

The Concept Design of Redevelopment of the 1543D County Road Connecting Jelcz-Laskowice to Nowy Dwór, with the Use of Innovative, Long-Lived Pavements

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The road that connects two towns Jelcz-Laskowice and Nowy Dwór, located in the Lower Silesia province, in Oława county, in Jelcz-Laskowice borough, with the number 1543D is a county road. It requires redevelopment due to the fact that at present it does not meet the norms in force, and it is a dirt (unpaved) road. According to maps of the Oława county, from the direction of Jelcz-Laskowice it crosses with the 1551D road, and from the direction of Nowy Dwór it connects to the 1546D road whose total length is 3,700 km.

Keywords: a county road, redevelopment, conceptual design.

1. INTRODUCTION

The article presents a concept design of redevelopment of the 1543D road with the use of innovative, long-lived pavements. A road with a long-lived pavement will allow the usage of this communication route for 50 years without any need to perform general renovation or redevelopment, in comparison to the typical construction which lasts for 20 years.

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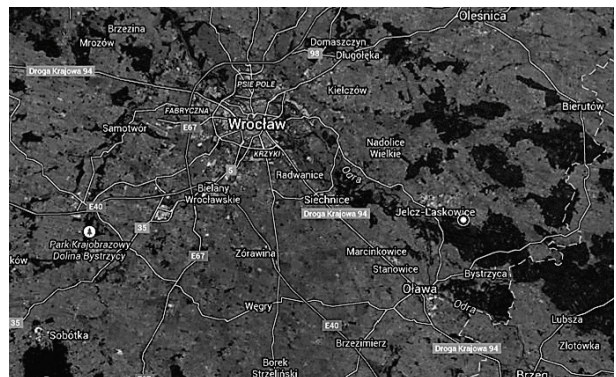


Fig. 1. The location of the 1543D road [8].

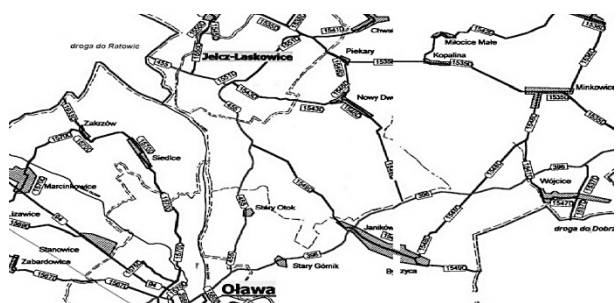


Fig. 2. The network of county roads [9].

This article presents the concept design of redevelopment for a section of the road, of the length of 1,900 km, which is located outside built-up area, and starts from KM 0+900.00 m till KM

2+800.00 m, as this section is a dirt (unpaved) road.

Figure 3 presents the location of the 1543D road.



Fig. 3. The location of the section of the 1543D road [10].

Due to structure of pavement prepared for insufficient number of vehicles moving on the road, the road does not serve its purpose. The number of holes, the lack of structures to carry the water away contributed to the present situation.

During the thaw or heavy rainfall the road becomes hardly passable, not to mention the situation of pedestrians. During the thaw or heavy rainfall also cyclist can hardly use the road as it is covered with water, which clearly indicates the lack of adequate channelling. The participation of both car and pedestrian traffic on the road in question is significant, due to neighbouring fish ponds, lakes, numerous fields and woods, as well as the local cemetery, but also due to shortcut it offers for the towns it connects.

In summertime, when it is dry, there is no problem with water on the road. However, another problem appears i.e. the dust suspended in the air, caused by cars or bicycles. For those travelling on that road, especially for pedestrians, the road becomes unattractive, but also dangerous as the clouds of dust impede visibility on the road which has no roadside which could serve as additional space when the traffic is heavy.

All the above mentioned arguments decrease the number of those willing to use the road, as many people prefer to take a longer but more comfortable route. As a result they cover more kilometres than they should and consequently increase the traffic on approach roads to the city. Those who decide to take this road risk damage to their cars e.g. the suspension.

Due to the existing condition of the pavement, the surrounding areas – despite the vicinity of nature, silence and calmness related to the

countryside become unattractive. Their attractiveness decreases not only for local people, but also for potential investors, as the low standard of roads results in numerous problems, lowering

the value of investment. As a result investors choose other, easily accessible locations.

In order to improve the conditions existing on Polish roads nowadays, and to enhance the development of the industry and disseminates available technologies, in this article I will present nonstandard, as for this class of road, solution for long-lived pavements. Due to ever-growing traffic, to atmospheric conditions in Poland, and to the need of frequent repairs of roads, the use of improved pavements is justified.

2. THE ROAD INVENTORY-TAKING

Figures 4,5,6 and 7 present photos from the 1543D road site inspection.



Fig. 4. Uneven structure of the surface, furrows and lack of water channelling [own photo].

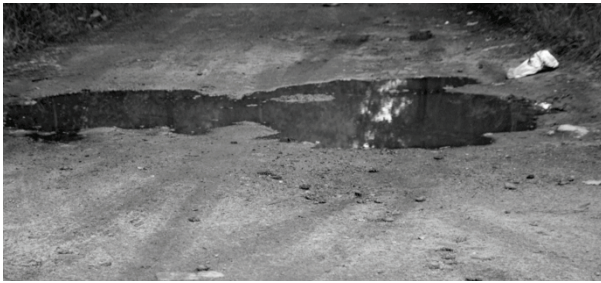


Fig. 5. Uneven surface, where water masses which hinders the traffic on this road [own photo].



Fig. 6. Water amassing on the roadsides, lack of ditches on the sides [own photo].



Fig. 7. The dust that floats in the air after a car has driven hinders visibility so much, that one can hardly notice the car that has just passed by [own photo].

As it has been presented in the above photos, the road is in a poor technical condition, does not meet any norms, its paving is full of holes that hinder daily use of the road. The road lacks basic elements such as improved paving, hardened roadsides and water channelling in the form of appropriate ditches.

The section of the county road in the project has been qualified as a technical class L (local) with traffic category KR2, which at present exists as a dirt road, with traffic flowing in two directions. The section of the road in question is characterised by numerous holes, pitches where water accumulates. Also the width of the road varies depending on the section, between 5 and 6 meters.

Additionally the road does not have hardened roadsides and water channelling in the form of ditches. As a result the level of safety on this road is highly unsatisfactory [11, 12, 13, 14].

3. THE CHARACTERISTICS OF L CLASS ROADS

On the basis of Road Design Guidelines – Annex no 3 to the edict no 5/95 of The General Director of Public Roads of 31st March 1995 [6], in case of a local road (L) – VI, available to all users, we acquire some additional remarks on road design[1]:

- A two-lane, two-way road,
- Provides connection to public roads at the crossroads,
- Does not require collision-free crossings with other types of communication routes, if it does not result from the need to provide safety and comfort of traffic,
- Serves the adjacent areas,
- Designated to serve local, not too heavy traffic, and provides connection between villages, commune residences, towns, farmer service points, institutions, other roads; also provides connections inside villages and village areas,
- Can be a consolidated road, next to the road with limited access.

The project should include the type of paving, roadside and channelling, in the form of trapezium ditches.

4. LONG-LIVED PAVEMENT

The use of long-lived (perpetual) pavements is of key importance as far as the country's economy is concerned, as it brings its infrastructure to a higher level which automatically translates into country's development.

Long-lived pavements originate from the USA where the technology has been used for several years.

The use of highly modified, new generation asphalts brings significant profits to Poland that results from the reliability of such roads, and the extended exploitation time. The whole idea of long-lived pavements relies on their improved qualities that ensure durability of pavements for at least 50 years. When compared with traditional pavements, it means a 30-year longer period of the road's use, without the need for total

redevelopment but with only periodical surface repairs.

The main characteristics of long-lived pavements are their extended durability, lack of crumbling, higher resistance to water and frost, higher resistance to permanent deformations i.e. furrows or cracking. The structural layer of the surface should show high resistance to temperature amplitude which quite high in Poland as it may reach up to several dozen degrees, and hence appropriate mineral-asphalt mixtures should be selected, with high resistance to furrowing. The key role for long-lived pavement is played by base course, where the highest stress resulting from vehicles moving on the road is concentrated, as they are the cause of first signs of pavement damage. Contrary to a standard pavement construction, there is an additional endurance layer which increases the durability of this innovative solution.

The Technical Research Institute - TPA – a research-development unit that belongs to STRABAG SE concern, specializing, among others, in asphalt and concrete technologies, presents two ways of limiting deformations in lower asphalt layers. One of them is the increase in thickness of asphalt layers, while the other one means using higher quality materials in the base. On the Polish market STRABAG is one of the leading companies in the area of infrastructure and has been present on the Polish market since 1985. In 2008 TPA cooperated with the Research Institute for Bridges and Roads in the area of research related to perpetual paving, and in 2014 the company constructed an experimental section with the use of this paving on S8 road. The whole concept of roads with perpetual paving bases on precisely selected materials and their thickness, and therefore a research must be carried out to establish the resistance of mixtures to water, stress, stiffness and furrowing.

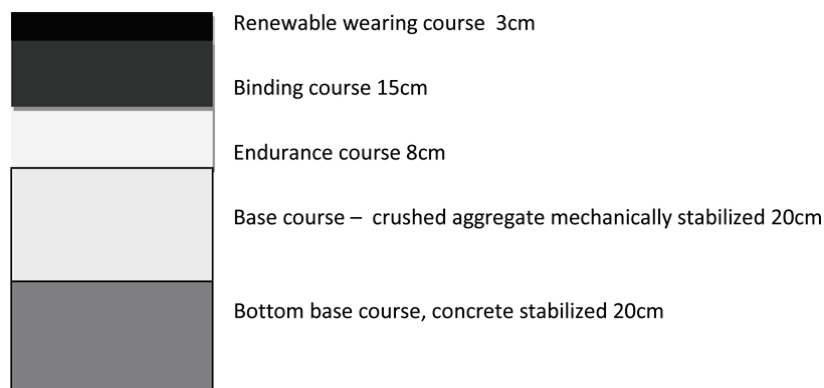


Fig. 8. The scheme of the perpetual paving construction [self-elaboration].

The road with perpetual paving is able to withstand approx. 60 million axes with a load of 100 KN more than a traditional one, which significantly increases the construction endurance.

5. ROAD REDEVELOPMENT PROJECT

Technical parameters of the road have been selected on the basis of the valid norms, among others: Regulation of the Minister of Transport and Maritime Economy of 2 March 1999 . on the conditions to be met by public roads and their location (Journal of Laws No. 43, item . 430) [4].

The width of the road in Table 1 includes: the road, roadsides, banks 0.75 m high, ditches and the lane of ground behind the ditches.

Dirt roadside for the L-class road should be no less than 0.75 m wide; due to the local and pedestrian traffic the project assumed the width of 1.5 m. Cross-fall ground shoulder to stretch straight or curved section of the inclination of the road as a simple stretch should be:

- 6% to 8% - with the roadside width of at least 1.0 m,
- 8% - with the roadside with less than 1.0 m.

For the technical class of the local (L) road the following requirements have been assumed [1,4]:

- Cross-section – undivided with two lanes, one for each direction
- Project speed of the road 50 km/h,
- Width of a lane 2 x 2.75 m,
- Pointed cross-section of the carriageway cross fall of 2.0 % for the improved hard surface
- Width of the dirt roadsides 2 x 1.5m,
- Diagonal decrease of dirt roadsides on a straight section should be 8%.

For the planned road a chevron cross-section profile of the road was established. The schematic cross-section is shown in Figure 9. The projected

decline in the profile is 2%. The total width of the road will be 5.50 m, after which movement will take place in two directions. You should also be taken shoulders on both sides of the road with dimensions of 1.5 m and road drainage trapezoid ditches with bottom width of 0.4 m and incline of the bottom slopes 1: 1.5

county road 1543D the traffic category was established as KR2.

In order to select the construction, the bearing capacity of the soil must be determined. The soil in question qualifies for G2 group and so it should be changed into G1. In order to do so the non-swelling course that responds to G1 group must be

A cross-section

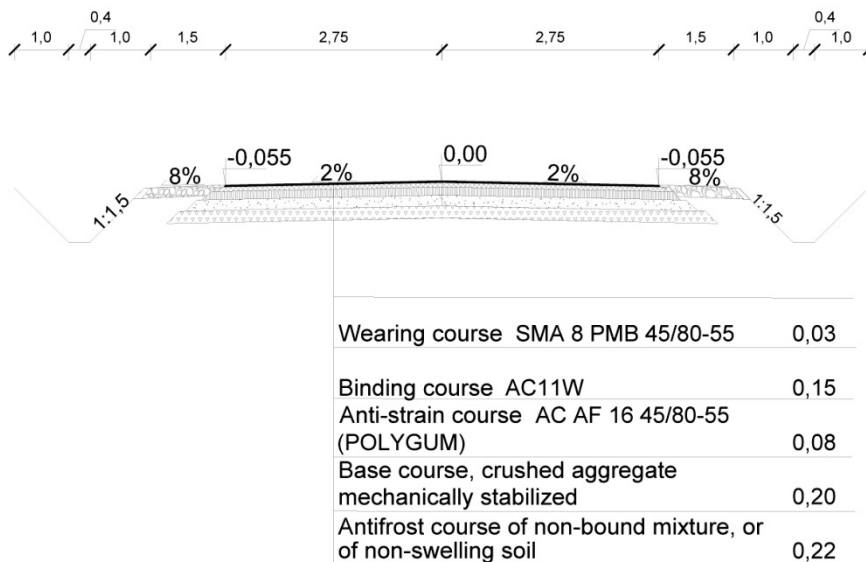


Fig. 9. A chevron cross-section profile of the road [own elaboration].

The traffic category is established on the basis of a calculated amount N_{100} .

In the project the traffic category was established on the basis of data provided by the District Road Administration in Oława. For the

changed.

Also, the anti-frost characteristics of the soil should be examined; in Poland these parameters are described by means of PN-81/B-03020 norm, depending on geographical location.

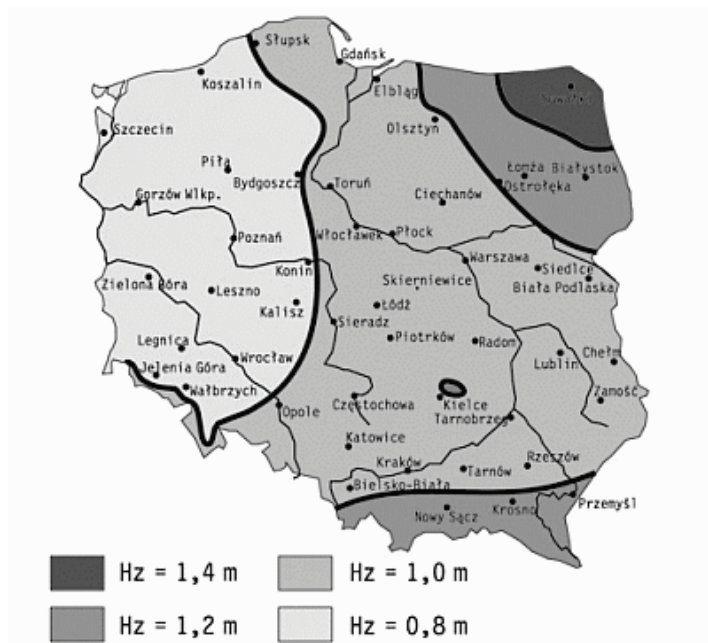


Fig. 10. The depth of the soil freezing Hz [3].

The depth of soil freezing in this area is $H_z=0.8$ m

Taking the above data into consideration, the thickness of all courses should not be less than 0.36 m.

The selection of a typical construction of paving according to the Catalogue of Typical Flexible and Composite Courses [7].

The selected type of the upper paving layer assumes making anti-frost course of non-bound mixture or non-swelling soil, of thickness of 22cm.

Designing upper layers of the paving construction.

KR1-KR2

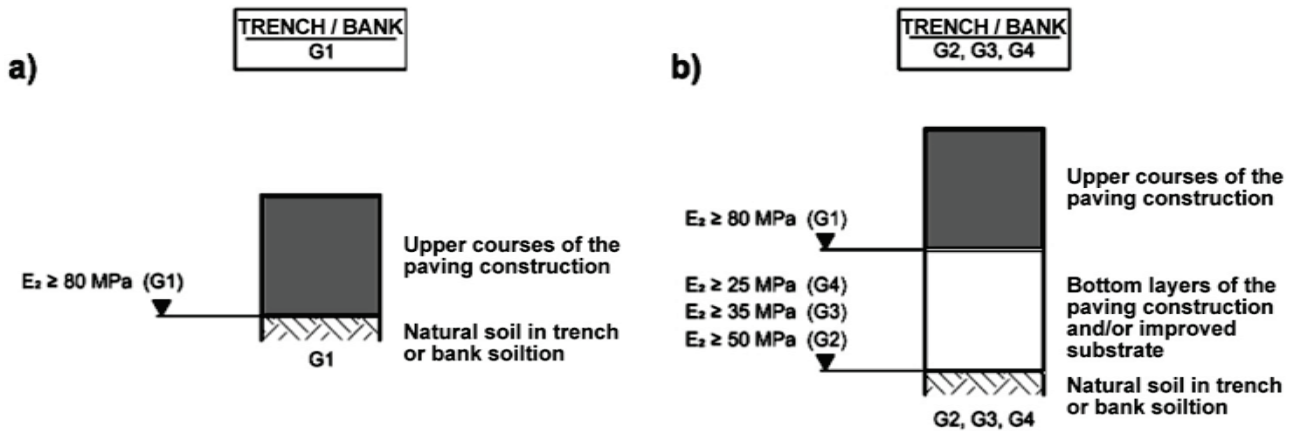


Fig. 11. Diagram of the layers of pavement structures for traffic KR1 - KR2 in the excavation and embankment and the required secondary values Modules strain on the surface layer; a) for the group G1 bearing capacity, b) where the group bearing capacity G2, G3 and G4 [7].

Table 1. Typical solutions lower layers of the pavement structure and the layers of an improved substrate for category KR1 and KR2 traffic [7].

		TYPE 10 (not applicable, if the drainage is used)	TYPE 11	TYPE 12	TYPE 13	TYPE 14	LEGEND
SUBSTRATE BEARING CAPACITY GROUP	G4	WM 30 80 MPa 25 MPa	WM 20 WUP 25 80 MPa 25 MPa	WM 22 WUP 24 80 MPa 25 MPa	WM 55 80 MPa 25 MPa	WUP 65 80 MPa 25 MPa	LEGEND PP - supportive substructure WM - anti-frost course WUP - improved substrate course ▾ - secondary deformation module required E. ATTENTION ! 1) Material requirements according to unit 7 2) The rules for course construction according to unit 9 3) The course thickness [h] is given in cm9
	G3	WM 22 80 MPa 35 MPa	WM 15 WUP 22 80 MPa 35 MPa	WM 22 WUP 15 80 MPa 35 MPa	WM 40 80 MPa 35 MPa	WUP 45 80 MPa 35 MPa	
	G2	WM 15 80 MPa 50 MPa	WM 15 80 MPa 50 MPa	WM 22 80 MPa 50 MPa	WM 22 80 MPa 50 MPa	WUP 25 80 MPa 50 MPa	
	G1	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	

Cross-section of a designed road [2,15]:

- 3cm of the wearing course SMA 8 PMB 45/80-55
- 15cm of the binding course AC11W
- 8cm of anti-strain course AC AF 16 45/80-55 (POLYGUM)
- 20cm of base substructure, crushed aggregate stabilized mechanically
- 22cm of anti-frost course made of non-bound mixture, or non-swelling soil.

Checking the anti-frost condition according to [7]

$$h=4+8+20+22=54 \text{ cm} > 0,45hz=0,45*0,8=0,36 \text{ cm}$$

the condition is met.

6. SUMMARY AND CONCLUSIONS

The project of redevelopment of the 1543D county road, located in Olawa county, in Jelcz-Laskowice borough will certainly result in improved conditions on the road. In the past, when the road infrastructure was not as developed as it is nowadays, the current standard of the pavement could be sufficient, but at present the requirements set for roads have significantly changed and therefore their standard must improve, in line with the progress.

The above mentioned road is used by many people every day, and the condition of the paving matters to them. The current condition does not meet any standards whatsoever. During every season the road is difficult to trespass. During thaws or rains, due to accumulating water, the road becomes inaccessible for pedestrians.

In order to avoid this phenomenon the project provides adequate drainage of the road in the form of trapezoidal ditches and chevron cross-section of the surface of the roadway, where the water will be drained into roadside ditches. And during the summer time the dust floating in the air, resulting from the dirt road and causing discomfort and danger for anybody travelling on this road, will disappear after the paving has been improved and replaced by the concrete asphalt. The change in the paving will also result in greater safety on this road, as traction will improve and there will be no holes or other irregularities who affect both drivers and cyclists or pedestrians who cannot freely travel on the road as they have to watch their steps and/or rides. During the increased traffic, the safety for pedestrians will be ensured thanks to roadsides on

both sides of the road, which at the moment do not exist. The new paving will facilitate a fast and easy access from the town of Jelcz-Laskowice to the village Nowy Dwór or other villages in the nearby. The inhabitants will not be forced to take long detours in order to reach their workplace, any office, school or the recreational area. Another also important argument for the redevelopment of the road is a quick access for any rescue team which at the moment need to take longer detours to get to surrounding town and villages. There is nothing more precious than human life, and the time saved on the road matters greatly in that situation.

Moreover, developing a road with long-lived paving will enable the route to be used for a longer period of time i.e. 50 years without the need to perform general repairs or redevelopment - as compared to a typical construction whose typical life is 20 years. Thanks to innovative solutions the maintenance costs will decrease with time as there are no serious repairs, apart from periodical change of the wearing course. Additionally, due to the fact that there are farmlands in the neighbourhood which means there will be a heavy traffic of heavy agricultural machines, the road will not be damaged thanks to its improved paving.

The redeveloped road will significantly improve the living comfort of inhabitants, and will also increase the interest of visitors to the area.

REFERENCES

- [1] Sandecki T. pod kier.: *Wytyczne projektowania dróg VI i VII klasy technicznej*, Biuro Projektowo - Badawcze Dróg i Mostów Transprojekt - Warszawa, Warszawa 1995.
- [2] Piłat J., Radziszewski P, *Nawierzchnie asfaltowe*, Wyd. WKiŁ, Warszawa 2010.
- [3] PN-81/B-03020 *Grunty budowlane, Posadowienie bezpośrednie budowli, Obliczenia statyczne i projektowanie*
- [4] Regulation of the Minister of Transport and Maritime Economy of 2 March 1999 on technical conditions to be met by public roads and their location
- [5] Stefańczyk B. pod kier.szej Szkołu Oficerskiej : *Budownictwo ogólne, tom 1: Materiały i wyroby budowlane*, Wydawnictwo Arkady, Warszawa 2008.
- [6] The Act of 21 March 1985. Public Roads - consolidated text of 24 August 2004 .
- [7] Ordinance No. 31 of the General Director for National Roads and Motorways : *Catalog of typical pavement construction flexible and semi rigid* , Warsaw, Legal status as at 16.06.2014

- [8] www.google.pl/maps/place/Wroc%C5%82aw/@51.1055261,17.0612151,12z/data=!4m2!3m1!1s0x470fe9c2d4b58abf:0xb70956aec205e0f5
- [9] <http://pzd-olawa.pl/zalaczniki/MapaCz.I.pdf>
- [10] www.google.pl/maps/@51.0244371,17.3448375,6916m/data=!3m1!1e3
- [11] Surowiecki A., Hutnik E., Haliniak J.; *Zagadnienia modernizacji i odbudowy infrastruktury drogowego transportu wiejskiego w świetle badań modelowych*. Wyd. Akademii Rolniczej we Wrocławiu, Zesz. Nauk. AR we Wrocławiu Nr 486, Monografie XXXVII, Wrocław 2004, ISBN 83-89189-41-0
- [12] Surowiecki A., Kozłowski W.; *Traffic Safety at the Cross-Roads and Interchanges*. Zbornik zo 17. Vedeckej Konferencie s Medzinarodnou Ucast'ou "Riesenie Krizovych Situacii v Specifickom Prostredi. 3. Cast, Zilina 30.-31. Maj 2012, Zilinska Univerzita v Ziline, s. 580-588, ISBN 978-80-554-0536-0
- [13] Surowiecki A., Kozłowski W.; *Design of Strengthening of Road Surface*. Zbornik zo 17. Vedeckej Konferencie s Medzinarodnou Ucast'ou "Riesenie Krizovych Situacii v Specifickom Prostredi. 3. Cast, Zilina 30.-31. Maj 2012, Zilinska Univerzita v Ziline, s. 573-580, ISBN 978-80-554-0536-0
- [14] Surowiecki A.; *Problems of Winter-Roads Exploitation under the Polish Directions*. Zbornik z 16. Vedeckej Konferencie s Medzinarodnou Ucast'ou "Riesenie Krizovych Situacii v Specifickom Prostredi. 3. Cast, Zilinska Univerzita v Ziline, Zilina 1.-2. Jun 2011, s. 661-666, ISBN 978-80-554-0368-7
- [15] www.gddkia.gov.pl/userfiles/articles/z/zarzadzenia-generalnego-dyrektor_13901/zarzadzenie%2054%20zalacznik.pdf

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