Building Colour Effects on the Ambient Temperature

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Abstract

In this research we study the effect of colours buildings on the amount of absorption and reflection of solar radiation that incident upon it and thus its impact on the rising ambient temperatures, we has been taking several tiles as a symbols for building material buildings, were painted with several colours refer to colour buildings and measure a power of solar radiation that falling on the tiles and temperatures that emitted from the tiles with the time ,The tiles were most colours darkness it be highest in temperature according to a mount of absorbed solar radiation.

Key words: color buildings, absorbed solar radiation, color of roof

تأثير الوان البنايات على درجة حرارة المحيط

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الخلاصة:

تم في هذا البحث دراسة تأثير الوان البنايات على مقدار امتصاصها وانعكاسها للإشعاع الشمسي الساقط عليها وبالتالي تأثيرها على ارتفاع معدلات درجات حرارة المحيط بها فقد تم اخذ عدة بلاطات كرموز لمادة بناء البنايات وتم صبغها بعدة الوان وقياس معدلات الاشعاع الشمسي الساقط ودرجات الحرارة المنبعثة من البلاطات مع الزمن وكانت البلاطات الاكثر الوانها عتمة اعلى درجة حرارة تبعا الى مقدار امتصاصها للإشعاع الشمسي.

Introduction

Solar energy comes from the Sun's power. How much of it is available depends on whether days are sunny or cloudy. Solar power can be used to heat homes, particularly in cooler climates. In warmer climates it can be desirable to reflect solar energy away from homes to keep them cool. A variety of materials absorbs or reflects solar energy may be used.

The ideal “cool” roof is one whose surface is minimally heated by the sun, such as a bright white roof. However, sometimes the term “cool” is applied to a roofing product whose surface is warmer than that of a bright white material, but still cooler than that of a comparable standard product. For example, the afternoon surface temperature of a specially designed “cool” red roof is higher than that of a bright white roof, but lower than that of a standard red roof.

An example of a “hot” roof is one with a standard black surface, which grows very warm in the sun. [1, 2, 3]

The most important feature of an ideal cool roof is that its surface strongly reflects sunlight. The surface of an ideal cool roof should also efficiently cool itself by emitting thermal radiation. Thus, a cool roof should have both high “solar reflectance” (ability to reflect sunlight, measured on a scale of 0 to 1) and high “thermal emittance” (ability to emit thermal radiation, also measured on a scale of 0 to 1). The solar reflectance and thermal emittance of a surface are called its “radiative” properties because they describe its abilities to reflect solar radiation and emit thermal radiation. [1, 3, 4]

An easy way to judge the coolness of a roof is to compare its surface temperature on a sunny afternoon to that of a reference black roof and that of a reference white roof. The “solar reflectance index” (SRI) assigns a coolness of 0 to the reference black roof (solar reflectance $R = 0.05$, thermal emittance $E = 0.90$) and a coolness of 100 to the reference white roof ($R = 0.80$, $E = 0.90$). Most roofing materials have an SRI (coolness rating) between 0 and 100, though values can be below 0 (hotter than reference black) or above 100 (cooler than reference white). The higher the SRI, the cooler the surface.

On a clear day about 80% of sunlight reflected from a horizontal roof will pass into space without warming the atmosphere or returning to Earth. . [1, 2, 3, 5]

About half of all sunlight arrives in the invisible “near-infrared” spectrum. Standard light-colored surfaces strongly reflect both visible and near-infrared sunlight, while standard dark colored surfaces reflect modestly in both spectra. Special dark and medium-colored surfaces that strongly reflect near-infrared sunlight are called “cool colors.” The solar reflectance of a cool dark color can exceed that of a standard dark color by about 0.4. [2, 4, 6]

We recommend selecting a cool product for new construction or when an old roof is scheduled to be retrofitted. It is rarely economical to replace a mechanically sound roof just to increase its solar reflectance

There are specialized white elastomeric coatings available for low-sloped products and cool colour polymer coatings available for tiles that can be sprayed on existing roofs. [3, 4, 7]

Selecting a cool roof instead of a standard (hot) roof directly benefits the occupants of the building, and indirectly benefits the entire community. Installing a solar-reflective roof can also immediately slow global warming through a process called “global cooling".

Substituting a cool material for a standard (hot) material lowers the daytime surface of temperature of the roof, which in turn reduces the flow of heat into the occupied space. This conserves energy in an air-conditioned building and makes an unconditioned building more comfortable.

Reducing the need for cooling doesn’t just save money—it also reduces the emission of pollutants from electric power plants, including carbon dioxide (CO_2), nitrogen oxides (NOx), sulfur dioxide (SO_2) and mercury (Hg).[2,3,4,5,8]

Reducing the building peak cooling load with a cool roof can allow the installation of a smaller, less expensive air conditioner. This is referred to as a “cooling equipment” saving. Smaller air conditioners are also typically less expensive to run, because air conditioners are more efficient near full load than at part load.

Choosing a cool roof instead of a standard roof can slightly increase the need for heating energy in winter. However, winter penalties are often much smaller than summer savings even in cold climates because the northern mainland U.S. (latitude $\geq$ 40°N) receives about 3 to 5 times as much daily sunlight in summer as in winter.[1,4,6,7,9]

Lowering the peak daytime temperature of soft roofing products, such as single-ply membranes and asphalt shingles, may help them last longer by reducing the stress resulting from thermal expansion during the day and thermal contraction at night.

The citywide installation of cool roofs can lower the average surface temperature, which in turn cools the outside air. Cool roofs thereby help mitigate the “daytime urban heat island” by making cities cooler in summer. This makes the city more habitable, and saves energy by decreasing the need for air conditioning in buildings. [4, 7.10, 11]

Cooler outside air improves air quality by slowing the temperature-dependent formation of smog. Decreasing the outside air temperature in Los Angeles

basin by 5°F [3 K] is predicted to reduce smog (ozone) to about 10%, worth about $300M/yr in avoided emissions of smog precursors (e.g., Knox).
Cool roofs decrease summer afternoon peak demand for electricity, reducing the strain on the electrical grid and thereby lessening the likelihood of brownouts and blackouts.
Replacing a hot roof with a cool roof immediately reduces the flow of thermal radiation into the troposphere ("negative radiative forcing"). [2, 12, 13, 13, 14]

Instruments and materials:

I've been in this research we are adoption the type of tiles as research materials is equal in dimensions and quality of the material which is fabricated from it (concrete) and in the same surrounding environmental conditions so that was painted these tiles by several colours represent almost colours of the building colours to determine the reflectivity and the heat transmission from of these tiles duty to absorption solar radiation with a tile without paint as a reference, we were also measured solar radiation that falling on the all tiles used to measure it the solar power meter and using thermometer . to measure the temperature of the tiles, the thermometer independent of measure temperature in infrared rays and measure the temperature ambient by taking readings temperature in the weather station, we measure temperature of the painted tiles and solar radiation incident in addition to ambient temperature with time, and by using the Wien displacements' equation to know the wavelength emitted by tiles painted

Results and discussions:

By measuring the solar radiation that falling on the tiles with the change of time every hour in horizontal situation by using in this measure solar power meter in W/m^2 units shown in figure (1) we notes that solar radiation change with time beginning from sunrise to sunset , this means a change in the amount of energy that falling on tiles, change in the amount of absorbed and reflectance of solar radiation according to the colour tile .

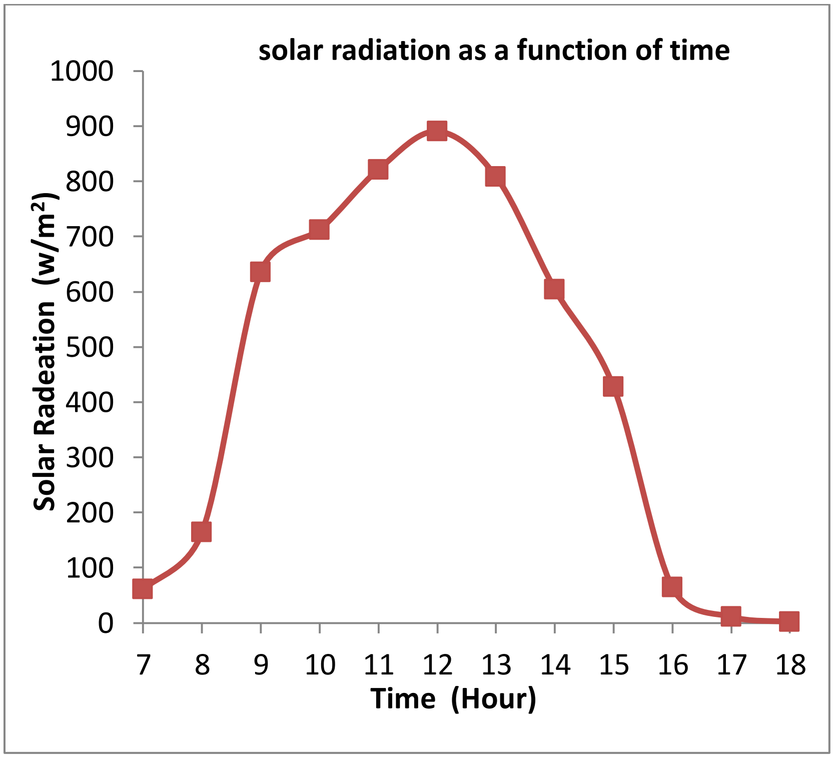

Fig (1) show the solar radiation with time

We measuer the temperature to all the tiles with the time by infrared thermometer, we note that the temperature change according to the color tiles, lighter colours tend to reflect more sunlight than they absorb. As a result, light-colour makes tiles tend to be cooler than their dark-coloured tiles; dark colours absorb more heat than lighter ones because they absorb more light energy. In fact, the closer to black colour is the more heat it absorbs from light sources. The key is that colours do not absorb different amounts of heat, only heat from light as shown in figuer (2),that mean dark-coloured materials heat up much faster in sunlight because they reflect less of it than lighter materials and absorb heat more rapidly, while color is the primary factor, other variables can affect how colors absorb heat. Shiny colors are able to reflect significant amounts of light and heat compared to flat colors. Even darker colors can reflect most heat they are exposed to if they have a reflective sheen.

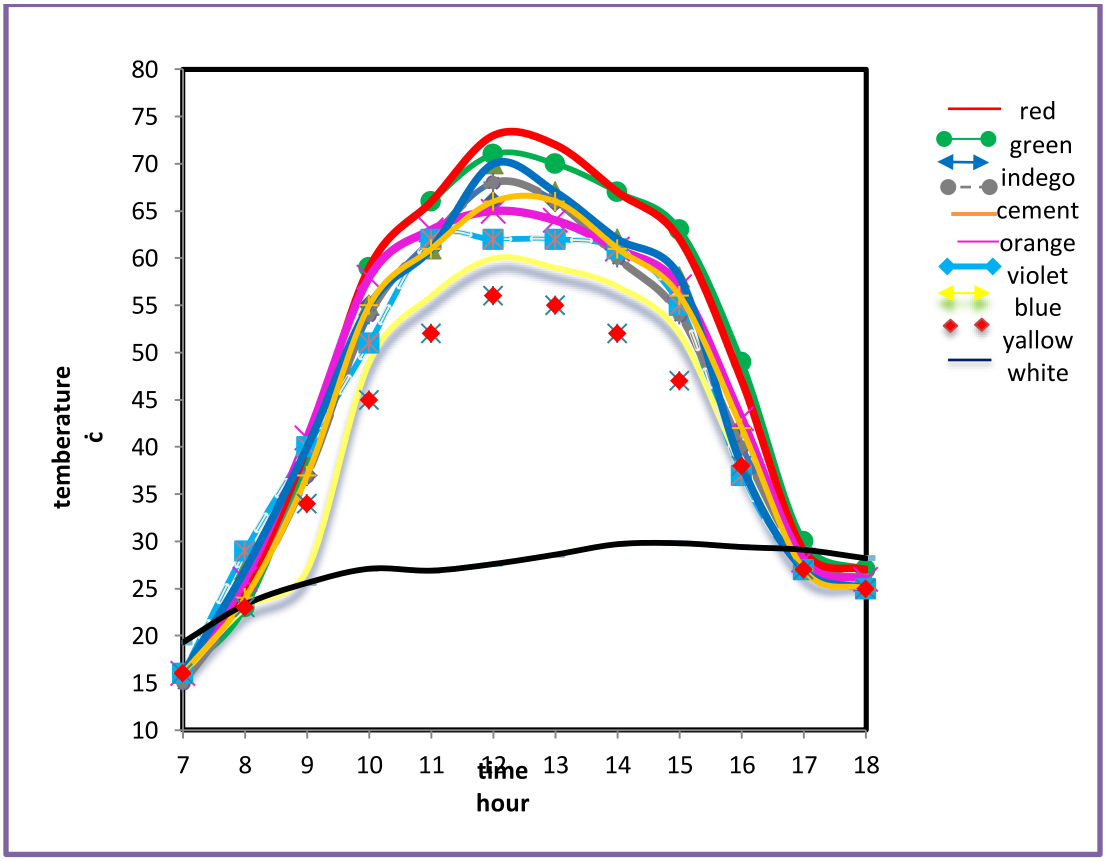

Fig (2) show tiels and ambient temperature the with time

The heat absorption hierarchy of colors will always remain if all other factors are equal. A blue will still absorb more heat than a yellow; Black is the ultimate heat absorber. It absorbs all light on the visual spectrum, creating a void of light. As a result of absorbing all light wavelengths, black is the hottest possible color. White is the opposite. White light is the sum of all wavelengths, so when some people view a white object, they are really viewing all visible light hitting the object's surface and reflecting back. Some heat is still absorbed based on the nature of the object's material, but minimal additional heat is absorbed, making white the coolest possible color, Colors like yellow white are often called "bright" because of the high degree of light they reflect back. Visual light is composed of numerous different colored wavelengths which make a white light when combined. Therefore light colors such as yellow white are perceived that way because of most light wavelengths are reflected back to our eyes. Since most light are reflected, little light (or heat) is absorbed , after that the dark color tiles be heat sourece emittiing temperature to ambient to be in heating balance with it , every tile be emitting to infrared radiation as temperature shown in figuer (3), the realative tiels temperature to ambient temperature the with time , from comparsion beteween the ambient temperature curve to the temperature tiels curve we note the differance between them ,to heat balance that will be heat transfer from the tiels to ambient.

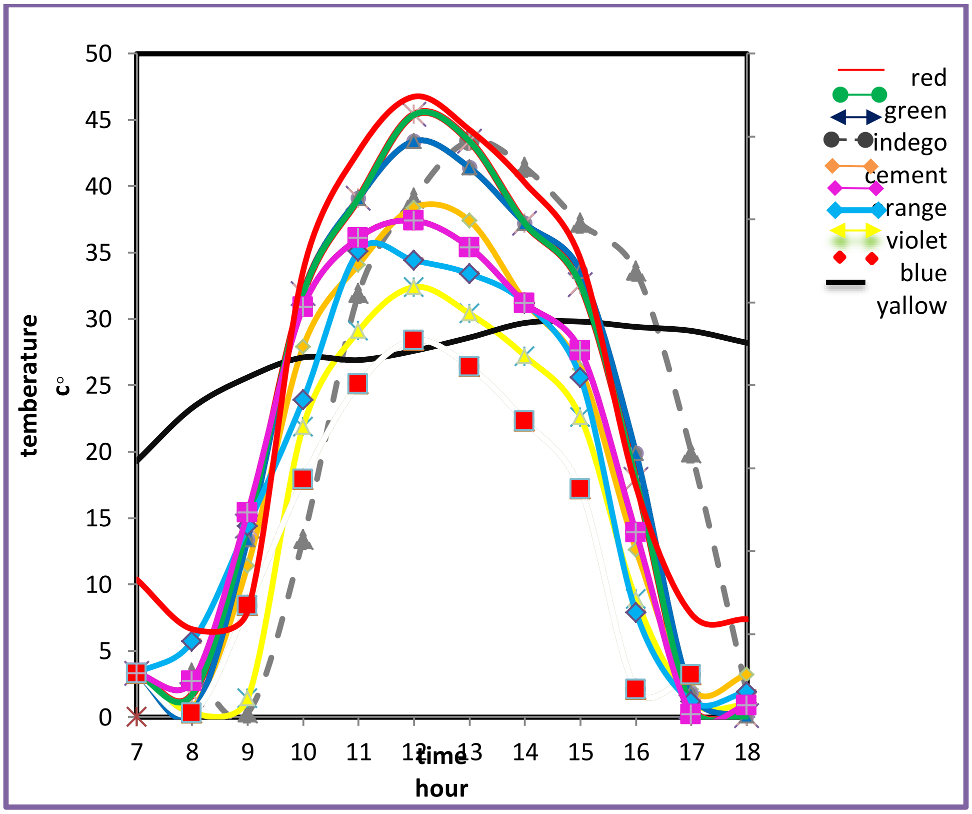

Fig (3) show the realative tiels temperature to ambient temperature the with time

Conclusion:

On this principle by using lighter-coloured materials to build roofs that are designed to reflect sunlight and produce significant energy savings for a house, apartment complex or office building. Runners, cyclists and other outdoor athletes also apply this principle by wearing light-coloured sportswear. It keeps their bodies cooler while competing or exercising, which can lead to an extra energy boost.

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