Early life skid resistance – an assessment of accident risk

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ABSTRACT

For some years it has been suspected that new asphalt surfacings may have different skid resistance properties to surfaces that have been in service for some time. This is thought to be due to the presence of a film of bitumen binder on the new surface that is eventually removed by weathering and traffic. New types of surfacing introduced in the mid 1990s have led to concerns that the risk of early-life skid resistance problems, and the time that any effects last, may have increased. Research has identified physical phenomena that might lead to an increase in accident risk in some circumstances.

This paper summarises the methodology and results of a study to investigate if a link could be observed between new surfacings and accident risk. The study used a combination of an analysis of accidents before and after resurfacing on the Highways Agency (HA) network, and collation and review of anecdotal comment from the HA's Area Teams and Service Providers, and from other Highway Authorities. The findings from this study are generally consistent with the physical phenomena that have been measured on new asphalt surfacings. Neither of the approaches used in the study identified widespread problems with modern asphalt surfacings in their early life but there is evidence of a small increased accident risk in some circumstances.

Full details of the study have been published in TRL PPR205.

1. INTRODUCTION

In the mid 1990s, new road surfacing materials were introduced in the UK that provided advantages such as faster and safer construction techniques, improved ride and reduced tyre/road noise. In the years following the introduction of the new materials there was an increase in anecdotal comment related both to dry and wet skidding resistance in the first few months of service, reinforced by police comments on lower than usual dry friction found in routine stopping-distance skid tests on some relatively new surfacings.

These materials often have a thicker initial binder film than traditional materials, such as Hot Rolled Asphalt (HRA), which may cause them to exhibit different skid resistance properties compared to roads that have been in service for some time. It was thought that the binder film could mask the microtexture of the aggregate in the surfacing and could also soften at the high temperatures generated by severe braking, both of which could affect the friction available.

Previous work has identified physical phenomena that might lead to an increase in accident risk in some circumstances. The report on that study by TRL on behalf of the Highways Agency (PPR060) made a number of recommendations, of which the first was that "Specific research into any link between new surfacings and accident risk should be carried out".

That study has now been carried out, using a combination of:

- An analysis of accidents before and after resurfacing on the Highways Agency (HA) network.
- Collation and review of anecdotal comment from the HA's Area Teams and Service Providers, and from other Highway Authorities.

This paper summarises the methodology and results of the study to investigate if a link could be observed between new surfacings and accident risk. Full details of the study are published in TRL PPR205 (Greene and Crinson, 2008).

2. METHODOLOGY

2.1 BASIS FOR THE ACCIDENT ANALYSIS

The basis of the analysis was a "before and after" study of accident statistics for sections of the Highways Agency (HA) network in the periods before and after a new surface had been laid as a result of maintenance works. The objective was to determine whether any significant changes in accident numbers occurred after the new surfacing had been laid. The analysis was developed through a number of stages which are summarised below.

- Identify sections that had been resurfaced. To achieve this, the location and dates of maintenance treatments undertaken between January 2001 and December 2004 were obtained by examining data from the Highways Agency Pavement Management System (HAPMS) and discussions with HA Service Providers. This resulted in a total of 2136 sections representing 1834

carriageway-km being included in the initial analysis.

- Analyse accidents for all the sections over the year before and year after resurfacing, broken down by quarters to allow for different trends to be identified. This included a breakdown of accidents by road class, severity, section function and perceived accident risk (judged by skid resistance Investigatory Level).
- A more detailed analysis on those sections where modern asphalt surfacings (so-called "thin surfacings") had been laid. This included an examination of accidents by road class, road surface condition and severity and a comparison of accidents on dry and wet/damp roads.
- The first phase had identified locations where resurfacing had occurred but not necessarily along the whole length (or on all lanes of dual carriageways) of the relevant sections. A further analysis was therefore made that was confined to those sections that had been substantially resurfaced (>80% of the lane length) with the same new surfacing material.
- The earlier work, reported by TRL in PPR060, had suggested that the physical phenomena observed on new thin surfacings might also have been present with traditional surfacings such as Hot Rolled Asphalt (HRA). To try and asses whether there was an associated increased accident risk on traditional as well as modern types of surfacing material, an analysis was made of accidents on the limited number of sections on the trunk road network treated in the study period where HRA surfacing had been used.
- General accident trends on the HA network during the analysis period were also determined to set a context for assessing the accident trends seen on the resurfaced sections.

2.2 REVIEW OF ANECDOTAL COMMENT

Requests for information were circulated via HA Area Performance Managers, County Material Engineers and members of the CSS Highway Condition Assessment Group with instructions to circulate it to representatives best placed to provide relevant information. A total of eight responses were received from the HA maintenance areas and 18 from other UK Highway Authorities. Follow-up meetings were also held with some of the Highway Authorities.

Other Highway Authorities were included in this element of the project because parts of their road networks are very different to those of the HA and it was felt that different issues could arise, or be more apparent, on these networks.

3. RESULTS

3.1 ACCIDENT ANALYSIS

The purpose of the accident analysis was to determine whether any significant patterns could be observed when comparing the before and after periods of the analysis and how these related to road type, accident severity and the perceived risk level of the site.

The accident numbers in each quarter after resurfacing (calculated as annual

equivalent values, i.e. the number of accidents in the quarter multiplied by four) were compared with the value for the year before resurfacing and the difference was tested for statistical significance. Throughout the analyses, results that are statistically significantly different at at least the 5% level are highlighted in green (reduction in accidents) or orange (increase in accidents). The change has been shown as the difference in each quarter from the one year before (1YB) value, expressed as a percentage of the 1YB value.

Following consultations with the HA Service Providers it was decided to end the 'before' period 60 days prior to the 'date laid' and commence the 'after' period 30 days later. This effectively gave a zero quarter during which the schemes would have been undertaken.

The results for those sections that had been resurfaced using thin surfacings are presented in Tables 1 to 3. The accident data have been analysed by accident severity, surface condition and road class respectively.

Table 1 Accidents on thin surfacing sections before and after resurfacing by accident severity

Accident severity	No. of accidents per year (annual equivalent)						Percentage change per year from one year before (1YB)				
	1YB	Q0	Q1	Q2	Q3	Q4	Q0	Q1	Q2	Q3	Q4
Fatal	69	28	44	36	44	52	-59.4	-36.2	-47.8	-36.2	-24.6
Serious	261	228	308	228	220	260	-12.6	18.0	-12.6	-15.7	-0.4
Slight	1743	2064	1900	1800	1572	1804	18.4	9.0	3.3	-9.8	3.5
Total	2073	2320	2252	2064	1836	2116	11.9	8.6	-0.4	-11.4	2.1

Table 2 Accidents on thin surfacing sections before and after resurfacing by road surface condition

Road surface condition	No. of accidents per year (annual equivalent)						Percentage change per year from one year before (1YB)				
	1YB	Q0	Q1	Q2	Q3	Q4	Q0	Q1	Q2	Q3	Q4
Dry	1329	1624	1424	1420	1268	1408	22.2	7.1	6.8	-4.6	5.9
Wet/damp	706	672	788	588	556	684	-4.8	11.6	-16.7	-21.2	-3.1
Other/unknown	38	24	40	56	12	24	-36.8	5.3	47.4	-68.4	-36.8
Total	2073	2320	2252	2064	1836	2116	11.9	8.6	-0.4	-11.4	2.1

Table 3 Accidents on thin surfacing sections before and after resurfacing by road class

Road class	No. of accidents per year (annual equivalent)						Percentage change per year from one year before (1YB)				
	1YB	Q0	Q1	Q2	Q3	Q4	Q0	Q1	Q2	Q3	Q4
A	789	868	792	864	728	812	10.0	0.4	9.5	-7.7	2.9
M and A(M)	1284	1452	1460	1200	1108	1304	13.1	13.7	-6.5	-13.7	1.6
Total	2073	2320	2252	2064	1836	2116	11.9	8.6	-0.4	-11.4	2.1

Overall the data show that there was little change in the total number of accidents in the year before and after resurfacing demonstrating that there was little change in the overall accident risk for the lengths of the network included in this analysis..

It can be seen clearly that fatal accidents were significantly lower following maintenance works but there was a significant increase in slight accidents in Q0 and both slight and serious accidents increased in Q1.

The data in Table 2 show increasing accident numbers in the dry in Quarters 0 to 2, with Q0 being significant. A significant increase in accidents on roads in wet/damp conditions also occurs in Q1, but this is followed by significant decreases, compared to the year before, in Quarters 2 and 3.

Table 3 indicates that the significant increases in accident numbers in Q0 and Q1 are occurring on motorways and A(M) roads with a significant reduction occurring in Q3. There are no significant changes in accident numbers on A class trunk roads, although the trends in accident numbers are similar to those on the motorways.

During the period covered by the accident analysis, only a small number of sections had been maintained using Hot Rolled Asphalt (109 compared to 1932 where thin surfacing was used). This means that the total number of accidents on those sections will be small, with greater random variation, and hence less likely to produce significant results. Nonetheless, the results of the analysis for these sections by road surface condition are presented in Table 4.

Table 4 Accidents on HRA sections before and after resurfacing by road surface condition

Road surface condition	No. of accidents per year (annual equivalent)						Percentage change per year from one year before (1YB)				
	1YB	Q0	Q1	Q2	Q3	Q4	Q0	Q1	Q2	Q3	Q4
Dry	58	84	64	52	56	80	44.8	10.3	-10.3	-3.4	37.9
Wet/damp	37	20	16	20	28	16	-45.9	-56.8	-45.9	-24.3	-56.8
Other/unknown	3	0	0	4	4	4	-100	-100	33.3	33.3	33.3
Total	98	104	80	76	88	100	6.1	-18.4	-22.4	-10.2	2.0

As for the thin surfacing sections, the data show that the overall numbers of accidents did not vary significantly between the before and after periods. However, although not significant, there was a increase in accidents during Q0 which was linked to a significant increase in accidents on dry roads. The increase in accidents on dry roads was also seen on the thin surfacing sections but on those sections it persisted into Q1. There were significant reductions in accidents occurring on wet/damp roads (Q0, 1, 2 and 4). Again this differs slightly to the data for thin surfacings where significant decreases occurred only in Q2 and 3 and were preceded by a significant increase in Q1.

3.2 ANECDOTAL COMMENT

Most of the responses from HA Service Providers reported that they were not aware of any unusual incidence of accidents on new surfacings. There were only three reports of skid resistance problems having been encountered and these related to a small number of specific cases, namely:

- Loss of control accidents on the bend of a motorway slip road,
- Loss of control accidents on bends on two A class roads, and
- A vehicle skidding on the approach to a roundabout at the top of a slip road.

Slightly more varied responses were received from the other Highway Authorities, but again many reported that they were not aware of any unusual incidence of accidents on new surfacings. Where problems were believed to have been encountered, they were mainly associated with loss of control accidents on bends, sometimes at relatively moderate speeds, both in wet and dry conditions. As could be expected it was often difficult for the respondents to definitely state the surfacing as a causation factor, but they believed that it was a contributing factor.

One of the Highway Authorities felt that problems they had encountered in the early days of using thin surfacings may have been due to the material specifications used at the time: these contained higher binder contents than used commonly now.

3.2.1 Other data

In addition to the anecdotal comment, accident analyses were received from two of the Highway Authorities. It should be noted that these analyses were not undertaken on the same basis as those in this study. Nonetheless, they did compare accident numbers on lengths of carriageway both before and after resurfacing.

In one case the after period was one year, while the other examined all data available following resurfacing and also the initial six month period. Both sets of data showed that the number of accidents increased at some sites but reduced at others. Overall there was little change in the number of accidents before and after resurfacing.

4. CONCLUSIONS

There were some variations but overall the accident data show that on trunk roads:

i. In the twelve months following resurfacing the accident risk is similar to or lower than before resurfacing.

ii. There is a significant decrease in fatal accidents on the resurfaced sections.

iii. There is a small, but statistically significant increase in accident risk in the initial months after laying modern asphalt surfacings. This is associated mainly with accidents on motorway and A(M) sections and those occurring in dry conditions.

iv. Although accident numbers increase by a small proportion on new surfacings, the additional accidents are in the "slight" severity category.

v. The period of increased risk appears to last for up to about six months after laying.

vi. Some of the accident increases are also apparent on more traditional surfacings but are probably shorter lived, although the numbers of sections for which data are available are too small to provide a robust study.

vii. In addition the accident rates on the resurfaced sections are somewhat lower than those for the entire HA network. However, the nature of the sections included within the analysis may not be indicative of the network as a whole.

The information from the anecdotal reports suggests that early life skid resistance issues are not widespread, either on the HA or other UK Highway Authority networks. However it would appear that it could be a contributory factor in a small proportion of accidents, that occur mainly on bends.

The findings from this study are generally consistent with the physical phenomena that have been measured on new asphalt surfacings.

Neither of the approaches used in the study identified widespread problems with modern asphalt surfacings in their early life but there is evidence of a small increased accident risk. Therefore, in the light of this evidence it was recommended that:

1. Current guidance on the use of warning signs for new asphalt surfacings should be reviewed and updated where justified.
2. Work to follow up the other recommendations of the previous research should continue: this should include work on methods to mitigate risks and further studies to improve understanding of the physical phenomena.
3. The need and methods for providing drivers with better information should be reviewed in the light of this report and the findings from recommendations 1 and 2 outlined above.

5. ACKNOWLEDGEMENTS

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6. REFERENCES

Greene M J and Crinson L (2008). Early life skid resistance – an assessment of accident risk. TRL Published Project Report PPR205. Crowthorne.

Roe P G and Lagarde-Forest R (2005). The early life skid resistance of asphalt surfaces. TRL Published Project Report PPR060. Crowthorne.

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