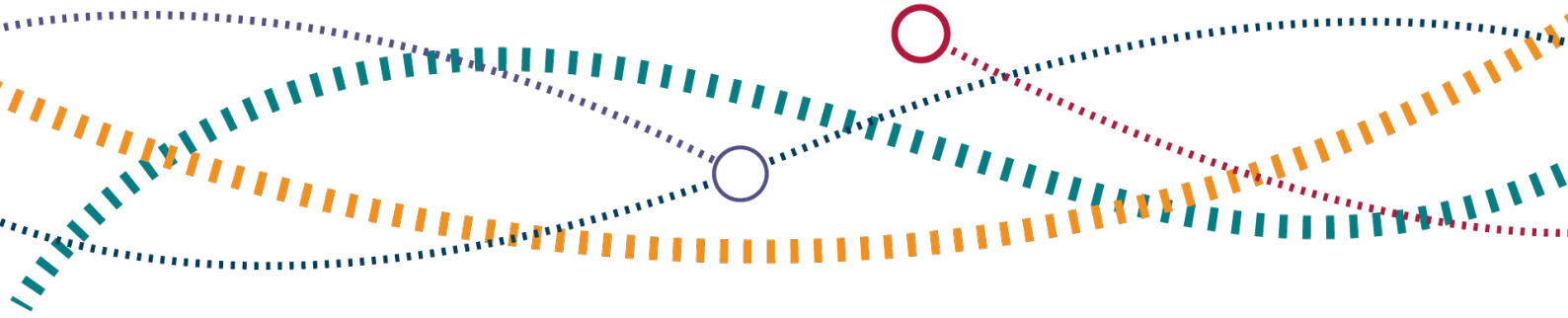
OFFICE OF RAIL AND ROAD

Benchmarking National Highways

Road surface condition

11 October 2023



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Executive summary

The condition of road surfaces (or ‘pavements’) on the Strategic Road Network (SRN) is a top priority for users and a critical aspect of safety. National Highways will invest around £1.8bn during the second road period (2020 to 2025) to renew (i.e. resurface or reconstruct) pavements on the SRN. This benchmarking report examines the outcomes of that investment.

We hold National Highways to account for achieving a national-level target for the proportion of road surfaces assessed as being in 'good condition' and thus not requiring further investigation for maintenance. In the first two years following its creation in 2015, the company missed its target. However, following a detailed review, it put in place a plan to improve its management of network condition and the quality of its reporting. Since 2018, it has consistently met its target.

The condition of the SRN varies by road type. A greater percentage of motorways than A--roads meet required levels of condition. Single carriageway A-roads perform least well against requirements. Our research also indicates that single carriageway A-roads undergo more frequent renewals compared to motorways. This could be attributed to the more stringent skid resistance requirements on these roads. However, despite their relatively younger age in terms of road renewal, users do not experience better ride quality on single carriageway A--roads. Therefore, the company should consider whether it can achieve better outcomes from its investment in single carriageway A-roads.

Road surface condition is broadly similar across National Highways’ regions with the exception of the East of England. This is partly due to the high proportion of A-roads and the presence of concrete roads in the region. However, the research set out in this report indicates there may be other factors at play. The company should continually review local and regional variations and ensure that asset management practices are applied consistently, but also based on need.

A-roads on the SRN compare favourably with a sample of local authority-maintained roads on the Primary Route Network (PRN). This is as we would expect – it suggests that the most strategically important roads are in the best condition. It should be noted that differences between the SRN and PRN are only evident for the poorest 10% of roads.

The condition of strategic roads in England, Wales and Scotland is broadly similar. However, the strategic road network in the Netherlands outperforms the equivalent networks in Great Britain (GB) in both ride quality and skid resistance, partly attributed to their extensive use of porous asphalt, a material not employed in GB due to its other attributes. However, differences in performance were also evident when comparing road surfaces constructed of similar materials. As with all areas of performance, engagement with road authorities elsewhere can be instrumental in identifying and adopting examples of good practice and innovation.

1. Introduction

1.1 The Strategic Road Network (SRN) comprises the main A-roads and motorways in England. National Highways is responsible for operating, maintaining, and improving the SRN. The Office of Rail and Road (ORR) monitors National Highways' performance and efficiency.

1.2 Benchmarking National Highways' performance and efficiency is an important element of our role. It helps us monitor the company's delivery of the government's Road Investment Strategy; informs our advice on future strategies; and increases transparency around its performance.

1.3 The condition of road surfaces (or 'pavements') on the SRN is an important concern for road users. It affects both the quality and safety of journeys on the SRN.

1.4 This report offers an overview of National Highways' performance since 2015. It compares road surface condition across the company's six operating regions and includes findings from research comparing the condition on the SRN with the local authority maintained Primary Route Network (PRN) in England and other strategic road networks in Great Britain (GB) and internationally.

1.5 This report draws on a road surface condition benchmarking study undertaken by TRL ltd on behalf of ORR. We would like to thank TRL ltd for their work and National Highways, Transport Scotland, the Welsh Government and Rijkswaterstaat (executive agency of the Ministry of Infrastructure and Water Management, responsible for the Netherlands main road network) for their co-operation.

1.6 The data in this report focuses on roads in England managed directly by National Highways. It does not include roads under Design, Build, Finance, and Operate (DBFO) contracts, like the M25 DBFO.

2. Measuring road surface condition

The importance of road surface condition

2.1 The SRN carries around a third of all motorised traffic in England and around two thirds of Heavy Goods Vehicle (HGV) traffic, making it a crucial national asset.

2.2 Research undertaken by Transport Focus consistently highlights the importance users of the SRN place on road surface condition. It finds that satisfaction with road surfaces is positively correlated with overall journey satisfaction. Transport Focus identifies 'improved quality of road surfaces' as users' top-ranking priority for the improvement of the SRN.

2.3 Road surface condition is also an important factor in safety performance. A well-maintained road surface provides better traction, allowing vehicles to maintain control and reduce the risk of skidding or sliding, especially during adverse weather conditions. Poorly maintained road surfaces can be a contributory factor in road vehicle collisions.

2.4 During the second road period (RP2, 2020 to 2025), National Highways will invest around £1.8bn in ongoing renewals (i.e., resurfacing or reconstruction) of road surfaces. This accounts for around 40% of its total expenditure on renewals (based on the company's Strategic Business Plan for RP2).

2.5 National Highways must balance a range of different factors when determining its approach to maintaining and renewing road surfaces. It is required to maintain SRN road surfaces in a manner that ensures the network is safe for users. It has to achieve a reasonable balance between affordability and meeting the expectations of users. It must also maintain road surfaces in a sustainable manner that considers the whole-life cost of these assets.

Measuring road surface condition on the SRN

2.6 The term road surface condition covers a range of different attributes and can be measured in different ways.

2.7 We hold National Highways to account for achieving target levels of performance against its **pavement condition Key Performance Indicator (KPI)**. The KPI measures the proportion of the network in 'good condition' and, as such, requiring no further investigation for maintenance.

2.8 National Highways surveys the condition of its network on an ongoing basis. The KPI is based on measurements of the following parameters:

(a) **Ride quality** – a measure of the smoothness of the road surface across its length as measured by its longitudinal profile variance, or eLPV for short. The KPI is based on measurements of the profile of the road surface over three different lengths: 3m, 10m and 30m).

(b) **Skid resistance** – a safety focused measure based on the friction between a tyre and the road surface.

(c) **Rutting** – a measure of the evenness of the road surface across its width. Higher levels of rutting can affect vehicle stability and can highlight problems with the underlying structural condition of a road.

2.9 If a section of road fails to meet threshold levels of condition for any of the above measures, it is assessed as requiring investigation for potential maintenance. Details of the threshold condition levels associated with the KPI are provided in the Technical Appendix.

2.10 The KPI is based on the condition of the main carriageway and does not include hard shoulders, slip roads, link roads or roundabouts on the network. It also excludes roads maintained via DBFO arrangements. DBFO companies must maintain road surface condition in accordance with their contracts. However, National Highways does not have direct control over maintenance of these sections on an ongoing basis.

2.11 The pavement condition KPI has been in existence since 2015. Originally, the KPI was based on the condition of lane one (i.e., the inside lane) only. In April 2022, National Highways implemented an improved metric. The updated metric measures the condition of all lanes. This provides a better representation of National Highways' management of overall road surface condition on the SRN.

2.12 In addition to the pavement condition KPI, we also monitor a performance indicator specifically focused on ride quality (i.e. smoothness) – the **ride quality Performance Indicator (PI)**. The ride quality metric was designed to better represent car drivers' experience of using the road, separate to the pavement condition KPI.

2.13 Unlike the 'KPI', the ride quality PI is not associated with a target level of performance. However, we expect the company to maintain or improve ride quality over time and address local issues as they arise.

Factors influencing road surface condition

2.14 A variety of factors contribute to the condition of road surfaces. These factors include:

(a) **Age** – Road surfaces deteriorate over time due to traffic, weather, and environmental factors. Therefore, the time since the road surface was last renewed is an important consideration for condition.

(b) **Material type** – The type and quality of materials used in road construction influence the surface condition. Road surfaces on the SRN are a combination of asphalt and concrete pavements.

(c) **Structural condition** – The condition of the underlying structure of the road affects the deterioration of the surface.

(d) **Traffic load** – The volume and weight of traffic that a road handles affect its surface condition. The volume of HGV traffic is likely to be a more substantial factor than overall traffic volumes.

(e) **Environmental factors** – Freezing temperatures or excessive heat, can cause expansion and contraction of the road, leading to cracks and potholes. Exposure to sunlight, moisture, and chemicals (such as gritting salt) can also degrade road surfaces.

(f) **Asset management practices** – Regular inspection, maintenance and repair of roads are essential for maintaining their condition.

2.15 In the remainder of this report, where we compare the condition of different road types and networks, we aim to explain differences using data on the following three factors: material type, the age of the road surface (i.e., the time elapsed since the last renewal), and traffic load.

3. National Highways' overall performance since 2015

3.1 This section describes trends in performance for the SRN as a whole since 2015.

Pavement condition KPI

3.2 The current target for the pavement condition KPI is 96.2%. In other words, National Highways must ensure that at least 96.2% of road surfaces are assessed as being in 'good condition' and requiring no further investigation for maintenance.

3.3 Prior to April 2022, under the original KPI, the target was set at 95%. The original KPI was based on the condition of lane one (the inside lane) which tends to be more heavily trafficked. By measuring condition across all lanes, average condition scores are slightly higher under the new metric. The target has therefore been revised upwards to take account of this. Although higher, the new target is equally stretching as the original one.

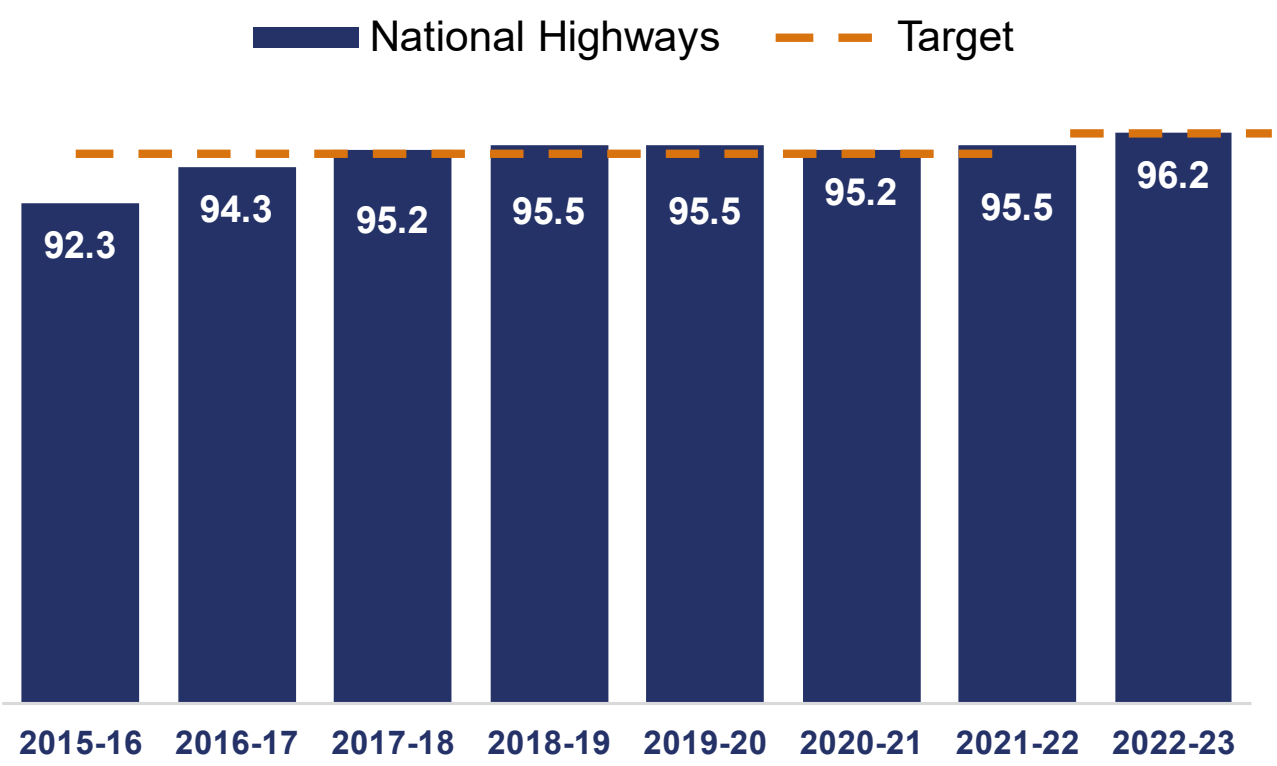
3.4 National Highways' performance against the pavement condition KPI since 2015 is plotted in Figure 3.1.

3.5 In the first year of the first road period (RP1, 2015 to 2020) performance was around 3% below target. This was primarily due to the proportion of the network failing to meet threshold levels of skid resistance. Following a detailed review, the company put in place a range of actions to improve its management of network condition and to improve the quality of its reporting. Its improvement plans included carrying out additional volumes of road renewal works to improve network condition. Since 2018, the company has consistently met its target.

3.6 As we reported in our 2022-23 Annual Assessment of National Highways, the company came close to missing the KPI target for March 2023. We worked closely with National Highways at all levels to understand the root cause of this issue and the company's plan to deliver additional work to improve performance. It used updated asset condition information to adjust its renewal programme and recovered its position to achieve its target.

3.7 National Highways told us that the decline in condition was predominantly due to the extreme hot weather experienced in July 2022. We want to ensure that the company's approach to road surface renewals builds in resilience to factors such as climate change.

Figure 3.1 Pavement condition KPI: percentage of road surfaces not requiring further investigation for maintenance

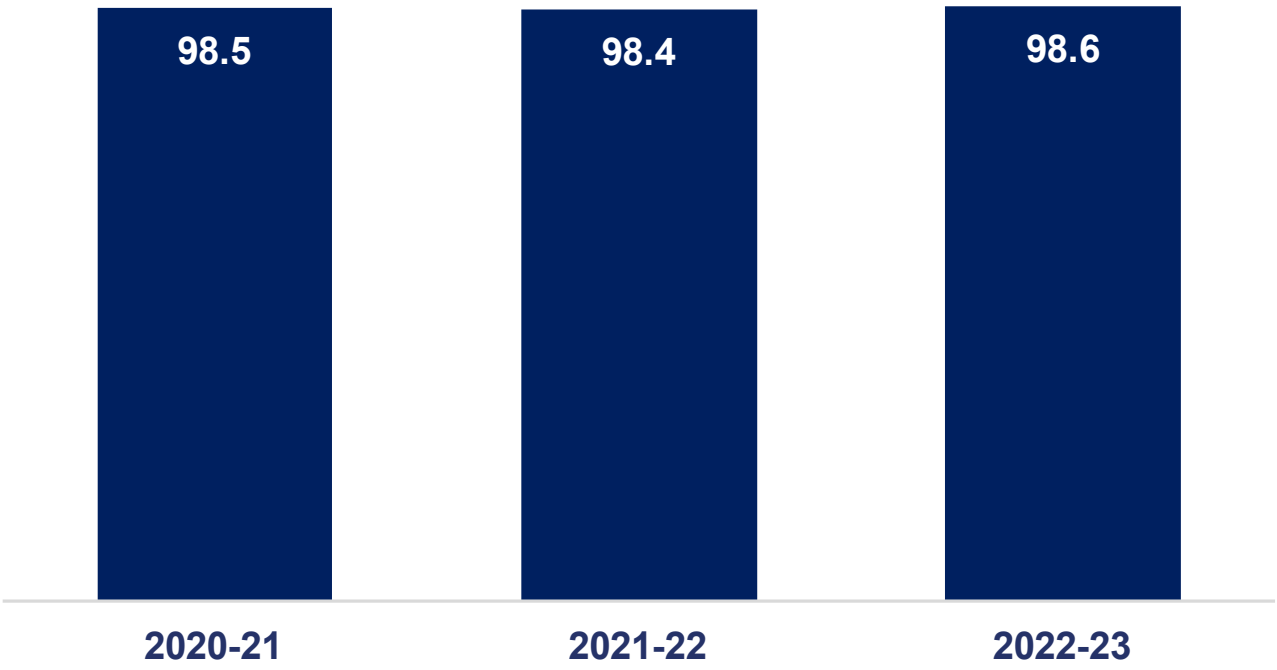


Ride quality PI

3.8 The ride quality PI is focussed specifically on the smoothness of the road surface. The PI measures the proportion of road surfaces assessed as showing no visible deterioration or a low level of deterioration such that no action is required.

3.9 The ride quality PI came into place in 2022, although data is available for the past three years. In that time, ride quality has been maintained at between 98% and 99%. This suggests that, for the SRN as a whole, users' experience of the road surface is being maintained at a broadly stable level.

Figure 3.2 Ride quality PI: percentage of the network meeting National Highways' standards for ride quality



Pavement renewals

3.10 Renewal of pavements is the primary means through which National Highways ensures it meets its KPI target. National Highways resurfaces or reconstructs around 6% of the total length of the network each year.

3.11 Whilst the pavement condition KPI has been sustained at a relatively stable level, the volume of renewals has fluctuated from year to year.

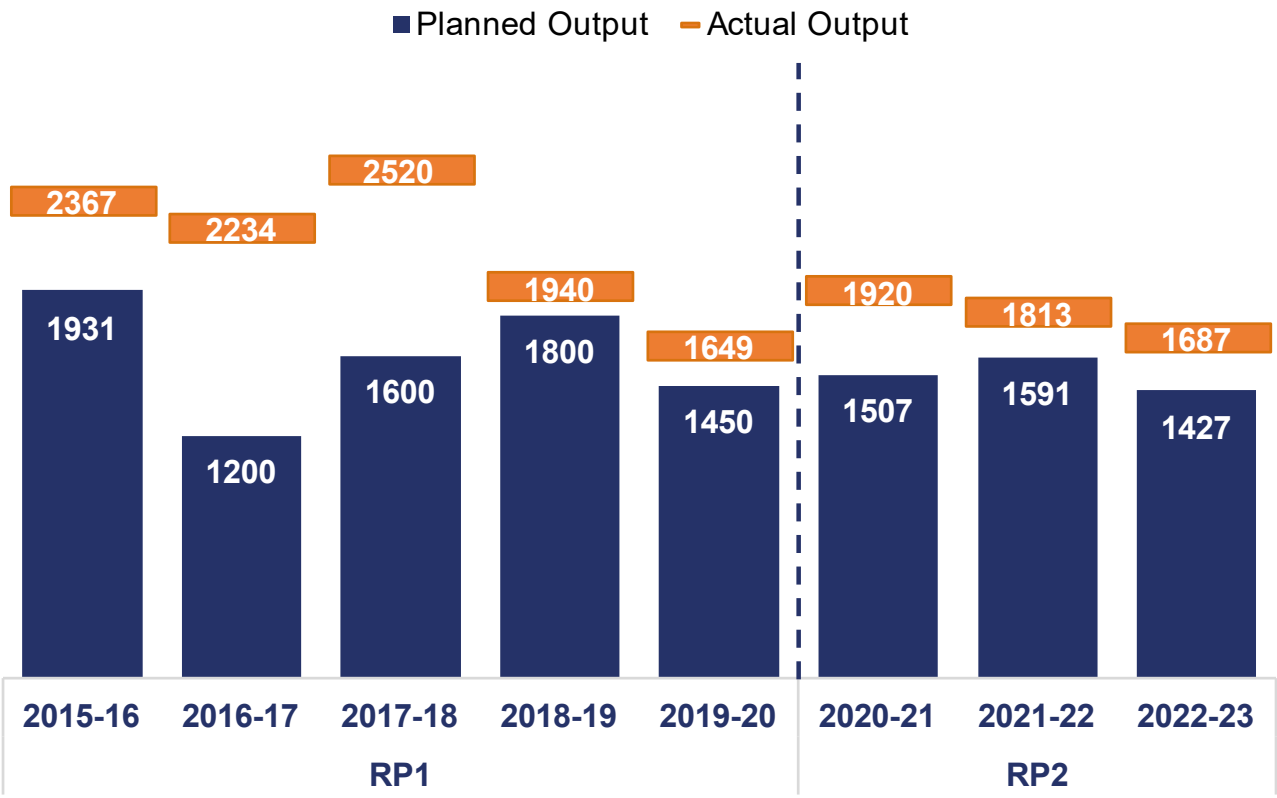
3.12 In the short term, the relationship between pavement renewals and road surface condition is complex. For example, total volume of renewals do not confer any information about the type of renewal delivered, such as the depth of the road surface reconstructed. Thin surface treatments deal with only the top surface of the road. Deeper pavement renewals can offer a more comprehensive solution to severely deteriorated pavements as they also improve the underlying structural condition of the road. Thin surface treatments are typically undertaken on a more frequent basis. Deeper surface renewals are more costly but are required less frequently.

3.13 As shown in Figure 3.3, the volume of pavement renewals delivered by National Highways fluctuated during RP1. In RP2, volumes have been more stable at around 1,800 lane kms per annum.

3.14 National Highways has consistently delivered higher renewals volumes than planned, as set out in its annual Delivery Plan updates. During the first three years of RP1, the gap between planned and actual volumes was very large. Since 2019, the company has delivered more in line with its plans. However, over the first three years of RP2, actual volumes exceeded planned volumes by 20%.

3.15 As noted in our most recent Annual Assessment of National Highways' performance, over delivery is not necessarily indicative of good performance or efficient delivery. For instance, over delivery could suggest that asset need is worse than anticipated, or that assets are being unnecessarily renewed and, as a result, an indication that the company is investing in an inefficient manner. Our priority is that the company delivers the renewals, aligned to its plans, in a way that sustains the condition of the network in the long-term.

Figure 3.3 Pavement renewals: planned and actual volumes (lane kilometres)



4. Road surface condition and road type

Road surface condition by road type

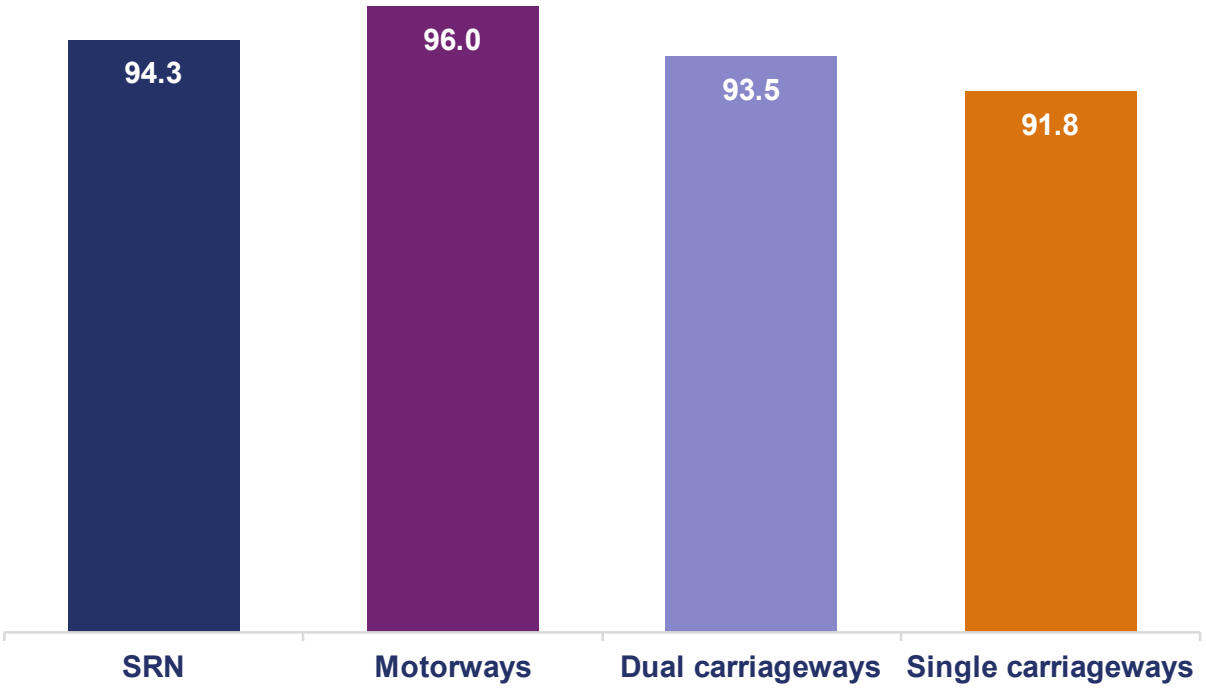
4.1 We have undertaken an analysis of road surface condition for different road types on the SRN, namely: motorways, dual carriageway A-roads and single carriageway A-roads.

4.2 The analysis is intended only for the purpose of comparing the condition of different road types. It employs data and methods that differ slightly from those used in the calculation of the network-level KPI and PI. Consequently, the results set out here differ slightly from those set out in Section 3. This is described in more detail in the Technical Appendix.

4.3 The analysis set out here uses condition data for lane one in 2021. For each road type, we estimate the proportion of the road surface that measurements indicate meet threshold condition levels associated with the KPI. It should be noted that condition requirements vary for different types of road. Further information on these requirements is also provided in the Technical Appendix.

4.4 Figure 4.1 provides an estimate of the proportion of each road type estimated to meet the KPI thresholds. A greater percentage of motorways meet required levels of condition than A-roads. Single carriageway A-roads perform least well against requirements.

Figure 4.1 Road surface condition by road type (2021): estimated percentage of the network meeting KPI threshold level



4.5 Figure 4.2 provides the same comparison broken down by individual component measure of road surface condition. For simplicity, it displays data only for the 10m eLPV measure of ride quality, whereas the KPI is based on scores at 3m, 10m and 30m).

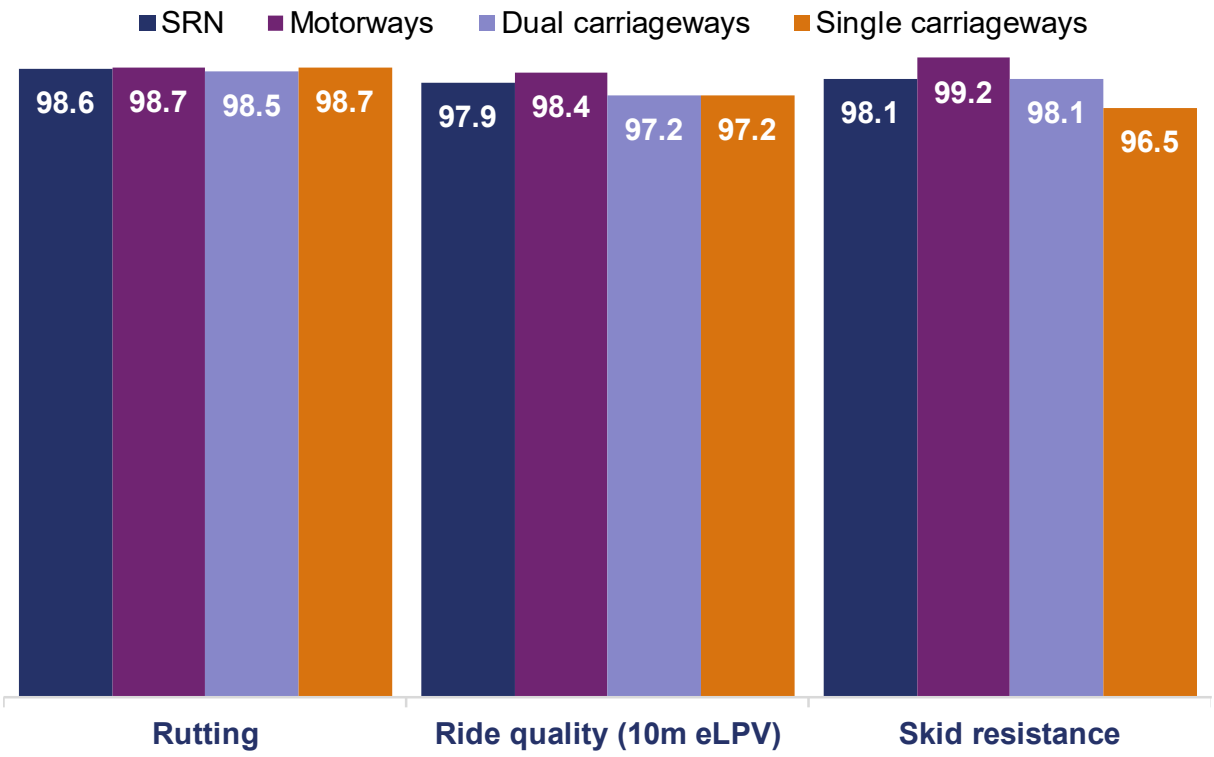
4.6 The extent of rutting (the evenness of the road surface across its width) is similar across the three road types. However, ride quality (the evenness of the road surface across its length), is worse for A-roads than motorways.

4.7 Skid resistance requirements are not uniform across the network. Every part of the network is assigned to a specific 'site category' which determines the threshold level of skid resistance which trigger the need for further investigation. Higher risk sites such as approaches to junctions have higher skid resistance requirements than the main carriageway of a motorway. Skid resistance requirements are more stretching on A-roads, particularly single carriageways, because of a greater density of higher risk sites.

4.8 Differences in requirements are reflected in the results shown in Figure 4.2. As compared with motorways, a lower proportion of A-roads meet the threshold levels

of skid resistance associated with the KPI. Single carriageway A-roads score less well than dual carriageway A-roads.

Figure 4.2 Road surface condition by road type for each parameter (2021): estimated percentage of the network meeting KPI threshold level



Explaining variations in condition by road type

4.9 In this section, we explore the reasons behind the relatively lower condition scores for single carriageway A-roads compared to both motorways and dual carriageway A--roads.

4.10 As shown in Figures 4.3 and 4.4, single carriageway road surfaces tend to be both younger (i.e. renewed more recently) and less heavily trafficked than either dual carriageway A-roads or motorways. This indicates that National Highways renews single carriageways more frequently than other road types.

Figure 4.3 **Percentage of network by age category (time elapsed since last renewal)**

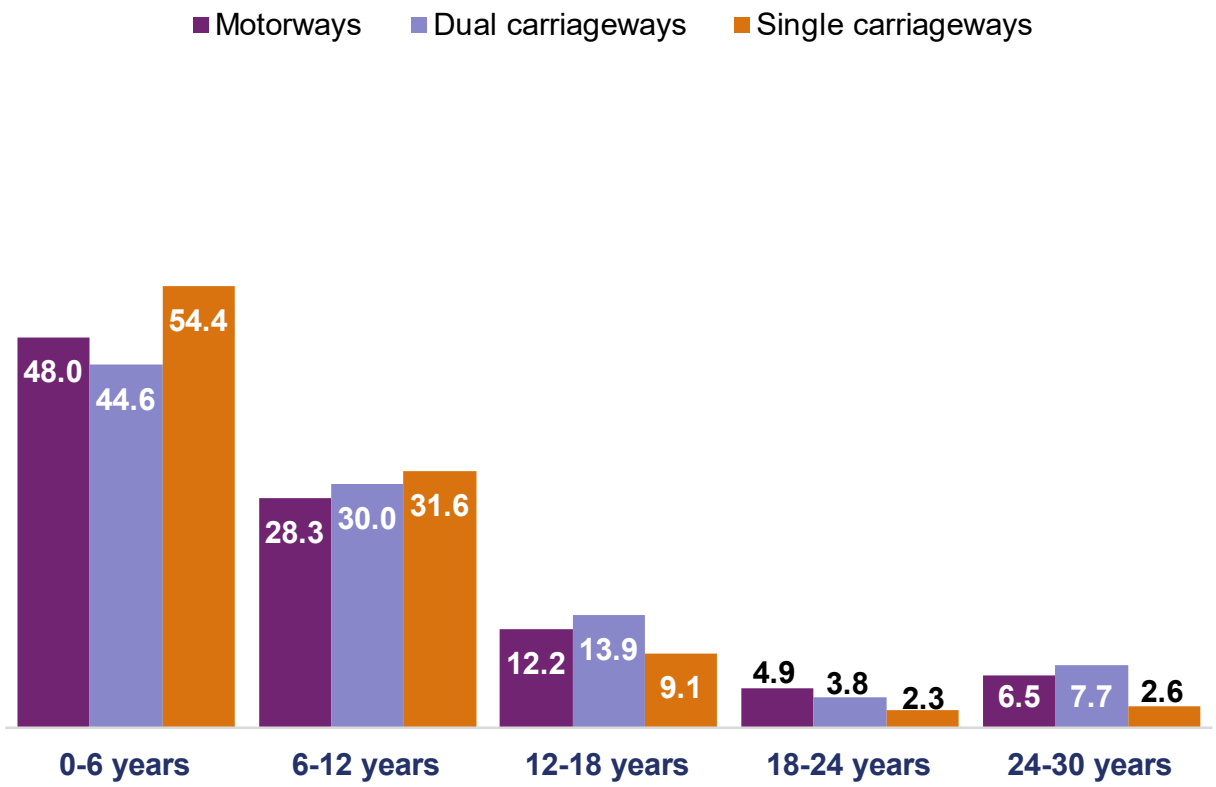
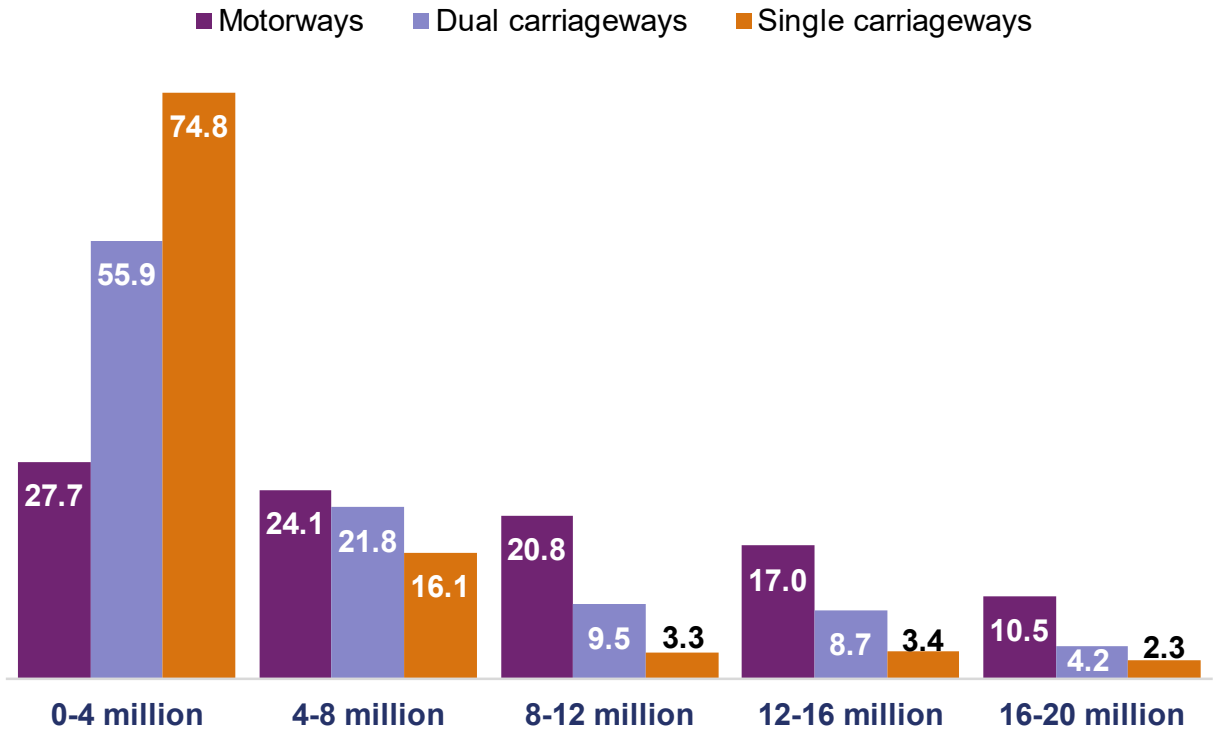


Figure 4.4 **Percentage of network by traffic volume (cumulative traffic flows since last renewal)**



4.11 The comparatively younger age of single carriageways could be attributed to the higher skid resistance requirements for these roads. As noted, single carriageway roads often encompass more high-risk locations, such as conflicting traffic movements and at-grade junctions, necessitating higher skid resistance standards. As a result, these roads may require more frequent renewals to maintain the required levels of skid resistance.

4.12 However, despite undergoing frequent renewals, single carriageways perform less well than the SRN average for both skid resistance *and* ride quality. When controlling for the age of road surfaces, Figure 4.5 illustrates that single carriageway A-roads are consistently in poorer condition (relative to requirements) than other road types, except in the 24-30 year category. Similarly, as shown in Figure 4.6, single carriageway roads perform less well against KPI thresholds notwithstanding differences in cumulative traffic volumes.

Figure 4.5 Road surface condition by road type and age of road surface (2021): estimated percentage of the network meeting KPI threshold level

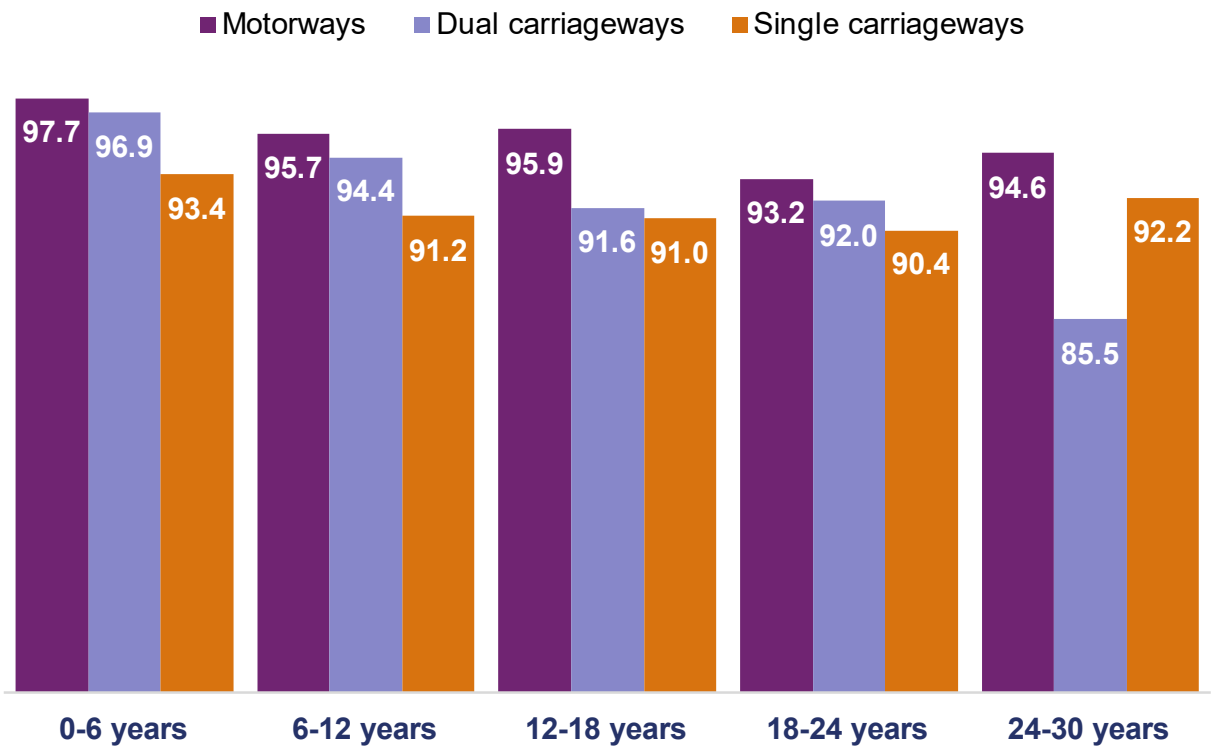
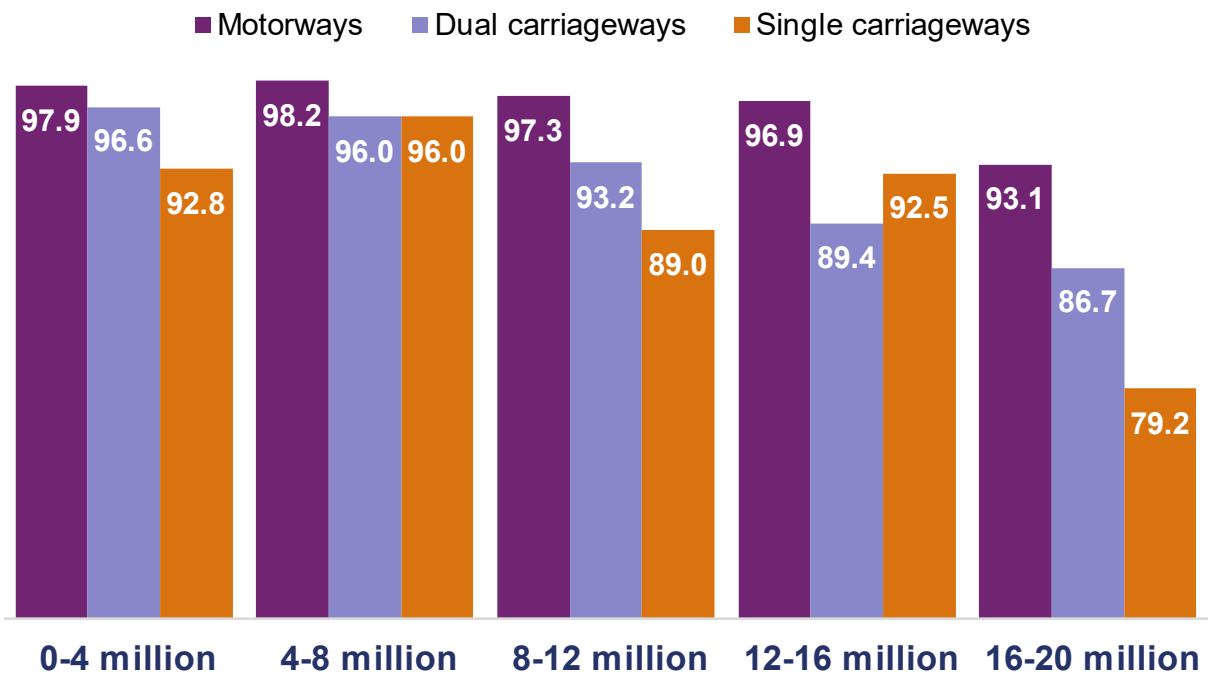


Figure 4.6 Road surface condition by road type and traffic volume - cumulative since last renewal (2021): estimated percentage of the network meeting KPI threshold level



4.13 Our data analysis did not offer a clear explanation for the lower ride quality scores of single carriageway A-roads. We hypothesise that maintaining single carriageway A-roads is inherently more challenging than other roads on the SRN.

4.14 One possible explanation could be related to the underlying structural condition of single carriageway A-roads. It is plausible that a poor structural condition might account for why frequent replacements of the road surface do not yield the same positive effects on ride quality as observed for other road types.

4.15 Additionally, renewing single carriageway A-roads presents practical challenges. These roads often feature more curved sections and steeper gradient slopes. As such, site access can prove more difficult for contractors, making the deployment of construction equipment challenging. Secondly, resurfacing single carriageways can be more disruptive to traffic due to limited road space (making it harder to implement contra-flow arrangements) and a lack of diversionary routes.

4.16 The connection between the structural condition of single carriageways and the practical challenges faced by National Highways is worth considering. Due to the increased operational difficulties with single carriageway renewals, it is possible that National Highways (and previously the Highways Agency before 2015) have

opted for thin surface treatments over deeper, structural pavement renewals, which tend to be more disruptive.

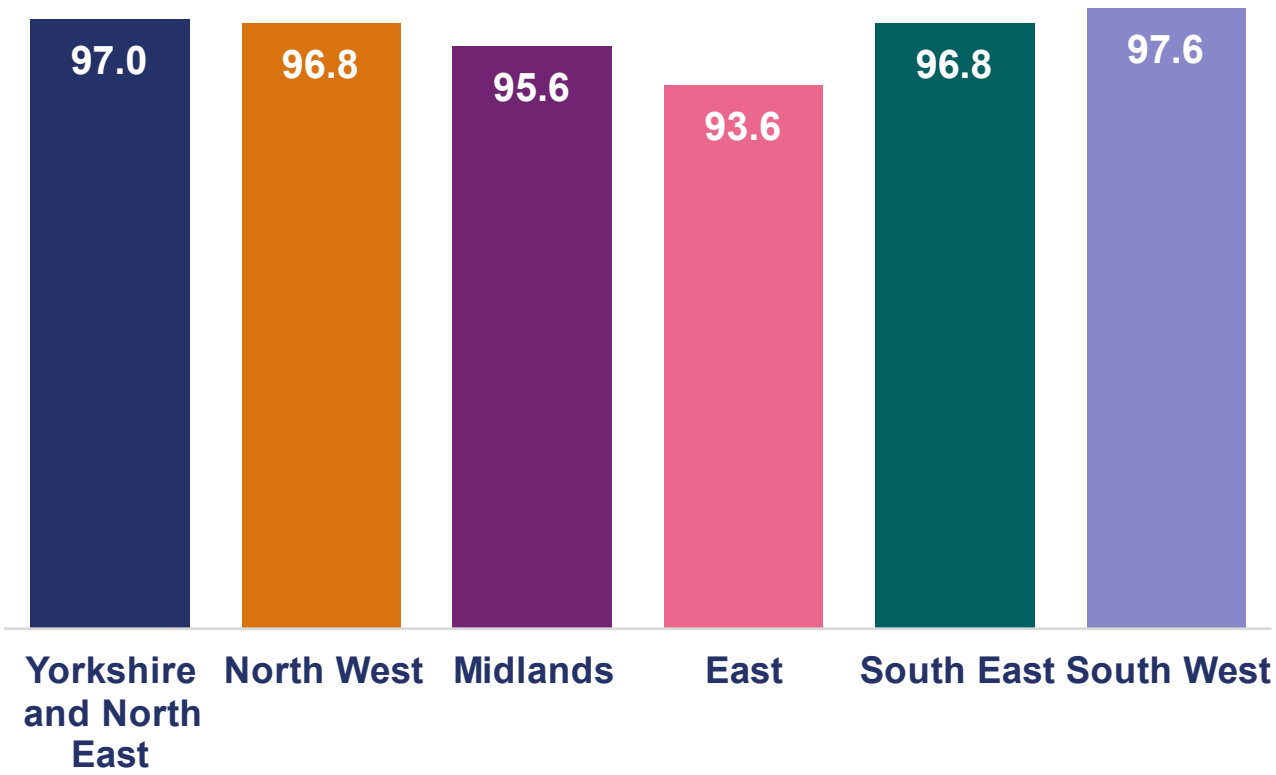
4.17 As discussed in Section 3, National Highways is successfully meeting its network-level road surface condition targets, and single carriageway A-roads represent a relatively small proportion of the SRN. Nevertheless, ensuring high standards for all roads is crucial. Hence, National Highways should consider whether it can achieve better outcomes from its investment in single carriageway A-roads.

5. Benchmarking National Highways' regions

Regional road surface condition

5.1 National Highways consists of six operating regions: the South East, South West, Midlands, East, North West and Yorkshire and the North East. The company is not held to account for achieving specific targets at a regional level. However, regional benchmarking can provide useful insights into the company's performance. Addressing issues identified at the local or regional level is essential for improving overall performance, and we expect the company to take proactive steps in this regard.

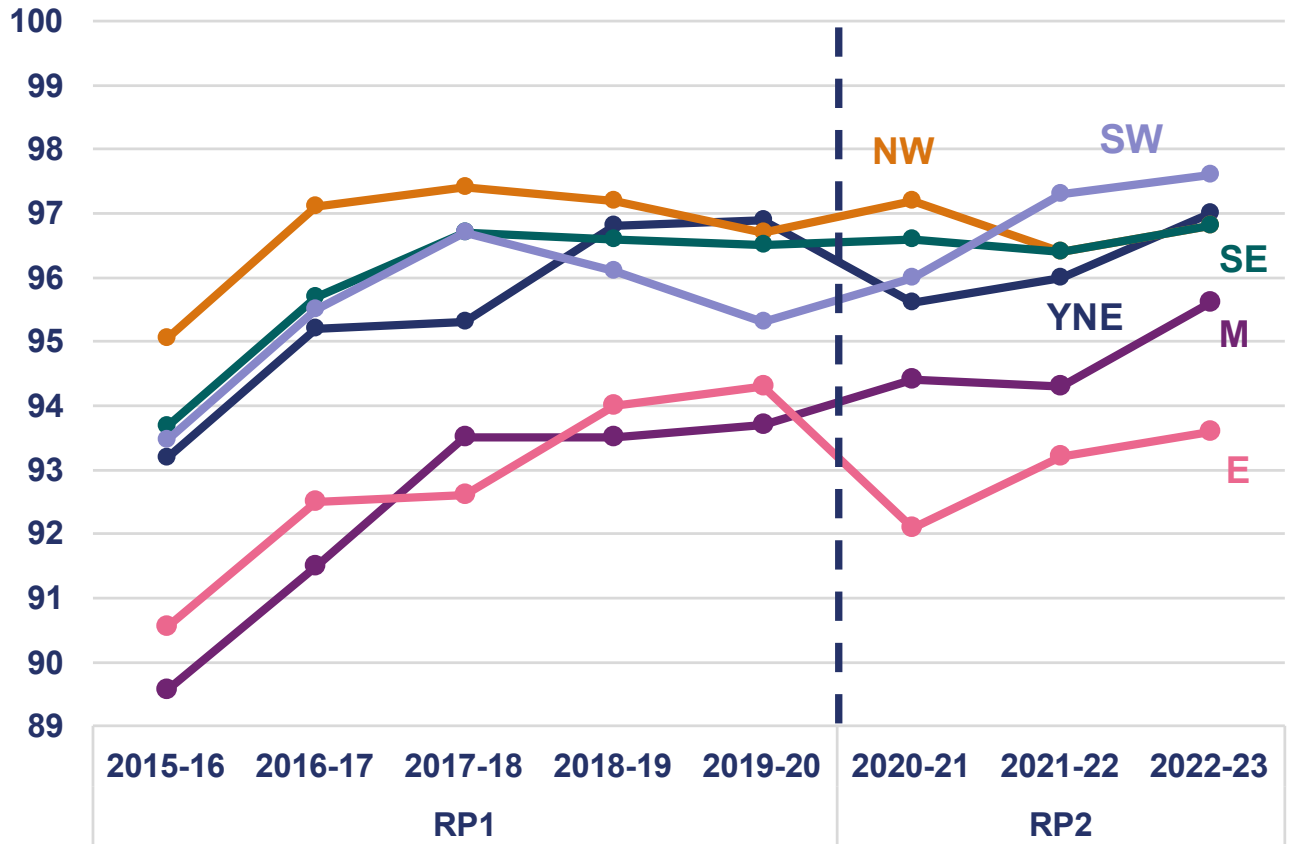
Figure 5.1 Regional condition: percentage of road surface not requiring further investigation for maintenance, April 2022 and March 2023



5.2 Road surface condition is relatively consistent across the regions. In 2023, only two of National Highways' regions – the East and Midlands – failed to meet the performance levels associated with the national-level condition target of 96.2%.

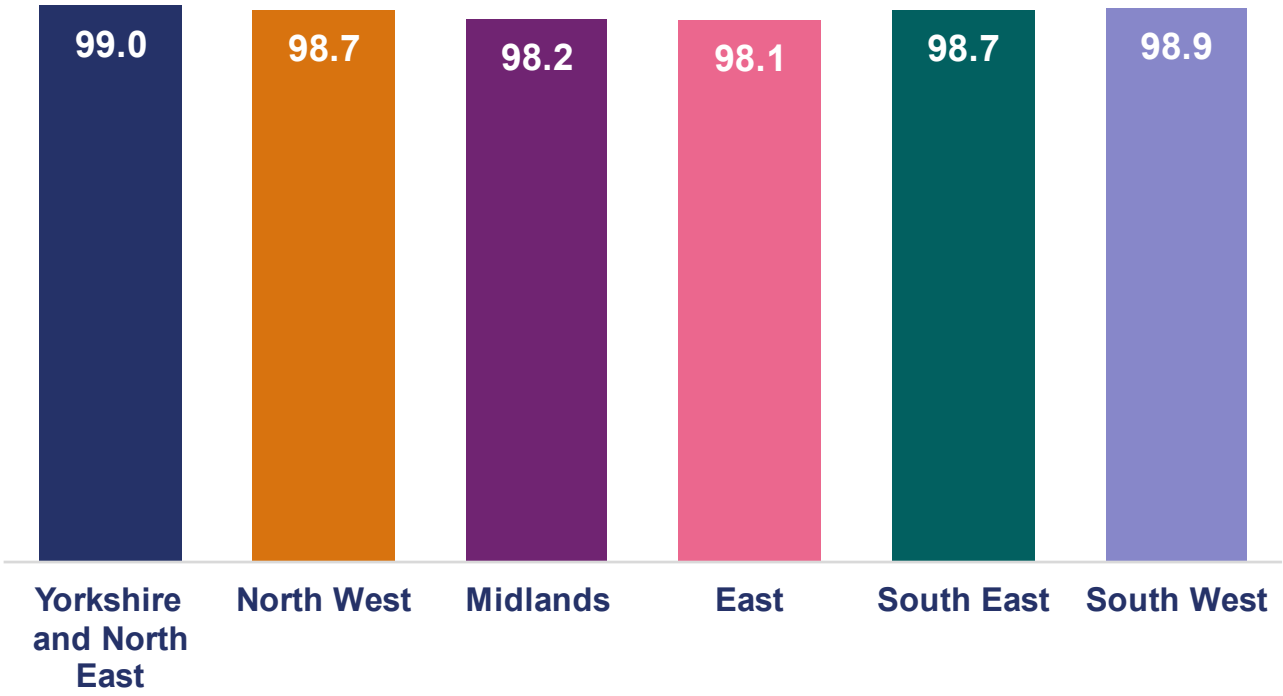
5.3 The East and Midlands regions have consistently shown below-average pavement condition. Notably, the Midlands has made substantial improvements, currently lagging the national average by less than 1%. However, the East region still faces a considerable gap, trailing the national-level target by nearly 3%.

Figure 5.2 Regional condition: percentage of road surfaces not requiring further investigation for maintenance



5.4 For the ride quality PI, performance has remained consistent with all regions performing above 97%. Across the regions, as for the pavement condition KPI, the East and the Midlands have shown the weakest performance. The Midlands improved performance by 0.7 percentage points in 2023, whilst the East has shown no improvement on the previous year.

Figure 5.3 Regional ride quality: percentage of the network meeting National Highways' standards for ride quality, April 2022 to March 2023

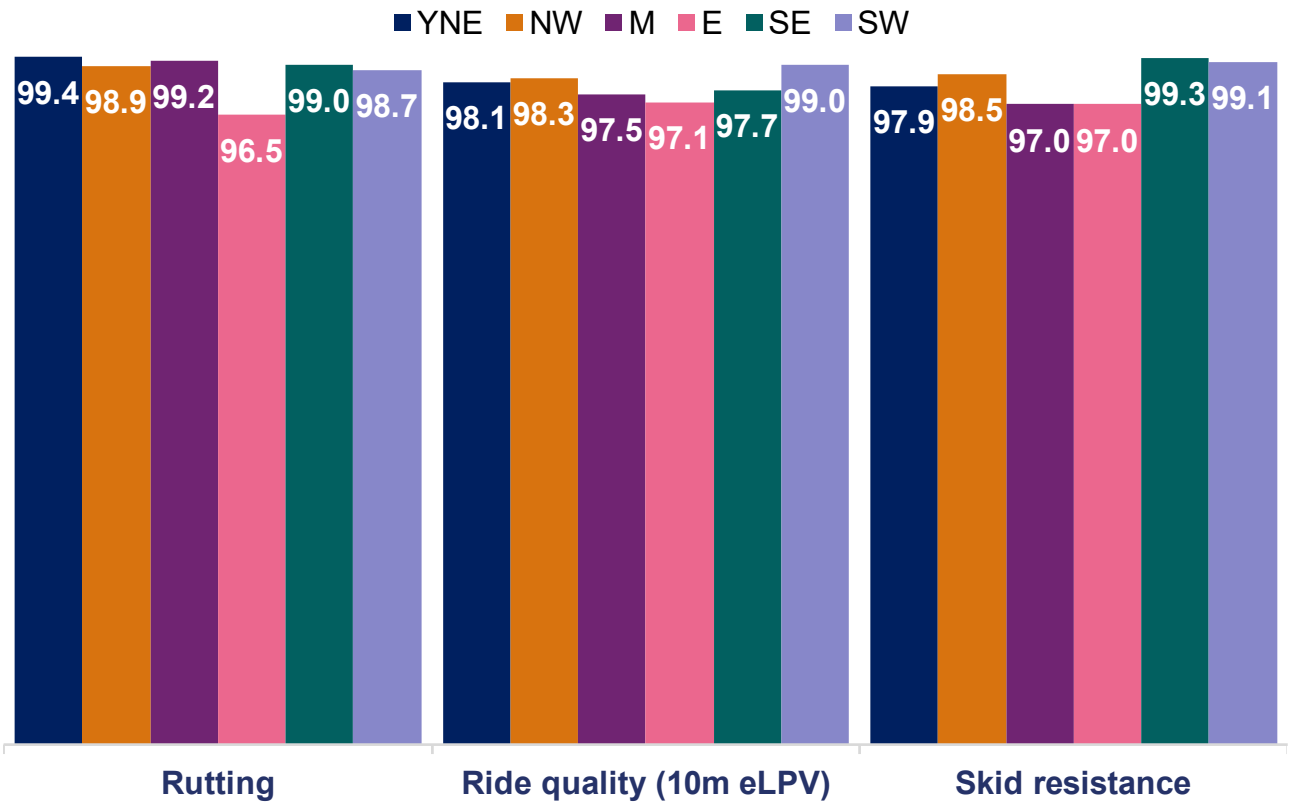


Explaining regional variation in road surface condition

5.5 We have undertaken further analysis to shed light on the lower-than-average KPI scores for the East region. As for Section 4, the following analysis employs data and methods that differ slightly from those used to generate figures 5.1 to 5.3.

5.6 As shown in Figure 5.4, the East exhibits the lowest scores for each of the three component measures that make up the KPI – rutting, ride quality and skid resistance.

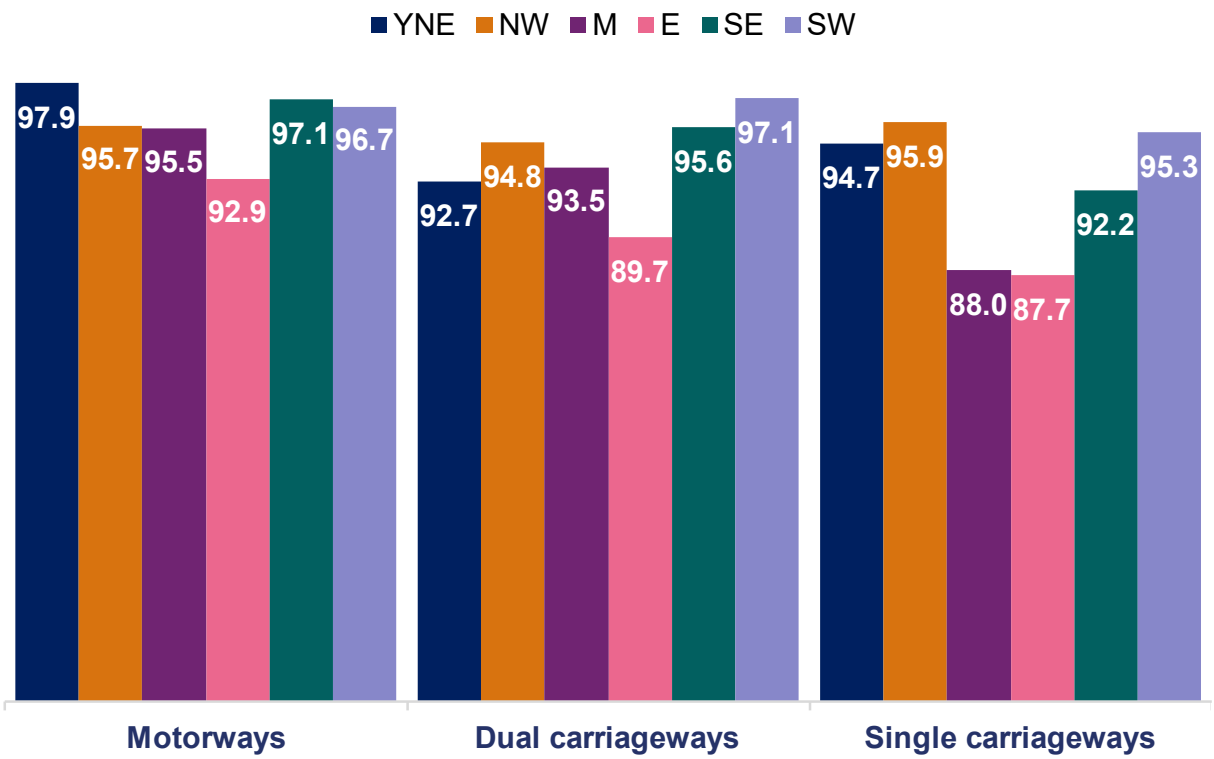
Figure 5.4 Road surface condition by region and KPI parameters (2021): estimated percentage of the network meeting KPI threshold level



5.7 One explanatory factor is the mix of road types in the East region. Just 22% of the SRN in the East is motorway. This compares with 55% for the SRN as a whole. As demonstrated in Section 4, road surfaces on motorways tend to perform better against the KPI than A-roads.

5.8 However, the mix of road types in the East does not fully explain its overall performance. As illustrated in Figure 5.5, the East exhibits the poorest condition for each of the three main road types.

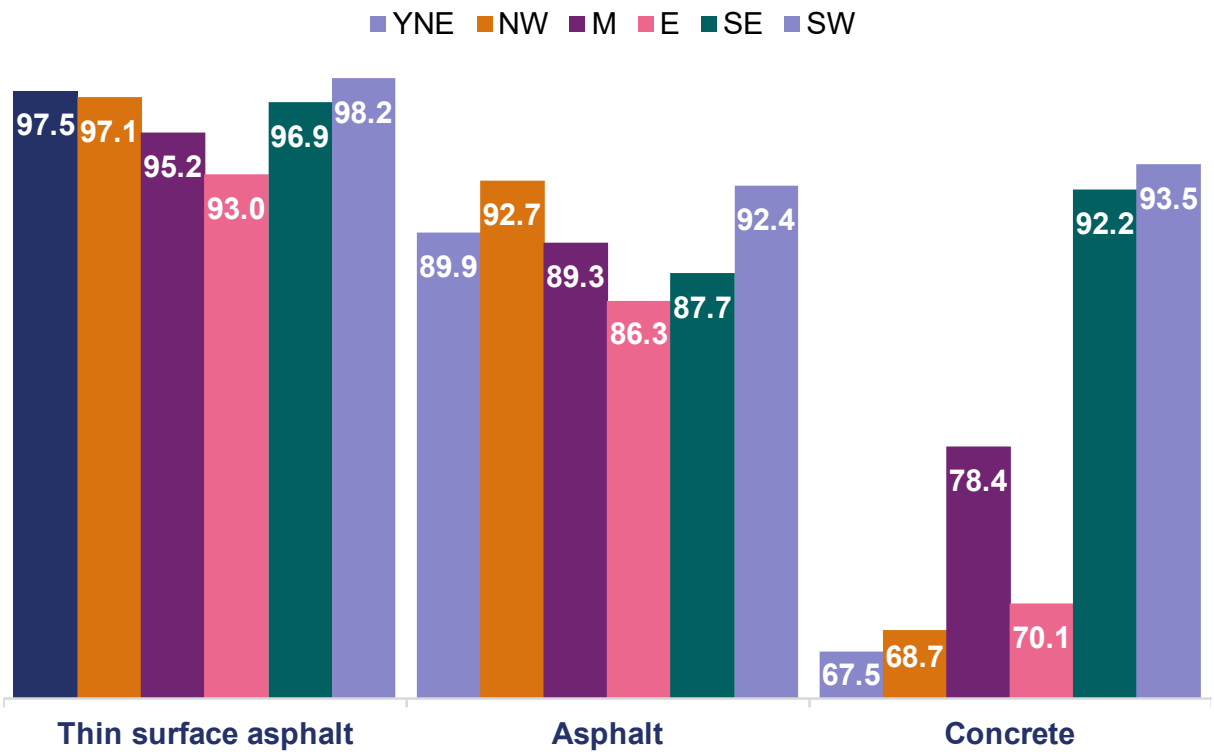
Figure 5.5 Road surface condition by region and road type (2021): estimated percentage of the network meeting KPI threshold level



5.9 A further explanatory factor is the prevalence of concrete roads in the East region. Road surfaces constructed of concrete tend to perform poorly in respect of both skid resistance and ride quality. In the East, 6% of roads are constructed of concrete (as opposed to asphalt), around twice that of any other region.

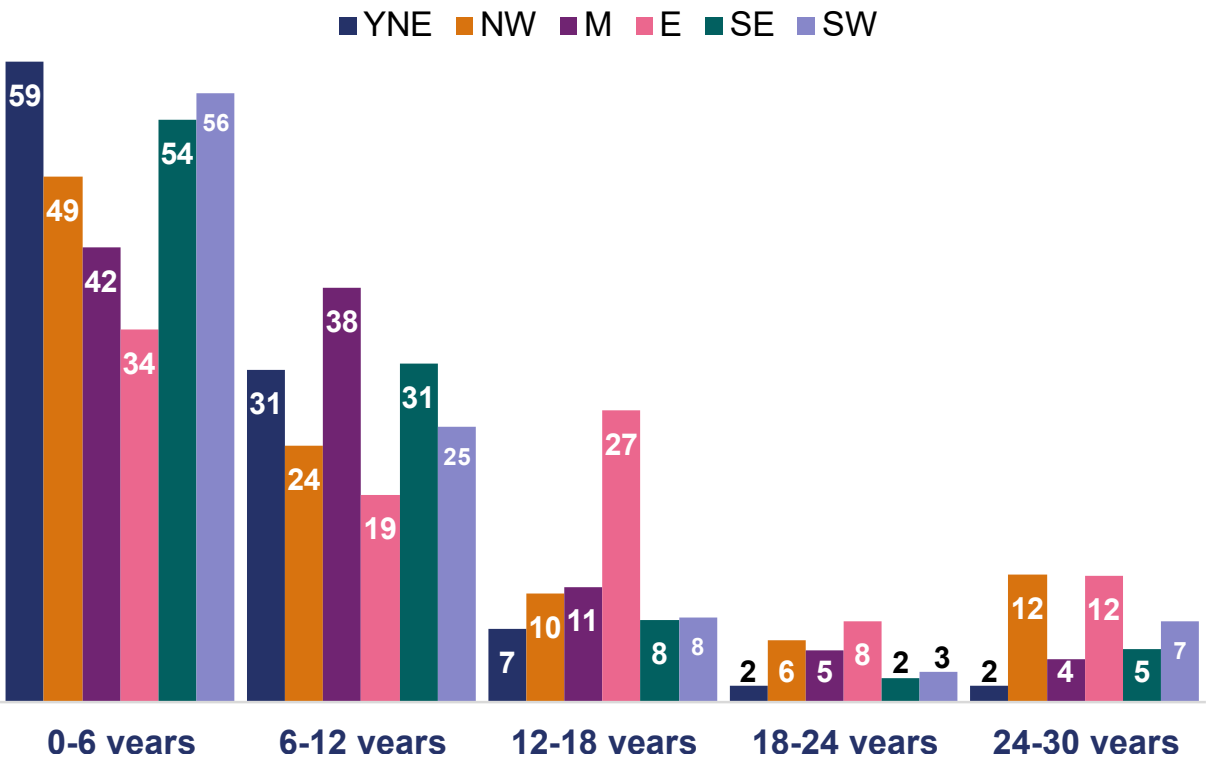
5.10 As shown in Figure 5.6, if condition scores are derived separately for asphalt and concrete roads, the differences between the East and other regions are substantially reduced. However, even for asphalt roads, a higher proportion of roads in the East fail to meet threshold condition levels. Again, this suggests that there are other factors at play.

Figure 5.6 Road surface condition by region and material type (2021): estimated percentage of the network meeting KPI threshold level



5.11 We expect National Highways to continually review local and regional variations – with a particular focus on the East region – and ensure that asset management practices are applied consistently, and based on need. For example, we note that a higher proportion of road surfaces in the East are between 12 and 30 years old (see Figure 5.7). Within the scope of this analysis, it is difficult to be certain whether this is explained by a difference in approach to road maintenance and what influence this has on condition.

Figure 5.7 Percentage of the network by age category (time elapsed since last renewal)



6. Comparing strategic and local road networks

6.1 As noted, we commissioned TRL ltd to benchmark the condition of the SRN with other road networks. Their work included comparisons between the SRN and local authority-managed roads in England.

6.2 Local authority-managed roads often have distinct characteristics compared to SRN roads. To ensure relevance, we focus specifically on the condition of local authority roads within the PRN. The PRN encompasses roads between significant traffic locations across the UK; those typically shown in green on most road maps as opposed to the more common red of an ordinary A-road. In our analysis, we compare road surface condition on the PRN with A-roads on the SRN.

6.3 The analysis uses condition data for a sample of local authorities, namely: Cumbria, Humberside (four authorities), Kent, Norfolk, North Yorkshire, Shropshire, and Somerset.

6.4 Local authorities have their own system of determining whether road surfaces require maintenance and are not subject to the same performance targets as National Highways. Therefore, whereas sections 4, 5 and 6 of this report focus on the proportion of the SRN achieving the pavement condition KPI, here we use raw data for individual aspects of condition.

6.5 Figure 6.1 compares the ride quality (10m eLPV) offered by the PRN and SRN A--roads. Ride quality is overall higher for the SRN. However, it should be noted that the differences between the PRN and SRN become evident only for a relatively small proportion of road surfaces which are in less ‘good condition’. For example, only around 10% of the sample of PRN roads exhibit levels of ride quality that do not meet National Highways’ threshold (for a rural dual carriageway) indicating that further investigation is required.

6.6 Similarly Figure 6.2, shows that SRN A-roads exhibit higher levels of skid resistance than PRN roads. Skid resistance is measured using a seasonally, and climatically adjusted measure, Characteristic Skid Coefficient (CSC). It should be noted that Figure 6.2 does not allow for different location characteristics (such as the presence of junctions) and speed limits which determine the level of skid resistance that highway authorities are required to deliver.

Figure 6.1 Ride quality comparison (2021): SRN A-roads and PRN

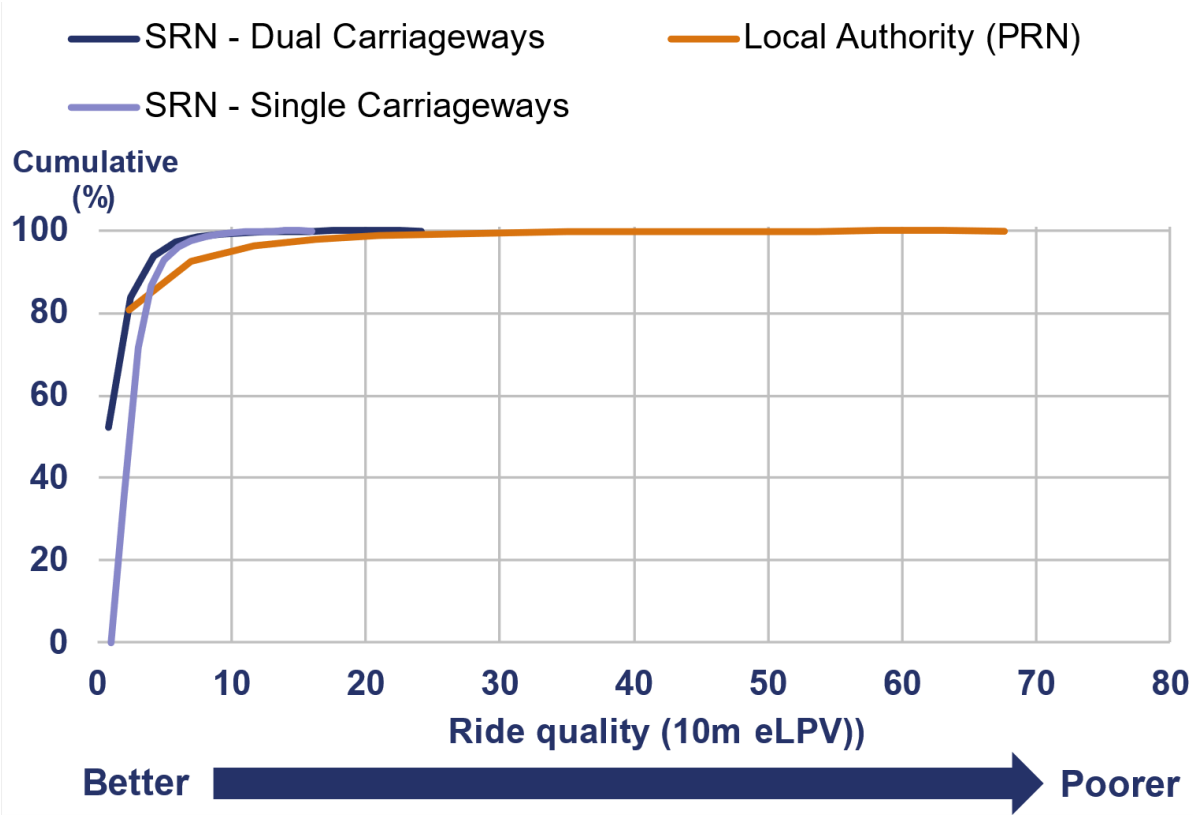
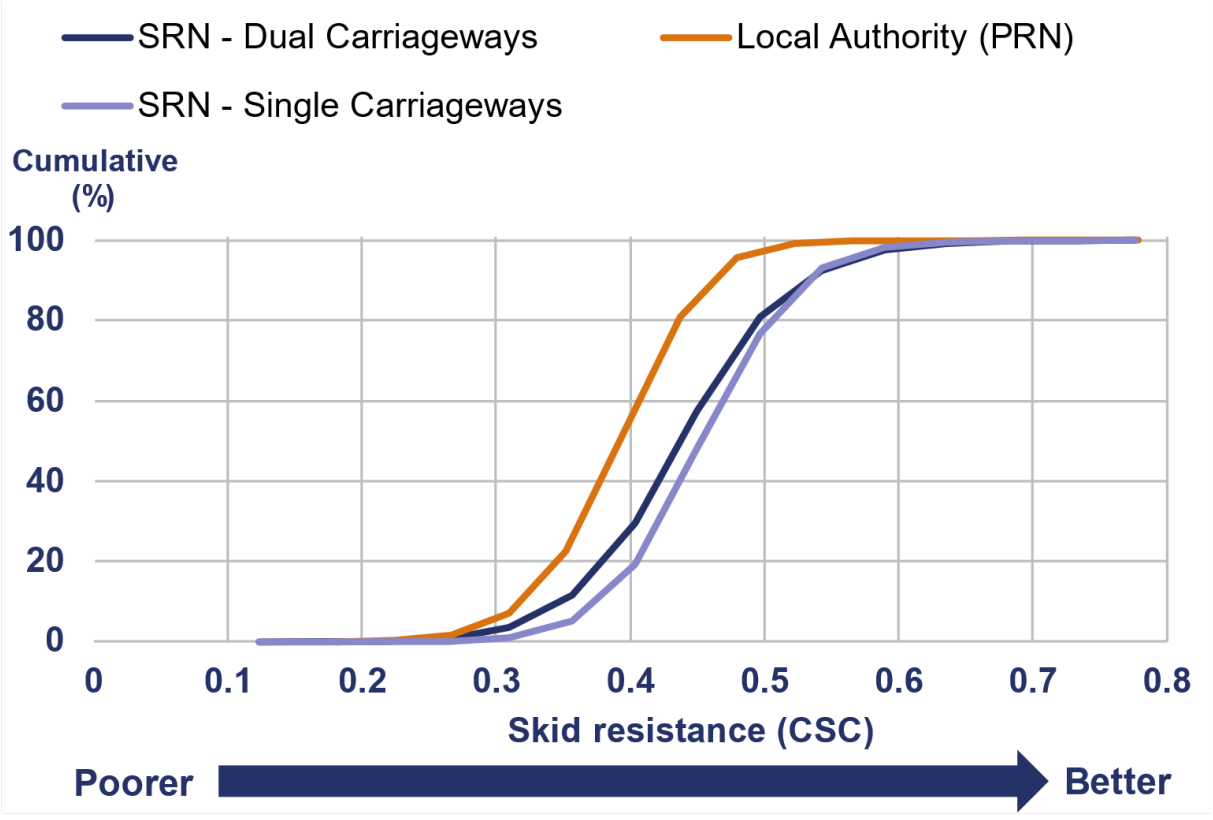


Figure 6.2 Skid resistance comparison (2021): SRN A-roads and PRN



6.7 Overall, our analysis confirms that, in general, the SRN is maintained to a higher standard than the PRN. This is as we would expect, given the implied greater strategic importance of the SRN. As noted, local authorities use different metrics to assess whether maintenance is required and therefore the analysis set out here is not intended to suggest that local authorities are failing to meet their obligations with respect to road surface condition.

7. International comparison

7.1 This section compares the condition of the SRN with the strategic road networks in Wales, Scotland, and the Netherlands (specifically, the Trunk Road Networks managed by the Welsh and Scottish Governments, and the network managed by Rijkswaterstaat in the Netherlands).

7.2 Road surface condition is measured in a similar way in England, Wales and Scotland. The Netherlands was identified in a feasibility report as a potential international comparator on the basis that its road network is broadly similar in character to the SRN. Furthermore, the approach to measuring condition in the Netherlands is sufficiently similar to allow quantitative comparison.

7.3 Each authority employs a system that categorises road sections based on specific condition requirements or standards. These systems are tailored to the unique needs of each authority. This is important to bear in mind as differences in condition can often be explained by differences in standards.

7.4 Benchmarking road surface condition between different countries is complicated by a range of other factors such as the mix of road types, differences in topography, and varying weather conditions. While our analysis accounts for some of these factors, it does not address all of them comprehensively. As a result, differences in condition should not be directly interpreted as one road authority maintaining their networks more or less effectively than another.

7.5 Figure 7.1 provide a comparison of ride quality levels across the four national networks. This is achieved using the International Roughness Index (IRI). Although this is not a measure used in GB, estimates of IRI are generated using 3m and 10m eLPV values which enables comparison.

7.6 Ride quality is better in the Netherlands compared to the GB networks. Over 50% of roads in the Netherlands have a ride quality of 0.8mm or better, while less than 25% of the SRN meets this level of condition. The strategic road networks in England, Wales, and Scotland display similar levels of ride quality.

7.7 The picture for skid resistance is more complex. The Netherlands demonstrates higher skid resistance levels than the networks in England and Scotland. On the other hand, the Trunk Road Network in Wales compares favourably with those in England and Scotland.

Figure 7.1 International comparison (2021): ride quality (IRI)

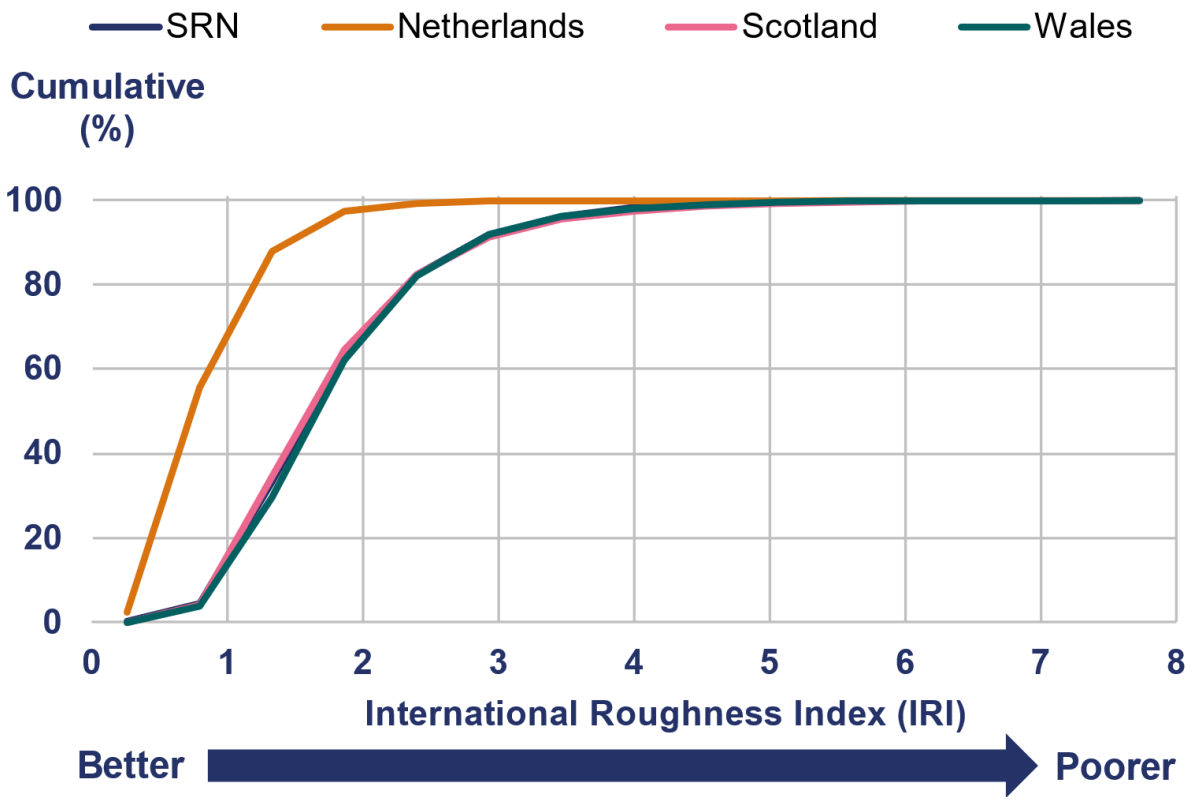
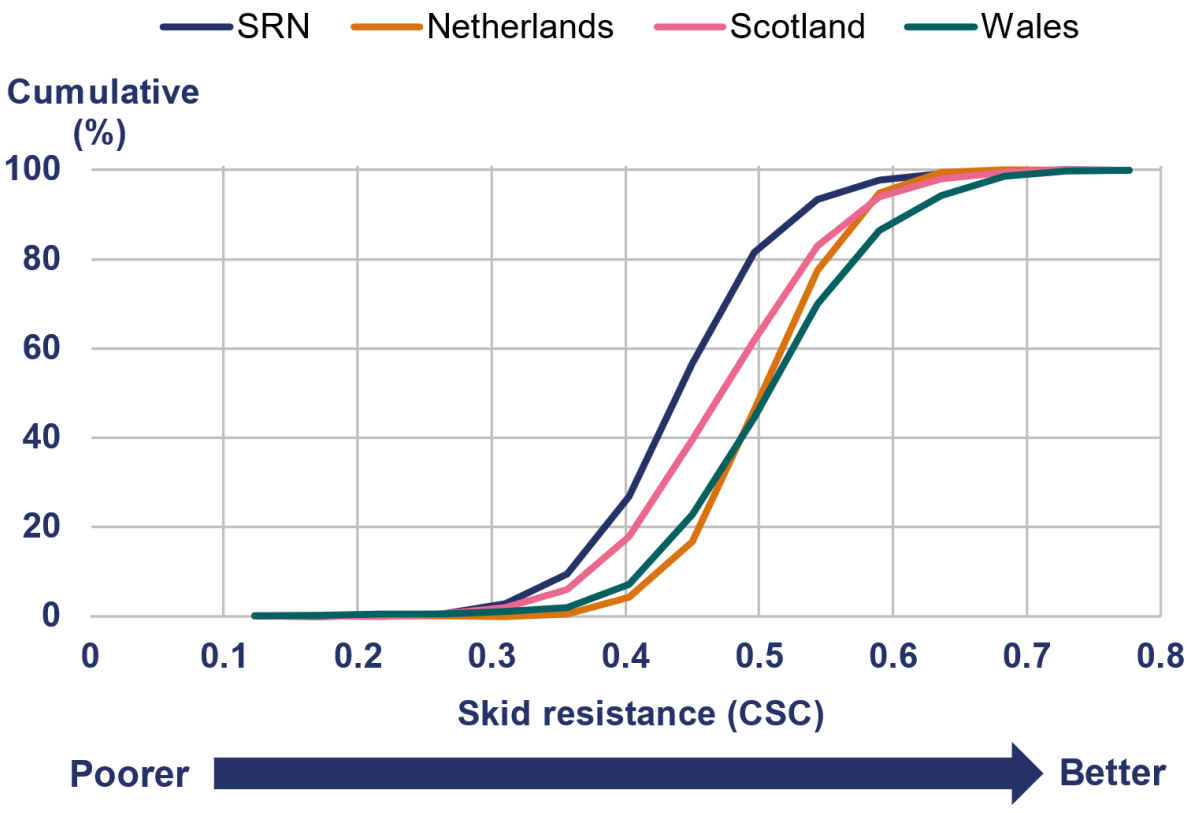


Figure 7.2 International comparison (2021): skid resistance (CSC)



7.8 Some of the variation in road surface condition at the network-level may be explained by differences in the mix of road types. To test this, we restricted the analysis only to motorways. However, as shown in Figures 7.3 and 7.4, similar patterns remain evident.

Figure 7.3 International comparison (2021): ride quality of motorways

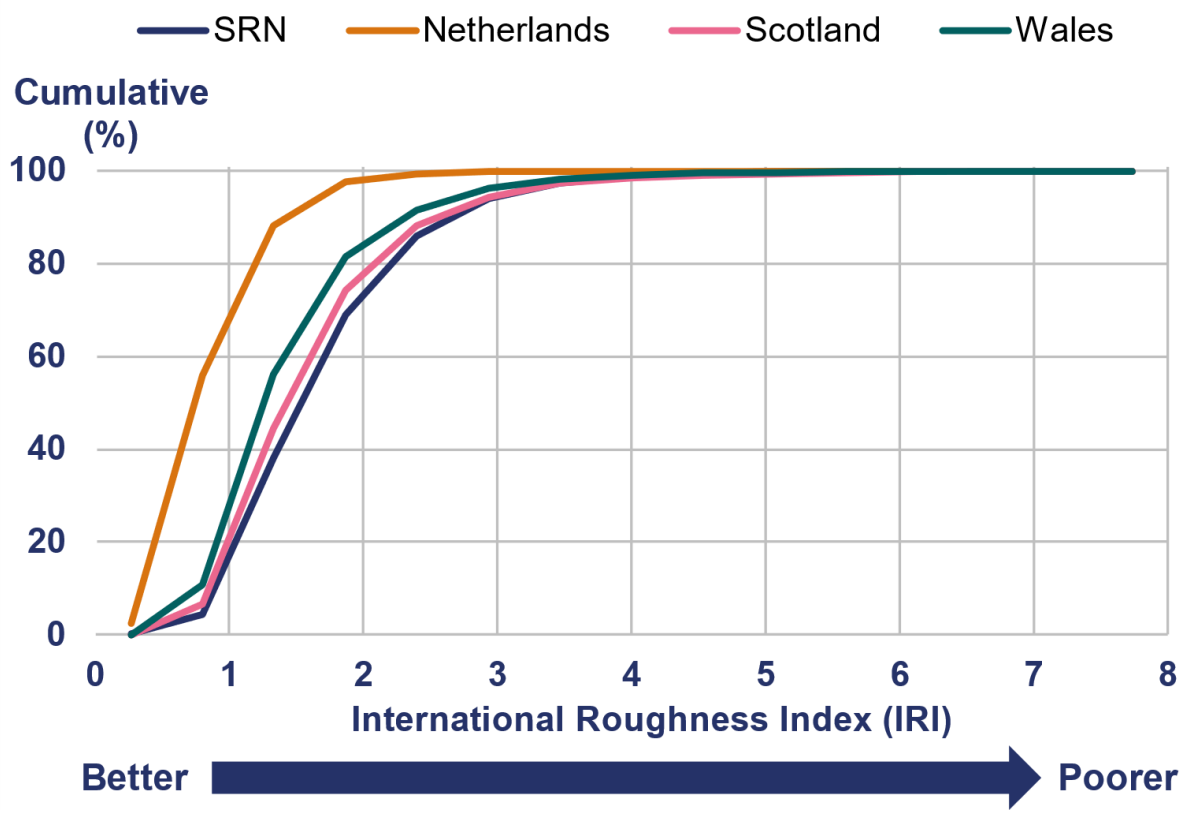
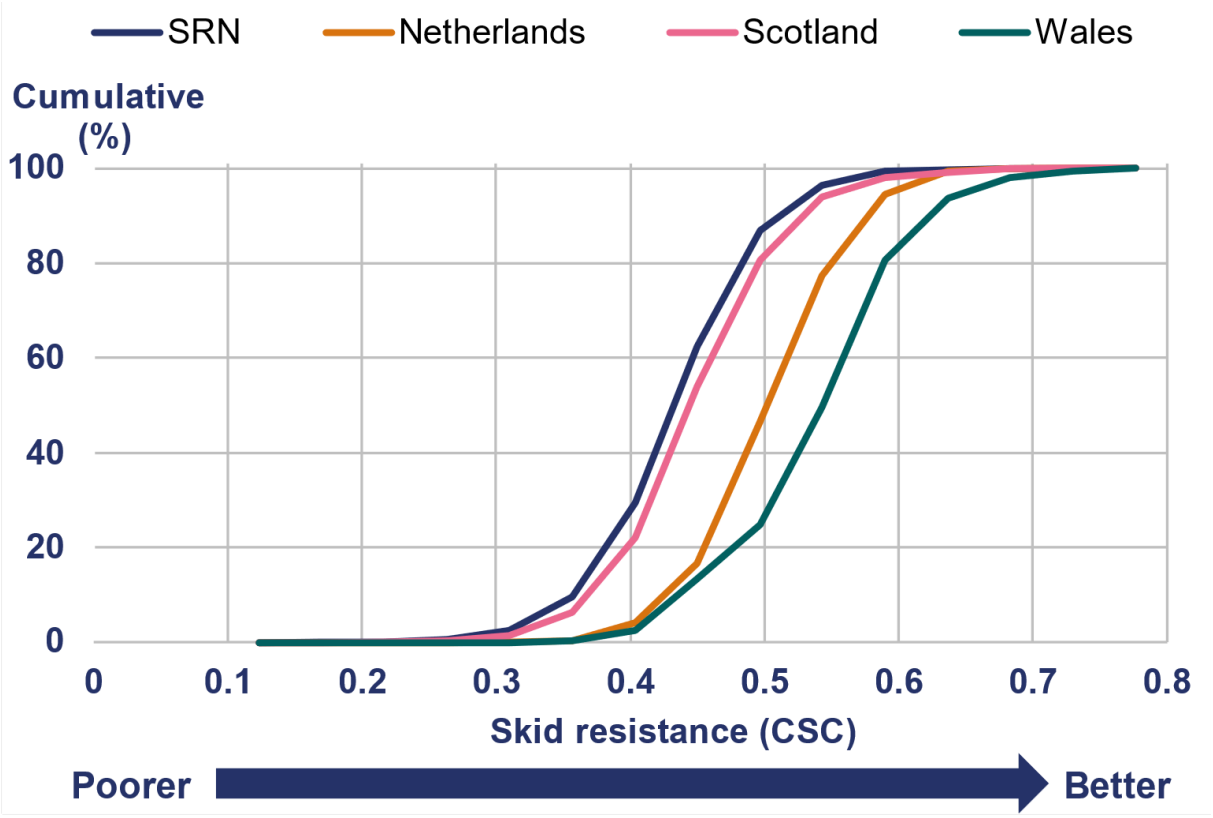


Figure 7.4 International comparison (2021): skid resistance of motorways

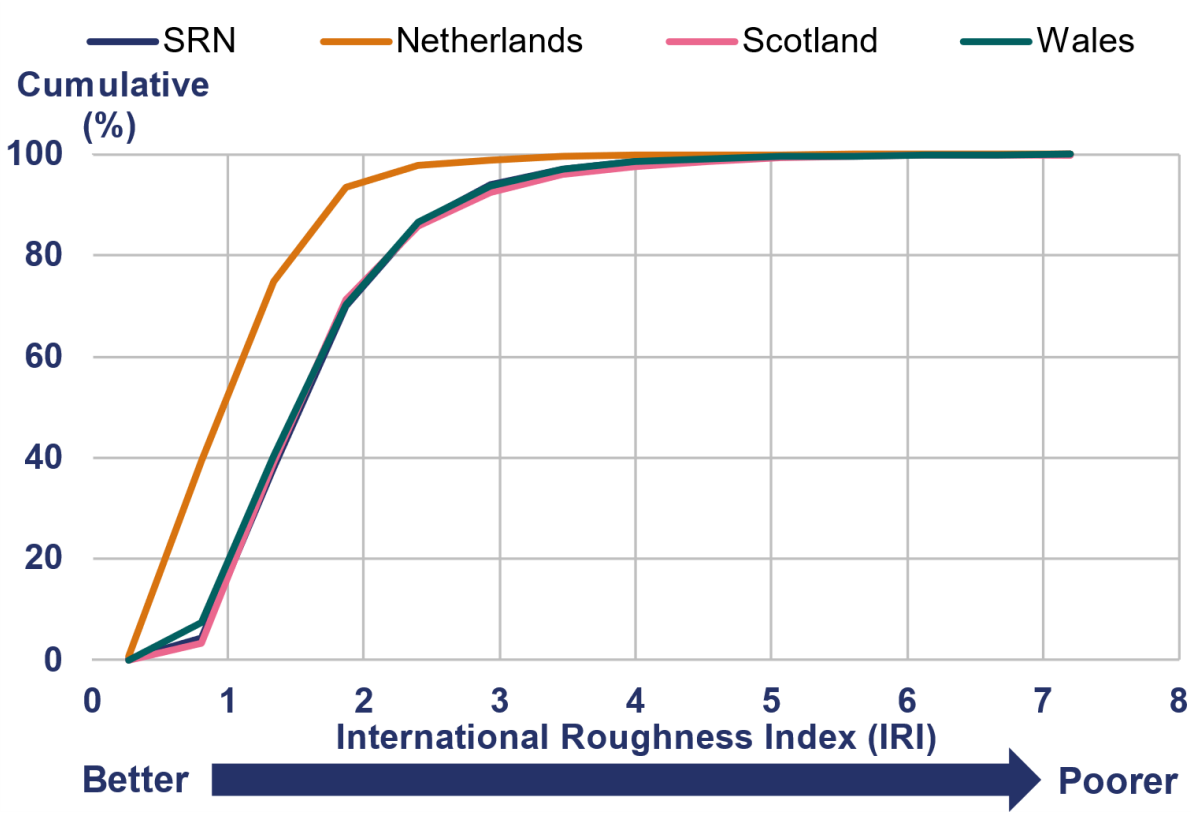


7.9 Our study was unable to fully explain why ride quality is superior in the Netherlands. One plausible explanation could be the difference in material type.

7.10 There are multiple criteria that influence the choice of surface material. Rise quality and skid resistance are just two such factors. Others include noise, embedded carbon emissions and whole life cost. The Netherlands is extensively surfaced with porous asphalt, which is not used in Britain. The most commonly used material on the SRN is thin surface asphalt which is considered to provide a longer lifespan than porous asphalt.

7.11 Porous asphalt may provide better ride quality compared to the thin surface asphalt. However, as shown in Figure 7.5, even the subset of the Netherlands' network constructed of thin surface asphalt demonstrates higher levels of ride quality compared to the GB networks.

Figure 7.5 International comparison (2021): ride quality of thin surface asphalt



7.12 Material type is very likely to influence skid resistance. Porous asphalt is known to offer intrinsically higher levels of skid resistance. However, as was the case for ride quality, skid resistance remains higher in the Netherlands even if roads constructed of similar material are compared.

7.13 Additional research is necessary, but our findings suggest that the average age of road surfaces in the Netherlands is lower than that of the SRN. This difference in age could potentially contribute to the disparities observed in road surface condition.

7.14 In summary, despite the complexities involved in comparing different road networks, such comparisons can offer valuable insights. Based on the findings of our review, we consider there is merit in National Highways collaborating with other road authorities to compare asset management approaches to identify if there are lessons that can been applied on the SRN.

Technical Appendix

Pavement condition KPI

A.1 This section describes the calculation of the Pavement Condition KPI detailed in Section 3. Full technical details can be found in National Highways' Operational Metrics Manual.

A.2 Pavement condition KPI measures the proportion of the network in 'good condition' and, as such, requiring no further investigation for maintenance. The KPI is based on three aspects of pavement condition: ride quality (Enhanced Longitudinal Profile Variance or eLPV), rutting, and skid resistance.

A.3 The condition of all the permanent lanes on the main carriageways (excluding turning lanes or hard shoulders) is evaluated in segments of 100 meters each. The metric excludes roads operated via DBFO arrangements.

A.4 The pavement condition KPI has been in existence since 2015. Originally, the KPI was based on the condition of lane one (i.e., the inside lane) only. In April 2022, National Highways implemented an improved metric. The updated metric measures the condition of all lanes. This provides a better representation of National Highways' management of overall road surface condition on the SRN.

A.5 TRACS – Traffic Speed Condition Surveys – measures the pavement surface condition, including measuring rutting and eLPV. SCRIM – Sideway-force Coefficient Routine Investigation Machines – measure skid resistance.

A.6 The UK Design Manual for Roads and Bridges (DMRB) standards CS228 for skid resistance data and CS230 for TRACS data define road conditions measured by network condition surveys. In the case of TRACS data, the condition is described using four categories:

- Category 1: Sound - showing negligible deterioration.
- Category 2: Some deterioration - indicating a low level of concern.
- Category 3: Moderate deterioration - warning level of concern.
- Category 4: Severe deterioration – intervention level of concern.

A.7 The target condition for defects is Category 3 (i.e. any section failing to achieve category 3 is deemed to be in 'poor' condition). The threshold values associated with category 3 are set out in Table A.1.

A.8 For skid resistance, CS228 defines two parameters: the Characteristic Skid Coefficient (CSC) and the Investigatory Level (IL). The IL determines the level of skid resistance below which an investigation of the skid resistance is to be undertaken. The IL varies by location. Every part of the network is assigned to a specific 'site category' which determines the IL for that location. A threshold of IL-0.05 means that the CSC must not fall more than 0.05 below the IL.

Table A.1 Condition category three thresholds

Condition Parameter	Category 3 Threshold
Rutt depth (mm)	11.0
Ride quality – 3m eLPV (mm^2)	
Motorways	2.2
Rural dual carriageways	2.2
Urban dual carriageways	2.2
Rural single carriageways	2.2
Urban single carriageways	3.8
Ride quality – 10m eLPV (mm^2)	
Motorways	6.5
Rural dual carriageways	6.5
Urban dual carriageways	8.6
Rural single carriageways	8.6
Urban single carriageways	18.3
Ride quality – 30m eLPV (mm^2)	
Motorways	66
Rural dual carriageways	66
Urban dual carriageways	75
Rural single carriageways	75
Urban single carriageways	97
Characteristic Skid Coefficient (CSC)	IL-0.05

Ride quality PI

A.9 Ride quality PI is a subset of the pavement condition KPI. The metric reports the ride quality for the strategic road network in good condition (i.e. category 2 or above) in accordance with the threshold values set out in Table A.1.

A.10 For the period to March 2023, the ride quality PI was based on 3m eLPV only. Going forward, an updated version of the PI will be implemented based on a

combination of 3m and 10m Enhanced Longitudinal Profile Variance) and a 'Bump Index' (a change in surface level).

A.11 Refer to the Operational Metrics Manual for further details.

Benchmarking methodology

A.12 For simplicity and to aid compatibility, the data and methodology used to inform the benchmarking analysis set out in chapters four to seven differs slightly from that used to calculate the KPI and PI.

A.13 For the SRN in England, chapters 4 to 7 are based on a snapshot of condition data in 2021. The analysis is based on the condition of lane one only.

A.14 Details of data transformations undertaken to facilitate comparison across different road authorities can be found in the original report.

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