EUPAVE
EUROPEAN CONCRETE PAVING ASSOCIATION

FACT SHEET
High albedo

Concrete roads can strongly contribute to reduction of CO_2 emissions from road transport

Albedo is the ability of a surface to reflect light rays. In case of a light-coloured concrete surface (high albedo: 0.20 to 0.40), more energy is reflected in the atmosphere compared to a black surface (lower albedo: 0.05 to 0.15), which absorbs the heat.

The high albedo of concrete pavements offers several benefits:

1. Slowing down the global heating

Changing 1m² of black asphalt surface into a light concrete helps countering the climate change as if **22.5 kg CO_2** was not emitted. That is enough to off-set **30 to 60%** of the CO_2 emitted during the manufacturing process of the cement used in that concrete pavement.

2. Reducing the Urban Heat Island Effect (UHIE)

UHIE is the warming effect that occurs in large metropolitan areas. Light-coloured pavements have lower heat absorption; they limit the harmful impacts of UHIE by a reduction of the ambient temperature, the number of extreme heat days and the likelihood of smog.

3. Saving cost and energy for road lighting

Road lighting designers base themselves on the reflected light as it is perceived by the driver of a vehicle. The superior reflectivity of concrete makes it possible to achieve savings by placing fewer lighting columns or by using lamps of a lower luminance. In both cases costs can be reduced up to 35%, either by the lower number of lighting columns or by reduced lighting power, both resulting in less electricity consumption.

4. Offering a better visibility

When road lighting is not available, the light coloured surface of a concrete road still offers a better visibility, especially in difficult circumstances when visibility plays an important role: at night and in bad weather conditions such as heavy rain or dense fog.

SOME MORE INFORMATION

WHAT IS ALBEDO?

The ability of a surface to reflect light rays (and therefore energy) is determined by its "albedo". It is the ratio of the reflected to the incident light or radiation. The higher the albedo, the more energy is reflected back into space, out of the atmosphere. On average the albedo of planet earth is 0.30 That is to say 30% of all the solar energy is reflected while 70% is absorbed. As a result, the average temperature at the earth's surface is 15° C. Polar ice with its high albedo plays an important role in maintaining this temperature balance. Should the polar ice melt the average albedo of the earth will fall because the oceans will absorb more heat than the ice. The temperatures on earth will rise and global warming will accelerate.

Table 1: Values of light reflection or albedo for different materials

SURFACE	ALBEDO
Fresh snow	0.81 – 0.88
Old snow	0.65 – 0.81
Ice	0.30 – 0.50
Rocks	0.20 – 0.25
Wood	0.05 – 0.15
Soil/Ground	0.35
Concrete	0.20 – 0.40
Asphalt	0.05 – 0.15

SLOWING DOWN THE GLOBAL WARMING

Surfaces with a higher albedo reflect more radiation and increase the outgoing radiation at the top-of-atmosphere. In this way they have the potential to alter the earth's energy balance and consequently also the climate change effects. This effect can be expressed in the form of a capture or release of CO_2, since greenhouse gases and surface albedo are both forcing agents that can have an impact on the climate.

Several scientific studies have calculated the impact of changing a pavement from asphalt to concrete, from a darker to a lighter surface. This increase of albedo, estimated at an average of 15%, can be modelled as a capture of CO_2 with an equivalent radiative forcing effect. This equivalence, for the most conservative results, taking into account cloud cover and other reducing factors, amounts to 1.5 kg/m² per Δ albedo of 0.01. For a Δ albedo of 0.15 the total equivalent "50 years GWP" savings are 22.5 kg CO_2/m² of pavement. That is a great amount, enough to offset 30 to 60% of the CO_2 emissions needed for the cement production (fuel burning + calcination) of that pavement! (Figures depend on the thickness of the pavement, the cement content of the concrete mix and the cement type)

REDUCING THE URBAN HEAT ISLAND EFFECT (UHIE)

Because of the global climate change, more and more extreme weather situations occur. It has been observed that during warm periods, the temperature in an urban environment is higher than the surrounding rural area. This phenomenon is called the Urban Heat Island (UHI) effect. It is explained by the calorific absorption during the day by the materials used in an urban environment. That heat is released during the evening and overnight, leading to a rise of the ambient temperature. The UHIE increases the energy demand during summer because of a higher use of air conditioning; it also reinforces the greenhouse gas effect and it leads to a higher risk on smog and air pollution, with negative impact on public health.

The increase of periods of heat waves will enhance the UHIE in the future. It is therefore appropriate to take measures to prevent this phenomenon in urban planning policy. The use of "cool pavement" surfaces is one of them. These can be light-reflecting (high albedo) and/or evaporative pavements such as pervious surfaces and vegetated permeable pavements.

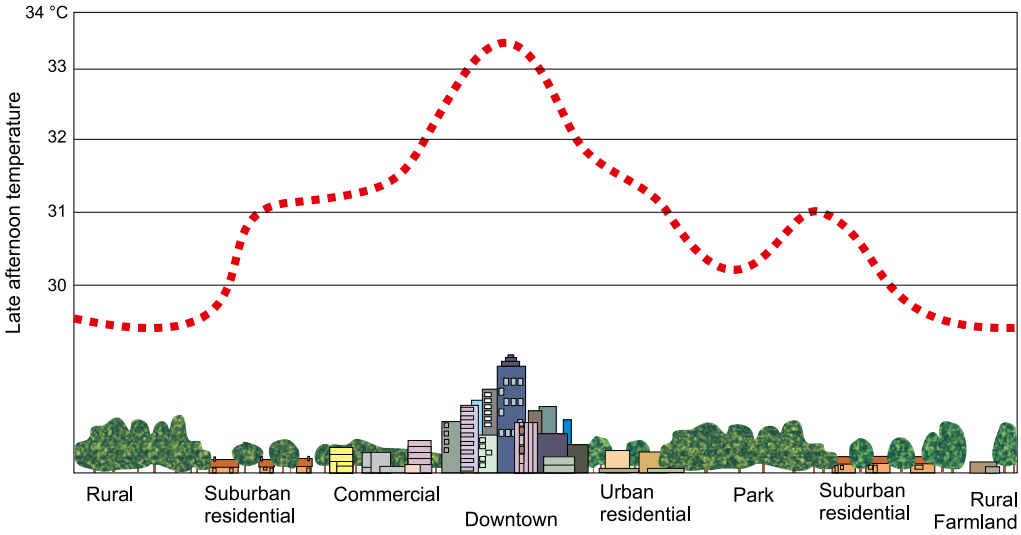


Figure Urban Heat Island Effect © EPA, U.S.

The lower calorific absorption of light surfaces such as concrete also contributes to the reduction of the heat island effect. The picture below shows a thermal image of an asphalt and concrete surface located next to each other. The measurement was carried out in August 2007 at about 17:00h on a slightly cloudy day and the temperature difference between the two road surfaces was about 11° C. Research has indicated a general average decrease of the urban heat island intensity of 0.4° C.

Another type of cool surface consists of permeable pavements with a structure that allows storing water. The evaporation of the surface water subtracts heat from the pavement, as it is the case with vegetated surface. In this context, the combination of a permeable surface and vegetated pavement is advantageous. Obviously that kind of pavements are aimed in the first place at retaining the water in situ and allowing it to infiltrate and so they already contribute considerably to sustainable water management.

The "cool pavements" strategy is supported by the DG Environment of the European Commission and the US Environmental Protection Agency. It is now up to the project leaders to take into account the Urban Heat Island effect in a contemporary vision of roads and urban public spaces. The integration of light-coloured concrete surfaces and/or permeable pavements into the concept can also be carried out in compliance with the aesthetic requirements. There are already many examples and sources of inspiration for such applications all around the world.

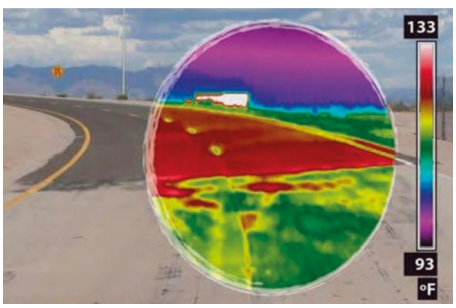
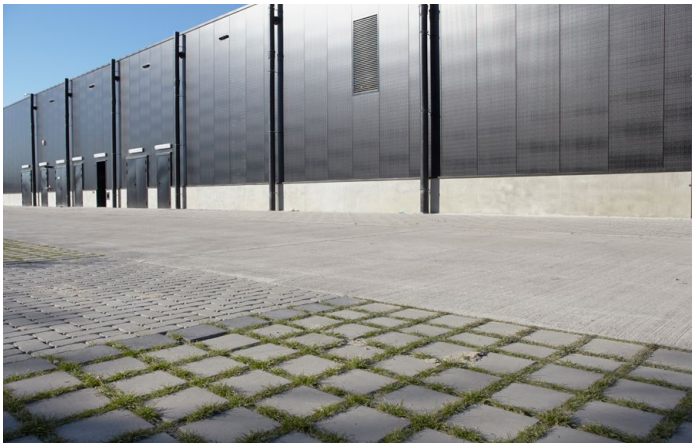


Figure showing a thermal image of a concrete-asphalt coating © ACPA, U.S.

Brussels, Atomium square © L. Rens / FEBELCEM

Brussels, Rogier square © L. Rens / FEBELCEM

Malaga Marina © L. Rens / FEBELCEM



Beringen B Mine © A. Nullens / FEBELCEM

SAVING COST AND ENERGY FOR ROAD LIGHTING

The superior reflectivity of concrete makes it possible to achieve savings in the costs of lighting streets and motorways. Designers of road lighting make their calculations indeed based on 'luminance', which is the reflected light in the direction of the observer. Savings can be achieved by placing fewer lighting columns or by using lamps of a lower luminance. In both cases costs can be reduced, primarily by being able to cut back on the number of lighting columns required and secondly in annual electricity consumption. Savings around 30 to 35% are being reported, both for lighting equipment and energy.

A Canadian study shows for example that whereas 14 lighting columns are required for a distance of one km of concrete carriageway, an asphalt road requires 20 lighting columns to achieve the same level of lighting.

OFFERING A BETTER VISIBILITY

When road lighting is not available, the light coloured surface of a concrete road still enhances visibility in difficult circumstances: at night and in bad weather conditions such as heavy rain or dense fog. Better visibility contributes to traffic safety.

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More environmental benefits from concrete roads can be found on EUPAVE's infographic "Concrete Pavements Make Roads More Sustainable" (2019), https://www.eupave.eu/resources-files/infographic

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