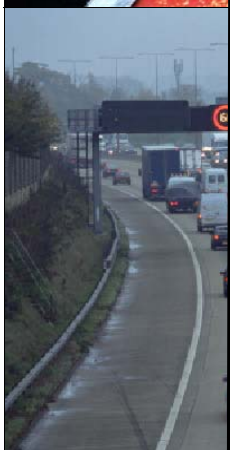
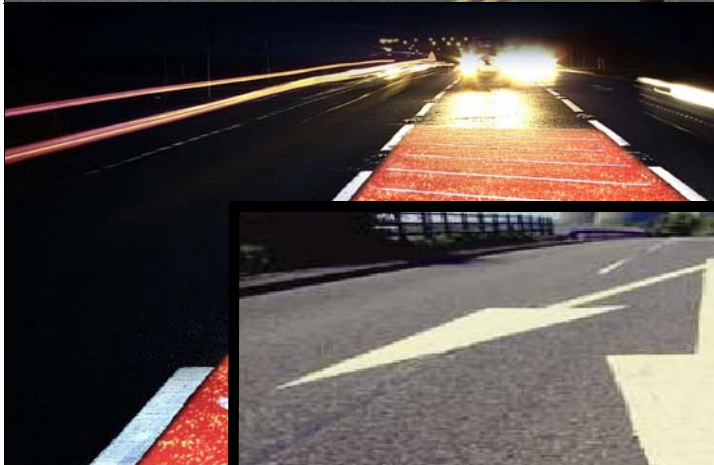




WHITE
LINES
SAVE LIVES
Are your lines up to the mark?



**Road Markings,
 Road Safety &
 Efficient Road
 Utilisation in
 21st Century
 Britain**





Road Safety Markings Association

The Road Safety Markings Association is one of the longest established Trade Associations within the Highways Sector, having been formed in 1975.

Representing some 95% of the sector by volume, the Association has been at the forefront of the development of Quality Assurance, Training and Health & Safety initiatives, not just in the markings sector but also across the entire highways construction field.

With a strong commercial base the Association has been actively involved in promoting road safety since its inception and is an active supporter of road safety initiatives with client groups and road safety charities such as BRAKE. The Association and its members work closely with public sector clients to develop better working practices, more effective specifications and enhanced products.

This report has been produced to highlight the clear road safety and economic benefits that would be achieved through enhanced budgets to national and local road authorities for investment in road marking based safety schemes.

At a time when urban design considerations are being given a priority by some highway authorities this paper suggests that such considerations should not be the 'default' position and that they should only be implemented when road safety will not be compromised. Furthermore, any savings achieved from the removal of markings for aesthetic reasons should be reinvested in additional road safety schemes by specifying authorities.

The RSMA firmly believes that 'White Lines Save Lives' and that they also have a crucial role to play in reducing congestion and the associated environmental difficulties from congestion. Consequently investment in an effective road-marking infrastructure should be a priority for all public policy makers.

Road Safety Markings Association - April 2007

For further information on RSMA contact us

By mail: Unit 35 Corringham Road Industrial Estate, Gainsborough, Lincolnshire DN21 1QB
By Phone: 01427 610101
On the web: rsma.org.uk



The Road Safety Markings Association is a founder member of the Highways Industry Confederation – The Voice of the UK Highways Industry. The HIC exists to provide lobbying and service support to all highways specialists in the UK and is committed to working with client bodies to drive up quality, safety and training standards across the highway sector. For more information visit us at hiconfed.com

ROAD MARKINGS, ROAD SAFETY AND EFFICIENT ROAD UTILISATION IN 21ST CENTURY BRITAIN

EXECUTIVE SUMMARY

The UK Highways network is a crucial economic tool in sustaining the prosperity of the country and increasingly is required to be responsive to environmental concerns (through reduced congestion and subsequent reduction in CO₂ emissions) and to provide safer travel for social and business users.

Road markings have always been a critical part of the safety infrastructure of the UK highways network, in addition to providing the foundation of congestion relief, as the principle tool for delineation and traffic direction.

In the last decade changes to European product standards have allowed road markings to be more clearly specified in a manner to define their performance requirements for safety and delineation on the highway.

Research at all levels from local authority level to a national and international level indicates that the rates of return from road safety schemes involving improved road markings, in all types of location on the highway, lead to a safer travelling environment for road users. Under cost benefit analysis the first year rate of return from these schemes will exceed 500% and will frequently be in excess of 1,500% making road-marking improvements amongst the most effective road safety mechanisms available to highways engineers. This is as a direct result of the relatively low level capital cost of road markings and the relatively high level safety gains from their utilisation.

Detailed academic research also indicates that road marking improvement schemes provide high value cost benefit gains in reducing congestion and improving journey times on all road types, whether rural or arterial, thereby fulfilling tough environmental targets through reduced emissions from standing or slow moving traffic.

Industry reviews and research into the quality of the road-marking infrastructure in the UK since 2001 identifies that at least one third of the UK network is below the lowest specifiable level and that consequently this is damaging both the safety and the efficiency of the UK road network that is so crucial to our economic well being.

The rate of reduction in road injury accidents in the UK is lagging behind the EU15 average in general and most specifically in similar nations such as France, Germany and Holland. This may be linked to the general under investment in more cost effective/beneficial road safety mechanisms such as road markings.

EU sponsored practical research and investigation into driver behaviour in a range of environments has identified that driver safety and driver decision-making can be positively influenced by clearer and higher performing road markings.

Increased (ring fenced) investment, even at relatively modest levels, in improved road marking infrastructure in the UK is likely to yield highly geared benefits to UK road users and the UK economy. This will be achieved through reduced congestion, improved environmental performance of our roads and most importantly through reduced accidents and subsequent reduction in the £15bn cost to the UK economy of accidents on the UK road network.

ROAD MARKINGS, ROAD SAFETY AND EFFICIENT ROAD UTILISATION IN 21ST CENTURY BRITAIN

INTRODUCTION

The challenges of a 21st Century economy mean different things to different people in Britain; however, there are certain constants that underpin the diverse range of challenges for the majority.

Business needs efficient transport systems to move goods to market, whilst people demand effective transportation, that is safe, allows them to commute, to socialise and to access leisure pursuits nationwide.

Whilst there are numerous different modes of transport, it is the road network that provides the most significant arterial system for the majority of British businesses and people; making that road network safer, more efficient and more environmentally friendly is a challenge that has to be addressed by any government that is serious about prosperity, sustainability and quality of life issues.

This paper outlines some simple and relatively inexpensive methods that can form part of meeting these challenges.

ROAD MARKINGS THE WHAT AND THE WHY

History

Road markings are horizontal signs designed to segregate and direct traffic safely and efficiently in a variety of road situations, from high-speed trunk roads and high volume urban environments to unlit rural roads.

The use of road markings has grown with the use of the motorcar, initially as a result of the 1st National Conference on Street and Highway Safety in Washington DC in 1925 to what is now a multi million pound international road safety industry serving all developed and developing nations.

From the earliest initiatives, that led the UK Minister for Transport in 1926 to declare:

“..... the opinion that the experience already gained tends to show that the White Line is calculated not only to reduce the number of accidents, but also to assist materially in the control of traffic by the police”

Through to the effective management of over thirty three million vehicles on the UK roads, road markings form the most common, cost effective and efficient mechanism for guiding traffic, safely across our highway network.



Performance & Standards

Road markings, whilst in themselves perfectly simple and straightforward, are manufactured and installed within a regulated environment that is designed to provide road users with a product most suited to the circumstances within which it operates, whether this is its performance in wet conditions, high performance light return to drivers, enhanced skid resistance, high level durability etc. It is this designed performance and output regime that means that road markings provide dynamic and flexible solutions to congestion and road safety issues throughout our network.

In technical terms the performance capacity of road marking materials is controlled through a range of European Product Standards managed in the UK by the British Standards Institution (BSI), details of which are shown in Appendix A, along with UK regulations and standards pertinent to in situ markings.

Durability

The types of materials used govern the resilience and durability of markings and the consequent timescales of replacement (influencing maintenance/road closure issues). Details of types of materials and related durability are provided in Appendix B.

ROAD MARKINGS AND ROAD SAFETY – REDUCING ACCIDENTS AND INCREASING EFFICIENCY ON OUR ROAD NETWORK.

Whilst there are a range of current debates surrounding the use of horizontal and vertical signage within the urban design environment, this paper is not designed to discuss these matters, rather it seeks to look at road safety and traffic management issues that can be assisted through the use of road markings.

Whilst acknowledging that urban design issues are important, safety of all road users is a priority for all public policy makers and it is this priority that should influence particular actions for specific areas. Whilst it may be that the removal of markings in some urban environments may be the correct solution, the evidence presented below suggests that it should not be the ‘default’ position and that all ‘savings’ should be invested in road marking infrastructure elsewhere.



Extensive research has been undertaken over the last thirty years into the relative impact of road markings in reducing accidents across the range circumstances presented on our road network and

such research provides an insight into the savings available to our economy through the provision of an effective, appropriate and well maintained road marking network.

Detailed below are the results of studies into the effectiveness of various road marking projects in accident reduction.

2007 Cheshire County Council – Analysis of Performance of Wet Night Product

This research not previously published and presented to the RSMA in March 2007 refers to the application of a high performance road marking material to the A556 in Cheshire, a road carrying some 23,000 vehicles per day.

The analysis is based on a wet night performance material applied in 2003 on a section of highway which had in the period 2000 to 2003 suffered 16 recorded personal injury accidents (14 slight & 2 serious, 4 of which occurred in wet-dark conditions). In financial terms the accident profile of this stretch of road is costed prior to treatment, using standard methodology, at £1.4m to the UK economy.

Figure 1, Source: Cheshire County Council 2007

Status	Total Accidents	Serious Accidents	Slight Accidents	Wet – Dark Accidents
Before treatment	16	2	14	4
After treatment	6	0	6	0



Cheshire County Council prioritise safety schemes on the basis of a minimum return to investment of 200%, the scheme as outlined above achieved a first year rate of return of 550%

The outcome of this scheme indicates the significant savings to the UK economy of a relatively modest investment in enhanced road safety using road markings. In this case the cost

of the new markings was £20,000. Beyond the cold financial cost of the accidents reduced by this measure there are also the ‘softer’ costs of distress and anxiety visited upon victims and families of road accidents along with the additional economic disruption suffered by those held up as a result of accidents.

2003 - 2006 Cheshire County Council – Application of Enhanced Wet Night Performance Materials to 50% of the A class road network

From 2003 to 2006 Cheshire County Council have applied road marking products with enhanced wet night performance characteristics to 50% of their A road network, resulting in a fall in accidents of 14.3%, saving the equivalent of £8.4m in costs to the local economy.

Source: Cheshire County Council 2007

2003-2006 Durham County Council - Junction Improvement Projects

Durham County Council, having undertaken extensive improvement work to junction layouts throughout the county has compiled data that identifies range of road safety improvement as a result of using improved and enhanced road marking to improve layouts, these improvements include: -

- A 50% reduction in accidents, associated with improved marking layouts.
- A reduction of speed in the 85th percentile
- Reduction in vehicles breaking the speed limit
- An average first year rate of return 1,868%

Source: Durham County Council 2007

1995 – 2006 TRL Molasses Database of Local Authority Accident Reduction Schemes

The last Conservative Government required Local Authorities receiving funding for Accident Reduction Schemes to provide data for the sites treated to TRL for inclusion in a specific database (Molasses) that facilitated the analysis of the success (or otherwise) of such schemes.

As a result of the multi-solution approach adopted by these schemes i.e. a mix of markings and signage of markings and road surface treatments it is often difficult to specifically analyse the sole impact of markings only, however what data as is available indicates that in the 600 schemes involving improved markings the average reduction in accidents achieved was 32%

Source: RSMA Analysis of TRL Data 2006

2000 ROSPA Cost Benefit Analysis of minor signing schemes

The Royal Society for the Prevention of Accidents (ROSPA) undertook an analysis of a range of data believed to include the TRL generated Molasses data detailed above (to 2000), which is presented below and identifies similar level of accident reduction capacity with cost benefit analysis first year rates of return approaching 1000%, more than ably demonstrating the high gearing of cost and benefit involved in the relatively low investment in road marking treatments on the highway. The contrasts in investment between say traffic speed cameras and road markings and the resultant drop in road accidents are particularly marked.

Category	No. of schemes	Av. Cost £	Reduction in Accidents %	FYRR %
Anti-skid	34	8,620	57	352
Area Traffic Calming	14	46,093	57	216
Controlled Crossing	73	15,916	31	89
Markings	43	2,020	34	957
Markings & Signs	63	2,537	41	820
Refuges	65	10,387	37	259
Speed Cameras	28	18,236	13	260

Signal Improvements	16	17,095	22	155
Speed Limits	6	1,117	33	1035
Traffic Calming Horizontal	16	22,606	46	125
Traffic Calming Vertical	58	23,333	65	198
Warning Signs	36	553	46	3491
Junction Improvements	34	18,513	44	168
New Traffic Signals	15	40,717	67	153
Mini Roundabout	18	14,769	49	134
Yellow bar markings to slip roads		1,000	25	
Yellow bar markings to roundabouts		1,000	50	

Figure 2, Source: ROSPA 2001

1986 – 1994 Various Research into ‘audible’ road markings and accident reduction



Various research projects have been undertaken into the effectiveness of audible or profile road-marking systems commonly found on the nearside carriageway of high-speed roads (dual carriageways and motorways). Such markings provide a profiled surface that emits a ‘rumble’ or similar audible warning when a vehicle travels

across it, providing an alert for drivers who may be sleeping or similar.

The earliest such study in the UK was undertaken on the M4 in Berkshire in 1986 and resulted in the adoption of such marking in the UK, providing the following three fold Road Safety benefits:-

- A sensory vibration when driven on,
- A warning noise for vehicles or occupants on the hard shoulder and in the vehicles driving on the line
- A clear definition of the edge line in dry and wet conditions

Further statistical surveys in the USA, referenced by ROSPA in 2001, indicated that the number accidents resulting from cars leaving the carriageway declined by 60% to 70% per month following the installation similar rumble strip markings. A 1994 study also referenced by ROSPA, analysing the result from 34 US States identified 20% to 50% reduction in ‘run off road accidents’.

Source: RSMA Desk Research 2006

1979 – 1985 Analysis of the impact of edge lines in reducing accidents in 5 UK Counties

Throughout the late 1970’s and early 1980’s many studies were undertaken to identify whether the use of edge lines on rural UK roads reduced the level of accidents, with particular reference to nighttime accidents. The results of studies for East Sussex and South Yorkshire are detailed below.

East Sussex

Test Roads				Control Roads			Net Accident Reduction
	Before	After	%Change	Before	After	%Change	% Change
Total Accidents	68	53	-22%	80	77	-4%	-18%
Light conditions							
Daylight	41	36	+12%	70	78	+10%	
Darkness	27	17	-37%	31	33	+6%	-43%

South Yorkshire

Test Roads				Control Roads			Net Accident Reduction
	Before	After	%Change	Before	After	%Change	% Change
Total Accidents	30	26	-13%	105	123	+17%	-30%
Light conditions							
Daylight	14	16	+14%	70	78	+11%	
Darkness	16	10	-38%	35	45	+29%	-68%

Figure 3, Source: RSMA 1989

These and related studies identified the significance of the provision of edge lines in the reduction of accidents on rural roads, with particular reference to accidents at night and whilst current research has not kept pace with technology whereby higher performance products with high performance in wet night conditions, it is probably safe to assume that accident reduction figures could now be exceeded with the use of such materials. It is worth noting that the majority of serious personal injury accidents happen in wet night conditions.

The results of the studies in East Sussex and South Yorkshire were combined by John Tanner in his paper entitled “ A Problem in the Combination of Accident Frequencies” published in *Biometrika*. This paper showed that the night time accident reduction was statistically significant, and that one could be



95% confident that the decrease in night time accidents would be between 5% and 66%, with a best estimate of 43% (*John Tanner’s method as described in Biometrika is currently used by the Department for Transport Statistics Section*).

Each of the above studies refers to different operational functions for road markings, whilst presenting a uniform improvement in road safety, regardless of the function undertaken. Road markings provide the single most cost effective and flexible mechanism of traffic control and road safety through the following functions:

- **Warn** - Of potential hazards informing us when to slow down.
- **Instruct** - Informing the driver where to stop, where to turn, which carriageway to be in.

- **Prohibit** - Double yellow lines indicate no parking, box junctions, that traffic should keep the space clear; double continuous lines no overtaking.
- **Segregate** - Centre Lines separate carriageways, lane lines keep traffic apart, including buses and bicycles; ghost islands provide non trafficked refuges.
- **Guide** - Directional Arrows indicate best turning lane, letters can indicate where a road is leading. At night edge lines are often the only indication of the carriageway.

It is the road safety benefits of road markings that have frequently been promoted as their prime benefit for road users and policy makers, with only limited research into other areas of benefit such a travel timesavings and congestion reduction for road users.

In his paper ‘Benefit-Cost Analysis of Lane Marking’ (Transportation Research Record 1334), Ted R. Miller identified specific benefits accruing from well-marked highways that resulted in timesavings and congestion reduction. Miller’s analysis indicated that the findings were statistically robust and that for all roads the benefit –cost ratio was 76. From this analysis it can be clearly demonstrated that a well-marked highway works to support the economic imperatives of reducing congestion in addition to the road safety benefits that are also obtained. Source: TRR1334 Publication date not known

MARKING MAINTENANCE AND QUALITY IN THE UNITED KINGDOM



As a consequence of the clear benefits that attract to road users and public policy makers from well-maintained and effective markings it could be assumed that the road-marking network would be maintained to a high standard with pro-active investment in developing the network.

Minimum standards for road marking performance have been introduced since 2004 following extensive revision of Highways Agency (HA) maintenance standards with the introduction of the standard TD26/04, however these standards are not compulsory for non HA roads and local authorities following the lead of the County Surveyors Society have set minimum standards at 12.5% lower than the Highways Agency.

The only national studies undertaken into the performance and quality of road markings have been those undertaken using dynamic (vehicle mounted) monitors by the Road Safety Markings Association (RSMA) since 1996.

Figure 4, Source: RSMA Up to the Mark Reports 2001, 2002, 2003, 2005, and 2006

Type of road	%age below 100mcd - 2001	%age below 100mcd - 2002	%age below 100mcd - 2003	%age below 100mcd - 2005	%age below 100mcd - 2006
Motorway	39	43	35	56	30
Dual Carriageway A roads	38	60	48	51	11
Single Carriageway A Roads	44	60	58	44	29

As a result of technical changes on monitoring equipment and a change in the European standards only data collected since 2001 is comparative and a summary of these findings are shown above.



These studies indicate the level of performance of road markings operating at below the minimum level of specifiable performance under the required European Standards equates to about one third of the entire 'A' road and Motorway network with lower performance levels recorded on local authority maintained roads. (This figure may be higher as the sample of A Class single carriageway roads in the 2006 survey was significantly restricted as a result of technical problems in measurement)

These results represent a fundamental under performance in terms of safety and operational capacity for the UK road network resulting from under investment and whilst the Highway Agency has taken steps to improve performance there are still issues surrounding whether their intervention levels are satisfactory or not and significant issues regarding the levels of under performance on their network.

The cost of marking maintenance when placed in context of the overall highways maintenance budget is estimated at circa £108 per km. When measured against HA and Local Authority spend of a total of circa £5.9bn this represents approximately three quarters of one per cent of total highways spend.

The level of investment when placed in the context of the clear benefits from a well-maintained and developed road-marking network, provide a source of concern. Although improvements in car design and additional road safety features are continuously added to car manufacture, maintenance budgets on local roads and particularly rural roads have not received co-ordinated investment, with a resultant backlog in maintenance levels and standards as reported in the CSS Road Condition Survey 2005.

Research into road casualty statistics 2005 has revealed the following results on Non Built Up Roads, which include rural roads

Figure 5, Source: Department for transport 2005

Non Built Up Roads				
	A class	B class	Other	Total
KSI	7,561	1,889	2,372	11,822
All Severities	46,526	10,853	16,799	74,178
Totals	57,087	12,742	19,171	86,000

In 2005 the total casualties, all severities was 271,017, the 86,000 above represents 32% of all accidents occurring in non built up areas. Additional research from the same statistical source indicates that that 42% (108,000) occur during the hours 5.00 pm and 6.00 am

Placing these figures within the context of the research (shown above) into the accident reduction data from improved markings schemes, where quality road markings are proven to reduce accidents, particularly, night time accidents by more than 40% identifies the true cost to the economy of the failure to adequately maintain the road markings on our highways network.

ACCIDENT REDUCTION – REDUCING THE EMOTIONAL AND ECONOMIC COST OF ACCIDENTS ON UK ROADS

Britain has long taken a leading role in road safety and has taken pride form its performance in reducing accidents and meeting targets, however between 2001 and 2004 statistics drawn together by the European Road Federation shows that the rate of accident reduction in Britain is lagging behind similar EU states and that of the EU 15 states. Figure 6, Source: ERF European Road Statistics 2006

Nation	UK	Germany	Holland	France	EU 15 average
% Reduction in accidents 2001-04	7.0%	9.5%	15.0%	26.8%	15.5%

Notwithstanding the under performance against our European neighbours, performance is in line with the targets set by the Government through to 2010, however, this appears to be driven by strong performance prior to 2001, furthermore there is a valid question as to whether the level of accidents and the cost to our communities is acceptable, especially when low cost solutions are available and capable of reducing accidents still further. Figure 7, Source: Department for Transport 2005

	KSI	Children KSI	Slight Injuries	Total
Average 1994/98	47,656	18,548	272,272	338,476
Actual 2005	31,929 33% reduction	11,250 39% reduction	238,832 13% reduction	271,017 19.9%reduction
Target 2010	28,600 40% reduction	9,274 50% reduction	245,045 10% reduction	282,919 16.4%reduction

In 2005 the total cost of injury accidents was a staggering £12.81 billion, whilst EURORAP UK data sets this figure in terms of costs to UK GDP of 1-2 % at £15 billion.

An increase in maintenance spending, particularly on road markings, could provide a major contribution to reducing accidents. Even if the lowest return rates identified above from the Molasses data base (using 1995 to 2006 data), indicating an average reduction of 32%, were adopted during an investment programme of improving road marking quality and standards, the returns based on EURORAP accident cost estimates would total £4 billion saved in reduced accident costs.

Source: EURORAP/AA FOUNDATION 2006/RSMA 2007

DRIVER BEHAVIOUR – INFLUENCING BEHAVIOUR AND REDUCING ACCIDENTS

Many of the road safety benefits from improved road marking infrastructure result from the influence the markings may have on driver behaviour and it is in this area that research commissioned by the European Union has identified how improved markings can be used to improve safety and influence driver behaviour.

The Project entitled **COST 331** was commissioned by the Directorate - General Transport and published in 1999 with the aim was to establish an up to date scientific method with which to determine the optimum road marking designs (which ensure that markings are visible by day and by night, in all weather conditions). The findings provide the necessary background to industry and road traffic engineers to improve – where necessary – the current value of road markings for drivers and have already influenced the UK Department for Transport policy on the width of road markings on some (but not all) arterial routes.

The research program included the following five overall research sections:

- The state of the art report which is a compilation of all longitudinal markings in each country
- Evaluation of drivers visual needs – An experiment in the VTI driving simulator
- Effects of markings on driver behaviour. A series of tests in several countries in a test car developed by VTT in Sweden
- Impact of road studs on road marking visibility and on mechanical and noise effects

COST 331 Results

In summary the main findings showed that:-

- Positioning of the vehicle on the road improved with the better quality of the markings
- Speed increased a little, but not dramatically, with improved driver comfort associated with clearer markings
- Reaction time varied with the quality and width of markings
- A maximum reaction time of 1.8 – 2.0 seconds was considered as safe for the motorist

The end result of COST 331 in Europe

The absolute minimum level of retro reflectivity to produce a reaction time of less than 2.0 seconds is 100 milicandelas / lux/metre sq. (It is this level that the RSMA research outlined above indicates is not reached by up to a third of markings on all UK A roads and motorways)

Consequently Germany has increased the lane line minimum width on all high-speed roads to 15 cm wide and there has been a major increase in the use of wet night visibility markings throughout the EC, with the exception of the UK.

The majority of European countries have now moved to wider markings on high-speed roads

The COST 331 research project proved good clear delineation with road markings as a key factor in “driver reaction time”

100-milicandelas/ lux/metre sq. is the absolute minimum retro reflectivity required to achieve the required less than 2.0-second reaction time

Currently 30% of our driver population are over 50 and it is forecast to increase over the next few years. It is a fact that aging drivers are less reactive than younger people

COST 331 and tests in Germany show that only 50% of the width of the line is focused on by the eye, the wider the line the more impact. Increasing retro reflectivity and width of line improves the visibility of the road markings.

The above research proves that effective road markings influence driver behaviour, maintaining markings to the required standard of performance must contribute to improving road safety and reduce accidents.

ACTION TO MAKE OUR ROADS SAFER AND MORE EFFICIENT

The evidence from Local Authority and Highway Agency roads clearly evidences the road safety and road efficiency outputs from improved road marking infrastructure. Related to this is the relatively low capital investment required to provide substantial returns for road users and public policy makers.

Research shows that there is significant under investment and resultant under performance in the UK road-marking infrastructure, at the same time the decline in UK accident levels is poor in comparison with equivalent European countries.

The road marking industry has the skills and products to improve the performance standards and quality of our road markings to the levels experienced in other European Union members.

Road markings are a national asset and should be maintained to a high standard

- The asset value is estimated to be in the region of £300,000,000
- Minimum retro reflective standards requirements should be increased to 150-milicandelas/lux/metre sq.
- Minimum Maintenance Standards should be increased to 100 milicandelas
- Current expenditure on markings is £50,000,000 and £10,000,000 on road studs
- To maintain the asset to required levels on a regular basis will require an increase in expenditure to an estimated £90,000,000 on markings and £14,000,000 on studs
- Existing contracts should be included in the TD26 requirements
- Monitoring of road marking performance in Local Authorities should be mandatory in line with the current Highways Agency requirements as set out in TD 26/05
- Funding should be allocated to Local Authority maintenance budgets to meet the requirements and ring fenced

APPENDIX A

1.1 Performance and standards

There are a number of specific documents, which govern the use and performance of road markings and road studs in the UK. These are listed below: -

1.1.1 E. U and British Standards

- For road markings –
BS EN 1436 (1998) Road Marking Materials – Road Marking Performance for Road Users
BS EN 1824 (1998) Road Marking Materials – Road Trials
BS EN 1790 (1998) Road Marking Materials – Physical Properties

Drop on Materials – BS EN 1423 (1998) Glass Beads and Antiskid
Premix Glass Beads – BS EN 1424 (1998)
- For Road studs - BS EN 1463 –1 (1998) & BS EN1463 -2 (2000)

1.1.2 Traffic Signs Regulations and General Directions 2002 – Statutory Instrument outlining operational and dimensional requirements of road markings and signage.

1.1.3 Specification For Highway Works (SHW) – Highways Agency Specification outlining requirements for road furniture and works, including road markings

1.1.4 Traffic Signs Manual (Chapter 5 and Chapter 8) – Department for Transport's guides to in situ usage

1.1.5 TD 26/05 (revision due in 2007) – Highways Agency Maintenance Standard for road markings, defining intervention and replacement and inspection criteria

1.1.6 StanSpec (published by RSMA in partnership with Road Marking Forum) – Specification document and notes for Guidance for public and private sector road marking specifiers.

With regard to road marking performance, two particular standards are of greatest relevance, as follows: -

BS EN 1436, which is based on six elements: -

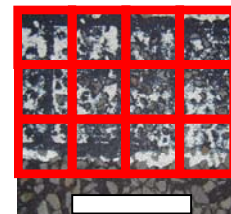
- Functional life
- Reflection in daylight or under road lighting (Luminance Coefficient Qd)
- Luminance factor under dry conditions
- Retro- reflection under vehicle headlight illumination (RL)
- Colour (Corner points of Chromaticity)
- Skid Resistance (SRT)

The specifying engineer can choose from a series of tables of minimum requirements of performance, which may meet his needs. The key to nighttime driving is retro reflectivity (RL) The UK minimum requirement is 100-milicandelas/lux/metre sq. and is usually the basis of most engineers' requirements with a few exceptions.

and

TD26/05 - which sets out, the minimum maintenance performance requirements for, retro-reflectivity, luminance, skid resistance and wear. At this present time the intervention level for maintenance is set at 80-milicandelas/lux/metre sq

Wear index photo grids for TD 26



APPENDIX B

Durability of road making materials

The durability of road markings depends on three factors, traffic volume, materials used and thickness applied

Standards and specifications restrict the thickness and width of roadmarkings so manufactures produce materials to meet traffic volumes and contract guarantees

BS EN Standard 1463 specifies performance requirements in various categories, which the specifying engineer can choose from. A road test certificate for each product is required. Road tests in the UK are for one year with an approximate traffic count of 1,000,000 roll –over

Materials

There are generally four basic road-marking materials on roads, thermoplastic, paint, two-component resin based systems and preformed. Each one of these systems use reflective glass beads to provide the required retro reflectivity

Thermoplastic

Of the worlds population of road markings probably 20-25% is with thermoplastic markings. Thermoplastic is generally used in colder climates and currently 95% of UK markings are thermoplastic

Thermoplastic is applied hot at temperatures of 200 degrees C. Thickness is from 1.5mm to 3mm dependant on the application process. Speed of application up to around five kms per hour, whilst effective (or functional life) varies between two years to five years dependant on location and traffic volumes

Generally retro reflective performance is in the range 80– 120 mcd/lux/m² varying with the exposure of the retro reflective beads within the mix and also applied to the surface

Paint

It is estimated that paint is used for approximately 70–75% of the world's population of road markings. Paint is used currently on 80% in France and 60% of markings in the USA

The benefit of paints that it does not require heating and can be applied very quickly at speeds up to 15 kms per hour, has little build up and has an affinity to glass beads which improves their retention and consequently the retro reflectivity of the marking. The draw back is that the application window is restricted to May until October because of weather conditions

Improved acrylic resins have increased durability and performance waterborne paints when compared with the old solvent based paints. Durability of between 2 - 3 years dependant on traffic volumes with high retro reflectivity within the range 140 – 250 can be expected

Two component resins (Cold plastic)

There are several two component resins used in road markings the predominant one in Europe being Methyl Methacrylate (MMA) This is often referred to as “Cold Plastic” MMA uses two resins which are mixed together within the application process; output is slow, around five kms per hour, and the product has a cure time up to 30 minutes. However irrespective of these drawbacks it has high output performance. High retro reflectivity in dry and wet conditions, coupled with its durability of up to ten years or more, make it a very worthwhile quality product and its use is increasing throughout Europe.

Preformed Road markings

These come in two types, preformed thermoplastic (which is ideal for repairs and symbols etc) and preformed resin coated rubber tape. The latter preformed tape is used in many situations in Europe and the USA as a high performance road marking for permanent markings as well as temporary road works situations. It has good wet night retro reflectivity properties. The benefits of this type of product is the durability and high performance. Retro reflectivity is between 300 and 1000 mcd/lux/m² and life expectancy up to ten years or more. The drawbacks are the slow application, ambient temperature restrictions and overall cost which is in the region five to ten times thermoplastic.

Materials used for road marking

The introduction of the new Standard, BS EN 1436 in 1998, released the previous restriction on the composition of road markings. This meant that the manufacturer could now use any material to produce the required performance shown in the Standard.

The UK road marking market has been predominantly thermoplastic for many years with only a small amount of paint being used in specific areas.

BS EN 1436 has encouraged the use of high performance products to be considered from mainland Europe such as acrylic waterborne paint and two component resin systems.

Retro-reflective glass beads, which are incorporated within and/or on top of road markings to provide the retro reflectivity of the marking at night, have also dramatically improved in performance.

Consequently it is now not uncommon for markings to be able to provide retro-reflectivity results in the range 200 – 500 mille-candelas/lux/metre sq. or even higher.

The results referred to above have been accepted in Europe and the USA for some years. However, the standards and maintenance requirements in the UK have consistently remained lower

If we are to sustain or improve on the current level of accident rates, whilst experiencing the current forecasts of increased traffic, maintaining markings to high standard must be a priority!