
Sustainable stormwater management through an innovative ceramic permeable pavement solution: Urban retrofitting demonstrator in Benicàssim (Spain)

La gestion durable des eaux pluviales avec une solution innovante de chaussée perméable céramique: un cas d'étude pour le renouvellement urbain à Benicàssim (Espagne)

Castillo-Rodríguez, J.T.* , Andrés-Doménech, I.* , Perales-Momparler, S.** , Mira-Peidro, J.*** , and Corrales-García, J.***

*Research Institute of Water and Environmental Engineering, Universitat Politècnica de València, Valencia, Spain (jecasrod@upv.es); **Green Blue Management, Valencia, Spain; *** Institute for Ceramic Technology (ITC), Castellón, Spain.

RÉSUMÉ

Cette contribution présente un revêtement urbain innovant en céramique perméable développé dans le cadre du projet LIFE CERSUDS dans la ville de Benicàssim (Espagne). Le revêtement, composé de modules construits à partir de carreaux céramiques en stock, permet d'infiltrer les eaux de ruissellement, les traiter et les réutiliser dans le cadre d'un système de drainage urbain durable (SUDS). La solution proposée représente une opportunité d'intégrer un système perméable dans une opération de renouvellement urbain, tout en utilisant un matériau céramique sans a peine valeur commerciale. Cette solution offre une utilisation alternative pour ce matériau, tout en favorisant une gestion durable des eaux pluviales grâce à la mise en œuvre de ce système de drainage. Ce nouveau système de chaussée perméable contribuera à stimuler un développement urbain durable, en combinant une gestion durable des eaux pluviales et la réutilisation tant des matériaux comme des eaux de ruissellement pour l'irrigation des jardins proches. L'étude de cas développé dans le projet représente un exemple de référence des actions de renouvellement urbain qui intègre les aspects sociaux, économiques et environnementaux.

ABSTRACT

This contribution briefly describes the innovative ceramic permeable pavement developed as part of the LIFE CERSUDS project in the city of Benicàssim (Spain). This pavement, composed by modules built from ceramic tiles in stock, allows water infiltration, runoff treatment and water reuse as part of a sustainable urban drainage system (SUDS). The proposed solution represents an opportunity for providing a permeable system for urban retrofitting actions, using low market value ceramic material. This solution offers an alternative use for this material, while promoting a sustainable stormwater management through the implementation of SUDS. This new permeable pavement system will help to boost a sustainable urban development, combining sustainable stormwater management, and reuse of materials and runoff water for irrigation. The demonstration case study represents a reference example of urban retrofitting actions which integrate social, economic and environmental aspects.

KEYWORDS

Ceramic permeable pavement, Climate change adaptation, Stormwater management, Sustainable drainage systems, Urban retrofitting

1 INTRODUCTION

1.1 An increasing demand for creating sustainable urban landscapes

Cities and towns have become the primary human living space. Since 2007, more than half of the world's population has been living in urban areas and the figure is estimated to exceed 70 per cent by 2050 (UN, 2013). This represents a hallmark of the transformation of humans' economic base and social structure. Cities can provide many socioeconomic benefits. By concentrating people, investment and resources, urban areas heighten the possibilities for economic development, innovation and social interaction. However, this requires adopting a sustainable framework to achieve the appropriate balance between urban growth and protection of the environment.

Therefore, although different strategies can be considered with regard to new urban development investments and retrofitting actions, stormwater management should become a core strategy when developing urban environments and for the design, implementation and management of actions for urban regeneration.

An integrated approach for urban planning and development is required, considering a multifunctional perspective, including social, economic, environmental development and urban governance, in which stormwater management represents a crosscutting issue.

1.2 Sustainable drainage systems and their role on urban retrofitting actions

Both new demanding regulations and the growing social demand for a sustainable urban development make necessary to accomplish enhanced approaches for stormwater management. This has led to an increased interest on the implementation of Sustainable Urban Drainage Systems (SUDS) to solve both current and future urban drainage problems. SUDS may be used either as an alternative to conventional drainage systems or in combination with them.

The philosophy of SUDS is to reproduce, as closely as possible, the natural hydrological cycle prior to land development in the area, thus minimizing the impacts of urban development as far as quantity and quality of runoffs are concerned, while maximizing landscape integration and social and environmental value of actions carried out for citizens and urban ecosystems (Woods-Ballard et al. 2015).

SUDS comprise a wide range of solutions for rainwater management from an environmental, social, hydrological and hydraulic perspective. These systems also allow water reuse of runoff waters suitable for other uses not requiring the quality standards required for drinking water, such as water tanks or garden irrigation. Among them, permeable pavements arise as a solution for urban retrofitting actions aiming at enhancing stormwater management, reducing runoff, and increasing infiltration. Permeable pavements provide a surface which, while being trafficable for both pedestrians and vehicles, allows for stormwater treatment (Andrés-Doménech et al. 2018), water infiltration and groundwater recharge, or water management for later reuse.

2 AN INNOVATIVE CERAMIC PERMEABLE PAVEMENT SOLUTION

Based on a studio, performed by KPMG Spain, analyzing balance sheets and income statements of 21 companies in the Spanish ceramic sector, the stock level of ceramic material in Spain in 2014 (base year of the study) was set at 30.44%. Therefore, considering a sales volume of €2.902 million in 2014, 30.44% of stock accounts for €883 million, where 5.44% of that amount (€48 million) would be overstock. This overstock might be considered as material for developing actions for urban regeneration.

The LIFE CERSUDS (Ceramic Sustainable Urban Drainage System) project is a European project executed in the 2016-2019 period and co-funded by the European Commission, which proposes an innovative permeable ceramic pavement, based on findings of a previous R&D project (IMIDIC, 2010). One of the results from this previous project (Mira et al. 2012), was a permeable urban pavement based on the use of low commercial value ceramic pieces in stock. These pieces are cut in strips as shown in Figure 1, thus turning ceramic material into an opportunity for providing a permeable material for paving actions.

The ceramic permeable modules have been tested and manufactured within the LIFE CERSUDS project to provide an innovative solution for permeable pavements (Figure 2).

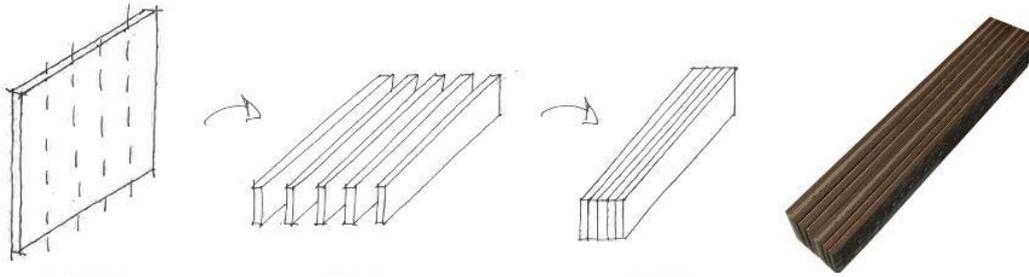


Figure 1. Cutting and assembling scheme for developing the ceramic permeable module.

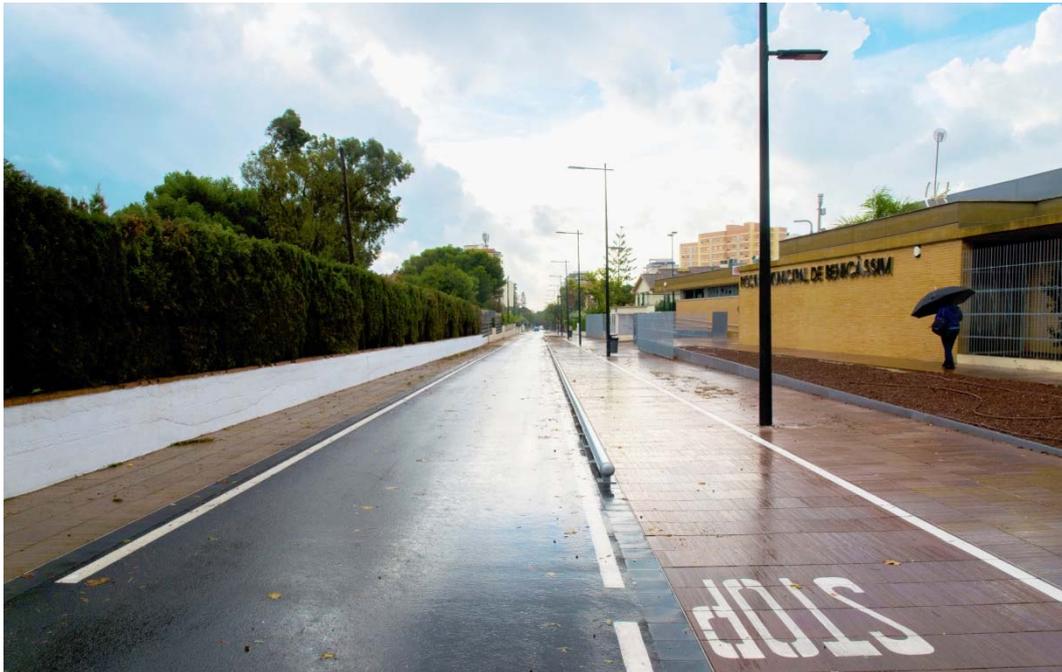


Figure 2. Ceramic tiles located at the demonstration site.

3 THE DEMONSTRATOR CASE STUDY IN BENICÀSSIM (SPAIN)

The LIFE CERSUDS project has developed a demonstrator case consisting of an urban retrofitting action using low commercial value ceramic material as a permeable pavement. The demonstrator site is located in the municipality of Benicàssim (Castellón, Spain), and consists of the reurbanization of a stretch of Torre de Sant Vicent Street. This street connects the city center with the coastline and represents one of the main axes on which the future Urban Green Infrastructure will be articulated, connecting environmental, landscape, social and cultural spaces.

The demonstrator, executed between February and June 2018, is 200 m long and has a variable width ranging from 10 to 27 m and a 1.5% descending longitudinal slope. The complete intervention area is 3000 m². The demonstration site is located in a low-density residential area, characterized by several municipal sport facilities which make the street not only a frequent connection point between the beach and the city center, but also an area linked to strategic public facilities.

The case study includes implementing a sustainable drainage system along the street which allows water infiltration and collection. The ceramic permeable pavement, in combination with drainage cells and geotextiles, provides runoff treatment and reduction of water flows to the existing drainage network (Figure 3). In addition, the system includes a rainwater harvesting tank, with a volume of approximately 10 m³, aiming at reusing water for irrigation at the demonstration site.

The demonstrator monitoring will be carried out from September 2018 to July 2019, for analysing its performance in terms of runoff quantity and quality. Results from monitoring will help to boost replicability at regional, national and European scales.

In addition to the demonstrator carried out in Spain, partners of the LIFE CERSUDS project work in two projects for replicating the system in the cities of Aveiro (Portugal) and Fiorano (Italy).

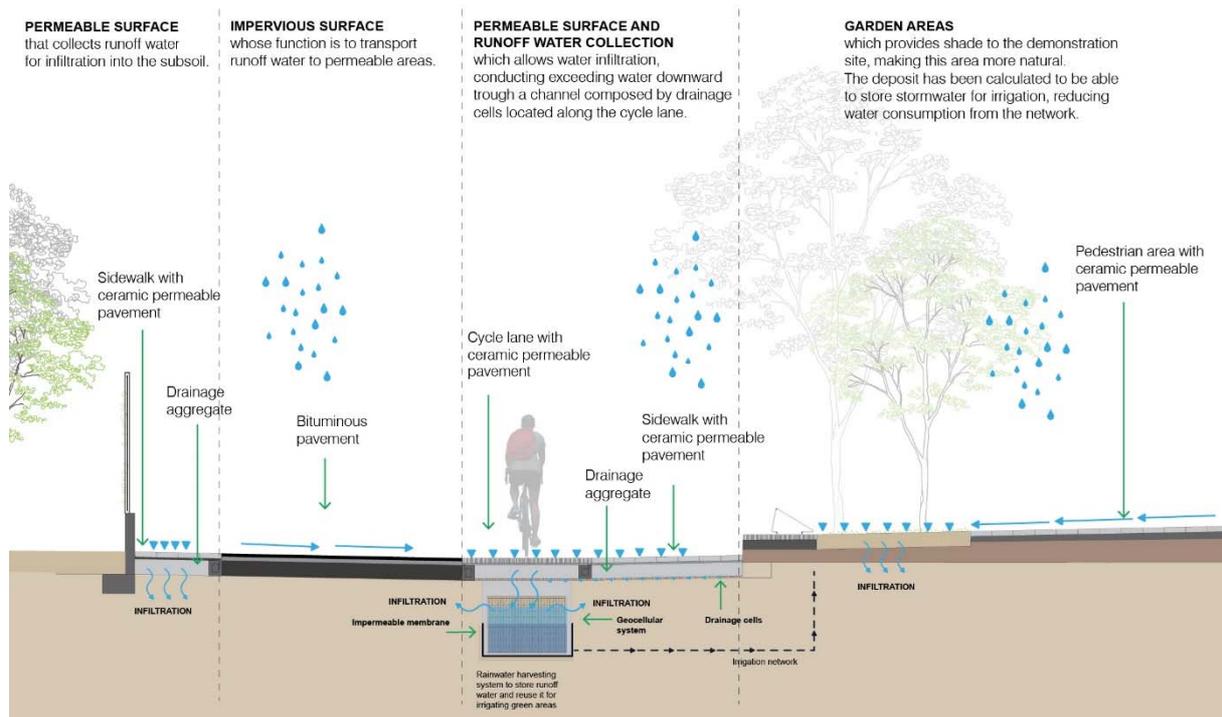


Figure 3. Cross section of the sustainable drainage system performed in Benicàssim (Spain).

4 CONCLUSIONS

The proposed solution represents an opportunity for providing a permeable system for urban retrofitting actions, using low market value ceramic material. This solution offers an alternative use for this material, while promoting a sustainable stormwater management through the implementation of SUDS.

This new permeable pavement system will help to boost a sustainable urban development, combining sustainable stormwater management, and reuse of materials and runoff water for irrigation. The demonstration case study represents a reference example of urban retrofitting actions which integrate social, economic and environmental aspects.

ACKNOWLEDGEMENTS

The LIFE CERSUDS project is financed by the LIFE Programme 2014-2020 of the European Union for the Environment and Climate Action under the project number LIFE15 CCA/ES/000091.

LIST OF REFERENCES

- Andrés Doménech, I.; Hernández Crespo, C.; Martín Moneris, M.; Andrés-Valeri, VC. (2018). Characterization of wash-off from urban impervious surfaces and SuDS design criteria for source control under semi-arid conditions. *The Science of The Total Environment*. 612:1320-1328. doi: 10.1016/j.scitotenv.2017.09.011
- IMIDIC (2010): "Reutilización y reciclado de productos obsoletos o desechos de fabricación para la generación de nuevos productos" Project financed by the Valencian government in 2010. Ref. IMIDIC/2010/73.
- MIRA, J., BARTOLOMÉ, M., CORRALES, J., LLORENS, M., RAMÓN, J. (2012). Prospectiva y diseño de nuevos productos basados en la reutilización y reciclaje de subproductos cerámicos. *Qualicer 12: XII World Congress on Tile and Ceramic Pavement*. Castellón: Cámara Oficial de Comercio, Industria y Navegación.
- UN (2013): *World Economic and Social Survey 2013, Chapter III: Towards sustainable cities*, United Nations.
- Woods-Ballard B.; Wilson, S., Udale-Clarke, H., Illman, S., Scott, T., Ashley, R., Kellagher, R. (2015): *The SUDS Manual (C753)*. London, UK.