PLAN 9732 NEW 84:07

Many animal and poultry barns can benefit from solar assisted winter ventilation. Recent Canadian research shows that a sloping, roof-mounted solar collector is more expensive (and less practical) than one built into a vertical south-facing wall. This is because in winter (when solar-assisted ventilation is needed) the solar angle above the horizon is quite low, even at noon. For example, at Windsor, Ontario, the December 21 noon solar angle is 25°; farther north at Edmonton (Alberta) or Prince Albert (Saskatchewan) this angle is only 13°. In fact, the solar 'boost' due to sunlight reflected from snow-covered ground in front of a solar wall is more significant than the direct noon sun on a roof-mounted collector sloped away from vertical.

Ideally a solar collector on the long wall of the barn should face true south, but buildings can face up to 20° or even 30° either way from south without serious loss of solar heating; an angle slightly away from south simply shifts the time of maximum solar heating away from noon.

This design includes a covered-plate collector and a heat storage, both combined into an outside wall. The collector is an air-space covered outside by clear corrugated fiberglass sheeting (Filon, Excelite or equal), and backed on the inside by black-painted concrete blocks. The heat storage is the concrete block wall. Collector efficiency can be increased up to 20% by adding black aluminum or fiberglass flyscreen midway between the transparent cover and the blocks.

Heat 'storage' is an essential part of this solar preheat system; without the 'thermal flywheel' effect of the massive concrete block wall, inlet air temperature-rise with a bright winter sun can be 30°C or more, but there would be no benefit at night. And night is when the heat is really needed, when heat production from the sleeping animals or poultry is minimal and when outside temperature goes down.

In this design, special heavy concrete blocks are specified (75% solid, 10" thick). This provides enough heat storage to give some heat all night after a bright winter day. Ordinary 8" concrete blocks are only 37 lb each, compared with 63 lb for the special blocks; this gives the heavy blocks 75% more heat storage capacity.

CONSTRUCTION DETAILS Figure 2 shows details of construction and method of operation. The solar wall may be built as the south wall of a new barn, or it may be added to an existing barn. Of course, the extra cost of the solar feature is much greater for an add-on wall than for a solar wall built as an essential part of a new building.

Cast-in-place concrete is the best choice for the foundation below grade. Depth of the footing depends on how deep the frost penetrates soil in your locality; see CPS Plan 9324 for more on this. The exterior perimeter insulation 3 is essential to conserve the heat collected in the wall and to prevent possible frostheave. The best way to fasten this insulation and the treated wood sill 4 to the foundation is to tack them to the inside face of the concrete forms, before pouring the foundation concrete. This guarantees a perfect airtight 'fit' between wood, insulation and concrete (any air leakage here will short-circuit the air from the collector and cancel the heating effect). If the wall exceeds 50 ft. long add a vertical construction joint through the foundation and blocks at mid-length (for expansion and contraction due to daily and seasonal temperature changes).

The preferred order of construction is outlined by the sequence of the numbered notes in Figure 2. After laying up the concrete block storage wall, it should be washed with 10% muriatic acid solution and then rinsed thoroughly with clean water, to ensure paint adhesion. Paint with two coats of flat black exterior latex, using roller or spray. Paint the cedar strapping 10 as well, after fastening it with ramsets or lead anchors to the painted block wall.

The clear corrugated fiberglass cover must be installed airtight, otherwise cold air leaks will dilute the warming air as it passes down through the collector. Use a clear caulking cement in all horizontal and vertical lapped joints, and fasten the cover with hex-head plated roofing screws with neoprene washers, not with roofing nails. The screws cost more than nails, but they will be much easier to replace when you might later want to remove the cover to make repairs or to clean out spiderwebs and dust. To prevent 'yellowing' of the fiberglass cover by ultraviolet light, coat the cover with a UV filter lacquer ('Excelac', by Graham Products Ltd., Inglewood, Ont., or equal). According to the manufacturer, this should be reapplied about every 5-8 years. Also, be sure to caulk the the brick-to-plate joint at the top of the wall, as well as between the plates and where the ceiling vapor barrier meets the plates. Any air leaks here will short-circuit the collector and storage, making the system completely ineffective. The glazing must also be sealed against air leakage at both ends of the collector; Figure 1 shows a rectangular 'stop' of sheet metal flashing that provides for caulking where the glazing terminates at the building corner.

Air passes down through the collector and back up through the block wall. To get air into the blocks at the bottom and into the barn at the top, two courses of concrete bricks are placed on edge to replace one full course of blocks. Use six bricks per block (four across, two along the face), with the cross-bricks aligned above the webs of the block to make continuous air channels. To anchor the roof against wind uplift, bolt the wall plate 9 securely to the top courses of block using threaded rod set in mortar, with nuts and washers both top and bottom.

The interior wall insulation 16 is required to prevent wall sweating and building heat loss when the wall has cooled (after a night of heat discharge is not effective). It also prevents unwanted heat gain in summer when the sun warms the blackened block wall.

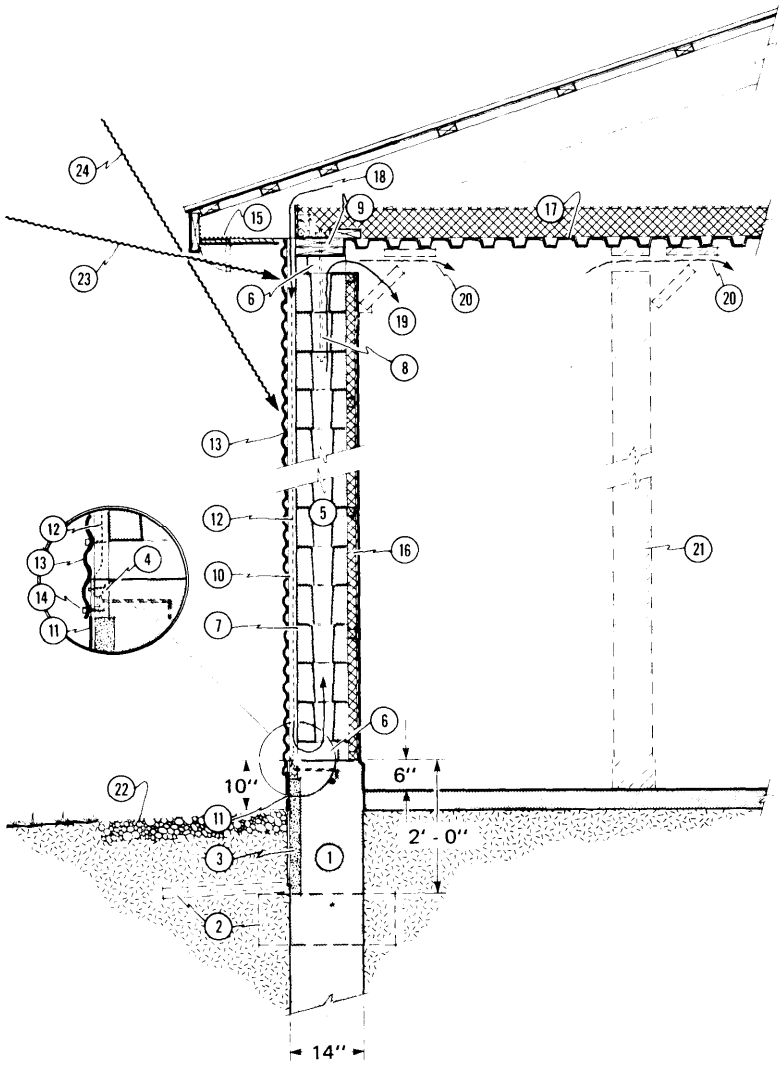


Figure 2. Details of construction

1. shallow or deep concrete foundation
2. optional shallow footing, 16" x 8", with 2" x 2'-0" horizontal perimeter insulation, (Dow Styrofoam SM, or equal)
3. 2" x 22" vertical perimeter insulation, (Dow Styrofoam SM, or equal); tack to formwork with finishing nail before placing concrete, or glue if 1 is concrete block
4. 2" x 4" wood sill, CCA pressure-treated, anchor to 1 with 3/8" x 6" bolts cast into concrete @ 4'-0" oc or less
5. 10" concrete block (size code 25), 3-core, 75% solid, laid in running bond pattern (not stack bond)
6. concrete bricks on edge, 6 bricks per block
7. collector surface, blocks and wood strapping 10 painted flat black
8. '/z" x 2'-0" threaded rod anchor bolt @ 4'-0" oc, 4" square washers and nuts top and bottom, set in mortar
9. 2-2" plates continuous, joints staggered (a 8'-0" oc, caulk airtight to bricks, blocking and ceiling
10. 2" x 2" cedar strapping @ 2'-0" oc
11. 3/16" x 2'-0" high-density recompressed cement-asbestos board, predrill and screw top edge to 4
12. optional black aluminum fly screen absorber bend to midway between blocks 5 and cover 13
13. glass-fibre-reinforced clear corrugated plastic (Filon, Excelite or equal, by Graham Products Ltd.), coat with UV-screen lacquer, caulk and lap all edge joints airtight
14. #8 x 1" hex-head roofing screws with neoprene washer, drill and drive in valleys @ 2'-0" horizontal and 8" vertical spacings
15. soffit vent slot with bird screen; 1" x 6" continuous flap door closed in winter, open in summer
16. 1½" strapping @ 2'-0" oc, glass fiber insulation, vapor barrier and plywood panelling; if air 20 enters directly into animal rooms, increase to 4" strapping and insulation
17. steel or plywood ceiling diaphragm (see 9371, 9373 or 9374)
18. winter air enters collector from ventilated attic
19. solar-heated it enters preheating hallway or 20
20. air enters animal room through adjustable slot inlet
21. optional insulated wall divides pre-heat hallway from animal room
22. coarse gravel or crushed stone, stops mud from splashing on wall
23. solar angle on Dec. 21, Winnipeg (50° N)
24. solar angle on June 21, Winnipeg (50° N)

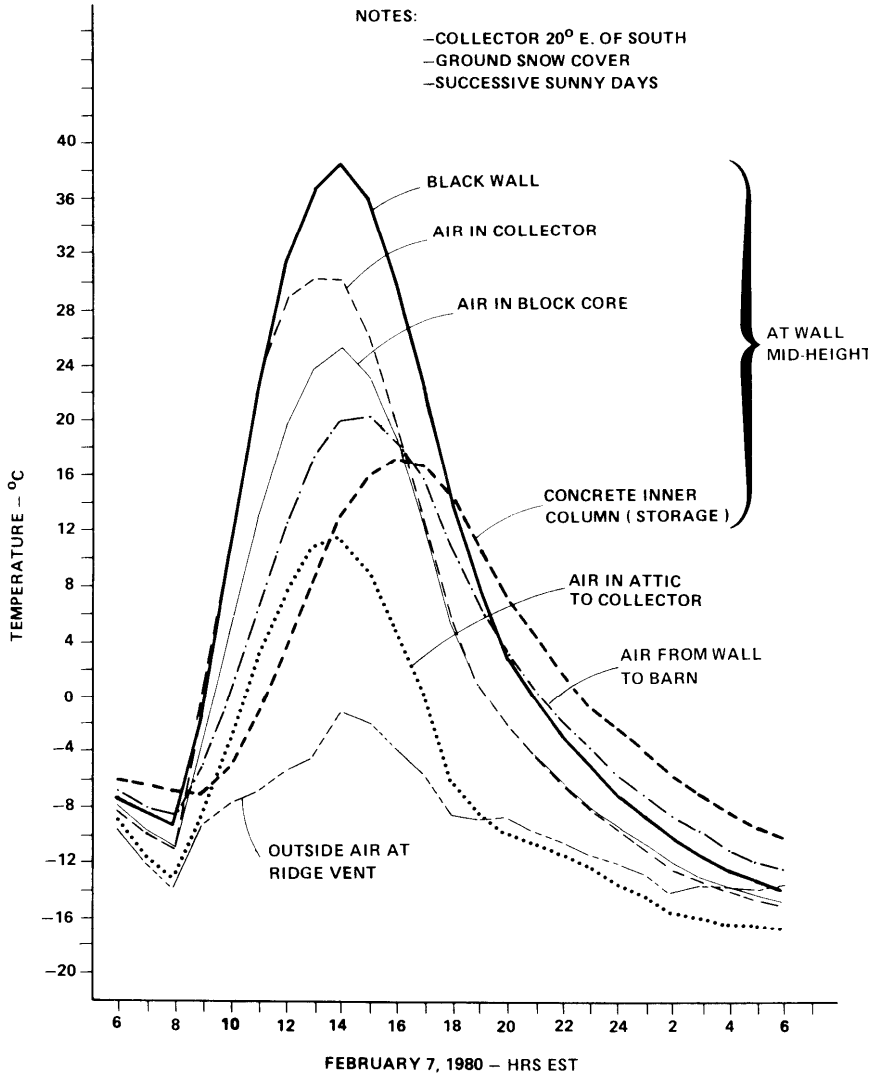


Figure 3. Temperature profiles vs time of day for vertical solar collector/storage wall.