# THE MEXICAN GREEN ROOF

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## ABSTRACT

The green roof movement, originating in Europe, is well established in North America but with no mention ever made of an ancient antecedent, the Mexican green roof. The green roof movement is mainly concerned with large commercial and public buildings while the Mexican green roof is associated with adobe dwellings. The Mexican green roof: 1) protects the major roof components from climatic extremes of hail and fire; 2) latent heat flux of the soil serves to stabilize temperature at the decking providing insulation. Data suggests that 8 inches of soil on a Mexican green roof is an equivalent to an R-30. Additional insulation is possible by being emplaced directly *on top* of the decking and *below* the waterproof membrane. With an adobe dwelling, the *roof decking also serves as the ceiling* and generally remains close to the indoor temperature regardless of outdoor ambient conditions. The decking of a contemporary type roof may exceed 150° F in the heat of the day while the decking and membrane of a Mexican green roof, under the same circumstances, may have a temperature less than 80° F; *a temperature difference of 70° F between the decking of two roof types.* The life span of green roofs exceeds many contemporary type roofs by a factor of 3 or greater. In New Mexico, a return to the Mexican green roof would resolve the roof problems of buildings affecting a Santa Fe look. It would improve the flat roof, from one of the most climatically vulnerable, to one of the most durable in addition to all the other advantages.

## INTRODUCTION

The Mexican brown or dirt roof, capping adobe dwellings, is a vernacular architecture of the arid and semiarid region of Mexico and parts of the southwestern United States, especially New Mexico. It has persisted for at least the past two centuries. However, the Mexican brown roof (if without vegetative cover) may become a green roof once weeds and grass are established thus I will refer to is as the Mexican green roof. In any event, the Mexican green roof bears no connection to the current green roof movement. Of the now significant corpus of literature on the European green roof I have yet to find any mention of the Mexican counterpart.

Originating in the German speaking countries the green roof movement is now well established in much of Europe and has taken root in parts of the United States and Canada; and for good reason. The green roof movement is a well considered architectural solution to two major urban problems associated with large commercial and public buildings: 1) abatement of storm water pour-off and, 2) the reduction of the heat island effect. Both problems result from extensive use of concrete and asphalt. In some instances large urban areas are reported to have temperatures 10°F above the surrounding rural area. By absorbing significant rain water, the green roof slows and lessens rain water pour-off into streets and drains while vegetated roofs greatly reduce surface temperatures. However, the Mexican green roof has been restricted to adobe dwelling for what are presumably practical reasons but none of which are a major concern the two urban problems just mentioned. Be that as it may, the urban green roof and Mexican green roofs share important similarities.

## GREEN ROOF TYPES

There are two types of urban green roofs; *intensive* and *extensive*. The intensive green roof, with garden-like vegetation, is developed on thick soil substrates and generally restricted to small areas. They will not be discussed further. Extensive green roofs are relatively light weight and may be as little as 4-inches

thick with specially selected vegetation. They are intended to cover expansive roofs of large public and commercial buildings and they are what is most often thought of as an urban green roof. The Mexican green roof is in between the intensive and extensive types in that the soil depths are generally much thicker (8 to 16-inches) than for the extensive green roof but with little concern for the nature of vegetative cover. However, what ever the difference in intended function both the urban and Mexican green roof share common properties distinguishing them from conventional type roofing.

Vegetation, considered an essential component for the urban green roof, tends to small succulents that are dominantly C4 or CAM plants. Such desert type plants may be very drought resistance due to specialized adaptations associated, in part, by severely limiting *transpiration* during the day. The leaf pores (stomata) that allow carbon dioxide to enter and oxygen and water vapor to exit are closed during the day. Emphasis on roof vegetation is a major difference between the European and Mexican green roof where presence or absence of roof vegetation is simply fortuitous. I know of no instance where vegetation is deliberately cultivated. I suspect that the gains with soil on the roof are so significant that the additional effort required to maintain a vegetative cover are not deemed to be worth the effort. However, some gain with vegetation is possible with the use of C4 plants, where the pores remain open and transpiration of water vapor may be vigorous during the day. *Transpiration is what is associated with evaporative cooling with plants.* However, C4 vegetation requires watering during dry periods but one can anticipate significant evaporative cooling during plant transpiration. For this reason a C4 vegetation may be best for a Mexican green roof. This subject of appropriate vegetation for a Mexican green roof needs more study.

## CONVENTIONAL ROOF (Figure 1)

- Roof surface and decking subject to climatic extremes of temperature, ultraviolet rays and wind.
- Subject to destruction by severe winds, hail and fire. Short roof life span.
- Insulation restricted to interior temperature controls only. <u>No protection provided roof.</u>
- Radiant barrier utilized in most instances.

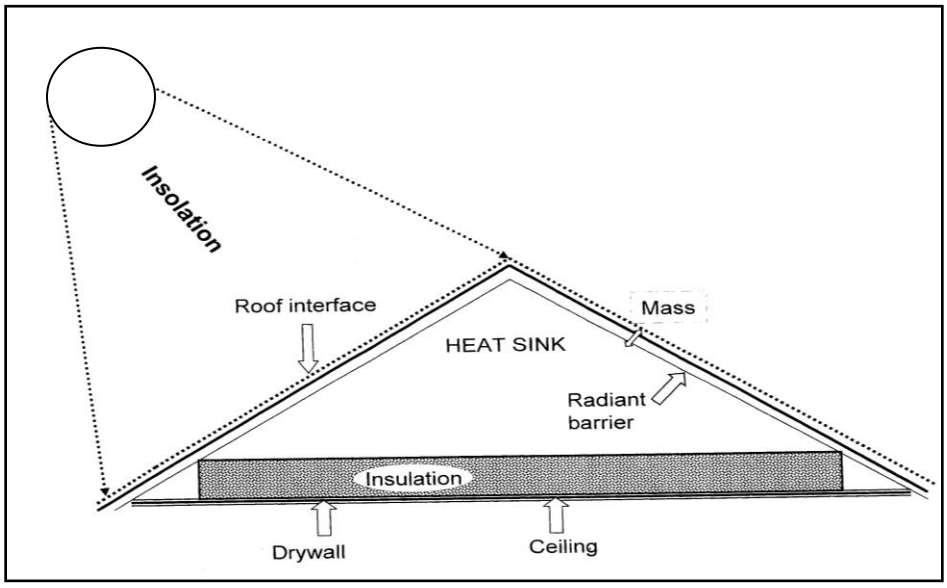


**Figure 1**. *Conventional Roof.* Note the location of insulation that does not provide protection to decking.

MEXICAN GREEN ROOF (Figure 2)

- Vegetation + soil serves as insulation and protection to major roof components of decking and water proof membrane.
- Decking and membrane experience very minor temperature fluctuation and are completely protected from solar radiation and weathering. Additionally, evaporative cooling from soil and plants, when present, serve to lower temperature of the green roof.
- Wind *advection* neutralized by vegetation when present.
- Green (living) roofs continually regenerate with minimal care.
- Roof components may last up to 100 yrs.
- Significant mass provided by soil and vegetation, serves to stabilize deck/ ceiling temperature.
- No requirement, or functional role, for a radiant barrier.

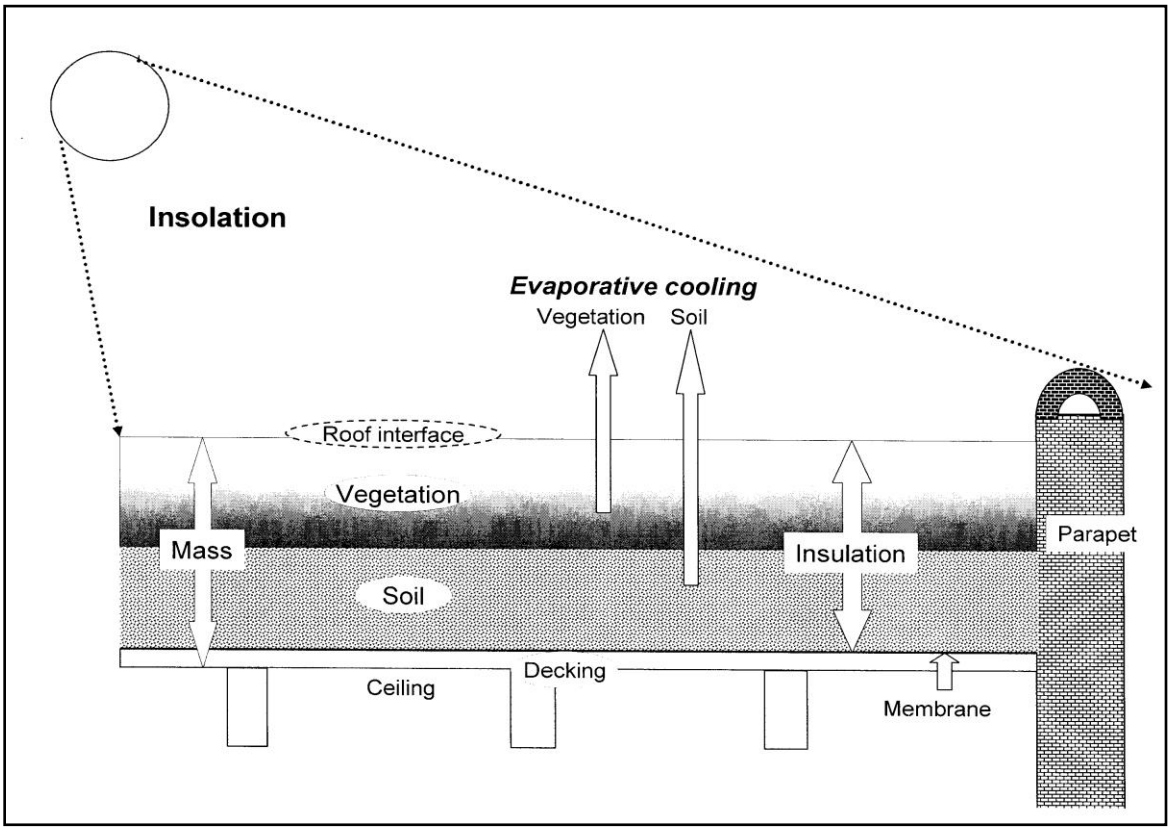


**Figure 2.** *Mexican Green Roof.* The profuse vegetation illustrated on the roof is very much an exception. Depending on location, as in non-arid lands, some vegetation can be expected in most parts of the year in most parts of Mexico. Where soil is not on *top* of the decking there is a need to have insulation *below* the decking. Where cold climate requires additional insulation, it can be emplaced directly on *top* the decking and *beneath* the waterproof membrane.

EXPERIMENTAL DATA – Del Rio, Texas

A Mexican 'brown' roof (no vegetation yet present) was constructed in conjunction with a control for comparison of data. The roof, with 8 inches of soil, rated R of .24 per inch would thus have an R-value of 2. The room with the conventional flat roof has rock wool insulation of an R-30 rating (Figure 3). However, the ceilings of both rooms varied but 1°- 3° F of one another regardless of fluctuations of

outdoor ambient temperature, summer or winter. In effect, the brown roof, without a vegetative cover, acted as an equivalent of R-30 insulation. The explanation is that, as the dirt roof contains clay, there is latent heat of vaporization taking place when the RH fluctuates.

Should a grass cover be well established on a Mexican roof, at least to the extent that sunlight does not reach the soil surface, the temperature of the decking/ceiling could be reduced significantly when ambient temperature are the highest; at least *in theory*. With a 100-degree ambient temperature in mid-summer, I was able to record temperature in the upper 70s some six inches below the surface of growing turf along the roadside. There remains the question of what effect this would have with respect to the internal ambient temperature? Would it be worth the effort and expense to maintain a vegetative cover? A factor to consider would be the total cubic feet on the internal spaces. The less the volume the greater the potential effect.

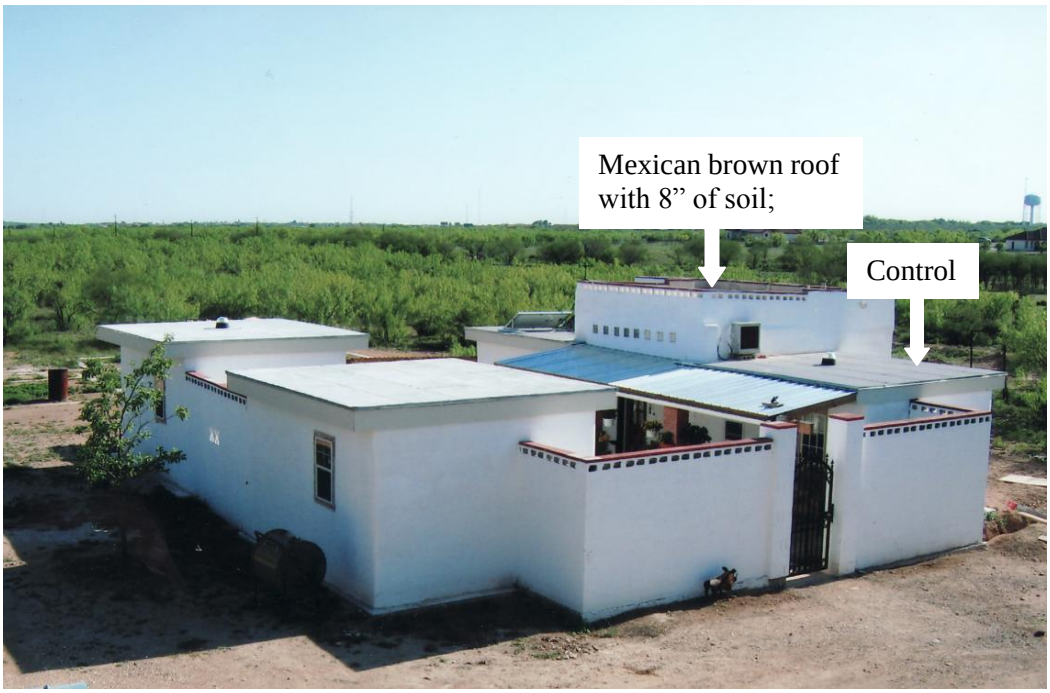


**Figure 3.** *Morony & J. O. Stewart building complex for experimental studies of earth blocks. Quail Run, Del Rio, Texas.* Arrow: Mexican brown roof with an R-2 value based on 8-inches of soil. The control; lower roof elevation of conventional construction with an R-30 value roof insulation.

**Figure 4**. *Construction the Mexican green roof:* Left: 2 x 12, emplaced on concrete bond beam with ¾ inch plywood decking. Center: Cinder blocks (CMUs) are used for parapets; gaps for canals. Right: Membrane, canals and soil emplaced.

**Figure 5.** *Room interior with the Mexican brown roof (no vegetation).* Ceiling is also the decking; 2x12 inch timber on bond beam noted by dashed line.

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DATA – MIDSUMMER, DEL RIO, TEXAS

Conventional *vs* Mexican green roof

CONVENTIONAL

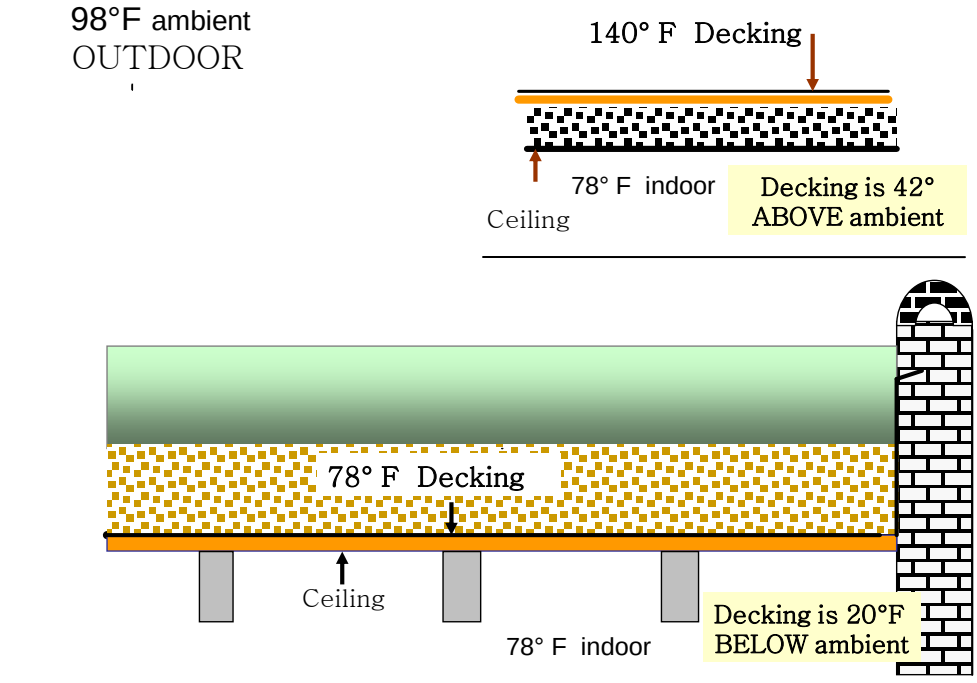

**Figure 6.** *Data comparisons of the conventional flat roof (top) and a Mexican brown roof (bottom) as illustrated in Fig. 3.* Disregard the symbol for vegetation lacking at the time of the experiment. Both building had the same interior building temperatures of **78° F**. With an outdoor ambient temperature of **98° F** the decking of the conventional flat roof was **140° F** or **42°** F above ambient; the Mexican green roof had a deck temperature the same as the ceiling: **78° F** or **20°** below outdoor ambient. There is thus a **62° F** difference the temperature of the two deck types.

## DISCUSSION

Why has the Mexican green roof prevailed for so long as vernacular architecture in Mexico? One may assume it was simply the recognition of the inherent advantages of soil on roof both as a heat barrier and durability as previously detailed for green roofs. The arguments against such a massive roof in the past are the same for the present: large vigas or timbers are required to hold a heavy roof; material often not readily available. Be that as it may, with respect to flat roofs in New Mexico, John O'Conner, in his *The Adobe Book*, page 61, comments that "… we are so in accord with traditional flat roof on adobe, that we won't even discuss the pitched roof." Oddly, the Santa Fe "look" has been a prevailing consideration for building in New Mexico, at least in Santa Fe. It is a style that includes the flat Mexican roof but often without the incorporation of soil. When so constructed, it has been necessary to emplace roof insulation below the decking and adding significant complications to roof construction.

## CONCLUSION

The Mexican green roof shares the same advantages of the European green roof: the soil and plant life, if present, serve to protect the roof from the elements and greatly extends the life of the roof. Damage by fire or hale is greatly minimized or, for all practical purposes, eliminated.