STRIVING FOR 100% - IMPROVING MACHINE LAY MODULAR PAVING TECHNIQUES

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SUMMARY

The Paper presents a history of innovative developments in mechanically installed concrete block pavements in the UK over a six year period. It deals with operational research, resource management, productivity and the achievement of a structurally stable surface.

There have been mechanically laid solutions in the form of shaped blocks in the UK for the last eighteen years. However, the UK market has an overwhelming preference for a rectangular block laid in fully interlocking herringbone pattern. The search for the most efficient rectangular paver machine lay solution began in the UK in 1999. At that stage suitable methods had been developed to mechanise screeding, compacting and joint filling operations and the missing link was the totally mechanical placement of the blocks.

Searching throughout the world for available systems at this time meant that the next logical step was to adopt a tried and tested 90 degree herringbone format. Whilst this offered a partial solution in which most, but not all, of the pavers could be installed mechanically, this was by no means the most efficient in terms of speed and structural efficiency and the desire was to keep pushing for improved techniques, aiming for a 100% machine laid answer.

A UK Paving Expert Group (UKPEG) established a holistic approach and collaborated to produce a cost effective, safe and rapid method of laying block paving suited to the UK market.

The team overcame many obstacles along the way including product quality, packaging, installation and machine capabilities. Any one of these could have prevented the success of this venture had it not been for the desire by members of UKPEG to keep striving for the perfect solution.

1. INTRODUCTION

This paper presents a history of innovative developments in mechanically installed concrete block pavements in the UK over a six year period. It deals with the operational research, resource management, productivity and the achievement of a structurally stable surface.

There are three essential components to any successful concrete block pavement and all are interdependent.

They are:

- Correct specification and design of pavement in relation to its intended use
- Product quality and availability
- Quality of installation

Historically the importance of these components has very much been in this order.

This paper set out to record the story of a group of people who decided to try a different approach in respect of machine laid paving.

Whilst the group was installer led, it was totally informal and also consisted of members involved with manufacturing and supply of the block paving as well as those involved with laying equipment manufacturers.

This then, is their story.

2. ORIGIN

The 1992 UK Health and Safety at Work Act introduced enhanced manual handling regulations which were designed to encourage a safe working environment for employee and employer.

Within the UK precast concrete industry, these regulations have taken time to filter through to modular paving and restraint systems whilst the occurrence of repetitive strain injury (RSI) and musculoskeletal injuries have been growing.

Informal discussions of these factors and the likely long term impact in terms of large areas of block paving led to the formation of a group known to its members as UKPEG (UK Paving Expert Group) consisting of experienced machine installers, representatives of block manufacturers and paving installation equipment manufacturers.

3. AIM

The aim of UKPEG was to produce a safe, cost effective and rapid method of laying larger areas of block paving which was suited to the UK market.

There have been mechanically laid solutions available in the form of shaped blocks in the UK for the last 18 years. However there is a huge reluctance to used shaped blocks as this market has an overwhelming preference to use rectangular pavers laid in a herringbone pattern.

A worldwide search of available systems at this time indicated that the following systems were in general use:

- Rectangular blocks in a 90° herringbone pattern
- Rectangular blocks in coursed pattern
- Shaped blocks in various patterns

Each of the above was being laid either in 'clusters' with no interlock or, alternatively interlock was being achieved by manually changing or inserting blocks between clusters.

Following research UKPEG felt that the UK CBP market had always been very conservative in respect of shape of block with a marked preference for a 200mm x 100mm rectangular block for most large areas.

There was also a perception that, unless the pavements were fully interlocking, de-clustering would inevitably occur leading to failure of the pavement.

Thus, whilst at least some of the evidence in respect of de-clustering was anecdotal, UKPEG felt that the preferred solution should be rectangular herringbone pattern laid without the need for stitching the clusters together or in other words a truly 100% machine laid solution.

This would mean that the client was being offered exactly the same product as he had become accustomed to, thus removing the perennial problem of consumer resistance to machine lay in the UK.

4. 90° HERRINGBONE

UKPEG initial efforts considered the tried and tested 90 herringbone layer format (In this system the blocks are manufactured in the herringbone pattern within the mould)

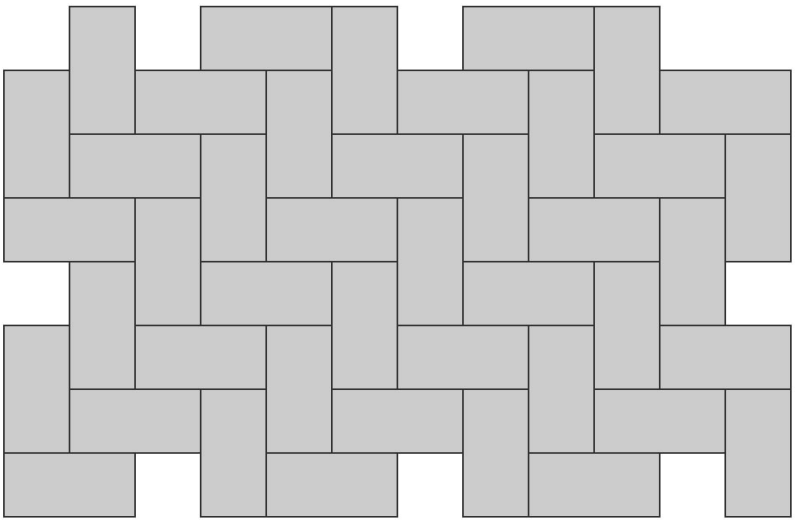

Figure 1. 90° herringbone layer

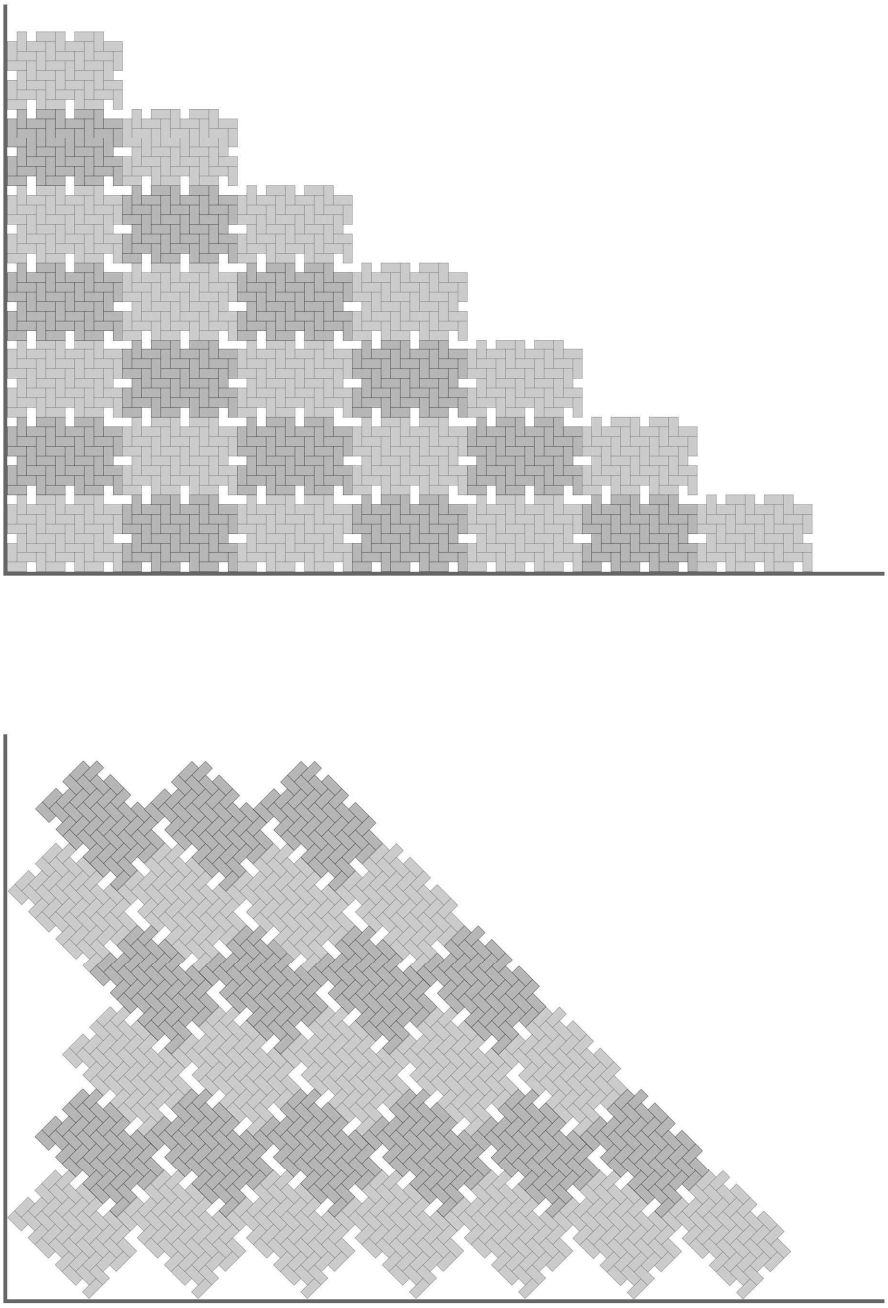

Figure 2. 90° herringbone laid at 45° and 90°

However, although this system had been in use for some years in other parts of the world UKPEG considered that it suffered from the following drawbacks:

- To create a fully interlocked pavement, blocks have to be bought from elsewhere and inserted by hand to link the clusters. This involves up to 10% of the blocks being laid by hand and the installers felt that the physical demands of bending/straightening and often forcing required to place these linking blocks was more demanding than actually laying blocks by hand all day.

- If the linking blocks are larger than those in the cluster it can result in the lines being forced out which it is believed was the cause of the perception within the industry that it is harder to achieve straight lines using this method (hence the reference in BS7533 Part 3 1997 which infers that machine laid paving is of lower quality than hand laid).
- Multi coloured blocks are difficult to produce by this method since moulded layers often show colour "patching" which is not apparent when blocks are mixed from different packs
- From a manufacturing perspective, the herringbone mould produces less product per machine drop thus increasing the unit cost of production. (*It should be noted that the big plus of this system from a manufacturing point of view, is that herringbone product can be produced on virtually any machine by merely changing the mould!)*

These drawbacks led UKPEG to the conclusion that, long term; this product would not fulfil the aim of achieving sustainability in the UK block laying market.

So, by going back to basics to find a solution a 'wish list' was produced to define the ultimate system:

- Rectangular blocks in herringbone format
- 100% interlocking
- 100% laid by machine (apart from infill at edges)
- No 'cluster effect'
- Optimum layer size
- Economically viable with improved laying rates over hand lay block paving systems
- Cost effective to package and transport

On paper a 45° herringbone, 64 block (8 rows by 8 rows) option appeared to fit the bill.

5. 45° HERRINGBONE

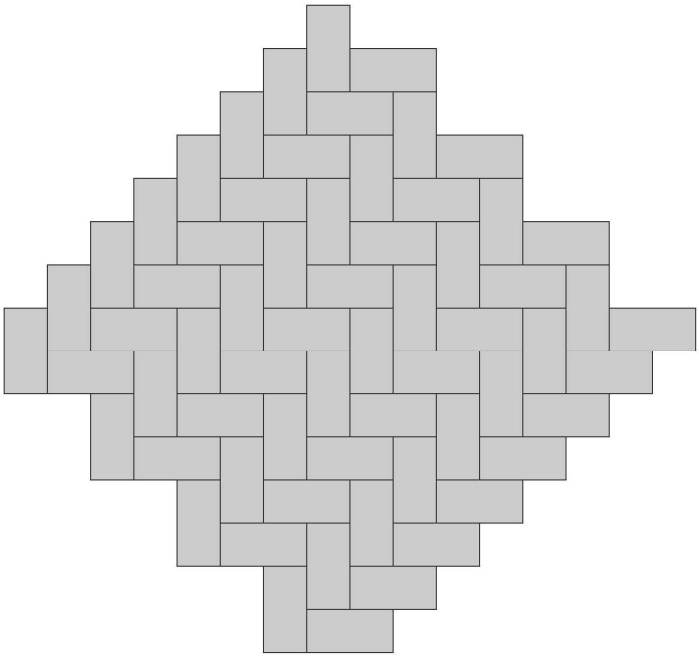

Figure 3. 45° herringbone layer

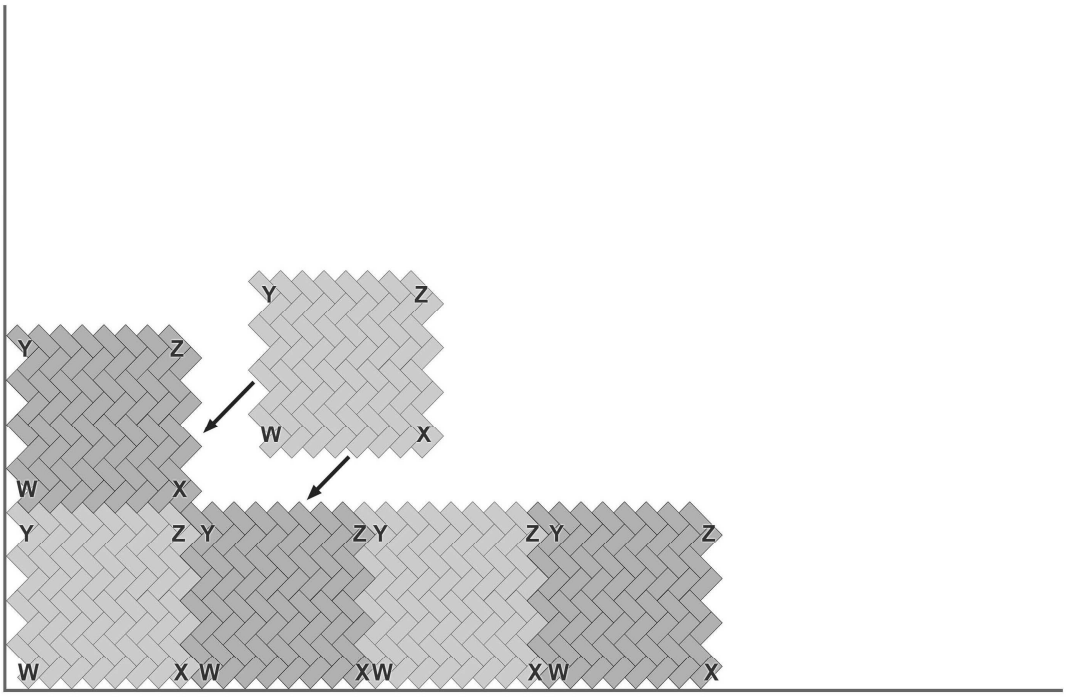

Figure 4. 45° herringbone layer location

With the only drawbacks being;

- That the installers did not know whether they could lay it at all, let alone economically!
- No UK manufacturer had the capability to produce such a layer!
- The laying machine manufacturer who claimed to have a machine capable of laying this product was unable to produce anything more than anecdotal evidence that such a system had ever been laid in a commercial situation.

Undeterred, and convinced they were on the right track, UKPEG arranged to visit the laying machine manufacturer to see hand stacked layers of blocks being placed by the machine. Furthermore they managed to get a commitment from a UK manufacturer to produce the 45 layer to enable trials to take place.

Following many months of hard work the members of UKPEG were ready for their first live trial involving the construction of a 1500m^2 car park. The laying machine was shipped in from Northern Germany, the installer was ready to screed the laying course sand and the block manufacturer ensured the product was waiting. It was an unmitigated disaster. The machine (which had been borrowed complete with driver) was incapable of laying two layers next to one another. The driver spent the day insisting that the installers should learn to lay blocks in the way that the machine had been designed to work, whilst the installers demanded that the machine should be constructed to lay blocks in the way which they required!

Time pressures to complete this area meant that in the end the car park was laid by hand and UKPEG went off to think some more! The installers had always envisaged the layers being placed in a specific orientation

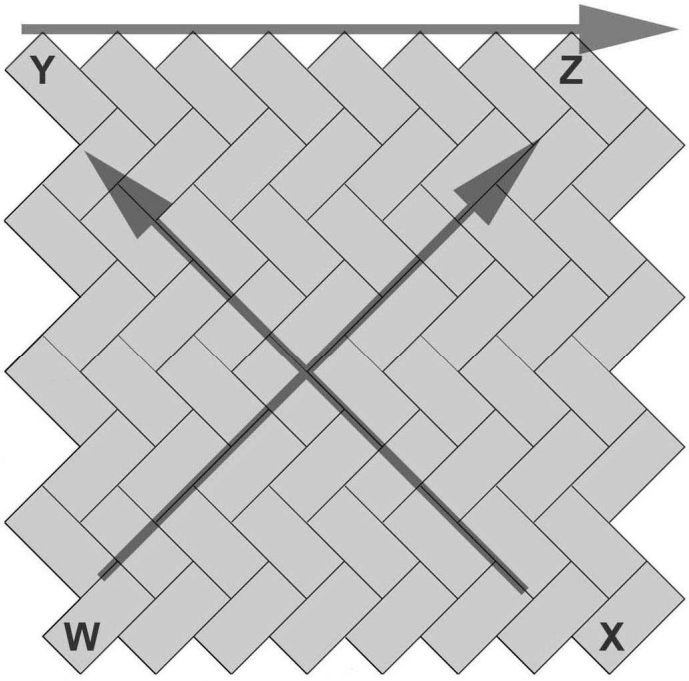

Figure 5. 45° herringbone layer sightlines

The reason being that firstly, the leading edge can be checked for straightness and secondly, the blocks can be tapped into alignment more easily

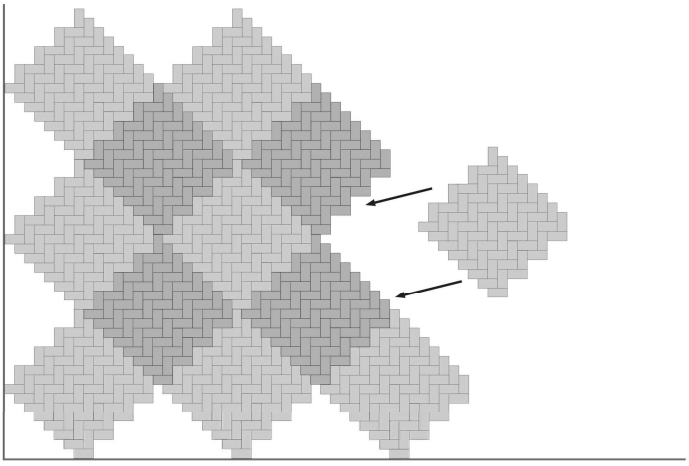

Figure 6. 45° herringbone laid at 90° to the edge

At this stage the original laying machine manufacturer had lost confidence in the viability of this project and no other manufacturers were interested in developing the idea so it seemed that the system was in danger of stalling. However the installers were very confident that the system could be made to work so they adapted an existing laying head with scraps of wood and metal (which very nearly worked) and sent their ideas to another laying machine manufacturer.

Until this point his response had been that a) 45° would not work and b) there was already a working 90° system so why change it?

However, convinced that their system was the best option the installer members of UKPEG now managed to persuade him that they were serious and he agreed to produce a prototype head to place the layer as required by the installers.

Some months later the UKPEG team were again gathered together to watch a trial of the prototype laying machine which the Managing Director of the laying equipment manufacturers had personally brought over from Germany.

The trial area was $1000m^2$ in a block manufacturer's yard in the North of England. The weather did not bode well for the trial with low heavy clouds promising rain to come.

Against this gloomy backdrop the first area of bedding sand was prepared, the packs of blocks were stacked close to the laying face whilst the laying machine was unloaded and set up.

The laying machine manufacturer was not over optimistic, saying 'I know this worked in trials in our factory but I am not confident that it is good enough to work under site conditions!'

Within two hours UKPEG knew they had the first commercially viable system for laying a fully interlocking herringbone layer 100% mechanically. The laying machine manufacturer declared that he would never, in future, say that something would not work until he had tried it!

Three days later, in spite of almost continuous heavy rain, the team had laid approx $1000m^2$ in both 90^0 and 45^0 pattern and were confident that the system was a winner.

Coincidentally there was a hand lay team working on a separate area of the same yard whilst the trial was going on and this gang laid less than $100m^2$ in the same period due to the appalling weather!

6. CONCLUSIONS

In the three years since this first trial both laying machine head and block production systems have been modified and improved as a result of working experience and the system has now been used to lay nearly half a million square metres of paving on projects all around the UK.

Whilst there are, and will continue to be, debates over the cost implications of manufacturing blocks in a format suitable for this system, the authors and UKPEG are convinced that the 45° system offers the safest and most efficient solution for installers wishing to lay herringbone paving rapidly over large areas.



Figure 7. Finished paving of trial area