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*PRODUCTION ENGINEERING ARCHIVES 2021, 27(4), 232-241*

***PRODUCTION ENGINEERING ARCHIVES***

ISSN 2353-5156 (print)
ISSN 2353-7779 (online)

Exist since 4th quarter 2013
Available online at https://pea-journal.eu

# Assessment of the quality of the repair process of local roads in the rural areas of the Częstochowa and Kłobuck poviats in the context of road safety

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**Article history**
Received 07.06.2021
Accepted 18.09.2021
Available online 15.11.2021

**Keywords**
operational security
road traffic safety
local roads
road repairs

**Abstract**

In recent years, numerous measures to modernize local roads in rural areas have been undertaken. Unfortunately, during renovations, especially at the poviat and commune level, errors are often made as a consequence of irregularities arising at the design stage. The article presents an assessment of the quality of local road renovations carried out in the last fifteen years, in the context of maintaining operational parameters over time, using a visual method based on the term "risk". The research was carried out for twenty-six sections of roads that were renovated or rebuilt in the Kłobuck and Częstochowa poviats. The categories of the most common errors were identified and actions were proposed to correct them and prevent new ones. Among the negative trends, the improper placement of road technical devices and the lack of appropriate marking of integral areas were distinguished. It was found that a positive aspect in the aspect of traffic safety, recently, is the widespread use of modern road marking systems and road signs, as well as greater care for proper maintenance of drainage devices. The use of modern solutions during the modernization of roads, despite co-financing from the Government Fund, is still limited by the financial deficit of local governments.

DOI: 10.30657/pea.2021.27.31

JEL: J28, R42, M11

## 1. Introduction

The problem of quality applies to both the manufactured products and the production process (Švecová et al., 2020; Pacana and Czerwińska, 2020; Karcz and Ślusarczyk, 2021). This subject is also important for the construction industry in the context of improving the properties of materials, erecting and modernizing buildings, air quality and managing the quality of construction services (Pietrzak and Ulewicz, 2018; Abdrassilova and Murzagaliyeva, 2020; Lis, 2019; Kowalik and Klimecka-Tatar, 2018). In the literature, can be found reports on the improvement of the quality and safety of road traffic and the assessment of the quality of road surface repairs. Kamenchukov et al. (Kamenchukov et al., 2018) have developed a method for the integrated assessment of the effectiveness of road surface repairs, which makes it possible to define actions aimed at restoring the appropriate road properties, depending on the conditions of its operation. According to the method, each of the repair methods proposed by the engineers is assessed in terms of economic benefits, which makes it possible to select the most optimal technique, while avoiding high costs.

The method of road safety assessment varies depending on the country and the infrastructure conditions prevailing there. Safarpour et al. (Safarpour et al., 2020) distinguish three basic approaches to road safety: traditional approach, vision zero and systemic approach. According to the traditional approach, road safety is strongly related to the human factor and depends mainly on the behavior of road users. This approach assumes that road accidents are mainly caused by mistakes made by road users and therefore they bear almost all legal responsibility. The traditional approach determines the optimal number of accidents and fatalities on the assumption that there is a certain limit to road safety. It focuses on activities aimed at changing negative human behavior through education, campaigning, training and law enforcement. The second approach of the so-called vision zero is a program aimed at the total elimination of fatalities and seriously injured in road accidents. Traffic user errors are understood to be inevitable and therefore accepted. The road network managers and designers are responsible for maintaining road safety. Sweden is at the forefront in the vision zero approach, followed by Norway, and other countries that use a systemic approach based on a zero vision. These are Canada, the United States and Poland, where traffic safety programs have been implemented at the provincial and poviat levels. The scope of the program includes, among others changes in driver training and examination, improvement of the monitoring system, creation of safe intersections, construction of motorways and expressways, use of traffic calming devices and conducting audits. The last of the discussed approaches is the systemic approach, including the human factor, the causative factor and the environmental factor, in relation to road incidents. According to this approach, both road users and designers of transport systems are responsible for the prevention of road accidents. Within the systemic approach, there are three sub-themes such as: sustainable safety, safety system and the United Nations plan for decade of action. The analysis has shown that the systemic approach is used in Great Britain, Japan, the Netherlands, Australia and partly in Germany.

Also Grzelak and Borucka (Grzelak and Borucka, 2019) showed that it is very important to identify general road safety problems in a regional perspective. In this case, analyses are most often carried out on the basis of statistical data provided by the Police on the number of road accidents, fatalities and injuries, which are grouped into individual categories (including time and place of the accident, prevailing weather conditions, road conditions).

The assessment of the level of road safety can be performed using several methods (Landowski and Kwasińska, 2014). The oldest of them is the accident concentration method, which consists in analysing registered road incidents, determining their causes and place of occurrence. The second method relates to the determination of the safety level in the area of intersections and consists in determining the so-called visibility triangle for inlets of minor roads. The third method is based on the use of appropriate indicators, including the road traffic risk index, accident seriousness index and the incident concentration index. These indicators relate to a specific area and the assumed period of the analysis. In 2020, a work was published on a modern methodology that allows for quick identification of critical road sections at low costs (Tripodi et al., 2020). The methodology was verified on the basis of road safety assessment on rural roads in Mozambique, based on the analysis of video images collected with a dashcam or smartphone. The obtained material was analysed with the use of specialized software, enabling automatic identification of road attributes and determination of the risk level. The developed methodology was based on the term "risk" understood as a combination of danger, vulnerability and exposure. The advantage of this method is the low cost of carrying out the tests, the speed of their execution, the possibility of obtaining reliable results without the need to have data on road accidents. The above research method, due to the similar terrain conditions and technical possibilities, was used in this study to analyse the quality of local road repairs. The analysis was performed for local roads in rural areas that were renovated in the last fifteen years. The research was carried out in the context of road safety and maintenance of road performance parameters over time. The categories of the most common errors that reduce the level of road safety were also identified, and options for correcting and preventing them in the future were proposed.

## 2. Road safety in the Silesian Voivodeship

In the last two decades, there has been a significant development of the road network of the Silesian Voivodeship. The data of the Central Statistical Office show that in 2019 there were 25 142.3 km of public roads in the Silesian Voivodeship, of which 1 267.3 km were national roads, 1 504.8 km - voivodeship roads, 6 329.3 km - poviat roads and 16 040.9 km - municipal roads (Statistics Poland, 2021). The administrative reform of Poland in 1999 initiated the need to adapt public roads to the new administrative division, which resulted, among others, in construction of new sections of roads, including local ones (currently they account for approx. 95% of all roads in Poland) and modernization activities (renovation and reconstruction) in order to improve the technical condition of roads, as well as driving comfort. The total length of public poviat and commune roads in individual poviats of the Silesian Voivodeship per 100 $km^2$ of area in 2005 and 2019 is shown in Figure 1. The largest increase in new roads in the analysed period occurred in the Lubliniec poviat (27.9%). On the other hand, the lowest number of road investments was carried out in Bielsko poviat, where a decrease of approx. 1.45% was recorded.

Road modernization activities are carried out not only to maintain traffic continuity, but also to increase road safety (Graczyk and Polasik, 2016). This safety is significantly improved by the constructed road traffic devices, such as road barriers, drainage devices or sidewalks with high curbs, as well as properly designed vertical and horizontal signage (Corazza et al., 2016; Corazza et al., 2020; Di Mascio et al., 2020). The report on the safety of road users of the Supreme Audit Office shows that insufficient road quality is one of the main causes of a large number of road accidents and collisions (Supreme Audit Office, 2021). Compared to other European Union countries, Poland has one of the most dangerous roads, which translates into the 26th place (out of 28 EU countries) it occupies in terms of safety, according to the data for 2019. Percentage of road accidents in 2015-2019 per 100 000 population in individual poviats of the Silesian Voivodeship is shown in Figure 2. Most accidents were recorded in Częstochowa poviat, where the rate in the analysed period is each time above 10.5%. On the other hand, the lowest number of accidents was recorded in Wodzisławski poviat (2.5%).

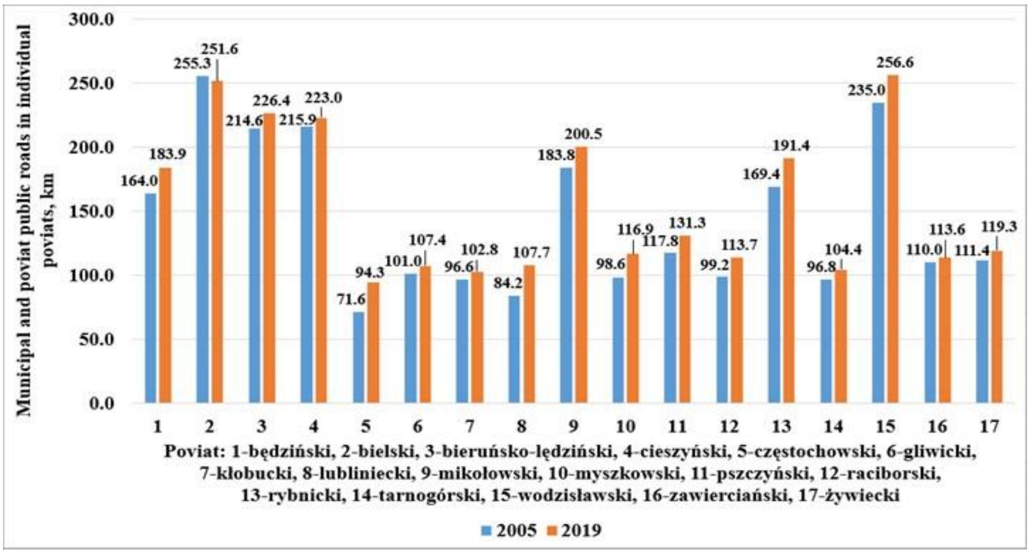


**Fig. 1.** Poviat and commune public roads with hard surface per 100 km$^2$ of surface (study based on the Central Statistical Office, as of July 15, 2019)

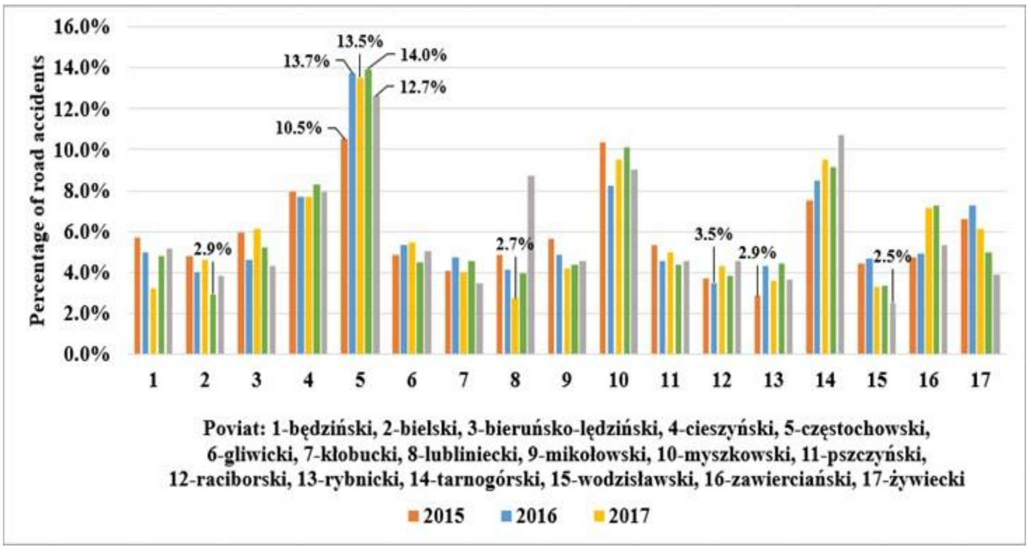


**Fig. 2.** Road accidents in the poviats of the Silesian Voivodeship per 100 thousand. population in 2015-2019

Road safety is significantly influenced by the technical condition of road surfaces and roadsides (Obłój, 2011). Unfortunately, it is often difficult to determine the relationship between road surface condition and the number of accidents due to insufficient accident data and the concomitant influence of other factors. The data from the Polish National Police (Polish National Police, 2021) show that the most accidents in the Silesian Voivodeship caused by the incorrect condition of roads were recorded in 2018 (Fig. 3). In 2020, the number of accidents, compared to 2018, decreased by nearly 50%.

Many studies (Mofolasayo, 2020; Mayerhofer et al., 2020) dealt with the topic of road accidents, also involving the so-called vulnerable road users (mainly pedestrians and cyclists). The main factors negatively affecting their safety have been identified, areas where some improvement can be made, identified integral areas of the road (Bassani et al., 2020) and a set of possible scenarios for dangerous road incidents. One of the studies also compared two methods of protection against hitting the tunnel wall in the emergency stop zone (Kunc et al., 2016).

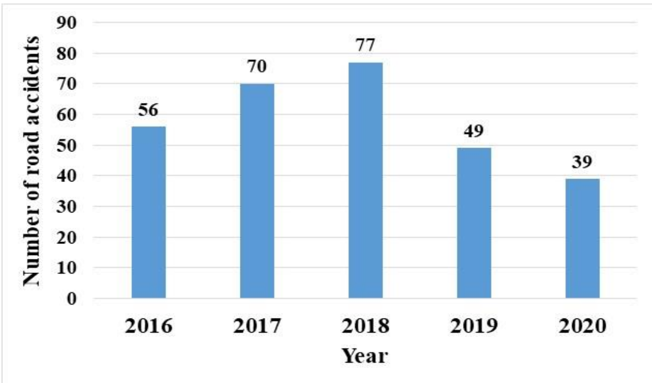


**Fig. 3.** Number of road accidents caused by the improper road condition in Poland in 2016-2020

According to the Supreme Audit Office, a particularly disturbing situation in recent years has taken place at the poviat and commune level, where modernization activities were severely limited due to insufficient funds. For this reason, by the Act of 23 October 2018 on the Government Fund for Road Development, a new system of financial support for local government units was established for the years 2019-2028. The aim of the Fund is to support the implementation of tasks on roads managed by local government units and to increase the safety of local road infrastructure. Co-financing of tasks on commune and poviat roads is carried out on the basis of a competition, after positive consideration of applications submitted by local government units. The amount of co-financing depends on the income of a given unit and may amount to a maximum of 80% of the costs of a given task. As part of the Fund, the Silesian Voivodeship will receive over PLN 260 million for repairs, reconstruction and construction of new roads, covering 34 continued multi-annual tasks, 44 new one-year tasks and 17 new multi-annual tasks. Co-financing accounts for over 53% of the total costs of poviat tasks and over 52% of the total costs of communal tasks. Government support will also be provided to the analysed poviats in the amount of over PLN 41 million. As a result, in the Częstochowa poviat, a total of 21.097 km of poviat roads and 6.026 km of commune roads will be renovated or rebuilt, and 7.12 km of commune roads in the Kłobuck poviat. So far, thanks to government support, it has been possible to implement, inter alia, reconstruction of poviat roads (including reconstruction of roadside, pavements, drainage and signage systems), expansion of intersections, cycle paths and renovation of municipal roads (Silesian Voivodeship Office in Katowice, 2021).

## 3. Methodology of reserach

The research was carried out in two stages in the period January-February 2021. The first stage concerned the assessment of the quality of local road repairs in the context of maintaining operational parameters. The field research was carried out in real road traffic conditions on twenty-six sections of local roads located in the area of two selected poviats. The "in situ" research consisted in recording the current technical condition of the sections of poviat and communal roads renovated in the last fifteen years with a camera. Particular attention was paid to the applied road safety devices. The mileage of each tested section was determined using the kilometer counter. The research was carried out taking into account the following seven parameters that have a particular impact on the level of road safety:

- vertical and horizontal signage,
- driving comfort,
- comfort of overtaking,
- roadside condition,
- road drainage condition,
- daytime driving,
- night driving.

With regard to "vertical and horizontal signage", the correct use of individual signs and devices as well as their location and impact on horizontal visibility were analysed. In terms of "driving comfort", the condition of the transverse and longitudinal evenness of the road surface was assessed, while "comfort of overtaking" concerned the analysis of the width of the roadway and the use of high curbs, affecting the safety of participants during the overtaking maneuver. "Roadside condition" and "road drainage condition" related to the technical condition of the roadsides made and the correct execution, location and maintenance of drainage devices. The last two parameters relate to the comfort and safety of moving the vehicle in day and night conditions.

Each parameter was assessed in accordance with the scale used for the assessment of the technical condition contained in the Regulation (Janas et al., 2019) in the range from 0 to 5, where the lowest score of "0" means an emergency, the need to undertake modernization measures, and the highest grade "5" - appropriate condition, not requiring renovation. In this way, the quality of the performed repairs was assessed in terms of the technical condition of the devices and the correctness of their use.

In the second stage of the research, some typical trends lowering the level of road safety were identified, which were divided into categories of the most common errors revealed during operation:

- incorrect vertical signage,
- no vertical signage,
- no horizontal signage,
- presence of high curbs on both sides of the road,
- incorrect connection of drainage devices,
- incorrect execution of a passage through the sewage,
- no road barriers,
- incorrect location of pavement barriers.

A quantification of errors from individual categories was made. For this purpose, two measures were used: the pieces determined the number of point devices incorrectly located, or their absence (incorrect or no vertical marking, no road barriers and incorrect location of pavement barriers), while meters determined the sum of the lengths of line elements (no horizontal marking, high curbs, incorrect connection of drainage devices and incorrect execution of a passage through the sewage). The percentage share of line elements in relation to the sum of the lengths of all analysed road sections was also calculated.

## 4. Results of the study

Table 1 shows the scores for individual parameters that affect the level of road safety on the analysed road sections, the length of each of them and the year of repair or reconstruction. The area where the road sections were located was also determined: the built-up area was conventionally marked with the symbol "BA", while the undeveloped area with the symbol "UA".

Figure 4 shows the average score for each parameter, calculated for the entire analysed area and divided into built-up and undeveloped areas. The conducted research showed that in the general terms of the analysed area, the condition of "vertical and horizontal signage" and "daytime driving" obtained the highest average scores among all parameters and amounted to 4.3 and 4.2, respectively.

The lowest average score of 3.5 was obtained for the parameter - "night driving". In the undeveloped area, this indicator was only 2.0. This fact is due to the very limited visibility when driving in the dark. Many road difficulties, which are sufficiently visible to drivers during the day, pose a great risk to road users in the evening and night hours, e.g. lack of appropriate marking of integral road areas, no use of reflective vests by pedestrians and cyclists, and the presence of wild animals near the road in forest areas. It was also found that the difference between the average parameter assessments in the built-up area and in the entire analysed area does not exceed 0.3. The highest differences in the average scores were noted between built-up and undeveloped areas for the following parameters: "night driving" (1.8), "roadside condition" (0.7) and "comfort of overtaking" (0.7). Interestingly, "comfort of overtaking" was the only parameter that obtained a better average score in undeveloped areas than in built-up areas (3.6). This is due to the more frequent use of high curbs, which make it difficult to overtake in built-up areas, especially when building pavements, which is quite unusual in undeveloped areas.

Figure 5 shows the average score for individual parameters in a given period. The analysed time period was divided into three periods: 2005-2011, 2012-2016 and 2017-2021, in which a similar number of road repairs were carried out. On the basis of the obtained results, it was found that the highest average scores were mostly obtained by parameters from the last four years. The upward trend is clearly visible, which results mainly from the short period of operation of the newly renovated sections of local roads. The following parameters obtained a value above 4.0: "driving comfort" (4.7), "vertical and horizontal signage" (4.4),"roadside condition" (4.4),"road drainage condition" (4.4) and "daytime driving" (4.4).

**Table 1.** Assessment of the quality of road repairs performed in terms of individual parameters and the year of their implementation

| Section of the road | Length of the road section, m | Vertical and horizontal signage | Driving comfort | Comfort of overtaking | Roadside condition | Road drainage condition | Daytime driving | Night driving | Built-up area / undeveloped area | Year of renovation |
|---|---|---|---|---|---|---|---|---|---|---|
| No 1 | 350 | 3 | 4 | 3 | 4 | 4 | 2 | 5 | BA | 2019 |
| No 2 | 700 | 4 | 5 | 5 | 4 | 4 | 5 | 4 | BA | 2009 |
| No 3 | 700 | 3 | 4 | 1 | 4 | 3 | 5 | 4 | UA | 2009 |
| No 4 | 900 | 4 | 5 | 4 | 4 | 4 | 4 | 4 | BA | 2009 |
| No 5 | 600 | 5 | 5 | 5 | 5 | 5 | 3 | 4 | BA | 2014 |
| No 6 | 3 200 | 4 | 5 | 5 | 4 | 4 | 4 | 4 | BA | 2016 |
| No 7 | 2 200 | 5 | 5 | 4 | 5 | 4 | 5 | 5 | BA | 2019 |
| No 8 | 3 300 | 4 | 5 | 5 | 4 | 4 | 5 | 5 | BA | 2018 |
| No 9 | 1 000 | 4 | 4 | 2 | 3 | 5 | 3 | 3 | UA | 2011 |
| No 10 | 1 200 | 2 | 3 | 2 | 4 | 3 | 3 | 3 | BA | 2011 |
| No 11 | 1 900 | 4 | 5 | 5 | 3 | 4 | 4 | 3 | BA | 2011 |
| No 12 | 1 200 | 4 | 4 | 3 | 4 | 5 | 3 | 3 | BA | 2012 |
| No 13 | 2 000 | 4 | 5 | 5 | 5 | 4 | 4 | 4 | BA | 2015 |
| No 14 | 700 | 4 | 5 | 4 | 3 | 3 | 3 | 1 | BA | 2009 |
| No 15 | 1 300 | 5 | 5 | 5 | 5 | 3 | 4 | 4 | BA | 2017 |
| No 16 | 6 100 | 5 | 5 | 5 | 5 | 4 | 5 | 4 | BA | 2019 |
| No 17 | 2 200 | 4 | 4 | 3 | 5 | 2 | 5 | 4 | BA | 2020 |
| No 18 | 1 200 | 5 | 5 | 5 | 5 | 4 | 5 | 5 | BA | 2019 |
| No 19 | 700 | 4 | 3 | 2 | 4 | 2 | 4 | 4 | BA | 2017 |
| No 20 | 3 775 | 5 | 3 | 2 | 4 | 3 | 3 | 4 | BA | 2015 |
| No 21 | 1 480 | 5 | 4 | 3 | 4 | 5 | 3 | 4 | UA | 2015 |
| No 22 | 1 845 | 5 | 4 | 3 | 3 | 2 | 4 | 4 | BA | 2015 |
| No 23 | 1 800 | 5 | 4 | 3 | 5 | 3 | 5 | 4 | BA | 2018 |
| No 24 | 2 000 | 4 | 4 | 3 | 3 | 4 | 4 | 5 | BA | 2011 |
| No 25 | 1 300 | 3 | 3 | 2 | 3 | 4 | 2 | 3 | UA | 2011 |
| No 26 | 5 200 | 4 | 4 | 3 | 3 | 4 | 3 | 4 | BA | 2011 |
| Sum | 48 850 | 108 | 112 | 92 | 105 | 96 | 100 | 101 | - | - |

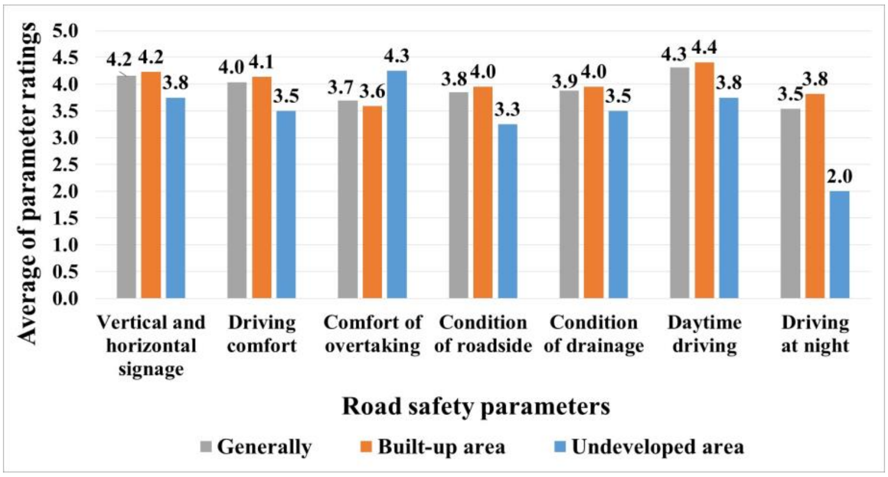


**Fig. 4.** Average of parameter assessments from the entire area and with the division into built-up and undeveloped areas

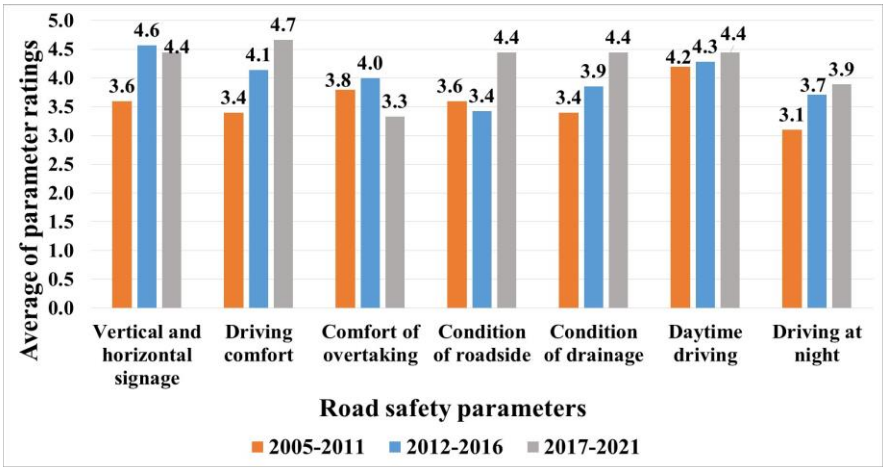


**Fig. 5.** Average of parameter assessments with the division by years

The main reason for this is the use of modern marking systems, which are more and more frequent in recent years, which is more visible to drivers and has a positive effect on the comfort and safety of driving in daytime conditions. Some of the examined parameters, such as "vertical and horizontal signage" and "comfort of overtaking" recorded a downward trend, which may result, inter alia, from the intensity of use of a given road section or execution errors made during the modernization.

During the research, several typical trends negatively influencing traffic safety were identified. The obtained data show that the highest rate determines the use of high curbs on both sides of the roadway and amounts to 44.0%, while the lowest rate, equal to 9.6%, concerns incorrect connection of drainage devices. For about 25% of the length of the tested roads, there is no horizontal marking, and on slightly more than 10% of the roads, the entry to the property through the drainage sewage was incorrectly made. There are also point irregularities, among which the highest number of 14 refers to the lack of vertical markings, mainly road sign „U-3" on dangerous turns of the road. Incorrect vertical marking was noted in 3 places, incorrect location of pavement barriers in 5 places, and no road barriers in 11 analysed research sites.

## 5. The most common mistakes and suggestions for correcting them

Some road equipment can have a negative impact on road safety. Examples include improper road markings (Pasetto and Barbati, 2012), incorrectly positioned vertical signs, which often contribute to reduced visibility at intersections (Brycht, 2020) and incorrect connection of drainage devices. Some of the activities that can prevent the formation of flaws at the design stage, e.g. by improving the condition of road infrastructure, were described by Ngoc and Thanh (Ngoc and Thanh, 2020).

Figure 6 shows an example of conflicting road markings at an intersection with a minor road. The white and green „U-2" edge posts (in a circle) are used at equivalent intersections, where the right-of-way vehicle has priority to the right. In this example, setting the prohibition sign „B-20" "STOP" (marked with an arrow) is correct because it introduces the obligation to stop before the road with priority. Therefore, the installation of edge posts at the junction with the minor road is incorrect, because the driver of the vehicle on the minor road, approaching the intersection, receives a contradictory right-of-way message, which implies a high risk of road accidents. In this case, the best solution is to remove unnecessary vertical markings.


**Fig. 6.** Incorrect vertical signage at the intersection with a minor road

Improper use of the marking is as dangerous for road users as its lack. A very common phenomenon of this type is the lack of the road signs „U-3a" – „U-3d", which indicates the direction of travel on particularly dangerous horizontal curves. In this situation, the risk of an accident is very high, especially in the period of limited visibility (from dusk to dawn and during intense sunlight) and during unfavorable weather conditions (heavy rain or snowfall, slippery road surface). The easiest way to fix this type of error is to fill the shortage.

A common executive error is incorrect placement of the sidewalk barriers. Their task is to separate and protect pedestrians walking on the pavement from possible vehicle impact. Therefore, they can be found along roads with heavy traffic, in places that require special protection, e.g. in front of schools, as well as over slopes and water obstacles. During the research, an example of the location of the barriers on the outer side of the pavement was noted, with no dangerous fault or special protection nearby. Therefore, there is no justification for such a solution, the more so as pedestrians are still exposed to danger, and the only element separated from the road is a concrete fence along the outside of the pavement. Incorrect barrier placement can also reduce visibility at intersections with a minor road.

Road safety largely depends on the influence of rainwater. Penetrating into the cracks in the road surface resulting from various breaks, they imply further damage, from cavities to corrosion of the material of substructure. For this reason, the main task of road managers is to prevent the destructive effects of rainwater (Respondek, 2019). For this purpose, modern drainage systems are made. However, the correct way of making them and adjusting the appropriate type of devices to the prevailing conditions guarantee the fulfillment of their protective functions. Figure 7 shows an example of incorrectly interconnecting drainage devices. Muld gutters, serving as drainage of excess water from the roadway, were made in the wrong place on the road. The sewage should be carried out directly at the edge of the road, and the water in it should be transported to drainage wells. Unfortunately, in a situation where an unpaved roadside is made between the muld gutters and the roadway, the water from the road surface along with the material from the roadside flows into the drain (arrow), causing its pollution and blockage. As a result, water that is not drained remains on the roadway, creating a layer that reduces the adhesion of the vehicle wheels to the road surface, which results in skidding.


**Fig. 7.** Incorrect connection of drainage devices

A frequent oversight already in the planning phase of road works is failure to take into account appropriate solutions at the entry to the property. In this situation, property owners perform various forms of crossing the "obstacle" on their own, usually in an incorrect manner, e.g by concreting the sewage, placing steel pipes or sheets and backfilling. Such practices silt the effluent and prevent proper drainage.

An example of implementation irregularities is also the construction of pavements on both sides of the roadway in built-up areas. The first disadvantage of this operation is the inability to properly park the vehicle in a place that is safe for road users. In such a situation, the vehicle driver parks partially on the pavement and the road, which makes it difficult for both pedestrians and drivers to move along the partially occupied lane. As a consequence, it poses a significant risk of a collision or even an accident, especially in the evening and night hours when visibility is limited. The second downside is the use of high curbs, which reduces the comfort of overtaking. This is an important issue, above all, for drivers of vehicles with larger dimensions, such as lorries. High curbs can also contribute to numerous scratches and more serious mechanical damage to the car as a result of the vehicle moving too close to the edge of the roadway. Their construction leads to the accumulation of impurities along them, which causes siltation of the road surface and the formation of puddles. In the above-mentioned case, water is drained from the roadway from the curb drain into the ditch through the inlet with a drain located under the pavement. This type of solution fulfills its functions only on condition that a inlet with an appropriate cross-section is used, and road managers undertake work related to cleaning the device from time to time. An interesting solution would be e.g. the use of streamlined or triangular curbs, which are safer for road users.

Many irregularities occurring during road repairs cannot be repaired in such an efficient way as, for example, removing or placing missing markings. In such cases, the best solution is to pay special attention to the appropriate adjustment of technical devices to the individual conditions of a given road section at the design stage. It is very important to use unconventional solutions. Sometimes there are cases of duplicating technical specifications previously issued by the General Directorate for National Roads and Motorways. Often, such documentation does not refer to the actual conditions, therefore it is recommended to prepare it in an accurate manner and in accordance with the existing condition. Unfortunately, a large number of repeated errors result from the financial limitations of road managers, who carry out repairs often inadequate to real conditions.

The discussed examples of errors and inaccuracies are not eliminated to a large extent for many reasons. The first is the financial shortcomings which prevent the implementation of recommendations after the periodic inspections carried out. Secondly, the acceptance of works by the investor takes place on the basis of checking the compliance of the actual state with the technical specification. Road managers, having incorrect documentation, resulting e.g. from inaccuracies in the design phase, are not able to identify them. Often, despite the compliance of the repairs carried out with the technical conditions, the devices actually made hinder the operation of the roads. As an example, there may be high curbs on both sides of the roadway, which from the perspective of technical conditions are properly made, but in real conditions they can pose a significant threat or vertical markings obscured by branches of roadside trees. Another reason is the failure to perform road safety analysis on lower class roads, including local roads. This study is carried out, inter alia, in the context of assessing the visibility on individual road sections. The results of the analysis would indicate weaknesses of local roads in the context of road safety, which would provide a basis for taking actions to improve the existing technical condition. Historical events have a particular impact on the low possibilities of eliminating the difficulties arising on the roads. Renovations are carried out on the traces of already existing roads, without the possibility of interfering with their widening or appropriate profiling of horizontal curves. These activities would entail the necessity to undertake projects related to, for example, the purchase of plots of land, which further complicates the entire renovation process. Therefore, it is a serious obstacle for both designers and contractors, who are forced to locate all technical devices of the road, limiting themselves to the existing geometrical parameters. The last issue is the regulations, on the basis of which, in justified cases, it is possible to request certain deviations from the norm. Thus, showing the existence of large difficulties that make it impossible to properly perform certain road elements, they are not corrected.

In addition to negative trends, it is also worth mentioning the positive aspects that have become visible recently. Figure 8 shows an example of a modernized roadside ditch. Before the renovation, the technical condition of the road was described as unsatisfactory. The main problem was, apart from the contaminated drainage device, numerous damage to the road surface in the form of mesh cracks and material chipping. Incorrect maintenance of the roadside ditch led to clogging of the culvert and, consequently, to a long retention of rainwater. In this case, the modernization activities included: replacement of the surface course, the use of horizontal markings in the form of lines separating opposite traffic lanes and the line marking the edge of the roadway, as well as a thorough replacement of the existing drainage device. The roadside ditch has been cleared, deepened and reinforced with openwork concrete slabs (arrows), thanks to which the risk of soil landslide was reduced. The culverts under the entry to the property were also renovated (in a circle).

**Fig. 8.** An example of the correct application of drainage devices

Despite the increasing use of modern road safety devices, the risk of road accidents is still very high. Therefore, it is extremely important to take measures to prevent them and apply solutions that minimize the negative effects of their occurrence. One of such elements of road equipment are energy absorbing barriers, shown in Figure 9. Their task is to prevent the vehicle which hit them from driving over the edge of the road and preventing it from being ejected elastically. Proper execution of the barriers also limits, as much as possible, the size of damage caused during a collision. These barriers are used over steep slopes, bridges and on multi-carriageway roads with opposite driving directions.


**Fig. 9.** An example of increasing the safety of vehicle drivers through the use of energy absorbing barriers

A recent modernization of the vertical signage system is painting the posts supporting the warning signs with a special fluorescent paint, which improves their visibility even from long distances. Some road signs are equipped with additional fluorescent contrast plates, thanks to which drivers in the evening and night hours have the opportunity to see the sign in advance, which increases safety. It is also worth paying special attention to the use of a modern horizontal signage system, i.e. acoustic and vibration belts. These are convex red stripes, thanks to which vibrations are generated when the vehicle is passed, which is intended to force the driver to slow down. This solution works very well, for example, on access roads to tracks. In order to paint other horizontal road signs, e.g lines separating two traffic lanes, a thick-layer paint is used, thanks to which the driver is "informed" when dangerously approaching the road axis. The special structure of the horizontal lines, during contact with the wheels of a moving vehicle, enables the generation of a characteristic sound that serves as a warning. In addition, thick-layer paint is more resistant to unfavorable weather conditions and wear and tear than thin-layer paints.

The last example of a technical device is the use of "pedestrian islands" (Fig. 10), which were located in twenty-two places in the analysed area. They are designed to make it easier for pedestrians to cross to the other side of the roadway. By dividing the passage into two stages, the safety of pedestrians is increased, as they can observe the road more precisely. Secondly, the implementation of the pedestrian island prevents drivers from exceeding the permissible speed at which they can travel on the road and hinders the overtaking maneuver, which also increases the safety of vehicle drivers.

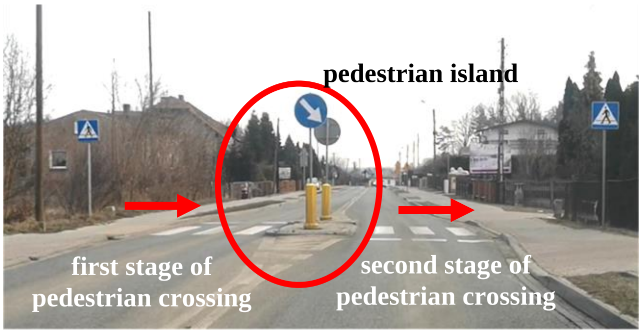


**Fig. 10.** An example of increasing pedestrian safety through the use of pedestrian islands

As already mentioned, road managers are mainly responsible for the technical condition of roads. In the case of local roads, these are local government units. Pursuant to the Act on Public Roads, one of the obligations of road administrators is *to carry out periodic road condition inspections (...), with particular emphasis on their impact on road safety, including verification of features and indication of defects that require maintenance or repair work due to on road safety* (Journal of Laws, 1985). Periodic inspections should be carried out at least once a year as part of basic surveys and every 5 years as extended surveys. They consist in checking the technical condition of roads and their suitability for use. The simplest method of assessing the condition of the pavement is visual assessment, which allows to determine the scale of damage and its impact on the general condition of the road. As part of the visual assessment, the BIKB-IBDM method is often used, which additionally enables obtaining data necessary to plan the scope of repairs and select appropriate technologies. The method is based on two basic criteria, which are driving safety and comfort. It is worth emphasizing that it is constantly being developed. The results obtained from the control are prepared in the form of protocols which, apart from the details of the person preparing the protocol, include the description of the subject of the control, its scope, an indication of any irregularities and recommendations for their removal, as well as the scope of the unimplemented recommendations from previous controls. In addition, apart from the annual and five-year inspections, ongoing inspections of the road network are also performed, and all the resulting comments are recorded in the Road Detour Log. If the technical condition of the facility is determined to be inadequate or life or health threatening, the supervisory authority may request additional expertise (Journal of Laws, 1994).

## 6. Conclusions

The conducted research shows that the general condition of the quality of road repairs carried out in the Częstochowa and Kłobuck poviats is good. The average scores obtained for the analysed parameters were most often around 4.0. The highest values, above this level, were obtained by parameters such as "daytime driving" (4.3) and "vertical and horizontal signage" (4.2). The lowest rated parameter is "night driving", the average rating of which was 3.5 for the entire analysed area and only 2.0 for undeveloped areas. It was also noticed that "comfort of overtaking" as the only parameter in undeveloped areas obtained an average rating higher than in built-up areas by 0.7. There is an upward trend for most parameters. The dominant values of the average assessments concerned the modernization activities carried out in the last four years, which results from the shortest operating time among all the analysed sections of local roads. Two of the tested parameters ("vertical and horizontal signage" and „comfort of overtaking") recorded a slight decrease, which could be caused, for example, by the intensity of use of a given road section or execution errors.

In the analysed area, many road elements negatively affecting road safety were identified, as well as modern vertical and horizontal signage systems, an increase in the number of erected "pedestrian islands" and care for drainage devices, which improves the quality of roads. Unfortunately, the lack of a stable source of financing tasks in the field of road safety is still a serious problem, which makes it difficult to carry out recommendations after periodic road inspections.

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# 在道路安全的背景下评估 Częstochowa 和 Kłobuck 观点 农村地区当地道路维修过程的质量

**關鍵詞**
操作安全
道路交通安全
地方道路
修路

**摘要**

近年来，已经采取了许多措施来使农村地区的地方道路现代化。不幸的是，在翻修期间，特别是在 观点 和公社层面，由于设计阶段出现的违规行为，经常会出现错误。本文使用基于术语“风险”的视觉方法，在保持运营参数随时间推移的背景下，对过去 15 年中进行的当地道路翻新质量进行了评估。对 Kłobuck 和 Częstochowa 观点 翻新或重建的 26 条道路进行了研究。确定了最常见错误的类别，并提出了纠正错误和防止新错误的措施。在负面趋势中，道路技术设备的放置不当和整体区域缺乏适当的标记是明显的。最近发现，交通安全方面的一个积极方面是现代道路标记系统和道路标志的广泛使用，以及对排水设备的适当维护更加小心。尽管有政府基金共同资助，在道路现代化过程中使用现代解决方案仍然受到地方政府财政赤字的限制。