

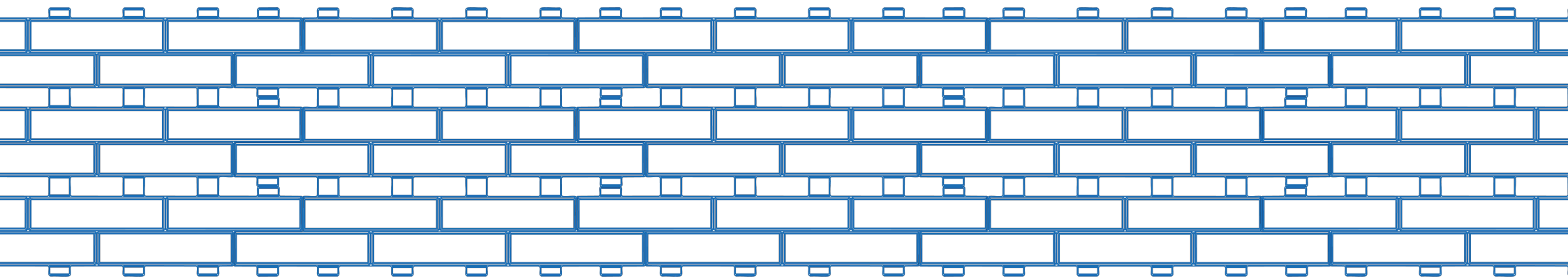
# Designing Permeable Grid Pavement: Integrating Stakeholder Needs and Sustainable Materials

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## Abstract

Urbanisation in combination with climate change threatens human life through the Urban Heat Island effect and Urban Flooding. Grid Pavement replaces impervious pavement by a combination of vegetation and infrastructure, creating climate adaptive urban areas with crucial infrastructure. However, current Grid Pavement materials have a detrimental effect on the environment. This study investigates sustainable materialisation of Grid Pavement, and demands of stakeholders, combining technical with human-centered material development.

This research consists of five analyses, contributing to a holistically improved Grid Pavement design. Stakeholders were interviewed to reveal key stakeholder and design requirements and wishes. The Grid Pavement market was analysed for design requirements and wishes. From current Grid Pavement materialisation and sustainable strategies an alternative material is identified. Tinkering was done to get a complete understanding of the material under varying conditions. To understand the user experience of the material, experiential characteristics were identified through stakeholder interviews. An understanding of the material mechanical properties was gained through material testing. The final concept was designed to enhance the material's experiential characteristics, while a Finite Element Analysis ensured structural integrity.

Stakeholder interviews identified Municipalities and (Landscape) Architects as key stakeholders. CoRncrete poses a potential sustainable material alternative for Grid Pavement. Forming CoRncrete in the hydraulic press using 0.250 to 0.500 mm sand grains produces the highest quality, while ensuring scalability and sustainability of the material. The user experience of CoRncrete is heavily dependent on the visibility of the sand grains. CoRncrete containing 0.250 to 0.500 mm sand grains is an ordinary, recognisable material, while its natural appearance can improve the sustainable perception of Grid Pavement, posing a competitive advantage compared to concrete and plastic. Additionally, visible sand grains provided a fascinating tactile experience, inviting curiosity and attraction. CoRncrete formed in the hydraulic press, containing 0.250 to 0.500 mm sand grains and potato starch, called PMP-CoRncrete, poses the optimal material composition for Grid Pavement. PMP-CoRncrete exhibits a Young's modulus of 660.40 MPa, a Yield Strength of 25.97 MPa and an Ultimate Compressive Strength of 27.05 MPa and a density of 1823 kg/m<sup>3</sup>. Combining the Young's Modulus and density shows PMP-CoRncrete is comparable to polymers, while being heavier than natural materials and having a lower Young's Modulus compared to composites. Curing time is found to significantly affect CoRncrete strength, where increasing the curing time from 2 to 9 days increases the UCS of potato starch-containing samples by 52.02%.

CoRnGrid is a CoRncrete Grid Pavement module that harmoniously integrates vegetation into infrastructure due to its design features and materialisation. One module measures 600 by 390 by 80 mm (L by W by H), weighs 23.26 kilograms and costs €10.68 per module.

This research pushes the boundaries of infrastructure materialisation while holistically advancing the development of CoRncrete, moving away from toxic material development, towards a sustainable future.

