Workshop on Cool Roofs and Pavements
Global Superior Energy Performance Partnership (GSEP)

Cool Roofs in México

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Current State of Cool Roofs Mexican Legislation

NOM = Mexican Compulsory Norm (standard)
NMX  = Mexican Voluntary Norm (standard)
PROY = Norm project (in development stage)

- NOM-008-ENER-2009
- NOM-020-ENER-2011
- NMX-C-460-ONNCCE-2009
- PROY-NMX-AA-164-2012 (Cool roofs included)
Government and Industry Sectors Involved

- National Energy Efficiency Commission (CONUEE)
- Thermal insulation (AEAEE)
- Coatings manufacturers (ANAFAPyT)
- Other roofing material manufacturers (Tile, metal sheet, acrylic sheet) (not yet involved)
Recent Actions and Events

- International Solar Buildings Workshop, Nov 2011, Mexico–Spain, Cuernavaca, México
- Cool Roofs Workshop, Feb 2012, Mex–USA, Mexico City
- Industrial and Commercial Roofs Energy Efficiency, Mex–USA, Sep 2012, Mexico City
Experimental Work

Experimental comparison of heat flow through concrete roofing flagstones with different coatings

- Compares heat flow through concrete slabs with different roofing systems
- Sponsored by ANAFAPyT
- Executed by CIMAV
- Results presented at ISES Solar World Congress 2011, Kassel, Germany
Energy balance for a low sloped roof

- Solar Radiation (incident and reflected)
- External Air Heat Convection
- Roof - Atmosphere Infrared Radiation

Heat Conduction

Internal Air Heat Convection
Controled Inner Conditions Testing Room

A

B

C

D
Instrumentation
Comparison of heat flux, October 10, 2010:
Bare concrete — versus —
White Cellular Reflective Coating

![Diagram showing heat flux comparison between bare concrete and white cellular acrylic white coating on October 10, 2010.](image)
Comparison of surface temperatures, October 10, 2010:

Bare concrete

— versus —

White Cellular Reflective Coating

Slab 1: Bare concrete (Reference slab)

Slab 2: Cellular Acrylic White (1.5 L/m^2)
Diurnal Heat Gain (MJ/m² · week)

- ½” Polinsulate (MS foamed non woven) + White Cellular Waterproof Acrylic Roof Coating (1.5 L/m²) (8)
- Microspheres based Cellular Concrete (un-covered) (12)
- 1” EPS sheet + White Cellular Waterproof Acrylic Roof Coating (1.5 L/m²) (6)
- White Acrylic Cellular Textured Paste (2 L/m²) (7)
- White Cellular Waterproof Acrylic Roof Coating (3 L/m²) (3)
- White Cellular Waterproof Acrylic Roof Coating (1.5 L/m²) (2)
- 1” PU Foam + Regular Red Waterproof Roof Coating (1 L/m²) (4)
- 1” EPS sheet + Regular Red Waterproof Roof Coating (1 L/m²) (5)
- Regular White Waterproof Roof Coating (1 L/m²) (9)
- Red Cellular Waterproof Acrylic Roof Coating (1.5 L/m²) (11)
- Bare Concrete (Reference Slab) (1)
- Regular Red Waterproof Roof Coating (1 L/m²) (10)

= Conductive Thermal Insulation
= Polymeric Microspheres

Cool Roof
Actions Needed
Modification of NOM-020-ENER-2011

Current State

- NOM-020 gives sol-air temperatures for roofs and walls of different cities in Mexico.

- With those data and R values given, the heat flow of a same size/shape reference building is calculated.

- Design heat flow must be less or equal than the calculated for the reference building, in order to comply.

- The norm uses the sol-air temperature method to determine reference heat flux.
Modification of NOM-020-ENER-2011

From ASHRAE Handbook Fundamentals 2009 (Pag 30.22) Sol-Air Temperature is defined as:

\[ t_e = t_o + \frac{\alpha E_t}{h_o} - \varepsilon \frac{\Delta R}{h_o} \]

- \( \alpha \) = absorptance of surface for solar radiation
- \( E_t \) = total solar radiation incident on surface, W/m²
- \( h_o \) = coefficient of heat transfer by long-wave radiation and convection at outer surface, W/(m²·K)
- \( t_o \) = outdoor air temperature, °C
- \( t_s \) = surface temperature, °C
- \( \varepsilon \) = hemispherical emittance of surface
- \( \Delta R \) = difference between long-wave radiation incident on surface from sky and surroundings and radiation emitted by blackbody at outdoor air temperature, W/m²
Modification of NOM-020 ENER-2011

- The norm fails to report the surface reflectance value used for the Sol-Air temperature calculation.

- Heat flux stated in NOM-020 is only true for one solar reflectance value.

- When questioned, CONUEE claimed that solar reflectance used in the Norm was: 0.71.

Improvements Proposed

- The Norm must specify that solar reflectance of roof coverings must be 0.71 or higher, in order to comply.

- Solar Reflectance considered must be the aged value.

- Some insulation penalty should be stated in case solar reflectance value is not met.
Cool Roofs Impact in Mexico Estimation
Winbuild-CENIDET-CIMAV

- Mexican authorities are not yet aware of Cool Roofs advantages
- The impact of Cool Roofs on energy efficiency, economy and health/comfort should be estimated
- Dimensioning the effect of Cool Roofs should make authorities and population more likely to accept and use the technology
IMPACT OF COOL ROOF SURFACES ON ENERGY SAVINGS IN BUILDINGS IN MEXICO
Winbuild-CENIDET-CIMAV

Project Scope:
• Investigate and gather information of solar radiation to elaborate solar radiation maps of Mexico.
• Effect of using cool roofs on the energy saving will be evaluated by using the database of climate variables and degree days of 700 cities.
• Estimate the area of different color of roofs in 5 typical cities of different climate zones in Mexico by using a digital process by satellite image identification in order to know the percentage of areas of roof different to cool roofs in cities of Mexico.

Project Goals:
• Elaborate monthly average solar radiation, temperature, humidity maps, and maximum and minimum climatic variables maps.
• Identify the different climatic zones in Mexico.
• Elaborate monthly heating and cooling degree day maps in Mexico.
• Determine the energy savings by the use of cool roofs in Mexico.
• Estimate the percentage areas of different colors of roofs of 5 cities representative of different climates.
Fortcomming Projects

• COMEX Group (the largest paint and coatings manufacturer in Latinamerica) wants to build a heat flux measuring facility, similar to the one developed by CIMAV. (COMEX-CIMAV-Nat. Research Council – Spain)

• Simulation study to estimate the effect of cool roofs on energy use and human comfort in low income housing with and without air conditioning, in different climatic zones of Mexico (CIMAV)
Most Important Work Ahead

- NOM-020 and 008 should explicitly include solar reflectance values
- A new NMX for Cool Roofs should be developed, including criteria for surface optical properties and its measuring methods
- Products certification laboratories and weathering farms should be established
Gracias!

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