

## From Modelled Design to Reality through Material and Machinery Lab and Field Tests: Porous Concrete Carpark at the Wanda Metropolitano Stadium in Madrid

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**Abstract :** The first-ever game in the Wanda Metropolitano Stadium, the new home of the Club Atletico de Madrid, was played on September 16, 2017, thanks to the work of a multidisciplinary team that made it possible to combine urban development with sustainability goals. The new football ground sits on a 1.2 km<sup>2</sup> land owned by the city of Madrid. Its construction has dramatically increased the sealed area of the site (transforming the runoff coefficient from 0.35 to 0.9), and the surrounding sewer network has no capacity for that extra flow. As an alternative to enlarge the existing 2.5 m diameter pipes, it was decided to detain runoff on site by means of an integrated and durable infrastructure that would not blow up the construction cost nor represent a burden on the municipality's maintenance tasks. Instead of the more conventional option of building a large concrete detention tank, the decision was taken on the use of pervious pavement on the 3013 car parking spaces for sub-surface water storage, a solution aligned with the city water ordinance and the Madrid + Natural project. Making the idea a reality, in only five months and during the summer season (which forced to pour the porous concrete only overnight), was a challenge never faced before in Spain, that required of innovation both at the material as well as the machinery side. The process consisted on: a) defining the characteristics required for the porous concrete (compressive strength of 15 N/mm<sup>2</sup> and 20% voids); b) testing of different porous concrete dosages at the construction company laboratory; c) establishing the cross section in order to provide structural strength and sufficient water detention capacity (20 cm porous concrete over a 5 cm 5/10 gravel, that sits on a 50 cm coarse 40/50 aggregate sub-base separated by a virgin fiber polypropylene geotextile fabric); d) hydraulic computer modelling (using the Full Hydrograph Method based on the Wallingford Procedure) to estimate design peak flows decrease (an average of 69% at the three car parking lots); e) use of a variety of machinery for the application of the porous concrete to achieve both structural strength and permeable surface (including an inverse rotating rolling imported from USA, and the so-called CMI, a sliding concrete paver used in the construction of motorways with rigid pavements); f) full-scale pilots and final construction testing by an accredited laboratory (pavement compressive strength average value of 15 N/mm<sup>2</sup> and 0.0032 m/s permeability). The continuous testing and innovating construction process explained in detail within this article, allowed for a growing performance with time, finally proving the use of the CMI valid also for large porous car park applications. All this process resulted in a successful story that converts the Wanda Metropolitano Stadium into a great demonstration site that will help the application of the Spanish Royal Decree 638/2016 (it also counts with rainwater harvesting for grass irrigation).

**Keywords :** construction machinery, permeable carpark, porous concrete, SUDS, sustainable development

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