



Going the extra mile: Building resilient roads with artificial intelligence

Building resilient roads is highly dependent on its initial design. ORIS, the first digital materials platform for sustainable roads supported by artificial intelligence, participates in the InfraChallenge 2021 to develop a new module of its platform to integrate climate resilience in the decision-making during the early stages of road projects.

Road infrastructures are one of the most valuable assets for our communities. A road offers access to marketplaces, to education and to healthcare facilities. Over the last few years, the effects of climate change have created vulnerability for our road networks with roads being washed by floods and joints pavement cracking due to extreme temperatures. Climate change is putting an unprecedented stress on our communities which mandates us to be resilient in what we build.

Ensuring resilient, sustainable and cost-efficient roads is a priority for ORIS. Developed by LafargeHolcim in partnership with IBM, ORIS is the first digital materials platform for sustainable roads. Supported by the latest artificial intelligence, ORIS analyses road designs, at the early stage of a project, in a holistic view to improve sustainability in road construction.

Enhanced sustainability with the right road design... which is unique to each road

We are convinced that improving resiliency and sustainability of road infrastructure starts at the design stage. Today, most roads are designed according to standardized and historical road design methods, where materials availability and adequacy are considered only later at the construction phase. Such approach from the road ecosystem (owners, investors, designers, contractors) lacks to integrate sustainability requirements such as resilience to climate change (both mitigation and adaptation), to natural resources scarcity and to social disparities.

Considering materials from the early stage of road designs - both for new-builds or refurbished infrastructure - will make the difference in terms of road sustainability and resiliency. According to our internal research, the choice of designs in road construction is a major factor on costs (60% of the total construction costs) and carbon footprint (85% of carbon emissions). Each road is unique and is dependent on its location. For increased sustainability, each road should be designed taking into account:

- Local sourcing: the best material is local and sometimes right under our feet;
- Circular economy: the preservation of natural resources must be part of this local equation from early stages of design;

- Carbon footprint: the majority of carbon emissions occur during the usage phase of a road and its design can mitigate its carbon footprint;
- Durability: the longevity of a road, including its resistance to extreme weather events, is essential to avoid multiple maintenance work and ensure a long service to communities.

ORIS is a digital materials platform that enables road professionals and decision makers - in particular governmental authorities - to make data-driven decisions for sustainable roads. As each road is unique, the platform takes into account the various parameters linked to the project (usage, local material availability, weather conditions) and offers to visualize multiple pavement designs and sourcing options. Once the parameters have been input, road decision-makers are able to list all possible design and material options for a given-project, and to choose their preferred design according to their priorities: carbon footprint mitigation, increased durability, use of local materials, cost reduction, increased job creation, etc.

With the use of ORIS, we see road projects costs reduced by -15 to -30%, carbon footprint mitigated by up to -50% and durability multiplied by x3.

Ensuring climate resiliency of road networks

We are convinced that resiliency in road infrastructure is a common shared interest for all and a priority for all communities. Roads are an essential need for development and are even more vital in case of extreme weather event impacts to ensure access for emergency services, healthcare, and reconstruction.

The resistance of road construction to extreme weather events is linked to its structural design, hence the materials used. Every layer will have different behaviour in case of extreme weather events and perform differently. We need to escape from old habits and design new roads or refurbish existing pavements taking into consideration the probability of such events. For example:

- Considering risks of flash flood leads to specific technical solutions using drainable surface, with pervious asphalt or concrete when available;
- Against raising water tables, we need water resistant foundations over the long term, as some open graded base layers, or waterproof systems as treated materials;
- Extreme heat will require specific surface material to limit rutting and keep the road surface safe.

Designing a road pavement is not a simple theoretical exercise. Anticipating extreme events, local conditions, and selecting the adequate material to build it is fundamental to the right balance between costs and performance. Resilience prediction goes the same way for maintaining existing infrastructures and roads. Engineers are still lacking the tools to pre-assess road durability in case of extreme events.

Based on ORIS's existing model for durability, we plan to add a module in our platform that would consider extreme impacts linked to climate change. Funding from the GI Hub Challenge would be used to develop this particular module. We will connect the current ORIS durability model with weather forecasts and the climate risk models where they exist. Classifying regions and roads according to different risk categories (water, storms, summer heats, winter frost or dry periods), ORIS will enable to have specific view on a series of KPIs :

- Albedo effect on roads;
- Risk mitigation to extreme climate event;
- Water drainage or absorption index.

Using this new functionality, road pavement solutions will be assessed comprehensively for cost, environmental impact, durability, natural resources consumption and resilience to climate change.

Market potential and scalability

ORIS targets the entire road investment ecosystem from developed countries to developing economies, for new-build and maintenance. Thanks to its digital outreach, ORIS targets improvement of all road investment portfolios, equivalent to \$500 bn per year (or 1% of the world GDP). We estimate that a generalized use of best practices in that field can reduce public spendings by \$40 bn to \$60 bn overall, relying simply on clear guidance and smart indicators on resilience and durability. ORIS is in development in 10 countries, as various as Azerbaijan, Germany, UK, US, Uganda, Algeria, Canada or Mexico.

In terms of technology readiness, ORIS is at 6-7 levels on the basic modules, with a ready-to-use Minimum Viable Product (MVP), while the resiliency module is at 4-5 levels. The development of a new resiliency module will be integrated in the existing platform. Modules are based on connecting available data with algorithms. The platform approach makes it highly replicable. Once built and customized for a region or a specific country, it will self learn and provide good resilience prediction indicators to orientate the investment towards the right road technology.

Construction efficiency and digitization are key levers for greener and more sustainable infrastructures. New digital technologies improving empirical approaches are raising money fast, as far as they are visible. Some development banks may also want to have a greater impact on their portfolio, having multi billions market footprint.

Sustainable road networks to benefit all

Although our approach is addressing a massive market with huge effect on population and public finances, the crosspoint between road investments and materials engineering has so far been left to very fragmented considerations, almost ignored at the pre-tender stage. Bringing materials engineering upfront in road construction and maintenance is a unique capability for the market and will become a necessary behaviour in the future.

ORIS offers the tool to assess, monitor and measure the performance and the impact of road investments, to the benefits of all actors, including end-users. It meets all the aspects of sustainability in its globality:

- Financial and economic growth: Value for money on 1% of public spending, with controlled public debts via less maintenance and repairs;
- Environmental performance: Long lasting infrastructures, particularly in rural areas and developing countries where climate events are even more dramatic;
- Social inclusion: Better network availability and improvement of rural roads in remote areas, leading to easier access to health, food, education etc.

ORIS brings together all actors of the ecosystem to participate around a common shared goal of sustainable and resilient road networks, from the early stage of a publicly financed road program. Working hand-in-hand with governmental authorities and the road ecosystem, we are convinced we can build the best, most sustainable and resilient road infrastructures for our communities.