PATTERN, TEXTURE AND GEOMETRY IN THE PAVED SURFACE

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SUMMARY
The legacy of the Roman Empire and its roadbuilding has been central to the practice of paving. The advent of the motor car and its early reliance on seamless surface brought fundamental changes to pavement construction. The advantages of concrete paving blocks are well known and the industry is growing accordingly. However, we now have the chance to re-establish links with many rich traditions of surface design which were overwhelmed in our century. Using disciplines of modular and geometrical analysis we can strengthen the aesthetics and design culture of the concrete paving block industry.

It is appropriate that we are meeting in Rome. The legacy of the Roman Empire, both technological and cultural, has formed the basis of all paving activity, at least in the Western world.

We must look briefly at the achievement of the Romans. During their Empire, a period of about seven centuries, the Romans created a network of roads which covered Europe and beyond. They understood that their control depended on movement and communication - on their ability to deploy armies, goods and information efficiently within their territories.

This Imperial nervous system needed an astonishing 90,000 kilometres of road and 150,000 kilometres of connecting track. The Roman Empire could not have existed without these roads, and the roads could not have been constructed without slave labour. A combination of sophisticated design and technology and a slave economy was essential.

Another essential was cultural and religious; the Romans had a respect for the surface of the earth which has virtually disappeared in our age. Before a town was established, a series of rituals were conducted to consecrate the site. The prime axes of the town, the Cardo and Decumanus, were laid out with great ceremony and became, eventually, the two main streets.

But, for us, the most interesting feature of the Roman road must be the way it was made. It was a unitary construction, made of separate elements, but it was designed to support an entirely different traffic to that dealt with in out time by concrete block paving. Roman traffic was horses, chariots and marching legions and all of these delivered a rythmic and repeated compaction force to the surface. The road was designed to cope with, and indeed to benefit from this compaction and the separate surface elements tended to lock more tightly after each use.

This principal, the interlocking of small units to resist compaction by horses and steel-rimmed wheels was for centuries the basis of road making. Whether using cobbles, baked bricks or wooden blocks, road construction relied on the repeated consolidation impact of relatively light traffic.

It was a principal which allowed for limitless interpretation, according to the geography, economics and culture of different countries in different ages. We can look back now and appreciate the richness of that legacy in terms of pattern-making, colour, texture and geometry. Stone cobbles, and particularly those laid in curves (the radius of the kneeling installer's arm), the huge and perfeclty tailored York stone flags in Britain, the herringbone clay bricks of Holland, the large black stone chevrons of Italian city streets, the end-grain wood blocks that briefly appeared at the turn of the century, the pebbles of sea-side villages.

All of these were overwhelmed by the advent of the motor car and, more particularly, by the development of the pneumatic tyre. The first tyre patent was taken out in 1845 by R W Thomson, a scot. He had developed an 'aerial wheel' made of air-filled leather, and claimed that this reduced the force necessary to draw a coach forward. In 1888, Dunlop, an Irish vet, appalled by the way his small son's tricycle became stuck in the boggy landscape, developed a primitive tyre (based on the tools of his trade, rubber and bandage) simply to give a broader tread to the narrow wheels. At about the same time the Michelins (a member of which family had coincidentally married the niece of Mackintosh, the inventor of the process for waterproofing canvas) developed the changeable repairable tyre. This, from 1894, was used on horse-drawn Paris fiacres and from 1895 on motor cars.

Unfortunately, nobody had carefully considered the effect of these new tyres (especially as they travelled at hitherto unimaginable speeds) on the surface of the road. They had the surprising characteristic, unlike metal

wheels, of delivering a negative pressure behind the tyre and sucking out the sand and gravel which in so many cases locked the cobbles in position. The seamless surface, of asphalt or concrete, became then, and still substantially remains, the preferred solution to this problem.

The seamless surface, in the wake of the motor car and its pneumatic tyre, spread rapidly and effectively acted as a blanket over a basic human activity - the design and construction of unitary paving. In many countires texture, pattern and geometry disappeared from the surface of the ground and, where it did exist, it was restricted to prestige pedestrian areas. Despite this hiatus, we associate historic urban areas with unitary paving of some sort and there seems to be a real need to provide small-scale paving units in places we value.

Looked at from this perspective then, the rapid global development of the concrete paving block industry does much more than provide a technology which is competitive in both economic and engineering terms. It also re-engages what appears to be a recurrent human need for small scale texture in paving. It reconnects to a classic tradition of construction which was, if not lost, then most certainly damaged, by the first decades of motor transport. It offers us an opportunity to reestablish our skills in the design and construction of geometrically patterned surfaces.

One cannot know exactly the areas of that Roman network of paving but, according to my calculations, those seven hundred centuries produced about six hundred and sixty million square metres of paving, and I refer here to road alone. It is one of the paradoxes of our industry that no-one has been able (or prepared0 to estimate its real size and yet it is clear that, in just a few decades, we have (without slave labour!) equalled the achievements of the Roman Empire - at least in area produced. There can be no doubt that now, with our production stronger and more sophisticated thatn ever, we can equal those production figures in just a handful of years.

I look through the programme of this conference and I find that, as is normal on these occasions, the majority of papers are devoted to that which can be quantified; the technology of production and construction, the economics of manufacture and marketing. This is not surprising. I suspect that, if we could talk to the master pavers who built, for example, the Piazza del Campo in Siena, we would find that their main concern was their wages!

However, we have the chance now to give even more thought to the design and appearance of our blocks.

Some time ago, I read an article by a leading consultant engineer who suggested first, that paving block design was simplicity itself and second, that we had all the shapes we needed, they were good enough anyway, that nothing of value was left to be invented so let's simply get on with the job in hand!

This view is widely held. It is easier to dismiss the possibilities of the future than to imagine them. It might be useful now to examine the principles of paving block geometry, from a shape- and pattern-making viewpoint.

A paver might, in theory, be any shape. For it to be of use, however, it must tesselate; that is, it must relate to its neighbours in a close-packing manner which leaves little or no significant spaces in between. The interest in the regular division of plane surfaces has been the province of mathematicians, particularly crystalographers, but few other disciplines have considered it.

Systems of modularity, used generally in building and building element design are essential here. Figure 1 shows a square modulargrid. The thin grid lines refer to the Geometry Module (M). The square drawn in a thicker line is a diagramatic block and its dimension is called Component Module (m). The Geometry Module is a theoretical grid, used to describe the finished position of the actual products when constructed, or, in our case, the paving blocks when laid. Figure 2 shows the same relationships within a triangular grid.

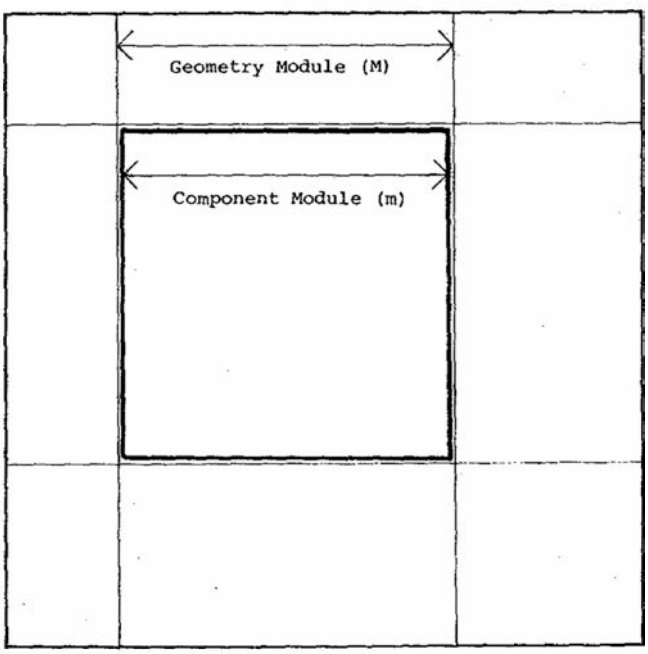


Figure 1

These two grids form the basis of all repeating packing geometries though, in many cases, they are subject to extreme distortion.

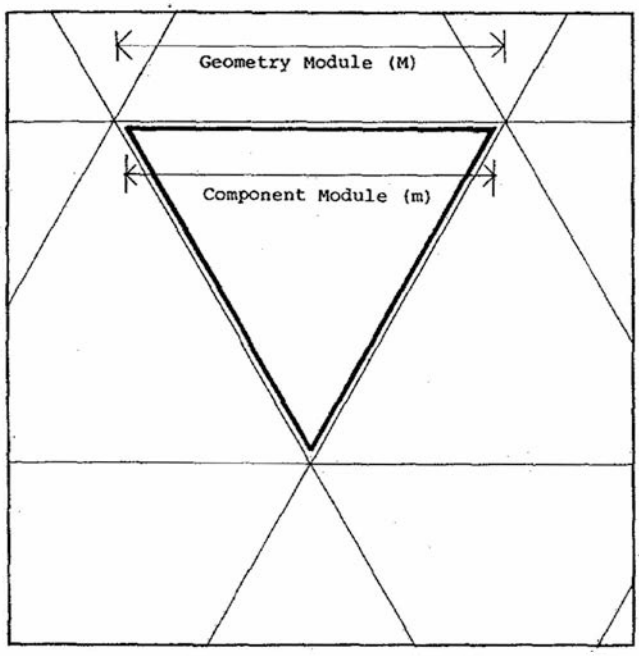


Figure 2

In an ideal world, the Geometry Module and the Component MOdule would have the same key dimen dimension, but production tolerances and site inaccuracies ensure that the Geometry Module is always larger than the Component Module. The difference between the two is the total working tolerance, which might be called the Tolerance Module.

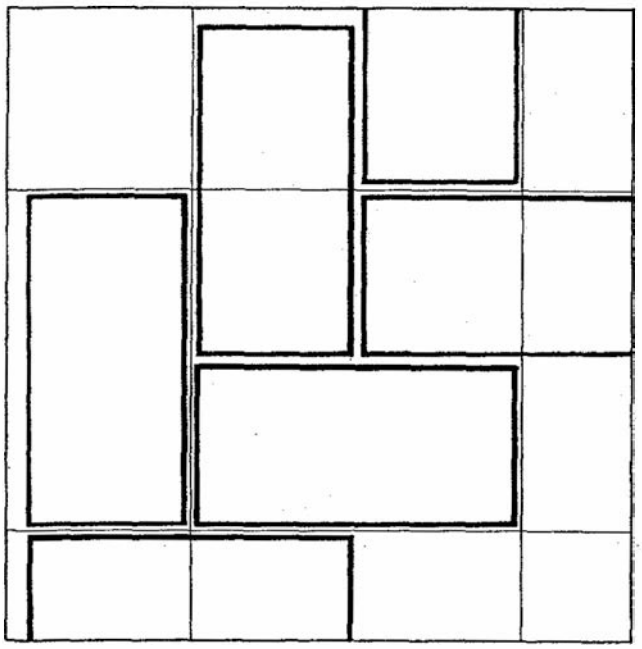


Figure 3

Figure 3 shows a standard rectangular paver laid in herringbone configuration. The component, or block is free to cross the theoretical grid but constantly reestablishes its relationship with it.

Figure 4 shows a classic paver shape which has an even freer relationship with the grid as the dentated surface repeatedly crosses the Geometry Module line. However, once again, the precise relationship is regularly confirmed.

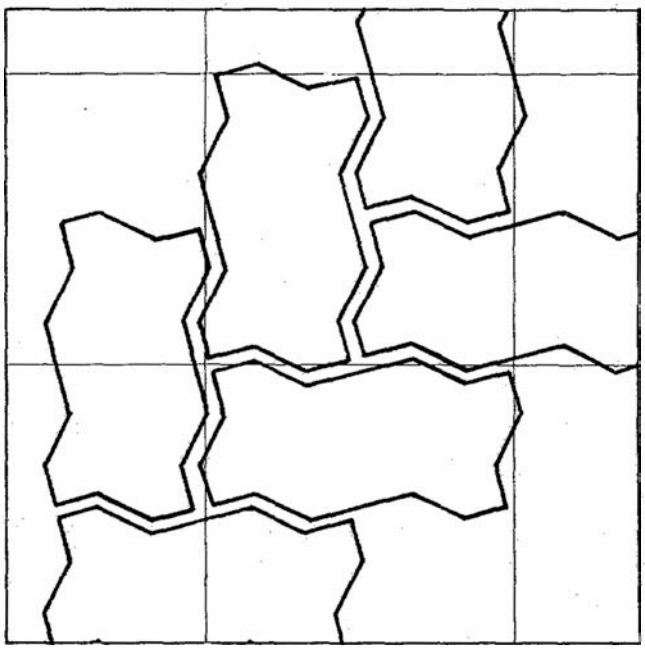


Figure 4

There is a class of paving block which offers flexibility of pattern by providing a large or irregularly shaped Tolerance Module. In other words, the space between block allows for a range of juxtapositions between one block and its neighbour. Figure 5 shows an example of this type of block. It can conform to grid regularity when required, but, as Figure 6 shows, it is capable of a large range of positions in relation to its neighbour.

These ideas and methods do not, on their own solve problems. However, as a working tool or an analytical principle they are most helpful as a design aid.

It is our view that, during the next years, the concrete paving block industry will move increasingly towards pattern, decoration and colour. Production methods have become more sophisticated and continue to do so; colour technology improves year by year. While, in engineering terms, the form of the industry is now set, from the point of view of design and aesthetics we have hardly touched the limitless possibilities.

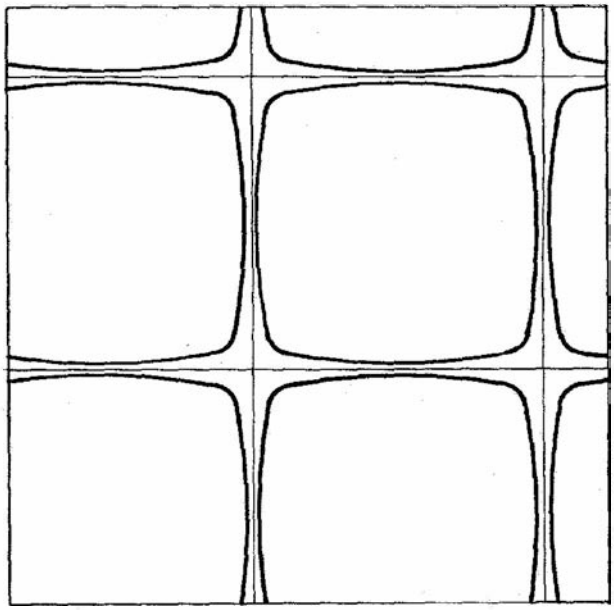


Figure 5

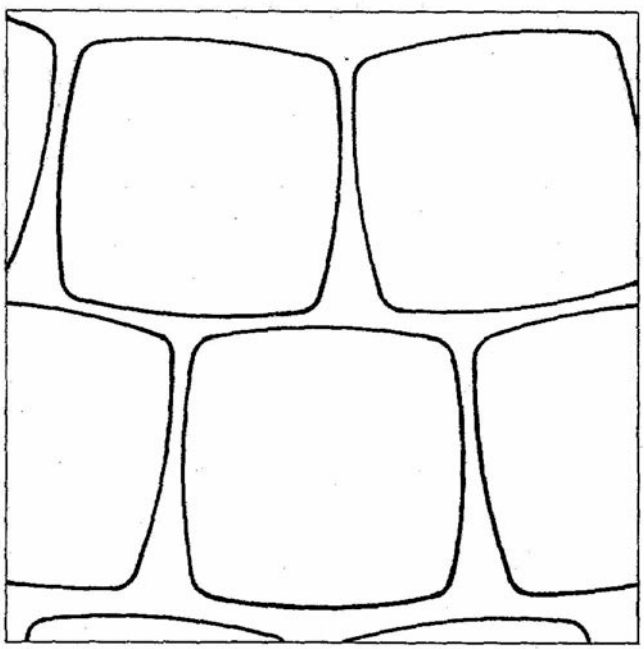


Figure 6