10th International Conference on Concrete Block Paving
Shanghai, Peoples Republic of China, November 24-26, 2012

HUELLA (footprint)
An Innovative Paving System:
Design, Combination Options and Commercial Activities

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Summary

This paper describes a new interlocking concrete paving system developed according to a universal geometric form: the human footprint. The HUELLA (footprint) design combines an excellent mechanical behaviour with several pattern combination options. The result is an innovative interlocking concrete pavement that can be used in private and public spaces, or in combination with any other small-stone paving system. This innovative paving system offers new design possibilities, and helps to expand the use of this paving technology thanks to one of its best features: shaping options. At the same time, HUELLA will be an answer to the increasing need of cities/landscapes for better design quality standards and better environmental behaviour.

Keywords: interlocking concrete paving patterns, Huella-Footprint, pattern combinations

1. State of the art

Currently there are several kinds of small pavement elements commercialized on the global market. All of them were obviously designed to achieve the most basic paving requirements, and - as described in most scientific papers - this paving system has an excellent environmental and mechanical behaviour. Moreover, production and construction technologies have rapidly improved over the last few years.

However, more focus on aesthetical considerations is necessary for these pavement systems to be increasingly used instead of continuous pavement technologies. As it is well known, aesthetical advantages are the most valued features of small pavement technologies. These provide architects, landscape architects and civil engineers with more options for their projects, and allow them to give cities and landscapes more character and high quality standards.

If we analyse the market, we can identify two major families of small-stone paving systems according to their shape. On the one hand we find rectangular shapes. These can be widely used, without a particular purpose, and do not offer any other aesthetical opportunities than to work with a few patterns and surfaces. Moreover, these pieces do not show any ‘visible geometry’ locking one piece with the others. On the other hand, we find the most complex-

shaped pieces. The design of these pieces is mainly based on research regarding best interlocking behaviour, and is used to produce non-rectangular shapes.

It is important to note that almost all the small paving systems analysed offer different possibilities in terms of orientation and how they can be landed over surfaces. These possibilities offer more visual effects and patterns, and have different mechanical behaviours according to the orientation of the pieces.

However, before HUELLA there were no paving systems that could be landed leaving different hole sizes between the pieces. This permeable interlocking concrete pavement allows to adapt the pattern according to rain water absorption needs, and can be combined with other materials (sand, grass, etc.) in order to obtain new visual effects and patterns by combining natural surfaces with pavement surfaces.

2. HUELLA (footprint) – Design development

The geometry of this piece is inspired on the parameterization of a well-known shape: the human footprint. The mark created by a foot when it steps on the sand. This geometry has been processed following lineal and polyhedral parameters to obtain an abstraction of this shape. *(Figure 1,2,3,4)*

The creator based this design on research about universal geometry. Over history, many civilizations used pavements as a symbol of their culture. In ancient Rome, the main *vias* were built using stone pieces as symbols of the lands conquered by the Empire. Moreover, Arabic civilisations worked with geometry by deriving inspiration from mathematical rules. The HUELLA paving system takes into consideration all this ancient pavement heritage.

Furthermore, a comprehensive study of Escher's geometries was also a source of inspiration in the development of this shape. Based on the rules of symmetry, rotation and parallelism, and using handmade drawings and CAD technologies, the design is a simple shape with multiple combination options.

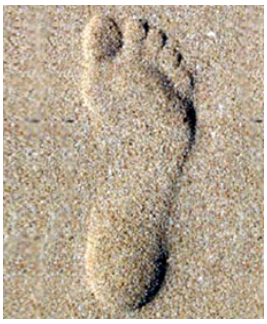

Figure 1

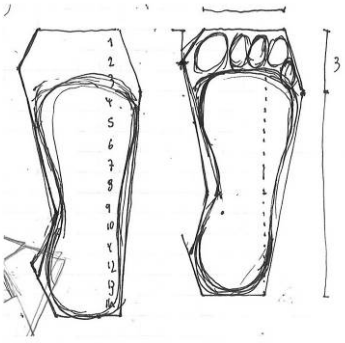

Figure 2

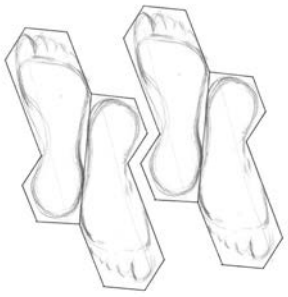

Figure 3

The result is a dry-cast bi-layer concrete paver - 10 cm thick, 38 cm long and 10 cm wide - which has an irregular shape made up of four equally-angled sides and two equal-length sides, enabling the interlocking effect and the different combination options. The different angles and a convex separating joint mean that the design has an excellent mechanical behaviour, able to endure vehicle traffic and preventing the lock from creeping horizontally under the pressure of accelerating and braking vehicles.

The research process started in 2004, after a design competition in which HUELLA was one of the winning proposals. Over the last few years, the designer has focused on improving the original idea and advancing the technology in order to introduce the design into the market. In 2010, after the research and design processes were completed, the paver's geometry was submitted and registered at the European Patent Office.

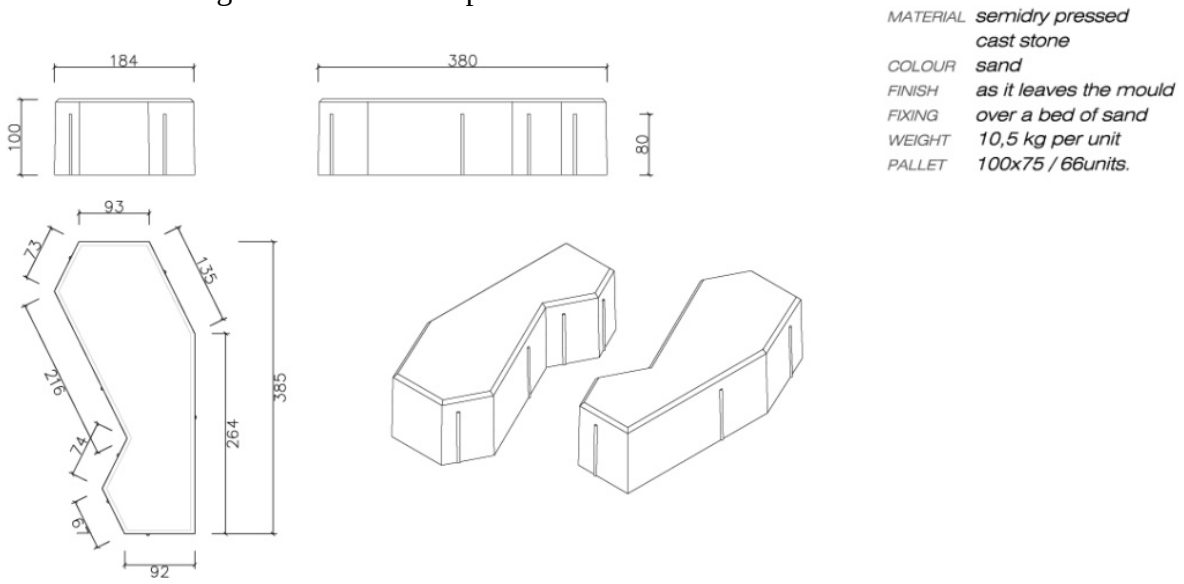

Figure 4

3. Combinations and patterns

The importance of a small-piece paving system is not just about the individual shapes or about its aesthetical appearance. The way the pavers are combined with each other or with other construction materials makes a simple design become a complex and well-performing pavement system.

The HUELLA pavers have multiple combination and interlocking options. An important feature of the design is the possibility to use compacted soil between the pavers, allowing different patterns to be created according to two considerations: aesthetical focus (growing grass between the pavers) or rain water absorption needs.

The 100% option *(Figure 5)* shows a surface completely covered by the HUELLA interlocking pavers. The 70% option *(Figure 6)* offers different combination possibilities, mixing soil, grass and pavers in different percentages. The HUELLA design allows to create a graduated pattern, going from a 100% to a 60% pavement grid *(Figure 7).* This offers an excellent solution when creating 'soft' boundaries between urban and natural surfaces.

Another combination option is one allowing to create rectangular areas *(Figure 8).*

Many more combinations than the ones explored until now are of course possible. HUELLA is an open paving system that will surely be used by landscape architects and civil engineers as a tool for their projects and as an excellent aesthetical and mechanical resource. Over the next few years, these professionals will undoubtedly explore new combinations as well.

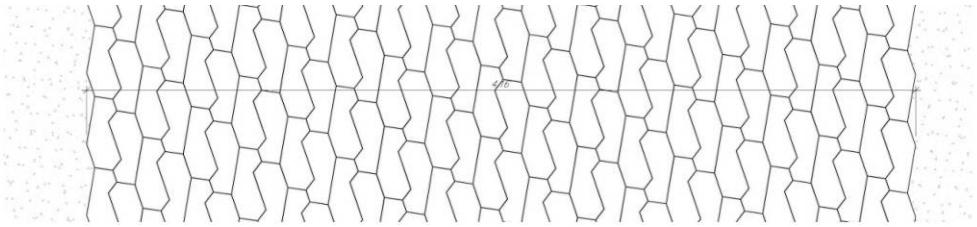

Figure 5

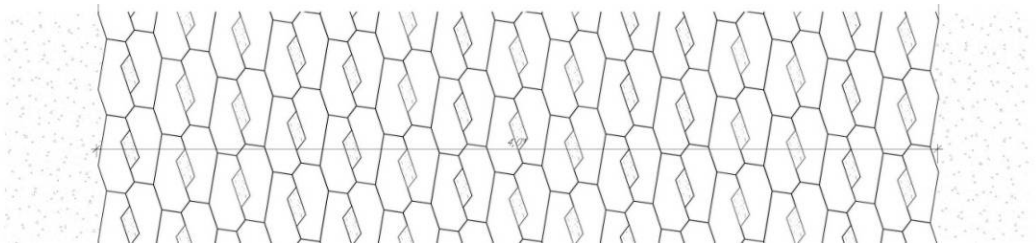

Figure 6

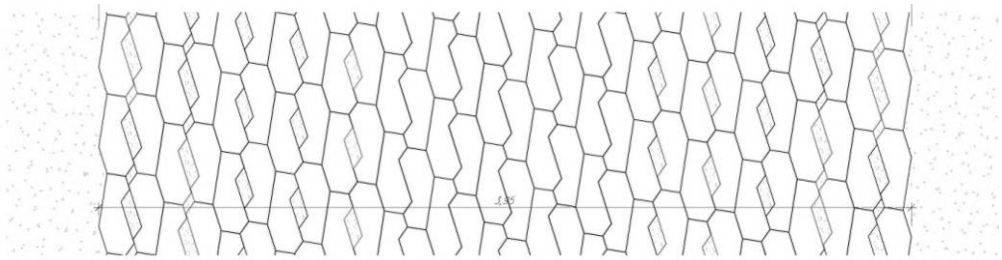

Figure 7

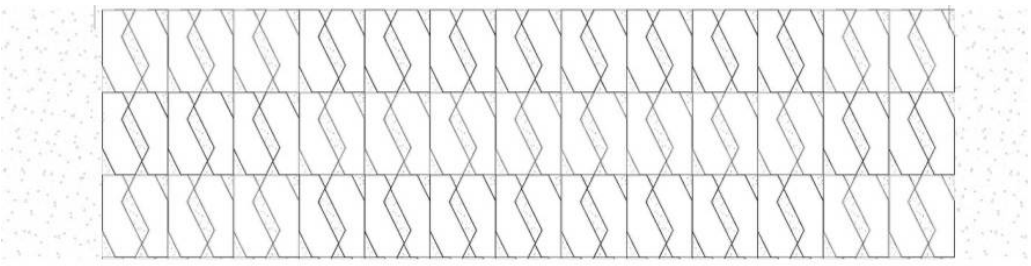

Figure 8

4. Mechanical behaviour

Aside from aesthetical considerations, the HUELLA segmental pavement performs very well under traffic and pedestrian transit. The multiple inclination angles, its geometry and the full-lock capacity between pieces means that the individual elements work as a net with a uniform mechanical capacity and excellent stress transmission.

When the pavers are submitted to a vertical weight, their own section (10 cm wide) *(Figure*

10), as well as the corrected land over a sand surface, guarantee an excellent performance under flexion stress. At the same time, when one or more pavers are submitted from all directions to horizontal weight, the contact between all the pavers transmits the load and all pavers create a 'working area' with high mechanical capacity. The design has chamfered block edges and uses sand in the joints in order to improve the influence on the structural performance of the space between adjoining blocks. When there is weight on the surface block, there is a degree of vertical deformation, which in turn generates horizontal forces. *(Figure 9*).

When the pavers do not cover the surface completely, the material placed between the pavers plays a role in the mechanical behaviour of the pavement. In this case, the sand needs to be well compacted, using water during the landing process, which should be done by specialized workers.

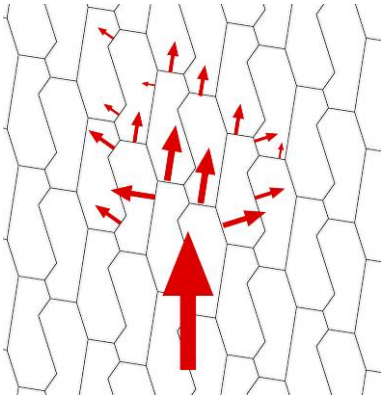

Figure 9

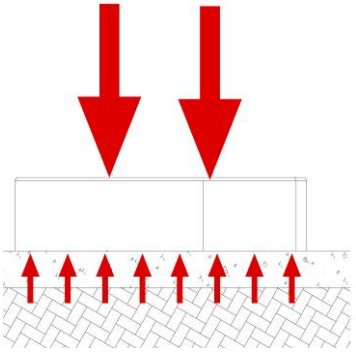

Figure 10

5. Paver surface type

Several types of paver surfaces have been tested during the design development process *(Figure 11A, 11B).* As a result of this research, the flat surface has been selected as the better one. Focusing on this option, it is important to note that the joints between the pavers are clearly defined, and their simplicity implies an excellent adaptation to any location. *(Figure 12)* Moreover, a flat surface is easier to maintain in comparison with other more irregular surfaces (on which pollution, sand and oil tend to deposit more easily).

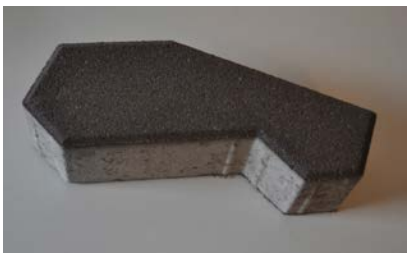

Figure 11A



Figure 11B

Colour has also been taken into consideration, trying to find the best adaptation of these pavers to natural and urban spaces. Five colours are available on the market (grey, off-white, black, brown and sienna), covering almost all possible applications. *(Figure 13)*

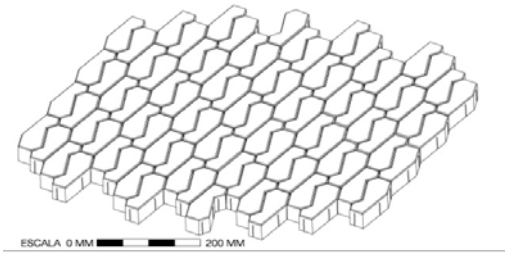

Figure 12



Figure 13

6. Applications and commercial activities

The designer and the company Escofet currently own and have patented the production licence of this segmental paving system. Escofet – a historical company that has always worked closely with architects, landscape architects and urban planners – has received excellent feedback on this design (www.escofet.com; www.footprint.cat).





Figure 14B



Figure 14A

HUELLA's simplicity, excellent mechanical behaviour and multiple pattern options mean that technicians choose this product in many situations. Moreover, the shape of the paver, with its poetical meaning and inspiration, is one of the most appreciated values of this interlocking concrete pavement. The universality of the human footprint becomes a symbol in many cultures and countries. *(Figure 14A, 14B)*

Since 2011, a special marketing campaign has been developed by the designer, together with Escofet, in order to present this small-stone paving system around the world. A special website, brochures, technical papers, and a box of miniature wood pieces (e:1/5) *(Figure 15)* have been developed to support the commercial manager and sales team with the task of adequately conveying the benefits and main features of HUELLA.



Figure 15

In line with Escofet's international sales objectives, and given its large number of clients around the world, the company is now looking for other international partners interested in acquiring the production licence. These partners will be able to produce the pavers close to where the pavers will be finally landed. By eliminating the transportation costs, this strategy aims to reduce the environmental and financial costs of this pavement.

7. Conceptual approach

Feelings and emotions are important aspects of all design activities. In the case of small paving systems, it is proved that this construction system has the ability to convey a language (David R. Smith. The Pattern language of concrete pavers). HUELLA also has its own language:

Footprint - a universal geometry. Because we only really understand the paths we have trodden, what better way to pave the ground than with the marks of our passage: footprints? Human footprints - a universal geometry - have the ability to bring cultures together in a common mosaic that is more than a simple coincidence of forms.

Moving beyond the mere act of decoration, the HUELLA project clads the soil with the trace of human transit, a metaphor and an anthropological message. Human dialects have made us aware that all actions – simple (footprint), and complex (urban) – leave their mark… accepting this, all we have to do is design the best way to sink our feet in the sand. The use of

our paths as a reminder of this, no matter where they lead us, is definitely an innovation".

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