Concrete versus asphalt for Nigeria's roads: which is better?

November 9 2023, by Hussein Mohammed

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Nigeria's new works minister, David Umahi, is pushing for the use of rigid pavement in road construction, as against the flexible pavement predominantly in use. This, as the minister noted, is due to the precarious state of flexible pavements in the country.

A rigid pavement is a road surface overlaid with reinforced concrete, while a flexible or asphalt one has a bituminous (tar) overlay.

Asphalt roads are the most common type of paved roads in Nigeria. Examples include the Lagos-Ibadan, Port Harcourt-Enugu, Lokoja-Abuja and Abuja-Kaduna expressways. Concrete roads include the Kaba-Obajana road in Kogi State and Apapa-Oshodi road in Lagos State.

Road infrastructure is essential in modern economies. Economic growth and development requires mobility and accessibility.

As a professor of engineering who has researched the use of reinforced concrete and asphalt on Nigerian roads, I offer some insights into the issues raised by the minister's decision.

The choice is between additional service and higher cost or reduced service and lower cost. This is a design challenge. The decision is not only technical, but also political.

However, there is no data to speak categorically on whether concrete pavement is better than flexible pavement for Nigeria.

Comparison of flexible and rigid pavements

Rigid pavements are generally more expensive and difficult to install and maintain. They're made out of a cement concrete with a base, sub base and subgrade underlay. Unlike flexible pavement, rigid pavements have a high flexural strength, making every layer virtually immune to bending under pressure. Flexural strength is the material's ability to resist deformation under load.

Flexible pavement is designed to bend and deflect according to external factors like traffic loads. Essentially, it is more adaptable to the elements

to which it's exposed. The initial cost of construction is low and with excellent regular maintenance, it has a lifespan of about 10–15 years. Regular maintenance is required for this type of pavement, and repair work is fairly easy.

Flexible pavements have low initial cost, but higher maintenance cost.

Comparatively, rigid pavements have high initial cost, but low maintenance cost.

Asphalt has a relatively smaller surface area of subgrade compared to a wider surface area for reinforced concrete. Subgrade is the material underneath the pavement structure.

Flexible pavements usually last for 10 to 15 years while rigid pavements last for 25 to 30 years.

There's a higher water penetration rate for flexible pavement but lower rate for rigid pavement. The longer moisture remains in a flexible (asphalt) pavement structure the more likely pavement failure will occur. In particular, the continuous presence of moisture in a pavement subgrade can significantly affect the subgrade's modulus and reduce pavement performance. Subgrade modulus is a conceptual relationship between applied pressure and deflection for a plate resting on an elastic support system.

Night driving is better on rigid pavements due to the light colored surface.

Extreme weather like high temperature affects flexible pavements but not rigid pavements. In flexible pavements, temperature fluctuations have a significant impact on structural performance, including stress and strain.

Noise pollution is also high on flexible pavements but lower on rigid pavements.

The way to go

The choice of any type of pavement depends on the life cycle and costs of materials, which include initial construction cost, maintenance and repair cost, and cost associated with environment factors such as emissions and energy consumption.

Consequently, a life cycle cost analysis should be carried out before choosing a pavement type.

A well-designed road will provide the intended level of service at an acceptable level of safety. It will also reflect local values and policy, which will vary from location to location, and it will place appropriate importance on cost, environmental values and appearance. These should guide the country's decision on the issue.

Asphalt roads (flexible pavement) have less initial cost of construction, lower construction and repair periods, they are quicker to repair, absorb traffic noise and can be recycled, thereby reducing waste. However, asphalt has a short life span, requires frequent maintenance, is less able to carry heavy traffic and so is more suitable for light traffic in residential streets and rural roads. It also has a greater carbon imprint, which is detrimental to the environment, as a result of bitumen production.

Concrete roads have a heavy construction cost, longer construction period due to the time required for curing, and longer repair times. They have a longer life span, low maintenance cost, high durability, and high load bearing capability, ideal for heavy traffic areas such as highways, ports and airports. Concrete roads have a lower carbon imprint from the

production of cement, and are less prone to developing pot holes, reducing fuel consumption and carbon emissions.