REFLECTIVE PAVERS AND KERBS PROMOTE SAFETY

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SUMMARY

The modular nature of concrete block paving lends itself to the provision of directional and informational markings when needed. On conventional surfaces it is usual to make these with specialist paints or thermoplastic materials. The products used for this purpose tend not to be durable, are expensive to maintain and lack luminosity at night and in severe weather conditions. This paper reports on innovative Reflective Pavers and Kerbs which have an integral surface layer of a cement-based proprietary mix comprising specially manufactured spherical clear glass beads, titanium dioxide, pigments and other materials to form a durable composite layer 5 to 8mm thick. The abrasion resistance of this layer is better than other similar products and capable of withstanding heavy trafficking. The base-mix of these units have the same raw materials used to manufacture conventional pavers and kerbs and the manufacturing process will be similar to that of any other composite pavers or kerbs.

The primary function of these products is to promote safety by providing clearly visible markings at all times and in all weather conditions. Appropriate areas for use of these products are roads, footpaths, pedestrian crossings, at accident 'black-spot' locations and traffic calming locations, aircraft pavements and port container handling areas. These reflective products have given proven performance in excess of nine years and a five year warranty is now given for their effective performance.

1. INTRODUCTION

Because of the versatility and popular appeal of concrete block paving, many Authorities are increasingly using this form of surfacing for roads, footpaths and many other applications. Where directional and informational markings are necessary, it is usual to make these either by using pigmented pavers or applying specialist paints or thermoplastic materials. Kerb units that form the delineation between footpaths and roadways are similarly treated to highlight the interface between them. Pigmented pavers tend to fade with time and lack reflectivity. Materials normally used for markings tend not to be durable, are expensive to maintain and lack luminosity at night and in severe weather conditions.

Reflective Pavers and Kerbs are now available which have an integral surface layer of a cement-based proprietary mix comprising specially manufactured spherical clear glass beads, titanium dioxide, pigments and other materials to form a durable composite layer 5 to 8mm thick. The abrasion

resistance of this layer is better than other similar products. The base-mix of these units will contain the same raw materials used to manufacture conventional pavers and kerbs and the manufacturing process will be similar to that of any other composite pavers or kerbs.

Extensive testing including soaking the reflective pavers in hydrochloric acid and bleaching liquid for 3 months did not affect the reflective composite layer and there was no evidence of surface cracking. In fact, the only change noticed was that the white surface appeared brighter. Testing in the UK revealed that in colder climates the reflective surface will be unaffected by de-icing salts and further testing will confirm the veracity of this statement.

As this surfacing is an integral part of the units, its visual luminosity impact will effectively remain for the lifetime of the units produced in this way. The aim of these products is to promote the safety of motorists and pedestrians alike by providing clearly visible markings at all times and in all weather conditions and to avoid the expense of frequent repainting of markings. There are other reflective paver systems in use having a surface-applied epoxy material. Unfortunately, they become contaminated with traffic dust and de-icing salts and require cleaning to maintain their reflective properties. Additionally, the coating used is unable to withstand trafficking. Conversely, the Luminance Factor (LF) of the reflective pavers described in this paper increases with age (typically having an LF of 45% at manufacture eventually increasing to and maintaining a LF of approximately 60%) and are able to withstand heavy industrial trafficking.

The National Science and Technology Board of Singapore and the Economic Development Board of Singapore, having identified problems with existing road markings and kerbing systems, have supported the research and development of the process. Comprehensive programmes of independent testing as well as performance surveys conducted by Government bodies have been made and are reported in Section 4 of this paper.

Appropriate areas for the use of reflective pavers and kerbs are on roads, footpaths, pedestrian crossings, car parks, traffic humps and other devices incorporated into traffic-calming schemes, at identified accident ‘black spots’, aircraft pavements and port container handling areas.

2. BACKGROUND AND HISTORY

Pigmented standard pavers are often used to provide contrast for markings on block-paved surfaces. However, these tend to lack visual impact and soon fade. Alternatively, pavers may be painted using specialist paints or thermoplastic materials. These deteriorate rapidly and become visually inefficient due to their poor luminosity as shown in Figure 1.

To overcome these problems a comprehensive range of directional and informational designs has been developed using reflective pavers. The notable feature of the reflective pavers is the enhancement of the visibility of markings in daylight, at night (see Figure 2) and in adverse weather conditions. The reflective surface, being an integral part of the manufactured units, is as permanent as the paver units are and, apart from occasional cleaning, maintenance-free. Such reflective pavers can also be used at airports to form centreline and edge markings on taxiways and lead-in markings for apron areas where surfaced with block paving.



Figure 1. Deterioration of painted markings



Figure 2. Reflective pavers at night

The function of kerbs, including channels quadrants, angles etc. is to separate surfaces at the same or at different levels to provide a physical and visual delineation or containment. They also provide a separation between surfaces subjected to different kinds of traffic. To improve visual contrast between different surfaces, for example between footpaths and roadways, kerb units may be painted. However, these painted kerbs are not clearly visible to the motorist during wet conditions, especially at night, and require frequent maintenance.

3. DEVELOPMENT OF DURABLE REFLECTIVE PAVERS AND KERBS

A further new development is the reflective directional kerb. These units are manufactured with an integrated surface reflective-mix similar to that described above for reflective pavers. The units provide an economic and more effective alternative to painted kerbs and, apart from occasional cleaning, are maintenance-free.



Figure 3. Curve using reflective kerbs



Figure 4. Curve in dark & wet conditions

Curves are easily accommodated using Directional Kerbs (see Figure 3) and may be used exclusively or in combination with other directional units. Radii in excess of 2 metres are achieved using standard units and special units are available for radii less than 2 metres down to a minimum of 500 mm. Figure 4 shows the same road project in dark and wet conditions. This reflective concept can be used to manufacture other types of kerb units if required.

Reflective pavers and kerbs are manufactured using standard block-making machines having a face-mix or composite layer facility. The reflective face-mix has a thickness of between 5 and 8 mm in compliance with BS 6717:2001. A cement-based reflective-mix is fed into a mixer and thoroughly mixed for 2 minutes, then discharged into the hopper of a block making plant. The production process thereafter is similar to that for normal composite pavers. Skid resistance of the reflective pavers comply with current BS requirements. Independent testing has also confirmed compliance of reflective pavers with BS/EN standards.

4. PERFORMANCE TRIALS OF REFLECTIVE PRODUCTS

Trials were made on pavements owned by the Port of Singapore Authority (PSA) to compare existing thermoplastic markings with reflective pavers. Under similar traffic conditions, the thermoplastic markings had disappeared within a month whereas the reflective pavers have continued to perform satisfactorily after seven years in use.

During this trial, Luminance-Factor Index (LFI) measurements were made on the thermoplastic markings and the reflective pavers. The thermoplastic markings exhibited an initial high LFI (above 70%), but dropped to below 40% within two weeks due to rapid abrasion of glass beads within the matrix. By comparison, the reflective pavers indicated an average LFI of 45% shortly after installation but after three years, it had increased to 55%. The reason for this increase is that as traffic abrasion occurs it exposes glass beads in the face-mix of the pavers. The low initial LFI is the result of the coating of glass beads with cement paste etc. during production

Following this long-term trial, it is now possible to give a five-year warranty for the performance of reflective pavers and kerbs. The PSA have confirmed the successful performance of the reflective pavers over a period of five years in the form of a certificate of approval. They have also estimated that they have saved approximately US$ 114,000 over five years by not having to repaint the markings on 113 of their ‘chassis’ lanes. Conventional markings in the same area at the port were repainted four times a year. After the installation of reflective pavers, no repainting or cleaning has been necessary and these pavers have now exceeded their warranty period by two years and are still in good condition. Figures 5 and 6 show reflective pavers that were installed in December 1996 and located on a chassis lane at the Port of Singapore Keppel Terminal. After nearly ten years use they continue to perform effectively as the day they were laid.



Figure 5. Day View



Figure 6. Night View

Figures 7 to 14 illustrate the aesthetic appeal of reflective pavers and their versatility in the applications for which they may be used. They also demonstrate that the system may be used for almost any shape of paver manufactured.



Figure 7. HDB Road – (showing humped pedestrian crossing) - Singapore



Figure 8. HDB Road - Singapore



Figure 9. Road junction - Singapore



Figure 10. Bus lane – Kuala Lumpur



Figure 11. Road junction (day) - Singapore



Figure 12. Road junction (night)



Figure 13. Pedestrain crossing - Dubai



Figure 14. Paved road – Kuala Lumpur

HDB = Housing and Development Board of Singapore

5. CONCLUSIONS

The authors consider that the use of reflective pavers and kerbs will contribute significantly to promoting road safety. Current research has indicated that 'speed kills' and it is for this reason that there has been a proliferation of traffic calming measures throughout the world. It is axiomatic that surfacing and kerbing materials used as part of traffic calming measures should be permanently highly visual in all lighting and weather conditions. Reflective pavers installed 5 to 9 years ago have shown no deterioration as evidenced in photographs given in this paper; they are very cost-effective and require little or no maintenance. A major advantage of the reflective units is that their Luminance Factor Index tends to increase with age, unlike thermoplastic road markings which may have a significant drop in LFI after three months trafficking. The reflective pavers and kerbs are abrasion resistant and capable of withstanding trafficking heavy vehicles, aircraft and port handling equipment.

There may be other applications where reflective pavers may be used which, whilst not necessarily contributing to safety, will nonetheless enhance the aesthetic appeal of block paving in general. The authors also consider that where tactile paving units are used to aid visually impaired pedestrians then improved performance can be achieved by manufacturing them with integral reflective surfaces. Government agencies in Singapore have recognised the inventive attributes of both the reflective pavers and kerb units by awarding the developer with certificates of merit for innovativeness.