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Highway landing strips as an element of critical and defence infrastructure of the country

Abstract: One of the essential elements of the Polish critical and defence infrastructure, apart from the network of military and civil airports, are highway landing strips, which function, importance and usefulness have taken on a special dimension in the current geopolitical situation, especially during the ongoing armed conflict in Ukraine. Highway Landing Strips (Polish. DOL) are specially prepared sections of public roads adapted to perform air operations of take-off and landing of military aircraft (Polish. WSP) intended for operational tasks during crisis and war, as well as tasks resulting from the implementation of the flight training process. Detailed information on the requirements for DOL is presented in NO-17-A207:2022 Airfield pavements – Airfield road strips – Requirements and tests [1]. The above normative document outlines the minimum requirements for geometric dimensions, runway obstacle free zones and DOL surface construction systems. Requirements for the basic operating parameters of pavements on facilities used by road services have been presented. In addition, these requirements should be primarily used in designing and constructing DOL, modernizing and reconstructing the existing road sections of airfields, accepting the performed works, and technical and operational assessment. The normative provisions are appropriate for assessing the technical condition of DOLs throughout their entire technical lifetime, especially during their use by military aircraft. The technical and operational condition of the DOL surface has a direct impact on the safety of air operations. This enforces the need for up-to-date, full knowledge about their technical condition, which will help make the appropriate decisions to ensure their safe operation. The article presents the results of testing the operational parameters of the newly built structures of the surface of the Highway Landing Strip of Wielbark airport along provincial road No. 604 and the requirements of the applicable defence standard NO-17-A207:2022. The possible operational hazards for performing air operations by military aircraft and the ongoing works aimed at improving the security of the DOL, which are part of the critical and defence infrastructure of the country, are also discussed.

Keywords: Road section of the airport; Critical infrastructure; Defence; Security; Airport pavement

Introduction

One of the elements of the critical infrastructure of the state's defense and security system is road airfield sections. The concept of DOL became popular in the post-war period. The idea was developed in parallel with work on vertical takeoff aircraft capable of operating from any location. Road airfield sections became popular in Poland, Germany (both West Germany and East Germany), Switzerland, Finland, Sweden, North Korea, China, and Czechoslovakia. Scandinavia continues to conduct exercises using highway sections as temporary air bases. The Finns, possessing F/A-18 Hornet aircraft in their arsenal—machines designed as carrier-based aircraft equipped with a tail hook—can utilize a braking line system that shortens the landing distance, which is extremely useful in operations on improvised runways. Singapore also conducts exercises operating from its highways. Americans, particularly within the framework of Cold War doctrine, trained their pilots in West Germany, and exercises on German highways were regularly conducted even in the 1980s. The use of roads as airfields is still common in Russia, Pakistan, the Republic of China, and currently also in Ukraine.

In Poland, the last aviation training on a road airfield section took place in 2003 on provincial road No. 142 (DW142) connecting the new junction of express road S3 with the former "Berlin" towards Chociwla, at the so-called DOL Kliniska. Figure **1** presents examples of performing takeoff and landing operations of WSP on a road airfield section.

a) Takeoff of Su-22 aircraft b) Landing of MiG-29 aircraft

1. Military aircraft flight training at DOL Kliniska

There are 21 road airfield sections in our country. The best technically and operationally maintained include: the aforementioned DOL Kliniska, DOL Jaźwiny (located on the A4 motorway between the Tarnów Północ and Dębica Wschód junctions), and DOL Września (situated on the A2 motorway near Września, near Poznań). The remaining road airfield sections are in varying conditions, most of them unsuitable for use due to their unsatisfactory technical condition. However, recently one of them has been rebuilt to new technical parameters meeting the requirements of the defense standard [8]. The subject road airfield section is located on provincial road No. 604 (DW604) on the Robaczewo – Wielbark section, the so-called DOL Wielbark. The road lane has a width of 90 m and includes the following functional elements:

- A concrete cement runway with a width of 30 m and a length of 2440 m,
- 2 side safety lanes with a width of 30 m on both sides of the runway and runways,
- 2 runways with a concrete cement surface extending the runway by 275 m each with a width of 30 m (as part of the front safety lanes),
- 2 aircraft parking areas with a concrete cement surface measuring 200 m x 45 m, adjacent to the end sections of the runway,
- 2 transition sections to the road cross-section with an asphalt concrete surface extending the runways by 125 m each (as part of the front safety lanes).

The aforementioned functional elements of DOL Wielbark have undergone detailed acceptance tests to verify compliance with the operational requirements dedicated to WSP.

The requirements regarding geometric dimensions, obstacle-limited areas, and the structural layout of the DOL surfaces have been thoroughly presented in the defense standard NO-17-A207:2022 [8]. Additionally, it discusses the requirements for the basic operational parameters of surfaces at facilities used by road services.

The provisions of the aforementioned standard should be applied when designing and constructing road airfield sections, modernizing and rebuilding existing DOLs, accepting completed works, as well as their technical and operational evaluation throughout their lifecycle. Consequently, DOLs must also meet the requirements specified in other defense standards that directly relate to airfield surfaces, such as:

- NO-17-A204:2015 Airfield Surfaces – Concrete Cement Surfaces – Requirements and Testing Methods [6],
- NO-17-A200:2017 Airfield Surfaces – Asphalt Concrete Surfaces – Requirements and Testing [5],
- NO-17-A500:2016 Airfield and Road Surfaces – Load-Bearing Tests [9],
- NO-17-A502:2015 Airfield Surfaces – Smoothness Tests [11],
- NO-17-A501:2015 Airfield Surfaces – Roughness Tests [10],
- NO-17-A503:2017 Airfield Surfaces – Turf and Ground Airfield Surfaces – Load-Bearing Tests [12],
- NO-17-A205:2017 Winter Maintenance of Airfield Surfaces – Use of Deicing Agents – Requirements and Testing [7].

The safety of aviation operations is influenced by many factors, which can be grouped into three categories: humans (crew personnel, personnel maintaining aircraft readiness, air traffic controllers, personnel operating airport equipment), aircraft (planes, helicopters, and other flying objects), and the environment (DOL, including airfield surfaces and airspace). The primary task of airport services is to ensure the safe operation of airfield surfaces by WSP.

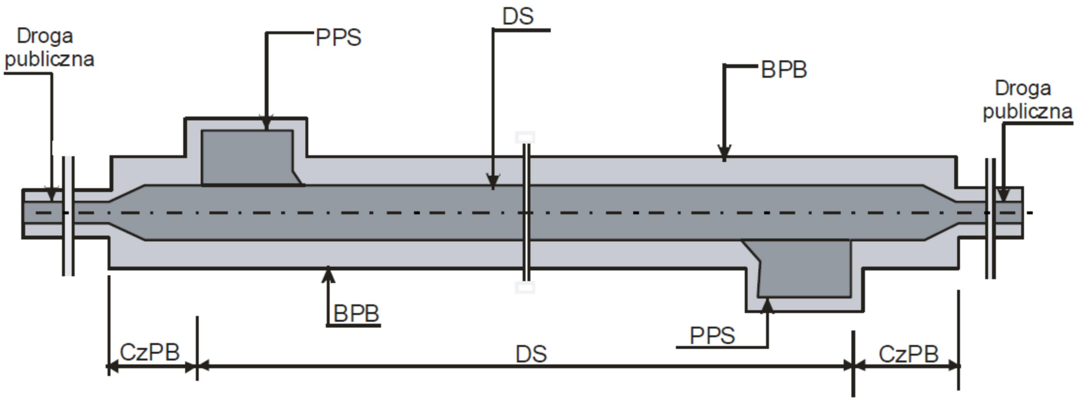
Requirements Regarding DOL

DOL is a straight road section with specified parameters and dimensions of the horizontal and vertical parts of the airspace necessary for performing aviation operations. Public roads [15] with the required length and appropriate load capacity managed by road services should be used for the location of DOL. The road network should allow for the bypassing of DOL by vehicular transport (in case of temporary closure of DOL for vehicular traffic during aviation operations). If DOL is located in a forested area where animals that may affect the safety of aviation operations by WSP could intrude onto the runway, DOL should be secured (e.g., with an external fence).

DOL should consist of the following functional elements:

- Runway (DS),
- Front safety lanes (CzPB),
- Side safety lanes (BPB),
- Aircraft parking areas (PPS),
- Taxiways (DK) – if needed,
- Obstacle-limited areas.

The layout of DOL elements is shown in Figure **2**. It should be emphasized that the surface of the aircraft parking area must be made of concrete cement meeting the requirements [6] and must meet the load-bearing requirements adopted for the runway.



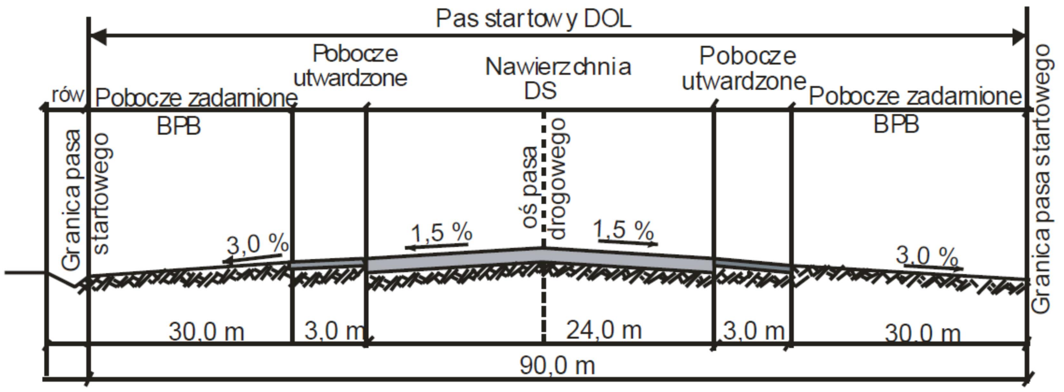
2. Elements of the airport road section [8]

Geometric Requirements

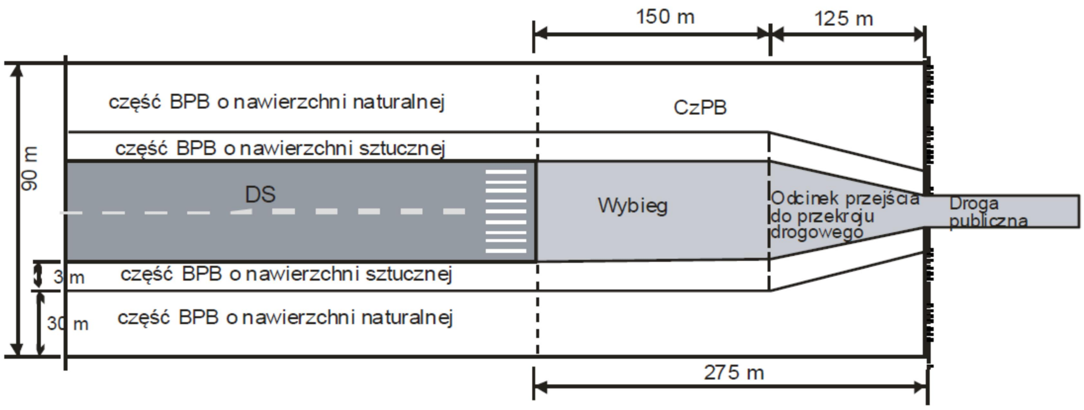
The surface of DOL consists of a straight road lane with a width of 90 m and a minimum length of 2990 m, contained within the boundaries of CzPB. Maintenance of the road lane according to airport rules also applies to sections of the public road outside the DOL runway by 1000 m if they run on air approach surfaces. Geometric requirements regarding dimensions, slopes, and vertical curves on DS, PPS, as well as CzPB and BPB of DOL are presented in Table **1.** A cross-section of DOL is exemplified in Figure **3**, while Figure **4** shows a schematic of the runway and BPB and CzPB.

Tab. 1. Geometric requirements for DOL

Parameter	Values
Total length of the DOL, including: **a) length of the DS** **b) length of the CzPB** **c) length of the runway**	≥ 2990 m ≥ 2440 m ≥ 275 m 150 m
Total width of the runway, including: **a) width of the DS** **b) width of each of the BPBs, including:** **- part with artificial surface** **- part with artificial surface**	≥ 90 m ≥ 24 m ≥ 33 m ≥ 3 m ≥ 30 m
Longitudinal slope of the surface	≤ 1,5 %
Transverse tilt DS	≥ 0,5 % i ≤ 1,5 %
Transverse tilt of BPB and CzPB	≤ 3,0 %
Vertical radius of curvature of DS and BPB surfaces in the longitudinal direction	≥ 8000 m
PPS Length	≥ 200 m
PPS Width	≥ 45 m
Width DK	≥ 15 m



3. Cross section of the DOL runway [8]



4. Geometric dimensions of the runway and BPB and CzPB DOL [8]

DOL will primarily accommodate vehicular traffic; therefore, the design or adaptation phase of these sections should consider road solutions and requirements (e.g., structural requirements). Design principles and technical requirements for DOL mainly concern the carriageway layer, sidewalks, and safety zones. Along the entire length of the DOL runway, there must be no aboveground or underground structures or any obstacles (trees, signs, embankments, barriers, etc.) except for existing road drainage culverts with inlets and outlets located outside the road lane. If elements that constitute obstacles (e.g., traffic barriers) are placed, they must be easy to disassemble and remove. Vertical signage in the DOL runway and in obstacle-limited areas should be minimized to the essential, with the possibility of quick removal. Additionally, intersections and connections with other roads are prohibited on the DOL runway; however, ground access roads for economic purposes are allowed, provided they do not include road culverts.

Transitions from one longitudinal slope of DS to another should be made with a curved plane, where the degree of slope change should not exceed 0.1% over 30 m. The smoothness of connecting adjacent DS sections with different longitudinal slopes should be ensured by maintaining permissible surface curvatures in the vertical plane. The minimum radius of this curvature should be 8000 m. If changes in DS slope cannot be avoided, they should be executed ensuring visibility lines so that every point situated at a height of 3 m above DS is visible from any other point also situated 3 m above DS at a distance of at least half the length of DS. To ensure the fastest possible water drainage, the DS surface should be bidirectional, with symmetrical slopes on both sides of the axis. The transverse slope should be approximately the same along the entire length of DS, where smooth transitions of slopes must be ensured to provide good water runoff.

The road shoulder surface of DS should be height-aligned with the DS surface, while the transverse slope of the shoulder should not exceed 3.0%. In case of difficulties in draining surface water from BPB, these surfaces may be terminated with triangular ditches featuring gentle slopes not less than 1:5 and counter-slopes of 1:2. The ditches should not exceed a depth of 1.0 m and must not be located within the road lane area.

PPS should be located at a minimum distance of 50 m from the external boundaries of DS. The minimum dimensions of PPS are: length of 200 m and width of 45 m (from the edge of DS).

In the case of locating DOL within a highway corridor, where PPS will utilize passenger service areas separated from DS, for example, by a green belt, such areas should be connected to DS via taxiways, ensuring access to them and merging onto DS with a minimum width of 15 m. The width of PPS in such cases is determined from the edge of the green belt. The longitudinal slope of PPS at WSP stands and DK should prevent water accumulation on these functional elements of DOL. PPS should be laid as horizontally as possible, depending on drainage conditions. The transverse slope of PPS should not exceed 2.5%. PPS shoulders should have a width of at least 5 m. The longitudinal slopes of the PPS shoulders should align with the PPS slopes, with maximum transverse slopes not exceeding 3.0% and minimum slopes ensuring the drainage of rainwater.

DK must have an artificial surface meeting the load-bearing requirements adopted for DS. The radius of the DK curve should not be less than: 30 m at the intersection with DS and 10 m at the intersection with PPS. The longitudinal slopes of the DK surface should not exceed 2.5%, while the transverse slopes should range from 1.0% to 2.5%.

In cases where PPS are separated from DS, for example, by a green belt, two DK should be constructed for each PPS - one allowing taxiing from DS to PPS and the other allowing merging from PPS to DS.

Construction Requirements

DOL surfaces can consist of flexible, rigid, or composite pavement structures. It should be emphasized that DOLs are primarily used by motor vehicles, and their operation by WSP is occasional. Therefore, the type and arrangement of the pavement structure must meet the requirements for surfaces intended for motor vehicle traffic. Design principles and technical requirements for DOL mainly concern the carriageway layer. Thus, the basis for designing or adapting roads for the anticipated traffic, i.e., motor transport and WSP aviation operations, are the requirements presented in the Catalog of Typical Rigid Pavement Structures, annex to Order No. 30 of the Director General of National Roads and Motorways dated June 16, 2014 [4], and the Catalog of Typical Flexible and Semi-Rigid Pavement Structures, annex to Order No. 31 of the Director General of National Roads and Motorways dated June 16, 2014 [3].

When adopting solutions for the pavement layer structure of DOL according to the aforementioned catalogs, a construction arrangement for at least traffic category KR 4 must be adopted. Individual pavement designs and improved subgrade layers are permissible in atypical situations, provided they are approved by the road authority. Innovative solutions not included in the aforementioned catalogs may be permitted for practical use after a detailed technical assessment. Materials used for constructing the carriageway layer of rigid or flexible DOL pavements must meet the requirements specified in [6] for rigid pavements or [5] for flexible pavements. The carriageway layer, including DS, PPS, and DK, should be free from defects that could compromise the safety of WSP takeoff and landing operations.

A cross-section of DOL should have symmetrical pavement slopes relative to the DS axis, in accordance with the requirements presented in Table **1** and Figure **3**, with a total minimum width of 90 m. The DS width with a concrete cement or asphalt concrete surface should be no less than 24 m. Additionally, shoulders hardened along DS with a minimum width of 3 m should have an artificial surface, e.g., asphalt concrete or cement concrete, laid on an appropriate subbase, allowing the transfer of loads from safety vehicles for safe operation in all seasons. Besides the hardened shoulders, BPB with a natural surface (grass-covered ground surface) symmetrically located along DS, adjacent to the hardened shoulders with a minimum width of 30 m, should be provided. Runways and transition sections to the road cross-section should have structures meeting the adopted load-bearing and operational requirements for DS.

The total thickness of the DOL pavement construction layers, including the subgrade, should protect the structural arrangement from the effects of frost heave and meet the requirements presented in [2]. The number and type of layers in a given pavement structure depend on soil-water conditions, traffic category, specific climatic conditions, and materials used for the pavement layers.

A rigid DOL should have a carriageway layer made of concrete cement, which, depending on the traffic category, can be laid as non-jointed, jointed and anchored, or reinforced, in accordance with the requirements provided in [6]. The thickness of the carriageway layer in the form of a monolithic slab, which does not interact with adjacent slabs and is neither reinforced nor provided with other strengthening elements, should not be less than 0.22 m. In justified cases, to ensure slab cooperation, it is recommended to connect them, for example, with tongue and groove joints or using dowels and anchors. If dowel connections are planned, the minimum thickness of the carriageway layer should be 0.26 m. The lower pavement layers (auxiliary subbase layer and frost-protective layer) form the foundation for the upper pavement layer. These layers are selected based on the load-bearing group of the subgrade and the required load-bearing capacity of the lower pavement layers. Proper functionality of the improved subbase layer and the lower pavement layers depends on the correct design and execution of earthworks and associated sub-surface and surface drainage elements.

In the case of flexible DOL structures, the type and arrangement of layers depend on the existing and anticipated traffic category at the location. The type of structure is determined based on the assumptions provided in [5] and [4] or based on other solutions agreed upon by the interested parties. When designing the DOL structure, local operational and traffic conditions must be considered. For the production of mineral-asphalt mixtures, materials meeting the requirements of [5] should be used. The minimum thickness of the wearing layer should be 50 mm.

Load-Bearing Requirements

The DOL pavement structure should ensure the safe execution of WSP aviation operations, both tactical and transport aviation. For DOL, a reference aircraft has been adopted, requiring a pavement classification number (PCN) of ≥ 35. The adopted load-bearing indicator applies to DS, PPS, DK, runways, and transition sections to the road cross-section. The load-bearing capacity of the DOL pavement structure, expressed as the pavement classification number (PCN), should be determined using the ACN-PCN method, in accordance with [9], Annex 14 of the ICAO Convention on International Civil Aviation [21], and the Aerodrome Design Manual Part 3, Pavements [2]. Control load-bearing tests of DOL pavements should be conducted periodically every 3 to 5 years. Measurements of elastic deflections should be performed in the spring and/or autumn periods, as specified in [9].

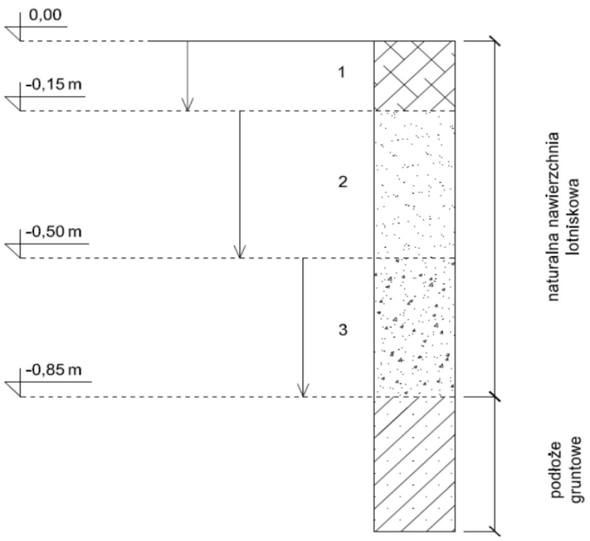
Natural surfaces (grass-covered and ground surfaces) of BPB and CzPB within the DOL area must also undergo comprehensive load-bearing assessments, in accordance with [12]. Control load-bearing tests of natural pavements should be conducted after the construction of DOL and periodically on used and/or to be replaced grass-covered and ground DOL pavements every 3 to 5 years. The tests should include:

- Testing the strength of the grass layer to a depth of 0.3 m below the ground level,

- Testing the load-bearing capacity of the natural pavement to a depth of 0.85 m below the ground level.

Field load-bearing tests of natural DOL pavements should be carried out according to the methodology presented in [7] to a depth of 0.85 m below ground level, for three distinct layers as shown in Figure **5**:

1. First layer to a depth of 0.15 m,
2. Second layer from a depth of 0.15 m to 0.50 m,
3. Third layer from a depth of 0.50 m to 0.85 m.



5. The arrangement of separated layers of natural pavement in load-bearing capacity tests [12]

Field measurements should be conducted in the spring, i.e., under the most unfavorable soil-water conditions [20]. Field measurements in the autumn period are permissible. The load-bearing capacity of natural airfield pavements is expressed by the California Bearing Ratio (CBR) index, calculated as follows:

$$CBR = 292/DCP^{1,12}$$

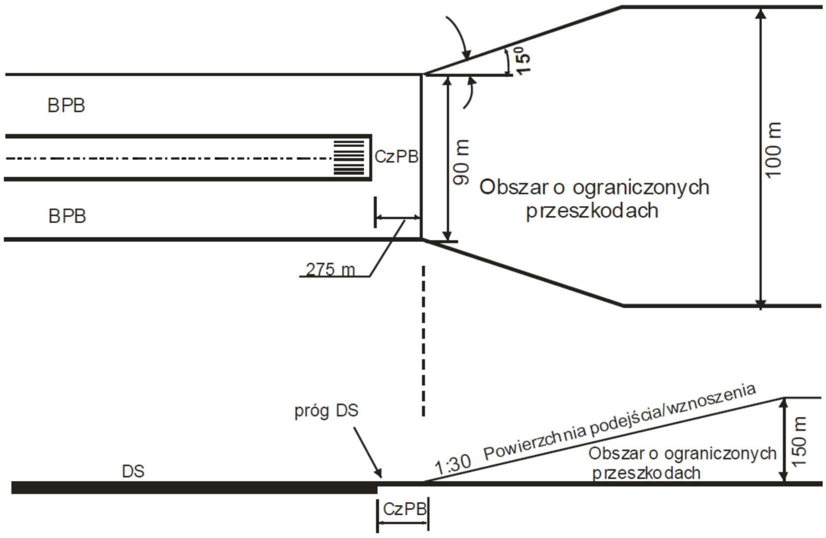
where:

- CBR – California Bearing Ratio [%],
- DCP – Cone penetration depth per single blow [mm].

The minimum CBR value should be 15% for the first layer (to a depth of 0.15 m) and 8% for the layer formed by the combination of the second and third layers (from a depth of 0.15 m to a depth of 0.85 m below ground level). Natural pavements that do not meet the load-bearing requirements should undergo remedial actions, such as granular filling, compaction, agronomic treatments, or strengthening measures, e.g., using geosynthetics [19].

Requirements for Approach Zones

Approach/elevation surfaces begin at the ends of CzPB (275 m beyond the DS threshold), are inclined at a 1:30 slope relative to the DS level, and rise to a height of 150 m. These surfaces have an initial width equal to the working width of the runway lane (90 m), then expand outward at a 15° angle to a width of 100 m. Approach/elevation surfaces are located at both ends of the CzPB of the road airfield section. No obstacles exceeding the height of the approach/elevation surfaces may be present in such zones. The schematic of these surfaces is presented in Figure **6**. Objects elevated beyond the approach/elevation surfaces must be agreed upon with the appropriate military authority to confirm that such objects do not negatively impact aviation operations.



6. Approach/Climb Surface for DOL [8]

Operational Parameters of DOL

DOL should ensure the safe execution of WSP aviation operations. Therefore, the operational DOL surface must meet specified requirements in terms of load-bearing capacity, smoothness, and roughness. Additionally, when artificial DOL surfaces are operated by WSP during the autumn-winter period, deicing agents must be applied in accordance with the requirements specified in [7].

Load-Bearing Capacity

The load-bearing capacity of the DOL pavement structure should meet the requirements specified in the technical design. The required pavement classification number (PCN) for the road airfield section pavement is PCN ≥ 35. The adopted indicator applies to DS, PPS, runways, transition sections to the road cross-section, and DK. The load-bearing capacity of the DOL pavement structure, expressed as the pavement classification number (PCN), should be determined using the ACN-PCN method, in accordance with [9], Annex 14 of the ICAO Convention on International Civil Aviation [21], and the Aerodrome Design Manual Part 3, Pavements [2]. Control load-bearing tests of DOL pavements should be conducted periodically every 3 to 5 years. Measurements of elastic deflections should be performed in the spring and/or autumn periods, as specified in [9].

The load-bearing assessment of the DOL pavement structure should be carried out using non-destructive dynamic loading methods. The load-bearing assessment should be conducted according to the ACN-PCN method required by ICAO, in accordance with [9]. This method takes into account:

- The type of airfield pavement,
- The category of the subgrade,
- The maximum tire pressure of the aircraft,
- The method of determining its load-bearing capacity.

For load-bearing tests of airfield pavements, a Heavy Weight Deflectometer (HWD) is used. During the tests, elastic deflections of the pavement are measured, based on which the PCN index and/or the permissible number of aviation operations for the adopted reference aircraft type are determined.

To conduct a comprehensive load-bearing analysis of the assessed DOL pavement, its construction should be identified by taking core samples, which are then subjected to strength tests under laboratory conditions [17]. The results obtained during the ACN-PCN load-bearing test can be presented as the PCN index and/or the determined permissible total number of aviation operations, which is determined for a specified number of repetitions N. The number of permissible repetitions is calculated based on the adopted computational model of the assessed airfield pavement structure. For rigid pavements made of concrete cement, the following formula derived from the permissible stress criterion is used:

$$N = \left[\frac{R_{zg}}{\sigma} \times \left(\frac{E}{30000} \right)^{1.3} \right]^{(-1/-0.233)} \times 10^{4}$$

where:
R_{zg} – Tensile strength of concrete under bending [MPa],
σ – tensile stresses under bending determined in the lower part of the concrete slab [MPa],
E – modulus of elasticity of concrete [MPa].

Verification of whether the WSP can safely perform operations on a given DOL involves comparing the PCN number of the pavement with the ACN number of the aircraft and checking the condition ACN ≤ PCN.

Smoothness

The smoothness of the DOL pavement should meet the criteria specified in [11]. The smoothness measurement should be performed according to the methodology provided in [11], using the modernized planograph P-3z. The state of smoothness determines not only the comfort of movement on the DOL pavement but also affects the magnitude of dynamic interactions on the pavement [14]. Achieving the required smoothness is also a condition for the effective and rapid drainage of rainwater from the DOL pavement. Even small surface irregularities can lead to water pooling, which in the winter period deteriorates the safety conditions of movement.

Airport pavement smoothness should meet the criteria defined by the level of defectiveness [13]. Defectiveness is understood as a percentage measure of the number of irregularity exceedances adopted in the standard as permissible. According to the aforementioned standard, based on the defectiveness criterion W (%) – the following ratings are adopted:

- Very good – W ≤ 5%,
- Good – 5% < W ≤ 10%,
- Sufficient – 10% < W ≤ 20%,
- Unsatisfactory – 20% < W ≤ 50%,
- Inadequate – W > 50%.

The result of the DOL pavement smoothness measurement is considered positive if the number of 5 m sections of the measurement route exceeding permissible irregularities is less than 20% for newly constructed or renovated pavements and less than 50% for pavements in operation. According to the requirements contained in [11], permissible irregularities for newly constructed DOL pavements and maximum irregularity values for operational pavements should meet the criteria presented in Table **2.**

Tab. 2. Maximum and allowable unevenness for DOL surfaces

Device type	Maximum unevenness	Allowable inequalities
Planograph or 4 m patch	12 mm	5 mm
Planograph or 3 m patch	9 mm	3 mm

Roughness

The roughness of the DOL pavement should meet the criteria for airport pavements specified in [10]. The state of pavement roughness is extremely important for the safety of aviation operations. Roughness measurements of the DOL pavement are carried out in accordance with the requirements of the defense standard [10], Annex 14 of the ICAO Convention on International Civil Aviation [21], and Advisory Circular No: 150/5320-12C Measurement, Construction, and Maintenance of Skid Resistant Airport Pavement Surfaces Document Information, FAA, 1997 [1]. The standard [10] discusses the methodology for measuring the roughness of airport pavements, defines the requirements for equipment used for field measurements, and presents the criteria for assessing the state of airport pavement roughness (average values of required friction coefficients) depending on the type of measuring device used and the measurement conditions (measurement speed, type of measuring tire, measurement with or without water).

The friction coefficient is the primary parameter characterizing airport pavement in terms of roughness [16]. Friction is a phenomenon that occurs at the interface of material bodies. The friction force depends on two parameters: the value of the normal force of one body on the other and the friction coefficient. In the case of static friction, when objects remain stationary relative to each other, the friction coefficient is constant. The general formula for the maximum friction force is:

$$T=\mu N$$

where:

- T – friction force value [N],
- μ – friction coefficient value [-],
- N – normal force value of one object on the other [N].

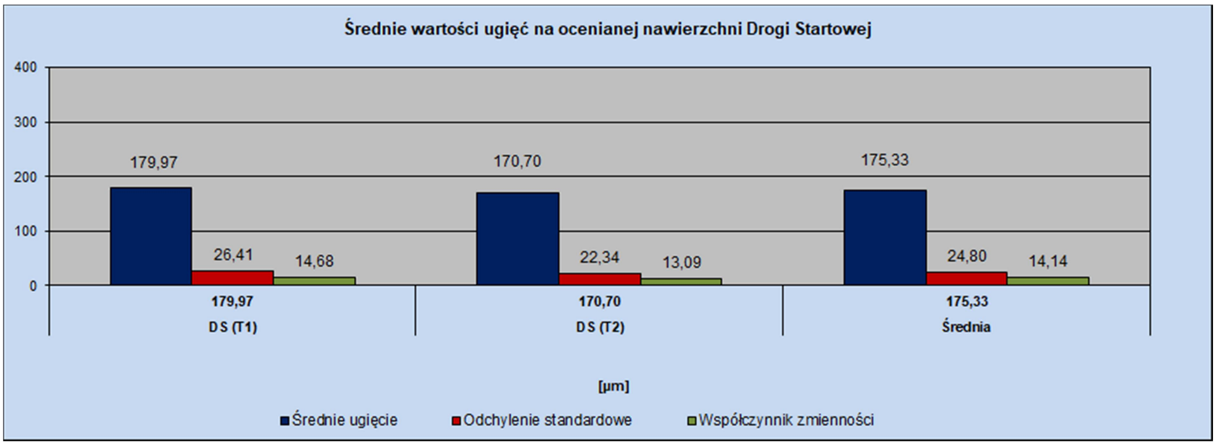
The required average values of friction coefficients are defined for three ranges, namely: for designed, new airport pavements, for those in use and/or subject to planned maintenance works, and the minimum (threshold) values. Roughness measurements of the DOL pavement should be conducted using devices that allow continuous measurement of the friction coefficient between the wheel of a moving aircraft and the airport pavement. Devices with a smooth tread tire, equipped with a self-watering system, enabling the measurement of the friction coefficient of the airport pavement covered with a water layer at a thickness of not less than 1 mm at two measurement speeds, namely 65 km/h or 95 km/h, should be used. For example, the required friction coefficient values for airport pavements assessed using a friction tester device such as the Airport Surface Friction Tester (ASFT) on a T-10 trailer at a measurement speed of 65 km/h are as follows:

- For designed, new airport pavements – 0.70,
- For those in use and/or subject to planned maintenance works – 0.50,
- Minimum (threshold) – 0.40.

Results of Studies for DOL Wielbark

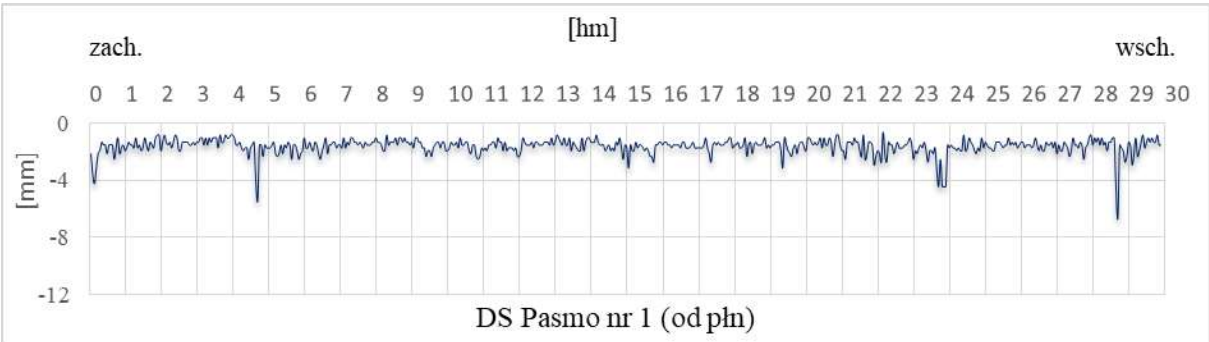
As part of the investment project titled "Expansion of Provincial Road No. 604 on the Robaczewo – Wielbark section," acceptance tests were conducted, which included determining the operational parameters of the DOL pavement in terms of load-bearing capacity, smoothness, and roughness. The functional elements of the evaluated DOL Wielbark were: a concrete cement runway with a width of 30 m and a length of 2440 m (total length including run-offs 2990 m) and two aircraft parking areas (PPS EAST and PPS WEST), also with concrete cement pavements measuring 200 m x 45 m. The article presents the results of the conducted studies, but only in relation to the DS (presumably a specific section or component).

The load-bearing capacity test was conducted using a HWD-type airport deflection gauge in accordance with the requirements of the defense standard [9]. As a result of the load-bearing capacity analysis, the total allowable number of aviation operations for the evaluated functional elements of the DOL was determined, taking into account the adopted PCN index of 35 in the project documentation. The obtained results during field measurements, in the form of a graph of average elastic deflection values for the tested DS pavement structure, are shown in Fig. **7** [18]. The determined total allowable number of aviation operations NNN was 125,000 for the PCN index 35/R/B/W/T.



7. Summary of elastic deflection values for the DS surface structure [18]

The smoothness assessment of the evaluated DOL Wielbark pavements was conducted using a modernized P-3z planograph, in accordance with the defense standard [11]. The pavement smoothness was evaluated based on the defectiveness criterion WWW. The obtained results during field measurements (for DS), in the form of longitudinal irregularity profiles for one of the routes, are presented in Fig. **8.** The determined defectiveness values WWW were: 0.9% in the longitudinal direction (very good condition) and 16.4% in the transverse direction (sufficient condition) [18].



8. Profile of longitudinal unevenness on measurement route No. 1 – band No. 1 (DS) [18]

Roughness measurements were carried out according to the methodology specified in the defense standard [10]. As a result of the conducted measurements, the current (as of the date of the study) values of the friction coefficient for the evaluated DOL Wielbark pavements were determined. The obtained results during field measurements (for DS), in the form of average friction coefficient values µ\muµ, are presented in Table **3** [18].

Tab. 3. Results of friction coefficient measurements for the DS surface at DOL Wielbark

EFL	Measurement route	Minimum value of the friction coefficient	Maximum value of the friction coefficient	Average value of the friction coefficient
DS	1	0,54	0,84	0,71
	2	0,53	0,88	0,72
			Average:	**0,72**

Based on the conducted acceptance tests of the DS pavement on DOL Wielbark in terms of load-bearing capacity, smoothness, and roughness, the following conclusions can be formulated:

1. Field tests using a HWD-type deflection gauge indicated that the soil foundation underlying the tested DS pavement structure can be classified as soils with medium load-bearing capacity at the time of testing.
2. The evaluated DS pavement structure met the load-bearing requirements for the adopted PCN index 35.
3. The evaluated DS pavement met the smoothness requirements specified for new airport pavements in the defense standard [11].
4. The assessed DS pavement also met the roughness requirements specified in [10] for new airport pavements.

Summary

Airport road sections adjacent to civil, military, and aeroclub airport networks are currently one of the most important elements of the critical and defense infrastructure of our country. Their role, tasks, significance, and usefulness have gained particular importance in the current geopolitical situation, i.e., during the ongoing armed conflict in Ukraine.

DOL refers to specially prepared sections of public roads adapted for conducting aviation operations, including the takeoff and landing of military aircraft performing operational tasks during crises and wars, as well as tasks resulting from the implementation of the aviation training process. DOL consists of straightforward road sections with specified parameters and horizontal and vertical dimensions of the airspace, which include: the runway, aircraft parking areas, taxiways (if necessary), lateral safety strips, frontal safety strips, and areas with limited obstacles. Proper placement of DOL should utilize public roads managed by road services, possessing the required length and appropriate load-bearing capacity.

The article presents the geometric, structural, load-bearing, and air approach zone requirements imposed on DOL, as detailed in the applicable defense standard NO-17-A207:2022. It also discusses the requirements for the basic operational parameters of pavements used by road services, which should be primarily applied: during the design and construction of DOL, modernization and reconstruction of existing airport road sections, acceptance of completed works, and technical and operational assessment. It should be emphasized that the provisions of the aforementioned standard are applicable for assessing the technical condition of DOL throughout their technical lifespan, especially during their use by military aircraft.

Furthermore, the article presents the obtained results of the operational parameter studies of the newly constructed runway pavement structure of DOL Wielbark on Provincial Road No. 604. Based on the obtained study results regarding load-bearing capacity, smoothness, and roughness, it was determined that the evaluated DS pavement structure met all standard requirements and design assumptions and can be approved for operation.

Source materials

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[2] Aerodrome Design Manual Part 3, Pavements, ICAO, Doc-9157-AN/901.
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[6] NO-17-A204:2015 Nawierzchnie lotniskowe – Nawierzchnie z betonu cementowego – Wymagania i metody badań.
[7] NO-17-A205:2017 Zimowe utrzymanie nawierzchni lotniskowych – Stosowanie środków do odladzania – Wymagania i badania.
[8] NO-17-A207:2022 Nawierzchnie lotniskowe – Drogowe odcinki lotniskowe – Wymagania i badania.
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[10] NO-17-A501:2015 Nawierzchnie lotniskowe – Badania szorstkości.
[11] NO-17-A502:2015 Nawierzchnie lotniskowe – Badania równości.
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