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The performance of road surfacing in Scotland

Scottish Inspection Panel Report 2018

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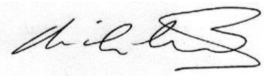
(Technical Reviewer)</td><td></td></tr>
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Executive summary

The Scottish Inspection Panel (SIP) was established by Transport Scotland in 2008 and consists of a team of experienced road engineers who are tasked with assessing the condition of pavement surfacings on Scotland's trunk road network. Annual surveys focus primarily on two-year-old sites that have been resurfaced as part of maintenance schemes. Older surface courses are also identified and selected to assess their current condition and longer-term performance. The process allows an assessment of the quality of the material and installation. The year-on-year surveys allow the identification of recurring issues and these are highlighted and corrective action plans developed. Where a concern is identified, subsequent SIP inspections are used to evaluate the effectiveness of the action plans.

The 2018 survey was carried out in the week commencing 3 September 2018. Transport Scotland's Integrated Road Information System (IRIS) was used to provide information on materials laid during the 2016/17 surfacing season (i.e. those that were nominally two years old) and previously assessed older sites ranging between four and seven years old. A total of 58 sites was assessed by the SIP inspection team: 40 two-year-old sites; 15 older sites; and three sites of special interest.

Seventy-five per cent of the two-year-old surfacing sites were assessed as defect free and performing well. A comparison with previous surveys showed that the 2018 results represent a slight drop in performance, but are within the natural variation of results recorded in recent years. The most common surface defect was aggregate loss, encountered at 20% of the two-year-old sites. More open and/or fretted joint defects were also observed when compared to recent past surveys. The data collected on older sites comprising TS2010 surface course is encouraging as it suggests that TS2010 materials could achieve double the service life of previous estimates for Scottish Clause 942 mixtures.

This report discusses the use and performance of 14mm mixtures and the influence of laid thickness of surface course on future performance. Several sites of interest were also visited including a Hot Rolled Asphalt (HRA) modified with recycled plastic pellets, a TS2010 material that recorded above average high speed friction results, and a heavily trafficked eight-year-old roundabout surfacing.

Based on the observations and results of the 2018 SIP survey, several recommendations are made. The report highlights that the life of all surfacing material, including TS2010, can be compromised by poor working practices. The need for a system or process that will stop the laying of cold materials to avoid expensive remedial works and consequent disruption to the travelling public is emphasised. It is also recommended that a survey should be carried out in 2019 to help ensure that the momentum to improve performance is maintained, to enable the evaluation of changes already implemented, and the identification of further positive changes.

1 Introduction

The Scottish Inspection Panel (SIP) was established by Transport Scotland in 2008 and consists of a team of experienced road engineers who are tasked with assessing the condition of pavement surfacings on Scotland's trunk road network. Annual surveys focus primarily on two-year-old sites that have been resurfaced as part of maintenance schemes. Older surface courses are also identified and selected to assess their current condition and longer-term performance. The process allows an assessment of the quality of the material and installation. The year-on-year surveys allow the identification of recurring issues and these are highlighted and corrective action plans developed. Where a concern is identified, subsequent SIP inspections are used to evaluate the effectiveness of the action plans.

The SIP team members represent Transport Scotland, the Mineral Products Association (MPA) Scotland and TRL. Each year the team assesses the surface condition of a number of pre-selected sites (Figure 1.1). The results are compared to those from previous SIP surveys which include materials of a similar age. The visual assessment also documents any features that could affect the service life of the materials, which helps establish initial causes and typical modes of failure.

Figure 1.1: SIP 2018

This report describes the results of the 2018 survey which was carried out in the week commencing 3 September 2018. The report provides information on the sites visited and reports the condition of the surfacing materials. The collected data is discussed and compared to other historical information, including results from previous SIP surveys and information held on Transport Scotland's Integrated Road Information System (IRIS). The findings from the 2018 survey are discussed and recommendations made.

2 Site Inspections

2.1 Site Selection

Transport Scotland’s pavement management system, IRIS, was used to provide information on materials laid during the 2016/17 surfacing season, i.e. nominally two years old. Older TS2010 surface courses (TSIA No 35, 2018) that had been previously assessed were also selected to determine their current condition and performance to date. A total of 58 sites was selected for inspection. The approximate site locations are shown in Figure 2.1.

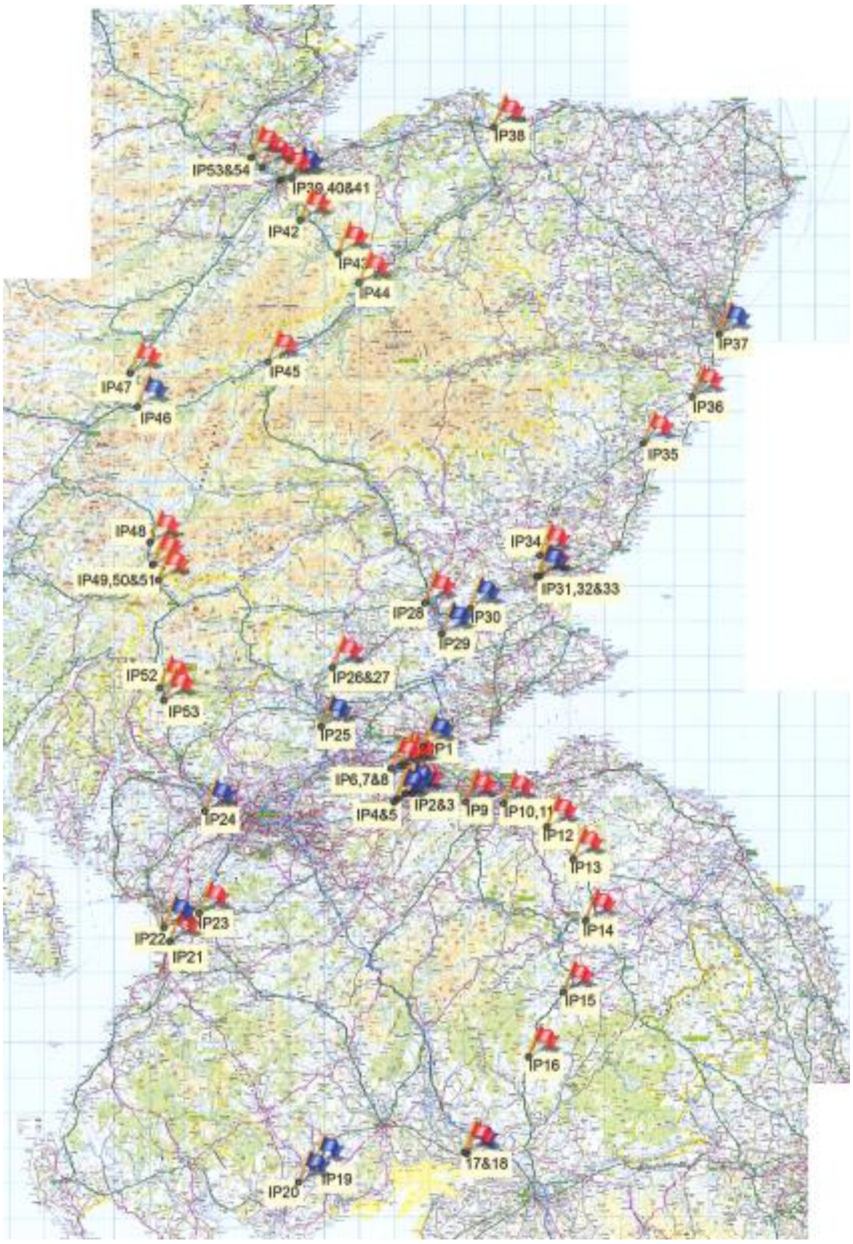

Figure 2.1: SIP 2018 site locations

Key: Two-year-old sites Older sites

As the surfacing season typically runs from April in one year to March in the following year, the actual age of the surface course at the time of inspection can range between 18 and 30 months. The condition of the surface at the nominal age of two years is selected as it provides a good indicator of the likely future performance of the surface course. Previous visual assessment exercises have shown that if a surface is free of defects at this stage, it is likely to provide a good service life.

2.2 Inspected sites

All sites inspected were allocated specific acronyms, e.g. IP1, IP2, etc. This is for the purpose of retaining supplier anonymity throughout the report. In some instances the site assessed is subdivided into separate parts and this is denoted by a subscript, e.g. $IP2_a$. This is typically done when the site contains areas that are subjected to different levels of traffic stress or appear to contain materials that are distinctly different. In addition three sites of special interest were visited and denoted as IPS1, IPS2 and IPS3.

All of the sites that were inspected are shown in Table 2.1. The table includes the age of the surface course at the time of inspection, material type and an estimation of traffic stress for the section being assessed.

2.3 Inspection Method

The sites were assessed visually and ranked in accordance with the TRL Scottish Inspection Panel marking system (McHale *et al.*, 2011). Full details of the method of inspection, including the meaning of each mark and defect suffix, are described in Appendix A.

Table 2.1: Inspected sites

Site No.	Type	Stress Level	Age (yrs.)	Site No.	Type	Stress Level	Age (yrs.)
IP1	TS2010	L/M	7.4	$IP30_a$	TAC	M	6.4
IP2	TAC	M	2.5	$IP30_b$	TS2010	M	6.4
IP3	TS2010	M	1.8	$IP30_c$	TS2010	M	6.4
IP4	TS2010	M	6.8	$IP30_d$	TAC	M	6.4
IP5	TS2010	M	5.2	$IP30_e$	TAC	M	6.4
IP6	TS2010	M	1.8	IP31	TS2010	L	6.2
IP7	TAC	M	2.6	IP32	TS2010	L/M	1.8
IP8	TS2010	M	1.9	IP33	TS2010	H	1.8
IP9	TS2010	M	2.2	IP34	TS2010	L/M	1.7
IP10	TS2010	M	1.8	IP35	TS2010	M	1.6
IP11	TS2010	H	1.8	IP36	TS2010	M	2.0
IP12	TS2010	L	1.9	$IP37_a$	TS2010	M	5.2
IP13	TAC	L/M	2.2	$IP37_b$	TS2010	M	5.2
IP14	TS2010	M	1.4	IP38	TS2010	M	1.9
IP15	TAC	M/H	1.4	IP39	TS2010	M	6.9
IP16	TAC	M/H	2.0	IP40	TS2010	M	1.5
IPS1	HRA	L/M	0.9	IP41	TS2010	M	2.3
IP17	TS2010	M	4.9	IP42	TS2010	L	2.1
IP18	TS2010	M	2.4	IP43	TSMA	L/M	2.0
IP19	TS2010	L	4.8	IPS2	TS2010	L	4.1
IP20	TS2010	M/H	5.0	IP44	TSMA	M	2.4
IP21	TS2010	M/H	2.3	IP45	TSMA	L	2.8
IP22	TS2010	H	7.2	IP46	TSMA	L	13.3
$IP23_a$	TS2010	M	2.1	IP48	TSMA	L/M	1.4
$IP23_b$	TS2010	M	2.1	IP49	TSMA	L/M	2.0
$IP23_c$	TS2010	M	2.1	IP50	TSMA	M	2.4
IP24	TS2010	M	6.2	IP51	TSMA	M	1.5
IP25	TS2010	M/H	5.0	IP52	TS2010	L/M	1.8
IP26	TS2010	M/H	1.4	IP53	TSMA	L/M	2.2
IP27	TS2010	M/H	1.4	IP54	TS2010	M	2.2
IP28	TAC	H	2.3	IP55	TS2010	M	1.5
IP29	TS2010	M/H	6.0	IPS3	TSMA	H	9.0

KEY:

TSMA: Thin stone mastic asphalt with unmodified bitumen and added fibres (Clause 942, MCHW 1); TAC - Thin asphaltic concrete with polymer-modified bitumen (Clause 942, MCHW 1); TS2010 - stone mastic asphalt with polymer modified bitumen and added fibres (TSIA No 35, 2018); and HRA – Hot Rolled Asphalt (Clause 943, MCHW 1).

Stress Level: L- Low stress site; M- Medium stress site; and H – High stress site.

3 Visual Condition

3.1 Results

Table 3.1 shows the visual assessment results for the 2018 survey. In all instances, the panel marks represent the average of seven individual assessments.

Table 3.1: Mean visual assessment results

Site No.	Type	Stress Level	Panel Mark	Agg. Size mm	Site No.	Type	Stress Level	Panel Mark	Agg. size
IP1	TS2010	L/M	*E/G*	10	IP30a	TAC	M	*S -vc*	14
IP2	TAC	M	*G*	10	IP30b	TS2010	M	*M -v*	14
IP3	TS2010	M	*G/M v*	10	IP30c	TS2010	M	*G*	10
IP4	TS2010	M	*G*	10	IP30d	TAC	M	*M -j_o*	10
IP5	TS2010	M	*G*	10	IP30e	TAC	M	*G*	10
IP6	TS2010	M	*G/M -*	10	IP31	TS2010	L	*E/G*	10
IP7	TAC	M	*E/G*	10	IP32	TS2010	L/M	*E/G*	10
IP8	TS2010	M	*E/G*	10	IP33	TS2010	H	*M -v*	6
IP9	TS2010	M	*G*	10	IP34	TS2010	L/M	*E*	10
IP10	TS2010	M	*G*	10	IP35	TS2010	M	*E*	10
IP11	TS2010	H	*E*	10	IP36	TS2010	M	*E/G*	10
IP12	TS2010	L	*E/G*	10	IP37a	TS2010	M	*G*	10
IP13	TAC	L/M	*G/M*	10	IP37b	TS2010	M	*G*	6
IP14	TS2010	M	*G*	10	IP38	TS2010	M	*E/G*	10
IP15	TAC	M/H	*G jo*	10	IP39	TS2010	M	*M -v*	10
IP16	TAC	M/H	*M -vj_o*	10	IP40	TS2010	M	*G*	10
IPS1	HRA	L/M	*G/M -v*	-	IP41	TS2010	M	*E/G j_o*	10
IP17	TS2010	M	*G/M -*	10	IP42	TS2010	L	*G*	10
IP18	TS2010	M	*E/G*	10	IP43	TSMA	L/M	*S -sj_f*	10
IP19	TS2010	L	*G*	10	IPS2	TS2010	L	*G*	10
IP20	TS2010	M/H	*G*	10	IP44	TSMA	M	*E*	6
IP21	TS2010	M/H	*E*	10	IP45	TSMA	L	*G/M -*	14
IP22	TS2010	H	*E*	10	IP46	TSMA	L	*M/A -vc*	14
IP23a	TS2010	M	*M -v*	10	IP48	TSMA	L/M	*E*	10
IP23b	TS2010	M	*A -v*	10	IP49	TSMA	L/M	*G/M -$j_o j_f$*	14
IP23c	TS2010	M	*E*	10	IP50	TSMA	M	*G*	14
IP24	TS2010	M	*G*	10	IP51	TSMA	M	*E/G*	10
IP25	TS2010	M/H	E	10	IP52	TS2010	L/M	*E/G*	10
IP26	TS2010	M/H	*E/G*	10	IP53	TSMA	L/M	*E/G*	10
IP27	TS2010	M/H	*E*	6	IP54	TS2010	M	*E*	10
IP28	TAC	H	*G/M -*	6	IP55	TS2010	M	*E/G*	10
IP29	TS2010	M/H	G v	10	IPS3	TSMA	H	M -vj_f	6

Key: Colour coded results: Green = ≥ G; Amber = G/M - *M/A; and Red = ≤ A;*

3.2 Assessment of performance after two years in service

Surface courses that are inspected and assessed as either Excellent or Good (coded Green in Table 3.1) after two years in service have proved, from previous surveys, to be likely to have been manufactured and compacted well and to be likely to have good durability and to perform well in the future. Research conducted for Highways England (Nicholls *et al.*, 2010) showed that if this criterion is met, then around 13 years of service life can be anticipated from thin surface course materials such as TSMA and TAC. This service life can be viewed as an optimum as it relates to a surface course material that has been manufactured and installed correctly in accordance with the appropriate specification (MCHW 1). The service life estimates were shown to vary depending on factors such as nominal aggregate size and traffic intensity.

3.2.1 Two-year-old sites

The distribution of the average panel marks for the 2018 survey is shown in Figure 3.1. The pie chart shows that 75% of the sites were assessed as being Excellent or Good, 20% as Good/Moderate, Moderate or Moderate/Acceptable, and 5% as Acceptable or below.

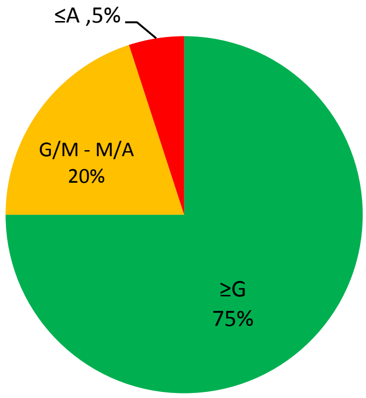

Figure 3.1: Average condition markings

The average panel marks for the 2018 survey are also shown in graphical form in Figure 3.2. The sites considered to be performing well have been circled. These sites lie above or are close to the idealised deterioration line developed by Nicholls *et al.* (2010).

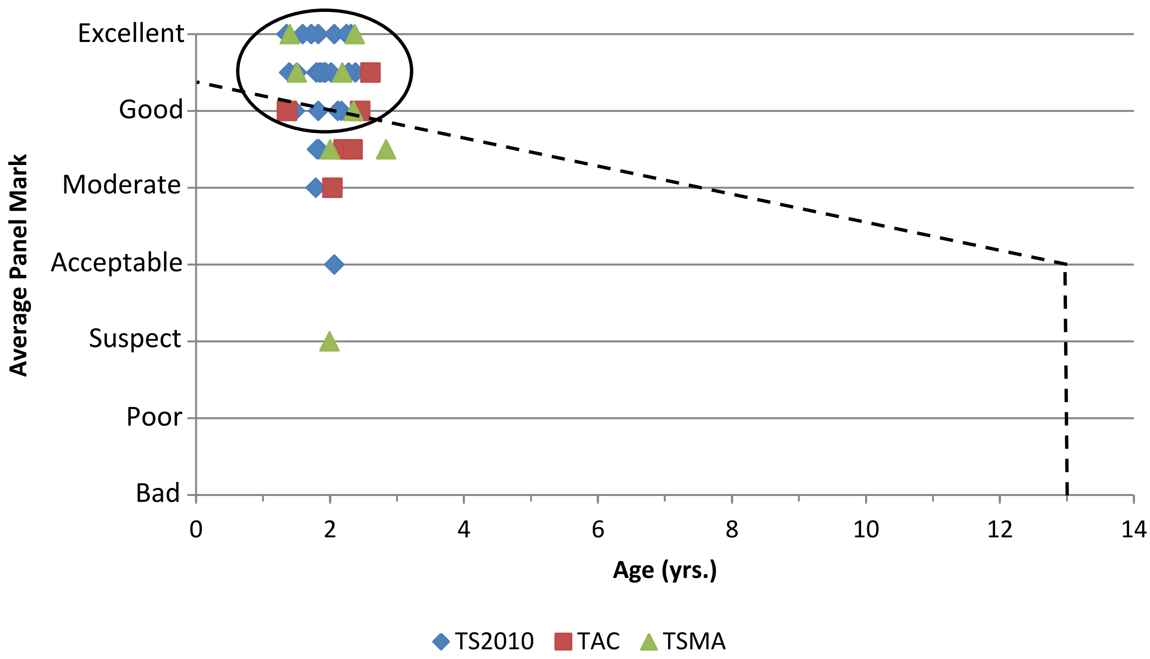

Figure 3.2: Average condition markings versus performance

3.2.2 Comparison with previous two-year-old site surveys

Figure 3.3 compares the breakdown of average survey markings for all SIP surveys undertaken since 2008. It can be seen that the 2018 results represent a drop in performance compared to recent years, although this could be explained by the natural variation witnessed over the last seven years. The figure shows that since 2012 there has been a step change in performance where the Excellent or Good (coded green) varies between 70 and 90%. In general the figure shows that the benefits of doing the SIP, and associated initiatives, have been realised.

The numbers above each data series represent the number of two-year-old sites surveyed in that year. Scaling effects mean that less confidence can be placed on a survey year that includes a small sample size, e.g. 2013*.

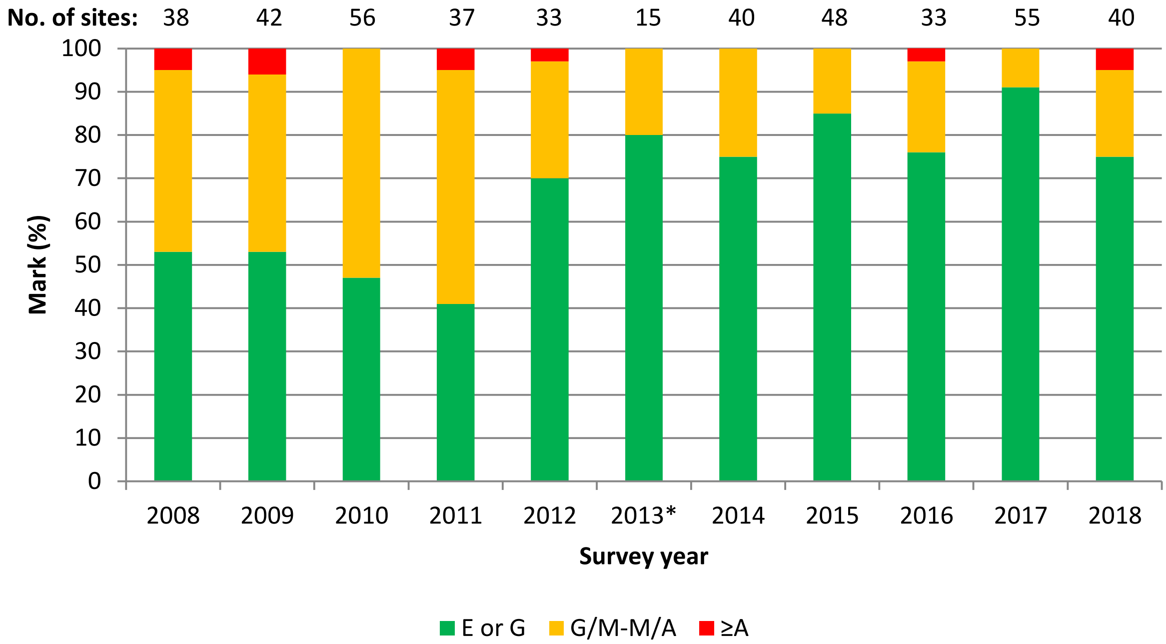

Figure 3.3: Comparison of average markings for SIP from 2008 to 2018

3.2.3 Recorded defects

Figure 3.4 shows the type and percentage of defects recorded over the past eleven SIP surveys. The type and number of defects, expressed as a percentage of the total number of two-year-old sites surveyed, is shown for each survey year.

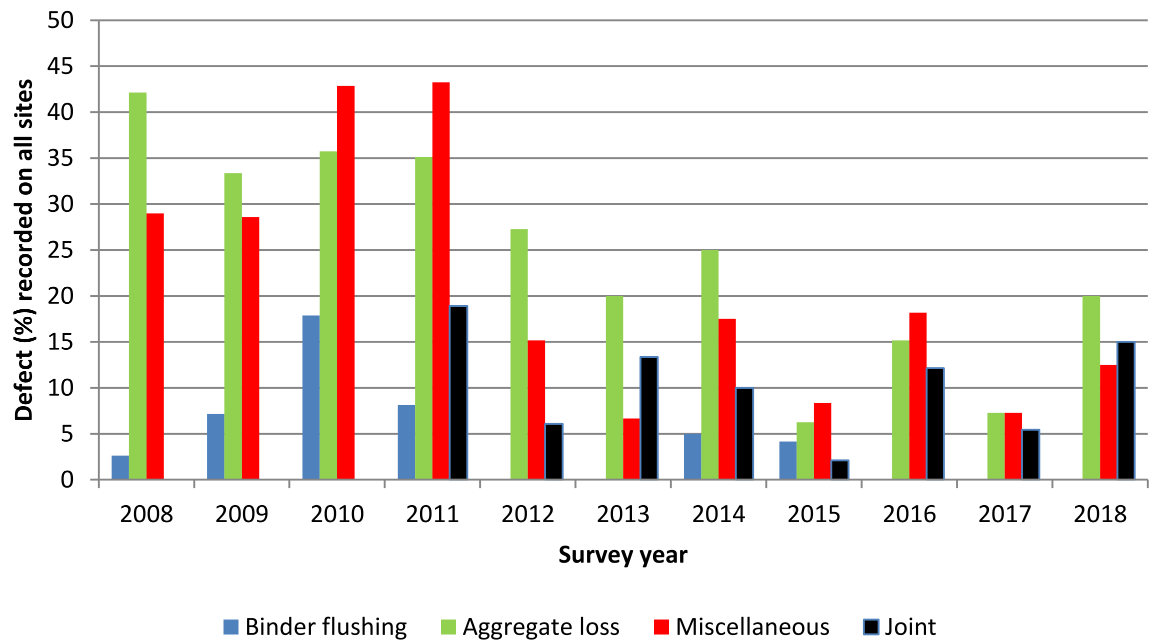

Figure 3.4: Types of defect recorded on SIP surveys

Aggregate loss (coded green) has been highlighted as one of the major defects that affects long-term durability (McHale, 2013). In 2008, 42% of the sites (16) were assessed to exhibit this defect, this compares with only 20% of sites (8) in 2018. An example of aggregate loss from the 2018 survey is shown in Figure 3.5. Although aggregate loss has increased since 2017 it should be noted that the longer-term trend of a decrease in the occurrence of this defect appears to be being maintained.

Figure 3.5: Aggregate loss at IP43 - material (including close-up) on the right

Similarly, more open and/or fretting joints were observed during the 2018 survey. This defect (coded black) has only been recorded since 2011, and the 2018 survey represents the second highest percentage of sites (15%) exhibiting this defect. Evidence from older sites indicates that poorly constructed joints will deteriorate further under the action of weathering and trafficking, resulting in aggregate loss of the adjacent surface course. Figure 3.6 shows an example of poorly constructed longitudinal and transverse joints from the 2018 survey. The surface courses are not tightly tied together and exhibit an open appearance.

Figure 3.6: Open joint at IP16

Miscellaneous defects (coded red) reflect the consistency and quality of the surface courses and their construction. Typical defects include features such as material variability, variability with traffic intensity, de-lamination and cracking. Although only 13% of sites were found to have miscellaneous defects in 2017, compared to 20% in 2018, the occurrence of this defect has remained reasonably constant since 2012 where a step change in performance was recorded.

3.3 Assessing the longer-term performance of TS2010

The opportunity was taken to assess older TS2010 surface courses to assess their current condition and performance to date. Figure 3.7 shows the average SIP markings allocated to sites surfaced with TS2010 between 2014 and 2018. In general the results are encouraging as the majority of the markings lie above the service life estimate line (dotted black) based on research carried out by Highways England (Nicholls *et al.*, 2010). Furthermore, the collected data suggests that the average service life of TS2010 could achieve double the service life of previous estimates for Scottish Clause 942 mixtures (McHale *et al.,* 2011). Mean visual condition marks for a survey carried out in 2006 are also shown in Figure 3.7. The findings of the 2006 survey raised a concern that surface courses were not representing good value for money. Nonetheless, panel marks for TS2010 that fall below the line are of concern and the reasons for low marks from the 2018 survey are discussed in Section 4 of this report.

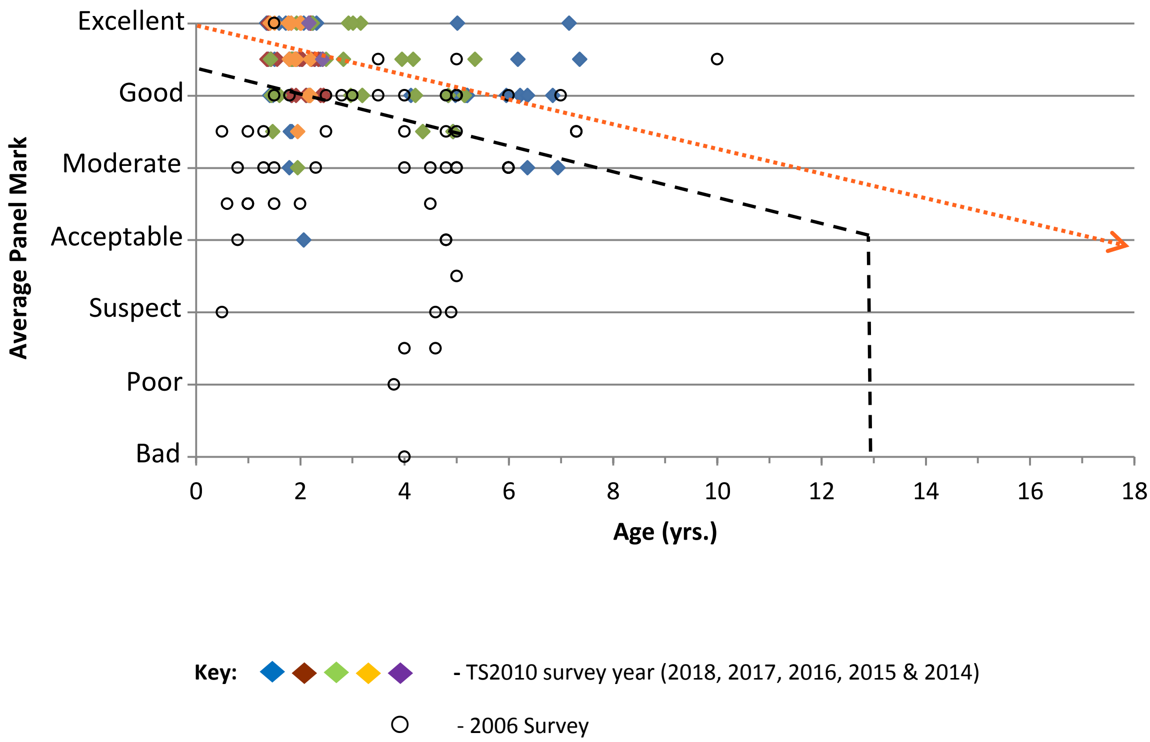

Figure 3.7: Performance of TS2010 to date

4 Discussion

4.1 Aggregate size and mixture type for two-year-old sites

Figure 4.1 and Figure 4.2 show the distribution of nominal aggregate sizes and mixture type, along with their assessed performance. The SIP 2018 survey showed that 10mm mixtures accounted for 82.5% of the sites surveyed. The remainder of the sites comprised 6mm (10%) and 14mm (7.5%). Three quarters of the sites received Good or higher ratings, including 10mm (67.5%), 6mm (5%) and 14mm (2.5%). The amber section represents 20% or eight sites that showed at least one defect, including two 14mm, two 6mm and four 10mm mixtures. The red area represents 5% or two sites assessed Acceptable or less.

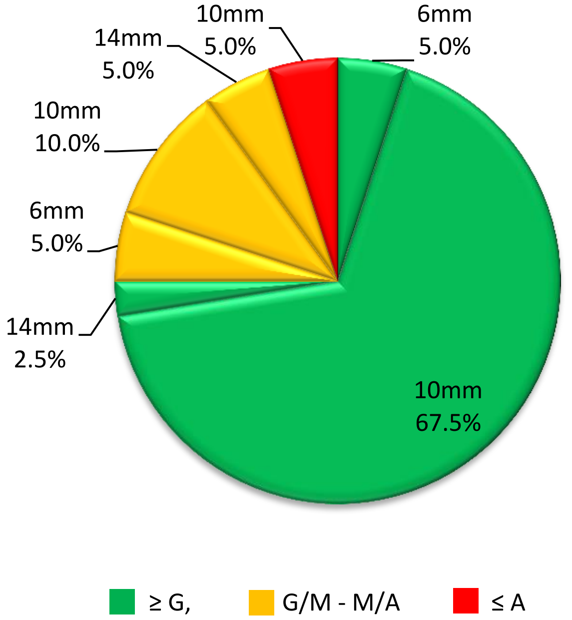

Figure 4.1: Aggregate size used for two-year-old sites

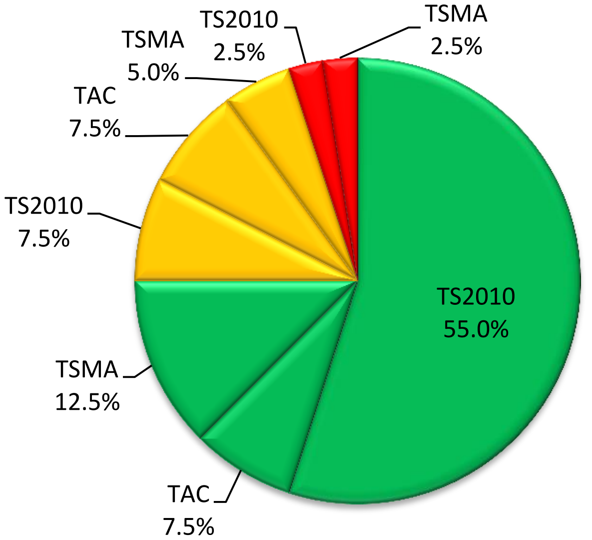

Figure 4.2: Mixture type for two-year-old sites

4.1.1 Sites rated amber

It can be seen from Figure 4.1 that only 7.5% of the sites (3 sites) contained 14mm mixtures. The general reduction in the use of 14mm mixtures over the last few years is partly due to the fact that previous SIP surveys have consistently shown that 14mm mixtures do not perform well, particularly if used on sites that are highly stressed. In the 2018 survey two of the three sites were observed to exhibit at least one defect. Neither site was assessed as being highly stressed: IP45 and IP49 were assessed as light (L) and light to medium (L/M), respectively. Located on the A86 and A82, both sites are situated in rural locations where edge restraint (kerbing) is not provided and where local environmental conditions can be severe, e.g. high levels of precipitation and frost. Both sites were assessed to have an open appearance and judged to have lost aggregate (see Figure 4.3).

Figure 4.3: IP49 – 14mm (G/M - $j_o j_f$)

The use of 6mm mixtures is being actively promoted as they are thought to provide enhanced skid resistance and have been assessed to perform well, attracting Excellent or Good (E/G) ratings. Two of the four 6mm sites exhibited defects: IP28 (TAC) and IP33 (TS2010). It is noteworthy that both sites were located on roundabouts, which attract the highest traffic stresses on the network due to a combination of turning and cornering manoeuvres, and heavy braking. Figure 4.4 shows a general view of IP33, the inset shows an isolated area where aggregate loss has resulted in the formation of a shallow pothole.

Figure 4.4: Site IP33 – 6mm (M - v)

Four sites (10%) surfaced with 10mm mixtures were assessed as having at least one defect. Two sites, IP3 and IP6 (both TS2010) received a G/M mark with a single suffix. Both these sites were assessed during heavy rainfall where the appearance of the surface is difficult to see clearly owing to the presence of standing water. It is possible that these markings could be more severe than might otherwise have been the case if they had been assessed in better weather conditions. Similarly IP13 was given a G/M marking where the recorded suffixes of the individual panel members cancelled each other out, suggesting a borderline mark. However, IP16 (shown in Figure 3.6 and Figure 4.5) was given a Moderate mark with three suffixes (M-vj_o). The site was located in a remote location on the A7 and the appearance of the material suggested a lean mixture (low bitumen content) with possible signs of being cold during compaction, possibly as a result of a long haul distance.

Figure 4.5: Site IP16 – 10mm (M - vj_o) exhibiting a lean and open appearance

4.1.2 Sites rated red

Two sites (5%) were assessed to have significant defects for materials that are only two years old. Site IP23 (TS2010) was broken into two parts as there was clear evidence of a cold load being laid at this site. A continuous linear section on lane one around 40m to 50m in length was clearly observed to have a different appearance from the rest of the scheme which was assessed as Excellent (E). It is important to note that the life of all material, including TS2010, can be compromised by poor working practices. It can be seen from Figure 4.6 that the slow lane (shown to the left of the image) has an open appearance compared to the fast lane (right).

A subsequent discussion by the SIP team led to agreement that this was clearly a cold load, i.e. the material displayed common features associated with laying and compaction of cold material. The consensus of the SIP team was that there is a need for a system or process to stop the laying of cold material to avoid expensive remedial works and consequent disruption to the travelling public. One suggestion was that the use of thermal mapping data, i.e. temperature of material being compacted, could be used to assist the paving team foremen in making a decision to accept or reject material at the time of laying.

Figure 4.6: Site IP23 – cold load detected in lane one

The other site showing significant defects was IP43. The 10mm (TSMA) exhibited significant aggregate loss and some oversized aggregate (see Figure 3.5). It was subsequently reported that the laid material was part of an on-going investigation associated with the durability of this mixture.

4.2 Older TS2010 sites

Sixteen older TS2010 sites ranging in age between 4.2 and 7.4 years were assessed by the panel to determine their on-going performance. As shown previously in Figure 3.7, the overall performance of TS2010 continues to be encouraging. Site IP22 is shown in Figure 4.7 and received a unanimous assessment of Excellent (E) after seven years in service.

Figure 4.7: IP22 - marked E at 7.2 year

4.2.1 TS2010 Layer thickness

The TS2010 surface course specification (TSIA No. 35, 2018) permits suppliers to lay material at different thicknesses dependent on the nominal aggregate size of the mixture. Figure 4.8 shows the layer thicknesses for the TS2010 materials inspected in 2018, along with the average panel mark. The thicknesses are based on data held on the IRIS database, and the figure includes two-year-old sites and historical sites ranging from 4.2 to 7.4 years.

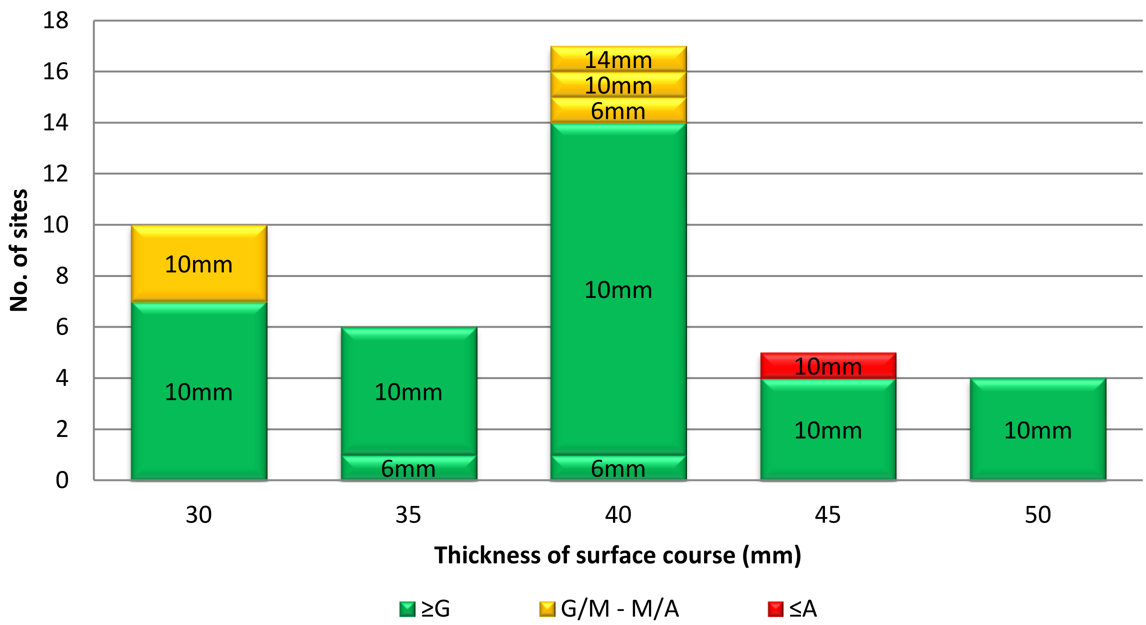

Figure 4.8: TS2010 layer thickness versus performance

The 10mm site that received a less than Acceptable score (marked red) is discussed in 4.1.2, i.e. its poor performance can be explained by other factors such as delivery or rolling temperature. Assuming the laid material thicknesses held in Transport Scotland's are accurate, there appears to be no clear evidence that thinner layers perform less well than thicker layers.

4.3 Miscellaneous

4.3.1 Sites of special interest

Three additional sites were visited. The first site (IPS1) was located on the A709, north of Dumfries. The road was surfaced with HRA that contained a bitumen modified with recycled plastic pellets, known as MacRebur. The material has attracted much media attention following a recent marketing campaign that claims that MacRebur products are greener and stronger than traditional mixtures. The material was believed to have been laid in October 2017 (11 months old). The surfacing exhibited some chip loss and was given a panel mark of G/M -v. Small threads of green plastic could be seen in the mat and were easily extracted. It is possible that the plastic pellets did not completely melt during the manufacturing process. As such, the un-melted fragments may cause the asphalt mortar to fret or crack under future trafficking, which could affect the material's long-term durability.

The second site (IPS2*)* was located on the A9 near Slochd. The site contained a section of TS2010 that was four years old (Figure 4.9). Above average high-speed friction results had been recorded for this material as part of a recent research study (Sanders *et al.*, 2017). The 10mm TS2010 surface course was assessed by the panel as *Good* (G). It was observed that the material exhibited a uniform appearance with a slightly higher surface texture than normal. It will be interesting to observe whether the higher texture is detrimental to the longer-term durability of the material.

Figure 4.9: IPS2 – TS2010 (G)

The third site (IPS3*)* was a heavily trafficked roundabout on the A9 north of Inverness (Figure 4.10). A bespoke material design had been developed specifically for the site and comprised a 6mm surface course that contained fibres and a polymer modified bitumen. The panel gave the site a mark of M -vj_f. The surface course was laid in April 2010 (and was almost 8.5 years old). It was considered to have performed well when taking into consideration its age and the traffic stresses experienced at the site.

Figure 4.10: Site IPS3

4.3.2 Carriageway markings

On one site located on the A90 near St Madoes, it was observed that a long section of new thermoplastic road marking material had failed (Figure 4.11). It appeared that the new material had been overlaid onto existing markings, but there was no visible bond between the materials, i.e. the new marking material could be easily dislodged.

Figure 4.11: Failed road marking

5 Conclusions

The IRIS database was used to provide information on surface course materials laid during the 2016/17 surfacing season. In total 58 sites were assessed by the SIP inspection team: 40 two-year-old sites; 15 historical (4 to 7+ years) TS2010 sites; and three sites of special interest. The main findings of the survey were as follows:

- The panel assessed 75% of the two-year-old surfacing sites to be defect free and performing well.
- A comparison with previous surveys showed that the 2018 results represented a slight drop in performance compared to recent years, particularly 2017. However, this could be explained by the natural variation witnessed over the last seven years' performance.
- In 2018, 20% of two-year-old sites exhibited aggregate loss, representing a 13% increase on the previous year, but the longer-term trend reduction of this defect appears to be being maintained.
- More open and/or fretted joint defects were observed during the 2018 survey, but again this could be explained by the natural variation witnessed over previous years.
- Two of the sites (5%) were assessed to display significant defects for materials that are only two years old.
- The data collected on older TS2010 sites suggests that the average service life of TS2010 could achieve double the service life of previous estimates for Scottish Clause 942 mixtures.
- Survey results collected over the last 11 years clearly demonstrate the success of the SIP process in introducing new materials (e.g. TS2010) and promoting best practice.
- Two of the two-year-old Clause 942 mixtures used in NW Scotland received poor marks and it is concluded that 14mm mixtures are less durable, particularly where road drainage is poor.
- Some sites were observed to display common defects associated with laying and compacting cold material.
- Based on the assumption that laid material thicknesses held in the IRIS database are accurate, there is no clear evidence to suggest that thinner layers perform less well than thicker layers.
- It was observed that a long section of new thermoplastic road marking material had failed at one of the sites.

6 Recommendations

Based on the results and observations made during the 2018 SIP survey, the following recommendations are made:

- There is a need for a system or process to be introduced that will stop the laying of cold material to avoid expensive remedial works and consequent disruption to the travelling public. It is important to note that the life of all material, including TS2010, can be compromised by poor working practices.
- The use of 14mm Clause 942 mixtures in NW Scotland should be restricted to roads that are well drained and carry low traffic stresses. The use of smaller aggregate sizes, although initially more expensive, can be justified through improved performance and an increase in service life.
- The failure of new thermoplastic road marking material should be investigated.
- A survey should be carried out in 2019 to ensure that positive changes continue to be implemented.
- While the focus on two-year-old sites should not be lost it is suggested that the balance of sites in 2019 should move toward the inclusion of a greater number of older sites in order to provide information on expected service lives for asset management purposes.

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Alan Ferguson	Transport Scotland
Angus Bowman	TRL/Consultant
Scott Buchanan	MPA Scotland
Stewart Scobie	MPA Scotland
Ian Carswell	TRL (Convener)

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Appendix A Inspection panel methodology

A.1 Selection of Sites

A1.1 The sites shall be selected using the IRIS database and in consultation with Transport Scotland to obtain a selection of sites laid across the whole Transport Scotland trunk road network that are coming up to their warranty period. In addition, further sites may be added at the discretion of Transport Scotland. Prior to the day of any visits, or during the visit if the site has not been visited before, the Convenor or Panel representative shall carry out a dynamic risk assessment for the sites to be visited and be responsible for making arrangements for the provision of any road closures and other precautions necessary to ensure that the inspections can be carried out in a safe and orderly manner. The route of the visit, methodology and risk assessment shall be sent electronically to all panel members in advance of the visits.

A.2 Inspection Panel

A2.1 The Inspection Panel shall consist of members agreed with Transport Scotland and, if appropriate, a local representative from either the Agent Authority and/or a representative from the client or Contracting/supplier side appropriate for the sites(s) to be inspected. The agreed members shall include a representative from TRL, who will act as Convenor. All members shall act in a personal capacity.

A2.2 Members of Panel shall provide details of H&S training they have undergone related to working on or near a highway. Where necessary the Panel Members shall undertake an induction with the Regional Authority responsible for maintaining the highway on behalf of Transport Scotland. Panel members will need to hold a Transport Scotland Motorway Pass. Transport Scotland or their representative shall assess whether there are any deficiencies in the training that will inhibit the Member from being allowed on any or all of the sites and advise accordingly. In addition to the information provided in this document a separate H&S and Environmental Risk assessment is provided for all members of the Inspection team. All members are to confirm that both of these documents have been understood and that they are content with the Risks Assessments prior to commencing inspections.

A2.3 Transport Scotland or their representative, after fixing the date for an inspection, shall inform other members as soon as possible before the inspection. A copy of this method of inspecting road trial sites shall be sent to any potential panel members who have not taken part before so that they can familiarise themselves with it.

A2.4 No Panel Member shall take part in the inspection of a site if they have had an alcoholic drink that day.

A.3 Initial Project Briefing

A3.1 Once the Inspection Panel has assembled, members shall be given an Inspection Panel Member's Report Forms. The itinerary of inspections and layout of each site will be provided in a separate document in advance to each of the panel members. The Convenor shall have an Inspection Panel Convenor's Report Form in addition to his/her Inspection Panel Member's Report Form.

A3.2 If appropriate, the Convenor shall brief members on particular aims of the trial and any implications on the emphasis of that inspection. In particular, the Convenor shall supply a list of any project specific suffixes to be used and their interpretation.

A3.3 The Panel shall agree on the weather conditions prevailing, and record it on their report forms. It is important to note both the weather (e.g. Sunny, Overcast, Raining) and surface condition (e.g. Wet, Drying, Dry) of the site.

A3.4 The panel shall agree on the ‘stress’ level for each site and categorised as Low (L), Medium (M) or High (H). As an example, H will be commensurate with very heavy traffic flows, long uphill sections (with a high level of HGV traffic) and Junctions with high levels of turning traffic.

A.4 Safety Signing of Vehicles

A4.1 The panel does not generally use closures for the inspections as these are of less than 15 minutes duration. However, if there is a closure in place on the site, not more than two vehicles shall be permitted to park in any closure, with personnel changing vehicles prior to entry when necessary. The preference is for as many people as practicable to be in each vehicle to minimise the number of vehicles in any closure. Inspection vehicles will be marked and equipped in accordance with Traffic Signs Manual, Chapter 8, Part 2: Operations, Section 05. When inspecting any site without a closure the site shall be inspected into the direction of oncoming traffic. Moving onto to the live carriageway shall not be permitted unless a spotter has been arranged whilst the member is in the live carriageway. Note: it is not permitted to go onto any live carriageway on motorways and high speed dual carriageways, or when a lane closure has been provided.

A4.2 Where an inspection is to be undertaken from a hard shoulder of a motorway, without a closure, only two vehicles will be permitted and they shall park with wheels facing the verge and no more than 100m apart. The inspection shall take place from the hard shoulder between the two vehicles. The panel shall inspect the site from the forward vehicle towards the rear vehicle (i.e. facing the traffic).

Motorway site inspections should take place when the traffic flows are at reduced levels. These surveys should therefore be planned to take place outside of peak traffic hours.

Should the traffic flows be considered very high at the time of arrival on site, the inspection should be deferred.

A4.3 Where parking availability is not known prior to arrival on site a suitable location off carriageway shall be sought so that access/egress from vehicles is safe and the vehicles do not inhibit the safety of other motorists or pedestrians.

A4.4 When sites have been visited previously, the previous risk assessment may be used but should be reassessed in case circumstances have changed. When visiting sites for the first time, the general risk assessment can be used, but any specific points noted and kept for future reference. Any amendment to specific risk assessments shall be recorded.

A4.5 All panel members shall confirm their agreement and register their understanding of the risk assessment and H&S requirements.

A.5 Personal Protection Equipment

A5.1 All Panel Members shall wear a high visibility long-sleeved vest or coat to BS EN 471, Table 1: Class 3 or better, that is done up during all inspections.

A5.2 In a closure, all Panel Members shall also wear safety footwear and, if the site is live with work being undertaken at high level or if otherwise required by those providing the traffic management, a helmet.

A5.3 Any Panel Member not properly attired shall be asked to leave the site until the situation is rectified to the satisfaction of the Convenor.

A.6 Inspection

A6.1 The Panel shall walk each section in turn, studying the condition as closely as practicable. Members shall stop and look back at intervals along each section so as to view the surfacing with the light in a different direction.

A6.2 As far as practicable, Panel Members shall stay together as a group when inspecting and not get extended which could be distracting to road users. The Panel shall walk, in order of preference if available:

a) within any closure provided;
b) on a footpath alongside the section of the road being inspected;
c) with a lay-by alongside the section of the road being inspected;
d) on the verge alongside the section of the road being inspected; or
e) along the road being inspected.

Panel Members shall walk towards the oncoming traffic wherever practicable.

A6.3 Localised areas that have been subject to untypical mechanical or chemical actions (e.g. damage caused by a vehicle running on its wheel-rim or by a diesel spillage) shall also be ignored. If variations are on a larger scale, such as between wagon loads when laid, the section shall be assessed in sub-sections. TRL shall try to establish the reasons for any large differences by checking the laying records and the compositional analysis at the appropriate time.

A6.4 Members shall record on their Inspection Panel Member's Report Form a mark for each section soon after inspecting it. Whilst members can discuss points of interest noted along the section, they shall not reveal how they intend to mark that section until all members have recorded their individual mark. Marks will general be collected by the convenor after each site has been inspected. Where the inspections are from the hard shoulder of the motorway the marks will be collected after moving off site to minimise the time on the hard shoulder.

A.7 Marking

A7.1 Each section shall be assessed on the basis of its current serviceability irrespective of the elapsed time since it was laid. In considering the serviceability of the surfacing, the aspects in Table 1 for the specific type of surfacing shall be considered, together with any project related aspects given in the initial briefing. If any of the aspects are evident to a significant degree on the section, the relevant suffix from Table A1 shall be applied to the basic marking. Suffix v shall not be applied to a section marked as t, nor + to one marked –.

A7.2 Joints are a particular issue with respect to initiation of fretting and subsequent failure of the surfacing so additional suffices have been added to record the presence of open joints and joints where fretting and ravelling have occurred. Note: an open joint (j_o) refers to joints that are clearly susceptible to the ingress of water and have been inadequately sealed at the time of construction.

A7.3 Once any appropriate fault suffixes have been assigned, the basic mark shall be allocated from the 7-point scale in Table 2. Intermediate markings between scales shall not be given. When considering the markings, any sections that warrant a suffix cannot have a basic mark of G or better (one exception is G j_o where the mat itself is considered to be in a good condition but the joint considered open (see above).

TABLE A1 - Revised Fault Suffixes

Suffix	Description	Material type	Notes
v	variable	all	Random variations from point to point within the section only, not "traffic laning" or of obvious variations from load to load.
t	variability with traffic intensity	all	Marked transverse differences caused by variations in traffic intensity between lanes.
+	fatting up	macadam, surface dressing	
–	loss of chippings	hot rolled asphalt	
	loss of aggregate	porous asphalt, macadam, thin surfacing, slurry surfacing	
	loose chippings	surface dressing	
	wearing causing substrate to "grin" through	high-friction surfacing	
j_o / j_f	Joint issue	j_o = *open joint** / j_f = fretting at joint	
f	fretting of mortar	hot rolled asphalt	
g	growth of vegetation	porous asphalt	
p	ponding	porous asphalt	
d	de-lamination from substrate	porous asphalt, thin surfacing, surface dressing, high-friction surfacing, slurry surfacing	
s	stripping	all except high-friction surfacing	
c	cracking	hot rolled asphalt, macadam, thin surfacing, high-friction surfacing	

**Applies to a poorly constructed joint, susceptible to the ingress of water and potential for early life failure*

A.8 Overall Assessment

8.1 When each member has reported his individual result, the Convenor shall convert them using the transformation:

E = 6; *G* = 5; *M* = 4; *A* = 3; *S* = 2; *P* = 1; and *B* = 0.

TABLE A2 - Basic 7-Point Scale

Mark		Description	
E	(excellent)	no discernible fault	Termed satisfactory
G	(good)	no significant fault	
M	(moderate)	some faults but insufficient for serious problem	
A	(acceptable)	several faults but would usually be just acceptable	
S	(suspect)	seriously faulted but still serviceable in the short term	Termed unsatisfactory
P	(poor)	requires remedial treatment	
B	(bad)	requires immediate remedial treatment	

8.2 The mean of the individual results shall be calculated to one decimal place and converted back into the Panel marking, rounding off as follows:

.8 to .2 Basic marking with symbol/s; and

.3 to .7 Intermediate marking with symbol/s.

8.3 Suffixes shall be applied to the Panel marking when at least a third of the Panel members, rounded up, give it on their individual markings provided:

- the basic Panel marking is not *G* or better, as then no suffixes can be applied (with the exception of j_o); and
- both *v* and *t*, or both *+* and –, are given, when only one of each pair can be applied to the basic Panel marking. The choice shall be based on the number of times the different suffixes occur on individual markings (in the case of a tie, the Convenor shall decide).

8.4 If the Panel consists of less than 6 members at an inspection, this fact shall be noted when reporting the results.

A.9 Confidentiality

Whilst the Panel marking can be reported, the individual marks allocated by members of the Panel shall be treated in confidence. This limitation is to allow members to make judgements as to the condition of the trial sections without consideration.

The performance of road surfacing in Scotland

The performance of asphalt surface courses laid on the Scottish trunk road network is assessed on an annual basis by The Scottish Inspection Panel (SIP). This report details the results of the 2018 survey and makes a comparison with previous SIP survey results dating back to 2008. The 2018 survey assessed 75% of the two-year-old surfacing sites to be defect free and performing well. The data collected on older sites comprising TS2010 surface course suggests that the material could achieve double the service life of previous estimates for Scottish Clause 942 mixtures. Several recommendations are made based on observations made during the survey to improve the performance of surface courses used in Scotland.

Other titles from this subject area

PPR825 High speed friction assessment of TS2010 . P D Sanders, M McHale, L A Martin and D Leal. 2017

PPR821 Scottish Inspection Panel Report 2016. M McHale and L A Martin. 2017

PPR790 Scottish Inspection Panel Report 2015. M J McHale. 2016

TRL670 New surface course specification for Scotland. M J McHale, I Carswell and P Roe. 2011

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