



Concrete roads show better resilience to climate change and extreme meteorological events



“Concrete pavements are durable and resilient, providing the ideal solution to the effects of a changing climate”

© National Weather Service, U.S.

One of the aspects of climate resilience is the capacity of a system to absorb stresses and maintain function in the face of external stresses imposed upon it by climate change.

For roads and infrastructure, climate resilience efforts aim at addressing the vulnerability with regard to the environmental consequences of climate change.

The two main consequences of climate change that will affect roads are the increase of temperature and precipitation. Europe's road network can be expected to suffer various stresses as a result: flooding, erosion of embankments and foundations, loss of road structure integrity and loss of pavement integrity. Therefore, an appropriate adaptation strategy and a preventive long-term approach are necessary, providing robust, 'future-proof' solutions.

All types of concrete roads are long-lasting and are built to withstand changes in temperature or moisture. Concrete stiffness remains constant in the range of ambient temperatures, not suffering softening or rutting and no hazardous pollutants are emitted at high temperature. Thanks to its fire resistance, concrete stands up to the heat of forest fires. Concrete surfaces keep their properties over time and show no risk of delamination. In addition, cement bound base layers are high quality, erosion- and frost-resistant solutions.

The societal benefits of a robust and resilient road network are numerous. First of all, in case of disruptive events, lives are saved because of the positive impact on road safety and the traffic flow of emergency services (ambulances, firefighters...). Secondly, money is saved due to less cost of repair and to less impact on the functioning of the economy during extreme events.

SOME MORE INFORMATION

WHAT IS RESILIENCE

In IPCC, 2014, resilience is defined as 'the capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation.'

The definition of resilience, given by the World Road Association PIARC, is the following: "The ability to prepare and plan for, absorb, recover from, or more successfully adapt to actual or potential adverse events."

Although any type of adverse event is considered, e.g. terrorist attacks, earthquakes etc., this fact sheet will focus on the negative effects of climate change.

THE EFFECTS OF CLIMATE CHANGE ON ROADS AND PAVEMENTS

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suffer various stresses as a result: flooding, erosion of embankments and foundations, loss of road structure integrity and loss of pavement integrity.

Most models project some increase in average air temperature from now to 2050. An increase in the frequency and duration of extreme temperatures is also projected, mainly in the south of Europe. According to the European Environment Agency, this increase in hot days during the summer will lead to softening and rutting of flexible pavements. Additionally, increased temperatures will intensify freeze-thaw cycles in the north of Europe, which could accelerate the deterioration of pavements and cause soil and slope instability and ground movement. The number of large forest fires has also dramatically increased with serious impacts on environment and local communities but also on the pavements that are needed to give access to fire fighters.

Moreover, the increased frequency of storm surges and flooding will affect granular subbases and subgrades of pavements if drainage systems have not taken this into account, leading to damage to pavements.

Road damaged after flooding, Gironde (France)
© Facebook page of Noaillan



Road damaged after floodwaters, Reading Drive, PA (USA) © Rich Hawk / sauconsource.com

CONCRETE SOLUTIONS

Resilience can be understood as the capacity to anticipate and minimize potential destructive forces through adaptation or resistance. Cement and concrete solutions for roads are therefore resilient solutions. Concrete pavements have proven to be durable and long-lasting in many different climatic conditions all over the world.

- All types of concrete roads (jointed plain – jointed reinforced – continuously reinforced – roller compacted concrete) are long-lasting and are designed and built to withstand changes in temperature or moisture, e.g. through adapted concrete mixes for improved frost resistance.
- In some cases, special construction techniques are being applied to allow working in extreme weather conditions.
- Thanks to a well-thought design of joints and reinforcement, it is possible to cope with large temperature variations.
- Concrete stiffness remains constant in the range of ambient temperatures, not suffering softening or rutting. In fact, the surface of concrete is robust and it keeps its properties over time, independently of climate effects. This is true for most of the surface characteristics such as micro- and macrotexture, skid resistance and rolling noise production.
- Delamination is no issue for concrete roads as they are built as a monolithic slab. This is also the case for two-layer concrete pavements.
- They are less susceptible to the swelling or shrinking of the subgrade compared to flexible pavements. Therefore, concrete roads are the best solution in case of cohesive soils such as clay.

- Concrete is a fire-resistant material. This makes it the ideal material for pavements in areas where wildfires may occur. Due to climate change the number of wildfires has significantly increased over the past years, in all parts of the world.

Among the different types of concrete roads, continuously reinforced concrete pavements (CRCP) can be seen as the most robust, especially in the case of flooding. The continuous reinforcement creates a bridging effect: it distributes the load over saturated bases and enables the pavement to cope with a local subsidence. In Texas, several sections of CRCP have been subjected to complete inundation on average every five years and to traffic loading four to five times expected levels, while incurring minimal annual maintenance costs, proving the robustness and resiliency of this pavement type.

Not only concrete roads but also hydraulically bound base layers are robust solutions, which withstand better the effects of flooding in comparison with unbound granular layers. Indeed, cement bound granular mixtures including lean concrete and roller compacted concrete are known as high quality, erosion- and frost-resistant solutions.

MITIGATION EFFECTS

Concrete roads and their surfaces can have several positive mitigation effects on climate change: slowing down global warming thanks to their high albedo, reduced CO₂- emissions due to lower fuel consumption for heavy trucks, recarbonation of recycled aggregates, reducing the risk for flooding with water pervious concrete pavements... For more information on all of these benefits, we refer to the other available factsheets of EUPAVE.

Parking lot in pervious concrete pavement, Dreux (France) © CIMbéton



WHAT POLICY IS NEEDED?

Taking a long-term approach to procurement of transport infrastructure has multiple advantages: reduced life-cycle costs and reduced environmental impact thanks to durability, reduced maintenance etc. This is also relevant for adaptation to climate change. It is clear that acting to make Europe's road network more resilient should be done sooner rather than later. In continuing to rely on short-term fixes, Europe will

find its road network less resilient in the face of the climate challenges of the future.

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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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