New materials, circular materials and models to monitor service life

Rationale/Challenge:

Decarbonisation has been correctly identified as one of the most pressing topics for transport infrastructure and use. Still, activities to reduce fuel use, or electrify production and use of infrastructure only go halfway, as the carbon content of the materials is significant, whilst recycling can also require significant energy use for processing. Activities are required that will enable the reuse of materials or recycling across multiple life cycles at the same level of utility.

With Europe's transport infrastructure largely completed, new materials are required to strengthen and renew existing transport infrastructure, or for low / zero / negative carbon where infrastructure needs to be replaced or new infrastructure is required.

The most sustainable infrastructure from an embodied carbon angle is one that already exists. Given the potential economic and environmental costs of significant reconstruction, models are required to give confidence for the continued use and prioritisation of replacement.

Scope Proposals should address one or more of the following:

The scope will cover the scarcity of natural resources and alternatives to extend the life of existing assets, place reuse and repair ahead of recycling and have multiple lifecycles of existing materials. New and innovative business models, such as infrastructure as a service or infrastructure hire will need to be considered as well as assessing the optimum cost and carbon benefit over the whole life of the scheme, not just the initial capital / carbon cost.

Research projects will need representatives of materials manufacturers, designers, consultants and contractors with strong input from infrastructure owners and operators.

The following R&I activities are proposed:

<u>CSA</u>

1. Assess the existing risk-based models for multiple material lifecycle use.
2. Develop a handbook for circular material use, including case studies of both materials, procurement models and facilities such as resource exchange centres to sort, process and store materials.
3. Report on the existing use of sensors, skins, and novel inspection methods to monitor transport infrastructure for life extension.
4. Develop guidance on the optimum locations for resource exchange mechanisms to be large enough to have sufficient material resources, yet local enough to not require excessive transport to the facility.

<u>RIA</u>

1. Investigate and develop novel eco-friendly materials for road construction that offer enhanced durability, reduced maintenance needs, and minimised environmental impact. Explore the use of recycled materials, innovative binders, or additives that improve pavement resilience against factors like heavy traffic, weathering, and degradation. Develop models to evaluate their performance over time, considering factors such as traffic load, weather variations, and ageing processes. Build models using big data to better understand the pavement degradation curve to predict pavement life more accurately and to optimise

maintenance interventions.

2. Research and analyse advanced composite materials suitable for lightweight and durable applications in transportation infrastructure, such as bridges and tunnels. Investigate the mechanical properties, fatigue resistance, and long-term durability of these materials under various stressors and environmental conditions. Develop predictive models or simulation tools to assess their service life and structural integrity, considering factors like vibrations, traffic loads, and environmental exposure.
3. Develop smart sensor-based materials or technologies embedded in transport infrastructure components (such as bridge decks, rail tracks, or airport runways) to continuously monitor structural health. Research the integration of these sensors into materials to detect stress, strain, and degradation in real time. Create models and algorithms to process sensor data, predict potential failure points, and assess the remaining service life of these critical infrastructure elements, aiding in proactive maintenance and ensuring safety and efficiency in transportation networks.

IA

1. Undertake live trials of the use of composite materials for bridges and structures in a range of transport scenarios.

Expected Impact

- Offer practical solutions to develop circularity within the transport infrastructure sector.
- Develop risk-based models for multiple lifecycle materials.
- Extend the service life of existing assets using models and new materials.
- Develop and test new low / zero / negative carbon materials.
- Support for procurement staff to purchase circular materials including new business models.

Relevant Clusters: Cluster 5

Project Type:	**Budget:** €32 million
CSA (€2 million) + RIA (€10 million) + IA (€20 million)	