1. INTRODUCTION

It is perhaps appropriate that my paper today presents a view of a group of surfacings that in many ways are the most "special" as they can demonstrate, not just in engineering, but also in a life saving capacity.

I have divided this presentation in five sections.

I will therefore:

- describe the problem and the solutions that High Skid Resistant Surfaces provide.

- tell you a little about the market

- give you some details of the development of the material and contracting activities.

- inform you about the B.B.A. / H.A.P.A.S. Scheme.

- and summarise where we are today and where we are likely to go in the future.
2. THE PROBLEM

As we are all aware, increased pressure is being put on the public roads infrastructure due to growth in personal wealth and mobility demands, which have, and will continue to put increased volumes on the network.

We live in a temperate climate with an average annual rain fall of about 30 inches a year in the U.K. and maybe greater in Scotland and experience wet road conditions approximately 25% of the time.

These features have combined to create a need for solutions to a problem of higher volume, perhaps higher speed traffic and a general demand for higher safety and less accidents.

After the first road fatality in Britain in 1896 the coroner said, “This must never happen again” But it has, nearly 25 million times world-wide since then.

In 1996 more than 45,000 people were killed as a result of road accidents in the European Union.

This slide shows recent UK road accident casualty statistics and concentrates the mind on the problem I have described.

In 1996 there were nearly 3,600 people killed and over 44,000 people seriously injured.

This slide includes casualty numbers for 1995, 1996 and the average for the years 1981 to 1985 (the basis for the national target for reducing the number of road casualties by one third by the year 2000).

In the year 1996, in comparison with the 1981-85 average, deaths were 36% lower and serious injuries were 40% lower. Slight injuries were 13% higher (almost entirely due to a 60% rise in car user slight injuries) and the overall number of casualties was half of 1% lower. In the same period road traffic was 50% higher but the casualty rate was 34% lower.

The Department of Transport have calculated that in 1996 each fatality cost the community £983,710 and each serious injury accident £118,030 and the total cost of road accidents, including non injury accidents cost the community £13,920 million.

Compare this with the total income - road user taxes and duty for 1996/97 of £28,300 million and the total road expenditure for 1996/97 of £5,450 million.

Research has shown that more that half of all road accidents in this country occur at road junctions.

Slippery road surfaces have been identified as a contributory factor in 28% of accidents.

In wet weather the percentage of accidents caused by skidding increases dramatically.

The conclusion drawn from all this, is that at junctions and other stress locations skid resistance must be high.

i.e. better skid resistance = fewer accidents.
Due to the relentless action of traffic on these high stress road surfaces, such areas experience extraordinary polishing of the road surface.

Other locations which experience similar polishing are:

- Approaches to pedestrian crossings
- Roundabouts
- Sharp deviations of alignment and/or level
- Bridge surfaces which can experience very low temperatures and therefore have a higher potential of freezing surfaces - this slide shows the Erskine Bridge.
- Motorway interchanges

The national target for reducing the number of road casualties by one third from the years 1981/1985 to the year 2000 introduced the first mandatory skidding standards for in-service trunk roads in Great Britain in 1987, which has now been superseded by HD 28/94 DMRB 7.3.1.

This standard’s highest classification for aggregate use on high stress sites requires a PSV of 70+.

The Standard HD 28/94 states that Resin Based High Skid Resistant Surface Treatment can only be used for this classification. (PSV 70+).

3. THE SOLUTION

These problems were first fully recognised in the 1960’s when pioneering work was undertaken by the Greater London Council with the Metropolitan Police.

This involved analysing and investigating the police injury RTA reports to find the root cause of the accidents and patterns of occurrence and cause.

It was found that 70% of personal injury accidents occurred at or within 20 metres of road junctions and pedestrian crossings.

Examination of these sites showed that they had a much lower skid resistance than had shown to be desirable, despite the fact that aggregates of high PSV’s had been used on these sites.

As a result, it was decided to find a very tough and high skid resistant aggregate that could be applied in some way to these critical areas of road surface.

The GLC enlisted the help of three organisations to develop a highly specialised Surface Dressing treatment. The first was the then named Transport and Road Research Laboratories at Crowthorne, Berkshire who investigated and tested 29 different minerals and aggregates.

This research and testing regime identified the most durable and most highly skid resistant aggregate that was available, to be Calcined Bauxite from Guyana, and it was recommended that a 1-3mm aggregate size be used to form a very special surface dressing treatment. These slides show a close-up of Calcined Bauxite on the road surface and high magnification which shows the extraordinary “sharp” micro-texture which helps produce this very high skid resistant aggregate.
The second organisation that was enlisted to help the GLC was Shell Research, who worked on a range of possible binders to hold the calcined bauxite in position and developed a two part bitumen extended epoxy resin.

The third organisation was Universal Highways Limited, who developed both a manufacturing unit for the production of the bitumen extended epoxy resin binder, and a truck mounted sprayer that could cope with the spraying of the film of binder developed by Shell Research on to the road surface.

The epoxy resin binder film is sprayed on to the road surface then immediately dressed with Calcined Bauxite. The binder cures for 2-5 hours depending upon air and road temperatures, then the loose aggregate is swept prior to opening the new surface to traffic.

All this resulted in epoxy resin based high skid resistant road surfacing.

Further trials were undertaken in 1968 for the GLC. As a result, four very important features of the system were proved:

- first, the ability of the binder to adhere to the road surface and to the bauxite chippings, and not be torn off by the very high forces exerted by heavy braking.

- second, the ability of the aggregate to provide an impressive long term resistance to abrasion and polishing.

- third, the GLC’s before and after study of accident rates on 37 intersection sites in London:-

**Accident types**

<table>
<thead>
<tr>
<th>Type</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet road surface</td>
<td>- 47%</td>
</tr>
<tr>
<td>Dry road surface</td>
<td>- 25%</td>
</tr>
<tr>
<td>Total accidents</td>
<td>- 31%</td>
</tr>
<tr>
<td>Skidding accidents</td>
<td>- 67%</td>
</tr>
<tr>
<td>Loss of control accidents</td>
<td>- 65%</td>
</tr>
<tr>
<td>Pedestrian accidents</td>
<td>- 44%</td>
</tr>
<tr>
<td>Vehicle accidents</td>
<td>- 15%</td>
</tr>
</tbody>
</table>

From figures quoted this demonstrated an substantial reduction of accidents, and a very good rate of return for the cost of the investment for this highly specialised surfacing.

- fourth - the application of high skid resistant surfacing was shown to reduce braking distances by up to one third.

The bitumen extended epoxy resin system thus became the industry standard, and was the basis for the inclusion of Clause 924 of the Specification for Roads and Bridges in the late 1970’s and early 80’s.

A 20 year patent was registered by Shell Research for the epoxy resin high skid resistant surfacing in the late 1960’s which restricted entry into the market, other than companies owned by Shell International or companies who had obtained licences from Shell.
Tarstone Limited, which was acquired by Johnston Surfacing Limited last year, was the first non-Shell company to enter the high skid resistant surfacing market after the patent had lapsed.

4. THE MARKET

As a result of the work in 1968 the GLC began an impressive investment in treating priority sites at major junctions and pedestrian crossings.

High Skid Resistant Surfacing was carried out over the whole capital network through the investment by the GLC. During that period hundreds of sites were treated, increasingly at night due to the pressure to maintain traffic flow at peak periods. Continued testing of the sites treated using SCRIM machines, demonstrated the longevity of the skid resistance system. Checks on the rate of return on the investment which came from the reduction of accident costs was very impressive.

With the growth in the UK of Highway Maintenance testing requirements including mandatory skidding standards, other highway authorities and the national government agencies began to use high skid resistant surfacing.

When the GLC was dismantled in 1986, the London Regional Office of the Department of Transport, accelerated the treatment to London trunk roads and many of the London Borough took up, or extended, the programme.

The use of high skid resistant surfacing grew in all parts of the country and was designed then almost entirely as a reactive treatment of existing skid problem “accident black spots”.

Overall, the Government’s stated commitment to invest in activities, to reduce injury and fatal accidents by the year 2000 has had a significant effect on the market in Britain.

One direct impact was the move to use high skid resistant surfacing not only on existing “accident black spot” sites, but to specify it on new road schemes.

So, on many new road schemes, high skid resistant surfacing is specified for pedestrian crossings, junctions, inter-changes, roundabouts and bridges.

The manufacturing quality of the binder is very important, and unique testing of the tensile strength and elongation at break was developed. Significantly, the major contractors and manufacturers became QA accredited.

The lorry mounted spraying equipment, has continually been improved to provide the heated and mixed two component epoxy binder to the spray bar in exactly the right proportions, so that a carefully measured film of binder is applied to the road surface, in conditions that are safe to both the operators and the public. These slides show examples of these machines which cost approximately £200,000.

Continued research on the calcined bauxite aggregate has enabled contractors to supply aggregates not only from Guyana, but also from China. Other high skid materials occasionally used include Aluminium Oxide.

The specialist use of the epoxy resin binder with high PSV aggregates has been used on high stress surface dressing sites very successfully. Coloured bus lanes have been treated for many years using the epoxy resin binder with Harden Red chippings.

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There is no doubt in my view, that calcined bauxite is a unique aggregate with extraordinary high PSV values, typically well over 70 and low aggregate abrasion value (AAV) at under 4. The major feature of that combination is very long in-service durability of high skid resistance values. Typical sites have given good service for 10 to 20 years.

Since the late 1980’s manufacturer and contractors have widened the options for different materials and level of services to customers by the use of:-

Hot Hand Applied Materials, which are based on the screeded thermoplastic road marking system which incorporates bauxite chippings to give good skid resistance. These materials are usually laid by hand-screed boxes much like hand applied road markings.

The use of coloured materials has been of particular interest to the customer especially for traffic calming and carriageway differentiation’s of surfacing of lanes of traffic.

Coloured surfaces are achieved by either colouring the binder or bauxite chippings or both. Some concerns have been expressed with regard to the pigmented coloured surfaces from a colour retention view point, and the use of a very high cost bauxite chippings where high skid properties are not normally required e.g. on hatched areas between lanes.

For these areas, epoxy resin binder with Harden Red or any other naturally coloured aggregate provides a naturally coloured and durable surface treatment.

5. B.B.A. / H.A.P.A.S. SCHEME

In 1996, the Highways Agency, County Surveyors Society (C.S.S.) and the Local Authority Technical Advisors Group (T.A.G.) established a Highway Authority Product Approval Scheme (HAPAS). This provides a means for manufacturers and contractors to gain approval for the use of innovative and proprietary products within the performance criteria

HAPAS certificates will be issued by the British Board of Agreement who will evaluate the products. At present five areas of work are being put through HAPAS and the first Specialist Group concerns High Friction Surfacing.

Work on the High Friction Surfacing Specialist Group is now complete and as a result, all high friction surfacing material manufacturers and contractors will need to have their systems and contracting activities approved under HAPAS from May 1998. The H.F.S.A. has played a significant part in this process as members of this Specialist Group.

The Specification for Highway Works (Clause 924) will be amended in May 1998 to state “that High Friction surfacing systems shall have a current British Board of Agreement (BBA/HAPAS) Roads and Bridges Certificate and shall be installed by a Contractor approved by the BBA as an Approved Installer for that system.”

The BBA system will in many ways revolutionise the use and specification of innovative highway materials and contracting processes.

In summary:

It is essential that High Friction Surfacings provide the highest standards of service on sites that are potentially very risky or dangerous for all road users.

Let us therefore use properly approved systems to ensure the public are best served.
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